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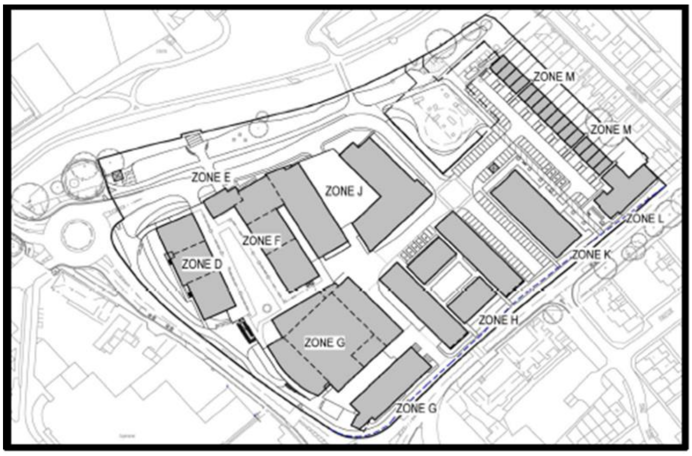

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Canterbury Riverside

Below Ground Drainage Philosophy

	Name	Date
Designed by/ Prepared by	Harry Wyatt	2019.12.13
Checked	Andrew Stanford	2019.12.13
Approved	Andrew Stanford	2019.12.13

SCALE & FORMAT	PROJECT STAGE
NTS @ A4	RIBA Stage:4

SUITABILITY CODE
S3: Suitable for Review and Comment

PROJECT	ISSUER	AREA	LEVEL	TYPE	TRADE	SEQUENCE	REV
CRS	WAL	XX	ZZ	RP	C	103001	P02

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P02	2020.01.20	Typographical error amended
P01	2019.12.13	First Issue

REV	**Date**	**Revision Title**

ALL REVISIONS

Structural and Civil Engineers

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Revision: P02

Below Ground Drainage Philosophy

Canterbury Riverside

20th January 2020

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Below Ground Drainage Philosophy

Canterbury Riverside

Walsh have prepared this report in accordance with the instruction of our client, Bouygues UK.

This report is for the sole and specific use of the client, and Walsh shall not be responsible for any use of the report or its contents for any purpose other than that for which it was prepared and provided. Should the Client require to pass copies of the report to other parties for information, then no professional liability or warranty shall be extended to other parties by Walsh in this connection without the explicit agreement thereto by Walsh.

Revision	Date	Notes	Prepared by	Checked by	Approved by
P01	13.12.2019	Issued for information	HTW	AV	AS
P02	20.01.2020	Typo error amended within table 3.2.1	HTW	AV	AS

Contents

1. Introduction

This report contains the site specific drainage design philosophy statement for the proposed development known as Canterbury Riverside, located adjacent to Kingsmead Road, opposite Sainsbury's shopping centre in Canterbury. This report was commissioned by our client: Bouygues UK as part of our role as civil engineers for the development. The purpose of this report is to demonstrate the proposed scheme is appropriate in relation to flood risk and drainage impact to support the wider planning application for the development. The proposed drainage philosophy has been written in line with best practice and current standards.

This Drainage Design Philosophy has been prepared to provide supplementary information for the discharge of pre commencement condition to Canterbury City Council planning permission reference CA/17/02092/FUL, Condition 27 – Foul and Surface Water Drainage.

As required by standards, Walsh confirm this report has been prepared by suitably qualified and experienced professionals. It has been prepared by Harry Wyatt, an Infrastructure Engineer with appropriate experience in below ground drainage and integrated Sustainable Urban Drainage Systems (SuDS) design. Andrew Stanford, a Walsh Director with over 25 years professional experience working on projects in all aspects of the public and private realm and an expert in SUDS has overseen the production and approved this report.

Sources of Information:

Prior to undertaking the detailed drainage design, a desk top study was undertaken and the following documents obtained which are referenced throughout this report:

- Architects General Arrangement Drawings and Information (PRC)
- Public Health General Arrangement Drawings and Information (Max Fordham)
- Previous Civil Engineers Drawings and Information (Kirksaunders Associates)
- Flood Risk Assessment and Outline Drainage Strategy (EPS)
- Topographical and GPR Utility Survey (MK Surveys)
- Southern Water Asset Plans and Correspondence
- EPS Phase II Geo-Environmental Assessment
- Kent County Council Condition 27 response and associated correspondence

Consideration has been given within this Drainage Design Philosophy report to the information requested by Kent County Council, acting as Lead Local Flood Authority, with specific focus on;

- Overview of the proposed Sustainable Urban Drainage System
- General Arrangement Drawing outlining Key Drainage features
- Proposed Surface Water Network Calculations
- Exceedance Flow Routes
- Drainage Maintenance Plan

A detailed Below Ground Drainage Maintenance Plan has been created in order to address the maintenance requirements for the proposed drainage infrastructure and SuDS features, refer to Part 10. It is intended that the included Below Ground Drainage Maintenance Plan is incorporated into the Management Plan for the wider development.

Glossary of Terms:

As referred to multiple times throughout this report the following acronyms are defined as follows:

FSR Flood Studies Report, *published in 1975 the Flood Studies Report is widely used and accepted method of designing flood estimation for rainfall events in the UK.*

FEH Flood Estimation Handbook, *published in 1999 The Flood Estimation Handbook is an improved and updated method of designing flood estimation for rainfall events in the UK since the publication of the Flood Studies Report.*

LA *Local Authority for the Development.*

EA Environment Agency, *Government authority with respect to environmental approvals.*

LLFA Lead Local Flood Authority, *are responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets.*

SuDS Sustainable Urban Drainage Systems, m*ethods to capture, store, treat, control and discharge surface water in urban environment using sustainable techniques.*

AEP Annual exceedance probability, *this is the percentage probability that a given event could occur in any given year.*

KCC Kent County Council

CCC Canterbury County Council

CC Climate Change, *this is a factor applied to surface water calculations*

FRA Flood Risk Assessment, *undertaken by EPS and submitted as part of the planning process*

2. Scope and Limitations

The proposed drainage system detailed design has been carried out in line with best practice and set out to ensure surface water flooding does not result in a hazard to people or property, exceedance flows have been considered. Calculations have been provided to show that the proposed infrastructure is sufficient to prevent the site from flooding during the design scenarios and criteria set out.

Only Zones D,E,G,H,J, and associated hard standing are to be designed by Walsh (refer to table 3.2.1 and Appendix A) and as such detailed consideration has only been given to these areas within the content of this report. Impermeable area calculations have been produced against the current whole site masterplan.

This report was commissioned by our client: Bouygues UK as part of our role as civil engineers for the development. The purpose of this report is to demonstrate the proposed scheme is appropriate in relation to flood risk and drainage impact to support the wider planning application for the development.

Walsh have not reassessed the flood risk on the site and are reliant on the fluvial risk assessment undertaken by EPS and summarised in Section 3.2.

3. Background

3. 1. Site Location

The Canterbury Riverside development site is encompassed by the Great Stour River to the North, Kingsmead Road to the West, Sturry Road to the South, and a row of houses followed by New Town Street to the East. Sainsbury's Shopping Centre is situated on the Site Adjacent to Kingsmead Road to the West. The site has a total area of 38,500m^2, of which 6,620m^2 is considered permeable – Refer to Appendix A for Pre and Post Development Permeable area plans.

Figure 1: Canterbury Riverside Existing Site Plan

3. 2. Project Description

The proposed mixed-use development comprises of the construction of an undercroft car park within the central-northern area of the site, which is accessed via Kingsmead road to the west. Constructed above the western portion of the new proposed car park will be 'The Square' featuring a series of Bars and Restaurants, with a multi-storey residential structure situated above the eastern portion.

A new proposed five screen cinema complex is proposed immediately adjacent and to the south of 'The Square' which is bordered to the south and east by student structures, the southern being a four storey structure and the eastern a part three part five storey structure with an internal courtyard.

The North Eastern portion of the site features an existing Southern Water Pumping station, a multi storey residential development and a series of single residential dwellings with associated gardens.

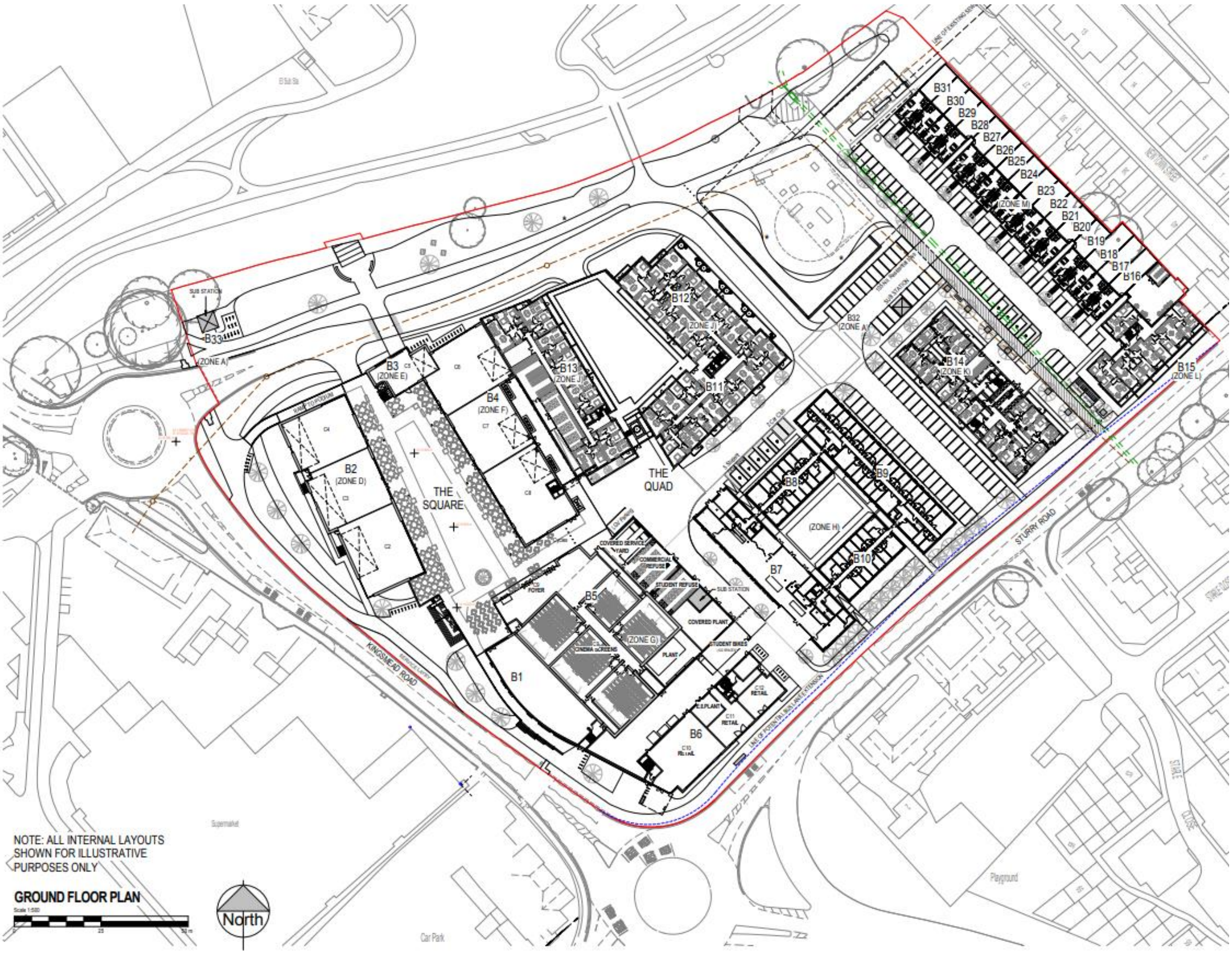

Figure 2: Canterbury Riverside Development Overview.

The proposed development includes significant redevelopment to the existing landscaping strategy. Proposed areas are summarised in Table 3.2.1 below.

Table 3.2.1 Summary of Permeable and Impermeable Areas.

		Existing (m²)	Proposed (m²)
Zones K,L,M	Permeable site area	1,315	3,427
	Impermeable site area	9,364	7,252
	Total	10,679	10,679
Zones D,E,G,H,J	Permeable site area	5,305	4,940
	Impermeable site area	22,519	22,884
	Total	27,824	27,824
Total	Permeable site area	6,620	8,367
	Impermeable site area	31,883	30,136
	Sum of Areas	38,503	38,503

3. 3. Submitted FRA

A Flood Risk Assessment (FRA) for the site was prepared by EPS and approved with the planning application for the development. The document dated May 2017, and subsequent correspondence with Canterbury County Council summarises the flood risk to the site. Refer to Appendix B for the submitted FRA.

3. 3. 1. EA Flood Zone

The Site spans between Flood Zones 1-3. An exception test was carried out to and determined that the proposed development is appropriate within the relevant the flood zones.

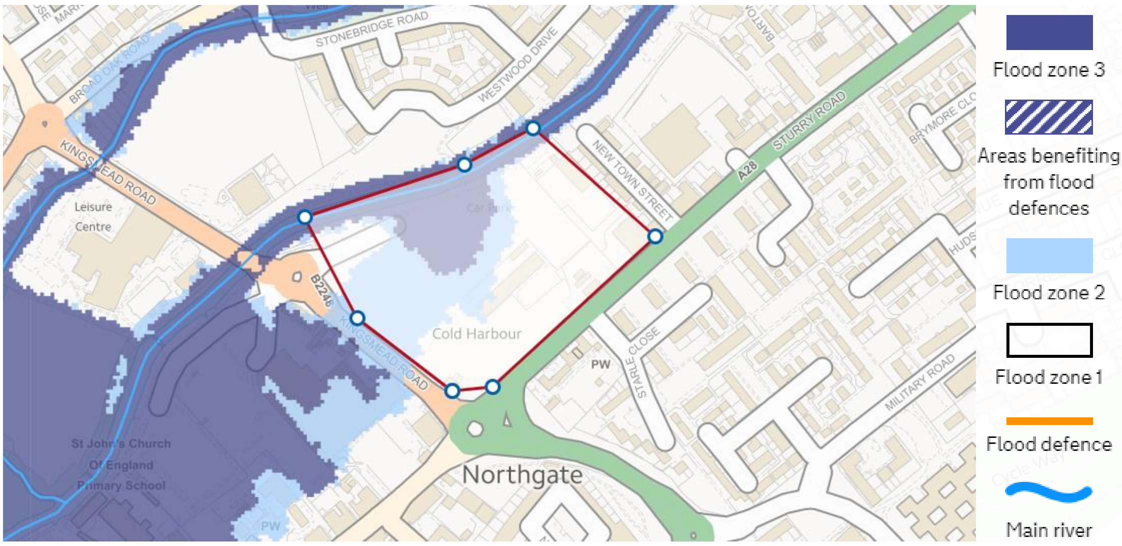

Figure 3 – Environment Agency Flood Zone Map

3. 3. 2. Existing Flood Risk

The Flood Risk Assessment for the site assessed the risk of flooding to the site in the existing condition, these findings are summarised below:

Historic Risk of Flooding

Historic flood maps were reviewed and have been reported to show no evidence that the site has been affected by flooding in the past, an area of flooding was reported adjacent to the west of the site, beyond Kingsmead Road in February 2001.

Rivers

The FRA assesses risk of flooding to the site in the 1 in 100 and 1 in 1000 fluvial events. The site has been assessed as being susceptible to flooding during these events.

Local Surface Watercourses

It has been assessed that the development is not considered to be at significant risk of flooding from local surface watercourses.

Sea (Tidal)

As the site is located approximately 16km from the coast and the tidal extent of the Great Stour is at Fordwich Bridge (downstream of the site) therefore the site has a very low risk of tidal flooding

Land (Overland Flow)

Ordnance Survey maps were reviewed during the production of the FRA, and it was concluded that it is likely that any large volumes of surface water would be intercepted prior to reaching the site by local drainage systems around Sturry Road and Tourtel Road. Additionally, Surface water mapping provided by the EA reports that the site lies within an area of very low surface water flooding risk. It is noted that there is an area on site with a high risk of surface water flooding (depths up to 900mm) which is currently occupied by a car park.

Groundwater

The FRA reports that it is likely that shallow groundwater local to the site will be hydraulically connected to the adjacent surface watercourse, and as such are likely to have been already taken into consideration by modelling information carried out in the area. As such the flood risk associated with groundwater have not been considered significant in the context of flooding from other sources.

Sewers

The risk of sewer flooding to the site has been assessed as being acceptable local sewers will be maintained by Southern Water.

Other Sources of Flooding

Reservoirs – Not deemed likely

Canals – Not deemed likely

Other – Not deemed likely

3. 3. 3. Post Development Flood Risk

The Flood Risk Assessment concludes that the flood risk post development is likely to remain the same. Flood risk will only increase total impermeable area increases from that of the pre development site. As flood risk needs to be considered for extreme events with a probability less than the 1% AEP. plus climate change, appropriate mitigation is warranted. The recommendations stated by the FRA to mitigate the risk are as follows;

- Raise floor levels to areas with a flood risk vulnerability classification of 'Less Vulnerable' to 7.64mAOD
- Raise floor levels to areas with a flood risk vulnerability classification of 'More Vulnerable' to 7.90mAOD
- Raise floor levels to areas located above 7.9mAOD to a minimum of 150mm above existing site levels.
- Flood Resilient materials and construction techniques to be incorporated into areas designed to flood.
- Flood Warning and evacuation plan to be prepared for the development
- Adequate surface water drainage systems to be provided

Table 3.3.3.1 below outlines the intended Finished Floor levels at the time the FRA was written

Table 3.3.3.1 – Proposed Finished Floor Levels

Area	FFL (mAOD)	Area	FFL (mAOD)
Undercroft Car Park & Canoe Store	6.95	Residential Apartments (E)	10.60
Commercial (N)	10.00	Residential Properties	From 7.80*
Cinema	10.00	Student (Habital Rooms)	10.00
Retail	9.50	Student (General Accommodation	9.80
Residential Apartments (N)	11.00		

* - The two northernmost residential properties have an FFL of 7.8mAOD, whilst this level is lower than the minimum specified by the EA for more vulnerable developments, the sleeping accommodation to these properties isn't proposed at ground level. On this basis the FRA has determined that the proposed FFL for these two dwellings is appropriate.

3. 4. Discharge of Surface Water

The FRA states that '*following correspondence with the client, it is understood that an agreement in principle has been reached with the relevant regulatory authorities for continued disposal of surface water in the existing method.'* Walsh have not seen this correspondence but have no reason to believe it does not exist and as such it is proposed for surface water collected onsite to be discharged to the local river Great Stour at an unrestricted rate. Appropriate pollution prevention controls (such as oil separators) to be provided where necessary.

3. 5. Summary of Modelled Flood Levels and Depths

EPS requested Product 4 information from the Environment Agency to determine the fluvial flood level within and surrounding to the site during fluvial events from the Great Stour River. It is worth noting that only the 1 in 100-year flood depths have been considered for the writing of the FRA, a summary of these 'critical levels' are reported in Table 3.5.1 below.

Table 3.5.1 – Product 4 summary extract

Watercourse	Node	100 Yr Level (mAOD)	100 Yr Plus CC Level (mAOD)	1000 Yr Level (mAOD)	100 Yr Plus CC Depth (m)
Great Stour	3	N/A	N/A	7.48	N/A
Great Stour	4	7.08	7.22	7.39	0.27
Great Stour	5	7.13	7.29	7.48	0.52
Great Stour	6	7.13	7.31	7.51	0.4
Great Stour	7	N/A	N/A	7.51	N/A
Great Stour	10	N/A	N/A	7.55	N/A
Great Stour	11	N/A	N/A	7.55	N/A
Great Stour	13	N/A	N/A	7.69	N/A
Great Stour	14	N/A	N/A	7.81	N/A
Great Stour	15	N/A	N/A	7.89	N/A
Great Stour	18	N/A	N/A	7.96	N/A
Great Stour	19	N/A	N/A	7.97	N/A
Great Stour	20	7.35	7.5	7.67	0.62
Great Stour	22	7.31	7.46	7.63	0.45

3. 6. Floodplain Compensation

Within the FRA, floodplain compensation has been assessed in regards to the 1 in 100-year fluvial floodplain from the Great Stour. A Flood Storage Compensation Report was prepared to determine an appropriate strategy of alleviating downstream flood risk which may occur if flood volumes were to be displaced by the development. It has been proposed that a lower ground level car park be provided as part of the development which is designed to flood in the instance that the 1 in 100-year fluvial event plus CC occurs. It is reported that an increase in flood storage of between 1077.5-1092.5m^3 will be provided as a result of the proposed development.

3. 7. Attenuation Requirement

The Flood Risk Assessment has concluded that attenuation may be required should impermeable areas across the development reduce from those of the existing site. Attenuation has been quantified against Greenfield Runoff rate from the site with consideration given for climate change. It was concluded that for every 0.1ha net increase in impermeable area 183m^3 of attenuation may be required.

3. 8. SuDS Guidance

The implementation of SuDS has only been discussed should unregulated discharge to the river not be approved.

4. Commentary on the Approved FRA

As part of Wash's appointment to develop a detailed strategy for the proposed drainage system, a detailed review of the approved Flood Risk Assessment was undertaken.

4. 1. Reported Modelled River Levels

Flood Risk to the site was assessed for fluvial events of a 1 in 100-year return period and greater. The FRA has neglected to report fluvial levels across the site for return periods with a more frequent occurrences than the 1% AEP.

It has been discovered that the likelihood of flooding may be more frequent than the submitted Flood Risk Assessment implies. The EA's product 4 pack which was provided during the undertaking of the FRA stated modelled flood depths during different fluvial events. Nodes 4, 5, and 6 as shown on the data points map give an indication of anticipated flood depths during fluvial events. Table 4.1.1 below summarises the modelled depths.

Table 4.1.1 – Modelled River Levels for vulnerable locations on-site

Node No	20% AEP (mAOD)	5% AEP (mAOD)	2% AEP (mAOD)	1.33% AEP (mAOD)	1% AEP (mAOD)	1% AEP +CC* (mAOD)
4	0.00	0.00	7.00	7.05	7.08	7.22
5	0.00	0.00	7.02	7.08	7.13	7.29
6	0.00	0.00	7.01	7.07	7.13	7.31

As highlighted above there is anticipated flooding to levels varying between 7.00mAOD and 7.02mAOD for the 2% AEP (1:50-year) event as such it can be concluded that flooding will occur with a frequency between the 2% and 5% AEP's, once a climate change factor is applied to these values flooding may occur between the 5% and 10% AEP's.

4. 2. Surcharged Discharge Assessment

Within the submitted FRA flooding has been assessed for fluvial events of 1% AEP and greater, no consideration has been given to the impact that different fluvial events will have on a pluvial event should they coincide.

We have determined that there are significant implications to the surface water system and the required pluvial on-site water management for fluvial events of a lesser return period. When these fluvial events occur the Great Stour river level will rise causing surcharge to the proposed river outfall, this surcharge will cause significant and frequent flow restriction which will need to be taken into account and rationalised in the proposed design.

Table 4.2.1 below summarises assessed river levels local to the proposed outfall locations.

Table 4.2.1 - Summary of Fluvial river levels at outfall locations

	Summary of Fluvial river levels						
	Node No	20% AEP (mAOD)	5% AEP (mAOD)	2% AEP (mAOD)	1.33% AEP (mAOD)	1% AEP (mAOD)	1% AEP +CC* (mAOD)
NW corner of Site	20	6.75	7.07	7.23	7.29	7.35	7.50
NE corner of Site	4	6.55**	6.87**	7.00	7.05	7.08	7.22

* - Denotes where 20% climate change factor has applied to modelled fluvial events

** - Received fluvial flood level noted as 0.00, conservative value applied stated against upstream levels

4. 3. Draining Flood Waters

It is noted that no strategy has been provided for management of flood waters incurred by the lower ground floor car park once flood waters have subsided. A methodology for this will be considered as part of this report.

5. Existing Drainage

The existing site is currently occupied by a variety of land uses. The Central North of the site is occupied by a large asphalt surfaced car/coach park, with associated access road from Kingsmead Road to the North West. The Eastern section of the site comprises of a small fenced off compound currently housing multiple steel storage containers, there is a builder's yard and associated brick build building to the Central East of the site, and finally a garage service located to the South East fronting onto Sturry Road.

The Current site is assumed to be well served by existing public surface and foul water sewers. There are multiple existing public sewers located within the site, a Southern Water pumping station located to the north east, and the Great Stour river flowing from West to East along the northern boundary.

Survey investigations were undertaken in January 2016 by MK surveys and are included in Appendix C. These investigations indicate that the majority of surface and foul water collected across the site are being directed to the 825Ø public sewer running beneath the norther access road directly to the Southern Water Pumping station. There are two headwall connections to the Great Stour river from the existing site indicated on the survey, an 825Ø connection is noted from the pumping station at IL 6.430, and a 1000Ø connection is identified from asset records, this connection hasn't been surveyed and is expected to be surcharged.

Figure 4 - Aerial View of Canterbury Site Pre-development (Google Maps Capture)

6. Design and Approval History

6.1. Third Party Consultations and Planning Conditions

A surface water drainage strategy was prepared by Kirksaunders Associates (KSA) in October 2019; the strategy illustrates unrestricted discharge to the Great Stour River via four outfalls (three of which serving the portion of the site covered in this report). It is noted that no philosophy or associated modelling calculations were provided accompanying the strategy drawings, as such functionality of the strategy is mostly speculative and does not appear to be justifiable under the scrutiny of detailed design.

6.1.1. Lead Local Flood Authority – Kent County Council

The Drawings provided by KSA and the FRA by EPS were submitted in order to discharge planning condition 27 (foul and surface water drainage) of planning permission reference CA//17/02092/FUL. Kent County Council (KCC) acting as Lead Local Flood Authority reviewed the submission and responded requesting the following information;

- *A summary statement or covering letter giving an overview of the proposed sustainable drainage system.*
- *'For construction' drainage layout drawings, annotated with pipe numbers, manhole cover and invert levels and key drainage features (such as attenuation devices, flow controls, soakaway locations etc.). General arrangement drawings of key drainage features or structures should also be provided.*
- *Information to support any key design inputs (e.g. greenfield and / or brownfield run-off rate calculations, existing and / or proposed impermeable area plan, ground investigation logs and infiltration test results (where applicable) and phasing plans (where applicable))*
- *Final full network calculations and model details to demonstrate the drainage system's operation and performance for the critical duration 1 year, 30 year, 100 year +20% and 100 year +40% storm intensities.*
- *We would expect to see the drainage system modelled using FeH rainfall data in any appropriate modelling or simulation software. Where FeH data is not available, 26.25mm should be manually input for the M5-60 value, as per the requirements of our latest drainage and planning policy statement (June 2017).*
- *Where there is any exceedance of the drainage network above the 30 year event, an exceedance plan should be provided illustrating where exceedance occurs and the extent and depth of flooding. Exceedance must be controlled within the site boundary.*
- *A description of the measures included within the drainage scheme to manage the quality of surface water runoff so that the receiving surface waters and / or groundwater are adequately protected against pollution.*

Email correspondence between Kent County Council (acting as LLFA) and Canterbury County Council (acting as LPA) dated 21st October 2019 confirms that KCC acknowledge that free discharge to the local watercourse is permitted.

6.1.2. Canterbury County Council

Meeting minutes have been provided summarising a meeting held at Canterbury County Councils offices to discuss the surface water strategy of the site. The meeting took place on the 18th of January 2016, attendees include David Payne – KSA, Stephen Hawkins – BYUK, Dan Simmons – CCC, Joe Williamson – LFA. The minutes include a note stating '*Dan Simmons confirmed that the strategy of discharging surface water flows into the river Stour with an unrestricted rate was acceptable.*' As such we can conclude that unrestricted discharge to the River is undisputed.

6. 1. 3. Southern Water Developer Services

Prior to Walsh's appointment to the project Southern Water were approached regarding a Section 106 application for the connection and discharge of Foul Water to the Public sewer. Southern Water responded on the 31st of May 2019 to confirm approval of the submitted strategy (Southern Water reference DS_CPS-108142) and as such no major deviation to the approved strategy should be proposed at the point of connections.

Southern Water have noted that the Section 106 approval does not confirm capacity is available for the proposed development in the public sewer network, it is proposed for Southern Water to be engaged in order to confirm adequate capacity exists within their system prior to this connection taking place.

Southern Water advised that they have no objections to discharge the outstanding planning condition 27 relating to foul and surface water drainage to the site based on the previously submitted information

6. 1. 4. Environment Agency

The Environment Agency were given the opportunity to comment on the proposed strategy within the planning submission and again during ongoing discussion regarding the aforementioned Planning Condition 27 as recommended by KCC. The Environment Agency advised that following review of previous information submitted to discharge condition 27 they have no objections.

6. 2. Site Hydrogeology and Discharge Method

Publically available hydrogeological maps available indicate that the site is located in an area of Woolwich and Reading beds, Thanet Beds. EPS undertook a Phase II Geo-Environmental Assessment across the site, as part of these works exploratory holes were excavated in the form of cable percussive Boreholes and Window Sampl Boreholes, recordings from these indicate that the site generally is formed of varying depths of made ground, underlain by Head Deposits, Alluvium, River Terrace Deposits and the Seaford Chalk Formation. Table 6.2.1 below summarises Strata's encountered during borehole investigations.

Table 6.2.1 Recorded Strata Depths

Geological Strata	Maximum Depth to Base of Strata (m BGL)	Strata Thickness (m)
Made Ground	2.80	0.75-20.80
Head Deposits	5.50	0.40-3.70
Alluvium	5.00	0.50-1.70
River Terrace Deposits	6.80	0.40-3.40
Seaford Chalk Formation	≥ 20.00	Not Proven

Infiltration has been stated in EPS FRA as only to be considered should unrestrictedly discharge to the adjacent watercourse not be approved, as covered in section 7.1 unrestricted discharge to Great Stour River is accepted and as such infiltration will not be considered as a potential strategy for the discharge of surface water.

With reference to EPS Phase II Geo-Environmental Assessment, Groundwater was encountered across the majority of the site within granular River Terrace Deposits between the strike levels of 3.4m and 6.0m. Groundwater levels were subsequently measured within monitoring wells on two separate visits between depths of 1.330m bgl (Borehole 4 located in the central parking area) and 3.377m bgl (Window Sample 17 Located on the eastern portion of the site). Based on this information it can be concluded that the water table is tied to the adjacent watercourse.

6. 3. Philosophy of Previously Submitted Drainage Strategy (KSA)

We have reviewed available relevant historic information and documentation uploaded to the Councils Planning Portal.

Two main sources of information are available detailing the proposed drainage philosophy, as such all reference will be made to these when discussing the 'previous strategy' in this document. Sources of information include;

- EPS Flood Risk and Drainage Assessment – Issue 1.3 – Date 25th August 2017
- KSA Below Ground Drainage Proposals Layout (GF/LGF) – Issue P06/P07 – Date 13th August 2019

The Drainage proposal will be discussed in terms of Surface Water and Foul Water each are proposed to have their own designated networks to facilitate the conveyance and subsequent discharge of waste to public sewer system/local watercourse without the cause of undue contamination.

6. 3. 1. Foul Water

The previous strategy included for all proposed foul flows generated from the site to be conveyed to a single new proposed outfall manhole constructed retaining the existing 825Ø public foul sewer running beneath the northern access road. This connection has been reviewed and approved by Southern Water under a Section 106 application.

A proposed discharge Rate of 30l/s is stated for the new foul flows generated from the site; no calculations have been provided. Southern Water have not undertaken capacity checks for the proposed foul discharge, and as such cannot guarantee capacity exists in the existing system for the proposed development flows.

A series of new foul water sewers are proposed within the site access roads which are to be offered for adoption by Southern Water. Southern Water have not yet been approached regarding the adoption of these sewers.

A number of internal manholes are proposed within the Cinema Block (Zone G), no details have been provided for these.

6. 3. 2. Surface Water

KSA GA plans illustrate a split catchment proposal for the discharge of surface water to the adjacent Great Stour River. From the submitted layouts it is assumed that the site is proposed to be split into 3 No. main catchments, each with its own designated 375Ø outfall.

Unrestricted discharge is proposed for all connections to the Great Stour River, additionally no provision has been shown for discharge velocity reduction and scour protection.

Bypass Interception is proposed on each outfall via new proposed Klargester Class 1 separators prior to connecting to the adjacent watercourse, connection the watercourse is to be via new proposed headwalls. Headwall connections are subject to approval by the Environment Agency, it is expected that Flood Risk activity permits will be required for the connections.

All outfall invert levels are noted as 5.810 MAOD, a surveyed water level for the river of 5.730 MAOD was recorded on the central eastern portion of the site noting an 80mm freeboard to the surveyed water level. No consideration has been given on potential river level fluctuations as such it is expected for the proposed outfalls to be surcharged the majority of the time.

No design consideration has been provided for discharge to different fluvial receiving water conditions.

6. 4. Commentary on KSA Design Strategy

The proposed development site has a number of constraints that don't appear to have been assessed relating to flood risk and drainage which all relate, directly or indirectly, to the adjacent river.

Our review of the current design highlighted a number of risks and potential shortcomings where consideration would typically have been given especially for a project progressing into Stage 4. Key issues have been outlined below and have split into general concerns and specific concerns relating to the low-level car park.

General Concerns

- Pipes of differing diameters appear not to have been designed with 'soffit to soffit' connection in line with best practice
- Drainage doesn't appear to have been designed with structural constraints considered, areas of compromising structural/civil clashes apparent, drainage runs may deepen to compensate.
- No hydraulic consideration appears to be given to the effect of fluctuating river levels; no philosophy provided for which pluvial/fluvial events are to be designed for.

Lower Ground Floor Car Park Concerns

- Current proposal doesn't allow for sufficient depth to drainage, stated level of outfall isn't achievable from gravity fed car park system.
- If fluvial and pluvial events coincide the LGF Car Park will flood due to inadequate discharge against a surcharged outfall, this will result in significantly more frequent flooding than allowed for.

- Flood Risk Assessment appears to not have fully considered the frequency of flooding to the car park from fluvial events. Based on fluvial flood level data, flooding is expected between the 5% and 2% AEP return period, these fluvial river levels do not take into account the effect of climate change.
- No strategy has been provided for the controlling of flooding or dealing with residual flood waters once the flooding has receded. Given potential frequency in which the car park may incur flood waters, it is imperative provision is made for such an event.

7. Design Detail and Philosophy

7.1. Proposed Surface Water Regime

This surface water drainage design has been prepared in accordance with the approved Flood Risk Assessment produced by EPS in August 2017. This strategy proposes the unrestricted discharge of surface water into the local watercourse (The Great Stour). Free discharge is proposed for all storms up to and including the 1in100 year (1% AEP) plus 40% climate change event, simulated using FeH Data.

The Proposed Surface Water Drainage strategy has been constructed based on the following principles;

- Promote natural percolation of soft landscaped areas to reduce runoff from the site
- Surface water generated on the site to be discharged to the Great Stour River
- Runoff from rainfall events up to and including 1% AEP to be collected and discharged without causing flooding off-site or flooding which would be damaging to person or property
- Exceedance flows considered to ensure there is not undue risk to people or property
- Surface water modelling to be undertaking using FeH rainfall data.

The fluvial events in the Great Stour river adjacent will be considered within the surface water drainage design. The proposed surface water networks will be designed against the following two conditions;

- A constant receiving water level of that stated in the modelled 5% AEP fluvial flood levels.
- A constant receiving water level of that stated in the modelled 1% AEP fluvial flood levels plus 20% CC. Note that a 1% AEP Pluvial event coinciding with a 1% AEP fluvial event is considered highly unlikely and as such exceedance flow occurring during this event can be considered low risk.

A non-surcharged outfall receiving water condition was modelled as the critical criteria for erosion. This results in a design velocity of between 2-3m/s for the discharge to the watercourse during a peak rainfall event. Scour protection against the QBar event will be considered for the design of the Headwalls.

Table 7.1.1 – Receiving Water Design Criteria

Condition	Fluvial Event	Assessment Parameter
1	1% AEP +CC	No flooding off-site or which would be damaging to person or property, should flooding occur risk to be assessed.
2	5% AEP	No flooding off-site or which would be damaging to person or property
3	No surcharge	Standard design criteria

7.2. Addressing Unresolved Issues

The majority of concerns highlighted in section 6.4 can be alleviated via designing in line with best practice guidance and standards covered in section 10. Redesign is required is the lower Ground Floor Car park, as outlined it has been deemed infeasible to discharge surface water collected in this area under gravity without significantly increasing flood risk onsite.

Proposed Car Park Strategy

Multiple options for a proposed strategy of discharge for the lower ground flood car park area have been considered as the sites associated constraints do not profit the capability of gravity discharge.

Due to the nature of how the proposed development has progressed, the area with the most design flexibility is currently established as below ground. To minimise the impact on the overall scheme, we are proposing for the incorporation of a new proposed pumping station to serve Zones D, E, F, J, The Square and associated hardstanding adjacent to the car park entrance.

Attenuation will be provided to store excess storm water that may enter the system in the event that run-off overwhelms the pumping station and it exceeds the proposed pump rate.

7. 3. Catchment Drainage Strategy

The proposed surface water strategy comprises of the overall development being divided into three main catchments. These catchments will be conveyed to two separate outfalls, with appropriate bypass separation prior to connection to the adjacent watercourse.

All surface water generated from the site will be conveyed to two new proposed headwall outfalls constructed on the Great Stour, headwalls are proposed on opposite ends of the site, one on the north western corner, local to the proposed substation, and the other on the north eastern corner, local to the existing access bridge.

Refer to Appendix D for proposed catchment plan, and refer to table 7.3.1 for Catchment area summary.

Table 7.3.1 – Catchment Area Summary

Catchment Number	Catchment Area (m^2)	Proposed Outfall	Outfall Diameter
1	9,500	North Eastern	600
2	6,100	North Western	600
3	9,800	North Western	600

7. 3. 1. Catchment 1

Catchment 1 comprises of the entirety of Zone H, a portion of Zone G (approximately 50%), and all associated hardstanding/access roads. Surface water will be collected at source and conveyed to a below ground network via rainwater pipes, gullies and channel drains. The network will subsequently discharge to the Great Stour River via the new proposed North Eastern outfall.

7. 3. 2. Catchment 2

Catchment 2 comprises of a portion of Zone G (the remaining approximate 50%), a portion of Zone D roof area, and all associated hardstanding. Surface water will be collected at source and conveyed to a below ground network via rainwater pipes, gullies and channel drains. The network be subject to pumped discharge from the lower ground flood network which will combine with gravity fed flows and subsequently discharge to the Great Stour River via the new proposed North Western outfall.

7. 3. 3. Catchment 3

Catchment 3 comprises of Zones D, E, F, J, The Square and associated hardstanding adjacent to the car park entrance. Surface water will be collected at source and conveyed to the suspended lower ground floor network via rainwater pipes, gullies and channel drains.

The Public Health Engineer (Max Fordham) have designed the above ground surface water drainage system with the intent of draining all rainwater catchments to higher ground floor areas where possible, but due to the limited head height, long suspended runs are not feasible. It has been determined that the majority of surface water in this area (Zones D, E, F, J and The Square) will need to drop to the lower ground floor area before being pumped back up to an appropriate level to facilitate gravity discharge to the adjacent watercourse.

The Surface water pump station has been designed with a pump rate based on the KCC stated M5-60 value for the site (26.25mm). As such the design for the proposed pump chamber will allow for the unattenuated discharge of surface water for the majority of storm occurrences, with cellular storage being utilised for storm events exceeding the M5-60. As shown on Table 7.3.1, the catchment area to discharge to the Lower Ground system totals 9,800m^2. Based on this area and pumping 26.25mm/m^2 the surface water pump station has a design pump rate of 71l/s. The design of the lower ground floor below ground drainage has been modelled using simulation software to ensure no flooding for all storm events up to and including the 1 in 100-year plus 40% CC event. The results of the modelling show for the design pump rate that an additional 291.2m^3 of attenuation storage is required. This will be provided via geo-cellular crates located beneath the lower ground floor car park area.

Calculations for the lower ground flood drainage with attenuation storage are included as an appendix to this report, refer to appendix E.

7. 3. 4. Outfall 1 – North Eastern 600Ø

The North Eastern Outfall has been designed based on parameters outlined in section 7.1, I.E.

- No flooding off-site or which would be damaging to person or property for 1% AEP + CC storms.
- Storms to be assessed based on discharge against the 5% AEP fluvial river level (6.87mAOD)
- Consideration of exceedance flows to be given based on discharge against the 1% AEP + CC fluvial river level (7.22mAOD)
- 9,500m^2 Catchment area
- Outfall invert level of 6.025
- Microdrainage calculations for the outfall are included as an appendix to this report.

Table 7.3.4.1 below outlines flooding as a result of surface water generated by the site for the criteria outlined above. We can summarise that all flooding created by pluvial flows is controlled safely for all design criteria.

Table 7.3.4.1 – Summary of Pluvial flooding for Fluvial design cases

	Pluvial event and associated flood volume		Fluvial event	
Outfall No	30% AEP +CC Flood Volume (m^3)	1% AEP +CC Flood Volume (m^3)	River Level (mAOD)	Return Period
1 - North East	0.00	9.00	6.55	20% AEP
	0.00	19.00	6.87	5% AEP
	29.00[2]	114.00[1]	7.22	1% AEP +CC

[1] Significant volumes of flooding are expected local to the outfall location, this is caused by network attempting to discharge against a river level which is at or close to that of the terminating outfall cover level. 97m^3 of the total 114m^3 of flooding created is local to the river. As such, we can conclude that all flooding at this location will end up in the Grout Stour via overland flow. The remaining 17m^3 of flooding occurs in access roads primarily during 15min storm durations, as such all flood water during this period will be controlled onsite.

[2] All flooding during the 30% AEP occurs local to the Gear Stour River, the reason for flooding is similar in nature to that of the 1% AEP + CC, as such it can be concluded that flooding is controlled and is a result of fluvial flooding already occurring onsite.

7. 3. 5. Outfall 2 – North Western 600Ø

The Catchment 2 network has been designed based on the following parameters;

- No flooding off-site or which would be damaging to person or property for 1% AEP + CC storms
- Storms to be assessed based on discharge against the 5% AEP fluvial river level (7.07mAOD)
- Consideration of exceedance flows to be given based on discharge against the 1% AEP + CC fluvial river level (7.50mAOD)
- 6,100m^2 Catchment area plus 71l/s pumped discharge from Catchment 3
- Outfall Invert level of 6.020
- Microdrainage calculations for the outfall are included as an appendix to this report.

Table 7.3.5.1 below outlines flooding as a result of surface water generated by the site for the criteria outlined above. We can summarise that all flooding created by pluvial flows is controlled safely for all design criteria.

Table 7.3.5.1 – Summary of Pluvial flooding for Fluvial design cases

	Pluvial event and associated flood volume		Fluvial event	
Outfall No	30% AEP +CC Flood Volume (m³)	1% AEP +CC Flood Volume (m³)	River Level (mAOD)	Return Period
2 - North West	0.00	0.00	6.75	20% AEP
	0.00	13.00[2]	7.07	5% AEP
	0.00	47.00[1]	7.50	1% AEP +CC

[1] Significant volumes of flooding are anticipated local to the new proposed Kingsmead Road Service Layby, due to the likelihood of the pluvial and fluvial events coinciding being negligible, and as flooding waters would be directed onto Kingsmead Road and not cause risk to person or property, it can be concluded that the proposal is satisfactory.

[2] A small volume of flooding is anticipated for the 5% AEP fluvial river level should it coincide with a 15minute 1% AEP plus 40% CC storm. We note that FeH rainfall data has been used for the simulation of these occurrences, FeH rainfall data typically exaggerates storm intensities compared to that of its predecessor (FSR) and as such a 30% CC factor would usually be applied when FeH data has been used in the simulation, if we were to apply the 30% CC rational to this scenario in isolation there would be no modelled flooding during the 1% AEP +CC Pluvial, 5% AEP Fluvial event.

7. 4. Discharge Rates

Surface water runoff has been modelled using hydraulic modelling software, to determine the peak flow rates for all storm events up to and including the 1 in100yr (1% AEP) + 40% climate change event. Peak flow rates and their associated velocities below have been stated against a non-surcharged outfall.

Table 7.4.1 - Peak Surface Water Flow Rates for various Design Storms

Outfall Number	Peak Flow Rate (1in1year +40%CC)	Peak Flow Rate (1in30year +40%CC)	Peak Flow Rate (1in100year +40%CC)	Peak Velocity
1 (NE)	137.60 l/s	488.00 l/s	716.40 l/s	2.50
2 (NW)	147.20 l/s	341.80 l/s	473.60 l/s	1.70
Total	284.80 l/s	829.80 l/s	1190.00 l/s	

Outfalls are to be provided via newly constructed headwall connections to the Great Stour River, appropriate scour protection will be provided to protect against Qbar discharge.

7. 5. Sustainable Urban Drainage Systems

Sustainable drainage systems have been implemented into the proposed scheme in accordance with the SuDS recommendations outlined in the FRA. The feasibility of green roofs has been explored and are to be provided. In addition to green roofs, large areas of soft landscaping are proposed across the site in line with recommendations from the FRA to not increase impermeable areas. Finally, all surface water is to be subject to bypass separation prior to discharging to the local watercourse to capture hydrocarbons and other gross pollutants.

Geocellular attenuation tanks will be provided in the lower ground floor car park to attenuate runoff before it is pumped back to high level to discharge under gravity.

The implementation of green roofs, and attenuation tanks will control runoff within the site boundary to reduce flood risk.

8. Foul Water Drainage Strategy

The foul water design has been prepared in accordance with the approved Outline Drainage Strategy produced by KSA.

8. 1. Public Sewer Connections

As outlined in section there is an existing 825Ø public sewer running beneath the norther access road directly to the Southern Water Pumping station occupying the central north east portion of the site. Southern Water were approached by KSA in the form of a section 106 application for the connection and discharge of Foul Water to the Public sewer. Southern Water responded on the 31st of May 2019 to confirm approval of the submitted strategy (Southern Water reference DS_CPS-108142) and as such no major deviation to the approved strategy is proposed.

Southern Water have noted that the Section 106 approval does not confirm capacity is available for the proposed development in the public sewer network, it is proposed for Southern Water to be engaged in order to confirm adequate capacity exists within their system prior to this connection taking place.

Southern Water advised that they have no objections to discharge the outstanding planning condition 27 relating to foul and surface water drainage to the site based on the previously submitted information

8. 2. Foul Water Strategy

Foul effluent generated by the Canterbury Riverside development is captured in an independent foul drainage system. It is required for a clear delineation of legal ownership and maintenance responsibilities during the systems operational life is developed.

The mixed-use development will be occupied by a large variety of different use classes. Foul effluent from the development will be generated from apartments, student dwellings, plant & amenity, commercial space, restaurants and a cinema. All foul drainage is to be collected under gravity and directed to a new proposed main sewer running within the public spaces proposed across the development.

At the time of writing this report it is understood that all new proposed main foul sewers are to be offered for adoption by the Local Water Authority, and as such will be designed and constructed in line with Sewers for Adoption 7th Edition.

All foul flows will discharge under gravity to the existing public sewer running within and serving the site. It is proposed that a new manhole will be constructed over the existing sewer run, and connection to this will be the methodology of connection to the existing system.

8. 3. Grey Water Strategy/Flood Water Drainage

It is currently proposed that the lower ground floor car park will be sacrificial in the event of a flood, and serve as functional flood plain. The requirement for floodplain compensation has been evaluated as part of the Flood Risk Assessment process, it has been concluded that the proposed development would provide circa 1000m^3 of floodplain compensation per 200mm flood band above existing site levels.

No strategy for draining flood waters once the flood event subsided has been submitted for LLFA review historically. It is proposed for a grey water network to be constructed for the purpose of draining car park wash down during the normal operation of the car park. All flows from the grey water system will pass through a bypass separator prior to discharging to the public foul water sewer under gravity. It is proposed for a manual mechanism to be provided to prevent flow through the grey water outfall during a flood occurrence, the valve will then be opened to allow for flood waters to drain away once the flood has subsided, this strategy will be included in the maintenance plan for the proposed development.

9. Design Standards and Assessment Criteria

9. 1. Design Standards

BS EN 752:2017	Drain and sewer systems outside buildings
BS EN 12056:2000	Gravity drainage systems inside buildings
BS EN 16933-2:2017	Drain and sewer systems outside buildings. Design. Hydraulic design.

9. 2. General References

CIRIA Report C753	The SuDS Manual
Water Research Centre	Sewers for Adoption 7th Edition
The Building Regulations Approved Document H	Drainage and waste disposal
Greater London Authority	The London Plan

9. 3. Assessment Criteria

When designing the below ground surface water drainage network it has been assessed against the following criteria to comply with British and European Standards BS EN 752:2017 and BS EN 16933-2:2017;

- No significant surcharging (gravity flow only) for storm flows with a 50% AEP
- No flooding for storm flows with a 3% AEP
- No flooding off-site or flooding that would present a risk to person or property for storms with a 1% AEP
- An additional 30% allowance for climate change will be applied to all calculations for network design
- The network will be checked against the effects of 40% climate change to check there is no significant flooding that could cause risk to person or property

Based on the above assessment, the volume of storage required on site has been determined using the Micro drainage analysis software based on the following input variables;

- Storm Water Return Period - 1 in 100 years + 40%
- Site location – to determine the rainfall hyetograph characteristics
- Pipe network volume – calculated by the automated process
- Out flow control device –vortex flow control (Hydrobrake or similar)

Foul water drainage design will be in accordance with BS EN 752:2017 and BS EN 16933-2:2017.

Flow rates will be based on the following;

- The frequency factor will be determined by the buildings use. (Table 3 BS EN 12056-2:2000)
- The volume of discharge will be determined by the number of appliances. (Table 2 BS EN 12056-2:2000)

The value of the summation of discharge units is then converted into a flow rate using where applicable cl 6.3.3 of BS EN 12056-2:2000.

Where the flow rate requires the use of a sewer greater than 150mmØ, the Population Method will be used based on flows of 0.007 l/s/person (105 litres/person/day, DWF of 6.

For peak flow the maximum proportional depth is to be no more than 0.75.

Minimum gradients to achieve self-cleansing velocities will be in accordance with BS EN 16933-2:2017 NA.5.2.4. Where it is not possible to achieve self-cleansing velocities, the following table will be used;

Table NA.7 — Minimum recommended gradients for foul drains and sewers

Peak flow [l/s][a]	Pipe size [mm]	Minimum gradient[b,c,d]
<1	75	1 in 40
	100	1 in 40
>1	75	1 in 80
	100	1 in 80[e]
	150	1 in 150[f,g]

[a] Peak flows should be based on probability flow calculation methods.

[b] These gradients have been empirically demonstrated on the basis of 6 l WC flush volumes. Further research is necessary to evaluate the recommended gradients for use in systems with very low WC flush volumes.

[c] Exceptionally, where the length of drain or sewer serving a small number of properties is very long, steeper gradients may be required.

[d] Where ground settlement is expected, steeper gradients are recommended.

[e] Minimum of one WC connected.

[f] Minimum of five WCs connected.

[g] Exceptionally, where a 150 mm diameter pipe is used to carry flows from fewer than five WCs, the minimum gradient should be 1 in 60.

It may be possible to use flatter gradients if standards of design and workmanship are high, and where buildings are close together so that the lengths of drain or sewer are short. Exceptionally, where the length of drain or sewer serving a small number of properties is very long, steeper gradients may be required.

9. 4. Provision for Maintenance

Foul drainage has been designed to promote self-cleansing velocities. The surface water system which is designed to surcharge in heavy rainfall events will reduce the likelihood of siltation. Attenuation features have been situated with access and capability for jet cleaning. Where possible drainage infrastructure has been located accessible by public roadway.

10. Below Ground Drainage Maintenance Plan

10.1. Introduction

This Below Ground Drainage Maintenance Plan has been prepared to provide supplementary information to aid in the amendment to Watford Borough planning permission reference 17/01367/FULM in regards to the proposed development in Watford.

All below ground drainage components on the Canterbury development should be inspected regularly and maintained to ensure design flow conditions are maintained. Inspection and maintenance will be the responsibility of the building management company.

The purpose of a Maintenance Plan is to ensure that the drain and sewer system is kept in such a condition that it can perform its function satisfactorily and meet the performance requirements. A maintenance plan should cover:

- Pipelines including inspection chambers, manholes and outfalls, taking into account the gradient and/or velocity.
- Pumping installations, according to potential risk and type of equipment.
- Overflows and detention tanks, taking into account storm frequency.
- Inverted siphons, depending on risk of blockage and potential consequences.
- Separators, according to technical requirements.
- Grit chambers, gullies etc., taking into account storm frequency, capacity and land use.

It is recommended that Below Ground Drainage Maintenance Plan is implemented. Reference should be made to Section 6.0 of BSEN 752:2017 but in general maintenance activities are likely to comprise of:

- Regular Maintenance – Litter collection, gardening to control vegetation growth, inlet checks.
- Occasional Tasks – Checking the SuDS features and removing any silt that builds up.
- Remedial Work – Repairing damage where necessary.

10. 2. Proposed Below Ground Drainage Maintenance Plan

Below is an indication of the minimum expected undertakings to inspect and monitor the onsite below ground drainage at the development. The below list is not extensive and is to be read in conjunction with any specific inspection and maintenance requirements set by product manufacturers.

Table 10.2.1– Drainage Maintenance Plan

Regular Maintenance	Frequency	Responsibility
The inspection of drainage channels, gullies and sumps in manholes. All traps should be topped up with water where unused to prevent drying out.	Monthly. More regular in warm weather	Site Maintenance Contractor
Inspect below ground drainage components from the surface, removing obstructions and silt as necessary. Check there is no physical damage.	6 Monthly.	Site Maintenance Contractor
Regular sweeping or blowing or pavement to remove any debris that can clog.	Monthly.	Site Maintenance Contractor
Inspection of flow control device to identify any areas that are not operating correctly and clear out and debris from chamber.	Monthly for first 3 months then every 6 months	Site Maintenance Contractor
Inspect inlet structures such as RWP's, channel drains and gullies removing silt as necessary. Check for any physical damage.	Monthly	Site Maintenance Contractor
Inspect and identify any areas of pipework that isn't operating correctly, undertake remedial works if required.	Monthly for first 3 months then annually	Site Maintenance Contractor
Maintain vegetation to designed limits within the vicinity of all below ground drainage structures and pipes.	Annually or as required	Site Maintenance Contractor
Remove debris from catchment surface where it presents a risk to the performance of the below ground drainage system.	Monthly or as required	Site Maintenance Contractor

Occasional Tasks	Frequency	Responsibility
Inspect drainage runs using CCTV technology and undertaking cleaning when required with a high-powered jet cleaner.	Every 6-8 Years	Specialist Maintenance Contractor
Sweep and vacuum permeable pavement to prevent silt blockage.	Annually	Specialist Maintenance Contractor
Remove covers on inspection chambers and inspect, ensure that water is flowing freely and is unobstructed. Remove debris and silt as required.	Annually	Site Maintenance Contractor

Remedial Work	Frequency	Responsibility
Monitor the effectiveness of areas of permeable paving, where water pools and does not infiltrate immediately advise Client of any remedial action required.	As required	Site Maintenance Contractor
Remedial works to be undertaken as necessary on below ground drainage systems following observations from regular and occasional maintenance tasks.	As required	Specialist Maintenance Contractor

Note:

- Special inspection and immediate appraisal may be required in the event of a structural accident, fire, flooding, reported structural distress or suspected inadequacy.
- It is recommended that in situations where an expected severe storm is to hit that all gullies, drainage channels and manhole sumps are cleared of any debris material.
- Refer to the manufactures of all attenuation systems and flow control devises for their specific inspection regime requirements for their products.
- All inspections should be carried out by the appropriate persons and they should be confined space trained if entering below ground structures such as manholes or attenuation tanks.

10. 3. SuDS Maintenance Requirements

It is imperative that regular Maintenance is undertaken on SuDS features across the site. Table 10.3.1 below outlines the minimum expected maintenance activities required on specific SuDS features to enable continuous operational performance in line with CIRIA SuDS Manual guidance.

Table 10.3.1 – Minimum SuDS Maintenance

Geocellular Attenuation Storage Tank Operations and Maintenance requirements		
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 may cause risk to performance)	Monthly
	Remove sediments 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

Proprietary Treatment System Operations and Maintenance requirements		
Maintenance schedule	**Required Action**	**Typical frequency**
Regular maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Change the filter media	As recommended by manufacturer
	Remove Sediment, oil, grease and floatables	As necessary - indicated by system inspections or immediately following significant spill
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operations	Six monthly
	Inspect filter media and establish appropriate replacement frequencies	Six monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operations, then every six months

It is recommended that the above Below Ground Drainage Maintenance Plan be adopted and undertaken for the development and incorporated into the wider Integrated Server System Management Plan for the entire development and overseen by suitable facilities management personnel.

For all attenuation systems, proprietary treatment systems, backflow prevention devices and pumps the above maintenance plan is to be read in conjunction with any specific inspection and maintenance requirements set by product manufacturers.

The above is not an exhaustive list and is a guide on the minimum expected inspection to be undertaken on the below ground drainage. Additional or more frequent inspections can be undertaken to ensure the below ground drainage network operates appropriately and is maintained to a level suitable to accommodate the peak design flows.

11. Conclusion

This Drainage Strategy has been prepared in accordance with best practice, the Outline Drainage Strategy by KSA, and in line with the submitted FRA. Where deviation from prior reviewed documents is proposed, this has been outlined.

The proposed drainage system detailed design has been carried out in line with best practice and set out to ensure surface water flooding does not provide a hazard to people or property, exceedance flows having been considered. Calculations have been provided to show the proposed attenuation volumes, and outfalls are sufficient to prevent the site from flooding during the design scenarios and criteria set out.

A sustainable drainage strategy has been applied to the site in line with best practice. SuDS components are to be constructed to encourage losses to atmosphere.

The site will not be unduly at risk from Pluvial flooding, and the development proposals should reduce flood risk on site and off site.

The detailed design of the proposed surface water drainage system has been carried out in accordance with BS EN 752:2017, and checked using XP Microdrainage modelling software using FeH data, to satisfy the requirements of the NPPF.

Onsite surface water will be managed by designing the developments surface water system so that no flooding will occur during storms up to and including that with an AEP of 1% with a 40% allowance for climate change and implementing appropriate pollution hazard mitigation.

It is proposed for a grey water network to be constructed for the purpose of draining car park wash down during the normal operation of the car park. Manual mechanism to be provided to prevent flow through the grey water outfall during a flood occurrence, the valve will then be opened to allow for flood waters to drain away once the flood has subsided, this strategy will be included in the maintenance plan for the proposed development.

This Drainage Design Philosophy demonstrates that the proposed development drainage design achieves the principles of sustainable drainage design set out in the NPPF in regards to surface water discharge strategy and sustainable drainage principles.