



Sustainable Drainage System Strategy

Site Address

Land To The Rear of 236 Ashby Road
Hinckley
LE10 1SW

Client

Dale Higgot

Report Reference

FRASW – 2025 – 000005

Prepared By

STM Environmental Consultants Ltd

Date

23/05/2025



**CONSULTING ENVIRONMENTAL
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1 Document Control

 Sustainable Drainage System Strategy 	
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Contents

1	Document Control	2
2	Abbreviations.....	5
3	Disclaimer	6
4	Executive Summary.....	7
5	Introduction.....	9
5.1	Proposed Development.....	9
5.2	Report Aims and Objectives.....	9
5.3	Legislative and Policy Context	9
5.4	Hinckley & Bosworth Borough Council.....	14
6	Site Characteristics	14
6.1	Location and Area	14
6.2	Current Site and Surrounding Uses	15
6.3	Site Topography.....	15
6.4	Geological and Hydrogeological Summary	17
6.5	Hydrological Setting	17
6.6	Site Investigation Summary.....	17
6.7	Flood Risk Summary.....	17
6.8	Existing Surface Water Drainage Features	18
7	Hydrological Run-off Assessment	19
7.1	Existing and Proposed Ground Cover.....	19
7.2	Peak Flow Control.....	20
7.3	Volume Control Requirements	20
7.4	Run-off and Storage Calculations	20
8	SuDS	22
8.1	SuDS Hierarchy	22
8.2	Drainage Hierarchy Discussion	22
8.3	Appraisal of Potential SuDS Options.....	24
8.4	SuDS Strategy	25
8.5	Water Quality Assessment.....	28
8.6	Maintenance and Adoption of SuDS	28
9	Conclusion and Recommendations.....	29
10	References	30
11	Appendices	31
11.1	Appendix 1 – Development Plans & Photos.....	31
11.2	Appendix 2.1– Site Topography and Drainage Characteristics	34

11.3	Appendix 2.2– Drainage Investigation.....	38
11.4	Appendix 3 – Flood Risk Mapping.....	42
11.5	Appendix 4 – Runoff Rate and Storage Calculations	47
11.6	Appendix 5 – Drainage Asset Search	48
11.7	Appendix 6 – Details of Proposed Of SuDS	49
11.8	Appendix 7 - Drainage Modelling	53
11.9	Appendix 8 – SuDS Maintenance Manual.....	56

List of Tables

Table 1: Breakdown of Ground Cover in the Proposed Development	19
Table 2: Summary of Permeable and Impermeable Areas.....	19
Table 3: All Permeable Surfaces	19
Table 4: Modified Rational Method – Discharge rates and volumes for the proposed dwellings	21
Table 5: SuDS Appraisal; Feasibility of various SuDS and the potential uses on site.	24
Table 6: Proposed Bungalow SuDS	25
Table 7: Permeable Driveway	25

List of Figures

Figure 1 Site location map and aerial photo	16
Figure 2 Highways Drainage	18

2 Abbreviations

Abbreviation	Description
STM	STM Environmental Consultants Limited
BGS	British Geological Survey
EA	Environment Agency
OS	Ordnance Survey of Great Britain
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
FWD	Floodline Warning Direct
FRMS	Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
SWMP	Surface Water Management Plan
SFRA	Strategic Flood Risk Assessment
CDA	Critical Drainage Area
SuDS	Sustainable Drainage Systems
GWSPZ	Groundwater Source Protection Zone

3 Disclaimer

This report and any information or advice which it contains, is provided by STM Environmental Consultants Ltd (STM) and is solely for use by Dale Higgot (Client).

STM has exercised such professional skill, care and diligence as may reasonably be expected of a properly qualified and competent consultant when undertaking works of this nature. However, STM gives no warranty, representation or assurance as to the accuracy or completeness of any information, assessments or evaluations presented within this report. STM accepts no liability for the performance of any drainage system based upon the recommendations of this report. Furthermore, STM accepts no liability whatsoever for any loss or damage arising from the interpretation or use of the information contained within this report. Any party using or placing reliance upon any information contained in this report, do so at their own risk.

4 Executive Summary

BACKGROUND			
Location	Land To The Rear of 236 Ashby Road, Hinckley, LE10 1SW Grid reference: 443155, 295830		
Site Area	3,704m ²		
<u>Proposed Development</u>	Construction of 2no. bungalows.		
Current Site and Surrounding Uses	The site is currently a residential property located along Ashby Road, which is formed from a mixture of residential, medical, commercial, leisure and greenspace land uses.		
<u>Topography</u>	The topography decreases from a high of 125.81mAOD, toward Ashby Road, to a low of 124.25mAOD to the very rear of the property with a sharp drop after the tennis court to the middle of the site.		
<u>Hydrology</u>	No statutory main rivers were identified within 250m of the site.		
<u>Geology</u>	BGS information indicates that the superficial deposits at the site consist of Oadby Member (Diamicton) while the bedrock is classified as belonging to the Mercia Mudstone Group (Mudstone).		
<u>Source Protection Zone</u>	The site is not located within a Source Protection Zone.		
<u>Hydrogeology</u>	BGS information indicates that the site is situated upon an Unproductive superficial and a Secondary B bedrock aquifer.		
<u>Permeability</u>	BGS information indicates that the superficial deposits have highly variable permeability and the bedrock is classified as poorly draining.		
<u>Infiltration Potential</u>	BGS information indicates that the site is probably compatible for infiltration SuDS. Onsite infiltration tests were undertaken, the rates ascertained were moderate with a rate of 0.037m/hr (1.05E-05 m/s).		
<u>Fluvial Flood Risk</u>	Low – The site lies within EA Flood Zone 1.		
<u>Surface Water Flood Risk</u>	Very Low - During both the Present Day (2025) and Climate Change (2040 – 2060) modelled scenarios, the site is at 'Very Low' risk of surface water flooding.		
<u>Groundwater Flood Risk</u>	Low – BGS mapping indicates that the groundwater table depth is indicated to be greater than 5mbgl.		
<u>Existing and Proposed Site Layout</u>	Ground Cover	Existing (m²)	Proposed (m²) (Without SuDS)
	Buildings	244	484
	Hard Standing	869	903
	Soft landscaping	2591	2317
	Total Impermeable Area	1113	1387
Changes in Impermeable	Without SuDS, the proposed development would increase the impermeable area of the site and therefore increase the post development runoff rate and volume.		

PROPOSED SUDS	
Drainage Hierarchy	The proposal will discharge all stormwater to ground via infiltration.
Storage	The proposal will introduce a total of 80m ³ of storm water attenuation, when including the permeable gravel driveway.
SuDS Strategy	The Bungalows (Plot 1 and plot 2) will introduce rainwater butts, permeable block paving, rain gardens and geocellular storage. In total, each dwelling will provide 14.1m³ of storm water attenuation. All stormwater will be discharged to ground. No flooding is indicated to be witnessed onsite during the modelled 1 in 100 year plus 40% climate change rainfall event.
Conclusion	With the proposed SuDS mitigation measures, which have been introduced into the scheme, we believe that the proposed development will reduce local flood risk and therefore be in compliance with the LLFA's current planning policy and the NPPF.

5 Introduction

STM Environmental Consultants Limited have been appointed by Dale Higgot to undertake a Sustainable Drainage System (SuDS) Strategy for a proposed development at Land To The Rear of 236 Ashby Road, Hinckley, LE10 1SW.

5.1 Proposed Development

The SuDS report is required to support a planning application for the construction of 2no. bungalows with associated access and carparking. Copies of the development plans are presented in [Appendix 1](#).

5.2 Report Aims and Objectives

This report sets out the proposed drainage strategy that will be employed in the designs to meet the requirements of the planning condition and the National Planning Policy Framework.

5.3 Legislative and Policy Context

5.3.1 Legislative Context

Section H3 of the Building Regulations 2010 requires that adequate provision is made for rainwater to be carried from the building roofs and paved areas, and be preferentially discharged to soakaways or some other adequate infiltration system. Where that is not reasonably practicable, a watercourse; or sewer can be used.

The Flood and Water Management Act was introduced in 2010. The Act defines the role of lead local flood authority (LLFA) for an area. All LLFA are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area, called “local flood risk management strategy”.

Alongside the Act, Flood Risk Regulations (2009) outline the roles and responsibilities of the various authorities, which include preparing Flood Risk Management Plans and identifying how significant flood risks are to be mitigated.

5.3.2 Policy Context

The National Planning Policy Framework (NPPF) sets out the Government's economic, environmental and social planning policies for England. The policies set out

in this framework apply to the preparation of local and neighbourhood plans and to decisions on planning applications.

The latest version of the NPPF can be view online [here](#). The below text it extracted from the online document from paragraphs 170 – 186.

Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards.

All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

-  Applying the sequential test and then, if necessary, the exception test as set out below;
-  Safeguarding land from development that is required, or likely to be required, for current or future flood management;
-  Using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management); and
-  Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations.

A sequential risk-based approach should also be taken to individual applications in areas known to be at risk now or in future from any form of flooding, by following the steps set out below.

Within this context the aim of the sequential test is to steer new development to areas with the lowest risk of flooding from any source. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding. The strategic flood risk assessment will provide the basis for applying this test.

The sequential test should be used in areas known to be at risk now or in the future from any form of flooding, except in situations where a site-specific flood risk assessment demonstrates that no built development within the site boundary, including access or escape routes, land raising or other potentially vulnerable elements, would be located on an area that would be at risk of flooding from any source, now and in the future (having regard to potential changes in flood risk).

Applications for some minor development and changes of use ⁽⁶²⁾ should also not be subject to the sequential test, nor the exception test set out below, but should still meet the requirements for site-specific flood risk assessments set out in footnote ⁽⁶³⁾.

Having applied the sequential test, if it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3.

The application of the exception test should be informed by a strategic or site-specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. To pass the exception test it should be demonstrated that:

- | |
|---|
|  a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and |
|---|

-  b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Both elements of the exception test should be satisfied for development to be allocated or permitted.

Where planning applications come forward on sites allocated in the development plan through the sequential test, applicants need not apply the sequential test again. However, the exception test may need to be reapplied if relevant aspects of the proposal had not been considered when the test was applied at the plan-making stage, or if more recent information about existing or potential flood risk should be taken into account.

Paragraph 181 of the National Planning Policy Framework (NPPF) states that:

When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment (See Note 1)
Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

-  within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location
-  the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;
-  it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
-  any residual risk can be safely managed; and
-  safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Paragraph 182 states that:

Applications which could affect drainage on or around the site should incorporate sustainable drainage systems to control flow rates and reduce volumes of runoff, and which are proportionate to the nature and scale of the proposal. These should provide multifunctional benefits wherever possible, through facilitating improvements in water quality and biodiversity, as well as benefits for amenity. Sustainable drainage systems provided as part of proposals for major development should:

-  a) take account of advice from the Lead Local Flood Authority;
-  b) have appropriate proposed minimum operational standards; and
-  c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development.

A major development is defined as:

-  a residential development: 10 dwellings or more or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known
-  a non-residential development: provision of a building or buildings where the total floor space to be created is 1000 square metres or more or where the floor area is not yet known, a site area of 1 hectare or more.

Footnote 62 - This includes householder development, small non-residential extensions (with a footprint of less than 250m²) and changes of use; except for changes of use to a caravan, camping or chalet site, or to a mobile home or park home site, where the sequential and exception tests should be applied as appropriate.

Footnote 63 - A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

Footnote 64 - As required by the Marine and Coastal Access Act 2009.

5.4 Hinckley & Bosworth Borough Council

CC03 Sustainable Drainage Systems

Development proposals are required to integrate well-designed and naturalised Sustainable Drainage Systems (SuDS), to manage flood risk and water quality in accordance with national and local standards unless it can be clearly demonstrated;

- a) That SuDS are not technically, operationally or financially deliverable or viable and that surface water drainage issues from the development can be alternatively mitigated; or
- b) That the SuDS scheme will adversely affect the environment or safety.

SuDS design should show how constraints have been considered and how the design provides multiple benefits in terms of landscape enhancement, biodiversity, recreation, amenity, leisure and the enhancement of historical features. Applicants should demonstrate how the design and layout of SuDS reflects and responds to the individual site's features such as following natural drainage routes to improve water quality and the local landscape character.

Applicants are expected to integrate SuDS proposals with green infrastructure and active travel proposals, as part of a multi-functional approach, which should be delivered and integrated as part of a green network. Where integration of SuDS is not proposed, applicants must provide evidence as to why it is not possible. Where SuDS are part of open space obligations, they should be safe and accessible whilst creating an enhancement to local distinctiveness.

Arrangements in accordance with national policy will need to be put in place for the management and long-term maintenance of the SuDS throughout the operational lifetime of the development. Planning applications for phased developments should be accompanied by a Drainage Strategy, which takes a strategic approach to drainage provision across the entire site and incorporates adequate provision for SuDS within each phase.

The impacts of flood risk and pollution during the construction phase(s) of development should be fully assessed, and where appropriate a Surface Water Management Plan should be put in place prior to commencement of development to identify and mitigate the potential impacts.

Proposals for the retrofitting of sustainable drainage systems will be supported.

6 Site Characteristics

6.1 Location and Area

The site is centred at national grid reference 443155, 295830 and has an area of 3,704m².

It falls within the jurisdiction of Hinckley & Bosworth Borough Council (HBBC) in terms of the planning consultation process on flood risk and surface water management. The LLFA is Leicestershire County Council (LCC).

Figure 1 provides the site location map and aerial imagery.

6.2 Current Site and Surrounding Uses

The site is currently a residential property located along Ashby Road, which is formed from a mixture of residential, medical, commercial, leisure and greenspace land uses.

6.3 Site Topography

The mapping provided in [Appendix 2](#) shows the 1m LiDAR DTM(2022) ground elevations within the site. A topographical survey was not available.

The topography ranges from 124.25mAOD to a high of 125.81mAOD.

The elevations are highest at the site entrance on Ashby Road (west), whilst the east of the site is situated between 124.25 – 124.9mAOD.

The position of the proposed dwelling are at 125.0mAOD.

The topography of the surrounding area ranges from a high of 126.48mAOD, to the south of the site toward the intersection of Ashby Road and Normandy Way, to a low of 120.61mAOD, in the greenspace to the northwest of the site.

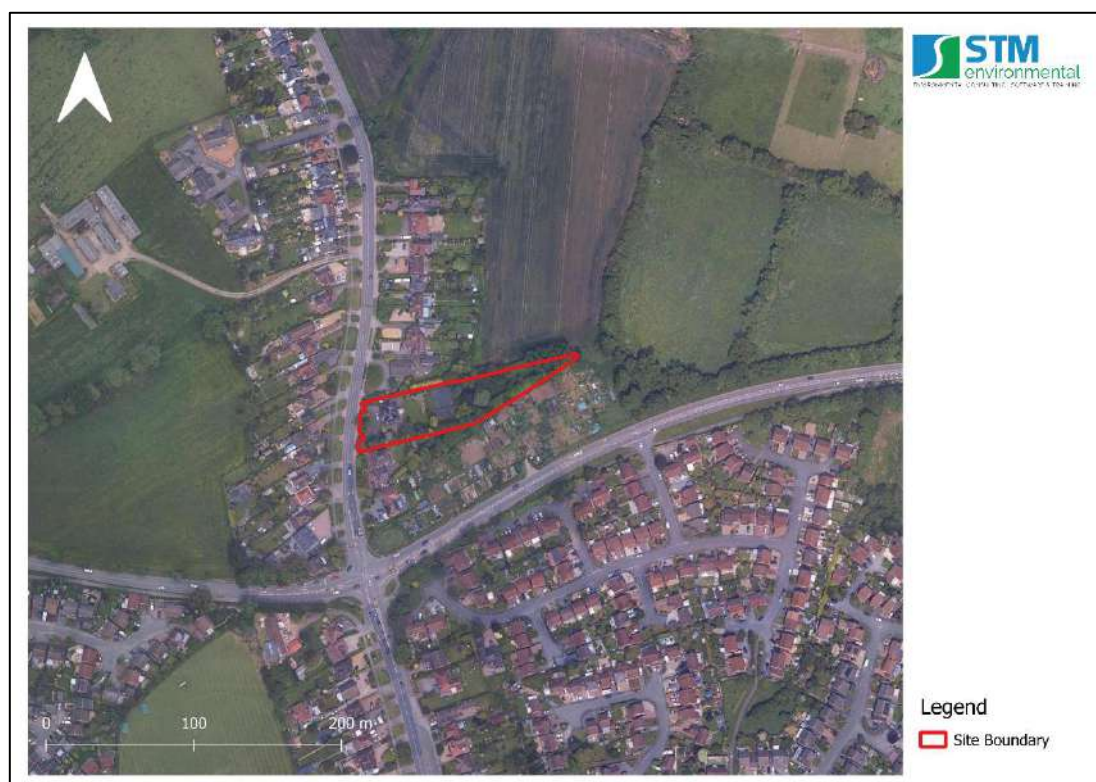
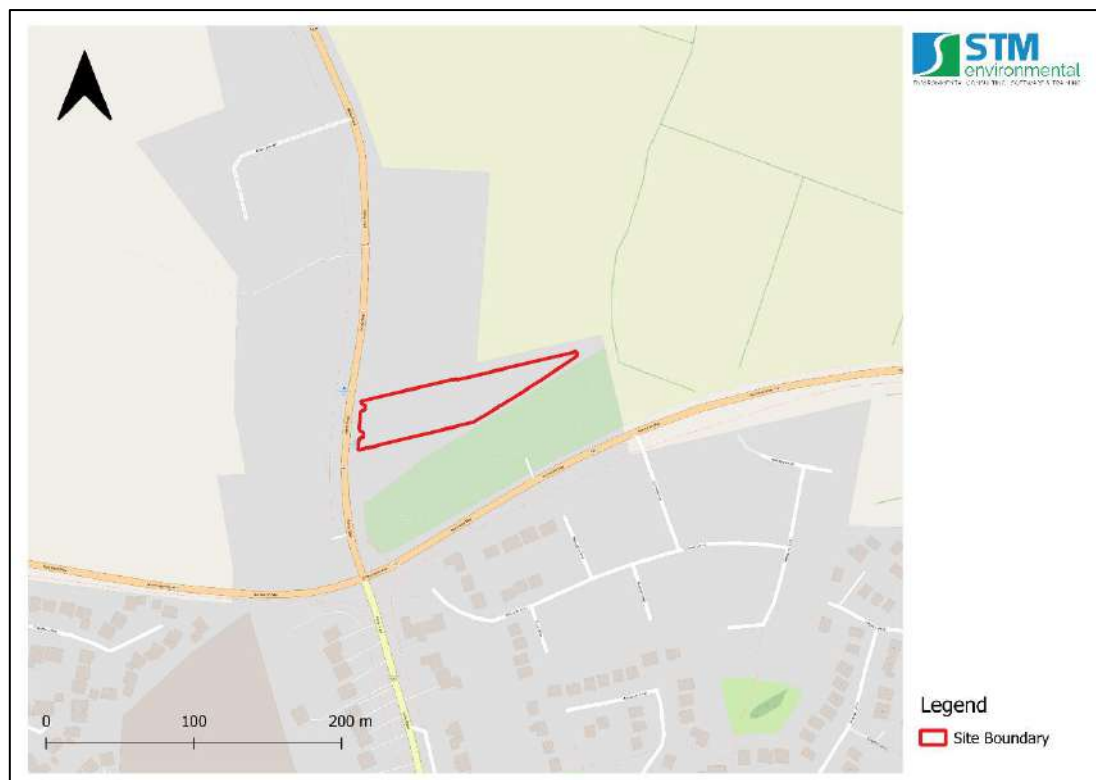


Figure 1 Site location map and aerial photo

6.4 Geological and Hydrogeological Summary

6.4.1 Nearby Boreholes

No boreholes were identified within 500m of the site.

6.5 Hydrological Setting

No statutory main rivers were identified within 250m of the site.

6.6 Site Investigation Summary

The ground investigation works were carried out on the 13th and 14th of May 2025.

The works were carried out under remote supervision by STM Consultants Ltd and completed by the Dale Higgot.

1no. trial pit was hand excavated to a maximum depth of 1.5mbgl for the purpose of undertaking infiltration testing in general accordance with the BRE 365 DG methodology.

6.6.1 Geological Findings

The geology encountered consisted of dark brown clayey topsoil from ground level to 0.4mbgl. This was underlain by light brown silty clay with gravel to a depth of 0.6mbgl. This in turn was underlain by very silty clayey red & yellow SAND to a depth of 1.5bmgl.

6.6.2 Infiltration Testing

The infiltration rate achieved in TP01 was moderate through all rounds of testing. The infiltration rate ascertained from the testing was calculated to be 0.037m/hr (1.05E-05 m/s).

The infiltration testing information, logs, graphs and pictures are available in [Appendix 2.2](#).

6.7 Flood Risk Summary

The overall flood risk to the site is considered to be low with no main sources of flood risk identified.

6.7.1 Fluvial – Rivers and Sea

As the site is located in Flood Zone 1, the risk of fluvial flooding is considered to be low.

6.7.2 Pluvial – Precipitation Events

During both the Present Day (2025) and Climate Change (2040 – 2060) modelled scenarios, the site is at very low risk of surface water flooding.

6.7.3 Groundwater

The groundwater table depth is indicated to be greater than 5mbgl. Therefore, the risk of groundwater flooding is considered to be low.

6.7.4 Artificial – Canals Reservoirs

The EA indicates that 'flooding from reservoirs is unlikely in this area'.

The flood risk maps area available in [Appendix 3](#).

6.8 Existing Surface Water Drainage Features

Severn Trent Water are the local sewage undertaker. The drainage asset map was not available.

6.8.1 Highways drainage

A total of 2no. drains were identified on the Ashby Street.



Figure 2 Highways Drainage

7 Hydrological Run-off Assessment

To minimise the impact of the new development on local flood risk, the NPPF requires that the water drainage arrangements for any development site are that the volumes and peak flow rates leaving the site post-development are improved upon those of the existing conditions. The following run-off assessment predicts the Greenfield, pre- and post-development run-off rates and provides the required SuDS necessary for complying with the relevant planning policies.

7.1 Existing and Proposed Ground Cover

Table 1: Breakdown of Ground Cover in the Proposed Development

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m ²)
	m ²	%	m ²	%	
Buildings	244	6.6	484	17.7	240
Hard Standing	869	23.5	903	45.6	34
Soft landscaping	2591	70.0	2317	36.7	-274
Total	3704	100	3704	100	

Table 2: Summary of Permeable and Impermeable Areas

	Impermeable Area		Permeable Area		Total Area
	m ²	%	m ²	%	m ²
Existing Site	1113	30.0	2591	70.0	3704
Proposed Site	1387	37.5	2317	62.5	3704
Difference	274	7.4	-274	-7.4	

The proposed development increases the impermeable area of the site by 7.4% to 1,387m². As such, without mitigation this will have a negative impact on the runoff rate without the introduction of SuDS.

The driveway to the proposed bungalows is due to be permeable, this will ensure that the proposal will reduce the total impermeable area and have a positive impact on the surface water runoff rates.

Table 3: All Permeable Surfaces

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m ²)
	m ²	%	m ²	%	
Buildings	244	6.6	484	17.7	240
Hard Standing	869	23.5	422	45.6	-447
Permeable Surfaces	2591	70.0	2798	36.7	207
Total	3704	100	3704	100	
	Impermeable Area		Permeable Area		Total Area
	m ²	%	m ²	%	m ²
Existing Site	1113	30.0	2591	70.0	3704
Proposed Site	906	24.5	2798	75.5	3704
Difference	-207	-5.6	207	5.6	

7.2 Peak Flow Control

With regard to peak flow control, the non-statutory technical standards for sustainable drainage systems state that:

-  S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

7.3 Volume Control Requirements

With regard to volume control, the non-statutory technical standards for sustainable drainage systems state that:

-  S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.
-  S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

7.4 Run-off and Storage Calculations

The IH124 & MRM methods were applied to calculate the Greenfield, pre and post-development run-off rates including allowances for climate change. The full calculations and results are presented in [Appendix 4](#). The table below gives a summary of the results:

Table 4: Modified Rational Method – Discharge rates and volumes for the proposed dwellings

	Pre – Development (l/s)	Discharge Volume (m ³)
1 in 1	0.1	18
1 in 30	0.4	
1 in 100	0.6	

When taking into account the proposed driveway (520m²) the required storage volume is estimated to be up to 41m³ during the 1 in 100 year plus 40% CC storm event. As shown in the figures below:

Pre-development discharge

Site Makeup: Brownfield ▼ OK Cancel

Brownfield Method: Greenfield ▼

Greenfield Method: FEH ▼

Positively Drained Area (ha): 0.090

SAAR (mm): 652 Load

Host: 14 ▼

BFIHost: 0.424

Region: 5 ▼

QBar/QMed conversion factor: 1.124

Betterment (%): 0

QMed (l/s): 0.3

QBar (l/s): 0.3

Note: FEH point descriptors can be downloaded from fehweb.ceh.ac.uk

Only XML file format can be used

FEH-22 is the current FEH data and this should be used for new development

ReFH2 legacy – Doesn't contain the new BFIHOST19 descriptor

ReFH2 – Contains the new BFIHOST19 descriptor

Return Period (years)	Growth Factor	Q (l/s)
1	0.87	0.3
30	2.55	0.8
100	3.56	1.1

Pre-development discharge

Site Makeup: Brownfield ▼ OK Cancel

Brownfield Method: Greenfield ▼

Greenfield Method: FSR/FEH ▼

Positively Drained Area (ha): 0.090

Soil Index: 5 ▼

SPR: 0.53

Catchment Wetness Index: 98.074 Calc

Return Period (years): 100

Climate Change (%): 40

Storm Duration (mins): 360

Betterment (%): 0

PR: 0.528

Runoff Volume (m³): 41

Note: FEH point descriptors can be downloaded from fehweb.ceh.ac.uk

Only XML file format can be used

FEH-22 is the current FEH data and this should be used for new development

ReFH2 legacy – Doesn't contain the new BFIHOST19 descriptor

ReFH2 – Contains the new BFIHOST19 descriptor

As the development is taking place on a previously developed site S3 (peak flow) and S5 and S6 (volume controls) apply.

The storage volume required to achieve the greenfield discharge rate for all storm events, is estimated to be up to 41m³.

Screenshots of the quick storage estimate and variables are available [Appendix 4](#).

8 SuDS

8.1 SuDS Hierarchy

The SuDS Hierarchy sets out the preferred method of selecting which Sustainable Drainage System should be used.

-  rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation);
-  rainwater infiltration to ground at or close to source;
-  rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens);
-  rainwater discharge direct to a watercourse (unless not appropriate);
-  controlled rainwater discharge to a surface water sewer or drain;
-  controlled rainwater discharge to a combined sewer;

The table outlined on the page below summarises the available SuDS, there potential suitability and the benefits.

8.2 Drainage Hierarchy Discussion

8.2.1 Rainwater Harvesting

The development has good potential to provide rainwater harvesting. As such, this is recommended in the form of rainwater butts.

8.2.2 Alternative Roofing – Green, brown and Blue

Based on the proposed roof design, which include pitched roofs, the use of alternative roofing is not deemed to be suitable.

8.2.3 Infiltration To Ground

On site infiltration test was successful on site. The infiltration rate established following the BRE 365 methodology was 0.037mh/r (1.05E-05 m/s).

The proposal will aim to discharge all stormwater to ground via infiltration SuDS.

8.2.4 Permeable Surfaces and Filter Drains

Approximately 45.6% of the development will consist of outdoor space, and patios all of which will be designed to be permeable. Where impermeable surface are introduced, the runoff will be directed onto areas of permeable surfaces.

8.3 Appraisal of Potential SuDS Options

8.3.1 SuDS Options

Table 5: SuDS Appraisal; Feasibility of various SuDS and the potential uses on site.

Key	H	M	L	Y	?	N	N/A								
Details	High Impact	Medium	Low Impact	Yes	Maybe	No	Not Applicable								
Flow Rate Control / Events															
Main Category	SuDS Features	Total Suspended Solids Removal	Heavy Metals Removal	Nutrient Removal	Bacteria Removal	Dissolved Pollutants	Runoff Volume Reduction		1-2 Years	10 - 30 Years	100 Years	Site Potential	Included	Discussion / Details	Potential Storage Provided
Source Control Measure	Green / Brown Roof	NA	NA	NA	NA	H	H		H	H	L	N	N	Poorly compatible with proposed; 0.4m3 Rainwater Reuse	0
	Rain Water harvesting	M	L	L	L	NA	M		M	H	L	Y	Y		0
Infiltration Methods	Infiltration trench	H	H	H	M	H	H		H	H	L	Y	N	Conveyance route to rear; 546m2 of permeable resin bound gravel and block paving surfaces Limited Space Geocellular soakaway installed within each garden plot	0
	Permeable Pavement	H	H	H	H	H	H		H	H	H	Y	Y		57.2
	Infiltration basin	H	H	H	M	H	H		H	H	H	Y	N		0
	Soakaway	L	L	L	L	L	L		H	H	H	Y	Y		12.2
Filtration	Filtration Surface sand	H	H	H	M	H	L		H	H	L	Y	N	Limited Space	0
	Sub-surface sand filter	H	H	H	M	H	L		H	H	L	Y	N	Limited Space	0
	Perimeter sand filter	H	H	H	M	H	L		H	H	L	Y	N	Limited Space	0
	Rain Gardens	H	H	H	M	H	L		H	H	L	Y	Y	Rain Garden to accept storm water runoff from rooftops.	10.8
	Filter trench	H	H	H	M	H	L		H	H	L	Y	N	Limited Space	0
Channels Features (Open)	Open channels Conveyance	H	M	M	M	H	M		H	H	H	Y	N	Limited Space	0
	Enhanced dry swale	H	H	H	M	H	M		H	H	H	Y	N	Limited Space	0
	Enhanced wet swale	H	H	M	H	H	L		H	H	H	Y	N	Limited Space	0
Wet SuDS	Wetland Shallow wetland	H	M	H	M	H	L		H	M	L	Y	N	Not required. Potential to rear of site.	0
	Extended detention wetland	H	M	H	M	H	L		H	M	L	Y	N	Not required. Potential to rear of site.	0
	Pond / wetland	H	M	H	M	H	L		H	M	L	Y	N	Not required. Potential to rear of site.	0
	Pocket wetland	H	M	H	M	H	L		H	M	L	Y	N	Not required. Potential to rear of site.	0
	Submerged gravel wetland	H	M	H	M	H	L		H	M	L	Y	N	Not required. Potential to rear of site.	0
	Wetland channel	H	M	H	M	H	L		H	M	L	Y	N	Not required. Potential to rear of site.	0
Retention	Retention pond	H	M	M	M	H	L		H	H	H	Y	N	Not required. Potential to rear of site.	0
Detention	Detention basin	M	M	L	L	L	L		H	H	H	Y	N	Not required. Potential to rear of site.	0
Tank Storage	Sub-surface storage (Tank)	L	L	L	L	L	L		H	H	H	Y	N	Good potential, least sustainable.	0
															80

8.4 SuDS Strategy

8.4.1 SuDS Options

The proposal will introduce a large permeable driveway that will only accept the runoff from the detached garage rooftop.

The proposed bungalows will introduce rainwater butts, permeable block paving, rain gardens and geocellular soakaways.

All storm water will discharge to ground via infiltration.

The combination of the SuDS measures introduce will provide 80m³ of attenuation the details are outline in the table below.

Table 6: Proposed Bungalow SuDS

Plot 1 & 2			
Location	Proposed Area (m ²)	SuDS Option	Estimated Storage Provided (m ³)
Plot 2	-	Rainwater Butt	0.2
Permeable Paving	46	300mm Sub-base	4.8
Driveway	520	Resin Bound Gravel	N/A
Rain Garden / Planters	40	200mm Sub-base	10.8
Geocellular Soakaway	16	0.8m thick Geocellular Crates	12.2
Total			27.8

Table 7: Permeable Driveway

Garage, Driveway and Parking			
Location	Proposed Area (m ²)	SuDS Option	Estimated Storage Provided (m ³)
Permeable Resin bound gravel	500	350mm Sub-base	52.5
Rainwater Butt		200 litre rainwater butt	

The drainage layout, model sections and model results are is available in [Appendix 7](#)

The descriptions of the proposed SuDS and how they interact with the different features is outlined below.

8.4.2 Rainwater Butt

2no. Rainwater harvesting Butts (200 litre) will be fitted to downpipes to allow for rainwater re-use within the garden. Once at capacity the excess will discharge onto permeable paving.

8.4.3 Permeable Block Paving – Block Paving

Permeable Paving (Marshalls Prior or similar) combines hardstanding with SuDS and works in a very different way to traditional pavement. It is designed to allow rainfall to percolate immediately through the surface near to where the raindrop lands – so surface ponding is completely eradicated without the need for an additional channel drainage system.

The construction will consist of 80mm interlocking concrete blocks with jointing and a 50mm underlying bedding layer with a 350mm sub-base consisting of a graded aggregate (MOT Type 3) with a porosity of 0.30. This construction over 23m² (per plot) will provide approximately 2.4m³ of interception, attenuation, treatment storage and will allow for direct infiltration. This permeable paving strip, located to the east of the bungalows, will act as a conveyance medium to distribute all stormwater flows into the rain gardens.

8.4.4 Permeable Resin Bound Gravel

Resin bound gravel is a permeable surfacing system made by mixing natural stone with a clear resin. It allows rainwater to drain through the surface into the ground, making it suitable for Sustainable Drainage Systems (SuDS).

The resin bound layer (15–25 mm thick) must be installed over a free-draining sub-base, such as: MOT Type 3 aggregate (350mm). This reduces surface water runoff, supports natural drainage and helps prevent local flooding.

This construction across the driveway and car park will provide approximately 50m³ of attenuation. No additional inflow will discharge into this feature.

8.4.5 Rain Garden

A rain garden is a shallow area of ground which receives run-off from roofs and other hard surfaces. A rain garden is planted with plants that can stand waterlogging for up to 48 hours at a time, but would typically drain completely within 12 - 24 hours. Which would depend on the drainage capacity of the shallow soils, the soils were shown to have an infiltration rate of $1.0 \times 10^{-5} \text{m/s}$.

A range of different plants can be included within the garden, as more drought-tolerant plants will be suitable towards the edges. During a storm water fills the depression and then drains.

A 20m^2 rain garden will be formed within the soft landscaping in each garden. They will accept all surface water runoff from the new accommodation rooftop in addition to the excess discharged from the rainwater butt and permeable paving described above.

The rain gardens will be 20m^2 each, providing 2.4m^3 attenuation within the sub-base based on an average porosity of 0.3. The well-draining substrate (good quality topsoil/sand) will have a porosity of 0.15 providing a further 1.2m^3 of attenuation. The surface will be formed from shallow depression, forming a void filled with suitable planting and decorative stone, which will provide a further 2.0m^3 of attenuation at ground level.

An overflow drainage channel will be formed to connect the surface water into the geocellular soakaway located below the garden.

8.4.6 Geocellular soakaway

The geocellular storage structures will be placed below the garden area to the rear of the bungalows. The structure will cover a total area of 8m^2 with a thickness of 0.8m.

The geocellular storage crates ([AquaCell Drainage Crates](#) or similar) will have a porosity of 91% and will be stacked together to create the desired storage volume of 6.1m^3 within each garden.

8.4.7 Surface Water Discharge Points

All stormwater will discharge to ground via infiltration.

8.5 Water Quality Assessment

The Simple Index Approach to water quality tool was used to ensure suitable water quality treatment has been provided within the proposed SuDS measures.

8.5.1 Treatment of Run-off

Treatment of roof water runoff will be provided, through the provision of the permeable paving and the rainwater tank filtration unit, to intercept gross solids and sediment. Guidance will be provided to the developer on appropriate maintenance.

8.5.2 Exceedance Flows

The elevation review of the LIDAR 1m DTM mapping indicates that, in the event of exceedance on the site upon completion, overland flows will flow towards the rear of the site, away from the buildings, ensuring safe access and egress can be maintained during such an event.

8.6 Maintenance and Adoption of SuDS

All SuDS features will be properly installed by competent persons. They will be maintained regularly to ensure that their design capacity and attenuation characteristics provide the required storage volume.

Landscaping and adjacent areas will be designed such that they do not cause soil, mulch and other materials to be washed onto the permeable surfaces and into drains causing clogging.

Owners of the properties/persons responsible for maintenance of SuDS components will be provided with operation and maintenance manuals which will include information such as:

 the location of SuDS components;
--

- an explanation of design intent and objective of the SuDS;
- the requirements for regular and occasional inspection and maintenance;
- visual indicators that may trigger maintenance.

Regular maintenance of SuDS components is relatively straightforward with the main tasks consisting of:

- Regular visual inspections – checking inlets are not blocked and verifying that clogging has not occurred;
- Litter and debris removal;
- Grass cutting;
- Preventive sweeping;
- Weeding and invasive plant control;
- Oil and stain removal.

Occasional maintenance activities to ensure the long-term performance of the SuDS features include

- Sediment removal;
- Vegetation and plant replacement.

These simple measures will ensure that the storage capacity of the system is maintained and that the need for reconstruction and replacement of components is minimised.

Further details on SuDS maintenance measures that will be employed at the site can be found in [Appendix 8](#).

9 Conclusion and Recommendations

With the proposed SuDS mitigation measures in place, it is considered that the proposed development will reduce local flood risk and enhance the local environment and will therefore be in compliance with the LLFA's current planning policy and the NPPF.

10 References

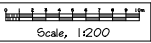
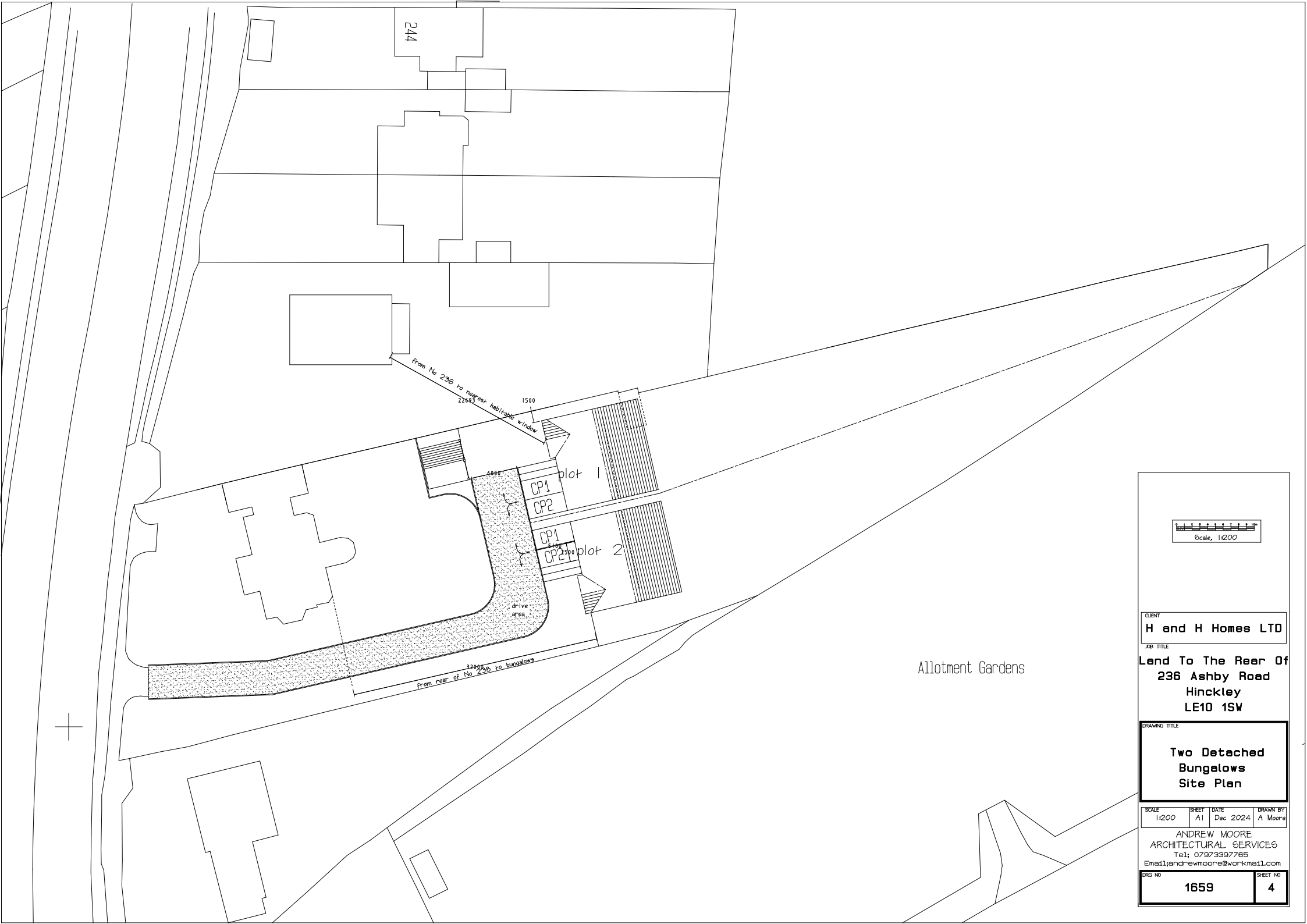
1. Communities and Local Government - National Planning Policy Framework NPPF, 2019.
2. CIRIA, Defra, Environment Agency – UK SuDS Manual, 2015.
3. Hinckley & Bosworth Borough Council – Local Plan 2020 – 2039, Consultation Draft Plan, Regulation 18, June 2021.

11 Appendices

11.1 Appendix 1 – Development Plans & Photos

11.1.1 Development Plans

See next page.



Scale, 1:200

CLIENT
H and H Homes LTD

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**Land To The Rear Of
236 Ashby Road
Hinckley
LE10 1SW**

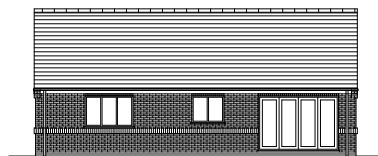
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Bungalows
Site Plan**

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ANDREW MOORE ARCHITECTURAL SERVICES Tel: 07973397765 Email: andrewmoore@workmail.com			

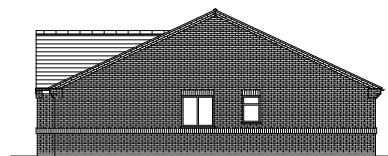
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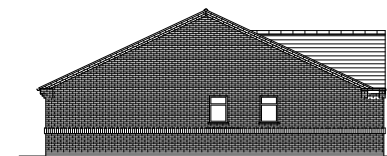
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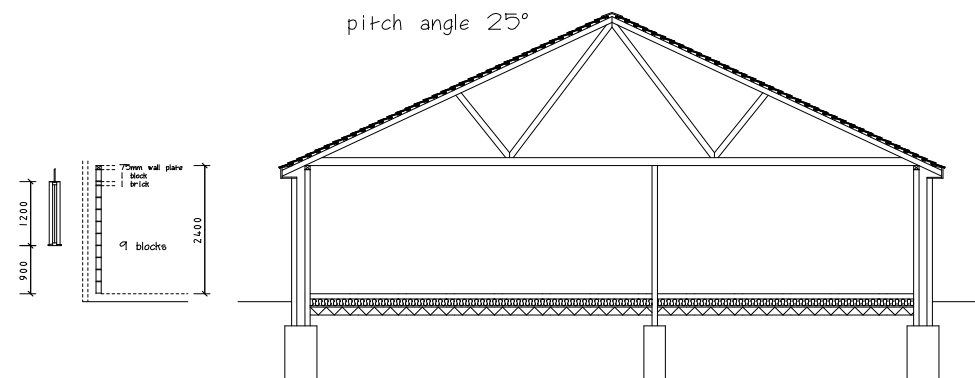
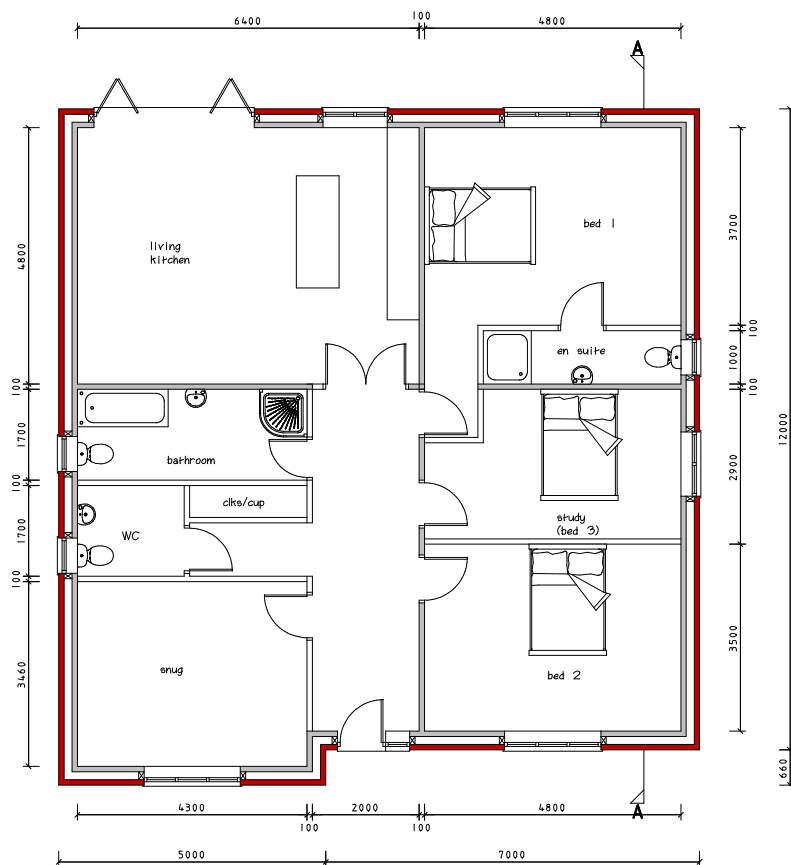
Rear Elevation



Side Elevation To Plot 2

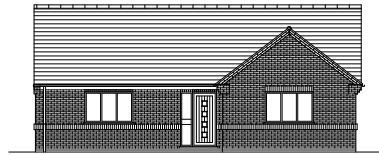


Side Elevation To No 238 Ashby Road

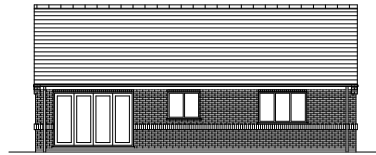


Section AA

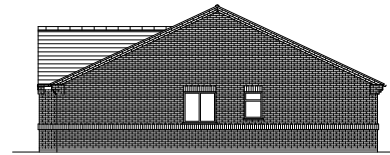
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H & H Homes LTD			
JOB TITLE			
Land To The Rear Of 236 Ashby Road Hinckley LE10 1SW			
DRAWING TITLE			
Two Detached Bungalows PLOT ONE			
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ANDREW MOORE ARCHITECTURAL SERVICES Tel: 07973397765 Email: andrewmoore@workmail.com			
DWG NO	SHEET NO		
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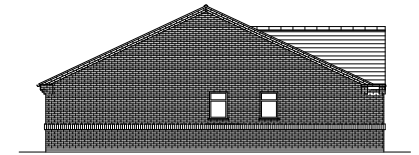
Front Elevation



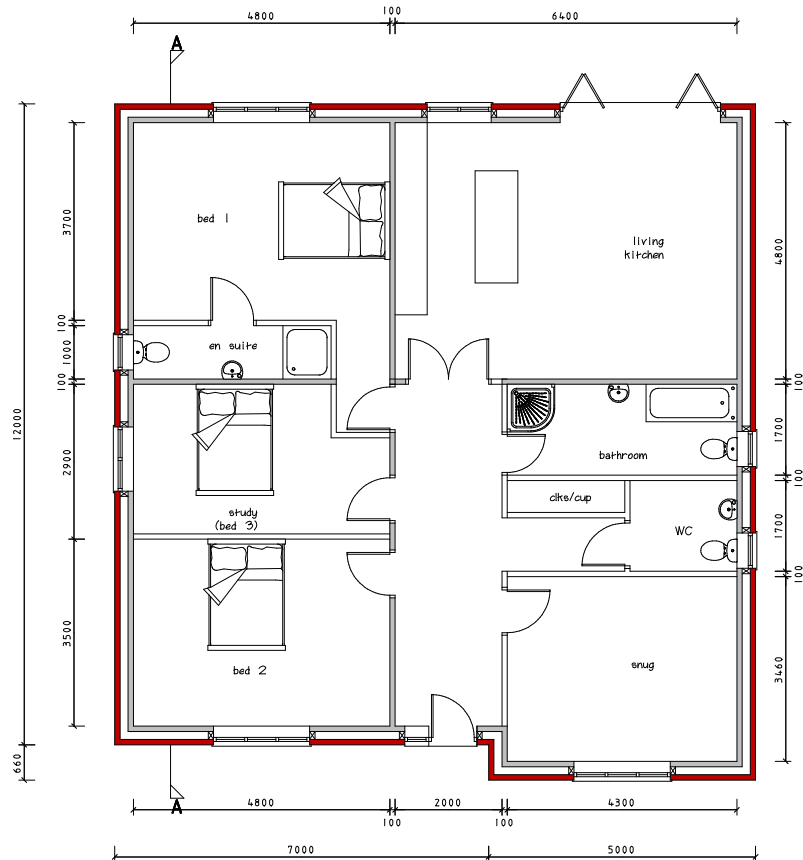
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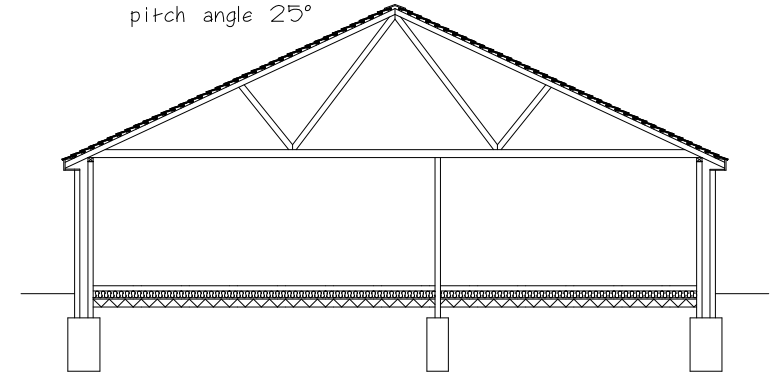
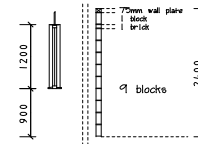
Side Elevation To Plot 1



Side Elevation To Boundary



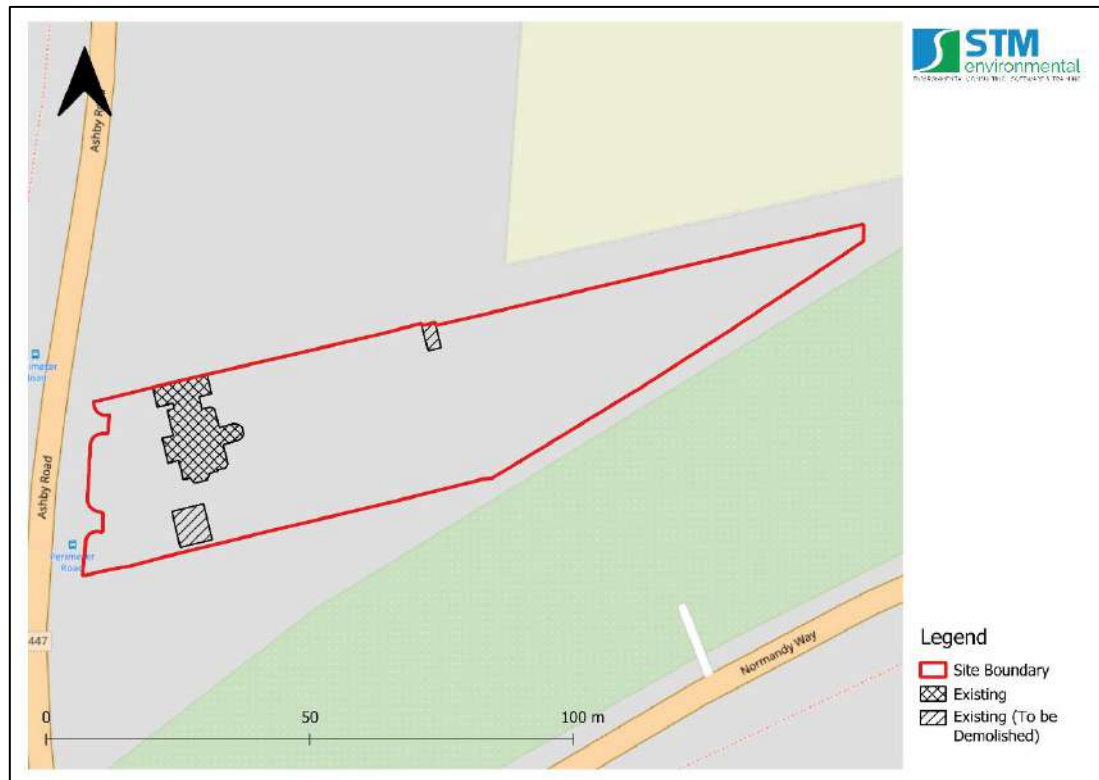
pitch angle 25°



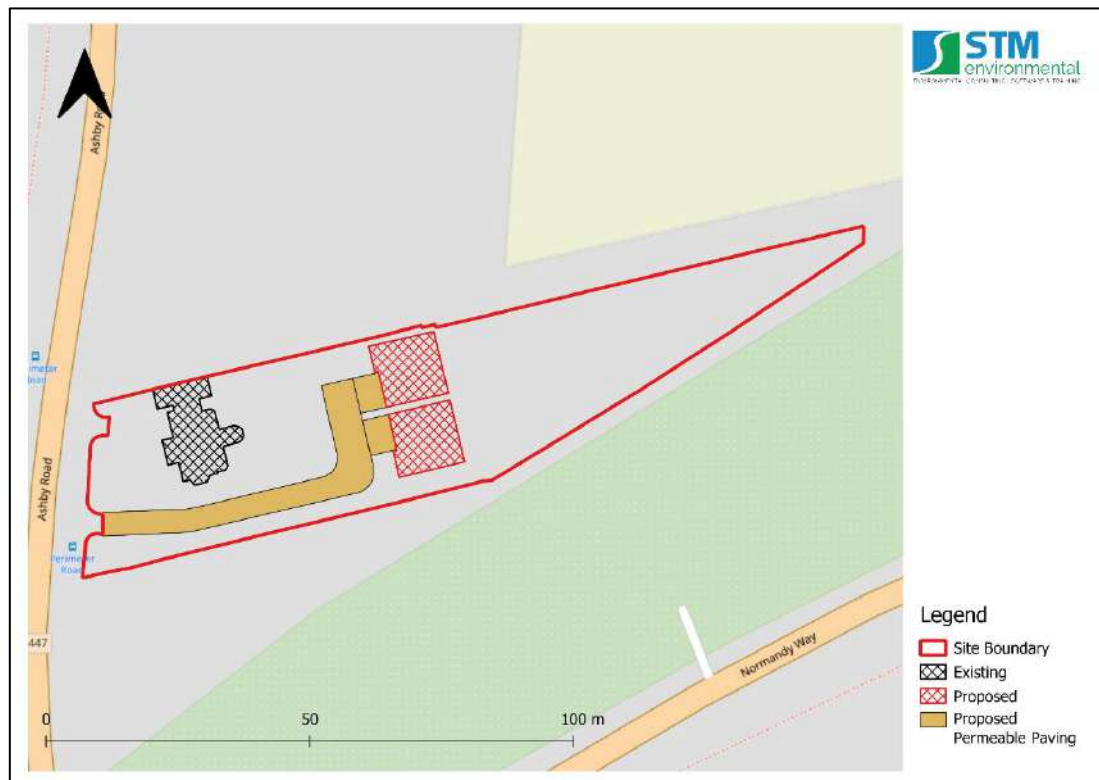
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ANDREW MOORE ARCHITECTURAL SERVICES Tel: 07973397765 Email: andrewmoore@workmail.com			
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1659		2	

11.1.2 Existing Development



11.1.3 Proposed (No Additional SuDS)



11.1.4 Site Photos

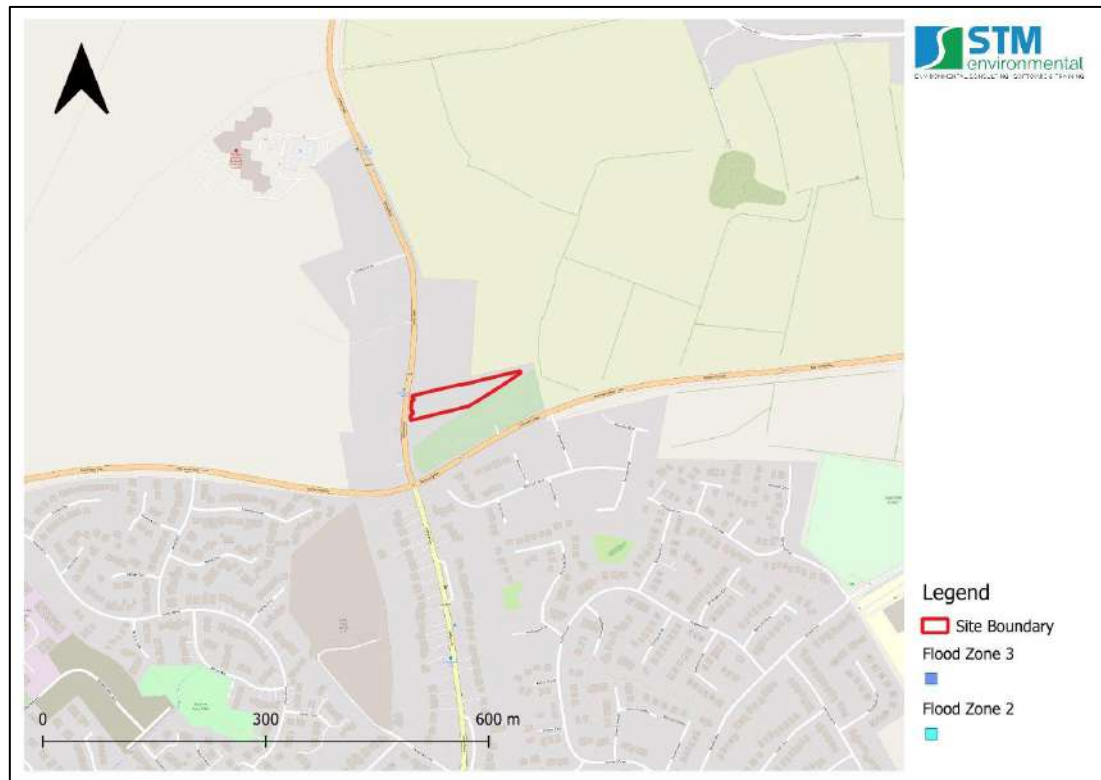


11.2 Appendix 2.1– Site Topography and Drainage Characteristics

11.2.1 LIDAR Mapping showing Site Topography - (Source: LiDAR DTM 2022)



11.2.2 Hydrology Map



11.2.3 Bedrock Geology, Hydrogeology & Permeability (Source: BGS, 2016)



11.2.4 Superficial Deposits, Hydrogeology, & Permeability (Source: BGS, 2016)



11.2.5 Infiltration Drainage Potential (Source: BGS, 2016)



11.2.6 Groundwater Table Depth (Source: BGS 2016)

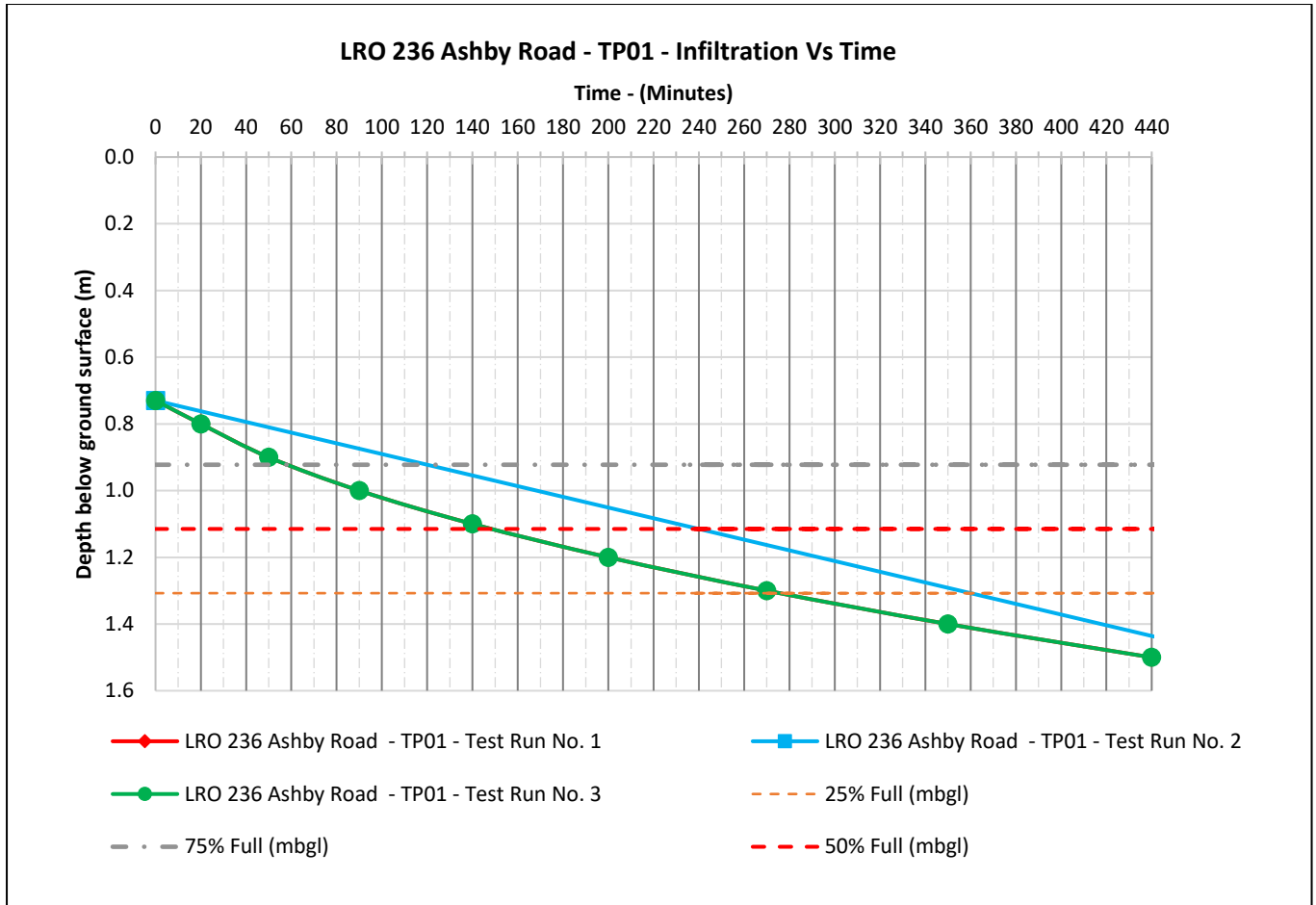


11.3 Appendix 2.2– Drainage Investigation

11.3.1 Site Investigation Photos



11.3.2 Infiltration Testing Graph



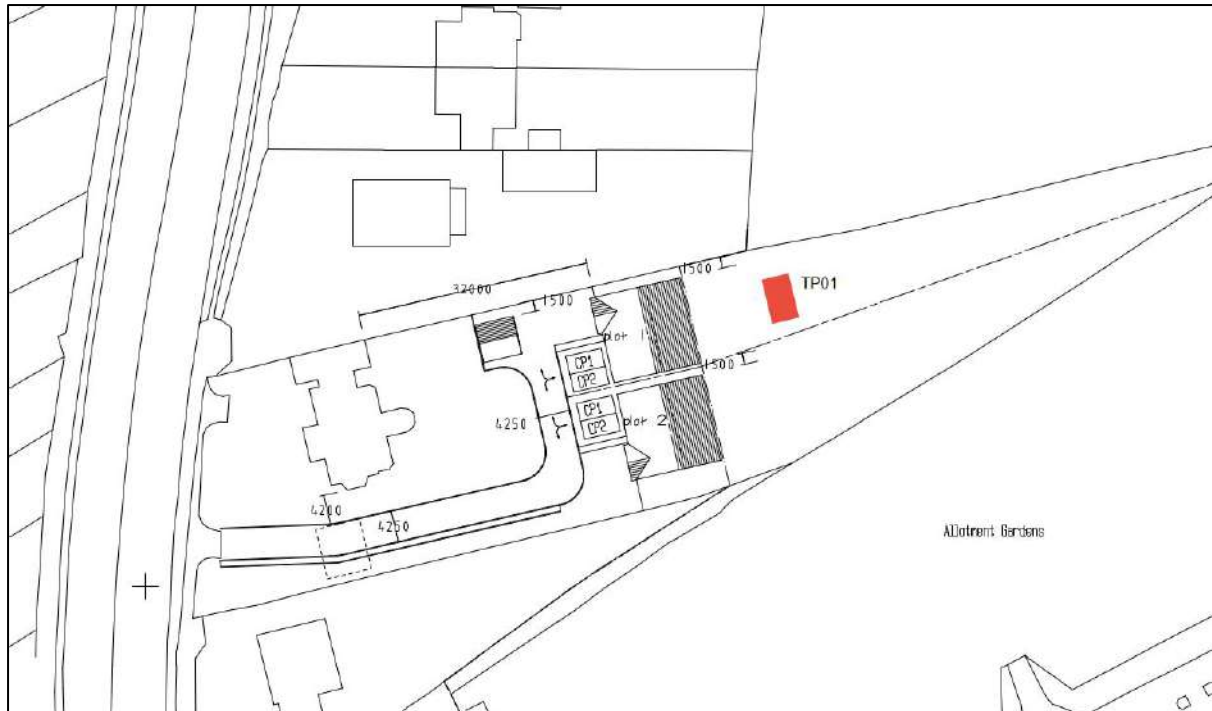
Site Location	LRO 236 Ashby Road
Area	LRO 236 Ashby Road
Trial Pit ID	TP01
Test Run	1

LRO 236 Ashby Road - TP01 - Test Run No. 1									
Insert time according to the measured units									
Dip Reading	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)	Time	25% Full (mbgl)	50% Full (mbgl)	75% Full (mbgl)
0.77	0.7	0.00	0	0	0 00:00	13:07s	1.307s	1.12	0.922s
0.7	0.8	0.33	20	1200.00 0:20	08:50:00	13:07s	1.307s	1.12	0.922s
0.6	0.9	0.83	50	3000.00 0:50	09:20:00	13:07s	1.307s	1.12	0.922s
0.5	1.0	1.50	90	5400.00 1:30	10:00:00	13:07s	1.307s	1.12	0.922s
0.4	1.1	2.33	140	8400.00 2:20	10:50:00	13:07s	1.307s	1.12	0.922s
0.3	1.2	3.33	200	12000.00 3:20	11:50:00	13:07s	1.307s	1.12	0.922s
0.2	1.3	4.50	270	16200.00 4:20	13:00:00	13:07s	1.307s	1.12	0.922s
0.1	1.4	5.83	350	21000.00 5:50	14:20:00	13:07s	1.307s	1.12	0.922s
0	1.5	7.33	440	26400.00 7:20	15:50:00	13:07s	1.307s	1.12	0.922s
			240.00			13:07s	1.307s	1.12	0.922s
			300.00			13:07s	1.307s	1.12	0.922s
Reached 25% within 24 hours. Second run undertaken.									

LRO 236 Ashby Road - TP01 - Test Run No. 2									
Insert time according to the measured units									
Dip Reading	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)	Time	25% Full (mbgl)	50% Full (mbgl)	75% Full (mbgl)
24/04/2025	0.77	0.7	0.00	0	0 00:00	17:00:00	1.307s	1.12	0.922s
25/05/2025	0	1.5	8.00	480	28800.00 08:00		1.307s	1.12	0.922s
Reached 25% within 24 hours. Second run undertaken.									

LRO 236 Ashby Road - TP01 - Test Run No. 3										
Insert time according to the measured units										
Dip Reading	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)	Time	25% Full (mbgl)	50% Full (mbgl)	75% Full (mbgl)	
0.77	0.7	0.00	0	0	0 00:00	09:45:00	13:07s	1.307s	1.12	0.922s
0.7	0.8	0.33	20	1200.00 0:20	10:05:00	13:07s	1.307s	1.12	0.922s	
0.6	0.9	0.83	50	3000.00 0:50	10:35:00	13:07s	1.307s	1.12	0.922s	
0.5	1.0	1.50	90	5400.00 1:30	11:15:00	13:07s	1.307s	1.12	0.922s	
0.4	1.1	2.33	140	8400.00 2:20	12:05:00	13:07s	1.307s	1.12	0.922s	
0.3	1.2	3.33	200	12000.00 3:20	13:05:00	13:07s	1.307s	1.12	0.922s	
0.2	1.3	4.50	270	16200.00 4:30	14:15:00	13:07s	1.307s	1.12	0.922s	
0.1	1.4	5.83	350	21000.00 5:50	15:35:00	13:07s	1.307s	1.12	0.922s	
0	1.5	7.33	440	26400.00 7:20	17:05:00	13:07s	1.307s	1.12	0.922s	

11.3.4 Soakaway Test Location Map



11.4 Appendix 3 – Flood Risk Mapping

11.4.1 Flood Map For Planning (EA)

PDF to follow this page.

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
443168/295830

Created
17 Feb 2025 10:16

Your selected location is in flood zone 1, an area with a low probability of flooding.

You will need to do a flood risk assessment if your site is **any of the following:**

- bigger than 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence **which** sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2024 OS AC0000807064. <https://flood-map-for-planning.service.gov.uk/os-terms>

Flood map for planning

Your reference
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Location (easting/northing)
443168/295830

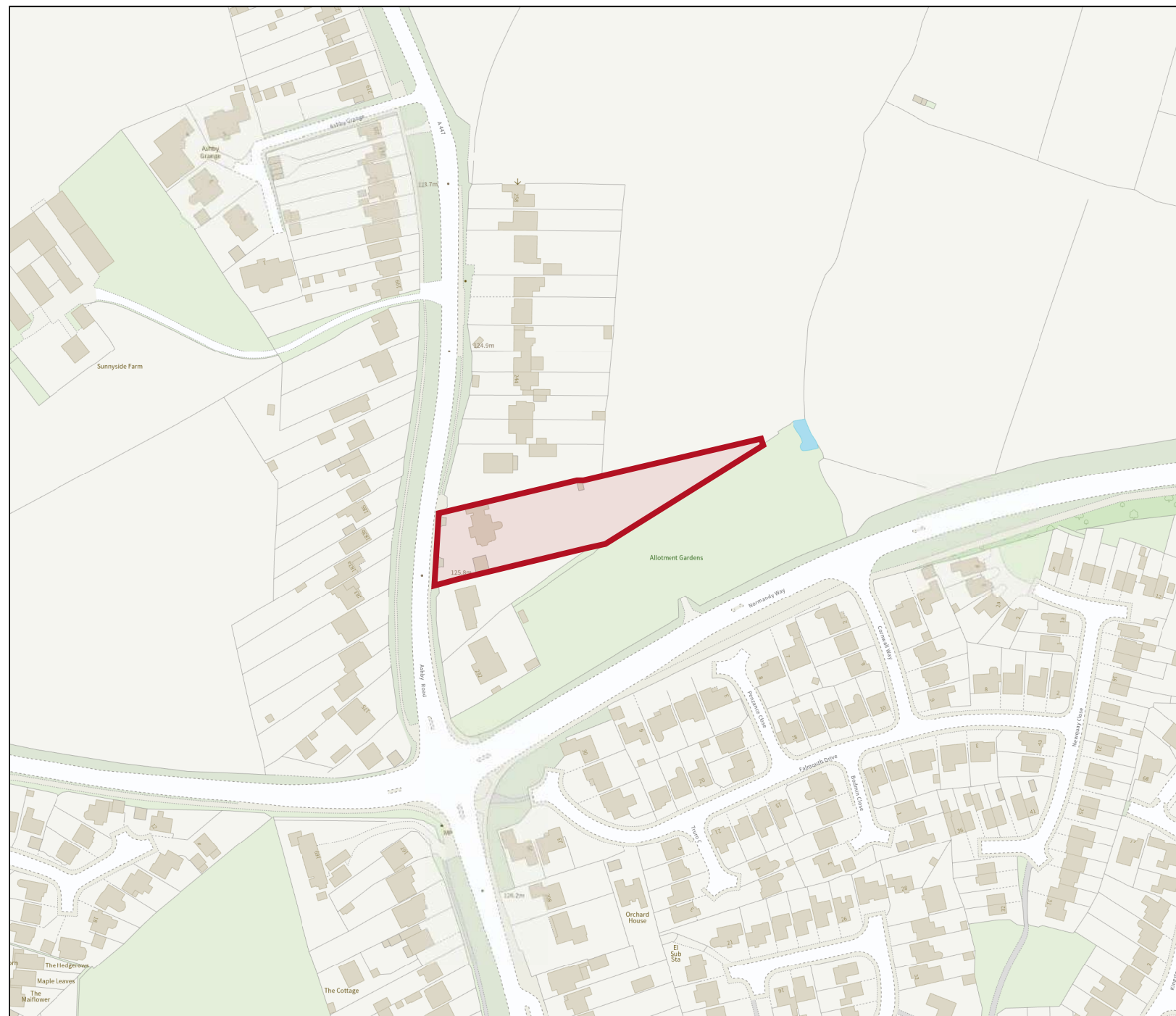
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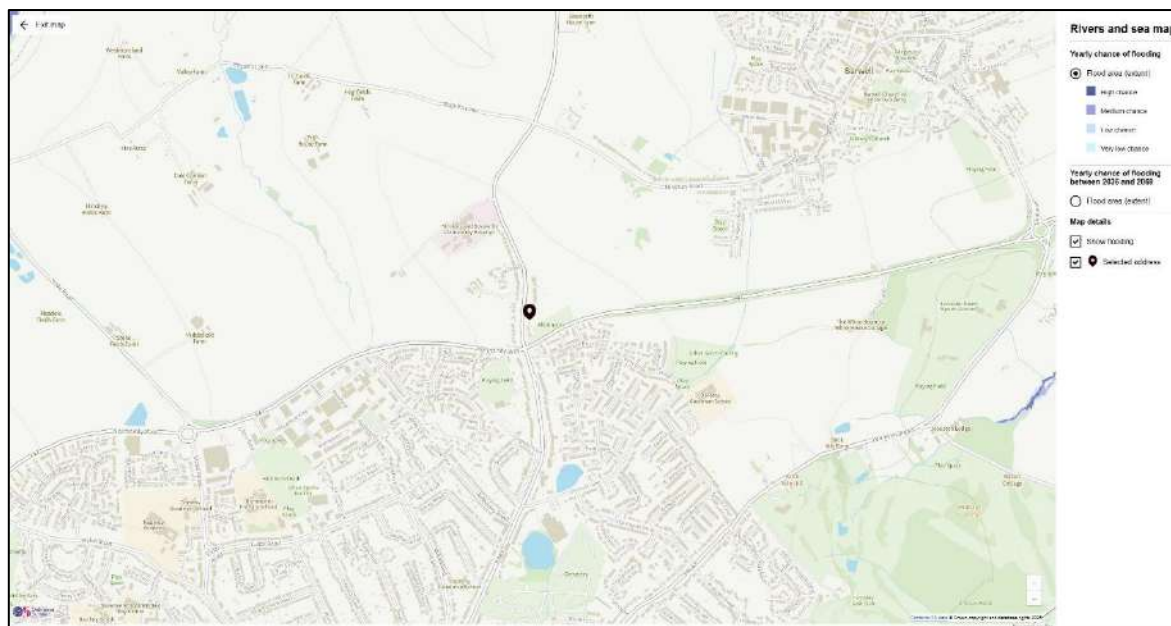
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-  Flood zone 3
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Water storage area

0 20 40 60m

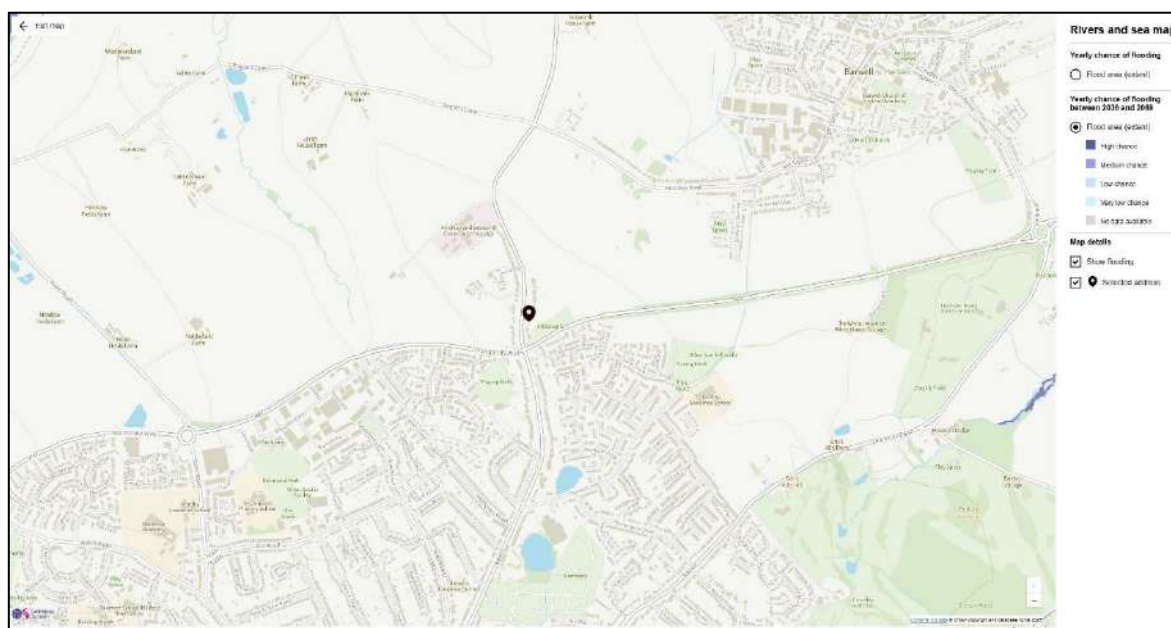
Page 2 of 2



11.4.2 Long Term Fluvial Flood Risk Map – Present Day (2025) (EA)



11.4.3 Long Term Fluvial Flood Risk Map – Climate Change (2036 - 2069) (EA)



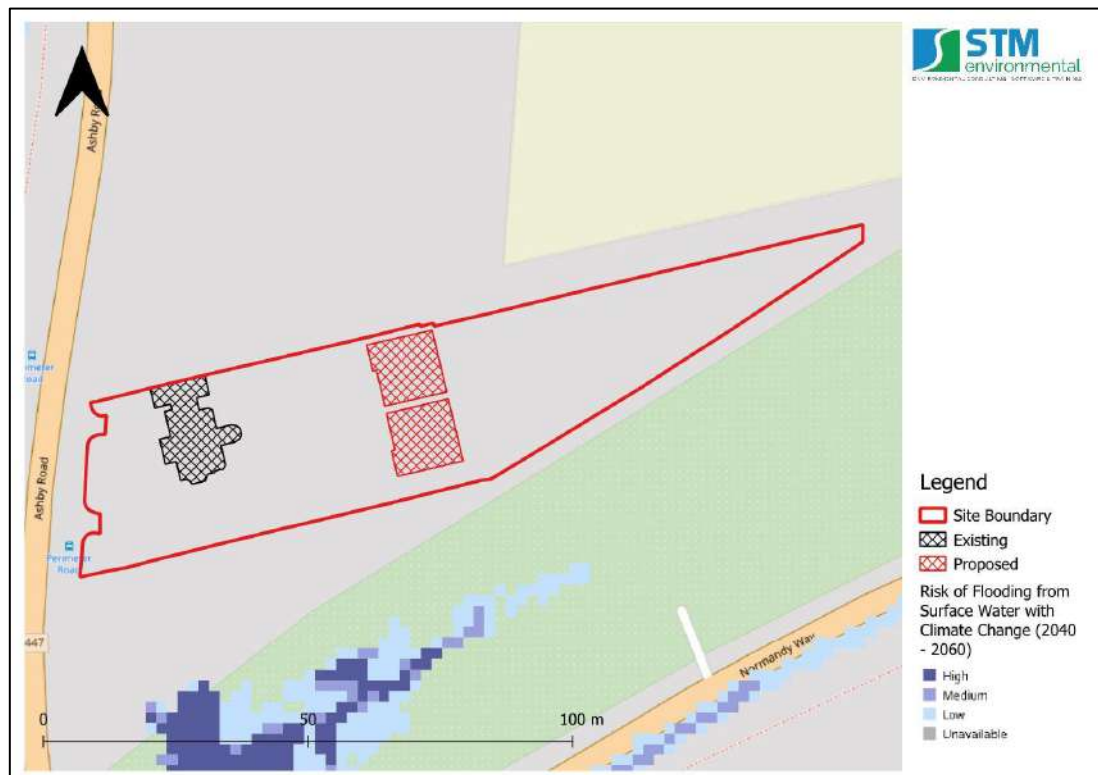
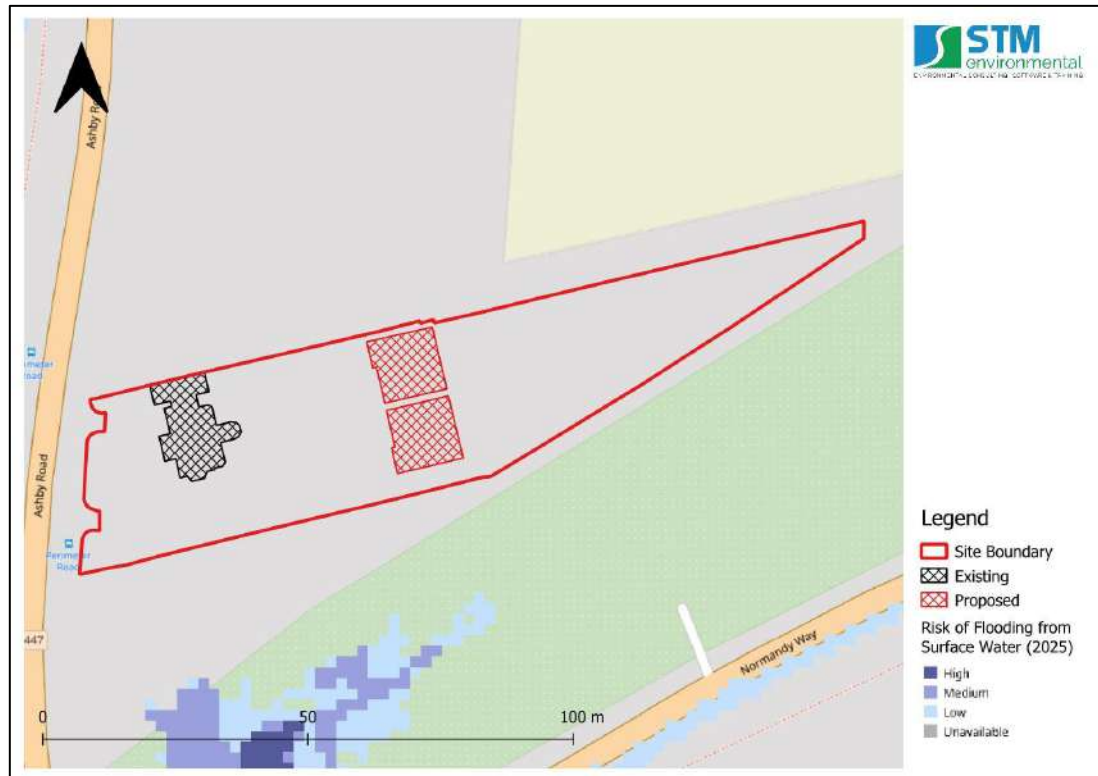
11.4.4 Long Term Pluvial Flood Risk Map – Present Day (2025) (EA)



11.4.5 Long Term Pluvial Flood Risk Map – Climate Change (2040 - 2060) (EA)



11.4.6 Surface water flood extent during the Present Day (2025) and Climate Change (2040 – 2060) modelled scenarios (Source: EA, 2025).



11.4.7 Groundwater flooding susceptibility (Source: BGS, 2016).



11.5 Appendix 4 – Runoff Rate and Storage Calculations

11.5.1 IH24 Method

Item	Value		Greenfield Run-off Rate - 1 in 100 + CC (l/s)	2.3666	
Climate Change Allowance Factor	1.40		Total Post Development Run-off Rate - 1 in 100 + CC (l/s)	3.7778	
SAAR (mm) - Current	652.00		Difference between Greenfield and Post Development Run Off Rates - 1 in 100 + CC (l/s)	1.4112	
SAAR (mm) + CC	912.80		Volume of Storage Required to meet Greenfield Discharge - Difference between Post Development and Greenfield 1 in 100 + CC volumes (m3)	30.4814	
SPR (Greenfield)	0.30		Difference between 3 * Greenfield and Post Development 1 in 100 + CC Run Off Rates	-3.3221	
SPR (Impermeable)	0.53		Volume of Storage Required to meet 3 * Greenfield Discharge - Difference between Proposed Development and 3 * Greenfield 1 in 100 + CC (m3)	-71.7579	
Site Area (ha)	0.3704				
Impermeable Area (Pre Development - ha)	0.11130				
Permeable Area (Pre Development - ha)	0.2591000		Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Impermeable Area (Post Development - ha)	0.0905850	Qbar	0.62	1.08	0.99
Permeable Area (Post Development - ha)	0.2798150	1 in 1	0.52	0.89	0.82
GCF (1 in 1)	0.83	1 in 30	1.24	2.15	1.98
GCF (1 in 30)	2.00	1 in 100	1.60	2.77	2.55
GCF (1 in 100)	2.57	1 in 100 + CC	2.37	4.10	3.78
Hydrological Region	4				
Soil Type	4				
Rainfall 100 Yrs 6 hours mm					
GREENFIELD RUN-OFF	QBAR50	Run-Off Rate l/s	l/s/ha (QBARA)	3 times greenfield (l/s)	Volume (6 hr) - Standard (m3)
Qbar	83.8552	0.6212	1.6771		
1 in 1		0.5156	1.3920	1.5468	11.1369
1 in 30		1.2424	3.3542	3.7272	26.8358
1 in 100		1.5965	4.3102	4.7894	34.4840
GREENFIELD RUN-OFF + CC	124.3082	0.9209	2.4862	2.7626	19.8909
1 in 1 + CC		0.7643	2.0635	2.2930	16.5094
1 in 30 + CC		1.8417	4.9723	5.5252	39.7818
1 in 100 + CC		2.2666	5.3894	7.0999	51.1195
PRE -DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (l/s/ha (QBARA))			Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	288.3071	0.6418	5.7661	1.9253	13.8623
1 in 1		0.5327	4.7859	1.5980	11.5057
1 in 30		1.2535	11.5323	3.8936	27.7245
1 in 100		1.6494	14.8190	4.9481	35.6260
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	83.8552	0.4345	1.5529	1.3036	
1 in 1		0.3607	1.2899	1.0820	7.7904
1 in 30		0.8691	3.1059	2.6072	18.7720
1 in 100		1.1168	3.9911	3.3503	24.1220
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	372.1623	1.0763	7.3191	3.2289	13.8623
1 in 1		0.8933	6.0748	2.6823	19.2961
1 in 30		2.1526	14.6382	6.4579	46.4966
1 in 100		2.7661	18.8101	8.2983	59.7481
PRE DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	427.3908	0.9514	10.5025		20.5496
1 in 1 + CC		0.7896	8.7171		17.0562
1 in 30 + CC		1.9027	21.0051		41.0993
1 in 100 + CC		2.4450	26.9915		52.8126
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	124.3082	0.6442	2.3021	1.9325	
1 in 1 + CC		0.5347	1.9108	1.6040	11.5486
1 in 30 + CC		1.2693	4.6042	3.8650	27.8279
1 in 100 + CC		1.6595	5.9154	4.9655	35.7989
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	551.6990	1.5955	12.8046	1.9325	20.5496
1 in 1 + CC		1.3243	10.6279	1.6040	28.6048
1 in 30 + CC		3.1811	25.6093	3.8650	68.9272
1 in 100 + CC		4.1005	32.9079	4.9655	88.5714
POST DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (l/s/ha (QBARA))			Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	288.3071	0.5223	5.7661	1.5670	
1 in 1		0.4335	4.7859	1.3006	9.2643
1 in 30		1.0447	11.5323	3.1340	22.5645
1 in 100		1.3424	14.8190	4.0271	28.9954
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	83.8552	0.4693	1.6771	1.4078	
1 in 1		0.3895	1.3920	1.1685	8.4132
1 in 30		0.9386	3.3542	2.8157	20.2728
1 in 100		1.2060	4.3102	3.6181	26.0506
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	372.1623	0.9916	7.4432	2.9748	
1 in 1	0.0000	0.8230	6.1779	2.4691	17.7775
1 in 30	0.0000	1.9832	14.8865	6.9496	42.8373
1 in 100	0.0000	2.5484	19.1291	7.6453	55.0460
POST DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	427.3908	0.7743	8.5478		16.7250
1 in 1 + CC		0.6427	7.0947		13.8817
1 in 30 + CC		1.5486	17.0956		33.4499
1 in 100 + CC		1.9900	21.9679		42.9832
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	124.3082	0.6957	2.4862	2.0870	
1 in 1 + CC		0.5714	2.0635	1.7322	12.4719
1 in 30 + CC		1.3913	4.9723	4.1740	30.0528
1 in 100 + CC		1.7879	6.3894	5.3636	38.6178
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	551.6990	1.4700	11.0340	2.0870	16.7250
1 in 1 + CC		1.2201	9.1582	1.7322	26.3536
1 in 30 + CC		2.9399	22.0680	4.1740	63.5027
1 in 100 + CC		3.7778	28.3573	5.3636	81.6010

Calculated by:	Joanna Hackett
Site name:	LRO 236 Ashby Road
Site location:	

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:	52.55861° N
Longitude:	1.36487° W
Reference:	1035320651
Date:	Mar 07 2025 13:15

Runoff estimation approach

IH124

Site characteristics

Total site area (ha):	0.3704
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Methodology

Q _{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Notes

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

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

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

(2) Are flow rates $< 5.0 \text{ l/s}$?

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.

Hydrological characteristics

	Default	Edited
SAAR (mm):	640	640
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57
Growth curve factor 200 years:	3.04	3.04

(3) Is $\text{SPR/SPRHOST} \leq 0.3$?

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

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Default

Edited

Q_{BAR} (l/s):	1.61	1.61
1 in 1 year (l/s):	1.34	1.34
1 in 30 years (l/s):	3.22	3.22
1 in 100 year (l/s):	4.14	4.14
1 in 200 years (l/s):	4.9	4.9

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

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Calculated by:	Georgia Travers
Site name:	Land to the Rear of 236 Ashby Road
Site location:	LE10 1SW

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:	52.55849° N
Longitude:	1.36536° W
Reference:	2256507413
Date:	Mar 10 2025 10:16

Site characteristics

Total site area (ha):	0.3704
Significant public open space (ha):	0.2317
Area positively drained (ha):	0.138700000000000000
Impermeable area (ha):	0.1387
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):	0.14
Net impermeable area for storage volume design (ha):	0.14
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.

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:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	87.78
FEH / FSR conversion factor:	1.14	1.14
SAAR (mm):	640	640
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 10 year:	1.49	1.49
Growth curve factor 30 year:	2	2

Design criteria

Climate change allowance factor:

1.4

Urban creep allowance factor:

1.1

Volume control approach

Use long term storage

Interception rainfall depth (mm):

5

Minimum flow rate (l/s):

2

Growth curve factor 100 years:

2.57

2.57

Q_{BAR} for total site area (l/s):

1.61

1.61

Q_{BAR} for net site area (l/s):

0.6

0.6

Site discharge rates

1 in 1 year (l/s):

2

2

1 in 30 years (l/s):

2

2

1 in 100 year (l/s):

2

2

Estimated storage volumes

Attenuation storage 1/100 years (m³):

85

85

Long term storage 1/100 years (m³):

0

0

Total storage 1/100 years (m³):

85

85

This report was produced using the storage estimation tool developed by HRWallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at <http://uksuds.com/terms-and-conditions.htm>. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

11.6 Appendix 5 – Drainage Asset Search

Not available at the time of writing.

11.7 Appendix 6 – Details of Proposed Of SuDS

11.7.1 Rain Water Harvesting Butt

See next page.

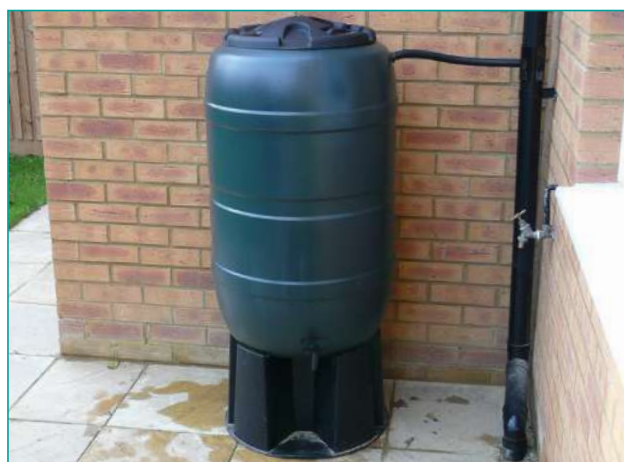
100L & 210L Water Butts and Rainwater Diverters





Product	Code
	WB100
	ST100
	WB200
	ST200

Product	Code
 Rainwater Diverter Connects to 65mm square and 68mm round downpipe (not available in sand).	RVS1
 Connector Kit (not available in brown, grey, sand or "cast iron" Style).	RVS2
 Rainwater Diverter Connects to 80mm Round Downpipe (not available in "cast iron" Style).	RVH1
 Rainwater Diverter Connects to 50mm round downpipe (not available in sand or "cast iron" Style).	RVM1
 "Cast Iron" Style Rainwater Diverter Connects to 65mm square and 68mm round downpipe.	RVS1CI



100L SLIM WATER BUTT

- 100L capacity.
- Space saving water butt ideal where space is at a premium.
- Supplied with tap and lid.
- Manufactured in the UK from recycled materials.

Dimensions

Water Butt:

32cm (12½") Length
 36cm (14") Width
 95.2cm (37½") Height

Stand:

33cm (13") Length
 33cm (13") Width
 30.5cm (12") Height

210L SLIM WATER BUTT

- 210L capacity.
- Traditional shape water butt with a large capacity.
- Supplied with tap and childproof lid.
- Manufactured in the UK from recycled materials.

Dimensions

Water Butt:

57cm (22½") Diameter
 97cm (38") Height

Stand:

53cm (21") Diameter
 31cm (12") Height

11.7.2 Permeable Paving

See next page.

Priora Sub-Base Construction

The aggregate installed beneath a Marshalls Priora surface is an essential element of the Marshalls Priora system. The aggregate must provide sufficient porosity to store water in the voids between the granular elements. It must also be of sufficient structural strength to withstand the loads to which the structure will be subjected.

Therefore, for the Marshalls Priora system to work effectively, we provide thorough aggregate specification to help source the correct material.

For detailed aggregate specification please see page 45, and for details of Marshalls Priora Aggregate, please see page 34.

6mm Jointing

6mm Laying Course

20mm Sub-base

Capping Layer (Optional)

Marshalls M15 Grid (Optional)

Jointing

A traditional concrete block pavement would use sand to fill the joints between the blocks. A Marshalls Priora system requires a more open graded coarse material, which will allow water to easily pass through into the sub-base without clogging.

It should also be of an angular nature to maximise interlock within the aggregate and between the blocks to provide additional stability to the surface layer.

Jointing Aggregate Specification:
6mm Open Graded Crushed Rock



6mm Aggregate

Laying Course

The large size of sub-base material aggregate creates an uneven surface when compacted and has an open textured surface. Therefore a laying course material is required, to provide a flatter platform onto which the blocks are laid. This should prevent any rocking or instability of the blocks in-situ.

Crucially, the laying course in a Marshalls Priora system should also provide maximum infiltration properties, allowing water to flow freely through the joints.

Laying Course Aggregate Specification:
6mm Open Graded Crushed Rock

Sub-Base

In addition to providing structural stability (as it would in a traditional pavement), the sub-base of a Marshalls Priora system must also provide sufficient hydraulic capacity to store water. This is achieved by using an aggregate with a high permeability.

Permeability is measured in terms of the aggregate/ void ratio. We recommend the use of an aggregate with a void ratio of between 30% - 32%. In effect this means that every 3m³ of aggregate can store approximately 1m³ of water

Sub-Base Aggregate Specification:
20mm Open Graded Crushed Rock

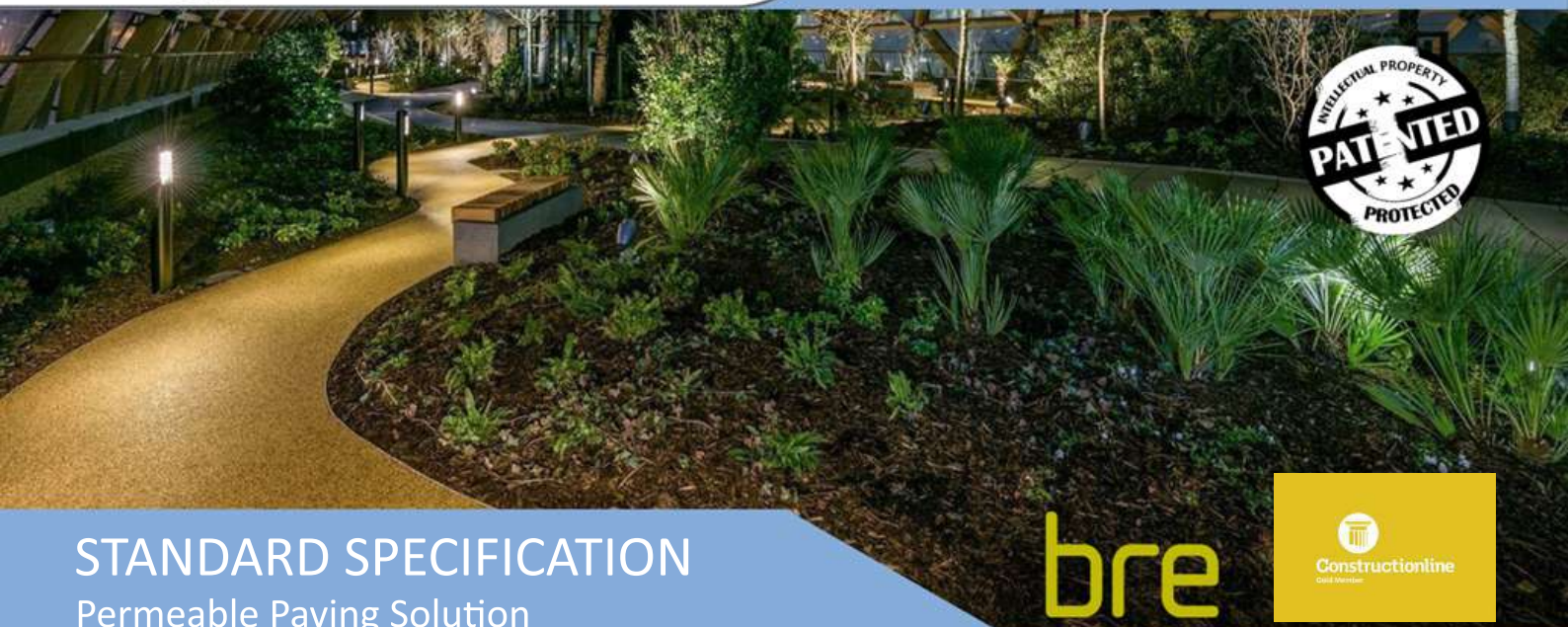


20mm Aggregate

Capping Layer

A capping layer is required on weak ground to improve the bearing capacity of the pavement. Ground is considered "weak" when the CBR (California Bearing Ratio) is below 5%. Marshalls M15 Grid can be used at the interface of the capping layer and the subgrade to confine the capping material and stabilise the structure, reducing the amount of capping material required. See page 45 for Capping Material specification. See page 33 for information on M15 Grid.

Full specification of suitable aggregate is set out in EN 13242: 2002



STANDARD SPECIFICATION

Permeable Paving Solution

bre



Sudstech is a high performance permeable paving solution that enables you to create beautifully decorative resin bound surfacing, with practical and durable qualities to match.

Sudstech permeable paving is an eco friendly SUDS-compliant (Sustainable Urban Drainage Systems) water management solution. Unlike other resin bound products, the Sudstech system utilises a recycled car tyre (SBRA) sub base eliminating delamination and clogging, ensuring unrivalled porosity of 80,000 ltrs per m2 per hour.

The slight flexibility offered by our unique sub-base allows fines,

that would usually facilitate weed growth, to agitate through the surface ensuring the system will never clog. Voids within the rubber sub base store rain fall until it can be released back into the water table. Sudstech is also tested for freeze thaw safety.

Available in a choice of colours and finishes, Sudstech offers endless possibilities and a truly unique finish.

ADVANTAGES

Patented flexible permeable base - Totally porous and clog resistant, forming a low maintenance surface paving solution

Requires no additional drainage - A highly effective soakaway that combats flash flooding

Crack free and delamination-proof - Designed to be impervious to tree root intrusion, cracking and delamination

SuDs Compliant system - The Sub-Base independent solution offers a 50mm 360 degree SuDs compliant, BBA approved, BREEAM accredited and BRE tested freeze thaw safe system

Fast installation and curing - Areas can be trafficked in under 24 hours after completion

3 - TYRES RECYCLED PER METRE²

Sudstech's unique system recycles up to 3 tyres for every square metre laid and can help offset your carbon footprint.* Contact us to find out more.

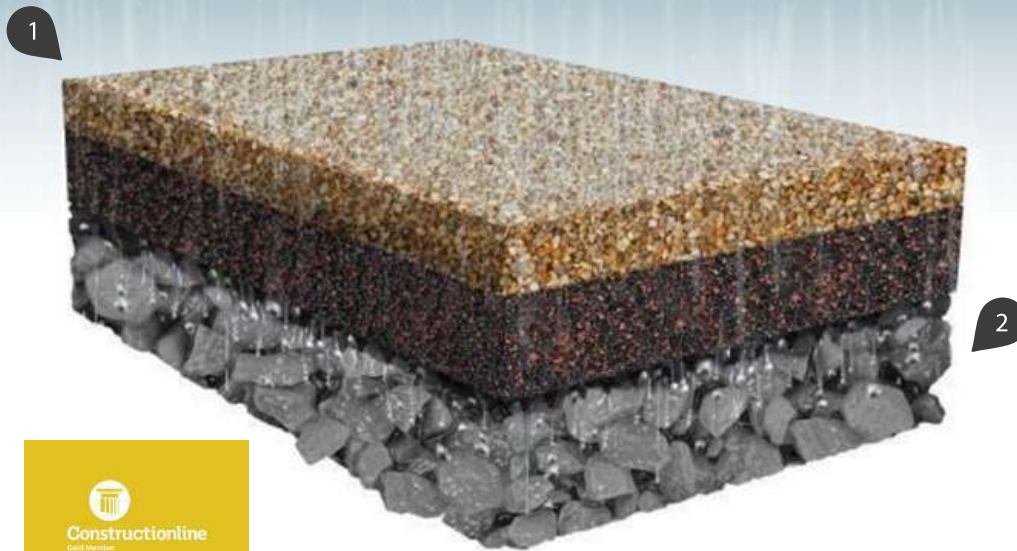
** This specification is based on normal good practice for flexible surfacing and does not absolve the specifier on designing a construction suitable for the expected traffic and ground conditions pertaining to a given site.*



10 - YEAR POROSITY GUARANTEE

Sudstech's unique blend of recycled rubber, stone and resin allows small particles of dirt and grit to agitate through the surface during use ensuring the surface remains permeable. This allows us to offer an industry first 10 year no clog guarantee.





bre



1

Sudstech Permeable Paving 50mm - An innovative blend of aggregates, unique tensile resins, recycled cross-cut rubber and plastic particles.

2

MOT Type 3 Sub-Base 50-200mm (Type 1X) (4-20mm)* - Clean, compacted angular stone with little to no fines.* Acts as an effective reservoir storing water until it can be absorbed back into the ground.

**Sub-base laid by others. May also be substituted with locally available secondary or recycled aggregates which comply with the above description.*

SPECIFICATION ADVICE

Typical groundwork specifications

Car parks/driveways 200mm MOT Type 3 (Type 1X) aggregate*
Footpaths (Urban) 50/200mm MOT Type 3 (Type 1X) aggregate*
Forest/Parks 50/200mm MOT Type 3 (Type 1X) aggregate* or
laid directly on to the existing ground using Terram.
(Subject to ground conditions & weight. Please check with technical for advice.)

Speed of cure

24 hours (Weather dependant)

Typical construction

50mm - Sudstech Permeable Paving
200mm Prepared Base - Type 3 (Type 1X) aggregate*

**Clean, Angular stone with little to no fines 4-20mm*

MAINTENANCE

Sudstech allows small fines/grit to agitate through the surface as the area is used. This produces a hostile environment for weeds and seedlings and ensures continual porosity.

Allowing expansion and contraction Sudstech is unaffected by low temperatures such as frost and ice which may otherwise cause damage during the freeze/thaw process.

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11.7.3 Rain Garden

See next page.

Stormwater Solutions for Homeowners Fact Sheet: Rain Gardens



Stormwater is rainwater and snowmelt that runs over the ground, picking up pollutants along the way—such as oil from roadways, silt and sand from exposed soil, nutrients from fertilizers, bacteria from pet waste, and pesticides from lawns. These pollutants are not treated or removed when the stormwater flows through a storm drain or directly to the nearest body of water, resulting in stormwater pollution that can contaminate shellfish beds and swimming areas, cause algae blooms and fish kills, and otherwise impact people, wildlife, and ecosystems. This runoff can also cause flooding and erosion on your property and beyond. To help address these problems, the Massachusetts Office of Coastal Zone Management (CZM) has developed Stormwater Solutions for Homeowners, a series of fact sheets on techniques to control runoff on your property and reduce stormwater contamination of local waters.

Introduction

Rain gardens are specially designed and planted depressions in the ground that collect, filter, and treat stormwater. These slightly sunken gardens allow collected water to be taken up by plants or slowly infiltrated (i.e., filtered into the ground), reducing the amount of water running off site. Rain garden soils—which are typically amended with mulch and sand to promote proper moisture levels and drainage properly—also remove pollutants (including metals, nutrients, sediments, oils/grease, and organic matter) before they reach groundwater or flow to coastlines and local waterbodies. By preventing stormwater from running into roads, storm drains, and waterways, rain gardens may also help reduce localized flooding and erosion. Rain gardens are an excellent choice for most properties and are a potential do-it-yourself project with many options for shape, plantings, and size (even small rain gardens provide great benefits). Planting a rain garden with flowering and fruiting plants, shrubs, and trees will also provide visual interest, as well as food and habitat for wildlife (see “Native Plants for Rain Gardens in Massachusetts” at the end of the fact sheet for recommendations, including options for coastal sites).



A rain garden planted along the road collects and filters stormwater before it runs off and drains to local waterbodies.

Rain gardens can be strategically located to collect and treat water flowing from roof downspouts, paved areas, or sump pumps, helping to reduce drainage problems and soggy areas in your yard—and because rain gardens more effectively capture and absorb rainwater than lawns, they make an excellent runoff-control alternative for yard areas. Rain gardens do require an appropriate soil depth to effectively treat stormwater, so they may not be suitable in areas with poorly drained or clay soils, ledge, or a high groundwater table. Be sure to follow the guidelines in this fact sheet for siting a rain garden to ensure success and avoid harmful effects.

Do You Need a Permit?

For properties near beaches, coastal banks, dunes, floodplains, rivers, salt marshes, wetlands, and other “resource areas” protected under the Massachusetts Wetlands Protection Act,* rain gardens can be particularly beneficial for helping to reduce stormwater impacts. Projects directly next to or within these resource areas, however, are likely to require a permit through the local Conservation Commission. To maximize benefits and avoid impacts to resource areas and adjacent properties, permitted projects must be properly designed, installed, and maintained. For example, rain gardens near coastal banks should be sited so there is no potential for infiltrated water to break out on the bank face and cause erosion problems. Also, a sufficient depth of soil must be maintained between the base of the rain garden and the water table to allow for proper filtration and treatment. Rain gardens must not be sited within wet resource areas, such as marshes, swamps, bogs, rivers, streams, ponds, and vegetated wetlands. During the construction of the rain garden, impacts must be minimized by providing erosion and sedimentation controls. The Massachusetts Department of Environmental Protection’s [Structural BMP Specifications for the Massachusetts Stormwater Handbook \(Volume 2, Chapter 2\)](#) (PDF, 6.5 MB) provides additional information and design requirements for stormwater control projects proposed in wetland resource areas and buffer zones. Homeowners are encouraged to contact their local Conservation Commission before undertaking any work to determine whether a resource area exists, what permitting requirements may apply, and how to avoid impacts.

* MGL Chapter 131, Section 40 and corresponding regulations at 310 CMR 10.00.

Impacts to Neighboring Properties

Stormwater management practices must be designed to responsibly manage runoff from your property without transferring problems to neighboring properties, roads, and municipal drainage systems. Rain gardens, vegetated swales, and other techniques that collect and hold stormwater have the potential to overflow “muddy” water in major storms. When designing these options, be sure that there is enough area on your property to effectively capture and treat any overflow onsite. Management practices that redirect or divert stormwater—such as disconnecting/redirecting downspouts or re-grading the land surface—can similarly cause flooding problems in roadways or neighboring yards, basements, or leach fields (potentially causing a septic system failure). These projects must therefore be designed to ensure that no additional stormwater is transferred offsite. Carefully following design guidelines in the Stormwater Solutions for Homeowners fact sheets will help you avoid impacts to neighboring properties. If in doubt about offsite impacts, consult a professional, such as a civil engineer or landscape architect.



Size and Location for a Rain Garden

Even small rain gardens capture and treat stormwater, so a project of any size can be beneficial on your property. The “Technical Specifications for Calculating Rain Garden Size” section on page 10 of this fact sheet provides some advanced, optional steps for calculating a specific rain garden size for treating runoff. As a general rule, rain gardens should be at least 1/8 to 1/3 the size of the drainage area (i.e., the area that drains runoff to the rain garden) and 3-8 inches deep to fully treat stormwater. (The specific size needed to fully treat stormwater will vary depending on your soil type and slope, which affects how well water infiltrates into the ground—see the last two bullets of this section or the “Technical Specifications” section for details.) When choosing the rain garden location, follow these steps:

- **Find places where rain or runoff can easily be collected** - Look for relatively flat areas in your yard that are downslope from roof downspouts and impervious surfaces (i.e., surfaces that do not allow water to filter into the ground, such as rooftops or driveways). Rain gardens should be located at least 10 feet away from home foundations and at least 50 feet away from septic systems or wells. If necessary, you can more efficiently direct water to the rain garden by adding extensions to downspouts or piping water underground. Directing water through rocky or grassy drainage swales is another option to convey water while providing additional infiltration (for more information on swales, see [Stormwater Solutions for Homeowners Fact Sheet: Vegetated Swales](#)). Be sure that any overflow from the rain garden will not run onto neighboring properties or roadways. Also, be sure that all components of the project are located on your property and not the road right-of-way.

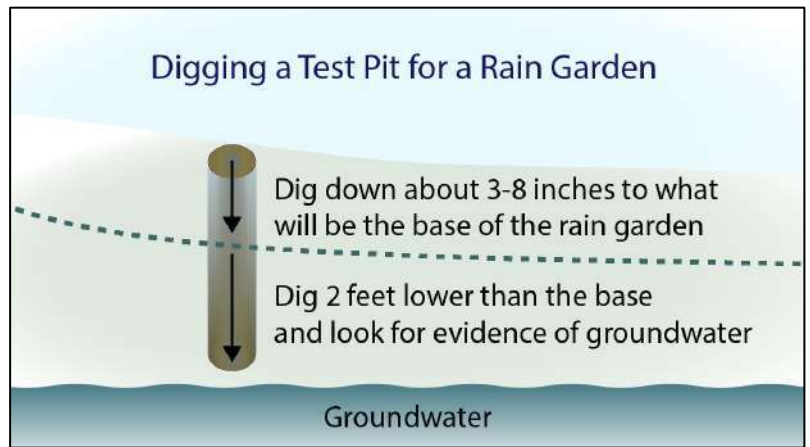


Water from a roof downspout runs through a rocky swale and into this small residential rain garden. The three photos show the sequence as native plants grew and filled in over time.

- **Check for groundwater** - Generally, at least 2 feet of soils are needed between the bottom of the rain garden and the water table to effectively filter out pollutants and protect groundwater. To check if the water table is too high, wait until the groundwater is normally at its highest (in the spring months, typically April through May), but not immediately after a heavy rain. Then, dig a hole 2 feet deeper than the planned base of your rain garden (see the “Digging a Test Pit for a Rain Garden” diagram). Leave the hole open for at least an hour, and if water seeps in or if you see soil mottling (a blotchy pattern of red, orange, or yellow that differs from the rest of the soil, indicating prolonged soil saturation from groundwater), gley (a sticky, waterlogged soil that is a green-blue-gray color), or organic muck, the location is unsuitable for a rain garden. An alternative to digging a hole is to drive

rebar or a pipe into the soil and then pull it out and check if it is damp (like using an oil dipstick). If signs of groundwater are found, you will need to try another location.

- **Ensure the water drains properly** - A rain garden will not drain properly when located too close to the groundwater level, in an area with clay or silty soils, or in a low spot that tends to collect standing water. (Please note, however, that placing a rain garden directly uphill from soggy, low spots can be ideal.) You can assess the drainage rate by digging a hole at least 1-2 feet deep (again, this is best done in the spring, and you can use the same hole you dug to check for groundwater). If water seeps into the hole within an hour, the site does not drain properly. If the hole stays dry, fill it with water and then time how long it takes the water to seep into the ground. If it drains in less than 24 hours, the location properly drains. If it takes more than 24 hours or does not fully drain, try another location or amend the soil to improve drainage (additional information on amending soils is given in the "Rain Garden Base" section).
- **Determine the soil type** - Soil type also affects how well the rain garden will drain. A "ribbon test" can be used to determine soil type—dig down below the topsoil (since organic matter can interfere with results), grab a handful of soil, roll it in a ball, and squeeze. If the soil sticks together and forms a clump (or "ribbon") more than 1.5 inches long, it is clay soil with low infiltration rates. If it forms a weak ribbon that breaks at a length of approximately 1.5 inches or less, it is a silty soil with medium infiltration rates. Sandy soil, which has high infiltration rates, will not form a ribbon at all. The type of soil and its infiltration rate will help determine whether soil amendments are necessary and can be used to help determine the ideal size for a rain garden.



Rain Garden Base

Follow these instructions to build the rain garden base:

- **Dig/excavate the base** - Mark the perimeter of the rain garden. Then remove the sod, grass, or other vegetation and dig out the rain garden area to a depth of 3-8 inches. For larger rain gardens, an excavator may be needed to remove soil or regrade the ground surface. (When using heavy equipment, be careful to avoid compacting the soil, which reduces infiltration and limits the growth of plants.) To minimize potential erosion, ensure that the rain garden base is level so the water spreads out and drains evenly. You may also grade the rain garden base so that it pitches slightly to the center to help avoid washouts and erosion along the edges.
- **Amend the soils** - Rain garden soils need to retain enough moisture for plants to grow, but also provide enough drainage so that water does not pool for extended periods. For ideal soil conditions, use 50-60% sand, 20-30% topsoil, and 20-30% shredded bark mulch—blended together as much as possible. (Triple shredded mulch should be used because it can be incorporated into the soil much faster than coarser mulch, which helps reduce compaction and improve water infiltration.) Mixing compost with rain garden soils is typically not recommended due to compost's high phosphorus content. If the ribbon test showed that your soils are high in clay and silt, dig

***Dig Safe** - At least 3 days before you plan to dig even a small hole in your yard, call [Dig Safe](#) at 811 for professional assistance in determining the location of underground utility lines!*

down an additional 6-18 inches and replace the soil with a layer of gravel or crushed stone covered with the recommended mix of sand, topsoil, and shredded mulch. (Once these materials are added, you can perform another drainage test to see if water infiltrates within 24 hours.) In some cases, you may be able to simply add amendments (such as sand) to increase the infiltration capacity of the rain garden. Soils can also be topped with a layer of bark mulch (either before or after planting) to help retain moisture and nutrients while preventing erosion and compaction. (Triple shredded mulch is also recommended for this top layer since the finer fibers interlock, helping the mulch to stay in place and providing better weed control; do not use light-weight wood chips or straw because they are easily washed away.)

- **Build a berm** - A berm (a raised barrier) built on the downhill side of the rain garden is an option to help hold water and give it time to seep into the soil. The soil removed when digging the rain garden base can be used to build the berm. If a berm is used, it should be no more than 6-8 inches high—just enough for stormwater to pond to improve infiltration into the ground.



A berm built around the downhill sides of a rain garden helps hold stormwater. The rain garden soils have been amended with sand and a planting soil mix.

- **Prevent erosion** - To help prevent runoff from washing out the mulch or soil during heavy rain, the rain garden should be relatively level or only slightly sloped and contained by a berm. In addition, the mulch used should be finely shredded and the ground surfaces should be well vegetated. During construction, you may want to install a temporary erosion-control blanket made of natural fibers over the rain garden to protect the soil until the vegetation becomes established (the natural fibers in the blanket disintegrate in 6-24 months, and the root systems of the plants take over the job of stabilizing the site; for details, see CZM's [StormSmart Fact Sheet 5: Bioengineering - Natural Fiber Blankets on Coastal Banks](#)). Optional approaches for slowing the speed of runoff flowing into the rain garden include spreading a layer of crushed stone on the uphill side of the area or creating a small stone drainage path (or drainage swale) from the source of the runoff to the rain garden (see the illustration on page 7).

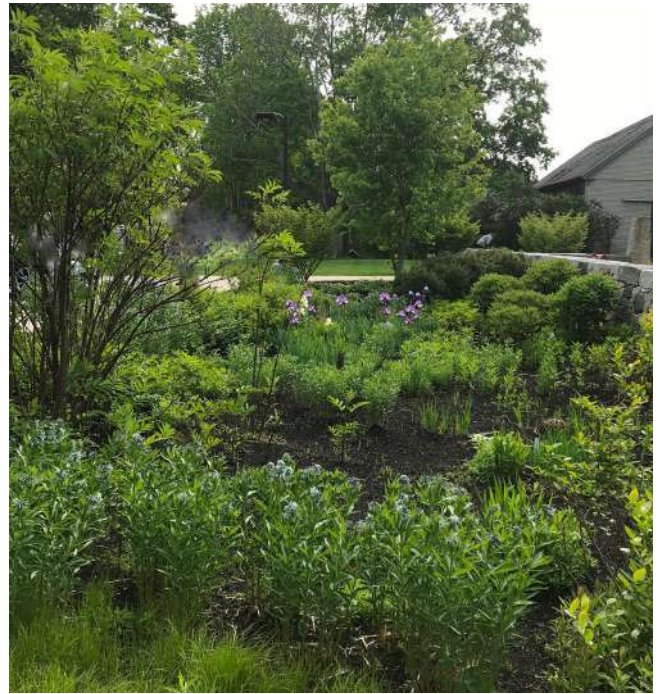
Rain Garden Plantings

Follow these guidelines to improve success of rain garden plantings.

- **Species selection and placement** - Choose hardy native species, which are well adapted to local conditions and typically do not require the use of chemical fertilizers and pesticides. Ideally, your rain garden should include a variety of plant species to ensure survival and diversity. All plants will need to tolerate some fluctuation in water levels and be able to withstand both wet and dry conditions (including droughts when soils drain completely for extended durations). Wet-tolerant plants should be placed in the wettest locations, such as in the deepest areas and where the water enters the rain garden. Plants better suited to moderate moisture or dry conditions should be placed on the edges and higher areas of the rain garden. To reduce initial planting costs, younger plants can be used—but since young plants do not necessarily thrive in standing water, for the first year you may need to dig out a small opening in your soil berm to allow water to drain. Rain gardens may also be planted with native grasses and mowed periodically. (Rain gardens should be mowed infrequently to

prevent soil compaction and to allow the growth of longer grasses and deeper root systems, which more effectively treat stormwater.) The “Native Plants for Rain Gardens in Massachusetts” box at the end of this fact sheet lists plants that are appropriate for different moisture levels. For additional plant options, see the [UMass Extension Rain Gardens fact sheet](#).

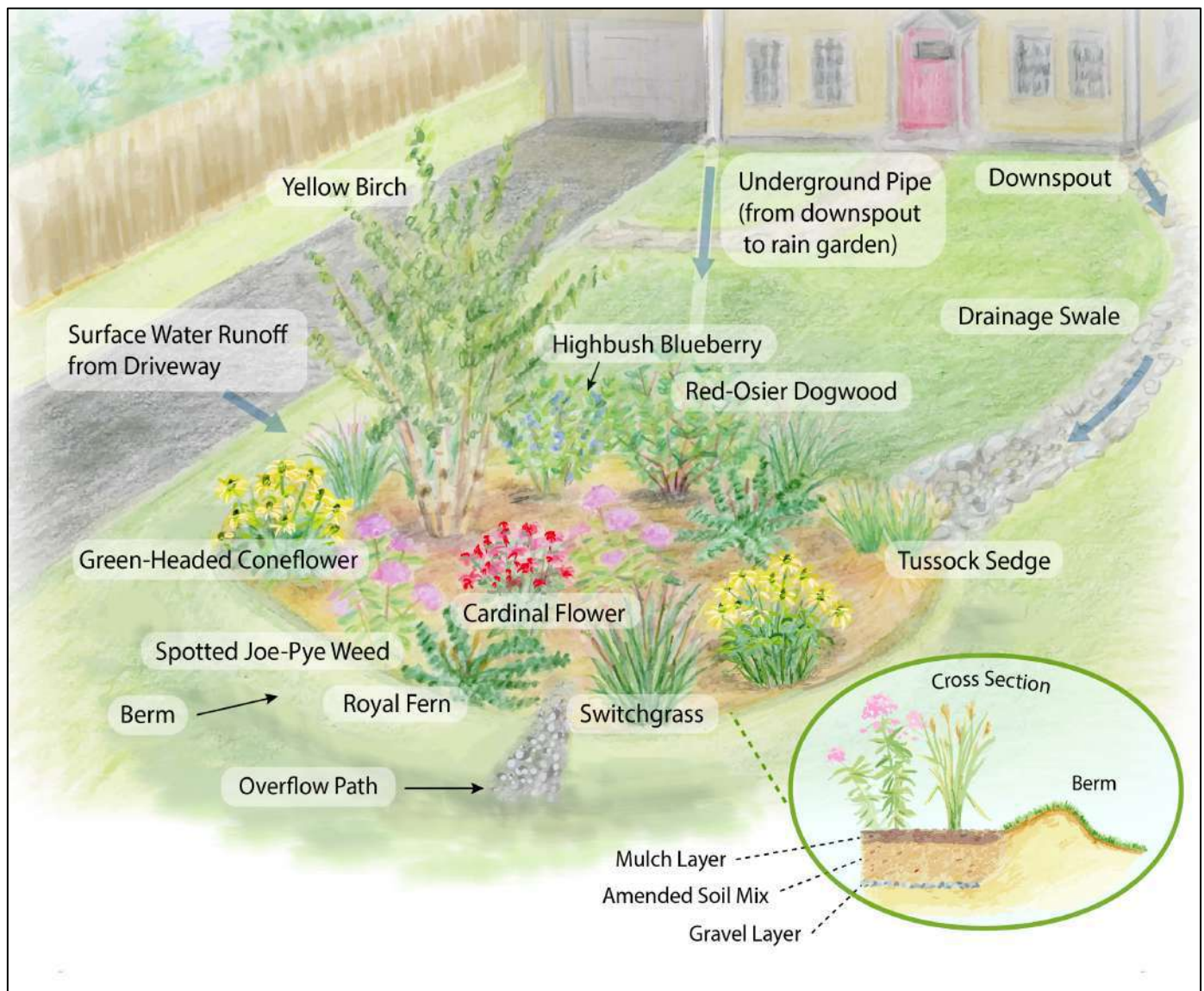
- **Aesthetics** - By planting trees, shrubs, perennials, and grasses that offer color, texture, light, and movement, rain gardens can be a source of beauty in your landscape. Planting a mix of species with different heights, forms, and flowering times can enhance appearance. Other useful design tips include placing taller flowers, shrubs, or trees behind shorter ones and arranging the plants in odd-numbered groupings. Spread plants out during the initial installation to give them room to grow—though it might look sparse at first, the plants will fill in and thrive throughout the years. Before digging, place the plants on top of the ground and move them around to find the best configuration. You can also design the shape of your rain garden to enhance the landscape, such as by creating a striking linear shape along a roadway or a more traditional round or kidney-shaped garden as landscape focal points.
- **Planting instructions** - Plant each species at the appropriate time of year (generally spring or fall when more moisture is available) and follow the specific planting and care instructions.



This rain garden was planted with a variety of native trees, shrubs, grasses, and perennials to tolerate local conditions, provide wildlife habitat, and control runoff.



Butterfly Milkweed (left), Red Columbine (middle), and White Turtlehead (right) can all be planted in the upper reaches of a rain garden where water tends to drain completely. Their long-blooming flowers are a colorful and attractive addition to a rain garden and an important nectar source for butterflies, bees, and hummingbirds.



This rain garden with native plants was sited at a low point in the yard to treat runoff from the driveway and rainwater from two roof downspouts (water is directed through a drainage swale from one downspout and an underground pipe for the other). The cross section shows the rain garden base—a layer of gravel, a 6-18" layer of soil mix, and a 2-3" layer of triple shredded mulch. The berm was built with soil removed when digging the rain garden base. An overflow path of crushed stone helps release heavy volumes of water in large rain events.

Management

These management steps can help ensure the long-term success of rain gardens.

- **Weed** - Weed newly planted rain gardens regularly to help the plants grow successfully and out-compete encroaching lawn grass and other undesirable plants. In particular, check for invasive species and remove them as soon as possible (see the Mass.Gov [Invasive Plants website](#) for more on identifying and managing these plants). Once the rain garden becomes established, less weeding will be required.
- **Prune, cut, and replace plants** - Only minimal pruning and cutting, such as removing dead or diseased limbs, is needed to keep established rain gardens in proportion and healthy. Avoid cutting or deadheading spent perennials in the fall so that they can continue to provide a seed source for birds and habitat for beneficial insects over the winter. Finally, when necessary, replace plants that have died.

- **Water** - Rain garden plants typically do not require watering once they become established. Newly planted vegetation, however, needs careful watering until the limited root system can effectively find and absorb water from the surrounding soils, particularly when planted in the hot, dry summer months. To ensure plant survival, follow the specific watering instructions on plant labels and seed packets. Adjust water levels if necessary for weather, time of year, and site conditions, such as soil type and sun and wind exposure (i.e., windblown areas, sandier soils, and dry, hot weather will warrant extra water). When watering larger perennials, shrubs, and trees, place an open hose (with a slow flow), a soaker hose, or drip tubing at the base of each plant, which will allow water to slowly seep into soils. You can water less each year, with only minimal watering needed in the third year, if at all. During long periods of drought, the rain garden will require watering. Use water that has been collected and stored in rain barrels to maximize your conservation efforts (see [Stormwater Solutions for Homeowners Fact Sheet: “Green” Lawn and Garden Practices](#) to find out how).
- **Greenscape** - Avoid using fertilizers, herbicides, and pesticides, and choose organic methods where possible (see [Greenscapes.org](#) for more information). [Stormwater Solutions for Homeowners Fact Sheet: “Green” Lawn and Garden Practices](#) has additional information on eco-friendly yard care methods that use less fertilizers and chemicals and promote the use of drought-tolerant native species that benefit the local environment.
- **Cover exposed areas with mulch or leaf litter** - If the soil dries out quickly, add 2-3 inches of organic bark mulch each spring to prevent moisture loss. (A finer mulch, such as triple shredded, is recommended.) Leaving leaf litter in place is another option for helping to retain moisture. Leaf litter also naturally fertilizes rain garden plants by releasing nutrients as the organic material decays and provides essential overwintering habitat for beneficial insects. Mulch and leaf litter can also help improve water infiltration and keep weeds down.
- **Remove sediment build-up** - Inspect rain garden areas once every 3-6 months, as well as after large storms, and remove excess sediment (such as silts) that may have accumulated from runoff. (Build-up of sediments decreases infiltration rates and smothers plants.)
- **Address any erosion impacts** - Inspect the area where water enters and exits the rain garden for signs of erosion and re-establish the vegetation or add gravel or pea-sized stone if needed to slow stormwater flow and reduce erosion impacts. Where berms show signs of washout or erosion, build them back up and replant with grass or other groundcover to stabilize the soils.
- **Minimize standing water** - To keep mosquitoes from breeding, check that water does not remain in the rain garden for longer than 24-36 hours. If water does not drain within this timeframe, create a temporary opening in the berm. If the problem persists, you may need to amend the soils to help improve infiltration. (Rain gardens with proper drainage, however, have the added advantage of serving as death traps for mosquito eggs and larvae when they regularly dry out!)
- **Expand rain garden size or create an overflow path as necessary** - If you find the rain garden is too small to hold and infiltrate the amount of water flowing into it, you can expand the size. Another option is to install a series of interconnected rain gardens or direct overflow to a drainage swale covered with crushed stone or stabilizing vegetation. To create an overflow path, dig a small channel (filled with a layer of gravel or pea-sized stone) from the rain garden to another rain garden or swale (for more on swales, see [Stormwater Solutions for Homeowners Fact Sheet: Vegetated Swales](#)). Make sure the runoff is not channeled directly to surface water, wetlands, municipal drainage systems, or your neighbor’s yard.

Additional Information

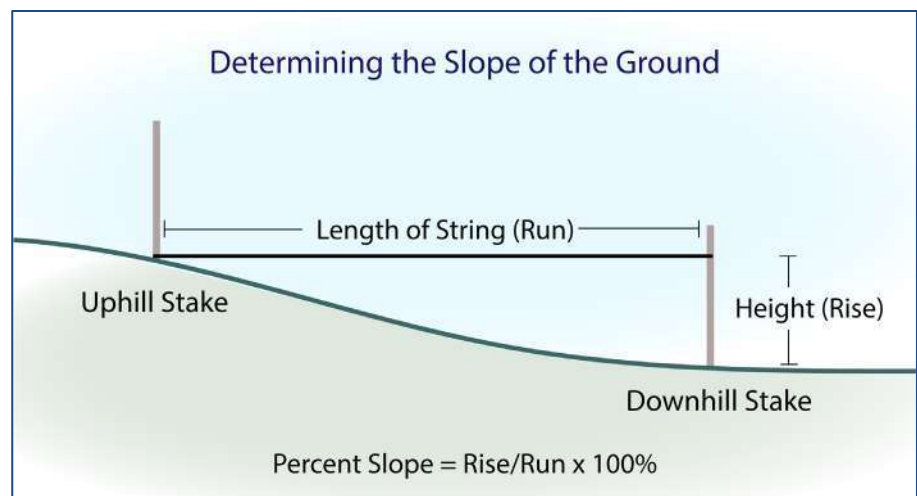
- For related fact sheets, see the CZM [Stormwater Solutions for Homeowners fact sheet website](#).
- The Massachusetts Executive Office of Energy and Environmental Affairs [Raingardens factsheet](#) (PDF, 1.2 KB), produced by GeoSyntec, describes how to design a rain garden and provides rain garden plant lists, sample plans, and photographs.
- The Massachusetts Department of Environmental Protection (MassDEP) [Structural BMP Specifications for the Massachusetts Stormwater Handbook \(Volume 2, Chapter 2\)](#) (PDF, 6.5 MB) has descriptions, design considerations, and pollutant removal efficiency information for various best management practices, including rain gardens.
- MassDEP's [Massachusetts Clean Water Toolkit](#) offers guidance on the prevention and control of nonpoint source pollution and gives links to many fact sheets, including [Bioretention Areas](#) (which use soil, plants, and microbes to treat stormwater before it is infiltrated or discharged).
- The [Think Blue Massachusetts website](#), part of a stormwater awareness campaign of MassDEP and the Statewide Stormwater Coalition, provides information to [residents](#), businesses, and developers about what they can do to reduce stormwater pollution in the environment, including methods for soaking up rainwater.
- [Massachusetts Watershed Coalition](#) has resources and information about protection and restoration of watershed ecosystems, including details, designs, and construction information on [rain gardens](#).
- New Hampshire's [Homeowner's Guide to Stormwater Management](#) (PDF, 4 MB) provides guidance to help homeowners manage stormwater on their properties and includes detailed information on rain gardens. Their [Soak Up the Rain program](#) also has useful tips and information on methods to minimize stormwater runoff.
- New Hampshire's [Native Plants for New England Rain Gardens](#) (PDF, 7 MB) identifies native plants that are adaptable, available, and have been successful for the northern New England region.
- The University of Connecticut's [Nonpoint Education for Municipal Officials \(NEMO\) program website](#) provides many useful stormwater resources, including a [Rain Gardens website](#) and a link to a mobile device app designed to help homeowners properly install a rain garden on their properties.
- The [Ecological Landscape Alliance website](#), which includes links to their newsletter, conferences, and webinars, offers design ideas and tips from professionals that install rain gardens and other ecological landscapes.
- The [Greenscapes web page](#) provides information on "green" lawn and gardening practices and includes a downloadable [Greenscapes Guide](#) that details information on how to use attractive, nature-friendly landscaping practices to reduce pollution, conserve water, support wildlife, and protect against climate change.
- Hingham's [Rain Garden Installation video](#) is an on-the-ground tutorial for building a rain garden, with details on how to dig and level the rain garden base, mix soils with compost, and select and install plants. *(Please note that compost is no longer recommended as a soil amendment for a rain garden; triple shredded mulch is recommended for its ability to stay in place, help reduce compaction, and lower nitrogen levels.)*
- The Association to Preserve Cape Cod's [Rain Garden video](#) showcases a recently installed rain garden as a natural and beautiful way to control storm water runoff and filter the groundwater.
- The U.S. Environmental Protection Agency (EPA) [Soak Up the Rain: Rain Gardens website](#) gives design details for rain gardens, including plant selection, soils, and maintenance requirements specific to Massachusetts.
- EPA's [National Stormwater Calculator](#) is a desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site. The calculator can also be used to help homeowners determine what mix of rain garden and other stormwater control options can be used to capture this runoff.
- CZM's [Coastal Landscaping website](#) provides information on landscaping coastal areas with salt-tolerant vegetation to reduce storm damage and erosion.

Technical Specifications for Calculating Rain Garden Size

While rain gardens of any size can provide benefits on your property, this section specifies how to more precisely calculate the size (depth and area) needed to fully treat stormwater from a typical storm in Massachusetts. Generally, a rain garden should be at least 1/8 to 1/3 the size of the drainage area to keep its water-level depths between 3-8 inches after a typical 1-inch rainfall. (Deeper water diminishes the ability of rain garden soils and plants to effectively treat and filter stormwater.) To specifically calculate the recommended size, follow these steps:

- 1. Drainage area** - First, identify the area that slopes toward the rain garden. Then, calculate the portion of that area with impervious surfaces, which include rooftops, driveways, patios, and other areas that do not readily absorb water (including lawns where soils tend to compact, making it difficult for water to infiltrate). For rooftops, only include the roof area that runs into the particular downspouts that flow to the rain garden. *For an example calculation, assume that **400 square feet** of driveway, walkway, and lawn are in the drainage area. In addition, a 40-foot by 30-foot roof has half of its area sloping toward and draining to the rain garden (40 feet x 30 feet x 0.5 = **600 square feet**). When added to the 400 square feet of other impervious surface, this makes for a total drainage area of **1,000 square feet**.*
- 2. Volume of runoff** - The rain garden should be built to hold runoff for a typical 1-inch rainfall. To calculate this figure in cubic feet, convert 1 inch to feet (1 inch ÷ 12 inches [per foot] = .08 feet). Then, multiply this number by the drainage area calculated in Step 1. *In this example, the volume of runoff from the drainage area is 1,000 square feet x .08 feet = **80 cubic feet**.* (This volume figure will be used in Step 7 to ensure that the size of the rain garden is sufficient.)

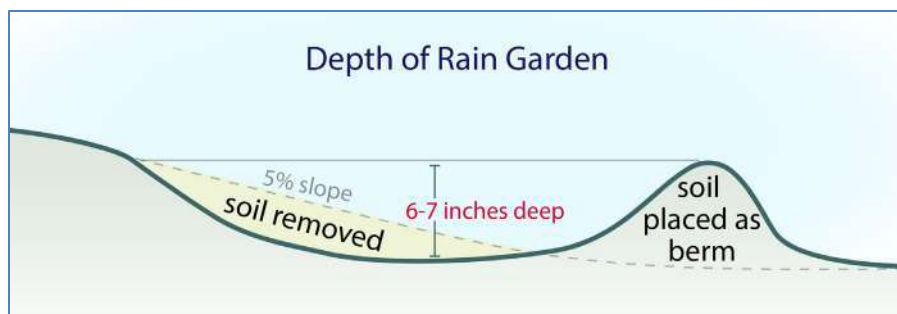
- 3. Slope** - The slope of the ground where the rain garden will be located affects how deep the rain garden needs to be. The slope is calculated using this formula: $(\text{rise} \div \text{run}) \times 100\%$. (The run is the rain garden length, and the rise is the difference in elevation along that length.) To find these measurements, place one stake on the uphill end of the proposed rain garden and another on the downhill end and tie a string between them. (Run the string from the base of the uphill stake horizontally to the downhill stake; use a line level to ensure the string is horizontal.) The run is the length of the string, and the rise is the height measured from the ground level to the string along the downhill stake. *For example, a string 6 inches high at the downhill stake and 120 inches long from stake to stake has a slope of 6 inches ÷ 120 inches x 100% = **5%**.*



This diagram illustrates the stake and string method for finding the ground slope at the location of the proposed rain garden.

4. **Depth** - Use this slope/depth chart to find the recommended rain garden depth based on the calculated slope. *In this example, a 5% slope would require a rain garden depth of 6-7 inches.*

SLOPE	DEPTH
< 4%	3-5 inches
5 - 7%	6-7 inches
8 - 12%	8+ inches



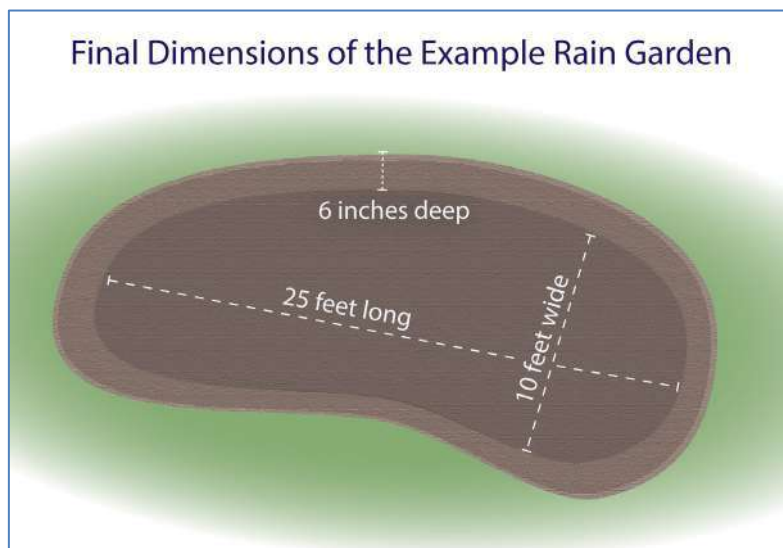
For a ground slope of 5%, a rain garden should be 6-7 inches deep. Soils can be removed from the uphill side of the slope to create the required depth and used to build a berm on the downhill side to contain the rain garden water.

5. **Size factor** - Once you know the appropriate depth, select the size factor for your soil type from this chart. *For example, if the soils were found to be silty during the ribbon test, the size factor would be 0.25 for the rain garden depth of 6-7 inches. (This 0.25 represents $\frac{1}{4}$ of the size of the drainage area and will be used in Step 6.)*

SIZE FACTOR	RAIN GARDEN DEPTH		
soil type	3-5 inches	6-7 inches	8+ inches
Sand	0.19	0.15	0.08
Silt	0.34	0.25	0.16
Clay	0.43	0.32	0.20

6. **Rain garden area** - Multiply the size factor by the drainage area calculated in Step 1 to determine the recommended square footage needed for the rain garden. *In this example, the drainage area of 1,000 square feet $\times$ 0.25 = 250 square feet.*

7. **Final dimensions** - Select an appropriate length and width to create a total rain garden area that is equal to or greater than the area calculated in Step 6, and then check that the final dimensions are sufficient. *For example, you could choose dimensions of 25 feet long by 10 feet wide to create a 250-square-foot rain garden. The final dimensions of our example rain garden would then be 25 feet long by 10 feet wide by 6 inches (or .5 feet) deep. This rain garden could hold up to 250 square feet $\times$.5 feet = 125 cubic feet of water, which can easily treat the 80 cubic feet of runoff from the drainage area (calculated in Step 2).*



The final dimensions for the example rain garden are 25 feet long, 10 feet wide, and 6 inches deep. This rain garden could hold approximately 125 cubic feet of water.

Native Plants for Rain Gardens in Massachusetts

	High-Moisture Areas	Moderate-Moisture or Dry Areas
Perennials and Grasses	Blue Flag Iris (<i>Iris versicolor</i>) Cardinal Flower (<i>Lobelia cardinalis</i>) Common Sneezeweed (<i>Helenium autumnale</i>) Golden Alexanders (<i>Zizia aurea</i>) Great Blue Lobelia (<i>Lobelia siphilitica</i>) Marsh Marigold (<i>Caltha palustris</i>) Royal Fern (<i>Osmunda regalis</i>) Sensitive Fern (<i>Onoclea sensibilis</i>) Soft Rush (<i>Juncus effuses</i>) Spotted Joe-Pye Weed (<i>Eutrochium maculatum</i>) Swamp Milkweed (<i>Asclepias incarnata</i>) Swamp Rose-Mallow (<i>Hibiscus moscheutos</i>) Sweet Flag (<i>Acorus americanus</i>) Tussock Sedge (<i>Carex stricta</i>) White Turtlehead (<i>Chelone glabra</i>)	Beebalm/Wild Bergamot (<i>Monarda fistulosa</i>) Boneset (<i>Eupatorium perfoliatum</i>) Butterfly Milkweed (<i>Asclepias tuberosa</i>) Culver's Root (<i>Veronicastrum virginicum</i>) Foamflower (<i>Tiarella cordifolia</i>) Foxglove Beardtongue (<i>Penstemon digitalis</i>) Green-Headed Coneflower (<i>Rudbeckia laciniata</i>) Indian Grass (<i>Sorghastrum nutans</i>)* Little Bluestem (<i>Schizachyrium scoparium</i>)* Meadowsweet (<i>Spiraea alba</i>) New England Aster (<i>Symphotrichum novae-angliae</i>)* Pink Tickseed (<i>Coreopsis rosea</i>) Red Columbine (<i>Aquilegia canadensis</i>)* Seaside Goldenrod (<i>Solidago sempervirens</i>)* Switchgrass (<i>Panicum virgatum</i>)*
Shrubs and Trees	Buttonbush (<i>Cephalanthus occidentalis</i>) Red-Osier, Silky, Gray Dogwoods (<i>Swida</i> spp.) Smooth Alder (<i>Alnus serrulata</i>) Spicebush (<i>Lindera benzoin</i>) Swamp Rose (<i>Rosa palustris</i>) Sweetgale (<i>Myrica gale</i>) Sweet Pepperbush (<i>Clethra alnifolia</i>)* Winterberry (<i>Ilex verticillata</i>)*	Arrowwood Viburnum (<i>Viburnum dentatum</i>)* Black Chokeberry (<i>Aronia melanocarpa</i>)* Cranberry Bush (<i>Viburnum opulus</i>) Highbush Blueberry (<i>Vaccinium corymbosum</i>)* Inkberry (<i>Ilex glabra</i>)* Red Chokeberry (<i>Aronia arbutifolia</i>)* Serviceberry (<i>Amelanchier</i> spp.)* Yellow Birch (<i>Betula alleghaniensis</i>)

*These plants are tolerant of coastal conditions, such as salt spray and wind, and may also be appropriate in rain gardens near roadways treated with salt or other deicers during the winter.

www.mass.gov/coastal-water-quality-program

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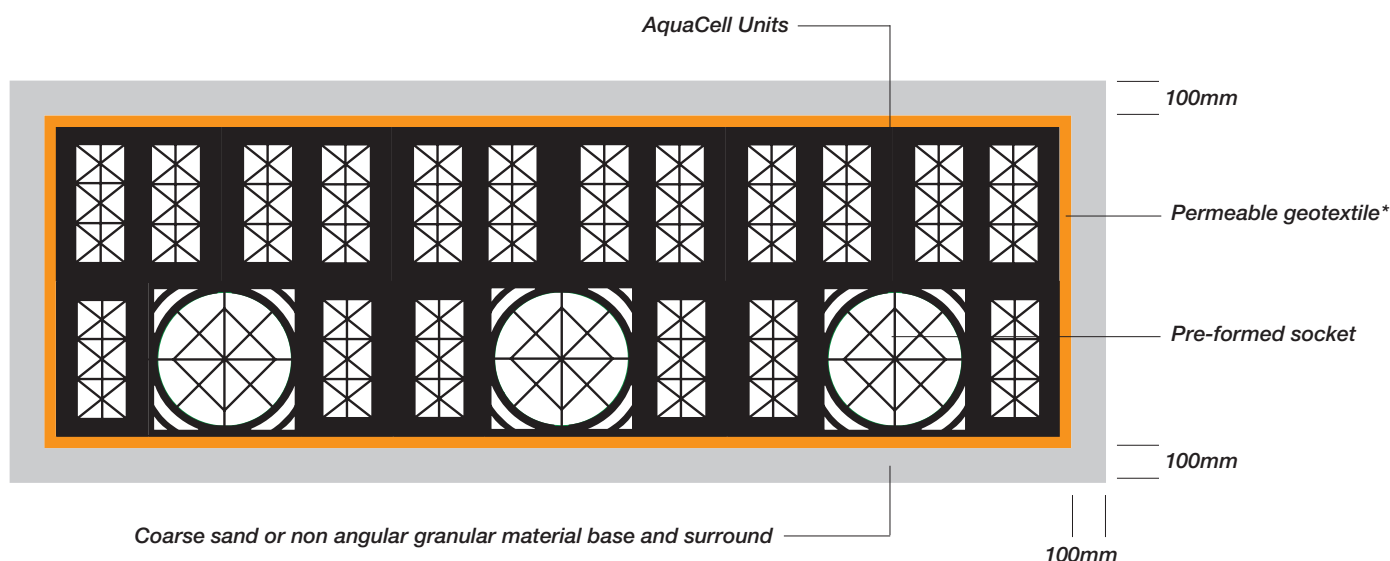


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11.7.4 Geocellular Storage Soakaway

See next page.

Guidance Note 1 – Typical Soakaway Installation Method



Example shows the use of AquaCell Eco. However, a soakaway can also be installed as shown using either of the other versions of AquaCell units (Prime, Core or Plus) as appropriate.

** The geotextile should be selected according to specific site conditions. Typically, however, a 300g non-woven material will be suitable. Specialist advice should be sought if surrounding soil characteristics exhibit a high degree of fines/low infiltration capacity and/or there is a high risk of damage from ground contaminants.*

Typical Installation Procedure

1. Excavate the trench to the required depth ensuring that the plan area is slightly greater than that of the AquaCell units.
2. Lay 100mm bed of coarse sand or non angular granular material, level and compact.
3. Lay the geotextile* over the base and up the sides of the trench.
4. Lay the AquaCell units parallel with each other. In multiple layer applications, wherever possible, continuous vertical joints should be avoided. AquaCell units can be laid in a 'brick bonded' formation (i.e. to overlap the joints below). For single layer applications use the AquaCell Clips and for multi layers use the AquaCell Clips and the AquaCell Shear Connectors (vertical rods).
5. Fix the Adaptors to the AquaCell units as required and connect pipework.
6. In order to prevent silt from entering the tank, clogging inlet pipework and reducing storage capacity, it is recommended that the Domestic Silt Trap (6LB300) or the standard Silt Trap (6LB600) is installed prior to the inlet pipework.
7. Wrap and overlap the geotextile covering the entire AquaCell structure.
8. Lay 100mm of coarse sand or non angular granular material between the trench walls and the AquaCell structure and compact.
9. Lay 100mm of coarse sand or non angular granular material over the geotextile and compact.
10. Backfill with suitable material.
11. Rainwater from roof areas may discharge directly into the soakaway but rainwater from car parks must discharge through a catchpit manhole and/or a petrol interceptor.

11.8 Appendix 7 - Drainage Modelling

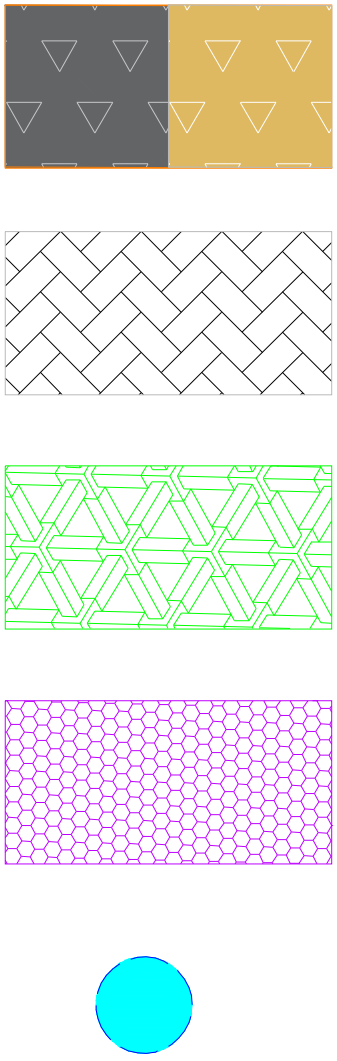
11.8.1 Drainage Layout

PDF to follow.

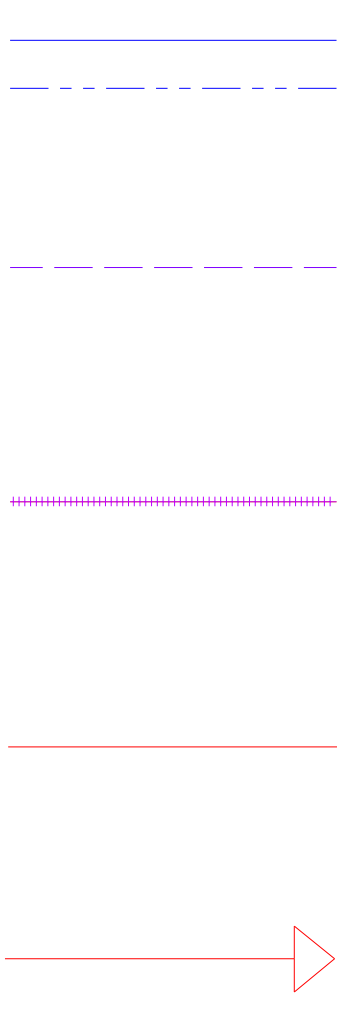


Map Legend

-  Surface Water Manhole
-  Surface Water Inspection Manhole
-  Flow Control Chamber
-  Rainwater Down Pipe with shoe Discharges to surface of structure

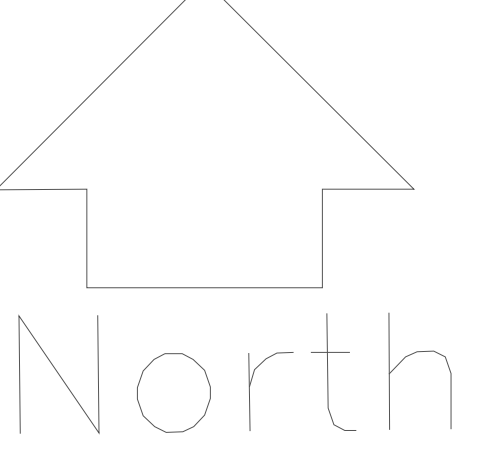


- Resin Bound Gravel - Permeable
- Block Paving
- Rain Garden
- Geocellular Soakaway
- Rainwater Butt



- Surface Water Pipe
- Perforated Pipe
- Acco Drainage Channel
- Foul Water Sewer
- Exceedance Flow

Project	:FRASW - 2025 - 000006
Site	:Land To The Rear of :236 Ashby Road :Hinckley :LE10 1SW
Company	:STM Environmental
Client	:Dale Higgot
Issue	:No.1.0
By	:Matthew Ashdown



11.8.2 Drainage Results

PDF to follow.

Design Settings

Rainfall Methodology	FEH-22	Time of Entry (mins)	5.00	Connection Type	Level Soffits	Enforce best practice design rules	x
Return Period (years)	1	Maximum Time of Concentration (mins)	30.00	Minimum Backdrop Height (m)	0.200		
Additional Flow (%)	0	Maximum Rainfall (mm/hr)	50.0	Preferred Cover Depth (m)	1.200		
CV	0.750	Minimum Velocity (m/s)	1.00	Include Intermediate Ground	✓		

Adoptable Manhole Type

Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)
374	1200	499	1350	749	1500	900	1800

>900 Link+900 mm

Max Depth (m)	Diameter (mm)	Max Depth (m)	Diameter (mm)
1.500	1050	99.999	1200

Circular Link Type

Shape	Circular	Barrels	1	Auto Increment (mm)	75	Follow Ground	x
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Available Diameters (mm)

100 | 150

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
P1	0.010	5.00	25.000	450	443161.042	295844.927	0.907
Vent			24.751	300	443175.507	295845.105	0.251
R1			24.800	300	443172.166	295847.526	1.100
S1			24.800	600	443172.918	295844.567	0.837
P1a	0.010	5.00	25.000	300	443163.967	295832.536	0.450

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	P1a	P1	12.732	0.600	24.550	24.393	0.157	81.1	100	5.25	36.6
1.001	P1	R1	11.424	0.600	24.393	24.268	0.125	91.4	100	5.48	35.9
1.002	R1	S1	3.053	0.600	24.000	23.963	0.037	82.5	100	5.54	35.8
1.003	S1	Vent	2.644	0.600	24.600	24.500	0.100	26.4	50	5.59	35.7

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	0.855	6.7	1.0	0.350	0.507	0.010	0.0	26	0.613
1.001	0.805	6.3	1.9	0.507	0.432	0.020	0.0	38	0.706
1.002	0.847	6.7	1.9	0.700	0.737	0.020	0.0	37	0.736
1.003	0.946	1.9	1.9	0.150	0.201	0.020	0.0	43	1.078

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	12.732	81.1	100	Circular	25.000	24.550	0.350	25.000	24.393	0.507
1.001	11.424	91.4	100	Circular	25.000	24.393	0.507	24.800	24.268	0.432
1.002	3.053	82.5	100	Circular	24.800	24.000	0.700	24.800	23.963	0.737
1.003	2.644	26.4	50	Circular	24.800	24.600	0.150	24.751	24.500	0.201

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	P1a	300	Manhole	Adoptable	P1	450	Manhole	Adoptable
1.001	P1	450	Manhole	Adoptable	R1	300	Manhole	Adoptable
1.002	R1	300	Manhole	Adoptable	S1	600	Manhole	Adoptable
1.003	S1	600	Manhole	Adoptable	Vent	300	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
P1	443161.042	295844.927	25.000	0.907	450	1 	1.000	24.393	100
Vent	443175.507	295845.105	24.751	0.251	300	0 	1.001	24.393	100
R1	443172.166	295847.526	24.800	1.100	300	1 	1.002	24.268	100
S1	443172.918	295844.567	24.800	0.837	600	0 	1.003	24.600	50
P1a	443163.967	295832.536	25.000	0.450	300	0 	1.000	24.550	100

Simulation Settings

Rainfall Methodology	FEH-22	Summer CV	0.750	Skip Steady State	x	Additional Storage (m³/ha)	20.0	Check Discharge Rate(s)	x
Rainfall Events	Singular	Analysis Speed	Normal	Drain Down Time (mins)	240	Starting Level (m)		Check Discharge Volume	x

Storm Durations

30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 1440 | 2160



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

Node P1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.02000	Safety Factor	2.0	Invert Level (m)	24.393
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.15	Time to half empty (mins)	5

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	23.0	23.0	0.300	23.0	28.1	0.301	0.0	28.1

Node R1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.03700	Safety Factor	2.0	Invert Level (m)	24.000
Side Inf Coefficient (m/hr)	0.03700	Porosity	0.30	Time to half empty (mins)	96

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	20.0	20.0	0.400	20.0	26.3	0.401	0.0	26.3

Node R1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	24.400
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.15	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	20.0	20.0	0.300	20.0	24.8	0.301	0.0	24.8

Node S1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.03000	Safety Factor	2.0	Invert Level (m)	23.500
Side Inf Coefficient (m/hr)	0.03000	Porosity	0.91	Time to half empty (mins)	704

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	8.0	8.0	0.800	8.0	16.0	0.801	0.0	16.0

Other (defaults)

Entry Loss (manhole)	0.250	Entry Loss (junction)	0.000	Apply Recommended Losses	x
Exit Loss (manhole)	0.250	Exit Loss (junction)	0.000	Flood Risk (m)	0.300

Approval Settings

Node Size	✓	Cover Depth	✓	Proportional Velocity	✓	Time to Half Empty	✓
Node Losses	✓	Minimum Cover Depth (m)	1.200	Return Period (years)	100	Return Period (years)	30
Link Size	✓	Maximum Cover Depth (m)	3.000	Minimum Proportional Velocity (m/s)	0.750	Discharge Rates	✓
Minimum Diameter (mm)	150	Backdrops	✓	Maximum Proportional Velocity (m/s)	3.000	100 year (l/s)	0.0
Link Length	✓	Minimum Backdrop Height (m)	0.200	Surcharged Depth	✓	Discharge Volume	✓
Maximum Length (m)	100.000	Maximum Backdrop Height (m)	1.500	Return Period (years)	30	100 year 360 minute (m³)	0
Coordinates	✓	Full Bore Velocity	✓	Maximum Surcharged Depth (m)	0.100		
Accuracy (m)	1.000	Minimum Full Bore Velocity (m/s)	1.000	Flooding	✓		
Crossings	✓	Maximum Full Bore Velocity (m/s)	3.000	Return Period (years)	30		

Approval Results

The network has been designed using IDF rainfall
It contains 5 nodes (1 outfall) and 4 links
The total impermeable area is 0.020 ha
4 structures have been defined, providing 10m³ of storage below the flood risk level
Infiltration based on BRE 365 has been applied at 3 of the structures
Simulations have been completed using FEH-22 summer storms from 15 to 1440 minute duration

5 manholes are smaller than that required by the library

Node	Required Dia (mm)	Actual Dia (mm)
P1	1200	450
Vent	1200	300
R1	1200	300
S1	1200	600
P1a	1200	300

3 connections have combined exit and entry losses less than the recommended total

Node	US Link	DS Link	US Exit Loss	DS Entry Loss	Angle (degrees)	Recommended Node Losses
P1	1.000	1.001	0.250	0.250	90	1.200
R1	1.001	1.002	0.250	0.250	89	0.900
S1	1.002	1.003	0.250	0.250	87	0.900

4 circular links have diameters < 150mm

US Node	DS Node	Link	Dia (mm)
P1a	P1	1.000	100
P1	R1	1.001	100
R1	S1	1.002	100
S1	Vent	1.003	50

No links have lengths > 100.000m

No links have lengths that differ from their coordinated length by more than 1.000m

No links cross one or more other links

4 links have cover depth outside the range 1.200-3.000m

US Node	DS Node	Link	Minimum Depth (m)	Maximum Depth (m)
P1a	P1	1.000	0.350	0.507
P1	R1	1.001	0.432	0.507
R1	S1	1.002	0.700	0.737
S1	Vent	1.003	0.150	0.201

No nodes have backdrops outside the range 0.200-1.500m

4 links have full bore velocity outside the range 1.000-3.000m/s

US Node	DS Node	Link	Velocity (m/s)
P1a	P1	1.000	0.855
P1	R1	1.001	0.805
R1	S1	1.002	0.847
S1	Vent	1.003	0.946

1 link has peak proportional velocity outside the range 0.750-3.000m/s during the 100 year return period

US Node	DS Node	Link	Velocity (m/s)	Event
P1a	P1	1.000	0.660	100 year 15 minute summer

No links have a surcharged depth greater than 0.100m during the 30 year return period

No nodes flood during the 30 year return period

No infiltrating structures failed to half empty in 1440 minutes during the 30 year return period

No outfalls have a discharge rate greater than 0.0l/s during the 100 year return period

No outfalls have a discharge volume greater than 0m³ during the 100 year 360 minute storm

Rainfall								
Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year 15 minute summer	264.024	74.710	100 year 15 minute summer	330.397	93.491	100 year +40% CC 15 minute summer	462.556	130.887
30 year 30 minute summer	170.722	48.308	100 year 30 minute summer	216.795	61.346	100 year +40% CC 30 minute summer	303.513	85.884
30 year 60 minute summer	114.220	30.185	100 year 60 minute summer	145.261	38.388	100 year +40% CC 60 minute summer	203.365	53.743
30 year 120 minute summer	71.201	18.816	100 year 120 minute summer	88.872	23.486	100 year +40% CC 120 minute summer	124.421	32.881
30 year 180 minute summer	54.698	14.076	100 year 180 minute summer	67.779	17.442	100 year +40% CC 180 minute summer	94.891	24.419
30 year 240 minute summer	43.021	11.369	100 year 240 minute summer	53.129	14.040	100 year +40% CC 240 minute summer	74.380	19.656
30 year 360 minute summer	32.283	8.307	100 year 360 minute summer	39.779	10.236	100 year +40% CC 360 minute summer	55.691	14.331
30 year 480 minute summer	24.949	6.593	100 year 480 minute summer	30.732	8.121	100 year +40% CC 480 minute summer	43.024	11.370
30 year 600 minute summer	20.083	5.493	100 year 600 minute summer	24.729	6.764	100 year +40% CC 600 minute summer	34.620	9.469
30 year 720 minute summer	17.626	4.724	100 year 720 minute summer	21.692	5.814	100 year +40% CC 720 minute summer	30.369	8.139
30 year 960 minute summer	14.104	3.714	100 year 960 minute summer	17.328	4.563	100 year +40% CC 960 minute summer	24.259	6.388
30 year 1440 minute summer	9.887	2.650	100 year 1440 minute summer	12.098	3.242	100 year +40% CC 1440 minute summer	16.938	4.539

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	P1	11	24.477	0.084	6.4	0.3292	0.0000	OK
15 minute summer	Vent	1	24.500	0.000	0.0	0.0000	0.0000	OK
360 minute summer	R1	360	24.117	0.117	1.3	0.7121	0.0000	SURCHARGED
360 minute summer	S1	360	24.117	0.154	1.2	4.5377	0.0000	OK
15 minute summer	P1a	10	24.598	0.048	3.2	0.0249	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	P1	1.001	R1	6.0	0.888	0.944	0.0770	
15 minute summer	P1	Infiltration		0.1				
360 minute summer	R1	1.002	S1	1.2	0.618	0.184	0.0239	
360 minute summer	R1	Infiltration		0.1				
360 minute summer	S1	1.003	Vent	0.0	0.000	0.000	0.0000	0.0
360 minute summer	S1	Infiltration		0.1				
15 minute summer	P1a	1.000	P1	3.2	0.636	0.473	0.0681	

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	P1	12	24.515	0.122	8.0	0.4791	0.0000	SURCHARGED
15 minute summer	Vent	1	24.500	0.000	0.0	0.0000	0.0000	OK
600 minute summer	R1	555	24.207	0.207	1.0	1.2575	0.0000	SURCHARGED
600 minute summer	S1	555	24.207	0.244	0.9	5.2171	0.0000	OK
15 minute summer	P1a	10	24.605	0.055	4.0	0.0285	0.0000	OK
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	P1	1.001	R1	6.9	0.887	1.089	0.0849	
15 minute summer	P1	Infiltration		0.1				
600 minute summer	R1	1.002	S1	0.9	0.565	0.131	0.0239	
600 minute summer	R1	Infiltration		0.1				
600 minute summer	S1	1.003	Vent	0.0	0.000	0.000	0.0000	0.0
600 minute summer	S1	Infiltration		0.1				
15 minute summer	P1a	1.000	P1	4.0	0.660	0.592	0.0781	

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	P1	12	24.611	0.218	10.6	0.8579	0.0000	SURCHARGED
15 minute summer	Vent	1	24.500	0.000	0.0	0.0000	0.0000	OK
600 minute summer	R1	420	24.505	0.505	1.4	2.7567	0.0000	FLOOD RISK
600 minute summer	S1	420	24.505	0.542	0.9	5.9813	0.0000	OK
15 minute summer	P1a	12	24.698	0.148	5.7	0.0760	0.0000	SURCHARGED
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	P1	1.001	R1	8.4	1.079	1.335	0.0873	
15 minute summer	P1	Infiltration		0.1				
600 minute summer	R1	1.002	S1	0.9	0.565	0.131	0.0239	
600 minute summer	R1	Infiltration		0.1				
600 minute summer	S1	1.003	Vent	0.0	0.000	0.000	0.0000	0.0
600 minute summer	S1	Infiltration		0.1				
15 minute summer	P1a	1.000	P1	5.2	0.710	0.771	0.0996	

Design Settings

Rainfall Methodology	FEH-22	Time of Entry (mins)	5.00	Connection Type	Level Soffits	Enforce best practice design rules	x
Return Period (years)	1	Maximum Time of Concentration (mins)	30.00	Minimum Backdrop Height (m)	0.200		
Additional Flow (%)	0	Maximum Rainfall (mm/hr)	50.0	Preferred Cover Depth (m)	1.200		
CV	0.750	Minimum Velocity (m/s)	1.00	Include Intermediate Ground	✓		

Adoptable Manhole Type

Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)
374	1200	499	1350	749	1500	900	1800

>900 Link+900 mm

Max Depth (m)	Diameter (mm)	Max Depth (m)	Diameter (mm)
1.500	1050	99.999	1200

Circular Link Type

Shape	Circular	Barrels	1	Auto Increment (mm)	75	Follow Ground	x
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Available Diameters (mm)

100	150
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Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
P2a	0.010	5.00	25.000	300	443167.795	295816.502	0.400
P2	0.010	5.00	25.000	450	443164.296	295831.469	0.897
R2			24.800	450	443176.450	295835.707	1.100
S2			24.800	600	443177.486	295832.019	0.889
V2			24.800	300	443180.511	295833.054	0.250

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	P2a	P2	15.370	0.600	24.600	24.403	0.197	78.0	100	5.29	36.4
1.001	P2	R2	12.872	0.600	24.403	24.278	0.125	103.0	100	5.58	35.7
1.002	R2	S2	3.831	0.600	24.000	23.911	0.089	43.0	100	5.63	35.6
1.003	S2	V2	3.197	0.600	24.600	24.550	0.050	63.9	100	5.69	35.4

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	0.872	6.8	1.0	0.300	0.497	0.010	0.0	25	0.614
1.001	0.757	5.9	1.9	0.497	0.422	0.020	0.0	39	0.678
1.002	1.178	9.3	1.9	0.700	0.789	0.020	0.0	31	0.928
1.003	0.964	7.6	1.9	0.100	0.150	0.020	0.0	34	0.800

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	15.370	78.0	100	Circular	25.000	24.600	0.300	25.000	24.403	0.497
1.001	12.872	103.0	100	Circular	25.000	24.403	0.497	24.800	24.278	0.422
1.002	3.831	43.0	100	Circular	24.800	24.000	0.700	24.800	23.911	0.789
1.003	3.197	63.9	100	Circular	24.800	24.600	0.100	24.800	24.550	0.150

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	P2a	300	Manhole	Adoptable	P2	450	Manhole	Adoptable
1.001	P2	450	Manhole	Adoptable	R2	450	Manhole	Adoptable
1.002	R2	450	Manhole	Adoptable	S2	600	Manhole	Adoptable
1.003	S2	600	Manhole	Adoptable	V2	300	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
P2a	443167.795	295816.502	25.000	0.400	300				
						0	1.000	24.600	100
P2	443164.296	295831.469	25.000	0.897	450		1	1.000	24.403
						0	1.001	24.403	100
R2	443176.450	295835.707	24.800	1.100	450		1	1.001	24.278
						0	1.002	24.000	100
S2	443177.486	295832.019	24.800	0.889	600		1	1.002	23.911
						0	1.003	24.600	100
V2	443180.511	295833.054	24.800	0.250	300		1	1.003	24.550
									100

Simulation Settings

Rainfall Methodology	FEH-22	Summer CV	0.750	Skip Steady State	x	Additional Storage (m³/ha)	20.0	Check Discharge Rate(s)	x
Rainfall Events	Singular	Analysis Speed	Normal	Drain Down Time (mins)	240	Starting Level (m)		Check Discharge Volume	x

Storm Durations

30	60	120	180	240	360	480	600	720	1440	2160
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Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0	100	0	0	0
30	0	0	0	100	40	0	0

Node P2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.03000	Safety Factor	2.0	Invert Level (m)	24.403
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	5

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	23.0	23.0	0.350	23.0	29.0	0.351	0.0	29.0

Node R2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.03000	Safety Factor	2.0	Invert Level (m)	24.000
Side Inf Coefficient (m/hr)	0.03000	Porosity	0.30	Time to half empty (mins)	240

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	20.0	20.0	0.300	20.0	24.8	0.301	0.0	24.8

Node R2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	24.300
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.15	Time to half empty (mins)	225

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	20.0	20.0	0.400	20.0	26.3	0.401	0.0	26.3

Node S2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.03000	Safety Factor	2.0	Invert Level (m)	23.500
Side Inf Coefficient (m/hr)	0.03000	Porosity	0.95	Time to half empty (mins)	795

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	8.0	8.0	0.800	8.0	16.0	0.801	0.0	16.0

Other (defaults)

Entry Loss (manhole)	0.250	Entry Loss (junction)	0.000	Apply Recommended Losses	x
Exit Loss (manhole)	0.250	Exit Loss (junction)	0.000	Flood Risk (m)	0.300

Approval Settings

Node Size	✓	Cover Depth	✓	Proportional Velocity	✓	Time to Half Empty	✓
Node Losses	✓	Minimum Cover Depth (m)	1.200	Return Period (years)	1	Return Period (years)	100
Link Size	✓	Maximum Cover Depth (m)	3.000	Minimum Proportional Velocity (m/s)	0.750	Discharge Rates	✓
Minimum Diameter (mm)	100	Backdrops	✓	Maximum Proportional Velocity (m/s)	3.000	100 year (l/s)	0.0
Link Length	✓	Minimum Backdrop Height (m)	0.200	Surcharged Depth	✓	Discharge Volume	✓
Maximum Length (m)	100.000	Maximum Backdrop Height (m)	1.500	Return Period (years)	1	100 year 360 minute (m³)	0
Coordinates	✓	Full Bore Velocity	✓	Maximum Surcharged Depth (m)	0.100		
Accuracy (m)	1.000	Minimum Full Bore Velocity (m/s)	1.000	Flooding	✓		
Crossings	✓	Maximum Full Bore Velocity (m/s)	3.000	Return Period (years)	30		

Approval Results

The network has been designed using IDF rainfall
It contains 5 nodes (1 outfall) and 4 links
The total impermeable area is 0.020 ha
4 structures have been defined, providing 11m³ of storage below the flood risk level
Infiltration based on BRE 365 has been applied at 3 of the structures
Simulations have been completed using FEH-22 summer storms from 15 to 1440 minute duration

5 manholes are smaller than that required by the library

Node	Required Dia (mm)	Actual Dia (mm)
P2a	1200	300
P2	1200	450
R2	1200	450
S2	1200	600
V2	1200	300

3 connections have combined exit and entry losses less than the recommended total

Node	US Link	DS Link	US Exit Loss	DS Entry Loss	Angle (degrees)	Recommended Node Losses
P2	1.000	1.001	0.250	0.250	84	0.900
R2	1.001	1.002	0.250	0.250	94	1.200
S2	1.002	1.003	0.250	0.250	93	1.200

No circular links have diameters < 100mm

No links have lengths > 100.000m

No links have lengths that differ from their coordinated length by more than 1.000m

No links cross one or more other links

4 links have cover depth outside the range 1.200-3.000m

US Node	DS Node	Link	Minimum Depth (m)	Maximum Depth (m)
P2a	P2	1.000	0.300	0.497
P2	R2	1.001	0.422	0.497
R2	S2	1.002	0.700	0.789
S2	V2	1.003	0.100	0.150

No nodes have backdrops outside the range 0.200-1.500m

3 links have full bore velocity outside the range 1.000-3.000m/s

US Node	DS Node	Link	Velocity (m/s)
P2a	P2	1.000	0.872
P2	R2	1.001	0.757
S2	V2	1.003	0.964

2 links have peak proportional velocity outside the range 0.750-3.000m/s during the 1 year return period

US Node	DS Node	Link	Velocity (m/s)	Event
P2a	P2	1.000	0.597	1 year 15 minute summer
P2	R2	1.001	0.614	1 year 15 minute summer

No links have a surcharged depth greater than 0.100m during the 1 year return period

No nodes flood during the 30 year return period

No infiltrating structures failed to half empty in 1440 minutes during the 100 year return period

No outfalls have a discharge rate greater than 0.0l/s during the 100 year return period

No outfalls have a discharge volume greater than 0m³ during the 100 year 360 minute storm

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 15 minute summer	73.507	20.800	30 year 180 minute summer	54.698	14.076	100 year 600 minute summer	24.729	6.764
1 year 30 minute summer	46.649	13.200	30 year 240 minute summer	43.021	11.369	100 year 720 minute summer	21.692	5.814
1 year 60 minute summer	31.029	8.200	30 year 360 minute summer	32.283	8.307	100 year 960 minute summer	17.328	4.563
1 year 120 minute summer	23.788	6.287	30 year 480 minute summer	24.949	6.593	100 year 1440 minute summer	12.098	3.242
1 year 180 minute summer	19.825	5.102	30 year 600 minute summer	20.083	5.493	100 year +40% CC 15 minute summer	462.556	130.887
1 year 240 minute summer	16.326	4.314	30 year 720 minute summer	17.626	4.724	100 year +40% CC 30 minute summer	303.513	85.884
1 year 360 minute summer	12.899	3.319	30 year 960 minute summer	14.104	3.714	100 year +40% CC 60 minute summer	203.365	53.743
1 year 480 minute summer	10.240	2.706	30 year 1440 minute summer	9.887	2.650	100 year +40% CC 120 minute summer	124.421	32.881
1 year 600 minute summer	8.379	2.292	100 year 15 minute summer	330.397	93.491	100 year +40% CC 180 minute summer	94.891	24.419
1 year 720 minute summer	7.436	1.993	100 year 30 minute summer	216.795	61.346	100 year +40% CC 240 minute summer	74.380	19.656
1 year 960 minute summer	6.030	1.588	100 year 60 minute summer	145.261	38.388	100 year +40% CC 360 minute summer	55.691	14.331
1 year 1440 minute summer	4.293	1.151	100 year 120 minute summer	88.872	23.486	100 year +40% CC 480 minute summer	43.024	11.370
30 year 15 minute summer	264.024	74.710	100 year 180 minute summer	67.779	17.442	100 year +40% CC 600 minute summer	34.620	9.469
30 year 30 minute summer	170.722	48.308	100 year 240 minute summer	53.129	14.040	100 year +40% CC 720 minute summer	30.369	8.139
30 year 60 minute summer	114.220	30.185	100 year 360 minute summer	39.779	10.236	100 year +40% CC 960 minute summer	24.259	6.388
30 year 120 minute summer	71.201	18.816	100 year 480 minute summer	30.732	8.121	100 year +40% CC 1440 minute summer	16.938	4.539

Results for 1 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	P2a	10	24.625	0.025	0.9	0.0140	0.0000	OK
15 minute summer	P2	12	24.437	0.034	1.8	0.2506	0.0000	OK
15 minute summer	R2	13	24.026	0.026	1.4	0.1576	0.0000	OK
1440 minute summer	S2	870	23.730	-0.181	0.2	1.7510	0.0000	OK
15 minute summer	V2	1	24.550	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	P2a	1.000	P2	0.9	0.597	0.132	0.0283	
15 minute summer	P2	1.001	R2	1.4	0.614	0.237	0.0296	
15 minute summer	P2	Infiltration		0.1				
15 minute summer	R2	1.002	S2	1.2	0.782	0.129	0.0058	
15 minute summer	R2	Infiltration		0.0				
1440 minute summer	S2	1.003	V2	0.0	0.000	0.000	0.0000	0.0
1440 minute summer	S2	Infiltration		0.0				

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	P2a	10	24.648	0.048	3.2	0.0273	0.0000	OK
15 minute summer	P2	12	24.484	0.081	6.4	0.5954	0.0000	OK
360 minute summer	R2	368	24.108	0.108	1.3	0.6672	0.0000	SURCHARGED
360 minute summer	S2	368	24.108	0.197	1.2	4.6794	0.0000	OK
15 minute summer	V2	1	24.550	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	P2a	1.000	P2	3.2	0.700	0.463	0.0793	
15 minute summer	P2	1.001	R2	5.5	0.837	0.921	0.0842	
15 minute summer	P2	Infiltration		0.1				
360 minute summer	R2	1.002	S2	1.2	0.786	0.131	0.0300	
360 minute summer	R2	Infiltration		0.1				
360 minute summer	S2	1.003	V2	0.0	0.000	0.000	0.0000	0.0
360 minute summer	S2	Infiltration		0.1				

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	P2a	10	24.655	0.055	4.0	0.0312	0.0000	OK
15 minute summer	P2	12	24.511	0.108	8.0	0.7953	0.0000	SURCHARGED
600 minute summer	R2	555	24.200	0.200	0.9	1.2347	0.0000	SURCHARGED
600 minute summer	S2	555	24.200	0.289	0.9	5.4056	0.0000	OK
15 minute summer	V2	1	24.550	0.000	0.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	P2a	1.000	P2	4.0	0.733	0.581	0.0934	
15 minute summer	P2	1.001	R2	6.3	0.846	1.055	0.0940	
15 minute summer	P2	Infiltration		0.1				
600 minute summer	R2	1.002	S2	0.9	0.667	0.096	0.0300	
600 minute summer	R2	Infiltration		0.1				
600 minute summer	S2	1.003	V2	0.0	0.000	0.000	0.0000	0.0
600 minute summer	S2	Infiltration		0.1				

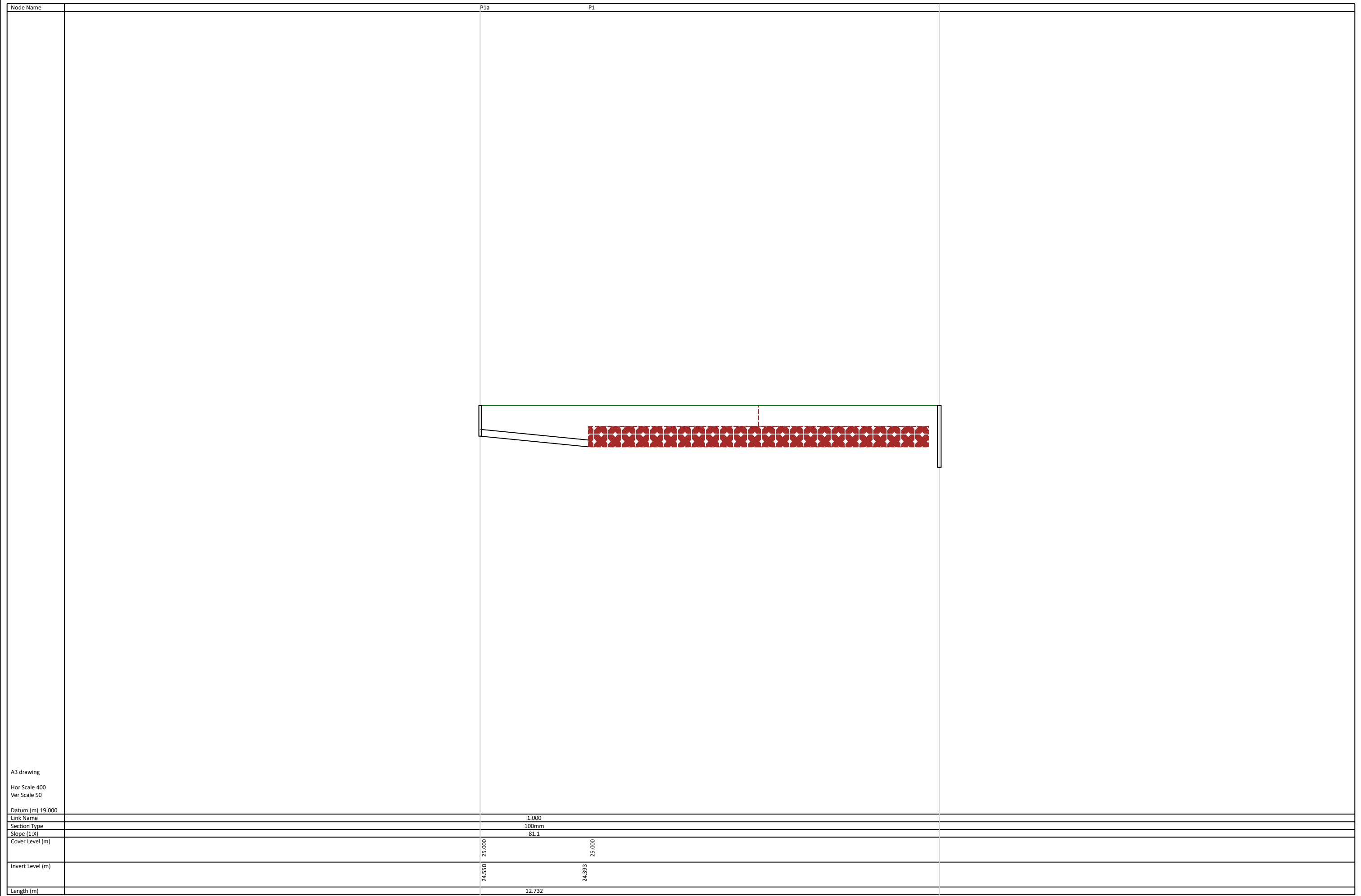
Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

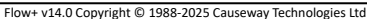
Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	P2a	11	24.673	0.073	5.7	0.0416	0.0000	OK
15 minute summer	P2	12	24.582	0.179	11.3	1.3251	0.0000	SURCHARGED
600 minute summer	R2	420	24.482	0.482	1.3	2.4258	0.0000	SURCHARGED
600 minute summer	S2	420	24.482	0.571	1.1	6.2454	0.0000	OK
15 minute summer	V2	1	24.550	0.000	0.0	0.0000	0.0000	OK

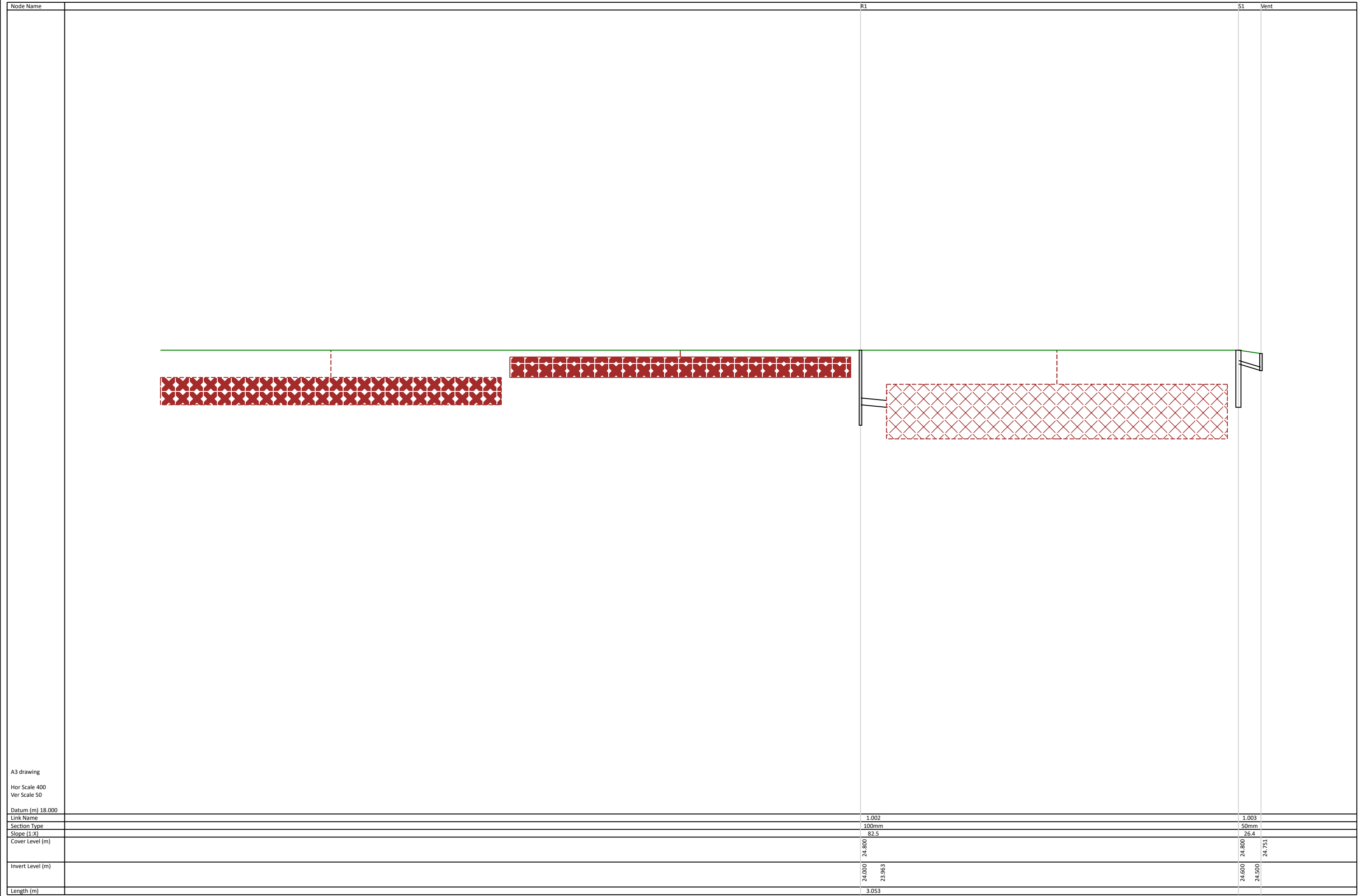
Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	P2a	1.000	P2	5.6	0.766	0.820	0.1071	
15 minute summer	P2	1.001	R2	7.6	0.970	1.274	0.0972	
15 minute summer	P2	Infiltration		0.1				
600 minute summer	R2	1.002	S2	1.1	0.717	0.114	0.0300	
600 minute summer	R2	Infiltration		0.1				
600 minute summer	S2	1.003	V2	0.0	0.000	0.000	0.0000	0.0
600 minute summer	S2	Infiltration		0.1				

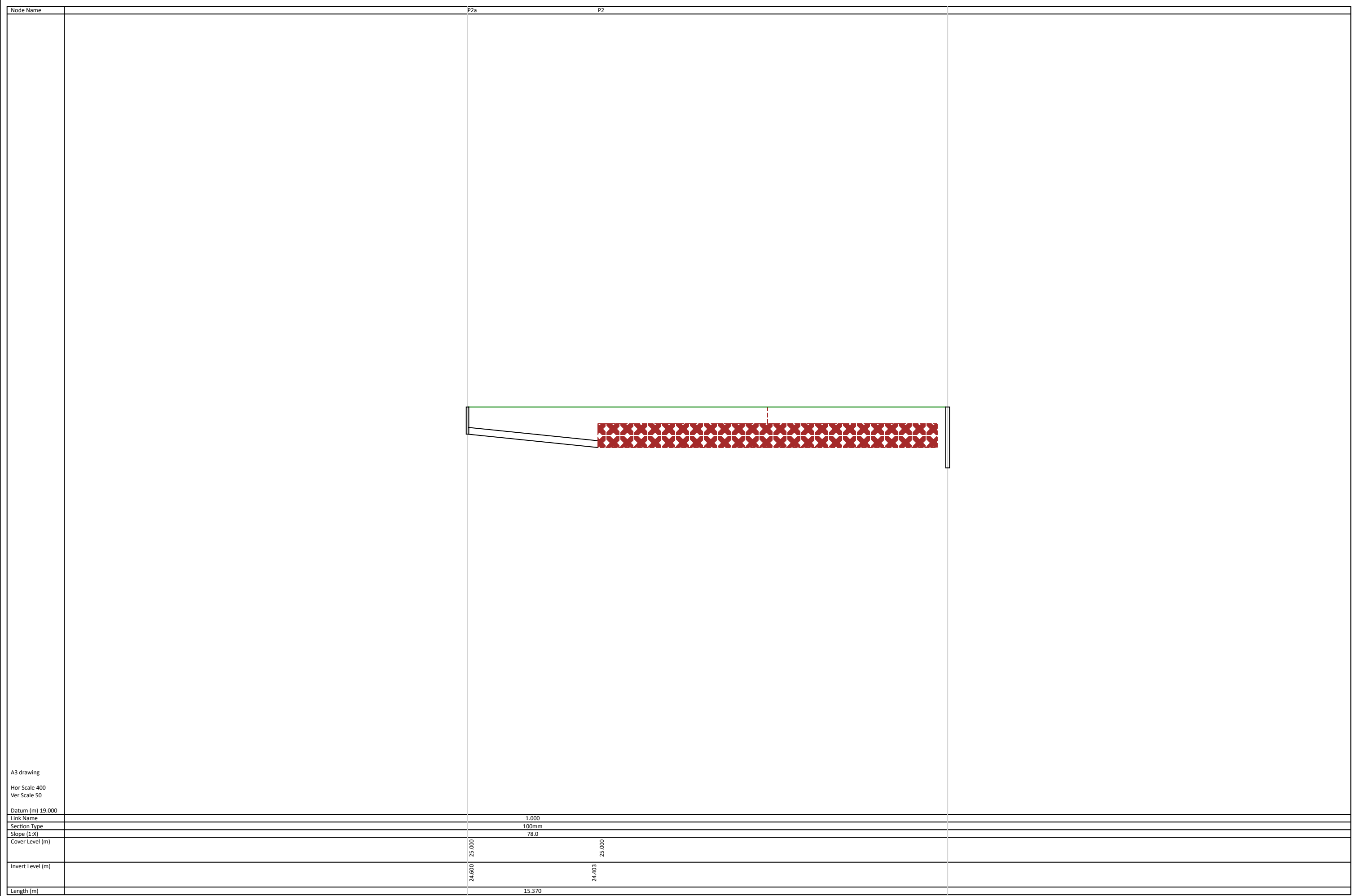
11.8.3 Drainage Sections

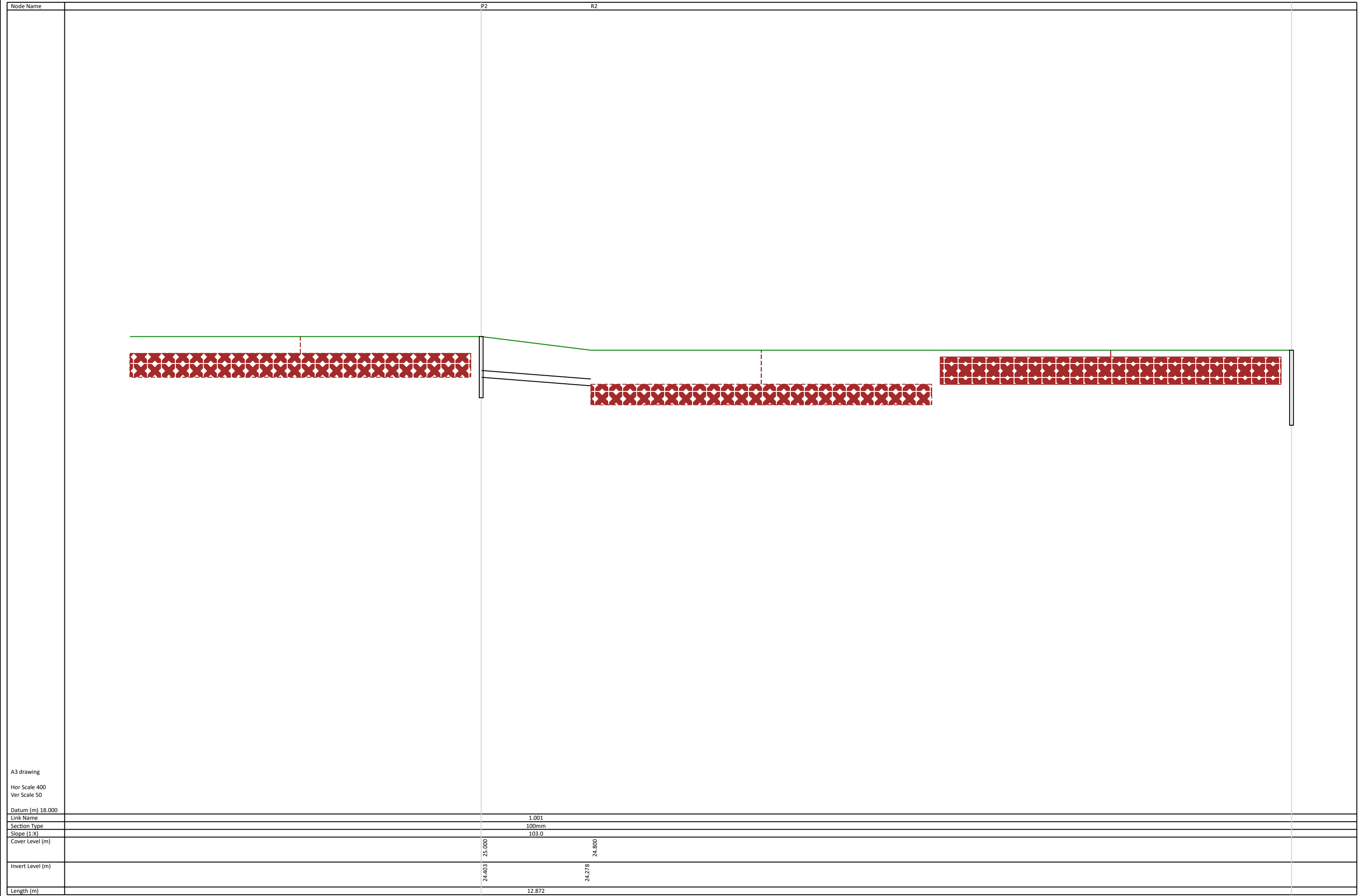
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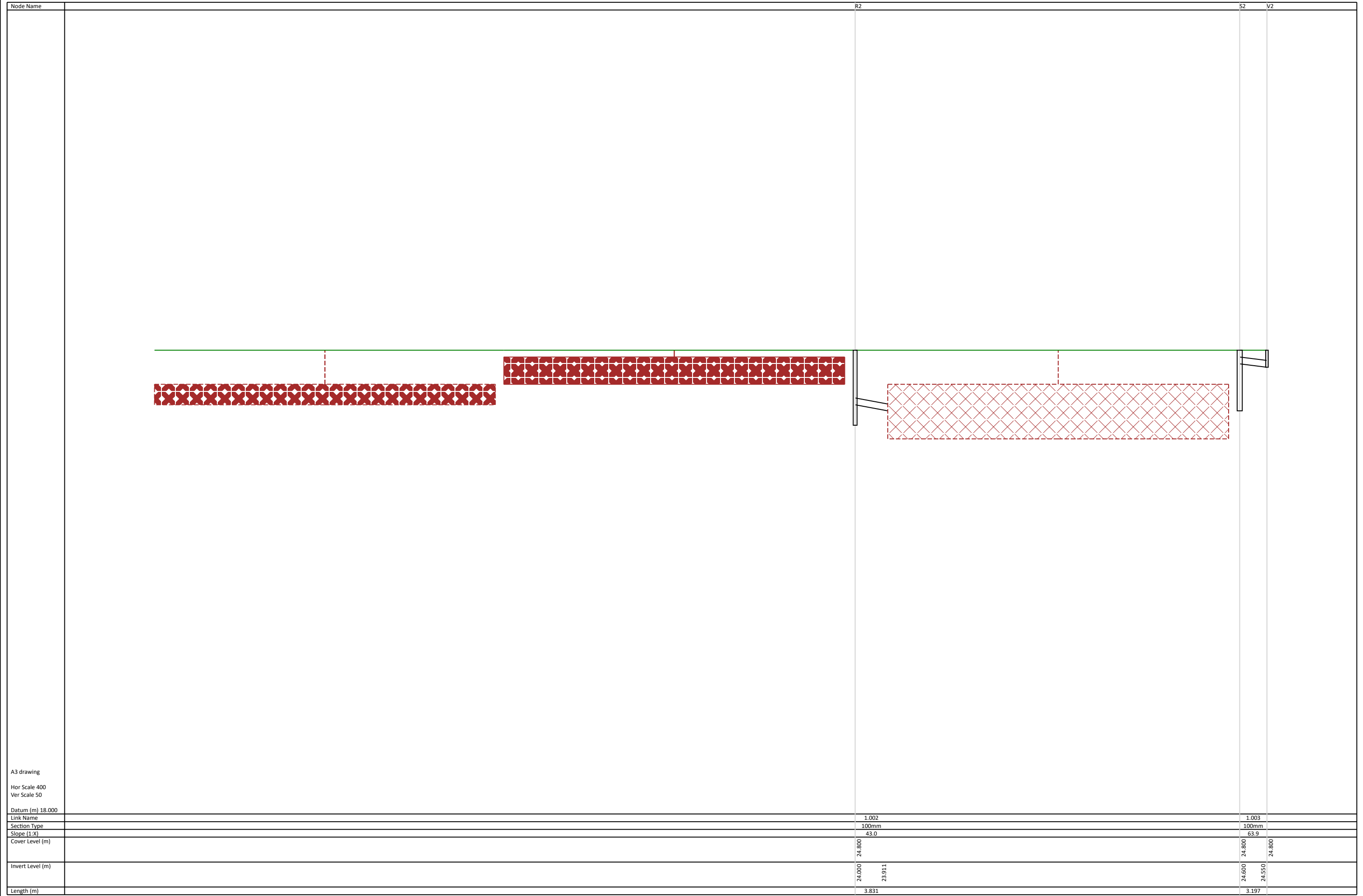














11.9 Appendix 8 – SuDS Maintenance Manual

All maintenance activities will be the responsibility of Dale Higgot. They will appoint a management company to undertake the general maintenance duties within the site and will join service agreements with the suppliers and manufactures of the SuDS/Pumps when required.

The information presented below is taken from the CIRIA SuDS Manual (Report c753) and [SuDS](#). Further details on installation and maintenance can be found detailed below and online.

11.9.1 SuDS Rain Water Butt Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components;	Quarterly; As required. Increase freq. to Monthly during Autumn;	Dale Higgot will be responsible for setting up the management company.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into the Rain Water Butts.	Quarterly; Increase freq. to Monthly during Autumn;	
Remedial actions	Cleaning of the water butt. Fully drain the water butt and clear out debris and enable access; Scrub out the inside of the butt or tank with a coarse brush, if accessible, using a proprietary cleaning product such as Just Water Butt Cleaner or garden disinfectant; Rinse with clean water; Cleaning of Gutters; Clean or fit a new filter;	Annually; Or as required.	
Remedial actions	Use water/empty water butts - to clean, water plants (inside & out); Empty water Butt more frequently during the winter, to allow for storage during storms and to keep the water fresh;	Once every two weeks; as required	

11.9.2 Rain Garden Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components	Quarterly; As required.	Dale Higgot will be responsible for setting up the management company.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into rain gardens as required.	Quarterly; As required.	
	Remove, replace and maintain vegetation as required; Ensuring cuttings are removed to prevent debris build up; Weeding of flower bed to maintain the desired vegetation, density and biodiversity - Vegetation management	Monthly inspections Summer; As required Quarterly during Winter month; Or as required.	
Remedial actions	Replace dead or overgrown vegetation as required.	As required.	
	Replacement of clogged geotextile (will require reconstruction of raingarden).	As required.	
Monitoring	Inspect silt traps / discharge points and note rate of sediment accumulation and ensure no erosion pathways forming.	Monthly in the first year and then annually.	
	Check raingardens are emptying as required following a storm event occurring.	After storms; When possible.	

11.9.3 Pervious Pavements

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
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.	Dale Higgot will be responsible for setting up the management company.
Occasional maintenance	Stabilise and mow contributing areas.	As required.	
	Removal of weeds or manage using weed killer applied directly into the weeds 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 lost material.	As required.	Dale Higgot will be responsible for setting up the management company.
	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, 48h after large storms in first six months.	
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.	
	Monitor Inspection chambers.	Annually.	

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy). Therefore, if litter management is already required at the site, this should have marginal cost implications.

11.9.4 Geo-Cellular Soakaway Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings.	Annually.	Dale Higgot will be responsible for setting up the management company.
	Cleaning of gutters and any filters on downpipes.	Annually (or as required based on inspections).	
	Trimming any roots that may be causing blockages.	Annually (or as required).	
Occasional maintenance	Remove sediment and debris from manhole, storage structure and components and floor of inspection tube or chamber and inside of concrete manhole rings.	As required, based on Inspections.	
Remedial actions	Reconstruct geocellular and/or replace or clean void fill, if performance failure occurs	As required	Dale Higgot will be responsible for setting up the management company.
	Replacement of clogged geotextile (will require reconstruction of soakaway).	As required.	
Monitoring	Inspect silt raps and note rate of sediment accumulation.	Monthly in the first year and then annually.	
	Check soakaway to ensure emptying is occurring.	Annually.	

Maintenance will usually be carried out manually, although a suction tanker can be used for sediment / debris removal for large systems. If maintenance is not undertaken for long periods, deposits can become hard-packed and require considerable effort to remove.

Replacement of the geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

Areas draining to infiltration components should be regularly swept to prevent silt being washed off the surface. This will minimize the need for maintenance.

Maintenance responsibility should be placed with an appropriate organisation, and maintenance schedules should be developed during the design phase.