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Flood Risk Assessment and Drainage Strategy

Homes England

CampbellReith
consulting engineers

Brislington Meadows,
Brislington, Bristol

Flood Risk Assessment & Drainage Strategy

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For

Homes England

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1.0 INTRODUCTION

1.1. Brief

1.1.1. Campbell Reith Hill LLP (CampbellReith) has been commissioned by Homes England (the client) to provide a formal Flood Risk Assessment and outline drainage strategy report (FRA) for a new residential development located at Brislington Meadows, Bristol, nearest postcode BS4 4NZ. The proposed development will comprise of up to 260 new dwellings.

1.1.2. This FRA report has been produced to address the requirements of the National Planning Policy Framework (NPPF), issued July 2021 in relation to flood risk.

1.1.3. The FRA aims to identify any potential flood risk sources or surface water management issues related to the proposed development site that may warrant further consideration. This assessment has been based on readily available existing information, including the Strategic Flood Risk Assessment (SFRA), Environment Agency (EA) Flood Maps and EA Standing Advice.

1.1.4. Further to identification of flood risks, the FRA outlines mitigation measures, where appropriate, in order for the proposed development to be made safe in terms of flood risk and in accordance with the NPPF and its supporting Technical Guidance.

1.2. Aims and Objectives

1.2.1. This report has been prepared in accordance with the National Planning Policy Framework (NPPF)[1] and the accompanying Planning Practice Guidance (PPG)[2].

1.2.1. This FRA aims to identify the sources of flooding related to the site whilst demonstrating the feasibility of the proposed development and how residual risks, if any, could be managed.

1.2.2. The objectives of this FRA are to:

- Establish whether the site is likely to be affected by current or future flooding from any source;
- Establish whether proposed future development will increase flood risk elsewhere;
- Establish whether the measures proposed to deal with these effects and risks are appropriate;
- Provide evidence to satisfy the Local Planning Authority's (LPA) Sequential Test if necessary;
- Establish whether the Lead Local Flood Authority (LLFA) has records of flood risk on the site and within the surrounding area;
- Present the findings of the assessment through a site constraints plan, if applicable.

[1] Ministry of Housing, Communities & Local Government (2018) National Planning Policy Framework. Ref: ISBN 978-1-5286-0745-2.
[2] Department for Environment, Food & Rural Affairs and Environment Agency (2014) Planning Practice Guidance: Flooding and Coastal Change

2.0 PLANNING POLICY

2.1. National Planning Policy Framework (NPPF, July 2021)

2.1.1. The NPPF sets out the government's national planning policies to protect people and property from flooding from either now or in the future which all Local Planning Authorities (LPAs) are expected to follow. There are three main steps which should be followed to ensure that the risk of flooding from development is minimised; assess the flood risk, avoid flood risk and manage and mitigate the flood risk.

2.1.2. The NPPF recommends that new development adopts a sequential, flood risk-based approach to the location of development, taking into account climate change and its impact to or by current or future flood risk. Subject to the type of development proposed and the relative flood zone (Zone 1 being the least risk and Zone 3b the greatest risk) in which the development site is located, there can be a requirement for a sequential test and an exception test. The aim of the sequential test is to steer development to areas considered to be at the lowest risk from sources of flooding. If this is not possible then the exception test would be required. This would demonstrate that the development would provide wider sustainability benefits to the community that would outweigh the flood risk and that the development would be safe for its lifetime. This would also take into account the vulnerability of the users without increasing flood risk elsewhere and where possible reducing the current risk of flooding.

2.1.3. The NPPF states that *"Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:*

a) Take account of advice from the lead local flood authority;

b) Have appropriate proposed minimum operational standards;

c) Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and

d) Where possible, provide multifunctional benefits."

2.2. Flood Risk and Coastal Change Planning Practice Guidance (PPG)

2.2.1. A FRA is required when developments are:

- Located within a Flood Zone 2 or 3 including minor development and change of use;
- More than 1 hectare (ha) in a Flood Zone 1;
- Less than 1 ha in a Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than rivers and sea (for example surface water, reservoirs); or
- In an area within a Flood Zone 1 which has critical drainage problems as notified by the Environment Agency (EA).

2.2.2. Table 1 below (Table 2 of PPG) defines the various flood risk vulnerability classifications and identifies the different types of development within each category. Table 2 (Table 3 of PPG) on the following page summarises the flood risk vulnerability and compatibility in relation to the above flood zones.

Flood Risk Vulnerability Classification				
Essential Infrastructure	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**	**Water Compatible**
• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.	• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. •Installations requiring hazardous substances consent.	• Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishment. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or shortlet caravans and camping, subject to a specific warning and evacuation plan.	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill* and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 1: Flood Vulnerability Classification

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**	**Water Compatible**
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test Required	✓	✓	✓
Zone 3a†	Exception Test required†	×	Exception Test Required	✓	✓
Zone 3b*	Exception Test required*	×	×	×	✓*

Table 2: Flood Vulnerability and Flood Zone Compatibility Table

Key ✓Development is appropriate.

× Development should not be permitted.

† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

2.3. Roles and Responsibilities

2.3.1. The roles of the LLFAs were established following the Flood Risk Regulations (2009) and the Flood and Water Management Act (2010). They are responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and maintaining a register of flood risk assets. They also have lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses.

2.3.2. The EA are a statutory consultee for planning applications. The EA are responsible for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea.

2.4. Bristol City Council (BCC)

2.4.1. The West of England Sustainable Drainage Developer Guide 2015 which sets out the policies in regards to Flood Risk within Bristol along with its supporting technical guidance has been referred to in preparation of this report.

2.4.2. The Bristol Local Flood Risk Management Strategy Report, February 2018, Bristol City Council's Development Framework Core Strategy (2011) and Bristol City Council's Level 1 Strategic Flood Risk Assessment (2020) have also been referred to.

2.5. Climate Change[3]

2.5.1. The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. The EA provide guidance on the climate change allowances which should be considered when assessing the future risk of flooding.

[3] EA Climate Change Allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

2.5.2. The EA has produced a range of climate change allowances to be applied to the peak river flow based upon the river basin district catchment. The site is located within the Severn River Basin District Catchment. Table 3 shows the anticipated changes to fluvial peak flow which should be considered for the area.

2.5.3. The range of allowances is based upon a statistical analysis above the 50th percentile which is regarded as being the central category. The higher central is based upon the 70th percentile and the upper end is based on the 90th percentile.

Allowance Category	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)
H++	25%	45%	90%
Upper end	25%	40%	70%
Higher central	15%	25%	35%
Central	10%	20%	25%

Table 3: Peak River flow allowances by Severn river basin district (use 1961 to 1990 baseline)

2.5.4. Based on the EA climate change allowances, the flood risk vulnerability classification of the development, i.e. 'More Vulnerable' and the development being outside of the current flood zones, no climate change has been accounted for in the fluvial flood levels.

2.5.5. Climate change allowances should be applied to the peak rainfall intensities. Table 4 shows the anticipated change in extreme rainfall intensity in small and urban catchments. The central and upper allowances should be applied to assess the range of impact. Due to the proposed design life for this development, an upper end figure of 40% is to be used.

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%

Table 4: EA Peak Rainfall Intensities

3.0 EXISTING SITE

3.1. Site Location

3.1.1. The site (9.61ha approx.) is located in Brislington, south east of Bristol within the administrative boundary of Bristol City Council and the Ward of Brislington East. The site is centred on National Grid Reference 326615E, 171114N and the nearest post code is BS4 4NZ, approximately 3.4km outside Bristol City Centre.

3.1.2. Refer to Appendix A for the site location plan.

3.2. Site Characterisation / Land Use

3.2.1. The proposed site is irregularly shaped and covers an approximate area of 9.61ha. Majority of the site comprises undeveloped greenfield land whilst a small section of land, north east of the site is occupied by the former Sinnot House building. Two public rights of way and a network of informal trodden paths currently cross the site. There are overhead electricity cables and a pylon located adjacent to the southern boundary of the site. A telecommunications mast is also located towards the north east of the site. The site is not subject to specific environmental or landscape designations and has an allocation for housing development in the Council's Local Plan.

3.2.2. The site is bound to the west by School Road and allotment gardens towards the south west. Residential properties including a children's nursery bound the site to the north. To the east is Bonville Road whilst grasslands border the site to the south with Victory Park located further beyond.

3.2.3. There is no public vehicular access into the site at present. There are two public rights of way across the site, one running east-west along the southern boundary connecting Bonville Road and School Road, and one north-south between Belroyal Avenue and Bonville Road. In addition, a network of informal trodden paths crosses the site.

3.2.4. The site has a direct informal connection Victory Park to the south. Eastwood Farm Local Nature Reserve is located approximately 150m north of the site on the northern side of Broomhill Road. Nightingale Valley Park is located approximately 600m west of the site off Allison Road.

3.3. Topography

3.3.1. A topographical survey for the full site was undertaken by Anthony Brookes Surveys Ltd. in September 2019.

3.3.2. The topographical survey indicates the site to be very steep with levels varying from 69.70m AOD (highest point) in the north eastern part of the site to 42.50m AOD (lowest point) in the south western part of the site. The steepest part of the site is located in the north west corner and has a gradient of approximately 1 in 6.5.

3.3.3. Refer to Appendix B for a copy of the topographical survey.

3.4. Geology

3.4.1. In determining the geology of the site, the following sources have been referred to:

- The British Geological Survey (BGS) online database, and
- Site Investigation works undertaken by Geotechnical Engineering Ltd. (2020)
- The Land Quality Statement by CampbellReith Hill LLP (2022)

3.4.2. Based on data obtained from the sources above, the site is underlain by the Farrington and Barren Red Formations of the Upper Coal Measures comprising "undivided mudstone with red sandstone and coals". The Farrington Formation comprises grey mudstones and sandstones with productive coal seams and fireclays. The coal seams are generally recorded to be mostly thin but occur at a shallow depth.

3.4.3. The Barren Red Formation is defined to include "all the unproductive measures between the Farrington and Radstock Formations" and is comprised of material similar to that in the Farrington Formation of red and grey colouration. The formation comprises of seatearth and is a brownish or maroon or grey colour when fresh, weathering to a purple or brown colour.

3.4.4. Head deposits are also indicated to be present at the north-eastern boundary of the site comprising "poorly stratified clay, silt, sands and gravel'.

3.4.5. Refer to Appendix C for the exploratory hole logs.

3.5. **Hydrology**

3.5.1. A partly culverted unnamed tributary of Brislington Brook is located south of the site with parts of it running along the southern boundary. The tributary flows from east to west and feeds into Brislington Brook approximately 0.33km west of the site. BCC's Flood Risk management Map indicates that the tributary is culverted approximately 0.30km downstream of the site and is a significant drainage network feature. The River Avon is located approximately 0.60km east of the site.

3.5.2. There are no surface water abstractions within 1km of the site.

3.6. **Hydrogeology**

3.6.1. In terms of the site's bedrock aquifer designation, the underlying strata is designated as a Secondary A aquifer. The EA defines Secondary A aquifers as permeable layers capable of supporting water supplies at a local rather than strategic scale.

3.6.2. The head deposits are classified as Secondary Undifferentiated. This means that it has not been possible to classify the bedrock as either Secondary A or Secondary B due to the variable characteristics of the rock type. The EA defines Secondary A aquifers as above whilst Secondary B aquifers are defined as predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features.

3.6.3. The site is identified to be at low risk with regards to soil leaching potential.

3.6.4. The Source Protection Zone maps indicate that the site is not within a groundwater source protection zone.

3.6.5. The site is not within 1km of any groundwater abstractions.

3.7. **Infiltration Testing**

3.7.1. Four infiltration tests have been carried out by Geotechnical. One test pit recorded an infiltration rate of 3.5×10^{-5}m/s whilst the other three of the trial pits were recorded as negligible as they yielded no infiltration capacity.

3.7.2. Refer to Appendix D for infiltration test locations & results.

3.8. **Existing Drainage Network**

3.8.1. Refer to Appendix E for the existing drainage plans.

3.8.2. Maps obtained from Wessex Water show a variety of public surface and foul water sewers within the adjacent roads and residential developments. Within School Road to the west of the site, there is a 225mm surface water sewer and a 150mm foul water sewer. In Bonville Road, east of the site, a surface water sewer comprising 300mm and 375mm diameter pipes is present and this discharges into a 450mm culverted sewer at the junction of Bonville Road and Dixon Road. At this point, it discharges into the watercourse that runs east to west south of the site. A 225mm foul water sewer is also indicated in Bonville Road and runs in a south west direction. The asset maps also indicate public foul and surface water sewers to be located within Belroyal Avenue and Broomhill Road to the north of the site.

3.9. **Existing Site Runoff**

3.9.1. The existing site accounts for a total area of 9.61ha. The area being proposed for development however equates to 6.90ha. Due to the site topography, the existing site is split into 4 drainage catchments.

3.9.2. The existing site greenfield runoff for the site has been calculated using the IH124 method with a greenfield site area of 6.90ha, SAAR of 850mm and soil value of 0.450. The resulting existing flows are indicated below in table 1 below. The existing greenfield rates for the development have been based on the greenfield areas being proposed for development.

Site Catchment	Area (ha)	Existing Discharge Rate (QBar)	Discharge Rate (Q_1)	Discharge Rate (Q_{30})	Discharge Rate (Q_{100})
A	0.120	0.7 l/s	0.5 l/s	1.3 l/s	1.6 l/s
B	3.220	17.8 l/s	13.8 l/s	33.8 l/s	43.0 l/s
C	3.144	17.3 l/s	13.5 l/s	33.0 l/s	41.9 l/s
D	0.420	2.3 l/s	1.8 l/s	4.4 l/s	5.6 l/s
Total	6.904	38.1 l/s	29.6 l/s	72.5 l/s	92.1 l/s

Table 5: Existing Greenfield Runoff Rates

3.9.3. Refer to Appendix F for the existing catchment areas, the existing catchment areas based upon the areas proposed for development and the corresponding greenfield runoff rates.

3.10. **Existing Flow Paths**

3.10.1. The existing surface water flow route replicates the site topography. The existing topography indicates overland flows will be directed towards the partly culverted unnamed tributary south of the site.

3.10.2. Refer to Appendix G for the existing overland flood routes and flow paths.

4.0 EXISTING FLOOD RISKS TO THE SITE

4.1. Flood Hazards

4.1.1. In preparing the Flood Risk Assessment (FRA), different types of flooding mechanisms which may affect the site have been identified and assessed to determine whether the application site is located within an area which is at risk of flooding from one or more of the applicable mechanisms.

4.1.2. In assessing the flood hazards, the following documents were reviewed:

i. The online Environment Agency (EA) Flood Maps

ii. The Bristol City Council Level 1 Strategic Flood Risk Assessment SFRA (2020)

4.1.3. Refer to Appendix H for extracts of flood mapping data obtained from the online EA website.

4.2. Fluvial Flood Risk

4.2.1. The EA classify fluvial flood risk as follows:

- VERY LOW – the area has a chance of fluvial flooding of less than 0.1%
- LOW – the area has a chance of fluvial flooding of between 0.1% and 1%
- MEDIUM – the area has a chance of fluvial flooding of between 1% and 3.3%
- HIGH - the area has a chance of fluvial flooding of greater than 3.3%

4.2.2. The EA Flood Map data reproduced in Appendix H indicates all of the proposed development to be within Flood Zone 1 indicating a very low risk of flooding, land having less than 1 in 1,000 annual probability of river flooding.

4.3. Tidal Flooding

4.3.1. The River Avon is located approximately 0.60km east of the site, however the EA flood maps show that the site is at very low risk of flooding tidally. There are also no recorded recent or relevant flood events attributed to tidal flooding in the Brislington area within the SFRA.

4.4. Surface Water/Overland Flow

4.4.1. The EA classify surface water flood risk as follows:

- VERY LOW – the area has a chance of surface water flooding of less than 0.1%
- LOW – the area has a chance of surface water flooding of between 0.1% and 1%
- MEDIUM – the area has a chance of surface water flooding of between 1% and 3.3%
- HIGH - the area has a chance of surface water flooding of greater than 3.3%

4.4.2. The EA Flood Map data included in Appendix H indicates majority of the site to be at very low risk of flooding from surface water. A very small slither of land in the south of the site is highlighted to be at low risk; however, this follows the exact same route as the unnamed tributary.

4.5. Groundwater Flood Risk

4.5.1. Although groundwater was encountered in a few of boreholes and soakaway test pits undertaken as part of the site investigation works, the SFRA identifies that the risk of groundwater flooding occurring within the Brislington area is low and has indicated that no recent or relevant flood events have been attributed to groundwater. The site can therefore be classified to be at low risk of groundwater flooding.

4.6. **Flood Risk from Infrastructure Failure**

4.6.1. Based on information from the online EA website, the site is at very low risk of inundation following major reservoir failures.

4.7. **Climate Change Impact**

4.7.1. Climate change must be considered as an integral part of any site specific FRA in order to minimise the impact of future flooding and allow adequate consideration for resilience to alleviate the burden on potential future users of the proposed development.

4.7.2. Based on the information provided above, the effect of climate change will not be of any significant impact to most of the flood risks sources indicated. Climate change will however increase the potential of flooding from surface water to occur. Refer to section 6 which identifies how this risk will be mitigated.

5.0 DEVELOPMENT PROPOSALS

5.1. Proposed Scheme

5.1.1. The proposed residential development will include the following:

- Construction of up to 260 new dwellings
- Private Gardens
- Internal Access Roads
- Cycle and Pedestrian Access routes
- Car Parking
- Soft Landscaping

5.1.2. As part of the development proposals, the client is in the process of formalising the public access rights of way to facilitate pedestrian and cycle access across and within the site. The telecommunications mast located in the north east of the site is to be relocated following the grant of planning consent for the proposed development.

5.1.3. A copy of the proposed site layout is included in Appendix I.

5.2. Vulnerability of Development

5.2.1. Paragraph 66 of the PPG, presented in Table 1, defines the different categories of development in terms of flood risk vulnerability. The proposed development is classified as 'More Vulnerable' in terms of flood risk.

5.2.2. This type of development is therefore suitable for Flood Zone 1 in line with Table 2.

5.3. Proposed Levels

5.3.1. The overall proposed ground levels will be designed to tie-in to existing ground levels at the site boundary and critical areas such as retained areas designated with Tree Protection Orders (TPOs) as well as 'Retained habitats'.

5.3.2. Refer to the Habitat Loss Plan extract by TEP in Appendix J.

5.4. Sequential Testing

5.4.1. As the site is entirely within Flood Zone 1, there will be no requirement for a sequential test.

6.0 FLOOD RISK FROM THE DEVELOPMENT

6.1.1. Through development of the site, there is potential to alter the flood risks on and off the site. This section of the report will address how flood risk generated as a result of developing the site will be managed to ensure that flood risks are not increased on and off the site. This section will also address how surface water is managed and how the impact of fluvial flood risks are to be managed.

6.1.2. The strategy for managing surface water drainage from the proposed scheme is a material consideration within the assessment of flood risk. The effect of development is generally to reduce the permeability of the site and change the site's ability to respond to rainfall events. The volume of water and peak runoff rate will increase, leading to an increase in the risk of flooding downstream of the site unless measures and management of surface water can be put in place.

6.1.3. The proposed drainage philosophy will at detail design stage be based upon the following best practice standards and documents:

- Bristol Local Flood Risk Management Strategy Report (2018)
- West of England Sustainable Drainage Developer Guide (2015)
- Design and Construction Guidance for foul and surface water sewers offered for adoption ("the Code")
- CIRIA C753 the SuDS Manual
- Building Regulations Part H Drainage and Waste disposal
- BS EN 752 Drain & Sewer systems outside buildings
- BS EN 12056 Gravity drainage systems inside buildings
- CIRIA C609 SuDS, Hydraulic, Structural and Water Quality Advice

6.1.4. In addition to the above the following Best Management Practices (BMPs), the following BMPs shall also be considered as part of the proposed surface water management strategy:

- DEFRA/ EA Preliminary Rainfall Run Off Management for Developments (2004)
- CIRIA Interim Code of Practice for Sustainable Drainage (2004)
- Environment Agency Rainfall Run Off Management for Development Interim Procedure
- CIRIA C539 Guidance on the Design of Rainwater Reuse Systems (2004)
- CIRIA C635 Designing for Exceedance in Urban Drainage Good Practice (2006); and
- CIRIA C737 Structural and Geotechnical design of Modular Geocellular Drainage Tanks (2016)

6.1.5. The surface water drainage strategy of the site will be developed around the SuDS pillars of water quantity control, water quality management, improving biodiversity and providing amenity value, taking into account site constraints and development use.

6.1.6. The proposed design will also consider storm exceedance where overland flow is managed and directed away from buildings to soft landscaped areas providing a safe means of access and egress for the development.

6.2. **Priority of Discharge**

6.2.1. In line with the SuDS hierarchy under paragraph 80 of the PPG, surface water should be managed by:

1.) Infiltration to the maximum extent that is practical – where it is safe and acceptable to do so

2.) Discharge to watercourses

3.) Discharge to surface water sewer, highway drain or another drainage system

4.) Discharge to combined sewers (last resort)

6.2.2. Geotechnical conducted four soakaway test pits within the ground investigation report. The results indicated that drainage to ground will not be a suitable means for surface water disposal as three of the trial pits showed no infiltration capacity. As indicated in section 2, there is a partially culverted unnamed tributary to Brislington Brook located just south of the site. Due to the very steep site topography, only Catchments B and C will discharge surface water flows into the tributary. Catchments A & D will discharge surface water flows into the public surface water sewers within the roads adjacent to the site boundary. The surface water disposal methods for the site are indicated below:

- Catchment A will discharge its surface flows into the 225mm public surface water sewer in School Road.
- Catchment B will discharge into the unnamed tributary south of the site. Two options are indicated on the preliminary drainage layout plan. Option 1 is to discharge directly into the tributary closer to the site boundary however discussions with Bristol City Council (BCC) will need to be undertaken to determine the feasibility of discharging surface flows at that location. Option 2 is to discharge surface flows into the 525mm culverted section of the unnamed tributary further south of the site boundary. Both options will require the drainage route passing through third party land (Victory Park). Option 1 is the preferred method of surface water connection and will require an agreement with Bristol City Parks team to enable drainage connection to be constructed through the third party land, however if this is not possible, a sewer requisition application would be made to Wessex Water to enable connection onto the Wessex Water culverted sewer as per Option 2.
- Catchment C will discharge surface flows directly into the unnamed tributary south of the site via a headwall arrangement.
- Catchment D will discharge its surface water flows into the 225mm public surface water sewer in Broomhill Road. Approximately, 100m of sewer will be constructed off site, within Broomhill Road to facilitate this connection.

6.2.3. For the proposed surface water catchment areas, refer to Appendix K.

6.3. **SuDS Options Considered**

6.3.1. The proposed drainage scheme will incorporate Sustainable Drainage Systems in order to reduce the risk of flooding onsite, and downstream of the proposed development. The SuDS will also be brought in to improve water quality, biodiversity and amenity value on the proposed development. The CIRIA Report C753 - The SuDS Manual defines the four pillars of SuDS Design as water quality, quantity, amenity and biodiversity. The SuDS strategy used aims to provide the best

outcome possible for all four sections. Table 3 below indicates all possible SuDS options, and whether or not they are considered as appropriate for the site.

SuDS Group	Technique	Water quality	Water Quantity	Appropriate?	Comments
Detention	Subsurface storage	N	Y	Yes	Cellular storage to be utilised
	Detention basin	Y	Y	Yes	Attenuation Pond to be Utilised
Wetland	Wetland/Retention Pond	Y	Y	Yes	Attenuation Pond to be utilised
Infiltration	Infiltration trench	Y	Y	No	N/A due to poor infiltration rates
	Infiltration basin	Y	Y	No	N/A due to poor infiltration rates
	Soakaway	Y	Y	No	N/A due to poor infiltration rates
Filtration	Bioretention/filter strips	Y	Y	Yes	Permeable Paving preferred
	Filter trench	Y	Y	Yes	Permeable Paving preferred
Open Channels	Conveyance swale	Y	Y	Yes	Attenuation Pond preferred
	Enhanced dry swale	Y	Y	No	Attenuation Pond Preferred
	Enhanced wet swale	Y	Y	No	Attenuation Pond Preferred
Source control	Green roof	Y	Y	No	Too Expensive. Affects project viability
	Rainwater harvesting	Y	Y	Yes	Water Butts could be explored during detail design stage
	Permeable pavement	Y	Y	Yes	Permeable paving (with an impermeable liner at the bottom) to be utilised in all car parking bays to improve water quality
Proprietary Treatment systems	Petrol Interceptor	Y	N	Yes	Petrol Interceptor will not be used. Permeable paving and attenuation pond to be utilised to improve water quality
Soft Landscaping	Grass and Trees	Y	Y	Yes	Soft landscaped areas are included as part of the scheme. This will help improve the quality of water discharged off site and enhance biodiversity.

Table 6: Potential SuDs Mechanisms

6.4. Proposed Surface Water Drainage Strategy

6.4.1. A copy of the preliminary surface water drainage strategy has been produced and is included in Appendix K.

6.4.2. The surface water network will be detail designed to manage storm water on site and ensure flood risk is not increased on or off the site.

6.4.3. Following discussions with BCC (LLFA) and our knowledge of the history of flooding downstream of the site, the surface water discharge from the proposed development is to be limited to the Qbar greenfield runoff rate for all events up to and including the 1 in 100 year rainfall event +40% climate change. This will ensure that flooding is not increased downstream of the site. BCC have also confirmed that a 4% allowance for urban creep is to be utilised in the design in line with the LASOO Industry Guidance and West of England Developer Design Guide. Table 7 below compares the proposed discharge rates against the existing discharge rates.

Site Catchment	Existing Discharge Rate (QBar) (l/s)	Proposed Discharge Rate (l/s)
A	0.7	2.5*
B	17.8	17.8
C	17.3	17.3
D	2.3	2.5*

Table 7: Existing vs Proposed Discharge Rates

6.4.4. As indicated in table 7 above, the flows from catchments A & D have been increased. Refer to p.6.4.5. for the reason behind the increase in flows.

6.4.5. Refer to Appendix L for correspondence with Bristol City Council.

6.4.6. In line with CIRIA C753 (the SuDS Manual), a minimum static flow control opening of 75mm is recommended based on sewerage undertakers experiences. This is to significantly reduce the risks of blockages occurring within the system, which will ultimately lead to flooding. The only exception to this where flow control openings smaller than 75mm are usually accepted is where the flow control is located just downstream of pervious pavements or other filtration devices where the risk of blockage is very small. Based on this, a flow control device with a minimum opening size of 75mm will usually provide a discharge rate of 2.5l/s or greater. Therefore the proposed discharge rates for Catchments A and D have been slightly increased to 2.5l/s, refer to table 6 above.

6.5. Underground Pipe Sizing

6.5.1. The underground pipe sizing will be undertaken at the detailed design stage. The pipes will be designed to ensure there is no flooding on the site up to the 1 in 30 year storm event. The system will also be designed to ensure there is no flooding to any buildings for all rainfall events up to the 1 in 100 year +40% climate change storm event. Surface flows off site are to be discharged at the rates stipulated in table 7 for all rainfall events up to the 1 in 100 year +40% climate change storm event.

6.5.2. The surface water calculations for pipe sizing and attenuation sizing will be prepared using Microdrainage software. The rainfall profiles to be used in the design will be based on the FSR method as stipulated by the LLFA and are based on the following parameters:

- M5-60 = 20.000

- R = 0.350
- Climate Change = 40%
- Urban Creep = 4%
- Cv_{summer} = 0.75
- Cv_{winter} = 0.84

6.6. **Attenuation Storage**

6.6.1. Surface water attenuation is to be provided through the use of SuDS and based upon the above parameters. The required attenuation storage volumes are to be derived based upon each respective catchment's proposed discharge rate as indicated in table 7. Attenuation storage is to be provided for all rainfall events up to the 1 in 100 year event +40% climate change. Using Microdrainage, preliminary storage calculations have been undertaken based upon each Catchment Area. The results are indicated in table 8 below.

Site Catchment	Proposed Discharge Rate (l/s)	Impermeable Area	Impermeable Area +4% Urban Creep	Storage Volume required
A	2.5	0.070ha	0.073ha	40m^3
B	17.8	1.648ha	1.714ha	1200m^3
C	17.3	1.777ha	1.848ha	1300m^3
D	2.5	0.286ha	0.297ha	220m^3

Table 8: Preliminary Storage Requirements

6.6.2. The preliminary drainage strategy incorporates the use of attenuation ponds and below ground cellular storage tanks to provide the required storage volumes for each catchment as indicated in table 8. Attenuation ponds are specified for catchments B & C, whilst below ground cellular storage tanks are specified for catchments A & D. Adequate space has been allocated within the development proposals to situate these SuDS systems, with the exact sizes subject to the detail design stage. Refer to the drainage strategy layout in Appendix K.

6.6.3. Refer to Appendix M for the preliminary storage calculations.

6.7. **Collection and Conveyance**

6.7.1. The proposed site will be served by four separate below ground surface water drainage networks. Each network will serve its respective catchment.

6.7.2. Surface water from all building roofs will be collected by roof gutters and conveyed towards its respective catchment discharge point via suitably sized rainwater pipes and the underground pipe network. From this point, the underground pipe network will convey the surface flows towards the discharge point via either an attenuation pond or a below ground cellular storage tank depending on the catchment.

6.7.3. Surface water from car parking areas will be collected in tanked permeable pavement arrangements and conveyed towards its respective catchment discharge point via the underground pipe network. Due to the steep site topography, the tanked permeable pavement

will only act as a means of improving water quality and not for attenuation as the storage will not be utilised efficiently. From this point, the underground pipe network will convey the surface flows towards the discharge point via either an attenuation pond or a below ground cellular storage tank depending on the catchment.

6.7.4. Surface Water from the pedestrian areas and other non-pervious areas will either be directed using falls to the permeable paving or positively drained using gullies and/or linear drains located within the roads. From this point, flows will be conveyed towards the discharge point via the underground pipe network and either an attenuation pond or a below ground cellular storage tank depending on the catchment.

6.8. **Biodiversity and Amenity Value**

6.8.1. Opportunities for improving biodiversity and amenity value is enhanced through soft landscaping around the site. The inclusion of attenuation ponds will allow for further variety to the green spaces already included within the development proposals. In addition, most of the existing trees are to be replanted/retained.

7.0 FLOOD RISK MITIGATION MEASURES

7.1. Fluvial Flooding

7.1.1. There is very low risk of fluvial flooding on the site and therefore no mitigation measures are deemed necessary.

7.2. Tidal Flooding

7.2.1. There is very low risk of tidal flooding on the site and therefore no mitigation measures are deemed necessary.

7.3. Surface Water/Overland Flow

7.3.1. The proposed surface water network will be designed to ensure there is no flooding to buildings within the proposed development up to and including the 1 in 100 year rainfall event, plus an allowance of 40% for climate change. Above-ground flow routes to lead surface water away from the proposed buildings in the event of rainfall in excess of the 1 in 100 year storm +40% climate change or blockages in the proposed system have been considered. The proposed flood routes mimic the existing site, guiding water to the drainage ditches and flowing north-west.

7.3.2. Refer to Appendix N for the proposed overland flood routes plan.

7.4. Groundwater Flooding

7.4.1. The site is at low risk of flooding from groundwater and therefore no mitigation measures are deemed necessary. However due to the perched water table noted on site during ground investigations, construction contractors will need to take note and provide suitable method statements to address potential presence of ground water during their works.

7.5. Flood Risk from Infrastructure Failure

7.5.1. The site is at very low risk of flooding from infrastructure failure and therefore no mitigation measures are deemed necessary.

8.0 PROPOSED FOUL WATER STRATEGY

8.1.1. Refer to Appendix K for the proposed drainage layout and foul catchment areas.

8.1.2. The proposed site will be split into three foul water catchments and therefore will consist of 3 below ground foul water drainage networks. The foul flows from each network will discharge into the public foul sewers located within the adjacent roads. Preliminary discussions regarding discharge points, flow rates and available capacity have been conducted with Wessex Water. The agreed discharge points are discussed below:

- Catchment A will discharge its foul flows into the existing 225mm public foul sewer located in 'The Rock', a road west of the site. Due to the site's steep topography, a pumping station and rising main will be required to pump flows from low lying areas within the catchment back up to a break manhole chamber, where foul flows can be conveyed by gravity towards the discharge point. In line with Industry Standard, emergency storage to contain 24-hour foul inflow is to be provided in the event of any disruption to the pumping station service such as blockages or equipment failure. Approximately 180mm of foul sewer will be constructed off site within the public highway to enable connection to the sewer located in 'The Rock'.
- Catchment B will discharge its foul flows by gravity into the existing 225mm public foul water sewer in Bonville Road.
- Catchment C will discharge its foul flows by gravity into the existing 225mm public foul water sewer in Broomhill Road. Approximately, 95m of sewer will be constructed off site, within Broomhill Road to facilitate this connection.

8.1.3. Pipe sizing of the foul drainage networks will be undertaken at the detailed design stage. In addition, detailed design of the pumping station will be undertaken at the detailed design stage.

9.0 IMPLEMENTATION AND MAINTENANCE

9.1. Implementation

9.1.1. In order to ensure that the development has a properly functioning sustainable drainage system, the implementation of the different SuDS components must be considered prior to construction in order best manage and reduce the risk of flooding during and after the construction phase.

9.1.2. In accordance with best practice, the drainage infrastructure, including all SuDS components, are to be in place prior to construction. The contractor is to have a surface water management scheme in place to ensure that surface water does not leave the site in an uncontrolled manner prior to the commissioning of the drainage system.

9.1.3. All SuDS components are to be installed with reference to and in accordance with the relevant product manuals and guides, to be obtained from the product manufacturers.

9.2. Maintenance

9.2.1. When the site is in use it is vital that the drainage systems on site operate at the required capacity at all times. In order to safeguard all components of the drainage networks, routine and regular maintenance should be carried out. In particular, the SuDS components on the site will need to be strictly monitored. All drainage components, including SuDS, will be owned and maintained by a private management company appointed by the client.

Drainage Element	Maintenance Requirements	Maintenance Frequency
Roof Gutters	Visual inspections should record locations where leaves are prevalent and additional attention to cleaning is required at these locations.	Once every **3 months**. One inspection should be carried out at the end of Autumn, after leaf fall.
Attenuation Pond	Inspect marginal and bankside vegetation, and remove nuisance plants. Inspect inlets, outlets and other pipework and structures for blockage and physical damage. Inspect water body for signs of poor water quality. Inspect silt quality and accumulation, and check mechanical devices. Remove and tidy excess and dead bank vegetation.	Once every **1 month** for first 3 years, and after heavy rain. One inspection should be carried out at the end of Autumn, after leaf fall. Once every **6 months.** Once every **Year**.
Permeable Pavement (with an impermeable liner at the base)	Brushing of surface blocks. Inspect silt accumulation rates and relay laying course if filled with silts and toxins. Removal of weeds, remediate any rutting or broken blocks, replace lost jointing material.	Once every **year**, and after heavy rain and autumn leaf fall. As required.

Drainage Element	Maintenance Requirements	Maintenance Frequency
Water Butts	The tanks should be inspected and cleaned regularly as debris and sediment build up is likely. The overflow pipes as well as the inlets should also be inspected regularly to ensure the system is performing efficiently. Cleaning and /or replacement ofany filters.	Once every **3 months** or as required.
Attenuation Tank	Inspect and Identify any areas that are not operating correctly. If required, take remedial action. Check for any silt build up in the catchpits upstream and downstream of the tank. Tank should be cleaned as required.	Monthly for **3 months**, then **annually**. Once every **4 months** and must be cleaned regularly. One inspection should be carried out at the end of Autumn, after leaf fall
Linear Drains	Jetting from the upstream end of the linear drain to clear any sediment build up, clearing the sump outlets for the drains, removing any debris from the surface that may inhibit performance.	Once every **6 months**, and after heavy rain. One inspection should be carried out at the end of Autumn, after leaf fall.
Gullies	Checking and removing the sumps of gullies, removing any large debris from the grating.	Once every **6 months**, and after heavy rain. One inspection should be carried out at the end of Autumn, after leaf fall.
Flow Controls	Check to ensure the flow control devices are free from any significant debris. Ensure there are no other potential blockages within the manhole.	Once every 2 months in first year of operation. Once every **4 months** thereafter if there are no significant build ups of silt in the first year. One inspection should be carried out after heavy rainfall. One inspection should be carried out at the end of Autumn, after leaf fall.

Table 9: Maintenance Requirements for on-site SuDS and drainage components

9.2.2. In addition to the specific elements, there should be general inspections of all drainage elements (i.e. pipework, manholes, inspection chambers etc.) at regular, 12 monthly intervals and after heavy rainfalls. All drainage components are to be replaced in line with the specified design life.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1.1. CampbellReith has been commissioned by Homes England to provide an FRA and outline drainage strategy to support a planning application for a new residential development at Brislington Meadows, Bristol, BS4 4NZ.

10.1.2. The proposed development comprises the construction of up to 260 new dwellings, private gardens, car parking, internal access roads and soft landscaping.

10.1.3. The site is located entirely within Flood Zone 1 as shown on the Environment Agency mapping. Whilst much of the site is at very low risk from surface water flooding, a very small slither of land in the south of the site is highlighted to be at low risk, however this follows the exact same route as the unnamed tributary.

10.1.4. The site is at low risk of flooding from groundwater and is not at risk of inundation in the event of a major reservoir failure.

10.1.5. The proposed surface water drainage strategy will incorporate 4 surface water catchments (A,B,C and D) and will discharge all flows generated from the proposed development off site at the greenfield Qbar equivalents for rainfall events up to and including the 1 in 100 year +40% climate change.

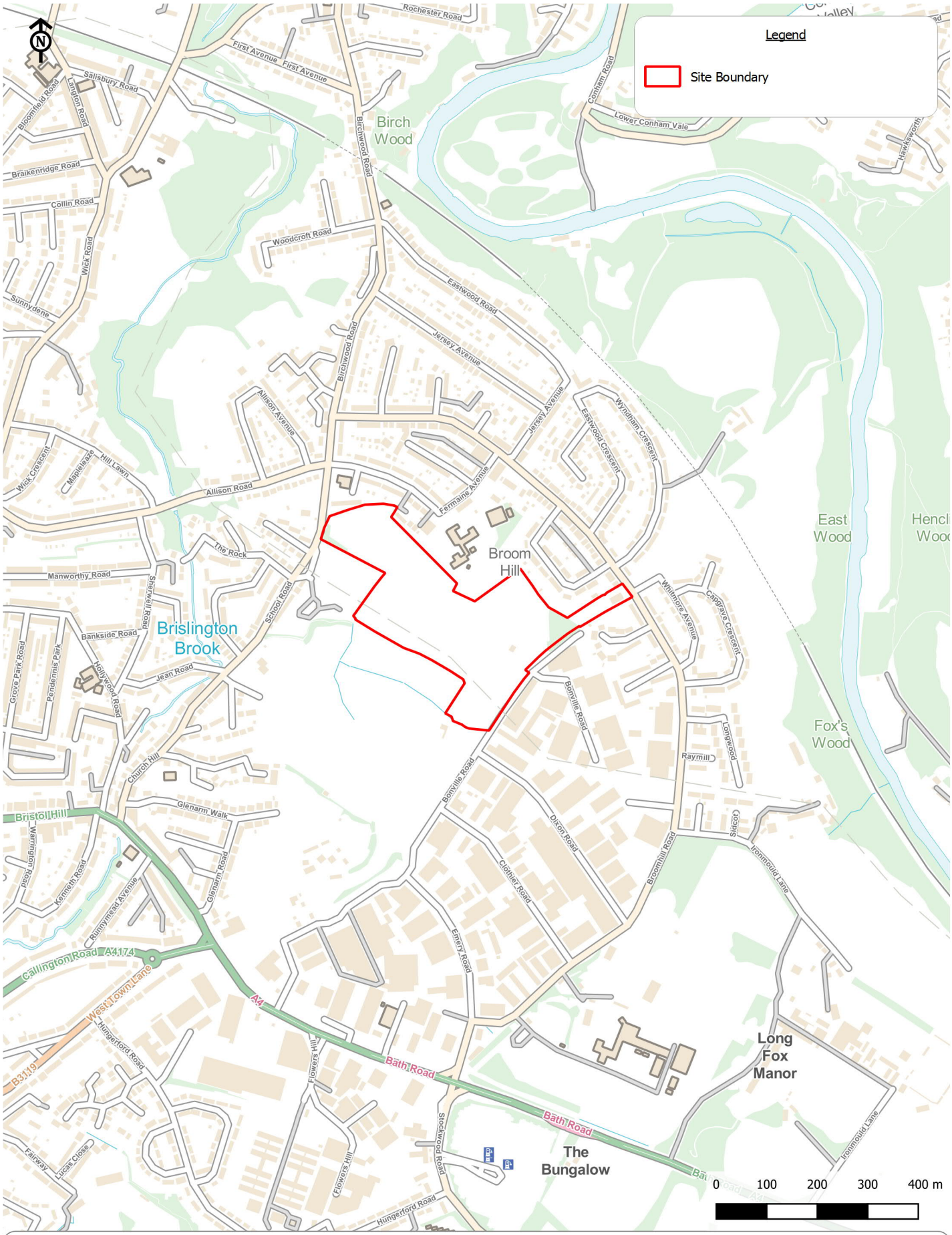
10.1.6. Surface water flows from the Catchment A will discharge its flows into the 225mm public surface water sewer in School Road. Catchments B and C will discharge their surface water flows into the unnamed tributary south of the site. Catchment D will discharge its surface water flows into the 225mm public surface water sewer in Broomhill Road.

10.1.7. Sustainable Drainage Systems (SuDS) will be introduced for the proposed development to attenuate surface water flows to the required rainfall events. In addition, the SuDS will also improve water quality in line with the recommendations within the NPPF.

10.1.8. Adequate space has been provided on the site to store storm water flows generated by the 1 in 100 year +40% climate change event. By adequately sizing the SuDS storage facilities on site, adequate measures will be provided to minimise flood risk on the site.

10.1.9. The proposed site will consist of 3 foul water drainage networks serving 3 catchment areas (A,B and C). The foul flows from each network will discharge into the public foul sewers located within the adjacent roads. Due to the site topography, Catchment A will require a pumping station and rising main to pump flows back up to a suitable point to allow flows discharge off site by gravity. In line with Industry Standard, emergency storage to contain 24-hour foul inflow is to be provided in the event of any disruption to the pumping station service such as blockages or equipment failure.

Appendix A: Site Location Plan



Brislington Meadows, Bristol

Client: Bristol City Council

Site Location Plan

Scale: 1:10000@A4

Job Number: 13492

Drawn by - Checked by: RP - TA

Drg No - Status/Revision: 13492-CRH-XX-XX-FG-G-7018 - P1

File location: N:\13250 - 13499\13492 B - Brislington Meadows\Project_Workspaces (pdf in Outputs)

Date (Revision History): 16/06/2021 (P1, First Issue, 16/06/21, RP)

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consulting engineers
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REDHILL 01737 784 500 ☐ ☐ BIRMINGHAM 01675 467 484
BRISTOL 0117 916 1066 ☒ ☐ DUBAI 00 971 4453 4735
www.campbellreith.com

Appendix B: Topographical Survey

Notes

1. This survey has been computed and drawn "true to scale" and relates to the OSTN15 GPS National Grid at a single point.
2. All levels are in metres and relate to the mean of the nearest five Ordnance Survey active GPS stations (OSGM15).
3. This survey was measured for a scale of 1:500, any subsequent enlargements should be verified on site.

Revisions

A. Survey extended October 2020.

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Surveyed	J Faron	Date	Sep 2019
Drawn	J Faron	Checked	P Szaryj

Drawing Title: Brislington Meadows, Broomhill Road, Brislington, Bristol

Client: Campbell Reith Hill LLP, Raven House, 29 Linkfield Lane, Redhill, Surrey

Drawing No.	Rev A	Scale A1 @
194/10967/1A		1:500

STANDARD REFERENCES

ABBREVIATIONS

bb	belisha beacon	ko	kerb outlet
bl	bollard	lp	lamp post
brw	brick ret. wall	mh	manhole
bs	bus stop	mk	marker post
bt	telecoms cover	np	nameplate (road)
bw	brick wall	obf	open boarded fence
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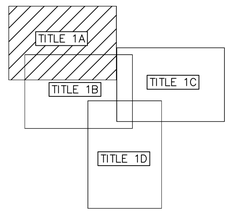
SHEET LAYOUT



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362600.00 E

171400.00 N

171300.00 N

171200.00 N

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Fox House

Allison Road

Broomhill Junior sch

Horse Chestnut ht 8.0

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Stn X2 362381.554 E 171257.872 N 44.408m

Stn X3 362394.360 E 171268.150 N 46.108m

Stn JR3 362626.422 E 171311.500 N 66.385m

Stn JR2 362644.894 E 171287.814 N 66.819m

Stn JR1 362617.530 E 171258.961 N 66.622m

Stn JR4 362374.081 E 171220.886 N 40.630m

Stn JR5 362365.513 E 171180.751 N 37.804m

171200.00 N

171100.00 N

171000.00 N

362400.00 E

362500.00 E

362600.00 E

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APPROX.

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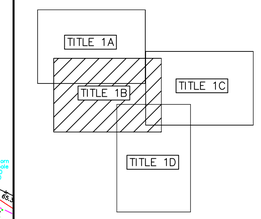

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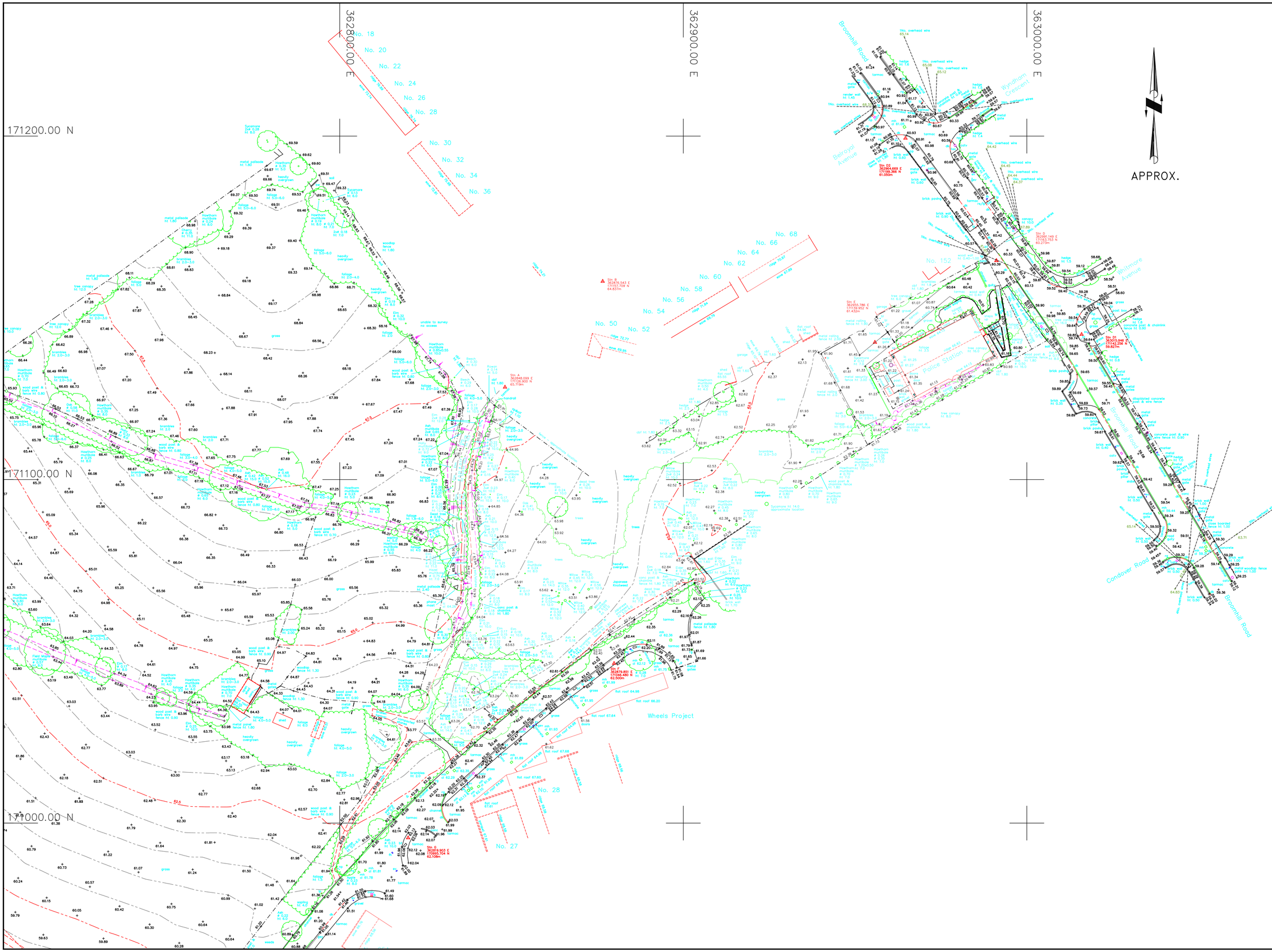

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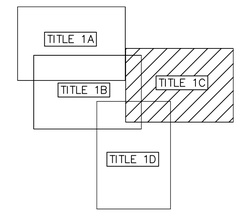

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Redhill Surrey

Drawing No.	Rev A	Scale A1 @
194/10967/1C		1:500

171000.00 N

170900.00 N

170800.00 N

170700.00 N

362600.00 E

362700.00 E

362800.00 E

APPROX.

Borville Road

Dixon Road

Regency House

No. 25A

No. 25

No. 24

No. 23

No. 22

No. 21

No. 20

Unit 9

Stn G
362819.903 E
170995.704 N
62.108m

Stn H
362771.322 E
170935.615 N
59.489m

Stn K
362684.974 E
170803.007 N
56.392m

Stn L
362661.677 E
170768.219 N
54.976m

Stn M
362619.886 E
170705.920 N
51.568m

Stn N
362594.121 E
170664.328 N
48.258m

Stn
362711.518 E
170844.416 N
56.651m

SHEET LAYOUT

TITLE 1A

TITLE 1B

TITLE 1C

TITLE 1D

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catv	cable TV cover	p	post
cbf	closeboarded fence	pb	post box
cbrw	conc block ret. wall	ret.	retaining wall
cbw	conc block wall	re	rodding eye
cl	cover level	rg	road gully
clf	chainlink fence	rs	road sign
conc	concrete	rwp	rainwater pipe
cp	concrete post	sp	signpost
cws	combined sewer	srw	stone ret. wall
dk	drop kerb	sv	stop valve
ep	electricity pole	svp	soil vent pipe
ESS	Elec. Sub-Station	sw	stone wall
fb	flower bed	s/w	stay wire
fh	fire hydrant	sws	storm water sewer
fl	floor level	tcb	telephone callbox
fws	foul water sewer	tl	traffic light
g	gully	tp	telegraph pole
gsv	gas valve	utr	unable to raise
ic	inspection cover	vp	vent pipe
	invert level	w'lap	woodlap fence
irf	iron railing fence	wm	water meter
jb	junction box	wp	wood post

Notes

1. This survey has been computed and drawn "true to scale" and relates to the OSTN15 GPS National Grid at a single point.
2. All levels are in metres and relate to the mean of the nearest five Ordnance Survey active GPS stations (OSGM15).
3. This survey was measured for a scale of 1:500, any subsequent enlargements should be verified on site.

Revisions

A. Survey extended October 2020.

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Drawing No.	Rev	Scale
194/10967/1D	A	1:500 @ A1

Appendix C: Exploratory Hole Logs