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Reference:	SWDS 3025
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Project: Surface Water Drainage Strategy (SWDS)

Prepared for: Maddox Associates

Reference: SWDS 3025

Site Location: Garages to the rear of Southbourne Gardens, Ruislip, Hillingdon, HA4 9SW.

Proposed Development: It is understood that the scheme is for the redevelopment of the site to include erection of a single, three storey accommodation block comprising six residential units.

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1. Summary

SITE DETAILS			
Site Name	Garages to the rear of Southbourne Gardens, Southbourne Gardens, Ruislip, Hillingdon, HA4 9SW		
Total Site Area	0.09 ha		
Site Area which is positively drained	0.09 ha		
Open Space	0.00 ha		
Predevelopment Use	Site already developed for residential purposes.		
Site Constraints	- Residential Site		
	- Groundwater Source Protection Zone:	N/A	
	- Groundwater Vulnerability Zone:	Minor Aquifer High	
	- Poor Infiltration Soils		
	- Unknown Groundwater Table		
IMPERMEABLE AREA			
	EXISTING	PROPOSED	DIFFERENCE (Proposed - Existing)
Impermeable Area (Ha)	0.072 ha	0.078 ha	0.006 ha
Drainage Method (Infiltration/Sewer/Watercourse)	Sewer	Sewer	N/A
PROPOSED TO DISCHARGE SURFACE WATER VIA			
	YES	NO	EVIDENCE
Infiltration		X	Soils with Poor Infiltration Media.
To Watercourse		X	There is not a watercourse close enough to the site.
To Surface water sewer	X		
Combination of above		X	
PEAK DISCHARGE RATES			
	Greenfield Rates (l/s)	Pre-development Rates (l/s)	Proposed Discharge Rates (l/s)
Greenfield QBAR	**0.41**	N/A	N/A
1 in 1	0.35	7.70	1.20
1 in 20	-	9.50	-
1 in 30	1.01	10.7	1.20
1 in 100	1.31	10.8	1.20
1 in 100 plus climate change	N/A	10.8	1.20

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SITE STORAGE VOLUME			
Source Control Provided	Yes		
Interception Volume (Capture and retention on site of the first 5 litres of the majority of all rainfall events)	3.45 m^3		
Attenuation Volume (Storage - 1 in 100 year + CC) Volume to control discharge rate	44.60 m^3	0.08 m^3/m^2	Use of Permeable Pavement & Hydrobrake
Long Term Storage (1 in 100 years, 6 hours event) Difference in runoff volume between the development state and the equivalent greenfield (or predevelopment state)	0.00 m^3	Discharge at very Low Rate, thus LTS is not taken into account	
Approach used for Long Term storage (Either Use Long Term Storage or Discharge at very low rate)	Either: • Approach A: Use Long Term Storage • Approach B: All runoff above 1 in 1 year return period discharged to max of 2 l/s/ha or QBAR	Long Term Storage and Attenuation Volumes are discharged at QBAR	
Total site Storage	48.05 m^3		
INFILTRATION FEASIBILITY ANALYSIS			
Site's Geology	Pre-quaternary Marine/Estuarine Sand and Silt Loam to Silty Loam		
Infiltration Rates	$2.6x10^{-6}$ m/s	This value must be confirmed through trial pit infiltration tests on site prior to the final detailed drainage design stage being carried out.	
Infiltration Rates Suitability	Unsuitable		
Ground Water Level	Unknown	It is highly recommended that a groundwater level check be undertaken at the later detailed design stage in order to accurately identify the depth of the water table at the site.	
Is the site within a known Source Protection Zones (SPZ)? Yes/No?	NO		
Is Infiltration feasible?	Infiltration is not feasible due to the low rate of infiltration of the soils's site.		
Site's Contamination	Site already developed, thus there is a potential contamination due to petrochemical pollutants of the cars.		
Infiltration Feasibility	NO	Infiltration is not feasible due to the poor permeability of the underlying site soils.	
If Infiltration is not feasible, how is the Storage Requirements Approach?	Simple Approach. Discharge Long Term Storage and Attenuation Volume at QBAR		

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PROPOSED DRAINAGE COMPONENTS		
Permeable Pavement	Pervious surfaces provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into underlying layers.	
Water Butts	Water butts are the most common means of harvesting rainwater for garden use. They are small, off-line storage devices that are designed to capture and store roof runoff.	
Rills/Channels	Canals and rills are open surface water channels with hard edges. They are simply channels that water flows along whereby they can have a variety of cross sections to suit the urban landscape, including the use of planting to provide both enhanced visual appeal and water treatment.	
Flow Control (Hydrobrakes)	A self-activating device that provides improved hydraulic performance over conventional flow controls such as orifice plates and throttle pipes and reduced maintenance requirements.	
DESIGN CHECKS		
Drainage Systems Measures	Water Butts, Permeable Pavement and Hydrobrake.	
How are rates being restricted	N/A	
Key Drainage component	Permeable Pavement	
Drainage Systems Maintenance	Supplier must provide appropriate guidance for maintenance	
All SuDS storage located outside Q100 floodplain	Yes	
Provision for blockage / Design Exceedance	Yes	Exceedance routes are provided
Time taken for 50% of storage to drain down	10.32 hours	

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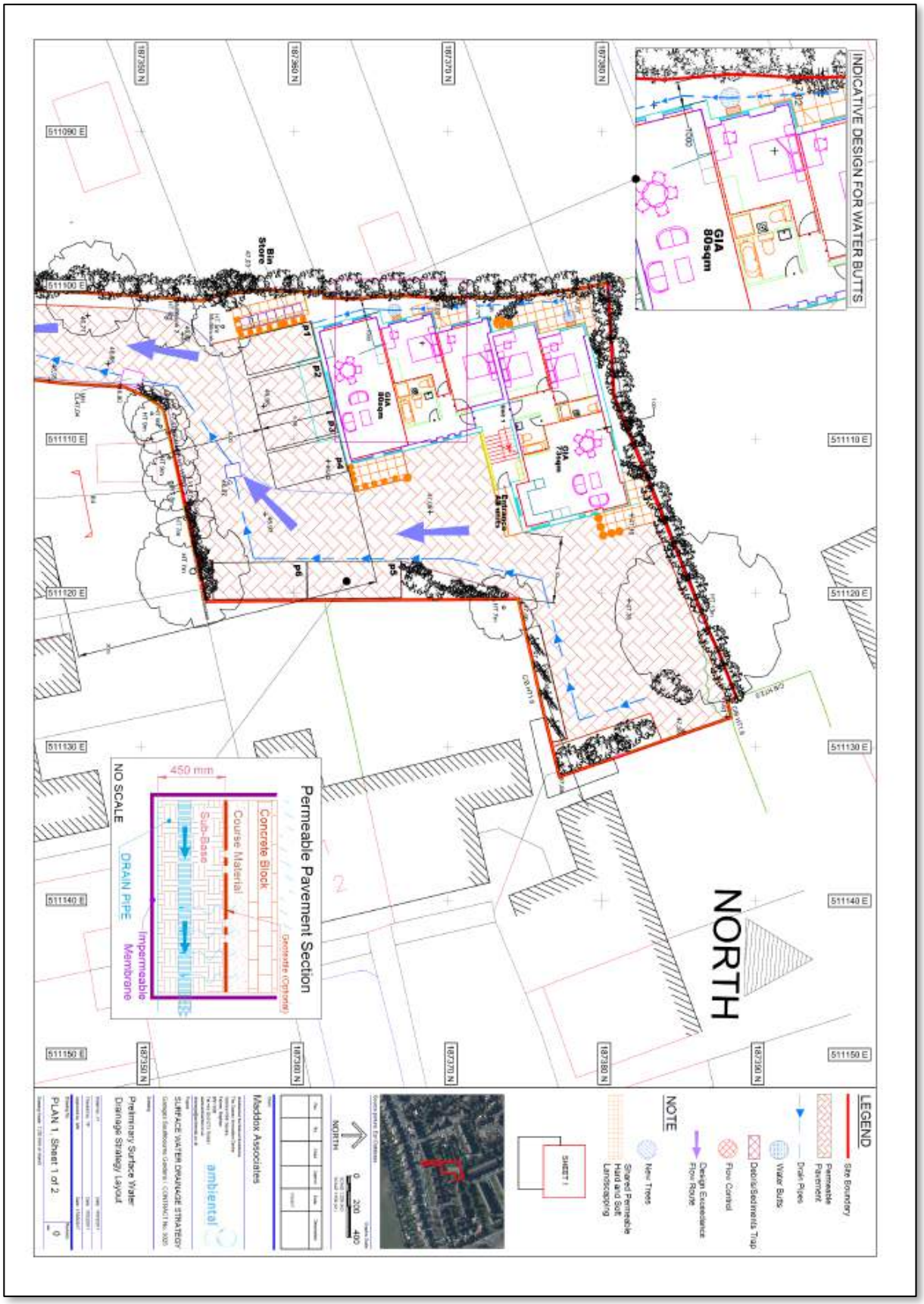

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2. Introduction

2.1 This Surface Water Drainage Strategy has been prepared by Ambiental Technical Solutions Ltd, in respect of a planning application for the development at the garages to the rear of Southbourne Gardens, Ruislip, Hillingdon, HA4 9SW (X = 511109; Y = 187368). Refer to Appendix 1, Plan 1 – Site Location, Plan 2 – Topographical Survey and an extract of Plan 1 on Figure 1 below.

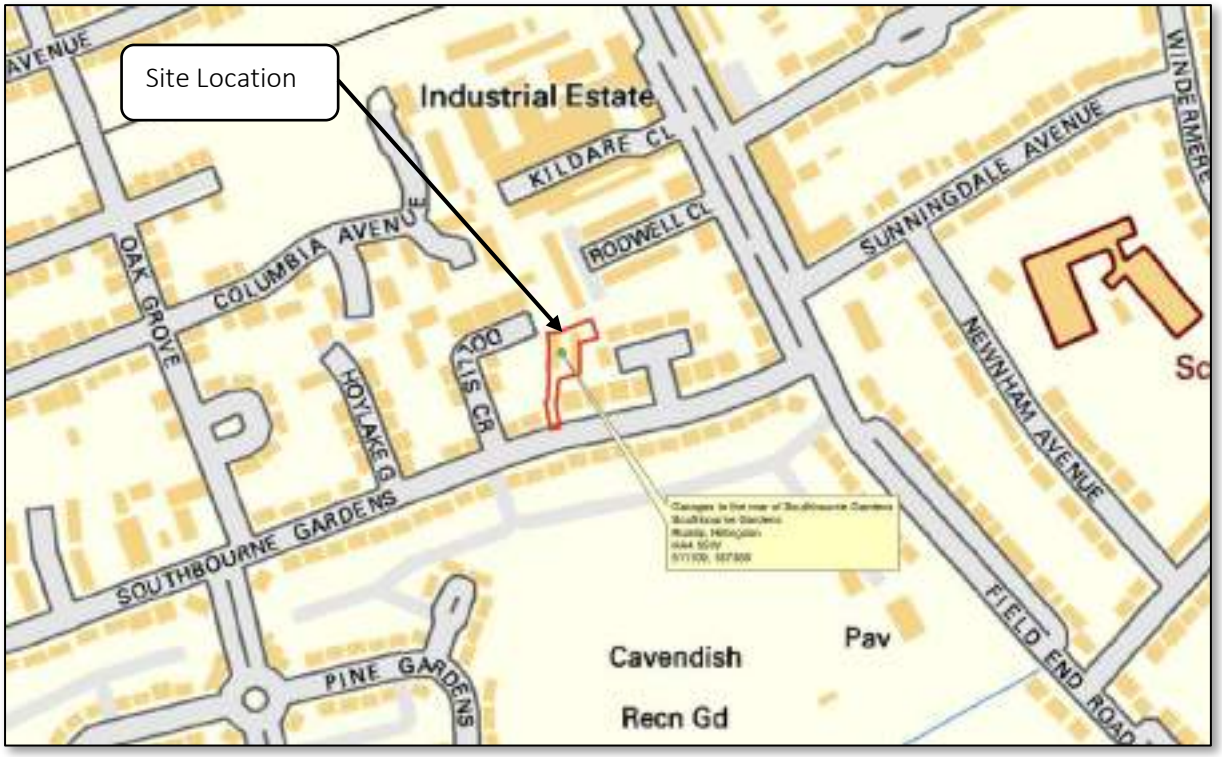

Figure 1 – Extract of Appendix 1, Plan 1 - Site Location (Source: OS-Street View). Site boundary shown in red.

Development Proposal

2.2 It is understood that the scheme is for the redevelopment of the site to include erection of a single, three storey accommodation block comprising of six residential units.

2.3 This study is based on the plans in Appendix 1 (refer to Plans 1 to 9. Plans 1 and 3 were made in-house, while the remaining plans were provided by the client, Maddox Associates).

Need for Study

2.4 The purpose of this assessment is to demonstrate that the development proposal outlined above can be satisfactorily accommodated without worsening flood risk for the area and without placing the development itself at risk of flooding, as per National guidance provided within the National Planning Policy Framework (NPPF).

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3. Development Description and Site Area

3.1 The site is located to the north-east of the London Borough of Hillingdon. Specifically, the existing site is formed by two roofed garages associated road access. The site is located to the rear of properties fronting Southbourne Gardens. The site is bounded by the rear gardens of dwellings to the north, east and west, while the Southbourne Gardens is to the south. Refer to Appendix 1, Plan 1 – Site Location, Plan 2 – Topographical Survey as well as the Figures 1 (above) and 2 (below).

Figure 2 - Aerial View of Development Site (Source: ESRI).

3.2 It is understood that the development is for the removal of the two existing garages to build new, three storey accommodation comprising six residential units, including car and pedestrian facilities. Refer to Appendix 1, Plans 4 to 9 and an extract of the Plan 4 on the Figure 3 overleaf.

3.3 As the existing site is already developed, it is considered **brownfield**.

3.4 The total area of the site is approximately 908m^2 (0.09 Ha) based on plans the provided by the client. The existing site is considered partly pervious (187m^2, approx. 0.02Ha), due to the existing green areas, thus there is an existing impervious area of 721m^2 (0.07 Ha). Following development, the pervious areas on site will be reduced to approximately 123m^2 (0.01Ha), while the impervious areas will be increased to approximately 785m^2 (approx. 0.08Ha).

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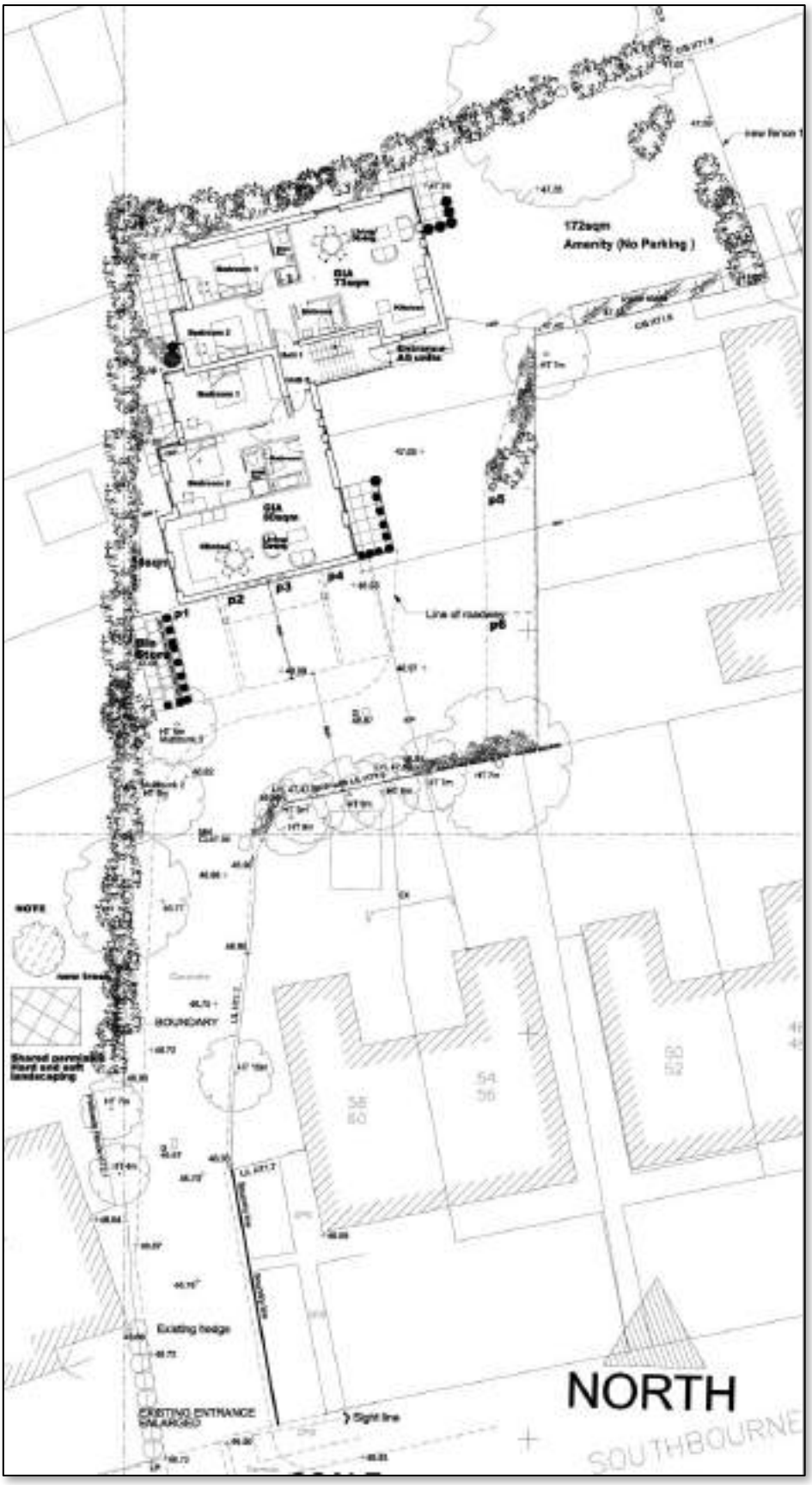

Figure 3 – Extract of the Appendix 1, Plan 4 – Proposed Block Plans

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3.5 According to the topographical survey provided by the client, the topography of the site ranges from 46.64mAOD[1] to 47.68mAOD. Hence the site can be considered to slope to the south with no likelihood of rapid runoff within the property boundary. Refer to Appendix 1, Plan 2 – Topographical Survey, Plan 3 – Existing Surface Water Flow Pathways and an extract of the Plan 3 on the Figure 4 below.

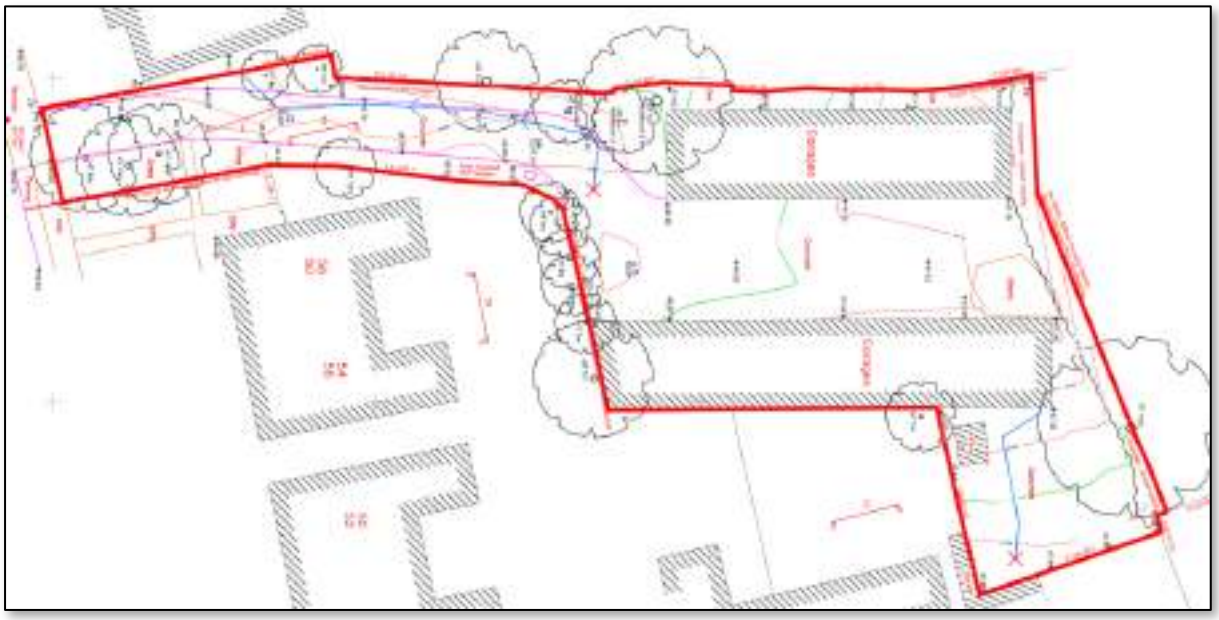

Figure 4 – Extract of Appendix 1, Plan 3 – Existing Surface Water Flow Pathways.

Existing Drainage Infrastructure

3.6 The existing site is currently developed, thus it is considered there is drainage infrastructure associated and, although this is confirmed by the topographical survey, this is not exhaustive and there are no details of the existing pipework. Refer to Appendix 1, Plan 2 – Topographical Survey of the Site and an extract of it on the Figure 5 below:

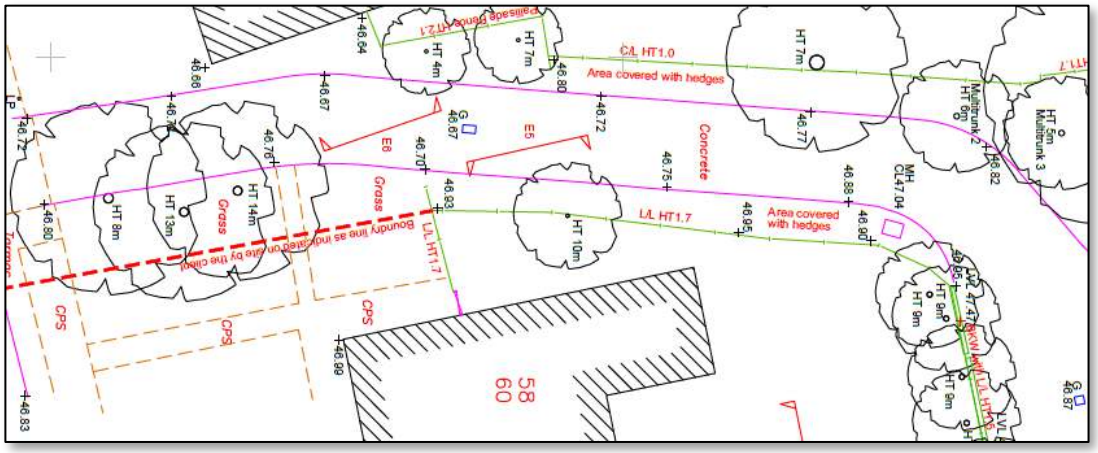

Figure 5 – Extract of the Appendix 1, Plan 2 – Topographical Survey

3.7 Although public sewer records were not provided by the client, **there is a potential opportunity of utilising either the public, or private, sewer network for surface water discharging purposes.**

[1] mAOD: meters Above Ordnance Datum.

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Existing Ground Conditions

3.8 The British Geological Survey (BGS) Map indicates that the bedrock underlying the site is the *Lambeth Group – clay, silt and sand*. It is a sedimentary bedrock formed approximately 56 to 66 million years ago in the Palaeogene Period. The local environment was previously dominated by swamps, estuaries and deltas, thus these rocks were formed in marginal coastal plains with lakes and swamps. (See an extract from the BGS Geology map in Appendix 2, Figure 1 – Bedrock Geology).

3.9 There are no records in relation to the Superficial Deposits in the BGS database. (See the extract from BGS Geology Map in Appendix 2, Figure 2 – Superficial Deposits).

3.10 The Soil Parental Material in the area taken from the UK Soil Observatory (UKSO) website is classified as 'Pre-quaternary Marine/Estuarine Sand and Silt' while the Soil Texture is loam to silty loam. See Appendix 2, Figure 3 – Soil Parental Material as well as the Appendix 2, Figure 4 – Soil Texture.

3.11 Standard values from the *CIRIA 753 'The SUDS Manual'* suggest the infiltration coefficient for loam soils is between 0.00036 m/h ($1x10^{-7}$ m/s) and 0.018 m/h ($5x10^{-6}$ m/s), while the range for silty loam soils is between 0.00036 m/h ($1x10^{-7}$ m/s) and 0.036 m/h ($1x10^{-5}$ m/s). Refer to Table 1 – Typical Infiltration Coefficients based on Soil Texture below. It is recommended that these values are checked through trial pit infiltration tests on site prior to the final detailed drainage design being carried out.

SOIL TYPE	Typical infiltration Coefficients (m/h)		
Poor Infiltration media			
Loam	0.00036	-	0.018
Silt Loam	0.00036	-	0.036

Table 1 – Typical Infiltration Coefficients based on Soil Texture

3.12 It is recommended that a groundwater level check be undertaken at the later detailed design stage in order to accurately identify the depth of the water table at the site.

3.13 Additionally, it is important to note that the infiltration devices should follow the guidance of the specialized literature, the *CIRIA 753 – 'The SuDS Manual'*, section 25.2.2:

> *"Groundwater levels should be investigated to ensure that the base of a proposed infiltration component is at least 1 m above the maximum anticipated groundwater level (taking account of seasonal variations in levels and any underlying trends)"*.

3.14 Thus, in compliance with the *CIRIA 753 – 'The SuDS Manual'*, if an infiltration device was proposed, the groundwater table must always be at least 1 m below of the bottom of the device. This measure could be flexible - to fix the bottom of the device just above the groundwater table, under the consent of the corresponding environmental regulator or drainage approval body.

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3.15 The site lies in within aquifers with significant intergranular flow and considered as a *Low Productive Aquifer* according to the BGS hydrogeological database (refer to Appendix 2, Figure 5 – Hydrogeology).

3.16 The EA's[2] Groundwater Source Protection Zone Map confirms that the site does not lie within a Source Protection Zone, and that it does lie within a Groundwater Vulnerability Zone classified as *Minor Aquifer High*. See Appendix 2, Figure 6 - Groundwater Source Protection Zones and Figure 7 – Groundwater Vulnerability Zones.

Nearby Watercourses and Drainage

3.17 In general terms, the runoff from the existing site flows to south of the site to the lowest point according to the topographical survey data provided by the client.

3.18 A watercourse, considered as a main river by the EA is located approximately 885m to south-east of the red line application boundary. See Figure 6 below.

3.19 **Thus, it is considered that there is no watercourse close enough to the site for discharging purposes.**

Figure 6 – Extract of EA Flood Map for Planning (Source: EA).

[2] EA: Environmental Agency

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4. Surface Water Drainage

4.1 In order to mitigate flood risk posed by the proposed development, adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk off site is not increased.

4.2 The existing site is already developed, being considered brownfield, and it is comprised of impervious surfaces areas; thus there is an existing drainage infrastructure which is confirmed by the Topographical Survey provided by the client. In accordance with the proposed development plans, the proposed development will increase the impermeable surface cover to the site by approximately 64m².

4.3 Based on the Policy 5.13 of the London Plan 2016:

"Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1. *Store rainwater for later use;*
2. *Use infiltration techniques, such as porous surfaces in non-clay 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.*

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation".

4.4 Therefore, the runoff arising from the redevelopment will need to be managed in accordance with sustainable drainage principles.

Infiltration Potential

4.5 The BGS database and the UK Soil Observatory records indicate the site is predominantly underlain by clayey soils which are unlikely to be suitable for infiltration drainage. Furthermore, the local Surface Water Management Plan, London Borough of Hillingdon, indicates that the area is unsuitable for infiltration drainage. See Appendix 2, Figure 8 – Infiltration SUDS Suitability Map.

4.6 Therefore it is proposed that surface water will be discharged post development via attenuation SuDS.

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Runoff rates

4.7 The specialised literature *CIRIA 753 'The SUDS Manual'* provides two approaches guidance for the rates of discharge in relation to the Long-Tem Storage:

- Approach A

  "Where there is extra volume generated by the development that has to be discharged (because there are no opportunities for it to be infiltrated and/or used on site), this volume should be released at a very low rate (eg < 2 l/s/ha or as agreed with the local drainage approving body and/or environmental regulator) and the 1:100 year greenfield allowable runoff rate reduced to take account of this extra discharge." (Kellagher, 2002).

- Approach B

  "An alternative approach to managing the extra runoff volumes from extreme events separately from the main drainage system is to release ***all runoff (above the 1 year event)*** *from the site at a maximum rate of 2 l/s/ha or Q_{BAR}, whichever is the higher value (or as agreed with the drainage approving body and/or environmental regulator). This avoids the need to undertake more detailed calculations and modelling."*

4.8 As Infiltration techniques are not viable, it is proposed to discharge all runoff due to any storm events above than 1 in 1 year event at a low rate such as Q_{BAR} or as agreed with the drainage approving body in compliance with the **Approach B** above.

4.9 Greenfield runoff rates have been calculated using the *Institute of Hydrology Report 124* (Marshall and Bayliss, 1994), as recommended in the CIRIA 753 'The SUDS Manual' (See calculations in Appendix 3, Table 1 – Greenfield Runoff Rates Calculation Summary).

4.10 The Greenfield runoff rates for the several storm duration for various return periods have been calculated based on the following equation:

$$QBAR_{rural} = 0.00108 * AREA^{0.89} * SAAR^{1.179} * SOIL^{2.17}$$

Where,

$Q_{BAR,rural}$: Mean Annual Flood (m^3/s).

AREA: Catchment Area (km^2).

SAAR: Standard Average Annual Rainfall for the 1941 to 1970 (mm).

SOIL: Soil Index of the catchment from Wallingford Procedure Volume 3.

Equation 1 – IH 124 Mean Annual flood flow Rate Equation.

4.11 Preliminary calculations based on Equation 1 show that the *Greenfield Runoff Rate* ($Q_{BAR,rural}$) from 50Ha is 226.93l/s. According to the size area positively drained (0.09Ha), **the *Greenfield Runoff Rate* from the area of the site is 0.41l/s**. Other results properly factored for each return period and area of the site are shown in Appendix 3, Table 1 – Greenfield Runoff Rates Calculation Summary.

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4.12 Following the guidance of the Sustainable Design and Construction SPG, Mayor of London:

"(…)

3.4.8 Most developments referred to the Mayor have been able to achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times. This is the minimum expectation from development proposals.

*3.4.9 There may be situations where it is not appropriate to discharge at greenfield runoff rates. These include, for example, sites where the calculated greenfield runoff rate is extremely low and the final outfall of a piped system required to achieve this would be prone to blockage. An appropriate minimum discharge rate would be **5 litres** per second per outfall.*

*3.4.10 All developments on greenfield sites must maintain greenfield runoff rates. **On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate**. The only exceptions to this, where greater discharge rates may be acceptable, are where a pumped discharge would be required to meet the standards or where surface water drainage is to tidal waters and therefore would be able to discharge at unrestricted rates provided unacceptable scour would not result.*

(…)".

4.13 It should be noted that although a rate of 5l/s has been historically considered as a limiting discharge, when Q_{BAR} was lower than that (this is due to the fact that most of devices would require an outlet orifice size smaller than 50mm which would increase the susceptibility of blockage and failure); currently there are flow control devices that can be designed up to a limiting discharge rate of 1.0l/s with a 50mm opening.

4.14 Therefore, taking into consideration the discharge restrictions exposed above, and according to the guidance of the Sustainable Design and Construction SPG, Mayor of London, if the QBar Greenfield Runoff Rate is 0.41l/s, a maximum limiting discharge of 3 x QBar could be proposed, 1.23l/s. This rate is also lower than the 50% of the existing 1 in 100 year pre-development runoff rate as required by the Sustainable Design and Construction SPG of the Mayor of London.

4.15 **Hence, a limiting discharge of 1.2l/s is proposed as the design runoff rate**. See Table 2 – Surface Water Discharge Rates Summary below:

SURFACE WATER DISCHARGE RATES SUMMARY						
	Approximate Impermeable Area (m²)	Discharge Rates (l/s)				
		Q_{BAR}	1 year	20 years	30 years	100 years
Greenfield Site	0	**0.41**	0.35	-	1.01	1.31
Existing Site (Using Microdrainage)	721	-	7.7	9.5	10.7	10.8
Reduction of 50% for the Existing Site	721	-	3.85	4.75	5.35	5.4
Limiting Discharge for Proposed Site	785	-	1.23	-	1.23	1.23
Designed Discharge for Proposed Site (from calculations in Appendix 3)	**863 (Urban Creep Factor applied)**	**-**	**1.0**	**-**	**1.2**	**1.2**

Table 2 – Surface Water Discharge Rates Summary

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4.16 It can be seen from the Table 2 that the proposed limiting discharge rates are lower than the existing runoff rates for the 1 in 1, 1 in 30, and 1 in 100 years rainfall events, reducing the outflow capacity of the existing drainage infrastructure network within the site and improving the existing discharge conditions.

Interception Storage

4.17 Preliminary calculations have been carried out for a typical rainfall depth of 5 mm/m^2 to store the volume owing to these very frequent storms.

4.18 Urban Creep Factor (UCF) is defined as any increase in the impervious area that is drained to an existing drainage system without planning permission being required, such as the construction of patios, conservatories, small extensions, etc. Hence, an increase in paved surface area of 10% is often suggested by the *CIRIA 753 'The SUDS Manual'*. Also, a typical *Runoff Percentage* of 80% have been taken into account.

4.19 **Based on the size of the whole area of the site, the UCF and the Runoff Percentage, the Interception Storage is 3.45m^3.**

Long Term Storage

4.20 **Long-Term Storage is not taken into account as defined by *Approach B* in Paragraph 4.7.**

Attenuation Storage

4.21 Attenuation storage is needed to temporarily store water during periods when the runoff rates from the development site exceed the allowable discharge rates from the site.

4.22 Rainfall depths for the 1 in 100 years Return Period plus 40% of climate change were produced using the *Microdrainage* software in order to estimate the largest volume, *critical storm*, for typical storm durations up to and including 48 hours for the proposed site limiting the discharge rate up to a rate of 1.23l/s. In addition to this, the Urban Creep Factor, 10%, is applied for the impervious surfaces in the Site. Refer to summary calculations in Appendix 3, Calculations, Summary of Results for Proposed SuDS – Permeable Pavement.

4.23 Thus, it meets with the minimum standards required by the DEFRA - Non-statutory technical standards for sustainable drainage systems (March 2015) to avoid the flood risk within the development in a 1 in 100 year rainfall event.

4.24 In terms of storage, for a 100 years storm event with an allowance for climate change **therefore the Attenuation Storage Volume required is 44.6m^3**. See summary calculations in Appendix 3, Calculations, Summary of Results for Proposed SuDS – Permeable Pavement.

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Storage Volumes

4.25 Preliminary calculations indicate that approximately 44.6m³ of storage will be required to attenuate all runoff above the 1:1 year storm events up to a 1 in 100 years storm event with a 40% climate change allowance and including a 10% of Urban Creep Factor. Approximately 3.5m³ of storage are required for the day-to-day rainfall as Interception Volume. Long-Term Storage Volume (6 hours, 100 year Return Period event) is not taken into account.

4.26 **Thus a Total Storage of 48.1m³ is required to be managed through SuDS techniques.**

5. SuDS Assessment

5.1 In accordance with a SuDS management train approach, the use of various SuDS measures to reduce and control surface water flows have been considered in details for the development. Based on the hierarchy line of discharge provided by the Policy 5.13 of the London Plan 2016:

Drainage Hierarchy			
		Suitability	Comment
1.	Store rainwater for later use.	✓	The use of rainwater for a potential non-potable use such as gardening might be suitable.
2.	Use infiltration techniques, such as porous surfaces in non-clay areas.	×	Due to the geology at the site, infiltration is considered unsuitable.
3.	Attenuate rainwater in ponds or open water features for gradual release.	×	There is no ponds or open water features within the site. Besides that, space and topographical constraints would make too complicate to incorporate this type of storage water to the development.
4.	Attenuate rainwater by storing in tanks or sealed water features for gradual release.	✓	Due to the proposed layout, sealed water features for gradual release is considered suitable.
5.	Discharge rainwater direct to a watercourse.	×	There is no watercourses close enough to the site.
6.	Discharge rainwater to a surface water sewer/drain.	✓	There is an existing surface water drainage infrastructure within the site, thus it is taking into consideration.
7.	Discharge rainwater to the combined sewer.	-	Not taken into account.

Table 3 –Drainage Hierarchy

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5.2 At this stage the practicality and viability of certain SuDS options have been ruled out on the basis of ground conditions and constraints presented by the site layout:

Suitability of SuDS Components		
SuDS Component	**Description**	**Suitability**
Infiltrating SuDS	Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The suitability and infiltration rate depends on the permeability of the surrounding soils	×
Permeable Pavement	Pervious surfaces can be used in combination with aggregate sub-base and/or geocellular/modular storage to attenuate and/or infiltrate runoff from surrounding surfaces and roofs. Liners can be used where ground conditions are not suitable for infiltration	✓
Green Roofs	Green Roofs provide areas of visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. They are generally more costly to install and maintain than conventional roofs but can provide many long-term benefits and reduce the on-site storage volumes	×
Rainwater Harvesting	Rainwater Harvesting is the collection of rainwater runoff for use. It can be collected form roofs or other impermeable area, stored, treated (where required) and then used as a supply of water for domestic, commercial and industrial properties. Rainwater butts are likely to be installed in accordance with best practice and harvesting could be utilised on this development but would be subject to detailed design. Thus, water butts are considered **suitable**.	✓
Swales	Swales are designed to convey, treat and attenuate surface water runoff and provide aesthetic and biodiversity benefits. They can replace conventional pipework as a means of conveying runoff, however space constraints of some sites can make it difficult incorporating them into the design.	×
Rills and Channels	This SuDS technique is an excellent choice as part of the SuDS train management to convey the runoff water into further SuDS features due to its appealing visual features in urban landscapes, amenity value and effectiveness to treat pollution in water, acting as pre-treatment to remove silt. As such they are considered **suitable**.	✓
Bioretention Systems	Bioretention systems can reduce runoff rates and volumes and treat pollution through the use of engineer soils and vegetation. They are particularly effective in delivering interception, but can also be an attractive landscape feature whilst providing habitat and biodiversity. Liners should be used if ground conditions are not suitable for infiltration.	×
Retention Ponds and Wetlands	Ponds and Wetlands are features with a permanent pool of water that provide both attenuation and treatment of surface water runoff. They enhance treatment processes and have great amenity and biodiversity benefits. Often a flow control system at the outfall controls the rates of discharge for a range of water levels during storm events. Nevertheless, they are dismissed as they are recommended to manage high volumes runoff due to large developments such as a neighbourhood.	×
Detention Basins	Detention Basins are landscaped depressions that are usually dry except during and immediately following storm events, and can be used as a recreational or other amenity facility. They generally appropriate to manage high volumes of surface water from larger sites such as a neighbourhood.	×
Geocellular Systems	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. The inherent flexibility in size and shape means they can be tailored to suit the specific characteristics and requirements of any site.	✓
Proprietary Treatment Systems	Proprietary treatment systems are manufactured products that remove specific pollutants from surface water runoff. They are especially useful where site constraints preclude the use of other methods and can be useful in reducing the maintenance requirements of downstream SuDS.	✓
Filter Drains and Filter Strips	Filter drains are shallow trenches filled with stone, gravel that cerate temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff. Filter strips are uniformly graded and gently sloping strips of grass or dense vegetation, designed to treat runoff from adjacent impermeable areas by promoting sedimentation, filtration and infiltration	×

Table 4 – Suitability of SuDS Components

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5.3 As such, several SuDS components are deemed appropriate. It is suggested to use a SuDS train management composed by **Water Butts** and a **lined Permeable Pavement** with No Infiltration (Type C). Rills/Channels could be used to convey water runoff from the hardstanding areas as long as the gradient and slope is adequate. A **throttle device** such as a hydrobrake should be set up to control the flow rates up to a maximum of 1.2l/s. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

5.4 Should permeable pavement be proposed with root protection areas these areas may be required to be constructed in 'no-dig' construction and with an un-lined permeable sub grade.

5.5 The combined action of the proposed SuDS train will be able to manage the arising runoff volume from hardstanding areas and roofs due to the day-to-day storms, Interception Volume, as well as the Attenuation Volume, being progressively stored and gradually discharged, and also, providing enough water quality treatment.

5.6 It is proposed to install Water Butts to collect water runoff due to the day-to-day storms (Interception Volume) from the roof of the proposed building. See conceptual design of this SuDS technique on Figure 7.

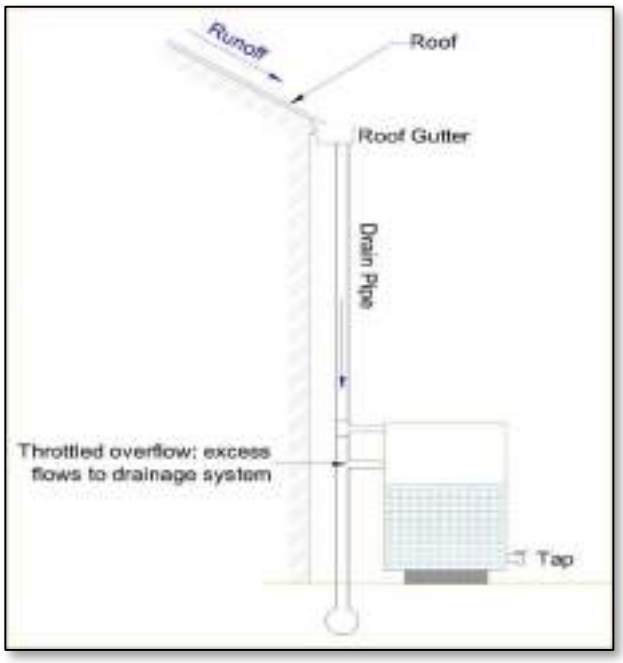

Figure 7 – Conceptual Design of the Components of Water Butts.

5.7 The proposed Permeable Paving will be Type C (NO infiltration), with Geotextile to retain pollutants. It would be formed by three layers:

- Permeable Concrete blocks.
- Laying Course Material.
- Geotextile filter.
- Sub-Base: Clean Stone (Depth: 450 mm).
- Impermeable membrane.

Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layouts.

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5.8 Throttle devices such as a Crown Vortex Valves and/or Hydrobrakes must be set up to control the limiting discharge up to a maximum rate of 1.23l/s, based on 3xQ_{BAR} greenfield runoff rate (as discussed in section 4.0) before being discharged to the public sewer network. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

5.9 Guidance about proper use, installation and maintenance of any proprietary system must be provided by the supplier and incorporated into the site proposals at detailed design stage.

6. Drainage Strategy

6.1 Following the hierarchy line provided by the Policy 5.13 of the London Plan 2016, it is proposed to store rainwater for later use, while the excess of water runoff should be stored to be gradually discharged to the public sewer network.

6.2 The proposed storm water management regime for the site is to store runoff in Permeable Paving located under the car access/facilities. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 &2.

Interception Volume

6.3 It is proposed to contain rainwater from the roof due to the day-to-day storms (Interception Volume) through the proposed Water Butts to be utilised for non-potable purposes such as gardening. The exceedance of runoff from the Water Butts would be conveyed to the sub-base of the Permeable Paving to be properly stored and gradually discharged. Debris traps should be installed on the connection to the sub-base of the Permeable Paving, to avoid any blockage. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

6.4 Water runoff from hardstanding surfaces for pedestrian facilities purposes such as pedestrian and car facilities, etc. would be conveyed to the proposed Permeable Paving through appropriate landscaping and/or Rills/Channels.

Attenuation Volume

6.5 Surface water runoff due to storm events above 1 in 1 year return period and up to a 1 in 100 + 40% climate change allowance would be stored in the sub-base of the Permeable Paving to be appropriate and gradually released up to a maximum rate of 1.2l/s to the existing storm drainage network.

6.6 The plan area of the proposed Permeable Pavement is approximately 495 m^2. Preliminary calculations show that the storage capacity of a typical Permeable Pavement (porosity, n=0.3, and depth, d=450mm) is approximately 67m^3 which is higher than the total required volume, approximately 48.1m^3.

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6.7 A throttle device such as a Hydrobrake at the Permeable Pavement drainage outfall will control the discharge up to a maximum rate of 1.2 l/s before the runoff is discharged to public sewer network. Refer to Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

6.8 In the case of a rainfall event that exceeds the storage capacity of these SuDS techniques, overland conveyance routes should be established that direct water away from property to landscaped areas or off site. Design of external ground levels should be undertaken at detailed design stage to finalise these routes but some indicative flow paths have been indicated on the outline strategy drawings. Additionally floor levels of the proposed development should be raised 300mm to reduce potential impact from overland flows. See Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy, Sheets 1 & 2.

6.9 It may be necessary to update or alter the drainage strategy at detailed design stage following confirmation of site constraints, or alterations to the overall layout. Calculations for, and the design of the SuDS devices, should be reviewed at detailed design stage to ensure a robust drainage strategy is maintained.

Water Quality

6.10 Adequate treatment must be delivered to the water runoff to remove pollutants through SuDS devices which are able to provide pollution mitigation. Pollution Hazards and the SuDS Mitigation have been indexed in the specialized literature *CIRIA 753 'The SUDS Manual'*. This is determined by the following restriction:

$$Total\ SuDS\ Mitigation\ Index\ \geq Pollution\ Hazard\ Index$$

6.11 The Pollution Hazard Indices are summarized in Table 5 – Summary of Pollution Hazard Indices for different Land Use below:

POLLUTION HAZARD INDICES FOR DIFFERENT LAND USE CLASSIFICATIONS				
LAND USE	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4

Table 5 – Summary of Pollution Hazard Indices for different Land Use.

6.12 Runoff from roof areas is considered to be uncontaminated, being properly treated by Sediment Traps.

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6.13 The Mitigation Indices of the proposed SuDS techniques are summarized in the Table 6 - Indicative SuDS Mitigation Indices below:

INDICATIVE SuDS MITIGATION INDICES FOR DISCHARGES TO SURFACE WATER			
SuDS Component	Total suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7

Table 6 – Indicative SuDS Mitigation Indices

6.14 Table 7 – Pollution Treatment below, summarizes the water treatment:

POLLUTION HAZARD TREATMENT					
LAND USE	Treatment	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydrocarbons
Roofs	Permeable Pavement	Very Low	0.7 > 0.2	0.6 > 0.2	0.7 > 0.05
Car Facilities / Pedestrian Accesses	Permeable Pavement	Low	0.7 > 0.5	0.6 > 0.4	0.7 > 0.4

Table 7 - Pollution Treatment

6.15 Thus, the water treatment provided by this SuDS train is enough to remove the pollutants.

Design Exceedance

6.16 In the event of drainage system failure under extreme rainfall events or blockage, flooding may occur within the site. In the event of the drainage system failure, the runoff flow will be dictated as per the existing situation along the driveway access to the site. Proposed external levels should be designed in accordance with this conveyance route.

6.17 It is advised that the finished floor level of the proposed building should be 150mm above surrounding finished ground levels to mitigate against any potential surface water flows. See plans on Appendix 4, Plan 1 - Preliminary Surface Water Drainage Strategy Layout, Sheets 1 & 2.

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Adoption and Maintenance

6.18 All onsite SuDS and drainage systems will be privately maintained. A long term maintenance regime should be agreed with the site owners before adoption. In addition to a long term maintenance regime it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction.

Proposed Schedule of Maintenance for Below Ground Drainage				
Item	Visual Inspection	Cleanse / De-sludge	CCTV Survey	Comments
Surface Water Drainage System (pipework, chambers etc.)	5 years	10 years	10 years	Cleansing to be carried as necessary
Gullies/Channels	1 year	1 year	N/A	Cleansing to be carried as necessary
Permeable Block Paving	1 year	'Swept' clean of debris every 2 years.	N/A	Lift blocks and remove sand bedding and replace and re-bed paving – refer to individual manufacturers recommendations.
Catchpits	1 year	-	N/A	Cleansing to be carried as necessary.

Table 8 – Proposed Schedule of Maintenance for Below Ground Drainage.

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7. Conclusions

7.1 This study has been undertaken in accordance with the principles set out in NPPF. We can conclude that providing the development adheres to the conditions advised in the conclusions of this report, the said development proposals can be accommodated without increasing flood risk within the locality in accordance with objectives set by Central Government and the EA.

7.2 The strategy for drainage of this site is to discharge to the existing surface water sewer within the Site utilising Water Butts and Permeable Pavement with managed offsite flows controlled by hydrobrake, or similar flow control, as necessary.

7.3 Initial calculations indicate a storage requirement of approximately 48.1m^3, being properly managed by the proposed SuDS train. This can be accommodated in the sub-base of the Permeable Paving.

7.4 The Treatment of the Permeable Paving is suitable to offer acceptable contamination treatment to runoff from parking bays and trafficked areas, prior to being discharged to local sewer network

7.5 It is advised that the finished floor level of the proposed building should be 150mm above surrounding finished ground levels to mitigate against any potential surface water flows. External levels should be designed to direct potential overland flows away from proposed development.

7.6 The findings and recommendations of this report are for the use of the client who commissioned the assessment, and no responsibility or liability can be accepted for the use of the report or its findings by any other person or for any other purpose.

Dr. J. B. Butler
B.Sc., M.Phil., PhD.
Ambiental Environmental Assessment Ltd. March 2017

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Appendix 1 – Plans

- *Plan 1 – Site Location*
- *Plan 2 – Topographical Survey*
- *Plan 3 – Existing Surface Water Flow Pathways*
- *Plan 4 – Proposed Block Plans*
- *Plan 5 – Proposed Ground Floor Plans*
- *Plan 6 – Proposed First Floor Plans*
- *Plan 7 – South and East Elevations*
- *Plan 8 – North and West Elevations*
- *Plan 9 – South and North Site Elevations*

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Appendix 1, Plan 1 – Site Location

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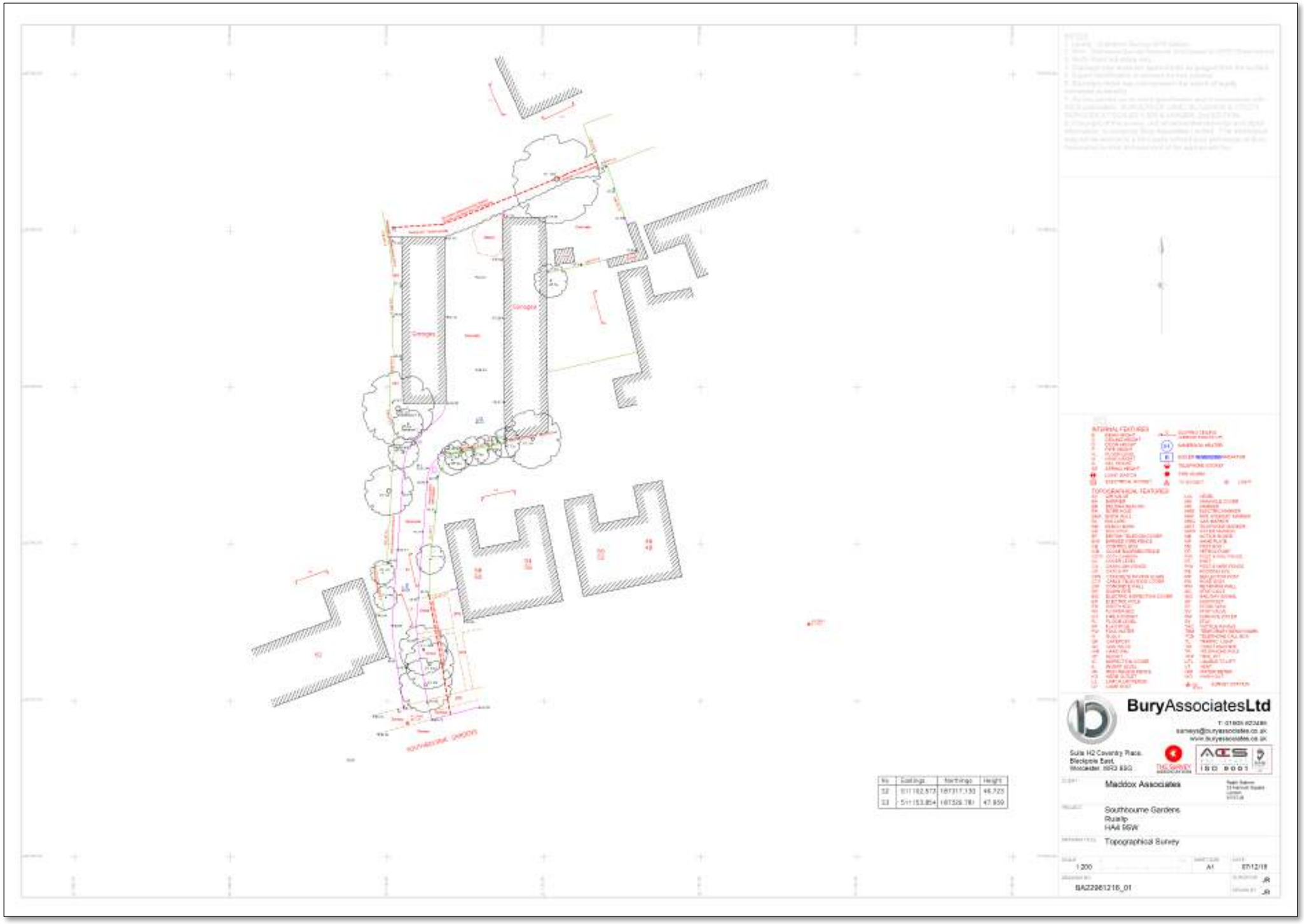

Appendix 1, Plan 2 – Topographical Survey

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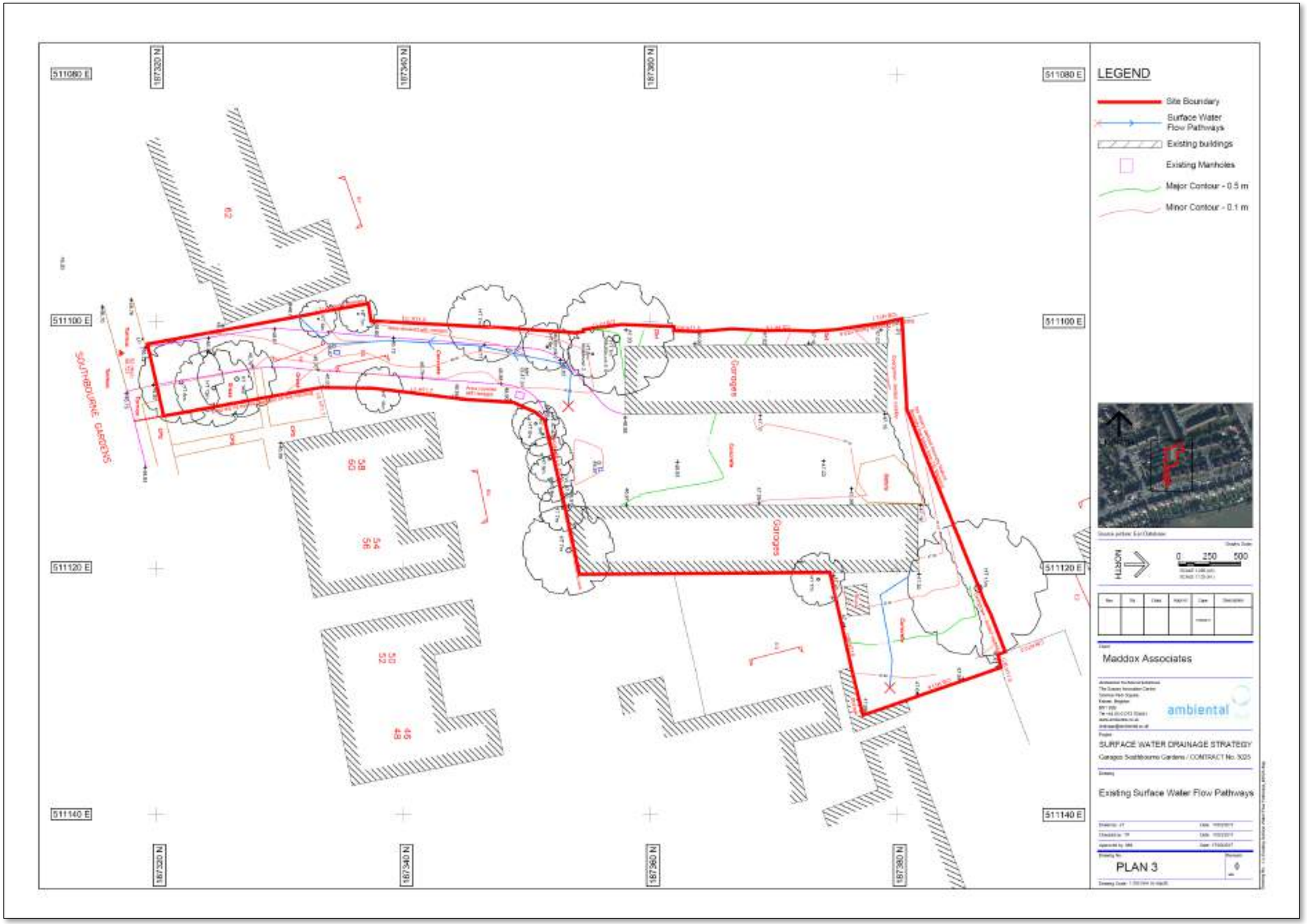

Appendix 1, Plan 3 – Existing Surface Water Flow Pathways

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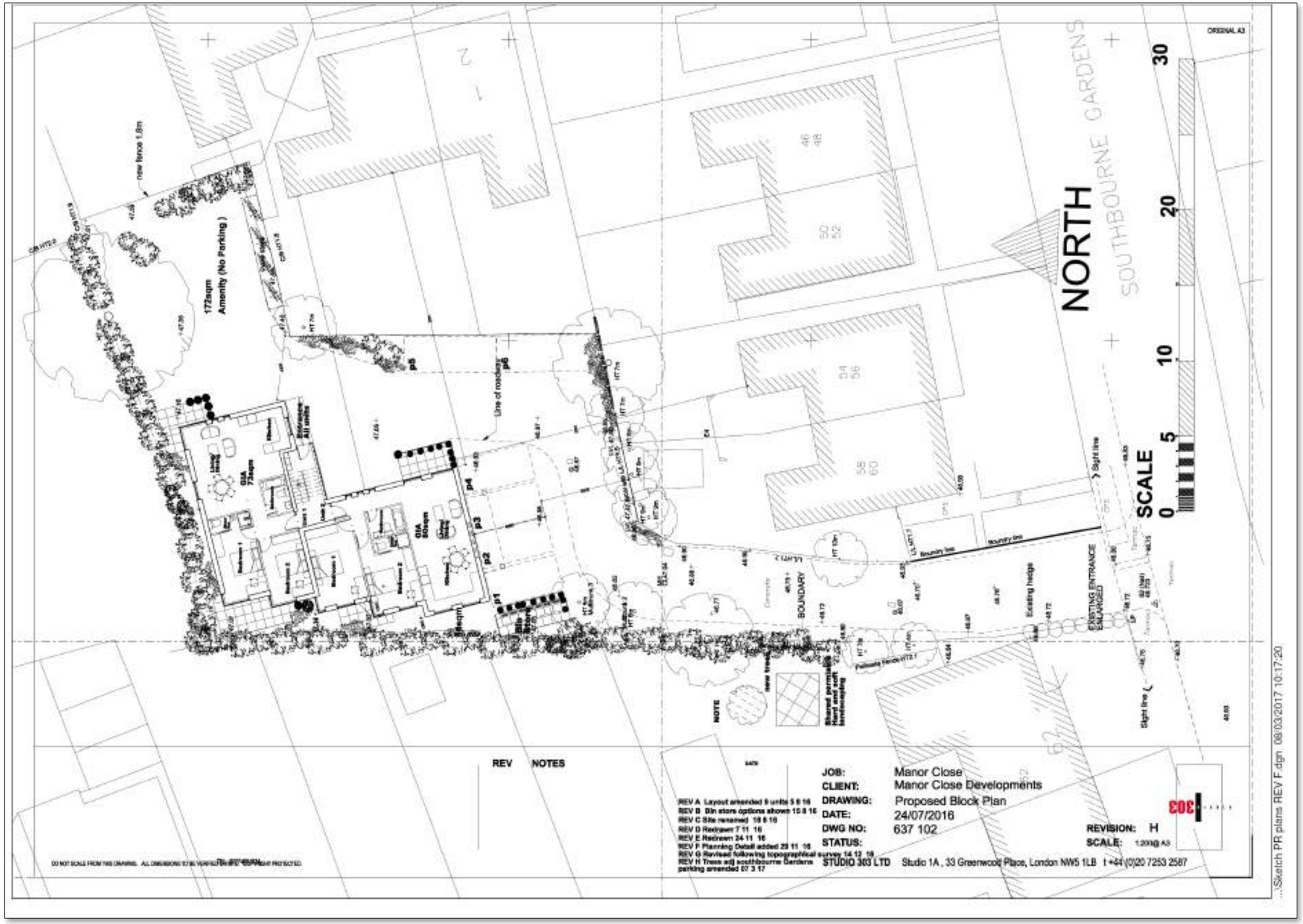

Appendix 1, Plan 4 – Proposed Block Plan

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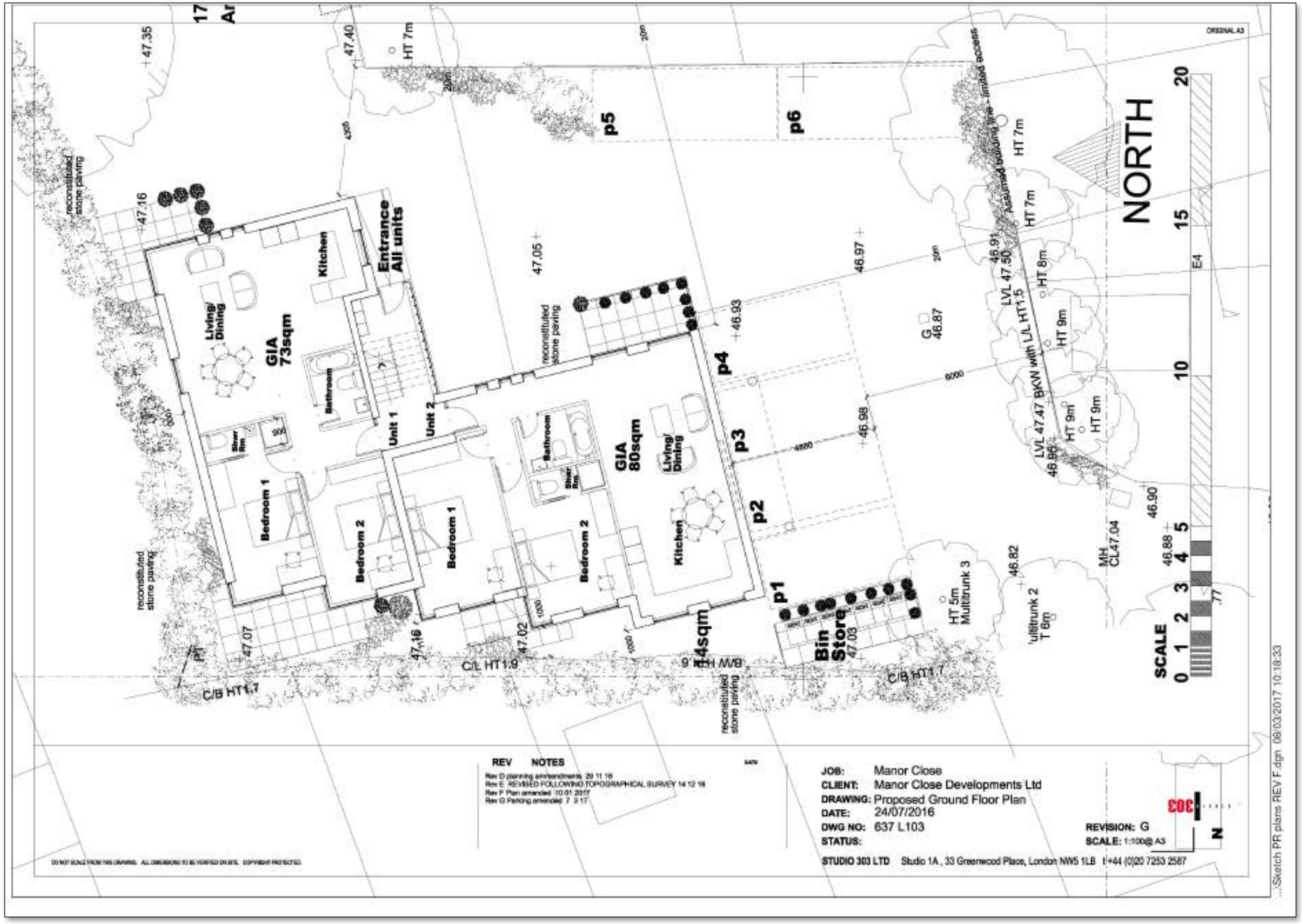

Appendix 1, Plan 5 – Proposed Ground Floor Plan

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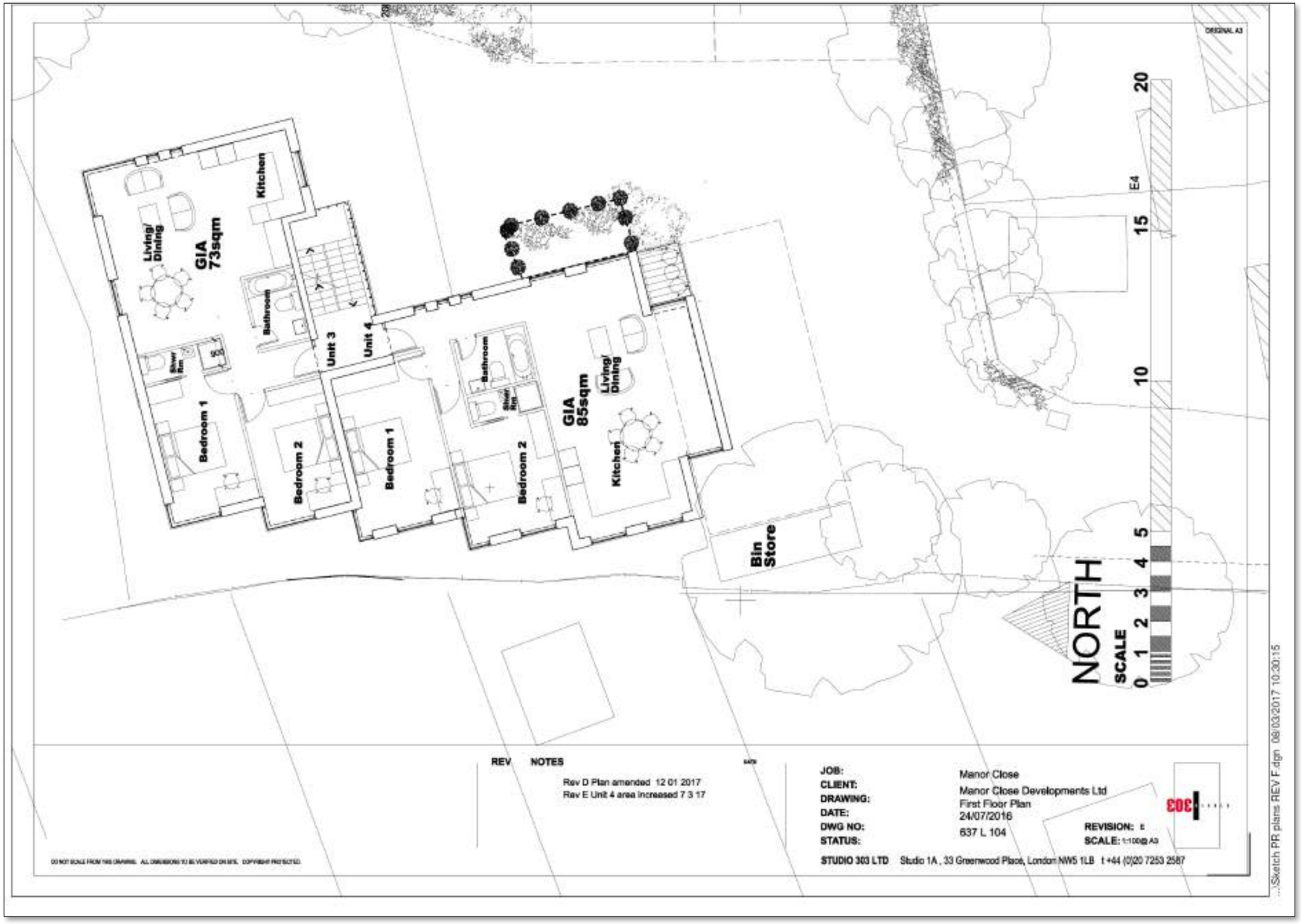

Appendix 1, Plan 6 – Proposed First Floor Plan

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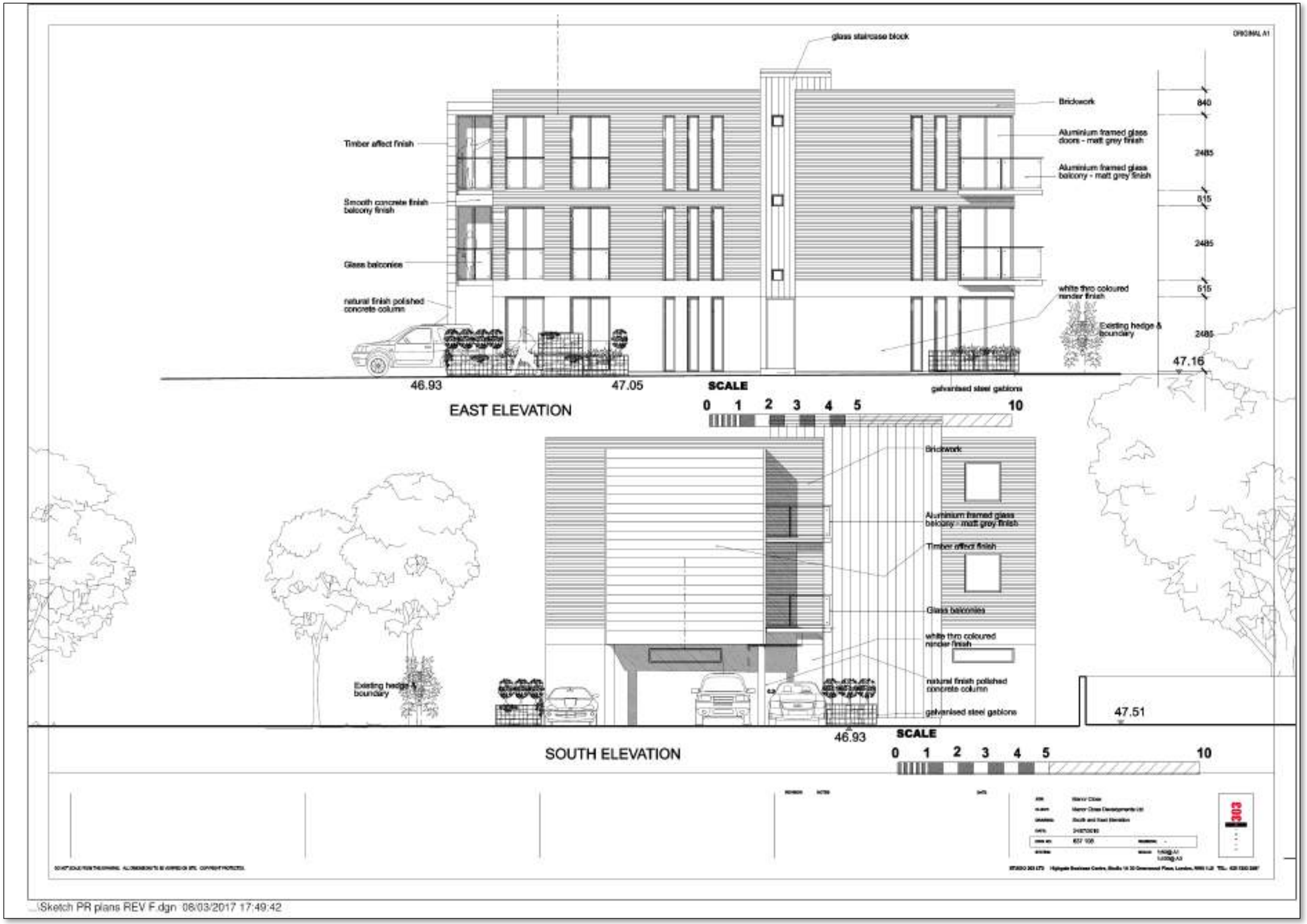

Appendix 1, Plan 7 – South and East Elevation

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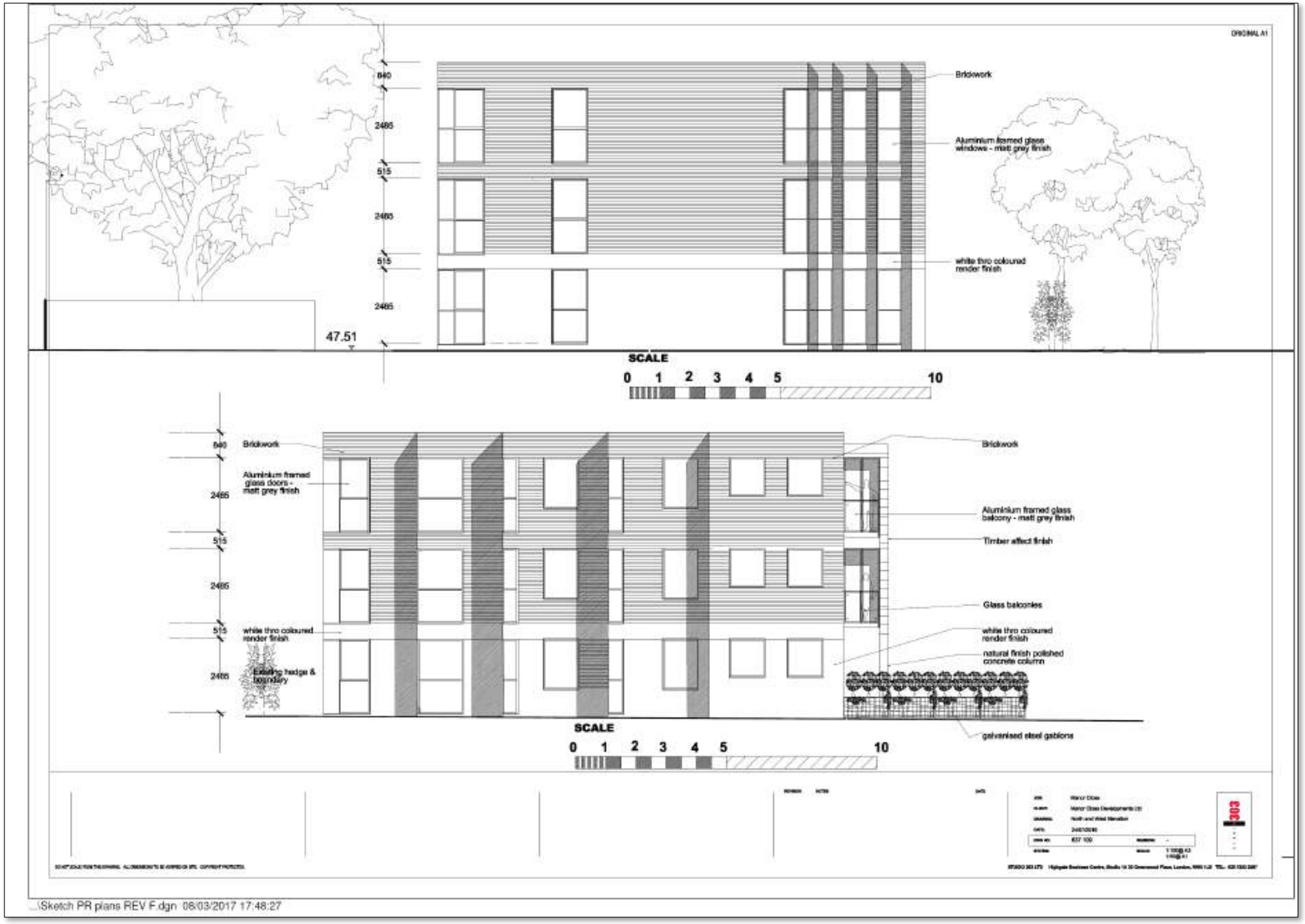

Appendix 1, Plan 8 – North and West Elevation

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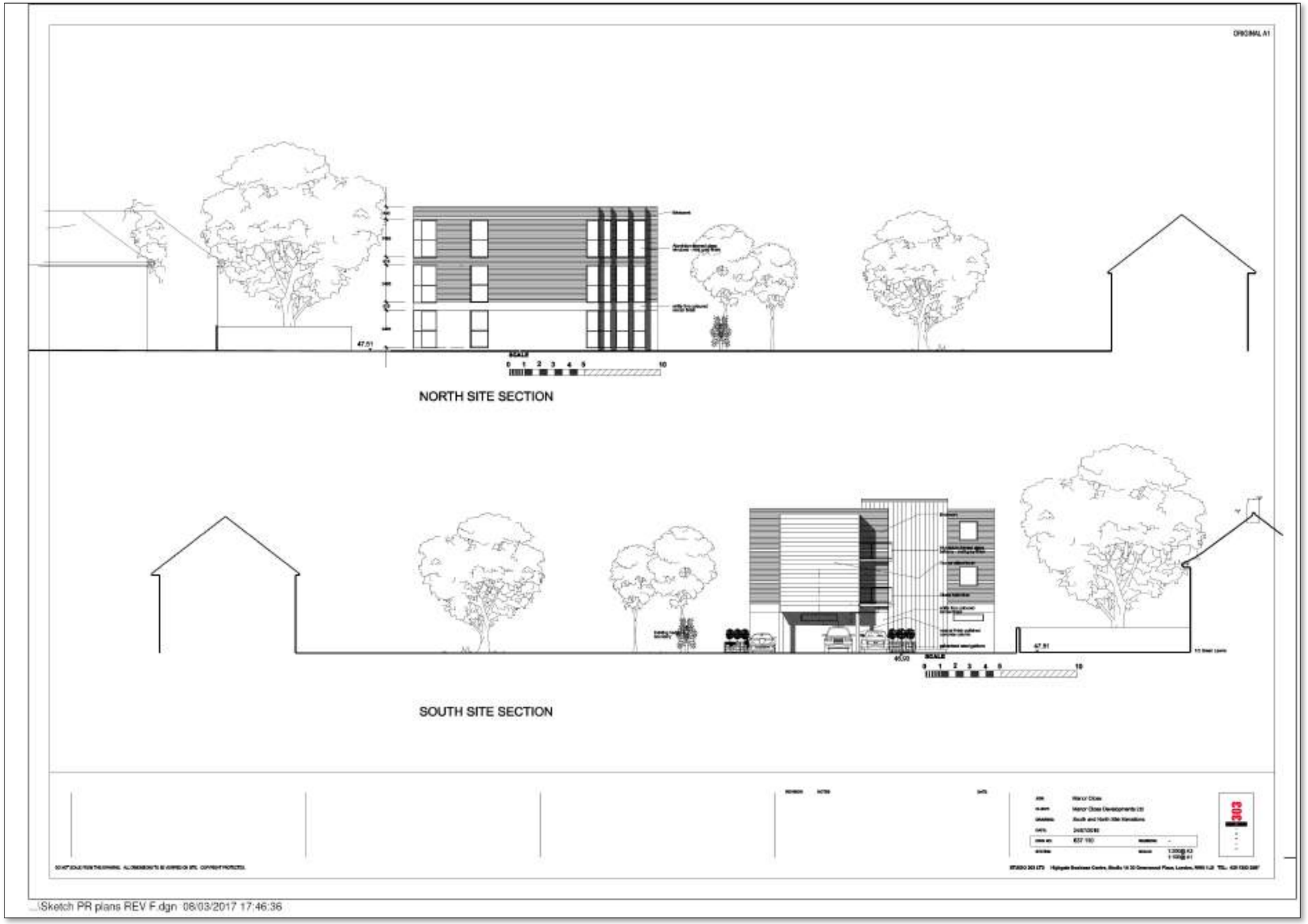

Appendix 1, Plan 9 – South and North Site Elevations

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Appendix 2 – Site Geology Maps

- *Figure 1 – Bedrock Geology*
- *Figure 2 – Superficial Deposits*
- *Figure 3 – Soil Parental Material*
- *Figure 4 – Soil Texture*
- *Figure 5 – Hydrogeology*
- *Figure 6 - Groundwater Source Protection Zones*
- *Figure 7 – Groundwater Vulnerability Zones*
- *Figure 8 – Infiltration SUDS Suitability Map*

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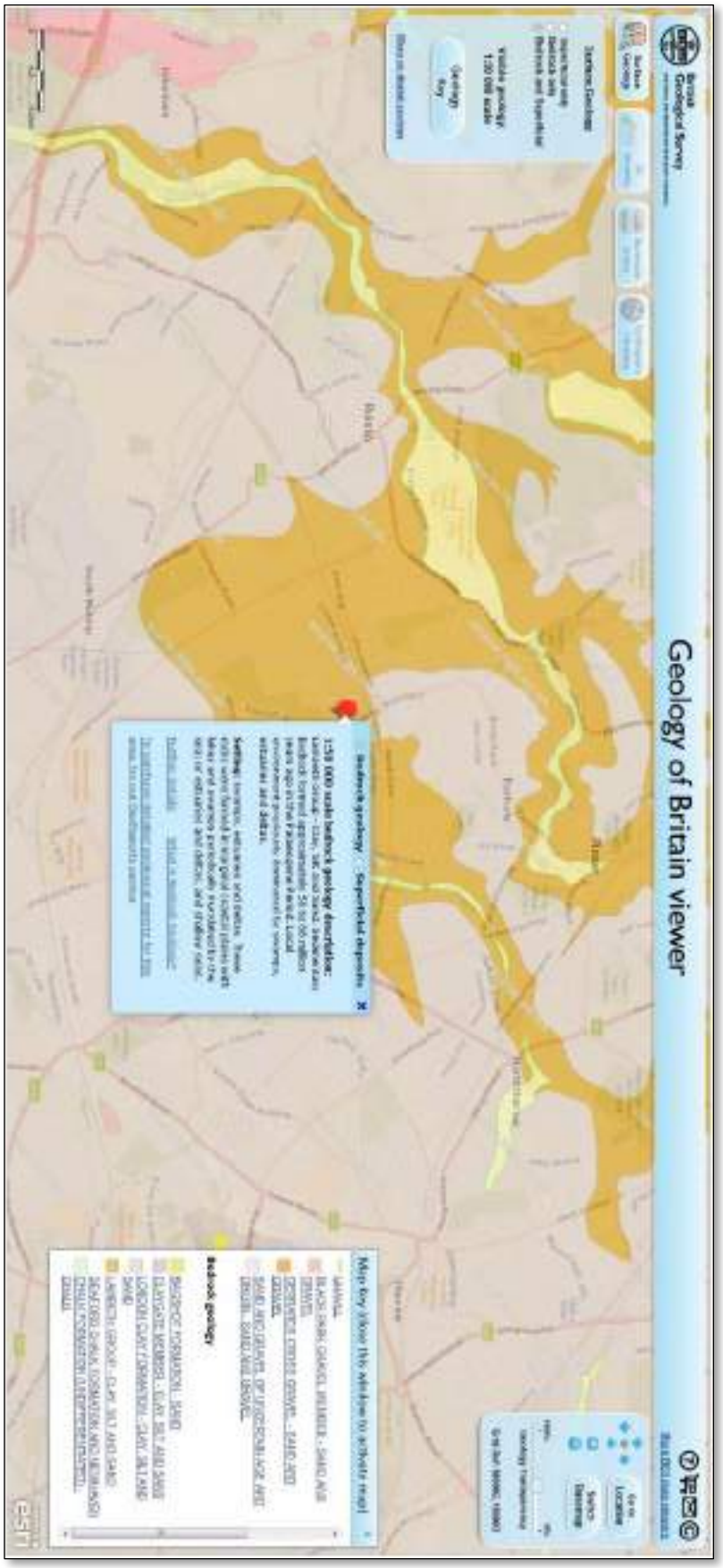

Appendix 2, Figure 1 - Bedrock Geology

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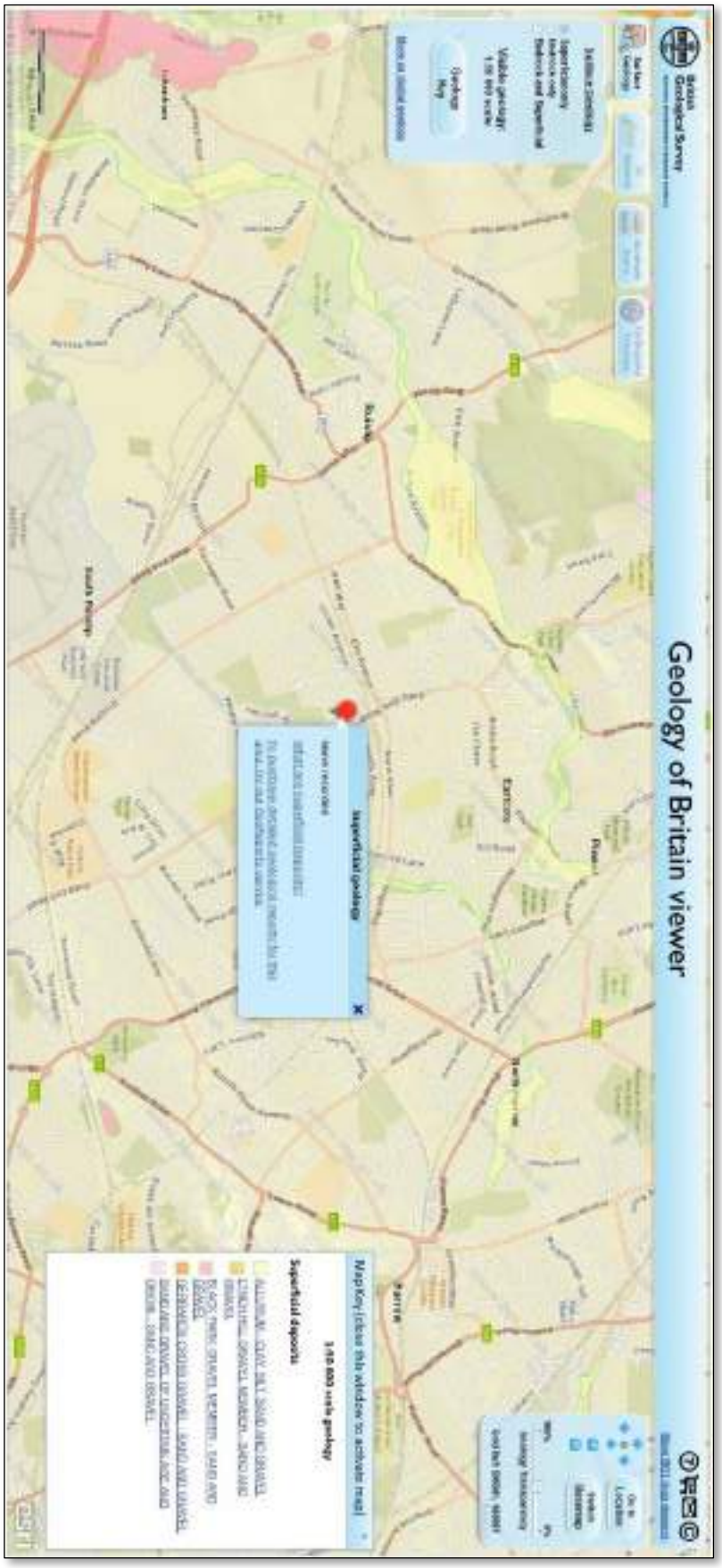

Appendix 2, Figure 2 - Superficial Deposits

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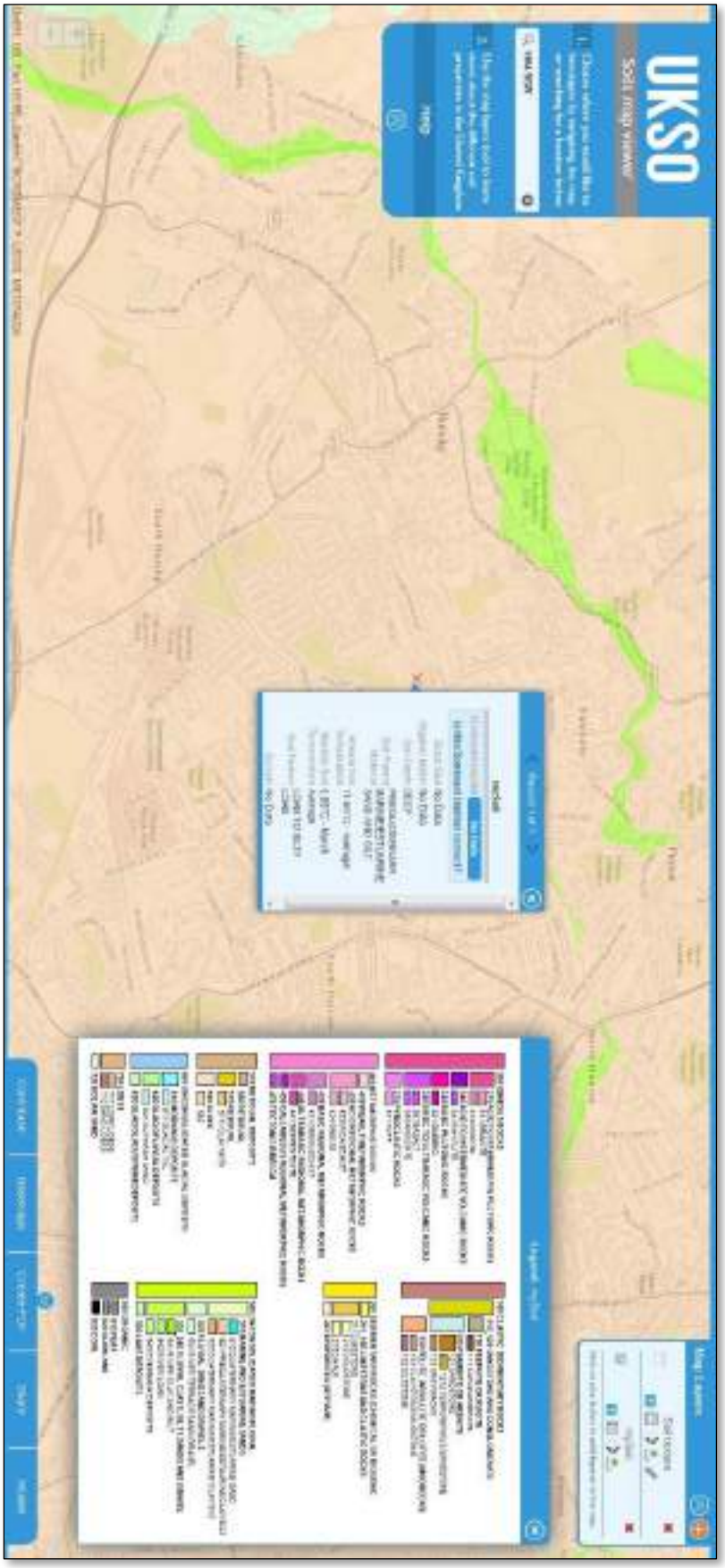

Appendix 2, Figure 3 - Soil Parental Material

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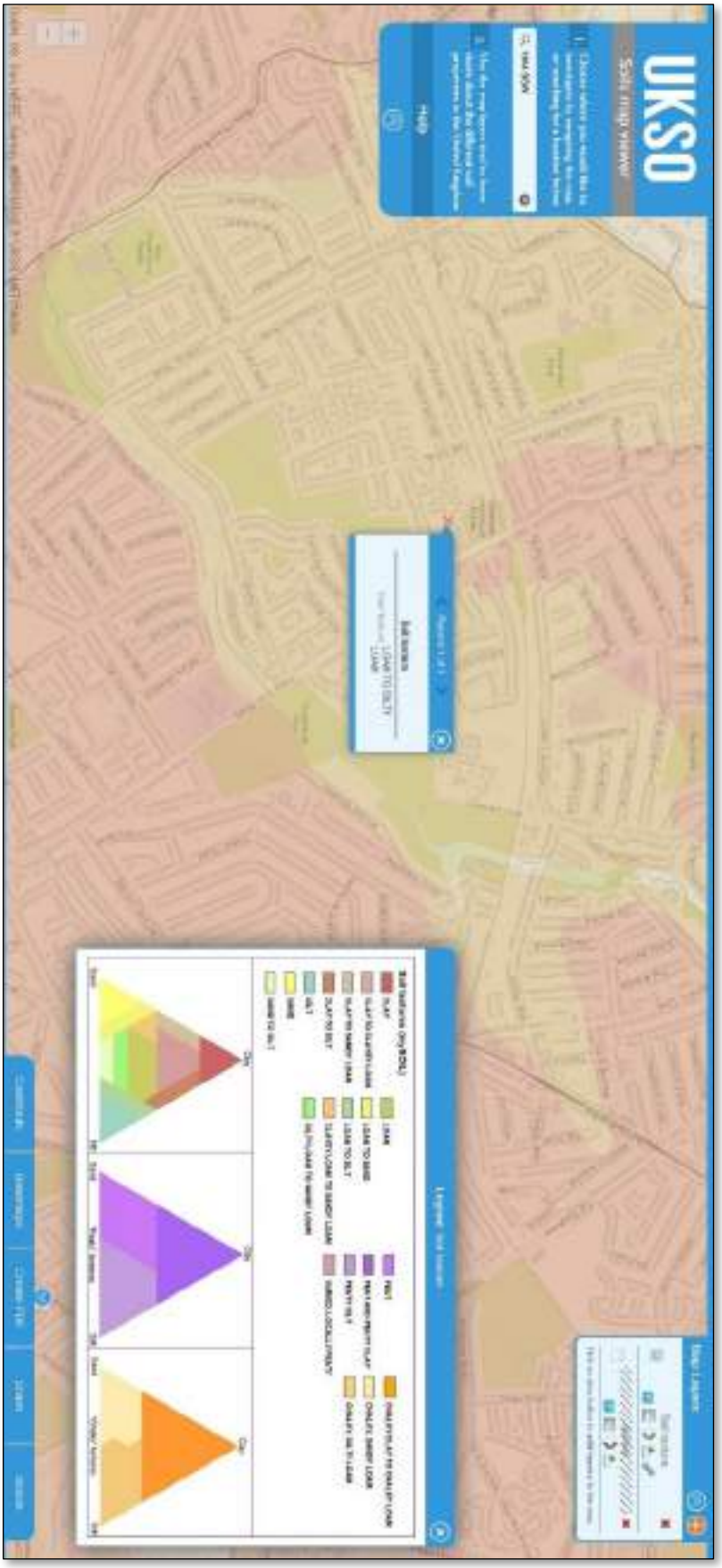

Appendix 2, Figure 4 - Soil Texture

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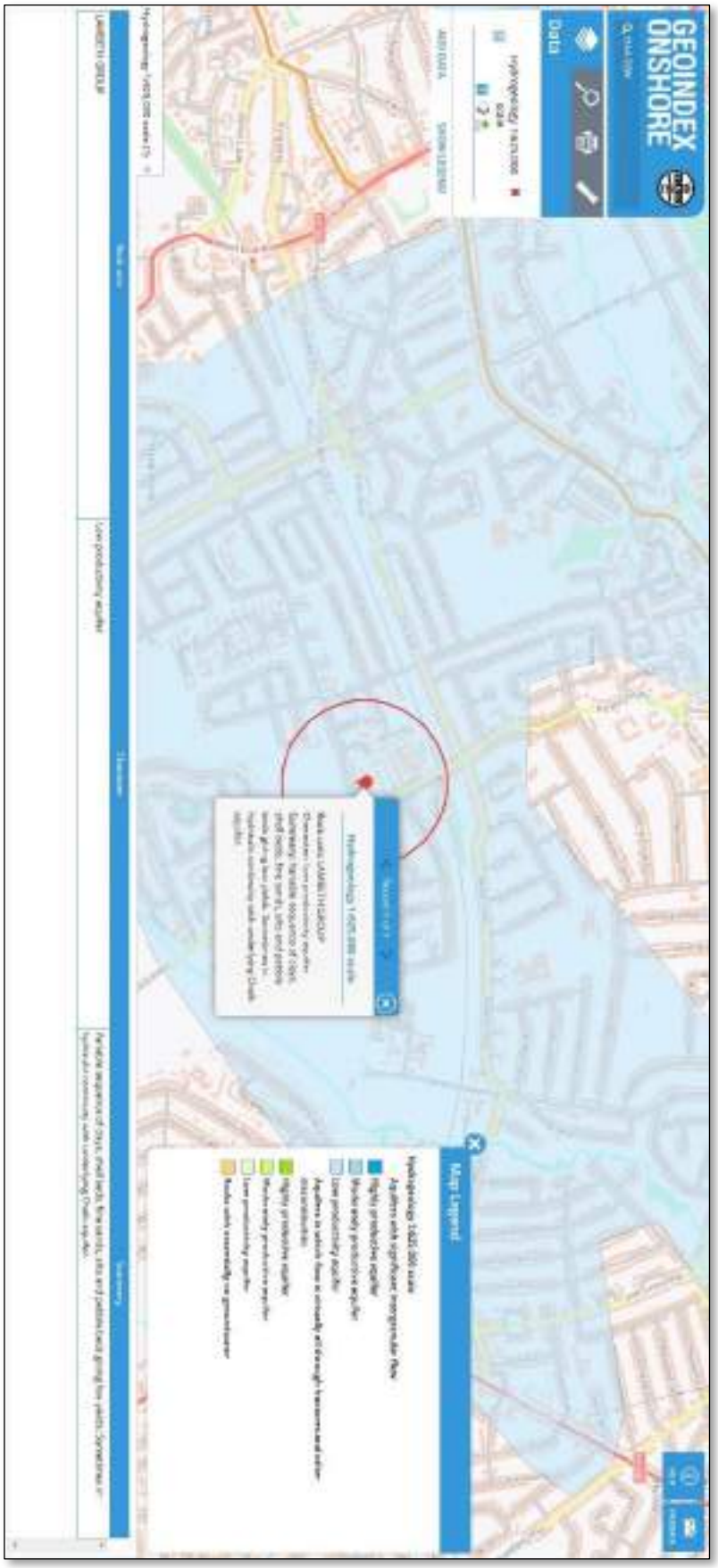

Appendix 2, Figure 5 – Hydrogeology

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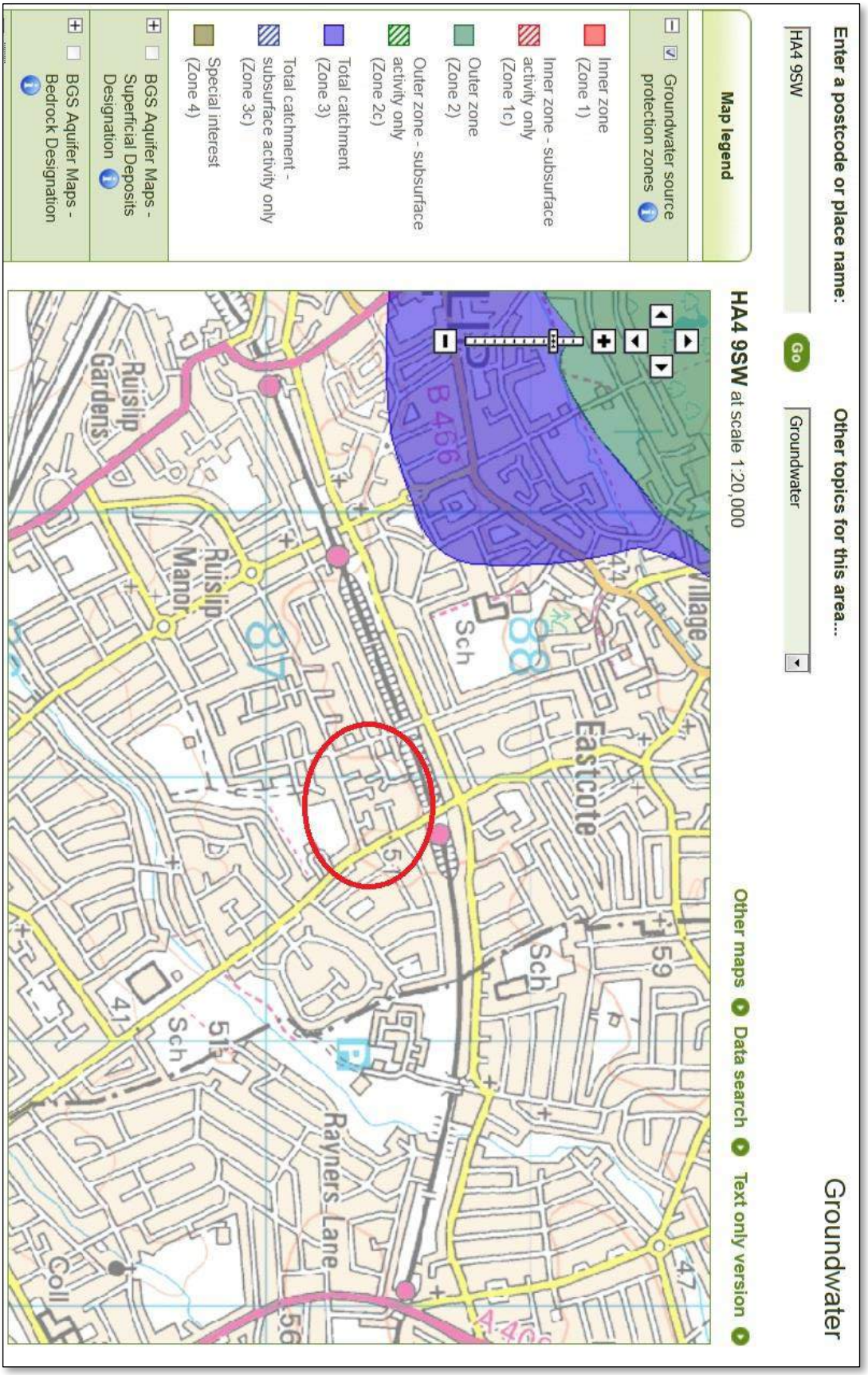

Appendix 2, Figure 6 – Groundwater Source Protection Zones

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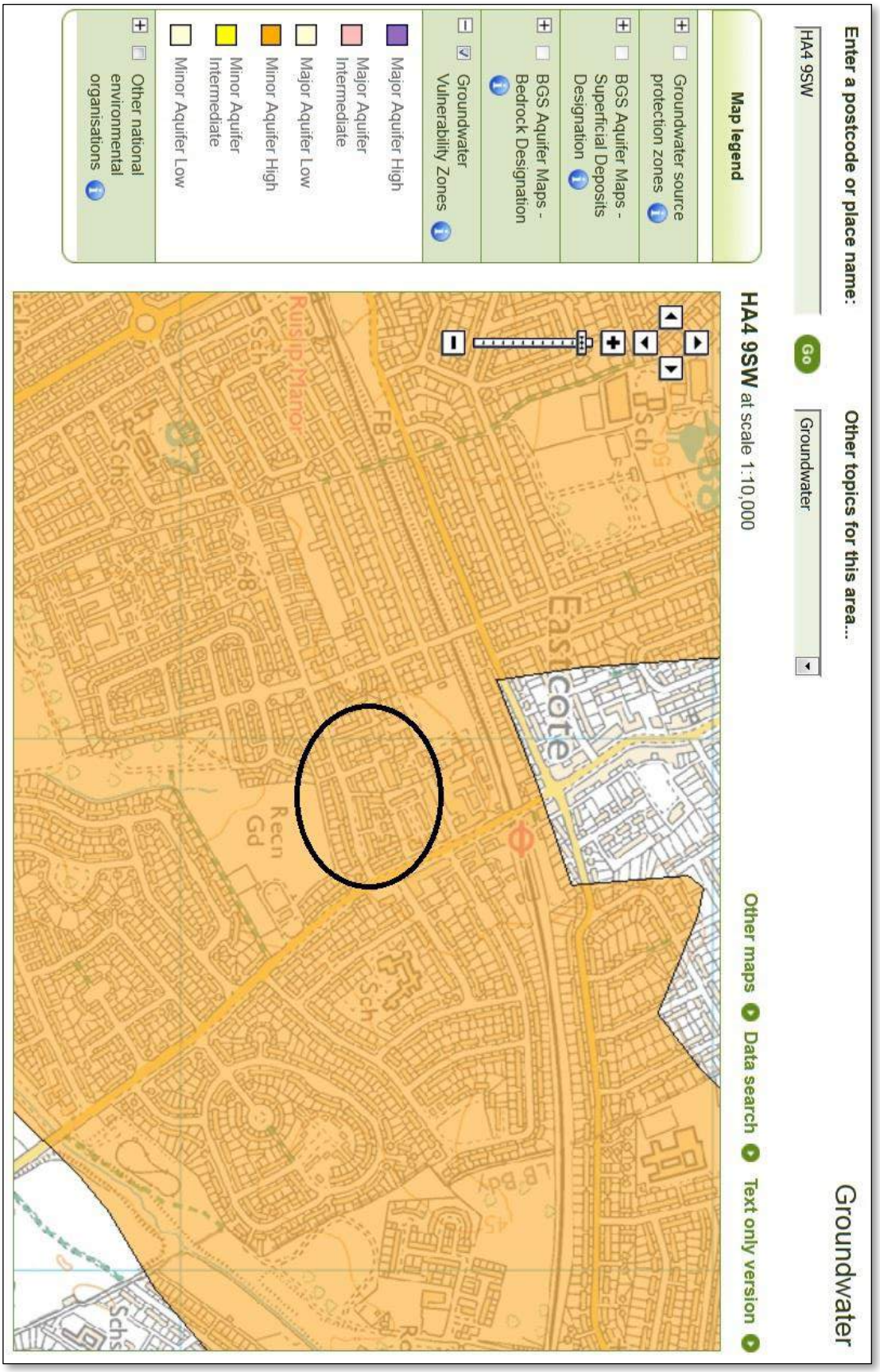

Appendix 2, Figure 7 – Groundwater Vulnerability Zones

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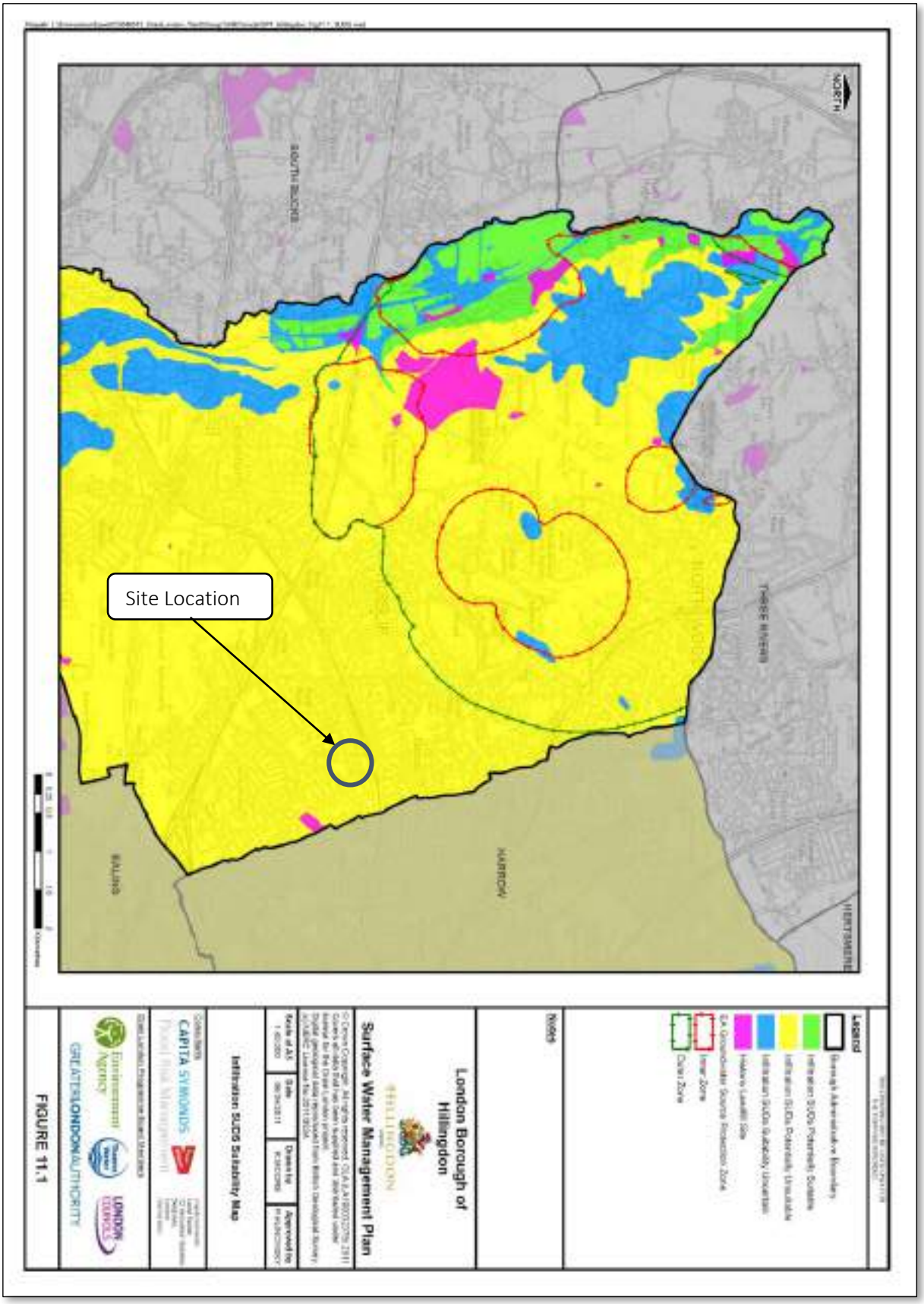

Appendix 2, Figure 8 – Infiltration SUDS Suitability Map

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Appendix 3 – Calculations

- *Table 1 – Greenfield Runoff Rates Calculation Summary*
- *Existing Runoff Rates Simulation*
- *Summary Results for Proposed SuDS – Permeable Pavement*

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Greenfield Runoff Rates Calculation Summary

GREENFIELD RUNOFF RATES CALCULATION SUMMARY		
PARAMETERS		
Catchment Area	907.62 m²	0.09 ha
Open Public Space	0.00 m²	0.00 ha
Area Positively Drained	907.62 m²	0.09 ha
SAAR (mm)	664 mm	
SOIL	4	
SPR	0.47	
$Q_{BAR,rural}$ (l/s) for 50 Ha	**226.93 l/s**	
Hydrological Region	6	
Growth Curve Factor 1 year	0.85	
Growth Curve Factor 30 year	2.46	
Growth Curve Factor 100 year	3.19	
Return Period	**Greenfield Runoff per Hectare (l/s/ha)**	
Q_{BAR}	4.54	
1	3.86	
30	11.17	
100	14.48	
Return Period	**Greenfield Runoff (l/s)**	
Q_{BAR}	**0.41**	
1	0.35	
30	1.01	
100	**1.31**	

Appendix 3, Table 1 – Greenfield Runoff Rates Calculation Summary

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Existing Runoff Rates Simulation

Ambiental		Page 1
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design Garages Southbourne Gardens Contract No 3025	
Date 17/03/2017 19:44 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2017.1	

Time Area Diagram for Existing

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.051	4-8	0.021

Total Area Contributing (ha) = 0.072

Total Pipe Volume (m^3) = 0.471

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Ambiental		Page 2
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design Garages Southbourne Gardens Contract No 3025	Micro Drainage
Date 17/03/2017 19:44 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2017.1	

Existing Network Details for Existing

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
E1.000	30.000	0.375	80.0	0.072	4.00	0.0	0.600	o	100	Pipe/Conduit
E1.001	30.000	0.375	80.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
E1.000	46.040	0.072	0.0	0.86	6.8
E1.001	45.750	0.072	0.0	0.86	6.8

Free Flowing Outfall Details for Existing

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
E1.001	E	46.375	45.375	0.000	0	0

Simulation Criteria for Existing

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.500	Storm Duration (mins)	30
Ratio R	0.417		

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Ambiental		Page 3
Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design Garages Southbourne Gardens Contract No 3025	Micro Drainage
Date 17/03/2017 19:44 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2017.1	

1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Existing

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.417
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.500 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 20, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
E1.000	E1	15 Winter	1	+0%	1/15 Summer	20/15 Summer			46.393
E1.001	E2	15 Winter	1	+0%	1/15 Summer				45.911

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
E1.000	E1	0.253	0.000	1.16		7.7	SURCHARGED	16
E1.001	E2	0.061	0.000	1.08		7.1	SURCHARGED	

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Science Park Square Brighton BN1 9SB	Existing Storm Sewer Design Garages Southbourne Gardens Contract No 3025	Micro Drainage
Date 17/03/2017 19:44 File Existing Runoff Rates#3...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Network 2017.1	

20 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Existing

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.417
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.500 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 20, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
E1.000	E1	15 Summer	20	+0%	1/15 Summer	20/15 Summer			47.041
E1.001	E2	30 Winter	20	+0%	1/15 Summer				46.255

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
E1.000	E1	0.901	0.997	1.63		10.8	FLOOD	16
E1.001	E2	0.405	0.000	1.45		9.5	SURCHARGED	

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XP Solutions	Network 2017.1	

30 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Existing

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.417
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.500 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 20, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
E1.000	E1	15 Summer	30	+0%	1/15 Summer	20/15 Summer			47.042
E1.001	E2	30 Winter	30	+0%	1/15 Summer				46.256

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
E1.000	E1	0.902	1.636	1.63		10.7	FLOOD	16
E1.001	E2	0.406	0.000	1.45		9.5	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Existing

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.417
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.500 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 20, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
E1.000	E1	15 Summer	100	+0%	1/15 Summer	20/15 Summer			47.044
E1.001	E2	30 Winter	100	+0%	1/15 Summer				46.257

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
E1.000	E1	0.904	4.080	1.64		10.8	FLOOD	16
E1.001	E2	0.407	0.000	1.45		9.6	SURCHARGED	

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Summary of Results for Proposed SuDS – Permeable Pavement

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Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving Garages Southbourne Gardens Contract No 3025	Micro Drainage
Date 20/03/2017 11:26 File PP_1in1yr+40%cc_VolumeC...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2017.1	

Summary of Results for 1 year Return Period (+40%)

Half Drain Time : 136 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	46.446	0.026	0.0	0.3	0.3	4.4	O K
30 min Summer	46.458	0.038	0.0	0.5	0.5	6.2	O K
60 min Summer	46.468	0.048	0.0	0.7	0.7	7.9	O K
120 min Summer	46.475	0.055	0.0	0.8	0.8	9.1	O K
180 min Summer	46.478	0.058	0.0	0.9	0.9	9.7	O K
240 min Summer	46.481	0.061	0.0	0.9	0.9	10.0	O K
360 min Summer	46.482	0.062	0.0	0.9	0.9	10.3	O K
480 min Summer	46.482	0.062	0.0	0.9	0.9	10.3	O K
600 min Summer	46.482	0.062	0.0	0.9	0.9	10.2	O K
720 min Summer	46.481	0.061	0.0	0.9	0.9	10.1	O K
960 min Summer	46.478	0.058	0.0	0.9	0.9	9.7	O K
1440 min Summer	46.473	0.053	0.0	0.8	0.8	8.8	O K
2160 min Summer	46.468	0.048	0.0	0.7	0.7	7.9	O K
2880 min Summer	46.463	0.043	0.0	0.6	0.6	7.2	O K
4320 min Summer	46.457	0.037	0.0	0.5	0.5	6.2	O K
5760 min Summer	46.453	0.033	0.0	0.4	0.4	5.5	O K
7200 min Summer	46.451	0.031	0.0	0.3	0.3	5.1	O K
8640 min Summer	46.448	0.028	0.0	0.3	0.3	4.7	O K
10080 min Summer	46.447	0.027	0.0	0.3	0.3	4.4	O K
15 min Winter	46.451	0.031	0.0	0.4	0.4	5.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	45.173	0.0	3.8	26
30 min Summer	29.319	0.0	6.0	39
60 min Summer	18.425	0.0	8.7	64
120 min Summer	11.339	0.0	11.3	108
180 min Summer	8.492	0.0	13.1	136
240 min Summer	6.910	0.0	14.4	170
360 min Summer	5.130	0.0	16.3	238
480 min Summer	4.144	0.0	17.6	304
600 min Summer	3.511	0.0	18.8	370
720 min Summer	3.067	0.0	19.7	434
960 min Summer	2.477	0.0	21.2	562
1440 min Summer	1.833	0.0	23.4	808
2160 min Summer	1.358	0.0	26.0	1172
2880 min Summer	1.097	0.0	27.6	1532
4320 min Summer	0.811	0.0	29.4	2252
5760 min Summer	0.655	0.0	31.0	3000
7200 min Summer	0.555	0.0	31.7	3680
8640 min Summer	0.485	0.0	32.1	4416
10080 min Summer	0.433	0.0	32.2	5152
15 min Winter	45.173	0.0	4.7	25

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Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving Garages Southbourne Gardens Contract No 3025	
Date 20/03/2017 11:26 File PP_1in1yr+40%cc_VolumeC...	Designed by Jose Tenedor Checked by Mark Naumann	
XP Solutions	Source Control 2017.1	

Summary of Results for 1 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	46.464	0.044	0.0	0.6	0.6	7.3	O K
60 min Winter	46.475	0.055	0.0	0.8	0.8	9.2	O K
120 min Winter	46.483	0.063	0.0	0.9	0.9	10.5	O K
180 min Winter	46.487	0.067	0.0	1.0	1.0	11.0	O K
240 min Winter	46.488	0.068	0.0	1.0	1.0	11.3	O K
360 min Winter	46.488	0.068	0.0	1.0	1.0	11.3	O K
480 min Winter	46.487	0.067	0.0	1.0	1.0	11.0	O K
600 min Winter	46.484	0.064	0.0	1.0	1.0	10.7	O K
720 min Winter	46.482	0.062	0.0	0.9	0.9	10.3	O K
960 min Winter	46.478	0.058	0.0	0.9	0.9	9.5	O K
1440 min Winter	46.470	0.050	0.0	0.7	0.7	8.3	O K
2160 min Winter	46.463	0.043	0.0	0.6	0.6	7.1	O K
2880 min Winter	46.458	0.038	0.0	0.5	0.5	6.4	O K
4320 min Winter	46.452	0.032	0.0	0.4	0.4	5.4	O K
5760 min Winter	46.449	0.029	0.0	0.3	0.3	4.7	O K
7200 min Winter	46.446	0.026	0.0	0.3	0.3	4.3	O K
8640 min Winter	46.444	0.024	0.0	0.2	0.2	4.0	O K
10080 min Winter	46.443	0.023	0.0	0.2	0.2	3.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	29.319	0.0	7.1	38
60 min Winter	18.425	0.0	10.1	64
120 min Winter	11.339	0.0	13.1	114
180 min Winter	8.492	0.0	15.0	144
240 min Winter	6.910	0.0	16.5	180
360 min Winter	5.130	0.0	18.6	254
480 min Winter	4.144	0.0	20.2	324
600 min Winter	3.511	0.0	21.5	394
720 min Winter	3.067	0.0	22.5	460
960 min Winter	2.477	0.0	24.3	588
1440 min Winter	1.833	0.0	26.8	838
2160 min Winter	1.358	0.0	29.8	1196
2880 min Winter	1.097	0.0	31.7	1564
4320 min Winter	0.811	0.0	34.0	2296
5760 min Winter	0.655	0.0	36.0	3000
7200 min Winter	0.555	0.0	37.1	3680
8640 min Winter	0.485	0.0	37.8	4416
10080 min Winter	0.433	0.0	38.1	5160

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XP Solutions	Source Control 2017.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.418	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.086

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.029	4	8	0.029	8	12	0.029

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Model Details

Storage is Online Cover Level (m) 47.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.0
Membrane Percolation (mm/hr)	1000	Length (m)	27.6
Max Percolation (l/s)	153.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	46.420	Membrane Depth (m)	130

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0059-1200-0450-1200
Design Head (m)	0.450
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	46.420
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.450	1.2
Flush-Flo™	0.131	1.2
Kick-Flo®	0.303	1.0
Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.2	1.200	1.9	3.000	2.8	7.000	4.3
0.200	1.2	1.400	2.0	3.500	3.1	7.500	4.4
0.300	1.0	1.600	2.1	4.000	3.2	8.000	4.6
0.400	1.1	1.800	2.2	4.500	3.4	8.500	4.7
0.500	1.3	2.000	2.4	5.000	3.6	9.000	4.8
0.600	1.4	2.200	2.5	5.500	3.8	9.500	5.0
0.800	1.6	2.400	2.6	6.000	4.0		
1.000	1.7	2.600	2.7	6.500	4.1		

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XP Solutions	Source Control 2017.1	

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 222 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	46.506	0.086	0.0	1.2	1.2	14.3	O K
30 min Summer	46.534	0.114	0.0	1.2	1.2	18.9	O K
60 min Summer	46.559	0.139	0.0	1.2	1.2	23.0	O K
120 min Summer	46.578	0.158	0.0	1.2	1.2	26.2	O K
180 min Summer	46.584	0.164	0.0	1.2	1.2	27.1	O K
240 min Summer	46.585	0.165	0.0	1.2	1.2	27.3	O K
360 min Summer	46.585	0.165	0.0	1.2	1.2	27.3	O K
480 min Summer	46.582	0.162	0.0	1.2	1.2	26.8	O K
600 min Summer	46.578	0.158	0.0	1.2	1.2	26.2	O K
720 min Summer	46.573	0.153	0.0	1.2	1.2	25.4	O K
960 min Summer	46.563	0.143	0.0	1.2	1.2	23.6	O K
1440 min Summer	46.541	0.121	0.0	1.2	1.2	20.0	O K
2160 min Summer	46.515	0.095	0.0	1.2	1.2	15.7	O K
2880 min Summer	46.498	0.078	0.0	1.1	1.1	12.9	O K
4320 min Summer	46.482	0.062	0.0	0.9	0.9	10.2	O K
5760 min Summer	46.472	0.052	0.0	0.8	0.8	8.7	O K
7200 min Summer	46.467	0.047	0.0	0.7	0.7	7.7	O K
8640 min Summer	46.462	0.042	0.0	0.6	0.6	7.0	O K
10080 min Summer	46.459	0.039	0.0	0.5	0.5	6.5	O K
15 min Winter	46.519	0.099	0.0	1.2	1.2	16.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	110.902	0.0	14.3	25
30 min Summer	71.653	0.0	19.5	39
60 min Summer	44.230	0.0	25.3	66
120 min Summer	26.494	0.0	30.9	122
180 min Summer	19.425	0.0	34.2	176
240 min Summer	15.520	0.0	36.6	204
360 min Summer	11.295	0.0	40.1	266
480 min Summer	9.010	0.0	42.7	332
600 min Summer	7.556	0.0	44.8	400
720 min Summer	6.543	0.0	46.5	468
960 min Summer	5.209	0.0	49.3	600
1440 min Summer	3.774	0.0	53.4	856
2160 min Summer	2.732	0.0	57.9	1212
2880 min Summer	2.170	0.0	60.8	1556
4320 min Summer	1.568	0.0	64.5	2256
5760 min Summer	1.244	0.0	67.5	2992
7200 min Summer	1.040	0.0	69.2	3680
8640 min Summer	0.898	0.0	70.4	4416
10080 min Summer	0.793	0.0	71.1	5144
15 min Winter	110.902	0.0	16.5	25

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XP Solutions	Source Control 2017.1	

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	46.550	0.130	0.0	1.2	1.2	21.6	O K
60 min Winter	46.579	0.159	0.0	1.2	1.2	26.4	O K
120 min Winter	46.602	0.182	0.0	1.2	1.2	30.2	O K
180 min Winter	46.609	0.189	0.0	1.2	1.2	31.4	O K
240 min Winter	46.610	0.190	0.0	1.2	1.2	31.5	O K
360 min Winter	46.607	0.187	0.0	1.2	1.2	31.0	O K
480 min Winter	46.602	0.182	0.0	1.2	1.2	30.1	O K
600 min Winter	46.594	0.174	0.0	1.2	1.2	28.9	O K
720 min Winter	46.586	0.166	0.0	1.2	1.2	27.5	O K
960 min Winter	46.568	0.148	0.0	1.2	1.2	24.6	O K
1440 min Winter	46.535	0.115	0.0	1.2	1.2	19.0	O K
2160 min Winter	46.501	0.081	0.0	1.2	1.2	13.4	O K
2880 min Winter	46.486	0.066	0.0	1.0	1.0	11.0	O K
4320 min Winter	46.471	0.051	0.0	0.7	0.7	8.4	O K
5760 min Winter	46.463	0.043	0.0	0.6	0.6	7.2	O K
7200 min Winter	46.459	0.039	0.0	0.5	0.5	6.4	O K
8640 min Winter	46.455	0.035	0.0	0.4	0.4	5.8	O K
10080 min Winter	46.453	0.033	0.0	0.4	0.4	5.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	71.653	0.0	22.2	39
60 min Winter	44.230	0.0	28.7	66
120 min Winter	26.494	0.0	34.9	122
180 min Winter	19.425	0.0	38.7	178
240 min Winter	15.520	0.0	41.4	230
360 min Winter	11.295	0.0	45.3	286
480 min Winter	9.010	0.0	48.3	362
600 min Winter	7.556	0.0	50.6	438
720 min Winter	6.543	0.0	52.6	510
960 min Winter	5.209	0.0	55.8	648
1440 min Winter	3.774	0.0	60.4	902
2160 min Winter	2.732	0.0	65.5	1236
2880 min Winter	2.170	0.0	68.9	1588
4320 min Winter	1.568	0.0	73.3	2296
5760 min Winter	1.244	0.0	76.8	3000
7200 min Winter	1.040	0.0	79.0	3680
8640 min Winter	0.898	0.0	80.5	4416
10080 min Winter	0.793	0.0	81.6	5136

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.418	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.086

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.029	4	8	0.029	8	12	0.029

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Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving Garages Southbourne Gardens Contract No 3025	Micro Drainage
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Model Details

Storage is Online Cover Level (m) 47.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.0
Membrane Percolation (mm/hr)	1000	Length (m)	27.6
Max Percolation (l/s)	153.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	46.420	Membrane Depth (m)	130

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0059-1200-0450-1200
Design Head (m)	0.450
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	46.420
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.450	1.2
Flush-Flo™	0.131	1.2
Kick-Flo®	0.303	1.0
Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.2	1.200	1.9	3.000	2.8	7.000	4.3
0.200	1.2	1.400	2.0	3.500	3.1	7.500	4.4
0.300	1.0	1.600	2.1	4.000	3.2	8.000	4.6
0.400	1.1	1.800	2.2	4.500	3.4	8.500	4.7
0.500	1.3	2.000	2.4	5.000	3.6	9.000	4.8
0.600	1.4	2.200	2.5	5.500	3.8	9.500	5.0
0.800	1.6	2.400	2.6	6.000	4.0		
1.000	1.7	2.600	2.7	6.500	4.1		

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Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 325 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	46.538	0.118	0.0	1.2	1.2	19.5	O K
30 min Summer	46.576	0.156	0.0	1.2	1.2	25.9	O K
60 min Summer	46.612	0.192	0.0	1.2	1.2	31.8	O K
120 min Summer	46.641	0.221	0.0	1.2	1.2	36.6	O K
180 min Summer	46.651	0.231	0.0	1.2	1.2	38.2	O K
240 min Summer	46.653	0.233	0.0	1.2	1.2	38.5	O K
360 min Summer	46.650	0.230	0.0	1.2	1.2	38.1	O K
480 min Summer	46.646	0.226	0.0	1.2	1.2	37.5	O K
600 min Summer	46.641	0.221	0.0	1.2	1.2	36.7	O K
720 min Summer	46.635	0.215	0.0	1.2	1.2	35.6	O K
960 min Summer	46.622	0.202	0.0	1.2	1.2	33.4	O K
1440 min Summer	46.593	0.173	0.0	1.2	1.2	28.7	O K
2160 min Summer	46.556	0.136	0.0	1.2	1.2	22.5	O K
2880 min Summer	46.528	0.108	0.0	1.2	1.2	17.9	O K
4320 min Summer	46.497	0.077	0.0	1.1	1.1	12.7	O K
5760 min Summer	46.483	0.063	0.0	0.9	0.9	10.5	O K
7200 min Summer	46.475	0.055	0.0	0.8	0.8	9.1	O K
8640 min Summer	46.469	0.049	0.0	0.7	0.7	8.1	O K
10080 min Summer	46.465	0.045	0.0	0.6	0.6	7.5	O K
15 min Winter	46.554	0.134	0.0	1.2	1.2	22.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	144.138	0.0	19.6	25
30 min Summer	93.872	0.0	26.6	39
60 min Summer	58.167	0.0	34.3	68
120 min Summer	34.802	0.0	41.5	126
180 min Summer	25.427	0.0	45.8	182
240 min Summer	20.231	0.0	48.7	240
360 min Summer	14.643	0.0	53.0	298
480 min Summer	11.635	0.0	56.2	358
600 min Summer	9.728	0.0	58.8	424
720 min Summer	8.401	0.0	60.9	492
960 min Summer	6.660	0.0	64.3	626
1440 min Summer	4.794	0.0	69.1	888
2160 min Summer	3.446	0.0	74.5	1260
2880 min Summer	2.724	0.0	77.9	1612
4320 min Summer	1.953	0.0	82.4	2292
5760 min Summer	1.541	0.0	85.9	3000
7200 min Summer	1.281	0.0	87.9	3688
8640 min Summer	1.102	0.0	89.3	4416
10080 min Summer	0.970	0.0	90.2	5144
15 min Winter	144.138	0.0	22.4	25

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	46.598	0.178	0.0	1.2	1.2	29.5	O K
60 min Winter	46.639	0.219	0.0	1.2	1.2	36.3	O K
120 min Winter	46.673	0.253	0.0	1.2	1.2	41.9	O K
180 min Winter	46.685	0.265	0.0	1.2	1.2	43.9	O K
240 min Winter	46.689	0.269	0.0	1.2	1.2	44.6	O K
360 min Winter	46.686	0.266	0.0	1.2	1.2	44.1	O K
480 min Winter	46.678	0.258	0.0	1.2	1.2	42.8	O K
600 min Winter	46.670	0.250	0.0	1.2	1.2	41.5	O K
720 min Winter	46.661	0.241	0.0	1.2	1.2	39.9	O K
960 min Winter	46.640	0.220	0.0	1.2	1.2	36.4	O K
1440 min Winter	46.596	0.176	0.0	1.2	1.2	29.2	O K
2160 min Winter	46.542	0.122	0.0	1.2	1.2	20.1	O K
2880 min Winter	46.507	0.087	0.0	1.2	1.2	14.3	O K
4320 min Winter	46.482	0.062	0.0	0.9	0.9	10.3	O K
5760 min Winter	46.471	0.051	0.0	0.7	0.7	8.4	O K
7200 min Winter	46.464	0.044	0.0	0.6	0.6	7.4	O K
8640 min Winter	46.460	0.040	0.0	0.5	0.5	6.6	O K
10080 min Winter	46.457	0.037	0.0	0.5	0.5	6.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	93.872	0.0	30.2	39
60 min Winter	58.167	0.0	38.8	68
120 min Winter	34.802	0.0	46.9	124
180 min Winter	25.427	0.0	51.7	180
240 min Winter	20.231	0.0	54.9	236
360 min Winter	14.643	0.0	59.8	344
480 min Winter	11.635	0.0	63.4	388
600 min Winter	9.728	0.0	66.3	462
720 min Winter	8.401	0.0	68.7	536
960 min Winter	6.660	0.0	72.5	684
1440 min Winter	4.794	0.0	78.0	956
2160 min Winter	3.446	0.0	84.1	1320
2880 min Winter	2.724	0.0	88.1	1624
4320 min Winter	1.953	0.0	93.3	2300
5760 min Winter	1.541	0.0	97.4	3000
7200 min Winter	1.281	0.0	99.9	3752
8640 min Winter	1.102	0.0	101.8	4416
10080 min Winter	0.970	0.0	103.0	5128

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.500	Shortest Storm (mins)	15
Ratio R	0.418	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.086

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.029	4	8	0.029	8	12	0.029

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Science Park Square Brighton BN1 9SB	Proposed SuDS-Permeable Paving Garages Southbourne Gardens Contract No 3025	Micro Drainage
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XP Solutions	Source Control 2017.1	

Model Details

Storage is Online Cover Level (m) 47.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.0
Membrane Percolation (mm/hr)	1000	Length (m)	27.6
Max Percolation (l/s)	153.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	46.420	Membrane Depth (m)	130

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0059-1200-0450-1200
Design Head (m)	0.450
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	46.420
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.450	1.2
Flush-Flo™	0.131	1.2
Kick-Flo®	0.303	1.0
Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.2	1.200	1.9	3.000	2.8	7.000	4.3
0.200	1.2	1.400	2.0	3.500	3.1	7.500	4.4
0.300	1.0	1.600	2.1	4.000	3.2	8.000	4.6
0.400	1.1	1.800	2.2	4.500	3.4	8.500	4.7
0.500	1.3	2.000	2.4	5.000	3.6	9.000	4.8
0.600	1.4	2.200	2.5	5.500	3.8	9.500	5.0
0.800	1.6	2.400	2.6	6.000	4.0		
1.000	1.7	2.600	2.7	6.500	4.1		

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Appendix 4 – Proposed Drainage Strategy

- *Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheet 1 of 2*
- *Plan 1 – Preliminary Surface Water Drainage Strategy Layout, Sheet 2 of 2*

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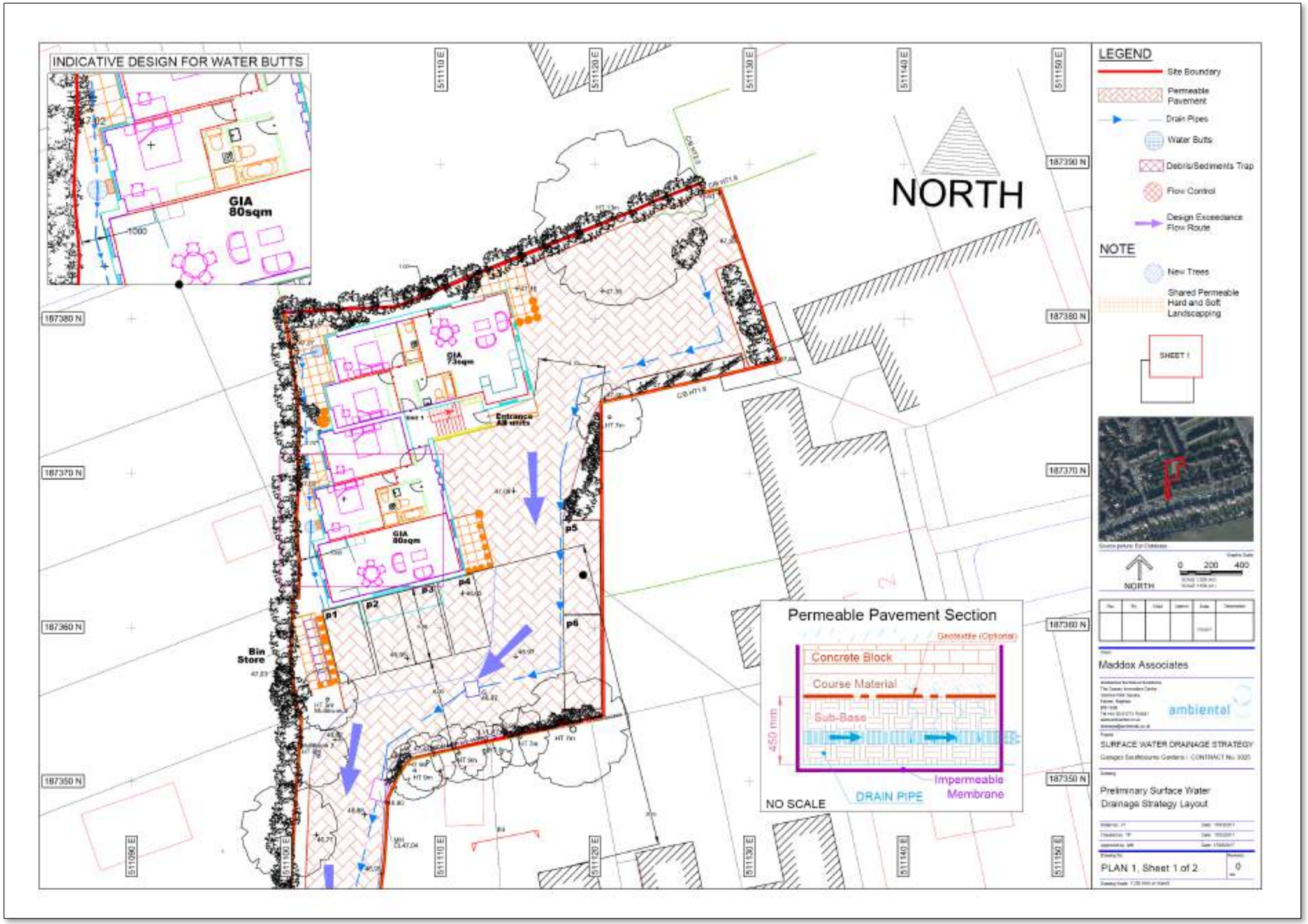

Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy layout, Sheet 1 of 2

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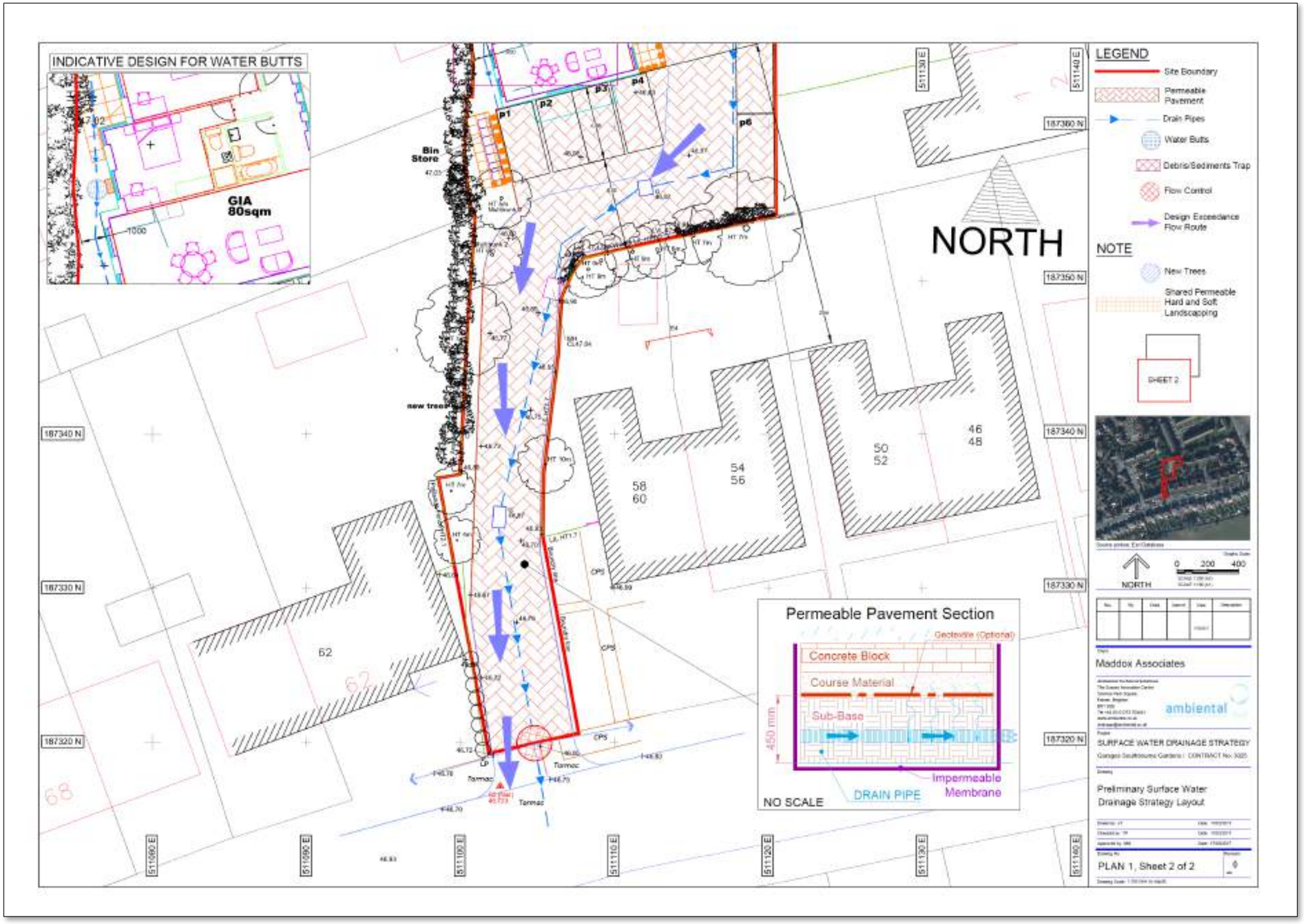

Appendix 4, Plan 1 – Preliminary Surface Water Drainage Strategy layout, Sheet 2 of 2

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Appendix 5 – Information

Surface Water Runoff Calculation Method

Rainfall data has been extracted from the FEH CD-ROM for several storm duration events for a number of return periods, including 1:1.01 year, 1:10 year and 1:100 year storm events. These return periods are industry standard, however it is important to be aware that return periods less than 1:2 years are not considered reliable and should not be used in detailed design calculations.

The 1:100 year with an allowance for climate change has been based on a 40% increase to the 1:100 year rainfall intensity and not the rainfall depth. This is to provide the most conservative runoff rates for the site possible.

Greenfield runoff rates have been calculated using The Institute of Hydrology Report 124 Marshall and Bayliss, 1994 method, as recommended in the SuDS Manual CIRIA (C753). In keeping with standard practice, the calculations are based on calculating the Greenfield runoff rates for a 50 Ha site and then factored to account for the actual site size.

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