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Building Assessments for a Sustainable Environment

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Surface Water and SuDS Assessment Rev1

Collins Court,
Cascade Avenue

27 February 2023

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Prepared by	Checked by	Date
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This document has been prepared solely as a Surface Water and SuDS Assessment for Firstplan Ltd. Base Energy accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

1. Introduction

This Surface Water and SuDS Assessment (Rev0) has been prepared to support the planning application for the proposed residential development at Collins Court, Cascade Avenue.

A site location plan is provided in **Appendix A**.

Existing Site

The existing site comprises a former tennis club house and associated asphalt tennis courts. The existing site layout plan is shown on the topographic survey in **Appendix B**.

The topographic survey confirms that site levels range from ~54.96m AOD at the boundary of the site nearest The Chine, sloping down to ~53.60m AOD at the boundary nearest Cascade Avenue.

Development Proposals

Proposals are for two new residential terraces, each comprising 4no. dwellings, with one terrace fronting The Chine and one terrace fronting Cascade Avenue. Additionally, the existing tennis club house, The Pavilion, is to be renovated and converted into a new dwelling.

The proposed site layout plans are shown in **Appendix C**.

2. Planning Policy- Surface Water Management

The London Plan 2021

Policy SI 13 Sustainable drainage

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

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

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

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

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

9.13.1 London is at particular risk from surface water flooding, mainly due to the large extent of impermeable surfaces. Lead Local Flood Authorities have responsibility for managing surface water drainage through the planning system, as well as ensuring that appropriate maintenance arrangements are put in place. Local Flood Risk Management Strategies and Surface Water Management Plans should ensure they address flooding from multiple sources including surface water, groundwater and small watercourses that occurs as a result of heavy rainfall.

9.13.2 Development proposals should aim to get as close to greenfield run-off rates as possible depending on site conditions. The well-established drainage hierarchy set out in this policy helps to reduce the rate and volume of surface water run-off. Rainwater should be managed as close to the top of the hierarchy as possible. There should be a preference for green over grey features, and drainage by gravity over pumped systems. A blue roof is an attenuation tank at roof or podium level; the combination of a blue and green roof is particularly beneficial, as the attenuated water is used to irrigate the green roof.

9.13.3 For many sites, it may be appropriate to use more than one form of drainage, for example a proportion of rainwater can be managed by more sustainable methods, with residual rainwater managed lower down the hierarchy. In some cases, direct discharge into the watercourse is an appropriate approach, for example rainwater discharge into the tidal Thames or a dock. This should include suitable pollution prevention filtering measures, ideally by using soft engineering or green infrastructure. In addition, if direct discharge is to a watercourse where the outfall is likely to be affected by tide-locking, suitable storage should be designed into the system. However, in other cases direct discharge will not be appropriate, for example discharge into a small stream at the headwaters of a catchment, which may cause flooding. This will need to be assessed on a case-by-case basis, taking into account the location, scale and quality of the discharge and the receiving watercourse. The maintenance of identified drainage measures should also be considered in development proposals.

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

Haringey Council

Local SuDS Standards

Haringey Council Local SuDS Standards document states:

SuDS Principles

LS1a Sustainable drainage systems are to be designed to control surface water run off close to where it falls as rainfall and mimic natural drainage as closely as possible in accordance with National Planning Practice Policy.

LS1b Proposals for SuDS must result in capture for reuse, discharge into the ground, to a surface water body or, where these are demonstrated to be not achievable, to the storm sewer or combined sewer where no storm sewer is available. The destination of runoff for proposed SuDS must be justified using a methodology acceptable to Haringey.

LS1c Storage and treatment of surface runoff should be provided through provision of a management train.

Peak flow control

LS2a For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

LS2b The design of the drainage system accounts for the likely impacts of climate change and potential changes in impermeable area over the design life of the development.

LS3a For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

LS3b Where Greenfield rates cannot be achieved Haringey request that 50% of the Greenfield runoff rate attenuation volume be provided and outflows controlled to Greenfield runoff rates.

LS3c For developments which were previously developed, the design of the drainage system accounts for the likely impacts of climate change and potential changes in impermeable area over the design life of the development.

Volume control

LS4 To ensure no increase in flood risk elsewhere, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

LS5 To make provision for reduction in catchment floodrisk, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event. Haringey will seek to ensure that all means of volume reduction have been fully explored.

LS6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with **S4** or **S5** above, the runoff volume must be discharged at a rate that does not adversely affect flood risk. Haringey will request this rate to be a maximum discharge rate of Q_{bar} for the 1 in 100 year rainfall event with allowance made for climate change and application of urban creep where appropriate. Where development proposals do not meet these proposals Haringey will request that detailed hydraulic modelling be provided to demonstrate that there is no increased flood risk elsewhere in the receiving catchment.

Flood risk within the development

LS7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

LS8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

LS9a The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

LS9b SuDS design to ensure resilience to blockage and provide for exceedance. Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure, blockage of inlets or outlets, blockage of pipes, impediments along conveyance routes), and the associated flood risks reduced where possible.

LS9c Where development proposals do not meet these proposals Haringey will request that detailed hydraulic modelling be provided to demonstrate the risk of flooding within the development is manageable and that there is no increased flood risk elsewhere in the receiving catchment.

Structural integrity

LS10 Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

LS11 The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use.

Designing for maintenance considerations

LS12 Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity. Designs should ensure accordance with **S1a** before pumping is considered.

Construction

LS13 The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.

LS14 Damage to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed.

Water Quality

LS15 For greenfield developments, the frequency of runoff from the development to any highway drain, sewer or surface water body should not be increased. The surface water runoff should be managed to prevent any discharge of surface water from the site for rainfall events less than 5mm in depth and prevent runoff from the first 5mm of rainfall for larger events. This should be achieved for the majority of all rainfall events that take throughout the year. S1a should be adhered to, otherwise the design should demonstrate that there is no runoff from 80% of rainfall events during summer events and 50% for winter rainfall events using time series rainfall hydraulic modelling analysis.

LS16 Where surface water is likely to be contaminated, effective management is required to reduce contaminant loads and concentrations in the runoff to acceptable levels, in order minimise the risk of pollution of receiving waterbodies and/or protect receiving sewers.

Non-Statutory Technical Standards for SuDS

The Non-Statutory Technical Standards for SuDS, (and accompanying Local Authority SuDS Officer Organisation (LASOO) Practice Guidance) sets out the details which should be addressed within a SuDS Report, including:

- Flood Risk Outside of the Development
- Peak Flow Control and Volume Control
- Flood Risk Within the Development
- Runoff Destinations
- Structural Integrity
- Designing for Maintenance Considerations
- Construction

3. Surface Water Management

The site comprises approximately 0.2ha.

Greenfield Runoff

In line with the London Plan, the Greenfield rate of runoff from the **total site** has been calculated using the **ICP SuDS** method within Micro Drainage (as detailed in **Appendix D** and shown in **Table 1**).

Table 1 – ICP SuDS – Existing Site Runoff Rates (l/s)

Return Period	Flow Rate from 0.2ha (l/s)
Qbar	0.2
1 in 30 year	1.9
1 in 100 year	2.7

Site Areas

The existing site is predominately occupied by hardstanding areas.

Following redevelopment, site areas will be:

- Roof areas (including The Pavilion) - ~0.07ha
- Gardens / landscaped areas - ~1ha
- Paving – ~0.03ha

The proposals will result in a decrease in hardstanding areas of ~1ha and will therefore provide significant betterment in terms of surface water management when compared with the existing situation.

The London Plan 2021 Hierarchy

The London Plan 2021 sets out the preferred hierarchy for the disposal of surface water runoff. This is reviewed below and outlines the most feasible ways that surface water runoff from hardstanding areas (~0.1ha) will be managed.

1) Rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)

There is the potential for simple rainwater harvesting. See the following section of this report.

2) Rainwater infiltration to ground at or close to source

Reference has been made to the British Geology Survey (BGS) Geology Maps. These show that the site is underlain by London Clay.

Additionally, as part of the Basement Impact Assessment for the site, 2 boreholes were taken. A copy of the results is provided in **Appendix E**. The records confirm that the ground conditions comprise a covering (up to 1.2m) of Made Ground over a silty CLAY of the London Clay Formation

On this basis, we would **not** recommend a SuDS strategy which is based infiltration.

However, permeable paving is a feature of the landscaping and therefore a Type C (non-infiltration) system is proposed.

3) Rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)

The site slopes from The Chine to Cascade Avenue. It is important to note that slopes increase the velocity of surface water, which can in turn increase erosion and potential scour. They can also affect the amount of storage capacity that can be provided within SuDS components. Additionally, lower ground floor development is proposed. A cross section of the proposed site is provided overleaf.

However, as shown on the site layout in **Appendix C**, landscaping is a key feature of the proposals, and hardstanding areas will slope towards the landscaped areas; this will help with the conveyance of surface water across the site.



4) Rainwater discharge direct to a watercourse (unless not appropriate)

There are no watercourses in the immediate vicinity of the site.

5) Controlled rainwater discharge to a surface water sewer or drain

It is understood that there are public sewers at the site location.

It is recommended that surface water runoff from hardstanding areas will drain via Type C permeable paving and ultimately connect into the public sewer system following attenuation with a controlled outlet set at 2.7ls which is the 1 in 100 year greenfield rate of runoff from the site.

SuDS Options

Based on the London Plan drainage hierarchy, and recognising the underlying ground conditions and constraints of the site, the following SuDS are proposed:

- Rainwater recycling (water butts)
- Landscaping to convey surface water away from the buildings
- Type C (non-infiltration) permeable paving with a controlled outlet into the public sewer

Water Butt

In order to provide a simple level of rainwater harvesting, each dwelling should have a water butt; this will afford the opportunity to reduce the impact on potable water supply by enabling future occupants of the dwelling to reuse collected water, for example washing the bins. If this supply is used frequently it may also ensure that some additional storage is available during an extreme rainfall event.

Type C (Non Infiltration) Permeable Paving with a Controlled Outlet

Micro Drainage has been used to calculate storage for surface water runoff from hardstanding areas in up to the 1 in 100 year plus 40% allowance for climate change.

As previously detailed, the London Plan requires flows to be restricted to existing greenfield rates of runoff. As such, flows will be restricted to 2.7ls which is the existing 1 in 100 year greenfield rate of runoff.

As shown in **Appendix F**, a **total** storage volume of 42.7m³ would be required. The storage has been designed at a depth of 1.5m, filling to 1.0m and with a 0.5m freeboard provided, should any excess flows be received.

Thames Water will be consulted to confirm capacity and agree the flow rates will be undertaken once planning permission has been granted. Detailed drainage drawings will be submitted at detailed drainage design stage.

The SuDS strategy has been put together based on our understanding of the ground conditions and site layout. Building Control will need to be consulted on the siting of the SuDS, and the recommendations and advice of the SuDS manufacturer / installer should always be followed.

4. SuDS Maintenance

Operation and maintenance schedules are provided below (taken from Ciria C753 The SuDS Manual): these should be adopted by the property owners.

Water Butt

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	<i>The water butt should be routinely checked for litter – leaves can become trapped in the water butt which could lead to blockage of the taps and overflow</i>	Monthly
	<i>Where appropriate, and if safe to do so, the water butt should be cleaned annually to prevent smells associated with stagnant water, and to remove any algae.</i>	Annually

Type C Permeable Paving (Storage)

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial Actions	Repair/ rehabilitate inlets, outlet, overflow, and vents	As required
Monitoring	Inspect/ check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build up and remove if necessary	Every five years, or as required

Pipe System

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required take remedial action.	Monthly for 3 months then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	Remove sediment from pre-treatment inlet structures and inspection chambers.	Annually or as required
	Maintain vegetation to designed limits within the vicinity of below ground drainage pipes and tanks to avoid damage to system	Monthly or as required
Remedial Actions	Repair physical damage if necessary	As required
Monitoring	Inspect all inlets, outlets and vents to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of pipe runs for sediment build up and remove if necessary.	Every 5 years or as required

Hydrobrake

Hydro International Warranty, Maintenance Statement

The following has been provided by Hydro International:

Normally, little maintenance is required as there are no moving parts within the Flow Control. Experience has shown that if blockages occur they do so at the intake, and the cause on such occasions has been due to a lack of attention to engineering detail such as approach velocities being too low, inadequate benching, or the use of units below the minimum recommended size.

The Flow Control (where applicable) is fitted with a pivoting bypass door, which allows the manhole chamber to be drained down should blockage occur. The smaller conical units, below the minimum recommended size, are also supplied with rodding facilities or vortex suppressor pipes as standard.

Following installation of the Flow Control it is vitally important that any extraneous material i.e. building materials are removed from the unit and the chamber.

After the system is made live, and assuming that the chamber design is satisfactory, it is recommended that each unit be inspected monthly for three months and thereafter at six monthly intervals with hose down if required.

5. Conclusions

This Surface Water and SuDS Assessment (Rev0) has been prepared to support the planning application for the proposed residential development at Collins Court, Cascade Avenue.

The existing site comprises a former tennis club house and associated asphalt tennis courts/.

Proposals are for two new residential terraces, each comprising 4no. dwellings, with one terrace fronting The Chine and one terrace fronting Cascade Avenue. Additionally, the existing tennis club house, The Pavilion, is to be renovated and converted into a new dwelling.

The proposals will result in a decrease in hardstanding areas of ~1ha and will therefore provide significant betterment in terms of surface water management when compared with the existing situation.

Based on the London Plan Drainage Hierarchy, and a desktop study of underlying ground conditions, the following are considered to be the most feasible ways that surface water runoff from hardstanding areas (~0.1ha) should be managed.

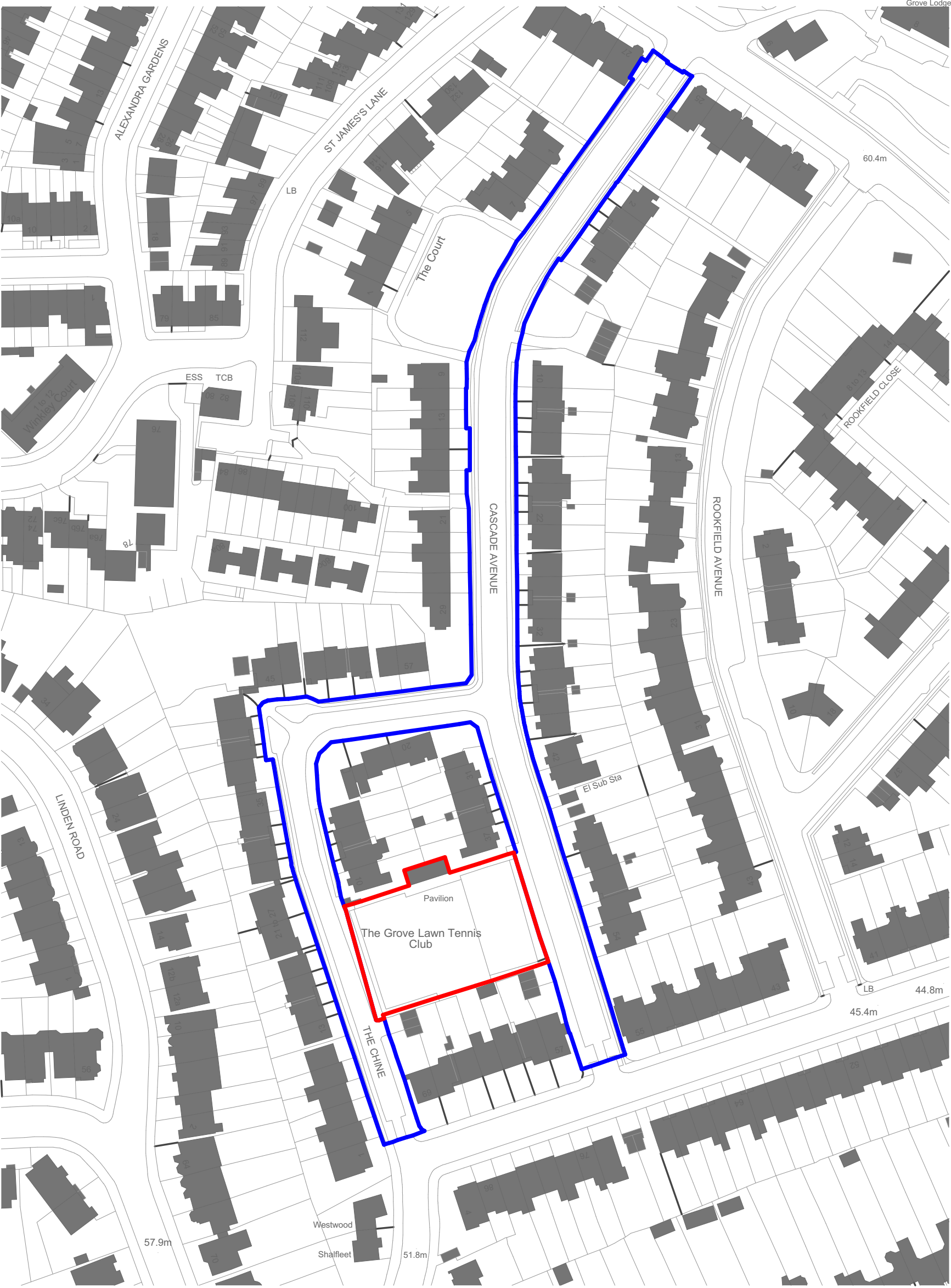
- Rainwater recycling (water butts)
- Landscaping to convey surface water away from the buildings
- Type C (non-infiltration) permeable paving with a controlled outlet into the public sewer (controlled outlet set at 2.7ls which is the exiting 1 in 100 year greenfield runoff rate from the site)

Operation and maintenance schedules have been provided; these (or similar) should be adopted by the property owners / management company.

It is important to note that the SuDS strategy is based on the desktop study of underlying ground conditions, along with our understanding of the site layout. Building Control will need to be consulted on the siting of the SuDS, and the recommendations and advice of the SuDS manufacturer / installer should always be followed.

Appendices

Appendix A - Site Location Plan



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Collins Court

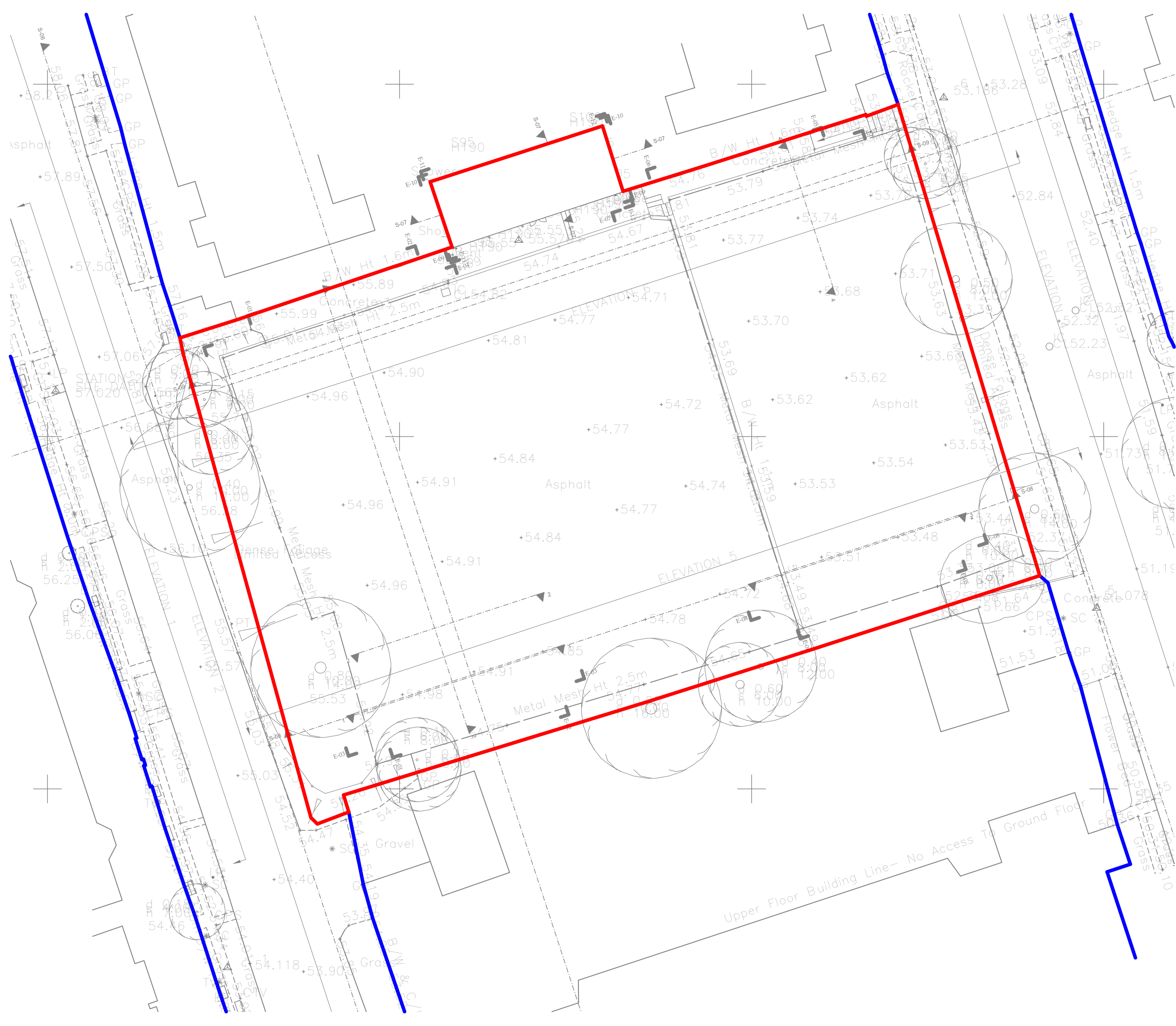
Cascade Avenue

Location Plan 6299 - PL 01

1:1250 0 10 20 30 40 50 60 70 80 90 100

Jan 23

Appendix B - Existing Site Layout and Topographic Survey



Adjacent Properties and Boundaries are shown for illustrative purposes only and have not been surveyed unless otherwise stated.

All areas shown are approximate and should be verified before forming the basis of a decision.

Do not scale other than for Planning Application purposes.

All dimensions must be checked by the contractor before commencing work on site.

No deviation from this drawing will be permitted without the prior written consent of the Architect.

The copyright of this drawing remains with the Architect and may not be reproduced in any form without prior written consent.

Ground Floor Slabs, Foundations, Sub-Structures, etc. All work below ground level is shown provisionally. Inspection of ground condition is essential prior to work commencing.

Reassessment is essential when the ground conditions are apparent, and redesign may be necessary in the light of soil conditions found. The responsibility for establishing the soil and sub-soil conditions rests with the contractor.



Rev	Date	Description	Initials
PROJECT		Collins Court Cascade Avenue	
TITLE:		Existing Site Plan	
SCALE:		1:250 @A3	
DATE:		January 2023	
DRAWING No:		6299 - PL 02	
DRAWN BY:		MB/SDR/CL	

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Appendix C - Proposed Site Layout Plans

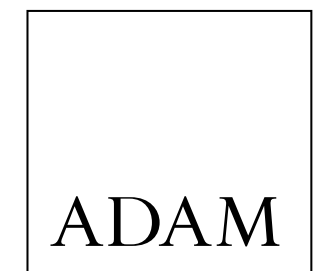


Collins Court

Cascade Avenue

Proposed Context Site Plan 6299 - PL 03

1:200 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Jan 23



ARCHITECTURE

Appendix D - Greenfield Rate of Runoff

Base Energy Services Limited		Page 1
44 Canal Street Bootle Liverpool L20 8QU	Collins Court Total Greenfield Runoff	
Date 23/01/2023 09:39 File	Designed by CC Checked by PK	
Micro Drainage Source Control 2020.1.3		
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 Soil 0.450 Area (ha) 0.200 Urban 0.000 SAAR (mm) 678 Region Number Region 6 Results 1/s QBAR Rural 0.8 QBAR Urban 0.8 Q100 years 2.7 Q1 year 0.7 Q30 years 1.9 Q100 years 2.7		
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Appendix E - Borehole Records

Logger:

VF

Levels approximate; taken from topographic plan provided by Client.

Levels approximate; taken from topographic plan provided by Client.

[illegible]

Base Energy Services Limited					Page 1
44 Canal Street Bootle Liverpool L20 8QU		Collins Court 100yr 40CC 2.7ls Attenuation			
Date 23/01/2023 File		Designed by CC Checked by PK			
Micro Drainage		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.589	0.589	2.7	25.0	O K
30 min Summer	0.743	0.743	2.7	31.6	O K
60 min Summer	0.849	0.849	2.7	36.1	O K
120 min Summer	0.870	0.870	2.7	37.0	O K
180 min Summer	0.839	0.839	2.7	35.6	O K
240 min Summer	0.801	0.801	2.7	34.0	O K
360 min Summer	0.726	0.726	2.7	30.8	O K
480 min Summer	0.654	0.654	2.7	27.8	O K
600 min Summer	0.573	0.573	2.7	24.3	O K
720 min Summer	0.501	0.501	2.7	21.3	O K
960 min Summer	0.383	0.383	2.7	16.3	O K
1440 min Summer	0.229	0.229	2.7	9.7	O K
2160 min Summer	0.125	0.125	2.4	5.3	O K
2880 min Summer	0.092	0.092	2.1	3.9	O K
4320 min Summer	0.067	0.067	1.5	2.9	O K
5760 min Summer	0.057	0.057	1.2	2.4	O K
7200 min Summer	0.050	0.050	1.0	2.1	O K
8640 min Summer	0.046	0.046	0.8	1.9	O K
10080 min Summer	0.043	0.043	0.8	1.8	O K
15 min Winter	0.668	0.668	2.7	28.4	O K
30 min Winter	0.841	0.841	2.7	35.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	148.221	0.0	27.7	25	
30 min Summer	95.453	0.0	35.7	38	
60 min Summer	58.456	0.0	43.8	64	
120 min Summer	34.593	0.0	51.9	118	
180 min Summer	25.135	0.0	56.5	148	
240 min Summer	19.934	0.0	59.8	180	
360 min Summer	14.335	0.0	64.5	250	
480 min Summer	11.346	0.0	68.1	318	
600 min Summer	9.458	0.0	70.9	382	
720 min Summer	8.148	0.0	73.3	442	
960 min Summer	6.435	0.0	77.2	562	
1440 min Summer	4.609	0.0	82.9	788	
2160 min Summer	3.296	0.0	89.0	1128	
2880 min Summer	2.597	0.0	93.5	1472	
4320 min Summer	1.853	0.0	100.0	2204	
5760 min Summer	1.458	0.0	104.9	2896	
7200 min Summer	1.209	0.0	108.8	3672	
8640 min Summer	1.038	0.0	112.1	4400	
10080 min Summer	0.912	0.0	114.9	5112	
15 min Winter	148.221	0.0	31.1	25	
30 min Winter	95.453	0.0	40.0	38	
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Appendix F - Micro Drainage Attenuation Calculations

Base Energy Services Limited				Page 2	
44 Canal Street		Collins Court			
Bootle		100yr 40CC 2.7ls			
Liverpool L20 8QU		Attenuation			
Date 23/01/2023		Designed by CC			
File		Checked by PK			
Micro Drainage		Source Control 2020.1.3			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.967	0.967	2.7	41.1	O K
120 min Winter	1.006	1.006	2.7	42.7	O K
180 min Winter	0.966	0.966	2.7	41.1	O K
240 min Winter	0.919	0.919	2.7	39.1	O K
360 min Winter	0.817	0.817	2.7	34.7	O K
480 min Winter	0.715	0.715	2.7	30.4	O K
600 min Winter	0.598	0.598	2.7	25.4	O K
720 min Winter	0.484	0.484	2.7	20.6	O K
960 min Winter	0.317	0.317	2.7	13.5	O K
1440 min Winter	0.146	0.146	2.5	6.2	O K
2160 min Winter	0.085	0.085	1.9	3.6	O K
2880 min Winter	0.068	0.068	1.5	2.9	O K
4320 min Winter	0.054	0.054	1.1	2.3	O K
5760 min Winter	0.046	0.046	0.9	2.0	O K
7200 min Winter	0.042	0.042	0.7	1.8	O K
8640 min Winter	0.038	0.038	0.6	1.6	O K
10080 min Winter	0.035	0.035	0.5	1.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	58.456	0.0	49.1	64	
120 min Winter	34.593	0.0	58.1	118	
180 min Winter	25.135	0.0	63.3	156	
240 min Winter	19.934	0.0	67.0	190	
360 min Winter	14.335	0.0	72.2	268	
480 min Winter	11.346	0.0	76.2	344	
600 min Winter	9.458	0.0	79.4	416	
720 min Winter	8.148	0.0	82.1	472	
960 min Winter	6.435	0.0	86.5	586	
1440 min Winter	4.609	0.0	92.9	794	
2160 min Winter	3.296	0.0	99.7	1112	
2880 min Winter	2.597	0.0	104.7	1468	
4320 min Winter	1.853	0.0	112.0	2160	
5760 min Winter	1.458	0.0	117.5	2920	
7200 min Winter	1.209	0.0	121.9	3648	
8640 min Winter	1.038	0.0	125.5	4408	
10080 min Winter	0.912	0.0	128.7	5088	
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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)	20.600	Shortest Storm (mins)	15
Ratio R	0.446	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.100

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.033	4 8	0.033	8 12	0.033

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Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	42.5	0.700	42.5	1.400	42.5	2.100	42.5
0.100	42.5	0.800	42.5	1.500	42.5	2.200	42.5
0.200	42.5	0.900	42.5	1.600	42.5	2.300	42.5
0.300	42.5	1.000	42.5	1.700	42.5	2.400	42.5
0.400	42.5	1.100	42.5	1.800	42.5	2.500	42.5
0.500	42.5	1.200	42.5	1.900	42.5		
0.600	42.5	1.300	42.5	2.000	42.5		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0078-2700-1000-2700
Design Head (m)	1.000
Design Flow (l/s)	2.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	78
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.7
Flush-Flo™	0.300	2.7
Kick-Flo®	0.622	2.2
Mean Flow over Head Range	-	2.4

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	2.2	1.200	2.9	3.000	4.5	7.000	6.7
0.200	2.6	1.400	3.2	3.500	4.8	7.500	6.9
0.300	2.7	1.600	3.4	4.000	5.1	8.000	7.1
0.400	2.7	1.800	3.5	4.500	5.4	8.500	7.3
0.500	2.5	2.000	3.7	5.000	5.7	9.000	7.5
0.600	2.3	2.200	3.9	5.500	6.0	9.500	7.7
0.800	2.4	2.400	4.0	6.000	6.2		
1.000	2.7	2.600	4.2	6.500	6.5		

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