SOLD-Thames Young Mariners

Drainage Strategy

Surrey County Council

13 October 2022

PR-200-ATK-ZZ-00-RP-C-00001

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This document has 37 pages including the cover.

Document history

Document title: Drainage Strategy

Document reference: PR-200-ATK-XX-XX-RP-C-00001

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	Issued for Planning	AG	RW	PB	CH	13/10/2022

Client signoff

Client	Surrey County Council
Project	SOLD-Thames Young Mariners
Job number	5210336
Client signature/date	

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1. Introduction

Atkins has been commissioned by Surrey County Council (SCC) to prepare a drainage strategy to support a full planning application for the Surrey Outdoor Learning and Development (SOLD) project on the Thames Young Mariners (TYM) site.

This report presents the surface and foul water drainage strategy for the proposed development. It provides details on the proposed surface and foul water networks, demonstrating how the use of Sustainable Urban Drainage System (SuDS) have been adopted to reduce flood risk and promote biodiversity benefits as well as improve water quality and amenity value.

The Design Assessment Checklist in the Richmond Planning Guidance – Delivering SUDS in Richmond[1] (Appendix 1) document is completed and included in Appendix A.1 of this report.

1.1. Proposed Development

The TYM scheme involves redevelopment of the site to provide modern, fit for purpose facilities that meet current health and safety standards which will allow SOLD to increase its service capacity and strengthen its commercial operation with SCC.

The proposed scheme is to demolish the existing buildings and re-build new structures comprising a main building, three guest residential building and one changing block. All buildings are single-storey except for the main building which is a two-storey structure. The proposed development layout extracted from the landscape masterplan prepared by Pick Everard (drawing ref: PR-200-PEV-XX-XX-DR-L-00200) is included in Figure 1-1 below and Appendix C.1 of the report.

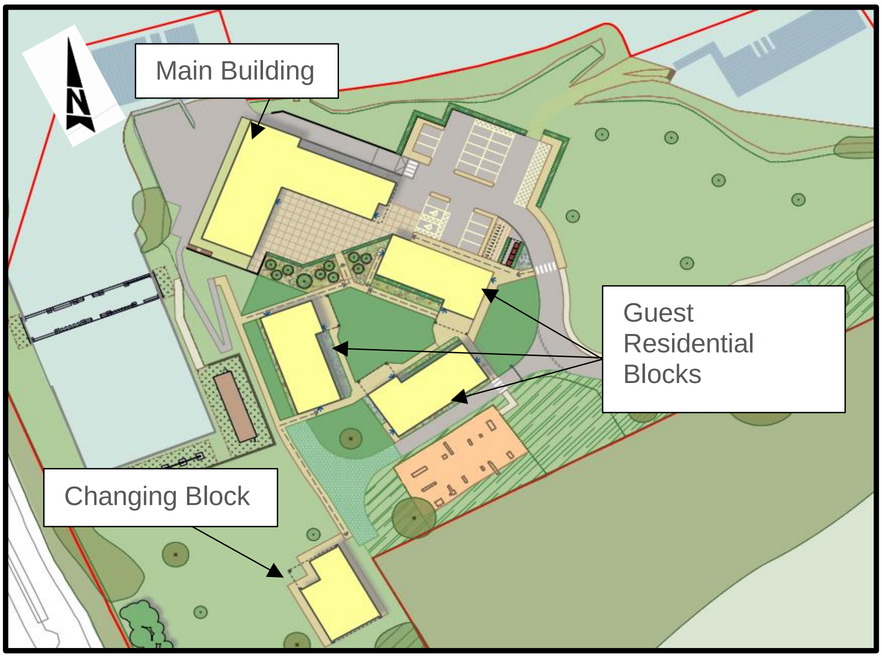

Figure 1-1 – Proposed development layout

1.2. Background Information

This drainage strategy has been informed by the following documents and drawings:

- Topographical survey – Greenhatch Group, (Ref: 43456_T; April 2022)
- Landscape Masterplan – Pick Everard (Ref: PR-200-PEV-XX-XX-DR-L-00200; September 2022)
- Public sewer records – Thames Water (Ref: ALS/ALS Standard/2022_4597733; March 2022)
- Arboriculture survey – Middlemarch (Ref: C157100-01-01; March 2022)
- On-site existing drainage CCTV survey – Greenhatch Group (Ref: 43456_CCTV; July 2022)

- Flood Risk Assessment – Soils limited (Ref: 20295/FRA Rev 1.0; September 2022)
- Scoping Investigation Report (Ground investigation) – Soils Limited (Ref: 20295/SIR Rev 1.0; September 2022)
- Historical Drainage Drawings - March 1961

2. Existing Site Features

2.1. Existing Layout

Total area of the site is 3.72 ha with the area proposed for redevelopment occupying approximately 0.67 ha. The site is located between Richmond and Kingston and is surrounded by Ham Lands. The River Thames is located to the west with Riverside Drive to the east. In addition to the existing buildings, the site contains open green spaces and access to an artificial lake which connects to the River Thames. The site is surrounded by approximately 80 ha of public open space, which has been designated as a Local Nature Reserve. The site is accessed via Riverside Drive.

A site location plan is shown in Figure 2-1.

Figure 2-1 - Site location plan

2.2. Topography and Site Features

The topographical survey undertaken by Greenhatch Group (as given in Appendix C.4) shows that the site elevations vary between 5m and 9m AOD (Above Ordnance Datum). It indicates that the overall high point of the site is at the location of existing development and the field area falls away to the lake. For the developed area the highest ground elevation is at the west of the site whilst the lowest ground elevation is at the north.

The present site access road from Riverside Drive is retained in both alignment and level, except for a small section on the west side of the existing buildings.

2.3. Existing Drainage

Historic drainage drawings (see Appendix C.6) suggest that when constructed, the surface water for the site from the existing buildings was discharged into several soakaways, in addition to a positive outfall connection to the lake. However, recent survey information indicates that, some of the surface water has been diverted into a combined sewer.

Thames Water (TW) sewer records (Appendix C.77) as given in show that there is an existing 150mm diameter foul water sewer running along the Riverside Drive. It also shows a 900mm diameter surface water sewer running along Riverside Drive, branching off in a westerly direction south of the site discharging most likely into the River Thames.

A drainage CCTV survey undertaken by Greenhatch Group in July 2022 (see Appendix C.5) indicated that the site in its current condition drains via an existing combined private drainage system. A 150mm diameter combined drain runs through the site collecting both surface and foul water flows. The drainage survey was abandoned at MH15 (for location see Appendix C.4) with no connection shown to the public sewerage network. This manhole is situated at the southeast extent of the development in proposed enhanced vegetation area. It is assumed that the combined drain will connect into the public Thames Water foul network along Riverside Drive as referred to above.

The lake to the north of the site is connected to the River Thames via a channel with lock gates that isolates the lake from the tidal river to maintain water levels.

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2.4. Ground Investigations

An intrusive ground investigation was carried out by Soils Limited in September 2022. The investigation results provided in the Scoping Investigation report (Ref: 20295/SIR Rev 1.0- September 2022) show that the ground conditions vary across the site extents. Refer to for trial pit and borehole locations from the investigations.

Infiltration testing was undertaken in trial pits TPSK1 and TPSK2 (see Figure 2-3) within the Worked Ground and Kempton Park Gravel Member respectively (see section 2.4.1 for details). The testing was undertaken in accordance with BRE Digest 365 Soakaway Design. A single test was carried in TPSK1, which observed insufficient soakage to allow the calculation of an infiltration rate. Three complete tests were carried out in TPSK2 within the Kempton Park Gravel Member, with a base depth of 2.40m bgl (below ground level). An infiltration rate was calculated as 1.99×10^{-3} m/sec (7.164 m/hr). The test results and trial pit logs from the Scoping Investigations report can be found in Appendix D.

Figure 2-2 - Ground investigation locations

2.4.1. Geology

The British Geological Survey (BGS) map (scale 1:50,000) showed the site to be located upon Artificial Deposits, with superficial deposits of Kempton Park Gravel Member and bedrock of the London Clay Formation.

Artificial Deposits refer to made ground and worked ground as classified below:

- **Made Ground**: Deposits that have been disturbed and placed by human activity and include anthropogenic material (brick, concrete fragments etc.).
- **Worked Ground**: Deposits that contain no anthropogenic material but exhibit signs of disturbance or appear to be fill material.

Table 2-1 - Ground Conditions

Strata	Depth encountered (m bgl)		Typical Thickness	Description
	Top	Bottom		
Made Ground	Ground level	2.1 to 4.5	3.4	Orangish brown/ dark brown slightly clayey/ clayey gravelly SAND. Soft to stiff orangish brown/ brown mottled dark brown slightly gravelly/ gravelly CLAY. Dark greyish brown mottled orangish brown, light brown clayey very sandy GRAVEL.
Worked Ground	1.1 to 4.5	1.1 to >7.5	Not proven	Soft to firm yellowish brown slightly gravelly sandy CLAY. The gravel was sub-angular, fine to medium flint.
Kempton Park Gravel Member	2.1 to 4.5	9.7	6.2	Yellowish brown slightly clayey gravelly fine to coarse SAND / sandy GRAVEL.
London Clay Formation	9.7	20.0	>11.3	Firm to stiff grey silty CLAY.

(Key: TPSK- Trial Holes, BH- Bore Holes, WS- Windowless sampler boreholes, DP- DCP-TRL Probes)

2.4.2. Groundwater

Groundwater investigation was conducted in August 2022 in a 6m deep borehole within a groundwater monitoring well. At this time of year, groundwater levels are typically reaching their annual minimum, with maximum levels expected in March. The recorded groundwater depths as referenced in the Scoping Investigations report, indicate a depth of 4.0m bgl (~5m AOD).

Groundwater equilibrium conditions may be established if a series of investigations are made via groundwater monitoring wells and maximum groundwater levels need to be established for appropriate performance of infiltration systems.

The aquifer designations for the site show the superficial drift as secondary A; which suggests low vulnerability to groundwater pollution. The bedrock is designated as unproductive suggesting the rock layers have negligible significance for water supply or river base flow.

3. Drainage Strategy

3.1. Policies, Regulations and Legislation

The following regulations, standards, policies, and guidance have been reviewed and considered within the proposed drainage strategy.

- Sewerage Sector Guidance, Water UK - Appendix C, Version 2.2 – 2022.
- The Building Regulations 2010 - Drainage and Waste Disposal - Approved Document H
- CIRIA C753 The SUDS Manual
- CIRIA C697 The SuDS Manual
- BS EN 752:2017 Drain and sewer systems outside buildings. Sewer system management
- BS EN 1295-1 Structural design of buried pipelines under various conditions of loading – Part 1: General requirements
- BS EN 1610 Construction and testing of drains and sewers
- Surrey County Council Sustainable Drainage System Design Guidance[1]
- London Sustainable Drainage Action Plan.
- Planning Guidance Document- Delivering SuDS in Richmond

It is assumed that the drainage systems (surface and foul) will remain private.

3.2. Design Criteria

3.2.1. Climate Change

The Environment Agency's (EA) Flood Risk Assessments: Climate Change Allowances Guidance has been used to select an appropriate climate change allowance for the scheme. A climate change adjustment of 40% for the 1 in 100-year storm event has been used to develop the proposed surface water drainage strategy.

3.2.2. Hydraulic Design Criteria

3.2.2.1. Surface Water

The surface water drainage strategy has been designed based on the following hydraulic criteria and parameters:

- Surface water discharge from the proposed development shall be restricted to a flow rate as close as practicably possible to the average annual greenfield equivalent run-off rate for the site or a flow control with a lower limit of 1l/s to minimise the blockage risk and the associated maintenance liability. This flow rate will apply to all rainfall events up to and including the 1 in 100-year plus climate change event.
- The system shall be designed not to flood any part of the site during the 1 in 30-year rainfall event. Any flooding that occurs for more extreme rainfall events, up to and including the 1 in 100-year plus climate change event, will be contained within the site in locations that do not create a risk to people or property.
- Sustainable drainage solutions shall be used.
- The following impermeability factors (PIMP) shall be used:
  - Access roads, hardstanding, parking and roofs: 100%
  - Landscaped areas: 25%
- For simulations, Cv value of 0.75 shall be used for summer and 0.84 for winter rainfall events.

The following network design criteria have been used to develop the surface water network with reference to the standards listed in section 3.1 above, where applicable:

- Minimum velocity for self-cleansing is 1m/s. (BS EN 752:2017)
- Maximum allowed distance between manholes is 90m. (BS EN 752:2017, Table NA.4)
- No surcharge in the network during a 1 in 2-year storm.

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[1] Sustainable Drainage System Design Guidance - Surrey County Council (surreycc.gov.uk)

3.2.2.2. Foul Water

The foul water drainage strategy has been designed based on the following criteria and parameters:

- Flow rates have been calculated using discharge units.
- Frequency factor 0.5 for residential blocks and 1 for main building and changing block have been considered.
- Minimum gradients associated with pipe sizes as defined in the Building Regulations (Part H).

The following network design criteria has been used to develop the foul water network with reference to the standards listed in section 5.1 above, where applicable.

- Pipe gradient to be provided as per The Building Regulations 2010.
- Maximum allowed distance between manholes is 90m. (BS EN 752:2017, Table NA.4)
- Maximum allowed distance from rodding point to an inspection chamber is 22m. (BS EN 752:2017, Table NA.4).

3.2.2.3. Physical Criteria

The proposed drainage systems outside of buildings will be designed based on the following physical criteria and parameters:

- Pipework with less than 1.2m cover within access roads and carparks, and 0.9m cover in other areas, shall be assessed, considering the pipe material, to determine the necessary pipe bedding to ensure structural integrity.
- Pipework adjacent to any building must be positioned outside the 45° influence zone of the footings or have concrete bed and surround extending up to at least the base level of the adjacent footings.
- A minimum cover depth of 0.5m over any geo-cellular storage tanks.
- Structures with the potential for allowing infiltration located at least 5m away from any building structure.

3.3. Surface Water Strategy

3.3.1. Outfall Options

The surface water discharge for the site will be via both a below ground infiltration system and a positive outfall to the lake. The roof run-off and flows from some footpaths is collected and infiltrated into the ground at the south-western side of the site, where the infiltration characteristics of the soil (as outlined in Section 2.4) were suitable. Surface run-off from the remaining roofs, roads and car park will be attenuated in a pond before discharging into the lake.

In accordance with CIRIA C753 SuDS Manual and Richmond SuDS Guidance, a hierarchical evaluation of the outfall options has been undertaken for the site. The results are presented in the Table 3-1.

Table 3-1 – Drainage Hierarchy Evaluation

Option	Discharge Location	Evaluation
1	At source reductions and reuse	**Viable solution** – The green roofs are proposed to intercept runoff from the roofs of the residential block and changing block. Porous asphalt paving parking bays to mimic natural drainage route.
2	Infiltration to ground	**Viable solution** Infiltration has been selected as a potential suitable method for disposal of runoff from roofs for the main building, two residential buildings, the changing block, and footpaths.
3	Attenuated discharge to a surface water body	**Viable solution** – Runoff from the roofs, roads and car park is stored in a pond and discharged to the lake at a controlled rate of 1l/s.
4	To a public surface water sewer	Not Required

5	To highway drain, or other private drainage system	Not Required
6	To a combined sewer where there are no other options, and only where agreed in advance with the relevant sewage undertaker	Not Required

3.3.2. Proposed Site Runoff

To establish compliance with SCC requirements and limit flow rates as close to greenfield rates as practically possible, the greenfield equivalent run-off rates have been calculated using Interim Code of Practice for Sustainable Drainage Design variant of IH124, as the site has an area of less than 50ha. Micro-Drainage Source Control was used to undertake the calculations (included in Appendix B) using the following parameters:

- Gross area: 0.67 ha
- Standard Average Annual Rainfall (SAAR): 600 mm
- Soil: 0.3
- Region: 6

The run-off rates calculated are:

- Q1 1.3 l/s/ha
- QBAR 1.5 l/s/ha (average annual run-off rate)
- Q30 3.4 l/s/ha
- Q100 4.8 l/s/ha

The greenfield runoff rates (QBAR) for Catchment B for an area of approximately 0.25ha proposed to be discharged into the lake are 0.37 l/s. However, the proposed runoff rates from are limited to a maximum of 1l/s based on minimum size of control structure to reduce the risk of blockage.

The total redevelopment area has been divided into two parts Catchment A and B. Within these catchments, Figure 3-2 indicates the percentage of impervious area factors (PIMP) which have been assumed (been taken as 100% for blue marked areas and 25% for pink areas).

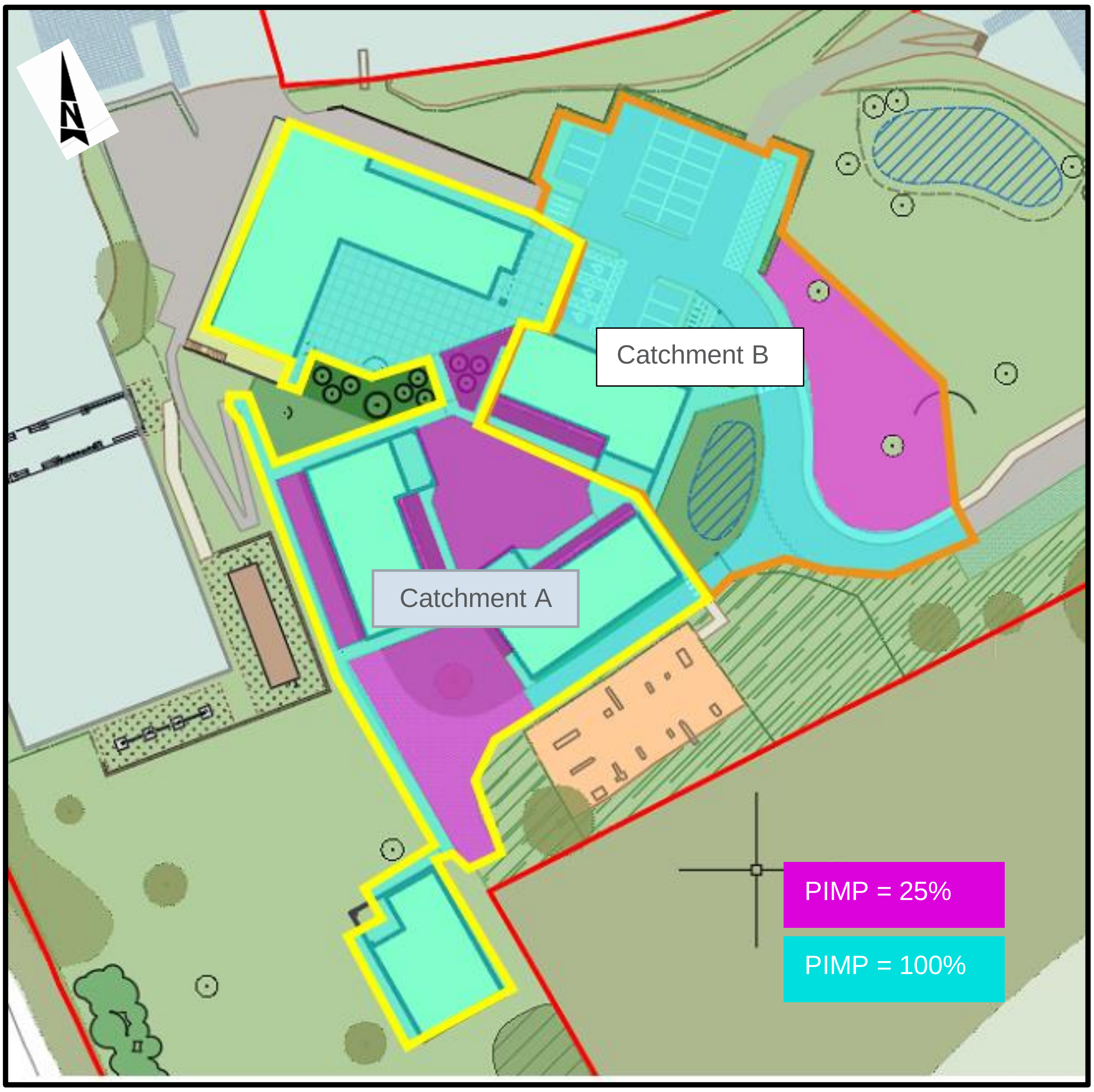

Figure 3-1 - Catchment Distribution

The runoff from catchment A is drained to an infiltration tank with no discharge into the lake whereas the surface water runoff from catchment B is discharged into the lake at a rate of 1l/s via a raingarden and detention pond.

The catchment distribution in shown in figure 3-2.

Table 3-2 - Restriction rate summary

Catchment	Gross Area (ha)	Proposed Discharge rate
Catchment A	0.407	N/A (Infiltration only)
Catchment B	0.257	1l/s

3.3.3. SuDS Appraisal

The LLFA (Lead Local Flood Authority) requires SuDS to be considered for inclusion within the drainage strategy for the Proposed Development. The SuDS techniques suitable for this development have been identified using the selection process defined in CIRIA C697.

The Proposed Development is brownfield and therefore, according to CIRIA C697, Table 5.2 (reproduced in Appendix B.1), all SuDS techniques are considered acceptable. Site specific parameters for the initial selection of SuDS components for this site have used CIRIA C697, Table 5.4 (Appendix B2 and B.3) to identify SUDS techniques suitable for two areas of the site. These are summarised below:

- Catchment A – The south-western section of the site with high permeability ground conditions:
  - Soils: Permeable
  - Area draining to a single SuDS component: 0-2ha
  - Minimum depth to water table: >1m
  - Site slope: 0-5%
  - Available head: 0-1m
  - Available space: High
- Catchment B– The north-eastern section of the site with low permeability ground conditions:
  - Soils: Impermeable
  - Area draining to a single SuDS component: 0-2ha
  - Minimum depth to water table: >1m
  - Site slope: 0-5%
  - Available head: 1-2m
  - Available space: High

The evaluation considered the following:

- Attenuation, amenity, biodiversity, and treatment properties of each SuDS element.
- Site spatial constraints.

The results of the evaluation and proposed solution are summarised in Table 3-3.

Table 3-3 - SuDS Evaluation Summary

SuDS group	Technique	Catchment B (Impermeable): Evaluation Comments	Catchment A (Permeable): Evaluation Comments	Conclusion
Retention	Retention Pond	The majority of the surface water storage for the proposed development is to be provided by infiltration and open structures. Retention pond is not provided for health and safety reasons		Suitable Not provided
	Subsurface storage	Subsurface storage on the site is provided in the form of permeable paving beneath car parks and access road.		Suitable provided
Wetland	Wetlands/ponds	Wetlands require either a continuous through-flow of water or high groundwater levels. As there is currently no evidence of consistently high groundwater this cannot be confirmed as a suitable technique		Not suitable
Infiltration	Infiltration tank, trench, basin or soakaway	Not suitable	Based on the infiltration test results, infiltration systems are suitable for the area. An infiltration tank is proposed for the development, integrated within the landscaping scheme to provide both run off interception and infiltration via below ground geo-cellular units.	Suitable - provided
Filtration	Filter trench	Filtration trenches can be incorporated into the landscaping scheme to intercept run-off from hardstanding areas and landscaped areas. They will provide flow conveyance and a small amount of supplementary storage.	Not suitable	Suitable - provided
Detention	Detention Basin	A detention basin is proposed to provide attenuation for surface water in order to discharge it at	Not suitable	Suitable - provided

		controlled rate into the outfall.		
Open Channels	Conveyance, dry and wet swales	Not suitable	Levels of the site do not provide adequate space for	
Source control	Green roof	Green roofs are viable to intercept runoff from building roofs. They are proposed within the residential blocks.		Suitable - provided
	Rainwater harvesting	Provided the yield could justify its economic viability, they could be incorporated into the scheme, but they have not been included as part of the drainage system.		Suitable – not provided
	Permeable paving	Permeable paving is suitable for use within the proposed development on parking bays and access roads; the extents of its use will be considered during future detailed design. It is primarily proposed to delivery water quality benefits; however, it will also provide a small amount of additional storage within the drainage system		Suitable - provided

3.3.4. Interception Strategy

In addition to controlled discharge rates and provision of storage, the strategy has considered how the first 5 mm of runoff can be intercepted and is disposed of via an alternative route usually into the ground, so it does not contribute to flows in watercourses or sewers.

The roof and footway areas within Catchment A drain to an infiltration tank; therefore, the first 5mm of rainfall onto these areas will be intercepted and not leave the site. Catchment B contains low permeability or impermeable ground conditions hence it is not possible to prevent the 5mm of rainfall from leaving the site as there is no alternative outfall other than the lake to the north.

3.3.5. Water Quality

Impacts to water quality can be mitigated with source control measures and a SuDS treatment train. The CIRIA C753 approach has been followed which demonstrates potential configurations of the SuDS techniques identified that will achieve the required degree of pollution mitigation for each of the different land uses.

Impacts to water quality is be mitigated by creating a treatment train of different SuDS techniques. The following measures are proposed to be adopted on the site. The SUDS Manual index approach has been followed (Chapter 26). It is summarised below for the site.

Table 3-4 - Pollution Hazard Indices (CIRIA C753 Table 26.2 excerpt)

Land use	Pollution hazard level	TSS	Metals	Hydrocarbons
Other roofs	Low	0.3	0.2	0.05
Low traffic roads/ residential car parks/ Schools	Low	0.5	0.4	0.4

Table 3-5 - SuDS pollution mitigation for discharge to surface waters (CIRIA C753 Table 26.3 excerpt)

SuDS component	Runoff Source	TSS	Metals	Hydrocarbons
Permeable pavement	Access Road/ Car park	0.7	0.6	0.7
Detention Basin (Pond)	Roof/ Access Road/ Car park	0.5	0.5	0.6
Filter Drain	Landscape areas	0.4	0.4	0.4
Bioretention system (Rain Garden)	Roof	0.8	0.8	0.8

The above table shows that the provided SuDS features are sufficient to mitigate the pollutants from the sources on site.

3.3.6. Proposed Outfall

The site is designed to ensure that no overland flooding from the site occurs during the 1 in 100 year + 40% CC storm event. This is achieved using a below ground infiltration tank to the south-west of the site, and an attenuation pond to the east. The tank is kept at least 5m away from the building.

The runoff from the parking areas, access road, footways and roof area passes through a rain garden, permeable paving and an attenuation pond before discharging into the lake.

3.3.7. Attenuation Volume Assessment

The proposed surface water drainage strategy has been designed using MicroDrainage. A network model was constructed, including flow controls. Refer to Appendix E.1 for storm water calculation from Microdrainage.

The surface water drainage has been divided in two parts to avoid risk of effluents from vehicles polluting the river water. The proposed storm water network has a pipe network collecting rainwater from designated catchment areas of varied permeability. The pipe sizes range from 150mm up to 450mm across the network.

Runoff from the roof and footpath is discharged into an infiltration tank. The calculated storage required to accommodate the 1 in 100-year storm event + 40% CC is 73 m^3. The runoff from roof of main building, two residential blocks, changing block and footpath discharges into the infiltration tank having half drain time of 58 mins provides complete infiltration into the ground.

The parking area to the north-east of the site, the landscaped area between the proposed development and the lake, one of the residential block discharges into a pond/detention basin before discharging into the lake to the north of the site. The proposed drainage system also comprises of a bio-retention area (rain garden) with a volume of 19 m^3. The pond has attenuation capacity of 187 m^3 from which the water is ultimately discharged to the lake at a rate of 1l/s.

The collection system proposed comprises several gullies, slot drains and linear channels for the paved surfaces. Filter drains are proposed in the green area to the west. Permeable paving is proposed at parking spaces and carriageways.

3.3.8. Amenity and Biodiversity

Amenity and biodiversity benefits can also be enhanced by the implementation of SuDS, the below table highlights, which SuDS technique selected as part of this drainage strategy will provide amenity and biodiversity benefits.

Table 3-6 - Amenity and biodiversity summary

SuDs Technique	Amenity Benefit	Biodiversity Benefit
Infiltration tank	Yes – Facilitates the multifunctional use of space by allowing the surface above the tank to be used for recreation or other activities.	No
Green Roofs	Yes – Makes roof areas more attractive.	Yes – Planting creates habitats.
Pond	Yes – Natural appearance with soft edges that blend with surrounding areas.	Yes – Habitat creation.
Bioretention System (Rain Garden)	Yes – Aesthetic benefits by incorporating vegetation. Provide water efficient landscaping.	Yes – Habitat creation.
Filter Drains	Yes – Inconspicuous feature providing drainage within landscaped areas where a hard feature is not appropriate.	No
Permeable/Porous Paving	Yes – Provide useful space for various activities that is uninterrupted by specific drainage features.	No

3.4. Foul Water Strategy

Foul water drainage will be provided a conventional gravity pipework.

3.4.1. Flow Generation

Foul water loading has been provided as discharge units (DU) (BS EN 752:2017) from the building by the Public Health design team. A total of 11.4l/s is expected to be generated by the site as per the calculations and has been used for the network design.

3.4.2. Foul Water Outfall

Based on the information received from the MEP team, a foul water gravity system has been designed using discharge unit loading from the buildings. Foul water flows will be conveyed by gravity via the existing on-site drainage system to the existing public foul water sewer within Riverside Drive (subject to approval with Thames Water).

Refer Appendix C.2 for details of proposed foul water drainage network.

4. Operation and Maintenance

The maintenance of the proposed drainage systems is summarised below:

- Pipework System – Litter, debris removal and periodic jetting. The surface water drainage will be designed for a self-cleansing velocity of 1 m/s and foul pipework in accordance will the minimum falls in BS EN 752, allowing for the appliances connected.
- Infiltration Tanks (Table in CIRIA C753) – it is recommended to have monthly inspections to check for compaction and ponding, inspect inlets and outlets for blockages and any areas which are not operating properly. Annual monitoring to reseed areas for poor vegetation growth. Remedial actions will be required where necessary to relevel irregular surfaces, rehabilitate inlets, outlets and overflows.
- Permeable Paving (Table 20.15 in CIRIA C753) - periodic biannual/annual maintenance will be required to prevent or address clogging this would be in the form of brushing and /or vacuuming. Remedial actions will be required where necessary to rectify any depressions, rutting or broken blocks.
- Green Roofs (Table 12.5 in CIRIA C753) - this will require biannual or annual maintenance, except in the establishment stage (first 12 to 15 months) where more regular maintenance will be required. All maintenance at roof level will comply with strict health and safety requirements.
- Tree pits (Table 19.3 in CIRIA C753) - it is recommended regular inspections are carried out to check the operation of underdrains and inlets and outlets for blockages, regular maintenance should remove litter, surface debris and weeds. Annually check tree health and manage the tree appropriately.
- Pond (Table 23.1 in CIRIA C753) – these will require monthly regular maintenance at first to remove litter and debris, cut grass, and inspect inlets, outlets and overflows. Occasional maintenance and remedial actions should be carried out as required.
- Filter Drains (Table 16.1 in CIRIA C753)- these will require regular monthly maintenance involving inspection of filter drain surface, inlet/outlet pipework and control system for blockages, clogging standing water and structural damage.
- Bioretention Systems (Table 18.3 in CIRIA C753) – these will require quarterly inspection to check for silting and ponding, plant diseases and insect inlet and outlets for blockages. Regular maintenance will be required to remove sediments, litter, and surface debris.

5. Conclusion

The proposed drainage strategy provides details of management of surface water and foul water from the proposed development.

The redevelopment area is divided into two catchments: A and B. Catchment A has a gross area of 0.4ha comprising of roof area, footways, green areas and access roads. Surface water run-off is discharged into the ground via an infiltration tank hence there is no discharge to the lake.

Catchment B has a gross area of 0.25ha comprising of the roof area from one residential block, a parking area, access road and landscaped areas. The surface water run-off is discharged to the lake at a controlled rate of 1l/s. SuDS features, including permeable paving, a rain garden and detention pond are used to provide storage and water quality benefits.

The foul water from the proposed development is conveyed via a gravity network to connect to the existing combined sewer within the site at MH15. This conveys flows to the existing Thames Water foul water sewer running with Riverside Drive. The proposed discharge rate for foul water is 11.4l/s.

At the next stage of the project, the following actions/surveys will be required to develop the design:

- Environment Assessment Form to be undertaken to analyse the impact of discharging water from site on the ecology of the lake.
- Maximum groundwater levels to be confirmed for site to check proper functionality of infiltration system.

Appendix A. Design Assessment Checklist

A.1. Delivering SuDS in Richmond

	SuDS Manual Page Ref*	Y	N	Summary of details	Comments / Remedial actions
PRINCIPLES					
Is the runoff managed at or close to its source, wherever possible? If not, give reasons.	3	Y		Green roofs and permeable paving are used to manage runoff to its source.	
Is the runoff managed at or close to the surface, wherever possible? If not, give reasons e.g., infiltration systems are being used to manage the runoff.	3	Y		Runoff from Catchment A is completely infiltrated through underground tank.	
Where the drainage system serves more than one property, is public space used and integrated with the drainage system in an appropriate and beneficial way? If not, give reasons.			N	Serves only one property. Public space is not used.	
Have the opportunities afforded by the drainage system in terms of green infrastructure, biodiversity, urban design, climate adaptation and amenity provision been maximised?	3	Y		Green roof, rain garden, permeable paving, filter drain, and detention pond provide amenity and biodiversity. (See Section 3.3.8)	Infiltration tank is provided to promote the multifunctional use of space, by allowing the surface about the tank to be amenity facilities.
Has an appropriate SuDS Management train been provided	18	Y		Water quality has been assessed by considering a sequence of water travelling through permeable paving before entering a detention basin to mitigate (See Table 4.4)	
Are the operating and maintenance requirements of the drainage system adequately defined?	3	Y		Provided in the strategy (see section -4.0)	
Is operation and maintenance achievable at an acceptable cost?	3	Y		Conventional SuDS components have been proposed, where possible using open structures to avoid cost implications. Refer to section 4 for operation and maintenance details.	
POINT OF DISCHARGE					
Does the design meet the following discharge hierarchy 1. Infiltration is preferred where it is safe and acceptable to do so; 2. If infiltration is not possible discharge to water course; 3. Discharge to sewer as last resort.	16	Y		Runoff from Catchment A is completely infiltrated. Catchment B discharge into water course is provided as infiltration is not possible. See Section – 3.3.1 for details	Infiltration is not suitable on the east of the site as per trial hole results
If infiltration is used: Confirm that an acceptable infiltration assessment has been undertaken and submitted?	16	Y		Infiltration testing completed as a part of ground investigation in accordance BRE365. Refer to section 2.4.1	

If discharge is to sewer, rather than a surface water body, provide justification.	16		N	Surface water is not proposed to discharge into the sewer	
If discharge to a sewerage asset is proposed, has evidence been provided that the design criteria have been agreed with the sewerage undertaker and that an appropriate connection detail has been agreed?	12		N	Surface water is not proposed to discharge into the sewer	
Have adequate and appropriate exceedance routes been provided and are they protected from future development?	9,11	Y		Any exceedance from the site would flow away from the buildings, following the topography of the land, until flowing into the existing lake.	
INTERCEPTION					
Does the scheme design demonstrate on-site retention of approximately the first 5mm of runoff from impermeable surfaces for most events? How is Interception to be delivered (e.g., infiltration, green roofs, permeable pavements, vegetated surfaces, bespoke design - provide details)?	12	Y		For the areas where we are using infiltration, this can be achieved. For the surrounding areas this cannot be achieved as the ground conditions are not suitable.	
PEAK FLOW RATE CONTROL					
Does the design demonstrate control of the 1-year, critical duration site event to the equivalent 1-year greenfield peak flow rate or below?	17		N	(See section 3.3.2)	
Does the design demonstrate control of the 100-year, critical duration site event to the equivalent 100year greenfield peak flow rate or below?	17		N	(See section 3.3.2)	
Do the design calculations take account of future development (urban creep) and climate change?	16	Y		Climate change allowance of 40% is used. A 10% urban creep considered for design. (See Section 3.2.1)	
VOLUMETRIC CONTROL (FOR THE 100 YEAR, 6 HOUR EVENT)					
Does the design demonstrate that, for the 100-year 6-hour event: The discharged site runoff volume is not greater than the equivalent greenfield runoff volume? Or: The discharged site runoff volume over and above the equivalent greenfield runoff volume (i.e. the Long Term Storage Volume) is discharged at a rate < 2 l/s/ha (or another rate that is considered acceptable in not negatively impacting flood risk of the receiving water body) Or: Peak flow rates from the site are restricted to 2 l/s/ ha or Qbar, whichever is the greater ha (or another rate that is considered acceptable in not negatively impacting flood risk of the receiving water body).	17		N	Maximum discharge rate of 1l/s proposed from site. Qbar for catchment B is 0.37l/s. The discharge rate is a close as practical for the requirements, at 1l/s. Designing for compliance would result in maintenance issues in terms of blockage etc. Refer to Section 3.3.2.	
WATER QUALITY TREATMENT					

Is the receiving water body (surface or groundwater) environmentally sensitive (E.g., Groundwater Source Protection Zone? What is its designation? Are any implications for drainage design clearly defined	6	Y		No groundwater source protection zone identified for site area. Please refer to Section 2.4.2	
Does the design include an appropriate treatment strategy that ensures: 1. Sediment is trapped and retained on site in accessible and maintainable areas? 2. Has a sufficient number of drainage components been provided in series prior to discharge? 3. Suitable pollution removal capability e.g., % TSS removal (where this is a requirement of the SAB)	6	Y		See Section 3.3.5	
FUNCTIONALITY					
Are the design features sufficiently durable to ensure structural integrity over the system design life (residential 100 years and commercial 60 years), with reasonable maintenance requirements?	13	Y		A minimum cover depth of 0.6m has been provided for non-traffic areas with casing and appropriate bedding to be provided to pipes. See Section 3.2.2.3	
Are all parts of the SuDS system outside any areas of flood risk? If not, provide justification and evidence that performance will not be adversely affected.	13	Y		All SuDS features are outside flood risk areas.	
Is pumping a requirement for operation of the system? If yes, provide justification and set out operation and maintenance/adoption arrangements.	20		N	N/A	
Has runoff and flooding from all sources (both on and off site) been considered and taken into account in the design?	13	Y		Surrounding areas fall away from the site due to the topography so this does not need to be considered.	
Are 1 in 30-year flows fully conveyed within the SuD system?	12	Y		See Section 3.2.2	
Are 1 in 100-year flows contained or stored on-site within safe exceedance storage areas and flow paths? Note some approving authorities may require greater return periods.	12	Y		See Section 3.2.2	
CONSTRUCTABILITY					
Has an acceptable construction method statement been submitted and approved?			N	This will be provided at a later stage of design process.	
MAINTAINABILITY					
Has an acceptable Maintenance Plan been submitted and approved?	3		N	This will be provided at a later stage of design process.	
INFORMATION PROVISION					
Do the design proposals include sufficient provision for community engagement and awareness raising?		Y		The site is secure and private so limited opportunity to engage with community. Information/signage can be provided to improve awareness of SuDS.	

Appendix B. CIRIA C697 The SuDS Manual

B.1. CIRIA C697 Table 5.2 Land Use Selection Matrix

SuDS group	Technique	Low density	Residential	Local roads	Commercial	Hotspots	Construction Site	Brownfield	Contaminated land
Retention	Retention pond	Y	Y	Y_1	Y_2	Y_2	Y_3	Y	Y_2
	Subsurface storage	Y	Y	Y	Y	Y	Y_3	Y	Y
Wetland	Shallow wetland	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Extended detention wetland	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Pond/wetland	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Pocket wetland	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Submerged gravel wetland	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Wetland channel	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
Infiltration	Infiltration trench	Y	Y	Y_1	Y_2	N	N	Y	Y_4
	Infiltration basin	Y	Y	Y_1	Y_2	N	N	Y	Y_4
	Soakaway	Y	Y	Y_1	Y_2	N	N	Y	Y_4
Filtration	Surface sand filter	N	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Sub-surface sand filter	N	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Perimeter sand filter	N	N	Y_1	Y_2	Y_2	N	Y	Y_2
	Bioretention/filter strip	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
	Filter trench	Y	Y	Y_1	Y_2	Y_2	N	Y	Y_2
Detention	Detention basin	Y	Y	Y_1	Y_2	$Y_{1,2}$	Y_3	Y	Y_2
Open channels	Conveyance swale	Y	Y	Y_1	Y_2	Y_2	Y_3	Y	Y_2
	Enhanced dry swale	Y	Y	Y_1	Y_2	Y_2	Y_3	Y	Y_2
	Enhanced wet swale	Y	Y	Y_1	Y_2	Y_1	Y_3	Y	Y_2
Source control	Green roof	Y	Y	N	Y_2	Y	N	Y	Y
	Rainwater harvesting	Y	Y	N	Y_2	N	N	Y	Y
	Permeable paving	Y	Y	N	Y_2	Y_1	N	Y	Y_2

Y: Yes N: No

1 May require two treatment train stages, depending on type and intensity of road use and receiving water sensitivity.

2 May require three treatment train stages, depending on receiving watercourse sensitivity.

3 Will require draw-down and rehabilitation following construction activities, prior to use as a permanent drainage system.

4 Providing designs prevent mobilisation of contamination.

B.2. CIRIA C697, Table 5.4 Site Characteristics Selection Matrix – Catchment B

SuDS group	Technique	Soils		Area draining to a single SuDS component		Minimum depth to water table		Site slope		Available head		Available space	
		Impermeable	Permeable	0 - 2ha	>2ha	0 - 1m	>1m	0 - 5%	>5%	0 - 1m	1 - 2m	Low	High
Retention	Retention pond	Y	Y_1	Y	Y_5	Y	Y	Y	Y	Y	Y	N	Y
	Subsurface storage	Y	Y	Y	Y_5	Y	Y	Y	Y	Y	Y	Y	Y
Wetland	Shallow wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Extended detention wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Pond/wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Pocket wetland	Y_2	Y_4	Y_4	N	Y_2	Y_2	Y	N	Y	Y	Y	Y
	Submerged gravel wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Wetland channel	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
Infiltration	Infiltration trench	N	Y	Y	N	N	Y	Y	Y	Y	N	Y	Y
	Infiltration basin	N	Y	Y	Y_5	N	Y	Y	Y	Y	N	N	Y
	Soakaway	N	Y	Y	N	N	Y	Y	Y	Y	N	Y	Y
Filtration	Surface sand filter	Y	Y	Y	Y_5	N	Y	Y	N	N	Y	N	Y
	Sub-surface sand filter	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y
	Perimeter sand filter	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*Y*	*N*	*Y*	*Y*	*Y*	*Y*
	Bio-retention/filter strip	Y	Y	Y	N	N	Y	Y	N	Y	Y	N	Y
	Filter trench	Y	Y_1	Y	N	N	Y	Y	N	Y	Y	Y	Y
Detention	Detention basin	Y	Y_1	Y	Y_5	N	Y	Y	Y	N	Y	N	Y
Open channels	Conveyance swale	Y	Y	Y	N	N	Y	Y	N_3	Y	N	N	Y
	Enhanced dry swale	Y	Y	Y	N	N	Y	Y	N_3	Y	N	N	Y
	Enhanced wet swale	Y_2	Y_4	Y	N	Y	Y	Y	N_3	Y	N	N	Y
Source control	Green roof	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
	Rainwater harvesting	Y	Y	Y	N	Y	Y	Y	Y	Y			
	Permeable paving	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y

Y: Yes N: No

1. With liner
2. With surface baseflow
3. Unless follows contours
4. With liner and constant surface baseflow, or high ground water table
5. Possible, but not recommended (implies appropriate management train not in place)
6. Where high flows are diverted around SuDS component.

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B.3. CIRIA C697, Table 5.4 Site Characteristics Selection Matrix – Catchment A

SuDS group	Technique	Soils		Area draining to a single SuDS component		Minimum depth to water table		Site slope		Available head		Available space	
		Impermeable	Permeable	0 - 2ha	>2ha	0 - 1m	>1m	0 - 5%	>5%	0 - 1m	1 - 2m	Low	High
Retention	Retention pond	Y	Y_1	Y	Y_5	Y	Y	Y	Y	Y	Y	N	Y
	Subsurface storage	Y	Y	Y	Y_5	Y	Y	Y	Y	Y	Y	Y	Y
Wetland	Shallow wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Extended detention wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Pond/wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Pocket wetland	Y_2	Y_4	Y_4	N	Y_2	Y_2	Y	N	Y	Y	Y	Y
	Submerged gravel wetland	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
	Wetland channel	Y_2	Y_4	Y_4	Y_6	Y_2	Y_2	Y	N	Y	Y	N	Y
Infiltration	Infiltration trench	N	Y	Y	N	N	Y	Y	Y	Y	N	Y	Y
	Infiltration basin	N	Y	Y	Y_5	N	Y	Y	Y	Y	N	N	Y
	Soakaway	N	Y	Y	N	N	Y	Y	Y	Y	N	Y	Y
Filtration	Surface sand filter	Y	Y	Y	Y_5	N	Y	Y	N	N	Y	N	Y
	Sub-surface sand filter	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y
	Perimeter sand filter	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*Y*	*N*	*Y*	*Y*	*Y*	*Y*
	Bio-retention/filter strip	Y	Y	Y	N	N	Y	Y	N	Y	Y	N	Y
	Filter trench	Y	Y_1	Y	N	N	Y	Y	N	Y	Y	Y	Y
Detention	Detention basin	Y	Y_1	Y	Y_5	N	Y	Y	Y	N	Y	N	Y
Open channels	Conveyance swale	Y	Y	Y	N	N	Y	Y	N_3	Y	N	N	Y
	Enhanced dry swale	Y	Y	Y	N	N	Y	Y	N_3	Y	N	N	Y
	Enhanced wet swale	Y_2	Y_4	Y	N	Y	Y	Y	N_3	Y	N	N	Y
Source control	Green roof	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
	Rainwater harvesting	Y	Y	Y	N	Y	Y	Y	Y	Y			
	Permeable paving	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y

Y: Yes N: No

7. With liner
8. With surface baseflow
9. Unless follows contours
10. With liner and constant surface baseflow, or high ground water table
11. Possible, but not recommended (implies appropriate management train not in place)
12. Where high flows are diverted around SuDS component.

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