Land North of Chichele Road
Oxted, Surrey

Flood Risk Assessment and Drainage Strategy

For

CALA Homes Ltd

motion

Document Control Sheet

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Oxted, Surrey

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This document has been issued and amended as follows:

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Contents

Appendices

1.0 Introduction

1.1 This Flood Risk Assessment (FRA) and drainage strategy has been produced by Motion on behalf of CALA Homes Ltd to support the planning application for 116 residential units on the land to the north of Chichele Road, Oxted. A layout of the proposed development can be seen in Appendix A. The proposed development falls within the administrative boundary of Tandridge District Council (TDC) and Surrey County Council (SCC).

1.2 The site is located within Flood Zone 1 according to the Environment Agency's (EA's) Flood Map for Planning and is at low risk from 'local' forms of flooding. However, because the site area is over one hectare (it is 6.57 ha) an FRA is required.

1.3 As a major development, a drainage strategy is required to demonstrate how the development will manage and discharge surface water generated in all rainfall events up to and including the 1 in 100-year + 40% storm with an inclusion for urban creep.

1.4 Therefore, this FRA and drainage strategy has been produced to discuss the flood risks to the proposed development, from all sources. This FRA and drainage strategy will also define how the development will manage its surface water and foul sewage so that the development does not increase flood risk in the area or to neighbouring properties/land.

- This FRA and drainage strategy follows the guidance set out in:
- National Planning Policy Framework (NPPF)
- Planning Practice Guidance (PPG) to the National Planning Policy Framework
- CIRIA SuDS Manual 2015 (C753)
- Environment Agency Rainfall Runoff Management for Developments
- Non-Statutory Technical Standards for SuDS (NSTS)

1.5 This FRA and drainage strategy report pertains only to the design of the drainage system for the built site. It does not provide details of how the site will be drained during the construction phase. This is considered to be temporary works and can only be prescribed and provided by the eventual appointed contractor.

1.6 Similarly, this report does not provide information on how the drainage infrastructure will be protected during the construction phase of the project. The provision of this information is, again, the responsibility of the appointed contractor.

2.0 Site Description

Table 2.1 – Site Summary

Site Name	Land North of Chichele Road
Location	Oxted, Surrey, RH8 0AG
Grid Reference	TQ 39413 53466 (centre of site)
Site Area	65,681m^2 (6.57 ha)
Development Type	The development of a greenfield site to provide 116 residential dwellings, plus associated access, parking and greenspace / landscaping.
Flood Zone	Flood Zone 1
Surface Water Flood Risk	Very Low Risk
Local Sewerage Authority	Southern Water
Local Planning Authority	Tandridge District Council (TDC)
Lead Local Flood Authority	Surrey County Council (KCC)

Site Location and Description

2.1 The irregularly shaped site is located north and east of Chichele Road, which is in the north of Oxted. Chichele Road runs between Bluehouse Lane and Silkham Road/Barrow Green Road. A site location plan can be seen in Appendix B.

2.2 The target site for development is currently greenfield and, on the date of the site visit, ground cover was typified by low level grass.

2.3 The site is bounded by Oxted School to the south, woodland and fields to the north and east, and St Mary's C of E Primary School and the residential development of Chichele Road to the west.

2.4 The site is bounded by trees on the majority of its borders and there are drainage ditches on the northern, eastern and north-western site boundaries.

Topography

2.5 A topographic survey of the existing site was carried out by the Wardell Survey Partnership in January 2013, and this can be seen in Appendix C.

2.6 The highest parts of the site are in the south-western corner, where levels are as high as 118.09 metres Above Ordnance Datum (mAOD). The site generally slopes north and east. In the centre of the site topographic levels are generally 114 – 115 mAOD. The southern part of the site slopes northwards, but falls to the east and, on the eastern boundary of the site levels are as low as 105.91 mAOD.

2.7 From the centre of the site, the land also falls to the west back towards Chichele Road. In the narrow part of the site near the access from Chichele Road, topographic levels are approximately 110 mAOD.

2.8 The drainage ditches are typically between 0.4m and 0.7m in depth from the top of the bank to the base of the ditch.

Geology

2.9 The 1:50,000 British Geological Survey (BGS) online Geoindex Mapping identifies that the majority of the site is underlain by a bedrock geology of the Folkstone Formation, which is a sandstone. The very northern part of the site may be Gault Formation, which is a mudstone. The BGS mapping does not identify the superficial deposits present on site. However, Defra's Magic Map Soilscape dataset describes the soils in the area as 'base-rich loamy and clayey soils'.

2.10 A geotechnical site investigation was carried out by AP Geotechnics in October 2015. As part of that investigation, 5 boreholes and 8 trial pits were dug to ascertain the stratigraphy across the site. The location of the intrusive investigations, along with all the borehole and trial pit logs, can be seen in Appendix D.

2.11 Clay was encountered in all locations beneath a surface layer of Made Ground or Topsoil. The clays encountered were somewhat variable in both composition and thickness. They were at their thinnest in the southern portion of the site where only 0.80m was present in BH1. In contrast, 6.0m of clay was recorded in BH4. The clay was generally brown-grey mottled and sandy clay and followed by a succession of clay layers that were generally both sandy and gravelly.

2.12 Folkestone Formation was encountered in all boreholes and trial pits at depths starting from 0.70m in TP2 to 6.0m in BH4. It was represented by a light yellow, white and brown fine to medium sand which continued to the limit of investigations at 15.0m depth.

Hydrogeology and Groundwater

2.13 Groundwater Source Protection Zones (SPZ's) are defined around groundwater abstraction sources such as wells, boreholes and springs that are used for public drinking water supply.

2.14 SPZ's show the risk of contamination to groundwater from any activities that might cause pollution in the area. The closer the activity to the source of abstraction, the greater the risk. The maps show three main zones; inner – Zone 1; outer – Zone 2 and; total catchment – Zone 3.

2.15 Zone 1 is defined as the 50-day travel time from any point below the water table to the source of abstraction. This zone has a minimum radius of 50 metres.

2.16 Zone 2 is defined by a 400-day travel time from a point below the water table to the source of abstraction. This zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.

2.17 Zone 3 is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source of abstraction, but is thought to be greater than 400 days travel time.

2.18 Certain geologies can contain fractures and pathways that allow groundwater to move more quickly than is defined above, so these should be used as a guideline and if it is suspected that there is potential for groundwater pollution even though a site is in a lower risk SPZ, professional advice should be sought from a geotechnical consultant.

2.19 Defra's Magic Map was reviewed to see where the site is in relation to the Groundwater SPZ's. This comparison can be seen in Appendix E.

2.20 Defra's Magic Map shows that the site is within Groundwater SPZ3. This is not defined as 'protected waters' but it is advised that sufficient pollution removal should be carried out prior to any discharge to groundwater.

2.21 This means that the drainage strategy would benefit from SuDS to ensure that pollution hazards are sufficiently mitigated.

Infiltration Potential

2.22 Although the site is in an area of clayey soils, BRE365 soakage tests were carried out by AP Geotechnics as part of their geotechnical site investigation. Soakage tests were only carried out in TP1 And TP2 due to difficulties in getting the water bowser and measuring equipment further into the site without it becoming stuck in the ground.

2.23 Soakage tests were carried out at depths of between 2.20m and 2.40m in TP1 and 1.17m and 1.80m in TP2. Two consecutive tests were carried out in TP1 and three consecutive tests were carried out in TP2. The results of these tests are in Table 2.2, below.

Table 2.2 – BRE365 Soakage Test Results

Test	TP1	TP2
1	3.53×10^{-5}	2.63×10^{-5}
2	3.72×10^{-5}	5.79×10^{-5}
3	-	4.04×10^{-5}

2.24 A full copy of the soakage tests can be seen in Appendix F.

2.25 The soakage tests carried out by AP Geotechnics show that favourable infiltration coefficients were encountered on site and, in TP2, the fully saturated third test recorded better soakage rates than the first test. It should be noted that only two tests were carried out in TP1 not because the ground did not allow the third test to complete, but because the superficial ground conditions were wet and very soft and prohibited the movement and refilling of the water bowser, thus it was not possible to complete all three tests. Therefore, the absence of three full tests is not an indication of unsuitability of ground for infiltration; the completed tests actually show that the ground is suitable for infiltration and at a time when the ground was wet.

2.26 Only one of the boreholes (BH2) recorded a water strike. All the other boreholes and trial pits did not record water strikes or the presence of groundwater. Therefore, it can be assumed that groundwater levels are deeper than 15m below surface.

2.27 However, the AP Geotechnics report concluded that, should infiltration media be used as part of a drainage solution, soakaways and SuDS features should ensure that they penetrate beyond the clay strata and into the granular material of the Folkestone Formation, as long as it is economical to do so.

Hydrology

2.28 As discussed above, there are drainage ditches located on the northern, eastern and north-western site boundaries. These drainage ditches are classified as 'ordinary watercourses' and Kent County Council in their role as the Lead Local Flood Authority (LLFA) are the competent authority who regulate and manage activities that could affect flood risk on these watercourses.

2.29 The drainage ditch on the eastern site boundary flows north-south to the south-eastern corner of the site. It passes through a two-metre section of concrete pipe joined by another watercourse flowing from the east in the vicinity of the south-eastern corner of the site. The watercourse then flows through a culvert under the playing fields and grounds of Oxted School.

2.30 The drainage ditch on the north-western site boundary flows east-west between the site and the grounds of St Mary's Church of England primary school. Surface water drains from the school discharge into this ditch, which is culverted at its western extent via a 300mm pipe that channels surface water under Chichele Road and beyond.

2.31 Photos of the drainage ditches and culverts/pipes discussed above can be seen in Appendix G.

2.32 The nearest designated main river is the River Eden, which flows east-west approximately 600 metres to the south of the site through the centre of Oxted.

Existing Drainage Regime

2.33 As a greenfield site, surface water falling on the existing ground cover will either run off with the prevailing gradient or be intercepted by the vegetation on site. The drainage ditches on the eastern, northern and north-western site boundaries commutes surface water runoff from the site and the surrounding land uses to the wider hydraulic network.

2.34 In terms of formal drainage infrastructure, Southern Water has supplied their asset location plans in the vicinity of Chichele Road and these plans can be seen in Appendix H.

2.35 The 300mm culvert that receives flow from the ordinary watercourse on the site's north-western site boundary is shown as a public sewer on Southern Water's asset location plans. This public sewer is joined by a 450mm diameter surface water sewer from Silkham Road and combined, they become a 525mm sewer that continues to flow west on Chichele Road.

2.36 There is also a 150mm public foul sewer that runs south-north along Chichele Road and past the entrance to the site.

2.37 This shows that there are ordinary watercourses and public surface water sewers locally, that are suitable receptors for surface water discharge as they are already part of the hydraulic regime of the site. There is also a public foul sewer near the site, which would potentially be able to accept a connection from the site, subject to confirmation from Southern Water that there is capacity.

The Proposed Development

2.38 The proposed development is to provide a 116-unit residential development, which will be made up of flats and semi-detached and detached houses, which are to provide a mixture of owner-occupied, affordable rent and 'first home' properties.

2.39 The development will also include accesses, driveways and parking courts, and areas of public open space. There will be a single vehicular access from Chichele Road.

2.40 The proposed development layout can be seen in Appendix A.

3.0 Current Flood Risk

3.1 Flooding can arise from a variety or combination of sources. These may be natural or artificial and may be affected by climate change. These are discussed, below, in the following two sections and summarised in Table 6.1. The probability of any likely impacts is also assessed, where necessary.

Flooding from Rivers and the Sea

3.2 The Environment Agency's Flood Map for Planning (Appendix I) shows that the entire site is located within Flood Zone 1 (less than 1 in 1,000-year probability of flooding from rivers or the sea).

3.3 Residential development is considered appropriate in Flood Zone 1 and, therefore, the development as presented in the site layout in Appendix A is appropriate with regards to fluvial flood risk.

Surface Water Flooding

3.4 Surface water, or pluvial flooding, results from rainfall-generated overland flow, where rainwater has not yet reached a watercourse or sewer and where the local drainage systems become overwhelmed. Pluvial flooding often occurs during short, very intense storms, but can also occur during longer periods of rainfall when the ground is already saturated, or where land has low permeability due to development.

3.5 In these conditions surface water can build up where the topography allows it to converge or pond. Where it gathers it will travel down prevailing gradients. Pluvial flooding then occurs at locations where significant surface water flow paths converge, at localised low points and/or due to overland obstructions. In urban areas pluvial flooding often occurs where the built environment channels overland flow routes (down roads that are bounded by kerbs, for example) or where there are obstacles to the natural overland flow routes. Boundary walls and buildings are often the main causes and, hence, the likelihood of pluvial flooding to impact property and gardens.

3.6 Pluvial flooding is exacerbated in many cases by the mistreatment or failure of the below ground infrastructure (including partial or full blockages of gullies and/or within the combined sewers and the accumulation of fats, oils and greases within the sewer networks).

3.7 The EA's Risk of Flooding from Surface Water (RoFSW) map for the site can be found in Appendix J.

3.8 The RoFSW maps shows that there is a very small area of 'medium to high' surface water flood risk on the western boundary of the site, but this is outside of the red line boundary of the development. There is a small area of 'low' surface water flood risk (areas of between the 1 in 100-year return period and the 1 in 1,000-year return period) in the northeast corner of the site. This area of 'low' surface water flood risk is not connected to any other surface water flood risk areas, thus is not part of a wider overland flow network and can be managed through the proposed drainage strategy for the site.

3.9 The Envirocheck Landmark FSR includes the JBA 1 in 1,000-year return period Flood Map (undefended) and this can be seen in Appendix K. This mapping supports the EA's RoFSW mapping and shows that the site is not in an area at risk of pluvial flooding, although there is a very small area on the western boundary of the site that is at risk of pluvial flooding of depths less than 0.1m.

3.10 In summary, Land North of Chichele Road is at low risk of surface water flooding.

Groundwater Flooding

3.11 There are no flood risk maps for groundwater, as stated by the Environment Agency in their 2011 guidance note 'flooding from groundwater'. Mapping products currently available only show areas where the geological and hydrogeological conditions *may* combine to cause groundwater flooding, but they should not be considered as groundwater flood risk maps. They only show *susceptibility* to groundwater flooding.

3.12 There are several mapping products that depict areas that may be susceptible to groundwater flooding, but they are not comparable in detail to the risk maps developed for fluvial, tidal and surface water, such as those used by practitioners and risk management authorities to support planning decisions. The mapping does not show the likelihood of groundwater flooding occurring and can only be considered as a hazard, but not a risk-based dataset.

3.13 As such, the mapping products can be viewed as indicative at best and should only be used as a prompt to review site-based information to determine whether groundwater is a risk factor that should be considered. Indeed, the Environment Agency state that:

"*The susceptibility data should not be used on its own to make planning decisions at any scale and, in particular, should not be used to inform planning decisions at the site scale. The susceptibility data cannot be used on its own to indicate risk of groundwater flooding*."

3.14 This FRA will review the groundwater flooding susceptibility mapping available, which has been supplied in the Envirocheck Landmark Flood Studies Report (FSR) and can be seen in Appendix K.

BGS Geological Indicators of Flooding

3.15 The BGS Geological Indicators of Flooding map shows that the site is not in an area with any indicators of groundwater flooding.

BGS Groundwater Flooding Susceptibility

3.16 The BGS Groundwater Flooding Susceptibility map shows that most of the site is in an area where there is limited potential for groundwater flooding to occur. There is a small corner of the site, to the northwest, that has no potential for groundwater flooding to occur.

Geosmart Information Groundwater Flood Map

3.17 The Geosmart Information Groundwater Flood Map places the site in an area of 'negligible' risk.

Groundwater Flood Risk Summary

3.18 Most of the site is in an area where there is limited to no potential for groundwater flooding to occur. Therefore, it can be suggested that the site is at low susceptibility to groundwater flooding.

Flooding from Infrastructure Failure

3.19 Sewer flooding can occur when the capacity of the infrastructure is exceeded by excessive flows, or because of a reduction in capacity due to collapse, siltation, blockage, or if the downstream system becomes surcharged. This can lead to the sewers flooding onto the surrounding ground via manholes and gullies, which can generate overland flows.

3.20 Typically, sewer systems are constructed to accommodate rainstorms with a 30-year return period or less, depending on their age. Consequently, rainstorm events greater than 1 in 30-years would be expected to result in surcharging of some parts of the sewer system. In fact, due to most gullies being poorly maintained and often partially blocked with silt, leaves and other debris, their capacity is often estimated to be closer to the 1 in 10-year storm.

3.21 Because the site currently has no surface water drainage infrastructure on it, it cannot be at risk of flooding from infrastructure failure.

3.22 Looking forward, the development's drainage must be designed in accordance with Sewers for Adoption, The Design and Construction Guidance (DCG), Building Regulations Approved Document Part H and BS EN 752. This will minimise the future risk of flooding due infrastructure failure.

Flooding from Artificial sources

3.23 The EA provides a map showing the maximum potential flood extent should all reservoirs with a capacity of greater than 25,000 cubic metres fail and release the water they hold.

3.24 The map shows that the Land north of Chichele Road would not experience flooding in this scenario.

3.25 There are no canals in the local area to create flood risk either.

Historic Flooding

3.26 The Envirocheck Landmark FSR includes a Historic Flood Map and this can be seen in Appendix K. This map shows that the site and most of the surrounding area of Oxted has no record of flooding in the past. Thus, the Historic Flood Map supports this report's conclusion that Land North of Chichele Road is at very low risk of flooding and that the proposed development is appropriate in this location.

4.0 Future Flood Risk & Climate Change

4.1 The NPPF and the supporting Technical Guidance document sets out how flood risk should be considered over the lifetime of a development. This requires an increase in flood risk due to climate change to be taken into account. Both peak river flows and rainfall intensity should be assessed.

Peak River Flows

4.2 Because the site is in Flood Zone 1, increases in future peak river flows do not need to be considered.

Peak Rainfall Intensity and Climate Change

4.1 As of May 2022, the NPPF's climate change rainfall increase predictions for developments was updated. Whereas previous climate change parameters for rainfall increases used set values (20% or 40%) across the UK depending on the probable lifetime of a development, the latest climate change advice is determined by which catchment the development is within and every river catchment in the UK has different climate change rainfall increase predictions.

4.2 This is because the southeast of England tends to see heavier, stormier rainfall than the northwest, which tends to see longer rainfall events with less intensity. This, in combination with the prevailing geo-environmental characteristics of each catchment, has determined the climate change increases that are to be used.

4.3 The other major change to the 2022 climate change rainfall predictions is that climate change increases should also be applied to the 1 in 30-year rainfall event, whereas previously it was only applied to the 1 in 100-year event. As such, the hydraulic modelling for the proposed development will also apply a climate change increase to the 1 in 30-year rainfall event.

4.4 Chichele Road is within the Medway Management Catchment. The 2022 peak rainfall climate change allowances are as follows in Table 4.1, below:

Table 4.1 – Climate Change Predictions for the Medway Management Catchment

1 in 30-year Rainfall Event	Central Allowance	Upper End Allowance
2050's epoch	20%	35%
2070's epoch	20%	35%
1 in 100-year Rainfall Event	**Central Allowance**	**Upper End Allowance**
2050's epoch	20%	45%
2070's epoch	25%	40%

4.5 For a residential development, which could have a lifespan of up to 100 years, the 2070's epoch should be used and the NPPF advises that for developments with a lifetime beyond 2100, flood risk assessments should assess the upper end allowances for both the 1% and 3.3% annual exceedance probability events.

4.6 Therefore, for the proposed development on Land North of Chichele Road, the climate change increase predictions that should be applied to the hydraulic modelling and the drainage strategy are 35% for the 1 in 30-year rainfall event and, although the 2070's epoch prescribes a 40% climate change increase, a

45% increase will be used for the 1 in 100-year event as this is the increase prescribed for the 2050's epoch. This provides a precautionary approach.

4.7 The site is currently in an area of low surface water flood risk and, as such, even with the climate change increase predictions outlined above, it is unlikely that surface water flood risk will increase on the site to the extent that the development would become inappropriate. Additionally, the drainage strategy for the development will take these latest climate change predictions into account so that the surface water generated in the 1 in 100-year + 45% rainfall event will be attenuated on site and will not cause flooding locally or to neighbouring areas.

Residual Flood Risk

4.8 It is important to recognise that flood risk can never be fully mitigated and there will always be a residual risk of flooding. The residual risk is associated with several potential risk factors, including (but not limited to):

- A flood event that exceeds that for which the local flood defences or local drainage system has been designed to withstand.
- A residual danger posed to property and life because of flood defence failure through overtopping or structural collapse.
- General uncertainties inherent in the prediction of flooding.

4.9 Modelling of flood events is not an exact science. Therefore, there is an inherent uncertainty in the prediction of flood levels and extents used in the assessment of flood risk. EA's Flood Map for Planning is largely based upon detailed modelling within the area. However, other mapping products require numerous assumptions to be made. Whilst they all provide a good depiction of flood risk for specific modelled conditions, all modelling requires the making of core assumptions and these might not occur in the open and dynamic environment of a flood event. Also, the EA's Flood Map for Planning and other flood modelling is updated regularly. Interested parties are recommended to keep abreast of this so that a significant change or increase in flood risk can be determined.

The Sequential and Exception Tests

4.10 The NPPF specifies that the suitability of all new development in relation to flood risk should be assessed by applying the Sequential Test to demonstrate that there are no reasonably alternative sites available in areas with a lower probability of flooding that would be appropriate to the type of proposed development.

4.11 As the site is within Flood Zone 1 and an area of low surface water flood risk, the Sequential Test does not apply.

5.0 Summary of Flood Risk

5.1 Table 5.1, below, summarises the level of flood risk to the Boons Park site.

Table 5.1: Summary of Flood Risk

Flood Source	Risk Level				Comment
	High	Medium	Low	Very Low	
Fluvial				X	Flood Zone 1
Tidal				X	Tidal Flood Zone 1
Groundwater				X	Groundwater not encountered during intrusive tests to depth
Surface Water			X	X	Low to very low risk
Canals				X	There are no canals in the vicinity
Reservoirs				X	The Reservoir Flood Risk Map places the site well outside a maximum extent of flooding
Infrastructure Failure				X	No existing infrastructure to fail
Increase due to Climate Change				X	Increased peak rainfall intensities are not expected to affect any infrastructure or properties.

5.2 In conclusion, the site is at low to very low risk of flooding from all sources and the site's surface water drainage strategy will reduce surface water runoff and flood risk on site by protecting the site from all surface water flood events up to and including the 1 in 100-year + 45% storm.

5.3 The proposed 'more vulnerable' development is acceptable in Flood Zone 1. As such, flood risk should not form an impediment to the proposed development on Land to the North of Chichele Road, Oxted.

6.0 Surface Water Drainage Strategy Options

Sustainable Drainage Overview

6.1 Current planning policy and Environment Agency guidance requires developments to employ SuDS (Sustainable Drainage Systems) techniques wherever feasible. Careful design of SuDS features can ensure that a development's surface water drainage closely reflects the natural hydrology of the pre-developed site.

6.2 SuDS will attenuate and treat surface water run-off quantities at the source (source control) in line with current guidance and best practice.

6.3 Source control systems treat surface water close to the point of origin, in features such as soakaways, permeable paving and swales, to name a few.

6.4 The key benefits of SuDS are as follows:

- Improving water quality over a conventional piped system by removing pollutants from diffuse pollutant sources (e.g., roads);
- Improving amenity through the provision of open green space;
- Improving biodiversity through increased areas for wildlife habitat; and
- Enabling a natural drainage regime that recharges groundwater (where possible).

6.5 SuDS provide a flexible approach to drainage, with a wide range of components from soakaways to large-scale basins or ponds. The individual techniques should be used where possible in a management train that mimics the natural pre-developed pattern of drainage.

Site Areas

6.6 Paragraph 12 of The Environment Agency's Rainfall Runoff for Developments states:

"*Calculation of the runoff volume from the developed site for preliminary assessment and design of drainage facilities will assume 100% runoff from paved areas and 0% runoff from pervious areas. This presumes that sites are developed with a degree of impermeability greater than 50%. Runoff from impermeable surfaces served by effective infiltration systems can be assumed to contribute no runoff for storage volumes assessment assuming the infiltration systems are designed to address the runoff from at least a 10-year event*."

6.7 Therefore, the impermeable areas of the site should be assessed to properly determine the greenfield runoff rates and volumes for the site, which will be used to set the appropriate surface water discharge rates for the development (where needed) and the volume of any attenuation structures.

6.8 The impermeable site areas to undergo development are to be assessed are as follows in Table 6.1.

Table 6.1 – Site Areas

Breakdown of site areas	Proposed (ha)
Total Area	6.568
Total impermeable areas	2.296
Total permeable areas	4.272

Greenfield Runoff Rate

6.9 The greenfield runoff rates have been calculated using HR Wallingford's UKSuDS online calculator and are presented in Table 6.2, below. The greenfield runoff rates have been calculated from the proposed impermeable areas (2.296 ha) in accordance with the requirements of Paragraph 12 of The Environment Agency's Rainfall Runoff for Developments, as these are the parts of the site that will positively drain into the on-site drainage infrastructure. For the purposes of the drainage design and hydraulic modelling, it has been assumed that the undeveloped parts of the site (gardens, verges, beds, etc.) will drain naturally by infiltration or that rainwater will be intercepted by vegetation.

6.10 The full greenfield runoff calculations can be seen in Appendix L.

Table 6.2 – Greenfield Runoff Rate/Volume – Total Impermeable Areas

Return Period	1 in 1	1 in 30	1 in 100	QBAR
Discharge Rate (l/s)	10.53	28.06	38.91	12.39

6.11 The calculated QBAR greenfield runoff rate of 12.39 l/s provides a runoff rate equal to 5.39 l/s/ha.

6.12 As stated above, the greenfield runoff rates in Table 6.2 will be used to guide the appropriate surface water discharge rates and volumes from the development, acknowledging the lowest practicable discharge rates that can be achieved using flow control structures without creating an excessive blockage risk.

The Drainage Hierarchy

6.13 The NPPF states that opportunities to reduce overall flood risk should be sought and achieved through sustainable development and careful drainage design. This can be achieved through the layout and form of development, including green infrastructure and the appropriate application of sustainable drainage systems (SuDS). SuDS are designed to control surface water runoff close to where it falls and mimic natural drainage as closely as possible. They provide opportunities to:

- Reduce the causes and impacts of flooding;
- Remove pollutants from urban run-off at source;
- Combine water management with green space with benefits for amenity, recreation and biodiversity.

6.14 To deliver SuDS benefits and ensure that a development reduces overall flood risk, there is an established hierarchy of surface water drainage methods that should be considered. The most preferable and sustainable are at the top and the least preferable and least sustainable at the bottom.

6.15 The drainage hierarchy is a sequential check that intends to ensure that all practical and reasonable measures are taken to manage surface water as high up the hierarchy (with '1' being the highest) as possible, and that the amount of surface water managed at the bottom of the hierarchy is minimised. The Planning Practice Guidance to the National Planning Policy Framework (NPPF) states that "*Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable*".

6.16 The drainage hierarchy presented in the NPPF presents only four tiers of drainage options. This has been expanded on and adopted by others and now can be viewed as the following:

1. Store rainwater for later use

2. Use infiltration techniques, such as porous surfaces in non-clay areas
3. Attenuate rainwater in ponds or open water features for gradual release
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water sewer/drain
7. Discharge rainwater to the combined sewer
8. Discharge rainwater to the foul sewer

6.17 Developers should not choose the method that is the most convenient or represents the lowest cost. LPA's, LLFA's and Water Authorities may enforce the surface water drainage hierarchy and demand that the highest practicable tier of the hierarchy is used.

6.18 The first two tiers of the drainage hierarchy ensure that surface water is retained within the site boundary and does not increase flood risk to others. This is always the most preferable method of surface water management.

6.19 The next six tiers of the hierarchy provide regional control, but with decreasing levels of pollution removal and reduced potential for amenity and habitat creation.

6.20 Within the lower six tiers of the drainage hierarchy, there must be some form of flow restriction, so that off-site surface water discharge resembles greenfield runoff rates, as much as is reasonably practicable. This requires on-site storage facilities, which may include ponds, swales, subsurface storage tanks and System C (non-infiltration) permeable paviours with flow control devices. Again, methods that provide the most potential for amenity and pollution removal should be favoured.

Drainage Strategy Overview

6.21 The infiltration testing for the site showed that the ground has moderate to good infiltration potential. In acknowledgment of this drainage strategy for the development proposes to use two SuDS basins that will be 'System B' (partial infiltration) and a 'System A' (total infiltration) geocellular soakaway tank. The SuDS basins will offer attenuation on site that provides all four SuDS pillars (water quality and quantity plus amenity and biodiversity benefits) and the geocellular soakaway will discharge surface water entirely on site, reducing the off-site surface water discharge so that it is less than the existing situation. This will reduce surface water flood risk.

6.22 The two attenuating SuDS basins and the geocellular soakaway will each serve one hydraulic 'catchment' on the site. The impermeable areas associated with each catchment and the QBAR greenfield runoff rate for each catchment is as follows in Table 6.3, below.

Table 6.3 – Catchments and their Impermeable Areas/Greenfield Runoff Rates

Catchment	Contributing Imp. Areas (ha)	QBAR Greenfield Runoff Rate	Runoff Rate per hectare
West	0.348	1.88	5.39 l/s
Central	0.843	4.54	5.39 l/s
East	1.105	5.96	5.39 l/s
TOTAL:	2.296	12.38	

6.23 By subdividing the site into catchments, it ensures that surface water from each part of the site has adequate attenuation for the 1 in 100 + 45% rainfall event while discharging at less than or equal to the greenfield runoff rate for that catchment and that the existing hydraulic regime is preserved.

6.24 Geocellular attenuation tanks are also used in two locations 'online' to the drainage system to provide attenuation upstream of the SuDS basins. This ensures that the drainage strategy doesn't rely on an 'end of pipe' solution and that attenuation volume provided at multiple stages across the development's drainage system.

6.25 The System A (total infiltration) geocellular soakaway is located where three full infiltration tests were achieved in accordance with BRE365 protocol.

6.26 Because the site showed successful infiltration at the other trial pit location, but ground conditions precluded three full tests and the mobilisation of the water bowser, the two SuDS basins serving the east and west catchments will be System B (partial infiltration) and an infiltration coefficient will only be applied to the base of the structure as a conservative approach. Both of these SuDS basins are adjacent to existing ordinary watercourses and can outfall to them by gravity.

6.27 The discharge rate for the eastern SuDS basin will be 6.5 l/s, which is marginally higher than the QBAR greenfield runoff rate for this catchment. The discharge rate for the western SuDS basin will be 1.7 l/s, which is less the QBAR greenfield runoff rate for this catchment. The central catchment will discharge entirely by infiltration, so much less than the 4.54 l/s QBAR greenfield runoff rate for this catchment.

6.28 Because the central catchment is discharging entirely via infiltration, this gives the development a total offsite discharge rate of 8.2 l/s, which is only 66% of the QBAR greenfield runoff rate for the whole development's impermeable areas. Therefore, this provides the site with a better-than-greenfield discharge rate and a betterment over the current undeveloped situation.

6.29 The proposed layout of the drainage strategy can be seen in Appendix M of this report, which displays the locations of the drainage layout and features, the SuDS basins and the proposed outfalls.

Urban Creep

6.30 An appropriate allowance should be made for urban creep throughout the lifetime of the development as per 'BS 8582:2013 Code of Practice for Surface Water Management for Developed Sites'.

6.31 In terms of impermeable areas, an uplift of 10% should be applied to the proposed impermeable areas to account for future development that may increase areas of hardstanding. This is because, as residential developments mature, property owners may extend patios, install decking, or increase driveways to accommodate extra vehicles.

6.32 The proposed site layout for the development and the discussion of proposed impermeable areas in Table 7.1 shows that impermeable areas are currently planned to be 2.296 ha. During the development of the MicroDrainage Network hydraulic model a 10% uplift in impermeable areas was also included to represent the effects of urban creep. An additional 10% as a percentage of the total flow was added to the Simulation Criteria and incorporated into the hydraulic model.

6.33 The results of the hydraulic modelling, inclusive of urban creep, will be discussed later in this report. At this stage, it should be noted that the proposed drainage strategy can attenuate all surface water arising in the 1 in 100-year + 45% rainfall event, inclusive of a 10% uplift due to urban creep, without flooding.

6.34 It should be borne in mind that homeowners would only have the right to make changes to the dwellings and areas within the gardens; they would not have the right or responsibility to make changes to the access road or co-owned parking courts, for example. Therefore, in terms of urban creep, the total impermeable areas of 2.296ha would not increase by 10% and the actual increase in impermeable areas would be less. Therefore, a site-wide impermeable area increase of 10% can be viewed as a precautionary approach.

6.35 This approach to the layout and design of the surface water drainage strategy for the development has been outlined. With specific reference to each tier of the drainage hierarchy, the proposed drainage strategy is discussed, below.

Tier 1 - Store rainwater for later use

6.36 Water re-use systems can rarely manage 100% of the surface water discharged from a development. This requires the surface water yield from the building and hardstanding areas to balance perfectly with the demand from the proposed development; too much demand will result in lack of water supply; too little demand will cause the storage systems to become overwhelmed and could result in flooding when the next rainfall event happens. Consequently, even if there are opportunities and a need for rainwater recycling systems, further solutions for attenuating and discharging surface water will almost always be required.

6.37 There is likely to be a moderate rainwater yield from the roof areas of the development that could be used for domestic non-potable water uses. The proposed development includes landscaping that may benefit from having a supply of recycled rainwater for the watering of gardens, beds, etc.

6.38 The opportunity for water re-use and recycling on site has been explored and this report recommends the use of water butts for each property. These will reduce the reliance on potable water supplies during activities such as gardening and car washing. They can also provide small amounts of storage for surface water. The typical types and storage volumes of water butts are in Table 7.3, below:

6.39 Water butts can also provide small amounts of storage for surface water and can often assist in achieving zero discharge for rainfall depths up to 5mm, which covers 50% of annual rainfall events (according to the EA's Rainfall Runoff Management for Developments report – SC030219). This would also capture contaminants carried within the 'first flush' of the initial surface water runoff in a storm.

Table 7.3 - Types and storage volumes of water butts

Typical Water Butt Options	Dimensions (m)	Storage Volume Provided
Type 1 (wall-mounted - small)	1.22 x 0.46 x 0.23	100 litres (0.10m^3)
Type 2 (standard house water butt)	0.9 x 0.68 diameter	210 litres (0.21m^3)
Type 3 (large house water butt)	1.26 x 1.24 x 0.8	510 litres (0.50m^3)
Type 4 (column tank – very large)	2.23 x 1.28 diameter	2000 litres (2.00m^3)

6.40 This report recommends that at least 1no. 'Type 2' standard water butt is installed on each property. Because there are proposed to be 116 dwellings, this approximately equates to up to 24,360 litres (24.36m^3) of surface water attenuation and recycled water on site.

6.41 The surface water storage available in the water butts has not been included in any hydraulic calculations as it can't be guaranteed that they will be empty at the start of a rainfall event.

Tier 2 - Use Infiltration techniques, such as porous surfaces in non-clay areas

6.42 As discussed earlier in this report, soakage tests were carried out on site. However, due to ground conditions and issues with moving the water bowser around the site, it was only possible to carry out a single BRE365-compatible test within the available time window. This soakage test showed moderate to good infiltration rates on the first, second and third tests. Another soakage test carried out, but only two fillings of the trial pit were possible with the remaining time. The two fillings yielded similar results to the first trial pit, which suggests that had a third filling been possible, this would have produced another successful BRE365 compatible soakage test.

6.43 Therefore, the drainage strategy has used infiltration. As discussed above, the geocellular tank in the location of the successful BRE365 soakage test has had an infiltration rate of 2.63×10^{-5} m/sec applied to the sides and base of the structure and is performing as a System A 'Total Infiltration' structure and no outfall is necessary. The size and location of this geocellular attenuation tank can be seen in the plan in Appendix M.

6.44 The two SuDS basins in the west and east of the site did not have soakage tests carried out in their specific locations, thus these will not be relied upon for total infiltration and will be used as System b' Partial Infiltration' structures. The soakage rate of 2.63×10^{-5} m/sec has been applied to just the base of the structures, which provides a conservative approach to the infiltration potential of the infiltration basins, which will have side slopes of 1 in 4 and will provide significant surface area.

6.45 It should be noted that 2.63×10^{-5} m/sec is the slowest infiltration rate encountered across all the soakage tests, thus is being used as a conservative rate. For the purposes of MicroDrainage, a soakage rate of 2.63×10^{-5} m/sec translates to 0.0947 m/hour, which is the rate used in the hydraulic calculations.

6.46 The rate of 0.0947 m/hour has also been applied to the geocellular attenuation tanks within the drainage system, acknowledging that the attenuated surface water in these structures would also be able to discharge via infiltration.

Tier 3 - Attenuate rainwater in ponds or open water features for gradual release

6.47 It is proposed to attenuate surface water within two open SuDS basins on the site in the locations discussed above, and these are shown in the drainage strategy layout plan in Appendix M.

6.48 The size, dimensions, cover levels and depths of the two SuDS basins are shown in the plan in Appendix M. The basins will have side-slopes of 1 in 4 to be compliant with local and regional design guidance on SuDS ponds.

6.49 As discussed already in this report, the two SuDS basins will attenuate surface water and use partial infiltration from their bases only.

6.50 Discharge from the two 'partial infiltration' SuDS basins will be to their adjacent ordinary watercourse. Discharge will be restricted at or near to the QBAR greenfield runoff rate for the impermeable areas draining to each of the SuDS basins, thus preserving the pre-existing hydraulic regime of each catchment.

6.51 The SuDs basins have been designed so that the maintain 300mm 'freeboard' between the highest water level in the design storm and the top of the bank of the basin. This provides space for exceedance events.

Tier 4 - Attenuate rainwater by storing in tanks or sealed water features for gradual release

6.52 There are to be 2no. geocellular attenuation tanks positioned online to the drainage system, which will offer useful mid-site attenuation and means that the development is not reliant on an end-of-pipe solution to the management of surface water on site.

6.53 The size and location of the attenuation tanks can be seen in the drainage layout plan in Appendix M. Discharge from the attenuation tanks will also be restricted using flow control devices to maximise their attenuation volume.

Tier 5 - Discharge rainwater direct to a watercourse

6.54 The two System B (partial infiltration) attenuation basins serving the eastern and western catchments of the site will discharge to their adjacent ordinary watercourses by gravity at or near to the QBAR greenfield runoff rate, as detailed in Table 6.3.

6.55 The discharge rate for the eastern SuDS basin will 6.5 l/s. The discharge rate for the western SuDS basin will be 1.7 l/s.

6.56 As noted above, this total offsite discharge rate is only 8.2 l/s, which is less than the whole site QBAR greenfield runoff rate of 12.38 l/s.

Tier 6 - Discharge rainwater to a surface water sewer/drain

6.57 This tier of the drainage hierarchy will not be needed for surface water discharge, however, it should be noted that downstream of the proposed discharge from the western catchment, the ordinary watercourse is listed as becoming a public surface water sewer at the point it is culverted.

Tier 7 - Discharge rainwater to the combined sewer

6.58 It is anticipated that this tier of the drainage hierarchy will not be needed for surface water discharge.

Tier 8 - Discharge rainwater to the foul sewer

6.59 It is anticipated that this tier of the drainage hierarchy will not be needed for surface water discharge.

MicroDrainage Hydraulic Modelling

6.60 The drainage strategy outlined above has been designed in MicroDrainage's Network hydraulic modelling module.

6.61 The results of the MicroDrainage hydraulic modelling for the proposed development can be seen in Appendix N.

6.62 The results of the hydraulic modelling show that the drainage strategy as outlined above can attenuate and discharge all surface water generated in the 1 in 100-year + 45% rainfall event, inclusive of a 10% uplift for urban creep, without flooding, while never discharging at greater than 8.2 l/s.

7.0 Foul Water Drainage

7.1 Southern Water's asset plans in Appendix H show that there is a 150mm public foul sewer that runs south-north along Chichele Road and past the entrance to the site.

7.2 This shows that there is a public foul sewer in close proximity to the site, which would potentially be able to accept a connection from the site, subject to confirmation from Southern Water that there is capacity or whether network reinforcement is needed.

7.3 The peak foul flow rate from the proposed development has been calculated based on Southern Water's foul sewerage modelling criteria, the details of which can be found in Appendix O. In summary, the calculation is based on the foul flow element, plus an allowance for misconnected surface water.

7.4 Based on Southern Water's foul sewerage modelling criteria, the calculated design foul flows from the proposed residential development are 0.85 l/s.

7.5 However, Foul Sewage will need to be pumped from the site, thus the discharge rate will not be the peak foul flows, but the minimum pump rates while the pumps are in use. This is typically between 2.5 – 3.5 l/s.

7.6 Foul waste will be pumped to the existing 150mm dia. foul sewer in Chichele Road and a capacity check will be carried out with Southern Water in due course.

7.7 Any foul pump stations should be provided with a segregated compound with access for maintenance. If the foul pumping station is to be adopted, the compound will require at least 15m distance from any part of a habitable building to minimise the impact of noise and odours. This "full deed of easement" can be agreed with Southern Water should the site's drainage be offered up for adoption.

8.0 Surface Water Runoff Quality

8.1 The NPPF states that developments should not have a detrimental impact on the environment, including the water environment. The technical guidance to the NPPF provides further advice on the benefits of ensuring runoff quality is to an appropriate standard.

8.2 The CIRIA SuDS Manual provides guidance on the treatment of surface water runoff. With regards to the proposed development on the land north of Chichele Road, Table 4.3 of the CIRIA SuDS Manual rates the pollution hazard from roof water runoff as 'very low'. The only requirement for roof water runoff is the removal of gross solids and sediments, which would be achieved using standard catchpits across the drainage network.

8.3 With regards to the property driveways and the access roads, Table 4.3 of the CIRIA SuDS Manual rates the pollution hazard from residential car parking and low traffic roads as 'low'. To mitigate a 'low' pollution hazard, the CIRIA SuDS Manual recommends using a simple index approach in line with Section 26.7.1. This is discussed, below.

8.4 Table 26.2 of the CIRIA SuDS Manual provides pollution hazard indices for different land use classifications. The land use classification that requires consideration for the parking areas on the site is in Table 8.1 below.

Table 8.1 – Excerpt from Table 26.2 of CIRIA SuDS Manual

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydro-Carbons
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de-sacs, homezones and general access roads with less than 300 traffic movements a day)	Low	0.5	0.4	0.4

8.5 To deliver adequate pollution treatment and mitigation, the CIRIA SuDS Manual recommends using a SuDS component that has a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index (for each contaminant type).

8.6 Table 26.3 of the CIRIA SuDS Manual provides indicative SuDS mitigation indices for each SuDS type. Table 8.2, below, which is an excerpt from Table 26.3, shows the mitigation index for SuDS basins.

Table 8.2 – Excerpt from Table 26.3 of CIRIA SuDS Manual

Type of SuDS Component	Total Suspended Solids (TSS)	Metals	Hydro-Carbons
Attenuation Basins	0.5	0.5	0.6

8.7 The mitigation indices for attenuation basins match or exceed those of the highest pollution hazard index figures from Table 8.1. Therefore, the development on the land north of Chichele Road can be done in the knowledge that it will be possible to mitigate the expected pollution hazards encountered on site.

9.0 Exceedance Events

9.1 The LLFA wish to see as part of a drainage strategy evidence that the drainage designers have considered 'exceedance events'.

9.2 Exceedance events are those greater than the design rainfall event (i.e., greater than the 1 in 100-year rainfall event plus 45% for climate change).

9.3 Any rainfall events greater than the design rainfall event may cause flooding due to them 'exceeding' the capacity of the drainage system. In this situation it is imperative to check whether flooding would occur and, if so, whether it needs to be contained on site. Exceedance flows should not ingress into any properties on site and should not cause nuisance to any neighbouring sites or buildings.

9.4 Therefore, this drainage strategy has been developed in conjunction with the site layout to ensure that no dwellings are positioned in the low spots on the site. This means that in an exceedance event, no properties will be flooded. The SuDS basins are in the lowest parts of the site.

9.5 The SuDS basins have been designed to have 300mm freeboard as well, so if there is an exceedance event these will have capacity for further surface water attenuation, which reduces flood risks off site.

9.6 Because the drainage strategy for the site is only discharging at (or less than) the QBAR greenfield runoff rate, the local drainage ditches will actually be running at a low level, thus there may also be capacity in the drainage network for additional flow during higher order and exceedance rainfall events.

10.0 Residual Risk

10.1 Whilst the drainage strategy for the development has been designed to attenuate surface water from the 1 in 100-year plus 45% rainfall event, plus an inclusion for urban creep, there could be a small residual risk of flooding due to blockage or failure of on-site infrastructure. Therefore, appropriate and regular maintenance of the drainage infrastructure should be undertaken by the site management company or their agents (and the residents, where applicable).

10.2 To assist with this process, a Drainage Management and Maintenance Plan has been prepared, which sets out the principles for the long-term management and maintenance of the proposed surface water drainage system on the development. The Drainage Management and Maintenance Plan can be seen in Appendix P.

10.3 The purpose of this document is to ensure that those responsible for site maintenance have a robust inspection and maintenance plan going forwards. This will help ensure the optimum operation of the surface water drainage system and that it will be regularly maintained for the lifetime of the development. This will contribute to reducing the risk of surface water flooding both on- and off-site.

11.0 Summary and Conclusion

11.1 This Flood Risk Assessment (FRA) and drainage strategy has been produced by Motion on behalf of CALA Homes Ltd to support the planning application for 116 residential units on the land to the north of Chichele Road, Oxted.

11.2 The site is located within Flood Zone 1 according to the Environment Agency's (EA's) Flood Map for Planning and is at low risk from 'local' forms of flooding. As such, the development is appropriate in this location.

11.3 Each tier of the drainage hierarchy has been considered. This has been done with reference to the geotechnical and geo-environmental conditions that exist on site, as well the topography and the availability of options for surface water discharge.

11.4 The infiltration testing for the site showed that the ground has moderate to good infiltration potential and so the drainage strategy for the site proposes to use a network of SuDS basins and a geocellular soakaway, which will discharge surface water by a mixture of infiltration and discharge to the local system of drainage ditches, which are proven to have ongoing connectivity. There are to be two SuDS basins (one in the east of the site and one in the west), both of which will use partial infiltration and discharge to the adjacent drainage ditches. The geocellular soakaway will be located in the centre of the site and will discharge surface water entirely by infiltration.

11.5 Geocellular attenuation tanks are also used in two locations 'online' to the drainage system to provide attenuation upstream of the SuDS basins. This ensures that the drainage strategy doesn't rely on an 'end of pipe' solution and that attenuation volume provided at multiple stages across the development's drainage system.

11.6 The discharge rate for the eastern SuDS basin will be 6.5 l/s, which is marginally higher than the QBAR greenfield runoff rate for this catchment. The discharge rate for the western SuDS basin will be 1.7 l/s, which is less the QBAR greenfield runoff rate for this catchment. The central catchment will discharge entirely by infiltration.

11.7 Because the central catchment is discharging entirely via infiltration, this gives the development a total offsite discharge rate of 8.2 l/s, which is only 66% of the QBAR greenfield runoff rate for the whole development's impermeable areas. Therefore, this provides the site with a better-than-greenfield discharge rate and a betterment over the current undeveloped situation. Flood risk will be significantly reduced in the higher-order rainfall events.

11.8 Hydraulic modelling has been carried out in MicroDrainage's Network hydraulic model and a 10% uplift in impermeable areas was also included to represent the effects of urban creep. The results of the hydraulic modelling showed that the proposed drainage strategy can attenuate all surface water arising in the 1 in 100-year + 45% rainfall event, inclusive of a 10% uplift due to urban creep, without flooding.

11.9 A drainage management and maintenance plan has been produced to demonstrate how the site's drainage infrastructure should be maintained going forward.

11.10 In summary, the site is at low risk of flooding and can sustainably attenuate and discharge surface water with no flooding in the design storm. Rainfall generated in the 1 in 100-year + 45% rainfall event can be attenuated on site, with an inclusion for urban creep, and is to be discharged at less than the QBAR greenfield runoff rate. This reduces flood risk on site and in the local area, this provides a betterment over the existing situation. As such, the principles of the site's management of flood risk and drainage have been fully established and should not form an impediment to the progress of this application.