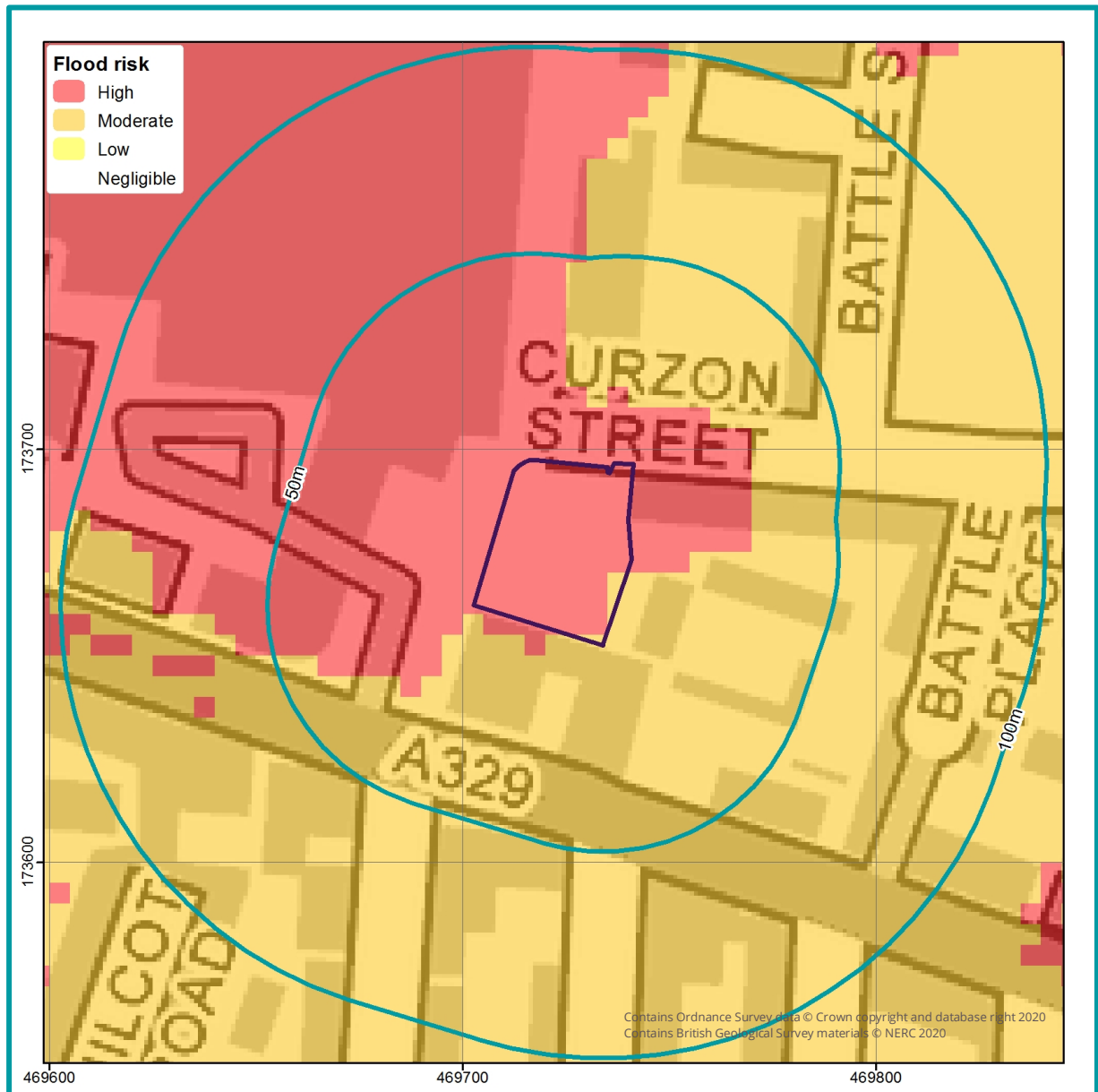


Figure 9. Groundwater flood risk (GW5) map (GeoSmart, 2020)



GeoSmart have undertaken an assessment of the risk of flooding from groundwater sources within the vicinity of the Site. The site has a High to Moderate risk of groundwater flooding.

Approximately 90 % of the Site is at a High risk of flooding with a minimum 1% annual probability of flooding from groundwater according to the GeoSmart GW5 map with the remaining 10 % of the Site at a Moderate risk.

The SuDS design could potentially be affected by flooding through the underlying geology. It is necessary that any SuDS are designed to operate in times when groundwater levels are high, so Site specific investigation is necessary to establish the depth to groundwater.

## 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 Oxford Road, Reading, RG30 1AH (the Site). The Site is located to the west of Reading in a setting of commercial and residential use. The land slopes to the north west from 42.51 mAOD to 39.74 mAOD in the north western corner (HB Surveys Ltd, 2020). Site plans and drawings are provided in Appendix A.

### Development

The Site is currently undeveloped, at present there are foundations of a disused structure on-Site. Development proposals include the construction of a mixed-use development comprised of commercial units at ground floor level and residential from first to fifth floors, including associated access from Curzon Street, parking and landscaping.

### Geology, permeability and thickness

British Geological Survey (BGS) national superficial and bedrock geology mapping confirms a number of different formations underlie the site and each formation may have a range of permeability.

**Table 3. Site Geology**

| Geology present on site |                                                                                        | Potentially permeable? |
|-------------------------|----------------------------------------------------------------------------------------|------------------------|
| Superficial geology     | Taplow Gravel Member (KPGR) (sand And gravel)                                          | ✓                      |
| Bedrock geology         | Seaford Chalk Formation and Newhaven Chalk Formation (SNCK) (undifferentiated) (chalk) | ✓                      |

Figure 10. Superficial Geology (BGS, 2020)

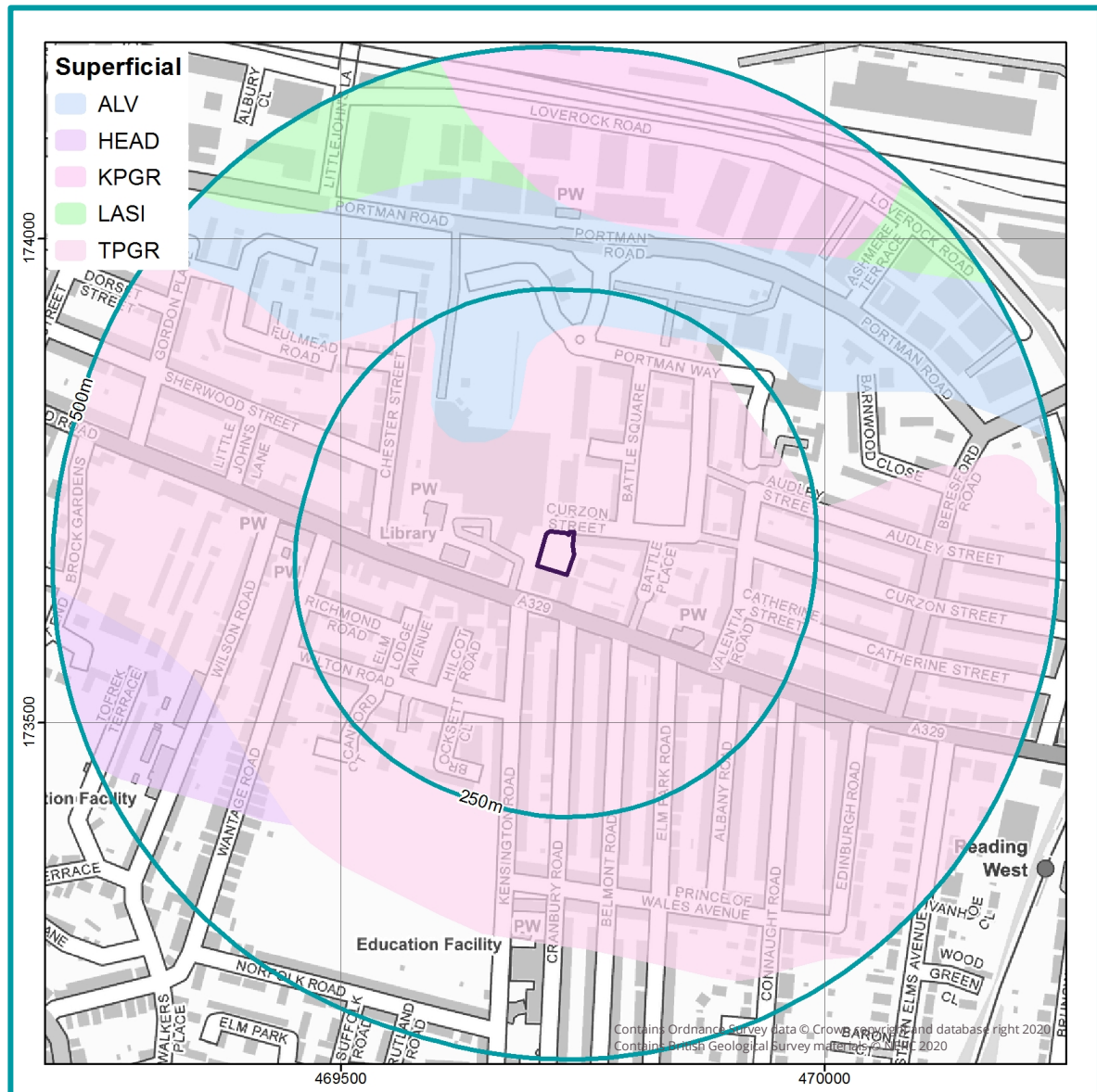


Figure 11. Bedrock Geology (BGS, 2020)



A nearby borehole record (ref: SU67SE101) was obtained from the BGS website, located approximately 55 m to the north east of the Site at an elevation of 42.32 mAOD.

The borehole record confirms the underlying geology in the surrounding area is likely to be comprised of Made Ground to a depth of 1.2 m below ground level (bgl) underlain by Gravel (drift) to a depth of 3.7 m bgl, underlain by Sand and Gravel (drift) to 10.4 m bgl. This is underlain by the chalk deposits with Rubble Chalk recorded between 10.4 m bgl and 15.2 m bgl, and Chalk with Flints between 15.2 m bgl and 45.7 m bgl, where the borehole was terminated.

## Depth to groundwater

According to GeoSmart's Groundwater Flood Risk (GW5) map, shallow groundwater is potentially a problem at the Site. The borehole record (ref: SU67SE101) recorded groundwater at 3.7 m below well top (38.62 mAOD, approximately 1.12 m lower than the lowest elevation of the Site).

Infiltration features are not proposed due to the anticipated high groundwater table identified at the Site which could lead to groundwater emergence at the Site. The SuDS system should be designed to operate in periods of extreme groundwater levels. Care should be taken to prevent groundwater ingress into the surface water attenuation features.

### Guidance

*'It is essential that the consideration of sustainable drainage takes place at the land acquisition due diligence stage'*

LASOO (2015), Practice Guidance, Local Authority SuDS Officer Organisation.

## Ground conditions

Infiltration SuDS features are not proposed at the Site, therefore a detailed investigation into the ground conditions is not required.

## 5 Water quality



The Site does not lie within an SPZ. Where infiltration is proposed, the infiltrated water quality should be of sufficient quality that it does not give rise to pollution of the underlying groundwater. Further consultation with the water company is unlikely to be required.

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.

## 6 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<sup>2</sup>) 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. Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)**

| Applies across all of England | Total potential change anticipated for 2010 to 2039 | Total potential change anticipated for 2040 to 2059 | Total potential change anticipated for 2060 to 2115 |
|-------------------------------|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| Upper end                     | 10%                                                 | 20%                                                 | 40%                                                 |
| Central                       | 5%                                                  | 10%                                                 | 20%                                                 |

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.

## Local Policy

### Reading Borough Council - Reading Borough Local Plan (2019)

#### "EN18: FLOODING AND SUSTAINABLE DRAINAGE SYSTEMS

Development will be directed to areas at lowest risk of flooding in the first instance, following the Sequential and Exceptions Test set out in the NPPF, and taking into account the effects of climate change. It will consider flooding from all sources, including fluvial, surface water, groundwater and sewer flooding. Where development in areas at risk of flooding is necessary, it will not reduce the capacity of the flood plain to store floodwater, impede the flow of floodwater or in any way increase the risks to life and property arising from flooding. Wherever possible, development should be designed to reduce flood risk, both on- and off-site. All major developments must incorporate sustainable drainage systems (SuDS) as appropriate and in line with the Government's Technical Standards. Smaller schemes are

encouraged to incorporate SuDS, where possible. Runoff rates should aim to reflect greenfield conditions and, in any case, must be no greater than the existing conditions of the site. Schemes should ensure that the movement of water through vertical infiltration as well as horizontal run-off does not worsen contamination effects. Wherever possible, SuDS provision should maximise ecological benefits, link into the existing Green Network, incorporate tree planting and landscaping and avoid damage to existing significant trees, including through changes to the site hydrology. All new developments in areas of flood risk should give priority to SuDS.

**4.2.104** Sustainable drainage systems aim to replicate natural drainage as closely as possible and minimise the impacts of development. In the first instance, schemes should consider the provision of SuDS through landscaping, with reference to Part D of the CIRIA SuDS manual, and in any case should consider the following:

- Integration with existing landscape;
- Tree planting provision fed by groundwater runoff that functions effectively in place of attenuation tanks;
- Additional capacity to cater for future development; and
- Techniques including, but not limited to, permeable pavements, swales, basins, rain gardens, green roofs, rainwater re-use, infiltration trenches, ponds and wetlands.

**4.2.105** Schemes for SuDS need to be careful to avoid resulting in contamination of watercourses and groundwater. Soakaways in contaminated land will not be appropriate. Infiltration SuDS techniques should only dispose of clean roof water into clean, uncontaminated ground, should not be used for foul discharges or trade effluent, and may not be suitable within Source Protection Zone 1.

**4.3.106** The SuDS elements of the policy apply to major development. Small-scale developments will be encouraged to adopt elements of SuDS wherever practicable, including the provision of permeable surfaces within the site, e.g. on front gardens or car parking areas."

## 7 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 to surface water sewer)**

| Attenuation scenario                    |                                | Attenuation required (m <sup>3</sup> ) | Explanation                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                  |
|-----------------------------------------|--------------------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Discharge runoff to surface water sewer | 1 in 30 year                   | 32.52                                  | <p>Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 30 year (2 hour, Critical Storm Duration) event*.</p> <p>Flooding of the Site of 12.7 m<sup>3</sup> should be contained within permeable landscaped areas within the Site to ensure no flooding of internal areas during the 1 in 100 year storm event.</p> | <p>A further 24.8 m<sup>3</sup> should be managed within overland flow routes to ensure there is no increase in flood risk in all events up to the 1 in 100 year including 40% allowance for climate change.</p> |
|                                         | 1 in 100 year                  | 45.17                                  | <p>Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 100 year (2 hour, Critical Storm Duration) event*.</p>                                                                                                                                                                                                      |                                                                                                                                                                                                                  |
|                                         | 1 in 100 year including 40% CC | 69.94                                  | <p>Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 100 year (3 hour, Critical Storm Duration) event including a 40% allowance for climate change*.</p>                                                                                                                                                         |                                                                                                                                                                                                                  |

\*See Appendix B for associated runoff and discharge calculations. Discharge rates all restricted 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 13 'Background Information'.

### Guidance

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

*"Where reasonably practicable, for Greenfield development, 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 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 6. Change in impermeable area associated with the development**

|                                                                                                                              |                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Total site area                                                                                                              | 1,264 m <sup>2</sup>                                                               |
| <b>Impermeable area (and as a percentage of the total area of the proposed development footprint of 1,264 m<sup>2</sup>)</b> |                                                                                    |
| Pre-development                                                                                                              | Post-development*                                                                  |
| 2 m <sup>2</sup> (0 %)                                                                                                       | 1237 m <sup>2</sup> (98%)                                                          |
| Impermeable Land use:<br>Disused building foundations                                                                        | New impermeable land use:<br>1,237 m <sup>2</sup> Building cover and parking areas |
| Permeable Land use:<br>Softstanding areas                                                                                    | New permeable land use:<br>27 m <sup>2</sup> of Landscaped areas                   |

\*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 13 'Background Information'.

**Table 7. Peak discharge rates associated with the development**

| Rainfall event                | Greenfield runoff rates (l/s) | Existing runoff rates <sup>1</sup> (l/s) | Potential runoff rates without attenuation (l/s) | Potential minus existing (l/s) |
|-------------------------------|-------------------------------|------------------------------------------|--------------------------------------------------|--------------------------------|
| QBAR                          | 0.56                          | N/A                                      | N/A                                              | N/A                            |
| 6 hour 1 in 1 year            | 0.47                          | 0.65                                     | 1.37                                             | 0.72                           |
| 6 hour 1 in 10 year           | 0.90                          | 1.08                                     | 2.20                                             | 1.12                           |
| 6 hour 1 in 30 year           | 1.25                          | 1.35                                     | 2.83                                             | 1.48                           |
| 6 hour 1 in 100 year          | 1.78                          | 1.68                                     | 3.53                                             | 1.85                           |
| 6 hour 1 in 100 year + 20% CC | N/A                           | N/A                                      | 4.24                                             | 2.56                           |
| 6 hour 1 in 100 year + 40% CC | N/A                           | N/A                                      | 4.95                                             | 3.26                           |

**1 Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the loH124 method.**

Relevant local and regional plan policy should be consulted to determine restrictions on runoff from previously developed sites. In some cases, green field rates may be requested. In practice it is difficult to restrict discharge rates at any one control point to less than 2 l/s.

## 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 12 'Methodology and Limitations'.

**Table 8. Total discharge volumes associated with the development**

| Rainfall event                | Greenfield runoff volume (m <sup>3</sup> ) | Existing runoff volume <sup>2</sup> (m <sup>3</sup> ) | Potential runoff volume without attenuation (m <sup>3</sup> ) | Potential minus existing (m <sup>3</sup> ) |
|-------------------------------|--------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------|
| QBAR                          | 16.31                                      | N/A                                                   | N/A                                                           | N/A                                        |
| 6 hour 1 in 1 year            | 14.12                                      | 14.14                                                 | 29.69                                                         | 15.55                                      |
| 6 hour 1 in 10 year           | 23.22                                      | 23.26                                                 | 47.44                                                         | 24.18                                      |
| 6 hour 1 in 30 year           | 29.08                                      | 29.13                                                 | 61.17                                                         | 32.04                                      |
| 6 hour 1 in 100 year          | 36.29                                      | 36.36                                                 | 76.34                                                         | 39.99                                      |
| 6 hour 1 in 100 year + 20% CC | N/A                                        | N/A                                                   | 91.61                                                         | 55.26                                      |
| 6 hour 1 in 100 year + 40% CC | N/A                                        | N/A                                                   | 106.88                                                        | 70.52                                      |

<sup>2</sup> Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the loH124 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 (40%) 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 2 l/s.

**Table 9. Critical Storm Duration and Attenuation volume requirements**

| Return Period                         | Runoff rate restriction (l/s) | Critical Storm Duration (hr) | Attenuation volume required (m <sup>3</sup> ) |
|---------------------------------------|-------------------------------|------------------------------|-----------------------------------------------|
| 1 in 30 year                          | 2                             | 2                            | 32.52                                         |
| 1 in 100 year                         | 2                             | 2                            | 45.17                                         |
| 1 in 100 year plus 40% climate change | 2                             | 3                            | 69.94                                         |

## 8 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, 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 permeable underlying chalk and gravel. Based on the available borehole information and groundwater flood risk mapping there is an increased potential for high groundwater levels at the Site leading to potential emergence of groundwater at the surface. There are no issues identified relating to site contamination or the presence of a SPZ.

### Discharge to surface watercourse

No surface watercourses are mapped in the vicinity of the Site.

### Discharge to sewer

Discharge to sewer is likely to be the optimum sustainable drainage option for the new development area. 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 onsite attenuation would be required. The topographic gradient on the site falls to the north west away from the existing drainage network along the main road, the depth of the sewer should be confirmed to ensure the flows can be discharged to the public sewer by gravity.

## 9 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 not lie within an SPZ and therefore additional treatment stages are not required.

**Table 10. 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 11. 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    |

Green roof and permeable car parking spaces would offer sufficient treatment stages (storage (attenuation) and filtration through the sub-base).

## 10 Proposed SuDS strategy



### Sustainable drainage systems

It is recommended the drainage system has the capacity to accommodate the 1 in 100 year event before flooding occurs. Drainage from areas outside the development footprint will continue to use the 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:

If infiltration to ground is achievable at the Site, a storage volume of 69.9 m<sup>3</sup> should be provided within SuDS features. This would ensure the attenuation of surface water runoff required to achieve greenfield run off volumes for a 1 in 100 year (6 hour) storm event, including a 40% allowance for climate change.

**Table 12. Proposed SuDS type, features, discharge location and rate restriction**

|                    |                                                                                                      |
|--------------------|------------------------------------------------------------------------------------------------------|
| SuDS type          | Source control (interception) and attenuation SuDS.                                                  |
| SuDS features      | Green roof, rainwater harvesting butts, and permeable paving underlain by Type 3 aggregate material. |
| Discharge location | Surface water sewer network                                                                          |
| Discharge rate     | 2 l/s                                                                                                |

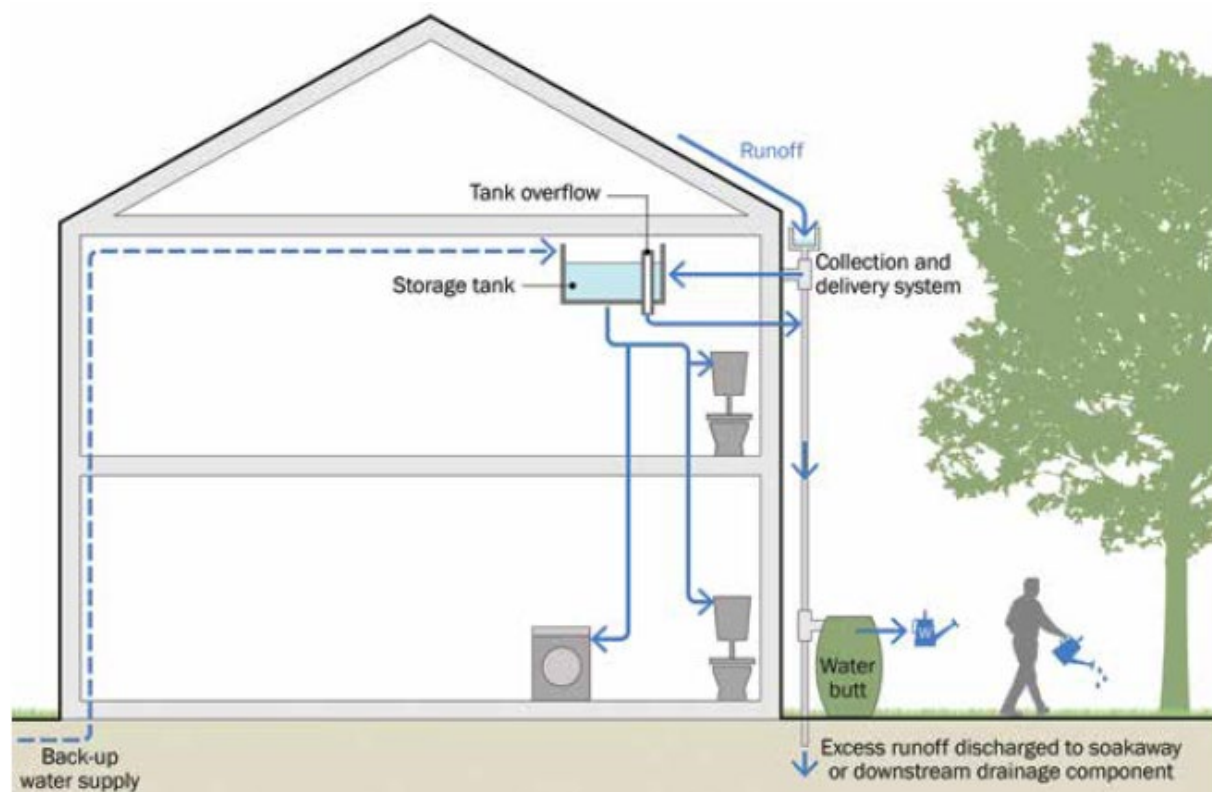
**Table 13. Proposed SuDS sizing (dimensions) and attenuation volumes**

|                        |                                                                                                                                                                                                                                                                                  |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rainwater Harvesting   | A rainwater harvesting butt should be established for each proposed development. In terms of attenuation storage within this SuDS scheme, volume of run-off which could be attenuated by Rainwater Harvesting has not been considered within the Preliminary SuDS schematic.     |
| Green Roof             | A green roof covering a total area of 297 m <sup>2</sup> (cover area of all roof spaces) with a green roof mix example volume of 41.6 m <sup>3</sup> (0.2m depth) and Geocomposite example volume of 3.12 m <sup>3</sup> (0.005m depth) would attenuate for 9.6 m <sup>3</sup> . |
| Lined permeable paving | A 259 m <sup>2</sup> area of permeable paving (underlain with a Type 3 aggregate material) within the proposed driveway areas to a depth of 0.8 m, with a 30% porosity would result in c. 62.2 m <sup>3</sup> attenuation.                                                       |

|                            |                     |
|----------------------------|---------------------|
| Total Attenuation Provided | 71.8 m <sup>3</sup> |
| Total Attenuation Required | 69.9 m <sup>3</sup> |
| Freeboard Storage Provided | 1.9 m <sup>3</sup>  |

A **rainwater harvesting butt** should be established for the proposed development. 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 infiltration 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 devices 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 contaminants that collect on a residential roof.

**Green Roofs** are proposed on the roof of the proposed development which will aim to intercept and store runoff within a porous substrate (depth of 0.2 m) over a total area of 297 m<sup>2</sup> would attenuate up to 9.6 m<sup>3</sup> of surface water runoff<sup>1</sup>

Interception via green/brown roofs will enable the storage of run-off and infiltrate collected water gradually into the underlying substrate; this provides various levels of storage depending on the surface area of the feature and the thickness / type of the substrate being used. The different types of green roof include the following:

- Extensive roofs, have low substrate depths (and therefore low loadings on the building structure), simple planting and low maintenance requirements; these tend not to be accessible.
- Intensive roofs (or roof gardens) have deeper substrates (and therefore higher loadings on the building structure) that can support a wide variety of accessible planting but which tend to require more intensive maintenance.

Green roofs can also provide improvements to water quality as they intercept water at the source, and the layering of the substrate can incorporate filtration measures to remove pollutants from the system. Green Roofs are roofs which incorporate planting, often sedum or wildflower and meadow planting, grasses and mosses. In fact, some can even be planted with trees and shrubs. Brown roofs are similar to green roofs, the main difference is that whilst green roofs are often installed partly for the aesthetic value, brown roofs tend to be installed for environmental reasons, mainly, to encourage plants and wildlife.

In addition, although green roofs absorb most of the rainfall that they receive during frequent events, there will always be a need to discharge excess water to the building's drainage system and these areas should be positively drained. The hydraulic performance of green roofs once saturated tends to be fairly similar to standard roofs. Therefore, the hydraulic design of green roof drainage should follow the advice in BS EN 12056-3:2000. Useful information is also provided in BS 6229:2003. Detailed guidelines for the planning, execution and upkeep of green roof sites are contained within GRO (2014).

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<sup>1</sup> Based upon green roof calculation guidance included within London Borough of Tower Hamlets SuDS Guidance, Section 3.5.

It is recommended that attenuation should be provided in the form of a high porosity substrate underlying the growing medium (approximately 50 % depending on the supplier), which would provide sufficient storage (depending on loading requirements of a fully saturated substrate). It is likely that the high porosity medium would only have to be relatively thin in order to achieve the attenuation requirements. Surface water would then be throttled to a suitable rate at a downpipe entrance before discharging to the combined sewer system, via an existing connection.

**Permeable Paving** is proposed for parking 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.



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<sup>3</sup> there is 0.95 m<sup>3</sup> of space available for water storage), which has been factored into the storage capacity calculations.

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.

**Hydrobrake Flow control systems** are required to reduce the runoff 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 (< 150 mm 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.

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

### **Exceedance Flow Routes**

Exceedance of SuDS features should be directed into attenuation features which include additional freeboard and into the highway, where raised kerbs allow for additional storage.

## 11 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 14. SuDS operation and recommended maintenance requirements**

| Asset type          | Maintenance schedule (and frequency)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Green Roofs         | <p>Regular inspection:</p> <ul style="list-style-type: none"> <li>Inspect all components (soil substrate, vegetation, drainage, irrigation systems, membranes and roof structure, waterproofing, structural stability (annually and after severe storms)</li> <li>Inspect soil substrate for evidence of erosion channels (annually and after severe storms).</li> <li>Inspect drain inlets for unrestricted run-off (annually and after severe storms).</li> <li>Inspect underside of roof for leakage (annually and after severe storms).</li> </ul> <p>Regular maintenance:</p> <ul style="list-style-type: none"> <li>Remove litter and debris from inlet drains (six monthly, annually or as required).</li> <li>Cleaning of clippings (six monthly or as required).</li> <li>Trimming of grasses and removal of nuisance weeds and invasive vegetation (six monthly or as required).</li> <li>Replace dead plants (annually or as required).</li> </ul> <p>Monitoring:</p> <ul style="list-style-type: none"> <li>Stabilise any erosion channels with extra soil substrate (as required).</li> <li>Identify sources of erosion and control (as required).</li> <li>Investigate and repair drain inlet if inlet has settled, cracked or moved (as required).</li> </ul> |
| Permeable pavements | <p>Regular maintenance:</p> <ul style="list-style-type: none"> <li>Brushing and vacuuming (three times per year).</li> <li>Trimming any roots and surrounding grass and weeds that may be causing blockages (annually or as required).</li> </ul> <p>Monitoring:</p> <ul style="list-style-type: none"> <li>Initial inspection (monthly).</li> </ul> <p>Inspect for poor performance and inspection chambers (annually).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| Asset type               | Maintenance schedule (and frequency)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hydro-Brake Flow Control | <p>Low amounts of maintenance required as there are no moving parts within the Hydro-Brake® Flow Control.</p> <ul style="list-style-type: none"> <li>Initial monthly inspection at the manhole once the construction phase is over.</li> </ul> <p>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.</p> <p>Inspection should be undertaken annually or when a storm event occurs.</p> |

## 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 15. 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 16. 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 Pro 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.

## 12 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](http://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 A.

## 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 (DGLC, 2014). For the impermeable surfaces, it has been assumed that 100% runoff will occur (calculations provided in Appendix A). Rainfall data is derived from the Flood Estimation Handbook (FEH) CD-ROM, 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.

## 13 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 web site: <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 (2007) 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/>

## 14 Further information



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

| Additional GeoSmart Products |                                                     |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ✓                            | Additional assessment:<br><b>FloodSmart Report</b>  |    | <p>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.</p> <p>Please contact <a href="mailto:info@geosmartinfo.co.uk">info@geosmartinfo.co.uk</a> for further information.</p>                                                                                                                                                                                                       |
| ✓                            | Additional assessment:<br><b>EnviroSmart Report</b> |  | <p>Provides a robust desk-based assessment of potential contaminated land issues, taking into account the regulatory perspective.</p> <p>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.</p> <p>Ideal for pre-planning or for addressing planning conditions for small developments. Can also be used for land transactions.</p> <p>Please contact <a href="mailto:info@geosmartinfo.co.uk">info@geosmartinfo.co.uk</a> for further information.</p> |

## 15 References and glossary



- British Geological Survey (BGS). (2020).** Geology of Britain Viewer. Based on British Geological Survey materials © NERC 2020. Accessed from: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html> on 25/09/2020.
- Building Research Establishment (BRE) (1991).** Digest 365, Soakaway design.
- CIRIA (2015)** The SuDS manual (C753).
- Department for Environment, Food and Rural Affairs (2015).** Non-statutory technical standards for SuDS (March 2015).
- Ministry of Housing, Communities & Local Government. (2006).** Planning Policy Statement 25: Development and Flood Risk (PPS25).
- Ministry of Housing, Communities & Local Government. (2012).** National Planning Policy Framework (NPPF).
- Ministry of Housing, Communities & Local Government. (2014).** National Planning Policy Guidance (NPPG).
- Environment Agency [EA] (2020).** MagicMap. Accessed from: <http://magic.defra.gov.uk/MagicMap.aspx> on 25/09/2020..
- GeoSmart (2020)** GeoSmart GW5 Version 2.3
- HM Government (2010).** The building regulations 2010 Part H drainage and waste disposal (2015 edition).
- LASOO (2015)** Practice Guidance, Local Authority SuDS Officer Organisation.
- NERC (2009)** WINFAP-FEH CD-ROM version 3.0.
- CEH (2020)** Online FEH web service Depth/duration/frequency modelling using the FEH 1999 and new 2013 models. Accessed from: <https://fehweb.ceh.ac.uk/> on 25/09/2020.

# 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.

## Data Sources

|                                                                   |                                                                                                                                                                                     |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Aerial Photography                                                | Contains Ordnance Survey data © Crown copyright and database right 2020<br>BlueSky copyright and database rights 2020                                                               |
| Bedrock & Superficial Geology                                     | Contains British Geological Survey materials © NERC 2020<br>Ordnance Survey data © Crown copyright and database right 2020                                                          |
| Flood Risk (RoFRS/Pluvial/Surface Water Features/SPZ)             | Environment Agency copyright and database rights 2020<br>Ordnance Survey data © Crown copyright and database right 2020                                                             |
| Flood Risk (Groundwater) and SuDS infiltration suitability (SD50) | GeoSmart, BGS & OS<br>GW5 (v2.3) Map (GeoSmart, 2020)<br>Contains British Geological Survey materials © NERC 2020<br>Ordnance Survey data © Crown copyright and database right 2020 |
| Sewer Location                                                    | Contains Ordnance Survey data © Crown copyright and database right 2020<br>Contains STL Regulated Drainage and Water Search data 2020                                               |
| Topographic Data                                                  | OS LiDAR/EA<br>Contains Ordnance Survey data © Crown copyright and database right 2020<br>Environment Agency copyright and database rights 2020                                     |

## 16 Appendices



## Appendix A



### Site plans (layout and topography)



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Client's Name  
Stonegate Homes

Job Title  
Oxford Road, Reading

Drawing Title  
Location Plan

Scale  
1:1250 @ A4  
metres 10 20 30 40 50

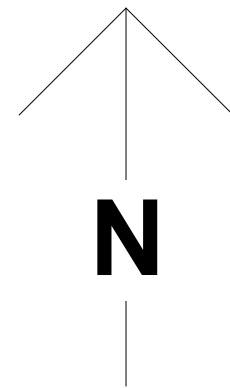
|                |                   |                  |
|----------------|-------------------|------------------|
| Drawn<br>NK    | Checked<br>MN     | Date<br>22.06.20 |
| Job No<br>6906 | Drawing No<br>LOC | Rev              |
| Status         |                   |                  |

INFORMATION

| Rev                                                                                                                              | Date | Revision Details | Dr | Ch |
|----------------------------------------------------------------------------------------------------------------------------------|------|------------------|----|----|
|                                             |      |                  |    |    |
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| <b>Bristol:</b> Westworks, Colston Tower, Colston Street, Bristol, BS1 4XE<br>T 0117 214 1101 E bristol@ecwestworks.com          |      |                  |    |    |
| <b>ECE Architecture</b><br>www.ecearchitecture.com                                                                               |      |                  |    |    |



1 Site Plan/GF  
1 : 200



|     |            |                     |    |    |
|-----|------------|---------------------|----|----|
| B   | 18.09.2020 | Revised Pack Issue  | NK | MN |
| A   | 09.09.2020 | Revised site layout | NK | MN |
| Rev | Date       | Revision Details    | Dr | Ch |

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T 01903 248777 E sussex@ecearchitecture.com  
Bristol: Westworks, Colston Tower, Colston Street, Bristol, BS1 4XE  
T: 0117 214 1101 E bristol@ecewestworks.com



Job Title  
Oxford Road Reading

Drawing Title  
Proposed Site Ground Plan

Scale  
1:200 @ A1 / 1:400 @ A3

metres 4 8 12 16 20

|         |            |     |
|---------|------------|-----|
| Project | Drawing No | Rev |
| 6906    | GA 0100    | B   |

|       |         |          |
|-------|---------|----------|
| Drawn | Checked | Date     |
| FH    | MN      | 08/23/16 |

Status

PRELIMINARY