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Sustainable Drainage Options Appraisal & Strategy

31 May 2024

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52 Gatehill Road, Northwood, HA6 3QP

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Supervised by Mr Joseph Turner

CONTENTS

1. Introduction

The following document is a Sustainable Drainage Options Appraisal & Strategy carried out by Oakshire Environmental, and includes details of the site, previous investigations, an evaluation of drainage options and an assessment of further investigations.

1.1 Project Overview

The client's proposed project involves the extension of an existing dwelling and associated work at 52 Gatehill Road, Northwood, HA6 3QP. Oakshire Environmental have carried out a Sustainable Drainage Options Appraisal & Strategy, as described below.

1.2 Purpose of Investigation

The objectives of the Sustainable Drainage Options Appraisal & Strategy were to:

- Establish the context and setting of development at the site.
- Assess the nature of existing surface water management at the site.
- Calculate surface water storage volumes and runoff rates.
- Identify suitable sustainable drainage option(s).
- Outline a strategy for the implementation of suitable sustainable drainage option(s).
- Determine the requirement or scope of further investigations or maintenance at the site.

1.3 Scope of Work

- Desk studies have been carried out to establish the context and setting of development and the nature of existing surface water management at the site, through analysis of information obtained from sources including the Environment Agency, Local & National Authorities, Strategic Flood Risk Assessments and Digital Terrain Model (DTM) LiDAR topographical surveys.
- Quantitative surface water analysis has been conducted, to calculate runoff rates and storage volume requirements needed to meet Environment Agency, DEFRA and CIRIA guidance.
- Initial feasible options for sustainable drainage at the site have been identified, including assessment of potential constraints and generic objectives, based on the estimated cost, practicality and regulatory implications of their application.
- A detailed evaluation of sustainable drainage options has been conducted, including development of site-specific objectives, in order to determine which option(s) are most appropriate for the site.
- A strategy for the implementation of suitable sustainable drainage option(s) has been outlined.
- Recommended sustainable drainage option(s) have been assessed to determine the requirement or scope of further investigations or maintenance at the site.
- Supporting appendix includes photographs, maps and plans of the site.
- Options Appraisal has been carried out by professional Environmental Consultants, with BSc (Hons) in Environmental Science or above, in accordance with Environment Agency technical guidance.

1.4 Limitations

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This report excludes consideration of potential hazards arising from any activities at the site other than normal use and occupancy for the intended land uses. Hazards associated with any other activities have not been assessed and must be subject to a specific risk assessment by the parties responsible for those activities. Oakshire Environmental does not warrant or guarantee that the site is free of hazardous or potentially hazardous materials or conditions. It should be noted that this report has been produced for environmental purposes only.

2. Site

The following section provides a description of the site, location and previous investigations, utilising information obtained from the client and publicly available sources.

2.1 Site Description and Location

The site is located on Gatehill Road in Northwood, north west London and covers an area of approximately 0.16ha. The site is comprised of a detached two-storey dwelling with single-storey extensions to the side and rear, a detached garage, driveways, paving and soft landscaping at the north west and a grass garden at the south east with an outbuilding at the east boundary.

The site is bordered by dwellings and gardens to the north east, south east and south west and Gatehill Road to the north west with additional dwelling beyond. The surrounding area is predominantly residential and the site is situated within a Critical Drainage Area.

Surface water from areas of concrete hardstanding and the existing building roofs is currently discharged to the existing sewer network along Gatehill Road to the north west and surface water in the rear garden and soft landscaping at the north west discharges into the ground.

National Grid Reference: TQ 10251 91611

2.2 Proposed Development

The proposed development involves the construction of a ground floor and first floor side and rear extension. According to proposed floor plans, the proposed additional footprint will be situated on areas of existing paving.

2.3 Previous Investigations

No previous investigations regarding surface water management have been carried out at the site.

A Tree Constraints Plan has been provided by Tree Sense Arboricultural Consultants which shows that the Root Protection Areas (RPAs) for the trees at the north west of the site cover the majority of the driveways, paving and soft landscaping to the front of the dwelling. This will present a significant constraint to the location of potential SuDS features and the volume of storage that can be provided.

3. Sustainable Drainage Options

A Sustainable Drainage Options Appraisal requires the initial identification of feasible options for sustainable drainage at a site, based on the costs involved and the practicality of their application. Some methods may not be appropriate to a particular site and some may not be cost effective. Other site specific constraints such as the available space can also determine the feasibility of a particular drainage option. The following section outlines objectives for the site, taking into account potential constraints, and includes a selection of feasible drainage options.

3.1 Feasible Drainage Options

The proposed development will result in no change to the impermeable surface cover across the site, however, the site is within a Critical Drainage Area, therefore, sustainable drainage measures will be designed to provide a reduction in the rate and volume of runoff from the site and reduce the flood risk off-site.

Given that the site has been 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 will be as close as reasonably practicable to the greenfield runoff rate for the same rainfall event and will not exceed the existing rate of discharge for that event.

In addition, 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 will be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event and will not exceed the runoff volume from the site.

The greenfield runoff rates for the 1 in 1 year and 1 in 100 year rainfall events are 0.63l/s and 2.35l/s, respectively.

The existing runoff rate from the site has been calculated using the modified rational method and the existing runoff rates in a 1 in 1 year and 1 in 100 year event are 5.94l/s and 19.21l/s, respectively.

It is not likely to be viable to restrict the runoff rate from the site to the greenfield rate due to the storage volume required and the constraints imposed by the RPAs at the north west of the site, therefore, the uksuds tool from HR Wallingford has been used to calculate the storage volume required to provide a 50% reduction to the existing 1 in 100 year runoff rate (i.e. 9.61l/s). Based on these calculations, a storage volume of 5m^3 would be required.

BGS mapping shows that the site is situated on London Clay bedrock with no superficial deposits, therefore, infiltration SuDS are not likely to be viable. The available space outside of the building footprint and the topography of the site will also preclude the use of above ground ponds or basins due to the land take these methods require and green roofs are also not considered feasible due to the limited flat roof area available on the site. There are also no surface water bodies on or in the vicinity of the site that could receive surface run off, therefore, the most suitable option is to provide attenuation storage and discharge surface water to the existing sewer along Gatehill Road.

These options will be subject to a more detailed evaluation in the following section.

1. *Attenuation Tank*

3.2 Detailed Evaluation of Drainage Options

Following the identification of feasible sustainable drainage options, a detailed evaluation of options, including development of site-specific objectives, is required to determine which option(s) are most appropriate for the site.

Table 1: Summary of Site-Specific Objectives

Mitigation Objective	Objective Type	Evaluation Criteria
Provide a reduction in the rate of runoff from the site	General/Technical	Provide a minimum 50% betterment to the 1 in 100 year runoff rate
Ensure that the volume of runoff from the site is not increased	General/Technical	Runoff volume for the 100 year, 6 hour event to be constrained to a value as close as is reasonably practicable to the greenfield runoff volume
Ensure that the implemented option can be maintained for the lifetime of the development	General/Technical	Allow maintenance of selected option for a minimum of 100 years
Enable development of a drainage strategy that meets regulatory requirements	Management	Drainage strategy to be agreed with Local Authority and carried out in accordance with relevant regulations
Enable development of a drainage strategy that meets the owner's requirements	Management	Drainage strategy to be agreed with site owner

3.3 Attenuation Tank

Given the limitations with regards to available space and permeability, the most appropriate sustainable drainage option is considered to be through the installation of a geo-cellular attenuation tank. Based on the existing RPAs for the trees at the north west of the site an attenuation tank would need to be installed beneath the existing driveway to the front of the existing garage building and should be constructed using plastic cellular crates that provide a high porosity to reduce the volume required to provide the necessary storage.

An attenuation tank with a volume of at least 5.26m^3 would be required to provide the required storage capacity to discharge the 1 in 100 year runoff volume at 9.61l/s.

4. Recommendations

Following a detailed evaluation of feasible sustainable drainage options, the final option is selected, taking into account site-specific factors and the constraints outlined previously. The most appropriate sustainable drainage option for the site is considered to be via discharge to the existing sewer to the north west of the site following storage within an attenuation tank. The details regarding this are outlined below.

4.1 Sustainable Drainage Strategy

An excavation should be carried out in the driveway area to the front of the existing garage at the south west of the site to accommodate geo-cellular storage crates with a total volume of at least 5.26m^3, assuming a void ratio of 95%, along with the required bedding, side fill and cover as per the manufacturer's recommendations. As an example, a tank with dimensions 3.5m x 2m x 0.8m could be implemented, based on typical geo-cellular crate sizes (typically 1m x 0.5m x 0.4m).

The excavation should be lined with an impermeable geomembrane and the geo-cellular crates should then be placed into the excavation, in alignment with the adjoining pipework, and wrapped in the membranes. The geo-cellular crates can be placed relatively close to the surface but should be a minimum of 300mm below the ground.

The attenuation tank will require a vent to avoid stagnant water and this should include the installation of a 110/160mm diameter vertical vent pipe fitted to the top layer of one of the geo-cellular crates via a flange adapter and the geomembrane should then be sealed around the flange.

Downpipes should direct roof water into underground pipes leading to an inspection chamber before connecting to the attenuation tank via a flange adapter which is then sealed with the geomembrane. Given the constraints present by Root Protection Areas on the site, it will not be feasible to discharge water from the roof of the entire dwelling, therefore, water from the roof of the proposed extension and existing garage will be discharged to the attenuation tank while surface water from the roof areas being retained will discharge as existing. A flange adapter should also be attached at the outlet which will then connect to another inspection chamber containing an orifice plate with a diameter of 72mm. This inspection chamber will then connect to the existing pipework at the north west of the site which will discharge to the existing sewer on Gatehill Road.

In the event of an exceedance of the design capacity of the drainage system or a blockage at the outlet, overland flows would be directed away from the dwelling and garage and would not pose a risk to residential end users. Exceedance routes are shown in the appendix.

4.2 Maintenance

The maintenance of the attenuation tank will be the responsibility of the homeowner and should include routine inspection of the geo-cellular crates and associated infrastructure to ensure that debris is removed and there are no blockages. The maintenance of crates and pipes and the removal of debris should be carried out monthly for the first 3 months after the development is in use and once every 6 months following this.

The following table provides guidance on the type of operational and maintenance requirements that are recommended and the frequency at which they should be carried out.

Table 2: Operation and maintenance requirements at the site

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Monitor inspection chamber	Annually
	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

5. Calculations

5.1 Greenfield Runoff Rate

The greenfield runoff rate for the whole site has been calculated using the uksuds tool from HR Wallingford. Outputs are provided in the appendix.

5.2 Existing Runoff Rate

To calculate the runoff rate from the existing site, the industry-standard Modified Rational Method has been used which uses the following equation:

$$Q = 2.78CiA$$

Where:

Q = design event peak rate of runoff (l/s)

C = non-dimensional runoff coefficient which is dependent on the catchment characteristics

The runoff coefficient was split into two terms when the modified rational method was originally produced, however, the two coefficients are usually incorporated into a single term with a value of between 0.8 and 1.0 - depending on how effectively the catchment is drained and the level of impermeability. A runoff coefficient of 0.95 has been applied in this case.

i = rainfall intensity for the design return period in (mm/hr) and for a duration equal to the "time of concentration" of the network

The rainfall intensity was calculated using the relevant maps from the Flood Studies Report and assumed a critical event duration of 15 minutes.

A = total catchment area being drained (ha)

Applying this to the existing impermeable area of the site (i.e. building footprint and external hardstanding) the equations are as follows:

$$Q_{1\text{yr}} = 2.78 \times 0.95 \times 30.26 \times 0.07 = 5.59\text{l}/s$$

$$Q_{100\text{yr}} = 2.78 \times 0.95 \times 96.72 \times 0.07 = 17.89\text{l}/s$$

The greenfield runoff rates will apply across the remainder of the site, therefore, the existing runoff rates for the whole site are as follows:

Existing runoff rate (1 in 1 year) = 5.94l/s

Existing runoff rate (1 in 100 year) = 19.21l/s

5.3 Storage Volume

The storage volume required to restrict the runoff rate for the 1 in 100 year rainfall event, including an allowance for climate change, to 50% of the existing 1 in 100 year runoff rate was calculated using the uksuds tool from HR Wallingford. An urban creep allowance of 10% and a climate change allowance of 40% were applied.

Outputs are shown in the appendix.

5.4 Flow Control

In order to determine the required diameter for an orifice plate to provide a 50% betterment to the existing 1 in 100 year runoff rate, the following equation was used:

$$Q = C_d A_o \sqrt{2gh}$$

Where:

Q = orifice discharge rate (m^3/s)

C_d = coefficient of discharge

A_o = area of orifice (m^2)

h = hydraulic head (m)

The maximum hydraulic head will be taken as the maximum thickness of the sub base

g = 9.81 m/s^2

Applying this to the site to determine the orifice area (A_o) the equation is as follows:

$$A_o = \frac{Q}{C_d\sqrt{2gh}} = \frac{0.00961}{0.6\sqrt{2\times 9.81\times 0.8}} = 0.004\text{m}^2$$

The required orifice plate diameter (D) to limit the rate of discharge to 9.61l/s would be:

$$D = 2\sqrt{\frac{A_o}{\mu}} = 2\sqrt{\frac{0.004}{\mu}} = 0.072\text{m}$$

Consequently, an orifice plate with a diameter of 72mm would be required to discharge the 1 in 100 year runoff volume, including a 40% allowance for climate change, at 9.61l/s.

6. References

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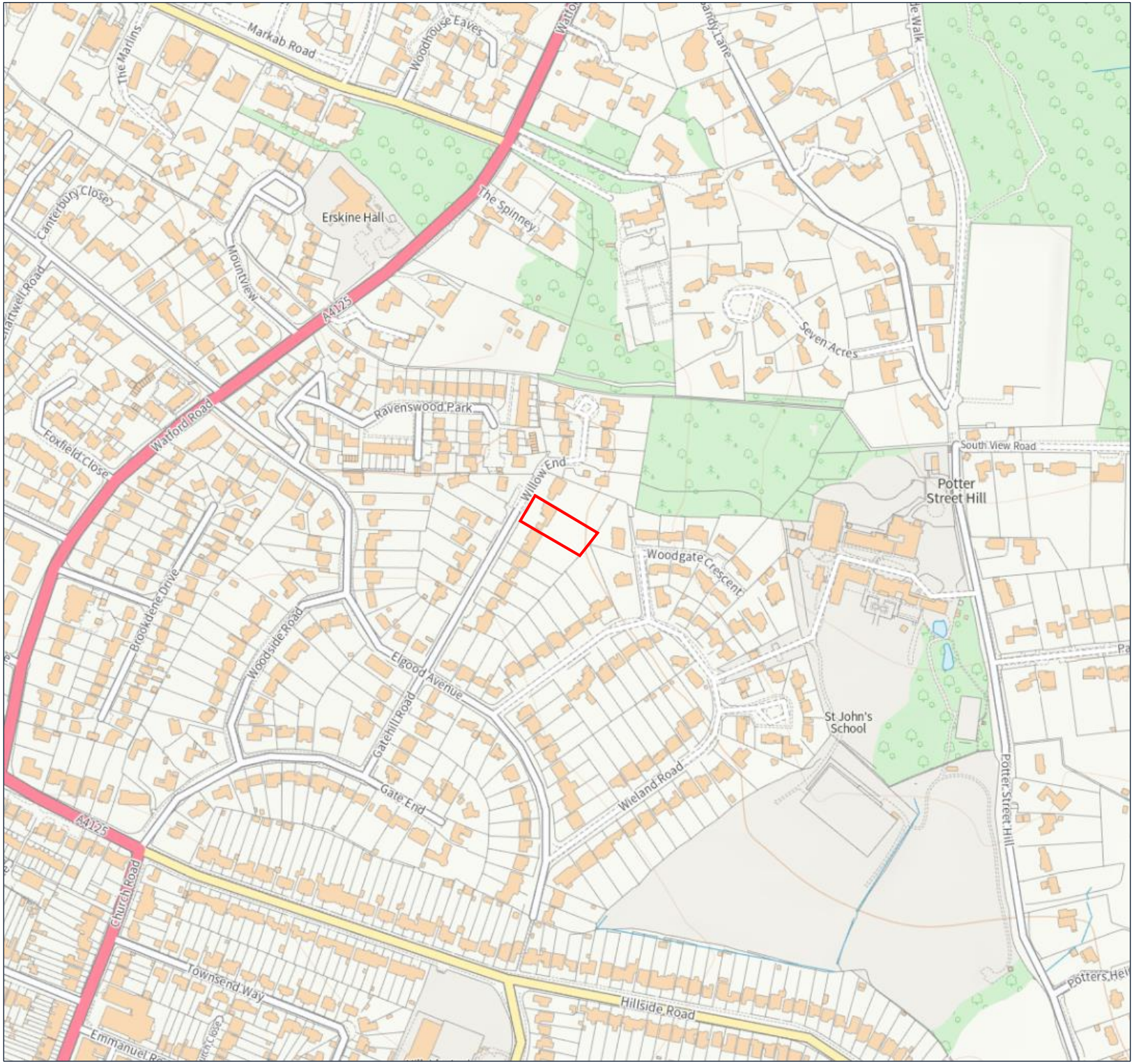
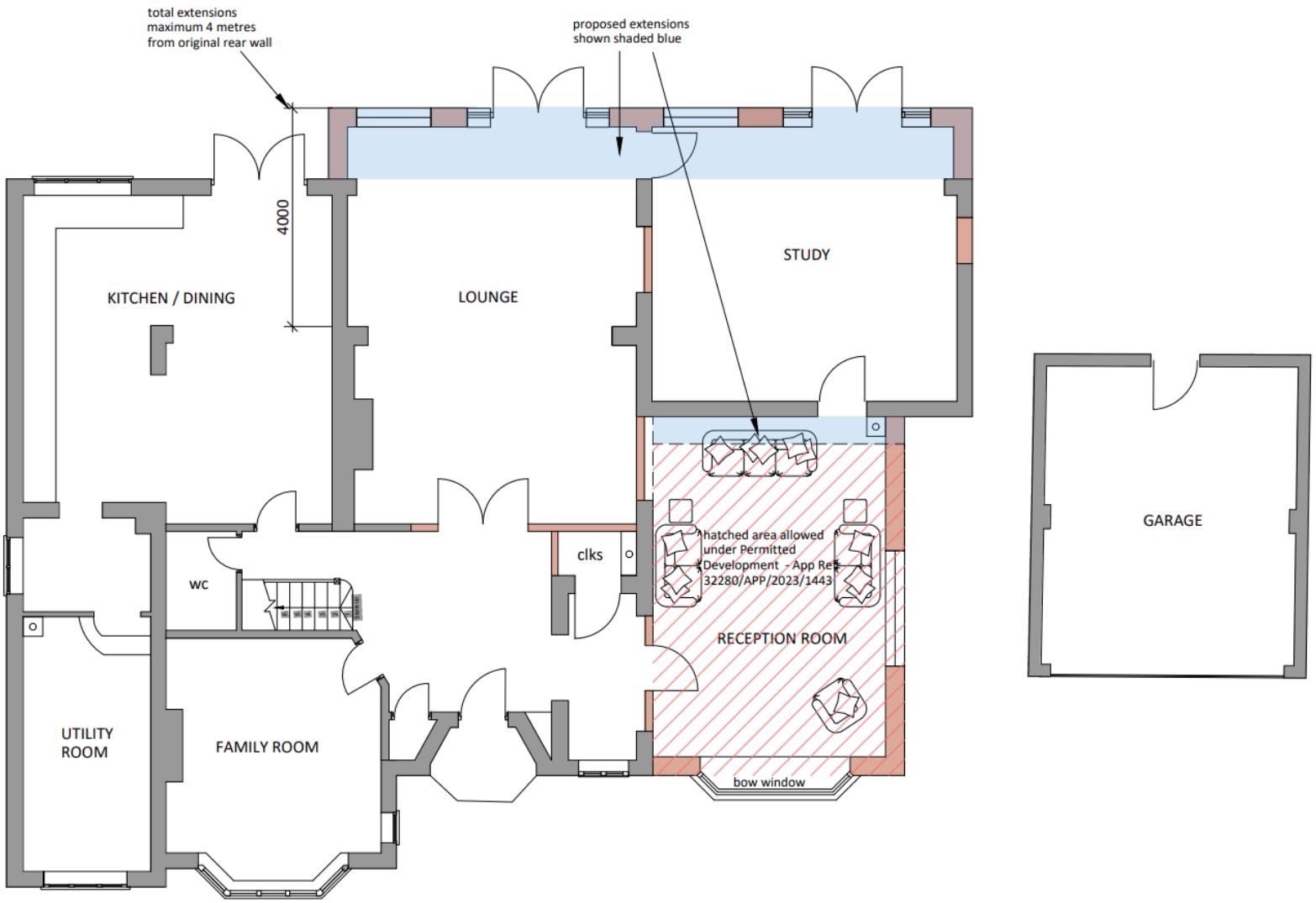
Oakshire Environmental. Available at: <oakshireenvironmental.co.uk>

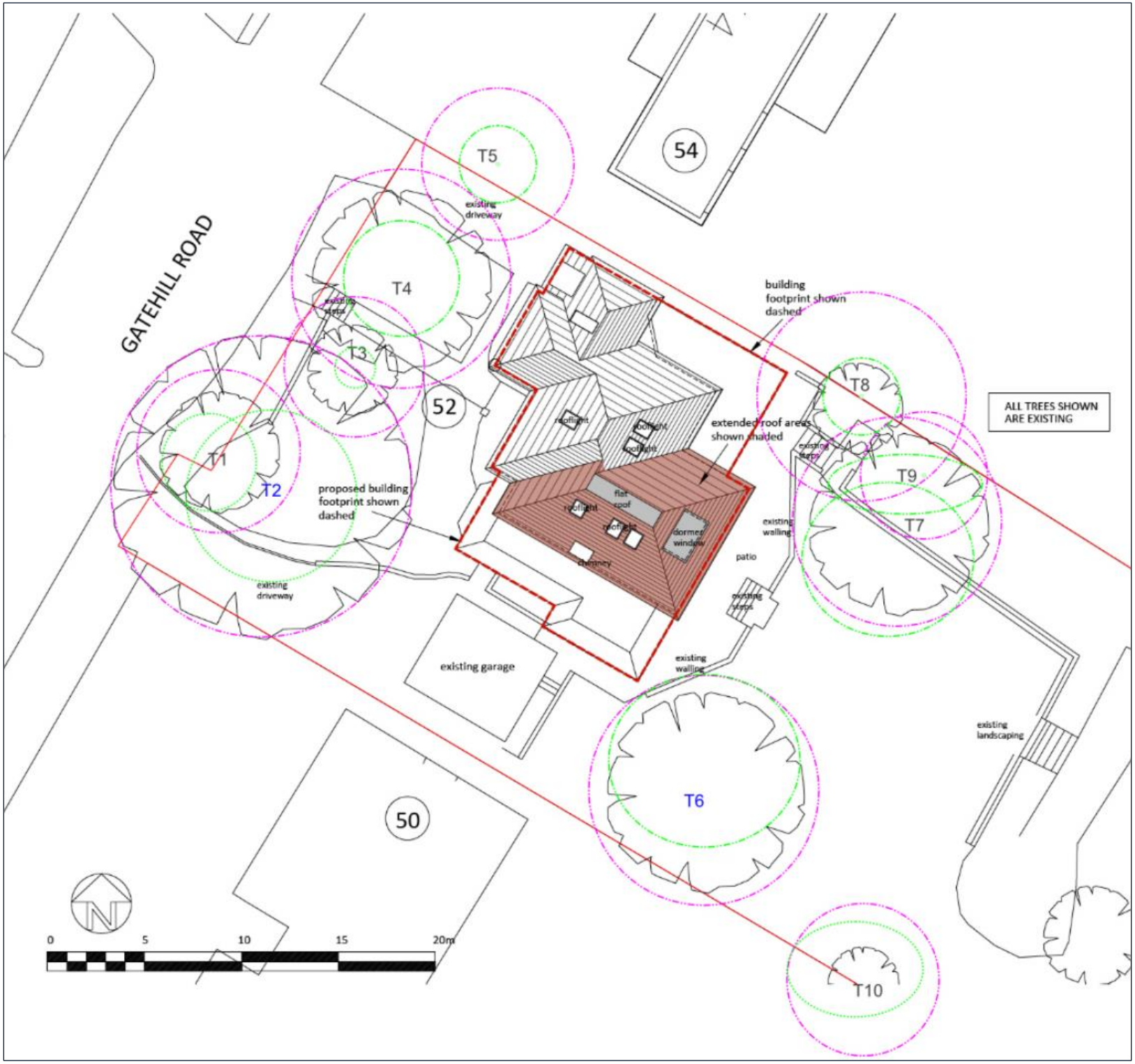


Appendix - Site Maps & Plans	
Description	
Site location plan	
Sources	
Contains OS data © Crown copyright and database right 2023	
Key	
	Site boundary
▲	North

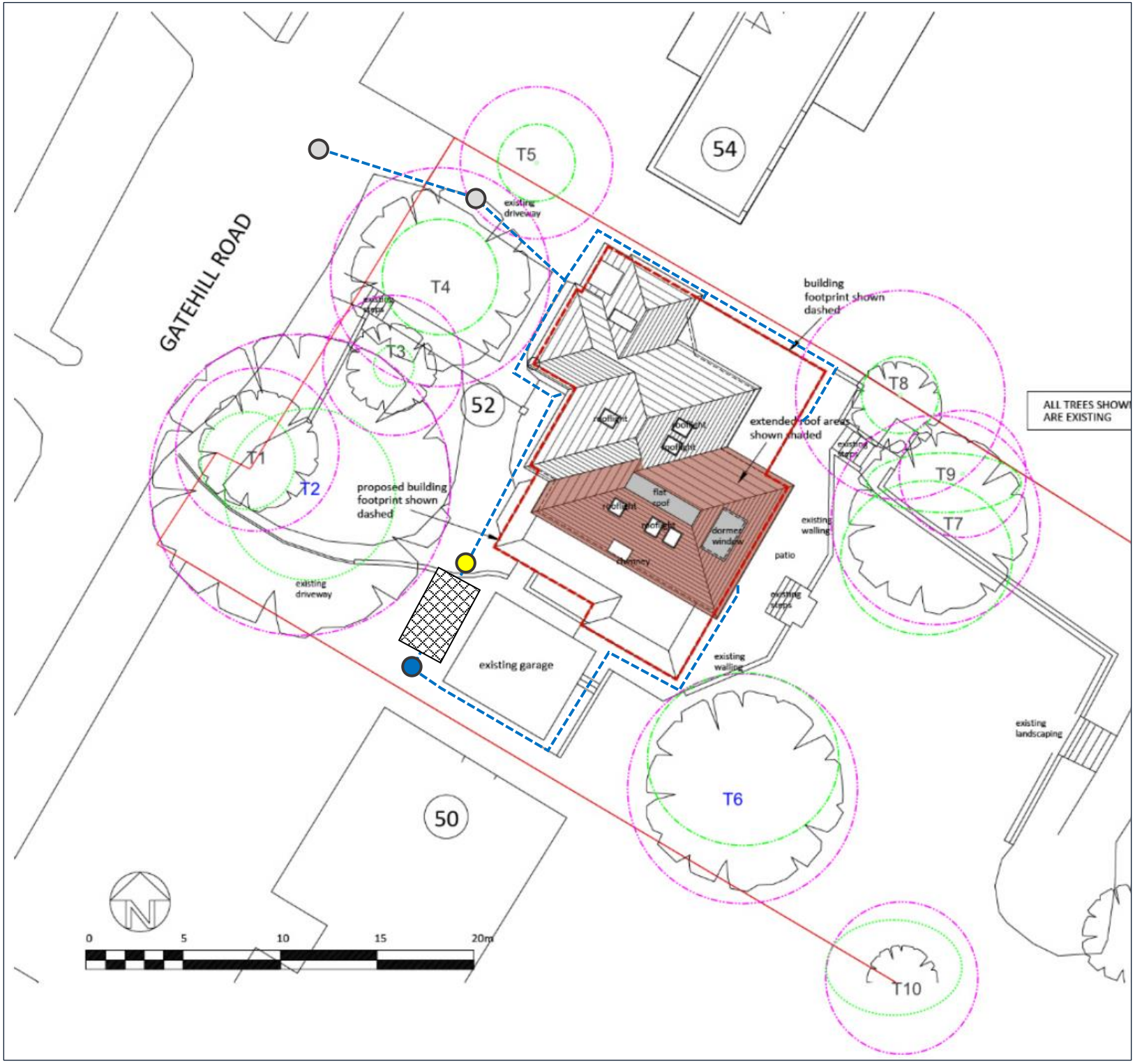
Appendix - Site Maps & Plans	
Description	
Proposed block plan	
Sources	
Amber Architecture	
Key	
	Site boundary
▲	North



Appendix - Site Maps & Plans
Description
Proposed ground floor plan
Sources
Amber Architecture
Key
Additional building footprint



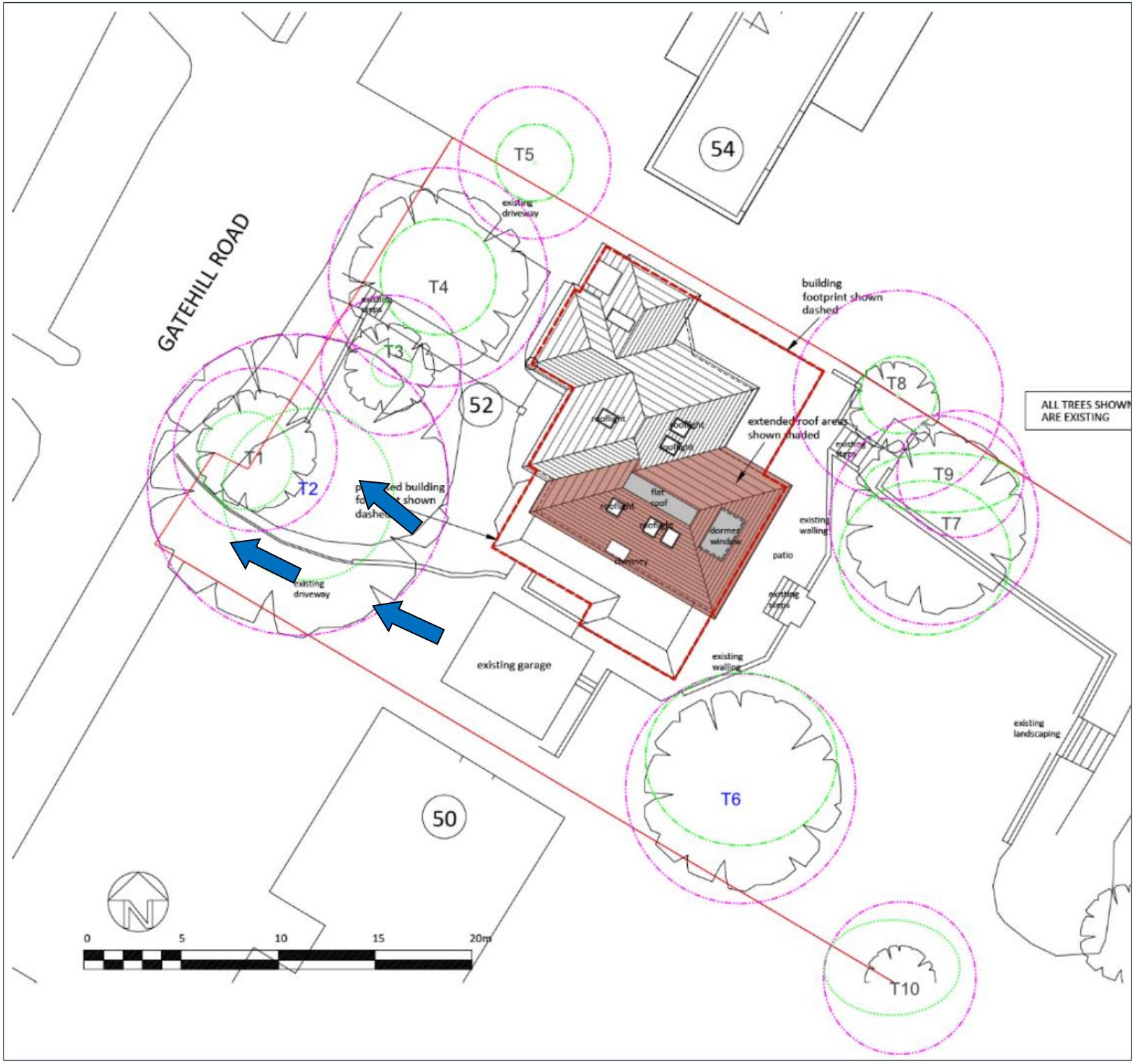
Appendix - Tree Constraints Plan	
Description	
Tree Constraints Plan	
Sources	
Tree Sense Arboricultural Consultants Oakshire Environmental	
Key	
	Site boundary
	Root Protection Area (RPA)
▲	North



Appendix - Indicative Drainage Layout

Description
Indicative site layout overlaid on Tree Constraints Plan (for illustrative purposes only – to be confirmed by engineer)
Sources
Tree Sense Arboricultural Consultants Oakshire Environmental
Key

	Site boundary
	Attenuation tank (3.5m x 2m x 0.8m)
	Surface water pipe (locations TBC)
	Existing inspection chamber
	New inspection chamber
	Inspection chamber w/ 72mm orifice plate



Appendix - Exceedance Plan	
Description	
Exceedance plan	
Sources	
Tree Sense Arboricultural Consultants Oakshire Environmental	
Key	
	Site boundary
	Exceedance route
▲	North

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Louis Turner
Site name:	Gatehill
Site location:	Northwood

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:	51.61251° N
Longitude:	0.40921° W
Reference:	3174856793
Date:	Apr 08 2024 15:09

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 1

Methodology

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

Soil characteristics

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

Hydrological characteristics

	Default	Edited
SAAR (mm):	671	671
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):	4.59	4.59
1 in 1 year (l/s):	3.91	3.91
1 in 30 years (l/s):	10.57	10.57
1 in 100 year (l/s):	14.66	14.66
1 in 200 years (l/s):	17.18	17.18

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Louis Turner
Site name:	Gatehill
Site location:	Northwood

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:	51.61255° N
Longitude:	0.4092° W
Reference:	3886389231
Date:	Apr 12 2024 10:35

Site characteristics

Total site area (ha):	0.16
Significant public open space (ha):	0.09
Area positively drained (ha):	0.07
Impermeable area (ha):	0.07
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	100
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):	0.07
Net impermable area for storage volume design (ha):	0.07
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:	--	89.32
FEH / FSR conversion factor:	1.16	1.16
SAAR (mm):	671	671
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		Growth curve factor 100 years:	3.19	3.19
Urban creep allowance factor:	1.1		Q_{BAR} for total site area (l/s):	0.74	0.74
Volume control approach	Use long term storage		Q_{BAR} for net site area (l/s):	0.32	0.32
Interception rainfall depth (mm):	5				
Minimum flow rate (l/s):	9.61				

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	9.6	9.6
1 in 30 years (l/s):	9.6	9.6
1 in 100 year (l/s):	9.6	9.6

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	5	5
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	5	5