

29/07/2022

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Dear Ms Parkin,

RE: S.73 Application at Former Gravesend Hospital (ref. PP-11405168), confirmation of validity documents submitted with parent permission (ref. 20190504).

We, Herrington Consulting Ltd., prepared a Flood Risk and Sustainable Drainage Assessment on behalf of Peker Holdings in support of approved application ref. 20190504 at the Former Gravesend and North Kent Hospital (M Block) Clifton Road Gravesend, Kent, approved on the 17th February 2022.

I, on behalf on Herrington Consulting Ltd, am writing to confirm that the conclusions of the Flood Risk and Sustainable Drainage Assessment remain unchanged by the amendments proposed through the S.73 application (ref. PP-11405168) submitted on behalf of Strawberry Star SL1 Limited.

I trust that the above confirmation is sufficient in confirming the veracity of the previously submitted report.

Yours faithfully,

Simon Maiden-Brooks BSc. (Hons) MSc. C.Eng C.WEM MCIWEM
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herrington

CONSULTING LIMITED



Client: Peker GYO

Flood Risk and Sustainable Drainage
Assessment for the Proposed
Development at M Block Former
Gravesend & Kent Hospital,
Bath Street, Gravesend,
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May 2019

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This report has been prepared by Herrington Consulting Ltd in accordance with the instructions of their client, **Peker Gayrimenkul Yatirim Ortakligi A.S.** for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

Client: Peker GYO

Flood Risk and Sustainable Drainage
Assessment for the Proposed Development at M
Block Former Gravesend & Kent Hospital,
Bath Street, Gravesend, Kent

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1 Scope of Appraisal

Herrington Consulting has been commissioned by **Peker Gayrimenkul Yatirim Ortakligi A.S** to prepare a Flood Risk and Sustainable Drainage (SuDS) Assessment for the proposed development at **M Block Former Gravesend & Kent Hospital, Bath Street, Gravesend, Kent, DA11 0DG.**

A Flood Risk Assessment (FRA) appraises the risk of flooding to development at a site-specific scale and recommends appropriate mitigation measures to reduce the impact of flooding to both the site and the surrounding area. New development has the potential to increase the risk of flooding to neighbouring sites and properties through increased surface water runoff and as such, an assessment of the proposed site drainage can help to accurately quantify the runoff rates, flow pathways and the potential for infiltration at the site. This assessment considers the practicality of incorporating Sustainable Drainage Systems (SuDS) into the scheme design, with the aim of reducing the risk of flooding by actively managing surface water runoff.

This report has been prepared to supplement a full planning application and has been prepared in accordance with the requirements of both national and local planning policy. To ensure that due account is taken of industry best practice, reference has also been made to, CIRIA Report C753 'The SuDS Manual' and any relevant local planning policy guidance. The surface water management strategy included within this report is not intended to constitute a detailed drainage design.

2 Background Information

2.1 Site Location and Existing Use

The site is located at OS coordinates 564460, 174335 off Bath Street in Gravesend and covers an area of approximately 0.4 hectares. The location of the site in relation to the surrounding area is shown in Figure 2.1.

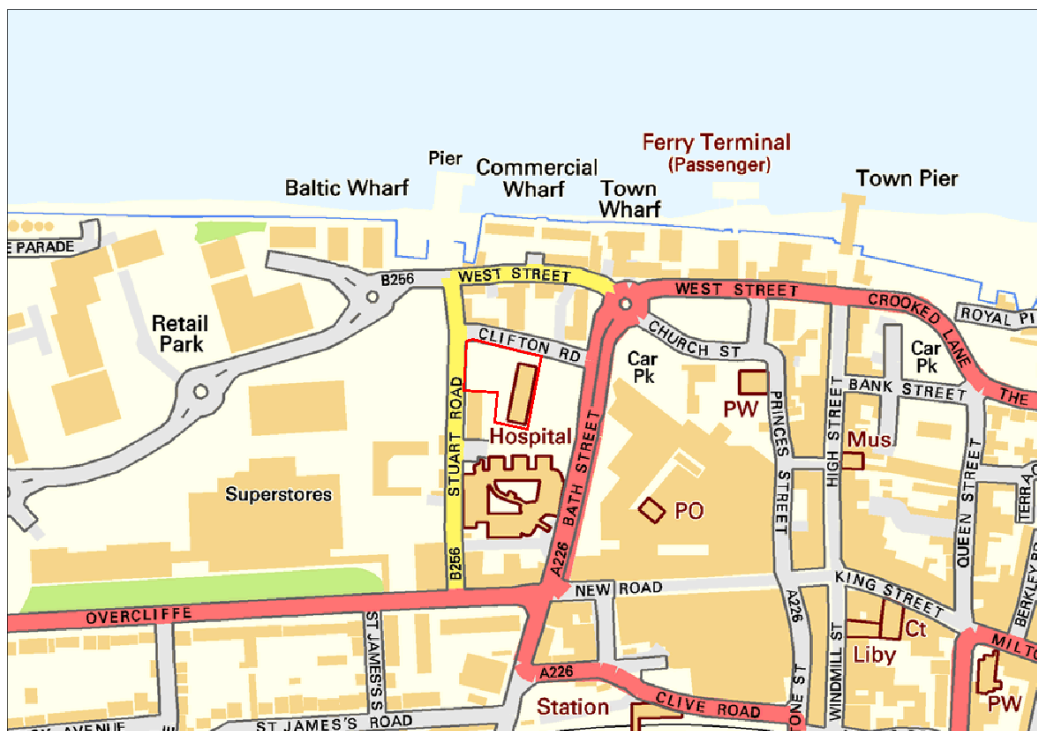


Figure 2.1 – Location map (Contains Ordnance Survey data © Crown copyright and database right 2019).

The site currently comprises a former hospital building and associated land.

2.2 Site Geology and Topography

Reference to the British Geological Survey (BGS) data identifies that the geology at the site comprises Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation [Undifferentiated] bedrock, with no overlying superficial deposits.

Reference to the site-specific topographic survey identifies that land levels at the site vary between 7.61m – 12.98m AODN, with a gradual fall towards the northeast.

2.3 Proposed Development

The development proposals comprise 110 residential dwellings, associated landscaping and parking.

Further drawings of the proposed scheme are included in Appendix A.1 of this report.



Figure 2.2 – Proposed Development Plan

The important characteristics of the site that have the potential to influence the surface water drainage strategy are summarised in Table 2.1 below.

Site characteristic	Existing site	Proposed development
Total area of site		~0.39 ha
Current site condition		Brownfield
Greenfield runoff rates (based on the IH124 methodology)		Q1 = 1.84 l/s/ha Qbar= 2.1 l/s/ha Q30= 4.98 l/s/ha Q100= 6.91 l/s/ha
Infiltration coefficient	0.0055 m/hr (assumed based on underlying geology and typical soil conditions).	
Current surface water discharge method	Assumed to drain to public surface water drain within Clifton Road.	
Is there a watercourse within close proximity to site?		No
Impermeable area		Existing = 2,000 m ² Proposed = 3,360 m ²

Table 2.1 – Site characteristics affecting rainfall runoff

Based on the table above, it is evident that the development proposals will increase the total impermeable area across the site. As a result, the rate at which the surface water runoff is discharged from the site is likely to increase. Consequently, measures will need to be put in place to ensure that the impact of this additional surface water runoff is appropriately managed.

2.4 Planning Policy and Context

The general requirement for all new development is to ensure that the runoff is managed sustainably, and that the development 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 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 provides additional detail and requirements not initially covered by the NPPF and are (non-statutory) Technical Standards for Sustainable Drainage Systems (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 110 residential units with a total floor space greater than 1,000m². As a result, the proposals are classified as ‘major’ development and therefore, the NTSS will apply. Reference to the NTSS has been made throughout the following sections of this report to ensure that the principles of sustainable drainage are considered.

In addition to the NTSS, Kent County Council’s (KCC) Drainage and Planning Policy Statement (June 2017) also applies. Most notably this document states that in the absence of FEH rainfall data, a rainfall depth of 26.25mm for M5-60 event should be applied

2.5 Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential futures changes in the climate and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present, and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall, and more frequent periods of long-duration rainfall (of the type responsible for the recent UK flooding) could be expected.

These effects will tend to increase the size of flood zones associated with rivers, and the amount of flooding experienced from other inland sources. Consequently, the following section of this report takes into consideration the impacts of climate change and references the most contemporary guidance which is applicable to the development site.

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on climate change predictions which are commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development should be considered for a minimum of 100 years, but that the lifetime of a non-residential development depends on the characteristics of the development. The development that is the subject of this SWMS is classified as residential, and therefore a design life of 100 years has been assumed.

Potential Changes in Climate

The recommended allowances for increases in peak rainfall intensity were updated by the Environment Agency in February 2016 and are applicable nationally. These allowances, shown in Table 2.2 below, provides a range of values which correspond with the Central and Upper End percentiles (i.e. the 50th and 90th percentile respectively) over three-time epochs.

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

Impacts of Climate Change on the Development Site

Potential increases in future rainfall need to be considered when designing surface water drainage systems. For this development, a design life of 100 years is assumed and therefore, an increase of 20% in peak rainfall intensity has been applied to the calculations used for the design rainfall event. Where this allowance has been applied the abbreviation “+20%cc” has been used.

To test the sensitivity of the proposed surface water drainage strategy to changes in peak rainfall intensity, the Environment Agency recommend testing the drainage system under a higher climate change allowance of 40%. This has been considered further within the following sections of this report.

3 Potential Sources of Flooding

In determining whether the proposals for development are compliant with the NPPF, it is necessary to determine whether the development will be sustainable in terms of flood risk. Consequently, the main sources of flooding have been assessed and are discussed in Table 3.1 below.

Source of Flooding	Evidence
Risk of Flooding from Rivers	The Environment Agency's Flood Zone mapping shows the site is situated in Flood Zone 1 and is therefore not at risk of flooding from a fluvial source. Consequently, the risk of flooding to the site from rivers is considered to be <i>low</i> .
Risk of Flooding from Sea/Estuaries	The site is elevated above predicted extreme tide levels and consequently, the risk of flooding from this source is considered to be <i>low</i> .
Risk of Flooding from Ordinary and man-made watercourses	Inspection of OS mapping of the site and surrounding area reveals that there are no non-main rivers or artificial watercourses within close proximity to the site and therefore the risk of flooding from this source is considered to be <i>low</i> .
Risk of Flooding from Overland flow	A review of the Environment Agency 'Flood Risk from Surface Water' mapping identifies that the majority of the site is at 'very low' risk of flooding from surface water. This is supported by the SWMP which indicates the site has not been affected by surface water flooding in the past. However, the mapping does show a small area of the site adjacent to the existing hospital building where surface water is shown to pond, marked as 'low' to 'high' risk. Inspection of the topographic survey reveals a small topographic depression in this part of the site, which could encourage surface water to pond. However, the accumulation of water at this location is likely to be directly linked to the runoff from the site itself and as the development proposals comprise the construction of an apartment block across the entire site, this small topographic depression is likely to be infilled. Therefore, surface water will be unable to accumulate in the location shown by the EA mapping. In addition, the proposals for development will include a sustainable drainage system (SuDS) to ensure that surface water runoff is managed appropriately. These SuDS will reduce the risk of surface water flooding to the proposed development, whilst limiting the risk of flooding to the surrounding area. Therefore, as a result of the proposed mitigation, the risk of flooding from this source is considered to be <i>low</i>.
Risk of Flooding from Groundwater	Groundwater flooding is most likely to occur in low lying areas underlain by permeable rock (aquifers). The underlying geology in this area is Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation. Chalk is characteristically impermeable; however, water can pass through faults and discontinuities in the rock, and as such chalk formations can be susceptible to groundwater emergence. Inspection of mapping provided as part of the Defra Groundwater Flood Scoping Study (May 2004) shows that no groundwater flooding events were recorded near the site during the very wet periods of 2000/01 or 2002/03. In addition, a review of nearby borehole records show that groundwater was recorded over 12m below ground level. Notwithstanding this, in the event that groundwater was to emerge at, or near to the site, any floodwater will flow away from the site to the northeast towards the River Thames following the sloping land levels. Consequently, the risk of flooding to the site from groundwater is considered to be <i>low</i>.

Source of Flooding	Evidence
Risk of Flooding from Sewers	Inspection of the asset location mapping provided by Southern Water identifies that there are no sewers on site. The mapping does show a small network of foul sewers to the south of the site which act to drain the residential properties in this location. These foul sewers connect to a larger combined sewer which runs along Stuart Road. This sewer continues away from the site to the north and west, towards a pumping station located approximately 120m from the site itself. In the event that this sewer network was to become overwhelmed (i.e. as a result of an extreme pluvial event), water is most likely to exit the sewer system away from the site, at the bottom of the network near to the pumping station. The asset location mapping also identifies a surface water sewer to the north of the site along Clifton Road. Interrogation of aerial height data shows that land levels along Clifton Road fall to the north and east. As such, in the event that water was to exit this surface water sewer (i.e. as a result of a blockage or extreme pluvial event), floodwater will be directed away from the site towards the lower lying land to the north and east. Therefore, taking the above into consideration, the risk of flooding to the site from sewers is considered to be <i>low</i>.
Risk of Flooding from Artificial Sources	Inspection of the OS mapping for the area shows that there are no artificial sources of flooding within close proximity to the site. In addition, the Environment Agency's 'Flood Risk from Reservoirs' website shows that the site is not within an area considered to be at risk of flooding from reservoirs. Consequently, the risk of flooding is considered to be <i>low</i>.

Table 3.1 – Assessment of the risk of flooding from all sources.

From the analysis in Table 3.1, it can be seen that the site is not exposed to any significant risks of flooding.

From Figure 4.1 (above) it is evident that the sewers in this area are typically separated into dedicated surface water and foul water networks. The nearest surface water sewer to the site is located within Clifton Road.

5 Sustainable Drainage Assessment

5.1 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 most preferential 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 conducted 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 – The soil and underlying geology at this location has been analysed using the British Geological Surveys mapping. The geology is made up of Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation, which is likely to have a high permeability, capable of discharging surface water runoff. Infiltration co-efficient details have been taken from the CIRIA SuDS manual to apply a value which represent a 'typical value'. Notwithstanding this, it is recommended that infiltration testing is carried out at detailed design stage to confirm the exact infiltration rate. Due to the lack of open space within the development, it is not possible to discharge all of the sites surface water runoff into the ground.

A joint solution termed by CIRIA C753 as 'Type B SuDS' can be used to discharge surface water from the site. This approach combines infiltration with attenuation to maximise discharge at source, whilst simultaneously ensuring any runoff which is not infiltrated into the ground can instead be restricted to policy compliant rates. A connection to the public surface water sewer would be required to ensure that this method is acceptable.

Discharge to Watercourses – There are no watercourses located within close proximity to the site which show onward connectivity to a main river, the sea, or any other large surface water body. As a result, there is no opportunity to discharge surface water runoff from the development to an existing watercourse.

Discharge to Public Sewer System – A solution for draining surface water runoff from the proposed development is viable via the (assumed) existing connection to the public sewer network. With no alternative preferred options available, it is assumed that the existing connection will present the most viable solution for managing the surface water runoff discharged from the

development. However, a type 'B' SuDS system should be used in conjunction with this piped drainage system where appropriate.

5.2 Proposed Surface Water Management Strategy

The drainage strategy set out below discusses each of the different elements of the proposed scheme, along with calculations that have been undertaken 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.

Surface water runoff landing on the roofs and hardstanding areas will be collected by a series green roofs and permeable surfacing before discharging to the into the ground via infiltration and overflowing into the public sewer. The green roofs and permeable surfacing will attenuate surface water in order to reduce the peak discharge rate and volume entering the public sewer. The peak discharge rate will be reduced using a vortex flow control device and an infiltration rate of 0.0055 m/hr has been assumed. Cellular storage has been proposed to provide further offline attenuation. The abovementioned SuDS, when combined with a vortex flow control device, will ensure the peak discharge rate into the public sewer is at least 50% of the existing brownfield runoff rate.

A schematic drainage layout showing the location of the SuDS features can be found in Figure 5.2 and a full indicative drainage layout is appended to this report.

Green Roofs

A green roof will be located across the podium deck. Rain landing on the green roof will be intercepted, and during low return period events, will store and filter a large amount of runoff from the roof area within the soil substrate of the planted areas. The location and extent of the proposed green roof is shown on Figure 5.1 (below). The design of the green roof should include an adequate drainage layer to avoid stagnation and overflow systems in case the primary discharge pipe becomes blocked.



Figure 5.1 – Plan showing the location of the proposed green roofs.

Although the incorporation of green roofs will provide a significant benefit to the quality of water discharged from the roofs under higher return period events, it is unlikely that a green roof can be designed to restrict the rate at which runoff which is discharged from the site. Consequently, additional storage for storm water will be provided.

Permeable Paving

The drainage strategy includes a permeable paving system situated in the proposed road, designed to provide attenuation and infiltration for the surface water runoff discharged from the roof and hardstanding areas of the development. A vortex flow control device is recommended to reduce discharge rates to at least 50% of the existing brownfield runoff rates. A schematic drainage layout showing the location of the SuDS features can be found in Appendix A.3.

A summary of the Causeway Flow+ analysis for permeable paving is shown in Table 5.1 below.

Parameter	Value (1:100yr+20%cc event)
SuDS	Permeable Paving
Total area draining to permeable paving	3,360 m ²
Area of permeable paving	360 m ²
Depth of Sub-base	~ 650 mm
Porosity	0.30
Infiltration	Yes (0.0055 m/hr)
Flow control device	Vortex flow control device (set at 200mm above IL).
Limiting discharge rate	20.0 l/s
Critical storm duration	240 minutes

Table 5.1 – Summary of analysis for permeable paving.

Cellular storage

In order to provide further attenuation for the surface water runoff from the roof of the development, it is proposed to locate a cellular storage system within the car park. Cellular storage typically provides the greatest volume of storage for surface water within a site, which is attributed to the high porosity associated with these SuDS features. The cellular storage is hydraulically linked to the permeable paving and will act as a form of offline storage.

A summary of the Causeway Flow+ analysis for cellular storage is shown in Tables 5.2 below.

Parameter	Value (1:100yr+20%cc event)
SuDS	Cellular storage
Volume of storage	~ 68.4 m ³
Porosity	0.95
Depth	400 mm
Infiltration	Not permitted (lined system)
Critical storm duration	240 minutes
Flooded volume	0 m ³

Table 5.2 – Summary of Causeway Flow+ analysis for the cellular storage.

A comparison of the pre and post development discharge rates for the site can be found in Table 5.3 below.

Discharge rates	(A) Pre-development brownfield runoff rates	(B) Post-development discharge rates	Difference (A-B)
1 year	39.8 l/s	0.0 l/s	39.8 l/s (reduction)
30 year	97.6 l/s	7.2 l/s	90.4 l/s (reduction)
100 year	126.6 l/s	16.9 l/s	109.7 l/s (reduction)
100 year +20%cc	N/A	20.0 l/s	106.6 l/s (reduction when compared to 1:100 no cc)

Table 5.3 – Comparative summary of peak discharge rates for a range of return period events.

It is evident that, with the inclusion of the proposed SuDS, there is the potential to accommodate all the surface water runoff from the site up to, and including, the design rainfall event. This assumes the rate at which water is discharged to the public sewer system will be attenuated to a minimum rate of 50% of the brownfield runoff rates.

5.3 Indicative Drainage Layout Plan

Figure 5.2 below is an indicative drainage layout plan delineating how the proposed SuDS can be incorporated into the scheme proposals.

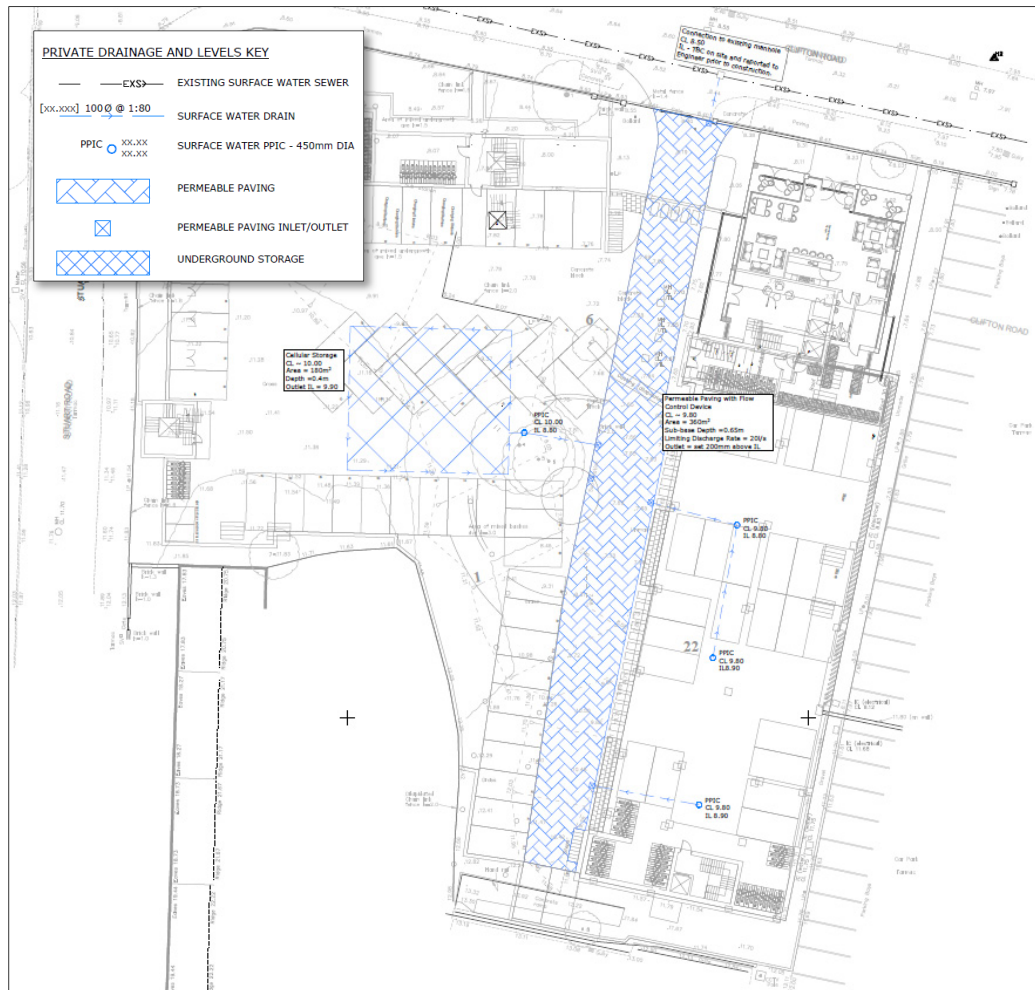


Figure 5.2 - Indicative drainage layout plan showing the proposed location of SuDS.

A full copy of this layout is located in Appendix A.3 of this report.

5.4 Management and Maintenance

In order for any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime. Therefore, over the lifetime of a development there is a possibility that the performance of the system could be reduced or could fail if it is not correctly maintained. This is even more important when SuDS form a part of the surface water management system, as these require a more onerous maintenance regime than a typical piped network.

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 features 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 the regular brushing and cleaning of the permeable surfacing and the pruning of vegetation across the site. Appendix A.5 provides details on the typical maintenance requirements for each of the proposed SuDS. It is acknowledged that inspections and maintenance procedures are likely to be required at a higher frequency during the first few years following construction as each of the systems becomes established.

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.

The management company responsible for maintaining the rest of the site will be tasked with the inspection and maintenance of the permeable paving system. In addition, the regular inspection and desilting of the manholes will need to be carried out.

For some elements of the drainage system, including the green roofs and flow control device, it may be necessary to use specialist contractors or have the original manufacturer inspect the features.

Further details of the maintenance and management strategy should be confirmed following the completion of a detailed drainage design for the development.

5.5 Sensitivity Testing and Residual Risk

When considering residual risk, it is necessary to consider the impact of a flood event that exceeds the design event, or the implications if the proposed drainage system was to become blocked.

To minimise the risk of the uncontrolled discharge of floodwater from the permeable surfacing system, an overflow pipe has been incorporated into the design of this drainage feature. If the primary flow control device becomes blocked, this pipe will be used to bypass the flow control device, allowing excess water to drain directly to the public sewer system.

The surface water drainage system has been designed to accommodate the runoff generated under an extreme rainfall event with a 1 in 100 year return period, including a 20% allowance for climate change (to account for the impacts of climate change). Nonetheless, based on the EA's current

climate change guidance, an Upper End climate change allowance of 40% has also been applied to account for any uncertainties associated with the predictions of future climate change, and to test the sensitivity of the proposed drainage system.

A summary of the Causeway Flow+ calculations is provided in Table 5.3 below, which can be used to measure the performance of the proposed drainage system for a rainfall event with a 1 in 100-year return period, including a 40% allowance for climate change.

Parameter	Value
Critical storm duration	360 minutes
Freeboard	0mm (storage is surcharged)
Flooded volume	26.5 m ³
Peak discharge rate	20.6 l/s

Table 5.3 - Summary of the Causeway Flow+ analysis for the permeable surfacing, including a 40% allowance or climate change.

The analysis in Table 5.3 shows that the proposed drainage system will flood if the peak rainfall intensity is increased to 40%. The access road could be installed with standard HB2 kerbs to provide 125mm of upstand within the car park. The flooded volume of 26.62m³ would pond within the access road and flood to a depth of approximately 73mm. This demonstrates that the flooding for the stated exceedance event would present a low risk to residents.

6 Conclusions and Recommendations

The overarching objective of this report is to appraise the proposals for the development at Bath Street, Gravesend to ensure that the risk of flooding to the occupants of the proposed residential units is acceptable and that the risk of flooding offsite will not increase as a result of the development proposals. This report has therefore been prepared to appraise the risk of flooding from all sources and to provide a sustainable solution for managing the surface water runoff discharged from the development site, in accordance with the NPPF and local planning policy.

As part of this assessment, the risk of flooding has been considered for a wide range of sources and it has been identified that the risk of flooding to the proposed development is low. Notwithstanding this, in order to minimise the impact that the building could have with respect to an increase in surface water runoff, the opportunities for managing surface water at the site have been further analysed.

It is concluded that the most viable solution for managing all of the surface water runoff discharged from the proposed development will be via type B SuDS, utilising a connection to the public surface water sewer system and infiltration.

In order to restrict the rate at which surface water runoff is discharged offsite, various SuDS have been proposed, including; green roofs, permeable surfacing and cellular storage. These SuDS will be used to store water onsite and maximise the water which can be adsorbed by vegetation, or infiltrated into the ground, before it is discharged to the public sewer system. A vortex flow control device has been specified to attenuate the rate at which surface water runoff is discharged from the site, limiting the rate to (a minimum of) 50% of the existing brownfield runoff rates.

Details of the typical maintenance and management requirements for each element of the drainage system have been provided to ensure that the proposed drainage solution can be maintained and will continue to operate in perpetuity. It is, however, recommended that an “owner’s manual” containing additional product specific maintenance requirements is produced as part of the detailed design for the site.

In conclusion, it is evident that the development is at low risk of flooding and a sustainable solution for managing the surface water runoff discharged from the proposed development at Bath Street is available. Consequently, the proposals will meet the requirements of the NPPF and local planning policy.

7 Appendices

Appendix A.1 – Drawings

Appendix A.2 – Southern Water Asset Location Data

Appendix A.3 – Indicative Drainage Layout Plan

Appendix A.4 – Surface Water Management Calculations

Appendix A.5 – Maintenance Schedules

Appendix A.1 – Drawings

PROPOSED GROUND FLOOR SITE LAYOUT



Notes:

- NOTES:
- Do not scale from this drawing.
 - All dimensions to be verified on site and is in mm.
 - Builder to verify all dimensions, heights and levels prior to commencement of work.
 - All documents shall be checked to ensure that they are compatible by the contractor before construction commences. In the event of apparent ambiguity or contradiction the engineer and/ or architect shall be notified immediately.
 - The contractor in preparing his estimate shall visit the site and acquaint himself with the problems involved.
 - The contractor shall issue all statutory notices to the local Authority during progress and completion of works.

REV:	DESCRIPTION:	BY:	DATE:
STATUS:	PLANNING		

**BARRON EDWARDS**
PLANNING & ARCHITECTURE

39 Wrotham Rd,
Gravesend, Kent
DA11 0PN
01474 247 787
info@barronedwards.co.uk
www.barronedwards.co.uk

SITE:	L-Block Former Gravesend and North Kent Hospital DA11 0BY
TITLE:	Proposed Ground Floor Site layout

SCALE: AT A1: 1:200	DATE: 18.04.2019	DRAWN: BE
PROJECT NO: ML-A	DRAWING NO: ML-A-P1	REVISION: A

PROPOSED GROUND FLOOR SITE LAYOUT



Notes:

- NOTES:
- Do not scale from this drawing.
 - All dimensions to be verified on site and is in mm.
 - Builder to verify all dimensions, heights and levels prior to commencement of work.
 - All documents shall be checked to ensure that they are compatible by the contractor before construction commences. In the event of apparent ambiguity or contradiction the engineer and/ or architect shall be notified immediately.
 - The contractor in preparing his estimate shall visit the site and acquaint himself with the problems involved.
 - The contractor shall issue all statutory notices to the local Authority during progress and completion of works.

REV:	DESCRIPTION:	BY:	DATE:
STATUS:	PLANNING		

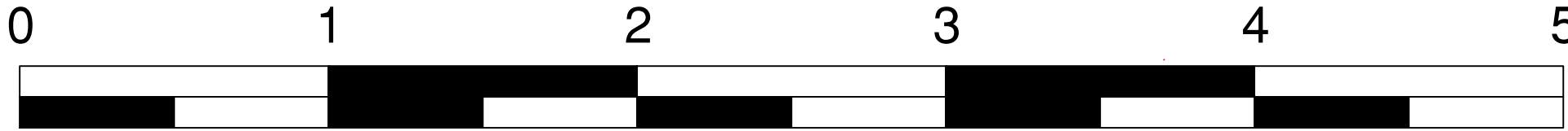
**BARRON EDWARDS**
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39 Wrotham Rd,
Gravesend, Kent
DA11 0PN
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SITE:	L-Block Former Gravesend and North Kent Hospital DA11 0BY		
TITLE:	Proposed First Floor Site layout		

SCALE: AT A1: 1:200	DATE: 18.04.2019	DRAWN: BE
PROJECT NO: ML-A	DRAWING NO: ML-A-P2	REVISION: A

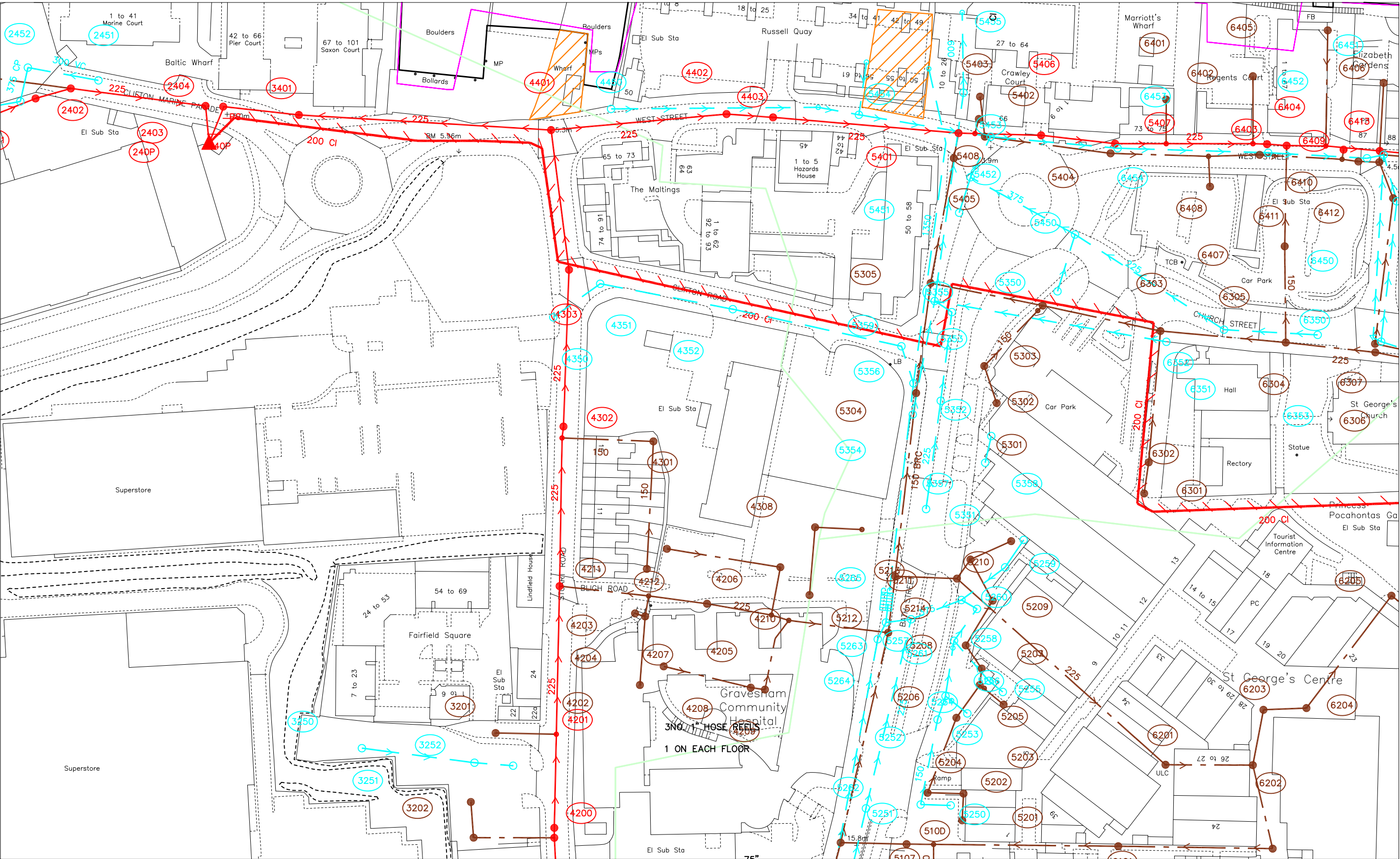
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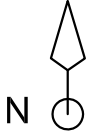
Appendix A.2 – Southern Water Asset Location Data

SEWER RECORDS PAGE 1 OF 2

174479



174191

564224	O.S. REF. TQ6474SW	Drawn by: rohandas	The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site. WARNING: BAC pipes are constructed of Bonded Asbestos Cement WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement	 N		564696
	Title: 322568_M Block Former Gravesen	Scale: 1:1250				
		Date: 04/01/2019	Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530.			

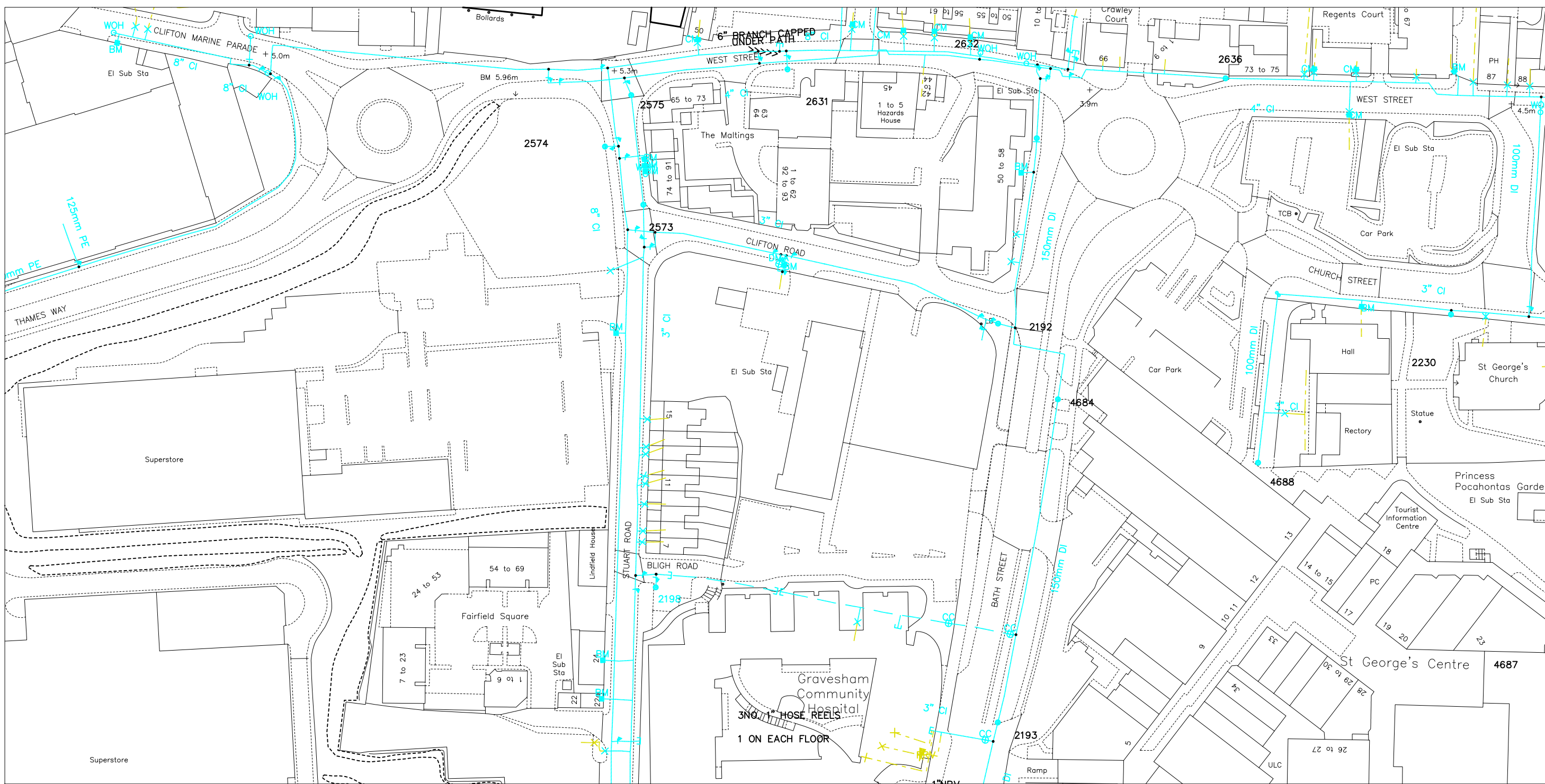
SEWER RECORDS PAGE 2 OF 2

Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape
2401X			225	UNK	CIRC	5251X	15.362	12.042	150	UNK	CIRC	6353X			UNK	UNK	CIRC	*					
2402X	4.735		225	UNK	CIRC	5252X	14.107	11.797	150	UNK	CIRC	6401X			UNK	UNK	CIRC						
2403X			225	UNK	CIRC	5253X	13.689	11.899	150	UNK	CIRC	6402X			UNK	UNK	CIRC						
2404X	4.932	2.702	225	UNK	CIRC	5254X	13.748		225	UNK	CIRC	6403X	4.18	2.61	225	UNK	CIRC						
2450X			375	UNK	CIRC	5255X	14.489	12.269	150	UNK	CIRC	6404X	4.785	1.825	225	UNK	CIRC						
2451X	4.74	3.87	300	VC	CIRC	5256X	13.341	12.131	150	UNK	CIRC	6405X			UNK	UNK	CIRC						
2452X	4.95	3.607	375	CP	CIRC	5257X	12.767		225	UNK	CIRC	6406X			UNK	UNK	CIRC						
3106X			UNK	UNK	CIRC	5258X	11.867	9.407	225	UNK	CIRC	6407X			UNK	UNK	CIRC						
3201X	16.837	15.397	150	UNK	CIRC	5259X	10.519	9.459	150	UNK	CIRC	6408X	4.243	3.503	225	UNK	CIRC						
3202X			UNK	UNK	CIRC	5260X			225	UNK	CIRC	6409X	4.785	4.825	UNK	UNK	CIRC						
3250X	17.64	16.7	UNK	UNK	CIRC	5261X	11.929		375	UNK	CIRC	640DX			225	UNK	CIRC						
3251X	17.07	15.47	UNK	UNK	CIRC	5262X	15.659	14.389	225	UNK	CIRC	6410X	4.488	3.688	225	UNK	CIRC						
3401X	5.087		225	UNK	CIRC	5263X	11.982	8.902	UNK	UNK	CIRC	6411X	5.156	4.126	225	UNK	CIRC						
4112X			225	UNK	CIRC	5264X	12.509	10.119	UNK	UNK	CIRC	6412X	4.532	3.562	225	UNK	CIRC						
4200X	17.518		225	UNK	CIRC	5265X	12.248		UNK	UNK	CIRC	6413X			225	UNK	CIRC						
4201X	14.283		225	UNK	CIRC	5301X	8.08	6.38	150	UNK	CIRC	641DX			225	UNK	CIRC						
4202X			150	UNK	CIRC	5302X	6.67	5.09	150	UNK	CIRC	642DX			225	UNK	CIRC						
4203X	14.385	13.795	150	UNK	CIRC	5303X	5.68		225	UNK	CIRC	643DX			225	UNK	CIRC						
4204X	14.245		150	UNK	CIRC	5304X	7.225	5.225	225	UNK	CIRC	644DX			225	UNK	CIRC						
4205X	13.793	11.133	225	UNK	CIRC	5305X	5.302		225	UNK	CIRC	6450X			UNK	UNK	CIRC						
4206X			UNK	UNK	CIRC	5350X	5.2	3.97	225	UNK	CIRC	6452X			UNK	UNK	CIRC						
4207X			UNK	UNK	CIRC	5351X	9.72	8.5	225	UNK	CIRC	6453X			UNK	UNK	CIRC						
4208X			UNK	UNK	CIRC	5352X	7.24	5.87	225	UNK	CIRC	6454X	3.9		UNK	UNK	CIRC						
4209X			UNK	UNK	CIRC	5353X	5.087	3.957	UNK	UNK	CIRC												
420DX			225	UNK	CIRC	5354X	7.82	4.25	600	UNK	CIRC												
4210X			UNK	UNK	CIRC	5355X	5.313		600	UNK	CIRC												
4211X	3.853	2.933	150	UNK	CIRC	5356X	7.15		1350	UNK	CIRC												
4212X	13.065		UNK	UNK	CIRC	5357X	8.955	6.945	150	UNK	CIRC												
421DX			225	UNK	CIRC	5359X	6.565		UNK	BRC	CIRC												
421DY			225	UNK	CIRC	5401X	3.687	2.297	225	UNK	CIRC												
422DX			225	UNK	CIRC	5402X	3.72	2.62	UNK	UNK	CIRC												
423DX			225	UNK	CIRC	5403X	3.909		UNK	UNK	CIRC												
4301X	11.765	10.715	150	UNK	CIRC	5404X	3.87		225	UNK	CIRC												
4302X	1.663		225	UNK	CIRC	5405X	3.735	2.925	225	UNK	CIRC												
4303X	8.295	6.275	225	UNK	CIRC	5406X	3.968	2.258	225	UNK	CIRC												
4308X			UNK	UNK	CIRC	5407X	3.896	2.156	225	UNK	CIRC												
430DX			150	UNK	CIRC	5408X			225	UNK	CIRC												
4350X			UNK	BRC	CIRC	540DX			225	UNK	CIRC												
4351X	8.437		UNK	BRC	CIRC	5450X	3.817		375	UNK	CIRC												
4352X	8.5		UNK	BRC	CIRC	5451X	4.015		375	UNK	CIRC												
4401X	5.434	3.594	225	UNK	CIRC	5452X	3.78		375	UNK	CIRC												
4401Y	5.434	3.594	225	UNK	CIRC	5453X			UNK	UNK	CIRC												
4402X	4.589	3.359	225	UNK	CIRC	5454X	4.12	2.56	UNK	UNK	CIRC												
4403X	4.37	3.15	225	UNK	CIRC	5455X	4.09	1.74	600	UNK	CIRC												
4450X	5.077		UNK	UNK	CIRC	548DX			UNK	UNK	CIRC												
445DX			UNK	UNK	CIRC	6101X			UNK	UNK	CIRC												
5106X	16.292	13.312	225	UNK	CIRC	6102Y			UNK	UNK	CIRC	*											
5107X	15.882		UNK	UNK	CIRC	6102X			UNK	UNK	CIRC	*											
510DX			UNK	UNK	CIRC	6201X			UNK	UNK	CIRC												
5201X	15.349	12.159	150	UNK	CIRC	6202X			UNK	UNK	CIRC												
5202X	15.339	11.879	150	UNK	CIRC	6203X			UNK	UNK	CIRC												
5203X	15.421	11.851	150	UNK	CIRC	6204X			UNK	UNK	CIRC												
5204X	13.794	11.434	150	UNK	CIRC	6205X			UNK	UNK	CIRC												
5205X	14.489	12.469	150	UNK	CIRC	6301X			UNK	UNK	CIRC												
5206X	3.354	11.254	150	UNK	CIRC	6302X	7.792		UNK	UNK	CIRC												
5207X	13.374	11.174	150	UNK	CIRC	6303X	6.347		225	UNK	CIRC												
5208X	12.661	10.291	150	UNK	CIRC	6304Y	7.114		150	UNK	CIRC	*											
5209X	11.181	9.981	150	UNK	CIRC	6304X	7.114	4.959	225	UNK	CIRC	*											
5210X	10.564	8.964	150	UNK	CIRC	6305X	5.114	3.564	150	UNK	CIRC												
5211X	10.701		150	UNK	CIRC	6306X	7.821		225	UNK	CIRC												
5212X			225	UNK	CIRC	6307X	7.72	6.37	225	UNK	CIRC												
5213Y	11.208		150	BRC	CIRC	6350X	7.152	5.862	225	UNK	CIRC												
5213X	11.208		225	UNK	CIRC	6351X	6.287	5.167	225	UNK	CIRC												
5214X	11.094		225	UNK	CIRC	6352X	6.389	4.739	UNK	UNK	CIRC												
5250X	15.238	12.088	150	UNK	CIRC	6353Y			UNK	UNK	CIRC	*											

LINE STYLES / COLOURS	MATERIALS	LEGEND - SEWERS
Brown Foul Foul Syphon Sewer Foul Vacuum Main Foul Rising Main	AK Alkathene BAC Bonded Asbestos Cement BRC Brick (Common) BRE Brick (Engineering) CC Concrete Box Culvert CI Cast Iron CO Concrete (In-Situ) CP Concrete (Pre-Cast) CSB Concrete Segments (bolted) CSU Concrete Segments (unbolted)	Manhole (SW) Manhole (F&C) Lamp hole (SW) Lamp hole (F&C) Pumping Station (SW) Pumping Station (F&C) Side entry manhole (SW) Side entry manhole (F&C) Blind shaft (SW) Blind shaft (F&C) Ejector station (SW) Ejector station (F&C) Watertight door (SW) Watertight door (F&C) Flushing ch. Min-e (SW) Flushing ch. Min-e (F&C) Flushing ch. No-e (SW) Flushing ch. No-e (F&C) Demarcation Chamber
Red Combined Combined Syphon Sewer Combined Rising Main Lateral Drain Building Over Agreement Area Treated Effluent Sludge Sewer Catchment Section 104 Area Surface Water Surface Water Rising Main Private Access Shaft Decommissioned	DI Ductile Iron GRC Glass Reinforced Concrete GRP Glass Reinforced Plastic MAC Masonry in regular Courses MAR Masonry in random Courses PE Polyethylene PF Pitch Fibre PP Polypropylene PVC Polyvinyl Chloride RPM Reinforced Plastic Matrix SI Spun Iron ST Steel VC Vitrified Clay XXX Other ZZZ Unknown	Washout (SW) Washout (F&C) Rodding Eye (SW) Rodding Eye (F&C) Gauging point (SW) Gauging point (F&C) Intercept chamber (SW) Intercept chamber (F&C) Storm Tank (SW) Storm Tank (F&C) Vortex chamber (SW) Vortex chamber (F&C) Label ellipse Dummy/S24 manhole Outfall Penstock chamber Dambards Storm Overflow Backdrop manhole Other (s) Other Change in sewer (s) Change in sewer Reflex valve Flap valve Cascade Anode Valve Closed Valve Air Valve Hatch box (SW) Hatch box (F&C) Direction arrow Emptying valve Catchpit Soakaway Inlet Balancing Pond
		Wastewater treatment works Marine treatment works Outfall headworks Vent Vent column Tidal storage tank Blank end Head of Public Sewer Micro Pumping Station
		SHAPES (S) A Arched B Barrel C Circular E Egg H Horseshoe R Rectangular S Square T Trapezoidal U U Shape X Other
		NODE REFERENCING SYSTEM 1st digit: hundred metre easting identifier 2nd digit: hundred metre northing identifier 3rd digit: sewer type identifier 4th digit: next sequential node

Drawn by:	rohandas	
Title:	322568_M Block Former Gravesen	
Date:	04/01/2019	

174456



174214

564219

564701

LEGEND - MAINS

	Distribution Main / Communication pipe		Clockwise closing valve
	Trunk Main		Fire Hydrant
	Raw water main		Washout
	Non potable		Washout hydrant
	Abandoned main		Meter
	Proposed Main		Capped end
	Fire main		Emptying plug
	Non SWS		Stopcock
	Sluice valve		Leak Noise Correlator Survey Point
	Closed valve		Anode
	Air valve		Telemetry cable
	Butterfly valve		Access point / hatchbox
	Pressure reducing valve		
	Reflux valve		
	Motorised valve		

MATERIALS

	Dialysis machine	Alkathene
	Break pressure tank	Cast iron
	Change node	Spun (grey) iron
	Pumping station	Concrete
	Booster station	Ductile iron
	Insertion Flow Meter Point	Bonded Asbestos Cement
	Water tower	Glass reinforced plastic
	Service reservoir	Glass reinforced epoxy
	Water Supply Works	(Unplasticised) Polyvinyl chloride
	Bore hole / Well	Polyethylene
	Intake	Steel
	Customer site	Concrete segments bolted
	Swab insertion point	Concrete segments unbolted
		Galvanised iron
		Ductile sleeve
		Concrete pre-stressed
		High performance polyethelene
		Unknown

AK	Drawn by:	rohandas
CI	Scale:	1:1250
SI	Date:	04/01/2019

O.S.Ref: TQ6474SW

TITLE: 322568_M Block Former Gravesen

The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd. accept no responsibility in the event of inaccuracy. The actual positions of pipes should be determined on site.

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WARNING: BAC pipes are constructed of Bonded Asbestos Cement

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement

Appendix A.3 – Indicative Drainage Layout Plan



PRIVATE DRAINAGE AND LEVELS KEY	
— EXS —	EXISTING SURFACE WATER SEWER
[xx.xxx] 100@ @ 1:80	SURFACE WATER DRAIN
PPIC ○ xx.xx xx.xx	SURFACE WATER PPIC - 450mm DIA
[Blue hatched box]	PERMEABLE PAVING
[Blue hatched box with cross]	PERMEABLE PAVING INLET/OUTLET
[Blue cross-hatched box]	UNDERGROUND STORAGE

Notes

- Contains Ordnance Survey data © Crown copyright and database right 2018.
- All dimensions are in metres unless otherwise stated elsewhere.
- Proposed drainage positions will be subject to detailed design.
- All drainage systems will need to be installed and designed for suitable loading requirements.

herrington

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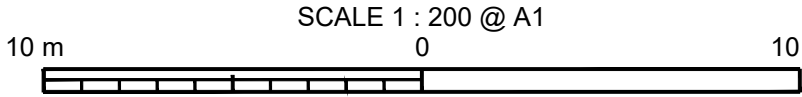
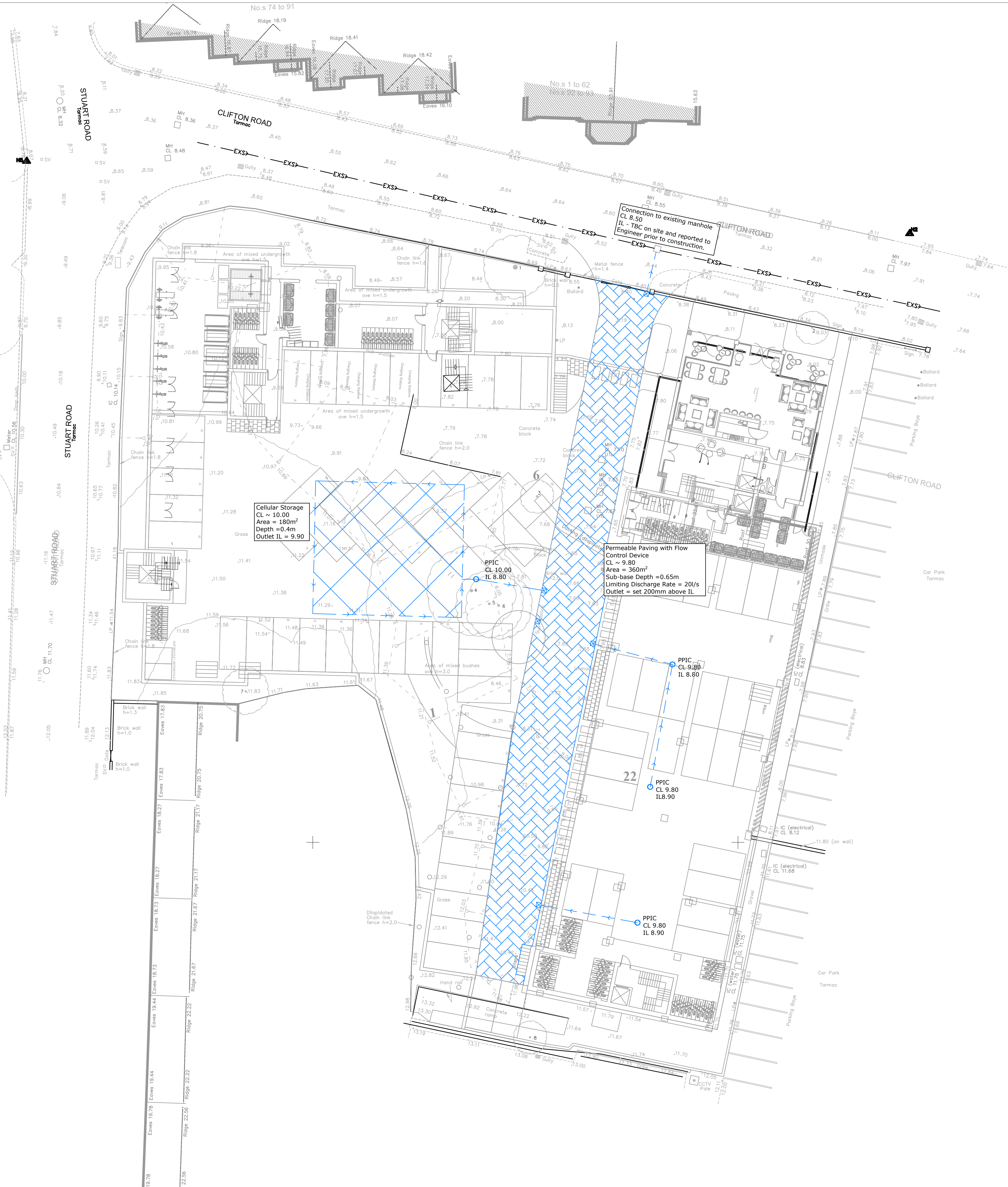
Rev	Description	Made	Checked	Date
P2	Masterplan updated	LA	SB	10/05/2019
P1	First issue	LA	SB	15/01/2019

CLIENT
Peker Holding

PROJECT
Bath Street, Gravesend

SCALE	PROJ REF	ORIGINATOR	CHECKED BY
1:200	2262	LA	SB

DWG REF: INDICATIVE DRAINAGE LAYOUT
DWG No.: HC-2262-501



Appendix A.4 – Surface Water Management Calculations

Drainage Design Report

Flow+

v7.0

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Network	Storm Network
Filename	S:\LIVE Project Files\2262 - Bath Street, Gravesend\Analysis\Causeway\Pre&Post Site Flow Characteristics Template.pfd
Username	Lee Adderley (lee@herringtonconsulting.co.uk)
Last analysed	10/05/2019 12:47:48
Report produced on	20/05/2019 15:11:39

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<http://support.causeway.com>

Rainfall Methodology	FSR
Return Period (years)	100
Additional Flow (%)	20
FSR Region	England and Wales
M5-60 (mm)	26.250
Ratio-R	0.400
CV	1.000
Time of Entry (mins)	4.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	200.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Inverts
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	0.800
Enforce best practice design rules	x

	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Diameter (mm)	Depth (m)	Notes
	E.Paved	0.200	4.00		9.500	Manhole	1800	1.950	Locked
	E.Paved Outlet				9.000	Manhole	1800	1.950	
	P.Paved	0.366	4.00		9.500	Manhole	1800	1.950	Locked
	P.Paved Outlet				9.000	Manhole	1800	1.950	
	SWMH1	0.183	4.00		9.000	Manhole	1800	0.988	
	SuDS				9.000	Manhole	1800	1.000	
	SWMH2	0.183	4.00		9.000	Manhole	1350	0.963	
	Outfall				9.000	Manhole	1350	1.150	
	SWMH3				9.000	Manhole	1800	1.012	

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)
	E.Pipeline	E.Paved	E.Paved Outlet	10.000	0.060	Colebrook-White	7.550	7.050	0.500	20.0	750	Circular	4.02	164.8		
	P.Pipeline	P.Paved	P.Paved Outlet	10.000	0.060	Colebrook-White	7.550	7.050	0.500	20.0	750	Circular	4.02	164.8		
	1.000	SWMH1	SuDS	10.000	0.600	Colebrook-White	8.012	8.000	0.012	833.3	800	Circular	4.33	200.0		8.000
	1.002	SWMH3	Outfall	10.000	0.600	Colebrook-White	8.350	7.850	0.500	20.0	400	Circular	4.54	200.0		
	2.000	SWMH2	SWMH1	10.000	0.600	Colebrook-White	8.037	8.012	0.025	400.0	450	Circular	4.16	200.0		
	1.001	SuDS	SWMH3	10.000	0.600	Colebrook-White	8.000	7.988	0.012	833.3	800	Circular	4.50	200.0	0.600	

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)
	E.Pipeline	E.Paved	E.Paved Outlet	7.878	3480.2	142.9	1.200	1.200	1.200	1.200	0.200
	P.Pipeline	P.Paved	P.Paved Outlet	7.878	3480.2	261.6	1.200	1.200	1.200	1.200	0.366
	1.000	SWMH1	SuDS	1.001	503.0	317.5	0.188	0.200	0.188	0.200	0.366
	1.002	SWMH3	Outfall	4.236	532.3	317.5	0.250	0.750	0.250	0.750	0.366
	2.000	SWMH2	SWMH1	1.010	160.7	158.7	0.513	0.538	0.513	0.538	0.183
	1.001	SuDS	SWMH3	1.001	503.0	317.5	0.200	0.212	0.200	0.212	0.366

Link Name	Length (m)	Slope (1:X)	Dia (mm)	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node Name	Dia (mm)	Width (mm)	Node Type	MH Type	DS Node Name	Dia (mm)	Node Type	MH Type
E.Pipeline	10.000	20.0	750	9.500	7.550	1.200	9.000	7.050	1.200	E.Paved	1800		Manhole	Adoptable	E.Paved Outlet	1800	Manhole	Adoptable
P.Pipeline	10.000	20.0	750	9.500	7.550	1.200	9.000	7.050	1.200	P.Paved	1800		Manhole	Adoptable	P.Paved Outlet	1800	Manhole	Adoptable
1.000	10.000	833.3	800	9.000	8.012	0.188	9.000	8.000	0.200	SWMH1	1800		Manhole	Adoptable	SuDS	1800	Manhole	Adoptable
1.002	10.000	20.0	400	9.000	8.350	0.250	9.000	7.850	0.750	SWMH3	1800		Manhole	Adoptable	Outfall	1350	Manhole	Adoptable
2.000	10.000	400.0	450	9.000	8.037	0.513	9.000	8.012	0.538	SWMH2	1350		Manhole	Adoptable	SWMH1	1800	Manhole	Adoptable
1.001	10.000	833.3	800	9.000	8.000	0.200	9.000	7.988	0.212	SuDS	1800		Manhole	Adoptable	SWMH3	1800	Manhole	Adoptable

Node Name	CL (m)	Depth (m)	Dia (mm)		Link ID	IL (m)	Dia (mm)
E.Paved	9.500	1.950	1800				
				0	E.Pipeline	7.550	750
E.Paved Outlet	9.000	1.950	1800	1	E.Pipeline	7.050	750
P.Paved	9.500	1.950	1800				
				0	P.Pipeline	7.550	750
P.Paved Outlet	9.000	1.950	1800	1	P.Pipeline	7.050	750
SWMH1	9.000	0.988	1800	1	2.000	8.012	450
				0	1.000	8.012	800
SuDS	9.000	1.000	1800	1	1.000	8.000	800
				0	1.001	8.000	800
SWMH2	9.000	0.963	1350				
				0	2.000	8.037	450
Outfall	9.000	1.150	1350	1	1.002	7.850	400

SWMH3	9.000	1.012	1800	1	1.001	7.988	800
				0	1.002	8.350	400

Rainfall Methodology	FSR		Return Period (years)	Climate Change (%)
FSR Region	England and Wales		1	0
M5-60 (mm)	20.000		30	0
Ratio-R	0.400		100	0
Summer CV	1.000		100	20
Winter CV	1.000		100	40
Analysis Speed	Normal			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
	2160			
	2880			
	4320			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				
100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

Hydro-Brake®													
Node	Flap Valve	Online / Offline	Downstream Link	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Objective	Sump Available	Product Number	Min Outlet Diameter (m)	Min Node Diameter (mm)
SWMH3	x	Online				8.350	0.800	20.0(HE)	Minimise upstream storage		CTL-SHE-0201-2000-0800-2000	0.225	1500

Depth/Area/Inf Area											
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Depth (m)	Area (m²)	Inf. Area (m²)		
1	0.01000	0.01000	2.0	1.00	0.000		0.000	1.0	0.0		
							0.500	1.0	0.0		
							1.000	10.0	0.0		
2	0.01000	0.01000	2.0	1.00	0.000		0.000	1.0	0.0		
							0.500	1.0	0.0		
							1.000	10.0	0.0		
SWMH1	0.00000	0.00000	2.0	0.95	8.012		0.000	180.0	0.0		
							0.400	180.0	0.0		
							0.401	0.0	0.0		
Carpark											
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Width (m)	Length (m)	Slope (1:X)	Depth (m)	Inf Depth (m)
SuDS	0.00550	0.00550	2.0	0.35	8.000		30.000	12.000	500.0	0.650	

Default Values		Overrides						
Entry Loss (manhole)	0.250	Link	Entry Loss	Exit Loss		Node	Flood Risk (m)	
Exit Loss (manhole)	0.250							
Entry Loss (junction)	0.000							
Exit Loss (junction)	0.000							
Flood Risk (m)	0.300							

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.98%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	E.Paved	10	7.608	0.058	39.7	0.2675	0.0000	OK	E.Pipeline	E.Paved Outlet	39.8	2.768	0.011	0.1437	15.5
15 minute summer	E.Paved Outlet	10	7.102	0.052	39.8	0.0000	0.0000	OK							
15 minute summer	P.Paved	10	7.631	0.081	72.6	0.5108	0.0000	OK	P.Pipeline	P.Paved Outlet	72.8	3.210	0.021	0.2268	28.4
15 minute summer	P.Paved Outlet	10	7.118	0.068	72.8	0.0000	0.0000	OK							
2880 minute summer	SWMH1	2640	8.314	0.302	2.9	53.5827	0.0000	OK	1.000	SuDS	1.4	0.116	0.003	1.7791	
2880 minute summer	SuDS	2640	8.314	0.314	1.4	38.8912	0.0000	OK	1.001	SWMH3	0.0	0.027	0.000	1.8726	
									Infiltration		0.3				
2880 minute summer	SWMH2	2640	8.314	0.277	1.5	1.4508	0.0000	OK	2.000	SWMH1	1.4	0.219	0.009	1.0786	
15 minute summer	Outfall	1	7.850	0.000	0.0	0.0000	0.0000	OK							
2880 minute summer	SWMH3	2640	8.314	0.326	0.0	0.8304	0.0000	OK	Hydro-Brake®	Outfall	0.0				0.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.98%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	E.Paved	9	7.646	0.096	97.6	0.4400	0.0000	OK	E.Pipeline	E.Paved Outlet	97.6	3.436	0.028	0.2848	37.9
15 minute summer	E.Paved Outlet	10	7.129	0.079	97.6	0.0000	0.0000	OK							
15 minute summer	P.Paved	9	7.687	0.137	178.5	0.8629	0.0000	OK	P.Pipeline	P.Paved Outlet	178.5	3.901	0.051	0.4599	69.4
15 minute summer	P.Paved Outlet	10	7.155	0.105	178.5	0.0000	0.0000	OK							
480 minute winter	SWMH1	328	8.453	0.441	16.0	71.2394	0.0000	OK	1.000	SuDS	10.1	0.343	0.020	2.8756	
480 minute winter	SuDS	328	8.453	0.453	10.1	56.6789	0.0000	OK	1.001	SWMH3	7.2	0.107	0.014	2.9703	
									Infiltration		0.3				
480 minute winter	SWMH2	328	8.453	0.416	8.2	2.1751	0.0000	OK	2.000	SWMH1	7.8	0.536	0.049	1.5532	
15 minute summer	Outfall	1	7.850	0.000	0.0	0.0000	0.0000	OK							
480 minute winter	SWMH3	328	8.453	0.465	7.2	1.1826	0.0000	OK	Hydro-Brake®	Outfall	7.2				61.7

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.98%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	E.Paved	9	7.661	0.111	126.5	0.5121	0.0000	OK	E.Pipeline	E.Paved Outlet	126.6	3.639	0.036	0.3496	49.2
15 minute summer	E.Paved Outlet	10	7.139	0.089	126.6	0.0000	0.0000	OK							
15 minute summer	P.Paved	9	7.711	0.161	231.5	1.0132	0.0000	OK	P.Pipeline	P.Paved Outlet	231.7	4.101	0.067	0.5684	90.1
15 minute summer	P.Paved Outlet	10	7.169	0.119	231.7	0.0000	0.0000	OK							
240 minute summer	SWMH1	152	8.529	0.517	54.0	71.7182	0.0000	OK	1.000	SuDS	30.6	0.467	0.061	3.4718	
240 minute summer	SuDS	152	8.529	0.529	30.6	66.5271	0.0000	OK	1.001	SWMH3	17.0	0.115	0.034	3.5623	
									Infiltration		0.3				
240 minute summer	SWMH2	152	8.529	0.492	27.6	2.5762	0.0000	SURCHARGED	2.000	SWMH1	26.4	0.731	0.164	1.5844	
15 minute summer	Outfall	1	7.850	0.000	0.0	0.0000	0.0000	OK							
240 minute summer	SWMH3	152	8.529	0.541	17.0	1.3774	0.0000	OK	Hydro-Brake®	Outfall	16.9				85.3

Results for 100 year +20% Critical Storm Duration. Lowest mass balance: 99.98%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	E.Paved	9	7.674	0.124	151.8	0.5710	0.0000	OK	E.Pipeline	E.Paved Outlet	151.9	3.776	0.044	0.4041	59.0
15 minute summer	E.Paved Outlet	10	7.147	0.097	151.9	0.0000	0.0000	OK							
15 minute summer	P.Paved	9	7.731	0.181	277.9	1.1370	0.0000	OK	P.Pipeline	P.Paved Outlet	278.1	4.238	0.080	0.6605	108.1
15 minute summer	P.Paved Outlet	10	7.180	0.130	278.1	0.0000	0.0000	OK							
240 minute summer	SWMH1	152	8.668	0.656	64.9	72.5869	0.0000	OK	1.000	SuDS	51.5	0.503	0.102	4.4369	
240 minute summer	SuDS	152	8.669	0.669	51.5	82.1538	0.0000	OK	1.001	SWMH3	22.5	0.138	0.045	4.5059	
									Infiltration		0.3				
240 minute summer	SWMH2	152	8.669	0.632	33.1	3.3062	0.0000	SURCHARGED	2.000	SWMH1	31.8	0.783	0.198	1.5844	
15 minute summer	Outfall	1	7.850	0.000	0.0	0.0000	0.0000	OK							
240 minute summer	SWMH3	152	8.668	0.680	22.5	1.7306	0.0000	OK	Hydro-Brake®	Outfall	20.0				126.8

Results for 100 year +40% Critical Storm Duration. Lowest mass balance: 99.98%															
Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	E.Paved	9	7.687	0.137	177.3	0.6275	0.0000	OK	E.Pipeline	E.Paved Outlet	177.3	3.896	0.051	0.4576	68.9
15 minute summer	E.Paved Outlet	10	7.154	0.104	177.3	0.0000	0.0000	OK							
15 minute summer	P.Paved	9	7.749	0.199	324.4	1.2547	0.0000	OK	P.Pipeline	P.Paved Outlet	324.4	4.359	0.093	0.7502	126.0
15 minute summer	P.Paved Outlet	10	7.190	0.140	324.4	0.0000	0.0000	OK							
180 minute summer	SWMH1	104	9.000	0.988	101.4	74.6595	6.8592	FLOOD	1.000	SuDS	102.1	0.595	0.203	5.0076	
360 minute summer	SuDS	200	9.000	1.000	54.5	82.9972	2.1662	FLOOD	1.001	SWMH3	21.0	0.113	0.042	5.0076	
									Infiltration		0.3				
360 minute summer	SWMH2	200	9.000	0.963	28.8	5.0384	16.4939	FLOOD	2.000	SWMH1	27.8	0.698	0.173	1.5844	
15 minute summer	Outfall	1	7.850	0.000	1.6	0.0000	0.0000	OK							
180 minute summer	SWMH3	104	9.000	1.012	22.7	2.5755	1.1142	FLOOD	Hydro-Brake®	Outfall	20.0				129.0

Appendix A.5 – Maintenance Schedules

Operation and Maintenance Schedule – Pervious Pavement		
Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over 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 50 mm 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 or a hazard to users, and replace lost jointing material.	As required.
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 Operation and Maintenance Table for Pervious Pavements in accordance with CIRIA C753 The SuDS Manual.

Operation and Maintenance Schedule – Crate Storage System		
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)
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 Crate Storage in accordance with CIRIA C753 The SuDS Manual.

Operation and Maintenance Schedule – Green Roofs		
Maintenance Schedule	Required Action	Typical Frequency
Routine Inspection	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Routine maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (i.e. year one), replace all dead plants as required	Monthly (usually the responsibility of the manufacturer)
	Post establishment replace dead plants as required (where >5% of coverage)	Annually (in Autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

General Operation and Maintenance Table for Green Roofs in accordance with CIRIA C753 The SuDS Manual.