Client: Yamuna House Ltd.
Flood Risk and Surface Water Management Assessment for the Proposed Development at 830 Uxbridge Road, Hayes, Hillingdon

March 2022

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1 Background and Scope of Appraisal

Flooding is a major issue in the United Kingdom. The impacts can be devastating in terms of the cost of repairs, replacement of damaged property, and loss of business. The objectives of the Flood Risk Assessment are, therefore, to establish the following:

- whether a proposed development is likely to be affected by current or future flooding from any source
- whether the development will increase flood risk elsewhere within the floodplain
- whether the measures proposed to deal with these effects and risks are appropriate
- whether the site will be safe to enable the passing of the Exception Test (where appropriate).

Herrington Consulting has been commissioned by Yamuna House Ltd. to prepare a Flood Risk Assessment (FRA) and Surface Water Management Strategy (SWMS) for the proposed development at **830 Uxbridge Road, Hayes, Hillingdon, UB4 0RR**.

This appraisal has been undertaken in accordance with the requirements of the National Planning Policy Framework (2021) and the accompanying Planning Practice Guidance Suite. To ensure that due account is taken of industry best practice, it has been carried out in line with the CIRIA Report C624 'Development and flood risk - guidance for the construction industry'.

Reference is also made to the National Planning Practice Guidance Suite (August 2021) that has been published by the Department for Communities and Local Government. The *Flood Risk and Coastal Change* planning practice guidance included within the Suite represents the most contemporary technical guidance on preparing FRAs.

2 Development Description and Planning Context

2.1 Site Location and Existing Use

The site is located at OS coordinates 509951 181448, off Uxbridge Road in Hayes. In total the site covers an area of approximately 0.145 hectares and currently comprises a public house. The location of the site in relation to the surrounding area is shown in Figure 2.1.

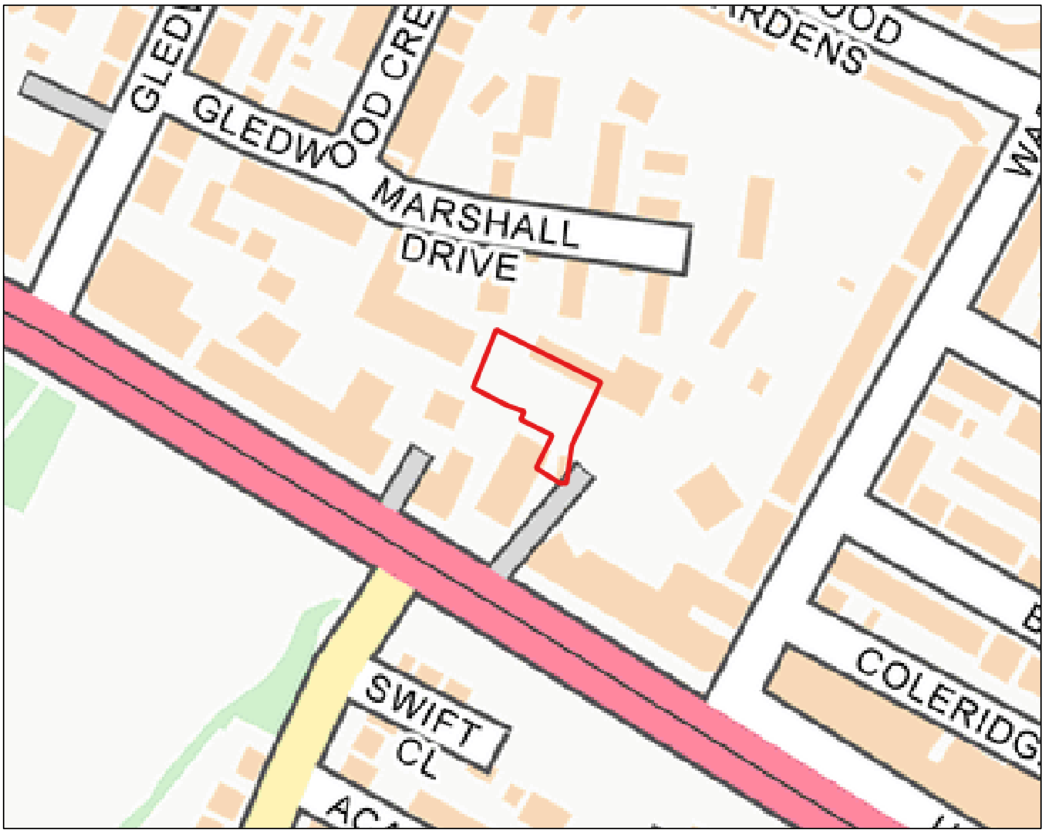


Figure 2.1 – Location map (Contains Ordnance Survey data © Crown copyright and database right 2022).

The site plan included in Appendix A.1 of this report provides more detail in relation to the site location and layout.

2.2 Proposed Development

The proposals for development comprise the construction of 6no. 3-bed houses at the rear of the plot, with associated parking.

Drawings of the proposed scheme are included in Appendix A.1 of this report.

2.3 The Sequential Test and Exception Test

Local Planning Authorities (LPA) are encouraged to take a risk-based approach to proposals for development in areas at risk of flooding through the application of the Sequential Test. The objectives of this test are to steer new development away from high risk areas towards those areas at lower risk of flooding. However, in some areas where developable land is in short supply there can be an overriding need to build in areas that are at risk of flooding. In such circumstances, the application of the Sequential Test is used to ensure that the lower risk sites are developed before the higher risk ones.

The National Planning Policy Framework (NPPF) requires the Sequential Test to be applied at all stages of the planning process and generally the starting point is the Environment Agency's (EA) 'Flood Map for Planning' (Figure 2.). These maps and the associated information are intended for guidance and cannot provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site-based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country. The Flood Zones are classified as follows:

Zone 1 – *Low probability of flooding* – This zone is assessed as having less than a 1 in 1000 annual probability of river or sea flooding in any one year.

Zone 2 – *Medium probability of flooding* – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between 1 in 200 and 1 in 1000 annual probability of sea flooding in any one year.

Zone 3a – *High probability of flooding* - This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any one year.

Zone 3b – *The Functional Floodplain* – This zone comprises land where water has to flow or be stored in times of flood and can be defined as land which would flood during an event having an annual probability of 1 in 20 or greater. This zone can also represent areas that are designed to flood in an extreme event as part of a flood alleviation or flood storage scheme.

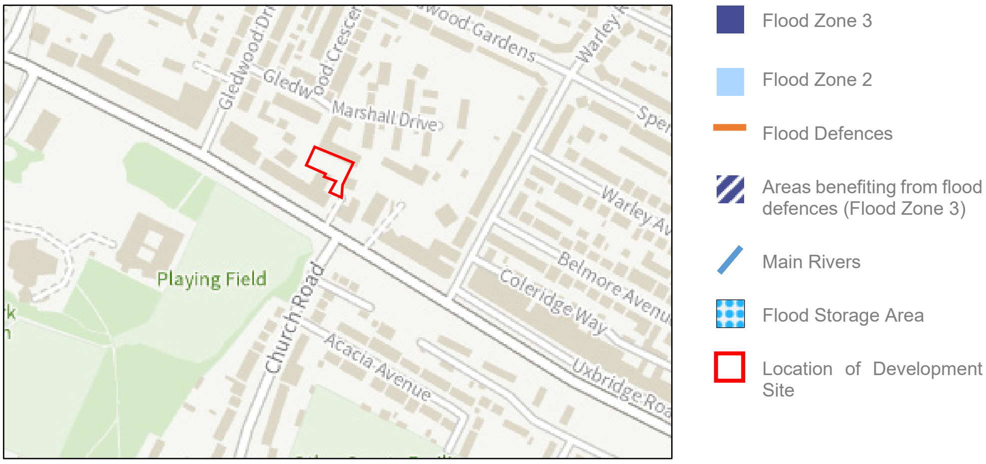


Figure 2.2 – EA's 'Flood Map for Planning' (© Environment Agency).

In this circumstance, it is recognised that the site is located within Flood Zone 1, and therefore is located in the lowest possible flood risk zone. As such, it is recognised that the requirements of the Sequential Test will be met and in accordance with the NPPF, there is no requirement to apply Exception Test. Notwithstanding this, the following sections provide an overall appraisal of flood risk at the site from all sources.

3 Definition of Flood Hazard

3.1 Site Specific Information

In addition to the high level flood risk information shown in the Environment Agency (EA) flood zone maps, additional data from detailed studies, and other information sources is referenced. This section summarises the additional information collected as part of this FRA.

Information contained within the SFRA – The West London SFRA (2018) contain detailed mapping of flood extents from a wide range of sources. These documents have been referenced as part of this site-specific FRA.

Information provided by Thames Water – Thames Water has provided the results of an asset location search for the site. Their response is included in Appendix A.2.

Site specific topographic surveys – A topographic survey has been undertaken for the site and a copy of this is included in Appendix A.1. From the survey it can be seen that the level of the site varies between 36.68m and 37.07m Above Ordnance Datum Newlyn (AODN). Land levels fall from south east to north west.

Geology – Reference to the Geological Survey map shows that the underlying solid geology in the location of the subject site is London Clay Formation (clay, silt and sand). There are no overlying superficial deposits.

Historic flooding – No information on historic flooding in this area has been provided or revealed through desktop searches.

3.2 Potential Sources of Flooding

The main sources of flooding have been assessed as part of this appraisal. The specific issues relating to each one and its impact on this development are discussed below. Table 3.1 at the end of this section summarises the risks associated with each of the sources of flooding.

Flooding from Rivers, Ordinary or Man-Made Watercourses (Fluvial) – Inspection of OS mapping identifies that there are no watercourses nearby and the site is not located within an area identified by the EA's 'Flood Map for Planning' as being at risk of flooding from a main river. Consequently, the risk of flooding from this source is considered to be *low.*

Flooding from the Sea – The site is located a significant distance inland and is elevated well above predicted extreme tide levels. Consequently, the risk of flooding from this source is considered to be *low*.

Flooding from Surface Water – Surface Water, or overland, flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This mechanism of flooding can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for runoff is restricted by terrain or man-made obstructions.

The EA's 'Flood Risk from Surface Water' map (Figure 3.) shows the development site is located in an area classified as having a 'low' risk of surface water flooding.

Inspection of the site and its surrounding area shows that land levels fall naturally across the site towards the northwest. In addition, there are no topographical low points within the site which could encourage flood water to pond. It is therefore considered that flooding through this mechanism is unlikely. Taking the above information into account and given that there is no historical evidence of flooding at this site, it is therefore considered that the risk of flooding from this source is *low*.

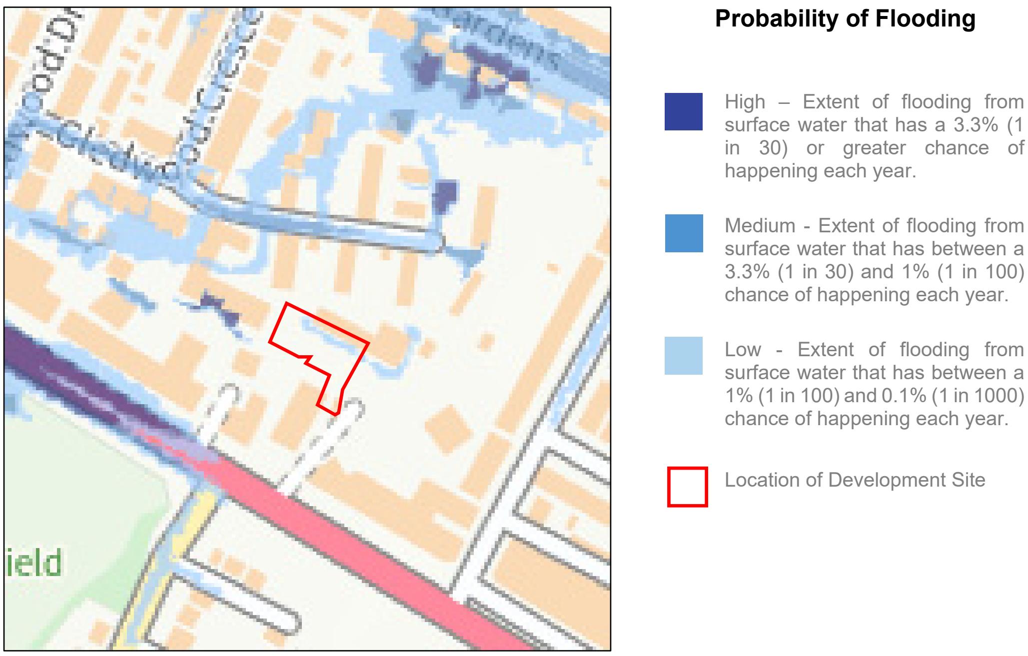


Figure 3.1 – EA's 'Flood Risk from Surface Water' map (© Environment Agency).

Flooding from Groundwater – Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year).

Groundwater flooding is most likely to occur in low-lying areas that are underlain by permeable rock (aquifers). The underlying geology in this area is London Clay Formation (clay, silt and sand), which is typically impermeable and therefore not associated with groundwater flooding. This is supported by data on groundwater flooding, compiled by the British Geological Survey, which identifies that the risk of groundwater flooding is low at the development site.

Inspection of the West London SFRA identifies that there are no historic records of flooding from groundwater at the site or in the surrounding area. Furthermore, detailed mapping on groundwater emergence provided as part of the Defra Groundwater Flood Scoping Study (May 2004), shows that no groundwater flooding events were recorded during the very wet periods of 2000/01 or 2002/03 and that the site itself is not located within an area where groundwater emergence is predicted. Given the above information, the risk of groundwater flooding is considered to be *low*.

Flooding from Sewers – In urban areas, rainwater is typically drained into surface water sewers or sewers containing both surface and wastewater known as "combined sewers". Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked, or has inadequate capacity; this will continue until the water drains away.

Inspection of the asset location mapping provided by Thames Water (Figure 3.) identifies that the sewers in this area are foul and surface water sewers. The absence of combined sewers significantly reduces the risk of the sewer network being overwhelmed during an extreme rainfall event.

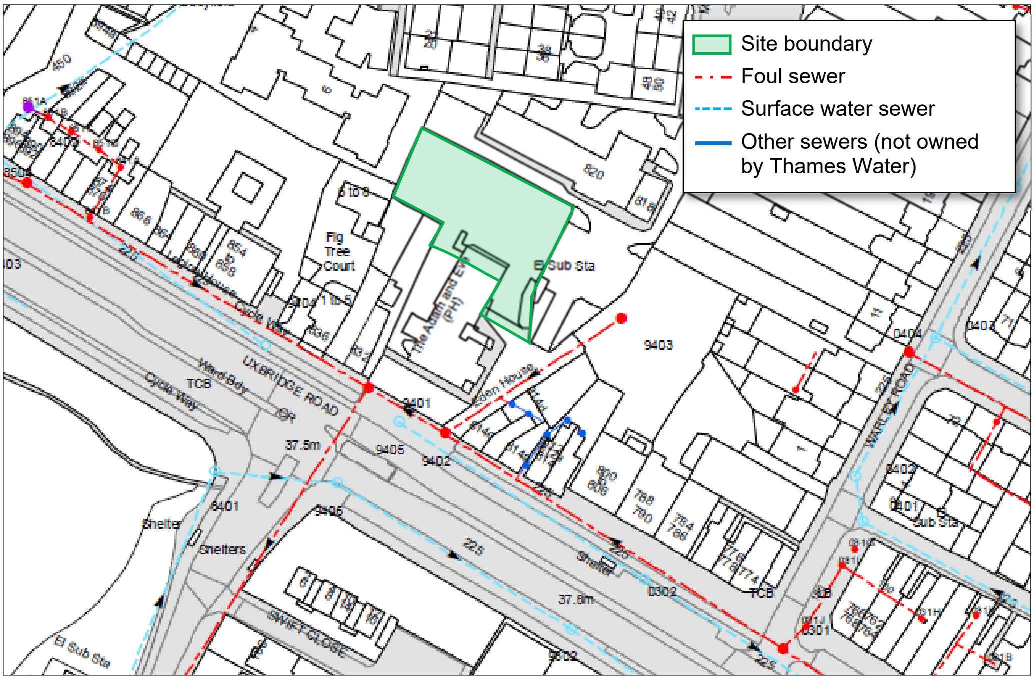


Figure 3.2 - Asset location mapping provided by Thames Water (a full scale copy can be found in Appendix A.2).

Inspection of the SFRA identifies that there are no known records of flooding from sewers in this area. Additionally, the topography of the land within the site and the surrounding area suggests that any above ground flooding that might occur as a result of a surcharged sewer would not pond at the site. The risk of flooding from this source is therefore considered to be *low*.

Flooding from Reservoirs, Canals and Other Artificial Sources – Non-natural or artificial sources of flooding can include reservoirs, canals, and lakes, where water is retained above natural ground level. In addition, operational and redundant industrial processes including; mining, quarrying, sand and gravel extraction, may also increase the depth of floodwater in areas adjacent to these features.

The potential effects of flood risk management infrastructure and other structures also needs to be considered. For example; reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

Inspection of the Ordnance Survey mapping for the area shows that there are no artificial sources of flooding within close proximity to the site. In addition, the Environment Agency's 'Risk of Flooding from Reservoirs' website shows that the site is not within an area considered to be at risk of flooding from reservoirs. The risk of flooding from this source is therefore considered to be *low*.

A summary of the overall risk of flooding from each source is provided in Table 3.1 below.

Source of Flooding	Initial Level of Risk	Appraisal method applied at the initial flood risk assessment stage
Rivers, Ordinary or Man-Made Watercourses (fluvial)	Low	OS mapping and the EA's 'Flood Map for Planning'
Sea	Low	OS mapping
Surface Water	Low	EA's 'Flood Risk from Surface Water' map, historic records contained within the West London SFRA, aerial height data and OS mapping
Groundwater	Low	BGS groundwater flood hazard maps, Defra Groundwater Flood Scoping Study, site-specific geological data, aerial height data, OS mapping, historic records contained within the SFRA
Sewers	Low	Aerial height data, OS mapping, asset location data provided by Thames Water, and historic sewer records contained within the SFRA
Artificial Sources	Low	OS mapping and EA's 'Flood Risk from Reservoirs' map

Table 3.1 – Summary of flood sources and risks.

3.3 Existing Flood Risk Management Measures

There are no formal flood defence structures that provide protection to the development site.

4 Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present, and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall could be expected.

4.1 Planning Horizon

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development, such as the development subject to this FRA, should be considered for a minimum of 100 years. Therefore, a design lifetime of 100 years has been assumed.

4.2 Potential Changes in Climate

Peak Rainfall Intensity

The recommended allowances for increases in peak rainfall intensity are applicable nationally. There is a range of values provided which correspond with the central and upper end percentiles (the 50th and 90th percentile respectively) over three time epochs. The recommended allowances are shown in Table 4.1 below.

Allowance Category (applicable nationwide)	**Total potential change anticipated for each epoch**		
	2015 to 2039	**2040 to 2069**	**2070 to 2115**
Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 4.1 – Recommended peak rainfall intensity allowance for small and urban catchments (1961 to 1990 baseline).

Guidance published by the EA states that the 'Upper End' allowance should be considered when designing a sustainable drainage system. As the development subject to this FRA has a planning horizon of 100 years, a 40% increase in peak rainfall intensity has been applied to the hydraulic model constructed to inform the outline surface water management strategy (refer to Section 6).

5 Flood Mitigation Measures

The key objectives of flood risk mitigation are:

- to reduce the risk of the development being flooded.
- to ensure continued operation and safety during flood events
- to ensure that the flood risk downstream of the site is not increased by increased runoff
- to ensure that the development does not have an adverse impact on flood risk elsewhere

Up to this point in the report the risk of flooding to the site has been appraised and the consequences of flooding to the site from each source has been considered. The following section of this report examines ways in which flood risk can be mitigated.

Mitigation Measure	Appropriate	Comment
Careful location of development within site boundaries (i.e. Sequential Approach)	x	Site is located outside of any areas at significant risk of flooding, therefore limited merit in applying these mitigation measures in this instance.
Raising floor levels	x	
Land raising	x	
Compensatory floodplain storage	x	
Alterations/ improvements to channels and hydraulic structures	x	
Flood defences	x	
Flood warning	x	
Flood resistance & resilience	x	
Management of development runoff	✓	Refer to Section 6

Table 5.1 – Appropriateness of mitigation measures.

6 Surface Water Management Strategy

6.1 Background and Policy

The general requirement for all new development with respect to managing surface water runoff is to ensure that the peak discharge rate and volume of surface water runoff does not exceed that of the existing site. In the case of brownfield sites, drainage proposals are typically measured against the existing performance of the site, although it is preferable (where practicable) to provide runoff characteristics that are similar to greenfield behaviour.

Changes relating to The Flood and Water Management Act 2010 National Standards (Schedule 3 – paragraph 5) for design, construction, maintenance and operation of Sustainable Drainage Systems (SuDS), came into effect from 6 April 2015. These changes provide additional detail and requirements not initially covered by the NPPF, and are (non-statutory) Technical Standards for SuDS (NTSS).

The NTSS specify criteria to ensure sustainable drainage is included within development classified as 'major development' as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010. It is, however, recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

In this instance, the proposed development is for the construction of 6 residential units with a total floor space smaller than 1000m^2. As a result, the proposals are classified as 'minor' development and therefore, the NTSS will not apply.

Notwithstanding this, local planning policy requirements and supplementary planning guidance should be considered. The LPA's website provides the following guidance on the use of SuDS for all developments *"Any new developments or redevelopment should undertake suitable development planning to ensure a water sensitive urban design. This design should incorporate sustainable drainage to help create beautiful, successful and resilient places."*

In addition, policy SI 13 of the London Plan states developments should incorporate SuDS wherever possible within schemes unless there is a practical reason for not doing so.

Policy SI 13 also states that developers should also follow the drainage hierarchy by prioritising the discharge of surface water runoff as close to source as possible. The London Plan Drainage Hierarchy is outlined below:

1. Rainwater use as a resource (for example: rainwater harvesting, blue roofs for irrigation).
2. Rainwater infiltration to ground at or close to source.
3. Rainwater attenuation in green infrastructure features for gradual release (for example: green roofs, rain gardens).

4. Rainwater discharge direct to a watercourse (unless not appropriate).

5. Controlled rainwater discharge to a surface water sewer or drain.

6. Controlled rainwater discharge to a combined sewer.

The proposed development must therefore attempt, where possible, to incorporate SuDS features in accordance with the requirements of the London Plan and any other adopted local planning policies pertaining to drainage. Consequently, the potential options for incorporating SuDS and their viability within the proposed scheme are discussed further in the following sections of this report.

6.2 Surface Water Management Overview

The main characteristics of the site that have the potential to influence surface water drainage are summarised in Table 6.1 below.

Site Characteristic	Value
Total area of site	~ 0.145 ha
Impermeable area (existing)	**~ 1450 m^2**
Impermeable area (proposed)	Roof area = 273 m^2 Hardstanding (including bike and bin store) = 788 m^2 **Total = 1061 m^2**
Current site condition	Brownfield site
Assumed Infiltration Rate	0.001m/hr - 0.01 m/hr (assumed based on underlying geology and typical soil conditions)
Current surface water discharge method	Assumed connection to the public sewer system.
Is there a watercourse within close proximity to site?	No

Table 6.1 – Site characteristics affecting rainfall runoff.

Reference to the table above shows the proposed development will decrease the percentage of impermeable area within the boundaries of the site. Consequently, this will not increase the rate and volume of surface water runoff discharged from the site.

Notwithstanding this, the potential use of SuDS within the proposed development will be considered to assess the practicality of better replicating greenfield behaviour, in accordance with Local Planning Policy.

6.3 Existing Drainage

It is assumed the existing site currently discharges surface water runoff directly to the public sewer located within Uxbridge Road.

Thames Water has provided sewer mapping as part of their asset location data for the site and surrounding area. An extract from this mapping is provided in Figure 6.1.

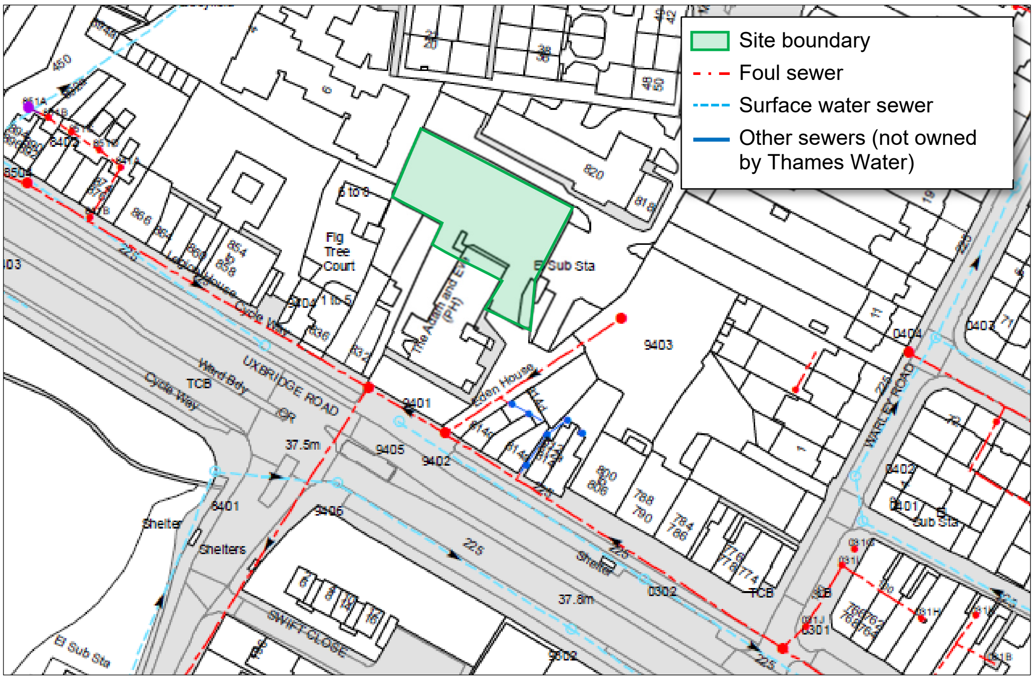


Figure 6.1 – Extract from Thames Water sewer mapping for the area around Uxbridge Road.

Flows from the existing site have been estimated using the Modified Rational Method, with calculations undertaken in Causeway Flow + using FEH point data obtained from the Centre for Ecology and Hydrology online web portal. The results of these calculations are summarised below in Table 6.2, alongside the estimated greenfield runoff rates for the site.

Return Period (years)	Existing Site Runoff (l/s)	Greenfield Runoff Rates (l/s) (for the total site area)
2	38	0.6
QBar	N/A	0.6
10	61	1.0
30	82	1.5
100	**108**	**2.0**

Table 6.2 – Summary of peak runoff rates.

Further investigation may be required as part of the detailed design to confirm the exact layout of the existing underground drainage network at the site and the potential to utilise any pre-existing connections to the public sewer system.

6.4 Opportunities to Discharge Surface Water Runoff

Policy SI 13 of the London Plan (2021) summaries a hierarchy of options for discharging surface water runoff from developments. Policy SI 13 favours managing surface water runoff at source, by either storing it for later **re-use** or allowing it to **infiltrate** into the ground. If this option is not viable, the next option of preference is for the runoff to be discharged into a **watercourse.** Only if neither of these options are possible, the water should be conducted into a **public sewer** system, with a connection into a surface water sewer being preferred over the discharge into either a combined or foul sewer.

The opportunities for managing surface water runoff from the proposed development are outlined below.

Water Re-use – Water re-use systems can rarely manage 100% of the surface water runoff discharged from a development, as this requires the yield from the building and areas of hardstanding to balance perfectly with the demand from the proposed development. Consequently, whilst rainwater recycling systems could be considered for inclusion within the scheme, an alternative solution for attenuating storm water would still be required.

Infiltration – Based on the underlying geology in this location (refer to Section 3.1) it is likely that infiltration rates will be insufficient for the use of infiltration SuDS. Furthermore, even in the event moderate infiltration rates are identified, there is insufficient space within the site to accommodate infiltration SuDS whilst maintaining the required 5m easement between the infiltration SuDS and the existing buildings. Consequently, the use of infiltration SuDS will not be possible at the development site.

Discharge to Watercourses – There are no watercourses within close proximity to the site in which to permit a direct connection and consequently, there is no opportunity to discharge surface water to an existing watercourse.

Discharge to Public Surface Water Sewer – As there are no alternative solutions for draining surface water runoff from the site, a connection to the public sewer system is the most viable option for managing surface water runoff discharged from the proposed development.

It is currently assumed that surface water runoff from the existing site is drained directly to the public foul sewer system. As a result, it is likely Thames Water will request the connection to this existing sewer is replaced with a new connection to the public surface water sewer within Uxbridge Road.

6.5 Constraints and Further Considerations

The key constraints that are relevant to this development are listed below:

- There is very little open space in which to incorporate SuDS that require significant areas of land such as wetlands.
- Due to the location of the site within a conservation area, green roofs have not been incorporated into the proposed development.
- The LPA strongly promote the use of green SuDS and the integration into the urban environment, as a result SuDS which provide these additional benefits will be prioritised for inclusion within the scheme. This includes utilising systems such as raised bioretention planters, raingardens, and swales, and where possible minimising the use of geo-cellular storage or other below ground SuDS.
- If a new connection to the public sewer system is required, it will be necessary to obtain consent from the Thames Water before construction can commence.
- Ideally post development runoff rates should be restricted to greenfield runoff rates. However, on small sites where discharge rates are exceptionally low (around 1.0l/s - 2.0l/s) higher rates are generally considered acceptable, due to the technical limitations of flow control devices. In this case a limiting discharge rate of 1.0l/s is considered likely to be acceptable to the Sewerage Undertaker and lower rates unlikely to be achievable.

6.6 Sustainable Drainage Systems (SuDS)

Appropriately designed SuDS can be utilised such that they not only attenuate runoff but also provide a level of improvement to the quality of the water passed on to watercourses or into the groundwater table. This is known as source control and is a fundamental part of the SuDS philosophy.

A range of typical SuDS that can be used to improve the environmental impact of a development is listed in Table 6.3 below along with the relative benefits of each feature and the appropriateness for the subject site.

SuDS	Environ-mental benefits	Water quality improve ment	Suitability for low permeability soils (k<10-6)	Ground-water recharge	Suitable for small/ confined sites?	Site-specific restrictions	Appropriate for subject site?
Wetlands	✓	✓	✓	x	x	Insufficient space	No
Retention ponds	✓	✓	✓	x	x	Insufficient space	No
Detention basins	✓	✓	✓	x	x	Insufficient space	No
Infiltration basins	✓	✓	x	✓	x	Insufficient space and poor infiltration	No
Soakaways	x	✓	x	✓	✓	Insufficient space and poor infiltration	No
Underground storage	x	x	✓	x	✓	None	Yes
Swales	✓	✓	✓	✓	x	Insufficient space	No
Filter strips	✓	✓	✓	✓	x	Insufficient space	No
Rainwater harvesting	x	✓	✓	✓	✓	None	Yes
Small Bioretention systems and rain gardens	✓	✓	✓	✓	✓	Limited space, tanked systems only	Yes
Permeable paving	x	✓	✓	✓	✓	Tanked systems only	Yes
Water butts	✓	x	✓	x	✓	None	Yes
Green roofs	✓	✓	✓	x	✓	Located in conservation area, possible use may be restricted	Unknown

Table 6.3 – Suitability of SuDS.

From Table 6.3 there are limited SuDS options available for this site. However, at this stage in the planning process it is envisaged that a combination of water butts and permeable paving will be used to store surface water runoff onsite, before discharging at an attenuated rate to the public sewer system.

6.7 Proposed Surface Water Management Strategy (SWMS)

The drainage strategy which discusses each of the different elements of the proposed scheme is set out below, along with the calculations that have been undertaken to demonstrate how the overall objectives can be achieved. This does not represent a detailed surface water drainage design; it is simply an assessment to demonstrate that the objectives and requirements of the NPPF can be met at the planning stage.

Water Butts – It is possible to incorporate water butts to provide storage for storm water which can then be used to irrigate the gardens and areas of communal open space. By using water butts this can reduce the development's reliance on potable water supplies, as promoted by the London Plan. Typical sizes and dimensions of water butts are outlined below.

Typical House Water Butt Options	Dimensions of a typical house water butt	Volume of storage provided (litres)
Type 1 (wall mounted – Small)	1.22m high x 0.46m x 0.23m	100
Type 2 (Standard house water butt)	0.9m high x 0.68m diameter	210
Type 3 (Large house water butt)	1.26m high x 1.24m x 0.8m	510
Type 4 (Column tank – Very large)	2.23m high x 1.28m diameter	2000

Table 6.4 – Estimated storage capacity of available water butts.

It is recommended that either small wall mounted, or standard sized water butts are considered for inclusion within the proposed drainage system. However, it is recognised that the proposed water butts may be full at the onset of a storm event and for this reason, this additional storage capacity has been excluded from further calculations.

Rain Garden and Rill – Runoff from the patio area within the HMO communal garden can be directed by a small rill or linear drainage channel into a rain garden. This rain garden will need to be planted with species that can tolerate regular inundation of water to depths of approximately 100mm – 200mm. Runoff can be held within the raingarden before being adsorbed by the vegetation, or evaporating. In the event the rain garden has insufficient capacity to accommodate inflows, as is likely to be the case for larger storms, including the design rainfall event, it will need to be designed to include an overflow control to allow excess water to drain into an underlying pipe that is connected to the rest of the drainage for the site.

An additional benefit of the lowered rain garden area is that, in the event the drainage for the rest of the site becomes surcharged and is about to overflow, water is likely to backflow from the overflow pipe, flooding the raingarden and providing a warning to residents/occupants. This is discussed further in the Residual Risk section below.

Raised Water Feature and/or Bioretention – The planters at the front of each property can be designed such that they accept runoff from the adjacent roof areas. The downpipes at the front of the buildings can be drained into these planters, which could also be designed as permanently wet water features if desired by the landscaping team. Small volumes of water can be held within these areas, before overflowing onto the adjacent permeable surfacing or draining through a granular drainage layer into the piped drainage network below. During the design rainfall event it is unlikely that these features will provide any volume of storage for stormwater. However, for lower return period rainfall events, such as the 5mm storm, they are likely to be beneficial. For the purposes of the drainage calculations included within this report, a worst-case situation has been adopted, whereby any raingardens or small ponds are assumed to provide no benefit during the design rainfall event.

Tree Pits – Tree pits can be used to provide additional drainage for the trees incorporated adjacent to the permeable surfacing (discussed below). Runoff from neighbouring areas of hardstanding, such as the bike store, can be drained into the tree pits providing irrigation for the trees. Runoff draining through the soil and granular layers can subsequently flow, via pipes, into the adjacent permeable surfacing, allowing the base of the tree pits to be drained in accordance with the arboriculturist's requirements.

Permeable Surfacing

The proposed parking area can be made permeable and laid atop a porous open graded sub-base, designed to provide storage for stormwater draining from above and defusing into the sub-base via the piped drainage network from across the site. Runoff from the site, including any water overflowing the bioretention systems, water butts, rain garden, or tree pits, can be drained into the sub-base of the permeable surfacing using diffusion pipes or boxes. The outflow from the permeable surfacing system can be controlled using a vortex flow control device (Hydro-Brake or similar). A summary of the permeable surfacing system is provided in Table 6.5 (below).

Parameter	Value
SuDS	Permeable Surfacing
Inflows From	Entire site including, Rain Garden, Bioretention Systems, Water Butts, and Tree Pits.
Total area draining to permeable paving	1061 m^2
Urban Creep Allowance	10%
Area of permeable paving	~ 545 m^2
Sub-Base Porosity	30%
Required sub-base depth	700 mm
Flow control device	Hydro-Brake (designed to discharge at 1.0l/s)
Volume stored within Drainage System during design rainfall event	~ 94m^3
Outfall	Public Surface Water Sewer
Critical storm duration for the permeable surfacing and flow control	360 minutes

Table 6.5 – Summary of permeable surfacing system.

6.8 Hydraulic Drainage Model

A Hydraulic Drainage model has been constructed for the proposed drainage at the site within Causeway Flow +. The sketch tool has been used to simulate drainage runs with dimensions and pipe lengths altered to match dimensions from the drainage layout plan.

For the purposes of this model, storage provided by the tree pits, bioretention systems, water butts, and rain garden have all been excluded, which in turn will maximise the required storage within the permeable surfacing system. This methodology will ensure that the proposals are sufficiently sized and capable of managing runoff from the design rainfall event, even if the other SuDS have no capacity and ground conditions are saturated prior to its onset. The drainage calculations include all of the runoff from across the site, and use FEH point data, CV values of 1.0, and a 10% allowance for increases in hardstanding as a result of Urban Creep. Table 6.6 (below) provides a summary of the pre- and post-development runoff rates calculated from this drainage model.

Return Period	Existing Runoff Rate (l/s)	Proposed Runoff Rate (including attenuation and SuDS) (l/s)	Percentage Reduction
2	38	0.9	98%
10	61	0.9	99%
30	82	0.9	99%
100	**108**	0.9	99%
100 + 40%	150	1.0	99%

Table 6.6 – Summary of pre and post development runoff rates.

From Table 6.6 and the results of the hydraulic model, it is evident that the proposed drainage system will allow for runoff rates to be reduced by more than 98% through the inclusion of SuDS within the scheme. Furthermore, when compared to the greenfield runoff calculations for the site, the proposed flow rates closely replicate the predeveloped greenfield site conditions, achieving the objectives of the NPPF and Local Planning Policy.

6.9 Water Quality, Biodiversity and Amenity

In addition to managing flows into the public sewer system, the SuDS will also provide additional benefits. Some of these are listed below.

- Runoff filtering through the permeable sub-base material will receive a level of treatment, improving the quality of water discharged offsite when compared with a more traditional piped drainage network.

- The trees, bioretention systems and rain garden will all provide further benefits to water quality, as well as providing potential new habitat spaces, improving biodiversity across the site.

- The SuDS have been integrated into the landscaping in a way which minimises their impact on available amenity space, whilst still providing a connection to water, which will provide benefits to the site in terms of amenity. Examples of this include the parking area, which doubles as permeable surfacing and an attenuation system, and the raingardens and bioretention systems, that improve site amenity whilst also managing runoff.

6.10 Indicative Drainage Layout Plan

Figure 6.2 below is an indicative drainage layout plan delineating how the proposed SuDS can be incorporated into the scheme proposals.

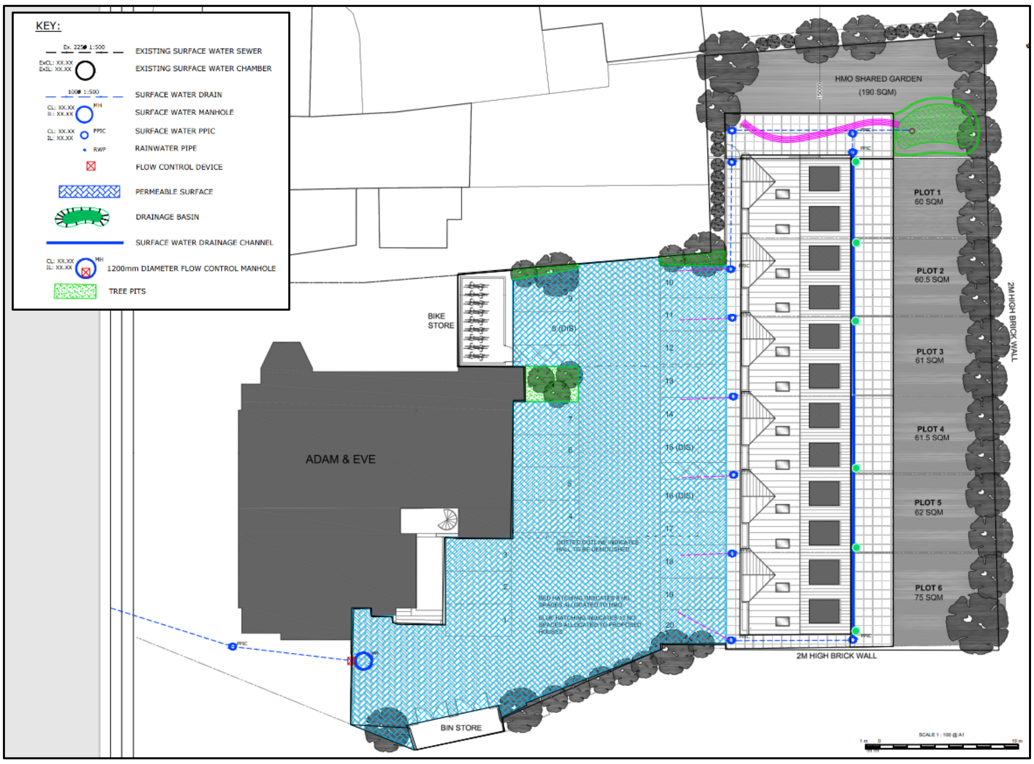


Figure 6.2 – Indicative drainage layout plan showing the proposed location of SuDS.

A full copy of this layout is included in Appendix A.4 of this report.

6.11 Management and Maintenance

For any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime.

The key requirements of any management regime are routine inspection and maintenance. When the development is taken forward to the detailed design stage an 'owner's manual' will need to be prepared. This should include:

- A description of the drainage scheme,
- A location plan showing all of the SuDS and equipment such as flow control devices etc.
- Maintenance requirements for each element, including any manufacturer specific requirements
- An explanation of the consequences of not carrying out the specified maintenance
- Details of who will be responsible for the ongoing maintenance of the drainage system.

For the SuDS recommended by this assessment, the most obvious maintenance tasks will be cleaning the permeable paving, and de-silting the sediment traps and the proposed outflow control device. Regular cleaning and removal of litter (predominantly leaves) may also be required for the bioretention systems and rain garden. Typical Maintenance schedules for the proposed SuDS have been included within Appendix A.5. of this report and these details along with any manufacture specific requirements should be included within the Owner's Manual at the detailed design stage.

For developments such as this that rely to some extent on the ongoing inspection and maintenance of SuDS, it will be necessary to ensure that measures are in place to maintain the system for the lifetime of the development. In this case, there are a combination of communal and plot specific SuDS. For the plot specific SuDS, Water Butts and Bioretention systems, it is envisaged that the residents/occupants will be tasked with the responsibility for ongoing maintenance for the individual properties. For the communal SuDS, one option would be to task the management company that are responsible for maintaining the rest of the site, with the inspection and maintenance of the SuDS.

6.12 Residual Risk

When considering residual risk, it is necessary to consider the impact of a flood event that exceeds the design event, or the implications if the proposed drainage system was to become blocked.

Figure 6.2 (below) shows the route water is likely to take if the drainage system was to fail or become blocked, and water was to overflow the permeable surfacing system or other SuDS onsite.

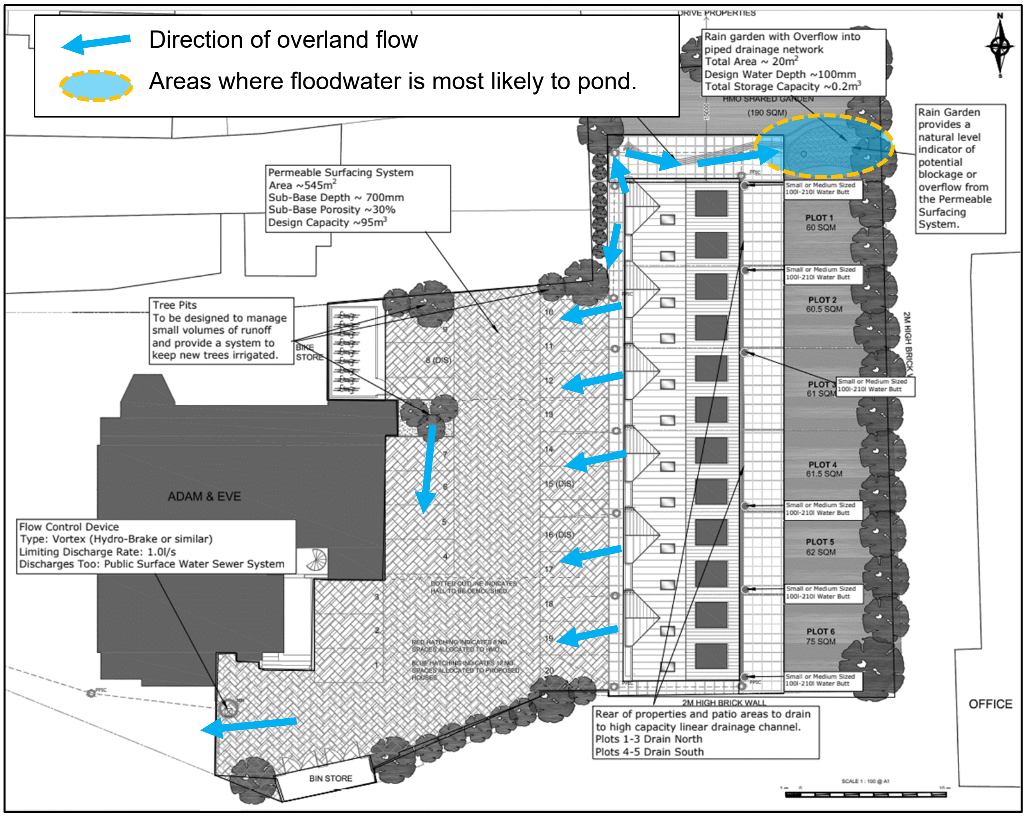


Figure 6.3 – Indicative drawing delineating the potential routes for the overland flow of runoff if the capacity of the drainage system was exceeded.

From Figure 6.3 it is evident that water will be directed away from the properties and across the permeable surfacing system, or towards the raingarden within the HMO communal garden area.

In this case, the rain garden is likely to fill up first, as water backs up within the onsite drainage network and backflows through the overflow pipe used to manage water levels within the raingarden area. This in turn will provide a visual indication to residents/occupants that water levels within the onsite drainage system are rising and can be used as a natural level indicator to initiate immediate inspection of the flow control device manhole for a potential blockage.

Further to this, it is recommended that the outfall chamber and flow control device are fitted with an overflow control system such as a small weir and pipe, that is designed to convey excess flows into the public sewer system in the event of a blockage or exceedance event. This system can be used to minimise the chance of these excess flows impacting surrounding buildings or contributing to flooding.

When all of the above is taken into consideration, alongside the fact the volume of water discharge offsite will be reduced by the proposals (due to the total reduction in impermeable surfacing), it is evident that with the inclusion of the recommended SuDS the proposed drainage system will not increase risk of flooding at the site or within the surrounding area, and the residual risk of flooding from the onsite drainage can be minimised.

7 Conclusions

The key aims and objectives for a development that is to be sustainable in terms of flood risk are summarised in the following bullet points:

- the development should not be at a significant risk of flooding, and should not be susceptible to damage due to flooding.
- the development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, is threatened
- normal operation of the development should not be susceptible to disruption as a result of flooding and safe access to and from the development should be possible during flood events
- the development should not increase flood risk elsewhere
- the development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences by the Environment Agency
- the development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk; the responsibility for any operation and maintenance required should be clearly defined
- the development should not lead to degradation of the environment
- the development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change

In determining whether the proposals for development at Uxbridge Road are sustainable in terms of flood risk and are compliant with the NPPF and its Planning Practice Guidance, all of the above have been taken into consideration as part of this FRA.

From Table 2.1 it can be seen that the proposed development is situated within Flood Zone 1 and is a development type that is classified as being 'more vulnerable'. For such a combination of risk and vulnerability, the NPPF does not require either the Sequential Test or the Exception Test to be applied.

Furthermore, the risk of flooding has been considered across a wide range of sources and it has been identified that the risk of flooding from all sources is low.

In addition to the above, this SWMS has also demonstrated that there is a sustainable solution for managing surface water runoff discharged from the proposed development. The options for managing surface water runoff at the site have been analysed and it is concluded that a new connection to the public surface water sewer system is likely to present the most feasible solution for draining surface water runoff from the proposed development.

The conclusions of the SWMS show that the development has the potential to closely mimic the discharge rates expected for a greenfield site, and can provide a significant betterment when compared to the existing situation. Furthermore, a wide range of SuDS have been used to help integrate water into the built environment in accordance with the objectives of planning policy. Additional benefits with respect to water quality and local biodiversity are also likely to be provided by the inclusion of green SuDS, and this has been achieved by utilising a combination of water butts, raingardens, bioretention systems, tree pits, and permeable paving. This combined drainage system can be used in conjunction with a suitable flow control device, such as a vortex flow control device.

Consequently, it has been shown that the development will meet the requirements of the NPPF, local planning policy, and the London Plan.

7.1 Recommendations

The findings of this report conclude that the development will not increase the risk of flooding at the site, or elsewhere. However, in order to achieve this a number of recommendations are discussed below. These comprise the following:

- The surface water management strategy for the development will need to be developed into a detailed drainage design.
- Before construction can commence a connection agreement for the proposed connection to the public sewer system will be required. Consequently, it will be necessary to contact Thames Water.

With the above mitigation measures incorporated into the design of the development the proposals will meet the requirements of the NPPF and its Planning Practice Guidance and will therefore be acceptable and sustainable in terms of flood risk.

8 Appendices

Appendix A.1 – Drawings

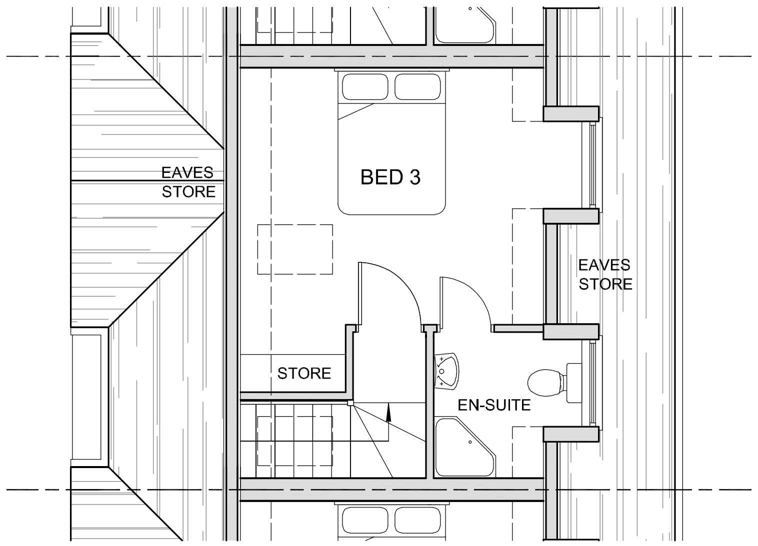
Appendix A.2 – Thames Water Asset Location Data

Appendix A.3 – Surface Water Management Calculations

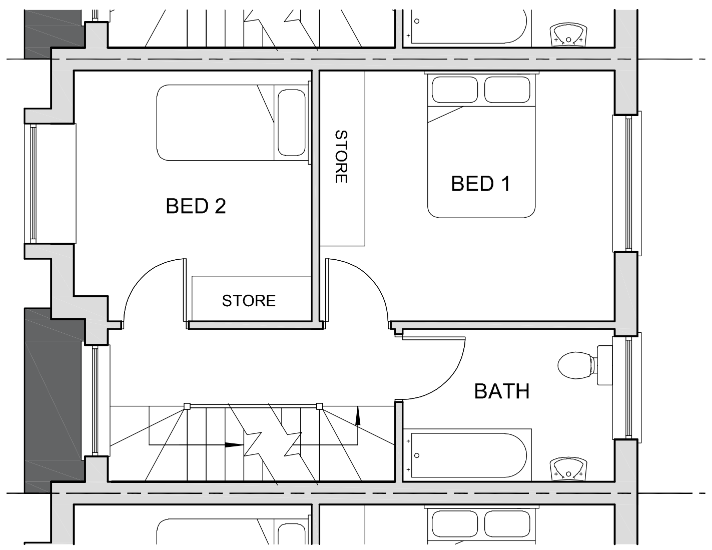
Appendix A.4 – Indicative Drainage Layout

Appendix A.5 – Maintenance and Management Schedules

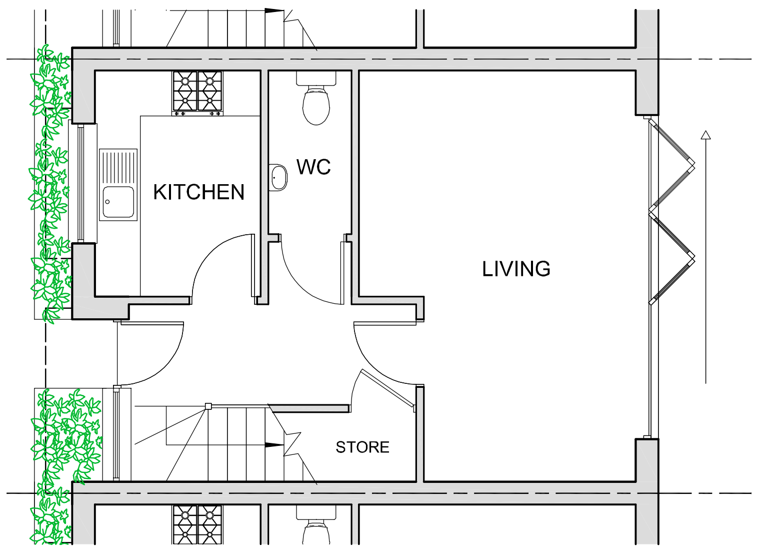
Appendix A.1 – Drawings



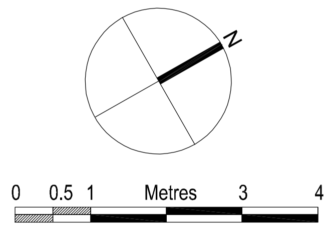
PROPOSED LOFT FLOOR PLAN
(20 SQM)



PROPOSED FIRST FLOOR PLAN
(37 SQM)



PROPOSED GROUND FLOOR PLAN
(37 SQM)



INTERNAL LAYOUT	NOV 2021	A
AMENDMENTS	DATE	REV.

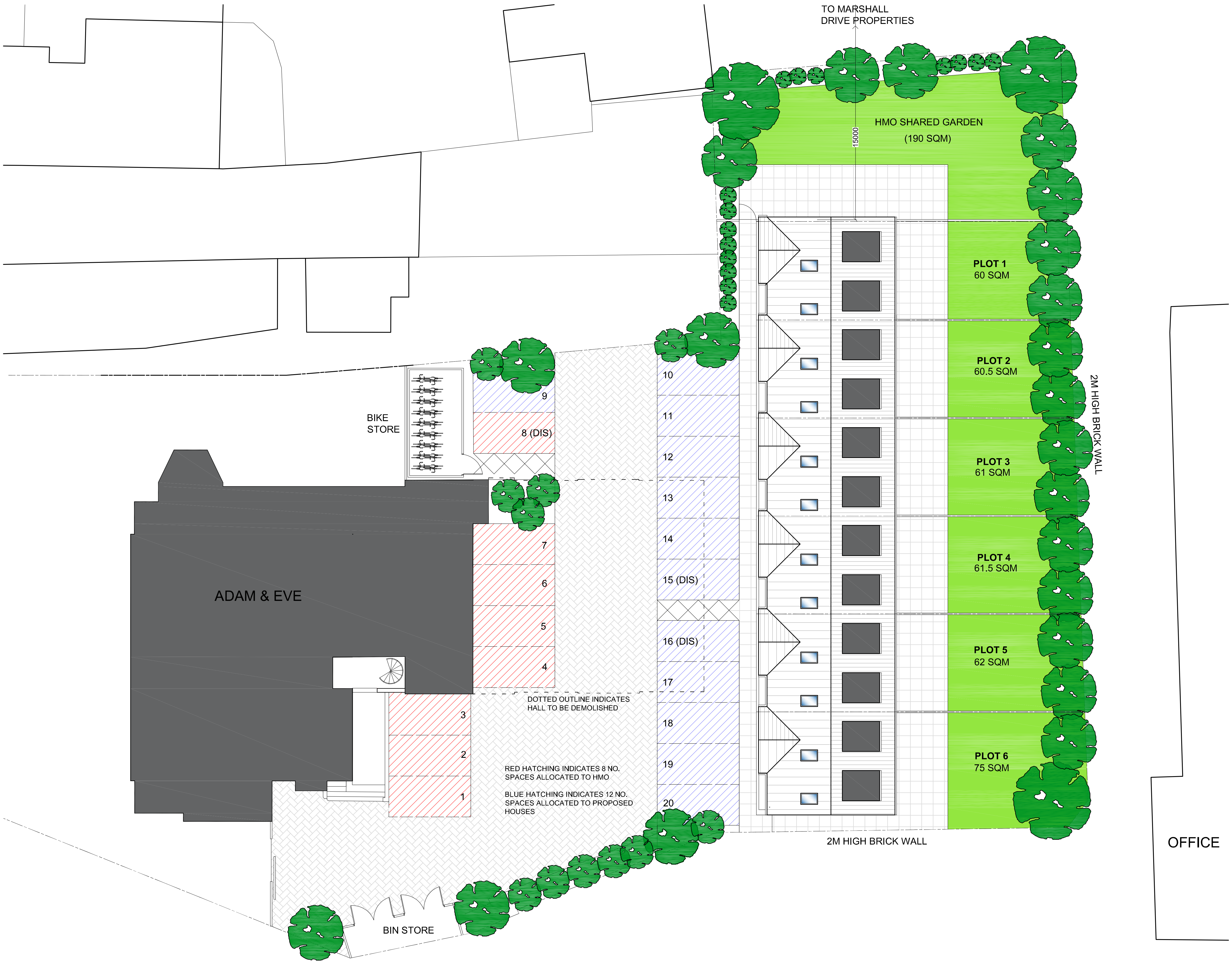
bernard murray design
chartered architect
WWW.BMURRAYDESIGN.CO.UK
78 BRIDGE ROAD, UXBRIDGE, MIDDLESEX UB82QW
TEL: 07958 471714 EMAIL: BMURRAYDESIGN@YAHOO.CO.UK

PROJECT
ADAM & EVE PUBLIC HOUSE
830 UXBRIDGE ROAD
HAYES
UB4 0RR

CLIENT
YAMUNA HOUSE LTD

DRAWING
TYPICAL HOUSE PLANS

SCALE	1:100 @ A3	DRAWING NUMBER	REV.
DATE	SEPT 2021	1129-17	A
DRAWN	BM		



AMENDMENTS	DATE	REV.

bernard murray design
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WWW.BMURRAYDESIGN.CO.UK
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TEL: 07958 471714 EMAIL: BMURRAYDESIGN@YAHOO.CO.UK

PROJECT
ADAM & EVE PUBLIC HOUSE
830 UXBRIDGE ROAD
HAYES
UB4 0RR

CLIENT
YAMUNA HOUSE LTD

DRAWING
PROPOSED SITE PLAN

SCALE	1:200 @ A3	DRAWING NUMBER	REV.
DATE	OCT 2021	1129-21	
DRAWN	BM		

Appendix A.2 – Thames Water Asset Location Data

Asset location search

Property Searches

Herrington Consulting Limited
Barham Business Park,Unit 6 Barham Business Park

CANTERBURY
CT4 6DQ

Search address supplied	Adam & Eve 830 Uxbridge Road Hayes UB4 0RR
Your reference	EG/1768
Our reference	ALS/ALS Standard/2022_4590972
Search date	17 February 2022

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0800 009 4540

Asset location search

Thames Water Property Searches

Search address supplied: Adam & Eve, 830, Uxbridge Road, Hayes, UB4 0RR

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0800 009 4540, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Affinity Water Ltd
Tamblin Way
Hatfield
AL10 9EZ
Tel: 0345 3572401

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

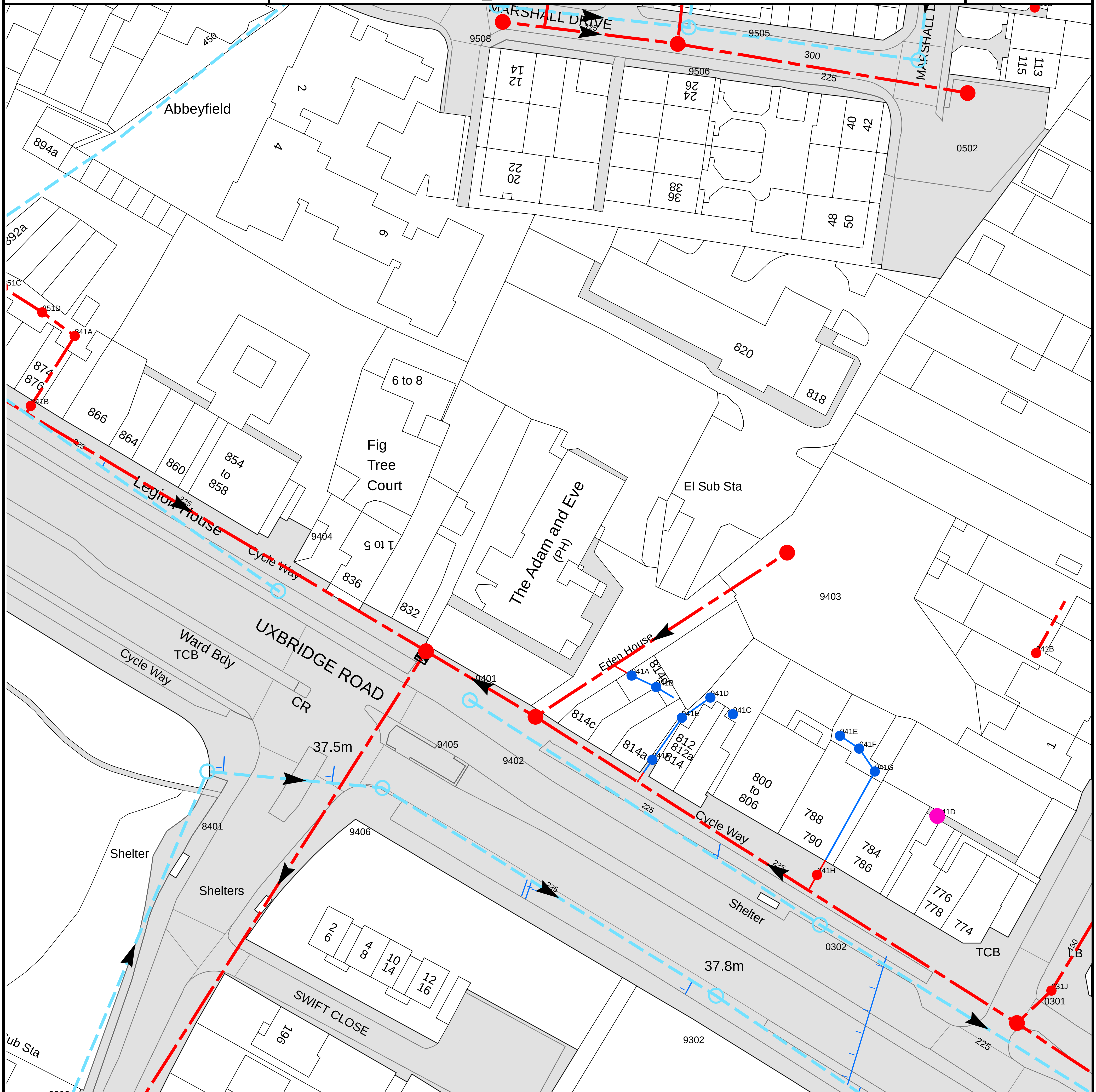
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2022_4590972



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 509956,181460

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.

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
0301	37.45	35.15
031J	n/a	n/a
0302	n/a	n/a
041H	n/a	n/a
041D	n/a	n/a
041G	n/a	n/a
041F	n/a	n/a
041E	n/a	n/a
041B	n/a	n/a
9403	n/a	n/a
0502	n/a	n/a
0501	n/a	n/a
051B	n/a	n/a
9302	n/a	n/a
9406	n/a	n/a
8401	n/a	n/a
941F	n/a	n/a
941E	n/a	n/a
9402	n/a	n/a
941C	n/a	n/a
9405	n/a	n/a
941D	n/a	n/a
941B	n/a	n/a
941A	n/a	n/a
9401	n/a	n/a
9404	n/a	n/a
841B	n/a	n/a
841A	n/a	n/a
851D	n/a	n/a
9506	n/a	n/a
9505	n/a	n/a
9508	n/a	n/a
9507	n/a	n/a

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.

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

- Storm Sewer
- Sludge Sewer
- Foul Trunk Sewer
- Surface Trunk Sewer
- Combined Trunk Sewer
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Vacuum
- Thames Water Proposed
- Vent Pipe
- Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

- Sewer
- Culverted Watercourse
- Proposed
- Decommissioned Sewer
- Content of this drainage network is currently unknown
- Ownership of this drainage network is currently unknown

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
- Meter
- Dam Chase
- Vent
- Fitting

Operational Controls

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

- Ancillary
- Drop Pipe
- Control Valve
- 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.

- Inlet
- Outfall
- Undefined End

Other Symbols

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

- Change of Characteristic Indicator
- Public / Private Pumping Station
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Chamber
- Operational Site

Ducts or Crossings

- Casement
- Conduit Bridge
- Subway
- Tunnel

Ducts may contain high voltage cables. Please check with Thames Water.

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the 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 indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters. 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, please contact Property Searches on 0800 009 4540.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to her at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

Credit Card	BACS Payment	Telephone Banking	Cheque
Call **0800 009 4540** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

Appendix A.3 – Surface Water Management Calculations

Design Settings

Rainfall Methodology	FEH-13	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	0.200
Return Period (years)	100	Maximum Rainfall (mm/hr)	200.0	Include Intermediate Ground	✓
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	1.000	Connection Type	Level Inverts		
Time of Entry (mins)	4.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Existing	0.145	4.00	10.000	1000	0.000	0.000	1.000
Existing1			10.000	1000	0.000	10.000	2.000
Plot 1	0.002	4.00	10.000	1200	37.531	38.445	0.720
Virtial MH at Inlet to Permeable Surfacing	0.064	4.00	10.000	300	37.293	22.600	1.000
Permeable Surfacing			10.000	1500	25.759	22.469	2.000
Plot 6	0.002	4.00	10.000	1200	37.799	5.510	0.629
Plot 2	0.002	4.00	10.000	1200	41.220	29.725	0.300
Plot 3	0.002	4.00	10.000	1200	41.354	25.499	0.300
Plot 4	0.002	4.00	10.000	1200	41.220	21.206	0.300
Plot 5	0.002	4.00	10.000	1200	41.690	16.443	0.300
MH1			10.000	1200	54.064	38.465	0.630
Plots 1-3 Rear	0.012	4.00	10.000	1200	54.233	24.090	0.350
Plots 4-6 Rear	0.012	4.00	10.000	1200	54.311	21.474	0.350
MH2			10.000	1200	54.166	4.436	0.539
HMO Patio	0.004	4.00	10.000	1200	44.708	41.263	0.300
Rain Garden			9.900	1200	59.081	39.105	0.445

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)
E.Pipline	Existing	Existing1	10.000	0.060	9.000	8.000	1.000	10.0
1.003	Plot 1	Virtial MH at Inlet to Permeable Surfacing	19.000	0.600	9.280	9.000	0.280	67.9
P.Pipeline	Virtial MH at Inlet to Permeable Surfacing	Permeable Surfacing	11.535	0.060	9.000	8.000	1.000	11.5
3.002	Plot 6	Virtial MH at Inlet to Permeable Surfacing	17.097	0.600	9.371	9.201	0.170	100.6
3.001	MH2	Plot 6	9.000	0.600	9.461	9.371	0.090	100.0
1.002	MH1	Plot 1	9.000	0.600	9.370	9.280	0.090	100.0
2.000	Plots 1-3 Rear	MH1	19.000	0.600	9.650	9.370	0.280	67.9
3.000	Plots 4-6 Rear	MH2	19.000	0.600	9.650	9.461	0.189	100.5
5.000	Plot 5	Virtial MH at Inlet to Permeable Surfacing	7.566	0.600	9.700	9.572	0.128	59.1
7.000	Plot 4	Virtial MH at Inlet to Permeable Surfacing	4.167	0.600	9.700	9.629	0.071	58.7
6.000	Plot 3	Virtial MH at Inlet to Permeable Surfacing	4.990	0.600	9.700	9.616	0.084	59.4
4.000	Plot 2	Virtial MH at Inlet to Permeable Surfacing	8.136	0.600	9.700	9.563	0.137	59.4
1.000	HMO Patio	Rain Garden	14.534	0.600	9.700	9.455	0.245	59.3
1.001	Rain Garden	MH1	5.058	0.600	9.455	9.370	0.085	59.5

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
E.Pipline	13.289	10436.9	146.7	0.000	1.000	0.145	0.0	80	5.070
1.003	1.222	21.6	17.6	0.570	0.850	0.018	0.0	103	1.360
P.Pipeline	5.973	422.2	102.0	0.700	1.700	0.104	0.0	99	4.965
3.002	1.002	17.7	13.7	0.479	0.649	0.014	0.0	99	1.104
3.001	1.005	17.8	11.8	0.389	0.479	0.012	0.0	89	1.073
1.002	1.005	17.8	15.7	0.480	0.570	0.016	0.0	110	1.132
2.000	1.222	21.6	11.8	0.200	0.480	0.012	0.0	79	1.247
3.000	1.002	17.7	11.8	0.200	0.389	0.012	0.0	89	1.070
5.000	1.004	7.9	2.0	0.200	0.328	0.002	0.0	34	0.833
7.000	1.007	7.9	2.0	0.200	0.271	0.002	0.0	34	0.836
6.000	1.001	7.9	2.0	0.200	0.284	0.002	0.0	34	0.831
4.000	1.001	7.9	2.0	0.200	0.337	0.002	0.0	34	0.831
1.000	1.002	7.9	3.9	0.200	0.345	0.004	0.0	50	0.998
1.001	1.000	7.9	3.9	0.345	0.530	0.004	0.0	50	0.997

Pipeline Schedule

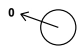
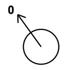
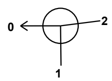
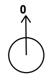
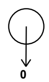
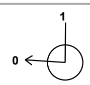
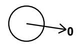
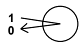
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
E.Pipline	10.000	10.0	1000	Circular	10.000	9.000	0.000	10.000	8.000	1.000
1.003	19.000	67.9	150	Circular	10.000	9.280	0.570	10.000	9.000	0.850
P.Pipeline	11.535	11.5	300	Circular	10.000	9.000	0.700	10.000	8.000	1.700
3.002	17.097	100.6	150	Circular	10.000	9.371	0.479	10.000	9.201	0.649
3.001	9.000	100.0	150	Circular	10.000	9.461	0.389	10.000	9.371	0.479
1.002	9.000	100.0	150	Circular	10.000	9.370	0.480	10.000	9.280	0.570
2.000	19.000	67.9	150	Circular	10.000	9.650	0.200	10.000	9.370	0.480
3.000	19.000	100.5	150	Circular	10.000	9.650	0.200	10.000	9.461	0.389
5.000	7.566	59.1	100	Circular	10.000	9.700	0.200	10.000	9.572	0.328
7.000	4.167	58.7	100	Circular	10.000	9.700	0.200	10.000	9.629	0.271
6.000	4.990	59.4	100	Circular	10.000	9.700	0.200	10.000	9.616	0.284
4.000	8.136	59.4	100	Circular	10.000	9.700	0.200	10.000	9.563	0.337
1.000	14.534	59.3	100	Circular	10.000	9.700	0.200	9.900	9.455	0.345
1.001	5.058	59.5	100	Circular	9.900	9.455	0.345	10.000	9.370	0.530

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
E.Pipline	Existing	1000	Manhole	Adoptable	Existing1	1000	Manhole	Adoptable
1.003	Plot 1	1200	Manhole	Adoptable	Virtial MH at Inlet to Permeable Surfacing	300	Manhole	Adoptable
P.Pipeline	Virtial MH at Inlet to Permeable Surfacing	300	Manhole	Adoptable	Permeable Surfacing	1500	Manhole	Adoptable
3.002	Plot 6	1200	Manhole	Adoptable	Virtial MH at Inlet to Permeable Surfacing	300	Manhole	Adoptable
3.001	MH2	1200	Manhole	Adoptable	Plot 6	1200	Manhole	Adoptable
1.002	MH1	1200	Manhole	Adoptable	Plot 1	1200	Manhole	Adoptable
2.000	Plots 1-3 Rear	1200	Manhole	Adoptable	MH1	1200	Manhole	Adoptable
3.000	Plots 4-6 Rear	1200	Manhole	Adoptable	MH2	1200	Manhole	Adoptable
5.000	Plot 5	1200	Manhole	Adoptable	Virtial MH at Inlet to Permeable Surfacing	300	Manhole	Adoptable
7.000	Plot 4	1200	Manhole	Adoptable	Virtial MH at Inlet to Permeable Surfacing	300	Manhole	Adoptable
6.000	Plot 3	1200	Manhole	Adoptable	Virtial MH at Inlet to Permeable Surfacing	300	Manhole	Adoptable
4.000	Plot 2	1200	Manhole	Adoptable	Virtial MH at Inlet to Permeable Surfacing	300	Manhole	Adoptable
1.000	HMO Patio	1200	Manhole	Adoptable	Rain Garden	1200	Manhole	Adoptable
1.001	Rain Garden	1200	Manhole	Adoptable	MH1	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Existing	0.000	0.000	10.000	1.000	1000	0	E.Pipline	9.000	1000
Existing1	0.000	10.000	10.000	2.000	1000	1	E.Pipline	8.000	1000
Plot 1	37.531	38.445	10.000	0.720	1200	1	1.002	9.280	150
						0	1.003	9.280	150
Virtial MH at Inlet to Permeable Surfacing	37.293	22.600	10.000	1.000	300	1	7.000	9.629	100
						2	6.000	9.616	100
						3	5.000	9.572	100
						4	4.000	9.563	100
						5	3.002	9.201	150
						6	1.003	9.000	150
						0	P.Pipeline	9.000	300
Permeable Surfacing	25.759	22.469	10.000	2.000	1500	1	P.Pipeline	8.000	300
Plot 6	37.799	5.510	10.000	0.629	1200	1	3.001	9.371	150
						0	3.002	9.371	150
Plot 2	41.220	29.725	10.000	0.300	1200	0	4.000	9.700	100
Plot 3	41.354	25.499	10.000	0.300	1200	0	6.000	9.700	100

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
Plot 4	41.220	21.206	10.000	0.300	1200		0	7.000	9.700	100
Plot 5	41.690	16.443	10.000	0.300	1200		0	5.000	9.700	100
MH1	54.064	38.465	10.000	0.630	1200		1	2.000	9.370	150
							2	1.001	9.370	100
							0	1.002	9.370	150
Plots 1-3 Rear	54.233	24.090	10.000	0.350	1200		0	2.000	9.650	150
Plots 4-6 Rear	54.311	21.474	10.000	0.350	1200		0	3.000	9.650	150
MH2	54.166	4.436	10.000	0.539	1200		1	3.000	9.461	150
							0	3.001	9.461	150
HMO Patio	44.708	41.263	10.000	0.300	1200		0	1.000	9.700	100
Rain Garden	59.081	39.105	9.900	0.445	1200		1	1.000	9.455	100
							0	1.001	9.455	100

Simulation Settings

Rainfall Methodology	FEH-13	Winter CV	1.000	Skip Steady State	✓	Additional Storage (m^3/ha)	0.0	Check Discharge Volume	x
Summer CV	1.000	Analysis Speed	Detailed	Drain Down Time (mins)	1000	Check Discharge Rate(s)	x		

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440	2160	2880	4320	5760	7200	8640	10080

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0	30	0	0	0
2	40	10	0	30	40	10	0
10	0	0	0	100	0	0	0
10	40	10	0	100	40	10	0

Node Permeable Surfacing Online Hydro-Brake® Control

Flap Valve	x	Design Flow (l/s)	1.0	Min Outlet Diameter (m)	0.075
Replaces Downstream Link	✓	Objective	(HE) Minimise upstream storage	Min Node Diameter (mm)	1200
Invert Level (m)	8.000	Sump Available	✓		
Design Depth (m)	1.800	Product Number	CTL-SHE-0041-1000-1800-1000		

Node Permeable Surfacing Online Weir Control

Flap Valve	x	Replaces Downstream Link	✓	Invert Level (m)	9.999	Width (m)	1.000	Discharge Coefficient	0.590

Node Permeable Surfacing Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Width (m)	23.000	Depth (m)	0.700
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	9.300	Length (m)	23.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	856	Slope (1:X)	1000.0		

Results for 2 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.038	0.038	28.1	0.0300	0.0000	OK
15 minute summer	Existing1	10	8.035	0.035	28.1	0.0000	0.0000	OK
240 minute winter	Plot 1	188	9.367	0.087	0.8	0.0984	0.0000	OK
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	188	9.367	0.367	4.3	0.0261	0.0000	SURCHARGED
240 minute winter	Permeable Surfacing	184	9.367	1.367	5.0	11.2325	0.0000	OK
15 minute summer	Plot 6	10	9.410	0.039	2.7	0.0442	0.0000	OK
15 minute summer	Plot 2	10	9.715	0.015	0.4	0.0174	0.0000	OK
15 minute summer	Plot 3	10	9.716	0.016	0.4	0.0177	0.0000	OK
15 minute summer	Plot 4	10	9.716	0.016	0.4	0.0177	0.0000	OK
15 minute summer	Plot 5	10	9.715	0.015	0.4	0.0175	0.0000	OK
15 minute summer	MH1	10	9.414	0.044	3.1	0.0492	0.0000	OK
15 minute summer	Plots 1-3 Rear	10	9.683	0.033	2.3	0.0374	0.0000	OK
15 minute summer	Plots 4-6 Rear	10	9.687	0.037	2.3	0.0419	0.0000	OK
15 minute summer	MH2	10	9.498	0.037	2.3	0.0423	0.0000	OK
15 minute summer	HMO Patio	10	9.722	0.022	0.8	0.0248	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	28.1	0.0881	10.9
240 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	0.7	0.2679	
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	5.0	0.8123	
240 minute winter	Permeable Surfacing	Hydro-Brake®		0.9		23.4
240 minute winter	Permeable Surfacing	Weir		0.0		0.0
15 minute summer	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	2.6	0.1734	
15 minute summer	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	0.4	0.0061	
15 minute summer	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	0.4	0.0038	
15 minute summer	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	0.4	0.0032	
15 minute summer	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	0.4	0.0057	
15 minute summer	MH1	1.002	Plot 1	3.0	0.0357	
15 minute summer	Plots 1-3 Rear	2.000	MH1	2.3	0.0675	
15 minute summer	Plots 4-6 Rear	3.000	MH2	2.3	0.0646	
15 minute summer	MH2	3.001	Plot 6	2.3	0.0318	
15 minute summer	HMO Patio	1.000	Rain Garden	0.8	0.0180	

Results for 2 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Rain Garden	10	9.476	0.021	0.8	0.0239	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Rain Garden	1.001	MH1	0.8	0.0113	

Results for 2 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.047	0.047	43.3	0.0372	0.0000	OK
15 minute summer	Existing1	10	8.043	0.043	43.3	0.0000	0.0000	OK
360 minute winter	Plot 1	272	9.430	0.150	0.9	0.1700	0.0000	SURCHARGED
360 minute winter	Virtial MH at Inlet to Permeable Surfacing	272	9.430	0.430	4.9	0.0306	0.0000	SURCHARGED
360 minute winter	Permeable Surfacing	280	9.430	1.430	4.8	21.3890	0.0000	OK
360 minute winter	Plot 6	288	9.430	0.059	0.7	0.0671	0.0000	OK
15 minute summer	Plot 2	10	9.719	0.019	0.6	0.0215	0.0000	OK
15 minute summer	Plot 3	10	9.719	0.019	0.6	0.0218	0.0000	OK
15 minute summer	Plot 4	10	9.719	0.019	0.6	0.0218	0.0000	OK
15 minute summer	Plot 5	10	9.719	0.019	0.6	0.0215	0.0000	OK
360 minute winter	MH1	280	9.430	0.060	0.8	0.0682	0.0000	OK
15 minute summer	Plots 1-3 Rear	10	9.691	0.041	3.6	0.0468	0.0000	OK
15 minute summer	Plots 4-6 Rear	10	9.697	0.047	3.6	0.0528	0.0000	OK
15 minute summer	MH2	10	9.509	0.048	3.6	0.0539	0.0000	OK
15 minute summer	HMO Patio	10	9.727	0.027	1.2	0.0305	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	43.3	0.1222	16.8
360 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	0.8	0.3344	
360 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	4.8	0.8123	
360 minute winter	Permeable Surfacing	Hydro-Brake®		0.9		39.8
360 minute winter	Permeable Surfacing	Weir		0.0		0.0
360 minute winter	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	0.7	0.2058	
15 minute summer	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	0.6	0.0083	
15 minute summer	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	0.6	0.0051	
15 minute summer	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	0.6	0.0043	
15 minute summer	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	0.6	0.0077	
360 minute winter	MH1	1.002	Plot 1	0.8	0.1090	
15 minute summer	Plots 1-3 Rear	2.000	MH1	3.6	0.0939	
15 minute summer	Plots 4-6 Rear	3.000	MH2	3.6	0.0901	
15 minute summer	MH2	3.001	Plot 6	3.6	0.0441	
15 minute summer	HMO Patio	1.000	Rain Garden	1.2	0.0242	

Results for 2 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Rain Garden	10	9.481	0.026	1.2	0.0297	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Rain Garden	1.001	MH1	1.2	0.0155	

Results for 10 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.056	0.056	61.1	0.0443	0.0000	OK
15 minute summer	Existing1	10	8.050	0.050	61.1	0.0000	0.0000	OK
180 minute winter	Plot 1	176	9.466	0.186	1.6	0.2108	0.0000	SURCHARGED
180 minute winter	Virtial MH at Inlet to Permeable Surfacing	176	9.466	0.466	9.2	0.0331	0.0000	SURCHARGED
180 minute winter	Permeable Surfacing	176	9.466	1.466	9.1	27.1883	0.0000	OK
180 minute winter	Plot 6	176	9.466	0.095	1.3	0.1079	0.0000	OK
15 minute summer	Plot 2	10	9.722	0.022	0.8	0.0249	0.0000	OK
15 minute summer	Plot 3	10	9.722	0.022	0.8	0.0252	0.0000	OK
15 minute summer	Plot 4	10	9.722	0.022	0.8	0.0253	0.0000	OK
15 minute summer	Plot 5	10	9.722	0.022	0.8	0.0249	0.0000	OK
180 minute winter	MH1	172	9.466	0.096	1.5	0.1089	0.0000	OK
15 minute summer	Plots 1-3 Rear	10	9.700	0.050	5.1	0.0560	0.0000	OK
15 minute summer	Plots 4-6 Rear	10	9.706	0.056	5.1	0.0637	0.0000	OK
15 minute summer	MH2	10	9.519	0.058	5.1	0.0656	0.0000	OK
15 minute summer	HMO Patio	10	9.732	0.032	1.7	0.0365	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	61.1	0.1587	23.7
180 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	1.5	0.3345	
180 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	9.1	0.8123	
180 minute winter	Permeable Surfacing	Hydro-Brake®		0.9		39.2
180 minute winter	Permeable Surfacing	Weir		0.0		0.0
180 minute winter	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	1.3	0.2515	
15 minute summer	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	0.8	0.0102	
15 minute summer	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	0.8	0.0063	
15 minute summer	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	0.8	0.0053	
15 minute summer	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	0.8	0.0095	
180 minute winter	MH1	1.002	Plot 1	1.4	0.1330	
15 minute summer	Plots 1-3 Rear	2.000	MH1	5.1	0.1205	
15 minute summer	Plots 4-6 Rear	3.000	MH2	5.1	0.1170	
15 minute summer	MH2	3.001	Plot 6	5.1	0.0571	
15 minute summer	HMO Patio	1.000	Rain Garden	1.7	0.0312	

Results for 10 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Rain Garden	10	9.487	0.032	1.7	0.0356	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Rain Garden	1.001	MH1	1.7	0.0194	

Results for 10 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.071	0.071	93.9	0.0561	0.0000	OK
15 minute summer	Existing1	10	8.061	0.061	94.0	0.0000	0.0000	OK
240 minute winter	Plot 1	232	9.597	0.317	1.8	0.3581	0.0000	SURCHARGED
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	236	9.597	0.597	10.8	0.0424	0.0000	SURCHARGED
240 minute winter	Permeable Surfacing	236	9.597	1.597	10.7	48.0916	0.0000	OK
240 minute winter	Plot 6	232	9.597	0.226	1.5	0.2551	0.0000	SURCHARGED
15 minute summer	Plot 2	10	9.728	0.028	1.3	0.0320	0.0000	OK
15 minute summer	Plot 3	10	9.729	0.029	1.3	0.0326	0.0000	OK
15 minute summer	Plot 4	10	9.729	0.029	1.3	0.0327	0.0000	OK
15 minute summer	Plot 5	10	9.728	0.028	1.3	0.0321	0.0000	OK
240 minute winter	MH1	232	9.597	0.227	1.7	0.2563	0.0000	SURCHARGED
15 minute summer	Plots 1-3 Rear	10	9.712	0.062	7.8	0.0704	0.0000	OK
15 minute summer	Plots 4-6 Rear	10	9.722	0.072	7.8	0.0812	0.0000	OK
240 minute winter	MH2	232	9.597	0.136	1.3	0.1533	0.0000	OK
15 minute summer	HMO Patio	10	9.741	0.041	2.6	0.0460	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	94.0	0.2200	36.5
240 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	1.6	0.3345	
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	10.7	0.8123	
240 minute winter	Permeable Surfacing	Hydro-Brake®		1.0		64.9
240 minute winter	Permeable Surfacing	Weir		0.0		0.0
240 minute winter	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	1.4	0.3010	
15 minute summer	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	1.3	0.0145	
15 minute summer	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	1.3	0.0090	
15 minute summer	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	1.3	0.0075	
15 minute summer	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	1.3	0.0135	
240 minute winter	MH1	1.002	Plot 1	1.6	0.1584	
15 minute summer	Plots 1-3 Rear	2.000	MH1	7.8	0.2130	
15 minute summer	Plots 4-6 Rear	3.000	MH2	7.8	0.1623	
240 minute winter	MH2	3.001	Plot 6	1.3	0.1546	
15 minute summer	HMO Patio	1.000	Rain Garden	2.6	0.0481	

Results for 10 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	Rain Garden	232	9.597	0.142	0.4	0.1602	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	Rain Garden	1.001	MH1	0.4	0.0396	

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.067	0.067	82.3	0.0523	0.0000	OK
15 minute summer	Existing1	10	8.058	0.058	82.4	0.0000	0.0000	OK
240 minute winter	Plot 1	236	9.539	0.259	1.6	0.2930	0.0000	SURCHARGED
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	232	9.539	0.539	9.4	0.0383	0.0000	SURCHARGED
240 minute winter	Permeable Surfacing	232	9.539	1.539	9.3	38.8532	0.0000	OK
240 minute winter	Plot 6	232	9.539	0.168	1.3	0.1901	0.0000	SURCHARGED
15 minute summer	Plot 2	10	9.726	0.026	1.1	0.0293	0.0000	OK
15 minute summer	Plot 3	10	9.726	0.026	1.1	0.0298	0.0000	OK
15 minute summer	Plot 4	10	9.726	0.026	1.1	0.0299	0.0000	OK
15 minute summer	Plot 5	10	9.726	0.026	1.1	0.0294	0.0000	OK
240 minute winter	MH1	236	9.539	0.169	1.5	0.1912	0.0000	SURCHARGED
15 minute summer	Plots 1-3 Rear	10	9.708	0.058	6.8	0.0653	0.0000	OK
15 minute summer	Plots 4-6 Rear	10	9.716	0.066	6.8	0.0749	0.0000	OK
240 minute winter	MH2	232	9.539	0.078	1.1	0.0883	0.0000	OK
15 minute summer	HMO Patio	10	9.738	0.038	2.3	0.0430	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	82.4	0.1988	32.0
240 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	1.5	0.3345	
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	9.3	0.8123	
240 minute winter	Permeable Surfacing	Hydro-Brake®		0.9		54.9
240 minute winter	Permeable Surfacing	Weir		0.0		0.0
240 minute winter	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	1.3	0.3010	
15 minute summer	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	1.1	0.0129	
15 minute summer	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	1.1	0.0080	
15 minute summer	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	1.1	0.0067	
15 minute summer	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	1.1	0.0120	
240 minute winter	MH1	1.002	Plot 1	1.4	0.1584	
15 minute summer	Plots 1-3 Rear	2.000	MH1	6.8	0.1599	
15 minute summer	Plots 4-6 Rear	3.000	MH2	6.8	0.1459	
240 minute winter	MH2	3.001	Plot 6	1.1	0.1209	
15 minute summer	HMO Patio	1.000	Rain Garden	2.3	0.0390	

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	Rain Garden	236	9.539	0.084	0.4	0.0951	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	Rain Garden	1.001	MH1	0.4	0.0376	

Results for 30 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.084	0.084	126.7	0.0660	0.0000	OK
15 minute summer	Existing1	10	8.070	0.070	126.8	0.0000	0.0000	OK
240 minute winter	Plot 1	236	9.718	0.438	2.3	0.4956	0.0000	FLOOD RISK
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	236	9.718	0.718	14.2	0.0510	0.0000	FLOOD RISK
240 minute winter	Permeable Surfacing	236	9.718	1.718	14.1	67.5999	0.0000	OK
240 minute winter	Plot 6	236	9.718	0.347	2.0	0.3927	0.0000	FLOOD RISK
15 minute summer	Plot 2	10	9.733	0.033	1.7	0.0370	0.0000	OK
15 minute summer	Plot 3	10	9.733	0.033	1.7	0.0377	0.0000	OK
15 minute summer	Plot 4	10	9.734	0.034	1.7	0.0379	0.0000	OK
15 minute summer	Plot 5	10	9.733	0.033	1.7	0.0370	0.0000	OK
240 minute winter	MH1	236	9.718	0.348	2.1	0.3938	0.0000	FLOOD RISK
15 minute summer	Plots 1-3 Rear	10	9.724	0.074	10.5	0.0833	0.0000	OK
15 minute summer	Plots 4-6 Rear	10	9.736	0.086	10.5	0.0978	0.0000	OK
240 minute winter	MH2	236	9.718	0.257	1.7	0.2909	0.0000	FLOOD RISK
15 minute summer	HMO Patio	9	9.747	0.047	3.5	0.0537	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	126.8	0.2761	49.2
240 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	2.2	0.3345	
240 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	14.1	0.8123	
240 minute winter	Permeable Surfacing	Hydro-Brake®		1.0		68.7
240 minute winter	Permeable Surfacing	Weir		0.0		0.0
240 minute winter	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	1.7	0.3010	
15 minute summer	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	1.7	0.0177	
15 minute summer	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	1.7	0.0110	
15 minute summer	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	1.7	0.0092	
15 minute summer	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	1.7	0.0164	
240 minute winter	MH1	1.002	Plot 1	2.0	0.1584	
15 minute summer	Plots 1-3 Rear	2.000	MH1	10.5	0.2489	
15 minute summer	Plots 4-6 Rear	3.000	MH2	10.5	0.2054	
240 minute winter	MH2	3.001	Plot 6	1.7	0.1584	
15 minute summer	HMO Patio	1.000	Rain Garden	3.5	0.0829	

Results for 30 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	Rain Garden	236	9.718	0.263	0.6	0.2976	0.0000	FLOOD RISK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	Rain Garden	1.001	MH1	0.5	0.0396	

Results for 100 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.077	0.077	107.5	0.0602	0.0000	OK
15 minute summer	Existing1	10	8.065	0.065	107.5	0.0000	0.0000	OK
360 minute winter	Plot 1	344	9.641	0.361	1.5	0.4085	0.0000	SURCHARGED
360 minute winter	Virtial MH at Inlet to Permeable Surfacing	352	9.641	0.641	9.2	0.0455	0.0000	SURCHARGED
360 minute winter	Permeable Surfacing	352	9.641	1.641	9.1	55.2610	0.0000	OK
360 minute winter	Plot 6	352	9.641	0.270	1.3	0.3057	0.0000	SURCHARGED
15 minute summer	Plot 2	10	9.731	0.031	1.5	0.0346	0.0000	OK
15 minute summer	Plot 3	10	9.731	0.031	1.5	0.0352	0.0000	OK
15 minute summer	Plot 4	10	9.731	0.031	1.5	0.0354	0.0000	OK
15 minute summer	Plot 5	10	9.731	0.031	1.5	0.0346	0.0000	OK
360 minute winter	MH1	344	9.641	0.271	1.4	0.3068	0.0000	SURCHARGED
15 minute summer	Plots 1-3 Rear	10	9.717	0.067	8.9	0.0757	0.0000	OK
15 minute summer	Plots 4-6 Rear	10	9.728	0.078	8.9	0.0880	0.0000	OK
360 minute winter	MH2	352	9.641	0.180	1.1	0.2041	0.0000	SURCHARGED
15 minute summer	HMO Patio	9	9.743	0.043	3.0	0.0492	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	107.5	0.2434	41.7
360 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	1.4	0.3345	
360 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	9.1	0.8123	
360 minute winter	Permeable Surfacing	Hydro-Brake®		1.0		73.0
360 minute winter	Permeable Surfacing	Weir		0.0		0.0
360 minute winter	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	1.1	0.3010	
15 minute summer	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	1.5	0.0161	
15 minute summer	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	1.5	0.0100	
15 minute summer	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	1.5	0.0084	
15 minute summer	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	1.5	0.0150	
360 minute winter	MH1	1.002	Plot 1	1.3	0.1584	
15 minute summer	Plots 1-3 Rear	2.000	MH1	8.9	0.2394	
15 minute summer	Plots 4-6 Rear	3.000	MH2	8.9	0.1806	
360 minute winter	MH2	3.001	Plot 6	1.1	0.1584	
15 minute summer	HMO Patio	1.000	Rain Garden	3.0	0.0779	

Results for 100 year Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	Rain Garden	344	9.641	0.186	0.4	0.2106	0.0000	FLOOD RISK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	Rain Garden	1.001	MH1	0.3	0.0396	

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	Existing	9	9.098	0.098	165.5	0.0770	0.0000	OK
15 minute summer	Existing1	10	8.080	0.080	165.6	0.0000	0.0000	OK
360 minute winter	Plot 1	352	9.880	0.600	2.3	0.6789	0.0000	FLOOD RISK
360 minute winter	Virtial MH at Inlet to Permeable Surfacing	352	9.880	0.880	14.0	0.0625	0.0000	FLOOD RISK
360 minute winter	Permeable Surfacing	352	9.880	1.880	13.9	93.5719	0.0000	OK
360 minute winter	Plot 6	352	9.880	0.509	1.8	0.5759	0.0000	FLOOD RISK
360 minute winter	Plot 2	352	9.880	0.180	0.3	0.2038	0.0000	FLOOD RISK
360 minute winter	Plot 3	352	9.880	0.180	0.3	0.2038	0.0000	FLOOD RISK
360 minute winter	Plot 4	352	9.880	0.180	0.3	0.2038	0.0000	FLOOD RISK
360 minute winter	Plot 5	352	9.880	0.180	0.3	0.2038	0.0000	FLOOD RISK
360 minute winter	MH1	352	9.880	0.510	2.2	0.5771	0.0000	FLOOD RISK
360 minute winter	Plots 1-3 Rear	352	9.880	0.230	1.7	0.2605	0.0000	FLOOD RISK
360 minute winter	Plots 4-6 Rear	352	9.880	0.230	1.7	0.2604	0.0000	FLOOD RISK
360 minute winter	MH2	352	9.880	0.419	1.7	0.4741	0.0000	FLOOD RISK
360 minute winter	HMO Patio	352	9.880	0.180	0.6	0.2040	0.0000	FLOOD RISK

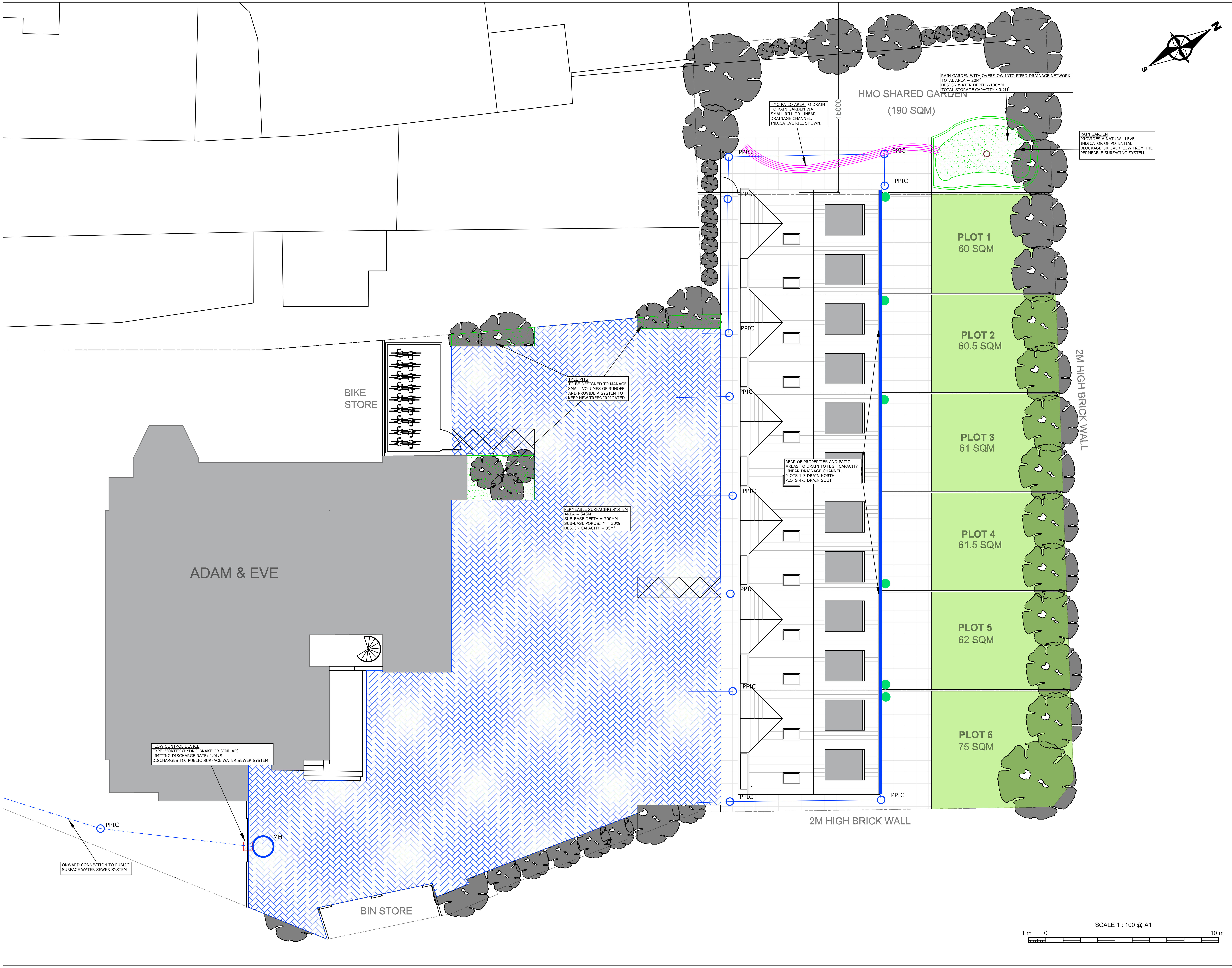
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	Existing	E.Pipline	Existing1	165.6	0.3406	64.2
360 minute winter	Plot 1	1.003	Virtial MH at Inlet to Permeable Surfacing	2.2	0.3345	
360 minute winter	Virtial MH at Inlet to Permeable Surfacing	P.Pipeline	Permeable Surfacing	13.9	0.8123	
360 minute winter	Permeable Surfacing	Hydro-Brake®		1.0		78.0
360 minute winter	Permeable Surfacing	Weir		0.0		0.0
360 minute winter	Plot 6	3.002	Virtial MH at Inlet to Permeable Surfacing	1.7	0.3010	
360 minute winter	Plot 2	4.000	Virtial MH at Inlet to Permeable Surfacing	0.3	0.0637	
360 minute winter	Plot 3	6.000	Virtial MH at Inlet to Permeable Surfacing	0.3	0.0390	
360 minute winter	Plot 4	7.000	Virtial MH at Inlet to Permeable Surfacing	0.3	0.0326	
360 minute winter	Plot 5	5.000	Virtial MH at Inlet to Permeable Surfacing	0.3	0.0592	
360 minute winter	MH1	1.002	Plot 1	2.0	0.1584	
360 minute winter	Plots 1-3 Rear	2.000	MH1	1.7	0.3345	
360 minute winter	Plots 4-6 Rear	3.000	MH2	1.7	0.3345	
360 minute winter	MH2	3.001	Plot 6	1.5	0.1584	
360 minute winter	HMO Patio	1.000	Rain Garden	0.6	0.1137	

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 98.29%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	Rain Garden	352	9.880	0.425	0.6	0.4810	0.0000	FLOOD RISK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Link Vol (m³)	Discharge Vol (m³)
360 minute winter	Rain Garden	1.001	MH1	0.5	0.0396	

Appendix A.4 – Indicative Drainage Layout



GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.
2. ALL WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE RELEVANT BRITISH STANDARDS, EUROPEAN NORMS, CODES OF PRACTICE AND BUILDING PRACTICE.
3. ALL DIMENSIONS ARE TO BE CHECKED BY THE CONTRACTOR PRIOR TO STARTING THE WORKS ON SITE. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
4. INFILTRATION FEATURES WILL BE SUBJECT TO SITE SPECIFIC INFILTRATION TESTING AND TRIAL HOLES.
5. ALL DRAINAGE SYSTEMS WILL NEED TO BE INSTALLED AND DESIGNED FOR SUITABLE LOADING REQUIREMENTS.
6. THE CONTRACTOR SHALL OBTAIN PRIOR APPROVAL AND ALL NECESSARY LICENCES FROM THE THE HIGHWAY AUTHORITY AND/OR SEWERAGE UNDERTAKER BEFORE CARRYING OUT ANY WORKS.

KEY:

Ex. 225ø 1:500	EXISTING SURFACE WATER SEWER
ExCL: XX.XX ExIL: XX.XX	EXISTING SURFACE WATER CHAMBER
100ø 1:500	SURFACE WATER DRAIN
CL: XX.XX IL: XX.XX MH	SURFACE WATER MANHOLE
CL: XX.XX IL: XX.XX PPIC	SURFACE WATER PPIC
RWP	RAINWATER PIPE
	FLOW CONTROL DEVICE
	PERMEABLE SURFACE
	RAIN GARDEN
	SURFACE WATER DRAINAGE CHANNEL
	TREE PITS
	WATER BUTT

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Rev	Description	Author	Checked	Date
P1	First issue	SAH	JK	10/03/22

CLIENT: Yamuna House Ltd.

PROJECT: 1768 Uxbridge Road, Hayes

SCALE	PROJ REF	ORIGINATOR	CHECKED BY
1:100	1768	SAH	JK

DWG REF	DWG No.
INDICATIVE DRAINAGE LAYOUT	HC-1761-501

Appendix A.5 – Maintenance and Management Schedules

Operation and Maintenance Schedule – Bioretention Systems		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary	Quarterly
	Check operation of underdrains by inspection of flows after rain	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace as necessary	Quarterly
	Inspect inlets and outlets for blockage	Quarterly
Regular Maintenance	Remove litter and surface debris and weeds	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays	Quarterly to biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch	As required
Remedial Actions	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years

General Operation and Maintenance Table for Bioretention Systems in accordance with CIRIA C753 The SuDS Manual.

Operation and Maintenance Schedule – Water Butts		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Inspections	Inspection and cleaning of sedimentation at the base of the tank	At least once per year
	Cleaning out of house guttering	As frequently as advised by maintenance plan for the property. Must be cleaned as soon as possible if blockage of guttering occurs.
	Inspection and repair of areas receiving overflow from the tank in the event of erosion	Inspected at least once every 3 months for the first year following installation, reduced inspection frequencies thereafter, at least once per year.
	inspection and repair of the inlet and outlet mechanisms	Inspected at least once every 3 months for the first year following installation, reduced inspection frequencies thereafter, at least once per year.
	cleaning of the tank, inlets, outlets, filters and removal of debris	At minimum once per year
Regular Maintenance (Following Storms)	Repairing of any erosive damage	As required, whenever damage leaks or erosion is detected.
	Inspection of the tank for debris, leaks or other damage.	
	Inspection of area receiving overflow from the tank in the event of erosion	
Occasional maintenance	Replacement of any filters	When Required, due to clogging, or manufacturer specific instructions.

Typical Maintenance Table for Water Butts.

Operation and Maintenance Schedule – Pervious paving / surfacing		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Maintenance	Brushing and vacuuming.	At minimum once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – particular attention must be payed 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.	As required.
	Removal of weeds or management using a suitable weed killer which will not adversely affect water quality. Weed killer should be applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving / surfacing.	As required when damage or erosion is detected following inspection. For block paving systems jointing material to be replaced shortly after installation and subsequently when required.
	Remedial work to any depressions. Rutting and cracked or broken blocks and replace lost jointing material (where block paving is used).	
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

General Maintenance Requirements for Permeable Surfacing (additional requirements may apply depending on type of surfacing material used).