

SUMMARY DRAINAGE REPORT



Project Name	Care home, Central Avenue, Gravesend		
Project Number	22 026	Note reference	22 026/JAB/SDR – REV C
Date	5th May 2023	Prepared by	J. Bowkett
Subject	Summary Drainage Report – Discharge Condition 8		

INTRODUCTION

A planning application 20220207 has been made to construct a 62 Bed Care Home for the proposed development at Central Avenue, Gravesend. The site has been previously developed with a public house centre with associated parking. All existing structures are to be demolished.

This Summary Drainage Report is to supplement drawings and information provided on the current drainage scheme, and aid in the discharge of planning Condition 8 providing information as requested by Kent County Council.

INITIAL DRAINAGE STRATEGY

A flood risk assessment and outline drainage strategy were submitted as part of the planning application. The document 'Flood Risk Assessment, Drainage Strategy for the Proposed Development at Ascot Arms, Central Avenue'(FRA) completed by Herrington Consulting Limited in January 2022 indicates SuDS which can be utilised for the scheme and an approximate size for a soakaway. This document is contained within **Appendix A**.

This document highlight that the practical SuDS to be considered on the site are Permeable Paving and Geo-cellular soakaway.

The FRA suggests that the surface water arising from the development could be discharged to the Geo-cellular soakaway, via the permeable paving and local RWP and Gullies.

The initial FRA indicates the use of a Petrol Interceptor to deal with the contamination risk of the car park and access road. The use of permeable paving alone to treat the contamination will be considered under the CIRIA SuDs Manual.

EXISTING SITE DRAINAGE

The existing site had a public house situated in the centre of the site with parking areas to the front and side. The surface water appear to be drained by a network of pipes around the building with a possible discharge into the public sewer on Central Avenue.

The current foul water is collected around the building and discharged into Ascot road via a 150mm pipe from inside the site.

It is proposed that the surface water is taken to a deep bore soakaway and no existing drainage areas are considered for the discharge.

SURFACE WATER DISCHARGE

In accordance with EA guidelines, CIRIA Documents and DEFRA's Non-statutory technical standards for sustainable drainage systems, surface water run-off should be managed as close to its source as possible with the re-use of rainwater within the building if practicable. The following surface water

run-off destination hierarchy is used to determine the most suitable SuDS strategy, with (1) being the most sustainable solution and (5) being the least sustainable.

1. Rainwater collected for later use, If viable.

Rainwater harvesting has not been considered as the potential re-use of water is limited to watering landscaped areas. The potential collection point at the front of the site is predominantly hard standing with only limited landscaping areas to utilise collected water.

2. Use infiltration techniques, such as soakaways in suitable areas.

Infiltration on the site is deemed to be the most practical discharge for the surface water as indicated in the FRA. The use of deep bore soakaways is proposed due to the poor permeability of the upper ground strata.

3. Discharge to a surface water body.

There is no watercourses within the vicinity of the site.

4. Discharge to a surface water sewer or highway drain.

This has been discounted as infiltration is to be used on the site.

5. Discharge to a combined sewer.

This is not required as there is a dedicated surface water sewer that runs through the site.

SURFACE WATER INFILTRATION

Following further ground investigation on site and the completion of BRE365 standard soakaway tests on the site within the location of the soakaway, the use of a shallow infiltration feature has been discounted as the infiltration rates are indicated as being far below the original design values used. Rates of 5.13×10^{-6} m/s and 1.30×10^{-6} m/s compared to the rate of 9.36×10^{-6} m/s used for the design. The revised tests are contained within **Appendix F**.

This has increased the proposed storage volume to a size that does not fit within the carpark and a draining time far in excess of the recommended 24hrs.

The surface water generated on the site is therefore be discharged by deep bore soakaways located under the car park. These have been positioned to be a min of 10m away from the proposed building.

The boreholes will be constructed as part of the pilling operation on site and soil and perforated pipes installed to secure them in the temporary case.

The boreholes are to be taken down to 16m to allow for a drainage length of min 9.5m. Design calculations have been completed within Causeway Flow to confirm the design of the deep bore soakaways and the attenuation required.

Further investigation works and falling head tests were completed in accordance with KCC Soakaway Design Guide on site within 2No. Boreholes located just within the building footprint. These tests have given infiltration rates of between 4.3×10^{-4} m/s and 1.7×10^{-3} m/s. The material within the borehole logs is consistent as this depth and described as 'White partially weathered CHALK, Recovered as fine to coarse chalk gravel in a comminuted silt Matrix. Scattered flint throughout'.

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This material extends to a min of 20m as indicated within the borehole logs.

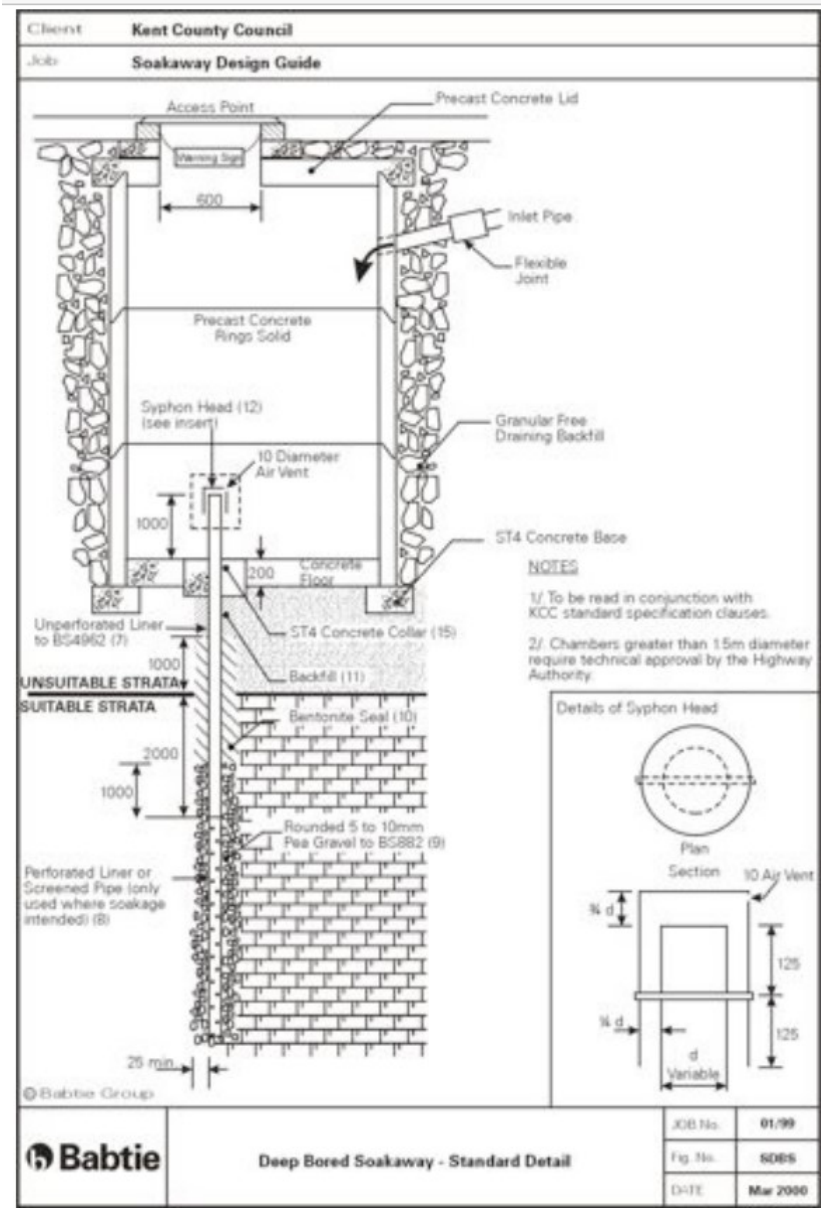
Falling head tests and bore hole logs are contained within **Appendix F**.

The drainage requirements for climate change were checked within EA documentations and the following requirements were extracted.

- 30 year 2050's upper end = 35% climate change
- 30 year 2070's upper end = 35% climate change
- 100 year 2050's upper end = 45% climate change
- 100 year 2070's upper end = 50% climate change

The Deep bore soakaways and attenuation have been designed to a min of 1 in 30 year event with 35% climate change and 1 in 100 year event with 50% climate change; with no overland flows or localised flooding of the site. The design calculations as completed in Causeway Flow with associated drainage area plan are contained within **Appendix D**.

Deep Bore soakaways are to be constructed in accordance with the KCC – The Soakaway Design Guide (July 2000), Appendix D2 – specification and drawing.



KCC – Deep Bore Soakaway Standard Detail

We have recommended that a min of 4No. boreholes are installed on site and that each is subject to a Falling head test to verify the infiltration rates obtained from the test bore holes.

If the infiltration rates do not achieve the min design values within the preferred locations either the alternative boreholes can be used or these can be incorporated into the scheme to increase the number of boreholes, details will be re-submitted as required.

ARC Engineers will be responsible for providing the Drainage Verification report as required for pre-occupation Condition 9. It is intended that the Verification of the infiltration rates for the deep bore soakaways will form part of this submission.

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ENVIROMENT AGENCY CONSULTATION

The Environment Agency have been contacted with regards to the discharge of Surface water from roof area and parking/access road to a deep bore soakaway. They have issued a pre-application advice letter.

Which concludes the flowing:

Application reference number	EPR/GP3120ST/A001
Summary and advice	Please find below a summary of our discussions and advice based on information provided within the online pre-application form and correspondence with your contact James Bowkett: You have requested advice about whether you need to apply for a discharge permit for your site 'Ascot Arms'. • You propose to discharge surface water runoff from roofs and hardstanding to ground via a borehole. • The surface water runoff will be treated by SuDS methods including a permeable paving system and infiltration/collection trench. • The maximum daily discharge volume will be around 160 m³/day (160 m³ for 1 in 100 + 40%). • Based on your site plan, the discharge point will be located near to national grid reference TQ 64912 72426. Based on the information that you have provided us within your pre-application form and correspondence, we can provide the following advice: Advice from our local Groundwater Team As part of this pre-application request, I have consulted with our local Area Groundwater Team who have advised that the proposed discharge does not require an environmental permit, so long as the following advice is implemented: The consultant/developer must <u>not</u> allow direct discharges to groundwater and there <u>must</u> be an unsaturated zone beneath the base of the proposed borehole and the highest seasonal groundwater table at all times. Provided that the operator can ensure the above advice is followed,

	which might mean making the borehole shallower, the Groundwater Team would not object here. Please note – the operator should also have regard to the Environment Agency's Groundwater Protection Position Statements: https://www.gov.uk/government/publications/groundwater-protection-position-statements, Section G. They should also look more generally at the pages on groundwater protection: https://www.gov.uk/government/collections/groundwater-protection. Discharges to boreholes are not our preferred method of surface water disposal, as they bypass the shallow soil layers where natural attenuation of pollutants occurs. If a borehole is proposed for the discharge of <u>clean</u> surface water, it must not discharge directly to groundwater. Direct discharges are <u>not</u> allowed. The borehole should be constructed as shallow as possible when required infiltration rates are reached. The surface water system should include pollution prevention measures, especially if draining roads. Such measures can include treatment methods such as oil interceptors, downstream defenders, etc., which must be maintained as per the manufacturer's guidance. Please be aware that the proposed site is located within groundwater Safeguard Zone and a Source Protection Zone 2. As such the groundwater is of high vulnerability. If you cannot meet our Groundwater Team's advice If you are unable to meet the above advice, provided by our Groundwater Team, then you will need to apply for an environmental permit, as outlined in the below sections.
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It is considered that the conditions of the EA Groundwater Team can be met and that a Permit to Discharge is not required. The full document is contained within **Appendix G**.

The following Guidance have been met with the following considerations.

1. *'The consultant/ developer must not allow direct discharge to ground water and there must be an unsaturated zone beneath the base of the proposed borehole and the highest seasonal ground water level.'*

The boreholes completed to a depth of 20m did not penetrate the ground water. The intended borehole are to be taken down 16m which provides a min of 4m of cover to the ground water. It is considered that there maybe some seasonal variation in the ground water level.

However, the borehole works were completed in early February when the water table would be near its peak. It is also noted from Environment Agency Report Water Situation: January 2023 Summary that

'The wettest hydrological area was Kent in south-east England which received 159% of LTA rainfall for January'

‘At the end of January, groundwater levels increased at all but 4 of the reported indicator sites as wet soils and above average rainfall in many areas helped aquifers continue their seasonal recharge’

The full report can be found at: <https://www.gov.uk/government/publications/water-situation-national-monthly-reports-for-england-2023/water-situation-january-2023-summary#rainfall>

We therefore consider that the water table would have been at or near its peak level during the investigation works.

2. *‘The operator should also have regard to the Environment Agency’s Groundwater Protection Position Statements: <https://www.gov.uk/government/publications/groundwater-protection-position-statement>, Section G.’*

The full section G is contained within **Appendix G**.

The document has been reviewed and the relevant section in relation to this scheme is G13.

In relation to G13 – sustainable drainage systems.

- The system is suitably designed
- It meets the current standards for sustainable drainage systems
- A SuDs management treatment has been provided and justification is contained within this document.

The discharge is within a SPZ2 and the final statement does not apply.

We therefore consider that this requirement has been met.

3. *‘They should look more generally at the pages on ground water protection: <https://www.gov.uk/government/collections/groundwater-protection>, ’*

These documents have been considered and the scheme proposed adheres to the principals and requirements of these documents.

4. *‘Discharge to boreholes are not our preferred method of surface water disposal, as they bypass the shallow soil layers where natural attenuation of pollutants occurs.’*

As noted shallow soakaways were considered, however due to the poor permeability of the upper strata is unsuitable. This is the only remaining option to soakaway within the site.

5. *‘If a borehole is proposed for the discharge of clean surface water, it must not discharge directly to ground water. Direct discharges are not allowed. The borehole should be constructed as shallow as possible when require infiltration rates are reached. ’*

This has been done and as noted above the ground water depth is in excess of 20m. The borehole is 16m deep which is the min required to soakaway.

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6. *'The surface water system should include pollution prevention measures, especially if draining roads. Such measures can include treatment methods such as oil interceptors, downstream defender etc, which must be maintained as per the manufacturer's guidance, This has been considered and suitable SuDs treatments have been provided as outlined within this report.*
7. *'Please be aware that the proposed site is located within ground water safeguard Zone and a Source Protection Zone 2. As such ground water is highly vulnerable.'*

This requirement has been considered and the contamination risk is considered to be low and has been managed by the proposed SuDs strategy.

ARC have followed and check the requirements and consider that a permit is not required to discharge the surface water into the deep bore soakaway.

DISCHARGE

SuDS PROPOSALS

The site drainage system is to be developed with SuDS features as indicated on the proposed Drainage scheme contained within **Appendix C**.

The carpark and access road are to be a permeable paving construction to manage both the flows and to deal with potential contamination.

Surface water is to be collected either directly by the soakaway or from the drainage trench located at the entry to the site.

The RWP's and drainage gullies are to be collected by a surface water pipe network and discharged via silt traps to the soakaway.

SuDS WATER QUALITY ASSESSMENT

With respect to Table 26.2 of the CIRIA SuDS Manual, the two principal areas of the site are considered as noted in the table .

Land Use	Pollution Hazard Level
Residential Roofs	VERY LOW
Low Traffic Roads and non-residential car parking with infrequent change (eg offices) < 300 traffic movements / day	LOW

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Pollution hazard indices for different land use classifications				
Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4

Extract of table 26.2 from The SuDS Manual (CIRIA Report C753)

The SuDS components proposed have been assessed in accordance with Table 26.3, below, in relation to their suitability for this site and type of development.

Indicative SuDS mitigation indices for discharges to groundwater			
Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates ¹	TSS	Metals	Hydrocarbons
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.6 ⁴	0.5	0.6
A soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.4 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 coarse aggregate such as 20 mm gravel) underlain by a soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.4 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 ² of at least 300 mm in depth ³	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential ² of at least 300 mm in depth ³	0.8 ⁴	0.8	0.8
Proprietary treatment systems ^{5, 6}	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		

Extract of table 26.4 from The SuDS Manual (CIRIA Report C753)

The water quality assessment have been completed using the above pollution indices and migration indices and direct by The SuDS Manual (CIRIA Report C753)

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RESIDENTIAL ROOF AREAS

HAZARD INDEX	Total SS	Metals	Hydrocarbons
ROOF	0.2	0.2	0.05
TOTAL HAZARD INDEX	0.2	0.2	0.05
MITIGATION MEANS			
A SOIL WITH GOOD CONTAMINATION ATTENUATION POTENTIAL	0.4	0.3	0.3

- Mitigation index scores are higher than hazard index scores.
- Proposed means of SuDS to catchment areas is appropriate.

LOW TRAFFIC ROADS

HAZARD INDEX	Total SS	Metals	Hydrocarbons
EXTERNALS	0.5	0.4	0.4
TOTAL HAZARD INDEX	0.5	0.4	0.4
MITIGATION MEANS			
CONSTRUCTED PERMEABLE PAVING	0.7	0.6	0.7

- Mitigation index scores are higher than hazard index scores.
- Proposed means of SuDS to catchment areas is appropriate.

WHOLE LIFE MAINTENANCE OF SuDS

The following section describes the required maintenance for each SuDS feature in turn. The maintenance requirements listed below should be reviewed after the first 5 years, with a view to agreeing a new regime for the ongoing maintenance.

Notwithstanding the routine inspections and maintenance requirements, after severe storm events all features shall be inspected to clear debris and repair damaged structures or features. Records of the maintenance carried out shall be prepared by the operator of the Care Home and their Term Maintenance Contractor.

GEOCELLULAR SYSTEM (SOAKAWAY)		
Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months then annually
	Remove debris from the catchment surface (where it	Monthly

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	may cause risks to performance)	
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial Actions	Repair/rehabilitate inlets, outlets, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build up and remove if necessary	Every 5 years or as required

PERMEABLE PAVEMENTS		
Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over the whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required- once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance	As required

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	or a hazard to users, and replace lost jointing material	
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after inspection
	Inspect for evidence of poor operation and/or weed growth – if required take remedial action	Three monthly 48h after large storms in first six months
	Inspect slit accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

DRAINAGE EXCEEDANCE ROUTES

Following the development of the site the proposed levels will be used to direct water away from the development and to local internal areas. These exceedance flows are for all events of 1:100 year with 40% climate change. An exceedance route plan is contained in **Appendix E**.

FOUL WATER DISCHARGE

The foul water is to be collected from around the building and discharged into the existing sewer in Ascot Road. It is proposed that the existing connection into FMH8404 is retained and re-used. A survey will be required to access the suitability of this re-use. If this is deemed unsuitable a new pipe connection will be installed as indicated on the GA drawing within **Appendix C**.

REQUIREMENTS OF PLANNING CONDITION 9

Planning Condition 9 states the following:

‘No building on any phase (or within an agreed implementation schedule) of the development hereby permitted shall be occupied until a Verification Report, pertaining to the surface water drainage system and prepared by a suitably competent person, has been submitted to and approved by the Local Planning Authority. The Report shall demonstrate that the drainage system constructed is consistent with that which was approved. The Report shall contain information and evidence (including photographs) of details and locations of inlets, outlets and control structures; landscape plans; full as built drawings; information pertinent to the installation of those items identified on the critical drainage assets drawing; and the submission of an operation and maintenance manual for the sustainable drainage scheme as constructed.’

ARC Engineers have been appointed to complete the validation report prior to the occupation of the site. Following the results of the BRE365 soakaway tests the previous scheme with shallow soakaways is no longer suitable for the site due to poor infiltration rates. The proposals have been amended to a Deep Bore Soakaways.

As part of the Validation report the following information will be included to verify the design:

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1. **Falling head tests to KCC Specification within the boreholes to be used.** The information provided following additional site investigation is valid for the design of the deep bore soakaways. However to reduce the risk of localised poor permeability within the ground we have requested tests be completed on the actual boreholes to be used. 2 contingency boreholes are also to be completed on site if we have a poor result and require alternative or additional boreholes to soakaway. As built details contained within the Validation report will detail any amendments within the proposed scope established in this report

APPENDIX A – FLOOD RISK ASSESSMENT

herrington

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Flood Risk Assessment, Drainage
Strategy for the Proposed Development
at Ascot Arms, Central Avenue,
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Project Reference: 3085

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Client: Avery Healthcare Group Limited
Flood Risk Assessment and Drainage Strategy
for the Proposed Development at Ascot Arms,
Central Avenue, Gravesend, Kent

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date
1	0	First issue of report sent by email.	26 March 2021
2	1	Drainage strategy added. Second issue of report sent by email.	31 March 2021
3	2	Updated for new legislation. Third issue of report sent by email.	25 January 2022

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Document Verification

Issue	Revision	Date:	26 March 2021	
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1 Background and Scope of Appraisal

Herrington Consulting has been commissioned to prepare a Flood Risk Assessment (FRA) and drainage strategy for the proposed development at **Ascot Arms, Central Avenue, Gravesend, Kent, DA12 5AW**.

This report has been undertaken to meet the objectives of the National Planning Policy Framework (2021) and the accompanying National Planning Practice Guidance Suite (March 2014) that has been published by the Department for Communities and Local Government. The *Flood Risk and Coastal Change* planning practice guidance included within the Suite has been referenced throughout this report as this represents the most contemporary technical guidance on preparing FRAs.

In addition to national planning policy requirements, this report also assesses the proposals for development against the Pol03 (Flood and surface water management) criteria, as outlined by the BREEAM UK New Construction for Non-domestic Buildings 2018 technical guidance.

The aims of this report are to establish the following:

- whether a proposed development is likely to be affected by current or future flooding from any source
- whether the development will increase flood risk elsewhere within the floodplain
- whether the measures proposed to address these effects and risks are appropriate
- whether the site will pass the second element of the Exception Test (where applicable)
- whether the site will obtain the relevant BREEAM credits

To ensure that due account is taken of industry best practice, this report has been carried out in line with the CIRIA Report C624 'Development and flood risk - guidance for the construction industry'.

2 Development Description and Planning Context

2.1 Site Location and Existing Development

The site is located at OS coordinates 564926, 172413, off Central Avenue in Gravesend, Kent. The site covers an area of approximately ~4000m² and currently comprises a permanently closed public house with car park and garden. The location of the site in relation to the surrounding area is shown in Figure 2.1.

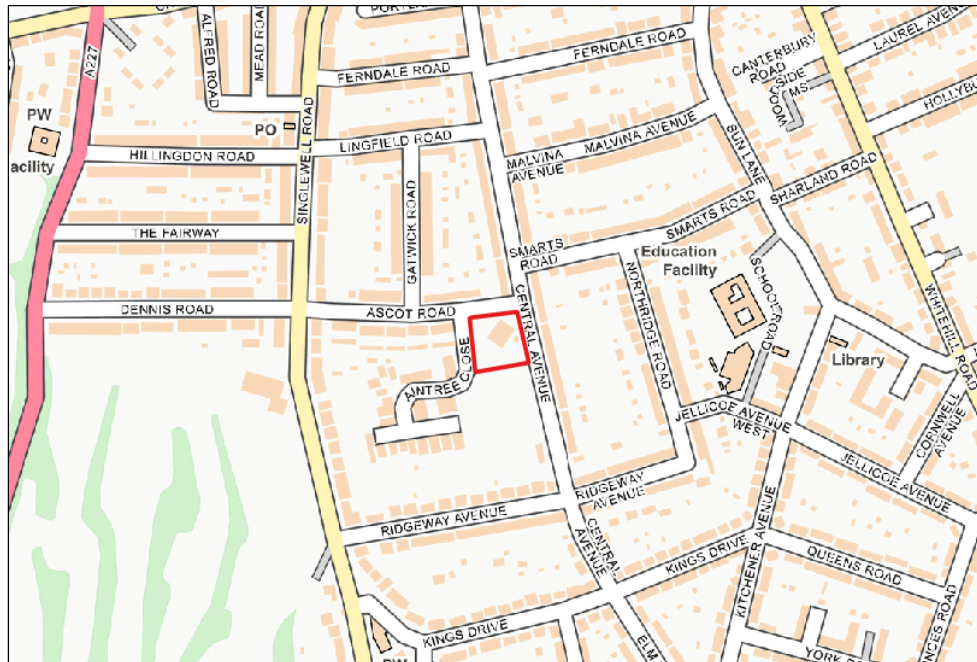


Figure 2.1 – Location map (contains Ordnance Survey data © Crown copyright and database right 2022).

The site plan included in Appendix A.2 of this report provides more detail in relation to the site location and layout.

2.2 Proposed Development

The proposals for the development site comprise demolition of the existing public house and the construction of a new care home with associated car parking and garden (Figure 2.2).



Figure 2.2 – Proposed site layout.

Further Drawings of the proposed scheme are included in Appendix A.2 of this report.

2.3 Site Specific Information

Information from a wide range of sources has been referenced to appraise the true risk of flooding at this location. This section summarises the additional information collected as part of this FRA.

Information on localised flooding contained within the SWMP – A Surface Water Management Plan (SWMP) is a study to understand the risk of flooding that arises from local surface water flooding, which is defined by the Flood and Water Management Act 2010 as flooding from surface runoff, groundwater, and ordinary watercourses. Such a document has been prepared for the Thameside area for Kent County Council (2013) and has therefore been referenced as part of this site-specific FRA.

Information provided by Southern Water (SW) – SW has provided the results of an asset location search for the site. The response is included in Appendix A.3.

Site specific topographic surveys – A topographic survey has been undertaken for the site and a copy of this is included in Appendix A.2. From the survey, it can be seen that the level of the site varies between 35.30m and 37.49m Above Ordnance Datum Newlyn (AODN). Ground levels gradually reduce from south to north.

Geology – Reference to the British Geological Survey (BGS) map shows that the underlying bedrock geology in the location of the subject site is undifferentiated Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (chalk). There are no overlying superficial deposits.

Historic flooding – Information provided the Thameside SWMP shows that there was one record of sewer flooding on Central Avenue in 2006 but that no properties were affected. No other information on historic flooding in this area has been provided or revealed through desktop searches.

3 Policy and Guidance

3.1 National Planning Policy Framework (NPPF)

Sequential Test and Exception Test

The first stage in the Flood Risk Assessment process is the application of the Sequential Test. The general starting point is the Environment Agency's (EA) 'Flood Maps for Planning'. These maps and the associated information are intended for guidance and cannot provide details for individual properties. They do not consider existing flood defences, alternative flooding mechanisms and climate change. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country.

Reference to the EA's 'Flood Map for Planning' (Figure 3.1) shows that the site is located entirely within Flood Zone 1, and therefore is located in the lowest possible flood risk zone. Consequently, the requirements of the Sequential Test will be met and in accordance with the NPPF, there is no requirement to apply Exception Test. Notwithstanding this, the following sections provide an appraisal of risk of flooding at the site from all sources.

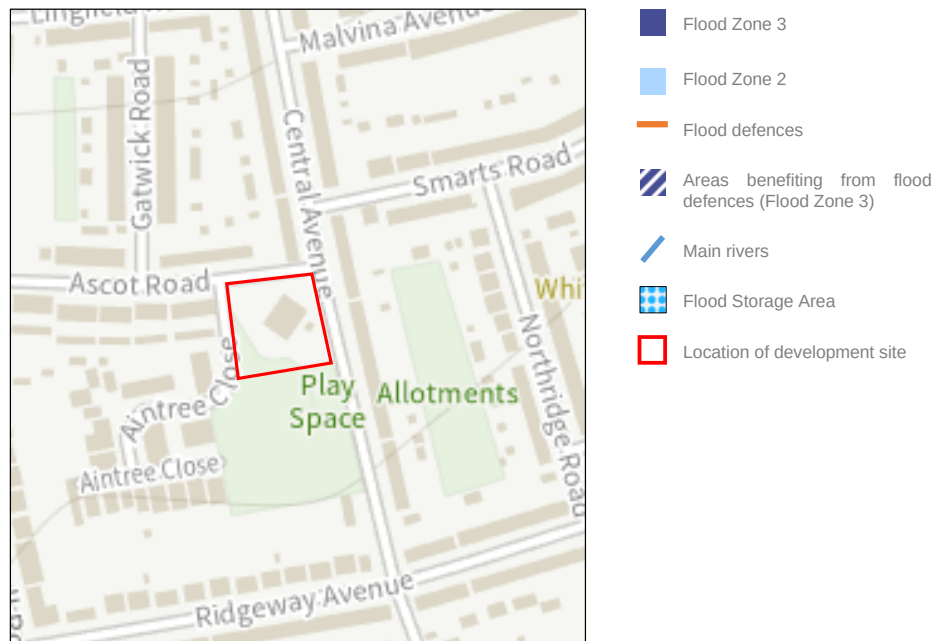


Figure 3.1 – EA's 'Flood Map for Planning' (© Environment Agency).

Climate Change

When assessing the risk of flooding from all sources, the NPPF requires that the impacts of climate change be taken into consideration. For a residential development, a design lifetime of 100 years is assumed. For non-residential development, the lifetime of the development is dependent on the uses of the development. The proposed development is for a residential care home and therefore a 100 year planning horizon has been assumed.

The EA provides guidance on sensitivity allowances for climatic changes into the future. The recommended allowances for increases in peak rainfall intensity are applicable nationally. There is a range of values provided which correspond with the central and upper end percentiles (the 50th and 90th percentile respectively) over three time epochs. The recommended allowances are shown in Table 3.1 below.

Allowance Category (applicable nationwide)	Total potential change anticipated for each epoch		
	2015 to 2039	2040 to 2069	2070 to 2115
Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 3.1 – Recommended peak rainfall intensity allowance for small and urban catchments (1961 to 1990 baseline).

Guidance published by the EA states that the 'Upper End' allowance should be considered when designing a sustainable drainage system. As the development subject to this FRA has a planning horizon of 100 years, a 40% increase in peak rainfall intensity has been used in the calculations in the outline surface water management strategy (refer to Section 5). In addition, the EA requires the 'Central' allowance of 20% increase in peak rainfall intensity should be considered when assessing the risk of flooding from surface water at this site. This is appraised further in Section 4.1.

3.2 Non-Statutory Technical Standards for Sustainable Drainage Systems (NTSS)

The Flood and Water Management Act 2010 National Standards (Schedule 3 – paragraph 5) for design, construction, maintenance and operation of Sustainable Drainage Systems (SuDS), came into effect from 6 April 2015 and provide additional detail and requirements not initially covered by the NPPF and are Non-statutory Technical Standards for SuDS (NTSS).

The NTSS specify criteria to ensure sustainable drainage is included within developments of 10 dwellings or more; or equivalent non-residential, or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010). It is, however, recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

In this instance, the proposed development is for the construction of a new care home with a total floor space greater than 1000m². As a result, the proposals are classified as 'major' development and therefore, the NTSS will apply. Reference to the NTSS has therefore been made throughout the following sections of this report to ensure the principles of sustainable drainage are considered.

3.3 BREEAM New Construction 2018 (UK)

The 2018 BREEAM New Construction Non-Domestic Buildings (UK) technical guidance specifies the method of assessing the environmental performance and impact of a new building. The assessment criteria are based on a scoring system for a wide range of different environmental criteria, one of which consist of 'Pollution' and sub-category 'Pol 03 – Flood and surface water management'. The focus of this report is to assess the proposed development with respect to the Pol 03 criteria.

The Pol03 criteria is split into three parts, each of which has a maximum number of credits available:

- Flood resilience - two credits
- Surface water run-off - two credits
- Minimising watercourse pollution - one credit

A **prerequisite** for achieving the Pol03 criteria is that *'an appropriate consultant is appointed to carry out and demonstrate the development's compliance with all criteria'*. Details of the consultants responsible for the preparation of this report are specified in Appendix A.1 of this report.

Flood Resilience – 2 credits available

Reference to the BREEAM criteria for the credits under *Flood resilience* identifies that 2 credits are available for sites at 'Low flood risk', to be demonstrated as follows;

- *2: A site-specific flood risk assessment (FRA) confirms the development is in a flood zone that is defined as having a low annual probability of flooding. The FRA takes all current and future sources of flooding into consideration.*

Reference to Figure 3.1 identifies that the site is located within Flood Zone 1, which is defined as having a low annual probability of flooding. However, to assess the risk of flooding to the development from all current and future sources of flooding, a Flood Risk Assessment has been undertaken for the subject site (refer to Section 4).

Surface Water Management – 2 credits available

Reference to the BREEAM criteria for the credits under *Surface water run-off* identifies that 2 credits are available as follows;

One Credit – Rate

- *6: For brownfield sites, drainage measures are specified so that the peak rate of run-off from the site to the watercourses (natural or municipal) shows a 30% improvement for the developed site compared with the pre-developed site. This should comply at the 1-year and 100-year return period events.*
- *7: For Greenfield sites, drainage measures are specified so that the peak rate of run-off from the site to the watercourses (natural or municipal) is no greater for the developed site*

than it was for the pre-development site. This should comply at the 1-year and 100-year return period events.

- *8: Relevant maintenance agreements for the ownership, long term operation and maintenance of all specified Sustainable Drainage Systems (SuDS) are in place.*
- *9: Calculations include an allowance for climate change. This should be made in accordance with current best practice planning guidance (see Definitions).*

One Credit – Volume

- *10: Flooding of property will not occur in the event of local drainage system failure (caused either by extreme rainfall or a lack of maintenance); AND*

EITHER

- *11: Drainage design measures are specified so that the post-development run-off volume, over the development lifetime, is no greater than it would have been prior to the assessed site's development. This must be for the 100-year 6-hour event, including an allowance for climate change (see criterion 15)*
- *12: Any additional predicted volume of run-off for this event is prevented from leaving the site by using infiltration or other SuDS techniques.*

OR (only where criteria 11 and 12 cannot be achieved):

- *13: Justification from the appropriate consultant indicating why the above criteria cannot be achieved, i.e., where infiltration or other SuDS techniques are not technically viable options.*
- *14: Drainage design measures are specified so that the post-development peak rate of run-off is reduced to the limiting discharge. The limiting discharge is defined as the highest flow rate from the following options:*
 - *14.a: The pre-development one-year peak flow rate*
 - *14.b: The mean annual flow rate (Qbar)*
 - *14.c: 2L/s/ha.*

(For the one-year peak flow rate, the one-year return period event criterion applies.)

- *15: Relevant maintenance agreements for the ownership, long term operation and maintenance of all specified SuDS are in place.*
- *16: For either option, above calculations must include an allowance for climate change; this should be made in accordance with current best practice planning guidance.*

The only **prerequisite** for all credits relating to the Surface Water run-off criteria is;

Surface water run-off design solutions must be bespoke, i.e., they must take account of the specific site requirements and natural or man-made environment of and surrounding

the site. The priority levels detailed in the Methodology must be followed, with justification given by the appropriate consultant where water is allowed to leave the site.

To assess the scheme under the criteria for *surface water management*, a bespoke Surface Water Management Strategy has been prepared for the subject site (refer to Section 5).

Minimising Watercourse Pollution – 1 credit available

Reference to the BREEAM criteria for the credits under *Minimising Watercourse Pollution* identifies that 1 credit is available as follows;

- *17: There is no discharge from the developed site for rainfall up to 5 mm (confirmed by the appropriate consultant).*
- *18: Areas with a low risk source of watercourse pollution, an appropriate level of pollution prevention treatment is provided, using appropriate SuDS techniques.*
- *19: Areas with a high risk of contamination or spillage of substances, such as petrol and oil, have separators (or an equivalent system) are installed in surface water drainage systems.*
- *20: Chemical or liquid gas storage areas have a means of containment fitted to the site drainage system (i.e., shut-off valves). This is to prevent the escape of chemicals to natural watercourses in the event of a spillage or bunding failure.*
- *21: All water pollution prevention systems have been designed and installed in accordance with the recommendations of documents such as the SuDS manual² and other relevant industry best practice. They must be bespoke solutions taking account of the specific site requirements and natural or man-made environment of and surrounding the site.*
- *22: A comprehensive and up to date drainage plan of the site will be made available for the building or site occupiers.*
- *23: Relevant maintenance agreements for the ownership, long term operation and maintenance of all specified SuDS must be in place.*
- *24: All external storage and delivery areas are designed and detailed in accordance with the current best practice planning guidance.*

To assess the scheme under the criteria for *minimising watercourse pollution*, a bespoke Surface Water Management Strategy and Foul Water Management Strategy has been prepared for the subject site (refer to Section 5 and 6).

4 Flood Risk Assessment

4.1 Flooding from Land (Overland Flow and Surface Water Runoff)

Overland flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This mechanism of flooding can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for runoff is restricted by terrain or man-made obstructions.

The EA's 'Flood Risk from Surface Water' map (Figure 4.1) shows that the majority of the site would remain unaffected during an extreme pluvial flood event with a return period of 1 in 100 years ('medium' probability event). Only a small area in the north west corner of the site is shown to flood during this scenario, and when the extent of flooding is compared to the location of the proposed care home, it can be seen the care home is predicted to remain dry. Furthermore, SuDS are proposed to be included in the scheme which will be designed to manage runoff from the site under during the design rainfall event. Consequently, it is considered that the risk of flooding from this source is *low*.

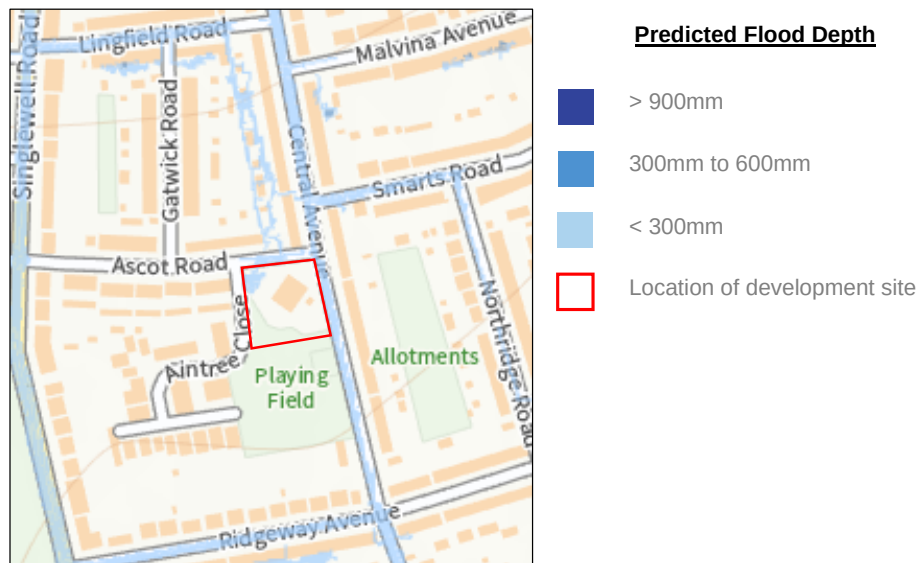


Figure 4.1 – EA's 'Flood Risk from Surface Water' map for a 'medium probability' event with a return period of up to 1 in 100 years. (© Environment Agency).

Climate Change

The EA's 'medium probability' mapping (Figure 4.1) does not include an allowance for climate change as required by the NPPF (Section 3.1). Nevertheless, the maps do include an event that exceeds the 1 in 100 year event, which can be considered to reflect the increase in rainfall intensity due to climate change. Reference to the EA's 'low probability' flood map (Figure 4.2) identifies that during the 'low' likelihood of occurrence event (i.e., an event with a return period up to 1 in 1000 years) surface water is shown to flow across the site in a northerly direction.

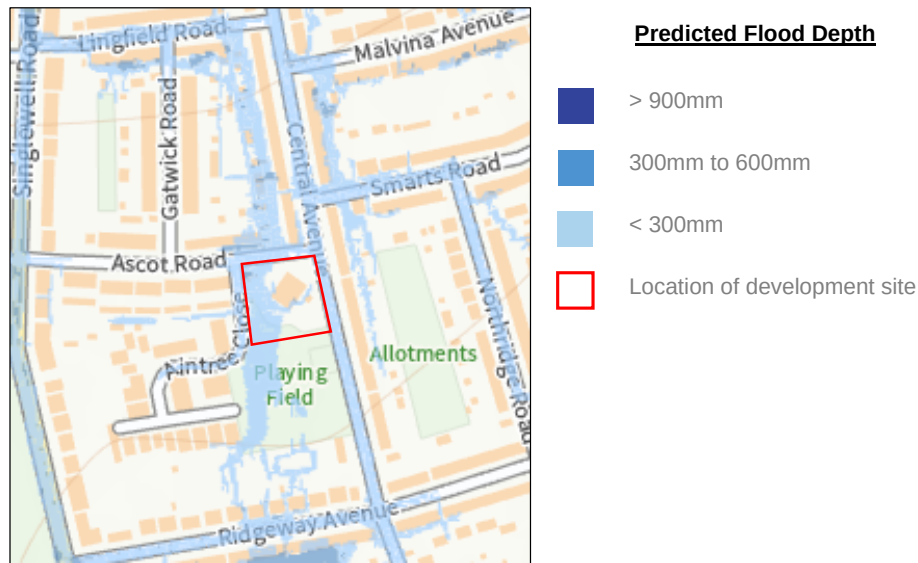


Figure 4.2 – EA's 'Flood Risk from Surface Water' map for a 'low probability' event with a return period of up to 1 in 1000 years. (© Environment Agency).

The EA's mapping is a national dataset which can provide an indication of the surface water flood risk to an area. However, there are limitations with the EA's national mapping as it does not accurately take into account the influence of local drainage systems, the geology or features such as boundary treatments (e.g., fences, walls etc.). Firstly, the local bedrock geology in this area is chalk, which is typically permeable and as such, much of the rain falling on the green space to the south of the site has the potential to infiltrate, rather than flow across the surface.

In addition, the topographic survey identifies that there are local drainage systems within the surrounding highways that would capture rain falling within the highways and surrounding area. If the drainage system was to become overwhelmed, the highways are bound by upstand kerbs and therefore it is likely that floodwater would be contained within the highway and flow towards the lower land to the north. The EA's mapping also does not take into account the local surface features which could obstruct overland flows (i.e. gardens and fences) and in this case could prevent the free flow of surface water towards the site from the south. Any floodwater that were to flow from Ridgeway Avenue (south of the site) would more likely be contained within the gardens of the adjacent properties, rather than be directed towards the site.

Taking into account all the information above, it is considered that the EA's mapping overestimates the risk of flooding to the proposed development from this source. Consequently, considering that the proposed development will also include SuDS designed to manage rain falling on site during the design rainfall event, it is concluded that the risk of flooding from surface water remains to be low, even when climate change is considered.

4.2 Flooding from Rivers, Ordinary or Man-Made Watercourses

Inspection of OS mapping identifies that the nearest watercourse to the site is the River Thames (main river), which is located 2km to the north of the site. However, the site is not located within an

area identified by the EA's 'Flood Map for Planning' as being at risk of flooding from a main river. Consequently, it is considered that the risk of flooding from this source is *low*.

Climate Change

Although the River Thames is tidal and would have an increase in water level over time due to climate change, the site is located on land which is elevated significantly higher than any anticipated rise in water levels as a result of climate change. In addition, the Thames Tidal Defences will be upgraded in line with the expected rise in water levels in accordance with the EA's Thames Estuary 2100 Plan. As a result, the risk of flooding to the site will remain *low*.

4.3 Flooding from the Sea

The site is located a significant distance inland and is elevated well above predicted extreme tide levels. Consequently, the risk of flooding from this source is considered to be *low*.

Climate Change

Sea levels are projected to rise by around 1m by the end of the century, however, given that the site is elevated significantly above the expected extreme sea level, this increase will not be of direct concern. Consequently, the risk of flooding from the sea will remain *low*, even when the effects of climate change are considered.

4.4 Flooding from 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).

Groundwater flooding is most likely to occur in low-lying areas that are underlain by permeable rock (aquifers). The underlying geology in this area is undifferentiated Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation, which is typically permeable and can be associated with groundwater emergence. However, the detailed mapping on groundwater emergence provided as part of the Defra Groundwater Flood Scoping Study (May 2004) shows that in this case the site itself is not located within an area where groundwater emergence is predicted and that no groundwater flooding events were recorded during the very wet periods of 2000/01 or 2002/03.

Furthermore, aerial height data shows that land levels fall away from the site towards the north and therefore, if the groundwater level were to rise in this area it would be in the lower lying areas to the north that above ground flooding would more likely occur, not at the site. There are also no historic records of the site being subject to groundwater flooding. It is therefore considered that the risk of flooding from this source is *low*.

Climate Change

Even in the event that groundwater levels were to increase (i.e., in response to increased rainfall), it would still be on the lower lying areas to the north of the site that groundwater emergence would

be more likely to occur, not at the site. Consequently, even when the impact of climate change is considered, the risk of flooding from groundwater emergence will remain *low*.

4.5 Flooding from Sewers

In urban areas, rainwater is typically drained into surface water sewers or sewers containing both surface and wastewater known as “combined sewers”. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked, or has inadequate capacity; this will continue until the water drains away.

Inspection of the asset location mapping provided by SW (Figure 4.3) identifies that there are foul and surface water public sewers within Central Avenue to the east of the site, as well as further foul sewers to the west of the site.

In the unlikely event that floodwater was to exit the sewer network (i.e., following an extreme rainfall event, or due to a blockage) land levels fall in a northerly direction and therefore any flooding is expected to occur within the highway where it would flow away from the site. This is supported by historic records contained within the SWMP which shows that no properties were affected by flooding during the historic incident recorded to have occurred within Central Avenue. The risk of flooding from this source is therefore considered to be *low*.

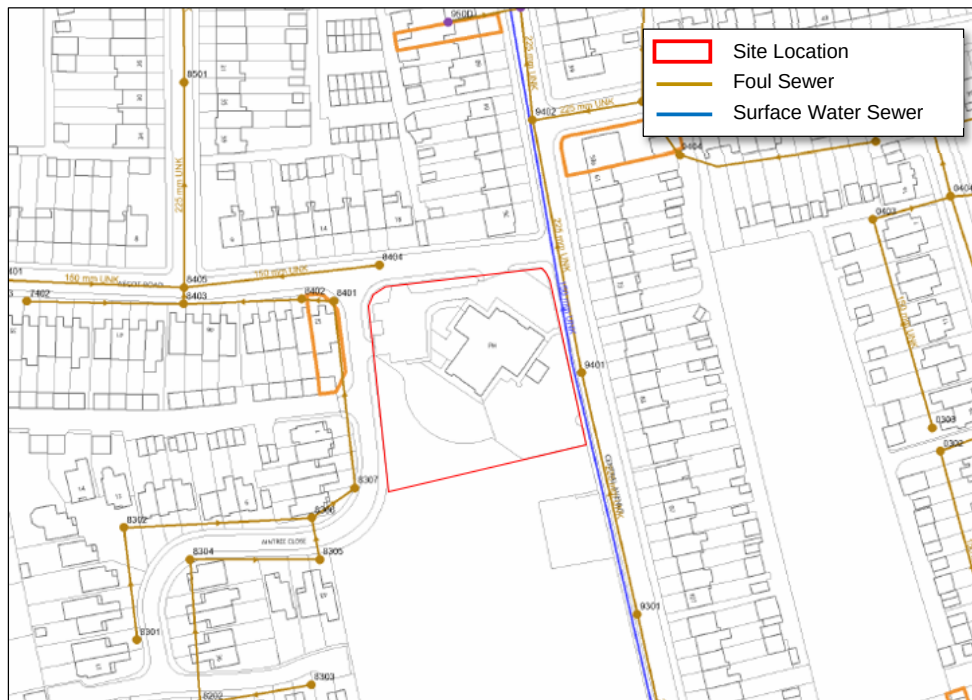


Figure 4.3 - Asset location mapping provided by SW (a full scale copy can be found in Appendix A.3).

Climate Change

An increase in peak rainfall intensity as a result of climate change is likely to increase the volume of surface water discharged into the sewer. This could increase the risk of the sewer network flooding as the capacity is reached. However, when the topography at the site and surrounding area is considered in relation to the sewer network, it is evident that water exiting the sewer system is unlikely to be directed towards the development site. Therefore, when the effects of climate change are taken into account and the risk of flooding from sewers is considered to remain *low*.

4.6 Flooding from Reservoirs, Canals and Other Artificial Sources

Non-natural or artificial sources of flooding can include reservoirs, canals, and lakes, where water is retained above natural ground level. In addition, operational and redundant industrial processes including; mining, quarrying, sand and gravel extraction, may also increase the depth of floodwater in areas adjacent to these features.

The potential effects of flood risk management infrastructure and other structures also needs to be considered. For example; reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

Inspection of the OS mapping for the area shows that there are no artificial sources of flooding near to the site. In addition, the EA's 'Flood Risk from Reservoirs' map shows that the site is not within an area considered to be at risk of flooding from reservoirs. Therefore, the risk of flooding from this source is considered to be *low*.

Climate Change

With a predicted increase in peak rainfall intensity, it is likely that reservoirs will reach their maximum storage capacity more frequently, thus increasing the requirements for maintenance and likelihood for failure. Notwithstanding this, there are no reservoirs or artificial sources nearby and therefore the risk of flooding from this source remains *low*.

4.7 Summary of Flood Risk

A summary of the overall risk of flooding from each source is provided in Table 4.1 below.

Source of flooding	Level of flood risk	Appraisal method applied at the initial flood risk assessment stage
Overland flow	Low	EA's 'Flood Risk from Surface Water' map, site-specific topographic survey, aerial height data and OS mapping
Rivers, ordinary and man-made watercourses	Low	OS mapping, the EA's 'Flood Map for Planning' and aerial height data
Sea	Low	OS mapping and the EA's 'Flood Map for Planning'
Groundwater	Low	Defra Groundwater Flood Scoping Study, BGS Geology of Britain Map, site-specific topographic survey and historic records within the SWMP
Sewers	Low	Aerial height data, OS mapping, site-specific topographic survey, and asset location data provided by SW
Artificial sources	Low	OS mapping and EA's 'Flood Risk from Reservoirs' map

Table 4.1 – Summary of flood sources and risks.

From Table 4.1 above, this FRA has concluded that there is a low probability of flooding at the subject site from all sources. This has been shown to remain the case even when taking into consideration the impacts of climate change over the lifetime of the development.

The development is therefore considered to be safe in terms of flood risk and will **meet the requirements of the NPPF in relation to the risk of flooding to the development.**

Furthermore, the site is shown to be located in an area that is **at 'Low flood risk' as specified by the BREEAM technical guidance.** Consequently, it is concluded that the proposed development is compliant with the *Flood Resilience* criteria and **two credits can be awarded under Pol 03 – Flood resilience.**

5 Surface Water Management Strategy

5.1 Background and Policy

The general requirement for all new development is to ensure that the runoff from the development is managed sustainably and that the drainage solution does not increase the risk of flooding at the site, or within the surrounding area. In the case of brownfield sites, drainage proposals are typically measured against the existing performance of the site, although it is preferable (where practicable) to provide runoff characteristics that are similar to greenfield behaviour.

The Non-statutory Technical Standards for SuDS (NTSS) specify criteria to ensure sustainable drainage is included within development classified as 'major development' as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010. It is, however, recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

The proposed development is for the construction of a 62-bed care home with floor space with is greater than 1000m². As a result, the proposals are classified as 'major' development and therefore, the NTSS will apply. Reference to the NTSS has therefore been made throughout the following sections of this report to ensure the principles of sustainable drainage are considered.

Gravesham Borough Council also require SuDS to be incorporated into developments to mitigate increases in surface water flows that result from climate change. Local policy prioritises the use of SuDS over more conventional drainage systems and requires developers to use drainage systems which mimic the natural environment. In addition, as the development is classified as major the LLFA's current SuDS guidance will also apply.

5.2 Surface Water Management Overview

The main characteristics of the site that have the potential to influence surface water drainage are summarised in Table 5.1 below.

Site Characteristic	Value
Total area of site	0.4 ha
Impermeable area (existing)	~ 525 m ²
Impermeable area (proposed)	Roof area = 1275 m ² Hardstanding = 930 m ² Total = 2205 m²
Current site condition	Brownfield site
Infiltration coefficient	~0.1 m/hr (assumed based on underlying geology and typical soil conditions)
Current surface water discharge method	Assumed to drain to public sewer system
Is there a watercourse within close proximity to site?	No

Table 5.1 – Site characteristics affecting rainfall runoff.

Reference to the tables above show the proposed development will increase the percentage of impermeable area within the boundaries of the site. Consequently, this will increase the rate and volume of surface water runoff discharged from the site. It will therefore be necessary to provide mitigation measures to ensure that the rate of runoff discharged from the site is not increased as a result of the proposed development.

Furthermore, the potential use of SuDS within the proposed development will be considered to assess the practicality of better replicating greenfield behaviour, in accordance with Local Planning Policy, and S3 and S5 of the NTSS.

5.3 Existing Drainage

The existing site drainage has not been surveyed and it is currently unknown how the existing buildings at the site drain exactly. Nonetheless, the topographic survey for the site does show several manholes and existing drains which connect to a private drainage network located north west of the existing building. It is therefore considered likely that these drains connect into the public sewer system near existing Manhole MH8404.

Greenfield and brownfield runoff rates for the site have been calculated using point data obtained from the Flood Estimation Handbook (FEH) Web Service. Calculations for the greenfield and brownfield runoff rates have also been undertaken using data from the Flood Studies Report (FSR). A summary of these calculations is provided in Table 5.2 (below).

Return Period (years)	Peak Runoff			
	Greenfield Runoff Rates FEH (l/s/ha)	Greenfield Runoff Rates FSR (l/s/ha)	Brownfield Runoff Rates FEH (l/s)	Brownfield Runoff Rates FSR (l/s)
2	0.35	2.0	10.6	14.0
10	0.64	3.7	22.4	20.9
30	0.95	5.5	30.2	26.5
100	1.3	7.3	39.4	34.4
100 + 40%	NA	NA	55.2	48.2

Table 5.2 – Summary of peak runoff rates for the existing site.

Sewer mapping for the site and surrounding area is shown in Figure 4.3, which delineates the existing sewer network to the north west of the site, into which runoff from the existing building is assumed to drain. Further investigation may be required as part of the detailed design to confirm the exact layout of the existing underground drainage network and the potential to utilise any pre-existing connections to the public sewer system.

5.4 Opportunities to Discharge Surface Water Runoff

Part H of the Building Regulations summarises a hierarchy of options for discharging surface water runoff from developments. The preferred option is to **infiltrate** water into the ground, as this deals with the water at source and serves to replenish groundwater. If this option is not viable, the next option of preference is for the runoff to be discharged into a **watercourse**. Only if neither of these options are possible, the water should be discharged into the **public sewer** system.

The following opportunities for managing the surface water runoff discharged from the development site are listed in order of preference:

Water Re-Use - Water re-use systems can rarely manage 100% of the surface water runoff discharged from a development, as this requires the yield from the building and hardstanding area to balance perfectly with the demand from the proposed development. Consequently, whilst rainwater recycling systems can be considered for inclusion within the scheme, an alternative solution for attenuating storm water will still be required.

Infiltration – Infiltration rates into the bedrock chalk deposits beneath the site may be sufficiently permeable to support the use of infiltration SuDS. At this stage in the development process an assumed infiltration rate of 0.1m/hr has been applied, based on the assumed ground conditions. The BREEAM criteria require evidence of infiltration rates, and as a result it will be necessary to undertake investigations to confirm this assumed infiltration rate. These investigations should be carried out in accordance with BRE365.

Discharge to Watercourses – There are no watercourses within close proximity to the site in which to permit a direct connection and consequently, there is no opportunity to discharge surface water to an existing watercourse.

Discharge to Public Sewer System – As an alternative solution is available, it is unlikely that the existing connection to the sewer system will need to be used. Notwithstanding this, if necessary, a connection to the public sewer system could be used as a last resort in the event that infiltration rates are found to be lower than assumed.

5.5 Constraints and Further Considerations

The key constraints that are relevant to this development are listed below:

- There is limited open space to incorporate SuDS that require significant areas of land such as wetlands.
- Infiltration SuDS should not be constructed through contaminated material.
- Any infiltration features which result in a concentrated discharge of surface water runoff to the ground, such as soakaways, should not typically be located within 5.0 metres of any existing, or proposed (adjacent) buildings.
- A minimum of a 1.0 metre unsaturated zone shall be maintained between the base of any infiltration SuDS and the maximum seasonal water table.
- To ensure compliance with BREEAM Criteria, infiltration SuDS intended to drain highway or parking areas will require additional safeguards, such as seal-trapped gullies and oil/grit separators.
- The site is located in an outer groundwater source protection zone. Whilst this will not prohibit the use of soakaways or infiltration SuDS, additional measures may be required to protect groundwater resources beneath the site and include measures such as covered downpipes.
- The use of borehole soakaways is always subject to written agreement from the EA.
- In the event infiltration SuDS are deemed unviable and an alternative solution is required, if additional surface water runoff is to be discharged into the public sewer system, or if a new connection is required, it will be necessary to gain consent for this connection from the sewerage undertaker.

5.6 Proposed Surface Water Management Strategy (SWMS)

The drainage strategy set out below discusses each of the different elements of the proposed scheme, along with the results of a hydraulic drainage model that has been constructed to demonstrate how the overall objectives can be achieved. This does not represent a detailed surface water drainage design; it is simply an assessment to demonstrate that the objectives and requirements of the NPPF can be met at the planning stage.

Lined Permeable Surfacing System

The access road and parking can be made permeable and designed to provide storage for stormwater. The permeable surfacing can be laid on top of a layer of porous, open graded aggregate, which in this case is estimated to be around 300mm deep. The base of the permeable surfacing will be wrapped in an impermeable geotextile liner, to prevent soakage into the underlying ground. The outlet from the permeable surfacing can be connected via a manhole to a soakaway located beneath the parking area. The permeable surfacing system is summarised in Table 5.3 (below).

Parameter	Value (1:100yr+40%cc event)
SuDS	Permeable Paving
Area draining to permeable paving	930 m ²
Area of permeable paving	~ 530 m ²
Sub-base depth	300 mm
Infiltration	Not Permitted
Flow control device	None (unrestricted outlet)

Table 5.3 – Summary of the permeable paving surfacing system.

Geo-Cellular Crate Soakaway

Surface water runoff from across the site can be drained to a geo-cellular crate soakaway. This soakaway can be constructed from geo-cellular storage crates and wrapped in a permeable geotextile liner. A summary of the geo-cellular soakaway is provided in Table 5.4 (below).

Parameter	Value (1:100yr+40%cc event)
SuDS	Geo-Cellular Soakaway
Total area draining directly to soakaway	2205 m ²
Infiltration	0.1m/hr (assumed)
Depth of soakaway	2.5 m
Area of soakaway	190 m ²
Porosity of crates	95 %
Flow control device	None (all runoff drains via infiltration)
Volume stored during design rainfall event	454 m ³
Critical storm duration	10080 minutes

Table 5.4 – Summary of geo-cellular soakaway.

5.7 Indicative Drainage Layout Plan

Figure 5.1 below is an indicative drainage layout plan delineating how the proposed SuDS can be incorporated into the scheme proposals.

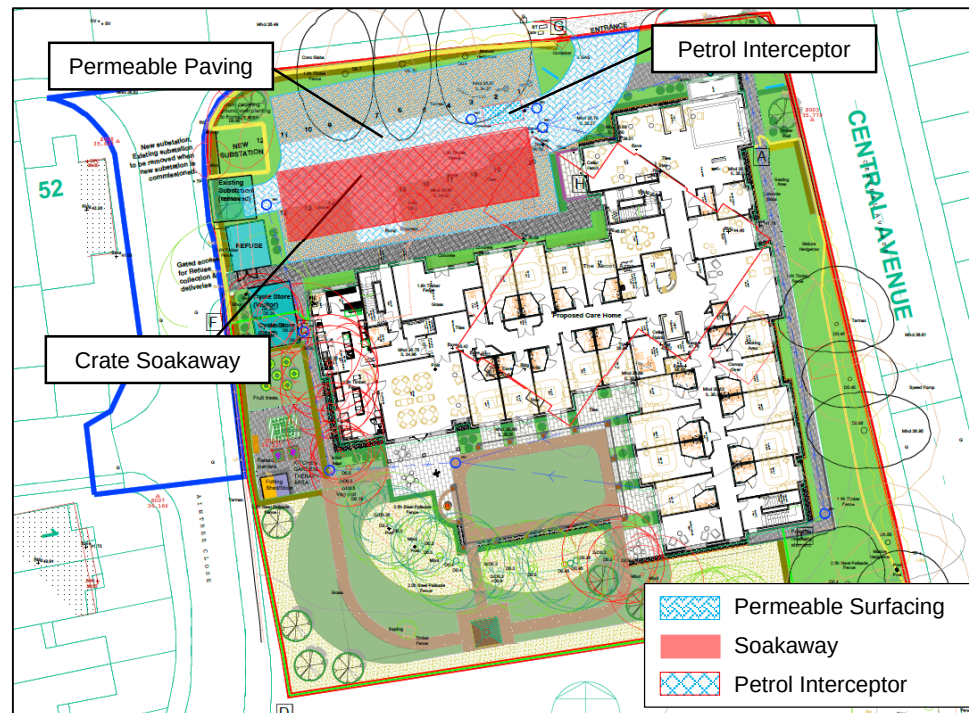


Figure 5.1 - Indicative drainage layout plan showing the proposed location of SuDS.

A full-scale copy of this layout is located in Appendix A.5 of this report.

5.8 Hydraulic Drainage Model

A hydraulic drainage model for the proposed drainage system has been constructed in Causeway Flow+ to test the surface water network during a range of storm events, with durations ranging between 15 minutes and 6 hours. The rainfall parameters used within the model were derived from FEH point data and the FEH methodology. The results of this model confirm that the proposed soakaway and permeable surfacing system will provide sufficient capacity to store runoff and allow it to infiltrate into the ground, based on the assumed infiltration rate.

Additional calculations have been undertaken based on FSR rainfall data, as required by the BREEAM assessment. These calculations also confirm that the proposed permeable paving and soakaway have sufficient capacity to accommodate runoff from the design rainfall event. For these calculations, a soil class of 3 and m5-60 value of 21mm have been used.

5.9 Pollution Control

As all runoff is discharged to the ground the 5mm event will not be discharged offsite. The proposed SuDS will also ensure that a level of treatment is provided for all runoff draining from the roofs with 2 levels provided for runoff draining from the hard surfacing.

By lining the permeable surfacing system and ensuring all runoff from the hard surfacing areas drains through the petrol interceptor, it is also possible to retain any spills within the permeable surfacing sub-base thus reducing the chance that contaminants could reach the underlying aquifer.

Calculations have been undertaken using the basic index methodology outlined within CIRIA C753 (The SuDS Manual) and confirm that the pollution produced by the hard surfacing is likely to be mitigated using a tanked permeable surfacing system providing it is constructed in accordance with best practice guidance. A summary of these calculations is provided in Table 5.5 (below).

Treatment for tanked permeable surfacing	Total Suspended Solids	Metals	Hydrocarbons
Indices produced by the development	0.5	0.4	0.4
Treatment indices from SuDS	0.7	0.6	0.7
Treatment Sum (remainder)	-0.2	-0.2	-0.3
Summary	Treatment Sufficient	Treatment Sufficient	Treatment Sufficient

Table 5.5 – Summary of Basic Index Method Calculations.

5.10 Alternative Drainage Strategy

In the event infiltration rates are lower than assumed it will be necessary to drain the site to the public sewer system. This approach would require the replacement of the soakaway with a geo-cellular storage tank with an outlet connecting into the existing sewer system. whilst this does present a viable solution for draining the development site it will impact on the potential credits that can be obtained under BREEAM Pol 3 as the volume reduction credit would no longer be obtainable. This report assumes this solution will not be required.

5.11 Management and Maintenance

For any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime.

The key requirements of any management regime are routine inspection and maintenance. When the development is taken forward to the detailed design stage, an 'owner's manual' will need to be prepared. This should include:

- A description of the drainage scheme.
- A location plan showing all of the SuDS and equipment, such as flow control devices etc.
- Maintenance requirements for each element, including any manufacturer-specific requirements.
- An explanation of the consequences of not carrying out the specified maintenance.
- Details of who will be responsible for the ongoing maintenance of the drainage system.

For the SuDS recommended by this assessment, the most obvious maintenance tasks will be cleaning the permeable paving system and de-silting the soakaway. For the latter, it is important to ensure that the design must recognise the need for this operation and thus incorporate silt traps and easy access for emptying. Typical maintenance tables for the proposed SuDS have been included within Appendix A.6. of this report.

For developments such as this that rely to some extent on the ongoing inspection and maintenance of SuDS, it will be necessary to ensure that measures are in place to maintain the system for the lifetime of the development. One option would be to task the management company responsible for maintaining the rest of the site with the inspection and maintenance of the SuDS.

5.12 Sensitivity Testing and Residual Risk

It is necessary to ensure that the drainage proposals will not increase the risk of flooding if the drainage system becomes blocked, or if a rainfall event which exceeds the design rainfall event occurs.

In this case if the soakaway was to become surcharged and overflow, water would simply backflow through the pipe network into the sub-base of the permeable surfacing system, which is located above the soakaway. As a result, the majority of the runoff will remain stored within the permeable surfacing sub-base, rather than result in flooding of the site or surrounding area. Nonetheless, if water does exit the drainage system and flow across the site, floodwater would likely flow into the adjacent highway, where it would be intercepted by the existing highway drainage infrastructure.

To remove the possibility of runoff discharging offsite in an uncontrolled way during an exceedance or blockage event, it is possible to incorporate an overflow control within the permeable surfacing system. This could direct excess water into the public sewer system rather than allowing the sub-base surcharge and overflow.

Based on the analysis above it is therefore concluded that with the inclusion of the proposed SuDS discussed within this strategy, the development will not increase the risk of flooding off-site.

6 Foul Water Management Strategy

6.1 Background

The objective of the foul water management strategy is to ensure a viable solution is available for managing foul waste discharged from the proposed development site at Central Avenue, Gravesend.

In general, there are two methods for draining effluent from developments. The preferred solution is a connection to the public sewer network, which is controlled by the sewerage undertaker (SW). Nonetheless, if there are no sewers near to the development site, as is commonly the case in rural locations, then the use of package treatment systems or cesspits is permitted.

The Environment Agency's "Binding Rules" control the use of package treatment systems. For example, if the site boundary is located within 30m from an existing sewer (plus an additional 30 meters for every proposed unit), the EA will require the development to connect to the public sewer system.

In this case there is a foul sewer located to the north west of the site and as a result, the use of package treatment systems is likely to be restricted. A connection to the public sewer system will therefore present the most viable solution for draining foul effluent from the development.

6.2 Proposed Connection

A connection to the public foul sewer will be required to facilitate the drainage of foul wastewater from the development. The most suitable location for this connection is likely to be the sewer which starts at the public house and drains across the road to an existing manhole MH8404.

6.3 Estimated Foul Discharge Rate

Peak flows of foul waste from the proposed development have been estimated using the 4,000l/day methodology outlined in Part B of the Design and Construction Guidance for foul and surface water sewers (DCG 2020). For the 62 proposed units, it is estimated that the peak discharge of foul effluent from the site will be approximately 2.87 l/s.

6.4 Capacity Checks and Pre-Development Enquiry

Before any foul waste from the development can be discharged to the public sewer system, it will be necessary to confirm that there is sufficient capacity within the existing sewers to accommodate any increase in foul effluent discharged by the development.

At this stage in the development design process a pre-development enquiry to confirm the available capacity within the sewer has not been undertaken. In the absence of this information a worst-case scenario has been considered, i.e., whereby it is assumed that there will not be capacity available within the existing public sewer network. If capacity is not available, then it may be necessary to

upgrade the existing sewers in this location. The following sections of this report discuss this option in more detail.

6.5 Water Industry Act

The Water Industry Act (WIA) 1991 provides developers with a mechanism for connecting to the public sewerage infrastructure.

To requisition a new connection to the public sewer system, along with any necessary upgrades to existing sewers, it will be necessary to undertake a Section 98 or 106 application. Costs may apply for any upgrades to the existing sewer system needed to accommodate the development and a connection charge will need to be paid for the new sewer connection. To reduce the risk of sewer flooding, it is recommended that a Grampian condition requiring any necessary sewer upgrades to be completed prior to construction is placed on planning consent. If this approach is taken the LPA should take into consideration the timescales required for the sewerage undertaker to make any necessary upgrades.

Following the award of planning permission, a full detailed design will be required as part of the Section 98 or 106 application. It is acknowledged that although upgrade works may be needed, under the WIA there is an automatic right for the developer to connect to the public sewer system via the Section Agreements and consequently, a solution for draining foul effluent from the proposed development will be available.

6.6 Foul Water Drainage Strategy Summary

It is envisaged that foul wastewater from the proposed development will be discharged to the existing public foul sewer located near MH8404. The peak rate at which foul waste is discharged from the site will be approximately 2.87l/s. Any increase in the capacity of the existing public sewer system which may be needed to facilitate the development, must be completed prior to construction. Figure 6.1 (below) is an indicative plan showing how foul wastewater could potentially be discharged from the site into the public sewer system.



Figure 6.1 – Indicative foul drainage layout plan.

In conclusion, based on the analysis above, it is evident that a viable solution for managing foul wastewater produced by the development is available.

7 Conclusions and Recommendations

This report has been prepared to appraise the proposed development at Central Avenue, Gravesend in Kent against the criteria specified within the NPPF, NTSS and BREAM New Construction Non-Domestic 2018 (UK) Pol03 – Flood and surface water management.

The objective of this report is to ensure that the proposals for development are acceptable in terms of flood risk, and that surface water runoff from the development is managed appropriately to prevent any increase in flood risk as a result of the development proposals. Opportunities for discharging foul water from the development have also been considered as part of this assessment.

The **Flood Risk Assessment** undertaken demonstrates that the risk of flooding from all sources to the development site is low. This remains the case even when taking the impacts of climate change into consideration. It is therefore concluded that the occupants of the development would remain safe for the lifetime of the development. The proposals are therefore considered to be acceptable with respect to the requirements of the NPPF (2021) in relation to flood risk. **Two credits can therefore be awarded under the BREAM Pol03 criteria for Flood resilience.**

Further to this, the surface water drainage strategy demonstrates that **two credits can be awarded under the BREAM Pol03 criteria for Surface Water Management, and an additional credit awarded for minimising watercourse pollution.**

BREEM Pol03 Criteria	Available Credits	Credits Awarded
Flood Resilience	2	2
Surface Water Management	2	2
Minimising Watercourse Pollution	1	1

Table 7.1 – Summary of available criteria under Pol03 – flood and surface water management and the credits awarded from this assessment.

8 Appendices

Appendix A.1 – Consultants Details

Appendix A.2 – Drawings

Appendix A.3 – Southern Water Asset Location Data

Appendix A.4 – Surface Water Management Calculations

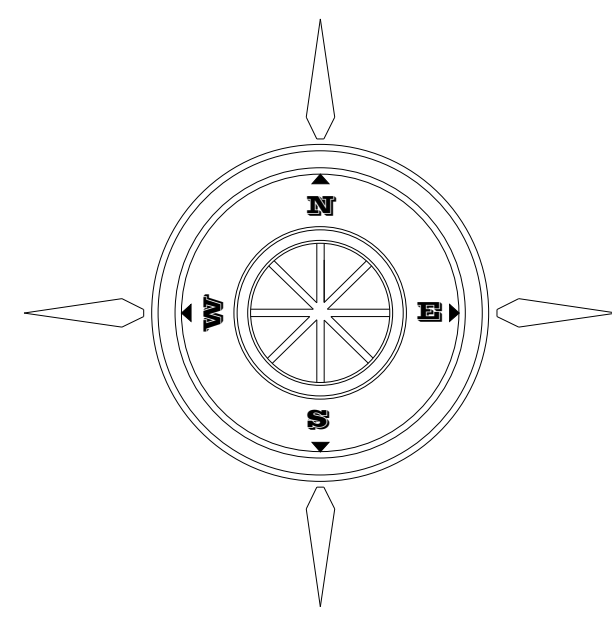
Appendix A.5 – Indicative Drainage Layout

Appendix A.6 – Maintenance Schedules

Appendix A.1 – Consultants Details

Parameter	Values
Company Name	Herrington Consulting Ltd
Company Address	Kent Office Unit 6 and 7 Barham Business Park Elham Valley Road Canterbury CT4 6DQ
Engineer	Simon Maiden-Brooks
Qualifications	BSc (Hons) MSc C.Eng C.WEM MCIWEM
Value of Consultants PI Cover	£2m

Appendix A.2 – Drawings



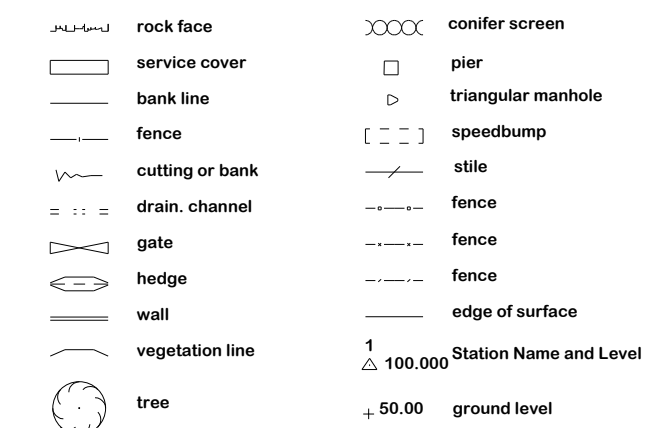
The survey has been related to national grid, established using an active commercial RTK network

A true O.S coordinate has been established on station S002 using OSGB36 and OSGM02. The survey has then been related to another OSGB36 point to create a true O.S bearing (north)

No scale factor has been applied to the survey meaning only 1 point on the survey is a true O.S coordinate.

Station	Easting	Northing	Levels	Description
S001	564902.509	172446.562	35.403	Pk Nail
S002	564941.363	172460.281	35.163	Pk Nail
S003	564949.205	172429.869	35.778	Pk Nail
S004	564961.081	172377.744	37.663	Pk Nail
S005	564920.996	172364.867	36.976	Peg
S006	564993.288	172395.715	36.227	Peg
S007	564884.492	172390.970	36.166	Hill
S008	564877.342	172427.708	35.647	Hill

Legend



SC	step rock	BDS	barbed
ME	manhole	ER	earth rod
VP	vent pipe	GP	gate post
RE	reading eye	ELEC	electric
ST	telephone	FP	fence post
WD	wood post	FLP	flag post
TV	television	SH	shrub
SV	water valve	SP	back inlet gully
GAS	gas	TH	threshold
FT	fire hydrant	C	gully
WV	water valve	BB	bone hole
IS	inspection cover	IS	iron hole
LS	letter box	PS	flag post
RS	road sign	LP	lamp hole
SS	bus stop	POST	post
LP	lamp post	PS	post
EP	electric pole	TL	traffic light
TP	telegraph post	ST	stop tap



Rev	Date	Description

This plan has been surveyed to the scale shown
Caution should be exercised when enlargements are made

Some services may not have been surveyed due to parked vehicles or other obstructions

All dimensions have been measured or estimated from ground level, unless stated otherwise.

Tree species shown should be treated with caution and expert identification is advised.

Drainage information has been taken from a surface inspection and should be treated as approximate only.

All critical dimensions should be confirmed onsite prior to the commencement of any works.

PROJECT
Ascot Arms P.H
Central Ave, Gravesend

CLIENT
Willowbrook Healthcare Developments LTD
TOPOGRAPHICAL SURVEY
Drg. No. MA20-4274-1 Date:- March 2020
Drawn by A.T.G Scale:- 1:200(A0)
Cad Scale 1:1

C L B Surveys Ltd
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Telephone: 01283 331788
Email: admin@clbsurveys.co.uk
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Notes

Do not scale, use figured dimensions only.

All dimensions to be verified on site prior to the commencement of any work or the production of any shop drawing. All discrepancies to be reported to the Architect.

This drawing is to be read in conjunction with all related Architect's and Engineer's drawings and any other relevant information.

This drawing is copyright © of TDC Architects Ltd.

REV	DATE	REVISION	INITIALS	CHECK
A	06.01.21	Clients comments applied.	GF	SEL
B	22.01.2021	Proposal revised following review with Design South East Panel.	RMJB	SEL
C	12.02.2021	Proposal revised following clients comments	RMJB	SEL
D	22.02.2021	Site Plan updated to reflect Landscaping plan.	GF	SEL
E	12.03.2021	New proposed Substation added and existing to be replaced.	GF	SEL

DRAWING STATUS

AS-RECORDED	☐
AS-BUILT	☐
FOR-CONSTRUCTION	☐
FOR COORDINATION	☐
FOR PLANNING	☒
FOR DISCUSSION	☐

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Project
Proposed Care Home,
Central Avenue, Gravesend

Drawing Title
Proposed Site Plan

Scale
1:200 @ A1

Date
Dec 2020

Drawn by
RMJB

Checked by
SEL

Job No.
A202043

Drawing No.
AL(9)901

Rev.
E

Appendix A.3 – Southern Water Asset Location Data

8 Appendices

Appendix A.1 – Consultants Details

Appendix A.2 – Drawings

Appendix A.3 – Southern Water Asset Location Data

Appendix A.4 – Surface Water Management Calculations

Appendix A.5 – Indicative Drainage Layout

Appendix A.6 – Maintenance Schedules

Appendix A.4 – Surface Water Management Calculations

Design Settings

Rainfall Methodology	FEH-13	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	✓
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	4.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Existing	0.053	4.00	10.000	1000	0.000	0.000	1.000
Existing 1	0.000		10.000	1000	0.000	10.000	2.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
Existing	Existing	Existing 1	10.000	0.600	9.000	8.000	1.000	10.0	1000	4.02	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
Existing	10.602	8327.0	9.6	0.000	1.000	0.053	0.0	25	1.858

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Existing	10.000	10.0	1000	Circular	10.000	9.000	0.000	10.000	8.000	1.000

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
Existing	Existing	1000	Manhole	Adoptable	Existing 1	1000	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Existing	0.000	0.000	10.000	1.000	1000				
						0	Existing	9.000	1000
Existing 1	0.000	10.000	10.000	2.000	1000		1	Existing	8.000
						1	Existing	8.000	1000

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m ³ /ha)	20.0
Summer CV	1.000	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	1.000	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440	10080
----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	------	-------

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
10	0	0	0
30	0	0	0

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	0	0	0
100	40	0	0

Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.028	0.028	10.6	0.0515	0.0000	OK
15 minute summer	Existing 1	10	8.027	0.027	10.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	10.6	1.889	0.001	0.0561	4.1

Results for 10 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.040	0.040	22.4	0.0730	0.0000	OK
15 minute summer	Existing 1	10	8.037	0.037	22.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	22.4	2.344	0.003	0.0956	8.7

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.046	0.046	30.2	0.0840	0.0000	OK
15 minute summer	Existing 1	10	8.043	0.043	30.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	30.2	2.535	0.004	0.1192	11.8

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.052	0.052	39.3	0.0952	0.0000	OK
15 minute summer	Existing 1	10	8.049	0.049	39.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	39.4	2.714	0.005	0.1451	15.3

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.061	0.061	55.1	0.1129	0.0000	OK
15 minute summer	Existing 1	10	8.057	0.057	55.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	55.2	2.976	0.007	0.1854	21.5

Design Settings

Rainfall Methodology	FEH-13	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	✓
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	4.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.064	4.00	10.000	1200	-8.461	-11.284	1.500
2			10.000	1200	-8.621	12.637	1.691
3			10.000	1200	18.069	13.317	3.000
4	0.093	4.00	10.000	1200	17.783	18.173	1.500
5	0.064	4.00	10.000	1200	45.159	-11.669	1.500
6			10.000	1200	43.976	14.981	1.754
Virtual Manhole			10.000	1200	19.722	11.154	3.100

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	5	6	26.676	0.600	8.500	8.246	0.254	105.0	300	4.29	50.0
1.001	6	3	25.960	0.600	8.246	8.000	0.246	105.5	300	4.57	50.0
3.000	4	3	4.864	0.600	8.500	8.300	0.200	24.3	300	4.03	50.0
2.001	2	3	26.699	0.600	8.309	7.000	1.309	20.4	300	4.41	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.534	108.4	11.6	1.200	1.454	0.064	0.0	66	1.011
1.001	1.530	108.1	11.6	1.454	1.700	0.064	0.0	66	1.008
3.000	3.201	226.2	16.8	1.200	1.400	0.093	0.0	55	1.899
2.001	3.496	247.1	11.6	1.391	2.700	0.064	0.0	44	1.811

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.000	1	2	23.922	0.600	8.500	8.309	0.191	125.2	300	4.28	50.0
1.002	3	Virtual Manhole	2.722	0.600	7.000	6.900	0.100	27.2	300	4.59	50.0

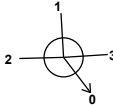
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
2.000	1.403	99.2	11.6	1.200	1.391	0.064	0.0	69	0.948
1.002	3.025	213.8	39.9	2.700	2.800	0.221	0.0	88	2.338

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	26.676	105.0	300	Circular	10.000	8.500	1.200	10.000	8.246	1.454
1.001	25.960	105.5	300	Circular	10.000	8.246	1.454	10.000	8.000	1.700
3.000	4.864	24.3	300	Circular	10.000	8.500	1.200	10.000	8.300	1.400
2.001	26.699	20.4	300	Circular	10.000	8.309	1.391	10.000	7.000	2.700
2.000	23.922	125.2	300	Circular	10.000	8.500	1.200	10.000	8.309	1.391
1.002	2.722	27.2	300	Circular	10.000	7.000	2.700	10.000	6.900	2.800

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	5	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
1.001	6	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
3.000	4	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
2.001	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
2.000	1	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
1.002	3	1200	Manhole	Adoptable	Virtual Manhole	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
1	-8.461	-11.284	10.000	1.500	1200					
						0	2.000	8.500	300	
2	-8.621	12.637	10.000	1.691	1200		1	2.000	8.309	300
						0	2.001	8.309	300	
3	18.069	13.317	10.000	3.000	1200		1	3.000	8.300	300
						2	2.001	7.000	300	
						3	1.001	8.000	300	
						0	1.002	7.000	300	
4	17.783	18.173	10.000	1.500	1200		0	3.000	8.500	300
5	45.159	-11.669	10.000	1.500	1200		0	1.000	8.500	300
						0	1.000	8.246	300	
6	43.976	14.981	10.000	1.754	1200		1	1.000	8.246	300
						0	1.001	8.246	300	
Virtual Manhole	19.722	11.154	10.000	3.100	1200		1	1.002	6.900	300

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Detailed	Additional Storage (m ³ /ha)	20.0
Summer CV	1.000	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	1.000	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440	10080
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Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	10	0	100	0	10	0
10	0	10	0	100	40	10	0
30	0	10	0				

Node Virtual Manhole Online Weir Control

Flap Valve	x	Invert Level (m)	9.999	Discharge Coefficient	0.590
Replaces Downstream Link	✓	Width (m)	1.000		

Node 3 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	7.000
Side Inf Coefficient (m/hr)	0.10000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	190.0	0.0	2.500	190.0	0.0	2.501	0.0	0.0

Node 4 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	23.000	Depth (m)	
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.700	Length (m)	23.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)		Slope (1:X)	1000.0		

Results for 2 year +10% A Critical Storm Duration. Lowest mass balance: 99.05%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	8.582	0.082	14.1	0.1690	0.0000	OK
15 minute summer	2	9	8.360	0.051	14.1	0.0579	0.0000	OK
10080 minute winter	3	8760	7.717	0.717	0.7	130.3108	0.0000	SURCHARGED
15 minute summer	4	10	8.569	0.069	20.5	0.1723	0.0000	OK
15 minute summer	5	10	8.575	0.075	14.1	0.1545	0.0000	OK
15 minute summer	6	10	8.321	0.075	14.1	0.0844	0.0000	OK
10080 minute winter	Virtual Manhole	9960	7.718	0.818	0.1	0.9246	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	2.000	2	14.1	1.231	0.142	0.2776	
15 minute summer	2	2.001	3	14.5	2.208	0.059	0.2872	
10080 minute winter	3	1.002	Virtual Manhole	0.1	0.013	0.000	0.1917	
10080 minute winter	3	Infiltration		0.0				
15 minute summer	4	3.000	3	20.5	1.834	0.091	0.0544	
15 minute summer	5	1.000	6	14.1	1.049	0.130	0.3639	
15 minute summer	6	1.001	3	13.9	1.045	0.128	0.3453	
10080 minute winter	Virtual Manhole	Weir		0.0				0.0

Results for 10 year +10% A Critical Storm Duration. Lowest mass balance: 99.05%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	8.621	0.121	29.8	0.2514	0.0000	OK
15 minute summer	2	10	8.379	0.070	29.8	0.0790	0.0000	OK
10080 minute summer	3	10140	8.148	1.148	1.4	208.4931	0.0000	SURCHARGED
15 minute summer	4	10	8.607	0.107	43.3	0.2662	0.0000	OK
15 minute summer	5	10	8.611	0.111	29.8	0.2304	0.0000	OK
15 minute summer	6	10	8.358	0.112	29.8	0.1267	0.0000	OK
10080 minute summer	Virtual Manhole	10200	8.148	1.248	0.1	1.4114	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	2.000	2	29.8	1.542	0.300	0.4685	
15 minute summer	2	2.001	3	29.8	2.343	0.121	0.7301	
10080 minute summer	3	1.002	Virtual Manhole	0.1	0.013	0.000	0.1917	
10080 minute summer	3	Infiltration		0.0				
15 minute summer	4	3.000	3	43.3	2.184	0.191	0.0966	
15 minute summer	5	1.000	6	29.8	1.256	0.275	0.6368	
15 minute summer	6	1.001	3	29.7	1.283	0.275	0.6013	
10080 minute summer	Virtual Manhole	Weir		0.0				0.0

Results for 30 year +10% A Critical Storm Duration. Lowest mass balance: 99.05%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	8.643	0.143	40.2	0.2967	0.0000	OK
10080 minute winter	2	10200	8.503	0.194	0.3	0.2195	0.0000	OK
10080 minute winter	3	9840	8.503	1.503	1.1	273.0044	0.0000	SURCHARGED
15 minute summer	4	10	8.628	0.128	58.4	0.3203	0.0000	OK
15 minute summer	5	10	8.632	0.132	40.2	0.2736	0.0000	OK
10080 minute winter	6	9780	8.503	0.257	0.3	0.2908	0.0000	OK
10080 minute winter	Virtual Manhole	9960	8.503	1.603	0.0	1.8131	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	2.000	2	40.2	1.671	0.405	0.5814	
10080 minute winter	2	2.001	3	0.3	0.189	0.001	1.5836	
10080 minute winter	3	1.002	Virtual Manhole	0.0	0.013	0.000	0.1917	
10080 minute winter	3	Infiltration		0.0				
15 minute summer	4	3.000	3	58.4	2.331	0.258	0.1221	
15 minute summer	5	1.000	6	40.2	1.344	0.371	0.8009	
10080 minute winter	6	1.001	3	0.3	0.340	0.003	1.7482	
10080 minute winter	Virtual Manhole	Weir		0.0				0.0

Results for 100 year +10% A Critical Storm Duration. Lowest mass balance: 99.05%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute summer	1	10260	8.905	0.405	0.6	0.8376	0.0000	SURCHARGED
10080 minute summer	2	10260	8.904	0.595	0.6	0.6735	0.0000	SURCHARGED
10080 minute summer	3	10200	8.904	1.904	2.1	345.8694	0.0000	SURCHARGED
10080 minute summer	4	10140	8.904	0.404	0.9	1.0087	0.0000	SURCHARGED
10080 minute summer	5	10320	8.904	0.404	0.6	0.8372	0.0000	SURCHARGED
10080 minute summer	6	10320	8.904	0.658	0.6	0.7447	0.0000	SURCHARGED
10080 minute summer	Virtual Manhole	10200	8.904	2.004	0.1	2.2668	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute summer	1	2.000	2	0.6	0.484	0.006	1.6846	
10080 minute summer	2	2.001	3	0.6	0.430	0.002	1.8801	
10080 minute summer	3	1.002	Virtual Manhole	0.1	0.016	0.000	0.1917	
10080 minute summer	3	Infiltration		0.0				
10080 minute summer	4	3.000	3	0.9	0.773	0.004	0.3425	
10080 minute summer	5	1.000	6	0.6	0.414	0.006	1.8785	
10080 minute summer	6	1.001	3	0.6	0.413	0.006	1.8281	
10080 minute summer	Virtual Manhole	Weir		0.0				0.0

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.05%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute summer	1	10140	9.733	1.233	0.9	2.5517	0.0000	FLOOD RISK
10080 minute summer	2	10140	9.733	1.424	0.9	1.6101	0.0000	FLOOD RISK
10080 minute summer	3	10140	9.733	2.733	4.8	454.4310	0.0000	FLOOD RISK
10080 minute summer	4	10260	9.733	1.233	2.3	6.4487	0.0000	FLOOD RISK
10080 minute summer	5	10140	9.733	1.233	0.9	2.5514	0.0000	FLOOD RISK
10080 minute summer	6	10140	9.733	1.487	0.9	1.6814	0.0000	FLOOD RISK
10080 minute summer	Virtual Manhole	10140	9.733	2.833	0.1	3.2039	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute summer	1	2.000	2	0.9	0.547	0.009	1.6846	
10080 minute summer	2	2.001	3	0.9	0.430	0.004	1.8801	
10080 minute summer	3	1.002	Virtual Manhole	0.1	0.016	0.000	0.1917	
10080 minute summer	3	Infiltration		0.0				
10080 minute summer	4	3.000	3	3.6	0.857	0.016	0.3425	
10080 minute summer	5	1.000	6	0.9	0.468	0.008	1.8785	
10080 minute summer	6	1.001	3	0.9	0.433	0.008	1.8281	
10080 minute summer	Virtual Manhole	Weir		0.0				0.0

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	21.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.370	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Existing	0.053	4.00	10.000	1000	0.000	0.000	1.000
Existing 1	0.000		10.000	1000	0.000	10.000	2.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
Existing	Existing	Existing 1	10.000	0.600	9.000	8.000	1.000	10.0	1000	4.02	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
Existing	10.602	8327.0	9.6	0.000	1.000	0.053	0.0	25	1.858

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Existing	10.000	10.0	1000	Circular	10.000	9.000	0.000	10.000	8.000	1.000

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
Existing	Existing	1000	Manhole	Adoptable	Existing 1	1000	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Existing	0.000	0.000	10.000	1.000	1000				
						0	Existing	9.000	1000
Existing 1	0.000	10.000	10.000	2.000	1000		1	Existing	8.000
						1	Existing	8.000	1000

Simulation Settings

Rainfall Methodology	FSR	Summer CV	1.000	Drain Down Time (mins)	240
FSR Region	England and Wales	Winter CV	1.000	Additional Storage (m³/ha)	20.0
M5-60 (mm)	21.000	Analysis Speed	Normal	Check Discharge Rate(s)	x
Ratio-R	0.370	Skip Steady State	x	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440	10080
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Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
10	0	0	0
30	0	0	0

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	0	0	0
100	40	0	0

Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.032	0.032	14.0	0.0585	0.0000	OK
15 minute summer	Existing 1	10	8.030	0.030	14.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	14.0	2.052	0.002	0.0682	5.5

Results for 10 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.038	0.038	20.9	0.0706	0.0000	OK
15 minute summer	Existing 1	10	8.036	0.036	20.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	20.9	2.300	0.003	0.0909	8.1

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.043	0.043	26.5	0.0791	0.0000	OK
15 minute summer	Existing 1	10	8.041	0.041	26.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	26.5	2.452	0.003	0.1081	10.3

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.048	0.048	34.4	0.0892	0.0000	OK
15 minute summer	Existing 1	10	8.046	0.046	34.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	34.4	2.618	0.004	0.1313	13.4

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	10	9.057	0.057	48.1	0.1053	0.0000	OK
15 minute summer	Existing 1	10	8.054	0.054	48.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	Existing	Existing 1	48.2	2.866	0.006	0.1681	18.7

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	21.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.370	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.064	4.00	10.000	1200	-8.461	-11.284	1.500
2			10.000	1200	-8.621	12.637	1.691
3			10.000	1200	18.069	13.317	3.000
4	0.093	4.00	10.000	1200	17.783	18.173	1.500
5	0.064	4.00	10.000	1200	45.159	-11.669	1.500
6			10.000	1200	43.976	14.981	1.754
Virtual Manhole			10.000	1200	19.722	11.154	3.100

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	5	6	26.676	0.600	8.500	8.246	0.254	105.0	300	4.29	50.0
1.001	6	3	25.960	0.600	8.246	8.000	0.246	105.5	300	4.57	50.0
3.000	4	3	4.864	0.600	8.500	8.300	0.200	24.3	300	4.03	50.0
2.001	2	3	26.699	0.600	8.309	7.000	1.309	20.4	300	4.41	50.0
2.000	1	2	23.922	0.600	8.500	8.309	0.191	125.2	300	4.28	50.0
1.002	3	Virtual Manhole	2.722	0.600	7.000	6.900	0.100	27.2	300	4.59	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.534	108.4	11.6	1.200	1.454	0.064	0.0	66	1.011
1.001	1.530	108.1	11.6	1.454	1.700	0.064	0.0	66	1.008
3.000	3.201	226.2	16.8	1.200	1.400	0.093	0.0	55	1.899
2.001	3.496	247.1	11.6	1.391	2.700	0.064	0.0	44	1.811
2.000	1.403	99.2	11.6	1.200	1.391	0.064	0.0	69	0.948
1.002	3.025	213.8	39.9	2.700	2.800	0.221	0.0	88	2.338

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	26.676	105.0	300	Circular	10.000	8.500	1.200	10.000	8.246	1.454
1.001	25.960	105.5	300	Circular	10.000	8.246	1.454	10.000	8.000	1.700
3.000	4.864	24.3	300	Circular	10.000	8.500	1.200	10.000	8.300	1.400
2.001	26.699	20.4	300	Circular	10.000	8.309	1.391	10.000	7.000	2.700

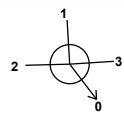
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	5	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
1.001	6	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
3.000	4	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
2.001	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
2.000	23.922	125.2	300	Circular	10.000	8.500	1.200	10.000	8.309	1.391
1.002	2.722	27.2	300	Circular	10.000	7.000	2.700	10.000	6.900	2.800

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
2.000	1	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
1.002	3	1200	Manhole	Adoptable	Virtual Manhole	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
1	-8.461	-11.284	10.000	1.500	1200				
						0	2.000	8.500	300
2	-8.621	12.637	10.000	1.691	1200		1	2.000	8.309
						0	2.001	8.309	300
3	18.069	13.317	10.000	3.000	1200		1	3.000	8.300
						2	2.001	7.000	300
						3	1.001	8.000	300
						0	1.002	7.000	300
4	17.783	18.173	10.000	1.500	1200				
						0	3.000	8.500	300
5	45.159	-11.669	10.000	1.500	1200				
						0	1.000	8.500	300

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
6	43.976	14.981	10.000	1.754	1200	1 	1	1.000	8.246	300
						0 	0	1.001	8.246	300
Virtual Manhole	19.722	11.154	10.000	3.100	1200	1 	1	1.002	6.900	300

Simulation Settings

Rainfall Methodology	FSR	Summer CV	1.000	Drain Down Time (mins)	240
FSR Region	England and Wales	Winter CV	1.000	Additional Storage (m ³ /ha)	20.0
M5-60 (mm)	21.000	Analysis Speed	Detailed	Check Discharge Rate(s)	x
Ratio-R	0.370	Skip Steady State	x	Check Discharge Volume	x

Storm Durations

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	10	0	100	0	10	0
10	0	10	0	100	40	10	0
30	0	10	0				

Node Virtual Manhole Online Weir Control

Flap Valve	x	Invert Level (m)	9.999	Discharge Coefficient	0.590
Replaces Downstream Link	✓	Width (m)	1.000		

Node 3 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	7.000
Side Inf Coefficient (m/hr)	0.10000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	190.0	0.0	2.500	190.0	0.0	2.501	0.0	0.0

Node 4 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	23.000	Depth (m)
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.700	Length (m)	23.000	Inf Depth (m)
Safety Factor	2.0	Time to half empty (mins)	0	Slope (1:X)	1000.0	

Results for 2 year +10% A Critical Storm Duration. Lowest mass balance: 99.06%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	8.594	0.094	18.5	0.1949	0.0000	OK
15 minute summer	2	9	8.366	0.057	18.5	0.0647	0.0000	OK
10080 minute winter	3	9660	7.916	0.916	0.7	166.4120	0.0000	SURCHARGED
15 minute summer	4	10	8.581	0.081	26.9	0.2011	0.0000	OK
15 minute summer	5	10	8.586	0.086	18.5	0.1779	0.0000	OK
15 minute summer	6	10	8.332	0.086	18.5	0.0975	0.0000	OK
10080 minute winter	Virtual Manhole	9600	7.916	1.016	0.1	1.1494	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	2.000	2	18.5	1.346	0.186	0.3332	
15 minute summer	2	2.001	3	18.8	2.275	0.076	0.4117	
10080 minute winter	3	1.002	Virtual Manhole	-0.1	0.013	0.000	0.1917	
10080 minute winter	3	Infiltration		0.0				
15 minute summer	4	3.000	3	26.9	1.958	0.119	0.0669	
15 minute summer	5	1.000	6	18.5	1.121	0.171	0.4449	
15 minute summer	6	1.001	3	18.3	1.128	0.170	0.4220	
10080 minute winter	Virtual Manhole	Weir		0.0				0.0

Results for 10 year +10% A Critical Storm Duration. Lowest mass balance: 99.06%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	8.617	0.117	27.7	0.2417	0.0000	OK
15 minute summer	2	9	8.377	0.068	27.7	0.0764	0.0000	OK
10080 minute summer	3	10200	8.231	1.231	1.4	223.5916	0.0000	SURCHARGED
15 minute summer	4	10	8.602	0.102	40.3	0.2550	0.0000	OK
15 minute summer	5	10	8.607	0.107	27.7	0.2213	0.0000	OK
15 minute summer	6	10	8.354	0.108	27.7	0.1216	0.0000	OK
10080 minute summer	Virtual Manhole	10260	8.231	1.331	0.1	1.5055	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	2.000	2	27.7	1.512	0.279	0.4445	
15 minute summer	2	2.001	3	27.7	2.337	0.112	0.6739	
10080 minute summer	3	1.002	Virtual Manhole	0.1	0.033	0.000	0.1917	
10080 minute summer	3	Infiltration		0.0				
15 minute summer	4	3.000	3	40.3	2.149	0.178	0.0914	
15 minute summer	5	1.000	6	27.7	1.235	0.256	0.6026	
15 minute summer	6	1.001	3	27.6	1.259	0.255	0.5695	
10080 minute summer	Virtual Manhole	Weir		0.0				0.0

Results for 30 year +10% A Critical Storm Duration. Lowest mass balance: 99.06%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	8.633	0.133	35.2	0.2754	0.0000	OK
10080 minute winter	2	10140	8.527	0.218	0.3	0.2466	0.0000	OK
10080 minute winter	3	9960	8.527	1.527	1.1	277.3506	0.0000	SURCHARGED
15 minute summer	4	10	8.618	0.118	51.2	0.2950	0.0000	OK
15 minute summer	5	10	8.622	0.122	35.2	0.2533	0.0000	OK
10080 minute winter	6	9900	8.527	0.281	0.3	0.3178	0.0000	OK
10080 minute winter	Virtual Manhole	9960	8.527	1.627	0.0	1.8402	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	2.000	2	35.2	1.613	0.355	0.5282	
10080 minute winter	2	2.001	3	0.3	0.189	0.001	1.6723	
10080 minute winter	3	1.002	Virtual Manhole	0.0	0.013	0.000	0.1917	
10080 minute winter	3	Infiltration		0.0				
15 minute summer	4	3.000	3	51.2	2.265	0.226	0.1101	
15 minute summer	5	1.000	6	35.2	1.305	0.325	0.7232	
10080 minute winter	6	1.001	3	0.3	0.340	0.003	1.8042	
10080 minute winter	Virtual Manhole	Weir		0.0				0.0

Results for 100 year +10% A Critical Storm Duration. Lowest mass balance: 99.06%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute summer	1	10200	8.831	0.331	0.6	0.6855	0.0000	SURCHARGED
10080 minute summer	2	10200	8.831	0.522	0.6	0.5905	0.0000	SURCHARGED
10080 minute summer	3	10260	8.831	1.831	2.1	332.5638	0.0000	SURCHARGED
10080 minute summer	4	10200	8.831	0.331	0.9	0.8258	0.0000	SURCHARGED
10080 minute summer	5	10320	8.831	0.331	0.6	0.6862	0.0000	SURCHARGED
10080 minute summer	6	10320	8.831	0.585	0.6	0.6620	0.0000	SURCHARGED
10080 minute summer	Virtual Manhole	10260	8.831	1.931	0.0	2.1840	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute summer	1	2.000	2	0.6	0.484	0.006	1.6846	
10080 minute summer	2	2.001	3	0.6	0.505	0.002	1.8801	
10080 minute summer	3	1.002	Virtual Manhole	0.0	0.029	0.000	0.1917	
10080 minute summer	3	Infiltration		0.0				
10080 minute summer	4	3.000	3	0.9	0.773	0.004	0.3425	
10080 minute summer	5	1.000	6	0.6	0.414	0.006	1.8785	
10080 minute summer	6	1.001	3	0.6	0.413	0.006	1.8281	
10080 minute summer	Virtual Manhole	Weir		0.0				0.0

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.06%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
10080 minute summer	1	10200	9.393	0.893	0.9	1.8485	0.0000	SURCHARGED
10080 minute summer	2	10200	9.393	1.084	0.9	1.2259	0.0000	SURCHARGED
10080 minute summer	3	10260	9.393	2.393	5.2	434.5731	0.0000	SURCHARGED
10080 minute summer	4	10140	9.393	0.893	1.2	2.2272	0.0000	SURCHARGED
10080 minute summer	5	10320	9.393	0.893	0.9	1.8482	0.0000	SURCHARGED
10080 minute summer	6	10320	9.393	1.147	0.9	1.2970	0.0000	SURCHARGED
10080 minute summer	Virtual Manhole	10200	9.393	2.493	0.1	2.8192	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
10080 minute summer	1	2.000	2	0.9	0.547	0.009	1.6846	
10080 minute summer	2	2.001	3	0.9	0.430	0.004	1.8801	
10080 minute summer	3	1.002	Virtual Manhole	0.1	0.016	0.000	0.1917	
10080 minute summer	3	Infiltration		0.0				
10080 minute summer	4	3.000	3	4.2	0.837	0.019	0.3425	
10080 minute summer	5	1.000	6	0.9	0.468	0.008	1.8785	
10080 minute summer	6	1.001	3	0.9	0.433	0.008	1.8281	
10080 minute summer	Virtual Manhole	Weir		0.0				0.0

Appendix A.5 – Indicative Drainage Layout



PERMEABLE PAVING
AREA DRAINING TO PAVING: 960m²
AREA OF PAVING:530m²
SUB-BASE DEPTH: 300mm
SUB-BASE POROSITY: 0.3
INFILTRATION: NOT PERMITTED

GEO-CELLULAR SOAKAWAY
AREA DRAINING TO SOAKAWAY: 2205 m²
AREA OF PAVING:190m²
DEPTH: 2.5m
POROSITY: 0.95
INFILTRATION: 0.1m/hr (Assumed)

PETROL INTERCEPTOR 5.3m

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GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.
2. ALL WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE RELEVANT BRITISH STANDARDS, EUROPEAN NORMS, CODES OF PRACTICE AND BUILDING PRACTICE.
3. ALL DIMENSIONS ARE TO BE CHECKED BY THE CONTRACTOR PRIOR TO STARTING THE WORKS ON SITE. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
4. INFILTRATION FEATURES WILL BE SUBJECT TO SITE SPECIFIC INFILTRATION TESTING AND TRIAL HOLES.
5. ALL DRAINAGE SYSTEMS WILL NEED TO BE INSTALLED AND DESIGNED FOR SUITABLE LOADING REQUIREMENTS.
6. THE CONTRACTOR SHALL OBTAIN PRIOR APPROVAL AND ALL NECESSARY LICENCES FROM THE HIGHWAY AUTHORITY AND/OR SEWERAGE UNDERTAKER BEFORE CARRYING OUT ANY WORKS.

KEY:

- SURFACE WATER DRAIN
- SURFACE WATER MANHOLE
- PETROL INTERCEPTOR
- PERMEABLE SURFACE
- GEOCELLULAR SOAKAWAY

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Rev	Description	Author	Checked	Date
P1	First issue	SH	SMB	30/03/21

CLIENT
Avery Healthcare Group Limited

PROJECT
CENTRAL AVENUE GRAVESEND

SCALE	PROJ REF	ORIGINATOR	CHECKED BY
1:200	3085	SH	SMB

DWG REF	DWG No.
INDICATIVE DRAINAGE LAYOUT	HC-3085-501

Appendix A.6 – Maintenance Schedules

Operation and Maintenance Schedule – Pervious paving / surfacing		
Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (for driveways this can be a standard cosmetic sweep over whole surface).	At minimum once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – particular attention must be paid to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using a suitable weed killer which will not adversely affect water quality. Weed killer should be applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving / surfacing.	As required when damage or erosion is detected following inspection. For block paving systems jointing material to be replaced shortly after installation and subsequently when required.
	Remedial work to any depressions. Rutting and cracked or broken blocks and replace lost jointing material (where block paving is used).	
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

General Maintenance Requirements for Permeable Surfacing (additional requirements may apply depending on type of surfacing material used).

Operation and Maintenance Schedule – Crate Soakaways		
Maintenance Schedule	Required Action	Typical Frequency
Routine maintenance	Inspect for sediment and debris in pre-treatment components and storage crate system	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required based on inspections)
Occasional maintenance	Remove sediment and debris from pre-treatment components and storage crate system	As required, based on inspections
Remedial Actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
	Replacement of geotextile surround if not intact or clogged	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
	Check crate system to ensure emptying is occurring	Annually

General Operation and Maintenance Table for Soakaways.