GeoSmart Information

Environmental Thinking

SuDSmart Pro

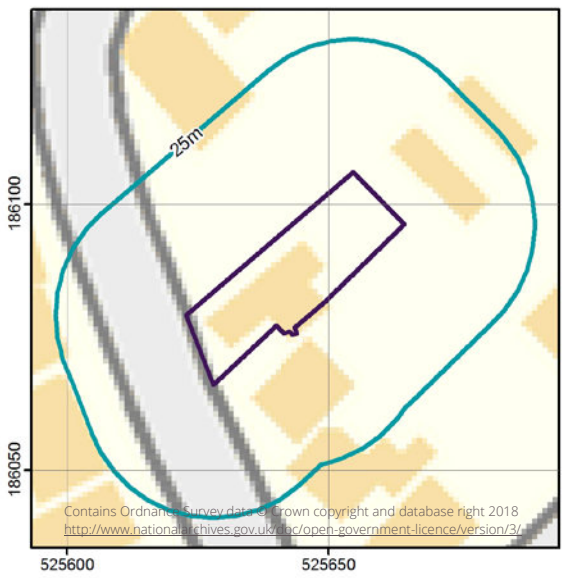
Report reference:	Report status:	Date issued:
70589R1REV1	Final	March 2018

Site address:

50 Redington Road, London, NW3 7RS

Overview:

A combination of SuDS features, comprising a rainwater harvesting butt and storm cell attenuation crates will reduce surface run-off to the greenfield volumes for the 1 in 100 year (6 hour) storm event, including a 30% allowance for climate change, by attenuating a minimum of 34 m³. This would be in line with the London Plan - Policy 5.13 Sustainable drainage (March, 2016) and London Borough of Camden condition notice (Planning Portal Reference: PP-06667395).



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1. Executive summary

SuDS suitability

Risk	Issue	Result
SuDS suitability	What is the infiltration potential at the Site?	Based on site investigation
		Low
	What is the potential to discharge to surface water features?	Low
	What is the potential to discharge to sewers?	High
Flooding	What is the overall flood risk at the Site?	Negligible
Pollution	Is the groundwater a protected resource?	No
	Is the surface water feature a protected resource?	No

SuDS runoff and volume summary

Potential increase in runoff due to the development*[1] Minimum attenuation assuming some off-site discharge.	Total runoff including climate change (+30%)*[1] Maximum attenuation assuming no off-site discharge	Change in impermeable area on a previously developed site As a % of total area
↑ +0.8 m^3	+60.8 m^3	↑ + 2.4%

*[1] for the 6 hour, 1 in 100 year event excluding mitigation

Drainage Hierarchy

- British Geological Survey (BGS) records and a site-specific Ground Investigation confirm discharge to ground is not feasible due to the impermeability of the underlying geology.
- There are no accessible surface water features within 100m of the Site, so discharging to a surface water feature is not considered to be feasible.
- A combined sewer is located within Redington Road and the Site already drains to this feature. Therefore, flows will be attenuated and restricted to the existing combined sewer for the new development. A Thames Water Pre-Development Enquiry has been submitted separately to obtain consent to discharge the proposed flow rates to the sewer.

Proposed Drainage Strategy (See Section 2 of this report)

A combination of SuDS features are proposed (see figure in section 2) to intercept and attenuate surface water runoff. These include a rainwater harvesting butt to store rainwater for non-potable garden use and storm cell attenuation crates which will attenuate surface water runoff from impermeable areas.

Storm cell attenuation crates are proposed to attenuate a minimum of 34 m^3, with the outflow rate from the site to the sewer limited to 1 l/s via an orifice control. This would ensure there is a 74% reduction in the Site's surface water runoff volume at peak times, prior to re-development and a 50% reduction in the Site's surface water runoff rate at peak times, prior to re-development. Surface water runoff will also be reduced to greenfield volumes for the 1 in 100 year (6 hour) storm event, including a 30% allowance for climate change; which is in line with:

- the London Plan - Policy 5.13 Sustainable drainage (March, 2016);
- in accordance with the minimum requirement within London Plan - Sustainable design and Construction SPG: Section 3.4.9 (April, 2014) and London Borough of Camden Planning Guidance (CPG 3: Sustainability); and
- the London Borough of Camden decision notice (Planning Portal Ref: PP-06667395) where there will be no flooding on the Site during the 1 in 100 year Critical Storm Duration (4 hour) including a 30% allowance for CC.

Environmental and ecological considerations:

The Site is not located within a Special Protected Area (SPA) or a Site of Special Scientific Interest (SSSI).

CDM considerations:

If your development is defined as 'Construction Work' under CDM 2015, you or the organisation that is having the work carried out will be defined as 'the Client' and have specific duties under the Regulations. A full list of CDM considerations and our Terms and Conditions can be found on our website, the links can be found in section 21 at the back of this report.

Report considerations:

This report includes the following features:

- Existing and proposed runoff rates and volumes including calculations
- A proposed surface water drainage strategy including confirmation of pipe invert levels and proposed discharge route.
- Detailed Management and Maintenance regime for the proposed drainage and SuDS features
- Details of proposed surface water drainage strategy during the Construction Period
- London Borough of Camden's Drainage Pro-Forma (Appendix D)
- Confirmation of Thames Water Pre-Development Enquiry Application (Appendix E)

2. SuDS scheme layout

Pipe size will reflect the gradients which will be encountered at the site in line with Sewer for Adoption 6th Edition and Building Regulations.

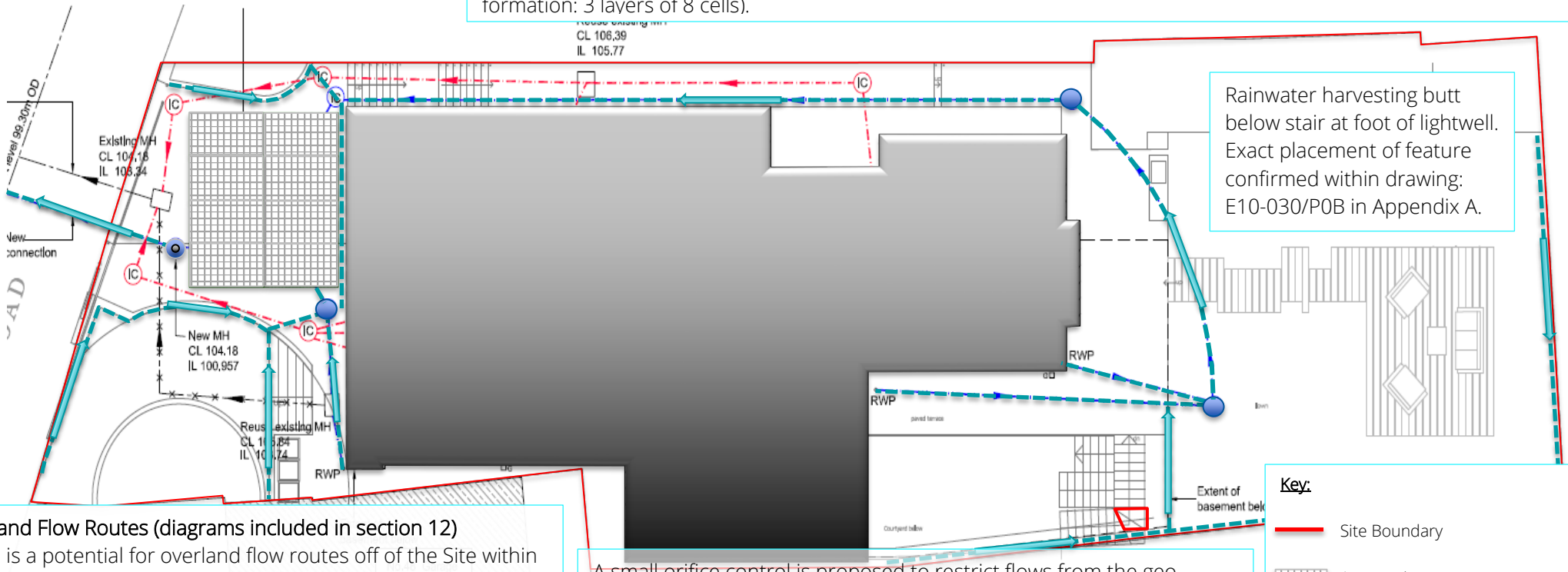
Proposed drainage strategy:

Rainwater Harvesting

A single rainwater harvesting butt is proposed for the Site. Due to the variable amounts of attenuation provided by rainwater harvesting systems, the volume of run-off which could be attenuated by rainwater harvesting has not been considered within the report.

Underground storm cell attenuation crates

Individual Storm Cell blocks have a dimension of 2.4 m x 1.2 m x 0.52 m with a void ratio of 95%. These dimensions, factoring in the void ratio, provides a holding capacity of 1.42m^3 per cell. 24 cells are required for the development and combined cell dimensions would be 4.8m width, 4.8m length and 1.56m depth to provide 34.08 m^3 of attenuation (cell formation: 3 layers of 8 cells).



Rainwater harvesting butt below stair at foot of lightwell. Exact placement of feature confirmed within drawing: E10-030/P0B in Appendix A.

Key:

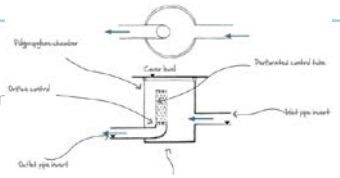
- Site Boundary
- Attenuation crates
- Rainwater harvesting butt
- Surface water drainage/ACO Drains
- Exceedance flow direction
- Inspection chambers
- Inspection chamber containing flow control measure

Overland Flow Routes (diagrams included in section 12)

There is a potential for overland flow routes off of the Site within the rear garden into the property of No. 48, located to the south of the development. Permeable areas to the front of the Site may also drain towards the proposed development and could potentially flow into the development itself when the ground is saturated and exceedance occurs.

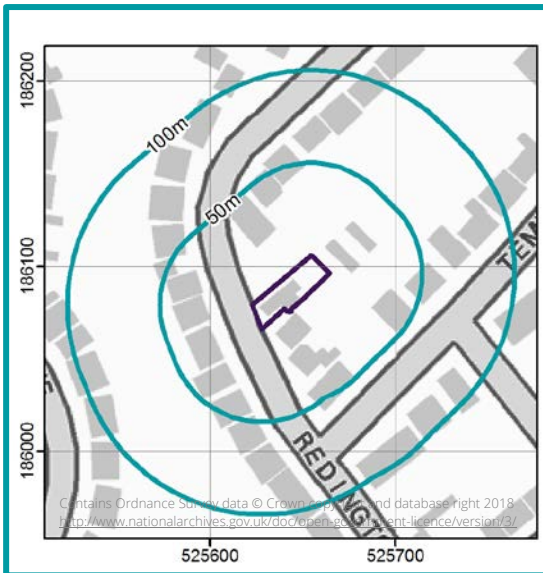
ACO drains should therefore be sited to the north, west and east of the Site, adjacent to areas which transition from permeable land to impermeable land to capture any exceedance flows from the paved areas and overflow from permeable areas to actively drain to the into the proposed underground storm cell attenuation crates, located to the west of the proposed development.

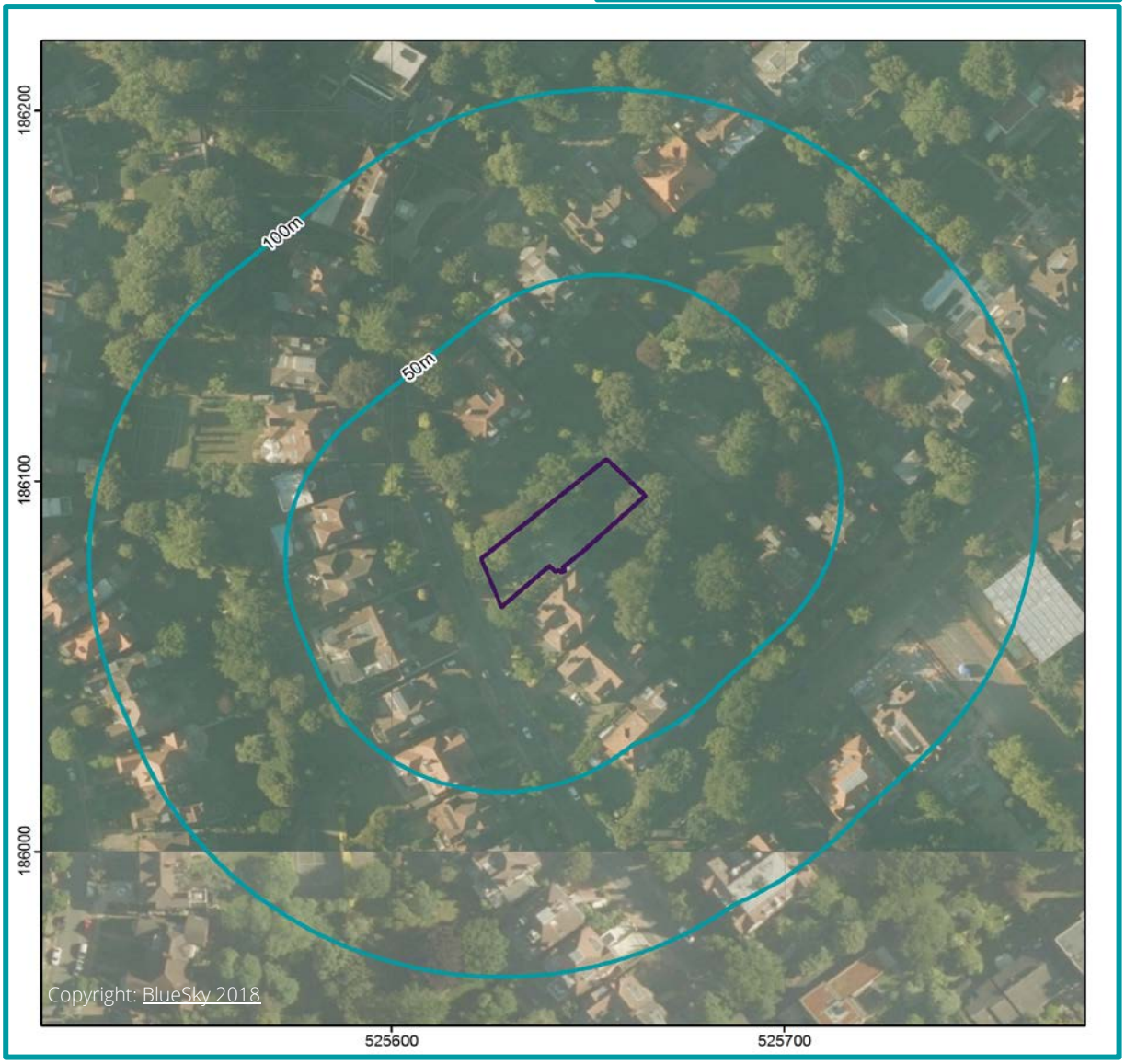
A small orifice control is proposed to restrict flows from the geo-cellular storage crates to the combined sewer at an acceptable rate. Orifices are circular or rectangular openings of a shape and size (small diameter holes) which allow a controlled rate of outflow when submerged. The flow rate depends on the height of the water above the opening (hydraulic head) and the size and edge treatment of the orifice.



3. Site location

Report prepared for:
Mr Marcus Donn
Site area:
622 m^2
Current use:
Residential, 4 bed-dwelling
Proposed use:
Residential, 8 bed-dwelling inc. 2 basement levels
Report author:
Sam Cogan
Report checker:
Mike Piotrowski
Report reviewer:
Bob Sargent



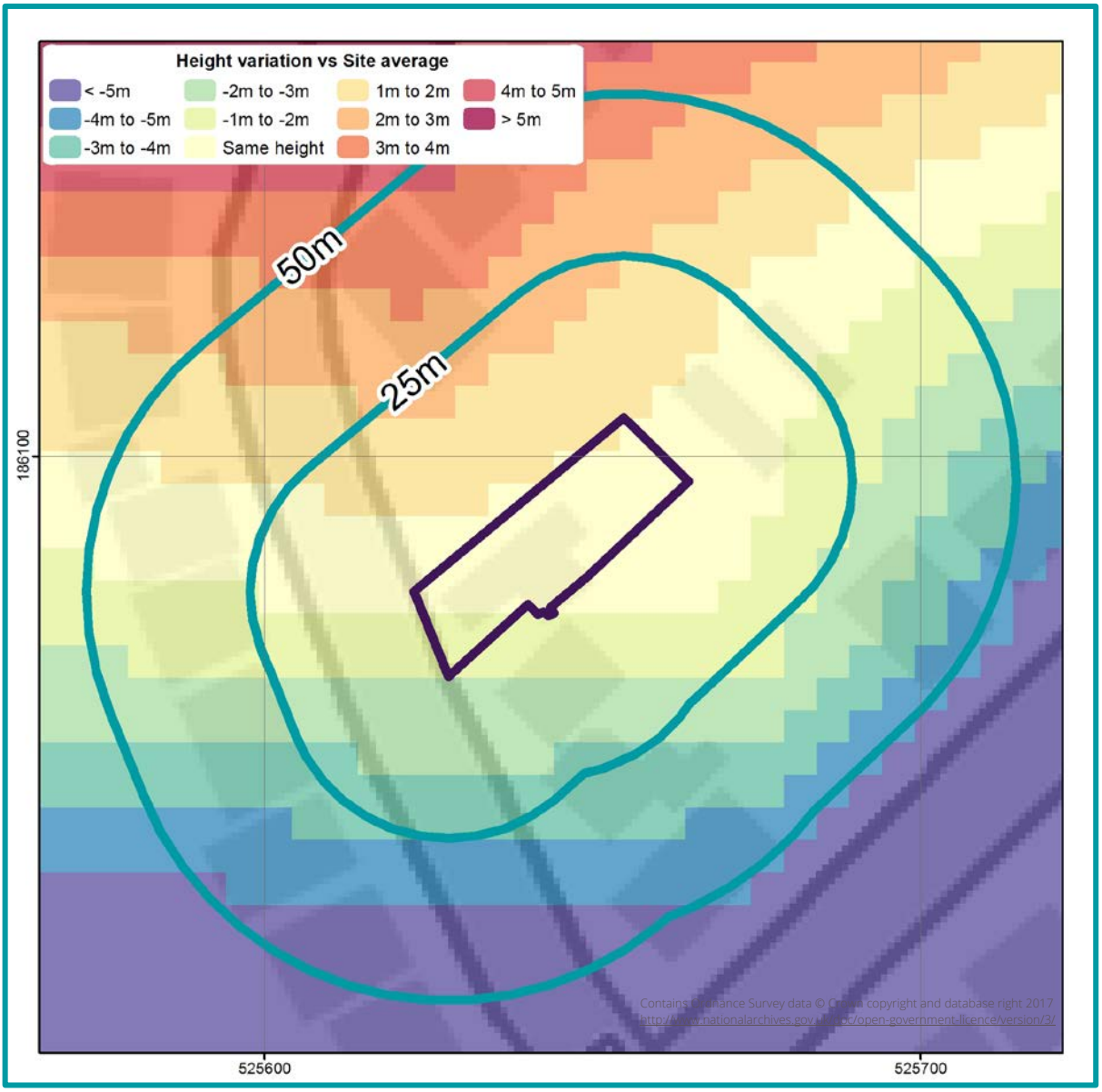


4. SuDS infiltration suitability (SD50) map

The Site has a moderate potential for infiltration SuDS, according to the GeoSmart infiltration map due to the potential variability of the Claygate Member however, a Ground Investigation (GI) indicates the underlying Claygate Member on the Site (located underneath a layer of made ground (depth of between 0.3-1.50 metres below ground level (mbgl)) generally had a varying constancy of sandy clay/clayey sand which is not considered suitable for infiltration (Geotechnical & Environmental Associates, 2014). See Section 14 for further discussion). According to the co-efficient of permeability (typical values of k) associated with the geological conditions within the Site[1] (sandy clay), the likely infiltration rate associated within the underlying geology is likely to be between 1 x 10^{-6} to 1 x 10^{-9} m/s. Guidance states that if infiltration SuDS are not possible, attenuation SuDS with a controlled discharge into nearby surface water feature or existing surface water drainage is recommended (London Plan, 2016. London Plan SPG, 2014).

[1] R.F. Craig (2002) Soil Mechanics. Table 2.1. Co-efficient of permeability (m/s) (BS 8004 : 1986); and Figure 20.17 (Pg 396) and Table 25.1 (Pg 546) within the CIRIA SuDS Manual, v.2 (C753) (2015).

5. Site topography



GeoSmart have undertaken an assessment of the topography at the Site and within its vicinity, using Environment Agency LiDAR Data and a site specific topographic survey, undertaken by Alan Rhodes Associates in November 2017. The EA LiDAR average elevation map shown above indicates ground levels fall generally to the southwest. However the site specific topographic survey indicates that ground levels on site vary with no general elevation fall in this direction.

Land from the south west falls in a north easterly direction from Redington Road towards the existing development from 104.18 to 104.05 mAOD. Grass land to the south west (front of the property) partly falls towards the north/north west, also towards the existing property/driveway (from 105.90 to 104.07 mAOD) but also falls towards the south west and Redington Road. Along the northern western Site boundary, land declines in a north easterly direction from 107.41 to 106.44 mAOD). At the garden to the rear of the existing development, land remains predominately level with a very gentle fall to the east (between 107.4 to 107.2 mAOD). See Section 14 for further discussion on existing and proposed overland flow routes (Alan Rhodes Associates, 2017).

6. Source protection zone map

GeoSmart have undertaken an assessment of the EA's groundwater Source Protection Zones (SPZ) within the vicinity of the Site.

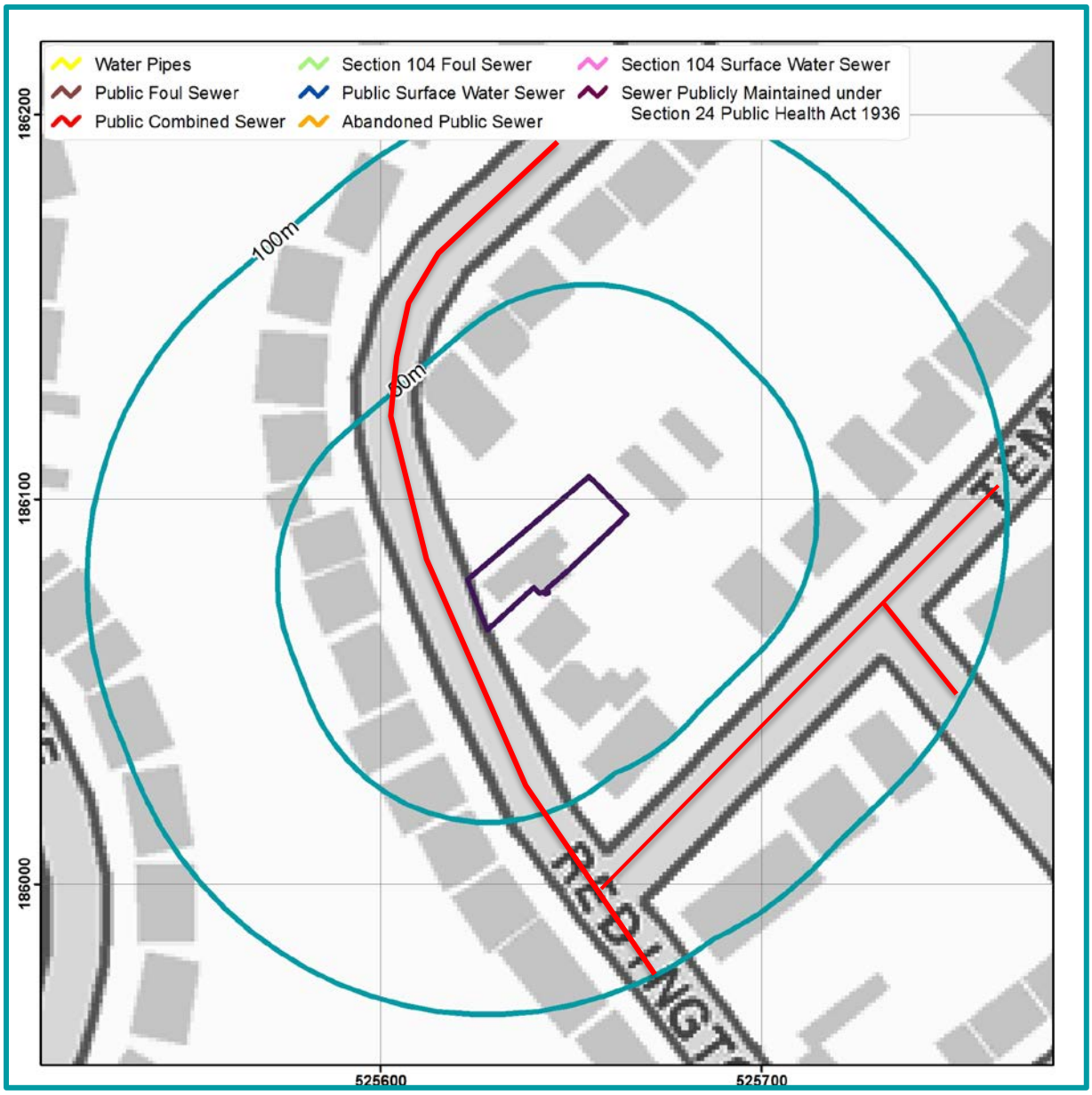
The site is not within a SPZ, therefore infiltration to the ground (if feasible) is likely to be acceptable providing suitable mitigation measures are in place to prevent an impact on water quality from contaminated land associated with the proposed or historical land use.

7. Surface water features map

GeoSmart have undertaken an assessment of the location of surface water features within the vicinity of the Site.
The Site is over 100m from an open channel surface water feature. The nearest surface water feature is a pond located 476 m northeast of the site, which forms part of the Golders Hill Pond chain is not an option for surface water discharge due to its distance away from the Site.
The Site is located within 50 m of the former course of the River Westbourne however this watercourse is not present at the surface and has been culverted to form part of the local surface water sewer (GEA, 2014). Discharge to surface water is therefore unlikely to be appropriate and is not considered a feasible option for the Site.

The site is not within 250m of a SSSI.

8. Sewer features map



GeoSmart have undertaken an assessment of the location of sewer features within the vicinity of the Site.

According to Thames Water records obtained for the Site (Appendix C), a combined sewer is located within 20m and runs within Redington Road. This sewer is located at a depth of between 4.8 to 5.2m below ground level (mbgl) with an invert level of 99.3 mAOD (Michael Alexander Consulting Engineers, 2018). It is understood the Site currently drains to the combined sewer located along Redington Road which will continue with the re-development. The implementation of the SuDS features discussed within this report will reduce the volume and rate of water entering this sewer system through the storm event, measures which are not currently in place on the development.

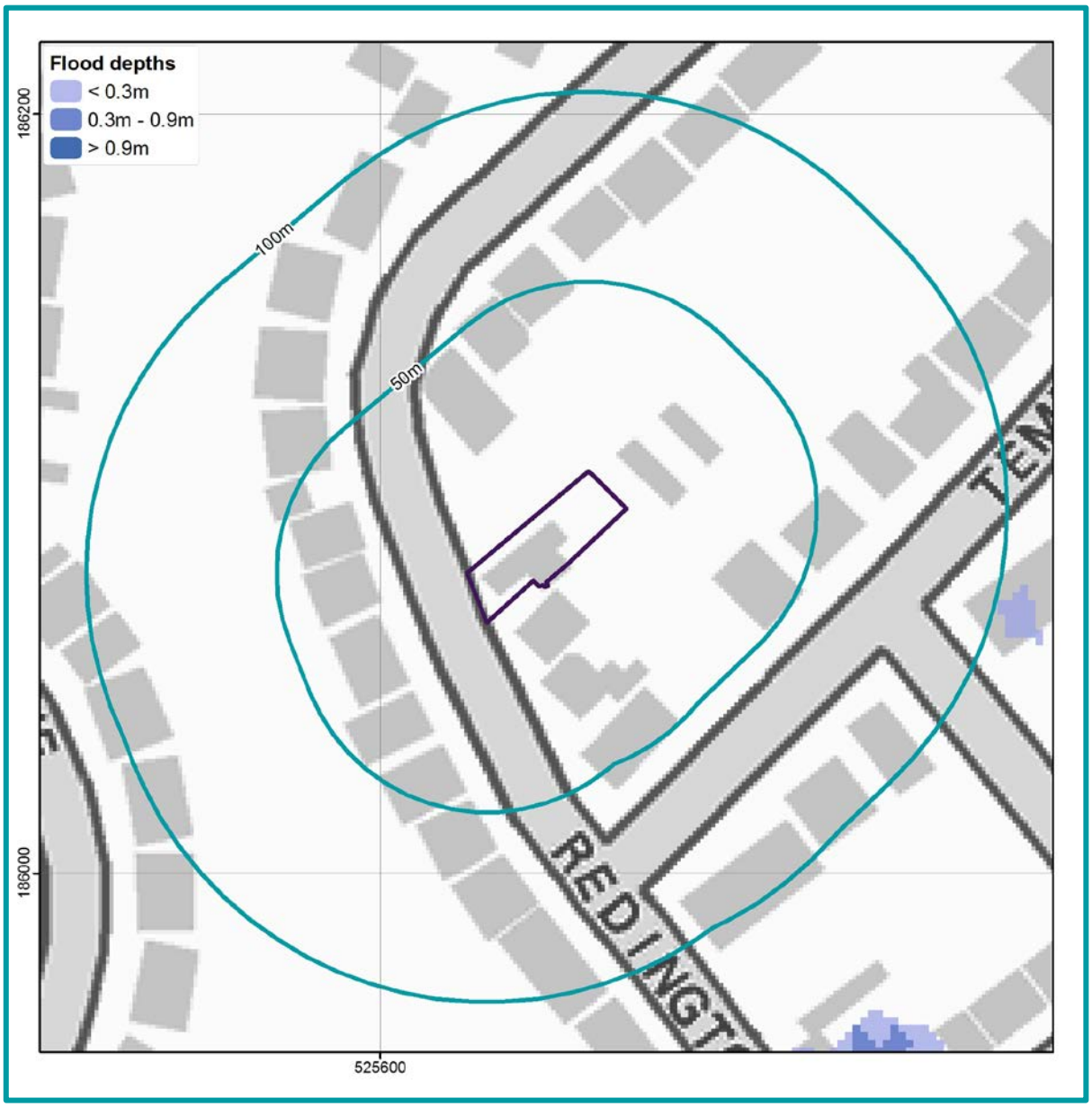
A Thames Water Pre-Development enquiry has been submitted to Thames Water separately to confirm the proposed surface water discharge rates into the combined sewer within Redington Road are acceptable.

9. Risk of flooding from rivers and sea map

GeoSmart have undertaken an assessment of the risk of flooding from the rivers and the sea within the vicinity of the Site.

According to the Environment Agency (EA) Risk of Flooding from Rivers and Sea (RoFRAS) mapping, the site is mapped as having a very low risk of flooding, where there is less than a 0.1% (1 in 1000 year) annual probability of flooding from rivers or the sea.

10. Risk of flooding from surface water map



According to Figure 6 of the Strategic Flood Risk Assessment (SFRA), the Site is located within a Critical Drainage Area (CDA)(Group3_010) however the site is not located within a Local Flood Risk Zone (LFRZ) (URS Ltd, 2014).

According to the EA's Risk of Flooding from Surface Water Mapping (EA, 2017), there is a 'Very Low' Risk of pluvial flooding at the Site which is supported by Figure 3 iv of the SFRA which maps the Site within a Very Low pluvial flood risk area (URS Ltd, 2014).

11. Groundwater flood risk (GW5) map

According to GeoSmart's Groundwater Flood Risk (GW5) map, the Site has a negligible risk of groundwater emergence and flooding of the Site during the 1 in 100 year event. The GI undertaken for the Site included groundwater monitoring over a period between 2012 and 2018 during the winter/spring months. In this time there was one record in March 2014 where a groundwater level of 0.52 metres below ground level (mbgl) was recorded at BH3a, which could potentially impact the SuDS design. An assessment of the strata of BH3a indicates groundwater, encountered as a depth of 0.52 mbgl, would have occurred within the made ground layer. BH3a is located to the rear of the existing development, within the garden area and is not a location where SuDS features would be proposed at the Site due to the overland flow route and topography of the Site. BH1, located to the front of the development, is more reflective of the conditions in which the proposed SuDS features will work to. Over the period between 2012 and 2018 during the winter/spring months, BH1 recorded a highest groundwater level of 4.28 mbgl which is unlikely to impact SuDS design but will be considered during SuDS sizing (Geotechnical & Environmental Associates, 2014).

12. Site conditions

Site information

The purpose of this report is to assess the potential for disposing of surface water through a sustainable drainage system (SuDS) for 50 Redington Road, London, NW3 7RS (the Site). The Site is located close to the boundary of the London Borough of Camden (LBC) between the Child's Hill and Hampstead area, in a setting of residential use.

The EA LiDAR average elevation map indicates ground levels fall generally to the southwest. However the site specific topographic survey (Alan Rhodes Associates, 2017) indicates that ground levels on site vary with no general elevation fall in this direction. Land from the south west falls in a north easterly direction from Redington Road towards the existing development from 104.18 to 104.05 mAOD. Grass land to the south west (front of the property) partly falls towards the north/north west, also towards the existing property/driveway (from 105.90 to 104.07 mAOD) but also falls towards the south west and Redington Road. Along the northern western Site boundary, land declines in a north easterly direction from 107.41 to 106.44 mAOD). At the garden to the rear of the existing development, land remains predominately level with a very gentle fall to the east (between 107.4 to 107.2 mAOD). See Section 14 for further discussion on existing and proposed overland flow routes.

Development

The Site is currently used within a residential capacity. At present there is a single, four bedroom building with driveway/car park and landscaped areas. Development proposals comprise the demolition of the existing development and the construction of a new, eight bedroom residential building which will comprise three storeys and the excavation of two basement levels. The proposed development would also include a driveway to be utilized for parking and changes to landscaped areas.

Geology, permeability and thickness

Geology present on site		Potentially permeable?
Superficial geology	None recorded on Site	N/A
Bedrock geology	Claygate Member	No (See below)

An GI undertaken for the Site (Geotechnical & Environmental Associates, 2014) indicates the underlying Claygate Member on the Site (located underneath a layer of made ground (depth of between 0.3-1.50 mbgl) generally had a varying constancy of sandy clay/clayey sand which is not conducive to infiltration.

Directly underlying the site is a layer of made ground, which has a variable thickness across the Site, ranging between 0.30 m and 1.50 m in depth. Made ground is not generally considered suitable for infiltration.

The underlaying Claygate Member was encountered directly beneath the made ground and was comprised brown mottled orange-brown and grey silty sandy clay interbedded with occasional layers of silty clayey fine sand, which extended to depths of between 4.00 mbgl and 10.50 mbgl. While the occasional layers of fine sand could accommodate infiltration, their location between bands of impermeable clay would result in parching of infiltrated run-off, which will increase the risk of groundwater flooding and impede the effectiveness of infiltration SuDS.

It is noted that a covering of Bagshot Formation may have been encountered towards the north eastern corner of the site, as the site is located close to the geological boundary between the Bagshot Formation and Claygate Member. However it is noted that this area is located at the high point of the Site and surface water could not be drained via gravity to this area and therefore would not be a viable area for the placement of infiltration SuDS.

According to the co-efficient of permeability (typical values of k) associated with the geological conditions within the Site (sandy clay), the likely infiltration rate associated within the underlying geology is likely to be between 1×10^{-6} to 1×10^{-9} m/s[2]. The London Borough of Camden SuDS Pro-Forma states that Infiltration rates should be no lower than 1×10^{-6} m/s.

Therefore infiltration to ground is not considered to be feasible for the Site.

Depth to groundwater

The GI (Geotechnical & Environmental Associates, 2014) included groundwater monitoring over a period between 2012 and 2018 during the winter/spring months. In this time there was one record in March 2014 where a groundwater level of 0.52 metres below ground level (mbgl) was recorded at BH3a, which could potentially impact SuDS design. An assessment of the strata of BH3a indicates groundwater, encountered as a depth of 0.52 mbgl, would have occurred within the made ground layer. BH3a is located to the rear of the existing development, within the garden area and is not a location where SuDS features would be proposed at the Site due to the overland flow route and topography of the Site (Geotechnical & Environmental Associates, 2014).

[2] R.F. Craig (2002) Soil Mechanics. Table 2.1. Co-efficient of permeability (m/s) (BS 8004 : 1986); and Figure 20.17 (Pg 396) and Table 25.1 (Pg 546) within the CIRIA SuDS Manual, v.2 (C753) (2015).

BH1, located to the front of the development, is more reflective of the conditions in which the proposed SuDS features will work to. Over the period between 2012 and 2018 during the winter/spring months, BH1 recorded a highest groundwater level of 4.28 mbgl which is unlikely to impact SuDS design but will be considered during SuDS sizing.

The GI states that groundwater is likely to be present within the Claygate Member and there is evidence of spring lines are present at the interface of the Bagshot Beds (located c. 20m north/north east of the Site and the Claygate Member (Geotechnical & Environmental Associates, 2014).

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.

Water quality

The site does not lie within a SPZ. In this case an assessment of the quality of infiltrating runoff and the possibilities for pre-treatment is not considered to be required.

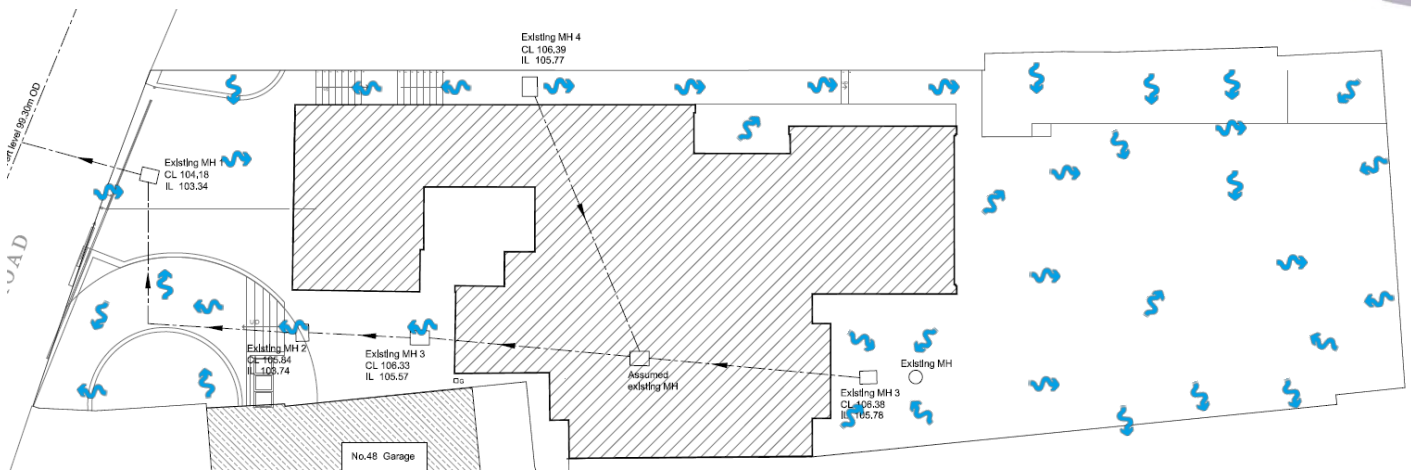
The influence of surface runoff on water quality will depend on whether there is a source of contamination on Site and the sensitivity of the receiving environment, either groundwater or surface water. The intervening pathway from source to receptor including mitigation and natural attenuation will determine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

The impact of contaminants on 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.

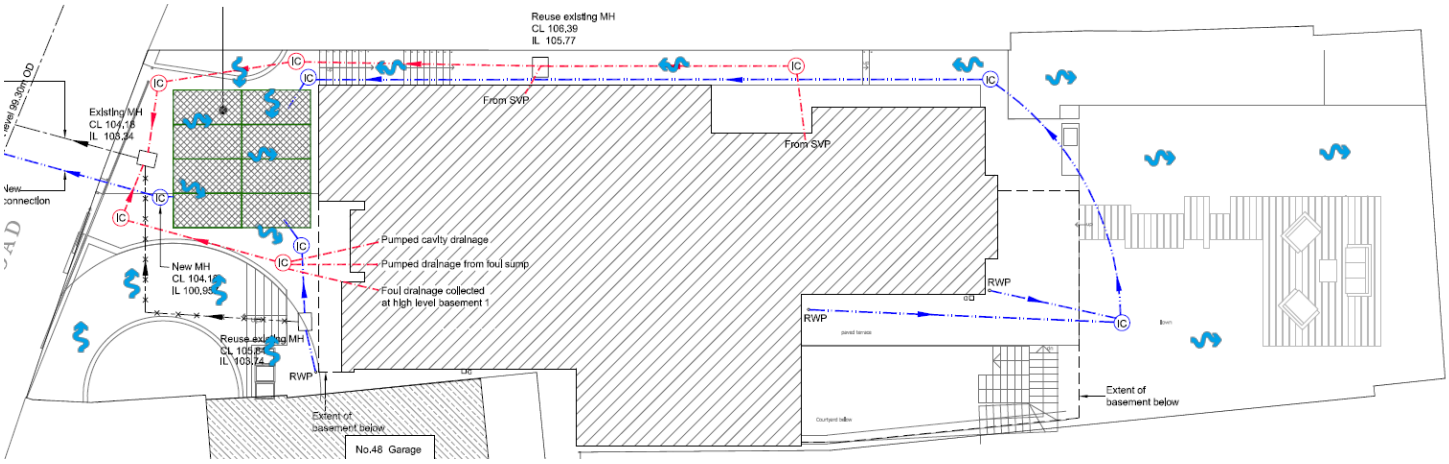
Overland flow route

The proposed redevelopment of the Site will include minor changes to the on-site elevations of the building and topography which will change the overland flow routes on and off the Site. Therefore, an assessment has been undertaken using topographic survey to assess the existing overland flow routes and the proposed plans to assess the proposed overland flow routes on the Site.

Existing overland flow routes



Proposed overland flow routes



The existing overland flow routes vary due to the uneven topography of the Site and the natural gradient of the Site would result in overland flow routes off of the Site and into neighboring properties, specifically for areas located within the rear garden. It is noted that, even with the proposed development, there is still the potential for overland flow routes off of the Site within the rear garden into the property of No. 48, located south of the development.

Whist the proposed landscaping will alter the topography in the rear garden, which will be relatively level (106.30 mAOD), it is noted that the garden of No. 48 is likely to be at a lower elevation than the Site (c 105.96-106.03 mAOD) based on the topographic survey (Alan Rhodes Associates, 2017).

In terms of potential run-off from the permeable areas of the Site and storage and run-off for the Site, calculations listed in Section 13 do factor in run-off from permeable areas due to the impeded drainage of the Site. An SPR value of 0.47 has been set to represent the

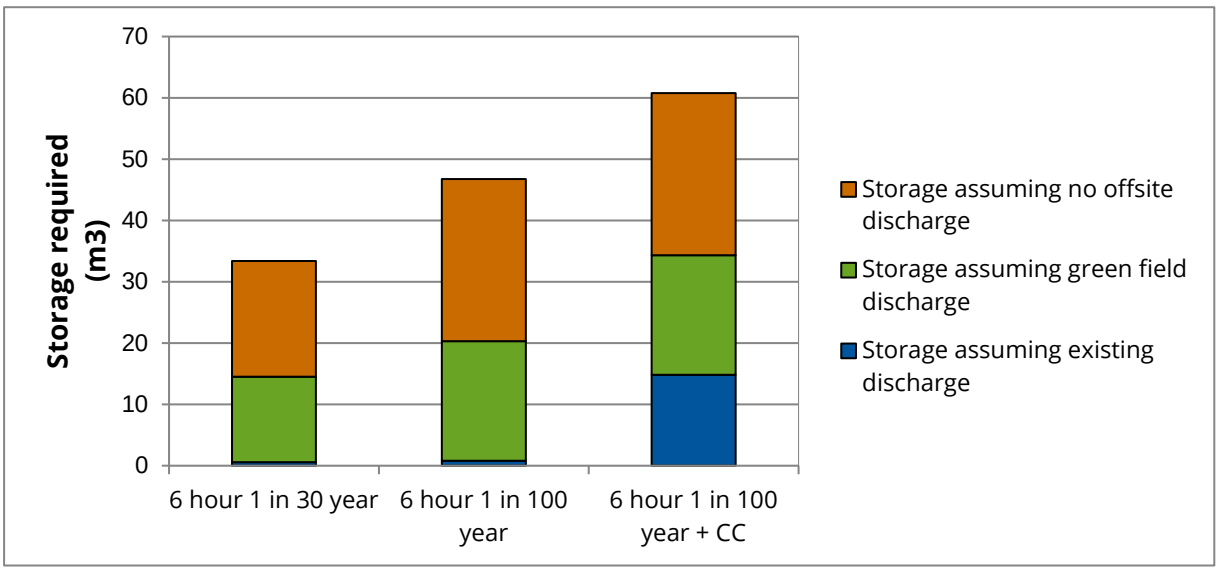
underlying geology of the Site, which is indicative of a Site with underlying slowly permeable seasonally wet acid loamy and clayey soils. This soil type has been taken from the Cranfield Soil and Agrifood Institute Soilscapes mapping (Cranfield, 2018).

Therefore, due to the poor infiltration potential of the underlying geology, mitigation measures are required to intercept any overland flows from exceedance of permeable areas to the front and the rear of the development. Permeable areas to the front of the Site would drain towards the proposed development and could potentially flow into the development itself.

This was highlighted by the LBC, pertaining to the initial SuDS scheme, proposed by Michael Alexander Consulting Engineers in 2018. ACO drains would be particularly suited to intercepting any exceedance flows, reducing any impacts to the development.

13. 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.



Attenuation scenario	Attenuation requirement (m^3)	Explanation
Minimum	30	Storage required to discharge surface water runoff at 1 l/s (during a 1 in 100 year rainfall (0.25 hour critical storm duration) event including a 30% allowance for climate change via a hydro-brake or similar (See Appendix B and table 2 for associated calculations). This would also ensure more than 50% of the Site's (prior to re-development) surface water runoff is attenuated in line with the minimum requirements stated within the London Plan's SDC SPG (2014) and the London Borough of Camden Planning Guidance (CPG 3: Sustainability) (2015) (See Appendix B and overleaf).
Medium *(Recommended)*	34	Attenuation required to ensure surface water runoff is reduced to the greenfield volumes for the 1 in 100 year (6 hour) storm event, including a 30% allowance for climate change in line with the London Plan - Policy 5.13 Sustainable drainage (March, 2016) and London Borough of Camden condition notice (Planning Portal Reference: PP-06667395)
Maximum	65	Storage required assuming no off-site drainage for the 6 hour 1 in 100 year event, including the maximum effects of climate change (30% in line with updated allowance guidance). *Note: discharge off site will reduce this, and the increase as a result of climate change is less for buildings with a limited design life.*

Local and National Guidance

Environment Agency Climate change Guidance (2016)

Projections of future climate change, in the UK, indicate more frequent, short-duration, high-intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the National Planning Policy Framework (NPPF) recommends that the effects of climate change are incorporated into Flood Risk Assessments (NPPF technical guidance note, DCLG, 2012).

Updated guidance (March 2016) on climate change recommends that both the 20% Central Allowance and 40% Upper End allowances should be added to the peak rainfall intensity for residential or commercial development, to understand the range of impacts. Where feasible, a precautionary approach should be taken particularly in areas at risk of flooding.

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 the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	+40%
Central	5%	10%	+20%

In line with the London Borough of Camden condition notice (Planning Portal Reference: PP-06667395), a 30% climate change allowance has been used within this report.

SuDS Manual

CIRIA SuDS Manual, v.2 (C753) (2015)

A development should utilise sustainable urban 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.

National Guidance

Defra - Sustainable Drainage Systems: Non-statutory technical standards for sustainable drainage systems (March, 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.

London Drainage Policy

London Plan - Policy 5.13 Sustainable drainage (March, 2016)

A development should utilise sustainable urban 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. store rainwater for later use;
2. use infiltration techniques, such as porous surfaces in non-clay areas;
3. attenuate rainwater in ponds or open water features for gradual release;
4. attenuate rainwater by storing in tanks or sealed water features for gradual release;
5. discharge rainwater direct to a watercourse;
6. discharge rainwater to a surface water sewer / drain;
7. discharge rainwater to the combined sewer.

London Plan - Sustainable design and Construction SPG: Section 3.4.9 (April, 2014).

Most developments have been able to achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times. This is the minimum expectation from development proposals.

On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. The only exceptions to this, where greater discharge rates may be acceptable, are where a pumped discharge would be required to meet the standards or where surface water drainage is to tidal waters and therefore would be able to discharge at unrestricted rates provided unacceptable scour would not result.

Discharge to surface water course/sewer

There may be situations where it is not appropriate to discharge at greenfield runoff rates. These include, for example, sites where the calculated greenfield runoff rate is extremely low and the final outfall of a piped system required to achieve this would be prone to blockage.

Pg 83:

"3.4.9 There may be situations where it is not appropriate to discharge at greenfield runoff rates. These include, for example, sites where the calculated greenfield runoff rate is extremely low and the final outfall of a piped system required to achieve this would be prone to blockage. An appropriate minimum discharge rate would be 5 litres per second per outfall"" London Plan - Sustainable design and Construction SPG: Section 3.4.9 (April, 2014).

London Borough of Camden Planning Guidance (CPG 3: Sustainability) (July, 2015)

Within Camden, SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments should utilise 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.

Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems.

Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required.

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 6 '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 1: Change in impermeable area associated with the development

Total site area 622 m^2

Impermeable area (and as a percentage of the total area of the proposed development footprint of 622 m^2)	
Pre-development	Post-development
407 m^2 (65%)	422 m^2 (68%)
Impermeable Land use: Existing residential use and areas of hard standing Permeable Land use: landscaped areas	New impermeable land use: 252 m^2 proposed development and roof cover 31 m^2 basement lightwell 139 m^2 hard paving New permeable land use: 202 m^2 of landscaped areas and permeable garden decking

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 6 'Background Information'.

Table 2: 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	0.3	N/A	N/A	N/A
6 hour 1 in 1 year	0.2	0.6	0.6	0.0
6 hour 1 in 10 year	0.5	1.1	1.1	0.0
6 hour 1 in 30 year	0.6	1.5	1.5	0.0
6 hour 1 in 100 year	0.9	2.1	2.2	0.0
6 hour 1 in 100 year + 30% CC	N/A	N/A	2.8	0.7

[1] Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the IoH124 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 5 l/s, although if sufficient upstream treatment is utilized (reducing the risk of blockage), then a lower discharge rate could be used.

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 18 'Methodology and Limitations'.

Table 3: 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	8.5	N/A	N/A	N/A
6 hour 1 in 1 year	7.9	13.6	13.9	0.2
6 hour 1 in 10 year	14.1	23.9	24.3	0.4
6 hour 1 in 30 year	18.9	32.8	33.4	0.6
6 hour 1 in 100 year	26.4	45.9	46.7	0.8
6 hour 1 in 100 year + 30% CC	N/A	N/A	60.8	14.8

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

Critical Storm Duration and volume requirements

According to calculations of runoff rates (Table 2) during a range of different intensity 6 hour storm events at the Site, the Greenfield QBar run-off rate was calculated to be 0.3 l/s. The existing run-off rates for the 1 in 100 year (6 hour) storm event are 2.1 l/s.

- Restricting flow rates to three times the greenfield runoff rate (in line with the London Plan SPD, 2014) would result in a run-off rate of 0.9 l/s.
- Restricting run-off rates to 50% of the existing 1 in 100 year (6 hour storm) would result in a run-off rate of 1.05 l/s.

Realistically restricting flow rates to less than 2 l/s. While there are flow control products available on the market can control flow rates to a minimum of 1 l/s via an orifice, 1 l/s is a very low rate which can carry an increased risk of flooding and of blockage, however, to comply with Camden preference and policy, a discharge rate of 1 l/s is still recommended within this report.

Measures to prevent blocking of the orifice will need to be incorporated into the design. A perforated raiser tube section with controls at each end would enable the control to function. A slightly different anti-clogging design would include debris guards, hooded outlets and orifices protected within T-pieces.

Appendix B presents storage volumes for the 1 in 100 year plus climate change (30%) and the critical storm duration where runoff is limited to a maximum discharge rate of 1 l/s. According to calculations within Appendix B, the critical storm duration is 4 hours when applying a discharge rate of 1 l/s. This would require a maximum attenuation volume of 30 m^3.

This would also ensure the development is able to achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff volume at peak times and would actually provide attenuation for 65% of the existing runoff, which is in line with the London Borough of Camden's Planning Guidance (CPG3, Pg 80).

An enquiry was sent to the LBC to establish a preferred discharge rate for the site on the 7th March 2018 however no response had been received within the timeframe allocated to this report (See Appendix B).

14. 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, 2010) and Defra's Draft National Standards for SuDS (2011). 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

As discussed in Section 12 and based on a site specific GI (Geotechnical & Environmental Associates, 2014), the underlying Claygate Member on the Site (located underneath a layer of made ground (depth of between 0.3-1.50 metres below ground level (mbgl)) generally had a varying constancy of sandy clay/clayey sand which is not generally considered to be conducive to infiltration. Whilst the layers of fine sand could accommodate infiltration, their location between bands of impermeable clay would result in perching of infiltrated run-off, which will increase the risk of groundwater flooding and impede the effectiveness of infiltration SuDS.

According to the co-efficient of permeability (typical values of k) associated with the geological conditions within the Site (sandy clay), the likely infiltration rate associated within the underlying geology is likely to be between 1×10^{-6} to 1×10^{-9} m/s[3]. The London Borough of Camden SuDS Pro-Forma states that Infiltration rates should be no lower than 1×10^{-6} m/s. Infiltration to ground is not considered a feasibly practical option for the Site.

Discharge to surface water feature

The Site is over 100m from an open channel surface water feature. The nearest surface water feature is a pond located 476 m north east of the site, which forms part of the Golders Hill Pond chain and due to its distance from the Site is not considered a suitable feature with which to discharge surface water from the Site. Discharge to surface water is therefore not appropriate and is not considered a feasible option for the Site.

Discharge to sewer

Discharging surface water runoff to the combined sewer is considered to be the optimum sustainable drainage option for the new development area, as discharging via infiltration and to the nearest surface water feature is not considered to be feasible.

According to an Thames Water Asset Location Report (Appendix C) there is a public combined sewer located within close proximity to the Site.

A Thames Water asset location search undertaken for the Site confirms the Site is within 20m of a combined sewer, located at a depth of between 4.8-5.2m below ground level

[3] R.F. Craig (2002) Soil Mechanics. Table 2.1. Co-efficient of permeability (m/s) (BS 8004 : 1986); and Figure 20.17 (Pg 396) and Table 25.1 (Pg 546) within the CIRIA SuDS Manual, v.2 (C753) (2015).

(mbgl) with an invert level of 99.30 mAOD (Michael Alexander Consulting Engineers, 2018). , therefore discharge to sewer is a feasible option.

It is understood the Site currently drains to the combined sewer located along Redington Road which will continue with the re-development of the Site. The implementation of the SuDS features discussed within this report will work to reduce the volume and rate of water entering this sewer system, measures which are not currently in place on the development.

A Thames Water Pre-Development enquiry has been submitted to Thames Water to confirm approval to discharge surface water flows into the combined water sewer within Redington Road.

A flow control device is required to limit peak discharge rates to the maximum selected rate as indicated in Section 13, along with the appropriate attenuation storage volume described in section 2 and 16 of this report. Measures and management of the control system will be required prevent blocking of the orifice due to the low discharge rate proposed for the Site.

15. 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 low (roof water) to medium hazard (runoff from car parking and road). The Site does not lie within a SPZ and the existing and proposed uses are residential in nature. In addition the GI confirms there were no issues with contamination at the Site and one treatment stage should be sufficient in this instance.

Table 5: 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 Table 6.

Table 6: 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

16. 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.

16.1 - Surface water drainage (SuDS) Strategy

SuDS type	Source control (interception) and attenuation SuDS.
SuDS features	Rainwater harvesting butt and underground storm cell attenuation crates
Discharge location	Existing surface water connection; combined sewer located within Redington Road.

16.2 - SuDS and Drainage Summary

An attenuation volume of 34 m³ will be stored within SuDS features prior to discharging to a surface water sewer at a restricted rate of 1l/s (to be confirmed and approved by Thames Water). This would ensure attenuation of surface water runoff from the development during the 1% AEP event plus a 30% allowance for climate change, as preferred by DEFRA non-statutory guidance (DEFRA, 2015).

Surface Water Run-off from the Proposed Building

Rainwater pipes will drain runoff from the development roof and feed run-off directly into the proposed SuDS features;

- To the west of the development, roof run-off should be directed into the proposed rainwater harvesting butt for re-use for amenity purposed. The rainwater butt must include an overflow valve to allow water to drain into the existing pipework towards the primary geo-cellular SuDS storage feature.
- For the rest of the development run-off and overflow from the rainwater butt, drainage pipes should feed runoff from the development into the proposed underground storm cell attenuation crates, located to the west of the proposed development.

Surface Water Run-off from impermeable and permeable areas

Aco drains should be sited to the north, west and east of the Site, adjacent to areas which transition from permeable to impermeable land. This will ensure exceedance flows from the paved areas and overflow from permeable areas are captured and drain to the into the proposed underground storm cell attenuation crates, located to the west of the proposed development.

Storage and discharge:

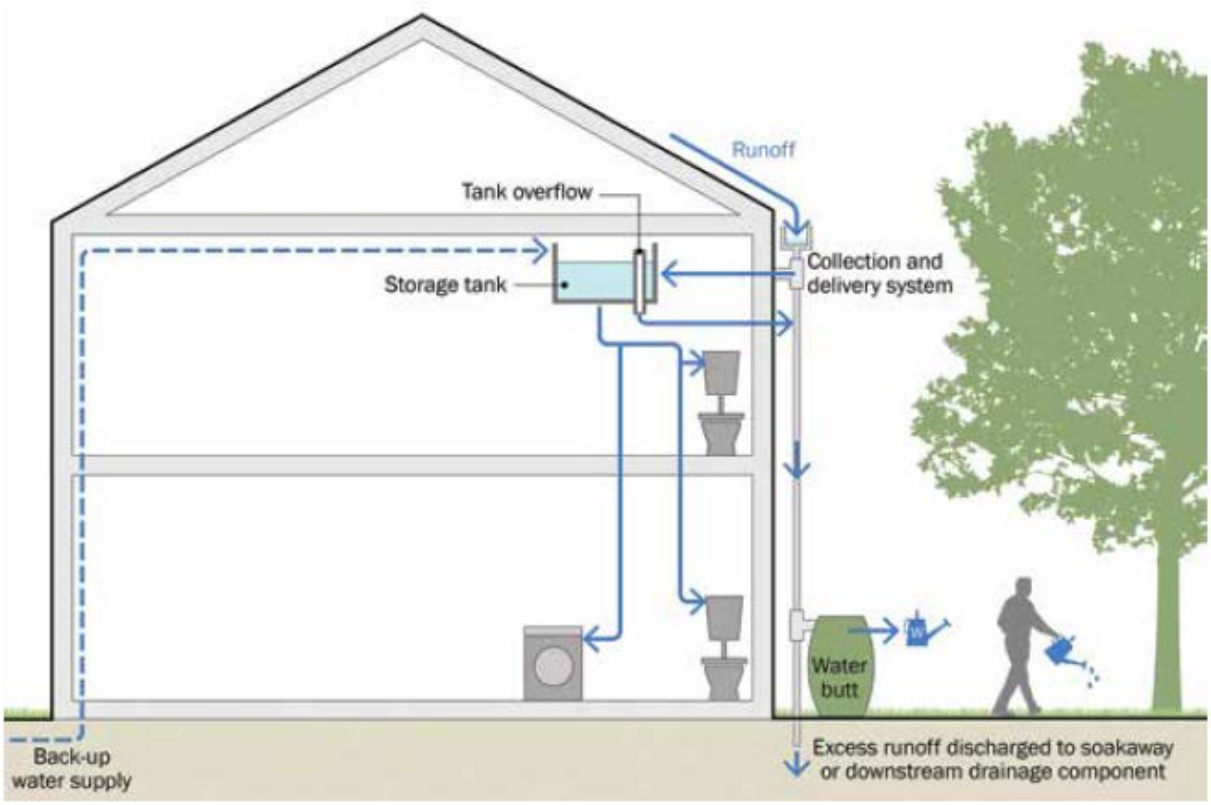
1. The storm cell attenuation crates will be developed to hold a minimum of 34 m³ to comply with local policy (discussed below). During rainfall events, the scheme will allow for full site drainage into the storm crates. An overflow pipe will allow for water to flow into a new surface water manhole (as proposed within the initial SuDS scheme (Michael Alexander Consulting Engineers, 2018))
2. The new surface water manhole will contain an orifice control which will limit water to the agreed discharge rate. Its location within the manhole will allow for easy access for maintenance and management.
3. A new connection will lead surface water from the proposed manhole, off site into the nearby combined sewer, located along Redington Road.

Drainage Strategy

To comply with London Plan policy, a **rainwater harvesting butt** will be established for the proposed development (see drawing ref: E10-030/P0B (REVB) in Appendix A).

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 underground pipework and crate system.

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.



Source: CIRIA (2015) The SuDS Manual-v2 CIRIA report C753

As there is an issue with the storage capability of Rainwater Harvesting tanks, this feature will have a fixed attenuation volume and a controlled outlet to discharge into the proposed geo-cellular crate storage 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 then 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.

Underground storm cell attenuation crates are proposed and within the initial SuDS scheme (Michael Alexander Consulting Engineers, 2018) to provide the necessary storage as above ground attenuation SuDS such as swales and ponds are not considered feasible as permeable grassed areas are located at a higher elevation than proposed impermeable areas. Geo-cellular storage crate systems provide a below-ground void space for use of temporary storage via infiltration or controlled release. They can also be modified to suit specific characteristics of a site.

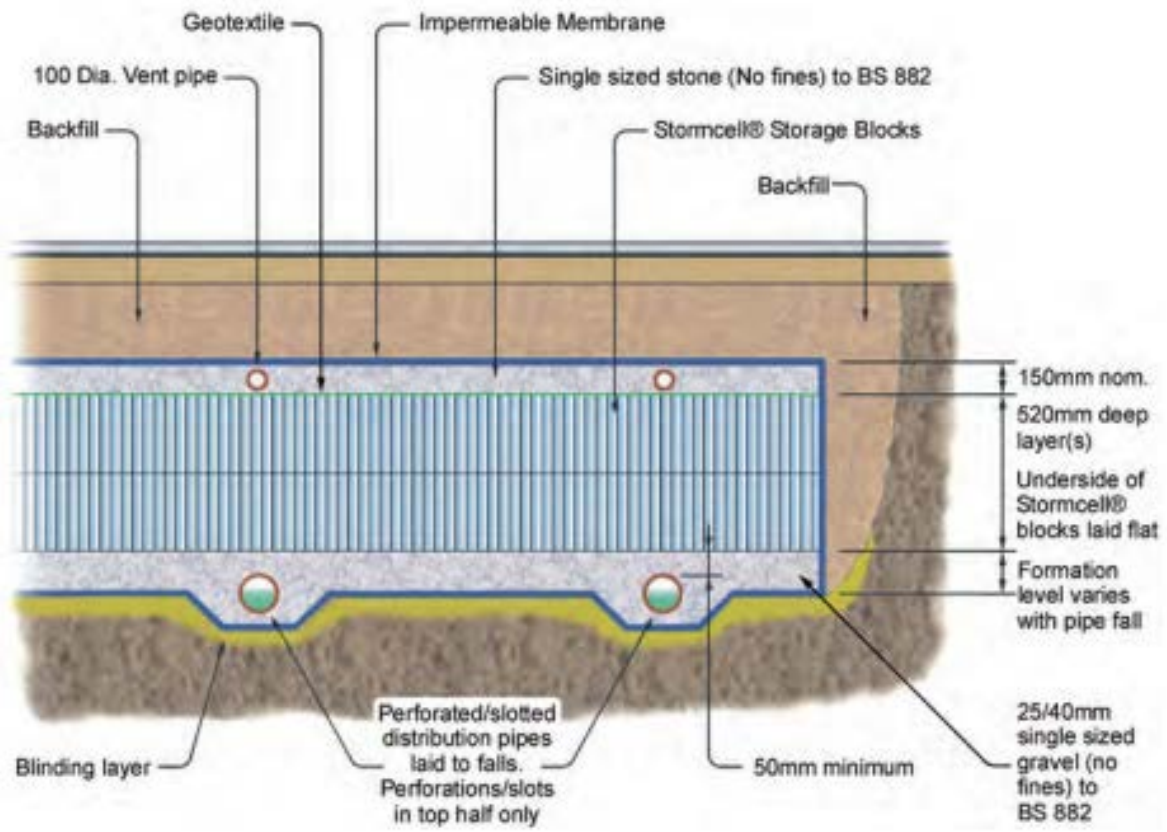
DEFRA, 2015 states that the run-off volume from the development to drain to any sewer of surface water body in the 1 in 100 year rainfall event must be constrained to a value as close as is reasonably practical to the greenfield runoff volume for the same event but should never exceed the runoff volume from the development prior to redevelopment from the Site. Issues with storage crates are the level of accessibility and lack of treatment performance. In terms of accessibility, an inspection chamber will be required above the crate system in order to allow for inspections and maintenance.

Michael Alexander Consulting Engineers (2018) proposed Hydro International 'Stormcell' crates due to their ability to stack cells which is ideal for sites with a limited area to install SuDS.

Hydro International states:

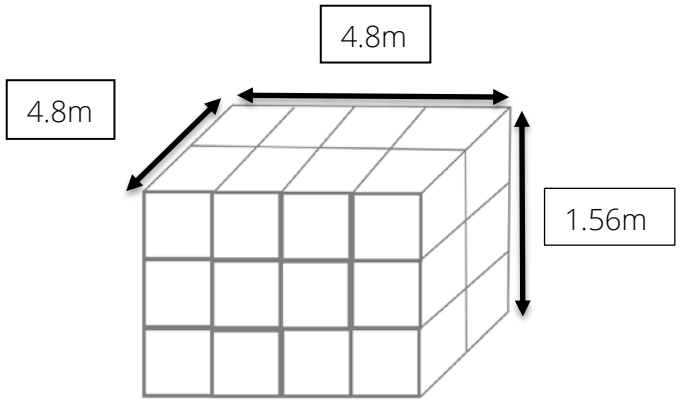
"The Stormcell® system demonstrates a major potential reduction in planned maintenance due to the perforated distribution pipes running beneath the storage tank. Any silts, grits or debris are washed through the pipework during the 'first flush' rather than into the tank. The system is therefore effectively maintenancefree. The only part of the system requiring periodic inspection is the distribution pipework which can be easily accessed from the manhole and jetted/rodded in the event of any obstruction"

Individual Storm Cell blocks have a dimension of 2.4 m x 1.2 m x 0.52 m with a void ratio of 95%. These dimensions, factoring in the void ratio, provides a holding capacity of 1.42m^3 per cell. Cells includes an impermeable membrane to prevent stormwater from escaping into the surrounding ground - which is required due to the topographic decline of the site towards the proposed development and the proposed basement levels.



Source: **Hydro International (Date Unknown)** Stormcell® Storage System.

Proposed SuDS sizing (dimensions) and attenuation volumes:

Underground storm cell attenuation crates:	Individual Storm Cell dimension = 2.4 m x 1.2 m x 0.52 m with a void ratio of 95%. Holding capacity per cell = 1.42m^3 Number of cells required = 24 cells Cell Layout: 3 layers of 8 cells per layer Storage per layer = 11.36 m^3 Storage available with 3 layers = 34.08 m^3 Combined cell dimensions: 

16.3 - Overflow and Exceedance events

Primary exceedance flow route:

The SuDS system has been designed to provide attenuation required for a discharge rate of 1 l/s and the primary exceedance flow route from the site will be into the nearby combined sewer at a discharge rate of 1 l/s.

An orifice flow control systems is a circular/rectangular opening of a prescribed shape and size that allows a controlled rate of outflow when the orifice is submerged and acts like a weir when not. Flow rate will depend on the height of the water above the hydraulic head and the size and edge treatment of the orifice. The principle function is to throttle the discharge passed downstream and thereby enable the attenuation storage volume to fill. Measures to prevent blocking of the orifice will be incorporated into the design. A perforated raiser tube section with controls at each end will enable the control to function. A slightly different anti-clogging design will include debris guards, hooded outlets and orifices protected within T-pieces.

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 public combined sewer during an extreme rainfall event or blockage in the receiving sewer.

Secondary exceedance flow route:

In the event of a blockage of the primary exceedance flow route from the Site, a secondary flow route has been suggested. The secondary route would only ever be utilized during a blockage of the primary exceedance flow route.

The SuDS system has been designed to provide attenuation required for a discharge rate of 1 l/s, but with a dual flow control system to allow any exceedance flows from SuDS features to discharge into the Thames Water sewer at a restricted rate of 5 l/s.

A Thames Water Pre-Development enquiry has been submitted for permission to discharge to 5 l/s via a hydro-brake or similar via the combined sewer located within Redington Road (to be confirmed by Thames Water).

This method will enable the SuDS system to work under extreme rainfall events and a discharge rate of 5 l/s would only require an attenuation volume of 14 m^3 which could be provided in open spaces and spare capacity in upstream pipework. The proposed geo-cellular storage crates provides 20m^3 more storage than is strictly required. This has been proposed due to feedback received for the initial SuDS scheme, proposed by Michael Alexander Consulting Engineers in 2018, which stated that the entire system must cope with the projected runoff without causing flood risk.

As the secondary exceedance flow route would be to a discharge rate of 5 l/s, a hydrobrake can be used for this method.

Hydrobrake Flow control systems will reduce the runoff from the Site during an exceedance event. This is a device used for controlling water flow into a connecting feature, such as a sewer, to a specific flow 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. The system will be designed to a 5 l/s discharge rate, pending agreement from Thames Water. A Vortex Control and non-return flap valve will still be required.

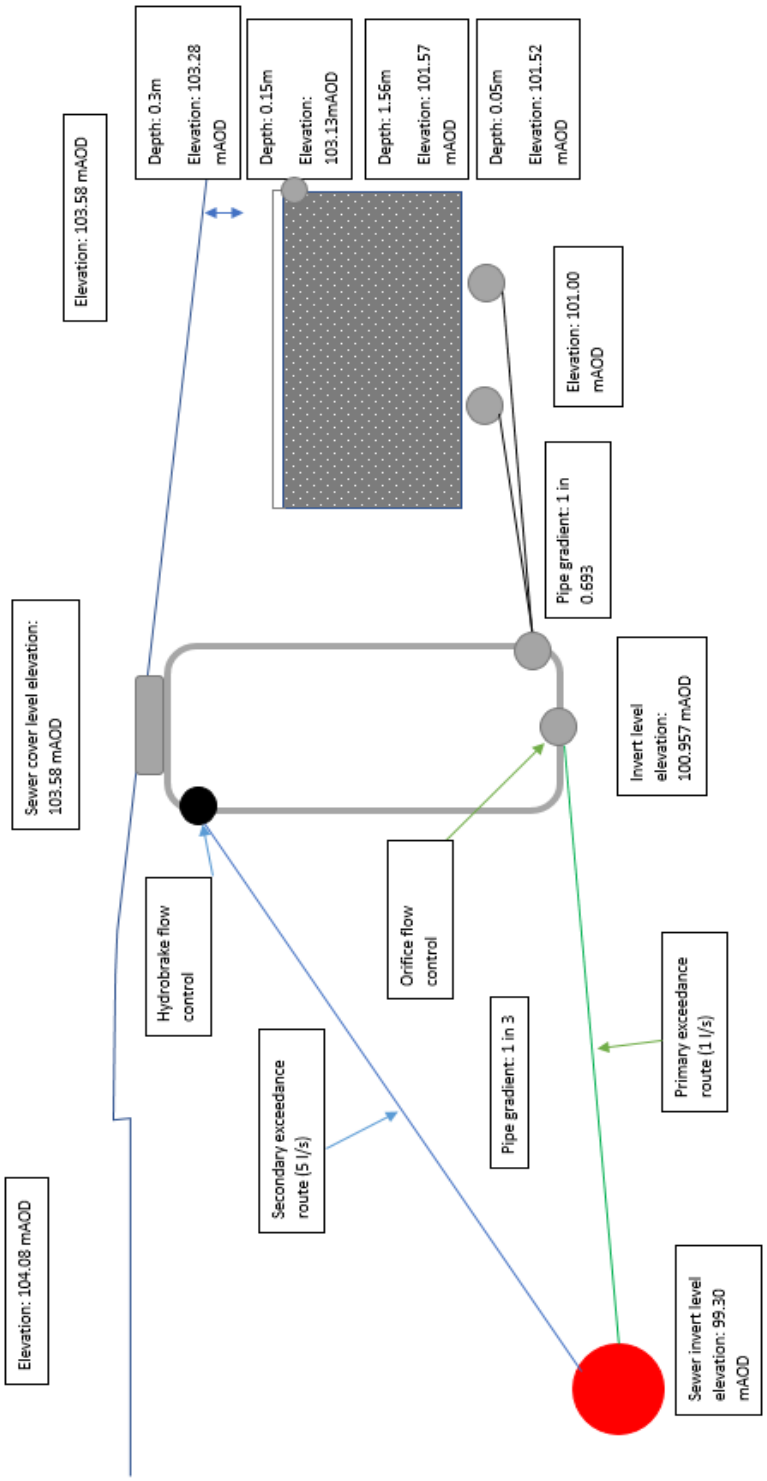
16.4 - Policy compliance

Providing an off-site discharge rate of 1 l/s and an attenuation volume of 34 m³ will comply with the London Plan SPD (2014) and the London Borough of Camden policies, as it will:

- Provide a 74% reduction in the Site's surface water runoff volume at peak times, prior to re-development (existing run off volume = 45.9 m^3)(in accordance with the minimum requirement within London Plan - Sustainable design and Construction SPG: Section 3.4.9 (April, 2014).
- Provide a 50% reduction in the Site's surface water runoff rate at peak times, prior to re-development (existing run off rate = 2.1 l/s)(in accordance with the minimum requirement within London Plan - Sustainable design and Construction SPG: Section 3.4.9 (April, 2014) and London Borough of Camden Planning Guidance (CPG 3: Sustainability).
- Reduce run-off volumes to greenfield scenario (in accordance with London Borough of Camden condition notice (Planning Portal Reference: PP-06667395).
- Reduce run-off rate to as close to three times the greenfield run off rate as is feasibly practical without increasing the potential of flood risk (in accordance with the minimum requirement within London Plan - Sustainable design and Construction SPG: Section 3.4.9 (April, 2014) and London Borough of Camden Planning Guidance (CPG 3: Sustainability).

16.5 - SuDS and drainage run gradient assessment

Based on all the information provided, including the initial SuDS scheme (Michael Alexander Consulting Engineers, 2018), Thames Water Asset location Plan (Thames Water, 2018), design specifications of the storage crates (Hydro International, 2018) and the Site specific topographic survey (Alan Rhodes Associates, 2017), the following pipe work elevations have been assessed for the SuDS connection.



16.6 - SuDS lifetime maintenance plan

Regular maintenance is essential to ensure effective operation of the 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.

The owner of the Site will be responsible for the implementation and upkeep of the features over the lifetime of the development. If the property is sold at any time, the maintenance schedule must be included within deeds to the document and ownership and responsibility transferred to the new owner.

The SuDS at the Site have been designed for easy maintenance to comprise:

- Regular day to day care - litter collection, grass cutting and checking any inlets and outlets where water enters or leaves a SuDS feature
- Occasional tasks - managing and cleaning permeable paving and removing any silt that builds up in the SuDS features
- Remedial work - repairing damage where necessary

1. Site SuDS management – Garden areas, Rainwater Harvesting butts, Attenuation crates and ACO / filter drains

The SuDS sequence begins where the rainwater pipes collect rainwater from the roofs and discharge directly into either the rainwater harvesting butt or into the underground attenuation crates.

Garden Area Action:

- Mow the path verges and grassed garden areas up to Site boundaries;
- Re-seed grassed areas if grass is not growing or has been eroded. Grassed areas are particularly good at storing surface water runoff in the event of exceedance;
- Re-landscape areas where siltation is identified.

Rainwater Harvesting Butt Action:

- Inspection of tank for debris and sediment build up;
- Cleaning of tank, inlets, outlets, gutters, roof drain filters and withdrawal devices;
- Repair or overflow erosion damage or damage to tank and associated components;
- Pump repair.

Attenuation Crates Action:

- Inspect and identify any areas that are not operating correctly;
- Remove debris from catchment surface;
- Check surface of filter for blockage by sediment or other matter.
- Inspect tank for silt accumulation.

ACO / Filter Drains and rainwater pipes Action:

- Mow grass surrounding the proposed ACO / filter drains and connections;
- Inspect condition of the filter drains and ACO drains regularly to clear siltation which could reduce their capacity.

- Clear gutters and rainwater pipes at roof level on an annual basis to clear moss, leaves and carefully remove any nesting habitats (contact Council / Environment Agency if protected species are located prior to removal).

		Frequency	Unit Rate	Total
	Regular maintenance			
1	Litter Management			
1.1	Pick up all litter in SuDS and Landscape areas and remove from site	monthly		
2	Grass Maintenance			
2.1	Mow all grass verges, paths 35-50mm with 75mm max.	As required or monthly		
2.2	Any wildflower areas strimmed to 50mm on 3 year rotation 30% each year	Annual basis		
3	Inlets and Outlets			
3.1	Inspect monthly, remove silt from slab aprons and debris. Strim 1m round for access	As required		
4	Hard Surfaces			
4.1	Sweep all paving regularly. Sweep and suction brush permeable paving in autumn after any leaf fall.	Annually		
	Occasional Tasks			
5	Inspection and Control Chambers			
5.1	Annual inspection, remove silt and check free flow	Annually		
7	Silt Management			
7.1	Inspect permeable paving and any low points within garden areas for silt accumulation	Annually		
7.2	Excavate silt, stack and dry within 10m of the SuDS feature, but outside the design profile where water flows, spread, rake and overseed	As required		
8	Native Planting			
8.1	Remove lower branches where necessary to ensure good ground cover to protect soil profile from erosion.	Annually (or in line with conditions).		
	Remedial Work			
9	Inspect SuDS system regularly to check for damage or failure. Undertake remedial work as required.	As required		

2. Sustainable Drainage Maintenance Specification

General Requirements

Maintenance activities comprise • Regular Maintenance • Occasional Tasks • Remedial Work	Frequency
Generally Litter Collect all litter or other debris and remove from site at each site visit	 Monthly

- Avoid use of weed killers and pesticides to prevent chemical pollution
- Avoid de-icing agents wherever possible to allow bio-remediation of pollutants in permeable surfaces.
- Protect all permeable, porous and infiltration surfaces from silt, sand, mulch and other fine particles.

Exclusions:

- Maintenance of rainwater harvesting chambers, pumps, etc.

3. Filter / Aco Drains

- Filter drains are stone filled trenches, sometimes with a perforated pipe in the bottom, that collect, clean and store runoff before conveying the water to another SuDS feature or allowing it to soak into the ground.
- Treatment trenches are enlarged filter drains designed to treat a known volume of dirty water or increase soakage into the ground. They may also be used to intercept overland flows when they are referred to as cut off drains.

Filter Drains and Infiltration Trenches	
Regular Maintenance	Frequency
Grass edges Mow 1m min. wide grass surround to drain at 100mm and 150mm maximum to filter runoff and protect drain from silt.	Monthly or as required
Occasional Tasks	Frequency
Weeds Hand pull or spot treat individual weed growth only if necessary ensuring weed killer does not enter the filter drain. Weed growth usually dies in dry weather	As required
Remedial Work	Frequency
Siltation at surface Where there is no protective geotextile remove all stone and perforated pipe replacing as original Spec. and include separating geotextile as below. Where there is a separating geotextile (see Spec.) then remove surface stone layer and separating geotextile that protects the stone drain below. Replace geotextile and top stone layer	As required

4. Rainwater Harvesting butts

Rainwater Harvesting butts	
Regular Maintenance	Frequency
Cleaning Inspection of tank for debris and sediment build up. Remove debris from catchment surface from roof gutters, filters and withdrawal devices where it may cause risks to performance. For systems where rainfall infiltrates into the butt from above, check surface of filter for blockage by sediment or other matter, remove and replace surface infiltration medium as necessary	Annually or following poor performance. Annually. Annually.
Occasional Tasks	Frequency
Cleaning and replacement of any filters	Three monthly or as required.
Remedial Work	Frequency
Repair or overflow erosion damage or damage to tank and associated components. Pump repairs.	As required

5. Geo-cellular storage (Attenuation) crates

Attenuation crates	
Regular Maintenance	Frequency
Cleaning Inspect and identify any areas that are not operating correctly. If required, take remedial actions. Remove debris from catchment surface where it may cause risks to performance. For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment or other matter, remove and replace surface infiltration medium as necessary	Monthly for 3 months then annually. Monthly. Annually
Remedial Work	Frequency
Siltation at surface Where there is no protective geotextile remove all stone and perforated pipe replacing as original Spec. and include separating geotextile as below. Where there is a separating geotextile (see Spec.) then remove surface stone layer and separating geotextile that protects the stone drain below. Replace geotextile and top stone layer	As required
Monitoring	Frequency
Inspect inlets, outlets and overflows for blockages. Inspect tank for silt accumulation	Annually Every 5 years

6. Inlets, Outlets, Controls, and Inspection Chambers

- Inlets and outlets structures may be surface structures or conveyance pipes with guards or headwalls. They must be free from obstruction at all times.
- SuDS flow control structures can be protected orifices, slots weirs or other controls such as hydrobrakes at or near the surface to be accessible and easy to maintain. They may be in baskets, in small chambers or in the open.
- Inspection Chambers and rodding eyes are used on bends or where pipes come together and allow cleaning of the system if necessary. They should be designed out of the system where possible.

Inlets, Outlets, Controls and Inspection Chambers	
Regular Maintenance	Frequency
Inlets, outlets and surface control structures Inspect surface structures removing obstructions and silt as necessary. Check there is no physical damage. Strim vegetation 1m min. surround to structures and keep hard aprons free from silt and debris	Monthly Monthly
Inspection chambers and below ground control chambers Remove cover and inspect ensuring water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt. Undertake inspection after leaf fall in autumn	Annually
Occasional maintenance	Frequency
Check topsoil levels are 20mm above edges of baskets and chambers to avoid mower damage	As necessary
Remedial work	Frequency
Unpack stone in basket features and unblock or repair and repack stone as design detail as necessary. Repair physical damage if necessary.	As required As required

7. Overflows and Flood Routes

- Overflows are overland across permeable surfaces and must be kept clear at all times to protect areas from flooding. They allow onward flow when part of the SuDS system is blocked.
- Flood routes (exceedance routes) allow water volumes that exceed the capacity of the SuDS system to pass through or round the site without causing damage to property. These routes must be clear of obstructions at all times.

Overflows and Flood Routes	
Regular Maintenance	Frequency
Overflows. Jet pipes leading from overflow structures annually and check by running water through the overflow. Check free flow at next SUDS feature – inlet to basin or chamber.	Annually
Overflows. Remove any accumulated grass cuttings or other debris on top of permeable paving.	Monthly
Flood Routes. Make visual inspection. Check route is not blocked by new fences, walls, soil or other rubbish. Remove as necessary.	Monthly
Remedial	Frequency
Overflows. If overflow is not clear then dismantle structure and reassemble to design detail.	As Required

8. Ornamental Planting and Existing Vegetation

- Ornamental Trees - All ornamental planting to be kept weed free and pruned using secateurs to keep the shrubs to an agreed and reasonable size.
- Native Trees and Shrubs – All native planting to be allowed to grow freely removing overhanging branches as required.

Planting and Existing Vegetation - Review	
Regular Maintenance	Frequency
Rough grass – Mow at 75-100mm but not to exceed 150mm All cuttings to wildlife piles	Every 3 months
Ornamental tree & shrub planting. Weed all shrub beds as detailed spec as necessary. Cut back planting from lights, paths and visibility sight lines in late autumn and as necessary. Cut hedges slightly tapered back from base with flat top at specified height. Do not mulch planting adjacent to permeable/ porous paving surfaces. Remove stakes and ties from trees when no longer needed for support and within 3 years of planting. Protect from strimmer damage and remove competitive growth until well established.	Every 3 months
Native trees & shrub planting. Prune to shape in year 1. Protect trees from strimmer damage and remove competitive growth until well established. Remove stakes and ties from trees when no longer needed for support and within 3 years from planting	Once a year
Existing trees Check existing trees for safety	Annually
Remedial	Frequency
Replace trees and shrubs which fail in the first five years after planting. Carry out tree surgery as necessary.	

16.7 - Drainage provisions during construction period of the new development

SuDS construction generally requires the use of fairly standard civil engineering construction and landscaping operations, such as excavation, filling, grading, topsoiling, seeding and planting.

The design process should also be mindful of the construction process and ensure that there is adequate access and the design process properly informs the construction program as well as pollution, sedimentation and erosion control. Design will also have a bearing on the availability of materials too, as it is likely to be easier to construct and maintain SuDS if the materials used are easy to procure and source.

The principles of Sustainable Drainage Systems (SuDS) shall be applied to all components of design and construction with regard to surface water management. Any design or site works that may impact on the Site drainage or water quality shall:

- Consider and manage erosion
- Retain any silts on site and prevent silts from discharging into watercourses or drains
- Remove pollutants in surface water
- Keep runoff rates at existing
- Prevent accidental spillages reaching watercourses

The design of all permanent and temporary drainage controls and silt mitigation measures will consider the following:

- Topography / falls toward drains or watercourses.
- Underlying geology, including likelihood and type of generation of silt in excavations, due to soil types, clays, rock type in excavation and rock used as track aggregate.
- Vegetation type, including sensitivity of vegetation and habitats.
- Location of sensitive receptors (e.g. watercourses or protected habitats and species) and high-risk areas (e.g. Pollution sources).

<u>Silt removal</u>

Silt laden runoff is expected from any areas of exposed soil, clay, aggregate, or rock. Prior to entering the water environment, all silt laden runoff will require treatment to remove suspended solids / silt before discharging to the sewer.

<u>Excavation Dewatering</u>

Drainage management should ensure that adequate provision is in place at all times to treat polluted or ponded water arising from all excavations.

<u>Design considerations are to include as a minimum:</u>

- Requirement to cover clays with topsoil to prevent wash off of fine sediments
- Provision of sediment settlement features down slope of stockpiled material until such times as potential for silt loading had reduced and vegetation has established.
- Avoidance of placing permanent or temporary spoil stockpiles in close proximity to watercourses / drains.

Site Drainage Runoff

Temporary swales located adjacent to the access point into the Site and site boundaries where excavation is to occur will be installed to comply with the following considerations:

- Swales to be designed to comply with the minimum performance specification hydraulic requirements previously stated.
- Swales to be re-vegetated by hydro-seeding with indigenous seed mix as soon as is practicable following excavation. This will reduce the flow velocity and increase the retention of silt.
- Clean aggregate check dams should be placed in swales at 8m centres. Check dams provide a level of attenuation, reduce velocity and promote settlement of suspended solids and silt. Check dams have a minimum 0.2m freeboard (from top of check dam) to top of swale level, to prevent overtopping of flows onto the access track.
- Additional settlement/silt removal features should be provided where concentrations of silt laden runoff are noted, or where the track alignment is in proximity to a drain.
- Retention basins will be developed around the site parameter to limit off site drainage and allow for conveyance into the existing surface water drainage route, at a controlled discharge of 1 l/s.

Rock filled check dams will be installed within swales at regular frequencies, in order to reduce flow velocities and improve conditions for the settlement of solids in transit. The stone used for the construction of the check dams will be 50-75mm 'clean' graded stone. The check dams will serve dual functions, by both removing and settling out silts and reducing flow velocities, therefore mitigating against the effects of erosion within the swale.

A degree of attenuation will also be provided If during construction silt loads are higher than expected, then further silt interception methods can be utilised, for instance, installing temporary catchpits using 600mm twinwall plastic pipe placed vertically in the base of the swale. These will be maintained regularly.

All check dams and settlement to be checked at least once weekly via a walkover survey during the full period of construction. All excess silts to be removed and disposed of appropriately. Where check dams have become full blocked with silt, they should be replaced.

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.

Conditions in Draft National Standards (Defra, 2011), 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?	

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.

17. 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 Draft National Standards for SuDS (2011):

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 A in Section 12 of this report.

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.

18. 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/

19. References and glossary

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Glossary[3]

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.

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

20. Further information

Disclaimer

This report has been prepared by GeoSmart in its professional capacity as soil and groundwater specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by GeoSmart solely for the internal use of its client.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to GeoSmart at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, GeoSmart may, by prior written agreement, agree to such release, provided that it is acknowledged that GeoSmart accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. GeoSmart accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against GeoSmart except as expressly agreed with GeoSmart in writing.

Further information

Information on confidence levels and ways to improve this report can be provided for any location on written request to info@geosmart.co.uk or via our website. Updates to our model are ongoing and additional information is being collated from several sources to improve the database and allow increased confidence in the findings. Further information on groundwater levels and flooding are being incorporated in the model to enable improved accuracy to be achieved in future versions of the map. Please contact us if you would like to join our User Group and help with feedback on infiltration SuDS and mapping suggestion.

Important consumer protection information

This search has been produced by GeoSmart Information Limited, Suite 9-11, 1st Floor, Old Bank Buildings, Bellstone, Shrewsbury, SY1 1HU.

Tel: 01743 298 100
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GeoSmart Information Ltd is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practice and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.
- by giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- 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 compensation of up to £5,000 to you if he finds that you have suffered actual loss 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
Tel: 01722 333306

Fax: 01722 332296
Email: admin@tpos.co.uk

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: 01722 333306, E-mail: admin@tpos.co.uk. We will co-operate fully with the Ombudsman during an investigation and comply with his final decision.

Complaints should be sent to:

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21. 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/

22. Appendices

Appendix A

Existing and proposed Site plans (layout and topography)

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THE CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE MAKING SHOP DRAWINGS OR COMMENCING WORK OF ANY KIND.
NO DIMENSIONS TO BE SCALED FROM THIS DRAWING.

REV. DATE REVISION

Osel architects and development consultants

PROJECT:

50 REDINGTON ROAD
HAMPSTEAD
LONDON NW3 7RS

CLIENT:

MARCUS DONN
50 REDINGTON ROAD
LONDON NW3 7RS

DRAWING:

ORDANCE SURVEY MAP
SITE LOCATION
-

DRAWING No.: REV:

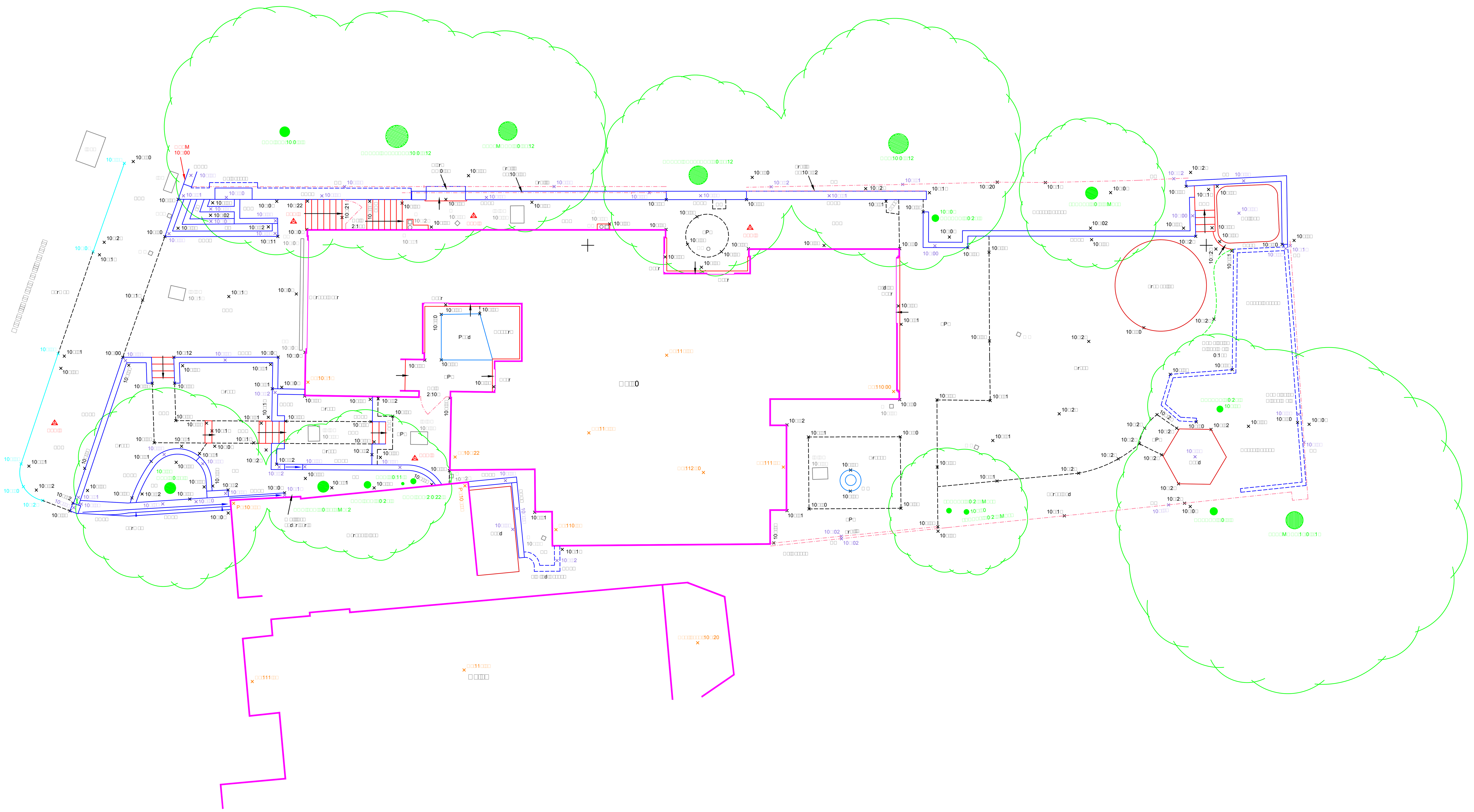
E10-030/S100 -

SCALE: 1:1250@A4

DRAWN: ZETA KACHRI DATE: OCT 2011

CHECKED: TERRY MONAN DATE: OCT 2011

26 Oldbury Place, London W1U 5PR Tel: 020 7224 2447 Fax: 020 7224 2997
E-mail: admin@oselarch.co.uk Web: www.oselarchitecture.co.uk



LEGEND :

NOTES :

DRAWING NO :

DATE :

DRAWN :

SHEET NO :

CHECKED :

SCALE :

SHEET SIZE :

CLIENT :

PROJECT TITLE:

SURVEYED BY :

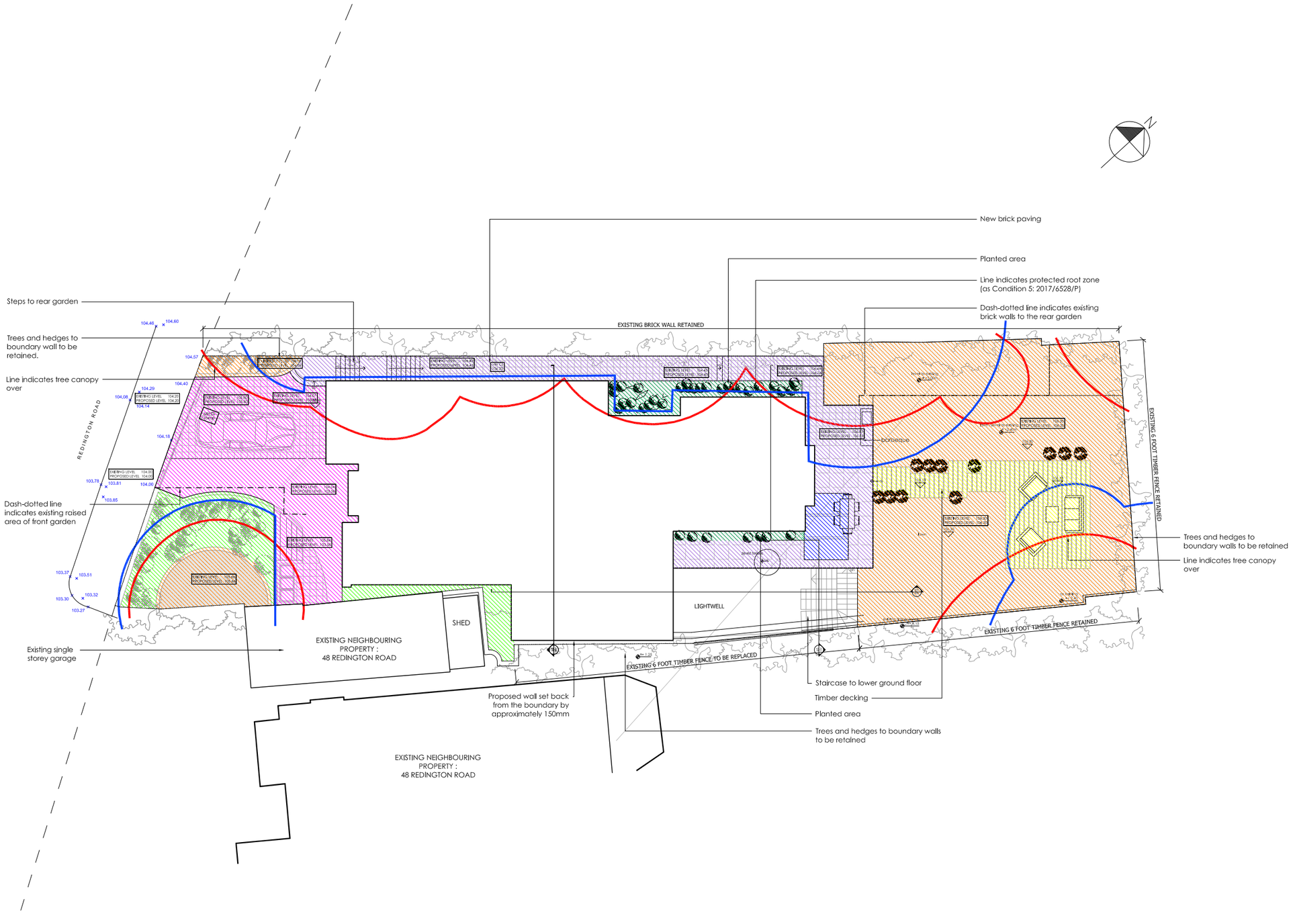
THE SURVEY ASSOCIATION

SCALE 1:100
SCALE 1:1

0m 1m 2m 4m 6m 8m 10m
0m 10mm 20mm 40mm 60mm 80mm 100mm

THE CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE MAKING SHOP DRAWINGS OR COMMENCING WORK OF ANY KIND.
NO DIMENSIONS TO BE SCALED FROM THIS DRAWING.

REV. DATE REVISION



Drawing Notes

Details of tree protection measures are all set-out within Crown Consulting Arboricultural Method Statement of Tree Protection Plan ref: CCL09882/TPP rev.1 as approved under Condition 5 (application reference 2017/6528/P: dated 7 December 2017).

Drawing Legend

- Existing trees, shrubs lawns to be retained and level unchanged.
- Existing level unchanged, existing pawing removed and new lawn laid
- New brick pavours to reduced levels to match adjacent public pavement (recently re-laid). Pavours to be Marshalls Drivesett Deco, colour terracotta.
- Existing paving removed and new lawn laid to raised level.
- New brick pavours to existing/ raised level- Marshalls Drivesett Deco, colour terracotta.
- Glass plank paving lights over lower ground floor with sand blasted toughened outer pane and laminated inner pane
- Timber decking raised on stakes over existing retained garden level.
- 103.85 Existing levels

FOR COMMENT

Osel architects and development consultants

PROJECT:
50 REDINGTON ROAD
HAMPSTEAD
LONDON NW3 7RS

CLIENT:
MARCUS DOWN
50 REDINGTON ROAD
LONDON NW3 7RS

DRAWING:
PROPOSED LANDSCAPE PLAN

DRAWING No.: E10-030/LAN01
REV: -

SCALE: 1:100 @ A1
DRAWN: RB DATE: JUN 2014
CHECKED: WTM DATE: JUN 2014

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REV. DATE REVISION

SCALE 1:50
SCALE 1:1

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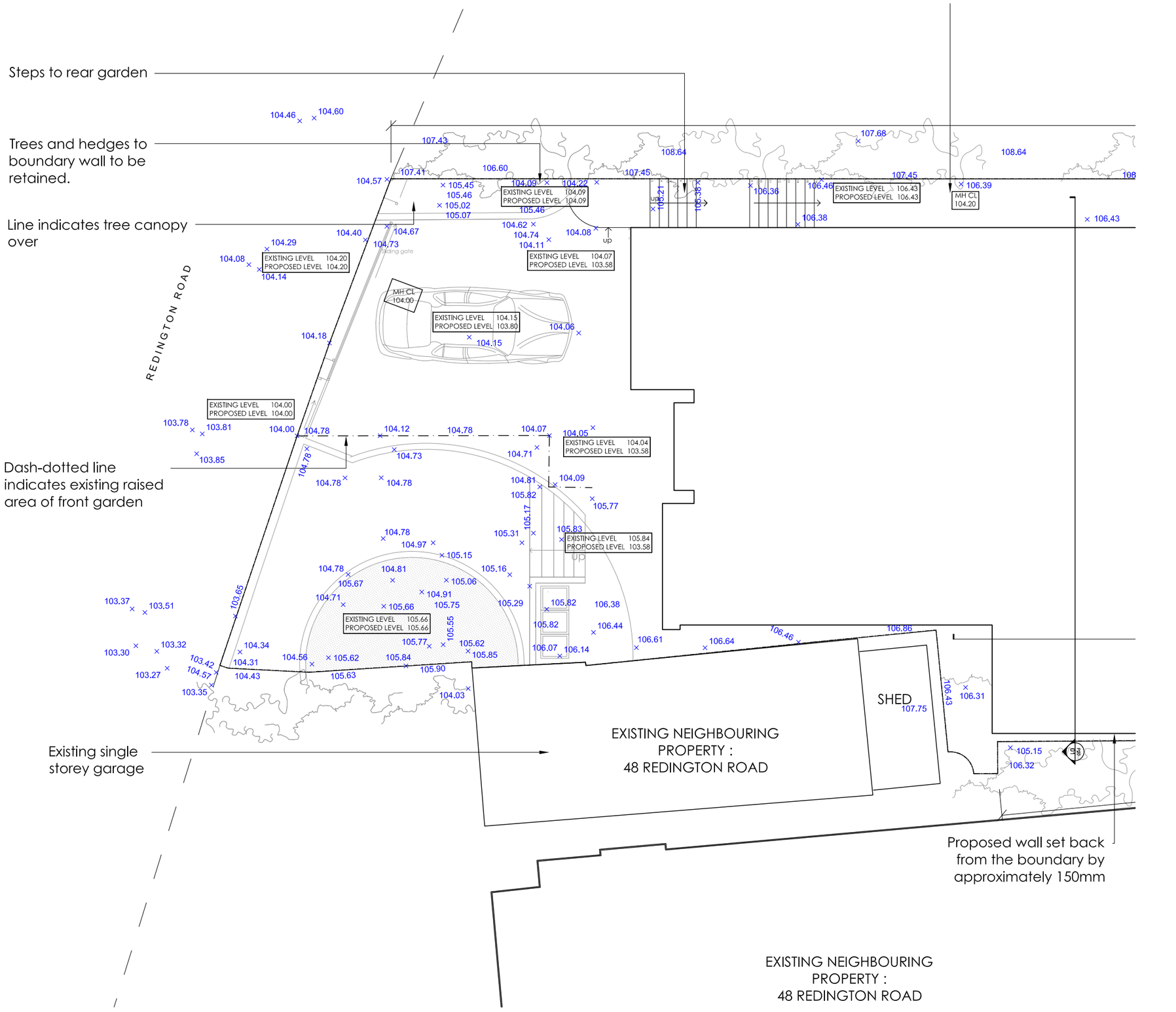
0m 10mm 20mm 40mm 60mm 80mm 100mm



Drawing Notes

Details of tree protection measures are all set-out within Crown Consulting Arboricultural Method Statement of Tree Protection Plan ref: CCL09882/TPP rev.1 as approved under Condition 5 (application reference 2017/6528/P: dated 7 December 2017).

Drawing Legend

103.85 Existing levels

FOR APPROVAL

Osel architects and development consultants

PROJECT:
50 REDINGTON ROAD
HAMPSTEAD
LONDON NW3 7RS

CLIENT:
MARCUS DOWN
50 REDINGTON ROAD
LONDON NW3 7RS

DRAWING:
LEVELS PLAN
(PROPOSED AND EXISTING)

DRAWING No.: E10-030/LAN02
REV: -

SCALE: 1:50 @ A1
DRAWN: RB DATE: JAN 2018
CHECKED: WTM DATE: JAN 2018

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NO DIMENSIONS TO BE SCALED FROM THIS DRAWING.

REV.	DATE	REVISION
B	11.02.2014	PREPARED FOR PLANNING SUBMISSION
C	08.12.2017	STRUCTURAL INFORMATION UPDATED
D	22.12.2017	UPDATED AS CLOUDED AND SECTION LINES ADDED

SCALE 1:20
SCALE 1:1

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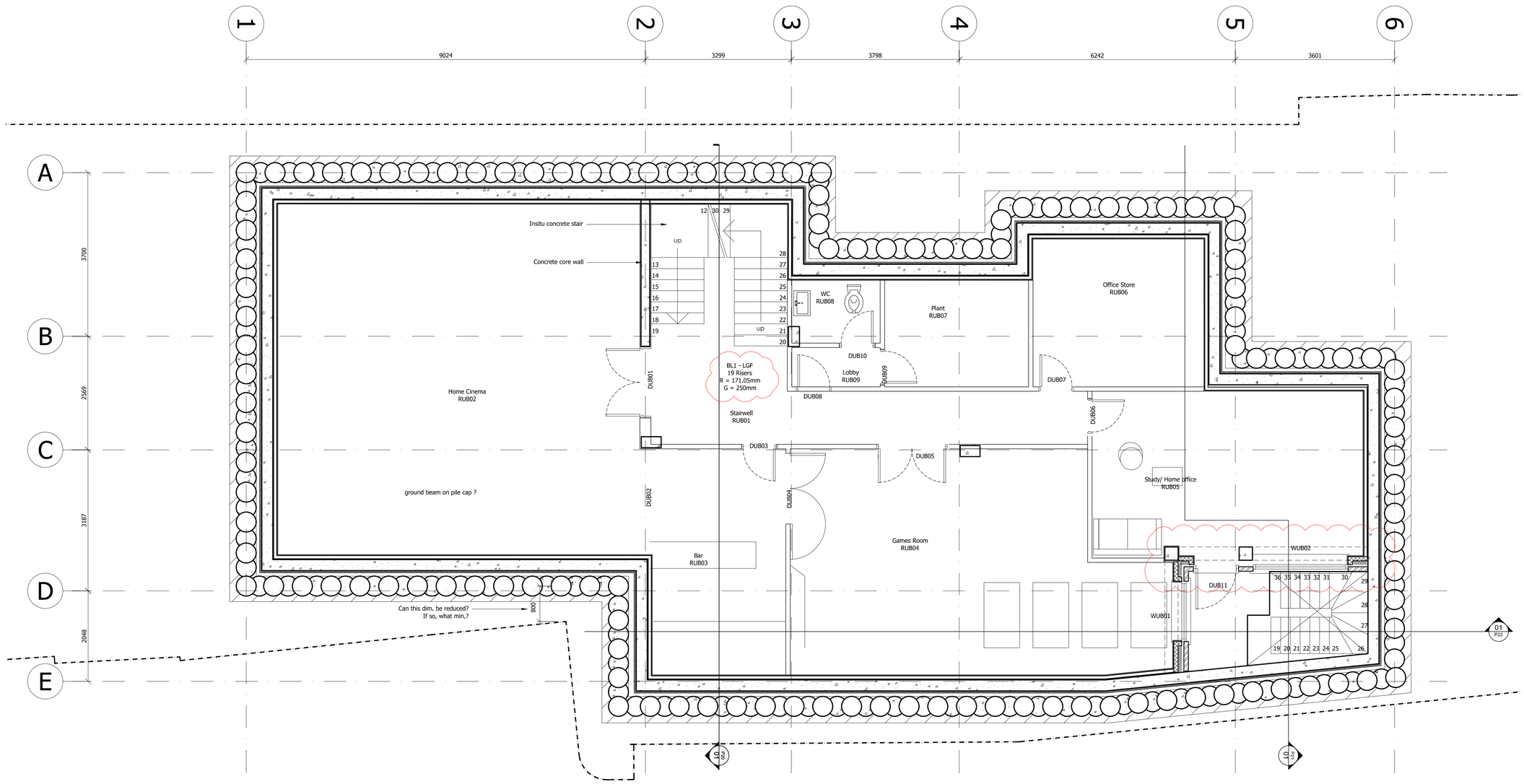
0m 10mm 20mm 40mm 60mm 80mm 100mm



Basement Wall

450mm piles
75mm shortcrete
INSULATION _ 50mm styrozone n300R
Cetco Voltex waterprrofing
250mm concrete
10mm waterproofing
10mm cavity
70mm stud zone
25mm wallboard build up

Retaining Wall

Alsecco Waterstop Sealant
Alsecco Basecoat render
Alsecco Insulation Board (200mm)
Alsecco Bitumen Adhesive 2C
Cetco Blacksheet
200mm retaining concrete wall
10mm waterproofing
25mm Gyplyner
25mm wallboard build up

External cavity wall 0.18w/m2k

102.5 brickwork
50mm cavity
80mm kingspan Kooltherm K108
100mm Porotherm Cellular Clay Block - PTH100 (332.5mm)

2mm eco parge (air tightness)
15mm dabs
12.5mm wallboard
3mm skim
(32.5mm)

Internal partitions - 42 dBA
100mm o/a

ref A206003
Gypframe 48 S50 C stud
2 x 12.5mm wallboard on either side

Drawing Notes

01 Internal walls to be non-load bearing MF partitions which will be part of a future fit-out works package.

Wall linings etc. also to be part of a future fit-out works package.

These layouts give indicative location and quantities for drainage services etc.

FOR COMMENT

PROPOSED BASEMENT LEVEL 1 PLAN

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LONDON NW3 7RS

CLIENT:
MARCUS DOWN
50 REDINGTON ROAD
LONDON NW3 7RS

DRAWING:
PROPOSED BASEMENT LEVEL 1 PLAN

DRAWING No.: E10-030/P00
REV: D

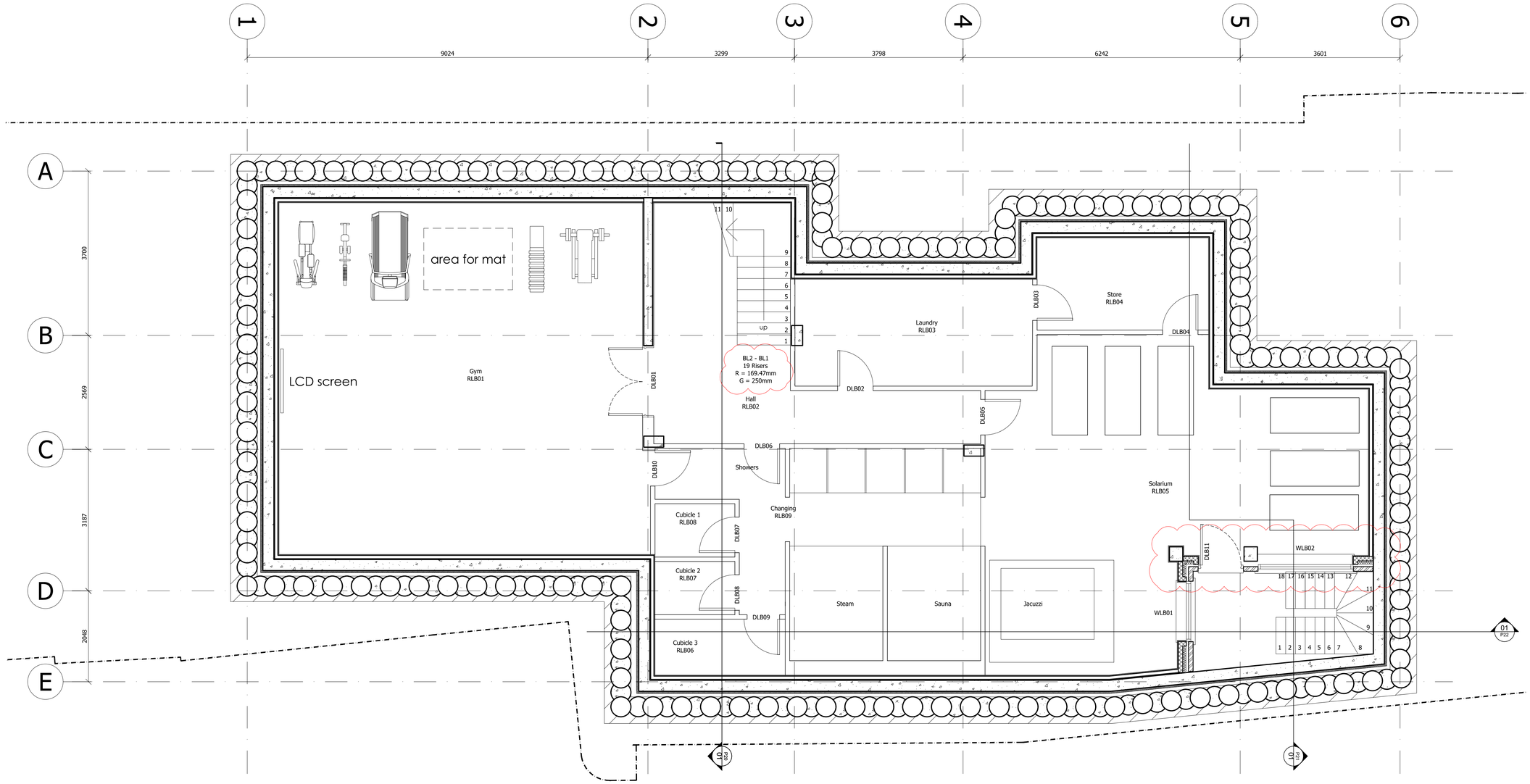
SCALE: 1:50 @ A1
DRAWN: JK DATE: FEB 2014
CHECKED: WTM DATE: FEB 2014

THE CONTRACTOR MUST VERIFY ALL DIMENSIONS ON SITE BEFORE MAKING SHOP DRAWINGS OR COMMENCING WORK OF ANY KIND.
NO DIMENSIONS TO BE SCALED FROM THIS DRAWING.

REV.	DATE	REVISION
B	08.12.2017	STRUCTURAL INFORMATION UPDATED
C	22.12.2017	UPDATED AS CLOUDED AND SECTION LINES ADDED

SCALE 1:20
SCALE 1:1

0m 0.5m 1m 1.5m 2m
0m 10mm 20mm 40mm 60mm 80mm 100mm



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FOR COMMENT

PROPOSED BASEMENT LEVEL 2 PLAN

Osel architects and development consultants

PROJECT:
50 REDINGTON ROAD
HAMPSTEAD
LONDON NW3 7RS

CLIENT:
MARCUS DOWN
50 REDINGTON ROAD
LONDON NW3 7RS

DRAWING: PROPOSED BASEMENT LEVEL 2 PLAN

DRAWING No.: E10-030/P0B

REV: C

SCALE: 1:50 @ A1

DRAWN: JK DATE: FEB 2014

CHECKED: WTM DATE: FEB 2014

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