LONDON STRATEGIC SUDS PILOT STUDY

SuDS Feature Schedule, Technical Note

DECEMBER 2020

1 SUMMARY

This technical note covers the selected SuDS features, including the key ‘design’ parameters derived within the supporting SuDS Feature Schedule and how they will be represented in the modelling.

Note: Illustrations citation – SuDS Manual C753 (2015) - Chapter 17, Figure 17.3 / Chapter 18, Figure 18.1 / Chapter 18, Figure 18.2 / Chapter 18, Figure 18.5, GreenBlue Urban Products (https://www.greenblue.com/na/products/rootspace/)

2 SUDS FEATURE SHORT-LIST

2.1 General ‘Design’ Principles

The ‘design’ principles referred to in this technical note (and related technical notes) refers to the structural and geometric values selected to consistently represent each SuDS feature within the modelling, related to both case studies and industry standards. It is recognised that while each SuDS feature design would be largely bespoke (inc. catering for service constraints, local ecological or social requirements, aligned with road traffic features and accommodating varying micro-scale ground conditions) the effective evaluation of catchment-scale benefit requires the simplicity of single ‘design’ parameters.

Each SuDS feature has specific selected or assumed parameters defined in the following sections and the following general principles:

- **No under-drainage and overflow systems have been explicitly included** – this is to simplify the ‘design’ and reduce complexity for the modelling
- **Evapotranspiration has not been included** – the net volume of water lost through evapotranspiration during periods of rainfall will be relatively insignificant in comparison to the attenuation volume provided
- **Inlet and outlet structures have not been explicitly included for bioretention features** – this is due to the inherent bespoke nature of these elements of the ‘design’ preventing the derivation of a common approach and to reduce complexity for the modelling

2.2 Bioretention Features

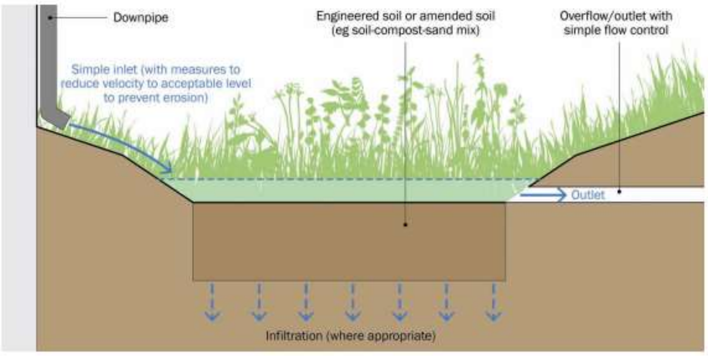
Bioretention is broadly defined as engineered streetscape features built into the footway and / or protruding into the carriageway plus grassed highway verges, designed to collect, attenuate and evapotranspirate surface water runoff from paved surfaces *(largely the highway)*. These features will include a porous filter media *(soil and drainage layer)*, vegetation, potentially including small trees, and under-drainage. Water is attenuated in the surface area *(based on depth of soil top layer)* and within filter media *(based on the effective void space capacity)* via infiltration.

The highly urbanised landscape of the Inner London area will require more engineered solutions to provide space to manage water (i.e. structural features instead of soft landscaped features such as swales), with more consideration for the aesthetic integration into the general streetscape.

Alma Road, Enfield

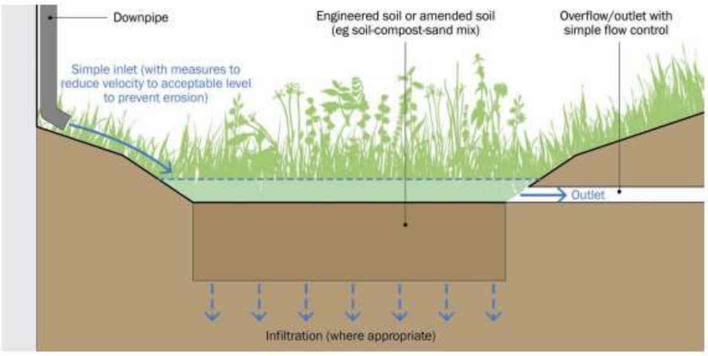
2.3 Property Rain Gardens

Relatively small naturalised depressions that serve a single property's roof runoff, typically disposing of collected water via infiltration.



2.4 Swales

Shallow, broad and vegetated channels designed to store and / or convey runoff and remove pollutants. They can be used as conveyance structures to pass the runoff to the next stage of the treatment train and can be designed to promote infiltration where soil and groundwater conditions allow.



2.5 Street trees

Trees provide an extensive opportunity to increase surface water attenuation, even within the more urbanised Inner London area. There is a wide variation in design approaches taken to construct SuDS tree pits, plus the associated costs and technical constraints. Instead of selecting a single design approach (which could create significant uncertainty) the effective volume provided from past cast study examples has been used solely to derive the capacity of these SuDS features.

Following PSG discussions and similar concerns raised within similar projects the evaluation of street tree SuDS will be based on replacement only and will not include new trees.

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2.6 Living roofs

Living roofs provide an exceptional and extensive opportunity to convert large areas of impermeable to semi-permeable, in areas where the construction of other types of ground-level SuDS are likely to be the most challenging. It is recognised that realising the retrofit of living roofs at a large scale is likely to be logistically and economically difficult, owing largely to the majority of opportunities being in private ownership. Influencing planning and design policy to ensure new build buildings and major renovation projects consider the inclusion of living roofs is likely to be more achievable, over the longer term. However, far more area of semi-permeable space could be created through retro fit so both approaches will be considered.

The two living roof types are as follows:

- **Retrofit (Extensive)** – Typified by shallow soil (20 mm-150 mm) and smaller plants (mosses, sedum, wild flowers), extensive living roofs are ideal for retrofit application as they can be highly effective in reducing peak runoffs and apply relatively low static and imposed loading to structures
- **Renovation / New Build (Extensive / Intensive)** – When incorporated into structural redesign or new construction, deeper living roofs can be implemented to include a wide variety of plants including bushes and small trees. These designs allow for landscaping and 'shared-use' roofs, i.e. usable outdoor areas that combine more significant water management with biodiversity and amenity

Living roofs *(also known as green roofs)* and permeable paving with both initially considered for inclusion but later discounted. Living roofs can provide a significant volume of effective attenuation but they are reliant on available flat roof space, which is typically sparse within the predominantly residential Outer London CDAs. In most cases the ideal roofs are on private property making them inappropriate for inclusion due to the focus on public realm features. The opportunity for permeable paving was also determined to be relatively sparse in these CDAs, with the few potential locations *(typically public car parks)* not likely to provide major flood benefit during heavy rainfall. Their lack of socio-environmental benefit is also likely to inhibit the generation of good benefit-cost ratios without a more significant volume of opportunities.

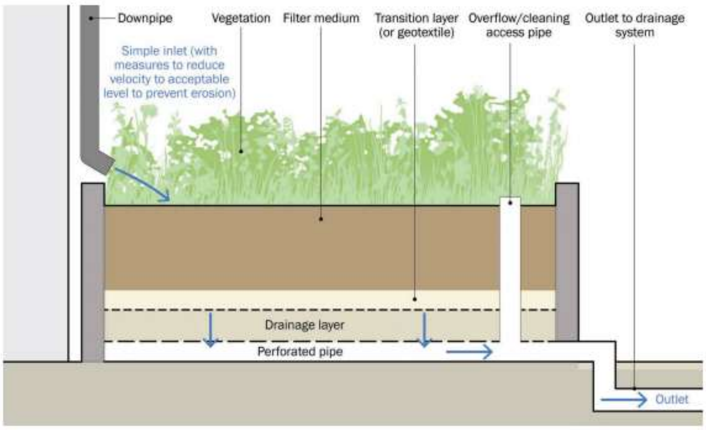
Cannon Bridge Roof Garden, Camden

2.7 Rainwater Planters

Rainwater planters have been included since Thames Water are currently developing and rolling out a product that features a limited discharge orifice device, enabling them to be use as rainfall attenuation systems. The planters are modular enabling them to be scaled to serve any building size, connecting to existing downpipes.

The rainwater planter details are as follows:

- Modular units 600(w) x 400(d) x 950(h) mm
- Approximate volume with lid = 216 l *(including inner tank)*
- Approximate volume with trays = 192 l *(including inner tank)*
- Nominally is about 200 litres.



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3 STAGE 1, PRELIMINARY CONCEPTUAL DEVELOPMENT

3.1 SuDS ‘Design’ Parameters

3.1.1 Location / Opportunities

To enable the efficient evaluation of hydraulic performance across whole CDA areas a simple and easily scalable approach was devised, focused solely on representing the effective storage capacity *(volume)* that each SuDS Feature would typically provide. This volume facilitates attenuation for surface water at selected gullies prior to drained flows discharging to the public sewer network. This creates the dual benefit of both reducing floodwater depths in their immediate proximity *(and downstream in some instances)* by storing more water below ground level and reducing the rate surface water discharges to the public sewers. Delaying surface water runoff entering the public sewer network can provide a greater capacity to more effectively drain other areas of the network, especially beneficial where the urban landscape provides little opportunity to construct SuDS.

A maximum geographical extent of possible SuDS was defined for each CDA, used to limit the scope to only public roads and property *(including grounds)* owned and / or managed by the local authorities. This ensured that SuDS opportunities could more readily be delivered by reducing the potential impact of land purchase, access issues and long-term maintenance challenges anticipated when considering private land / property. The potential benefit of delivering SuDS within private land and through developers will be an essential component of successful long-term strategies seeking to improve resilience and sustainability through SuDS or BGI but has not been considered within The Pilot Project *(to-date)*.

The determination of ‘applicability’ for each SuDS Feature configuration at every Paved Surface Source Control and Roof Runoff Source Control location required the consideration of a range of constraint factors *(See Table 1)*. Factoring in these constraints enabled rationalisation and an indicative evaluation of feasibility, removing those considered inapplicable and resulting in a defined schedule of SuDS Features applicable for each location.

Source Control	Constraint Type	Constraint Details
Paved Surface	Surface water flood depth	+/- 0.2m compatibility, related to SuDS type and configuration
Paved Surface	Cumulative gully inflow	+/- 5m3 compatibility, related to SuDS effective attenuation volumes and need for overflow connections
Paved Surface	BGS Infiltration Classification	2 <= infiltrating SuDS Features / >=3 non-infiltrating SuDS Features
Paved Surface	Highway classification	District road / Principal road / Classified road / TFL road
Paved Surface	Presence of existing street tree	Within 10m
Roof Runoff	School land	Within extent of project
Roof Runoff	Council ownership	Within footprint
Roof Runoff	Council owned car parks	Within footprint

Table 1 – Constraints Analysis Constraint Factors

3.1.2 SuDS Feature Configurations

To account for the highly variable nature of the urban landscape, rainfall runoff and the siting and design of SuDS, a set of proposed design 'configurations' were devised for the five SuDS Feature types. These configurations account for available space *(e.g. open commercial paved landscape, small residential streets etc.)*, local hydrogeology *(i.e. permeability of the ground)*, hydraulic function *(i.e. typical magnitude of local runoff and predicted flooding)* and scale *(i.e. to account for scalability of SuDS Features)*. This sub-set of SuDS configurations enables a more specific selection of SuDS 'options' for the development of the SuDS Evaluation Scenarios, based on hydraulic applicability and benefit-cost *(See Section **Error! Reference source not found.**)*.

All the defined SuDS Feature configurations, including their dimensions, function and proposed layout are listed in Table 2.

Property Raised Planter	Property Rain Garden	Swale	Bioretention Rain Garden	Tree Pit
Small (Asm. x4 features per property)	Small	10m Length / Wet*	Traffic Calming Build-out***	Small Wet
Large (Asm. x4 features per property)	Medium	25m Length / Wet	Highway Build-out	Medium Wet
	Large	50m Length / Wet	Pavement Build-in****	Large Wet
		100m Length / Wet	Non-residential Build-in Small	Small Dry
		10m Length / Dry**	Non-residential Build-in Large	Small Medium
		25m Length / Dry		Small Large
		50m Length / Dry		Retro-fit Wet
		100m Length / Dry		Retro-fit Dry

Note:
* These components do not have the capacity to infiltrate attenuated water (due to site conditions and design)
** These components have the capacity to infiltrate attenuated water
*** A 'build-out' configuration is based on the SuDS feature being projected into the carriageway from the pavement
**** A 'build-in' configuration is based on the SuDS feature being cut into the pavement

Table 2 – SuDS Feature Configurations Overview

3.1.3 SuDS Applicability Assessment

The applicability of each SuDS Feature at each source location, following the constraints analysis rationalisation *(See Section **Error! Reference source not found.**)*, has been based on three key components:

- **SuDS Location Hydraulic-Benefit Ratio** (See Section 3.1.4) – Projected hydraulic effectiveness of every SuDS Feature at each location
- **SuDS Feature Investment-Benefit Ratio** (See Section 3.1.5) – Cost effectiveness of each SuDS Feature type
- **SuDS Features Wider-Benefit Ratio** (See Section 3.1.5) – Estimated wider financial benefits of each SuDS Feature type

3.1.4 SuDS Location Hydraulic-Benefit Ratio

It was agreed by the Project Steering Group to define a conceptual SuDS design standard, based on the volume of water predicted to drain to each SuDS Location during a range of rainfall events, to assess the

Hydraulic-Benefit Ratio. The criteria selected was the percentage utilisation of the available attenuation storage, selected as a measurable proxy for how appropriate each SuDS type and configuration is likely to for at each location based on predicted surface water flows.

An optimal hydraulic design capacity was assumed to be 75% utilisation of available volume during a 1 in 5-year rainfall event. This assumption was selected to identify the most optimal SuDS Feature for each location that could store a significant proportion of local runoff while retaining some capacity for larger more infrequent events.

Utilisation figures were derived from predicted cumulative volumes discharging to each drainage location compared to the proposed SuDS Features effective attenuation volume. The variation of model predictions for each SuDS Feature type and configuration from the specified optimal utilisation was then calculated, providing the basis for the Hydraulic-Benefit Ratio.

An example of the process for a single SuDS Location is demonstrated in Figure 1.

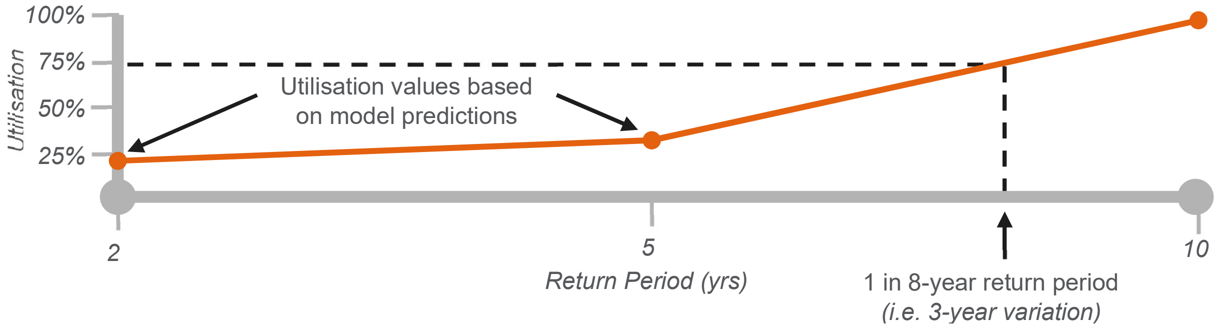


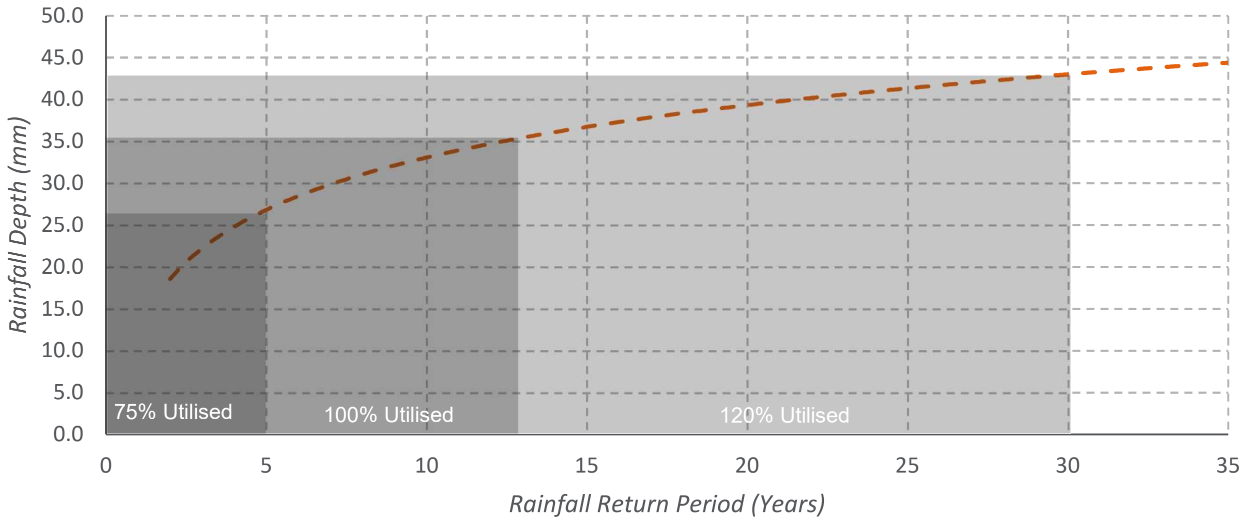
Figure 1 – Selected SuDS Features Types

Where the calculated 75% utilisation return period was either less than 1 in 2-years or greater than 1 in 10-years the specific SuDS Feature was discounted. This provides a second level of rationalisation (after the main analysis detailed in Section **Error! Reference source not found.**), to ensure hydraulically inappropriate SuDS Features were not selected, to prevent the following:

- The promotion of SuDS Features that would rarely be fully utilised, potentially leading to drying out of aquatic vegetation and increased investment with limited flood risk value
- The promotion of SuDS Features that are undersized and are regularly fully utilised, over-saturating soils and causing dieback of planted vegetation, resulting in heavy sedimentation and potentially becoming a maintenance burden.

Within this hydraulic optimisation the selection process would typically defer to the larger SuDS Features requiring greater investment. Since this project is funded by local flood risk authorities and aims to develop a framework to support investment in SuDS to drive flood risk benefit, aligning hydraulic function with potential investment is essential.

The selection of 75% utilisation during a 1 in 5-year event was considered an optimal assumption to provide suitable capacity to comfortably accommodate highway runoff up-to typical drainage standards (i.e. 1 in 5 years) whilst also providing approximately 85% of the general runoff volume requirement for a 1 in 30-year event. The assumed optimal design target for each SuDS Features based on rainfall depth and return period is shown in Figure 2.



Key:

▬ ▬ FEH rainfall depth versus return period (plotted trendline based on 2, 5, 10 and 30-year rainfall depth figures)

Note: Rainfall depths calculated from modelled FEH 180-minute duration rainfall used in project, originally derived for the Enfield Flood Alleviation Schemes

Figure 2 – Effective Capacity of the SuDS Features Provided by the Optimal Design Target

3.1.5 SuDS Feature Investment-Benefit & Wider-Benefit Ratios

In addition to the SuDS Location Hydraulic-Benefit Ratio evaluated for each location a high-level consideration of potential investment and wider financial benefits has been included within the selection process. These ratios have been derived for the SuDS Feature types and are consistent for all SuDS Locations.

The investment benefit has been based on unit costs The total CAPEX and OPEX costs defined were converted into a ratio between the maximum and minimum figures. The wider financial benefit has been derived using the B£ST Tool.

3.1.6 Optimised SuDS Feature List

All three benefit 'ratios' were combined into a weighted Unit Benefit-Cost Ratio, which has subsequently been used to rank the proposed SuDS Features for each location. The Optimised SuDS Feature List provides the ranked SuDS Features, facilitating the creation of the Conceptual Implementation Scenarios *(See Section **Error! Reference source not found.**)* based on the Unit Benefit-Cost Ratio.

3.1.7 GLA SuDS Opportunity Mapping

The project was originally planned to consider using the GLA SuDS Opportunity Mapping as the basis for the location and dimensions of SuDS features, given that the evaluation of effective volume required, and projected runoff areas is embedded in the data.

However, the concept of Dispersed SuDS, as defined for this study, required the adaptation of highway gullies which do not align directly with the likely location for most of the proposed SuDS feature types *(e.g. a bioretention raingarden in many cases would be built into the pavement)*. The use of the gully location as a proxy for the actual location of the SuDS feature enables the use of the associated node in the model as a SuDS unit, utilising predicted runoff drained to support the SuDS applicability assessment. No workable solution was identified at the time to link the gully locations in the model *(i.e. in the carriageway)* with the OS MasterMap polygon data that the GLA SuDS Opportunity Mapping is based on.

A single scenario was developed based on the 'Baseline (30Yr)' dominant solutions data for all road features identified in the GLA SuDS Opportunity Mapping, using a more manual process. For more details around the development of the tool and data refer to the guidance online[1].

3.2 Model Integration

3.2.1 SuDS Features

All SuDS Features were represented in the models in one of two standard methods, depending on general relation to the public highway network.

- **Paved Surface Source Control locations** – These cover the SuDS Features which are proposed to be constructed within the streetscape, either the pavement or jutting out into the carriageway, at existing gully locations
- **Roof Runoff Source Control locations** – These cover the SuDS Features which are proposed to be constructed away from the road network within public owner green spaces

3.2.1.1 Paved Surface Source Control Locations

The proposed standard structural dimensions for each SuDS Feature provide an effective attenuation volume to be applied to the models. The application of this volume in the models was achieved by adjusting the node dimensions, representing the existing gully pots and adjusting the level of the connecting pipework, a process which was automated *(using SQL functionality in InfoWorks ICM)* for efficiency and precision.

The representation of these streetscape SuDS Features in the model is graphically demonstrated in Figure 3.

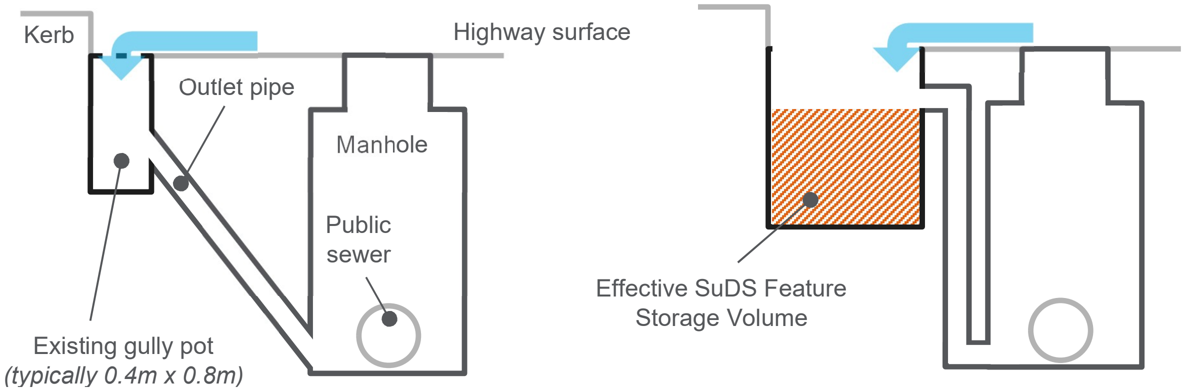


Figure 3 – Demonstration of the Representation of Streetscape SuDS Features Using Model Nodes

Infiltration rates for relevant SuDS configurations, although specified within the SuDS short-listing process, were not included in the model representations. This was due to complexity of the model representation and projected insignificance, when compared to the benefit of the attenuation volume itself.

The discharge of attenuated flows back into the system was not included in the modelling approach, to maintain simplicity and efficiency. The return of flows would only occur once the system has reached capacity, at which point surface flooding is likely to have largely receded and any discharge of attenuated volume will not affect the calculated flood benefits.

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[1] https://data.london.gov.uk/dataset/suds-opportunity-mapping-tool

3.2.1.2 Roof Runoff Source Control Locations

The Roof Runoff Source Control location SuDS Features function is to attenuate property roof runoff and are not associated with the highway drainage network. They have been included by adjusting the defined runoff area values within the model subcatchments, which individually replicate the effective area of each roof.

The subcatchment area which represents the effective volume attenuation for each SuDS configuration was derived based on the following equations:

Property Raised Planter	Rain Garden
$Area = \frac{(V \times 4)}{D}$	$Area = \frac{V}{D}$

Where V = Effective SuDS attention volume / D = Rainfall depth during 1 in 5-year design event *(ReFH parameters)*

* Volume multiplied by four to account for there being four features proposed for each property, as defined in Table 2

4 STAGE 2, COMPREHENSIVE ECONOMIC VALUATION

For each 'design' parameter minimum and maximum values have been derived, based on either the range of values from the selected case studies or ranges staged in design standards / guidance *(if relevant)*. From this range 'typical' values have been identified, either as the average or a non-average value *(with justification)*. These typical values will be used to define the physical structure and placement of the SuDS features in the hydraulic model, effectively representing the volume of attenuation at each location.

4.1 Bioretention Features

4.1.1 Location / Opportunities

4.1.1.1 Derivation

A new GIS workflow has been developed to create proposed bioretention SuDS footprints within pavement areas based on SuDS Design Parameters, using the OS MasterMap data. This workflow ensures that all key design parameters are complied with, resulting in a complete schedule of potential locations, including their width, length and profiling along pavements. The schedule should be considered a high-level opportunity assessment only, and will not consider the impacts of utilities, access implications and other local constraints.

The derived footprints will not account for SuDS features along a single pavement being broken sequentially, to allow vehicular and pedestrian access to the road due to the inherent uncertainty for each location. To account for this within the modelling *(and calculation TOTEX costs)*, spacing adjustment factors have been derived. These factors have been based on a set of assumptions around typical pedestrian and vehicular access widths *(i.e. width of paved area cutting through a line of SuDS features)* and their frequency. The factors *(percentages)* area applied to adjust down the effective attenuation volume that each footprint would provide *(i.e. the storage depth will be decreased)*. The derivation of typical spacing has been made using the assumptions laid out in the Assumptions sheet of the SuDS Feature Schedule spreadsheet (row 18 to 35).

SuDS footprints within existing grassed highway verges will be derived based on OS MasterMap classification and the buffering of the road polygons, based on the width detailed in the SuDS Design Parameters.

4.1.1.2 Optimisation

The general approach to optimising the selection of SuDS features *(to create the scenario realisation levels detailed in the SuDS Scenario Technical Note)* has remained unchanged from Stage 1, except for an adjustment to the proposed level of service *(i.e. 1 in 5-years)*. Since Stage 2 has more of a focus on Thames Water (TW) assets and benefits the general TW SuDS / drainage design standard of 1 in 30-years will be used instead.

To calculate 'utilisation', predicted volumes attenuated in the 100% realisation level Public Realm Implementation Scenario will be extracted and compared to the effective maximum capacity of each SuDS feature. The resultant variation from 100% 'full' during a 1 in 30-year event will be used to rank the feature, enabling the derivation of the various realisation levels.

The selected locations are show in the Figure 4.

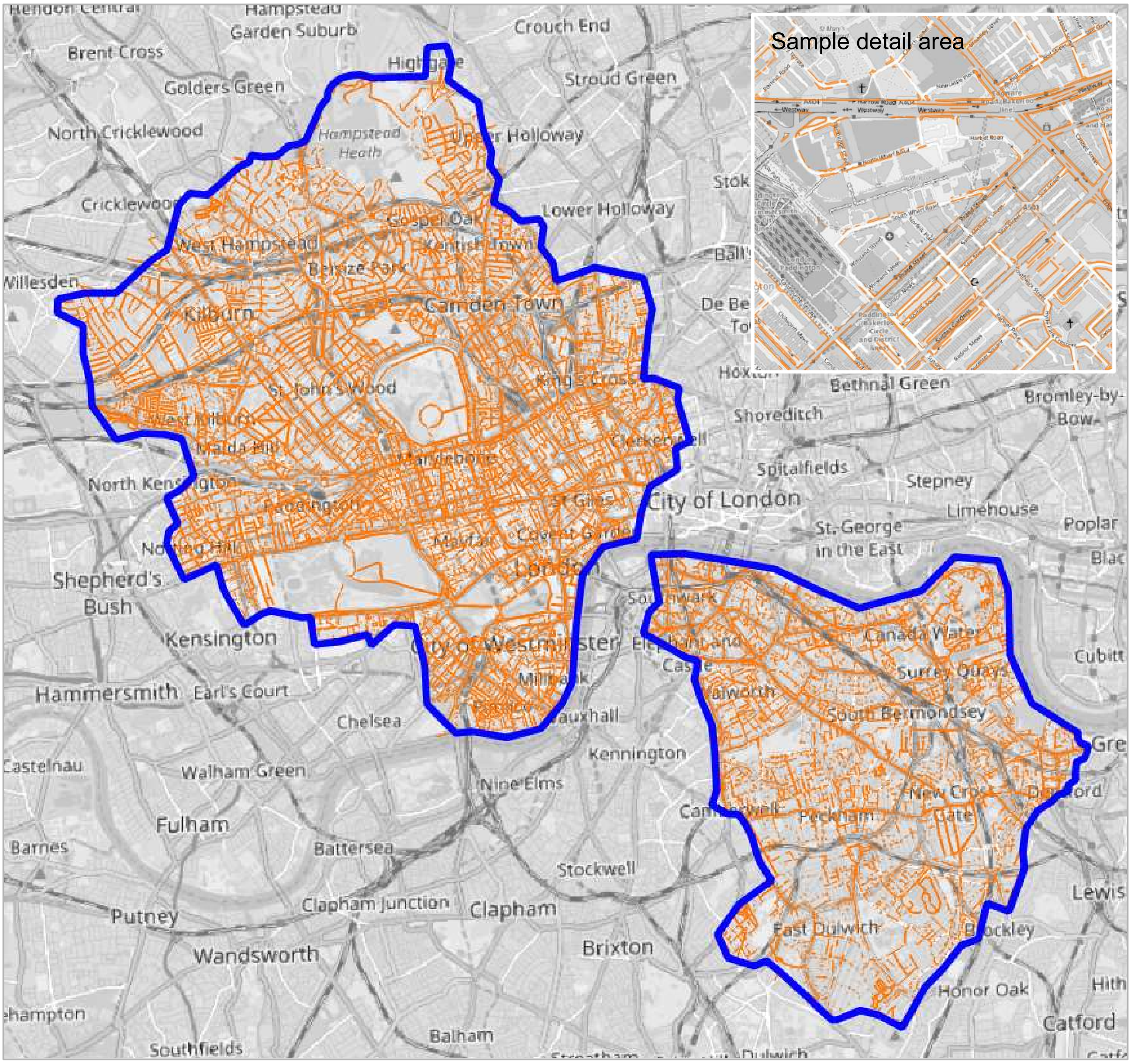

Figure 4 – Selected Locations for Bioretention Features

4.1.2 Selected 'Design' Parameters

Parameter	Value	Comments / Justification
Depth of Surface Detention (i.e. road surface to soil surface)	0.12 m	Weighted* average of case studies and design standards / policy
Depth to Base (i.e. soil surface to base of excavation)	0.60 m	Weighted average of case studies and design standards / policy
Min Width (carriageway to pavement)	0.7 m	Weighted average of case studies and design standards / policy
Max Width	4.5 m	Weighted average of case studies and design standards / policy
Min Length	5.0 m	Min case studies

Parameter	Value	Comments / Justification
Max Length	22.0 m	Weighted average of case studies and design standards / policy
Min Pavement Width	1.9 m	Weighted average of design standards / policy
Growing Media Void Space	28 %	Weighted average of case studies and design standards / policy
Spacing Adjustment Factor *(SuDS Features < Max SuDS Area)*	100 %	99 m^2 *(Max Width x Max Length)*
Spacing Adjustment Factor *(SuDS Features > Max SuDS Area)*	46%	Applied to the area SuDS feature area > Max SuDS Area

** 75% case studies / 25% design standards and policy*

Table 3 – Selected SuDS Design Parameters

An additional adjustment factor has been applied to account for the variable constraints on the effective space of SuDS dependent on the type of road. The adjustment factors, applied to the effective SuDS area, are shown below.

Road Type	Adjustment Factor	Comments / Justification
A Road	75%	Accounts for potential need for larger public accesses / pavement width, shop frontages and street furniture
B Road	85%	Accounts for potential need for larger pavement width and street furniture
Minor Road	100%	-
Local Street	100%	-
Private Road - Publicly Accessible	75%	Accounts for reduced opportunity and / or acceptance
Private Road - Restricted Access	50%	Accounts for reduced opportunity and / or acceptance
Pedestrianised Street	100%	-

Table 4 – SuDS Adjustment Factors

4.1.3 Model Integration

The generated footprints will be directly imported into InfoWorks as Mesh Zones, which can then have the necessary topographic adjustments made to create the required attenuation volume within each feature. Since the GIS workflow has created features which abut up directly to the roads *(which will also be mesh zones, lowered by 100 mm to account for road kerbs)* 2D flows will drain directly.

4.2 Street Trees

4.2.1 Location / Opportunities

The GLA London Tree Map[2] data has been used to specify location and evaluate potential locations for new street trees. No additional data has been used, imparting confidence in the reliability of this dataset.

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[2] https://www.london.gov.uk/what-we-do/environment/parks-green-spaces-and-biodiversity/trees-and-woodlands/london-tree-map

The location of street trees which could be replaced with a SuDS tree have been split into three categories:

- **Highway Tree Replacement** – trees located within 2 m of the highway that *(when replaced with a SuDS tree)* would drain surface water directly from the carriageway
- **New Highway Trees –** locations for new trees at least 13 m from an existing tree *(based on the average tree separation value derived from the whole GLA London Tree Map dataset)*
- **Pavement Tree Replacement** – trees located within a paved surface greater than 2 m of the highway that *(when replaced with a SuDS tree)* would drain any overland flows from the immediate surrounding

For the highway trees the specific digitised location varies between being on the pavement and within the carriageway. To enable the model representation of tree pit attenuation within the 2D surface the 'Highway trees' will be manually shifted into the centre of the adjacent highway, to allow 2D flows to discharge into them.

The selected locations are show in Figure 5.

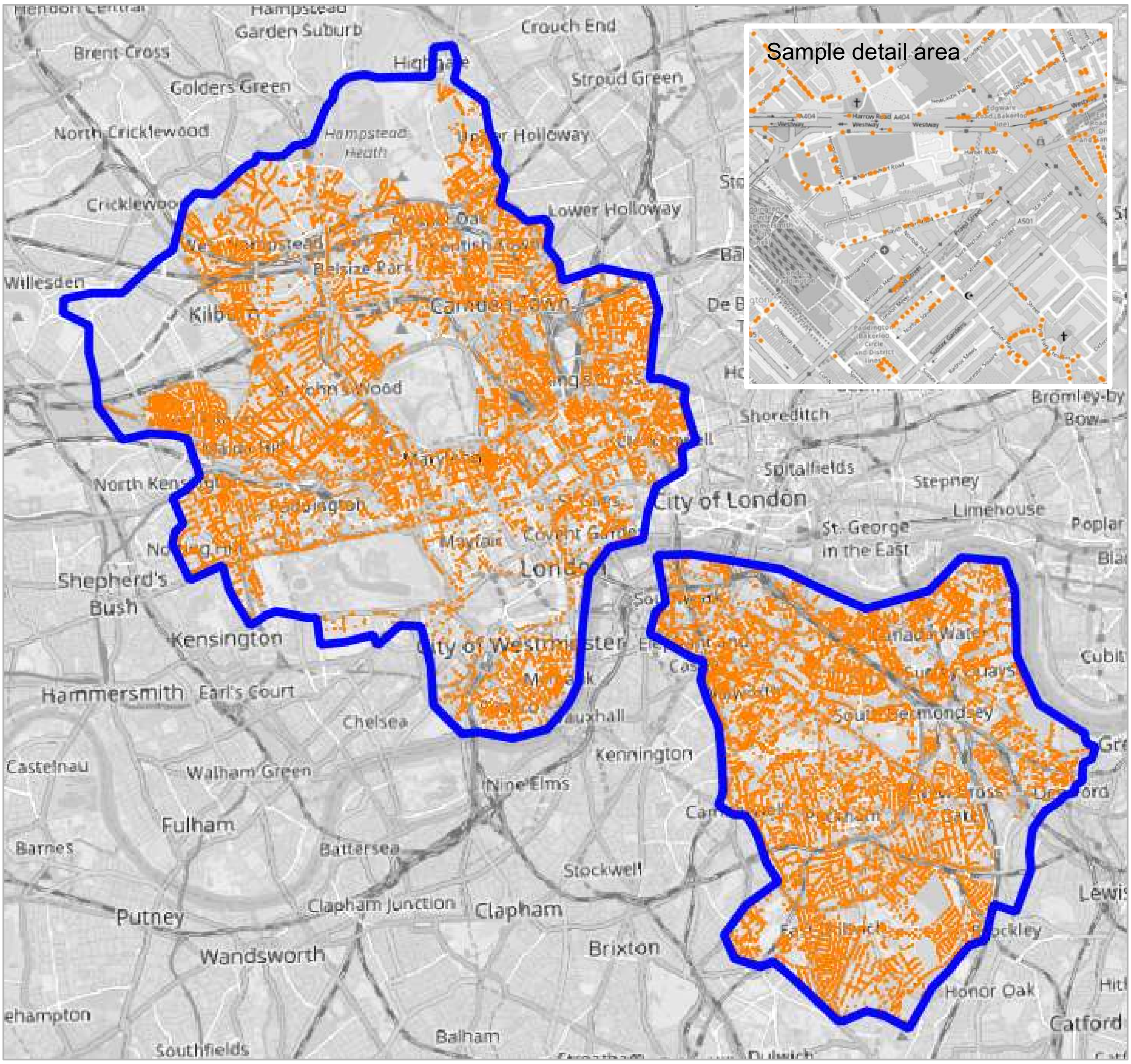

Figure 5 – Selected Locations for Tree Planting

4.2.2 Selected 'Design' Parameters

Parameter	Value	Comments / Justification
Depth of Surface Detention (i.e. road surface to soil surface)	0.04 m	Middle estimate from case studies
Depth to Base (i.e. soil surface to base of excavation)	0.94 m	Weighted* average of case studies and design standards / policy
Area	6.9 m^2	Weighted average of case studies and design standards / policy
Growing Media Void Space	32 %	Weighted average of case studies and design standards / policy

** 40% case studies / 60% design standards and policy*

Table 5 – Tree Planting Design Parameters

4.2.3 Model Integration

Each SuDS tree pit will be represented with a single 1 m deep node, based on the refined GIS locations. The chamber area will be adjusted to achieve the defined attenuation capacity. The shaft area will be defined to ensure the effective circumference equals the typical inlet diameter, as evaluated from the case studies. The flood type will be set to 2D which will enable 2D flows to directly discharge into each node, based on the shaft circumference *(which acts as a broad crested weir)*.

4.3 Living Roofs

4.3.1 Location / Opportunities

The selection of opportunities will be made solely on OS MasterMap building footprint area, based on the defined parameters.

4.3.1.1 Retrofit

Parameter	Value (m^2)	Comments / Justification
Minimum roof size	600	Weighted average of case studies
Maximum roof size	5,000	Maximum value of selected case studies

Table 6 – Retrofit Living Roof Details

4.3.1.2 Renovation / New Build

Parameter	Value (m^2)	Comments / Justification
Minimum roof size	820	Weighted average of case studies
Maximum roof size	5,000	Maximum value of selected case studies

Table 7 – Renovation/New Build Living Roof Details

The maximum value for both Retrofit and Renovation / New Build was sensitivity tested by reviewing its selection of major London buildings and landmarks, such as Buckingham Palace, major museums and train stations. The value of 5,000 m^2 has been found to be sensible.

The selected locations are show in the Figure 6 *(based on Retrofit Living Roofs)*.

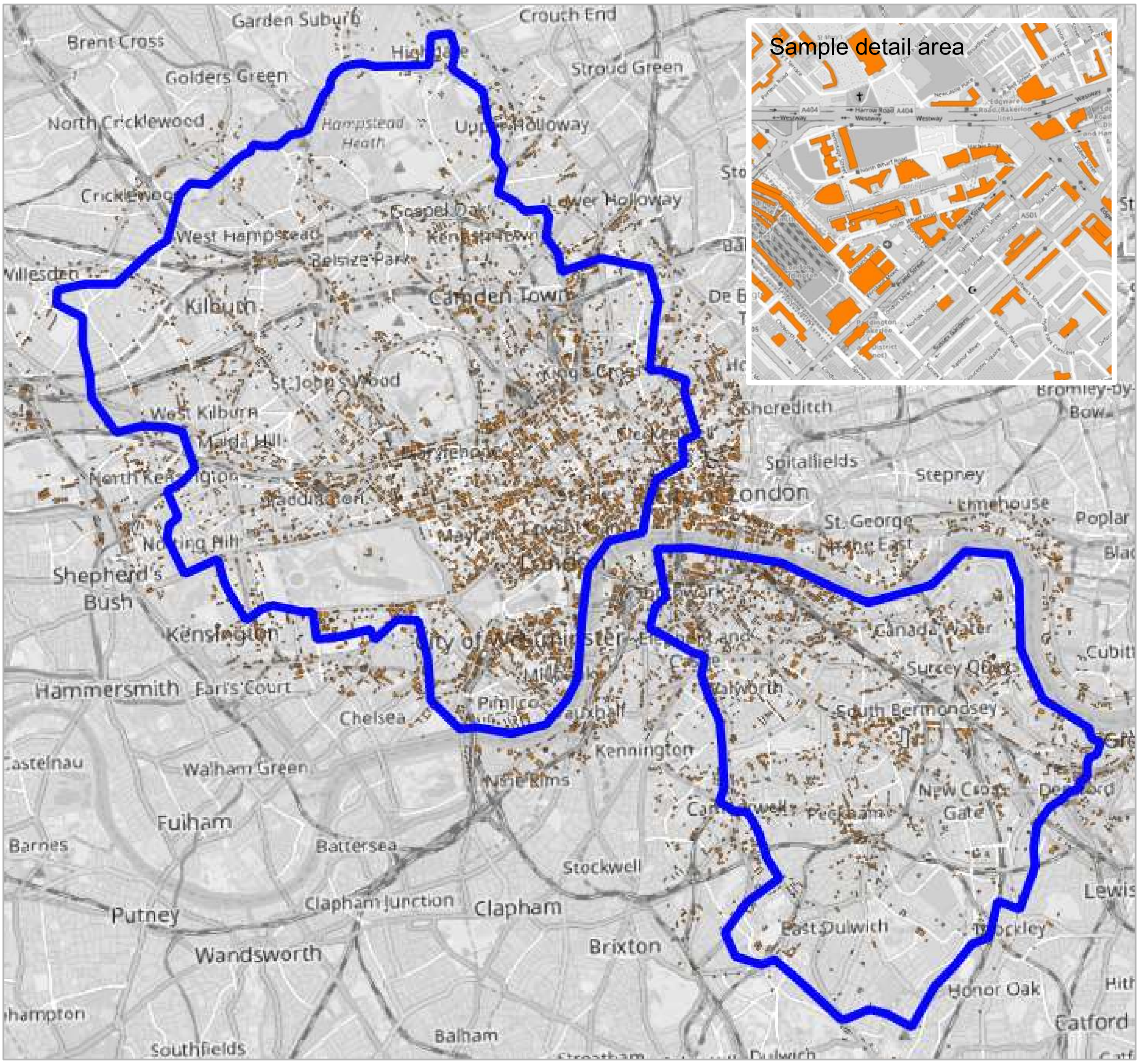

Figure 6 – Selected Locations for Living Roofs

4.3.2 Selected 'Design' Parameters

4.3.2.1 Retrofit (Extensive)

Parameter	Value	Comments / Justification
Depth to Base (i.e. soil surface to impermeable layer)	0.10 m	Weighted* average of case studies and design standards / policy
Min Roof Area	600 m^2	Average of case studies Lower and Middle estimates (conservative)
Living Roof Coverage (% of total roof)	76 %	Case studies Middle estimate
Growing Media Void Space	32 %	Case studies Middle estimate

** 75% case studies / 25% design standards and policy*

Table 8 – Living Roof Retrofit Design Parameters

4.3.2.2 Renovation / New Build (Extensive/Intensive)

Parameter	Value	Comments / Justification
Depth to Base (i.e. soil surface to impermeable layer)	0.23 m	Weighted* average of case studies and design standards / policy
Min Roof Area	817 m	Average of case studies Lower and Middle estimates (conservative)
Living Roof Coverage (% of total roof)	42 %	Case studies Middle estimate
Growing Media Void Space	32 %	Case studies Middle estimate

** 75% case studies / 25% design standards and policy*

Table 9 – Living Roof Renovation/New Build Design Parameters

4.3.3 Model Integration

The SuDS module will be employed directly within building subcatchments, with the relevant parameters defined here. The effective Depth to Base will be adjusted for each Realisation Level to account for the percentage implementation, distributed across all potential opportunities.

4.4 Rainwater Planters

4.4.1 Location / Opportunities

The selection of a maximum area value required to define the schedule of buildings suitable for rainwater planters has been based on sensitivity testing of OS MasterMap selections. It has been assumed that buildings without pitched roofs typical have internal roof drainage, so would not be suitable and provide an upper area limit. Starting at the defined Living Roofs minimum area, the value was reduced to ensure the resulting selection largely covered residential areas and lower-density commercial areas. A value of 250 m^2 was selected.

The minimum value has been set at 50 m^2, considered to represent the typical area of a small terraced property *(omitting smaller mapped buildings such as garages and sheds)*.

The selected locations are show in the Figure 7.

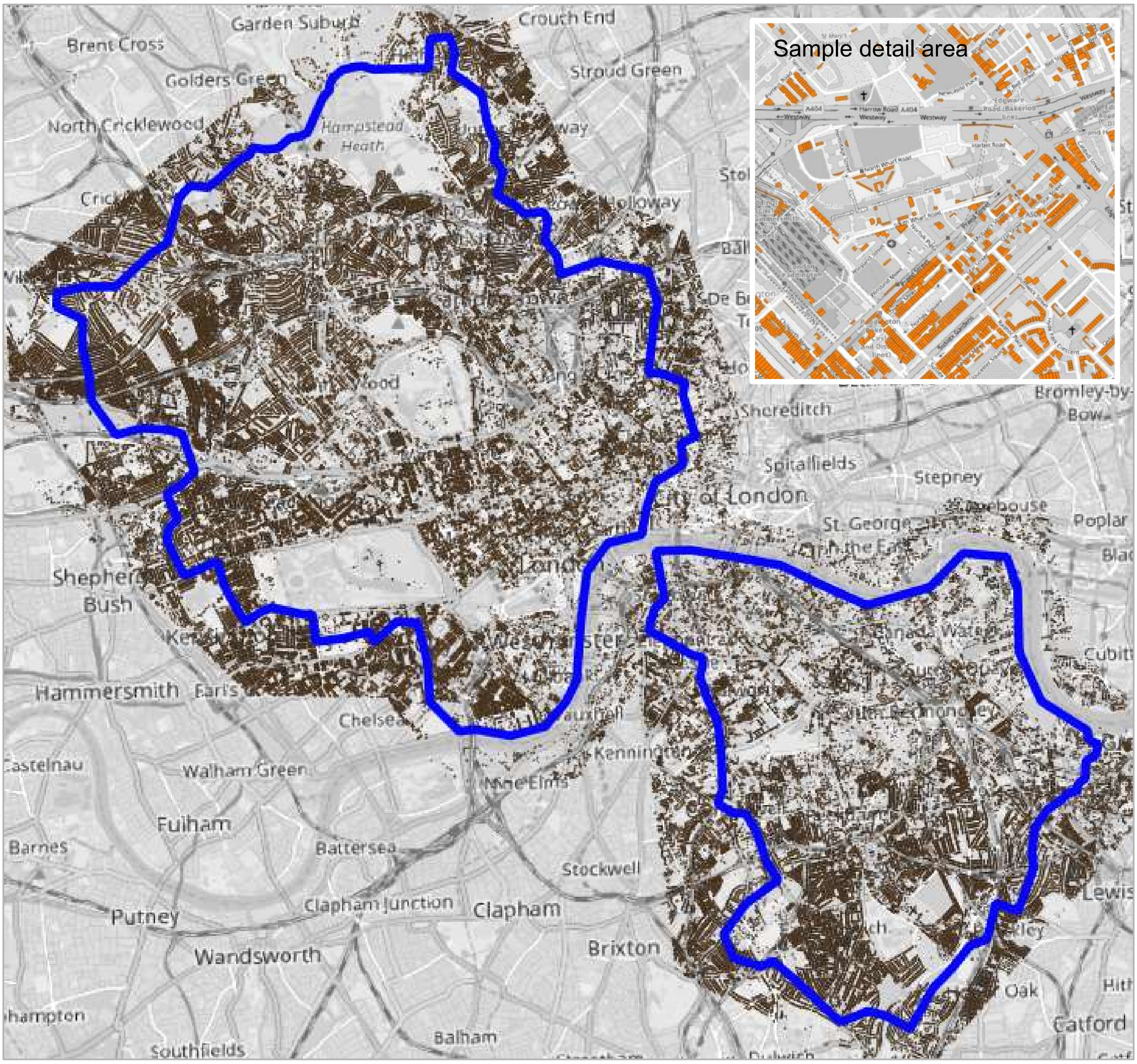

Figure 7 – Selected Locations for Rainwater Planters

4.4.2 Selected 'Design' Parameters

It has been assumed that the since the majority of the study area is served by a combined system roof drainage within the rear properties is likely to be integrated with foul flows, preventing the use of rainwater planters. Therefore, it has been assumed that one rainwater planter is likely to be applicable, connecting to the property frontage. To account for rear roof drainage sometimes being separated this value has been uplifted to 1.25 per property *(on average)*.

Based on the average capacity of 0.21 m^3 each property will have an effective maximum storage capacity of 0.26 m^3.

4.4.3 Model Integration

The SuDS module will be employed directly within building subcatchments, with the relevant parameters defined here. The defined volume will be adjusted for each Realisation Level to account for the percentage implementation, distributed across all potential opportunities.

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