MWP

Drainage Report to Discharge Condition 10 & Revised Drainage Strategy Report

9 Nestles Avenue, Hayes, London UB3 4SA

OUR REF: 22973

Hillingdon Council – Planning Service

04/07/2022

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Project No.	Doc. No.	Rev.	Date	Prepared By	Checked By	Approved By	Status
22973	22973- Planning Appeal Report	P01	04/07/2022	DH	TM	PL	

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1. Introduction

MWP (Malachy Walsh & Partners) are working with our client Charles Edwards Ltd., to develop the drainage strategy that was proposed during planning, and discharge planning condition 10 that was laid by Hillingdon Council's planning department as part of planning permission.

This is in relation to the development at 9 Nestles Avenue, Hayes. Planning permission (Ref 51175/APP/2020/2543) has been granted to demolish existing buildings and redevelop the land to provide a building up to 11 storeys comprising residential accommodation, associated landscaping, access, car parking and cycle parking. As a result, 103 residential units (2 x studio, 57 x 1-bed, 31 x 2-bed and 13 x 3-bed will be made.

Figure 1.1 shows the location of the site.

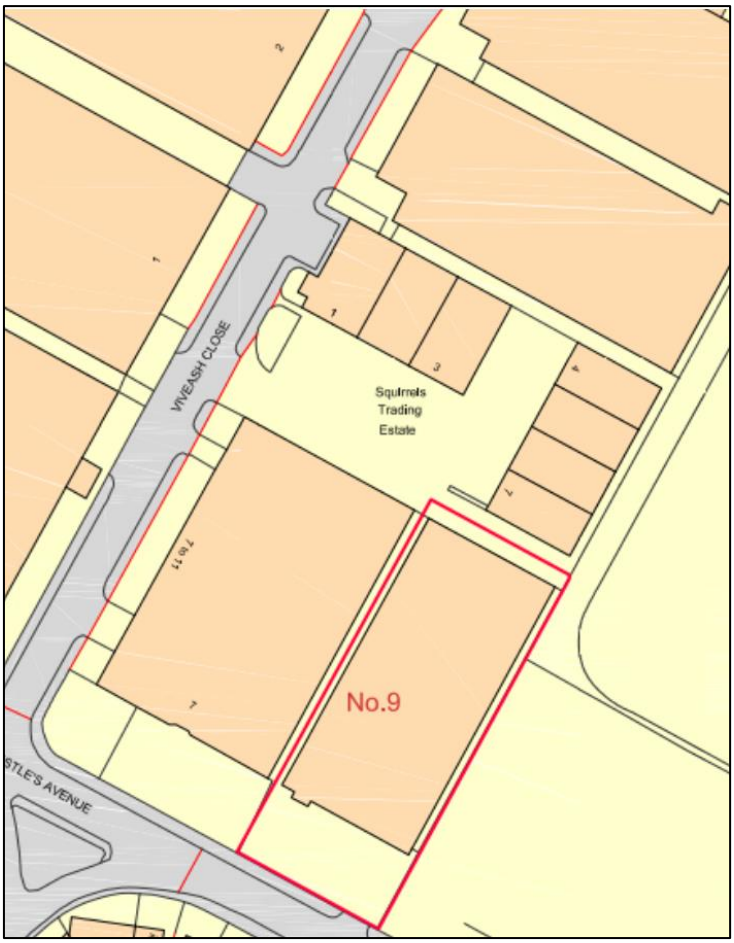


Figure 1.1: Site location

The site is neighbouring Squirrels Trading Estate to the north of the site, a factory site to the north east and Hayes & Harlington station beyond. Number 7 Nestles Avenue neighbours the site immediately to the west, with the Nestle Factory redevelopment to the east and Nestles Avenue to the south.

The existing site has a single commercial building measuring 2 floors in height, as well as a small car parking area at the front. The building covers most of the site area. The building on site has a ground floor level of approximately 31.4m AOD and the car park falls gently from north to south at an approximate gradient of 1:60.

The existing site is considered to be 100% impermeable which will be reduced in the proposed scheme.

See the below ground drainage strategy drawing by MWP included in Appendix A.

The two aims of this report are explained in the sub-sections below.

1.1 Aim 1 - Drainage Strategy Revision

A summary of the changes to the drainage layout by MWP are listed below:

- Exclusion of the proposed rainwater harvesting system
- Increased area for permeable paving
- Inclusion of runoff attenuation from green grassy areas around site
- Amendment of the outflow rate from 1.5 l/s to 3.8 l/s (as previously approved by Thames Water, see Appendix B).
- Thus, a revised volume for the attenuation storage tank from 105m^3 to 67.5m^3
- And the repositioning of the attenuation tank to below the west and east side of the building.

The reasoning for the above will be explained further in this report.

1.2 Aim 2 - Planning Permission

Planning permission (Application Ref: 51175/APP/2020/2543) was granted by Hillingdon Council, along with a set of conditions.

The second aim of this report is to discharge condition 10 which relates to the site's drainage strategy. Condition 10 is stated as follows:

> 10. *(a) Prior to commencement, (excluding demolition and site clearance) the details of a scheme for the provision of sustainable water management shall be submitted to, and approved in writing by the Local Planning Authority. The scheme shall clearly demonstrate how it, manages water in the most sustainable ways and its compliance with the strategy set out in the Flood Risk Assessment produced by Heyne Steel dated 31st July 2020 which sets out the site will: Achieve a run off rate from the site of 1.5l/ha/s Provided through the following SuDs elements: Blue Roof, Permeable Paving and Rain Garden. Any changes to the strategy should be justified and evaluated and the final proposals must be integrated with provision of green infrastructure, air quality and urban greening requirements to justify the most sustainable final solution is provided. Further details should be provided on: Any proposal should use of methods to minimise the use of potable water through*
>
> *i. incorporating water saving measures and equipment.*
>
> *ii. Collecting water for use and recycling*
>
> *iii Blue roof detail and overflow.*
>
> *iv. Levels of the site and Safe access and egress must be demonstrated – any above ground storage and or overland flooding or flows paths should be mapped, (please include depths and velocities and hazards) above the 100, plus climate change.*
>
> *v. Rain Garden design*
>
> *(b) Prior to occupation of the development, a Verification Report demonstrating that the approved drainage/SuDS measures have been fully implemented shall be submitted to the Local Planning Authority for approval in writing. This report must include: As built drawings of the sustainable drainage systems including level information (if appropriate) Photographs of the completed sustainable drainage systems throughout the construction process Any relevant certificates from manufacturers/suppliers of any drainage features A confirmation statement of the above signed by a chartered engineer Management*

and Maintenance Prior to occupation a management and maintenance plan should be submitted to the Local Authority for approval in writing. This should cover the lifetime of the development of arrangements (through temporary works) to secure the operation of the scheme throughout its lifetime. Including appropriate details of Inspection regimes, Appropriate performance specification, Remediation and timescales for the resolving of issues. Where there is overland flooding proposed, the plan should include the appropriate actions to ensure the safety of the users of the site should that be required.

REASON

To ensure that surface water run off is controlled and to ensure the development does not increase in accordance with Policy EM6 Flood Risk Management in Hillingdon Local Plan: Part 1- Strategic Policies (Nov 2012), Policy DMEI 10 of Local Plan Part 2 Development Management Policies (January 2020), National Planning Policy Framework (2021) and Policies SI 12 & SI 13 of the London Plan (2021).

This report focuses on discharging part 10a of planning condition 10, this is because 10b concerns a verification report prior to the occupation of the building to show the implementation of SuDS on site. Therefore, this should be addressed at a later stage of the development.

2. Existing Drainage Strategy

2.1 Public Drainage

The Thames Water asset location map confirms the location of surface and foul water sewers near the site. There are two sewers in Nestles Avenue to the south of the site, a 225mmØ FW sewer and a 450mmØ SW sewer, both running in a west to east direction. Close to the site cover levels are at 31.07 m AOD and Close to the site the sewer cover levels are approximately 31.21m AOD. Invert levels are estimated to be approximately 29.64m AOD for FW and 29.895m AOD for SW – this gives approximate depths of 1.57m and 1.315m respectively to the public sewer pipes.

Overall the surface water sewers are very shallow and are run at shallow gradients due to relatively small variance in topographical levels, with minimal depth of soil/road cover above the pipes.

2.2 Pre-Development Runoff Rates

Table 1 shows the site's existing runoff rates, with the proposed runoff rate as a comparison. The rainfall intensity calculations have been adopted by Heyne Steel's previous drainage report.

Table 1: Comparison of Existing and Proposed Run-off rates

Return Period	Run-off Rate (l/s)			Reduction
	Rainfall Intensity (15-minute storm)	Existing (unmitigated)	Proposed	
1 in 2	30.16 mm/hr	26.4 l/s	3.8 l/s	85.6%
1 in 30	87.88 mm/hr	76.9 l/s	3.8 l/s	95%
1 in 100	114.36 mm/hr	100 l/s	3.8 l/s	96.2%
1 in 100 +40%	149 mm/hr	130 l/s	3.8 l/s	97%

Table 1 shows that during rainfall, the volume of water that will be discharged post-development from the site would be considerably less than the current runoff rate. This complies with Ciria C753 and The London Plan as it reduces the rate of discharge of water into the local sewers/rivers thus reducing the risk of flooding further downstream.

3. MWP Proposed Drainage Strategy

MWP has proposed a drainage strategy for the drainage of stormwater at 9 Nestles Avenue - see the below ground drainage drawing included in Appendix A.

Causeway Flow+ drainage modelling software was used to simulate the drainage infrastructure, see the full report from the software included in Appendix E.

3.1 Greenfield Runoff Rate

HR Wallingford's online Greenfield Runoff Rate Estimation Tool was used to verify the greenfield runoff rate. See the full greenfield runoff rate estimation report performed by MWP included in Appendix C.

Table 2 shows the greenfield runoff rates for 9 Nestles Avenue.

Table 2: Greenfield Runoff Rate (HR Wallingford Estimation Tool)

Q_{BAR}	0.37 l/s
1 in 1 year	0.31 l/s
1 in 30 year	0.84 l/s
1 in 100 year	1.37 l/s

As the Q_{BAR} is less than 2.0, HR Wallingford recommends that the outfall rate post-development should be higher than 2.0 l/s/ha.

Thames Water corresponded on the outflow rate into their public sewer system, they have accepted 3.8l/s as a reasonable rate of outflow, for this reason, MWP has used 3.8 l/s as an outflow rate. See the letter by Thames Water included in Appendix B.

3.2 SuDS Assessment

A hierarchy that lists the most to least preferred solutions for surface water runoff management is included in The London Plan. Table 3 shows the hierarchy and explains the reasons for feasibility/non-feasibility for the proposed drainage at the proposed building at 9 Nestles Avenue.

Table 3: Surface Water Discharge Hierarchy (The London Plan and Hillingdon Councils SuDS Proforma)

SuDS Techniques		Feasibility	Explanation
1	Store water for later use.	✓	A blue roof will be designed for storage of approximately 36m^3 of rainwater on the 11th terrace
2	Use infiltration techniques, such as porous surfaces in non-clay areas.	✓	There is insufficient space around the site for soakaways to be a feasible option, but the development does propose a rain garden at the front of the site. Furthermore, the site boundary will have planters.
3	Attenuate rainwater in ponds or open water features for gradual release.	✓	There is insufficient space to provide ponds for the entire site, but a rain garden at the frontage of the site will provide some open water features.
4	Discharge rainwater direct to a watercourse.	✗	There are no viable watercourses to discharge to near the site.
5	Discharge rainwater to a surface water sewer/drain.	✓	There is a surface water sewer in the vicinity of the site. This will be used to discharge runoff from the site.

6	Discharge rainwater to the combined sewer.	×	N/A as there already is a separate drainage system nearby.

From Table 3 we can infer that we can use a variety of methods to manage the surface water runoff. The following sections explain how the SuDS techniques will be implemented at 9 Nestles Avenue.

3.3 Blue Roof

A blue roof has been proposed for the 11th floor terrace, ABG Limited have designed a blue roof – see the proposed design, and calculations by ABG included in Appendix G.

3.4 Green Roof

Green roofs have been proposed for the 9th, 6th and 4th floors, they will also provide communal space for the residents.

The attenuation volume from the green roof and green grassy areas around the site is approximately 486m^2 in area. Assuming that 5mm of water can infiltrate/attenuate on these green areas, we can assume that 2.43m^3 of runoff will be attenuated on the green roof/grassy areas.

3.5 Permeable Paving

Permeable paving with an area of 341m^2 (providing 20m^3 of attenuation) was proposed by Heyne Steel's drainage strategy. MWP has increased the area of permeable paving to 416m^2, providing approximately 24.26m^3 of storage. This calculation is based on a typical permeable paving depth of 0.195m with a 30% sub-base void ratio.

Furthermore, in the event of a surcharge where the drainage infrastructure is overwhelmed, runoff can attenuate on the surface of the paving around the site.

3.6 Attenuation Storage

3.6.1 Attenuation Tank Size

As the discharge rate from the site has increased, the volume required to store runoff on-site can be reduced. This is essential as if the tank is kept as 105m^3 as previously proposed, then it would be difficult to position a shallow tank on-site due to space constraints. Previously it was proposed to position the tank below the car park however this would be an issue as the pile/pile caps cross this location.

MWP used the FSR/Wallingford Procedure to estimate the size of the underground attenuation tank.

Assuming 100% impermeability around the site, an area of 2330m^2 was used in the calculation. A 40% increase for climate change was added and we found that a volume of 130m^3 would be required.

The blue roof, green roof, green grassy areas and permeable paving around the site can attenuate a combined 62.69m^3 of runoff during a rainfall event, therefore these volumes were subtracted from the total to provide a tank size of 67.62m^3. Note that the tank capacity on our drawing is 67.45m^3 assuming 95% capacity.

We believe that 67.45m^3 of underground attenuation storage for surface water runoff would be sufficient for the site.

As a verification check for the attenuation tank sizing, we used HR Wallingford's Storage Estimation Tool to estimate the required tank size, this method recommends a tank size of 137m^3 which is close to our total attenuation estimation – see full report included in Appendix D.

3.6.2 Attenuation Tank Location

MWP has proposed that the location of the tank is split into two tanks and relocated to the east and west sides of the building. There are two main reasons for this proposal

1) To allow the below-ground drainage pipes on-site to have a sufficient fall. Positioning the tank below the sides of the property would reduce the length of the longest run on-site – therefore allowing a deeper cover level and reducing the risk of flooding on the surface.

2) To avoid below-ground collisions with tree roots on the frontage of the property, and piles/pile caps under the building.

Our strategy uses shallow attenuation crates that are 500mm in depth, this allows more flexibility allowing sufficient falls to be designed as well as reducing the area required on-site for crates.

4. Rainwater Harvesting

Initially, it was proposed to incorporate rainwater harvesting into the drainage strategy. The previously proposed rainwater harvesting system would collect runoff from the 11th terrace and channel the water to a rainwater harvesting tank located in the basement. This water would then be pumped to the other terraces for the green roof's irrigation or used for non-potable uses in the building.

Following our assessment and as per our design calculations, using a site discharge rate of 3.8l/s, it is possible to remove the harvesting system from the drainage strategy.

In our opinion, we should not have a harvesting system due to the following reasons:

- It would require a large water storage tank, a filtering system, a pump, and an additional water pipe scheme will need to be installed – this system would greatly increase the complexity of the project. This increases costs as well as the requirements of electricity for pumps – ultimately increasing the carbon footprint of the building.
- If the rainwater storage tank gets to a lower water level, it will need to be filled in with water from the mains water, in the event of the storage tank being at full capacity and there's a rain discharge from the roofs, the rainwater will be released from the rainwater storage tank to the attenuation tank – deeming the rainwater storage tank useless at attenuating rainwater runoff.
- A harvesting system that includes a filtering system and the pump would significantly increase the maintenance tasks involved in keeping the system working.
- With time (15/20 years), those maintenance services will require some sort of replacement of mechanical parts and chances are that the selected system will be then out of date and with no parts available anymore, leading to a complete replacement of the filters or pumps.

Overall, rainwater harvesting systems at 9 Nestles Avenue would increase the complexity of the project and may include a risk of failure – which could pose a flood risk. It would also increase the operation and maintenance requirements from the building management, and if this isn't done properly then the efficiency of the drainage strategy may be affected. Installing pumps to pump rainwater from the basement to the terraces would increase the use of electricity on-site – which would increase the carbon footprint of the building.

4.1 Causeway Flow+ Analysis

MWP used Causeway Flow+ drainage modelling software to simulate the above drainage strategy in different intensity storm events – see Appendix E for the full report. The software used FEH data, obtained from the HR Wallingford website.

From the results shown in Appendix E, we can determine that the proposed drainage infrastructure will be able to withstand each of the inputted flood events: 1 in 1-year storm, 1 in a 30-year storm (plus 40% CC), 1 in 100-year storm event (with 40% CC).

For the 1 in 100-year event (with 40% CC), the critical storm event results show that flooding will occur at some nodes, for example, the results show that SWIC 2 will surcharge by 1.8783m^3. In our professional opinion, we believe that this small volume of runoff would be able to attenuate in the green roof, green garden area at the frontage of the building, or temporarily pond of the surface before entering the drainage system.

It must be noted that although the discharge rate of surface water has increased it does not necessarily mean that 3.8 l/s of runoff will be discharged during a storm. A lower intensity/duration storm will discharge less than 3.8 l/s. therefore the maximum discharge rate of 3.8 l/s will only be reached during the long duration and/or intense storm events.

4.2 Operation and Maintenance of SuDS Infrastructure

The responsibility of the drainage and SuDS infrastructure will be handed over to the property owners/building management once construction is completed. Operation and maintenance tasks must be carried out as per the recommendations as this will ensure the effectiveness of the components.

As a guide, MWP has compiled a set of general operation and maintenance tasks extracted from Ciria C753 – see Appendix F for information. It must be noted that this compilation is for general operation and maintenance, for more detailed information the manufacturer's manuals must be read.

5. Conclusion

In conclusion, this report has expressed how and why we believe that the previously submitted drainage strategy should be revised to the new strategy. A variety of SuDS techniques have been explored and the most feasible and suitable options for 9 Nestles Avenue have been selected.

- The entire site has been considered 100% impermeable however in reality there will be permeable areas on-site with grass and trees planted, as well as green roofs on 3 of the building's terraces.
- MWP has proposed the elimination of the rainwater harvesting system due to the blue roof already designed. Furthermore, there was a concern as to whether rainwater harvesting systems could be utilized if the blue roof attenuates most of the rainwater at the source. We also identified operation and maintenance issues that may not be addressed in the future.
- The area of permeable paving around the site has been increased to attenuate a greater volume of runoff from the source.
- The rate of discharge has been increased to 3.8l/s – this helps reduce the size of the attenuation tank which reduces the quantity of materials needed for attenuation crates.
- The previously proposed attenuation tank volume was 105m^3 and has been reduced to 67.45m^3.
- The location of the below-ground attenuation tank has been split and moved to the east and west of the site, this is to reduce the risk of collision with piles/pile caps.
- Causeway Flow+ modelling software has been used to simulate various storm events (up to a 1 in 100 years +40% CC event) to support the proposed drainage strategy (see Appendix E for report).
- Typical operation and maintenance schedules explained and considered - specific device maintenance methods must be provided by the manufacturing company.

To reduce the volume of water usage in the building, we propose that water-reducing cisterns would be installed in toilets, as well as water-reducing shower heads/taps. This would reduce the volume required for water supply ultimately improving the carbon footprint of the building. In addition, it would reduce the usage of the foul discharge, consequently, reducing the risk of the foul water infrastructure surcharging on-site or downstream.

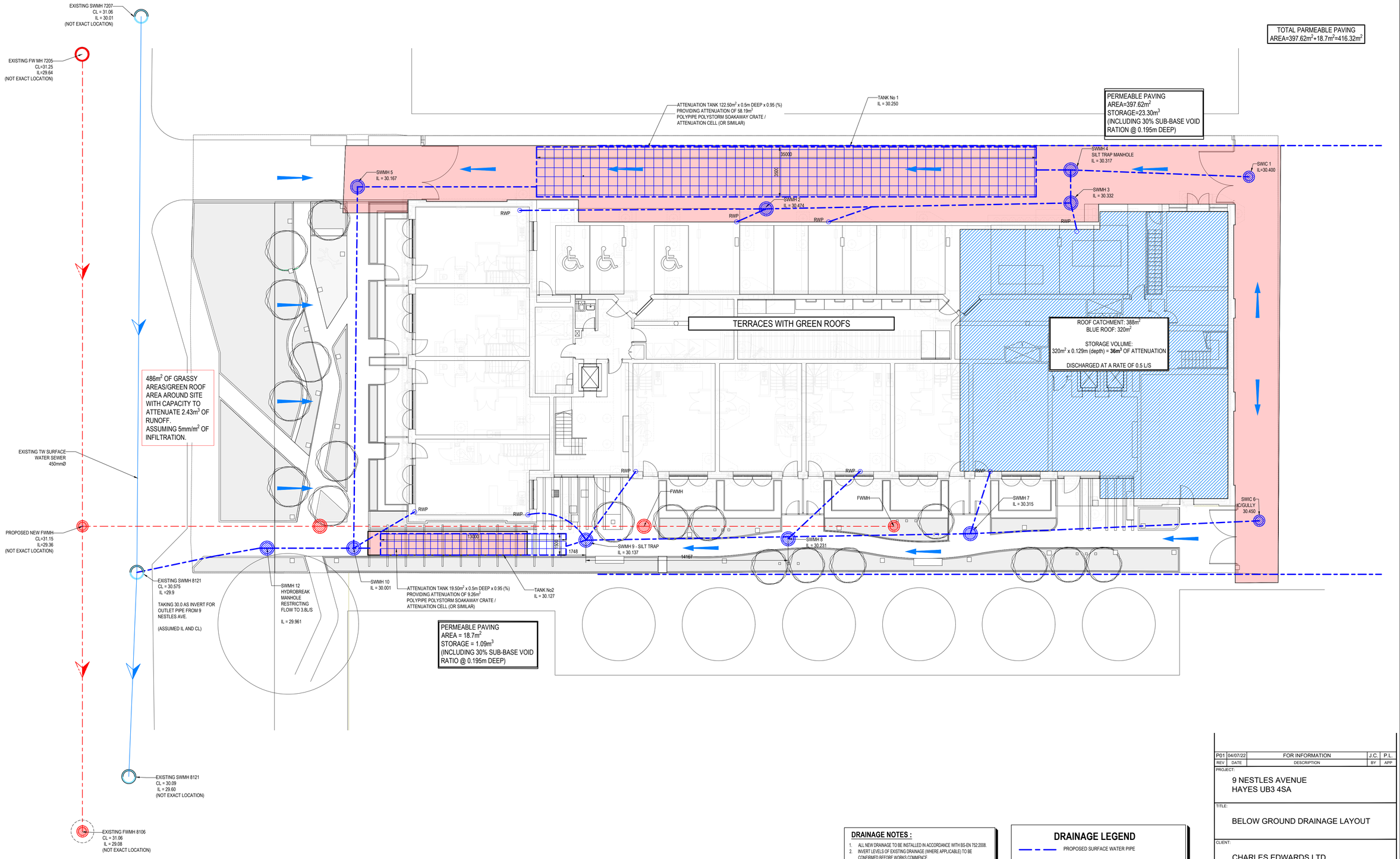
In our professional opinion, we believe that the revised drainage strategy as per the drawing included in Appendix A is the most efficient, effective and feasible method for dealing with the surface water on site. We believe that this method is better than the previously submitted drainage strategy as we have increased the area of permeable paving around the site and reduced the volume of below-ground attenuation needed.

A rainwater harvesting system would not be ideal for this project as it would require tanks/pumps and an increase in operation and maintenance tasks. Also, it may not be viable as we have already designed for a blue roof on the 11th terrace.

For the reasons outlined in this report, we believe that planning condition 10a should be discharged.

Appendix A

MWP – Below Ground Drainage Layout



1. ALL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS, BILLS OF QUANTITIES,ARCHITECTURAL, SERVICES AND ENGINEERING DRAWINGS.
2. ANY DISCREPENCIES BETWEEN THESE DOCUMENTS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
3. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS NOTED OTHERWISE. (TBC ON SITE)
4. ALL LEVELS ARE IN METRES RELATED TO ORDNANCE DATUM. (TBC ON SITE)
5. DRAWINGS ARE NOT TO BE SCALED.
6. CONTRACTOR TO APPROVE ALL SET OUT INFORMATION PRIOR TO CONSTRUCTION.

DRAINAGE NOTES :

1. ALL NEW DRAINAGE TO BE INSTALLED IN ACCORDANCE WITH BS-EN 752.2008.
2. INVERT LEVELS OF EXISTING DRAINAGE (WHERE APPLICABLE) TO BE CONFIRMED BEFORE WORKS COMMENCE.
3. ALLOW FOR CARRYING OUT CCTV SURVEY AFTER WORKS ARE COMPLETE TO VERIFY DRAINAGE SYSTEM. CARRY OUT AIR TEST ON ALL RUNS BETWEEN ACCESS CHAMBERS/MANHOLES.
4. ANY DISCREPANCIES TO BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
5. REFER TO DRAWING 22335 - 2401 FOR TYPICAL MANHOLE DETAILS.
6. ALL FOUL WATER PIPES TO BE 100mm DIAMETER AT 1:60 FALLS U.N.O.
7. ALL SURFACE WATER PIPES TO BE 150mm DIAMETER AT 1:100 FALLS U.N.O.
9. ALL PIPES TO HAVE RODDING EYE'S @ DROP LOCATIONS AND PIPE RUN ENDS.
10. MINIMUM COVER TO TOP OF ALL PIPEWORK IN TRAFFICKED AREAS IS 600mm.
11. FOR INTERNAL DRAINAGE LAYOUTS AND INFORMATION REFER TO MEP CONSULTANTS DRAWINGS.
12. INTERNAL BELOW GROUND DRAINAGE TO BE uPVC PIPE AND FITTINGS.
13. ALL MANHOLES TO BE 1000mm DIAMETER (INTERNAL) PRECAST RINGS U.N.O.
14. ALL INSPECTION CHAMBERS TO BE 600mm DIAMETER (INTERNAL) WITH 200mm CONCRETE SURROUND
15. ALL DRAINAGE TO BE UPVC TO ADOPTABLE STANDARDS.
16. EXTERNAL ACO DRAINS TO ARCHITECT / LANDSCAPE ARCHITECT DETAILS.
17. ALL GULLEYS TO BE TRAPPED
18. ALL PIPES THAT GO THROUGH PILE CAPS TO HAVE ROCKER JOISTS AT ENDS, AND PIPES TO BE SLEEVED WITHIN CAPS. ALTERNATIVELY STEEL PIPES CAN BE USED WITH ROCKER JOISTS AT ENDS.
19. ALL SVP/RWP LOCATIONS TO BE DETERMINED BY THE ARCHITECT
20. ALL BEDDING AND BACKFILLING IN ACCORDANCE WITH TECHNICAL GUIDANCE DOCUMENT H.

DRAINAGE LEGEND

- PROPOSED SURFACE WATER PIPE
- PROPOSED FOUL WATER PIPE
- THAMES WATER SURFACE/FOUL WATER SEWER MANHOLES
- PROPOSED 1m DIA. FOUL/SURFACE WATER MANHOLES ACCESS COVER TO BE 600x600 WITH DOUBLE SEALED RECESSED MANHOLE COVER
- PROPOSED 0.6m DIA. FOUL/SURFACE INSPECTION CHAMBERS. ACCESS COVER TO BE 450x450 WITH DOUBLE SEALED RECESSED MANHOLE COVER
- ACO CHANNEL TO LANDSCAPE ARCHITECTS DETAILS
- RWP RAIN WATER PIPE
- SVP SOIL VENT PIPE
- OVERLAND FLOW ROUTE
- PERMEABLE PAVING

REV	DATE	DESCRIPTION	BY	APP
P01	04/07/22	FOR INFORMATION	J.C.	P.L.

PROJECT:
9 NESTLES AVENUE
HAYES UB3 4SA

TITLE:
BELOW GROUND DRAINAGE LAYOUT

CLIENT:
CHARLES EDWARDS LTD

MWP
ENGINEERING AND ENVIRONMENTAL CONSULTANTS
CORK | TRALEE | LONDON | LIMERICK
mwp.ie

DRAWN:	CHECKED:	APPROVED:
J.C.	D.H.	P.L.
PROJECT NUMBER:	DATE:	SCALE @ A1:
22973	04/07/22	1:100
STATUS DESCRIPTION:		STATUS:
FOR INFORMATION		S2
DRAWING NUMBER:		REV:
00000 - MWP -XX-ZZ-DR-S-2000		P01

Appendix B

Thames Water Surface Discharge Approval Letter

Mr A McNaughton
Mecserve
83 Blackfriars rd
London SE1 8HA

Our ref: DS6076132

0800 009 3921
Monday to Friday, 8am to 5pm

29th July 2020

Pre-planning enquiry: Wastewater Capacity check

Dear Mr McNaughton

Thank you for providing details of your development with the Pre-Planning application dated 23rd July 20 for development @ 9 Nestles Avenue UB3 4SA

Existing brownfld site ,developed to { 103 Flats } as per your above application.

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 sewerage capacity within the existing Thames Water sewer network, in liaison with TW Asset Planners.

Foul

If your proposals progress in line with the details you've provided as above, we're pleased to confirm that there will be sufficient sewerage capacity in the nearest TW foul sewer network to serve your foul discharges from your development, provided it is by gravity.

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.

You'll need to 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 capacity and has to be investigated again.

Surface Water
When developing a 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.

In accordance with the Building Act 2000 Clause H3.3, positive connection of surface water 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. Before we can consider your surface water needs, you'll need written approval from the lead local flood authority that you have followed the sequential approach to the disposal of surface water and considered all practical means.

The disposal hierarchy being:

1. store rainwater for later use.
2. use infiltration techniques where possible.
3. attenuate rainwater in ponds or open water features for gradual release.
4. attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. discharge rainwater direct to a watercourse.
6. discharge rainwater to a surface water sewer/drain.
7. discharge rainwater to the combined sewer.
8. discharge rainwater to the foul sewer

Approval for 3.8l/s discharge into Thames Water Sewer

Where connection to the public sewerage network is still required to manage surface water flows we will accept these flows at a discharge rate in line with ***CIRIA's best practice guide on SuDS or that stated within the sites planning approval.***

If the above surface water hierarchy has been followed and if the flows are restricted to a total of 3.8 l/s to TW surface water sewer network, then Thames Water would not have any objections to the proposal. We have noted that the impermeable area of this site is only 0.224 HA ;

Please see the attached 'Planning your wastewater' leaflet for additional information. At the appropriate time, you will have to apply for a S106 connection application to DS Connection team

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.

What happens next?

Please make sure you submit your connection application, when you are ready, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me.

Yours sincerely

Siva Sivarajan

Developer Services- Wastewater Adoptions Engineer
Office:0203 577 7752 Mobile: 07747842608
siva.sivarajan@thameswater.co.uk

Thames Water Utilities Ltd, Clearwater Court, Vastern Road, Reading, Berkshire, RG1 8DB
Find us online at developers.thameswater.co.uk

TW Int ref : DTS 59072

Planning your wastewater

We've put together some information on sewerage to help you plan your new development.

How long does it take to get consent to connect to a sewer?

If you're applying for consent to connect to a sewer under Section 106 of the Water Industry Act 1991, you'll need to give us 21 days' notice.

I think I'll need to connect to a trunk sewer – is that possible?

Connecting directly to trunk sewers can be complex and dangerous, and we won't permit this at all in London. If you're considering a trunk sewer as a point of connection, please contact us as soon as possible to discuss.

How do I handle trade effluent and groundwater discharges?

You mustn't discharge non-domestic waste to our sewers without a valid trade effluent consent - doing this is an offence under Section 109(1) of the Water Industry Act 1991. You can call our trade effluent team on 0203 577 9200 to get help with trade effluent consents and ground water discharge permits.

Where can I discharge surface water?

The Lead Local Flood Authority, or if you are in a London Borough, 'The London Plan', advises that your development should utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. You should aim to achieve greenfield run-off rates and ensure you manage surface water run-off as close to its source as possible in line with the following drainage hierarchy:

1. Store rainwater for later use.
2. Use infiltration techniques, such as porous surfaces in non-clay areas.
3. Attenuate rainwater in ponds or open water features for gradual release.
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. Discharge rainwater direct to a watercourse.
6. Discharge rainwater to a surface water sewer or drain.
7. Discharge rainwater to a combined sewer.

Please note that if you're discharging surface water anywhere other than to a public sewer – such as to a watercourse – you'll need approval from the relevant authority, for example the Environment Agency, the local authority or the Canals and Rivers Trust.

If you don't follow the surface water hierarchy you may not be granted planning permission, and Thames Water may seek to put conditions on the planning application.

There's no right of discharge of highway drainage into the public sewerage system, and we'd need to agree this with the relevant highway authority under Section 115 of the Water Industry Act 1991. You can contact us to discuss this further.

What can I do about redundant sewers and rising mains on my site?

On brownfield sites where existing sewers or rising mains need to be made redundant or diverted, the developer will need to fund the work, as set out in Section 185 of the Water Industry Act. If there's no practical way of making a diversion, we'll apply the standoff distances in Sewers for Adoption 7th edition to assess the width of easement required.

Planning your wastewater

We've put together some information on sewerage to help you plan your new development.

How long does it take to get consent to connect to a sewer?

If you're applying for consent to connect to a sewer under Section 106 of the Water Industry Act 1991, you'll need to give us 21 days' notice.

I think I'll need to connect to a trunk sewer – is that possible?

Connecting directly to trunk sewers can be complex and dangerous, and we won't permit this at all in London. If you're considering a trunk sewer as a point of connection, please contact us as soon as possible to discuss.

How do I handle trade effluent and groundwater discharges?

You mustn't discharge non-domestic waste to our sewers without a valid trade effluent consent - doing this is an offence under Section 109(1) of the Water Industry Act 1991. You can call our trade effluent team on 0203 577 9200 to get help with trade effluent consents and ground water discharge permits.

Where can I discharge surface water?

The Lead Local Flood Authority, or if you are in a London Borough, 'The London Plan', advises that your development should utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. You should aim to achieve greenfield run-off rates and ensure you manage surface water run-off as close to its source as possible in line with the following drainage hierarchy:

1. Store rainwater for later use.
2. Use infiltration techniques, such as porous surfaces in non-clay areas.
3. Attenuate rainwater in ponds or open water features for gradual release.
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. Discharge rainwater direct to a watercourse.
6. Discharge rainwater to a surface water sewer or drain.
7. Discharge rainwater to a combined sewer.

Please note that if you're discharging surface water anywhere other than to a public sewer – such as to a watercourse – you'll need approval from the relevant authority, for example the Environment Agency, the local authority or the Canals and Rivers Trust.

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There's no right of discharge of highway drainage into the public sewerage system, and we'd need to agree this with the relevant highway authority under Section 115 of the Water Industry Act 1991. You can contact us to discuss this further.

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Appendix C

Greenfield Runoff Rate Estimation (HR Wallingford)

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Dillan Halai
Site name:	9 Nestles Avenue
Site location:	Hillingdon

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:	51.50135° N
Longitude:	0.41878° W
Reference:	3648922208
Date:	May 30 2022 15:04

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.233

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics	Default	Edited
SAAR (mm):	616	616
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):	0.37	0.37
1 in 1 year (l/s):	0.31	0.31
1 in 30 years (l/s):	0.84	0.84
1 in 100 year (l/s):	1.17	1.17
1 in 200 years (l/s):	1.37	1.37

Appendix D

Attenuation Storage Estimation

MWP

9 Nestles Ave

Project No.	22973
Date	Jul-22
Design By	DH
Checked By	PL
Calc Pg No.	1

RAINFALL & STORAGE VOLUME CALCULATION

FSR/Wallingford Procedure

M5-60 (mm)	20
r (Ratio)	0.4
Site area (m2)	2330
Impermeable area (m2)	2330
Outfall capacity (L/sec)	3.8
Increase for Climate Change	1.4

Storage Volume Calculation

M1-D (1-year event)	92.84	m3
M30-D (30-year event)	92.84	m3
M100-D (100-year event)	130.31	m3

Blue Roof Attenuation	36	m3
Permeable Paving Attenuation	24.26	m3
Green Grassy areas (assumed 5mm/m2 of attenuatuation)	2.43	m3
Tank size required - **Volume**	67.62	m3
Area of tank size required (assuming 95% capacity and 0.5m depth) - **Area**	142.36	m2

M5-D (5-year event)

Duration, D (mins)	M5-60 (mm)	Z1	M5-D (mm)
1			
2			
5	20	0.38	7.6
10	20	0.53	10.6
15	20	0.64	12.8
30	20	0.81	16.2
60	20	1.00	20.0
120	20	1.20	24.0
240	20	1.42	28.4
360	20	1.57	31.4
720	20	1.74	34.8
1440	20	2.16	43.2
2880	20	2.50	50.0

Z2 growth factor

M5 rainfall (mm)	M1	M20	M30 (int)		M50	M100
1						
2						
5	0.62	1.36	1.4267		1.56	1.79
10	0.61	1.41	1.4900		1.65	1.91
15	0.62	1.44	1.5267		1.70	1.99
20	0.64	1.45	1.5433		1.73	2.03
25	0.66	1.44	1.5333		1.72	2.01
30	0.68	1.42	1.5133		1.70	1.97
40	0.7	1.38	1.4667		1.64	1.89
50	0.72	1.34	1.4200		1.58	1.81
75	0.76	1.28	1.3433		1.47	1.64
100	0.78	1.25	1.3000		1.40	1.54
150		1.21	1.2500		1.33	1.45
200		1.19	1.2267		1.30	1.40

MWP

Project No	22973	
Calc Pg No.		2

M1-D (1-year event)

Duration (mins)	M5-D (mm)	Z2	M1-D (mm)	With Global Warming
1				
2				
5	7.6	0.61	4.7	6.5
10	10.6	1.49	15.8	22.2
15	12.8	1.51	19.3	27.1
30	16.2	1.53	24.8	34.7
60	20.0	1.54	30.9	43.2
120	24.0	1.54	36.8	51.6
240	28.4	1.52	43.2	60.4
360	31.4	1.51	47.3	66.2
720	34.8	1.49	51.9	72.6
1440	43.2	1.45	62.7	87.8
2880	50.0	1.42	71.0	99.4

M1-D (1-year event) - Storage Volume Calculation

Duration (minutes)	Duration (seconds)	Rainfall Total (mm)	Rainfall Rate (mm/h)	Qin (m3)	Equivalent Flow rate l/s	Qout (m3)	Storage Required (m3)
1	60	0.0					
2	120	0.0					
5	300	6.5	78.5	15.2	50.8	1.1	14.1
10	600	22.2	133.1	51.7	86.1	2.3	49.4
15	900	27.1	108.3	63.1	70.1	3.4	59.7
30	1800	34.7	69.4	80.9	44.9	6.8	74.0
60	3600	43.2	43.2	100.7	28.0	13.7	87.0
120	7200	51.6	25.8	120.2	16.7	27.4	92.8
240	14400	60.4	15.1	140.8	9.8	54.7	86.1
360	21600	66.2	11.0	154.3	7.1	82.1	72.3
720	43200	72.6	6.1	169.2	3.9	164.2	5.1
1440	86400	87.8	3.7	204.6	2.4	328.3	-
2880	172800	99.4	2.1	231.6	1.3	656.6	-
						Maximum	**92.84**

MWP

Project No	22973	
Calc Pg No.		3

M30-D (30-year event)

Duration (mins)	M5-D (mm)	Z2	M30-D (mm)	With Global Warming
1				
2				
5	7.6	1.46	11.1	15.5
10	10.6	1.49	15.8	22.2
15	12.8	1.51	19.3	27.1
30	16.2	1.53	24.8	34.7
60	20.0	1.54	30.9	43.2
120	24.0	1.54	36.8	51.6
240	28.4	1.52	43.2	60.4
360	31.4	1.51	47.3	66.2
720	34.8	1.49	51.9	72.6
1440	43.2	1.45	62.7	87.8
2880	50.0	1.42	71.0	99.4

M30-D (30-year event) - Storage Volume Calculation

Duration (minutes)	Duration (seconds)	Rainfall Total (mm)	Rainfall Rate (mm/h)	Qin (m3)	Equivalent Flow rate l/s	Qout (m3)	Storage Required (m3)
1	60	0.0					
2	120	0.0					
5	300	15.5	186.4	36.2	120.6	1.1	35.0
10	600	22.2	133.1	51.7	86.1	2.3	49.4
15	900	27.1	108.3	63.1	70.1	3.4	59.7
30	1800	34.7	69.4	80.9	44.9	6.8	74.0
60	3600	43.2	43.2	100.7	28.0	13.7	87.0
120	7200	51.6	25.8	120.2	16.7	27.4	92.8
240	14400	60.4	15.1	140.8	9.8	54.7	86.1
360	21600	66.2	11.0	154.3	7.1	82.1	72.3
720	43200	72.6	6.1	169.2	3.9	164.2	5.1
1440	86400	87.8	3.7	204.6	2.4	328.3	-
2880	172800	99.4	2.1	231.6	1.3	656.6	-
						Maximum	**92.84**

MWP

Project No	22973	
Calc Pg No.		4

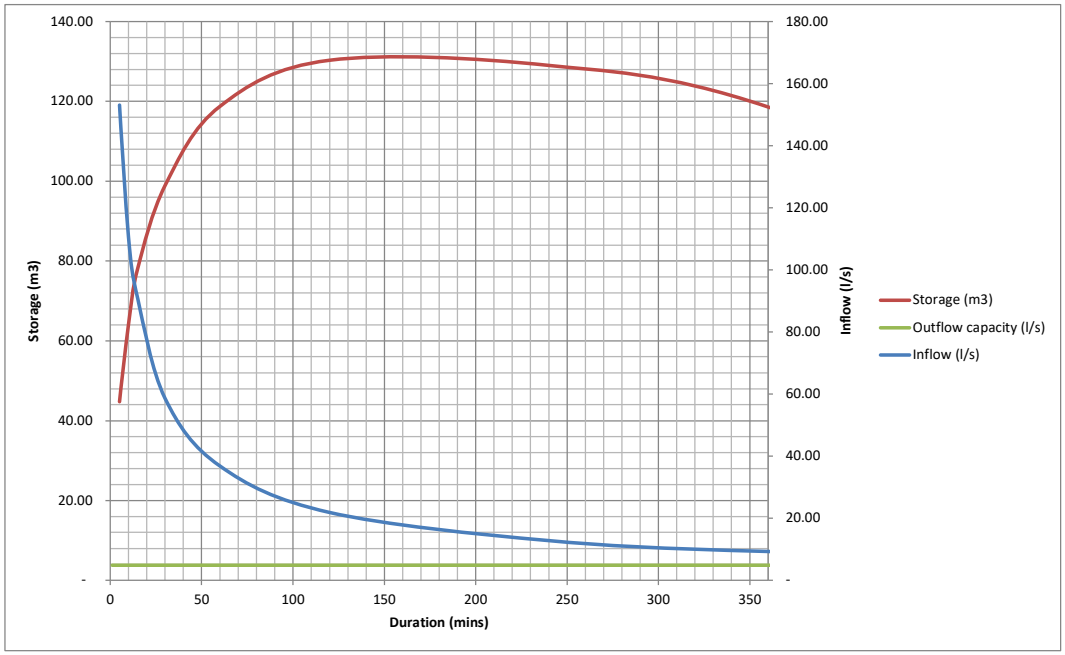
M100-D (100-year event)

Duration (mins)	M5-D (mm)	Z2	M100-D (mm)	**With Global Warming**
1				
2				
5	7.6	1.85	14.1	19.7
10	10.6	1.92	20.3	28.5
15	12.8	1.95	25.0	35.0
30	16.2	2.00	32.4	45.4
60	20.0	2.03	40.6	56.8
120	24.0	2.01	48.3	67.7
240	28.4	1.98	56.3	78.8
360	31.4	1.96	61.5	86.1
720	34.8	1.93	67.2	94.1
1440	43.2	1.86	80.5	112.8
2880	50.0	1.81	90.5	126.7

M100-D (100-year event) - Storage Volume Calculation

Duration (minutes)	Duration (seconds)	Rainfall Total (mm)	Rainfall Rate (mm/h)	Qin (m3)	Equivalent Flow rate l/s	Qout (m3) (Max)	Storage Required (m3)	Outflow rate (l/s) (Max)	Volume of inflow (m3)
1	60	0.0						3.80	-
2	120	0.0						3.80	-
5	300	19.7	236.5	45.9	153.1	1.1	44.8	3.80	45.92
10	600	28.5	170.9	66.4	110.6	2.3	64.1	3.80	66.37
15	900	35.0	140.1	81.6	90.7	3.4	78.2	3.80	81.62
30	1800	45.4	90.7	105.7	58.7	6.8	98.8	3.80	105.67
60	3600	56.8	56.8	132.4	36.8	13.7	118.8	3.80	132.44
120	7200	67.7	33.8	157.7	21.9	27.4	130.3	3.80	157.67
240	14400	78.8	19.7	183.7	12.8	54.7	129.0	3.80	183.69
360	21600	86.1	14.4	200.6	9.3	82.1	118.6	3.80	200.63
720	43200	94.1	7.8	219.3	5.1	164.2	55.1	3.80	219.27
1440	86400	112.8	4.7	262.7	3.0	328.3	0.0	3.80	262.73
2880	172800	126.7	2.6	295.2	1.7	656.6	0.0	3.80	295.21
						Maximum	**130.3**		

Project No	22973
Chart	1



Print | Close Report

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Dillan Halai
Site name:	9 Nestles Avenue
Site location:	Hillingdon

This is an estimation of the storage volume requirements that are needed 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). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	51.50123° N
Longitude:	0.41871° W
Reference:	1010613654
Date:	Jun 29 2022 16:51

Site characteristics

Total site area (ha):	0.233
Significant public open space (ha):	0
Area positively drained (ha):	0.233
Impermeable area (ha):	0.233
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.23
Net impermable area for storage volume design (ha):	0.23
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.4
Urban creep allowance factor:	1.0
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	3.8

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	97.79
FEH / FSR conversion factor:	1.27	1.27
SAAR (mm):	616	616
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.37	0.37
Q_{BAR} for net site area (l/s):	0.37	0.37

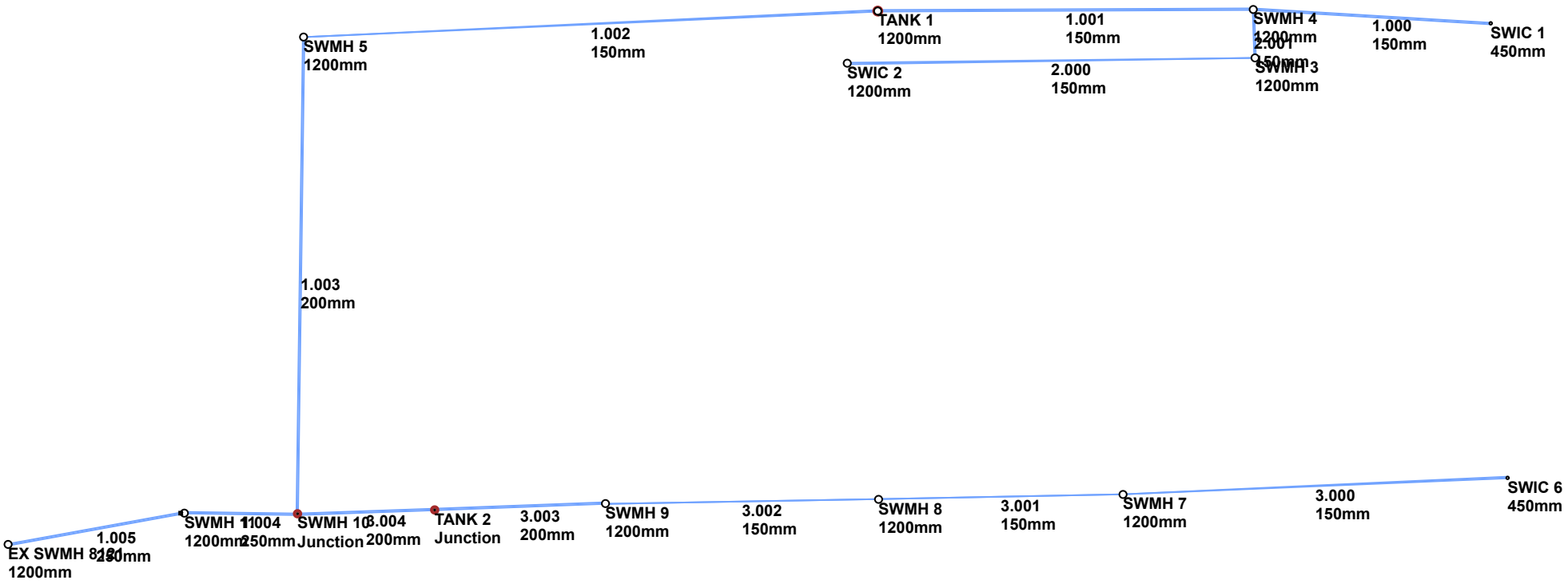
Site discharge rates	Default	Edited
1 in 1 year (l/s):	3.8	3.8
1 in 30 years (l/s):	3.8	3.8
1 in 100 year (l/s):	3.8	3.8

Estimated storage volumes	Default	Edited
Attenuation storage 1/100 years (m^3):	137	137
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	137	137

Appendix E

Causeway Flow+ Drainage Strategy Model

MWP	Malachy Walsh & Co. (UK) Ltd	File: 9 Nestles Avenue - Flow Analysis.pfd Network: Storm Network Dillan Halai 04/07/2022	Page 1



Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Inverts
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	0.500
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWIC 1	0.020	5.00	31.290	450	313.861	65.725	0.650
SWIC 2	0.041	5.00	31.290	1200	208.519	59.147	0.660
SWMH 3	0.018	5.00	31.290	1200	275.279	60.024	0.827
SWMH 4	0.000	5.00	31.290	1200	274.983	68.003	1.036
TANK 1	0.000		31.290	1200	213.510	67.744	1.049
SWMH 5	0.035	5.00	31.290	1200	119.508	63.461	1.124
SWIC 6	0.020	5.00	31.290	450	316.623	-9.221	0.873
SWMH 7	0.017	5.00	31.290	1200	253.665	-11.953	1.007
SWMH 8	0.028	5.00	31.290	1200	213.642	-12.762	1.084
SWMH 9	0.054	5.00	31.290	1200	168.935	-13.456	1.185
TANK 2	0.000		31.290		140.975	-14.506	1.199
SWMH 10	0.000		31.290		118.519	-15.132	1.293
SWMH 11	0.000	5.00	31.290	1200	99.990	-15.033	1.327
EX SWMH 8121	0.000		31.290	1200	71.136	-20.189	1.387

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
1.000	SWIC 1	SWMH 4	38.945	0.600	30.640	30.254	0.386	100.9	150
2.000	SWIC 2	SWMH 3	25.000	0.600	30.630	30.463	0.167	150.0	150
2.001	SWMH 3	SWMH 4	13.100	0.600	30.463	30.376	0.087	150.0	150
1.001	SWMH 4	TANK 1	2.000	0.600	30.254	30.241	0.013	150.0	150
1.002	TANK 1	SWMH 5	11.200	0.600	30.241	30.166	0.075	150.0	150
1.003	SWMH 5	SWMH 10	25.400	0.600	30.166	29.997	0.169	150.0	200
3.000	SWIC 6	SWMH 7	20.100	0.600	30.417	30.283	0.134	150.0	150
3.001	SWMH 7	SWMH 8	11.600	0.600	30.283	30.206	0.077	150.0	150
3.002	SWMH 8	SWMH 9	15.100	0.600	30.206	30.105	0.101	150.0	150

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.000	17.7	2.7	0.500	0.886	0.020	0.0	40	0.724
2.000	0.818	14.5	5.6	0.510	0.677	0.041	0.0	65	0.766
2.001	0.818	14.5	8.0	0.677	0.764	0.059	0.0	79	0.837
1.001	0.818	14.5	10.7	0.886	0.899	0.079	0.0	96	0.895
1.002	0.818	14.5	10.7	0.899	0.974	0.079	0.0	96	0.895
1.003	0.987	31.0	15.4	0.924	1.093	0.114	0.0	100	0.985
3.000	0.818	14.5	2.7	0.723	0.857	0.020	0.0	44	0.630
3.001	0.818	14.5	5.0	0.857	0.934	0.037	0.0	61	0.743
3.002	0.818	14.5	8.8	0.934	1.035	0.065	0.0	85	0.858

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
3.003	SWMH 9	TANK 2	2.100	0.600	30.105	30.091	0.014	150.0	200
3.004	TANK 2	SWMH 10	1.000	0.600	30.091	30.084	0.007	150.0	200
1.004	SWMH 10	SWMH 11	5.102	0.600	29.997	29.963	0.034	150.0	250
1.005	SWMH 11	EX SWMH 8121	9.000	0.600	29.963	29.903	0.060	150.0	250
1.001	SWIC 1	SWMH 3	7.984	0.600	29.963	29.883	0.080	99.8	150

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
3.003	0.987	31.0	16.1	0.985	0.999	0.119	0.0	103	0.998
3.004	0.987	31.0	16.1	0.999	1.006	0.119	0.0	103	0.998
1.004	1.140	56.0	31.6	1.043	1.077	0.233	0.0	134	1.173
1.005	1.140	56.0	31.6	1.077	1.137	0.233	0.0	134	1.173
1.001					1.257				

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	38.945	100.9	150	Circular	31.290	30.640	0.500	31.290	30.254	0.886
2.000	25.000	150.0	150	Circular	31.290	30.630	0.510	31.290	30.463	0.677
2.001	13.100	150.0	150	Circular	31.290	30.463	0.677	31.290	30.376	0.764
1.001	2.000	150.0	150	Circular	31.290	30.254	0.886	31.290	30.241	0.899
1.002	11.200	150.0	150	Circular	31.290	30.241	0.899	31.290	30.166	0.974
1.003	25.400	150.0	200	Circular	31.290	30.166	0.924	31.290	29.997	1.093
3.000	20.100	150.0	150	Circular	31.290	30.417	0.723	31.290	30.283	0.857
3.001	11.600	150.0	150	Circular	31.290	30.283	0.857	31.290	30.206	0.934
3.002	15.100	150.0	150	Circular	31.290	30.206	0.934	31.290	30.105	1.035
3.003	2.100	150.0	200	Circular	31.290	30.105	0.985	31.290	30.091	0.999
3.004	1.000	150.0	200	Circular	31.290	30.091	0.999	31.290	30.084	1.006
1.004	5.102	150.0	250	Circular	31.290	29.997	1.043	31.290	29.963	1.077
1.005	9.000	150.0	250	Circular	31.290	29.963	1.077	31.290	29.903	1.137
1.001	7.984	99.8	150			29.963		31.290	29.883	1.257

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	SWIC 1	450	Manhole	Adoptable	SWMH 4	1200	Manhole	Adoptable
2.000	SWIC 2	1200	Manhole	Adoptable	SWMH 3	1200	Manhole	Adoptable
2.001	SWMH 3	1200	Manhole	Adoptable	SWMH 4	1200	Manhole	Adoptable
1.001	SWMH 4	1200	Manhole	Adoptable	TANK 1	1200	Manhole	Adoptable
1.002	TANK 1	1200	Manhole	Adoptable	SWMH 5	1200	Manhole	Adoptable
1.003	SWMH 5	1200	Manhole	Adoptable	SWMH 10		Junction	
3.000	SWIC 6	450	Manhole	Adoptable	SWMH 7	1200	Manhole	Adoptable
3.001	SWMH 7	1200	Manhole	Adoptable	SWMH 8	1200	Manhole	Adoptable
3.002	SWMH 8	1200	Manhole	Adoptable	SWMH 9	1200	Manhole	Adoptable
3.003	SWMH 9	1200	Manhole	Adoptable	TANK 2		Junction	
3.004	TANK 2		Junction		SWMH 10		Junction	
1.004	SWMH 10		Junction		SWMH 11	1200	Manhole	Adoptable
1.005	SWMH 11	1200	Manhole	Adoptable	EX SWMH 8121	1200	Manhole	Adoptable
1.001					SWMH 3	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	IL (m)	Dia (mm)
SWIC 1	313.861	65.725	31.290	0.650	450	0	30.640	150
SWIC 2	208.519	59.147	31.290	0.660	1200	0	30.630	150
SWMH 3	275.279	60.024	31.290	0.827	1200	1	30.463	150
						0	30.463	150
SWMH 4	274.983	68.003	31.290	1.036	1200	1	30.376	150
						2	30.254	150
						0	30.254	150
TANK 1	213.510	67.744	31.290	1.049	1200	1	30.241	150
						0	30.241	150
SWMH 5	119.508	63.461	31.290	1.124	1200	1	30.166	150
						0	30.166	200
SWIC 6	316.623	-9.221	31.290	0.873	450	0	30.417	150
SWMH 7	253.665	-11.953	31.290	1.007	1200	1	30.283	150
						0	30.283	150
SWMH 8	213.642	-12.762	31.290	1.084	1200	1	30.206	150
						0	30.206	150
SWMH 9	168.935	-13.456	31.290	1.185	1200	1	30.105	150
						0	30.105	200
TANK 2	140.975	-14.506	31.290	1.199		1	30.091	200
						0	30.091	200
SWMH 10	118.519	-15.132	31.290	1.293		1	30.084	200
						2	29.997	200
						0	29.997	250
SWMH 11	99.990	-15.033	31.290	1.327	1200	1	29.963	250
						0	29.963	250

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	IL (m)	Dia (mm)
EX SWMH 8121	71.136	-20.189	31.290	1.387	1200	1 	29.903	250

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	0.0
M5-60 (mm)	20.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	3.8
Summer CV	0.750	30 year (l/s)	3.8
Winter CV	0.840	100 year (l/s)	3.8
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year 360 minute (m³)	38

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	40	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Brownfield	Growth Factor 1 year	0.85
Brownfield Method	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)	0.233	Betterment (%)	0
SAAR (mm)	616	QBar	0.4
Soil Index	2	Q 1 year (l/s)	0.3
SPR	0.30	Q 30 year (l/s)	0.7
Region	6	Q 100 year (l/s)	0.9

Pre-development Discharge Volume

Site Makeup	Brownfield	Return Period (years)	100
Brownfield Method	Greenfield	Climate Change (%)	0
Greenfield Method	FSR/FEH	Storm Duration (mins)	360
Positively Drained Area (ha)	0.233	Betterment (%)	0
Soil Index	2	PR	0.259
SPR	0.30	Runoff Volume (m³)	38
CWI	92.741		

Node SWMH 11 Online Hydro-Brake® Control

Flap Valve	x	Objective	(CL) Minimise blockage risk
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	29.963	Product Number	CTL-SCL-0082-3800-1500-3800
Design Depth (m)	1.500	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.8	Min Node Diameter (mm)	1200

Node TANK 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	30.241
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	122

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	116.3	0.0	0.500	116.3	0.0	0.501	0.0	0.0

Node TANK 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	30.091
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	211

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	19.9	0.0	0.500	19.9	0.0	0.501	0.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 72.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SWIC 1	10	30.680	0.040	2.8	0.0063	0.0000	OK
15 minute winter	SWIC 2	10	30.695	0.065	5.8	0.0734	0.0000	OK
15 minute winter	SWMH 3	10	30.573	0.110	8.2	0.1241	0.0000	OK
15 minute summer	SWMH 4	10	30.545	0.291	11.7	0.3297	0.0000	SURCHARGED
60 minute winter	TANK 1	47	30.294	0.053	5.8	6.1685	0.0000	OK
60 minute winter	SWMH 5	49	30.293	0.127	2.8	0.1441	0.0000	OK
15 minute winter	SWIC 6	10	30.461	0.044	2.8	0.0070	0.0000	OK
15 minute winter	SWMH 7	11	30.344	0.061	5.2	0.0692	0.0000	OK
60 minute winter	SWMH 8	41	30.295	0.089	4.8	0.1011	0.0000	OK
60 minute winter	SWMH 9	49	30.294	0.189	8.8	0.2133	0.0000	OK
60 minute winter	TANK 2	49	30.294	0.203	8.3	4.0301	0.0000	SURCHARGED
60 minute winter	SWMH 10	49	30.294	0.297	6.8	0.0000	0.0000	SURCHARGED
60 minute winter	SWMH 11	49	30.293	0.330	5.5	0.3735	0.0000	SURCHARGED
60 minute winter	EX SWMH 8121	49	29.946	0.043	3.6	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SWIC 1	1.000	SWMH 4	2.7	0.388	0.155	0.4156	
15 minute winter	SWIC 2	2.000	SWMH 3	5.7	0.660	0.392	0.2638	
15 minute winter	SWMH 3	2.001	SWMH 4	9.4	0.812	0.647	0.2057	
15 minute summer	SWMH 4	1.001	TANK 1	15.9	1.516	1.099	0.0189	
30 minute winter	TANK 1	1.002	SWMH 5	2.9	0.452	0.199	0.1143	
30 minute winter	SWMH 5	1.003	SWMH 10	3.1	0.311	0.099	0.6563	
15 minute winter	SWIC 6	3.000	SWMH 7	2.8	0.502	0.191	0.1111	
15 minute winter	SWMH 7	3.001	SWMH 8	5.1	0.584	0.351	0.1011	
15 minute winter	SWMH 8	3.002	SWMH 9	9.0	0.742	0.622	0.1952	
15 minute winter	SWMH 9	3.003	TANK 2	16.1	1.214	0.520	0.0617	
15 minute summer	TANK 2	3.004	SWMH 10	11.0	0.928	0.354	0.0274	
15 minute winter	SWMH 10	1.004	SWMH 11	8.7	0.470	0.155	0.2495	
60 minute winter	SWMH 11	1.005	EX SWMH 8121	3.6	0.630	0.064	0.0513	20.4

Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 72.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SWIC 1	10	30.822	0.182	9.7	0.0289	0.0000	SURCHARGED
15 minute winter	SWIC 2	10	31.290	0.660	19.9	0.7465	0.2357	FLOOD
15 minute winter	SWMH 3	10	31.022	0.559	25.9	0.6325	0.0000	FLOOD RISK
15 minute winter	SWMH 4	9	30.707	0.453	37.4	0.5124	0.0000	SURCHARGED
120 minute winter	TANK 1	104	30.601	0.360	20.3	42.2707	0.0000	SURCHARGED
30 minute winter	SWMH 5	23	30.689	0.523	23.5	0.5916	0.0000	SURCHARGED
15 minute winter	SWIC 6	12	31.074	0.657	9.7	0.1044	0.0000	FLOOD RISK
15 minute winter	SWMH 7	12	31.032	0.749	14.9	0.8476	0.0000	FLOOD RISK
30 minute winter	SWMH 8	22	30.950	0.744	21.1	0.8414	0.0000	SURCHARGED
30 minute winter	SWMH 9	22	30.817	0.712	39.7	0.8055	0.0000	SURCHARGED
30 minute winter	TANK 2	22	30.797	0.706	38.7	9.9600	0.0000	SURCHARGED
30 minute winter	SWMH 10	22	30.792	0.795	30.2	0.0000	0.0000	SURCHARGED
30 minute winter	SWMH 11	22	30.792	0.829	6.3	0.9374	0.0000	SURCHARGED
600 minute summer	EX SWMH 8121	300	29.946	0.043	3.6	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SWIC 1	1.000	SWMH 4	10.8	0.662	0.613	0.6856	
15 minute winter	SWIC 2	2.000	SWMH 3	17.8	1.009	1.228	0.4401	
15 minute winter	SWMH 3	2.001	SWMH 4	26.6	1.509	1.838	0.2306	
15 minute winter	SWMH 4	1.001	TANK 1	38.3	2.760	2.647	0.0352	
30 minute winter	TANK 1	1.002	SWMH 5	-23.1	-1.312	-1.598	0.1972	
30 minute winter	SWMH 5	1.003	SWMH 10	-23.5	-0.749	-0.756	0.7950	
15 minute winter	SWIC 6	3.000	SWMH 7	7.3	0.586	0.508	0.3539	
15 minute winter	SWMH 7	3.001	SWMH 8	13.4	0.762	0.928	0.2042	
15 minute winter	SWMH 8	3.002	SWMH 9	23.7	1.344	1.637	0.2658	
15 minute winter	SWMH 9	3.003	TANK 2	46.8	1.495	1.509	0.0657	
60 minute winter	TANK 2	3.004	SWMH 10	52.1	1.663	1.679	0.0313	
120 minute winter	SWMH 10	1.004	SWMH 11	-19.7	-0.403	-0.352	0.2495	
600 minute summer	SWMH 11	1.005	EX SWMH 8121	3.6	0.631	0.064	0.0514	109.8

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 72.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SWIC 1	9	30.951	0.311	12.6	0.0494	0.0000	SURCHARGED
15 minute winter	SWIC 2	9	31.290	0.660	25.8	0.7465	1.8783	FLOOD
15 minute winter	SWMH 3	9	31.098	0.635	26.9	0.7181	0.0000	FLOOD RISK
15 minute winter	SWMH 4	9	30.768	0.514	40.6	0.5812	0.0000	SURCHARGED
120 minute winter	TANK 1	96	30.713	0.472	30.5	55.4064	0.0000	SURCHARGED
30 minute winter	SWMH 5	22	30.916	0.750	31.7	0.8479	0.0000	SURCHARGED
30 minute winter	SWIC 6	19	31.290	0.873	9.7	0.1388	1.4537	FLOOD
30 minute winter	SWMH 7	19	31.290	1.007	15.3	1.1389	0.5619	FLOOD
30 minute winter	SWMH 8	20	31.282	1.076	26.0	1.2171	0.0000	FLOOD RISK
30 minute winter	SWMH 9	21	31.145	1.040	49.7	1.1757	0.0000	FLOOD RISK
30 minute winter	TANK 2	21	31.111	1.020	156.8	9.9600	0.0000	FLOOD RISK
30 minute winter	SWMH 10	21	31.104	1.107	74.6	0.0000	0.0000	FLOOD RISK
30 minute winter	SWMH 11	21	31.103	1.140	18.2	1.2894	0.0000	FLOOD RISK
120 minute summer	EX SWMH 8121	310	29.946	0.043	3.6	0.0000	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SWIC 1	1.000	SWMH 4	13.2	0.748	0.745	0.6856	
30 minute winter	SWIC 2	2.000	SWMH 3	18.6	1.057	1.287	0.4401	
15 minute winter	SWMH 3	2.001	SWMH 4	27.5	1.563	1.904	0.2306	
15 minute winter	SWMH 4	1.001	TANK 1	41.4	2.943	2.867	0.0352	
15 minute winter	TANK 1	1.002	SWMH 5	-30.9	-1.758	-2.141	0.1972	
15 minute winter	SWMH 5	1.003	SWMH 10	-33.1	-1.059	-1.069	0.7950	
15 minute summer	SWIC 6	3.000	SWMH 7	8.4	0.591	0.584	0.3539	
15 minute summer	SWMH 7	3.001	SWMH 8	15.0	0.854	1.040	0.2042	
15 minute summer	SWMH 8	3.002	SWMH 9	28.2	1.603	1.952	0.2658	
60 minute winter	SWMH 9	3.003	TANK 2	93.1	2.974	3.002	0.0657	
120 minute winter	TANK 2	3.004	SWMH 10	165.5	5.287	5.337	0.0313	
180 minute winter	SWMH 10	1.004	SWMH 11	-79.1	-1.619	-1.414	0.2495	
120 minute summer	SWMH 11	1.005	EX SWMH 8121	3.6	0.631	0.064	0.0514	71.7

Appendix F

Operation and Maintenance of SuDS Components

Operation and Maintenance for Green/Blue Roofs

TABLE 12.5 Operation and maintenance requirements for green roofs

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

Operation and Maintenance for Permeable Paving

TABLE 20.15 Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Operation and Maintenance for Pipes, Manholes & Gully's

Maintenance Schedule	*Action*	*Frequency*
Regular Maintenance	Cleaning of gutters and filters on downpipes and brushing/sweeping of leaves debris that may cause blockages in gulies.	Annually
	Inspect for sediment and debris in pre-treatment components (i.e. catchpits and gully silt traps), and inside manhole rings.	Annually (or as required)
Occasional Maintenance	Remove sediment/debris from pre-treatment components (i.e. catchpits).	As required, based on regular inspections
Remedial Actions	Trimming of roots that may be causing blockages and patch repair of pipework that has cracked or deformed.	As required
	Repair/rehabilitate manhole and gully inlets & outlets.	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in 1st year, then annually
	Check to ensure gullies and manholes are emptying fully.	Annually

Operation and Maintenance for Attenuation Storage Tanks

TABLE 21.3 Operation and maintenance requirements for attenuation storage tanks

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

Operation and Maintenance for Flow Control Devices

SUDS Element	Flow Control Unit	
Maintenance Issues	Failure of components, blockage from debris	
Maintenance Period	Maintenance Task	Frequency
Before Start	Removal of any inappropriate material from within the chambers and dispose off-site	At start
Regular Maintenance	Removal of debris (which could include) leaves, rubbish and branches) from areas served by the drainage (where it may cause risk to performance).	Monthly or as required
Remedial Work	For blockages resulting in flooded manhole chambers, drain down manhole chamber and unblock	As required.
Monitoring	Inspect unit and hose down if required	Monthly at the start for three months, then six monthly

Appendix G

Blue Roof Design (ABG Ltd.)

BLUE ROOF STORAGE AND OUTFLOW SUMMARY

PRIVATE & CONFIDENTIAL - NOT FOR DISTRIBUTION

abg creative geosynthetic engineering

Project Name:	9 Nestles Avenue, Hayes - Blue Roof		
Prepared for:	HTS, London		
Date:	06/08/2020		
ABG Project ID:	21517	Calculator version:	1.27
Prepared by:	Andrew Keer, andrew@abgltd.com, 07525-808700		
Notes/description:	Amenity/pedestrian terrace; potential for freestanding planters - TBC. Pedestrian/amenity access only. Warm/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 10400 78800		

Input Parameters - Roof Information			
Total catchment area:	388	m^2	*As supplied by Client*
Attenuation area:	320	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	12 hours and 50 minutes	0.3
30 mins	16 hours and 20 minutes	0.4
1 hour	19 hours and 20 minutes	0.4
2 hours	22 hours and 40 minutes	0.5
4 hours	25 hours and 10 minutes	0.5
6 hours	25 hours and 40 minutes	0.6
10 hours	25 hours and 10 minutes	0.5
24 hours	19 hours and 50 minutes	0.4
48 hours	10 hours and 0 minutes	0.3

Total attenuation required: 33.9 m^3
Half empty time: 9 hours and 10 minutes.

Output - Recommended Blue Roof System		
System Name:	ABG blueroof VF HD 130mm	
Description:	No.of control positions TBC by design team, and also with the structural engineer's deflection analysis. Additional 'visual'/overflow only, parapet positions, may be utilised by the architect. Any areas of soft landscaping to include locally an additional 25mm deep reservoir board ('ABG Roofdrain 25').	
Total attenuation capacity:	36.1	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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1. DEFINITIONS

'Consultant' means ABG Geosynthetics Ltd and its legal successors. 'Client' means the person, firm, company or organisation for whom the Consultant is performing the Services. 'Agreement' means the contract referred to in Clause 2. 'Services' means the services to be performed by the Consultant in accordance with the proposal from the Consultant. 'Project' means the project or works for which the Client has commissioned the Services.

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.

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

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.

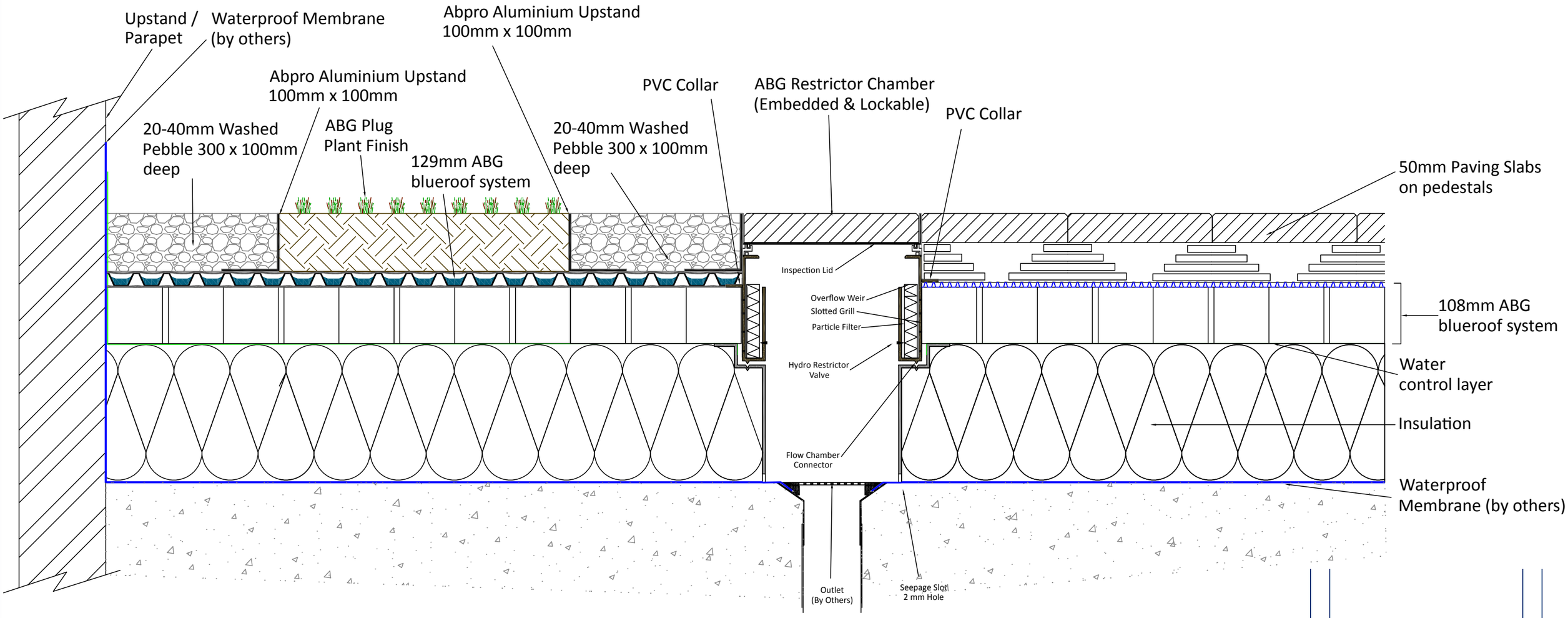
10. DISPUTE RESOLUTION

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.



Rev:	Comments:	By:	Date:

Project: Blue Roof - Inverted

Title: Restrictor Chamber & Green Roof / Paved Details

Drawn by:	Date:	
RH	13/01/20	
Scale: NTS	Drawing Ref: BRST02	Rev: 1.03

abg creative geosynthetic engineering

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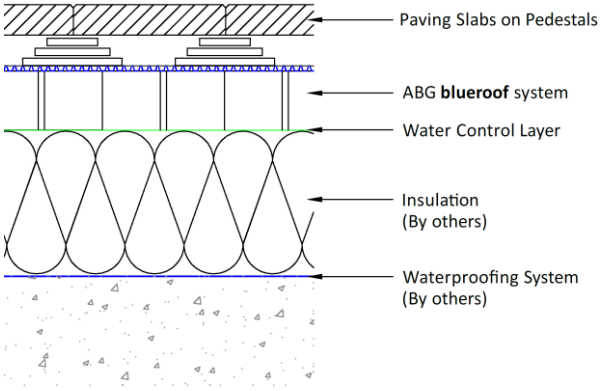
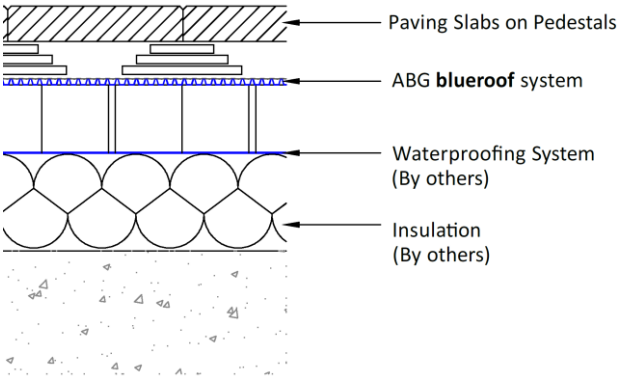
blueroof System Range D

creative geosynthetic engineering



Inverted Roof Construction



Warm Roof Construction

Data Sheet

ABG **blueroof** systems provide a constant drainage path, SuDS attenuation, filtration and controlled release of stormwater, combining all the key elements of a good SuDS design. The storage element of the system must be used in conjunction with the 'blue roof' restrictor chamber. These chambers are bespoke to each project in order to help achieve the project engineer's maximum discharge rates, and to suit the required build-up and final use of the podium/roof area. ABG's 'blue roofs' are generally used for zero falls, inverted/warm roof and podium applications, under a mix of hard and soft landscaped finishes. Other combinations of ABG **blueroof** systems and most surface finishes are available. Please refer to ABG's Technical team for project/system specific advice & 'blue roof' SuDS calculations.

		ABG blueroof VF HD							
System Properties		**58mm**	**80mm**	**108mm**	**130mm**	**158mm**	**180mm**		
Thickness at 2kPa	(mm)	58	80	108	130	158	180	±10%	EN ISO 9863-1
Maximum saturated weight	(kg/m²)	58	80	108	130	158	180	approx.	EN ISO 9864
Stormwater attenuation volume	(l/m^2)	50	65	97	113	145	160		
Growing medium recharge value	(l/m^2)	25	25	25	25	25	25		Per 100mm depth
Drainable void space	%	86	81	90	87	92	89		
Resistance to weathering		Greater than 60% retained tensile strength							EN 12224
Resistance to chemicals		Excellent							EN 14030
Upper Filter/Separator Properties									
Pore size O_{90}	(µm)	120						±30%	EN ISO 12956
Breakthrough head	(mm)	0						nominal	BS 6906 Part 3
CBR puncture resistance	(N)	1 600						-20%	EN ISO 12236
Dynamic perforation cone drop	(mm)	32						+20%	EN ISO 13433
Type and material	Non-woven needle-punched and heat-treated long staple fibre polypropylene Protector: Non-woven felt of polypropylene. Min wt. of 120g/m^2								
'Blue roof' system use & compatible surface finishes									
Suitable for ABG Load Class 2 (Pedestrians, cycles and light vehicles, MUGAs, medium sized plant installations). Landscaped, paved or permeable resin-bound gravel finishes.									

Notes

1. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time.
2. Any additional installations such as plant/services, PV panels, paved areas or additional vehicular/traffic access, must be discussed with ABG prior to their installation/use.
3. 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.
4. Can be used in conjunction with rainwater harvesting & grey water recycling systems. Any petrochemical pollution waste discharged from the system to be treated by others.

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