Pell Frischmann

excellence through innovation

Twickenham Station Yard Block D

November 2019

Drainage Strategy Report

102135-PF-ZZ-XX-RP-D-0001

Submitted by Pell Frischmann

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CONTENTS

EXECUTIVE SUMMARY

This document outlines the strategy for the proposed surface water drainage that is to be provided as part the Twickenham Station Yard, Block D development.

The strategy has been prepared to support the detailed planning application. It will also be submitted to Thames Water as part of the consultation and statutory approvals process.

The proposed development seeks to incorporate green roofs where possible, and a 35m^3 buried geo-cellular attenuation tank below the ground floor slab. We aim to restrict the flows to 5l/s in line with EA guidance, which has been agreed with Thames Water.

This report, along with the enclosed supporting documents demonstrates that the proposed development can be adequately provided with all necessary drainage infrastructure. These achievements align with the aims and objectives for the required legislative guidelines.

1. INTRODUCTION

This document outlines the drainage strategy for both foul and surface water that is to be provided as part the Twickenham Station Yard, Block D development.

The strategy has been prepared to support the detailed planning application and listed building consent applications. It will also be submitted to Thames Water as part of the consultation and statutory approvals process.

1.1 REFERENCES

This drainage strategy is based on the proposed site layout drawings provided by the architects Wimhurst Pelleriti, submitted as part of this planning application. Refer to drawing reference: WP-0689-A-0100-P-L0

The following adopted national, regional and local planning policies have been assessed;

- National Planning Policy Framework 2019 (NPPF);
- The London Plan 2016;
- Planning Guidance Document Delivering SuDS in Richmond;
- C697 The SUDS manual.

2. SITE DESCRIPTION

The following site description is based upon a review of currently available information.
The site is located in the southern end of the London Borough of Richmond, post code TW1 4LJ, with the centre of the site roughly at grid reference TQ106735. The lead local flood authority for Twickenham Station is the London Borough of Richmond upon Thames.

The existing site consists entirely of impremeable surfacing (asphalt) used for car parking. The site is encompassed to the north by railway, to the east and south by highway and to the west by TFL (Transport For London) land.

The closest watercourse to the site is the River Crane located approximately 100m to the north. Environment Agency records show that the site location is in flood zone 1, an area with a low probability of flooding. Please refer to Appendix E.

The site location (Solum Site) and aerial images are provided below in Figure 2.1 and Figure 2.2 respectively.

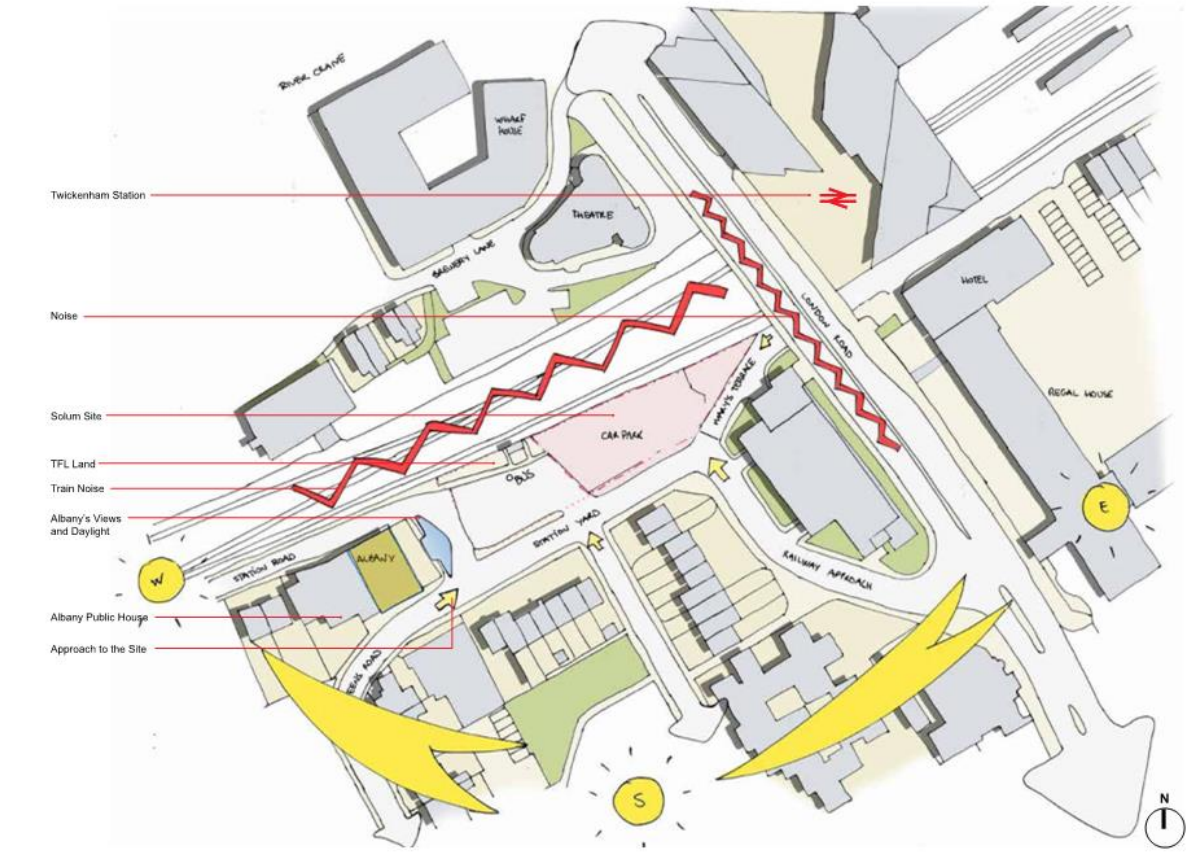


Figure 2.1: Approximate Twickenham station block D site location

Figure 2.2: Aerial image

2.1 EXISTING UTILITY ARRANGEMENTS

A variety of underground services pass through the site, including a water main, surface water sewer and foul water sewers. These are all part of the Thames Water network. In close proximity to the site there are buried electricity, telecoms and gas services. The Thames Water sewers impose exclusion zones of 1.5m to either side of the associated sewer. These easements restrict where foundations, more specifically where piles can be located. The foundation layout should therefore accommodate this.

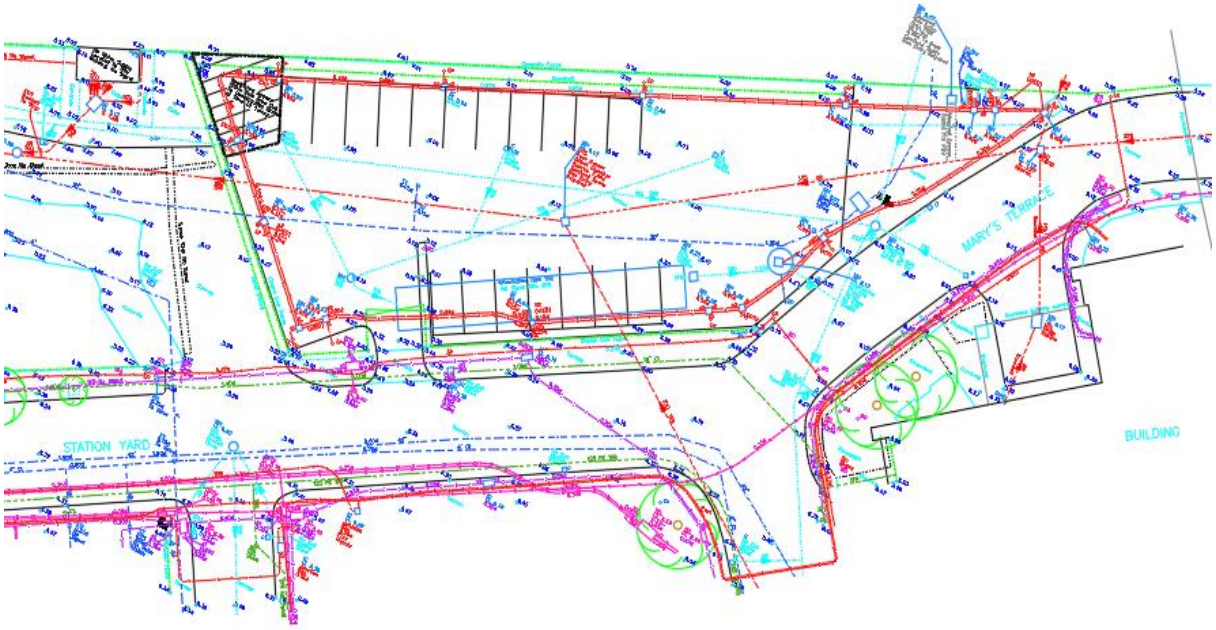
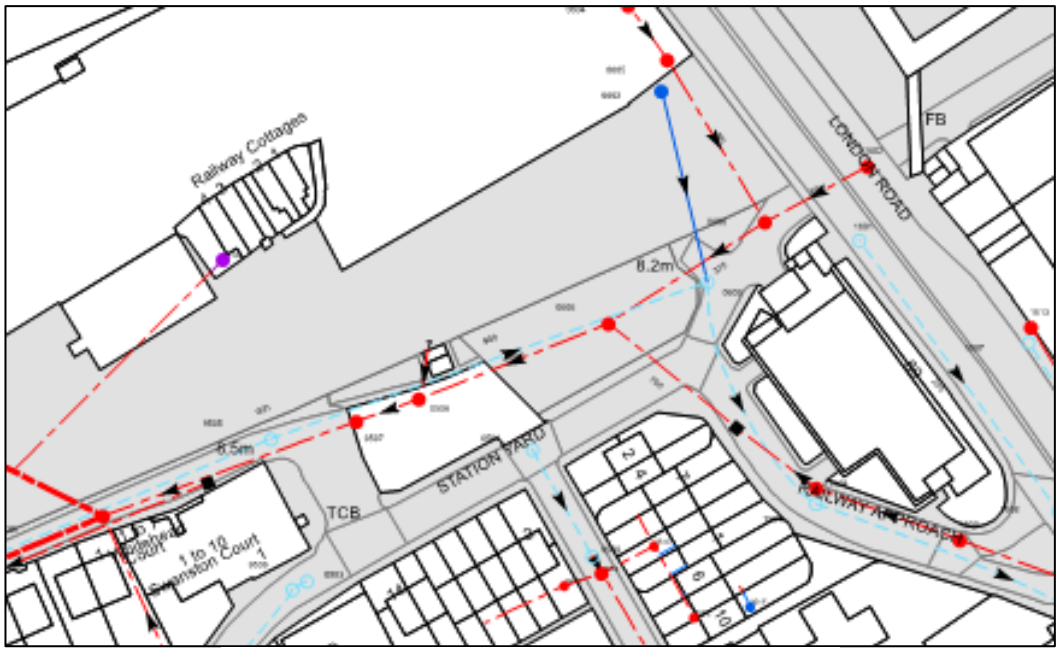


Figure 2.3: Existing services plan

2.2 EXISTING SURFACE AND FOUL WATER DRAINAGE

The site is currently served by separate foul and surface water networks. The 900mm diameter Thames Water foul sewer is crossing the site from east to west and the 900mm diameter Thames Water surface sewer crossing the site west to east. The existing situation is shown within the extract below. The depth of the surface water sewer is 2.1m below the surface, and the depth of the foul water sewer is 5.6m below the surface. Refer to figure 2.4 below.



Public Sewer Types (Operated & Maintained by Thames Water)

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

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

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

Figure 2.4: Thames Water Asset Search
(Source: Thames Water)

3. PROPOSED DEVELOPMENT

Solum is proposing a stepped residential building that is proportionate in scale to its context of Bridge House, the Twickenham Gateway and Regal House to east, whilst also addressing the scale of the Building of Townscape Merit, the Albany Pub & housing to the south and west of the site. At ground level there is provision for a flexible space to provide active frontage and proposals for improvements to the public realm in front of the Albany Pub.

As part of the development, the proposal is to build-over the existing surface water sewer and to divert the existing foul water sewer and water main under Station Yard road, to comply with Thames Water's required clearances. Build-over and diversion agreements are currently being persued with Thames Water and have been approved in principle.

Figure 3.1: Indicative Site Development Plan

4. GENERAL DRAINAGE DESIGN PROPOSALS

It is proposed to provide a Sustainable Urban Drainage System (SuDS) as part of the drainage design of the site to maximise attenuation, improve water treatment and reduce runoff.

The existing sewers under the site will be utilised for the surface water connection subject to the approval of the Thames Water pre-development enquiry which has been submitted and approved, ref DS6065721. No alterations are necessary at this stage however a survey is required to understand the line, level and condition of the existing sewer network. This is currently being arranged at the time of drafting the report.

The following guidance will be adhered to when designing the drainage system:

- Building Regulations Part H;
- National Planning Policy Framework 2019 (NPPF);
- Sewers for Adoption 7th Edition (for adopted connections);
- BS EN 752:20017, Drainage & Sewer Systems Outside Buildings;
- BS EN 12056-2:2000, Gravity Drainage Inside Buildings;
- Specific design criteria for the system includes.

The network will attenuate all storm events upto and including the 1 in 100year storm event with a 40% allowance for climate change. Surface water drainage will convey the runoff that cannot be soaked away from roofs, roads and other hard-standing areas to the public sewer at a controlled rate. The discharge rate will be set at 5l/s which has been approved by Thames Water via a pre-development enquiry.

Foul drainage will be conveyed by a traditional gravity piped system to the nearby existing sewer.

4.1 NATIONAL PLANNING POLICY REQUIREMENTS

NPPF (National Planning Policy Framework 2019) specifies that surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development. Opportunities to reduce the flood risk to the site itself and elsewhere, taking climate change into account, should be investigated. The drainage proposals within this strategy have been prepared to meet planning policy requirements including CPG Water and Flooding 2019. Nevertheless, the developer should provide evidence to show how the proposed development has maximised the use of sustainable drainage systems (SuDS) across the site.

4.2 DRAINAGE PRINCIPLES

Ground infiltration is normally the most suitable method of discharging surface water runoff from a proposed development and should be used wherever feasible to mimic the existing diffuse discharge to ground. Ground conditions at the site are unsuitable for infiltration drainage such as soakaways. Interception, attenuation and connection to the existing sewer is considered to be the only viable drainage option for the development.

The main options considered to drain surface water from the proposed development are:

- *Ground infiltration within the site* – this is **not** considered practical for the development site due to ground conditions as:
  - The general geology of the site is that it is underlain by the London Clay Formation. London has a high proportion of impermeable surfaces, which prevent water from soaking into the ground. In addition to this, London's Clay soils reduce the rate of infiltration, which results in more water at the surface. Infiltration devices should not be built within 5m of a building, road or areas of unstable land.

- *Large scale attenuation and connection to existing watercourses* – this is not considered practical for the development site due to the relatively small scale of the development, limited ground floor build-up and no watercourse within proximity.

- *Management of land drainage providing interception and storage* – surface water on site will be partially intercepted and stored before discharging at a controlled rate into the existing sewer.

- *Provision of localised storage features* – 'on-site' small storage will be provided for schematically by permeable areas at ground floor level (subject to further design development).

- Although not a prioritised SuDS feature, below ground drainage tanks will be required on the site, due to spatial constraints and the requirements to limit flows as far as is practically possible. Based on the site area of 0.093 ha an attenuation volume of 35m³ will be required to limit surface water to the discharge rate of 5 l/s. This aspect of a 5l/s per connection is set as a practical limitation to avoid the risk of blockage at the Hydro-Brake and is specified by the Environment Agency.

- *Green/Blue Roofs* – Green roofs/planters are being considered. The additional build-up for blue roofs would increase the building height which is not desirable as this will have an impact on strategic and local views. In addition, the risk of leakage of blue rooves would pose an unacceptable waterproofing risk for the development that is not desired by the client. Therefore the use of green roofing only is considered viable for the development.

- Permeable Paving – This option is being considered below the paved areas at ground floor level. Permeable Paving will aid in surface water runoff and will be connected to the 35m3 attenuation tank.

- *Connection to existing surface water sewer* – this is the proposed solution.

4.3 SURFACE WATER DRAINAGE STRATEGY

The proposed surface water drainage strategy layout and techniques used are included in Appendix B.

The principles employed in the drainage strategy are to provide measures to improve the quality of the run-off with the use of suitable SuDS source control, as well as to provide small-scale attenuation.

SuDS are water sensitive drainage systems which mimic natural catchment processes to manage urban runoff. A "treatment train" of various SuDS is required to capture, detain, convey and discharge water from an urban environment. The treatment train concept is fundamental to designing a successful SuDS strategy.

The treatment train philosophy uses drainage techniques to systematically control the three elements of runoff: pollution, flow rates and volumes. This is achieved in three main steps: Source Control, Conveyance Control and Discharge Control. Source control is preferred to those further down the train as they lead to the retention of pollutants and control of water before it enters the proposed or existing drainage network or watercourse. All of the methods suggested are recommended controls considered for SuDS and will be utilised where practical.

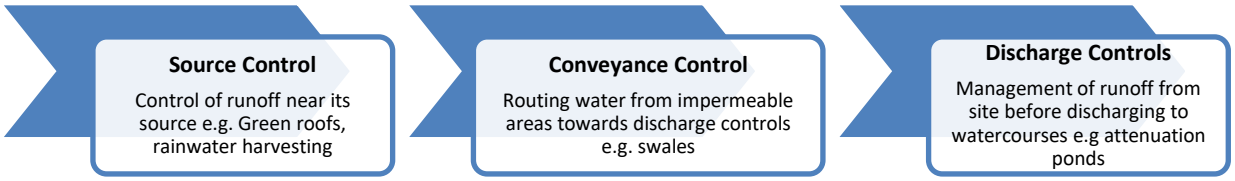


Figure 4.1 SuDS Treatment Train

To comply with the current best practice, the proposed drainage system at the proposed development will:

- Manage runoff at or close to its source;
- Manage runoff at the surface;
- Integrate with public open space areas and contribute towards meeting the objectives of the urban plan;
- Be cost-effective to operate and maintain.
- Ensure that:
  - Natural hydrological processes are protected through maintaining interception of an initial depth of rainfall and prioritising infiltration;
  - Flood risk is managed through the control of runoff peak flow rates and volumes discharged from the site;
  - Storm water runoff is treated to prevent detrimental impacts to the receiving water body as a result of urban contaminants.

4.4 LEVELS OF SERVICE, DETENTION STORAGE AND OVERLAND FLOW PATHS

The NPPF and Sewers for Adoption requires that surface water drainage systems are provided for new development sites should be designed to retain all runoff for events up to the 100-year rainfall event where possible, with an appropriate allowance for climate change. This is to prevent downstream flooding.

As this development is located in a confined area of land, it would not be possible to attenuate and reduce runoff to greenfield rates, however the use of SuDS has been maximised and justified accordingly. This will improve the situation of proposed refurbishment over the existing development by reducing discharge rates, providing an overall betterment to the existing situation.

The SuDS features discharging directly to piped systems and storage are designed to provide a level of service to ensure that surface water is discharged safely away from property to a suitable drainage feature via overland flow paths along exceedance routes (where applicable).

Open space design and drainage management will ensure natural flow paths are not intercepted by new development infrastructure.

Fences, walls and other potential obstructions should make provision to allow exceedance flows to continue above the ground unhindered during extreme rainfall events. This will be addressed during the detailed design stage.

5. PROPOSED DRAINAGE

Existing drainage records are contained within Appendix A of this report, which has been used to inform this Drainage Strategy.

The design of a surface water drainage system to serve the development considers both water treatment and on-site attenuation for the proposed development in accordance with CIRIA 753 The SuDS Manual.

The SuDS components aim to emulate the natural drainage system of the site through attenuation of flows and natural percolation. This has the added benefit of alleviating water quality issues associated with urban drainage runoff.

In addition, The Environment Agency provides a hierarchy for the disposal of surface water, in order of preference, as follows:

1. *Site Infiltration Techniques* – Not possible due to level of impermeability and compact nature of the site.
2. *Outfall to Watercourse* - not possible in this case due to the site's proximity to a suitable receiving body of water. The closest surface water feature identified by aerial images is understood to be the River Thames.
3. *Use of existing connections to Existing Sewer* – the designed solution. Being a connection to the combined sewer that is surrounding the site.

The SuDS measures being incorporated within the design of the development are a green roof, and a 35m^3 attenuation tank buried below the ground floor slab. Permeable paving is being considered as an option for the paved areas at ground floor level. All will aid in reducing runoff across the site, improving building performance and adding ecological value. Further details relating to their performance and location can be found in Appendix D.

5.1 PROPOSED SURFACE WATER FLOWS AND DISCHARGE RATES

Surface water runoff rates for both the existing and proposed were calculated for this site (Appendix C & F).

The introduction of green roof and a 35m^3 attenuation tank below the basement will reduce runoff rates for the Q100 + 40% CC to approximately 5 l/s providing a 81% betterment on existing rates. This shows that the proposed development provides a betterment over the existing situation as required by LLFA (Lead Local Flood Authority) guidance. This aspect of a 5l/s per connection is set as a practical limitation to avoid the risk of blockage and is specified in TRW5.

It is proposed a green roof system is to be installed at roof level. A green roof is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. The proposal is for a seedam styled roof finish.

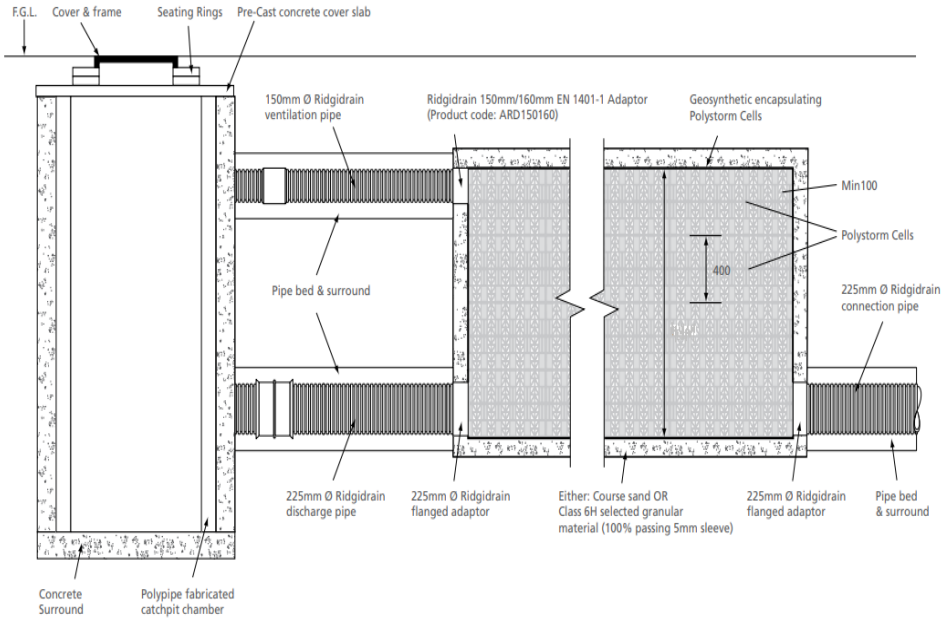
They serve several purposes for a building:

- They absorb and store rainfall;
- Filter pollutants from rainfall;
- Provide insulation;
- Create habitats for wildlife;
- Help lower urban air temperatures and combat urban temperature.

6. SITE-SPECIFIC USE OF SUDS COMPONENTS

During the summer months, where ground conditions are not saturated, SuDS components can contribute to the requirements for interception (see Appendix D), i.e. there should normally be no runoff from the site for an initial depth of rainfall - usually 5mm.

The following devices are proposed to be incorporated as part of the proposed development.

SuDS	*DESCRIPTION*
	Attenuation tank cross section view of typical arrangement by Polypipe ***Location:*** Below the building
 **1 XF301 Sedum System** with integrated water retention and filter layer + **2 AL40** edge trim, frames and retains the XF301 system + **3 SDF Mat** drainage layer for shallow pitch roofs +	Green roof system (by bauder) ***Location:*** Building Roof top

7. ADOPTION AND MAINTENANCE

For the SuDS features/structures within the curtilage of the proposed development it is envisaged that the landowner will assume responsibility for the maintenance and upkeep of all the SuDS attenuation features. A private maintenance company could manage shared facilities on the site, with occupiers paying a maintenance fee.

7.1 TYPICAL SUDS MAINTENANCE SCHEDULE

7.1.1 GREEN ROOF AND LANDSCAPING

The following table outlines the general maintenance principles for landscaped area.
The maintenance schedule below is indicative and taken CIRIA Report C753, a site specific maintenance plan will be required at the later stages of the project and not all of the items outlined may be required.

Table 12.5: Green roof Maintenance (Source: CIRIA report C753 – The SuDS Manual v6, 2015)

Maintenance Schedule	Required Action	Typical Frequency
Regular inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof struture for proper operation, integrity of waterproofing and strutural stability.	Annually and after severe storms
	Inspect soil substrate for evisdence of erosion channels and identify any sediments sources.	Annually and after severe storms
	Inspect drain inlets to ensure unrestrited runoff from the drainage layer to the conveyance or 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 establisment (ie year one), replace dead plants as required	Monthly (but usually responsibility manufacturer)
	Post establishment, replace dead plants as required (where>5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduos plant folage	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	Annually, 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

Table 7.4: Landscaping Maintenance (Source: CIRIA report C753 – The SuDS Manual v6, 2015)

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets and outlets	Inspect monthly
Occasional maintenance	Check tree health and manage tree appropriately	Annually
	Remove silt build-up from inlets and surface and replace as necessary	Annually, or as required
	Water	As required (in periods of drought)
Monitoring	Inspection silt accumulation rates and establish appropriate removal frequencies	Half Yearly

7.1.2 ATTENUATION STORAGE TANK

The following table outlines the general maintenance principles for attenuation storage tank. The maintenance schedule below is indicative and taken CIRIA Report C753, a site specific maintenance plan will be required at the later stages of the project and not all of the items outlined may be required.

Table 21.3: Attenuation storage tank (Source: CIRIA report C753 – The SuDS Manual v6, 2015)

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 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 Maintenance	Repair/rehabilitation of 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 and after large storms
	Survey inside of tank for sediment build up and remove if necessary	Every 5 years or as required

7.1.3 Permeable Paving

The following table outlines the maintanence requirements for permeable paving. A site specific maintanence plan will need to be defiend at the alter phases of the project and and not all of the items outloined may be required. This schedule has been extracted from the CIRIA Report C753.

TABLE 20.15 Operation and maintenance requirements for pervious pavements

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

7.2 CONSULTATIONS

As the overall discharge rates of the proposed development will be less than the existing, the risk to the approval of the Thames Water application will be negligible. A pre-development enquiry has been made which has approved by Thames Water, and is subject to further applicable submissions during later stages of the design development. As part of this, details of the site's connection will be agreed with Thames Water and a diversion/buildover application to Thames Water is required to confirm the design, which has already been approved by Thames Water in principle. As a betterment is being provided, no capacity concerns are envisaged.

8. CONCLUSION

This document has set out a viable drainage strategy for the proposed new scheme. This report has demonstrated that the proposed development can be adequately provided with all necessary surface and foul water infrastructure.

Through the use of green roof and small scale attenuation, the proposed development will attenuate surface water flows, provide water quality treatment and prevent downstream flooding and reduce overall discharge rates. These achievements comply and align with the aims and objectives of the Local Authorities and other legislative guidelines set out in section 1.1 of this report, including The National Planning Policy Framework 2019 (NPPF), The London Plan, Borough of Richmond upon Thames Local Plan and Planning Practice Documents.

9. APPENDIX A

Existing Drainage Records (TW Asset Search)

Asset location search

Property Searches

Amethyst Surveys Limited
Unit 6aDavy Court
RUGBY
CV23 0UZ

Search address supplied Station Yard
Station Yard
Twickenham

Your reference Station Yard

Our reference ALS/ALS Standard/2018_3866293

Search date 4 September 2018

Keeping you up-to-date

Notification of Price Changes

From 1 September 2018 Thames Water Property Searches will be increasing the price of its Asset Location Search in line with RPI at 3.23%.

For further details on the price increase please visit our website: www.thameswater-propertysearches.co.uk
Please note that any orders received with a higher payment prior to the 1 September 2018 will be non-refundable.

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

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

0845 070 9148

searchcode

Asset location search

Property Searches

Search address supplied: Station Yard, Station Yard, Twickenham,

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

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

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

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

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

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

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

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

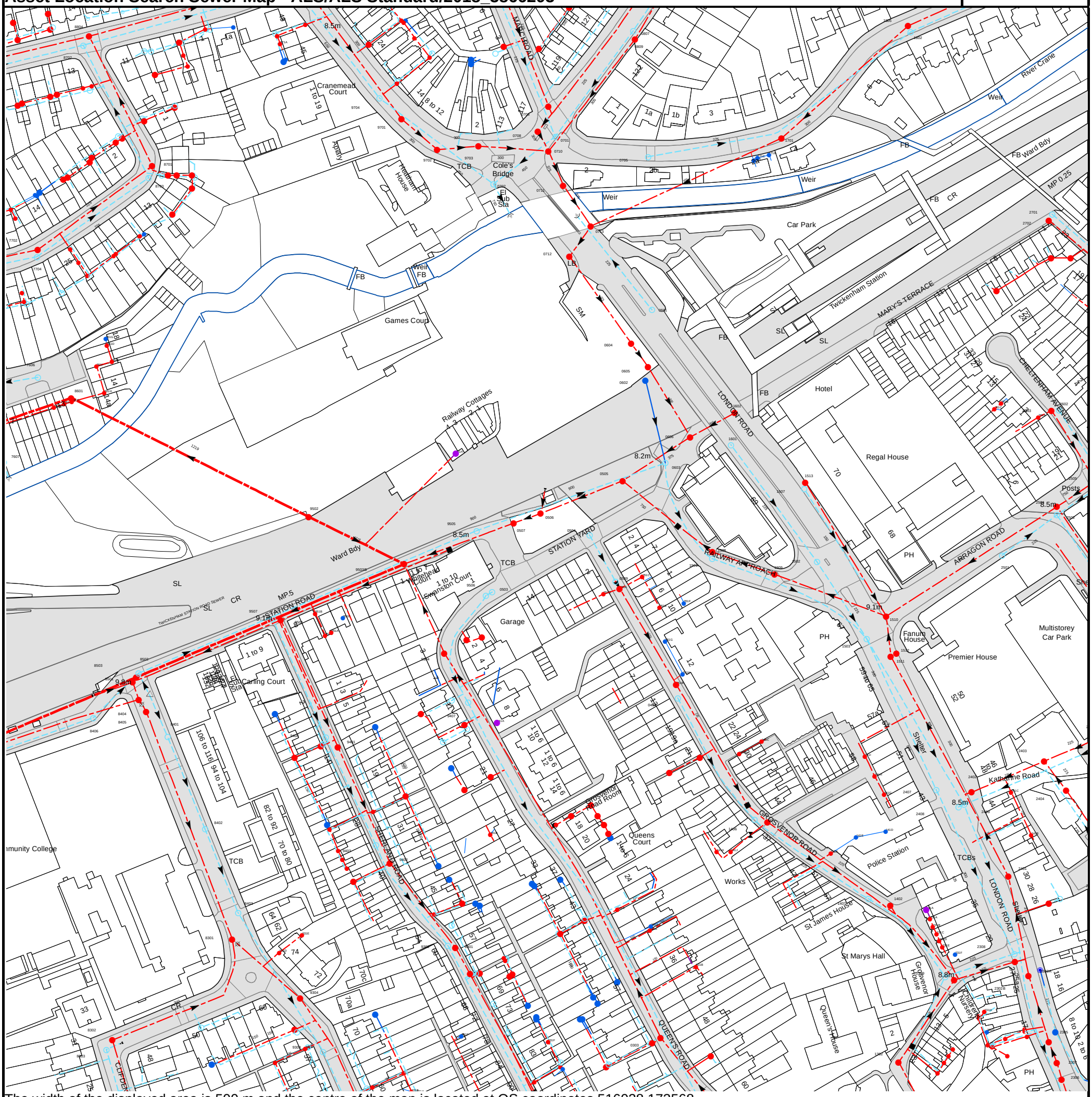
Clean Water queries

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

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

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

Asset Location Search Sewer Map - ALS/ALS Standard/2018_3866293



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 516028,173568

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
1802	6.72	5.65
1805	6.77	4.2
261B	n/a	n/a
26NH	n/a	n/a
27NM	n/a	n/a
27NL	n/a	n/a
2702	n/a	n/a
2701	n/a	n/a
171A	n/a	n/a
171C	n/a	n/a
171B	n/a	n/a
1701	7.3	4.13
141C	n/a	n/a
0404	8.6	6.89
1511	8.75	4.43
1512	n/a	n/a
1503	8.96	5.28
1510	5.4	1.34
051F	n/a	n/a
1509	9.02	.87
1502	10.01	8.31
1501	8.75	5.34
2501	8.4	6.7
1508	8.73	.78
2502	8.38	6.16
2504	8.4	.98
1507	10.87	7.37
1513	10.99	7.13
2601	8.28	7.19
1601	9.65	7.13
0606	8.15	3.14
261A	n/a	n/a
1602	8.34	3.69
2603	8.19	6.14
2602	8.18	7.21
261C	n/a	n/a
241A	n/a	n/a
1402	8.42	6.39
24ND	n/a	n/a
24NE	n/a	n/a
1407	8.43	6.4
2401	8.39	4.68
141F	n/a	n/a
141J	n/a	n/a
141A	n/a	n/a
141E	n/a	n/a
241B	n/a	n/a
141D	n/a	n/a
1401	8.56	5.66
1406	8.57	6.52
2408	n/a	n/a
2409	8.41	5.06
141G	n/a	n/a
2402	8.32	4.59
241C	n/a	n/a
2404	8.18	6.07
2407	8.41	5.1
141H	n/a	n/a
2403	8.08	5.2
04LN	n/a	n/a
141I	n/a	n/a
141B	n/a	n/a
23LK	n/a	n/a
23NL	n/a	n/a
23LF	n/a	n/a
2305	7.76	5.06
23HF	n/a	n/a
23LJ	n/a	n/a
23HN	n/a	n/a
23MK	n/a	n/a
231G	n/a	n/a
23NC	n/a	n/a
23MM	n/a	n/a
23NJ	n/a	n/a
231H	n/a	n/a
231K	n/a	n/a
2301A	8.76	5.11
2309	8.88	6.16
2303A	8.14	4.8
23KJ	n/a	n/a
2302B	8.15	4.77
231F	n/a	n/a
2308	8.16	5.11
23ND	n/a	n/a
23LM	n/a	n/a
1302	8.68	5.04
13MM	n/a	n/a
031B	n/a	n/a
231E	n/a	n/a
231D	n/a	n/a
231C	n/a	n/a

Manhole Reference	Manhole Cover Level	Manhole Invert Level
231B	n/a	n/a
231A	n/a	n/a
2306	n/a	5.25
2307	7.86	5.16
23LL	n/a	n/a
23LN	n/a	n/a
23NE	n/a	n/a
87ZQ	n/a	n/a
87WS	n/a	n/a
87WZ	n/a	n/a
87WY	n/a	n/a
87ZY	n/a	n/a
87ZS	n/a	n/a
87ZT	n/a	n/a
8702	n/a	n/a
78SW	n/a	n/a
8804	n/a	n/a
78SX	n/a	n/a
88TQ	n/a	n/a
78SV	n/a	n/a
88VQ	n/a	n/a
78SY	n/a	n/a
88VW	n/a	n/a
97ZW	n/a	n/a
9704	8.32	5.84
98YZ	n/a	n/a
97ZS	n/a	n/a
97ZP	n/a	n/a
98ZV	n/a	n/a
98YY	n/a	n/a
9701	8.27	4.78
98YX	n/a	n/a
98YV	n/a	n/a
98YW	n/a	n/a
97ZT	n/a	n/a
97ZQ	n/a	n/a
9702	8.27	4.64
97YW	n/a	n/a
97YT	n/a	n/a
9703	8.31	4.49
0702	7.93	5.72
07ZW	n/a	n/a
07ZY	n/a	n/a
87VX	n/a	n/a
87WP	n/a	n/a
87VQ	n/a	n/a
88XX	n/a	n/a
88XT	n/a	n/a
87ZW	n/a	n/a
87ZX	n/a	n/a
87VS	n/a	n/a
87VR	n/a	n/a
87TW	n/a	n/a
88XW	n/a	n/a
88XS	n/a	n/a
88XP	n/a	n/a
98PQ	n/a	n/a
98PT	n/a	n/a
971A	n/a	n/a
97XX	n/a	n/a
97XY	n/a	n/a
98PS	n/a	n/a
87SW	n/a	n/a
7702	n/a	n/a
87ST	n/a	n/a
87SX	n/a	n/a
87SP	n/a	n/a
77QY	n/a	n/a
87VT	n/a	n/a
77QX	n/a	n/a
771A	n/a	n/a
77QR	n/a	n/a
77YN	n/a	n/a
87YT	n/a	n/a
8703	n/a	n/a
87ZP	n/a	n/a
87TV	n/a	n/a
87VP	n/a	n/a
8701	n/a	n/a
87YW	n/a	n/a
87YZ	n/a	n/a
87YY	n/a	n/a
87YX	n/a	n/a
87XW	n/a	n/a
87VZ	n/a	n/a
87VW	n/a	n/a
77XS	n/a	n/a
77XR	n/a	n/a
77XQ	n/a	n/a
0708	8.37	4.22
07ZP	n/a	n/a
0706	8.22	4.85
0710	8.67	4.17

Manhole Reference	Manhole Cover Level	Manhole Invert Level
0701	8.35	5.82
0711	9.39	4
08WW	n/a	n/a
0712	10.76	3.72
0713	10.2	3.85
0604	8.42	3.44
0807	8.46	6.02
0809	8.56	4.29
0602	7.53	5.85
0705	7.9	6.41
0605	7.82	3.36
0601	12.12	9.55
861B	n/a	n/a
861C	n/a	n/a
8601	8.02	.38
861H	n/a	n/a
7606	n/a	n/a
861I	n/a	n/a
861E	n/a	n/a
861D	n/a	n/a
861G	n/a	n/a
76YW	n/a	n/a
76ZR	n/a	n/a
86ZR	n/a	n/a
76ZS	n/a	n/a
86ZY	n/a	n/a
86ZT	n/a	n/a
86ZX	n/a	n/a
7704	n/a	n/a
87SV	n/a	n/a
861A	n/a	n/a
8406	9.75	7.79
8501	n/a	n/a
8503	9.62	.46
8502	n/a	n/a
8404	9.88	6.3
8405	n/a	n/a
8401	10.17	7.6
9507	n/a	n/a
94WX	n/a	n/a
9501	n/a	n/a
94XY	n/a	n/a
9502	9.35	.48
951B	n/a	n/a
94XX	n/a	n/a
94XS	n/a	n/a
951C	n/a	n/a
9404	n/a	n/a
951A	n/a	n/a
9401	n/a	n/a
951D	n/a	n/a
94WP	n/a	n/a
9503B	8.66	.43
94QP	n/a	n/a
94PT	n/a	n/a
94WN	n/a	n/a
04KH	n/a	n/a
04MC	n/a	n/a
94TQ	n/a	n/a
94PS	n/a	n/a
94PX	n/a	n/a
041A	n/a	n/a
9407	n/a	n/a
94PQ	n/a	n/a
051B	n/a	n/a
051H	n/a	n/a
9504	8.67	n/a
051G	n/a	n/a
95XW	n/a	n/a
95XY	n/a	n/a
051E	n/a	n/a
9506	n/a	n/a
051D	n/a	n/a
0503	n/a	n/a
051A	n/a	n/a
0509	8.6	6.19
051C	n/a	n/a
0504	8.32	6.59
9505	n/a	n/a
0507	8.2	.66
0506	7.95	5.58
0505	8.11	.73
0603	8.09	5.76
961A	n/a	n/a
8402	10.46	7.88
8301	10.51	6.65
8403	10.63	8.1
931D	n/a	n/a
931E	n/a	n/a
94YP	n/a	n/a
94ZT	n/a	n/a
94SY	n/a	n/a
94SZ	n/a	n/a

Manhole Reference	Manhole Cover Level	Manhole Invert Level
94ZX	n/a	n/a
94YX	n/a	n/a
94VX	n/a	n/a
9403	n/a	n/a
9402	n/a	n/a
94VY	n/a	n/a
94SS	n/a	n/a
94RX	n/a	n/a
94VV	n/a	n/a
9302	n/a	n/a
94SW	n/a	n/a
93WW	n/a	n/a
9301	n/a	n/a
94ST	n/a	n/a
93XQ	n/a	n/a
93WZ	n/a	n/a
94PP	n/a	n/a
93VZ	n/a	n/a
93WQ	n/a	n/a
94FY	n/a	n/a
041B	n/a	n/a
03KC	n/a	n/a
03HC	n/a	n/a
03FM	n/a	n/a
03JN	n/a	n/a
0306	n/a	n/a
0305	n/a	n/a
04LH	n/a	n/a
04LL	n/a	n/a
04ME	n/a	n/a
03JF	n/a	n/a
04LD	n/a	n/a
03JL	n/a	n/a
04MF	n/a	n/a
03JE	n/a	n/a
03JK	n/a	n/a
04MH	n/a	n/a
04MJ	n/a	n/a
04MK	n/a	n/a
04ML	n/a	n/a
04MM	n/a	n/a
03HN	n/a	n/a
041C	n/a	n/a
031E	n/a	n/a
031A	n/a	n/a
03FJ	n/a	n/a
03EC	n/a	n/a
03HE	n/a	n/a
03FC	n/a	n/a
03FF	n/a	n/a
03EM	n/a	n/a
031F	n/a	n/a
03FD	n/a	n/a
03EK	n/a	n/a
03ME	n/a	n/a
03KJ	n/a	n/a
03LC	n/a	n/a
03JD	n/a	n/a
03JJ	n/a	n/a
03KF	n/a	n/a
03KM	n/a	n/a
03KL	n/a	n/a
03KE	n/a	n/a
0303	8.79	1.25
8303	10.64	8.1
8302	10.58	6.79
83YV	n/a	n/a
83ZR	n/a	n/a
93ZP	n/a	n/a
93VW	n/a	n/a
93ZN	n/a	n/a
9304	10.44	8.05
931G	n/a	n/a
93YX	n/a	n/a
9303	10.39	8.38
93XX	n/a	n/a
931C	n/a	n/a
93YQ	n/a	n/a
93YS	n/a	n/a
93XY	n/a	n/a
931B	n/a	n/a
931A	n/a	n/a
931F	n/a	n/a

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

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

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

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

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

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

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

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

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

Control Valve

Drop Pipe

Ancillary

Weir

End Items

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

Outfall

Undefined End

Inlet

Other Symbols

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

Public/Private Pumping Station

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

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

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

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

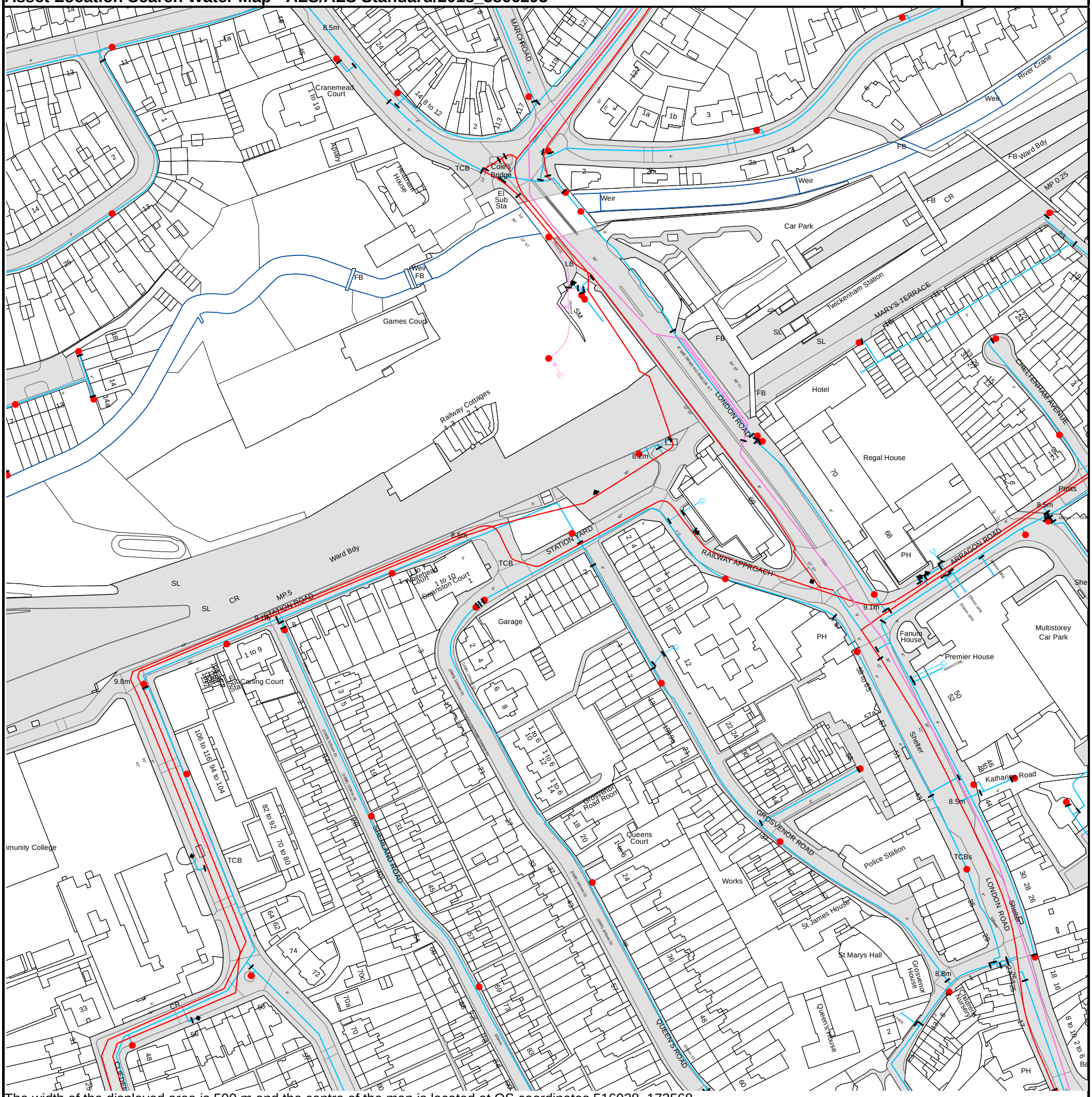
Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2018_3866293



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 516028, 173568.

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

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16"

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

Terms and Conditions

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

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

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

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

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

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

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0845 070 9148** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

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

Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

10. APPENDIX B

Site Wide Drainage Strategy Drawing

BUILD-OVER AGREEMENT REQUIRED

NEW CONNECTION TO EX TW SEWER

WATER MAIN DIVERSION START

TW MH 0603
CL 8.09
IL 5.76

HYDRO-BRAKE
5 L/S

ATTENUATION TANK
(PROPOSED LOCATION)
PLAN AREA = 30m²
CRATE DEPTH = 1.2m
VOLUME = 36m³

REFER TO WATER MAIN DIVERSION DRAWING

NEW THAMES WATER MANHOLE

NOTES:

1. WHERE THE CONTRACTOR UNDERTAKES OR ENGAGES A THIRD PARTY TO UNDERTAKE TEMPORARY WORKS DESIGN, OR VARIES THE PELL FRISCHMANN DESIGN IN ANY WAY, THEN THE CONTRACTOR WILL TAKE FULL RESPONSIBILITY AND LIABILITY FOR ALL DESIGN ASPECTS, INCLUDING A DESIGN RISK ASSESSMENT. THE CONTRACTOR SHALL INFORM PELL FRISCHMANN OF ANY PROPOSED VARIANCES TO THE DESIGN.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER ELECTRICAL, MECHANICAL, PUBLIC HEALTH & ARCHITECTURAL DRAWINGS & THE SPECIFICATION.
3. SEWER SIZES TAKEN FROM TW ASSET SEARCH.
4. CCTV SURVEY TO BE COMMISIONED TO ALLOW DETAILED DESIGN OF SEWER.
5. DIVERSION ROUTE SELECTED BASED ON THAMES WATER EASMRNT REQUIREMENTS AND EASE OF CONSTRUCTION.
6. WATER MAIN LEVELS TO BE CONFIRMED UPON RECEIPT OF CCTV SURVEY.
7. BUILD-OVER AGREEMENT TO BE SOUGHT FOR SURFACE WATER SEWER.
8. COVER LEVELS SHOWN ARE BASED ON EXISTING LEVELS.

A PRE DEVELOPMENT ENQUIRY, NEW CONNECTION AND BUILDOVER APPLICATION TO THAMES WATER IS REQUIRED TO CONFIRM DESIGN.

TO ENSURE THAT FLOW CONTROL DEVICES ARE NOT AT RISK OF BLOCKAGE WHERE THE DESIGN CONTROL DISCHARGE RATE IS LESS THAN 5L/S, THEN A MINIMUM OF 5 L/S IS APPLIED.
THIS ASPECT OF A 5L/S PER CONNECTION IS SET AS A PRACTICAL LIMITATION TO AVOID THE RISK OF BLOCKAGE AND IS SPECIFIED IN TRWS.

KEY:

- EXISTING FOUL WATER SEWER
- EXISTING SURFACE WATER SEWER
- EXISTING WATER MAINS
- EXISTING SURFACE WATER SEWER RETAINED
- EXISTING FOUL WATER SEWER REMOVED
- EXISTING WATER MAINS REMOVED
- PROPOSED FOUL WATER SEWER
- PROPOSED WATER MAINS
- SITE BOUNDARY
- BUILDING EXTENTS
- ATTENUATION TANK UNDER THE BASEMENT (PROPOSED LOCATION) VOLUME 35 m³

REV	DESCRIPTION	DRN	CHK	APP	DATE
A	UPDATED TO LATEST DESIGN	GRH	RW	LR	07.11.19
-	FOR INFORMATION	CC	RW	LR	SEP 2019

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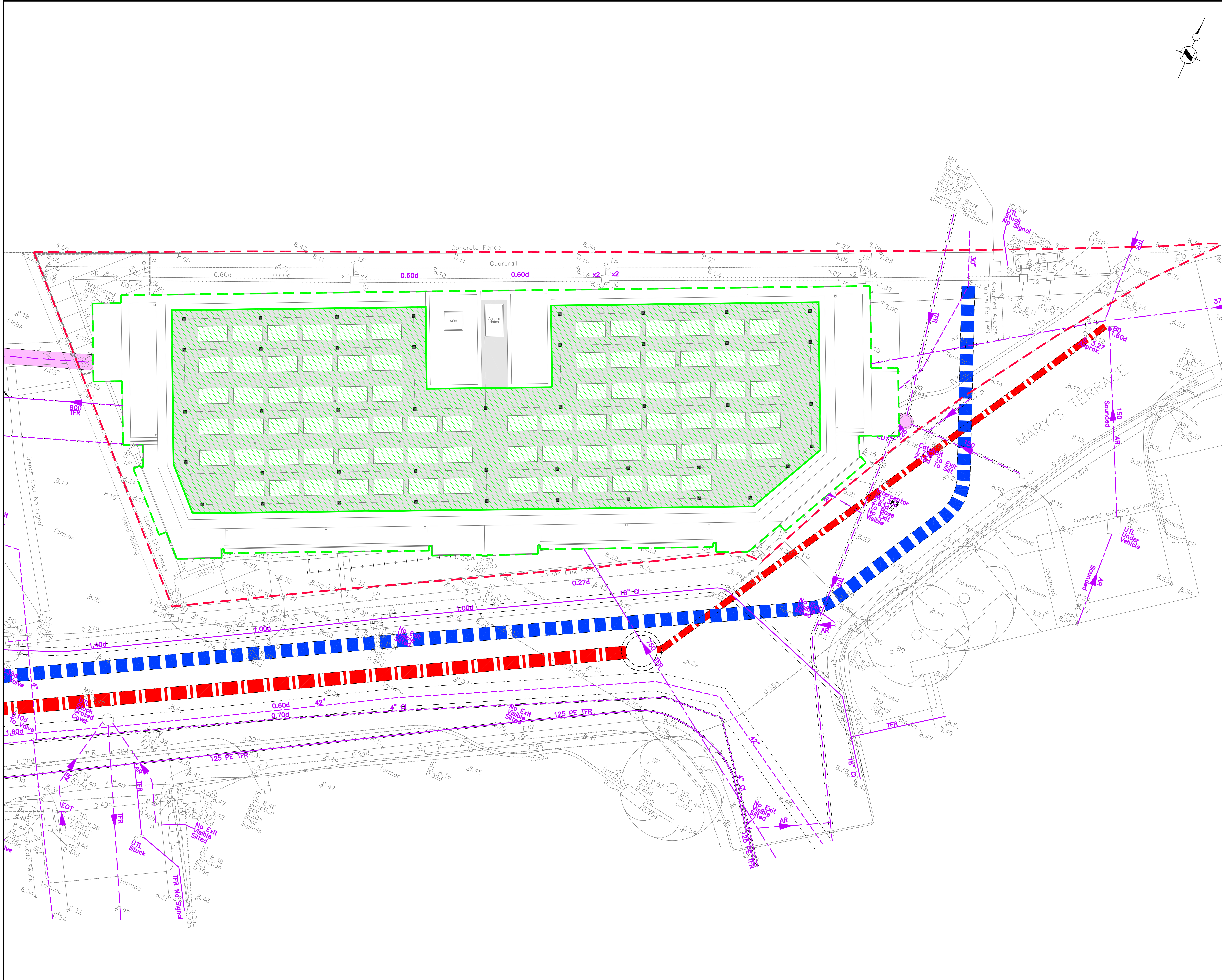
Client: Solum REGENERATION — Network Rail & Kier in partnership

Project: TWICKENHAM STATION YARD BLOCK D

Drawing Title: PROPOSED SuDS STRATEGY GROUND FLOOR LEVEL

	Name	Date
Drawn	GRH	15.09.19
Designed	CC	15.09.19
Checked	RW	15.09.19
Approved	LR	15.09.19

Scale: 1:100 @ A1
File No: 102135-PF-ZZ-XX-DR-D-0004.dwg
Drawing Status: PRELIMINARY
Drawing No.: 102135-PF-ZZ-XX-DR-D-0004
Revision: A



NOTES:

1. WHERE THE CONTRACTOR UNDERTAKES OR ENGAGES A THIRD PARTY TO UNDERTAKE TEMPORARY WORKS DESIGN, OR VARIES THE PELL FRISCHMANN DESIGN IN ANY WAY, THEN THE CONTRACTOR WILL TAKE FULL RESPONSIBILITY AND LIABILITY FOR ALL DESIGN ASPECTS, INCLUDING A DESIGN RISK ASSESSMENT. THE CONTRACTOR SHALL INFORM PELL FRISCHMANN OF ANY PROPOSED VARIANCES TO THE DESIGN.
2. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER ELECTRICAL, MECHANICAL, PUBLIC HEALTH & ARCHITECTURAL DRAWINGS & THE SPECIFICATION.
3. SEWER SIZES TAKEN FROM TW ASSET SEARCH.
4. CCTV SURVEY TO BE COMMISIONED TO ALLOW DETAILED DESIGN OF SEWER.
5. DIVERSION ROUTE SELECTED BASED ON THAMES WATER EASMRNT REQUIREMENTS AND EASE OF CONSTRUCTION.
6. WATER MAIN LEVELS TO BE CONFIRMED UPON RECEIPT OF CCTV SURVEY.
7. BUILD-OVER AGREEMENT TO BE SOUGHT FOR SURFACE WATER SEWER.
8. COVER LEVELS SHOWN ARE BASED ON EXISTING LEVELS.

A PRE DEVELOPMENT ENQUIRY, NEW CONNECTION AND BUILDOVER APPLICATION TO THAMES WATER IS REQUIRED TO CONFIRM DESIGN.

TO ENSURE THAT FLOW CONTROL DEVICES ARE NOT AT RISK OF BLOCKAGE WHERE THE DESIGN CONTROL DISCHARGE RATE IS LESS THAN 5L/S, THEN A MINIMUM OF 5 L/S IS APPLIED.
THIS ASPECT OF A 5L/S PER CONNECTION IS SET AS A PRACTICAL LIMITATION TO AVOID THE RISK OF BLOCKAGE AND IS SPECIFIED IN TRW5.

KEY:

- EXISTING FOUL WATER SEWER
- EXISTING SURFACE WATER SEWER
- EXISTING WATER MAINS
- EXISTING SURFACE WATER SEWER RETAINED
- EXISTING FOUL WATER SEWER REMOVED
- EXISTING WATER MAINS REMOVED
- FW — PROPOSED FOUL WATER SEWER
- PROPOSED WATER MAINS
- SITE BOUNDARY
- BUILDING EXTENTS
- GREEN ROOF (PROPOSED AREA 393.5m²)

REV	DESCRIPTION	DRN	CHK	APP	DATE
A	FIRST ISSUE	GRH	RW	LR	07.11.19

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Client
Solum REGENERATION
Network Rail & Kier in partnership

Project
TWICKENHAM STATION YARD BLOCK D

Drawing Title
PROPOSED SuDS STRATEGY ROOF LEVEL

	Name	Date
Drawn	GRH	15.09.19
Designed	CC	15.09.19
Checked	RW	15.09.19
Approved	LR	15.09.19

Scale: 1:100 @ A1
File No.: 102135-PF-ZZ-XX-DR-D-0013.dwg
Drawing Status: PRELIMINARY

Drawing No.: 102135-PF-ZZ-XX-DR-D-0013
Revision: A

P:\1021--\102135 - Twickenham Station Block D\5 BIM\5.1 PF Disciplines\5.1.4 Civil\03 Auto CAD\Sheet Files\102135-PF-ZZ-XX-DR-D-0013.dwg Plotted on 07/11/19 at 15:49 by GHall

11. APPENDIX C

Existing and Proposed Calculation Sheets

Proposed Surface Water Runoff Calculations

Wallingford Maps

Rainfall Intensity

M5-60	20.9 mm
R	0.431

1 Year Return Period

Duration	Z1	M5-D	Z2	M2-D	I (mm/hr)
10	0.55	11.495	0.61	7.01	42.06
15	0.65	13.585	0.61	8.29	33.16
30	0.8	16.72	0.62	10.37	20.74

$I15_{min}$ 33.16 mm/hr

2 Year Return Period

Duration	Z1	M5-D	Z2	M2-D	I (mm/hr)
10	0.55	11.495	0.79	9.08	54.48
15	0.65	13.585	0.79	10.73	42.92
30	0.8	16.72	0.8	13.38	26.76

I_{15min} 42.92 mm/hr

30 Year Return Period

Duration	Z1	M5-D	Z2	M30-D	I (mm/hr)
10	0.55	11.495	1.5	17.24	103.44
15	0.65	13.585	1.52	20.65	82.6
30	0.8	16.72	1.53	25.58	51.16

I_{15min} 82.6 mm/hr

100 Year Return Period

Duration	Z1	M5-D	Z2	M100-D	I (mm/hr)
10	0.55	11.495	1.93	22.19	133.14
15	0.65	13.585	1.96	26.63	106.52
30	0.8	16.72	2	33.44	66.88

I_{15min} 106.52 mm/hr

Greenfield Analysis

Assumed as greenfield runoff rate

Hydrological Region	6
Soil Type	2
Development Size	0.093 ha
Annual Rainfall (SAAR)	622.5 mm
Soil Runoff Coefficient (SPR)	0.3

Development area under 50 ha, therefore calculate Q_{BAR50} and linearly interpolate

$Q_{BAR50} = 1.08(A/100)^{0.89} x SAAR^{1.17} x SPR^{2.17}$

Q_{BAR50}	79.43 l/s
Q_{BAR}	0.15 l/s

Calculate Q for different return periods using growth curve value for region 10 (GC)

GC_1	0.85
Q_{1yr}	0.1 l/s
GC_{30}	2.3
Q_{30yr}	0.3 l/s
GC_{100}	3.19
Q100yr	0.5 l/s

Existing Site Discharge Rates

All existing rainfall discharges from the site into the Themes Water combined sewer.

Total Area	0.093 ha
Impermeable Area	0.093 ha
CV	0.75
CR	1.3

Calculate surface water flow using 15 minute duration rainfall intensities at 1, 2, 30 and 100 year return periods

Q_1	8.4 l/s
Q_2	10.8 l/s
Q_{30}	20.8 l/s
Q_{100}	26.9 l/s
$Q_{100+40CC}$	37.66 l/s

12. APPENDIX D

SUDS Components Performance

The effectiveness of SuDS components in improving development surface water run-off quality for this site is summarised in Appendix D, Table 1 below. Combinations of treatments can be used to reduce potential pollutants from reaching the receiving course.

Appendix D, Table 1: SuDS Treatment Train

	Interception	Peak flow control: Low	Peak flow control: High	Volume reduction	Volume control	Gross sediments	Fine sediments	Hydrocarbons/ PAHs	Metals	Nutrients
Rainwater Harvesting	Y	Y	S	Y	N	N	N	N	N	N
Pervious Pavement	Y	Y	Y	Y	Y	Y	Y	Y	Y	Var
Filter Strips	Y	N	N	N	N	Y	N	Y	Y	Var
Swales	Y	Y	S	Y (*)	N	Y	Y (+)	Y	Y	Y (-)
Trenches	Y	Y	S	Y (*)	N	N	N	Y	Y	Y (-)
Detention Basins	Y	Y	Y	N	Y	Y	Y (+)	Y	Y	Var
Ponds	N	Y	Y	N	Y	N (~)	Y	Limited	Y	Var
Wetlands	N	Y	S	N	Y	N (~)	Y	Limited	Y	Y
Green Roofs	Y	Y	N	N	N	N	N	Y	N	N
Bioretention Systems	Y	Y	S	Y (*)	N	N (~)	Y	Y	Y	Y
Proprietary Treatment Systems	N	N	N	N	N	Y	Y	Y (!)	Y (!)	Y (!)
Subsurface Storage	N	Y	Y	N	Y	N (~)	N	N	N	N
Subsurface Conveyance Pipes	N	N	N	N	Y	N (~)	N	N	N	N

Notes:

- S: Not normally with standard designs, but possible where space is available and designs mitigate impact of high flow rates.
- Y (*): Where infiltration is facilitated by the design.
- N (~): Gross sediment retention is possible, but not recommended due to negative maintenance and performance implications.
- Y (+): Where designs minimise the risk of fine sediment mobilisation during larger events.
- Y (!): Where designs specifically promote the trapping and breakdown of soils and PAH based constituents.
- Y (“): Where subsurface soil structure facilitates the trapping and breakdown of oils and PAH based constituents.
- Var: The nutrient removal performance is variable, and can be negative in some situations.
- Y (~): Good nutrient removal performance where subsurface bio-filtration system with a permanently saturated zone included within the design.

HYDRAULIC DESIGN CRITERIA

Best practice criteria for hydraulic control required interception, runoff rate control and volume control.

Interception

To fulfil the requirements for Interception, there should normally be no runoff from the site for an initial depth of rainfall - usually 5mm. This is achieved through the use of infiltration, evapotranspiration, or rainwater harvesting.

Flow and Volume Control

Discharge rates are to be managed to current Greenfield run-off rates or 5 l/s minimum flow. The sites are to be considered Greenfield development, therefore runoff from the site needs to be constrained to the equivalent Greenfield rates and volumes.

Attenuation and hydraulic controls will be used to manage flow rates

Rainwater harvesting, or the use of Long Term Storage can be used to achieve Greenfield runoff volume control. Where volume control is not practicable, flows discharged from the site will be constrained to QBAR or 5 l/s/ (whichever is the greater).

Water Quality Design Criteria

Current best practice takes a risk-based approach to managing discharges of surface runoff to the receiving environment. The following text provides guidance on the extent of water quality management likely to be appropriate for the site.

Hazard Classification

Runoff from clean roof surfaces (i.e. not metal roofs, roofs close to polluted atmospheric discharges, or roofs close to populations of flocking birds) is classified as Low in terms of hazard status.

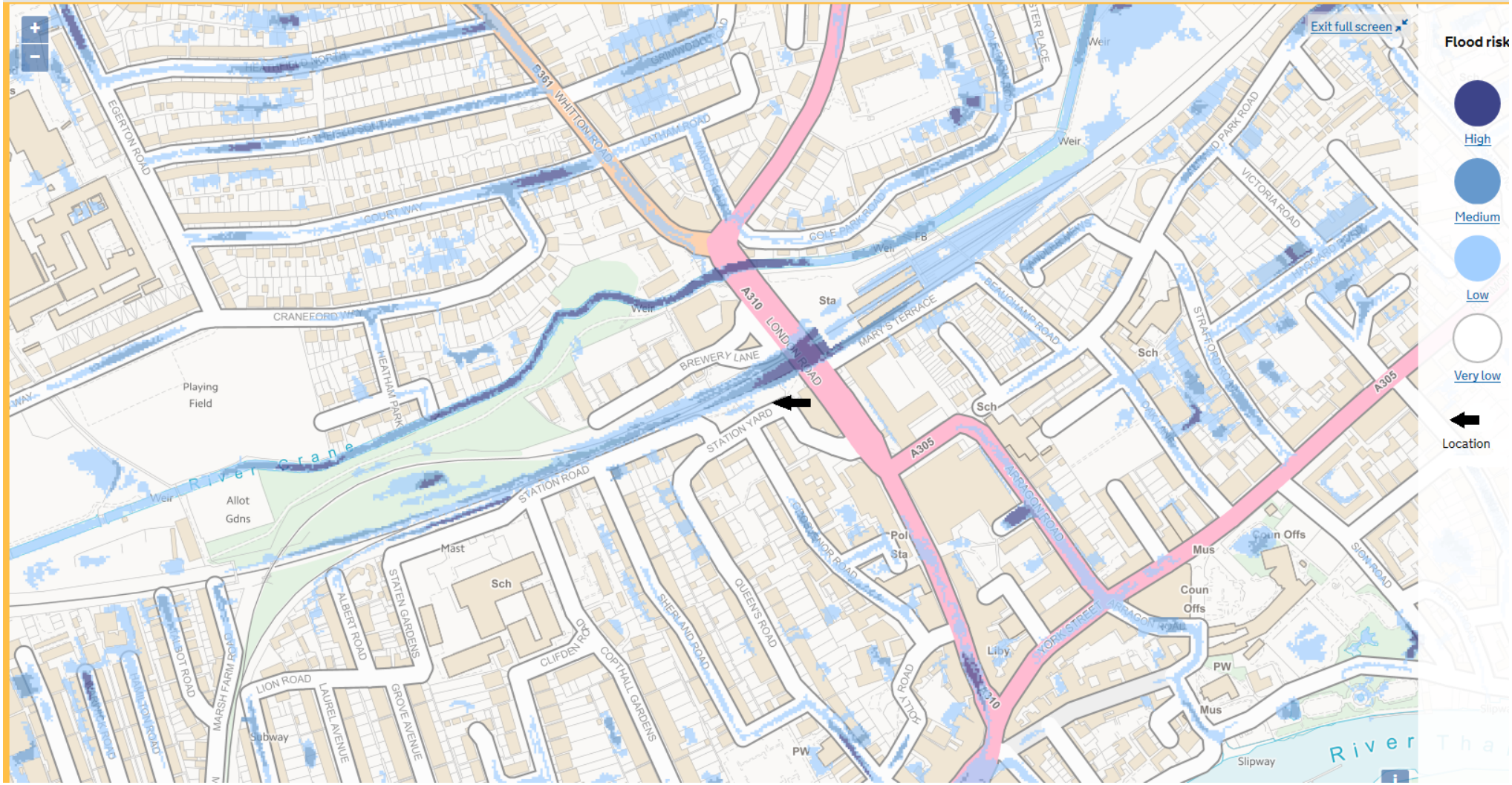
Runoff from roads, parking and other areas of residential, commercial and industrial sites (that are not contaminated with waste, high levels of hydrocarbons, or other chemicals) is classified as Medium in terms of hazard status.

Treatment requirements for disposal to surface water systems

Roof runoff will require 1 treatment stage prior to discharge. Runoff from other parts of this site such as roads, parking and other areas will require ideally 3 treatment stages prior to discharge.

13. APPENDIX E

Flood Risk From Surface Water


Exit full screen
Flood risk
High
Medium
Low
Very low
Location
A310
A305
B361
WHITTON ROAD
LONDON ROAD
COLE PARK ROAD
CRANEFORD WAY
HEATHAM PARK
BREWERY LANE
STATION YARD
STATION ROAD
MARY'S TERRACE
BEAUCHAMP ROAD
VICTORIA ROAD
STRAFFORD ROAD
ARRAGON ROAD
YORK STREET
QUEEN'S ROAD
SHERLAND ROAD
COPTHALL GARDENS
CLIFDEN RD
LION ROAD
ALBERT ROAD
LAUREL AVENUE
GROVE AVENUE
STATEN GARDENS
MARSH FARM ROAD
TALBOT ROAD
HAMPTON ROAD
HOLLY ROAD
SION ROAD
EGERTON ROAD
Playing Field
Allot Gdns
River Crane
River Tha
Weir
Sta
Sch
Mast
Pol Sta
Liby
Mus
Coun Offs
PW
Subway
Slipway

14. APPENDIX F

MICRODRAINAGE CALCS

Summary of Results for 1 year Return Period

Half Drain Time : 16 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.097	0.097	0.0	3.3	3.3	3.7	O K
30 min Summer	0.109	0.109	0.0	3.7	3.7	4.1	O K
60 min Summer	0.111	0.111	0.0	3.8	3.8	4.2	O K
120 min Summer	0.102	0.102	0.0	3.5	3.5	3.9	O K
180 min Summer	0.092	0.092	0.0	3.1	3.1	3.5	O K
240 min Summer	0.084	0.084	0.0	2.8	2.8	3.2	O K
360 min Summer	0.073	0.073	0.0	2.3	2.3	2.8	O K
480 min Summer	0.066	0.066	0.0	1.9	1.9	2.5	O K
600 min Summer	0.061	0.061	0.0	1.7	1.7	2.3	O K
720 min Summer	0.057	0.057	0.0	1.5	1.5	2.2	O K
960 min Summer	0.051	0.051	0.0	1.3	1.3	1.9	O K
1440 min Summer	0.044	0.044	0.0	1.0	1.0	1.7	O K
2160 min Summer	0.037	0.037	0.0	0.7	0.7	1.4	O K
2880 min Summer	0.033	0.033	0.0	0.6	0.6	1.3	O K
4320 min Summer	0.029	0.029	0.0	0.4	0.4	1.1	O K
5760 min Summer	0.026	0.026	0.0	0.4	0.4	1.0	O K
7200 min Summer	0.024	0.024	0.0	0.3	0.3	0.9	O K
8640 min Summer	0.022	0.022	0.0	0.3	0.3	0.8	O K
10080 min Summer	0.021	0.021	0.0	0.2	0.2	0.8	O K
15 min Winter	0.106	0.106	0.0	3.6	3.6	4.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	31.195	0.0	5.4	20
30 min Summer	20.288	0.0	7.1	28
60 min Summer	12.800	0.0	8.9	44
120 min Summer	7.911	0.0	11.0	74
180 min Summer	5.941	0.0	12.4	104
240 min Summer	4.843	0.0	13.5	134
360 min Summer	3.610	0.0	15.1	196
480 min Summer	2.922	0.0	16.3	256
600 min Summer	2.479	0.0	17.3	316
720 min Summer	2.168	0.0	18.1	376
960 min Summer	1.754	0.0	19.6	498
1440 min Summer	1.302	0.0	21.8	738
2160 min Summer	0.967	0.0	24.3	1104
2880 min Summer	0.783	0.0	26.2	1472
4320 min Summer	0.581	0.0	29.1	2196
5760 min Summer	0.470	0.0	31.5	2888
7200 min Summer	0.399	0.0	33.4	3608
8640 min Summer	0.349	0.0	35.0	4400
10080 min Summer	0.312	0.0	36.5	5120
15 min Winter	31.195	0.0	6.1	20

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	0.119	0.119	0.0	4.0	4.0	4.5	O K
60 min Winter	0.116	0.116	0.0	3.9	3.9	4.4	O K
120 min Winter	0.098	0.098	0.0	3.3	3.3	3.7	O K
180 min Winter	0.084	0.084	0.0	2.8	2.8	3.2	O K
240 min Winter	0.076	0.076	0.0	2.4	2.4	2.9	O K
360 min Winter	0.064	0.064	0.0	1.9	1.9	2.4	O K
480 min Winter	0.057	0.057	0.0	1.6	1.6	2.2	O K
600 min Winter	0.052	0.052	0.0	1.3	1.3	2.0	O K
720 min Winter	0.049	0.049	0.0	1.2	1.2	1.8	O K
960 min Winter	0.043	0.043	0.0	0.9	0.9	1.6	O K
1440 min Winter	0.037	0.037	0.0	0.7	0.7	1.4	O K
2160 min Winter	0.032	0.032	0.0	0.5	0.5	1.2	O K
2880 min Winter	0.028	0.028	0.0	0.4	0.4	1.1	O K
4320 min Winter	0.024	0.024	0.0	0.3	0.3	0.9	O K
5760 min Winter	0.022	0.022	0.0	0.3	0.3	0.8	O K
7200 min Winter	0.020	0.020	0.0	0.2	0.2	0.8	O K
8640 min Winter	0.019	0.019	0.0	0.2	0.2	0.7	O K
10080 min Winter	0.018	0.018	0.0	0.2	0.2	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	20.288	0.0	7.9	29
60 min Winter	12.800	0.0	10.0	44
120 min Winter	7.911	0.0	12.3	76
180 min Winter	5.941	0.0	13.9	106
240 min Winter	4.843	0.0	15.1	136
360 min Winter	3.610	0.0	16.9	198
480 min Winter	2.922	0.0	18.2	258
600 min Winter	2.479	0.0	19.3	318
720 min Winter	2.168	0.0	20.3	376
960 min Winter	1.754	0.0	21.9	500
1440 min Winter	1.302	0.0	24.4	748
2160 min Winter	0.967	0.0	27.2	1096
2880 min Winter	0.783	0.0	29.3	1468
4320 min Winter	0.581	0.0	32.6	2148
5760 min Winter	0.470	0.0	35.2	2984
7200 min Winter	0.399	0.0	37.4	3680
8640 min Winter	0.349	0.0	39.3	4400
10080 min Winter	0.312	0.0	40.9	5112

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.093

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.031	4	8	0.031	8	12	0.031

Model Details

Storage is Online Cover Level (m) 1.200

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	40.0	0.0	1.210	0.0	0.0
1.200	40.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0103-5000-1200-5000
Design Head (m)	1.200
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	103
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	5.0
Flush-Flo™	0.354	5.0
Kick-Flo®	0.745	4.0
Mean Flow over Head Range	-	4.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.4	1.200	5.0	3.000	7.7	7.000	11.5
0.200	4.7	1.400	5.4	3.500	8.3	7.500	11.8
0.300	5.0	1.600	5.7	4.000	8.8	8.000	12.2
0.400	5.0	1.800	6.0	4.500	9.3	8.500	12.6
0.500	4.9	2.000	6.3	5.000	9.8	9.000	12.9
0.600	4.7	2.200	6.6	5.500	10.2	9.500	13.3
0.800	4.1	2.400	6.9	6.000	10.7		
1.000	4.6	2.600	7.2	6.500	11.1		

Summary of Results for 30 year Return Period

Half Drain Time : 26 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.253	0.253	0.0	4.9	4.9	9.6	O K
30 min Summer	0.303	0.303	0.0	5.0	5.0	11.5	O K
60 min Summer	0.312	0.312	0.0	5.0	5.0	11.9	O K
120 min Summer	0.278	0.278	0.0	4.9	4.9	10.6	O K
180 min Summer	0.237	0.237	0.0	4.9	4.9	9.0	O K
240 min Summer	0.200	0.200	0.0	4.7	4.7	7.6	O K
360 min Summer	0.148	0.148	0.0	4.4	4.4	5.6	O K
480 min Summer	0.121	0.121	0.0	4.1	4.1	4.6	O K
600 min Summer	0.105	0.105	0.0	3.6	3.6	4.0	O K
720 min Summer	0.095	0.095	0.0	3.2	3.2	3.6	O K
960 min Summer	0.081	0.081	0.0	2.7	2.7	3.1	O K
1440 min Summer	0.067	0.067	0.0	2.0	2.0	2.5	O K
2160 min Summer	0.055	0.055	0.0	1.5	1.5	2.1	O K
2880 min Summer	0.049	0.049	0.0	1.2	1.2	1.8	O K
4320 min Summer	0.041	0.041	0.0	0.9	0.9	1.5	O K
5760 min Summer	0.036	0.036	0.0	0.7	0.7	1.4	O K
7200 min Summer	0.033	0.033	0.0	0.6	0.6	1.2	O K
8640 min Summer	0.030	0.030	0.0	0.5	0.5	1.1	O K
10080 min Summer	0.028	0.028	0.0	0.4	0.4	1.1	O K
15 min Winter	0.288	0.288	0.0	5.0	5.0	10.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.545	0.0	13.3	21
30 min Summer	49.669	0.0	17.3	31
60 min Summer	30.811	0.0	21.5	48
120 min Summer	18.553	0.0	25.9	80
180 min Summer	13.645	0.0	28.5	112
240 min Summer	10.926	0.0	30.5	142
360 min Summer	7.968	0.0	33.3	200
480 min Summer	6.367	0.0	35.5	258
600 min Summer	5.347	0.0	37.3	316
720 min Summer	4.634	0.0	38.8	376
960 min Summer	3.696	0.0	41.2	496
1440 min Summer	2.684	0.0	44.9	738
2160 min Summer	1.947	0.0	48.9	1104
2880 min Summer	1.550	0.0	51.9	1468
4320 min Summer	1.122	0.0	56.3	2200
5760 min Summer	0.892	0.0	59.7	2896
7200 min Summer	0.746	0.0	62.4	3648
8640 min Summer	0.645	0.0	64.7	4280
10080 min Summer	0.570	0.0	66.7	5136
15 min Winter	76.545	0.0	14.9	21

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	0.346	0.346	0.0	5.0	5.0	13.1	O K
60 min Winter	0.350	0.350	0.0	5.0	5.0	13.3	O K
120 min Winter	0.290	0.290	0.0	5.0	5.0	11.0	O K
180 min Winter	0.225	0.225	0.0	4.8	4.8	8.6	O K
240 min Winter	0.175	0.175	0.0	4.6	4.6	6.6	O K
360 min Winter	0.119	0.119	0.0	4.1	4.1	4.5	O K
480 min Winter	0.098	0.098	0.0	3.3	3.3	3.7	O K
600 min Winter	0.086	0.086	0.0	2.9	2.9	3.2	O K
720 min Winter	0.077	0.077	0.0	2.5	2.5	2.9	O K
960 min Winter	0.067	0.067	0.0	2.0	2.0	2.5	O K
1440 min Winter	0.055	0.055	0.0	1.5	1.5	2.1	O K
2160 min Winter	0.046	0.046	0.0	1.1	1.1	1.7	O K
2880 min Winter	0.041	0.041	0.0	0.9	0.9	1.5	O K
4320 min Winter	0.034	0.034	0.0	0.6	0.6	1.3	O K
5760 min Winter	0.030	0.030	0.0	0.5	0.5	1.1	O K
7200 min Winter	0.028	0.028	0.0	0.4	0.4	1.0	O K
8640 min Winter	0.026	0.026	0.0	0.4	0.4	1.0	O K
10080 min Winter	0.024	0.024	0.0	0.3	0.3	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	49.669	0.0	19.4	32
60 min Winter	30.811	0.0	24.1	50
120 min Winter	18.553	0.0	29.0	86
180 min Winter	13.645	0.0	32.0	118
240 min Winter	10.926	0.0	34.1	148
360 min Winter	7.968	0.0	37.3	200
480 min Winter	6.367	0.0	39.8	260
600 min Winter	5.347	0.0	41.8	318
720 min Winter	4.634	0.0	43.4	378
960 min Winter	3.696	0.0	46.2	498
1440 min Winter	2.684	0.0	50.3	742
2160 min Winter	1.947	0.0	54.7	1108
2880 min Winter	1.550	0.0	58.1	1464
4320 min Winter	1.122	0.0	63.1	2136
5760 min Winter	0.892	0.0	66.9	2872
7200 min Winter	0.746	0.0	69.9	3688
8640 min Winter	0.645	0.0	72.5	4280
10080 min Winter	0.570	0.0	74.8	5104

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.093

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.031	4	8	0.031	8	12	0.031

Model Details

Storage is Online Cover Level (m) 1.200

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	40.0	0.0	1.210	0.0	0.0
1.200	40.0	0.0	1.220	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0103-5000-1200-5000
Design Head (m)	1.200
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	103
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	5.0
Flush-Flo™	0.354	5.0
Kick-Flo®	0.745	4.0
Mean Flow over Head Range	-	4.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.4	1.200	5.0	3.000	7.7	7.000	11.5
0.200	4.7	1.400	5.4	3.500	8.3	7.500	11.8
0.300	5.0	1.600	5.7	4.000	8.8	8.000	12.2
0.400	5.0	1.800	6.0	4.500	9.3	8.500	12.6
0.500	4.9	2.000	6.3	5.000	9.8	9.000	12.9
0.600	4.7	2.200	6.6	5.500	10.2	9.500	13.3
0.800	4.1	2.400	6.9	6.000	10.7		
1.000	4.6	2.600	7.2	6.500	11.1		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 57 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.514	0.514	0.0	5.0	5.0	19.5	O K
30 min Summer	0.644	0.644	0.0	5.0	5.0	24.5	O K
60 min Summer	0.706	0.706	0.0	5.0	5.0	26.8	O K
120 min Summer	0.674	0.674	0.0	5.0	5.0	25.6	O K
180 min Summer	0.610	0.610	0.0	5.0	5.0	23.2	O K
240 min Summer	0.543	0.543	0.0	5.0	5.0	20.6	O K
360 min Summer	0.423	0.423	0.0	5.0	5.0	16.1	O K
480 min Summer	0.328	0.328	0.0	5.0	5.0	12.5	O K
600 min Summer	0.258	0.258	0.0	4.9	4.9	9.8	O K
720 min Summer	0.207	0.207	0.0	4.8	4.8	7.9	O K
960 min Summer	0.144	0.144	0.0	4.4	4.4	5.5	O K
1440 min Summer	0.102	0.102	0.0	3.5	3.5	3.9	O K
2160 min Summer	0.079	0.079	0.0	2.6	2.6	3.0	O K
2880 min Summer	0.068	0.068	0.0	2.1	2.1	2.6	O K
4320 min Summer	0.056	0.056	0.0	1.5	1.5	2.1	O K
5760 min Summer	0.049	0.049	0.0	1.2	1.2	1.8	O K
7200 min Summer	0.044	0.044	0.0	1.0	1.0	1.7	O K
8640 min Summer	0.041	0.041	0.0	0.9	0.9	1.5	O K
10080 min Summer	0.038	0.038	0.0	0.7	0.7	1.4	O K
15 min Winter	0.587	0.587	0.0	5.0	5.0	22.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	139.112	0.0	24.2	22
30 min Summer	91.026	0.0	31.7	34
60 min Summer	56.713	0.0	39.5	58
120 min Summer	34.134	0.0	47.6	90
180 min Summer	25.027	0.0	52.3	124
240 min Summer	19.963	0.0	55.7	156
360 min Summer	14.472	0.0	60.5	218
480 min Summer	11.519	0.0	64.3	278
600 min Summer	9.643	0.0	67.2	336
720 min Summer	8.336	0.0	69.8	392
960 min Summer	6.619	0.0	73.9	506
1440 min Summer	4.775	0.0	79.9	740
2160 min Summer	3.440	0.0	86.4	1104
2880 min Summer	2.723	0.0	91.1	1468
4320 min Summer	1.956	0.0	98.2	2200
5760 min Summer	1.545	0.0	103.5	2872
7200 min Summer	1.287	0.0	107.7	3624
8640 min Summer	1.107	0.0	111.2	4368
10080 min Summer	0.975	0.0	114.2	5136
15 min Winter	139.112	0.0	27.1	23

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	0.743	0.743	0.0	5.0	5.0	28.3	O K
60 min Winter	0.825	0.825	0.0	5.0	5.0	31.4	O K
120 min Winter	0.783	0.783	0.0	5.0	5.0	29.7	O K
180 min Winter	0.680	0.680	0.0	5.0	5.0	25.8	O K
240 min Winter	0.571	0.571	0.0	5.0	5.0	21.7	O K
360 min Winter	0.388	0.388	0.0	5.0	5.0	14.7	O K
480 min Winter	0.261	0.261	0.0	4.9	4.9	9.9	O K
600 min Winter	0.182	0.182	0.0	4.6	4.6	6.9	O K
720 min Winter	0.136	0.136	0.0	4.3	4.3	5.2	O K
960 min Winter	0.104	0.104	0.0	3.6	3.6	4.0	O K
1440 min Winter	0.080	0.080	0.0	2.6	2.6	3.0	O K
2160 min Winter	0.065	0.065	0.0	1.9	1.9	2.5	O K
2880 min Winter	0.056	0.056	0.0	1.5	1.5	2.1	O K
4320 min Winter	0.046	0.046	0.0	1.1	1.1	1.8	O K
5760 min Winter	0.041	0.041	0.0	0.9	0.9	1.5	O K
7200 min Winter	0.037	0.037	0.0	0.7	0.7	1.4	O K
8640 min Winter	0.034	0.034	0.0	0.6	0.6	1.3	O K
10080 min Winter	0.032	0.032	0.0	0.5	0.5	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	91.026	0.0	35.5	36
60 min Winter	56.713	0.0	44.3	60
120 min Winter	34.134	0.0	53.3	100
180 min Winter	25.027	0.0	58.6	136
240 min Winter	19.963	0.0	62.4	168
360 min Winter	14.472	0.0	67.8	230
480 min Winter	11.519	0.0	72.0	288
600 min Winter	9.643	0.0	75.3	340
720 min Winter	8.336	0.0	78.1	390
960 min Winter	6.619	0.0	82.7	502
1440 min Winter	4.775	0.0	89.5	738
2160 min Winter	3.440	0.0	96.7	1100
2880 min Winter	2.723	0.0	102.1	1472
4320 min Winter	1.956	0.0	110.0	2208
5760 min Winter	1.545	0.0	115.9	2936
7200 min Winter	1.287	0.0	120.6	3672
8640 min Winter	1.107	0.0	124.5	4408
10080 min Winter	0.975	0.0	127.9	5008

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.408	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.093

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.031	4	8	0.031	8	12	0.031

Model Details

Storage is Online Cover Level (m) 1.200

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	40.0	0.0	1.201	0.0	0.0
1.200	40.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0103-5000-1200-5000
Design Head (m)	1.200
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	103
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	5.0
Flush-Flo™	0.354	5.0
Kick-Flo®	0.745	4.0
Mean Flow over Head Range	-	4.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.4	1.200	5.0	3.000	7.7	7.000	11.5
0.200	4.7	1.400	5.4	3.500	8.3	7.500	11.8
0.300	5.0	1.600	5.7	4.000	8.8	8.000	12.2
0.400	5.0	1.800	6.0	4.500	9.3	8.500	12.6
0.500	4.9	2.000	6.3	5.000	9.8	9.000	12.9
0.600	4.7	2.200	6.6	5.500	10.2	9.500	13.3
0.800	4.1	2.400	6.9	6.000	10.7		
1.000	4.6	2.600	7.2	6.500	11.1		