Sustainable
Drainage System Strategy

Site Address
33 Beech Hill Avenue
Barnet
EN4 0LU

Client
Vahid Tahmasvand

Report Reference
SWDS - 2024 - 000019

Prepared By
STM Environmental Consultants Ltd

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1 Document Control

Sustainable Drainage System Strategy

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2 Abbreviations

Abbreviation	Description
STM	STM Environmental Consultants Limited
BGS	British Geological Survey
EA	Environment Agency
OS	Ordnance Survey of Great Britain
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
FWD	Floodline Warning Direct
FRMS	Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
SWMP	Surface Water Management Plan
SFRA	Strategic Flood Risk Assessment
CDA	Critical Drainage Area
SuDS	Sustainable Drainage Systems
GWSPZ	Groundwater Source Protection Zone
TPH	Total Petroleum Hydrocarbons
BTEX	Benzene, Toluene, Ethylene, Xylene
PAH	Poly-Aromatic Hydrocarbons

3 Disclaimer

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4 Executive Summary

<table>
<tr><th colspan="4">BACKGROUND</th></tr>
<tr><td>Location</td><td colspan="3">33 Beech Hill Avenue, Barnet, EN4 0LU
Grid reference: 526578, 197589</td></tr>
<tr><td>Site Area</td><td colspan="3">1585m^2</td></tr>
<tr><td>Proposed Development</td><td colspan="3">Part single, part 2- storey side/rear extension, with 2 x front dormers and with doors and balustrade (Ref: 23/03644/HOU).</td></tr>
<tr><td>Current Site and Surrounding Uses</td><td colspan="3">The site is currently used as a residential dwelling. The close surrounding area consists of mainly residential properties to the north and west, Covert Way Local Nature Reserve to the south and Hadley Wood Golf Course to the east.</td></tr>
<tr><td>Topography</td><td colspan="3">The site elevations are variable with a very steep incline towards the west, the site ranges from 75.24mAOD (E) to 80.34mAOD (W).</td></tr>
<tr><td>Hydrology</td><td colspan="3">The nearest main watercourse is the Green Brook which is located approximately 73m southeast of the site.</td></tr>
<tr><td>Geology</td><td colspan="3">BGS information indicates that there are no identifiable superficial deposits while the bedrock is classified as belonging to the London Clay (Clay, Silt and Sand).</td></tr>
<tr><td>Hydrogeology</td><td colspan="3">BGS information indicates that the site is situated upon an Unproductive bedrock aquifer.</td></tr>
<tr><td>Permeability</td><td colspan="3">BGS information indicates that the bedrock is classified as being of highly variable permeability.</td></tr>
<tr><td>Infiltration Potential</td><td colspan="3">BGS information indicates that there are opportunities for bespoke infiltration SuDS at the site.</td></tr>
<tr><td>Fluvial Flood Risk</td><td colspan="3">Very Low – the site lies within EA Flood Zone 1.</td></tr>
<tr><td>Surface Water Flood Risk</td><td colspan="3">Very Low - the site is not impacted by the EA modelled surface water flood scenarios. There is however pluvial flooding on the adjoining road (Beach Hill Avenue) during all modelled events.</td></tr>
<tr><td>Groundwater Flood Risk</td><td colspan="3">Low - the EA indicates there no information regarding groundwater flooding susceptibility for the site. The groundwater table is indicated to be less than 3mbgl for at least part of the year.</td></tr>
<tr><td rowspan="5">Existing and Proposed Site Layout</td><td>Ground Cover</td><td>Existing (m^2)</td><td>Proposed (m^2) (Without SuDS)</td></tr>
<tr><td>Buildings</td><td>194</td><td>387</td></tr>
<tr><td>Driveways/Patio</td><td>381</td><td>259</td></tr>
<tr><td>Gardens/ Soft landscaping</td><td>1010</td><td>939</td></tr>
<tr><td>Total Impermeable Area</td><td>575</td><td>646</td></tr>
<tr><td>Changes in Impermeable Area</td><td colspan="3">Without SuDS, the proposed development would increase the impermeable area of the site by 5% (i.e. 71m^2). The combined proposals increase the total positive catchment by 125m^2.</td></tr>
</table>

PROPOSED SUDS			
Run-Off Rates	Greenfield (GF) (l/s)	Pre - Development (l/s)	Post Development Without SuDS (l/s)
Qbar	0.74	0.82	0.83
1 in 1	0.63	0.70	0.71
1 in 30	1.70	1.89	1.91
1 in 100	2.36	2.61	2.65
1 in 100 + CC (40%)	3.50	3.88	3.93
SuDS Target Requirement	As the development is taking place on a previously developed site S3 (peak flow) and S5 and S6 (volume controls) apply. The proposal will aim to achieve a discharge rate of 2.0l/s for all storm events.		
Storage Required	36m^3 of attenuation is required;		
Infiltration Testing	The site investigation works were carried out on the 24th and 25th of January 2023. 2no. trial pits were excavated to a maximum depth of 1.5mbgl for undertaking infiltration testing in accordance with BRE DG 365. The pits failed to drain more than 50% of their volume during the 1st test run. Testing was therefore terminated and infiltration SuDS methods concluded to be unsuitable for the Site.		
SuDS Strategy	The proposal will introduce rainwater butts, bespoke SuDS planters and large rain garden within the front garden to work in combination with the existing permeable block paving. The scheme will be supplemented with a geocellular attenuation storage tank. These measures provide 35m^3 attenuation and a further 0.4m^3 dedicated for rainwater re-use. The discharge from the geocellular storage tank will be limited to 2.0 l/s during all storm events via an Hydro-Break vortex flow control chamber. All excess surface water runoff will be discharged via the existing Thames Water surface water sewer connection to the front of the site.		
Conclusion	With the proposed SuDS mitigation measures in place, we believe that the proposed development will reduce local flood risk and therefore be in compliance with the LLFA's current planning policy and the NPPF.		

5 Introduction

STM Environmental Consultants Limited were appointed by Vahid Tahmasvand to undertake a Sustainable Drainage System (SuDS) Strategy for a proposed development at 33 Beech Hill Avenue, Barnet, EN4 0LU.

5.1 Proposed Development

The SuDS strategy is required to support a planning application (ref: 23/03644/HOU) for “Part single, part 2- storey side/rear extension, with 2 x front dormers and with doors and balustrade”.

Condition No. 4 states:

> The development shall not commence until a Sustainable Drainage Strategy has been submitted to and approved in writing by the Local Planning Authority. The details shall be based on the disposal of surface water by means of a sustainable drainage system in accordance with the principles as set out in the Technical Guidance to the National Planning Policy Framework and should be in line with our DMD Policy SuDS Requirements:

> - Shall be designed to a 1 in 1 and 1 in 100-year storm event with the allowance for climate change;
> - Follow the London Plan Drainage Hierarchy and providing evidence of the potential for full infiltration SuDS and maximising above ground storage;
> - Follow the SuDS management train by providing source control for the site, and a number of treatment phases corresponding to their pollution potential;
> - Maximise opportunities for sustainable development, improve water quality, biodiversity, local amenity, and recreation value;
> - The system must be designed to allow for flows that exceed the design capacity to be stored on site or conveyed off-site with minimum impact;
> - Clear ownership, management and maintenance arrangements must be established;
> - The details submitted shall include levels, sizing, cross sections and specifications for all drainage features;

> Reason: To ensure the sustainable management of water, minimise flood risk, minimise discharge of surface water outside of the curtilage of the property and ensure that the drainage system will remain functional throughout the lifetime of the development in accordance with Policy CP28 of the Enfield Core Strategy (2010), Policy DMD61 Enfield Development Management Document (2014), Policies SI12 & SI13 of the London Plan (2021) and the NPPF and to maximise opportunities for sustainable development, improve water quality, biodiversity, local amenity and recreation value.

Copies of the development plans are presented in Appendix 1.

5.2 Report Aims and Objectives

This report sets out the proposed drainage strategy that will be employed in the designs to meet the requirements of the planning condition and the National Planning Policy Framework.

This report has been written in conjunction with a separate report (SWDS – 2024 – 000010), which has been written to address condition No. 4 attached to planning ref: 23/03903/HOU for the “Two storey rear extension, installation of rooflight to first floor bathroom and demolition of bay window to the living room and installation of bifold”.

The strategies that have been provided for each planning application are the same, as the developer will be aiming to undertake the works simultaneously, allowing for reduction in costs and minimise the chance of clashes or errors within the systems.

5.3 Legislative and Policy Context

5.3.1 Legislative Context

Section H3 of the Building Regulations 2010 requires that adequate provision is made for rainwater to be carried from the building roofs and paved areas. and be preferentially discharged to soakaways or some other adequate infiltration system. Where that is not reasonably practicable, a watercourse; or sewer can be used.

The Flood and Water Management Act was introduced in 2010. The Act defines the role of lead local flood authority (LLFA) for an area. All LLFA are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area, called “local flood risk management strategy”.

Alongside the Act, Flood Risk Regulations (2009) outline the roles and responsibilities of the various authorities, which include preparing Flood Risk Management Plans and identifying how significant flood risks are to be mitigated.

5.3.2 Policy Context

The National Planning Policy Framework (NPPF) sets out the Government's economic, environmental and social planning policies for England. The policies set out in this framework apply to the preparation of local and neighbourhood plans and to decisions on planning applications.

Paragraph 167 of the National Planning Policy Framework (NPPF) states that:

> When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment (See Note 1) Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:
>
> - within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location
> - the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;
> - it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
> - any residual risk can be safely managed; and
> - safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Applications for some minor development and changes of use (See Note.2) should not be subject to the sequential or exception tests but should still meet the requirements for site-specific flood risk assessments set out in (See Note 1).

Paragraph 169 states that:

> Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- take account of advice from the lead local flood authority;
- have appropriate proposed minimum operational standards;
- have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
- where possible, provide multifunctional benefits.

A major development is defined as:

- a residential development: 10 dwellings or more or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known
- a non-residential development: provision of a building or buildings where the total floor space to be created is 1000 square metres or more or where the floor area is not yet known, a site area of 1 hectare or more.

Note. 1 - A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

Note. 2 - This includes householder development, small non-residential extensions (with a footprint of less than 250m^2) and changes of use; except for changes of use to a caravan, camping or chalet site, or to a mobile home or park home site, where the sequential and exception tests should be applied as appropriate.

5.3.3 The London Plan - Policy SI 13 Sustainable drainage

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.

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:

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

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.

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 (2).

5.4 Local Planning Policy - London Borough of Enfield

5.4.1 DMD 59 Avoiding and Reducing Flood Risk

New development must avoid and reduce the risk of flooding, and not increase the risks elsewhere. New development must:

- Be appropriately located and informed by a site-specific Flood Risk Assessment (FRA) if proposed in flood risk areas in line with DMD 60 'Assessing Flood Risk';
- Preserve overland flood and flow routes, where applicable;
- Ensure no net loss of flood storage on site, or in exceptional circumstances, provide adequate off-site compensatory storage;

- Manage surface water as part of all development to reduce run off in line with DMD 60 'Assessing Flood Risk'; and
- Prevent the loss of permeable surfaces/areas of soft landscaping, and maximise the use of green infrastructure as potential sources of flood storage.

Planning permission will only be granted for proposals which have addressed all sources of flood risk and would not be subject to, or result in unacceptable levels of flood risk on site or increase the level of flood risk to third parties.

This policy should be read in conjunction with Core Strategy Policy 28

5.4.2 DMD 61 Managing Surface Water A Drainage Strategy

Will be required for all developments to demonstrate how proposed measures manage surface water as close to its source as possible and follow the drainage hierarchy in the London Plan. All developments must maximise the use of and, where possible, retrofit Sustainable Drainage Systems (SuDS) which meet the following requirements:

- Suitability; SuDS measure(s) should be appropriate having regard to the proposed use of site, site conditions/context (including proximity to Source Protection Zones and potential for contamination) and geology.
- Quantity; All major developments must achieve greenfield run off rates (for 1 in 1 year and 1 in 100 year events). All other development should seek to achieve greenfield run off and must maximise the use of SuDS, including at least one 'at source' SuDS measure resulting in a net improvement in water quantity or quality discharging to sewer in-line with any SuDS guidance or requirements.
- Quality; Major developments must have regard to best practice and where appropriate follow the SuDS management train by providing a number of treatment phases corresponding to their pollution potential and the environmental sensitivities of the locality.
- Functionality; The system must be designed to allow for flows that exceed the design capacity to be stored on site or conveyed off-site with minimum impact.

Clear ownership, management and maintenance arrangements must be established. Other; Where appropriate, developments must incorporate relevant measures identified in the Surface Water Management Plan.

The criteria above must be demonstrated through the submission of a site-specific FRA, where one is required, or a Sustainable Design and Construction Statement.

5.4.3 DMD 62 Flood Control and Mitigation

Measures Development that increases flood risk to third parties or is not defined as safe in line with Enfield's Strategic Flood Risk Assessment (SFRA) will not be acceptable. All new developments at risk of flooding should be accompanied by appropriate flood mitigation measures.

New development should:

- Maintain or provide new or upgraded flood infrastructure at a sufficient standard of protection and/or provide a financial contributions towards measures which reduce and mitigate against flood risk.
- Where new infrastructure or protection results in a loss of floodplain storage volume this must be compensated for in an appropriate manner; Maintain adequate distances from rivers/watercourses in line with DMD 63 'Protection and Improvement of Watercourses and Flood Defences'.
- Incorporate flood resilient and flood resistant design measures;
- Apply appropriate construction techniques to limit the disturbance to natural groundwater flows, such as the use of piled foundations; and
- Provide flood Warning arrangements and Evacuation Plans.
- Where the development is for essential infrastructure, the measures should ensure that the site is designed to remain operational when floods occur. The Council will refuse proposals which provide an unacceptable standard of safety.

6 Site Characteristics

6.1 Location and Area

The site is centred at national grid reference 526578, 197589 and has an area of 1,585m^2.

It falls within the jurisdiction of London Borough of Enfield in terms of the planning consultation process on flood risk and surface water management. The LLFA is also the London Borough of Enfield.

Figure 1 below shows the site location with OS mapping and world imagery.

6.2 Current Site and Surrounding Uses

The site is currently used as a residential dwelling. The close surrounding area consists of mainly residential properties to the north and west, Covert Way Local Nature Reserve to the south and Hadley Wood Golf Course to the east.

6.3 Site Topography

The mapping provided in Appendix 2 shows 1m DTM LiDAR and a topographical survey of show the elevations within the site.

The elevations within the site range from 75.24mAOD (east) to 80.34mAOD (west). The rear garden (west) forms part of a steep eastern facing slope. The existing dwelling is situated at elevations of 76.5mOAD (driveway) to 77.0mAOD (rear patio).

6.4 Hydrology

The nearest main watercourse is the Green Brook which is located approximately 73m southeast of the site. A direct discharge connection to the brook is not considered feasible.

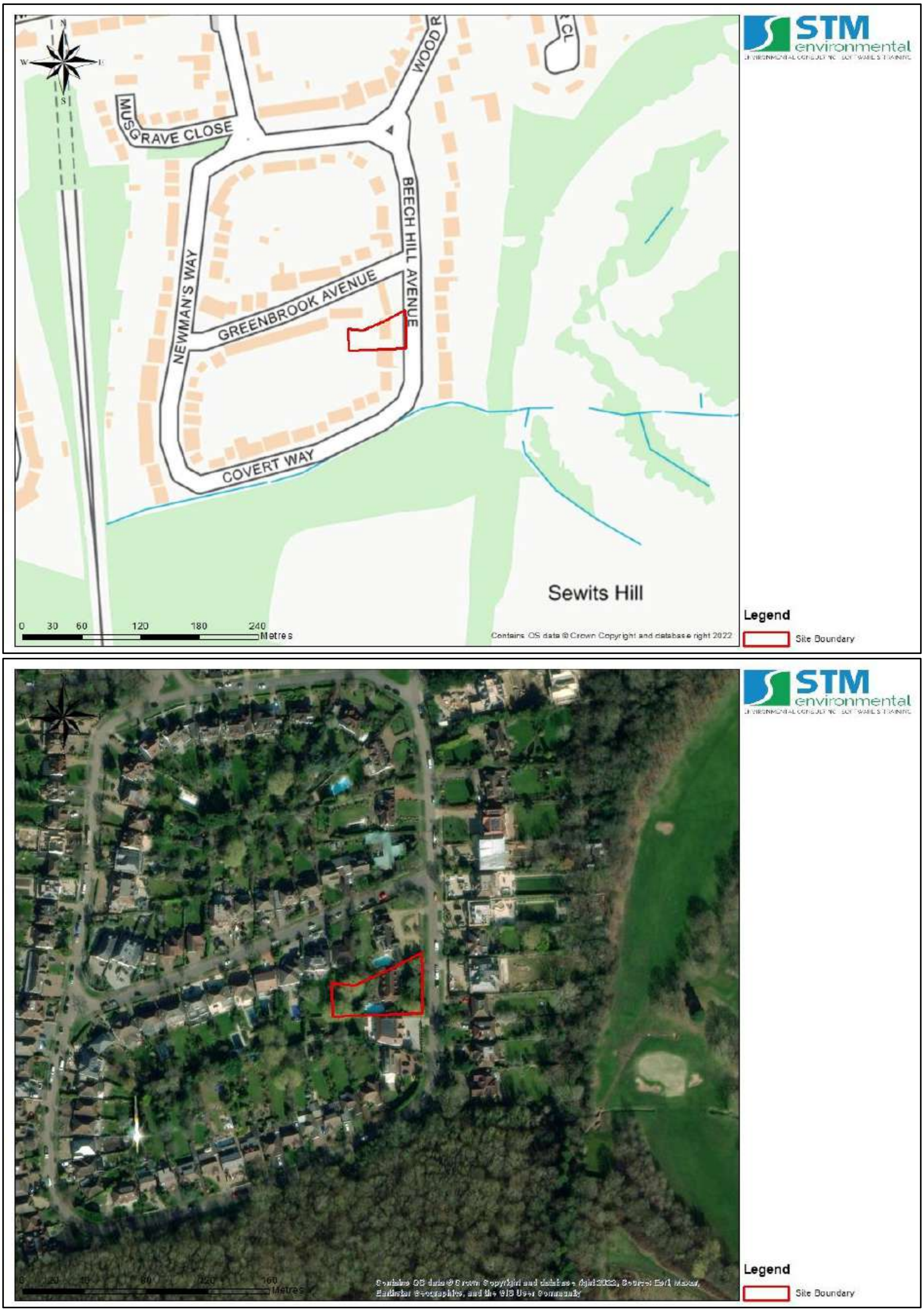

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Figure 1: Site location map and aerial photo

6.5 Geology and Hydrogeology

BGS mapping showing the geological and hydrogeological characteristics of the site are presented in Appendix 2.

The BGS information indicates that there are no identifiable superficial deposits while the bedrock is classified as belonging to London Clay (Clay, Silt and Sand).

The permeability of the bedrock geology is considered to be highly variable.

The BGS infiltration potential map suggests that there are opportunities for bespoke infiltration SuDS at the site.

The maps also indicate that the groundwater table is less than 3mbgl for at least part of the year.

The site lies upon an Unproductive bedrock aquifer. The site does not lie within a Groundwater Source Protection Zone.

6.6 Flood Risk

6.6.1 Fluvial Flood Risk

Fluvial and tidal risk is assessed using flooding maps produced by the Environment Agency (EA). These maps use available historic data and hydraulic modelling to define zones of flood risk. The maps allow a site to be defined in terms of its Flood Zone (e.g. 1, 2, 3a or 3b) and in terms of the overall flood risk (very low, low, medium or high).

The EA Flood Zones are defined as:

- Flood Zone 1: Less than a 1 in 1000 annual probability of fluvial and/or tidal flooding;
- Flood Zone 2: Between 1 in 100 and 1 in 1000 annual probability of fluvial flooding and/or between 1 in 200 and 1 in 1000 annual probability of tidal flooding;

- Flood Zone 3a: Greater than 1 in 100 annual probability of fluvial flooding and/or greater than 1 in 200 annual probability of tidal flooding;
- Flood Zone 3b: functional flood plain (definition specific to the LLFA). Less than a 1 in 20 annual probability of fluvial and/or tidal flooding.

The site is designated as being within Flood Zone 1 and is therefore considered to have a very low risk of flooding. This equates to a potential yearly risk of flooding of less than 0.1% Annual Expected Probability.

6.6.2 Surface Water Flood Risk

Surface water flooding occurs when high intensity rainfall leads to run-off which flows over the ground surface, causing ponding in low-lying areas when the precipitation rate or overland flow rate is greater than the rate of infiltration, or return into watercourses. Surface water flooding can be exacerbated when the underlying soil and geology is saturated (as a result of prolonged precipitation or a high-water table) or when the drainage network has insufficient capacity.

The chief mechanisms for flooding can be divided into the following categories:

- Runoff from higher topography – the areas of greatest flood depths tend to be at the base of the steeper land;
- Localised surface water runoff – within the central parts of the borough, surface water flooding tends to be a result of localised ponding of surface water;
- Sewer Flooding – areas where extensive and deep surface water flooding is likely to be influenced by sewer flooding. Where the sewer network has reached capacity, and surcharged, this will exacerbate the flood risk in these areas.
- Low Lying Areas – areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;
- Railway Cuttings – leading to internal ponding and transport disruption;

- Railway Embankments – discrete surface water flooding locations along the up-stream side of the raised network rail embankments where water flows are interrupted and ponding can occur.

A map showing the site and the modelled prediction of surface water flood risk and depth provided by the EA is available in Appendix 3. This indicates that the site is at very low risk of flooding.

6.6.3 Groundwater Flood Risk

Groundwater flooding occurs when water rises from the underlying aquifer at the location of a spring – where the underlying impermeable geology meets the ground surface. This tends to occur after much longer periods of intense precipitation, in often low-lying areas where the water table is likely to be at a shallow depth. Groundwater flooding is known to occur in areas underlain by principal aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

BGS data was examined, however no information regarding groundwater susceptibility at the site was found.

6.7 Existing Drainage

Drainage plans showing the existing surface water drainage system at the site are were not available. It is assumed that a surface water connection into the Thames Water Asset is already present on site.

A utility search was undertaken which identified Thames Water as the local sewage undertaker. The Asset map is available in Appendix 4.

Table 1: Asset Information

Asset ID	Manhole Cover Level (mAOD)	Manhole Invert Level (mAOD)	Depth (m)
6601	79.58	77.88	1.70
6501	75.85	74.26	1.59

7 Hydrological Run-off Assessment

To minimise the impact of the new development on local flood risk, the NPPF requires that post development surface water run-off volumes and peak flow rates are improved upon those of the existing conditions. The following section provides an assessment of greenfield as well as pre- and post-development run-off rates.

7.1 Existing and Proposed Ground Cover

A summary of the existing and proposed site ground cover is shown below in Table 2 and Table 3 below. These tables assume all hardstanding will remain as impermeable surfaces.

Table 2: Breakdown of Ground Cover in the Proposed Development

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m^2)
	m^2	%	m^2	%	
Buildings	194	12	387	24	193
Hard Standing	381	24	259	16	-122
Soft landscaping	1010	64	939	59	71
Total	1585	100	1585	100	

Table 3: Summary of Permeable and Impermeable Areas

	Impermeable Area		Permeable Area		Total Area
	m^2	%	m^2	%	m^2
Existing Site	575	36	1010	64	1585
Proposed Site	646	41	939	59	1585
Difference	71	5	-71	-5	

The proposal will increase the impermeable area of the site and as such it has potential to have an impact on the surface water runoff rates.

The combined areas, from both proposals are outlined in Appendix 5.

8 SuDS Requirements

8.1 Peak Flow Control

With regard to peak flow control, the non-statutory technical standards for sustainable drainage systems state that:

- S3 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.

The London Plan SI.13 states that 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. The London Plan Sustainable Design and Construction SPG (section 3.4.10) states that 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.

8.2 Volume Control Requirements

With regard to volume control, the non-statutory technical standards for sustainable drainage systems state that:

- S5 Where reasonably practicable, 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.
- S6 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.

8.3 Run-off and Storage Calculations

The IH124 & Modified Rational Method (MRM) methods were applied to calculate the Greenfield and pre-development run-off rates. The full results are presented in

Appendix 5. Table 4 below gives a summary of the results when taking into account both proposal.

Table 4: Calculation of post-development run-off rates for the site.

	Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Qbar	0.74	0.82	0.83
1 in 1	0.63	0.70	0.71
1 in 30	1.70	1.89	1.91
1 in 100	2.36	2.61	2.65
1 in 100 + CC	3.50	3.88	3.93

As the development is taking place on a previously developed site S3 (peak flow) and S5 and S6 (volume controls) apply.

The IH24 methodology was used, to achieve the greenfield runoff rate, it is estimated to require approximately 9m^3 of attenuation storage.

To achieve a 2.0 l/s discharge rate for all storm events, it is estimated to require between 27 and 36m^3 of attenuation when taking into account the entire positive catchment area (0.07ha) and taking into account the impact of urban creep.

Full details of the storage estimates and discharge rates are available in Appendix 5.

9 Site Investigation

9.1 Site Investigation

The site investigation works were carried out on the 24th and 25th of January 2023. A total of 2no. trial pits were excavated to a maximum depth of 1.5mbgl for undertaking infiltration testing in accordance with BRE DG 365.

Additionally, 1no. borehole was advanced to a maximum depth of 9mbgl using a dynamic windowless sampler rig. In-situ Standard Penetration Tests (SPT) were carried out at 1m intervals during a separate investigation undertaken on the 18th of February 2021.

9.2 Ground Conditions Encountered

The investigation encountered ground conditions consistent with the published geological records of the area. Firm CLAY was encountered to a depth of 1mbgl underlain by stiff light brown CLAY to 6mbgl followed by very stiff dark brown CLAY to a maximum depth of 9mbgl.

9.3 Infiltration Testing

Infiltration testing in general accordance with the methodology outlined in BRE Digest 365 was conducted in the two trial pits.

The trial pits were rapidly filled with water from a 1.2m^3 water bowser. The pits were left to drain for a 24 - hour period. The water level was continuously monitored using a water level logger. The water level failed to infiltrate and remained close to the original water level throughout the course of the investigation. As the pits failed to drain more than 50% of its volume, the testing was abandoned.

Based on these findings, infiltration SuDS methods are considered to be unsuitable for the site.

Full details including photos, graphs, location map and results of the infiltration testing are available in Appendix 6.

9.3.1 Groundwater

Groundwater was not encountered during the investigation.

10 SuDS Options

As mentioned above, planning policies require that SuDS strategies consider source control (i.e. disposal of runoff within the plot boundary), followed by site control (site wide disposal) and then regional control (appropriate for larger development with strategic drainage infrastructure). They also require that that those methods that give the most benefits in terms of sustainability are prioritised for employment (generally known as the SuDS Hierarchy) as further described below.

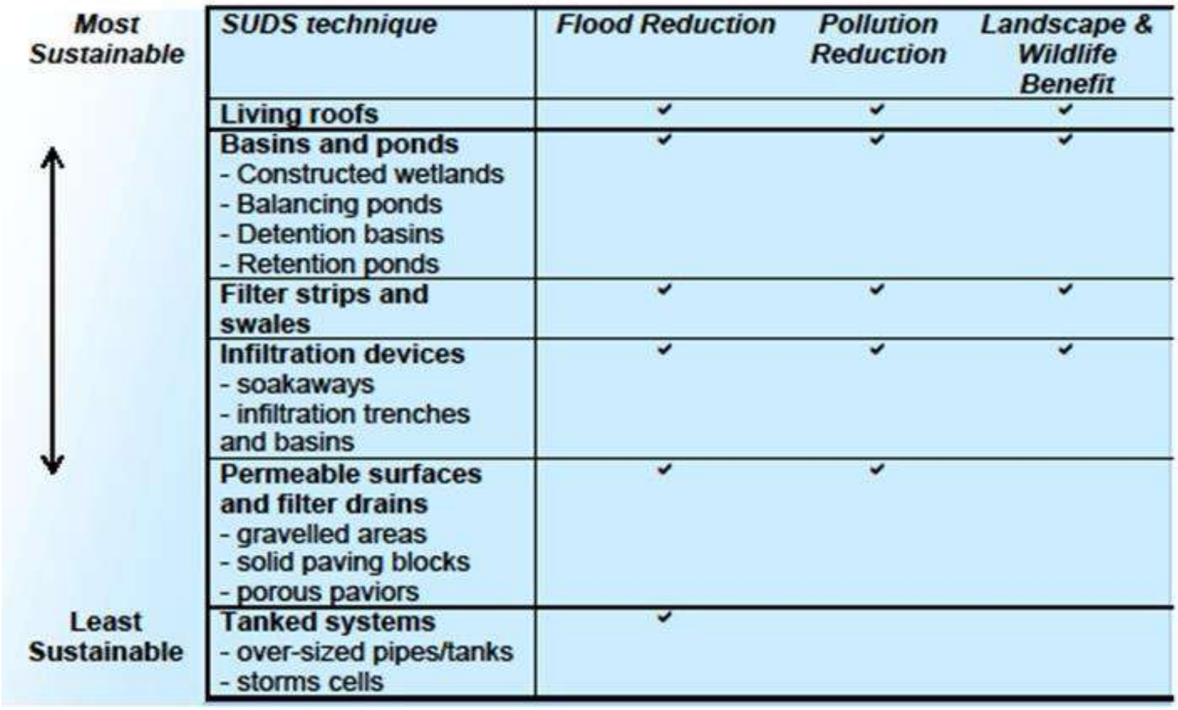
10.1 SuDS Hierarchy

The SuDS Hierarchy sets out the preferred method of selecting which Sustainable Drainage System should be used. Generally, 'soft SuDS' such as ponds and swales are the preferred drainage systems as they mimic natural drainage and provide a number of benefits including attenuation of surface water flows and flow rates as well as pollution.

Smaller developments which may not have the physical room for pond and swales would need to consider other options. In these cases, preference should be given to infiltration systems. However, care should be taken if implementing infiltration systems near aquifer protection zones, close to buildings or structural foundations or in areas where soils may be polluted.

The SuDS hierarchy is summarised in Figure 2 below.

Figure 2: SuDS Hierarchy



Most Sustainable

SUDS technique	*Flood Reduction*	*Pollution Reduction*	*Landscape & Wildlife Benefit*
Living roofs	✓	✓	✓
Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✓	✓	
Tanked systems - over-sized pipes/tanks - storms cells	✓		

Least Sustainable

10.2 Assessment of SuDS Options

An assessment was made of the suitability of a range of potential SuDS techniques that could be implemented as part of the development. The results of the assessment are summarised in Appendix 7 and are further discussed below.

10.2.1 Living Roofs

Although buildings account for more than 27% (387m^2) of the site cover, there is limited availability to included green roof due to the pitch style roofs and addition of sky lights upon the proposed flat roof.

10.2.2 Rainwater Harvesting

The use of rainwater harvesting could be employed within the proposal to provide rainwater re-use within the new dwelling and gardens.

Rainwater butts will be implemented upon downpipes to the rear of the site to allow for rainwater re-use in the garden.

10.2.3 Basins, Ponds, Filter Strips and Swales

Basins, ponds, filters strips and swales are not considered suitable due to the elevations upon completion.

10.2.4 Infiltration Devices

Infiltration techniques should be given priority in any SuDS design as they deal with discharge on the site by returning water to the aquifer and subsequently rivers via baseflow.

As discussed in Section 10, infiltration SuDS methods are not considered suitable for the site due to the impermeable Clay bedrock geology.

10.2.5 Permeable Surfaces

Over 22% (345m^2) of the development consist of driveways, pathways and patios all of which could be designed to be permeable. Although any infiltration would likely be minimal due to the poor permeability of the underlying Clay, these areas could be used to provide attenuation storage.

10.2.6 Tanked Systems

A tanked system incorporating a hydro brake restricting flow to the sewer would be a viable option as infiltration is not suitable. However, this option is ranked as being the least sustainable in the SuDS hierarchy.

10.2.7 Summary of results of SuDS Options Assessment

A summary of the results of the SuDS Options Assessment is presented in Table 5 below. Full details of the options assessment along with descriptions of the SuDS options are presented in Appendix 7 and Appendix 8.

Table 5: Summary of Results of SuDS Options Assessment

SuDS Technique	Potential Suitability
Rainwater Harvesting	Suitable – Rain Water Butts
Infiltration SuDS	Unsuitable – Poor infiltration
Green/brown /blue roofs	Unsuitable – Pitch Style Roofing
Rain Gardens	Partially Suitable – difficult to locate due to lower rear patios;
Permeable Pavements / Surfaces	Suitable – Attenuation storage only
Swales	Unsuitable - Space
Detention basin/ponds	Unsuitable - Space
Storage tanks/ Geocellular storage	Suitable
Oversized piping	Suitable

11 SuDS Implementation

11.1 Proposed SuDS

The proposal will introduce rainwater butts, bespoke SuDS planters and large rain garden within the front garden to work in combination with the existing permeable block paving. The scheme will be supplemented with a geocellular attenuation storage.

These measures provide 35m^3 attenuation and a further 0.4m^3 dedicated for rainwater re-use. The discharge from the geocellular storage tank will be limited to 2.0 l/s during all storm events via an Hydro-Break vortex flow control chamber.

All excess surface water runoff will be discharged via the existing Thames Water surface water sewer connection to the front of the site.

The proposed SuDS measures are designed to capture and attenuate all excess surface waters generated from the existing, and proposed positive catchment areas, including those under the application 23/03903/HOU.

The proposed SuDS is further detailed below. A detailed drainage layout is available in Appendix 9.

11.1.1 Permeable Block Paving

2no. 200litre rainwater butts will be attached to the downpipes adjoining the rear of the property. Once at capacity the excess will discharge into the SuDS planter or drainage gullies.

11.1.2 SuDS Planters

A raised bed planter will be installed along the northern wall of the enclosed end of the patio. The planter will allow for water retention and a natural reduction in the runoff velocity and provide a minimal amount of attenuation.

The excess will discharge into gullies and acco drainage channels which collect the excess surface water runoff from the impermeable paved patio area. All excess stormwater from the rear of the site will be conveyed via a standard gravity drainage network towards the front garden.

11.1.3 Rain Garden

A 40m^2 rain garden will be formed within the soft landscaping within the front garden, which will accept approximately half the surface water runoff from the existing and proposed rooftops (150m^2).

It will provide approximately 12.0m^3 of attenuation, based on the variable porosities of the construction layer which form each structure, the details are in the Table below.

Table 6: Rain Garden Details

Rain Garden Storage Calculator				
Construction	**Area (m^2)**	**Depth(m)**	**Porosity #**	**Storage Volume (m^3)**
Void	40	0.15	1	6
Soil	40	0.4	0.15	2.4
Gravel Sub-Base	40	0.3	0.3	3.6

A rain garden is a shallow area of ground which receives run-off from roofs and other hard surfaces. A rain garden is planted with plants that can stand waterlogging for up to 48 hours at a time, but would typically drain completely within 12 - 24 hours. Which would depend on the drainage capacity of the shallow soils, as infiltration is poor on site, the structure will be fitted with perforated pipe to convey flows away and into the geocellular storage.

A range of different plants can be included within the garden, as more drought-tolerant plants will be suitable towards the edges. During a storm water fills the depression and structure and then drains overtime.

11.1.4 Geocellular Storage

A Geocellular attenuation tank (Geocell Drainage Crates or similar) will be installed below the front garden. The storage structure will cover an area of 30m^2 with a thickness of 1.0m with a porosity of 95%. The geocellular storage crates will be stacked together to create the desired storage volume and will provide a total of 28.5m^3. The structure will be topped with vegetation and back fill material which will allow for infiltration from the surface.

11.1.5 Discharge Control Device

A hydro-brake flow control chamber (or similar) will be used to limit the discharge rate to 2.0l/s from site into the Thames Water surface water sewer.

11.1.6 Drainage Modelling

Drainage Network Modelling was carried out to assess the performance of the proposed drainage system under a variety of modelled storm events.

The designed system provides a total attenuation storage of 35.0m^3 and accepts the rooftop runoff from the existing rooftops, proposed and new patio area.

The proposal ensures a maximum discharge rate of 2.0 l/s is achieve during all storm events, reducing the sites discharge rate in line with the estimated greenfield runoff rates.

No flooding was indicated during any of the modelled scenarios, including the 1 in 100 year plus 40% climate change.

Full results, drainage layout including the proposed discharge point and exceedance flows of this are available in Appendix 9.

11.1.7 Surface Water Discharge Points

As infiltration is not suitable and direct connection to the nearby watercourses is not available, run-off from the development will be conveyed via 150mm diameter lateral drains to the surface water sewer Beech Hill Avenue (location).

A copy drainage asset search is available in Appendix 4.

11.1.8 Treatment of Run-off

Treatment of roof water runoff will be provided through the provision the rainwater butt filtration units, catchpit manholes, rain garden and sumps to intercept gross solids and sediment. Guidance will be provided to householders on appropriate maintenance requirements.

11.1.9 Exceedance Flows

The existing dwelling is situated at elevations of 76.5mOAD (driveway) to 77.0mAOD (rear patio). Upon completion the site will largely maintain the existing elevations.
If an exceedance flow were to occur, the excess storm water would be contained within the rear patio area and would be conveyed overland following the pathway to front of the site towards the front gardens and Beech Hill.

It can be seen from the design proposals that the proposed system includes approximately 35m^3 of additional storage capacity (not including pipes and manholes). In addition, a safety factor of 2 was applied to the drainage modelling, which gives a further degree of confidence that exceedance flows are unlikely to occur. Nonetheless, appropriate level design will be employed to ensure that flood waters are directed away from buildings in the unlikely event that an inundation of the proposed system results in overland flows.

A map displaying the exceedance flow is available in Appendix 9.

11.2 Maintenance and Adoption of SuDS

All SuDS features will be properly installed by competent persons. They will be maintained regularly to ensure that their design capacity and attenuation characteristics provide the required storage volume.

Landscaping and adjacent areas will be designed such that they do not cause soil, mulch and other materials to be washed onto the permeable surfaces and into drains causing clogging.

The maintenance will be carried out (under guarantee) by the drainage contractors responsible for installing it in the first 1 or 2 years of operation (dependent upon the contract specification). After which the responsibility will be transferred to the property owner, Vahid Tahmasvand, who will instruct a suitable Management Company to undertake the routine maintenance.

Owners of the properties/persons responsible for maintenance of SuDS components will be provided with operation and maintenance manuals which will include information such as:

- the location of SuDS components;
- an explanation of design intent and objective of the SuDS;
- the requirements for regular and occasional inspection and maintenance;
- visual indicators that may trigger maintenance.

An inspection checklist should be generated based on the maintenance strategy to facilitate consistent inspection of the condition of the system and as a method for recording inspections. Inspections should also be accompanied by photographic records to assist with the monitoring of the system. It is recommended that an annual maintenance report should be prepared and retained within the Operation and Maintenance Manual.

Regular maintenance of SuDS components is relatively straightforward with the main tasks consisting of:

- Regular visual inspections – checking inlets are not blocked and verifying that clogging has not occurred;
- Litter and debris removal;
- Grass cutting;
- Preventive sweeping;
- Weeding and invasive plant control;
- Oil and stain removal.

Occasional maintenance activities to ensure the long-term performance of the SuDS features include:

- Sediment removal
- Vegetation and plant replacement

These simple measures will ensure that the storage capacity of the system is maintained and that the need for reconstruction and replacement of components is minimised.

Further details on SuDS maintenance measures that will be employed at the site can be found in Appendix 10.

12 Conclusion and Recommendations

With the proposed SuDS mitigation measures in place, it is considered that the proposed development will reduce local flood risk and enhance the local environment and will therefore be in compliance with the LLFA’s current planning policy and the NPPF.

13 References

1. Communities and Local Government - National Planning Policy Framework NPPF, 2019.
2. The London Plan – The Spatial Development Strategy for Greater London - March 2021
3. CIRIA, Defra, Environment Agency – UK SuDS Manual, 2015.
4. Local Flood Risk Management Strategy 2016 - London Borough of Enfield
5. Sustainable drainage systems - https://new.enfield.gov.uk/services/planning/sustainable-drainage-systems/ - Accessed March 2023.

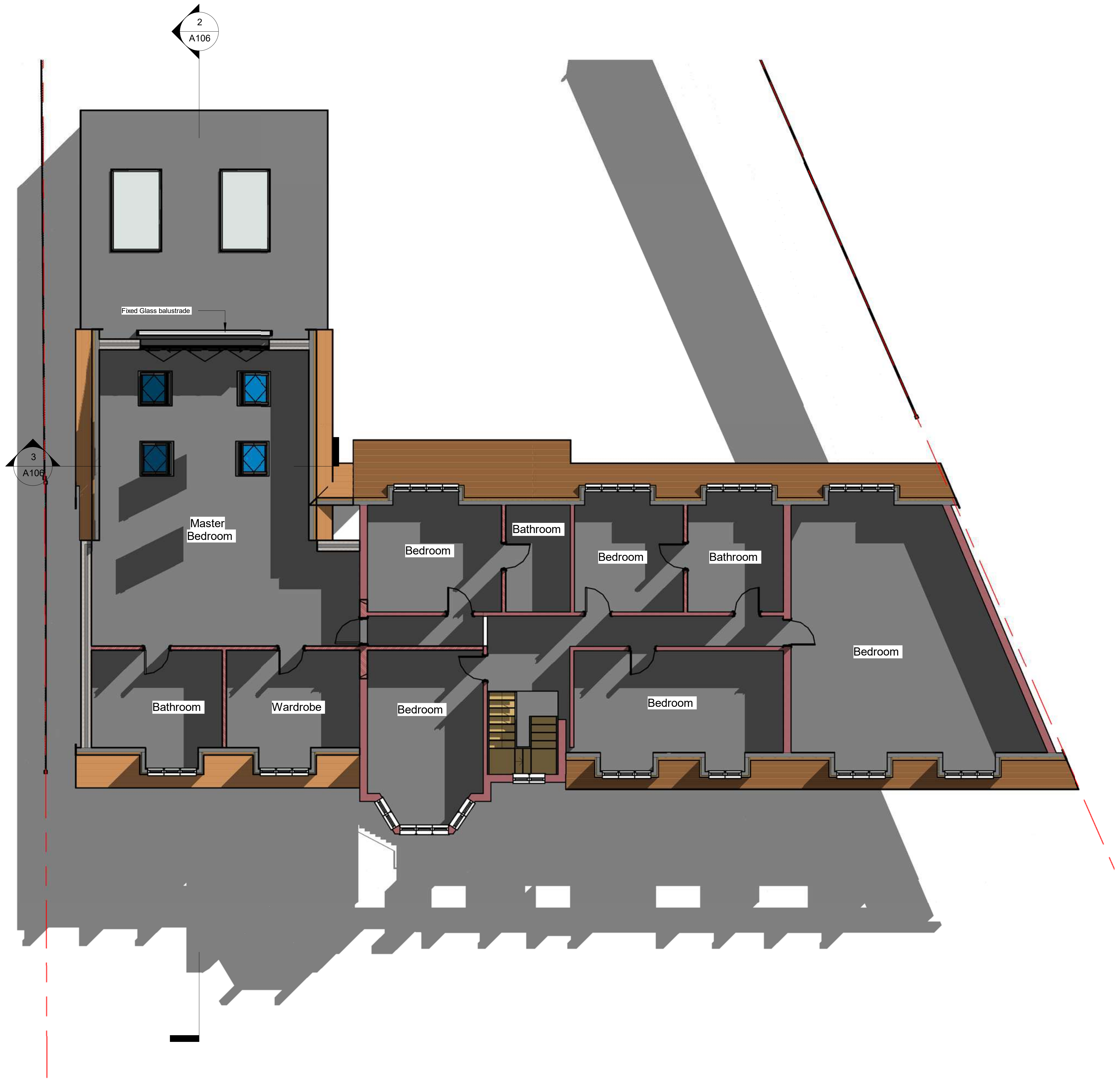
14 Appendices

14.1 Appendix 1 – Development Plans

Contractor to check all dimensions , drain runs and general conditions on site before commencing work. Any discrepancies
to be notified to ADL before continuing work. All works to be carried out in accordance with Building Regulations, British Standards, Code of Practice, CDM Regulations and Local Authority requirements. The building owner must obtain formal agreement under the Party Wall Act 1996.

Architectural Design London
Chartered Building Engineer
E: info@myadl.co.uk www.myadl.co.uk T: 07939 666006

2 **0-Proposed Ground Floor**
1 : 100



3 **1-Proposed First Floor**
1 : 100

0 1 2 3 4m 1:100
0 1 2 1:50

Architectural Design London Reg No: 09568114

33 Beech Hill Ave EN4 0LU
003 Rev A
20/20/2020
Extension

Contractor to check all dimensions , drain runs and general conditions on site before commencing work. Any discrepancies
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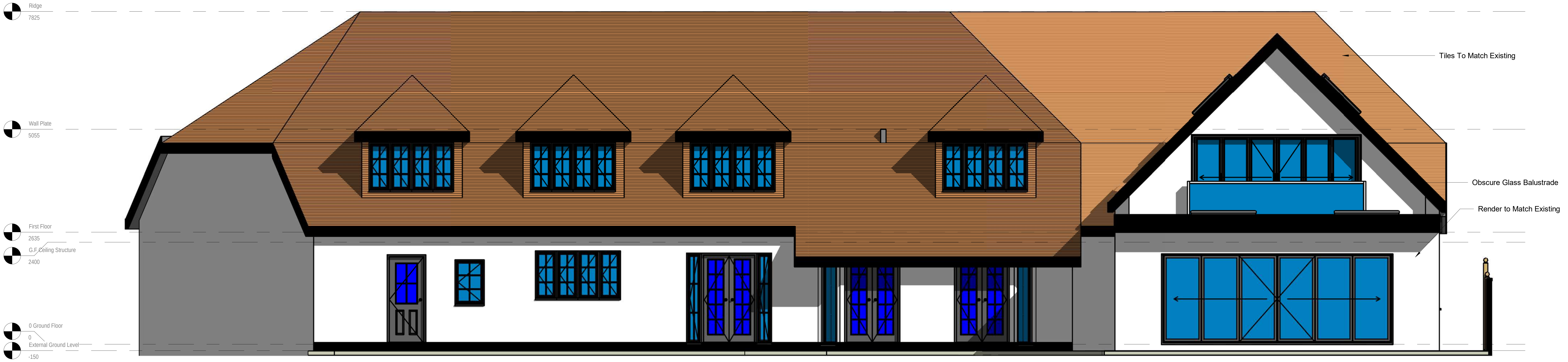
2 **Proposed Front Elevation**
1 : 50



1 **Proposed Back Elevation**
1 : 50

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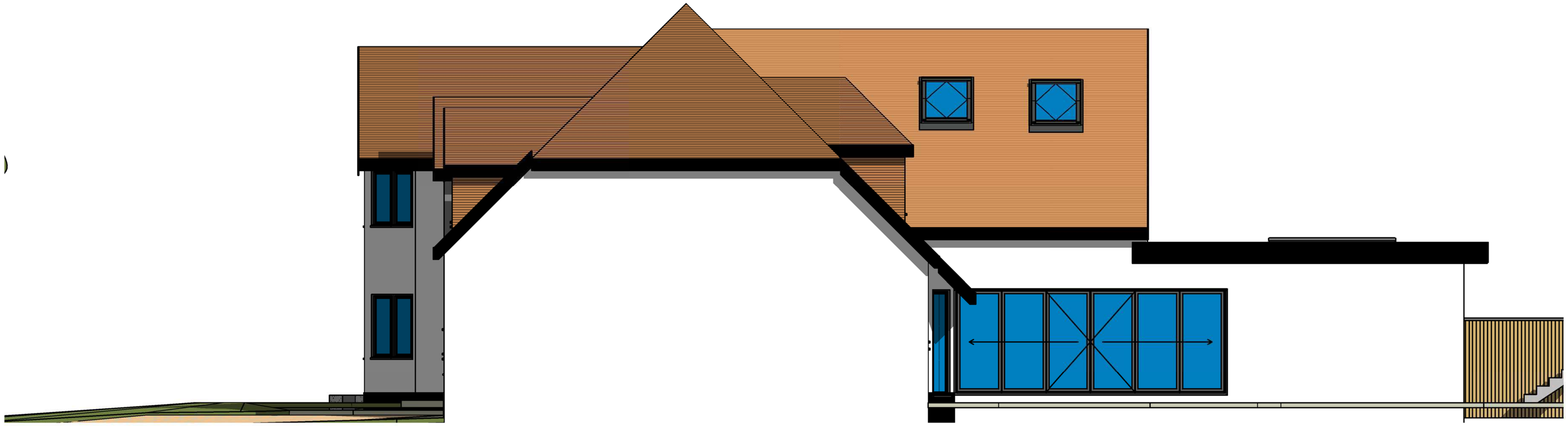
0 1 2 1:50

Architectural Design London Reg No: 09568114

33 Beech Hill Ave EN4 0LU
004 Rev A
20/20/2020
Extension



1 **Proposed Side Elevation**
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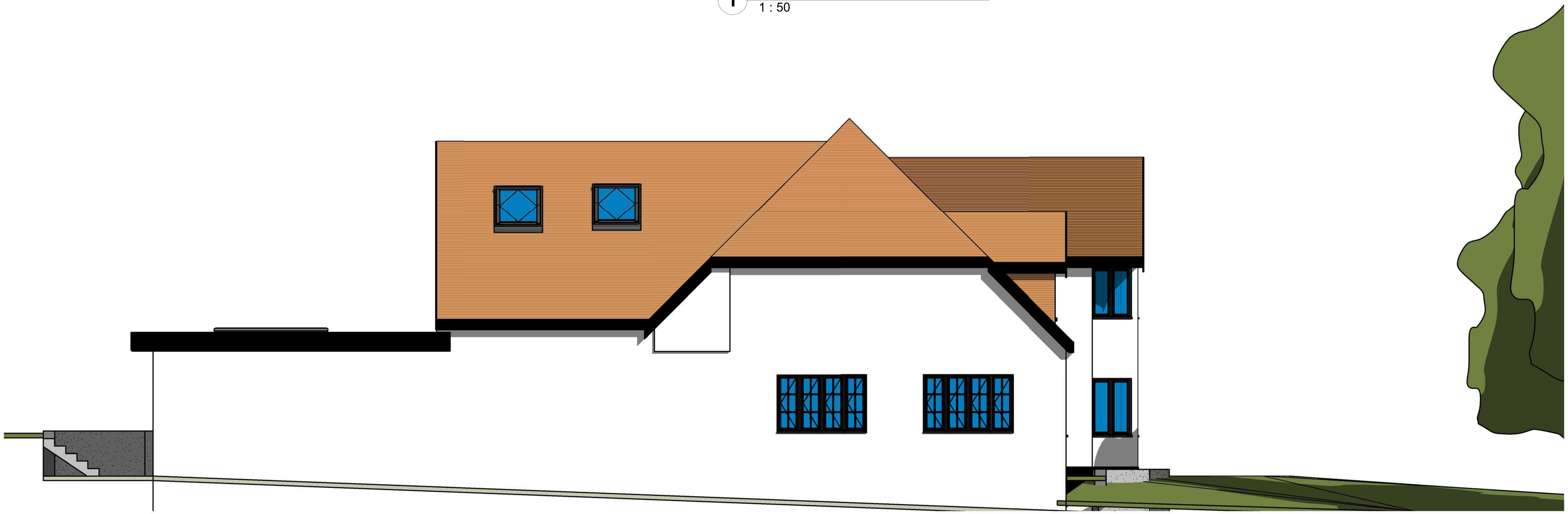

2 **Proposed Side Elevation 2**
1 : 50

0 1 2 3 4m 1:100
0 1 2 1:50

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005 Rev A
20/20/2020
Extension

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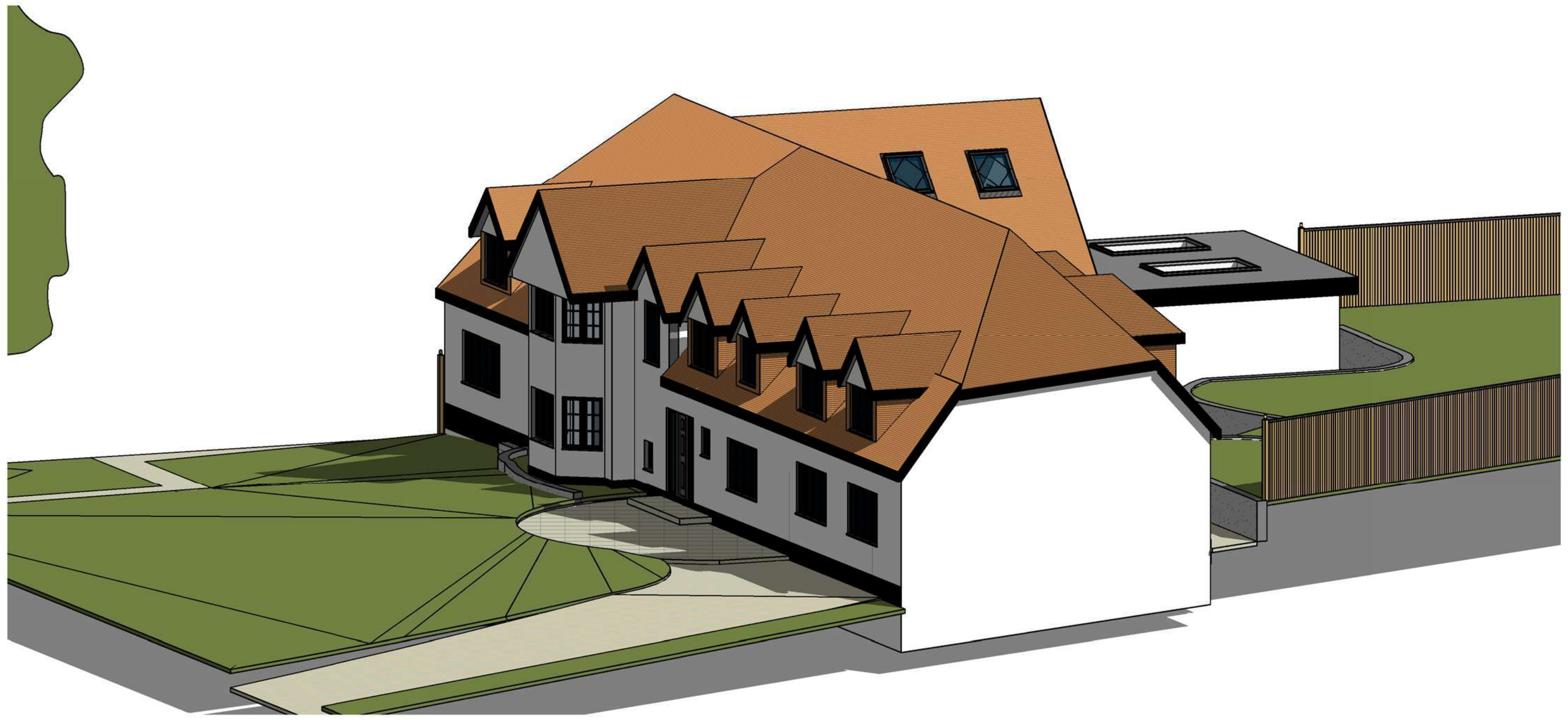
1 3D Architecture Proposed 1

3 3D Architecture Proposed 3

2 3D Architecture Proposed 2



4 3D Architecture Proposed 4

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Architectural Design London
Chartered Building Engineer

0 1 2 3 4m 1:100
0 1 2 1:50

Architectural Design London Reg No: 09568114

33 Beech Hill Ave EN4 0LU
006 Rev A
20/20/2020
Extension

Contractor to check all dimensions , drain runs and general conditions on site before commencing work. Any discrepancies
to be notified to ADL before continuing work. All works to be carried out in accordance with Building Regulations, British Standards, Code of Practice, CDM Regulations and Local Authority requirements. The building owner must obtain formal agreement under the Party Wall Act 1996.

2 Section 2 Proposed
1 : 100

3 Section 1 Proposed
1 : 100

1 3D Architecture Proposed

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Chartered Building Engineer

0 1 2 3 4m 1:100
0 1 2 1:50

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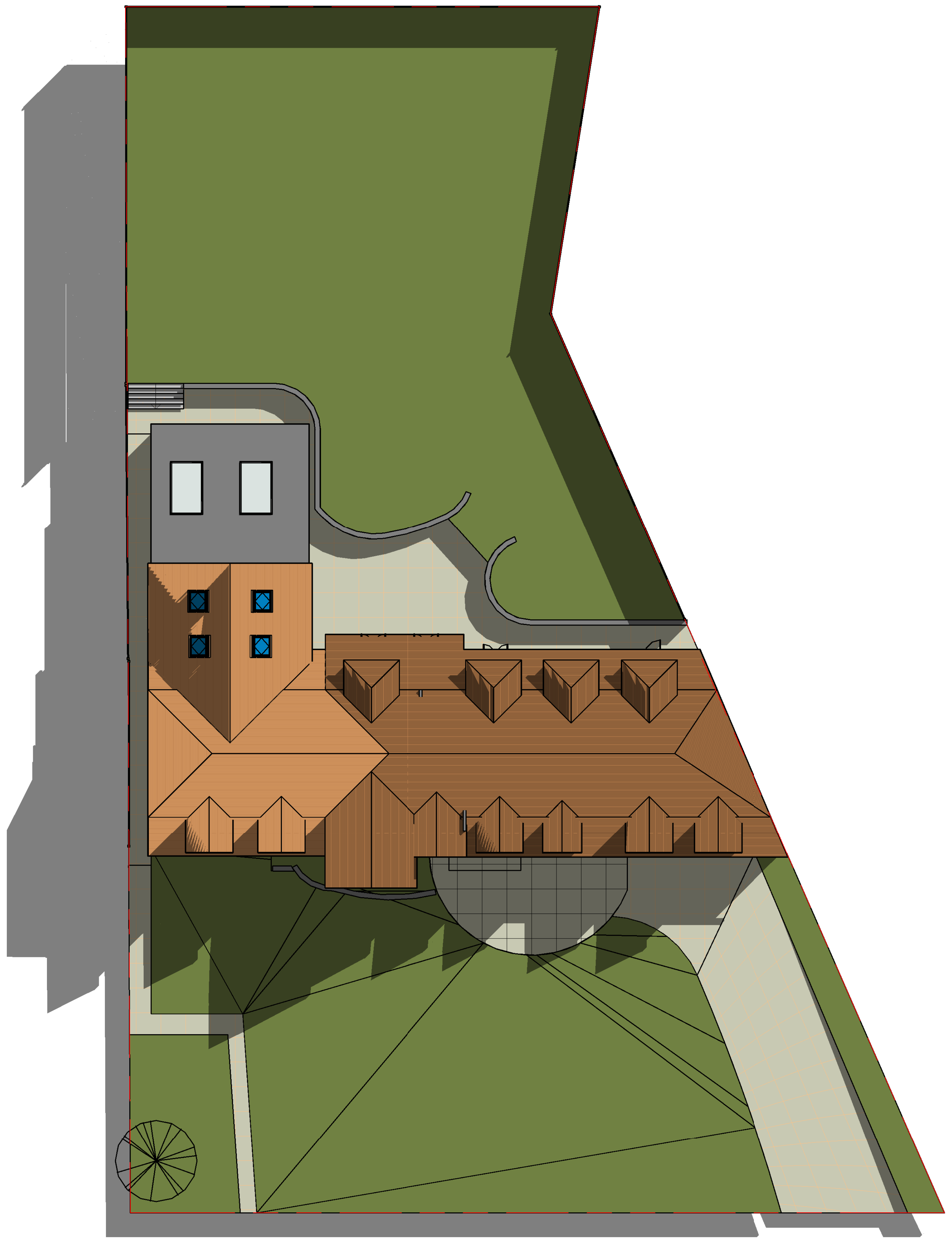
007 Rev A
20/20/2020
Extension

Architectural Design London
Chartered Building Engineer
E: info@myadl.co.uk www.myadl.co.uk T: 07939 666006



1 -2-Proposed Block Plan
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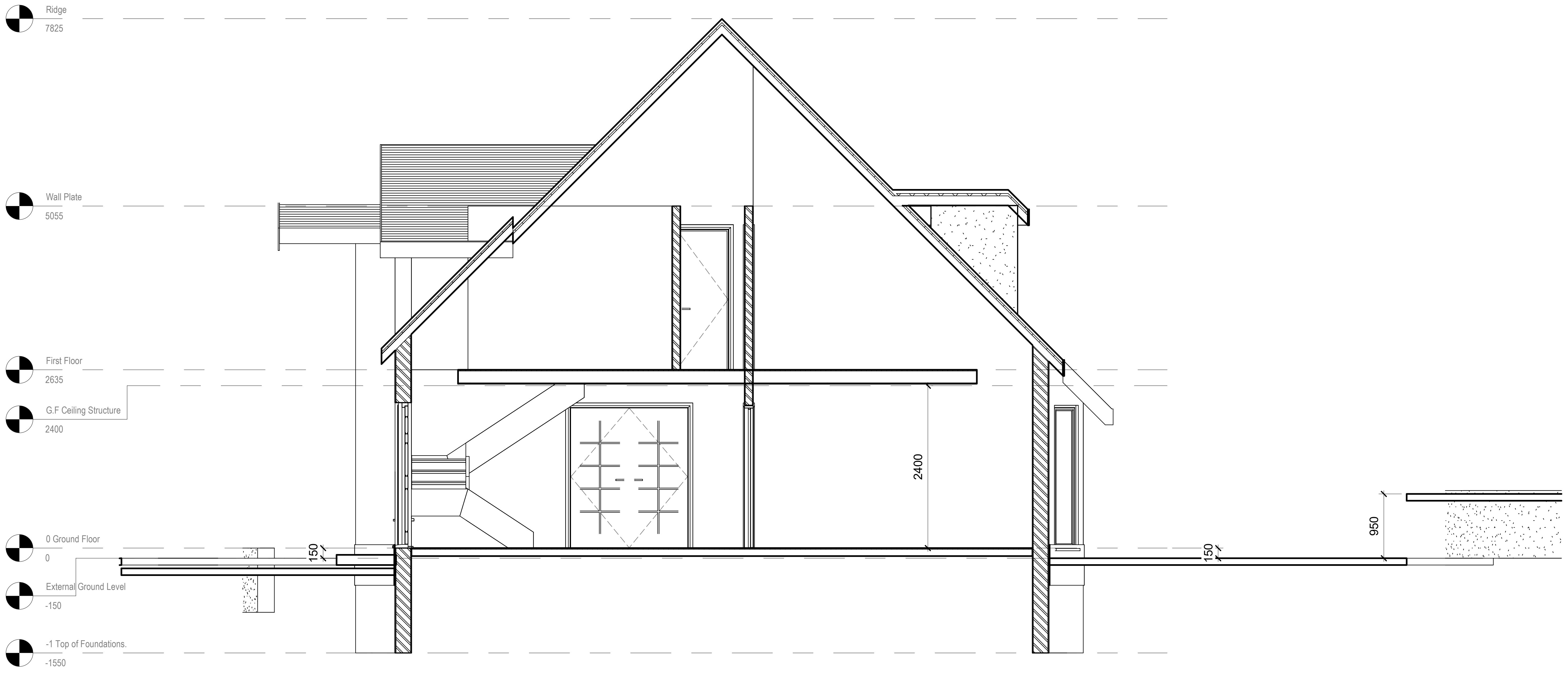

2 Section 2 Existing
1 : 50

Contractor to check all dimensions , drain runs and general conditions on site before commencing work. Any discrepancies
to be notified to ADL before continuing work. All works to be carried out in accordance with Building Regulations, British Standards, Code of Practice, CDM Regulations and Local Authority requirements. The building owner must obtain formal agreement under the Party Wall Act 1996.

0 1 2 3 4m 1:100
0 1 2 1:50

Architectural Design London Reg No: 09568114

33 Beech Hill Ave EN4 0LU
008 Rev A
15/11/2023

Architectural Design London
Chartered Building Engineer
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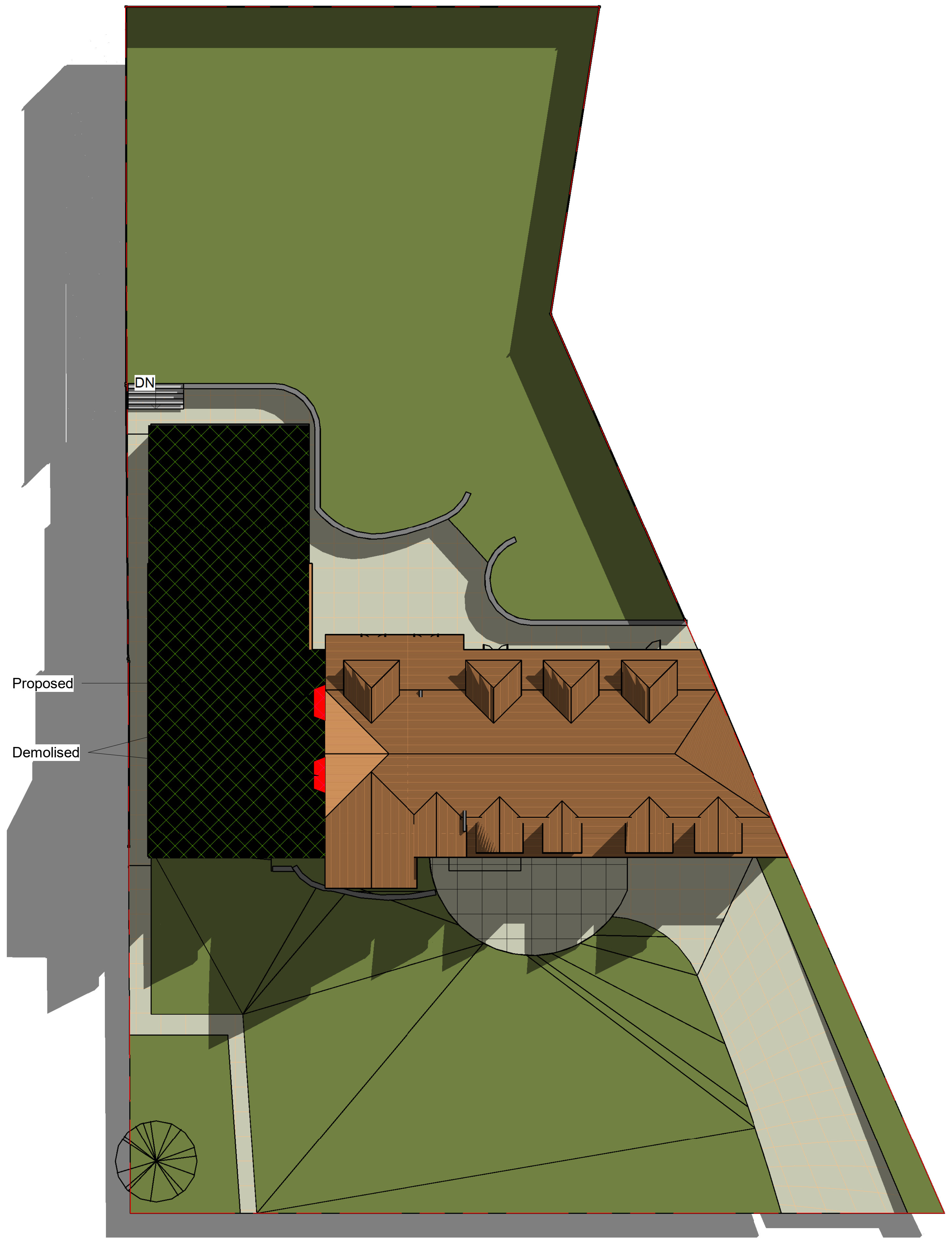
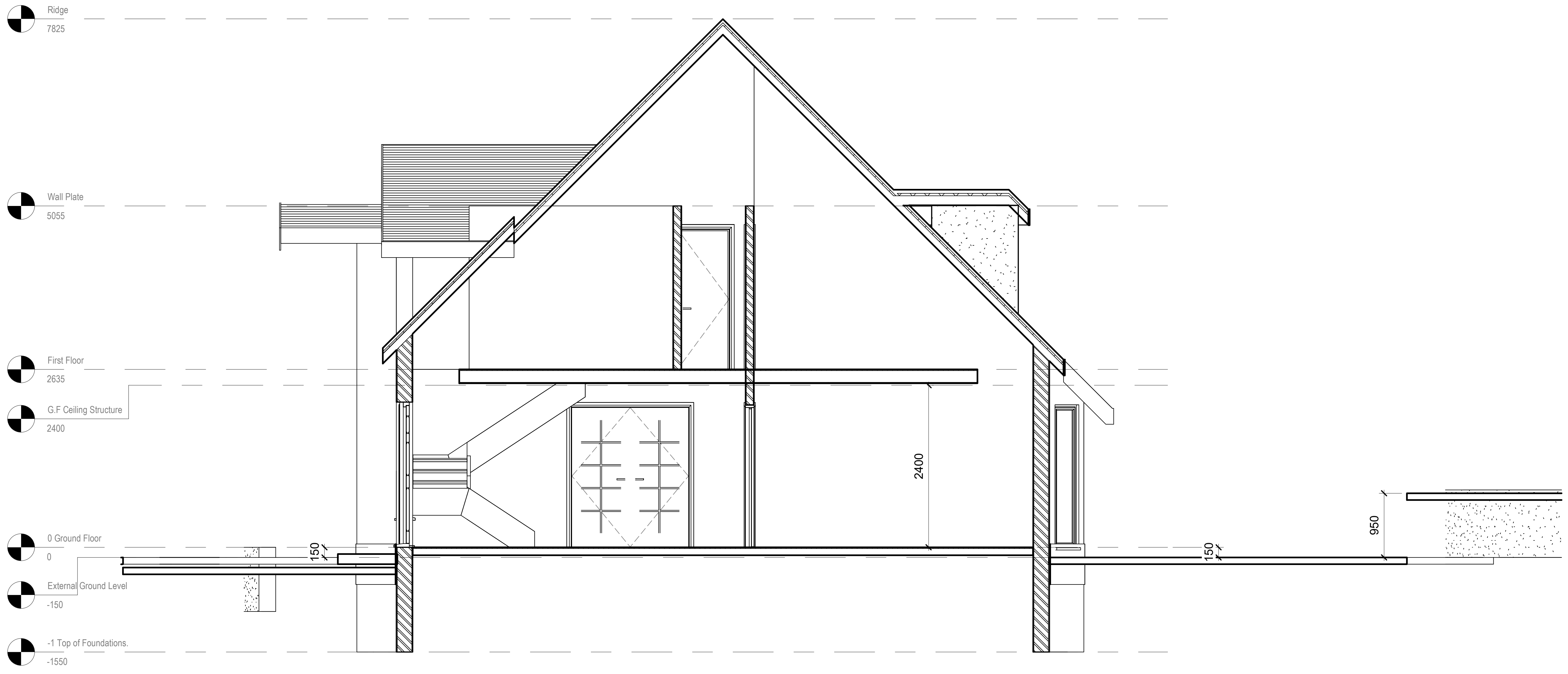
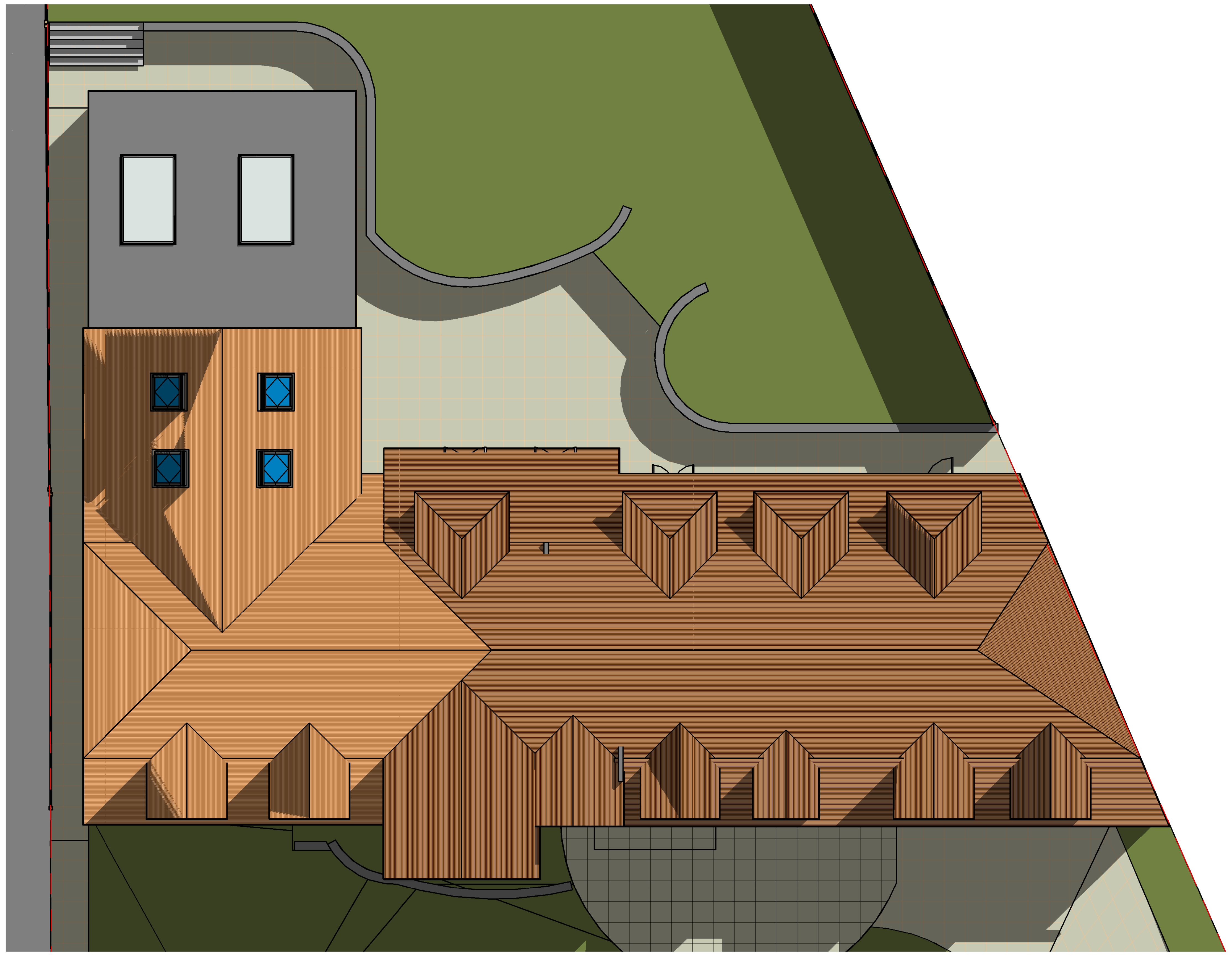


1 -2-Proposed Block Plan
1 : 200



2 Section 2 Existing
1 : 50



3 3-Proposed Roof Plan
1 : 100

Contractor to check all dimensions , drain runs and general conditions on site before commencing work. Any discrepancies
to be notified to ADL before continuing work. All works to be carried out in accordance with Building Regulations, British Standards, Code of Practice, CDM Regulations and Local Authority requirements. The building owner must obtain formal agreement under the Party Wall Act 1996.

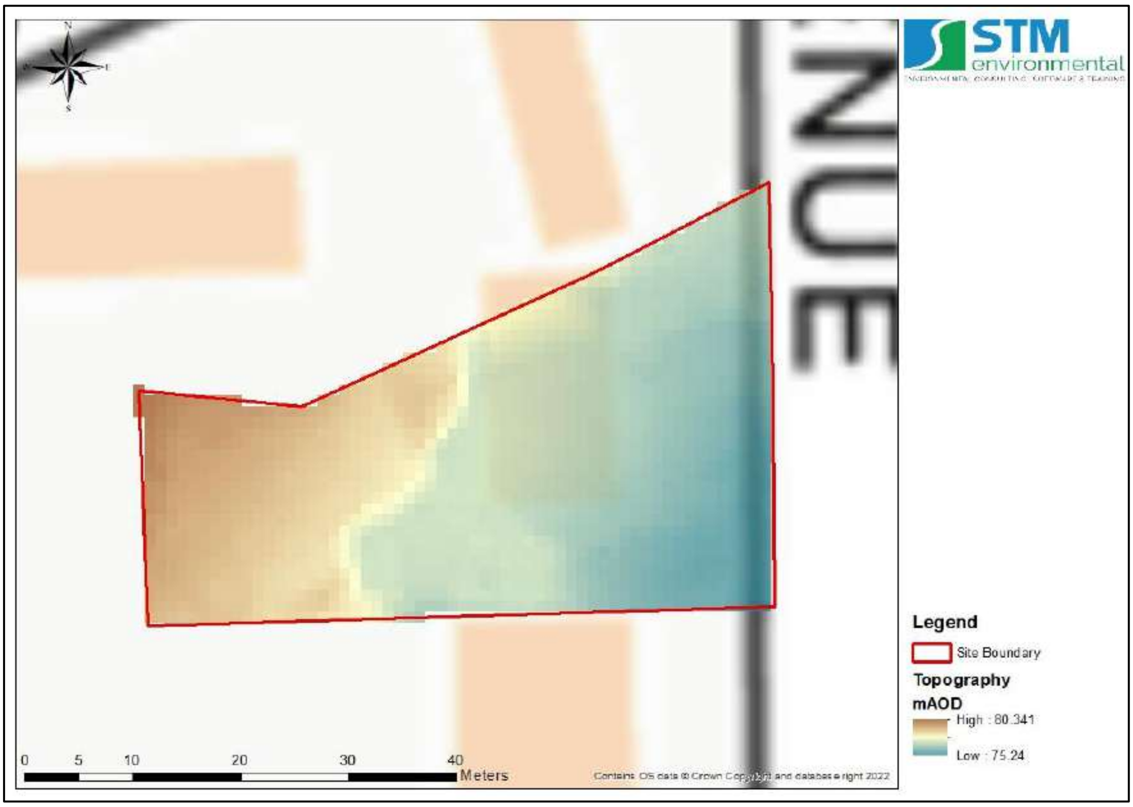
0 1 2 3 4m 1:100
0 1 2 1:50

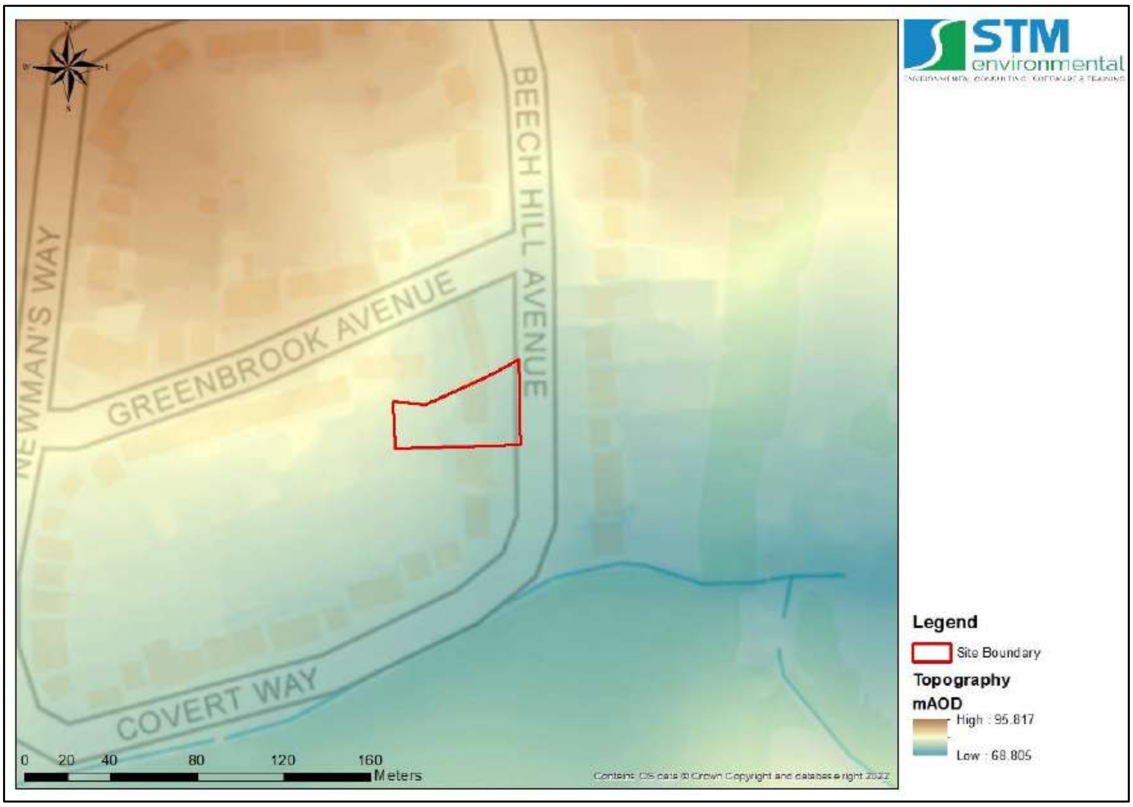
Architectural Design London Reg No: 09568114

33 Beech Hill Ave EN4 0LU
008 Rev B
22/11/2023

14.2 Appendix 2– Site Topography and Drainage Characteristics

14.2.1 LIDAR Mapping showing Site Topography - (Source: OS 2017)





14.2.2 Topographic Survey

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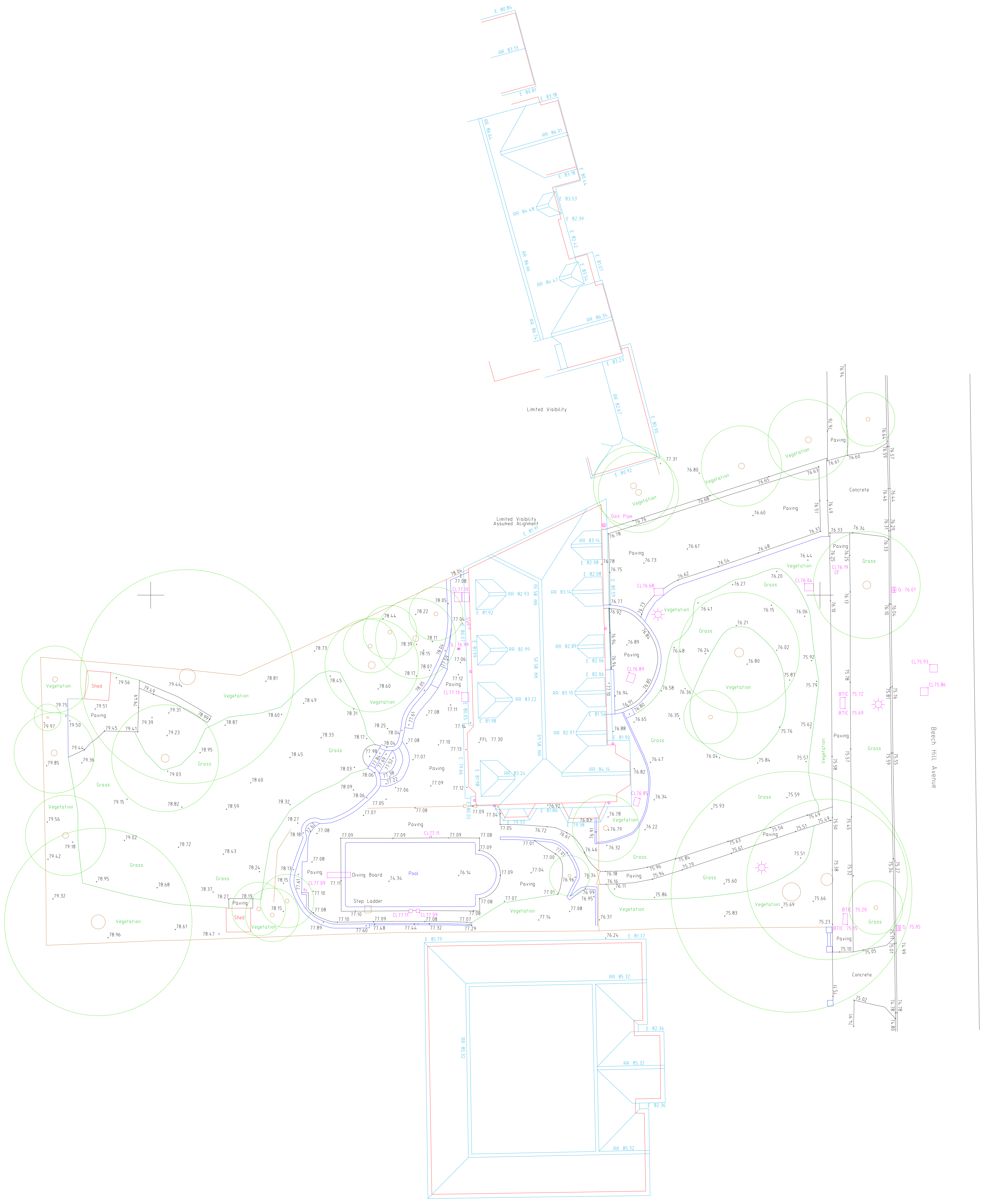


General Notes

CRITICAL LEVELS AND DIMENSIONS SHOULD BE CHECKED ON SITE PRIOR TO START OF DESIGN AND SITE WORKS BY USER

THE ACCURACY OF THIS DRAWING IS DEPENDANT ON THE ORIGINAL SPECIFICATION

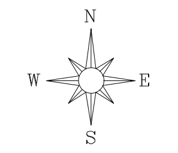
THE SURVEY IS IN TERMS OF OS GRID AND DATUM DERIVED BY GPS

ALL REASONABLE CARE HAS BEEN TAKEN IN THE SURVEY. OUR AIM IS TO PRODUCE THE BEST POSSIBLE RESULTS WITHIN THE SPECIFICATION

THE DRAWING IS THE PROPERTY OF JTW SURVEYS LTD. IT MAY NOT BE COPIED, ALTERED OR INCORPORATED INTO OTHER DATA WITHOUT PRIOR CONSENT

LEGEND :

SVP ○	SOIL VENT PIPE
Ⓓ	DOWN PIPE
□	SERVICE COVER
▤	GULLY
Ⓖ	GAS PIPE
◎	TREE
⋈	GATE
—	WALL / RETAINING WALL
—	FENCE
—	CHANGE IN SURFACE
—	BUILDING
—	BUILDING ROOF
E 32.99	EAVE LEVEL
RR 33.23	ROOF RIDGE LEVEL



No.	Revision/Issue	Date
1	First Issue	20/01/22

www.jtwsurveysltd.co.uk

Project Name and Address

SITE PLAN
33 BEECH HILL AVENUE
BARNET
LONDON
UNITED KINGDOM

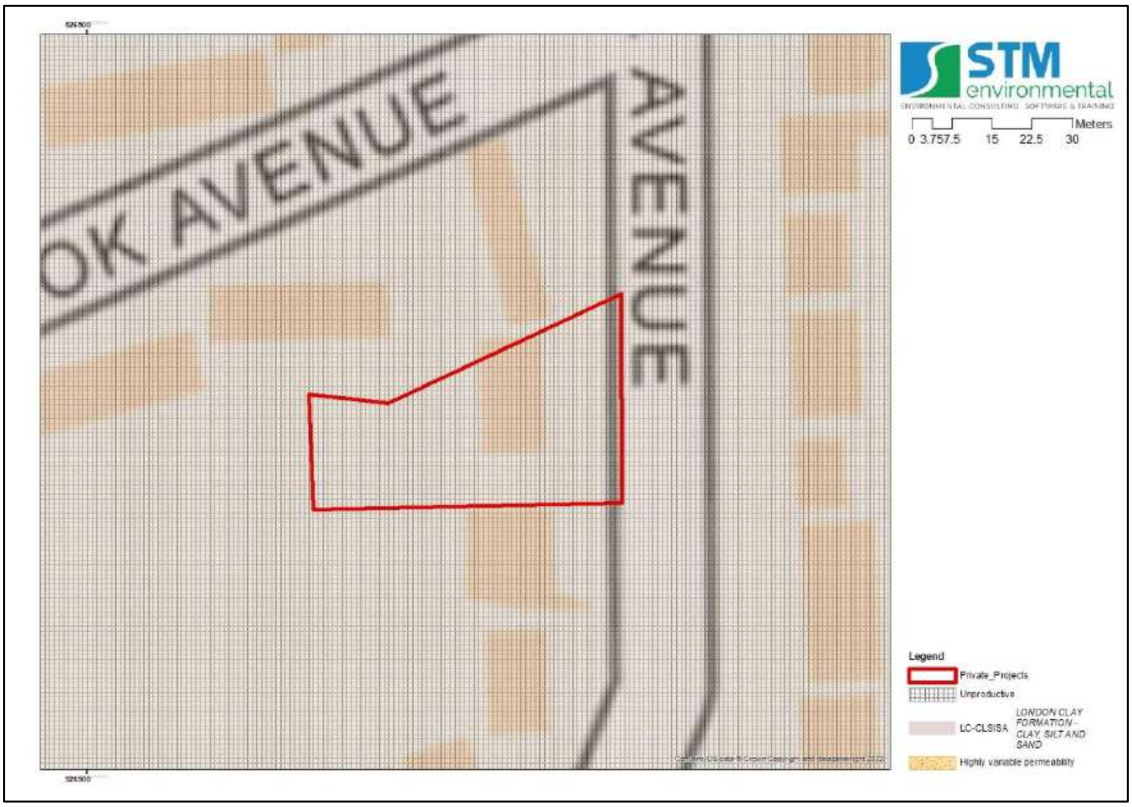
Project
33 BEECH HILL AVENUE

Date
JANUARY 2022

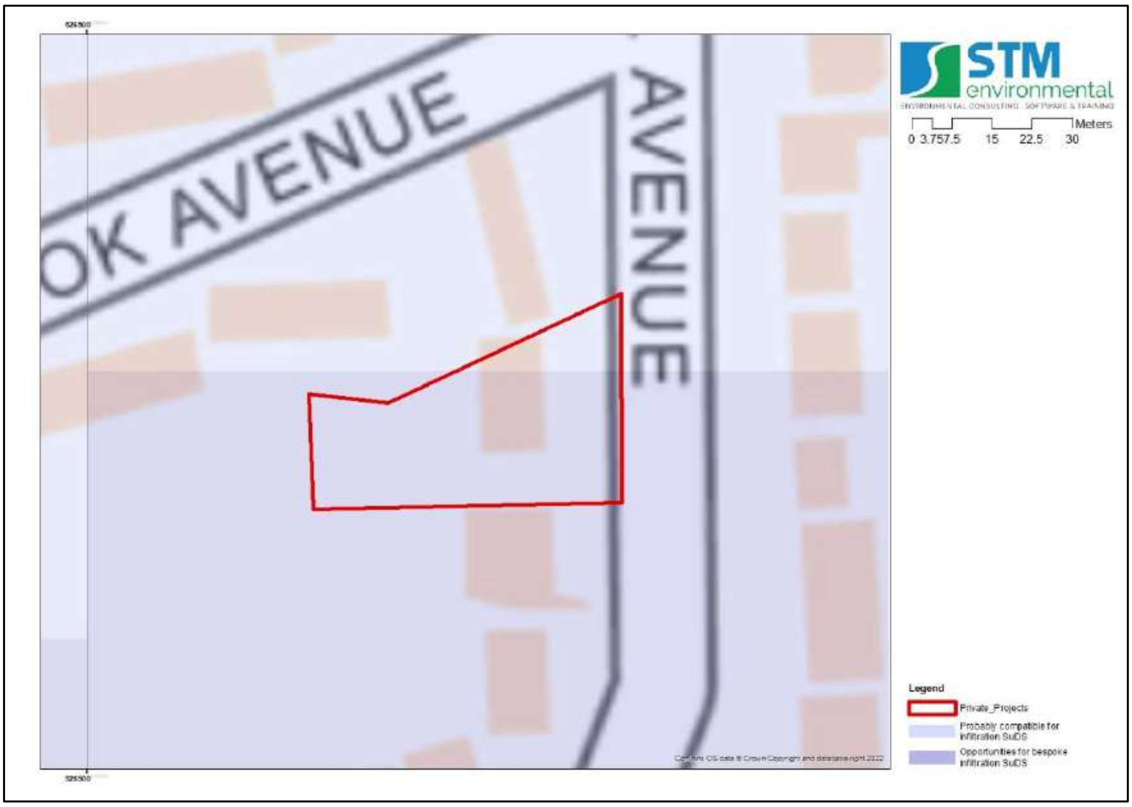
Scale
1:200 @ A1

Sheet
1 of 2

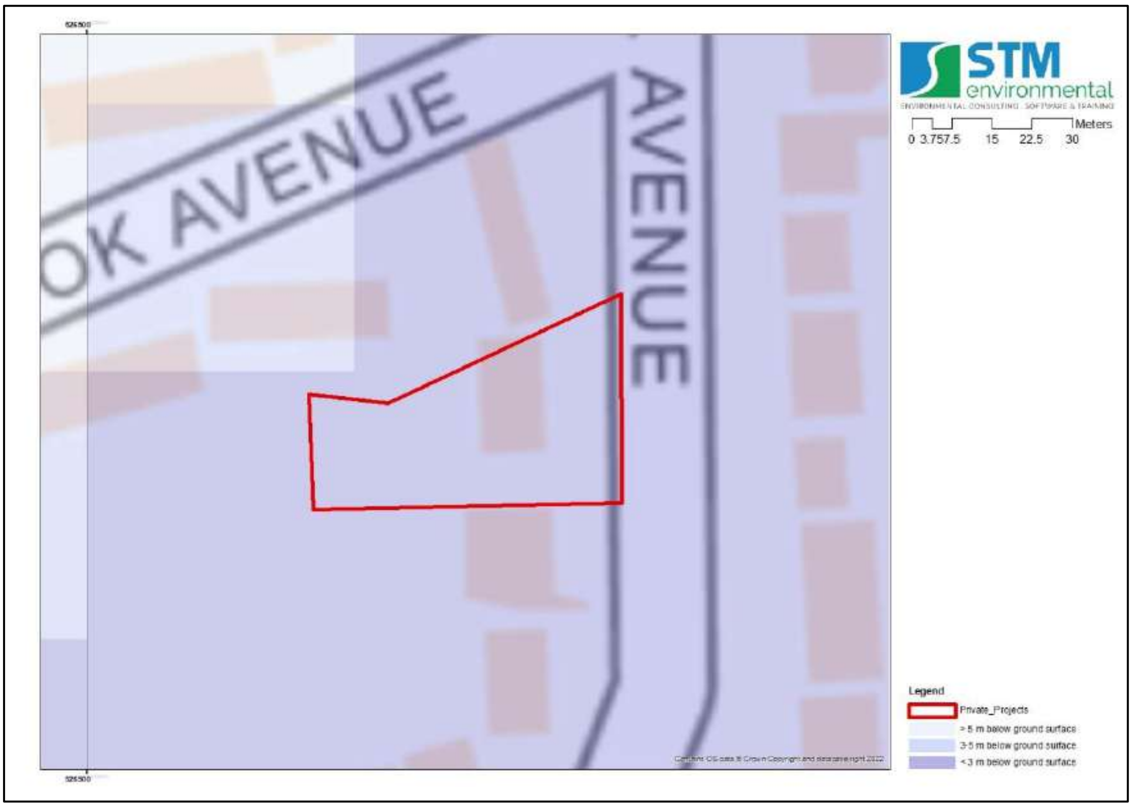
14.2.3 Bedrock Hydrogeology and Permeability (Source: BGS, 2016)



14.2.4 Infiltration Drainage Potential (Source: BGS, 2016)

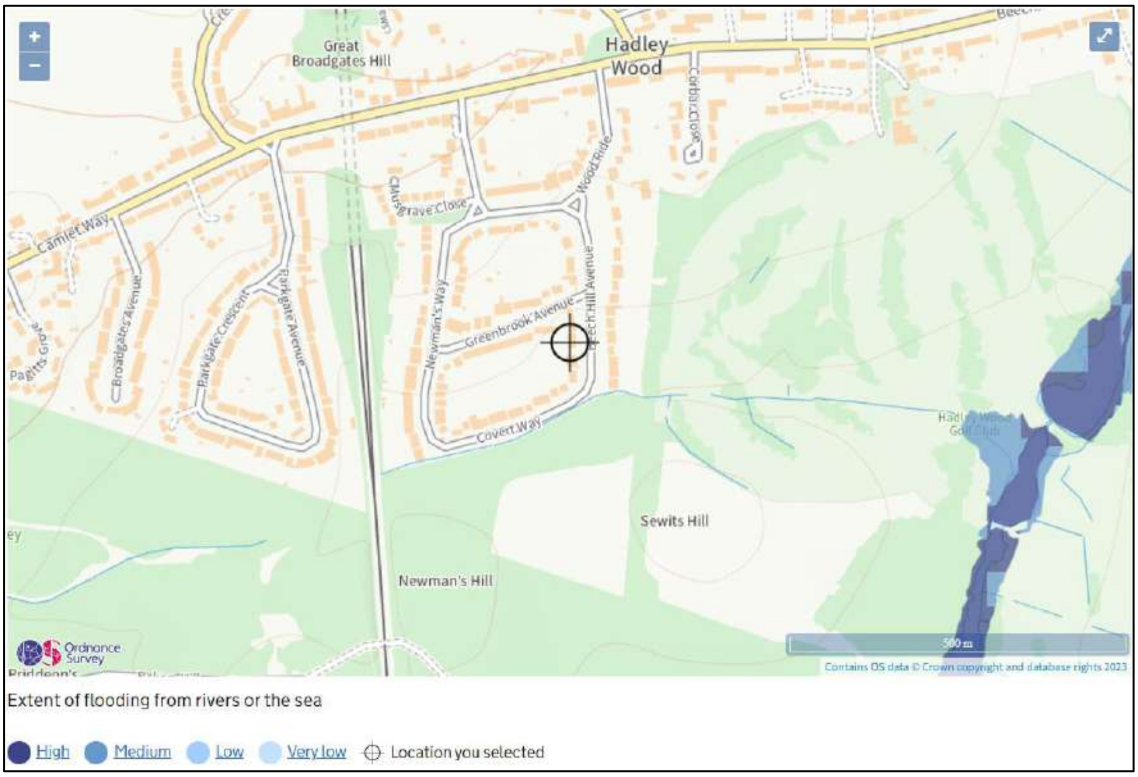


14.2.5 Groundwater Table Depth (Source: BGS 2016)



14.3 Appendix 3 – Flood Risk Mapping

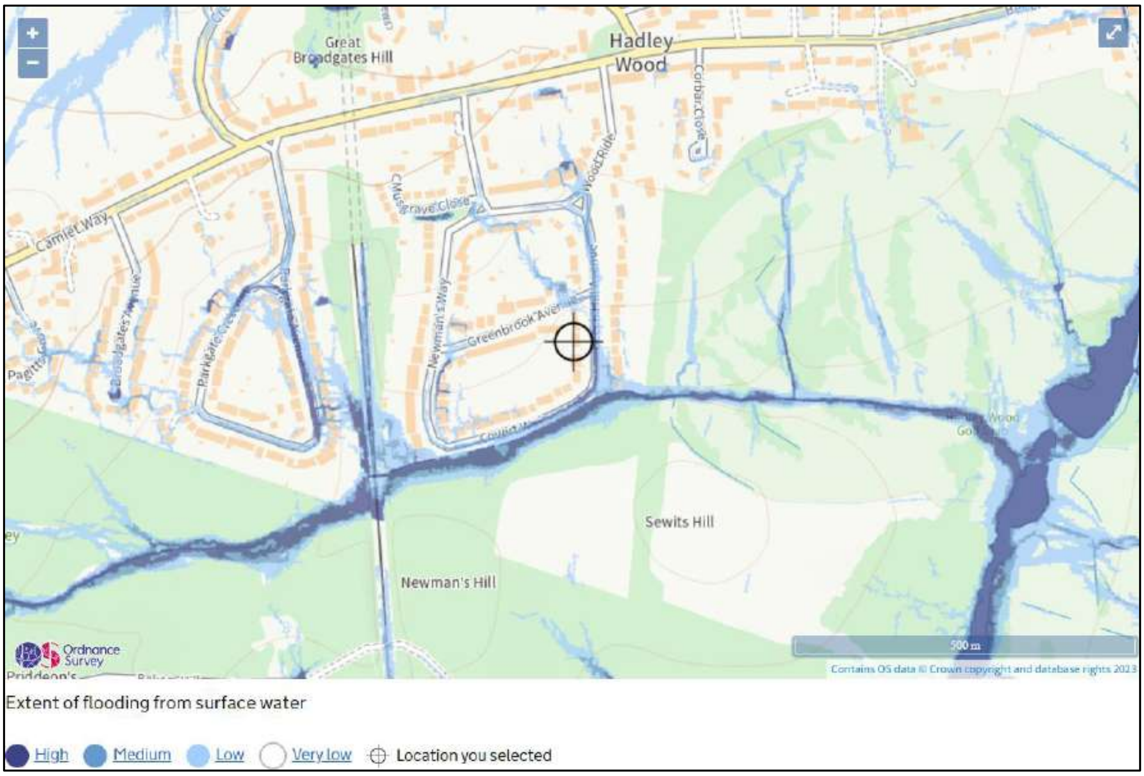
14.3.1 Long Term Fluvial Flood Risk Map (EA)



Extent of flooding from rivers or the sea

● High ● Medium ● Low ● Very low ⊕ Location you selected

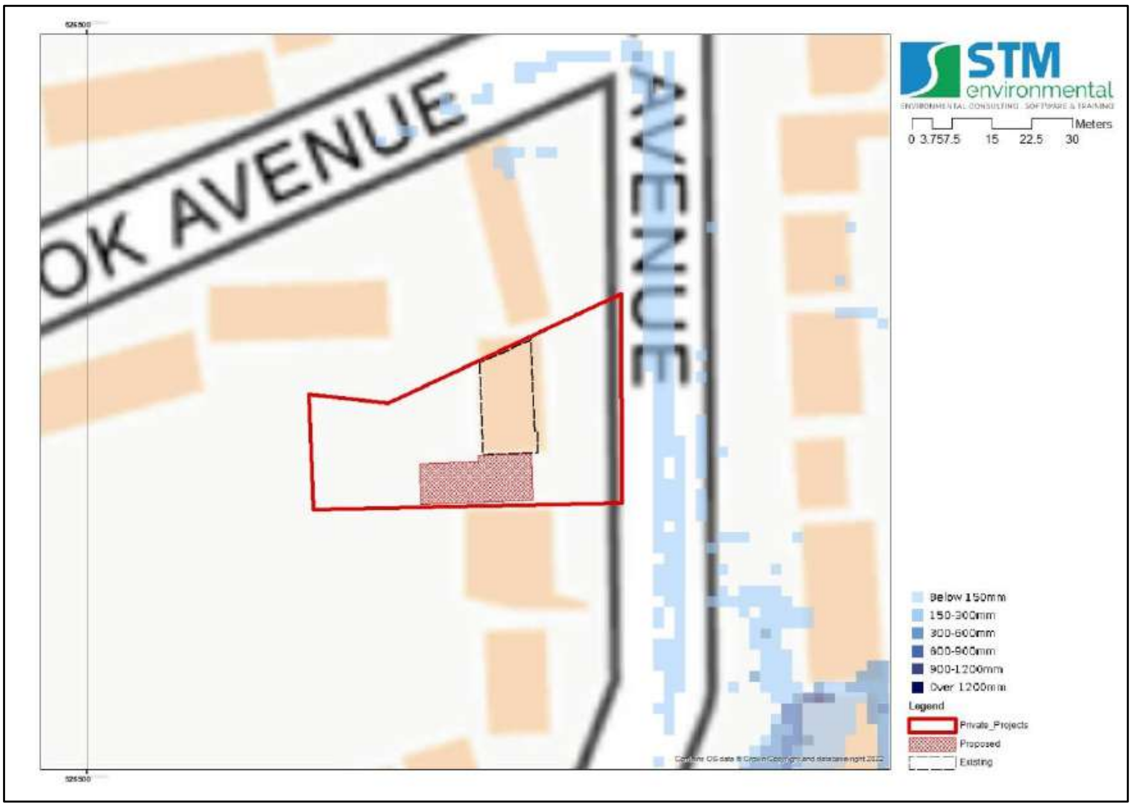
14.3.2 Long Term Pluvial Flood Risk Map (EA)



Extent of flooding from surface water

● High ● Medium ● Low ○ Very low ⊕ Location you selected

14.3.3 Surface water flood depth during the 1 in 1000 year rainfall return periods (Source: EA, 2016).



14.3.4 Groundwater flooding susceptibility (Source: BGS, 2016).

N.A. – No identifiable information regarding groundwater susceptibility.

14.4 Appendix 4 – Thames Water / Asset Information

14.4.1 Asset Map

Asset location search

Thames Water Property Searches

STM Environmental
TWICKENHAM
TW2 6RS

Search address supplied

33
Beech Hill Avenue
Barnet
EN4 0LU

Your reference	33 Beech Hill Ave Barnet EN4 0LU
Our reference	ALS/ALS Standard/2023_4775432
Search date	20 January 2023

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0800 009 4540

Search address supplied: 33, Beech Hill Avenue, Barnet, EN4 0LU

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0800 009 4540, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Affinity Water Ltd
Tamblin Way
Hatfield
AL10 9EZ
Tel: 0345 3572401

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

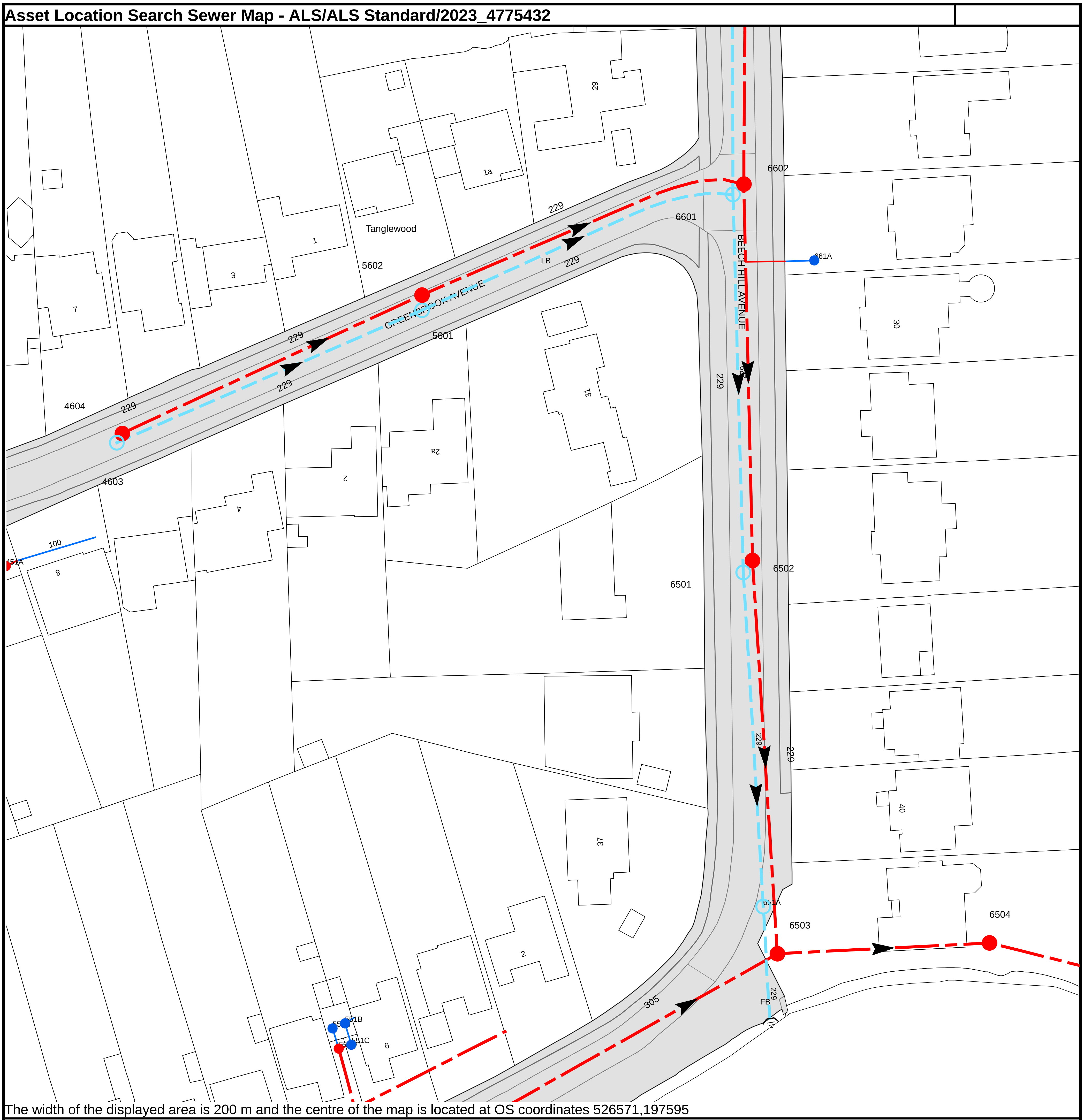
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2023_4775432



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 526571,197595

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
451A	**n/a**	**n/a**
551D	**n/a**	**n/a**
551C	**n/a**	**n/a**
551A	**n/a**	**n/a**
551B	**n/a**	**n/a**
6503	**74.49**	**70.41**
6504	**71.49**	**69.15**
651A	**n/a**	**n/a**
4603	**84.36**	**81.23**
4604	**84.36**	**80.9**
5601	**81.08**	**79.07**
5602	**81.03**	**78.71**
6601	**79.58**	**77.88**
6501	**75.85**	**74.28**
6602	**79.63**	**77.6**
6502	**75.93**	**74.05**
661A	**n/a**	**n/a**

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

- Storm Sewer
- Sludge Sewer
- Foul Trunk Sewer
- Surface Trunk Sewer
- Combined Trunk Sewer
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Vacuum
- Thames Water Proposed
- Vent Pipe
- Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

- Sewer
- Culverted Watercourse
- Proposed
- Decommissioned Sewer
- Content of this drainage network is currently unknown
- Ownership of this drainage network is currently unknown

Sewer Fittings

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

- ◆ Air Valve
- Meter
- ▯ Dam Chase
- Vent
- ■ Fitting

Operational Controls

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

- Ancillary
- Drop Pipe
- ⧓ Control Valve
- Weir

End Items

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

- Inlet
- Outfall
- Undefined End

Other Symbols

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

- ✳ Change of Characteristic Indicator
- ▲/▲ Public / Private Pumping Station
- ⊠ Invert Level
- ◁ Summit

Areas

Lines denoting areas of underground surveys, etc.

- ▨ Agreement
- ▨ Chamber
- ⁘ Operational Site

Ducts or Crossings

- ▨ Casement
- ▨ Conduit Bridge
- ▨ Subway
- ▨ Tunnel

Ducts may contain high voltage cables. Please check with Thames Water.

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters.

Text next to a manhole indicates the manhole reference number and should not be taken as a measurement.
If you are unsure about any text or symbology, please contact Property Searches on 0800 009 4540.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law ‘The Late Payment of Commercial Debts (Interest) Act 1998’.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water’s standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to her at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

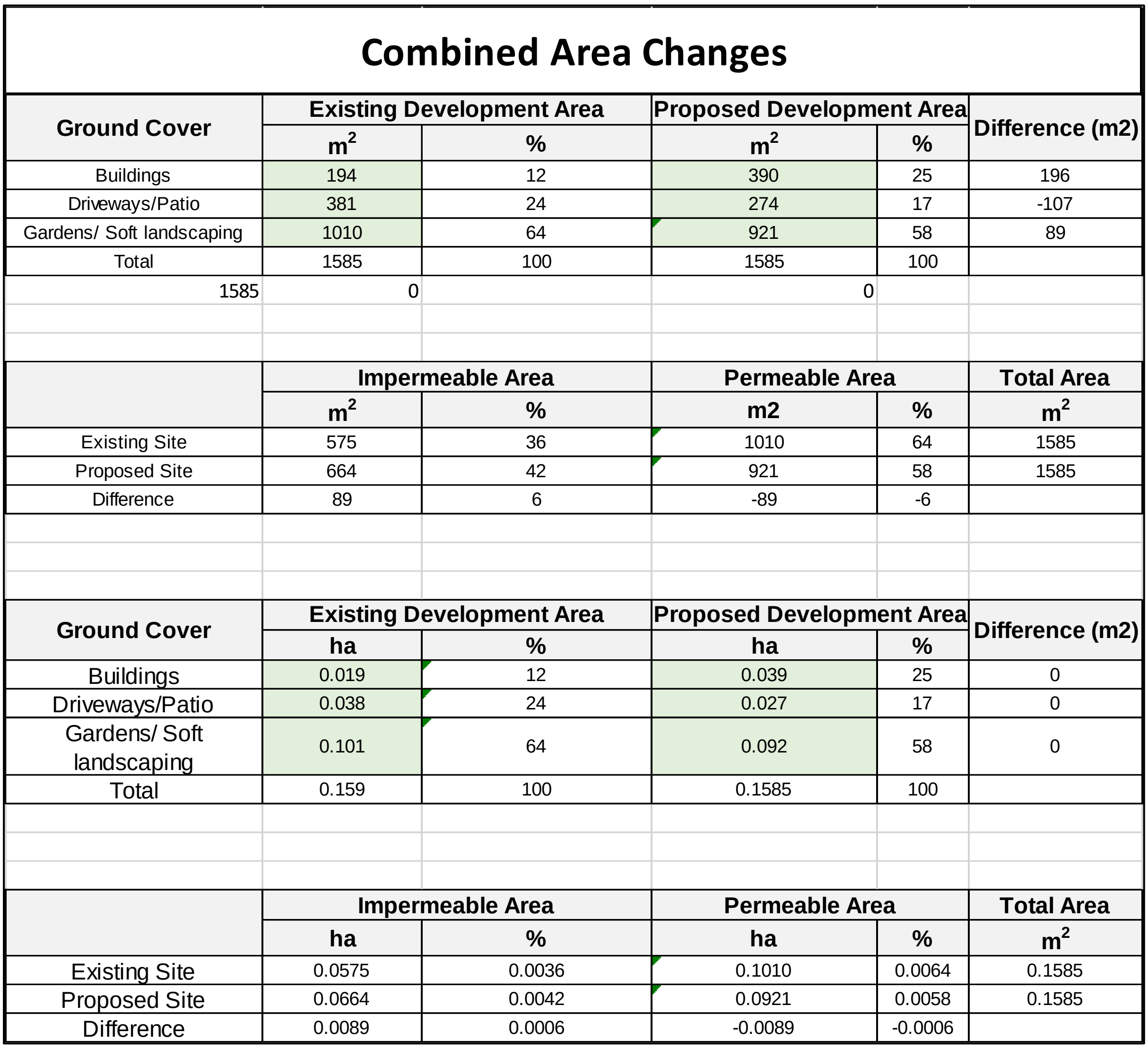
Ways to pay your bill

Credit Card	BACS Payment	Telephone Banking	Cheque
Call **0800 009 4540** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to ‘**Thames Water Utilities Ltd**’ Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

14.5 Appendix 5 – Run-Off Rate and Storage Calculations

14.5.1 Combined Site Area Changes



Combined Area Changes

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m2)
	m^2	%	m^2	%	
Buildings	194	12	390	25	196
Driveways/Patio	381	24	274	17	-107
Gardens/ Soft landscaping	1010	64	921	58	89
Total	1585	100	1585	100	
1585	0		0		

	Impermeable Area		Permeable Area		Total Area
	m^2	%	m2	%	m^2
Existing Site	575	36	1010	64	1585
Proposed Site	664	42	921	58	1585
Difference	89	6	-89	-6	

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m2)
	ha	%	ha	%	
Buildings	0.019	12	0.039	25	0
Driveways/Patio	0.038	24	0.027	17	0
Gardens/ Soft landscaping	0.101	64	0.092	58	0
Total	0.159	100	0.1585	100	

	Impermeable Area		Permeable Area		Total Area
	ha	%	ha	%	m^2
Existing Site	0.0575	0.0036	0.1010	0.0064	0.1585
Proposed Site	0.0664	0.0042	0.0921	0.0058	0.1585
Difference	0.0089	0.0006	-0.0089	-0.0006	

14.5.2 UK SuDS

hr wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Matthew Ashdown
Site name:	33 Beech Hill
Site location:	EN4 0LU

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

Site Details

Latitude:	51.66390° N
Longitude:	0.17124° W
Reference:	1494697824
Date:	Mar 20 2024 11:32

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 0.1585

Methodology

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

Soil characteristics

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

Hydrological characteristics

	Default	Edited
SAAR (mm):	680	680
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates

Default Edited

Q_{BAR} (l/s):	0.74	0.74
1 in 1 year (l/s):	0.63	0.63
1 in 30 years (l/s):	1.7	1.7
1 in 100 year (l/s):	2.36	2.36
1 in 200 years (l/s):	2.77	2.77

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

hr wallingford

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Matthew Ashdown
Site name:	33 Beech Hill
Site location:	Barnet, EN4 0LU

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	51.66390° N
Longitude:	0.17124° W
Reference:	2946315983
Date:	Mar 20 2024 11:23

Site characteristics

Total site area (ha):	0.159
Significant public open space (ha):	0.101
Area positively drained (ha):	0.057999999999999996
Impermeable area (ha):	0.0575
Percentage of drained area that is impermeable (%):	99
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.06
Net impermable area for storage volume design (ha):	0.06
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	96.25
FEH / FSR conversion factor:	1.25	1.25
SAAR (mm):	680	680
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3

Design criteria

Climate change allowance factor:	1.4
Urban creep allowance factor:	1.1
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.74	0.74
Q_{BAR} for net site area (l/s):	0.27	0.27

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	2	2
1 in 30 years (l/s):	2	2
1 in 100 year (l/s):	2	2

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	26	26
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	26	26

This report was produced using the storage estimation tool developed by HRWallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at http://uksuds.com/terms-and-conditions.htm. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

Print Close Report

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by: Georgia Travers

Site name: 33 Beech Hill Avenue

Site location: EN4 0LU

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

Site Details

Latitude: 51.66289° N

Longitude: 0.17125° W

Reference: 2549230165

Date: Mar 01 2023 16:54

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.1585

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics

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

Hydrological characteristics

	Default	Edited
SAAR (mm):	680	680
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

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

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

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

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

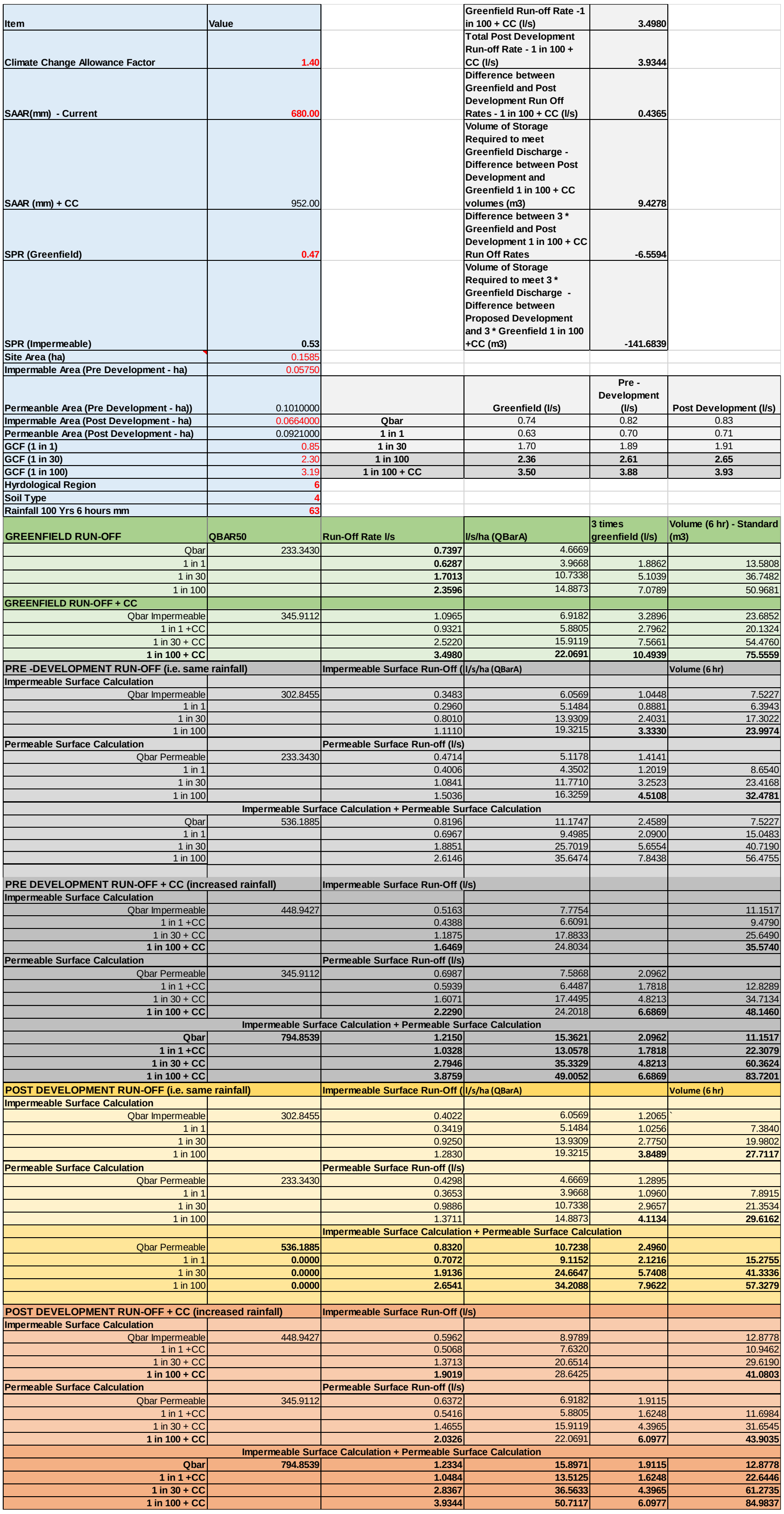
(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates

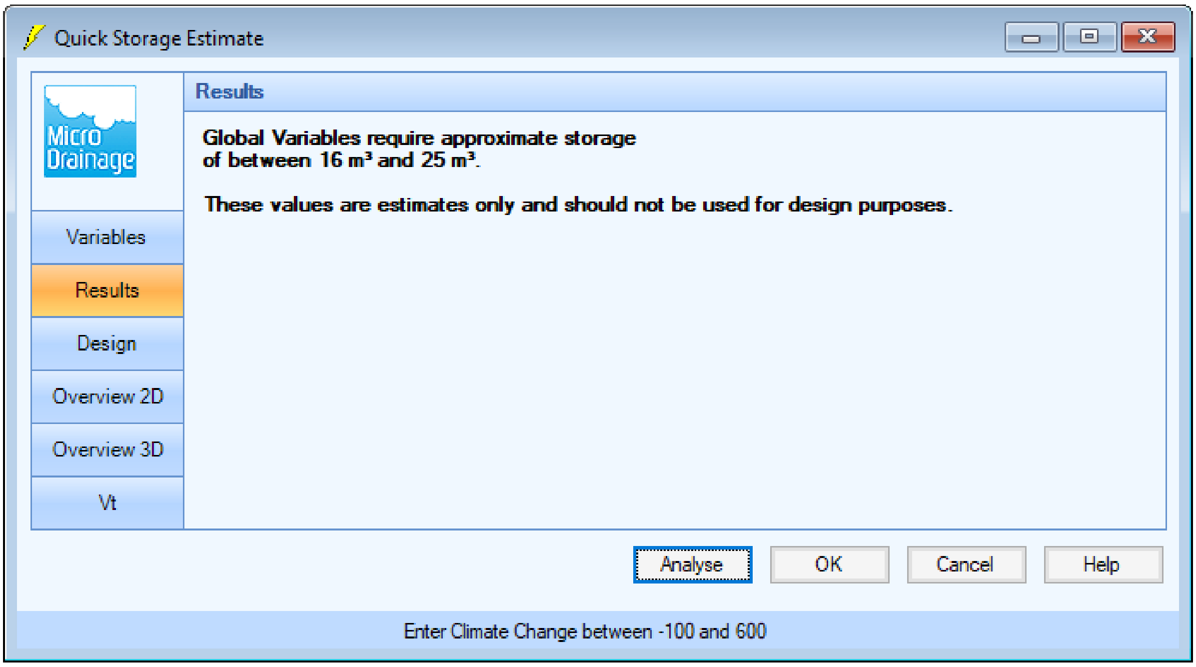
	Default	Edited
Q_{BAR} (l/s):	0.74	0.74
1 in 1 year (l/s):	0.63	0.63
1 in 30 years (l/s):	1.7	1.7
1 in 100 year (l/s):	2.36	2.36
1 in 200 years (l/s):	2.77	2.77

14.5.3 IH124 method



Item	Value		Greenfield Run-off Rate -1 in 100 + CC (l/s)	3.4980	
Climate Change Allowance Factor	1.40		Total Post Development Run-off Rate - 1 in 100 + CC (l/s)	3.9344	
SAAR(mm) - Current	680.00		Difference between Greenfield and Post Development Run Off Rates - 1 in 100 + CC (l/s)	0.4365	
SAAR (mm) + CC	952.00		Volume of Storage Required to meet Greenfield Discharge - Difference between Post Development and Greenfield 1 in 100 + CC volumes (m3)	9.4278	
SPR (Greenfield)	0.47		Difference between 3 * Greenfield and Post Development 1 in 100 + CC Run Off Rates	-6.5594	
SPR (Impermeable)	0.53		Volume of Storage Required to meet 3 * Greenfield Discharge - Difference between Proposed Development and 3 * Greenfield 1 in 100 +CC (m3)	-141.6839	
Site Area (ha)	0.1585				
Impermable Area (Pre Development - ha)	0.05750				
Permeanble Area (Pre Development - ha))	0.1010000		Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Impermable Area (Post Development - ha)	0.0664000	Qbar	0.74	0.82	0.83
Permeanble Area (Post Development - ha)	0.0921000	1 in 1	0.63	0.70	0.71
GCF (1 in 1)	0.85	1 in 30	1.70	1.89	1.91
GCF (1 in 30)	2.30	1 in 100	2.36	2.61	2.65
GCF (1 in 100)	3.19	1 in 100 + CC	3.50	3.88	3.93
Hyrdological Region	6				
Soil Type	4				
Rainfall 100 Yrs 6 hours mm	63				
GREENFIELD RUN-OFF	QBAR50	Run-Off Rate l/s	l/s/ha (QBarA)	3 times greenfield (l/s)	Volume (6 hr) - Standard (m3)
Qbar	233.3430	0.7397	4.6669		
1 in 1		0.6287	3.9668	1.8862	13.5808
1 in 30		1.7013	10.7338	5.1039	36.7482
1 in 100		2.3596	14.8873	7.0789	50.9681
GREENFIELD RUN-OFF + CC					
Qbar Impermeable	345.9112	1.0965	6.9182	3.2896	23.6852
1 in 1 +CC		0.9321	5.8805	2.7962	20.1324
1 in 30 + CC		2.5220	15.9119	7.5661	54.4760
1 in 100 + CC		3.4980	22.0691	10.4939	75.5559
PRE -DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (	l/s/ha (QBarA)		Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	302.8455	0.3483	6.0569	1.0448	7.5227
1 in 1		0.2960	5.1484	0.8881	6.3943
1 in 30		0.8010	13.9309	2.4031	17.3022
1 in 100		1.1110	19.3215	3.3330	23.9974
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	233.3430	0.4714	5.1178	1.4141	
1 in 1		0.4006	4.3502	1.2019	8.6540
1 in 30		1.0841	11.7710	3.2523	23.4168
1 in 100		1.5036	16.3259	4.5108	32.4781
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	536.1885	0.8196	11.1747	2.4589	7.5227
1 in 1		0.6967	9.4985	2.0900	15.0483
1 in 30		1.8851	25.7019	5.6554	40.7190
1 in 100		2.6146	35.6474	7.8438	56.4755
PRE DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	448.9427	0.5163	7.7754		11.1517
1 in 1 +CC		0.4388	6.6091		9.4790
1 in 30 + CC		1.1875	17.8833		25.6490
1 in 100 + CC		1.6469	24.8034		35.5740
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	345.9112	0.6987	7.5868	2.0962	
1 in 1 +CC		0.5939	6.4487	1.7818	12.8289
1 in 30 + CC		1.6071	17.4495	4.8213	34.7134
1 in 100 + CC		2.2290	24.2018	6.6869	48.1460
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	794.8539	1.2150	15.3621	2.0962	11.1517
1 in 1 +CC		1.0328	13.0578	1.7818	22.3079
1 in 30 + CC		2.7946	35.3329	4.8213	60.3624
1 in 100 + CC		3.8759	49.0052	6.6869	83.7201
POST DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (	l/s/ha (QBarA)		Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	302.8455	0.4022	6.0569	1.2065	`
1 in 1		0.3419	5.1484	1.0256	7.3840
1 in 30		0.9250	13.9309	2.7750	19.9802
1 in 100		1.2830	19.3215	3.8489	27.7117
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	233.3430	0.4298	4.6669	1.2895	
1 in 1		0.3653	3.9668	1.0960	7.8915
1 in 30		0.9886	10.7338	2.9657	21.3534
1 in 100		1.3711	14.8873	4.1134	29.6162
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar Permeable	536.1885	0.8320	10.7238	2.4960	
1 in 1	0.0000	0.7072	9.1152	2.1216	15.2755
1 in 30	0.0000	1.9136	24.6647	5.7408	41.3336
1 in 100	0.0000	2.6541	34.2088	7.9622	57.3279
POST DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	448.9427	0.5962	8.9789		12.8778
1 in 1 +CC		0.5068	7.6320		10.9462
1 in 30 + CC		1.3713	20.6514		29.6190
1 in 100 + CC		1.9019	28.6425		41.0803
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	345.9112	0.6372	6.9182	1.9115	
1 in 1 +CC		0.5416	5.8805	1.6248	11.6984
1 in 30 + CC		1.4655	15.9119	4.3965	31.6545
1 in 100 + CC		2.0326	22.0691	6.0977	43.9035
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	794.8539	1.2334	15.8971	1.9115	12.8778
1 in 1 +CC		1.0484	13.5125	1.6248	22.6446
1 in 30 + CC		2.8367	36.5633	4.3965	61.2735
1 in 100 + CC		3.9344	50.7117	6.0977	84.9837

14.5.4 Storage Estimates – 3.5l

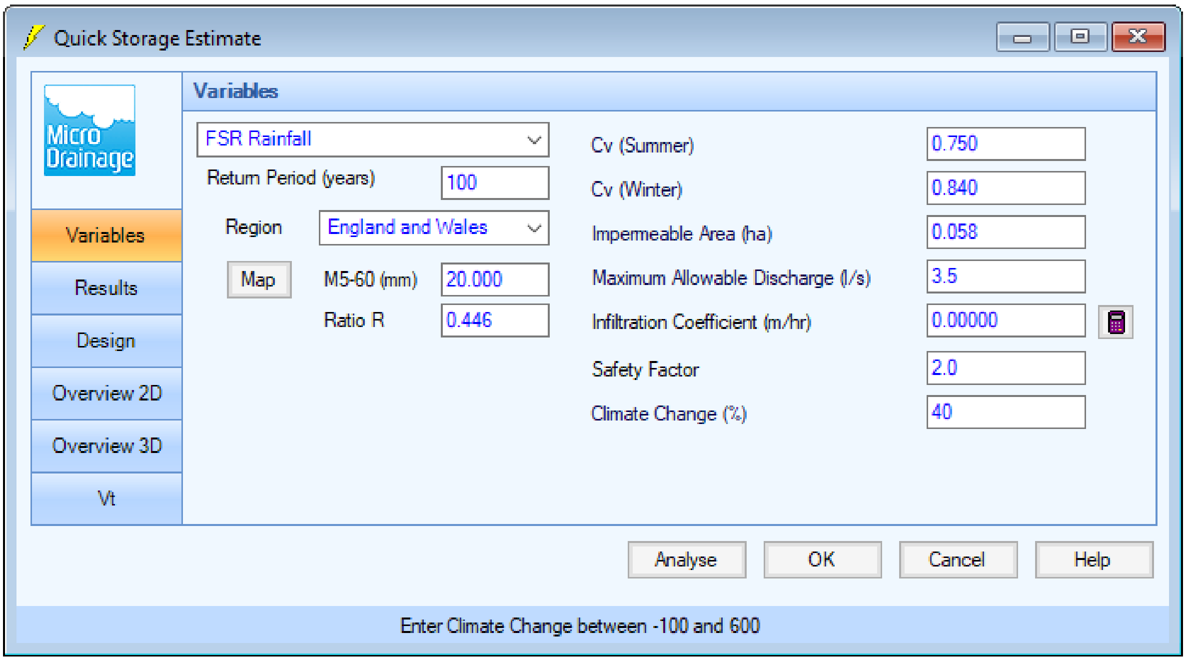


Results

Global Variables require approximate storage of between 16 m³ and 25 m³.

These values are estimates only and should not be used for design purposes.

Enter Climate Change between -100 and 600



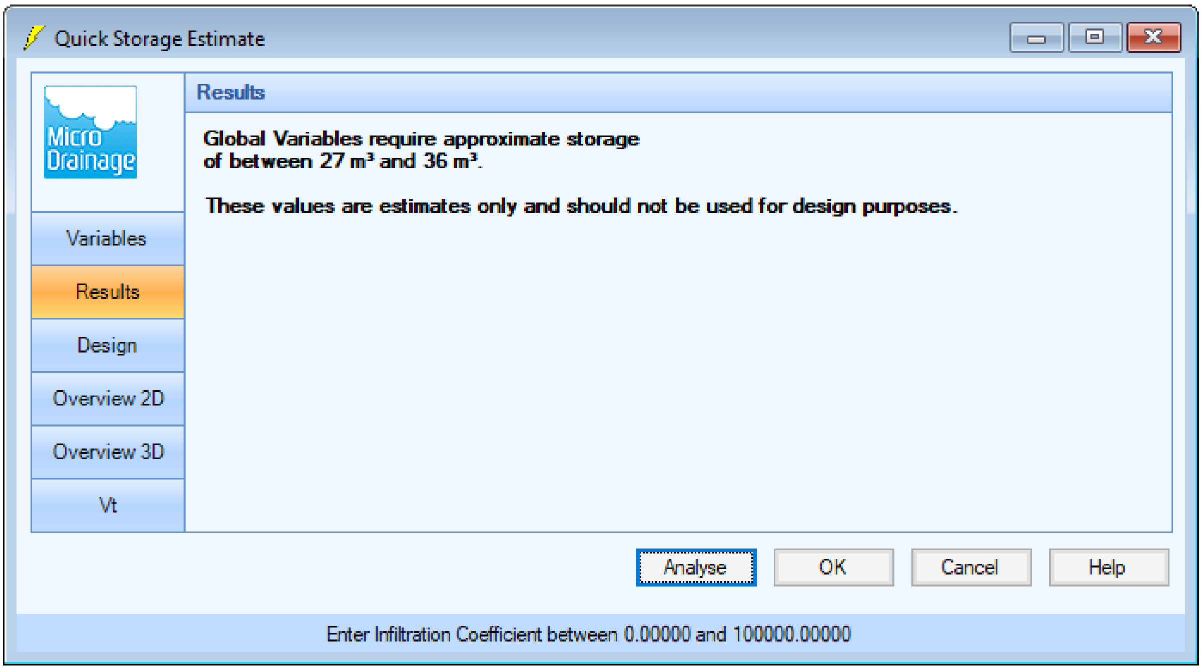
Variables

FSR Rainfall

Return Period (years)	100
Region	England and Wales
M5-60 (mm)	20.000
Ratio R	0.446
Cv (Summer)	0.750
Cv (Winter)	0.840
Impermeable Area (ha)	0.058
Maximum Allowable Discharge (l/s)	3.5
Infiltration Coefficient (m/hr)	0.00000
Safety Factor	2.0
Climate Change (%)	40

Enter Climate Change between -100 and 600

14.5.5 Storage Estimates – 0.75 - Pre



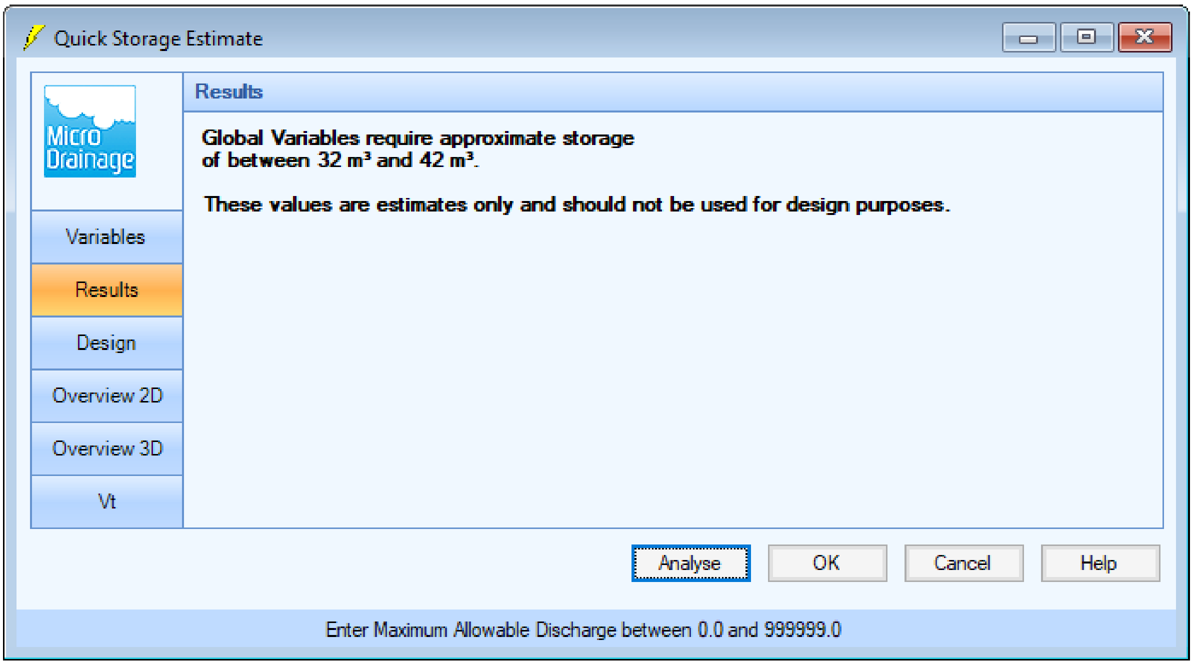
Results

Global Variables require approximate storage
of between 27 m³ and 36 m³.

These values are estimates only and should not be used for design purposes.

Enter Infiltration Coefficient between 0.00000 and 100000.00000

14.5.6 Storage Estimates – 0.75 – Post



Results

Global Variables require approximate storage
of between 32 m³ and 42 m³.

These values are estimates only and should not be used for design purposes.

Enter Maximum Allowable Discharge between 0.0 and 999999.0

14.6 Appendix 6 - Site Investigation

14.6.1 Site Investigation Photos

	
01	02
	

14.6.2 Infiltration Testing Results – TP01

Site Location	33 Beech Hill		
Area	Front of House		
Trial Pit ID	TP01		
Test Run	1	2	3

Front of House - TP01 - Test Run No. 1

insert time according to the measured units

Dip Readng	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)		Time	*25% Full (mbgl)*	*50% Full (mbgl)*	*75% Full (mbgl)*
	1.39	0.2	0.00	0	0	0:00	11:20:00	1.35	1.10	0.85
	1.35	0.3	1.50	90	5400.00	1:30	12:50:00	1.35	1.10	0.85
	1.15	0.5	24.00	1440	86400.00	00:00	10:52:00	1.35	1.10	0.85

Failed to reach 50% within 24 hours. Second run not undertaken.

f = Vp75 - 25*0.3/as50*tp75-25

Infiltration Coef. Calculations		
Width	0.30	m
Depth	1.60	m
Length	1.40	m
Total Volume	0.67	m3
Effective Storage Depth	1.00	m
25% Full	1.35	mbgl
50% Full	1.10	mbgl
75% Full	0.85	mbgl
Pipe Depth	**1.85**	
***a** s50*	2.24	m^2
***V** p75-25*	0.21	m^3
***t** p75-25 (read from graph)*	NA	mins
f	**#VALUE!**	m/s
f	#VALUE!	mm/hr
f	#VALUE!	m/hr

Infiltration Rate (mm/hr)	
IR < 0.036	IMPERMEABLE
0.036 < IR < 0.38	VERY SLOW
0.38 < IR < 3.7	MODERATELY SLOW
3.7 < IR < 37	MODERATE
37 < IR < 370	MODERATELY RAPID
IR > 370	RAPID

BASIC INFILTRATION RATES FOR VARIOUS SOIL

Soil type	Basic infiltration rate (mm/hour)
sand	less than 30
sandy loam	20 - 30
loam	10 - 20
clay loam	5 - 10
clay	1 - 5

Water level = Pipe Depth - Dip

14.6.3 Infiltration Testing Results – TP02

Site Location	33 Beech Hill		
Area	Front of House		
Trial Pit ID	TP02		
Test Run	1	2	3

Front of House - TP02 - Test Run No. 1

insert time according to the measured units

Dip Readng	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)		Time	*25% Full (mbgl)*	*50% Full (mbgl)*	*75% Full (mbgl)*
	0.5	0.1	0.00	0	0	0:00	11:35:00	0.5	0.40	0.3
	0.46	0.1	1.83	110	6600.00	1:50	13:25:00	0.5	0.40	0.3
	0.289	0.3	24.00	1440	86400.00	00:00	10:52:00	0.5	0.40	0.3

Failed to reach 50% within 24 hours. Second run not undertaken.

f = Vp75 - 25*0.3/as50*tp75-25

Infiltration Coef. Calculations		
Width	0.50	m
Depth	0.60	m
Length	0.60	m
Total Volume	0.18	m3
Effective Storage Depth	0.40	m
25% Full	0.50	mbgl
50% Full	0.40	mbgl
75% Full	0.30	mbgl
Pipe Depth	**1.85**	
a_{s50}	0.84	m^2
V_{p75-25}	0.06	m^3
t_{p75-25} *(read from graph)*	NA	mins
f	**#VALUE!**	m/s
f	#VALUE!	mm/hr
f	#VALUE!	m/hr

33 Beech Hill Front Of Dwelling - TP02 - Infiltration Vs Time

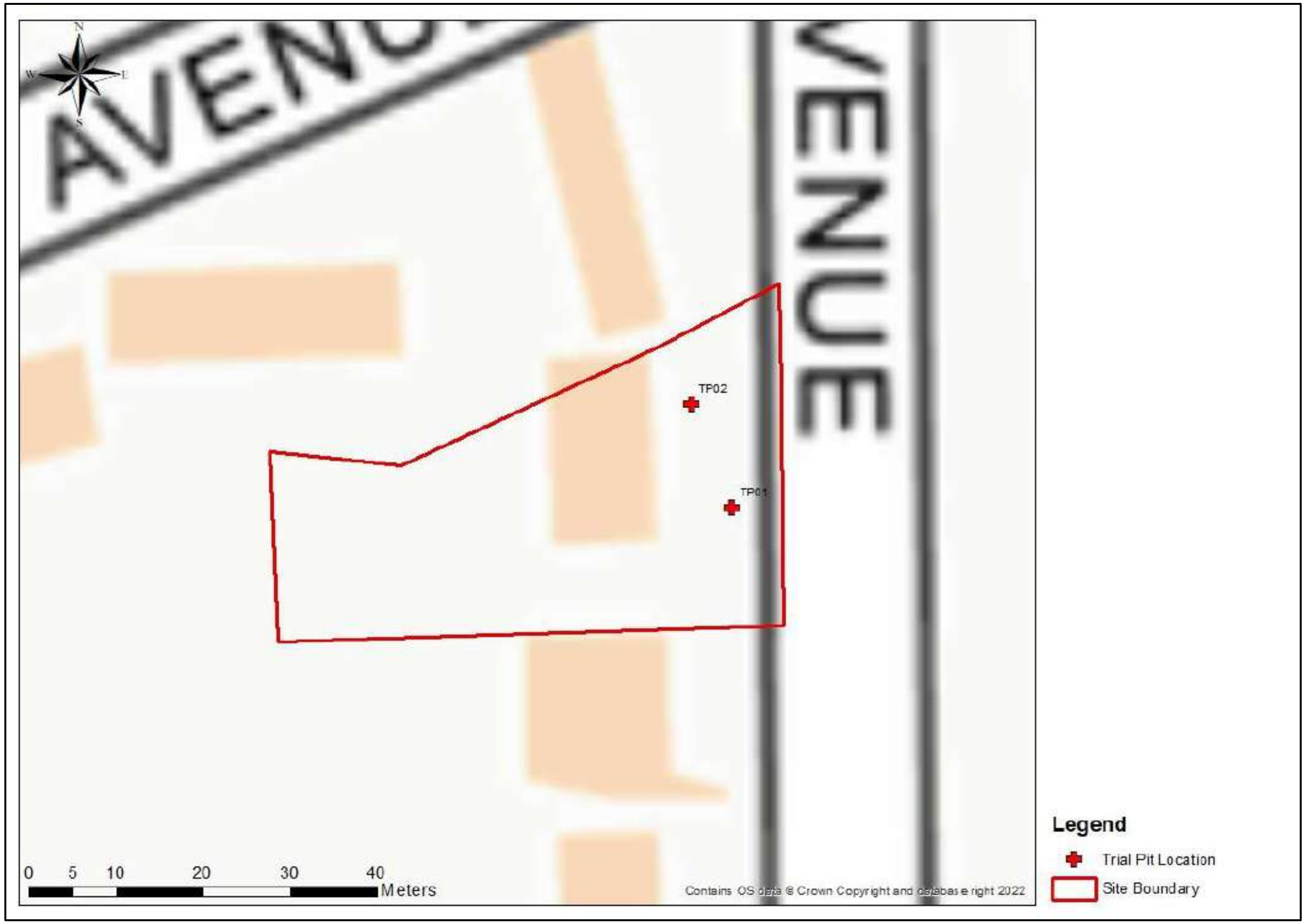
Infiltration Rate (mm/hr)	
IR < 0.036	IMPERMEABLE
0.036 < IR < 0.38	VERY SLOW
0.38 < IR < 3.7	MODERATELY SLOW
3.7 < IR < 37	MODERATE
37 < IR < 370	MODERATELY RAPID
IR > 370	RAPID

BASIC INFILTRATION RATES FOR VARIOUS SOIL

Soil type	**Basic infiltration rate (mm/hour)**
sand	less than 30
sandy loam	20 - 30
loam	10 - 20
clay loam	5 - 10
clay	1 - 5

Water level = Pipe Depth - Dip

14.6.4 Soakaway Test Location Map



Contains OS data © Crown Copyright and database right 2022

14.6.5 HoleBase Trial Pit Logs

Borehole Log

Project Name: 33 Beech Hill	Project No. 33 Beech Hill, Barnet	Co-ords: 521028.00 - 191966.00	Borehole No. **BH01** Sheet 1 of 1
			Hole Type WLS
Location: 33 Beech Hill, Barnet, EN4 0JN		Level: 70.00	Scale 1:50
Client: N & K Property Services		Dates: 18/02/2021 - 18/02/2021	Logged By M.Forshaw

Well	Water Strikes	**Samples and In Situ Testing**			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	69.90		TOPSOIL - Dark brown Clayey SILT.	
								Firm light brown slightly organic CLAY with abundant organic wood material, some pockets and black thin laminations.	
		1.00		N=9 (1,1/2,2,3,2)	1.00	69.00		Firm to stiff light brown slightly organic CLAY with pale greenish grey laminations throughout. Rare woody organic material.	1
		2.00		N=7 (1,1/2,1,2,2)					2
		3.00	D		3.00	67.00		Stiff dark brown CLAY.	3
		3.00		N=12 (2,2/3,2,3,4)					
		4.00	D						4
		4.00		N=15 (3,2/3,4,4,4)					
		5.00		N=17 (3,4/3,4,5,5)	5.00	65.00		Very stiff dark brown CLAY.	5
		6.00		N=22 (5,4/5,5,6,6)					6
		6.00 - 6.50	U						
		7.00	D						7
		7.00		N=26 (5,5/6,6,7,7)					
		7.50 - 8.00	U						
		8.00		N=25 (4,4/5,7,6,7)					8
		9.00		N=24 (4,4/5,6,6,7)	9.00	61.00		End of borehole at 9.00 m	9
									10

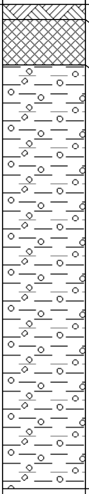
Remarks

Borehole advanced to a maximum depth of 9mbgl. No GW encountered. Borehole location grid references and elevation values estimated based off of aerial imagery (not measured).

Trial Pit Log

Trialpit No **TP01**
Sheet 1 of 1

Project Name: 33 Beech Hill Ave
Project No. SWDS-2023-000002
Co-ords: -
Level:
Date 24/01/2023
Location: 33 Beech Hill Ave, Barnet, EN4 0LU
Dimensions (m):
Depth 1.60
Scale 1:25
Client: My ADL
Logged M.Forshaw/A.Akanu



Water Strike	**Samples and In Situ Testing**			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.05			Turf
				0.20			Made Ground - Dark greyish brown slightly clayey SILT. Rare brick fragments.
				1.60			Mottled light brown dark yellow and light grey slightly cobbly CLAY.
							End of pit at 1.60 m

Remarks: Trial pit advanced to a maximum depth of 1.6mbgl. No water encountered. Elevation levels and borehole location grid references are approximated based on satellite imagery (not measured).

Stability:

STM environmental
NVIRONMENTAL CONSULTING, SOFTWARE & TRAINING

Trial Pit Log

Trialpit No
TP02
Sheet 1 of 1

Project Name: 33 Beech Hill Ave	Project No. SWDS-2023-000002	Co-ords: - Level:	Date 24/01/2023
Location: 33 Beech Hill Ave, Barnet, EN4 0LU		Dimensions (m): Depth 0.60	Scale 1:25
Client: My ADL			Logged M.Forshaw/A.Akanu

Water Strike	**Samples and In Situ Testing**			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.05		▨	Turf
				0.15		▩	Made Ground - Dark grey and dark brown clayey slightly gravelly SILT. Rare fragments of bricks and concrete.
				0.60		☰	Dark brown and dark grey CLAY.
							End of pit at 0.60 m

Remarks: Trial pit advanced to a maximum depth of 0.6mbgl. No water encountered. Elevation levels and borehole location grid references are approximated based on satellite imagery (not measured).

Stability:

14.7 Appendix 7 – SuDS Suitability Assessment

14.7.1 SuDS Suitability Table

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
Rainwater Harvesting	Capture of rainwater into a tank(s) for use (usually non-potable) such as irrigation, toilet flushing, vehicle or plant cleansing.	Care is needed to prevent the development of bacteria, algae and insect infestation.	Suitable.
Infiltration: Soakaways Infiltration Trenches and Basins	Infiltration components are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, into the groundwater.	Highly variable CLAY bedrock and groundwater table is potentially < 3m below surface. Could increase flood risk. Maintenance	Unsuitable – Poor infiltration
Green/Brown /Blue Roofs	Used on flat or shallow pitched roofs to provide a durable roof covering which also provides thermal insulation, amenity space, biodiversity habitat as well as attenuation of rainwater.	Maintenance - Ensuring safe access	Partially Suitable – Small scale
Rain Gardens	Creation of planted landscaped areas to allow the diversion of a portion of rainwater from either downpipes or surrounding paved surfaces. Raingardens can either allow infiltration into the ground or have tanked systems for water retention.	Require maintenance	Suitable – No infiltration / Storage only.
Permeable Pavements / Surfaces	Permeable hard surfaces that allow rainwater to pass through either into the ground or to tanked systems. Good as interception storage.	Potential impact of saturation on pavement stability to be considered. May require extensive use of impermeable membranes and under-drainage. Maintenance required.	Suitable – No infiltration
Swales	Dry ditches used as landscape features to allow the storage and infiltration of rainwater. Often used as linear features alongside roads, footpaths or rail lines but capable of being integrated into the design of many open spaces.	Finding available space in proposed site layout	Unsuitable to located on site.
Detention Basin/Ponds	Landscape features designed to store and in some cases infiltrate rainwater. Detentions basins are usually dry, whereas a pond should retain water. These features need areas of open space but can often be combined with other sustainable drainage techniques.	Potential health and safety issues. Finding available space in proposed site layout	Unsuitable
Storage Tanks/ Geocellular Storage	Usually below ground level, they attenuate rainwater for later slow release back into the drainage system.	Pumping may sometimes be required to empty the tank into the drainage system	Suitable
Oversized Piping	Using larger than necessary pipework creates additional space to store rainwater.	Lacks the wider benefits of the green infrastructure-based techniques	Suitable

14.8 Appendix 8 – Descriptions Of SuDS Techniques

14.8.1 Rainwater Butts

FloPlast

building the future

100L & 210L Water Butts and Rainwater Diverters

PVC-UE Roofline, Window & Cladding Systems

Rainwater Systems

Soil & Waste Systems

Underground Drainage Systems

MDPE Systems

Hot & Cold Plumbing Systems

○ White ● Black ● Brown ● Grey ● Sand ● Cast Iron

Product		Code
	100L Slim Water Butt	WB100
	100L Slim Water Butt Stand	ST100
	210L Slim Water Butt	WB200
	210L Slim Water Butt	ST200

Product		Code
	Rainwater Diverter Connects to 65mm square and 68mm round downpipe (not available in sand).	RVS1
	Connector Kit (not available in brown, grey, sand or "cast Iron" Style).	RVS2
	Rainwater Diverter Connects to 80mm Round Downpipe (not available in "cast Iron" Style).	RVH1
	Rainwater Diverter Connects to 50mm round downpipe (not available in sand or "cast Iron" Style).	RVM1
	"Cast Iron" Style Rainwater Diverter Connects to 65mm square and 68mm round downpipe.	RVS1CI

100L SLIM WATER BUTT

- 100L capacity.
- Space saving water butt ideal where space is at a premium.
- Supplied with tap and lid.
- Manufactured in the UK from recycled materials.

Dimensions

Water Butt:	**Stand:**
32cm (12½") Length	33cm (13") Length
36cm (14") Width	33cm (13") Width
95.2cm (37½") Height	30.5cm (12") Height

210L SLIM WATER BUTT

- 210L capacity.
- Traditional shape water butt with a large capacity.
- Supplied with tap and childproof lid.
- Manufactured in the UK from recycled materials.

Dimensions

Water Butt:	**Stand:**
57cm (22½") Diameter	53cm (21") Diameter
97cm (38") Height	31cm (12") Height

14.8.2 SuDS Planters

Structural Flow-Through Planter

buildings

parking areas
& impermeable
landscape

impermeable
soils

Y - Public System Approvable

Y - Quantity for Conveyance

Y - Hydromodification Approach

N - Water Quality Treatment Approach

Description

Flow-through planters are structural landscaped reservoirs that collect stormwater and filter out pollutants as the water percolates through the vegetation, growing medium and gravel. These are appropriate where soils do not drain well or there are site constraints. A liner may be required when located adjacent to buildings, over contaminated soils and on unstable slopes. Excess stormwater collects in a perforated pipe at the bottom of the flow-through planter and drains to an approved discharge point.

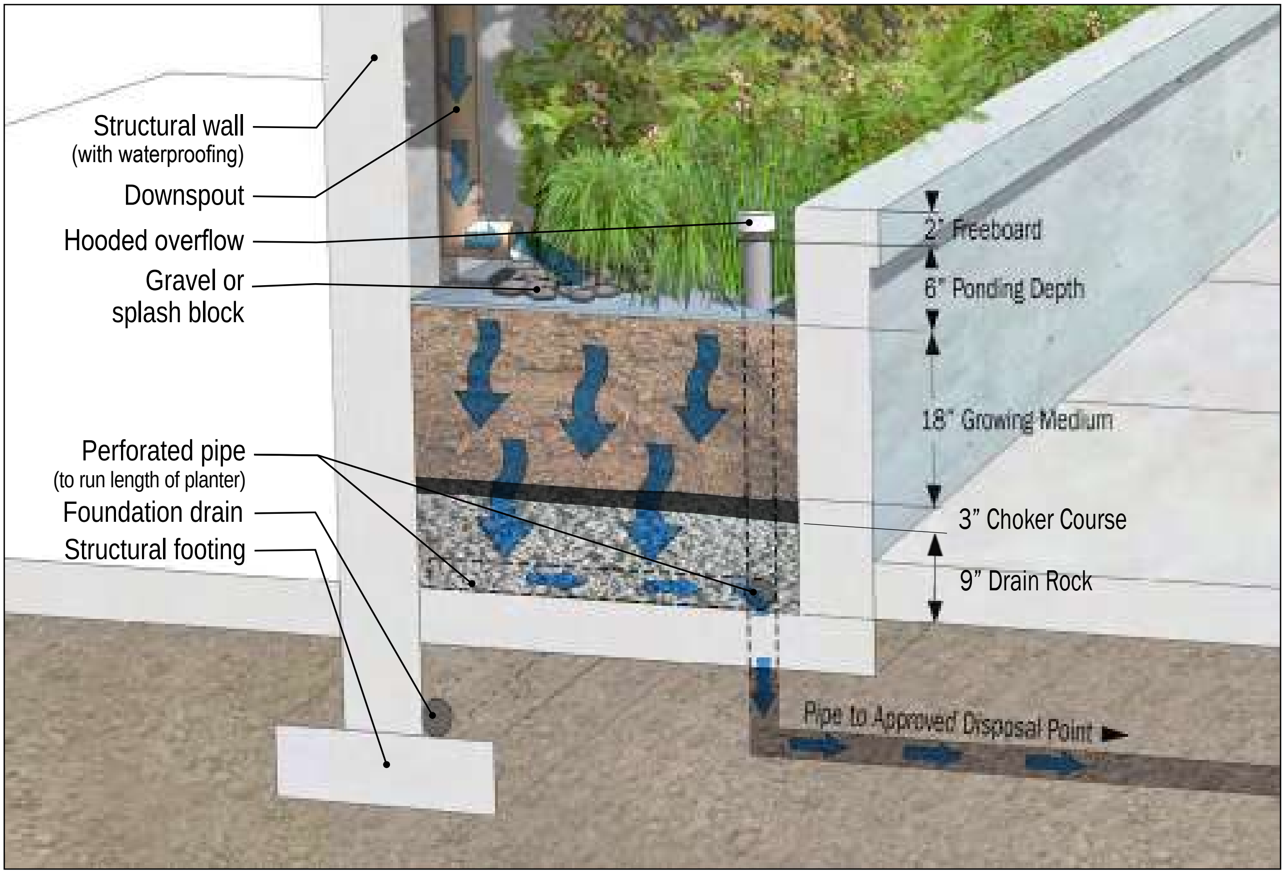
Tree box filters are flow-through planters with a concrete “box” that contains filtering growing media and a tree or large shrub. Tree box filters are used singly or in multiples, often adjacent to streets where runoff is directed to them to treat stormwater runoff before it enters a catch basin.

Application & Limitations

Flow-through planters may help fulfill a site’s landscaping area requirement and can be used to manage stormwater runoff from all types of impervious surfaces on private property and within the public right-of-way. Check with the local jurisdiction if proposing to use a flow-through planter in the public right-of-way. Flow-through planters can be placed next to buildings and are ideal for sites with poorly draining soils, steep slopes or other constraints. Design variations of shape, wall treatment and planting scheme will fit the character of any site.

Headwaters at Tryon Creek, Portland

Structural Flow-Through Planter



Design Factors

Sizing

To calculate the planter size, multiply the impervious surface (rooftops, driveways, parking lots, etc.) area by 6%. The square footage is the peak water surface prior to overflow. For example, a 1,200-sf rooftop and 300-sf driveway (1,500 sf total impervious area) requires a 90-sf stormwater planter (1,500 x 0.06). This could be accomplished with one 9-foot by 10-foot flow-through planter. Note, pretreatment is required for any contributing impervious area greater than 15,000 sf.

Geometry/Slopes

- Stormwater planters may be any shape, and can be designed as square, rectangular, circular, oblong or irregular.
- Regardless of the shape, a minimum planter width of 30 inches is needed to achieve sufficient time for treatment and to avoid short-circuiting.
- The minimum treatment depth of 18 inches is achieved in the growing medium.
- Planters are designed to evenly distribute and filter flows. Surface longitudinal slopes should be less than 0.5%.

Piping for Flow-Through Planters

Follow Plumbing Code requirements for piping that directs stormwater from impervious surfaces to flow-through planters. Stormwater may flow directly from the public street right-of-way or adjacent parking lot areas via curb openings. The overflow drain allows not more than six inches of water to pond in the planter prior to overflow. A perforated pipe system under the planter drains water that has filtered through the topsoil to prevent long-term ponding. On private property, the overflow drain and piping must meet Plumbing Code requirements and direct excess and filtered stormwater to an approved disposal point. Check with the local jurisdiction or use Clean Water Services Design and Construction Standards for additional information on piping material for use in the public right-of-way.

Setbacks

Check with the local building department to confirm site-specific requirements.

- For planters without an impermeable liner, generally the minimum setback from building structures is 10 feet.

PSU Stephen Epler Hall, Portland

RiverEast Center, SE Portland

Design Factors (continued)

- Typically, no building setback is required for planters lined with waterproofed concrete or 60 mil. PVC liner to prevent infiltration.

Soil Amendment/Mulch

Amended soils with appropriate compost and sand provide numerous benefits: infiltration; detention; retention; better plant establishment and growth; reduced summer irrigation needs; reduced fertilizer need; increased physical/chemical/microbial pollution reduction; and, reduced erosion potential. Primary treatment will occur in the top 18 inch flow-through planter. Amended soil in the treatment area is composed of organic compost, gravelly sand and topsoil. Compost is weed-free, decomposed, non-woody plant material; animal waste is not allowed. Check with the local jurisdiction or Clean Water Services for Seal of Testing Approval Program (STA) Compost provider.

To avoid erosion, use approved erosion control BMPs for flow- through planters.

Vegetation

Planted vegetation helps to attenuate stormwater flows and break down pollutants by interactions with bacteria, fungi, and other organisms in the planter soil. Vegetation also traps sediments, reduces erosion, and limits the spread of weeds. Appropriate, carefully selected plantings enhance the aesthetic and habitat value. For a complete list of allowable plants refer to page 76.

The entire water quality treatment area should be planted appropriately for the soil conditions.

Because the entire facility will be inundated periodically, plant the water quality treatment area with herbaceous species such as rushes sedges, perennials, ferns appropriate for wet-to-moist soil conditions. Most moisture-tolerant plants can withstand seasonal droughts during the dry summer months and do not need irrigation after they become established.

Native plants are encouraged, but non-invasive ornamentals that add aesthetic and functional value are acceptable upon approval from local jurisdiction. All vegetation should be planted densely and evenly to ensure proper hydrological function of the flow-through planter.

Quantities per 100 square feet:

- 115 herbaceous plants, 1’ on center spacing, 6” or ½-gal container size; or
- 100 herbaceous plants, 1’ on center, and 4 shrubs, 1-gal container size 2’ on center.

Structural Flow-Through Planter

Rose Quarter parking structure, NE Portland

Washougal Town Square

Aloha Dog and Cat Clinic, Washington County

Buckman Terrace Apartments, Portland

Required Maintenance Period

- Water-efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation after these two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the flow-through planter for a minimum of two years following construction and acceptance of the facility.

Long-Term Maintenance

If private, the property owner will be responsible for ongoing maintenance per a recorded maintenance agreement (see page 88 for example maintenance agreement).

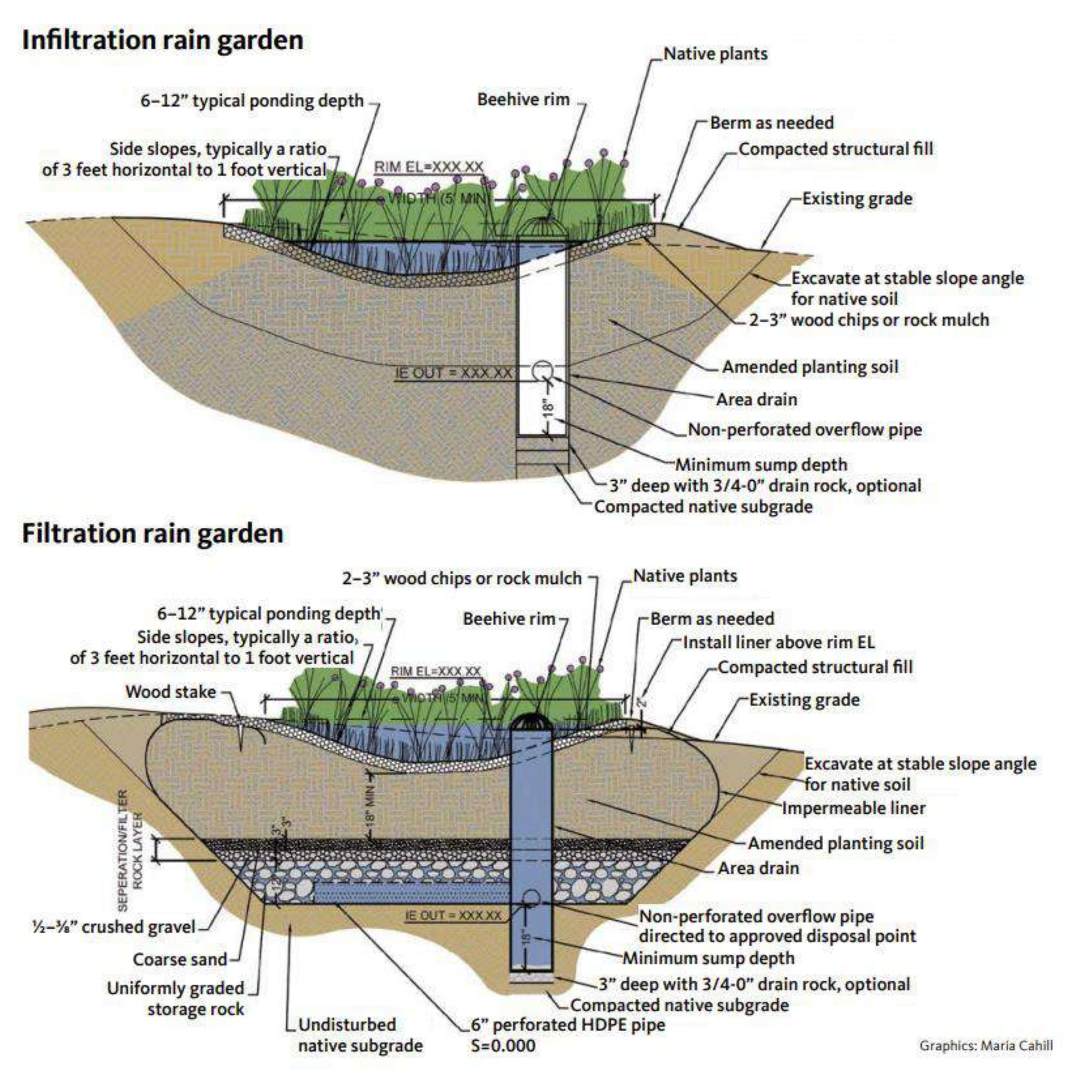
For detailed Operation and Maintenance Plans that describe proper maintenance activities please refer to page 91.

All publicly maintained facilities not located in the public right-of-way must have a public easement to ensure access for maintenance.

References

Clean Water Services Design and Construction Standards

14.8.3 Rain Gardens Example



14.8.4 Permeable Paving

Various options are available for the type of permeable paving that can be installed. Permeable block paving allows for infiltration through gaps in the surface. This can be underlain by a geotextile membrane and fine gravel course followed by with a sub-base or geocellular crates as shown in the figures below.

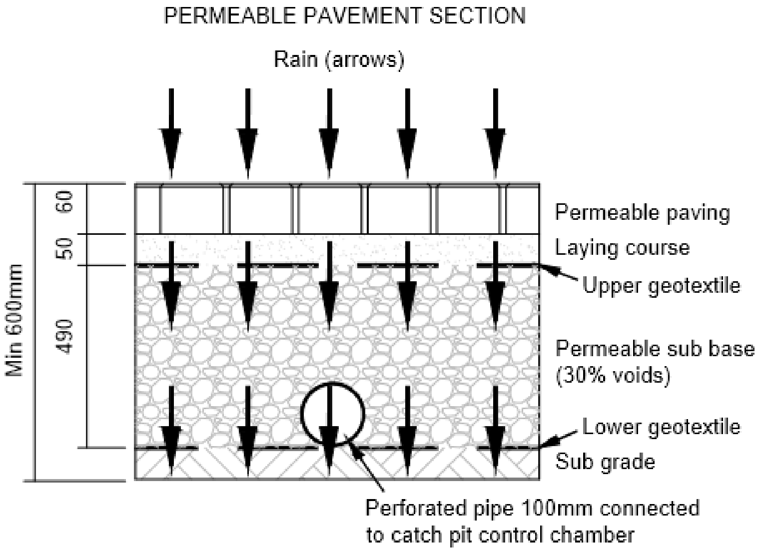


Figure 3 Block Permeable Paving with sub-base

The use of geocellular module storage provides structural strength (up to 400kN/m2) and high-water storage capacity with void space of 95%+.

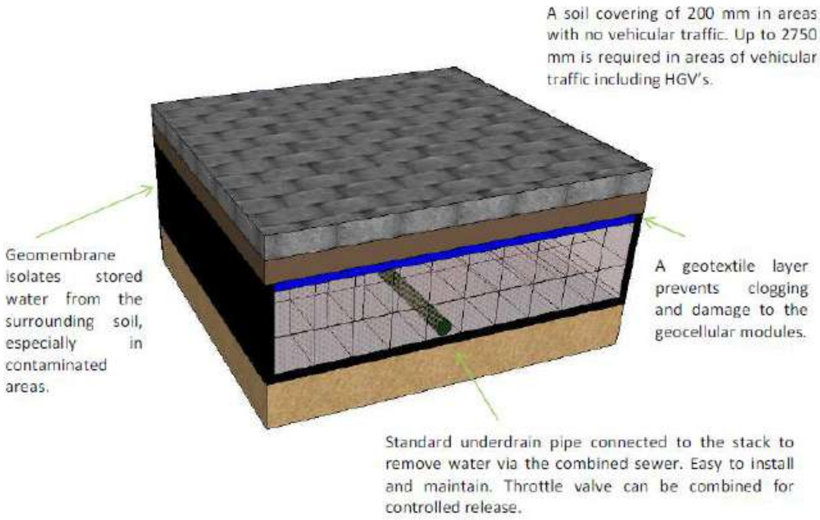


Figure 4: Block Permeable Paving with Geocellular Module

The plastic or concrete grid system is usually installed with a depth of 40 mm, with gaps between filled with an appropriate planting soil and seeded with a turf mix.

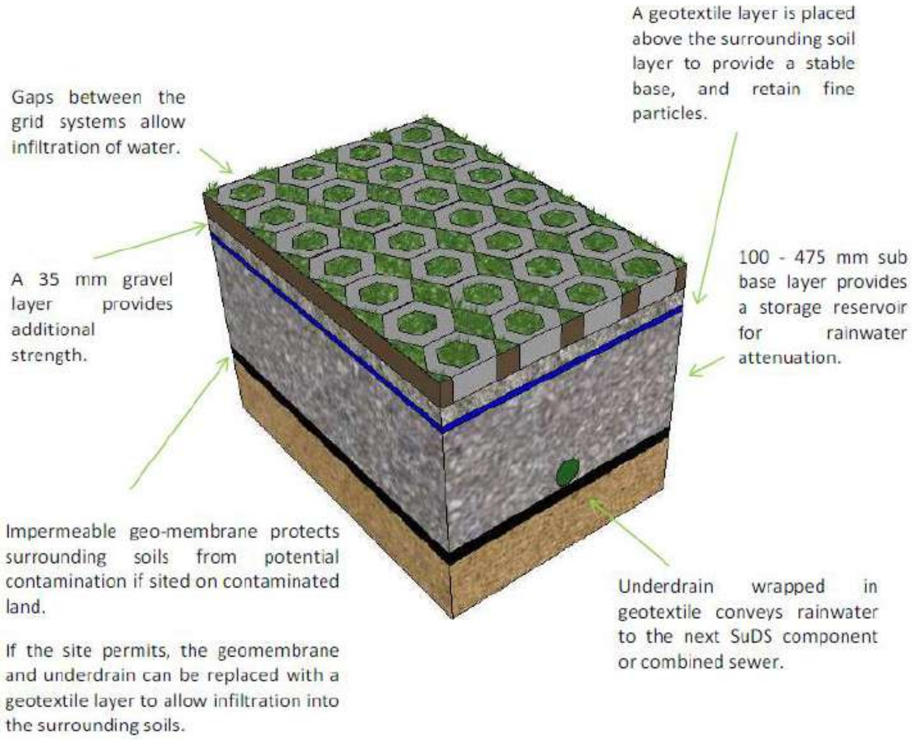


Figure 5: Plastic or Grid Permeable Paving with Sub-base

14.8.5 Geocellular structures, oversized pipes and tanks

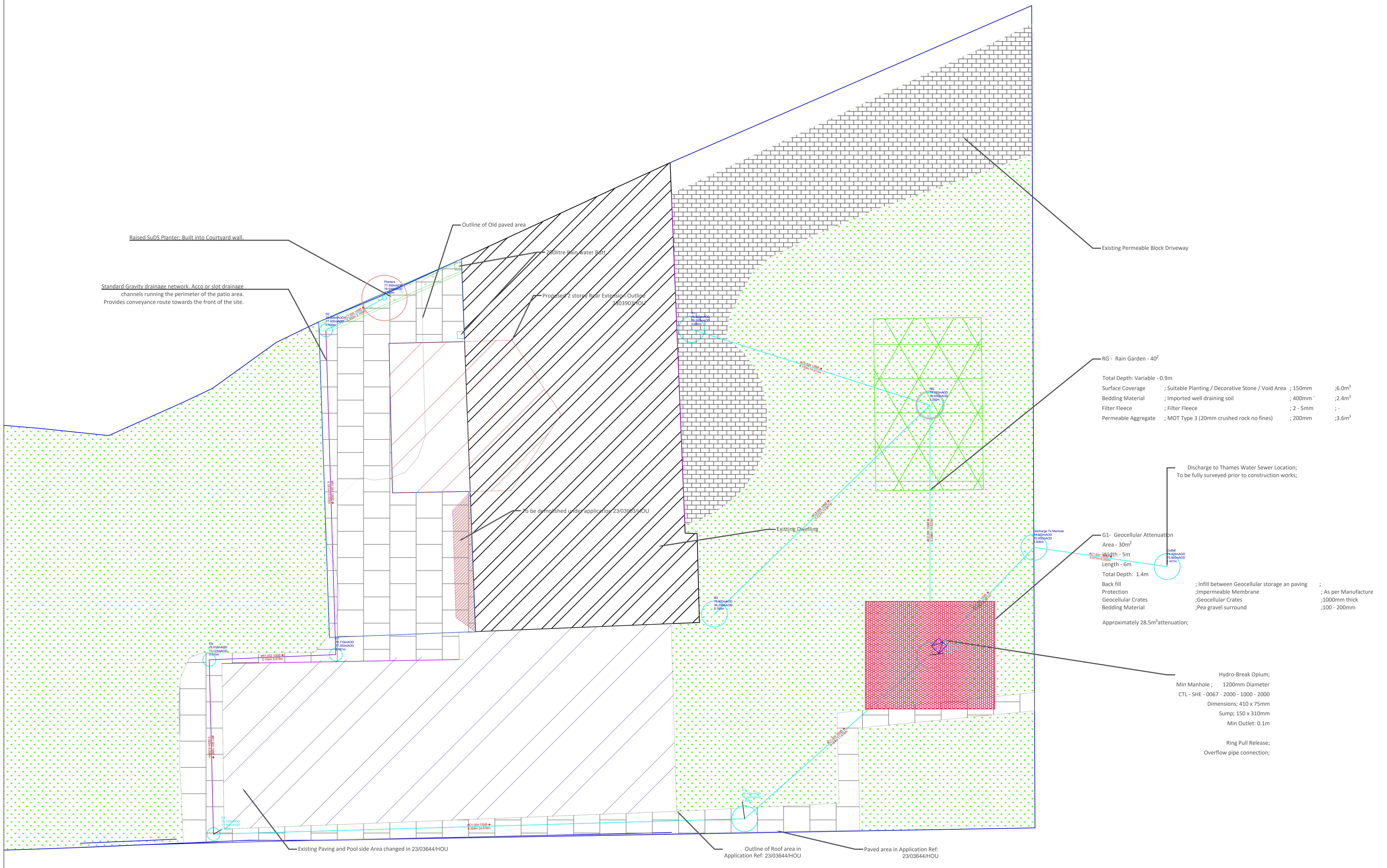
Modular plastic geocellular structures, with a high void ratio, are a new below ground storage arrangement that can replace underground pipes or tanks that have been used to store water. They can also be used to convey or infiltrate surface water runoff into the ground.

Underground storage features attenuate an agreed volume with a control structure to limit the discharge rate. Structural design must be provided to ensure integrity of the box, pipe or tank under loading. Silt interception and management arrangement is critical to long-term effectiveness of these structures and this must be demonstrated at design stage and confirmed for the design life of the development. It can be implemented either in the form if a modular box system with inlet and outlet pipework connected to the sides of the structure or in the form of a honeycomb structure with perforated pipes running under or through the box. Water is forced into the box when flows increase. There are now shallow, load bearing boxes which can be used under pavements and in particular below permeable pavement which protects the box from silt contamination and provides treatment with enhanced storage. Moreover, geocellular systems can be installed above a high-water table.

14.9 Appendix 9 - Microdrainage Modelling

14.9.1 Layout of Network - Features, Exceedance flows and Sewer Connection

PDF to follow this page.



Raised SuDS Planter; Built into Courtyard wall.

Standard Gravity drainage network. Acco or slot drainage
channels running the perimeter of the patio area.
Provides conveyance route towards the front of the site.

Outline of Old paved area

200litre Rain water Butt

Proposed 2 storey Rear Extension Outline
2303903HOU

To be demolished under application 23/03903/HOU

Existing Dwelling

Existing Permeable Block Driveway

RG - Rain Garden - 40^2

Total Depth: Variable - 0.9m

Surface Coverage	; Suitable Planting / Decorative Stone / Void Area	; 150mm	;6.0m^3
Bedding Material	; Imported well draining soil	; 400mm `	;2.4m^3
Filter Fleece	; Filter Fleece	; 2 - 5mm	; -
Permeable Aggregate	; MOT Type 3 (20mm crushed rock no fines)	; 200mm	;3.6m^3

Discharge to Thames Water Sewer Location;
To be fully surveyed prior to construction works;

G1- Geocellular Attenuation
Area - 30m^2
Width - 5m
Length - 6m
Total Depth: 1.4m

Back fill	; Infill between Geocellular storage an paving	;
Protection	;Impermeable Membrane	; As per Manufacture
Geocellular Crates	;Geocellular Crates	;1000mm thick
Bedding Material	;Pea gravel surround	;100 - 200mm

Approximately 28.5m^{3}attenuation;

Hydro-Break Opium;
Min Manhole ; 1200mm Diameter
CTL - SHE - 0067 - 2000 - 1000 - 2000
Dimensions; 410 x 75mm
Sump; 150 x 310mm
Min Outlet: 0.1m

Ring Pull Release;
Overflow pipe connection;

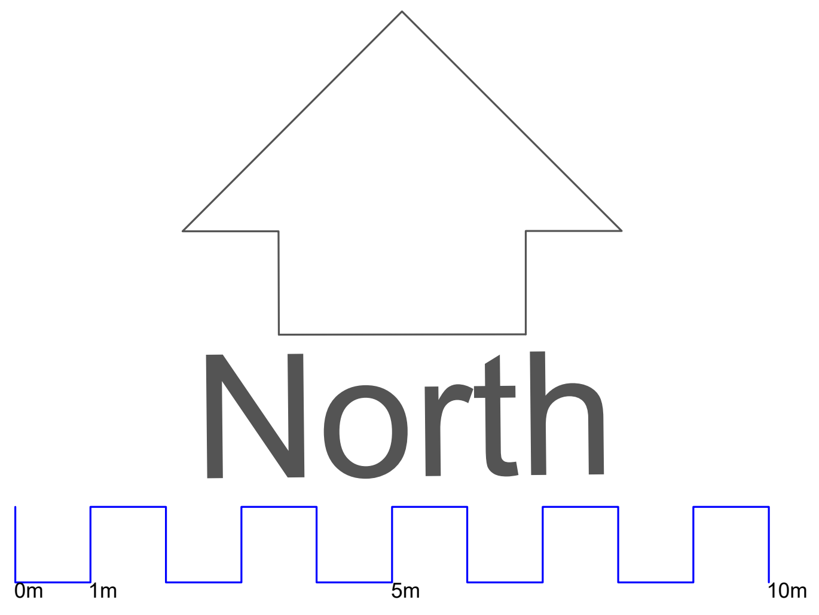
Existing Paving and Pool side Area changed in 23/03644/HOU

Outline of Roof area in
Application Ref: 23/03644/HOU

Paved area in Application Ref:
23/03644/HOU

Map Legend

Symbology	Description
MH4 88.700(mAOD) 87.400(mAOD) 1.300(m) ○	Surface Water Manhole
◇	Flow Control Chamber
○	Rainwater Down Pipe
▨	Rain Garden
▨	Geocellular Storage
▨	Existing Permeable Block Paving
▨	Impermeable Paving
#1.008 150Ø → 0.120m	Surface Water Pipe
—	Site Boundary
—	Drainage Channel
▨	2303903HOU
▨	23/03644/HOU



33 Beech Hill Avenue, Barnet, EN4 0LU

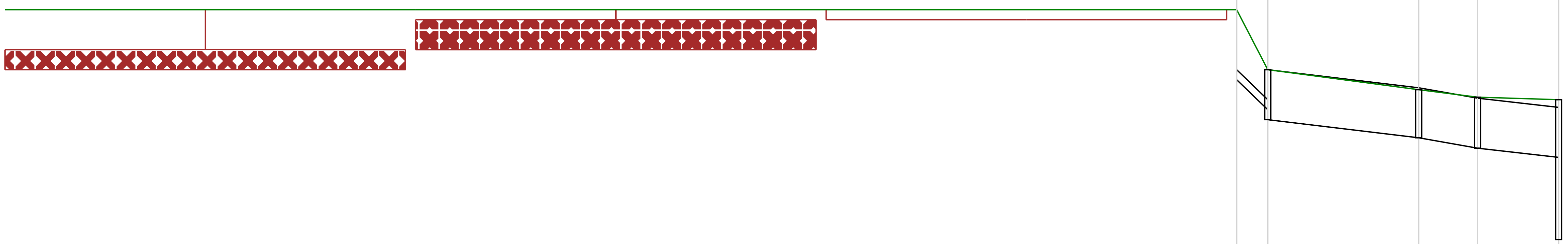
PROJECT : PRV/002987
Case Ref : SWDS -2024 - 000010/19
Date : March 2024
Issue : No. 1

STM environmental
ENVIRONMENTAL CONSULTING . SOFTWARE & TRAINING

STM Environmental Consultants
Model Version 1.2
SWDS - 2024 - 000010/19

File: 33BeechHill_P1.pfd
Network: 33BeechHill
M. Ashdown
22/03/2024

33 Beech Hill Avenue,
Barnet, EN4 0LU



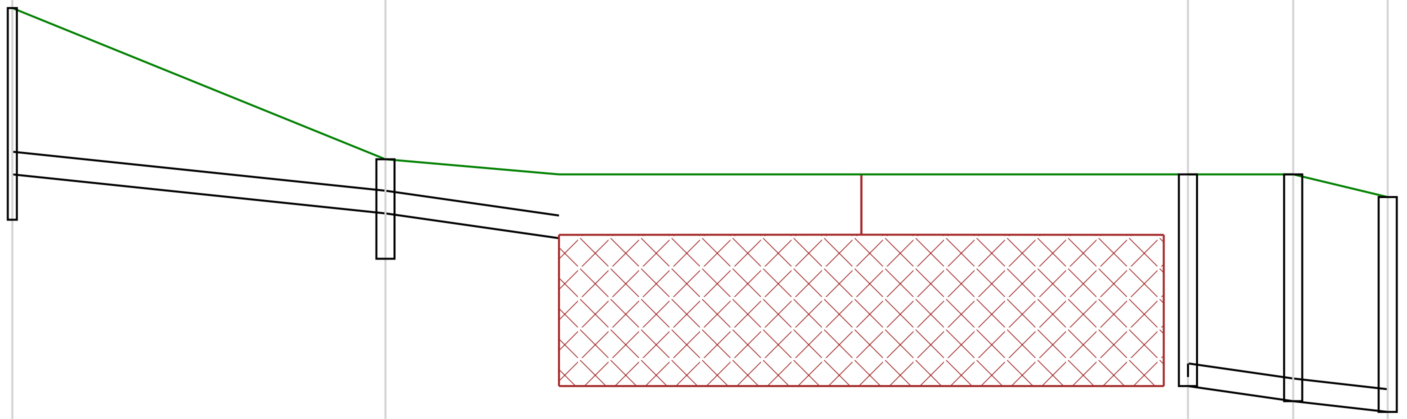
A3 drawing

Hor Scale 500
Ver Scale 50

Datum (m) 72.000

Node Name	Planters		D2		D1		E5		E4
Link Name		1.00		1.001		1.002		1.003	
Section Type		100r		|_| 100x500mm		|_| 100x		|_| 100x50	
Slope (1:X)		10.4		83.3		56.5		88.0	
Cover Level (m)	78.000		77.400		77.200		77.125		77.100
Invert Level (m)	77.300 77.000		76.900	76.719	76.719	76.615	76.615	76.523	
Length (m)		3.10		15.076		5.878		8.099	

STM Environmental Consultants Model Version 1.2 SWDS - 2024 - 000010/19	File: 33BeechHill_P1.pfd Network: 33BeechHill M. Ashdown 22/03/2024	Page 2 33 Beech Hill Avenue, Barnet, EN4 0LU



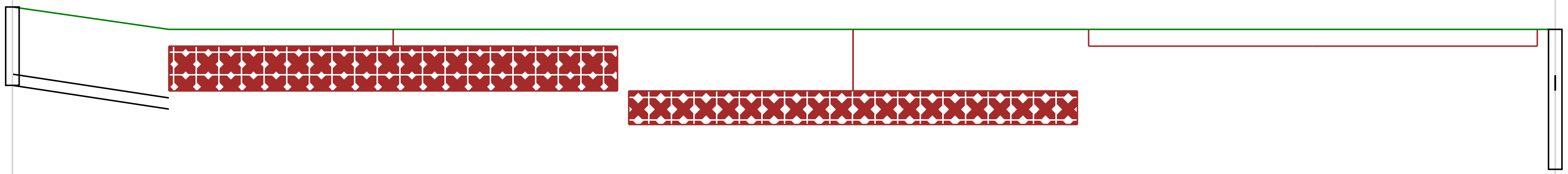
A3 drawing

Hor Scale 500
Ver Scale 50

Datum (m) 71.000

Node Name	E4		E3		G1		Discharge To Manhole		Outfall
Link Name		1.004		1.005		1.006		1.007	
Section Type		150mm		150mm		150mm		150mm	
Slope (1:X)		95.7		70.0		69.6		88.1	
Cover Level (m)	77.100		76.100		76.000		76.000		75.850
Invert Level (m)	76.000		75.742 75.742	75.578	74.600		74.500 74.500		74.429
Length (m)		24.679		11.478		6.961		6.253	

Flow+ v10.8 Copyright © 1988-2024 Causeway Technologies Ltd

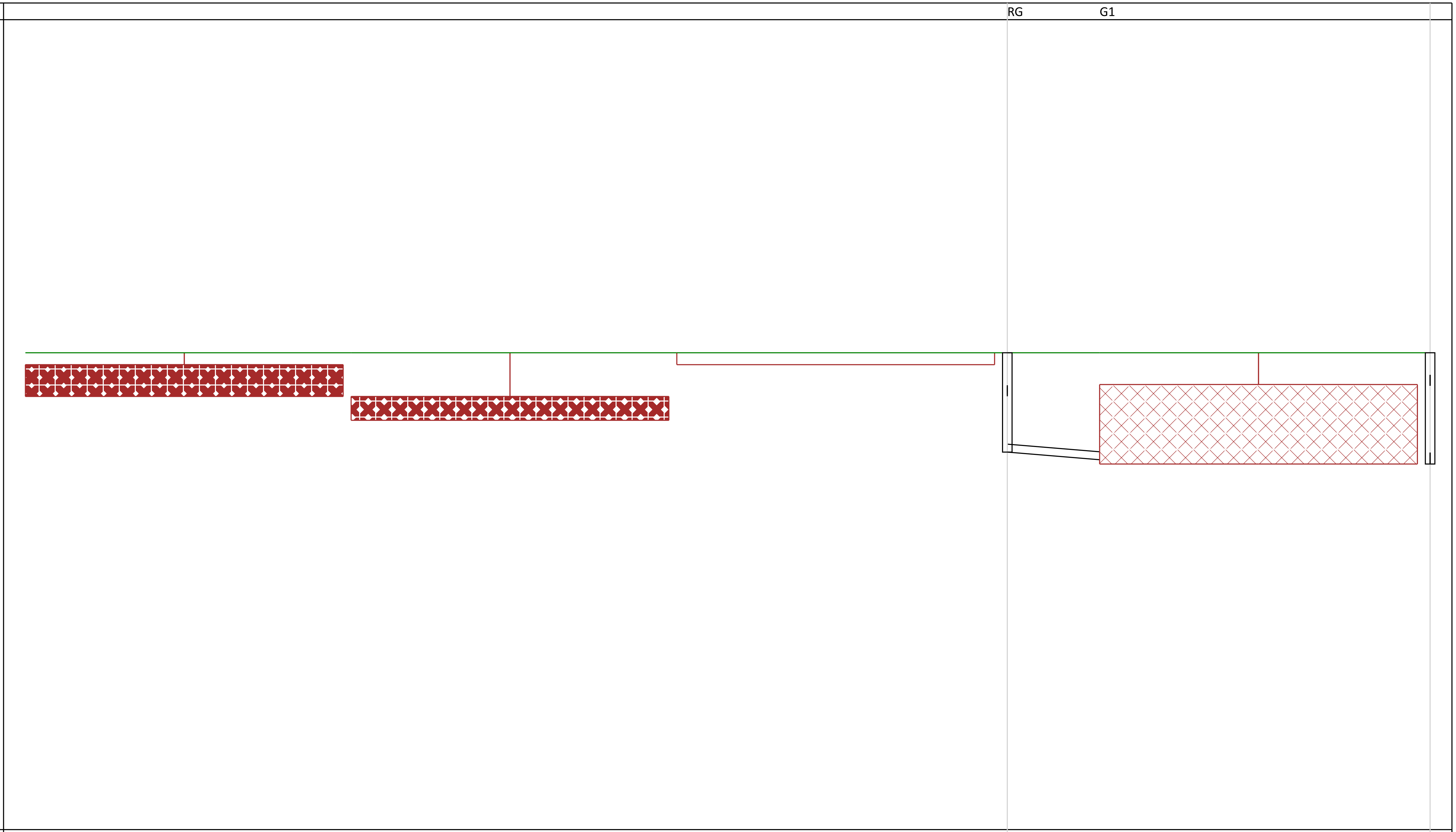


A3 drawing

Hor Scale 500
Ver Scale 50

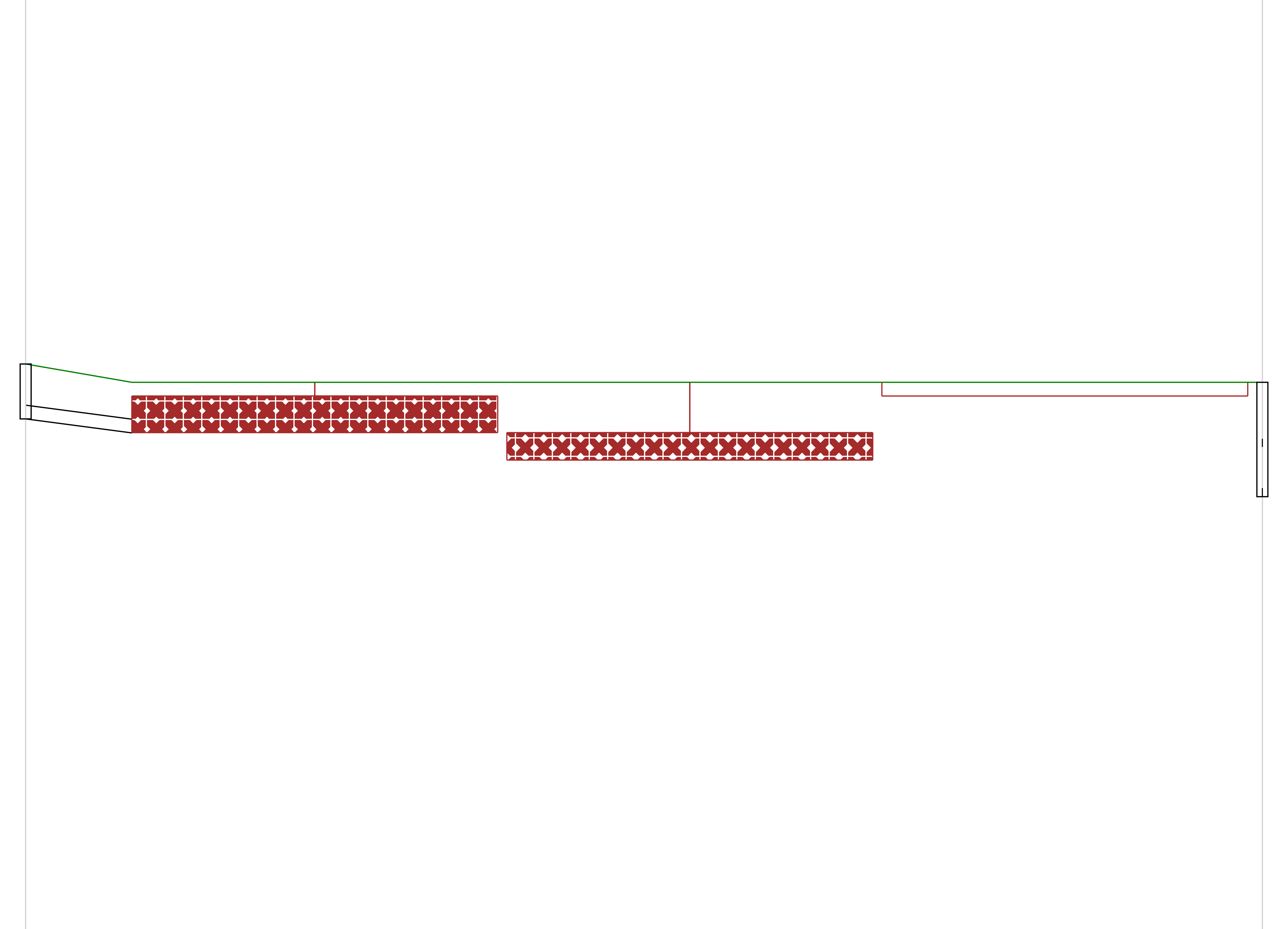
Datum (m) 70.000

Node Name	D3	RG
Link Name	2.000	
Section Type	100mm	
Slope (1:X)	65.8	
Cover Level (m)	76.200	76.000
Invert Level (m)	75.500	75.288
Length (m)	13.947	



Link Name	2.001	
Section Type	100mm	
Slope (1:X)	121.1	
Cover Level (m)	76.000	76.000
Invert Level (m)	74.750	74.654
Length (m)	11.622	

Node Name	E1	RG

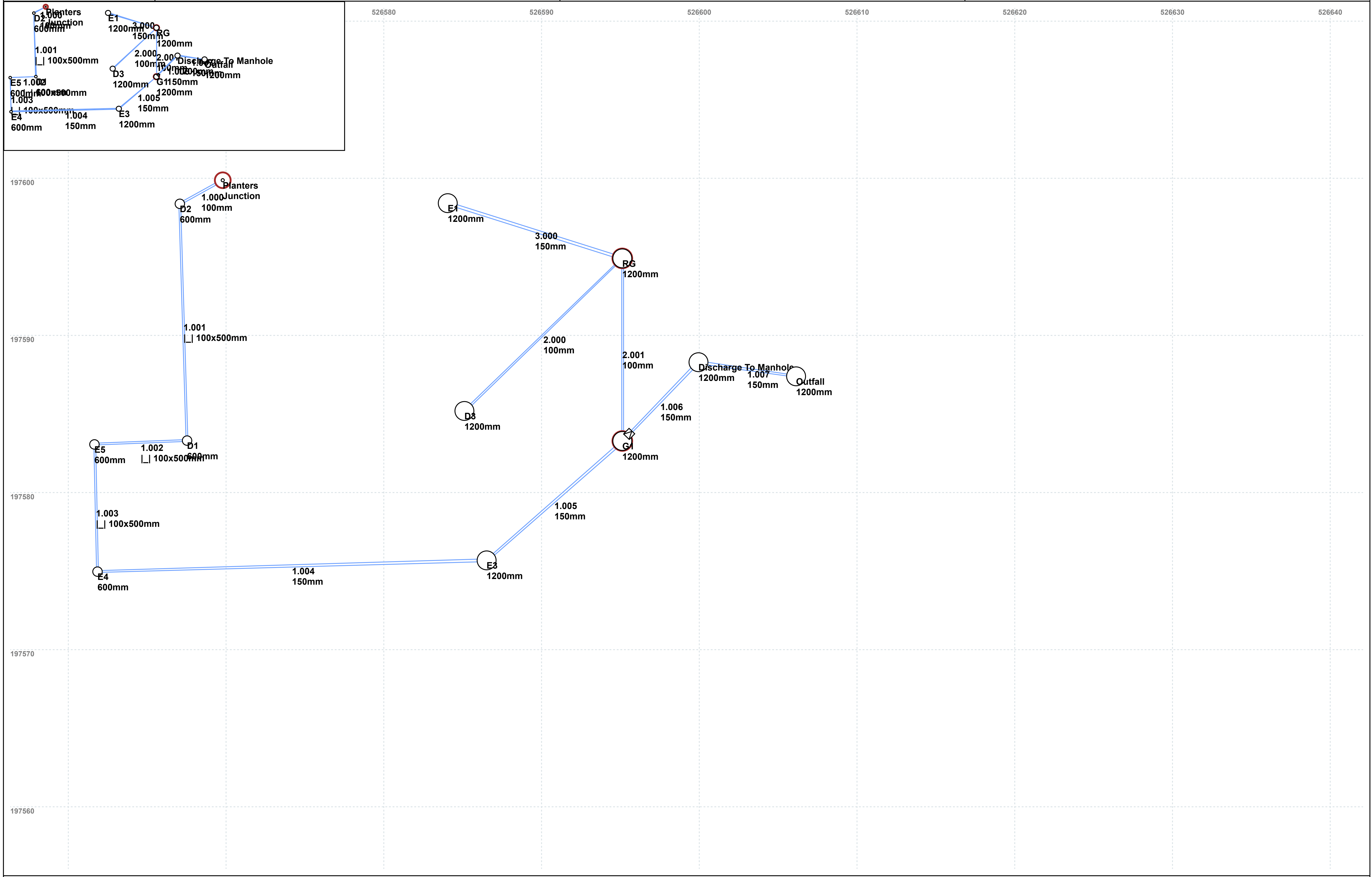


A3 drawing

Hor Scale 500
Ver Scale 50

Datum (m) 70.000

Link Name	3.000	
Section Type	150mm	
Slope (1:X)	75.9	
Cover Level (m)	76.200	76.000
Invert Level (m)	75.600	75.447
Length (m)	11.611	


526580
526590
526600
526610
526620
526630
526640
197600
197590
197580
197570
197560
Planters
Junction
1.000
100mm
D2
600mm
1.001
|_| 100x500mm
E1
1200mm
3.000
150mm
RG
1200mm
2.000
100mm
2.001
100mm
D3
1200mm
Discharge To Manhole
1200mm
1.007
150mm
Outfall
1200mm
1.006
150mm
G1
1200mm
E5
600mm
1.002
|_| 100x500mm
D1
600mm
1.003
|_| 100x500mm
1.005
150mm
E4
600mm
1.004
150mm
E3
1200mm

14.9.2 Model Results

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	0.600
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Adoptable Manhole Type

Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)
374	1200	499	1350	749	1500	900	1800

>900 Link+900 mm

Max Depth (m)	Diameter (mm)	Max Depth (m)	Diameter (mm)
1.500	1050	99.999	1200

Circular Link Type

Shape	Circular	Barrels	1	Auto Increment (mm)	75	Follow Ground	x

Available Diameters (mm)

100	150

Rectangular-500h Link Type

Shape	Rectangular	Height (mm)	500	Follow Ground	x
Barrels	1	Auto Increment (mm)	50		

Available Diameters (mm)

100

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
D2	0.004	5.00	77.400	600	526567.070	197598.376	0.500
D3	0.010	5.00	76.200	1200	526585.110	197585.192	0.700
E4	0.010	5.00	77.100	600	526561.849	197574.967	1.400
E3	0.010	5.00	76.100	1200	526586.518	197575.683	0.658
G1	0.010	5.00	76.000	1200	526595.121	197583.281	1.400
Discharge To Manhole			76.000	1200	526599.950	197588.295	1.500
Outfall			75.850	1200	526606.137	197587.396	1.421
E1	0.010	5.00	76.200	1200	526584.055	197598.417	0.600
E5	0.005	5.00	77.125	600	526561.655	197583.063	0.510
D1	0.010	5.00	77.200	600	526567.528	197583.307	0.481
RG			76.000	1200	526595.121	197594.903	1.250
Planters	0.010	5.00	78.000		526569.789	197599.876	0.700

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	Planters	D2	3.106	0.600	77.300	77.000	0.300	10.4	100	5.02	50.0
1.001	D2	D1	15.076	0.600	76.900	76.719	0.181	83.3	100	5.22	50.0
1.002	D1	E5	5.878	0.600	76.719	76.615	0.104	56.5	100	5.29	50.0
1.003	E5	E4	8.099	0.600	76.615	76.523	0.092	88.0	100	5.40	50.0
1.004	E4	E3	24.679	0.600	76.000	75.742	0.258	95.7	150	5.80	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	2.416	19.0	1.4	0.600	0.300	0.010	0.0	18	1.407
1.001	1.249	62.5	1.9	0.000	-0.019	0.014	0.0	28	0.674
1.002	1.519	75.9	3.3	-0.019	0.010	0.024	0.0	36	0.908
1.003	1.215	60.7	3.9	0.010	0.077	0.029	0.0	48	0.811
1.004	1.027	18.2	5.3	0.950	0.208	0.039	0.0	55	0.892

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.005	E3	G1	11.478	0.600	75.742	75.578	0.164	70.0	150	5.96	50.0
2.000	D3	RG	13.947	0.600	75.500	75.288	0.212	65.8	100	5.24	50.0
3.000	E1	RG	11.611	0.600	75.600	75.447	0.153	75.9	150	5.17	50.0
2.001	RG	G1	11.622	0.600	74.750	74.654	0.096	121.1	100	5.52	50.0
1.006	G1	Discharge To Manhole	6.961	0.600	74.600	74.500	0.100	69.6	150	6.05	50.0
1.007	Discharge To Manhole	Outfall	6.253	0.600	74.500	74.429	0.071	88.1	150	6.15	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.005	1.203	21.3	6.6	0.208	0.272	0.049	0.0	58	1.067
2.000	0.951	7.5	1.4	0.600	0.612	0.010	0.0	29	0.716
3.000	1.155	20.4	1.4	0.450	0.403	0.010	0.0	26	0.653
2.001	0.698	5.5	2.7	1.150	1.246	0.020	0.0	50	0.695
1.006	1.207	21.3	10.7	1.250	1.350	0.079	0.0	75	1.209
1.007	1.071	18.9	10.7	1.350	1.271	0.079	0.0	81	1.103

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	3.106	10.4	100	Circular	78.000	77.300	0.600	77.400	77.000	0.300
1.001	15.076	83.3	100	Rectangular-500h	77.400	76.900	0.000	77.200	76.719	-0.019
1.002	5.878	56.5	100	Rectangular-500h	77.200	76.719	-0.019	77.125	76.615	0.010
1.003	8.099	88.0	100	Rectangular-500h	77.125	76.615	0.010	77.100	76.523	0.077

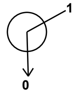
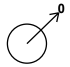
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	Planters		Junction		D2	600	Manhole	Adoptable
1.001	D2	600	Manhole	Adoptable	D1	600	Manhole	Adoptable
1.002	D1	600	Manhole	Adoptable	E5	600	Manhole	Adoptable
1.003	E5	600	Manhole	Adoptable	E4	600	Manhole	Adoptable

Pipeline Schedule

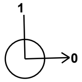
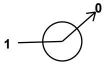
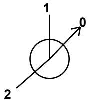
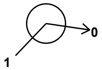
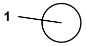
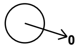
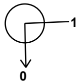
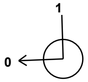
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.004	24.679	95.7	150	Circular	77.100	76.000	0.950	76.100	75.742	0.208
1.005	11.478	70.0	150	Circular	76.100	75.742	0.208	76.000	75.578	0.272
2.000	13.947	65.8	100	Circular	76.200	75.500	0.600	76.000	75.288	0.612
3.000	11.611	75.9	150	Circular	76.200	75.600	0.450	76.000	75.447	0.403
2.001	11.622	121.1	100	Circular	76.000	74.750	1.150	76.000	74.654	1.246
1.006	6.961	69.6	150	Circular	76.000	74.600	1.250	76.000	74.500	1.350
1.007	6.253	88.1	150	Circular	76.000	74.500	1.350	75.850	74.429	1.271

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.004	E4	600	Manhole	Adoptable	E3	1200	Manhole	Adoptable
1.005	E3	1200	Manhole	Adoptable	G1	1200	Manhole	Adoptable
2.000	D3	1200	Manhole	Adoptable	RG	1200	Manhole	Adoptable
3.000	E1	1200	Manhole	Adoptable	RG	1200	Manhole	Adoptable
2.001	RG	1200	Manhole	Adoptable	G1	1200	Manhole	Adoptable
1.006	G1	1200	Manhole	Adoptable	Discharge To Manhole	1200	Manhole	Adoptable
1.007	Discharge To Manhole	1200	Manhole	Adoptable	Outfall	1200	Manhole	Adoptable

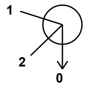
Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
D2	526567.070	197598.376	77.400	0.500	600		1	1.000	77.000	100
							0	1.001	76.900	100
D3	526585.110	197585.192	76.200	0.700	1200		0	2.000	75.500	100

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
E4	526561.849	197574.967	77.100	1.400	600		1	1.003	76.523	100
							0	1.004	76.000	150
E3	526586.518	197575.683	76.100	0.658	1200		1	1.004	75.742	150
							0	1.005	75.742	150
G1	526595.121	197583.281	76.000	1.400	1200		1	2.001	74.654	100
							2	1.005	75.578	150
							0	1.006	74.600	150
Discharge To Manhole	526599.950	197588.295	76.000	1.500	1200		1	1.006	74.500	150
							0	1.007	74.500	150
Outfall	526606.137	197587.396	75.850	1.421	1200		1	1.007	74.429	150
E1	526584.055	197598.417	76.200	0.600	1200					
							0	3.000	75.600	150
E5	526561.655	197583.063	77.125	0.510	600		1	1.002	76.615	100
							0	1.003	76.615	100
D1	526567.528	197583.307	77.200	0.481	600		1	1.001	76.719	100
							0	1.002	76.719	100

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
RG	526595.121	197594.903	76.000	1.250	1200	 1 2 0	1	3.000	75.447	150
							2	2.000	75.288	100
							0	2.001	74.750	100
Planters	526569.789	197599.876	78.000	0.700		 0	0	1.000	77.300	100

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal	2 year (l/s)	11.2
FSR Region	England and Wales	Skip Steady State	x	30 year (l/s)	20.7
M5-60 (mm)	20.000	Drain Down Time (mins)	240	100 year (l/s)	26.2
Ratio-R	0.400	Additional Storage (m³/ha)	20.0	Check Discharge Volume	✓
Summer CV	0.750	Check Discharge Rate(s)	✓	100 year +40% 360 minute (m³)	
Winter CV	0.840	1 year (l/s)	8.7		

Storm Durations

30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	30	40	0	0
2	0	0	0	100	40	0	0

Pre-development Discharge Rate

Site Makeup	Brownfield	PIMP (%)	100	Betterment (%)	0	Q 30 year (l/s)	20.7
Brownfield Method	MRM	CV	0.750	Q 1 year (l/s)	8.7	Q 100 year (l/s)	26.2
Contributing Area (ha)	0.059	Time of Concentration (mins)	5.00	Q 2 year (l/s)	11.2		

Pre-development Discharge Volume

Site Makeup	Brownfield	PIMP (%)	100	Climate Change (%)	40	PR	0.750
Brownfield Method	MRM	CV	0.750	Storm Duration (mins)	360	Runoff Volume (m³)	39
Contributing Area (ha)	0.059	Return Period (years)	100	Betterment (%)	0		

Node G1 Online Hydro-Brake® Control

Flap Valve	✓	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	74.600	Product Number	CTL-SHE-0067-2000-1000-2000
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node G1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	74.600
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	192

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	30.0	0.0	1.000	30.0	0.0	1.001	0.0	0.0

Node RG Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	75.450
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.15	Time to half empty (mins)	28

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	40.0	0.0	0.400	40.0	0.0	0.401	0.0	0.0

Node RG Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	75.150
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	146

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	40.0	0.0	0.300	40.0	0.0	0.301	0.0	0.0

Node RG Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	75.850
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	45.0	0.0	0.150	45.0	0.0

Node Planters Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	77.400
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.40	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	10.0	0.0	0.200	10.0	0.0	0.201	0.0	0.0

Node Planters Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	77.600
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.15	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	10.0	0.0	0.300	10.0	0.0	0.301	0.0	0.0

Node Planters Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	77.900
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	10.0	0.0	0.100	10.0	0.0	0.101	0.0	0.0

Other (defaults)

Entry Loss (manhole)	0.250	Entry Loss (junction)	0.000	Apply Recommended Losses	x
Exit Loss (manhole)	0.250	Exit Loss (junction)	0.000	Flood Risk (m)	0.300

Approval Settings

Node Size	✓	Backdrops	✓	Maximum Surcharged Depth (m)	0.100
Node Losses	✓	Minimum Backdrop Height (m)	0.200	Flooding	✓
Link Size	✓	Maximum Backdrop Height (m)	1.500	Return Period (years)	30
Minimum Diameter (mm)	150	Full Bore Velocity	✓	Time to Half Empty	✓
Link Length	✓	Minimum Full Bore Velocity (m/s)	1.000	Return Period (years)	100
Maximum Length (m)	100.000	Maximum Full Bore Velocity (m/s)	3.000	Discharge Rates	✓
Coordinates	✓	Proportional Velocity	✓	1 year (l/s)	7.4
Accuracy (m)	1.000	Return Period (years)	100	2 year (l/s)	9.5
Crossings	✓	Minimum Proportional Velocity (m/s)	0.750	30 year (l/s)	17.5
Cover Depth	✓	Maximum Proportional Velocity (m/s)	3.000	100 year (l/s)	22.2
Minimum Cover Depth (m)	0.600	Surcharged Depth	✓	Discharge Volume	✓
Maximum Cover Depth (m)	3.000	Return Period (years)	100	100 year 360 minute (m³)	60

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 30 minute summer	71.439	20.215	1 year 240 minute summer	18.475	4.882
1 year 30 minute winter	50.133	20.215	1 year 240 minute winter	12.274	4.882
1 year 60 minute summer	48.435	12.800	1 year 360 minute summer	14.169	3.646
1 year 60 minute winter	32.179	12.800	1 year 360 minute winter	9.210	3.646
1 year 120 minute summer	30.053	7.942	1 year 480 minute summer	11.185	2.956
1 year 120 minute winter	19.966	7.942	1 year 480 minute winter	7.431	2.956
1 year 180 minute summer	23.233	5.979	1 year 600 minute summer	9.182	2.511
1 year 180 minute winter	15.102	5.979	1 year 600 minute winter	6.274	2.511

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 720 minute summer	8.203	2.199
1 year 720 minute winter	5.513	2.199
1 year 960 minute summer	6.768	1.782
1 year 960 minute winter	4.483	1.782
1 year 1440 minute summer	4.949	1.326
1 year 1440 minute winter	3.326	1.326
2 year 30 minute summer	91.753	25.963
2 year 30 minute winter	64.388	25.963
2 year 60 minute summer	61.301	16.200
2 year 60 minute winter	40.727	16.200
2 year 120 minute summer	37.449	9.897
2 year 120 minute winter	24.880	9.897
2 year 180 minute summer	28.672	7.378
2 year 180 minute winter	18.637	7.378
2 year 240 minute summer	22.636	5.982
2 year 240 minute winter	15.039	5.982
2 year 360 minute summer	17.235	4.435
2 year 360 minute winter	11.203	4.435
2 year 480 minute summer	13.550	3.581
2 year 480 minute winter	9.003	3.581
2 year 600 minute summer	11.088	3.033
2 year 600 minute winter	7.576	3.033
2 year 720 minute summer	9.878	2.647
2 year 720 minute winter	6.639	2.647
2 year 960 minute summer	8.113	2.136
2 year 960 minute winter	5.374	2.136
2 year 1440 minute summer	5.891	1.579
2 year 1440 minute winter	3.959	1.579
30 year +40% CC 30 minute summer	244.900	69.298
30 year +40% CC 30 minute winter	171.860	69.298
30 year +40% CC 60 minute summer	163.225	43.136
30 year +40% CC 60 minute winter	108.443	43.136
30 year +40% CC 120 minute summer	98.613	26.061
30 year +40% CC 120 minute winter	65.516	26.061
30 year +40% CC 180 minute summer	74.617	19.202
30 year +40% CC 180 minute winter	48.503	19.202
30 year +40% CC 240 minute summer	58.245	15.393
30 year +40% CC 240 minute winter	38.697	15.393
30 year +40% CC 360 minute summer	43.710	11.248
30 year +40% CC 360 minute winter	28.413	11.248
30 year +40% CC 480 minute summer	34.053	8.999
30 year +40% CC 480 minute winter	22.624	8.999
30 year +40% CC 600 minute summer	27.658	7.565
30 year +40% CC 600 minute winter	18.898	7.565
30 year +40% CC 720 minute summer	24.485	6.562
30 year +40% CC 720 minute winter	16.456	6.562
30 year +40% CC 960 minute summer	19.901	5.240
30 year +40% CC 960 minute winter	13.183	5.240
30 year +40% CC 1440 minute summer	14.225	3.812
30 year +40% CC 1440 minute winter	9.560	3.812
100 year +40% CC 30 minute summer	320.551	90.705
100 year +40% CC 30 minute winter	224.948	90.705
100 year +40% CC 60 minute summer	214.603	56.713
100 year +40% CC 60 minute winter	142.577	56.713
100 year +40% CC 120 minute summer	129.587	34.246
100 year +40% CC 120 minute winter	86.094	34.246
100 year +40% CC 180 minute summer	97.729	25.149
100 year +40% CC 180 minute winter	63.526	25.149
100 year +40% CC 240 minute summer	75.977	20.078
100 year +40% CC 240 minute winter	50.477	20.078
100 year +40% CC 360 minute summer	56.677	14.585
100 year +40% CC 360 minute winter	36.841	14.585
100 year +40% CC 480 minute summer	43.979	11.622
100 year +40% CC 480 minute winter	29.219	11.622

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +40% CC 600 minute summer	35.604	9.738	100 year +40% CC 960 minute summer	25.432	6.697
100 year +40% CC 600 minute winter	24.327	9.738	100 year +40% CC 960 minute winter	16.847	6.697
100 year +40% CC 720 minute summer	31.433	8.424	100 year +40% CC 1440 minute summer	18.055	4.839
100 year +40% CC 720 minute winter	21.125	8.424	100 year +40% CC 1440 minute winter	12.134	4.839

Results for 1 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
30 minute summer	D2	18	76.926	0.026	1.7	0.0114	0.0000	OK
30 minute summer	D3	18	75.528	0.028	1.2	0.0390	0.0000	OK
30 minute summer	E4	18	76.052	0.052	4.6	0.0242	0.0000	OK
30 minute summer	E3	19	75.798	0.056	5.8	0.0940	0.0000	OK
60 minute winter	G1	47	74.774	0.174	5.6	5.1878	0.0000	SURCHARGED
60 minute winter	Discharge To Manhole	48	74.533	0.033	1.8	0.0368	0.0000	OK
60 minute winter	Outfall	48	74.460	0.031	1.8	0.0000	0.0000	OK
30 minute summer	E1	18	75.625	0.025	1.2	0.0368	0.0000	OK
30 minute summer	E5	18	76.662	0.047	3.5	0.0223	0.0000	OK
30 minute summer	D1	18	76.753	0.034	2.9	0.0241	0.0000	OK
30 minute summer	RG	18	74.797	0.047	2.4	0.0536	0.0000	OK
30 minute summer	Planters	18	77.318	0.018	1.2	0.0050	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m^3)	Discharge Vol (m^3)
30 minute summer	D2	1.001	D1	1.7	0.563	0.027	0.0455	
30 minute summer	D3	2.000	RG	1.2	0.690	0.160	0.0241	
30 minute summer	E4	1.004	E3	4.6	0.814	0.253	0.1394	
30 minute summer	E3	1.005	G1	5.7	0.996	0.270	0.0661	
60 minute winter	G1	1.006	Discharge To Manhole	1.8	0.674	0.084	0.0186	
60 minute winter	Discharge To Manhole	1.007	Outfall	1.8	0.659	0.095	0.0170	8.1
30 minute summer	E1	3.000	RG	1.2	0.626	0.059	0.0222	
30 minute summer	E5	1.003	E4	3.4	0.764	0.057	0.0365	
30 minute summer	D1	1.002	E5	2.9	0.712	0.038	0.0238	
30 minute summer	RG	2.001	G1	2.3	0.661	0.429	0.0519	
30 minute summer	Planters	1.000	D2	1.2	1.325	0.063	0.0028	

Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	D2	18	76.930	0.030	2.1	0.0133	0.0000	OK
30 minute summer	D3	18	75.531	0.031	1.5	0.0439	0.0000	OK
30 minute summer	E4	18	76.059	0.059	5.9	0.0275	0.0000	OK
30 minute summer	E3	19	75.806	0.064	7.3	0.1074	0.0000	OK
60 minute winter	G1	49	74.829	0.229	7.2	6.8198	0.0000	SURCHARGED
60 minute winter	Discharge To Manhole	49	74.534	0.034	1.9	0.0379	0.0000	OK
60 minute winter	Outfall	49	74.461	0.032	1.9	0.0000	0.0000	OK
30 minute summer	E1	18	75.628	0.028	1.5	0.0411	0.0000	OK
30 minute summer	E5	18	76.671	0.056	4.4	0.0267	0.0000	OK
30 minute summer	D1	18	76.760	0.041	3.6	0.0288	0.0000	OK
60 minute winter	RG	49	74.830	0.080	1.8	0.0900	0.0000	OK
30 minute summer	Planters	18	77.320	0.020	1.5	0.0056	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	D2	1.001	D1	2.1	0.590	0.034	0.0536	
30 minute summer	D3	2.000	RG	1.5	0.735	0.200	0.0284	
30 minute summer	E4	1.004	E3	5.8	0.863	0.321	0.1668	
30 minute summer	E3	1.005	G1	7.3	1.058	0.341	0.0787	
60 minute winter	G1	1.006	Discharge To Manhole	1.9	0.684	0.089	0.0194	
60 minute winter	Discharge To Manhole	1.007	Outfall	1.9	0.670	0.100	0.0178	10.5
30 minute summer	E1	3.000	RG	1.5	0.668	0.073	0.0260	
30 minute summer	E5	1.003	E4	4.4	0.809	0.072	0.0437	
30 minute summer	D1	1.002	E5	3.6	0.742	0.047	0.0285	
60 minute winter	RG	2.001	G1	1.8	0.579	0.329	0.0843	
30 minute summer	Planters	1.000	D2	1.5	1.413	0.079	0.0033	

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	D2	18	76.962	0.062	5.7	0.0277	0.0000	OK
30 minute summer	D3	18	75.555	0.055	4.1	0.0778	0.0000	OK
30 minute summer	E4	18	76.113	0.113	15.9	0.0527	0.0000	OK
30 minute summer	E3	19	75.869	0.127	19.9	0.2147	0.0000	OK
120 minute winter	G1	116	75.341	0.741	11.5	22.0547	0.0000	SURCHARGED
30 minute summer	Discharge To Manhole	102	74.534	0.034	2.0	0.0385	0.0000	OK
30 minute summer	Outfall	102	74.462	0.033	2.0	0.0000	0.0000	OK
30 minute summer	E1	18	75.647	0.047	4.1	0.0693	0.0000	OK
30 minute summer	E5	18	76.741	0.126	11.9	0.0601	0.0000	OK
30 minute summer	D1	18	76.814	0.095	9.8	0.0665	0.0000	OK
120 minute winter	RG	116	75.341	0.591	3.0	2.9718	0.0000	SURCHARGED
30 minute summer	Planters	18	77.333	0.033	4.1	0.0095	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	D2	1.001	D1	5.7	0.723	0.091	0.1188	
30 minute summer	D3	2.000	RG	4.1	0.953	0.548	0.0599	
30 minute summer	E4	1.004	E3	15.8	1.049	0.872	0.3719	
30 minute summer	E3	1.005	G1	19.6	1.297	0.922	0.1731	
120 minute winter	G1	1.006	Discharge To Manhole	2.0	0.689	0.092	0.0198	
30 minute summer	Discharge To Manhole	1.007	Outfall	2.0	0.675	0.103	0.0181	19.8
30 minute summer	E1	3.000	RG	4.1	0.885	0.201	0.0538	
30 minute summer	E5	1.003	E4	11.8	0.993	0.195	0.0964	
30 minute summer	D1	1.002	E5	9.8	0.887	0.129	0.0649	
120 minute winter	RG	2.001	G1	2.6	0.456	0.482	0.0909	
30 minute summer	Planters	1.000	D2	4.1	1.860	0.216	0.0068	

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	D2	18	76.978	0.078	7.6	0.0347	0.0000	OK
120 minute winter	D3	118	75.572	0.072	2.0	0.1026	0.0000	OK
30 minute summer	E4	19	76.359	0.359	21.0	0.1667	0.0000	SURCHARGED
30 minute summer	E3	19	75.992	0.250	24.8	0.4218	0.0000	FLOOD RISK
120 minute winter	G1	118	75.572	0.972	14.5	28.9286	0.0000	SURCHARGED
30 minute winter	Discharge To Manhole	197	74.534	0.034	2.0	0.0385	0.0000	OK
30 minute winter	Outfall	197	74.462	0.033	2.0	0.0000	0.0000	OK
30 minute summer	E1	18	75.655	0.055	5.4	0.0805	0.0000	OK
30 minute summer	E5	18	76.773	0.158	15.7	0.0755	0.0000	OK
30 minute summer	D1	18	76.842	0.123	13.0	0.0858	0.0000	OK
120 minute winter	RG	118	75.572	0.822	4.4	5.2790	0.0000	SURCHARGED
30 minute summer	Planters	18	77.339	0.039	5.4	0.0111	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	D2	1.001	D1	7.6	0.758	0.122	0.1516	
120 minute winter	D3	2.000	RG	2.0	0.795	0.268	0.0969	
30 minute summer	E4	1.004	E3	19.9	1.133	1.099	0.4345	
30 minute summer	E3	1.005	G1	24.5	1.392	1.152	0.1985	
120 minute winter	G1	1.006	Discharge To Manhole	2.0	0.689	0.092	0.0198	
30 minute winter	Discharge To Manhole	1.007	Outfall	2.0	0.675	0.103	0.0181	27.5
30 minute summer	E1	3.000	RG	5.4	0.952	0.265	0.0659	
30 minute summer	E5	1.003	E4	15.6	1.064	0.257	0.1186	
30 minute summer	D1	1.002	E5	13.0	0.925	0.171	0.0824	
120 minute winter	RG	2.001	G1	3.3	0.495	0.606	0.0909	
30 minute summer	Planters	1.000	D2	5.4	1.997	0.285	0.0084	

14.10 Appendix 10 – SuDS Maintenance Manual

All maintenance activities will be the responsibility of the developer Vahid Tahmasvand. They will appoint a management company to undertake the general maintenance duties within the site and will join service agreements with the suppliers and manufactures of the SuDS/Pumps when required.

The cost of the services and management company will be funded through the service charge fee which will be paid and manged by home owners.

The information presented below is taken from the CIRIA SuDS Manual (Report c753) and SuDS. Further details on installation and maintenance can be found detailed below and online.

14.10.1 Pervious Pavements

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface).	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations - pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.	Vahid Tahmasvand will be responsible for setting up the management company.
Occasional maintenance	Stabilise and mow contributing and areas.	As required.	
	Removal of weeds or manage using weed killer applied directly into the weeds rather than spraying.	As required - once per year on less frequently used pavements.	
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving.	As required.	
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and lost material.	As required.	

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).	Vahid Tahmasvand will be responsible for setting up the management company.
Monitoring	Initial Inspection.	Monthly for three months after installation.	
	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action.	Three-monthly, 48h after large storms in first six months.	
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.	
	Monitor Inspection chambers.	Annually.	

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy). Therefore, if litter management is already required at the site, this should have marginal cost implications.

14.10.2 Geo-Cellular Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings.	Annually.	Vahid Tahmasvand will be responsible for setting up the management company.
	Cleaning of gutters and any filters on downpipes.	Annually (or as required based on inspections).	
	Trimming any roots that may be causing blockages.	Annually (or as required).	
Occasional maintenance	Remove sediment and debris from manhole, storage structure and components and floor of inspection tube or chamber and inside of concrete manhole rings.	As required, based on Inspections.	
Remedial actions	Reconstruct geocellular and/or replace or clean void fill, if performance failure occurs	As required	Vahid Tahmasvand will be responsible for setting up the management company.
	Replacement of clogged geotextile (will require reconstruction of soakaway).	As required.	
Monitoring	Inspect silt raps and note rate of sediment accumulation.	Monthly in the first year and then annually.	
	Check soakaway to ensure emptying is occurring.	Annually.	

Maintenance will usually be carried out manually, although a suction tanker can be used for sediment / debris removal for large systems. If maintenance is not undertaken for long periods, deposits can become hard-packed and require considerable effort to remove.

Replacement of the geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

Areas draining to infiltration components should be regularly swept to prevent silt being washed off the surface. This will minimize the need for maintenance.

Maintenance responsibility should be placed with an appropriate organisation, and maintenance schedules should be developed during the design phase.

14.10.3 Rain Water Harvesting Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components;	Monthly;	Vahid Tahmasvand will be responsible for setting up the management company.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into the Rain Water Butts.	Monthly; Increase freq. to weekly during Autumn; After storm events;	
Remedial actions	Cleaning of the rainwater Tanks. Fully drain the clear out debris and enable access; Scrub / Pressure wash out the inside of the tank if accessible, use appropriate cleaning product Rinse with clean water; Cleaning of Gutters; Clean or fit a new filter;	2 - 5 years;	
Monitoring	Check Correct pumping operations; Check volume of water being held in tank after storm events; Replace parts as required; Replace pump as required	Quartlery	

Maintenance will be carried out manually. All monitoring and maintenance will be carried out by the appointed the Owner (Lars Mosesson) who will instruct a management company to undertake the tasks.

14.10.4 Flow Control Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris;	Quarterly; As required. Increase freq. to Monthly during Autumn;	Vahid Tahmasvand will be responsible for setting up the management company.
	Inspection & Cleaning of SuDS components upstream of flow control element.	Quarterly; Increase freq. to Monthly during Autumn;	
Remedial actions	Removal of debris and sediment;	Annually; Or as required.	
Remedial actions	Replacement of parts; Manhole cover, filters or components of flow control device;	As required;	
Monitoring	Ensure flow control device is function correctly during and after storm events; Check water levels up stream and downstream of flow control device	Monthly; During 1st year of installation or during and after storm event; When possible Reduce to Quarterly following the 1st year;	
	Check for damage to flow control components	Annually;	
	Check for securely fitting manhole lid; Ensures debris cannot enter the system unfiltered;	Annually;	