Proposed Residential Development at
36, 38 & 40 Rickmansworth Road
Northwood
London

Surface Water and SUDS Statement

June 2016

EAS

Document History

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Contents

1 Introduction

1.1 EAS has been commissioned by Howarth Homes to prepare a Surface Water Drainage and SUDS Statement to support a proposed residential development located at 36, 38 & 40 Rickmansworth Road, Hillingdon HA6 2QG. The site covers 0.36 hectares and there are three existing houses on the site with gardens. The location plan is included in **Appendix A**.

1.2 The proposed scheme will be 25 residential units comprising 1, 2 and 3 bedroom dwellings in a single apartment block, with undercroft/semi-basement car parking, several external parking spaces and a communal garden. The proposed development plan is included in **Appendix B**.

1.3 The contents of this SUDS Statement are based on the advice set out in The National Planning Policy Framework (NPPF) and the Technical Guidance to the NPPF, published March 2012, and the Planning Practice Guidance (PPG), published March 2014.

1.4 This report will assess the surface water flood risk to the site and include a suitable surface water drainage strategy to ensure that runoff will not increase flood risk to the site for the lifetime of the development.

1.5 The surface water and SUDS statement includes the following:

- Surface Water drainage calculations for all rainfall events up to and including the 1 in 100 year plus climate change.
- Existing and proposed discharge rates and volumes, including an assessment for providing pre-development greenfield runoff rates.
- Detailed drainage layout plan for the entire site, including the location of the point of discharge and existing overland flow routes.
- Assessment of existing surface water flood risk within the site.

1.6 The information set out in this report covers the above points and demonstrates that the proposed development will not increase risk elsewhere and where possible reduces flood risk overall.

2 Policy Guidance

National Policy

2.1 The contents of this FRA are based on the advice set out in The National Planning Policy Framework (NPPF) published March 2012 and the Planning Practice Guidance (PPG), published March 2014.

2.2 The Planning Practice Guidance NPPF Table 1 (Paragraph 065) defines each Flood Zone along with appropriate land use and FRA requirements. The flood risk zones are defined as follows:

- Flood Zone 1 – This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river flooding (<0.1%).
- Flood Zone 2 – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding.
- Flood Zone 3a – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), and for tidal flooding at least a 0.5% annual probability of flooding from tidal sources.
- Flood Zone 3b – This zone comprises land where water has to flow or be stored in times of flood.

2.3 Online EA mapping shows the site to be located entirely in Flood Zone 1, at low risk of flooding from fluvial sources. This is considered to be an area with a less than 1 in 1000 chance of flooding each year. As the site is located in Flood Zone 1 and is less than 1 hectare, a full Flood Risk Assessment (FRA) is not required.

2.4 For sites located within Flood Zone 1, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems.

2.5 This surface water drainage and SUDS statement explores the appropriate application of sustainable drainage systems as required for sites within Flood Zone 1.

Local Policy

London Borough of Hillingdon Local Plan: Part 1 Strategic Policies (November 2012)

2.6 The Strategic Policies document adopted in November 2012 sets out the policies for the London Borough of Hillingdon and the strategy for the borough up to the year 2026. This document will guide future development in terms of housing, jobs, infrastructure, health, leisure, community, heritage and environment.

2.7 Policy EM6: Flood Risk Management describes how the Council will approach flood risk throughout the

borough. The policy states that:

"The Council will require all developments across the borough to use sustainable urban drainage systems (SUDS) unless demonstrated it is not viable. The Council will encourage SUDS to be linked to water efficiency methods. The Council may require developer contributions to guarantee the long term maintenance and performance of SUDS is to an appropriate standard."

2.8 Policy EM6 has been considered when preparing the drainage strategy set out in this report, and the report is consistent with the aims for the borough.

London Borough of Hillingdon Preliminary Flood Risk Assessment (2011)

2.9 The London Borough of Hillingdon Preliminary Flood Risk Assessment (PFRA) was published in 2011. This is a high level screening exercise to identify areas of significant flood risk, based on past information within the borough. The PFRA looks not only at the fluvial risk but also surface water, groundwater and sewer flood risk.

2.10 The PFRA and associated mapping was consulted during the preparation of this report. The PFRA and mapping highlights an overland flowpath and surface water flood risk adjacent to the eastern boundary of the development site. This flowpath is shown on the PFRA mapping as an 'ordinary watercourse', although no open watercourse can be identified on aerial photographs. It is therefore assumed the flowpath is a drainage ditch rather than a permanent watercourse.

2.11 PFRA Figure A-1.1 does not show any historic reported surface water flooding incidents in the vicinity of the site.

2.12 PFRA Figure A-4.1 shows recorded sewer flooding incidents in the borough. The 'HA6_2' postcode area experienced 11 to 20 sewer flooding incidents in the ten years prior to June 2010. This data was taken from the Thames Water DG5 register, and suggests a moderate level of sewer flooding. It should be noted that immediately east of this postcode area is the 'HA6_1' postcode area which has experienced 21 to 50 sewer flooding incidents; this is the greatest number of sewer flooding incidents in the borough.

London Borough of Hillingdon Surface Water Management Plan (2013)

2.13 The London Borough of Hillingdon Surface Water Management Plan was published in 2013 as part of the Drain London Project. This document outlines the preferred surface water management strategy in Hillingdon and considers flooding from sewers, drains, groundwater and runoff from land.

2.14 The site was not identified as being in a Critical Drainage Area (CDA) within the SWMP, although there is a CDA approximately 600m north of the site.

2.15 The SWMP Figure 18.1 shows the 1 in 100 year plus climate change surface water hazard on the site to

be 'moderate'.

2.16 Groundwater flooding is not highlighted as being a significant issue in the area and the Potential Elevated Groundwater mapping (Figure A-5.1) does not show the site to be in or near to a groundwater risk area.

London Borough of Hillingdon Strategic Flood Risk Assessment (SFRA) (2008)

2.17 The London Borough of Hillingdon Strategic Flood Risk Assessment (SFRA) was published in 2008 to guide planning in the borough. Although this has now been superseded by the PFRA and the SWMP, this document was still consulted for information. SFRA Figure 4 'Other Sources of Flood Risk' does not identify any sources of flooding in the vicinity of the site.

3 Site Description

3.1 A location plan is included in **Appendix A.** The site is located at 36, 38 & 40 Rickmansworth Road, Hillingdon HA6 2QG. The site covers 0.36 hectares and there are three existing houses on the site with driveways and gardens. The location plan is included in **Appendix A**.

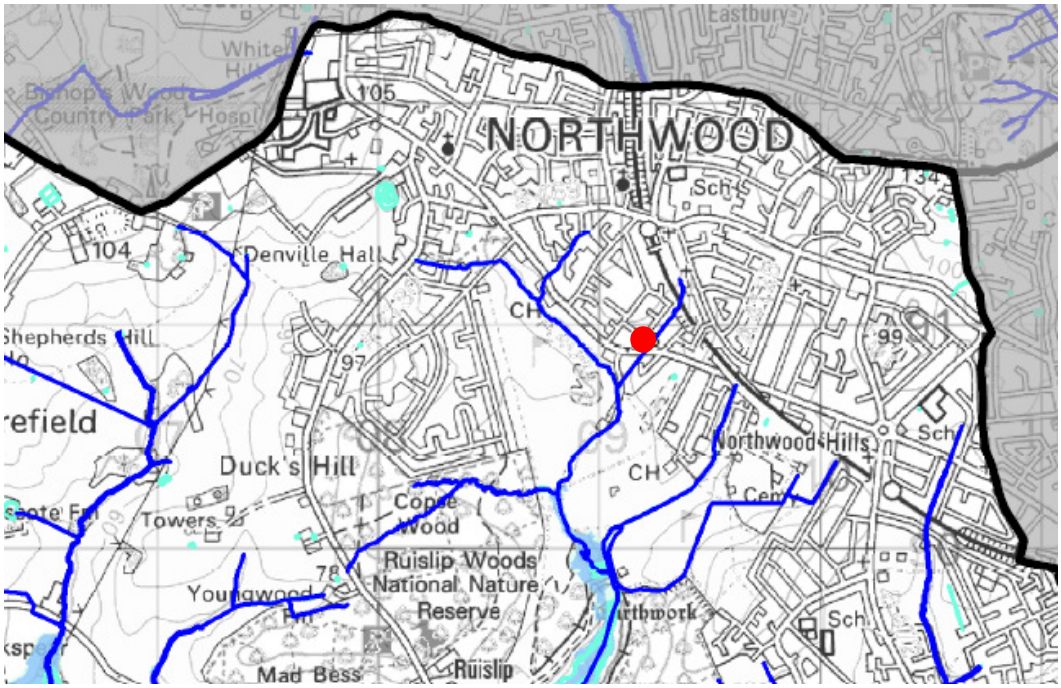
3.2 The site is located in the residential area of Northwood, Hillingdon, immediately north of Rickmansworth Road. It is surrounded on all sides by residential dwellings. The railway line passes the site approximately 200m to the north. Northwood Golf Course is around 190m to the south west

3.3 The proposed development is a single apartment block with 25 residential units comprising 1, 2 and 3 bedroom dwellings. There will be undercroft/semi-basement parking on the ground floor and several external car parking spaces. There will also be a new access road and communal garden. The development plans are included at **Appendix B.**

Local Watercourses

3.4 The River Pinn, which is a 'Main River' on the EA floodmap, passes the site around 1.5 km to the south east.

3.5 There are numerous minor watercourses and streams in the local area, particularly crossing the golf course to the south west of the site. The minor watercourses appear to drain to the Ruislip Lido located around 1km south of the site, and ultimately the River Pinn. These minor watercourses are classed as 'ordinary watercourses' by the EA and are better shown on the surface water mapping than the fluvial mapping. The minor watercourses are also shown on the PFRA and SWMP maps and are included in **Appendix C**. An extract of SWMP Figure 6.1 is shown in Figure 1 below, and highlights the ordinary watercourses in the vicinity of the site. This shows a minor watercourse immediately east of the site, and this will be discussed further in Section 4.



Site Location

Figure 1: Extract of SWMP Figure 6.1 showing ordinary watercourses in the vicinity of the site (source: https://www.hillingdon.gov.uk/article/26460/Surface-Water-Management-Plan-maps)

Site Levels

3.6 A topographic survey of the site is included in **Appendix D**. This indicates a steep hill to the north of the site with levels reaching 64.00m AOD, falling to around 58.50m AOD in Rickmansworth Road to the south. The levels also fall from west to east, with levels in the middle of the site (around the existing houses) being around 62.00m AOD to the west and falling to approximately 59.00m AOD to the east.

Geology

3.7 With reference to the British Geological Survey online mapping, the site is located within an area with a bedrock of Lambeth Group – Clay, Silt and Sand. No superficial deposits were recorded at the site.

3.8 The bedrock of clay, silt and sand suggests that infiltration methods of draining the site are likely to be unviable due to the low permeability of the bedrock. It is therefore assumed for the purpose of this report that an attenuation and discharge method will be adopted at the site.

Sewers

3.9 The Thames Water sewer records included at **Appendix E** show there to be both surface water and foul

sewers to the north, east and south of the site. A 225mm surface water sewer flows west to east along the northern site boundary and connects to a 600mm sewer to the east. This seems to be a culverted minor watercourse immediately east of the site which appears to have been re-designated as a surface water sewer on the Thames Water mapping. This 600mm diameter sewer then passes beneath the neighbouring dwelling to the east and connects to the 450mm diameter surface water sewer in Rickmansworth Road. The sewer then falls to the south along Hills Lane.

3.10 It should be noted that the 600mm surface water sewer/culverted minor watercourse crosses the far south eastern corner of the site.

3.11 There is a 225mm diameter sewer passing east to west along the northern boundary, which then flows south beneath the neighbouring dwelling to the east of the site, before connecting into the foul sewer in Rickmansworth Road.

Existing Site Drainage

3.12 There are three residential dwellings on the existing site. With reference to the sewer records (**Appendix E**), it is likely that these houses drain surface water unrestricted to the adopted Thames Water surface water sewer in Rickmansworth Road.

4 Surface Water Flood Risk

4.1 As the proposed development site is less than 1 hectare in area and located wholly in Flood Zone 1, a full FRA is not required. This surface water and SUDS statement instead assesses the risk to the site from surface water sources (including sewers) and identifies existing overland flowpaths and exceedance areas.

Historic Surface Water Incidents

4.2 The 2011 PFRA and SWMP prepared by Hertfordshire County Council do not specifically highlight any surface water flood risk areas near to the site. Figure A-1.1 of the PFRA shows historic surface water flood incidents, and it is noted that no incidents have been reported in the vicinity of the site.

4.3 Northwood Station, around 500m to the north, is identified on Figure 1.1 of the SWMP as a critical drainage area. This is due to the station being located at a topographical low point to which the local catchment drains. The site, to the south of the station, is not identified as being in a critical drainage area.

4.4 The SWMP notes that the majority of surface water flooding within the Borough is as a result of low areas and obstructions to natural overland flowpaths, along with runoff within historical river valleys. No historical records of flooding were available from ordinary watercourses from the London Borough of Hillingdon for the preparation of the SWMP, however this is not to say such incidents have not occurred.

Historic and Existing Sewer Flood Risk

4.5 Figure 9.1 of the SWMP displays the recorded sewer flooding incidents in the borough, taken from the Thames Water DG5 register in 2010. The site is located in postcode area 'HA6_2', which is shown to have had 11 to 20 reported sewer flooding incidents. This is a moderate number of reported incidents and likely linked to the more urban nature of this postcode in relation to the predominantly rural postcode areas to the north and west.

4.6 The Thames Water sewer records included at **Appendix E** show there to be a both a surface water and foul sewer located to the north, east and south of the site. The sewers to the east and south are at the lowest topographical levels so it is unlikely that these would pose a significant flood risk to the site if there was a blockage or the sewer surcharged. However, the sewers passing the northern boundary are higher than the site, with cover levels of 60.50m AOD to 63.20m AOD. Should a manhole surcharge in this area, it is possible that flows could pass to the lower land to the south and towards the site. The mitigation measures discussed in Section 5 will demonstrate how the site will be protected from sewer flooding.

Existing Surface Water Flood Risk

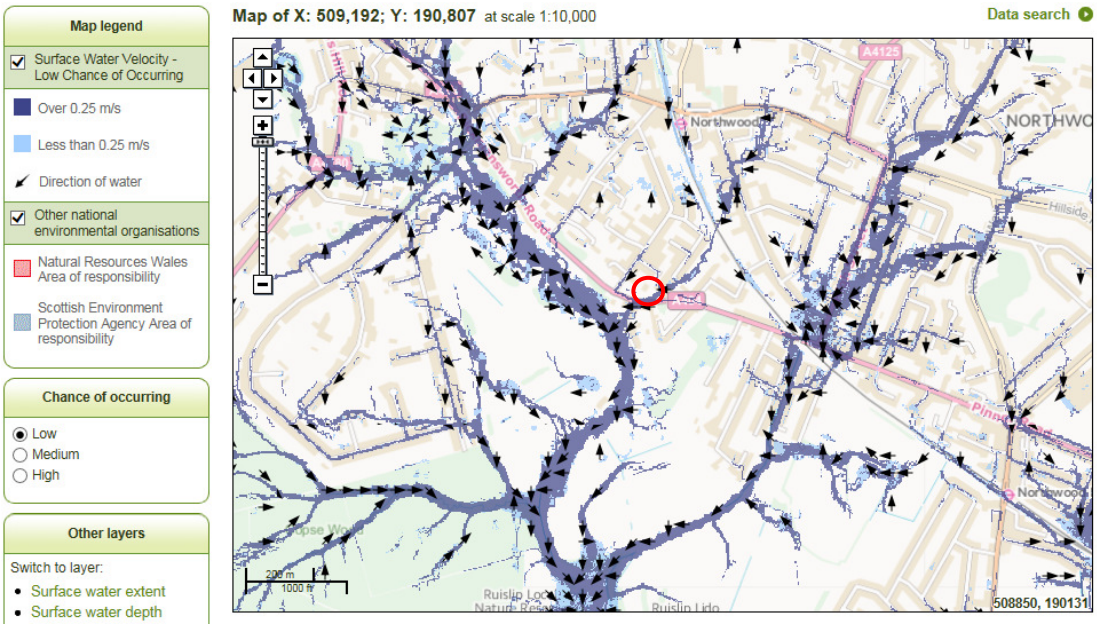
4.7 With reference to the online EA surface water flood risk map (**Appendix F**), the eastern edge of the site is located in a 'High' risk area. A 'high' risk area has a greater than 1 in 30 chance of flooding each year. The EA online mapping resolution is not very clear and it is difficult to establish exactly where the surface water extends into the site. However, it is likely that this overland flowpath is the ordinary watercourse which is indicated on the SWMP and PFRA mapping and passes the eastern site boundary. As the EA fluvial mapping does not pick up ordinary watercourses which are small streams and brooks, these are often shown on the surface water mapping.

4.8 As previously mentioned, the Thames Water sewer mapping (**Appendix E**) indicates a headwall of a minor watercourse to the north east of the site, which then becomes a surface water sewer. It is therefore assumed that the surface water risk shown on EA mapping is from the minor watercourse which is in fact culverted. As this is a historic river valley, there is still a low lying area along the eastern site boundary which channels surface water runoff past the site and towards Rickmansworth Road. Therefore, measures must be included in the proposed development to ensure this overland flowpath remains and not obstructed which could result in a flood risk to others.

4.9 The EA online mapping shows the likely surface water flood extents from a 'high' (i.e. frequent) chance of occurring to a 'low' (i.e. infrequent) chance of occurring. The 'low' frequency map shows the worst case scenario, with between 300mm and 900mm flood depth experienced onsite. The 'high' frequency map represents a normal storm event and does not show surface water flood depth to extend onto the site. In reality, it is highly unlikely that 900mm of surface water would reach the site. Given the topographic survey shows levels to fall to the south towards Rickmansworth Road, it is likely that water would continue to flow towards the road and would not flow towards the higher land to the west.

Overland Flowpaths

4.10 Overland flow paths are indicated on the EA surface water flood map in **Appendix F,** and an extract of the 'low' probability map is shown in Figure 2. This shows the surface water to be flowing at over 0.25 m/s and it appears to be mainly restricted to the historic river valley rather than being directed across the development site to the west. The overland flowpath would then continue across Rickmansworth Road and into Northwood Golf Course where it would eventually flow into the Ruislip Lido.



Site Location

Figure 2: Likely surface water flowpaths in the vicinity of the site (source: EA website www.environment-agency.gov.uk) *Contains Environment Agency information © Environment Agency and database right*

4.11 While the EA surface water risk maps are a good overview of the risk on the area, the poor resolution means it is difficult to establish how much of the site lies within the flood extent.

4.12 For a clearer understanding of the likely flow routes, it is necessary to analyse the topographic levels in the vicinity of the site. The topographic survey is contained in **Appendix D,** and it shows the site to fall to the south and east. Comparison between the levels in the historic river valley along the eastern boundary are around 59.00m AOD, falling to 58.90m AOD and lower in Rickmansworth Road. The development site has a typical level of 59.50m AOD, some 0.5m higher than the valley. This suggests that much of the surface water would remain in the channel and continue along the flowpath to the south. An indicative drawing depicting the surface water flood risk areas and the proposed development is included in **Appendix F.** It is clear from this drawing that the main areas at risk of surface water flooding are the eastern side of the proposed development and the land to the south.

4.13 While there is clearly a surface water risk to the site, the mitigation measures discussed in the following section will demonstrate how the proposed development will remain safe and dry for the development lifetime.

5 Mitigation Measures

5.1 The eastern and southern parts of the existing site are currently at risk of surface water flooding as the result of low lying land and a historic river valley passing along the site boundary (**Appendix F**). The proposed development will therefore include the following mitigation measures to ensure the dwellings will not be at risk of flooding.

5.2 Topographic levels on the neighbouring land to the east are somewhat higher than the site so it is unlikely that surface water will be directed towards the houses to the east.

5.3 Levels along the eastern edge of the site will remain unchanged, to prevent surface water being directed offsite and to ensure the overland flowpaths remain. The overland flowpath will therefore continue to enter the site from the north east corner and flow to the south and south west, towards Rickmansworth Road. It is important that the new access road/driveway maintains these existing levels, going from 59.30m AOD in the north east corner down to 59.20m AOD at Rickmansworth Road.

5.4 Proposed finished floor levels on the ground floor are 59.50m AOD. This is 0.4m higher than the areas which are shown to be at high risk of surface water flooding. Given that the overland flowpath along the access road/driveway to the east is being maintained, it is highly unlikely that surface water flows would be directed towards the building and cause an internal flood risk.

5.5 It is important to highlight here that the eastern part of the undercroft/semi-basement car park may experience some surface water flooding in periods of heavy rainfall, as the ground level here is set at 59.35m AOD. However, this is unlikely to pose a significant risk to the car park or to people, as the main route of the surface water will be to the south and not into the car park. It is recommended that levels in the semi-basement car park are locally adjusted so there is a slight fall from west to east. This will allow any water entering the car park to flow back out again. Sump pumps should be used in low points to remove water from these areas.

5.6 Although these mitigation measures focus specifically on surface water flood risk, the previous section noted how a surcharging sewer from the north of the site could potentially direct flows onto the site. While a surcharging sewer is a residual risk (i.e. it cannot be predicted or completely prevented), the landscaping of the site to ensure the ground levels to the east remain the same will also direct flows from a surcharging sewer along the eastern boundary as would be the case in the existing situation. In addition, the roof of the undercroft car park will be constructed as a green roof, which will be connected to the onsite drainage system. Therefore, any sewer flows from the north would enter the green roof and be drained away before it became a flood hazard.

5.7 The mitigation measures are shown on the drawing in **Appendix G**.

5.8 The proposed development would implement a new drainage system which includes SUDS measures,

to reduce runoff to greenfield rates. This has been discussed further in Section 6. Assuming this drainage system is regularly inspected and maintained, the proposed development will not increase surface water flood risk within the site boundary.

6 Sustainable Drainage Strategy

Relevant SUDS Policy

6.1 The NPPF states within Flood Zone 1, *"developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques (SUDS)".*

6.2 SUDS mimic the natural drainage system and provide a method of surface water drainage which can decrease the quantity of water discharged, and hence reduce the risk of flooding. In addition to reducing flood risk, these features can improve water quality and provide biodiversity and amenity benefits.

6.3 The SUDS management train incorporates a hierarchy of techniques and considers all three SUDS criteria of flood reduction, pollution reduction, and landscape and wildlife benefit. In decreasing order of preference, the preferred means of disposal of surface water runoff is:

- Discharge to ground.
- Discharge to a surface water body.
- Discharge to a surface water sewer.
- Discharge to a combined sewer.

6.4 The philosophy of SUDS is to replicate as closely as possible the natural drainage from a site pre-development and to treat runoff to remove pollutants, resulting in a reduced impact on the receiving watercourses. The benefits of this approach are as follows:

- Reducing runoff rates, thus reducing the flood risk downstream.
- Reducing pollutant concentrations, thus protecting the quality of the receiving water body.
- Groundwater recharge.
- Contributing to the enhanced amenity and aesthetic value of development areas.
- Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

Site-Specific SUDS

6.5 The various SUDS methods have been considered in relation to site-specific constraints. Table 1 outlines the constraints and opportunities to each of the SUDS devices in accordance with the hierarchical approach outlined in The SUDS Manual CIRIA C753. It also indicates what could and could not be incorporated within the development, based upon site-specific criteria.

Device	Description	Constraints / Comments	Appropriate
Living roofs (source control)	Provide soft landscaping at roof level which reduces surface water runoff.	Green roofs will be provided above the undercroft/semi basement car park.	Yes
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	Low permeability of geology unlikely to make infiltration viable.	No
Pervious surfaces (source control)	Storm water is allowed to infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers.	Lined permeable paving is proposed to offer a water quality benefit.	No
Rainwater harvesting (source control)	Reduces the annual average rate of runoff from the Site by reusing water for non-potable uses e.g. toilet flushing, recycling processes.	Unlikely to be viable due to development constraints.	No
Swales (permeable conveyance)	Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting).	May be possible to provide conveyance swales through landscaped areas to maintain existing overland flowpaths.	Possibly
Filter drains & perforated pipes (permeable conveyance)	Trenches filled with granular materials (which are designed to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration.	Low permeability of geology unlikely to make infiltration viable.	No
Infiltration basins (end of pipe treatment)	Depressions in the surface designed to store runoff and allow infiltration.	Low permeability of geology unlikely to make infiltration viable.	No
Wet ponds & constructed wetlands (end of pipe treatment)	Provide water quality treatment & temporary storage above the permanent water level.	Spatial limitations within site boundary and other SUDS preferred.	No
Attenuation Underground (end of pipe treatment)	Oversized pipes or geo-cellular tanks designed to store water below ground level.	Cellular storage is preferred option due to surface water risk and geological constraints.	Yes

Table 1: Site-Specific Sustainable Drainage Techniques

6.6 Any SUDS methods which require infiltration will not be viable at the site due to the likely low permeability of the clay, silt and sand geology in the area. It is therefore recommended that an attenuation and discharge method is used to drain the proposed development.

6.7 Lined permeable paving would be located in the medium to high surface water flood risk area (and a known overland flowpath), and as such was not recommended in the previous SUDS scheme submitted with the application. However consultation comments to the application from the Hillingdon Council SUDS officer requested that permeable paving form part of the SUDS strategy, as it would have the joint benefit of storing some of the surface water runoff within the site to be released at a controlled rate, and

would provide the additional benefit of water quality control.

6.8 Unlike other attenuation systems, the pollutants carried within the surface water run-off are filtered out as they pass through the course grade aggregate and sub-base. Once trapped they are then broken down over time; figures from the Construction Industry Research and Information Association have shown that 60-95% of suspended solids and 70-90% of hydrocarbons are removed by permeable pavements; as such no further filtration of pollutants will be required.

6.9 As such it is proposed that lined permeable paving forms part of the SUDS layout for all hardstandings. However as the available storage within the permeable paving will be impacted upon by the overland flow route under extreme rainfall conditions, it is recommended that the required attenuation for the whole site is provided in a cellular storage system as per the previous SUDS proposal.

6.10 Green roofs are also recommended above the undercroft/semi-basement car park to provide additional SUDS features. However, these will have to be drained to the cellular storage system too as infiltration is not viable above a car park.

6.11 It will be necessary to discharge the runoff to the existing Thames Water surface water sewer in Rickmansworth Road to the south. Thames Water consent will be required to connect to the sewer.

7 Proposed Drainage Strategy

Pre-development Runoff Rate

7.1 The existing site comprises three houses with hardstandings and driveways on a 0.36 hectare site. The existing houses, outbuildings, hardstandings and driveways cover approximately 1531m^2.

7.1 Using the Modified Rational Method detailed in Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed., SPON, the surface water runoff for the existing site has been calculated as follows:-

Q = CiA where Q = maximum flow rate (l/s)
C= PIMP/PR
i= rainfall intensity (mm/hr),
A=area (ha)

7.2 It should be noted that a fixed rainfall intensity of 50mm/hr is used in this case, which has been recommended by Butler & Davies (2006) to avoid using inappropriately high intensities for very low concentration times, i.e. small sites.

7.3 This assumes that none of the surface water is attenuated prior to discharge to the sewer. The total rate of runoff for the existing site is estimated to be **21.26 l/s**. The existing site runoff calculations are included in **Appendix H**.

Post-Development Runoff Rate

7.4 As shown on the drawing in **Appendix I**, in total, there is 1665m^2 of impermeable area in the proposed development, inclusive of the green roof.

7.5 Greenfield runoff rates calculations were carried out using the WinDes MicroDrainage software. The ICP SUDS Mean Annual Flood method was used. Greenfield runoff rates at the site for QBAR, 1 year, 30 year and 100 year events are summarised below per hectare, and for the total impermeable area of 0.1685 hectare:

- QBAR – 4.4 l/s/ha (0.73 l/s)
- 1 in 100 year – 14.0 l/s/ha (2.33 l/s)
- 1 in 30 year – 10.0 l/s/ha (1.67 l/s)
- 1 in 1 year – 3.7 l/s/ha (0.62 l/s)

7.6 The WinDes runoff rates are included at **Appendix H**.

7.7 The WinDes MicroDrainage software calculated the Greenfield runoff rate for the proposed impermeable area of 0.1665 hectares to be **2.3 l/s** for a 100 year storm, and it is proposed to limit the surface water runoff rate to between **0-2.3 l/s**.

7.8 The following SUDS methods will be implemented at the site to provide the required attenuation volume and restrict runoff to the above greenfield rates.

Roof, Driveway and Hardstandings

7.9 It was confirmed above that permeable paving now forms part of the SUDS layout for all hardstandings to provide. However as the available storage within the permeable paving will be impacted upon by the overland flow route under extreme rainfall conditions, it is recommended that the required attenuation for the whole site is provided in a cellular storage system as per the previous SUDS proposal.

7.10 It is therefore proposed that the all impermeable areas of the proposed development are drained via gravity to the cellular storage crate system. A 1 in 100 year (+40% climate change) storm was modelled and a simplified network was set up using WinDes Microdrainage, with the proposed inverts and cover levels included. This has established that the levels and falls across the site are sufficient to attenuate the runoff from all roof and hardstanding areas within oversized pipes and cellular storage. The cellular storage crate would cover an area of 97.2m^2 and be 0.7m deep, thereby providing 68.04m^3 attenuation volume. The storage crate will be located to the south west of the proposed apartment block.

7.11 It is proposed that runoff is discharged to the adopted surface water sewer through Thames Water manhole 1807. Runoff will be restricted to 2.3 l/s via a hydrobrake and a gravity connection will be suitable.

7.12 The simplified network details are included in **Appendix J** and the proposed drainage layout is shown in the drawing in **Appendix J**.

Green Roof

7.13 It is recommended that the roof of the undercroft/semi-basement car park is drained through a green roof. With reference to the drawing in **Appendix I**, the green roof would cover 441m^2 of the car park. This will reduce the volume and rate of runoff before directing it to the new drainage network and ultimately the surface water sewer.

7.14 Details on the design and benefits of green roofs are included in the CIRIA SUDS Manual (C753). However, some key points have been summarised here.

7.15 Green roofs should be designed for a minimum roof pitch of 1 in 80, and maximum of 1 in 3. It is important that the structural roof strength can provide for the additional load of saturated green roof elements. The design should include multiple outlets to reduce risks from blockages, and consist of lightweight soil and appropriate vegetation.

7.16 Figure 3, taken from the CIRIA SUDS manual, shows the typical structure of a green roof and outlet pipe.

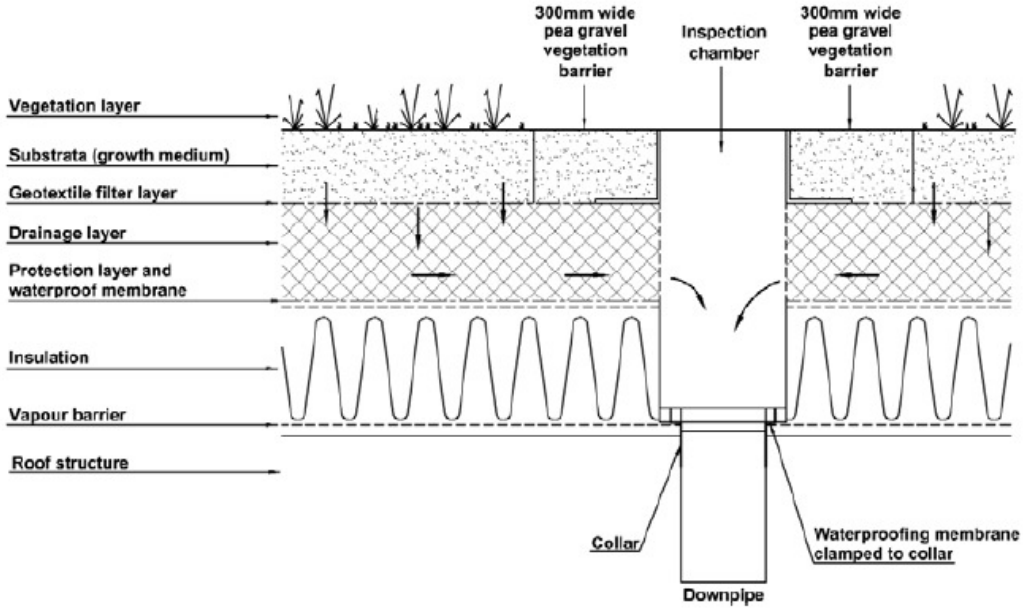


Figure 6.4 *Example detail of outlet from a green roof (adapted from Wilson et al, 2004)*

Figure 3: Typical structure of a green roof and outlet, from CIRIA SUDS Manual (C697)

7.17 There are three main types of green roofs:

7.18 **Extensive green roofs –** These cover the whole roof with low growing, low maintenance plants. These typically comprise a 25mm to 125mm thick growing medium on which a variety of hardy, drought tolerant low level plants grow, such as mosses, succulents, herbs or grasses. This type of roof is designed to be self-sustaining and only accessed for maintenance. These are also light weight and cost effective.

7.19 **Intensive green roofs** – These are landscaped environments with high amenity benefits. Can include planters or trees and are usually accessible. May also include water features and storage of rainwater for irrigation. These types of roofs generally impose much greater loads on the roof structure and require significant on-going maintenance.

7.20 **Simple intensive green roofs –** These are vegetated with lawns or ground covering plants. This vegetation required regular maintenance such as irrigation, feedings and cutting. Demands on the buildings structure are moderate and the roof system will be less expensive. While these are occasionally accessible, they are more often designed to be overlooked.

7.21 The green roofs at the site will be designed to be overlooked and possibly accessed on occasion. Therefore it is envisaged that simple intensive green roofs will be used at in the proposed development.

7.22 Advantages include:

- Ability to mimic the state of the pre-development building footprint;
- Good removal capability of atmospheric urban pollutants;
- Can be applied in high density developments;
- Ecological, aesthetic and amenity benefits;
- No additional land take;
- Insulated buildings against temperature extremes.

7.23 Disadvantages include:

- Cost (when comparing to conventional roofs);
- Not appropriate for steeply sloping roofs;
- Limitations by roof structure (particularly when retrofitting);
- Maintenance of roof vegetation;
- Any damage to waterproof membrane is likely to be more critical as water is encourange to remain on the roof.

7.24 Green roofs are noted to have a medium influence on peak flow and volume reduction. However, this form of SUDS has good performance in water quality treatment, amenity potential and ecology potential.

7.25 It is important to regularly inspect and maintain the green roof to ensure its continued effectiveness. Some key maintenance requirements are:

- Irrigation during establishment of vegetation;
- Inspection for bare patches and replacement of plants;
- Litter removal (depending on setting and use).

Maintenance of Development Drainage System

7.26 It is proposed that the maintenance of the surface water drainage systems will be the responsibility of the site owner/manager and will not be offered for adoption.

7.27 A regular maintenance schedule must be prepared for the green roofs and permeable paving to ensure they area carefully managed throughout the year. A number of tasks are required at different points in the year, including but not limited to those set out in **Tables 3 and 4.**

7.28 In addition, the proposed surface water sewers and oil interceptors should be regularly inspected and maintained to ensure they are effective throughout the lifetime of the development and do not become blocked or damaged over time.

Maintenance Schedule	**Required Action**	**Frequency**
Regular maintenance	• Remove debris and litter	• Six monthly/annually as

	• During establishment (i.e. year one), replace dead plants as required • Post establishment, replace dead plants as required. • Remove fallen leaves and debris from deciduous plant foliage • Remove weeds and nuisance plants • Mow grass and remove clippings	required • Monthly (but usually responsibility of manufacturer) • Annually (autumn) • Six monthly/as required • Six monthly/as required • Six monthly/as required.
Remedial actions	• If erosion channels are evident, stabilise them with additional soil substrate similar to original material. Identify and control erosion. • If drain inlet has settled, cracked or moved, investigate and repair as appropriate.	• As required • As required
Monitoring	• Inspect all components including soil substrate, vegetation, drains, irrigation systems, membranes and roof structure for proper operation, integrity of waterproofing and structural stability. • Inspect soil substrate for evidence of erosion • Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain systems • Inspect underside of roof for evidence of leakage	• Annually/after severe storms • Annually/after severe storms • Annually/after severe storms • Annually/after severe storms

Table 3: Maintenance tasks for green roofs (Source: CIRIA C753, The SUDS Manual)

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Brushing and vacuuming.	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas. Removal of weeds.	As required. As required.
Remedial actions	Remediate any landscaping which, through vegetation maintenance of soil slip, has been raised to within 50mm of the level of the paving. Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance of a hazard to the user. Rehabilitation of surface and upper sub-surface.	As required As required As required (if infiltration performance is reduced as a result of significant clogging.)
Monitoring	Initial inspection Inspect for evidence of poor operation and/or weed growth. If required, take remedial action. Inspect silt accumulation rates and establish appropriate brushing frequencies. Monitor inspection chambers.	Monthly for 3 months after installation. 3 monthly, 48 hours after large storms. Annually. Annually.

Table 4: Maintenance tasks for lined permeable paving (The SUDS Manual C753, CIRIA)

8 Conclusions

8.1 This Surface Water Drainage and SUDS statement has been prepared to support a planning application for a residential development comprising 25 units of 1, 2, and 3 bedroom dwellings at 36, 38 & 40 Rickmansworth Road, Hillingdon HA6 2QG.

8.2 The site is less than 1 hectare so a full FRA is not required. However, with reference to the EA surface water flood risk mapping and the available information from the SWMP, PFRA and SFRA, it is clear that the edge of the site is in a high surface water flood risk area. As such, this document has assessed the risk of flooding to the proposed development and detailed how the drainage system and SUDS measures will prevent the development from increasing flood risk to others in the future.

8.3 A review of historic surface water flood risk in the local area and the most recent available data on the EA website indicated a potential overland flowpath along the eastern and southern boundaries and into Rickmansworth Road to the south. This is likely due to a historic river valley and low lying land in this area. Thames Water sewer mapping shows the headwall of a minor watercourse going into the surface water sewer. This suggests that the minor watercourse has been re-designated as a surface water sewer.

8.4 It is also possible that a surcharging sewer on the high land to the north of the site could potentially flow towards the site.

8.5 Mitigation measures would be to keep ground levels the same as existing levels along the eastern edge of the site where the proposed driveway is located. This will ensure the existing overland flowpath through the site is not obstructed and will remain onsite, thereby not increasing flood risk to the site or to others. The proposed finished floor levels will be set at 59.50m AOD which is around 0.4m higher than the areas which are shown to be at high risk of surface water flooding. Ground levels on the adjacent site to the east are significantly higher than the overland flowpath so it is unlikely the flows would be directed towards the existing properties to the east.

8.6 The undercroft/semi-basement car park may be at risk of surface water flooding in heavy rainfall but this is unlikely to pool to a significant depth which would pose a hazard to people.

8.7 In the unlikely event of flows from a surcharging sewer being directed towards the site, the roof of the car park will be a green roof and flows will be collected on the green roof and drained via the onsite drainage system. Assuming the levels along the eastern edge of the site remain, this would likely direct flows along the new driveway and towards Rickmansworth Road.

8.8 An attenuation and discharge drainage system is recommended for the site. Cellular storage crates will be used to attenuate the runoff. The cellular storage crate will be located to the south west of the proposed apartment block. It is proposed that the cellular storage crate will have a controlled outfall via

a hydrobrake to the existing Thames Water surface water sewer within Rickmansworth Road. The anticipated connection point is Thames Water manhole 1807. It is proposed that the 1 in 100 year (+40%CC) runoff rate is restricted to 2.3 l/s. A gravity connection should be suitable given the site levels and inverts, and a simplified network produced in Windes Microdrainage shows that the proposed drainage strategy is feasible.

8.9 Permeable paving has been included at the request of Hillingdon Council to provide some additional storage and water quality benefits.

8.10 A green roof will be included above the undercroft car park as an additional SUDS feature. The green roof will have biodiversity, aesthetic and amenity benefits, as well as reducing the peak flow and volume prior to runoff reaching the drainage system.

8.11 The maintenance of the proposed surface water drainage system and green roof will be the responsibility of the site manager/owner. Part of the maintenance strategy should be regular inspections of the drainage system to ensure the water is able to discharge effectively and not increase the surface water flood risk at the site.

8.12 We believe that the development proposals comply with the guidance provided by the NPPF and the proposed surface water drainage system demonstrates that there will not be a surface water or sewer flood risk to the proposed development.

9 Appendices

Appendix: A	Location Plan
Appendix: B	Proposed Development Plans
Appendix: C	Hillingdon PFRA and SWMP Mapping
Appendix: D	Topographical Survey
Appendix: E	Thames Water Sewer Records
Appendix: F	EA Surface Water Flood Maps
Appendix: G	Proposed Mitigation Measures
Appendix: H	WinDes Greenfield Runoff Rates and Existing Runoff Rates
Appendix: I	Proposed Impermeable Areas
Appendix: J	Proposed Drainage Strategy and Indicative Schematic

Appendix: A LOCATION PLAN

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:
FOR INFORMATION

Unit 108, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
Tel: 01920 871777

www.eastp.co.uk

CLIENT:
HOWARTH HOMES

ARCHITECT:
WILLCOX & MEILWES

PROJECT:
RICKMANSWORTH ROAD,
NORTHWOOD

TITLE:
LOCATION PLAN

SCALE @ A3:	DESIGN–DRAWN:	DATE:
NTS	SA	31.03.2016

PROJECT No:	DRAWING No:
1025	FIG01

Appendix: B PROPOSED DEVELOPMENT PLANS

13
12
8
9
75
10
37
11
34
27
85
107
37
35
SHARED SURFACE
Hatched area denotes extent of site within visibility splay where planting and boundary treatment to be kept below 600mm
Recreation Site
Rickmansworth Road

0m 5m 10m N

willcox and meilwes

REV	DATE	DESCRIPTION	DRAWN
01	Jun '15	Issued for comment	KR

CLIENT
Howarth Homes

PROJECT
Rickmansworth Road
Northwood

DRAWING TITLE
Proposed Site Plan

PROJECT No	DWG TYPE	DWG No	REV	SCALE
170	PL	100	01	1:200 @ A1

DATE	DRAWN	CHECKED	STATUS
29/10/2015	DB	BW	Provisional

Castle Hill House, 12 Castle Hill,
Windsor, Berkshire, SL4 1PD
t: +44 (0) 1753 839460 f: +44 (0) 1753 831113
www.WillcoxArchitecture.com

RIBA

PARTIAL BASEMENT

14

1

27

1
1 Bed WC

2
2 Bed

3
1 Bed

4
1Bed

5
1 Bed

37

SHARED SURFACE

30

34

85

107

Rickmansworth Road

0m 5m 10m

N

REV	DATE	DESCRIPTION	VN
01	Jun '16	Issued for comment	

CLIENT
Howarth Homes

PROJECT
Rickmansworth Road
Northwood

DRAWING TITLE
Proposed Ground Floor Plan

PROJECT No	DWG TYPE	DWG No	REV	SCALE
170	PL	200	01	1:200 @ A2
DATE	DRAWN	CHECKED	STATUS	
21/03/2016	KR	BW	Provisional	

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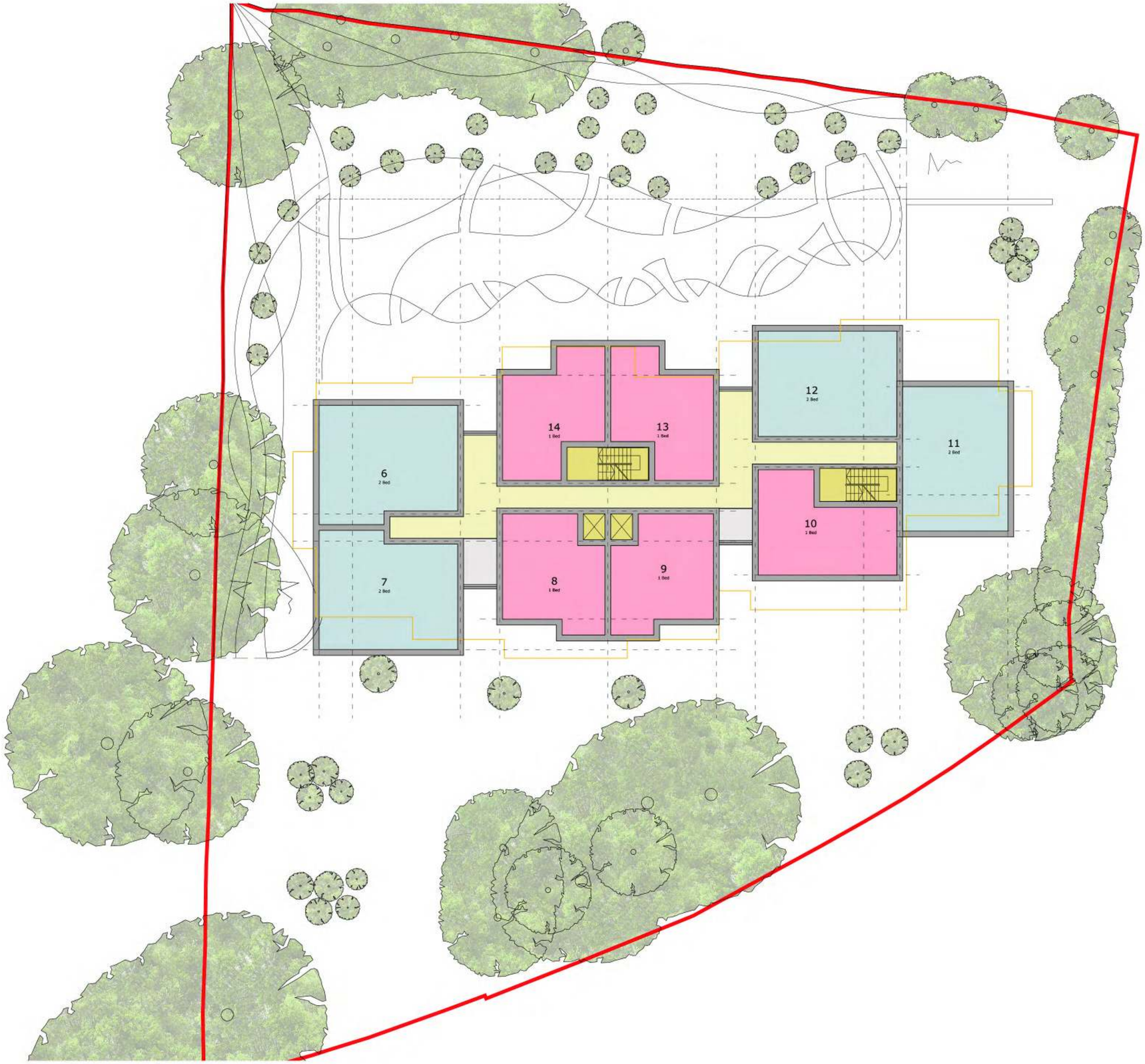

0m 5m 10m

N

REV	DATE	DESCRIPTION	DRAWN
00	Jun '16	Issued for comment	KR

CLIENT
Howarth Homes

PROJECT
Rickmansworth Road
Northwood

DRAWING TITLE
Proposed First Floor Plan

PROJECT No	DWG TYPE	DWG No	REV	SCALE
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DATE	DRAWN	CHECKED	STATUS
21/03/2016	KR	BW	Provisional

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REV	DATE	DESCRIPTION	DRAWN
00	Jun '16	Issued for planning	KR

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CLIENT
Howarth Homes

PROJECT
Rickmansworth Road
Northwood

DRAWING TITLE
Proposed Second Floor Plan

PROJECT No	DWG TYPE	DWG No	REV	SCALE
170	PL	202	01	1:200 @ A2

DATE	DRAWN	CHECKED	STATUS
21/03/2016	KR	BW	Provisional

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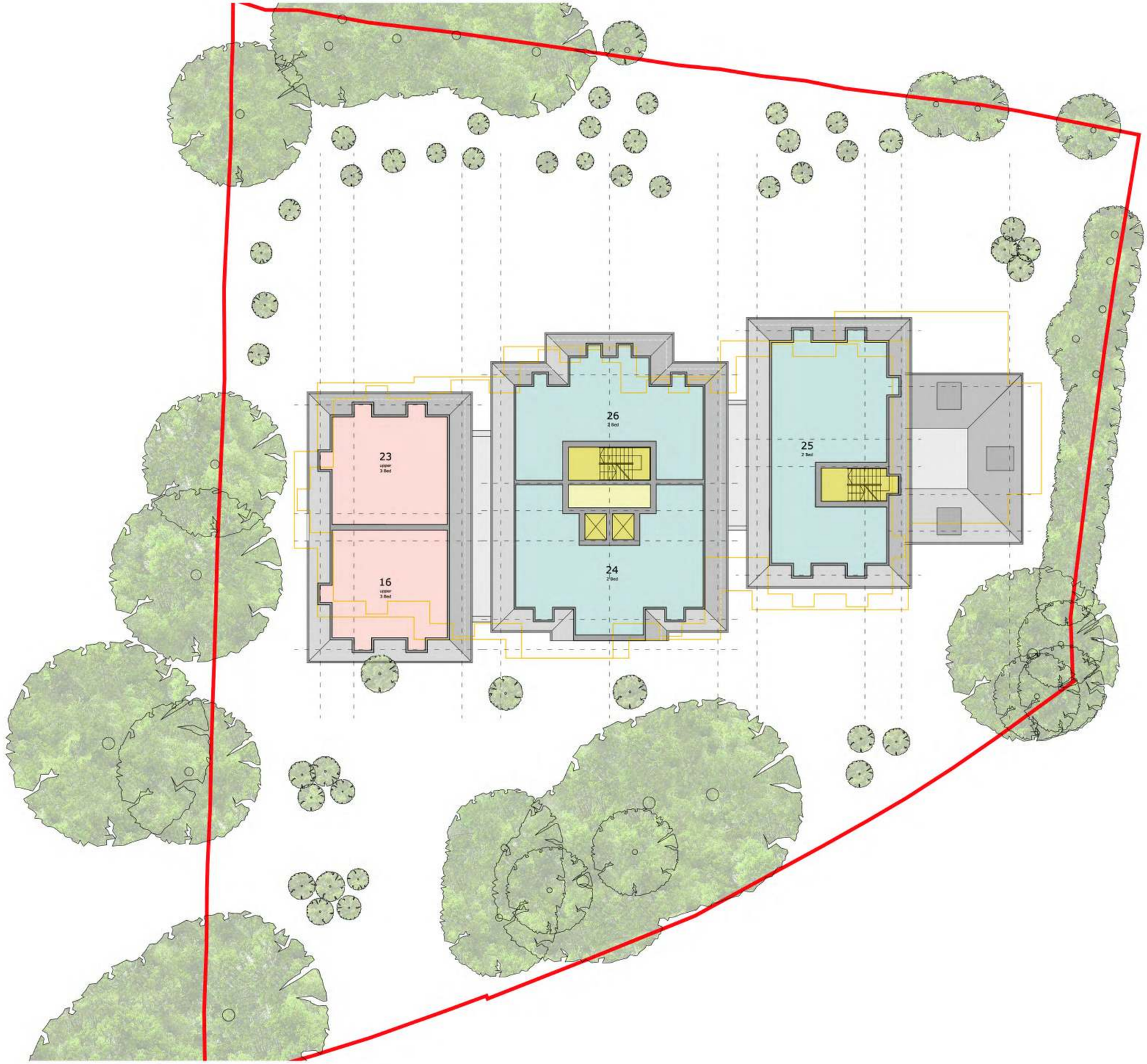

0m 5m 10m

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REV	DATE	DESCRIPTION	DRAWN
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-	-	-	-

CLIENT
Howarth Homes

PROJECT
Rickmansworth Road
Northwood

DRAWING TITLE
Proposed Third Floor Plan

PROJECT No	DWG TYPE	DWG No	REV	SCALE
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DATE	**DRAWN**	**CHECKED**	**STATUS**	
21/03/2016	KR	BW	Provisional	

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0m 5m 10m

N

REV	DATE	DESCRIPTION	DRAWN
01	Jun '16	Issued for comment	KR

CLIENT
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PROJECT
Rickmansworth Road
Northwood

DRAWING TITLE
Proposed Roof Plan

PROJECT No	DWG TYPE	DWG No	REV	SCALE
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DATE	DRAWN	CHECKED	STATUS
21/03/2016	KR	BW	Provisional

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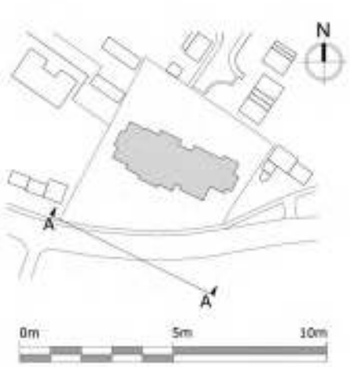
ELEVATION A-A



REV	DATE	DESCRIPTION	DRAWN
01	Jun '16	Issued for Comment	BW

CLIENT
Howarth Homes

PROJECT
Rickmansworth Road
Northwood

DRAWING TITLE
Proposed South West Elevation

PROJECT No	DWG TYPE	DWG No	REV	SCALE
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DATE	DRAWN	CHECKED	STATUS
25/08/2015	BW	BW	Provisional

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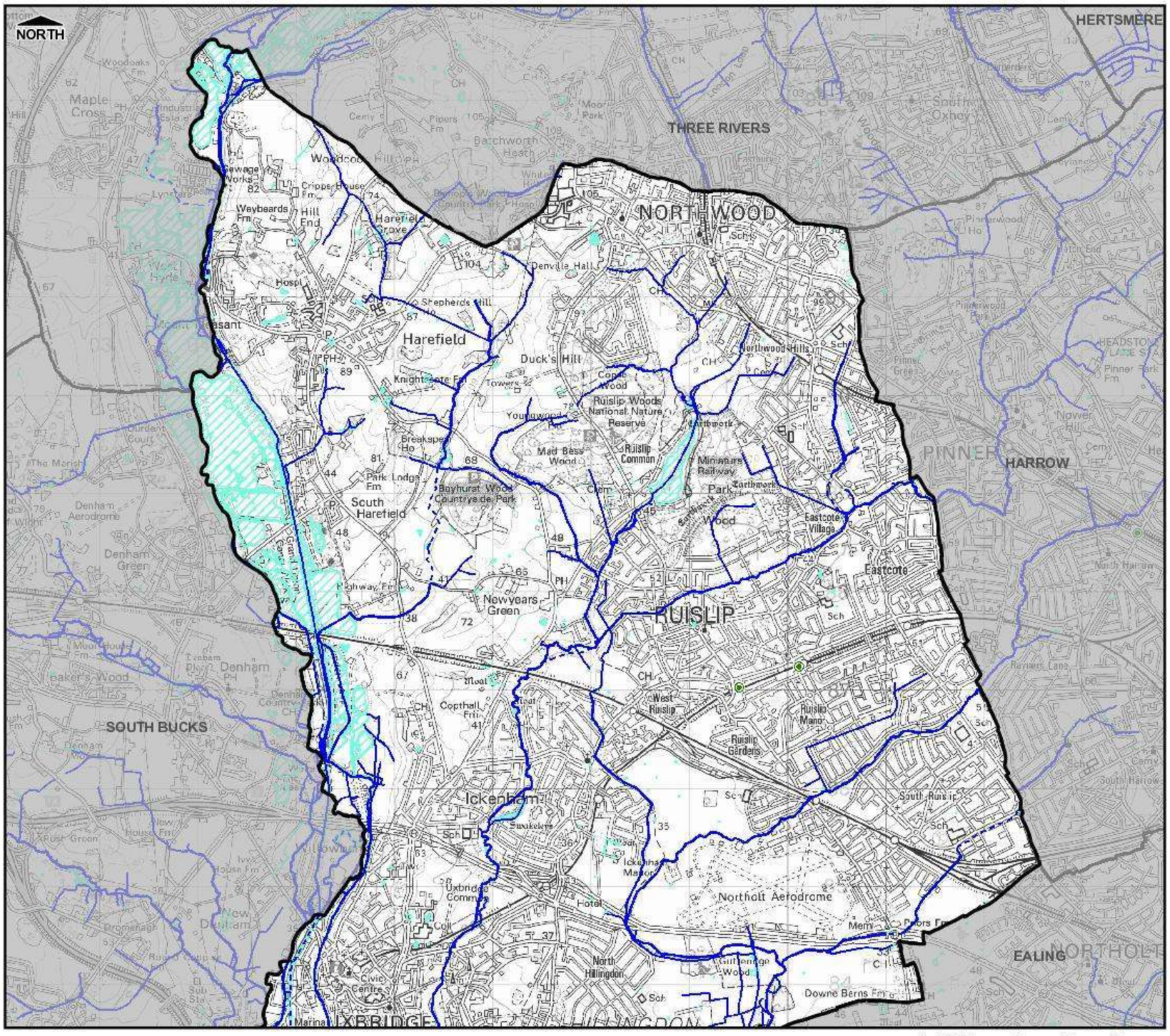
Appendix: C

HILLINGDON PFRA AND SWMP MAPPING

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED



Legend

- Borough Administrative Boundary
- Main River
- Ordinary Watercourse
- Culverted Watercourse (Main River)
- Permanent Water Bodies
- Surface Water Flooding Incidents
- Surface Water Flood Outline

London Borough of Hillingdon

HILLINGDON

Preliminary Flood Risk Assessment

Scale at A3	Date	Drawn by	Approved by
1:40,000	06/04/2011	R.MOORE	P.HUNOVSKY

Summary Map of Past Floods - Surface Water Incidents

Consultants
CAPITA SYMONDS Flood Risk Management
Scott Wilson
Capita Symonds
Level Seven,
52 Grosvenor Gardens,
Belgravia,
London
SW1W 0AU

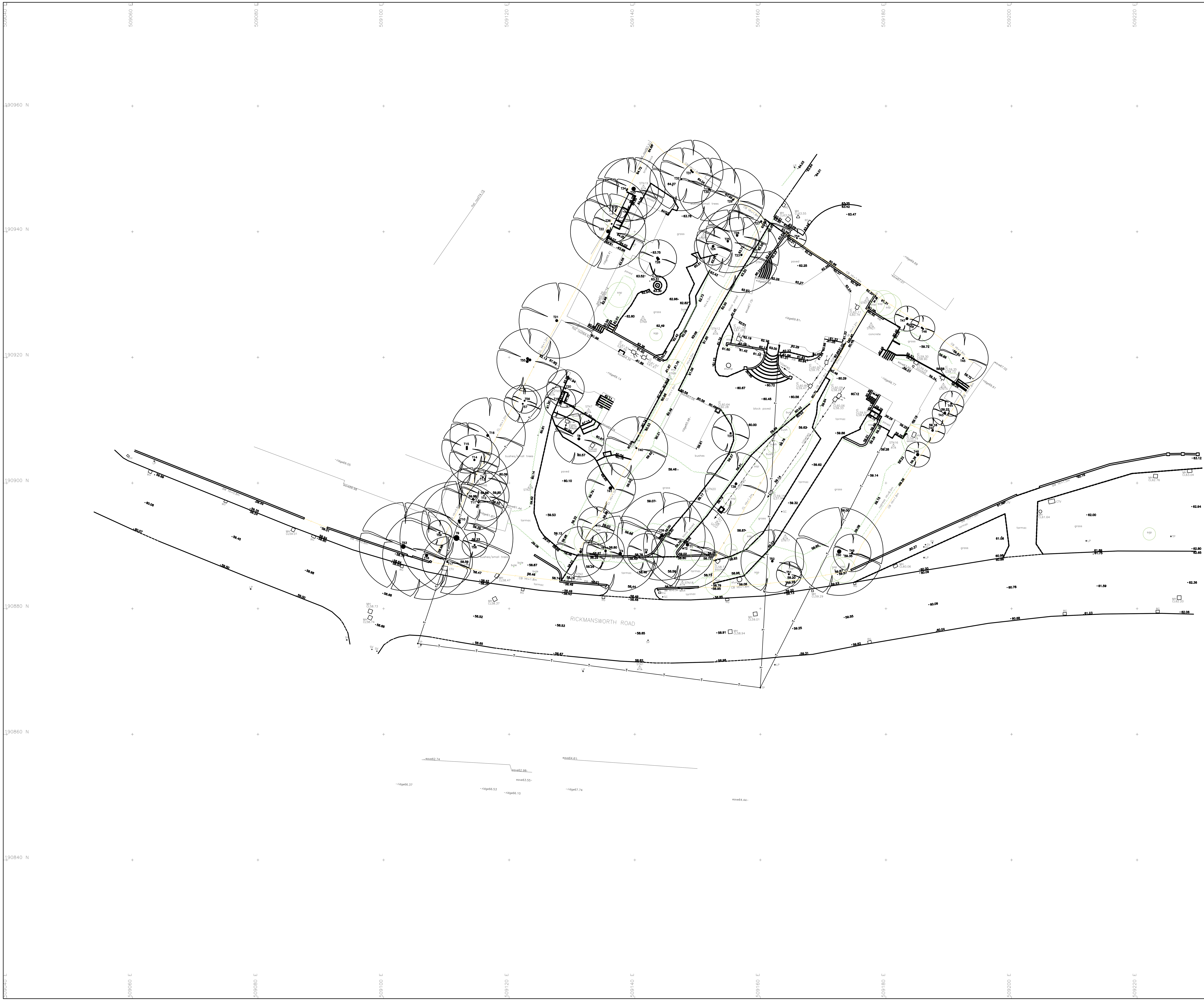
Drain London Programme Board Members

Environment Agency · Thames Water · LONDON COUNCILS · GREATERLONDONAUTHORITY

FIGURE A-1.1

Filepath: L:\Environment\ewef\CS\046913_Drain London_Tier2Group1\ARC\mxds\PFRA\GP1_Hillingdon_Fig4-1.1_SWIncidents_100.mxd

Appendix: D TOPOGRAPHICAL SURVEY



LEGEND

FEATURE STYLES

- SURVEY CONTROL
- FENCE
- HEDGE
- FWS
- SWS
- WATER
- POWER LINE (OVERHEAD)
- TELECOM LINE (OVERHEAD)
- ELECTRIC MAIN
- GAS MAIN
- EMBANKMENT

FENCE TYPES

BWR Barbed Wire
CB Close Board
CI Corrugated Iron
CL Chain Link
CPL Conc Panel
CP Chestnut Paling
CW Chicken Wire
IW Interwoven
IR Iron Railing
OB Openboard
PR Post and rail
PW Post and Wire

FEATURE ABREVIATIONS

AV Air Valve
BS Bus Stop
BT British Telecom
BW Brick Wall
CB Conc Bollard
CL Cover Level
CTO cable TV outlet
EB Electric Box
EC Electric Cover
EP Electricity Pole
FH Fire Hydrant
FL Floor level
G Gully
GM Gas Meter
GV Gas Valve
IL Invert Level
IC Inspection Chamber
KLS Keep Left Sign
KO Kerb Offlet
LB Letter Box
LP Lamp Post
MKR Marker
MP Metal Post
MH Manhole
MB Metal Bollard
P Post
PI Petrol Interceptor
RG Road Gully
RNB Road Name Board
RS Road Sign
RW Retaining Wall
SA Soakaway
SC Stopcock
SV Sluice Valve
TP Telegraph Pole
TCB Telephone Box
TJB Tel.Junc.Box
TL Traffic Light
V Valve
VP Vent Pipe
WL Water Level
WM Water Meter
WO Water Outlet
WV Water Valve

DATUM
GRID – ORDNANCE SURVEY NATIONAL GRID (OSTN02)
LEVELS – ORDNANCE SURVEY (OSGM02)

SURVEY CONTROL

STN	–E–	–N–	–Z–
1	509140.778	190870.507	58.900
2	509131.118	190884.852	58.166
3	509123.367	190899.426	59.991
4	509139.818	190905.955	60.555
5	509126.828	190914.243	61.696
6	509114.970	190900.046	60.219
7	509132.639	190911.441	61.287
8	509145.513	190916.765	61.659
9	509141.316	190926.177	62.588
10	509150.966	190939.370	63.779
11	509159.407	190935.896	63.381
12	509152.848	190923.924	62.028
13	509171.616	190919.566	60.930
14	509176.997	190929.185	62.221
15	509189.136	190915.474	59.262
16	509181.197	190905.794	59.322
17	509163.970	190891.358	59.058
18	509147.571	190883.991	58.564
19	509141.384	190947.036	64.125
20	509151.152	190898.916	59.248
21	509177.640	190925.110	60.491

TREE SCHEDULE

TREE	GIRTH	HEIGHT	SPREAD	SPECIES
1	1.4	16.0	7.0	HORNBEAM
2	0.7	8.0	5.0	BEECH
3	0.8	8.0	3.0	PURPLE PRUNUS
4	1.5	15.0	6.0	BEECH
5	1.0	8.0	3.0	PRUNUS
6	1.1	11.0	4.0	BEECH
7	0.7	8.0	3.0	BEECH
8	1.2	11.0	4.0	APPLE
9	2.6	20.0	9.0	SCOTS PINE
10	1.1/0.8	14.0	6.0	ACACIA
11	1.0	10.0	5.0	HOLLY
12	0.5	7.0	4.0	HAWTHORN
13	0.7	9.0	4.0	HAWTHORN
14	0.9	10.0	4.0	HOLLY
15	2x0.9	14.0	4.0	ACACIA
16	1.2	17.0	6.0	ACACIA
17	0.8	9.0	4.0	YEW
18	1.3	17.0	7.0	SCOTS PINE
19	1.2	12.0	2.5	CYPRESS
20	0.7	7.0	3.0	YEW
21	1.2	14.0	6.0	SPRUCE
22	1.7	16.0	6.0	MAPLE
23	0.9	11.0	6.0	BEECH
24	1.1	9.0	3.0	CYPRESS
25	0.9	11.0	5.0	MAPLE
26	1.1	11.0	5.0	MAPLE
27	0.8	11.0	5.0	MAPLE
28	0.8	9.0	3.0	CYPRESS
29	0.9	4.0	5.0	LAUREL
30	0.9	4.0	5.0	LAUREL
31	3x0.7	10.0	5.0	MAPLE
32	0.6	10.0	5.0	MAPLE
33	1.9	16.0	5.0	CYPRESS
34	2x0.6	15.0	5.0	MAPLE
35	3x0.5	15.0	5.0	MAPLE
36	0.6	8.0	3.0	MAPLE
37	0.8	5.0	3.0	APPLE
38	1.1	9.0	5.0	APPLE
39	1.1/1.4	16.0	7.0	BEECH
40	MB	10.0	5.0	BEECH
41	1.6	13.0	4.0	CYPRESS
42	1.0	7.0	2.0	CYPRESS
43	1.1	7.0	2.0	CYPRESS
44	0.8	7.0	2.0	CYPRESS
45	MB	7.0	4.0	HAZEL
46	2x0.8	7.0	2.0	LAUREL
47	1.2	7.0	2.0	CYPRESS
48	1.4	7.0	2.0	CYPRESS
49	0.8	7.0	3.0	HORSE CHESTNUT
50	1.9	14.0	7.0	SCOTS PINE
51	MB	5.0	2.0	HAWTHORN
52	1.0	9.0	5.0	MAPLE
53	2.1	17.0	7.0	SCOTS PINE
54	0.6	4.0	1.5	APPLE
55	3x1.2	16.0	5.0	MAPLE
56	0.6	6.0	2.0	HOLLY
57	0.6	8.0	3.0	HAWTHORN
58	0.6	6.0	2.0	CYPRESS
59	0.6	6.0	3.0	CYPRESS

NOTES

Surveyed boundaries are not necessarily the site legal boundaries. Client should refer to the relevant Land Registry document for confirmation of title.

Drainage and service covers that were buried, obscured or not visible at the time of the survey cannot be shown. Sewer connections between manholes are assumed to be straight and only pipes visible from the cover are shown.

Tree canopy measured values are written as maximium spreads.
Tree species and condition to be confirmed by an arboriculturist

SURVEYED BY
groundsurveys ltd
land & engineering surveyors

units 9&10
woodlands farm
spring lane
cookham dean
berkshire
SL6 9PN

t: 01628 485200
f: 01628 485300
e:office@groundsurveys.com
www.groundsurveys.com

CLIENT

HOWARTH HOMES PLC

SITE

34,36&38 RICKMANSWORTH ROAD
NORTHWOOD
GREATER LONDON
HA6 2QG

TITLE

SITE SURVEY

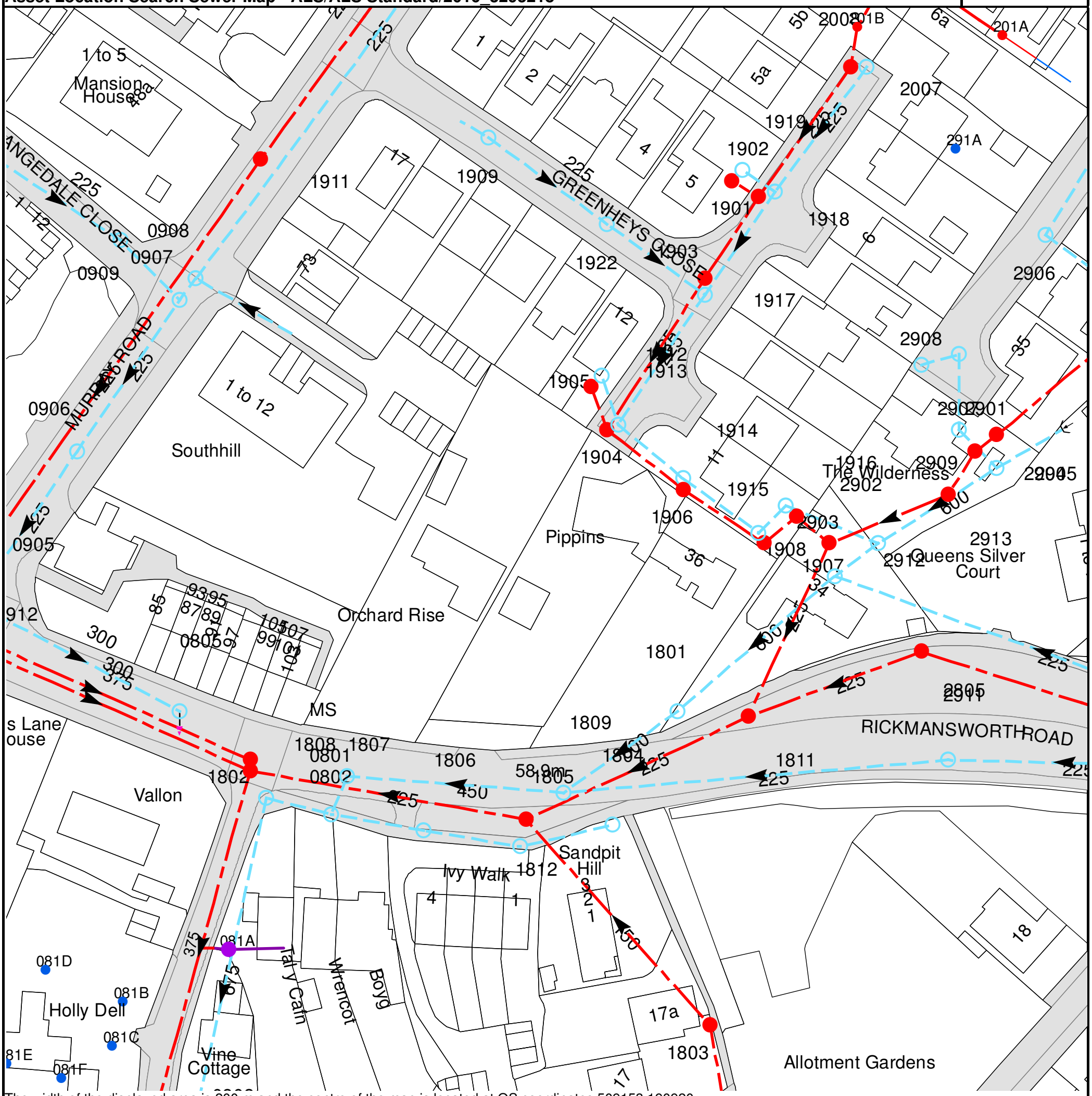
AS EXISTING

SCALE	DATE
1/200 (A0)	OCT 2015

DRAWING No.	JOB No.
01	6157

Appendix: E THAMES WATER SEWER RECORDS

Asset Location Search Sewer Map - ALS/ALS Standard/2016_3293218



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 509153,190920

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
0906	63.18	61.8
081F	n/a	n/a
081E	n/a	n/a
081C	n/a	n/a
081B	n/a	n/a
081D	n/a	n/a
081A	n/a	n/a
1807	58.54	57.04
1802	58.54	56.66
0802	58.72	54.67
0801	58.71	54.71
0805	59.4	57.79
201B	n/a	n/a
201A	n/a	n/a
1906	n/a	n/a
2901	60.93	59.78
2904	61.09	59.87
2905	61.09	59.89
1913	n/a	n/a
2909	61.12	60.32
1904	63.24	61.15
1912	63.39	61.75
1905	63.39	62.05
2907	61.62	60.68
2908	61.77	60.58
0907	65.57	64.07
1903	66.91	64.26
1917	65.17	62.21
0908	65.8	64.38
0909	66.78	64.58
2906	63.88	62.37
1922	66.26	64.92
1918	69.15	64.5
1902	65.9	64.84
1919	n/a	n/a
1901	n/a	n/a
1911	67.27	65.06
291A	n/a	n/a
1909	67.28	65.59
2007	n/a	n/a
2008	n/a	n/a
1803	64.29	62.99
1805	59.1	58.8
1806	58.8	57.8
1804	59.25	59
1812	59.05	56.52
1809	58.94	57.81
1808	58.39	57.29
2805	62.12	60.81
1811	60.47	58.33
1801	59.53	58.3
2911	62.74	59.8
2903	60.38	59.19
2902	59.95	59.01
2912	59.92	58.3
1915	n/a	n/a
1907	59.64	58.77
1916	60.32	58.69
1908	60.56	59.21
2913	60.94	59.46
1914	61.68	59.14

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

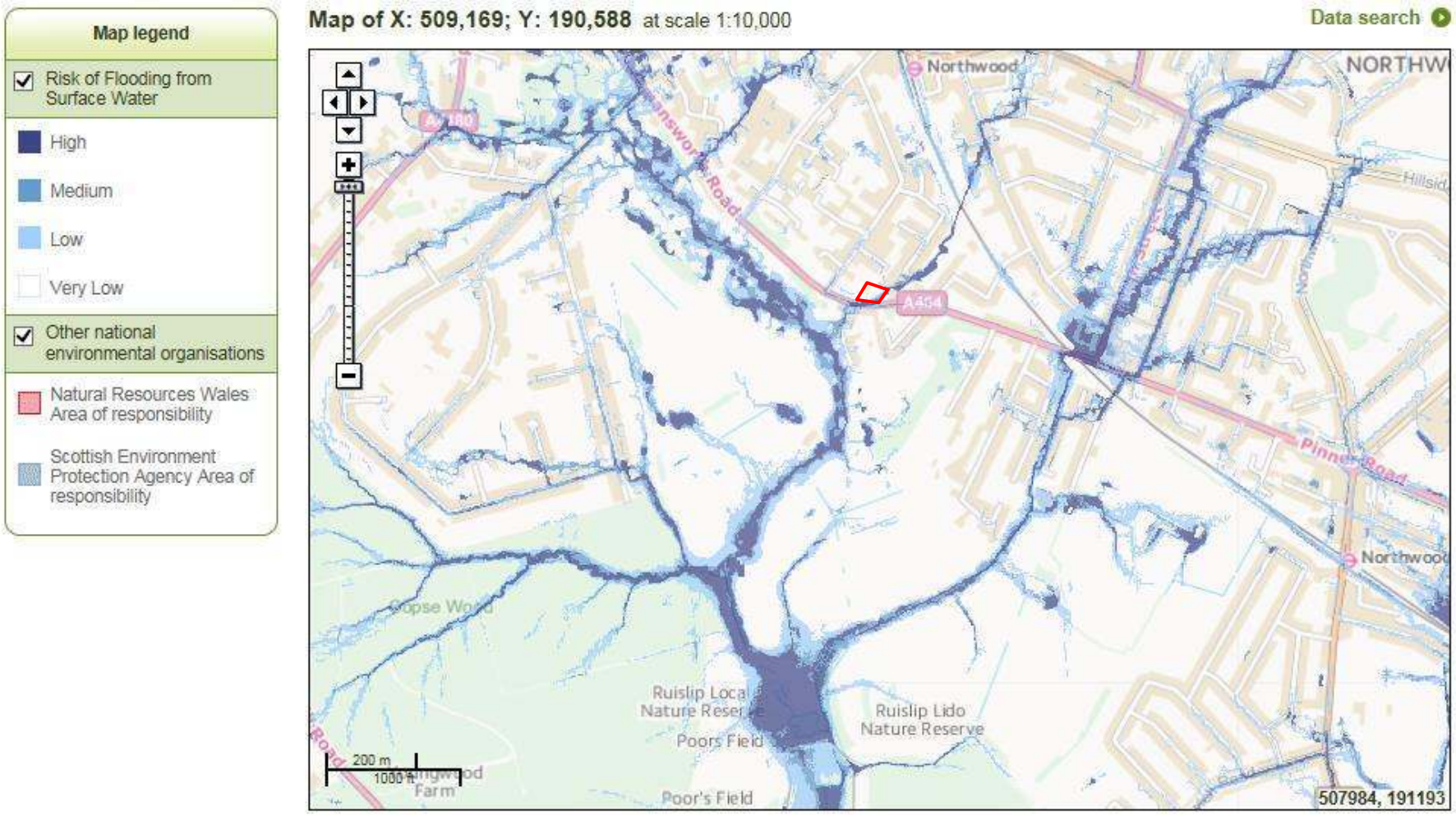
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Appendix: F EA SURFACE WATER FLOOD MAPS

EA Risk of Surface Water Flooding



Site Boundary

EA Surface Water Depth Mapping

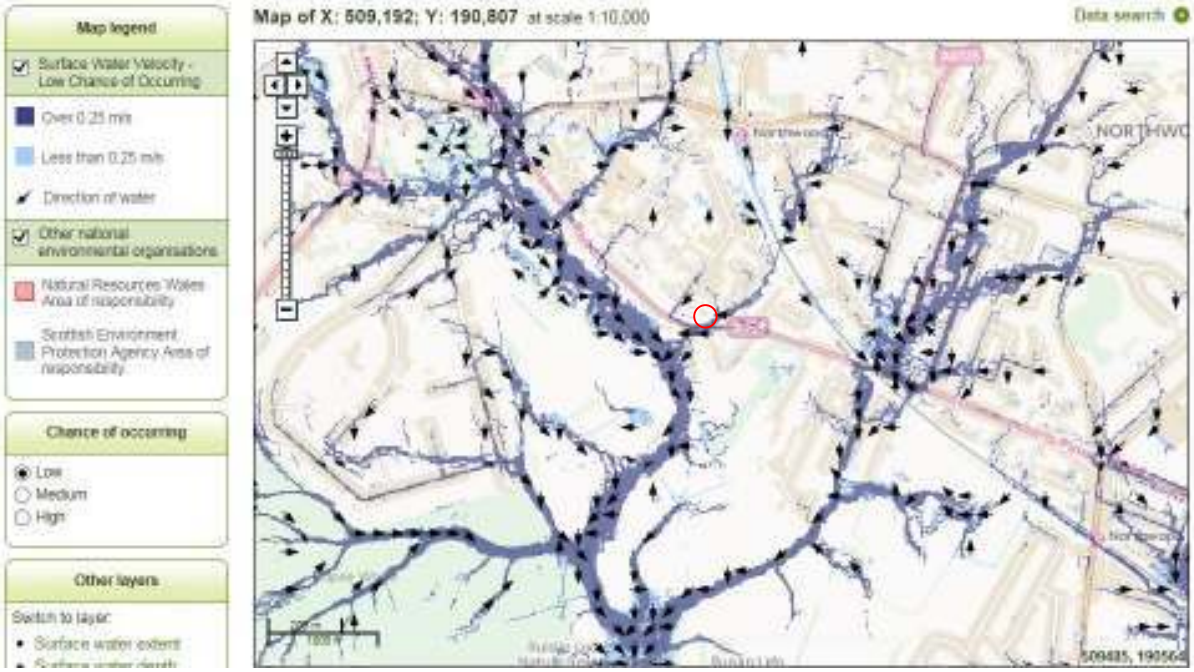
Low Frequency

Medium Frequency

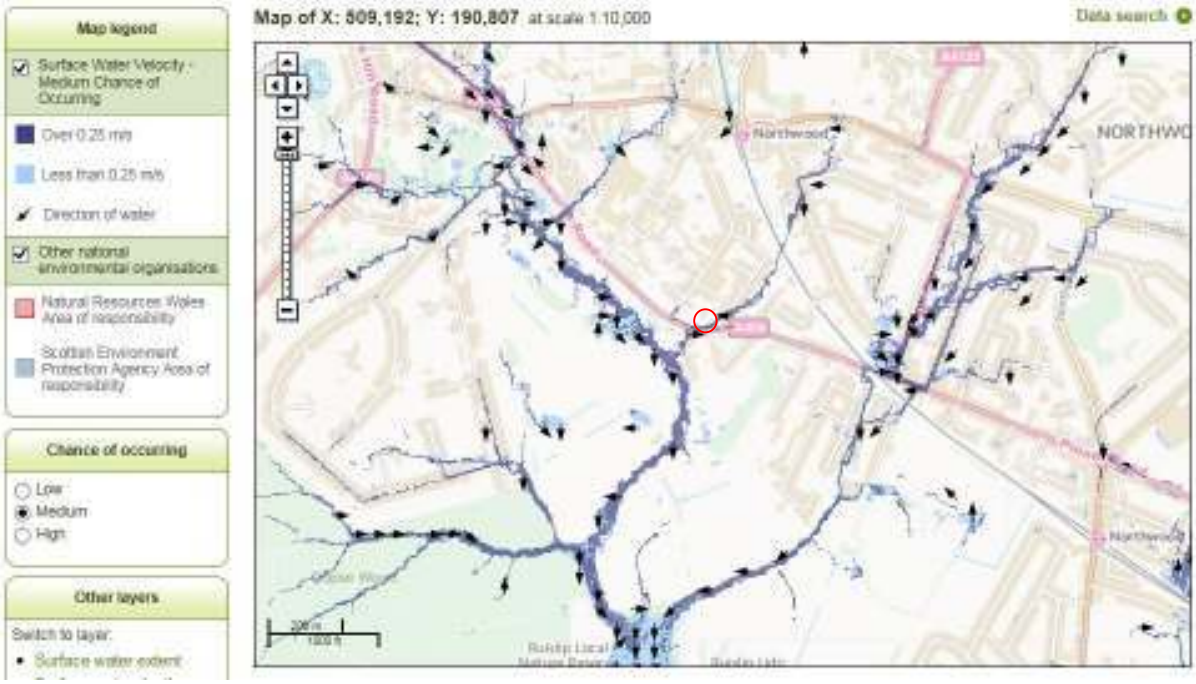
High Frequency

EA Surface Water Flowpaths

Low Frequency



Medium Frequency



High Frequency

509080 E

509100 E

509120 E

509140 E

509160 E

509180 E

509200 E

13

12

7

8

9

75

11

34

85

107

HIGH RISK OF SURFACE WATER FLOODING AS IDENTIFIED ON THE ENVIRONMENT AGENCY WEBSITE

MEDIUM TO LOW RISK OF SURFACE WATER FLOODING AS IDENTIFIED ON THE ENVIRONMENT AGENCY WEBSITE

Rickmansworth Road

Recrea

Talycafn

Wrencot

Boyg

4

3

2

1

1-3 Sand Pit Hill

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:

FOR INFORMATION

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Tel: 01920 871777

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CLIENT:

HOWARTH HOMES

ARCHITECT:

WILLCOX & MEILWES

PROJECT:

RICKMANSWORTH ROAD,
NORTHWOOD

TITLE:

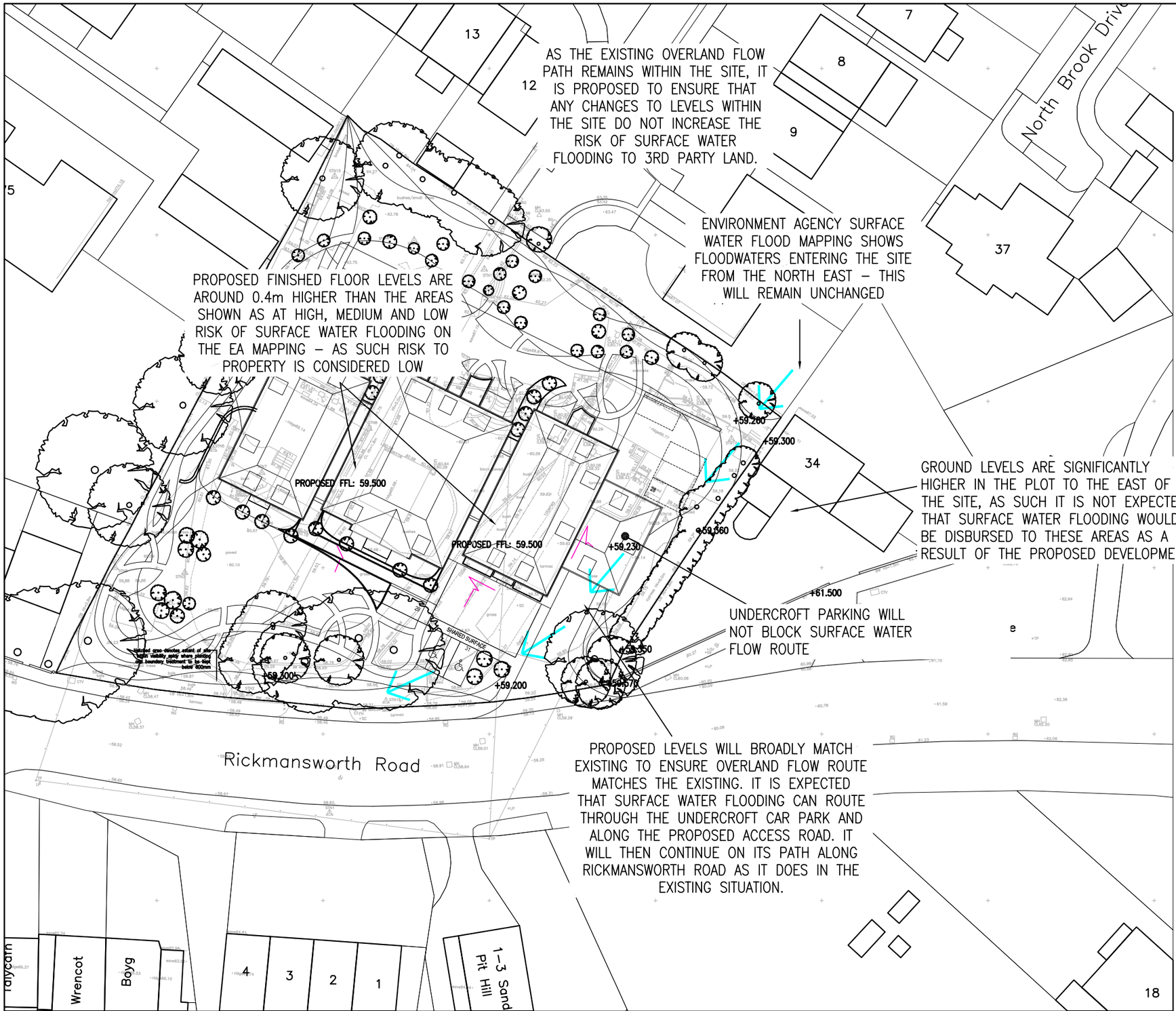
EXISTING OVERLAND FLOW ROUTES
SURFACE WATER FLOOD RISK
OVERLAID ONTO PROPOSED LAYOUT

SCALE @ A3:	DESIGN–DRAWN:	DATE:
1:500	MD	31.03.2016

PROJECT No:	DRAWING No:
1025	FIG02 REV A

Appendix: G

PROPOSED MITIGATION MEASURES



REV	DATE	BY	DESCRIPTION	CHK	APD

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ARCHITECT:
WILLCOX & MEILWES

PROJECT:
RICKMANSWORTH ROAD,
NORTHWOOD

TITLE:
PROPOSED OVERLAND FLOW ROUTES
AND
SURFACE WATER FLOOD RISK

SCALE @ A3:	DESIGN–DRAWN:	DATE:
1:500	MD	31.03.2016

PROJECT No:	DRAWING No:
1025	FIG03 REV A

Appendix: H

WinDes Greenfield Runoff Rates and Existing Runoff Rates

Run-off from Existing Site

Methodology

Using the Modified Rational Method, the surface water run-off rate, has been calculated for the existing impermeable part of the developed site that are understood to be formally drained. A fixed rainfall intensity of 50mm/hr has been used which was recommended by Butler and Davies for small sites.

Ref: Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed, SPON.

$Q = CiA$

where

$$C = \frac{PIMP}{PR}$$

PIMP = Percentage of impervious area to total area
PR = Percentage Runoff

	Surface Area (m^2)
Existing Impervious Areas	1531
Total Area	1531

i (Rainfall intensity, mm/hr) = 50.00
i (Rainfall intensity, m/hr) = 0.050
i (Rainfall intensity, m/s) = 1.38×10^{-5}

Percentage run-off (PR)
Existing Impervious Area = 100%

Percentage of impervious area to total area (PIMP)
PIMP = 12000/12000 = 100%

Therefore $C = \frac{PIMP}{PR} = 1$

Runoff from existing site:
$Q = CiA$
$Q = 1 \times 1.38 \times 10^{-5} \times 1531 m^2$
$Q = 0.0212 m^3 s^{-1}$
$Q = 21.26 ls^{-1}$

Total Q for the existing site = 21.26 ls^{-1}

ICP SUDS Mean Annual Flood

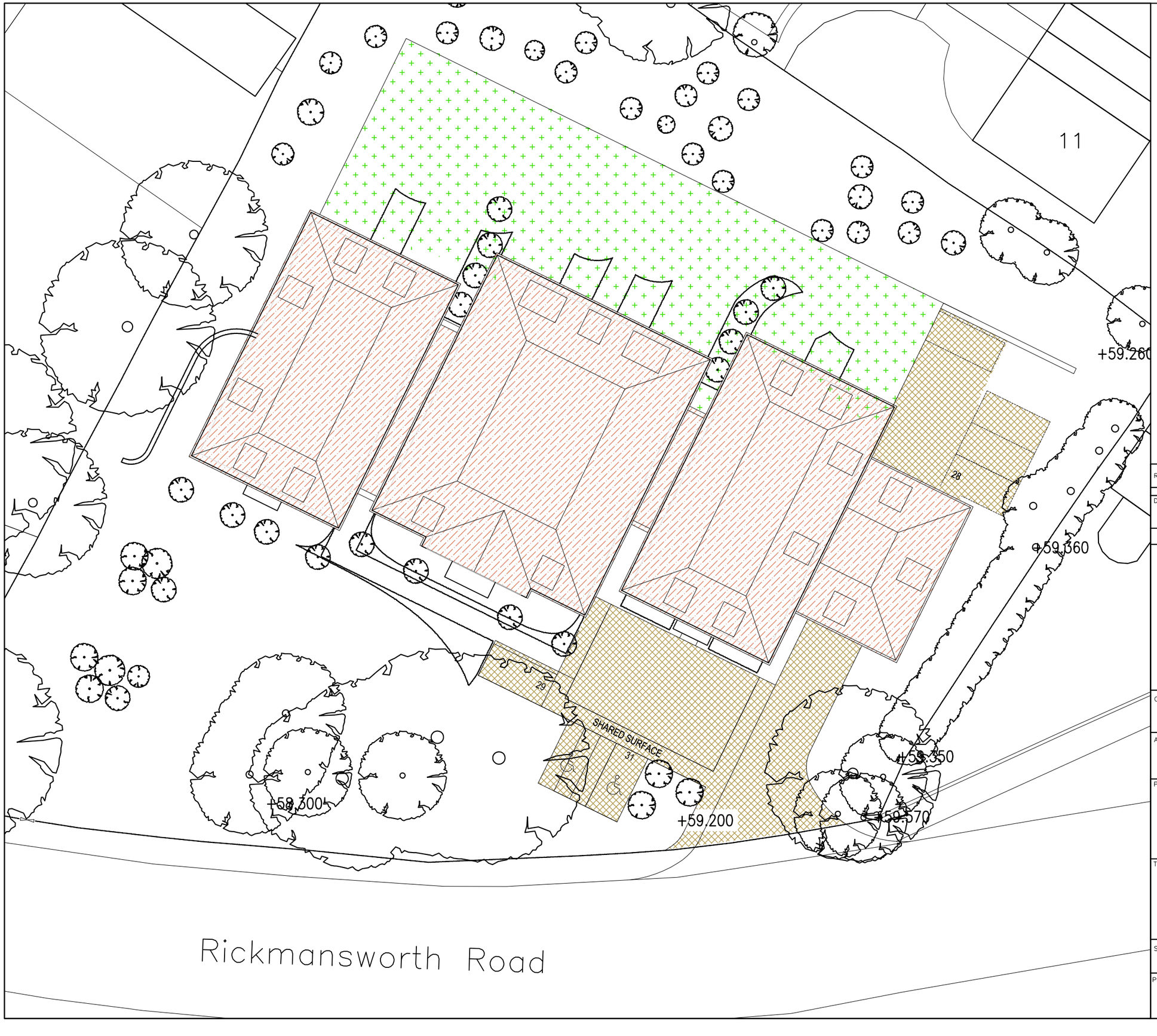
Input

Return Period (years)	100	Soil	0.450
Area (ha)	1.000	Urban	0.000
SAAR (mm)	700	Region Number	Region 6

Results l/s

QBAR Rural	4.4
QBAR Urban	4.4
Q100 years	14.0
Q1 year	3.7
Q30 years	10.0
Q100 years	14.0

Appendix: I PROPOSED IMPERMEABLE AREAS



KEY:

PROPOSED GREEN ROOF OVER UNDERCROFT CAR PARK 441sqm

PROPOSED BUILDING ROOF AREA 886sqm

PROPOSED EXTERNAL HARDSTANDING AREAS 328sqm

TOTAL SITE AREA: 3580sqm

TOTAL IMPERMEABLE AREA: 1665sqm (46%)

TOTAL PERMEABLE AREA: 1925sqm (54%)

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:

FOR INFORMATION

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Tel: 01920 871777

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CLIENT:

HOWARTH HOMES

ARCHITECT:

WILLCOX & MEILWES

PROJECT:

RICKMANSWORTH ROAD,
NORTHWOOD

TITLE:

PROPOSED
PERMEABLE AND IMPERMEABLE
AREAS

SCALE @ A3:	DESIGN–DRAWN:	DATE:
1:250	MD	31.03.2016

PROJECT No:	DRAWING No:
1025	FIG05 REV A

Appendix: J

PROPOSED DRAINAGE STRATEGY AND INDICATIVE SCHEMATIC

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	39.600	0.396	100.0	0.040	3.00	0.0	0.600	o	150
1.001	23.900	0.239	100.0	0.070	0.00	0.0	0.600	o	150
1.002	26.900	0.269	100.0	0.025	0.00	0.0	0.600	o	150
2.000	4.000	0.640	6.2	0.015	3.00	0.0	0.600	o	150
1.003	22.000	0.220	100.0	0.015	0.00	0.0	0.600	o	150
1.004	20.000	0.040	500.0	0.000	0.00	0.0	0.600	o	450

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	59.014	0.040	0.0	1.00	17.8
1.001	58.618	0.110	0.0	1.00	17.8
1.002	58.379	0.135	0.0	1.00	17.8
2.000	58.750	0.015	0.0	4.06	71.7
1.003	57.560	0.165	0.0	1.00	17.8
1.004	57.040	0.165	0.0	0.90	143.5

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	150	MH1	59.600	59.014	0.436	Open Manhole	600
1.001	o	150	MH2	59.300	58.618	0.532	Open Manhole	600
1.002	o	150	MH3	59.250	58.379	0.721	Open Manhole	600
2.000	o	150	MH4	59.500	58.750	0.600	Open Manhole	600
1.003	o	150	STORAGE	59.500	57.560	1.790	Open Manhole	600
1.004	o	450	TW1807	58.540	57.040	1.050	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	39.600	100.0	MH2	59.300	58.618	0.532	Open Manhole	600
1.001	23.900	100.0	MH3	59.250	58.379	0.721	Open Manhole	600
1.002	26.900	100.0	STORAGE	59.500	58.110	1.240	Open Manhole	600
2.000	4.000	6.2	STORAGE	59.500	58.110	1.240	Open Manhole	600
1.003	22.000	100.0	TW1807	58.540	57.340	1.050	Open Manhole	1500
1.004	20.000	500.0		58.540	57.000	1.090	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		58.540	57.000	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	1
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.300	Storm Duration (mins)	30
Ratio R	0.414		

Online Controls for Storm

Hydro-Brake® Manhole: STORAGE, DS/PN: 1.003, Volume (m³): 1.1

Design Head (m) 0.650 Hydro-Brake® Type Md9 Invert Level (m) 57.560
Design Flow (l/s) 2.3 Diameter (mm) 61

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	3.0	3.000	4.8	7.000	7.4
0.200	1.2	1.400	3.3	3.500	5.2	7.500	7.6
0.300	1.5	1.600	3.5	4.000	5.6	8.000	7.9
0.400	1.8	1.800	3.7	4.500	5.9	8.500	8.1
0.500	2.0	2.000	3.9	5.000	6.2	9.000	8.3
0.600	2.2	2.200	4.1	5.500	6.5	9.500	8.6
0.800	2.5	2.400	4.3	6.000	6.8		
1.000	2.8	2.600	4.5	6.500	7.1		

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	1
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR Ratio R	0.414
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.300	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	OFF
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+40%	100/15 Summer				
1.001	15 Winter	100	+40%	100/15 Summer				
1.002	15 Winter	100	+40%	100/15 Summer				
2.000	15 Summer	100	+40%					
1.003	240 Winter	100	+40%	100/15 Summer				
1.004	240 Winter	100	+40%					

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	MH1	59.596	0.432	0.000	1.19	0.0	20.4	FLOOD RISK
1.001	MH2	59.255	0.487	0.000	1.13	0.0	19.0	FLOOD RISK
1.002	MH3	59.047	0.518	0.000	1.69	0.0	28.7	FLOOD RISK
2.000	MH4	58.799	-0.101	0.000	0.23	0.0	11.7	OK
1.003	STORAGE	58.253	0.543	0.000	0.14	0.0	2.3	SURCHARGED
1.004	TW1807	57.089	-0.401	0.000	0.02	0.0	2.3	OK

KEY:

PROPOSED GREEN ROOF OVER UNDERCROFT CAR PARK

PROPOSED BUILDING ROOF AREA

PROPOSED PERMEABLE PAVING

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:
FOR INFORMATION

EAS

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Tel: 01920 871777

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CLIENT:
HOWARTH HOMES

ARCHITECT:
WILLCOX & MEILWES

PROJECT:
RICKMANSWORTH ROAD,
NORTHWOOD

TITLE:
PROPOSED
SURFACE WATER DRAINAGE
ARRANGEMENT

SCALE @ A3:	DESIGN–DRAWN:	DATE:
1:250	MD	31.03.2016

PROJECT No:	DRAWING No:
1025	FIG04 REV A

GREENROOF OUTFALL

MH1
CL: 59.600
IL: 59.014

150ø @ 1:80

GREENROOF OUTFALL

MH2
CL: 59.300
IL: 58.618

PROPOSED FFL: 59.500

PROPOSED FFL: 59.500

PERMEABLE PAVING OUTFALL

MH4
CL: 59.500
IL: 58.750

HYDROBRAKE
CL: 59.220
IL: 58.379

CELLULAR STORAGE
CL: 59.500
IL: 58.260
57.560
57.2sqm @ 0.7m DEEP

150ø @ 1:100

PERMEABLE PAVING OUTFALL

MH3
CL: 59.250
IL: 58.379

150ø @ 1:80

SHARED SURFACE

Hatched area denotes extent of site within visibility splay where planting and boundary treatment to be kept below 600mm

TW 1807
CL: 58.540
IL: 57.040

450ø

TW 1809
CL: 58.940
IL: 57.810

TW 1801
CL: 59.530
IL: 58.300

EXISTING THAMES WATER SEWER

+59.260
+59.300
+59.360
+59.230
+59.350
+59.570
+59.200
+59.300
+61.500

9
10
11
34

Rickmansworth Road