Ham Close Regeneration

Planning Application:

Flood Risk Assessment & Drainage Strategy

Author: Jubb
April 2022

Contents

1 Project Information

1.1 Project Information

Client	Hill Residential

1.2 Project Details

Project Name	Ham Close, Richmond
Location	Ham Close, Ham, Richmond Upon Thames, TW10 7PG
Jubb Project Number	21246

1.3 Report Details

Version	V2
Status	Planning
Date	March 2022

1.4 Project Authorisation

ISSUE HISTORY: AUTHORISATION:

Version	Date	Detail	Prepared By	Approved By
DRAFT	24/01/22	Draft Issue	KG	
V1	07/02/22	First Issue	KG	RL
V2	23/03/22	Updated to suit comments	KG	RL

2 Introduction

2.1 Instruction

2.1.1 Jubb has been commissioned by Hill Residential to provide flood risk and drainage advice in relation to proposals for the residential development in Ham Close, Ham, Richmond Upon Thames, TW10 7PG.

2.1.2 This report may not be reproduced by any third party for any use without the written agreement of Jubb Consulting Engineers Ltd.

2.2 Brief

2.2.1 This Drainage Statement is prepared in accordance with the requirements of the National Planning Policy Framework (NPPF) published by the Department of Communities and Local Government. The NPPF sets out the government's national policies to protect people and property from flooding in both existing and future situations as a result of development.

2.2.2 Section 14 of the NPPF and the associated Planning Practice Guidance for Flood Risk and Coastal Change sets out the framework for planning decisions made by the local, regional and national government and the Environment Agency (EA). In order for planning authorities to make informed decisions on the Development of sites in areas at risk of flooding, NPPF requires the developer to carry out an assessment of flood risk.

2.2.3 This report addresses the requirements given in Section 14 of the NPPF and other issues which are deemed relevant to flood risk. These requirements include the following:

- Assessment of the magnitude and severity of flood risk to the Site, including consideration of current and future impacts of climate change;
- Assess suitability of the site and future development through the application of the Sequential Test and Exception Test (where required);
- Assess the impacts of current and future development of the site on flood risk to adjacent developments;
- Determine ability of existing and proposed drainage to accommodate development flows with respect to surface water runoff and flood risk;
- Demonstrate that appropriate mitigation measures have been taken to prevent flooding;
- Demonstrate that appropriate emergency situations have been considered e.g. overland flow path and evacuation routes.

2.2.4 This report also considers the disposal of wastewater generated by the proposed Development. Existing infrastructure will be reviewed to identify potential options for the disposal of foul and surface water runoff for future development.

3 Site Location & Description

3.1 Existing Site Context

3.1.1 The Application Site area is 4.69 Hectares. The site is located on Ham Close, between St Richard's CE Primary School and Ham Street/Wiggins Lane, in a predominantly residential setting. The site is centred at National Grid Reference TQ 0030585, OS co-ordinates 550309 158566.

3.1.2 The application site currently houses 192 homes, a community centre and a Maker Labs use as part of the existing Ham Close Estate, existing site layout can be seen in Figure 1.

3.1.3 Access is provided from Ham Close which forms two parallel minor roads that generally run north-west to south-east, connecting to Ashburnham Road in the south and Woodville Road in the north.

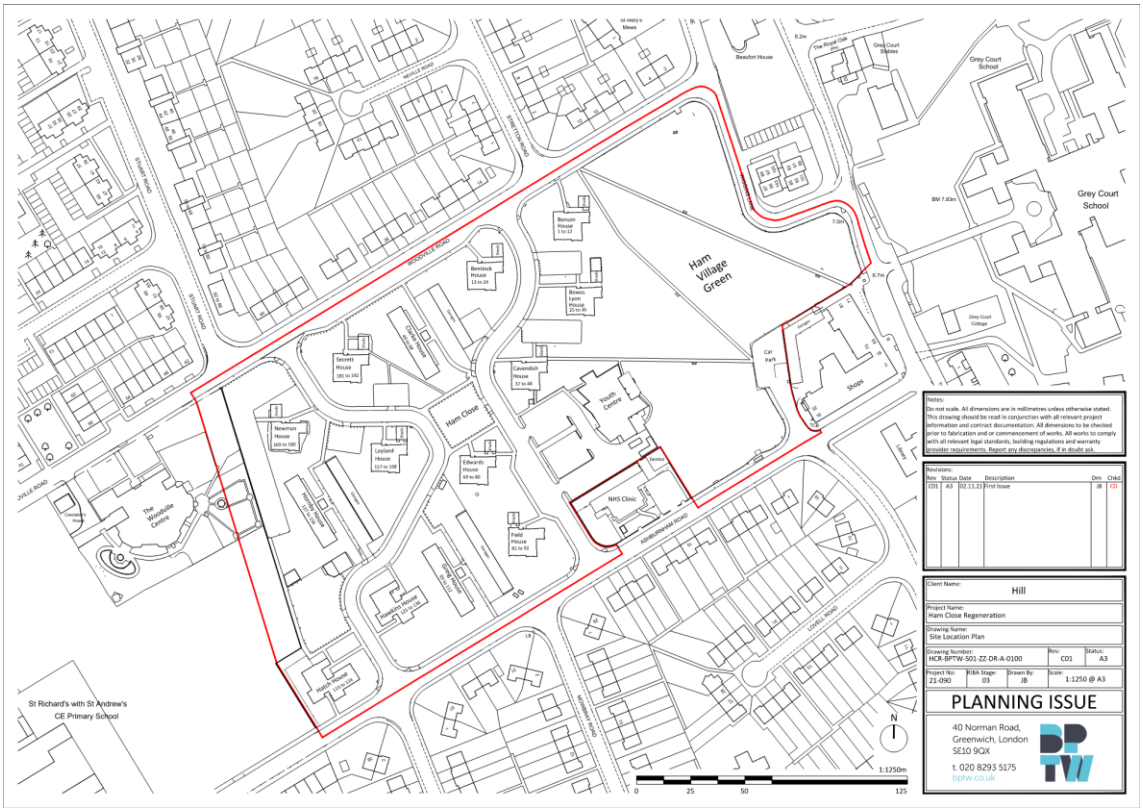

Figure 1: Indicative Site Masterplan

3.2 Development Proposals

3.2.1 The development proposals comprise the "demolition of the existing buildings on-site and phased mixed-use development comprising 452 residential homes (Class C3) up to six storeys; a Community/Leisure Facility (Class F2) of up to three storeys in height, a "Maker Labs" (sui generis) of up to two storeys together with basement car parking and site wide landscaping ('the Development')."

3.2.2 This application is being submitted to the London Borough of Richmond upon Thames (LBRuT). Architectural layouts can be found in Appendix A.

3.3 Site Topography

3.3.1 The site levels vary between 7.5mAOD at the north boundary (Woodville Road) and 6.7mAOD at the south-eastern boundary (Ashburnham Road).

3.3.2 Refer to Appendix B for topographical survey.

3.4 Site Geology

3.4.1 A Geo-Environmental Report prepared by Enzygo Geoenvironmental Ltd (Aug 2021) summarises the ground conditions to comprise Made Ground over firm clay and loose becoming dense with depth sand and gravel. This is underlain by London Clay comprising stiff clay. The report extracts can be found in Appendix C.

3.4.2 Groundwater was encountered at depth between 2.2m and 4.3m below ground level.

3.4.3 The site is not located within a designated Source Protection Zone.

3.5 Existing Sewers

3.5.1 There are number of existing Thames Water sewers within the site boundary, all avaliable sewer information can be found in Appendix D, extract of the asset map can be seen in Figure 2.

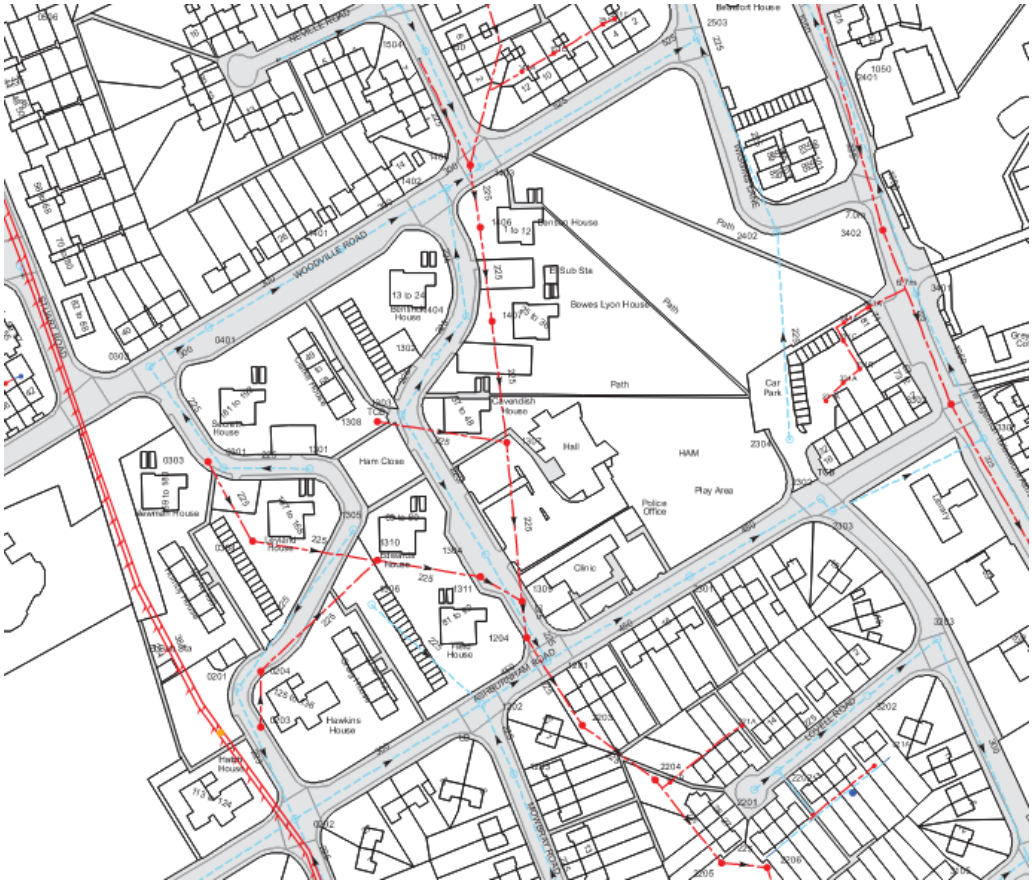

Figure 2, Existing Drainage Layout

3.5.2 The surface water sewers onsite follow the layout of the existing road infrastructure, with 5 total discharge locations: 2 outfalls towards the 300-525mmØ sewer in Woodville Road to the north, and 3 outfalls towards the 300-450mmØ sewer in Ashburnham Road to the south. All surface water outfalls are 225mmØ and have invert levels roughly at 2m below ground levels.

3.5.3 There is also an existing 225mmØ surface water sewer running in the northern direction through the eastern part of the Ham Village Green, originating within the existing car park, at a location of the proposed Community Centre. This sewer runs towards Wiggins Lane and joints the 525mmØ sewer in Woodville Road north of the site.

3.5.4 The foul water network onsite is connected towards a 225mmØ sewer running directly across the site. This sewer appears to drain the residential properties along Stretton Road north of the site (outside of the site boundary) and is routed in a straight line through the site running under landscaping and car parking areas. Once outside of the site boundary, the sewer crosses Ashburnham Road and is routed through private gardens in the southern direction. The levels of this sewer appear to be relatively flat, with some areas showing no falls between manholes, with an invert level approximately 3m below ground level.

3.5.5 Two Thames Water rising mains are also present onsite, running south to north, parallel to each other along the western boundary.

3.5.6 To the east of the site, there are two sewers located within Ham Street, a 225mmØ foul water sewer running in the southern direction and a 1050mmØ surface water sewer running in the northern direction.

3.5.7 There are private drainage networks onsite, an Underground Survey drawing can be found in Appendix D. The drains appear to serve the development only, with no drains from outside of the site boundary, other than the public sewers described above.

3.6 Existing runoff rates

3.6.1 For the purposes of drainage calculations, the Ham Village Green has been excluded from the catchment as the existing and proposed use of this area will remain unchanged and will not drain towards the neighbouring sewers.

3.6.2 The Site area discharging to the sewers measures approximately 2.96Ha, of which approximately 1.24Ha is landscaped (30% impermeable). The existing runoff rates have been estimated using Modified Rationale Method, results can be seen in Table 1 below.

Storm	***Rainfall Intensity (mm/hr)***	***Existing Rainfall (l/s)***
1 in 1	*28.2*	*231.8*
1 in 30	*86.0*	*708.4*
1 in 100	*113.8*	*936.9*

Table 1, Existing Runoff Rates

3.6.3 The Site is currently split into 5 catchments, each with their own 225mmØ outfall. As the areas are similar in size, it can be assumed the current discharge rate per outfall is ~187 l/s for a 1 in 100 year storm.

3.7 Existing Watercourses

3.7.1 The site is located approximately 750m east from the river Thames. The nearest watercourse appears to be a ditch in Ham Lands, approximately 300m west of the site, Ham Pond is also located approximately 400m southeast of the site. All of these are too distant to be significantly impacted by the site.

4 Proposed Development

4.1 Development Description

4.1.1 The development proposals comprise the "demolition of the existing buildings on-site and phased mixed-use development comprising 452 residential homes (Class C3) up to six storeys; a Community/Leisure Facility (Class F2) of up to three storeys in height, a "Maker Labs" (sui generis) of up to two storeys together with basement car parking and site wide landscaping ('the Development')."

4.2 Development Suitability

4.2.1 The NPPF sets out the Sequential Test to steer developments towards areas of lowest probability of flooding, taking account of their vulnerability to flooding.

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1 **(<1 in 1000)**	✓	✓	✓	✓	✓
Flood Zone 2 **(up to 1 in 1000)**	✓	✓	Exception Test	✓	✓
Flood Zone 3a **(1 in 100 fluvial) (1 in 200 tidal)**	Exception Test	✓	X	Exception Test	✓
Flood Zone 3b **(functional floodplain)**	Exception Test	✓	X	X	X

Table 2, Development Suitability

4.2.2 The development use is classified as a 'More Vulnerable' development. Under Table 2 of the NPPF Planning Practice Guidance as the site is in Flood Zone 1, all vulnerability classes are suitable and thus the proposed scheme is deemed acceptable.

5 Flood Risk

5.1 Fluvial Flooding

5.1.1 The Environment Agency (EA) produces floodplain maps for the UK, which show the area at risk of fluvial and tidal flooding. The EA flood zone maps identify undefended floodplain, giving the horizontal extent of low (Zone 1), medium (Zone 2) and high-risk flood zones (Zones 3a and 3b) depending on the severity of the flood event.

5.1.2 The EA's Flood Map for Planning (Figure 3) indicates the site to be wholly located within Flood Zone 1 (Low Probability) and therefore defined as having less than a 1 in 1,000 annual probability of river flooding.

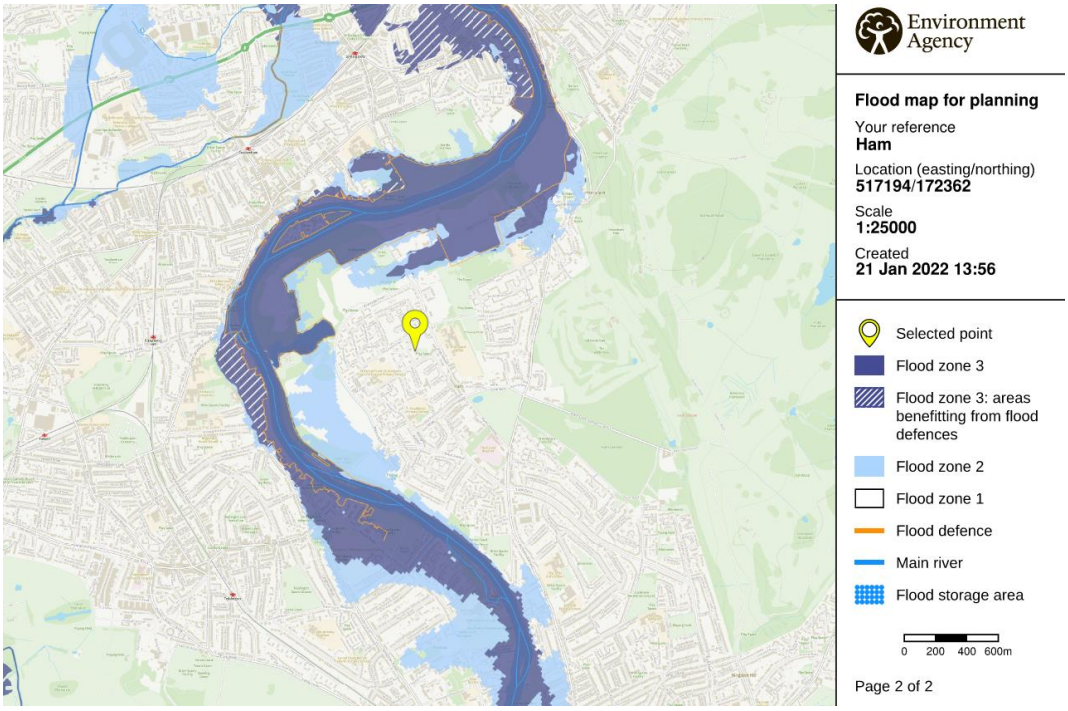

Figure 3, Extract from Environment Agency Tidal and Fluvial Flood Risk Map

5.1.3 Table 2 of the NPPF Planning Practice Guidance for Flood Risk and Coastal Change states in terms of flood risk vulnerability, that all types of development are suitable within this flood zone. Sequential and exception tests are not required.

5.1.4 The risk of fluvial and tidal flooding to the development is low.

5.2 Overland (Surface Water) Flooding

5.2.1 The EA also produces maps which highlight the risk of flooding from surface water flows. The Long-Term Flood Risk Information maps can illustrate when the capacity of existing surface water drainage networks or channels are exceeded in extreme rainfall events. These maps are produced, as with fluvial modelling, based on generalised information, and need to be verified in terms of topographical ground levels and indicated flow routes.

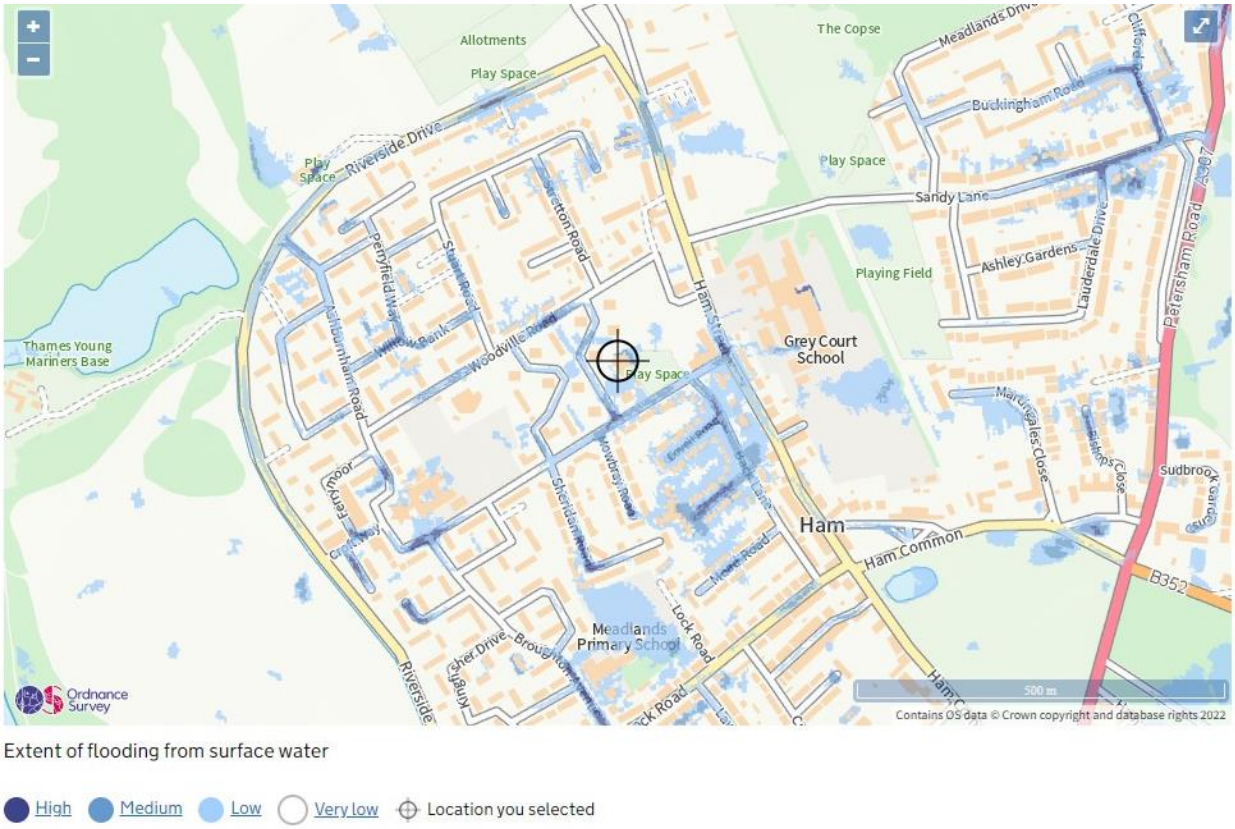

Figure 4, Extract from Environment Agency's Long-Term Flood Risk mapping indicating Surface Water Flood Risk

5.2.2 Figure 4 indicates there are number of flood risk areas within the site. The locations shown on the map correspond to topographical low points, which as shown on the topographical survey, have gullies to ensure that area is drained during rainfalls.

5.2.3 A review of the capacity of existing pipes shows the maximum capacity of the 225mmØ outlet pipes to be ~63 l/s. The maximum rainfall flows amount to ~187 l/s (as discussed in section 3.6.2). This would result in surface water flooding during times of extreme rainfall which would contribute to the surface water flooding shown above.

5.2.4 The proposed development will provide suitable drainage arrangements for all areas within the site boundary, with the onsite drainage designed to accommodate all storms up to and including 1 in 100 year + 40% climate change. The runoff rates from site will also be reduced, as a result helping with any existing sewer capacity concerns.

5.2.5 The risk of surface water flooding to the development is low.

5.3 Flooding from Groundwater

5.3.1 Groundwater flooding can occur after a prolonged period of rainfall, a considerable rise in the water table can result in inundation for extended periods of time.

5.3.2 The LBRuT web page contains an interactive map, which compiles information on the geology and the risks of groundwater flooding from numerous sources, such as the Environmental Agency (EA), GLA Drain London and the British Geological Survey (BGS). Summary of the results can be seen in the Table 3:

Source (Map)	Result
EA, Area Susceptible to Groundwater Flooding	75% or more
GLA Drain London, Increased Potential for Elevated Groundwater	Consolidated & Permeable Superficial
BGS, Susceptibility to Groundwater Flooding	Potential for groundwater flooding to occur at surface

Table 3, Groundwater vulnerability mapping summary

5.3.3 Based on the mapping information, the site is susceptible to groundwater flooding and mitigation measures will be required to ensure that the proposals are sufficiently protected from groundwater ingress.

5.3.4 The Geo-Environmental Report prepared by Enzygo Geoenvironmental Ltd (Aug 2021) states that the groundwater onsite was encountered at depths of between 2.2m and 4.3m below ground level. Further groundwater monitoring is being undertaken and will be used to inform any further design.

5.3.5 Groundwater will be considered during construction, especially during excavations and will have an impact on the below ground design, such as the drainage strategy. Additionally, all basements onsite will be designed to be safe from groundwater, a specialist waterproofing design will be implemented, to ensure that the required level of protection is achieved.

5.3.6 In terms of risk, the basements onsite are proposed to be used for 'less vulnerable' uses, such as car parking and plant. Therefore, in the unlikely event of the waterproofing measures failing, the consequences will be minimised. A separate Basement Impact Assessment is being submitted as part of the planning application.

5.3.7 Given the mitigation measures above, groundwater flooding is considered low risk.

5.4 Flooding from Sewers

5.4.1 The LBRuT web page contains an interactive map, which provides information on historic flooding incidents from sewers. The site lies within an area classified as "0 to 10 incidents recorded", which indicates a low risk of flooding from sewers.

5.4.2 The drainage strategy for the development aims to reduce the surface water runoff from site to greenfield. This will increase the capacity within the neighbouring sewer network – reducing any potential risk of surface water sewers flooding.

5.4.3 Thames Water have been consulted via a pre-development application and confirmed that the neighbouring sewer network has sufficient capacity.

5.4.4 The risk of flooding from sewers is low.

5.5 Flooding from Artificial Sources

5.5.1 The EA's Long-Term Flood Risk Information mapping indicates the potential extent of flooding from reservoir breach/failure. The site is safe from reservoir flooding while the river levels are normal.

5.5.2 Risk of flooding from reservoirs is very low, as in line with the Reservoirs Act 1975, reservoirs need to be regularly inspected and maintained, therefore reservoir flooding is unlikely.

5.5.3 Flood risk from artificial sources is considered to be low risk.

6 Proposed Drainage Strategy

6.1 Works to existing sewers

6.1.1 As highlighted in the earlier section of this report, there are numerous existing sewers onsite. There are three sewers which are identified to convey water from outside of the site, which will need to be retained or diverted. A description of the proposed works to the existing sewers can be found in Table 4 below.

Existing route of sewer	Proposed Works	Comment
Pumped Foul Water rising mains to the west of the site.	To be retained.	The proposed layout has allowed for the existing sewer easement. This easement is a big constraint onsite and has a significant impact on the landscaping and the drainage strategy.
Gravity Foul Water 225mmØ sewer between manholes TW1405 – TW1204.	To be diverted.	The existing route of the sewer cannot be accommodated within the proposals and must be diverted towards the 225mmØ sewer in Ham Street, through the Green. Thames Water have been consulted and confirmed capacity for the diversion.
Gravity Surface Water 225mmØ sewer from existing car park (from manhole TW2304).	To be abandoned	Sewer underneath the proposed structure. Any existing connections will be diverted towards the new connection into sewer in Ashburnham Road.
All other drains onsite.	To be abandoned	All other drains onsite appear to only serve the existing development. As the proposals are to demolish the existing buildings, the drains will become redundant and will be abandoned.

Table 4, Works to Existing Sewers

6.1.2 To complete the diversions and sewer abandonments, Section 185 applications will be made to Thames Water during the next design stage.

6.2 Foul Water Drainage

6.2.1 A new foul water drainage network will be required to service the proposed development. The new network will collect and convey foul water discharge from the development to a point of connection on the existing sewer network.

6.2.2 As shown on the proposed drainage plan (Appendix E) two gravity foul water outfalls can be made to existing manholes TW1403 and TW1204.

6.2.3 Thames Water have been contacted via the pre-planning application and confirmed sufficient capacity for the neighbouring development. Confirmation can be found in Appendix G.

6.3 Surface Water Drainage

6.3.1 New surface water drainage will be required to drain surface water runoff from the proposed buildings. In line with the LBRuT Local Plan and the London Plan, the runoff from the proposed development will aim to restrict runoff rates to greenfield rates and the SuDS measures and discharge methods have been evaluated in accordance with the hierarchy, as shown in Table 5.

Hierarchy	Method	Feasibility	Comment
1	Rainwater use as a resource (rainwater harvesting / blue roofs).	✓	The proposals utilise green and blue roofs wherever possible.
2	Rainwater infiltration	X	Infiltration is not suitable for this site, due to minimum space requirements for soakaways to be positioned away from structures and the underlaying clay ground conditions.
3	Rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)	✓	Green roofs, raingardens and permeable paving will be utilised across the scheme.
4	Rainwater discharge direct to a watercourse (unless not appropriate)	X	There is no suitable watercourse near the site.
5	Controlled rainwater discharge to a surface water sewer or drain	✓	It is proposed to discharge towards the neighbouring surface water sewers at greenfield runoff rates.
6	Controlled rainwater discharge to a combined sewer	X	There are no combined sewers in the area.

Table 5, Surface Water Discharge Hierarchy

6.3.2 As highlighted above, the site will discharge towards the neighbouring surface water sewer. The site can accommodate green and blue roofs, raingardens, permeable paving and below ground attenuation tanks to treat and attenuate runoff. A drainage strategy included in Appendix E shows the possible sizes and locations of these SuDS features, extract can be seen in Figure 5.

Figure 5 Proposed Drainage Layout

6.3.3 Greenfield Runoff Tool (from UKSuDS website) was used to calculate the greenfield runoff rate for the site, extract can be found in Appendix F. The site aims to discharge at greenfield runoff rates of 11.7 l/s/ha for all storms up to and including a 1 in 100 year + 40% climate change.

6.3.4 The site has been split into catchments taking the phasing and the outfall locations into account. The storage requirement for each outfall has been calculated and summarised on the drainage strategy drawings in Appendix E, all calculations can be found in Appendix F.

6.3.5 Constraints within the ground, such as the Thames Water easement, tree root protections and the required space for the services limit how much attenuation can be provided within some of the catchments. As a result, Catchment 1 will only be able to provide 315m³ of the 355m³ required to restrict the runoff to the greenfield target of 8.4 l/s. Based on the avaliable storage, the achievable runoff rate for this catchment is 10.7 l/s (equivalent to ~15 l/s/ha), which still offers a significant improvement compared to the existing unmitigated scenario.

6.3.6 It's important to highlight, that although the greenfield rates are shown to be achievable for all other catchments, further constraints may emerge during the detailed design stages and runoff rates may need to be increased (as highlighted above with regards to Catchment 1). The drainage strategy for the Site is a 'best endeavours' aproach, to meet the greenfield rates, without the need for pumping.

6.3.7 In total, approximately 7,000m² of the site area will be attenuated via blue roofs, these will be restricted to approximately 11.1 l/s in total (see blue roof manufacturer calculations in Appendix F). The remaining site area will require approximately 1,570m³ of attenuation below ground. This is estimated to be split as ~340m³ of permeable paving, ~740m³ of podium storage (200mm of geo-cellular storage layer above the basement) and approximately 540m³ of attenuation tank storage.

6.3.8 This will provide a betterment of up to 97% over the existing unrestricted scenario, as shown in Table 6.

Storm	*Rainfall Intensity (mm/hr)*	*Existing Rainfall (l/s)*	Proposed Runoff (l/s)	*Betterment (%)*
1 in 1	*28.2*	*231.8*	37	*84%*
1 in 30	*86.0*	*708.4*	37	*95%*
1 in 100	*113.8*	*936.9*	37	*96%*
1 in 100 + 40%	*159.3*	*1311.7*	37	*97%*

Table 6, Existing vs Proposed Runoff Rates

6.4 Water Quality

6.4.1 Surface water management should incorporate sustainable drainage techniques to restrict surface water discharge from the Site, in addition to improving water quality of runoff. Runoff from the proposed development may contain hydrocarbons, pollutants and nutrients which may be harmful if discharged directly to the ground.

6.4.2 It is proposed to utilise green and blue roofs, raingardens, permeable paving, and extensive green landscaping throughout the site to provide biodiversity, amenity, treatment and control the rate of runoff.

6.4.3 A SuDS pro-forma for LBRuT has been completed and can be found in Appendix G.

7 SuDS Management & Maintenance

7.1.1 SuDs features will be managed in accordance with the guidelines outlined within The SuDS Manual (CIRIA C753, Chapter 32).

7.1.2 The drainage infrastructure to be constructed as part of proposed development will be a mixture of adopted and privately owned. All diversions and public sewers will be maintained by Thames Water. All other drainage infrastructure will be maintained privately, by a management company.

7.1.3 As the scheme is progressed management and maintenance practices for taking care of the SuDS/drainage infrastructure will be constantly reviewed and updated with a final confirmed plan to be detailed at the completion of the construction.

7.1.4 SuDS features will be managed in accordance with the guidelines in Ciria C753, Chapter 32. As this is early in the application process the final details of the SuDS system and exact maintenance requirements are not yet fully known. However, a few fundamental actions can be specified now, these are noted in the maintenance schedule in Appendix H.

8 Conclusions and Recommendations

8.1.1 It is considered that this assessment represents a comprehensive and robust analysis of the flood impact of the current proposals on the Site itself and on adjacent properties. In addition, this report demonstrates that the proposed development can be delivered sustainably in terms of flood risk, which can be summarised as follows:

Subject	Conclusion
TIDAL & FLUVIAL FLOOD RISK	The Development is located in Flood Zone 1 – classified as low probability for tidal and fluvial flooding on the Environment Agency flood maps.
FLOOD RISK FROM OTHER SOURCES	Groundwater risk is considered to be mitigated through waterproofing of the basement and using it for less vulnerable uses such as parking and plant space. All other sources of flood risk are considered low risk.
DEVELOPMENT SUITABILITY	The proposed land-use is considered suitable for the Site which lies within Flood Zone 1 – all vulnerability classifications appropriate in accordance with Table 3 of the NPPG Technical Guidance.
EXISTING DRAINAGE	The existing Site is drained via sewers onsite and within the neighbouring roads. The existing TW rising main will be retained and the foul water sewer will be diverted. Thames Water have been consulted regarding the proposals.
PROPOSED DRAINAGE	The London Plan drainage hierarchy has been followed to provide a reduction in runoff rates to as close as possible to greenfield rates, for all storms of up to and including 1 in 100 years + 40% climate change. The proposals will discharge both surface and foul water towards the neighbouring sewers; Thames Water have been consulted and confirmed capacity for the development.
SURFACE WATER MANAGEMENT	Proposals will utilise green and blue roofs, raingardens, permeable paving, and extensive green landscaping throughout the site to provide biodiversity, amenity, treatment and control the rate of runoff. Overland flow routes have been considered in the design, a SuDS Proforma has been completed and a Maintenance Schedule has been provided as part of this report.

Table 7, Summary Table

Appendix A: Architectural Plans

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	02.11.21	First Issue	JB	CD

Client Name: Hill

Project Name: Ham Close Regeneration

Drawing Name: Site Location Plan

Drawing Number:	Rev:	Status:
HCR-BPTW-S01-ZZ-DR-A-0100	C01	A3

Project No:	RIBA Stage:	Drawn By:	Scale:
21-090	03	JB	1:1250 @ A3

PLANNING ISSUE

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KEY

- Planning red line boundary
- OOLTI
- Tree to be retained & RPA
- Tree to be removed
- Proposed buildings
- Basement outline
- FW Sewer & easement zone

Storeys — A 4 | 12 — Block/Terrace Letter, Units

Notes:
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Revisions:

Rev	Status	Date	Description	Drn	Chkd
P01	S3	18.11.21	Updated to revised masterplan	JB	
P02	S4	23.12.21	Masterplan Design Freeze	JB	CD
P03	S4	18.01.22	Masterplan Design Freeze	JB	CD
P04	S4	18.02.22	Design Freeze	JB	CD

Client Name: Hill

Project Name: Ham Close Regeneration

Drawing Name: Draft Masterplan

Drawing Number: HCR-BPTW-ZZ-ZZ-SK-A-7426 | Rev: P04 | Status: S4

Project No: 21-090 | RIBA Stage: 03 | Drawn By: JB | Scale: 1:500 @ A1

PRELIMINARY - FOR APPROVAL

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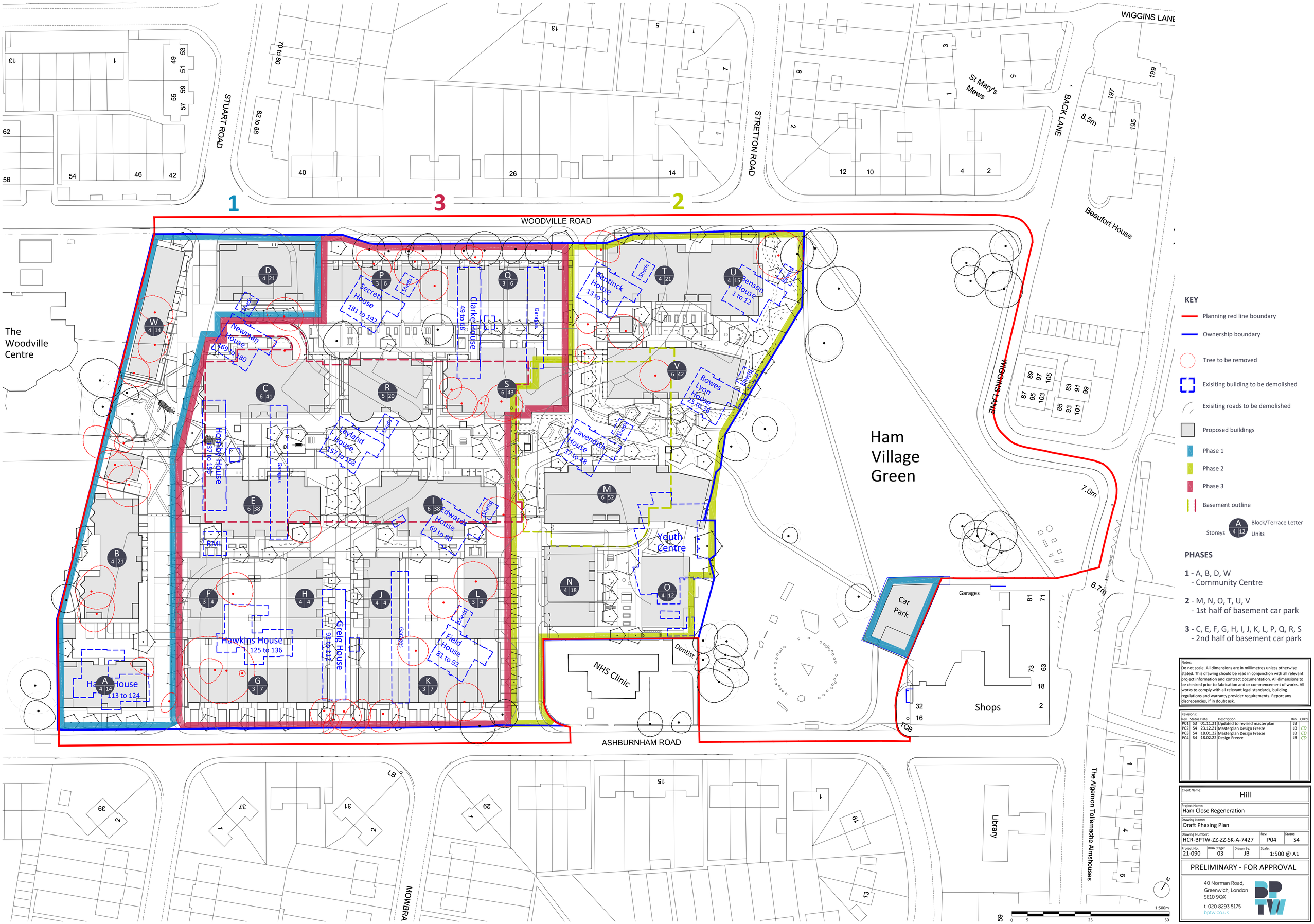

KEY

- Planning red line boundary
- Ownership boundary
- Tree to be removed
- Exisiting building to be demolished
- Exisiting roads to be demolished
- Proposed buildings
- Phase 1
- Phase 2
- Phase 3
- Basement outline
- Storeys / Block/Terrace Letter / Units

PHASES

1 - A, B, D, W
- Community Centre

2 - M, N, O, T, U, V
- 1st half of basement car park

3 - C, E, F, G, H, I, J, K, L, P, Q, R, S
- 2nd half of basement car park

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
P01	S3	01.11.21	Updated to revised masterplan	JB	
P02	S4	23.12.21	Masterplan Design Freeze	JB	CD
P03	S4	18.01.22	Masterplan Design Freeze	JB	CD
P04	S4	18.02.22	Design Freeze	JB	CD

Client Name: Hill

Project Name: Ham Close Regeneration

Drawing Name: Draft Phasing Plan

Drawing Number:	Rev:	Status:
HCR-BPTW-ZZ-ZZ-SK-A-7427	P04	S4

Project No:	RIBA Stage:	Drawn By:	Scale:
21-090	03	JB	1:500 @ A1

PRELIMINARY - FOR APPROVAL

40 Norman Road,
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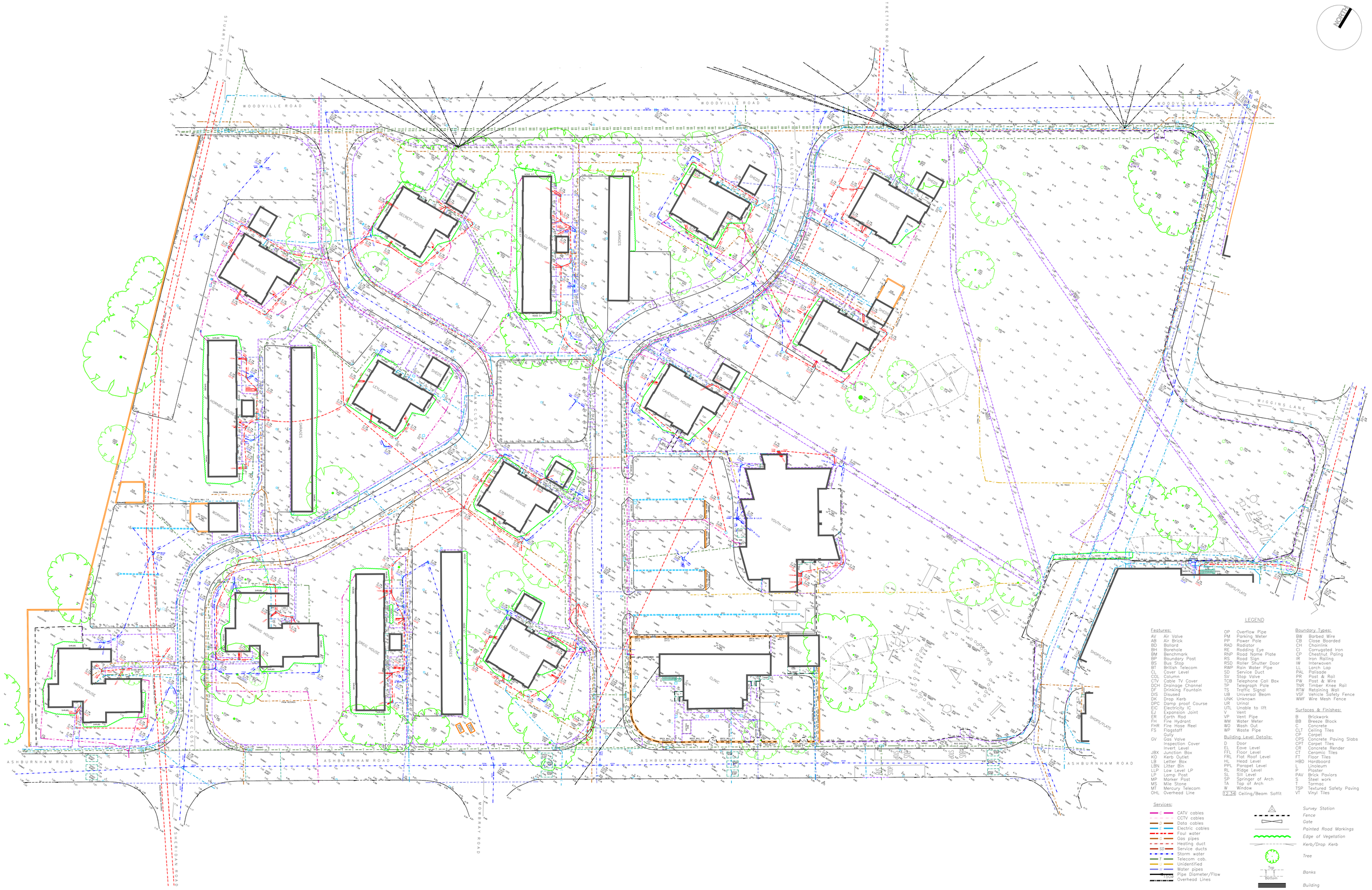
Appendix B: Topographical Survey



LEGEND

Features:

AV	Air Valve
AB	Air Brick
BD	Bollard
BH	Borehole
BM	Benchmark
BP	Boundary Post
BS	Bus Stop
BT	British Telecom
CL	Cover Level
COL	Column
CTV	Cable TV Cover
DCH	Drainage Channel
DF	Drinking Fountain
DIS	Disused
DK	Drop Kerb
DPC	Damp proof Course
EIC	Electricity IC
EJ	Expansion Joint
ER	Earth Rod
FH	Fire Hydrant
FHR	Fire Hose Reel
FS	Flagstaff
GV	Gully Gas Valve
	Inspection Cover
	Invert Level
JBX	Junction Box
KO	Kerb Outlet
LB	Letter Box
LBN	Litter Bin
LLP	Low Level LP
LP	Lamp Post
MP	Marker Post
MS	Mile Stone
MT	Mercury Telecom
OHL	Overhead Line
OP	Overflow Pipe
PM	Parking Meter
PP	Power Pole
RAD	Radiator
RE	Rodding Eye
RNP	Road Name Plate
RS	Road Sign
RSD	Roller Shutter Door
RWP	Rain Water Pipe
SD	Service Duct
SV	Stop Valve
TCB	Telephone Call Box
TP	Telegraph Pole
TS	Traffic Signal
UB	Universal Beam
UNK	Unknown
UR	Urinal
UTL	Unable to lift
V	Vent
VP	Vent Pipe
WM	Water Meter
WO	Wash Out
WP	Waste Pipe

Building Level Details:

D	Door
EL	Eave Level
FFL	Floor Level
FRL	Flat Roof Level
HL	Head Level
PPL	Parapet Level
RL	Ridge Level
SL	Sill Level
SP	Springer of Arch
TA	Top of Arch
W	Window
12.34	Ceiling/Beam Soffit

Boundary Types:

BW	Barbed Wire
CB	Close Boarded
CH	Chainlink
CI	Corrugated Iron
CP	Chestnut Paling
IR	Iron Railing
IW	Interwoven
LL	Larch Lap
PAL	Palisade
PR	Post & Rail
PW	Post & Wire
TNR	Timber Knee Rail
RTW	Retaining Wall
VSF	Vehicle Safety Fence
WMF	Wire Mesh Fence

Surfaces & Finishes:

B	Brickwork
BB	Breeze Block
C	Concrete
CLT	Ceiling Tiles
CP	Carpet
CPS	Concrete Paving Slabs
CPT	Carpet Tiles
CR	Concrete Render
CT	Ceramic Tiles
FT	Floor Tiles
HBD	Hardboard
L	Linoleum
P	Plaster
PAV	Brick Paviors
S	Steel work
T	Tarmac
TSP	Textured Safety Paving
VT	Vinyl Tiles

Services:

C	CATV cables
C	CCTV cables
D	Data cables
E	Electric cables
FW	Foul water
G	Gas pipes
H	Heating duct
SD	Service ducts
SW	Storm water
T	Telecom cab.
U	Unidentified
W	Water pipes
75x50	Pipe Diameter/Flow
	Overhead Lines

Survey Station
Fence
Gate
Painted Road Markings
Edge of Vegetation
Kerb/Drop Kerb
Tree
Top / Bottom
Banks
Building
Overhead Building Detail
Wall

Notes:

Do not scale. All dimensions to be checked on site. This drawing is copyright of bptw partnership.

Topographical information on this drawing was produced for RHP by EDI.

Notes:

Revisions:

Rev		Date	Drwn	Chkd
*	First Issue	21.01.2019	CD	CB

Revisions:

Rev		Date	Drwn	Chkd

Revisions:

Rev		Date	Drwn	Chkd

Revisions:

Rev		Date	Drwn	Chkd

FOR COMMENTS ONLY

Date: JAN 2019	Client: RHP		
Drawn: CD	Project: Ham Close - Further Appraisal		
Check: CB	Title: Topographical Survey		
Scale: 1:300 @ A0	Dwgno: J17.114 / SK3000	Revision: *	

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Appendix C: Soil Investigation Report

enzygo
geo environmental

Geo-Environmental Report

Ashburnham Rd, Richmond, TW10 7PB
for:

Hill Residential Ltd

'Experience and expertise working in union'

enzygo.com

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Geo-Environmental Report

Project:	Ham Close, Ham, Richmond Upon Thames, TW10 7PG
For:	Hill Residential Ltd
Ref:	CRM.1027.087.GE.R.004.
Status:	Revision D
Date:	April 2022
Author:	Steve Rhodes **Director**
Reviewer:	Richard Hamilton **Director of Geoenvironmental**

Executive Summary

Proposed Development

This document is a report of this survey and has been produced to support a planning submission for the site which seeks the demolition of the existing buildings on-site and phased mixed-use development comprising 452 residential homes (Class C3) up to six storeys, a Community/Leisure Facility (Class F2) of up to three storeys in height, a "MakerLabs" (sui generis) of up to two storeys together with basement car parking and site wide landscaping.

Investigation

Site investigation, desk study and monitoring visits were undertaken by Enzygo Geoenvironmental Ltd.

Ground Conditions

Ground Conditions comprise Made Ground over firm clay and loose becoming dense with depth sand and gravel. Shallow groundwater was not encountered.

Contamination

Elevated PAH, Lead and Arsenic was encountered together with asbestos. Remediation and management procedures are proposed.

Foundations

Spread foundations should be suitable for domestic houses but piled foundations are likely to be required for apartments.

Pavement Design

An equilibrium CBR of 3% is recommended. Soils are not considered to be frost susceptible.

Buried Concrete

It is recommended that Class AC-1s conditions of Special Digest 1 are used.

Ground Gas and Radon

No radon risk has been identified. No significant ground gas has been measured.

TABLE OF CONTENTS

1.0 INTRODUCTION

Background

1.1 Enzygo Geoenvironmental Limited has been commissioned to prepare a Geo-Environmental Report for a site at Ham Close, Ham, Richmond Upon Thames, TW10 7PG.

Proposed Development

1.2 This document is a report of this survey and has been produced to support a planning submission for the site which seeks the demolition of the existing buildings on-site and phased mixed-use development comprising 452 residential homes (Class C3) up to six storeys, a Community/Leisure Facility (Class F2) of up to three storeys in height, a "MakerLabs" (sui generis) of up to two storeys together with basement car parking and site wide landscaping.

Objectives

1.3 The objectives of the study are to:

- Review an existing Phase I desk study, a copy of which is included in Appendix A;
- Undertake a ground investigation;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors; and
- Provide a factual and interpretative report relating to the desk study and site investigations. Provide a revised conceptual model and recommendations on any potential development issues and mitigation measures, where appropriate.
- Provide geotechnical recommendations in relation to foundations and infrastructure.

Risk Classification

1.4 Enzygo Geoenvironmental has utilised the available information, together with our experience to assess the likely risks to development from land quality issues. Definitions of the risk terms used are provided on the following table.

Risk	Description
Negligible	No contamination risk has been identified which is likely to affect development.
Low	No significant contaminated land risks have been encountered affecting development and a low risk that remediation will be required.
Low-Moderate	There are unlikely to be significant contaminated land issue associated with the site which will adversely affect its re-development. However, minor or localised contamination may be present requiring remediation. Remediation should be possible under a discovery strategy and with a call out service.
Moderate	Some potential contaminated land risks have been encountered or identified which may affect re- development. The risks identified are unlikely to affect the entire site or preclude development. Remediation is considered feasible as part of the development process and no further investigation is considered necessary.
Moderate-High	Some potentially significant contaminated land risks have been identified at the property that requires remediation. It is recommended that a separate remedial methodology is prepared supported by a site-specific risk assessment
High	Significant potential contaminated land risks have been identified and remediation is required supported by further intrusive ground investigation, risk assessment and remedial design.

1.5 Where adverse risks from ground instability are identified these are discussed within the report.

2.0 SITE SETTING

Site Description

Item	Description
Site Address	Ham Close, Ham, Richmond Upon Thames, TW10 7PG
National Grid Reference	Site centred at National Grid Reference TQ0030585 and Ordnance Survey Co-ordinates 550309, 158566.
Site Area	4.7 Ha

Current Site Description

2.1 The following site description has been compiled from the site inspection undertaken by Enzygo Geoenvironmental staff, together with current maps, aerial photographs and a topographical survey.

2.2 The site comprises existing residential buildings arranged in five storey blocks, four storey deck access flats and three storey 'T' shaped blocks. The public realm consists of large areas of surface parking and amenity grassland with scattered trees. The Youth Centre and associated car park occupies a central location on the site. Ham Village Green sits at the eastern edge of the site. The site is bound by Woodville Road to the north, Wiggins Lane and Ham Street to the east, Ham Clinic and Ashburnham Road to the south and St Richard's C of E Primary School playing fields and the children's garden pre-school to the west.

2.3 Internal roadways, parking areas and lock-up garages were present between the apartment blocks.

2.4 Within the southern area of the site an amenity hall, clinic and estate office are present with associated parking.

2.5 The eastern area of the site is open land vegetated with grass and including footpaths.

2.6 An electricity sub station is present on the western boundary. This appears to be of modern construction with no evidence of leakage. The sub-station is not considered a significant risk.

Surrounding Area

2.7 The surrounding land uses are summarised as follows:

Direction	Land Use
South	Ashburnham Road with residential development beyond.
East	Wiggins Lan with residential development beyond.
West	School and open space.
North	Woodville Road with residential development beyond.

2.8 No significant sources of potential contamination were noted on or adjacent to the site.

3.0 SITE HISTORY

3.1 A review of historical Ordnance Survey maps and information pertinent to the site obtained from the existing desk study report is summarised below:

3.2 The site is shown as open land prior to construction of a farm in the eastern part of the site by 1868.

3.3 The site was redeveloped for residential use by 1947. A ruin is shown in the eastern part of the site by 1959 which is likely to be from bomb damage.

3.4 The current residential development is shown by 1983 and with open space in the east.

3.5 There is the potential for Made Ground associated with historic buildings, demolished prior to the current development. No other significant potential sources identified on or near to the site.

3.6 No significant off-site contamination sources are identified.

3.7 A low Unexploded Ordnance Risk was identified in relation to ground investigation works.

4.0 ENVIRONMENTAL SETTING

Ground Conditions

4.1 The British Geological Survey (BGS) indicates that the site is underlain by the following geological sequence:

Geological Unit	Type	Description	Aquifer Classification
Drift	Kempton Park Gravels	Sand and Gravel	Secondary A
Solid	London Clay	Clay	Unproductive

4.2 There are no records of Made Ground below the site. Made Ground is shown 41m south west. Given the distance from the site this is not considered a significant risk.

4.3 There are no records of landslips on the site.

4.4 BGS borehole records on site show 0.6m of Made ground over gravel and with London Clay encountered at depths of 6m.

Groundwater

4.5 The Desk Study Report shows that the site is not within a Source Protection Zone.

4.6 BGS records show that the site is at potential risk of groundwater flooding.

Coal Mining

4.7 No historical or current coal mining extraction has been identified within 1000m of the site.

Non Coal Mining

4.8 No other mining activity has been identified within 1000m of the site.

Cavities

4.9 No natural cavities or solution features are identified on site.

Hydrology

4.10 There are no water courses on the site.

4.11 Environment Agency records show that the site is not within an Environment Agency Flood Zone.

Radon Risk Potential

4.12 The Groundsure GeoInsight Report indicates that the site is not within a Radon Affected Area. No radon protective measures are necessary in the construction of new dwellings.

Natural Hazards Finding

4.13 BGS information presented within the Groundsure Geoinsight report identifies the following:

Hazard	Risk Designation (Groundsure)
Coal Mining.	None Identified.
Collapsible Ground.	Very Low.
Compressible Ground.	Very Low.
Ground Dissolution.	Very Low.
Landslide.	Very Low.
Running Sand.	Very Low.
Swelling / Shrinking Clay.	Very Low.

4.14 No significant geotechnical risks are identified.

Sensitive Land Uses

4.15 There are no sites of special interest on or surrounding the site.

4.16 English Heritage has not identified any listed buildings or scheduled ancient monuments on or close to the site. No sensitive geology has been identified at the site.

Environmental Sensitivity

4.17 Overall the site is currently considered to be of low/moderate sensitivity due to the following:

- The underlying stratum is classified as a Secondary A Aquifer;
- Not within a source protection zone;
- No surface water courses on or adjacent to the site; and
- No sensitive ecology is noted adjacent to or on the site.

4.18 The proposed end use of the site is residential and as such future sensitivity will be high for end users.

Industrial Land Uses

4.19 No significant current industrial activities are identified on or adjacent to the site.

Landfill Sites and Waste Treatment Sites

4.20 There are no active or historic landfills within 250m of the site.

Planning Records

4.21 A review of London Borough of Richmond's planning history shows no relevant information for the site.

5.0 PREVIOUS REPORTS

5.1 No previous ground investigation reports were provided.

6.0 PRELIMINARY CONCEPTUAL MODEL

6.1 Based on the desk study information the following Preliminary Conceptual Model has been prepared:

Source	Location	Exposure Pathway	Potential Receptor	Probability of Exposure	Details
Human Health					
Asbestos, Hydrocarbon and metals.	Unforeseen Contamination.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal site management practices and PPE will address risk.
			Site users.	Negligible.	No source identified.
Asbestos, Hydrocarbon and metals.	Made Ground.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal PPE will address risk.
			Site users.	Very Low.	If present can easily be addressed through development.
Hydrocarbon and metals.	Potential migration from off-site source.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	No significant off site sources identified.
			Site users.		
Ground Gas.	Historic Landfill.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No source identified.
			Site users.		
	Potential Made Ground.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No significant source identified.
			Site users.		
Groundwater					
Hydrocarbon and metals.	Potential spillage on site.	Vertical Migration.	Groundwater.	Dismissed.	No source identified.
Surface Water					
Hydrocarbon and metals.	Potential spillage on site.	Horizontal Migration.	River Network.	Dismissed.	No source or credible receptor.
Environmental Receptors					
On site contaminants		Ingestion dermal and inhalation.	Ecology.	Dismissed.	No sensitive ecology designation.
		Direct.	Archaeology.	Dismissed.	None present.
		Direct.	Geology.	Dismissed.	No sensitive receptor present.
		Phytotoxic.	Woodland.	Dismissed.	None present.
		Phytotoxic.	Crops.	Dismissed.	No source identified.
		Ingestion dermal and inhalation.	Livestock.	Dismissed.	No source identified.
Building Services					
On site contaminants		Direct.	Historic Buildings.	Dismissed.	None present.
		Direct.	Proposed Buildings.	Dismissed.	No source identified.
		Permeate into pipework.	Water Pipes.	Dismissed.	No significant source identified.

6.2 There is a very low risk from Made Ground, including former buildings which will be investigated. Should contamination be present this can easily be addressed through development. No other significant risks are identified.

7.0 SITE INVESTIGATION

General

7.1 A ground investigation was undertaken based on the findings of the desk study. The locations of the exploratory holes are shown on Drawing CRM.1027.087.GE.D.001.

Site Works

7.2 The site investigation works comprised window sampler holes (WS1 to WS18) advanced between 27th and 29th April 2021 and six deep boreholes (BH1 to BH6) advanced between 16th and 19th August 2021.

7.3 A subsequent visit was undertaken during October 2021 with six window sampler holes (WS101 to WS106) being advanced on 25th October 2021 in areas of car park where access was not previously permitted. Six soakaway tests (SA1 to SA6) were undertaken on 26th and 27th October 2021.

7.4 Exploratory hole locations were determined to provide general coverage of the site within areas where access was permitted by the land owner. The investigation works are summarised in the table below:

Rational	Exploratory Holes	Notes
Site Coverage.	WS1 to WS18.	Across site.
Car park areas	WS101 to WS106	Car parks
Soakaways	SA1 to SA6	To assess viability of soil infiltration.
Monitoring.	WS5 WS6 WS7 WS9 WS14 WS16 & WS18.	Installations.
Deep foundations.	BH1 to BH6.	Deep boreholes.

7.5 Strength of soils were assessed using Standard Penetration Tests (SPT). The results of which are included on the borehole logs presented in Appendix B.

7.6 Representative soil samples were collected for chemical and geotechnical testing. Soil samples destined for chemical analysis were collected in appropriate containers provided by the analytical laboratory. Samples were stored in cool boxes prior to dispatch to the laboratory for analysis. All samples were collected using appropriate sampling equipment that was cleaned at each sampling location.

7.7 Generally samples were collected from Made Ground, which may contain potential inclusions of contaminating materials and materials displaying evidence of potential contamination.

7.8 In the absence of any evidence of contamination samples were collected near surface as this material is more likely to be contaminated by surface spillages and also will potentially be in contact with future residents.

Monitoring

7.9 Return visits to monitor groundwater levels were undertaken and during these visits ground gas was also measured.

Laboratory Testing

7.10 Samples for geotechnical testing were sent to the laboratories of I2, which is UKAS accredited, for the following analysis:

- California Bearing Ratio(CBR) tests undertaken on re-compacted samples
- Atterberg Limits Determinations;
- Moisture Content; and
- Soluble sulphate and pH.

7.11 Samples for chemical analysis were sent to the laboratories of The I2 Ltd who are UKAS and MCERTS accredited. Samples were tested for the CLEA metal suite, pH, sulphate, cyanide, phenols, speciated Polycyclic Aromatic Hydrocarbons (PAH), organic carbon, banded Total Petroleum Hydrocarbon (TPH), asbestos quantification, and two stage WAC tests.

8.0 GROUND AND GROUNDWATER CONDITIONS

Summary of Ground and Groundwater Conditions

8.1 The investigations undertaken by Enzygo Geoenvironmental Ltd identify the following strata:

Strata	Summary Description	Thickness (m)
Made Ground	Brown and grey clayey fine sand and flint gravel with fragments of brick concrete and ash.	0.4 to 1.2
Kempton Park Gravels	Firm and stiff brown clay and gravelly clay.	0 to 0.9
	Loose becoming medium dense and dense with depth brown sand and flint gravel.	3.8 to 5.3
London Clay	Stiff grey brown silty clay with occasional claystone gravel.	>20
Groundwater	Seepages	2.2m to 4.3 bgl.

8.2 Details of the ground and groundwater conditions encountered are given on the exploratory hole records included in Appendix B and are summarised in the sections below:

Made Ground

8.3 Made Ground was encountered across the site comprising brown and grey clayey fine sand and flint gravel with fragments of brick concrete and ash.

8.4 This material is consistent with typical Made Ground comprising natural soils with anthropogenic inclusions associated with demolition and removal of historic buildings

Kempton Park Gravels

8.5 The Kempton Park Gravels were encountered at depths of between 0.4m and 1.2m below ground level (bgl). The upper horizon of the Kempton Park Gravels generally comprised firm and stiff brown clay and gravelly clay.

8.6 The clay layer was underlain by loose becoming medium dense and dense with depth brown sand and flint gravel. The granular Kempton Park Gravels were encountered at depths of between 0.4m and 1.5m bgl.

London Clay

8.7 The London Clay was only encountered in deep boreholes and comprised stiff grey brown silty clay with occasional claystone gravel.

Visual and Olfactory Evidence of Contamination

8.8 Potential asbestos fragments were encountered in Window Sampler boreholes WS6 and WS8. No other visual or olfactory evidence of contamination was encountered during the site works. Samples of potential asbestos were collected for laboratory testing and this is discussed in Section 9.

Soil Strength

8.9 Undrained shear strength of cohesive Kempton Park Gravels were calculated using the correlations of Stroud and Butler. These show the undrained shear strength values to vary from 45kN/m^2 to 100kN/m^2 at 1m bgl. Granular soils ere noted to be loose medium dense and dense with depth. SPT values increasing 7 at 1m bgl to over 50 at 4m bgl being recorded.

8.10 London Clay was noted to have undrained shear strength values increasing from 60kN/m^2 at 6m to 170kN/m^2 at 25m bgl.

Groundwater

8.11 Groundwater was encountered as a seepages at depths of between 2.2m to 4.3 bgl from within the Kempton Park Gravels. The depth to groundwater measured during the monitoring visit is summarised on the table below:

Exploratory Hole	Depth m(bgl)					
	12.5.21	19.5.21	2.6.21	16.6.21	30.6.21	14.7.21
WS5	Dry	Dry	Dry	Dry	Dry	Dry
WS6	Dry	Dry	Dry	Dry	Dry	Dry
WS7	Dry	Dry	Dry	Dry	Dry	Dry
WS9	Dry	Dry	Dry	Dry	Dry	Dry
WS14	Dry	Dry	Dry	Dry	Dry	Dry
WS16	Dry	Dry	Dry	Dry	Dry	Dry
WS18	Dry	Dry	Dry	Dry	Dry	Dry

Ground Gas

8.12 Ground gas was monitored during the return visit to monitor groundwater levels and the results are summarised on the table below:

Exploratory Hole	Atmos pressure (Mb)	Flow (l/hr)	CH4		CO2		O2
			Concentration (%)	GSV (l/hr)	Concentration (%)	GSV (l/hr)	Concentration (%)
12.5.21							
WS5	997	<0.1	<0.1	<0.0001	1.8	<0.0018	19.5
WS6	997	<0.1	<0.1	<0.0001	1.8	<0.0018	19.4
WS7	997	<0.1	<0.1	<0.0001	1.5	<0.0015	19.1
WS9	997	<0.1	<0.1	<0.0001	1.2	<0.0012	19.3

WS14	997	<0.1	<0.1	<0.0001	1.6	<0.0016	18.9
WS16	997	<0.1	<0.1	<0.0001	0.8	<0.0008	18.8
19.5.21							
WS5	1017	<0.1	<0.1	<0.0001	1.9	<0.0019	18.1
WS6	1017	<0.1	<0.1	<0.0001	1.1	<0.0011	18.8
WS7	1017	<0.1	<0.1	<0.0001	2.0	<0.0020	18.0
WS9	1017	<0.1	<0.1	<0.0001	1.3	<0.0013	19.6
WS14	1017	<0.1	<0.1	<0.0001	1.7	<0.0017	18.2
WS16	1017	<0.1	<0.1	<0.0001	1.4	<0.0014	18.9
WS18	1017	<0.1	<0.1	<0.0001	1.1	<0.0011	19.6
2.6.21							
WS5	1014	<0.1	<0.1	<0.0001	2.1	<0.0021	18.2
WS6	1014	<0.1	<0.1	<0.0001	1.2	<0.0012	18.6
WS7	1014	<0.1	<0.1	<0.0001	1.7	<0.0017	18.5
WS9	1014	<0.1	<0.1	<0.0001	1.2	<0.0012	19.1
WS14	1014	<0.1	<0.1	<0.0001	1.6	<0.0016	18.8
WS16	1014	<0.1	<0.1	<0.0001	1.5	<0.0015	18.7
WS18	1014	<0.1	<0.1	<0.0001	1.0	<0.0010	19.7
16.6.21							
WS5	1009	<0.1	<0.1	<0.0001	2.1	<0.0023	18.3
WS6	1009	<0.1	<0.1	<0.0001	1.4	<0.0014	18.7
WS7	1009	<0.1	<0.1	<0.0001	1.5	<0.0015	18.8
WS9	1009	<0.1	<0.1	<0.0001	1.3	<0.0013	19.2
WS14	1009	<0.1	<0.1	<0.0001	1.6	<0.0016	18.9
WS16	1009	<0.1	<0.1	<0.0001	1.7	<0.0017	18.5
WS18	1009	<0.1	<0.1	<0.0001	0.7	<0.0007	19.9
30.6.21							
WS5	1015	<0.1	<0.1	<0.0001	1.8	<0.0018	18.2
WS6	1015	<0.1	<0.1	<0.0001	1.3	<0.0013	18.9
WS7	1015	<0.1	<0.1	<0.0001	1.6	<0.0016	18.7
WS9	1015	<0.1	<0.1	<0.0001	1.4	<0.0014	18.9
WS14	1015	<0.1	<0.1	<0.0001	1.5	<0.0015	19.0
WS16	1015	<0.1	<0.1	<0.0001	1.6	<0.0016	18.8
WS18	1015	<0.1	<0.1	<0.0001	1.0	<0.0010	19.2
14.7.21							
WS5	1017	<0.1	<0.1	<0.0001	1.9	<0.0019	18.3
WS6	1017	<0.1	<0.1	<0.0001	1.5	<0.0015	18.9
WS7	1017	<0.1	<0.1	<0.0001	1.6	<0.0016	18.7
WS9	1017	<0.1	<0.1	<0.0001	1.2	<0.0012	18.7
WS14	1017	<0.1	<0.1	<0.0001	1.7	<0.0017	18.8
WS16	1017	<0.1	<0.1	<0.0001	0.9	<0.0009	19.3
WS18	1017	<0.1	<0.1	<0.0001	0.8	<0.008	19.5

8.13 No significant ground gas has been measured.

Soakaways

8.14 Results of the soakaway testing is provided on the table below:

Soakaway	Depth (m bgl)	Test No	Soil Infiltration Rate	
SA 1	2.0	Test 1	Insufficient soakage	
SA 2	2.0	Test 1	$9.1E^{-6}$ m/s	
SA 3	2.0	Test 1	Insufficient soakage	
SA4	2.1	Test 1	$5.6E^{-6}$ m/s	
SA5	2.0	Test 1	Insufficient soakage	
SA6	2.0	Test 1	$7.7E^{-4}$m/s	Extrapolated

9.0 CONTAMINATION ASSESSMENT

General

9.1 A Tier I risk assessment has been undertaken using available and current screening values for human health and where appropriate controlled waters. The risk assessment is undertaken based on the findings of the preliminary conceptual model presented in Section 6. Based on the contamination testing and Tier I assessment a revised Conceptual Model has been prepared, which is presented later in this section.

9.2 Where significant risks are identified remedial measures are recommended.

Human Health

9.3 Assessment of the risks to human health has been undertaken by comparing the soil quality data with reference values obtained from the Contaminated Land Exposure Assessment (CLEA), Soil Guideline Values (SGV) and General Acceptance Criteria (GAC) published by LQM and derived in consultation with the Chartered Institute of Environmental Health. The LQM/CIEH S4ULs values are used and summary tables of the reference values are included in Appendix C.

9.4 Where an exceedance is identified the risk is assessed by considering the sensitivity of the proposed development and the potential pathway. The proposed development comprises conventional residential houses with domestic gardens.

9.5 The GAC values for residential use with plant uptake are used as the development includes domestic properties.

9.6 The soil quality shows exceedances of the GAC values for the following contaminants.

Exploratory Hole	Determinant	Concentration (mg/kg)	
		GAC	Soil
WS2 0.2m	Asbestos	Absent	0.006%
	Arsenic	37	40
WS6 0.4m	Asbestos	Absent	<0.001%
WS8 0.4m	Asbestos	Absent	3.127%
	Benzo(b)fluoranthene	2.6	3.4
	Benzo(a)pyrene	2.2	2.6
	Dibenzo(a,h)anthracene	0.24	0.53
	Lead	200	320
WS1 0.4m	Benzo(b)fluoranthene	2.6	8.1
	Benzo(a)pyrene	2.2	7.0
	Dibenzo(a,h)anthracene	0.24	1.1
	Lead	200	310
WS10 0.4m	Lead	200	250

WS102 @ 0.3m	Lead	200	1400
WS104 @ 0.3m	Lead	200	510
WS105 @ 0.35m	Lead	200	320

9.7 No other exceedances were recorded.

Controlled Waters

9.8 Risk to groundwater resources is dismissed due to the absence of any significant source of mobile contamination.

9.9 The risk to surface waters risk has been dismissed within the Initial Conceptual Model. No new risks are identified.

Ground Gas

9.10 Following the guidance provided in Section 3 of CIRIA C665 an initial assessment is undertaken to determine if there are any significant sources of potential ground gas. Such sources include landfills, organic clays and made ground incorporating putrescible materials such as rags, paper and wood. Where no significant source is identified no further assessment is necessary.

9.11 This approach is further supported by supplementary guidance given in RB17, published by CL:AIRE which confirms that gas monitoring is not generally required on sites where Made Ground is less than 5m thick and with low organic matter content or on natural soils such as alluvial clays and Chalk as the ground gas sources are not considered significant. The supplementary guidance given in RB17 also takes account of the current requirements for sealing of floor slabs and substructures to meet air tightness requirements under Part L of the Building Regulations which were not considered in CIRIA C665. The advice given in RB17 is consistent with CIRIA C665 and the Local Authority Guide to Ground Gas published by CIEH.

9.12 Where significant potential risk from ground gas is identified from the Initial Conceptual Model and the intrusive ground investigation works ground gas monitoring is undertaken and the results of the monitoring are compared against the Gas Screening Values given in CIRIA Report 665. From this the Characteristic Situation is identified and remedial measures proposed.

9.13 When assessing the risk and type of remedial measures appropriate consideration is given to the likely construction of the development, the nature of the gas posing a risk and the nature of the likely source. The use of engineering judgement when determining risk from

ground gas is consistent with the recommendations given in CIRIA C665 using a pollutant linkage model.

9.14 Gas monitoring was undertaken during return visits which has not recorded elevated concentrations of Methane and no flow. Based on the gas monitoring undertake the Gas Screening Value is less than 0.07l/hr and therefore falls within Characteristic Situation 1 (CS1).

9.15 Additional monitoring is being undertaken.

Revised Conceptual Model

9.16 The Initial Conceptual Model presented in Section 6 has been revised based on the findings of the ground investigation and the revised Conceptual Model is presented below:

Source	Location	Exposure Pathway	Potential Receptor	Probability of Exposure	Details
Human Health					
Asbestos, Hydrocarbon and metals.	Made Ground.	Ingestion dermal and inhalation.	Construction Workers.	Low	Management procedures proposed.
			Site users.	Low	Remediation proposed.
Asbestos, Hydrocarbon and metals.	Unforeseen Contamination.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal PPE will address risk.
			Site users.	Negligible.	No source identified.
Hydrocarbon and metals.	Potential migration from off-site source.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	No source and no exceedance of GAC.
			Site users.		
Ground Gas.	Historic Landfill.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No significant source identified and no significant ground gas measured.
			Site users.		
	Potential Made Ground.	Inhalation & Explosive.	Construction Workers.		
			Site users.		
Groundwater					
Hydrocarbon and metals.	Potential spillage on site	Vertical Migration.	Groundwater	Dismissed.	No mobile source identified.
Surface Water					
Hydrocarbon and metals.	Potential spillage on site	Horizontal Migration.	River Network	Dismissed.	No source or credible receptor.
Environmental Receptors					
On site contaminants		Ingestion dermal and inhalation.	Ecology.	Dismissed.	No sensitive ecology designation.
		Direct.	Archaeology.	Dismissed.	None present.
		Direct.	Geology.	Dismissed.	No sensitive receptor present.
		Phytotoxic.	Woodland.	Dismissed.	None present.
		Phytotoxic.	Crops.	Dismissed.	No source identified.
		Ingestion dermal and inhalation.	Livestock.	Dismissed.	No source identified.
Building Services					
On site contaminants		Direct.	Historic Buildings.	Dismissed.	None present.
		Direct.	Proposed Buildings.	Dismissed.	No source identified.
		Permeate into pipework.	Water Pipes.	Dismissed.	No significant source identified.

9.17 Elevated Lead, Arsenic and PAH have been identified and it is recommended that remediation is undertaken.

9.18 Within areas of buildings and pavements the use of hardstanding will provide remediation by breaking the potential pollutant linkage. Within proposed soft landscape areas it is

recommended that clean cover soils are provided comprising 600mm in domestic garden areas and 400mm in communal areas over a geotextile no dig layer. Validation of the cover soils should be undertaken using hand pits with testing of cover soils.

9.19 Asbestos contaminated material has been identified during the ground investigation and it is possible that further material could be encountered during construction works. The use of clean cover soils discussed above will provide remediation to protect future site users. Measures should to be incorporated in to the Contractors Construction Stage Health and Safety Plan and asbestos management plan as required under the Construction Design and Management (CDM) Regulations to mitigate risk to construction works. Measures may include:

- Designing temporary works to minimise disturbance of the Back fill material;
- Separating material and disposal of soils containing asbestos;
- Wetting down during excavation;
- Sheeting of stockpiles where asbestos is suspected;
- Testing of soils and off-site disposal of any soils found or suspected of containing asbestos;
- Preventing access to the construction site by members of the public;
- Use of good hygiene measures, including washing down of plant; and
- Use of appropriate PPE, including face masks..

9.20 If unforeseen contamination is encountered during construction works such as localised spillage outside the areas investigated an Environmental consultant will be available on a 'call out' basis to undertake an assessment of risk. If 'unforeseen contamination' is encountered such as hydrocarbon contamination or solvent odours the discovery strategy will be to remove the source as it is likely to be very limited in extent or encapsulate it on site as appropriate and the Local Planning Authority advised.

9.21 As part of this discovery strategy it is recommended that additional investigation by trial pits is undertaken in areas of existing hardstanding where access can not currently be obtained to identify potential areas of contamination. This supplementary investigation is best undertaken following demolition works where safe access can be gained.

Waste Classification

9.22 Two part WAC test has been undertaken, the results of which are included in Appendix C. These show no exceedances above the inert threshold values PAH, TPH or TOC. Exceedance above leachable thresholds for Inert Waste by Antimony and Lead were recorded. In addition, asbestos above 0.1% has been recorded.

9.23 The Waste Management paper 2 has been updated to version 3 which states that sites which previously could be considered 'uncontaminated land' surplus soils if they did not exceed the GAC values now requires the landfill to make an appropriate assessment of the waste classification. As such final assessment, will be undertaken by the receiving landfill based on the requirements of their permit.

9.24 Based on the results received it is considered that Made Ground is likely to be classified as Stable Non Reactive Waste.

10.0 GEOTECHNICAL ASSESSMENT

Proposed Development

10.1 This document is a report of this survey and has been produced to support a planning submission for the site which seeks the demolition of the existing buildings on-site and phased mixed-use development comprising 452 residential homes (Class C3) up to six storeys, a Community/Leisure Facility (Class F2) of up to three storeys in height, a "MakerLabs" (sui generis) of up to two storeys together with basement car parking and site wide landscaping.

10.2 It is considered that the scheme meets the criteria of Geotechnical Category 1 of Eurocode 7.

Ground Conditions

10.3 Ground Conditions comprise Made Ground over firm clay and loose becoming dense with depth sand and gravel. This is underlain by London Clay comprising stiff clay.

10.4 Additional groundwater monitoring is being undertaken shortly pre-planning application and that the basement will be designed accordingly with the groundwater flood risk in mind.

Site Preparation

10.5 The site should be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the Specification for Highway Works. This should include:

- Any redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill; and
- Any tree roots should be grubbed out.

Foundations

10.6 It is considered that conventional strip foundations should be suitable for low rise buildings with wall loadings of 75kN/m or les assuming an allowable bearing capacity of 100kN/m^2 for natural soils at depths of 1.5m bgl. Within the natural firm clay or medium dense sand and gravel. An assessment of likely settlements has been undertaken and these are estimated to be less than 25mm.

10.7 Foundations may need to be stepped down locally where Made Ground is deeper. Foundations may also need to be deepened in accordance with NHBC requirements for building near trees. Foundations should be designed assuming soils of moderate shrinkage potential. It is recommended that foundations are reinforced to allow them to span both clay and granular soils.

10.8 No evidence of desiccation was noted.

10.9 It is likely that apartment blocks and structures with wall loadings above 75kN per m will require piled foundations.

10.10 For preliminary purposes and an initial pile assessment has been undertaken using the following assumptions:

- Upper 1.5m is ignored.
- Soil properties have been taken from the ground investigation and laboratory testing.
- A global factor of safety of 2.5 has been used, together with factors of 1.5 on shaft resistance and 3 on base resistance.

10.11 The following preliminary pile working loads have been calculated:

Pile depth (m bgl)	Working Load kN					
	200mm	250mm	300mm	350mm	450mm	600mm
10	80	100	125	150	200	300
15	150	180	235	280	370	530
20	220	290	350	420	560	770
25	320	400	500	590	780	1080

10.12 Final design should be undertaken by a specialist piling contractor who ca use case studies to negotiate more economic pile designs.

Ground Floor Slab

10.13 Based on thickness of Made Ground suspended floor slabs are recommended.

Pavement Construction

10.14 An assessment of the likely California Bearing Ratio (CBR) has been assessed from the following sources:

- Description of the materials encountered in the exploratory holes; and

- Guidance given in HD25/94.

10.15 Based on the above it is considered that an equilibrium CBR of 3% is suitable.

10.16 It is recommended that the sub-formation is proof rolled with any soft materials being excavated and replaced with suitable compacted capping.

10.17 Soils are not considered to be frost susceptible.

Drainage

10.18 Soakaway testing identified poor soil infiltration rates due to the clay content of the sand and gravel deposits. Soakaway drainage is not considered feasible.

10.19 Chemical results should be provided to the water authority to confirm the design of potable water supply pipes.

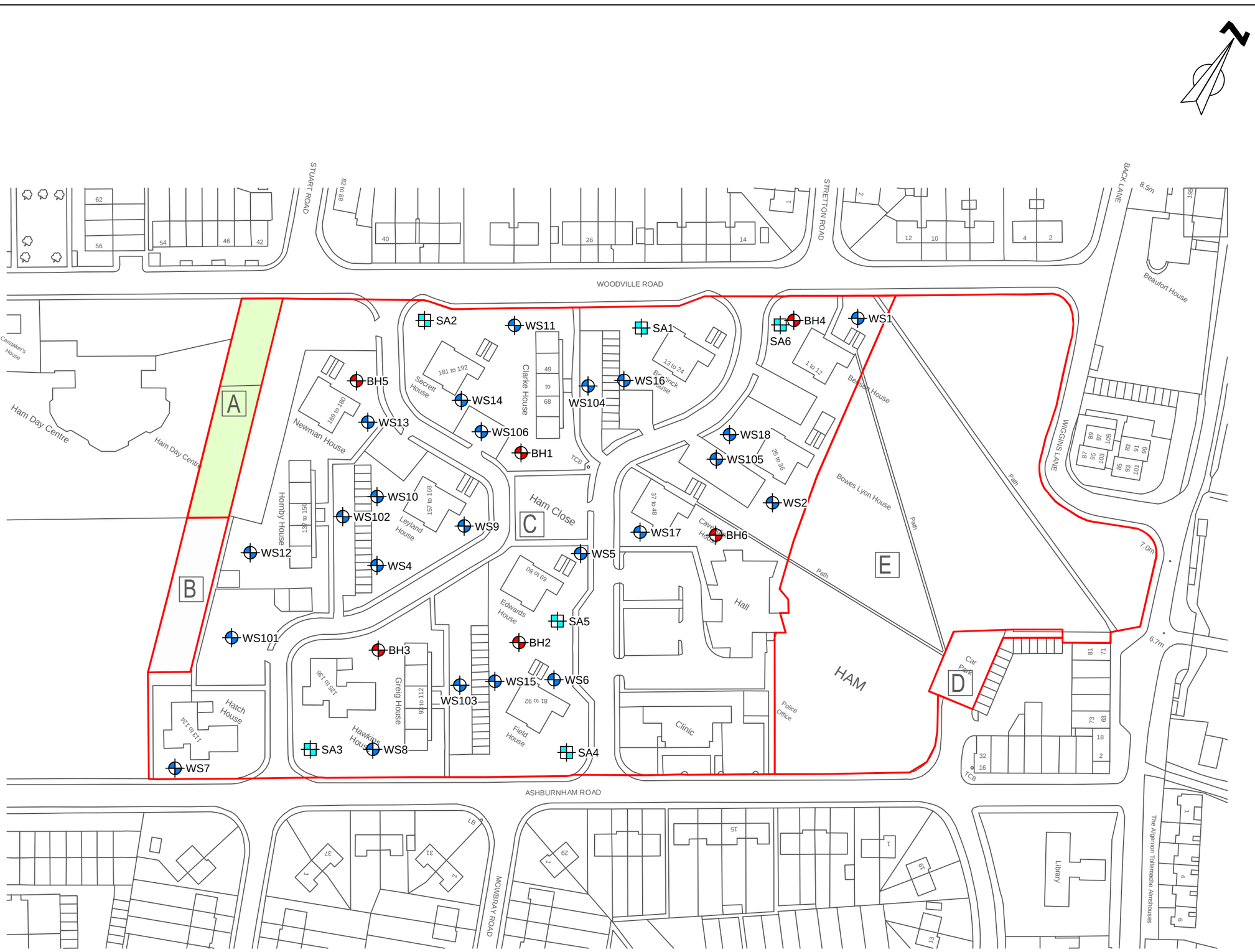
Buried Concrete

10.20 Results of the sulphate and pH testing indicate that shallow soils have soluble sulphate concentrations are generally less than 0.5 g/l consistent with DS1 Conditions. Samples from the London Clay below 6m bgl recorded a concentration above 0.5 g/l within the London Clay at 25m bgl but the soils have a neutral pH. Taking account of pH and sulphate concentrations it is considered that shallow buried concrete can be deigned to Class AC1-s.

Excavation and Materials Re-Use

10.21 Site observations indicated that excavations should be feasible in the near surface. Where access is required the excavations should be designed in accordance with CIRIA RR97.

10.22 Significant dewatering of excavations is not likely to be required.



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Key

- Site Boundary
- Window Sampler Locations (WS)
- Borehole Locations (BH)
- Soakaway Locations (SA)

enzygo environmental consultants

Samuel House, 5 Fox Valley Way, Stocksbridge, Sheffield, S36 2AA

CLIENT: Hill Partnership

SCALE: 1:1000@A3

PROJECT REF: CRM.1027.087

DRAWN: VR

CHECKED: MG

DATE: October 2021

PROJECT: Richmond

TITLE: Site Plan

DRAWING NO: CRM.1027.087.GE.D.001.B

Appendix D: Existing Drainage Information

Asset location search

Property Searches

Cornerstone Projects LTD
91Market Street
HOYLAKE
WIRRAL
CH47 5AA

Search address supplied Ham Close

Your reference 20106

Our reference ALS/ALS Standard/2017_3577459

Search date 25 May 2017

Notification of Price Changes…

From **1 September 2016** Thames Water Property Searches will be increasing the prices of its Asset Location Searches. This will be the first price rise in three years and is in line with the RPI at 1.84%. The increase follows significant capital investment in improving our systems and infrastructure.

Enquiries received with a higher payment prior to 1 September 2016 will be non-refundable. For further details on the price increase please visit our website at

www.thameswater-propertysearches.co.uk

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

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

0845 070 9148

searchcode

Asset location search

Search address supplied: Ham Close,

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

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

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

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

Waste Water Services

Asset location search

Thames Water Property Searches

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

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

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

Asset location search

Property Searches

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Asset location search

Property Searches

Further contacts:

Waste Water queries

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

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

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

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Clean Water queries

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

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

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2017_3577459

The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 517178,172359

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
061C	n/a	n/a
9604	n/a	n/a
9602	n/a	n/a
0605	n/a	n/a
9603	n/a	n/a
251F	n/a	n/a
151E	n/a	n/a
151F	n/a	n/a
251G	n/a	n/a
2502	n/a	n/a
2507	n/a	n/a
2501	n/a	n/a
161C	n/a	n/a
241A	n/a	n/a
1407	7.25	4.23
1404	7.12	5.32
341A	n/a	n/a
3401	6.69	3.13
1401	7.15	5.13
2402	7.79	5.11
3402	6.96	4.06
1406	7.44	4.41
1402	7.62	4.78
1403	7.83	4.74
1405	7.83	4.47
2401	7.66	3.12
141A	n/a	n/a
151D	n/a	n/a
1504	n/a	n/a
2503	n/a	n/a
251A	n/a	n/a
251E	n/a	n/a
1503	n/a	n/a
1506	n/a	n/a
2505	n/a	n/a
2506	n/a	n/a
3501	n/a	n/a
1501	n/a	n/a
1507	n/a	n/a
3502	n/a	n/a
9507	n/a	n/a
9502	n/a	n/a
9506	n/a	n/a
9503	n/a	n/a
9403	7.6	6.61
951D	n/a	n/a
951F	n/a	n/a
951A	n/a	n/a
951B	n/a	n/a
9401	n/a	n/a
0506	n/a	n/a
0505	n/a	n/a
0501	n/a	n/a
0401	7.29	5.52
0502	n/a	n/a
051B	n/a	n/a
0503	n/a	n/a
051F	n/a	n/a
051D	n/a	n/a
051E	n/a	n/a
0504	n/a	n/a
151A	n/a	n/a
151B	n/a	n/a
051C	n/a	n/a
1502	n/a	n/a
151C	n/a	n/a
1202	6.83	4.76
3202	6.5	5.1
1201	6.81	4.67
3204	6.62	3.75
3203	6.49	4.88
1204	6.8	3.77
321B	n/a	n/a
1306	6.8	5.1
1309	6.8	4.07
431A	n/a	n/a
2301	6.79	4.46
1311	6.94	4.27
1310	7.23	5.3
1304	6.94	5.27
2303	6.73	4.24
2302	6.73	4.27
1307	6.95	4.07
2304	6.99	5.11
3301	6.59	3.21
1308	7.26	4.77
1303	7.12	5.31
3302	6.62	3.75
231A	n/a	n/a
331A	n/a	n/a
331B	n/a	n/a

Manhole Reference	Manhole Cover Level	Manhole Invert Level
1302	7.04	5.32
331C	n/a	n/a
1203	6.92	5.23
2203	6.91	3.7
2204	n/a	n/a
221B	n/a	n/a
2205	6.7	3.2
221A	n/a	n/a
2201	6.37	5
2206	6.58	3.17
2202	6.38	4.95
221E	n/a	n/a
221C	n/a	n/a
221D	n/a	n/a
321C	n/a	n/a
321A	n/a	n/a
3105	6.47	4.76
311C	n/a	n/a
3201	6.61	4.66
3102	6.7	4.63
3108	6.78	2.95
4201	6.92	3.31
411F	n/a	n/a
411G	n/a	n/a
411C	n/a	n/a
421A	n/a	n/a
0102	6.04	5.48
011A	n/a	n/a
1103	7	5.23
0202	7.14	5.11
0203	n/a	n/a
0201	7.16	5.56
0204	7.14	5.74
0304	7.35	5.57
9306	7.72	5.87
1305	7.16	6
9305	7.7	5.97
1301	7.2	6.29
0301	7.32	6.1
0303	7.34	5.8
9301	n/a	n/a
931B	n/a	n/a
931A	n/a	n/a
0302	7.48	5.68
3106	6.77	5.27
2104	6.53	2.52
3107	6.58	2.6
4102	6.95	5.59
3109	6.66	2.7
3103	6.37	5
311B	n/a	n/a
3104	6.38	4.95
311A	n/a	n/a
1102	6.83	5.42
1101	6.81	5.48
1106	n/a	n/a
1105	n/a	n/a
1104	n/a	n/a
2111	n/a	n/a
2102	6.7	5.28
2101	6.72	5.39
2109	7.6	3.2
2110	6.8	3.27
2108	6.58	3.11
2107	6.51	3
2105	7.59	2.48
2103	6.54	2.94
0101	7.92	5.79
911B	n/a	n/a
9103	7.26	4.47
9101	n/a	n/a
911D	n/a	n/a
111A	n/a	n/a
0103	n/a	n/a

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

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

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

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

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

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

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

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

Control Valve

Drop Pipe

Ancillary

Weir

End Items

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

Outfall

Undefined End

Inlet

Other Symbols

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

Public/Private Pumping Station

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

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

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

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

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

Asset Location Search Water Map - ALS/ALS Standard/2017_3577459

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

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

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

16"

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

3" SUPPLY

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

3" FIRE

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

3" METERED

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

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

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

Valves

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

Hydrants

- Single Hydrant

Meters

- Meter

End Items

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

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

Operational Sites

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

Other Symbols

- Data Logger

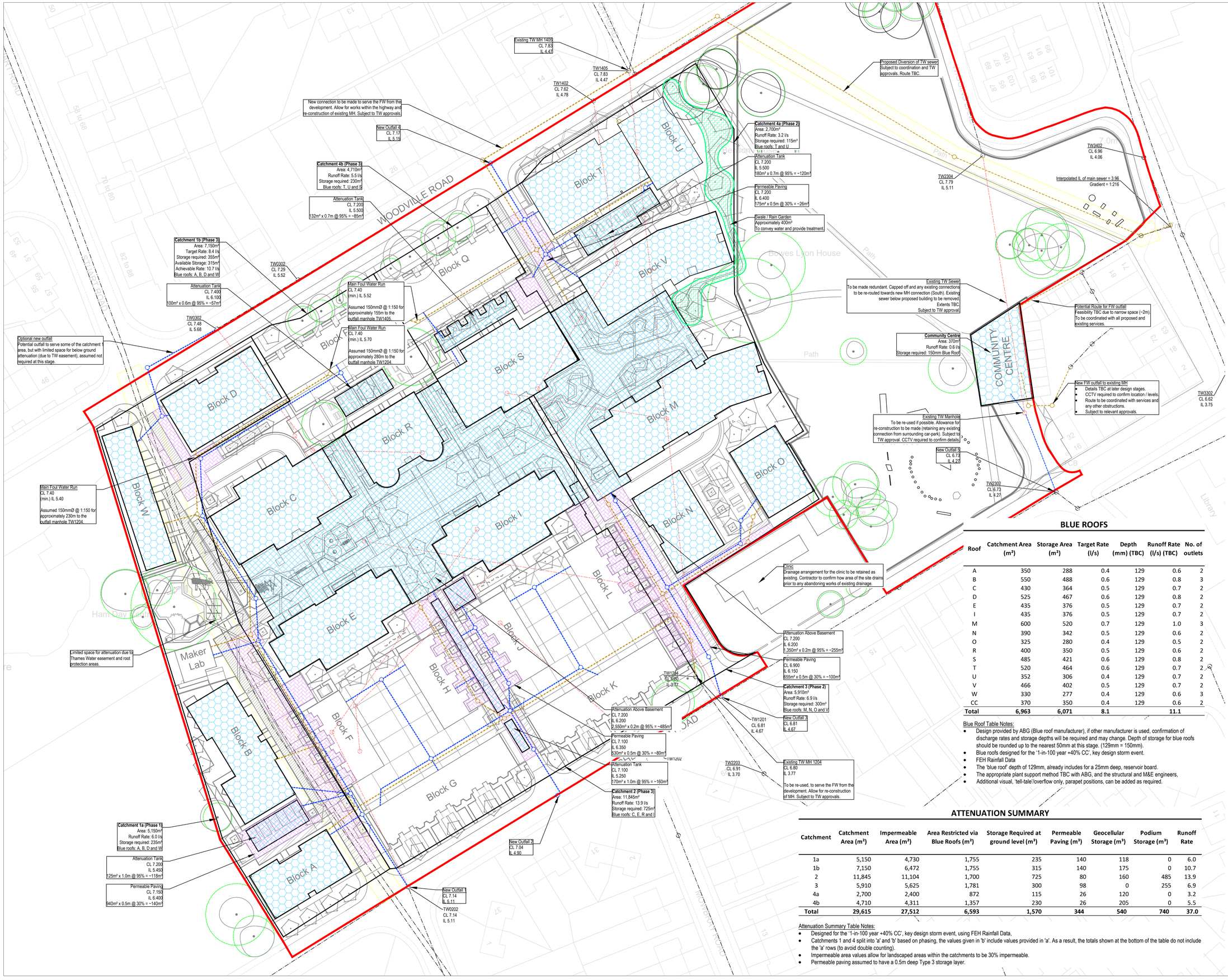
PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

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

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

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

Appendix E: Proposed Drainage Drawings



NOTES

1. Drawing to be viewed in colour,
2. Indicative drainage strategy, subject to coordination,
3. Blue roof details, depths and runoff rates to be confirmed by the architect and the manufacturer,
4. Surface Water runoff rates based on greenfield rate of 11.7 l/s/ha
5. Any diversions / works to Thames Water sewers subject to relevant approvals, allowance for removal of all abandoned sewers to be made.
6. Allowance for new manholes to be constructed online of the existing sewers to allow for new connections from site,
7. Temporary works to enable phasing of construction to be reviewed at a later stage, where proposed phase cuts off drainage to an area being retained, allowance should be made for re-providing new runs suitable with the layout for that area.
8. Do not scale from this drawing.
9. Locations of existing sewers taken from record information and maybe incorrect. Confirmation of levels onsite is required prior to any works.
10. Exact routes of sewers through site TBC at later stage, subject to detailed coordination with the services and landscaping.

LEGEND

- Proposed Surface Water Sewer
- Proposed Foul Water Sewer
- Proposed Attenuation Tank
- Proposed Permeable Paving
- Proposed Blue Roof
- Rain Garden / Swale
- Existing Public Foul Water Sewer
- Existing Public Surface Water Sewer
- Foul Water Sewer To Be Abandoned
- Surface Water Sewer To Be Abandoned
- Sewer Easement (6m)
- Utilities Strip (2.75m)
- Utilities Strip (2.0m)
- Utilities Strip (1.5m)
- Proposed Tree Zone (2.0m)

BLUE ROOFS

Roof	Catchment Area (m²)	Storage Area (m²)	Target Rate (l/s)	Depth (mm) (TBC)	Runoff Rate (l/s) (TBC)	No. of outlets
A	350	288	0.4	129	0.6	2
B	550	488	0.6	129	0.8	3
C	430	364	0.5	129	0.7	2
D	525	467	0.6	129	0.8	2
E	435	376	0.5	129	0.7	2
I	435	376	0.5	129	0.7	2
M	600	520	0.7	129	1.0	3
N	390	342	0.5	129	0.6	2
O	325	280	0.4	129	0.5	2
R	400	350	0.5	129	0.6	2
S	485	421	0.6	129	0.8	2
T	520	464	0.6	129	0.7	2
U	352	306	0.4	129	0.7	2
V	466	402	0.5	129	0.7	2
W	330	277	0.4	129	0.6	3
CC	370	350	0.4	129	0.6	2
Total	**6,963**	**6,071**	**8.1**		**11.1**	

Blue Roof Table Notes:

- Design provided by ABG (Blue roof manufacturer), if other manufacturer is used, confirmation of discharge rates and storage depths will be required and may change. Depth of storage for blue roofs should be rounded up to the nearest 50mm at this stage. (129mm = 150mm).
- Blue roofs designed for the '1-in-100 year +40% CC', key design storm event.
- FEH Rainfall Data
- The 'blue roof' depth of 129mm, already includes for a 25mm deep, reservoir board.
- The appropriate plant support method TBC with ABG, and the structural and M&E engineers,
- Additional visual, 'tell-tale'/overflow only, parapet positions, can be added as required.

ATTENUATION SUMMARY

Catchment	Catchment Area (m²)	Impermeable Area (m²)	Area Restricted via Blue Roofs (m²)	Storage Required at ground level (m³)	Permeable Paving (m³)	Geocellular Storage (m³)	Podium Storage (m³)	Runoff Rate
1a	5,150	4,730	1,755	235	140	118	0	6.0
1b	7,150	6,472	1,755	315	140	175	0	10.7
2	11,845	11,104	1,700	725	80	160	485	13.9
3	5,910	5,625	1,781	300	98	0	255	6.9
4a	2,700	2,400	872	115	26	120	0	3.2
4b	4,710	4,311	1,357	230	26	205	0	5.5
Total	**29,615**	**27,512**	**6,593**	**1,570**	**344**	**540**	**740**	**37.0**

Attenuation Summary Table Notes:

- Designed for the '1-in-100 year +40% CC', key design storm event, using FEH Rainfall Data,
- Catchments 1 and 4 split into 'a' and 'b' based on phasing, the values given in 'b' include values provided in 'a'. As a result, the totals shown at the bottom of the table do not include the 'a' rows (to avoid double counting).
- Impermeable area values allow for landscaped areas within the catchments to be 30% impermeable.
- Permeable paving assumed to have a 0.5m deep Type 3 storage layer.

Rev	Date	Description	By	Apvd
P2	04.03.22	Updated Layout	KG	RL
P1	31.01.22	FRA Report Issue	KG	RL

PROJECT:
HAM CLOSE, RICHMOND

TITLE:
DRAINAGE LAYOUT
SITE WIDE STRATEGY

CLIENT:
HILL RESIDENTIAL

SCALE@A1:
1:500

PROJECT REF:
21246

DRAWING No: JUB_XX_XX_DR_C_0500 **REV:** P2

Revision Referencing
P = Preliminary A = Approval T = Tender C = Construction

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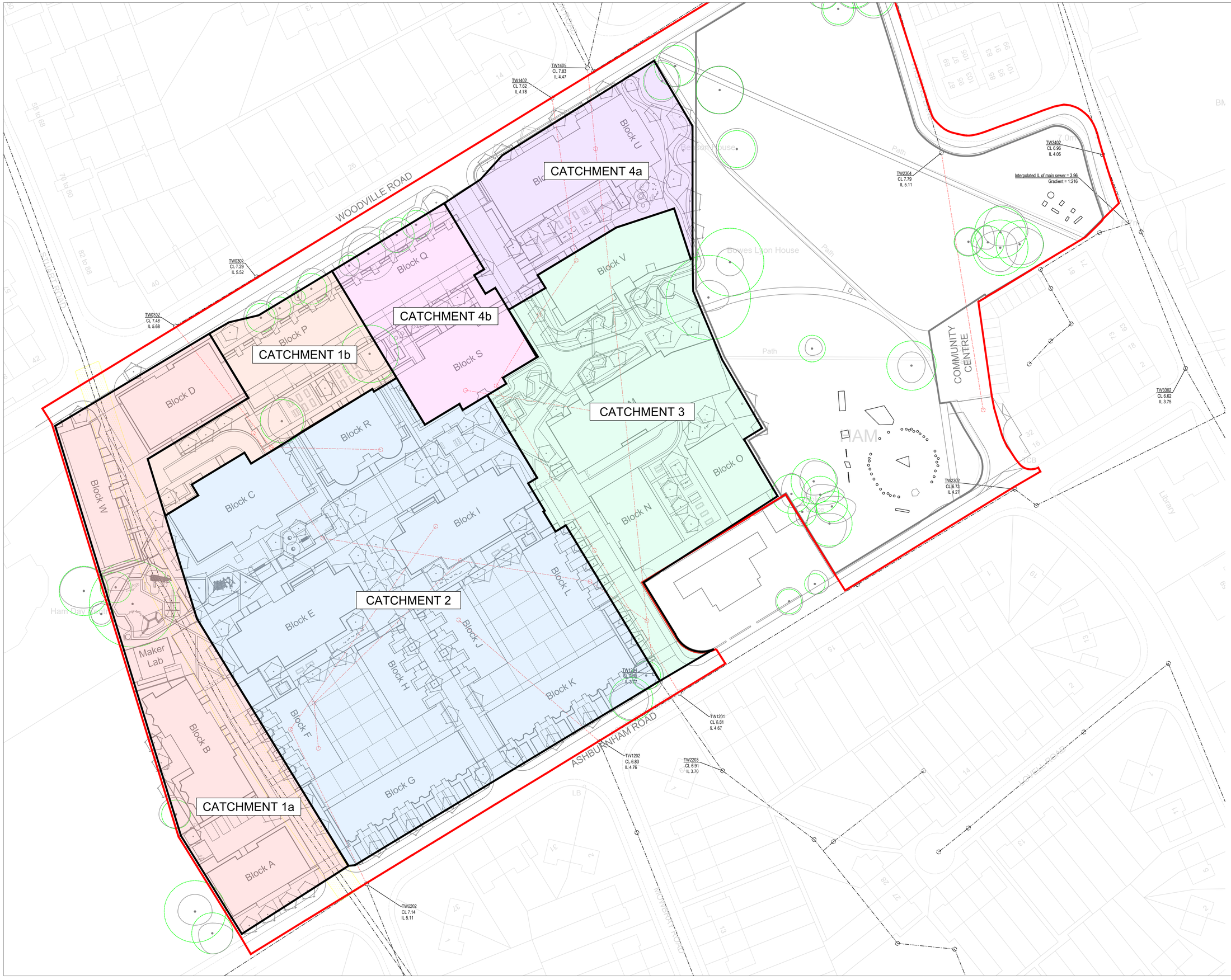

NOTES

1. Drawing to be viewed in colour.
2. Indicative drainage strategy, subject to coordination.
3. Temporary works to enable phasing of construction to be reviewed at a later stage, where proposed phase cuts off drainage to an area being retained, allowance should be made for re-providing new runs suitable with the layout for that area.
4. Do not scale from this drawing.
5. Locations of existing sewers taken from record information and maybe incorrect. Confirmation of levels onsite is required prior to any works.
6. Routes of sewers through site TBC at later stage, to be coordinated with the services and landscaping.

LEGEND

- Catchment 1a
- Catchment 1b
- Catchment 2
- Catchment 3
- Catchment 4a
- Catchment 4b

Rev	Date	Description	By	Apvd
P2	04.03.22	Updated Layout	KG	RL
P1	31.01.22	FRA Report Issue	KG	RL

PROJECT:
HAM CLOSE, RICHMOND

TITLE:
DRAINAGE LAYOUT
CATCHMENT PLAN

CLIENT:
HILL RESIDENTIAL

SCALE@A1:
1:500

PROJECT REF:
21246

DRAWING No: JUB_XX_XX_DR_C_0510

REV: P2

Revision Referencing
P = Preliminary A = Approval T = Tender C = Construction

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LEGEND

Overland Flow Route

Rev	Date	Description	By	Apvd
P2	04.03.22	Updated Layout	KG	RL
P1	31.01.22	FRA Report Issue	KG	RL

PROJECT:
HAM CLOSE, RICHMOND

TITLE:
OVERLAND FLOW ROUTES

CLIENT:
HILL RESIDENTIAL

SCALE@A1:
1:500

PROJECT REF:
21246

DRAWING No: JUB_XX_XX_DR_C_0520

REV: P2

Revision Referencing
P = Preliminary A = Approval T = Tender C = Construction

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Appendix F: Calculations

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Karol Gyba
Site name:	Ham Close
Site location:	Richmond

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.43758° N
Longitude:	0.31669° W
Reference:	253435498
Date:	Jan 17 2022 16:13

Runoff estimation approach FEH Statistical

Site characteristics

Total site area (ha): 1

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Calculate from dominant
HOST class:	HOST 12
BFI / BFIHOST:	0.271
Q_{MED} (l/s):	3.22
Q_{BAR} / Q_{MED} factor:	1.14

Hydrological characteristics	Default	Edited
SAAR (mm):	599	599
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	3.66	3.66
1 in 1 year (l/s):	3.11	3.11
1 in 30 years (l/s):	8.41	8.41
1 in 100 year (l/s):	11.67	11.67
1 in 200 years (l/s):	13.68	13.68

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.295	0.295	6.0	92.1	O K
30 min Summer	8.372	0.372	6.0	116.1	O K
60 min Summer	8.438	0.438	6.0	136.7	O K
120 min Summer	8.523	0.523	6.0	163.1	O K
180 min Summer	8.561	0.561	6.0	175.1	O K
240 min Summer	8.593	0.593	6.0	184.9	O K
360 min Summer	8.641	0.641	6.0	200.0	O K
480 min Summer	8.664	0.664	6.0	207.1	O K
600 min Summer	8.662	0.662	6.0	206.6	O K
720 min Summer	8.648	0.648	6.0	202.1	O K
960 min Summer	8.599	0.599	6.0	186.8	O K
1440 min Summer	8.467	0.467	6.0	145.6	O K
2160 min Summer	8.286	0.286	6.0	89.4	O K
2880 min Summer	8.191	0.191	5.8	59.5	O K
4320 min Summer	8.122	0.122	5.0	38.0	O K
5760 min Summer	8.099	0.099	4.0	30.7	O K
7200 min Summer	8.086	0.086	3.3	26.9	O K
8640 min Summer	8.079	0.079	2.9	24.6	O K
10080 min Summer	8.077	0.077	2.8	24.1	O K
15 min Winter	8.332	0.332	6.0	103.5	O K
30 min Winter	8.419	0.419	6.0	130.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.920	0.0	207.9	18
30 min Summer	110.600	0.0	235.5	33
60 min Summer	67.760	0.0	289.5	62
120 min Summer	43.120	0.0	330.8	122
180 min Summer	32.548	0.0	356.3	182
240 min Summer	26.390	0.0	374.0	242
360 min Summer	19.297	0.0	396.8	362
480 min Summer	15.250	0.0	410.7	482
600 min Summer	12.635	0.0	420.4	584
720 min Summer	10.803	0.0	427.8	614
960 min Summer	8.400	0.0	438.4	676
1440 min Summer	5.851	0.0	451.9	896
2160 min Summer	4.052	0.0	468.1	1236
2880 min Summer	3.124	0.0	477.1	1560
4320 min Summer	2.176	0.0	491.5	2244
5760 min Summer	1.693	0.0	505.7	2944
7200 min Summer	1.404	0.0	518.9	3672
8640 min Summer	1.211	0.0	531.9	4408
10080 min Summer	1.073	0.0	544.4	512
15 min Winter	171.920	0.0	219.5	18
30 min Winter	110.600	0.0	250.3	33

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.495	0.495	6.0	154.6	O K
120 min Winter	8.597	0.597	6.0	186.1	O K
180 min Winter	8.646	0.646	6.0	201.6	O K
240 min Winter	8.684	0.684	6.0	213.3	O K
360 min Winter	8.734	0.734	6.0	228.9	O K
480 min Winter	8.753	0.753	6.0	234.9	O K
600 min Winter	8.753	0.753	6.0	234.8	O K
720 min Winter	8.735	0.735	6.0	229.4	O K
960 min Winter	8.683	0.683	6.0	213.2	O K
1440 min Winter	8.502	0.502	6.0	156.6	O K
2160 min Winter	8.257	0.257	6.0	80.1	O K
2880 min Winter	8.145	0.145	5.5	45.2	O K
4320 min Winter	8.099	0.099	4.0	30.7	O K
5760 min Winter	8.082	0.082	3.1	25.5	O K
7200 min Winter	8.080	0.080	2.9	24.8	O K
8640 min Winter	8.078	0.078	2.9	24.3	O K
10080 min Winter	8.077	0.077	2.8	24.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	67.760	0.0	307.7	62
120 min Winter	43.120	0.0	353.9	120
180 min Winter	32.548	0.0	382.5	178
240 min Winter	26.390	0.0	402.3	238
360 min Winter	19.297	0.0	427.9	354
480 min Winter	15.250	0.0	443.4	468
600 min Winter	12.635	0.0	454.3	574
720 min Winter	10.803	0.0	462.6	664
960 min Winter	8.400	0.0	474.5	738
1440 min Winter	5.851	0.0	489.5	968
2160 min Winter	4.052	0.0	507.2	1280
2880 min Winter	3.124	0.0	517.3	1560
4320 min Winter	2.176	0.0	533.5	2240
5760 min Winter	1.693	0.0	549.3	520
7200 min Winter	1.404	0.0	564.1	528
8640 min Winter	1.211	0.0	578.6	520
10080 min Winter	1.073	0.0	592.8	520

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 541450 180700 TQ 41450 80700
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.298

Time (mins) From:	To:	Area (ha)
0	4	0.298

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	0.0	202	1.6	302	2.8	402	2.8	502	2.6
4	0.0	104	0.0	204	1.7	304	2.8	404	2.8	504	2.6
6	0.0	106	0.0	206	1.8	306	2.8	406	2.8	506	2.6
8	0.0	108	0.0	208	1.8	308	2.8	408	2.8	508	2.6
10	0.0	110	0.0	210	1.9	310	2.8	410	2.8	510	2.6
12	0.0	112	0.0	212	2.0	312	2.8	412	2.8	512	2.6
14	0.0	114	0.0	214	2.0	314	2.8	414	2.8	514	2.6
16	0.0	116	0.0	216	2.1	316	2.8	416	2.8	516	2.6
18	0.0	118	0.1	218	2.1	318	2.8	418	2.8	518	2.6
20	0.0	120	0.1	220	2.2	320	2.8	420	2.8	520	2.5
22	0.0	122	0.1	222	2.2	322	2.8	422	2.8	522	2.5
24	0.0	124	0.1	224	2.3	324	2.8	424	2.8	524	2.5
26	0.0	126	0.1	226	2.3	326	2.8	426	2.8	526	2.5
28	0.0	128	0.1	228	2.4	328	2.8	428	2.8	528	2.5
30	0.0	130	0.1	230	2.4	330	2.8	430	2.8	530	2.5
32	0.0	132	0.1	232	2.4	332	2.8	432	2.8	532	2.5
34	0.0	134	0.1	234	2.5	334	2.8	434	2.8	534	2.5
36	0.0	136	0.1	236	2.5	336	2.8	436	2.8	536	2.5
38	0.0	138	0.2	238	2.6	338	2.8	438	2.8	538	2.5
40	0.0	140	0.2	240	2.6	340	2.8	440	2.8	540	2.5
42	0.0	142	0.2	242	2.6	342	2.8	442	2.8	542	2.5
44	0.0	144	0.2	244	2.6	344	2.8	444	2.8	544	2.4
46	0.0	146	0.2	246	2.7	346	2.8	446	2.8	546	2.4
48	0.0	148	0.3	248	2.7	348	2.8	448	2.8	548	2.4
50	0.0	150	0.3	250	2.7	350	2.8	450	2.8	550	2.4
52	0.0	152	0.3	252	2.7	352	2.8	452	2.8	552	2.4
54	0.0	154	0.3	254	2.8	354	2.8	454	2.8	554	2.4
56	0.0	156	0.4	256	2.8	356	2.8	456	2.8	556	2.4
58	0.0	158	0.4	258	2.8	358	2.8	458	2.8	558	2.4
60	0.0	160	0.5	260	2.8	360	2.8	460	2.8	560	2.4
62	0.0	162	0.5	262	2.8	362	2.8	462	2.8	562	2.4
64	0.0	164	0.5	264	2.8	364	2.8	464	2.8	564	2.4
66	0.0	166	0.6	266	2.8	366	2.8	466	2.8	566	2.4
68	0.0	168	0.6	268	2.8	368	2.8	468	2.7	568	2.4
70	0.0	170	0.7	270	2.8	370	2.8	470	2.7	570	2.4
72	0.0	172	0.7	272	2.8	372	2.8	472	2.7	572	2.4
74	0.0	174	0.8	274	2.8	374	2.8	474	2.7	574	2.3
76	0.0	176	0.8	276	2.8	376	2.8	476	2.7	576	2.3
78	0.0	178	0.9	278	2.8	378	2.8	478	2.7	578	2.3
80	0.0	180	0.9	280	2.8	380	2.8	480	2.7	580	2.3
82	0.0	182	1.0	282	2.8	382	2.8	482	2.7	582	2.3
84	0.0	184	1.1	284	2.8	384	2.8	484	2.7	584	2.3
86	0.0	186	1.1	286	2.8	386	2.8	486	2.7	586	2.3
88	0.0	188	1.2	288	2.8	388	2.8	488	2.7	588	2.3
90	0.0	190	1.2	290	2.8	390	2.8	490	2.7	590	2.3
92	0.0	192	1.3	292	2.8	392	2.8	492	2.7	592	2.3
94	0.0	194	1.4	294	2.8	394	2.8	494	2.6	594	2.3
96	0.0	196	1.4	296	2.8	396	2.8	496	2.6	596	2.3
98	0.0	198	1.5	298	2.8	398	2.8	498	2.6	598	2.3
100	0.0	200	1.6	300	2.8	400	2.8	500	2.6	600	2.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	2.2	702	1.8	802	1.5	902	1.2	1002	1.0	1102	0.9
604	2.2	704	1.8	804	1.5	904	1.2	1004	1.0	1104	0.9
606	2.2	706	1.8	806	1.5	906	1.2	1006	1.0	1106	0.9
608	2.2	708	1.8	808	1.5	908	1.2	1008	1.0	1108	0.9
610	2.2	710	1.8	810	1.5	910	1.2	1010	1.0	1110	0.8
612	2.2	712	1.8	812	1.5	912	1.2	1012	1.0	1112	0.8
614	2.2	714	1.8	814	1.5	914	1.2	1014	1.0	1114	0.8
616	2.2	716	1.8	816	1.5	916	1.2	1016	1.0	1116	0.8
618	2.2	718	1.8	818	1.5	918	1.2	1018	1.0	1118	0.8
620	2.2	720	1.8	820	1.5	920	1.2	1020	1.0	1120	0.8
622	2.1	722	1.8	822	1.5	922	1.2	1022	1.0	1122	0.8
624	2.1	724	1.8	824	1.4	924	1.2	1024	1.0	1124	0.8
626	2.1	726	1.8	826	1.4	926	1.2	1026	1.0	1126	0.8
628	2.1	728	1.8	828	1.4	928	1.2	1028	1.0	1128	0.8
630	2.1	730	1.7	830	1.4	930	1.2	1030	1.0	1130	0.8
632	2.1	732	1.7	832	1.4	932	1.2	1032	1.0	1132	0.8
634	2.1	734	1.7	834	1.4	934	1.2	1034	1.0	1134	0.8
636	2.1	736	1.7	836	1.4	936	1.2	1036	1.0	1136	0.8
638	2.1	738	1.7	838	1.4	938	1.2	1038	1.0	1138	0.8
640	2.1	740	1.7	840	1.4	940	1.2	1040	1.0	1140	0.8
642	2.1	742	1.7	842	1.4	942	1.2	1042	1.0	1142	0.8
644	2.1	744	1.7	844	1.4	944	1.2	1044	0.9	1144	0.8
646	2.1	746	1.7	846	1.4	946	1.2	1046	0.9	1146	0.8
648	2.1	748	1.7	848	1.4	948	1.1	1048	0.9	1148	0.8
650	2.0	750	1.7	850	1.4	950	1.1	1050	0.9	1150	0.8
652	2.0	752	1.7	852	1.4	952	1.1	1052	0.9	1152	0.8
654	2.0	754	1.7	854	1.4	954	1.1	1054	0.9	1154	0.8
656	2.0	756	1.7	856	1.4	956	1.1	1056	0.9	1156	0.8
658	2.0	758	1.6	858	1.3	958	1.1	1058	0.9	1158	0.8
660	2.0	760	1.6	860	1.3	960	1.1	1060	0.9	1160	0.8
662	2.0	762	1.6	862	1.3	962	1.1	1062	0.9	1162	0.8
664	2.0	764	1.6	864	1.3	964	1.1	1064	0.9	1164	0.8
666	2.0	766	1.6	866	1.3	966	1.1	1066	0.9	1166	0.8
668	2.0	768	1.6	868	1.3	968	1.1	1068	0.9	1168	0.8
670	2.0	770	1.6	870	1.3	970	1.1	1070	0.9	1170	0.8
672	2.0	772	1.6	872	1.3	972	1.1	1072	0.9	1172	0.8
674	2.0	774	1.6	874	1.3	974	1.1	1074	0.9	1174	0.8
676	1.9	776	1.6	876	1.3	976	1.1	1076	0.9	1176	0.8
678	1.9	778	1.6	878	1.3	978	1.1	1078	0.9	1178	0.8
680	1.9	780	1.6	880	1.3	980	1.1	1080	0.9	1180	0.8
682	1.9	782	1.6	882	1.3	982	1.1	1082	0.9	1182	0.8
684	1.9	784	1.6	884	1.3	984	1.1	1084	0.9	1184	0.8
686	1.9	786	1.6	886	1.3	986	1.1	1086	0.9	1186	0.7
688	1.9	788	1.6	888	1.3	988	1.1	1088	0.9	1188	0.7
690	1.9	790	1.5	890	1.3	990	1.1	1090	0.9	1190	0.7
692	1.9	792	1.5	892	1.3	992	1.0	1092	0.9	1192	0.7
694	1.9	794	1.5	894	1.3	994	1.0	1094	0.9	1194	0.7
696	1.9	796	1.5	896	1.3	996	1.0	1096	0.9	1196	0.7
698	1.9	798	1.5	898	1.2	998	1.0	1098	0.9	1198	0.7
700	1.9	800	1.5	900	1.2	1000	1.0	1100	0.9	1200	0.7

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.7	1302	0.6	1402	0.5	1502	0.5	1602	0.4	1702	0.3
1204	0.7	1304	0.6	1404	0.5	1504	0.5	1604	0.4	1704	0.3
1206	0.7	1306	0.6	1406	0.5	1506	0.5	1606	0.4	1706	0.3
1208	0.7	1308	0.6	1408	0.5	1508	0.5	1608	0.4	1708	0.3
1210	0.7	1310	0.6	1410	0.5	1510	0.5	1610	0.4	1710	0.3
1212	0.7	1312	0.6	1412	0.5	1512	0.5	1612	0.4	1712	0.3
1214	0.7	1314	0.6	1414	0.5	1514	0.4	1614	0.4	1714	0.3
1216	0.7	1316	0.6	1416	0.5	1516	0.4	1616	0.4	1716	0.3
1218	0.7	1318	0.6	1418	0.5	1518	0.4	1618	0.4	1718	0.3
1220	0.7	1320	0.6	1420	0.5	1520	0.4	1620	0.4	1720	0.3
1222	0.7	1322	0.6	1422	0.5	1522	0.4	1622	0.4	1722	0.3
1224	0.7	1324	0.6	1424	0.5	1524	0.4	1624	0.4	1724	0.3
1226	0.7	1326	0.6	1426	0.5	1526	0.4	1626	0.4	1726	0.3
1228	0.7	1328	0.6	1428	0.5	1528	0.4	1628	0.4	1728	0.3
1230	0.7	1330	0.6	1430	0.5	1530	0.4	1630	0.4	1730	0.3
1232	0.7	1332	0.6	1432	0.5	1532	0.4	1632	0.4	1732	0.3
1234	0.7	1334	0.6	1434	0.5	1534	0.4	1634	0.4	1734	0.3
1236	0.7	1336	0.6	1436	0.5	1536	0.4	1636	0.4	1736	0.3
1238	0.7	1338	0.6	1438	0.5	1538	0.4	1638	0.4	1738	0.3
1240	0.7	1340	0.6	1440	0.5	1540	0.4	1640	0.4	1740	0.3
1242	0.7	1342	0.6	1442	0.5	1542	0.4	1642	0.4	1742	0.3
1244	0.7	1344	0.6	1444	0.5	1544	0.4	1644	0.4	1744	0.3
1246	0.7	1346	0.6	1446	0.5	1546	0.4	1646	0.4	1746	0.3
1248	0.7	1348	0.6	1448	0.5	1548	0.4	1648	0.4	1748	0.3
1250	0.7	1350	0.6	1450	0.5	1550	0.4	1650	0.4	1750	0.3
1252	0.7	1352	0.6	1452	0.5	1552	0.4	1652	0.4	1752	0.3
1254	0.7	1354	0.6	1454	0.5	1554	0.4	1654	0.4	1754	0.3
1256	0.7	1356	0.6	1456	0.5	1556	0.4	1656	0.4	1756	0.3
1258	0.7	1358	0.6	1458	0.5	1558	0.4	1658	0.4	1758	0.3
1260	0.7	1360	0.6	1460	0.5	1560	0.4	1660	0.4	1760	0.3
1262	0.7	1362	0.6	1462	0.5	1562	0.4	1662	0.4	1762	0.3
1264	0.7	1364	0.6	1464	0.5	1564	0.4	1664	0.4	1764	0.3
1266	0.7	1366	0.6	1466	0.5	1566	0.4	1666	0.4	1766	0.3
1268	0.7	1368	0.6	1468	0.5	1568	0.4	1668	0.4	1768	0.3
1270	0.7	1370	0.6	1470	0.5	1570	0.4	1670	0.4	1770	0.3
1272	0.6	1372	0.6	1472	0.5	1572	0.4	1672	0.4	1772	0.3
1274	0.6	1374	0.5	1474	0.5	1574	0.4	1674	0.4	1774	0.3
1276	0.6	1376	0.5	1476	0.5	1576	0.4	1676	0.4	1776	0.3
1278	0.6	1378	0.5	1478	0.5	1578	0.4	1678	0.4	1778	0.3
1280	0.6	1380	0.5	1480	0.5	1580	0.4	1680	0.4	1780	0.3
1282	0.6	1382	0.5	1482	0.5	1582	0.4	1682	0.4	1782	0.3
1284	0.6	1384	0.5	1484	0.5	1584	0.4	1684	0.4	1784	0.3
1286	0.6	1386	0.5	1486	0.5	1586	0.4	1686	0.4	1786	0.3
1288	0.6	1388	0.5	1488	0.5	1588	0.4	1688	0.4	1788	0.3
1290	0.6	1390	0.5	1490	0.5	1590	0.4	1690	0.3	1790	0.3
1292	0.6	1392	0.5	1492	0.5	1592	0.4	1692	0.3	1792	0.3
1294	0.6	1394	0.5	1494	0.5	1594	0.4	1694	0.3	1794	0.3
1296	0.6	1396	0.5	1496	0.5	1596	0.4	1696	0.3	1796	0.3
1298	0.6	1398	0.5	1498	0.5	1598	0.4	1698	0.3	1798	0.3
1300	0.6	1400	0.5	1500	0.5	1600	0.4	1700	0.3	1800	0.3

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.3	1902	0.3	2002	0.2	2102	0.2	2202	0.2	2302	0.2
1804	0.3	1904	0.3	2004	0.2	2104	0.2	2204	0.2	2304	0.2
1806	0.3	1906	0.3	2006	0.2	2106	0.2	2206	0.2	2306	0.2
1808	0.3	1908	0.3	2008	0.2	2108	0.2	2208	0.2	2308	0.2
1810	0.3	1910	0.3	2010	0.2	2110	0.2	2210	0.2	2310	0.2
1812	0.3	1912	0.3	2012	0.2	2112	0.2	2212	0.2	2312	0.2
1814	0.3	1914	0.3	2014	0.2	2114	0.2	2214	0.2	2314	0.2
1816	0.3	1916	0.3	2016	0.2	2116	0.2	2216	0.2	2316	0.2
1818	0.3	1918	0.3	2018	0.2	2118	0.2	2218	0.2	2318	0.2
1820	0.3	1920	0.3	2020	0.2	2120	0.2	2220	0.2	2320	0.2
1822	0.3	1922	0.3	2022	0.2	2122	0.2	2222	0.2	2322	0.2
1824	0.3	1924	0.3	2024	0.2	2124	0.2	2224	0.2	2324	0.2
1826	0.3	1926	0.3	2026	0.2	2126	0.2	2226	0.2	2326	0.2
1828	0.3	1928	0.3	2028	0.2	2128	0.2	2228	0.2	2328	0.2
1830	0.3	1930	0.3	2030	0.2	2130	0.2	2230	0.2	2330	0.2
1832	0.3	1932	0.3	2032	0.2	2132	0.2	2232	0.2	2332	0.2
1834	0.3	1934	0.3	2034	0.2	2134	0.2	2234	0.2	2334	0.2
1836	0.3	1936	0.3	2036	0.2	2136	0.2	2236	0.2	2336	0.2
1838	0.3	1938	0.3	2038	0.2	2138	0.2	2238	0.2	2338	0.2
1840	0.3	1940	0.3	2040	0.2	2140	0.2	2240	0.2	2340	0.2
1842	0.3	1942	0.3	2042	0.2	2142	0.2	2242	0.2	2342	0.2
1844	0.3	1944	0.3	2044	0.2	2144	0.2	2244	0.2	2344	0.2
1846	0.3	1946	0.3	2046	0.2	2146	0.2	2246	0.2	2346	0.2
1848	0.3	1948	0.3	2048	0.2	2148	0.2	2248	0.2	2348	0.2
1850	0.3	1950	0.3	2050	0.2	2150	0.2	2250	0.2	2350	0.2
1852	0.3	1952	0.3	2052	0.2	2152	0.2	2252	0.2	2352	0.2
1854	0.3	1954	0.3	2054	0.2	2154	0.2	2254	0.2	2354	0.2
1856	0.3	1956	0.3	2056	0.2	2156	0.2	2256	0.2	2356	0.2
1858	0.3	1958	0.3	2058	0.2	2158	0.2	2258	0.2	2358	0.2
1860	0.3	1960	0.3	2060	0.2	2160	0.2	2260	0.2	2360	0.2
1862	0.3	1962	0.3	2062	0.2	2162	0.2	2262	0.2	2362	0.2
1864	0.3	1964	0.3	2064	0.2	2164	0.2	2264	0.2	2364	0.2
1866	0.3	1966	0.3	2066	0.2	2166	0.2	2266	0.2	2366	0.2
1868	0.3	1968	0.3	2068	0.2	2168	0.2	2268	0.2	2368	0.2
1870	0.3	1970	0.3	2070	0.2	2170	0.2	2270	0.2	2370	0.2
1872	0.3	1972	0.3	2072	0.2	2172	0.2	2272	0.2	2372	0.2
1874	0.3	1974	0.3	2074	0.2	2174	0.2	2274	0.2	2374	0.2
1876	0.3	1976	0.3	2076	0.2	2176	0.2	2276	0.2	2376	0.2
1878	0.3	1978	0.3	2078	0.2	2178	0.2	2278	0.2	2378	0.2
1880	0.3	1980	0.3	2080	0.2	2180	0.2	2280	0.2	2380	0.2
1882	0.3	1982	0.3	2082	0.2	2182	0.2	2282	0.2	2382	0.2
1884	0.3	1984	0.3	2084	0.2	2184	0.2	2284	0.2	2384	0.2
1886	0.3	1986	0.3	2086	0.2	2186	0.2	2286	0.2	2386	0.2
1888	0.3	1988	0.3	2088	0.2	2188	0.2	2288	0.2	2388	0.2
1890	0.3	1990	0.3	2090	0.2	2190	0.2	2290	0.2	2390	0.2
1892	0.3	1992	0.2	2092	0.2	2192	0.2	2292	0.2	2392	0.2
1894	0.3	1994	0.2	2094	0.2	2194	0.2	2294	0.2	2394	0.2
1896	0.3	1996	0.2	2096	0.2	2196	0.2	2296	0.2	2396	0.2
1898	0.3	1998	0.2	2098	0.2	2198	0.2	2298	0.2	2398	0.2
1900	0.3	2000	0.2	2100	0.2	2200	0.2	2300	0.2	2400	0.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.2	2482	0.2	2562	0.1	2642	0.1	2722	0.1	2802	0.1
2404	0.2	2484	0.2	2564	0.1	2644	0.1	2724	0.1	2804	0.1
2406	0.2	2486	0.2	2566	0.1	2646	0.1	2726	0.1	2806	0.1
2408	0.2	2488	0.2	2568	0.1	2648	0.1	2728	0.1	2808	0.1
2410	0.2	2490	0.2	2570	0.1	2650	0.1	2730	0.1	2810	0.1
2412	0.2	2492	0.2	2572	0.1	2652	0.1	2732	0.1	2812	0.1
2414	0.2	2494	0.2	2574	0.1	2654	0.1	2734	0.1	2814	0.1
2416	0.2	2496	0.2	2576	0.1	2656	0.1	2736	0.1	2816	0.1
2418	0.2	2498	0.2	2578	0.1	2658	0.1	2738	0.1	2818	0.1
2420	0.2	2500	0.2	2580	0.1	2660	0.1	2740	0.1	2820	0.1
2422	0.2	2502	0.2	2582	0.1	2662	0.1	2742	0.1	2822	0.1
2424	0.2	2504	0.2	2584	0.1	2664	0.1	2744	0.1	2824	0.1
2426	0.2	2506	0.1	2586	0.1	2666	0.1	2746	0.1	2826	0.1
2428	0.2	2508	0.1	2588	0.1	2668	0.1	2748	0.1	2828	0.1
2430	0.2	2510	0.1	2590	0.1	2670	0.1	2750	0.1	2830	0.1
2432	0.2	2512	0.1	2592	0.1	2672	0.1	2752	0.1	2832	0.1
2434	0.2	2514	0.1	2594	0.1	2674	0.1	2754	0.1	2834	0.1
2436	0.2	2516	0.1	2596	0.1	2676	0.1	2756	0.1	2836	0.1
2438	0.2	2518	0.1	2598	0.1	2678	0.1	2758	0.1	2838	0.1
2440	0.2	2520	0.1	2600	0.1	2680	0.1	2760	0.1	2840	0.1
2442	0.2	2522	0.1	2602	0.1	2682	0.1	2762	0.1	2842	0.1
2444	0.2	2524	0.1	2604	0.1	2684	0.1	2764	0.1	2844	0.1
2446	0.2	2526	0.1	2606	0.1	2686	0.1	2766	0.1	2846	0.1
2448	0.2	2528	0.1	2608	0.1	2688	0.1	2768	0.1	2848	0.1
2450	0.2	2530	0.1	2610	0.1	2690	0.1	2770	0.1	2850	0.1
2452	0.2	2532	0.1	2612	0.1	2692	0.1	2772	0.1	2852	0.1
2454	0.2	2534	0.1	2614	0.1	2694	0.1	2774	0.1	2854	0.1
2456	0.2	2536	0.1	2616	0.1	2696	0.1	2776	0.1	2856	0.1
2458	0.2	2538	0.1	2618	0.1	2698	0.1	2778	0.1	2858	0.1
2460	0.2	2540	0.1	2620	0.1	2700	0.1	2780	0.1	2860	0.1
2462	0.2	2542	0.1	2622	0.1	2702	0.1	2782	0.1	2862	0.1
2464	0.2	2544	0.1	2624	0.1	2704	0.1	2784	0.1	2864	0.1
2466	0.2	2546	0.1	2626	0.1	2706	0.1	2786	0.1	2866	0.1
2468	0.2	2548	0.1	2628	0.1	2708	0.1	2788	0.1	2868	0.1
2470	0.2	2550	0.1	2630	0.1	2710	0.1	2790	0.1	2870	0.1
2472	0.2	2552	0.1	2632	0.1	2712	0.1	2792	0.1	2872	0.1
2474	0.2	2554	0.1	2634	0.1	2714	0.1	2794	0.1	2874	0.1
2476	0.2	2556	0.1	2636	0.1	2716	0.1	2796	0.1	2876	0.1
2478	0.2	2558	0.1	2638	0.1	2718	0.1	2798	0.1	2878	0.1
2480	0.2	2560	0.1	2640	0.1	2720	0.1	2800	0.1	2880	0.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.460	0.460	10.7	144.8	O K
30 min Summer	8.578	0.578	10.7	182.1	O K
60 min Summer	8.679	0.679	10.7	213.8	O K
120 min Summer	8.801	0.801	10.7	252.2	O K
180 min Summer	8.843	0.843	10.7	265.7	O K
240 min Summer	8.864	0.864	10.7	272.2	O K
360 min Summer	8.873	0.873	10.7	274.9	O K
480 min Summer	8.863	0.863	10.7	271.7	O K
600 min Summer	8.844	0.844	10.7	266.0	O K
720 min Summer	8.817	0.817	10.7	257.4	O K
960 min Summer	8.740	0.740	10.7	233.0	O K
1440 min Summer	8.527	0.527	10.7	166.0	O K
2160 min Summer	8.300	0.300	10.7	94.6	O K
2880 min Summer	8.194	0.194	10.3	61.1	O K
4320 min Summer	8.135	0.135	8.2	42.4	O K
5760 min Summer	8.112	0.112	6.4	35.3	O K
7200 min Summer	8.099	0.099	5.3	31.3	O K
8640 min Summer	8.091	0.091	4.6	28.6	O K
10080 min Summer	8.085	0.085	4.1	26.6	O K
15 min Winter	8.517	0.517	10.7	162.9	O K
30 min Winter	8.652	0.652	10.7	205.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.920	0.0	264.9	18
30 min Summer	110.600	0.0	308.5	33
60 min Summer	67.760	0.0	378.3	62
120 min Summer	43.120	0.0	443.7	122
180 min Summer	32.548	0.0	484.1	180
240 min Summer	26.390	0.0	512.1	240
360 min Summer	19.297	0.0	548.3	316
480 min Summer	15.250	0.0	570.3	378
600 min Summer	12.635	0.0	585.7	440
720 min Summer	10.803	0.0	597.3	504
960 min Summer	8.400	0.0	614.2	636
1440 min Summer	5.851	0.0	635.5	868
2160 min Summer	4.052	0.0	658.6	1196
2880 min Summer	3.124	0.0	672.9	1528
4320 min Summer	2.176	0.0	696.0	2204
5760 min Summer	1.693	0.0	717.9	2936
7200 min Summer	1.404	0.0	738.9	3672
8640 min Summer	1.211	0.0	759.5	4400
10080 min Summer	1.073	0.0	779.7	5136
15 min Winter	171.920	0.0	283.2	18
30 min Winter	110.600	0.0	332.0	33

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.768	0.768	10.7	242.0	O K
120 min Winter	8.910	0.910	10.7	286.7	O K
180 min Winter	8.964	0.964	10.7	303.8	O K
240 min Winter	8.991	0.991	10.7	312.0	O K
360 min Winter	9.001	1.001	10.7	315.4	O K
480 min Winter	8.977	0.977	10.7	307.8	O K
600 min Winter	8.952	0.952	10.7	299.8	O K
720 min Winter	8.915	0.915	10.7	288.3	O K
960 min Winter	8.813	0.813	10.7	256.1	O K
1440 min Winter	8.518	0.518	10.7	163.3	O K
2160 min Winter	8.223	0.223	10.5	70.3	O K
2880 min Winter	8.147	0.147	9.0	46.2	O K
4320 min Winter	8.110	0.110	6.2	34.5	O K
5760 min Winter	8.093	0.093	4.8	29.2	O K
7200 min Winter	8.082	0.082	3.9	25.8	O K
8640 min Winter	8.075	0.075	3.4	23.6	O K
10080 min Winter	8.071	0.071	3.0	22.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	67.760	0.0	407.1	62
120 min Winter	43.120	0.0	480.3	118
180 min Winter	32.548	0.0	525.5	176
240 min Winter	26.390	0.0	556.9	232
360 min Winter	19.297	0.0	597.4	342
480 min Winter	15.250	0.0	622.1	392
600 min Winter	12.635	0.0	639.4	464
720 min Winter	10.803	0.0	652.4	536
960 min Winter	8.400	0.0	671.3	684
1440 min Winter	5.851	0.0	695.1	924
2160 min Winter	4.052	0.0	720.5	1212
2880 min Winter	3.124	0.0	736.6	1500
4320 min Winter	2.176	0.0	762.6	2204
5760 min Winter	1.693	0.0	787.0	2880
7200 min Winter	1.404	0.0	810.5	3672
8640 min Winter	1.211	0.0	833.6	4408
10080 min Winter	1.073	0.0	856.4	496

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 541450 180700 TQ 41450 80700
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.472

Time (mins) From:	To:	Area (ha)
0	4	0.472

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	315.0	1.000	315.0	1.100	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0150-1070-1000-1070
Design Head (m)	1.000
Design Flow (l/s)	10.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	150
Invert Level (m)	8.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	10.7
Flush-Flo™	0.306	10.7
Kick-Flo®	0.679	8.9
Mean Flow over Head Range	-	9.2

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	5.4	1.200	11.7	3.000	18.0	7.000	27.1
0.200	10.4	1.400	12.5	3.500	19.4	7.500	28.0
0.300	10.7	1.600	13.4	4.000	20.7	8.000	28.9
0.400	10.6	1.800	14.1	4.500	21.9	8.500	29.7
0.500	10.3	2.000	14.9	5.000	23.0	9.000	30.5
0.600	9.8	2.200	15.5	5.500	24.1	9.500	31.4
0.800	9.6	2.400	16.2	6.000	25.1		
1.000	10.7	2.600	16.8	6.500	26.1		

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	0.0	202	1.6	302	2.8	402	2.8	502	2.6
4	0.0	104	0.0	204	1.7	304	2.8	404	2.8	504	2.6
6	0.0	106	0.0	206	1.8	306	2.8	406	2.8	506	2.6
8	0.0	108	0.0	208	1.8	308	2.8	408	2.8	508	2.6
10	0.0	110	0.0	210	1.9	310	2.8	410	2.8	510	2.6
12	0.0	112	0.0	212	2.0	312	2.8	412	2.8	512	2.6
14	0.0	114	0.0	214	2.0	314	2.8	414	2.8	514	2.6
16	0.0	116	0.0	216	2.1	316	2.8	416	2.8	516	2.6
18	0.0	118	0.1	218	2.1	318	2.8	418	2.8	518	2.6
20	0.0	120	0.1	220	2.2	320	2.8	420	2.8	520	2.5
22	0.0	122	0.1	222	2.2	322	2.8	422	2.8	522	2.5
24	0.0	124	0.1	224	2.3	324	2.8	424	2.8	524	2.5
26	0.0	126	0.1	226	2.3	326	2.8	426	2.8	526	2.5
28	0.0	128	0.1	228	2.4	328	2.8	428	2.8	528	2.5
30	0.0	130	0.1	230	2.4	330	2.8	430	2.8	530	2.5
32	0.0	132	0.1	232	2.4	332	2.8	432	2.8	532	2.5
34	0.0	134	0.1	234	2.5	334	2.8	434	2.8	534	2.5
36	0.0	136	0.1	236	2.5	336	2.8	436	2.8	536	2.5
38	0.0	138	0.2	238	2.6	338	2.8	438	2.8	538	2.5
40	0.0	140	0.2	240	2.6	340	2.8	440	2.8	540	2.5
42	0.0	142	0.2	242	2.6	342	2.8	442	2.8	542	2.5
44	0.0	144	0.2	244	2.6	344	2.8	444	2.8	544	2.4
46	0.0	146	0.2	246	2.7	346	2.8	446	2.8	546	2.4
48	0.0	148	0.3	248	2.7	348	2.8	448	2.8	548	2.4
50	0.0	150	0.3	250	2.7	350	2.8	450	2.8	550	2.4
52	0.0	152	0.3	252	2.7	352	2.8	452	2.8	552	2.4
54	0.0	154	0.3	254	2.8	354	2.8	454	2.8	554	2.4
56	0.0	156	0.4	256	2.8	356	2.8	456	2.8	556	2.4
58	0.0	158	0.4	258	2.8	358	2.8	458	2.8	558	2.4
60	0.0	160	0.5	260	2.8	360	2.8	460	2.8	560	2.4
62	0.0	162	0.5	262	2.8	362	2.8	462	2.8	562	2.4
64	0.0	164	0.5	264	2.8	364	2.8	464	2.8	564	2.4
66	0.0	166	0.6	266	2.8	366	2.8	466	2.8	566	2.4
68	0.0	168	0.6	268	2.8	368	2.8	468	2.7	568	2.4
70	0.0	170	0.7	270	2.8	370	2.8	470	2.7	570	2.4
72	0.0	172	0.7	272	2.8	372	2.8	472	2.7	572	2.4
74	0.0	174	0.8	274	2.8	374	2.8	474	2.7	574	2.3
76	0.0	176	0.8	276	2.8	376	2.8	476	2.7	576	2.3
78	0.0	178	0.9	278	2.8	378	2.8	478	2.7	578	2.3
80	0.0	180	0.9	280	2.8	380	2.8	480	2.7	580	2.3
82	0.0	182	1.0	282	2.8	382	2.8	482	2.7	582	2.3
84	0.0	184	1.1	284	2.8	384	2.8	484	2.7	584	2.3
86	0.0	186	1.1	286	2.8	386	2.8	486	2.7	586	2.3
88	0.0	188	1.2	288	2.8	388	2.8	488	2.7	588	2.3
90	0.0	190	1.2	290	2.8	390	2.8	490	2.7	590	2.3
92	0.0	192	1.3	292	2.8	392	2.8	492	2.7	592	2.3
94	0.0	194	1.4	294	2.8	394	2.8	494	2.6	594	2.3
96	0.0	196	1.4	296	2.8	396	2.8	496	2.6	596	2.3
98	0.0	198	1.5	298	2.8	398	2.8	498	2.6	598	2.3
100	0.0	200	1.6	300	2.8	400	2.8	500	2.6	600	2.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	2.2	702	1.8	802	1.5	902	1.2	1002	1.0	1102	0.9
604	2.2	704	1.8	804	1.5	904	1.2	1004	1.0	1104	0.9
606	2.2	706	1.8	806	1.5	906	1.2	1006	1.0	1106	0.9
608	2.2	708	1.8	808	1.5	908	1.2	1008	1.0	1108	0.9
610	2.2	710	1.8	810	1.5	910	1.2	1010	1.0	1110	0.8
612	2.2	712	1.8	812	1.5	912	1.2	1012	1.0	1112	0.8
614	2.2	714	1.8	814	1.5	914	1.2	1014	1.0	1114	0.8
616	2.2	716	1.8	816	1.5	916	1.2	1016	1.0	1116	0.8
618	2.2	718	1.8	818	1.5	918	1.2	1018	1.0	1118	0.8
620	2.2	720	1.8	820	1.5	920	1.2	1020	1.0	1120	0.8
622	2.1	722	1.8	822	1.5	922	1.2	1022	1.0	1122	0.8
624	2.1	724	1.8	824	1.4	924	1.2	1024	1.0	1124	0.8
626	2.1	726	1.8	826	1.4	926	1.2	1026	1.0	1126	0.8
628	2.1	728	1.8	828	1.4	928	1.2	1028	1.0	1128	0.8
630	2.1	730	1.7	830	1.4	930	1.2	1030	1.0	1130	0.8
632	2.1	732	1.7	832	1.4	932	1.2	1032	1.0	1132	0.8
634	2.1	734	1.7	834	1.4	934	1.2	1034	1.0	1134	0.8
636	2.1	736	1.7	836	1.4	936	1.2	1036	1.0	1136	0.8
638	2.1	738	1.7	838	1.4	938	1.2	1038	1.0	1138	0.8
640	2.1	740	1.7	840	1.4	940	1.2	1040	1.0	1140	0.8
642	2.1	742	1.7	842	1.4	942	1.2	1042	1.0	1142	0.8
644	2.1	744	1.7	844	1.4	944	1.2	1044	0.9	1144	0.8
646	2.1	746	1.7	846	1.4	946	1.2	1046	0.9	1146	0.8
648	2.1	748	1.7	848	1.4	948	1.1	1048	0.9	1148	0.8
650	2.0	750	1.7	850	1.4	950	1.1	1050	0.9	1150	0.8
652	2.0	752	1.7	852	1.4	952	1.1	1052	0.9	1152	0.8
654	2.0	754	1.7	854	1.4	954	1.1	1054	0.9	1154	0.8
656	2.0	756	1.7	856	1.4	956	1.1	1056	0.9	1156	0.8
658	2.0	758	1.6	858	1.3	958	1.1	1058	0.9	1158	0.8
660	2.0	760	1.6	860	1.3	960	1.1	1060	0.9	1160	0.8
662	2.0	762	1.6	862	1.3	962	1.1	1062	0.9	1162	0.8
664	2.0	764	1.6	864	1.3	964	1.1	1064	0.9	1164	0.8
666	2.0	766	1.6	866	1.3	966	1.1	1066	0.9	1166	0.8
668	2.0	768	1.6	868	1.3	968	1.1	1068	0.9	1168	0.8
670	2.0	770	1.6	870	1.3	970	1.1	1070	0.9	1170	0.8
672	2.0	772	1.6	872	1.3	972	1.1	1072	0.9	1172	0.8
674	2.0	774	1.6	874	1.3	974	1.1	1074	0.9	1174	0.8
676	1.9	776	1.6	876	1.3	976	1.1	1076	0.9	1176	0.8
678	1.9	778	1.6	878	1.3	978	1.1	1078	0.9	1178	0.8
680	1.9	780	1.6	880	1.3	980	1.1	1080	0.9	1180	0.8
682	1.9	782	1.6	882	1.3	982	1.1	1082	0.9	1182	0.8
684	1.9	784	1.6	884	1.3	984	1.1	1084	0.9	1184	0.8
686	1.9	786	1.6	886	1.3	986	1.1	1086	0.9	1186	0.7
688	1.9	788	1.6	888	1.3	988	1.1	1088	0.9	1188	0.7
690	1.9	790	1.5	890	1.3	990	1.1	1090	0.9	1190	0.7
692	1.9	792	1.5	892	1.3	992	1.0	1092	0.9	1192	0.7
694	1.9	794	1.5	894	1.3	994	1.0	1094	0.9	1194	0.7
696	1.9	796	1.5	896	1.3	996	1.0	1096	0.9	1196	0.7
698	1.9	798	1.5	898	1.2	998	1.0	1098	0.9	1198	0.7
700	1.9	800	1.5	900	1.2	1000	1.0	1100	0.9	1200	0.7

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.7	1302	0.6	1402	0.5	1502	0.5	1602	0.4	1702	0.3
1204	0.7	1304	0.6	1404	0.5	1504	0.5	1604	0.4	1704	0.3
1206	0.7	1306	0.6	1406	0.5	1506	0.5	1606	0.4	1706	0.3
1208	0.7	1308	0.6	1408	0.5	1508	0.5	1608	0.4	1708	0.3
1210	0.7	1310	0.6	1410	0.5	1510	0.5	1610	0.4	1710	0.3
1212	0.7	1312	0.6	1412	0.5	1512	0.5	1612	0.4	1712	0.3
1214	0.7	1314	0.6	1414	0.5	1514	0.4	1614	0.4	1714	0.3
1216	0.7	1316	0.6	1416	0.5	1516	0.4	1616	0.4	1716	0.3
1218	0.7	1318	0.6	1418	0.5	1518	0.4	1618	0.4	1718	0.3
1220	0.7	1320	0.6	1420	0.5	1520	0.4	1620	0.4	1720	0.3
1222	0.7	1322	0.6	1422	0.5	1522	0.4	1622	0.4	1722	0.3
1224	0.7	1324	0.6	1424	0.5	1524	0.4	1624	0.4	1724	0.3
1226	0.7	1326	0.6	1426	0.5	1526	0.4	1626	0.4	1726	0.3
1228	0.7	1328	0.6	1428	0.5	1528	0.4	1628	0.4	1728	0.3
1230	0.7	1330	0.6	1430	0.5	1530	0.4	1630	0.4	1730	0.3
1232	0.7	1332	0.6	1432	0.5	1532	0.4	1632	0.4	1732	0.3
1234	0.7	1334	0.6	1434	0.5	1534	0.4	1634	0.4	1734	0.3
1236	0.7	1336	0.6	1436	0.5	1536	0.4	1636	0.4	1736	0.3
1238	0.7	1338	0.6	1438	0.5	1538	0.4	1638	0.4	1738	0.3
1240	0.7	1340	0.6	1440	0.5	1540	0.4	1640	0.4	1740	0.3
1242	0.7	1342	0.6	1442	0.5	1542	0.4	1642	0.4	1742	0.3
1244	0.7	1344	0.6	1444	0.5	1544	0.4	1644	0.4	1744	0.3
1246	0.7	1346	0.6	1446	0.5	1546	0.4	1646	0.4	1746	0.3
1248	0.7	1348	0.6	1448	0.5	1548	0.4	1648	0.4	1748	0.3
1250	0.7	1350	0.6	1450	0.5	1550	0.4	1650	0.4	1750	0.3
1252	0.7	1352	0.6	1452	0.5	1552	0.4	1652	0.4	1752	0.3
1254	0.7	1354	0.6	1454	0.5	1554	0.4	1654	0.4	1754	0.3
1256	0.7	1356	0.6	1456	0.5	1556	0.4	1656	0.4	1756	0.3
1258	0.7	1358	0.6	1458	0.5	1558	0.4	1658	0.4	1758	0.3
1260	0.7	1360	0.6	1460	0.5	1560	0.4	1660	0.4	1760	0.3
1262	0.7	1362	0.6	1462	0.5	1562	0.4	1662	0.4	1762	0.3
1264	0.7	1364	0.6	1464	0.5	1564	0.4	1664	0.4	1764	0.3
1266	0.7	1366	0.6	1466	0.5	1566	0.4	1666	0.4	1766	0.3
1268	0.7	1368	0.6	1468	0.5	1568	0.4	1668	0.4	1768	0.3
1270	0.7	1370	0.6	1470	0.5	1570	0.4	1670	0.4	1770	0.3
1272	0.6	1372	0.6	1472	0.5	1572	0.4	1672	0.4	1772	0.3
1274	0.6	1374	0.5	1474	0.5	1574	0.4	1674	0.4	1774	0.3
1276	0.6	1376	0.5	1476	0.5	1576	0.4	1676	0.4	1776	0.3
1278	0.6	1378	0.5	1478	0.5	1578	0.4	1678	0.4	1778	0.3
1280	0.6	1380	0.5	1480	0.5	1580	0.4	1680	0.4	1780	0.3
1282	0.6	1382	0.5	1482	0.5	1582	0.4	1682	0.4	1782	0.3
1284	0.6	1384	0.5	1484	0.5	1584	0.4	1684	0.4	1784	0.3
1286	0.6	1386	0.5	1486	0.5	1586	0.4	1686	0.4	1786	0.3
1288	0.6	1388	0.5	1488	0.5	1588	0.4	1688	0.4	1788	0.3
1290	0.6	1390	0.5	1490	0.5	1590	0.4	1690	0.3	1790	0.3
1292	0.6	1392	0.5	1492	0.5	1592	0.4	1692	0.3	1792	0.3
1294	0.6	1394	0.5	1494	0.5	1594	0.4	1694	0.3	1794	0.3
1296	0.6	1396	0.5	1496	0.5	1596	0.4	1696	0.3	1796	0.3
1298	0.6	1398	0.5	1498	0.5	1598	0.4	1698	0.3	1798	0.3
1300	0.6	1400	0.5	1500	0.5	1600	0.4	1700	0.3	1800	0.3

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.3	1902	0.3	2002	0.2	2102	0.2	2202	0.2	2302	0.2
1804	0.3	1904	0.3	2004	0.2	2104	0.2	2204	0.2	2304	0.2
1806	0.3	1906	0.3	2006	0.2	2106	0.2	2206	0.2	2306	0.2
1808	0.3	1908	0.3	2008	0.2	2108	0.2	2208	0.2	2308	0.2
1810	0.3	1910	0.3	2010	0.2	2110	0.2	2210	0.2	2310	0.2
1812	0.3	1912	0.3	2012	0.2	2112	0.2	2212	0.2	2312	0.2
1814	0.3	1914	0.3	2014	0.2	2114	0.2	2214	0.2	2314	0.2
1816	0.3	1916	0.3	2016	0.2	2116	0.2	2216	0.2	2316	0.2
1818	0.3	1918	0.3	2018	0.2	2118	0.2	2218	0.2	2318	0.2
1820	0.3	1920	0.3	2020	0.2	2120	0.2	2220	0.2	2320	0.2
1822	0.3	1922	0.3	2022	0.2	2122	0.2	2222	0.2	2322	0.2
1824	0.3	1924	0.3	2024	0.2	2124	0.2	2224	0.2	2324	0.2
1826	0.3	1926	0.3	2026	0.2	2126	0.2	2226	0.2	2326	0.2
1828	0.3	1928	0.3	2028	0.2	2128	0.2	2228	0.2	2328	0.2
1830	0.3	1930	0.3	2030	0.2	2130	0.2	2230	0.2	2330	0.2
1832	0.3	1932	0.3	2032	0.2	2132	0.2	2232	0.2	2332	0.2
1834	0.3	1934	0.3	2034	0.2	2134	0.2	2234	0.2	2334	0.2
1836	0.3	1936	0.3	2036	0.2	2136	0.2	2236	0.2	2336	0.2
1838	0.3	1938	0.3	2038	0.2	2138	0.2	2238	0.2	2338	0.2
1840	0.3	1940	0.3	2040	0.2	2140	0.2	2240	0.2	2340	0.2
1842	0.3	1942	0.3	2042	0.2	2142	0.2	2242	0.2	2342	0.2
1844	0.3	1944	0.3	2044	0.2	2144	0.2	2244	0.2	2344	0.2
1846	0.3	1946	0.3	2046	0.2	2146	0.2	2246	0.2	2346	0.2
1848	0.3	1948	0.3	2048	0.2	2148	0.2	2248	0.2	2348	0.2
1850	0.3	1950	0.3	2050	0.2	2150	0.2	2250	0.2	2350	0.2
1852	0.3	1952	0.3	2052	0.2	2152	0.2	2252	0.2	2352	0.2
1854	0.3	1954	0.3	2054	0.2	2154	0.2	2254	0.2	2354	0.2
1856	0.3	1956	0.3	2056	0.2	2156	0.2	2256	0.2	2356	0.2
1858	0.3	1958	0.3	2058	0.2	2158	0.2	2258	0.2	2358	0.2
1860	0.3	1960	0.3	2060	0.2	2160	0.2	2260	0.2	2360	0.2
1862	0.3	1962	0.3	2062	0.2	2162	0.2	2262	0.2	2362	0.2
1864	0.3	1964	0.3	2064	0.2	2164	0.2	2264	0.2	2364	0.2
1866	0.3	1966	0.3	2066	0.2	2166	0.2	2266	0.2	2366	0.2
1868	0.3	1968	0.3	2068	0.2	2168	0.2	2268	0.2	2368	0.2
1870	0.3	1970	0.3	2070	0.2	2170	0.2	2270	0.2	2370	0.2
1872	0.3	1972	0.3	2072	0.2	2172	0.2	2272	0.2	2372	0.2
1874	0.3	1974	0.3	2074	0.2	2174	0.2	2274	0.2	2374	0.2
1876	0.3	1976	0.3	2076	0.2	2176	0.2	2276	0.2	2376	0.2
1878	0.3	1978	0.3	2078	0.2	2178	0.2	2278	0.2	2378	0.2
1880	0.3	1980	0.3	2080	0.2	2180	0.2	2280	0.2	2380	0.2
1882	0.3	1982	0.3	2082	0.2	2182	0.2	2282	0.2	2382	0.2
1884	0.3	1984	0.3	2084	0.2	2184	0.2	2284	0.2	2384	0.2
1886	0.3	1986	0.3	2086	0.2	2186	0.2	2286	0.2	2386	0.2
1888	0.3	1988	0.3	2088	0.2	2188	0.2	2288	0.2	2388	0.2
1890	0.3	1990	0.3	2090	0.2	2190	0.2	2290	0.2	2390	0.2
1892	0.3	1992	0.2	2092	0.2	2192	0.2	2292	0.2	2392	0.2
1894	0.3	1994	0.2	2094	0.2	2194	0.2	2294	0.2	2394	0.2
1896	0.3	1996	0.2	2096	0.2	2196	0.2	2296	0.2	2396	0.2
1898	0.3	1998	0.2	2098	0.2	2198	0.2	2298	0.2	2398	0.2
1900	0.3	2000	0.2	2100	0.2	2200	0.2	2300	0.2	2400	0.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.2	2482	0.2	2562	0.1	2642	0.1	2722	0.1	2802	0.1
2404	0.2	2484	0.2	2564	0.1	2644	0.1	2724	0.1	2804	0.1
2406	0.2	2486	0.2	2566	0.1	2646	0.1	2726	0.1	2806	0.1
2408	0.2	2488	0.2	2568	0.1	2648	0.1	2728	0.1	2808	0.1
2410	0.2	2490	0.2	2570	0.1	2650	0.1	2730	0.1	2810	0.1
2412	0.2	2492	0.2	2572	0.1	2652	0.1	2732	0.1	2812	0.1
2414	0.2	2494	0.2	2574	0.1	2654	0.1	2734	0.1	2814	0.1
2416	0.2	2496	0.2	2576	0.1	2656	0.1	2736	0.1	2816	0.1
2418	0.2	2498	0.2	2578	0.1	2658	0.1	2738	0.1	2818	0.1
2420	0.2	2500	0.2	2580	0.1	2660	0.1	2740	0.1	2820	0.1
2422	0.2	2502	0.2	2582	0.1	2662	0.1	2742	0.1	2822	0.1
2424	0.2	2504	0.2	2584	0.1	2664	0.1	2744	0.1	2824	0.1
2426	0.2	2506	0.1	2586	0.1	2666	0.1	2746	0.1	2826	0.1
2428	0.2	2508	0.1	2588	0.1	2668	0.1	2748	0.1	2828	0.1
2430	0.2	2510	0.1	2590	0.1	2670	0.1	2750	0.1	2830	0.1
2432	0.2	2512	0.1	2592	0.1	2672	0.1	2752	0.1	2832	0.1
2434	0.2	2514	0.1	2594	0.1	2674	0.1	2754	0.1	2834	0.1
2436	0.2	2516	0.1	2596	0.1	2676	0.1	2756	0.1	2836	0.1
2438	0.2	2518	0.1	2598	0.1	2678	0.1	2758	0.1	2838	0.1
2440	0.2	2520	0.1	2600	0.1	2680	0.1	2760	0.1	2840	0.1
2442	0.2	2522	0.1	2602	0.1	2682	0.1	2762	0.1	2842	0.1
2444	0.2	2524	0.1	2604	0.1	2684	0.1	2764	0.1	2844	0.1
2446	0.2	2526	0.1	2606	0.1	2686	0.1	2766	0.1	2846	0.1
2448	0.2	2528	0.1	2608	0.1	2688	0.1	2768	0.1	2848	0.1
2450	0.2	2530	0.1	2610	0.1	2690	0.1	2770	0.1	2850	0.1
2452	0.2	2532	0.1	2612	0.1	2692	0.1	2772	0.1	2852	0.1
2454	0.2	2534	0.1	2614	0.1	2694	0.1	2774	0.1	2854	0.1
2456	0.2	2536	0.1	2616	0.1	2696	0.1	2776	0.1	2856	0.1
2458	0.2	2538	0.1	2618	0.1	2698	0.1	2778	0.1	2858	0.1
2460	0.2	2540	0.1	2620	0.1	2700	0.1	2780	0.1	2860	0.1
2462	0.2	2542	0.1	2622	0.1	2702	0.1	2782	0.1	2862	0.1
2464	0.2	2544	0.1	2624	0.1	2704	0.1	2784	0.1	2864	0.1
2466	0.2	2546	0.1	2626	0.1	2706	0.1	2786	0.1	2866	0.1
2468	0.2	2548	0.1	2628	0.1	2708	0.1	2788	0.1	2868	0.1
2470	0.2	2550	0.1	2630	0.1	2710	0.1	2790	0.1	2870	0.1
2472	0.2	2552	0.1	2632	0.1	2712	0.1	2792	0.1	2872	0.1
2474	0.2	2554	0.1	2634	0.1	2714	0.1	2794	0.1	2874	0.1
2476	0.2	2556	0.1	2636	0.1	2716	0.1	2796	0.1	2876	0.1
2478	0.2	2558	0.1	2638	0.1	2718	0.1	2798	0.1	2878	0.1
2480	0.2	2560	0.1	2640	0.1	2720	0.1	2800	0.1	2880	0.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.391	0.391	13.9	293.6	O K
30 min Summer	8.497	0.497	13.9	372.6	O K
60 min Summer	8.592	0.592	13.9	443.8	O K
120 min Summer	8.723	0.723	13.9	542.2	O K
180 min Summer	8.786	0.786	13.9	589.5	O K
240 min Summer	8.822	0.822	13.9	616.2	O K
360 min Summer	8.849	0.849	13.9	637.1	O K
480 min Summer	8.843	0.843	13.9	631.9	O K
600 min Summer	8.826	0.826	13.9	619.6	O K
720 min Summer	8.806	0.806	13.9	604.2	O K
960 min Summer	8.755	0.755	13.9	566.5	O K
1440 min Summer	8.624	0.624	13.9	467.9	O K
2160 min Summer	8.451	0.451	13.9	338.0	O K
2880 min Summer	8.331	0.331	13.9	248.3	O K
4320 min Summer	8.206	0.206	13.5	154.3	O K
5760 min Summer	8.162	0.162	11.8	121.2	O K
7200 min Summer	8.141	0.141	10.1	106.0	O K
8640 min Summer	8.129	0.129	8.9	96.5	O K
10080 min Summer	8.120	0.120	8.0	89.6	O K
15 min Winter	8.440	0.440	13.9	329.8	O K
30 min Winter	8.559	0.559	13.9	419.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.920	0.0	396.6	19
30 min Summer	110.600	0.0	483.3	33
60 min Summer	67.760	0.0	604.0	62
120 min Summer	43.120	0.0	734.2	122
180 min Summer	32.548	0.0	814.6	182
240 min Summer	26.390	0.0	870.3	242
360 min Summer	19.297	0.0	942.3	360
480 min Summer	15.250	0.0	986.0	460
600 min Summer	12.635	0.0	1016.6	506
720 min Summer	10.803	0.0	1039.6	564
960 min Summer	8.400	0.0	1072.9	684
1440 min Summer	5.851	0.0	1114.8	924
2160 min Summer	4.052	0.0	1163.0	1296
2880 min Summer	3.124	0.0	1191.2	1644
4320 min Summer	2.176	0.0	1235.5	2292
5760 min Summer	1.693	0.0	1281.9	2992
7200 min Summer	1.404	0.0	1323.3	3680
8640 min Summer	1.211	0.0	1363.7	4408
10080 min Summer	1.073	0.0	1402.6	5144
15 min Winter	171.920	0.0	432.9	18
30 min Winter	110.600	0.0	530.0	33

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.668	0.668	13.9	500.9	O K
120 min Winter	8.817	0.817	13.9	612.8	O K
180 min Winter	8.890	0.890	13.9	667.3	O K
240 min Winter	8.932	0.932	13.9	698.6	O K
360 min Winter	8.967	0.967	13.9	724.9	O K
480 min Winter	8.963	0.963	13.9	722.2	O K
600 min Winter	8.941	0.941	13.9	705.6	O K
720 min Winter	8.912	0.912	13.9	684.1	O K
960 min Winter	8.851	0.851	13.9	638.0	O K
1440 min Winter	8.687	0.687	13.9	515.1	O K
2160 min Winter	8.433	0.433	13.9	325.0	O K
2880 min Winter	8.273	0.273	13.8	204.5	O K
4320 min Winter	8.161	0.161	11.8	120.9	O K
5760 min Winter	8.132	0.132	9.3	99.0	O K
7200 min Winter	8.117	0.117	7.7	87.4	O K
8640 min Winter	8.106	0.106	6.6	79.7	O K
10080 min Winter	8.099	0.099	5.9	74.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	67.760	0.0	661.3	62
120 min Winter	43.120	0.0	807.1	120
180 min Winter	32.548	0.0	897.1	178
240 min Winter	26.390	0.0	959.5	236
360 min Winter	19.297	0.0	1040.1	350
480 min Winter	15.250	0.0	1089.0	460
600 min Winter	12.635	0.0	1123.2	560
720 min Winter	10.803	0.0	1149.0	584
960 min Winter	8.400	0.0	1186.2	724
1440 min Winter	5.851	0.0	1232.9	1024
2160 min Winter	4.052	0.0	1286.4	1380
2880 min Winter	3.124	0.0	1318.0	1696
4320 min Winter	2.176	0.0	1368.2	2288
5760 min Winter	1.693	0.0	1419.4	2944
7200 min Winter	1.404	0.0	1465.9	3712
8640 min Winter	1.211	0.0	1511.4	4416
10080 min Winter	1.073	0.0	1555.5	5152

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 541450 180700 TQ 41450 80700
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.940

Time (mins) From:	To:	Area (ha)
0	4	0.940

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	0.0	202	1.6	302	2.8	402	2.8	502	2.5
4	0.0	104	0.0	204	1.6	304	2.8	404	2.8	504	2.5
6	0.0	106	0.0	206	1.7	306	2.8	406	2.8	506	2.5
8	0.0	108	0.0	208	1.8	308	2.8	408	2.8	508	2.5
10	0.0	110	0.0	210	1.8	310	2.8	410	2.8	510	2.5
12	0.0	112	0.0	212	1.9	312	2.8	412	2.8	512	2.5
14	0.0	114	0.0	214	1.9	314	2.8	414	2.8	514	2.5
16	0.0	116	0.0	216	2.0	316	2.8	416	2.8	516	2.4
18	0.0	118	0.1	218	2.1	318	2.8	418	2.8	518	2.4
20	0.0	120	0.1	220	2.1	320	2.8	420	2.8	520	2.4
22	0.0	122	0.1	222	2.1	322	2.8	422	2.8	522	2.4
24	0.0	124	0.1	224	2.2	324	2.8	424	2.8	524	2.4
26	0.0	126	0.1	226	2.2	326	2.8	426	2.8	526	2.4
28	0.0	128	0.1	228	2.3	328	2.8	428	2.8	528	2.4
30	0.0	130	0.1	230	2.3	330	2.8	430	2.8	530	2.4
32	0.0	132	0.1	232	2.4	332	2.8	432	2.8	532	2.4
34	0.0	134	0.1	234	2.4	334	2.8	434	2.8	534	2.4
36	0.0	136	0.1	236	2.4	336	2.8	436	2.8	536	2.4
38	0.0	138	0.2	238	2.5	338	2.8	438	2.8	538	2.4
40	0.0	140	0.2	240	2.5	340	2.8	440	2.7	540	2.4
42	0.0	142	0.2	242	2.5	342	2.8	442	2.7	542	2.4
44	0.0	144	0.2	244	2.6	344	2.8	444	2.7	544	2.4
46	0.0	146	0.2	246	2.6	346	2.8	446	2.7	546	2.3
48	0.0	148	0.3	248	2.6	348	2.8	448	2.7	548	2.3
50	0.0	150	0.3	250	2.6	350	2.8	450	2.7	550	2.3
52	0.0	152	0.3	252	2.7	352	2.8	452	2.7	552	2.3
54	0.0	154	0.3	254	2.7	354	2.8	454	2.7	554	2.3
56	0.0	156	0.4	256	2.7	356	2.8	456	2.7	556	2.3
58	0.0	158	0.4	258	2.7	358	2.8	458	2.7	558	2.3
60	0.0	160	0.4	260	2.7	360	2.8	460	2.7	560	2.3
62	0.0	162	0.5	262	2.8	362	2.8	462	2.7	562	2.3
64	0.0	164	0.5	264	2.8	364	2.8	464	2.7	564	2.3
66	0.0	166	0.5	266	2.8	366	2.8	466	2.6	566	2.3
68	0.0	168	0.6	268	2.8	368	2.8	468	2.6	568	2.3
70	0.0	170	0.6	270	2.8	370	2.8	470	2.6	570	2.3
72	0.0	172	0.7	272	2.8	372	2.8	472	2.6	572	2.2
74	0.0	174	0.7	274	2.8	374	2.8	474	2.6	574	2.2
76	0.0	176	0.8	276	2.8	376	2.8	476	2.6	576	2.2
78	0.0	178	0.8	278	2.8	378	2.8	478	2.6	578	2.2
80	0.0	180	0.9	280	2.8	380	2.8	480	2.6	580	2.2
82	0.0	182	0.9	282	2.8	382	2.8	482	2.6	582	2.2
84	0.0	184	1.0	284	2.8	384	2.8	484	2.6	584	2.2
86	0.0	186	1.1	286	2.8	386	2.8	486	2.6	586	2.2
88	0.0	188	1.1	288	2.8	388	2.8	488	2.6	588	2.2
90	0.0	190	1.2	290	2.8	390	2.8	490	2.6	590	2.2
92	0.0	192	1.2	292	2.8	392	2.8	492	2.5	592	2.2
94	0.0	194	1.3	294	2.8	394	2.8	494	2.5	594	2.1
96	0.0	196	1.4	296	2.8	396	2.8	496	2.5	596	2.1
98	0.0	198	1.4	298	2.8	398	2.8	498	2.5	598	2.1
100	0.0	200	1.5	300	2.8	400	2.8	500	2.5	600	2.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	2.1	702	1.7	802	1.4	902	1.2	1002	1.0	1102	0.8
604	2.1	704	1.7	804	1.4	904	1.2	1004	1.0	1104	0.8
606	2.1	706	1.7	806	1.4	906	1.2	1006	1.0	1106	0.8
608	2.1	708	1.7	808	1.4	908	1.2	1008	1.0	1108	0.8
610	2.1	710	1.7	810	1.4	910	1.2	1010	1.0	1110	0.8
612	2.1	712	1.7	812	1.4	912	1.2	1012	1.0	1112	0.8
614	2.1	714	1.7	814	1.4	914	1.2	1014	1.0	1114	0.8
616	2.1	716	1.7	816	1.4	916	1.2	1016	0.9	1116	0.8
618	2.1	718	1.7	818	1.4	918	1.2	1018	0.9	1118	0.8
620	2.1	720	1.7	820	1.4	920	1.1	1020	0.9	1120	0.8
622	2.1	722	1.7	822	1.4	922	1.1	1022	0.9	1122	0.8
624	2.0	724	1.7	824	1.4	924	1.1	1024	0.9	1124	0.8
626	2.0	726	1.7	826	1.4	926	1.1	1026	0.9	1126	0.8
628	2.0	728	1.7	828	1.4	928	1.1	1028	0.9	1128	0.8
630	2.0	730	1.7	830	1.4	930	1.1	1030	0.9	1130	0.8
632	2.0	732	1.6	832	1.3	932	1.1	1032	0.9	1132	0.8
634	2.0	734	1.6	834	1.3	934	1.1	1034	0.9	1134	0.8
636	2.0	736	1.6	836	1.3	936	1.1	1036	0.9	1136	0.8
638	2.0	738	1.6	838	1.3	938	1.1	1038	0.9	1138	0.8
640	2.0	740	1.6	840	1.3	940	1.1	1040	0.9	1140	0.8
642	2.0	742	1.6	842	1.3	942	1.1	1042	0.9	1142	0.8
644	2.0	744	1.6	844	1.3	944	1.1	1044	0.9	1144	0.8
646	2.0	746	1.6	846	1.3	946	1.1	1046	0.9	1146	0.8
648	1.9	748	1.6	848	1.3	948	1.1	1048	0.9	1148	0.8
650	1.9	750	1.6	850	1.3	950	1.1	1050	0.9	1150	0.8
652	1.9	752	1.6	852	1.3	952	1.1	1052	0.9	1152	0.8
654	1.9	754	1.6	854	1.3	954	1.1	1054	0.9	1154	0.8
656	1.9	756	1.6	856	1.3	956	1.1	1056	0.9	1156	0.8
658	1.9	758	1.6	858	1.3	958	1.1	1058	0.9	1158	0.7
660	1.9	760	1.6	860	1.3	960	1.1	1060	0.9	1160	0.7
662	1.9	762	1.6	862	1.3	962	1.1	1062	0.9	1162	0.7
664	1.9	764	1.5	864	1.3	964	1.1	1064	0.9	1164	0.7
666	1.9	766	1.5	866	1.3	966	1.0	1066	0.9	1166	0.7
668	1.9	768	1.5	868	1.3	968	1.0	1068	0.9	1168	0.7
670	1.9	770	1.5	870	1.2	970	1.0	1070	0.9	1170	0.7
672	1.9	772	1.5	872	1.2	972	1.0	1072	0.9	1172	0.7
674	1.8	774	1.5	874	1.2	974	1.0	1074	0.9	1174	0.7
676	1.8	776	1.5	876	1.2	976	1.0	1076	0.9	1176	0.7
678	1.8	778	1.5	878	1.2	978	1.0	1078	0.9	1178	0.7
680	1.8	780	1.5	880	1.2	980	1.0	1080	0.9	1180	0.7
682	1.8	782	1.5	882	1.2	982	1.0	1082	0.8	1182	0.7
684	1.8	784	1.5	884	1.2	984	1.0	1084	0.8	1184	0.7
686	1.8	786	1.5	886	1.2	986	1.0	1086	0.8	1186	0.7
688	1.8	788	1.5	888	1.2	988	1.0	1088	0.8	1188	0.7
690	1.8	790	1.5	890	1.2	990	1.0	1090	0.8	1190	0.7
692	1.8	792	1.5	892	1.2	992	1.0	1092	0.8	1192	0.7
694	1.8	794	1.5	894	1.2	994	1.0	1094	0.8	1194	0.7
696	1.8	796	1.4	896	1.2	996	1.0	1096	0.8	1196	0.7
698	1.8	798	1.4	898	1.2	998	1.0	1098	0.8	1198	0.7
700	1.8	800	1.4	900	1.2	1000	1.0	1100	0.8	1200	0.7

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.7	1302	0.6	1402	0.5	1502	0.4	1602	0.4	1702	0.3
1204	0.7	1304	0.6	1404	0.5	1504	0.4	1604	0.4	1704	0.3
1206	0.7	1306	0.6	1406	0.5	1506	0.4	1606	0.4	1706	0.3
1208	0.7	1308	0.6	1408	0.5	1508	0.4	1608	0.4	1708	0.3
1210	0.7	1310	0.6	1410	0.5	1510	0.4	1610	0.4	1710	0.3
1212	0.7	1312	0.6	1412	0.5	1512	0.4	1612	0.4	1712	0.3
1214	0.7	1314	0.6	1414	0.5	1514	0.4	1614	0.4	1714	0.3
1216	0.7	1316	0.6	1416	0.5	1516	0.4	1616	0.4	1716	0.3
1218	0.7	1318	0.6	1418	0.5	1518	0.4	1618	0.4	1718	0.3
1220	0.7	1320	0.6	1420	0.5	1520	0.4	1620	0.4	1720	0.3
1222	0.7	1322	0.6	1422	0.5	1522	0.4	1622	0.4	1722	0.3
1224	0.7	1324	0.6	1424	0.5	1524	0.4	1624	0.4	1724	0.3
1226	0.7	1326	0.6	1426	0.5	1526	0.4	1626	0.4	1726	0.3
1228	0.7	1328	0.6	1428	0.5	1528	0.4	1628	0.4	1728	0.3
1230	0.7	1330	0.6	1430	0.5	1530	0.4	1630	0.4	1730	0.3
1232	0.7	1332	0.6	1432	0.5	1532	0.4	1632	0.4	1732	0.3
1234	0.7	1334	0.6	1434	0.5	1534	0.4	1634	0.4	1734	0.3
1236	0.7	1336	0.6	1436	0.5	1536	0.4	1636	0.4	1736	0.3
1238	0.7	1338	0.6	1438	0.5	1538	0.4	1638	0.4	1738	0.3
1240	0.7	1340	0.6	1440	0.5	1540	0.4	1640	0.4	1740	0.3
1242	0.7	1342	0.6	1442	0.5	1542	0.4	1642	0.4	1742	0.3
1244	0.7	1344	0.6	1444	0.5	1544	0.4	1644	0.4	1744	0.3
1246	0.6	1346	0.5	1446	0.5	1546	0.4	1646	0.4	1746	0.3
1248	0.6	1348	0.5	1448	0.5	1548	0.4	1648	0.4	1748	0.3
1250	0.6	1350	0.5	1450	0.5	1550	0.4	1650	0.4	1750	0.3
1252	0.6	1352	0.5	1452	0.5	1552	0.4	1652	0.4	1752	0.3
1254	0.6	1354	0.5	1454	0.5	1554	0.4	1654	0.4	1754	0.3
1256	0.6	1356	0.5	1456	0.5	1556	0.4	1656	0.4	1756	0.3
1258	0.6	1358	0.5	1458	0.5	1558	0.4	1658	0.4	1758	0.3
1260	0.6	1360	0.5	1460	0.5	1560	0.4	1660	0.4	1760	0.3
1262	0.6	1362	0.5	1462	0.5	1562	0.4	1662	0.3	1762	0.3
1264	0.6	1364	0.5	1464	0.5	1564	0.4	1664	0.3	1764	0.3
1266	0.6	1366	0.5	1466	0.5	1566	0.4	1666	0.3	1766	0.3
1268	0.6	1368	0.5	1468	0.5	1568	0.4	1668	0.3	1768	0.3
1270	0.6	1370	0.5	1470	0.5	1570	0.4	1670	0.3	1770	0.3
1272	0.6	1372	0.5	1472	0.5	1572	0.4	1672	0.3	1772	0.3
1274	0.6	1374	0.5	1474	0.5	1574	0.4	1674	0.3	1774	0.3
1276	0.6	1376	0.5	1476	0.5	1576	0.4	1676	0.3	1776	0.3
1278	0.6	1378	0.5	1478	0.5	1578	0.4	1678	0.3	1778	0.3
1280	0.6	1380	0.5	1480	0.5	1580	0.4	1680	0.3	1780	0.3
1282	0.6	1382	0.5	1482	0.5	1582	0.4	1682	0.3	1782	0.3
1284	0.6	1384	0.5	1484	0.5	1584	0.4	1684	0.3	1784	0.3
1286	0.6	1386	0.5	1486	0.5	1586	0.4	1686	0.3	1786	0.3
1288	0.6	1388	0.5	1488	0.4	1588	0.4	1688	0.3	1788	0.3
1290	0.6	1390	0.5	1490	0.4	1590	0.4	1690	0.3	1790	0.3
1292	0.6	1392	0.5	1492	0.4	1592	0.4	1692	0.3	1792	0.3
1294	0.6	1394	0.5	1494	0.4	1594	0.4	1694	0.3	1794	0.3
1296	0.6	1396	0.5	1496	0.4	1596	0.4	1696	0.3	1796	0.3
1298	0.6	1398	0.5	1498	0.4	1598	0.4	1698	0.3	1798	0.3
1300	0.6	1400	0.5	1500	0.4	1600	0.4	1700	0.3	1800	0.3

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.3	1902	0.3	2002	0.2	2102	0.2	2202	0.2	2302	0.2
1804	0.3	1904	0.3	2004	0.2	2104	0.2	2204	0.2	2304	0.2
1806	0.3	1906	0.3	2006	0.2	2106	0.2	2206	0.2	2306	0.2
1808	0.3	1908	0.3	2008	0.2	2108	0.2	2208	0.2	2308	0.2
1810	0.3	1910	0.3	2010	0.2	2110	0.2	2210	0.2	2310	0.2
1812	0.3	1912	0.3	2012	0.2	2112	0.2	2212	0.2	2312	0.2
1814	0.3	1914	0.3	2014	0.2	2114	0.2	2214	0.2	2314	0.2
1816	0.3	1916	0.3	2016	0.2	2116	0.2	2216	0.2	2316	0.2
1818	0.3	1918	0.3	2018	0.2	2118	0.2	2218	0.2	2318	0.2
1820	0.3	1920	0.3	2020	0.2	2120	0.2	2220	0.2	2320	0.2
1822	0.3	1922	0.3	2022	0.2	2122	0.2	2222	0.2	2322	0.2
1824	0.3	1924	0.3	2024	0.2	2124	0.2	2224	0.2	2324	0.2
1826	0.3	1926	0.3	2026	0.2	2126	0.2	2226	0.2	2326	0.2
1828	0.3	1928	0.3	2028	0.2	2128	0.2	2228	0.2	2328	0.2
1830	0.3	1930	0.3	2030	0.2	2130	0.2	2230	0.2	2330	0.2
1832	0.3	1932	0.3	2032	0.2	2132	0.2	2232	0.2	2332	0.2
1834	0.3	1934	0.3	2034	0.2	2134	0.2	2234	0.2	2334	0.2
1836	0.3	1936	0.3	2036	0.2	2136	0.2	2236	0.2	2336	0.2
1838	0.3	1938	0.3	2038	0.2	2138	0.2	2238	0.2	2338	0.2
1840	0.3	1940	0.3	2040	0.2	2140	0.2	2240	0.2	2340	0.2
1842	0.3	1942	0.3	2042	0.2	2142	0.2	2242	0.2	2342	0.2
1844	0.3	1944	0.3	2044	0.2	2144	0.2	2244	0.2	2344	0.2
1846	0.3	1946	0.3	2046	0.2	2146	0.2	2246	0.2	2346	0.2
1848	0.3	1948	0.3	2048	0.2	2148	0.2	2248	0.2	2348	0.2
1850	0.3	1950	0.3	2050	0.2	2150	0.2	2250	0.2	2350	0.2
1852	0.3	1952	0.3	2052	0.2	2152	0.2	2252	0.2	2352	0.2
1854	0.3	1954	0.3	2054	0.2	2154	0.2	2254	0.2	2354	0.2
1856	0.3	1956	0.3	2056	0.2	2156	0.2	2256	0.2	2356	0.2
1858	0.3	1958	0.3	2058	0.2	2158	0.2	2258	0.2	2358	0.2
1860	0.3	1960	0.3	2060	0.2	2160	0.2	2260	0.2	2360	0.2
1862	0.3	1962	0.3	2062	0.2	2162	0.2	2262	0.2	2362	0.2
1864	0.3	1964	0.2	2064	0.2	2164	0.2	2264	0.2	2364	0.2
1866	0.3	1966	0.2	2066	0.2	2166	0.2	2266	0.2	2366	0.2
1868	0.3	1968	0.2	2068	0.2	2168	0.2	2268	0.2	2368	0.2
1870	0.3	1970	0.2	2070	0.2	2170	0.2	2270	0.2	2370	0.2
1872	0.3	1972	0.2	2072	0.2	2172	0.2	2272	0.2	2372	0.2
1874	0.3	1974	0.2	2074	0.2	2174	0.2	2274	0.2	2374	0.2
1876	0.3	1976	0.2	2076	0.2	2176	0.2	2276	0.2	2376	0.2
1878	0.3	1978	0.2	2078	0.2	2178	0.2	2278	0.2	2378	0.2
1880	0.3	1980	0.2	2080	0.2	2180	0.2	2280	0.2	2380	0.2
1882	0.3	1982	0.2	2082	0.2	2182	0.2	2282	0.2	2382	0.2
1884	0.3	1984	0.2	2084	0.2	2184	0.2	2284	0.2	2384	0.2
1886	0.3	1986	0.2	2086	0.2	2186	0.2	2286	0.2	2386	0.2
1888	0.3	1988	0.2	2088	0.2	2188	0.2	2288	0.2	2388	0.2
1890	0.3	1990	0.2	2090	0.2	2190	0.2	2290	0.2	2390	0.2
1892	0.3	1992	0.2	2092	0.2	2192	0.2	2292	0.2	2392	0.2
1894	0.3	1994	0.2	2094	0.2	2194	0.2	2294	0.2	2394	0.2
1896	0.3	1996	0.2	2096	0.2	2196	0.2	2296	0.2	2396	0.2
1898	0.3	1998	0.2	2098	0.2	2198	0.2	2298	0.2	2398	0.2
1900	0.3	2000	0.2	2100	0.2	2200	0.2	2300	0.2	2400	0.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.2	2482	0.1	2562	0.1	2642	0.1	2722	0.1	2802	0.1
2404	0.2	2484	0.1	2564	0.1	2644	0.1	2724	0.1	2804	0.1
2406	0.2	2486	0.1	2566	0.1	2646	0.1	2726	0.1	2806	0.1
2408	0.2	2488	0.1	2568	0.1	2648	0.1	2728	0.1	2808	0.1
2410	0.2	2490	0.1	2570	0.1	2650	0.1	2730	0.1	2810	0.1
2412	0.2	2492	0.1	2572	0.1	2652	0.1	2732	0.1	2812	0.1
2414	0.2	2494	0.1	2574	0.1	2654	0.1	2734	0.1	2814	0.1
2416	0.2	2496	0.1	2576	0.1	2656	0.1	2736	0.1	2816	0.1
2418	0.2	2498	0.1	2578	0.1	2658	0.1	2738	0.1	2818	0.1
2420	0.2	2500	0.1	2580	0.1	2660	0.1	2740	0.1	2820	0.1
2422	0.2	2502	0.1	2582	0.1	2662	0.1	2742	0.1	2822	0.1
2424	0.2	2504	0.1	2584	0.1	2664	0.1	2744	0.1	2824	0.1
2426	0.2	2506	0.1	2586	0.1	2666	0.1	2746	0.1	2826	0.1
2428	0.2	2508	0.1	2588	0.1	2668	0.1	2748	0.1	2828	0.1
2430	0.2	2510	0.1	2590	0.1	2670	0.1	2750	0.1	2830	0.1
2432	0.2	2512	0.1	2592	0.1	2672	0.1	2752	0.1	2832	0.1
2434	0.2	2514	0.1	2594	0.1	2674	0.1	2754	0.1	2834	0.1
2436	0.2	2516	0.1	2596	0.1	2676	0.1	2756	0.1	2836	0.1
2438	0.2	2518	0.1	2598	0.1	2678	0.1	2758	0.1	2838	0.1
2440	0.2	2520	0.1	2600	0.1	2680	0.1	2760	0.1	2840	0.1
2442	0.2	2522	0.1	2602	0.1	2682	0.1	2762	0.1	2842	0.1
2444	0.2	2524	0.1	2604	0.1	2684	0.1	2764	0.1	2844	0.1
2446	0.2	2526	0.1	2606	0.1	2686	0.1	2766	0.1	2846	0.1
2448	0.2	2528	0.1	2608	0.1	2688	0.1	2768	0.1	2848	0.1
2450	0.2	2530	0.1	2610	0.1	2690	0.1	2770	0.1	2850	0.1
2452	0.2	2532	0.1	2612	0.1	2692	0.1	2772	0.1	2852	0.1
2454	0.2	2534	0.1	2614	0.1	2694	0.1	2774	0.1	2854	0.1
2456	0.2	2536	0.1	2616	0.1	2696	0.1	2776	0.1	2856	0.1
2458	0.2	2538	0.1	2618	0.1	2698	0.1	2778	0.1	2858	0.1
2460	0.2	2540	0.1	2620	0.1	2700	0.1	2780	0.1	2860	0.1
2462	0.2	2542	0.1	2622	0.1	2702	0.1	2782	0.1	2862	0.1
2464	0.2	2544	0.1	2624	0.1	2704	0.1	2784	0.1	2864	0.1
2466	0.2	2546	0.1	2626	0.1	2706	0.1	2786	0.1	2866	0.1
2468	0.2	2548	0.1	2628	0.1	2708	0.1	2788	0.1	2868	0.1
2470	0.2	2550	0.1	2630	0.1	2710	0.1	2790	0.1	2870	0.1
2472	0.2	2552	0.1	2632	0.1	2712	0.1	2792	0.1	2872	0.1
2474	0.2	2554	0.1	2634	0.1	2714	0.1	2794	0.1	2874	0.1
2476	0.2	2556	0.1	2636	0.1	2716	0.1	2796	0.1	2876	0.1
2478	0.1	2558	0.1	2638	0.1	2718	0.1	2798	0.1	2878	0.1
2480	0.1	2560	0.1	2640	0.1	2720	0.1	2800	0.1	2880	0.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.322	0.322	6.9	119.1	O K
30 min Summer	8.407	0.407	6.9	150.6	O K
60 min Summer	8.481	0.481	6.9	178.1	O K
120 min Summer	8.579	0.579	6.9	214.3	O K
180 min Summer	8.627	0.627	6.9	231.8	O K
240 min Summer	8.663	0.663	6.9	245.3	O K
360 min Summer	8.706	0.706	6.9	261.2	O K
480 min Summer	8.718	0.718	6.9	265.6	O K
600 min Summer	8.712	0.712	6.9	263.3	O K
720 min Summer	8.697	0.697	6.9	257.9	O K
960 min Summer	8.651	0.651	6.9	240.8	O K
1440 min Summer	8.519	0.519	6.9	192.0	O K
2160 min Summer	8.337	0.337	6.9	124.6	O K
2880 min Summer	8.229	0.229	6.8	84.6	O K
4320 min Summer	8.139	0.139	6.3	51.5	O K
5760 min Summer	8.112	0.112	5.0	41.4	O K
7200 min Summer	8.097	0.097	4.2	36.1	O K
8640 min Summer	8.089	0.089	3.7	32.9	O K
10080 min Summer	8.082	0.082	3.3	30.5	O K
15 min Winter	8.362	0.362	6.9	133.9	O K
30 min Winter	8.458	0.458	6.9	169.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.920	0.0	234.7	18
30 min Summer	110.600	0.0	270.2	33
60 min Summer	67.760	0.0	334.2	62
120 min Summer	43.120	0.0	387.5	122
180 min Summer	32.548	0.0	420.3	182
240 min Summer	26.390	0.0	443.1	242
360 min Summer	19.297	0.0	472.5	362
480 min Summer	15.250	0.0	490.4	480
600 min Summer	12.635	0.0	503.0	572
720 min Summer	10.803	0.0	512.4	608
960 min Summer	8.400	0.0	526.1	704
1440 min Summer	5.851	0.0	543.4	910
2160 min Summer	4.052	0.0	563.9	1256
2880 min Summer	3.124	0.0	575.5	1588
4320 min Summer	2.176	0.0	594.0	2248
5760 min Summer	1.693	0.0	612.4	2944
7200 min Summer	1.404	0.0	629.4	3672
8640 min Summer	1.211	0.0	646.0	4408
10080 min Summer	1.073	0.0	662.1	5144
15 min Winter	171.920	0.0	249.6	18
30 min Winter	110.600	0.0	289.3	33

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.544	0.544	6.9	201.2	O K
120 min Winter	8.660	0.660	6.9	244.4	O K
180 min Winter	8.718	0.718	6.9	265.5	O K
240 min Winter	8.756	0.756	6.9	279.8	O K
360 min Winter	8.801	0.801	6.9	296.4	O K
480 min Winter	8.813	0.813	6.9	300.9	O K
600 min Winter	8.809	0.809	6.9	299.2	O K
720 min Winter	8.789	0.789	6.9	291.9	O K
960 min Winter	8.738	0.738	6.9	272.9	O K
1440 min Winter	8.565	0.565	6.9	209.2	O K
2160 min Winter	8.312	0.312	6.9	115.5	O K
2880 min Winter	8.177	0.177	6.6	65.7	O K
4320 min Winter	8.112	0.112	5.0	41.4	O K
5760 min Winter	8.091	0.091	3.9	33.9	O K
7200 min Winter	8.080	0.080	3.2	29.6	O K
8640 min Winter	8.075	0.075	2.9	27.8	O K
10080 min Winter	8.074	0.074	2.8	27.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	67.760	0.0	357.7	62
120 min Winter	43.120	0.0	417.3	120
180 min Winter	32.548	0.0	454.1	178
240 min Winter	26.390	0.0	479.6	238
360 min Winter	19.297	0.0	512.5	354
480 min Winter	15.250	0.0	532.6	466
600 min Winter	12.635	0.0	546.6	572
720 min Winter	10.803	0.0	557.2	664
960 min Winter	8.400	0.0	572.5	740
1440 min Winter	5.851	0.0	591.9	994
2160 min Winter	4.052	0.0	614.4	1320
2880 min Winter	3.124	0.0	627.4	1612
4320 min Winter	2.176	0.0	648.2	2248
5760 min Winter	1.693	0.0	668.6	2888
7200 min Winter	1.404	0.0	687.6	3672
8640 min Winter	1.211	0.0	706.3	560
10080 min Winter	1.073	0.0	724.6	560

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 541450 180700 TQ 41450 80700
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.384

Time (mins) From:	To:	Area (ha)
0	4	0.384

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	370.0	1.000	370.0	1.100	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0123-6900-1000-6900
Design Head (m)	1.000
Design Flow (l/s)	6.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	123
Invert Level (m)	8.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	6.9
Flush-Flo™	0.299	6.9
Kick-Flo®	0.656	5.7
Mean Flow over Head Range	-	6.0

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	4.4	1.200	7.5	3.000	11.6	7.000	17.3
0.200	6.7	1.400	8.1	3.500	12.5	7.500	17.9
0.300	6.9	1.600	8.6	4.000	13.3	8.000	18.5
0.400	6.8	1.800	9.1	4.500	14.0	8.500	19.0
0.500	6.6	2.000	9.6	5.000	14.8	9.000	19.6
0.600	6.2	2.200	10.0	5.500	15.4	9.500	20.1
0.800	6.2	2.400	10.4	6.000	16.1		
1.000	6.9	2.600	10.8	6.500	16.7		

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	0.0	202	1.7	302	2.7	402	2.7	502	2.6
4	0.0	104	0.0	204	1.7	304	2.7	404	2.7	504	2.6
6	0.0	106	0.0	206	1.8	306	2.7	406	2.7	506	2.6
8	0.0	108	0.0	208	1.9	308	2.7	408	2.7	508	2.6
10	0.0	110	0.0	210	1.9	310	2.7	410	2.7	510	2.6
12	0.0	112	0.0	212	2.0	312	2.7	412	2.7	512	2.6
14	0.0	114	0.0	214	2.0	314	2.7	414	2.7	514	2.6
16	0.0	116	0.0	216	2.1	316	2.7	416	2.7	516	2.6
18	0.0	118	0.1	218	2.1	318	2.7	418	2.7	518	2.6
20	0.0	120	0.1	220	2.2	320	2.7	420	2.7	520	2.6
22	0.0	122	0.1	222	2.2	322	2.7	422	2.7	522	2.6
24	0.0	124	0.1	224	2.3	324	2.7	424	2.7	524	2.6
26	0.0	126	0.1	226	2.3	326	2.7	426	2.7	526	2.6
28	0.0	128	0.1	228	2.4	328	2.7	428	2.7	528	2.5
30	0.0	130	0.1	230	2.4	330	2.7	430	2.7	530	2.5
32	0.0	132	0.1	232	2.4	332	2.7	432	2.7	532	2.5
34	0.0	134	0.1	234	2.5	334	2.7	434	2.7	534	2.5
36	0.0	136	0.1	236	2.5	336	2.7	436	2.7	536	2.5
38	0.0	138	0.2	238	2.5	338	2.7	438	2.7	538	2.5
40	0.0	140	0.2	240	2.6	340	2.7	440	2.7	540	2.5
42	0.0	142	0.2	242	2.6	342	2.7	442	2.7	542	2.5
44	0.0	144	0.2	244	2.6	344	2.7	444	2.7	544	2.5
46	0.0	146	0.2	246	2.6	346	2.7	446	2.7	546	2.5
48	0.0	148	0.3	248	2.7	348	2.7	448	2.7	548	2.5
50	0.0	150	0.3	250	2.7	350	2.7	450	2.7	550	2.5
52	0.0	152	0.3	252	2.7	352	2.7	452	2.7	552	2.4
54	0.0	154	0.4	254	2.7	354	2.7	454	2.7	554	2.4
56	0.0	156	0.4	256	2.7	356	2.7	456	2.7	556	2.4
58	0.0	158	0.4	258	2.7	358	2.7	458	2.7	558	2.4
60	0.0	160	0.5	260	2.7	360	2.7	460	2.7	560	2.4
62	0.0	162	0.5	262	2.7	362	2.7	462	2.7	562	2.4
64	0.0	164	0.5	264	2.7	364	2.7	464	2.7	564	2.4
66	0.0	166	0.6	266	2.7	366	2.7	466	2.7	566	2.4
68	0.0	168	0.6	268	2.7	368	2.7	468	2.7	568	2.4
70	0.0	170	0.7	270	2.7	370	2.7	470	2.7	570	2.4
72	0.0	172	0.7	272	2.7	372	2.7	472	2.7	572	2.4
74	0.0	174	0.8	274	2.7	374	2.7	474	2.7	574	2.4
76	0.0	176	0.8	276	2.7	376	2.7	476	2.7	576	2.4
78	0.0	178	0.9	278	2.7	378	2.7	478	2.7	578	2.4
80	0.0	180	1.0	280	2.7	380	2.7	480	2.7	580	2.4
82	0.0	182	1.0	282	2.7	382	2.7	482	2.7	582	2.3
84	0.0	184	1.1	284	2.7	384	2.7	484	2.7	584	2.3
86	0.0	186	1.1	286	2.7	386	2.7	486	2.7	586	2.3
88	0.0	188	1.2	288	2.7	388	2.7	488	2.7	588	2.3
90	0.0	190	1.3	290	2.7	390	2.7	490	2.7	590	2.3
92	0.0	192	1.3	292	2.7	392	2.7	492	2.7	592	2.3
94	0.0	194	1.4	294	2.7	394	2.7	494	2.7	594	2.3
96	0.0	196	1.5	296	2.7	396	2.7	496	2.7	596	2.3
98	0.0	198	1.5	298	2.7	398	2.7	498	2.6	598	2.3
100	0.0	200	1.6	300	2.7	400	2.7	500	2.6	600	2.3

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	2.3	702	1.9	802	1.6	902	1.3	1002	1.1	1102	0.9
604	2.3	704	1.9	804	1.6	904	1.3	1004	1.1	1104	0.9
606	2.3	706	1.9	806	1.6	906	1.3	1006	1.1	1106	0.9
608	2.3	708	1.9	808	1.6	908	1.3	1008	1.1	1108	0.9
610	2.3	710	1.9	810	1.6	910	1.3	1010	1.1	1110	0.9
612	2.2	712	1.9	812	1.6	912	1.3	1012	1.1	1112	0.9
614	2.2	714	1.9	814	1.5	914	1.3	1014	1.1	1114	0.9
616	2.2	716	1.9	816	1.5	916	1.3	1016	1.0	1116	0.9
618	2.2	718	1.9	818	1.5	918	1.3	1018	1.0	1118	0.9
620	2.2	720	1.9	820	1.5	920	1.2	1020	1.0	1120	0.9
622	2.2	722	1.9	822	1.5	922	1.2	1022	1.0	1122	0.9
624	2.2	724	1.8	824	1.5	924	1.2	1024	1.0	1124	0.9
626	2.2	726	1.8	826	1.5	926	1.2	1026	1.0	1126	0.9
628	2.2	728	1.8	828	1.5	928	1.2	1028	1.0	1128	0.9
630	2.2	730	1.8	830	1.5	930	1.2	1030	1.0	1130	0.9
632	2.2	732	1.8	832	1.5	932	1.2	1032	1.0	1132	0.8
634	2.2	734	1.8	834	1.5	934	1.2	1034	1.0	1134	0.8
636	2.2	736	1.8	836	1.5	936	1.2	1036	1.0	1136	0.8
638	2.2	738	1.8	838	1.5	938	1.2	1038	1.0	1138	0.8
640	2.1	740	1.8	840	1.5	940	1.2	1040	1.0	1140	0.8
642	2.1	742	1.8	842	1.5	942	1.2	1042	1.0	1142	0.8
644	2.1	744	1.8	844	1.5	944	1.2	1044	1.0	1144	0.8
646	2.1	746	1.8	846	1.4	946	1.2	1046	1.0	1146	0.8
648	2.1	748	1.8	848	1.4	948	1.2	1048	1.0	1148	0.8
650	2.1	750	1.8	850	1.4	950	1.2	1050	1.0	1150	0.8
652	2.1	752	1.7	852	1.4	952	1.2	1052	1.0	1152	0.8
654	2.1	754	1.7	854	1.4	954	1.2	1054	1.0	1154	0.8
656	2.1	756	1.7	856	1.4	956	1.2	1056	1.0	1156	0.8
658	2.1	758	1.7	858	1.4	958	1.2	1058	1.0	1158	0.8
660	2.1	760	1.7	860	1.4	960	1.2	1060	1.0	1160	0.8
662	2.1	762	1.7	862	1.4	962	1.2	1062	1.0	1162	0.8
664	2.1	764	1.7	864	1.4	964	1.2	1064	1.0	1164	0.8
666	2.1	766	1.7	866	1.4	966	1.2	1066	1.0	1166	0.8
668	2.0	768	1.7	868	1.4	968	1.2	1068	1.0	1168	0.8
670	2.0	770	1.7	870	1.4	970	1.1	1070	1.0	1170	0.8
672	2.0	772	1.7	872	1.4	972	1.1	1072	1.0	1172	0.8
674	2.0	774	1.7	874	1.4	974	1.1	1074	1.0	1174	0.8
676	2.0	776	1.7	876	1.4	976	1.1	1076	0.9	1176	0.8
678	2.0	778	1.7	878	1.4	978	1.1	1078	0.9	1178	0.8
680	2.0	780	1.7	880	1.4	980	1.1	1080	0.9	1180	0.8
682	2.0	782	1.6	882	1.3	982	1.1	1082	0.9	1182	0.8
684	2.0	784	1.6	884	1.3	984	1.1	1084	0.9	1184	0.8
686	2.0	786	1.6	886	1.3	986	1.1	1086	0.9	1186	0.8
688	2.0	788	1.6	888	1.3	988	1.1	1088	0.9	1188	0.8
690	2.0	790	1.6	890	1.3	990	1.1	1090	0.9	1190	0.8
692	1.9	792	1.6	892	1.3	992	1.1	1092	0.9	1192	0.8
694	1.9	794	1.6	894	1.3	994	1.1	1094	0.9	1194	0.8
696	1.9	796	1.6	896	1.3	996	1.1	1096	0.9	1196	0.8
698	1.9	798	1.6	898	1.3	998	1.1	1098	0.9	1198	0.8
700	1.9	800	1.6	900	1.3	1000	1.1	1100	0.9	1200	0.8

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.8	1302	0.6	1402	0.6	1502	0.5	1602	0.4	1702	0.4
1204	0.8	1304	0.6	1404	0.6	1504	0.5	1604	0.4	1704	0.4
1206	0.8	1306	0.6	1406	0.6	1506	0.5	1606	0.4	1706	0.4
1208	0.7	1308	0.6	1408	0.6	1508	0.5	1608	0.4	1708	0.4
1210	0.7	1310	0.6	1410	0.5	1510	0.5	1610	0.4	1710	0.4
1212	0.7	1312	0.6	1412	0.5	1512	0.5	1612	0.4	1712	0.4
1214	0.7	1314	0.6	1414	0.5	1514	0.5	1614	0.4	1714	0.4
1216	0.7	1316	0.6	1416	0.5	1516	0.5	1616	0.4	1716	0.4
1218	0.7	1318	0.6	1418	0.5	1518	0.5	1618	0.4	1718	0.4
1220	0.7	1320	0.6	1420	0.5	1520	0.5	1620	0.4	1720	0.4
1222	0.7	1322	0.6	1422	0.5	1522	0.5	1622	0.4	1722	0.4
1224	0.7	1324	0.6	1424	0.5	1524	0.5	1624	0.4	1724	0.4
1226	0.7	1326	0.6	1426	0.5	1526	0.5	1626	0.4	1726	0.4
1228	0.7	1328	0.6	1428	0.5	1528	0.5	1628	0.4	1728	0.4
1230	0.7	1330	0.6	1430	0.5	1530	0.5	1630	0.4	1730	0.3
1232	0.7	1332	0.6	1432	0.5	1532	0.5	1632	0.4	1732	0.3
1234	0.7	1334	0.6	1434	0.5	1534	0.5	1634	0.4	1734	0.3
1236	0.7	1336	0.6	1436	0.5	1536	0.5	1636	0.4	1736	0.3
1238	0.7	1338	0.6	1438	0.5	1538	0.5	1638	0.4	1738	0.3
1240	0.7	1340	0.6	1440	0.5	1540	0.5	1640	0.4	1740	0.3
1242	0.7	1342	0.6	1442	0.5	1542	0.5	1642	0.4	1742	0.3
1244	0.7	1344	0.6	1444	0.5	1544	0.5	1644	0.4	1744	0.3
1246	0.7	1346	0.6	1446	0.5	1546	0.5	1646	0.4	1746	0.3
1248	0.7	1348	0.6	1448	0.5	1548	0.5	1648	0.4	1748	0.3
1250	0.7	1350	0.6	1450	0.5	1550	0.5	1650	0.4	1750	0.3
1252	0.7	1352	0.6	1452	0.5	1552	0.5	1652	0.4	1752	0.3
1254	0.7	1354	0.6	1454	0.5	1554	0.4	1654	0.4	1754	0.3
1256	0.7	1356	0.6	1456	0.5	1556	0.4	1656	0.4	1756	0.3
1258	0.7	1358	0.6	1458	0.5	1558	0.4	1658	0.4	1758	0.3
1260	0.7	1360	0.6	1460	0.5	1560	0.4	1660	0.4	1760	0.3
1262	0.7	1362	0.6	1462	0.5	1562	0.4	1662	0.4	1762	0.3
1264	0.7	1364	0.6	1464	0.5	1564	0.4	1664	0.4	1764	0.3
1266	0.7	1366	0.6	1466	0.5	1566	0.4	1666	0.4	1766	0.3
1268	0.7	1368	0.6	1468	0.5	1568	0.4	1668	0.4	1768	0.3
1270	0.7	1370	0.6	1470	0.5	1570	0.4	1670	0.4	1770	0.3
1272	0.7	1372	0.6	1472	0.5	1572	0.4	1672	0.4	1772	0.3
1274	0.7	1374	0.6	1474	0.5	1574	0.4	1674	0.4	1774	0.3
1276	0.7	1376	0.6	1476	0.5	1576	0.4	1676	0.4	1776	0.3
1278	0.7	1378	0.6	1478	0.5	1578	0.4	1678	0.4	1778	0.3
1280	0.7	1380	0.6	1480	0.5	1580	0.4	1680	0.4	1780	0.3
1282	0.7	1382	0.6	1482	0.5	1582	0.4	1682	0.4	1782	0.3
1284	0.7	1384	0.6	1484	0.5	1584	0.4	1684	0.4	1784	0.3
1286	0.7	1386	0.6	1486	0.5	1586	0.4	1686	0.4	1786	0.3
1288	0.7	1388	0.6	1488	0.5	1588	0.4	1688	0.4	1788	0.3
1290	0.7	1390	0.6	1490	0.5	1590	0.4	1690	0.4	1790	0.3
1292	0.7	1392	0.6	1492	0.5	1592	0.4	1692	0.4	1792	0.3
1294	0.6	1394	0.6	1494	0.5	1594	0.4	1694	0.4	1794	0.3
1296	0.6	1396	0.6	1496	0.5	1596	0.4	1696	0.4	1796	0.3
1298	0.6	1398	0.6	1498	0.5	1598	0.4	1698	0.4	1798	0.3
1300	0.6	1400	0.6	1500	0.5	1600	0.4	1700	0.4	1800	0.3

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.3	1902	0.3	2002	0.3	2102	0.2	2202	0.2	2302	0.2
1804	0.3	1904	0.3	2004	0.3	2104	0.2	2204	0.2	2304	0.2
1806	0.3	1906	0.3	2006	0.3	2106	0.2	2206	0.2	2306	0.2
1808	0.3	1908	0.3	2008	0.3	2108	0.2	2208	0.2	2308	0.2
1810	0.3	1910	0.3	2010	0.3	2110	0.2	2210	0.2	2310	0.2
1812	0.3	1912	0.3	2012	0.3	2112	0.2	2212	0.2	2312	0.2
1814	0.3	1914	0.3	2014	0.3	2114	0.2	2214	0.2	2314	0.2
1816	0.3	1916	0.3	2016	0.3	2116	0.2	2216	0.2	2316	0.2
1818	0.3	1918	0.3	2018	0.3	2118	0.2	2218	0.2	2318	0.2
1820	0.3	1920	0.3	2020	0.3	2120	0.2	2220	0.2	2320	0.2
1822	0.3	1922	0.3	2022	0.3	2122	0.2	2222	0.2	2322	0.2
1824	0.3	1924	0.3	2024	0.3	2124	0.2	2224	0.2	2324	0.2
1826	0.3	1926	0.3	2026	0.3	2126	0.2	2226	0.2	2326	0.2
1828	0.3	1928	0.3	2028	0.3	2128	0.2	2228	0.2	2328	0.2
1830	0.3	1930	0.3	2030	0.3	2130	0.2	2230	0.2	2330	0.2
1832	0.3	1932	0.3	2032	0.3	2132	0.2	2232	0.2	2332	0.2
1834	0.3	1934	0.3	2034	0.3	2134	0.2	2234	0.2	2334	0.2
1836	0.3	1936	0.3	2036	0.2	2136	0.2	2236	0.2	2336	0.2
1838	0.3	1938	0.3	2038	0.2	2138	0.2	2238	0.2	2338	0.2
1840	0.3	1940	0.3	2040	0.2	2140	0.2	2240	0.2	2340	0.2
1842	0.3	1942	0.3	2042	0.2	2142	0.2	2242	0.2	2342	0.2
1844	0.3	1944	0.3	2044	0.2	2144	0.2	2244	0.2	2344	0.2
1846	0.3	1946	0.3	2046	0.2	2146	0.2	2246	0.2	2346	0.2
1848	0.3	1948	0.3	2048	0.2	2148	0.2	2248	0.2	2348	0.2
1850	0.3	1950	0.3	2050	0.2	2150	0.2	2250	0.2	2350	0.2
1852	0.3	1952	0.3	2052	0.2	2152	0.2	2252	0.2	2352	0.2
1854	0.3	1954	0.3	2054	0.2	2154	0.2	2254	0.2	2354	0.2
1856	0.3	1956	0.3	2056	0.2	2156	0.2	2256	0.2	2356	0.2
1858	0.3	1958	0.3	2058	0.2	2158	0.2	2258	0.2	2358	0.2
1860	0.3	1960	0.3	2060	0.2	2160	0.2	2260	0.2	2360	0.2
1862	0.3	1962	0.3	2062	0.2	2162	0.2	2262	0.2	2362	0.2
1864	0.3	1964	0.3	2064	0.2	2164	0.2	2264	0.2	2364	0.2
1866	0.3	1966	0.3	2066	0.2	2166	0.2	2266	0.2	2366	0.2
1868	0.3	1968	0.3	2068	0.2	2168	0.2	2268	0.2	2368	0.2
1870	0.3	1970	0.3	2070	0.2	2170	0.2	2270	0.2	2370	0.2
1872	0.3	1972	0.3	2072	0.2	2172	0.2	2272	0.2	2372	0.2
1874	0.3	1974	0.3	2074	0.2	2174	0.2	2274	0.2	2374	0.2
1876	0.3	1976	0.3	2076	0.2	2176	0.2	2276	0.2	2376	0.2
1878	0.3	1978	0.3	2078	0.2	2178	0.2	2278	0.2	2378	0.2
1880	0.3	1980	0.3	2080	0.2	2180	0.2	2280	0.2	2380	0.2
1882	0.3	1982	0.3	2082	0.2	2182	0.2	2282	0.2	2382	0.2
1884	0.3	1984	0.3	2084	0.2	2184	0.2	2284	0.2	2384	0.2
1886	0.3	1986	0.3	2086	0.2	2186	0.2	2286	0.2	2386	0.2
1888	0.3	1988	0.3	2088	0.2	2188	0.2	2288	0.2	2388	0.2
1890	0.3	1990	0.3	2090	0.2	2190	0.2	2290	0.2	2390	0.2
1892	0.3	1992	0.3	2092	0.2	2192	0.2	2292	0.2	2392	0.2
1894	0.3	1994	0.3	2094	0.2	2194	0.2	2294	0.2	2394	0.2
1896	0.3	1996	0.3	2096	0.2	2196	0.2	2296	0.2	2396	0.2
1898	0.3	1998	0.3	2098	0.2	2198	0.2	2298	0.2	2398	0.2
1900	0.3	2000	0.3	2100	0.2	2200	0.2	2300	0.2	2400	0.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.2	2482	0.2	2562	0.1	2642	0.1	2722	0.1	2802	0.1
2404	0.2	2484	0.2	2564	0.1	2644	0.1	2724	0.1	2804	0.1
2406	0.2	2486	0.2	2566	0.1	2646	0.1	2726	0.1	2806	0.1
2408	0.2	2488	0.2	2568	0.1	2648	0.1	2728	0.1	2808	0.1
2410	0.2	2490	0.2	2570	0.1	2650	0.1	2730	0.1	2810	0.1
2412	0.2	2492	0.2	2572	0.1	2652	0.1	2732	0.1	2812	0.1
2414	0.2	2494	0.2	2574	0.1	2654	0.1	2734	0.1	2814	0.1
2416	0.2	2496	0.2	2576	0.1	2656	0.1	2736	0.1	2816	0.1
2418	0.2	2498	0.2	2578	0.1	2658	0.1	2738	0.1	2818	0.1
2420	0.2	2500	0.2	2580	0.1	2660	0.1	2740	0.1	2820	0.1
2422	0.2	2502	0.2	2582	0.1	2662	0.1	2742	0.1	2822	0.1
2424	0.2	2504	0.2	2584	0.1	2664	0.1	2744	0.1	2824	0.1
2426	0.2	2506	0.2	2586	0.1	2666	0.1	2746	0.1	2826	0.1
2428	0.2	2508	0.2	2588	0.1	2668	0.1	2748	0.1	2828	0.1
2430	0.2	2510	0.2	2590	0.1	2670	0.1	2750	0.1	2830	0.1
2432	0.2	2512	0.2	2592	0.1	2672	0.1	2752	0.1	2832	0.1
2434	0.2	2514	0.2	2594	0.1	2674	0.1	2754	0.1	2834	0.1
2436	0.2	2516	0.2	2596	0.1	2676	0.1	2756	0.1	2836	0.1
2438	0.2	2518	0.2	2598	0.1	2678	0.1	2758	0.1	2838	0.1
2440	0.2	2520	0.2	2600	0.1	2680	0.1	2760	0.1	2840	0.1
2442	0.2	2522	0.2	2602	0.1	2682	0.1	2762	0.1	2842	0.1
2444	0.2	2524	0.2	2604	0.1	2684	0.1	2764	0.1	2844	0.1
2446	0.2	2526	0.2	2606	0.1	2686	0.1	2766	0.1	2846	0.1
2448	0.2	2528	0.2	2608	0.1	2688	0.1	2768	0.1	2848	0.1
2450	0.2	2530	0.2	2610	0.1	2690	0.1	2770	0.1	2850	0.1
2452	0.2	2532	0.2	2612	0.1	2692	0.1	2772	0.1	2852	0.1
2454	0.2	2534	0.2	2614	0.1	2694	0.1	2774	0.1	2854	0.1
2456	0.2	2536	0.2	2616	0.1	2696	0.1	2776	0.1	2856	0.1
2458	0.2	2538	0.2	2618	0.1	2698	0.1	2778	0.1	2858	0.1
2460	0.2	2540	0.2	2620	0.1	2700	0.1	2780	0.1	2860	0.1
2462	0.2	2542	0.2	2622	0.1	2702	0.1	2782	0.1	2862	0.1
2464	0.2	2544	0.2	2624	0.1	2704	0.1	2784	0.1	2864	0.1
2466	0.2	2546	0.2	2626	0.1	2706	0.1	2786	0.1	2866	0.1
2468	0.2	2548	0.2	2628	0.1	2708	0.1	2788	0.1	2868	0.1
2470	0.2	2550	0.2	2630	0.1	2710	0.1	2790	0.1	2870	0.1
2472	0.2	2552	0.2	2632	0.1	2712	0.1	2792	0.1	2872	0.1
2474	0.2	2554	0.1	2634	0.1	2714	0.1	2794	0.1	2874	0.1
2476	0.2	2556	0.1	2636	0.1	2716	0.1	2796	0.1	2876	0.1
2478	0.2	2558	0.1	2638	0.1	2718	0.1	2798	0.1	2878	0.1
2480	0.2	2560	0.1	2640	0.1	2720	0.1	2800	0.1	2880	0.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.392	0.392	3.2	47.0	O K
30 min Summer	8.493	0.493	3.2	59.1	O K
60 min Summer	8.579	0.579	3.2	69.4	O K
120 min Summer	8.690	0.690	3.2	82.8	O K
180 min Summer	8.734	0.734	3.2	88.1	O K
240 min Summer	8.768	0.768	3.2	92.1	O K
360 min Summer	8.809	0.809	3.2	97.1	O K
480 min Summer	8.816	0.816	3.2	98.0	O K
600 min Summer	8.809	0.809	3.2	97.1	O K
720 min Summer	8.793	0.793	3.2	95.2	O K
960 min Summer	8.738	0.738	3.2	88.6	O K
1440 min Summer	8.548	0.548	3.2	65.7	O K
2160 min Summer	8.307	0.307	3.2	36.8	O K
2880 min Summer	8.188	0.188	3.1	22.6	O K
4320 min Summer	8.104	0.104	2.6	12.5	O K
5760 min Summer	8.081	0.081	2.1	9.7	O K
7200 min Summer	8.069	0.069	1.7	8.3	O K
8640 min Summer	8.063	0.063	1.5	7.5	O K
10080 min Summer	8.062	0.062	1.5	7.4	O K
15 min Winter	8.441	0.441	3.2	52.9	O K
30 min Winter	8.556	0.556	3.2	66.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.920	0.0	107.2	18
30 min Summer	110.600	0.0	121.4	33
60 min Summer	67.760	0.0	147.5	62
120 min Summer	43.120	0.0	168.7	122
180 min Summer	32.548	0.0	181.8	182
240 min Summer	26.390	0.0	190.9	242
360 min Summer	19.297	0.0	202.6	360
480 min Summer	15.250	0.0	209.8	476
600 min Summer	12.635	0.0	214.8	510
720 min Summer	10.803	0.0	218.5	558
960 min Summer	8.400	0.0	224.0	672
1440 min Summer	5.851	0.0	230.9	906
2160 min Summer	4.052	0.0	238.4	1232
2880 min Summer	3.124	0.0	243.0	1556
4320 min Summer	2.176	0.0	250.6	2208
5760 min Summer	1.693	0.0	257.6	2936
7200 min Summer	1.404	0.0	264.4	3672
8640 min Summer	1.211	0.0	271.1	4400
10080 min Summer	1.073	0.0	277.7	448
15 min Winter	171.920	0.0	113.2	18
30 min Winter	110.600	0.0	129.0	33

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.657	0.657	3.2	78.9	O K
120 min Winter	8.785	0.785	3.2	94.2	O K
180 min Winter	8.839	0.839	3.2	100.7	O K
240 min Winter	8.876	0.876	3.2	105.2	O K
360 min Winter	8.922	0.922	3.2	110.6	O K
480 min Winter	8.930	0.930	3.2	111.6	O K
600 min Winter	8.917	0.917	3.2	110.0	O K
720 min Winter	8.895	0.895	3.2	107.4	O K
960 min Winter	8.830	0.830	3.2	99.6	O K
1440 min Winter	8.597	0.597	3.2	71.6	O K
2160 min Winter	8.258	0.258	3.2	31.0	O K
2880 min Winter	8.129	0.129	2.9	15.4	O K
4320 min Winter	8.080	0.080	2.1	9.6	O K
5760 min Winter	8.065	0.065	1.6	7.9	O K
7200 min Winter	8.064	0.064	1.5	7.6	O K
8640 min Winter	8.063	0.063	1.5	7.5	O K
10080 min Winter	8.062	0.062	1.5	7.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	67.760	0.0	156.9	62
120 min Winter	43.120	0.0	180.6	120
180 min Winter	32.548	0.0	195.3	178
240 min Winter	26.390	0.0	205.4	236
360 min Winter	19.297	0.0	218.6	350
480 min Winter	15.250	0.0	226.6	460
600 min Winter	12.635	0.0	232.2	554
720 min Winter	10.803	0.0	236.4	572
960 min Winter	8.400	0.0	242.5	712
1440 min Winter	5.851	0.0	250.2	982
2160 min Winter	4.052	0.0	258.5	1260
2880 min Winter	3.124	0.0	263.7	1556
4320 min Winter	2.176	0.0	272.2	2204
5760 min Winter	1.693	0.0	280.0	456
7200 min Winter	1.404	0.0	287.6	456
8640 min Winter	1.211	0.0	295.1	456
10080 min Winter	1.073	0.0	302.6	456

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 541450 180700 TQ 41450 80700
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.153

Time (mins) From:	To:	Area (ha)
0	4	0.153

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	120.0	1.000	120.0	1.100	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0085-3200-1000-3200
Design Head (m)	1.000
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	85
Invert Level (m)	8.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.2
Flush-Flo™	0.296	3.2
Kick-Flo®	0.624	2.6
Mean Flow over Head Range	-	2.8

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	2.6	1.200	3.5	3.000	5.3	7.000	7.9
0.200	3.1	1.400	3.7	3.500	5.7	7.500	8.2
0.300	3.2	1.600	4.0	4.000	6.1	8.000	8.5
0.400	3.1	1.800	4.2	4.500	6.4	8.500	8.7
0.500	3.0	2.000	4.4	5.000	6.8	9.000	8.9
0.600	2.7	2.200	4.6	5.500	7.1	9.500	9.2
0.800	2.9	2.400	4.8	6.000	7.4		
1.000	3.2	2.600	5.0	6.500	7.7		

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	0.0	202	0.8	302	1.4	402	1.4	502	1.3
4	0.0	104	0.0	204	0.9	304	1.4	404	1.4	504	1.3
6	0.0	106	0.0	206	0.9	306	1.4	406	1.4	506	1.3
8	0.0	108	0.0	208	0.9	308	1.4	408	1.4	508	1.3
10	0.0	110	0.0	210	0.9	310	1.4	410	1.4	510	1.3
12	0.0	112	0.0	212	1.0	312	1.4	412	1.4	512	1.3
14	0.0	114	0.0	214	1.0	314	1.4	414	1.4	514	1.3
16	0.0	116	0.0	216	1.0	316	1.4	416	1.4	516	1.2
18	0.0	118	0.0	218	1.0	318	1.4	418	1.4	518	1.2
20	0.0	120	0.0	220	1.1	320	1.4	420	1.4	520	1.2
22	0.0	122	0.0	222	1.1	322	1.4	422	1.4	522	1.2
24	0.0	124	0.0	224	1.1	324	1.4	424	1.4	524	1.2
26	0.0	126	0.0	226	1.1	326	1.4	426	1.4	526	1.2
28	0.0	128	0.0	228	1.2	328	1.4	428	1.4	528	1.2
30	0.0	130	0.1	230	1.2	330	1.4	430	1.4	530	1.2
32	0.0	132	0.1	232	1.2	332	1.4	432	1.4	532	1.2
34	0.0	134	0.1	234	1.2	334	1.4	434	1.4	534	1.2
36	0.0	136	0.1	236	1.2	336	1.4	436	1.4	536	1.2
38	0.0	138	0.1	238	1.2	338	1.4	438	1.4	538	1.2
40	0.0	140	0.1	240	1.3	340	1.4	440	1.4	540	1.2
42	0.0	142	0.1	242	1.3	342	1.4	442	1.4	542	1.2
44	0.0	144	0.1	244	1.3	344	1.4	444	1.4	544	1.2
46	0.0	146	0.1	246	1.3	346	1.4	446	1.4	546	1.2
48	0.0	148	0.1	248	1.3	348	1.4	448	1.4	548	1.2
50	0.0	150	0.1	250	1.3	350	1.4	450	1.4	550	1.2
52	0.0	152	0.2	252	1.3	352	1.4	452	1.4	552	1.2
54	0.0	154	0.2	254	1.3	354	1.4	454	1.4	554	1.2
56	0.0	156	0.2	256	1.4	356	1.4	456	1.3	556	1.2
58	0.0	158	0.2	258	1.4	358	1.4	458	1.3	558	1.2
60	0.0	160	0.2	260	1.4	360	1.4	460	1.3	560	1.2
62	0.0	162	0.2	262	1.4	362	1.4	462	1.3	562	1.2
64	0.0	164	0.3	264	1.4	364	1.4	464	1.3	564	1.2
66	0.0	166	0.3	266	1.4	366	1.4	466	1.3	566	1.2
68	0.0	168	0.3	268	1.4	368	1.4	468	1.3	568	1.2
70	0.0	170	0.3	270	1.4	370	1.4	470	1.3	570	1.1
72	0.0	172	0.4	272	1.4	372	1.4	472	1.3	572	1.1
74	0.0	174	0.4	274	1.4	374	1.4	474	1.3	574	1.1
76	0.0	176	0.4	276	1.4	376	1.4	476	1.3	576	1.1
78	0.0	178	0.4	278	1.4	378	1.4	478	1.3	578	1.1
80	0.0	180	0.5	280	1.4	380	1.4	480	1.3	580	1.1
82	0.0	182	0.5	282	1.4	382	1.4	482	1.3	582	1.1
84	0.0	184	0.5	284	1.4	384	1.4	484	1.3	584	1.1
86	0.0	186	0.6	286	1.4	386	1.4	486	1.3	586	1.1
88	0.0	188	0.6	288	1.4	388	1.4	488	1.3	588	1.1
90	0.0	190	0.6	290	1.4	390	1.4	490	1.3	590	1.1
92	0.0	192	0.7	292	1.4	392	1.4	492	1.3	592	1.1
94	0.0	194	0.7	294	1.4	394	1.4	494	1.3	594	1.1
96	0.0	196	0.7	296	1.4	396	1.4	496	1.3	596	1.1
98	0.0	198	0.8	298	1.4	398	1.4	498	1.3	598	1.1
100	0.0	200	0.8	300	1.4	400	1.4	500	1.3	600	1.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	1.1	702	0.9	802	0.8	902	0.6	1002	0.5	1102	0.4
604	1.1	704	0.9	804	0.8	904	0.6	1004	0.5	1104	0.4
606	1.1	706	0.9	806	0.8	906	0.6	1006	0.5	1106	0.4
608	1.1	708	0.9	808	0.8	908	0.6	1008	0.5	1108	0.4
610	1.1	710	0.9	810	0.8	910	0.6	1010	0.5	1110	0.4
612	1.1	712	0.9	812	0.8	912	0.6	1012	0.5	1112	0.4
614	1.1	714	0.9	814	0.7	914	0.6	1014	0.5	1114	0.4
616	1.1	716	0.9	816	0.7	916	0.6	1016	0.5	1116	0.4
618	1.1	718	0.9	818	0.7	918	0.6	1018	0.5	1118	0.4
620	1.1	720	0.9	820	0.7	920	0.6	1020	0.5	1120	0.4
622	1.1	722	0.9	822	0.7	922	0.6	1022	0.5	1122	0.4
624	1.1	724	0.9	824	0.7	924	0.6	1024	0.5	1124	0.4
626	1.1	726	0.9	826	0.7	926	0.6	1026	0.5	1126	0.4
628	1.0	728	0.9	828	0.7	928	0.6	1028	0.5	1128	0.4
630	1.0	730	0.9	830	0.7	930	0.6	1030	0.5	1130	0.4
632	1.0	732	0.9	832	0.7	932	0.6	1032	0.5	1132	0.4
634	1.0	734	0.9	834	0.7	934	0.6	1034	0.5	1134	0.4
636	1.0	736	0.9	836	0.7	936	0.6	1036	0.5	1136	0.4
638	1.0	738	0.9	838	0.7	938	0.6	1038	0.5	1138	0.4
640	1.0	740	0.9	840	0.7	940	0.6	1040	0.5	1140	0.4
642	1.0	742	0.9	842	0.7	942	0.6	1042	0.5	1142	0.4
644	1.0	744	0.9	844	0.7	944	0.6	1044	0.5	1144	0.4
646	1.0	746	0.9	846	0.7	946	0.6	1046	0.5	1146	0.4
648	1.0	748	0.9	848	0.7	948	0.6	1048	0.5	1148	0.4
650	1.0	750	0.8	850	0.7	950	0.6	1050	0.5	1150	0.4
652	1.0	752	0.8	852	0.7	952	0.6	1052	0.5	1152	0.4
654	1.0	754	0.8	854	0.7	954	0.6	1054	0.5	1154	0.4
656	1.0	756	0.8	856	0.7	956	0.6	1056	0.5	1156	0.4
658	1.0	758	0.8	858	0.7	958	0.6	1058	0.5	1158	0.4
660	1.0	760	0.8	860	0.7	960	0.6	1060	0.5	1160	0.4
662	1.0	762	0.8	862	0.7	962	0.6	1062	0.5	1162	0.4
664	1.0	764	0.8	864	0.7	964	0.6	1064	0.5	1164	0.4
666	1.0	766	0.8	866	0.7	966	0.6	1066	0.5	1166	0.4
668	1.0	768	0.8	868	0.7	968	0.6	1068	0.5	1168	0.4
670	1.0	770	0.8	870	0.7	970	0.6	1070	0.5	1170	0.4
672	1.0	772	0.8	872	0.7	972	0.6	1072	0.5	1172	0.4
674	1.0	774	0.8	874	0.7	974	0.5	1074	0.5	1174	0.4
676	1.0	776	0.8	876	0.7	976	0.5	1076	0.5	1176	0.4
678	1.0	778	0.8	878	0.7	978	0.5	1078	0.4	1178	0.4
680	1.0	780	0.8	880	0.7	980	0.5	1080	0.4	1180	0.4
682	1.0	782	0.8	882	0.7	982	0.5	1082	0.4	1182	0.4
684	1.0	784	0.8	884	0.7	984	0.5	1084	0.4	1184	0.4
686	0.9	786	0.8	886	0.7	986	0.5	1086	0.4	1186	0.4
688	0.9	788	0.8	888	0.6	988	0.5	1088	0.4	1188	0.4
690	0.9	790	0.8	890	0.6	990	0.5	1090	0.4	1190	0.4
692	0.9	792	0.8	892	0.6	992	0.5	1092	0.4	1192	0.4
694	0.9	794	0.8	894	0.6	994	0.5	1094	0.4	1194	0.4
696	0.9	796	0.8	896	0.6	996	0.5	1096	0.4	1196	0.4
698	0.9	798	0.8	898	0.6	998	0.5	1098	0.4	1198	0.4
700	0.9	800	0.8	900	0.6	1000	0.5	1100	0.4	1200	0.4

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.4	1302	0.3	1402	0.3	1502	0.2	1602	0.2	1702	0.2
1204	0.4	1304	0.3	1404	0.3	1504	0.2	1604	0.2	1704	0.2
1206	0.4	1306	0.3	1406	0.3	1506	0.2	1606	0.2	1706	0.2
1208	0.4	1308	0.3	1408	0.3	1508	0.2	1608	0.2	1708	0.2
1210	0.4	1310	0.3	1410	0.3	1510	0.2	1610	0.2	1710	0.2
1212	0.4	1312	0.3	1412	0.3	1512	0.2	1612	0.2	1712	0.2
1214	0.4	1314	0.3	1414	0.3	1514	0.2	1614	0.2	1714	0.2
1216	0.4	1316	0.3	1416	0.3	1516	0.2	1616	0.2	1716	0.2
1218	0.4	1318	0.3	1418	0.3	1518	0.2	1618	0.2	1718	0.2
1220	0.4	1320	0.3	1420	0.3	1520	0.2	1620	0.2	1720	0.2
1222	0.3	1322	0.3	1422	0.3	1522	0.2	1622	0.2	1722	0.2
1224	0.3	1324	0.3	1424	0.3	1524	0.2	1624	0.2	1724	0.2
1226	0.3	1326	0.3	1426	0.3	1526	0.2	1626	0.2	1726	0.2
1228	0.3	1328	0.3	1428	0.3	1528	0.2	1628	0.2	1728	0.2
1230	0.3	1330	0.3	1430	0.3	1530	0.2	1630	0.2	1730	0.2
1232	0.3	1332	0.3	1432	0.3	1532	0.2	1632	0.2	1732	0.2
1234	0.3	1334	0.3	1434	0.3	1534	0.2	1634	0.2	1734	0.2
1236	0.3	1336	0.3	1436	0.3	1536	0.2	1636	0.2	1736	0.2
1238	0.3	1338	0.3	1438	0.2	1538	0.2	1638	0.2	1738	0.2
1240	0.3	1340	0.3	1440	0.2	1540	0.2	1640	0.2	1740	0.2
1242	0.3	1342	0.3	1442	0.2	1542	0.2	1642	0.2	1742	0.2
1244	0.3	1344	0.3	1444	0.2	1544	0.2	1644	0.2	1744	0.2
1246	0.3	1346	0.3	1446	0.2	1546	0.2	1646	0.2	1746	0.2
1248	0.3	1348	0.3	1448	0.2	1548	0.2	1648	0.2	1748	0.2
1250	0.3	1350	0.3	1450	0.2	1550	0.2	1650	0.2	1750	0.2
1252	0.3	1352	0.3	1452	0.2	1552	0.2	1652	0.2	1752	0.2
1254	0.3	1354	0.3	1454	0.2	1554	0.2	1654	0.2	1754	0.2
1256	0.3	1356	0.3	1456	0.2	1556	0.2	1656	0.2	1756	0.2
1258	0.3	1358	0.3	1458	0.2	1558	0.2	1658	0.2	1758	0.2
1260	0.3	1360	0.3	1460	0.2	1560	0.2	1660	0.2	1760	0.2
1262	0.3	1362	0.3	1462	0.2	1562	0.2	1662	0.2	1762	0.2
1264	0.3	1364	0.3	1464	0.2	1564	0.2	1664	0.2	1764	0.2
1266	0.3	1366	0.3	1466	0.2	1566	0.2	1666	0.2	1766	0.2
1268	0.3	1368	0.3	1468	0.2	1568	0.2	1668	0.2	1768	0.2
1270	0.3	1370	0.3	1470	0.2	1570	0.2	1670	0.2	1770	0.2
1272	0.3	1372	0.3	1472	0.2	1572	0.2	1672	0.2	1772	0.2
1274	0.3	1374	0.3	1474	0.2	1574	0.2	1674	0.2	1774	0.2
1276	0.3	1376	0.3	1476	0.2	1576	0.2	1676	0.2	1776	0.2
1278	0.3	1378	0.3	1478	0.2	1578	0.2	1678	0.2	1778	0.2
1280	0.3	1380	0.3	1480	0.2	1580	0.2	1680	0.2	1780	0.2
1282	0.3	1382	0.3	1482	0.2	1582	0.2	1682	0.2	1782	0.2
1284	0.3	1384	0.3	1484	0.2	1584	0.2	1684	0.2	1784	0.2
1286	0.3	1386	0.3	1486	0.2	1586	0.2	1686	0.2	1786	0.2
1288	0.3	1388	0.3	1488	0.2	1588	0.2	1688	0.2	1788	0.2
1290	0.3	1390	0.3	1490	0.2	1590	0.2	1690	0.2	1790	0.2
1292	0.3	1392	0.3	1492	0.2	1592	0.2	1692	0.2	1792	0.2
1294	0.3	1394	0.3	1494	0.2	1594	0.2	1694	0.2	1794	0.2
1296	0.3	1396	0.3	1496	0.2	1596	0.2	1696	0.2	1796	0.2
1298	0.3	1398	0.3	1498	0.2	1598	0.2	1698	0.2	1798	0.2
1300	0.3	1400	0.3	1500	0.2	1600	0.2	1700	0.2	1800	0.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.2	1902	0.1	2002	0.1	2102	0.1	2202	0.1	2302	0.1
1804	0.2	1904	0.1	2004	0.1	2104	0.1	2204	0.1	2304	0.1
1806	0.2	1906	0.1	2006	0.1	2106	0.1	2206	0.1	2306	0.1
1808	0.2	1908	0.1	2008	0.1	2108	0.1	2208	0.1	2308	0.1
1810	0.2	1910	0.1	2010	0.1	2110	0.1	2210	0.1	2310	0.1
1812	0.2	1912	0.1	2012	0.1	2112	0.1	2212	0.1	2312	0.1
1814	0.2	1914	0.1	2014	0.1	2114	0.1	2214	0.1	2314	0.1
1816	0.2	1916	0.1	2016	0.1	2116	0.1	2216	0.1	2316	0.1
1818	0.2	1918	0.1	2018	0.1	2118	0.1	2218	0.1	2318	0.1
1820	0.2	1920	0.1	2020	0.1	2120	0.1	2220	0.1	2320	0.1
1822	0.2	1922	0.1	2022	0.1	2122	0.1	2222	0.1	2322	0.1
1824	0.2	1924	0.1	2024	0.1	2124	0.1	2224	0.1	2324	0.1
1826	0.2	1926	0.1	2026	0.1	2126	0.1	2226	0.1	2326	0.1
1828	0.2	1928	0.1	2028	0.1	2128	0.1	2228	0.1	2328	0.1
1830	0.2	1930	0.1	2030	0.1	2130	0.1	2230	0.1	2330	0.1
1832	0.2	1932	0.1	2032	0.1	2132	0.1	2232	0.1	2332	0.1
1834	0.2	1934	0.1	2034	0.1	2134	0.1	2234	0.1	2334	0.1
1836	0.1	1936	0.1	2036	0.1	2136	0.1	2236	0.1	2336	0.1
1838	0.1	1938	0.1	2038	0.1	2138	0.1	2238	0.1	2338	0.1
1840	0.1	1940	0.1	2040	0.1	2140	0.1	2240	0.1	2340	0.1
1842	0.1	1942	0.1	2042	0.1	2142	0.1	2242	0.1	2342	0.1
1844	0.1	1944	0.1	2044	0.1	2144	0.1	2244	0.1	2344	0.1
1846	0.1	1946	0.1	2046	0.1	2146	0.1	2246	0.1	2346	0.1
1848	0.1	1948	0.1	2048	0.1	2148	0.1	2248	0.1	2348	0.1
1850	0.1	1950	0.1	2050	0.1	2150	0.1	2250	0.1	2350	0.1
1852	0.1	1952	0.1	2052	0.1	2152	0.1	2252	0.1	2352	0.1
1854	0.1	1954	0.1	2054	0.1	2154	0.1	2254	0.1	2354	0.1
1856	0.1	1956	0.1	2056	0.1	2156	0.1	2256	0.1	2356	0.1
1858	0.1	1958	0.1	2058	0.1	2158	0.1	2258	0.1	2358	0.1
1860	0.1	1960	0.1	2060	0.1	2160	0.1	2260	0.1	2360	0.1
1862	0.1	1962	0.1	2062	0.1	2162	0.1	2262	0.1	2362	0.1
1864	0.1	1964	0.1	2064	0.1	2164	0.1	2264	0.1	2364	0.1
1866	0.1	1966	0.1	2066	0.1	2166	0.1	2266	0.1	2366	0.1
1868	0.1	1968	0.1	2068	0.1	2168	0.1	2268	0.1	2368	0.1
1870	0.1	1970	0.1	2070	0.1	2170	0.1	2270	0.1	2370	0.1
1872	0.1	1972	0.1	2072	0.1	2172	0.1	2272	0.1	2372	0.1
1874	0.1	1974	0.1	2074	0.1	2174	0.1	2274	0.1	2374	0.1
1876	0.1	1976	0.1	2076	0.1	2176	0.1	2276	0.1	2376	0.1
1878	0.1	1978	0.1	2078	0.1	2178	0.1	2278	0.1	2378	0.1
1880	0.1	1980	0.1	2080	0.1	2180	0.1	2280	0.1	2380	0.1
1882	0.1	1982	0.1	2082	0.1	2182	0.1	2282	0.1	2382	0.1
1884	0.1	1984	0.1	2084	0.1	2184	0.1	2284	0.1	2384	0.1
1886	0.1	1986	0.1	2086	0.1	2186	0.1	2286	0.1	2386	0.1
1888	0.1	1988	0.1	2088	0.1	2188	0.1	2288	0.1	2388	0.1
1890	0.1	1990	0.1	2090	0.1	2190	0.1	2290	0.1	2390	0.1
1892	0.1	1992	0.1	2092	0.1	2192	0.1	2292	0.1	2392	0.1
1894	0.1	1994	0.1	2094	0.1	2194	0.1	2294	0.1	2394	0.1
1896	0.1	1996	0.1	2096	0.1	2196	0.1	2296	0.1	2396	0.1
1898	0.1	1998	0.1	2098	0.1	2198	0.1	2298	0.1	2398	0.1
1900	0.1	2000	0.1	2100	0.1	2200	0.1	2300	0.1	2400	0.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.1	2482	0.1	2562	0.1	2642	0.1	2722	0.1	2802	0.1
2404	0.1	2484	0.1	2564	0.1	2644	0.1	2724	0.1	2804	0.1
2406	0.1	2486	0.1	2566	0.1	2646	0.1	2726	0.1	2806	0.1
2408	0.1	2488	0.1	2568	0.1	2648	0.1	2728	0.1	2808	0.1
2410	0.1	2490	0.1	2570	0.1	2650	0.1	2730	0.1	2810	0.1
2412	0.1	2492	0.1	2572	0.1	2652	0.1	2732	0.1	2812	0.1
2414	0.1	2494	0.1	2574	0.1	2654	0.1	2734	0.1	2814	0.1
2416	0.1	2496	0.1	2576	0.1	2656	0.1	2736	0.1	2816	0.1
2418	0.1	2498	0.1	2578	0.1	2658	0.1	2738	0.1	2818	0.1
2420	0.1	2500	0.1	2580	0.1	2660	0.1	2740	0.1	2820	0.1
2422	0.1	2502	0.1	2582	0.1	2662	0.1	2742	0.1	2822	0.1
2424	0.1	2504	0.1	2584	0.1	2664	0.1	2744	0.1	2824	0.1
2426	0.1	2506	0.1	2586	0.1	2666	0.1	2746	0.1	2826	0.1
2428	0.1	2508	0.1	2588	0.1	2668	0.1	2748	0.1	2828	0.1
2430	0.1	2510	0.1	2590	0.1	2670	0.1	2750	0.1	2830	0.1
2432	0.1	2512	0.1	2592	0.1	2672	0.1	2752	0.1	2832	0.1
2434	0.1	2514	0.1	2594	0.1	2674	0.1	2754	0.1	2834	0.1
2436	0.1	2516	0.1	2596	0.1	2676	0.1	2756	0.1	2836	0.1
2438	0.1	2518	0.1	2598	0.1	2678	0.1	2758	0.1	2838	0.1
2440	0.1	2520	0.1	2600	0.1	2680	0.1	2760	0.1	2840	0.1
2442	0.1	2522	0.1	2602	0.1	2682	0.1	2762	0.1	2842	0.1
2444	0.1	2524	0.1	2604	0.1	2684	0.1	2764	0.1	2844	0.1
2446	0.1	2526	0.1	2606	0.1	2686	0.1	2766	0.1	2846	0.1
2448	0.1	2528	0.1	2608	0.1	2688	0.1	2768	0.1	2848	0.1
2450	0.1	2530	0.1	2610	0.1	2690	0.1	2770	0.1	2850	0.1
2452	0.1	2532	0.1	2612	0.1	2692	0.1	2772	0.1	2852	0.1
2454	0.1	2534	0.1	2614	0.1	2694	0.1	2774	0.1	2854	0.1
2456	0.1	2536	0.1	2616	0.1	2696	0.1	2776	0.1	2856	0.1
2458	0.1	2538	0.1	2618	0.1	2698	0.1	2778	0.1	2858	0.1
2460	0.1	2540	0.1	2620	0.1	2700	0.1	2780	0.1	2860	0.1
2462	0.1	2542	0.1	2622	0.1	2702	0.1	2782	0.1	2862	0.1
2464	0.1	2544	0.1	2624	0.1	2704	0.1	2784	0.1	2864	0.1
2466	0.1	2546	0.1	2626	0.1	2706	0.1	2786	0.1	2866	0.1
2468	0.1	2548	0.1	2628	0.1	2708	0.1	2788	0.1	2868	0.1
2470	0.1	2550	0.1	2630	0.1	2710	0.1	2790	0.1	2870	0.1
2472	0.1	2552	0.1	2632	0.1	2712	0.1	2792	0.1	2872	0.1
2474	0.1	2554	0.1	2634	0.1	2714	0.1	2794	0.1	2874	0.1
2476	0.1	2556	0.1	2636	0.1	2716	0.1	2796	0.1	2876	0.1
2478	0.1	2558	0.1	2638	0.1	2718	0.1	2798	0.1	2878	0.1
2480	0.1	2560	0.1	2640	0.1	2720	0.1	2800	0.1	2880	0.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.305	0.305	5.5	91.4	O K
30 min Summer	8.385	0.385	5.5	115.4	O K
60 min Summer	8.454	0.454	5.5	136.2	O K
120 min Summer	8.545	0.545	5.5	163.4	O K
180 min Summer	8.587	0.587	5.5	176.1	O K
240 min Summer	8.619	0.619	5.5	185.7	O K
360 min Summer	8.662	0.662	5.5	198.6	O K
480 min Summer	8.675	0.675	5.5	202.5	O K
600 min Summer	8.668	0.668	5.5	200.4	O K
720 min Summer	8.652	0.652	5.5	195.6	O K
960 min Summer	8.601	0.601	5.5	180.3	O K
1440 min Summer	8.473	0.473	5.5	142.0	O K
2160 min Summer	8.302	0.302	5.5	90.6	O K
2880 min Summer	8.205	0.205	5.4	61.5	O K
4320 min Summer	8.126	0.126	4.8	37.9	O K
5760 min Summer	8.101	0.101	3.9	30.4	O K
7200 min Summer	8.088	0.088	3.3	26.4	O K
8640 min Summer	8.080	0.080	2.9	24.1	O K
10080 min Summer	8.074	0.074	2.5	22.3	O K
15 min Winter	8.342	0.342	5.5	102.7	O K
30 min Winter	8.433	0.433	5.5	129.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.920	0.0	181.8	18
30 min Summer	110.600	0.0	209.0	33
60 min Summer	67.760	0.0	256.9	62
120 min Summer	43.120	0.0	297.8	122
180 min Summer	32.548	0.0	323.0	182
240 min Summer	26.390	0.0	340.5	242
360 min Summer	19.297	0.0	363.1	362
480 min Summer	15.250	0.0	376.9	480
600 min Summer	12.635	0.0	386.5	568
720 min Summer	10.803	0.0	393.8	606
960 min Summer	8.400	0.0	404.3	676
1440 min Summer	5.851	0.0	417.6	908
2160 min Summer	4.052	0.0	433.1	1252
2880 min Summer	3.124	0.0	442.0	1584
4320 min Summer	2.176	0.0	456.2	2248
5760 min Summer	1.693	0.0	470.3	2944
7200 min Summer	1.404	0.0	483.3	3672
8640 min Summer	1.211	0.0	496.1	4408
10080 min Summer	1.073	0.0	508.6	5144
15 min Winter	171.920	0.0	193.2	18
30 min Winter	110.600	0.0	223.7	33

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.513	0.513	5.5	154.0	O K
120 min Winter	8.621	0.621	5.5	186.3	O K
180 min Winter	8.675	0.675	5.5	202.5	O K
240 min Winter	8.711	0.711	5.5	213.4	O K
360 min Winter	8.754	0.754	5.5	226.3	O K
480 min Winter	8.767	0.767	5.5	230.1	O K
600 min Winter	8.761	0.761	5.5	228.3	O K
720 min Winter	8.741	0.741	5.5	222.2	O K
960 min Winter	8.687	0.687	5.5	206.1	O K
1440 min Winter	8.510	0.510	5.5	153.1	O K
2160 min Winter	8.274	0.274	5.5	82.3	O K
2880 min Winter	8.157	0.157	5.1	47.1	O K
4320 min Winter	8.101	0.101	3.8	30.3	O K
5760 min Winter	8.083	0.083	3.0	24.8	O K
7200 min Winter	8.072	0.072	2.4	21.7	O K
8640 min Winter	8.069	0.069	2.3	20.8	O K
10080 min Winter	8.068	0.068	2.2	20.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	67.760	0.0	274.9	62
120 min Winter	43.120	0.0	320.7	120
180 min Winter	32.548	0.0	348.9	178
240 min Winter	26.390	0.0	368.5	238
360 min Winter	19.297	0.0	393.9	354
480 min Winter	15.250	0.0	409.3	466
600 min Winter	12.635	0.0	420.0	572
720 min Winter	10.803	0.0	428.2	658
960 min Winter	8.400	0.0	440.0	738
1440 min Winter	5.851	0.0	454.9	980
2160 min Winter	4.052	0.0	471.8	1300
2880 min Winter	3.124	0.0	481.8	1588
4320 min Winter	2.176	0.0	497.9	2248
5760 min Winter	1.693	0.0	513.4	2888
7200 min Winter	1.404	0.0	528.1	3680
8640 min Winter	1.211	0.0	542.5	536
10080 min Winter	1.073	0.0	556.5	536

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 541450 180700 TQ 41450 80700
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.295

Time (mins) From:	To:	Area (ha)
0	4	0.295

Model Details

Storage is Online Cover Level (m) 10.000

Tank or Pond Structure

Invert Level (m) 8.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	300.0	1.000	300.0	1.100	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0110-5500-1000-5500
Design Head (m)	1.000
Design Flow (l/s)	5.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	110
Invert Level (m)	8.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.5
Flush-Flo™	0.298	5.5
Kick-Flo®	0.645	4.5
Mean Flow over Head Range	-	4.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.8	1.200	6.0	3.000	9.2	7.000	13.8
0.200	5.4	1.400	6.4	3.500	9.9	7.500	14.2
0.300	5.5	1.600	6.8	4.000	10.5	8.000	14.7
0.400	5.4	1.800	7.2	4.500	11.2	8.500	15.1
0.500	5.2	2.000	7.6	5.000	11.7	9.000	15.5
0.600	4.8	2.200	7.9	5.500	12.3	9.500	15.9
0.800	5.0	2.400	8.3	6.000	12.8		
1.000	5.5	2.600	8.6	6.500	13.3		

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	0.0	202	1.3	302	2.2	402	2.2	502	2.0
4	0.0	104	0.0	204	1.4	304	2.2	404	2.2	504	2.0
6	0.0	106	0.0	206	1.4	306	2.2	406	2.2	506	2.0
8	0.0	108	0.0	208	1.5	308	2.2	408	2.2	508	2.0
10	0.0	110	0.0	210	1.5	310	2.2	410	2.2	510	2.0
12	0.0	112	0.0	212	1.6	312	2.2	412	2.2	512	2.0
14	0.0	114	0.0	214	1.6	314	2.2	414	2.2	514	2.0
16	0.0	116	0.0	216	1.6	316	2.2	416	2.2	516	2.0
18	0.0	118	0.0	218	1.7	318	2.2	418	2.2	518	2.0
20	0.0	120	0.0	220	1.7	320	2.2	420	2.2	520	2.0
22	0.0	122	0.1	222	1.8	322	2.2	422	2.2	522	2.0
24	0.0	124	0.1	224	1.8	324	2.2	424	2.2	524	2.0
26	0.0	126	0.1	226	1.8	326	2.2	426	2.2	526	2.0
28	0.0	128	0.1	228	1.9	328	2.2	428	2.2	528	2.0
30	0.0	130	0.1	230	1.9	330	2.2	430	2.2	530	2.0
32	0.0	132	0.1	232	1.9	332	2.2	432	2.2	532	2.0
34	0.0	134	0.1	234	2.0	334	2.2	434	2.2	534	2.0
36	0.0	136	0.1	236	2.0	336	2.2	436	2.2	536	1.9
38	0.0	138	0.1	238	2.0	338	2.2	438	2.2	538	1.9
40	0.0	140	0.1	240	2.0	340	2.2	440	2.2	540	1.9
42	0.0	142	0.2	242	2.1	342	2.2	442	2.2	542	1.9
44	0.0	144	0.2	244	2.1	344	2.2	444	2.2	544	1.9
46	0.0	146	0.2	246	2.1	346	2.2	446	2.2	546	1.9
48	0.0	148	0.2	248	2.1	348	2.2	448	2.2	548	1.9
50	0.0	150	0.2	250	2.1	350	2.2	450	2.2	550	1.9
52	0.0	152	0.3	252	2.2	352	2.2	452	2.2	552	1.9
54	0.0	154	0.3	254	2.2	354	2.2	454	2.2	554	1.9
56	0.0	156	0.3	256	2.2	356	2.2	456	2.2	556	1.9
58	0.0	158	0.3	258	2.2	358	2.2	458	2.2	558	1.9
60	0.0	160	0.4	260	2.2	360	2.2	460	2.2	560	1.9
62	0.0	162	0.4	262	2.2	362	2.2	462	2.2	562	1.9
64	0.0	164	0.4	264	2.2	364	2.2	464	2.2	564	1.9
66	0.0	166	0.5	266	2.2	366	2.2	466	2.1	566	1.8
68	0.0	168	0.5	268	2.2	368	2.2	468	2.1	568	1.8
70	0.0	170	0.5	270	2.2	370	2.2	470	2.1	570	1.8
72	0.0	172	0.6	272	2.2	372	2.2	472	2.1	572	1.8
74	0.0	174	0.6	274	2.2	374	2.2	474	2.1	574	1.8
76	0.0	176	0.7	276	2.2	376	2.2	476	2.1	576	1.8
78	0.0	178	0.7	278	2.2	378	2.2	478	2.1	578	1.8
80	0.0	180	0.8	280	2.2	380	2.2	480	2.1	580	1.8
82	0.0	182	0.8	282	2.2	382	2.2	482	2.1	582	1.8
84	0.0	184	0.9	284	2.2	384	2.2	484	2.1	584	1.8
86	0.0	186	0.9	286	2.2	386	2.2	486	2.1	586	1.8
88	0.0	188	1.0	288	2.2	388	2.2	488	2.1	588	1.8
90	0.0	190	1.0	290	2.2	390	2.2	490	2.1	590	1.8
92	0.0	192	1.1	292	2.2	392	2.2	492	2.1	592	1.8
94	0.0	194	1.1	294	2.2	394	2.2	494	2.1	594	1.8
96	0.0	196	1.2	296	2.2	396	2.2	496	2.1	596	1.8
98	0.0	198	1.2	298	2.2	398	2.2	498	2.1	598	1.8
100	0.0	200	1.3	300	2.2	400	2.2	500	2.1	600	1.8

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	1.8	702	1.4	802	1.2	902	1.0	1002	0.8	1102	0.7
604	1.7	704	1.4	804	1.2	904	1.0	1004	0.8	1104	0.7
606	1.7	706	1.4	806	1.2	906	1.0	1006	0.8	1106	0.6
608	1.7	708	1.4	808	1.2	908	1.0	1008	0.8	1108	0.6
610	1.7	710	1.4	810	1.2	910	1.0	1010	0.8	1110	0.6
612	1.7	712	1.4	812	1.2	912	1.0	1012	0.8	1112	0.6
614	1.7	714	1.4	814	1.2	914	0.9	1014	0.8	1114	0.6
616	1.7	716	1.4	816	1.2	916	0.9	1016	0.8	1116	0.6
618	1.7	718	1.4	818	1.1	918	0.9	1018	0.8	1118	0.6
620	1.7	720	1.4	820	1.1	920	0.9	1020	0.8	1120	0.6
622	1.7	722	1.4	822	1.1	922	0.9	1022	0.8	1122	0.6
624	1.7	724	1.4	824	1.1	924	0.9	1024	0.8	1124	0.6
626	1.7	726	1.4	826	1.1	926	0.9	1026	0.8	1126	0.6
628	1.7	728	1.4	828	1.1	928	0.9	1028	0.8	1128	0.6
630	1.7	730	1.4	830	1.1	930	0.9	1030	0.8	1130	0.6
632	1.6	732	1.4	832	1.1	932	0.9	1032	0.8	1132	0.6
634	1.6	734	1.4	834	1.1	934	0.9	1034	0.7	1134	0.6
636	1.6	736	1.4	836	1.1	936	0.9	1036	0.7	1136	0.6
638	1.6	738	1.3	838	1.1	938	0.9	1038	0.7	1138	0.6
640	1.6	740	1.3	840	1.1	940	0.9	1040	0.7	1140	0.6
642	1.6	742	1.3	842	1.1	942	0.9	1042	0.7	1142	0.6
644	1.6	744	1.3	844	1.1	944	0.9	1044	0.7	1144	0.6
646	1.6	746	1.3	846	1.1	946	0.9	1046	0.7	1146	0.6
648	1.6	748	1.3	848	1.1	948	0.9	1048	0.7	1148	0.6
650	1.6	750	1.3	850	1.1	950	0.9	1050	0.7	1150	0.6
652	1.6	752	1.3	852	1.1	952	0.9	1052	0.7	1152	0.6
654	1.6	754	1.3	854	1.1	954	0.9	1054	0.7	1154	0.6
656	1.6	756	1.3	856	1.1	956	0.9	1056	0.7	1156	0.6
658	1.6	758	1.3	858	1.1	958	0.9	1058	0.7	1158	0.6
660	1.6	760	1.3	860	1.1	960	0.9	1060	0.7	1160	0.6
662	1.6	762	1.3	862	1.1	962	0.9	1062	0.7	1162	0.6
664	1.6	764	1.3	864	1.0	964	0.9	1064	0.7	1164	0.6
666	1.6	766	1.3	866	1.0	966	0.9	1066	0.7	1166	0.6
668	1.5	768	1.3	868	1.0	968	0.9	1068	0.7	1168	0.6
670	1.5	770	1.3	870	1.0	970	0.8	1070	0.7	1170	0.6
672	1.5	772	1.3	872	1.0	972	0.8	1072	0.7	1172	0.6
674	1.5	774	1.3	874	1.0	974	0.8	1074	0.7	1174	0.6
676	1.5	776	1.2	876	1.0	976	0.8	1076	0.7	1176	0.6
678	1.5	778	1.2	878	1.0	978	0.8	1078	0.7	1178	0.6
680	1.5	780	1.2	880	1.0	980	0.8	1080	0.7	1180	0.6
682	1.5	782	1.2	882	1.0	982	0.8	1082	0.7	1182	0.6
684	1.5	784	1.2	884	1.0	984	0.8	1084	0.7	1184	0.6
686	1.5	786	1.2	886	1.0	986	0.8	1086	0.7	1186	0.6
688	1.5	788	1.2	888	1.0	988	0.8	1088	0.7	1188	0.6
690	1.5	790	1.2	890	1.0	990	0.8	1090	0.7	1190	0.6
692	1.5	792	1.2	892	1.0	992	0.8	1092	0.7	1192	0.6
694	1.5	794	1.2	894	1.0	994	0.8	1094	0.7	1194	0.6
696	1.5	796	1.2	896	1.0	996	0.8	1096	0.7	1196	0.6
698	1.5	798	1.2	898	1.0	998	0.8	1098	0.7	1198	0.6
700	1.5	800	1.2	900	1.0	1000	0.8	1100	0.7	1200	0.6

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.5	1302	0.5	1402	0.4	1502	0.3	1602	0.3	1702	0.3
1204	0.5	1304	0.5	1404	0.4	1504	0.3	1604	0.3	1704	0.3
1206	0.5	1306	0.5	1406	0.4	1506	0.3	1606	0.3	1706	0.3
1208	0.5	1308	0.5	1408	0.4	1508	0.3	1608	0.3	1708	0.3
1210	0.5	1310	0.5	1410	0.4	1510	0.3	1610	0.3	1710	0.3
1212	0.5	1312	0.5	1412	0.4	1512	0.3	1612	0.3	1712	0.3
1214	0.5	1314	0.5	1414	0.4	1514	0.3	1614	0.3	1714	0.3
1216	0.5	1316	0.5	1416	0.4	1516	0.3	1616	0.3	1716	0.3
1218	0.5	1318	0.4	1418	0.4	1518	0.3	1618	0.3	1718	0.3
1220	0.5	1320	0.4	1420	0.4	1520	0.3	1620	0.3	1720	0.3
1222	0.5	1322	0.4	1422	0.4	1522	0.3	1622	0.3	1722	0.3
1224	0.5	1324	0.4	1424	0.4	1524	0.3	1624	0.3	1724	0.3
1226	0.5	1326	0.4	1426	0.4	1526	0.3	1626	0.3	1726	0.3
1228	0.5	1328	0.4	1428	0.4	1528	0.3	1628	0.3	1728	0.3
1230	0.5	1330	0.4	1430	0.4	1530	0.3	1630	0.3	1730	0.3
1232	0.5	1332	0.4	1432	0.4	1532	0.3	1632	0.3	1732	0.3
1234	0.5	1334	0.4	1434	0.4	1534	0.3	1634	0.3	1734	0.2
1236	0.5	1336	0.4	1436	0.4	1536	0.3	1636	0.3	1736	0.2
1238	0.5	1338	0.4	1438	0.4	1538	0.3	1638	0.3	1738	0.2
1240	0.5	1340	0.4	1440	0.4	1540	0.3	1640	0.3	1740	0.2
1242	0.5	1342	0.4	1442	0.4	1542	0.3	1642	0.3	1742	0.2
1244	0.5	1344	0.4	1444	0.4	1544	0.3	1644	0.3	1744	0.2
1246	0.5	1346	0.4	1446	0.4	1546	0.3	1646	0.3	1746	0.2
1248	0.5	1348	0.4	1448	0.4	1548	0.3	1648	0.3	1748	0.2
1250	0.5	1350	0.4	1450	0.4	1550	0.3	1650	0.3	1750	0.2
1252	0.5	1352	0.4	1452	0.4	1552	0.3	1652	0.3	1752	0.2
1254	0.5	1354	0.4	1454	0.4	1554	0.3	1654	0.3	1754	0.2
1256	0.5	1356	0.4	1456	0.4	1556	0.3	1656	0.3	1756	0.2
1258	0.5	1358	0.4	1458	0.4	1558	0.3	1658	0.3	1758	0.2
1260	0.5	1360	0.4	1460	0.4	1560	0.3	1660	0.3	1760	0.2
1262	0.5	1362	0.4	1462	0.4	1562	0.3	1662	0.3	1762	0.2
1264	0.5	1364	0.4	1464	0.4	1564	0.3	1664	0.3	1764	0.2
1266	0.5	1366	0.4	1466	0.4	1566	0.3	1666	0.3	1766	0.2
1268	0.5	1368	0.4	1468	0.4	1568	0.3	1668	0.3	1768	0.2
1270	0.5	1370	0.4	1470	0.4	1570	0.3	1670	0.3	1770	0.2
1272	0.5	1372	0.4	1472	0.4	1572	0.3	1672	0.3	1772	0.2
1274	0.5	1374	0.4	1474	0.4	1574	0.3	1674	0.3	1774	0.2
1276	0.5	1376	0.4	1476	0.4	1576	0.3	1676	0.3	1776	0.2
1278	0.5	1378	0.4	1478	0.4	1578	0.3	1678	0.3	1778	0.2
1280	0.5	1380	0.4	1480	0.4	1580	0.3	1680	0.3	1780	0.2
1282	0.5	1382	0.4	1482	0.4	1582	0.3	1682	0.3	1782	0.2
1284	0.5	1384	0.4	1484	0.3	1584	0.3	1684	0.3	1784	0.2
1286	0.5	1386	0.4	1486	0.3	1586	0.3	1686	0.3	1786	0.2
1288	0.5	1388	0.4	1488	0.3	1588	0.3	1688	0.3	1788	0.2
1290	0.5	1390	0.4	1490	0.3	1590	0.3	1690	0.3	1790	0.2
1292	0.5	1392	0.4	1492	0.3	1592	0.3	1692	0.3	1792	0.2
1294	0.5	1394	0.4	1494	0.3	1594	0.3	1694	0.3	1794	0.2
1296	0.5	1396	0.4	1496	0.3	1596	0.3	1696	0.3	1796	0.2
1298	0.5	1398	0.4	1498	0.3	1598	0.3	1698	0.3	1798	0.2
1300	0.5	1400	0.4	1500	0.3	1600	0.3	1700	0.3	1800	0.2

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.2	1902	0.2	2002	0.2	2102	0.2	2202	0.1	2302	0.1
1804	0.2	1904	0.2	2004	0.2	2104	0.2	2204	0.1	2304	0.1
1806	0.2	1906	0.2	2006	0.2	2106	0.2	2206	0.1	2306	0.1
1808	0.2	1908	0.2	2008	0.2	2108	0.2	2208	0.1	2308	0.1
1810	0.2	1910	0.2	2010	0.2	2110	0.2	2210	0.1	2310	0.1
1812	0.2	1912	0.2	2012	0.2	2112	0.2	2212	0.1	2312	0.1
1814	0.2	1914	0.2	2014	0.2	2114	0.2	2214	0.1	2314	0.1
1816	0.2	1916	0.2	2016	0.2	2116	0.2	2216	0.1	2316	0.1
1818	0.2	1918	0.2	2018	0.2	2118	0.2	2218	0.1	2318	0.1
1820	0.2	1920	0.2	2020	0.2	2120	0.2	2220	0.1	2320	0.1
1822	0.2	1922	0.2	2022	0.2	2122	0.2	2222	0.1	2322	0.1
1824	0.2	1924	0.2	2024	0.2	2124	0.2	2224	0.1	2324	0.1
1826	0.2	1926	0.2	2026	0.2	2126	0.2	2226	0.1	2326	0.1
1828	0.2	1928	0.2	2028	0.2	2128	0.2	2228	0.1	2328	0.1
1830	0.2	1930	0.2	2030	0.2	2130	0.2	2230	0.1	2330	0.1
1832	0.2	1932	0.2	2032	0.2	2132	0.2	2232	0.1	2332	0.1
1834	0.2	1934	0.2	2034	0.2	2134	0.2	2234	0.1	2334	0.1
1836	0.2	1936	0.2	2036	0.2	2136	0.2	2236	0.1	2336	0.1
1838	0.2	1938	0.2	2038	0.2	2138	0.2	2238	0.1	2338	0.1
1840	0.2	1940	0.2	2040	0.2	2140	0.2	2240	0.1	2340	0.1
1842	0.2	1942	0.2	2042	0.2	2142	0.2	2242	0.1	2342	0.1
1844	0.2	1944	0.2	2044	0.2	2144	0.2	2244	0.1	2344	0.1
1846	0.2	1946	0.2	2046	0.2	2146	0.2	2246	0.1	2346	0.1
1848	0.2	1948	0.2	2048	0.2	2148	0.2	2248	0.1	2348	0.1
1850	0.2	1950	0.2	2050	0.2	2150	0.2	2250	0.1	2350	0.1
1852	0.2	1952	0.2	2052	0.2	2152	0.2	2252	0.1	2352	0.1
1854	0.2	1954	0.2	2054	0.2	2154	0.2	2254	0.1	2354	0.1
1856	0.2	1956	0.2	2056	0.2	2156	0.2	2256	0.1	2356	0.1
1858	0.2	1958	0.2	2058	0.2	2158	0.2	2258	0.1	2358	0.1
1860	0.2	1960	0.2	2060	0.2	2160	0.2	2260	0.1	2360	0.1
1862	0.2	1962	0.2	2062	0.2	2162	0.2	2262	0.1	2362	0.1
1864	0.2	1964	0.2	2064	0.2	2164	0.2	2264	0.1	2364	0.1
1866	0.2	1966	0.2	2066	0.2	2166	0.2	2266	0.1	2366	0.1
1868	0.2	1968	0.2	2068	0.2	2168	0.2	2268	0.1	2368	0.1
1870	0.2	1970	0.2	2070	0.2	2170	0.2	2270	0.1	2370	0.1
1872	0.2	1972	0.2	2072	0.2	2172	0.2	2272	0.1	2372	0.1
1874	0.2	1974	0.2	2074	0.2	2174	0.2	2274	0.1	2374	0.1
1876	0.2	1976	0.2	2076	0.2	2176	0.2	2276	0.1	2376	0.1
1878	0.2	1978	0.2	2078	0.2	2178	0.2	2278	0.1	2378	0.1
1880	0.2	1980	0.2	2080	0.2	2180	0.2	2280	0.1	2380	0.1
1882	0.2	1982	0.2	2082	0.2	2182	0.2	2282	0.1	2382	0.1
1884	0.2	1984	0.2	2084	0.2	2184	0.2	2284	0.1	2384	0.1
1886	0.2	1986	0.2	2086	0.2	2186	0.2	2286	0.1	2386	0.1
1888	0.2	1988	0.2	2088	0.2	2188	0.2	2288	0.1	2388	0.1
1890	0.2	1990	0.2	2090	0.2	2190	0.2	2290	0.1	2390	0.1
1892	0.2	1992	0.2	2092	0.2	2192	0.2	2292	0.1	2392	0.1
1894	0.2	1994	0.2	2094	0.2	2194	0.2	2294	0.1	2394	0.1
1896	0.2	1996	0.2	2096	0.2	2196	0.2	2296	0.1	2396	0.1
1898	0.2	1998	0.2	2098	0.2	2198	0.2	2298	0.1	2398	0.1
1900	0.2	2000	0.2	2100	0.2	2200	0.1	2300	0.1	2400	0.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.1	2482	0.1	2562	0.1	2642	0.1	2722	0.1	2802	0.1
2404	0.1	2484	0.1	2564	0.1	2644	0.1	2724	0.1	2804	0.1
2406	0.1	2486	0.1	2566	0.1	2646	0.1	2726	0.1	2806	0.1
2408	0.1	2488	0.1	2568	0.1	2648	0.1	2728	0.1	2808	0.1
2410	0.1	2490	0.1	2570	0.1	2650	0.1	2730	0.1	2810	0.1
2412	0.1	2492	0.1	2572	0.1	2652	0.1	2732	0.1	2812	0.1
2414	0.1	2494	0.1	2574	0.1	2654	0.1	2734	0.1	2814	0.1
2416	0.1	2496	0.1	2576	0.1	2656	0.1	2736	0.1	2816	0.1
2418	0.1	2498	0.1	2578	0.1	2658	0.1	2738	0.1	2818	0.1
2420	0.1	2500	0.1	2580	0.1	2660	0.1	2740	0.1	2820	0.1
2422	0.1	2502	0.1	2582	0.1	2662	0.1	2742	0.1	2822	0.1
2424	0.1	2504	0.1	2584	0.1	2664	0.1	2744	0.1	2824	0.1
2426	0.1	2506	0.1	2586	0.1	2666	0.1	2746	0.1	2826	0.1
2428	0.1	2508	0.1	2588	0.1	2668	0.1	2748	0.1	2828	0.1
2430	0.1	2510	0.1	2590	0.1	2670	0.1	2750	0.1	2830	0.1
2432	0.1	2512	0.1	2592	0.1	2672	0.1	2752	0.1	2832	0.1
2434	0.1	2514	0.1	2594	0.1	2674	0.1	2754	0.1	2834	0.1
2436	0.1	2516	0.1	2596	0.1	2676	0.1	2756	0.1	2836	0.1
2438	0.1	2518	0.1	2598	0.1	2678	0.1	2758	0.1	2838	0.1
2440	0.1	2520	0.1	2600	0.1	2680	0.1	2760	0.1	2840	0.1
2442	0.1	2522	0.1	2602	0.1	2682	0.1	2762	0.1	2842	0.1
2444	0.1	2524	0.1	2604	0.1	2684	0.1	2764	0.1	2844	0.1
2446	0.1	2526	0.1	2606	0.1	2686	0.1	2766	0.1	2846	0.1
2448	0.1	2528	0.1	2608	0.1	2688	0.1	2768	0.1	2848	0.1
2450	0.1	2530	0.1	2610	0.1	2690	0.1	2770	0.1	2850	0.1
2452	0.1	2532	0.1	2612	0.1	2692	0.1	2772	0.1	2852	0.1
2454	0.1	2534	0.1	2614	0.1	2694	0.1	2774	0.1	2854	0.1
2456	0.1	2536	0.1	2616	0.1	2696	0.1	2776	0.1	2856	0.1
2458	0.1	2538	0.1	2618	0.1	2698	0.1	2778	0.1	2858	0.1
2460	0.1	2540	0.1	2620	0.1	2700	0.1	2780	0.1	2860	0.1
2462	0.1	2542	0.1	2622	0.1	2702	0.1	2782	0.1	2862	0.1
2464	0.1	2544	0.1	2624	0.1	2704	0.1	2784	0.1	2864	0.1
2466	0.1	2546	0.1	2626	0.1	2706	0.1	2786	0.1	2866	0.1
2468	0.1	2548	0.1	2628	0.1	2708	0.1	2788	0.1	2868	0.1
2470	0.1	2550	0.1	2630	0.1	2710	0.1	2790	0.1	2870	0.1
2472	0.1	2552	0.1	2632	0.1	2712	0.1	2792	0.1	2872	0.1
2474	0.1	2554	0.1	2634	0.1	2714	0.1	2794	0.1	2874	0.1
2476	0.1	2556	0.1	2636	0.1	2716	0.1	2796	0.1	2876	0.1
2478	0.1	2558	0.1	2638	0.1	2718	0.1	2798	0.1	2878	0.1
2480	0.1	2560	0.1	2640	0.1	2720	0.1	2800	0.1	2880	0.1

BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof A		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	350	m^2	*As supplied by Client*
Attenuation area:	288	m^2	*As supplied by Client*
Maximum allowable runoff:	0.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	14 hours and 0 minutes	0.4
30 mins	16 hours and 30 minutes	0.4
1 hour	18 hours and 50 minutes	0.5
2 hours	21 hours and 20 minutes	0.5
4 hours	23 hours and 10 minutes	0.6
6 hours	23 hours and 20 minutes	0.6
10 hours	22 hours and 30 minutes	0.5
24 hours	16 hours and 50 minutes	0.4
48 hours	7 hours and 10 minutes	0.2

Total attenuation required: 30.9 m^3
Half empty time: 8 hours and 20 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	32.8	m^3
Number of Blue Roof outlets:	2	

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given for the performance of the system relate to testing, modelling and analysis of our systems obtained from laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes to our systems without notice at any time.
3. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, ABG should be contacted to provide a revised estimate.
4. This estimate is specific to the characteristics of ABG products/systems and is not applicable to other competitor products. The substitution of the whole or any component of this design for a material supplied from another source renders this estimate invalid.
5. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.

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www.abgltd.com

1. DEFINITIONS

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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof B		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC. 3 x small ASHP units - appropriate plant support method TBC with ABG, structural and M&E engineers.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)		
Return period:	100 years	*As supplied by Client*
Allowance for Climate Change:	40 %	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290	

Input Parameters - Roof Information		
Total catchment area:	550 m^2	*As supplied by Client*
Attenuation area:	488 m^2	*As supplied by Client*
Maximum allowable runoff:	0.9 l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	13 hours and 50 minutes	0.6
30 mins	16 hours and 30 minutes	0.7
1 hour	18 hours and 40 minutes	0.7
2 hours	21 hours and 20 minutes	0.8
4 hours	23 hours and 0 minutes	0.9
6 hours	23 hours and 20 minutes	0.9
10 hours	22 hours and 30 minutes	0.8
24 hours	16 hours and 40 minutes	0.7
48 hours	7 hours and 0 minutes	0.4

Total attenuation required: 48.8 m^3
Half empty time: 7 hours and 40 minutes.

Output - Recommended Blue Roof System

System Name:	ABG blueroof VF HD 129mm
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.
Total attenuation capacity:	55.6 m^3
Number of Blue Roof outlets:	3

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given for the performance of the system relate to testing, modelling and analysis of our systems obtained from laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes to our systems without notice at any time.
3. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, ABG should be contacted to provide a revised estimate.
4. This estimate is specific to the characteristics of ABG products/systems and is not applicable to other competitor products. The substitution of the whole or any component of this design for a material supplied from another source renders this estimate invalid.
5. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.

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Project Name:	Ham Close, Richmond, TW10 - Roof C		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	430	m^2	*As supplied by Client*
Attenuation area:	364	m^2	*As supplied by Client*
Maximum allowable runoff:	0.7	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	13 hours and 50 minutes	0.5
30 mins	16 hours and 20 minutes	0.5
1 hour	18 hours and 40 minutes	0.6
2 hours	21 hours and 20 minutes	0.6
4 hours	23 hours and 0 minutes	0.7
6 hours	23 hours and 20 minutes	0.7
10 hours	22 hours and 30 minutes	0.7
24 hours	16 hours and 50 minutes	0.5
48 hours	7 hours and 10 minutes	0.3

Total attenuation required: 38.3 m^3
Half empty time: 8 hours and 10 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	41.4	m^3
Number of Blue Roof outlets:	2	

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part of the appointment process prior to ABG Geosynthetics commencing work.

BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof CC		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	370	m^2	*As supplied by Client*
Attenuation area:	350	m^2	*As supplied by Client*
Maximum allowable runoff:	0.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	13 hours and 40 minutes	0.4
30 mins	16 hours and 20 minutes	0.4
1 hour	18 hours and 30 minutes	0.5
2 hours	21 hours and 10 minutes	0.5
4 hours	22 hours and 50 minutes	0.6
6 hours	23 hours and 10 minutes	0.6
10 hours	22 hours and 20 minutes	0.6
24 hours	16 hours and 40 minutes	0.5
48 hours	7 hours and 0 minutes	0.2

Total attenuation required: 33 m^3
Half empty time: 7 hours and 0 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	39.9	m^3
Number of Blue Roof outlets:	2	

Notes:

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contract between the Client and the Consultant which contract will be subject to any terms and conditions contained or referred to in the aforementioned proposal and these terms and conditions. In the event of any conflict, the terms and conditions in the proposal shall prevail over these terms and conditions. The Agreement so formed shall supersede all previous understandings, commitments or agreements whether written or oral between the Client and the Consultant relating to the subject matter hereof. No person or entity shall have any rights in relation to this Agreement, whether as third parties or otherwise, save the parties to this Agreement. Should any term or condition of this Agreement be held to be unenforceable or invalid by the courts of any jurisdiction to which it is subject then such term or condition shall be disregarded and the remaining terms and conditions shall remain in full force and effect.

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aforesaid programme shall show the key dates for final information and the delivery of such to the Consultant so as to enable the Consultant to carry out the services in an efficient once through manner to achieve the programme delivery dates for the Services.

The Consultant provides various services including Design and Product use advice which is distinct from a Design Service. The Design Service may or may not attract a fee.

Where the Consultant's services are of an advisory nature and dependent upon the degree of information and release thereof by the Client then the Client agrees that any reliance placed on the services by the Client shall take due account of such constraints.

4. CONFIDENTIALITY AND INTELLECTUAL PROPERTY RIGHTS

i. The Consultant and the Client shall keep confidential all information pertaining to the Services.

ii. Copyright for all reports, documents and the like produced by the Consultant in the performance of the Services
shall remain vested with the Consultant but the Consultant shall grant an irrevocable royalty free license to the Client to use such reports, documents and the like for any purpose in connection with the Project.

5. LIABILITY

i. The Consultant shall be liable to pay compensation to the Client arising out of or in connection with this
Agreement only if a breach of the duty of care in Clause 3 is established against the Consultant.

ii. Notwithstanding any other term to the contrary in this Agreement or any related document and whether the cause of action for any claim arises under or in connection with the Agreement in contract or in tort, in negligence or for breach of statutory duty or otherwise the Consultant shall have no liability to the Client in respect of any claim for loss or damage arising from acts of war or terrorism or arising from flooding, burst water mains or failed drainage or arising from any incidence of toxic mould or asbestos but otherwise in relation to any cause of action as aforesaid the total liability of the Consultant in the aggregate for all claims shall be limited to a sum equivalent to ten (10) times the fee payable under this Agreement or £50,000, whichever is the lesser, or such other sum as may be expressly stated in the Consultant's proposal, and further but without prejudice to the aforesaid limit of liability any such liability of the Consultant shall be limited to such sum or sums as it would be just and equitable for the Consultant to pay having regard to the Consultant's responsibility for the same and on the basis that all other parties appointed or to be appointed by the Client to perform related services in connection with the Project shall be deemed to have provided undertakings on terms no less onerous than this Agreement and shall be deemed to have paid to the Client such contribution as it would be just and equitable for them to pay having regard to their responsibility for any loss or damage and providing that it shall be deemed that such other parties have not limited or excluded their liability to the Client for such loss or damage in any way which may be prejudicial to the Consultant's liability under this clause. Nothing in this clause shall operate to exclude or limit the Consultant's liability for death or personal injury.

iii. The Client shall indemnify and keep indemnified the Consultant from and against all claims, demands,
proceedings, damages, costs and expenses arising out of or in connection with this Agreement or the Project
arising from acts of terrorism or arising otherwise in excess of the liability of the Consultant under this
Agreement or which may be made in respect of events occurring after the expiry of the period of liability stated
in this Agreement.

iv. No action or proceedings under or in connection with this Agreement shall be commenced against the Consultant after the expiry of one year from completion of the Services.

v. ABG Geosynthetics Ltd is not responsible for consequential, indirect or incidental losses.

6. INSURANCE

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The Client shall supply, without charge and in such time so as not to delay or disrupt the performance of the Consultant in carrying out the Services, all necessary and relevant information, in his possession or available to him from his other agents or consultants and all necessary approvals or consents. Any deviation on any information from the proposal shall be confirmed in writing and any attendant consequential fees will be forwarded for approval by the Client before any changes are made. The Consultant shall not be liable for any consequential delays on site. Every reasonable effort will be made to mitigate against delays, however no liability for losses and costs will be accepted. The approval or consent by the Client to the Services shall not relieve the Consultant from any liability under this Agreement. All work undertaken by the Consultant must be ratified and signed off by the Client.

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reasonable control of the Consultant then the Consultant shall be entitled to such additional fees as are fair and
reasonable in the circumstances. The Consultant may render an invoice at monthly intervals for services properly
performed. The agreed invoice, or in the event of a dispute the undisputed element, shall be paid within 28 days of receipt of the invoice by the Client. Any invoice paid after this period will attract interest at 3% above the base
rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

ii. The Client shall not withhold any payment of any sum or part of a sum due to the Consultant under this
Agreement by reason of claims or alleged claims against the Consultant unless the amount to be withheld has
been agreed between the Client and the Consultant as due to the Client or such sum arises from an award in
adjudication, arbitration or litigation in favour of the Client and arises under or in connection with the Agreement.
Save as aforesaid all rights of set off at common law, in equity or otherwise which the Client may otherwise be
entitled to exercise are hereby expressly excluded.

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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof D		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	525	m^2	*As supplied by Client*
Attenuation area:	467	m^2	*As supplied by Client*
Maximum allowable runoff:	0.8	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	15 hours and 10 minutes	0.5
30 mins	18 hours and 10 minutes	0.6
1 hour	20 hours and 40 minutes	0.6
2 hours	23 hours and 40 minutes	0.7
4 hours	25 hours and 40 minutes	0.7
6 hours	26 hours and 10 minutes	0.8
10 hours	25 hours and 30 minutes	0.7
24 hours	19 hours and 50 minutes	0.6
48 hours	10 hours and 0 minutes	0.4

Total attenuation required: 47.9 m^3
Half empty time: 9 hours and 0 minutes.

Output - Recommended Blue Roof System	
System Name:	ABG blueroof VF HD 129mm
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.
Total attenuation capacity:	53.2 m^3
Number of Blue Roof outlets:	2

Notes:

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performed. The agreed invoice, or in the event of a dispute the undisputed element, shall be paid within 28 days of receipt of the invoice by the Client. Any invoice paid after this period will attract interest at 3% above the base
rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

ii. The Client shall not withhold any payment of any sum or part of a sum due to the Consultant under this
Agreement by reason of claims or alleged claims against the Consultant unless the amount to be withheld has
been agreed between the Client and the Consultant as due to the Client or such sum arises from an award in
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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof E		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	435	m^2	*As supplied by Client*
Attenuation area:	376	m^2	*As supplied by Client*
Maximum allowable runoff:	0.7	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	14 hours and 0 minutes	0.4
30 mins	16 hours and 40 minutes	0.5
1 hour	19 hours and 0 minutes	0.6
2 hours	21 hours and 40 minutes	0.6
4 hours	23 hours and 30 minutes	0.7
6 hours	23 hours and 50 minutes	0.7
10 hours	23 hours and 0 minutes	0.7
24 hours	17 hours and 20 minutes	0.5
48 hours	7 hours and 40 minutes	0.3

Total attenuation required: 38.9 m^3
Half empty time: 8 hours and 20 minutes.

Output - Recommended Blue Roof System

System Name:	ABG blueroof VF HD 129mm
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.
Total attenuation capacity:	42.8 m^3
Number of Blue Roof outlets:	2

Notes:

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ii. Notwithstanding any other term to the contrary in this Agreement or any related document and whether the cause of action for any claim arises under or in connection with the Agreement in contract or in tort, in negligence or for breach of statutory duty or otherwise the Consultant shall have no liability to the Client in respect of any claim for loss or damage arising from acts of war or terrorism or arising from flooding, burst water mains or failed drainage or arising from any incidence of toxic mould or asbestos but otherwise in relation to any cause of action as aforesaid the total liability of the Consultant in the aggregate for all claims shall be limited to a sum equivalent to ten (10) times the fee payable under this Agreement or £50,000, whichever is the lesser, or such other sum as may be expressly stated in the Consultant's proposal, and further but without prejudice to the aforesaid limit of liability any such liability of the Consultant shall be limited to such sum or sums as it would be just and equitable for the Consultant to pay having regard to the Consultant's responsibility for the same and on the basis that all other parties appointed or to be appointed by the Client to perform related services in connection with the Project shall be deemed to have provided undertakings on terms no less onerous than this Agreement and shall be deemed to have paid to the Client such contribution as it would be just and equitable for them to pay having regard to their responsibility for any loss or damage and providing that it shall be deemed that such other parties have not limited or excluded their liability to the Client for such loss or damage in any way which may be prejudicial to the Consultant's liability under this clause. Nothing in this clause shall operate to exclude or limit the Consultant's liability for death or personal injury.

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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof I		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)		
Return period:	100 years	*As supplied by Client*
Allowance for Climate Change:	40 %	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290	

Input Parameters - Roof Information		
Total catchment area:	435 m^2	*As supplied by Client*
Attenuation area:	376 m^2	*As supplied by Client*
Maximum allowable runoff:	0.7 l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	14 hours and 0 minutes	0.4
30 mins	16 hours and 40 minutes	0.5
1 hour	19 hours and 0 minutes	0.6
2 hours	21 hours and 40 minutes	0.6
4 hours	23 hours and 30 minutes	0.7
6 hours	23 hours and 50 minutes	0.7
10 hours	23 hours and 0 minutes	0.7
24 hours	17 hours and 20 minutes	0.5
48 hours	7 hours and 40 minutes	0.3

Total attenuation required: 38.9 m^3
Half empty time: 8 hours and 20 minutes.

Output - Recommended Blue Roof System

System Name:	ABG blueroof VF HD 129mm
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.
Total attenuation capacity:	42.8 m^3
Number of Blue Roof outlets:	2

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given for the performance of the system relate to testing, modelling and analysis of our systems obtained from laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes to our systems without notice at any time.
3. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, ABG should be contacted to provide a revised estimate.
4. This estimate is specific to the characteristics of ABG products/systems and is not applicable to other competitor products. The substitution of the whole or any component of this design for a material supplied from another source renders this estimate invalid.
5. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.

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www.abgltd.com

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contract between the Client and the Consultant which contract will be subject to any terms and conditions contained or referred to in the aforementioned proposal and these terms and conditions. In the event of any conflict, the terms and conditions in the proposal shall prevail over these terms and conditions. The Agreement so formed shall supersede all previous understandings, commitments or agreements whether written or oral between the Client and the Consultant relating to the subject matter hereof. No person or entity shall have any rights in relation to this Agreement, whether as third parties or otherwise, save the parties to this Agreement. Should any term or condition of this Agreement be held to be unenforceable or invalid by the courts of any jurisdiction to which it is subject then such term or condition shall be disregarded and the remaining terms and conditions shall remain in full force and effect.

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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof M		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC. 3 x larger ASHP units - appropriate plant support method TBC with ABG, structural and M&E engineers.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	600	m^2	*As supplied by Client*
Attenuation area:	520	m^2	*As supplied by Client*
Maximum allowable runoff:	1.0	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	12 hours and 50 minutes	0.7
30 mins	15 hours and 20 minutes	0.8
1 hour	17 hours and 30 minutes	0.8
2 hours	19 hours and 50 minutes	0.9
4 hours	21 hours and 30 minutes	1.0
6 hours	21 hours and 40 minutes	1.0
10 hours	20 hours and 50 minutes	1.0
24 hours	15 hours and 0 minutes	0.8
48 hours	5 hours and 40 minutes	0.4

Total attenuation required: 52.7 m^3
Half empty time: 7 hours and 20 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	59.2	m^3
Number of Blue Roof outlets:	3	

Notes:

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Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	390	m^2	*As supplied by Client*
Attenuation area:	342	m^2	*As supplied by Client*
Maximum allowable runoff:	0.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	14 hours and 10 minutes	0.4
30 mins	16 hours and 50 minutes	0.5
1 hour	19 hours and 0 minutes	0.5
2 hours	21 hours and 40 minutes	0.6
4 hours	23 hours and 30 minutes	0.6
6 hours	23 hours and 50 minutes	0.6
10 hours	23 hours and 0 minutes	0.6
24 hours	17 hours and 20 minutes	0.5
48 hours	7 hours and 30 minutes	0.3

Total attenuation required: 34.7 m^3
Half empty time: 8 hours and 0 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	38.9	m^3
Number of Blue Roof outlets:	2	

Notes:

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shall remain vested with the Consultant but the Consultant shall grant an irrevocable royalty free license to the Client to use such reports, documents and the like for any purpose in connection with the Project.

5. LIABILITY

i. The Consultant shall be liable to pay compensation to the Client arising out of or in connection with this
Agreement only if a breach of the duty of care in Clause 3 is established against the Consultant.

ii. Notwithstanding any other term to the contrary in this Agreement or any related document and whether the cause of action for any claim arises under or in connection with the Agreement in contract or in tort, in negligence or for breach of statutory duty or otherwise the Consultant shall have no liability to the Client in respect of any claim for loss or damage arising from acts of war or terrorism or arising from flooding, burst water mains or failed drainage or arising from any incidence of toxic mould or asbestos but otherwise in relation to any cause of action as aforesaid the total liability of the Consultant in the aggregate for all claims shall be limited to a sum equivalent to ten (10) times the fee payable under this Agreement or £50,000, whichever is the lesser, or such other sum as may be expressly stated in the Consultant's proposal, and further but without prejudice to the aforesaid limit of liability any such liability of the Consultant shall be limited to such sum or sums as it would be just and equitable for the Consultant to pay having regard to the Consultant's responsibility for the same and on the basis that all other parties appointed or to be appointed by the Client to perform related services in connection with the Project shall be deemed to have provided undertakings on terms no less onerous than this Agreement and shall be deemed to have paid to the Client such contribution as it would be just and equitable for them to pay having regard to their responsibility for any loss or damage and providing that it shall be deemed that such other parties have not limited or excluded their liability to the Client for such loss or damage in any way which may be prejudicial to the Consultant's liability under this clause. Nothing in this clause shall operate to exclude or limit the Consultant's liability for death or personal injury.

iii. The Client shall indemnify and keep indemnified the Consultant from and against all claims, demands,
proceedings, damages, costs and expenses arising out of or in connection with this Agreement or the Project
arising from acts of terrorism or arising otherwise in excess of the liability of the Consultant under this
Agreement or which may be made in respect of events occurring after the expiry of the period of liability stated
in this Agreement.

iv. No action or proceedings under or in connection with this Agreement shall be commenced against the Consultant after the expiry of one year from completion of the Services.

v. ABG Geosynthetics Ltd is not responsible for consequential, indirect or incidental losses.

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reasonable control of the Consultant then the Consultant shall be entitled to such additional fees as are fair and
reasonable in the circumstances. The Consultant may render an invoice at monthly intervals for services properly
performed. The agreed invoice, or in the event of a dispute the undisputed element, shall be paid within 28 days of receipt of the invoice by the Client. Any invoice paid after this period will attract interest at 3% above the base
rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

ii. The Client shall not withhold any payment of any sum or part of a sum due to the Consultant under this
Agreement by reason of claims or alleged claims against the Consultant unless the amount to be withheld has
been agreed between the Client and the Consultant as due to the Client or such sum arises from an award in
adjudication, arbitration or litigation in favour of the Client and arises under or in connection with the Agreement.
Save as aforesaid all rights of set off at common law, in equity or otherwise which the Client may otherwise be
entitled to exercise are hereby expressly excluded.

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If a party is in breach of a material term of this Agreement and despite written notice from the other party fails to
remedy such breach within 30 days or such other period as may be agreed between the parties, then the other party shall be entitled to terminate this Agreement forthwith. The Consultant may seek to recoup costs incurred for works completed prior to termination.

10. DISPUTE RESOLUTION

Any dispute between the parties that cannot be settled by mutual agreement shall be referred for final settlement to the arbitration of a person agreed between the parties or failing such agreement appointed upon the application of either party by the President of the Chartered Institute of Arbitrators and the said arbitration shall be carried out in accordance with the Construction Industry Model Arbitration Rules 1998 or such other version current at the time of the referral under this clause. Where the Agreement is subject to a governing law other than that of England and Wales then any dispute between the parties that cannot be settled by mutual agreement shall be finally settled by arbitration in accordance with the UNCITRAL Arbitration Rules by one arbitrator appointed in compliance with the said Rules. In either case such rules as appropriate are deemed to be incorporated into this Agreement by reference.

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part of the appointment process prior to ABG Geosynthetics commencing work.

BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof O		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	325	m^2	*As supplied by Client*
Attenuation area:	280	m^2	*As supplied by Client*
Maximum allowable runoff:	0.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	13 hours and 10 minutes	0.4
30 mins	15 hours and 40 minutes	0.4
1 hour	17 hours and 40 minutes	0.5
2 hours	20 hours and 10 minutes	0.5
4 hours	21 hours and 40 minutes	0.5
6 hours	21 hours and 50 minutes	0.5
10 hours	21 hours and 0 minutes	0.5
24 hours	15 hours and 10 minutes	0.4
48 hours	5 hours and 50 minutes	0.2

Total attenuation required: 28.4 m^3
Half empty time: 7 hours and 20 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	31.9	m^3
Number of Blue Roof outlets:	2	

Notes:

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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

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Project Name:	Ham Close, Richmond, TW10 - Roof R		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	400	m^2	*As supplied by Client*
Attenuation area:	350	m^2	*As supplied by Client*
Maximum allowable runoff:	0.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	14 hours and 30 minutes	0.4
30 mins	17 hours and 10 minutes	0.5
1 hour	19 hours and 30 minutes	0.5
2 hours	22 hours and 20 minutes	0.6
4 hours	24 hours and 10 minutes	0.6
6 hours	24 hours and 30 minutes	0.6
10 hours	23 hours and 40 minutes	0.6
24 hours	18 hours and 0 minutes	0.5
48 hours	8 hours and 10 minutes	0.3

Total attenuation required: 35.8 m^3
Half empty time: 8 hours and 10 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	39.9	m^3
Number of Blue Roof outlets:	2	

Notes:

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ii. Notwithstanding any other term to the contrary in this Agreement or any related document and whether the cause of action for any claim arises under or in connection with the Agreement in contract or in tort, in negligence or for breach of statutory duty or otherwise the Consultant shall have no liability to the Client in respect of any claim for loss or damage arising from acts of war or terrorism or arising from flooding, burst water mains or failed drainage or arising from any incidence of toxic mould or asbestos but otherwise in relation to any cause of action as aforesaid the total liability of the Consultant in the aggregate for all claims shall be limited to a sum equivalent to ten (10) times the fee payable under this Agreement or £50,000, whichever is the lesser, or such other sum as may be expressly stated in the Consultant's proposal, and further but without prejudice to the aforesaid limit of liability any such liability of the Consultant shall be limited to such sum or sums as it would be just and equitable for the Consultant to pay having regard to the Consultant's responsibility for the same and on the basis that all other parties appointed or to be appointed by the Client to perform related services in connection with the Project shall be deemed to have provided undertakings on terms no less onerous than this Agreement and shall be deemed to have paid to the Client such contribution as it would be just and equitable for them to pay having regard to their responsibility for any loss or damage and providing that it shall be deemed that such other parties have not limited or excluded their liability to the Client for such loss or damage in any way which may be prejudicial to the Consultant's liability under this clause. Nothing in this clause shall operate to exclude or limit the Consultant's liability for death or personal injury.

iii. The Client shall indemnify and keep indemnified the Consultant from and against all claims, demands,
proceedings, damages, costs and expenses arising out of or in connection with this Agreement or the Project
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Agreement or which may be made in respect of events occurring after the expiry of the period of liability stated
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rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

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Agreement by reason of claims or alleged claims against the Consultant unless the amount to be withheld has
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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof S		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	485	m^2	*As supplied by Client*
Attenuation area:	421	m^2	*As supplied by Client*
Maximum allowable runoff:	0.8	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	14 hours and 0 minutes	0.5
30 mins	16 hours and 30 minutes	0.6
1 hour	18 hours and 50 minutes	0.6
2 hours	21 hours and 30 minutes	0.7
4 hours	23 hours and 20 minutes	0.7
6 hours	23 hours and 40 minutes	0.8
10 hours	22 hours and 50 minutes	0.7
24 hours	17 hours and 10 minutes	0.6
48 hours	7 hours and 30 minutes	0.3

Total attenuation required: 43.4 m^3
Half empty time: 8 hours and 10 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	47.9	m^3
Number of Blue Roof outlets:	2	

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given for the performance of the system relate to testing, modelling and analysis of our systems obtained from laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes to our systems without notice at any time.
3. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, ABG should be contacted to provide a revised estimate.
4. This estimate is specific to the characteristics of ABG products/systems and is not applicable to other competitor products. The substitution of the whole or any component of this design for a material supplied from another source renders this estimate invalid.
5. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.

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www.abgltd.com

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2. GENERAL

Unless and until a formal agreement is entered into, the Client's acceptance of the proposal for Services from the Consultant or a request for some or all the Services to be performed by the Consultant, shall constitute a binding
contract between the Client and the Consultant which contract will be subject to any terms and conditions contained or referred to in the aforementioned proposal and these terms and conditions. In the event of any conflict, the terms and conditions in the proposal shall prevail over these terms and conditions. The Agreement so formed shall supersede all previous understandings, commitments or agreements whether written or oral between the Client and the Consultant relating to the subject matter hereof. No person or entity shall have any rights in relation to this Agreement, whether as third parties or otherwise, save the parties to this Agreement. Should any term or condition of this Agreement be held to be unenforceable or invalid by the courts of any jurisdiction to which it is subject then such term or condition shall be disregarded and the remaining terms and conditions shall remain in full force and effect.

3. PERFORMANCE OF SERVICES AND SCOPE

The Consultant shall perform the Services using the degree of skill care and diligence to be expected from a consultant experienced in the provision of services of similar scope size and complexity. The Consultant shall use reasonable endeavours to complete the Services within the time or programme agreed but shall not be responsible for any delay beyond the reasonable control of the Consultant.

The fee contained in the proposal is for the scope of services as defined therein. If not already contained in the proposal the Consultant and the Client shall agree as an initial activity an integrated project services programme to
include the activities of all the parties to the Project relevant to the Services to be supplied by the Consultant. The
aforesaid programme shall show the key dates for final information and the delivery of such to the Consultant so as to enable the Consultant to carry out the services in an efficient once through manner to achieve the programme delivery dates for the Services.

The Consultant provides various services including Design and Product use advice which is distinct from a Design Service. The Design Service may or may not attract a fee.

Where the Consultant's services are of an advisory nature and dependent upon the degree of information and release thereof by the Client then the Client agrees that any reliance placed on the services by the Client shall take due account of such constraints.

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i. The Consultant and the Client shall keep confidential all information pertaining to the Services.

ii. Copyright for all reports, documents and the like produced by the Consultant in the performance of the Services
shall remain vested with the Consultant but the Consultant shall grant an irrevocable royalty free license to the Client to use such reports, documents and the like for any purpose in connection with the Project.

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Agreement by reason of claims or alleged claims against the Consultant unless the amount to be withheld has
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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof T		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	520	m^2	*As supplied by Client*
Attenuation area:	464	m^2	*As supplied by Client*
Maximum allowable runoff:	0.8	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	15 hours and 0 minutes	0.5
30 mins	18 hours and 0 minutes	0.6
1 hour	20 hours and 30 minutes	0.6
2 hours	23 hours and 30 minutes	0.7
4 hours	25 hours and 30 minutes	0.7
6 hours	25 hours and 50 minutes	0.7
10 hours	25 hours and 10 minutes	0.7
24 hours	19 hours and 40 minutes	0.6
48 hours	9 hours and 40 minutes	0.4

Total attenuation required: 47.4 m^3
Half empty time: 8 hours and 50 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	52.8	m^3
Number of Blue Roof outlets:	2	

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given for the performance of the system relate to testing, modelling and analysis of our systems obtained from laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes to our systems without notice at any time.
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performed. The agreed invoice, or in the event of a dispute the undisputed element, shall be paid within 28 days of receipt of the invoice by the Client. Any invoice paid after this period will attract interest at 3% above the base
rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

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Project Name:	Ham Close, Richmond, TW10 - Roof U		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	353	m^2	*As supplied by Client*
Attenuation area:	306	m^2	*As supplied by Client*
Maximum allowable runoff:	0.9	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	10 hours and 10 minutes	0.5
30 mins	12 hours and 0 minutes	0.6
1 hour	13 hours and 30 minutes	0.6
2 hours	15 hours and 20 minutes	0.7
4 hours	16 hours and 20 minutes	0.7
6 hours	16 hours and 20 minutes	0.7
10 hours	15 hours and 10 minutes	0.7
24 hours	9 hours and 20 minutes	0.5
48 hours	1 hour and 30 minutes	0.2

Total attenuation required: 29.3 m^3
Half empty time: 5 hours and 10 minutes.

Output - Recommended Blue Roof System

System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	34.8	m^3
Number of Blue Roof outlets:	2	

Notes:

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arising from acts of terrorism or arising otherwise in excess of the liability of the Consultant under this
Agreement or which may be made in respect of events occurring after the expiry of the period of liability stated
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reasonable in the circumstances. The Consultant may render an invoice at monthly intervals for services properly
performed. The agreed invoice, or in the event of a dispute the undisputed element, shall be paid within 28 days of receipt of the invoice by the Client. Any invoice paid after this period will attract interest at 3% above the base
rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

ii. The Client shall not withhold any payment of any sum or part of a sum due to the Consultant under this
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been agreed between the Client and the Consultant as due to the Client or such sum arises from an award in
adjudication, arbitration or litigation in favour of the Client and arises under or in connection with the Agreement.
Save as aforesaid all rights of set off at common law, in equity or otherwise which the Client may otherwise be
entitled to exercise are hereby expressly excluded.

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If a party is in breach of a material term of this Agreement and despite written notice from the other party fails to
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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

creative geosynthetic engineering

Project Name:	Ham Close, Richmond, TW10 - Roof V		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	466	m^2	*As supplied by Client*
Attenuation area:	402	m^2	*As supplied by Client*
Maximum allowable runoff:	0.7	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	15 hours and 0 minutes	0.4
30 mins	17 hours and 50 minutes	0.5
1 hour	20 hours and 20 minutes	0.6
2 hours	23 hours and 20 minutes	0.6
4 hours	25 hours and 20 minutes	0.7
6 hours	25 hours and 40 minutes	0.7
10 hours	25 hours and 0 minutes	0.7
24 hours	19 hours and 30 minutes	0.5
48 hours	9 hours and 30 minutes	0.3

Total attenuation required: 42.3 m^3
Half empty time: 9 hours and 10 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	45.8	m^3
Number of Blue Roof outlets:	2	

Notes:

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rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

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BLUE ROOF SYSTEM AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

Project Name:	Ham Close, Richmond, TW10 - Roof W		
Prepared for:	Jubb Consulting, Winchester.		
Date:	07/01/2022		
ABG Project ID:	24502	Calculator version:	1.30
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Green roof or biodiverse roof, with potential for free-standing/ballasted PV panels to be installed, on top of the 'blue roof' system (recommended); and maintenance access only (access on roof via a man-safe system) - TBC. Warm roof/inverted roof, construction, with zero falls - TBC. 3 x small ASHP units - appropriate plant support method TBC with ABG, structural and M&E engineers.		

Blue Roof Estimate

Input Parameters - Rainfall Information (Flood Estimation Handbook 2013)			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
OS grid reference selected for FEH data:	TQ 17035 72290		

Input Parameters - Roof Information			
Total catchment area:	330	m^2	*As supplied by Client*
Attenuation area:	277	m^2	*As supplied by Client*
Maximum allowable runoff:	0.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Time to Empty	Restricted Outflow (l/s)
15 mins	11 hours and 50 minutes	0.4
30 mins	14 hours and 0 minutes	0.5
1 hour	15 hours and 50 minutes	0.5
2 hours	17 hours and 50 minutes	0.6
4 hours	19 hours and 10 minutes	0.6
6 hours	19 hours and 10 minutes	0.6
10 hours	18 hours and 10 minutes	0.6
24 hours	12 hours and 20 minutes	0.4
48 hours	3 hours and 30 minutes	0.2

Total attenuation required: 28 m^3
Half empty time: 6 hours and 20 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 129mm	
Description:	The blue roof depth of 129mm, includes for a 25mm reservoir board. No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'tell-tale' parapet overflow outlets, may also be added by the architect.	
Total attenuation capacity:	31.5	m^3
Number of Blue Roof outlets:	2	

Notes:

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in this Agreement.

iv. No action or proceedings under or in connection with this Agreement shall be commenced against the Consultant after the expiry of one year from completion of the Services.

v. ABG Geosynthetics Ltd is not responsible for consequential, indirect or incidental losses.

6. INSURANCE

The Consultant shall arrange Professional Indemnity Insurance cover for the amount stated in Clause 5(ii). The Consultant will use all reasonable endeavours to maintain Professional Indemnity Insurance cover for the period stated in 5(iv) above, providing such insurance remains available to the Consultant at commercially reasonable rates.

7. CLIENT'S OBLIGATIONS

The Client shall supply, without charge and in such time so as not to delay or disrupt the performance of the Consultant in carrying out the Services, all necessary and relevant information, in his possession or available to him from his other agents or consultants and all necessary approvals or consents. Any deviation on any information from the proposal shall be confirmed in writing and any attendant consequential fees will be forwarded for approval by the Client before any changes are made. The Consultant shall not be liable for any consequential delays on site. Every reasonable effort will be made to mitigate against delays, however no liability for losses and costs will be accepted. The approval or consent by the Client to the Services shall not relieve the Consultant from any liability under this Agreement. All work undertaken by the Consultant must be ratified and signed off by the Client.

8. PAYMENT

i. The Client shall pay the Consultant for the Services in accordance with the proposal and this Agreement. If the Consultant performs any additional services or if the Services are delayed or disrupted for reasons beyond the
reasonable control of the Consultant then the Consultant shall be entitled to such additional fees as are fair and
reasonable in the circumstances. The Consultant may render an invoice at monthly intervals for services properly
performed. The agreed invoice, or in the event of a dispute the undisputed element, shall be paid within 28 days of receipt of the invoice by the Client. Any invoice paid after this period will attract interest at 3% above the base
rate of the central bank of the country of the currency of payment along with any collection costs which may occur.

ii. The Client shall not withhold any payment of any sum or part of a sum due to the Consultant under this
Agreement by reason of claims or alleged claims against the Consultant unless the amount to be withheld has
been agreed between the Client and the Consultant as due to the Client or such sum arises from an award in
adjudication, arbitration or litigation in favour of the Client and arises under or in connection with the Agreement.
Save as aforesaid all rights of set off at common law, in equity or otherwise which the Client may otherwise be
entitled to exercise are hereby expressly excluded.

9. TERMINATION

If a party is in breach of a material term of this Agreement and despite written notice from the other party fails to
remedy such breach within 30 days or such other period as may be agreed between the parties, then the other party shall be entitled to terminate this Agreement forthwith. The Consultant may seek to recoup costs incurred for works completed prior to termination.

10. DISPUTE RESOLUTION

Any dispute between the parties that cannot be settled by mutual agreement shall be referred for final settlement to the arbitration of a person agreed between the parties or failing such agreement appointed upon the application of either party by the President of the Chartered Institute of Arbitrators and the said arbitration shall be carried out in accordance with the Construction Industry Model Arbitration Rules 1998 or such other version current at the time of the referral under this clause. Where the Agreement is subject to a governing law other than that of England and Wales then any dispute between the parties that cannot be settled by mutual agreement shall be finally settled by arbitration in accordance with the UNCITRAL Arbitration Rules by one arbitrator appointed in compliance with the said Rules. In either case such rules as appropriate are deemed to be incorporated into this Agreement by reference.

11. COMPLIANCE WITH LAWS

This Agreement shall be governed by and construed in accordance with the law of England and Wales unless stated
otherwise in the proposal for services from the Consultant.

Changes to the above terms and conditions will only be considered if agreed in writing as
part of the appointment process prior to ABG Geosynthetics commencing work.

Appendix G: SuDS Proforma & TW Correspondence

LONDON BOROUGH OF RICHMOND UPON THAMES

GREATERLONDONAUTHORITY

LoDEG

1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	Ham Close
Address & post code	Ham Close, Richmond, TW10 7PD
OS Grid ref. (Easting, Northing)	E 517098
	N 172336
LPA reference (if applicable)	SA 15 Ham Close, Ham
Brief description of proposed work	Demolition of existing buildings on-site and phased mixed-use development comprising 452 residential homes a Community/Leisure Facility, a "Makers Lab" together with basement car parking and site wide landscaping.
Total site Area	46900 m^2
Total existing impervious area	17360 m^2
Total proposed impervious area	22605 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	No
Existing drainage connection type and location	5no locations - TW0302, TW1402, TW0202, TW1202, TW1201
Designer Name	Karol Gyba
Designer Position	Senior Civil Engineer

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	Kempton Park Gravel Formation
Bedrock geology classification	London Clay Formation
Site infiltration rate	m/s
Depth to groundwater level	2.2 - 4.3 m below ground level
Is infiltration feasible?	No

2b. Drainage Hierarchy

	Feasible (Y/N)	*Proposed (Y/N)*
1 store rainwater for later use	Y	Y
2 use infiltration techniques, such as porous surfaces in non-clay areas	N	N
3 attenuate rainwater in ponds or open water features for gradual release	N	N
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
5 discharge rainwater direct to a watercourse	N	N
6 discharge rainwater to a surface water sewer/drain	Y	Y
7 discharge rainwater to the combined sewer.	N	N

2c. Proposed Discharge Details

Proposed discharge location	Refer to Drainage Strategy Plan TW1402, TW0202, TW1202, TW1201
Has the owner/regulator of the discharge location been	Yes, Thames Water confirmed capacity

	Designer Company	Jubb		consulted?	

LONDON BOROUGH OF RICHMOND UPON THAMES

GREATERLONDONAUTHORITY

LoDEG

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar	11			
1 in 1	9.2	231.8	480	37
1 in 30	24.9	708.4	940	37
1 in 100	34.6	936.9	1270	37
1 in 100 + CC			1960	37
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Blue Roofs and Hydrobrakes		

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	6963	0	0
Blue roofs	0	6071	790
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	200	200	0
Pervious pavements	2300	2300	344
Swales	400	400	0
Basins/ponds	0	0	0
Attenuation tanks	17650		1226
Total	**27513**	**8971**	**2360**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	SI report, Appendix C, Site Geology section 3.4 of Drainage Report.
Drainage hierarchy (2b)	Section 6.3 from Drainage Report
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Drainage Plans, Appendix E. Approvals from TW, Appendix G.
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Calculations in Appendix F, Drianage Drawings Appendix E.
Proposed SuDS measures & specifications (3b)	Section 6.3 from Drainage Report
4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Appendix A & E
Detailed drainage design drawings, including exceedance flow routes	Appendix E
Detailed landscaping plans	Appendix A
Maintenance strategy	Appendix H
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Section 6.4 of Drainage Report.
b) biodiversity?	Section 6.4 of Drainage Report.
c) amenity?	Section 6.4 of Drainage Report.

Karol Gyba

Jubb
Ground Floor
Crondall House
1 Exchange Square
Jewry Street
Winchester
Hampshire
SO23 8FJ

Wastewater pre-planning
Our ref DS6088658

2nd December 2021

Pre-planning enquiry: Confirmation of sufficient capacity

Site Address: Ham Close, Richmond, London, TW10 7PL

Dear Mr Gyba,

Thank you for providing information on the proposals to construct 452 residential units (410 flats and 42 houses) and a new youth centre, NHC clinic and hobby club replacing 192 flats and the existing youth centre, NHC clinic and hobby club at the above location.

We have completed the assessment of the foul water flows and surface water run-off based on the information submitted in your application with the purpose of assessing sewer capacity within the existing Thames Water sewer network.

Foul Water

If your proposals progress in line with the details you've provided, we're pleased to confirm that there will be sufficient sewerage capacity in the adjacent foul water sewer network to serve your development.

This is based on the foul water flows from the majority of the development gravitating from the site and discharging to the 225mm dia. foul water sewer to the South of the site between manhole refs 1204 and 2203 and the foul water flows from the youth centre gravitating from the site and discharging to the diverted 225mm dia. foul water sewer.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

Please note that you must keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient sewerage capacity.

Surface Water

Please note that discharging surface water to the public sewer network should only be considered after all other methods of disposal have been investigated and proven to not be viable. In accordance with the Building Act 2000 Clause H3.3, positive connection to a public sewer will only be consented when it can be demonstrated that the hierarchy of disposal methods have been examined and proven to be impracticable. The disposal hierarchy being: 1st Soakaways; 2nd Watercourses; 3rd Sewers.

Only when it can be proven that soakage into the ground or a connection into an adjacent watercourse is not possible would we consider a restricted discharge into the public surface water sewer network.

When redeveloping an existing site, policy 5.13 of the London Plan and Policy 3.4 of the Supplementary Planning Guidance (Sustainable Design And Construction) states that every attempt should be made to use flow attenuation and SUDS/storage to reduce the surface water discharge from the site as much as possible.

If they are consulted as part of any planning application, Thames Water's Planning team would ask to see why it is not practicable to attenuate the flows to Greenfield run-off rates i.e. 5l/s/hectare of the total site area. Should the policy above be followed, we would envisage no capacity concerns with regards to surface water for this site.

Please note that the Local Planning authority may comment on surface water discharge under the planning process.

Please Note

There are existing public sewers crossing the site. New buildings will need to be kept between 3 and 6.5m away from existing sewer depending on the size and depth of the sewer. Alternatively, it may be possible for sewers to be diverted around the new development. If you wish us to review a diversion proposal please submit this via a Section 185 Diversion application. On some occasions it may be possible to abandon existing public sewers. Please contact us for further information on this process.

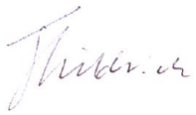
All connection requests are subject to a full Section 106 (Water Industry Act 1991) application before the Company can confirm approval to the connection itself. Please also note that capacity in the public sewerage system cannot be reserved. Please make sure you submit your connection application giving us at least 21 days' notice of the date you wish to make your new connection/s.

The discharge of non-domestic effluent is not permitted until a valid trade effluent consent has been issued by Thames Water. If anything other than domestic sewage is discharged into the public sewers without the above agreement an offence is committed and the applicant will be liable to the penalties contained in Section 109(1) (WIA 1991).

Applicants should contact Trade Effluent prior to seeking a connection approval, to discuss trade effluent consent and conditions of discharge. For Trade Effluent queries and to apply for Discharge Consents please call 0203 577 9200 or email trade.effluent@thameswater.co.uk.

The views expressed by Thames Water in this letter are in response to this pre-planning enquiry at this time and do not represent our final views on any future planning applications made in relation to this site.

Yours sincerely,



Jonathan Shildrick BSc
Development Engineer
Developer Services

Karol Gyba

From: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 23 November 2021 11:24
To: Karol Gyba
Subject: RE: RE: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

Hi Karol,

Natayla is currently off recuporating after an accident so I will take this forward for you.

I note that our Asset Planners have confirmed that they would have no concerns in regards to capacity for the proposed diversion of the 225mm dia. from MH1405 into a new manhole downstream of MH3402 in Ham Street.

In regards to the flows from the new development, I cannot see that Natayla managed to also consult our Asset Planners on this before she went off work so I will do this now. Apologies for the delay but we will need to give our Asset Planners another 5 working days to get back to us on this element. I will issue our formal response as soon as I can after hearing from them.

Regards

Jonathan Shildrick BSc
Development Engineer
Sewer Adoptions Team
Developer Services
Helpdesk: 0800 009 3921
Clearwater Court, Vastern Road, Reading, RG1 8DB
Find us online at developers.thameswater.co.uk

Original Text

From: Karol Gyba <K.Gyba@jubb.uk.com>
To: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
CC:
Sent: 19.11.21 15:02:53
Subject: RE: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

---

<color="salmon">

Good afternoon,

I'm just following up on this, as I haven't seen any responses. Can you please let me know if you're after anymore information from us? Also, if the two applications are now separate, could you let me know the application numbers, for our reference in the future?

Regards,
Karol Gyba
Senior Civil Engineer

Direct: +44 (0) 1962 279979

Ground Floor, Crondall House, 1 Exchange Square, Jewry Street, Winchester, SO23 8FJ | www.jubb.uk.com
<![if !vml]>
<![endif]>

In light of the Coronavirus pandemic I am best contacted by email, mobile or via Microsoft Teams. The office landline may not get me if I'm working from home.

From: Karol Gyba
Sent: 21 October 2021 13:25
To: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Subject: RE: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry [Filed 21 Oct 2021 13:24]

Hi Natalya,

That sounds like a good idea to keep the two items separate.

Correct, the existing flats will be demolished.

Regards,
Karol Gyba
Senior Civil Engineer

Direct: +44 (0) 1962 279979

Ground Floor, Crondall House, 1 Exchange Square, Jewry Street, Winchester, SO23 8FJ | www.jubb.uk.com
<![if !vml]>

<![endif]>

In light of the Coronavirus pandemic I am best contacted by email, mobile or via Microsoft Teams. The office landline may not get me if I'm working from home.

From: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 21 October 2021 11:29
To: Karol Gyba <K.Gyba@jubb.uk.com>
Subject: RE: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

Hi Karol,

I have raised a separate consulation for a diversion purpose and will raise a separate enquiry for the proposed site. What happens to the existing 192 flats? are they being demolished?

Thank you

Natalya

Original Text

From: Karol Gyba <K.Gyba@jubb.uk.com>
To: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
CC:
Sent: 18.10.21 12:46:42
Subject: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

This email contains a reference to Coronavirus or COVID-19. Please be aware of coronavirus-themed active phishing campaigns, and use extra vigilance when responding or clicking.

<color="salmon">

Hi Natalya,

I think the reference is this: DS6088658

Confirmation Email attached FYI.

Regards,
Karol Gyba
Senior Civil Engineer

Direct: +44 (0) 1962 279979

Ground Floor, Crondall House, 1 Exchange Square, Jewry Street, Winchester, SO23 8FJ | www.jubb.uk.com
<![if !vml]>
<![endif]>

In light of the Coronavirus pandemic I am best contacted by email, mobile or via Microsoft Teams. The office landline may not get me if I'm working from home.

From: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 18 October 2021 12:36
To: Karol Gyba <K.Gyba@jubb.uk.com>
Subject: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

Hi Karol,

Thanks for this. Can you please confirm if you have submitted an application form? I can't seem to find it. If you have, please can you provide a reference number? You would have received it in a courtesy email sent to you when application was submitted.

Thank you

Natalya

Original Text

From:	Karol Gyba <K.Gyba@jubb.uk.com>
To:	DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
CC:	
Sent:	11.10.21 17:24:03
Subject:	RE: 21246 Ham Close - TW Diversion - Initial Enquiry

This email contains a reference to Coronavirus or COVID-19. Please be

aware of coronavirus-themed active phishing campaigns, and use extra vigilance when responding or clicking.

<color="salmon">

Hi Natalya,

Thank you for a quick response,

In addition to the residential aspect, there are 3 other uses:

- **NHS Clinic / dentistry** – it falls outside of the site boundary and will remain the same as the existing scenario (the flows will be directed to new MH between ExMH 1204 - 2203).
- **'Makers Lab' (a hobby DYI club)** with capacity of ~10 people – it will be re-provided onsite with the same occupancy as existing (the flows will be directed to new MH between ExMH 1204 - 2203).
- **Youth Club (community centre)** with the sports hall – these facilities will be re-located towards the east of the site and discharge towards the new manhole formed online of the existing sewer as part of the diversion (new MH between ExMH 3402-3302). The Community Centre / youth club will be re-provided in the same capacity as the existing scenario.

We're in the process of finalising the proposals, hence the surface water flows and the exact areas are not yet avaliable. I've completed the table below assuming that each of the 5 connections takes approximately 1/5th of the site (0.61ha), as shown they're all limited by the capacity of the outfalls. We will look to lower the runoff rates further with use of SuDS to as close to greenfield rates as possible, in line with the policy, but for now please assess based on the below:

Connections to MHs 1402, 0302, 1202, 1201 and 0202, all limited to max 20 l/s:

Storm	*Rainfall Intensity (mm/hr)*	*Existing Rainfall (l/s)*	**Existing Runoff (l/s) ***	**Proposed Runoff (l/s) ****	*Betterment (%)*
1 in 1	*28.2*	*47.8*	40	20	*58%*
1 in 30	*86.0*	*145.9*	40	20	*86%*
1 in 100	*113.8*	*193.0*	40	20	*90%*

* Existing Runoff Based on capacity of a 225mmØ pipe at 1:170,

** Proposed Runoff TBC following co-ordination of onsite proposals,

Diversion of existing car-park to the east (MH 2302): The development only accounts for 400m² of the new area to MH 2302, the remaining 2,000m² is the existing car-park re-routed from MH 2304 as part of the diversion, the car-park is not within the works boundary, hence the flows from that area cannot be controlled. The community centre section (400m²) is summarised in the table below:

Storm	*Rainfall Intensity (mm/hr)*	*Existing Rainfall (l/s)*	**Existing Runoff (l/s) ***	**Proposed Runoff (l/s) ****	*Betterment (%)*
1 in 1	*28.2*	*3.1*	3.1	1.6	*50%*
1 in 30	*86.0*	*9.6*	9.6	4.8	*50%*
1 in 100	*113.8*	*12.7*	12.7	6.3	*50%*

* Existing Runoff Based on capacity of a 225mmØ pipe at 1:170,

** Proposed Runoff TBC following co-ordination of onsite proposals,

I've copied the text from the form below, please let me know if there's anything else you need:

"Re-use existing 5no 225mmØ connections to SW sewers & provide min. 50% betterment over the existing scenario. Existing rates assumed 40 l/s per connection, based on 225mmØ @ 1:170.

Assumed the same IMP. area ratios as in existing scenario:

Northern sewer:
~0.5 ha to MH 1402
~0.5 ha to MH 0302

Southern sewer:
~0.5 ha to MH 1202
~0.75 ha to MH 1201
~0.75 ha to MH 0202

Easter Sewer (Community Centre):
400m² to MH 2302
Remove sewer between MHs 2304-2402 to accommodate new building and re-direct max ~0.2 ha of carparking towards MH 2302."

Regards,

Karol Gyba
Senior Civil Engineer

Direct: +44 (0) 1962 279979

Ground Floor, Crondall House, 1 Exchange Square, Jewry Street, Winchester, SO23 8FJ | www.jubb.uk.com
<![if !vml]>
<![endif]>

From: DEVELOPER.SERVICES@THAMESWATER.CO.U
<DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 05 October 2021 11:58
To: Karol Gyba <K.Gyba@jubb.uk.com>
Subject: 21246 Ham Close - TW Diversion - Initial Enquiry

Hi Karol,

Thank you for the submitted application form. I have noted from our records the current site is more than 192 flats. Can you please provide full description of the current site? I think it could include a sports hall, NHS clinic and a dentistry. Can you please provide full details in sqm and occupancy number?

Also, a part of a section describing "amount of proposed impermeable area per connection* is not visible. can you please re-submit these details separately?

Can you please summarise runoff for each connection as per table below:

	Existing Runoff (l/s)	Proposed Runoff (l/s)

1 in 1		
1 in 30		
1 in 100		

Thank you

Natalya

Original Text

From: Karol Gyba <K.Gyba@jubb.uk.com>
To: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
CC:
Sent: 04.10.21 12:31:40
Subject: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

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<color="salmon">

Hi Jonathan,

Thanks for your response, good question regarding the additional flows from the development. Our current approach is that the diverted sewer will only serve the existing (~150) properties north of our site, the new flows from site will drain via the outfall towards the south (to the MH which will now be head of the run due to the diversion).

I've completed the Pre-development application (attached), I've also updated the sketch (P3) to highlight the proposed discharge locations. The SW / FW flows for the proposed development are all very provisional at this stage, the important check is the FW diversion capacity please.

Regards,
Karol Gyba
Senior Civil Engineer

Direct: +44 (0) 1962 279979

Ground Floor, Crondall House, 1 Exchange Square, Jewry Street, Winchester, SO23 8FJ | www.jubb.uk.com
<![if !vml]>

From: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 01 October 2021 13:57
To: Karol Gyba <K.Gyba@jubb.uk.com>
Subject: RE: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

Hi Karol,

Many thanks for your email below.

As I mentioned in my previous email, we would need to assess the proposals as part of a Pre-Planning Enquiry application as we would need to consult with our Asset Planners for their comments on whether to sewers to the East of the area would have capacity to accommodate the diverted flows. Can you please complete the attached on this basis.

As part of that application can you please confirm whether the estimate of 150 properties served by the sewer that you wish to divert includes the new properties on the proposed development?

Regards

Jonathan Shildrick BSc
Development Engineer
Sewer Adoptions Team
Developer Services
Helpdesk: 0800 009 3921
Clearwater Court, Vastern Road, Reading, RG1 8DB
Find us online at developers.thameswater.co.uk

Original Text

From: Karol Gyba <K.Gyba@jubb.uk.com>
To: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
CC:
Sent: 28.09.21 10:40:18
Subject: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

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aware of coronavirus-themed active phishing campaigns, and use extra vigilance when responding or clicking.

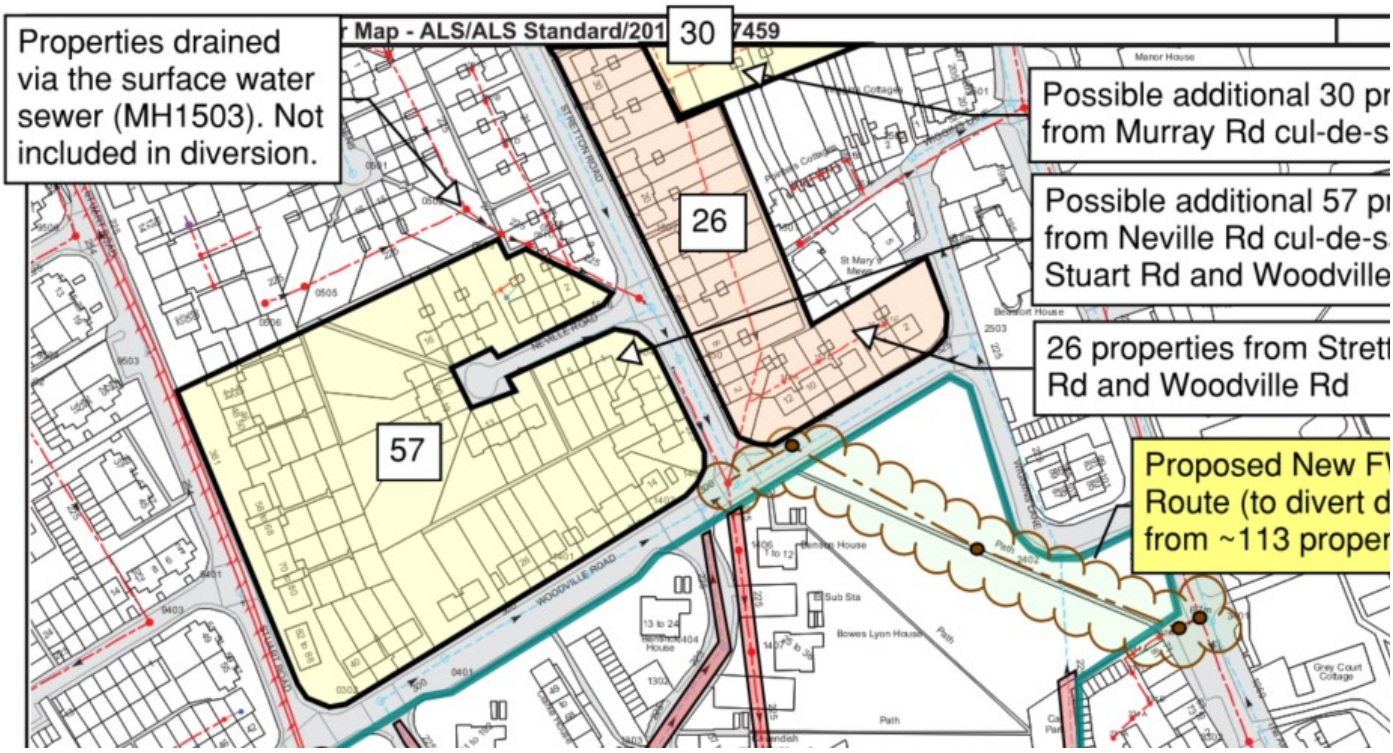
<color="salmon">

Good morning,

Thank you very much for a quick response. We estimate a maximum of approximately 113 properties are currently drained via this sewer (based on the road layout and the avaliable TW asset information). Could we check if a diversion would be possible based on a conservative value of ~150 properties please? I also note from the maps that the sewers do eventually combine south of Cleves Rd, hence only a small section of the network will be impacted.

Understood & agree with regards to Section 185 and 3rd party agreements. Could you also confirm if a S98 (Sewer Requisition) agreement could be used for this diversion (it's not our intention, but would like to know our options)?

I've attached an updated mark-up now also showing the assumptions for the number of properties drained via the existing drain.



Please let me know if there's any more information you need,

Regards,

Karol Gyba
Senior Civil Engineer

Direct: +44 (0) 1962 279979

Ground Floor, Crondall House, 1 Exchange Square, Jewry Street, Winchester, SO23 8FJ | www.jubb.uk.com
<![if !vml]>
<![endif]>

In light of the Coronavirus pandemic I am best contacted by email, mobile or via Microsoft Teams. The office landline may not get me if I'm working from home.

From: DEVELOPER.SERVICES@THAMESWATER.CO.U
<DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 21 September 2021 10:17
To: Karol Gyba <K.Gyba@jubb.uk.com>
Subject: RE: 21246 Ham Close - TW Diversion - Initial Enquiry

Dear Mr Gyba,

Many thanks for your email below.

As you propose to divert an existing sewer into a different part of the network, as part of the Pre-Planning Enquiry application we may need to undertake an assessment of the capacity of that receiving sewer to accommodate the existing flows as well as the proposed flows from the new development. If an accurate figure of the number of properties served by the existing sewer cannot be provided as part of this then we may need you to install flow meters to determine the existing level of flow that would be diverted into the sewer East of the site.

If we provide confirmation that there is sufficient capacity to accommodate the flows then in principle the diversion of this sewer would be possible and could be undertaken by a contractor or your client's choosing subject to a detailed technical review of the design of the diverted sewer and a Section 104/116 legal agreement being in place before works are undertaken on the public sewer. Please submit the Section 185 application initially.

In regards to the route of the proposed diversion, unfortunately you would need to secure all rights to constuct the sewer across any third party owned land. As part of the application please provide evidence that this has been obtained.

Regards

Jonathan Shildrick BSc
Development Engineer
Sewer Adoptions Team
Developer Services
Helpdesk: 0800 009 3921
Clearwater Court, Vastern Road, Reading, RG1 8DB
Find us online at developers.thameswater.co.uk

Original Text

From: Karol Gyba <K.Gyba@jubb.uk.com>

To: developer.services@thameswater.co.u <developer.services@thameswater.co.uk>
CC: Rob Lowe <r.lowe@jubb.uk.com>
Sent: 20.09.21 16:07:47
Subject: 21246 Ham Close - TW Diversion - Initial Enquiry

<color="salmon">

Good afternoon,

We're working on a project in Richmond Upon Thames, the site area is ~ 4ha and the nearest postcode is TW10 7PN. We're looking to submit the scheme for planning approval soon, the proposals are still being finalised, but based on the position of the existing TW assets, diversions will be required.

We would like to divert the foul water sewer between manholes **1405** and **2203**, to run from manhole **1405** to a new manhole between **3402** and **3302**. We will submit a diversion application once at the detailed design stage, but for now could you please let us know if the proposed diversion is possible and let us know if you have any comments ahead of the planning application.

I've attached a markup showing the proposed diversion and highlighting the sewers running through our development site.

The route proposed is within a 'protected open space' highlighted in the London Plan, could you advise if there are any restrictions on providing a diversion through this area? Looking through the policies and based on the presence of existing assets in the area, we presume it is acceptable, but please let us know if you have any comments.

We'll submit the pre-planning capacity enquiry for the discharges from the development once we have finalised the proposals.

Looking forward to hearing back from you,

Regards,
Karol Gyba
Senior Civil Engineer

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In light of the Coronavirus pandemic I am best contacted by email, mobile or via Microsoft Teams. The office landline may not get me if I'm working from home.

Information supplied by electronic means:

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Appendix H: Maintenance Schedule

Title: SuDS Management & Maintenance Technical Note

Project Ham Close, Richmond,

Date: 1st Feb 2022

1.0 Introduction

1.1 Jubb have been appointed by Hill Residential to produce a Sustainable Drainage Systems (SuDS) Maintenance and Management plan to support the planning application at Ham Close, Richmond.

2.0 Drainage Description

2.1 Reference should be made to drainage layouts submitted as part of this application. The development will have Surface water and Foul water sewer networks, as described below:

- Foul water will be conveyed from the buildings towards the external sewers and routed towards the outfalls from site. The main site has 2no foul water outfalls to Thames Water (TW) sewers, one to the north and one to the south. The community centre has 1no outfall to sewer in Ham Street (formed as part of the new diversion). All FW from ground level and above aims to leave site via gravity, any flows from the basements will require to be pumped.
- Surface water will be collected and controlled by green and blue roofs, where possible. From there it will be conveyed via pipes, raingardens, or permeable paving towards the belowground drainage which will control the runoff via hydrobrakes located on the outfall manholes. The main site will have 4no outfalls to TW sewers, 3no to the south and 1no to the north. The community centre will have 1no outfall to the south. All surface water will flow via gravity.

3.0 SuDS Features

3.1 SuDS drainage networks are designed to prevent flooding of a site, whilst providing water quality benefits and amenity value. SuDS and other proposed drainage infrastructure within the site as shown in the proposed drainage strategy include:

- Gully drains,
- Manholes,
- Pipes,
- Pumps,
- Petrol Interceptors,
- Green Roofs,
- Blue Roofs,
- Permeable Paving,
- Raingardens,
- Geocellular Attenuation,
- Hydrobrake,

4.0 SuDS Management & Ownership

4.1 The drainage infrastructure to be constructed as part of proposed development will be a mixture of adopted and privately owned. All diversions and public sewers will be maintained by Thames Water. All other drainage infrastructure will be maintained privately.

4.2 All private drainage features will be managed and maintained by Hill either through an internal maintenance team or an external site management company.

4.3 A contractor will be held on standby for emergency reactive maintenance such as the removal of oil from the petrol interceptor after an oil spill on site.

4.4 As the scheme is progressed management and maintenance practices for taking care of the SuDS/drainage infrastructure will be constantly reviewed and updated with a final confirmed plan to be detailed at the completion of the construction.

5.0 SuDS Maintenance

General Requirements

Regular Maintenance	**Frequency**
Litter Collect all litter or other debris and remove from site at each site visit.	Monthly or when deemed necessary
Grass maintenance Amenity Grass – Mow all grass verges, paths and amenity grass at 35-50mm with 75mm max. All cuttings to remain in situ.	Monthly or when deemed necessary
Flood Routes Make visual inspection of proposed overland flow routes. Check that the route is not obstructed by rubbish, new features etc. Remove obstructions as necessary.	Monthly

Catch Pit

Regular Maintenance	***Frequency***
Silt Trap, Inspection chambers *Open cover to inspect level of silt present, where required remove the excess silt.*	*Monthly within first year, annually thereafter*
Reactive Maintenance	***Frequency***
If the level of silt is above the level of the pipes it may be necessary to mechanically extract the silt and jets the drains both upstream and downstream to ensure continued performance.	*As required*

Gullies, Manholes

Regular Maintenance	***Frequency***
Gully Inlets *Inspect physical structure of gully removing surface obstructions and silt as necessary. Check there is no physical damage.*	*Monthly*
Silt Trap, Inspection chambers *Remove cover and inspect ensuring water is flowing freely and that the existing route for water is unobstructed. Remove debris and silt.* *Undertake inspection after leaf fall in autumn in which silt build up is more likely to occur.*	*Annually*
Reactive Maintenance	***Frequency***
Replace gully grating and manhole if physical damage has occurred. *If a blockage in the drainage system occurs rod the necessary region within the system to ensure the blockage is removed.*	*As required*

Petrol Interceptor

Regular Maintenance	**Frequency**
Inspection Chambers Remove cover and inspect ensuring water is flowing freely and that the existing route for water is unobstructed. Undertake inspection after leaf fall in autumn in which silt build up is more likely to occur.	Annually
Alarm System Run a test to the alarm system to ensure that it is still operational.	Annually
Reactive Maintenance	**Frequency**
In the instance that the alarm within the system goes off silt/oil from the interceptor is to be removed and properly disposed of offsite. In the case of an oil/chemical spill relevant pipes within the drainage system will be jetted and the oil flushed into the separator removed appropriately afterwards.	As required

Hydrobrake

Regular Maintenance	**Frequency**
Inspection Chamber Remove cover to inspect and note any high-water levels, re-inspect 24hrs later to evaluate reduction of water levels. Inspect ensuring that water is flowing appropriately through the flow control device and there are no obstructions to the flow of water immediately upstream or within the device. Remove debris and silt where necessary.	Monthly or following severe storms, within first year. Monthly for 3 months, then every 6 months.
Reactive Maintenance	**Frequency**
If a blockage within the hydrobrake unit occurs, it will need to be either jetted or replaced depending on the severity of the blockage.	As required

Permeable Paving

Regular Maintenance	***Frequency***
Surface Protection *Remove litter and debris.* *Brush or suction sweep surface to remove silt build up and replace grit as required*	 *Monthly* *Annually*
Bedding Replacement *Lift blocks and remove bedding material. Clean geotextile and replace bedding material with new silt-free granular material.*	*Every 10 years or as required*
Reactive Maintenance	***Frequency***
Brush or suction sweep to remove any materials left on surface. *Lift and re-bed blocks where movement has occurred. In case of settlement, full reconstruction and compaction of sub-base may be required. Sub-grade should be checked to washout of fines.*	 *As required*

Bio-retention Areas / Raingardens

Regular Maintenance	**Frequency**
Remove debris, litter and weeds	Quarterly
Inspect surface for infiltration, ponding/siltation	Quarterly
Inspect perforated pipe drainage	Annually (after rain)
Maintain planting and replace where required	Annually (during growing season)
Remove sediment	Annually or as required
Reactive Maintenance	**Frequency**
Replace planting and filter medium as required	
Relevel uneven surfaces and reinstate design levels	As required

Green / Blue / Brown Roofs

Regular Maintenance	***Frequency***
Vegetation Management	
Remove debris that includes fallen leaves and litter to prevent clogging of inlet drains and interference with plant growth	*Six monthly and annually or as required*
Remove nuisance and invasive vegetation, including weeds. Mow grasses, prune shrubs and manage other planting as required	*Six monthly or as required*
During establishment (i.e. year one), replace dead plants as required. Post establishment, replace dead plants as required (where >5% of coverage)	*Annually (in autumn)*
Inspections	
Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	*Annually and after severe storms*
Inspect underside of roof for evidence of leakage	
Inspect soil substrate for evidence of erosion channels and identify and sediment sources	
Reactive Maintenance	***Frequency***
If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	*As required*
If drain inlet has settled, cracked or moved, investigate and repair as appropriate	

Pump Installations

Regular Maintenance	**Frequency**
Visual inspection of the unit. Rise and inspection of the pump. Seal chamber oil check. Level control equipment cleaned and tested. Inspection and test of Control Panel functionality. Motor Insulation tested and recorded.	Annually or as agreed with manufacturer to maintain efficient and reliable system in operation
Reactive Maintenance	**Frequency**
Repair / rehabilitation of inlets, outlets, vents and other components	As required or stated by manufacturer

Attenuation Tank

Regular Maintenance	**Frequency**
Remove cover and inspect ensuring water inflow is unobstructed and check for siltation and debris. Remove debris and silt. Undertake inspection after leaf fall in autumn in which silt build up is more likely to occur.	Annually
Review covers and surface for signs of settlement or structural degradation	Annually
Reactive Maintenance	**Frequency**
Replace inspection cover if physical damage has occurred. If siltation is impeding flow and reducing volumne then the tank is to be flushed and cleared with a gully sucker or similar. Visual inspection or CCTV survey of the tank to be carried out where possible.	As required