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STATION HILL, READING PHASE 1 DRAINAGE STRATEGY AND SUDS REPORT

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1. INTRODUCTION

1.1 Objective

The objective of this document is to provide a detailed description of foul and surface water drainage systems for Phase 1 of the proposed development at Station Hill, Reading RG1 1NF, Grid Reference (GR): N 471370, E 173710. Phase 1 (Plots E and F), comprising land between Friar Street (south) and Garrard Street (north), bisected by Friars Walk. The proposed Block E is situated to the west of Friars Walk, and Block F to the east.

This report is submitted in support of Planning Condition 21 and Reserved Matter no.3. It references the proposed drainage strategy principles set out in the Flood Risk Assessment (Ref. CIV13174 ES 003) prepared by Waterman in March 2013. The report further references the revised surface water drainage strategy summarised in the Storm Water Drainage Strategy report prepared by Hoare Lea dated 13 July 2015.

The document is to be presented to key project stakeholders to confirm that they understand the current proposals and are in agreement that the philosophy will be adopted during future design phases. The document is prepared in support of the Planning Application, and thereon the development of the scheme.

1.2 Constraints and Limitations

This report has been prepared for exclusive use by Lincoln MGT for the purpose of explaining the proposed drainage strategy and associated constraints and opportunities that have been integrated within this development. The information presented in this report is based on the information outlined in the sections below.

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2. SITE INFORMATION

2.1 Records Review

The key reports and websites reviewed as part of this study are listed in Table 2.1, below.

Table 2.1 – Key Documents and Reports

Title	Author	Date
Site Topographical Survey	Plowman Craven	21 September 2018
Utility Search Report / Survey (Ref. PK/40652-001)	Plowman Craven	30 October 2018
Block E & F Layout Drawings	CallisonRTKL	27 November 2018
Flood Risk Assessment (Ref. CIV13174 ES 003)	Waterman	March 2013
Storm Water Drainage Strategy	Hoare Lea	13 July 2015
Contaminated Land Desk Study Document	Ramboll	October 2018
Party Wall Below Ground Drainage Report (Ref. 1620004716-SHR-RAM-RP-C-000001)	Ramboll	28 February 2019

2.2 Consultation

Following initial discussion with Thames Water, a pre-planning application was submitted outlining the principles of the proposed drainage strategy. At the time of writing a response to the submitted pre-planning application is pending. However, Thames Water indicated that the outfall connections proposed appear satisfactory, subject to further assessment by Thames Water on receipt of the detailed design information at the following design stage.

The Lead Local Flood Authority, Reading Borough Council, has been contacted to obtain their comment on the proposed drainage strategy. The Lead Local Flood Authority has stated in email correspondence dated 12 February 2019 that they have no objection in principle to the proposal considering an allowance of 40% for climate change and the pre-development rates previously agreed.

An existing services survey was undertaken by Plowman Craven in October 2018. A separate report has been prepared by Ramboll assessing the impact of the proposed development on existing services in the site boundary, and adjacent to the development site. Further discussions are required with statutory utility companies assess the existing services strategy, i.e. water, gas and electrical system. This assessment to be undertaken by others.

Where identified in the existing foul and surface water report prepared by Ramboll, existing services, identified as relevant, are to be maintained live for the duration of the proposed works and following completion. Several existing drainage connections from the adjacent site has been identified to be included in the proposed surface and foul water drainage strategy.

It is proposed to develop a foul and surface water drainage strategy utilising Thames Water manholes in Garrard Street, Friar Street and Merchants Place. New connections are proposed to the existing large diameter Thames Water foul water sewer to the north of Garrard Street, and a new connection to the existing Thames Water surface water sewer in Garrard Street.

It is assumed that the foul water drainage will outfall unattenuated to the aforementioned Thames Water infrastructure. Surface water flows will be attenuated to pre-development discharge rates previously agreed with Thames Water as outlined in the Storm Water Drainage Strategy report prepared by Hoare Lea, dated 13 July 2015, appended to this report for information.

2.3 Site Topography and Geology

The brownfield site that forms Phase 1 of the proposed development is located to the south of Station Hill, Reading, and comprises the disused Telecoms House and the Friars Walk Shopping Centre, currently used as a Zombie experience setting, and several small retail outlets.

The overall site area for Phase 1 and Phase 2 is circa 2.56 ha. However, for the purpose of this Drainage Strategy report, only the Phase 1 development site including an area of 0.9 ha is considered.

The topography of the site generally ranges in levels from circa 39.0m AOD in Garrard Street to the north, and circa 45.7m AOD in Friar Street to the south. Site levels fall toward the northwest of the site.

Figure 2.1 – Site Extents of Phase 1



Extract from CRTKL drawing SHR-CRL-SB-00-DR-A-113-103-9

2.4 Surface Waters

The River Thames and river Kennet are located in close proximity to the site, with the Thames approximately 420m to the northwest and the Kennett approximately 500m southeast of the development site.

The Environment Agency (EA) website has been interrogated to determine the hydrogeology of the area. The EA classifies the Alluvium and Taplow Gravel Formation as Secondary A aquifers and the Upper Chalk formation as a Principle Aquifer.

The EA¹ defines these as follows;

Principal Aquifer: *layers of bedrock or drift deposits with high intergranular and/or fracture permeability able to provide a high level of water storage. These aquifers may support water supply and/or river base flow on a strategic scale.*

Secondary A Aquifer: *permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.*

Although the site is not located within a Source Protection Zone, 12 groundwater extraction sites were recorded within a 1km radius of the development site. The closest borehole is 0.16km southwest of the development, and is understood to be used as drinking and washing water.

2.5 Ground Conditions and Groundwater

The geology of the site comprises superficial deposits of Alluvium and Taplow Gravel Formation, underlain by the Upper Chalk Formation. The upper layers of the Upper Chalk Formation comprise variable and significant thicknesses of Structureless Chalk.

Shallow groundwater was found within the Alluvium, Taplow Gravel Formation and Upper Chalk Formation, at depths between 2.7m bgl and 5.3m bgl, usually at or near the boundary of the Alluvium and Taplow Gravel Formation, or within the Structureless Chalk when the other forms of geology were absent.

The storm water attenuation tanks serving the proposed site will be located above the ground water table and is not expected to increase the risk of ground water flooding. The proposed invert level of the lowest attenuation tank proposed to the north of Phase 1 of the development is 37.7m AOD. From ground water monitoring the ground water levels encountered were between 2.15m bgl and 2.75m bgl, corresponding to 36.07m AOD and 36.44m AOD. Isolated perched groundwater bodies may also be present within parts of the Made Ground or Fill.

As advised in Sustainable Design and Construction Supplementary Planning Guidance, where the ground water is close to the surface, special considerations must be given when designing drainage systems such as inclusions of SuDS, soft landscaping as well as provision of adequate drainage. These parameters were all taken into consideration and implemented in the drainage strategy.

¹ From Environment Agency website, accessed 06 December 2018

2.6 Existing Site Foul and Surface Water Drainage

As discussed above, the development site comprises the disused Telecomms Building and Friars Walk Shopping Centre, including several small retail outlets. The shopping centre is currently being used as a leisure destination (Zombie experience).

From Thames Asset maps, included in Appendix 4, and a separate report discussing existing drainage systems, several existing drainage sewers were identified in Garrard Street, Merchants Place and Friar Street. The demolition of the existing buildings is covered under a separate application.

A large diameter foul water sewer north of Garrard Street is noted on the Thames Water Asset Plan as 1100 x 750, depth and condition unknown. The foul water sewer in Friar Street and Merchants Place are noted as 225mm diameter and 150mm diameter, respectively.

The existing surface water sewers in Garrard Street and Friar Street is noted on the Thames Water asset plans as 375mm diameter and 225mm diameter, respectively, depth and condition unknown.

The site-wide drainage assessments and recommendations of this report are based on the information provided below;

- Architectural General Arrangements by CallistonRTKL

2.7 Existing Drainage Consideration

The existing foul and surface water drainage from the proposed development site is assumed to discharge into below ground public sewers within Garrard Street and Friar Street. A conditional site investigation and associated CCTV survey works were undertaken to validate and identify the existing utility sewage drainage infrastructure on, and adjacent to, the site, particularly to identify the location of discharge points for both Foul and Surface Water systems. The findings of this survey are included in a separate report entitled Party Wall Below Ground Drainage Report (ref. SHR-RAM-XX-XX-RP-C-000001), dated 28 February 2019.

The total development comprising Phase 1 and Phase 2 is circa 2.56 ha, of which the northern site, identified as Phase 2, will be developed under a separate planning application. The Phase 1 application site boundary includes an area to the south of Garrard Street approximately 0.9 ha. 0.9 ha was used for all hydraulic network calculations and greenfield/brownfield run-off estimates.

The existing peak foul water discharge rate from existing buildings are not known. For the purpose of this Drainage Strategy report, peak flow discharge was estimated based on the gross internal floor area (GIA). Estimating a GIA circa 25,680 m² for assumed office and amenity use, the existing peak flow discharge was estimated.

Existing Land-use	No. Floors (Approx.)	Area (m ²)	Land Use	Approx. Peak Foul Water Discharge (l/s)
Telecoms House	Basement Level 1	1,510	Office	1.75
	Basement Level 2	1,370	Office	
	Ground Floor	1,570	Office	
	First Floor	1,840	Office	
	Basement	4,730	Retail	2.69

Existing Land-use	No. Floors (Approx.)	Area (m ²)	Land Use	Approx. Peak Foul Water Discharge (l/s)
Friars Walk Shopping Centre	Ground Floor	5,270	Retail	
	First Floor	5,190	Retail	
	Second Floor	2,290	Retail	
	Third Floor	1,360 (350 + 1,010)	Office	
	Fourth Floor	550	Office	
			Total (l/s)	4.44

The existing peak foul water discharge rate into the public sewer from the site has been calculated as 4.4l/s, based on GIA in accordance with Sewers for Adoption (7th Edition).

- Surface Water - The greenfield run-off calculated using Micro-Drainage Quick Storage calculation returned a surface water discharge from the site (area 0.9 ha) approximately 0.3l/s. Given the extent of the development site located on brownfield site, it is not considered feasible using the calculated greenfield run-off rate. Therefore, the discharge from the site will be limited as discussed in Section 2.10 of this report.

For reference, brownfield run-off was estimated using Modified Rational Method for 0.9 ha site and rainwater intensity of 76mm/hr. The calculated runoff is 190 l/s:

$Q = 2.78 CiA$, where

C = permeable coefficient, taken as 1

i = rainfall intensity (mm/hr), taken as 76mm/hr

A = area (ha), taken as 0.9 ha

2.8 Existing Site Constraints with Public Sewers

Existing drainage connections with public sewers will be retained and utilised where possible to avoid the need for any excavation near existing services and in public highway. The precise size, location and levels are subject to verification and confirmation from intrusive CCTV survey investigations.

The ability and suitability of on-site infiltration of surface water was discounted given the extent of development proposed, which includes a podium level with two levels of basement car park below that. It is intended that surface water run-off from the development site would be attenuated in below ground storage tanks.

2.9 Stakeholder Consultations

Thames Water

Following initial communication with Thames Water, a Pre-Planning application was submitted detailing the potential outfall locations to the existing Thames Water drainage network. The application enables Thames Water to carry out a capacity assessment of the connections proposed from the development to the existing Thames Water sewers adjacent to the proposed development site. The pre-planning application included options to re-use existing connections into the public sewer network where such arrangements are found to be of a suitable size, location, condition and level for re-use, as well as new connection to existing Thames Water

sewers. The purpose of this application is to verify and establish capacity available in the existing public sewers to accommodate the proposed discharge from the development site.

In a previous section of this report, assessing the greenfield run-off rate at the proposed development site, it was not considered feasible to restrict the surface water discharge from the development site to greenfield rates. It is proposed that surface water run-off is restricted to the proposed pre-development run-off rates agreed in the Storm Water Drainage Strategy prepared by Hoare Lea, dated 13 July 2015. Surface water run-off will be attenuated on-site prior to discharging, at the restricted peak discharge rate, into the existing Thames Water outfalls.

The foul water drainage from the development site is proposed to be discharged unattenuated into existing Thames Water outfalls.

The proposed surface water and foul water connections to the Thames Water sewers will need to be confirmed with the Lead Local Flood Authority and Thames Water, NPPF guidelines and referenced within Reading Borough Council guidance on flooding and climate change. Confirmation of the public sewer for capacity to cater for the proposed foul and surface water rates from the proposed development is required.

2.10 Proposed Surface Water Drainage

The proposed drainage strategy is based on the discharge rates agreed in the Storm Water Drainage Strategy produced by Hoare Lea, dated 13 July 2015; Block E 42.47 l/s and Block F 20.16 l/s. It is proposed that the surface water run-off is attenuated in below ground cellular storage tanks prior to discharging into the existing Thames Water sewerage network. The discharge from the attenuation structures will be restricted prior to discharge.

The precise outfall locations and connection details, where and if new outfalls are required, will be agreed with Thames Water as part of the detailed design stages as necessary.

The peak discharge rate for the proposed development for 1 in 100-year return period will include an allowance for climate change in accordance with the guidance published in NPPF 2012. The considered national standard approach of 40% allowance due to climate change has been considered in the design at this stage

The Industry standard Micro-Drainage software, version 2018.1, has been used to model the site in its geographical location. Refer to Appendix 3 for the relevant calculation reference documents.

Please refer to the table below for the proposed surface water flow rates.

Storm Event	Q _{1 year}	Q _{bar}	Q _{30 year}	Q _{100 year}
Discharge Rates (l/s)	0.3	0.3	0.8	1.1
Block E Quick Storage Estimate (m ³) = 223				
Block F Quick Storage Estimate (m ³) = 94				

The proposed attenuation storage systems located at the northern and southern parts of the development site will collect water from rain water pipes and external landscaped areas. Where found as part of the assessment carried out to produce the Party Wall Below Ground Drainage Report (ref. SHR-RAM-XX-XX-RP-C-000001), surface water drainage from identified existing adjacent structures will be considered as part of the development site drainage strategy.

For proposed connections into the existing public sewers, application will be made to Thames Water under a Section 106 Consent to Discharge application of the Water Industry Act 1991, at later detail design stage.

The Sustainable Design and Construction Supplementary Planning Document, adopted July 2011, does not specifically advise a value for climate change and instead advocates climate change principles in accordance with the NPPF – 40% climate change was used as per flood risk assessment guidance.

Following hydraulic modelling, no surcharging occurs in the 1:5 storm event, and no flooding occurs for 1:30, 1:100 and 1:100+40% CC storms.

The hydraulic surface water and storm analysis undertaken ensures that the Non-Statutory Standards for Sustainable Drainage Systems and flood risk on the site are satisfied and adhered to.

2.11 Proposed Foul Water Drainage

The proposed foul water drainage strategy assumes unrestricted discharge from the development into existing Thames Water sewers in Garrard Street, Friar Street and Merchants Place. The precise location and discharge rate will be confirmed with Thames Water as part of the pre-development enquiry and application, at later detail design stages.

Based on the layout, the peak foul water discharge was calculated in accordance with BS EN 12056 Part 2, for residential units in the table below. The calculations were undertaken by others as part of the above ground drainage design. At the time of writing this report, the same for the retail component was not known, and an assessment made based on the area of retail space and anticipate use. An unattenuated foul water discharge rate was assumed, based on the information provided in the Waterman FRA (Ref. CIV13174 ES 003) dated 2013. Refer to Appendix 2 for the foul discharge calculation reference documents.

	Plot E	Plot F
Residential Units	370	168
Commercial Uses	Flexible Retail (Class A1-A5)	Flexible Retail (Class A1-A5) and Assembly & Leisure (Class D2)

It is envisaged that all building drainage will discharge to ground level, via gravity, to private external foul water networks, prior to discharging via gravity off site to the existing Thames Water public sewers.

2.12 SuDS Analysis

Surface water drainage systems need to be developed in line with sustainable development collectively referred to as Sustainable Urban Drainage Systems (SuDS). The objective of SuDS is to minimise the impact of the development on the quantity and quality of site run-off and maximise amenity and biodiversity opportunities. Surface water sustainable drainage systems will be designed and installed in accordance with current National Planning Policy Frameworks (NPPF) requirements and Planning Policy Statement 25 (Note: Retracted, but still referenced PPS25) and associated CIRIA 521, 522, 523, 625, 626, 609, 697 and 753, and associated reference documents.

It has been calculated that the proposed combined attenuation system will require circa 317m³ of attenuation storage volume design to contain a 1 in 100 year 24hr storm event (including 40% allowance for climate change) without causing any flooding on site. The attenuation volume is based on the proposed hardstanding areas being drained at a restricted discharge rate (as agreed in the Hoare Lea Storm Water Drainage Strategy dated 13 July 2015). The required storm water attenuation storage can be provided by means of pipework/manhole chambers and attenuation tanks. The following attenuation medium and volumes have been identified;

- Below ground attenuation tanks (3no. tanks proposed)
- Oversized pipes (supplementing the attenuation tanks), where required

Phase 1 Development Site	Attenuation Storage Type	Attenuation Storage Volume (m ³) ²
Block E (North), including external area	Storage tank (cellular units, or similar)	107
Block E (South), including part of Friars Walk and external area	Storage tank (cellular units, or similar)	116
Block F, including part of Friars Walk and part of external area	Storage tank (cellular units, or similar)	94

The gravity drainage system will convey surface water to the storm water management and attenuation systems. These systems will manage the flow which will be restricted by means of a control device, such as an orifice plate, prior to discharging off-site by gravity into the Thames Water public sewerage network.

The total impermeable area for the site identified in the SuDS analysis report is 0.9 ha. Further hydraulic modelling in the following design stages is required to determine the precise network capacity and surface water attenuation volumes. The hydraulic analysis and modelling criteria for the surface water drainage design to be undertaken at detailed design stage is;

- FSR Rainfall Data
- M5-60(mm) – 18.9
- Ration (R) – 0.40
- Climate Change (CC) – 40% for 1 in 100-year return period
- Area (ha) – 0.9ha (planning area with 100% PIMP)
- Maximum Allowable Discharge – Block E 42.47 l/s and Block F 20.16l/s

The above criteria are to be input into the industry standard, MicroDrainage hydraulic modelling Software;

- To achieve the pre-development run-off rates previously agreed, a sustainable urban drainage system is proposed, and drainage hierarchy is followed as outlined in the Lead Local Flood Authority's guidance. Current SuDS measures include attenuation tanks. The benefit of the tank system is mainly a flood reduction. This clearly is in line with Sustainable Design and Construction Supplementary Planning Guidance.

² Subject to detail design at following works stage

3. LEGISLATION

Design Standards and Criteria

It is proposed that all below ground surface and foul water drainage from the development site will be collected in separate gravity drainage networks and discharged off site to the existing Thames Water sewerage network in Garrard Street (for Block E (north) and Block F (north)), Friar Street (for Block E (south)), and Merchants Place (Block F (south)). The precise location and levels of the existing sewerage network and outfall systems are subject to verification and confirmation from intrusive CCTV survey investigations.

The proposed surface water and foul water drainage networks will be designed and installed to achieve self-cleaning velocity. Flows will generally be kept above 0.75m/s and 1 m/s, respectively, within the pipelines to ensure that self-cleaning velocities are achieved. This is subject to the condition, location and level of the existing off-site below ground drainage and sewerage network.

The development will be drained by dedicated and fully segregated surface and foul water systems designed in accordance with the following documents (where appropriate);

- Building Regulations - Approved Document Part H;
- BS EN 12056: Parts 1-5: Gravity Drainage Systems Inside Buildings
- BS EN 752: Drain and Sewer Systems outside buildings
- Sustainable Drainage Systems - Design manual for England and Wales (CIRIA)
- Sewers for Adoption - 7th edition
- BS 8000-14: Workmanship on Building Sites: Code of Practice for Below Ground Drainage
- The Local Authorities guidelines, rules and regulations (such as Lead Local Flood Authority Representative (LLFA)).
- Sustainable Design and Construction Supplementary Planning Guidance, April 2014
- Non-statutory Technical Standards for Sustainable Drainage Systems, S5 and S6
- Reading Borough Council (Lead Local Flood Authority) requirements.

To give a long design life, with minimum embodied energy, the buried pipework will generally be;

- Vitrified clay, where possible; and
- Cast iron when laid below or cast within or through foundations or building structures.

Chambers will generally be either (subject to availability of space);

- Polypropylene inspection chambers (if less than 1.2m to invert level), or
- Pre-cast manholes (if deeper than 1.2m to invert and in areas subject to vehicle over-run)
- In-situ concrete manholes (cast within the basement slab in basement car parking level)
- Non-entry polypropylene inspection chamber will be used, where required, up to a depth of 3.0m.

Pipe diameters will generally be as follows;

- Foul water drainage – DN150 to minimise the risk of blockage; and
- Connections from appliances and stacks – DN100 to maintain self-cleansing flows.

The actual below ground drainage sizes will be determined once the flow rates are available from building services engineers, during the design development stages.

4. SITE AND PROJECT CONSTRAINTS

Table 4.1 below, details the site-specific constraints which have been evaluated in order to determine the most appropriate drainage solution. Where elements are yet to be fully considered, this is noted alongside any additional comments. If the constraints lead to a specific risk, this have been highlighted and transferred to the Risk Register within Section 6.

Table 4.1 – Site and Project Constraints

Site / Project Constraints	Potential Impact on Development	Considered in Current Drainage Strategy	Comments	Linked to Risk Register
Environment				
Sensitive environmental receptors	Restrictions on foul and surface water discharge location and quality; inclusion of additional polishing techniques such as separators, reed beds etc.	Yes/No	Discharge is to local utility sewerage systems.	Yes/No
Presence of contamination	Restricts the use of infiltration for surface water disposal	Yes/No	Proposed drainage strategy comprises attenuation storage – no infiltration considered.	Yes/No
Presence of shallow aquifers	Restricts the use of infiltration for surface water disposal	Yes/No	Shallow groundwater in some locations of the site are present.	Yes/No
Presence of nearby watercourses	Restrictions on discharging water quality	Yes/No	Discharge to nearby watercourses not considered. Discharge to existing Thames Water sewers	Yes/No
Flood zone/flood relief areas	Limitations on SUDS systems that can be used (retention of attenuation capacity during flood events)	Yes/No	Known high water table and sensitivity requires significant storm water management and control.	Yes/No
Ground Conditions				

Site / Project Constraints	Potential Impact on Development	Considered in Current Drainage Strategy	Comments	Linked to Risk Register
Infiltrations rates (at required location/depth)	Applicability of infiltration devices for surface water disposal; size of infiltration devices	Yes/No	Proposed drainage strategy comprises attenuation storage – no infiltration considered.	Yes/No
Groundwater level	Restricts infiltration potential; authorities may prevent discharge from potential sources of pollution, i.e. paved areas. Pumping in excavations.	Yes/No	High water table. Location/depth of proposed attenuation structures located above ground water level.	Yes/No
Buried obstructions	May require localised removal within drainage locations or drainage to be re-routed around obstruction	Yes/No	Existing obstructions to be surveyed and where applicable grubbed out and removed.	Yes/No
Existing Infrastructure				
Foul water discharge point locations and invert levels	May require pumping; restrictions on pipe routing (shortest length); additional protection to shallow drains	Yes/No	Levels subject to survey works to be defined during detailed design for the drainage systems.	Yes/No
Surface water discharge point locations and invert levels	May require pumping; restrictions on pipe routing (shortest length); additional protection to shallow drains	Yes/No	Pumping station may be required/proposed. Levels subject to survey works to be defined during detailed design for the drainage systems	Yes/No
Availability of foul water infrastructure nearby	May require 'self sufficiency' i.e. packaged treatment units, reed beds etc.	Yes/No	Existing drainage outfall systems to be utilised for disposal to utility sewerage systems.	Yes/No
Off-site drainage infrastructure capacity	Upgrading of water company assets; use of flow restrictors; additional storage/attenuation	Yes/No	Existing drainage outfall systems to be utilised for disposal to utility sewerage systems. Flows thus assumed capacity is available.	Yes/No
Authority Requirements				
Allowable discharging flow rates	Impacts on volume of attenuation required	Yes/No	Pre-development discharge rates agreed in FRA by Waterman dated March 2013 used (use of greenfield rates not considered feasible for development site) to calculate proposed storm water flows and attenuation capacity. It is proposed that foul flows will discharge off-site unattenuated.	Yes/No

Site / Project Constraints	Potential Impact on Development	Considered in Current Drainage Strategy	Comments	Linked to Risk Register
Allowable discharging flow volumes	Allowable impermeable area/volume of long-term attenuation	Yes/ No	Pre-development discharge rates agreed in FRA by Waterman dated 2013 proposed for storm water flows and attenuation capacity.	Yes/ No
Specific authority requirements	Limits SUDS systems/materials specifications that can be used	Yes/ No	Not advised as any specific requirements from Local Authority.	Yes /No
Easements for services, rivers, critical infrastructure	Reduces available space; restricts drainage element locations	Yes/ No	Known service routes and existing infrastructure does not affect the drainage systems.	Yes/ No
BREAA/CfSH credit requirement	Enhanced restriction of surface water discharge requiring additional controls and increased attenuation	Yes/ No	Attenuation and surface water management targeted for BREEAM Excellent.	Yes/ No
Site Requirements				
Available external area (space for SUDS)	Limits SUDS systems that can be used (low land take)	Yes/ No	Attenuation tanks located below the proposed building.	Yes/ No
Land use (appropriateness for open water)	Limits SUDS systems that can be used (health and safety)	Yes /No	Not considered within development site.	Yes/ No
Traffic level type/volume	Pervious paving foundation thickness	Yes/ No	Infrequent use by traffic; i.e. maintenance and or fire tender access, usage. Loading for access and manoeuvring requires suitable surface and sub-grade arrangements.	Yes/ No
Construction phasing	Position of attenuation; pipe routing; temporary oversizing of elements due to temporary retention of buildings	Yes/ No	Not anticipated as required. Works contractor to programme drainage installations as required.	Yes/ No
Construction hoarding lines/access routes	Position of attenuation; pipe routing	Yes/ No	Not anticipated as required. Works contractor to programme drainage installations as required.	Yes/ No
Future development (i.e. extensions)	Oversizing of elements to provide additional capacity	Yes /No	Proposed development occupies the total site available.	Yes/ No
Need for new outlets/headwalls to watercourses	Additional correspondence (fees) with authorities; construction of headwall to approved standards; issues relating to banks/bed (scour)	Yes/ No	Not applicable.	Yes/ No

Site / Project Constraints	Potential Impact on Development	Considered in Current Drainage Strategy	Comments	Linked to Risk Register
Abnormal foul water discharge requirements (i.e. laboratories)	Separate laboratory waste; chemically and temperature resistant pipework; inclusion of sample chambers; inclusion of grease separators.	Yes/No	Not applicable, domestic foul waste water discharge only.	Yes/No
Retained trees	Limitation in excavation location/depth to prevent root damage	Yes/No	Not applicable, brownfield site (100% impermeable). Details covered in appropriate report with the Application.	Yes/No
Maintenance requirements	Required maintenance regime is not acceptable to client requiring amendments to proposed drainage scheme	Yes/No	Maintenance of drainage and pumping systems (where required) and storm water attenuation tanks required.	Yes/No

5. SURFACE WATER DRAINAGE OPTIONS

The use of sustainable urban drainage systems (SUDS) is mandatory for most new surface water drainage systems within the UK. SUDS can be used as source control (interception of surface water), conveyance, storage and discharge dependent on various site conditions. Table 5.1 below describes many of the SUDS approaches that are available and explains their advantages, disadvantages and appropriateness for use on the proposed development site.

Table 5.1 – Sustainable Urban Drainage (SuDS) Options

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
Retention	Balancing pond		Provides both storm water attenuation and treatment. Runoff from each rain event is detained and treated in the pool. The retention time promotes pollutant removal through sedimentation.	Good removal of pollutants, can be used where groundwater is vulnerable, good community acceptability, high ecological, and amenity benefits.	No reduction in runoff volume, land take may limit use in high density sites.	☐ ☐ ☒ No
	Subsurface storage		Oversized pipes, tank systems and modular geocellular systems that can be used to create a below ground storage structure.	Modular and flexible, dual usage (infiltration/storage, high void ratios, can be installed beneath trafficked and soft landscaped areas.	No water quality treatment.	☒ ☐ ☐ Yes
	Shallow wetland					☐ ☐ ☒

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
Wetland	Extended detention wetland		Wetlands provide stormwater attenuation and treatment. They comprise shallow ponds and marshy areas, covered in aquatic vegetation. Wetlands detain flows for an extended period to allow sediments to settle and to remove contaminants. They can provide significant ecological benefits.	Good pollutant removal and if lined can be used where groundwater is vulnerable. Good community acceptability, ecological and amenity benefits.	Land take is high, requires baseflow, little reduction in runoff volume, not suitable for steep sites.	No
	Pond wetland					
	Pocket wetland					
	Submerged gravel wetland					
	Wetland channel					

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
Infiltration	Infiltration trench Infiltration basin Soakaway		Surface water runoff can be discharged directly to ground for infiltration by soakaways, basins, or trenches. A prerequisite is that both groundwater and ground conditions are appropriate to receive the quality and quantity of water generated.	Reduces the volume of runoff, effective at pollutant removal, contributes to groundwater recharge, simple and cost-effective, easy performance observation.	Requires appropriate pre-treatment, basins require a large flat area, offset from foundations.	☐ ☐ ☒ No – High water table
	Surface sand filter Sub-surface sand filter Perimeter sand filter		Structures designed to treat surface water runoff through filtration using a sand bed filter medium. The filters can be designed with or without infiltration. Temporary storage of runoff is achieved through ponding above the filter layer. They are used where particularly high pollutant removal is required.	Flexibility of design, efficient in removing pollutants, suitable for retrofits and in tightly constrained urban locations.	Not for high sediment content, detention times can support algae growth, minimum hydraulic head of 1.2m required, possible odour problems, high capital and maintenance cost.	☐ ☐ ☒ No – High water table

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
Detention	Bioretention/filter swale		Vegetated strips of land designed to accept runoff as overland sheet flow between a hard-surfaced area and a receiving system.	Landscaping features, effective in removing pollutants, flexible layout to fit into landscape, suited for highly impervious areas, good retrofit capability, effective pre-treatment option	Requires landscaping and management, large land requirement, not suitable for steep sites, no significant attenuation or reduction of flows.	☐ ☐ ☒ X No – High water table
	Filter trench/drain		Shallow excavations filled with rubble or stone that create temporary subsurface storage for filtration of storm water runoff. Receive lateral inflow from an adjacent impermeable surface.	Hydraulic benefits achieved with filter trenches, trenches can be incorporated into site landscaping and fit well beside roads and car parks.	High clogging potential without effective pre-treatment, limited to small catchments, high cost of replacing filter material.	☐ ☐ ☒ X No – Not suitable for development site (land constraints)
	Detention basin		Surface storage basins that provide flow control through attenuation. Normally dry and in certain situations the land may also function as a recreational facility.	Cater for a wide range of rainfall events, can be used where groundwater is vulnerable, potential for dual land use, easy to maintain.	Land take, little reduction in runoff volume, detention depths constrained by levels.	☐ ☐ ☒ X No – Not suitable for development site (land constraints)

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
Conveyance	Enhanced dry swale		Swales are linear vegetated drainage features in which surface water can be stored or conveyed. They can be designed to allow infiltration, where appropriate.	Incorporate into landscaping, good removal of pollutants, reduces runoff rates and volumes, low cost.	Not suitable for steep areas, significant land take, not suitable in areas with roadside parking.	X□□ Yes – Not suitable for development site (land constraints)
	Enhanced wet swale					
	Conveyance swales		Formal linear drainage features in which surface water can be stored or conveyed. They can be incorporated with water features such as ponds or waterfalls where appropriate.	Negate the need for underground pipework. Can provide some attenuation. Possible reduction in runoff volume via plant uptake and infiltration.	Potential trip/wheel hazard, disabled access issues.	□□X No – Space Constraints.
	Rills					
Source control	Green/Brown roof		Multi-layered system that covers the roof of a building with vegetation cover/landscaping over a drainage layer. Designed to intercept and retain precipitation, reducing the volume of runoff and attenuating peak flows.	Mimics greenfield state of building footprint for high density developments, good removal of pollutants, ecological benefits, insulates buildings, sound absorption.	Additional weight, not appropriate for steep roofs, maintenance of roof vegetation.	□□X No – Space Constraints.

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for use at site?
	Rainwater harvesting		Uses rainwater coming from roofs to supply toilets, washing machines and irrigation systems. Harvested rainwater is stored underground and is substituted for potable water mains supply, reducing both site discharge and water consumption.	Can provide source control of storm water runoff, reduces demand on mains water.	Use is dependent on demand requirements, contributing surface area, and seasonal rainfall characteristics	☐ ☐ ☒ X No – Not suitable for development site (land constraints)

6. RISK REGISTER

Table 6.1 below details the site specific drainage related risks which are currently outstanding, and the implication on the project should that risk transpire. The action required in order to mitigate the risk is also stated alongside the proposed owner of that action. Should a 'closed' item retain an agreed residual risk to the client, this will be described within the drainage strategy section and should be included within any operation and maintenance manual documentation.

Table 6.1 – Risk Register

Risk	Implication	Action to close out risk	By	Status
Specialist sub-contractor design input required (i.e. pervious paving)	Late selection of preferred supplier prevents incorporation of proprietary information. May impact on associated elements i.e. kerb setting out, formation levels, drainage connections etc.	Preferred specialist sub-contractor to be nominated/selected during design stage.	Cli/Con	Live/Closed Not applicable
Condition of existing drainage system (recent CCTV surveys complete)	Existing system may require significant remedial works. Routing of pipework may differ from that expected requiring modification to the proposed system.	CCTV survey to be commissioned of proposed retained drains.	Cli/Con	Live/Closed Surveys required
Local Authority approvals	Local authorities may request changes to proposed scheme at planning.	Pre-planning discussions to be held with all relevant Local Authorities, where appropriate.	Ram	Live/Closed
Existing drainage connection point invert levels are different to that anticipated.	Requirement for pumping; shallow drains requiring additional protection; use of backdrops.	Level survey to be undertaken of proposed connection point drainage inverts.	Cli/Con	Live/Closed Surveys required
Movement/addition of foul water drain points	Additional drain runs/manholes required. Possible requirement to pump if distance to discharge point increases.	Frozen above ground drainage layouts to be issued to Ramboll prior to issue of project stage information.	Arch/M&E	Live/Closed Surveys required
Change of legislation during project	Reduced allowable flow rates/volumes leading to greater volumes of attenuation. Change of material specifications.	Ramboll to keep abreast of proposed legislation changes and inform Client, design team of possible implications where appropriate.	Ram	Live/Closed Subject to consultation with Local Authority
Change of building drainage strategy (i.e. move to siphonic rainwater pipes)	Siphonic break manholes/drainage laterals required. Possible need to introduce velocity reducing measures to prevent erosion of SUDS.	Preferred roof rainwater strategy to be agreed and design team informed.	Arch/M&E	Live/Closed Design principles agreed
Client/design team approval of philosophy (i.e. acceptability/inclusion of open water)	Addition/increased volume of below ground attenuation. Lack of SUDS train may require introduction of additional cleansing measures.	Present drainage philosophy to design team and inform client of residual H&S risks, maintenance risks. Obtain Client approval to proceed.	Ram/Cli	Live/Closed Design principles agreed

PHASE 1 DRAINAGE STRATEGY AND SUDS REPORT STATION HILL, READING

Risk	Implication	Action to close out risk	By	Status
Co-ordination with foundations/other below ground services	Additional drain runs/manholes required. Realignment of pipework. Increased embedment of pipework.	Co-ordinated below ground services and foundation drawings to be produced and agreed by design team.	Arch/Ram/M&E	Live/ Closed To be developed as part of detailed design
CBR values lower than anticipated	Increased subbase depth/hydraulically bound subbase required for pervious paving.	CBR testing at proposed pervious paving locations.	Ch/Con	Live/ Closed Site CBR testing required by Contractor
Previously unidentified contamination found on site	Infiltration devices restricted. Drainage philosophy re-evaluated.	Detailed assessment of contamination risk to be undertaken during design stages.	Cli/Con	Live/ Closed
Buried Obstructions	Localised removal required at proposed drainage locations or drainage to be re-routed around obstruction.	Detailed desk study of construction history to be undertaken during design stages. Possible use of geophysical maps.	Cli/Con	Live/ Closed

Action by:

- Client (Cli)
- Contractor (Con)
- Architect (Arch)
- M&E Engineer (M&E)
- Ramboll (RAM)

7. CONSTRUCTION APPROACH

Table 7.1 below details the site specific approach to construction of the below ground drainage system. In order to provide the most cost efficient solution, the preferred design option or material specification for each element of the system has been determined in accordance with Clients and/or contractors requirements.

Table 7.1 – Construction Method

Element	Standard Options	Selected Option
Pipework Below Ground	Clay Plastic Ductile iron HDPE Concrete	Clay Ductile Iron Concrete (300mm dia and above)
Pipework External	Clay Plastic Ductile iron HDP Concrete	Clay Plastic Ductile Iron Concrete (300mm dia and above)
Access chambers	Concrete rings Brick chambers PPIC Reduced access	Concrete rings PPIC
Building Drain Point Connection	Below slab 'y' connections External 'y' connections Connect to internal manholes Connect to external manholes	Below slab 'y' connections External 'y' connections Connect t internal Manholes Connect to external manholes
Repair to existing drainage systems	No re-use of existing drains Localised pipe replacement Pipe lining/patching	No re-use of existing Drains (exception of final outfall systems of-site)
Pipework through foundations/floor slabs	Cast within rafts/ground beams/pile caps Cast below rafts/ground beams/pile caps	Cast below raft/ground Beams/pile caps
Below ground attenuation	Oversized pipework Geocellular modular storage units GRP tanks Gravel filled pits	Oversized pipework Geo-cellular modular storage units
Infiltration devices	Granular pits/trenches Concrete ring chambers Geocellular modular storage units Borehole soakaways	N/A
Pervious Paving Finishes	Interlocking blocks Pervious asphalt Reinforced gravel/grass	N/A
Pipe Bedding	Standard single sized aggregate Recycled aggregate	Standard single size Aggregate Recycled aggregate (Contractors choice)
Significant invert level changes	Backdrops (at what level change) Steep graded pipework	N/A

PHASE 1 DRAINAGE STRATEGY AND SUDS REPORT STATION HILL, READING



Element	Standard Options	Selected Option
Point Drainage Preference	Gullies Channel drains Channel drains at door thresholds	Gullies Channel drains Channel drains at door thresholds
Pump Stations	Preferred supplier Single/dual pumps Storage time period/volume	Single/dual pumps

8. MAINTENANCE REQUIREMENTS OF DRAINAGE COMPONENTS

The long term maintenance of the below ground drainage network within the site boundary is the responsibility of the Estate Management Company.

8.1 Cellular Tanks and Catchpits

Regular Maintenance

- A system of regular inspections should be established to prevent siltation of the system which, if allowed to develop, would reduce effectiveness.
- Inspection of the tank structures should be carried out via the manufacturers inspection regime and on a monthly basis for the first three months following commission. This can then be reduced to once every six months, and following every major storm event.
- The pipe work, gullies, manhole chambers and catch-pits should be inspected on a monthly basis for the first three months following commission. This can then be reduced to once every six months, and following every major storm event.
- Debris removal from the catchment (where may cause a risk to performance) should be undertaken on a monthly basis.

Inspection/Testing

- Inspect all inlets, outlets, vents, overflows and chambers to ensure that they are in good condition and operating as designed.
- Inspect all catch-pit sumps for any sediment, trash, debris and any other pollutant.

Remediation

- Silt accumulation within pipework, gullies, manhole chambers and catch-pits should be removed in order to ensure correct performance of the system.
- Repair inlets, outlets, vents, overflows and chambers as required.

8.2 Light Liquid Separators

Regular Maintenance

- A system of regular inspections should be established to ensure correct operation of the separator, oil filters and alarm system which, if allowed to develop, would reduce effectiveness.
- Inspection of the separator structures should be carried out on a monthly basis for the first three months following commission. This can then be reduced to once every six months, and following every major storm event for surface water pumps.
- The separator and oil filters and alarm systems should be inspected on a monthly basis for the first three months following commissioning. This can then be reduced to once every six months, and following every major storm event for surface water pumps.
- Debris removal from the separators (where may cause a risk to performance) should be undertaken on a monthly basis.

Inspection/Testing

- Inspect all inlets, outlets, vents, overflows oil alarms and primary silt chamber to ensure that they are in good condition and operating as designed.
- Inspect all separator for any sediment, trash, debris and any other pollutant.

Remediation

- Silt accumulation within separator and should be removed in order to ensure correct performance of the system.
- Repair inlets, outlets, vents, overflows oil alarms and primary silt chamber as required.

9. APPROVALS

This form is part of the Drainage Philosophy Document. It should be signed and dated by the Project Drainage Engineers to confirm that the content of this report has been read, explained and is understood.

The signed form should be returned to Ramboll and appended to the Project File.

PROJECT No: 1620004716

PROJECT Title: Station Hill Reading (Phase 1)

STAGE: Contract Issue

DATE of SUBMISSION: 10.09.2019

Project Engineer:

Date 10.09.2019

Printed Name: L. February

I have read and understood the content of this report and the impact of the drainage philosophy on the development.

Signature:



Project Manager:

Date: 10.09.2019

Printed Name: G. Chisholm

I have read and understood the content of this report and the impact of the drainage philosophy on the development.

Signature:



Project Owner:

Date: 20.12.2019

Printed Name: K.Jones

C02 Revision Updated as follows:

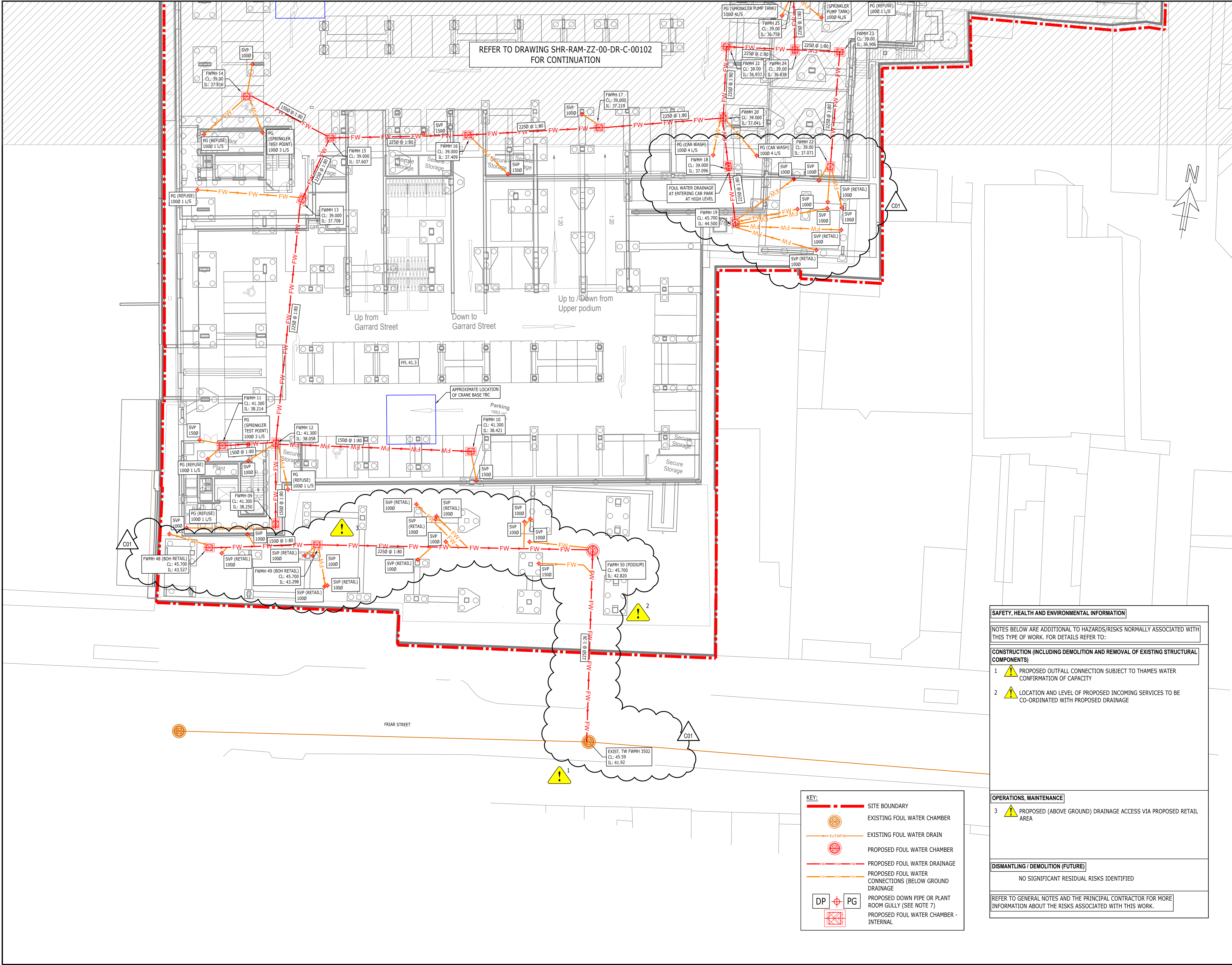
Section 1. Introduction updated to reference Reserve Matters No.3

Section 2. Maintenance Requirements updated to include Estate Management Company responsibility



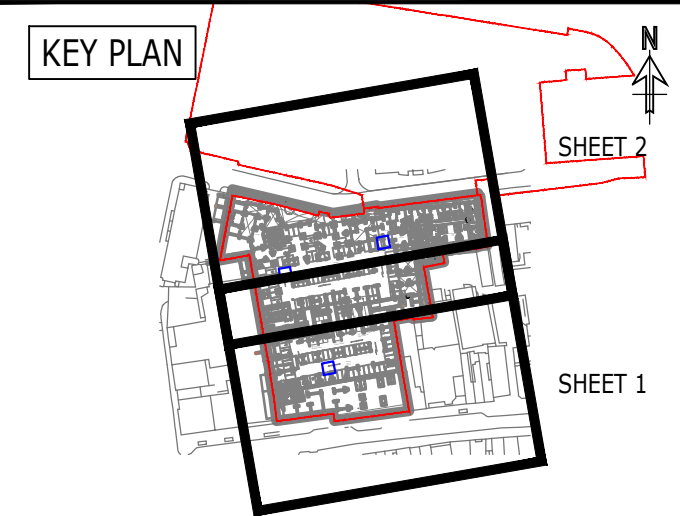
PHASE 1 DRAINAGE STRATEGY AND SUDS REPORT STATION HILL, READING

APPENDIX 1 DRAINAGE STRATEGY PLAN



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 - PLOWMAN CRAVEN UNDERGROUND SERVICES SURVEY '40652-01T-01', REVISION A, DATED 13.11.2018.
 - ARCHITECTURAL LAYOUT SHR-CRL-BE-GF-A-113-103, SHR-CRL-BE-LG-A-113-101, SHR-CRL-BE-MZ-A-113-102, SHR-CRL-BF-GF-A-150-003, SHR-CRL-BF-MZ-A-133-002, SHR-CRL-BF-LG-A-133-001, RECEIVED 22.08.19
 - WHERE PROPOSED DRAINAGE IS SHOWN EXITING THE BUILDING, THE PIPE INVERT LEVEL AND GRADIENTS AT THESE LOCATIONS HAVE BEEN DESIGNED BASED ON THE AVAILABLE INFORMATION.
 - THE UNDERCOVER CAR PARK AREAS ARE NOT PROVIDED WITH POSITIVE DRAINAGE, EXCEPT FOR THE PROPOSED CAR WASHING BAY. REFER TO FOUL WATER DRAINAGE LAYOUTS.
 - THE PROPOSED BELOW GROUND DRAINAGE DESIGN IS SUBJECT TO ONGOING DISCUSSIONS WITH THAMES WATER TO AGREE THE PROPOSED OUTFALL LOCATIONS, AND THAMES WATER APPROVAL.
 - PRE-DEVELOPMENT ENQUIRY HAS BEEN SUBMITTED TO THAMES WATER TO CONFIRM THE CAPACITY OF EXISTING SEWER.
 - PRESENCE AND SIZE OF EXISTING DOWNPIPES SERVING ADJOINING SITE TO BE CONFIRMED. DEDICATED DRAINAGE TO BE INSTALLED AS REQUIRED. TYPICAL ARRANGEMENT SHOWN.
 - REFER TO RAMBOLL DRAWINGS SHR-RAM-XX-XX-DR-C-000401, SHR-RAM-XX-XX-DR-C-000402, SHR-RAM-XX-XX-DR-C-000403 AND SHR-RAM-XX-XX-DR-C-000404 FOR DRAINAGE DETAILS
 - PROPOSED ATTENUATION TANK IS LOCATED BELOW PODIUM LEVEL. SUBJECT TO DESIGN BY OTHERS, CONNECTIONS MAY BE PROVIDED THROUGH RETAIL SPACES



C01	ISSUED FOR CONTRACT	06.09.2019	LF	EK
T02	STAGE 4A SUPERSTRUCTURE ISSUE	08.07.2019	CS	EK
T01	STAGE 4A ISSUE	26.04.2019	PC	EK
Rev	Description	Date	By	App

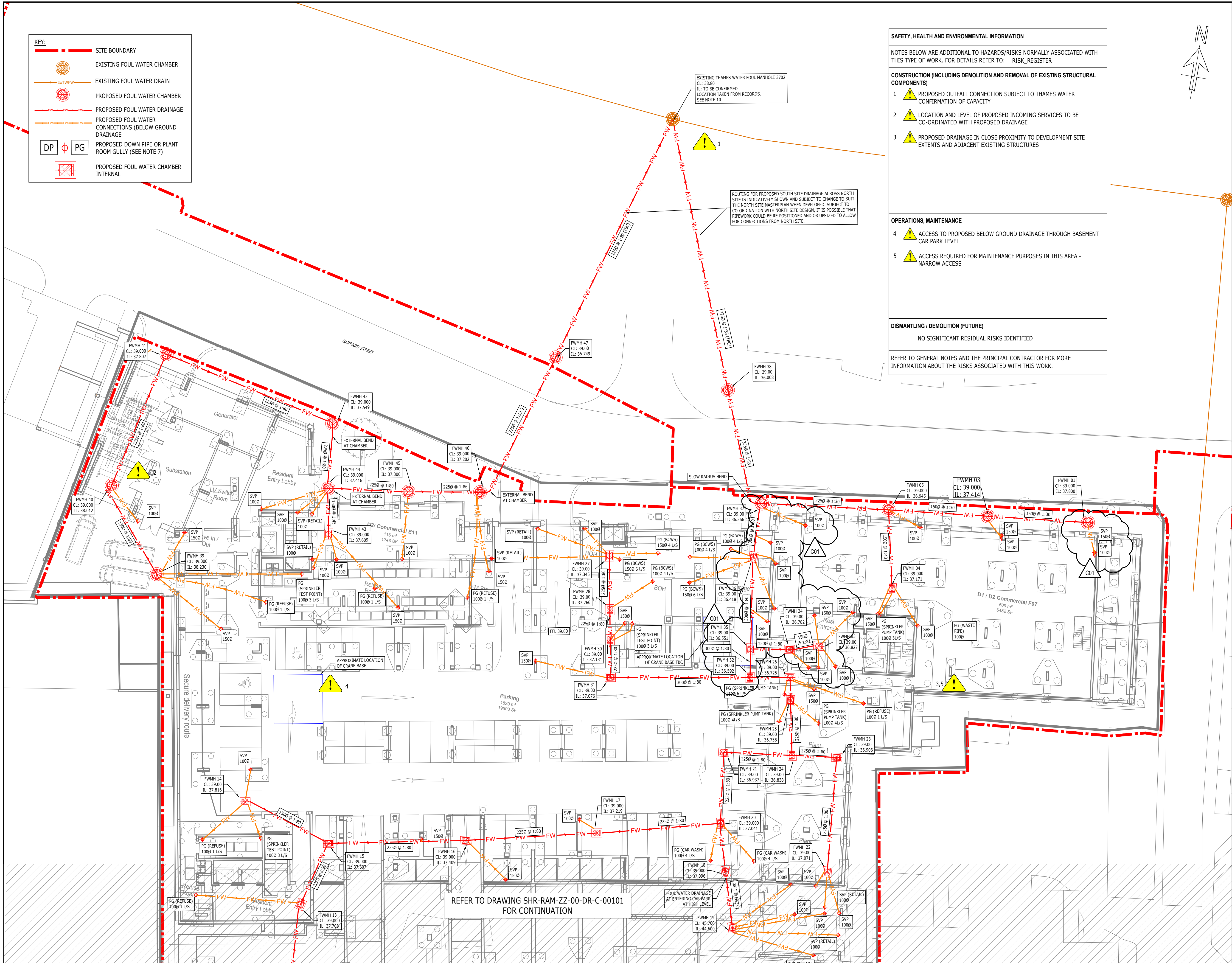
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STATION HILL READING



BLOCK E & F PROPOSED FOUL WATER DRAINAGE LAYOUT SHEET 1 OF 2

Project No:	Scale (@A1):	Drawn:	Date:
1620004716	1:200	CS	DEC 2018
Drawing No:	Rev:		
SHR-RAM-ZZ-00-DR-C-000101	C01		



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

NOTES BELOW ARE ADDITIONAL TO HAZARDS/RISKS NORMALLY ASSOCIATED WITH THIS TYPE OF WORK. FOR DETAILS REFER TO: RISK_REGISTER

CONSTRUCTION (INCLUDING DEMOLITION AND REMOVAL OF EXISTING STRUCTURAL COMPONENTS)

1

PROPOSED OUTFALL CONNECTION SUBJECT TO THAMES WATER CONFIRMATION OF CAPACITY

2

LOCATION AND LEVEL OF PROPOSED INCOMING SERVICES TO BE CO-ORDINATED WITH PROPOSED DRAINAGE

3

PROPOSED DRAINAGE IN CLOSE PROXIMITY TO DEVELOPMENT SITE EXTENTS AND ADJACENT EXISTING STRUCTURES

OPERATIONS, MAINTENANCE

4

ACCESS TO PROPOSED BELOW GROUND DRAINAGE THROUGH BASEMENT CAR PARK LEVEL

5

ACCESS REQUIRED FOR MAINTENANCE PURPOSES IN THIS AREA - NARROW ACCESS

DISMANTLING / DEMOLITION (FUTURE)

NO SIGNIFICANT RESIDUAL RISKS IDENTIFIED

REFER TO GENERAL NOTES AND THE PRINCIPAL CONTRACTOR FOR MORE INFORMATION ABOUT THE RISKS ASSOCIATED WITH THIS WORK.

Notes

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5.

WHERE PROPOSED DRAINAGE IS SHOWN EXITING THE BUILDING, THE PIPE INVERT LEVEL AND GRADIENTS AT THESE LOCATIONS HAVE BEEN DESIGNED BASED ON THE AVAILABLE INFORMATION.

6.

THE UNDERCOVER CAR PARK AREAS ARE NOT PROVIDED WITH POSITIVE DRAINAGE, EXCEPT FOR THE PROPOSED CAR WASHING BAY. REFER TO FOUL WATER DRAINAGE LAYOUTS.

7.

THE PROPOSED BELOW GROUND DRAINAGE DESIGN IS SUBJECT TO ONGOING DISCUSSIONS WITH THAMES WATER TO AGREE THE PROPOSED OUTFALL LOCATIONS, AND THAMES WATER APPROVAL.

8.

PRE-DEVELOPMENT ENQUIRY HAS BEEN SUBMITTED TO THAMES WATER TO CONFIRM THE CAPACITY OF EXISTING SEWER.

9.

PRESENCE AND SIZE OF EXISTING DOWNPIPES SERVING ADJOINING SITE TO BE CONFIRMED. DEDICATED DRAINAGE TO BE INSTALLED AS REQUIRED. TYPICAL ARRANGEMENT SHOWN.

10.

REFER TO RAMBOLL DRAWINGS

- SHR-RAM-XX-XX-DR-C-000401,
- SHR-RAM-XX-XX-DR-C-000402,
- SHR-RAM-XX-XX-DR-C-000403 AND
- SHR-RAM-XX-XX-DR-C-000404 FOR DRAINAGE DETAILS

11.

PROPOSED ATTENUATION TANK IS LOCATED BELOW PODIUM LEVEL. SUBJECT TO DESIGN BY OTHERS, CONNECTIONS MAY BE PROVIDED THROUGH RETAIL SPACES

KEY PLAN

SHEET 1

SHEET 2

C01	ISSUED FOR CONTRACT	06.09.2019	LF	EK
T02	STAGE 4A SUPERSTRUCTURE ISSUE	08.07.2019	CS	EK
T01	STAGE 4A ISSUE	26.04.2019	CS	EK
Rev	Description	Date	By	App

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RAMBOLL

tel 020 7631 5291 london@ramboll.co.uk www.ramboll.co.uk

PHASE 1 (BLOCK E & F) PROPOSED FOUL WATER DRAINAGE LAYOUT SHEET 2 OF 2

Project No: 1620004716

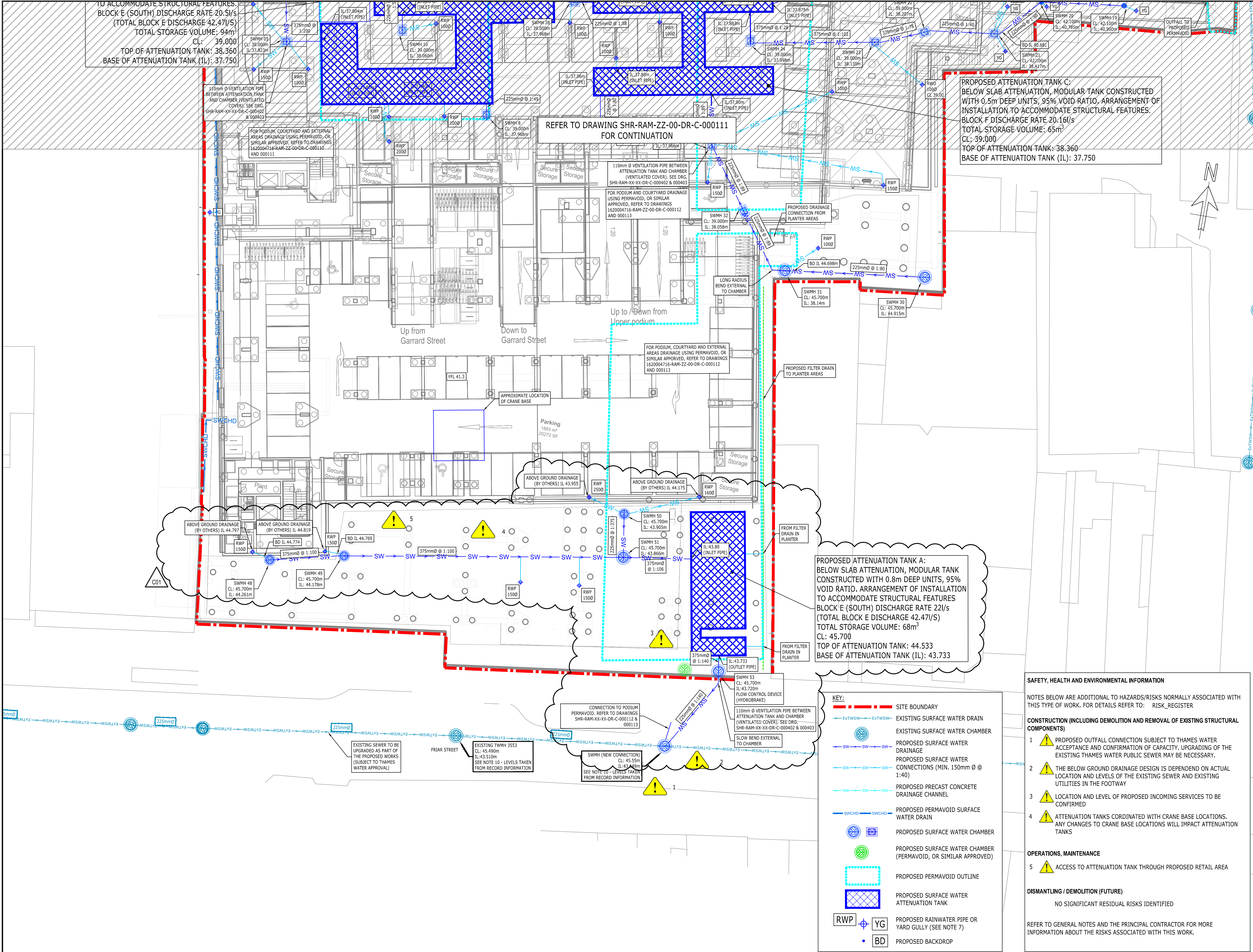
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Drawn: CS

Date: DEC 2018

Drawing No: SHR-RAM-ZZ-00-DR-C-00102

Rev: C01



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- THE INFORMATION INCLUDED ON THIS DRAWING IS IN SUPPORT OF THE PHASE 1 STAGE 4A SUBMISSION ONLY.
- THE BELOW GROUND DRAINAGE DESIGN IS BASED ON INFORMATION RECEIVED FROM THE MEP ENGINEERS, DATED 11 APRIL 2019. THE INFORMATION RECEIVED ON THIS DATE WAS IDENTIFIED AS WORK IN PROGRESS, AND SUBJECT TO CHANGE.
- ALL ABOVE GROUND / INTERNAL DRAINAGE IS DESIGNED BY HOARE LEA. LOCATIONS OF OUTLETS ARE SHOWN BASED UPON AVAILABLE INFORMATION AND ARE SUBJECT TO CHANGE / FINAL CO-ORDINATION.
- WHERE PROPOSED DRAINAGE IS SHOWN EXITING THE BUILDING, THE PIPE INVERT LEVEL AND GRADIENTS AT THESE LOCATIONS HAVE BEEN DESIGNED BASED ON THE AVAILABLE INFORMATION.
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- ALL PROPOSED COVER AND INVERT LEVELS ARE SUBJECT TO CHANGE PENDING FURTHER CO-ORDINATION DURING STAGE 4 DESIGN.
- PRE-DEVELOPMENT ENQUIRY HAS BEEN SUBMITTED TO THAMES WATER TO CONFIRM THE CAPACITY OF EXISTING SEWER.
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KEY PLAN

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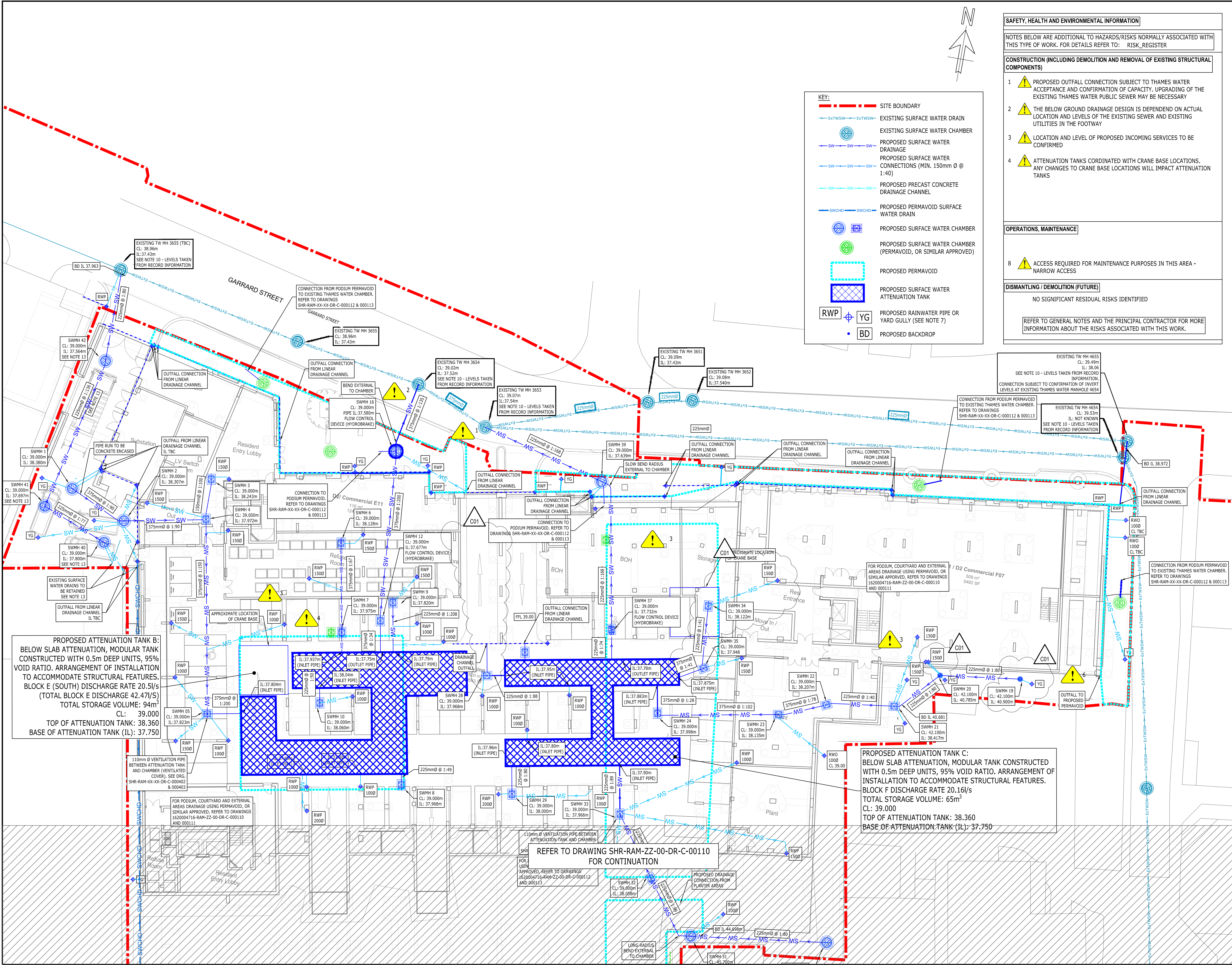
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**BLOCK E & F
PROPOSED SURFACE WATER DRAINAGE LAYOUT
SHEET 1 OF 2**

Project No:	Scale (@A1):	Drawn:	Date:
1620004716	1:200	CS	DEC 2018
Drawing No:			Rev:
SHR-RAM-ZZ-00-DR-C-000110			C01



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

NOTES BELOW ARE ADDITIONAL TO HAZARDS/RISKS NORMALLY ASSOCIATED WITH THIS TYPE OF WORK. FOR DETAILS REFER TO: RISK REGISTER

CONSTRUCTION (INCLUDING DEMOLITION AND REMOVAL OF EXISTING STRUCTURAL COMPONENTS)

1. PROPOSED OUTFALL CONNECTION SUBJECT TO THAMES WATER ACCEPTANCE AND CONFIRMATION OF CAPACITY. UPGRADING OF THE EXISTING THAMES WATER PUBLIC SEWER MAY BE NECESSARY
2. THE BELOW GROUND DRAINAGE DESIGN IS DEPENDENT ON ACTUAL LOCATION AND LEVELS OF THE EXISTING SEWER AND EXISTING UTILITIES IN THE FOOTWAY
3. LOCATION AND LEVEL OF PROPOSED INCOMING SERVICES TO BE CONFIRMED
4. ATTENUATION TANKS COORDINATED WITH CRANE BASE LOCATIONS. ANY CHANGES TO CRANE BASE LOCATIONS WILL IMPACT ATTENUATION TANKS

OPERATIONS, MAINTENANCE

8. ACCESS REQUIRED FOR MAINTENANCE PURPOSES IN THIS AREA - NARROW ACCESS

DISMANTLING / DEMOLITION (FUTURE)

NO SIGNIFICANT RESIDUAL RISKS IDENTIFIED

REFER TO GENERAL NOTES AND THE PRINCIPAL CONTRACTOR FOR MORE INFORMATION ABOUT THE RISKS ASSOCIATED WITH THIS WORK.

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Notes

1. THIS DRAWING IS NOT TO BE SCALED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTURAL, STRUCTURAL AND M&E DRAWINGS.
3. THIS IS NOT AN INSTALLATION DRAWING NOR A CO-ORDINATION DRAWING.
4. THIS DRAWING IS BASED ON:
 - PLOWMAN CRAVEN UNDERGROUND SERVICES SURVEY '40652-01T-01', REVISION A, DATED 13.11.2018.
 - ARCHITECTURAL LAYOUT SHR-CRL-BE-GF-A-113-103, SHR-CRL-BE-LG-A-113-101, SHR-CRL-BE-M2-A-113-102, SHR-CRL-BF-GF-A-150-003, SHR-CRL-BF-M2-A-133-002, SHR-CRL-BF-LG-A-133-001, RECEIVED 22.08.19
5. WHERE PROPOSED DRAINAGE IS SHOWN EXITING THE BUILDING, THE PIPE INVERT LEVEL AND GRADIENTS AT THESE LOCATIONS HAVE BEEN DESIGNED BASED ON THE AVAILABLE INFORMATION.
6. THE UNDERCOVER CAR PARK AREAS ARE NOT PROVIDED WITH POSITIVE DRAINAGE, EXCEPT FOR THE PROPOSED CAR WASHING BAY. REFER TO FOUL WATER DRAINAGE LAYOUTS.
7. THE PROPOSED BELOW GROUND DRAINAGE DESIGN IS SUBJECT TO ONGOING DISCUSSIONS WITH THAMES WATER TO AGREE THE PROPOSED OUTFALL LOCATIONS, AND THAMES WATER APPROVAL.
8. PRE-DEVELOPMENT ENQUIRY HAS BEEN SUBMITTED TO THAMES WATER TO CONFIRM THE CAPACITY OF EXISTING SEWER.
9. PRESENCE AND SIZE OF EXISTING DOWNPIPES SERVING ADJOINING SITE TO BE CONFIRMED. DEDICATED DRAINAGE TO BE INSTALLED AS REQUIRED. TYPICAL ARRANGEMENT SHOWN.
10. REFER TO RAMBOLL DRAWINGS SHR-RAM-XX-XX-DR-C-000401, SHR-RAM-XX-XX-DR-C-000402, SHR-RAM-XX-XX-DR-C-000403 AND SHR-RAM-XX-XX-DR-C-000404 FOR DRAINAGE DETAILS
11. PROPOSED ATTENUATION TANK IS LOCATED BELOW PODIUM LEVEL. SUBJECT TO DESIGN BY OTHERS, CONNECTIONS MAY BE PROVIDED THROUGH RETAIL SPACES

KEY PLAN



C01	ISSUED FOR CONTRACT	06/09/2019	LF	EK
T02	STAGE 4A SUPERSTRUCTURE ISSUE	08/07/2019	LF	EK
T01	STAGE 4A ISSUE	26.04.2019	LF	EK
Rev	Description	Date	By	App

CONTRACT

STATION HILL READING

RAMBOLL

tel 020 7631 5291 london@ramboll.co.uk
www.ramboll.co.uk

**BLOCK E & F
PROPOSED SURFACE WATER
DRAINAGE LAYOUT
SHEET 2 OF 2**

Project No:	Scale (041):	Drawn:	Date:
1620004716	1:200	CS	DEC 2018
Drawing No:		Rev:	
SHR-RAM-ZZ-00-DR-C-000111		C01	

PHASE 1 DRAINAGE STRATEGY AND SUDS REPORT STATION HILL, READING

APPENDIX 2 FOUL WATER CALCULATIONS

Ramboll UK Ltd		Page 1
240 Blackfriars Road London SE1 8NW		
Date 04/03/2019 11:08	Designed by LF	
File SHR FW LAYOUT.MDX	Checked by LF	
Micro Drainage		Network 2018.1

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Main

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.000
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	0.000
Persons per House	3.00	Min Design Depth for Optimisation (m)	0.900
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	1.00
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	100

Designed with Level Soffits

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F2.000	11.583	0.290	40.0	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F2.001	14.384	0.364	39.5	0.000	0	3.0	1.500	o	150	Pipe/Conduit	
F2.002	14.480	0.362	40.0	0.000	0	3.9	1.500	o	150	Pipe/Conduit	
F3.000	12.422	0.293	42.4	0.000	0	0.8	1.500	o	150	Pipe/Conduit	
F3.001	12.422	0.292	42.5	0.000	0	2.4	1.500	o	150	Pipe/Conduit	
F3.002	16.836	0.397	42.4	0.000	0	1.4	1.500	o	150	Pipe/Conduit	
F2.003	13.199	1.219	10.8	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F2.004	28.740	1.219	23.6	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F4.000	8.906	0.169	52.7	0.000	0	5.6	1.500	o	150	Pipe/Conduit	
F5.000	10.880	0.174	62.5	0.000	0	7.7	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F2.000	37.734	0.000	0.0	0	0.0	0	0.00	1.39	24.5	0.0
F2.001	37.444	0.000	3.0	0	0.0	35	0.94	1.40	24.7	3.0
F2.002	37.080	0.000	6.9	0	0.0	54	1.19	1.39	24.5	6.9
F3.000	37.700	0.000	0.8	0	0.0	19	0.61	1.35	23.8	0.8
F3.001	37.407	0.000	3.2	0	0.0	37	0.93	1.35	23.8	3.2
F3.002	37.115	0.000	4.6	0	0.0	45	1.04	1.35	23.8	4.6
F2.003	36.718	0.000	11.5	0	0.0	51	2.20	2.67	47.2	11.5
F2.004	35.499	0.000	11.5	0	0.0	62	1.66	1.81	32.0	11.5
F4.000	37.440	0.000	5.6	0	0.0	53	1.02	1.21	21.4	5.6
F5.000	38.230	0.000	7.7	0	0.0	65	1.04	1.11	19.6	7.7

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Micro Drainage		Network 2018.1

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F5.001	21.197	0.303	69.8	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F5.002	5.725	0.072	79.5	0.000	0	2.2	1.500	o	150	Pipe/Conduit	
F5.003	16.187	0.202	80.1	0.000	0	4.0	1.500	o	150	Pipe/Conduit	
F5.004	8.244	0.103	80.0	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F5.005	8.394	0.104	80.7	0.000	0	2.0	1.500	o	150	Pipe/Conduit	
F4.001	21.141	1.448	14.6	0.000	0	7.3	1.500	o	150	Pipe/Conduit	
F4.002	28.670	1.448	19.8	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F6.000	6.351	0.159	39.9	0.000	0	11.5	1.500	o	150	Pipe/Conduit	
F6.001	9.454	0.236	40.1	0.000	0	8.9	1.500	o	150	Pipe/Conduit	
F6.002	14.353	0.565	25.4	0.000	0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	E Area (ha)	E Base Flow (l/s)	E Hse Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F5.001	38.056	0.000	7.7	0	0.0	67	1.00	18.5	7.7
F5.002	37.753	0.000	9.9	0	0.0	81	1.02	17.4	9.9
F5.003	37.681	0.000	13.9	0	0.0	102	1.09	17.3	13.9
F5.004	37.479	0.000	13.9	0	0.0	102	1.09	17.3	13.9
F5.005	37.375	0.000	15.9	0	0.0	114	1.11	17.2	15.9
F4.001	37.271	0.000	28.8	0	0.0	93	2.50	40.7	28.8
F4.002	35.823	0.000	28.8	0	0.0	104	2.21	34.9	28.8
F6.000	42.880	0.000	11.5	0	0.0	72	1.37	24.5	11.5
F6.001	42.721	0.000	20.4	0	0.0	105	1.55	24.5	20.4
F6.002	42.485	0.000	20.4	0	0.0	89	1.86	30.8	20.4

Free Flowing Outfall Details for Foul - Main

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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F2.004	F	0.000	34.280	0.000	0	0
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Free Flowing Outfall Details for Foul - Main

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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F4.002	F	0.000	34.375	0.000	0	0
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PHASE 1 DRAINAGE STRATEGY AND SUDS REPORT STATION HILL, READING

APPENDIX 3 SURFACE WATER (MICRODRAINAGE) CALCULATIONS

Ramboll UK Ltd		Page 1
240 Blackfriars Road London SE1 8NW		
Date 04/03/2019 10:59	Designed by LF	
File PHASE 1 SW (BELOW GROUN...	Checked by LF	
Micro Drainage		Network 2018.1

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.800	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm at outfall S (pipe S1.006)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.279	4-8	0.067

Total Area Contributing (ha) = 0.345

Total Pipe Volume (m³) = 9.685

Time Area Diagram at outfall S (pipe S2.004)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.116	4-8	0.062

Total Area Contributing (ha) = 0.177

Total Pipe Volume (m³) = 3.077

Time Area Diagram at outfall S (pipe S3.001)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.036	4-8	0.013

Total Area Contributing (ha) = 0.050

Total Pipe Volume (m³) = 1.237

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240 Blackfriars Road London SE1 8NW																																						
Date 04/03/2019 10:59 File PHASE 1 SW (BELOW GROUN...	Designed by LF Checked by LF																																					
Micro Drainage		Network 2018.1																																				
<u>Time Area Diagram at outfall S (pipe S4.004)</u> <table><tr><th>Time (mins)</th><th>Area (ha)</th><th>Time (mins)</th><th>Area (ha)</th></tr><tr><td>0-4</td><td>0.210</td><td>4-8</td><td>0.091</td></tr></table> Total Area Contributing (ha) = 0.301 Total Pipe Volume (m³) = 5.340 <u>Time Area Diagram at outfall S (pipe S6.001)</u> <table><tr><th>Time (mins)</th><th>Area (ha)</th></tr><tr><td>0-4</td><td>0.000</td></tr></table> Total Area Contributing (ha) = 0.000 Total Pipe Volume (m³) = 0.648 <u>Time Area Diagram at outfall S (pipe S7.000)</u> <table><tr><th>Time (mins)</th><th>Area (ha)</th><th>Time (mins)</th><th>Area (ha)</th></tr><tr><td>0-4</td><td>0.012</td><td>4-8</td><td>0.004</td></tr></table> Total Area Contributing (ha) = 0.017 Total Pipe Volume (m³) = 0.363 <u>Time Area Diagram at outfall S (pipe S8.000)</u> <table><tr><th>Time (mins)</th><th>Area (ha)</th><th>Time (mins)</th><th>Area (ha)</th></tr><tr><td>0-4</td><td>0.005</td><td>4-8</td><td>0.002</td></tr></table> Total Area Contributing (ha) = 0.007 Total Pipe Volume (m³) = 0.321 <u>Time Area Diagram at outfall S (pipe S9.000)</u> <table><tr><th>Time (mins)</th><th>Area (ha)</th><th>Time (mins)</th><th>Area (ha)</th></tr><tr><td>0-4</td><td>0.012</td><td>4-8</td><td>0.005</td></tr></table> Total Area Contributing (ha) = 0.016 Total Pipe Volume (m³) = 0.557			Time (mins)	Area (ha)	Time (mins)	Area (ha)	0-4	0.210	4-8	0.091	Time (mins)	Area (ha)	0-4	0.000	Time (mins)	Area (ha)	Time (mins)	Area (ha)	0-4	0.012	4-8	0.004	Time (mins)	Area (ha)	Time (mins)	Area (ha)	0-4	0.005	4-8	0.002	Time (mins)	Area (ha)	Time (mins)	Area (ha)	0-4	0.012	4-8	0.005
Time (mins)	Area (ha)	Time (mins)	Area (ha)																																			
0-4	0.210	4-8	0.091																																			
Time (mins)	Area (ha)																																					
0-4	0.000																																					
Time (mins)	Area (ha)	Time (mins)	Area (ha)																																			
0-4	0.012	4-8	0.004																																			
Time (mins)	Area (ha)	Time (mins)	Area (ha)																																			
0-4	0.005	4-8	0.002																																			
Time (mins)	Area (ha)	Time (mins)	Area (ha)																																			
0-4	0.012	4-8	0.005																																			
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Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	7.324	0.073	100.3	0.000	5.00	0.0	0.600	o	375	Pipe/Conduit	
S1.001	18.997	0.190	100.0	0.013	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.002	7.343	0.073	100.6	0.182	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.003	21.300	0.139	153.2	0.150	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.004	9.179	0.056	163.9	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.005	20.651	0.126	163.9	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.006	8.032	0.048	167.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	22.922	0.099	231.5	0.091	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.001	11.182	0.250	44.7	0.086	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.002	9.704	0.047	206.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.003	16.538	0.080	206.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.004	17.032	0.083	205.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	10.831	0.135	80.2	0.050	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	20.273	0.253	80.1	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.000	5.045	0.066	76.4	0.153	5.00	0.0	0.600	o	375	Pipe/Conduit	
S5.000	7.887	0.099	79.7	0.148	5.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.07	38.300	0.000	0.0	0.0	0.0	1.81	199.8	0.0
S1.001	50.00	5.24	38.227	0.013	0.0	0.0	0.0	1.81	200.1	1.8
S1.002	50.00	5.31	38.037	0.196	0.0	0.0	0.0	1.81	199.5	26.5
S1.003	50.00	5.55	37.889	0.345	0.0	0.0	0.0	1.46	161.4	46.8
S1.004	50.00	5.66	37.750	0.345	0.0	0.0	0.0	1.41	156.0	46.8
S1.005	50.00	5.90	37.694	0.345	0.0	0.0	0.0	1.41	156.0	46.8
S1.006	50.00	6.04	37.568	0.345	0.0	0.0	0.0	1.01	40.1«	46.8
S2.000	50.00	5.45	38.099	0.091	0.0	0.0	0.0	0.86	34.0	12.3
S2.001	50.00	5.54	38.000	0.177	0.0	0.0	0.0	1.96	78.0	24.0
S2.002	50.00	5.72	37.750	0.177	0.0	0.0	0.0	0.91	36.1	24.0
S2.003	50.00	6.02	37.703	0.177	0.0	0.0	0.0	0.91	36.1	24.0
S2.004	50.00	6.34	37.623	0.177	0.0	0.0	0.0	0.91	36.1	24.0
S3.000	50.00	5.12	45.050	0.050	0.0	0.0	0.0	1.46	58.1	6.7
S3.001	50.00	5.35	44.915	0.050	0.0	0.0	0.0	1.46	58.1	6.7
S4.000	50.00	5.04	44.357	0.153	0.0	0.0	0.0	2.07	229.1	20.7
S5.000	50.00	5.06	44.390	0.148	0.0	0.0	0.0	2.03	224.4	20.0

Ramboll UK Ltd

240 Blackfriars Road

London

SE1 8NW

Date 04/03/2019 10:59

File PHASE 1 SW (BELOW GROUN...

Designed by LF

Checked by LF

Micro Drainage

Network 2018.1

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section	Type	Auto Design
S4.001	9.800	0.098	100.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit		
S4.002	7.614	0.076	100.2	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit		
S4.003	11.922	0.060	198.7	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit		
S4.004	9.500	0.050	190.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit		
S6.000	8.190	0.102	80.3	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit		
S6.001	28.489	0.268	106.3	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit		
S7.000	20.556	0.257	80.0	0.017	5.00	0.0	0.600	o	150	Pipe/Conduit		
S8.000	18.149	0.408	44.5	0.007	5.00	0.0	0.600	o	150	Pipe/Conduit		
S9.000	31.532	0.540	58.4	0.016	5.00	0.0	0.600	o	150	Pipe/Conduit		

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S4.001	50.00	5.15	44.291	0.301	0.0	0.0	0.0	1.81	200.1	40.7
S4.002	50.00	5.22	44.193	0.301	0.0	0.0	0.0	1.81	199.9	40.7
S4.003	50.00	5.38	43.620	0.301	0.0	0.0	0.0	1.28	141.6	40.7
S4.004	50.00	5.52	43.560	0.301	0.0	0.0	0.0	1.14	80.4	40.7
S6.000	50.00	5.12	37.800	0.000	0.0	0.0	0.0	1.12	19.8	0.0
S6.001	50.00	5.61	37.698	0.000	0.0	0.0	0.0	0.97	17.2	0.0
S7.000	50.00	5.30	38.220	0.017	0.0	0.0	0.0	1.12	19.9	2.3
S8.000	50.00	5.20	39.380	0.007	0.0	0.0	0.0	1.51	26.7	1.0
S9.000	50.00	5.40	38.600	0.016	0.0	0.0	0.0	1.32	23.3	2.2

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1
Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	4	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR
Return Period (years)	100

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Profile Type	Summer																	
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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S6, DS/PN: S1.005, Volume (m³): 2.7

Unit Reference	MD-SHE-0194-2050-1500-2050
Design Head (m)	1.500
Design Flow (l/s)	20.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	194
Invert Level (m)	37.694
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	20.5
Flush-Flo™	0.451	20.5
Kick-Flo®	0.983	16.8
Mean Flow over Head Range	-	17.7

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	6.7	1.200	18.4	3.000	28.6	7.000	43.0
0.200	18.0	1.400	19.8	3.500	30.7	7.500	44.4
0.300	19.9	1.600	21.1	4.000	32.8	8.000	45.8
0.400	20.4	1.800	22.4	4.500	34.7	8.500	47.2
0.500	20.4	2.000	23.5	5.000	36.5	9.000	48.5
0.600	20.2	2.200	24.6	5.500	38.2	9.500	49.8
0.800	19.3	2.400	25.7	6.000	39.9		
1.000	16.9	2.600	26.7	6.500	41.4		

Hydro-Brake® Optimum Manhole: S7, DS/PN: S1.006, Volume (m³): 4.2

Unit Reference	MD-SHE-0201-2050-1000-2050
Design Head (m)	1.000
Design Flow (l/s)	20.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	201
Invert Level (m)	37.568
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

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Hydro-Brake® Optimum Manhole: S11, DS/PN: S2.003, Volume (m³): 1.8

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
1.200	18.2	2.400	25.3	5.000	35.9	8.000	45.1
1.400	19.5	2.600	26.2	5.500	37.6	8.500	46.5
1.600	20.8	3.000	28.1	6.000	39.3	9.000	47.8
1.800	22.0	3.500	30.3	6.500	40.8	9.500	49.0
2.000	23.2	4.000	32.3	7.000	42.3		
2.200	24.2	4.500	34.2	7.500	43.7		

Hydro-Brake® Optimum Manhole: S22, DS/PN: S4.004, Volume (m³): 4.2

Unit Reference	MD-SHE-0195-2200-1800-2200
Design Head (m)	1.800
Design Flow (l/s)	22.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	195
Invert Level (m)	43.560
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	22.0
Flush-Flo™	0.529	22.0
Kick-Flo®	1.138	17.7
Mean Flow over Head Range	-	19.1

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	6.8	1.200	18.1	3.000	28.1	7.000	42.2
0.200	18.2	1.400	19.5	3.500	30.2	7.500	43.7
0.300	20.8	1.600	20.8	4.000	32.2	8.000	45.1
0.400	21.7	1.800	22.0	4.500	34.1	8.500	46.4
0.500	22.0	2.000	23.1	5.000	35.9	9.000	47.7
0.600	21.9	2.200	24.2	5.500	37.6	9.500	49.0
0.800	21.3	2.400	25.2	6.000	39.2		
1.000	19.9	2.600	26.2	6.500	40.8		

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Storage Structures for Storm

Cellular Storage Manhole: S5, DS/PN: S1.004

Invert Level (m) 37.750 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	214.0	0.0	0.501	0.0	0.0
0.500	214.0	0.0			

Cellular Storage Manhole: S10, DS/PN: S2.002

Invert Level (m) 37.750 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	188.0	0.0	0.501	0.0	0.0
0.500	188.0	0.0			

Cellular Storage Manhole: S21, DS/PN: S4.003

Invert Level (m) 43.620 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	116.0	0.0	1.001	0.0	0.0
1.000	116.0	0.0			

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Date 04/03/2019 10:59 File PHASE 1 SW (BELOW GROUN...	Designed by LF Checked by LF																																																																																																																																																																																															
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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Simulation Criteria Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000 Hot Start Level (mm) 0 Inlet Coefficient 0.800 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000 Foul Sewage per hectare (l/s) 0.000 Number of Input Hydrographs 0 Number of Storage Structures 3 Number of Online Controls 4 Number of Time/Area Diagrams 0 Number of Offline Controls 0 Number of Real Time Controls 0 Synthetic Rainfall Details Rainfall Model FSR Ratio R 0.400 Region England and Wales Cv (Summer) 0.750 M5-60 (mm) 18.900 Cv (Winter) 0.840 Margin for Flood Risk Warning (mm) 300.0 Analysis Timestep 2.5 Second Increment (Extended) DTS Status ON DVD Status ON Inertia Status ON Profile(s) Summer and Winter Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440 Return Period(s) (years) 1, 30, 100 Climate Change (%) 0, 0, 40 <table><thead><tr><th>PN</th><th>US/MH Name</th><th>Storm</th><th>Return Period</th><th>Climate Change</th><th>First (X) Surge</th><th>First (Y) Flood</th><th>First (Z) Overflow</th><th>Overflow Act.</th><th>Water Level (m)</th></tr></thead><tbody><tr><td>S1.000</td><td>S1</td><td>120 Winter</td><td>1</td><td>+0%</td><td></td><td></td><td></td><td></td><td>38.300</td></tr><tr><td>S1.001</td><td>S2</td><td>15 Winter</td><td>1</td><td>+0%</td><td></td><td></td><td></td><td></td><td>38.243</td></tr><tr><td>S1.002</td><td>S3</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>38.152</td></tr><tr><td>S1.003</td><td>S4</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>38.024</td></tr><tr><td>S1.004</td><td>S5</td><td>60 Winter</td><td>1</td><td>+0%</td><td>100/30 Summer</td><td></td><td></td><td></td><td>37.845</td></tr><tr><td>S1.005</td><td>S6</td><td>60 Winter</td><td>1</td><td>+0%</td><td>100/15 Winter</td><td></td><td></td><td></td><td>37.831</td></tr><tr><td>S1.006</td><td>S7</td><td>60 Winter</td><td>1</td><td>+0%</td><td>100/15 Winter</td><td></td><td></td><td></td><td>37.695</td></tr><tr><td>S2.000</td><td>S8</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>38.196</td></tr><tr><td>S2.001</td><td>S9</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>38.089</td></tr><tr><td>S2.002</td><td>S10</td><td>60 Winter</td><td>1</td><td>+0%</td><td>100/30 Summer</td><td></td><td></td><td></td><td>37.813</td></tr><tr><td>S2.003</td><td>S11</td><td>60 Winter</td><td>1</td><td>+0%</td><td>100/15 Winter</td><td></td><td></td><td></td><td>37.786</td></tr><tr><td>S2.004</td><td>S12</td><td>60 Winter</td><td>1</td><td>+0%</td><td></td><td></td><td></td><td></td><td>37.681</td></tr><tr><td>S3.000</td><td>S13</td><td>15 Winter</td><td>1</td><td>+0%</td><td></td><td></td><td></td><td></td><td>45.105</td></tr><tr><td>S3.001</td><td>S14</td><td>15 Winter</td><td>1</td><td>+0%</td><td></td><td></td><td></td><td></td><td>44.968</td></tr><tr><td>S4.000</td><td>S15</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>44.467</td></tr><tr><td>S5.000</td><td>S16</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>44.490</td></tr><tr><td>S4.001</td><td>S17</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>44.438</td></tr><tr><td>S4.002</td><td>S18</td><td>15 Winter</td><td>1</td><td>+0%</td><td>100/15 Summer</td><td></td><td></td><td></td><td>44.350</td></tr></tbody></table> ©1982-2018 Innovyze			PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	S1.000	S1	120 Winter	1	+0%					38.300	S1.001	S2	15 Winter	1	+0%					38.243	S1.002	S3	15 Winter	1	+0%	100/15 Summer				38.152	S1.003	S4	15 Winter	1	+0%	100/15 Summer				38.024	S1.004	S5	60 Winter	1	+0%	100/30 Summer				37.845	S1.005	S6	60 Winter	1	+0%	100/15 Winter				37.831	S1.006	S7	60 Winter	1	+0%	100/15 Winter				37.695	S2.000	S8	15 Winter	1	+0%	100/15 Summer				38.196	S2.001	S9	15 Winter	1	+0%	100/15 Summer				38.089	S2.002	S10	60 Winter	1	+0%	100/30 Summer				37.813	S2.003	S11	60 Winter	1	+0%	100/15 Winter				37.786	S2.004	S12	60 Winter	1	+0%					37.681	S3.000	S13	15 Winter	1	+0%					45.105	S3.001	S14	15 Winter	1	+0%					44.968	S4.000	S15	15 Winter	1	+0%	100/15 Summer				44.467	S5.000	S16	15 Winter	1	+0%	100/15 Summer				44.490	S4.001	S17	15 Winter	1	+0%	100/15 Summer				44.438	S4.002	S18	15 Winter	1	+0%	100/15 Summer				44.350
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)																																																																																																																																																																																							
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S5.000	S16	15 Winter	1	+0%	100/15 Summer				44.490																																																																																																																																																																																							
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S4.002	S18	15 Winter	1	+0%	100/15 Summer				44.350																																																																																																																																																																																							

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

PN	US/MH Name	Surcharged Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)		
S1.000	S1	-0.375	0.000	0.00	0.0	OK	
S1.001	S2	-0.359	0.000	0.01	1.5	OK	
S1.002	S3	-0.260	0.000	0.20	21.7	OK	
S1.003	S4	-0.240	0.000	0.28	38.3	OK	
S1.004	S5	-0.280	0.000	0.10	10.5	OK	
S1.005	S6	-0.238	0.000	0.08	10.4	OK	
S1.006	S7	-0.098	0.000	0.34	10.4	OK	
S2.000	S8	-0.128	0.000	0.38	11.7	OK	
S2.001	S9	-0.136	0.000	0.32	21.4	OK	
S2.002	S10	-0.162	0.000	0.16	4.8	OK	
S2.003	S11	-0.142	0.000	0.15	4.8	OK	
S2.004	S12	-0.167	0.000	0.15	4.8	OK	
S3.000	S13	-0.170	0.000	0.13	6.5	OK	
S3.001	S14	-0.172	0.000	0.12	6.5	OK	
S4.000	S15	-0.265	0.000	0.19	19.9	OK	
S5.000	S16	-0.275	0.000	0.16	19.2	OK	
S4.001	S17	-0.228	0.000	0.32	39.3	OK	
S4.002	S18	-0.218	0.000	0.37	39.6	OK	

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

												Water
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.				Level (m)
S4.003	S21	30 Winter	1	+0%	100/15 Summer							43.738
S4.004	S22	30 Winter	1	+0%	30/15 Winter							43.722
S6.000	S23	120 Winter	1	+0%								37.800
S6.001	S24	120 Winter	1	+0%								37.698
S7.000	S25	15 Winter	1	+0%								38.254
S8.000	S26	15 Winter	1	+0%								39.399
S9.000	S27	15 Winter	1	+0%								38.631

		Surcharged		Flooded			Pipe			
PN	US/MH Name	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (1/s)	Pipe Flow (1/s)	Status	Level Exceeded		
S4.003	S21	-0.257	0.000	0.14		14.5	OK			
S4.004	S22	-0.138	0.000	0.24		14.4	OK			
S6.000	S23	-0.150	0.000	0.00		0.0	OK			
S6.001	S24	-0.150	0.000	0.00		0.0	OK			
S7.000	S25	-0.116	0.000	0.12		2.2	OK			
S8.000	S26	-0.131	0.000	0.04		0.9	OK			
S9.000	S27	-0.119	0.000	0.09		2.1	OK			

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm									
Simulation Criteria									
Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000									
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000									
Hot Start Level (mm) 0 Inlet Coefficient 0.800									
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000									
Foul Sewage per hectare (l/s) 0.000									
Number of Input Hydrographs 0 Number of Storage Structures 3									
Number of Online Controls 4 Number of Time/Area Diagrams 0									
Number of Offline Controls 0 Number of Real Time Controls 0									
Synthetic Rainfall Details									
Rainfall Model FSR Ratio R 0.400									
Region England and Wales Cv (Summer) 0.750									
M5-60 (mm) 18.900 Cv (Winter) 0.840									
Margin for Flood Risk Warning (mm) 300.0									
Analysis Timestep 2.5 Second Increment (Extended)									
DTS Status ON									
DVD Status ON									
Inertia Status ON									
Profile(s) Summer and Winter									
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440									
Return Period(s) (years) 1, 30, 100									
Climate Change (%) 0, 0, 40									
Water									
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)
S1.000	S1	120 Winter	30	+0%					38.300
S1.001	S2	15 Winter	30	+0%					38.277
S1.002	S3	15 Winter	30	+0%	100/15 Summer				38.253
S1.003	S4	15 Winter	30	+0%	100/15 Summer				38.160
S1.004	S5	60 Winter	30	+0%	100/30 Summer				37.989
S1.005	S6	60 Winter	30	+0%	100/15 Winter				37.979
S1.006	S7	60 Winter	30	+0%	100/15 Winter				37.761
S2.000	S8	15 Winter	30	+0%	100/15 Summer				38.273
S2.001	S9	15 Winter	30	+0%	100/15 Summer				38.165
S2.002	S10	60 Winter	30	+0%	100/30 Summer				37.888
S2.003	S11	60 Winter	30	+0%	100/15 Winter				37.873
S2.004	S12	60 Winter	30	+0%					37.718
S3.000	S13	15 Winter	30	+0%					45.139
S3.001	S14	15 Winter	30	+0%					45.000
S4.000	S15	15 Winter	30	+0%	100/15 Summer				44.557
S5.000	S16	15 Winter	30	+0%	100/15 Summer				44.565
S4.001	S17	15 Winter	30	+0%	100/15 Summer				44.545
S4.002	S18	15 Winter	30	+0%	100/15 Summer				44.470
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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	US/MH Name	Surcharged Flooded		Pipe		Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Overflow Cap. (l/s)	Flow (l/s)	
S1.000	S1	-0.375	0.000	0.00	0.0	OK
S1.001	S2	-0.325	0.000	0.03	4.5	OK
S1.002	S3	-0.159	0.000	0.63	67.1	OK
S1.003	S4	-0.104	0.000	0.86	118.0	OK
S1.004	S5	-0.136	0.000	0.17	18.5	OK
S1.005	S6	-0.090	0.000	0.14	18.3	OK
S1.006	S7	-0.032	0.000	0.59	18.3	OK
S2.000	S8	-0.051	0.000	0.92	28.7	OK
S2.001	S9	-0.060	0.000	0.87	57.1	OK
S2.002	S10	-0.087	0.000	0.40	12.0	OK
S2.003	S11	-0.055	0.000	0.37	12.0	OK
S2.004	S12	-0.130	0.000	0.37	12.0	OK
S3.000	S13	-0.136	0.000	0.32	15.9	OK
S3.001	S14	-0.140	0.000	0.30	15.8	OK
S4.000	S15	-0.175	0.000	0.45	48.7	OK
S5.000	S16	-0.200	0.000	0.38	46.9	OK
S4.001	S17	-0.121	0.000	0.78	95.5	OK
S4.002	S18	-0.098	0.000	0.89	96.2	OK

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

US/MH		Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level
PN	Name								(m)
S4.003	S21	30 Winter	30	+0%	100/15 Summer				43.937
S4.004	S22	30 Winter	30	+0%	30/15 Winter				43.909
S6.000	S23	120 Winter	30	+0%					37.800
S6.001	S24	120 Winter	30	+0%					37.698
S7.000	S25	15 Winter	30	+0%					38.275
S8.000	S26	15 Winter	30	+0%					39.411
S9.000	S27	15 Winter	30	+0%					38.649

US/MH		Depth (m)	Surcharged Volume (m³)	Flooded Flow / Cap. (l/s)	Pipe Flow (l/s)	Status	Level
PN	Name						Exceeded
S4.003	S21	-0.058	0.000	0.21	22.9	OK	
S4.004	S22	0.049	0.000	0.35	21.3	SURCHARGED	
S6.000	S23	-0.150	0.000	0.00	0.0	OK	
S6.001	S24	-0.150	0.000	0.00	0.0	OK	
S7.000	S25	-0.095	0.000	0.28	5.3	OK	
S8.000	S26	-0.119	0.000	0.09	2.3	OK	
S9.000	S27	-0.101	0.000	0.23	5.1	OK	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000

Additional Flow - % of Total Flow 0.000

Hot Start (mins) 0

MADD Factor * 10m³/ha Storage 2.000

Hot Start Level (mm) 0

Inlet Coefficient 0.800

Manhole Headloss Coeff (Global) 0.500

Flow per Person per Day (l/per/day) 0.000

Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0

Number of Storage Structures 3

Number of Online Controls 4

Number of Time/Area Diagrams 0

Number of Offline Controls 0

Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR

Ratio R 0.400

Region England and Wales Cv (Summer) 0.750

M5-60 (mm) 18.900 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0

Analysis Timestep 2.5 Second Increment (Extended)

DTS Status ON

DVD Status ON

Inertia Status ON

Profile(s) Summer and Winter

Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440

Return Period(s) (years) 1, 30, 100

Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	100	+40%					38.526
S1.001	S2	15 Winter	100	+40%					38.527
S1.002	S3	15 Winter	100	+40%	100/15 Summer				38.522
S1.003	S4	15 Winter	100	+40%	100/15 Summer				38.427
S1.004	S5	60 Winter	100	+40%	100/30 Summer				38.237
S1.005	S6	60 Winter	100	+40%	100/15 Winter				38.235
S1.006	S7	60 Winter	100	+40%	100/15 Winter				37.842
S2.000	S8	15 Winter	100	+40%	100/15 Summer				38.828
S2.001	S9	15 Winter	100	+40%	100/15 Summer				38.556
S2.002	S10	60 Winter	100	+40%	100/30 Summer				38.015
S2.003	S11	60 Winter	100	+40%	100/15 Winter				37.992
S2.004	S12	60 Winter	100	+40%					37.742
S3.000	S13	15 Winter	100	+40%					45.176
S3.001	S14	15 Winter	100	+40%					45.035
S4.000	S15	15 Winter	100	+40%	100/15 Summer				44.946
S5.000	S16	15 Winter	100	+40%	100/15 Summer				44.959
S4.001	S17	15 Winter	100	+40%	100/15 Summer				44.854
S4.002	S18	15 Winter	100	+40%	100/15 Summer				44.661

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Flooded		Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m³)					
S1.000	S1	-0.149	0.000	0.02		2.1	OK	
S1.001	S2	-0.075	0.000	0.07		12.1	OK	
S1.002	S3	0.110	0.000	1.07		114.3	SURCHARGED	
S1.003	S4	0.163	0.000	1.46		199.1	SURCHARGED	
S1.004	S5	0.112	0.000	0.21		22.2	SURCHARGED	
S1.005	S6	0.166	0.000	0.15		20.3	SURCHARGED	
S1.006	S7	0.049	0.000	0.66		20.2	SURCHARGED	
S2.000	S8	0.504	0.000	1.64		51.2	SURCHARGED	
S2.001	S9	0.331	0.000	1.51		99.7	SURCHARGED	
S2.002	S10	0.040	0.000	0.59		17.8	SURCHARGED	
S2.003	S11	0.064	0.000	0.55		17.8	SURCHARGED	
S2.004	S12	-0.106	0.000	0.55		17.8	OK	
S3.000	S13	-0.099	0.000	0.59		28.8	OK	
S3.001	S14	-0.105	0.000	0.54		28.6	OK	
S4.000	S15	0.214	0.000	0.80		85.9	SURCHARGED	
S5.000	S16	0.194	0.000	0.67		82.7	SURCHARGED	
S4.001	S17	0.188	0.000	1.38		168.7	SURCHARGED	
S4.002	S18	0.093	0.000	1.56		168.2	SURCHARGED	

Ramboll UK Ltd		Page 18
240 Blackfriars Road London SE1 8NW		
Date 04/03/2019 10:59	Designed by LF	
File PHASE 1 SW (BELOW GROUN...	Checked by LF	
Micro Drainage		Network 2018.1

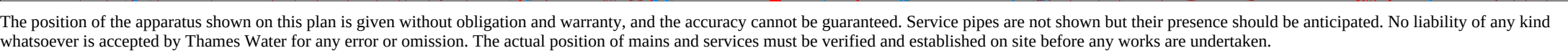
100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

										Water
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.		Level (m)
S4.003	S21	60 Winter	100	+40%	100/15 Summer					44.328
S4.004	S22	60 Winter	100	+40%	30/15 Winter					44.322
S6.000	S23	120 Winter	100	+40%						37.800
S6.001	S24	120 Winter	100	+40%						37.698
S7.000	S25	15 Winter	100	+40%						38.298
S8.000	S26	15 Winter	100	+40%						39.421
S9.000	S27	15 Winter	100	+40%						38.668

		Surcharged		Flooded	Flow / Overflow		Pipe Flow	Level	
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Exceeded	
S4.003	S21	0.333	0.000	0.23		24.3	SURCHARGED		
S4.004	S22	0.462	0.000	0.36		21.9	SURCHARGED		
S6.000	S23	-0.150	0.000	0.00		0.0	OK		
S6.001	S24	-0.150	0.000	0.00		0.0	OK		
S7.000	S25	-0.072	0.000	0.52		9.7	OK		
S8.000	S26	-0.109	0.000	0.17		4.1	OK		
S9.000	S27	-0.082	0.000	0.42		9.3	OK		

PHASE 1 DRAINAGE STRATEGY AND SUDS REPORT STATION HILL, READING

APPENDIX 4 THAMES WATER ASSET PLAN



 PROPOSED SURFACE WATER DRAINAGE

 PROPOSED FOUL WATER DRAINAGE