| Report No: | Date: |
|---|---|
| **FCL/489/01** | **06 Aug 2021** |

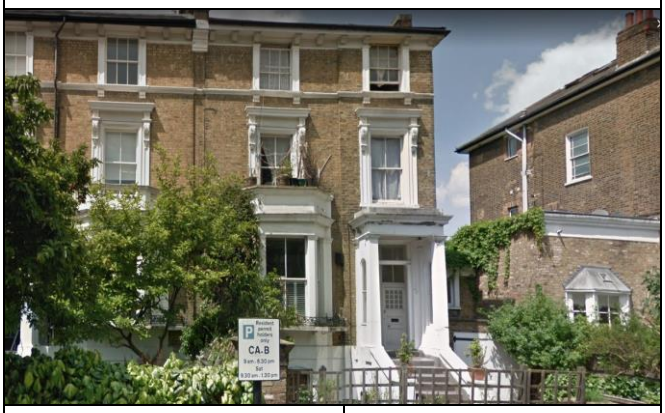
Project:

# 5 & 5A Parkhill Road
# London, NW3 2YH

## SuDS Drainage Strategy Report

Client:

Vita Architecture



| Revision: | Status: |
|---|---|
| **A** | **Issue 1** |

Floodline Consulting Ltd, The Annex, Warren Wood,
Pyle Hill, Woking, Surrey, GU22 0SR, UK

www.floodlineconsulting.co.uk

# Document Control Sheet

## Report Details

| | |
|---|---|
| *Project Title* | 5 & 5A Parkhill Road, London, NW3 2YH |
| *Report Title* | SuDS Drainage Strategy Report |
| *Revision* | A |
| *Status* | Issue 1 |
| *Control Date* | 06 August 2021 |
| *Authorised for Issue* | Faruk Pekbeken, BEng CEng MICE<br>Technical Director |

## Distribution

| *Organisation* | *Contact* | *Copies* |
|---|---|---|
| Vita Architecture | Ben Lee | 1 (pdf) |
| HouseUP | Vincenzo Palomba | 1 (pdf) |
| Floodline Consulting Ltd | Justin Meredith | 1 |
| | | |

# Contents

# 1 Introduction

## 1.1 Terms of Reference

Floodline Consulting Ltd (FCL) was commissioned by Vita Architecture to produce a site-specific Sustainable Drainage Strategy (SuDS) report for the proposed redevelopment of the existing residential property at 5 & 5A Parkhill Road, Hampstead, London, NW3 2YH, as shown in **Figures 01a and 01b** below.

## 1.2 Site Location

The application site is located in a highly urbanised setting within the London Borough of Camden (LBC). The property is located on the west side of Parkhill Road, close to the junction with Haverstock Hill and midway between Belsize Park and Chalk Farm underground stations.

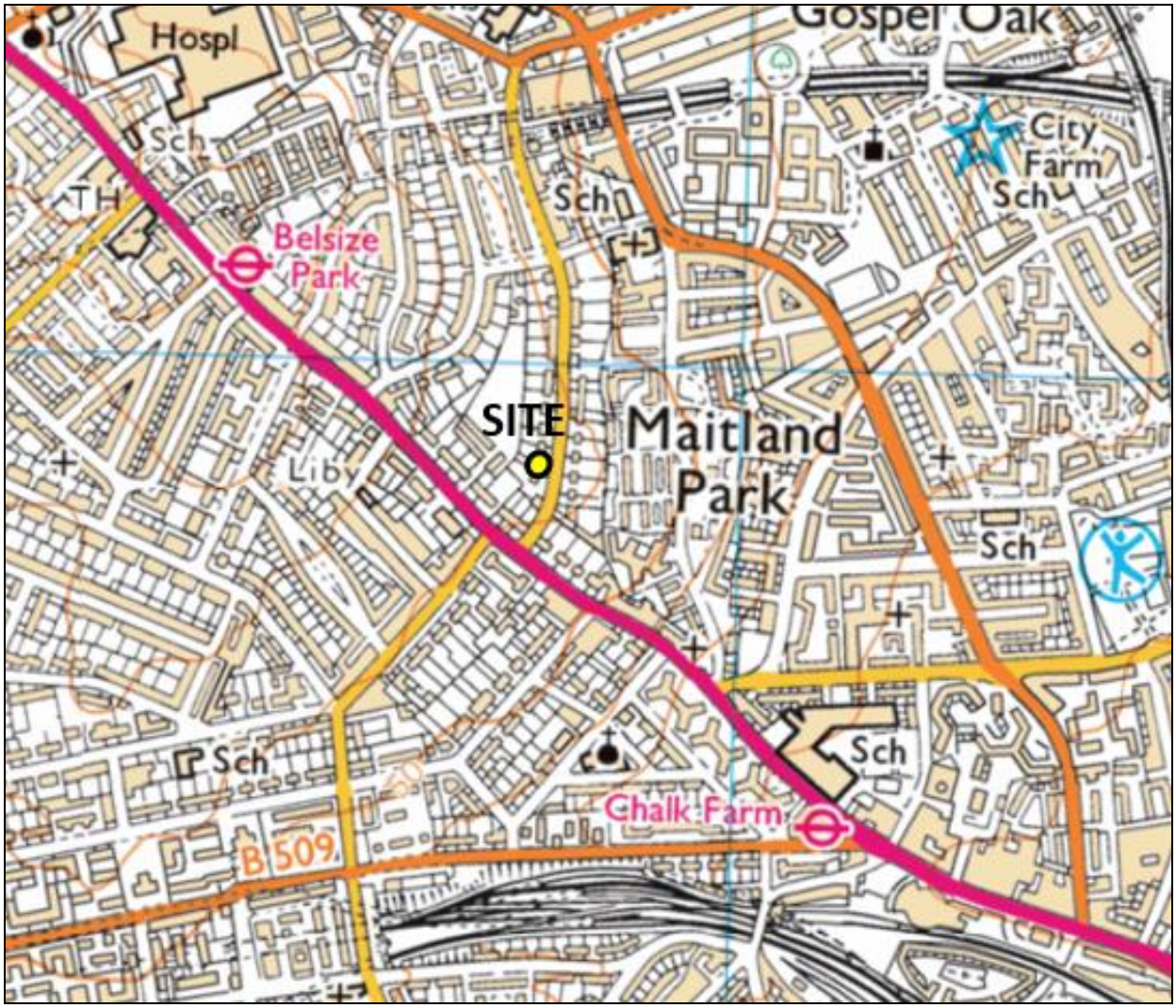



***Figure 01a:*** *Site Location Plan*

***Figure 01b:*** *Aerial View of the Site*

## 1.3 Camden SuDS and Flood Risk Policy Documents

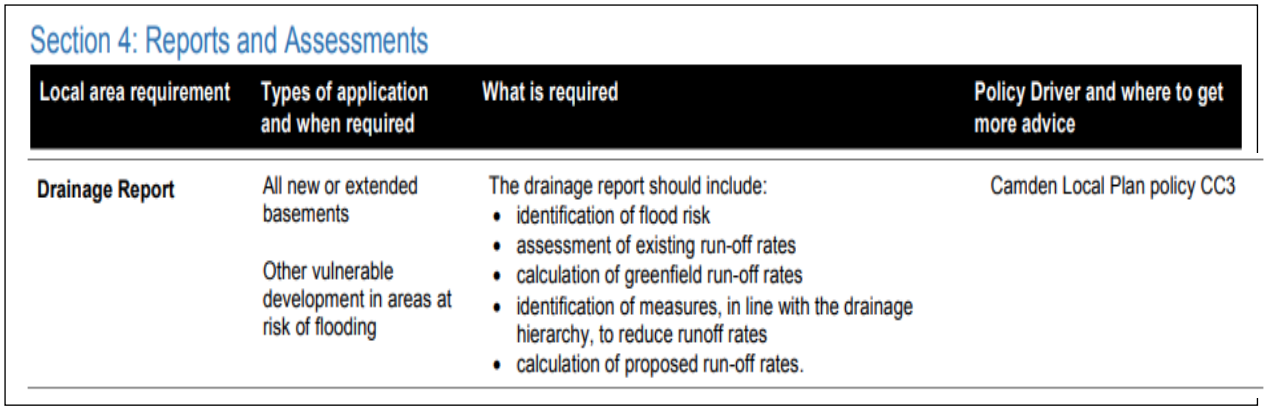
The sustainable drainage systems detailed in this report are fully complaint with the following policy of the LBC and the Mayor of London;

1. **LBC – Local Area Requirements (LAR), July 2018**

   Camden Council is the Lead Local Flood Authority (LLFA) and has adopted the revised LAR for 'Sustainability Drainage Systems in Planning Applications' in July 2018 which refers to minor and major planning applications.

   Major applications are defined in Section 5 of the LAR as 10 or more dwelling net or 1,000m$^2$ additional non-residential floor space. This application involves redevelopment of an existing residential dwelling and is not a major application.

   Section 4 of the LAR is applicable to this dwelling and reflects the reports and assessments required to address sustainable drainage taking the Council's policy drivers into consideration. Section 4 requirements are shown in **Table 1** below;



Section 4: Reports and Assessments

| Local area requirement | Types of application and when required | What is required | Policy Driver and where to get more advice |
|---|---|---|---|
| **Drainage Report** | All new or extended basements<br><br>Other vulnerable development in areas at risk of flooding | The drainage report should include:<br>• identification of flood risk<br>• assessment of existing run-off rates<br>• calculation of greenfield run-off rates<br>• identification of measures, in line with the drainage hierarchy, to reduce runoff rates<br>• calculation of proposed run-off rates. | Camden Local Plan policy CC3 |

***Table 1:*** *Local Area Requirements*

The LAR also states that a 'development should follow the drainage hierarchy in **Policy 5.13** of the **London Plan** as listed below;

- store rainwater for later use
- use infiltration techniques, such as porous surfaces in non-clay areas
- reduce the force of rainwater in ponds or open water features for gradual release
- reduce the force of rainwater by storing in tanks or sealed water features for gradual release
- discharge rainwater direct to a watercourse
- discharge rainwater to a surface water sewer/drain
- discharge rainwater to the combined sewer

**2. London Plan, 2021**

The London Plan was updated in 2021, therefore LBC's reference to the Policy 5.13 is no longer applicable. The new Policy SI13 covering 'Sustainable Drainage' is summarised in **Table 2** below.

The plan states;

- Local Flood Risk Management Strategies and Surface Water Management Plans should ensure they address flooding from multiple sources including surface water, groundwater and small watercourses that occurs as a result of heavy rainfall.

- Development proposals should aim to get as close to greenfield run-off rates as possible depending on site conditions. Rainwater should be managed as close to the top of the hierarchy as possible. There should be a preference for green over grey features, and drainage by gravity over pumped systems.

- It may be appropriate to use more than one form of drainage, for example a proportion of rainwater can be managed by more sustainable methods, with residual rainwater managed lower down the hierarchy.

- The London Sustainable Drainage Action Plan complements this policy. It contains a series of actions to make the drainage system work in a more natural way with a particular emphasis on retrofitting.

## Policy SI 13 Sustainable drainage

A Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks. Increases in surface water run-off outside these areas also need to be identified and addressed.

B Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

1) rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)
2) rainwater infiltration to ground at or close to source
3) rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)
4) rainwater discharge direct to a watercourse (unless not appropriate)
5) controlled rainwater discharge to a surface water sewer or drain
6) controlled rainwater discharge to a combined sewer.

C Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

D Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation.

***Table 2:*** *London Plan Policy SI13, 2021*

### 3. Camden Local Plan, 2017

Policy CC3 – Water and Flooding is defined under Section 8 of the Local Plan titled, 'Sustainability and Climate Change'. The policy is summarised in **Table 3** below.

Only major developments are required to achieve greenfield run-off rates, where it is reasonably practical, to reduce surface water (SW) run-off volumes to greenfield run-off volumes during a 1 in 100 year storm of 6 hours duration. The superseded London Plan called for a minimum 50% reduction from the existing peak run-off rate. The new London Plan 2021 states development proposals 'should aim to achieve greenfield run-off rates'.

This report confirms that the existing **peak SW run-off rate from the site has been reduced by 80% from 6.84 l/s to 1.38 l/s.**

**Policy CC3 Water and flooding**

The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible.

We will require development to:

a. incorporate water efficiency measures;
b. avoid harm to the water environment and improve water quality;
c. consider the impact of development in areas at risk of flooding (including drainage);
d. incorporate flood resilient measures in areas prone to flooding;
e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible; and
f. not locate vulnerable development in flood-prone areas.

Where an assessment of flood risk is required, developments should consider surface water flooding in detail and groundwater flooding where applicable.

The Council will protect the borough's existing drinking water and foul water infrastructure, including the reservoirs at Barrow Hill, Hampstead Heath, Highgate and Kidderpore.

***Table 3:*** *LBC Policy CC3*

4. **SW Management Plan for the London Borough of Camden, 2011**

   The LBC SW Management Plan was produced in July 2011 as part of the Drain London project and identifies source control options and the need to reduce the run-off coefficient to reclaim permeability and disconnect new and existing development from the combined sewer network. Potential to incentivise developers and residents, retrofit sustainable drainage options, permeable paving etc.

5. **Camden Strategic Flood Risk Assessment (SFRA), 2014**

   The SFRA report was produced by URS in 2014 and advises on flood risk in the borough and provides guidance for planning as stipulated by the National Planning Practice Guidance and Non-Statutory Technical Standards. The SFRA provides several drawings identifying the types of flood risk relevant to the application site. The drawings have been used in various sections of this report as evidence.

## 1.4 Flood Risk at the Site

All forms of flood risk has been assessed for the development site in the production of the sustainable drainage strategy for the proposed redevelopment. The Environment Agency flood risk maps show that;

- The site is in Flood Zone 1 (lowest risk category in England) where risk of river or sea flooding is less than 1 in 1,000 (ie 0.1%) in any given year.
- The site is not at risk from reservoir flooding.
- The site is not at risk from SW flooding (ie, overland flooding) as shown in **Figure 02** below;


***Figure 02:*** *Site is Not at Risk of SW Flooding*

Camden SFRA shows that;

- The site is not in a Critical Drainage Area (CDA) or in a Local Flood Risk Zone (LFRZ) therefore the existing dwelling is not at risk from foul sewer flooding (see **Figures 03a and 03b** below);

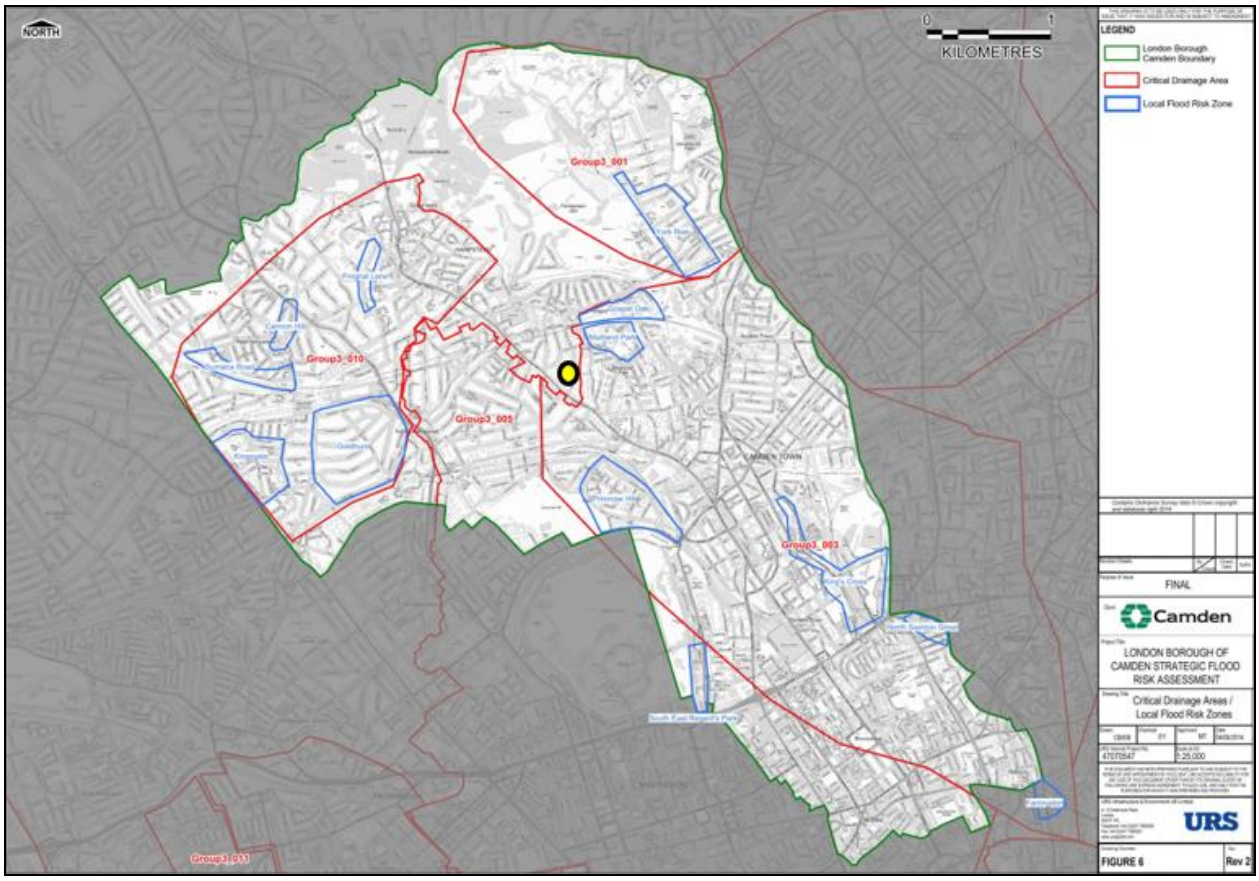



***Figure 03a:*** *Camden SFRA - Site is Not in a CDA*

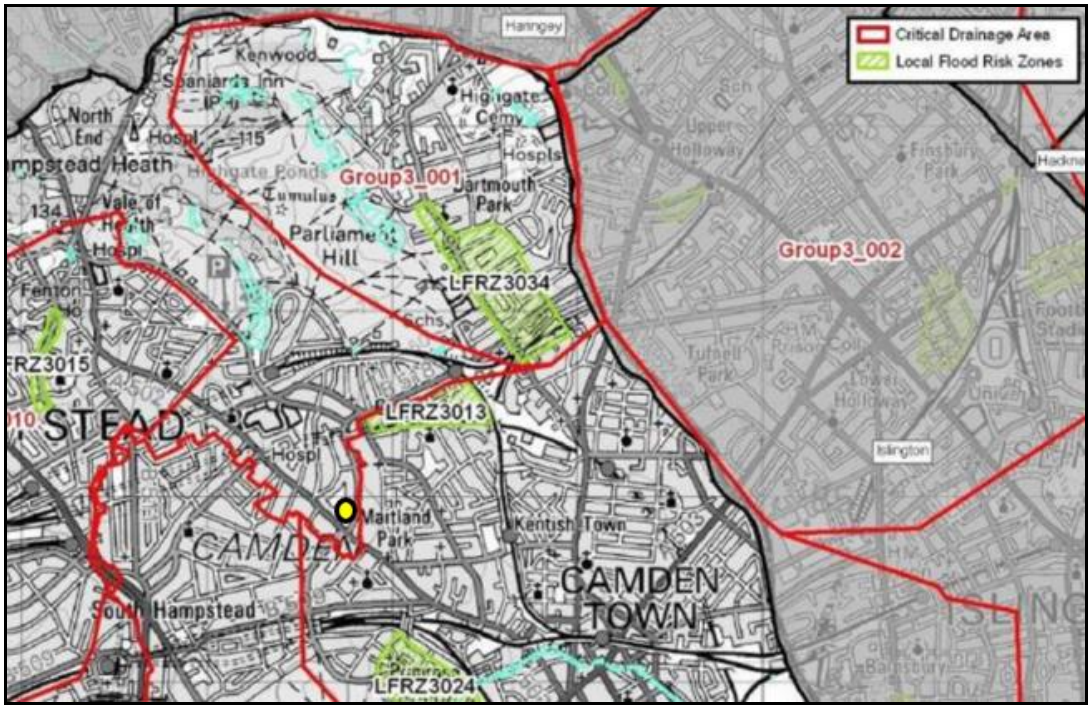



***Figure 03b:*** *Site is Not in a LFRZ*

**Figure 04a** below shows the site is not in area with a record of Internal Sewer Flooding. The map is generated from Thames Water's DG5 list of internal property flooding database.

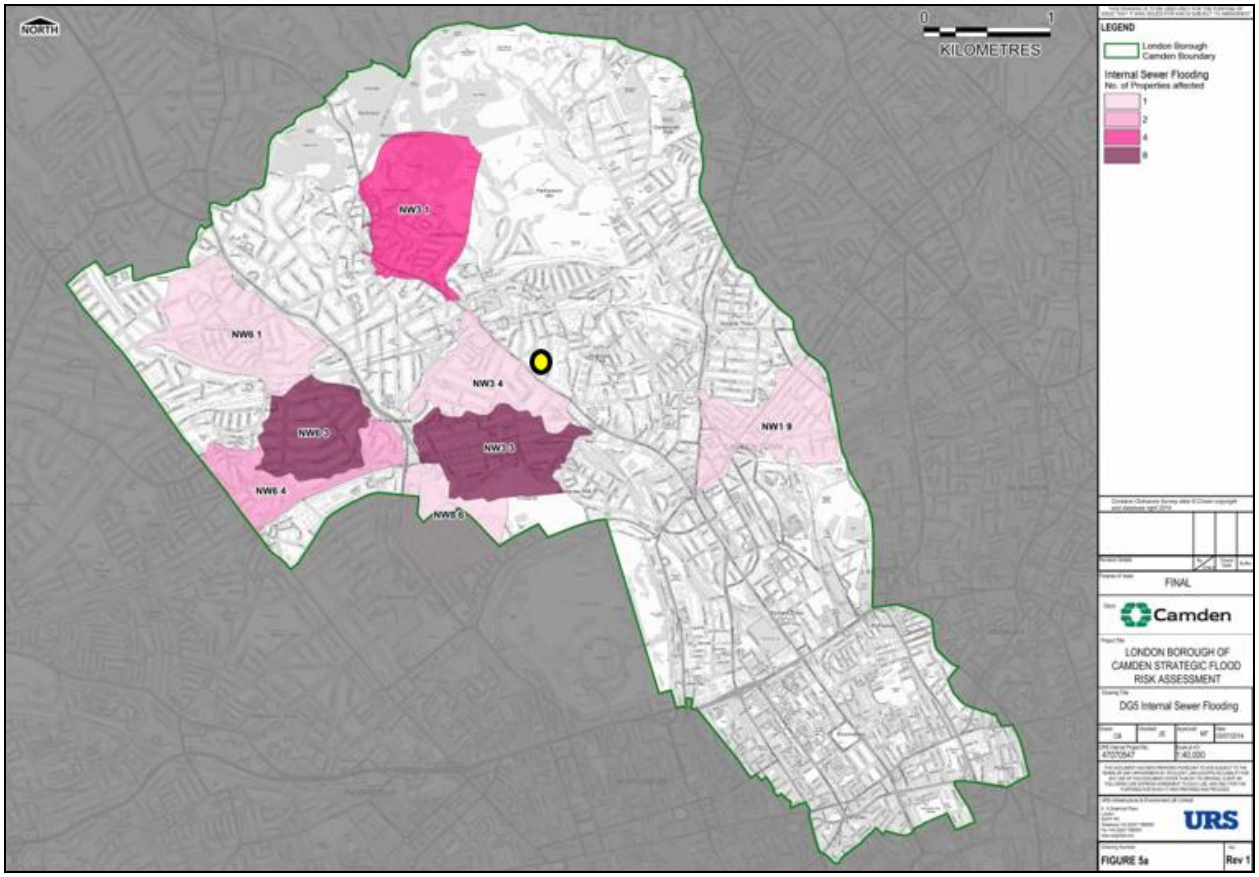



***Figure 04a:*** *Camden SFRA – There is No History of Internal Sewer Flooding at the Site*

**Figure 04b** below shows the site is not in area with a record of External Sewer Flooding. The map is generated from Thames Water's DG5 list of External property flooding database.

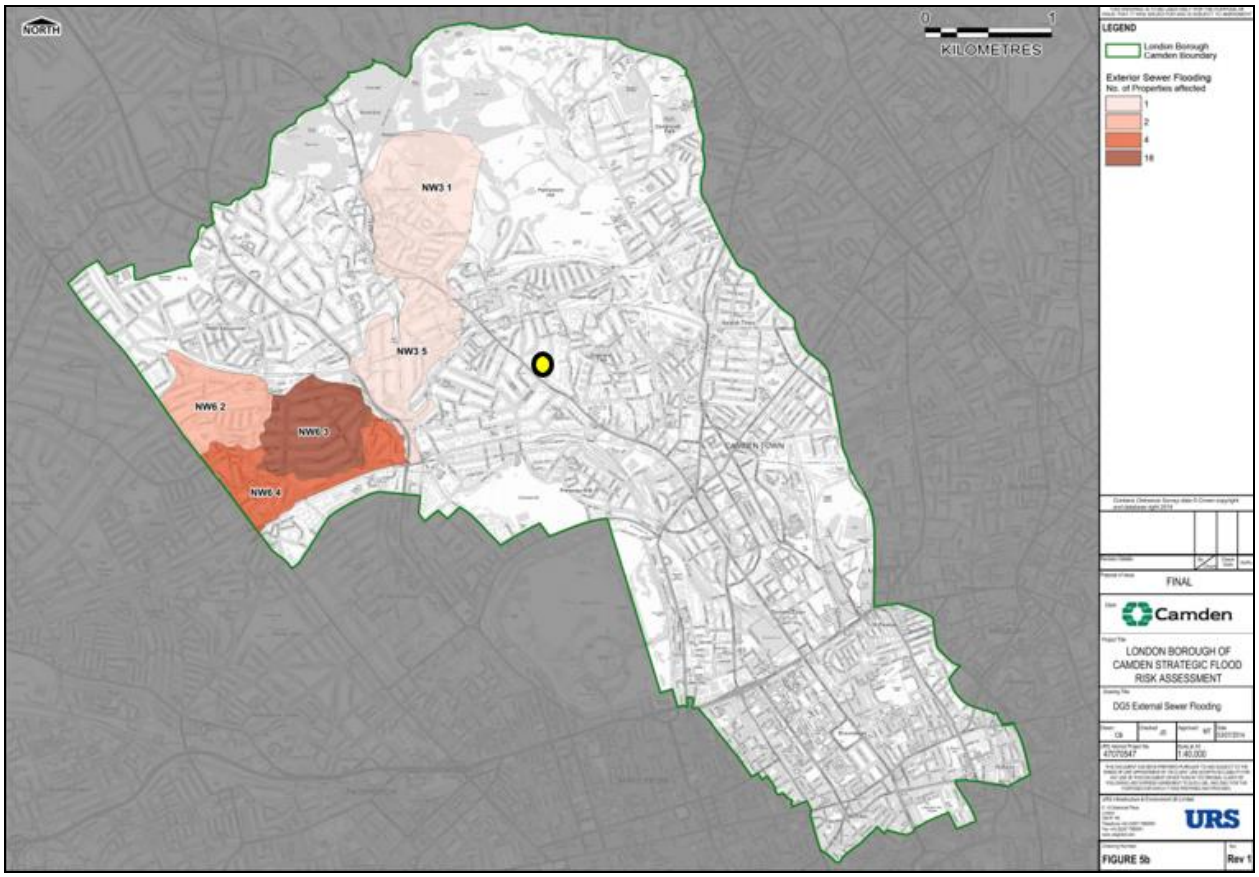



***Figure 04b:*** *Camden SFRA – There is No History of External Sewer Flooding at the Site*

**Figure 05** below taken from LBC flood risk documents confirms that the site is;

- Not in a LFRZ
- Not located on the Environment Agency's Groundwater Source Protection Zone
- Not located close to existing or historic watercourses
- Not prone to flooding from streets as there is no history of flooding on Parkhill Road

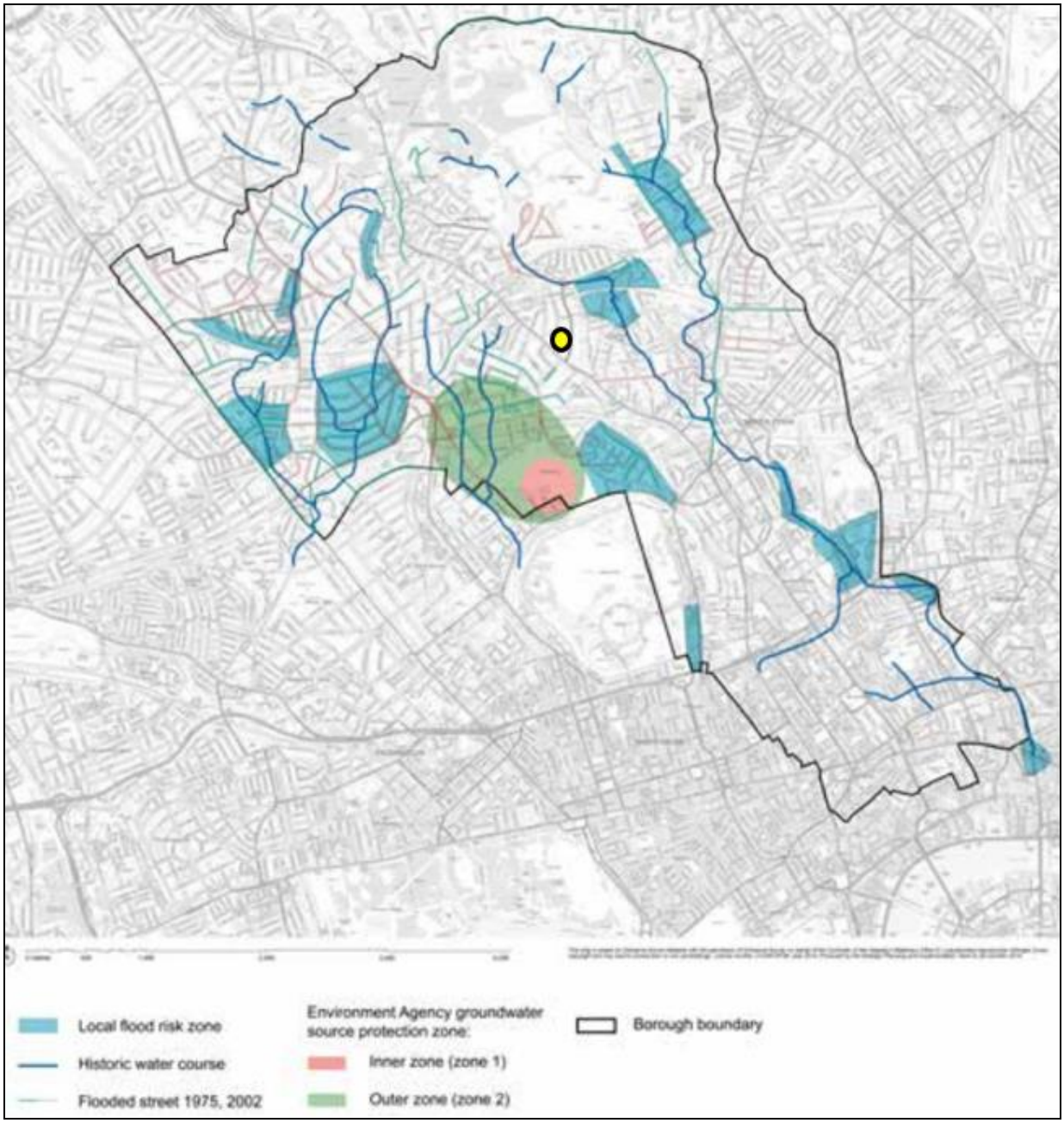



***Figure 05:*** *Site Location in Relation to Historic Flooding and Local Flood Risk*

**Figure 06** below, taken from the Camden SFRA, shows that the site is not in an area exposed to 'Increased Susceptibility to Elevated Groundwater'. Therefore the risk of groundwater flooding is low.

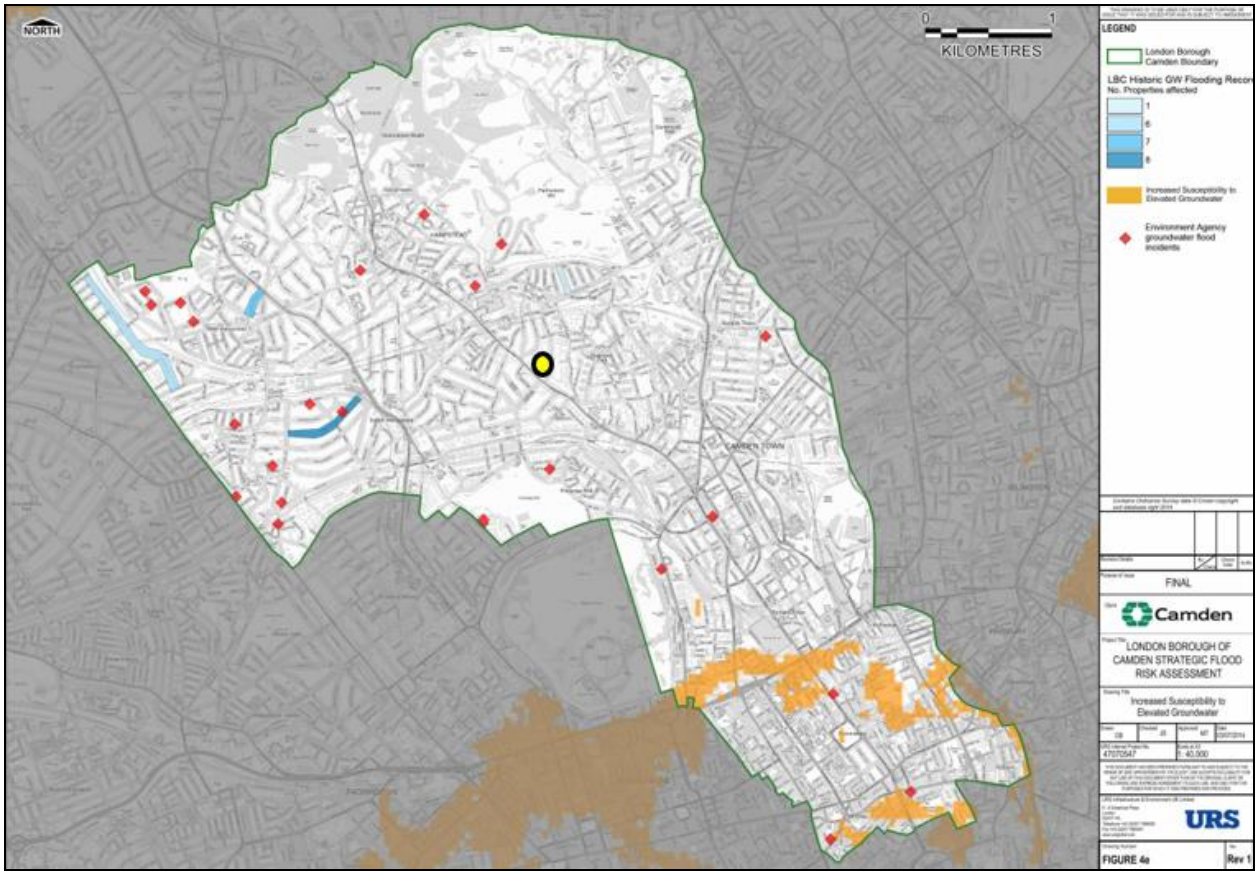



***Figure 06:*** *Camden SFRA - Site is in an Area with Increased Susceptibility to Elevated Groundwater*

# 2 Description of Existing and Proposed Development

## 2.1 Existing

The application site comprises an early 19th Century, four storey terraced dwelling comprising a lower ground floor, raised ground floor, first and second floor arrangement (as shown in **Figure 07a** below). A plan of the site is shown in **Figure 07b**.

From the front the property presents three storeys with the raised ground, first and second floors most evident as shown in **Figure 07c**. The property has a side extension adjoining no.7 with accommodation above a garage. **Figures 07d and 07e** shows the rear elevation and section through the building showing the existing upper and lower ground floors.

The property has a front garden with planted areas, small trees and tiled drive to the garage. The rear garden contains several trees and three out houses and is surfaced with a combination of lawn and stone paved areas surrounded by trees. There are lightwells at the front and rear of the property.

***Figure 07a:*** *Aerial View of the Main House and Side Extension looking West*

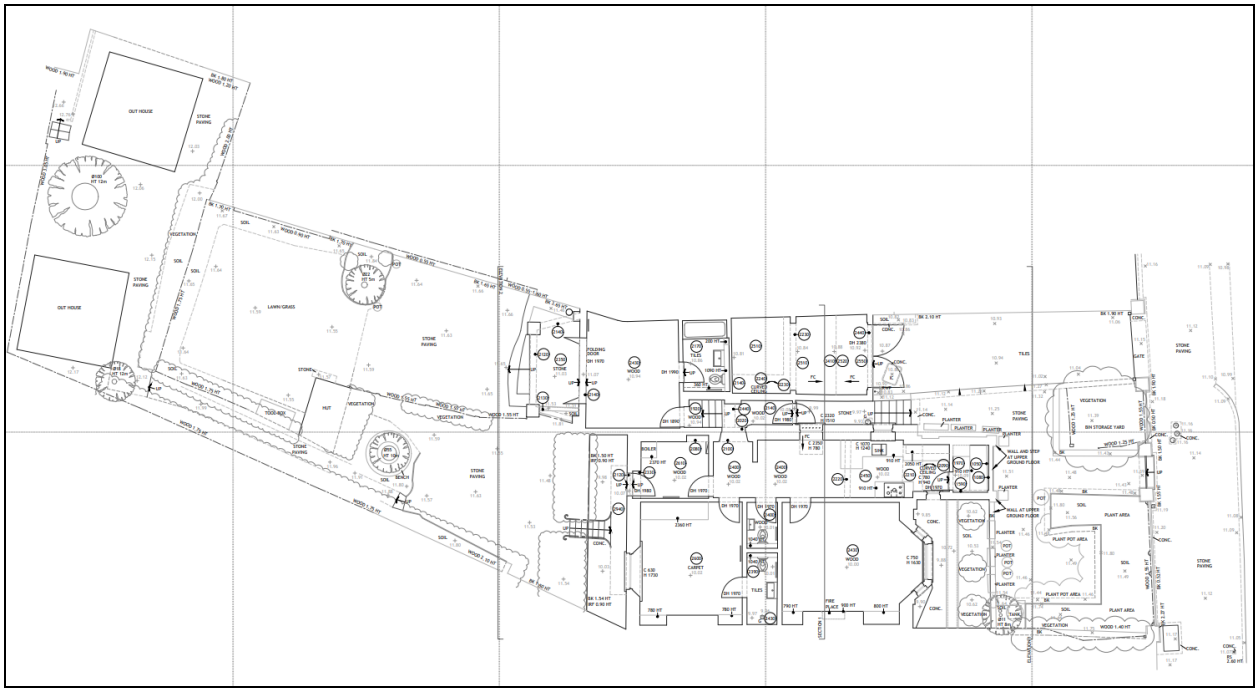


***Figure 07b:*** *Plan of the Site*

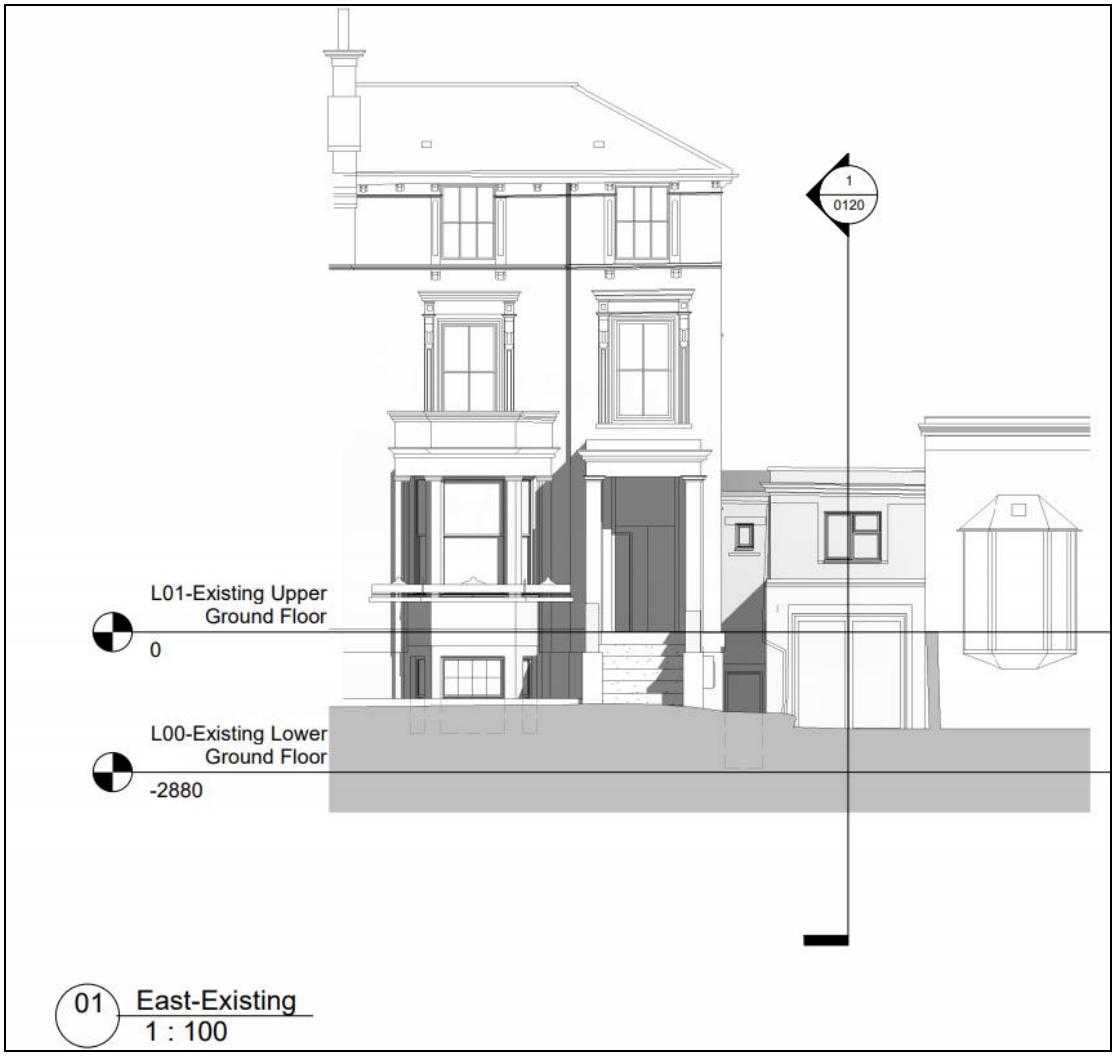



***Figure 07c:*** *View of the Existing Front (East) Elevation*

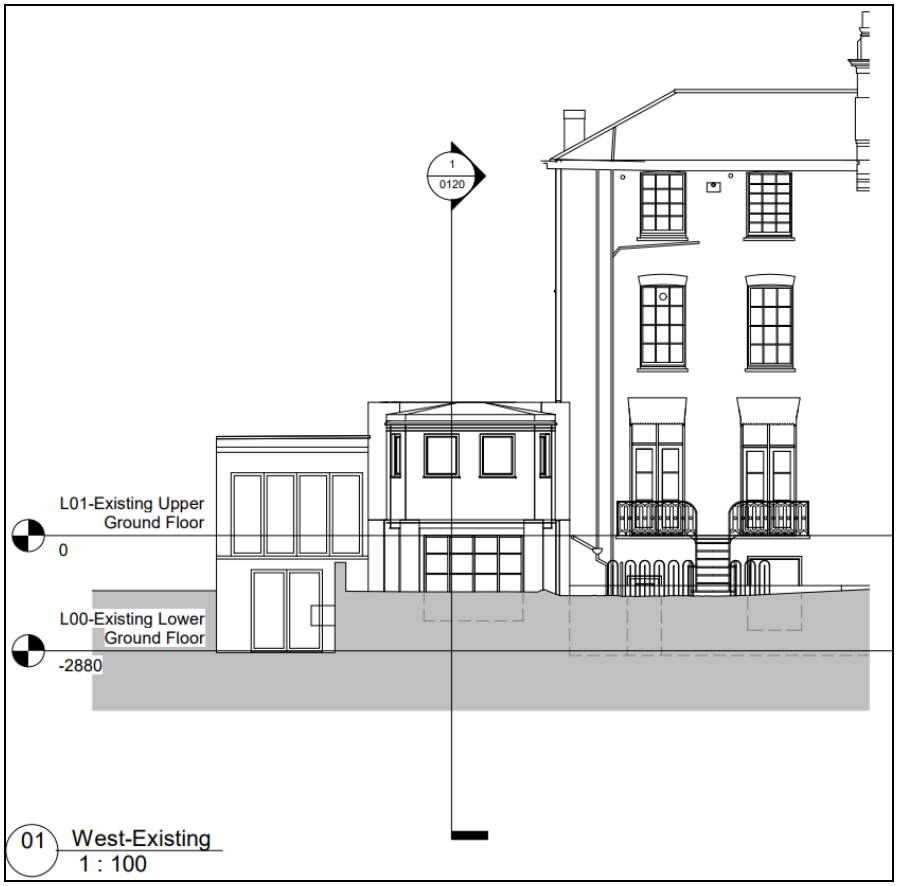



***Figure 07d:*** *View of the Existing Rear (West) Elevation*

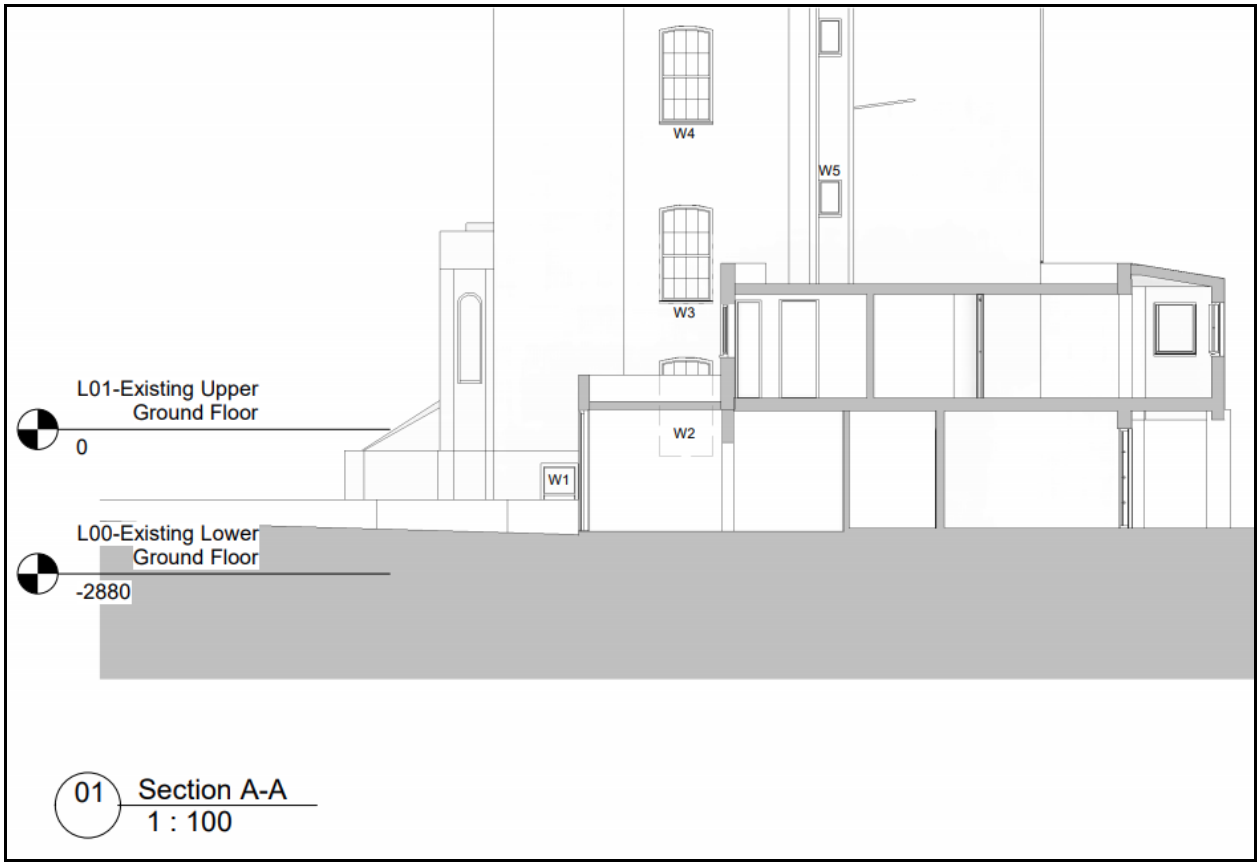



***Figure 07e:*** *Section through the Existing Side Extension*

The existing Upper Ground Floor and Lower Ground Floor Plans are shown in **Figures 07f and 07g** below.

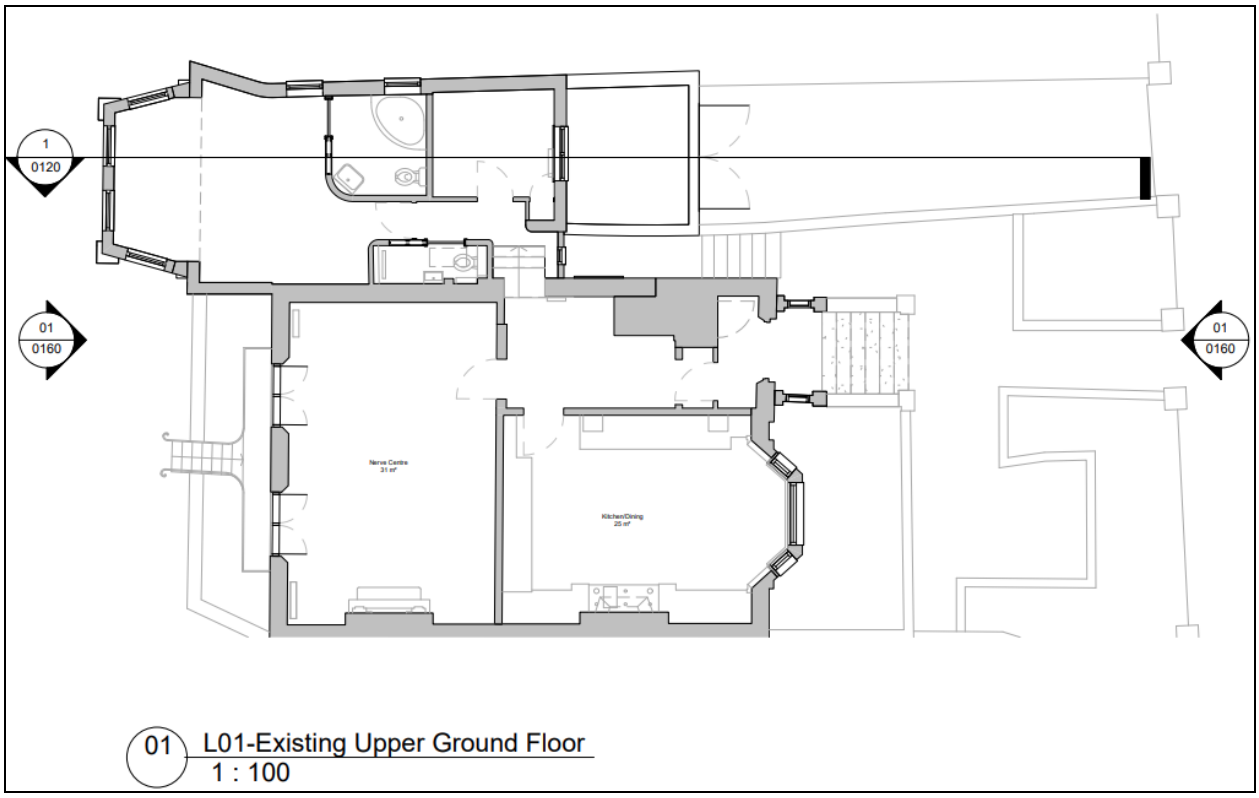



***Figure 07f:*** *Existing Upper Ground Floor Plan*

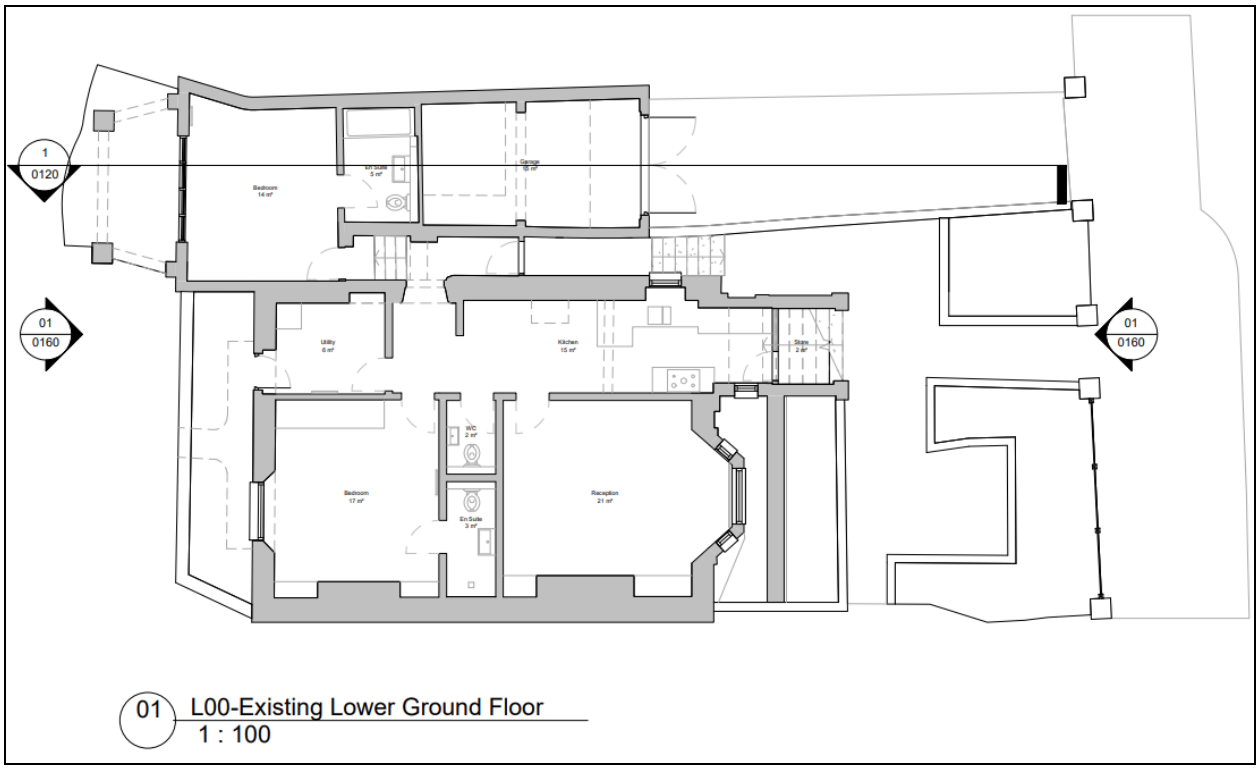



***Figure 07f:*** *Existing Lower Ground Floor Plan*

The existing site area is approximately 494m$^2$ formed of;

- 62m$^2$ Front Garden (Impermeable paved surfaces)
- 35m$^2$ Front Garden (Permeable hedge and tree area)
- 144m$^2$ Footprint of the House (Impermeable roof area)
- 28m$^2$ Rear Garden Footprint of the Out Houses in (Impermeable roof area)
- 139m$^2$ Rear Garden (Impermeable paving)
- 86m$^2$ Rear Garden (Permeable lawns, soil and planted surfaces)

The contributing Impermeable area of the site is 373m$^2$. Total contributing Permeable area is 121m$^2$. The existing 494m$^2$ site area is therefore formed of **76% impermeable** and **24% permeable** surfaces.

**Table 4** below shows a breakdown of the existing drained area;

| | Area, m$^2$ | Hectares (ha) | % of Site |
|---|---|---|---|
| **Existing buildings** | 172 | 0.0172 | 35 |
| **Existing hard landscaping** | 201 | 0.0201 | 41 |
| **Existing soft landscaping** | 121 | 0.0121 | 24 |
| **TOTALS** | **494** | **0.0494** | **100** |

***Table 4:*** *Existing Drained Area Breakdown*

## 2.2 Proposed

The proposed development involves;

- Part demolition and replacement of the side extension as shown in **Figures 08a and 08b** including excavation to drop the lower ground floor level, raise the upper ground floor level, introduce a mezzanine floor (as shown in **Figure 08c**) and raise the roof level
- Modification to the front and rear facades of the side extension as shown in **Figures 08a and 08b**
- Modification to the existing upper and lower ground floor internal layouts of the side extension and minor consequential modification to the layout of the existing upper and lower ground floors of the main house as shown in **Figures 08d and 08e**
- Replacing 60m$^2$ of impermeable paved area in the rear garden to permeable paving to provide 11m$^3$ stormwater attenuation in a 1 in 100 year storm of 6 hr duration
- Minor modifications to the steps to the rear of the main house

A comparison of the Existing and Proposed sections through the Side Extension is shown in **Figure 08f.**

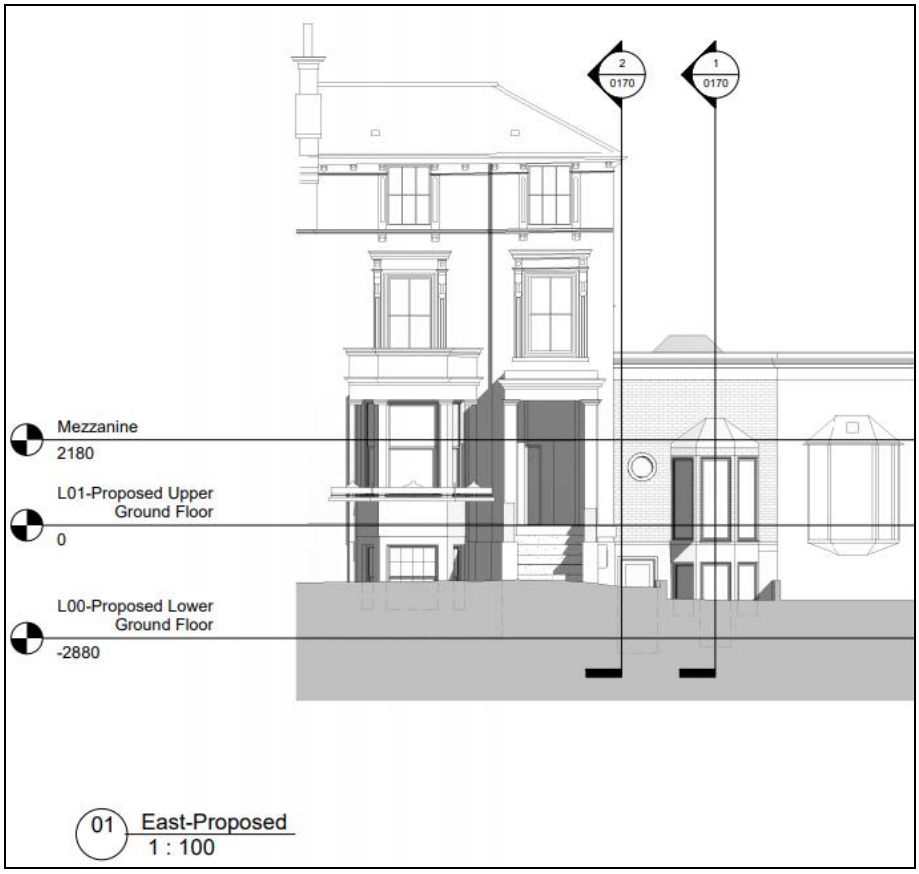



***Figure 08a:*** *View of the Proposed Front Elevation*

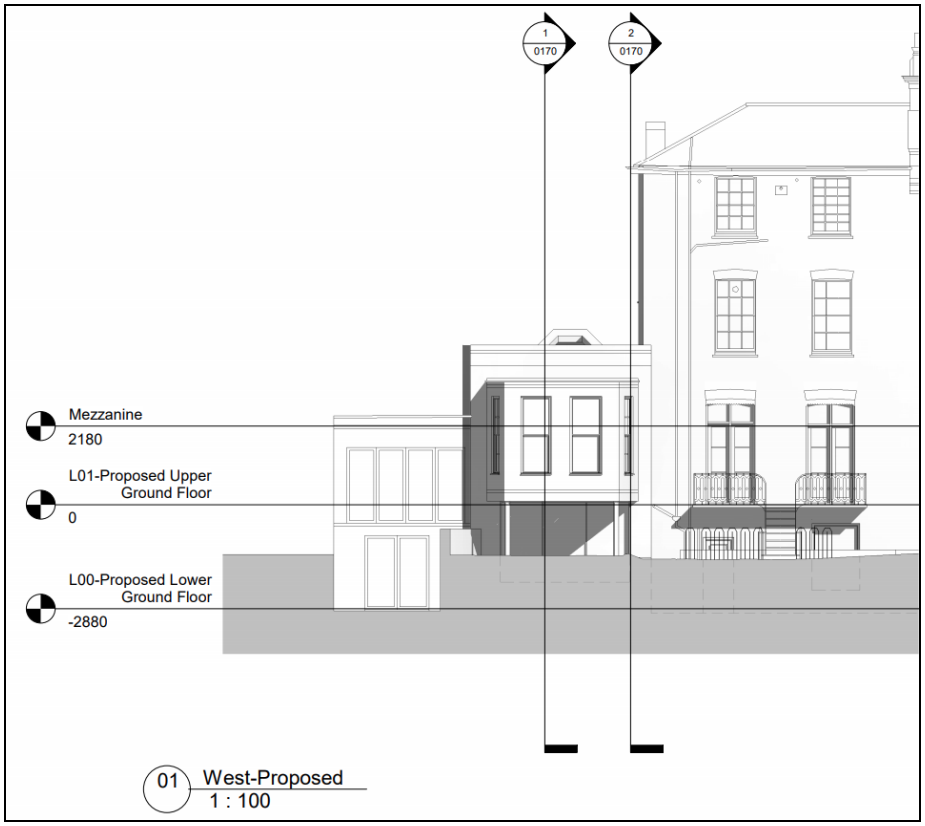



***Figure 08b:*** *View of the Proposed Rear Elevation*

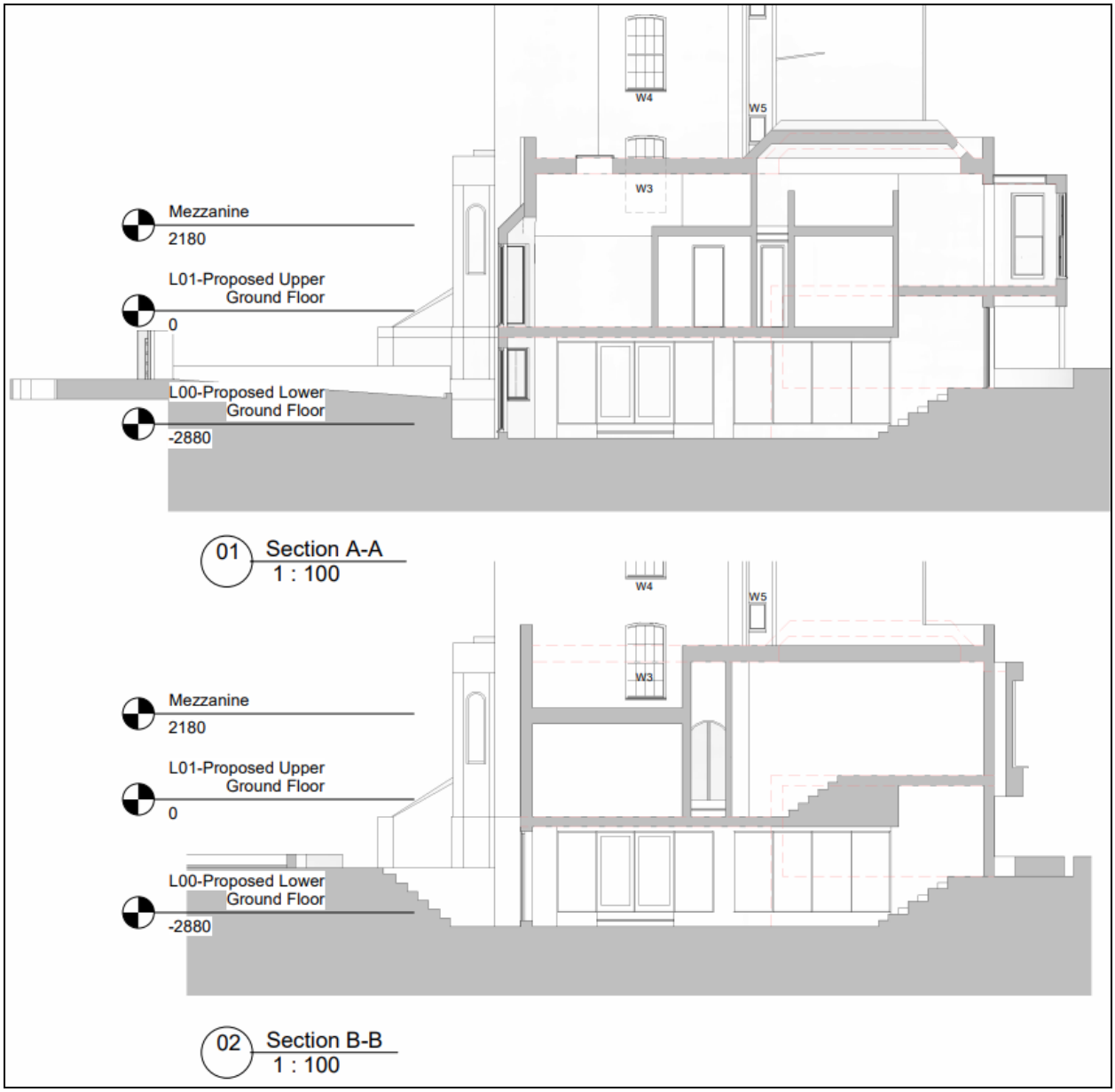



***Figure 08c:*** *Sections through the Proposed Side Extension*

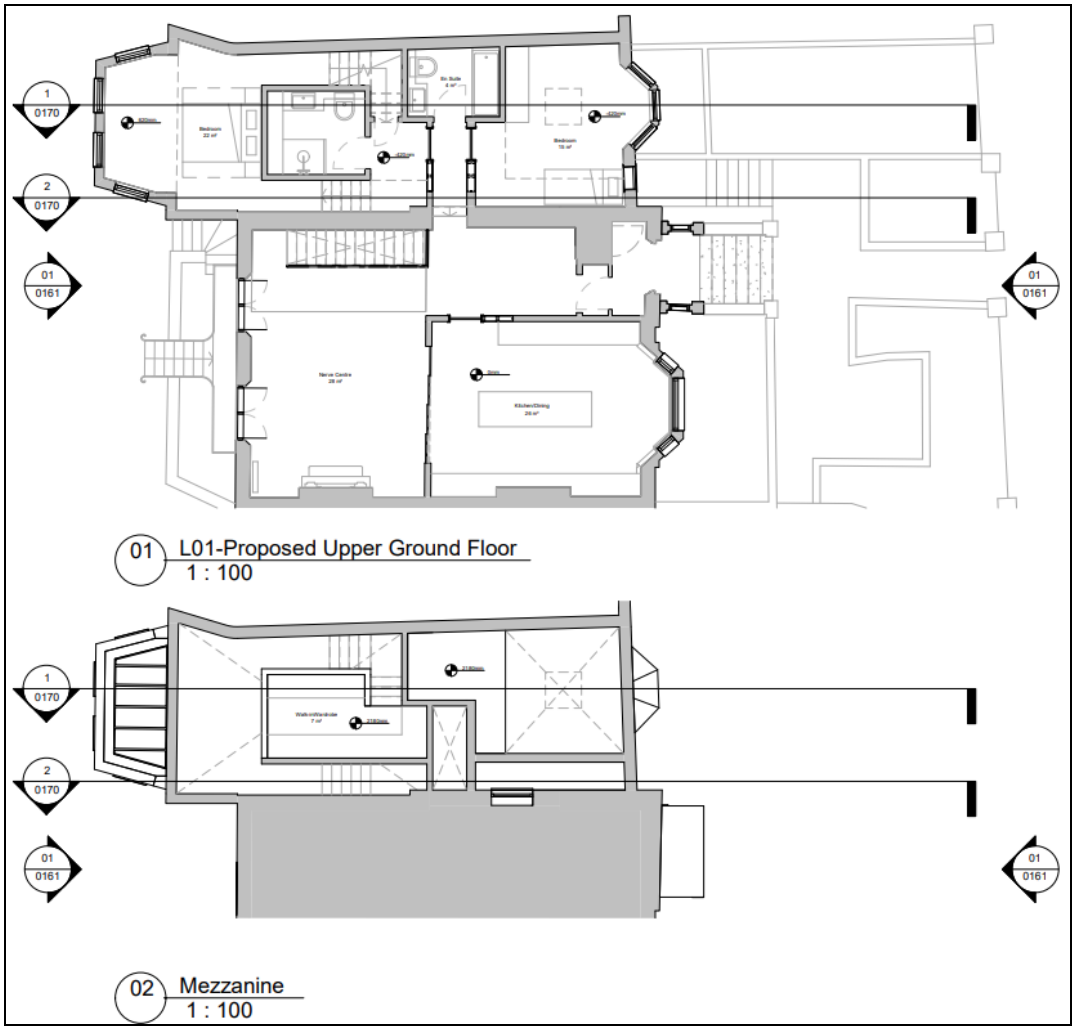



***Figure 08d:*** *Proposed Plans of the Upper Ground Floor and Mezzanine Levels*

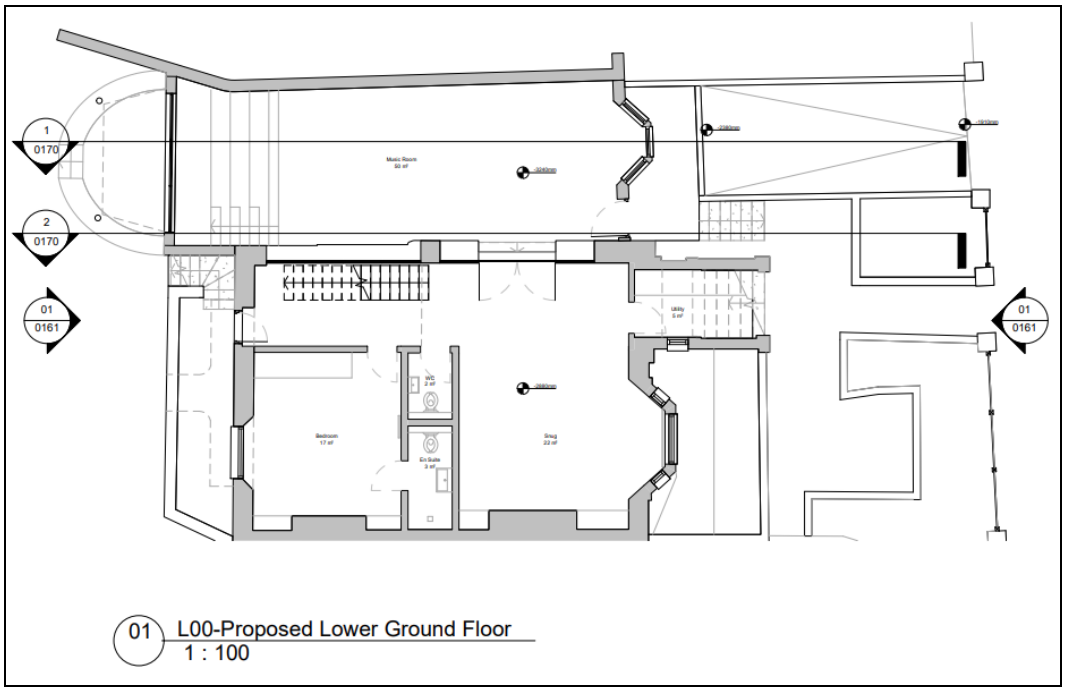



***Figure 08e:*** *Proposed Lower Ground Floor Plan*

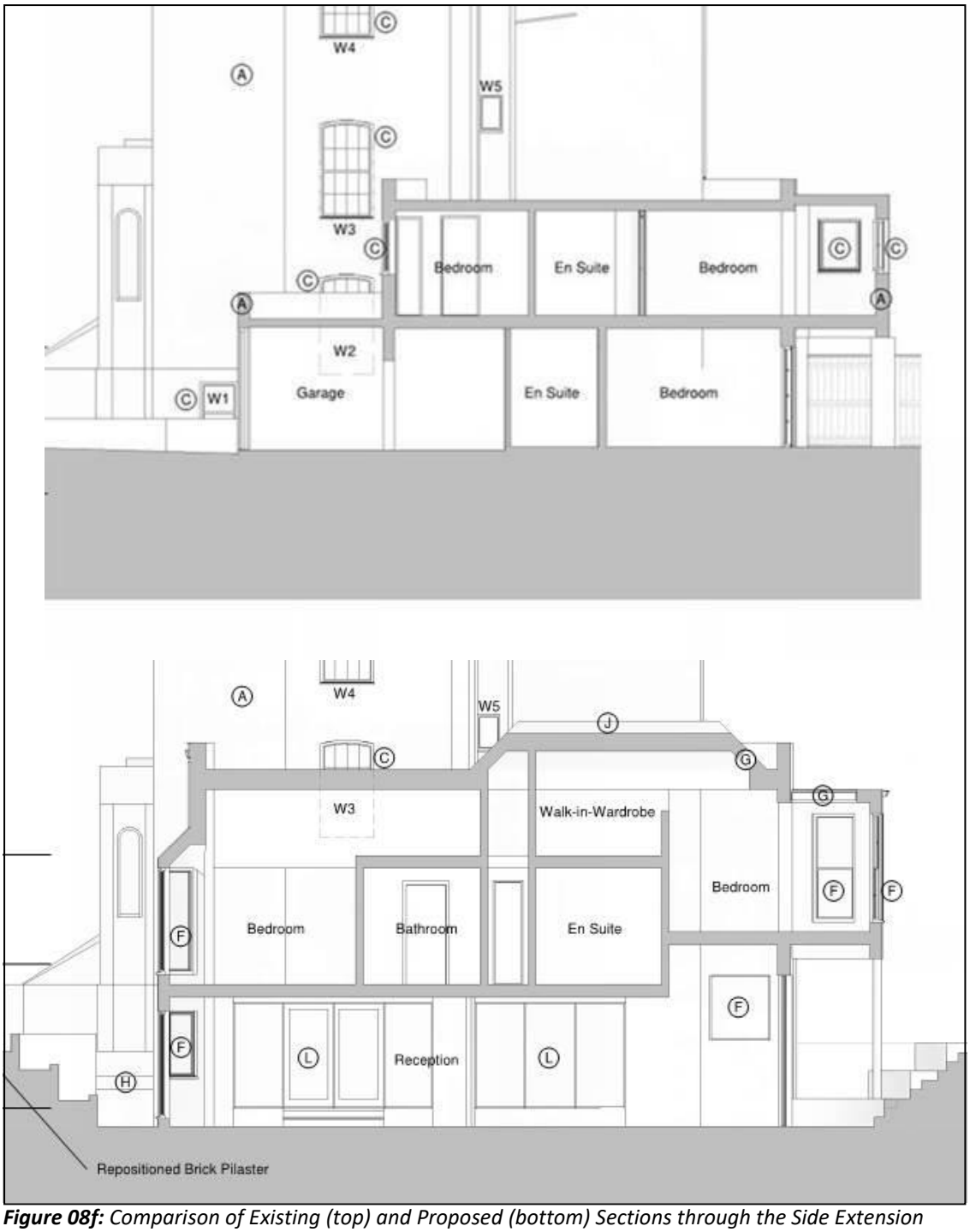



***Figure 08f:*** *Comparison of Existing (top) and Proposed (bottom) Sections through the Side Extension*

# 3 Details of Sewers Serving the Existing Site

## 3.1 Existing Public Sewers

Thames Water sewer asset plans were procured for the site in July 2021 as shown in **Appendix A** to assess the extent and location of public sewers serving the local area. There is a large, combined sewer in Parkhill Road 1,143mm wide x 762mm high, which receives combined Surface Water (SW) and Foul Water (FW) discharges from the property. The sewer flows in a northerly direction and there is a manhole in the road in front of the property (ref. 7803) but the invert and cover levels of the chamber are not provided on the Thames Water asset dataset.

## 3.2 Existing Drainage at the Site

A CCTV Drainage survey was undertaken on 29 July 2021 to identify the existing below ground drainage network at the site as provided in **Appendix B**.

Their report shows the presence of a rainwater gully in the rear garden which received run-off from the roof. The trapped gully discharged via a 100mm vitrified clay (VC) pipe to a Soil Vent Pipe (SVP) located beside the rainwater gully. The combined flows are conveyed to manhole MH2 located within the footprint of the building (assumed to be located within the garage). This manhole has three branches delivering wastewater and rainwater flows from the property. The CCTV survey shows manhole MH2 as being 1m deep and discharges combined flows to MH1 located in the front driveway (in front of the garage) via a 150mm diameter VC pipe.

MH1 is also recorded as being 1m deep and contains three branches with two delivering rainwater from downpipes and trapped gullies and one delivering wastewater from the property. Combined flows are discharged via a 150mm dia sewer to the large Thames Water combined sewer in Parkhill Road 14.75m downstream of MH1.

The existing sewers are in good condition except for a section of the 150mm dia combined sewer immediately downstream of MH2 which has collapsed restricting free flow to MH1. The collapse is approximately 3.75m from the manhole and is evident on the CCTV images recorded during the drainage survey. The collapsed section is located under the house; therefore the pipework will require replacing during the redevelopment works. Once the new pipe is installed, the entire sewer network will require pressure jetting to remove residual silt and debris.

# 4 Existing Topography, Geology and Hydrogeology

## 4.1 Existing Site Topography

The topographical survey in **Figure 07b** has used local levels. The road outside the drive is at approximately 55.75m Above Ordnance Datum. The driveway level joining Parkhill Road has a local level of 11.00m. The existing Lower Ground Floor Level of the building is set at 10.00m which equates to approximately 54.75m AOD. The Upper Ground Floor level is 2.88m above the Lower Ground Floor therefore the Upper Ground Flood level is 57.63m AOD.

Similarly;

- Cover level of manhole MH1 is (10.86) is 55.61m AOD
- Invert level of manhole MH1 is 54.61m AOD
- Front garden level is 56.23m AOD
- Rear garden level is 56.23m AOD rising to 56.81m AOD at the westernmost boundary

- Existing Lower Ground Floor Level of the main house (10.00) is 54.75m AOD
- Existing Upper Ground Floor level of the main house is 57.63m AOD
- Existing Lower Ground Floor Level of the Side Extension (10.88) is 55.63m AOD
- Existing Upper Ground Floor level of the Side Extension is approx. 58.00m AOD

- Proposed Lower Ground Floor Level of the Side Extension is reduced by 0.36m to 54.39m AOD
- Proposed Upper Ground Floor Level of the Side Extension will be 57.21m AOD
- Proposed Mezzanine Floor Level will be 59.81m AOD

## 4.2 Existing Geology of the Site

The geology information for the site has been obtained from British Geological Survey (BGS) and Environment Agency (EA) data. The underlying geology within LBC comprises mainly of bedrock formed primarily of London Clay Formation (as shown in **Figure 09a** below taken from the Camden SFRA), with the exception of Claygate Member and Bagshot Formation which underlie the higher ground in the north of the borough on Hampstead Heath.

The majority of the borough is shown to be free of superficial deposits.

**Figure 09b** from the Camden SFRA identifies the site as being 'Probably Suitable for Infiltration SuDS'. **Figure 09c** suggests the site does not have any infiltration constraints.

However the Seepage Test carried out on site (detailed in **Section 4.5** below) confirms the site is not suitable for infiltration techniques.

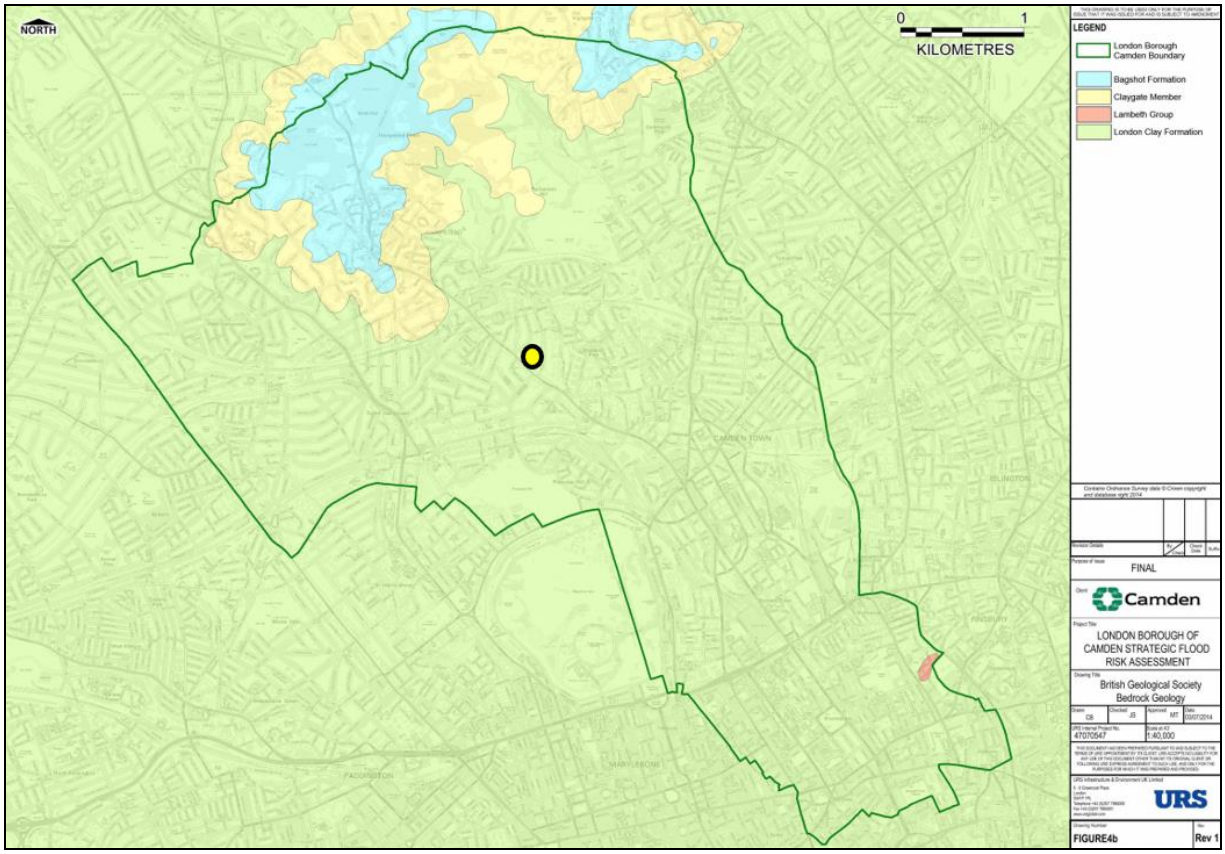



***Figure 09a:*** *Site Location on London Clay Formation*

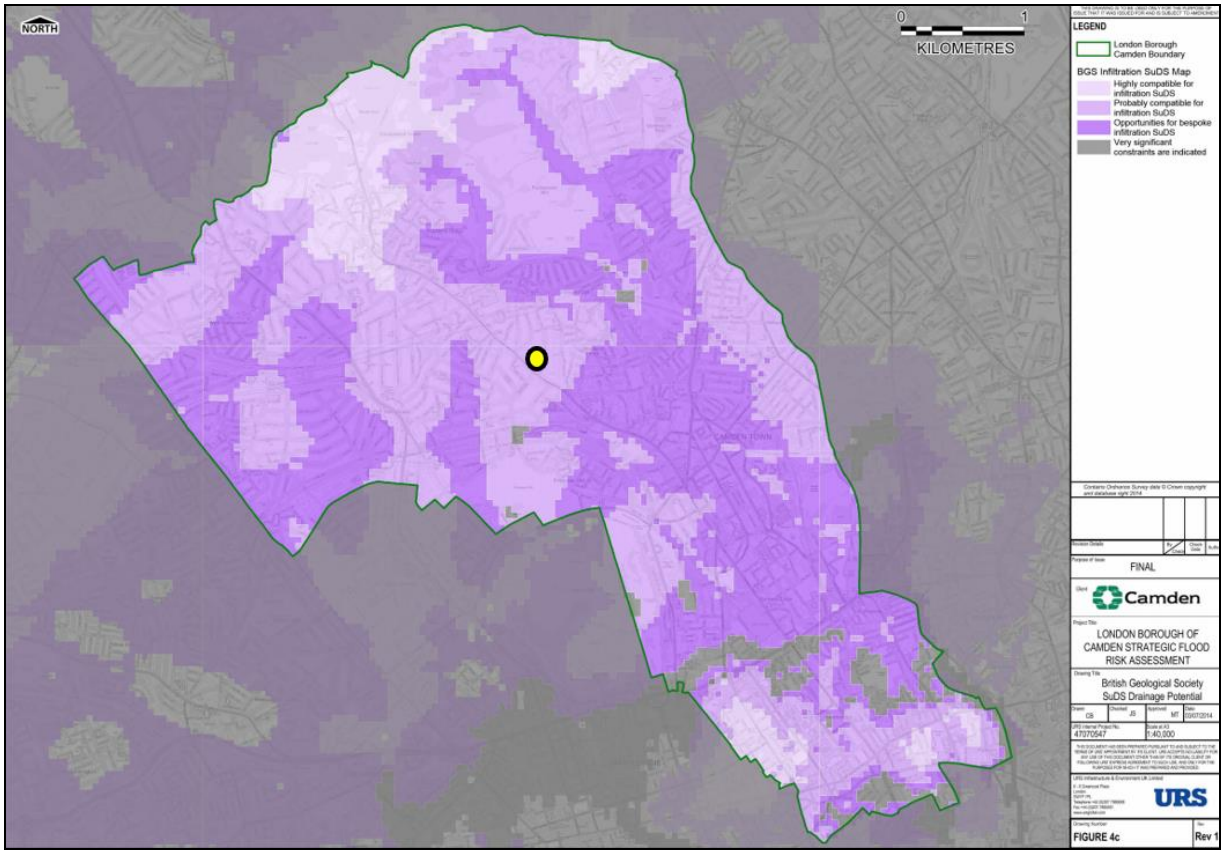



***Figure 09b:*** *Site 'Probably Compatible to Infiltration SuDS'*


***Figure 09c:*** *Site 'Infiltration Constraints'*

## 4.3 Existing Hydrogeology of the Site

The London Clay Formation is a non-aquifer or unproductive strata – these are rocks with low permeability that have negligible significance for water supply or river base flow.

The Inner Zone of a Groundwater Source Protection Zone (GSPZ) is located within the south-west of Primrose Hill park. An Outer Protection Zone covers a section of South Hampstead from Prince Albert Road to Swiss Cottage. The site is not above a source protection zone as confirmed in **Figure 05**.

The Claygate Member and London Clay Formation are classified as bedrock whose permeability is spatially variable, but likely to permit moderate infiltration.

## 4.4 SuDS Manual

The SuDS Manual provides approximate rates for varying soil conditions and the approximate infiltration rate for London Clay is less than 3 x $10^{-8}$ m/s which makes infiltration unsuitable for this development. The DEFRA Magic Map Soilscape supports this by confirming the site as being located on 'slow permeable clayey soil'.

Soakaways: **'**BRE Digest 365 – Soakaway Design' suggests soakaways are unsuitable when seepage rate is less than 1x$10^{-6}$ m/s. Soakaways constructed in soils with infiltration rates lower than this value will generally be very slow to empty and therefore will not comply with the requirement for soakaway emptying time (ie to be 50% empty within 24 hrs).

The top organic soil layers are expected to be suitable for infiltration and therefore permeable paving has been proposed for the rear garden as they can still be useful for intercepting the first 5mm of rainfall or as part of attenuation storage and source control.

Deeper soakaways, however, are not considered feasible at the site and has not been allowed for.

## 4.5 Seepage Tests

Seepage Tests were carried out on site in July 2021 in accordance with BRE Digest 365 guidelines which confirmed the unsuitability of the underlying strata for infiltration techniques.

Two trial pits were excavated in the rear garden 400mm wide x 400mm long x 400mm deep as shown in **Figure 10**. The pits were filled with water and timed to check the drop in water level over several hours. After 4 hours there was no measurable difference in the starting water level. The trial was repeated 3 times at both pits and eventually halted as there was no measurable change in water level.

***Figure 10:*** *Trial Pit at the Site*

Consequently, the testing confirmed the ground to be highly unsuitable for infiltration due to its significant clay content.

# 5 Existing Peak Surface Water Discharge Rate

**Table 4** in **Section 2.1** provides a summary of the existing drained area for the site. The existing surface water discharge rate has been calculated for the 1 in 1 year return period using the Rational Method, for a 60 minute storm duration, in line with the LBC SuDS Policy:

$$Q = 2.78 \times I \times A \times Cv \times Cr$$

Where:

$I - Rainfall\ Intensity\ (mm/h)$ = 49.801 mm/hr from **Figure 11**
$A - Drained\ Areas\ (ha)$ = 0.0494 ha
$Cv - Volumetric\ Runoff\ Coefficient$ = 1
$Cr - Routing\ Coefficient$ = 1

The peak rainfall intensity for a 1 in 1 year, 60 minute storm duration was generated using nationally applied Microdrainage software as shown in **Figure 11 below**.

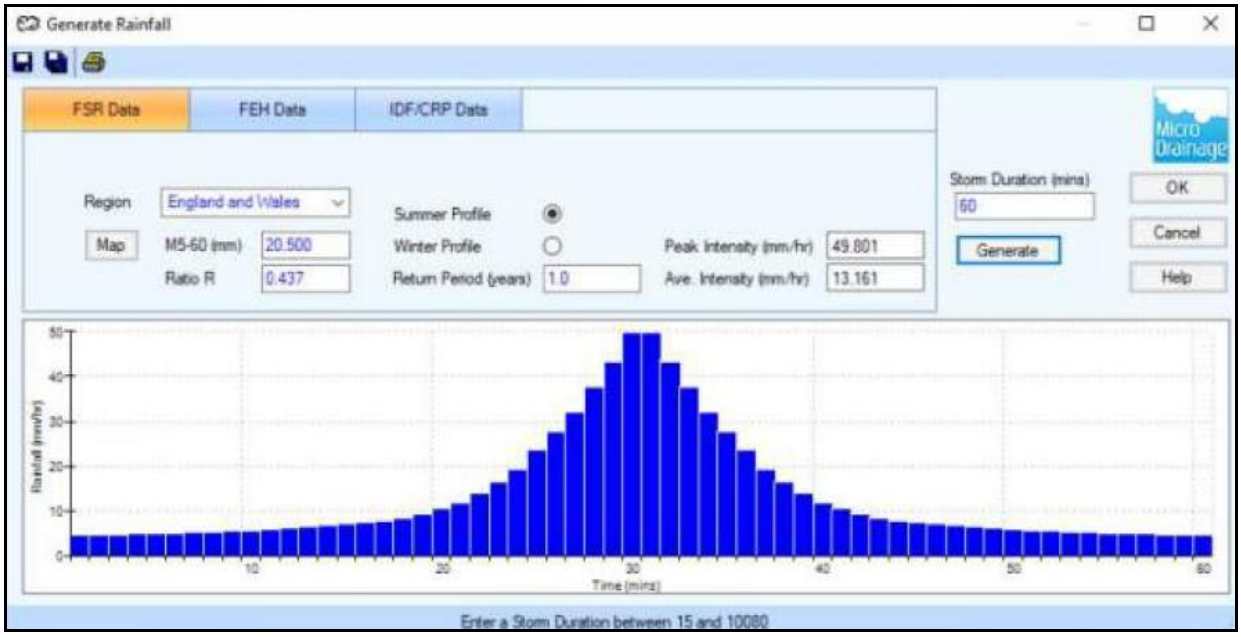



***Figure 11:*** *Peak Rainfall intensity for the 1 in 1 year 60-minute storm event (50mm/hr)*

The existing Peak SW discharge rate for the 1 in 1 year return period is shown in **Table 5** below;

| Return Period | Existing SW Discharge Rate, l/s |
|---|---|
| **1 in 1 year storm event** | 6.84 |

***Table 5:*** *Existing Peak SW Flow Rate from the Site*

# 6 Surface Water Drainage Strategy

## 6.1 SuDS Hierarchy

In accordance with the Council's and EA's guidelines, CIRIA documents, SuDS Manual and the London Plan, surface water run-off should be managed as close to its source as possible, with the re-use of rainwater within the building prioritised. The following drainage hierarchy was used to determine the most suitable and sustainable SuDS strategy:

1. Store rainwater for later use
2. Use infiltration techniques, such as soakaways in suitable areas
3. Attenuate rainwater in ponds or open water features for gradual release
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water sewer/drain
7. Discharge rainwater to the combined sewer.

The preferred SuDS method should be supplemented by water re-use, via systems to collect run-off from roofs or other impermeable surfaces and make it available for non-potable use. Water butts have not to be taken into account when calculating site run-off or storage.

The following drainage hierarchy (shown in **Table 6** below) has been considered when developing the surface water drainage philosophy for the proposed redevelopment. This is in accordance with Policy SI13 of the London Plan (2021).

| SuDS Hierarchy Level | Surface Water Disposal Method | Comments |
|---|---|---|
| **1** | Rainwater harvesting | Rainwater harvesting is not considered practical or appropriate for the existing building as it would involve installation of a deep tank that would require pumping to empty and potential impact on existing tree root protection zones |
| **2** | Infiltration techniques and green roofs | Clay subsoil makes infiltration unviable as confirmed by the Seepage Tests. Permeable paving is proposed to replace 60m$^2$ of existing impermeable paving in the rear garden. A green roof is not feasible due to existing pitched roofs and availability of land in the rear garden for managing SW run-off |

| | | |
|---|---|---|
| **3** | Rainwater attenuation in open water features for gradual release | Open water features have not been considered for the site as the rear garden is preferred for use as amenity space |
| **4** | Rainwater discharge direct to a watercourse (unless not appropriate) | There are no watercourses in close proximity to the site |
| **5** | Rainwater attenuation below ground | It is proposed to attenuate excess volumes of rainwater on site through the use of permeable paving in the rear garden laid above voided sub-base material. The impact on root protection zones is negligible |
| **6** | Rainwater discharge to a surface water sewer or drain | Thames Water does not have a separate SW sewer in Parkhill Road |
| **7** | Rainwater discharge to a combined sewer | As the only available Thames Water public sewer network in the vicinity of the site is a large, combined, box-culvert, it is proposed to retain the existing combined drainage connections from the site but with a significantly restricted SW run-off rate |

***Table 6:*** *SuDS Hierarchy (According to Policy SI13 of the London Plan, 2021)*

## 6.2 Proposed SW Drainage Strategy

The proposed surface water drainage strategy for the planned redevelopment aims to restrict the peak SW discharge rates off the site as far as reasonably practicable. The greenfield run-off rate from the site is provided in **Appendix C** and the proposed SuDS scheme will restrict peak SW run-off from the site by **80%.** The design storm considered is the 1 in 100 year 6 hour storm to comply with policies in the London Plan and LBC's surface water management plan and SuDS guidelines.

**Table 7** below highlights the existing and proposed surface water discharge rates for the development.

| | **Peak Run-off Rate, l/s** |
|---|---|
| **Existing run-off rate** | 6.84 |
| **Proposed run-off rate** | 1.38 |

***Table 7:*** *Peak SW Run-off Rates from the Site*

The drained area breakdown of the proposed redevelopment is summarised in **Table 8** below. The proposed contributing site area remains 494m$^2$ formed of;

- 62m$^2$ Front Garden (Impermeable paved surfaces)
- 35m$^2$ Front Garden (Permeable hedge and tree area)

- 144m$^2$ Footprint of the House (Impermeable roof area)
- 28m$^2$ Rear Garden Footprint of the Out Houses in (Impermeable roof area)
- 79m$^2$ Rear Garden (Impermeable paving)
- 86m$^2$ Rear Garden (Permeable lawns, soil and planted surfaces)
- **60m$^2$ Rear Garden Permeable Paving Blocks to replace Impermeable Paving**

The contributing Impermeable area of the site is 313m$^2$. Total contributing Permeable area is 181m$^2$. The existing 494m$^2$ site area is therefore formed of **64% impermeable** and **36% permeable** surfaces.

| | Area, m$^2$ | Hectares (ha) | % of Site |
|---|---|---|---|
| **Proposed buildings – impermeable roofs** | 172 | 0.0172 | 35% |
| **Proposed retained paving - impermeable** | 141 | 0.0141 | 29% |
| **Proposed permeable paving** | 60 | 0.0060 | 12% |
| **Proposed retained soft permeable landscaping** | 121 | 0.0121 | 24% |
| **TOTALS** | **494** | **0.0494** | **100** |

***Table 8:*** *Proposed Drained Area Breakdown*

From **Table 8**, the contributing proposed impermeable building roof area is 172m$^2$ and retained paving/patio area is 141m$^2$. Soft landscaping represents 121m$^2$ of the overall site and the new permeable paving in the rear garden will increase permeable surfaces by a further 60m$^2$. Consequently, the impermeable surface area reduces from 76% to **64%** and soft landscaped/permeable areas increase from 24% to **36%** which is a betterment.

It is proposed to restrict peak SW run-off from the proposed development through provision of 60m$^2$ permeable paving in the rear garden by replacing the impermeable paved area near the dwelling. The voided sub-base material will provide rainwater attenuation volume in the graded subsoil. Peak SW discharge from the site to the Thames Water combined sewer will be at the reduced greenfield run-off rate of 1.38 l/s. A hydrobrake flow control chamber will be provided in the rear garden, with an accompanying sediment control chamber (catchpit), to provide control at source.

The proposed permeable paving will not require tanking due to underlying clayey ground conditions and its limited suitability for infiltration. The lightwells around the property will be provided with new trapped floor gullies.

Hydraulic modelling calculations in **Appendix D** show the hydraulic input parameters and the storage volume required at the site to manage peak SW run-off. It is proposed to mimic the existing situation

whereby all flow is drained into the large Thames Water box sewer in Parkhill Road via existing manhole MH1.

The hydraulic modelling calculations indicated that the overall attenuation volume required in a 1 in 30 year storm event is 7m$^3$. The volume required in a 1 in 100 year 6 hr event is 11m$^3$.

A significant permeable paved area with a storage depth of 650mm is being provided as a SuDS and source control measure. Course graded aggregate will be used to form the required sub-base depth to achieve a void ratio of 30%. Therefore 60m$^2$ of proposed permeable paving area will provide 11.16m$^3$ of storage volume in the rear garden (60m$^2$ area x 0.62m deep x 0.3 void ratio).

The permeable paved area will discharge to the catchpit via dedicated pipes. Introduction of permeable paving will provide in-situ rainwater management from the severe 1 in 100 year design storm event of 6 hr duration.

These SuDS features will provide significant betterment by reducing the peak SW run-off rate from the site by 80% from 6.84 l/s to 1.38 l/s. The reduced SW run-off rate will be discharged to the Thames Water public combined sewer in Parkhill Road via new inspection chamber IC3 and MH1. Peak rate will be limited to 1.38 l/s via the use of a hydrobrake flow control device located in a dedicated chamber as shown on the proposed drainage layout plan shown in **Figure 12** below.

### SW and FW Lift Pumping Stations

The proposed lower ground floor level of 54.39m AOD at the front and rear of the side extension is 220mm lower than the 54.61m AOD invert level of MH1. Therefore a new dual-pump package SW Lift pumping station is to be installed in the lightwell in front of the new side extension to lift SW flows to MH1 as shown in **Figure 12**.

A dual SW Package Pumping Station to be as shown in link below or similar product. Sump to be vented with a 100mm dia pipework located as shown on the proposed drainage layout plan.

https://www.deltamembranes.com/products/dual-v3-sump-pump-station/

Similarly, a dual-pump package FW Lift pumping station is required to lift FW flows from the new sewer to be laid below the Lower Ground Floor slab of the new side extension. These works provide an opportunity to replace the collapsed sewer under the building near MH2.

A dual unit FW Package Lift Pumping Station to be as shown in link below or similar product. Sump to be vented with a 100mm dia vent pipe located as shown on the proposed drainage layout plan.

https://www.jtpumps.co.uk/jtdual--800l-sewage-pumping-station-2-inch-rigged-twin-guide-rail-upto-10m-lift-1142-p.asp

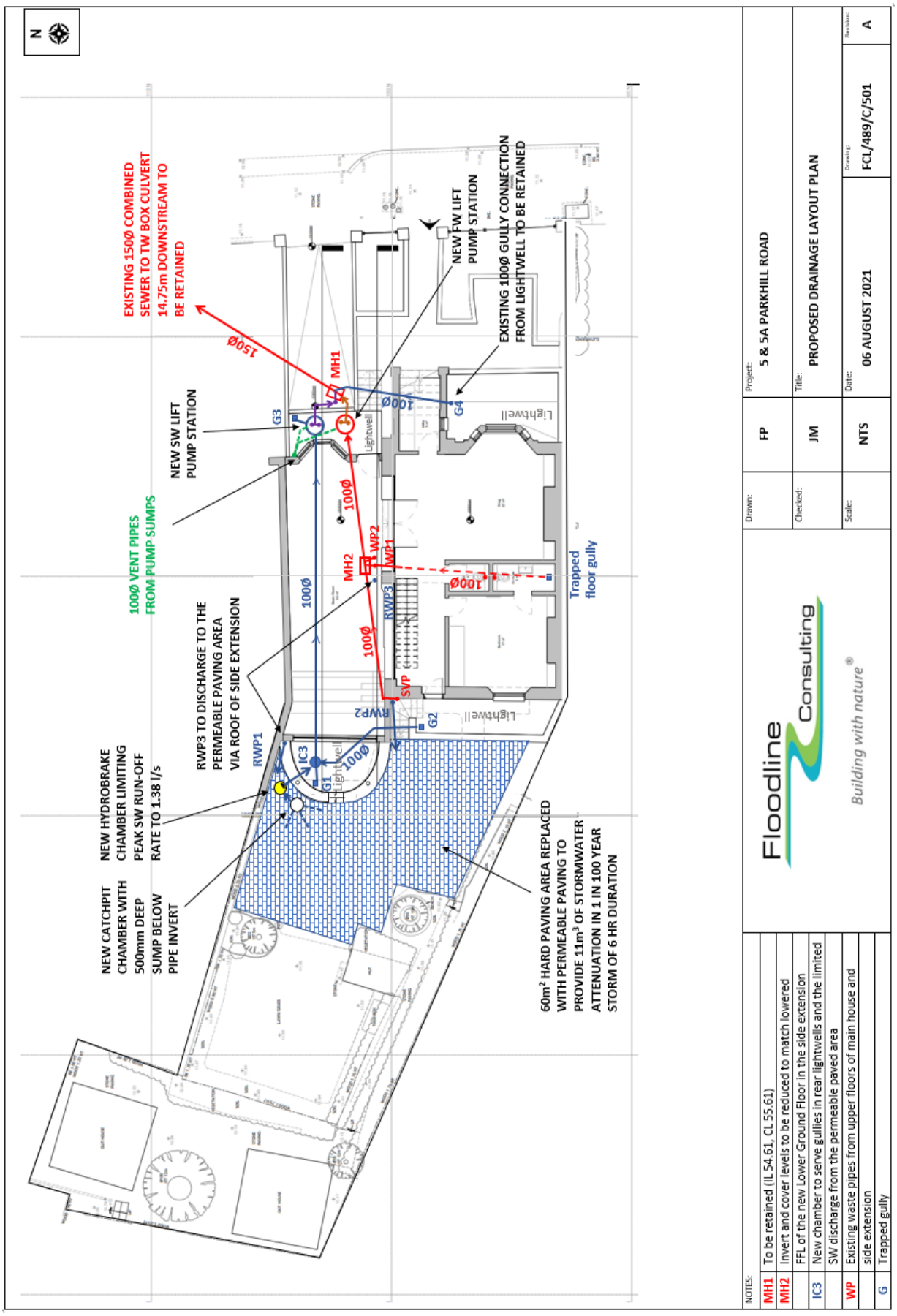



***Figure 12:*** *Proposed Drainage Layout Plan*

## 6.3 Connection to the Existing Thames Water Public Sewer

The existing 150mm diameter combined sewer under the building will be retained to continue to serve the property by discharging combined flows to the existing Thames Water box sewer in Parkhill Road. The new permeable paved area in the rear garden will discharge to the combined sewer via a sediment tank (catchpit) and a hydrobrake flow control device.

## 6.4 Pollution Prevention and Treatment of Surface Water Run-off

SuDS Manual Table 26.2 'Pollution hazard indices for different land use classifications', indicates the development would fall into the classifications shown below;

**Table 2 Pollution hazard indices for different land use classifications, Table 26.2, CIRIA SuDS Manual C753.**

| Land use | Pollution hazard level | Total suspended solids (TSS) | Metals | Hydrocarbons |
|---|---|---|---|---|
| Residential roofs | Very low | 0.2 | 0.2 | 0.05 |
| Residential car parks and low traffic roads | Low | 0.5 | 0.4 | 0.4 |

Based on the above, the proposed drainage systems formed of permeable paving, trapped gullies, roof drains, catchpit, flow control device etc, will provide sufficient treatment for contaminants that may be present in surface water run-off generated at the site.

Water from roof areas is generally considered 'clean' and does not require dedicated treatment.

The SW drainage system will maintain the current level of water quality discharged from the existing site as the trafficked area exposed to rainwater is very small.

**Catchment**: ***Roof Water*** **Hazard Level**: ***Low***
**Catchment**: ***Access Road, Car Parks and Externals*** **Hazard Level**: ***Low***

# 7 Peak FW Discharged from the Site

## 7.1 Existing Peak FW Discharge

The standard calculation adopted by Thames Water for peak FW discharge from a residential dwelling is 4,000 litres/dwelling/day which equates to 0.046 l/s. As the residential use of the existing property will remain largely the same the peak FW discharge rate is unlikely to alter significantly. As peak SW discharge rate will be 1.38 l/s, the addition of the peak FW rate represents 3% of the total discharge in the 150mm diameter sewer.

There is no record of sewer flooding at the site as confirmed in Thames Water's DG5 records.

# 8 Whole-Life Maintenance and Management Plan

## 8.1 The Benefits of Whole Life Costing Approach

The whole life costing approach involves estimating the present day value of the total costs of the drainage systems serving the new development throughout its entire life. The objective is to enable informed decisions to be made regarding total lifetime expenditure. The benefits of a whole life costing approach are;

- Improved understanding of long-term scheme investment requirements, in addition to capital costs
- More cost-effective project choices at the project appraisal stage
- Explicit assessment and management of long-term risk through the encouragement of a planned monitoring and maintenance regime
- Reduced uncertainties associated with the development of appropriate adoption agreements/commuted sum contributions.

All expenses incurred by the drainage owner, whether it is termed operational or capital, results from the requirement to maintain drainage of the surface water run-off.

Adopting a long-term approach complements the fact that most sustainable drainage assets have a relatively long 'useful' life, providing appropriate management and maintenance is undertaken.

One of the advantages of sustainable drainage is that they are robust and easy to maintain. However, the effectiveness and ease of their long-term management will be dependent to a certain extent on their initial design characteristics.

Considerations that affect the design of drainage structures, methods and components should include;

- The drainage and water quality functions they are required to perform
- The maintenance required to ensure they continue to work as intended
- An assessment of the future repair or replacement requirements.

## 8.2 Management and Maintenance of the Proposed SuDS Systems

A key feature of any drainage system is its integration within the local landscape and their amenity contribution, and it is appropriate therefore that maintenance practice is applied to their management by the property owner through its management company.

In the case of this development, new, separate FW and SW drainage systems will be installed to discharge to the existing combined Thames Water public sewer in Parkhill Road. Peak SW run-off rate will be reduced by 80% to 1.38 l/s and peak FW discharge rate limited to 0.046 l/s.

The private sewers serving the building are expected to be owned and maintained by the homeowners for the lifetime of the development.

The proposed SuDS drainage components at the site include;

- A 60m$^2$ Permeable Paved Area in the rear garden with voided sub-base to attenuate 11m$^3$ of stormwater from a 1 in 100 year storm of 6 hour duration
- A Hydrobrake Flow Control Device chamber to limit peak SW discharge to greenfield run-off rate of 1.38 l/s
- A Sediment Control Chamber (Catchpit)
- Existing landscaped garden areas and planters
- A SW Lift pump station in the Lower Ground Floor area
- A FW Lift pump station for the building
- SW drainage system for the building inclusive of manholes, inspection chambers, gutters, rainwater downpipes and trapped gullies
- FW drainage system for inclusive of manholes, inspection chambers, sewers to serve the domestic sanitary facilities

Typical key SuDS components operation and maintenance activities are summarised in **Table 9** below. The activities include programming to include regular maintenance, occasional maintenance, remedial maintenance and monitoring requirements.

| O & M activity | SuDS component | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond/wetland | Detention basin | Infiltration basin | Silt traps and catchpits | Soakaway | Infiltration trench | Filter trench | Modular storage | Pervious pavement | green roofs | Filter strip | Sand filter | Pre-treatment systems | Perforated ring soakaways | Bio retention areas | Rain gardens | Oil interceptors | Flow control devices |
| **Regular maintenance** | | | | | | | | | | | | | | | | | | |
| Inspection | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Litter/debris removal | ■ | ■ | ■ | □ | □ | ■ | ■ | □ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | □ | □ |
| Grass cutting | ■ | ■ | ■ | □ | □ | ■ | ■ | □ | □ | ■ | ■ | □ | □ | | ■ | | □ | □ |
| Weed/invasive plant control | □ | □ | □ | | | □ | □ | | □ | □ | □ | □ | □ | | □ | ■ | | |
| Shrub management | □ | □ | □ | | | | | | □ | □ | □ | | □ | | □ | ■ | | |
| Shoreline vegetation management | ■ | □ | | | | | | | | | | | □ | | | | | |
| Aquatic vegetation managment | ■ | □ | | | | | | | | | | | □ | | | | | |
| **Irregular maintenance** | | | | | | | | | | | | | | | | | | |
| Sediment management (*) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ |
| Vegetation/plant replacement | □ | □ | □ | | | | | | | □ | □ | | □ | | □ | □ | | |
| Vacumn sweeping and brushing | | | | | | | | | ■ | | | | | | | | | |
| **Remedial maintenance** | | | | | | | | | | | | | | | | | | |
| Structure rehabilitation/repair | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| Infiltration surface reconditioning | | | □ | | □ | □ | □ | | □ | □ | □ | □ | | □ | □ | □ | | |

***Table 9:*** *Operation and Maintenance Activities for Key SuDS Components*

■ Will be required

□ May be required

* Sediment should be collected and managed in pre-treatment systems, upstream of the main device.

The maintenance regime of a site also needs to consider the response to extreme pollution events. A response action plan should be developed and communicated to all those involved in the operation of a site, so that if a spillage occurs it can be prevented from causing pollution to receiving waters.

## Flow Control Chambers and Devices

| | | |
|---|---|---|
| Regular maintenance | Inspect and identify any areas that are not operating correctly. If required, take remedial action. | Monthly for 3 months, then six monthly |
| | Debris removal from catchment surface (where may cause risks to performance) | Monthly |
| | Inspection of flow control chamber to assess if system is draining down correctly and that the orifice or flow control device is not blocked. Assess if there are any silt accumulations in the chamber sump. | Monthly (and after large storms) |
| | Removal of accumulated silt from silt trap and catchpit sumps | Annually, or as required |
| Remedial actions | Repair/rehabilitation of inlets, outlet, overflows and vents | As required |
| Monitoring | Inspect/check all inlets, outlets, and overflows to ensure that they are in good condition and operating as designed | Annually and after large storms |

## Attenuation/Water Harvesting Tank - Operation and Maintenance

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

## Permeable Paving - Operation and Maintenance

| Maintenance Schedule | Required Action | Typical Frequency |
|---|---|---|
| Regular Maintenance | Brushing and vacuuming (standard cosmetic sweep over the whole surface) | Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is mostly likely to collect the most sediment. |
| **Occasional Maintenance** | Stabilise and mow contributing 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 Maintenance** | Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the paving | As Required |
| | Remedial works 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 |
| | Rehabilitation of surface and upper substructure by remedial removal of blocks and cleaning of material and replacing where necessary. | Every 10 – 15 years or as required (if infiltration performance is reduced due to significant clogging) |
| **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 hr after large storms in first six months |
| | Inspect silt accumulation rates and establish appropriate brushing frequencies | Annually |
| | Monitor inspection chambers | Annually |

**Sediment Traps and Catch Pits - Operation and Maintenance**

| | | |
|---|---|---|
| Regular maintenance | Inspect and identify any areas that are not operating correctly. If required, take remedial action. | Monthly for 3 months, then six monthly |
| | Debris removal from catchment surface (where may cause risks to performance) | Monthly |
| | Inspection of silt traps and catch pits to assess silt accumulation | Monthly (and after large storms) |
| | Removal of accumulated silt from silt trap and catch pit sumps | Annually, or as required |
| Remedial actions | Repair/rehabilitation of inlets, outlet, overflows and vents | As required |
| Monitoring | Inspect/check all inlets, outlets, and overflows to ensure that they are in good condition and operating as designed | Annually and after large storms |

## 8.3 Timetable for Implementation of the Drainage Scheme

The detail design of the drainage system will be carried out shortly after discharge of any drainage conditions that may be presented. No development shall take place until the conditions have been discharged and drainage approved in writing by the LPA. The Client will be producing a detailed programme covering the enabling works and subsequent dates for the main drainage installations in due course.

# 9 Summary

- The proposed SuDS drainage systems are compliant with Camden Council's Local Area Requirements (LAR), July 2018 and the London Plan 2021 (Policy SI13) as peak surface water discharge rate from the site has been reduced by 80% from 6.84 l/s to 1.38 l/s

- The proposed drainage strategy is also compliant with the Camden's Local Plan 2017, SW Management Plan 2011, SFRA 2014 and Policy CC3: Water and Flooding as the proposed SW attenuation is provided for the 1 in 100 year 6 hour duration storm with discharge limited to greenfield run-off rate

- The peak SW discharge rate is limited to 1.38 l/s using a hydrobrake flow control device. All discharges are controlled at source and pollution prevention measures are provided with a catchpit, permeable paved area and trapped gullies

- Seepage Tests have been carried out on site in accordance with BRE Digest 365 guidelines and results indicated that infiltration techniques would not work due to the clayey ground conditions. Therefore permeable paved surfacing has been provided to reduce peak SW discharge rate from the site

- The proposed SW drainage systems complies with the Lead Local Flood Authority's SuDS hierarchy, SuDS policy documents and national sustainable drainage standards including CIRIA SuDS Manual C753. The SuDS hierarchy has been fully applied to the proposed drainage system

- The site is not at risk of fluvial, tidal, reservoir or surface water flooding. The site is not in an area susceptible to groundwater flooding due to the underlying ground conditions

- The site is not in a Critical Drainage Area or in a Local Flood Risk Zone. The property is not on Thames Water's DG5 list and there is no history of sewer flooding at the site or to adjacent properties

- 60m2 of existing impermeable paved areas in the rear garden are being converted to permeable paving to allow 11m$^3$ stormwater attenuation in 650mm deep voided sub-base material below the paving

- A section of collapsed sewer under the side extension is to be replaced when the new structure is built to allow free flow and the entire network will be pressure washed after installation to prevent blockages

- The proposed peak FW discharge rate to the Thames Water public sewer is very small and does not exceed 0.046 l/s. FW discharge rate from the site will not change significantly and is not expected to be a constraint

- The existing 150mm diameter combined sewer between MH1 and the Thames Water public sewer in Parkhill Road is in good condition and is to be retained to prevent construction activity in the road or in neighbouring properties

- The reduction of peak SW discharge from the site provides betterment in the local sewers by helping to reduce surcharging and potential flood risk thus relieving pressure on Thames Water, Camden Council and the Highways Authority by *'installing green infrastructure or localised methods to improve management of Surface Water during intense rainfall'*


- All foul and surface water drainage systems have been designed in accordance with Building Regulations 2010 (2015 Edition) Part H1 and H2 and BS EN 752:2008 'Drain and sewer systems outside of buildings'
- The site is not located on any sensitive sources of groundwater, whether aquifer or drinking water source
- All road and building drainage systems shall be suitably trapped in accordance with current Building Regulations Part H and Pollution Prevention Guidelines
- All SuDS drainage features will be managed, operated and maintained by the homeowner for the lifetime of the development
- Operation and maintenance guidelines for the proposed SuDS systems have been detailed in this report.

# 10 Limitations & Copyright

### Limitations

Floodline Consulting has prepared this report for the sole use of the Client in accordance with the Agreement under which our services were performed. No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by us. This Report may not be relied upon by any other party without the prior and express written agreement of Floodline. The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested. Information obtained from third parties has not been independently verified by Floodline, unless otherwise stated in the Report.

### Copyright

# 11 Appendices

***Appendix A*** *– Thames Water Asset Plans*

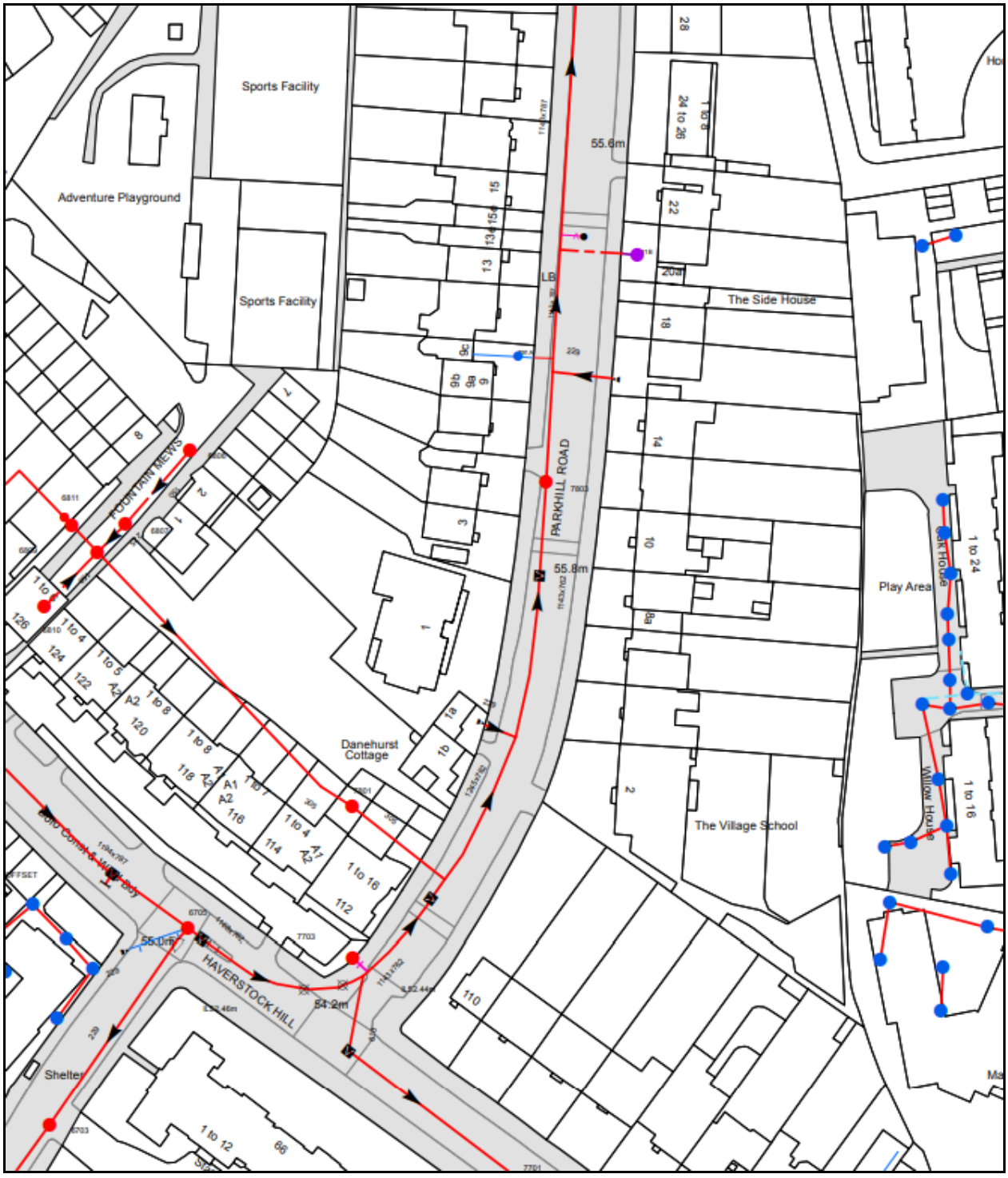
***Appendix B*** *– CCTV Survey of Existing Sewers*

***Appendix C*** *– Greenfield Run-Off Rate Calculations*

***Appendix D*** *– Surface Water Hydraulic Modelling Calculations*

# Appendix A

Thames Water Asset Plans


Sports Facility
Adventure Playground
Sports Facility
55.6m
PARKHILL ROAD
55.8m
The Side House
Play Area
Oak House
Willow House
1 to 24
1 to 16
The Village School
Danehurst Cottage
FOUNTAIN MEWS
HAVERSTOCK HILL
54.2m
55.0m
Shelter
1 to 12
66
110
112
114
116
118
120
122
124
126

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

| Manhole Reference | Manhole Cover Level | Manhole Invert Level |
|---|---|---|
| 711E | n/a | n/a |
| 711A | n/a | n/a |
| 711B | n/a | n/a |
| 8101 | n/a | 49.11 |
| 81AH | n/a | n/a |
| 81AI | n/a | n/a |
| 81AJ | n/a | n/a |
| 81BA | n/a | n/a |
| 81BC | n/a | n/a |
| 401C | n/a | n/a |
| 5101 | 61.5 | 57.66 |
| 6102 | n/a | n/a |
| 4101 | 64.04 | 57.4 |
| 611B | n/a | n/a |
| 4102 | n/a | n/a |
| 611A | n/a | n/a |
| 5104 | n/a | n/a |
| 99DD | n/a | n/a |
| 99BD | n/a | n/a |
| 90AC | n/a | n/a |
| 90AB | n/a | n/a |
| 901A | n/a | n/a |
| 901B | n/a | n/a |
| 9005 | 46.1 | 43.96 |
| 911A | n/a | n/a |
| 911B | n/a | n/a |
| 88BA | n/a | n/a |
| 88BE | n/a | n/a |
| 88AJ | n/a | n/a |
| 88BB | n/a | n/a |
| 88BG | n/a | n/a |
| 88DD | n/a | n/a |
| 88CC | n/a | n/a |
| 88CB | n/a | n/a |
| 88CA | n/a | n/a |
| 88BJ | n/a | n/a |
| 6809 | 56.21 | 54.49 |
| 88BI | n/a | n/a |
| 6807 | 56.59 | 54.92 |
| 88BH | n/a | n/a |
| 7803 | n/a | n/a |
| 6806 | 57.14 | 55.64 |
| 791A | n/a | n/a |
| 791B | n/a | n/a |
| 89AC | n/a | n/a |
| 89AD | n/a | n/a |
| 7902 | 54.74 | n/a |
| 701A | n/a | n/a |
| 701B | n/a | n/a |
| 701C | n/a | n/a |
| 701D | n/a | n/a |
| 7101 | 55.44 | 51.44 |
| 711C | 53.05 | 48.63 |
| 711D | 52.22 | 43.38 |
| 5801 | 59.22 | 53.73 |
| 6810 | 55.62 | 54.7 |
| 581A | n/a | n/a |
| 681A | n/a | n/a |
| 581B | n/a | n/a |
| 581C | n/a | n/a |
| 581D | n/a | n/a |
| 6811 | n/a | 54.54 |
| 581E | n/a | n/a |
| 581F | n/a | n/a |
| 5802 | n/a | n/a |
| 5901 | 58.93 | 54.97 |
| 5903 | 60.87 | 56.22 |
| 401J | n/a | n/a |
| 401G | n/a | n/a |
| 88DE | n/a | n/a |
| 88CD | n/a | n/a |
| 88BF | n/a | n/a |
| 88CE | n/a | n/a |
| 88CH | n/a | n/a |
| 88CG | n/a | n/a |
| 88CI | n/a | n/a |
| 88DF | n/a | n/a |
| 88CJ | n/a | n/a |
| 88DA | n/a | n/a |
| 88CF | n/a | n/a |
| 88DG | n/a | n/a |
| 98CB | n/a | n/a |
| 98CA | n/a | n/a |
| 98CC | n/a | n/a |
| 98CE | n/a | n/a |
| 98CD | n/a | n/a |
| 98BA | n/a | n/a |
| 98CF | n/a | n/a |
| 98CG | n/a | n/a |
| 9907 | 50.82 | 46.8 |
| 9004 | 47.34 | 42.85 |

| Manhole Reference | Manhole Cover Level | Manhole Invert Level |
|---|---|---|
| 98BB | n/a | n/a |
| 99DF | n/a | n/a |
| 99DB | n/a | n/a |
| 98AJ | n/a | n/a |
| 99DC | n/a | n/a |
| 98BF | n/a | n/a |
| 98ED | n/a | n/a |
| 98EE | n/a | n/a |
| 98EC | n/a | n/a |
| 9802 | 49.53 | n/a |
| 9803 | 50.34 | n/a |
| 97DB | n/a | n/a |
| 97DE | n/a | n/a |
| 87AF | n/a | n/a |
| 87AH | n/a | n/a |
| 87AG | n/a | n/a |
| 97EC | n/a | n/a |
| 87AI | n/a | n/a |
| 97DJ | n/a | n/a |
| 97EA | n/a | n/a |
| 97EB | n/a | n/a |
| 87AE | n/a | n/a |
| 97ED | n/a | n/a |
| 87BB | n/a | n/a |
| 9703 | 48.19 | n/a |
| 87BC | n/a | n/a |
| 98BH | n/a | n/a |
| 88AH | n/a | n/a |
| 88BC | n/a | n/a |
| 98BI | n/a | n/a |
| 88AI | n/a | n/a |
| 88BD | n/a | n/a |
| 98BJ | n/a | n/a |
| 481A | n/a | n/a |
| 57BH | n/a | n/a |
| 57BI | n/a | n/a |
| 57AG | n/a | n/a |
| 57AJ | n/a | n/a |
| 5701 | 56.91 | 52.16 |
| 5604 | 55.41 | n/a |
| 56AC | n/a | n/a |
| 56BE | n/a | n/a |
| 57DA | n/a | n/a |
| 67BH | n/a | n/a |
| 6701 | n/a | n/a |
| 67CA | n/a | n/a |
| 67CH | n/a | n/a |
| 67CB | n/a | n/a |
| 67CD | n/a | n/a |
| 67CI | n/a | n/a |
| 67CC | n/a | n/a |
| 67CE | n/a | n/a |
| 6703 | 54.98 | 51.63 |
| 67CJ | n/a | n/a |
| 67CF | n/a | n/a |
| 67CG | n/a | n/a |
| 6705 | 54.81 | 52.51 |
| 7801 | 55.51 | 53.36 |
| 7703 | n/a | n/a |
| 7701 | 52.25 | 48.57 |
| 87AD | n/a | n/a |
| 88AF | n/a | n/a |
| 87AC | n/a | n/a |
| 88AG | n/a | n/a |
| 9701 | 43.09 | 38.35 |
| 97BJ | n/a | n/a |
| 97CA | n/a | n/a |
| 97CB | n/a | n/a |
| 9702 | n/a | n/a |
| 97CC | n/a | n/a |
| 97CE | n/a | n/a |
| 97CF | n/a | n/a |
| 87AJ | n/a | n/a |
| 87BA | n/a | n/a |
| 511A | n/a | n/a |
| 611C | n/a | n/a |

# ALS Sewer Map Key

## Public Sewer Types (Operated & Maintained by Thames Water)

**Foul:** A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

**Surface Water:** A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

**Combined:** A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

- Trunk Surface Water
- Trunk Foul
- Storm Relief
- Trunk Combined
- Vent Pipe
- Bio-solids (Sludge)
- Proposed Thames Surface Water Sewer
- Proposed Thames Water Foul Sewer
- Gallery
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Sludge Rising Main
- Proposed Thames Water Rising Main
- Vacuum

## Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

- Air Valve
- Dam Chase
- Fitting
- Meter
- Vent Column

## Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

- Control Valve
- Drop Pipe
- Ancillary
- Weir

## End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

- Outfall
- Undefined End
- Inlet

## Other Symbols

Symbols used on maps which do not fall under other general categories

- Public/Private Pumping Station
- Change of characteristic indicator (C.O.C.I.)
- Invert Level
- Summit

### Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Operational Site
- Chamber
- Tunnel
- Conduit Bridge

## Other Sewer Types (Not Operated or Maintained by Thames Water)

- Foul Sewer
- Surface Water Sewer
- Combined Sewer
- Gulley
- Culverted Watercourse
- Proposed
- Abandoned Sewer

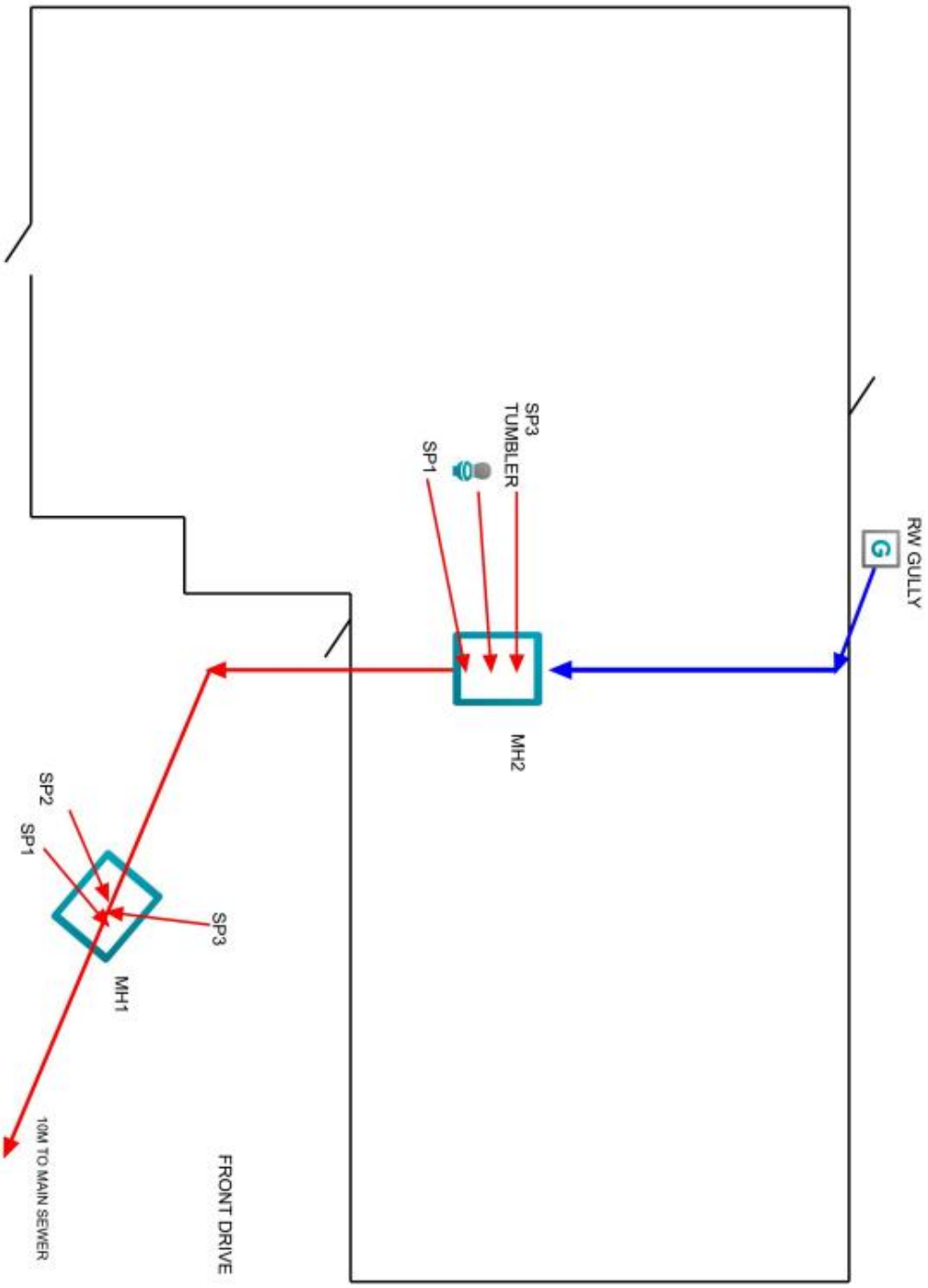
**Notes:**

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Searches on 0800 009 4540.

# Appendix B

CCTV Survey of Existing Sewers

## Project Drawing, Page '5 Parkhill Road'



# Appendix C

Greenfield Run-Off Rate Calculations

HR Wallingford
Working with water

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Faruk Pekbeken |
| Site name: | 5/5A Parkhill Road |
| Site location: | London NW3 2YH |

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

## Site Details

| | |
|---|---|
| Latitude: | 51.54837° N |
| Longitude: | 0.15881° W |
| Reference: | 1603395265 |
| Date: | Aug 09 2021 07:34 |

## Runoff estimation approach

IH124

## Site characteristics

Total site area (ha): 0.1

## Methodology

| | |
|---|---|
| $Q_{BAR}$ estimation method: | Calculate from SPR and SAAR |
| SPR estimation method: | Calculate from SOIL type |

## Soil characteristics

| | Default | Edited |
|---|---|---|
| SOIL type: | 4 | 4 |
| HOST class: | N/A | N/A |
| SPR/SPRHOST: | 0.47 | 0.47 |

## Hydrological characteristics

| | Default | Edited |
|---|---|---|
| SAAR (mm): | 638 | 638 |
| Hydrological region: | 6 | 6 |
| Growth curve factor 1 year: | 0.85 | 0.85 |
| Growth curve factor 30 years: | 2.3 | 2.3 |
| Growth curve factor 100 years: | 3.19 | 3.19 |
| Growth curve factor 200 years: | 3.74 | 3.74 |

## Notes

### (1) Is $Q_{BAR}$ < 2.0 l/s/ha?

When $Q_{BAR}$ is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

### (2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

### (3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

## Greenfield runoff rates

| | Default | Edited |
|---|---|---|
| $Q_{BAR}$ (l/s): | 0.43 | 0.43 |
| 1 in 1 year (l/s): | 0.37 | 0.37 |
| 1 in 30 years (l/s): | 1 | 1 |
| 1 in 100 year (l/s): | 1.38 | 1.38 |
| 1 in 200 years (l/s): | 1.62 | 1.62 |

# Appendix D

Surface Water Hydraulic Modelling Calculations

# CALCULATION SHEET

Prepared By FP Date: 31/07/2021
Checked By: JM Date: 31/07/2021

**Project: 5 & 5A Parkhill Rd, NW3 2YH** Rev: A

**Subject: Surface Water Runoff Estimates - Greenfield Rate**

| | | |
|---|---|---|
| Site Location | London NW3 2YH | |
| SAAR | 638 | mm |
| Soil Type | 1 | |
| M5-D60 | 20 | mm |
| r | 0.35 | |
| Climate Change Factor | 0 | % |
| Total Site Area | 0.0494 | ha |

Note

Calculating 1 in 30 & 1 in 100 attenuation vols

# CALCULATION SHEET

Prepared By: FP Date: 31/07/2021
Checked By: JM Date: 31/07/2021
Rev: A

**Project: 5 & 5A Parkhill Rd, NW3 2YH**

**Subject: Surface Water Runoff Estimates - Proposed Discharge Rate**

Total Site Area 0.0494 ha

Proposed Site Area

| **Surface Type** | **Area ($m^2$)** | **Runoff Coefficient** | **Equivalent Runoff Area ($m^2$)** |
|---|---|---|---|
| Impervious roof & pavement | 313 | 1 | 313 |
| Green roof | 0 | 0.8 | 0 |
| Other semi pervious surfaces | 60 | 0.8 | 48 |
| Landscape | 121 | 0.25 | 30 |
| **Total** | **494** | **Total** | **391** |

Proposed Equivalent Runoff Area 391 m2
Proposed Discharge Rate 1.38 l/s

Note

Proposed Discharge Rate (the 1 in 100 year greenfield run-off rate) = 1.38 l/s

## CALCULATION SHEET

Prepared By: FP Date: 31/07/2021
Checked By: JM Date: 31/07/2021
Rev: A

**Project: 5 & 5A Parkhill Rd, NW3 2YH**

**Subject: Surface Water Runoff Estimates - 1.4 l/s**

| | | |
|---|---|---|
| Proposed Discharge Rate | 1.38 | l/s |
| Effective Runoff Area | 391 | m2 |
| Total Runoff Area | 494 | m2 |

**Required Storage Volume**

| Storm Duration (min) | M30-D Rainfall Depth (mm) | M30-D Rainfall Volume (m3) | Discharge Rate (l/s) | Required Storage Volume for a 1 in 30 Year Event (m3) |
|---|---|---|---|---|
| 30 | 24.22 | 9 | 1.38 | 7 |
| 60 | 30.87 | 12 | 1.38 | 7 |
| 120 | 37.46 | 15 | 1.38 | 5 |
| 240 | 42.60 | 17 | 1.38 | n/a |
| 360 | 48.33 | 19 | 1.38 | n/a |
| 600 | 54.56 | 21 | 1.38 | n/a |

| | | | |
|---|---|---|---|
| Required Storage Volume | 7 | m3 | 1 in 30 year storm |

Note

Proposed Discharge Rate 1.38 l/s in 1 in 30 year storm

## CALCULATION SHEET

Prepared By: FP Date: 31/07/2021
Checked By: JM Date: 31/07/2021
Rev: A

**Project: 5 & 5A Parkhill Rd, NW3 2YH**

**Subject: Surface Water Runoff Estimates - 1.38 l/s**

| | | |
|---|---|---|
| Proposed Discharge Rate | 1.38 | l/s |
| Effective Runoff Area | 391 | m2 |
| Total Runoff Area | 494 | m2 |

**Required Storage Volume**

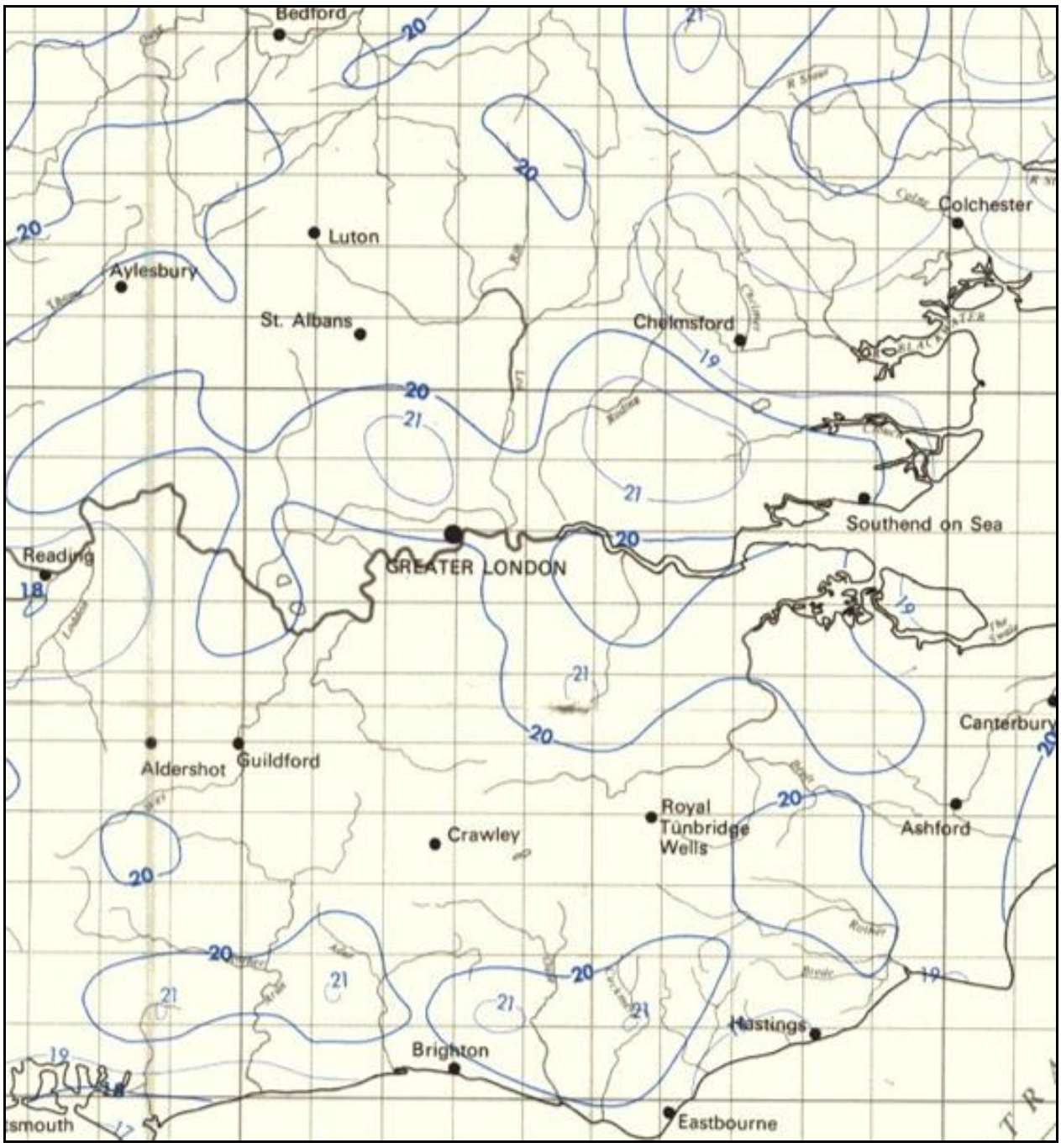
| Storm Duration (min) | M100 -D Rainfall Depth (mm) | M100-D Rainfall Volume (m3) | Discharge Rate (l/s) | Required Storage Volume for a 1 in 100 Year Event (m3) |
|---|---|---|---|---|
| 30 | 31.57 | 12 | 1.38 | 10 |
| 60 | 40.60 | 16 | 1.38 | 11 |
| 120 | 49.14 | 19 | 1.38 | 9 |
| 240 | 55.61 | 22 | 1.38 | 2 |
| 360 | 62.79 | 25 | 1.38 | n/a |
| 600 | 70.60 | 28 | 1.38 | n/a |

| | | | |
|---|---|---|---|
| Required Storage Volume | 11 | m3 | 1 in 100yr storm |

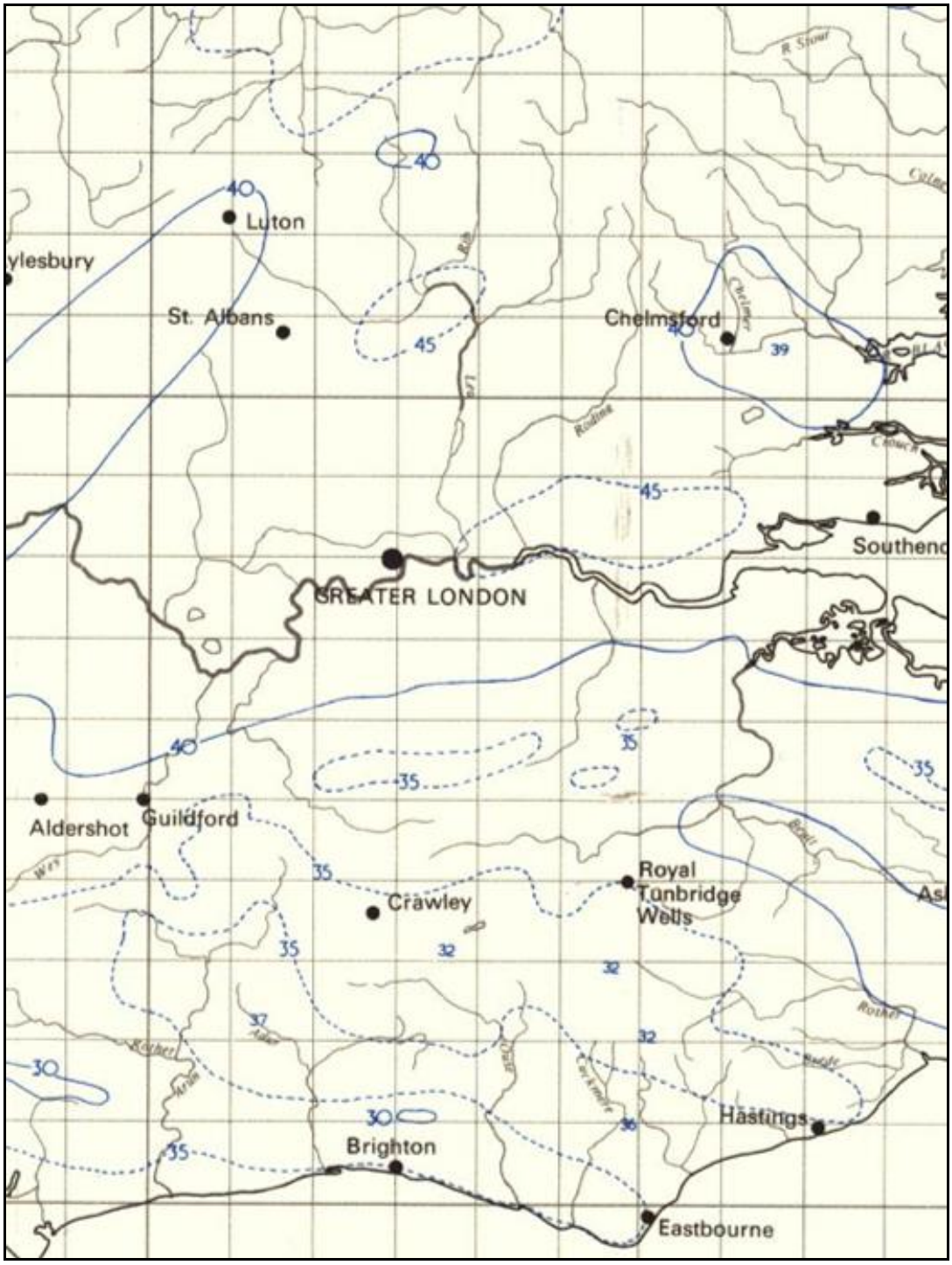
Note

Proposed discharge rate 1.38 l/s during the 1 in 100 year storm

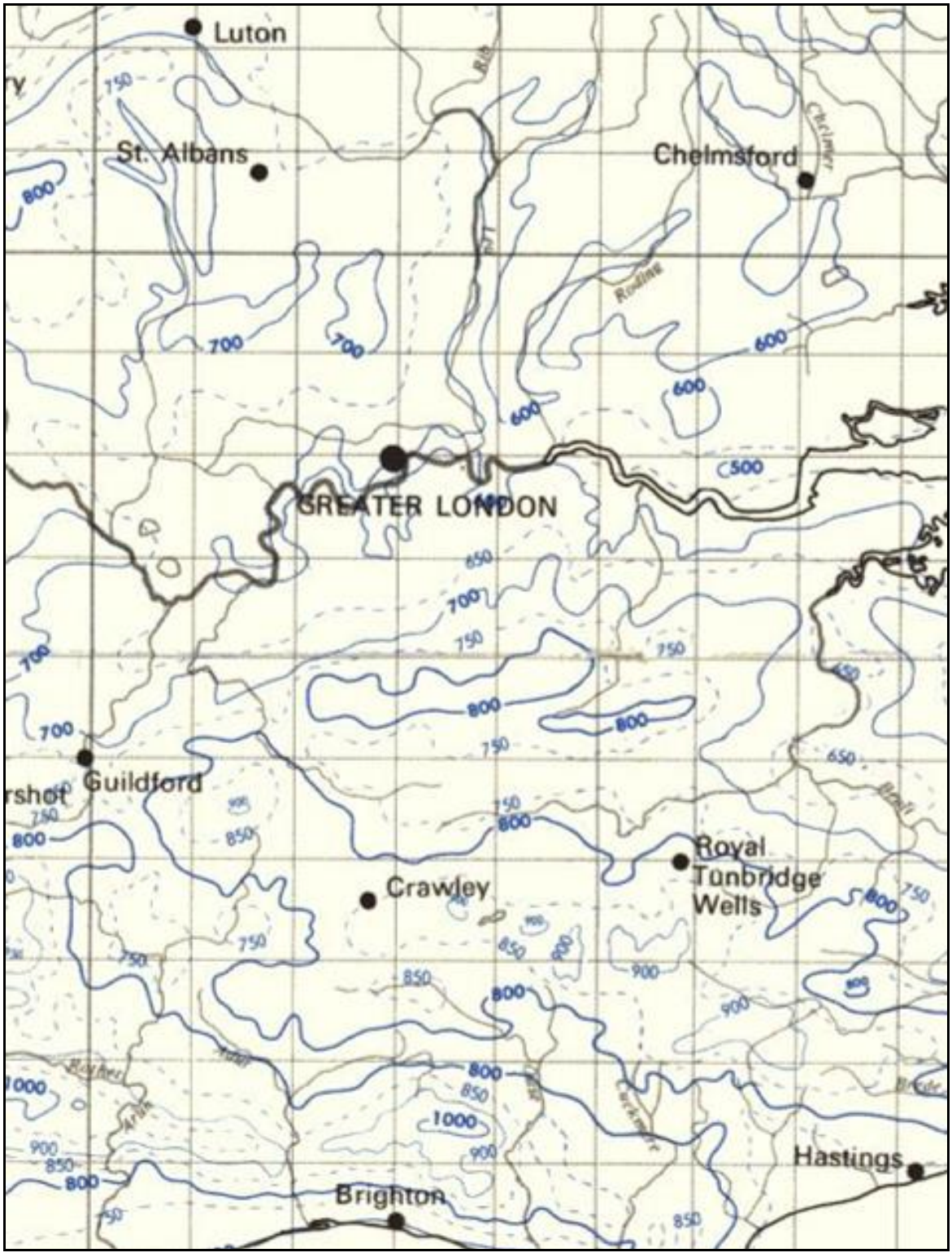
## M5-D60 Chart


Bedford
Luton
Aylesbury
St. Albans
Chelmsford
Colchester
Southend on Sea
Reading
GREATER LONDON
Canterbury
Aldershot
Guildford
Crawley
Royal Tunbridge Wells
Ashford
Hastings
Brighton
Eastbourne
20
21
19
18

## r Chart


Luton
ylesbury
St. Albans
Chelmsford
GREATER LONDON
Southend
Aldershot
Guildford
Crawley
Royal Tunbridge Wells
Hastings
Brighton
Eastbourne
40
45
39
35
32
37
30

## SAAR Chart


Luton
St. Albans
Chelmsford
GREATER LONDON
Guildford
Crawley
Royal Tunbridge Wells
Hastings
Brighton
700
600
500
650
750
800
850
900
1000

## Rainfall Chart

| M5-60 | mm | 20 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ratio | r | 0.35 | | | | | | | | | |
| % climate change | | 40% | | | | | | | | | |
| | | | | Z1 | **M5-D** | | | | | | |
| | | | | ratio | mm | | | | | | |
| 5 | 0.0833 | 0.0035 | | 0.35 | 7.07 | | | | | | |
| 10 | 0.1667 | 0.0069 | | 0.51 | 10.20 | | | | | | |
| 15 | 0.25 | 0.0104 | | 0.62 | 12.33 | | | | | | |
| 30 | 0.5 | 0.0208 | | 0.79 | 15.87 | | | | | | |
| 60 | 1 | 0.0417 | | 1.00 | 20.00 | | | | | | |
| 120 | 2 | 0.0833 | | 1.22 | 24.40 | | | | | | |
| 240 | 4 | 0.1667 | | 1.40 | 28.00 | | | | | | |
| 360 | 6 | 0.25 | | 1.61 | 32.13 | | | | | | |
| 600 | 10 | 0.4167 | | 1.84 | 36.73 | | | | | | |
| 1440 | 24 | 1 | | 2.27 | 45.33 | | | | | | |
| 2880 | 48 | 2 | | 2.75 | 55.07 | | | | | | |
| | | | | **1 year** | | | | | | | |
| Duration | | | | Z2 | M1-D | Rainfall intensity | with climate change | | | | |
| minutes | hours | days | | ratio | mm | mm/hour | | | | | |
| 5 | 0.0833 | 0.0035 | | 0.62 | 4.37 | 52.41 | 73.37 | | | | |
| 10 | 0.1667 | 0.0069 | | 0.61 | 6.22 | 37.33 | 52.26 | | | | |
| 15 | 0.25 | 0.0104 | | 0.61 | 7.57 | 30.29 | 42.41 | | | | |
| 30 | 0.5 | 0.0208 | | 0.62 | 9.84 | 19.67 | 27.54 | | | | |
| 60 | 1 | 0.0417 | | 0.64 | 12.80 | 12.80 | 17.92 | | | | |
| 120 | 2 | 0.0833 | | 0.66 | 16.01 | 8.00 | 11.20 | | | | |
| 240 | 4 | 0.1667 | | 0.67 | 18.82 | 4.70 | 6.59 | | | | |
| 360 | 6 | 0.25 | | 0.68 | 21.98 | 3.66 | 5.13 | | | | |
| 600 | 10 | 0.4167 | | 0.69 | 25.42 | 2.54 | 3.56 | | | | |
| 1440 | 24 | 1 | | 0.71 | 32.19 | 1.34 | 1.88 | | | | |
| 2880 | 48 | 2 | | 0.73 | 40.09 | 0.84 | 1.17 | | | | |
| | | | | **30 year** | | | | | | | |
| Duration | | | | Z2 | M30-D | Rainfall intensity | | | | | |
| minutes | | | | ratio | mm | mm/hour | | | | | |
| 5 | | | | 1.44 | 10.17 | 122.06 | 170.88 | | | | |
| 10 | | | | 1.43 | 15.20 | 91.19 | 127.66 | | | | |
| 15 | | | | 1.50 | 18.56 | 74.23 | 103.92 | | | | |
| 30 | | | | 1.53 | 24.22 | 48.45 | 67.82 | | | | |
| 60 | | | | 1.54 | 30.87 | 30.87 | 43.21 | | | | |
| 120 | | | | 1.54 | 37.46 | 18.73 | 26.22 | | | | |
| 240 | | | | 1.52 | 42.60 | 10.65 | 14.91 | | | | |
| 360 | | | | 1.50 | 48.33 | 8.05 | 11.28 | | | | |
| 600 | | | | 1.43 | 54.56 | 5.46 | 7.64 | | | | |
| 1440 | | | | 1.44 | 65.43 | 2.73 | 3.82 | | | | |
| 2880 | | | | 1.40 | 77.35 | 1.61 | 2.26 | | | | |
| | | | | **100 year** | | | | | | | |
| Duration | | | | Z2 | M100-D | Rainfall intensity | | | | | |
| minutes | | | | ratio | mm | mm/hour | | | | | |
| 5 | | | | 1.81 | 12.82 | 153.83 | 215.36 | | | | |
| 10 | | | | 1.91 | 19.48 | 116.89 | 163.65 | | | | |
| 15 | | | | 1.94 | 23.95 | 95.81 | 134.13 | | | 30% | 40% |
| 30 | | | | 1.99 | 31.57 | 63.15 | 88.41 | | | 41.05 | 44.205 |
| 60 | | | | 2.03 | 40.60 | 40.60 | 56.84 | | | 52.78 | 56.84 |
| 120 | | | | 2.01 | 49.14 | 24.57 | 34.40 | | | 63.88 | 68.798 |
| 240 | | | | 1.99 | 55.61 | 13.90 | 19.46 | | | 72.29 | 77.851 |
| 360 | | | | 1.95 | 62.79 | 10.46 | 14.65 | | | 81.63 | 87.904 |
| 600 | | | | 1.92 | 70.60 | 7.06 | 9.88 | | | 91.78 | 98.842 |
| 1440 | | | | 1.85 | 83.87 | 3.49 | 4.89 | | | | |
| 2880 | | | | 1.78 | 97.80 | 2.04 | 2.85 | | | | |

## Ratio Z1 Data

| Duration | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| minute | 5 | 10 | 15 | 30 | 60 | 120 | 240 | 360 | 600 | 1440 | 2880 |
| hour | 0.083 | 0.167 | 0.25 | 0.5 | 1 | 2 | 4 | 6 | 10 | 24 | 48 |
| day | 0.003 | 0.007 | 0.01 | 0.021 | 0.042 | 0.083 | 0.167 | 0.25 | 0.417 | 1 | 2 |
| 0.300 | 0.330 | 0.490 | 0.600 | 0.780 | 1.000 | 1.190 | 1.390 | 1.500 | 1.680 | 2.000 | 2.380 |
| 0.301 | 0.330 | 0.490 | 0.600 | 0.780 | 1.000 | 1.191 | 1.390 | 1.502 | 1.683 | 2.005 | 2.387 |
| 0.302 | 0.331 | 0.491 | 0.601 | 0.781 | 1.000 | 1.191 | 1.390 | 1.504 | 1.686 | 2.011 | 2.395 |
| 0.303 | 0.331 | 0.491 | 0.601 | 0.781 | 1.000 | 1.192 | 1.391 | 1.506 | 1.689 | 2.016 | 2.402 |
| 0.304 | 0.332 | 0.492 | 0.601 | 0.781 | 1.000 | 1.192 | 1.391 | 1.509 | 1.693 | 2.021 | 2.410 |
| 0.305 | 0.332 | 0.492 | 0.602 | 0.781 | 1.000 | 1.193 | 1.391 | 1.511 | 1.696 | 2.027 | 2.417 |
| 0.306 | 0.333 | 0.492 | 0.602 | 0.782 | 1.000 | 1.194 | 1.391 | 1.513 | 1.699 | 2.032 | 2.425 |
| 0.307 | 0.333 | 0.493 | 0.602 | 0.782 | 1.000 | 1.194 | 1.391 | 1.515 | 1.702 | 2.037 | 2.432 |
| 0.308 | 0.334 | 0.493 | 0.603 | 0.782 | 1.000 | 1.195 | 1.392 | 1.517 | 1.705 | 2.043 | 2.440 |
| 0.309 | 0.334 | 0.494 | 0.603 | 0.782 | 1.000 | 1.195 | 1.392 | 1.519 | 1.708 | 2.048 | 2.447 |
| 0.310 | 0.335 | 0.494 | 0.603 | 0.783 | 1.000 | 1.196 | 1.392 | 1.521 | 1.711 | 2.053 | 2.455 |
| 0.311 | 0.335 | 0.494 | 0.604 | 0.783 | 1.000 | 1.197 | 1.392 | 1.523 | 1.714 | 2.059 | 2.462 |
| 0.312 | 0.336 | 0.495 | 0.604 | 0.783 | 1.000 | 1.197 | 1.392 | 1.526 | 1.718 | 2.064 | 2.470 |
| 0.313 | 0.336 | 0.495 | 0.604 | 0.783 | 1.000 | 1.198 | 1.393 | 1.528 | 1.721 | 2.069 | 2.477 |
| 0.314 | 0.337 | 0.496 | 0.605 | 0.784 | 1.000 | 1.198 | 1.393 | 1.530 | 1.724 | 2.075 | 2.485 |
| 0.315 | 0.337 | 0.496 | 0.605 | 0.784 | 1.000 | 1.199 | 1.393 | 1.532 | 1.727 | 2.080 | 2.492 |
| 0.316 | 0.337 | 0.496 | 0.605 | 0.784 | 1.000 | 1.200 | 1.393 | 1.534 | 1.730 | 2.085 | 2.499 |
| 0.317 | 0.338 | 0.497 | 0.606 | 0.785 | 1.000 | 1.200 | 1.393 | 1.536 | 1.733 | 2.091 | 2.507 |
| 0.318 | 0.338 | 0.497 | 0.606 | 0.785 | 1.000 | 1.201 | 1.394 | 1.538 | 1.736 | 2.096 | 2.514 |
| 0.319 | 0.339 | 0.498 | 0.606 | 0.785 | 1.000 | 1.201 | 1.394 | 1.541 | 1.740 | 2.101 | 2.522 |
| 0.320 | 0.339 | 0.498 | 0.607 | 0.785 | 1.000 | 1.202 | 1.394 | 1.543 | 1.743 | 2.107 | 2.529 |
| 0.321 | 0.340 | 0.498 | 0.607 | 0.786 | 1.000 | 1.203 | 1.394 | 1.545 | 1.746 | 2.112 | 2.537 |
| 0.322 | 0.340 | 0.499 | 0.607 | 0.786 | 1.000 | 1.203 | 1.394 | 1.547 | 1.749 | 2.117 | 2.544 |
| 0.323 | 0.341 | 0.499 | 0.608 | 0.786 | 1.000 | 1.204 | 1.395 | 1.549 | 1.752 | 2.123 | 2.552 |
| 0.324 | 0.341 | 0.500 | 0.608 | 0.786 | 1.000 | 1.204 | 1.395 | 1.551 | 1.755 | 2.128 | 2.559 |
| 0.325 | 0.342 | 0.500 | 0.608 | 0.787 | 1.000 | 1.205 | 1.395 | 1.553 | 1.758 | 2.133 | 2.567 |
| 0.326 | 0.342 | 0.500 | 0.609 | 0.787 | 1.000 | 1.206 | 1.395 | 1.555 | 1.761 | 2.139 | 2.574 |
| 0.327 | 0.343 | 0.501 | 0.609 | 0.787 | 1.000 | 1.206 | 1.395 | 1.558 | 1.765 | 2.144 | 2.582 |
| 0.328 | 0.343 | 0.501 | 0.609 | 0.787 | 1.000 | 1.207 | 1.396 | 1.560 | 1.768 | 2.149 | 2.589 |
| 0.329 | 0.344 | 0.502 | 0.610 | 0.788 | 1.000 | 1.207 | 1.396 | 1.562 | 1.771 | 2.155 | 2.597 |
| 0.330 | 0.344 | 0.502 | 0.610 | 0.788 | 1.000 | 1.208 | 1.396 | 1.564 | 1.774 | 2.160 | 2.604 |
| 0.331 | 0.344 | 0.502 | 0.610 | 0.788 | 1.000 | 1.209 | 1.396 | 1.566 | 1.777 | 2.165 | 2.611 |
| 0.332 | 0.345 | 0.503 | 0.611 | 0.789 | 1.000 | 1.209 | 1.396 | 1.568 | 1.780 | 2.171 | 2.619 |
| 0.333 | 0.345 | 0.503 | 0.611 | 0.789 | 1.000 | 1.210 | 1.397 | 1.570 | 1.783 | 2.176 | 2.626 |
| 0.334 | 0.346 | 0.504 | 0.611 | 0.789 | 1.000 | 1.210 | 1.397 | 1.573 | 1.787 | 2.181 | 2.634 |
| 0.335 | 0.346 | 0.504 | 0.612 | 0.789 | 1.000 | 1.211 | 1.397 | 1.575 | 1.790 | 2.187 | 2.641 |
| 0.336 | 0.347 | 0.504 | 0.612 | 0.790 | 1.000 | 1.212 | 1.397 | 1.577 | 1.793 | 2.192 | 2.649 |
| 0.337 | 0.347 | 0.505 | 0.612 | 0.790 | 1.000 | 1.212 | 1.397 | 1.579 | 1.796 | 2.197 | 2.656 |
| 0.338 | 0.348 | 0.505 | 0.613 | 0.790 | 1.000 | 1.213 | 1.398 | 1.581 | 1.799 | 2.203 | 2.664 |
| 0.339 | 0.348 | 0.506 | 0.613 | 0.790 | 1.000 | 1.213 | 1.398 | 1.583 | 1.802 | 2.208 | 2.671 |
| 0.340 | 0.349 | 0.506 | 0.613 | 0.791 | 1.000 | 1.214 | 1.398 | 1.585 | 1.805 | 2.213 | 2.679 |
| 0.341 | 0.349 | 0.506 | 0.614 | 0.791 | 1.000 | 1.215 | 1.398 | 1.587 | 1.808 | 2.219 | 2.686 |
| 0.342 | 0.350 | 0.507 | 0.614 | 0.791 | 1.000 | 1.215 | 1.398 | 1.590 | 1.812 | 2.224 | 2.694 |
| 0.343 | 0.350 | 0.507 | 0.614 | 0.791 | 1.000 | 1.216 | 1.399 | 1.592 | 1.815 | 2.229 | 2.701 |
| 0.344 | 0.351 | 0.508 | 0.615 | 0.792 | 1.000 | 1.216 | 1.399 | 1.594 | 1.818 | 2.235 | 2.709 |
| 0.345 | 0.351 | 0.508 | 0.615 | 0.792 | 1.000 | 1.217 | 1.399 | 1.596 | 1.821 | 2.240 | 2.716 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.346 | 0.351 | 0.508 | 0.615 | 0.792 | 1.000 | 1.218 | 1.399 | 1.598 | 1.824 | 2.245 | 2.723 |
| 0.347 | 0.352 | 0.509 | 0.616 | 0.793 | 1.000 | 1.218 | 1.399 | 1.600 | 1.827 | 2.251 | 2.731 |
| 0.348 | 0.352 | 0.509 | 0.616 | 0.793 | 1.000 | 1.219 | 1.400 | 1.602 | 1.830 | 2.256 | 2.738 |
| 0.349 | 0.353 | 0.510 | 0.616 | 0.793 | 1.000 | 1.219 | 1.400 | 1.605 | 1.834 | 2.261 | 2.746 |
| 0.350 | 0.353 | 0.510 | 0.617 | 0.793 | 1.000 | 1.220 | 1.400 | 1.607 | 1.837 | 2.267 | 2.753 |
| 0.351 | 0.354 | 0.510 | 0.617 | 0.794 | 1.000 | 1.221 | 1.400 | 1.609 | 1.840 | 2.272 | 2.761 |
| 0.352 | 0.354 | 0.511 | 0.617 | 0.794 | 1.000 | 1.221 | 1.400 | 1.611 | 1.843 | 2.277 | 2.768 |
| 0.353 | 0.355 | 0.511 | 0.618 | 0.794 | 1.000 | 1.222 | 1.401 | 1.613 | 1.846 | 2.283 | 2.776 |
| 0.354 | 0.355 | 0.512 | 0.618 | 0.794 | 1.000 | 1.222 | 1.401 | 1.615 | 1.849 | 2.288 | 2.783 |
| 0.355 | 0.356 | 0.512 | 0.618 | 0.795 | 1.000 | 1.223 | 1.401 | 1.617 | 1.852 | 2.293 | 2.791 |
| 0.356 | 0.356 | 0.512 | 0.619 | 0.795 | 1.000 | 1.224 | 1.401 | 1.619 | 1.855 | 2.299 | 2.798 |
| 0.357 | 0.357 | 0.513 | 0.619 | 0.795 | 1.000 | 1.224 | 1.401 | 1.622 | 1.859 | 2.304 | 2.806 |
| 0.358 | 0.357 | 0.513 | 0.619 | 0.795 | 1.000 | 1.225 | 1.402 | 1.624 | 1.862 | 2.309 | 2.813 |
| 0.359 | 0.358 | 0.514 | 0.620 | 0.796 | 1.000 | 1.225 | 1.402 | 1.626 | 1.865 | 2.315 | 2.821 |
| 0.360 | 0.358 | 0.514 | 0.620 | 0.796 | 1.000 | 1.226 | 1.402 | 1.628 | 1.868 | 2.320 | 2.828 |
| 0.361 | 0.358 | 0.514 | 0.620 | 0.796 | 1.000 | 1.227 | 1.402 | 1.630 | 1.871 | 2.325 | 2.835 |
| 0.362 | 0.359 | 0.515 | 0.621 | 0.797 | 1.000 | 1.227 | 1.402 | 1.632 | 1.874 | 2.331 | 2.843 |
| 0.363 | 0.359 | 0.515 | 0.621 | 0.797 | 1.000 | 1.228 | 1.403 | 1.634 | 1.877 | 2.336 | 2.850 |
| 0.364 | 0.360 | 0.516 | 0.621 | 0.797 | 1.000 | 1.228 | 1.403 | 1.637 | 1.881 | 2.341 | 2.858 |
| 0.365 | 0.360 | 0.516 | 0.622 | 0.797 | 1.000 | 1.229 | 1.403 | 1.639 | 1.884 | 2.347 | 2.865 |
| 0.366 | 0.361 | 0.516 | 0.622 | 0.798 | 1.000 | 1.230 | 1.403 | 1.641 | 1.887 | 2.352 | 2.873 |
| 0.367 | 0.361 | 0.517 | 0.622 | 0.798 | 1.000 | 1.230 | 1.403 | 1.643 | 1.890 | 2.357 | 2.880 |
| 0.368 | 0.362 | 0.517 | 0.623 | 0.798 | 1.000 | 1.231 | 1.404 | 1.645 | 1.893 | 2.363 | 2.888 |
| 0.369 | 0.362 | 0.518 | 0.623 | 0.798 | 1.000 | 1.231 | 1.404 | 1.647 | 1.896 | 2.368 | 2.895 |
| 0.370 | 0.363 | 0.518 | 0.623 | 0.799 | 1.000 | 1.232 | 1.404 | 1.649 | 1.899 | 2.373 | 2.903 |
| 0.371 | 0.363 | 0.518 | 0.624 | 0.799 | 1.000 | 1.233 | 1.404 | 1.651 | 1.902 | 2.379 | 2.910 |
| 0.372 | 0.364 | 0.519 | 0.624 | 0.799 | 1.000 | 1.233 | 1.404 | 1.654 | 1.906 | 2.384 | 2.918 |
| 0.373 | 0.364 | 0.519 | 0.624 | 0.799 | 1.000 | 1.234 | 1.405 | 1.656 | 1.909 | 2.389 | 2.925 |
| 0.374 | 0.365 | 0.520 | 0.625 | 0.800 | 1.000 | 1.234 | 1.405 | 1.658 | 1.912 | 2.395 | 2.933 |
| 0.375 | 0.365 | 0.520 | 0.625 | 0.800 | 1.000 | 1.235 | 1.405 | 1.660 | 1.915 | 2.400 | 2.940 |
| 0.376 | 0.365 | 0.520 | 0.625 | 0.800 | 1.000 | 1.236 | 1.405 | 1.662 | 1.918 | 2.405 | 2.947 |
| 0.377 | 0.366 | 0.521 | 0.626 | 0.801 | 1.000 | 1.236 | 1.405 | 1.664 | 1.921 | 2.411 | 2.955 |
| 0.378 | 0.366 | 0.521 | 0.626 | 0.801 | 1.000 | 1.237 | 1.406 | 1.666 | 1.924 | 2.416 | 2.962 |
| 0.379 | 0.367 | 0.522 | 0.626 | 0.801 | 1.000 | 1.237 | 1.406 | 1.669 | 1.928 | 2.421 | 2.970 |
| 0.380 | 0.367 | 0.522 | 0.627 | 0.801 | 1.000 | 1.238 | 1.406 | 1.671 | 1.931 | 2.427 | 2.977 |
| 0.381 | 0.368 | 0.522 | 0.627 | 0.802 | 1.000 | 1.239 | 1.406 | 1.673 | 1.934 | 2.432 | 2.985 |
| 0.382 | 0.368 | 0.523 | 0.627 | 0.802 | 1.000 | 1.239 | 1.406 | 1.675 | 1.937 | 2.437 | 2.992 |
| 0.383 | 0.369 | 0.523 | 0.628 | 0.802 | 1.000 | 1.240 | 1.407 | 1.677 | 1.940 | 2.443 | 3.000 |
| 0.384 | 0.369 | 0.524 | 0.628 | 0.802 | 1.000 | 1.240 | 1.407 | 1.679 | 1.943 | 2.448 | 3.007 |
| 0.385 | 0.370 | 0.524 | 0.628 | 0.803 | 1.000 | 1.241 | 1.407 | 1.681 | 1.946 | 2.453 | 3.015 |
| 0.386 | 0.370 | 0.524 | 0.629 | 0.803 | 1.000 | 1.242 | 1.407 | 1.683 | 1.949 | 2.459 | 3.022 |
| 0.387 | 0.371 | 0.525 | 0.629 | 0.803 | 1.000 | 1.242 | 1.407 | 1.686 | 1.953 | 2.464 | 3.030 |
| 0.388 | 0.371 | 0.525 | 0.629 | 0.803 | 1.000 | 1.243 | 1.408 | 1.688 | 1.956 | 2.469 | 3.037 |
| 0.389 | 0.372 | 0.526 | 0.630 | 0.804 | 1.000 | 1.243 | 1.408 | 1.690 | 1.959 | 2.475 | 3.045 |
| 0.390 | 0.372 | 0.526 | 0.630 | 0.804 | 1.000 | 1.244 | 1.408 | 1.692 | 1.962 | 2.480 | 3.052 |
| 0.391 | 0.372 | 0.526 | 0.630 | 0.804 | 1.000 | 1.245 | 1.408 | 1.694 | 1.965 | 2.485 | 3.059 |
| 0.392 | 0.373 | 0.527 | 0.631 | 0.805 | 1.000 | 1.245 | 1.408 | 1.696 | 1.968 | 2.491 | 3.067 |
| 0.393 | 0.373 | 0.527 | 0.631 | 0.805 | 1.000 | 1.246 | 1.409 | 1.698 | 1.971 | 2.496 | 3.074 |
| 0.394 | 0.374 | 0.528 | 0.631 | 0.805 | 1.000 | 1.246 | 1.409 | 1.701 | 1.975 | 2.501 | 3.082 |
| 0.395 | 0.374 | 0.528 | 0.632 | 0.805 | 1.000 | 1.247 | 1.409 | 1.703 | 1.978 | 2.507 | 3.089 |
| 0.396 | 0.375 | 0.528 | 0.632 | 0.806 | 1.000 | 1.248 | 1.409 | 1.705 | 1.981 | 2.512 | 3.097 |
| 0.397 | 0.375 | 0.529 | 0.632 | 0.806 | 1.000 | 1.248 | 1.409 | 1.707 | 1.984 | 2.517 | 3.104 |
| 0.398 | 0.376 | 0.529 | 0.633 | 0.806 | 1.000 | 1.249 | 1.410 | 1.709 | 1.987 | 2.523 | 3.112 |
| 0.399 | 0.376 | 0.530 | 0.633 | 0.806 | 1.000 | 1.249 | 1.410 | 1.711 | 1.990 | 2.528 | 3.119 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.400 | 0.377 | 0.530 | 0.633 | 0.807 | 1.000 | 1.250 | 1.410 | 1.713 | 1.993 | 2.533 | 3.127 |
| 0.401 | 0.377 | 0.530 | 0.634 | 0.807 | 1.000 | 1.251 | 1.410 | 1.715 | 1.996 | 2.539 | 3.134 |
| 0.402 | 0.378 | 0.531 | 0.634 | 0.807 | 1.000 | 1.251 | 1.410 | 1.718 | 2.000 | 2.544 | 3.142 |
| 0.403 | 0.378 | 0.531 | 0.634 | 0.807 | 1.000 | 1.252 | 1.411 | 1.720 | 2.003 | 2.549 | 3.149 |
| 0.404 | 0.379 | 0.532 | 0.635 | 0.808 | 1.000 | 1.252 | 1.411 | 1.722 | 2.006 | 2.555 | 3.157 |
| 0.405 | 0.379 | 0.532 | 0.635 | 0.808 | 1.000 | 1.253 | 1.411 | 1.724 | 2.009 | 2.560 | 3.164 |
| 0.406 | 0.379 | 0.532 | 0.635 | 0.808 | 1.000 | 1.254 | 1.411 | 1.726 | 2.012 | 2.565 | 3.171 |
| 0.407 | 0.380 | 0.533 | 0.636 | 0.809 | 1.000 | 1.254 | 1.411 | 1.728 | 2.015 | 2.571 | 3.179 |
| 0.408 | 0.380 | 0.533 | 0.636 | 0.809 | 1.000 | 1.255 | 1.412 | 1.730 | 2.018 | 2.576 | 3.186 |
| 0.409 | 0.381 | 0.534 | 0.636 | 0.809 | 1.000 | 1.255 | 1.412 | 1.733 | 2.022 | 2.581 | 3.194 |
| 0.410 | 0.381 | 0.534 | 0.637 | 0.809 | 1.000 | 1.256 | 1.412 | 1.735 | 2.025 | 2.587 | 3.201 |
| 0.411 | 0.382 | 0.534 | 0.637 | 0.810 | 1.000 | 1.257 | 1.412 | 1.737 | 2.028 | 2.592 | 3.209 |
| 0.412 | 0.382 | 0.535 | 0.637 | 0.810 | 1.000 | 1.257 | 1.412 | 1.739 | 2.031 | 2.597 | 3.216 |
| 0.413 | 0.383 | 0.535 | 0.638 | 0.810 | 1.000 | 1.258 | 1.413 | 1.741 | 2.034 | 2.603 | 3.224 |
| 0.414 | 0.383 | 0.536 | 0.638 | 0.810 | 1.000 | 1.258 | 1.413 | 1.743 | 2.037 | 2.608 | 3.231 |
| 0.415 | 0.384 | 0.536 | 0.638 | 0.811 | 1.000 | 1.259 | 1.413 | 1.745 | 2.040 | 2.613 | 3.239 |
| 0.416 | 0.384 | 0.536 | 0.639 | 0.811 | 1.000 | 1.260 | 1.413 | 1.747 | 2.043 | 2.619 | 3.246 |
| 0.417 | 0.385 | 0.537 | 0.639 | 0.811 | 1.000 | 1.260 | 1.413 | 1.750 | 2.047 | 2.624 | 3.254 |
| 0.418 | 0.385 | 0.537 | 0.639 | 0.811 | 1.000 | 1.261 | 1.414 | 1.752 | 2.050 | 2.629 | 3.261 |
| 0.419 | 0.386 | 0.538 | 0.640 | 0.812 | 1.000 | 1.261 | 1.414 | 1.754 | 2.053 | 2.635 | 3.269 |
| 0.420 | 0.386 | 0.538 | 0.640 | 0.812 | 1.000 | 1.262 | 1.414 | 1.756 | 2.056 | 2.640 | 3.276 |
| 0.421 | 0.386 | 0.538 | 0.640 | 0.812 | 1.000 | 1.263 | 1.414 | 1.758 | 2.059 | 2.645 | 3.283 |
| 0.422 | 0.387 | 0.539 | 0.641 | 0.813 | 1.000 | 1.263 | 1.414 | 1.760 | 2.062 | 2.651 | 3.291 |
| 0.423 | 0.387 | 0.539 | 0.641 | 0.813 | 1.000 | 1.264 | 1.415 | 1.762 | 2.065 | 2.656 | 3.298 |
| 0.424 | 0.388 | 0.540 | 0.641 | 0.813 | 1.000 | 1.264 | 1.415 | 1.765 | 2.069 | 2.661 | 3.306 |
| 0.425 | 0.388 | 0.540 | 0.642 | 0.813 | 1.000 | 1.265 | 1.415 | 1.767 | 2.072 | 2.667 | 3.313 |
| 0.426 | 0.389 | 0.540 | 0.642 | 0.814 | 1.000 | 1.266 | 1.415 | 1.769 | 2.075 | 2.672 | 3.321 |
| 0.427 | 0.389 | 0.541 | 0.642 | 0.814 | 1.000 | 1.266 | 1.415 | 1.771 | 2.078 | 2.677 | 3.328 |
| 0.428 | 0.390 | 0.541 | 0.643 | 0.814 | 1.000 | 1.267 | 1.416 | 1.773 | 2.081 | 2.683 | 3.336 |
| 0.429 | 0.390 | 0.542 | 0.643 | 0.814 | 1.000 | 1.267 | 1.416 | 1.775 | 2.084 | 2.688 | 3.343 |
| 0.430 | 0.391 | 0.542 | 0.643 | 0.815 | 1.000 | 1.268 | 1.416 | 1.777 | 2.087 | 2.693 | 3.351 |
| 0.431 | 0.391 | 0.542 | 0.644 | 0.815 | 1.000 | 1.269 | 1.416 | 1.779 | 2.090 | 2.699 | 3.358 |
| 0.432 | 0.392 | 0.543 | 0.644 | 0.815 | 1.000 | 1.269 | 1.416 | 1.782 | 2.094 | 2.704 | 3.366 |
| 0.433 | 0.392 | 0.543 | 0.644 | 0.815 | 1.000 | 1.270 | 1.417 | 1.784 | 2.097 | 2.709 | 3.373 |
| 0.434 | 0.393 | 0.544 | 0.645 | 0.816 | 1.000 | 1.270 | 1.417 | 1.786 | 2.100 | 2.715 | 3.381 |
| 0.435 | 0.393 | 0.544 | 0.645 | 0.816 | 1.000 | 1.271 | 1.417 | 1.788 | 2.103 | 2.720 | 3.388 |
| 0.436 | 0.393 | 0.544 | 0.645 | 0.816 | 1.000 | 1.272 | 1.417 | 1.790 | 2.106 | 2.725 | 3.395 |
| 0.437 | 0.394 | 0.545 | 0.646 | 0.817 | 1.000 | 1.272 | 1.417 | 1.792 | 2.109 | 2.731 | 3.403 |
| 0.438 | 0.394 | 0.545 | 0.646 | 0.817 | 1.000 | 1.273 | 1.418 | 1.794 | 2.112 | 2.736 | 3.410 |
| 0.439 | 0.395 | 0.546 | 0.646 | 0.817 | 1.000 | 1.273 | 1.418 | 1.797 | 2.116 | 2.741 | 3.418 |
| 0.440 | 0.395 | 0.546 | 0.647 | 0.817 | 1.000 | 1.274 | 1.418 | 1.799 | 2.119 | 2.747 | 3.425 |
| 0.441 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.442 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.443 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.444 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.445 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.446 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.447 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.448 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.449 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |
| 0.450 | 0.400 | 0.550 | 0.650 | 0.820 | 1.000 | 1.280 | 1.420 | 1.820 | 2.150 | 2.800 | 3.500 |

## Ratio Z2 Data

M5 Rainfall mm

| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 10 | 20 | 30 | 50 | 100 |
| 5 | 0.62 | 0.79 | 0.89 | 0.97 | 1.02 | 1.19 | 1.36 | 1.43 | 1.56 | 1.79 |
| 6 | 0.62 | 0.79 | 0.89 | 0.97 | 1.02 | 1.20 | 1.37 | 1.44 | 1.58 | 1.81 |
| 7 | 0.62 | 0.79 | 0.89 | 0.97 | 1.02 | 1.20 | 1.37 | 1.44 | 1.58 | 1.81 |
| 8 | 0.61 | 0.79 | 0.90 | 0.97 | 1.03 | 1.21 | 1.39 | 1.46 | 1.61 | 1.86 |
| 9 | 0.61 | 0.79 | 0.90 | 0.97 | 1.03 | 1.21 | 1.40 | 1.48 | 1.63 | 1.89 |
| 10 | 0.61 | 0.79 | 0.90 | 0.97 | 1.03 | 1.22 | 1.41 | 1.49 | 1.65 | 1.91 |
| 11 | 0.61 | 0.79 | 0.90 | 0.97 | 1.03 | 1.22 | 1.42 | 1.50 | 1.66 | 1.93 |
| 12 | 0.61 | 0.79 | 0.90 | 0.97 | 1.03 | 1.23 | 1.42 | 1.50 | 1.67 | 1.94 |
| 13 | 0.62 | 0.80 | 0.90 | 0.97 | 1.03 | 1.23 | 1.43 | 1.51 | 1.68 | 1.96 |
| 14 | 0.62 | 0.80 | 0.90 | 0.97 | 1.03 | 1.24 | 1.43 | 1.52 | 1.69 | 1.97 |
| 15 | 0.62 | 0.80 | 0.90 | 0.97 | 1.03 | 1.24 | 1.44 | 1.53 | 1.70 | 1.99 |
| 16 | 0.62 | 0.80 | 0.90 | 0.97 | 1.03 | 1.24 | 1.44 | 1.53 | 1.71 | 2.00 |
| 17 | 0.63 | 0.80 | 0.90 | 0.97 | 1.03 | 1.24 | 1.44 | 1.53 | 1.71 | 2.01 |
| 18 | 0.63 | 0.81 | 0.90 | 0.97 | 1.03 | 1.24 | 1.45 | 1.54 | 1.72 | 2.01 |
| 19 | 0.64 | 0.81 | 0.90 | 0.97 | 1.03 | 1.24 | 1.45 | 1.54 | 1.72 | 2.02 |
| 20 | 0.64 | 0.81 | 0.90 | 0.97 | 1.03 | 1.24 | 1.45 | 1.54 | 1.73 | 2.03 |
| 21 | 0.64 | 0.81 | 0.90 | 0.97 | 1.03 | 1.24 | 1.45 | 1.54 | 1.73 | 2.03 |
| 22 | 0.65 | 0.81 | 0.90 | 0.97 | 1.03 | 1.24 | 1.45 | 1.54 | 1.73 | 2.02 |
| 23 | 0.65 | 0.82 | 0.91 | 0.97 | 1.03 | 1.24 | 1.44 | 1.54 | 1.72 | 2.02 |
| 24 | 0.66 | 0.82 | 0.91 | 0.97 | 1.03 | 1.24 | 1.44 | 1.54 | 1.72 | 2.01 |
| 25 | 0.66 | 0.82 | 0.91 | 0.97 | 1.03 | 1.24 | 1.44 | 1.53 | 1.72 | 2.01 |
| 26 | 0.66 | 0.82 | 0.91 | 0.97 | 1.03 | 1.24 | 1.44 | 1.53 | 1.72 | 2.00 |
| 27 | 0.67 | 0.82 | 0.91 | 0.97 | 1.03 | 1.23 | 1.43 | 1.53 | 1.71 | 1.99 |
| 28 | 0.67 | 0.83 | 0.91 | 0.97 | 1.03 | 1.23 | 1.43 | 1.52 | 1.71 | 1.99 |
| 29 | 0.68 | 0.83 | 0.91 | 0.97 | 1.03 | 1.22 | 1.42 | 1.52 | 1.70 | 1.98 |
| 30 | 0.68 | 0.83 | 0.91 | 0.97 | 1.03 | 1.22 | 1.42 | 1.51 | 1.70 | 1.97 |
| 31 | 0.68 | 0.83 | 0.91 | 0.97 | 1.03 | 1.22 | 1.42 | 1.51 | 1.69 | 1.96 |
| 32 | 0.68 | 0.83 | 0.91 | 0.97 | 1.03 | 1.21 | 1.41 | 1.50 | 1.69 | 1.95 |
| 33 | 0.69 | 0.83 | 0.91 | 0.97 | 1.03 | 1.21 | 1.41 | 1.50 | 1.68 | 1.95 |
| 34 | 0.69 | 0.83 | 0.91 | 0.97 | 1.03 | 1.21 | 1.40 | 1.49 | 1.68 | 1.94 |
| 35 | 0.69 | 0.84 | 0.92 | 0.97 | 1.03 | 1.21 | 1.40 | 1.49 | 1.67 | 1.93 |
| 36 | 0.69 | 0.84 | 0.92 | 0.97 | 1.02 | 1.20 | 1.40 | 1.49 | 1.66 | 1.92 |
| 37 | 0.69 | 0.84 | 0.92 | 0.97 | 1.02 | 1.20 | 1.39 | 1.48 | 1.66 | 1.91 |
| 38 | 0.70 | 0.84 | 0.92 | 0.97 | 1.02 | 1.20 | 1.39 | 1.48 | 1.65 | 1.91 |
| 39 | 0.70 | 0.84 | 0.92 | 0.97 | 1.02 | 1.19 | 1.38 | 1.47 | 1.65 | 1.90 |
| 40 | 0.70 | 0.84 | 0.92 | 0.97 | 1.02 | 1.19 | 1.38 | 1.47 | 1.64 | 1.89 |
| 41 | 0.70 | 0.84 | 0.92 | 0.97 | 1.02 | 1.19 | 1.38 | 1.46 | 1.63 | 1.88 |
| 42 | 0.70 | 0.84 | 0.92 | 0.97 | 1.02 | 1.19 | 1.37 | 1.46 | 1.63 | 1.87 |
| 43 | 0.71 | 0.84 | 0.92 | 0.97 | 1.02 | 1.18 | 1.37 | 1.45 | 1.62 | 1.87 |
| 44 | 0.71 | 0.84 | 0.92 | 0.97 | 1.02 | 1.18 | 1.36 | 1.45 | 1.62 | 1.86 |
| 45 | 0.71 | 0.85 | 0.93 | 0.98 | 1.02 | 1.18 | 1.36 | 1.44 | 1.61 | 1.85 |
| 46 | 0.71 | 0.85 | 0.93 | 0.98 | 1.02 | 1.18 | 1.36 | 1.44 | 1.60 | 1.84 |
| 47 | 0.71 | 0.85 | 0.93 | 0.98 | 1.02 | 1.18 | 1.35 | 1.43 | 1.60 | 1.83 |
| 48 | 0.72 | 0.85 | 0.93 | 0.98 | 1.02 | 1.17 | 1.35 | 1.43 | 1.59 | 1.83 |
| 49 | 0.72 | 0.85 | 0.93 | 0.98 | 1.02 | 1.17 | 1.34 | 1.42 | 1.59 | 1.82 |
| 50 | 0.72 | 0.85 | 0.93 | 0.98 | 1.02 | 1.17 | 1.34 | 1.42 | 1.58 | 1.81 |
| 51 | 0.72 | 0.85 | 0.93 | 0.98 | 1.02 | 1.17 | 1.34 | 1.42 | 1.58 | 1.80 |
| 52 | 0.72 | 0.85 | 0.93 | 0.98 | 1.02 | 1.17 | 1.34 | 1.41 | 1.57 | 1.80 |
| 53 | 0.72 | 0.85 | 0.93 | 0.98 | 1.02 | 1.17 | 1.33 | 1.41 | 1.57 | 1.79 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 54 | 0.73 | 0.85 | 0.93 | 0.98 | 1.02 | 1.17 | 1.33 | 1.41 | 1.56 | 1.78 |
| 55 | 0.73 | 0.85 | 0.93 | 0.98 | 1.02 | 1.16 | 1.33 | 1.40 | 1.56 | 1.78 |
| 56 | 0.73 | 0.85 | 0.93 | 0.98 | 1.02 | 1.16 | 1.33 | 1.40 | 1.55 | 1.77 |
| 57 | 0.73 | 0.86 | 0.93 | 0.98 | 1.02 | 1.16 | 1.32 | 1.40 | 1.55 | 1.76 |
| 58 | 0.73 | 0.86 | 0.93 | 0.98 | 1.02 | 1.16 | 1.32 | 1.40 | 1.54 | 1.76 |
| 59 | 0.73 | 0.86 | 0.93 | 0.98 | 1.02 | 1.16 | 1.32 | 1.39 | 1.54 | 1.75 |
| 60 | 0.74 | 0.86 | 0.93 | 0.98 | 1.02 | 1.16 | 1.32 | 1.39 | 1.54 | 1.74 |
| 75 | 0.76 | 0.87 | 0.93 | 0.98 | 1.02 | 1.14 | 1.28 | 1.34 | 1.47 | 1.64 |
| 100 | 0.78 | 0.88 | 0.94 | 0.98 | 1.02 | 1.13 | 1.25 | 1.30 | 1.40 | 1.54 |
| 150 | 0.78 | 0.88 | 0.94 | 0.98 | 1.01 | 1.12 | 1.21 | 1.25 | 1.33 | 1.45 |
| 200 | 0.78 | 0.88 | 0.94 | 0.98 | 1.01 | 1.11 | 1.19 | 1.23 | 1.30 | 1.40 |