conisbee | Consulting Structural Engineers
Consulting Civil Engineers

Sondheim (Ambassadors) Theatre, West Street, WC2H 9HD

Surface Water Drainage Statement

London
1 – 5 Offord Street
London N1 1DH
Telephone 020 7700 6666

Norwich
6 Upper King Street
Norwich NR3 1HA
Telephone 01603 628 074

Cambridge
47 – 51 Norfolk Street
Cambridge CB1 2LD
Telephone 01223 656 058

design@conisbee.co.uk
www.conisbee.co.uk

Ref: 140352/T Noble

Date: 26 Jan 2017

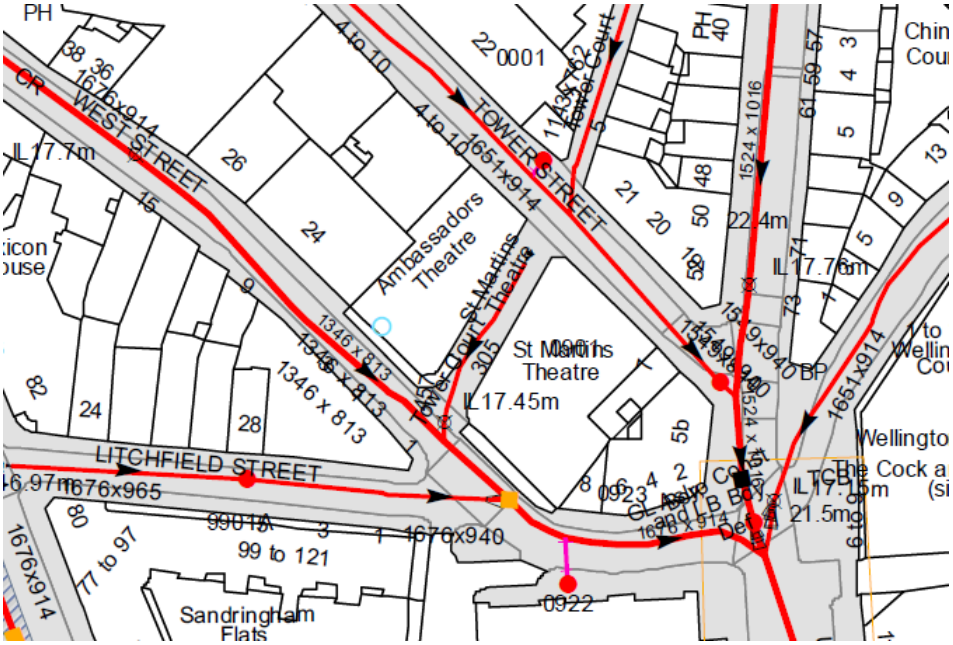
Version: 1

1.0 DRAINAGE & FLOOD RISK

1.1 Existing Drainage

1.1.1 A topographical survey was completed for the site in July 2014 which shows a combined surface and foul water system within the existing building draining via two 150mm diameter connections to the Thames Water sewers in West Street and Tower Street. There are currently two separate sump pumps, assumed to be for ground water, in the theatre basement.

1.1.2 The Thames Water asset maps have been obtained for the site. An existing combined Thames Water sewer (size 1346x813) runs from North West to South East along West Street. A further combined Thames Water sewer (size 1651x914) runs from North West to South East along Tower Street. The invert level (IL) of a manhole to upstream of the site is 18.33 at a depth of 4.76m. There are no details for invert levels for manholes downstream of the site. There is a combined 305 diameter sewer running South in Tower Court which connects to the combined sewer in West Street. An extract from the records is shown in the Figure below.



1.1.3 The existing runoff characteristics are as follows:

Existing Runoff Characteristics		
M5_60 Rainfall Depth	20.0	mm
Ratio, r	0.44	
Total Site Area	548	m²
Existing Impermeable Area	548	m²
	0	%
1 in 1 year, Q_1*	1.8	l/s
1 in 30 year, Q_{30}*	4.2	l/s
1 in 100 year, Q_{100}*	5.6	l/s
Mean Annual Flow, Q_{BAR}*	2.2	l/s
Pre-Development Runoff Volume, $Vol_{M100-360}$	30	m³
*Based on modified rational method. 60 minute duration.		

1.1.4 A copy of the completed Camden SuDs proforma is appended to this report.

1.2 Proposed Surface Water Drainage

1.2.1 For the new theatre it is proposed to re-use the existing drainage connections to the Thames Water sewers.

1.2.2 Initial discussions have taken place with Thames Water Developer Services who have confirmed that they have no objections if the existing connections to the sewers are re-used as long as the flows remain similar to the existing situation.

1.2.3 The initial Stage D report issued 23rd December 2014 was based on earlier advice from Thames Water that they would not require any runoff reduction from the site, providing that the impermeable area remains the same. However, this predated a change in national planning policy guidance and initial pre-planning consultation has identified that:

- A SUDS strategy will need to be submitted with the planning application targeting a green field run off rate for all events up to a 1 in 100 year event. If this cannot be achieved then a minimum of 50% reduction in runoff will need to be targeted.
- Rain water/grey water harvesting will need to be incorporated into the scheme

1.2.4 The Camden Development Policies Document (paragraph 23.7) states that the most sustainable methods of SuDS will be sought wherever possible. The London Plan Policy 5.13 requires SuDS unless there are practical reasons for not doing so

1.2.5 An effective SuDS system needs to follow the SuDS Management Train. This means capturing and disposing of as much rainfall at source as possible and using multiple SuDS components to manage rainfall across the site. The management train should generally follow this hierarchy:

- **Source Control**
- **Site Control**
- **Regional Control**

1.2.6 Source control methods are often the most simple and effective methods of reducing runoff from existing sites, especially small sites where Greenfield rates cannot be achieved. In central London the existing sewerage system is at capacity after only a few millimetres of rainfall and regularly overflows into the Thames. Source control methods that intercept rainfall before it enters the drainage system therefore have significant benefit. Site control methods, such as attenuation tanks, are of less benefit as they only reduce the peak flow from larger storms when the sewers would already be full and overflowing.

1.2.7 A SuDS design will also need to consider failure of the drainage system, due to capacity being exceeded or physical faults, by ensuring flood flows are directed away from buildings.

1.2.8 Given that the site has been and will remain fully developed with negligible external space most SuDS methods can be dismissed. For example, there is no space for rain gardens and infiltration drainage (soakaways) would be impossible. The following methods have been assessed in greater detail.

Method	Assessment
Green Roofs	The proposed building will have a mansard roof and a larger area of flat roof to the rear of the site which is used for a plant enclosure. It is not feasible to install a green roof within the plant enclosure, there is little space between plant and these items cannot be place over a green roof. However, the flat part of the mansard roof to the front is only occupied by solar panels and it will be feasible to install a green roof here. It is feasible to install a green roof measuring approximately 95m², a plan showing the extent is appended to this report.
Permeable Pavements	The only area where permeable paving could be laid is at the front entrance of the building. This measures 51m² in area but is mostly covered by a canopy, so would not receive rainfall, and is situated entirely above a basement slab. The site is within a conservation area so it is unlikely that permeable paving would be an acceptable surfacing material.
Rainwater Harvesting	Rainwater harvesting has been discounted for the following reasons:

1. The site is completely occupied by a large basement and the only place a harvesting tank could be located is beneath the basement slab. This would require significant excavation and use of reinforced concrete that will probably offset any energy saved through the use of harvesting. Any excess flows would also need to be pumped resulting in increased energy usage and a less resilient system.

2. Installing rainwater harvesting into the basement would result in surface water being routed to the basement which would increase flood risk as all excess rainwater that is not harvested will need to be pumped out. In the event of pump or power failure this could overflow.

3. The cost of installing and maintaining a system is high relative to the sustainability benefits it would provide.

1.2.9 The only feasible method of providing attenuation would be to provide below ground attenuation in a tank. Based on a 5l/s restriction an attenuation volume of 13.5m³ would be required for the 1 in 100 year critical storm with a 30% allowance for climate change.

1.2.10 Due to lack of external space any tank would have to be located beneath the basement slab which would result in all surface water from site being pumped up to the level of the sewer. There are several reasons why this is not an appropriate option:

- The ongoing operation and maintenance costs of the pumps will be high and energy intensive. Pumping is unsustainable and should always be minimised where possible.
- By routing surface water into the basement and relying on mechanical plant for drainage the risk of flooding would actually be increased.
- In line with current best practice a 5l/s minimum discharge would be used. This is only a slight decrease from the existing 1 in 100 year rate of 5.6l/s. It is also difficult to achieve a complex control regime using pumps therefore the 1 in 1 year discharge rate may not be lower than the existing.
- There would be no interception of small rainfall events, as discussed above, and no reduction in runoff volume. The runoff rate would only be reduced for more extreme events when the sewers would already be full and overflowing through the combined sewer overflows (CSOs).

1.2.11 Given the constraints of the site, and that Thames Water have no requirement for runoff reduction, it is not thought to be practical or beneficial to provide attenuation storage.

1.2.12 Where feasible a green roof will be installed to provide source control in line with the SuDS management train. The proposed green roof will cover an area of 95m² and will have a biodiverse or wildflower type build up with growing substrate at least 100mm thick. This will provide interception of small rainfall events, a reduction in runoff volume and increased biodiversity. Based on current guidance[1] it is estimated that the roof will intercept a rainfall depth of up to 15mm which equates to a volume of 1.4m³ over the roof area.

1.2.13 Otherwise it is proposed to simply connect the new rainwater pipes to the existing system and discharge surface water via gravity.

1.2.14 There will be zero increase in impermeable area, and therefore no detriment to the existing system, and the proposals are in line with national, regional and local planning policy

2.0 PROPOSED FOUL WATER DRAINAGE

2.1.1 It is proposed to use the existing combined connections to the Thames Water sewers.

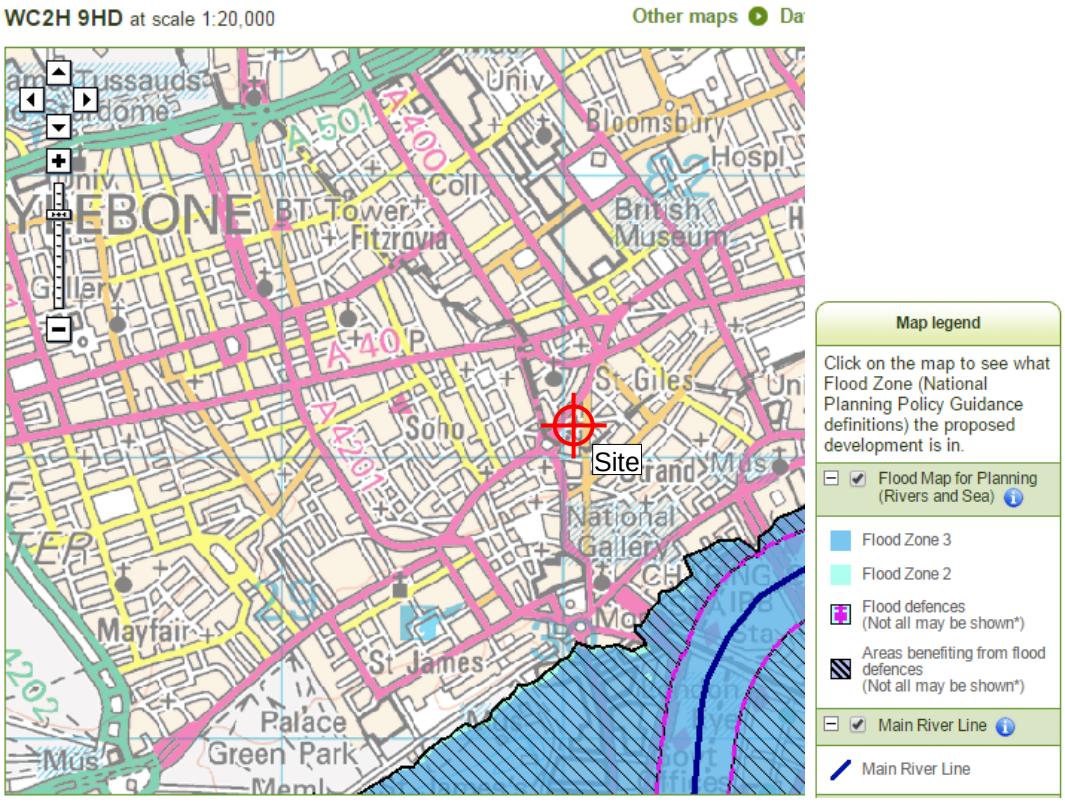
2.1.2 The foul drainage in the proposed basement will be pumped up to the required level and a suitable volume of emergency storage will be provided in line with Building Regulations. Efforts will be made to ensure that foul drainage from the upper floors can drain via gravity.

[1] C753 CIRIA SuDS Manual – Chapter 12

3.0 FLOOD RISK

3.1 Fluvial Flooding

3.1.1 The nearest reaches of the River Thames is located 850m south of the site. The site is located at a higher elevation of 18.00m AOD generally and therefore lies within Flood Zone 1, outside the flood risks areas associated with the River as can be seen below from the EA Flood Risk Map.



Environment Agency Flood Map.

3.2 Tidal Flooding

3.2.1 The site is located 850m from the Thames therefore it is not at risk from Tidal Flooding

3.3 Overland Flooding

3.3.1 Overland flooding can occur when high intensity rainfall overwhelms man made drainage systems or cannot soak into the ground. Excess water can flow across the ground following the contour gradient and cause flooding downstream. It is exacerbated by steep topography. The information available (Strategic Flood Risk Assessment and Flood Risk Management Strategy) does not state that the site is an area at risk from overland flooding.

3.4 Groundwater Flooding

3.4.1 Groundwater flooding occurs when the water table rises to the ground surface and inundates low lying areas. The Flood Risk Management Strategy states that the risk from groundwater flooding in Camden is uncertain and more information is required to build up an understanding of it; however currently the Environment Agency Maps show that the site is not at risk from groundwater flooding.

3.4.2 The new basement will be constructed to the latest standards (BS 8102) and is likely to incorporate a cavity drainage system to mitigate against groundwater ingress.

3.5 Sewer and Surface Water Flooding

3.5.1 Thames Water surface water sewer, foul water sewer and combined water sewer flooding data indicates that no flooding events occurred in the vicinity of the site.

3.5.2 The new basement will incorporate foul water pumps so there is little risk of flooding to the lower levels due to sewer surcharging.

3.6 Flooding from Artificial Sources

3.6.1 The site is not located in close proximity to any reservoirs, canals or other artificial sources. It is considered that the site is not at risk from flooding from artificial sources.

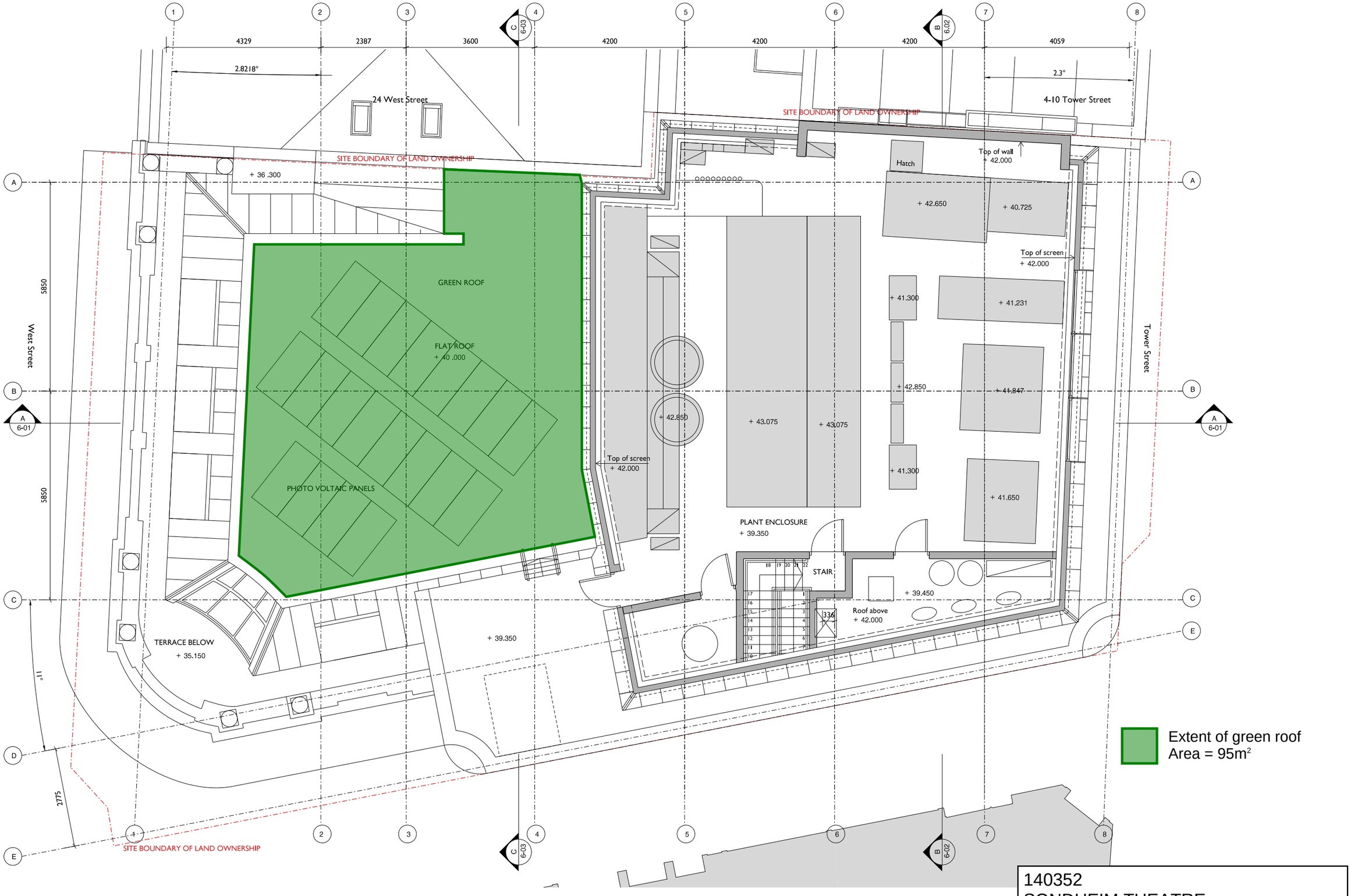
3.7 Overall Flood Risk

3.7.1 The site is thought to be at very low risk from flooding.

conisbee

APPENDIX A

Green Roof Extents



Extent of green roof
Area = 95m²

140352
SONDHEIM THEATRE
INDICATIVE GREEN ROOF EXTENTS
25.01.2017

APPENDIX B

Camden SuDS Proforma

Surface Water Drainage Pro-forma for new developments

This pro-forma accompanies our advice note on surface water drainage. Developers should complete this form and submit it to the Local Planning Authority, referencing from where in their submission documents this information is taken. The pro-forma is supported by the Defra/EA guidance on Rainfall Runoff Management and uses the storage calculator on www.UKsuds.com. This pro-forma is based on current industry best practice and focuses on ensuring surface water drainage proposals meet national and local policy requirements. The pro-forma should be considered alongside other supporting SuDS Guidance.

1. Site Details

Site	Sondheim (Ambassadors) Theatre
Address & post code or LPA reference	West Street, London, WC2H 9HD (Ref: 2016/4869/P)
Grid reference	530055, 181140
Is the existing site developed or Greenfield?	Developed
Is the development in a LFRZ or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with DP23?	No
Total Site Area served by drainage system (excluding open space) (Ha)*	0.0548

***** The Greenfield runoff off rate from the development which is to be used for assessing the requirements for limiting discharge flow rates and attenuation storage from a site should be calculated for the area that forms the drainage network for the site whatever size of site and type of drainage technique. Please refer to the Rainfall Runoff Management document or CIRIA manual for detail on this.

2. Impermeable Area

	Existing	Proposed	Difference (Proposed-Existing)	Notes for developers
Impermeable area (ha)	0.0548	0.0548	0	If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in.
Drainage Method (infiltration/sewer/watercourse)	Sewer	Sewer	N/A	If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposed is not, discharge volumes may increase. Fill in section 6.

3. Proposing to Discharge Surface Water via

	Yes	No	Evidence that this is possible	Notes for developers
Existing and proposed MicroDrainage calculations			N/A Modified Rational Method used	Please provide MicroDrainage calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology or the results of a full infiltration test (see line below) if infiltration is proposed.
Infiltration		X	Site 100% developed and has deep basement	e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		X	No watercourse nearby	e.g. Is there a watercourse nearby?
To surface water sewer		X	No SW sewer available	Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above		X	N/A	e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	X		Refer to report. Source control incorporated where practical	Evidence must be provided to demonstrate that the proposed Sustainable Drainage strategy has had regard to the SuDS hierarchy as outlined in Section 2.5 above.
Layout plan showing where the sustainable drainage infrastructure will be located on site.	X		Refer to report.	Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Peak Discharge Rates – This is the maximum flow rate at which storm water runoff leaves the site during a particular storm event.

	Existing Rates (l/s)	Proposed Rates (l/s)	Difference (l/s) (Proposed-Existing)	% Difference (difference /existing x 100)	Notes for developers
Greenfield QBAR	N/A	N/A	N/A	N/A	QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed.
1 in 1	1.8	1.8	0	0	Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events.
1 in 30	4.2	4.2	0	0	
1in 100	5.6	5.6	0	0	
1 in 100 plus climate change	N/A	7.28	N/A	N/A	The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

5. Calculate additional volumes for storage –The total volume of water leaving the development site. New hard surfaces potentially restrict the amount of stormwater that can go to the ground, so this needs to be controlled so not to make flood risk worse to properties downstream.

	Greenfield runoff volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	Notes for developers
1 in 1	N/A	N/A	N/A	N/A	Proposed discharge volumes (with mitigation) should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable and as a minimum should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased section 6 must be filled in.
1 in 30	N/A	N/A	N/A	N/A	
1in 100 6 hour	8.4	32.9	31.5	1.4	
1 in 100 6 hour plus climate change	10.9	42.8	41.4	-1.4	The proposed 1 in 100 +CC discharge volume should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable. As a minimum, to mitigate for climate change the proposed 1 in 100 +CC volume discharge from site must be no greater than the existing 1 in 100 storm event. If not, flood risk increases under climate change.

6. Calculate attenuation storage – Attenuation storage is provided to enable the rate of runoff from the site into the receiving watercourse to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)	N/A	Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to reduce rates by 50% (m^3)	N/A	Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible] (m^3)	N/A	Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to retain rates as existing (m^3)	N/A	Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing
Percentage of attenuation volume stored above ground,	N/A	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

Storage is required for the additional volume from site but also for holding back water to slow down the rate from the site. This is known as attenuation storage and long term storage. The idea is that the additional volume does not get into the watercourses, or if it does it is at an exceptionally low rate. You can either infiltrate the stored water back to ground, or if this isn't possible hold it back with on site storage. Firstly, can infiltration work on site?

			Notes for developers
Infiltration	**State the Site's Geology and known Source Protection Zones (SPZ)**	Lynch Hill Gravels over London Clay. No SPZ	Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ)
	Are infiltration rates suitable?	No	Infiltration rates should be no lower than $1x10^{-6}$ m/s.
	State the distance between a proposed infiltration device base and the ground water (GW) level	N/A	Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible.

	Were infiltration rates obtained by desk study or infiltration test?	N/A	Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided..
	Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.	N/A	Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered.
In light of the above, is infiltration feasible?	**Yes/No? If the answer is No, please identify how the storm water will be stored prior to release**	No. Green roofs will be incorporated.	If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section.

Storage requirements

The developer must confirm that either of the two methods for dealing with the amount of water that needs to be stored on site.

Option 1 Simple – Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.

Option 2 Complex – If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site.

		Notes for developers
Please confirm what option has been chosen and how much storage is required on site.	N/A	The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved.

8. Please confirm

		Notes for developers
Which Drainage Systems measures have been used, including green roofs?	Green roofs have been used where feasible	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	Yes	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	No. Site is covered 100% by roof. Gutters and outlets will incorporate overflows, building will be protected in event of failure.	National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	Not feasible.	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.
How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	N/A	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. Exceedance events are defined as those larger than the 1 in 100 +CC event.
How are rates being restricted (vortex control, orifice etc)	N/A	Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided.
Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.		If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma.
How is the entire drainage system to be maintained?	Green roof will be maintained by building maintenance staff.	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

9. Evidence Please identify where the details quoted in the sections above were taken from. i.e. Plans, reports etc. Please also provide relevant drawings that need to accompany your proforma, in particular exceedance routes and ownership and location of SuDS (maintenance access strips etc

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2	140352 - Surface Water Drainage Statement	
Section 3	140352 - Surface Water Drainage Statement	
Section 4	140352 - Surface Water Drainage Statement	
Section 5	140352 - Surface Water Drainage Statement	
Section 6	140352 - Surface Water Drainage Statement	
Section 7	140352 - Surface Water Drainage Statement	
Section 8	140352 - Surface Water Drainage Statement	

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By..... (TOM NOBLE)
Qualification of person responsible for signing off this pro-forma ...BENG MICE.....

Company.....CONISBEE.....
On behalf of (Client's details) ...DELFONT MACKINTOSH THEATRES LTD.....
Date:...26/01/2017.....