GeoSmart Information

SuDSmart Plus

Sustainable Drainage Assessment

Site Address

Chadwell Clinic
River View
Chadwell St Mary
RM16 4BA

Grid Reference

564145, 178507

Report Prepared for

V K Homes Ltd

Date

2023-06-22

Report Status

FINAL

Site Area

0.08 ha

Report Reference

79509R1

Discharge to Ground

The proposed Sustainable Drainage Scheme (SuDS) strategy is comprised of a rainwater harvesting, permeable paving and BioMat to treat and discharge surface water runoff.

Surface water will be discharged to ground, subject to infiltration testing and the incorporation of SuDS.

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1 Executive summary

This report assesses the feasibility of a range of Sustainable Drainage Scheme (SuDS) options in support of the Site development process. A SuDS strategy is proposed to ensure surface water runoff can be managed effectively over the lifetime of the development.

SuDS suitability

Risk	Issue	Result
Discharge Location	What is the infiltration potential at the Site?	Moderate
	What is the potential to discharge to surface water features?	Low
	What is the potential to discharge to sewers?	High
	What is the potential to discharge to highway drains?	High
Flooding	What is the river (fluvial) flood risk at the Site?	Very Low
	What is the surface water (pluvial) flood risk at the Site?	Very Low
	What is the groundwater flood risk at the Site?	Negligible
Pollution	Is the groundwater a protected resource?	Yes
	Is the surface water feature a protected resource?	N/A

Summary of existing and proposed development

The Site is currently used within a commercial capacity. At present there is a single building with car park and landscaped areas. Development proposals comprise the construction of a three storey block containing 9 flats, associated parking and soft landscaping.

Summary of discharge routes

GeoSmart's SuDS Infiltration Potential (SD50) map indicates the Site has a Moderate potential for infiltration, primarily due to the variable permeability of the underlying geology. Infiltration to ground is therefore potentially feasible.

Ordnance Survey (OS) mapping indicates a surface water feature is not located within 100 m south and east of the Site. Discharging surface water runoff to the nearest surface water feature would require drainage pipework to cross a significant distance across third-party, urbanised land and therefore, discharge into this feature should not be considered.

The Anglian Water Sewer Asset Location search included in Appendix C confirms the Site is located within 5 m of the public sewer network, located within the highway of River View adjacent to the southern Site boundary. Due to the short distance to nearby sewers discharging surface water runoff to the sewer is feasible.

According to Google Streetview, highway gullies are located within River View, indicating the presence of the highway drainage network.

Runoff rate and attenuation requirements

Discharging via infiltration requires 45.6m^3 of attenuation to be provided to ensure there is no flooding as a result of the development in all storm events up to and including the 1 in 100 year including a 45% allowance for climate change. This volume is subject to the results of infiltration testing and would ensure runoff is not increased above the greenfield scenario.

Discharging off-Site requires 59.4 m^3 of attenuation to be provided to ensure there is no flooding within the development in all storm events up to and including the 1 in 100 year including a 45% allowance for climate change. This volume is subject to the discharge rate being restricted to 1 l/s (as close to the Greenfield 1 in 1 year rate as possible, without increasing the potential for blockages).

Proposed SuDS strategy

SuDS features comprised of rainwater harvesting, permeable surfacing and BioMat are proposed to attenuate a minimum of 59.4m^3 of surface water runoff. The SuDS features would provide some water quality benefits (interception and filtration) prior to infiltrating to ground. Focused infiltration features should be sited at least 5m from building foundations and 2-3m from adjacent highways.

The proposed SuDS strategy would ensure surface water runoff is stored on-Site in SuDS features for the 1 in 100 year event including a 45% allowance for climate change and will not cause flooding to the proposed development in accordance with DEFRAs non-statutory technical standards (DEFRA, 2015).

SuDS & drainage network maintenance

The management and maintenance of the SuDS features, in line with the details and schedules outlined in Section 10 of this report, will be undertaken by contractors appointed by the owners and occupiers of the new residential building, where payments for the works will form part of the property deeds and / or rental agreements.

Recommendations

A site investigation is required to confirm the infiltration capacity of the ground in line with BRE 365 guidelines to confirm the infiltration rate and the groundwater level.

Where site investigation confirms the underlying ground conditions are not conducive to infiltration and where discharging to surface watercourse is not viable, the capacity of the public sewer network should be confirmed with the utility provider and gain permission to connect where required.

2 Proposed SuDS strategy

The most suitable SuDS options are outlined below and a SuDS strategy schematic is shown overleaf. Supporting information is provided in subsequent sections.

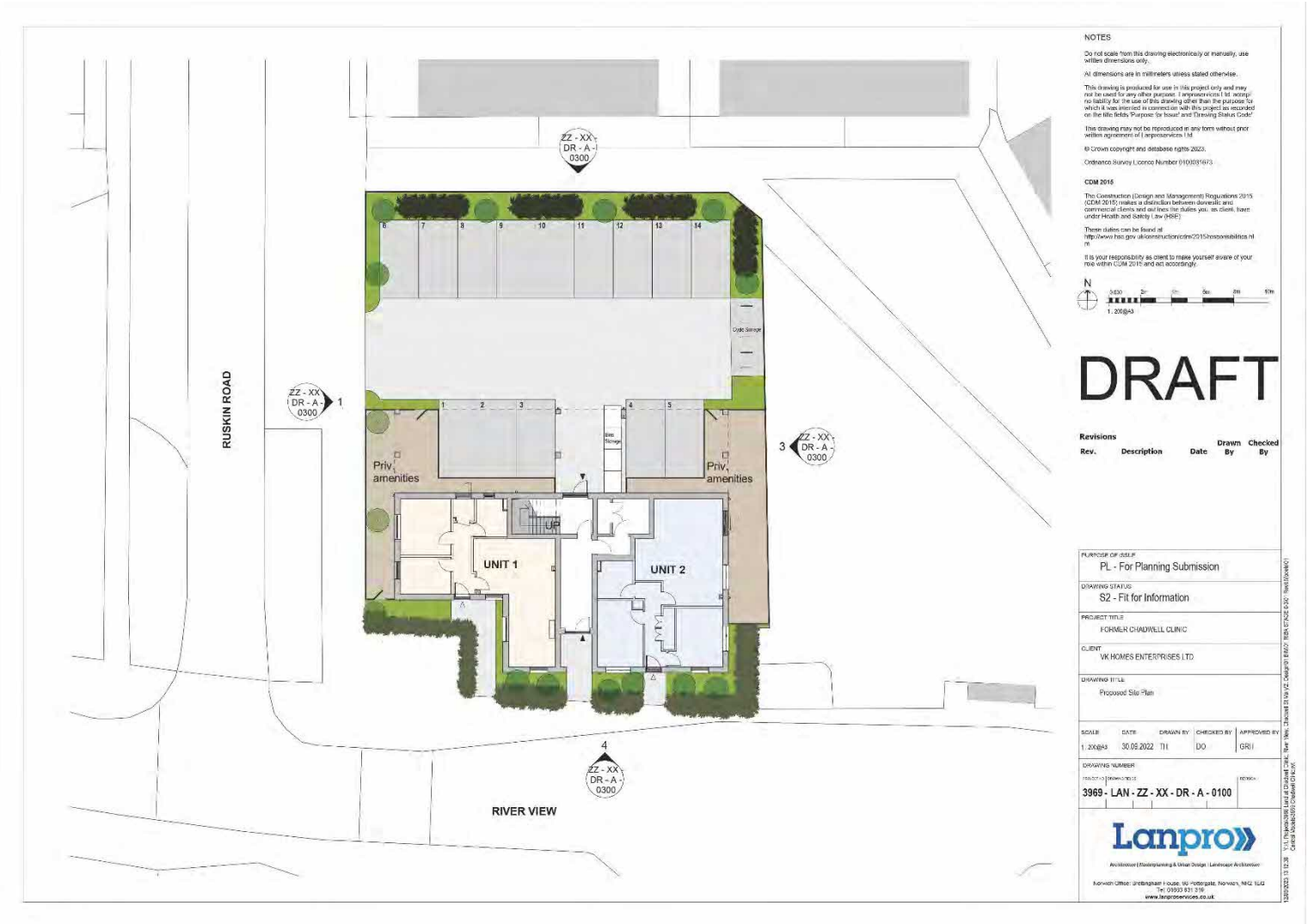
Table 1. Proposed SuDS type, features, discharge location and rate restriction

SuDS type	Source control (interception) and infiltration SuDS.
SuDS features	Rainwater harvesting, permeable paving and BioMat
Discharge location	Infiltration
Discharge rate	1 x 10^{-5} m/s This is based on the worst-case infiltration rate for sand as per Table 25.1 of the CIRIA SuDS manual (2015).*

*Subject to confirmation through infiltration testing. See Appendix B for associated runoff and discharge calculations.

Table 2. Proposed SuDS sizing (dimensions) and attenuation volumes

Rainwater Harvesting	Rainwater harvesting butts should be established for the proposed development. In terms of attenuation storage within this scheme, the volume of run-off which could be attenuate rainwater harvesting has not been considered within the Preliminary SuDS schematic.
Permeable paving	A 380 m^2 area of permeable paving (underlain with a Type 3 aggregate material) and BioMat for required additional treatment stages within the proposed driveway areas to a depth of 0.40 m, with a 30% porosity would result in c. 45.6 m^3 attenuation.
Total Attenuation Provided	45.6 m^3
Total Attenuation Required	45.6m^3


RUSKIN ROAD
RIVER VIEW
ZZ - XX - DR - A - 0300
UNIT 1
UNIT 2
Priv. amenities
Priv. amenities
UP
Cycle Storage
Bin Storage
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DRAFT
Revisions
Rev. Description Date Drawn By Checked By
PURPOSE OF ISSUE
PL - For Planning Submission
DRAWING STATUS
S2 - Fit for Information
PROJECT TITLE
FORMER CHADWELL CLINIC
CLIENT
VK HOMES ENTERPRISES LTD
DRAWING TITLE
Proposed Site Plan
SCALE DATE DRAWN BY CHECKED BY APPROVED BY
1:200@A3 30.06.2022 TH DO GRH
DRAWING NUMBER
3969 - LAN - ZZ - XX - DR - A - 0100
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3 Site analysis

Site location

Figure 2. Aerial Imagery (Bluesky, 2023)

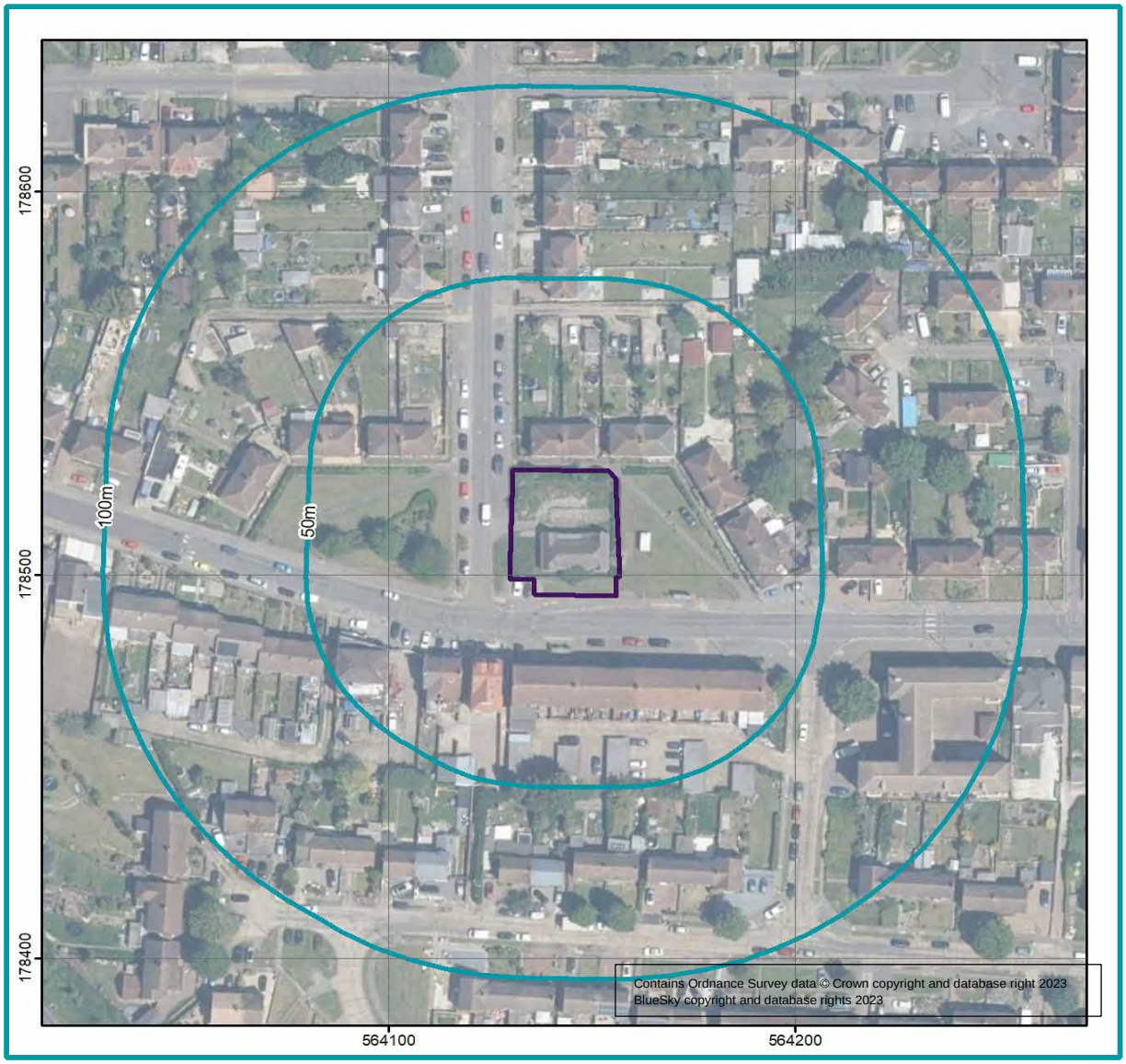
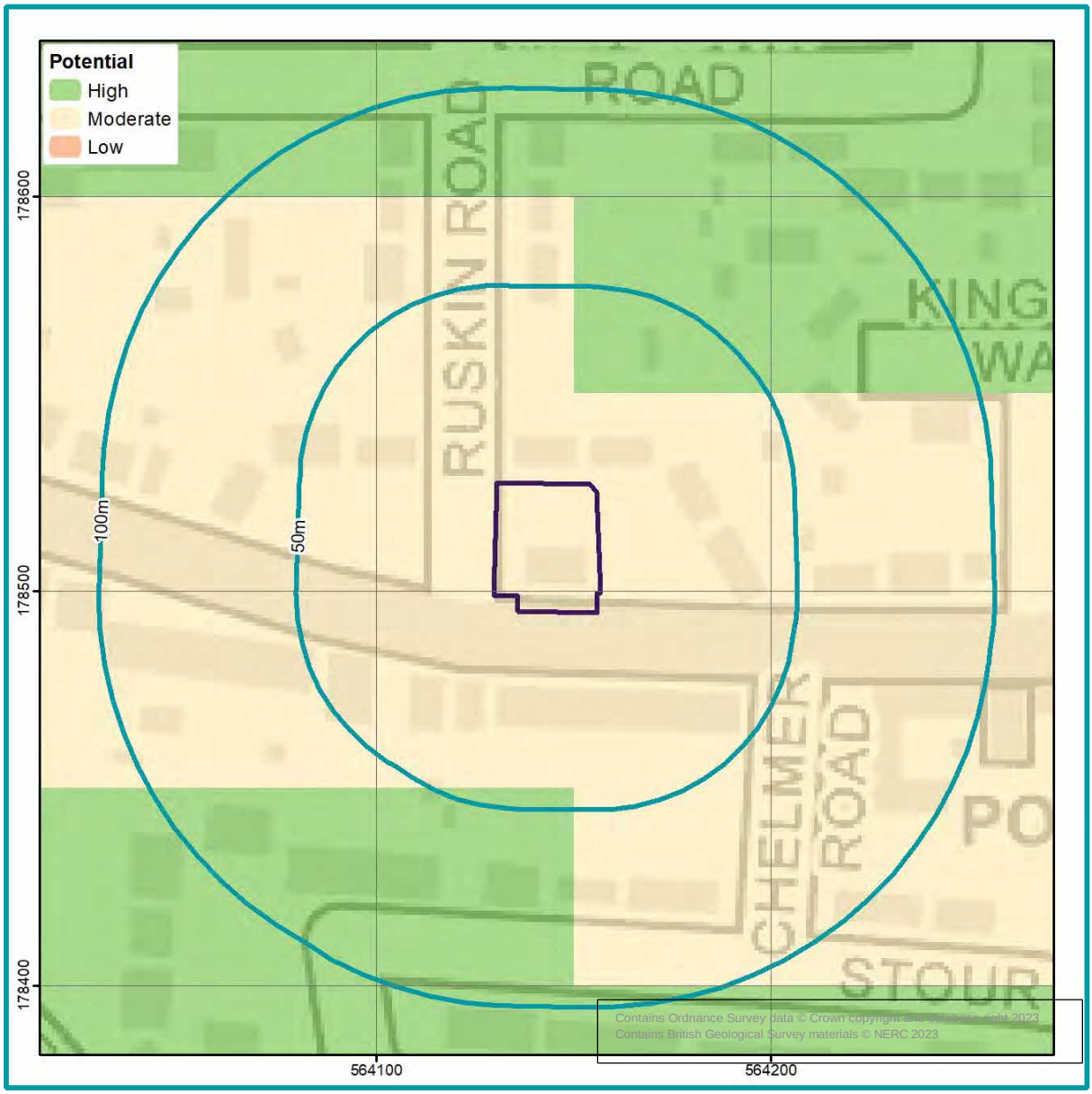


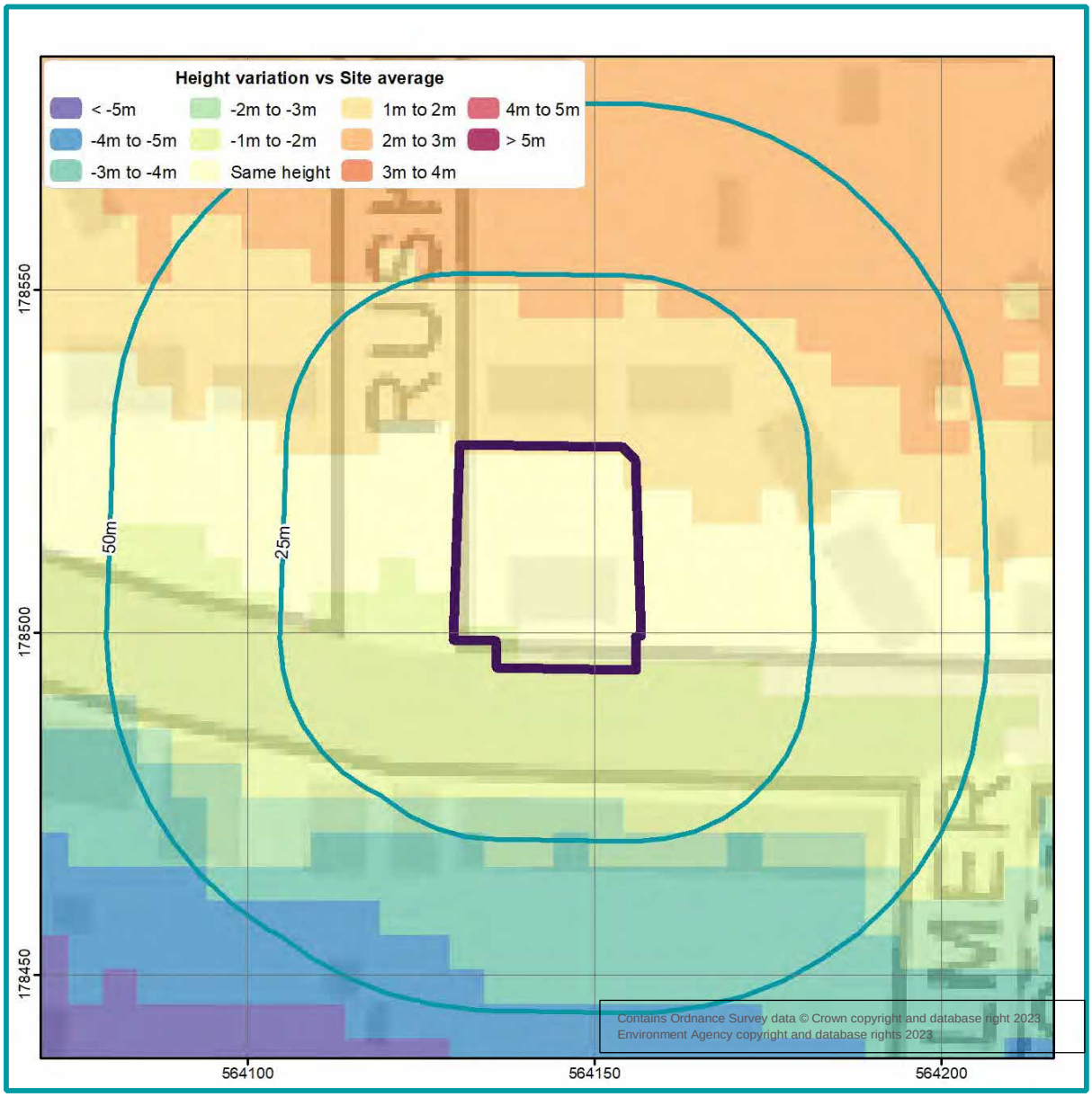
Figure 3. SuDS infiltration suitability (SD50) map (GeoSmart, 2023)



The GeoSmart SuDS Infiltration Suitability Map (SD50) screens the potential for infiltration drainage at the Site and indicates where further assessment is recommended. The map combines information on the thickness and permeability of the underlying material and the depth to the high groundwater table. It supports conceptual Site drainage design and the planning of further Site investigation.

There is a Moderate potential for infiltration SuDS across the Site. It is likely that the underlying geology at the Site has variable permeability, and an infiltration SuDS scheme may be possible at the Site.

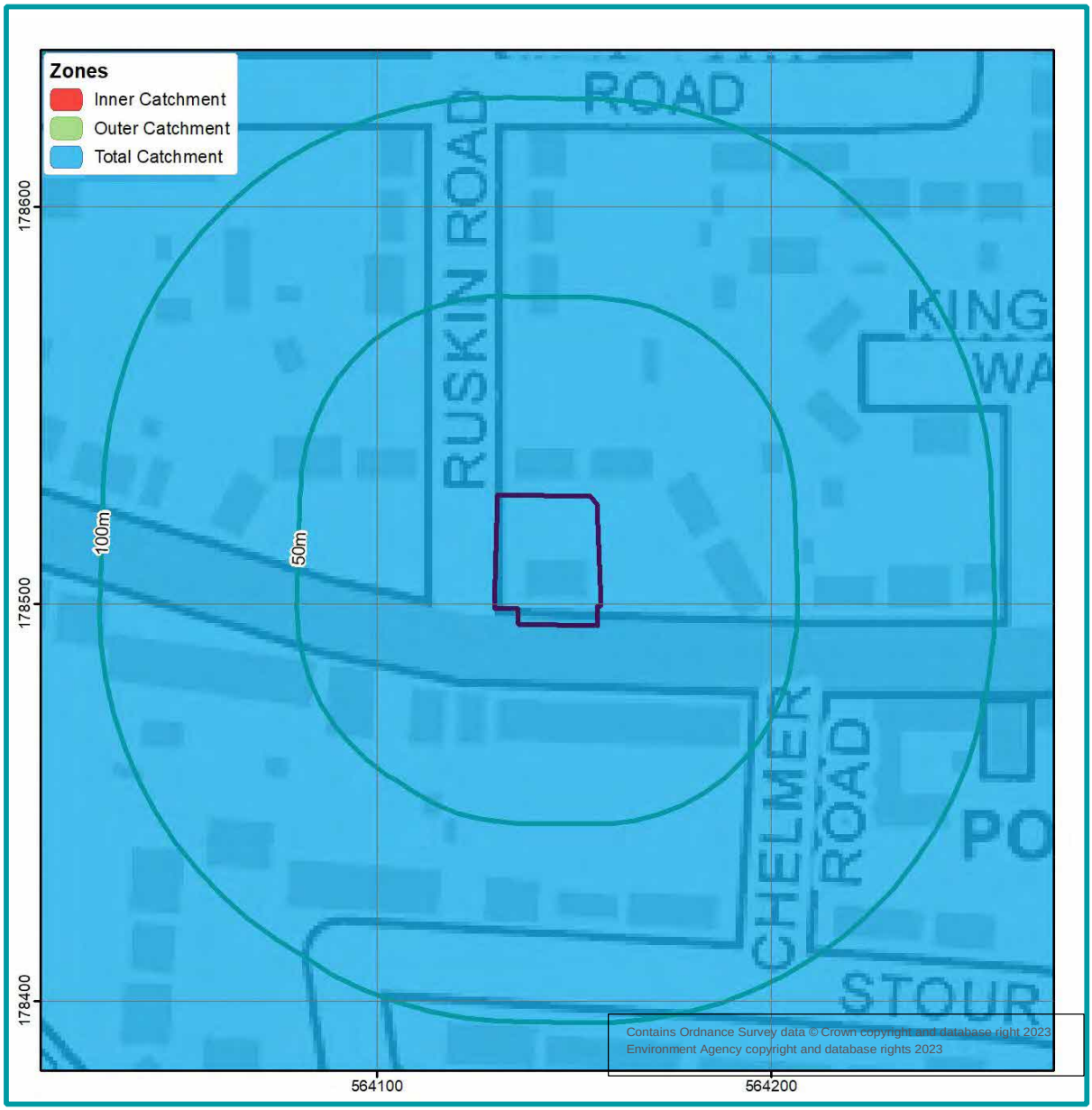
Figure 4. Site topography (GeoSmart, 2023)



An assessment of the topography at the Site has been undertaken using LiDAR DTM5 elevation data to identify the general slope and any localised depressions. The mapping shows a comparison between average ground levels on the Site with ground levels in the surrounding area. The mapping confirms the overall Site is on a gradual slope to the southwest.

Further analysis could be undertaken by visiting the Site or by collecting additional topographic survey to provide further confirmation of ground levels.

Figure 5. Source protection zone map (EA, 2023)

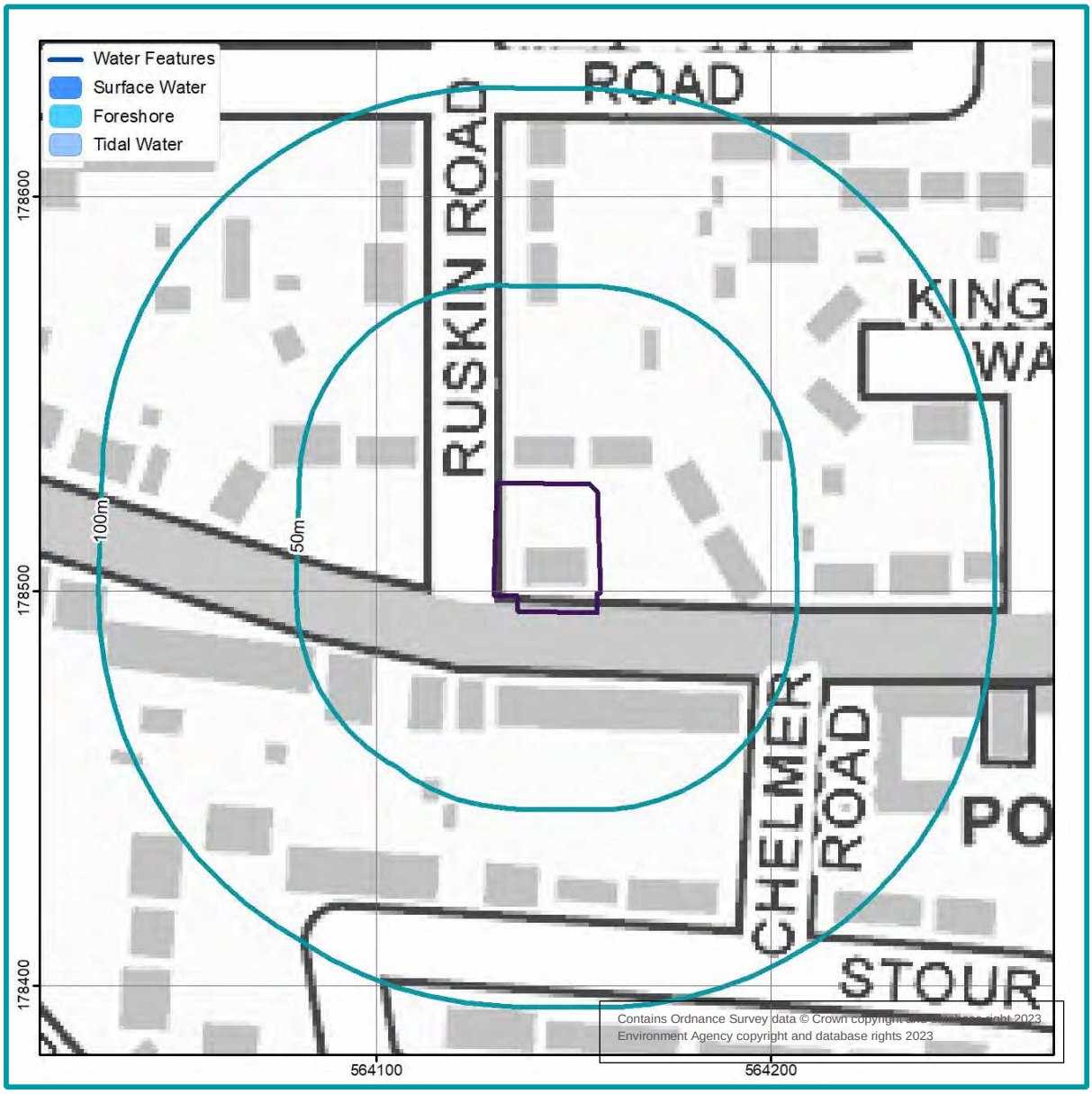


An assessment of the EA's groundwater Source Protection Zones (SPZs) has been undertaken within the vicinity of the Site and confirms the Site lies within a total groundwater Source Protection Zone (SPZ III).

Infiltration, if possible, is likely to be acceptable providing risk screening identifies suitable mitigation measures, if required, to prevent an impact on water quality from the proposed or historical land use and contaminated land.

If further analysis is required, this would involve a review of Site specific contaminated land data. If hazards are identified, it is recommended that the Local Authority and the Environment Agency are contacted to confirm the susceptibility of any SPZs within the wider area.

Figure 6. Surface water features map (EA, 2023)

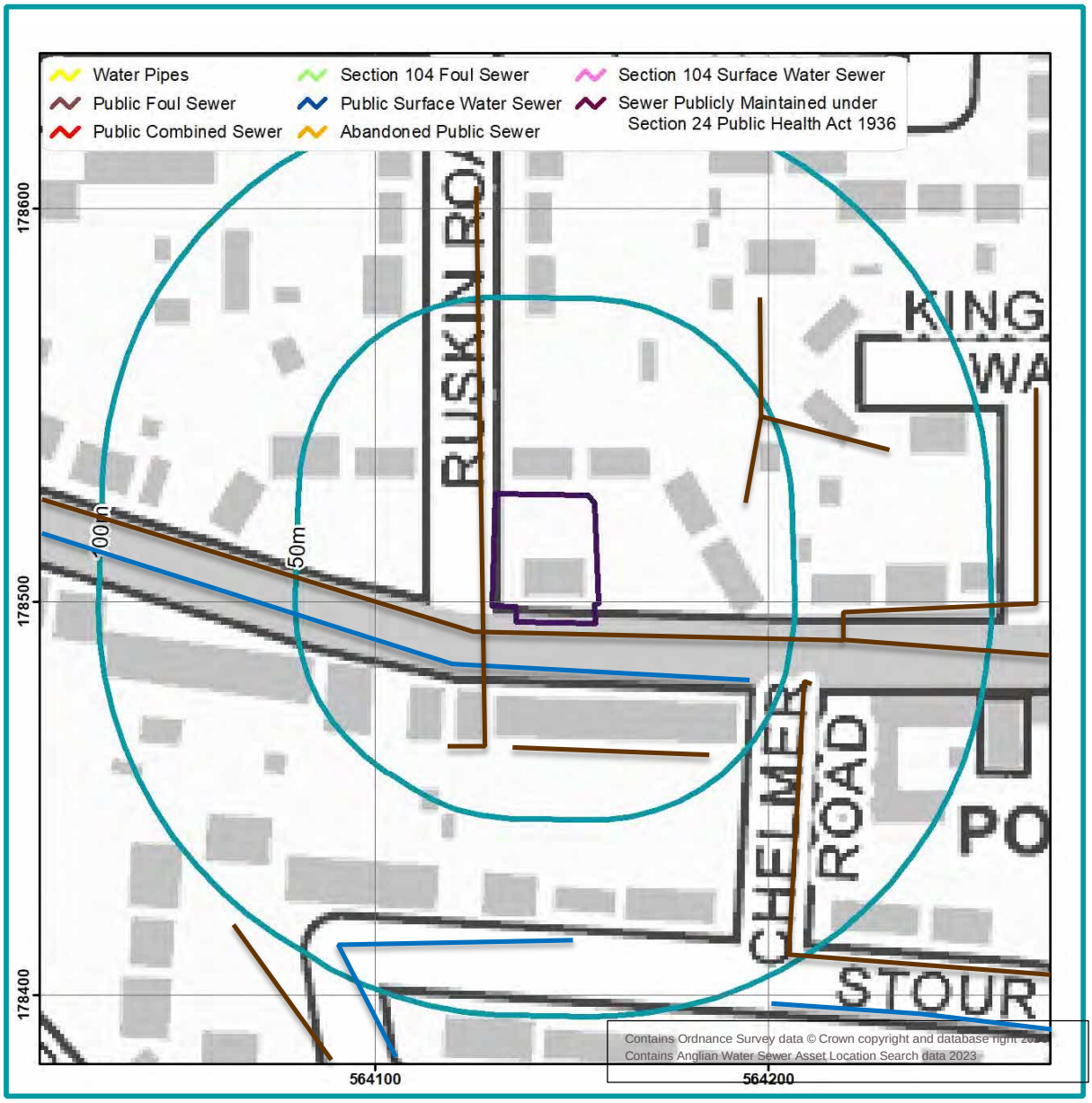


OS mapping indicates a surface water feature is not located within 100 m of the Site. According to DEFRA's Magic Map, the Site is not within 250m of a SSSI or SPA.

Discharging surface water runoff to the nearest suitable surface water feature would require drainage pipework to cross a significant distance across third-party, urbanised land and therefore, should not be considered.

Further analysis could be undertaken by visiting the Site or by contacting the Local Council and the Environment Agency (EA) to confirm the presence, location and condition of any mapped or additional unmapped surface water features.

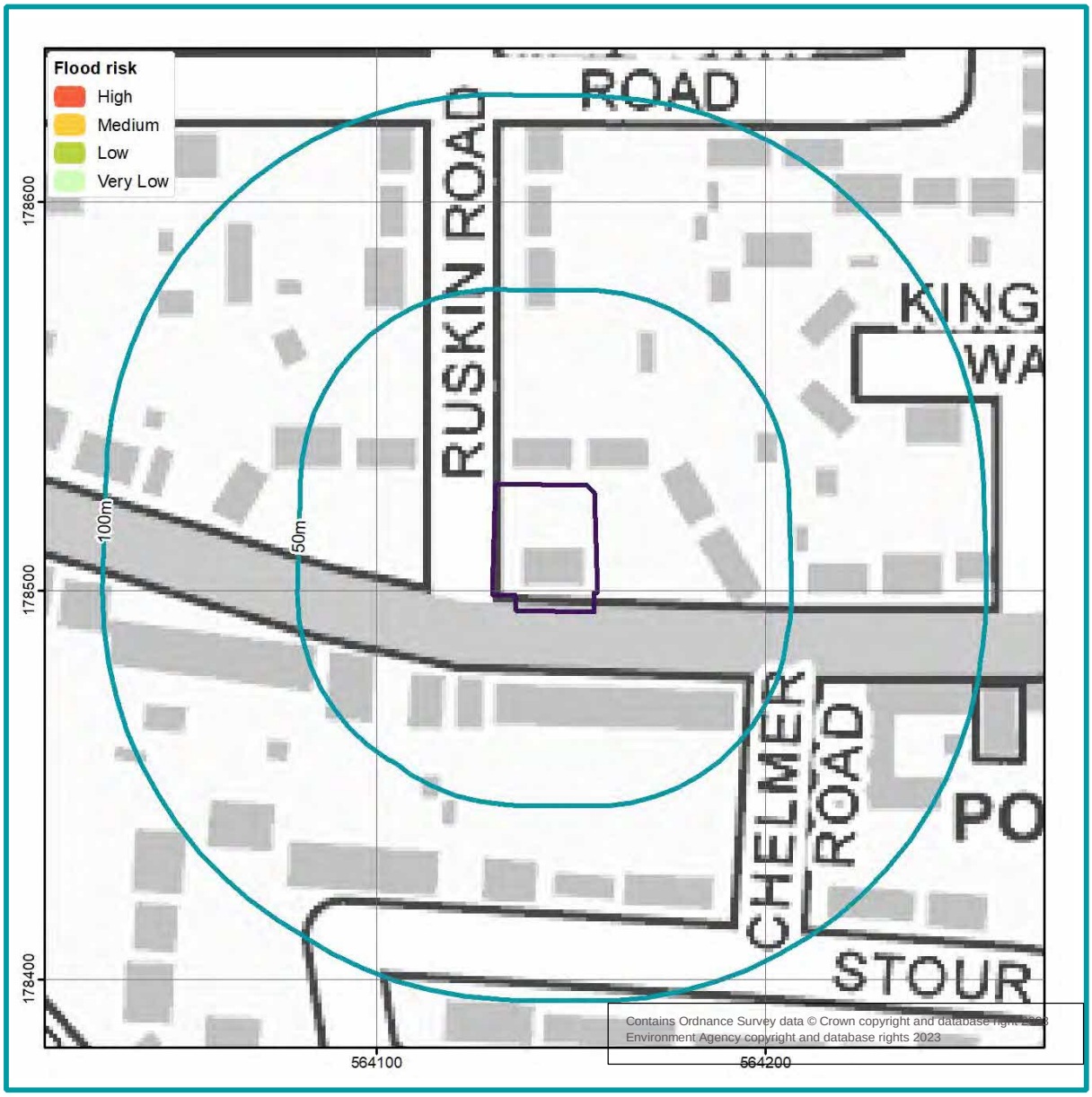
Figure 7. Sewer features map (OS & Anglian Water, 2023)



GeoSmart has undertaken an assessment of the location of sewer features within the vicinity of the Site. There is a public surface water sewer, located within the highway of River View, approximately 5m south of the Site, therefore discharge to sewer is likely to be appropriate.

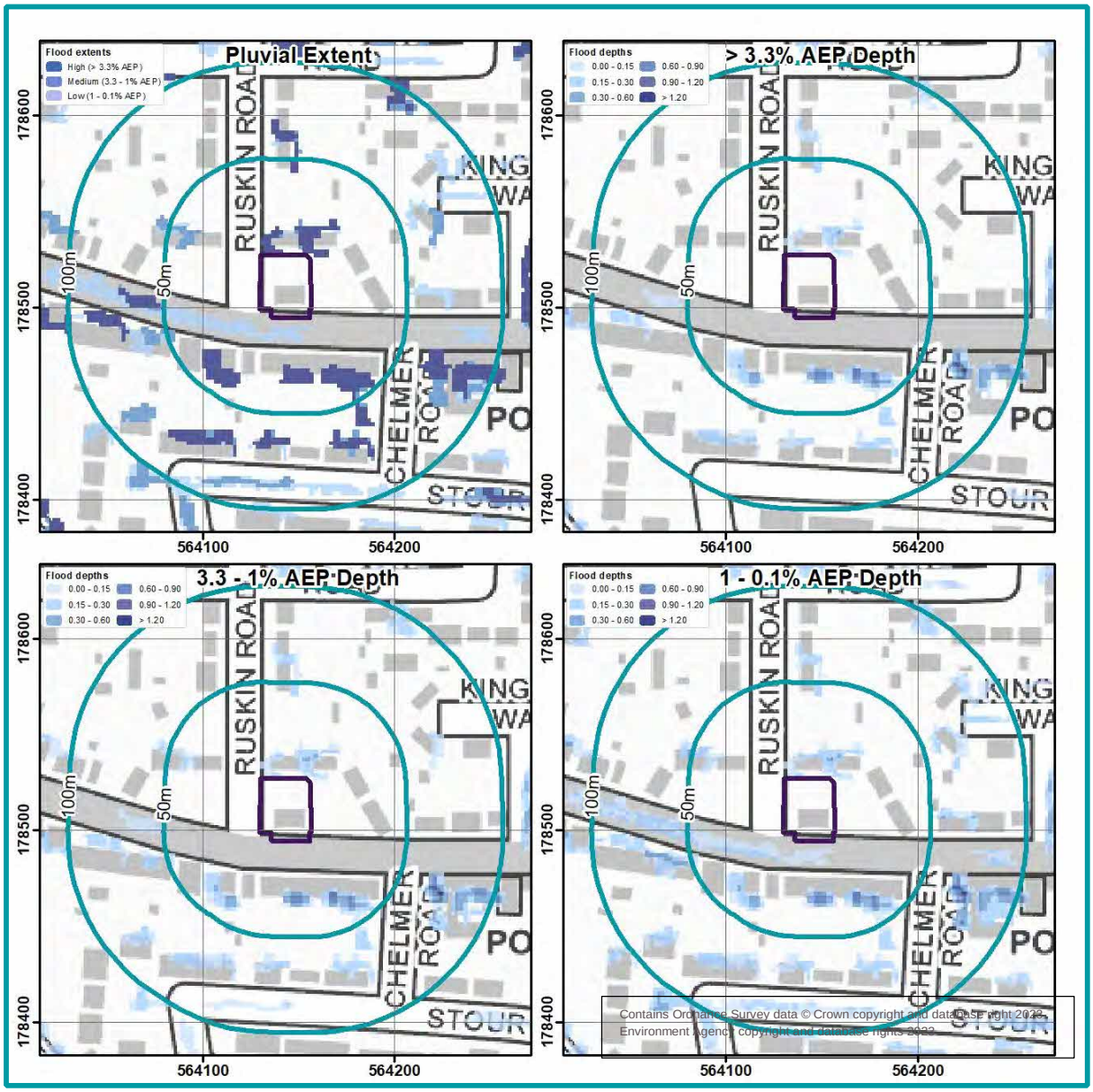
Further analysis of the connections and condition of the public surface water drainage system should be undertaken by carrying out a CCTV survey or by contacting the drainage provider or the Local Council to confirm the presence, location and condition of the sewer. Consultation with the drainage provider would also be required to determine that sufficient capacity is available to accept the proposed discharge, and to gain permission to connect if required.

Figure 8. Risk of flooding from rivers & sea map (EA, 2023)



According to the EA's Risk of Flooding from Rivers and the Sea (RoFRS) map, the Site has a Very Low risk of flooding from fluvial or coastal flooding, with less than 0.1% annual probability of flooding, therefore the SuDs design is unlikely to be affected.

Figure 9. Risk of surface water flooding map (EA,2023)

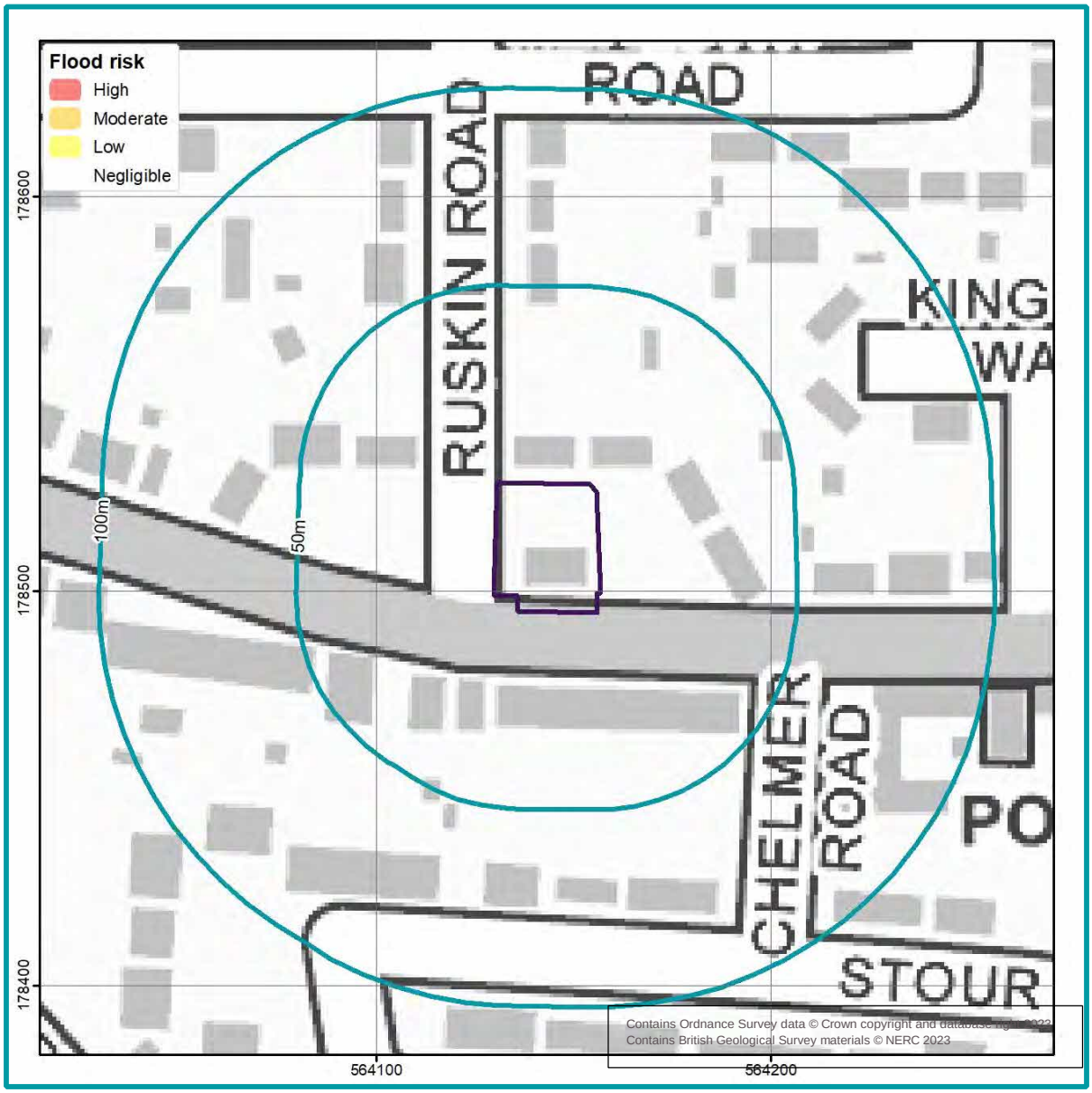


GeoSmart have undertaken an assessment of the risk of flooding from surface water (pluvial) sources within the vicinity of the Site using the EA's Risk of Flooding from Surface Water (RoFSW) mapping. The EA's mapping confirms the Site is considered to be at Very Low risk of surface water flooding.

The above map shows the extent and depth of flooding during multiple return periods (1 in 30 –1 in 1000 year), this confirms there are no areas on the Site which would be affected by flooding up to and including the 1000 year event.

Further analysis could be undertaken by visiting the Site or by contacting the Local Council and the Environment Agency to confirm the pluvial flood risk, flood depths and velocities where applicable.

Figure 10. Groundwater flood risk (GW5) map (GeoSmart, 2023)



GeoSmart have undertaken an assessment of the risk of flooding from groundwater within the vicinity of the Site. GeoSmart's Groundwater Flood Risk Screening (GW5) map confirms the Site has a Negligible risk of groundwater flooding during a 1% annual probability (1 in 100 year) event.

4 Site context

Site information

The purpose of this report is to assess the potential for disposing of surface water through a Sustainable Drainage System (SuDS) for the site of Chadwell Clinic River view Chadwell St Mary, RM16 4BA (the Site). The Site is located in a setting of commercial and residential use. The land slopes to the south from 29.26 mAOD to 27.72 mAOD along the southeastern boundary (EA, 2023). Site plans and drawings are provided in Appendix A.

Development

The Site is currently used within a commercial capacity. At present there is a single building with car park and landscaped areas. Development proposals comprise the construction of a three storey block containing 9 flats, associated parking and soft landscaping.

Geology, permeability and thickness

British Geological Survey (BGS) national superficial and bedrock geology mapping confirms the geological formations underlying the Site and each formation may have a range of permeability.

Table 3. Site Geology

Geology present on-Site		Potentially permeable?
Superficial geology (Figure 11)	Head (HEAD)	✓
Bedrock geology (Figure 12)	Thanet Formation (sandstone) (TAB)	✓

The permeability of the underlying material at the Site shown within the BGS mapping is moderate, confirmation of the infiltration capacity is required.

The BGS website was used to extract ground information from the nearest borehole records to the Site (ref: TQ67NW10 and TQ67NW45). These boreholes are located approximately 275m and 300m to the west of the Site.

The borehole record of TQ67NW10 confirms the underlying geology is comprised of topsoil to a depth of 0.46m below ground level (bgl) underlain by sand and gravel to a depth of 1.83 m bgl, gravel to a depth of 2.74 m bgl, sand to a depth of 3.66 m bgl and loamy sand 12.2 m bgl.

The borehole record of TQ67NW45 confirms the underlying geology is comprised of topsoil to a depth of 0.70 m bgl underlain by gravel and fine sand to a depth of 3.5mbgl, silty fine sand to a depth of 16.0 m bgl, sand to a depth of 22.50 m bgl, flint and chalk to a depth of 23.50 m bgl and chalk to the end of the borehole record at 30.0 m bgl.

Infiltration SuDs are proposed directly into permeable superficial deposits, subject to infiltration testing to confirm feasibility of this discharge route.

The soil infiltration coefficient must be sufficient to accommodate the constraints on the dimensions of the soakaway and its emptying time.

Depth to groundwater

The SuDS system should be designed to operate in periods of extreme groundwater levels.

According to borehole data and GeoSmart's Groundwater Flood Risk (GW5) map, shallow groundwater is unlikely to be an issue at the Site.

The relevant borehole records did not encounter groundwater.

The base of the infiltration system needs to be 1 m above the expected seasonal high-water table. Passage through unsaturated soil is important for improving the quality of infiltrating water before it reaches the water table.

Figure 11. Superficial Geology (BGS, 2023)

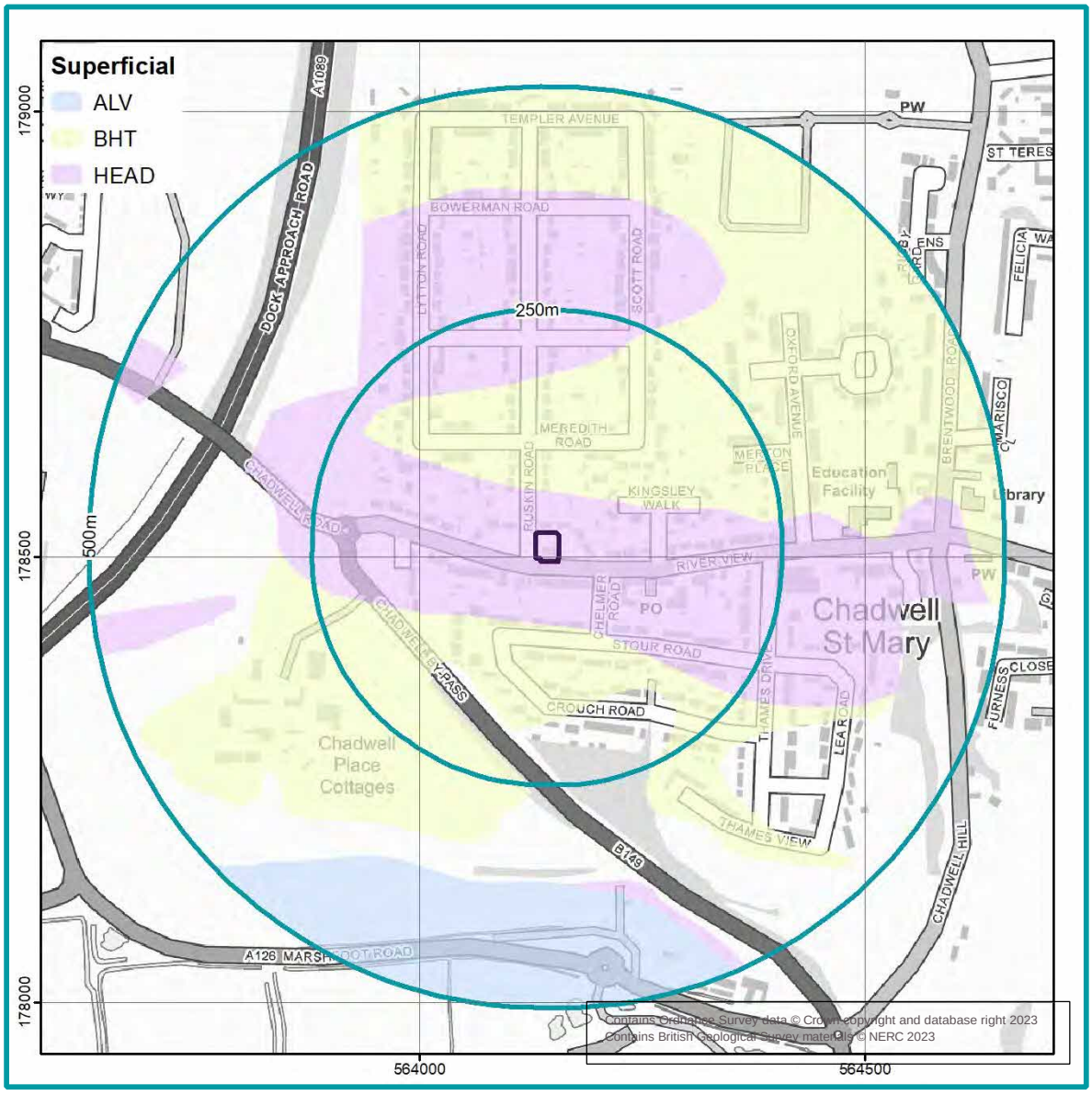
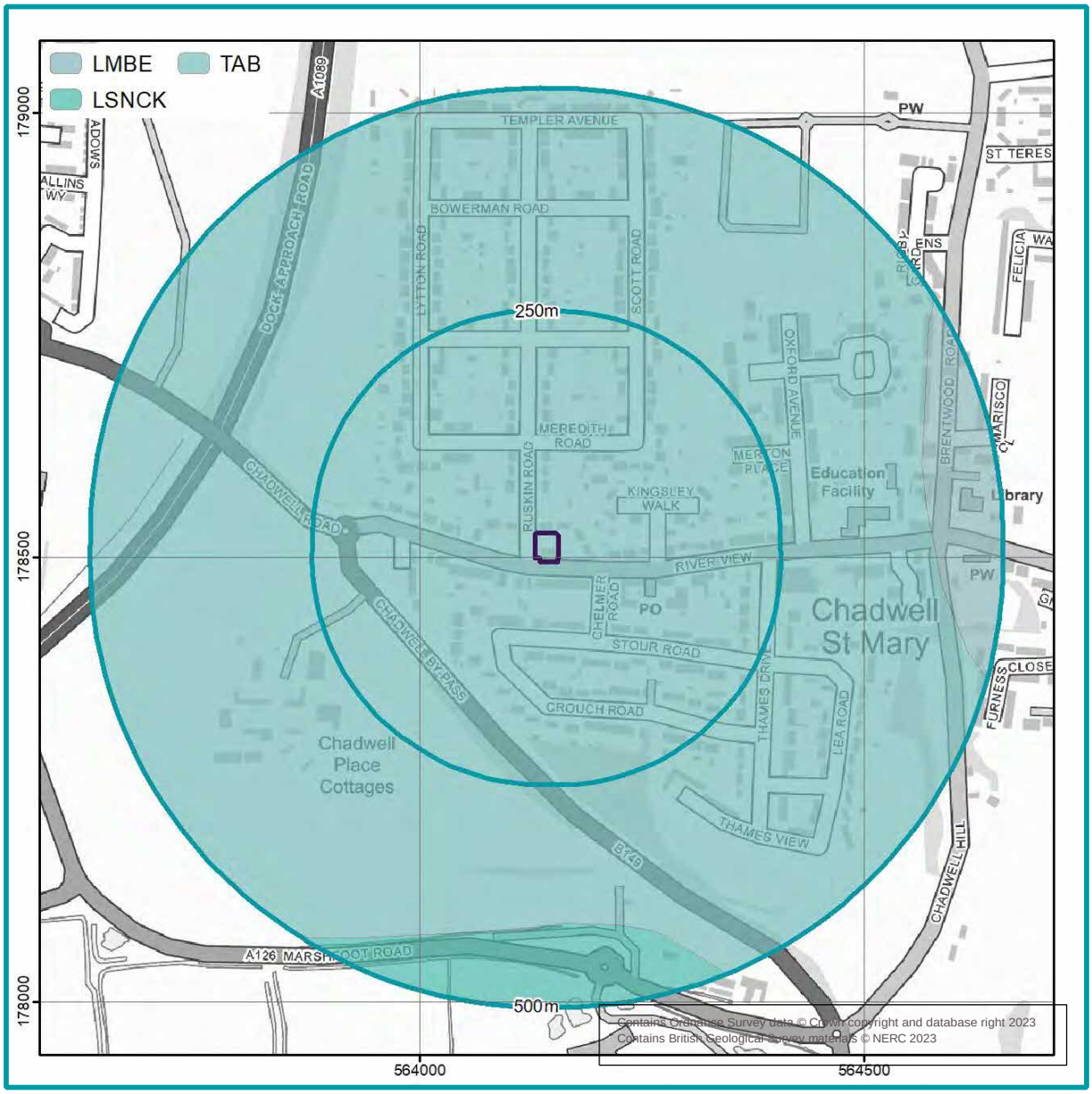


Figure 12. Bedrock Geology (BGS, 2023)



Ground conditions

Infiltration SuDS are proposed within permeable superficial deposits above sandstone bedrock therefore a detailed review of underlying ground conditions is recommended to ensure focused infiltration does not cause ground instability as a result of landslide or collapse associated with running sand.

Soakaways should be a minimum of 5m away from the foundations of a building and local guidance may recommend a greater distance, such as 10m on some areas of the Chalk.

Water quality

The Site lies within an SPZ, therefore consultation with the Local Authority and assessment of historical land uses should be undertaken to confirm the presence of contaminated material; as this could limit the use of infiltration SuDS

Infiltration systems should not be used where there is a risk of contaminating groundwater by infiltrating polluted runoff or where receiving groundwater is particularly sensitive.

The influence of surface runoff on water quality will depend on whether there is a source of contamination on-Site and the sensitivity of the receiving environment, either groundwater or surface water. The intervening pathway from source to receptor including mitigation and natural attenuation will determine the final impact.

The impact of contaminants on the groundwater will be reduced by travel and natural attenuation through the unsaturated soil zone. A greater depth of unsaturated zone and the presence of significant clay and organic material will provide greater protection for the underlying groundwater. Rapid flow through fractures will provide less protection than intergranular flow around soil and rock particles.

5 National & local policy context

National Guidance

CIRIA SuDS Manual (C753) (2015)

A development should utilise sustainable drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

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

Defra - Sustainable Drainage Systems: Non-statutory technical standards for sustainable drainage systems (2015)

Peak Flow control

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

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

Volume control

Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event. The runoff volume must be discharged at a rate that does not adversely affect flood risk.

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

Ministry of Housing, Communities & Local Government – National Planning Practice Guidance: Flood risk assessments: climate change allowances (2014)

The Peak rainfall intensity allowances section provides advice on the increased rainfall effects on river levels and land and urban drainage systems. The anticipated changes in peak rainfall intensity in small catchments (less than 5 km^2) and urban catchments are shown in Table 4.

For large rural catchments use the alternative allowances defined for rivers.

In order to understand the range of impact, both the central and upper end allowances should be assessed.

Table 4. South Essex Management Catchment peak rainfall allowances

South Essex Management Catchment peak rainfall allowances	3.3% AEP Event		1% AEP Event	
	2050's	2070's	2050's	2070's
Central	20%	20%	20%	25%
Upper End	35%	35%	45%	40%

The drainage system should be designed to make sure there is no increase in the rate of runoff discharged from the Site for the upper end allowance.

Where on-Site flooding for the upper end allowance presents a significant flood hazard (for example, depths and velocities of surface water runoff cause a significant danger to people), you will need to take further mitigation measures to protect people and property (for example, raising finished floor levels). As a minimum, there should be no significant flood hazard to people from on-Site flooding for the central allowance.

Sub-national Drainage Policy

Essex County Council Sustainable Drainage Systems Design Guide (2020)

2.2 The drainage hierarchy

All sites must manage surface water via the following hierarchy. When managing rainfall, the SuDS network should be designed to match natural drainage routes, infiltration rates and discharge rates as far as possible. In addition to this, with concern over climate change and increasing risk of water scarcity, re-use of rainwater wherever possible should be utilised. Therefore, in accordance with the drainage hierarchy contained in Approved Document H of the Building Regulations(7) , Planning Practice Guidance(8) and the need to mitigate against water scarcity, all surface water run-off must aim to be discharged as high up the following hierarchy as possible:

- Rainwater re-use (rainwater harvesting/ greywater recycling)

An adequate soakaway or other infiltration system

Hybrid solution of infiltration and discharging to a surface water body

To a surface water body (e.g. an ordinary watercourse)

To a surface water sewer, highway drain, or another drainage system

To a combined sewer It should be noted that if out falling to public sewer or watercourse that is not in or adjacent to the development site then it is necessary to demonstrate permission in principle or thirdparty agreement.

2.5 Infiltration

Where possible infiltration must be used in order to prevent increased volumes of water leaving the site. After reuse, infiltration is the next option within the drainage hierarchy. As the potential for infiltration can vary across the county due to soil types, ground water levels, and topography, sufficient ground investigations and infiltration testing should be undertaken and supplied to support any application.

Any ground investigations should include data from the British Geological Society, intrusive testing such as borehole tests (to determine soil type, depth and the depth of water table), detailed topographic drawings, and infiltration testing in line with the BRE365(6) testing procedure and the infiltration testing methods found in chapter 25.3 of the CIRIA SuDS Manual C753(4). This testing requests that three consecutive tests are required within each test pit and if infiltration is found to be viable then the lowest rate should be used. In addition, when conducting detailed infiltration testing, the tests should be carried out at the location, depth and head of water that replicates the proposed design. Groundwater monitoring should preferably be undertaken between November and April. When seasonal groundwater levels are below average levels, consideration should be taken, and onsite monitoring should be adjusted accordingly.

At the outline stage of the planning process it is accepted that intensive infiltration testing is not always achievable, therefore a preliminary investigation on the soil and geology of the site is acceptable. The LLFA would accept borehole testing or a desktop study with the condition that infiltration testing is undertaken at a later stage. Where the capacity to infiltrate is undetermined from a desk study a borehole percolation test could be undertaken to ascertain the likelihood of infiltration. If infiltration is the chosen discharge option within an outline application and detailed testing has not been possible, then an alternative approach should also be provided in case subsequent infiltration testing demonstrates that discharge to the ground will not be viable.

Ground stability should be taken into consideration when infiltration is proposed. The base of the soakaway should be 1 metre or higher than the highest ground water levels. Point infiltration features such as soakaways should not be within 5 metres of a building. If infiltrating into chalk, where it is medium to high density, soakaways should be 5m away from all structures, roads, and railways. Where it is low density soakaways should be a minimum of 10m away, and where dissolution features are known to be prevalent soakaways should be at least 20m away from roads, structures, and railways. In addition, Essex Highways require

that point infiltration should not be within 6m of the highway. Blanket infiltration however, (such as permeable paving) can be located as close as possible to buildings as long as there is an impermeable barrier between the two. However, if the permeable paving is to infiltrate additional water from other surfaces e.g. roof areas an offset from the building foundations is needed. In addition, infiltration should not occur on made ground. The minimum acceptable rate of infiltration is 1x10-6 m/s. Rates found to be slower than this may potentially have to deliver a hybrid drainage solution. If rates are found to be too slow for formal infiltration this does not rule out the possibility of some soakage taking place. Features (for example permeable/ porous paving) should be unlined or use permeable lining wherever possible regardless of infiltration rates in order to maximise infiltration capacity. This should be approached with care, as should all infiltrating sites, when dealing with areas that are subject to previous contamination or other issues such as structural stability. Whilst Essex Highways will not adopt permeable paving within roads, if this option is to be used, the features should be lined. This lining can be permeable to encourage infiltration, but there has to be a material separating the storage medium from the formation.

2.6 Greenfield runoff rates

Surface water runoff can be discharged in three ways: Restricting to the 1 in 1-year greenfield rate Restricting to the 1 in 1-year greenfield rate The LLFA preference is that runoff must not increase due to the development and all runoff should be first restricted to the greenfield 1 in 1-year runoff rate during all events up to and including the 1 in 100-year rainfall event with climate change. Restricting to flow matching rates Alternatively, if restricting to the 1 in 1-year greenfield rate approach is not possible discharge rates can be limited to a range of equivalent greenfield discharge rates. For example, the 1 in 1-year storm event will be limited to the 1 in 1-year greenfield run-off rate, the 1 in 30-year storm event will be limited to the 1 in 30-year storm event and the 1 in 100year rate will be limited to the 1 in 100-year storm event (inclusive of a climate change allowance). If this alternative approach is used, then there should also be an inclusion of long-term storage. It is however the LLFA's preference that a single rate discharge is used unless it is proven that a flow matching scheme is the more conservative approach. Discharging to a tidal estuary In instances where the final discharge location is to a tidal estuary then it is accepted that discharge rates are unrestricted. However, evidence should be provided to ensure that the surface water will be managed during a tide locking scenario. This should be demonstrated by showing that the surface water can be managed for a 1 in 100-year pluvial storm event plus climate change and a 1 in 20 year fluvial/ tidal storm event coinciding. Likewise, when discharging to a main river, consideration should be given to a 1 in 20-year fluvial event coinciding with a 1 in 100-year pluvial event plus climate change at the development site.

The LLFA require that runoff rates are limited to 1l/s or the 1 in 1-year greenfield rate, whichever is higher, unless discharge is via permeable paving which is further able to reduce the risk of blockage.

2.7 Brownfield runoff rates

The LLFA expects surface water drainage schemes on brownfield development sites to follow the same principles as if the site is greenfield. If it is unfeasible to restrict runoff rates back to

the 1 in 1-year greenfield runoff rate or the alternative flow matching approach, the LLFA will accept discharge rates to be restricted to as close as feasibly possible to the 1 in 1-year greenfield runoff rate or flow matching rates with limiting to a 50% betterment of the brownfield 1 in 1-year runoff rate or flow matching rates as a last resort. If this approach is to be chosen, then it should be clearly evidenced that restricting to the greenfield rate is unfeasible and that the new rate proposed is as close as feasibly possible to the 1 in 1-year greenfield runoff rate or flow matching rates. This supporting evidence should include a range of rates and the corresponding storage volumes associated with those rates. It should be noted that a 50% betterment is a last resort option and is only acceptable when lower rates are proven to be unviable.

6 Storage, volume and peak flow rate

Suggested minimum and aspirational storage requirements for an infiltration or attenuation SuDS scheme for the development footprint are set out below, with more detail provided in subsequent sections. Storage volumes may be reduced (but not below the minimum level) if the design incorporates off-Site discharge.

Table 5. Storage requirements at the proposed development Site (Discharge runoff via infiltration)

Attenuation scenario		Attenuation required (m^3)	Explanation
Discharge runoff via infiltration	1 in 100 year including 45% CC	45.6	Attenuation required to ensure surface water ru attenuated in all storm events up to and including the 1 100 year event including a 45% allowance for climate change based upon an assumed infiltration rate of 1 x 10-5 m/s (0.036 m/hr)*.

*Subject to confirmation through infiltration testing. See Appendix B for associated runoff and discharge calculations.

Table 6. Storage requirements at the proposed development Site (Discharge runoff to surface water sewer)

Attenuation scenario		Attenuation required (m^3)	Explanation	
Discharge runoff to surface water sewer	1 in 30 year	24.2	Attenuation required to ensure surface wate runoff is attenuated in all storm events up and including the 1 in 30 year (2 hour, Critical Storm Duration) event*. Flooding of the Site of 12.0 m^3 should be contained within permeable landscaped areas within the Site to ensure no flooding o internal areas during the 1 in 100 year storr event.	A further 23.2 m^3 should be managed withi overland flow routes to ensure there is no increase in flood risk in all event up to the 1 100 year including 45% allowance for climate change.
	1 in 100 year	36.2	Attenuation required to ensure surface wate runoff is attenuated in all storm events up	

			and including the 1 in 100 year (4 hour, Critical Storm Duration) event*.	
	1 in 100 year including 45% CC	59.4	Attenuation required to ensure surface water runoff attenuated in all storm events up to and including the 1 in 100 year (5 hour, Critical Storm Duration) event including a 45% allowance for climate change*.	

*See Appendix B for associated runoff and discharge calculations. Discharge rates all restricted as close as possible to greenfield rates in their respective events.

Surface water runoff

An increase in impermeable area on-Site will result in greater rainfall runoff. Reduction in runoff will help mitigate flood risk both on and off-Site. Further information on the surface water runoff calculations is provided in Section 12 'Background Information'.

Guidance

The Non-Statutory Technical Guidance for SuDS (Defra, March 2015) states:

"Where reasonably practicable, for Greenfield development, the runoff volume from development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the Greenfield runoff volume for the same event. Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the Greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event."

Table 7. Change in impermeable area associated with the development

Total Site area	837 m^2
Impermeable area (and as a percentage of the total area of the proposed development footprint of 837 m^2)	
Pre-development	Post-development
279m^2 (33%)	696m^2 (83%)
Impermeable Land use: Welfare centre, car park Permeable Land use: landscaped areas	New impermeable land use: 219 m^2 residential flats, 387m^2 parking and access*, 90m^2 private amenities

*Please note, while these areas will be utilized for SuDS, for the calculations these areas will be classed as impermeable in order to assess the potential run-off volumes and rates for the Site post- development and the potential holding capability of the proposed SuDS features.

Guidance

"The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event' and 'flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development"

(Defra, March 2015, non-statutory guidance).

Peak discharge rates

The table below presents peak discharge rates for a range of storm events used to assess the impact of the proposed development and select the maximum permitted discharge rate. Further information on the calculation and control of peak discharge rates is provided in Section 12 'Background Information'.

Table 8. Peak discharge rates associated with the development

Rainfall event	Greenfield runoff rates (l/s)	Existing runoff rates[1] (l/s)	Potential runoff rates without attenuation (l/s)	Potential minus existing (l/s)
QBAR	0.11	N/A	N/A	N/A
6 hour 1 in 1 year	0.10	0.51	0.84	0.33
6 hour 1 in 10 year	0.18	0.89	1.47	0.57
6 hour 1 in 30 year	0.25	1.20	1.99	0.79
6 hour 1 in 100 year	0.36	1.65	2.73	1.08
6 hour 1 in 100 year + 20% CC	N/A	N/A	3.28	1.63
6 hour 1 in 100 year + 45% CC	N/A	N/A	3.96	2.31

[1] Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the IoH124 method.

Relevant national, regional and local planning policy has been consulted in Section 5 to determine restrictions on runoff from previously developed and greenfield sites. In some

cases, greenfield rates may be requested, but in practice it is difficult to restrict discharge rates at any one control point to less than 1 l/s, without increasing the risk of any potential blockages occurring in the drainage network.

Total discharge volumes

The table below presents discharge volumes for a range of storm events used to assess the impact of the proposed development and calculate the required storage volumes. Further information on the calculation of total discharge volumes is provided in Section 11 'Methodology and Limitations'. Total discharge volumes associated with the development.

Table 9. Total discharge volumes associated with the development

Rainfall event	Greenfield runoff volume (m^3)	Existing runoff volume[2] (m^3)	Potential runoff volume without attenuation (m^3)	Potential minus existing (m^3)
QBAR	6.65	N/A	N/A	N/A
6 hour 1 in 1 year	6.18	10.99	18.18	7.19
6 hour 1 in 10 year	11.04	19.32	31.70	12.37
6 hour 1 in 30 year	14.61	25.98	42.96	16.99
6 hour 1 in 100 year	20.06	35.65	58.97	23.31
6 hour 1 in 100 year + 20% CC	N/A	N/A	70.76	35.11
6 hour 1 in 100 year + 45% CC	N/A	N/A	85.50	49.85

[2] Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the IoH124 method.

Critical storm duration and volume requirements

Storage volumes for a range of return periods including the 1 in 30 year, 1 in 100 year and 1 in 100 year plus climate change (45%) events have been calculated to assess the impact of the proposed development. The required storage volumes for attenuation features have been calculated for the critical storm durations, limited to a maximum discharge rate of 1 l/s.

Table 10. Critical Storm Duration and Attenuation volume requirements

Return Period	Runoff rate restriction (l/s)	Critical Storm Duration (hr)	Attenuation volume required (m^3)
1 in 30 year	1	2	24.2

1 in 100 year	1	4	36.2
1 in 100 year including a 45% climate change	1	5	59.4

7 Runoff destination

Options for the destination for the runoff generated on-Site have been assessed in line with the prioritisation set out in the Building Regulations Part H document (HM Government, published in 2010 and updated in 2015) and Defra's Non-statutory Technical Standards for SuDS (2015).

Flow attenuation using infiltration SuDS (discharge to ground) is generally the preferred option. If discharge to ground is not available, runoff discharge to surface water is the other preferred method. Only if these two options are impractical should discharge to the sewer network be considered.

Discharge to ground

The Site has moderate potential for infiltration, with potentially permeable underlying deposits. Based on the available borehole information (subject to confirmation by site investigation) and groundwater flood risk mapping there is unlikely to be the potential for high groundwater levels the Site (See SuDS Infiltration Suitability Map (SD50)).

There are no known issues identified relating to Site contamination, but the Site is located within a SPZ.

A site investigation comprising trial pits is recommended to confirm the depth to groundwater and allow infiltration tests to be undertaken to confirm the feasibility of an infiltration SuDS scheme.

Discharge to surface watercourse

A surface watercourse has not been identified within 100m of the Site, and discharging to the nearest suitable surface water feature would require pipework to travel a significant distance across third-party, urbanised land and therefore is not considered a viable SuDS strategy for the Site.

Discharge to sewer

Discharge to sewer is not likely to be the optimum sustainable drainage option for the new development area. If required consultation with the local sewer undertaker should be undertaken. Discharge to sewer would only be accepted if it can be demonstrated that none of the above options are reasonably practical. Discharge would have to be controlled and on-Site attenuation would be required.

The topographic gradient on the Site falls gradually to the southeast towards the existing drainage network within the Highway of River View ~5m south of the Site. Therefore, it would not be difficult to drain the Site under gravity to the existing sewer network should infiltration be unfeasible.

8 Water quality

A key requirement of any SuDS system is that it protects the receiving water body from the risk of pollution. This can be effectively managed by an appropriate “train” or sequence of SuDS components that are connected in series. The frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10 mm of rainfall (first flush) should be adequately treated with SuDS.

The minimum number of treatment stages will depend on the sensitivity of the receiving water body and the potential hazard associated with the proposed development SuDS Manual (CIRIA, 2015). The proposed development is a combination of very low (roof water) to low hazard (runoff from car parking and road). The Site does lie within an SPZ and therefore additional treatment stages may be required.

Table 11. Level of hazard

Hazard	Source of hazard
Very Low	Residential roof drainage
Low	Residential, amenity uses including low usage car parking spaces and roads, other roof drainage.
Medium	Commercial, industrial uses including car parking spaces and roads (excluding low usage roads, trunk roads and motorways).
High	Areas used for handling and storage of chemicals and fuels, handling of storage and waste (incl. scrap-yards).

The recommended minimum number treatment stages suggested for the different runoff waters identified for the proposed development is highlighted in the table below.

Table 12. Minimum number of treatment stages for runoff

		Sensitivity of the receiving water body		
		Low	Medium	High
Hazard	Low	1	1	1
	Med	2	2	2
	High	3	3	3

9 Proposed SuDS strategy

Sustainable drainage systems

DEFRA's non-statutory requirements for SuDS require the below ground drainage systems to have the capacity to accommodate at least the 1 in 30 year event and to manage the 1 in 100 year event without flooding of on-site buildings and substations. All runoff should be managed on-Site though for the 1 in 100 year event, accounting for the maximum impacts of climate change to ensure flood risk is not increased to third-parties.

It is assumed that drainage from areas outside the development footprint will continue to use existing drainage arrangements.

A surface water drainage strategy (summarised in Section 2 of this report) includes the following SuDS features to intercept, attenuate and treat surface water runoff.

Primary SuDS Strategy:

Ground conditions at the Site are conducive to infiltration, surface water runoff will be managed within SuDS features and infiltrated to ground.

Table 13. Proposed SuDS type, features, discharge location and rate restriction

SuDS type	Source control (interception) and infiltration SuDS.
SuDS features	Rainwater harvesting, permeable paving and BioMat
Discharge location	Infiltration
Discharge rate	1 x 10^{-5} m/s* This is based on the worst-case infiltration rate for sand as per Table 25.1 of the CIRIA SuDS manual (2015)

*Subject to confirmation through infiltration testing. See Appendix B for associated runoff and discharge calculations.

Table 14. Proposed SuDS sizing (dimensions) and attenuation volumes

Rainwater Harvesting	Rainwater harvesting butts should be established for the proposed development. In terms of attenuation storage within this scheme, the volume of run-off which could be attenuate rainwater harvesting has not been considered within the Preliminary SuDS schematic.
Permeable paving	A 380 m^2 area of permeable paving (underlain with a Type 3 aggregate material) and BioMat for required additional treatment stages within the proposed driveway areas to a depth of 0.4 m, with a 30% porosity would result in c. 45.6 m^3 attenuation.

Total Attenuation Provided	45.6 m^3
Total Attenuation Required	45.6 m^3

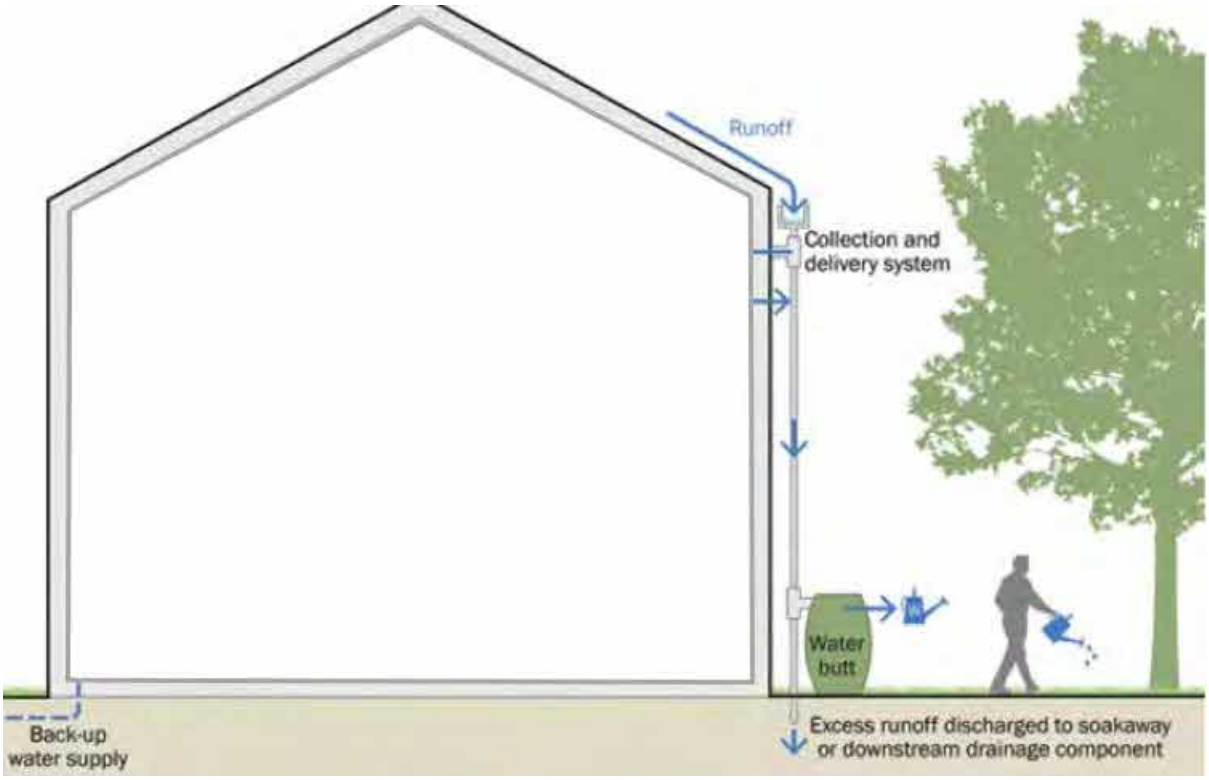
Rainwater harvesting

The run-off from the proposed development roof should be led into rainwater harvesting butts via rainwater downpipes and guttering to catch run-off from the extension roof. Overflow from the butts should be discharged into the storage system provided by the permeable paving.

Due to the relatively insignificant amounts of attenuation provided by rainwater harvesting tanks in this instance and the requirement to retain water for non-potable uses such garden maintenance, the volume of run-off which could be attenuated by rainwater harvesting has not been considered within the report.

As there is an issue with the storage capability of Rainwater Harvesting tanks, this method should have a fixed attenuation volume and a controlled outlet to discharge into the proposed SuDS feature. An overflow system will be required for implementation on the Site due to exceedance events (where the pumps fail or there is a blockage within the system / or the number of residents and subsequent water usage is reduced).

Roof run-off is generally less polluted than run-off from road surfaces but can still generate pollutants such as sediments. Pollutants would be captured by the collection and filtration system and, by reducing the volume of run-off generated from the Site. Primary screening devices are used to prevent leaves and other debris from entering the butt and first flush devises can be designed to divert the first part of the rainfall away from the main storage tank and can pick up most of the dirt, debris and contaminates that collect on a residential roof.



Modified from Figure 11.3 of the CIRIA SuDS Manual (C753) (2015)

Permeable paving

Permeable Paving is proposed for driveway areas to intercept runoff. Suitable aggregate materials (angular gravels with suitable grading as per CIRIA, 2015) will improve water quality due to their filtration capacity and usually work to a 30% porosity. A geotextile layer will be required for paving underlain by aggregate material to intercept silt/particles. Permeable pavements are multi-layered surfacing systems. The surface layer is constructed out of permeable material allowing infiltration of water through gaps along its surface. A geomembrane isolates stored water from the surrounding soil, especially in contaminated areas and a geotextile layer prevents clogging and damage to the geo-cellular modules.

The geotextile layer works to intercept silt/particles flowing through the system via direct rainfall, or through vehicle use deposited onto the car park area and into the permeable paving. The majority of silt would be trapped within the top 30mm of the joining material between the paving blocks. Rainfall flowing into the permeable paving directly from the development roof/rainwater butts would not contain enough volumes of silt and or particles to cause blockage so will be fed directly into underlying porous substrate via rainwater pipes. Downpipes from the development roofs/rainwater butts should extend through the paving for c.5 meters to divert roof run-off away from building foundations. Paving could also implement an impermeable liner close to the building or creating a separate compartment within the permeable sub-base close to the building to further divert attenuated water away from building foundations.

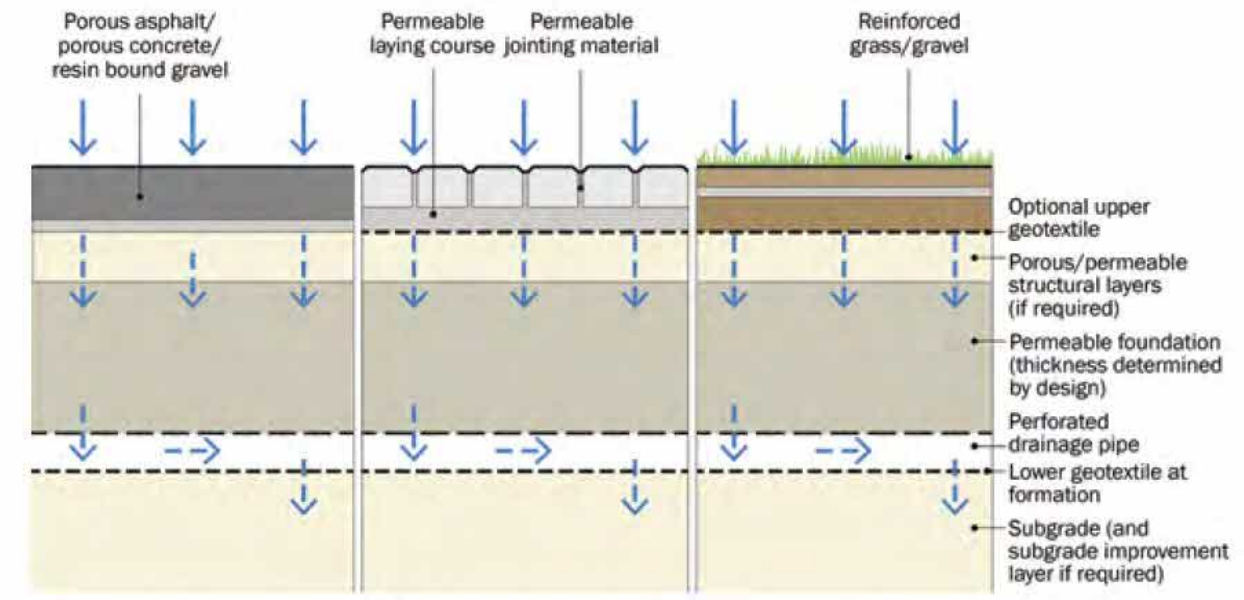


Figure 20.13 of the CIRIA SuDS Manual (C753) (2015)

Plastic geo-cellular systems could also be used, which can increase the void space and therefore storage but do not allow filtration unless they are combined with aggregate material and/or permeable geotextiles which could increase their storage potential by up to 20%. Geo-cellular modules also have the added advantage of reducing the amount of aggregate sub base required, thus keeping costs lower. Void systems, such as permavoids, have a void ratio of 95% (i.e. for every 1 m^3 there is 0.95 m^3 of space available for water storage), which has been factored into the storage capacity calculations.

Permavoid with BioMat

Permavoid Medium Duty with Biomat is designed for use with Polystorm attenuation and infiltration systems and comprises of a tri-laminate of low density plastic composite (biomat). The biomat floats on water and is designed to intercept and treat any potential residual emulsified oils that may be present within the surface water. The use of Permavoid Medium Duty with Biomat provides additional oil retention and water treatment capability to an underground water storage system.

Key benefits:

- Pollutant-intercepting floating mat degrades residual oils by absorption and aerobic digestion
- Can be incorporated into Polystorm retention, infiltration and attenuation systems
- 95% void ratio
- Light in weight yet robust –excellent health & safety and
- installation benefits
- 60 years creep limited life expectancy
- 100% recyclable

- Units are manufactured from recycled materials.

Exceedance Flows

Exceedance flow routes are included within the proposed SuDS drainage layout. Where possible, exceedance flows should be directed away from buildings and into non-essential areas of the Site such as the car park. The SuDS system recommended for the Site should provide enough storage that this method would only be utilized during a worst case scenario.

During an exceedance event, flows should also be directed into the nearest surface water channel/sewer network. The SuDS system recommended for the Site provides enough storage that this method would only be utilized during a worst case scenario.

Secondary SuDS strategy:

Where infiltration to ground is not achievable at the Site, an attenuation volume of 56.8 m^3 should be stored within lined SuDS features to accommodate the calculated 5 hour Critical Storm Duration for surface water discharge runoff, restricted to 1 l/s.

SuDS features listed in the primary recommendations are still applicable to the secondary recommendation the Site.

Permeable paving can still be incorporated if discharge to ground is not achievable however paving will need to be lined to ensure groundwater does not interact with the system.

Table 15. Proposed SuDS type, features, discharge location and rate restriction

SuDS type	Source control (interception) and attenuation SuDS.
SuDS features	Rainwater harvesting, permeable paving and BioMat
Discharge location	Public surface water sewer network
Discharge rate	1 l/s

Table 16. Proposed SuDS sizing (dimensions) and attenuation volumes

Rainwater Harvesting	Rainwater harvesting butts should be established for the proposed development. In terms of attenuation storage within this scheme, the volume of run-off which could be attenuate rainwater harvesting has not been considered within the Preliminary SuDS schematic.
Permeable paving	A 380 m^2 area of permeable paving (underlain with a Type 3 aggregate material) and BioMat for required additional treatment stages within the proposed driveway areas to a depth of 0.55 m, with a 30% porosity would result in c. 62.7 m^3 attenuation.

Total Attenuation Provided	62.7 m^3
Total Attenuation Required	59.4 m^3
Freeboard Storage Provided	3.3 m^3

Flow control devices and systems

Hydrobrake Flow control systems can be used to reduce the runoff rate from the Site. These are usually a device used for controlling water flow into a connecting feature, such as a sewer, to a specific attenuation performance. The design consists of an intake, a volute and an outlet and the configuration is critical to ensure discharge control. For drainage areas which are less than 3 ha, outlet throttle diameters would have to be small (<150mm diameter) to achieve outflow rates which could result in blockage. For most SuDS features, a flow control device will comprise a fixed orifice or a throttle such as a short pipe.

A Vortex Control is usually a self-activating vortex flow device which directs water into a volute to form a vortex. For the Site, rainwater down pipes from the development roof should drain directly into the attenuation feature to reduce infill from potential flood water.

Drainage protection devices

A non-return flap value is recommended for outflow pipes to reduce the risk of backflow from the channel/sewer during a large scale rainfall event.

10 SuDS maintenance

Regular maintenance is essential to ensure effective operation of the SuDS features over the intended lifespan of the proposed development. The SuDS Manual (C753) (CIRIA, 2015) provides a maintenance schedule for SuDS with details of the necessary required actions as shown in the Table below.

Table 17. SuDS operation and recommended maintenance requirements

Asset type	Maintenance schedule (and frequency)
Permeable pavements with BioMat	Regular maintenance: Brushing and vacuuming (three times per year). Trimming any roots and surrounding grass and weeds that may be causing blockages (annually or as required). Monitoring: Initial inspection (monthly). Inspect for poor performance and inspection chambers (annually).
Hydro-Brake Flow Control	Low amounts of maintenance required as there are no moving parts within the Hydro-Brake® Flow Control. Initial monthly inspection at the manhole once the construction phase is over. If blockages occur they normally do so at the intake. Hydro-Brake® Flow Controls are fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should blockages occur. Inspection should be undertaken annually or when a storm event occurs.
Underground drainage pipe network	Regular maintenance: Remove sediment and debris from pre-treatment devices and floor of inspection tube or chamber (annually). Cleaning of gutters and any filters on downpipes (annually). Trimming any roots that may be causing blockages (annually or as required). Monitoring: Inspect silt traps and note rate of sediment accumulation (monthly in the first year and then annually).
Rainwater Harvesting	Regular maintenance: Inspection of tank for debris and sediment build up (annually and following poor performance).

Asset type	Maintenance schedule (and frequency)
	Inspection of inlets, outlets, overflow areas, pumps and filters (annually and following poor performance). Cleaning of tank, inlets, outlets, gutters, roof drain filters and withdrawal devices (annually or as required). Remedial actions: Repair or overflow erosion damage or damage to tank and associated components (as required)

Client checklist

A drainage strategy has been recommended as suitable on the basis of the information provided. Prior to installation of the Site drainage system it is recommended that the client carries out the following checks to confirm the development proposals. Geosmart would be able to support with any updates required to the drainage scheme, please contact us and we would be happy to provide you with a proposal to undertake the work.

Table 18. Potential SuDS limitations

Conditions in Non-Statutory Technical Standards (Defra, 2015), limitations to infiltration SuDS	Do these conditions arise at the Site?
Is the surface runoff greater than the rate at which water can infiltrate into the ground?	
Is there an unacceptable risk of ground instability?	
Is there an unacceptable risk of mobilising contaminants?	
Is there an unacceptable risk of pollution to groundwater?	
Is there an unacceptable risk of groundwater flooding?	
Is the infiltration system going to create a high risk of groundwater leakage to the combined sewer?	

Table 19. SuDS design considerations

Confirm that potential flooding on-Site in excess of the design storm event and exceedance flow routes have been considered.	
Review options for the control of discharge rates (e.g. hydrobrake).	
Confirm the owners/adopters of the drainage system. Consider management options for multiple owners.	
Is there an unacceptable risk of pollution to groundwater?	
Review access and way leave requirements.	
Review maintenance requirements.	

Health and safety considerations for SuDS

GeoSmart reports may include outline strategies or designs to support with development plans. Any drawings or advice provided do not comprise any form of detailed design. Implementation of any conceptual scheme options may constitute 'Construction Work' as defined by CDM Regulations (2015).

The CDM Regulations place specific Health and Safety duties on those commissioning, planning and undertaking construction works. If you are uncertain what this means you should seek the advice of your architect, builder or other competent professional.

GeoSmart does not provide health and safety advisory services but we are required to advise you of your general responsibilities under CDM (visit http://geosmartinfo.co.uk/knowledge-hub/cdm-2015/ for more information).

Please remember that detailed design work should be undertaken by a competent professional who might be your engineer, architect, builder or another competent party.

11 Methodology and limitations of study

This report assesses the feasibility of infiltration SuDS and alternative drainage strategies in support of the Site development process. From April 6th 2015 SuDS are regulated by Local Planning Authorities and will be required under law for major developments in all cases unless demonstrated to be inappropriate. What is considered appropriate in terms of costs and benefits by the Planning Authority will vary depending on local planning policy, and Site setting. The Lead Local Flood Authority will require information as a statutory consultee on major planning applications with surface water drainage implications. The National Planning Policy Framework requires that new developments in areas at risk of flooding should give priority to the use of SuDS and demonstrate that the proposed development does not increase flood risk downstream to third parties.

How was the suitability of SuDS estimated for the Site?

There are a range of SuDS options available to provide effective surface water management that intercept and store excess runoff. When considering these options, the destination of the runoff should be assessed using the order of preference outlined in the Building Regulations Part H document (HM Government, 2010) and Defra's National Standards for SuDS (2015):

1. Discharge to the ground;
2. Discharge to a surface water body;
3. Discharge to a surface water sewer;
4. Discharge to a local highway drain; and
5. Discharge to a combined sewer.

Data sets relating to each of the potential discharge options have been analysed to assess the feasibility of each option according to the hierarchy set out above. Hydrogeological characteristics for the Site are assessed in conjunction with the occurrence of SPZ's to assess infiltration suitability. The Site has been screened to determine whether flood risk from groundwater, surface water, fluvial or coastal sources may constrain SuDS. The distance to surface water bodies and sewers has been reviewed gauge whether these provide alternative options.

GeoSmart SuDS Infiltration Suitability Map (SD50)

The GeoSmart SuDS Infiltration Suitability Map (SD50) screens the suitability for infiltration drainage in different parts of the Site and indicates where further assessment is recommended. In producing the SuDS Infiltration Suitability Map (SD50), GeoSmart used data from the British Geological Survey on groundwater levels, geology and permeability to screen

for areas where infiltration SuDS may be suitable. The map classifies areas into 3 categories of High, Medium and Low suitability for infiltration SuDS. This can then be used in conjunction with additional data on Site constraints to give recommendations for SuDS design and further investigation.

The primary constraint on infiltration potential is the minimum permeability of the underlying material and in some cases the range in permeability may be considerable, ranging down to low. The map classifies these areas as moderate infiltration suitability requiring further investigation. In cases where the thickness of the receiving permeable horizon is less than 1.5 meters then additional Site investigation is recommended. If the Site is at risk of groundwater flooding for up to the 1% annual occurrence the map classifies these areas as moderate infiltration suitability requiring further investigation.

The GeoSmart SuDS Infiltration Suitability Map (SD50) is a national screening tool for infiltration SuDS techniques but a Site specific assessment should be used before final detailed design is undertaken. Further information on the GeoSmart SuDS Infiltration Suitability Map (SD50) is available at geosmartinfo.co.uk

How is the suitability to discharge to sewers and watercourses calculated?

The suitability to discharge to discharge to sewers and watercourses has been calculated using the distance from the Site to both. For example, where the Site is within 50m of a surface water body. Discharge to surface water is potentially appropriate subject to land access arrangements and a feasibility assessment. Where the Site is within 50m of a sewer, discharge to sewer is potentially appropriate subject to land access arrangements and a feasibility assessment. The utility company should be contacted to agree connection feasibility and sewer capacity.

Further information relating to sewers available in the area can be found in Appendix C.

What is a Source Protection Zone?

The Environment Agency have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which is occasionally applied. The zones are used to set up pollution prevention measures in areas which are at a higher risk. The shape and size of a zone depends on the condition of the ground, how the groundwater is removed, and other environmental factors. Inner zone (Zone 1) is defined as the 50 day travel time from any point below the water table to the source (minimum radius of 50 metres). Outer zone (Zone 2) is defined by a 400 day travel time. Total catchment (Zone 3) is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

How was surface water runoff estimated from the Site?

In accordance with The SuDS Manual (C753) (CIRIA, 2015), the Greenfield runoff from the Site has been calculated using the IoH124 method and is assumed representative of the runoff generated on the undeveloped surfaces that are affected by the proposed development. The method used for calculating the runoff complies with the NPPF (MHCLG, 2019). For the impermeable surfaces, it has been assumed that 100% runoff will occur (calculations provided in Appendix B). Rainfall data is derived from the Flood Estimation Handbook (FEH), developed by NERC (2009). Only areas affected by the proposed development are considered in the flow and volume calculations. Permeable areas that remain unchanged are not included in the calculations as it is assumed these will not be actively drained and attenuated.

What is the peak discharge rate?

An estimation of peak runoff flow rate and volume is required to calculate infiltration, storage and discharge requirements. The peak discharge rate is the maximum flow rate at which surface water runoff leaves the Site during a particular storm event, without considering the impact of any mitigation such as storage, infiltration or flow control. Proposed discharge rates (with mitigation) should be no greater than existing rates for all corresponding storm events. If all drainage is to infiltration there will be no discharge off-Site. Discharging all flow from Site at the existing 1 in 100 event would increase flood risk during smaller events. Flow restriction is generally required to limit the final discharge from Site during all events as a basic minimum to the green field QBAR rate. A more complex flow restriction which varies the final discharge rate from the Site depending on the storm event will reduce the volume of storage required on-Site. Drainage to infiltration SuDS is subtracted from the total discharge off-Site to achieve a beneficial net affect.

What is the total discharge volume?

The total discharge volume is calculated on the basis of the surface water runoff that has the potential to leave the Site as a result of the assumed 6 hour duration design storm event. The runoff is related to the underlying soil conditions, impermeable cover, rainfall intensity and duration of the storm event. The total volume generated by the current Site is compared to the potential total volume from the developed Site (not taking into consideration any mitigation). The difference provides the minimum total volume that will need to be stored and infiltrated on-Site or released at a controlled rate. Guidance indicates that the total discharge volume should never exceed the runoff volume from the development Site prior to redevelopment for that event and should be as close as is reasonably practicable to the Greenfield runoff volume.

12 Background SuDS information

SuDS control surface water runoff close to where it falls. SuDS are designed to replicate, as closely as possible, the natural drainage from the Site before development to ensure that the flood risk downstream does not increase as a result of the Site being developed, and that the Site will have satisfactory drainage under current and likely future climatic conditions. SuDS provide opportunities to reduce the causes and impacts of flooding; remove pollutants from urban runoff at source; and combine water management with green space with benefits for amenity, recreation and wildlife. Government planning policy and planning decisions now include a presumption in favour of SuDS being used for all development Sites, unless they can be shown to be inappropriate.

For general information on SuDS see our website: http://geosmartinfo.co.uk/

Infiltration SuDS

Government policy for England is to introduce sustainable drainage systems (SuDS) via conditions in planning approvals. Guidance indicates that capturing rainfall runoff on-Site and infiltrating it into the ground (infiltration SuDS) is the preferred method for managing surface water without increasing flood risk downstream.

The greatest benefit to general flood risk is if all runoff is infiltrated on-Site, however, this may not be feasible due to physical and economic constraints in which case infiltration may be considered as a part of an integrated drainage solution. The final design capacity for an infiltration SuDS system depends on the Site constraints and the requirements of the individual Planning Authority and the Lead Local Flood Authority.

The capacity of the ground to receive infiltration depends on the nature, thickness and permeability of the underlying material and the depth to the high groundwater table. The final proportion of the Site drained by infiltration will depend on topography, outfall levels and a suitable drainage gradient. It is important to note that, even if the whole Site cannot be drained by infiltration, the use of partial infiltration is encouraged, with the remainder of runoff discharged via other SuDS systems.

Types of infiltration SuDS

Infiltration components include infiltration trenches, soakaways, swales and infiltration basins without outlets, rain gardens and permeable pavements. These are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, before returning it to the water table below.

An infiltration trench is usually filled with permeable granular material and is designed to promote infiltration of surface water to the ground. An infiltration basin is a dry basin or depression designed to promote infiltration of surface water runoff into the ground. Soakaways are the most common type of infiltration device in the UK where drainage is often connected to over-sized square or rectangular, rubble-filled voids sited beneath lawns.

According to the guidance in Building Research Establishment (BRE) Digest 365 (2016) a soakaway must be able to discharge 50% of the runoff generated during a 1 in 10 year storm event within 24 hours in readiness for subsequent storm flow. This is the basic threshold criteria for a soakaway design and the internal surface area of the proposed soakaway design options should be calculated on this basis by taking into account the soil infiltration rate for the Site.

Developers need to ensure their design takes account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any machinery access required.

SuDS maintenance and adoption

Regular maintenance is essential to ensure effective operation of the soakaway(s) over the intended lifespan of the proposed development. A maintenance schedule for SuDs is required. Sewerage undertakers or Local Authorities may adopt SuDS and will require maintenance issues to be dealt with in accordance with their Management Plan. If the SuDS will not be adopted other provision is required with associated financial implications. Maintenance is a long-term obligation requiring the upkeep of all elements of the SuDS, including mechanical components (e.g. pumps), as well as inspections, regular maintenance and repair.

Additional background SuDS information can be found on our website: http://geosmartinfo.co.uk/

13 Further information

The following table includes a list of additional products by GeoSmart:

Additional GeoSmart Products			
✓	Additional assessment: FloodSmart Report		The FloodSmart Report range provides clear and pragmatic advice regarding the nature and potential significance of flood hazards which may be present at a Site. Our consultants assess available data to determine the level of risk based on professional judgement and years of experience. Please contact info@geosmartinfo.co.uk for further information.
✓	Additional assessment: EnviroSmart Report		Provides a robust desk-based assessment of potential contaminated land issues, taking into account the regulatory perspective. Our EnviroSmart reports are designed to be the most cost effective solution for planning conditions. Each report is individually prepared by a highly experienced consultant conversant with Local Authority requirements. Ideal for pre-planning or for addressing planning conditions for small developments. Can also be used for land transactions. Please contact info@geosmartinfo.co.uk for further information.

14 References and glossary

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Glossary

General terms

Attenuation	Reduction of peak flow and increased duration of a flow event.
Combined sewer	A sewer designed to carry foul sewage and surface water in the same pipe.
Detention basin	A vegetated depression, normally is dry except after storm events, constructed to store water temporarily to attenuate flows. May allow infiltration of water to the ground.
Evapotranspiration	The process by which the Earth's surface or soil loses moisture by evaporation of water and by uptake and then transpiration from plants.
FEH	Flood Estimation Handbook, produced by Centre for Ecology and Hydrology, Wallingford (formerly the Institute of Hydrology).
Filter drain or trench	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water, but may also be designed to permit infiltration.
First flush	The initial runoff from a site or catchment following the start of a rainfall event. As runoff travels over a catchment it will collect or dissolve pollutants, and the "first flush" portion of the flow may be the most contaminated as a result. This is especially the case for intense storms and in small or more uniform catchments. In larger or more complex catchments pollution.
Flood plain	Land adjacent to a watercourse that would be subject to repeated flooding under natural conditions (see Environment Agency's Policy and practice for the protection of flood plains for a fuller definition).
Greenfield runoff	This is the surface water runoff regime from a site before development, or the existing site conditions for brownfield redevelopment sites.
Impermeable surface	An artificial non-porous surface that generates a surface water runoff after rainfall.
Permeability	A measure of the ease with which a fluid can flow through a porous medium. It depends on the physical properties of the medium, for example grain size, porosity and pore shape.

Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or if rainfall is particularly intense.
Sewerage undertaker	This is a collective term relating to the statutory undertaking of water companies that are responsible for sewerage and sewage disposal including surface water from roofs and yards of premises.
Soakaway	A subsurface structure into which surface water is conveyed to allow infiltration into the ground.
Treatment	Improving the quality of water by physical, chemical and/or biological means.

The terms included in this glossary have been taken from CIRIA (2015) guidance.

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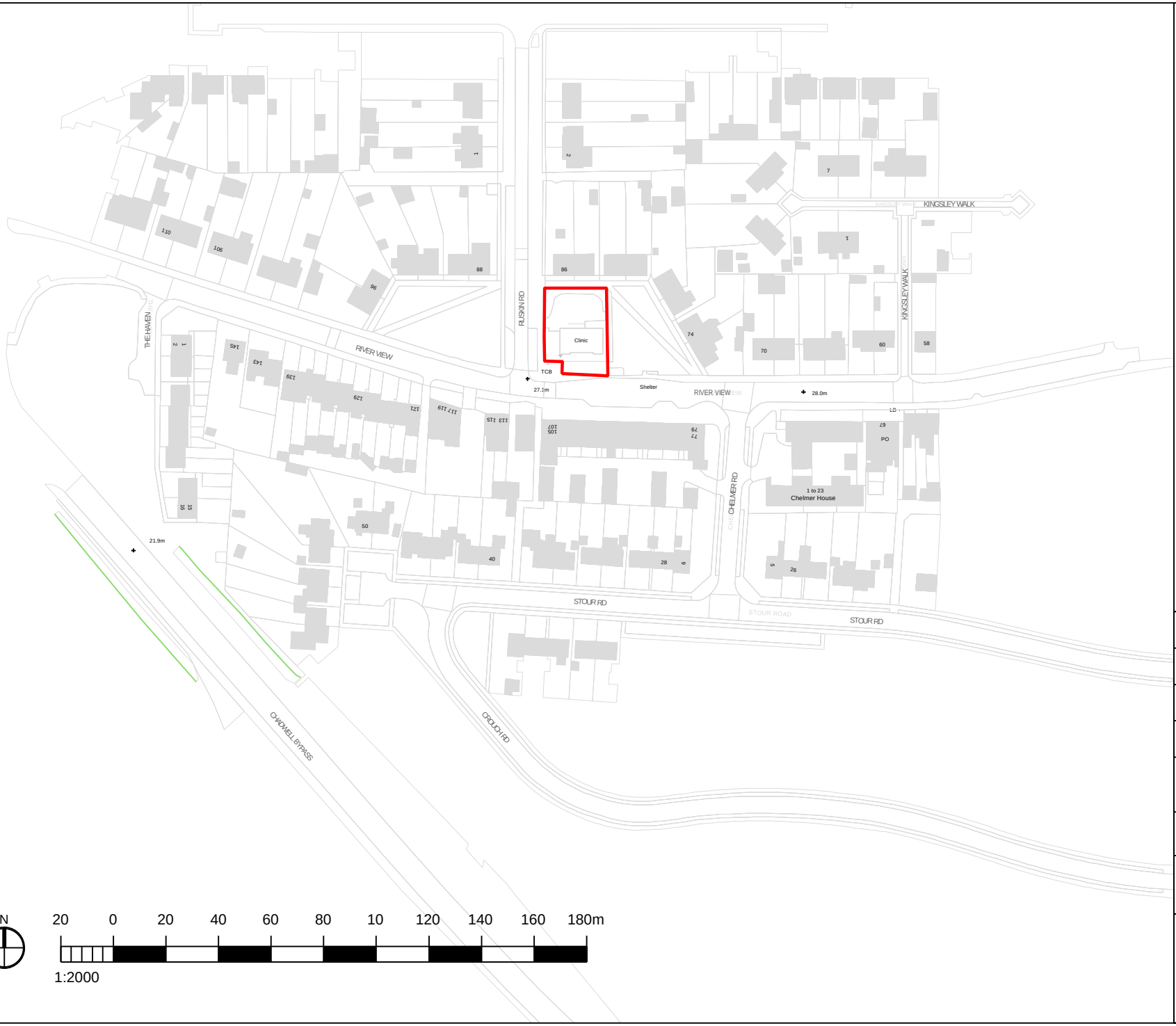
15 Appendices

Appendix A

Site plans



PURPOSE OF ISSUE: PL - PLANNING SUBMISSION
RIBA STAGE: 3

DRAWING STATUS: S2-FIT FOR INFORMATION

PROJECT TITLE: Project Title

CLIENT: Prestige London Home Ltd

DRAWING TITLE: LOCATION PLAN
SCALE: 1:2000 @A4

DATE	DRAWN BY	CHECKED BY	APPROVED BY
Sep 2022	TO		

DRAWING NUMBER

PROJECT NO	DRAWING FIELDS	REVISION
3969	LAN - ZZ - XX - DR - A - 0001	P01

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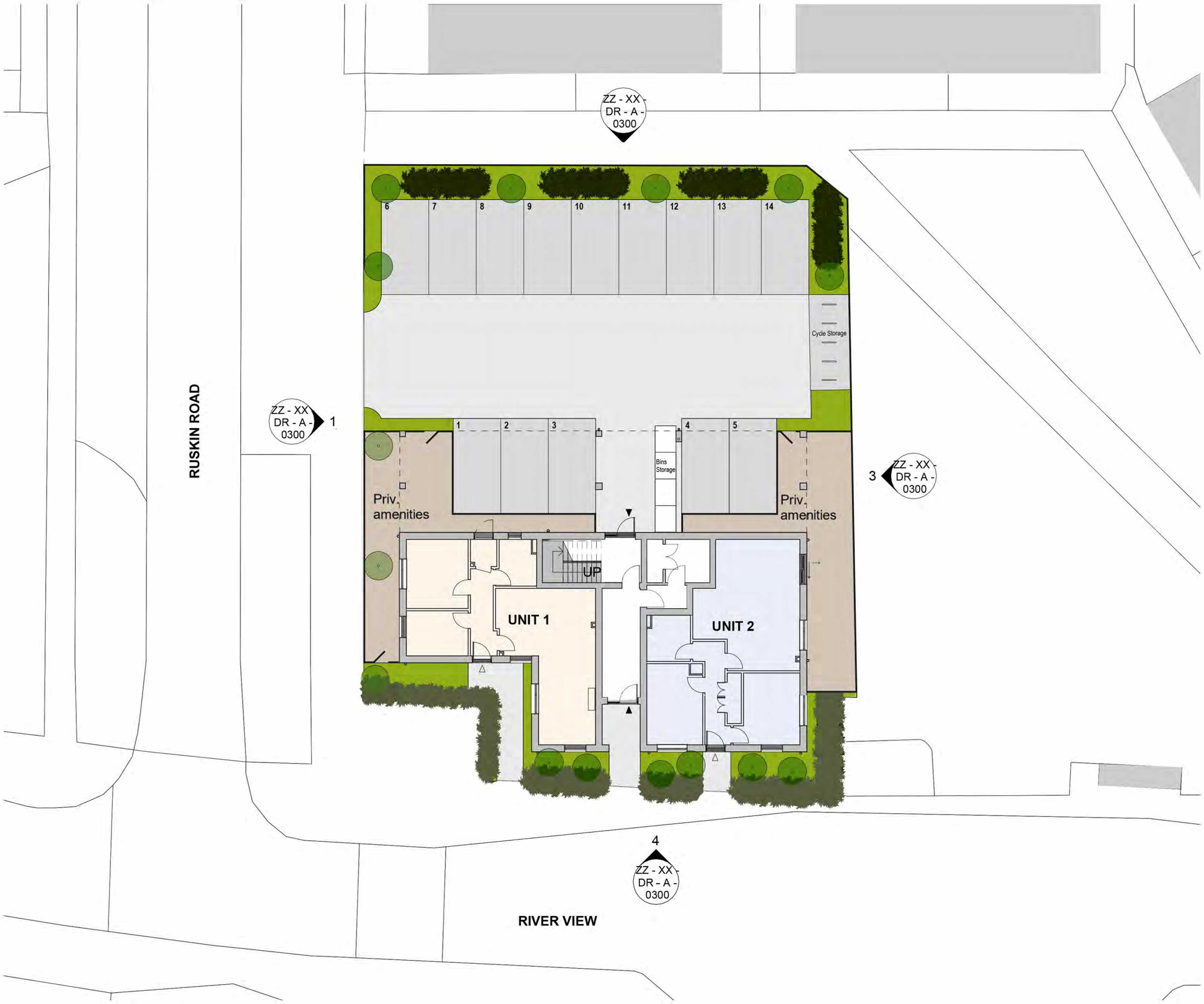

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It is your responsibility as client to make yourself aware of your role within CDM 2015 and act accordingly.

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Revisions

Rev.	Description	Date	Drawn By	Checked By

PURPOSE OF ISSUE
PL - For Planning Submission

DRAWING STATUS
S2 - Fit for Information

PROJECT TITLE
FORMER CHADWELL CLINIC

CLIENT
VK HOMES ENTERPRISES LTD

DRAWING TITLE
Proposed Site Plan

SCALE	DATE	DRAWN BY	CHECKED BY	APPROVED BY
1 : 200@A3	30.09.2022	TH	DO	GRH

DRAWING NUMBER

PROJECT NO	DRAWING FIELDS	REVISION
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12/05/2023 13:12:39 Y:\1. Projects\3969 Land at Chadwell Clinic, River View, Chadwell St Mary\2. Design\01 BIM\01 RIBA STAGE 0-3\01 Revit Models\01 Central Models\3969 Chadwell Clinic.rvt

GeoSmart Information

Appendix B

Rainfall runoff calculations

Greenfield Site Run-Off Calculations usng the IoH124 method

Greenfield peak run-off rate (QBAR):

Parameters	Input	Units	Comments
Area	50	ha	mimimum 50ha
SAAR	545	mm	FEH CD ROM (NERC, 2009)
SPR	0.30	N/A	Soil run-off coefficient
Region	6	N/A	Region on Hydrological area map

QBAR

$$Q_{BAR(rural)} = 1.08AREA^{0.89}SAAR^{1.17}SPR^{2.17}$$

Where:

$Q_{BAR(rural)}$	is the mean annual flood (a return period of 2.3 years) in l/s
AREA	is the area of the catchment in km² (minimum of 0.5km²)
SAAR	is the standard average rainfall for the period 1941 to 1970 in mm
SPR	is the soil run-off coefficient

$Q_{BAR(rural)}$ can be factored by the UK Flood Studies Report regional growth curves to produce peak flood flows for any return period.

$Q_{BAR(rural)}$	=	67.99	l/s for 50ha site
Divided by 50 to scale down	=	1.36	l/s/ha
Actual Area of the entire Site	=	0.08	ha

Return Periods (Growth curves obtained from DEFRA report)

Return Period		Growth Factor	l/s/ha	Peak site run-off rate (l/s)
1	$Q_{BAR(rural)}$ x	0.85	1.16	0.097
2	$Q_{BAR(rural)}$ x	0.88	1.20	0.10
5	$Q_{BAR(rural)}$ x	1.28	1.74	0.15
10	$Q_{BAR(rural)}$ x	1.62	2.20	0.18
25	$Q_{BAR(rural)}$ x	2.14	2.91	0.24
30	$Q_{BAR(rural)}$ x	2.24	3.05	0.255
50	$Q_{BAR(rural)}$ x	2.62	3.56	0.30
100	$Q_{BAR(rural)}$ x	3.19	4.34	0.36
200	$Q_{BAR(rural)}$ x	3.86	5.25	0.44

Greenfield total run-off volume:

= actual area of the entire site x SPR x 6 hour rainfall depth

Return Period	6 hour rainfall (mm) from FEH CD-ROM	Area (ha)	SPR	Total run-off (m^3)
2.3 (QBAR)	26.49	0.08	0.30	6.7
1	24.62	0.08	0.30	6.2
10	43.98	0.08	0.30	11.0
30	58.19	0.08	0.30	14.6
100	79.87	0.08	0.30	20.1

Developed site run-off calculation sheet

1 in 1 year

Proposed impermeable area	0.070	ha
CC Factor	45%	
Total volume for surfaces during 6 hour event	17.14	m³
Total volume for 6 hour event inc CC	24.85	m³
Total volume for 6 hour event exc CC	17.14	m³

Duration	Rainfall 1 yr event	Run-off rate 1 yr event	Run-off rate 1 yr +cc event
hours	mm	m³	m³
0.25	7.90	5.50	7.97
0.5	10.00	6.96	10.09
0.75	11.30	7.86	11.40
1	12.20	8.49	12.31
2	17.20	11.97	17.36
3	20.08	13.98	20.26
4	22.05	15.35	22.25
5	23.49	16.35	23.71
6	24.62	17.14	24.85
8	26.26	18.28	26.50
10	27.48	19.13	27.73
12	28.45	19.80	28.71
16	29.99	20.87	30.27
20	31.23	21.74	31.52
24	32.30	22.48	32.60
28	33.30	23.18	33.61
32	34.23	23.82	34.54
36	35.13	24.45	35.45
40	35.98	25.04	36.31
44	36.81	25.62	37.15
48	37.62	26.18	37.97

1 in 30 year

Proposed impermeable area	0.070	ha
CC Factor	45%	
Total volume for surfaces during 6 hour event	40.50	m³
Total volume for 6 hour event inc CC	58.73	m³
Total volume for 6 hour event exc CC	40.50	m³

Duration	Rainfall 30 yr event	Run-off volume 30 yr event	Run-off volume 30 yr +cc event
hours	mm	m³	m³
0.25	23.25	16.18	23.46
0.5	29.87	20.79	30.14
0.75	33.73	23.48	34.04
1	36.41	25.34	36.74
2	45.12	31.40	45.54
3	50.22	34.95	50.68
4	53.70	37.38	54.19
5	56.22	39.13	56.74
6	58.19	40.50	58.73
8	61.11	42.53	61.67
10	63.26	44.03	63.84
12	64.95	45.21	65.55
16	67.49	46.97	68.11
20	69.44	48.33	70.08
24	71.07	49.46	71.72
28	72.48	50.45	73.15
32	73.78	51.35	74.46
36	74.98	52.19	75.67
40	76.12	52.98	76.82
44	77.20	53.73	77.91
48	78.24	54.46	78.96

Outflow at 1l/s	inflow from rain	Diff (storage required)
0.90	16.18	15.28
1.80	20.79	18.99
2.70	23.48	20.78
3.60	25.34	21.74
7.20	31.40	24.20
10.80	34.95	24.15
14.40	37.38	22.98
18.00	39.13	21.13
21.60	40.50	18.90
28.80	42.53	13.73
36.00	44.03	8.03
43.20	45.21	2.01
57.60	46.97	-10.63
72.00	48.33	-23.67
86.40	49.46	-36.94
100.80	50.45	-50.35
115.20	51.35	-63.85
129.60	52.19	-77.41
144.00	52.98	-91.02
158.40	53.73	-104.67
172.80	54.46	-118.34

1 in 100 year

Proposed impermeable area	0.070	ha
CC Factor	45%	
Total volume for surfaces during 6 hour event	55.59	m³
Total volume for 6 hour event inc CC	80.60	m³
Total volume for 6 hour event exc CC	55.59	m³

Duration	Rainfall 100 yr event	Run-off volume 100 yr event	Run-off volume 100 yr +cc event
hours	mm	m³	m³
0.25	30.55	21.26	30.83
0.5	39.50	27.49	39.86
0.75	44.70	31.11	45.11
1	48.48	33.74	48.93
2	60.08	41.82	60.63
3	67.45	46.95	68.07
4	72.73	50.62	73.40
5	76.71	53.39	77.42
6	79.87	55.59	80.60
8	84.59	58.87	85.37
10	87.99	61.24	88.80
12	90.60	63.06	91.43
16	94.34	65.66	95.21
20	97.03	67.53	97.92
24	99.15	69.01	100.06
28	100.89	70.22	101.82
32	102.41	71.28	103.35
36	103.78	72.23	104.73
40	105.04	73.11	106.01
44	106.21	73.92	107.19
48	107.32	74.69	108.31

		100yr Scenario	CC Scenario
Outflow at 1 l/s	inflow from rain	Diff (storage required)	Diff (storage required)
0.90	30.83	20.36	29.93
1.80	39.86	25.69	38.06
2.70	45.11	28.41	42.41
3.60	48.93	30.14	45.33
7.20	60.63	34.62	53.43
10.80	68.07	36.15	57.27
14.40	73.40	36.22	59.00
18.00	77.42	35.39	59.42
21.60	80.60	33.99	59.00
28.80	85.37	30.07	56.57
36.00	88.80	25.24	52.80
43.20	91.43	19.86	48.23
57.60	95.21	8.06	37.61
72.00	97.92	-4.47	25.92
86.40	100.06	-17.39	13.66
100.80	101.82	-30.58	1.02
115.20	103.35	-43.92	-11.85
129.60	104.73	-57.37	-24.87
144.00	106.01	-70.89	-37.99
158.40	107.19	-84.48	-51.21
172.80	108.31	-98.11	-64.49

GeoSmart Information

Appendix C

Anglian Water Sewer Asset Location Search

Date: 05/06/23 | Scale: 1:1250 | Map Centre: 564188,178471 | Data updated: 31/05/23 | Our Ref: 1192320 - 1 | Wastewater Plan A4

- Foul Sewer
- Surface Sewer
- Combined Sewer
- Final Effluent
- Rising Main*
- Private Sewer*
- Decommissioned Sewer*
- Outfall*
- Inlet*
- Manhole*
- Sewage Treatment Works
- Public Pumping Station
- Decomissioned Pumping Station

*(Colour denotes effluent type)

davidsouth@geosmartinfo.co.uk

79509

love every drop anglianwater

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
0401	F	22.56	21.29	1.27
0501	F	27.24	20.98	6.26
0502	F	-	-	-
1401	F	-	-	-
1402	F	-	-	-
1403	F	27.48	20.79	6.69
1404	F	-	-	-
1405	F	-	-	-
1406	F	-	-	-
1407	F	-	-	-
1408	F	-	-	-
1502	F	-	-	-
2401	F	22.89	21.65	1.24
2402	F	23.07	21.87	1.2
2403	F	27.1	23.95	3.15
2404	F	27.21	24.03	3.18
2405	F	27.74	26.63	1.11
2406	F	28.04	20.46	7.58
2407	F	-	-	-
2408	F	28.15	27.44	0.71
2409	F	-	-	-
2410	F	-	-	3.3
2501	F	29.43	27.79	1.64
2502	F	-	-	-
2504	F	-	-	-
3402	F	28.72	20.06	8.66
3403	F	-	-	1.68
3404	F	-	-	-
0451	S	-	-	-
0452	S	-	-	-
1451	S	-	-	-
1453	S	-	-	-

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
1454	S	-	-	-
2352	S	22.3	20.98	1.32
2451	S	-	-	-
3352	S	-	-	-

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monitor their compliance with the Code.

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award up to £5,000 to you if the Ombudsman finds that you have suffered actual financial loss and/or aggravation, distress or inconvenience as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs contact details:

The Property Ombudsman scheme

Milford House

43-55 Milford Street

Salisbury

Wiltshire SP1 2BP

[redacted]

You can get more information about the PCCB from www.propertycodes.org.uk.

Please ask your search provider if you would like a copy of the search code

Complaints procedure

GeoSmart Information Limited is registered with the Property Codes Compliance Board as a subscriber to the Search Code. A key commitment under the Code is that firms will handle any complaints both speedily and fairly. If you want to make a complaint, we will:

Acknowledge it within 5 working days of receipt.

Normally deal with it fully and provide a final response, in writing, within 20 working days of receipt.

Keep you informed by letter, telephone or e-mail, as you prefer, if we need more time.

Provide a final response, in writing, at the latest within 40 working days of receipt.

Liaise, at your request, with anyone acting formally on your behalf.

If you are not satisfied with our final response, or if we exceed the response timescales, you may refer the complaint to The Property Ombudsman scheme (TPOs): Tel: [redacted]
E-mail: [redacted]

We will co-operate fully with the Ombudsman during an investigation and comply with his final decision. Complaints should be sent to:

Martin Lucass

Commercial Director

GeoSmart Information Limited

Suite 9-11, 1st Floor,

Old Bank Buildings,

Bellstone, Shrewsbury, SY1 1HU

[redacted]

16 Terms and conditions, CDM regulations and data limitations

Terms and conditions can be found on our website:

http://geosmartinfo.co.uk/terms-conditions/

CDM regulations can be found on our website:

http://geosmartinfo.co.uk/knowledge-hub/cdm-2015/

Data use and limitations can be found on our website:

http://geosmartinfo.co.uk/data-limitations/