

5822 2-4 Whitworth Street, Manchester

Drainage Assessment

March 2025

Consulting Structural and Civil Engineers

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Revision	Date	Status
D	24.03.2025	Minor Amendments
C	22.11.2024	Stage 2 Issue
B	18.11.2024	Draft Stage 2 Issue
A	02.09.2024	Draft Stage 2 Issue

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1 Introduction

AKT II have been commissioned to undertake a foul and surface water drainage strategy in support of the proposed redevelopment of 2-4 Whitworth Street on behalf of the Clients, Glenbrook WWS Limited, Maizelands Limited and Arringford Limited.

The site area is approximately 0.1610 hectares and consists of two unoccupied buildings as existing, which will be redeveloped to form a new residential tower of up to 44 storeys as proposed.

The site is located at 2-4 Whitworth Street West and the Northings and Eastings for the development land are 383510, 397523 respectively.

The topography of the development land is generally flat with a slight fall from north east (34.00m AOD) to south west (33.00m AOD).

This report is intended to cover only the aspects of drainage design and provide the guidelines and parameters for the detailed design at later stages of the project.

This report has been prepared in accordance with the guidance contained in the National Policy Framework (NPPF) and the accompanying Planning Practice guidance and a more detailed explanation of the requirements nationally and locally are laid out in Section 10 of this report.

The following drainage report and strategy will need to be approved by the Lead Local Flood Authority (LLFA) to obtain planning approval and satisfy the relevant consultees (the local Water Authority and the Environment Agency, where relevant)

2 Executive Summary

	SCOPE
Purpose of the report	To highlight the surface and foul water drainage strategy to inform the preparation of the planning stage for the proposed development.
Current Site status	2-4 Whitworth Street West - Whitworth house and Wrendal House
Future Site end-use	Residential
Development Proposal	The demolition of existing buildings and development of a residential development of up to 44 stories and public realm works. The development will be delivered in a single phase.
	SITE INFORMATION
National Grid Reference	383510 E, 397523 N
Site Area	Approximately 1,610 m² (to edge of pavement).
History	According to the existing records since 1848, it seems the site has been within an urban environment surrounded by buildings. The site seems to have been redeveloped between 1896 and 1909 as the building footprints within it appear to have changed. Post-1909 the footprints remain the same. The Rail line seems to have remained unchanged since the earliest available records.
Geology	Published British Geological Survey maps and BGS borehole records indicate that the soil underlying the site is likely to comprise Made Ground, clayey sand and gravel & sandstone. The bedrock geology map indicates the Site is underlain by Chester Formation.
Hydrogeology	The superficial sheet deposits expected beneath the site are classified as a Secondary A Aquifer and the Chester Formation is classified as a Principal Aquifer The site is not located within an Environment Agency designated source protection zone (SPZ). The groundwater level will be confirmed during a site-specific ground investigation.
Hydrology	The nearest water features are the River Medlock 400 m to the south of the site and the Rochdale Canal on the northern side of Whitworth Street West. The Environment Agency maps indicate that the site has a limited potential for groundwater flooding to occur.
Site constraints	Utility maps indicate a large number of in-use utilities running underground around all four edges of the site.
	SURFACE WATER DRAINAGE DESIGN
Conceptual scheme design	Surface water runoff will be limited to the Q_{100} greenfield rate of 1.5 litres/sec under the 1 in 100 year + 40% storm. This will be achieved using an attenuation tank with a flow control device.
	FOUL WATER DRAINAGE DESIGN
Conceptual scheme design	Foul water will be disposed of by gravity to the public combined sewer(s).

3 The Site

3.1 Site Location

The Site comprises circa 0.16 hectares of brownfield land located within Manchester City Centre at 2 - 4 Whitworth Street West.

It is bound by Whitworth Street West to the north, with the listed railway viaduct and Deansgate Station platform immediately to the south and at first floor level to the existing buildings. Rowendale Street bisects the Site travelling under the railway viaduct providing vehicle and pedestrian links to Hewitt Street to the south.

The Site is bound by Cameron Street to the east and Bugle Street to the west, which also provide vehicle and pedestrian access into the Knott Mill area, characterised by a mix of employment and residential buildings. Beyond Bugle Street is a live music venue (Rebellion) and Deansgate Station is beyond this.

The Site is located within Flood Zone 1 which is a site designated as having a low probability of flooding and has a very low risk of surface water flooding.

The National Grid Reference for the site is SJ 83510 97523 and the the nearest postcode is M1 5WY.

Figures 3.1 to 3.3 below show the location of the proposed development.

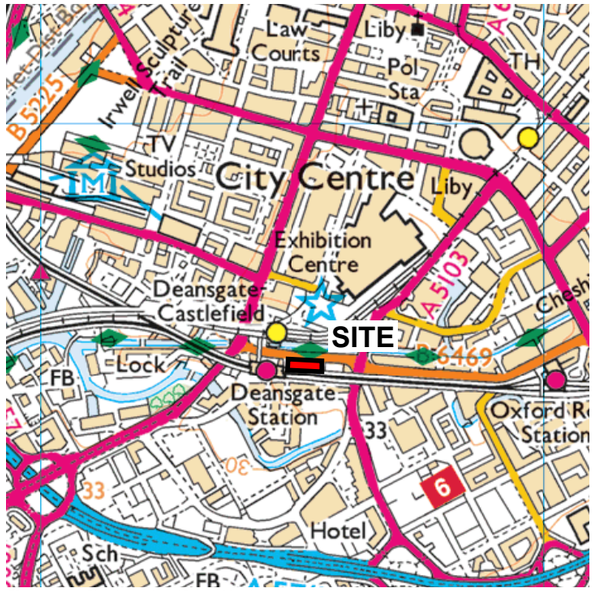


Figure 3.1 Site Location (StreetMap)

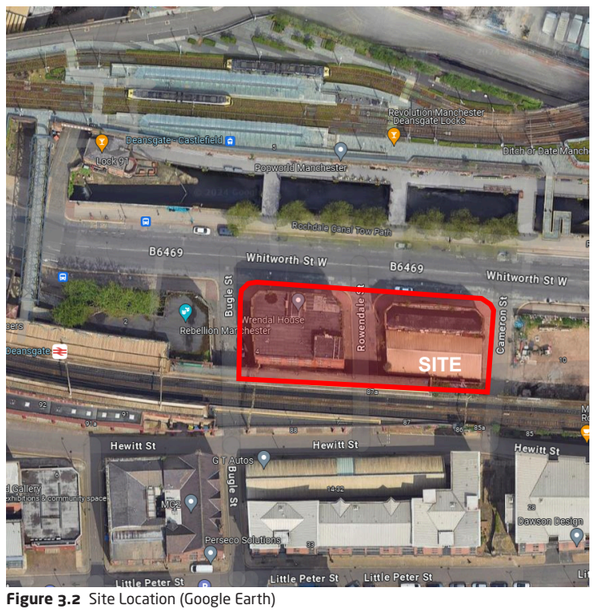


Figure 3.2 Site Location (Google Earth)

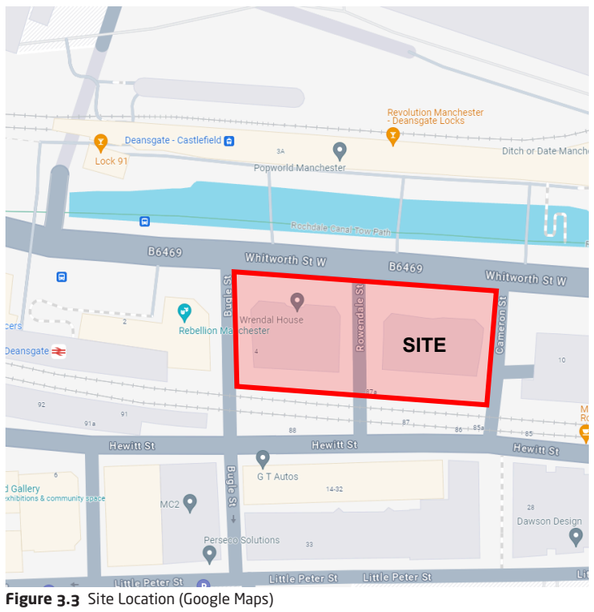


Figure 3.3 Site Location (Google Maps)

3.2 Site Description

The Site is currently occupied by 2 buildings:

- 2 Whitworth Street West is a four-storey, red-brick building which is vacant.
- 4 Whitworth Street West is a three-storey red brick building which is also vacant.

The existing vacant buildings on the Site are not listed, nor are they classed as non-designated heritage assets, and the Site is not located within a Conservation Area.

The railway viaduct and Deansgate Station are Grade II listed. Lock 90, 91 and Rochdale canal lock keeper's cottage at lock number 91 to the north are Grade II listed. Castlefield Conservation Area is located 120m west of the Site.

3.2.1 Topography

Dimensionally, the site is roughly 49 m long by 17 m wide and is generally flat with existing levels varying between 34.0 m AOD in the north east corner to 33.0 m AOD in the south west.

3.2.2 Geology

The following maps related to the Site's geology were received by Envirocheck:

- BGS Superficial Geology Map
- BGS Bedrock Geology Map
- BGS Combined Geology Map (Figure 3.4 below)

The superficial geology map indicates that the Site is underlain by Glaciofluvial Sheet Deposits and the bedrock geology map indicates the Site is underlain by Chester Formation.

Published British Geological Survey maps and borehole records in the local area indicate that the geology underlying the Site is likely to comprise Made Ground, clayey sand and gravel & sandstone.

The superficial sheet deposits expected beneath the site are classified as a Secondary A Aquifer and the Chester Formation is classified as a Principal Aquifer (Figure 3.5).

Secondary A aquifers comprise permeable layers that can support local water supplies and may form an important source of base flow to rivers.

Principal Aquifers are designated by the EA as strategically important rock units that have high permeability and water storage capacity.

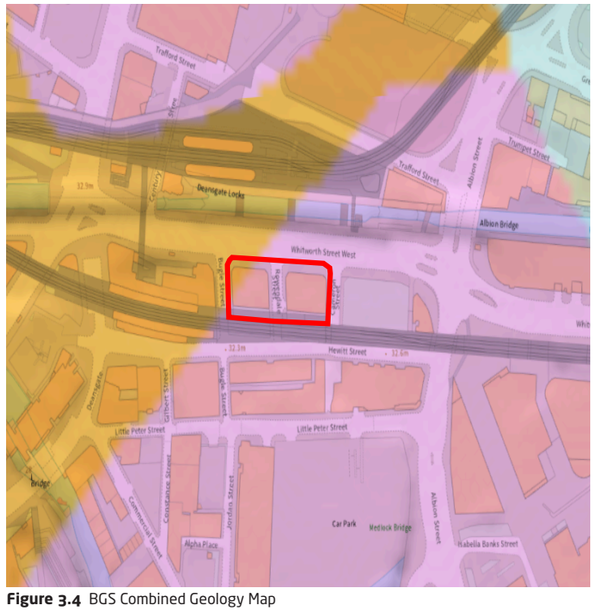


Figure 3.4 BGS Combined Geology Map

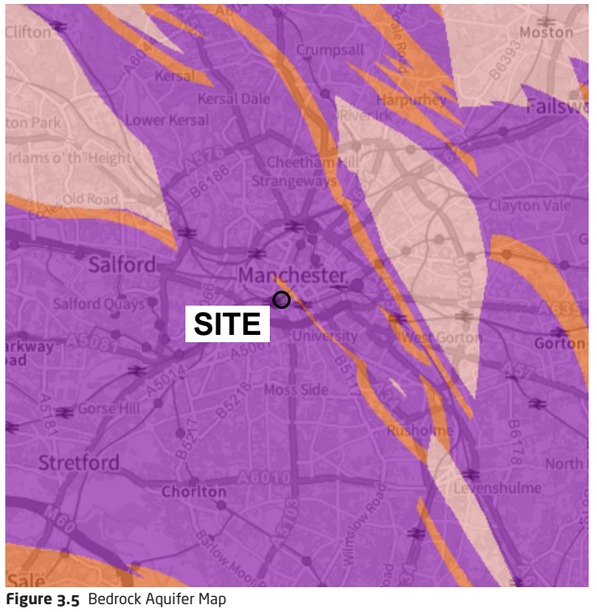


Figure 3.5 Bedrock Aquifer Map

3.2.3 Groundwater

At present no site investigation works have been carried out to provide information on groundwater levels.

3.2.4 Source Protection zones

The site is not located within a Source Protection Zone (Figure 3.6).

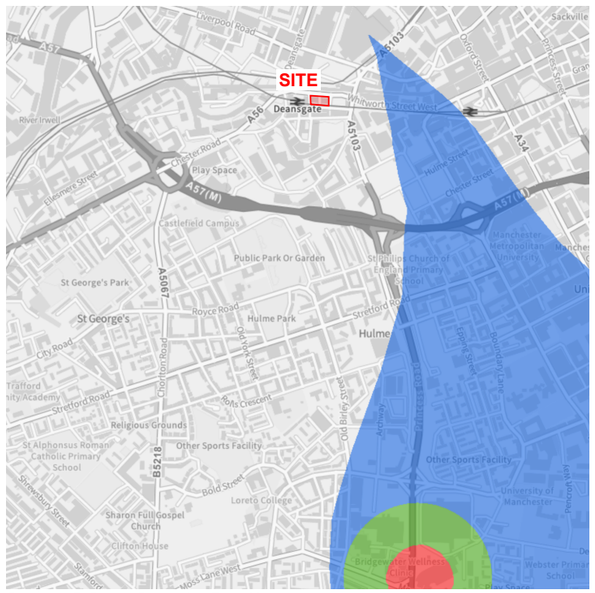


Figure 3.6 Source Protection Zone Map

3.3 Development Proposals

The proposed development will involve the construction of a new 44 storey tower.

- Ground floor level will consist of a reception area, bike storage, a bin store, plant rooms, a kiosk and a post room.
- First floor will contain more plant space, a lounge area, studio and gym.
- Third floor and above will house the residential units.

The proposed plans are shown in Figures 3.7 to 3.9 for reference.

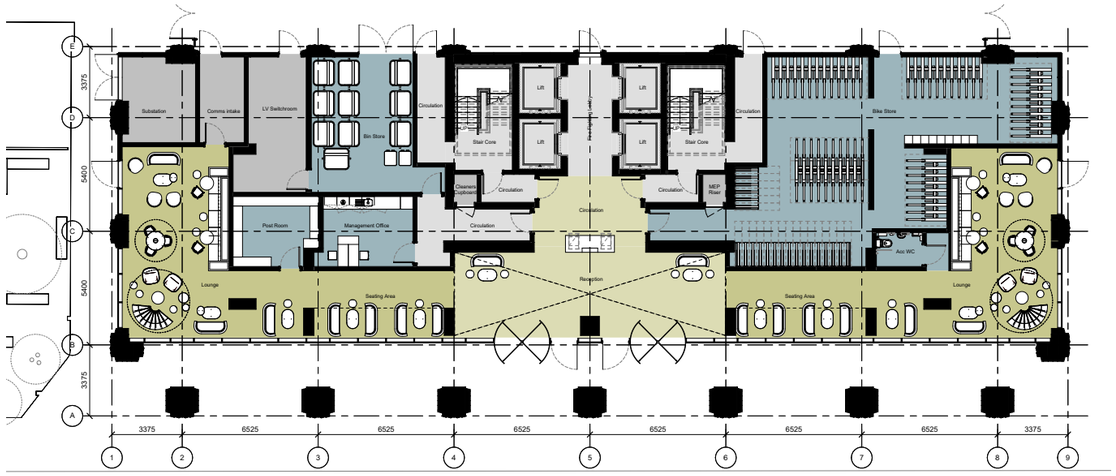


Figure 3.7 Ground Floor Layout

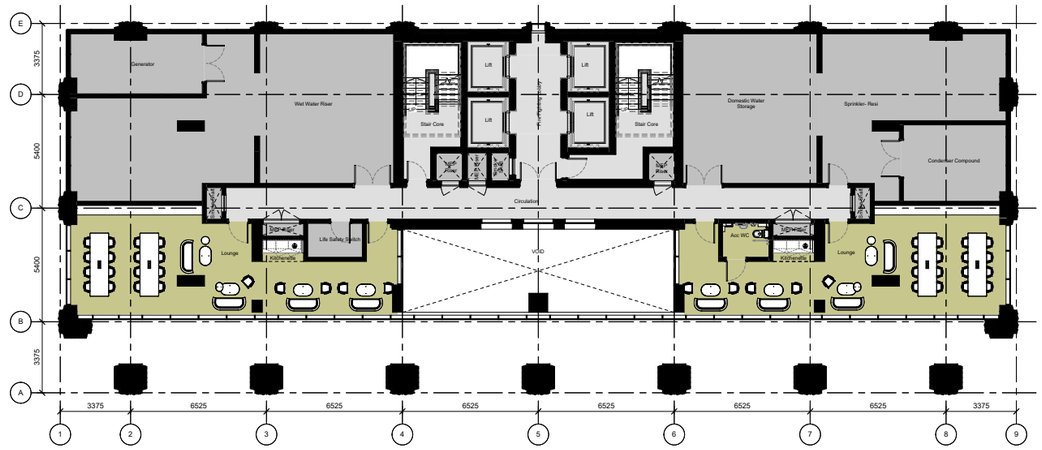


Figure 3.8 First Floor Layout

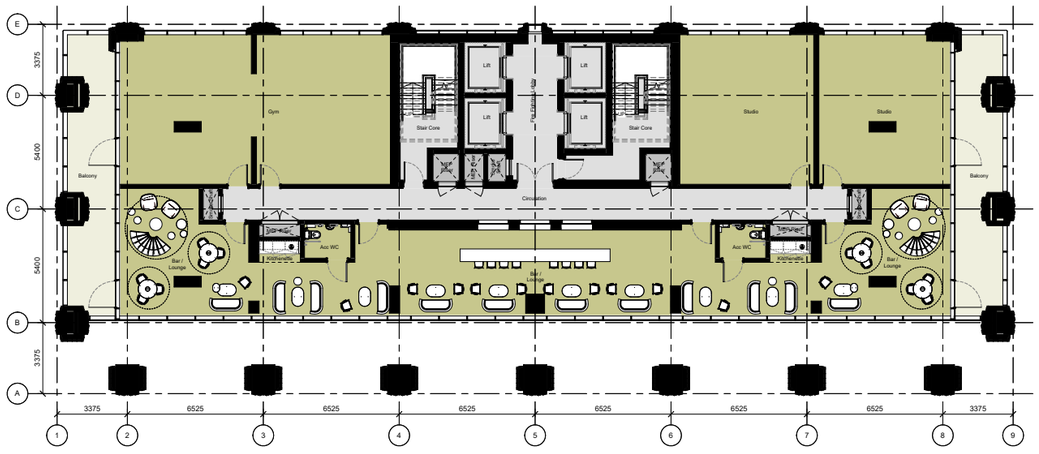


Figure 3.9 Second Floor Layout

4 Surface water drainage

4.1 Existing scheme

The available United Utilities record plans indicate that the closest surface water or combined public sewers to the site are:

- A 225mm dia. combined sewer in Bugle Street to the west of the site.
- A 375 mm dia. combined water sewer in Cameron Street to the east of the site.
- A 375 mm dia. combined water sewer in Whitworth Street West to the north of the site.
- A 300 mm dia. combined sewer in Rowendale Street in the centre of the site.

An extract from the record plans is shown Figure 4.1 for reference.

It is believed that all surface water from the existing buildings currently discharges directly to these public sewers without any form of attenuation but it is not clear which ones. Although a CCTv survey of the existing site drainage network has been undertaken it is inconclusive regarding the connection points of the existing building's surface water connections and so further investigation will be required.

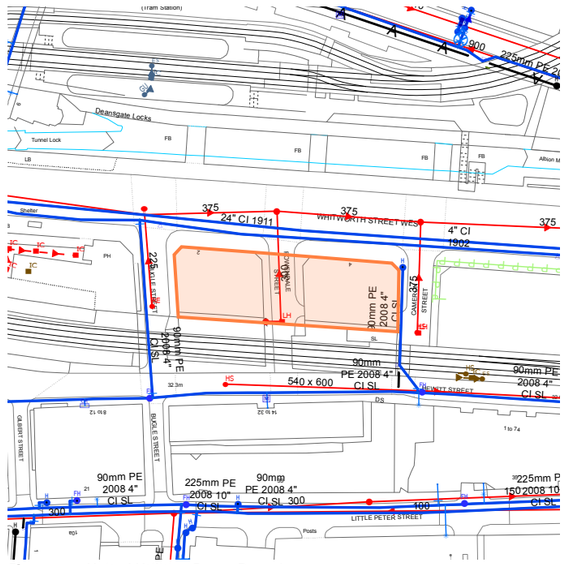


Figure 4.1 United Utilities Sewer Record

4.1.1 Site Characteristics

- Site Location: GB 524400 234600 TL 24400 34600
- FEH Version: 2022
- SAAR = 880mm
- SPRHOST = 35.83
- URBEXT2000 = 0.3879
- Areal Reduction Factor = 1.00
- BFIHOST = 0.379
- FARL = 0.974
- Total site area = 1,610 m²
- Existing impermeable area = 1,350 m² (excluding public footpath and railway arch)
- Percentage Impermeable (PIMP) = 100
- IH 124 Soil Type = 4

Detailed calculations are contained in Appendix B for reference. The discharge rates and volumes are summarised below.

Return Period	Existing peak runoff rate[1]	Greenfield Run Off Rate[2]	Existing Discharge Volume[3]
1 year	13.9 litres/sec	0.81 litres/sec	6.01 m³
30 year	41.7 litres/sec	1.59 litres/sec	14.47 m³
100 year	52.8 litres/sec	1.94 litres/sec	17.254m³
100 year (+40%)	73.9 litres/sec	2.72 litres/sec	24.55 m³

[1] *The existing run off rates were determined by the Wallingford Rational Method with a rainstorm of 15 minutes duration*

[2] *Calculated based on EA "Rainfall runoff management for developments"*

[3] *Based on BS 8582 Section 9.8*

4.2 Proposed scheme

The philosophy for the proposed SUDS strategy is to limit the proposed surface water discharge rate to the greenfield Q_{100} rate of 1.5 litres/sec. This will primarily be achieved through the provision of an attenuation tank located to the west of the building which will discharge to the sewer in Bugle Street. There are options for green/blue roof, permeable paving and rainwater harvesting to be introduced to the scheme and these will need to be confirmed.

The proposed drainage strategy drawings are contained in Appendix D for reference.

The SuDS selection process undertaken is outlined in detail in Appendix C and the proposed SuDS devices are summarised in Figure 4.2 below.

4.2.1 Design criteria and modelling results

- Proposed site area = 1,610 m²
  - Building footprint = 810 m²
  - Private hardstanding = 200 m²
  - Public footpath = 180 m²
  - Railway bridge area = 95 m²
  - Soft / permeable landscaping = 325 m²
- Percentage Impermeable (PIMP) = 95%
- Climate change allowance = 40% ("Upper Limit" of the DEFRA guidance (refer to Figure 4.3 below)
- Standard Annual Average Rainfall (SAAR) = 880 mm
- Volumetric runoff coefficient C_v (summer) = 0.950
- Volumetric runoff coefficient C_v (winter) = 0.950
- Hydrological Growth Curve Region = 10 (North West England)

The area beneath the railway bridge and the public footpath have both been excluded from the attenuation calculations. The railway bridge rainwater is drained by the railway infrastructure and the public footpath will continue to drain as present and so neither contribute to the new development. Therefore, a hardstanding area of 1,010 m² has been considered.

The InfoDrainage results demonstrate that all water is contained within the proposed drainage system for every event up to and including the 1 in 100 year plus 40% climate change allowance event.

Detailed calculations for the proposed run off rates and discharge volumes are contained in Appendix B for reference and are summarised below.

Return Period	Existing Peak run off rate[1] (litres/sec)	Proposed scheme unattenuated peak run off rate (litres/sec)	Greenfield run off rate (litres/sec)	Proposed Design Peak run off rate (litres/sec)	Existing Discharge Volume (m³)	Proposed Discharge Volume (m³)
1 in 1 year	10.9	8.2	0.67	1.30	3.81	2.85
1 in 30 years	32.9	24.6	1.32	1.40	6.97	5.21
1 in 100 years	41.7	31.2	1.61	1.60	8.75	6.54
1 in 100 years (+40%)	58.4	43.6	2.27	1.60	12.25	9.16

[1] *The existing run off rates were determined by the Wallingford Rational Method with a rainstorm of 15 minutes duration and an assumed runoff of 100% for impermeable areas and 0% for permeable areas*

4.2.2 Water quality and quantity

The SuDS features set out in this strategy will help to intercept the majority of the small rainfall events so there should be almost no runoff generated by the first 5 mm of rainfall.

The proposed uses of the site along with the SuDS measures proposed will ensure that water leaving the site through the piped system to the sewer will be of good quality. Although the site is close to a Source Protection Zone, the necessary measures have been undertaken to ensure that groundwater will be protected from any potential pollution.

The proposed drainage strategy will provide a 95% reduction in the peak flow rate and volume of surface water leaving the site and will therefore reduce the potential risk to the site itself and also the surrounding area from overland flow or sewer flooding.

Element	Management stage	Water quantity	Water quality	Amenity & biodiversity	Proposed in scheme
Rainwater harvesting	Prevention	✓	✗	✗	✓ / ✗
Green/brown / blue roof	Source control	✓	✓	✓	✓ / ✗
Raingardens	Source control	✓	✓	✓	✗
Bio-retention	Source control	✓	✓	✓	✗
Permeable surfacing	Source control	✓	✓	✗	✓ / ✗
Swales	Source control	✓	✓	✓	✗
Detention basin / ponds	Source control	✓	✓	✓	✗
Discharge to tidal river / dock / canals	Site control	✓	✗	✗	✗
Storage tanks / Geocellular storage	Site control	✓	✗	✗	✓
Oversized piping	Site control	✓	✗	✗	✗
Design for exceedance	Site control	✓	✗	✗	✗

Figure 4.2 Summary of proposed SuDS devices

Range	Total potential change anticipated for 2010-2039	Total potential change anticipated for 2040-2059	Total potential change anticipated for 2060-2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Figure 4.3 Peak rainfall intensity climate change allowance

4.3 Disposal methods

SuDS management train

A useful concept used in the development of sustainable drainage systems is the SuDS management train (sometimes referred to as the treatment train). Just as in a natural catchment, drainage techniques can be used in series to change flow and quality characteristics of the runoff in stages. There are a variety of measures that can be implemented to achieve these goals:

Site management / Prevention

Site management procedures are used to limit or prevent runoff and pollution and include:

- Minimising the hardened areas within the site
- Frequent maintenance of impermeable surfaces
- Minimising the use of de-icing products

Source control

Source control techniques will be used where possible as they control runoff at source in smaller catchments. They can also provide effective pollution control and treatment, thereby improving the quality of the effluent discharged to the receiving waters.

Site control

Where source control techniques do not provide adequate protection to the receiving watercourses in terms of flood protection and pollution control, site control may be required.

Regional control

Where large areas of public space are available regional control can be incorporated to provide additional 'communal' storage and treatment to runoff from a number of sites. However, in this case, all storage and treatment will be implemented on site.

Drainage hierarchy

Based on the above and in line with the London Plan and the Sustainable Drainage Manual published by CIRIA, the following drainage hierarchy will therefore need to be considered when preparing the surface water disposal strategy:

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 atenuation 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

Assessment of SuDS techniques

Rainwater harvesting

This involves the capture of rainwater into a tank for re-use (usually non-potable) such as irrigation, toilet flushing or vehicle cleaning. Systems are now available which combine rain water harvesting with tanked attenuation. This means that water is stored during dry periods for re-use but released ahead of predicted storms in order to ensure that the full attenuation capacity remains available when it is needed.

It is unlikely that the actual roof area available will generate sufficient water yield to meet enough of the demand to make a system viable but the MEP engineer will confirm this at the next stage.

Green / brown / blue roofs

These are used on flat or shallow pitched roofs to provide a durable roof covering which also provides thermal insulation, amenity space, biodiversity habitat as well as attenuation of rainwater. Depending on the design, these roofs can attenuate differing volumes of rainwater. The term 'blue roof' is reserved for those roofs designed to maximise water retention. This is a relatively recent area of increased focus and can involve effectively an attenuation tank at roof level which reduces (or avoids) the need for pumping of basement tanks.

The presence of PV panels on the roof make it unlikely that a green roof would be suitable on this development. However, there is potential to provide brown or blue roofs in the scheme which would be compatible with PVs. Any areas able to be provided will help to offset the size of the attenuation tank required. The Architect will confirm if they are to be provided at the next stage.

Raingardens

Raingardens are planted areas (usually close to buildings but not immediately adjacent) that allow the diversion of a portion of rainwater from either downpipes or the surrounding paved surfaces. These techniques can be incorporated into the landscaping plans for a site and are most effective where the landscaping regime is designed with the aim of capturing as much rainfall as possible. They can either allow infiltration into the ground or have tanked systems for water retention, depending on the site and soil conditions. There are also a number of vertical raingardens attached to building walls with rainwater downpipes diverted through a stacked series of planters.

Raingardens are proposed at ground level - refer to the Landscape Architect's layout contained in Appendix C for details.

Bio-retention

This refers to a chain of landscaped features, potentially including reed beds, filter drains, etc. designed to hold and treat surface water. They are often used where there is a high risk of low-level pollution, for example from road run-off. However, it does require areas of open space. The design of a bio-retention system can vary widely depending on site conditions and available space. At a small scale this could include flow through planters or tree pits.

Bio-retention cannot be incorporated into the scheme due to the lack of external space available.

Infiltration

There are many different types of drainage component that can be used to facilitate infiltration. These include soakaways, infiltration trenches, infiltration blankets and infiltration basins.

Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The rate at which water can be infiltrated depends on the infiltration capacity (permeability) of the surrounding soils.

Site investigation works will be required to confirm if the porosity of the underlying soil is sufficient to allow disposal by infiltration. The anticipated soil strata suggest that there may be some porosity within the subsoils.

Permeable surfacing

Permeable hard surfaces which work in much the same way as traditional impermeable surfaces apart from the ability to allow rainwater to pass through. Permeable blocks are traditionally used but there are now a range of permeable asphalt and resin bound gravel pavings being used increasingly commonly. Permeable surfaces can either allow infiltration into the ground or have tanked systems for water retention, depending on the site and soil conditions. They are suitable in even the most densely built-up development. However, they're not well suited to roads carrying heavy or fast motor traffic.

As there are areas of paving proposed as part of the scheme it will be possible to implement permeable paving. However, until the site investigation has been undertaken, it is uncertain whether this would be for disposal or, if the underlying soil has little or no porosity, a tanked system for water retention and conveyance only.

Swales

These are dry ditches used as landscape features to allow the storage, carriage and infiltration of rainwater and are often used as linear features alongside roads, footpaths or rail lines. They can also be integrated into the design of many open spaces.

Swales cannot be incorporated into the scheme due to the lack of external space available.

Detention basin / ponds

Landscape features designed to store and in some cases infiltrate rainwater. Detentions basins are usually dry, whereas a pond should retain water. These features need areas of open space but can often be combined with other sustainable drainage techniques.

As the area is heavily developed with limited external space there is insufficient space to provide a basin or pond.

Discharge to tidal river / dock / canals

Discharging clean rainwater directly to tidal rivers, canals or docks isn't normally a sustainable drainage technique. Other more productive techniques should be used first. However, it is generally more sustainable than discharging to the combined or surface drainage systems. Residual surface water can be discharged to tidal / large waterbodies, in some cases with no limitation on volumes. Some storage may be required to allow for outfalls becoming tide locked. Care is needed to prevent scour in the receiving waterbody and potentially to prevent pollution. Consent from the Environment Agency, the asset owner and where applicable the Canal and River Trust is required.

Although the Rochdale Canal is located to the north of Whitworth Street it is unlikely to be practical to form a new connection to it.

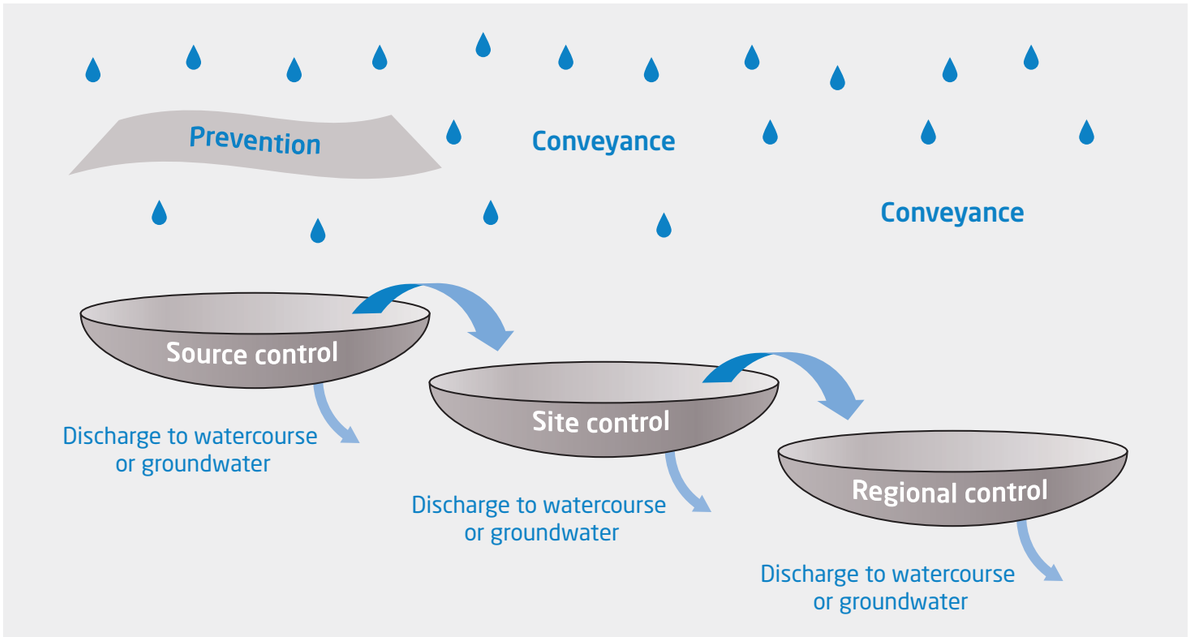


Figure 4.4 SuDS management train

Storage tanks / geocellular storage

Storage tanks are single GRP units usually located (but not necessarily) below ground level which attenuate rainwater for later slow release back into the drainage system but do not provide the wider benefits of green infrastructure sustainable drainage. They can also have the disadvantage that pumping may be required to empty the tank into the drainage system – especially if the tank is located at or below basement level. Where tanks are designed for large storm events, care is needed to ensure that they still perform a useful sustainable drainage function for low order storms.

Geocellular storage tanks are similar to storage tanks except that the volume is made up from multiple units rather than a single tank meaning they can be more flexible in terms of shape to suit constrained sites.

It is believed that this is the most feasibly disposal option for the site. Detailed calculations have been undertaken based on an attenuation tank being the only form of SuDS used as a worst case scenario. These calculations are contained in Appendix B for reference.

Based on these calculations it is recommended that at this stage a cost and space allowance is made for a storage volume of 65 m³ (Greenfield rate) as our recent experience United Utilities and Manchester City Council suggests this will be the required discharge rate for Planning.

The attenuation tank should be located at a high enough level so as to allow a connection to be made to the public sewer by gravity – in this case, it is assumed that this would be just below ground level within the external areas to the east or west of the tower.

Oversized piping

Using larger than necessary pipework creates more room to store rainwater. Potentially more sustainable than storage tanks / geocellular storage if the pipes drain by gravity and do not require pumping. However, lacks the wider benefits of the green infrastructure based techniques.

Due to the restricted nature of the site the pipework would become impractically large to provide the volume of storage required to achieve the required run-off rate.

Summary of the proposed SuDS strategy

The use of brown or blue roof and rainwater harvesting will be investigated to determine if either are practical under the constraints of the site. Further testing of compatibility during the detailed design stage will be required and the final drainage strategy agreed via a pre-commencement condition.

It is proposed to provide permeable paving in the hard landscaped areas. Depending upon the site investigation results this may be for disposal or for water retention and conveyance purposes.

Areas of raingarden will be provided at ground floor level to collect and treat runoff from paved areas.

An attenuation tank of 100 m³ is proposed which will reduce the peak discharge rate from the site to the Greenfield rate.

The outfall from the site will connect to the existing public sewer either with a new connection or, preferably, by reusing one of the existing connections.

Once the CCTv and level survey of the existing network has been undertaken the location and layout of the outfall(s) can be determined but due to the depth of the existing public combined sewers it is recommended that, if possible, the existing drainage connection(s) should be reused to prevent the need for constructing a new, deep connection. This would minimise both the cost of the work and the disruption to the surrounding roads which are busy thoroughfares and consequently require significant traffic management to be provided during the work.

The proposed drainage drawings are contained in Appendix D for reference.

Element	Management stage	Water quantity	Water quality	Amenity & biodiversity	Proposed in scheme
Rainwater harvesting	Prevention	✓	×	×	✓ / ×
Green / brown / blue roof	Source control	✓	✓	✓	✓ / ×
Raingardens	Source control	✓	✓	✓	✓
Bio-retention	Source control	✓	✓	✓	×
Permeable surfacing	Source control	✓	✓	×	✓ / ×
Swales	Source control	✓	✓	✓	×
Detention basin / ponds	Source control	✓	✓	✓	×
Discharge to tidal river / dock / canals	Site control	✓	×	×	×
Storage tanks / Geocellular storage	Site control	✓	×	×	✓
Oversized piping	Site control	✓	×	×	×
Design for exceedance	Site control	✓	×	×	×

Figure 4.7 Summary of proposed SuDS devices

5 Flood risk assessment requirements

The Environment Agency's Indicative Floodplain Map (see Figure 5.1) shows that the site lies in Zone 1 – an area with a low probability of flooding. As the site is also less than 1 ha in area, there would be no requirement for a Flood Risk Assessment in accordance with the National Planning Policy Framework and, as there is no increase in the hardstanding area on site, there is no increase in flood risk from the site to other properties.

AKT II have undertaken a site specific flood risk assessment for the redevelopment and the main findings of this assessment are summarised below:

- In accordance with the National Planning Policy Framework, we would categorise the site as lying entirely within Flood Zone 1 - an area assessed as having a less than 1 in 1000 annual probability of river or sea and river flooding (<0.1%).
- In accordance with the NPPF, all proposed land uses are acceptable within Flood Zone 1 and therefore the site passes the Sequential Test.
- The site has been assessed as being at **very low risk** of flooding from rivers or tidal sources.
- The site has been assessed as being at **low risk** from surcharging sewers.
- The site has been assessed as being at **low risk** from groundwater sources.
- The site has been assessed as being at **very low risk** from artificial sources.
- The site has been assessed as being at **very low risk** from surface water flooding sources.
- The proposed redevelopment has an acceptable flood risk within the terms and requirements of the National Planning Policy Framework.

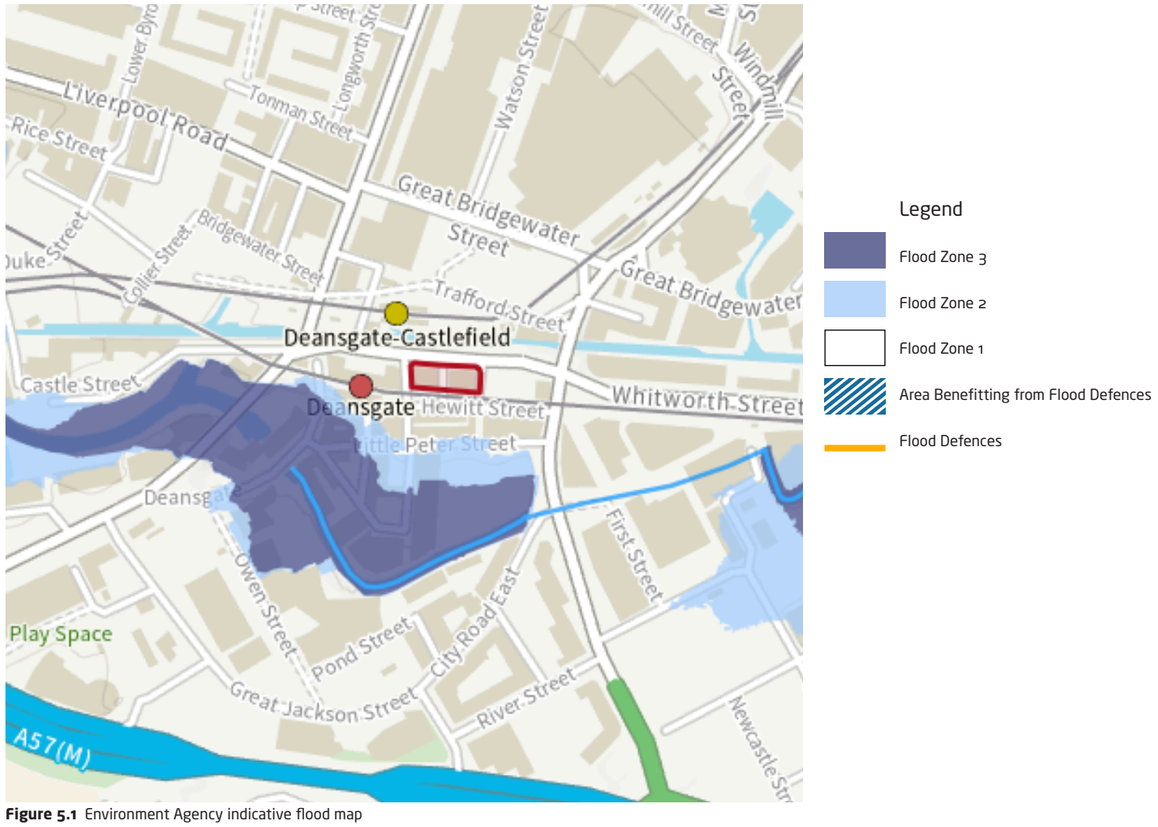


Figure 5.1 Environment Agency indicative flood map

6 Foul water drainage

6.1 Existing scheme

The available United Utilities record plans indicate that the closest surface water or combined public sewers to the site are:

- A 225mm dia. combined sewer in Bugle Street to the west of the site.
- A 375 mm dia. combined water sewer in Cameron Street to the east of the site.
- A 375 mm dia. combined water sewer in Whitworth Street West to the north of the site.
- A 300 mm dia. combined sewer in Rowendale Street in the centre of the site.

An extract from the record plans is shown Figure 4.1 for reference.

It is believed that all foul water from the buildings currently discharges directly to one of these public sewers but it is not clear which one. Although a CCTv survey of the existing site drainage network has been undertaken it is inconclusive regarding the connection points of the existing building's foul water connections and so further investigation will be required.

Floor plans are not currently available for the existing building and so it has not been possible to assess the current foul water discharge rate from the site.

6.2 Proposed scheme

The proposed foul water discharge rate from the site has been calculated as **27 litres / sec** (detailed calculations are contained in Scetion B.2 of Appendix B for reference).

Although it has not been possible to make an assessment of the existing foul water flow, as the buildings are currently unoccupied it is likely that United Utilities will consider the existing flow to be zero even though there would have been flow historically. This increase will need to be agreed with United Utilities and their written approval of this will be required once a more detailed assessment can be made of the existing and proposed situations.

It is assumed that any foul water drainage from ground floor level and above will be drained by gravity in order to minimise the amount of pumping required.

As with the surface water drainage, due to the depth of the public sewers it is recommended that, if possible, the existing drainage connection(s) should be reused.

7 BREEAM

Pol 03: Flood and surface water management

Prerequisite

1. An appropriate consultant is appointed to carry out and demonstrate the development's compliance with all criteria.

Up to two credits – Flood resilience

Two credits - Low flood risk

2. A site specific flood risk assessment (FRA) confirms the development is in a flood zone that is defined as having a low annual probability of flooding. The FRA takes all current and future sources of flooding into consideration.

One credit - Medium or high flood risk

3. A site specific FRA confirms the development is in a flood zone that is defined as having a medium or high annual probability of flooding and is not in a functional floodplain. The FRA must take all current and future sources of flooding into consideration.
4. To increase the resilience and resistance of the development to flooding, one of the following must be achieved:
   - **a.** The ground level of the building and access to both the building and the site, are designed (or zoned) so they are at least 600 mm above the design flood level of the site's flood zone; **OR**
   - **b.** The final design of the building and the wider site reflects the recommendations made by an appropriate consultant in accordance with the hierarchy approach outlined in Section 5 of BS 8533:2017.

Two credits – Surface water run-off

Prerequisite for surface water run-off credits

5. Surface water run-off design solutions must be bespoke, i.e. they must take account of the specific site requirements and natural or man-made environment of and surrounding the site. The priority levels detailed in the Methodology must be followed, with justification given by the appropriate consultant where water is allowed to leave the site.

One credit - Surface Water Run-Off - Rate

6. Drainage measures are specified so that the peak rate of run-off from the site to the watercourses (natural or municipal) shows a 30% improvement for the developed site compared with the pre-developed site. This should comply at the 1-year and 100-year return period events.
7. Relevant maintenance agreements for the ownership, long term operation and maintenance of all specified Sustainable Drainage Systems (SuDS) are in place.
8. Calculations include an allowance for climate change. This should be made in accordance with current best practice planning guidance.

One Credit - Surface Water Run-Off - Volume

9. Flooding of property will not occur in the event of local drainage system failure (caused either by extreme rainfall or a lack of maintenance); **AND EITHER**
10. Drainage design measures are specified so that the post-development run-off volume, over the development lifetime, is no greater than it would have been prior to the assessed site's development. This must be for the 100-year 6-hour event, including an allowance for climate change.
11. Any additional predicted volume of run-off for this event is prevented from leaving the site by using infiltration or other SuDS techniques.

OR (only where Criteria 10 & 11 cannot be achieved)

12. Justification from the appropriate consultant indicating why the above criteria cannot be achieved, i.e. where infiltration or other SuDS techniques are not technically viable options.
13. Drainage design measures are specified so that the post-development peak rate of run-off is reduced to the limiting discharge. The limiting discharge is defined as the highest flow rate from the following options:
    - **a.** The pre-development one-year peak flow rate **OR**
    - **b.** The mean annual flow rate Q_{BAR} **OR**
    - **c.** 2 litres/sec/ha

    For the one-year peak flow rate, the one year return period event criterion applies.
14. Relevant maintenance agreements for the ownership, long-term operation and maintenance of all specified SuDS are in place.
15. For either option, above calculations must include an allowance for climate change; this should be made in accordance with current best practice planning guidance.

One credit – Minimising watercourse pollution

One credit

16. There is no discharge from the developed site for rainfall up to 5 mm (confirmed by the appropriate consultant).
17. Areas with a low risk source of watercourse pollution, an appropriate level of pollution prevention treatment is provided, using appropriate SuDS techniques.
18. Areas with a high risk of contamination or spillage of substances, such as petrol and oil, have separators (or an equivalent system) installed in surface water drainage systems.
19. Chemical or liquid gas storage areas have a means of containment fitted to the site drainage system (i.e. shutoff valves). This is to prevent the escape of chemicals to natural watercourses in the event of a spillage or bunding failure.
20. All water pollution prevention systems have been designed and installed in accordance with the recommendations of documents such as the SuDS Manual and other relevant industry best practice. They must be bespoke solutions taking account of the specific site requirements and natural or man-made environment of and surrounding the site.
21. A comprehensive and up-to-date drainage plan of the site will be made available for the building or site occupiers.
22. Relevant maintenance agreements for the ownership, long term operation and maintenance of all specified SuDS must be in place.
23. All external storage and delivery areas designed and detailed in accordance with the current best practice planning guidance.

Up to two credits – Simple buildings – Surface water run-off

Two credits

For "simple buildings", the criteria below should be applied to award one or two credits. Alternatively, two credits and an Exemplary credit is awarded where criteria 5-15 are achieved.

24. Either 24a below or 24b below is met:
    - **a.** There is a decrease in the impermeable area by 50% or more, from the pre-existing impermeable hard surfaces; **OR**
    - **b.** All run-off from the roof, including new and existing parts of the building, has been managed on site using source control methods. This must be achieved for rainfall depths up to 5 mm.

One credit - Simple buildings - Surface water run-off

25. Either 25a below or 25b below is met:
    - **a.** There is no increase in the impermeable surfaces as a result of the new construction; **OR**
    - **b.** If there is an increase in the impermeable surface as a result of the new construction then the following must be met:
      - **i.** Hard standing areas: additional (or equivalent area of) hardstanding must be permeable or be provided with on-site SuDS to allow full infiltration of the additional volume. The permeable hardstanding must include all pavements and public rights of way, car parks, driveways and non-adoptable roads. Small garden paths which will drain onto a naturally permeable surface can be excluded.
      - **ii** Building (new-build or extension): for an increase in building footprint, extending onto any previously permeable surfaces, the additional run-off caused by the area of the new construction must be managed on site using an appropriate SuDS technique for rainfall depths up to 5 mm.

Assessment of available credits

Prerequisite

Criterion	AKT II assessment	
1.	AKT II are appropriate consultants with the relevant qualifications and experience to design SuDS and flood prevention measures and completing peak rate of run-off calculations.	✓

Flood resilience

Criterion	AKT II assessment	
2.	The site is situated in Zone 1 – an area with a low probability of flooding according to the Environment Agency's Indicative Floodplain Map. The site-specific FRA carried out by AKTII confirms that the site is at low risk of flooding from all other current and future sources	✓
3.	Not applicable – the site is located in Flood Zone 1.	N/A
4a.	Not applicable – the site is located in Flood Zone 1.	N/A
4b.	Not applicable – the site is located in Flood Zone 1.	N/A

Based on this we believe that potentially two credits out of a possible two can be awarded under these criteria.

Surface water run-off

Run-off criteria	AKT II assessment	
5.	The drainage strategy has been prepared in line with the drainage hierarchy and the priority levels detailed in the BREEAM Methodology.	✓
6.	The proposed peak run-off rate has been reduced to greenfield rate which represents a 95% reduction on the pre-developed site.	✓
7.	The ownership, operation and maintenance requirements for each SuDS device will be written into the O&M Manual for the site.	✓
8.	An allowance of 40% has been made for climate change in all calculations in line with the Environment Agency's guidance.	✓
9.	The site-specific FRA carried out by AKTII confirms that the site is at low risk of flooding from local drainage system failure.	✓
10.	As the pre and post development hard standing areas are the same then there cannot be any more run-off volume over the lifetime of the building.	✓
11.	The site investigation confirms that there is insufficient porosity to make infiltration a viable option. Therefore, it is not possible to prevent the additional run-off from leaving the site.	✗
12.	The site investigation confirms that there is insufficient porosity to make infiltration a viable option. Extracts are contained in Appendix 2 for reference.	✓
13.	Pre-development 1-year peak flow rate = 10.8 litres/sec Mean annual flow rate Q_{bar} = 0.73 litres/sec 2 litres/sec/ha = 0.32 litres/sec It is proposed to reduce the proposed peak discharge rate to greenfield rate.	✓
14.	The ownership, operation and maintenance requirements for each SuDS device will be written into the O&M Manual for the site.	✓
15.	An allowance of 40% has been made for climate change.	✓

Based on this we believe that potentially two credits out of a possible two can be awarded under these criteria.

Minimising watercourse pollution

Pollution criteria	AKT II assessment	
16.	As confirmed in Section 4.3, no infiltration is possible and there is insufficient green roof coverage therefore this criterion cannot be achieved.	✗
17.	SuDS devices will be specified where possible within the limitations of the development.	✓
18.	As there are no high risk areas being provided as part of the scheme and therefore no separators require to be provided.	N/A
19.	There are no chemical/liquid gas storage areas proposed as part of the scheme.	N/A
20.	All water pollution prevention and SuDS devices will be designed in accordance with the SuDS Manual.	✓
21.	An up-to-date drainage plan will be made available to the site occupiers upon completion.	✓
22.	The ownership, operation and maintenance requirements for each SuDS device will be written into the O&M Manual for the site.	✓
23.	There are no external storage or delivery areas proposed as part of the scheme.	N/A

Based on this we believe that potentially no credits out of a possible one can be awarded under these criteria.

Simple buildings – Surface water run-off

Pollution criteria	AKT II assessment	
24a.	The impermeable area is the same as the pre-existing impermeable hard surfaces.	✗
24b.	As confirmed in Section 4.3, no infiltration is possible and there is insufficient green roof coverage therefore this criterion cannot be achieved.	✗
25a.	The impermeable area is the same as the pre-existing impermeable hard surfaces.	✓
25bi.	As confirmed in Section 4.3, no infiltration is possible and therefore this criterion cannot be achieved.	✗
25bii.	As confirmed in Section 4.3, no infiltration is possible and therefore this criterion cannot be achieved.	✗

Based on this we believe that potentially no credits out of a possible two can be awarded under these criteria.

Overall, we believe that potentially four credits out of a possible five can be awarded under the Polo3 criteria outlined above.

8 Maintenance and operation

Before cleaning, final testing and immediately before handover the Contractor will:

- Lift covers to manholes, inspection chambers and access points. Remove mortar droppings, debris and loose wrappings.
- Thoroughly flush pipelines with water to remove silt and check for blockages. Rod pipelines between access points if there is any indication that they may be obstructed.
- Carry out a CCTV of the pipework to ensure that it is free of silt and blockages.

The End User shall then follow the "Waste Management, The Duty of Care - A Code of Practice (Revised 1996)" and shall ensure that their waste does not escape from their control and is transferred only to a registered waste carrier to be sent for recycling or disposal at a suitably licensed facility.

All waste arising from the maintenance of the drains and sewers shall be handled, stored and disposed of correctly to avoid pollution. Waste may be designated as hazardous / special waste and, as such, the End User shall ensure that they comply with the Hazardous Waste (England and Wales) Regulations 2005.

Reference shall be made to CIRIA publication C753 - The SuDS Manual by the Contractor and the End User. A suitable maintenance schedule must be developed, maintained, followed and updated as required to reflect observed performance. The following items are highlighted for guidance.

8.1 General drainage

The below ground drainage network has been designed in accordance with the requirements of the Building Regulations whilst acknowledging the need to limit the number of inspection chambers within "front of house" areas. To this end, all main runs have rodding eyes, manholes or inspection chambers at the head of the run and at all changes of direction to provide access to rod or jet the main pipework.

Where possible, connections from stacks or gullies have been made directly to these manholes or inspection chambers to allow the connection to be rodded or jetted from the downstream end. Where this is not possible, each stack has been detailed to have an access hatch provided just above floor level (see Figure 5.1) to allow the connection to be rodded or jetted from the upstream end. Similarly, the gullies have a rodding access provided within their body allowing the pipework to be rodded or jetted from the gully downstream.

Gullies and channels have been specified with silt buckets and silt trap manholes have been provided upstream of all tanks and infiltration structures to prevent the ingress of silts into the drainage network and impairing the performance of the system.

Maintenance schedule	Required action	Recorded frequency
Regular maintenance	Inspect and identify areas that are not operating correctly. If required, take remedial action.	Monthly for the first three months then six-monthly
	Remove sediment from pre-treatment structures (e. g. gullies, channels, silt traps).	Six-monthly or as required
Occasional maintenance	Debris removal from catchment surface where this may cause risks to performance.	Monthly
Remedial actions	Repair / rehabilitation of inlets, outlets, overflows and vents.	As required
Monitoring	Inspect all manholes, inspection chambers, inlets, outlets, overflows and vents to ensure they are in good condition and operating as designed.	Annually and after large storms

8.2 Pumped systems

Pumps have been designed as duplex units operating on a duty / standby based on hours run, pump failure and high / high water level. A suitable BMS interface shall be provided monitoring each pump system for the following status points:

- Pump 1 running / Pump 2 running - These statuses shall be provided to the BMS in the form of a volt free contact that is closed when the pump is running.
- Pump 1 failed / Pump 2 failed - These statuses shall be provided to the BMS in the form of a volt free contact that is closed when the pump has deemed to have failed, i. e. failed to run when requested. This shall cause a latched general alarm on the BMS.
- High water level - This status shall be provided to the BMS in the form of a volt free contact that is closed when a high water level is breached. The level shall set at a level that is higher than the normal pump control level switch. This shall cause a latched general alarm on the BMS.
- High / High water level - This status shall be provided to the BMS in the form of a volt free contact that is closed when a high / high water level is breached. The level shall set at a level that is higher than the high water level switch. This shall cause a critical latched alarm on the BMS.
- System not in automatic / not available - This status shall be provided to the BMS in the form of a volt free contact that is open (failsafe) when the system is not available to operate. This shall operate should any event occur that could prevent the system from operating, such as power loss to the control panel, hand / off / auto switches not in Auto, isolators opened. This shall cause a critical latched alarm on the BMS.

The BMS shall be capable of raising the following alarms:

- Excessive Pump Running Alarm - The BMS shall monitor the running status of each pump. Should any pump run for longer than 20 minutes, a general alarm shall be raised on the BMS.
- Excessive Pump Starts Alarm - The BMS shall calculate from the running status the number of starts per hour. Should the number of starts per hour exceed 4, a general alarm shall be raised on the BMS.

A control panel local to each pump station shall be provided to monitor the same status points and alarms as defined for the BMS Interface above.

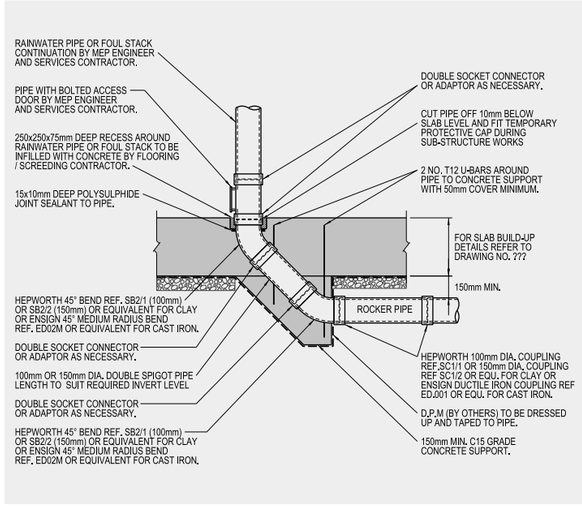


Figure 8.1 Rodding / jetting access detail

8.3 Rainwater Harvesting

Any property with a rainwater harvesting system installed should be provided with appropriate information as to what equipment has been installed, its purpose, its operation and maintenance requirements, the actions needed to address any potential failure and the expected performance of the system. Information on the options for external maintenance support should also be provided.

Most systems require periodic checking and maintenance to ensure troublefree and reliable operation. There are wide differences in the extent of maintenance required for different systems, and manufacturers' guidelines should always be followed. The table of actions below is not exhaustive and some actions may not always be required.

Maintenance requirements are largely dependent on the runoff source and the runoff use (and thus treatment processes provided). This will range from weekly input through to rare intervention. Routine inspection of the filter system at quarterly annual intervals is advised, even if they do not appear to need specific intervention. Pumps need very little attention, but their design life is generally regarded as only being 10 years. Where automatic provision of potable water occurs (if and when rainwater is either not available or the system has failed), it is useful to have sensor warnings relayed in such a manner as to inform the user of the current status of the system.

Tanks should be accessible for internal inspection, and the cover should preferably be lockable.

The maintenance responsibility for a rainwater harvesting system is usually with the owner of the property, but any communal systems require the participating community to be informed of the system, as detailed, but also be provided with information of who the organisation is that is maintaining the system and any financial commitments and any legally binding maintenance agreement.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspection of the tank for debris and sediment buildup, inlets/outlets/ withdrawal devices, overflow areas, pumps, filters	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris	Annually (and following poor performance)
Occasional maintenance	Cleaning and/or replacement of any filters	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required

8.4 Green Roofs

Intensive green roofs are likely to require regular inspection and maintenance. Grassed areas may require mowing weekly or fortnightly, plant beds may require weeding on a weekly or fortnightly basis during the growing season, and wildflower meadows may require annual mowing with the cuttings removed.

Extensive green roofs should normally only require biannual or annual visits to remove litter, check fire breaks and drains and, in some cases, remove unwanted invasive plants. The most maintenance is generally required during the establishment stage (12 to 15 months), and this should usually be made the responsibility of the green roof provider. Maintenance contractors with specialist training should be used, where possible.

All maintenance actions carried out at roof level must be in full compliance with the appropriate health and safety regulations, and particularly those specifically dealing with working at height. Training and guidance information on operating and maintaining the roof should be provided to all property owners and tenants. Safety fastenings will be required for personnel working on the roof. Specific maintenance needs of the green roof should be monitored and maintenance schedules adjusted to suit requirements.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (ie year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required - clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

8.5 Attenuation tanks

By aligning AquaCell Plus units end-to-end,full length viewing channels have been created within the base of the attenuation tank allowing for CCTV inspection if required. CCTV inspection of the tank is recommended at six-monthly intervals and after every major storm. Should the CCTV reveal a build up of silt in the base of the tank these channels also allow for jetting of the tank structure to clear the system.

Silt traps prior to inlet pipework should be routinely inspected and cleaned out to minimise debris reaching the tank. It is important to prevent construction silt from entering the AquaCell structure.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

8.6 Pervious Pavements

Regular inspection and maintenance is important for the effective operation of pervious pavements. Maintenance responsibility for a pervious pavement and its surrounding area should be placed with an appropriate responsible organisation. Before handing over the pavement to the client, it should be inspected for clogging, litter, weeds and water ponding, and all failures should be rectified. After handover, the pavement should be inspected regularly, preferably during and after heavy rainfall to check effective operation and to identify any areas of ponding.

Pervious pavements need to be regularly cleaned of silt and other sediments to preserve their infiltration capacity. Extensive experience suggests that sweeping once per year should be sufficient to maintain an acceptable infiltration rate on most sites. However, in some instances, more or less sweeping may be required and the frequency should be adjusted to suit sitespecific circumstances and should be informed by inspection reports.

A brush and suction cleaner (which can be a lorrymounted device or a smaller precinct sweeper) should be used for regular sweeping. Care should be taken in adjusting vacuuming equipment to avoid removal of jointing material. Any lost material should be replaced. It is also possible to clean the surface using lightweight rotating brush cleaners combined with power spraying using hot water.

If the surface has clogged then a more specialist sweeper with water jetting and oscillating and rotating brushes may be required, especially for porous asphalt surfaces, to restore the surface infiltration rate to an acceptable level. The specialist equipment should be adjusted so that it does not strip binder from the aggregate in the asphalt.

The likely design life of grass reinforcement will be dictated by trafficking and is likely to be about 20 years if designed correctly. For concrete block permeable paving the design life should be no different from standard paving, assuming that an effective maintenance regime is in place to minimise risks of infiltration clogging. Porous asphalt will lose strength and begin to fatigue due to oxidation of the binder. This is likely to occur slightly faster in porous asphalt than normal asphalt, so the design life will be reduced slightly. Porous concrete should have a similar design life to a normal concrete slab.

The reconstruction of failed areas of concrete block pavement should be less costly and disruptive than the rehabilitation of continuous concrete or asphalt porous surfaces due to the reduced area that is likely to be affected. Materials removed from the voids or the layers below the surface may contain heavy metals and hydrocarbons and may need to be disposed of as controlled waste. Sediment testing should be carried out before disposal to confirm its classification and appropriate disposal methods.

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy) and therefore, if litter management is already required at site, this should have marginal cost implications.

Generally, pervious pavements require less frequent gritting in winter to prevent ice formation. There is also less risk of ice formation after snow melt, as the melt water drains directly into the underlying subbase and does not have chance to refreeze. A slight frost may occur more frequently on the surface of pervious pavements compared to adjacent impermeable surfaces, but this is only likely to last for a few hours. It does not happen in all installations and, if necessary, this can be dealt with by application of salt. It is not likely to pose a hazard to vehicle movements.

The table below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive and some actions may not always be required.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate 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	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
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

9 Design Standards

9.1 National Standards

The following guides and current British Standards will be used for the design of the drainage elements on this project:

- BS EN 752:2017 Drain and Sewer Systems Outside Buildings. Sewer System Management
- BS EN 12056 Gravity Drainage Systems Inside Buildings: Part 2
- Building Regulations 2010 Part H1 – Foul Water Drainage (2015 Edition)
- Building Regulations 2010 Part H2 – Wastewater Treatment Systems and Cesspools (2015 Edition)
- Building Regulations 2010 Part H3 – Rainwater Drainage (2015 Edition)
- Building Regulations 2010 Part H4 – Building Over Sewers (2015 Edition)
- Building Regulations 2010 Part H5 – Separate Systems of Drainage (2015 Edition)
- Building Regulations 2010 Part H6 – Solid Waste Storage (2015 Edition)
- Environment Agency "Control of Runoff from New Developments Interim Regional Guidance"
- National Planning Policy Framework Planning Practice Guidance
- Manchester's Local Development Framework - Core Strategy Development Plan Document
- Greater Manchester Combined Authority Places for Everyone Joint Development Plan Document

9.2 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) superseded Planning Policy Statement 25 "Development and Flood Risk" (PPS 25) although the requirements and goals remain essentially the same:

- The susceptibility of land to flooding is a material planning consideration;
- The Environment Agency has the lead role in providing advice on flood issues, at a strategic level and in relation to planning applications;
- Planning decisions should apply the precautionary principle to the issue of flood risk, using a risk-based search sequence to avoid inappropriate development on undeveloped and undefended flood plains etc;
- Developers should fund flood defences and warning measures required because of the development;
- Planning policies and decisions should recognise that the consideration of flood risk and its management needs to be applied on a whole-catchment basis and not only be restricted to flood plains.

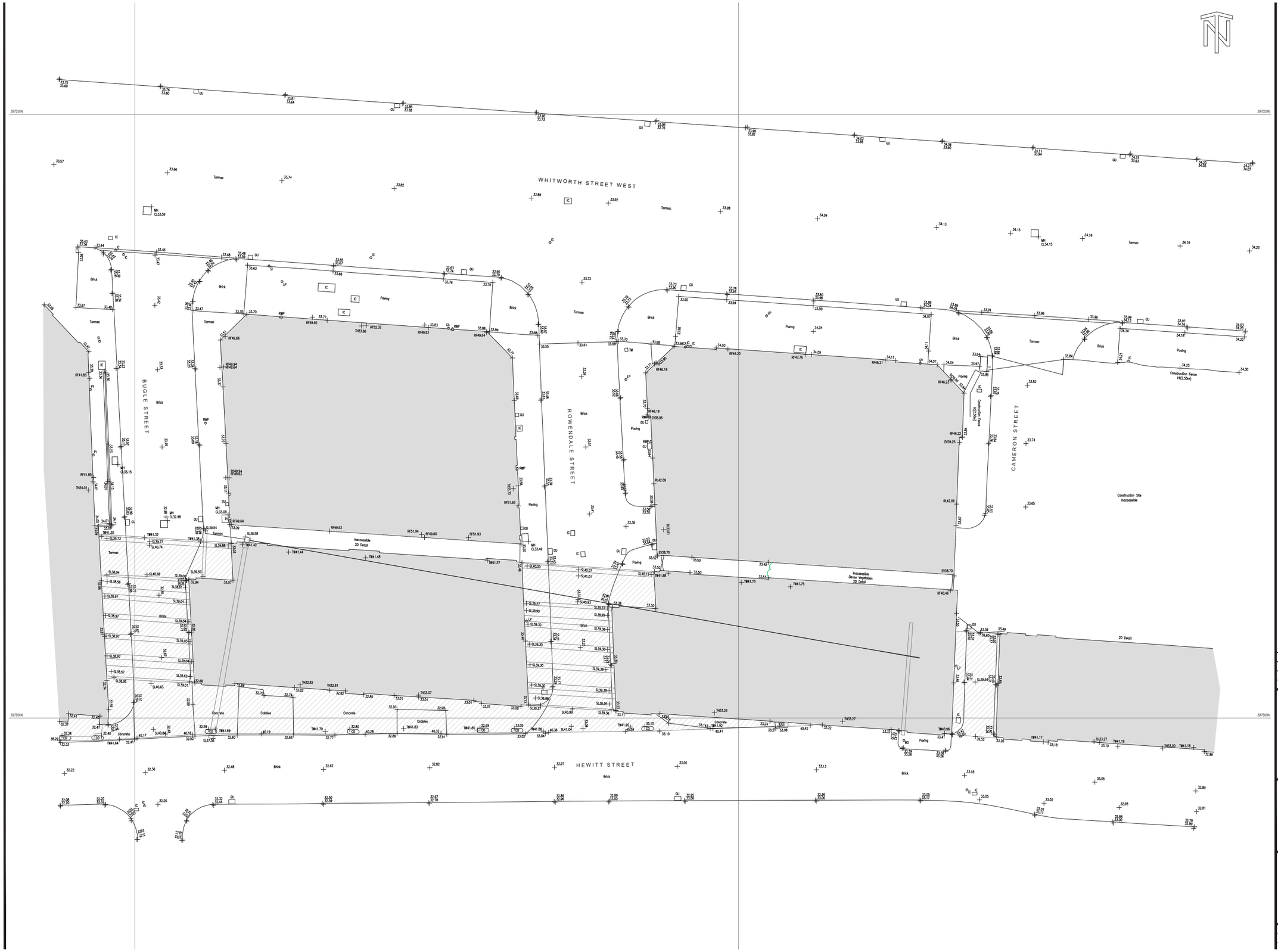
With regard to the NPPF, those proposing particular developments are responsible for:

- Providing an assessment of whether any proposed development is likely to be affected by flooding and whether it will increase flood risk elsewhere and the measures proposed to deal with these effects and risks and;
- Satisfying the local planning authority that any flood risk to the development or additional risk arising from the proposal will be successfully managed with the minimum environmental effect thus ensuring the safe development and secure future occupancy of the site.

After this has been addressed, it is then the local planning authority's responsibility (advised as necessary by the Environment Agency on fluvial and tidal flood risk, and the LLFA on surface water flood risk) to determine an application for planning permission after taking into account all material considerations, including the issue of flood risk and how it might be managed or mitigated. Local planning authorities are required to adopt a risk-based approach to proposals for development in flood risk areas.

Appendix A

Topographic survey



Grid & Datum - Local Plane Grid related to OS National Grid & Datum By GNSS RTK Observations

STANDARD ABBREVIATIONS

STREET FURNITURE

A/C - AIR CONDITIONING
AE - AERIAL
AL - ALARM
AV - AIR VALVE
BA - BUOY ANCHOR
BB - BUOY BEACON
BD - BUILDING DIVIDE
BH - BOREHOLE
BI - BOLLARD ILLUMINATED
BL - BASEMENT LIGHT
BO - BOLLARD
BP - BOUNDARY POST
BR - BOULDER
BS - BUS STOP
BU - BUSH
CA - CABLE
CB - CONTROL BOX
CC - CLOSE CIRCUIT TV
CE - CONCRETE BIN
Col - COLUMN
CT - CLOSE CIRCUIT TV POLE
DP - DOWN PIPE
DR - DRAIN
Dr Ch - DRAINAGE CHANNEL
DU - DUCT
EL - ELECTRIC
EP - ELECTRICITY POLE
ER - EARTH ROD
FA - FLOOD ALLEVIATOR
FB - FLOWER BED
FH - FIRE HYDRANT
FL - FLOODLIGHT
FS - FLAG STAFF
GA - GAS
GM - GAS METER
G - GIRTH
GP - GATE POST
GU - GULLY
GV - GAS VALVE
Hyd - HYDRANT
IC - INSPECTION COVER
IT - TRAFFIC COVER
JB - JUNCTION BOX
KO - KERB OFFLET
LA - LADDER
LB - LITTER BIN
LC - LIGHTING COLUMN
LI - LIGHT
LP - LAMP POST
MBO - MOORING BOLLARD
MA - MAST
MH - MANHOLE
MK - MARKER POST
MP - MILE POST
MR - MOORING RING
MW - MONITORING WELL
NP - NAME PLATE
O/H - OVERHEAD
OSBM - ORDNANCE SURVEY BENCH MARK
PA - PLAY APPARATUS
PB - PILLAR BOX
PH - PUBLIC HOUSE
PI - PIER
PM - PLANT
PMM - PARKING METER
PN - PLANTER
PO - POST
PP - PETROL PUMP
RH - RIDGE HEIGHT
RS - ROAD SIGN
RI - ROAD SIGN ILLUMINATED
RTW - RETAINING WALL
RWP - RAINWATER PIPE
SA - STANCHION
SC - SPEED CAMERA
SD - SATELLITE DISH
SF - SAFETY FENCE
SG - SIGNAL
SI - SIGN
SI - SIGN ILLUMINATED
SMP - SERVICE MARKER POST
SS - SECURITY SENSOR
ST - STOP TAP
SU - STUMP
SV - STOP VALVE
SW - SWITCHGEAR
TA - TEE
TA - TJA
TBM - TEMPORARY BENCH MARK
TCB - TELEPHONE CALL BOX
TE - TELEPHONE
TM - TICKET MACHINE
TS - TRAFFIC SIGNAL
TP - TELEGRAPH POLE
UTL - UNABLE TO LIFT
VDP - VEHICLE DETECTOR PAD
VP - VENT PIPE
WB - WHISTLE BLOW
WM - WATER METER
WO - WASH OUT
WP - WASTE PIPE

FENCE TYPES

B/W - BARBED WIRE
C/B - CLOSE BOARDED
C/I - CORRUGATED IRON
C/P - CONCRETE PANEL
H/R - HANDRAIL
I/R - IRON RAILING
P/C - PALISADE
P/L - POST & CHAIN
P/P - POST & PANEL
P/R - POST & RAIL
PSB - PEDESTRIAN SAFETY BARRIER
P/W - POST & WIRE
W/M - WIRE MESH

LEVELS

BL43.45 - BED LEVEL
EV43.45 - EAVE LEVEL
IL43.45 - INVERT LEVEL
43.45 - SPOT LEVEL
RF43.45 - ROOF LEVEL
RL43.45 - RIDGE LEVEL
SB43.45 - SOFT BED LEVEL
SL43.45 - SOFFIT LEVEL
TH43.45 - THRESHOLD LEVEL
WL43.45 - WATER LEVEL

SYMBOLS

HEDGE
GATE
BUILDING
TREE CANOPY
CONTROL STATION
EMBANKMENT
TREE
BUSH

Rev	Date	Drawn	Description	Ch'kd	App'd
A	31.10.23	TB	Client Details Changed	AM	NDO

N D OLIVER & CO
CHARTERED GEOMATIC SURVEYORS
Jupiter House, 21 Roebuck Lane, Sale, Manchester, M33 7SY
T: 0161 973 3495 F: 0161 962 6819
E: mail@ndoliver.com www.ndoliver.com

Client

GLENBROOK WWS LIMITED
UNION
2 - 10 ALBERT SQUARE
MANCHESTER
M2 6LW

Title

2 - 4 WHITEWORTH STREET
MANCHESTER

TOPOGRAPHICAL SURVEY
SHEET 1 OF 1

Surveyed	TB	Drawn	TB	Drawn Date:
Checked	AM	Approved	NDO	20/10/2023

Scale | Project 12624 | Status

Appendix B

Calculations

B.1 Climate Change Allowance

In the following calculations, a climate change allowance of 40% has been made which corresponds with the "Upper Limit" of the DEFRA guidance (refer to the table below):

Range	Total potential change anticipated for 2010-2039	Total potential change anticipated for 2040-2059	Total potential change anticipated for 2060-2115
Upper end	10%	20%	40%
Central	5%	10%	20%

B.2 Existing site surface water runoff rates

The development site occupies a total area of 1,610 m² which is currently 100% hardstanding. The area beneath the railway bridge (95 m²) and the public footpath (165 m²) have both been excluded from the calculations. The railway bridge rainwater is drained by the railway infrastructure and the public footpath will continue to drain as present and so neither contribute to the new development. Therefore, a hardstanding area of 1,350 m² has been considered.

In accordance with the Modified Rational Method, the peak existing run-off from the site is calculated from the formula:

$Q = 3.61 \times C_v \times A \times i$

where C_v is the volumetric runoff coefficient, A is the catchment area in hectares and i is the peak rainfall intensity in mm/hr.

For this site, the following site characteristics have been used in the calculation:

- Peak run off rates have been based on a 15 minute rainfall event
- Impermeable Area Factor = 1.00
- Permeable Area Factor = 0.00
- C_v (summer) = 0.95
- C_v (winter) = 0.95

For the peak return period storm events this gives existing discharge rates from the site of:

Q_1 = 3.61 × 0.95 × 0.135 × 23.6 = **10.9 litres/sec**

Q_{30} = 3.61 × 0.95 × 0.135 × 71.1 = **32.9 litres/sec**

Q_{100} = 3.61 × 0.95 × 0.135 × 90.0 = **41.7 litres/sec**

Q_{100+CC} = 3.61 × 0.95 × 0.135 × 126.0 = **58.4 litres/sec**

B.3 Existing Discharge Volumes

The existing discharge volumes have been calculated in accordance with BS 8582 which requires the volume for the 6 hour storm event to be considered. The volume discharged during the storm event is calculated from the formula:

$Vol_x = A \times i \times 6$ hrs

where A is the existing hardstanding area in hectares and i is the X-year, 6 hour event rainfall intensity in mm/hr.

Vol_1 = 0.135 × 4.70 x 6 = **3.81 m³**

Vol_{30} = 0.135 × 8.60 x 6 = **6.97 m³**

Vol_{100} = 0.135 × 10.80 x 6 = **8.75 m³**

Vol_{100+CC} = 0.135 × 15.12 x 6 = **12.25 m³**

B.4 Existing Runoff Summary

The existing runoff values are summarised below:

Return Period	Existing peak runoff rate	Existing Discharge Volume
1 year	10.9 litres/sec	3.00 m³
30 year	32.9 litres/sec	7.22 m³
100 year	41.7 litres/sec	8.75 m³
100 year (+40%)	58.4 litres/sec	12.25 m³

B.5 Greenfield Runoff Rates

In accordance with the method outlined in the Institute of Hydrology Report 124, the Greenfield runoff for the site is calculated from the formula:

$Q_{BAR} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

where AREA is the site area in km² (pro rata of 50 ha if the site is less than 50 ha), SAAR is the Standard Average Annual Rainfall in mm and SOIL is the Soil Index. For this site, the following site characteristics have been used in the calculation:

- IH 124 Soil Type = 4, therefore, SOIL = 0.45
- Standard Annual Average Rainfall (SAAR) = 800 mm
- Hydrological Growth Curve Region = 10 (North West England)

For a 50 ha site this gives a greenfield runoff rate of:

Q_{BAR} = 0.00108 × $0.5^{0.89}$ × $800^{1.17}$ × $0.45^{2.17}$ = **287.1 litres/sec**

Scaling this for the actual site area gives:

Q_{BAR} = (287.1 × 0.135) ÷ 50 = **0.78 litres/sec**

Using the Hydrological Growth Curve for north west England, gives:

Q_1 = 0.870 × 0.78 = **0.67 litres/sec**

Q_{30} = 1.700 × 0.78 = **1.32 litres/sec**

Q_{100} = 2.080 × 0.78 = **1.61 litres/sec**

Q_{100+CC} = 2.912 × 0.78= **2.27 litres/sec**

B.6 Proposed Unattenuated Surface Water Runoff Rates

The proposed development will contain approximately 325 m² of soft / permeable landscaping giving an impermeable area of 1,010 m². Again using the Modified Rational Method, the proposed (unattenuated) peak run-off rates from the site would be:

Q_1 = 3.61 × 0.95 × 0.101 × 23.6 = **8.2 litres/sec**

Q_{30} = 3.61 × 0.95 × 0.101 × 71.1 = **24.6 litres/sec**

Q_{100} = 3.61 × 0.95 × 0.101 × 90.0 = **31.2 litres/sec**

Q_{100+CC} = 3.61 × 0.95 × 0.101 × 126.0 = **43.6 litres/sec**

B.7 Proposed Attenuated Surface Water Runoff Rates

In accordance with the Environment Agency's guidelines, the Building Regulations and the Water Authority's advice, the preferred means of surface water drainage for any new development is into a suitable soakaway or infiltration drainage system. Sustainable Urban Drainage Systems (SuDS) can reduce the impact of urbanisation on watercourse flows, ensure the protection and enhancement of water quality and encourage recharging of groundwater in a manner which mimics nature.

In addition to this, the National Planning Policy Framework requires that surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic surface water flows arising from the site prior to the proposed development, whilst reducing flood risk to the site itself and elsewhere, taking climate change into account.

Therefore, as an absolute minimum, the proposed site discharge under the 1-in-100-year storm plus climate change should be no greater than the existing 1-in-100-year storm discharge (i.e. mitigate the impact of climate change and any increase in the area of hardstanding). In this case, this would mean that, rather than discharging **43.6 litres/sec**, the maximum permissible discharge from the site would be **41.7 litres/sec**.

Further to the above, the London Plan's Policy SI 13 states that "Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible". The Environment Agency (EA) suggests that Developers should aim to achieve greenfield run off from their site.

However, Clause 17 of the DEFRA / EA publication 'Rainfall runoff management for developments' states that "A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low flow rate while keeping the risk of blockage to an acceptable level. This limit is set at 5 litres per second, using an appropriate vortex or other flow control device. Where sedimentation could be an issue, the minimum size of orifice for controlling flow from an attenuation device should normally be 150 mm laid at a gradient not flatter than 1 in 150, which meets the requirements of Sewers for Adoption 7th Edition".

Based on the above considerations, it is proposed to match the post-development 1 in 100 year + 40% runoff rate to the **Q_{100} greenfield rate of 1.6 litres/sec.**

B.8 Proposed Discharge Volumes

The existing discharge volumes have been calculated in accordance with BS 8582 which requires the volume for the 6 hour storm event to be considered. The volume discharged during the storm event is calculated from the formula:

$Vol_x = A \times i \times 6$ hrs

where A is the existing hardstanding area in hectares and i is the X-year, 6 hour event rainfall intensity in mm/hr.

Vol_1 = 0.110 × 4.70 x 6 = **2.85 m³**

Vol_{30} = 0.110 × 8.60 x 6 = **5.21 m³**

Vol_{100} = 0.110 × 10.80 x 6 = **6.54 m³**

Vol_{100+CC} = 0.110 × 15.12 x 6 = **9.16 m³**

B.9 Network Design

The InfoDrainage results contained on the following pages demonstrate that all water is contained within the proposed drainage system for every event up to and including the 1 in 100 year plus 40% climate change allowance event.

B.10 Summary

The proposed and existing runoff values are summarised below:

Return Period	Existing Peak run off rate² (litres/sec)	Proposed scheme unattenuated peak run off rate (litres/sec)	Greenfield run off rate (litres/sec)	Proposed Design Peak run off rate (litres/sec)	Existing Discharge Volume (m³)	Proposed Discharge Volume (m³)
1 in 1 year	10.9	8.2	0.67	1.30	3.81	2.85
1 in 30 years	32.9	24.6	1.32	1.40	6.97	5.21
1 in 100 years	41.7	31.2	1.61	1.60	8.75	6.54
1 in 100 years (+40%)	58.4	43.6	2.27	1.60	12.25	9.16

Project:	Date:		
2-4 Whitworth Street Manchester	06/11/2024		
	Designed by:	Checked by:	Approved By:
	MJD		
Report Details:	Company Address:		
Type: Inflows Storm Phase: Phase	AKTII White Collar Factory, 1 Old Street Yard London EC1Y 8AF		

Building Footprint

Type : Catchment Area

Area (ha)	0.081

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff Coefficient	0.950
Winter Volumetric Runoff Coefficient	0.950
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Private Hardstanding

Type : Catchment Area

Area (ha)	0.02

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff Coefficient	0.950
Winter Volumetric Runoff Coefficient	0.950
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Project:	Date:		
2-4 Whitworth Street Manchester	06/11/2024		
	Designed by:	Checked by:	Approved By:
	MJD		
Report Details:	Company Address:		
Type: Stormwater Controls Storm Phase: Phase	AKTII White Collar Factory, 1 Old Street Yard London EC1Y 8AF		

Cellular Storage

Type : Cellular Storage

Dimensions

Exceedance Level (m)	33.100
Depth (m)	1.200
Base Level (m)	30.600
Number of Crates Long	10
Number of Crates Wide	11
Number of Crates High	3
Porosity (%)	95
Crate Length (m)	1
Crate Width (m)	0.5
Crate Height (m)	0.4
Total Volume (m³)	64.000

Inlets

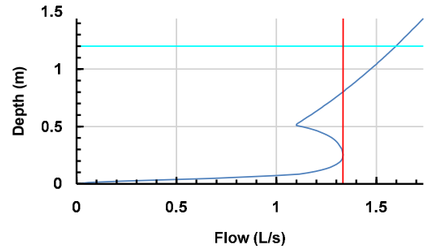
Inlet

Inlet Type	Point Inflow
Incoming Item(s)	Private Hardstanding Building Footprint
Bypass Destination	(None)
Capacity Type	No Restriction

Outlets

Outlet

Outgoing Connection	(None)
Outlet Type	Hydro-Brake®
Invert Level (m)	30.600
Design Depth (m)	1.200
Design Flow (L/s)	1.6
Objective	Minimise Upstream Storage Requirements
Application	Surface Water Only
Sump Available	☑
Unit Reference	SHE-0057-1600-1200-1600



Project:	Date:			
2-4 Whitworth Street Manchester	06/11/2024			
	Designed by:	Checked by:	Approved By:	
	MJD			
Report Details:	Company Address:			
Type: Network Design Criteria Storm Phase: Phase	AKTII White Collar Factory, 1 Old Street Yard London EC1Y 8AF			

Flow Options

Peak Flow Calculation	(UK) Modified Rational Method
Min. Time of Entry (mins)	5
Max. Travel Time (mins)	30

Pipe Options

Lock Slope Options	None
Design Options	Minimise Excavation
Design Level	Level Soffits
Min. Cover Depth (m)	1.200
Min. Slope (1:X)	500.00
Max. Slope (1:X)	40.00
Min. Velocity (m/s)	1.0
Max. Velocity (m/s)	3.0
Use Flow Restriction	☐
Reduce Channel Depths	☐

Manhole Options

Apply Offset	☐

Project:	Date:			
2-4 Whitworth Street Manchester	06/11/2024			
	Designed by:	Checked by:	Approved By:	
	MJD			
Report Title:	Company Address:			
Rainfall Analysis Criteria	AKTII White Collar Factory, 1 Old Street Yard London EC1Y 8AF			

Runoff Type	Dynamic
Output Interval (mins)	5
Time Step	Default
Urban Creep	Apply Global Value
Urban Creep Global Value (%)	0
Junction Flood Risk Margin (mm)	300
Perform No Discharge Analysis	☐

Rainfall

FEH

Type: FEH

Site Location	GB 383600 397400 SJ 83600 97400
Rainfall Version	2022
Summer	☑
Winter	☑

Return Period

Return Period (years)	Increase Rainfall (%)
2.0	40.000
30.0	40.000
100.0	40.000

Storm Durations

Duration (mins)	Run Time (mins)
15	30
30	60
60	120
120	240
180	360
240	480
360	720
480	960
600	1200
720	1440
960	1920
1440	2880

Project: 2-4 Whitworth Street Manchester	Date: 06/11/2024		
	Designed by: MJD	Checked by:	Approved By:
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase	Company Address: AKTII White Collar Factory, 1 Old Street Yard London EC1Y 8AF		

FEH: 2 years: Increase Rainfall (%): +40: Summary Results for Cellular Storage: Rank By: Max. US Depth

Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Percentage Available (%)	Status
FEH: 2 years: +40 %: 15 mins: Summer	30.789	30.789	0.189	0.189	24.0	9.907	0.000	0.000	1.3	1.741	84.521	OK
FEH: 2 years: +40 %: 15 mins: Winter	30.789	30.789	0.189	0.189	22.6	9.896	0.000	0.000	1.3	1.751	84.538	OK
FEH: 2 years: +40 %: 30 mins: Summer	30.840	30.840	0.240	0.240	16.6	12.579	0.000	0.000	1.3	3.792	80.345	OK
FEH: 2 years: +40 %: 30 mins: Winter	30.840	30.840	0.240	0.240	15.6	12.559	0.000	0.000	1.3	3.812	80.376	OK
FEH: 2 years: +40 %: 60 mins: Summer	30.888	30.888	0.288	0.288	14.7	15.042	0.000	0.000	1.3	7.884	76.497	OK
FEH: 2 years: +40 %: 60 mins: Winter	30.888	30.888	0.288	0.288	11.9	15.048	0.000	0.000	1.3	7.940	76.488	OK
FEH: 2 years: +40 %: 120 mins: Summer	30.947	30.947	0.347	0.347	11.8	18.151	0.000	0.000	1.3	16.176	71.639	OK
FEH: 2 years: +40 %: 120 mins: Winter	30.948	30.948	0.348	0.348	8.5	18.181	0.000	0.000	1.3	16.288	71.592	OK
FEH: 2 years: +40 %: 180 mins: Summer	30.973	30.973	0.373	0.373	9.8	19.469	0.000	0.000	1.3	24.224	69.580	OK
FEH: 2 years: +40 %: 180 mins: Winter	30.969	30.969	0.369	0.369	6.8	19.286	0.000	0.000	1.3	24.384	69.865	OK
FEH: 2 years: +40 %: 240 mins: Summer	30.985	30.985	0.385	0.385	8.5	20.129	0.000	0.000	1.3	30.707	68.549	OK
FEH: 2 years: +40 %: 240 mins: Winter	30.979	30.979	0.379	0.379	5.7	19.797	0.000	0.000	1.3	30.803	69.067	OK
FEH: 2 years: +40 %: 360 mins: Summer	30.993	30.993	0.393	0.393	6.7	20.545	0.000	0.000	1.3	37.297	67.898	OK
FEH: 2 years: +40 %: 360 mins: Winter	30.977	30.977	0.377	0.377	4.4	19.701	0.000	0.000	1.3	37.317	69.218	OK
FEH: 2 years: +40 %: 480 mins: Summer	30.987	30.987	0.387	0.387	5.7	20.214	0.000	0.000	1.3	41.554	68.416	OK
FEH: 2 years: +40 %: 480 mins: Winter	30.960	30.960	0.360	0.360	3.7	18.818	0.000	0.000	1.3	41.572	70.597	OK
FEH: 2 years: +40 %: 600 mins: Summer	30.975	30.975	0.375	0.375	4.9	19.578	0.000	0.000	1.3	44.817	69.409	OK
FEH: 2 years: +40 %: 600 mins: Winter	30.936	30.936	0.336	0.336	3.2	17.558	0.000	0.000	1.3	44.853	72.565	OK
FEH: 2 years: +40 %: 720 mins: Summer	30.960	30.960	0.360	0.360	4.3	18.831	0.000	0.000	1.3	47.589	70.577	OK
FEH: 2 years: +40 %: 720 mins: Winter	30.910	30.910	0.310	0.310	2.8	16.209	0.000	0.000	1.3	47.556	74.674	OK
FEH: 2 years: +40 %: 960 mins: Summer	30.928	30.928	0.328	0.328	3.5	17.151	0.000	0.000	1.3	52.093	73.201	OK
FEH: 2 years: +40 %: 960 mins: Winter	30.859	30.859	0.259	0.259	2.3	13.553	0.000	0.000	1.3	52.051	78.823	OK
FEH: 2 years: +40 %: 1440 mins: Summer	30.863	30.863	0.263	0.263	2.7	13.762	0.000	0.000	1.3	58.721	78.497	OK
FEH: 2 years: +40 %: 1440 mins: Winter	30.774	30.774	0.174	0.174	1.7	9.106	0.000	0.000	1.3	58.684	85.772	OK

Project: 2-4 Whitworth Street Manchester	Date: 06/11/2024		
	Designed by: MJD	Checked by:	Approved By:
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase	Company Address: AKTII White Collar Factory, 1 Old Street Yard London EC1Y 8AF		

FEH: 30 years: Increase Rainfall (%): +40: Summary Results for Cellular Storage: Rank By: Max. US Depth

Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Percentage Available (%)	Status
FEH: 30 years: +40 %: 15 mins: Summer	31.036	31.036	0.436	0.436	53.0	22.803	0.000	0.000	1.3	1.844	64.370	OK
FEH: 30 years: +40 %: 15 mins: Winter	31.036	31.036	0.436	0.436	49.9	22.785	0.000	0.000	1.3	1.864	64.399	OK
FEH: 30 years: +40 %: 30 mins: Summer	31.179	31.179	0.579	0.579	37.1	30.239	0.000	0.000	1.3	3.627	52.752	OK
FEH: 30 years: +40 %: 30 mins: Winter	31.178	31.178	0.578	0.578	34.8	30.217	0.000	0.000	1.3	3.647	52.786	OK
FEH: 30 years: +40 %: 60 mins: Summer	31.320	31.320	0.720	0.720	33.2	37.613	0.000	0.000	1.3	7.980	41.230	OK
FEH: 30 years: +40 %: 60 mins: Winter	31.319	31.319	0.719	0.719	26.7	37.604	0.000	0.000	1.3	7.983	41.244	OK
FEH: 30 years: +40 %: 120 mins: Summer	31.411	31.411	0.811	0.811	23.9	42.385	0.000	0.000	1.3	16.730	33.774	OK
FEH: 30 years: +40 %: 120 mins: Winter	31.416	31.416	0.816	0.816	17.2	42.617	0.000	0.000	1.3	16.707	33.411	OK
FEH: 30 years: +40 %: 180 mins: Summer	31.451	31.451	0.851	0.851	18.9	44.463	0.000	0.000	1.4	25.391	30.527	OK
FEH: 30 years: +40 %: 180 mins: Winter	31.457	31.457	0.857	0.857	13.0	44.769	0.000	0.000	1.4	25.344	30.048	OK
FEH: 30 years: +40 %: 240 mins: Summer	31.466	31.466	0.866	0.866	15.9	45.232	0.000	0.000	1.4	33.721	29.324	OK
FEH: 30 years: +40 %: 240 mins: Winter	31.475	31.475	0.875	0.875	10.7	45.720	0.000	0.000	1.4	33.657	28.562	OK
FEH: 30 years: +40 %: 360 mins: Summer	31.475	31.475	0.875	0.875	12.2	45.722	0.000	0.000	1.4	50.510	28.560	OK
FEH: 30 years: +40 %: 360 mins: Winter	31.479	31.479	0.879	0.879	8.0	45.907	0.000	0.000	1.4	50.430	28.270	OK
FEH: 30 years: +40 %: 480 mins: Summer	31.476	31.476	0.876	0.876	10.2	45.786	0.000	0.000	1.4	67.772	28.459	OK
FEH: 30 years: +40 %: 480 mins: Winter	31.475	31.475	0.875	0.875	6.6	45.722	0.000	0.000	1.4	67.748	28.560	OK
FEH: 30 years: +40 %: 600 mins: Summer	31.474	31.474	0.874	0.874	8.8	45.660	0.000	0.000	1.4	79.665	28.656	OK
FEH: 30 years: +40 %: 600 mins: Winter	31.466	31.466	0.866	0.866	5.7	45.236	0.000	0.000	1.4	79.668	29.319	OK
FEH: 30 years: +40 %: 720 mins: Summer	31.468	31.468	0.868	0.868	7.8	45.354	0.000	0.000	1.4	85.116	29.135	OK
FEH: 30 years: +40 %: 720 mins: Winter	31.452	31.452	0.852	0.852	5.0	44.494	0.000	0.000	1.4	85.081	30.478	OK
FEH: 30 years: +40 %: 960 mins: Summer	31.453	31.453	0.853	0.853	6.4	44.582	0.000	0.000	1.4	93.779	30.340	OK
FEH: 30 years: +40 %: 960 mins: Winter	31.417	31.417	0.817	0.817	4.1	42.693	0.000	0.000	1.3	93.703	33.293	OK
FEH: 30 years: +40 %: 1440 mins: Summer	31.408	31.408	0.808	0.808	4.9	42.240	0.000	0.000	1.3	106.919	34.000	OK
FEH: 30 years: +40 %: 1440 mins: Winter	31.329	31.329	0.729	0.729	3.1	38.089	0.000	0.000	1.3	106.786	40.485	OK

Project: 2-4 Whitworth Street Manchester	Date: 06/11/2024		
	Designed by: MJD	Checked by:	Approved By:
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase	Company Address: AKTII White Collar Factory, 1 Old Street Yard London EC1Y 8AF		

FEH: 100 years: Increase Rainfall (%): +40: Summary Results for Cellular Storage: Rank By: Max. US Depth

Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Percentage Available (%)	Status
FEH: 100 years: +40 %: 15 mins: Summer	31.158	31.158	0.558	0.558	67.1	29.167	0.000	0.000	1.3	1.751	54.427	OK
FEH: 100 years: +40 %: 15 mins: Winter	31.158	31.158	0.558	0.558	63.1	29.140	0.000	0.000	1.3	1.773	54.468	OK
FEH: 100 years: +40 %: 30 mins: Summer	31.345	31.345	0.745	0.745	47.3	38.931	0.000	0.000	1.3	3.991	39.171	OK
FEH: 100 years: +40 %: 30 mins: Winter	31.345	31.345	0.745	0.745	44.4	38.914	0.000	0.000	1.3	4.002	39.197	OK
FEH: 100 years: +40 %: 60 mins: Summer	31.541	31.541	0.941	0.941	42.8	49.204	0.000	0.000	1.4	8.904	23.119	OK
FEH: 100 years: +40 %: 60 mins: Winter	31.542	31.542	0.942	0.942	34.4	49.244	0.000	0.000	1.4	8.878	23.056	OK
FEH: 100 years: +40 %: 120 mins: Summer	31.649	31.649	1.049	1.049	30.2	54.826	0.000	0.000	1.5	18.671	14.334	OK
FEH: 100 years: +40 %: 120 mins: Winter	31.655	31.655	1.055	1.055	21.7	55.106	0.000	0.000	1.5	18.587	13.897	OK
FEH: 100 years: +40 %: 180 mins: Summer	31.705	31.705	1.105	1.105	23.8	57.702	0.000	0.000	1.5	28.431	9.841	OK
FEH: 100 years: +40 %: 180 mins: Winter	31.712	31.712	1.112	1.112	16.4	58.110	0.000	0.000	1.5	28.304	9.202	OK
FEH: 100 years: +40 %: 240 mins: Summer	31.734	31.734	1.134	1.134	19.9	59.242	0.000	0.000	1.6	37.977	7.434	OK
FEH: 100 years: +40 %: 240 mins: Winter	31.746	31.746	1.146	1.146	13.4	59.860	0.000	0.000	1.6	37.818	6.468	OK
FEH: 100 years: +40 %: 360 mins: Summer	31.760	31.760	1.160	1.160	15.4	60.597	0.000	0.000	1.6	56.218	5.317	OK
FEH: 100 years: +40 %: 360 mins: Winter	31.774	31.774	1.174	1.174	10.2	61.330	0.000	0.000	1.6	56.023	4.172	OK
FEH: 100 years: +40 %: 480 mins: Summer	31.779	31.779	1.179	1.179	13.0	61.607	0.000	0.000	1.6	73.478	3.739	OK
FEH: 100 years: +40 %: 480 mins: Winter	31.785	31.785	1.185	1.185	8.4	61.935	0.000	0.000	1.6	73.240	3.226	OK
FEH: 100 years: +40 %: 600 mins: Summer	31.792	31.792	1.192	1.192	11.2	62.283	0.000	0.000	1.6	91.583	2.683	OK
FEH: 100 years: +40 %: 600 mins: Winter	31.794	31.794	1.194	1.194	7.3	62.386	0.000	0.000	1.6	91.336	2.522	OK
FEH: 100 years: +40 %: 720 mins: Summer	31.799	31.799	1.199	1.199	10.0	62.641	0.000	0.000	1.6	107.717	2.123	OK
FEH: 100 years: +40 %: 720 mins: Winter	31.795	31.795	1.195	1.195	6.4	62.433	0.000	0.000	1.6	107.633	2.448	OK
FEH: 100 years: +40 %: 960 mins: Summer	31.829	31.829	1.229	1.229	8.3	62.747	0.000	0.000	1.6	121.104	1.958	OK
FEH: 100 years: +40 %: 960 mins: Winter	31.779	31.779	1.179	1.179	5.3	61.612	0.000	0.000	1.6	121.102	3.731	OK
FEH: 100 years: +40 %: 1440 mins: Summer	31.766	31.766	1.166	1.166	6.3	60.904	0.000	0.000	1.6	138.300	4.837	OK
FEH: 100 years: +40 %: 1440 mins: Winter	31.703	31.703	1.103	1.103	4.1	57.651	0.000	0.000	1.5	138.323	9.920	OK

B.11 Foul Water Flows

One method of calculating the peak foul flow is to use the statisical or "discharge unit" method outlined in BS 12056. This method of design is based on probability theory to estimate the maximum peak flows from appliances. It assumes that only a proportion of appliances will be in use at any one time and that appliances on a factory, school, etc. would be used more frequently than in domestic installations. For this reason discharge units (DU) are given higher values in congested and commercial use than they are for domestic.

Alternatively, foul flows can be computed using the "population method". This method calculates a daily discharge volume from typical figures of discharge per person, per day. It then factors it evenly over the day, to calculate base flow. A peaking factor is then applied (conservatively 6 or a variable factor based upon population such as the Babbitt Formula) to determine peak flow.

Estimates can also be based on internal floor area, which can also be arrived at as a product of an assumed population density and daily discharge per person.

As to which method is the more appropriate, typically, outside the building and at the street and city scale, the population method is considered more accurate and is the preferred method utilised by sewer companies. For sizing pipes inside the building, and in drains near to the point of discharge from the building, the statistical method should be used. Consideration of high peak flows from pump stations is also required.

BS 16933-2 recommends that the statistical method can be used for the design of gravity drains and sewers where the population is less than 1000 and the population method can be used where the population is greater than 500.

B.12 Existing Foul Water

Discharge Unit Method

There are currently no available record drawings for the existing building and so it has not been possible to make an assessment of the existing foul water discharge rate. However, as the buildings are unoccupied the existing foul water discharge is assumed to currently be zero.

B.13 Proposed Foul Water

Discharge Unit Method

The MEP engineer has provided the following estimate for the number of foul appliances in the proposed development. Using the guidelines for commercial developments given in BS EN 12056-2:2000 - "Gravity Drainage Systems Inside Buildings - Part 2: Sanitary Pipework, layout and calculation", the proposed foul flow is calculated from the formula:

$Q = K \times \sqrt{DU}$

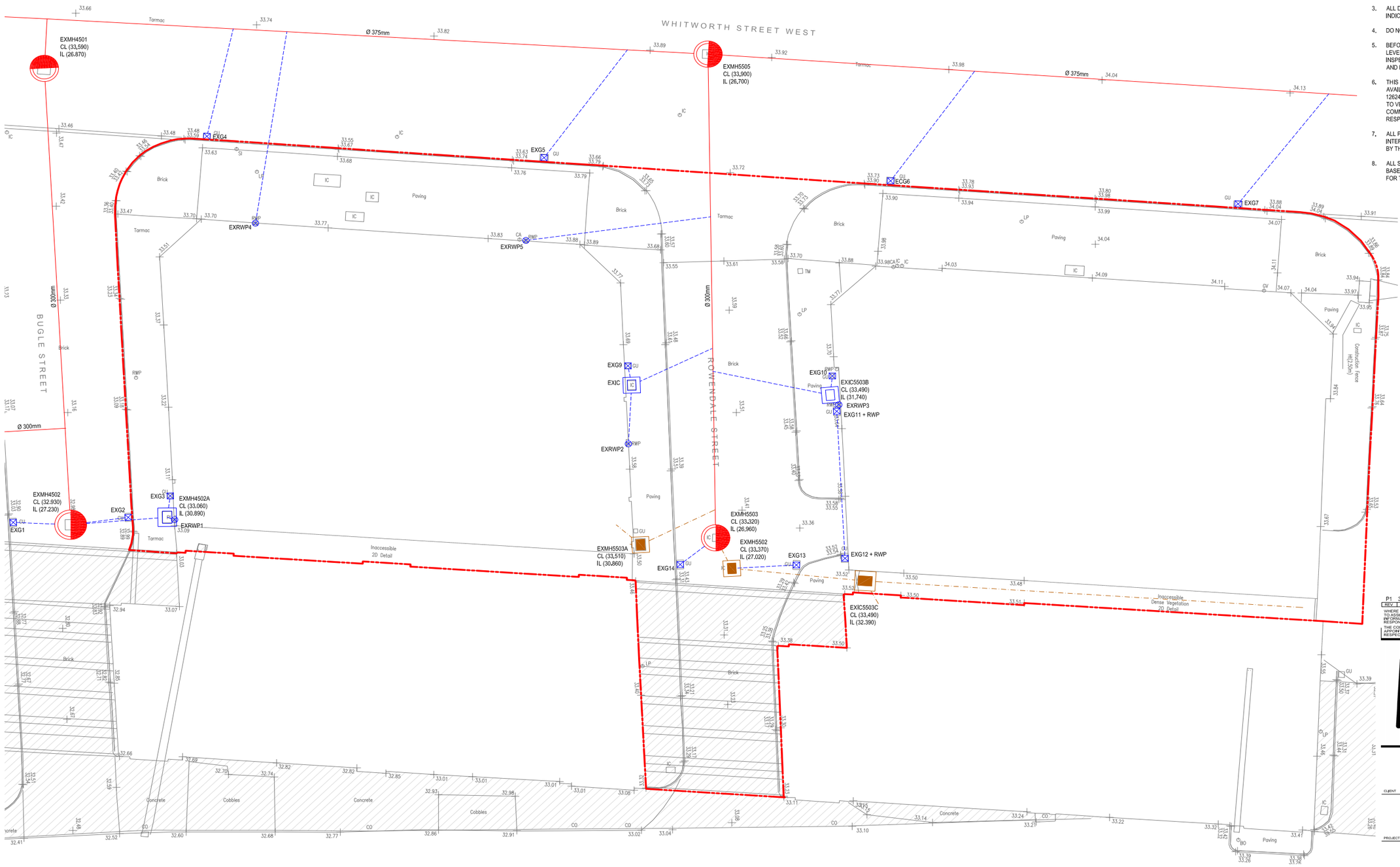
For 'intermittent use' (representing dwellings, offices, etc.) K has a value of 0.5 giving:

Appliance	No.	Discharge units per appliance	Total number of discharge units
Wash hand basin	626	0.3	187.8
Shower	276	0.4	110.4
Baths	366	1.3	475.8
Sinks	370	1.3	481.0
Dishwasher	370	0.2	74.0
Washing Machine	366	0.6	219.6
WCs	626	1.8	1,126.8
		Total discharge units for site =	**2675.4**
		Therefore, total flow from site =	**25.86 litres / sec**

At this early design stage it is suggested that an allowance is made for **27 litres / sec** to accommodate any design development.

Appendix C

Proposed Drawings



NOTES

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LEGEND

- SITE BOUNDARY
- EXISTING COMBINED SEWER
- EXISTING COMBINED MANHOLE
- EXISTING SURFACE WATER PIPE
- EXISTING SURFACE WATER MANHOLE
- EXISTING FOUL WATER PIPE
- EXISTING FOUL WATER MANHOLE
- EXISTING RAINWATER PIPE
- EXISTING ROAD GULLY

REV	DATE	DESCRIPTION	BY	CHECKED
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GLENBROOK

CLIENT

2-4 WHITWORTH STREET
MANCHESTER

PROJECT

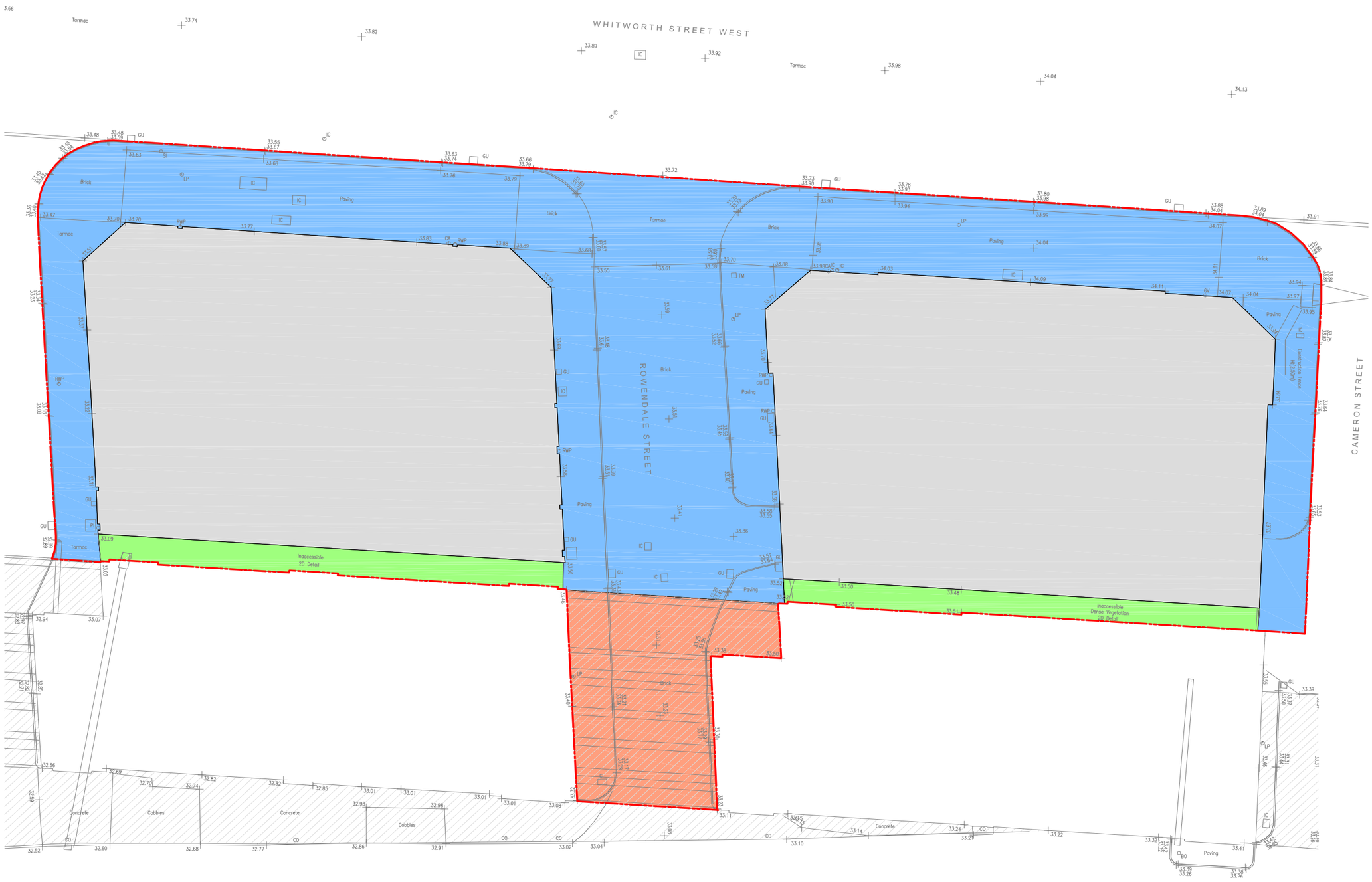
EXISTING DRAINAGE LAYOUT

TITLE

MD DRAWN BY	28.06.2024 DRAWN DATE	HL CHECKED BY	A1 SHEET SIZE
5822 PROJECT No.	PRELIMINARY PROJECT STAGE	S0 SUITABILITY CODE	1:100 SCALE

5822 AKT XX XX DR C 41000 P1
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NOTES

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DENOTES EXISTING BUILDING FOOTPRINT (855 m²)

DENOTES EXISTING PUBLIC HIGHWAY (605 m²)

DENOTES EXISTING PRIVATE HARDSTANDING (67 m²)

DENOTES EXISTING AREA BENEATH RAILWAY BRIDGE (97 m²)

DENOTES SITE BOUNDARY (1,624 m²)

PRELIMINARY

REV.	DATE	DESCRIPTION	BY	CHECKED
P1	31/08/24	PRELIMINARY ISSUE	MD	HL

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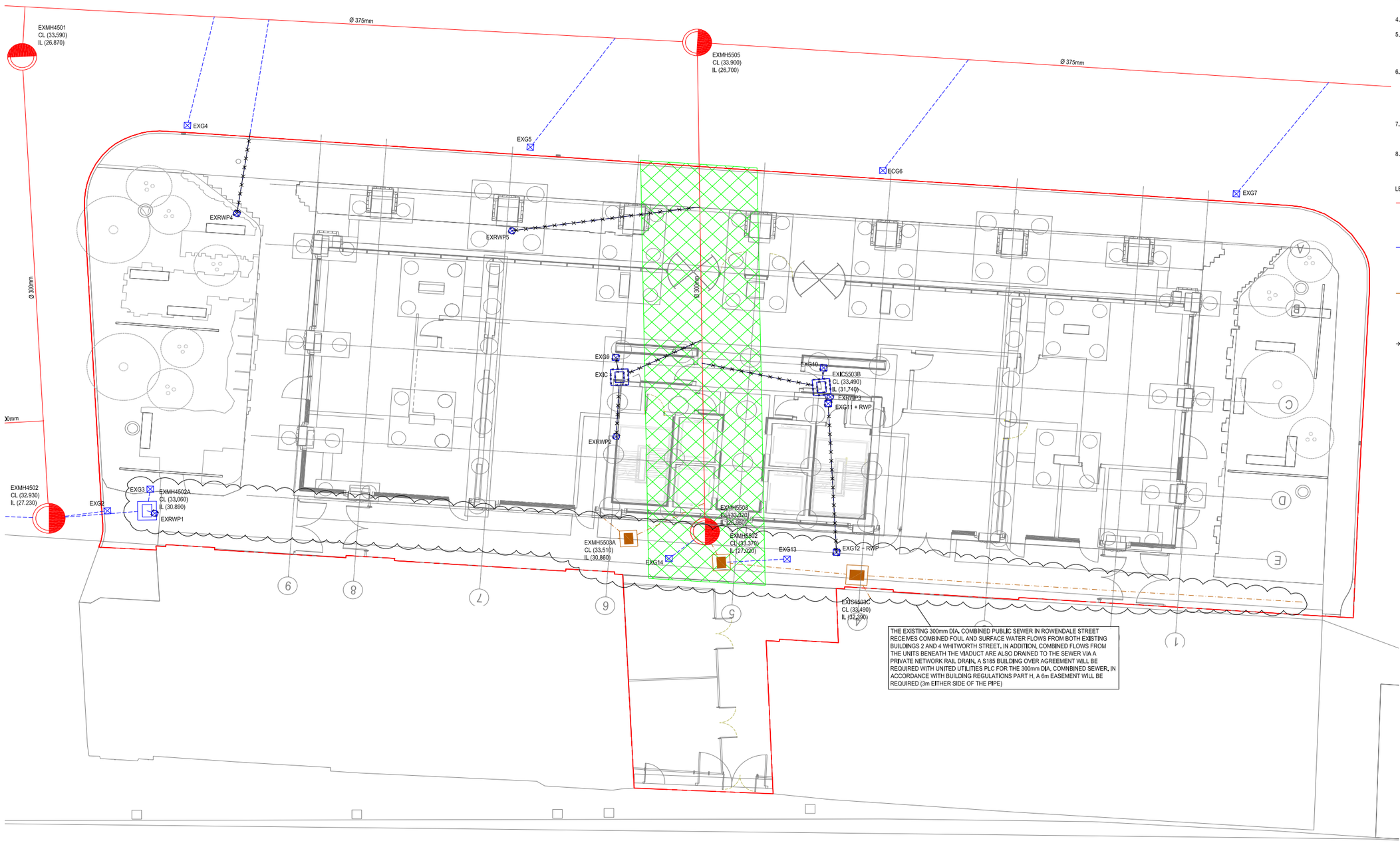
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PROJECT
2-4 WHITWORTH STREET
MANCHESTER

TITLE
EXISTING AREAS

MD DRAWN BY	28.06.2024 DRAWN DATE	HL CHECKED BY	A1 SHEET SIZE
5822 PROJECT No.	PRELIMINARY PROJECT STAGE	S0 SUITABILITY CODE	1:100 SCALE

PROJECT ID	ORIGINATOR	ZONE	LEVEL	TYPE	ROLE	DRAWING No.	REVISION
5822	AKT	XX	XX	DR	C	41010	P1



THE EXISTING 300mm DIA. COMBINED PUBLIC SEWER IN ROWENDALE STREET RECEIVES COMBINED FOUL AND SURFACE WATER FLOWS FROM BOTH EXISTING BUILDINGS 2 AND 4 WHITWORTH STREET. IN ADDITION, COMBINED FLOWS FROM THE UNITS BENEATH THE VIADUCT ARE ALSO DRAINED TO THE SEWER VIA A PRIVATE NETWORK RAIL DRAIN. A S185 BUILDING OVER AGREEMENT WILL BE REQUIRED WITH UNITED UTILITIES PLC FOR THE 300mm DIA. COMBINED SEWER, IN ACCORDANCE WITH BUILDING REGULATIONS PART H, A 6m EASEMENT WILL BE REQUIRED (3m EITHER SIDE OF THE PIPE)

NOTES

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LEGEND

- EXISTING COMBINED SEWER
- EXISTING COMBINED MANHOLE
- EXISTING SURFACE WATER PIPE
- EXISTING SURFACE WATER MANHOLE
- EXISTING FOUL WATER PIPE
- EXISTING FOUL WATER MANHOLE
- EXISTING DRAINAGE TO BE REMOVED
- 6m EXCLUSION ZONE TO EXISTING SEWER

REV	DATE	DESCRIPTION	BY	CHECKED
P2	15/11/24	ISSUED FOR INFORMATION	MD	HL
P1	31/08/24	PRELIMINARY ISSUE	MD	HL

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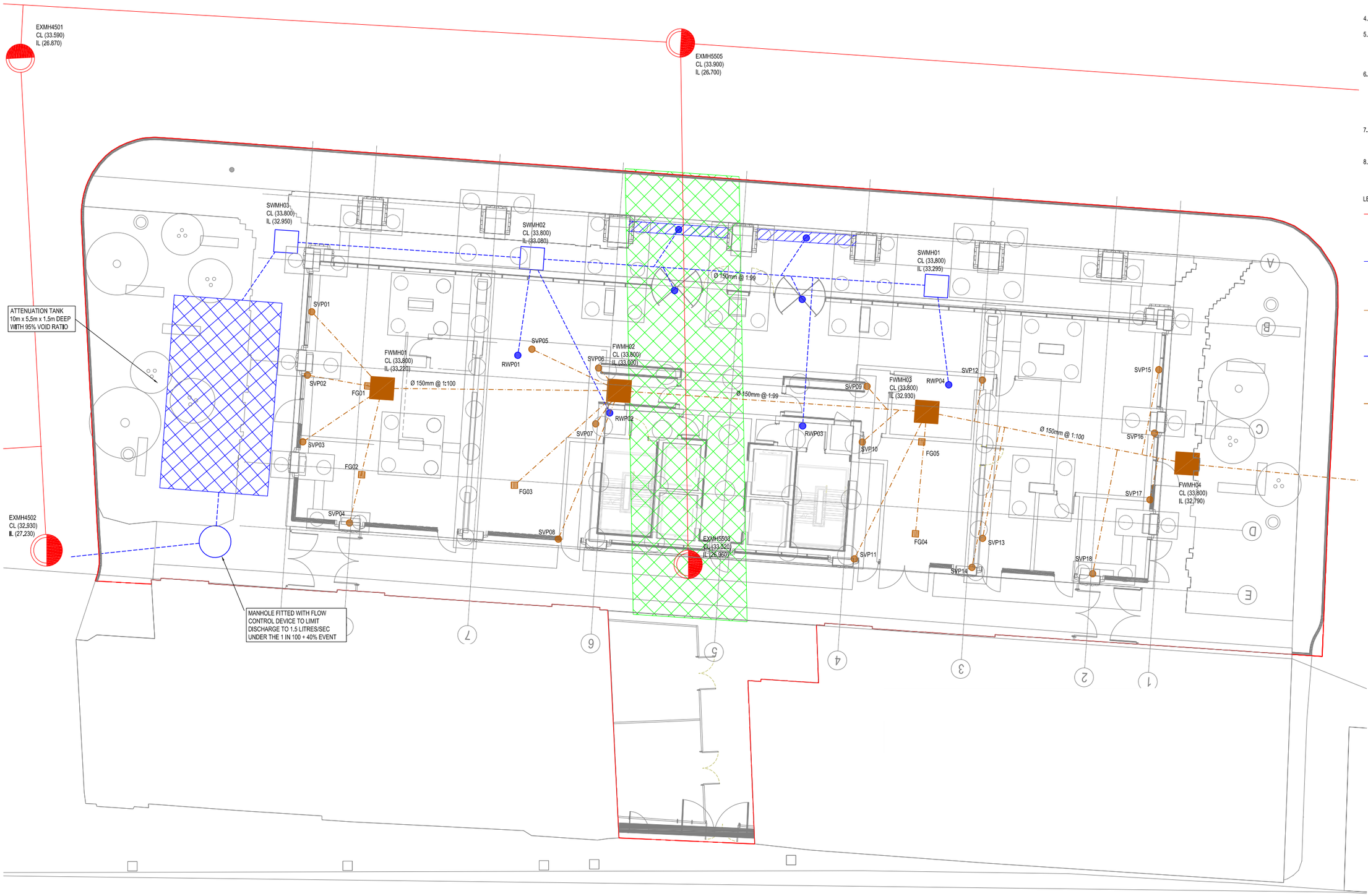
PROJECT
2-4 WHITWORTH STREET
MANCHESTER

TITLE
EXISTING DRAINAGE
TO BE REMOVED

MD DRAWN BY	28.06.2024 DRAWN DATE	HL CHECKED BY	A1 SHEET SIZE
5822 PROJECT No.	PRELIMINARY PROJECT STAGE	S0 SUITABILITY CODE	1:100 SCALE

5822 AKT XX XX DR C 41020 P2
PROJECT ID | ORIGINATOR | ZONE | LEVEL | TYPE | ROLE | DRAWING No. | REVISION

PRELIMINARY



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LEGEND

- EXISTING COMBINED SEWER
- EXISTING COMBINED MANHOLE
- EXISTING SURFACE WATER PIPE
- EXISTING SURFACE WATER MANHOLE
- EXISTING FOUL WATER PIPE
- EXISTING FOUL WATER MANHOLE
- PROPOSED SURFACE WATER DRAINAGE
- PROPOSED SURFACE WATER MANHOLE
- PROPOSED FOUL WATER DRAINAGE
- PROPOSED FOUL WATER MANHOLE
- RWP — PROPOSED RAIN WATER PIPE
- SVP — PROPOSED SOIL VENT PIPE
- SS — PROPOSED STUB STACK
- FG — PROPOSED FLOOR GULLY
- 6m EXCLUSION ZONE TO EXISTING SEWER

REV	DATE	DESCRIPTION	BY	CHECKED
P3	24/03/25	ISSUED FOR INFORMATION	MD	HL
P2	15/11/24	ISSUED FOR INFORMATION	MD	HL
P1	31/08/24	PRELIMINARY ISSUE	MD	HL

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GLENBROOK

CLIENT

2-4 WHITWORTH STREET
MANCHESTER

PROJECT

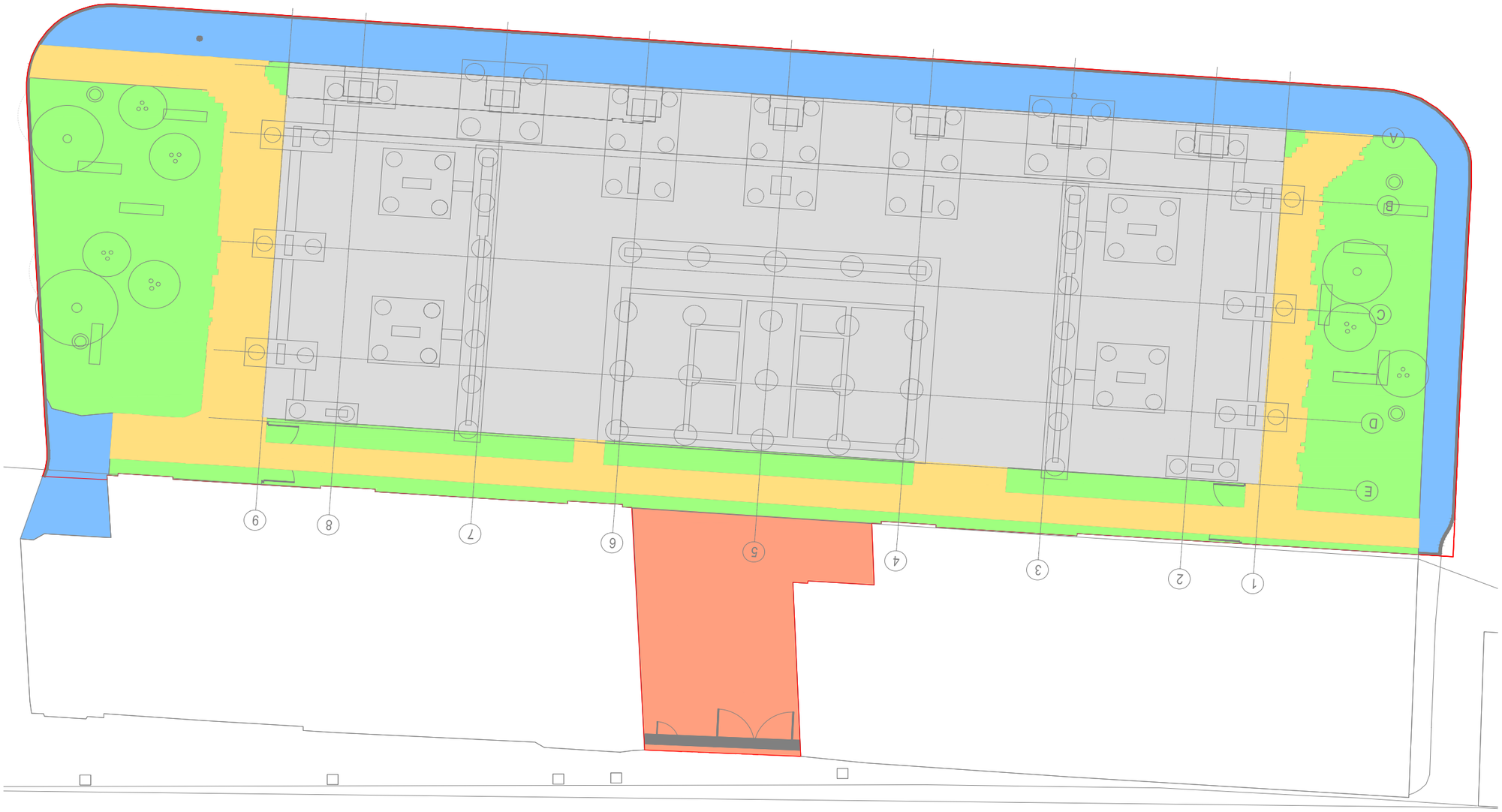
PROPOSED DRAINAGE LAYOUT

TITLE

MD	28.06.2024	HL	A1
DRAWN BY	DRAWN DATE	CHECKED BY	SHEET SIZE
5822	PRELIMINARY	S0	1:100
PROJECT No.	PROJECT STAGE	SUITABILITY CODE	SCALE

5822	AKT	XX	XX	DR	C	51000	P2
PROJECT ID	ORIGINATOR	ZONE	LEVEL	TYPE	ROLE	DRAWING No.	REVISION

PRELIMINARY



NOTES

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL AKT II DRAWINGS AND ALL OTHER RELEVANT ARCHITECT'S, ENGINEER'S AND LANDSCAPE ARCHITECT'S DRAWINGS AND SPECIFICATIONS.
2. FOR GENERAL NOTES REFER TO DRAWING NOS. 5822-S-001 TO 004.
3. ALL DIMENSIONS AND LEVELS SHOWN ARE IN METRES UNLESS INDICATED OTHERWISE.
4. DO NOT SCALE FROM THIS DRAWING.
5. BEFORE STARTING WORK, THE CONTRACTOR IS TO CHECK INVERT LEVELS AND POSITIONS OF ALL EXISTING DRAINS, SEWERS, INSPECTION CHAMBERS AND MANHOLES AGAINST DRAWINGS AND REPORT ANY DISCREPANCIES TO THE ENGINEER.
6. THIS SCHEME HAS BEEN DESIGNED USING THE SURVEY INFORMATION AVAILABLE, IN PARTICULAR N D OLIVER & CO DRAWING NUMBER 12624001A1, IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL LEVELS, BOUNDARIES, FEATURES, ETC, PRIOR TO COMMENCING WORKS ON SITE. AKT II SHALL NOT ACCEPT ANY RESPONSIBILITY FOR ERRORS RESULTING FROM THE SURVEY.
7. ALL PROPOSED COVER LEVELS HAVE BEEN CLARIFIED BY INTERPOLATION FROM THE PROPOSED LEVELS DRAWING PRODUCED BY THE LANDSCAPE ARCHITECT (DRAWING NO. ??????).
8. ALL STACK, RAINWATER PIPE AND GULLY POSITIONS HAVE BEEN BASED ON M&E ENGINEER'S DRAWING NO. ????. EXACT SETTING OUT FOR THESE TO BE OBTAINED FROM M&E ENGINEER AND ARCHITECT.

DENOTES PROPOSED BUILDING FOOTPRINT (810 m²)

DENOTES PROPOSED PUBLIC HIGHWAY (180 m²)

DENOTES PROPOSED PRIVATE HARDSTANDING (200 m²)

DENOTES PROPOSED SOFT / PERMEABLE LANDSCAPING (325 m²)

DENOTES AREA BENEATH RAILWAY BRIDGE (95 m²)

DENOTES SITE BOUNDARY (1,610 m²)

PRELIMINARY

REV	DATE	DESCRIPTION	BY	CHECKED
P3	24/03/25	REVISED PER LANDSCAPE CHANGES P6	AM	MD
P2	15/11/24	ISSUED FOR INFORMATION	MD	HL
P1	31/08/24	PRELIMINARY ISSUE	MD	HL

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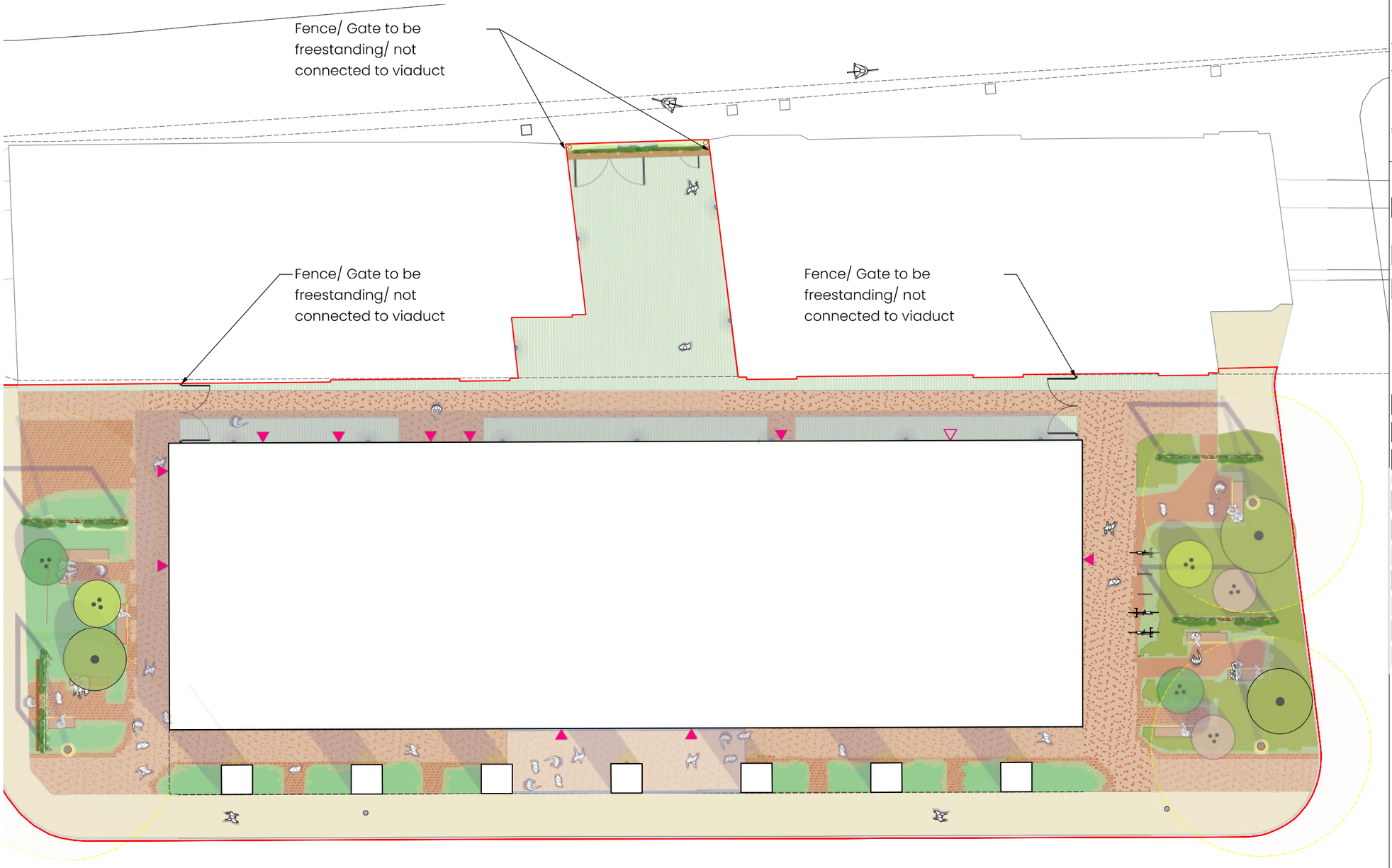
CLIENT
GLENBROOK

PROJECT
2-4 WHITWORTH STREET
MANCHESTER

TITLE
PROPOSED AREAS

MD DRAWN BY	28.06.2024 DRAWN DATE	HL CHECKED BY	A1 SHEET SIZE
5822 PROJECT No.	PRELIMINARY PROJECT STAGE	S0 SUITABILITY CODE	1:100 SCALE

PROJECT ID	ORIGINATOR	ZONE	LEVEL	TYPE	ROLE	DRAWING No.	REVISION
5822	AKT	XX	XX	DR	C	51010	P3



NOTES:

1. DO NOT SCALE FROM THIS DRAWING. ALWAYS WORK TO NOTED DIMENSIONS.
2. ALL SETTING OUT, LEVELS AND DIMENSIONS TO BE CHECKED ON SITE PRIOR TO THE INSTALLATION OF MATERIALS AND ANY DISCREPANCIES ARE TO BE BROUGHT TO THE ATTENTION OF THE CONTRACT ADMINISTRATOR IMMEDIATELY.
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6. NOTE DRAWING SUITABILITY CODE SHOWN BELOW. DRAWING NOT TO BE USED FOR CONTRACTUAL AGREEMENT WITHOUT AS STATUS.

THIS DRAWING WAS PLOTTED ON:
20/02/2025

REVISION HISTORY

DATE	REV	ZONE	DESCRIPTION	CHK
10/10/2024	P04		Update with Planners and Highways Comments	
13/12/2024	P05		Label added	OK
20/02/2025	P06		Highways update	OK

KEY

GENERAL INFORMATION

APPLICATION SITE BOUNDARY

HARDWORKS

SURFACE TYPE A
To Adopted footways
Subject to S278 Agreement

SURFACE TYPE B
Using recycled 'site won' materials
Subject to Future Detail

SURFACE TYPE C
Using recycled 'site won' materials
Subject to Future Detail

SURFACE TYPE D
Using recycled 'site won' materials
Subject to Future Detail

FURNITURE

FEATURE SEAT
Subject to Future Detail

FEATURE ARCHWAY
Subject to Future Detail

CYCLE STAND
To Courtyard
Subject to Future Detail

SOFTWORKS

CLEAR-STEM TREE PLANTING
Refer to Planting Schedule

MULTI-STEM TREE PLANTING
Refer to Planting Schedule

RAIN GARDEN PLANTING
Refer to Planting Schedule

BIODIVERSITY PLANTING
Refer to Planting Schedule

RECLAIMED BRICK & GROUND PLANTING
Refer to Planting Schedule / Hardworks

GREENGAP PAVING
Refer to Planting Schedule / Hardworks

CLIMBER PLANTING
Refer to Planting Schedule

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Project
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Manchester

Drawing Title
Landscape General Arrangement

Created By	Checked By	Scale	Sheet Size
OK	ST	1:100	A1

Project Number	Originator	Volume	Level	File Type	Discipline	Number
389	LYR	XX-ZZ-DWG-L-1001				

Work Stage	Status	Revision
Stage 2	S2 Review & comment	P06

Appendix D

SuDS Options

Bioretention / Raingardens

Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes, and treat pollution through the use of engineered soils and vegetation. They are particularly effective in delivering Interception and can also provide attractive landscape features that are self-irrigating and fertilising, habitat and biodiversity and cooling of the local microclimate due to evapotranspiration.

They are a very flexible surface water management component that can be integrated into a wide variety of development landscapes using different shapes, materials, planting and dimensions. In a low density development, the system might have soft edges and gentle side slopes, while a high density application might have hard edges with vertical sides.

They are generally used for managing and treating runoff from frequent rainfall events. Where larger events are directed to the system, consideration of the impact of design velocities on the system will be required. It is often more appropriate to pass runoff from extreme events directly to drainage components further downstream, via an overflow or bypass.

Runoff collected by the system ponds temporarily on the surface and then filters through the vegetation and underlying soils. Specified engineered soil mixes can be used as filter media to enhance bioretention treatment performance, and designs can be implemented that include submerged anaerobic zones to promote nutrient removal.

The filtered runoff is either collected using an underdrain system or, if site conditions allow, fully or partially infiltrated into the surrounding soil. Part of the runoff volume will be removed through evaporation and plant transpiration. The main hydraulic benefit of using bioretention systems is providing Interception. However, attenuation storage on the surface or within the drainage layer can be used to help manage runoff rates. Check dams or weirs can also be used to slow the flow of water moving across the surface of the system.

In general, the systems should not have impermeable liners, unless there is a specific need to prevent water from infiltrating, such as at locations close to structural foundations or for groundwater protection.

ADVANTAGES

- Can be planned as landscaping features and flexible layout to fit in with overall landscaping scheme
- Effective in removing pollutants
- Can reduce rate and volume of runoff
- Well suited to installation in impermeable areas provided space is available
- Good retrofit capability

DISADVANTAGES

- Requires landscaping and management
- Prone to clogging if maintenance of the surrounding landscaping is poor
- Not suitable for areas with steep gradients

PERFORMANCE

Interception	Can provide interception where underlying soils have capacity to infiltrate	Good
Peak flow control	Can help to manage peak flows by naturally limiting rates of conveyance through the filter medium, and also by providing attenuation storage which fills when the outlet flow rate is controlled	Medium
Volume Control	Can provide volume control based on expected infiltration, available attenuation storage and specified flow control	Medium
Exceedance Flow	An exceedance flow route will be required for rainfall events that exceed the design capacity	
Treatment	Can help reduce pollutant levels in runoff by filtering out sediments, metals, hydrocarbons and other pollutants.	Good
Amenity	Can deliver significant aesthetic benefits by incorporating vegetation into streetscape and general landscape features. Easily integrated.	Good
Bio-diversity	Can provide quality habitat conditions for wildlife, contributing positively to biodiversity enhancement in urban areas	Medium

SITE SUITABILITY

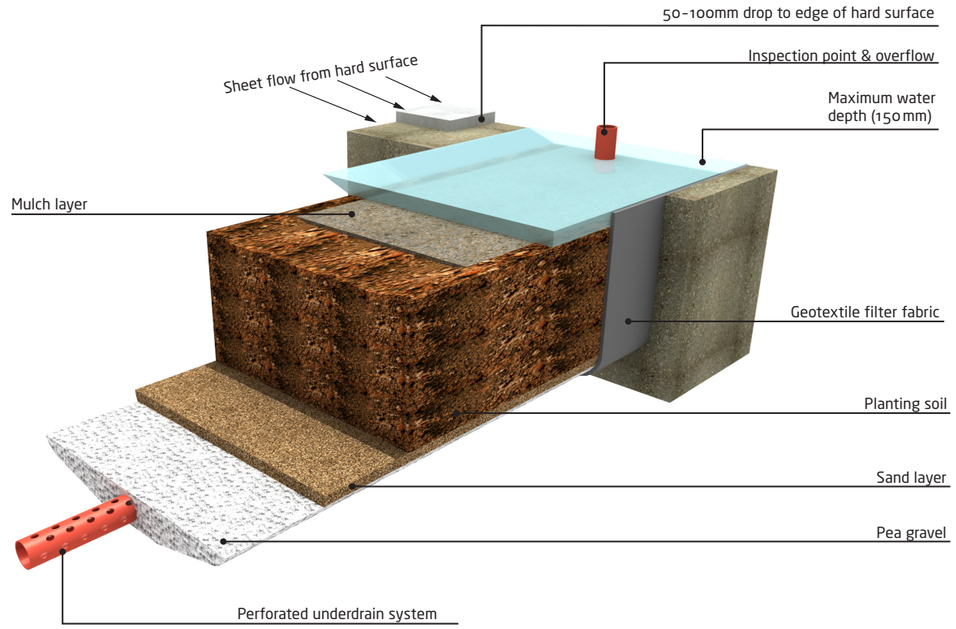
Residential	Yes
Commercial / industrial	Yes
High density	No
Retrofit	Yes
Contaminated site / sites above vulnerable groundwater	Yes

COST IMPLICATION

Land-take	High
Capital cost	Low
Maintenance burden	Medium

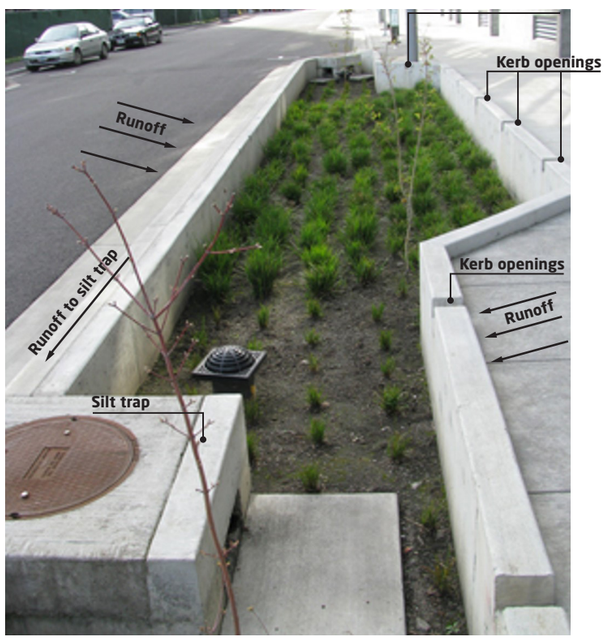
MAINTENANCE

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









Pervious Pavements

Pervious pavements provide a pavement suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored beneath the overlying surface before use, infiltration to the ground, or controlled discharge downstream.

Pervious surfaces, together with their associated substructures, are an efficient means of managing surface water runoff close to its source – intercepting runoff, reducing the volume and frequency of runoff, and providing a treatment medium. Treatment processes that occur within the surface structure, the subsurface matrix (including soil layers where infiltration is allowed) and the geotextile layers include filtration, adsorption, biodegradation and sedimentation.

There are two types of pervious pavements that are defined on the basis of the surfacing materials:

Porous pavements infiltrate water across their entire surface material, for example reinforced grass or gravel surfaces, resin bound gravel, porous concrete and porous asphalt.

Permeable pavements have a surface that is formed of material that is itself impervious to water. The materials are laid to provide void space through the surface to the subbase (eg standard concrete block paving is specifically designed to allow rainwater falling onto the surface or runoff discharged over the surface to infiltrate through the joints or voids between the blocks into the underlying pavement structure).

Types of surfaces used as part of pervious pavement construction include modular permeable paving, porous asphalt, grass reinforcement, resin bound gravel, porous concrete, sports surfaces and porous block paving.

ADVANTAGES

- Effective in removing pollutants
- Significant reduction in rate and volume of runoff
- Good retrofit capability
- Low maintenance and no additional land-take as there is dual use of space
- Removes need for gullies and manholes
- Eliminates surface ponding and icing
- Lined systems can be used

DISADVANTAGES

- Can't be used in areas where large sediment loads may be washed on to the surface
- UK current practice is to use only in areas of low traffic volume, low axle loads & low speed limits therefore limited range of sites
- Risk of long-term clogging and weed growth if poorly maintained

PERFORMANCE

Interception	The frequency of runoff from pervious pavements is significantly reduced when compared to gulley and pipe systems draining impermeable surface	Good
Peak flow control	Permeable pavements help reduce flow rates from a site by providing attenuation storage	Good
Volume Control	Can provide volume control based on expected infiltration, available attenuation storage and specified flow control	Medium
Exceedance Flow	An exceedance flow route will be required for rainfall events that exceed the design capacity	
Treatment	Decreases concentrations of a range of surface water pollutants when compared to impermeable surface drainage, including heavy metals, oil and grease, sediment and some nutrients	Good
Amenity	Can provide amenity in the form of both the usefulness and the visual aspects of the surface	Medium
Bio-diversity	Do not provide any direct biodiversity benefits	Poor

SITE SUITABILITY

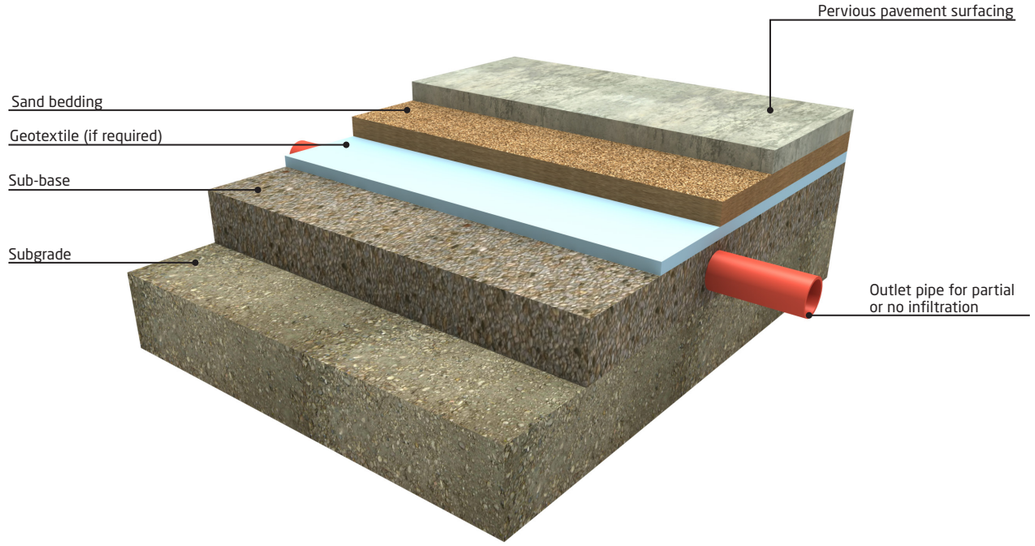
Residential	Yes
Commercial / industrial	Yes
High density	Yes
Retrofit	Yes
Contaminated site / sites above vulnerable groundwater (with liner)	Yes

COST IMPLICATION

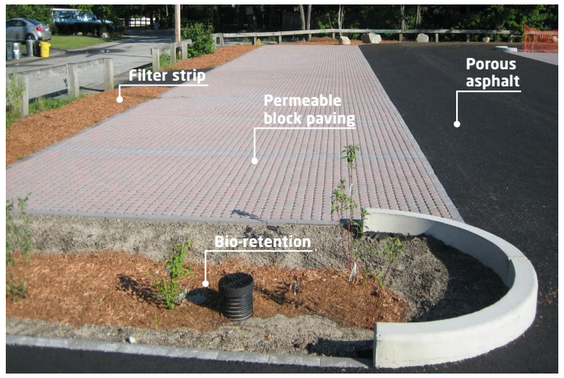
Land-take	High
Capital cost	Medium
Maintenance burden	Low

MAINTENANCE

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate 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	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
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









Attenuation storage tanks

Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or reuse. The storage structure is usually formed using one of the following methods:

- geocellular storage systems
- oversize pipes
- corrugated steel pipes
- precast or in situ concrete box culvert sections and tanks
- glass-reinforced plastic (GRP) tanks

The inherent flexibility in size and shape (and in some cases modularity) of the above systems means that they can be tailored to suit the specific characteristics and requirements of any site. Their main benefits are their high storage volume (compared to structures filled with aggregates) and their potential for installation beneath roads and car parks, recreational areas and other public open space.

Important considerations are the level of accessibility and maintainability with some types of system, the lack of treatment performance when used in isolation and cost (compared to surface systems, assuming that these can be implemented in public space, that is without requiring extra landtake).

These systems can be designed for use under areas trafficked by HGVs and other heavy plant, but it should be noted that their use under public (or adopted) roads will generally be subject to technical approval by the relevant highway authority. This should be sought at an early stage in the design process.

The maintainability of these systems requires careful consideration. They lie beneath the ground, so any failures or blockages will tend not to be noticed, which may increase risks to the site. Geocellular systems tend not to be easily accessible for inspection or cleaning, so very effective upstream treatment is required to ensure adequate sediment removal. There are some systems that incorporate "access" tunnels. However, in practice these only provide limited access, and it is difficult to see beyond the tunnels or to manoeuvre CCTV cameras within the tanks. Unless surface access points are provided for every tunnel, access for jetting is also limited.

These systems require integration with the overall surface water treatment strategy, as they don't have inherent treatment capability.

ADVANTAGES

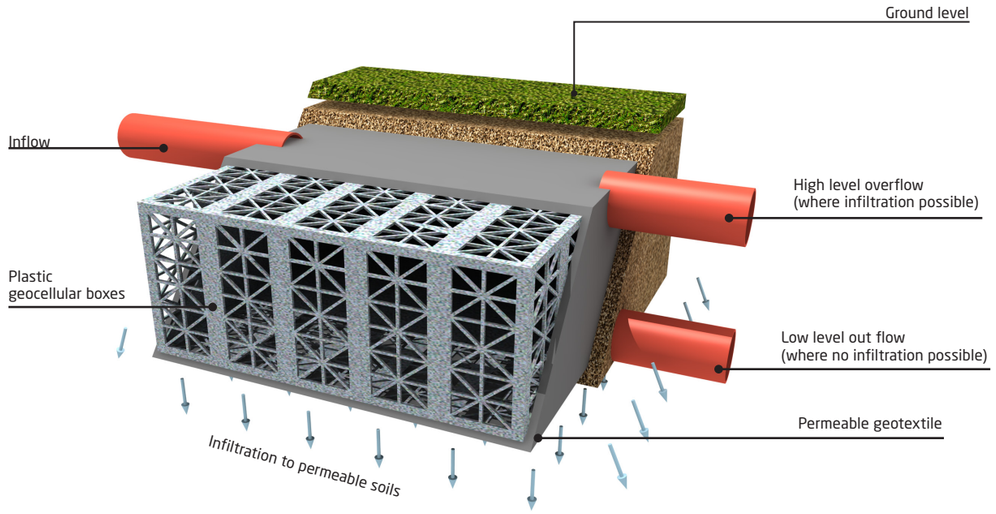
- Modular and flexible (dual use) – robust, lightweight and easy to install
- High void ratio giving large storage capacity
- Can be installed in both trafficked and pedestrian areas and also beneath public open space
- Long-term physical and chemical stability

DISADVANTAGES

- No water quality treatment – purely storage

PERFORMANCE

Interception	Tanks that are designed as attenuation systems and are fully impermeable do not provide any Interception, because all runoff will flow through and be discharged from the tank	Poor
Peak flow control	Attenuation tanks can help reduce flow rates from a site by providing attenuation storage	Good
Volume Control	Can provide volume control based on expected infiltration, available attenuation storage and specified flow control	Medium
Exceedance Flow	An exceedance flow route will be required for rainfall events that exceed the design capacity	
Treatment	Storage tank systems do not provide any form of treatment of surface water runoff, and they therefore need to be combined in a Management Train with other methods that do provide suitable treatment of all relevant pollutants	Poor
Amenity	Storage tank systems can provide amenity value if they are storing water for reuse. They can also promote the multi-functional use of space by allowing the surface above the tank to be used for recreation or other amenity facilities	Medium
Bio-diversity	Storage tank systems do not have any inherent biodiversity value but can help reduce the impact of heavy flows on the downstream system and help biodiversity in those areas.	Poor



SITE SUITABILITY

Residential	Yes
Commercial / industrial	Yes
High density	Yes
Retrofit	Yes
Contaminated site / sites above vulnerable groundwater	Yes

COST IMPLICATION

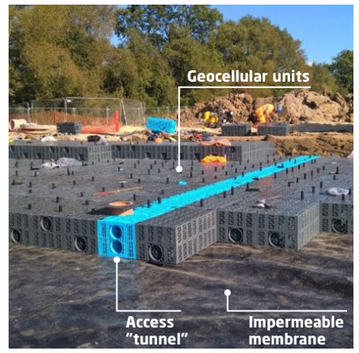
Land-take	Low
Capital cost	Low
Maintenance burden	Low

MAINTENANCE

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required



GRP attenuation tank



Geocellular attenuation tank with access tunnel



Steel pipe attenuation storage system



Geocellular attenuation tank



Modular precast concrete attenuation tank

Green / blue roofs

Green roofs are areas of living vegetation, installed on the top of buildings, for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. Green roofs can be divided into two main categories:

- Extensive roofs, have low substrate depths, simple planting and low maintenance requirements; they tend not to be accessible.
- Intensive roofs (or roof gardens) have deeper substrates that can support a wide variety of planting but which tend to require more intensive maintenance; they are usually accessible.

A blue roof is a roof design explicitly intended to store water. This storage can be designed as attenuation storage (with water released in a controlled manner), as storage for use such as irrigation, cooling water, non-potable use within the building and recreational opportunities. Blue roofs can include open water surfaces, storage within or beneath a porous medium or modular surfaces, below a raised deck or impermeable cover. Green roofs that include reservoir storage beneath the growing medium can also be termed "blue roofs". The key design considerations for blue roofs are the structural capacity of the roof to deal with the extra loadings and the waterproofing required to protect the building.

Although green roofs are generally more expensive than conventional roofs to construct and maintain, they can provide many long-term benefits. The vegetated cover should be compatible with and designed to protect the underlying roof waterproofing materials. The design life of roof waterproofing can be extended by protecting the waterproofing from mechanical damage, shielding it from ultraviolet radiation, and buffering temperature extremes.

Green roofs can improve the thermal performance of buildings, potentially reducing building energy costs, due to the plants and substrate cooling the roof through evapotranspiration during summer months. Winter insulation properties depend on the amount of water held by the roof - in wet winters gains will tend to be low. Green roofs help combat the urban heat island effect as well as contributing to improved air quality by capturing dust particles.

ADVANTAGES

- Mimic predevelopment state of building footprint
- Effective in removing pollutants
- Can be applied in high density developments
- Ecological, aesthetic and amenity benefits
- No additional land take
- Improved air quality
- Can insulate building against temperature extremes
- Can absorb sound

DISADVANTAGES

- Cost (compared to conventional runoff)
- Not suitable for steep roofs
- Maintenance of roof vegetation
- Waterproofing is critical

PERFORMANCE

Interception	The performance of green roofs in terms of reducing or preventing the runoff from normal rainfall events is usually very significant in the summer due to the evapotranspiration processes and temporary storage provided by the roof.	Good
Peak flow control	Green roofs can provide benefits in terms of reducing peak flow rates to the site drainage system - principally for small and medium sized events. Their impact tends to be most significant in summer, where intense short duration events may generate little runoff from the roof.	Medium
Volume Control	green roofs considerably reduce the volume of runoff in warmer periods when the soil moisture deficit is high. The type of plants used and soil depths will influence evapotranspiration rates and available potential storage in the soil	Good
Exceedance Flow	very roof structure and all roof drainage design should consider the impact of events that are greater than the design event, and the risks associated with exceedance flows should be assessed and managed in an appropriate and safe way	
Treatment	Through a variety of physical, biological and chemical treatment processes, within the soil and root uptake zone, which filter airborne pollutants and pollutants entrained within rainwater, green roofs can help to reduce the amount of pollution delivered to the local drainage system	Good
Amenity	Green roofs can be used to provide valuable amenity if the roof is intended to be accessible or is overlooked	Good
Bio-diversity	Green roofs can be designed to provide high ecological value. They can help to conserve valuable habitat and biodiversity and provide an oasis of life in an otherwise sterile urban environment	Good

SITE SUITABILITY

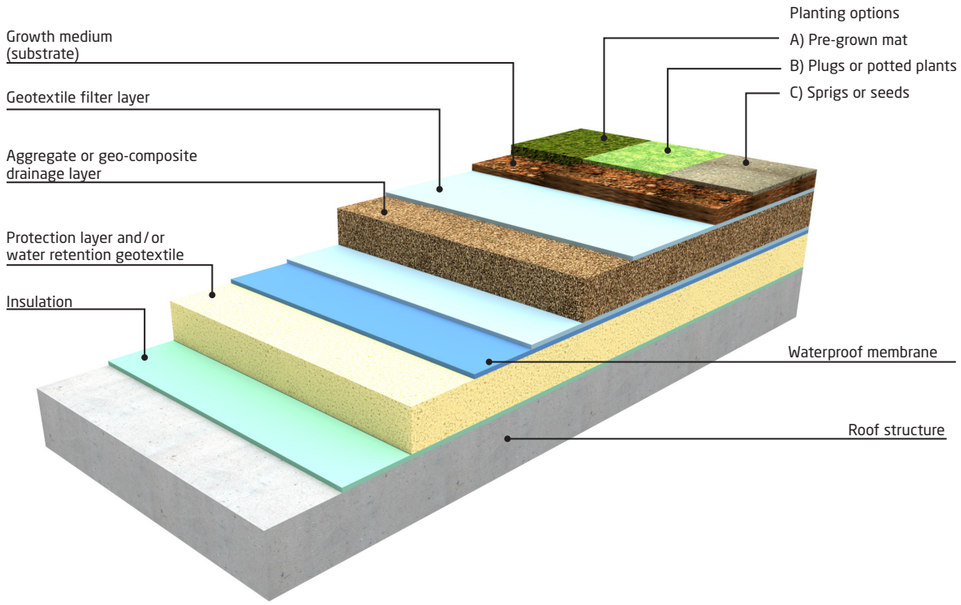
Residential	Yes
Commercial / industrial	Yes
High density	Yes
Retrofit	Yes
Contaminated site / sites above vulnerable groundwater	Yes

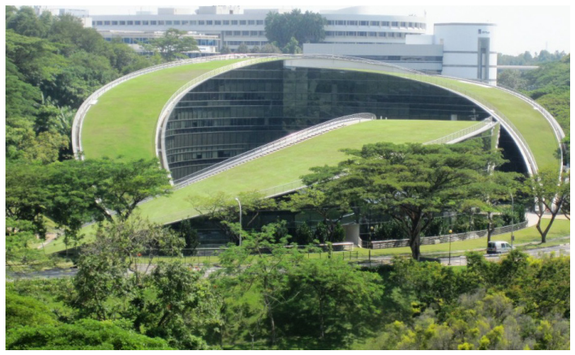
COST IMPLICATION

Land-take	Low
Capital cost	High
Maintenance burden	Medium

MAINTENANCE

Maintenance schedule	Required action	Typical frequency
Regular inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (ie year one), replace dead plants as required	Monthly (but usually by manufacturer)
	Post establishment, replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required - clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required









Rainwater Harvesting

Rainwater harvesting (RWH) is the collection of rainwater runoff for use. Runoff can be collected from roofs and other impermeable areas, stored, treated (where required) and then used as a supply of water for domestic, commercial, industrial and/or institutional properties. RWH systems have a number of key benefits:

- They can meet some of the building's water demand, delivering sustainability and climate resilience benefits.
- They can help reduce the volume of runoff from a site.
- They can help reduce the volume of attenuation storage required on the site.

Where the runoff is from trafficked areas, the potential for harvesting will depend on the proposed use of the water, the extent of pollution and the treatment provided. The collected water can generally be used for a range of nonpotable purposes, such as flushing toilets, washing machines (which may require adaptation) and for external uses such as car washing and irrigation. RWH systems are rarely used to provide potable water for consumption or bathing in the UK, as this requires specialised treatment and monitoring to manage the contamination risks. In the UK, private water supplies for locations not connected to main water supply networks have to comply with the Private Water Supplies Regulations 2009.

RWH systems are designed to a specific level of service, which may address water supply only (water conservation systems) or surface water management as well (via the inclusion of further storage capacity). Provided the system is designed for supply purposes (ie it has a regular daily demand), RWHs can be considered to deliver Interception for the contributing impermeable area and to reduce the runoff volume.

Although water butts are often regarded as a form of RWH, in practice their value is limited to domestic watering during dry periods when there is garden water in the container. Water butts do not guarantee that storage will always be available and there is no robust evidence regarding the potential effectiveness of such components during significant events and no guidance on the size of orifice and storage volume that may be required to ensure suitable performance levels.

ADVANTAGES

- Can provide source control of stormwater runoff
- Reduces demand on mains water

DISADVANTAGES

- Potential risks to public health
- Systems can be complex and costly to install
- Above ground tanks can be unsightly

PERFORMANCE

Interception	RWH, whether designed for water conservation only or surface water management as well, provides benefits in delivering Interception for all connected surfaces - where demand from the system is regular and consistent through the year.	Good
Peak flow control	RWH systems will only contribute to peak flow rate reductions during the period where upstream storage tanks are filling, that is when there is no runoff from the contributing surfaces. Once the tank storage is full, there will be no reduction in flow rates as it should be assumed that runoff then passes to the site drainage system	Medium
Volume Control	RWH systems can be designed to capture and retain the design rainfall event depth required for volumetric control	Good
Exceedance Flow	RWH systems for surface water management are designed to capture a specific depth of rainfall. They therefore only contribute to extreme event flow management during the initial stages of extended extreme events and during high intensity, short duration rainfall when site drainage systems are overwhelmed while the rainwater tanks are still capturing and storing runoff.	
Treatment	Where roof runoff is captured by the RWH system, any pollutants from the roof surface will be captured by the collection and filtration system. Maintenance of the system is essential to prevent debris, sediment and other pollutants that accumulate in the filters from being discharged downstream, and to ensure the long-term performance of the system	Poor
Amenity	RWH systems provide indirect amenity value by supporting the resilience of developments and their landscape to changes in climate and water resource availability	Poor
Bio-diversity	RWH tanks do not have any inherent biodiversity value, but they can help to reduce flows on the downstream system, and this can help facilitate biodiversity delivery in those areas	Poor

SITE SUITABILITY

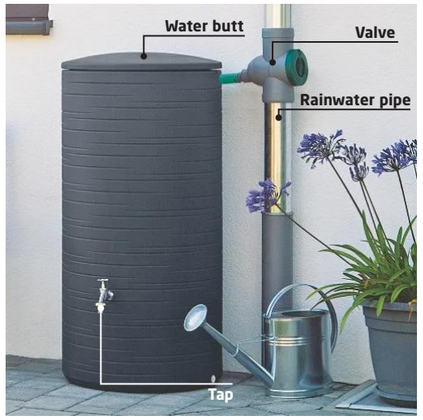
Residential	Yes
Commercial / industrial	Yes
High density	Yes
Retrofit	Unlikely
Contaminated site / sites above vulnerable groundwater	Yes

COST IMPLICATION

Land-take	Low
Capital cost	High
Maintenance burden	Medium

MAINTENANCE

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspection of the tank for debris and sediment buildup, inlets/outlets/withdrawal devices, overflow areas, pumps, filters	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris	Annually (and following poor performance)
Occasional maintenance	Cleaning and/or replacement of any filters	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required



Water butt harvesting system



Above ground rainwater harvesting system

