

Surface Water Drainage Strategy

Manor Hotel Best Western, Gravesend

Date	Prepared For	Reference
May 2023	Manor Hotel Best Western	73050



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Contract

GeoSon Limited were instructed by Tim Cropper of Mialex, on behalf of Mike Rossi at Manor Hotel Best Western, by an email dated 2nd March 2023 to undertake a Surface Water Drainage Strategy to support a proposed planning application for development at Manor Hotel, Hever Court Road, Gravesend.

Project	Surface Water Drainage Strategy
Prepared For	Manor Hotel Best Western
Location	Manor Hotel, Hever Court Road, Gravesend DA12 5UQ
Application	Construction of twelve residential dwellings with associated access road, parking and amenity space
Our Reference	73050
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Issued To	Mike Rossi (Manor Hotel Best Western) and Tim Cropper (Mialex)
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Purpose

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Introduction

Context

GeoSon Limited have been instructed by Tim Cropper of Mialex, on behalf of Mike Rossi at Manor Hotel Best Western, to undertake a Surface Water Drainage Strategy (SWDS) to support a proposed planning application for construction of twelve residential dwellings at Manor Hotel, Hever Court Road, Gravesend.

Study Objectives

The site is currently formed of a hotel with an associated car park and is therefore considered brownfield land.

According to plans provided by the client the hotel will remain in-situ and the car park area will be redeveloped to provide twelve residential dwellings with associated access road, parking and amenity space.

Given that the proposed development will alter the impermeable coverage at the site, thus will impact the existing runoff regime, details of the post development surface water drainage arrangements will be required to accompany the proposed planning application in line with current industry standards and Kent County Council's local policy guidance.

In accordance with the NPPF, CIRIA SuDS manual and Kent County Council's Sustainable Drainage guidance all surface water drainage strategies should follow the Drainage Hierarchy whereby discharge options are considered in the following order:

1. Stormwater reuse,
2. Discharge to ground,
3. Discharge to watercourse,
4. Discharge to surface water sewer,
5. Discharge to combined sewer.

This report details the preferred method for managing post development surface water runoff generated by newly introduced impermeable surfacing at the site. This includes how runoff can be managed now and for the lifetime of the development, so that future site users and third party land will not be at an increased risk of flooding as a result of the proposals.

Site Details

Site Description

The proposed development is located at Manor Hotel, Hever Court Road, Gravesend DA12 5UQ. The site is approximately 8118m² in size and is currently occupied by a Best Western Hotel building in the west and a car park in the centre and east.

According to plans provided by the client the site is currently underlain by 4920m² of impermeable surfacing comprised of 2050m² of built footprint and 2870m² of hardstanding.

Having reviewed aerial imagery, Manor Hotel is accessed via Hever Court Road which runs along the length of the northern boundary. The south of the site is bound by vacant land with a Premier Inn Hotel and car park located adjacent west.

Site Address	Manor Hotel, Hever Court Road, Gravesend DA12 5UQ
Site Area	8118m ²
Current Use	Hotel and Car Park (Brownfield Land)
Current Impermeable Area	4920m ²
OS NGR	TQ 65624 70618
County	Kent
Local Planning Authority	Gravesham Borough Council
Lead Local Flood Authority	Kent County Council

Table 1: Site Details

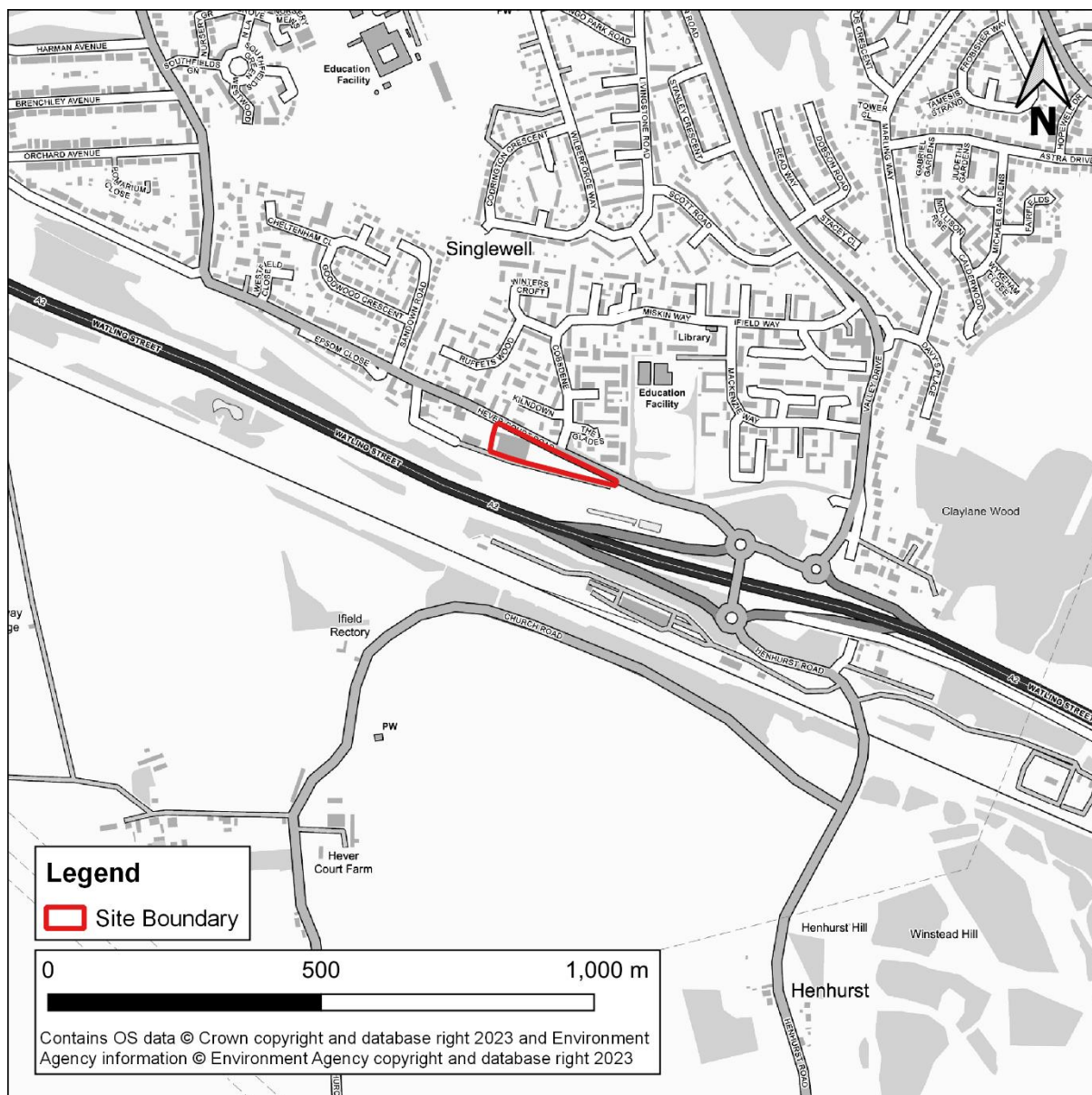


Figure 1: Site Location

Topography

A topographic survey was undertaken at the site by Datum Survey Services Limited in December 2017 and provided by the client for inclusion within this report. The topographical survey indicates that ground levels at the site have a 1.47m elevation range between 65.66mAOD and 67.13mAOD.

According to information provided by the client the area of land where the proposed dwellings will be developed is relatively flat and has an elevation of between 66.22mAOD to 66.38mAOD.

1.0m resolution LiDAR data obtained from the Environment Agency indicates that site is situated on a plateau with the land to the north sloping away from the development in a north easterly direction. Land to the east of the site appears to be elevated higher than the development. Figure 2 shows the elevation profile of the site and surrounding area. The topographic survey can be seen in Appendix A.

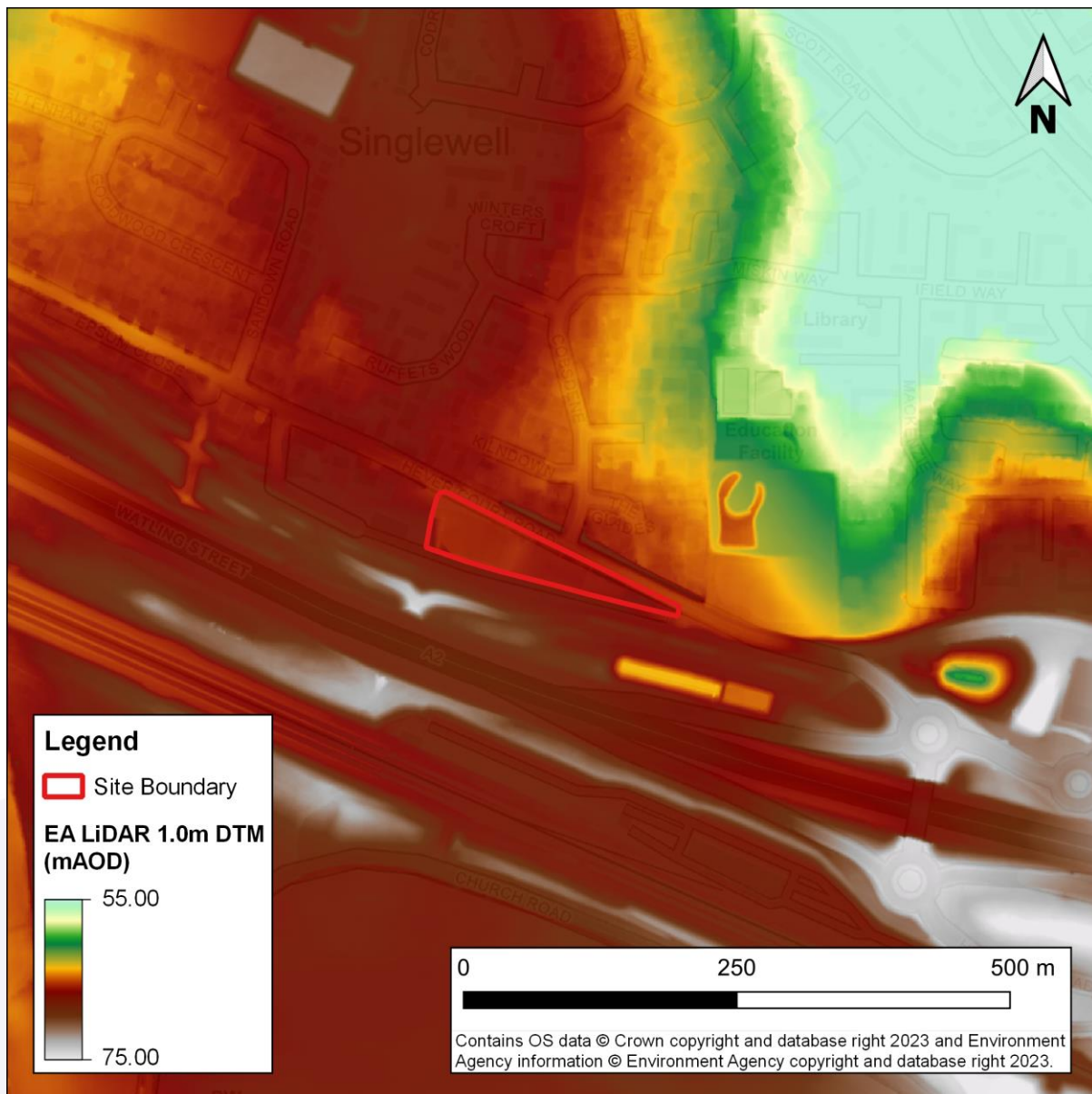


Figure 2: Topography of the Site and Surrounding Area

Geology and Hydrogeology

Review of online British Geological Survey (BGS) records indicates that the majority of the site is located directly upon Lewes Nodular, Seaford and Newhaven Chalk Formation bedrock. This geological strata was formed between the Turonian Age and Campanian Age some 72.1 to 93.9 million years ago.

According to BGS data the west of the site, associated with land beneath part of the existing hotel building, is located directly upon Thanet Formation (Sand) bedrock. This geological strata was formed during the Thanetian Age approximately 56.0 to 59.2 million years ago.

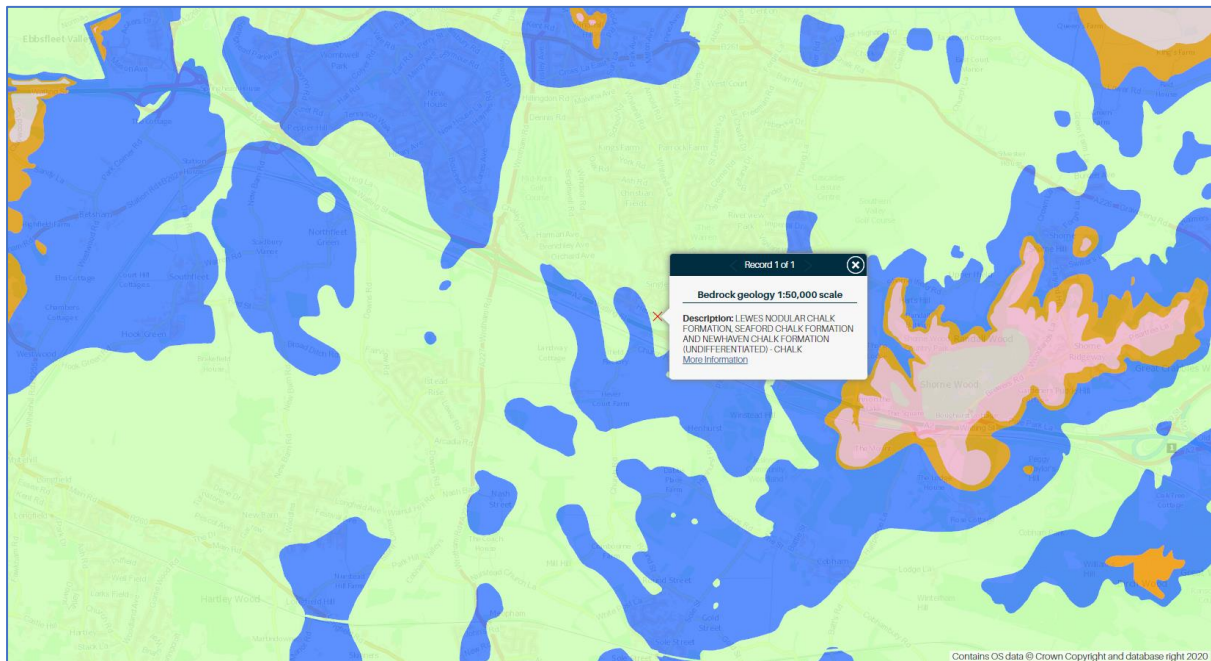


Figure 3: Bedrock Geology Map (Source: British Geological Survey)

Review of Landis Soils online viewer suggests that the site is located in area where the soils are classified as 'Freely draining lime-rich loamy soils'.

According to BGS records the nearest borehole log to the development, undertaken within the same geological strata as that beneath the centre and east of the site, is located some 300m south east of the car park. Borehole log reference TQ67SE183 was undertaken in August 1997 in connection with the Channel Tunnel rail link and reportedly encountered the following geological profile.

Level (mOD)	Depth (m) (Thickness)	Description
		TOPSOIL.
67.95	(0.40) 0.40 (0.40)	Structureless CHALK composed of cream, brown and white sand and silt size fragments with some subangular fine to coarse gravel size fragments. Occasional rinded flint cobbles.;(UPPER CHALK - GRADE VI, Dm)
67.55	0.80	
	(1.10)	Structureless CHALK composed of white subangular fine to coarse gravel size fragments with some cemented sand and silt size comminuted chalk. Occasional coarse gravel, cobbles and boulders of rinded flint.;(UPPER CHALK - GRADE V, Dc)
66.45	1.90	White slightly weathered CHALK, weak, medium density. Fractures very closely to closely spaced, randomly orientated, infilled greater than 3mm with silt size comminuted chalk, surfaces stained orange brown. Occasional flint cobbles.;(UPPER CHALK - GRADE III/IV, medium density, C3-C4)
65.65	2.70	
	(1.30)	White slightly weathered CHALK, weak, medium density. Fractures closely to medium spaced, infilled up to 3mm with comminuted chalk, locally clean and tight. Occasional flint cobbles.;(UPPER CHALK - GRADE III/IV, medium density, C3-C2)
64.35	4.00	
		Complete at 4.00m

Figure 4: Extract from BGS Borehole Log (Source: British Geological Survey)

According to BGS borehole records, groundwater ingress was not encountered during the trial pit investigation.

DEFRA 'Magic Maps' indicates that the site is located within a groundwater Source Protection Zone III - Total Catchment.

Existing Surface Water Drainage Arrangements

The client has confirmed that surface water runoff generated by the existing hotel and car park is currently directed towards a soakaway system located beneath the car park entrance.

According to the client the main catchment chamber of the soakaway system (annotated as 'A' in Figure 7) is constructed of pre-cast concrete and has the following dimensions: 1.0m diameter and 3.0m depth.

The client has confirmed that runoff from the car park area, proposed to be developed, currently drains either informally onto the surrounding soft landscaping or is directed towards the site entrance where it is collected in two drain chambers (marked 'B' and 'C' on Figure 7). Any stored water within the drain chambers is subsequently conveyed towards the soakaway before being discharged to ground.

The soakaway system was installed in the 1980s in relation to planning application reference 19860158 and has been in operational use since. The client has confirmed that there have been no incidents of water exceedance or flooding at the site during this time.

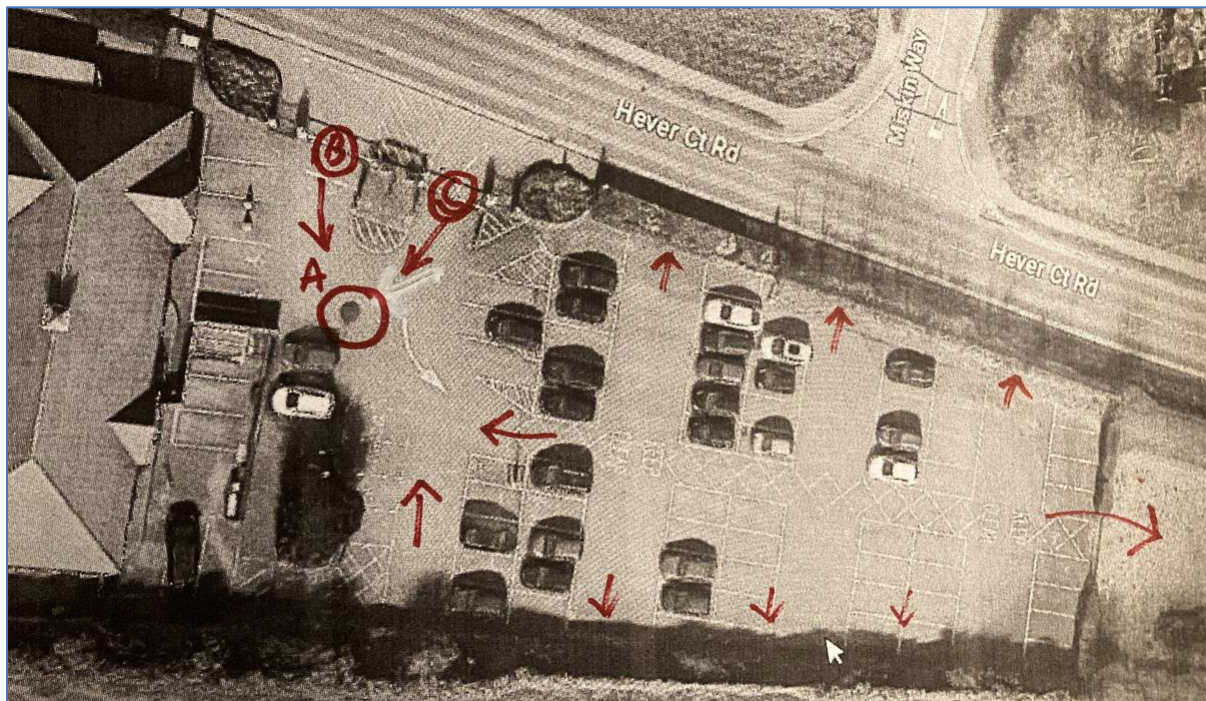


Figure 7: Existing Drainage Arrangements

Proposed Development

Development Proposals

The proposed planning application is for redevelopment of the site including internal reconfiguration of part of the existing hotel and construction of twelve new residential dwellings in the car park area.

The applicant has confirmed that the development is being submitted as two separate applications and that the site has been split into two parcels of land. Refer to Figure 8.



Figure 8: Proposed Application Boundaries

Western Parcel of Land

The client has confirmed that all works associated with the existing hotel will be internal and that there will be no change to the impermeable surfaced area in the western parcel of land as a result of the development. In light of this, it is considered that there will be no change to the existing runoff rates and volumes generated by the western parcel of land when compared to the existing situation. As such, the drainage arrangements for the main hotel will remain as is with runoff being directed into the existing soakaway beneath the site entrance.

Eastern Parcel of Land

This surface water drainage strategy will focus on how surface water runoff will be managed from new impermeable surfacing introduced into the eastern parcel of land associated with the development of twelve new residential dwellings.

From this point on the eastern parcel of land will be referred to as The Site.

According to plans provided by the client the developable area of land in the eastern parcel measures approximately 2500m². Post development the total impermeable area at The Site will amount to approximately 1800m², comprising 707m² of roof area and 1093m² of hardstanding (paving and roads).

However, it is worth noting that The Site is classified as brownfield land and is already underlain by 1530m² of hardstanding, associated with the hotel car park. Therefore, the true increase in impermeable area as a result of the development will amount to only 270m².

Despite this, attenuation sizing within the strategy will be based on a total impermeable area of 1800m². As such, significant betterment will be provided post development when compared to the current situation.

A copy of the proposed site layout plan for the twelve dwellings is shown in Figure 9.

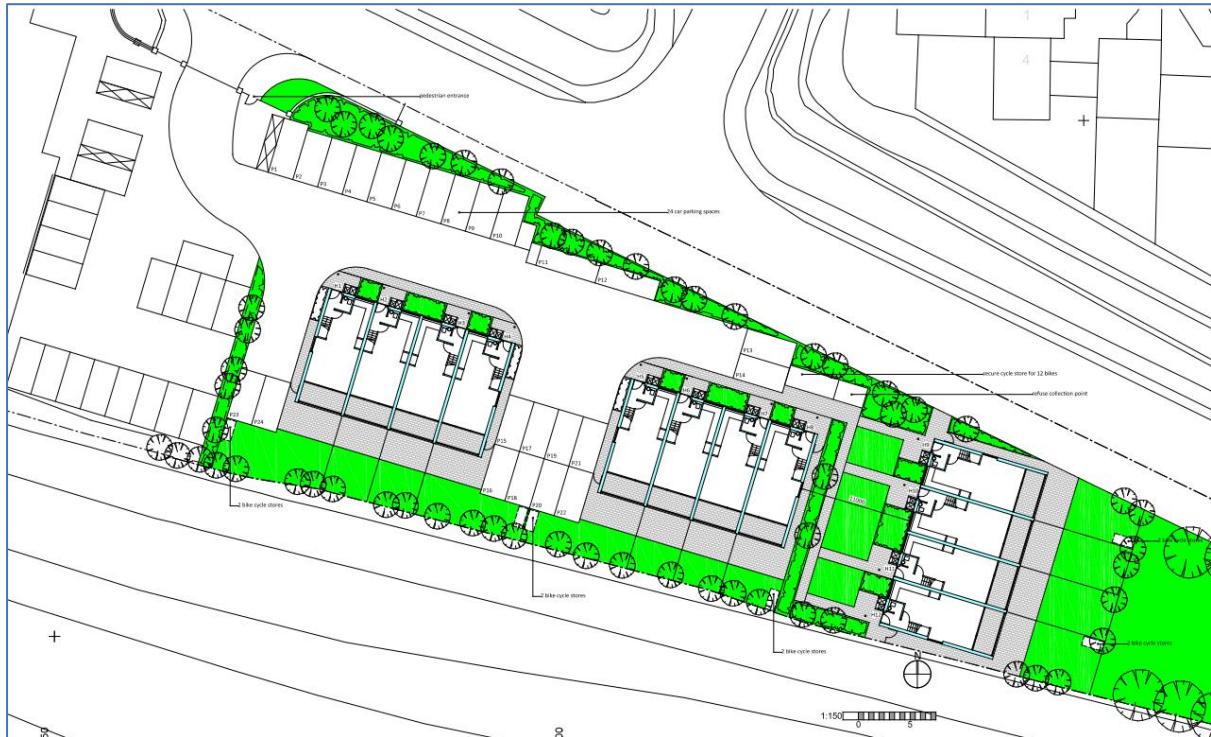


Figure 9: Proposed Layout Plan

Surface Water Drainage Strategy

Planning and Relevant Guidance

Given that the proposed development will alter the impermeable surfacing at The Site and will impact the existing runoff regime, details of post development surface water management will be required to accompany the planning proposals.

The aim of this Surface Water Drainage Strategy is to assess how surface water runoff generated by the proposed development can be managed now and for the lifetime of the development so that future site users and third party land will not be at an increased risk of flooding as a result of the proposals.

This Surface Water Drainage Strategy has been designed in accordance with national and local guidance including:

- Kent County Council SuDS Design Guidance: Master Planning Sustainable Drainage into Developments
- Thameside Stage 1 Surface Water Management Plan (2013)
- Sustainable Drainage - Making it Happen Guidance Document
- National Planning Policy Framework (NPPF)
- Planning Practice Guidance on Flood Risk and Coastal Change (Updated August 2022)
- Sustainable Drainage Systems: Non-Statutory Technical Standards
- CIRIA SuDS Manual (c753)
- Sewerage Sector Guidance – Design and Construction Standards
- ICE SuDS Route Maps

Peak Rainfall Intensity Allowance

In May 2022 the Environment Agency issued revised peak rainfall intensity allowances for Management Catchments in England. The update introduced a regional variation in rainfall uplifts to account for Climate Change based on Management Catchment and development lifetime.

The Environment Agency published the Peak Rainfall Allowance Map which shows anticipated changes in peak rainfall intensity over time based on drainage catchment. According to the EA's Peak Rainfall Allowance Map the site is located within the Medway Management Catchment. Peak rainfall allowances for this catchment are as follows:

3.3% Annual Exceedance Rainfall Event		
Epoch	Central Allowance	Upper End Allowance
2050s	20%	35%
2070s	20%	35%
1% Annual Exceedance Rainfall Event		
Epoch	Central Allowance	Upper End Allowance
2050s	20%	45%
2070s	20%	40%

Table 2: Medway Management Catchment Peak Rainfall Allowances

The specific Climate Change allowance required to be applied within the attenuation storage calculations to account for future change in peak rainfall intensity is dependent on the design lifetime of the proposed development.

In accordance with the development lifetime guidance, residential developments should be considered to have a minimum lifetime of 100 years. Developments with a lifetime beyond 2100 should use the Upper End Allowance for the 2070s epoch for both the 1% and 3.3% annual exceedance probability events.

As such, this drainage strategy has been designed to accommodate all surface water runoff during the 1% annual exceedance probability Upper End Allowance (40%) Climate Change event.

Urban Creep

Urban creep is the conversion of permeable surfaces to impermeable over time. Typical examples include paving of front gardens to provide parking or extensions to existing buildings.

An allowance for urban creep is required to be considered within the drainage design for residential developments only to account for the incremental change of use from permeable to impermeable surfacing over the lifetime of a development.

Where applicable, the following allowances must be applied to the impermeable area within the site curtilage to account for urban creep:

Residential Development Density (Dwellings per Hectare)	Urban Creep Allowance (%)
≤ 25	10
30	8
35	6
45	4
≥ 50	2
Flats and Apartments	0

Table 3: Urban Creep Allowances

Note: Where the inclusion of the urban creep allowance would increase the total impermeable area to greater than 100% of the site area, the drainage system should be sized to accommodate runoff generated by 100% of the site area.

The client intends to construct twelve dwellings on a 0.25ha parcel of land. As such, considering the density of the development proposals, a 4% allowance to account for future urban creep is required to be applied within the design calculations.

Proposed Surface Water Drainage Scheme

Area of Focus

This Surface Water Drainage Strategy and the calculations here within relate to the development of the twelve residential dwellings and associated access road.

According to plans provided by the client, the application boundary measures approximately 3000m² and the developable area of land amounts to 2500m². The client has confirmed that there will be no change to the surface materials outside of the development area.

Post development the total area of newly introduced impermeable surfacing will amount to approximately 1800m², comprised of 707m² of roof area and 1093m² of hardstanding (paving and roads). Refer to Figure 10.

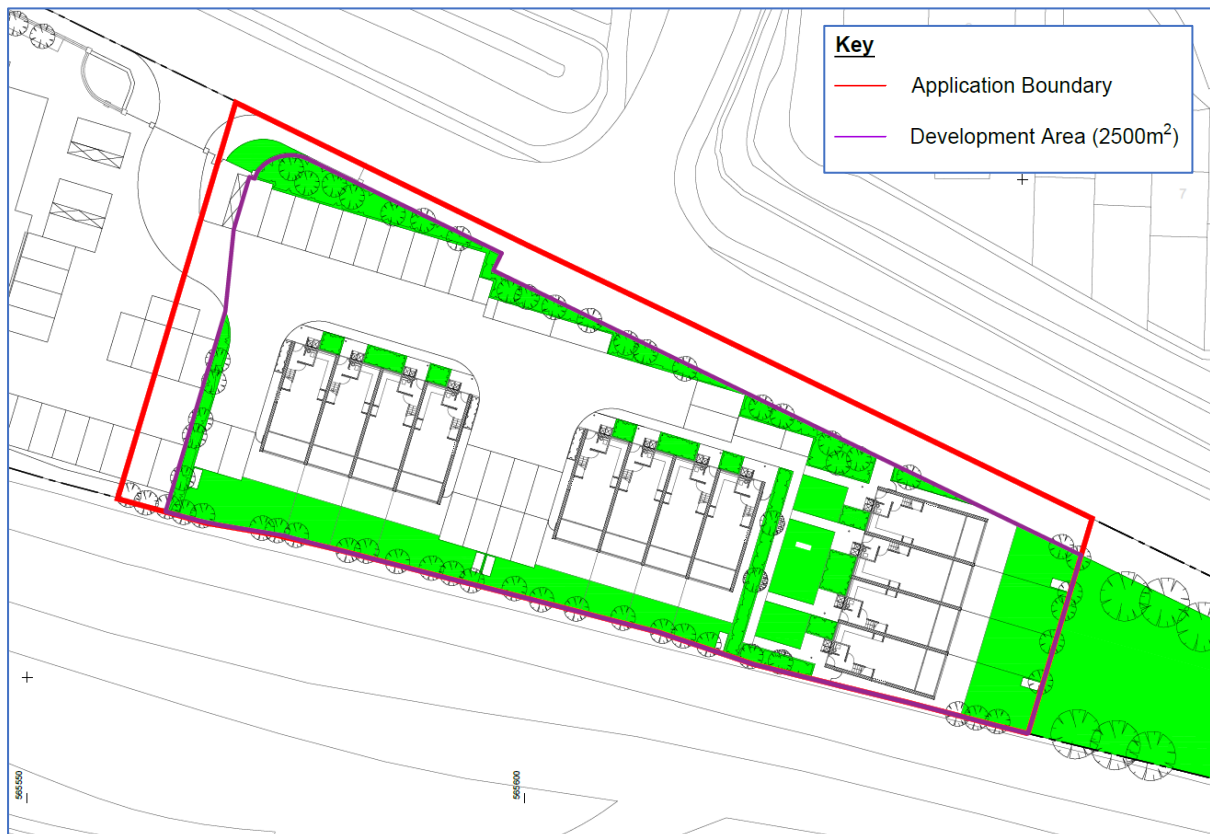


Figure 10: Proposed Development Area and Newly Introduced Impermeable Surfacing

Drainage Hierarchy

In accordance with NPPF guidance and the CIRIA SuDS manual all surface water drainage strategies should follow the Drainage Hierarchy whereby discharge options are considered in the following order:

1. Stormwater reuse,
2. Discharge to ground,
3. Discharge to watercourse,
4. Discharge to surface water sewer,
5. Discharge to combined sewer.

The following sections detail how the drainage hierarchy has been followed and each of the discharge locations considered as part of this drainage strategy.

Water Re-Use (Optional)

Review of the design layout indicates that each plot will have an associated area of soft landscaping. Therefore, it is considered likely that there will be a demand for non-potable water supply post development.

Rainwater butts offer a simple mechanism for water re-use. They typically take the form of an above ground storage tank which collects roof runoff from building downpipes. Any stored water within the rainwater butt can subsequently be drawn off at a later time for non-potable uses such as wash-down purposes or irrigation use. In accordance with CIRIA SuDS Manual water re-use SuDS provide an '*indirect amenity value by supporting the resilience of developments and their landscape to changes in climate and water resource availability*'.

Rainwater butts are simple to incorporate within residential developments and can easily be added onto building downpipes at any stage of a development, with the tank overflow connected to the site's wider drainage system.

In practise, water re-use SuDS provide little in the way of attenuation storage therefore are not accounted for within the formal attenuation storage calculations. However, they do increase the lag time for storm water to enter a drainage system.

In light of the above, it is considered that there would a benefit from incorporating rainwater butts into the scheme as a form of water re-use SuDS to reduce post development water demand.

Infiltration to Ground

An intrusive site investigation has not been undertaken. However, given that the development is underlain by chalk bedrock and all existing impermeable surfaces currently discharge to a soakaway located beneath entrance to Manor Hotel, it is considered that infiltration drainage is feasible at the development.

In the absence of in-situ testing, the minimum viable infiltration rate of 1×10^{-6} m/s has been utilised to base the sizing of SuDS features at the development.

The effectiveness of infiltration drainage at The Site will be dependent on the composition of the chalk strata beneath the development, in particular the frequency of the fissures and their degree of openness. Therefore, the final sizing of infiltration drainage features will be subject to in-situ infiltration testing and groundwater monitoring undertaken at a later date, prior to detailed design.

In the absence of a site-specific investigation, for the purposes of this report it has been assumed that the resting groundwater level is more than 2.0m below ground level and that buoyancy will not be a concern. This should be confirmed by long-term groundwater monitoring.

Considering that The Site lies within a groundwater Source Protection Zone 3 and is located directly upon chalk bedrock geology, an Environment Agency discharge permit may be required.

Discharge to Watercourse

Review of aerial imagery indicates that the closest watercourse to the development is located some 300m south of the application area associated with a drainage ditch which runs along the southern edge of Church Road.

In order to discharge post development surface water runoff into this ordinary watercourse third party land (including roads and a railway line) would need to be crossed.

As such, given the constraints associated with this option, discharge to watercourse is not considered feasible and has not been considered further as part of this study.

Discharge to Sewer

According to Southern Water records there are no main surface water sewers located beneath Hever Court Road or within at least a 750m radius of the development.

Additionally, it is proposed to discharge post development runoff to ground therefore a connection to the main sewer network has not been explored further within this drainage strategy.

Existing Runoff Rates

The Institute of Hydrology Report 124 Flood Estimation for Small Catchments (IH124) is appropriate for use where the site area is between 0 – 200 ha. Where the site is less than 50ha the analysis for determining the peak run-off-rate should use 50ha in the formula and scale it down using linear interpolation.

Considering that The Site area is below 50ha the ICP SuDS method has been used to estimate the greenfield runoff rate for several return period events including QBAR.

Storm Event	Greenfield Runoff Rate (l/s)
QBAR	0.04
1 in 1 year	0.03
1 in 30 year	0.08
1 in 100 year	0.11

Table 4: Greenfield Runoff Rates

However, The Site is currently occupied by brownfield land and underlain by approximately 1530m² of hardstanding associated with the car park area. Therefore, the greenfield rates detailed above are not considered to represent the current situation at the site.

Brownfield runoff rates for the 1-year, 30-year and 100-year 15-minute storm duration events have been calculated using the Modified Rational Method. Refer to Table 5 (below). The rates shown in Table 5 are based on the existing hardstanding area only (1530m²).

Storm Event	Existing Runoff Rate (l/s)
1 in 1 year	16.10
1 in 30 year	40.18
1 in 100 year	51.04

Table 5: Existing Runoff Rates from the Car Park Hardstanding Only

Permeable Paving

Considering that The Site is located on chalk bedrock geology, and the fact that runoff from existing impermeable surfacing currently discharges to ground via a soakaway which serves the wider hotel, it is proposed to discharge all post development surface water runoff to ground.

It is proposed that all surface water runoff generated by newly introduced impermeable areas at the development will be conveyed and stored within 735m² of permeable paving located beneath the access road and parking bays.

Precipitation which lands on these areas will percolate through the paving surface and be stored within the gravel/geocellular storage sub-base. From the sub-base any stored water will be gradually discharged to ground.

Surface water runoff generated by the remaining impermeable surfacing comprising 707m² of roof areas and 358m² of external paving, will be directed towards the permeable paving sub-base via linear drains and subterranean pipework.

In the absence of in-situ testing, the minimum viable infiltration rate of 1×10^{-6} m/s has been used to base the sizing of permeable paving SuDS at the development. However, considering that surface water runoff from the entire Manor Hotel site is already managed via a soakaway it is considered that use of the minimum viable rate is cautionary and true infiltration rates are likely to be higher.

Given the nature of the development, and the housing density, a 4% allowance for urban creep needs to be taken into account within the design calculations. As such, the proposed SuDS system has been designed based on a total impermeable contribution area of 1872m².

All preliminary surface water drainage calculations have been undertaken using Innovyze InfoDrainage software. A summary of the design parameters and results are shown in Table 6 below. The InfoDrainage calculation sheets are included in Appendix D.

Area of Impermeable Surfacing (m²)	1800
Impermeable Surfacing with Urban Creep (m²)	1872
Dimension of Proposed Permeable Paving (m)	735m ² x 0.4m
Void Ratio (%)	78.75
Assumed infiltration rate (m/s)	1.0×10^{-6}
Volume of Attenuation Required to Accommodate runoff for the 1 in 100yr + (40%) CC Event (m³)	195.18
Total Volume Provided by Permeable Paving (m³)	231.53

Table 6: Summary of Proposed Permeable Paving SuDS System

A void ratio of 78.75% has been used within the permeable paving calculations.

It is proposed that the 400mm permeable paving sub-base depth is made up of a combination of 300mm permavoid geocellular storage underlain by 100mm gravel. Graded gravel is

considered to have a void ratio of 30% and geocellular storage has a void ratio of 95%. Therefore, a void ratio of 78.75% has been derived from the following calculation:

$$=(((0.3 \times 0.95) + (0.1 \times 0.3)) / 0.4) \times 100$$

The 100mm of graded gravel will be located beneath the permavoid geocellular storage. This will ensure that any stored water percolates through the graded gravel component of the sub-base before discharging to ground, enabling the proposed SuDS system to meet the water quality requirements as set out within CIRIA SuDS Manual.

In order to achieve sufficient fall from impermeable areas associated with the four residential dwellings in the east, land beneath the four plots will need to be raised by approximately 250mm as part of the development or the permeable paving sub-base invert level reduced by 250mm. Final site levels will be determined at detailed design stage.

The SuDS system has been sized to provide sufficient storage to accommodate all runoff generated by post development impermeable surfacing at the site during the 1 in 100yr plus (40%) Climate Change event.

Raingardens (Optional Addition)

Raingardens (also referred to as bioretention schemes) can take the form of shallow landscaped depressions or raised planters and are used to reduce rainfall runoff whilst also mitigating the impact of pollution.

Raingardens are flexible, 'green' surface water drainage features which can be incorporated into most development schemes and provide a wide range of benefits including:

- Reducing rainfall runoff from a development,
- Improving water quality by removing sediment and other pollutants through the filtration process,
- Creating biodiverse habitats, and
- Enhancing amenity value for local residents and site users.

Having reviewed the proposed site layout, there is the opportunity to incorporate raingardens within the design proposals. According to plans provided by the client planters measuring an accumulative area of 54m² are proposed to be located at the entrance of each dwelling. These planters could be utilised as raingardens to provide additional attenuation storage upstream of the permeable paving along with providing wider biodiversity and amenity benefits for future residents.

Roof runoff from the front elevation of each of the twelve dwellings could be directed into private raingardens via a downpipe(s) located on the front façade of each building. If incorporated within the design, it is recommended that stones and gravel are laid at the downpipe inlets within all of the raingardens to dissipate the energy of entering water and prevent heavy flows from washing soils away.

Any water conveyed into the raingarden would percolate through the topsoil and be stored within a gravel sub-base. Given that the underlying geology is permeable, it is recommended that the raingardens are unlined to allow infiltration, where possible.

It is also recommended that a perforated under-drain is installed within the gravel sub-base of the raingardens so that should any water accumulate it can be directed towards the permeable paving sub-base. It is envisaged that the majority of the stored water will naturally infiltrate through the unlined base. However, the incorporation of an under-drain would

ensure that any water build up within the individual raingardens is drained effectively and would prevent waterlogging.

Considering the cover and invert levels of the proposed permeable paving SuDS systems, should raingardens be utilised within the final design, the planters would need to be raised to allow gravity connection into the permeable paving sub-base.

Assuming that each raingarden planter has a height of 0.8m a total additional attenuation storage volume of 15.66m³ could be provided at the development. Storage volume calculations have been undertaken in accordance with Designing Rain Gardens: A Practical Guide, by Urban Design London, and are detailed below.

Raingarden parameters:

- Combined area of raingardens - 54m²
- Depth of freeboard - 0.2m
- Depth of topsoil (ratio 50% sand, 30% topsoil and 20% compost) - 0.3m
- Depth of sub-base - 0.3m
- Approximate invert level of raingarden – 66.20mAOD. This would allow gravity discharge from the raingardens into the permeable paving sub-base.

Depth of Storage (m)	=	Depth of Freeboard (m)	+	30% of Sub-base (m)
	=	0.2	+	30% of 0.3
	=	0.29		
Volume of Storage (m ³)	=	Depth of Storage (m)	×	Area of Raingarden (m ²)
	=	0.29	×	54
	=	15.66		

Note, the attenuation volumes which could be provided by the raingardens have not been taken into account within the overall attenuation storage calculations provided for The Site.

The proposed permeable paving SuDS system alone will provide sufficient storage to accommodate all runoff generated by impermeable surfaces during the 100 year plus (40%) Climate Change event. Therefore, should raingardens be included within the final design proposals the overall SuDS scheme will provide an attenuation storage capacity greater than what is required by policy.

Design Exceedance

The SuDS system has been designed to accommodate all surface water runoff generated by post development impermeable surfacing during the 1 in 100yr plus (40%) Climate Change event. As such, the SuDS system also has capacity to accommodate all runoff generated by the 1 in 30yr plus (35%) Climate Change rainfall event with no exceedance.

Despite this it is recommended that the profile of the site is designed to direct any exceedance surface water flows towards the formal drainage system.

In addition, it is advised that raised entry thresholds are put in place in line with building regulations, linear drains are installed at entrance points and all landscaping is designed to slope away from doorways. These measures will mitigate against water ingress.

Potential exceedance flow routes can be seen on the proposed SuDS layout plan in Appendix E.

Water Quality

In accordance with The Simple Index Approach, detailed in the CIRIA SuDS Manual, residential roof runoff is considered to have a 'very low' pollution hazard level (refer to Table 7). Nevertheless, it is recommended that debris / sediment traps are included on any new drainage.

Runoff from private driveways and low trafficked roads (eg. cul de sacs, homezones and general access roads) are considered to have a 'low' pollution hazard level.

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05
Private Driveways and Low Trafficked Roads	Low	0.5	0.4	0.4

Table 7: Pollution Hazard Indices for Different Land Use Classifications

It is proposed to manage all surface water runoff from the development via permeable paving and potentially raingardens (bioretention systems). Indicative SuDS mitigation indices for both features are as follows:

Type of SuDS Component	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7
Bioretention System	0.8	0.8	0.8

Table 8: Indicative SuDS Mitigation Indices for Discharges to Surface Waters

The proposed permeable paving alone will provide adequate treatment for surface water runoff and is shown to have a higher mitigation index than the pollution hazard index for the development. However, if the client decides to incorporate raingardens additional water quality benefits will be provided (as shown in Table 8).

According to CIRIA SuDS Manual raingardens provide a very effective treatment functionality through the removal of sediments and pollutants by filtration through the vegetation and underlying filter mediums.

Adoption and Maintenance

It is foreseen that all SuDS components will be maintained privately by the future site owner(s) / operators or an appropriate management company.

All SuDS components should be maintained in line with the guidance provided in The SuDS Manual (C753). The following operation and maintenance requirements are recommended for the SuDS elements proposed in this strategy.

Drainage Infrastructure	Required Action	Typical Frequency
Conveyance Pipes	Inspect and remove silt/debris. Jet where appropriate.	To be inspected annually and as required.
Chambers and Catchpits	Inspect and remove silt/debris. Jet where appropriate. Replace damaged covers.	To be inspected annually and following a large storm event.
Flow Control and Associated Chamber	Inspect for blockages and clear where required. Remediate any faults.	To be inspected annually and following a large storm event.

Table 9: Suggested Maintenance Requirements for Drainage Infrastructure

TABLE 20.15 Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
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
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator 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 replace lost jointing material	As required
	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)
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, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Table 10: Maintenance Requirements for Pervious Pavements (Source: CIRIA SuDS Manual)

TABLE 18.3 Operation and maintenance requirements for bioretention systems

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular maintenance	Remove litter and surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

Table 11: Maintenance Requirements for Bioretention Systems (Source: CIRIA SuDS Manual)

Conclusions

GeoSon Limited have been instructed by Tim Cropper of Mialex, on behalf of Mike Rossi at Manor Hotel Best Western, to undertake a Surface Water Drainage Strategy (SWDS) to support a proposed planning application for construction of twelve residential dwellings at Manor Hotel, Hever Court Road, Gravesend.

The proposed planning application is for redevelopment of the site including internal reconfiguration of part of the existing hotel and construction of twelve new residential dwellings in the car park area.

The applicant has confirmed that the development is being submitted as two separate applications and that the site has been split into two parcels of land.

This surface water drainage strategy focuses on how surface water runoff will be managed from new impermeable surfacing introduced into the eastern parcel of land associated with the development of twelve new residential dwellings.

According to plans provided by the client the developable area of land in the eastern parcel measures approximately 2500m². Post development the total impermeable area at The Site will amount to approximately 1800m², comprising 707m² of roof area and 1093m² of hardstanding (paving and roads).

However, it is worth noting that The Site is classified as brownfield land and is already underlain by 1530m² of hardstanding, associated with the hotel car park. Therefore, the true increase in impermeable area as a result of the development will amount to only 270m².

Despite this, attenuation sizing within the strategy will be based on a total impermeable area of 1800m². As such, significant betterment will be provided post development when compared to the current situation.

It is proposed that all surface water runoff generated by newly introduced impermeable areas at the development will be conveyed and stored within 735m² of permeable paving located beneath the access road and parking bays.

Precipitation which lands on these areas will percolate through the paving surface and be stored within the gravel/geocellular storage sub-base. From the sub-base any stored water will be gradually discharged to ground.

Surface water runoff generated by the remaining impermeable surfacing comprising 707m² of roof areas and 358m² of external paving, will be directed towards the permeable paving sub-base via linear drains and subterranean pipework.

In the absence of in-situ testing, the minimum viable infiltration rate of 1×10^{-6} m/s has been used to base the sizing of permeable paving SuDS at the development. However, given that surface water runoff from the entire Manor Hotel site is already managed via a soakaway it is considered that use of the minimum viable rate is cautionary and true infiltration rates are likely to be higher. True infiltration rates should be determined by in-situ testing undertaken prior to detailed design.

The SuDS system has been designed to accommodate all surface water runoff generated by post development impermeable surfacing during the 1 in 100yr plus (40%) Climate Change event. As such, the SuDS system also has capacity to accommodate all runoff generated by the 1 in 30yr plus (35%) Climate Change rainfall event with no exceedance.

In addition to the permeable paving, there is the potential to incorporate raingardens within the proposals (considered an optional addition in this strategy). Should raingardens be included within the final design proposals the overall SuDS schemes will provide an attenuation storage capacity greater than what is required by policy.

The proposed permeable paving will provide adequate treatment for surface water runoff and is shown to have a higher mitigation index than the pollution hazard index for the development.

Appendix

- A. Existing Plans / Topographic Survey
- B. Development Proposals
- C. Southern Water Asset Location Search
- D. Calculation Sheets
 - ICP SUDS Greenfield Runoff Calculations
 - Modified Rational Method Brownfield Runoff Calculations
 - Innovyze InfoDrainage Permeable Paving Calculations
- E. Proposed SuDS Layout Plan

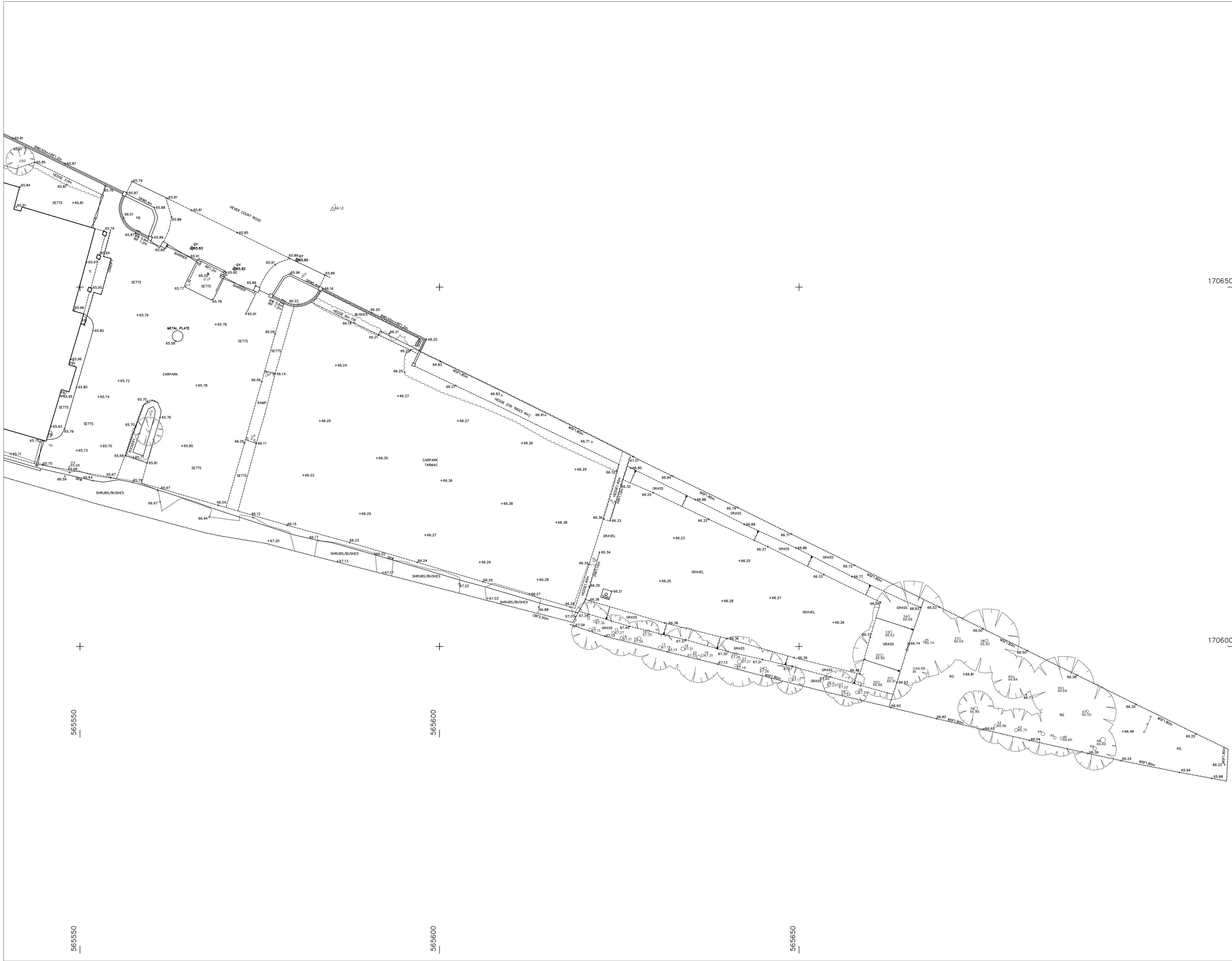
Appendix A

170600

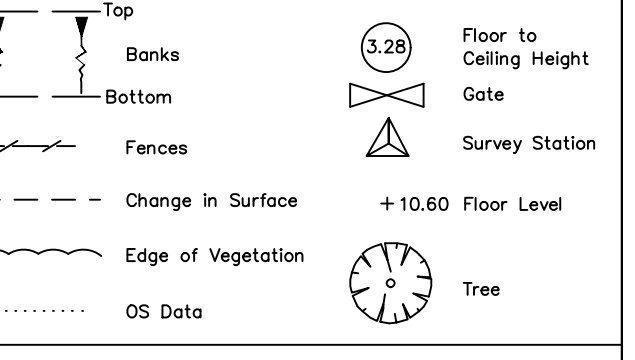
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2	565535.989	170683.571	65.788

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2. TREE TYPES SHOWN ON THIS DRAWING CANNOT BE GUARANTEED AND IF CRITICAL SHOULD BE VERIFIED BY A TREE SPECIALIST. TREE SPREADS ARE AVERAGES UNLESS OTHERWISE INDICATED. TREE HEIGHTS ARE APPROXIMATE.
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ABBREVIATIONS	
AB	Ap Brick
B	Brick
BAL	Balcony
BB	Beisha Beacon
BD	Beisha Beacon
BH	Borehole or Beam Height
BL	Bed Level
BP	Brick Pier
BRW	Brick Retaining Wall
BS	Bus Stop
BT	British Telecom
BW	Brick Wall
BWF	Barbed Wire Fence
C	Concrete
CAB	Cabinet
CBF	Close Boarded Fence
CBW	Concrete Block Wall
CF	Corrugated Iron Fence
CL	Cover Level
CLF	Chain Link Fence
COL	Column
CPF	Concrete Panel Fence
CPS	Concrete Paving Slabs
CRW	Concrete Retaining Wall
CSU	Ceiling Slopes Up
CTV	Cable Television
CW	Concrete Wall
CZY	Crazy Paving
D	Door
DHL	Door Head Level
DC	Drainage Channel
EC	Electricity Cover
EH	Eave Height
EP	Electricity Pole
FB	Flower Bed
FC	False Ceiling
F/E	Fire Escape
PH	Fire Hydrant
FL	Floor Level
FWS	Foul Water Sewer
GY	Gully
GV	Gas Valve
IC	Inspection Cover
IL	Invert Level
IRF	Iron Rolling Fence
IWF	Interwoven Fence
KO	Kerb Outlet
L	Light
LP	Lamp Post
MH	Manhole
MKR	Marker
MSF	Metall Security Fence
NA	No Access
OHC	Overhead Cables
P	Post
PAF	Palisade Fence
PF	Picket Fence
PIT	Triad Pit
PL	Pavement Light
PM	Parking Meter
PRF	Post & Rail Fence
PWF	Post & Wire Fence
R	Render
RH	Road Height
RE	Rodding Eye
RH	Ridge Height
RS	Road Sign
RWP	Rain Water Pipe
S	Stone
SV	Stop VALVE
SL	Soffit Level or Skylight
SP	Soil Pipe
SF	Stone Paving Slabs
SRW	Stone Retaining Wall
SW	Stone Wall
TAC	Tactile Paving
TJ	Top of Joist
T	Tile
TB	Telephone Box
TL	Traffic Light
UJ	Underside of Roof Joist
UR	Underside of Ridge Board
UWP	Underside of Wall Plate
V	Vent
VP	Vent Pipe
W	Window
WL	Water Level
WM	Water Meter
WMF	Wire Mesh Fence
WPF	Wooden Panel Fence
WCL	Window Cill Level
WHL	Window Head Level
WRW	Wooden Retaining Wall



STATION CO-ORDINATE TABLE			
Ref.	East	North	Elevation
1	565585.118	170660.830	66.122
2	565535.989	170683.571	65.788

- NOTES**
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REVISIONS	DATE
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A MEMBER OF
THE SURVEY ASSOCIATION

SCALE: 1:250@A1

DATE: DECEMBER 2017

DRAWN: JL / GR

JOB No:

TITLE: SITE SURVEY
SHEET 2 OF 2

JOB: THE MANOR HOTEL, GRAVESEND

CLIENT: MR MIKE ROSSI

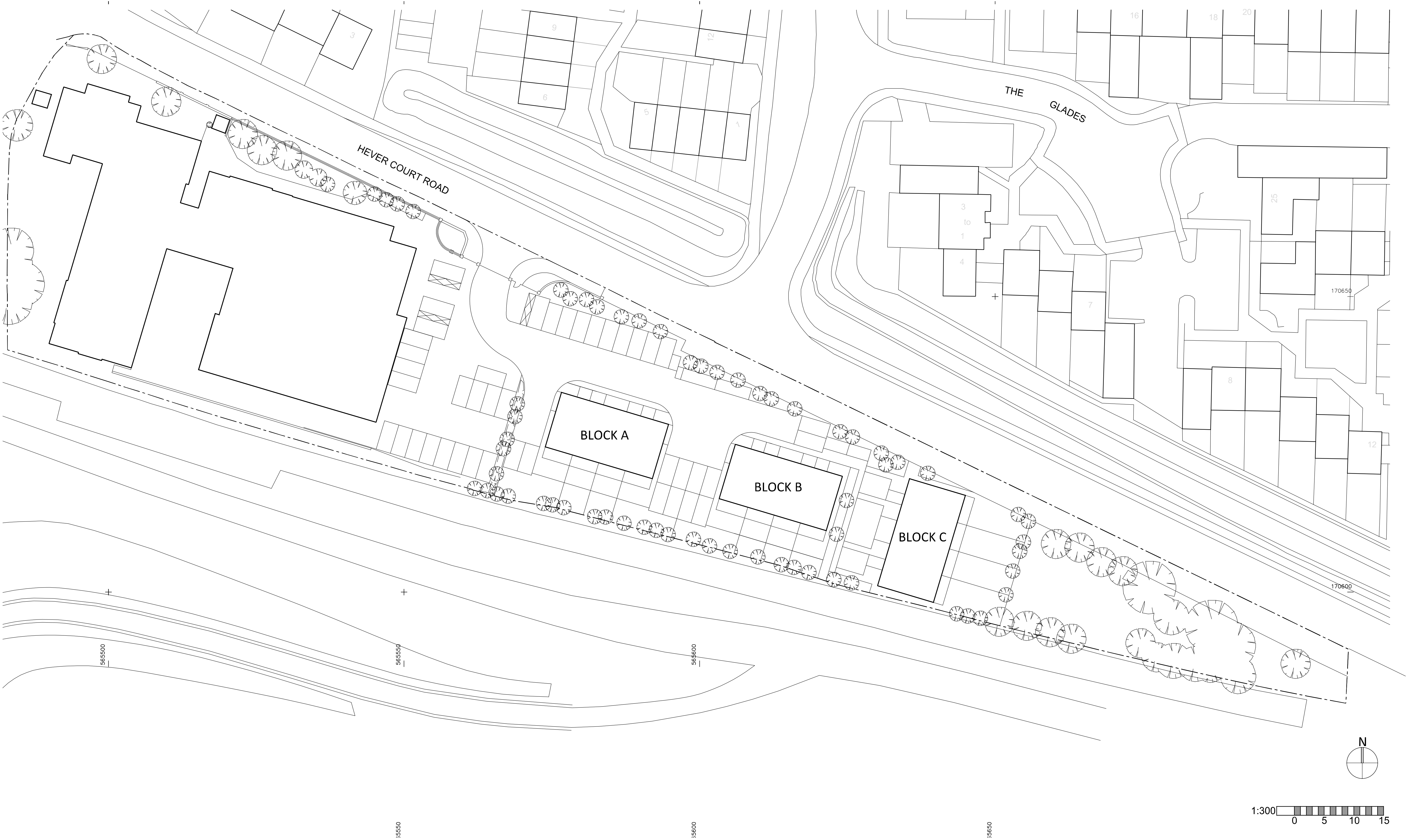
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Appendix B



New Housing
The Manor Hotel Hever Court Road
As proposed block plan

DRAWING STATUS

Preliminary ☐
For Approval ☒
Information ☐

Tender ☐
Construction ☐
As-Built ☐

Revisions

Project	New Housing
Client	Manor Hotel
Site	The Manor Hotel Hever Court Road
Title	As proposed block plan
Scale at A1	1:300
Date	Mar 22

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architecture

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DRAWING NUMBER

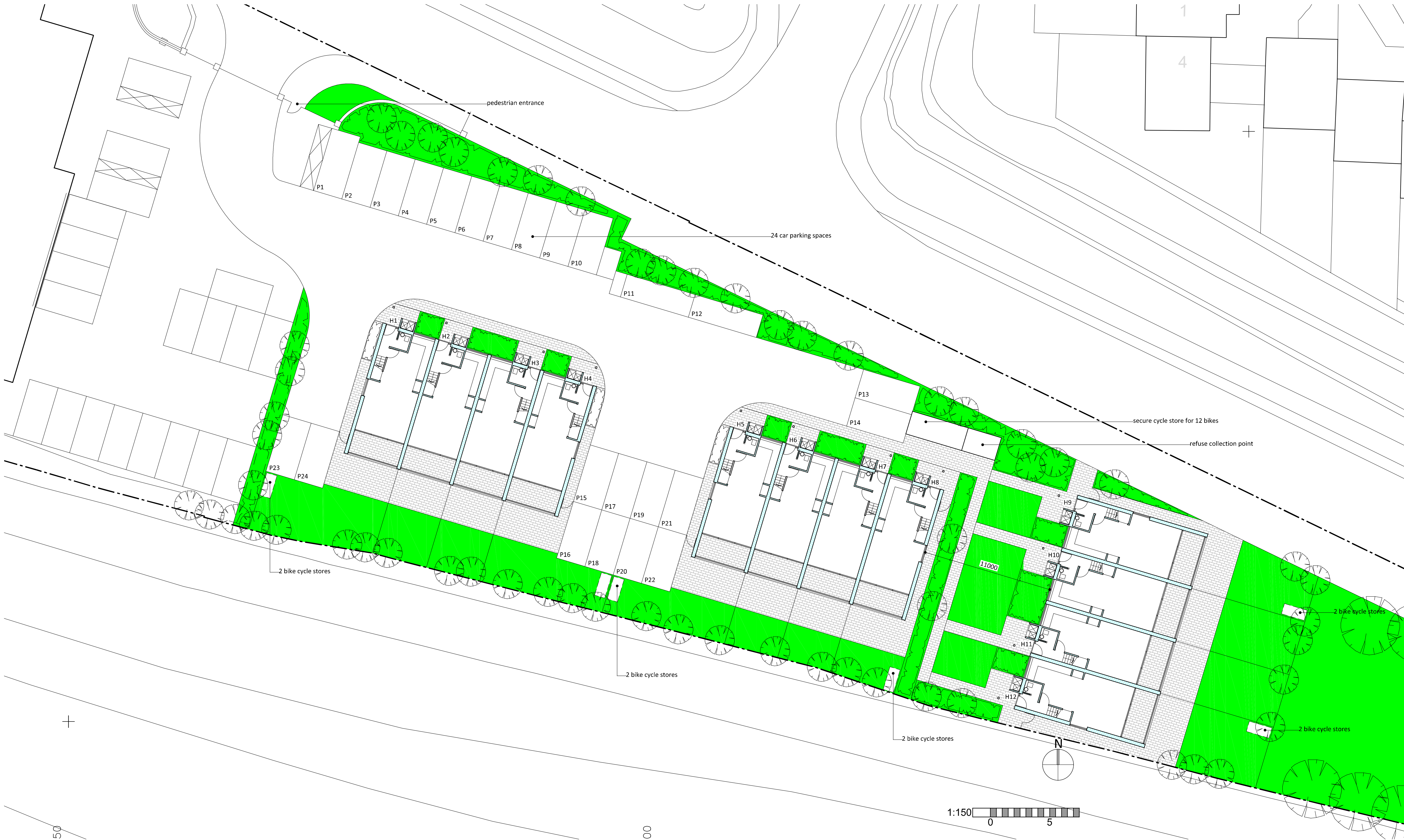
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New Housing
The Manor Hotel Hever Court Road
As proposed block plan ground

DRAWING STATUS

Preliminary ☐
For Approval ☒
Information ☐

Tender ☐
Construction ☐
As-Built ☐

Revisions

Project

New Housing
Manor Hotel
The Manor Hotel Hever Court Road
As proposed block plan ground
1:150
Mar 22

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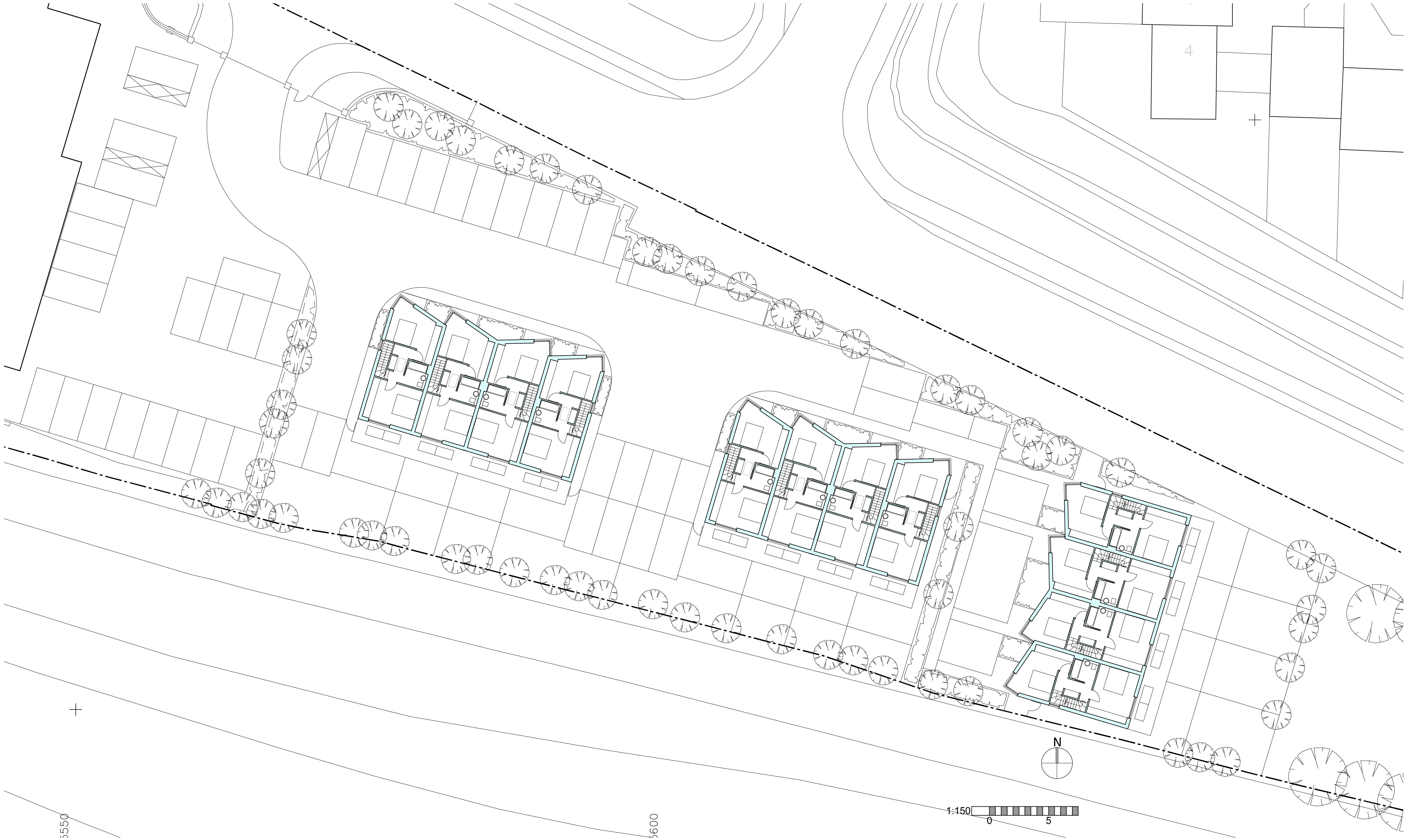
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New Housing
The Manor Hotel Hever Court Road
As proposed block plan first floor

DRAWING STATUS

Preliminary ☐
For Approval ☒
Information ☐

Tender ☐
Construction ☐
As-Built ☐

Revisions

Project

New Housing
Manor Hotel
The Manor Hotel Hever Court Road
As proposed block plan first floor
1:150
Mar 22

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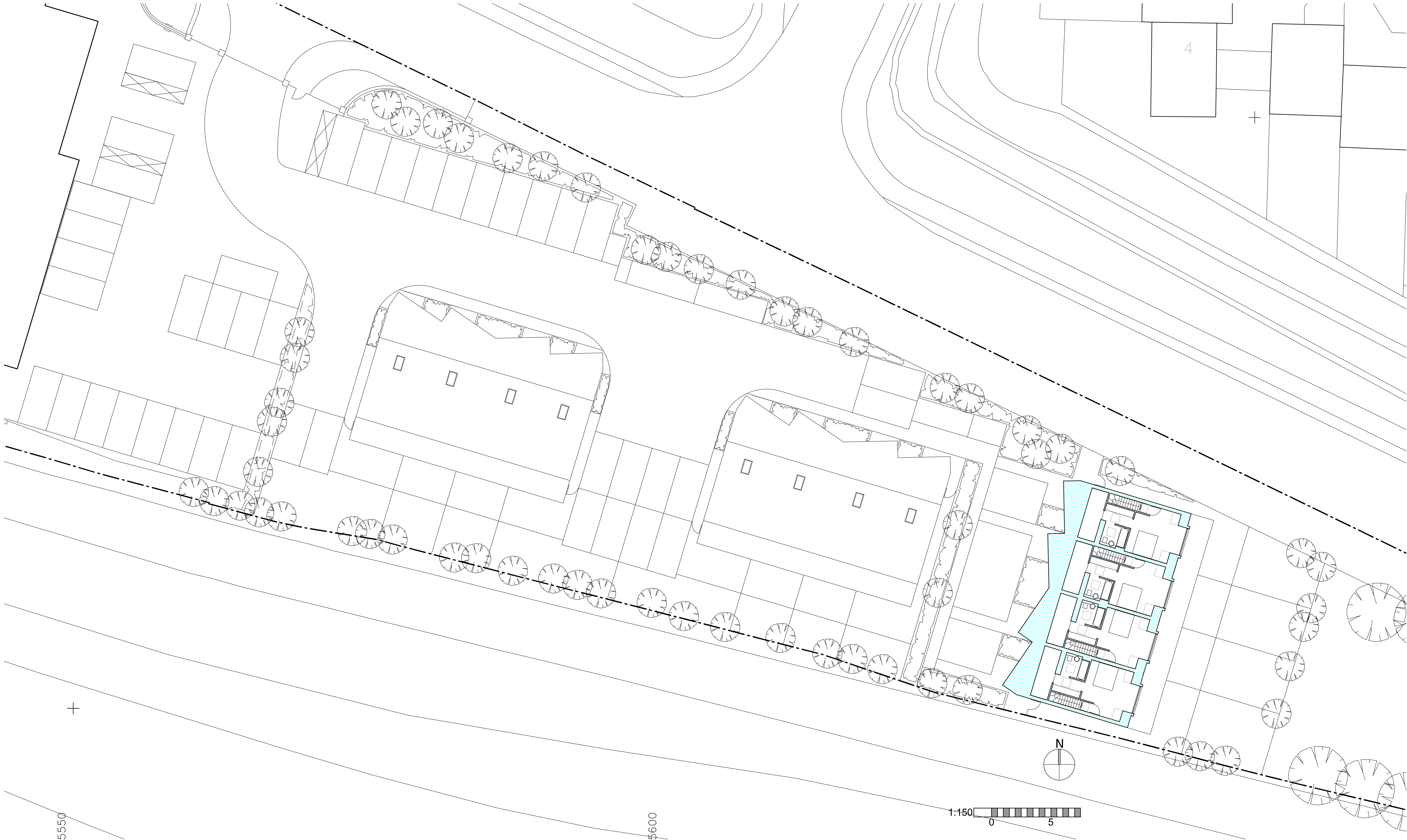
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New Housing
The Manor Hotel Hever Court Road
As proposed block plan roof level

DRAWING STATUS

Preliminary ☐
For Approval ☒
Information ☐

Tender ☐
Construction ☐
As-Built ☐

Revisions

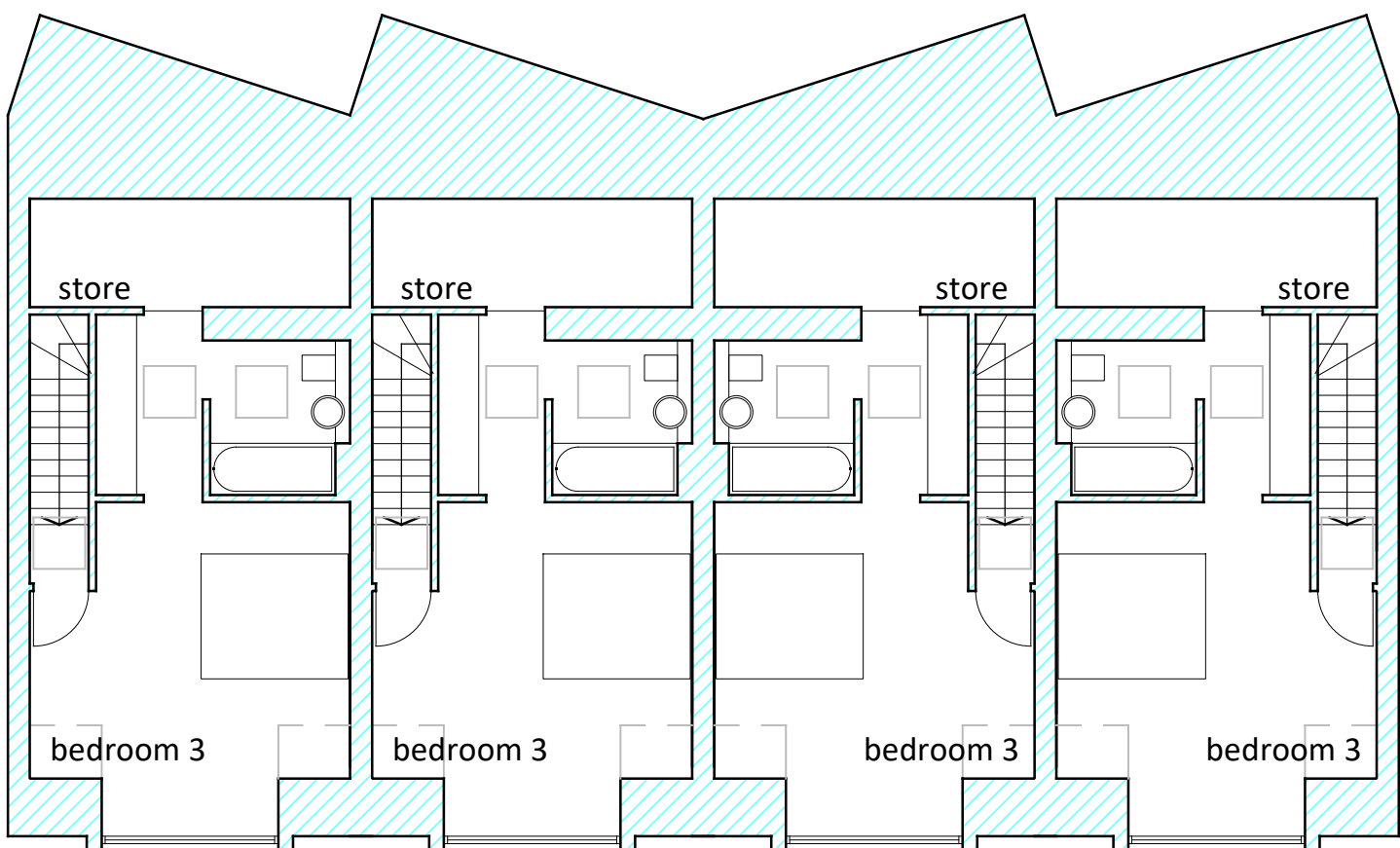
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Client New Housing
Site Manor Hotel
Title The Manor Hotel Hever Court Road
Scale at A1 As proposed block plan roof level
Date 1:150
Sept 22

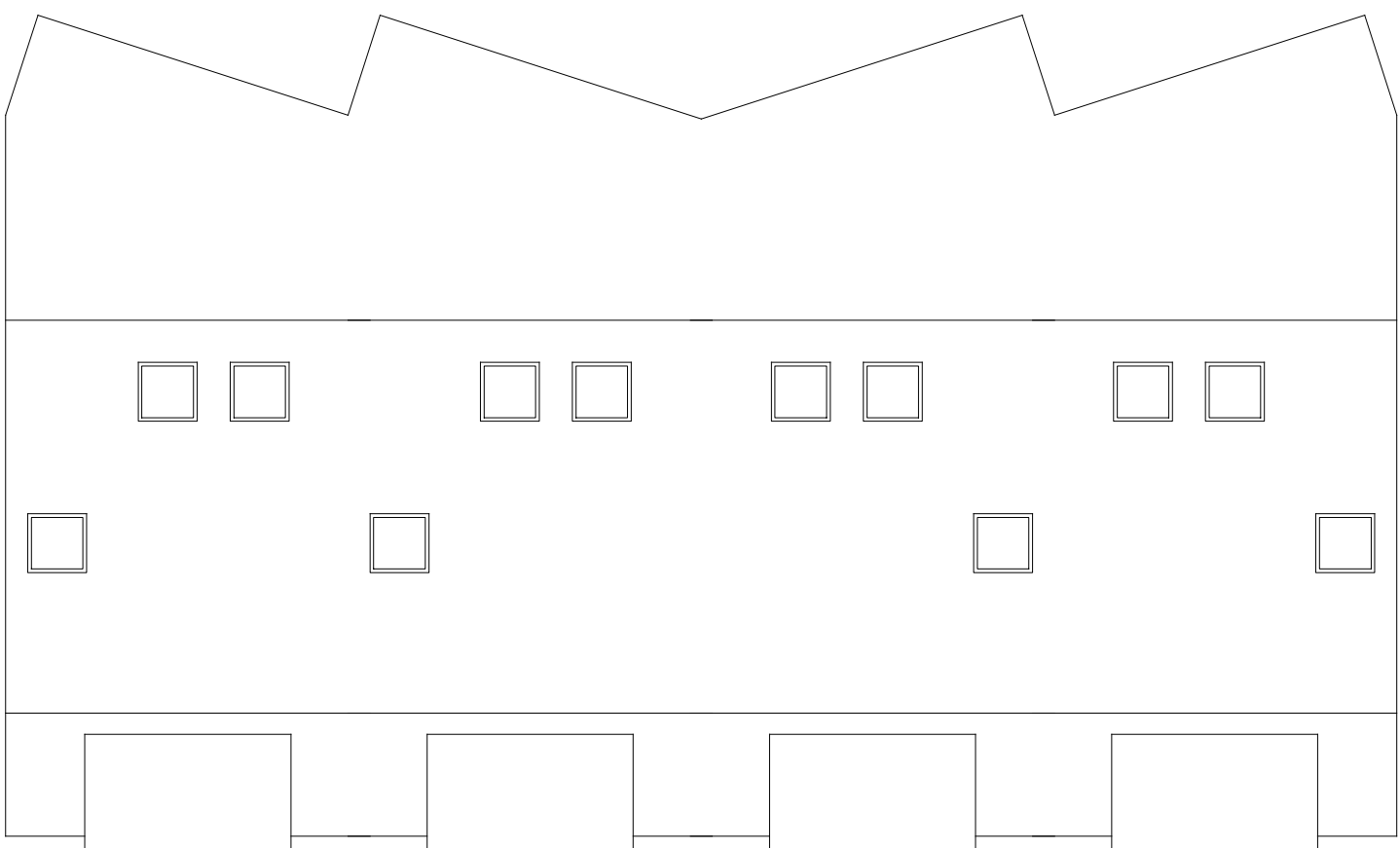
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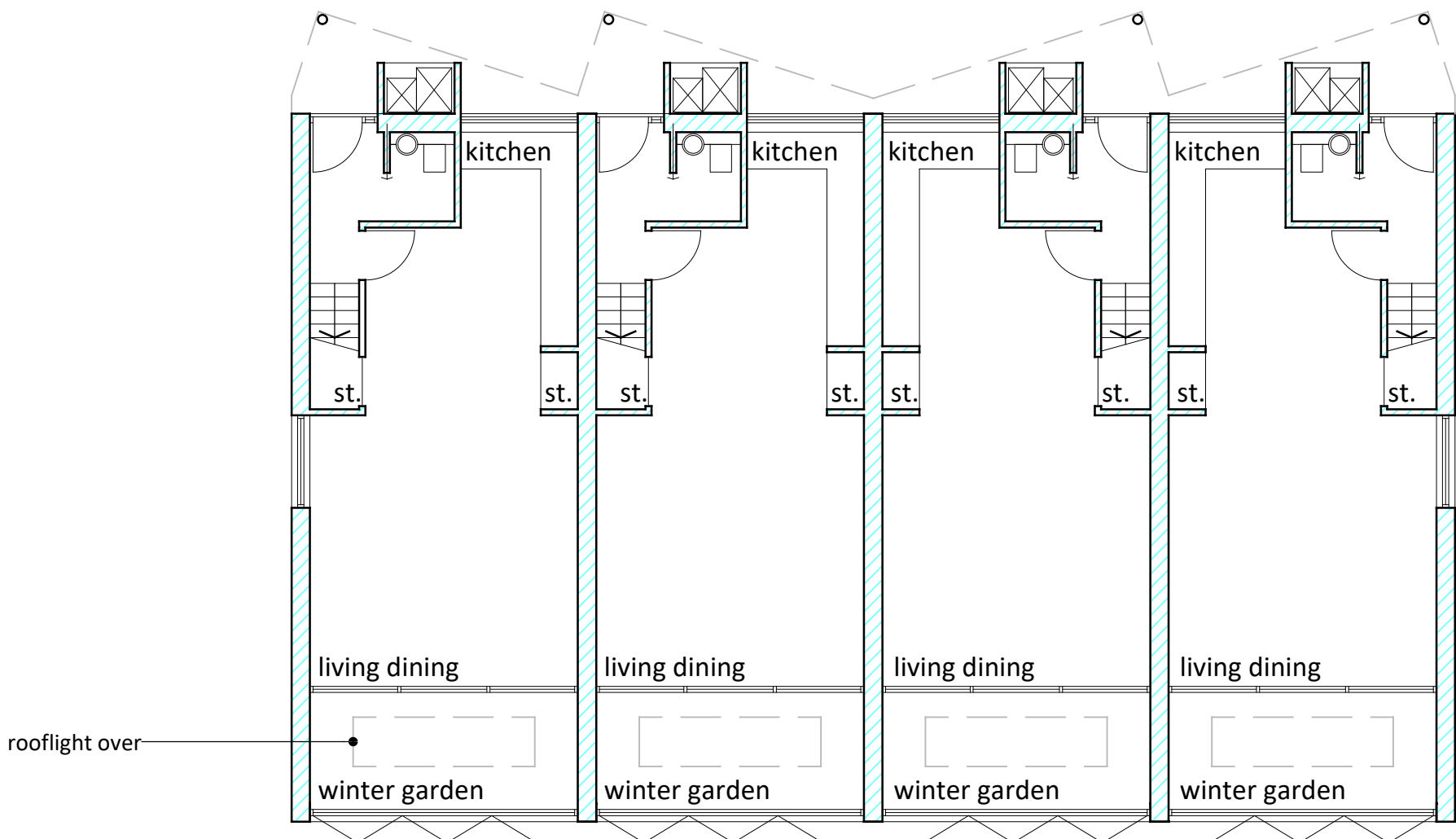
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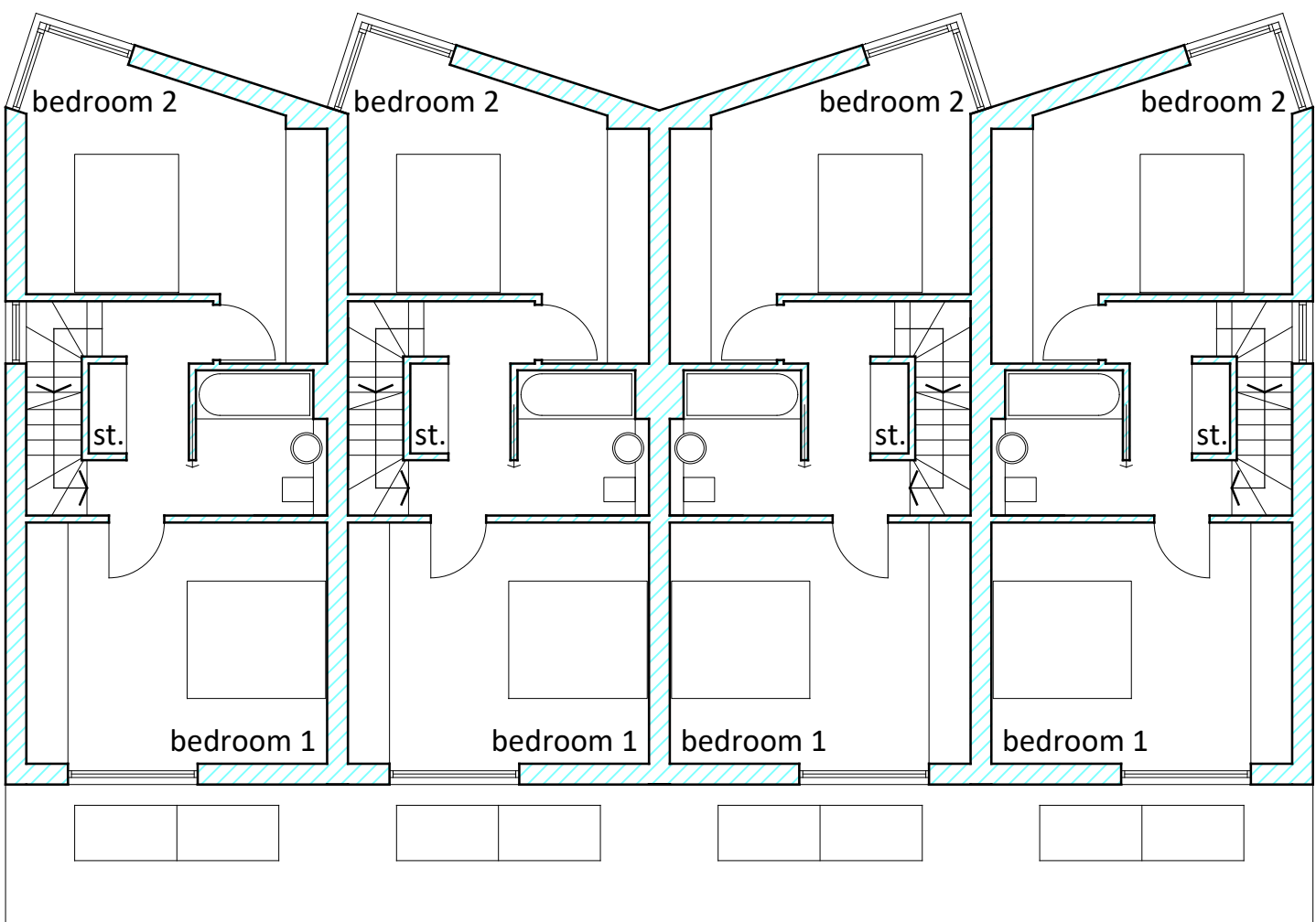
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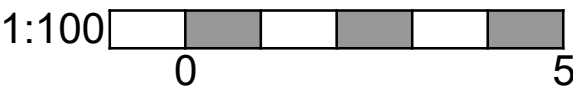
Block C roof plan



Block C ground plan



Block C first floor plan

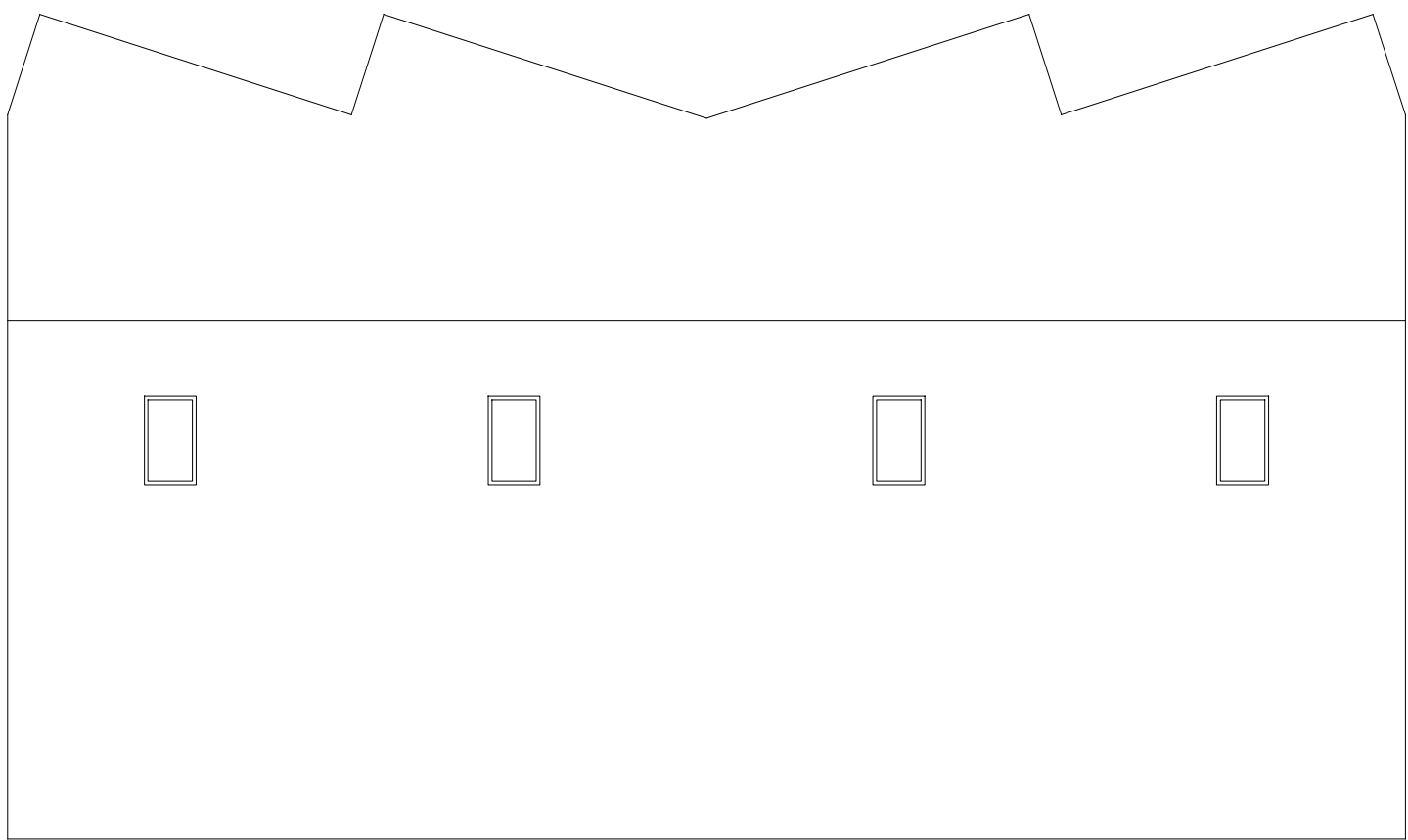


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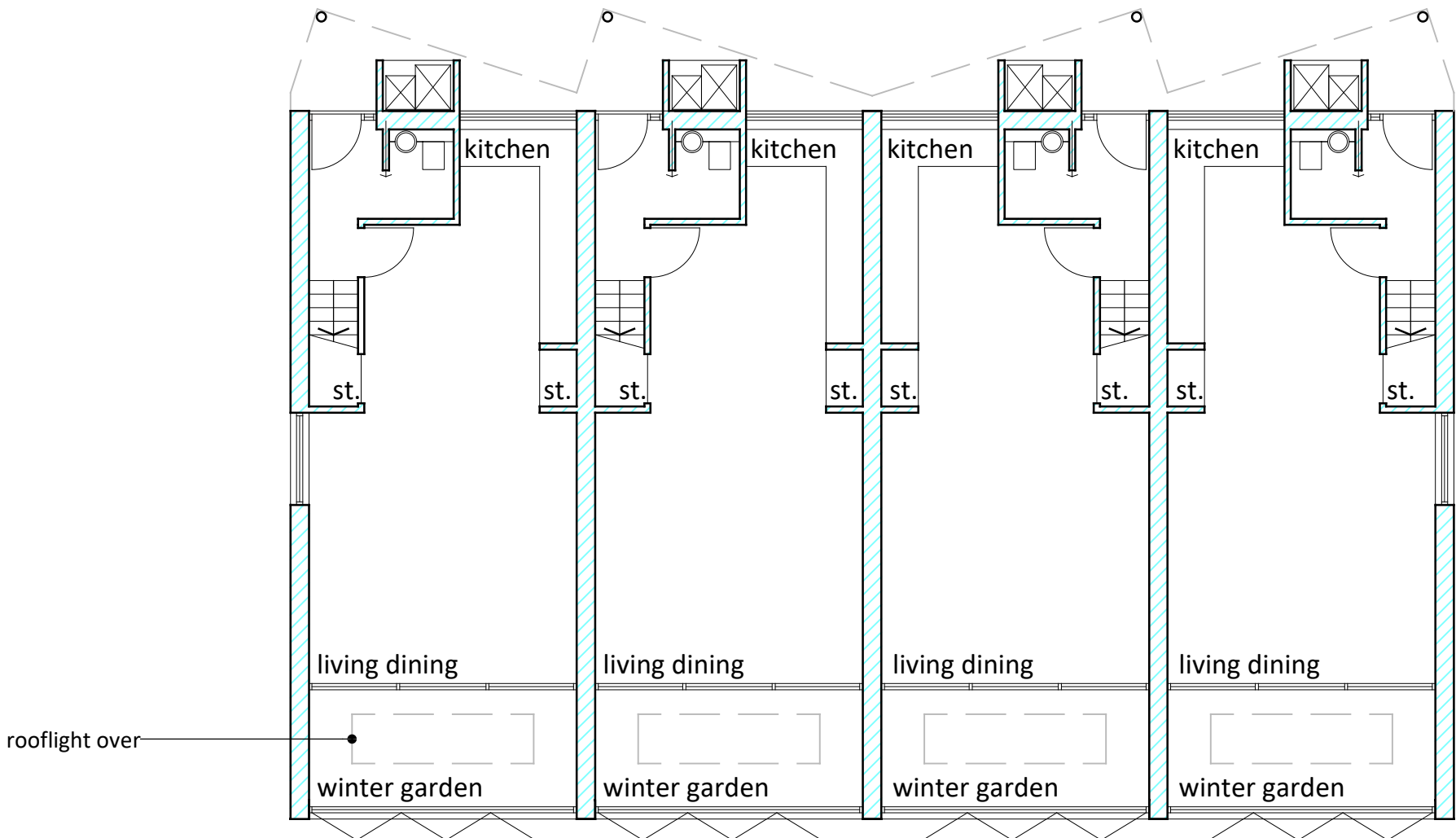
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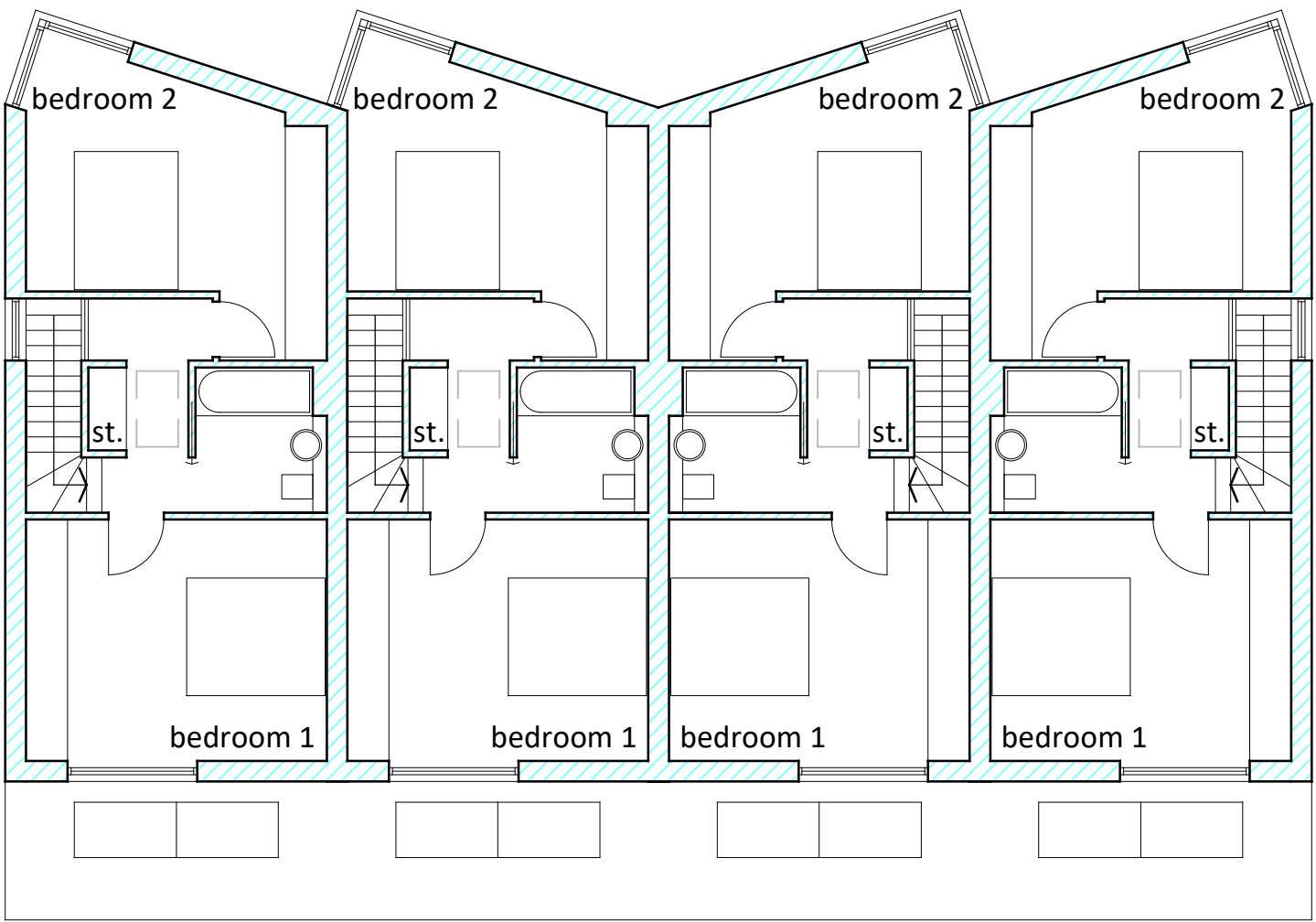
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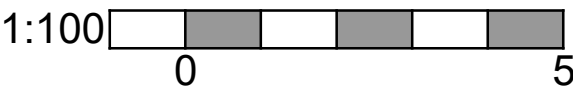
Block A+B roof floor plan



Block A+B ground plan



Block A+B first floor plan



New Housing
The Manor Hotel Hever Court Road
As proposed house plans

DRAWING STATUS

Preliminary ☐
For Approval ☒
Information ☐

Tender ☐
Construction ☐
As-Built ☐

Revisions

Project

New Housing

Client

Manor Hotel

Site

The Manor Hotel Hever Court Road

Title

As proposed house plans

Scale at A1

1:100

Date

Jun 21

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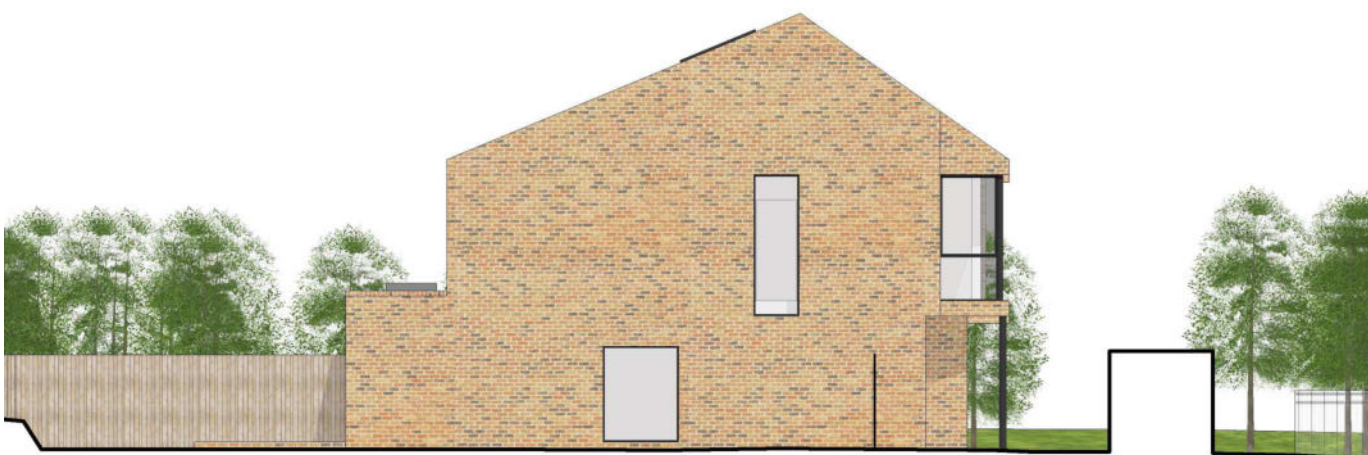
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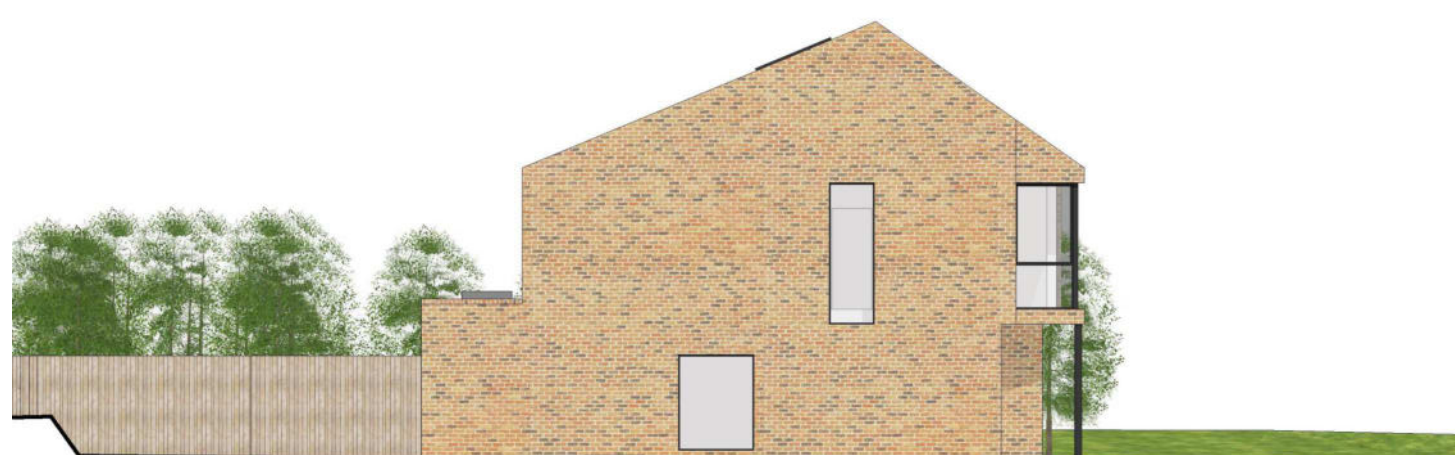
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E1 east elevation



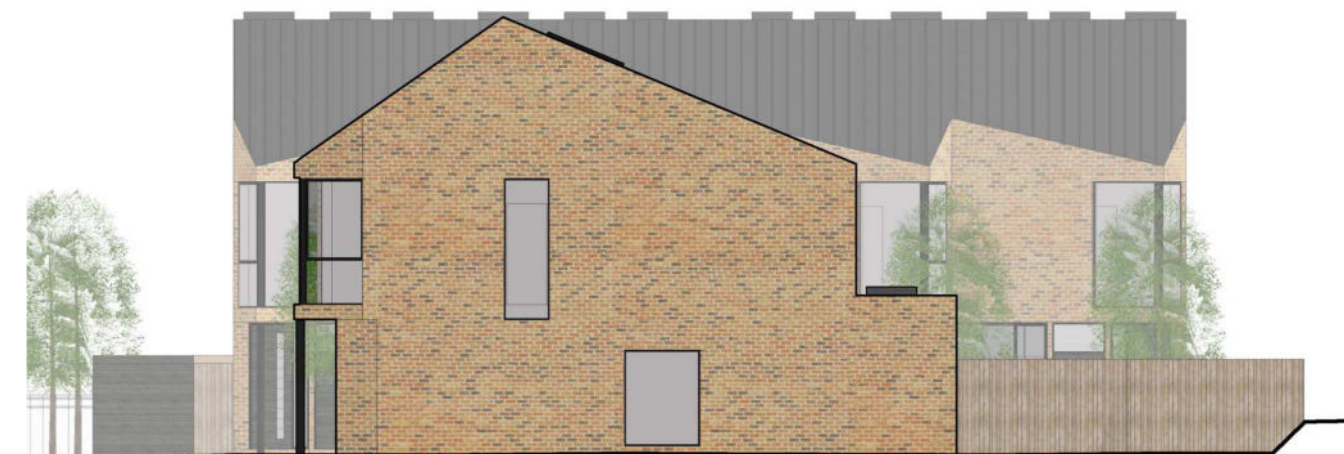
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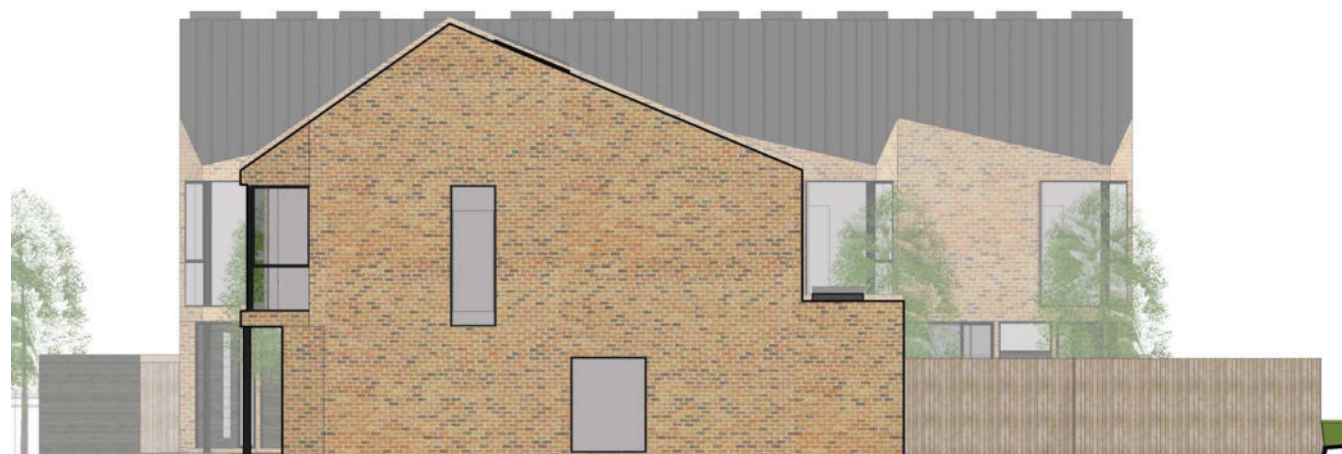
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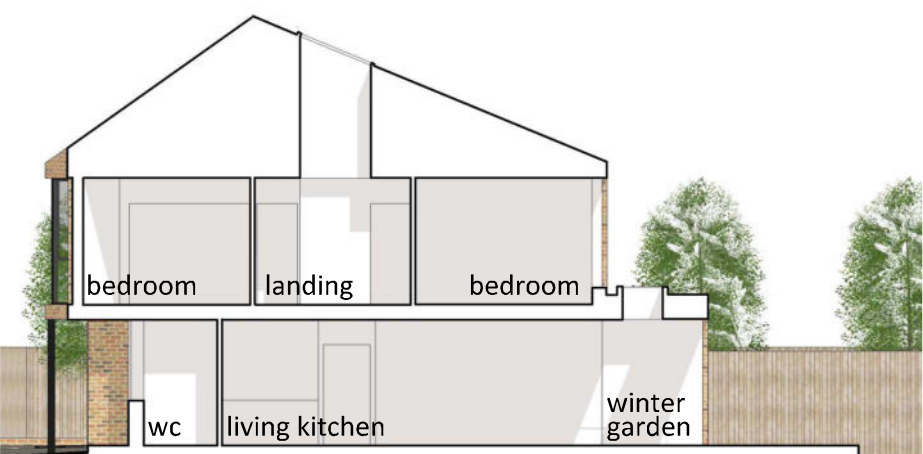
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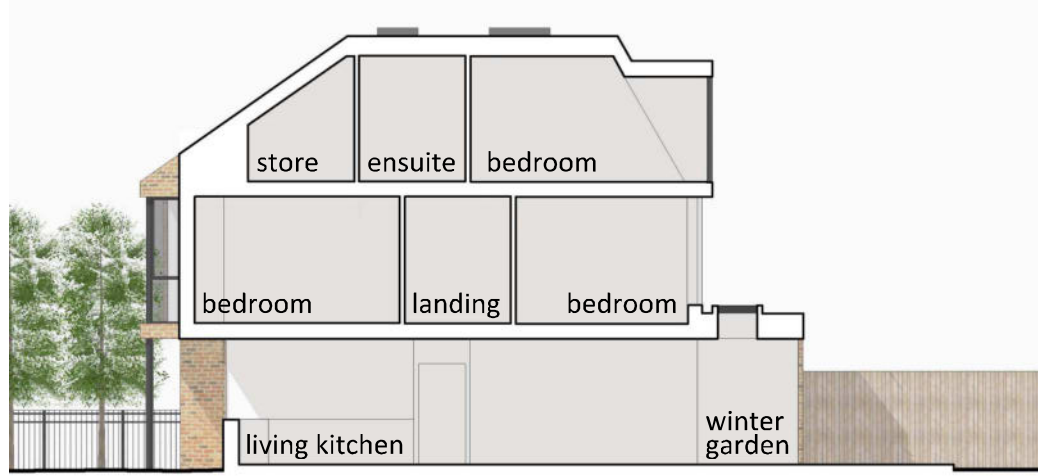
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W3 west elevation

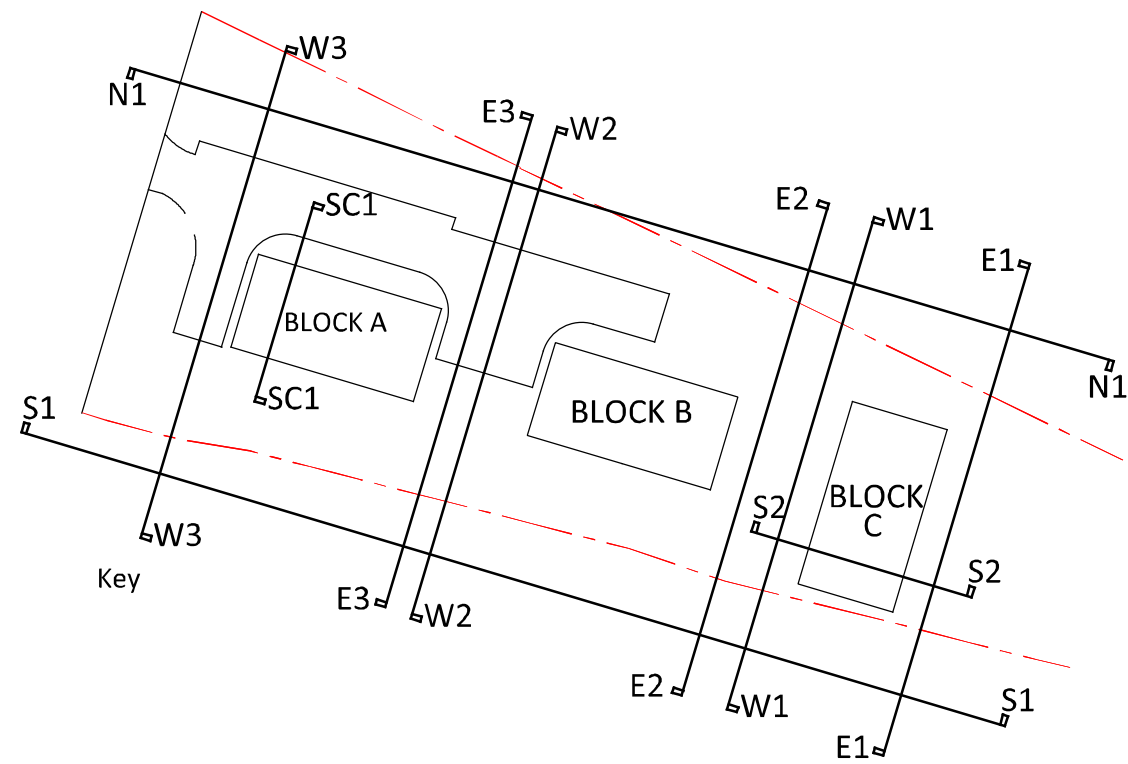


SC1 section 1



SC2 section 2

1:150
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New Housing
The Manor Hotel Hever Court Road
Elevations and section

DRAWING STATUS

Preliminary ☐
For Approval ☒
Information ☐

Tender ☐
Construction ☐
As-Built ☐

Revisions

Project

New Housing

Client

Manor Hotel

Site

The Manor Hotel Hever Court Road

Title

Elevations and section

Scale at A1

1:150

Date

Mar 22

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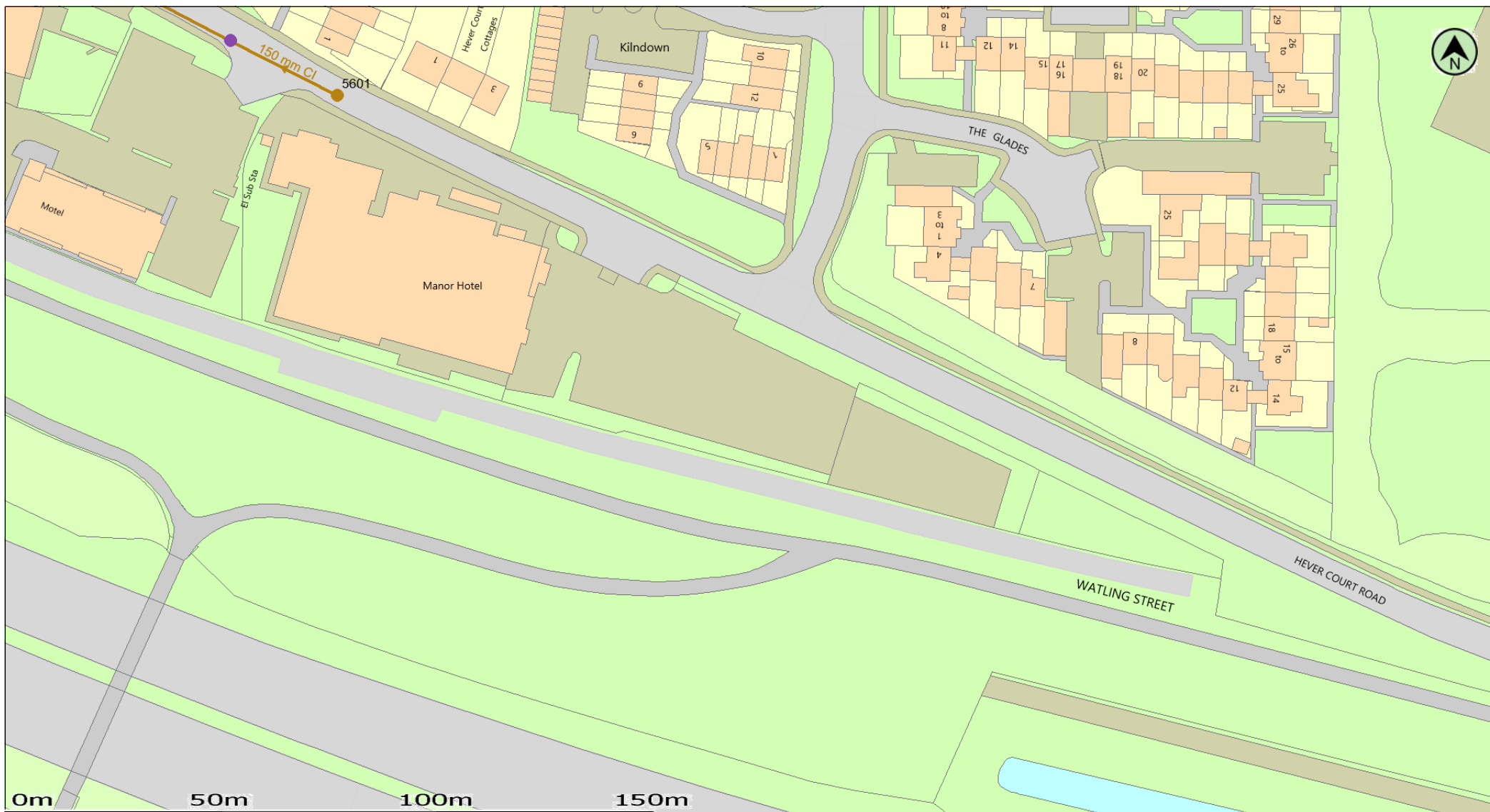
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Appendix C



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Date: 06/04/23

Scale: 1:1250

Map Centre: 565601,170620

Data updated: 21/03/23

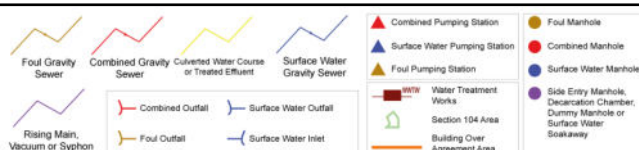
Our Ref: 1139777 - 1

Wastewater Plan A4

The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site. This plan is produced by Southern Water Services Ltd (c) Crown copyright and database rights 2023 Ordnance Survey 100031673. This map is to be used for the purposes of viewing the location of Southern Water plant only. Any other uses of the map data or further copies is not permitted.

WARNING: BAC pipes are constructed of Bonded Asbestos Cement.

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement.



tom@geoson.co.uk
73050



Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
0001	F	0.00	0.00		1008	F	51.66	50.56		2403	F	74.40	73.84		8701	F	0.00	0.00		0953	S	0.00	0.00																
0001	F	0.00	0.00		1009	F	51.84	50.52		2404	F	0.00	0.00		8702	F	0.00	0.00		0954	S	0.00	0.00																
0002	F	0.00	0.00		1010	F	53.38	0.00		2405	F	75.57	72.64		8703	F	0.00	0.00		0955	S	0.00	0.00																
0003	F	0.00	0.00		1011	F	55.24	54.75		2406	F	75.69	72.67		8704	F	0.00	0.00		0956	S	0.00	0.00																
0003	F	0.00	0.00		1012	F	56.26	55.22		2407	F	0.00	72.47		8705	F	0.00	0.00																					
0004	F	0.00	0.00		1101	F	59.28	58.73		2408	F	75.63	73.31		8706	F	0.00	0.00																					
0004	F	0.00	0.00		1102	F	59.18	58.37		2501	F	69.80	68.42		8707	F	0.00	0.00																					
0005	F	0.00	0.00		1103	F	58.82	57.82		2502	F	72.73	71.46		8708	F	0.00	0.00																					
0005	F	0.00	0.00		1104	F	57.33	56.43		2503	F	0.00	0.00		8709	F	0.00	0.00																					
0006	F	47.42	47.42		1105	F	59.62	58.84		2601	F	0.00	0.00		8710	F	0.00	0.00																					
0006	F	0.00	0.00		1106	F	58.15	57.57		2602	F	0.00	0.00		8711	F	0.00	0.00																					
0007	F	62.81	60.40		1107	F	57.19	56.38		2603	F	0.00	0.00		8712	F	0.00	0.00																					
0007	F	47.95	47.20		1108	F	65.05	64.58		2604	F	67.12	65.45		8713	F	0.00	0.00																					
0008	F	47.36	47.07		1109	F	64.99	64.25		2605	F	54.93	52.98		8714	F	0.00	0.00																					
0008	F	63.24	60.70		1110	F	64.83	64.20		2701	F	52.35	50.19		8801	F	55.96	0.00																					
0009	F	0.00	0.00		1111	F	64.35	0.00		2702	F	50.49	48.98		8902	F	55.13	53.71																					
0009	F	0.00	0.00		1112	F	0.00	0.00		2703	F	53.79	52.39		8903	F	53.20																						
0010	F	48.48	47.93		1201	F	0.00	0.00		2704	F	52.02	50.92		8804	F	54.98	52.45																					
0011	F	47.38	0.00		1204	F	0.00	0.00		2705	F	54.97	52.72		8805	F	54.57	52.75																					
0012	F	48.54	0.00		1205	F	65.68	64.70		2801	F	65.73	64.37		8806	F	0.00	0.00																					
0013	F	48.49	48.95		1206	F	0.00	0.00		2801	F	0.00	0.00		8807	F	0.00	0.00																					
0014	F	53.96	52.46		1207	F	0.00	0.00		2802	F	49.98	49.61		8901	F	54.46	54.46																					
0015	F	52.66	51.71		1208	F	64.80	64.14		2802	F	65.69	64.62		8902	F	57.34	55.77																					
0016	F	48.74	47.96		1209	F	64.61	64.00		2803	F	0.00	0.00		8903	F	0.00	0.00																					
0101	F	61.99	59.43		1210	F	64.54	63.94		2803	F	49.53	48.23		8904	F	0.00	0.00																					
0101	F	47.85	0.00		1211	F	64.49	63.85		2804	F	0.00	0.00		8905	F	0.00	0.00																					
0102	F	62.41	59.74		1212	F	64.68	63.52		2804	F	50.41	48.70		8906	F	0.00	0.00																					
0102	F	48.82	0.00		1213	F	0.00	0.00		2805	F	0.00	0.00		8907	F	0.00	0.00																					

Appendix D

Calculated by:	Thomas Smith	Site Details	
Site name:	73050 - Manor Hotel Gravesend		
Site location:	Development Area (2500m2)		
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.		Latitude:	51.41046° N
		Longitude:	0.37978° E
		Reference:	4004381956
		Date:	May 26 2023 16:28

Runoff estimation approach

IH124

Site characteristics

Total site area (ha):

0.25

Methodology

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

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.

Soil characteristics

	Default	Edited
SOIL type:	1	1
HOST class:	N/A	N/A
SPR/SPRHOST:	0.1	0.1

(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.

Hydrological characteristics

	Default	Edited
SAAR (mm):	610	610
Hydrological region:	7	7
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

(3) Is $SPR/SPRHOST \leq 0.3$?

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):	0.04	0.04
1 in 1 year (l/s):	0.03	0.03
1 in 30 years (l/s):	0.08	0.08
1 in 100 year (l/s):	0.11	0.11
1 in 200 years (l/s):	0.13	0.13

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.

Modified Rational Method Calculation Sheet

$$Q_p = C_i A / 0.36$$

	T (Return Period)		
	1 in 1 year	1 in 30 year	1 in 100 year
Q _p (l/s)	16.10	40.18	51.04
C	1.30	1.30	1.30
ARF x i (mm/hr)	29.14	72.72	92.38
A (ha)	0.153	0.153	0.153

Modified Rational Method Workings for the 15-Minute Storm Duration:

	1 in 1 year	1 in 30 year	1 in 100 year
Determination of C			
C _v	1.00	1.00	1.00
C _r	1.30	1.30	1.30
C	1.30	1.30	1.30
Determination of i			
M5-60min (mm)	20	20	20
r	0.407	0.407	0.407
D (mins)	15	15	15
T (yrs)	1	30	100
Determination of M5-D			
Z ₁	0.63	0.63	0.63
M5-D (mm)	12.60	12.60	12.60
Determination of MT-D			
Z ₂	0.615	1.535	1.950
MT-D (mm)	7.749	19.341	24.570

	<i>Determination of point rainfall intensities</i>		
i (mm/hr)	30.996	77.364	98.280
	<i>Application of areal reduction factor</i>		
ARF	0.94	0.94	0.94
i (mm/hr)	29.14	72.72	92.38

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 30year +35% CC Event	Date: 25/05/2023			
Report Details: Type: Inflows Storm Phase: Phase	Designed by: TS	Checked by:	Approved By:	
	Company Address: GeoSon Limited			



Catchment Area

Type : Catchment Area

Area (ha)	0.187
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Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.750
Winter Volumetric Runoff	0.840
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 30year +35% CC Event		Date: 25/05/2023			
Report Details: Type: Stormwater Controls Storm Phase: Phase		Designed by: TS	Checked by:		Approved By:
		Company Address: GeoSon Limited			



Porous Paving

Type : Porous Paving

Dimensions

Exceedance Level (m)	66.240
Depth (m)	0.530
Base Level (m)	65.710
Paving Layer Depth (mm)	130
Membrane Percolation (m/hr)	1.0
Porosity (%)	78.75
Length (m)	36.750
Long. Slope (1:X)	1000.00
Width (m)	20.000
Total Volume (m³)	231.525

Inlets

Inlet

Inlet Type	Lateral Inflow
Incoming Item(s)	Catchment Area
Bypass Destination	(None)
Capacity Type	No Restriction

Advanced

Base Infiltration Rate (m/hr)	0.0036
Safety Factor	2.0
Conductivity (m/hr)	50.0

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 30year +35% CC Event	Date: 25/05/2023					
Report Title: Rainfall Analysis Criteria	Designed by: TS <table border="1" style="display: inline-table; vertical-align: top;"> <tr> <td>Checked by:</td> <td>Approved By:</td> </tr> <tr> <td> </td> <td> </td> </tr> </table>		Checked by:	Approved By:		
Checked by:	Approved By:					
	Company Address: GeoSon Limited					

Runoff Type	Dynamic
Output Interval (mins)	5
Time Step	Default
Urban Creep	Apply Global Value
Urban Creep Global Value (%)	0
Junction Flood Risk Margin (mm)	300
Perform No Discharge Analysis	☐

Rainfall		
FEH	Type: FEH	
Site Location	GB 566000 171000 TQ 66000 71000	
Rainfall Version	2013	
Data Type	Catchment	
Summer	☒	
Winter	☒	

Return Period	
Return Period (years)	Increase Rainfall (%)
30.0	35.000
Storm Durations	

Duration (mins)	Run Time (mins)
15	30
30	60
60	120
120	240
180	360
240	480
360	720
480	960
600	1200
720	1440
960	1920
1440	2880
2160	4320
2880	5760
4320	8640
5760	11520
7200	14400
8640	17280
10080	20160

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 30year +35% CC Event	Date: 25/05/2023			
	Designed by:	Checked by:	Approved By:	
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase	TS			
	Company Address: GeoSon Limited			



Summary Results for Porous Paving: Rank By: Max. Avg. Depth

Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Residual Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
FEH: 30 years: +35 %: 15 mins: Summer	65.815	65.778	0.068	0.068	88.3	39.369	0.000	0.660	0.0	0.000	952	82.996	OK
FEH: 30 years: +35 %: 15 mins: Winter	65.823	65.786	0.076	0.076	93.1	44.140	0.000	0.660	0.0	0.000	1063	80.935	OK
FEH: 30 years: +35 %: 30 mins: Summer	65.834	65.798	0.088	0.088	59.6	50.878	0.000	1.320	0.0	0.000	1595	78.025	OK
FEH: 30 years: +35 %: 30 mins: Winter	65.845	65.809	0.098	0.099	62.7	57.081	0.000	1.321	0.0	0.000	1758	75.346	OK
FEH: 30 years: +35 %: 60 mins: Summer	65.855	65.819	0.108	0.109	51.2	62.611	0.000	2.642	0.0	0.000	1799	72.957	OK
FEH: 30 years: +35 %: 60 mins: Winter	65.868	65.832	0.121	0.122	46.1	70.298	0.000	2.641	0.0	0.000	1935	69.637	OK
FEH: 30 years: +35 %: 120 mins: Summer	65.877	65.842	0.131	0.132	37.5	76.161	0.000	5.286	0.0	0.000	2028	67.105	OK
FEH: 30 years: +35 %: 120 mins: Winter	65.894	65.859	0.147	0.149	30.2	85.635	0.000	5.281	0.0	0.000	2184	63.013	OK
FEH: 30 years: +35 %: 180 mins: Summer	65.891	65.857	0.144	0.147	29.6	84.375	0.000	7.930	0.0	0.000	2151	63.557	OK
FEH: 30 years: +35 %: 180 mins: Winter	65.909	65.876	0.163	0.166	22.9	95.005	0.000	7.918	0.0	0.000	2337	58.965	OK
FEH: 30 years: +35 %: 240 mins: Summer	65.900	65.867	0.154	0.157	24.7	90.026	0.000	10.574	0.0	0.000	2239	61.116	OK
FEH: 30 years: +35 %: 240 mins: Winter	65.920	65.887	0.173	0.177	18.6	101.493	0.000	10.551	0.0	0.000	2449	56.163	OK
FEH: 30 years: +35 %: 360 mins: Summer	65.912	65.881	0.165	0.171	18.6	97.116	0.000	15.863	0.0	0.000	2350	58.054	OK
FEH: 30 years: +35 %: 360 mins: Winter	65.933	65.903	0.187	0.193	13.7	109.871	0.000	15.814	0.0	0.000	2600	52.545	OK

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 30year +35% CC Event						Date: 25/05/2023											
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase						Designed by: TS								Checked by:		Approved By:	
						Company Address: GeoSon Limited											

FEH: 30 years: +35 %: 480 mins: Summer	65.918	65.889	0.171	0.179	15.2	101.34 4	0.000	21.152	0.0	0.000	2418	56.228	OK
FEH: 30 years: +35 %: 480 mins: Winter	65.941	65.913	0.194	0.203	11.0	114.94 0	0.000	21.066	0.0	0.000	2692	50.355	OK
FEH: 30 years: +35 %: 600 mins: Summer	65.922	65.894	0.175	0.184	12.8	104.01 1	0.000	26.441	0.0	0.000	2459	55.076	OK
FEH: 30 years: +35 %: 600 mins: Winter	65.946	65.919	0.199	0.209	9.2	118.27 0	0.000	26.335	0.0	0.000	2753	48.917	OK
FEH: 30 years: +35 %: 720 mins: Summer	65.924	65.898	0.177	0.188	11.0	105.67 6	0.000	31.731	0.0	0.000	2482	54.357	OK
FEH: 30 years: +35 %: 720 mins: Winter	65.949	65.924	0.202	0.214	8.0	120.52 7	0.000	31.594	0.0	0.000	2794	47.942	OK
FEH: 30 years: +35 %: 960 mins: Summer	65.925	65.902	0.178	0.192	8.7	107.14 0	0.000	42.310	0.0	0.000	2497	53.724	OK
FEH: 30 years: +35 %: 960 mins: Winter	65.952	65.930	0.205	0.220	6.3	122.95 7	0.000	42.099	0.0	0.000	2836	46.893	OK
FEH: 30 years: +35 %: 1440 mins: Summer	65.922	65.903	0.175	0.193	6.3	106.68 3	0.000	63.469	0.0	0.000	2466	53.921	OK
FEH: 30 years: +35 %: 1440 mins: Winter	65.951	65.934	0.205	0.224	4.5	124.09 7	0.000	63.068	0.0	0.000	2847	46.400	OK
FEH: 30 years: +35 %: 2160 mins: Summer	65.912	65.897	0.166	0.187	4.5	102.00 6	0.000	95.209	0.0	0.000	2346	55.942	OK
FEH: 30 years: +35 %: 2160 mins: Winter	65.945	65.932	0.198	0.222	3.3	121.64 0	0.000	94.380	0.0	0.000	2781	47.462	OK
FEH: 30 years: +35 %: 2880 mins: Summer	65.905	65.889	0.158	0.179	3.6	97.121	0.000	125.938	0.0	0.000	2228	58.052	OK
FEH: 30 years: +35 %: 2880 mins: Winter	65.936	65.926	0.189	0.216	2.6	117.01 5	0.000	125.486	0.0	0.000	2671	49.459	OK
FEH: 30 years: +35 %: 4320 mins: Summer	65.894	65.878	0.147	0.168	2.6	90.816	0.000	172.941	0.0	0.000	2077	60.775	OK
FEH: 30 years: +35 %: 4320 mins: Winter	65.920	65.909	0.173	0.199	1.9	107.46 4	0.000	185.271	0.0	0.000	2448	53.584	OK
FEH: 30 years: +35 %: 5760 mins: Summer	65.886	65.871	0.140	0.161	2.1	86.643	0.000	185.223	0.0	0.000	1978	62.577	OK

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 30year +35% CC Event		Date: 25/05/2023		
		Designed by: TS	Checked by:	Approved By:
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase		Company Address: GeoSon Limited		



FEH: 30 years: +35 %: 5760 mins: Winter	65.909	65.899	0.163	0.189	1.5	101.73 9	0.000	207.687	0.0	0.000	2316	56.057	OK
FEH: 30 years: +35 %: 7200 mins: Summer	65.880	65.865	0.134	0.155	1.8	83.382	0.000	196.725	0.0	0.000	1902	63.986	OK
FEH: 30 years: +35 %: 7200 mins: Winter	65.900	65.891	0.153	0.181	1.3	96.637	0.000	220.743	0.0	0.000	2198	58.261	OK
FEH: 30 years: +35 %: 8640 mins: Summer	65.875	65.860	0.128	0.150	1.6	80.429	0.000	207.393	0.0	0.000	1833	65.261	OK
FEH: 30 years: +35 %: 8640 mins: Winter	65.891	65.883	0.145	0.173	1.1	91.784	0.000	232.761	0.0	0.000	2087	60.357	OK
FEH: 30 years: +35 %: 10080 mins: Summer	65.870	65.857	0.124	0.147	1.4	78.081	0.000	218.235	0.0	0.000	1778	66.275	OK
FEH: 30 years: +35 %: 10080 mins: Winter	65.884	65.876	0.137	0.166	1.0	87.443	0.000	244.833	0.0	0.000	1987	62.232	OK

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 100year +40% CC Event	Date: 25/05/2023			
	Designed by: TS	Checked by:	Approved By:	
Report Details: Type: Inflows Storm Phase: Phase	Company Address: GeoSon Limited			



Catchment Area

Type : Catchment Area

Area (ha)	0.187
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Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.750
Winter Volumetric Runoff	0.840
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 100year +40% CC Event	Date: 25/05/2023			
Report Details: Type: Stormwater Controls Storm Phase: Phase	Designed by: TS	Checked by:	Approved By:	
	Company Address: GeoSon Limited			



Porous Paving

Type : Porous Paving

Dimensions

Exceedance Level (m)	66.240
Depth (m)	0.530
Base Level (m)	65.710
Paving Layer Depth (mm)	130
Membrane Percolation (m/hr)	1.0
Porosity (%)	78.75
Length (m)	36.750
Long. Slope (1:X)	1000.00
Width (m)	20.000
Total Volume (m³)	231.525

Inlets

Inlet

Inlet Type	Lateral Inflow
Incoming Item(s)	Catchment Area
Bypass Destination	(None)
Capacity Type	No Restriction

Advanced

Base Infiltration Rate (m/hr)	0.0036
Safety Factor	2.0
Conductivity (m/hr)	50.0

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 100year +40% CC Event	Date: 25/05/2023					
Report Title: Rainfall Analysis Criteria	Designed by: TS <table border="1" style="display: inline-table; vertical-align: top;"> <tr> <td>Checked by:</td> <td>Approved By:</td> </tr> <tr> <td> </td> <td> </td> </tr> </table>		Checked by:	Approved By:		
Checked by:	Approved By:					
	Company Address: GeoSon Limited					

Runoff Type	Dynamic
Output Interval (mins)	5
Time Step	Default
Urban Creep	Apply Global Value
Urban Creep Global Value (%)	0
Junction Flood Risk Margin (mm)	300
Perform No Discharge Analysis	☐

Rainfall		
FEH	Type: FEH	
Site Location	GB 566000 171000 TQ 66000 71000	
Rainfall Version	2013	
Data Type	Catchment	
Summer	☒	
Winter	☒	

Return Period	
Return Period (years)	Increase Rainfall (%)
100.0	40.000
Storm Durations	

Duration (mins)	Run Time (mins)
15	30
30	60
60	120
120	240
180	360
240	480
360	720
480	960
600	1200
720	1440
960	1920
1440	2880
2160	4320
2880	5760
4320	8640
5760	11520
7200	14400
8640	17280
10080	20160

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 100year +40% CC Event	Date: 25/05/2023			
	Designed by:	Checked by:	Approved By:	
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase	TS			
	Company Address: GeoSon Limited			



Summary Results for Porous Paving: Rank By: Max. Avg. Depth

Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Residual Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
FEH: 100 years: +40 %: 15 mins: Summer	65.838	65.802	0.092	0.092	118.6	53.010	0.000	0.660	0.0	0.000	1281	77.104	OK
FEH: 100 years: +40 %: 15 mins: Winter	65.849	65.813	0.103	0.103	125.0	59.422	0.000	0.660	0.0	0.000	1431	74.335	OK
FEH: 100 years: +40 %: 30 mins: Summer	65.867	65.830	0.120	0.120	81.2	69.595	0.000	1.321	0.0	0.000	2180	69.941	OK
FEH: 100 years: +40 %: 30 mins: Winter	65.881	65.845	0.135	0.135	85.4	78.042	0.000	1.321	0.0	0.000	2403	66.292	OK
FEH: 100 years: +40 %: 60 mins: Summer	65.896	65.860	0.149	0.150	70.5	86.633	0.000	2.643	0.0	0.000	2487	62.582	OK
FEH: 100 years: +40 %: 60 mins: Winter	65.914	65.878	0.167	0.168	63.5	97.200	0.000	2.643	0.0	0.000	2675	58.018	OK
FEH: 100 years: +40 %: 120 mins: Summer	65.927	65.893	0.180	0.183	51.2	105.162	0.000	5.287	0.0	0.000	2764	54.579	OK
FEH: 100 years: +40 %: 120 mins: Winter	65.949	65.915	0.203	0.205	41.3	118.115	0.000	5.284	0.0	0.000	2983	48.984	OK
FEH: 100 years: +40 %: 180 mins: Summer	65.949	65.916	0.202	0.206	40.9	118.001	0.000	7.932	0.0	0.000	2978	49.033	OK
FEH: 100 years: +40 %: 180 mins: Winter	65.974	65.941	0.227	0.231	31.6	132.665	0.000	7.923	0.0	0.000	3262	42.700	OK
FEH: 100 years: +40 %: 240 mins: Summer	65.965	65.933	0.218	0.223	34.5	127.684	0.000	10.577	0.0	0.000	3172	44.851	OK
FEH: 100 years: +40 %: 240 mins: Winter	65.992	65.961	0.245	0.251	26.0	143.687	0.000	10.560	0.0	0.000	3466	37.939	OK
FEH: 100 years: +40 %: 360 mins: Summer	65.987	65.958	0.240	0.248	26.4	141.151	0.000	15.867	0.0	0.000	3412	39.034	OK
FEH: 100 years: +40 %: 360 mins: Winter	66.017	65.989	0.271	0.279	19.5	159.138	0.000	15.831	0.0	0.000	3764	31.265	OK

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 100year +40% CC Event						Date: 25/05/2023											
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase						Designed by: TS								Checked by:		Approved By:	
						Company Address: GeoSon Limited											

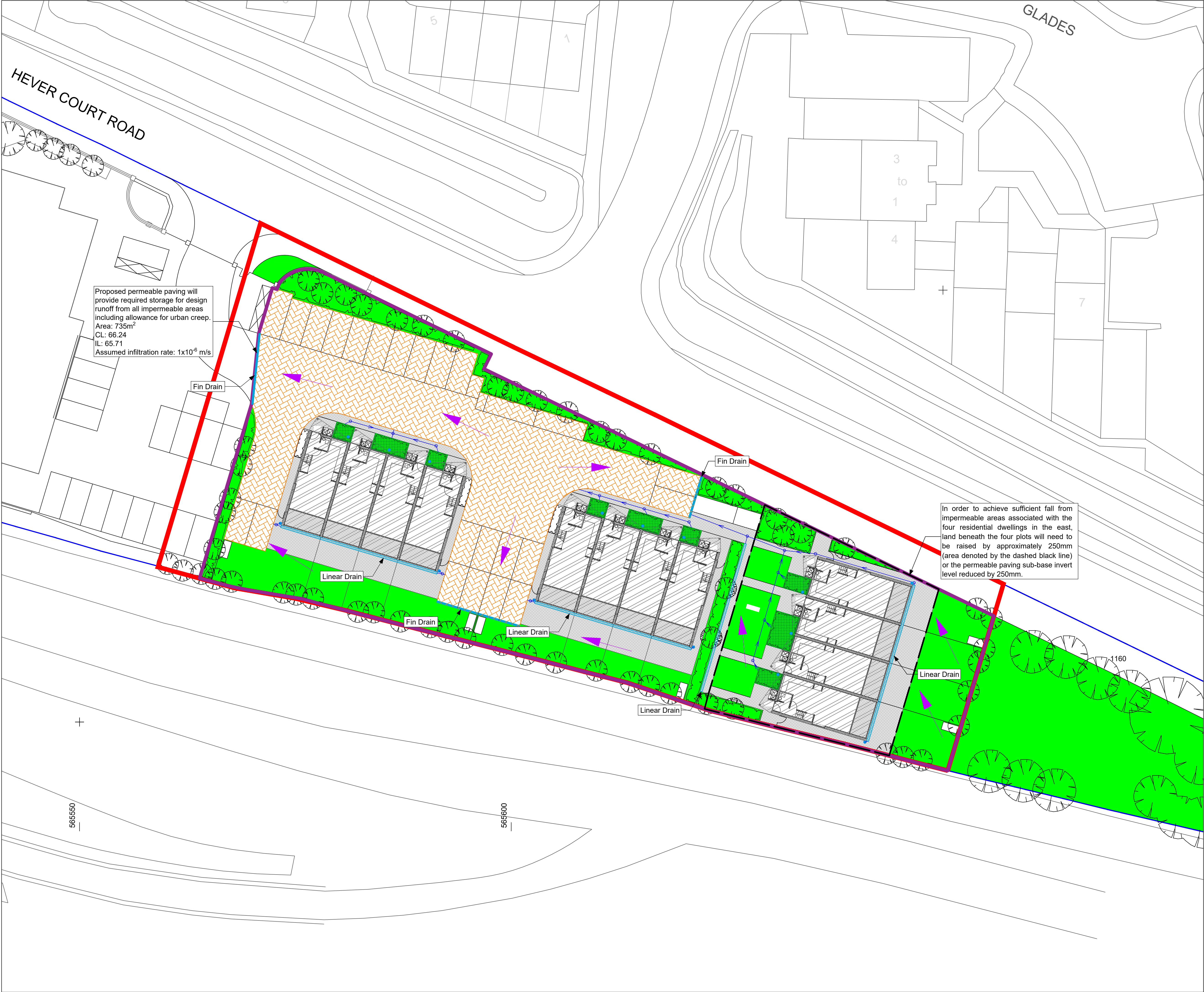
FEH: 100 years: +40 %: 480 mins: Summer	66.001	65.975	0.254	0.265	21.8	150.08 8	0.000	21.157	0.0	0.000	3577	35.174	OK
FEH: 100 years: +40 %: 480 mins: Winter	66.034	66.008	0.287	0.298	15.8	169.50 6	0.000	21.087	0.0	0.000	3969	26.787	OK
FEH: 100 years: +40 %: 600 mins: Summer	66.010	65.986	0.263	0.276	18.5	156.21 6	0.000	26.448	0.0	0.000	3689	32.527	OK
FEH: 100 years: +40 %: 600 mins: Winter	66.045	66.022	0.298	0.312	13.3	176.74 1	0.000	26.361	0.0	0.000	4112	23.662	OK
FEH: 100 years: +40 %: 720 mins: Summer	66.017	65.995	0.270	0.285	16.0	160.53 2	0.000	31.738	0.0	0.000	3767	30.663	OK
FEH: 100 years: +40 %: 720 mins: Winter	66.053	66.032	0.306	0.322	11.6	181.94 2	0.000	31.637	0.0	0.000	4216	21.416	OK
FEH: 100 years: +40 %: 960 mins: Summer	66.023	66.005	0.277	0.295	12.7	165.48 0	0.000	42.319	0.0	0.000	3852	28.526	OK
FEH: 100 years: +40 %: 960 mins: Winter	66.062	66.045	0.315	0.335	9.2	188.21 0	0.000	42.154	0.0	0.000	4339	18.709	OK
FEH: 100 years: +40 %: 1440 mins: Summer	66.027	66.014	0.280	0.304	9.1	169.23 7	0.000	63.481	0.0	0.000	3908	26.903	OK
FEH: 100 years: +40 %: 1440 mins: Winter	66.069	66.058	0.322	0.348	6.6	194.00 1	0.000	63.191	0.0	0.000	4449	16.207	OK
FEH: 100 years: +40 %: 2160 mins: Summer	66.023	66.015	0.276	0.305	6.5	168.18 3	0.000	95.226	0.0	0.000	3863	27.359	OK
FEH: 100 years: +40 %: 2160 mins: Winter	66.069	66.062	0.322	0.352	4.7	195.17 9	0.000	94.648	0.0	0.000	4460	15.699	OK
FEH: 100 years: +40 %: 2880 mins: Summer	66.013	66.008	0.266	0.298	5.2	163.32 1	0.000	126.971	0.0	0.000	3741	29.459	OK
FEH: 100 years: +40 %: 2880 mins: Winter	66.063	66.059	0.316	0.349	3.7	192.49 5	0.000	125.996	0.0	0.000	4391	16.858	OK
FEH: 100 years: +40 %: 4320 mins: Summer	65.991	65.986	0.244	0.276	3.7	150.48 2	0.000	189.284	0.0	0.000	3438	35.004	OK
FEH: 100 years: +40 %: 4320 mins: Winter	66.043	66.041	0.296	0.331	2.7	181.53 3	0.000	188.329	0.0	0.000	4134	21.592	OK
FEH: 100 years: +40 %: 5760 mins: Summer	65.977	65.971	0.230	0.261	2.9	142.01 5	0.000	247.245	0.0	0.000	3240	38.661	OK

Project: 73050 - Manor Hotel Gravesend Permeable Paving Calculations 1 in 100year +40% CC Event		Date: 25/05/2023		
		Designed by: TS	Checked by:	Approved By:
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase		Company Address: GeoSon Limited		



FEH: 100 years: +40 %: 5760 mins: Winter	66.020	66.019	0.274	0.309	2.1	168.37 3	0.000	249.920	0.0	0.000	3831	27.276	OK
FEH: 100 years: +40 %: 7200 mins: Summer	65.967	65.961	0.220	0.251	2.4	136.45 0	0.000	269.121	0.0	0.000	3110	41.065	OK
FEH: 100 years: +40 %: 7200 mins: Winter	66.007	66.005	0.261	0.295	1.8	160.86 6	0.000	300.099	0.0	0.000	3658	30.519	OK
FEH: 100 years: +40 %: 8640 mins: Summer	65.958	65.953	0.211	0.243	2.1	131.26 6	0.000	279.753	0.0	0.000	2990	43.304	OK
FEH: 100 years: +40 %: 8640 mins: Winter	65.996	65.994	0.250	0.284	1.5	154.61 6	0.000	314.127	0.0	0.000	3515	33.219	OK
FEH: 100 years: +40 %: 10080 mins: Summer	65.952	65.947	0.205	0.237	1.9	127.78 3	0.000	291.159	0.0	0.000	2909	44.808	OK
FEH: 100 years: +40 %: 10080 mins: Winter	65.986	65.984	0.239	0.274	1.4	148.75 1	0.000	326.217	0.0	0.000	3380	35.752	OK

Appendix E



- Key**
- Application Boundary
 - Development Area (2500m²)
 - Client Ownership Boundary
 - Proposed Roof Areas
 - Proposed Hardstanding
 - Proposed Permeable Paving
 - Proposed Linear Drain
 - Proposed Fin Drain
 - Assumed Downpipe Locations
 - Proposed Surface Water Pipework
 - Proposed Surface Water Manhole
 - Potential Overland Flow Route
 - Proposed Soft Landscaping
 - Potential Raingardens (TBD at detailed design)

- Notes**
- All dimensions in this drawing are in millimetres unless stated otherwise.
 - All levels are in metres Above Ordnance Datum (mAOD).
 - The proposed drainage layout is based on drawing reference 1420_planning_01K.dwg provided by Mialex. Drawing reference SURVEY_PLANS has been used to establish ground levels at the site.
 - It is proposed to manage post development surface water runoff via permeable paving.
 - Preliminary calculations indicate that permeable paving with an area of 735m², sub-base depth of 0.4m and void ratio of 78.75 will provide sufficient storage to accommodate all runoff generated by impermeable areas during the 1 in 100 year plus (40%) Climate Change event.
 - SuDS sizing has been based on the minimum viable infiltration rate of 1 x 10⁻⁶m/s. True infiltration rates should be confirmed by in-situ testing and groundwater monitoring undertaken prior to detailed design.
 - To achieve sufficient fall from impermeable surfacing associated with the four plots in the east, the plots will need to be raised by approximately 250mm or the permeable paving sub-base invert lowered by 250mm. To be determined at detailed design stage.
 - No deep rooted vegetation should be planted within proximity of the proposed below ground drainage components.
 - It is currently unknown whether there are any utilities beneath the site. A survey of the existing service infrastructure should be undertaken to determine the location of any utilities prior to detailed design.
 - At this stage, detailed modelling of the drainage system has not been undertaken therefore the proposed SuDS scheme should be taken as indicative.
 - This drawing is for planning purposes only. Not for construction. Do not scale from this drawing.

Client
Manor Hotel Best Western

Title
Drainage Layout Plan

Location
Manor Hotel, Hever Court Road, Gravesend

Drawing Number:	Revision:	
73050-01	v.1.0	
Date:	Scale:	
30/05/2023	1:200	
Designed By:	Checked By:	Approved By:
TS	JN	TS

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