Foul and Surface Water Management Strategy

Former ADAS Site

Olantigh Road

Wye

Ashford

TN25 5EP

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CONTENTS

1. Background and Introduction

This Foul and Surface Water Management Strategy accompanies a planning application submitted to Ashford Borough Council. The planning application is for residential development at the former ADAS Site, Olantigh Road, Wye, Ashford, TN25 5EP.

2. Development Location and Description

Development Location

The site is situated to the east of Olantigh Road, Wye. It is a brownfield site, formerly used as ADAS offices, covering 2.4ha, Figure 1.

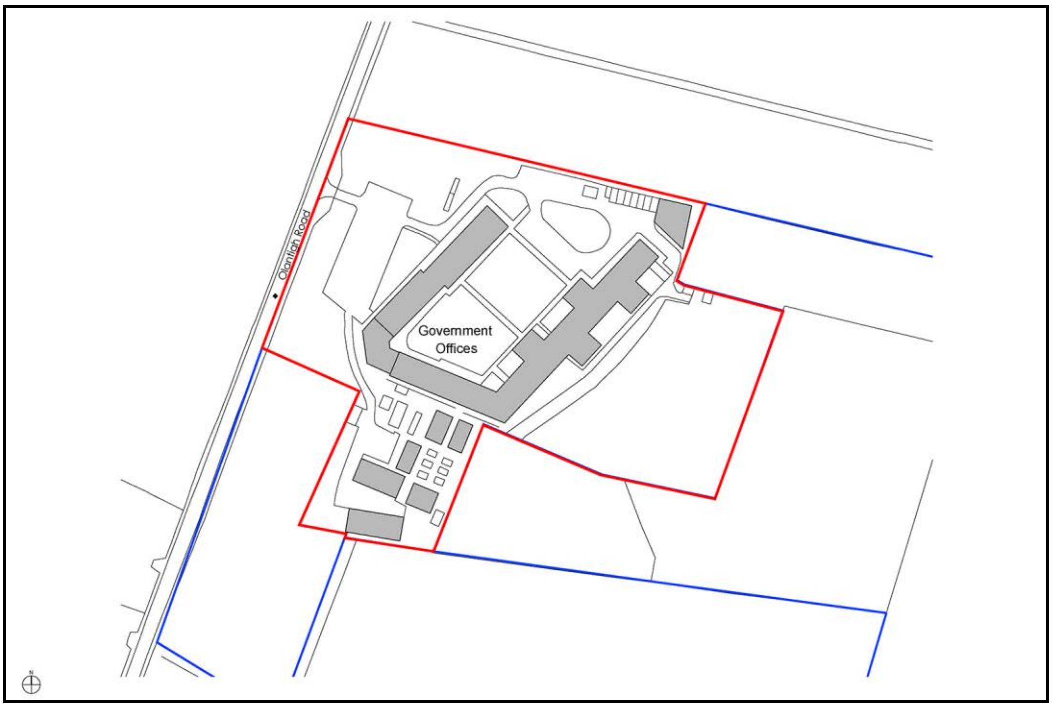

Figure 1. Site location plan.

Development Proposals

A planning application is being made for the demolition of the existing buildings and the construction of 20 dwellings, Figure 2.

Figure 2. Proposed development.

3. Policy Background

National Planning Policy Framework

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally-prepared plans for housing and other development can be produced.

Chapter 14 Meeting the challenge of climate change, flooding and coastal change states:

163. When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment50. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- *a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- *b) the development is appropriately flood resistant and resilient;*
- *c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- *d) any residual risk can be safely managed; and*
- *e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.*

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

- *a) take account of advice from the lead local flood authority;*
- *b) have appropriate proposed minimum operational standards;*
- *c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- *d) where possible, provide multifunctional benefits.*

Ashford Local Plan 2030

The Ashford Local Plan was adopted in February 2019. The following policies are relevant to foul and surface water drainage and the proposed development.

Policy ENV8 - Water Quality, Supply and Treatment

Major proposals for new development must be able to demonstrate that there are, or will be, adequate water supply and wastewater treatment facilities in place to serve the whole development, or where development is being carried out in phases, the whole of the phase for which approval is being sought. Improvements in these facilities, the timing of their provision and funding sources will be key to the delivery of development.

All development proposals must provide a connection to the sewerage system at the nearest point of adequate capacity wherever feasible, as advised by the service provider, and ensure future access to the existing sewerage systems for maintenance and upsizing purposes.

Schemes that would be likely to result in a reduction in the quality or quantity of groundwater resources will not be permitted. The Council will support, in principle, infrastructure proposals designed to increase water supply and wastewater treatment capacity subject to there being no significant adverse environmental impacts and the minimisation of those that may remain.

Where a site overlies a Groundwater Protection Zone an appropriate site investigation and risk assessment may be required to be undertaken in consultation with the Environment Agency prior to any grant of planning permission.

Policy ENV9 - Sustainable Drainage

All development should include appropriate sustainable drainage systems (SuDS) for the disposal of surface water, in order to avoid any increase in flood risk or adverse impact on water quality, and to mimic the drainage from the pre-developed site.

On greenfield sites, development should discharge at a maximum of 4l/s/ha, or 10% below current greenfield rates for the existing 1:100 storm event, whichever is lower. There must be no increase in discharge rate from less severe rainfall events, with evidence submitted to demonstrate this principle.

On Previously Developed Land, development must endeavor to achieve 4 l/s/ha runoff or seek to achieve 50% reduction of existing peak runoff rates for the site where existing discharge rates can be established.

On smaller sites (less than 0.25ha), development should achieve a maximum discharge of 2l/s.

Any SuDS scheme must demonstrate regard to the adopted Sustainable Drainage SPD and any subsequent revisions.

SuDS features should always be the preferred option and provided onsite wherever practicable.

All development proposals will be required to:

a) *Ensure all new developments are designed to reduce the risk of flooding, and maximise environmental gain, such as: water quality, water resources, biodiversity, landscape and recreational open space;*
b) *Ensure that all new developments are designed to mitigate and adapt to the effects of climate change;*
c) *Lower runoff flow rates, reducing the impact of urbanisation on flooding;*
d) *Protect or enhance water quality. Incorporating appropriate pollution control measures, to ensure there are no adverse impacts on the water quality of receiving waters, both during construction and in operation;*
e) *Be sympathetic to the environmental setting and the needs of the local community;*
f) *Incorporate a SuDS scheme that is coherent with the surrounding landscape and/or townscape;*
g) *Provide a habitat for wildlife in urban watercourses; and encourage natural groundwater recharge (where appropriate);*
h) *Demonstrate that opportunities have been taken to integrate sustainable drainage with biodiversity enhancements through appropriately designed surface water systems, as well as contribute to amenity and open spaces;*
i) *Demonstrate that the first 5mm of any rainfall event can be accommodated and disposed of on-site; and,*
j) *Demonstrate that clear arrangements have been established for the operation and maintenance of the SuDS component for the lifetime of the development.*

Sustainable Drainage SPD

Ashford Borough Council adopted its Sustainable Drainage Supplementary Planning Document (SPD) in October 2010.

The key objectives of the SPD are:

- *To ensure all new developments are designed to reduce the risk of flooding, and maximise environmental gain, such as: water quality, water resources, biodiversity, landscape and recreational open space.*
- *To ensure that all new developments are designed to mitigate and adapt to the effects of climate change.*

The SPD sets out the runoff standards applied to different parts of the Borough. The acceptable runoff rate is shown in Table 1.

Site	Acceptable runoff rate
Previously developed	Based on the following hierarchy: • Best endeavours to achieve 2 l/s/ha • Failing that, aim to achieve a reduction from the existing run-off rate for the site (where this can be established) • As an absolute minimum, must not lead to a net increase in run-off rate above the existing rate for the site (where this can be established) or 10.26 l/s/ha (where the existing rate cannot be established)

Table 1. SPD runoff requirements.

The SPD identifies the most appropriate SuDS (Sustainable Urban Drainage Systems) for the Borough as:

- Green roofs
- Water butts
- Swales
- Wet ponds
- Detention basins

4. Site Characteristics

Topography - Site contours have been derived from Lidar data, Figure 3. The site falls from south east to north west. The highest level on the south eastern site boundary is 50.0mAOD (Above Ordnance Datum). The lowest level on the north western boundary is 38.5mAOD. The eastern part of the site is steeper at an average gradient of 1 in 12. The western part of the site has an average gradient of 1 in 28.

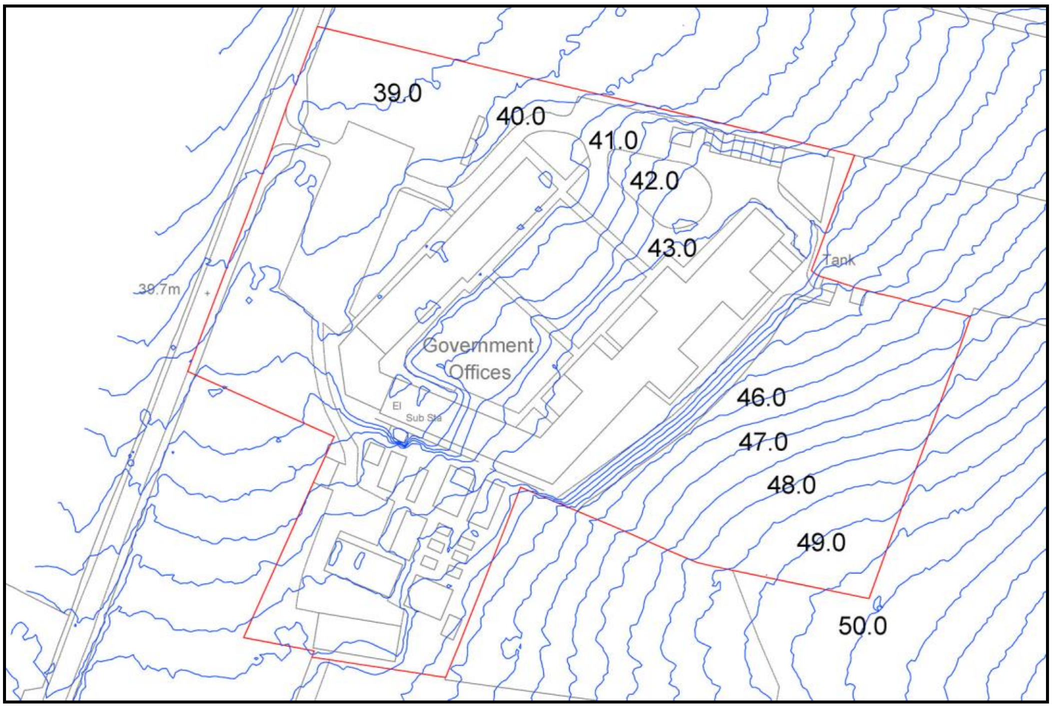

Figure 3. Local topography.

Geology and Soils - The bedrock geology consists of the West Melbury Marly Chalk Formation, chalk. Superficial deposits consist of Head, clay, silt, sand and gravel. Soils are classified as freely draining loamy soils draining to chalk groundwater over the eastern part of the site and to local groundwater and rivers over the western part of the site.

Groundwater - Records of boreholes sunk near the site indicate that groundwater is at approximately -30mAOD, 69m below the lowest level at the site.

The site does not lie above any groundwater source protection zones.

The chalk is designated a principal bedrock aquifer. These are rocks that provide significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale. They typically have a high intergranular and/or fracture permeability meaning they usually provide a high level of water storage.

The Head deposits are designated a secondary (undifferentiated) aquifer.

The site lies above a major aquifer intermediate groundwater vulnerability zone.

Infiltration Rates - Soakage testing has been carried out for the school site to the south of the ADAS site. These tests indicate an infiltration rate of 2.65 x 10^{-5} m/s.

This rate has been used for the draft design of infiltration structures. It will need to be verified through site specific percolation tests before the design and construction of any infiltration devices.

Existing Surface Water Drainage Patterns - The site is part of a wider catchment that drains to the Great Stour, north east of the site, Figure 4. Point rainfall data has been obtained from the Flood Estimation Handbook (FEH) Web Service. The FEH 2013 XML rainfall data has been used in the design. This provides rainfall data for return periods greater than 2 years.

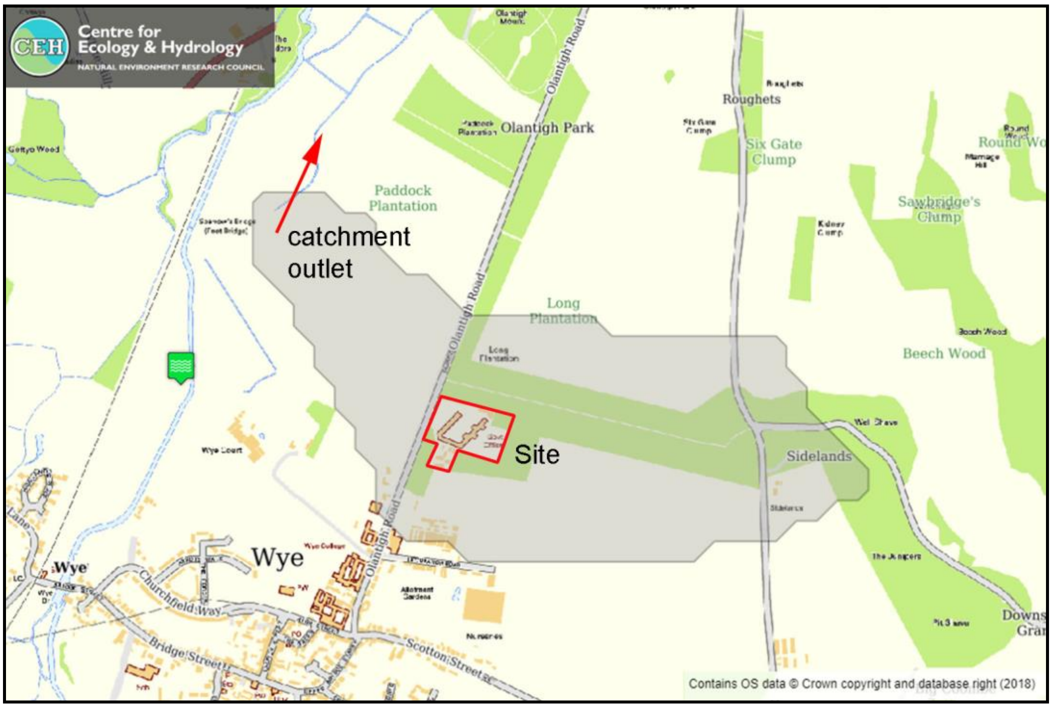

Figure 4. Local drainage catchment. (© Flood Estimation Handbook)

The British Geological Survey hydrogeology map shows the site lies over a highly productive aquifer with fissured rocks, coloured green in Figure 5.

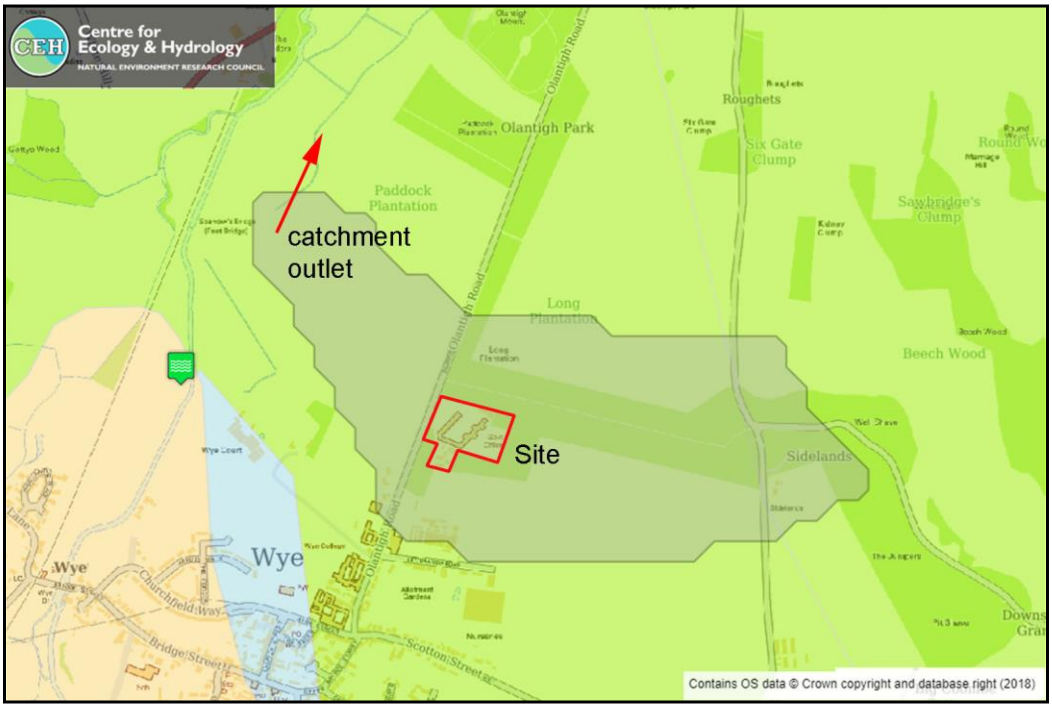

Figure 5. British Geological Survey hydrogeology map. (© Flood Estimation Handbook)

Sewer Record - Wye is served by public foul and surface water sewers. The site is connected to the public sewerage system via an existing private pumping station and rising main. The nearest public sewer to the site is at the junction of Olantigh Road with Occupation Road, Figure 6. This is a 150mm diameter sewer that runs south.

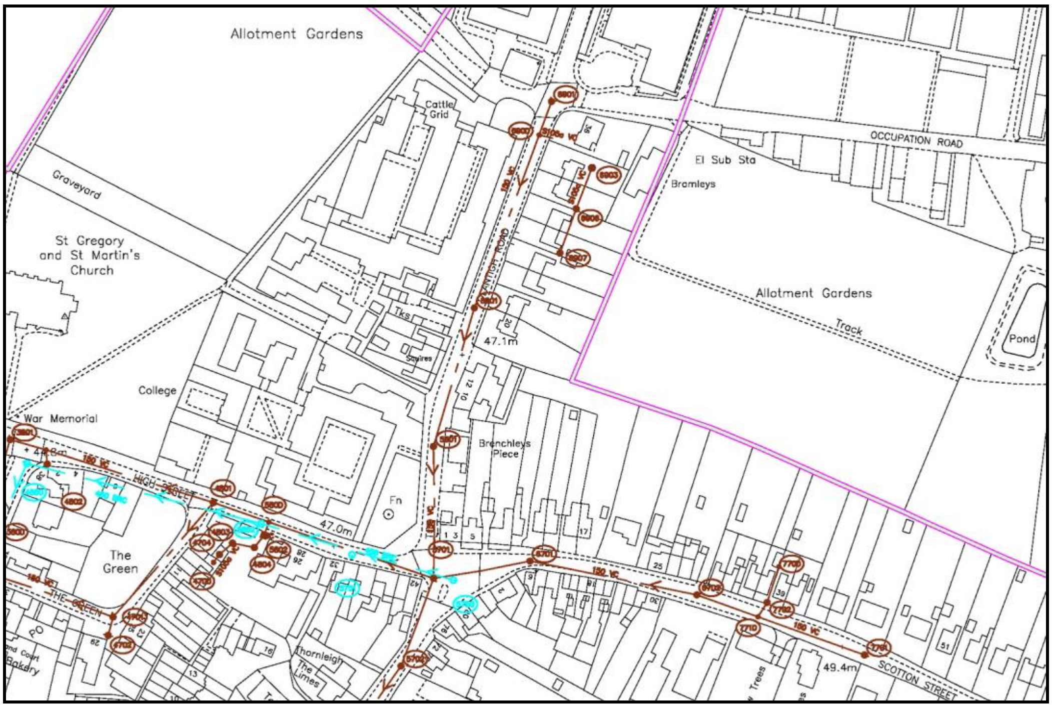

Figure 6. Public sewer record. (© Southern Water)

Existing Site - The site is a brownfield site. 9,100m^2 of the existing site is covered with impermeable materials consisting of 4,200m^2 of roof and 4,900m^2 of paving, Figure 7.

The peak rate of runoff and volume of runoff for the critical storm duration for the pre-development site, is shown in Table 2.

Storm Return Period (years)	Peak Runoff (Q l/s)	Volume of Runoff 360 minute duration storm (m^3)
2	84	226
30	190	426
100	244	570
100 + 20%	293	684
100 + 40%	342	798

Table 2. Peak rate of runoff and volume of runoff from the existing site.

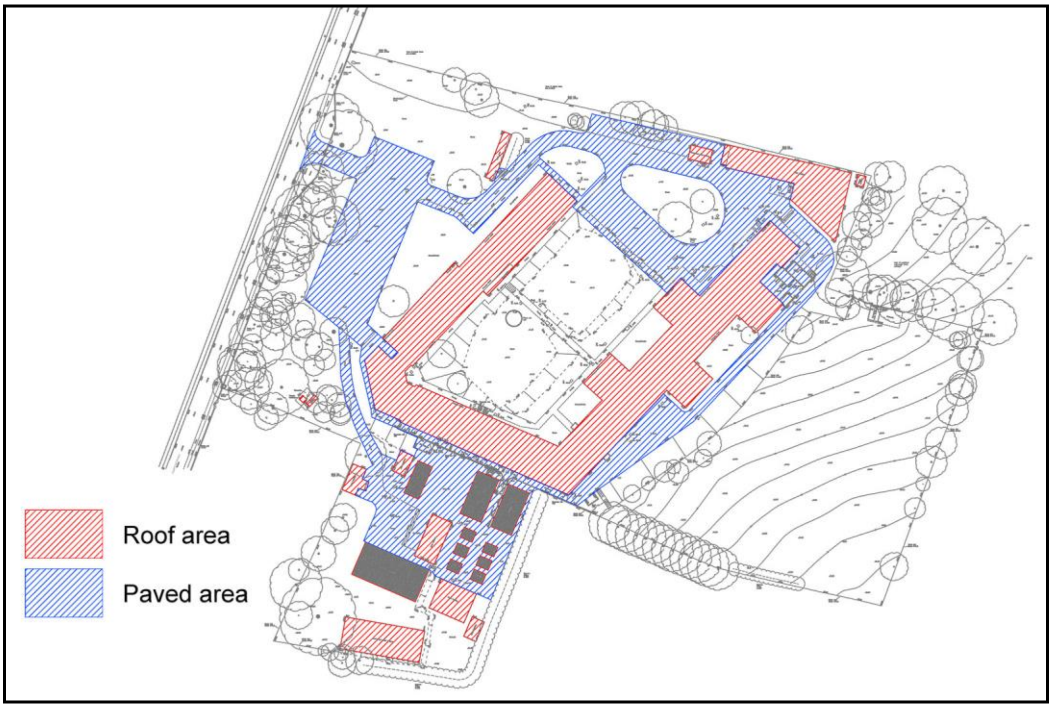

Figure 7. Existing impermeable areas.

Existing drainage - The existing roof and paved areas are positively drained. Runoff is assumed to discharge to soakaways.

Greenfield runoff - The peak greenfield runoff rate for the critical storm duration has been calculated using the IH124 method from the greenfield runoff rate estimation tool published online by HR Wallingford at uksuds.com, Table 3.

Return Period	Runoff Rate Q l/s	
	per ha.	Site (2.4 ha)
QBar	0.2	0.5
1	0.2	0.5
30	0.4	1.0
100	0.6	1.4

Table 3. Greenfield runoff rate for the site.

5. Flood Risk Assessment

The NPPF states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change by applying the Sequential Test.

Flood zones are the starting point for the Sequential Test. These zones are a broad assessment of flood risk as given below.

Zone 1 Low Probability - land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

Zone 2 Medium Probability - land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

Zone 3a High Probability - land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Zone 3b The Functional Floodplain - land where water has to flow or be stored in times of flood, land which would flood with an annual probability of 1 in 20 (5%) of greater in any year or designed to flood in an extreme flood.

The site lies within flood zone 1 and therefore residential development is appropriate, Figure 8.

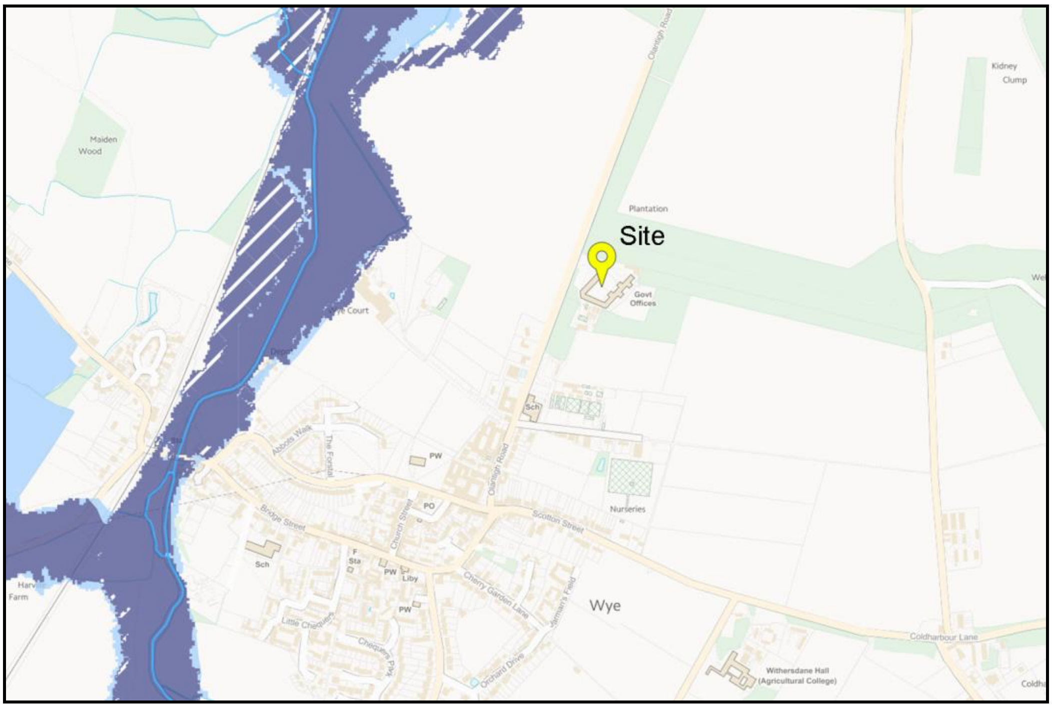

Figure 8. Flood Map for Planning with the site highlighted.

Surface Water - The Government has published surface water flooding maps. These show the majority of the site to be at very low risk of surface water flooding, Figure 9. There are areas at medium to low surface water flood risk within the site. These are generally adjacent to the existing buildings.

The definition of each category is given below:

Very Low (white) a chance of flooding of less than 1 in 1000 (0.1%)
Low (pale blue) a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)
Medium (mid blue) a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%)
High (dark blue) a chance of flooding of greater than 1 in 30 (3.3%)

The depth of water associated with the low, medium and high risk events is shown in Figures 10-12. The definition of each colour is given below:

Below 300mm (light blue)
300-900mm (medium blue)
Over 900mm (dark blue)

Figure 9. Surface water flood map with the site edged red.

Figure 10. Surface water flood depth map for the low risk flood event with the site edged red.

Figure 11. Surface water flood depth map for the medium risk flood event with the site edged red.

Figure 12. Surface water flood depth map for the high risk flood event with the site edged red.

The surface water flood maps also give an indication of velocity and direction of flow. The definition of each colour is given as:

Over 0.25 m/s (dark blue)

Less than 0.25 m/s (light blue)

The arrows indicate the direction of flow.

The surface water velocity map for the low risk event in shown in Figure 13.

Figure 13. Surface water flood velocity map for the low risk flood event with the site edged red.

Under the medium and low risk flood events the maximum depth of flooding is 300-900mm. The Environment Agency surface water flood modelling makes the following assumption:

- The ground level within building footprints was raised by 0.3m above the average height of the building footprint to give an upstand with a horizontal floor level which deflects flow or acts as a weir.

The modelling also excludes existing drainage. The existing buildings therefore represent a weir within the model and water running south east to north west following the topography is trapped by the buildings. As building footprints are raised and existing drainage is not represented in the model, this water cannot escape within the model and it represents an overestimate of flood depth at this location. The existing buildings are demolished as part of the development and the implementation of the surface water management strategy will manage any potential surface water flood risk.

The risk of flooding from surface water is therefore considered to be very low.

Groundwater - Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in ‘bournes’ (streams that only flow for part of the year). Where land that is prone to groundwater flooding has been built on, the effect of a flood can be very costly, and because groundwater responds slowly compared with rivers, floods can last for weeks or months.

Records of boreholes sunk near the site indicate that groundwater is 69m below the lowest site level. Rising groundwater will emerge at lower levels to the west of the site. The risk of groundwater flooding at the site is considered to be low.

Infrastructure - The SWMP identifies localised flooding incidents reported in Ashford, Figure 14. There are no incidents of flooding recorded at the site. Parts of Wye to the south of the site have suffered sewer and surface water flooding. The site is not served by public sewers.

The risk of infrastructure flooding at the site is low.

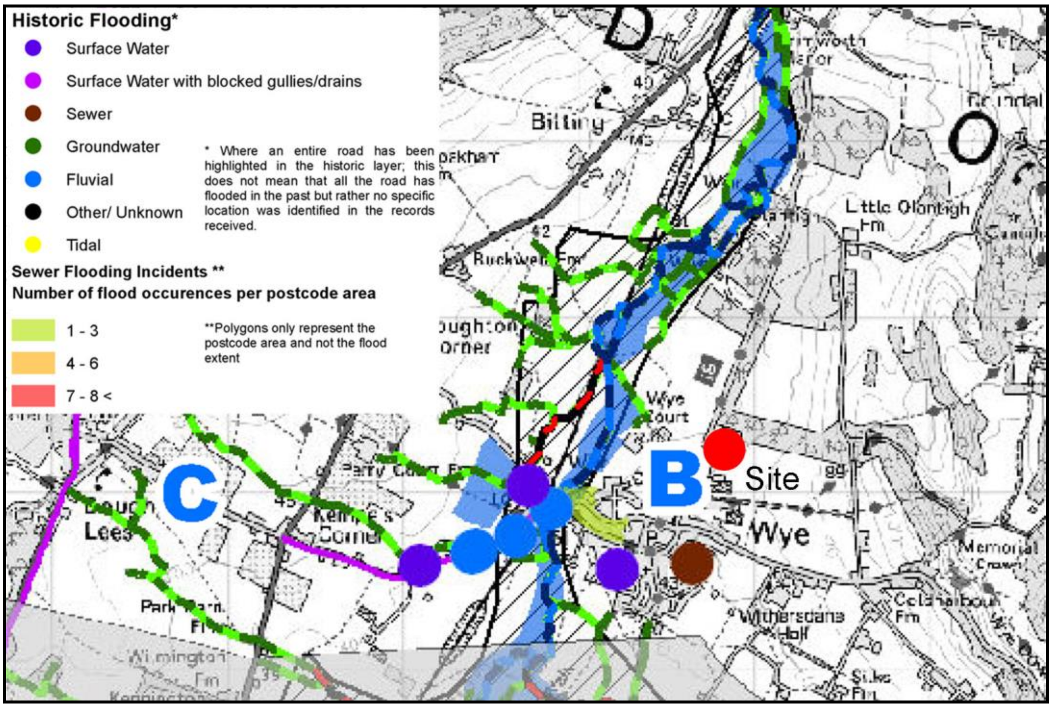

Figure 14. Historic flooding incidents. (© Kent County Council).

The site lies within flood zone 1 and is at low risk of flooding from all other sources.

6. Foul Water Management Strategy

Choosing the right sewage treatment and disposal method is essential for the protection of public health and the environment and ensures effective long term performance of the system. Sewage treatment and disposal can be provided by a sewerage undertaker or by a private treatment system.

There is therefore a hierarchy of methods for disposing of foul sewage.

connection to public sewer

septic tank or package sewage treatment plant with discharge to a drainage field

package sewage treatment plant with discharge to a watercourse, surface water sewer or coastal water

sealed system / cesspool

Connection to Public Sewer

The existing site is connected to the public sewerage system via a private pumping station and rising main.

Southern Water introduced new connection charges on 1st April 2018. Network reinforcement costs are now recovered through the new infrastructure charge. This is £550 per property for developments of up to 20 properties for 2019/20.

Network reinforcement is work that needs to be carried out to the existing network to support development-related growth. This work is needed to ensure there is enough capacity in wastewater network to serve the new homes that are built without impacting on the service to existing customers.

Network Reinforcement may include the following activities:

- Enlarging existing pipes or installing larger new pipes to increase capacity for a specific development, or further expected growth in the future.

- Upsizing existing or proposed pumping stations.
- Providing new cross-connections to improve network capacity under differing network conditions.
- Other infrastructure required to provide network capacity for growth resulting from new development.

The introduction of the new infrastructure change means that the capacity of the existing sewerage network is not a constraint on development as any necessary upgrades will be carried out by Southern Water and paid for through the new infrastructure charge.

The developer will still be responsible for delivering on-site sewers and connecting the site to the existing sewerage network.

Foul Sewage Flows

Sewers for Adoption 7th Edition states that design flow rates for dwellings should be 4,000 litres per dwelling per day. For 20 dwellings this equates to a design flow of 0.9 l/s.

Foul Drainage Strategy

This strategy provides a solution for the on-site foul drainage in line with Sewers for Adoption 7th Edition.

The topography does not allow foul water to be drained to the existing foul sewer in Olantigh Road by gravity. A pumping station is proposed within the site. A rising main will then be constructed to discharge the pumped effluent to the existing public sewer in Olantigh Road. Two options are available for the route of the rising main, the first is along Olantigh Road with the second being a connection to the school site with a gravity connection to Olantigh Road via Occupation Road.

A preliminary foul drainage design has been produced, the illustrative layout is shown in Figure 15.

The strategy has been modelled using MicroDrainage software published by XP Solutions to ensure that it meets the requirements of Sewers for Adoption 7th Edition. Model output details are in Appendix A.

The above demonstrates that suitable foul drainage provision can be made to serve the site.

Figure 15. Illustrative foul drainage layout.

7. Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Climate change will result in an increase in sea levels, rainfall intensity and river flows.

The impact of climate change will be to reduce the standard of protection provided by current defences with time and increase the risk of flooding in undefended areas. The Planning Practice Guidance to the National Planning Policy Framework (NPPF) recommends using the following range of increases in peak rainfall intensity due to climate change to 2115 in any assessment:

Upper End	+40%
Central	+20%

The range is based on percentiles. The 50th percentile is the point at which half of the possible scenarios for peak rainfall intensity fall below it and half fall above it. The Central allowance is based on the 50th percentile whilst the Upper End is based on the 90th percentile.

The Central allowance is 20% and scientific evidence suggests that it is just as likely that the increase in rainfall intensity will be more than 20% as less than 20%. The Upper End allowance is 40% and current scientific evidence suggests that there is a 90% chance that peak rainfall intensity will increase by less than this value, but there remains a 10% chance that peak rainfall intensity will increase by more.

The Planning Practice Guidance suggests that flood risk assessments and strategic flood risk assessments should assess both the Central and Upper End allowances to understand the range of impact.

The surface water calculations include an increase of 20% in peak rainfall intensity for the sizing of structures. The structures are then tested with a 40% increase in peak rainfall intensity. If this results in any flooding, the extent of this flooding and its impact on the development is then considered.

8. Detailed Development Proposals

The proposed development consists of 20 dwellings. Analysis of the layout indicates that potential impermeable surfaces will cover approximately 7,900m^2, consisting of 3,800m^2 of roof and 4,100m^2 of paving, Figure 16. The proposed development reduces the impermeable area by 1,200m^2, 13% of the existing impermeable area.

Figure 16. Proposed impermeable areas.

The peak rate of runoff and volume of runoff for the critical storm duration for the existing and proposed site is shown in Table 4.

Storm Return Period (years)	Peak Runoff (Q l/s)		Volume of Runoff 360 minute duration storm (m^3)	
	Existing (9,100m^2)	Proposed (7,900m^2)	Existing (9,100m^2)	Proposed (7,900m^2)
2	84	73	226	196
30	190	165	426	369
100	244	212	570	495
100 + 20%	293	255	684	594
100 + 40%	342	297	798	693

Table 4. Peak rate of runoff and volume of runoff from the existing and proposed site.

9. Surface Water Management Strategy

Overview

The broad strategy is to use suitable SuDS elements to attenuate and dispose of surface water via infiltration. The geology, greenfield runoff rate and infiltration rate from the neighbouring site indicate that this is an appropriate strategy.

Drainage Elements

The appropriateness of different SuDS is considered in Table 5.

SuDS Type	Appropriate to site	Comment
Permeable paving (Infiltration)	Yes	Although Head deposits may restrict the use of shallow infiltration in parts of the site.
Permeable paving (Attenuation)	Yes	Permeable paved areas can be used to attenuate runoff from the development if infiltration is not feasible.
Green roof	No	Traditional pitched roofs are proposed
Filter strips	No	Insufficient space
Swales	No	Insufficient space
Infiltration devices	Yes	Infiltration is feasible into the Chalk
Filter drains	Possible	Other infiltration devices are likely to be more appropriate
Infiltration basin	No	Insufficient space
Detention pond	No	Insufficient space
Wet pond	No	Insufficient space
On/offline storage	Yes	Appropriate if additional attenuation required

Table 5. SuDS suitability for development.

The following drainage elements are identified as being the most appropriate to the site:

- water butts,
- permeable paving,
- soakaways,
- piped systems

Water Butts - The expectation under the SPD is that all individual properties have water butts. Water butts act as source control devices intercepting rainfall early in the management train. Water butts will be provided on all residential units. It is recognised that water butts may be full during critical rainfall conditions and not provide storage. The SPD however states that *to encourage their use they can be considered as empty when sizing storage requirements.*

Permeable Paving - Permeable paving allows water to infiltrate through the surface into a coarse graded sub-base which can store runoff. The base of the pavement can be open to allow infiltration or lined. For sub-base storage to operate effectively the system requires flow controls. These are generally small orifice plates in a control chamber and can be very small, minimum 20mm, because the risk of blockage is low since the water has been filtered through the sub-base. The frequency of runoff from permeable paving is significantly reduced when compared to gully and pipe systems draining impermeable surfaces. Permeable paving acts as interception storage and runoff typically does not occur from permeable paving for rainfall events up to 5mm even without infiltration, due to evaporation.

Infiltration devices - Soakaways can be provided for each house or as structures in public areas to receive runoff from communal paved areas. Soakaways allow water to infiltrate into the ground and provide storage to accommodate more extreme rainfall events.

Piped Systems/Storage - Pipes can be used for connections between SuDS elements. Additional storage can be provided using cellular storage crate systems if required.

Surface Water Management Strategy

The surface water management strategy is to discharge all runoff from the site to ground using soakaways and permeable paving.

Soakaways should not normally be constructed closer than 5m to building foundations. In chalk, the advice of a specialist geotechnical engineer should be sought concerning the risk of solution features and the interaction of any soakaways with foundations. This should be carried out as part of the detailed design.

Runoff from roofs is assumed to drain to individual soakaways for each property. The roof areas vary across the site and two soakaway sizes have been considered to drain 50m^2 and 110m^2 respectively. The parameters used for the assessment of these individual soakaways are shown in Tables 6 and 7. The assessment is presented in Appendix B.

Parameter	Type A Roof Soakaway (50m^2)				
Rainfall return period	2 year	30 year	100 year	100 year + 20%	100 year + 40%
Infiltration rate (m/s)	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}
Factor of safety	2	2	2	2	2
Soakaway type	lined	lined	lined	lined	lined
Soakaway size (m dia.)	0.9	0.9	0.9	0.9	0.9
Pit multiplier	1.5	1.5	1.5	1.5	1.5
Soakaway depth (m)	3.0	3.0	3.0	3.0	3.0
Contributing area (m^2)	50	50	50	50	50
Number of soakaways	5	5	5	5	5
Maximum water depth (m)	0.747	1.406	1.888	2.485	2.983
Half drain time (minutes)	160	159	158	172	192
Flood volume (m^3)	0	0	0	0	0

Table 6. Design parameters for Type A roof soakaways.

Parameter	Type B Roof Soakaway (110m^2)				
Rainfall return period	2 year	30 year	100 year	100 year + 20%	100 year + 40%
Infiltration rate (m/s)	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}
Factor of safety	2	2	2	2	2
Soakaway type	lined	lined	lined	lined	lined
Soakaway size (m dia.)	1.2	1.2	1.2	1.2	1.2
Pit multiplier	2.0	2.0	2.0	2.0	2.0
Soakaway depth (m)	3.2	3.2	3.2	3.2	3.2
Contributing area (m^2)	110	110	110	110	110
Number of soakaways	33	33	33	33	33
Maximum water depth (m)	0.722	1.357	1.868	2.299	3.200
Half drain time (minutes)	225	225	221	224	253
Flood volume (m^3)	0	0	0	0	0.7

Table 7. Design parameters for Type B roof soakaways.

The total number of soakaways is 38. There is sufficient space on site to provide the number of individual soakaways required. The potential layout for soakaways is shown in Figure 17. The total area served by 38 soakaways is 3,880m^2, more than the proposed roof area of 3,800m^2.

Figure 17. Proposed soakaway locations.

Under the 1 in 100 year rainfall event with an allowance of 40% for climate change there is a flood volume of 0.7m^3 from the Type B soakaways. This equates to is 23.1m^3. There is sufficient space in gardens to accommodate this water during extreme events. Properties will have a finished floor level at least 150mm above the surrounding ground level and flow paths will be maintained to allow excess runoff to flow to Olantigh Road.

The private drives are assumed to be laid with permeable paving. The area of private drives is shown in Figure 18. The parameters used for the assessment of the permeable paving are shown in Table 8. The assessment is presented in Appendix C. Larger areas of permeable paving will incorporate check dams to maximise surface water storage.

Figure 18. Proposed permeable paving over private drives.

Parameter	**Permeable Paving**				
Rainfall return period	2 year	30 year	100 year	100 year + 20%	100 year + 40%
Infiltration rate (m/s)	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}
Factor of safety	10	10	10	10	10
Sub-base depth (m)	0.3	0.3	0.3	0.3	0.3
Contributing area (m^2)	2,300	2,300	2,300	2,300	2,300
Permeable area 70% (m^2)	1,610	1,610	1,610	1,610	1,610
Maximum water depth (m)	0.045	0.111	0.168	0.220	0.277
Half drain time (minutes)	64	106	163	209	266
Flood volume (m^3)	0	0	0	0	0

Table 8. Design parameters for the permeable paving.

The access road is assumed to be impermeable. It can be drained to crate soakaways in communal areas. Two communal soakaway locations have been identified, Figure 19.

Figure 19. Communal road soakaway locations.

The parameters used for the assessment of the communal road soakaways are shown in Tables 9 and 10. The assessment is presented in Appendix D.

Parameter	Road Soakaway 1 ($400m^2$)				
Rainfall return period	2 year	30 year	100 year	100 year + 20%	100 year + 40%
Infiltration rate (m/s)	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}
Factor of safety	2	2	2	2	2
Soakaway type	Crate	Crate	Crate	Crate	Crate
Soakaway size (m)	5 x 5	5 x 5	5 x 5	5 x 5	5 x 5
Soakaway depth (m)	1.2	1.2	1.2	1.2	1.2
Contributing area (m^2)	400	400	400	400	400
Maximum water depth (m)	0.243	0.558	0.841	1.067	2.001
Half drain time (minutes)	126	252	331	382	446
Flood volume (m^3)	0	0	0	0	1.5

Table 9. Design parameters for road soakaway 1.

Parameter	Road Soakaway 2 ($1,400m^2$)				
Rainfall return period	2 year	30 year	100 year	100 year + 20%	100 year + 40%
Infiltration rate (m/s)	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}	2.65×10^{-5}
Factor of safety	2	2	2	2	2
Soakaway type	Crate	Crate	Crate	Crate	Crate
Soakaway size (m)	9 x 9	9 x 9	9 x 9	9 x 9	9 x 9
Soakaway depth (m)	1.2	1.2	1.2	1.2	1.2
Contributing area (m^2)	1,400	1,400	1,400	1,400	1,400
Maximum water depth (m)	0.240	0.560	0.863	1.100	2.008
Half drain time (minutes)	134	284	404	484	573
Flood volume (m^3)	0	0	0	0	8.9

Table 10. Design parameters for road soakaway 2.

The total flood volume from the 1 in 100 year rainfall event with an allowance of 40% for climate change is $10.4m^3$. This can be accommodated in depressions around the soakaways.

The above demonstrates that disposal of surface water via infiltration is an appropriate surface water management strategy for the site. Soakaways can be designed to retain surface water runoff on site for all rainfall events up to and including the 1 in 100 year event with an allowance of 20% for climate change.

The total flood volume from all structures under the 1 in 100 year rainfall event with an allowance of 40% for climate change is 33.5m^3. The exceedance event flow paths are to Olantigh Road and to the east and north, Figure 20.

The final drainage design will need to be based on site specific infiltration rates. Additional storage is available throughout the development either as permeable paving or cellular storage crates. There is also sufficient space on site to accommodate surface water runoff generated by the development.

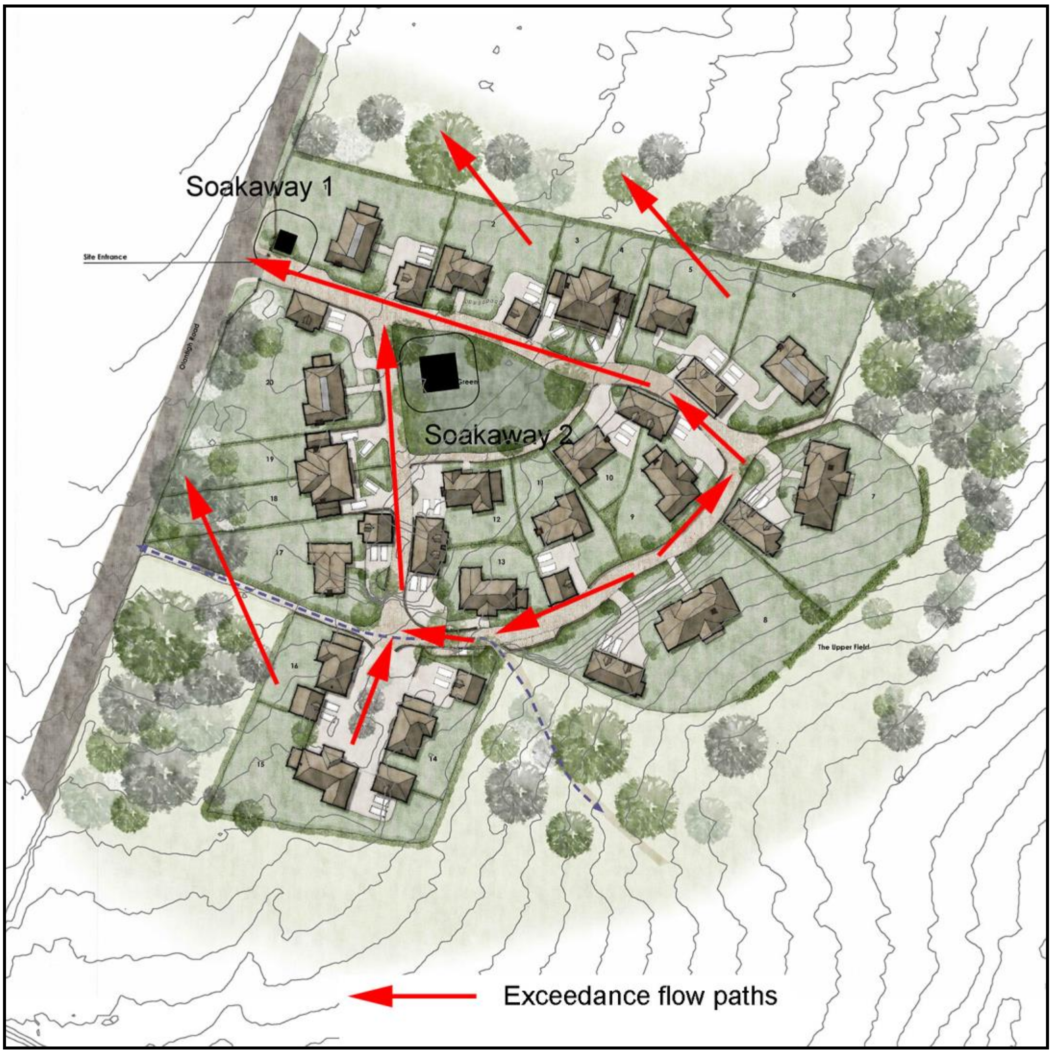

Figure 20. Exceedance event flow paths.

A summary of the surface water management strategy is attached at Appendix E.

10. Water Quality

The SuDS Manual gives the following as standards of good practice for water quality:

Water quality standard 1: Prevent runoff from the site to receiving surface waters for the majority of small rainfall events.

No runoff should be discharged from the site to receiving surface waters or sewers for the majority of small (eg < 5 mm) rainfall events. This is termed Interception.

Water quality standard 2: Treat runoff to prevent negative impacts on the receiving water quality.

Runoff should be adequately treated to protect the receiving water body from:

1. Short-term acute pollution that may result from accidental spills or temporary high pollution loadings within the catchment area.
2. Long-term chronic pollution from the spectrum of runoff pollutant sources within the urban environment.

Water Quality Standard 1 - Interception

Disposal of surface water via permeable paving and soakaways will prevent water discharging from the site for rainfall events of less than 5mm. The proposed strategy therefore meets the interception standard.

Water Quality Standard 2 - Treatment

The extent of treatment required depends on the land use, the level of pollution prevention in the catchment and for groundwater the natural protection afforded by underlying soil layers. High hazard sites will have a higher potential pollution load and higher potential maximum pollution concentrations. They therefore tend to require more treatment than low hazard sites in order to deliver discharges of an acceptable quality.

The SuDS Manual sets out minimum water quality management requirements for discharges to receiving surface waters and groundwater for various land use types, Table 11. The site consists of two land use types:

1. Roofs to houses classed as *residential roofs*, very low pollution hazard.
2. The access road and parking areas classed as *property driveways/low traffic roads*, low pollution hazard.

<table>
<tr><th rowspan="2">Land use</th><th rowspan="2">Pollution hazard level</th><th colspan="2">Requirements for discharge to:</th></tr>
<tr><th>surface waters</th><th>groundwater</th></tr>
<tr><td>Residential roofs</td><td>Very low</td><td colspan="2">Removal of gross solids and sediments only</td></tr>
<tr><td>Individual property driveways, roofs (excluding residential), residential car parks, low traffic roads (eg cul de sacs, home zones, general access roads), non-residential car parking with infrequent change (eg schools, offices)</td><td>Low</td><td colspan="2">Simple index approach
Note: extra measures may be required for discharges to protected resources</td></tr>
<tr><td rowspan="2">Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways</td><td rowspan="2">Medium</td><td colspan="2">Simple index approach
Note: extra measures may be required for discharges to protected resources</td></tr>
<tr><td></td><td>In England and Wales, Risk Screening must be undertaken first to determine whether consultation with the environmental regulator is required.</td></tr>
<tr><td>Trunk roads and motorways</td><td>High</td><td colspan="2">Follow the guidance and risk assessment process set out in HA (2009)</td></tr>
<tr><td>Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites</td><td>High</td><td colspan="2">Discharges may require an environmental licence or permit. Obtain pre-permitting advice from the environmental regulator. Risk assessment is likely to be required.</td></tr>
<tr><td colspan="4">Note 1. Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.
Note 2. Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.
Note 3. Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.</td></tr>
</table>

Table 11. Water quality requirements for discharge to surface waters and groundwater.

For each land use type a simple index approach is appropriate which involves the following steps:

1. Allocate suitable pollution hazard indices for the proposed land use, Table 12.
2. Select SuDS with a total pollution mitigation index that equals or exceeds the pollution hazard index, Table 13.
3. Where the discharge is to protected surface waters or groundwater, consider the need for a more precautionary approach.

Land Use	Pollution hazard level	Total suspended solids	Metals	Hydro-carbons
Residential Roofs	Very low	0.2	0.2	0.05
Other roofs (commercial/industrial)	Low	0.3	0.2[1]	0.05
Individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change (eg schools, offices) <300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites, sites where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites, trunk roads and motorways[2]	High	0.8[3]	0.8[3]	0.9[3]
Note 1. Up to 0.8 where there is potential for metals to leach from the roof. Note 2. Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009) Note 3. These should only be used if considered appropriate as part of a detailed risk assessment.				

Table 12. Pollution hazard indices for different land use classifications.

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index, for each contaminant type, that equals or exceeds the pollution hazard index, for each contaminant type. Where the mitigation index of an individual component is insufficient, two components, or more, in series will be required. A factor of 0.5 is used to account for the reduced performance of secondary or tertiary components.

Characteristics of the material overlying the proposed infiltration surface through which the runoff percolates	Total suspended solids	Metals	Hydro-carbons
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.6	0.5	0.6
A soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment, ie graded gravel with sufficient smaller particles but not single size course aggregate such as 20mm gravel) underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.8	0.8	0.8
Proprietary treatment system	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		
Note 1. All designs must include a minimum of 1m unsaturated depth of aquifer material between the infiltration surface and the maximum likely groundwater level.			

Table 13. Indicative SuDS mitigation indices for discharge to groundwater.

For residential roofs infiltration within soakaways has a total pollution mitigation index that is greater than the pollution hazard index for all pollutants, Table 14. For drives, permeable paving has a total pollution mitigation index that is greater than the pollution hazard index for all pollutants. For the impermeable access road, infiltration within soakaways does not provide sufficient water quality treatment. Runoff from roads will have to be treated by passing through trapped gullies before discharging to the soakaways. With this additional treatment measure in place the total pollution mitigation index will be equal or greater than the pollution hazard index for all pollutants. All runoff from the site will therefore receive an appropriate level of water quality treatment.

The site does not lie within any groundwater source protection zones. Groundwater levels are approximately 69m below ground level. The deepest soakaways proposed are 3.2m deep which leaves an unsaturated zone of 65.8m between the base of the soakaway and groundwater. This will ensure that the development does not have a negative impact on groundwater quality.

Indices	Total suspended solids	Metals	Hydro-carbons
Residential roofs			
Maximum hazard index	0.2	0.2	0.05
Minimum SuDS mitigation index (300mm soil)	0.4	0.3	0.3
Appropriate treatment	✓	✓	✓
Drives			
Maximum hazard index	0.5	0.4	0.4
Minimum SuDS mitigation index (Permeable pavement)	0.7	0.6	0.7
Appropriate treatment	✓	✓	✓
Access road			
Maximum hazard index	0.5	0.4	0.4
Minimum SuDS mitigation index (300mm soil)	0.4	0.3	0.3
Appropriate treatment	✗	✗	✗

Table 14. Pollution hazard indices and SuDS mitigation indices for the development.

11. Ashford Borough Council SuDS Checklist

Ashford Borough Council's Sustainable Drainage SPD includes a Sustainable Drainage Checklist. The checklist has been produced to help developers demonstrate compliance with Policy CS20 and is designed to be included with any surface water drainage assessment.

The checklist is reproduced below, Table 15.

SECTION 1 Site Details		
1	Planning Reference Number	Not available
2	Site Name	Former ADAS site
3	Location (NGR)	605825E 147302N
4	Total size of site	2.4ha
5	Developable area	2.4ha
6	Current use	Brownfield
7	Catchment	Stour
8	Max allowable discharge rate	10.26 l/s/ha
9	Max discharge	9.3 l/s (0.91ha existing impermeable)
SECTION 2 Assessment of storage volume required		
10	Design life of development	Beyond 2085
11	Indicative storage volume	685 m^3/ha
12	Total indicative storage volume required	541m^3 (0.79ha proposed impermeable)
SECTION 3 Assessment of storage to be provided		
13	Indicative storage to be provided	463m^3 (Analysis indicates that this is sufficient storage for the proposed development)
made up as follows:		

Storage Type	Volume (m^3)	Siltation/vegetation allowance (%)	Total (m^3)
Green roof		-	
Water butts		-	
Other rainwater harvesting		-	
Permeable paving	145	-	145
Soakaways/infiltration	391	-	391

Filter strips		-	
Conveyance (swale/rill etc)		10	
Infiltration basin		10	
Wet ponds (retention basins)		20	
Detention basins/ponds		10	
Construction wetlands		20	
Underground systems including modular storage (not preferred)		10	
Other		-	
Total	536		536
Total indicative storage required	541	Total indicative storage provided	536

Table 15. Ashford Borough Council SuDS Checklist.

The proposed surface water management strategy provides sufficient storage to attenuate runoff from the development to allow infiltration for all rainfall events up to and including the 1 in 100 year plus climate change event.

12. Conclusion

This Foul and Surface Water Management Strategy accompanies a planning application submitted to Ashford Borough Council. The planning application is for residential development at the former ADAS Site, Olantigh Road, Wye, Ashford, TN25 5EP.

The site is situated to the east of Olantigh Road, Wye. It is a brownfield site, formerly used as ADAS offices, covering 2.4ha.

A planning application is being made for the demolition of the existing buildings and the construction of 20 dwellings.

The site lies within flood zone 1 and therefore residential development is appropriate. With the implementation of the development and this surface water management strategy the site is at very low risk from surface water flooding.

Foul Water

The existing site is connected to the public sewerage system via a private pumping station and rising main.

Southern Water introduced new connection charges on 1st April 2018. The introduction of the new infrastructure change means that the capacity of the existing sewerage network is not a constraint on development, as any necessary upgrades will be carried out by Southern Water and paid for through the new infrastructure charge.

The topography does not allow foul water to be drained to the existing foul sewer in Olantigh Road by gravity. A pumping station is proposed within the site. A rising main will then be constructed to discharge the pumped effluent to the existing public sewer in Olantigh Road. Two options are available for the route of the rising main, the first is along Olantigh Road with the second being a connection to the school site with a gravity connection to Olantigh Road via Occupation Road.

The foul water management strategy demonstrates that suitable foul drainage provision can be made to serve the site.

Surface Water

9,100m^2 of the existing site is covered with impermeable materials consisting of 4,200m^2 of roof and 4,900m^2 of paving. The existing roof and paved areas are positively drained. Runoff is assumed to discharge to soakaways.

Analysis of the layout indicates that potential impermeable surfaces will cover approximately 7,900m^2, consisting of 3,800m^2 of roof and 4,100m^2 of paving. The proposed development reduces the impermeable area by 1,200m^2, 13% of the existing impermeable area.

The surface water management strategy is to discharge all runoff from the site to ground using soakaways and permeable paving. Runoff from roofs is assumed to drain to individual soakaways. The private drives are assumed to be laid with permeable paving. The access road is assumed to be impermeable. It can be drained to crate soakaways in communal areas. Soakaways should not normally be constructed closer than 5m to building foundations. In chalk, the advice of a specialist geotechnical engineer should be sought concerning the risk of solution features and the interaction of any soakaways with foundations. This should be carried out as part of the detailed design.

Structures can be designed to retain surface water runoff on site for all rainfall events up to and including the 1 in 100 year event with an allowance of 20% for climate change. Detailed design will need to be based on site specific infiltration rates.

The total flood volume from all structures under the 1 in 100 year rainfall event with an allowance of 40% for climate change is 33.5m^3. The exceedance event flow paths are to Olantigh Road and to the east and north.

Disposal of surface water via permeable paving and soakaways will prevent water discharging from the site for rainfall events of less than 5mm. The proposed strategy therefore meets the water quality interception standard.

For residential roofs infiltration within soakaways has a total pollution mitigation index that is greater than the pollution hazard index for all pollutants. For drives, permeable paving has a total pollution mitigation index that is greater than the pollution hazard index for all pollutants. For the impermeable access road, infiltration within soakaways does not provide sufficient water quality treatment. Runoff from roads will have to be treated by passing through trapped gullies before discharging to the soakaways. With this additional treatment measure in place the total pollution mitigation index will be equal or greater than the pollution hazard index for all pollutants. All runoff from the site will therefore receive an appropriate level of water quality treatment as recommended within the SuDS Manual.

The proposed development is considered acceptable from a surface water management perspective.

Appendix A - Draft Foul Drainage Design

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Main

Pipe Sizes STANDARD Manhole Sizes RMB

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	1.500
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
F1.000	21.860	0.671	32.6	0.000	3	0.0	1.500	o	150	Pipe/Conduit
F2.000	25.853	0.431	60.0	0.000	2	0.0	1.500	o	150	Pipe/Conduit
F2.001	32.414	0.540	60.0	0.000	1	0.0	1.500	o	150	Pipe/Conduit
F1.001	44.946	2.329	19.3	0.000	0	0.0	1.500	o	150	Pipe/Conduit
F3.000	10.736	0.179	60.0	0.000	1	0.0	1.500	o	150	Pipe/Conduit
F3.001	25.595	1.621	15.8	0.000	1	0.0	1.500	o	150	Pipe/Conduit
F1.002	39.090	0.600	65.1	0.000	3	0.0	1.500	o	150	Pipe/Conduit
F4.000	30.028	0.800	37.5	0.000	3	0.0	1.500	o	150	Pipe/Conduit
F4.001	71.039	3.100	22.9	0.000	3	0.0	1.500	o	150	Pipe/Conduit
F1.003	17.611	0.200	88.1	0.000	1	0.0	1.500	o	150	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.000	41.650	0.000	0.0	3	0.0	8	0.38	1.54	27.2	0.1
F2.000	41.950	0.000	0.0	2	0.0	8	0.27	1.13	20.0	0.1
F2.001	41.519	0.000	0.0	3	0.0	9	0.31	1.13	20.0	0.1
F1.001	40.979	0.000	0.0	6	0.0	10	0.57	2.00	35.4	0.3
F3.000	40.450	0.000	0.0	1	0.0	6	0.21	1.13	20.0	0.0
F3.001	40.271	0.000	0.0	2	0.0	6	0.42	2.21	39.1	0.1
F1.002	38.650	0.000	0.0	11	0.0	17	0.46	1.09	19.2	0.5
F4.000	41.950	0.000	0.0	3	0.0	8	0.36	1.43	25.3	0.1
F4.001	41.150	0.000	0.0	6	0.0	10	0.54	1.84	32.4	0.3
F1.003	38.050	0.000	0.0	18	0.0	23	0.48	0.93	16.5	0.8

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
F1.004	23.793	0.600	39.7	0.000	2	0.0	1.500	o	150	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.004	37.850	0.000	0.0	20	0.0	20	0.65	1.39	24.6	0.9

Manhole Schedules for Foul - Main

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
F1	43.000	1.350	Open Manhole	1200	F1.000	41.650	150				
F2	43.300	1.350	Open Manhole	1200	F2.000	41.950	150				
F3	43.500	1.981	Open Manhole	1200	F2.001	41.519	150	F2.000	41.519	150	
F4	42.600	1.621	Open Manhole	1200	F1.001	40.979	150	F1.000	40.979	150	
								F2.001	40.979	150	
F5	41.800	1.350	Open Manhole	1200	F3.000	40.450	150				
F6	41.700	1.429	Open Manhole	1200	F3.001	40.271	150	F3.000	40.271	150	
F7	40.000	1.350	Open Manhole	1200	F1.002	38.650	150	F1.001	38.650	150	
								F3.001	38.650	150	
F8	43.300	1.350	Open Manhole	1200	F4.000	41.950	150				
F9	42.500	1.350	Open Manhole	1200	F4.001	41.150	150	F4.000	41.150	150	
F10	39.400	1.350	Open Manhole	1200	F1.003	38.050	150	F1.002	38.050	150	
								F4.001	38.050	150	
F11	39.200	1.350	Open Manhole	1200	F1.004	37.850	150	F1.003	37.850	150	
F12	38.600	1.350	Open Manhole	1200		OUTFALL		F1.004	37.250	150	

PIPELINE SCHEDULES for Foul - Main

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	o	150	F1	43.000	41.650	1.200	Open Manhole	1200
F2.000	o	150	F2	43.300	41.950	1.200	Open Manhole	1200
F2.001	o	150	F3	43.500	41.519	1.831	Open Manhole	1200
F1.001	o	150	F4	42.600	40.979	1.471	Open Manhole	1200
F3.000	o	150	F5	41.800	40.450	1.200	Open Manhole	1200
F3.001	o	150	F6	41.700	40.271	1.279	Open Manhole	1200
F1.002	o	150	F7	40.000	38.650	1.200	Open Manhole	1200
F4.000	o	150	F8	43.300	41.950	1.200	Open Manhole	1200
F4.001	o	150	F9	42.500	41.150	1.200	Open Manhole	1200
F1.003	o	150	F10	39.400	38.050	1.200	Open Manhole	1200
F1.004	o	150	F11	39.200	37.850	1.200	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	21.860	32.6	F4	42.600	40.979	1.471	Open Manhole	1200
F2.000	25.853	60.0	F3	43.500	41.519	1.831	Open Manhole	1200
F2.001	32.414	60.0	F4	42.600	40.979	1.471	Open Manhole	1200
F1.001	44.946	19.3	F7	40.000	38.650	1.200	Open Manhole	1200
F3.000	10.736	60.0	F6	41.700	40.271	1.279	Open Manhole	1200
F3.001	25.595	15.8	F7	40.000	38.650	1.200	Open Manhole	1200
F1.002	39.090	65.1	F10	39.400	38.050	1.200	Open Manhole	1200
F4.000	30.028	37.5	F9	42.500	41.150	1.200	Open Manhole	1200
F4.001	71.039	22.9	F10	39.400	38.050	1.200	Open Manhole	1200
F1.003	17.611	88.1	F11	39.200	37.850	1.200	Open Manhole	1200
F1.004	23.793	39.7	F12	38.600	37.250	1.200	Open Manhole	1200

Free Flowing Outfall Details for Foul - Main

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F1.004	F12	38.600	37.250	0.000	1200	0

Appendix B - Draft Roof Soakaway Design

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 172 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	37.040	1.040	0.1	1.0	O K
30 min Summer	37.355	1.355	0.1	1.3	O K
60 min Summer	37.637	1.637	0.1	1.6	O K
120 min Summer	37.809	1.809	0.1	1.8	O K
180 min Summer	37.911	1.911	0.1	1.9	O K
240 min Summer	37.984	1.984	0.1	2.0	O K
360 min Summer	38.125	2.125	0.1	2.1	O K
480 min Summer	38.199	2.199	0.1	2.1	O K
600 min Summer	38.212	2.212	0.1	2.1	O K
720 min Summer	38.184	2.184	0.1	2.1	O K
960 min Summer	38.055	2.055	0.1	2.0	O K
1440 min Summer	37.839	1.839	0.1	1.8	O K
2160 min Summer	37.577	1.577	0.1	1.6	O K
2880 min Summer	37.377	1.377	0.1	1.4	O K
4320 min Summer	37.099	1.099	0.1	1.1	O K
5760 min Summer	36.919	0.919	0.1	0.9	O K
7200 min Summer	36.800	0.800	0.1	0.8	O K
8640 min Summer	36.711	0.711	0.1	0.7	O K
10080 min Summer	36.641	0.641	0.0	0.6	O K
15 min Winter	37.166	1.166	0.1	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	114.497	0.0	18
30 min Summer	76.928	0.0	33
60 min Summer	49.396	0.0	62
120 min Summer	30.598	0.0	104
180 min Summer	23.308	0.0	134
240 min Summer	19.305	0.0	168
360 min Summer	14.922	0.0	238
480 min Summer	12.472	0.0	306
600 min Summer	10.828	0.0	374
720 min Summer	9.622	0.0	442
960 min Summer	7.919	0.0	570
1440 min Summer	5.895	0.0	824
2160 min Summer	4.301	0.0	1192
2880 min Summer	3.413	0.0	1560
4320 min Summer	2.439	0.0	2292
5760 min Summer	1.922	0.0	3008
7200 min Summer	1.606	0.0	3752
8640 min Summer	1.389	0.0	4496
10080 min Summer	1.231	0.0	5240
15 min Winter	114.497	0.0	18

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	37.521	1.521	0.1	1.5	O K
60 min Winter	37.842	1.842	0.1	1.8	O K
120 min Winter	38.062	2.062	0.1	2.0	O K
180 min Winter	38.230	2.230	0.1	2.1	O K
240 min Winter	38.345	2.345	0.1	2.2	O K
360 min Winter	38.463	2.463	0.1	2.3	O K
480 min Winter	38.485	2.485	0.1	2.3	O K
600 min Winter	38.435	2.435	0.1	2.3	O K
720 min Winter	38.343	2.343	0.1	2.2	O K
960 min Winter	38.095	2.095	0.1	2.0	O K
1440 min Winter	37.781	1.781	0.1	1.8	O K
2160 min Winter	37.455	1.455	0.1	1.4	O K
2880 min Winter	37.225	1.225	0.1	1.2	O K
4320 min Winter	36.928	0.928	0.1	0.9	O K
5760 min Winter	36.752	0.752	0.1	0.7	O K
7200 min Winter	36.638	0.638	0.0	0.6	O K
8640 min Winter	36.557	0.557	0.0	0.6	O K
10080 min Winter	36.497	0.497	0.0	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	76.928	0.0	32
60 min Winter	49.396	0.0	60
120 min Winter	30.598	0.0	114
180 min Winter	23.308	0.0	142
240 min Winter	19.305	0.0	182
360 min Winter	14.922	0.0	258
480 min Winter	12.472	0.0	334
600 min Winter	10.828	0.0	406
720 min Winter	9.622	0.0	476
960 min Winter	7.919	0.0	606
1440 min Winter	5.895	0.0	866
2160 min Winter	4.301	0.0	1236
2880 min Winter	3.413	0.0	1616
4320 min Winter	2.439	0.0	2336
5760 min Winter	1.922	0.0	3064
7200 min Winter	1.606	0.0	3816
8640 min Winter	1.389	0.0	4504
10080 min Winter	1.231	0.0	5240

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 605831 147300	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.005

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.005

Model Details

Storage is Online Cover Level (m) 39.000

Lined Soakaway Structure

Infiltration Coefficient Base (m/hr)	0.00000	Ring Diameter (m)	0.90
Infiltration Coefficient Side (m/hr)	0.09540	Pit Multiplier	1.5
Safety Factor	2.0	Number Required	1
Porosity	0.30	Cap Volume Depth (m)	2.500
Invert Level (m)	36.000	Cap Infiltration Depth (m)	2.000

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 224 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	36.707	0.907	0.1	2.3	O K
30 min Summer	36.993	1.193	0.2	3.0	O K
60 min Summer	37.269	1.469	0.2	3.7	O K
120 min Summer	37.473	1.673	0.2	4.2	O K
180 min Summer	37.574	1.774	0.2	4.5	O K
240 min Summer	37.654	1.854	0.2	4.7	O K
360 min Summer	37.771	1.971	0.3	5.0	O K
480 min Summer	37.842	2.042	0.3	5.1	O K
600 min Summer	37.877	2.077	0.3	5.2	O K
720 min Summer	37.887	2.087	0.3	5.3	O K
960 min Summer	37.859	2.059	0.3	5.2	O K
1440 min Summer	37.721	1.921	0.2	4.8	O K
2160 min Summer	37.496	1.696	0.2	4.3	O K
2880 min Summer	37.310	1.510	0.2	3.8	O K
4320 min Summer	37.036	1.236	0.2	3.1	O K
5760 min Summer	36.853	1.053	0.1	2.7	O K
7200 min Summer	36.727	0.927	0.1	2.3	O K
8640 min Summer	36.630	0.830	0.1	2.1	O K
10080 min Summer	36.557	0.757	0.1	1.9	O K
15 min Winter	36.816	1.016	0.1	2.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	114.497	0.0	22
30 min Summer	76.928	0.0	36
60 min Summer	49.396	0.0	64
120 min Summer	30.598	0.0	120
180 min Summer	23.308	0.0	154
240 min Summer	19.305	0.0	184
360 min Summer	14.922	0.0	250
480 min Summer	12.472	0.0	318
600 min Summer	10.828	0.0	386
720 min Summer	9.622	0.0	456
960 min Summer	7.919	0.0	590
1440 min Summer	5.895	0.0	854
2160 min Summer	4.301	0.0	1236
2880 min Summer	3.413	0.0	1616
4320 min Summer	2.439	0.0	2340
5760 min Summer	1.922	0.0	3064
7200 min Summer	1.606	0.0	3816
8640 min Summer	1.389	0.0	4504
10080 min Summer	1.231	0.0	5248
15 min Winter	114.497	0.0	22

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	37.138	1.338	0.2	3.4	O K
60 min Winter	37.450	1.650	0.2	4.2	O K
120 min Winter	37.686	1.886	0.2	4.8	O K
180 min Winter	37.795	1.995	0.3	5.0	O K
240 min Winter	37.875	2.075	0.3	5.2	O K
360 min Winter	37.982	2.182	0.3	5.5	O K
480 min Winter	38.076	2.276	0.3	5.6	O K
600 min Winter	38.099	2.299	0.3	5.7	O K
720 min Winter	38.061	2.261	0.3	5.6	O K
960 min Winter	37.948	2.148	0.3	5.4	O K
1440 min Winter	37.732	1.932	0.2	4.9	O K
2160 min Winter	37.433	1.633	0.2	4.1	O K
2880 min Winter	37.205	1.405	0.2	3.5	O K
4320 min Winter	36.893	1.093	0.1	2.8	O K
5760 min Winter	36.698	0.898	0.1	2.3	O K
7200 min Winter	36.568	0.768	0.1	1.9	O K
8640 min Winter	36.475	0.675	0.1	1.7	O K
10080 min Winter	36.405	0.605	0.1	1.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	76.928	0.0	36
60 min Winter	49.396	0.0	64
120 min Winter	30.598	0.0	118
180 min Winter	23.308	0.0	168
240 min Winter	19.305	0.0	190
360 min Winter	14.922	0.0	268
480 min Winter	12.472	0.0	344
600 min Winter	10.828	0.0	416
720 min Winter	9.622	0.0	488
960 min Winter	7.919	0.0	628
1440 min Winter	5.895	0.0	898
2160 min Winter	4.301	0.0	1284
2880 min Winter	3.413	0.0	1672
4320 min Winter	2.439	0.0	2420
5760 min Winter	1.922	0.0	3168
7200 min Winter	1.606	0.0	3888
8640 min Winter	1.389	0.0	4584
10080 min Winter	1.231	0.0	5344

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 605831 147300	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.011

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.005	4	8	0.006

Model Details

Storage is Online Cover Level (m) 39.000

Lined Soakaway Structure

Infiltration Coefficient Base (m/hr)	0.00000	Ring Diameter (m)	1.20
Infiltration Coefficient Side (m/hr)	0.09540	Pit Multiplier	2.0
Safety Factor	2.0	Number Required	1
Porosity	0.30	Cap Volume Depth (m)	2.700
Invert Level (m)	35.800	Cap Infiltration Depth (m)	2.200

Appendix C - Draft Permeable Paving Design

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 209 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	38.581	0.081	4.2	38.9	O K
30 min Summer	38.611	0.111	4.2	53.5	O K
60 min Summer	38.640	0.140	4.2	67.4	O K
120 min Summer	38.662	0.162	4.2	77.6	O K
180 min Summer	38.672	0.172	4.2	82.5	O K
240 min Summer	38.679	0.179	4.2	86.0	O K
360 min Summer	38.689	0.189	4.2	90.8	O K
480 min Summer	38.694	0.194	4.2	93.3	O K
600 min Summer	38.695	0.195	4.2	93.8	O K
720 min Summer	38.694	0.194	4.2	93.1	O K
960 min Summer	38.685	0.185	4.2	89.0	O K
1440 min Summer	38.658	0.158	4.2	76.0	O K
2160 min Summer	38.616	0.116	4.2	55.8	O K
2880 min Summer	38.583	0.083	4.2	39.9	O K
4320 min Summer	38.549	0.049	4.1	23.5	O K
5760 min Summer	38.540	0.040	3.4	19.1	O K
7200 min Summer	38.534	0.034	2.9	16.2	O K
8640 min Summer	38.529	0.029	2.5	14.1	O K
10080 min Summer	38.526	0.026	2.2	12.6	O K
15 min Winter	38.593	0.093	4.2	44.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	114.497	0.0	18
30 min Summer	76.928	0.0	33
60 min Summer	49.396	0.0	62
120 min Summer	30.598	0.0	120
180 min Summer	23.308	0.0	160
240 min Summer	19.305	0.0	192
360 min Summer	14.922	0.0	260
480 min Summer	12.472	0.0	332
600 min Summer	10.828	0.0	402
720 min Summer	9.622	0.0	470
960 min Summer	7.919	0.0	608
1440 min Summer	5.895	0.0	868
2160 min Summer	4.301	0.0	1236
2880 min Summer	3.413	0.0	1584
4320 min Summer	2.439	0.0	2208
5760 min Summer	1.922	0.0	2944
7200 min Summer	1.606	0.0	3672
8640 min Summer	1.389	0.0	4408
10080 min Summer	1.231	0.0	5136
15 min Winter	114.497	0.0	18

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	38.628	0.128	4.2	61.3	O K
60 min Winter	38.661	0.161	4.2	77.3	O K
120 min Winter	38.687	0.187	4.2	89.6	O K
180 min Winter	38.700	0.200	4.2	95.8	O K
240 min Winter	38.707	0.207	4.2	99.2	O K
360 min Winter	38.716	0.216	4.2	103.8	O K
480 min Winter	38.720	0.220	4.2	105.8	O K
600 min Winter	38.719	0.219	4.2	105.3	O K
720 min Winter	38.715	0.215	4.2	103.2	O K
960 min Winter	38.699	0.199	4.2	95.6	O K
1440 min Winter	38.655	0.155	4.2	74.6	O K
2160 min Winter	38.593	0.093	4.2	44.6	O K
2880 min Winter	38.554	0.054	4.2	25.7	O K
4320 min Winter	38.538	0.038	3.2	18.0	O K
5760 min Winter	38.530	0.030	2.5	14.3	O K
7200 min Winter	38.525	0.025	2.1	11.9	O K
8640 min Winter	38.522	0.022	1.8	10.3	O K
10080 min Winter	38.519	0.019	1.6	9.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	76.928	0.0	32
60 min Winter	49.396	0.0	60
120 min Winter	30.598	0.0	118
180 min Winter	23.308	0.0	172
240 min Winter	19.305	0.0	224
360 min Winter	14.922	0.0	280
480 min Winter	12.472	0.0	360
600 min Winter	10.828	0.0	440
720 min Winter	9.622	0.0	514
960 min Winter	7.919	0.0	664
1440 min Winter	5.895	0.0	938
2160 min Winter	4.301	0.0	1296
2880 min Winter	3.413	0.0	1560
4320 min Winter	2.439	0.0	2244
5760 min Winter	1.922	0.0	2944
7200 min Winter	1.606	0.0	3680
8640 min Winter	1.389	0.0	4392
10080 min Winter	1.231	0.0	5128

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 605831 147300	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.230

Time (mins) From:	To:	Area (ha)
0	4	0.230

Model Details

Storage is Online Cover Level (m) 39.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.09540	Width (m)	40.0
Membrane Percolation (mm/hr)	1000	Length (m)	40.0
Max Percolation (l/s)	444.4	Slope (1:X)	0.0
Safety Factor	10.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	38.500	Cap Volume Depth (m)	0.300

Appendix D - Draft Road Soakaway Design

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 382 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	37.382	0.382	0.4	8.2	O K
30 min Summer	37.506	0.506	0.4	10.8	O K
60 min Summer	37.629	0.629	0.5	13.5	O K
120 min Summer	37.732	0.732	0.5	15.6	O K
180 min Summer	37.789	0.789	0.5	16.9	O K
240 min Summer	37.825	0.825	0.5	17.6	O K
360 min Summer	37.871	0.871	0.5	18.6	O K
480 min Summer	37.902	0.902	0.5	19.3	O K
600 min Summer	37.920	0.920	0.5	19.7	O K
720 min Summer	37.927	0.927	0.5	19.8	O K
960 min Summer	37.921	0.921	0.5	19.7	O K
1440 min Summer	37.868	0.868	0.5	18.6	O K
2160 min Summer	37.764	0.764	0.5	16.3	O K
2880 min Summer	37.664	0.664	0.5	14.2	O K
4320 min Summer	37.489	0.489	0.4	10.5	O K
5760 min Summer	37.357	0.357	0.4	7.6	O K
7200 min Summer	37.259	0.259	0.4	5.5	O K
8640 min Summer	37.185	0.185	0.3	3.9	O K
10080 min Summer	37.129	0.129	0.3	2.8	O K
15 min Winter	37.429	0.429	0.4	9.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	114.497	0.0	26
30 min Summer	76.928	0.0	40
60 min Summer	49.396	0.0	68
120 min Summer	30.598	0.0	126
180 min Summer	23.308	0.0	182
240 min Summer	19.305	0.0	240
360 min Summer	14.922	0.0	308
480 min Summer	12.472	0.0	374
600 min Summer	10.828	0.0	440
720 min Summer	9.622	0.0	510
960 min Summer	7.919	0.0	650
1440 min Summer	5.895	0.0	926
2160 min Summer	4.301	0.0	1332
2880 min Summer	3.413	0.0	1732
4320 min Summer	2.439	0.0	2504
5760 min Summer	1.922	0.0	3232
7200 min Summer	1.606	0.0	3960
8640 min Summer	1.389	0.0	4664
10080 min Summer	1.231	0.0	5344
15 min Winter	114.497	0.0	26

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	37.570	0.570	0.4	12.2	O K
60 min Winter	37.711	0.711	0.5	15.2	O K
120 min Winter	37.833	0.833	0.5	17.8	O K
180 min Winter	37.904	0.904	0.5	19.3	O K
240 min Winter	37.951	0.951	0.5	20.3	O K
360 min Winter	38.008	1.008	0.6	21.5	O K
480 min Winter	38.041	1.041	0.6	22.3	O K
600 min Winter	38.061	1.061	0.6	22.7	O K
720 min Winter	38.067	1.067	0.6	22.8	O K
960 min Winter	38.049	1.049	0.6	22.4	O K
1440 min Winter	37.963	0.963	0.5	20.6	O K
2160 min Winter	37.809	0.809	0.5	17.3	O K
2880 min Winter	37.665	0.665	0.5	14.2	O K
4320 min Winter	37.429	0.429	0.4	9.2	O K
5760 min Winter	37.259	0.259	0.4	5.5	O K
7200 min Winter	37.140	0.140	0.3	3.0	O K
8640 min Winter	37.064	0.064	0.3	1.4	O K
10080 min Winter	37.047	0.047	0.3	1.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	76.928	0.0	39
60 min Winter	49.396	0.0	68
120 min Winter	30.598	0.0	124
180 min Winter	23.308	0.0	180
240 min Winter	19.305	0.0	236
360 min Winter	14.922	0.0	342
480 min Winter	12.472	0.0	390
600 min Winter	10.828	0.0	466
720 min Winter	9.622	0.0	546
960 min Winter	7.919	0.0	702
1440 min Winter	5.895	0.0	1002
2160 min Winter	4.301	0.0	1432
2880 min Winter	3.413	0.0	1844
4320 min Winter	2.439	0.0	2604
5760 min Winter	1.922	0.0	3344
7200 min Winter	1.606	0.0	4032
8640 min Winter	1.389	0.0	4584
10080 min Winter	1.231	0.0	5136

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 605831 147300	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.040

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.013	4	8	0.013	8	12	0.014

Model Details

Storage is Online Cover Level (m) 39.000

Cellular Storage Structure

Invert Level (m) 37.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.09540 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.09540

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	22.5	22.5	1.300	0.0	45.3
1.200	22.5	45.3			

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 484 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	38.872	0.372	1.3	28.6	O K
30 min Summer	38.994	0.494	1.3	38.0	O K
60 min Summer	39.117	0.617	1.4	47.5	O K
120 min Summer	39.224	0.724	1.4	55.7	O K
180 min Summer	39.287	0.787	1.4	60.6	O K
240 min Summer	39.330	0.830	1.5	63.9	O K
360 min Summer	39.383	0.883	1.5	67.9	O K
480 min Summer	39.416	0.916	1.5	70.5	O K
600 min Summer	39.436	0.936	1.5	72.0	O K
720 min Summer	39.446	0.946	1.5	72.8	O K
960 min Summer	39.445	0.945	1.5	72.7	O K
1440 min Summer	39.400	0.900	1.5	69.3	O K
2160 min Summer	39.303	0.803	1.5	61.8	O K
2880 min Summer	39.204	0.704	1.4	54.2	O K
4320 min Summer	39.023	0.523	1.3	40.3	O K
5760 min Summer	38.880	0.380	1.3	29.3	O K
7200 min Summer	38.773	0.273	1.2	21.0	O K
8640 min Summer	38.691	0.191	1.2	14.7	O K
10080 min Summer	38.630	0.130	1.1	10.0	O K
15 min Winter	38.918	0.418	1.3	32.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	114.497	0.0	26
30 min Summer	76.928	0.0	40
60 min Summer	49.396	0.0	68
120 min Summer	30.598	0.0	126
180 min Summer	23.308	0.0	184
240 min Summer	19.305	0.0	242
360 min Summer	14.922	0.0	350
480 min Summer	12.472	0.0	410
600 min Summer	10.828	0.0	476
720 min Summer	9.622	0.0	542
960 min Summer	7.919	0.0	678
1440 min Summer	5.895	0.0	956
2160 min Summer	4.301	0.0	1368
2880 min Summer	3.413	0.0	1764
4320 min Summer	2.439	0.0	2548
5760 min Summer	1.922	0.0	3288
7200 min Summer	1.606	0.0	3968
8640 min Summer	1.389	0.0	4672
10080 min Summer	1.231	0.0	5344
15 min Winter	114.497	0.0	26

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	39.057	0.557	1.3	42.9	O K
60 min Winter	39.198	0.698	1.4	53.7	O K
120 min Winter	39.324	0.824	1.5	63.4	O K
180 min Winter	39.401	0.901	1.5	69.4	O K
240 min Winter	39.456	0.956	1.5	73.5	O K
360 min Winter	39.528	1.028	1.6	79.1	O K
480 min Winter	39.569	1.069	1.6	82.3	O K
600 min Winter	39.588	1.088	1.6	83.7	O K
720 min Winter	39.600	1.100	1.6	84.7	O K
960 min Winter	39.594	1.094	1.6	84.2	O K
1440 min Winter	39.523	1.023	1.6	78.7	O K
2160 min Winter	39.376	0.876	1.5	67.4	O K
2880 min Winter	39.229	0.729	1.4	56.1	O K
4320 min Winter	38.974	0.474	1.3	36.5	O K
5760 min Winter	38.781	0.281	1.2	21.6	O K
7200 min Winter	38.645	0.145	1.1	11.1	O K
8640 min Winter	38.562	0.062	1.1	4.7	O K
10080 min Winter	38.546	0.046	1.0	3.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	76.928	0.0	40
60 min Winter	49.396	0.0	68
120 min Winter	30.598	0.0	124
180 min Winter	23.308	0.0	182
240 min Winter	19.305	0.0	238
360 min Winter	14.922	0.0	350
480 min Winter	12.472	0.0	456
600 min Winter	10.828	0.0	504
720 min Winter	9.622	0.0	572
960 min Winter	7.919	0.0	728
1440 min Winter	5.895	0.0	1038
2160 min Winter	4.301	0.0	1476
2880 min Winter	3.413	0.0	1904
4320 min Winter	2.439	0.0	2684
5760 min Winter	1.922	0.0	3408
7200 min Winter	1.606	0.0	4040
8640 min Winter	1.389	0.0	4584
10080 min Winter	1.231	0.0	5144

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 605831 147300	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.140

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.046	4	8	0.047	8	12	0.047

Model Details

Storage is Online Cover Level (m) 40.500

Cellular Storage Structure

Invert Level (m) 38.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.09540 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.09540

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	81.0	81.0	1.300	0.0	124.2
1.200	81.0	124.2			

Appendix E - Surface Water Drainage Strategy

Drainage Strategy Summary

1. Site details	
Site/development name	Former ADAS Site
Address including post code	Former ADAS Site Olantigh Road Wye Ashford, TN25 5EP
Grid reference	E 605825 N 147302
LPA reference	n/a
Type of application	Outline ☒ Full ☐ Discharge of Conditions ☐ Other ☐
Site condition	Greenfield ☐ Brownfield ☒

2. Existing drainage			Document/Plan where information is stated:
Total site area (ha)	2.4		Foul and Surface Water Management Strategy
Impermeable area (ha)	0.91		
Final discharge location	Infiltration ☒ Watercourse ☐ Sewer ☐ Tidal reach/sea ☐		
Greenfield discharge rate (l/s) for existing site area	QBAR (l/s)	0.5	Foul and Surface Water Management Strategy
	1 in 1 year (l/s)	0.5	
	1 in 30 year (l/s)	1.0	
	1 in 100 year (l/s)	1.4	
3. Proposed drainage areas			**Document/Plan where information is stated:**
Impermeable area (ha)	Roof	0.38	Foul and Surface Water Management Strategy
	Highway/road	0.41	
	Other paved areas		
	Total	0.79	
Permeable area (ha)	Open space	1.61	
	Other permeable areas		
	Total	2.40	
Final discharge location	Infiltration ☒ Infiltration rate 2.65×10^{-05} m/s Watercourse ☐ Sewer ☐ Tidal reach/sea ☐		Foul and Surface Water Management Strategy
Climate change allowance included in design	20% ☒ 30% ☐ 40% ☐		

4. Post-Development Discharge rates, without mitigation			**Document/Plan where information is stated:**
Developed discharge rates (l/s)	1 in 2 year	73	Foul and Surface Water Management Strategy
	1 in 30 year	165	
	1 in 100 year	212	
	1 in 100 year + CC	255	

5. Post-Development Discharge rates, with mitigation			**Document/Plan where information is stated:**
Describe development drainage strategy in general terms: Discharge to permeable paving and soakaways			Foul and Surface Water Management Strategy
(a) No control required, all flows infiltrating		☒	
(b) Controlled developed discharge rates (l/s)	1 in 1 year		Foul and Surface Water Management Strategy
	1 in 30 year		
	1 in 100 year		
	1 in 100 year + CC		

6. Discharge Volumes			**Document/Plan where information is stated:**
	Existing volume (m^3)	Proposed volume (m^3)	Foul and Surface Water Management Strategy
1 in 2 year	226	196	
1 in 30 year	426	369	
1 in 100 year	570	495	
1 in 100 year + CC	684	594	

All information presented above should be contained within the attached Flood Risk Assessment, Drainage Strategy or Statement and be substantiated through plans and appropriate calculations.

Form completed by	Robert Beck
Qualifications	Chartered Civil Engineer
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On behalf of (client's details)	Telereal Trillium
Date	05/09/19