16 C. IRISH WATER / STATUTORY BODIES

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CONFIRMATION OF FEASIBILITY

Portal Asset Holding Ltd.

C/o David Murphy
MHL & Associates
10 High Street
Douglas Road
Cork
T12KC66

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

Uisce Éireann
PO Box 448
South City
Delivery Office
Cork City

www.water.ie

10 April 2024

Our Ref: CDS24003093 Pre-Connection Enquiry
Coollegran, Port Road, Killarney, Co. Kerry – 224 units & crèche

Dear Applicant/Agent,

We have completed the review of the Pre-Connection Enquiry.

Uisce Éireann has reviewed the pre-connection enquiry in relation to a Water & Wastewater connection for a Multi/Mixed Use Development of 373 unit(s) at Coollegran, Port Road, Killarney, Kerry, (the **Development)**.

Based upon the details provided we can advise the following regarding connecting to the networks;

- **Water Connection**
  - Feasible without infrastructure upgrade by Irish Water
  - This Connection Offer to connect to the Irish Water infrastructure does not extend to your fire flow requirements. In order to determine the potential flow that could be delivered during normal operational conditions, an on site assessment of the existing network is required. Please note that Irish Water cannot guarantee a flow rate to meet fire flow requirements and in order to guarantee a flow to meet the Fire Authority requirements, you should provide adequate fire storage capacity within your development.
-
- **Wastewater Connection**
  - Feasible without infrastructure upgrade by Irish Water
  - In order to accommodate the proposed connection at the Premises, upgrade works are required to increase the capacity of the Irish Water

wastewater network. It is necessary to upsize approximately 1.2km of 450mm diameter combined sewer. Alternatively, storm water separation from the existing 450mm diameter combined sewer for an area of 0.2ha is necessary to accommodate the proposed connection at the premises.
Should you wish to have such upgrade works progressed, Irish Water will require you to provide a contribution of a relevant portion of the costs for the required upgrades, please contact Irish Water to discuss this further.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Uisce Éireann infrastructure. Before the Development can be connected to our network(s) you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann.

As the network capacity changes constantly, this review is only valid at the time of its completion. As soon as planning permission has been granted for the Development, a completed connection application should be submitted. The connection application is available at www.water.ie/connections/get-connected/

Where can you find more information?

- **Section A -** What is important to know?
- **Section B -** Details of Uisce Éireann's Network(s)

This letter is issued to provide information about the current feasibility of the proposed connection(s) to Uisce Éireann's network(s). This is not a connection offer and capacity in Uisce Éireann's network(s) may only be secured by entering into a connection agreement with Uisce Éireann.

For any further information, visit **www.water.ie/connections**, **email newconnections@water.ie** or contact 1800 278 278**.**

Yours sincerely,

Dermot Phelan
Connections Delivery Manager

Section A - What is important to know?

What is important to know?	Why is this important?
Do you need a contract to connect?	• Yes, a contract is required to connect. This letter does not constitute a contract or an offer in whole or in part to provide a connection to Uisce Éireann's network(s). • Before the Development can connect to Uisce Éireann's network(s), you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann.
When should I submit a Connection Application?	• A connection application should only be submitted after planning permission has been granted.
Where can I find information on connection charges?	• Uisce Éireann connection charges can be found at: https://www.water.ie/connections/information/charges/
Who will carry out the connection work?	• All works to Uisce Éireann's network(s), including works in the public space, must be carried out by Uisce Éireann*. *Where a Developer has been granted specific permission and has been issued a connection offer for Self-Lay in the Public Road/Area, they may complete the relevant connection works
Fire flow Requirements	• The Confirmation of Feasibility does not extend to fire flow requirements for the Development. Fire flow requirements are a matter for the Developer to determine. • **What to do?** - Contact the relevant Local Fire Authority
Plan for disposal of storm water	• The Confirmation of Feasibility does not extend to the management or disposal of storm water or ground waters. • **What to do?** - Contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges.
Where do I find details of Uisce Éireann's network(s)?	• Requests for maps showing Uisce Éireann's network(s) can be submitted to: datarequests@water.ie

What are the design requirements for the connection(s)?	• The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this Development shall comply with ***the Uisce Éireann Connections and Developer Services Standard Details and Codes of Practice,*** available at www.water.ie/connections
Trade Effluent Licensing	• Any person discharging trade effluent** to a sewer, must have a Trade Effluent Licence issued pursuant to section 16 of the Local Government (Water Pollution) Act, 1977 (as amended). • More information and an application form for a Trade Effluent License can be found at the following link: https://www.water.ie/business/trade-effluent/about/ **trade effluent is defined in the Local Government (Water Pollution) Act, 1977 (as amended)

Section B – Details of Uisce Éireann's Network(s)

The map included below outlines the current Uisce Éireann infrastructure adjacent the Development: To access Uisce Éireann Maps email datarequests@water.ie

Reproduced from the Ordnance Survey of Ireland by Permission of the Government. License No. 3-3-34

Note: The information provided on the included maps as to the position of Uisce Éireann's underground network(s) is provided as a general guide only. The information is based on the best available information provided by each Local Authority in Ireland to Uisce Éireann.

Whilst every care has been taken in respect of the information on Uisce Éireann's network(s), Uisce Éireann assumes no responsibility for and gives no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided, nor does it accept any liability whatsoever arising from or out of any errors or omissions. This information should not be solely relied upon in the event of excavations or any other works being carried out in the vicinity of Uisce Éireann's underground network(s). The onus is on the parties carrying out excavations or any other works to ensure the

exact location of Uisce Éireann’s underground network(s) is identified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.

David Murphy
10 High Street
Douglas Road
Cork
T12KC66

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

Uisce Éireann
PO Box 448
South City
Delivery Office
Cork City
www.water.ie

14 May 2024

Re: Design Submission for Coollegran, Port Road, Killarney, Kerry (the "Development") (the "Design Submission") / Connection Reference No: CDS24003093

Dear David Murphy,

Many thanks for your recent Design Submission.

We have reviewed your proposal for the connection(s) at the Development. Based on the information provided, which included the documents outlined in Appendix A to this letter, Uisce Éireann has no objection to your proposals.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Uisce Éireann infrastructure. Before you can connect to our network you must sign a connection agreement with Uisce Éireann. This can be applied for by completing the connection application form at www.water.ie/connections. Uisce Éireann's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities (CRU)(https://www.cru.ie/document_group/irish-waters-water-charges-plan-2018/).

You the Customer (including any designers/contractors or other related parties appointed by you) is entirely responsible for the design and construction of all water and/or wastewater infrastructure within the Development which is necessary to facilitate connection(s) from the boundary of the Development to Uisce Éireann's network(s) (the "**Self-Lay Works**"), as reflected in your Design Submission. Acceptance of the Design Submission by Uisce Éireann does not, in any way, render Uisce Éireann liable for any elements of the design and/or construction of the Self-Lay Works.

If you have any further questions, please contact your Uisce Éireann representative:
Name: Kyle Jackson
Email: kyle.jackson@water.ie

Yours sincerely,

Dermot Phelan
Connections Delivery Manager

Appendix A

Document Title & Revision

- [PR-MHL-WM-P01]
- [PR-MHL-WM-P02]
- [PR-MHL-WM-P03]
- [PR-MHL-WM-P04]
- [PR-MHL-WM-P05]
- [PR-MHL-WM-P06]
- [PR-MHL-SLM-P01]
- [PR-MHL-PWS-P01]
- [PR-MHL-PWS-P02]
- [PR-MHL-PWS-P03]
- [PR-MHL-PWS-P04]
- [PR-MHL-PWS-P05]
- [PR-MHL-PWS-P06]
- [PR-MHL-PWS-P07]
- [PR-MHL-PWS-P08]
- [PR-MHL-PS-P01]
- [PR-MHL-PS-P02]

*For further information, visit **www.water.ie/connections***

Notwithstanding any matters listed above, the Customer (including any appointed designers/contractors, etc.) is entirely responsible for the design and construction of the Self-Lay Works. Acceptance of the Design Submission by Uisce Éireann will not, in any way, render Uisce Éireann liable for any elements of the design and/or construction of the Self-Lay Works.

LOCATION OF SITE NOTICE

Potential Pedestrian Connection

Potential Pedestrian Connection

HOSPITAL

PORT ROAD

Site Entrance

Port Cottage

MAGENTA CIRCLE INDICATES 20M DIAMETER OF EXISTING BARROW

129 - 160

193 - 224

NOTES:

All dimensions in metres.
Do not scale from drawing.
For any discrepancies found please consult with design office.
This drawing is for PLANNING purposed only.
Not for Construction.

Legend:
Note: Drawing To Be Read in Conjunction With Irish Water: Water Infrastructure Standard Details Document Number: IW-CDS-5030-01 & Irish Water Code of Practice for Wastewater Infrastructure: IW-CDS-5030-03

Standard separation distances refer to STD-WW-05 & STD-WW-06

- Foul Manhole (STD-WW-09R1, STD-WW-10R1, STD-WW-11R1 & STD-WW-12R1)
- Foul Inspection Chamber (STD-WW-13R1)
- Foul Sewer Line 150/225mm dia. (STD-WW-04, STD-WW-05, STD-WW-06R1, STD-WW-07& STD-WW-08)
- Foul house connection 100mm dia. (STD-WW-01, STD-WW-03 & STD-WW-04)
- Proposed 100mm Polyethylene Foul Rising Main
- Site Boundary
- Proposed Storm Sewer Line
- Proposed Storm MH
- Proposed Storm Tank

Rev	By	Date	Description
H	DM	05/24	IW Revision

Drawing Status: PLANNING

Project Title:
Residential Development at Inch / Coollegrean, Port Road, Killarney

Drawing Title:
Proposed Sewer Lines
Sheet 1 of 2

Client:
Portal Asset Holdings Ltd.

M.H.L & Associates Ltd.
Consulting Engineers
Unit 1b, The Atrium, Blackpool, Cork
Tel: 021-4840214
Fax: 021-4840215
E-Mail:info@mhl.ie

Designed:	Drawn:	Checked:
DM	DM	BM

Scale:	Date:
1:500 @A1 1:1000 @A3	MAY 2024

Job No:	Drawing No:	Revision:
18137HD	PR-MHL-PS-P01	_H

NOTES:

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- Foul house connection 100mm dia. (STD-WW-01, STD-WW-03 & STD-WW-04)
- Proposed 100mm Polyethylene Foul Rising Main
- Site Boundary
- Proposed Storm Sewer Line
- Proposed Storm MH
- Proposed Storm Tank

Rev	By	Date	Description
H	DM	05/24	IW Revision

Drawing Status: PLANNING

Project Title: Residential Development at Inch / Coollegrean, Port Road, Killarney

Drawing Title: Proposed Sewer Lines
Sheet 2 of 2

Client: Portal Asset Holdings Ltd.

M.H.L & Associates Ltd.
Consulting Engineers
Unit 1b, The Atrium, Blackpool, Cork
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Fax: 021-4640215
E-Mail:info@mhl.ie

Designed:	Drawn:	Checked:
DM	DM	BM

Scale:	Date:
1:500 @A1 1:1000 @A3	MAY 2024

Job No:	Drawing No:	Revision:
18137HD	PR-MHL-PS-P01	_H

SITE NOTICE

SITE NOTICE

LOCATION OF SITE NOTICE

HEADER MANHOLE

100mm POLYETHYLENE RISING MAIN

TYPE 3 FOUL PUMPING STATION IN ACCORDANCE WITH IRISH WATER STANDARD DETAILS. EMERGENCY STORAGE TO BE PROVIDED

ECOLOGICAL HABITAT AREA

Potential Pedestrian Connection

Potential Pedestrian Connection

FOLLY STREAM WATERCOURSE

MILLWOOD

PORT ROAD

HOSPITAL

Site Entrance

MAGENTA CIRCLE INDICATES 20M DIAMETER OF EXISTING BARROW

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Foul Inspection Chamber (STD-WW-13R1)

Foul Sewer Line 150/225mm dia. (STD-WW-04, STD-WW-05, STD-WW-06R1, STD-WW-07& STD-WW-08)

Foul house connection 100mm dia. (STD-WW-01, STD-WW-03 & STD-WW-04)

Proposed 100mm Polyethylene Foul Rising Main

Site Boundary

IRISH WATER PUMP STATION NOTES

1. Type 3 pumping stations to be located no closer than 15.0 metres to a property boundary.
2. There shall be a clear opening in front of the gates to ensure adequate access.
3. Kiosks to STD-WW-30 and STD-WW-31.
4. fence and gate to STD-WW-25.
5. Refer to STD-WW-32 for permeable, impermeable roadway and hardstanding area detail.
6. Indicative layout relates to small pumping stations as per type 1, type 2 and type 3 in the Irish water code of practice for wastewater infrastructure.
7. Lamp standard and lamp bollard locations to be site specific and to Irish water agreement. Refer to STD-WW-33 for details.

Rev	By	Date	Description
H	DM	05/24	IW Revision

Drawing Status: PLANNING

Project Title: Residential Development at Inch / Coollegrean, Port Road, Killarney

Drawing Title: Proposed Wastewater Sewer Lines Sheet 1 of 2

Client: Portal Asset Holdings Ltd.

M.H.L & Associates Ltd.
Consulting Engineers
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Designed:	Drawn:	Checked:
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Scale:	Date:
1:500 @A1 1:1000 @A3	MAY 2024

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18137HD	PR-MHL-PWS-P01	_H

100mm POLYETHYLENE RISING MAIN

TYPE 3 FOUL PUMPING STATION IN ACCORDANCE WITH IRISH WATER STANDARD DETAILS. EMERGENCY STORAGE TO BE PROVIDED

FOLLY STREAM WATERCOURSE

ECOLOGICAL HABITAT AREA

Potential Pedestrian Connection

Potential Pedestrian Connection

WAYLEAVE

Port Cottage

Holy Cross Gardens

Oakwood Retirement Village

MAGENTA CIRCLE INDICATES 20M DIAMETER OF EXISTING BARROW

BM 29.71

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Foul house connection 100mm dia. (STD-WW-01, STD-WW-03 & STD-WW-04)

Proposed 100mm Polyethylene Foul Rising Main

Site Boundary

IRISH WATER PUMP STATION NOTES

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2. There shall be a clear opening in front of the gates to ensure adequate access.
3. Kiosks to STD-WW-30 and STD-WW-31.
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Rev	By	Date	Description
H	DM	05/24	IW Revision

Drawing Status: PLANNING

Project Title: Residential Development at Inch / Coollegrean, Port Road, Killarney

Drawing Title: Proposed Wastewater Sewer Lines
Sheet 2 of 2

Client: Portal Asset Holdings Ltd.

M.H.L & Associates Ltd.
Consulting Engineers
Unit 1b, The Atrium, Blackpool, Cork
Tel: 021-4640214
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E-Mail:info@mhl.ie

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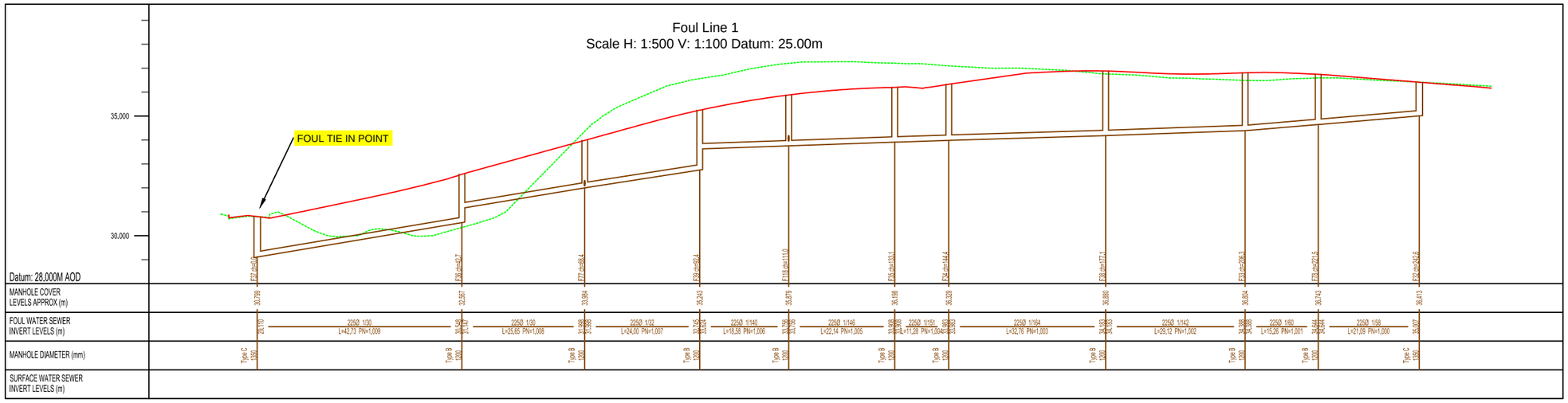
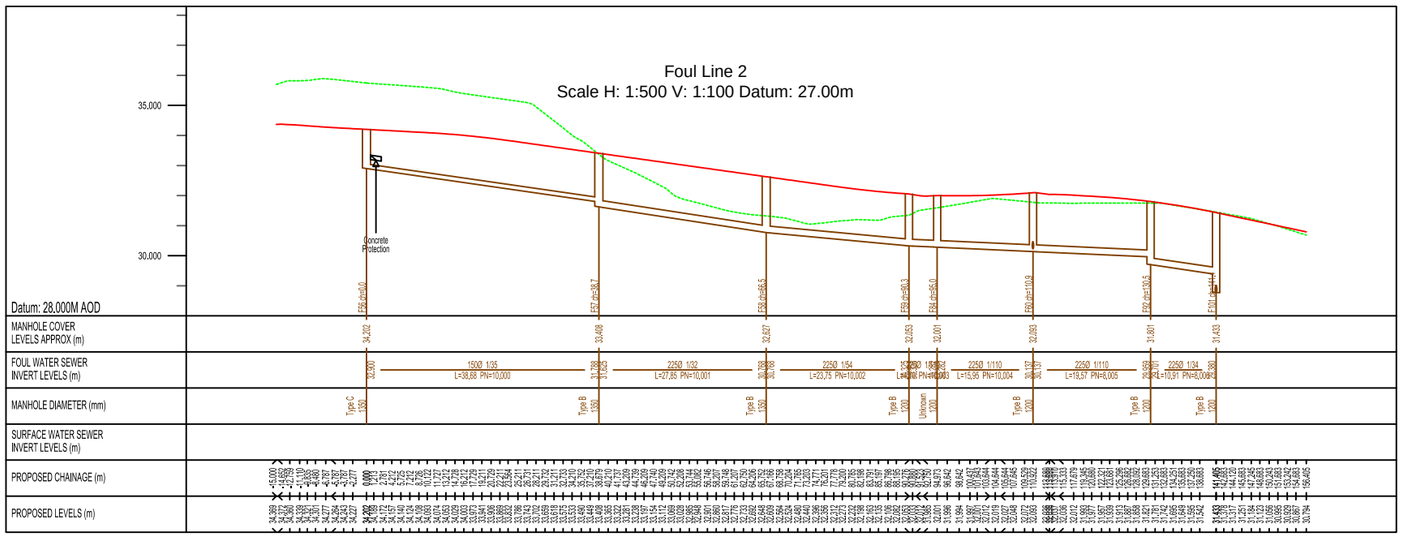
Scale:	Date:
1:500 @A1 1:1000 @A3	MAY 2024

Job No:	Drawing No:	Revision:
18137HD	PR-MHL-PWS-P02	_H





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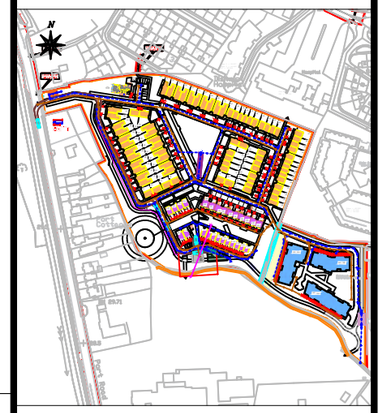
Standard separation distances refer to STD-WW-05 & STD-WW-06

All gravity foul sewers to be uPVC.
All rising mains to be Polyethylene (P.E)



Rev	By	Date	Description
G	DM	04/24	IW Revision

Drawing Status:
PLANNING

Project Title:
Residential Development at Inch / Coollegrean, Port Road, Killarney

Drawing Title:
Proposed Wastewater Lines Longsections Sheet 1

Client:
Portal Asset Holdings Ltd.

M.H.L & Associates Ltd.
Consulting Engineers
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E-Mail:info@mhl.ie

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Scale:	Date:
1:500 @A1 1:1000 @A3	APRIL 2024

Job No:	Drawing No:	Revision:
18137HD	PR-MHL-PS-P03	_G

18 E. UKSUDS SITE EVALUATION REPORT

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Site Drainage Evaluation

Site name: Coollegrean Port Road
Site location: Killarney

Report Reference: 1604076583263
Date: 30/10/2020

1. INTRODUCTION

This is a bespoke report providing initial guidance on potential implementation of SuDS for the development site in line with current best practice.

The use of this tool should be supplemented by more detailed guidance on SuDS best practice provided in a number of sources, principally the CIRIA SUDS Manual (2007), other CIRIA documents; the Use of SUDS in High Density Developments, HR Wallingford, (2005) and other HR Wallingford documents.

The objective is to provide some early guidance on the numbers and types of components that might be suitable for consideration within the site design. This may facilitate pre-application discussions with planners and other relevant authorities.

This guidance has been provided prior to the completion of the SUDS standards and the supporting guidance. However the principles of this tool are unlikely to be very different to the aims of the SUDS standards. HR Wallingford is not liable for the use of any output from the use of this tool and the performance of the drainage system. It is recommended that detailed design using appropriately experienced engineers professionals and tools is undertaken before finalising any drainage scheme arrangement for a site.

THE CONTENT OF THE REPORT

This report is split into 8 sections as follows:

2. Generic SuDS Best Practice Principles
3. Runoff Destination
4. Hydraulic Design Criteria
5. Water Quality Design Criteria
6. Site-Specific Drainage Design Considerations
7. SuDS Construction
8. SuDS Components Performance
9. Guidance on The Use of Individual Components

2. GENERIC SuDS BEST PRACTICE PRINCIPLES

To comply with current best practice, the drainage system should:

(i) manage runoff at or close to its source;
(ii) manage runoff at the surface;
(iii) be integrated with public open space areas and contribute towards meeting the objectives of the urban plan;
(iv) be cost-effective to operate and maintain.

The drainage system should endeavour to ensure that, for any particular site:

(i) natural hydrological processes are protected through maintaining Interception of an initial depth of rainfall and prioritising infiltration, where appropriate;
(ii) flood risk is managed through the control of runoff peak flow rates and volumes discharged from the site;
(iii) stormwater runoff is treated to prevent detrimental impacts to the receiving water body as a result of urban contaminants.

In addition, it is desirable to maximise the amenity and ecological benefits associated with the drainage system where there are appropriate opportunities. SuDS are green infrastructure components and can provide health benefits, and

reduce the vulnerability of developments to the impacts of climate change.

3. RUNOFF DESTINATION

Introduction
Infiltration should be prioritised as the method of controlling surface water runoff from the development site, unless it can be demonstrated that the use of infiltration would have a detrimental environmental impact.

Groundwater (via Infiltration)
Infiltration may not be appropriate for managing runoff from this site. Robust studies are reqired to confirm the significance of the following constraints to infiltration:

(1) This is a steeply sloping site and full consideration must be given to the hydrogeological infiltration pathways, to ensure that there is no risk of water re-emerging on the site or on other sites and contributing to downstream flood risk.

The groundwater beneath the site is designated as *SPZ I*, and this designation will define the treatment requirement for any infiltrated water (See Water Quality Design Criteria).

Surface water body
All runoff that cannot be discharged to groundwater will be managed on site and discharged to a surface water body.

The receiving surface water body for runoff from the site is: the *River Deenagh*. The riparian owner is: *.*

4. HYDRAULIC DESIGN CRITERIA

Introduction
Best practice criteria for hydraulic control require Interception, runoff and volume control.

Interception
To fulfill the requirements for Interception, there should normally be no runoff from the site for an initial depth of rainfall - usually 5mm. This is achieved through the use of infiltration, evapotranspiration, or rainwater harvesting.

If practicable, infiltration systems should be used to meet the Interception requirements for the site.

Flow and Volume Control
The site is a greenfield development, therefore runoff from the site needs to be constrained to the equivalent greenfield rates and volumes.

Infiltration and rainwater harvesting, or the use of Long Term Storage provide the means to limit runoff to the greenfield volume. Where volume control is not practicable, flows discharged from the site will need to be constrained to Qbar or 2 l/s/ha (whichever is the greater).

If practicable, infiltration systems should be used to manage runoff up to the 10 year event. Other components within the drainage system will need to be designed to manage runoff in excess of this event.

Attenuation and hydraulic controls will be used to manage flow rates.

5. WATER QUALITY DESIGN CRITERIA

Introduction
Current best practice takes a risk-based approach to managing discharges of surface runoff to the receiving environment. The following text provides guidance on the extent of water quality management likely to be appropriate for the site.

Hazard Classification
Runoff from clean roof surfaces (ie not metal roofs, roofs close to polluted atmospheric discharges, or roofs close to

populations of flocking birds) is classified as Low in terms of hazard status.

Runoff from roads, parking and other areas of residential, commercial and industrial sites (that are not contaminated with waste, high levels of hydrocarbons, or other chemicals) is classified as Medium in terms of hazard status.

Treatment requirements for disposal to groundwater systems
Runoff from roofs will need one effective treatment stage prior to disposal to groundwater. Where sediment and other litter is prevented from entering the infiltration device, and the underlying subsoils can be demonstrated to provide effective treatment, then the process of infiltration will usually be sufficient.

Runoff from roads and parking areas will need 3 effective treatment stages prior to disposal to groundwater. Where sediment and litter is prevented from entering the infiltration device, and the underlying subsoils can be demonstrated to provide effective treatment, then the process of infiltration will usually be deemed to constitute one treatment stage. Two further upstream treatment stages will also be required.

Infiltration may only be used where a risk assessment has been undertaken in accordance with http://www.netregs.gov.uk/netregs/100789.aspx, and the design effectively addresses the risks identified within the risk assessment.

Treatment requirements for disposal to surface water systems
The level of urbanisation of the catchment at the point of the discharge from the site is < 20%, therefore it may be classified as a sensitive receptor.

The receiving catchment is designated as an environmentally sensitive receptor.

Roof runoff will require 1 treatment stage prior to discharge.

Runoff from other parts of this site such as roads, parking and other areas will require 3 treatment stages prior to discharge.

6. SITE-SPECIFIC DRAINAGE DESIGN CONSIDERATIONS

The site is a high density residential site. The HR Wallingford documenet 'SuDS for high density developments' is a useful guidance document for efficient drainage design where space is heavily constrained.

Components likely to be particularly suitable for high density sites include:

- permeable pavement parking areas which can often manage roof runoff as well as rainfall falling on the parking surface;
- green roofs which limit runoff from roof surfaces;
- bioretention areas integrated within impermeable zones;
- individual property soakaways;
- subsurface infiltration and/or detention systems (eg beneath functional, permeable surfaces);
- infiltration/detention/retention ponds/basins/channels integrated within public open space areas.

Where SuDS are being designed for sites with steep slopes, careful consideration of site layout planning and SUDS alignment is needed to minimise gradients of conveyance pathways and construction of large embankments, and to minimise flood risk when drainage systems are exceeded.

The design of SuDS with access to temporary or permanent water should consider public health and safety as well as issues associated with construction and operational management of the structures. Health and safety issues and risk mitigation features are presented in the CIRIA SuDS Manual.

Individual SuDS components should not be treated in isolation, but should be seen together as providing a suite of drainage features which are appropriate in different combinations for varying scales. It is always desirable to have a mix of SuDS components across the site as different components have different capacities for treatment of individual pollutants.

7. SuDS CONSTRUCTION

SuDS are a combination of civil engineering structures and landscaping practice. Due to the limited experience of building SuDS in the water industry, there are a number of key issues which need to be particularly considered as their construction requires a change in approach to some standard construction practices.

• SuDS components should be constructed in line with either the manufacturer's guidelines or best practice methods.
• The construction of SuDS usually only requires the use of fairly standard civil engineering construction and landscaping operations, such as excavation, filling, grading, top-soiling, seeding, planting etc. These operations are specified in various standard construction documents, such as the Civil Engineering Specification for the Water Industry (CESWI).
• Construction of soakaways is regulated by the Buildings Regulations part H (Drainage and waste disposal) which sets out the requirements for drainage of rainwater from the roofs of buildings.
• During construction, any surfaces which are intended to enable infiltration must be protected from compaction. This includes protecting from heavy traffic or storage of materials.
• Water contaminated with silt must not be allowed to enter a watercourse or drain as it can cause pollution. All parts of the drainage system must be protected from construction runoff to prevent silt clogging the system and causing pollution downstream. Measures to prevent this include soil stabilisation, early construction of sediment management basins, channelling run-off away from watercourses and surface water drains, and erosion prevention measures.
• After the end of the construction period and prior to handover to the site owner/operator:
  - Subsoil that has been compacted during construction activities should be broken up prior to the re-application of topsoil to garden areas and other areas of public open space to reinstate the natural infiltration performance of the ground;
  - Any areas of the SuDs that have been compacted during construction but are intended to permit infiltration must be completely refurbished;
  - Checks must be made for blockages or partial blockages of orifices or pipe systems;
  - Any silt deposited during the construction must be completely removed;
  - Soils must be stabilised and protected from erosion whilst planting becomes established.

Detailed guidance on the construction related issues for SuDS is available in the SuDS Manual and the associated Construction Site handbook (CIRIA, 2007).

8. SuDS COMPONENTS PERFORMANCE

	Interception	Peak flow control: Low	Peak flow control: High	Volume reduction	Volume control	Gross sediments	Fine sediments	Hydrocarbons/ PAHs	Metals	Nutrients
Rainwater Harvesting	Y	Y	S	Y	N	N	N	N	N	N
Pervious Pavement	Y	Y	Y	Y	Y	Y	Y	Y	Y	Var
Filter Strips	Y	N	N	N	N	Y	N	Y	Y	Var
Swales	Y	Y	S	Y(*)	N	Y	Y(+)	Y	Y	Y(-)
Trenches	Y	Y	S	Y(*)	N	N	N	Y	Y	Y(-)
Detention Basins	Y	Y	Y	N	Y	Y	Y(+)	Y	Y	Var
Ponds	N	Y	Y	N	Y	N(~)	Y	Limited	Y	Var
Wetlands	N	Y	S	N	Y	N(~)	Y	Limited	Y	Y
Soakaways	Y	Y	S	Y	N	N(~)	N(~)	Y(")	Y(")	N
Infiltration Basins	Y	Y	S	Y	N	N(~)	N(~)	Y(")	Y(")	N
Green Roofs	Y	Y	N	N	N	N	N	Y	N	N
Bioretention Systems	Y	Y	S	Y(*)	N	N(~)	Y	Y	Y	Y
Proprietary Treatment Systems	N	N	N	N	N	Y	Y	Y(!)	Y(!)	Y(!)
Subsurface Storage	N	Y	Y	N	Y	N(~)	N	N	N	N
Subsurface Conveyance Pipes	N	N	N	N	Y	N(~)	N	N	N	N

Notes:
S: Not normally with standard designs, but possible where space is available and designs mitigate impact of high flow rates.
Y(*): Where infiltration is facilitated by the design.

N(~): Gross sediment retention is possible, but not recommended due to negative maintenance and performance implications.
Y(+): Where designs minimise the risk of fine sediment mobilisation during larger events.
Y(!): Where designs specifically promote the trapping and breakdown of oils and PAH based constitutents.
Y("): Where subsurface soil structure facilitates the trapping and breakdown of oils and PAH based constituents.
Var: The nutrient removal performance is variable, and can be negative in some situations.
Y(-): Good nutrient removal performance where subsurface biofiltration systems with a permanently saturated zone included within the design.

9. GUIDANCE ON THE USE OF INDIVIDUAL COMPONENTS

Rainwater Harvesting

• *High density*
For large occupancy buildings (offices, supermarkets, etc.), communal rainwater harvesting systems may provide significant stormwater management benefits.

• *Roofs*
Rainwater harvesting systems can be used to effectively drain roofs and provide both water supply and stormwater management benefits.

Pervious Pavement

• *High density*
Pervious pavement systems provide an effective way to drain, store and treat the surface runoff, all within the footprint of the car park area. Larger areas of communal parking will provide the most cost effective systems.

• *Roofs*
Roof water can be drained into pervious pavement areas using diffusers to dissipate the point inflows. Detailed design of the pavement will need to take account of the additional impermeable roof area.

• *Roads*
Some types of pervious pavement can be used for relatively highly trafficked roads and pavement manufacturers should be consulted on the appropriate specification.

• *Car parks/other impermable surfaces*
Pervious pavements provide effective drainage, storage and treatment of car park surfacing,

• *Steep site*
Pervious pavements can be used on sloping sites, with the use of internal dams in order to attenuate and store the water effectively through a cascade system.

Filter Strips

• *High density*
Filter strips can be used as treatment for road or car park runoff where space allows.

• *Roads*
Filter strips can provide treatment for road runoff, upstream of swales or trench components. They can reduce the need for kerbing and runoff collection systems.

• *Car parks/other impermable surfaces*
Filter strips can provide treatment for runoff from impermeable surfaces, upstream of swales or trench components. They can reduce the need for kerbing and runoff collection systems.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*

Filter strips can be used on sloping sites, where implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Swales

• *High density*
Swales can be used for road or car park drainage where space allows. Underdrained swales (ie with a subsurface gravel filled conveyance and treatment trench) can provide a more efficient solution for hydraulic control and water quality treatment.

• *Roofs*
Swales can be used to convey roof water to other parts of the site.

• *Roads*
Swales provide treatment and conveyance of road runoff. There are a range of swale types - standard grass channels, underdrained swales, and wetland swales - depending on drainage requirements.

• *Car parks/other impermable surfaces*
Swales provide treatment and conveyance of runoff from impermeable areas. There are a range of swale types - standard grass channels, underdrained swales, and wetland swales - depending on drainage requirements.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Swales can be used on sloping sites, where implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Trenches

• *High density*
Trenches can provide treatment and runoff control for road or car park drainage.

• *Roofs*
Trenches can be used to convey roof water to other parts of the site.

• *Roads*
Trenches can provide treatment and conveyance of road runoff. They require effective pretreatment to minimise the risk of blockage.

• *Car parks/other impermable surfaces*
Trenches can provide treatment and conveyance of runoff for impermeable areas.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Trenches can be used on sloping sites, where implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Detention Basins

• *High density*
Detention basins can be used in high density developments when effectively integrated within public open space areas.

• *Roofs*
Detention basins can be used to attenuate and treat runoff.

• *Roads*
Detention basins can be used to attenuate and treat runoff.

• *Car parks/other impermable surfaces*
Detention basins can be used to attenuate and treat runoff.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria. A risk assessment should be used to determine the maximum appropriate depth of stored water in the basin.

• *Steep site*
Large basins may require embankments that may pose a safety risk to site residents.

Ponds

• *High density*
It is unlikely that a pond would be suitable for high density development, unless it is an integral amenity feature within the public open space area.

• *Roofs*
Ponds can be used to attenuate and treat roof runoff.

• *Roads*
Ponds can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in ponds for extended periods, nutrient concentrations can rise - particularly in the summer months, and the pond can become unattractive with poor amenity and biodiversity potential.

• *Car parks/other impermable surfaces*
Ponds can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in ponds for extended periods, nutrient concentrations can rise - particularly in the summer months, and the pond can become unattractive with poor amenity and biodiversity potential.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Large ponds may require embankments that may pose a safety risk to site residents.

• *Other*
Ponds built in permeable soils will require lining to maintain the water level of the permanent pool. The lining may be finished 100 or 200 mm lower than the outlet invert to encourage some infiltration to take place to contribute to interception.

Wetlands

• *High density*
It is unlikely that a wetland would be suitable for high density development, unless it is an integral amenity feature within the public open space area.

• *Roofs*
Wetlands can be used to attenuate and treat roof runoff.

• *Roads*
Wetlands can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in wetlands for extended periods, nutrient concentrations can rise - particularly in the summer months, and the wetland can become unattractive with poor amenity and biodiversity potential.

• *Car parks/other impermable surfaces*
Wetlands can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in wetlands for extended periods, nutrient concentrations can rise - particularly in the summer months, and the wetland can become unattractive with poor amenity and biodiversity potential.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
It is likely that wetlands would require embankments that may pose safety risks to site residents.

Soakaways

• *High density*
Individual property soakaways can be built in garden areas. Attenuation storage can be built beneath impermeable surfaces such as roads or car parks or public spaces, thus minimising the use of space needed for the drainage system.

• *Roofs*
Soakaways can be used to store, treat, and dispose roof runoff.

• *Roads*
Upstream treatment is normally required if soakaways are used to manage road runoff directly. Sediments and litter should be prevented from entering the soakaway.

• *Car parks/other impermable surfaces*
Upstream treatment is normally required if soakaways are used to manage road runoff directly. Sediments and litter should be prevented from entering the soakaway.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Consideration must be given to the risk of infiltrated water re-emerging further down the slope and causing a downstream flood hazard.

Infiltration Basins

• *HighDensity*
Infiltration basins can often be used in high density developments when effectively integrated within public open space areas.

• *Roofs*
Infiltration basins can be used to attenuate and treat roof runoff.

• *Roads*
Upstream treatment is normally required if infiltration basins are used to manage road runoff. Sediments should be prevented from entering the system.

• *Car parks/other impermable surfaces*
Upstream treatment is normally required if infiltration basins are used to manage runoff from trafficked surfaces. Sediments should be prevented from entering the system.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria. A risk assessment should be used to determine the maximum depth of stored water in the basin.

• *Steep site*
Consideration must be given to the risk of infiltrated water re-emerging further down the slope and causing a downstream flood hazard. Large basins may require embankments that may pose safety risks to downstream residents.

Green Roofs

• *HighDensity*
Green roofs can be implemented most cost-effectively on larger roofs. They provide a range of benefits in addition to stormwater management, including combatting the heat island effect, biodiversity and amenity functions.

• *Roofs*
Green roofs can be designed to provide interception, management and treatment of rainfall up to specified rainfall depths.

Bioretention Systems

• *High density*
Biorention systems (either cells or linear systems) can be used for road or car park drainage where space allows.

• *Roofs*
Bioretention systems can be used to attenuate and treat roof runoff.

• *Roads*
Linear bioretention systems (ie biofiltration swales) can be used to attenuate and treat road runoff.

• *Car parks/other impermable surfaces*
Bioretention systems canbe used for car park drainage.

• *Site size > 50 ha*
Bioretention systems will tend to be suitable for managing small areas only.The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Bioretention systems can be used on sloping sites, when implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Proprietary Treatment Systems

• *High density*
Proprietary treatment systems may be appropriate to use particularly where there is no space for surface, vegetated treatment systems. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *Roads*
Proprietary treatment systems can be used where surface vegetated systems are impracticable. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *Car parks/other impermable surfaces*
Proprietary treatment systems could be used where surface vegetated systems are impracticable. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *Site size > 50 ha*
Proprietary treatment systems will tend to be suitable for managing small areas only. The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

Subsurface Storage

• *High density*
Subsurface storage of runoff is likely to be needed for high density developments. This can be implemented via a range of proprietary high void systems, or within gravels beneath permeable pavements which provide treatment as well. Sub-surface storage allows the land above the storage system to be used for car parking or public open space areas.

• *Roofs*
Subsurface storage can be used to attenuate roof runoff.

• *Roads*
Subsurface storage can be used to attenuate road runoff.

• *Car parks/other impermable surfaces*
Subsurface storage can be used to attenuate car park runoff.

Subsurface Conveyance Pipes

• *High density*
Subsurface conveyance systems may be an important means of connecting drainage components together and routing flows downstream. Space constraints in high density developments are likely to constrain the use of surface conveyance options.

19 F. GREENFIELD RUNOFF RATE

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HR Wallingford
Working with water

Greenfield runoff estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	James Daly
Site name:	Port Road
Site location:	KIllarney

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site coordinates

Latitude:	52.06472° N
Longitude:	9.51891° W

Reference:	6523016
Date:	2019-02-04T10:37:24

Methodology	IH124

Site characteristics

Total site area (ha)	5

Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	1666	1560
Hydrological region	13	13
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	1.65	1.65
Growth curve factor: 100 year	1.95	1.95

Notes:

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	25.13	23.27
1 in 1 year (l/s)	21.36	19.78
1 in 30 years (l/s)	41.47	38.4
1 in 100 years (l/s)	49.01	45.38

20 G. SURFACE WATER INFILTRATION/STORAGE

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Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 55 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	0.677	0.677	9.3	5.0	13.7	60.5	O K
30 min Winter	0.897	0.897	9.9	5.0	14.4	80.2	O K
60 min Winter	1.037	1.037	10.2	5.0	15.1	92.7	O K
120 min Winter	1.061	1.061	10.3	5.0	15.2	94.8	O K
180 min Winter	1.017	1.017	10.2	5.0	15.0	90.9	O K
240 min Winter	0.955	0.955	10.0	5.0	14.7	85.3	O K
360 min Winter	0.811	0.811	9.7	5.0	14.0	72.5	O K
480 min Winter	0.656	0.656	9.3	5.0	13.7	58.7	O K
600 min Winter	0.510	0.510	8.9	5.0	13.7	45.6	O K
720 min Winter	0.389	0.389	8.6	5.0	13.5	34.8	O K
960 min Winter	0.216	0.216	8.1	4.9	13.0	19.3	O K
1440 min Winter	0.091	0.091	7.8	3.2	11.0	8.1	O K
2160 min Winter	0.047	0.047	7.3	1.1	8.4	4.2	O K
2880 min Winter	0.040	0.040	6.1	0.8	7.0	3.5	O K
4320 min Winter	0.031	0.031	4.7	0.5	5.3	2.7	O K
5760 min Winter	0.025	0.025	3.9	0.4	4.3	2.2	O K
7200 min Winter	0.022	0.022	3.4	0.3	3.7	2.0	O K
8640 min Winter	0.020	0.020	3.1	0.2	3.3	1.8	O K
10080 min Winter	0.018	0.018	2.7	0.2	2.9	1.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	94.243	0.0	75.2	23
30 min Winter	65.085	0.0	103.8	35
60 min Winter	42.570	0.0	135.8	60
120 min Winter	27.128	0.0	173.2	96
180 min Winter	20.694	0.0	198.2	134
240 min Winter	17.041	0.0	217.5	172
360 min Winter	12.934	0.0	247.7	244
480 min Winter	10.625	0.0	271.3	314
600 min Winter	9.120	0.0	291.1	374
720 min Winter	8.049	0.0	308.3	434
960 min Winter	6.606	0.0	337.3	540
1440 min Winter	4.991	0.0	382.3	752
2160 min Winter	3.764	0.0	432.5	1104
2880 min Winter	3.078	0.0	471.6	1452
4320 min Winter	2.317	0.0	532.5	2200
5760 min Winter	1.895	0.0	580.6	2832
7200 min Winter	1.621	0.0	621.1	3640
8640 min Winter	1.429	0.0	656.6	4272
10080 min Winter	1.284	0.0	688.6	5032

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.380

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.127	4	8	0.127	8	12	0.127

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.36700 Porosity 0.60
Infiltration Coefficient Side (m/hr) 0.36700

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	149.0	149.0	1.200	0.0	203.8
1.100	149.0	203.8			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0104-5000-1100-5000
Design Head (m)	1.100
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	104
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.100	5.0
Flush-Flo™	0.323	5.0
Kick-Flo®	0.690	4.0
Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.5	1.200	5.2	3.000	8.0	7.000	12.0
0.200	4.8	1.400	5.6	3.500	8.6	7.500	12.4
0.300	5.0	1.600	6.0	4.000	9.2	8.000	12.7
0.400	5.0	1.800	6.3	4.500	9.7	8.500	13.1
0.500	4.8	2.000	6.6	5.000	10.2	9.000	13.5
0.600	4.6	2.200	6.9	5.500	10.7	9.500	13.8
0.800	4.3	2.400	7.2	6.000	11.1		
1.000	4.8	2.600	7.5	6.500	11.5		

Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 41 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	0.737	0.737	29.4	5.0	33.5	104.8	O K
30 min Winter	0.963	0.963	30.8	5.0	35.5	137.0	O K
60 min Winter	1.066	1.066	31.5	5.0	36.4	151.6	O K
120 min Winter	1.033	1.033	31.3	5.0	36.1	146.9	O K
180 min Winter	0.941	0.941	30.7	5.0	35.3	133.9	O K
240 min Winter	0.834	0.834	30.0	5.0	34.4	118.5	O K
360 min Winter	0.612	0.612	28.6	5.0	33.1	87.1	O K
480 min Winter	0.420	0.420	27.3	5.0	32.3	59.7	O K
600 min Winter	0.269	0.269	26.4	5.0	31.3	38.3	O K
720 min Winter	0.162	0.162	25.7	4.6	30.3	23.1	O K
960 min Winter	0.064	0.064	25.1	1.9	27.0	9.2	O K
1440 min Winter	0.040	0.040	20.1	0.8	20.9	5.7	O K
2160 min Winter	0.031	0.031	15.4	0.5	15.9	4.4	O K
2880 min Winter	0.025	0.025	12.6	0.4	13.0	3.6	O K
4320 min Winter	0.019	0.019	9.6	0.2	9.8	2.7	O K
5760 min Winter	0.016	0.016	7.9	0.1	8.0	2.3	O K
7200 min Winter	0.014	0.014	6.9	0.3	7.0	1.9	O K
8640 min Winter	0.012	0.012	6.1	0.3	6.2	1.7	O K
10080 min Winter	0.011	0.011	5.4	0.3	5.4	1.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	94.243	0.0	140.5	22
30 min Winter	65.085	0.0	194.0	33
60 min Winter	42.570	0.0	253.8	56
120 min Winter	27.128	0.0	323.6	92
180 min Winter	20.694	0.0	370.2	130
240 min Winter	17.041	0.0	406.5	166
360 min Winter	12.934	0.0	462.8	232
480 min Winter	10.625	0.0	506.9	294
600 min Winter	9.120	0.0	543.8	350
720 min Winter	8.049	0.0	576.0	402
960 min Winter	6.606	0.0	630.3	506
1440 min Winter	4.991	0.0	714.3	736
2160 min Winter	3.764	0.0	808.0	1076
2880 min Winter	3.078	0.0	881.1	1452
4320 min Winter	2.317	0.0	995.0	2160
5760 min Winter	1.895	0.0	1084.8	2848
7200 min Winter	1.621	0.0	1160.4	3552
8640 min Winter	1.429	0.0	1226.8	4264
10080 min Winter	1.284	0.0	1286.6	5032

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.710

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.237	4	8	0.237	8	12	0.237

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.74880 Porosity 0.60
Infiltration Coefficient Side (m/hr) 0.74880

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	237.0	237.0	1.200	0.0	304.8
1.100	237.0	304.8			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0104-5000-1100-5000
Design Head (m)	1.100
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	104
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.100	5.0
Flush-Flo™	0.323	5.0
Kick-Flo®	0.690	4.0
Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.5	1.200	5.2	3.000	8.0	7.000	12.0
0.200	4.8	1.400	5.6	3.500	8.6	7.500	12.4
0.300	5.0	1.600	6.0	4.000	9.2	8.000	12.7
0.400	5.0	1.800	6.3	4.500	9.7	8.500	13.1
0.500	4.8	2.000	6.6	5.000	10.2	9.000	13.5
0.600	4.6	2.200	6.9	5.500	10.7	9.500	13.8
0.800	4.3	2.400	7.2	6.000	11.1		
1.000	4.8	2.600	7.5	6.500	11.5		

Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 65 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	0.650	0.650	1.0	5.0	5.9	27.8	O K
30 min Winter	0.871	0.871	1.1	5.0	5.9	37.2	O K
60 min Winter	1.022	1.022	1.1	5.0	6.0	43.7	O K
120 min Winter	1.066	1.066	1.1	5.0	6.1	45.5	O K
180 min Winter	1.040	1.040	1.1	5.0	6.0	44.4	O K
240 min Winter	0.990	0.990	1.1	5.0	5.9	42.3	O K
360 min Winter	0.866	0.866	1.1	5.0	5.9	37.0	O K
480 min Winter	0.725	0.725	1.0	5.0	5.9	31.0	O K
600 min Winter	0.552	0.552	1.0	5.0	5.9	23.6	O K
720 min Winter	0.421	0.421	0.9	5.0	5.9	18.0	O K
960 min Winter	0.245	0.245	0.9	4.9	5.8	10.5	O K
1440 min Winter	0.119	0.119	0.8	4.2	5.0	5.1	O K
2160 min Winter	0.087	0.087	0.8	3.0	3.8	3.7	O K
2880 min Winter	0.073	0.073	0.8	2.3	3.1	3.1	O K
4320 min Winter	0.057	0.057	0.8	1.5	2.3	2.4	O K
5760 min Winter	0.048	0.048	0.8	1.2	1.9	2.1	O K
7200 min Winter	0.043	0.043	0.7	1.0	1.6	1.8	O K
8640 min Winter	0.040	0.040	0.6	0.8	1.4	1.7	O K
10080 min Winter	0.037	0.037	0.6	0.7	1.3	1.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	94.243	0.0	33.6	23
30 min Winter	65.085	0.0	46.4	35
60 min Winter	42.570	0.0	60.8	60
120 min Winter	27.128	0.0	77.5	98
180 min Winter	20.694	0.0	88.7	138
240 min Winter	17.041	0.0	97.3	176
360 min Winter	12.934	0.0	110.8	250
480 min Winter	10.625	0.0	121.4	324
600 min Winter	9.120	0.0	130.2	382
720 min Winter	8.049	0.0	137.9	438
960 min Winter	6.606	0.0	150.9	544
1440 min Winter	4.991	0.0	171.0	744
2160 min Winter	3.764	0.0	193.5	1104
2880 min Winter	3.078	0.0	211.0	1464
4320 min Winter	2.317	0.0	238.2	2192
5760 min Winter	1.895	0.0	259.7	2888
7200 min Winter	1.621	0.0	277.8	3672
8640 min Winter	1.429	0.0	293.7	4400
10080 min Winter	1.284	0.0	308.1	5040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.170

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.057	4	8	0.057	8	12	0.057

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.07704 Porosity 0.60
Infiltration Coefficient Side (m/hr) 0.07704

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	71.2	71.2	1.200	0.0	108.4
1.100	71.2	108.4			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0104-5000-1100-5000
Design Head (m)	1.100
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	104
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.100	5.0
Flush-Flo™	0.323	5.0
Kick-Flo®	0.690	4.0
Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.5	1.200	5.2	3.000	8.0	7.000	12.0
0.200	4.8	1.400	5.6	3.500	8.6	7.500	12.4
0.300	5.0	1.600	6.0	4.000	9.2	8.000	12.7
0.400	5.0	1.800	6.3	4.500	9.7	8.500	13.1
0.500	4.8	2.000	6.6	5.000	10.2	9.000	13.5
0.600	4.6	2.200	6.9	5.500	10.7	9.500	13.8
0.800	4.3	2.400	7.2	6.000	11.1		
1.000	4.8	2.600	7.5	6.500	11.5		

Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 61 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	0.685	0.685	6.6	28.8	O K
30 min Winter	0.903	0.903	7.1	37.9	O K
60 min Winter	1.041	1.041	7.4	43.7	O K
120 min Winter	1.064	1.064	7.5	44.7	O K
180 min Winter	1.024	1.024	7.4	43.0	O K
240 min Winter	0.964	0.964	7.2	40.5	O K
360 min Winter	0.831	0.831	6.9	34.9	O K
480 min Winter	0.700	0.700	6.6	29.4	O K
600 min Winter	0.581	0.581	6.3	24.4	O K
720 min Winter	0.473	0.473	6.1	19.9	O K
960 min Winter	0.293	0.293	5.6	12.3	O K
1440 min Winter	0.067	0.067	5.1	2.8	O K
2160 min Winter	0.040	0.040	4.0	1.7	O K
2880 min Winter	0.033	0.033	3.3	1.4	O K
4320 min Winter	0.025	0.025	2.5	1.0	O K
5760 min Winter	0.020	0.020	2.0	0.8	O K
7200 min Winter	0.017	0.017	1.7	0.7	O K
8640 min Winter	0.015	0.015	1.5	0.6	O K
10080 min Winter	0.014	0.014	1.4	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Winter	94.243	0.0	23
30 min Winter	65.085	0.0	34
60 min Winter	42.570	0.0	58
120 min Winter	27.128	0.0	96
180 min Winter	20.694	0.0	134
240 min Winter	17.041	0.0	172
360 min Winter	12.934	0.0	242
480 min Winter	10.625	0.0	310
600 min Winter	9.120	0.0	376
720 min Winter	8.049	0.0	440
960 min Winter	6.606	0.0	562
1440 min Winter	4.991	0.0	766
2160 min Winter	3.764	0.0	1096
2880 min Winter	3.078	0.0	1460
4320 min Winter	2.317	0.0	2168
5760 min Winter	1.895	0.0	2848
7200 min Winter	1.621	0.0	3552
8640 min Winter	1.429	0.0	4232
10080 min Winter	1.284	0.0	5040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.180

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.060	4	8	0.060	8	12	0.060

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.50760 Porosity 0.60
Infiltration Coefficient Side (m/hr) 0.50760

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	70.0	70.0	1.200	0.0	107.4
1.100	70.0	107.4			

21 H. MAPPING

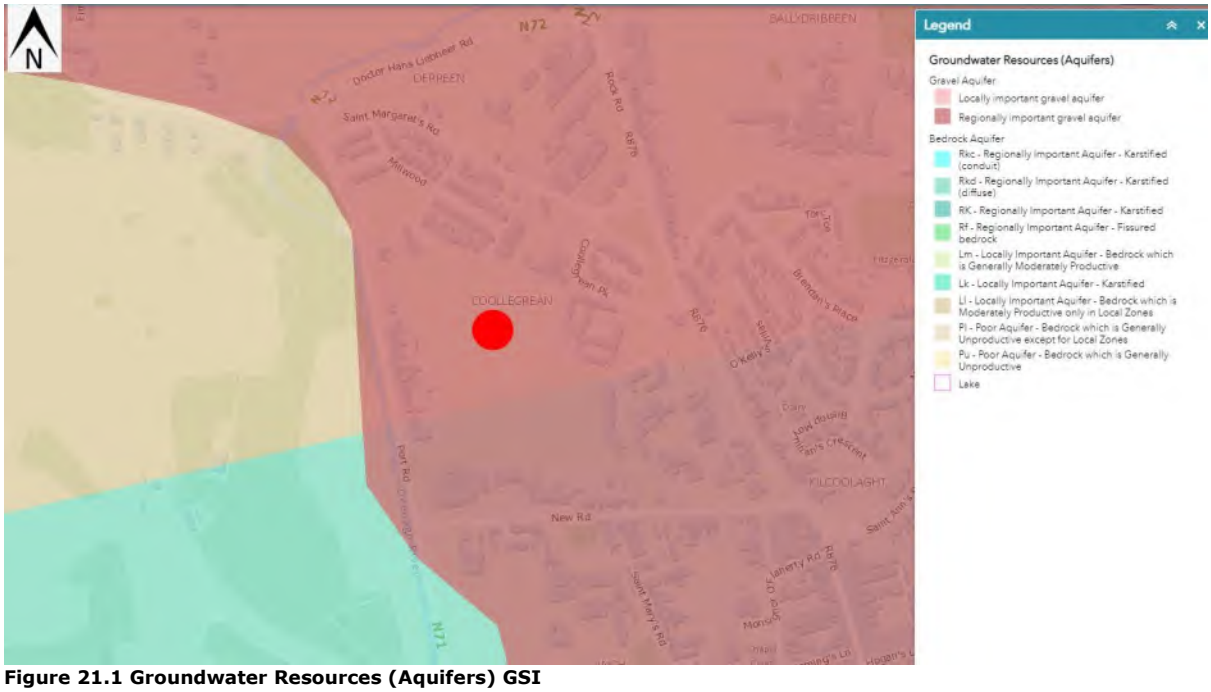

Figure 21.1 Groundwater Resources (Aquifers) GSI

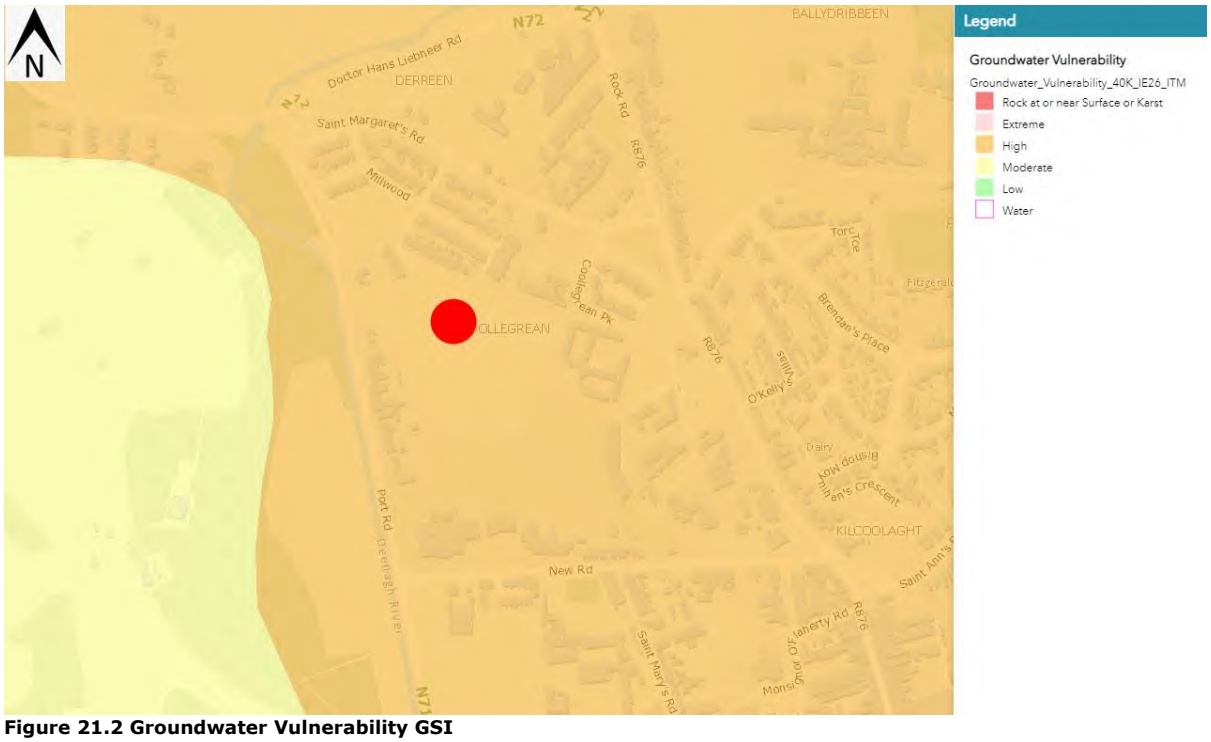

Figure 21.2 Groundwater Vulnerability GSI

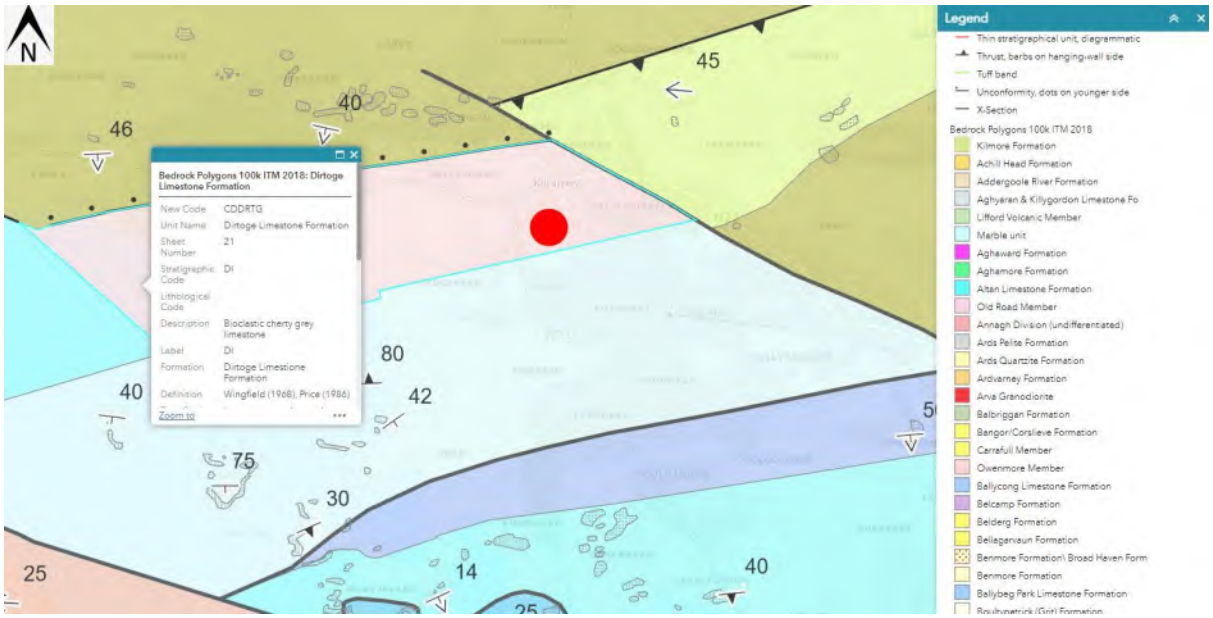

Figure 21.3 Bedrock Geology GSI

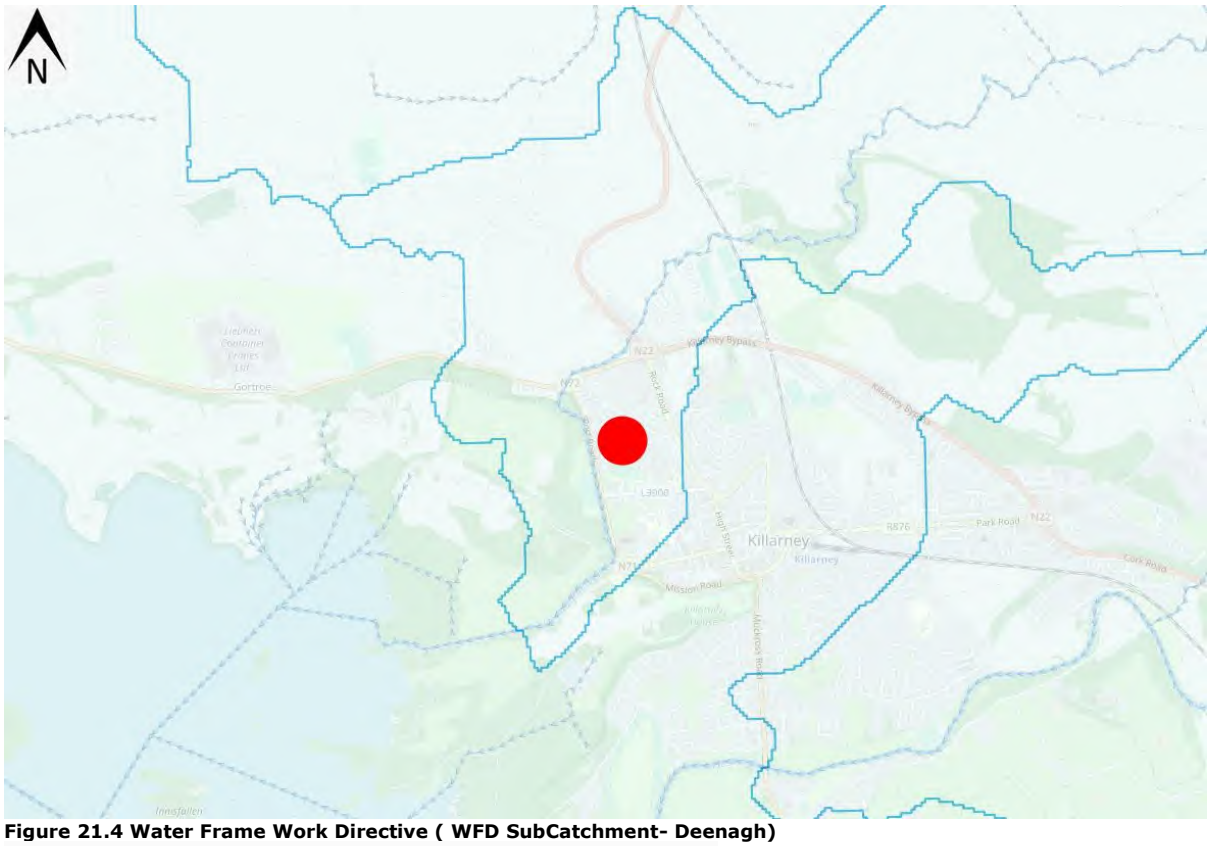

Figure 21.4 Water Frame Work Directive (WFD SubCatchment- Deenagh)

EU Water Framework Directive (2000/60/EC) (WFD).

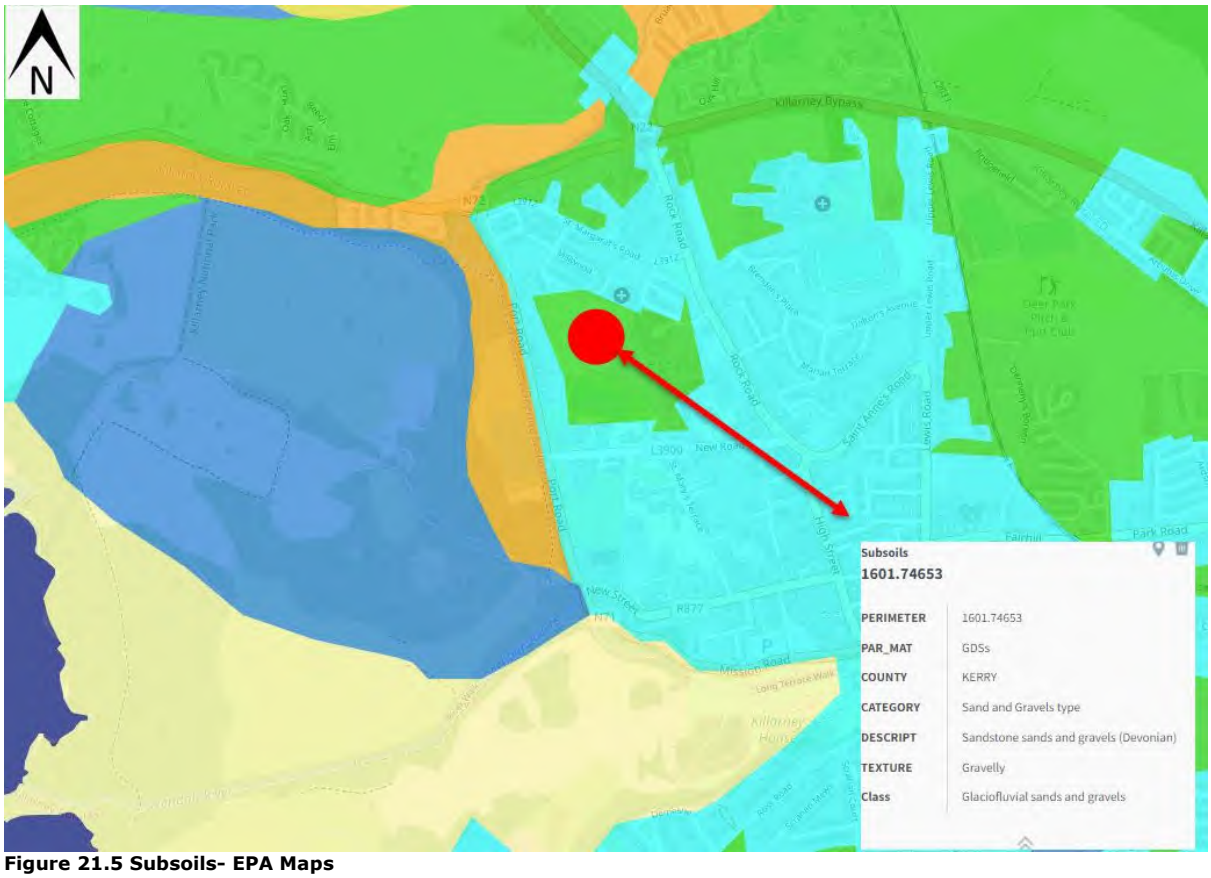

Figure 21.5 Subsoils- EPA Maps

22 I. FLOOD RISK ASSESSMENT

Please refer to the FRA carried out by Donal Moynihan BE. C.Eng., MIEI.

23 J. PRODUCT SPECIFICATIONS

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SWALES

SOURCE / SITE CONTROL

Example of a Swale

PRIMARY CONSIDERATIONS	
Construction Cost	MEDIUM
Maintenance Requirements	MEDIUM
Land Take	LOW

BENEFITS	
☑Water Quality Control	YES
☑Water Quantity Control	YES
☒Amenity Value	NO
☑Habitat Creation Value	YES
☒Biological Treatment	NO

DESCRIPTION

Swales are channels lined with grass, which are used to convey run-off to infiltration and in the process trap pollutants and reduce run-off velocity. Pollutant removal is achieved by the filtering channel vegetation, sub-soil matrix, and/or infiltration into the underlying soils. Swales are particularly suitable for controlling run-off from small residential developments, parking areas and roads.

Swale Drain in Residential Area, Scotland

DESIGN

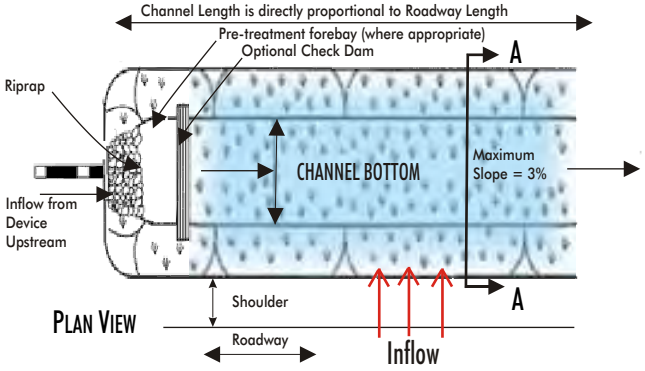
- Trapezoidal or parabolic cross section with relatively flat side slopes (less than 3:1) to maximise contact with the vegetation thus enhance treatment.
- Position along the side of the impervious area that they drain to facilitate sheet flow.
- Kerb cuts or a low earth weir may be required at the edge of the swale to admit flow.
- Point inflows should be minimised to prevent erosion.
- Outflow can be :

A) Invert Level: (Rough channel); Water level is a function of normal depth or of the throttle and in-flow rate. Not advisable to meet either volume reduction or attenuation targets for design events.

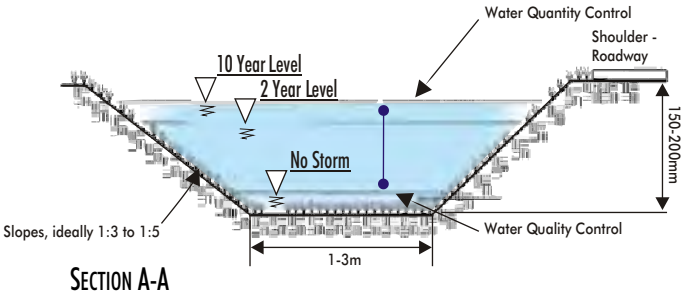
B) High Level: (Mini-retention basin combined with a conveyance channel); "Deep" water allows low values of conveyance velocity to be determined, which will reduce scour. Appropriate where soil conditions are relatively permeable or under drainage is provided.

C*) Infiltration:* (Not a conveyance channel); All in-flows infiltrated naturally or a land drainage pipe is used below the swale to ensure winter saturated conditions do not prevent infiltration taking place. Considerably less risk of erosion problems. Pipe connections are avoided.

- The use is constrained to where saturation of the soil is unlikely.
- The width of the base should not exceed 3m to prevent the formation of small channels or gullies.
- Slopes should be 1-3%, if longitudinal slope > 4%, incorporate check-dams to reduce effective slope, run-off velocities and consequent potential for erosion.
- Accuracy of grading is essential, as departure from design slopes will reduce effectiveness of treatment (Minnesota Urban Small Sites BMP Manual).
- The swale should be wider than deep, minimising any safety risks.
- The depth of flow should not exceed 0.1m.
- Flow Velocity should be less than 0.3m/s (CIRIA, 2000).
- Design to empty within 24 hours of a storm.
- Install an underdrain, typically a gravel layer encasing a longitudinal perforated pipe, beneath the soil layer to assist infiltration (filter drains) in most cases.
- Construct the base at least 1.5m above the maximum groundwater level and only where the groundwater classification allows.
- Hydraulic Design should avoid flooding for 1:30 year storm. For 100 year events property flooding should not take place and overland flows should not pass from the site and cause flooding to other areas.



PLAN VIEW



SECTION A-A
(NOT TO SCALE)

MORE OVERLEAF - 1 of 2

SWALES

SOURCE / SITE CONTROL

DESIGN

- Size pipes, as large as possible, connecting swales under driveways and roads to provide clogging.
- In areas where infiltration is not possible under-drains can be incorporated into the design (filter drain design) and the filtered run-off can be returned to the sewer network or outfall to watercourses.
- Swales should treat areas of 5 hectares or less.
- A thick vegetation cover is needed for proper function.
- Grass species should be selected taking into account their vigorousness, the soil type, their ability to tolerate silt and the available light. Should also be tolerant to periodic inundation and exposure to flow velocities.
- Native grasses are best for enhancing bio-diversity and wildlife.
- During construction, it is important to stabilise the channel before the turf has been established, either with a temporary grass cover or with the use of natural or synthetic erosion control products.
- Protect from construction run-off.
- No flow should be routed through the swale, until the vegetation becomes established.
- Avoid end of pipe swales, as they are susceptible to erosion.

POLLUTANT REMOVAL

A study by the Centre for Watershed Protection Monitoring suggest relatively high removal rates for some pollutants (TSS) but addition of bacteria and fair performance for phosphorus. A suggested source for the bacteria is dog faeces.

The Centre for Watershed Protection Monitoring studies carried out in Scotland (Macdonald 2002) have shown an overall improvement in the quality of run-off from swales. The results also suggested that a gravel layer below the soil, a shallow slope and a raised outlet enhances performance. Details of other studies are available from the (US) National Stormwater Best Management Practices Database. (www.bmpdatabase.org)

MAINTENANCE CONSIDERATIONS

Mowing in the first year is critical in order to eliminate competition from weeds. Lawn-mowing to an ideal height of 100mm should be maintained (CIRIA, 2000), as grasses tend to flatten down when water is flowing over them, reducing sedimentation.

Maintenance includes:

- Periodic litter removal.
- Occasional stabilisation of eroded side slopes and base.
- Sediment clean-up may be needed on good occasion.
- Check regularly for formation of any rills, channels or gullies.

The preservation of swales for the express purpose of serving roads will require these verges to be retained by the local authority and not located within private land.

INTERNATIONAL EXPERIENCE

Scotland

In Scotland, many swales have been located in inappropriate places and so-called end of pipe 'swales' have been fitted in to the available space on the periphery of the site. This has led to erosion problems in many of the systems. Another problem has been careless attention to detail, e.g.; the base of a swale slightly higher than the road, it was supposed to drain.

Pollutant	Removal (%)
TSS	81
TP	29
Nitrate	38
Metals	14-55
Bacteria	-50

ADVANTAGES

- ☑ Provides pollutant removal.
- ☑ Controls peak discharges by reducing run-off velocity.
- ☑ Linear nature makes them work well for treating highway and residential road run-off.
- ☑ Little water ponding on surface except during large storms.
- ☑ Shallow side slopes make them easy to mow.
- ☑ Operational problems or failures are easily detected on the surface.
- ☑ Can be used to link up other types of SUDS creating green wildlife corridors which can also provide aesthetic value.
- ☑ Can be used on most soils.
- ☑ Minimum safety concerns.
- ☑ Relatively inexpensive, simple to build and maintain.
- ☑ Maintenance not technically complicated; mainly involves lawn-mowing.

LIMITATIONS

- ☒ Individual swales can only treat a small area.
- ☒ Roadside swales may be subject to damage from off street parking (although bollards can be used to prevent this).
- ☒ Do not appear effective in reducing levels of bacteria in run-off.
- ☒ Limits the location of trees on roadside verges.
- ☒ Depth requires careful design for the accommodation of services.

Swale conveys Road Drainage, Scotland

FROM PREVIOUS - 2 of 2

Clima-Pave™

Permeable Paving Solutions

Kilsaran

ideas taking shape

Clima-Pave™

The rapid development of previously green-field sites and the associated creation of impermeable areas such as roofs, car parks and footpaths will mean that at project conception stage there will be potentially large volumes of surface water to be dealt with. Traditionally this has been done by piping the surface water into storage tanks or discharging it into nearby streams or surface water drainage. This method of drainage is not currently favoured by planners and designers, as it simply moves the surface water downstream where it still has to be dealt with. This is especially important where large volumes of water need to be dealt with during heavy rainfall events. Piping large volumes of water into streams and rivers increases the risk of flooding and also allows for the potential pollution of local water courses and drinking water supplies.

Sustainable Urban Drainage Systems (SUDS) and Water Source Control

Planners are encouraging the use of Sustainable Urban Drainage Systems (SUDS) in all new developments, in particular the use of appropriate source control techniques is important as this allows for the containment of the surface water collected on the site and for this surface water to be dealt with on-site as opposed to traditionally draining it off-site. SUDS, as a sustainable development approach to Surface Water Design Techniques, has the aim of balancing the following:

1. **To manage water run-off from developed areas to similar quantities prior to development (Source Control)**
2. **Reduce and avoid incidences of downstream flooding**
3. **To protect or enhance water quality of the run-off**
4. **To improve or enhance the amenity where possible**

Advantages of Permeable Paving

- Permeable Paving is a ‘source control’ method. Water is managed and dealt with on-site without piping off to storage tanks or surface water treatment systems
- The Water Framework Directive (Directive 2000/60/EC) requires that surface water discharges are managed to ensure that risk of contamination or pollution are mitigated. Permeable paving systems filter contaminants by microbial action. There is no requirement for additional filtering/polishing with Permeable Paving in normal use
- Separate attenuation tank systems are not required
- No need for gullies or channels or conventional drainage
- Recharges ground water
- Roofs, roads and other non-permeable areas can be discharged into permeable paving (No gullies required)
- No ponding or surface water
- Collected water can potentially be re-used for non-potable purposes
- Improves water quality

Clima-Pave™, the permeable paving solution from Kilsaran, offers an advantage over traditional SUDS techniques, such as storm water attenuation tanks. This is because the stone based sub-base, which needs to be installed for any type of surfacing material, is adapted to an open graded material in permeable paving systems. This allows the water collected from the site to be stored in the pavement and either infiltrated back into the ground or discharged at a controlled rate into the surface water drainage system.

The Clima-Pave™ system is constructed using our specially engineered permeable paving block, which has enlarged joints on all sides, typically 4-8mm in width. When the blocks have been laid, a corresponding slot is formed between the paving blocks which are then filled with a clean 3mm aggregate. This allows water to rapidly drain from the surface down into the pavement.

Traditional block paving is laid on a sand bedding layer and a Type 1/CL. 804 sub-base. To allow for storage and infiltration of the surface water percolating through the block, permeable block paving is laid on a grit laying course instead of sand and an open-graded stone sub-base instead of Type 1/CL. 804.

Clima-Pave™
Permeable Paving Solutions

Advantages of Clima-Pave™ for your project

Clima-Pave™ from Kilsaran offers the widest range of permeable paving products for use in commercial, retail and civic projects.

Kilsaran can also offer a full site-specific permeable paving design for your project, taking into account the site ground conditions, drainage requirements and structural and traffic loading requirements for the site. This is a chargeable service and Kilsaran will provide an indemnified design provided by our nominated Consulting Engineer who will visit the site if required to appraise the installation.

Design Guidance

Clima-Pave™ permeable paving provides a structural pavement suitable for both pedestrian and vehicular traffic depending on design. The water management and permeable functionality of the pavement is largely dependent on the correct specification and design of the pavement to meet the unique requirements of the individual site. The correct specification, testing and installation of aggregates is of paramount importance with any permeable paving system to ensure the finished pavement meets both initial and long term design requirements.

We advise that all permeable pavements require a site-specific design which should be carried out in accordance with BS 7533-13:2009 'Pavements constructed with clay, natural stone of concrete pavers. Part 13 Guide for the design of permeable pavements constructed with concrete paving blocks and flags, natural stone slabs and setts and clay pavers'.

We can provide a design service to customers who require a site specific design to be carried out for their project. In order to carry out this, we require a completed Clima-Pave™ Permeable Paving Design form available to download from our website, from our Sales team or can be requested by emailing technical@kilsaran.ie. This form should be returned via email with the supporting information about the site to enable a design to be carried out.

The information required includes:

- **Drawings of proposed site layout in AutoCad**
- **Full existing and proposed site levels for the pavement**
- **Full site investigation report to establish ground conditions and soaked CBR values of the sub-grade at formation level**
- **Infiltration values from soak-pit testing to BRE 365**
- **Overall drainage design strategy for the site**
- **Planning requirements or conditions for the site relating to paving and drainage (e.g. discharge limits)**
- **Any other pertinent site specific information or client / contractor requirements**

Design Guidance Basics

The below information is provided for guidance purposes only at project conception stage to allow appraisal of a permeable pavement system. Full independent advice should be sought from both the Consulting Engineer and the Contractor prior to the commencement of works. A full site-specific design will always be required in accordance with the above guidelines and BS 7533-13:2009.

The design information below is based on BS 7533-13:2009 which should also be consulted at project appraisal stage.

Types of Permeable Pavement

There are three main types of permeable pavement commonly used on sites:

System A – Full Infiltration: All water from the pavement is infiltrated to the ground

Suitable for sites with good ground conditions, higher CBR values and soils which will readily allow water to dissipate through the ground. These favourable conditions are rarely encountered on larger sites.

System B – Partial Infiltration: Most water infiltrated to ground with excess water piped off

Suitable for sites with medium ground conditions. The soil will infiltrate some of the water in the system. When storm events occur and water builds up in the system due to the soil being at capacity for drainage, perforated pipes are laid in the bottom of the sub-base to deal with the excess, taking it to the surface water drainage system. This is the most commonly used type of permeable pavement.

System C – Fully Tanked System: No water is allowed to infiltrate to ground

This type of system is used where poor sub-grade drainage conditions exist (heavy clays), where the stability of the sub-grade would diminish if extra surface water was introduced, or where ground water levels are within 1 metre of the formation level (system could gain water). In this system the sub-base acts essentially as an attenuation tank, wrapped in an impermeable polythene membrane and all water is piped out.

Selection of Pavement Type

The type of permeable pavement system to be adapted is based primarily on site ground conditions, site suitability and the permeability values of the sub-grade encountered on site from infiltration soak-pit testing. Table 1 gives guidance on the suitability of the three types of permeable pavement system.

Table 1: Guidance on selection of a pavement system

		System A - total infiltration	System B - partial infiltration	System C - no infiltration
Permeability of subgrade defined by coefficient of permeability, *k* (m/s)	10^{-6} to 10^{-3}	✓	✓	✓
	10^{-8} to 10^{-6}	✗	✓	✓
	10^{-10} to 10^{-8}	✗	✗	✓
Highest recorded water table within 1000mm of formation level		✗	✗	✓
Pollutants present in subgrade		✗	✗	✓

Selection of Pavement Sub-Base Thickness

The design of the sub-base for the permeable pavement should take into account the traffic loadings likely to use the pavement. It is essential to take into account any future increase in traffic volume and any HGV traffic which may use the pavement irrespective of how frequent. The correct loading category should be then selected from Table 2 taking into account the above considerations. It should be noted that no layers of the permeable pavement are designed for site traffic to use them and when finished the permeable pavement surface should not be trafficked by site traffic vehicles which are heavier than that for which the pavement was designed. It is advisable to complete paving works after all other work in the vicinity has been completed.

Typical build up details for each traffic category are illustrated on page 20 and 21 for guidance purposes.

Table 2: Loading Categories

1 DOMESTIC PARKING	2 CAR	3 PEDESTRIAN	4 SHOPPING	5 COMMERCIAL	6 HEAVY TRAFFIC
No Large Goods Vehicles	Emergency Large Goods Vehicles only	One Large Goods Vehicles per week	Ten Large Goods Vehicles per week	100 Large Goods Vehicles per week	1000 Large Goods Vehicles per week
Zero standard axles	**100 standard axles**	**0.015msa**	**0.15msa**	**1.5msa**	**15msa**
Patio	Car Parking Bays and Aisles	Town/city Pedestrian Street	Retail development delivery access route	Industrial Premises	Main road
Private Drive	Railway Station platform	Nursery Access	School/college access road	Lightly Trafficked Public Road	Distribution Centre
Decorative feature	External Car Showroom	Parking area to residential development	Office block delivery route	Light Industrial development	Bus Station (bus every 5 minutes)
Enclosed Playground	Sports Stadium Pedestrian route	Garden centre external display area	Deliveries to small residential development	Mixed retail/ industrial development	Motorway Truck Stop
Footway with zero vehicle overrun	Footway with occasional overrun	Cemetery Crematorium	Garden centre delivery route	Town Square	Bus Stop
	Private drive/ footway crossover	Hotel Parking	Fire Station Yard	Footway with regular overrrun	Roundabout
		Airport Car Park with no bus pickup	Airport Car Park with bus to terminal	Airport landside roads	Bus Lane
		Sports Centre	Sports Stadium access route/ forecourt		

msa = millions of standard 8,000 kg axles

Sub-Base Thickness For Water Storage

The sub base depth must also take into consideration the water storage requirements for the site. The depth of sub-base may have to be adjusted to allow for increased site specific water storage. Further guidance on hydraulic factors can be found in BS 7533-13:2009 section 5.4.

Adjustment To Pavement Design For Low CBR Sub-Grade

In the case of CBR values below 5%, either ground improvement work will be required for the site, or the thickness of the coarse graded aggregate sub-base will have to be adjusted in accordance with 5.6.3 and table 9 of BS 7533-13:2009

Permeable Paving Aggregates

All materials used as permeable paving aggregate must comply to the grading and physical requirements below, as well at the general requirements of BS EN 12620 and BS EN 13242. Sub-base laying course materials should be clean, sound, non-friable and sound crushed rock material. Rounded gravel materials are not recommended for sub-base layers. The jointing material may be either clean crushed material or clean gravel material. The materials should be tested to confirm that it meets the requirements below.

The contractor shall also ensure that on-going deliveries to site are checked frequently for grading, shape and inspected to ensure cleanliness.

During installation on site, great care and attention must be paid to ensure that the aggregates are kept free of contamination and deleterious matter. Construction traffic cannot be allowed to traverse the layers of permeable paving aggregates during installation.

4/40mm Coarse Graded Permeable Paving Aggregate

Sieve Size (mm)	Percentage Passing
80	100
63	98-100
40	90-99
31,5	-
20	25-70
10	-
4	0-15
2	0-5

4/20mm Coarse Graded Permeable Paving Aggregate

Sieve Size (mm)	Percentage Passing
40	100
31,5	98-100
20	90-99
10	25-70
4	0-15
2	0-5

2/6.3mm Laying Course Paving Aggregate

Sieve Size (mm)	Percentage Passing
14	100
10	98-100
6.3	80-99
2	0-20
1	0-5

3mm Jointing Grit

Sieve Size (mm)	Percentage Passing
40	100
8	100
6.3	95-100
4	85-99
2	15-35
1	0-10
0.063	0.0-1.5

Property	Category to BS EN 13242 or BS EN 12620
Grading	4/20 (preferred) or 4/40 as per table above
Fines Content	F4
Shape	FI20
Resistance to Fragmentation	LA30
Water Absorption to BS EN 1097-6:2000	WA2
For water absorption > 2% Magnesium Sulfate Soundness	MS18
Resistance to Wear	MDE20
Acid Soluble Sulfate Content	AS0.2
Total Sulfur	≤1% by mass
Recycled Aggregates	Seek guidance from Kilsaran Technical Department

Typical Design Diagrams

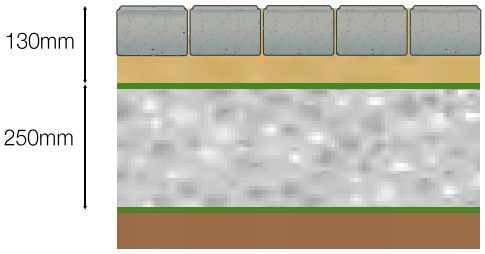
Below are typical build-up details for permeable pavement systems based on BS 7533-13:2009. These diagrams are based on ideal site conditions for drainage and CBR values of 5% or greater. The diagrams are for project appraisal purposes only and in all cases a site specific design in accordance with BS 7533-13:2009 will be required.

Key:

- 2 / 6.3mm Laying Course
- Hydraulically-Bound Coarse Graded Aggregate or 80mm of DBM Macadam
- 4 / 20mm Coarse Graded Aggregate and /or 4/40mm Coarse Graded Aggregate
- Capping Material
- Approved Geotextile
- Approved Impermeable Membrane

System A & B (Infiltrating & Partial Infiltration Systems)

LOAD CATEGORY 1



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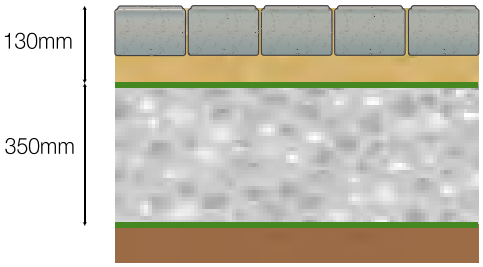

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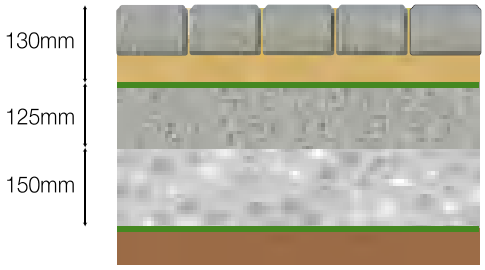

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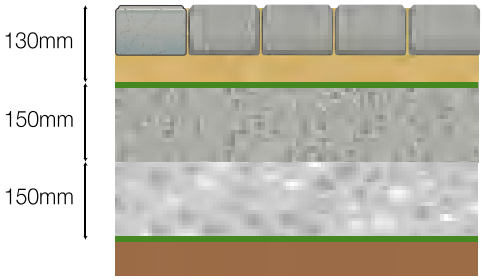

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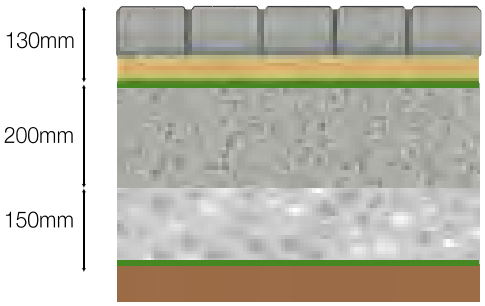

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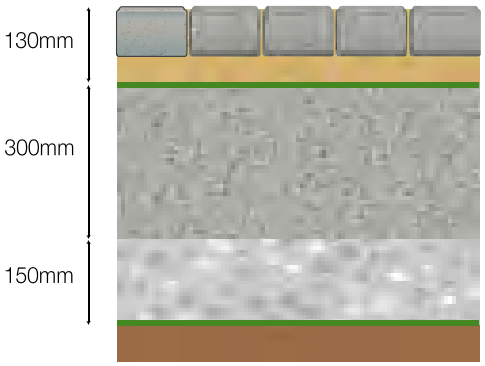


Alternative build up / materials may be used depending on project specific details.

For load categories 3-6 the hydraulically-bound coarse graded aggregate (porous no fines concrete) layer may be replaced with 80mm depth of DBM Macadam to act as a stiffening layer. The macadam layer should be punctured at 750mm centres on grid. Further details on the DBM macadam layer are given on page 19.

Where the depth of aggregate sub-base is in excess of 350mm for the given loading category, it may be possible to reduce the depth of aggregate required and provide a more cost effective design with the use of an appropriate and approved geo-grid. This can be appraised at design stage.

PLANNING GUIDE

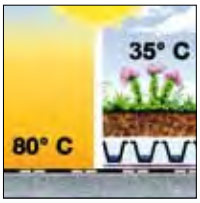
System Solutions for Extensive Green Roofs

Life on Roofs

Why Have a Green Roof?

Urban, construction and ecological advantages:

Extended Roof Life



- Protects the roof membrane from UV exposure, heat cold and hail and mechanical damage.

New Habitat

- Encourages wild-life to remain within build-up areas.

Stormwater Management

- Reduces immediate water run-off. The sewer pipes can be reduced in capacity.

Reduction of Dust and Smog Levels

- Enhances the micro-climate by cooling, filtering out dust and smog particles.

Improve Building Operations

- Thermal protection in both summer and winter and reduction of heating and cooling costs.

Noise Reduction

- Improves sound insulation.

Features

Unlike intensive green roofs, extensive green roofs require little maintenance.

The features at a glance:

- **Minimum maintenance**:
  - Inspection and maintenance once or twice a year
  - Water and nutrient supply mostly by natural means
- **Plant communities close to nature**:
  - Undemanding
  - Extensive
  - Self-regenerating
- **Low loads and build-up heights**:
  - Mainly mineral growing medias with depths of up to about 5 in.
  - Loads about 20-40 lbs/sq.ft.
- **Low-cost**:
  - For installation and maintenance

Principles

ZinCo extensive green roofs are installed in accordance with current standards.

Our six principles at a glance:

- The System Build-up is tailored to suit each roof.
- The System Build-up ensures permanent drainage, even under load.
- The System Build-up provides for a good water/air balance.
- The System Build-up is adapted to suit the required type of vegetation.
- The System Build-up keeps maintenance and upkeep to a minimum.
- The System Build-up provides for a long green roof life.

All vegetation specific information is based on moderate continental climate. Please contact us for any other climatic condition.

ZinCo Extensive Green Roof Systems

→ Please see our Planning Guides :

- *“System Solutions for Sloped Green Roofs”*
- *“System Solutions for Intensive Green Roofs”*

for more information.

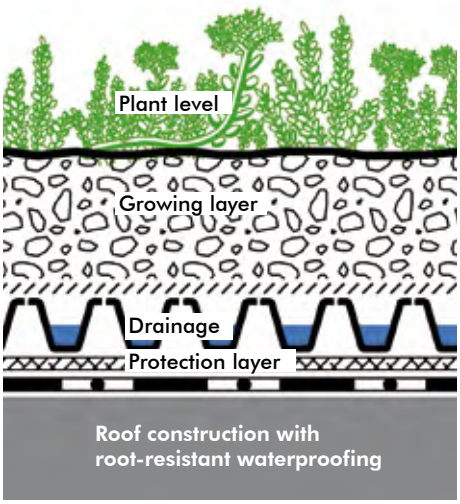
System Build-up “Sedum Carpet”

“Sedum Carpet“ is a shallow, ground-covering extensive green roof type. In moderate climates, it requires approx. 2.5 in. of “Zincoblend E“ Growing Media. The System Build-up is adapted to the particular roof condition. “Sedum Carpet“ is used, when the load bearing capacity of the roof and the expenses for maintenance, are restrictive.

Proven Sedum species, in combination with the appropriate System Build-up, guarantee a long-lasting low maintenance green roof. The plant community “Sedum Carpet“ contains various low-growing Sedum species.
The main blooming time is in early summer, with yellow or red and white flowers dominating at different times. Throughout the rest of the year, “Sedum Carpet“ is represented in various shades of green. Red shades, particulary in autumn, are a pleasant change in the visual appearance. “Sedum Carpet“ is installed either by Sedum cuttings or plug plants or pre-cultivated vegetation mats.

Plant Suggestions "Sedum Carpet"
Minimum of four different Sedum species

Botanical Name	Common Name	Height (in.)	Blossom Color	Time of Bloom
Sedum album varieties	White Stonecrop Varieties	2-4	white	early mid summer
Sedum cauticolum	Nettle-Leaved Goosefoot	4-6	pink	late summer - early fall
Sedum floriferum 'Weihenstep. Gold'	Gold Sedum	2-4	yellow	early mid summer
Sedum hybridum 'Immergrünchen'	Hybrid Stonecrop	4-6	yellow	mid summer
Sedum reflexum	Crooked Yellow Stonecrop	8-10	yellow	early mid summer
Sedum sexangulare	Tasteless Yellow Stonecrop	2-4	yellow	early mid summer
Sedum spurium in varieties.	Dragon`s Blood	4-6	red, white, pink	mid summer



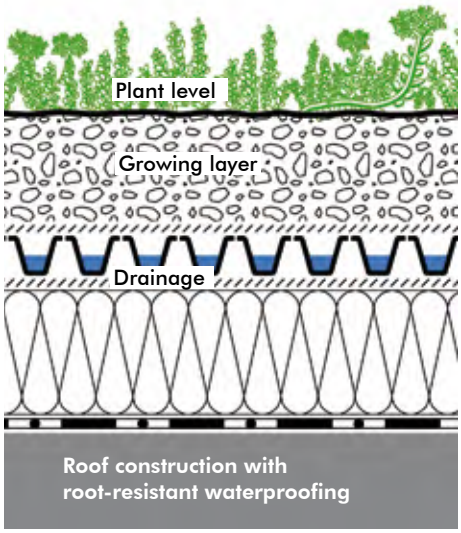
Plant Community "Sedum Carpet"

Growing Media "Zincoblend E",
Depth: ≈ 2.5 in.,
for vegetation mats ≈ 1.5 in.
Filter Sheet SF

Drainage Element Floradrain® FD 25-E
Protection Mat SSM 45
Root Barrier WSF 40 (optional)

Slope:	1/48 – 2/12
Height	≈ 3 ¾ in.
Weight:	≈ 20 lbs/sq. ft.
Water retention capacity:	≈ 0.8 gal/sq. ft.

System Build-up “Sedum Carpet” on Inverted Roofs



Roof construction with root-resistant waterproofing

Inverted Roof (Slope 1/48–2/12)

Plant Community “Sedum Carpet”

growing media “Zincoblend E”,
Depth: ≈ 2.5 in. (≈ 60 mm),
for vegetation mats ≈ 1.5 in. (≈ 45 mm)
Filter Sheet SF
Drainage Element Floradrain® FD 25-E
Separation Membrane TGV 21

(XPS thermal insulation)

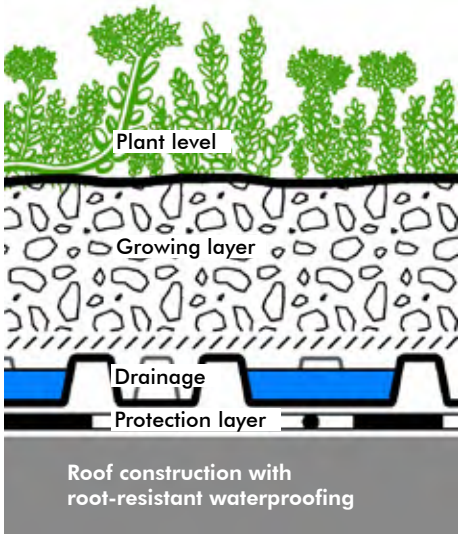
Root Barrier WSF 40 (optional)

Slope:	1/48–2/12
Height	≈ 3 ¾ in.
Weight:	≈ 19 lbs/sq. ft.
Water retention capacity:	≈ 0.7 gal/sq. ft.

With inverted roofs, layers that prevent the diffusion of water vapor must not be installed above the XPS thermal insulation boards. Therefore, the water retaining protection mat must be replaced by the diffusion permitting Separation Membrane TGV 21. If root barriers are necessary they have to be placed below the insulation boards directly onto the waterproofing.

System Build-up “Sedum Carpet” for Large Industrial Roofs

The bigger the roof area, the higher the costs. You can avoid this by omitting certain layers.
ZinCo has combined a number of functional layers in one product. Fixodrain® XD 20 can be installed without an additional protection layer, due to its extremely large contact surface and continuous connection over a large area. The filter sheet is laminated to the drainage mat, the roll-out takes place quick and easy. The elements are interlocking with an overlapping filter sheet.



Roof construction with root-resistant waterproofing

Plant Community “Sedum Carpet”

Growing Media “Zincoblend E”,
Depth: ≈ 2.5 in. ,
for vegetation mats ≈ 1.5 in.

Drainage Mat Fixodrain® XD 20

Root Barrier WSF 40 (optional)
covered with Filter Sheet PV

Slope:	1/48–2/12
Height	≈ 3 ¾ in.
Weight:	≈ 19 lbs/sq. ft.
Water retention capacity:	≈ 0.7 gal/sq. ft.

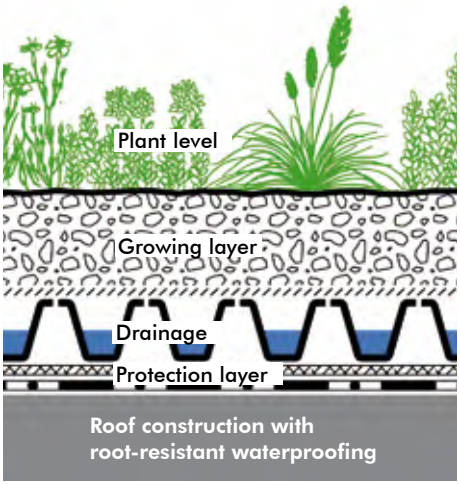
System Build-up “Ornamental Sedum“

“Ornamental Sedum“ allows for an extensive green roof with sophisticated design and individual character. The growing media is applied with a minimum depth of 2.75 in. “Ornamental Sedum“ vegetation consists of a wide variety of species which results in a long blooming period and allows for different accents throughout the vegetation period.
Sedum species and other perennials are primarily used as a ground cover. Drought resistant perennials add flowering accents and height to the design.

The color spectrum is significantly more diverse in comparison to “Sedum Carpet“. The Build-up is realized by manually planting plug plants. Thus the desired result can be designed.

Plant Suggestions "Ornamental Sedum"

Botanical Name	Common Name	Height (in.)	Blossom Color	Time of Bloom
Accent plants (groups of 3,5, or 7)				
Allium schoenoprasum	Wild Chives	10	pink	late spring
Armeria maritima 'Alba'	White Sea Thrift	6	white	mid spring
Dianthus deltoides 'Brillant'	Maiden Pink	4-6	red	early summer
Saponaria ocymoides	Rock Soapwort	12	pink	early-late summer
Sedum ellacombianum	Orange Stonecrop	4-6	yellow	mid-summer
Sempervivum tectorum 'Emerald Empress'	Common Houseleek	2-4	pink	early-mid summer
Talinum calycinum	Fameflower	10-12	pink	late spring - late summer
Ground covers (Minimum of four different Sedum species)				
Antennaria dioica	Stoloniferous Pussytoes	4	pink	early-mid summer
Delosperma nubigenum "Basutoland"	Ice Plant	2-3	yellow	late spring
Sedum floriferum 'Weihenstephaner Gold'	Gold Sedum	2-4	white	early-mid summer
Sedum hybridum 'Immergruenchen'	Hybrid Stonecrop	4-6	yellow	mid summer
Sedum middendorfianum diffusum	Stonecrop	5	yellow	mid summer
Thymus serpyllum 'Coccineum'	Red Thyme	12	red	early summer
Thymus serpyllum 'Pink Chintz'	Creeping Thyme	12	pink	spring



Plant Community "Ornamental Sedum"

Growing Media "Zincoblend E",
Depth: ≈ 2.75 in.

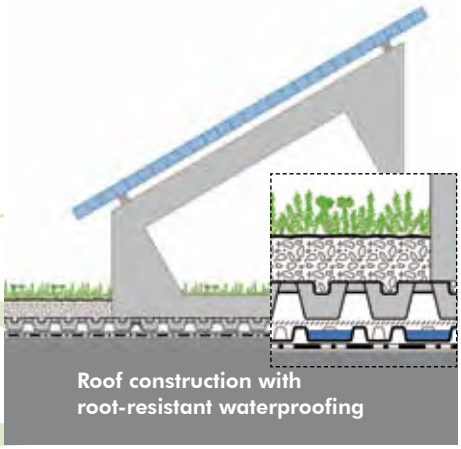
Filter Sheet SF
Floradrain® FD 40-E

Protection Mat SSM 45
Root Barrier WSF 40 (optional)

Slope:	0/12–2/12
Height	≈ 4 ½ in.
Weight:	≈ 23 lbs/sq. ft.
Water retention capacity:	≈ 1.0 gal/sq. ft.

System Build-up “Solar Green”

Solar energy and green roofs can now be combined. With our System Build-up “Solar Green” (Fixodrain® XD 20, ZinCo Solar Base SB 200 and Base Frame SGR) solar panels can be combined with a green roof.
Solar panels are more energy efficent with the cooling effects of the Sedum. And, there is no need for roof penetration, because the weight of the green roof build-up ballasts the entire system.



Roof construction with
root-resistant waterproofing

Solar panel

Solar Base Frame SGR

Plant Community “Sedum Carpet”
Growing Media “Zincoblend E”
ZinCo Solar Base® SB 200 with infill
Fixodrain® XD 20
Root Barrier WSF 40 (optional)

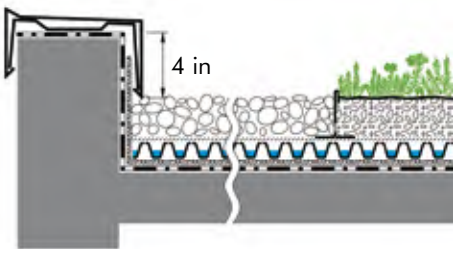
Build-up height:	from ≈ 5 in.
Weight, saturated:	from ≈ 25 lbs/sq. ft.*
Water storage capacity:	from ≈ 0.6 gal/sq. ft.*

** The required growing media quantity depends on the project. Thus the total weight can change.*

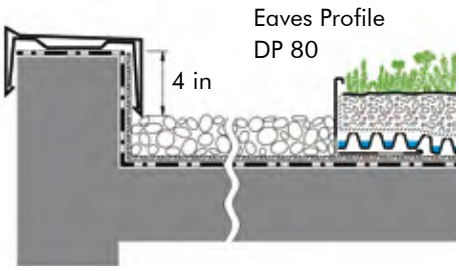
Accessories and Details

Perimeters

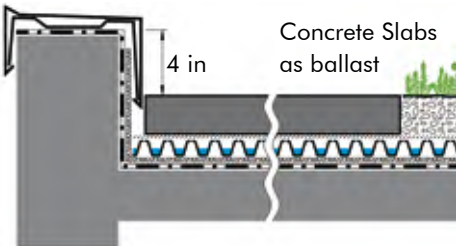
In line with local roofing codes a height of 4 inches above the roof surface is required. The protection mat and root barrier are required to be tucked up under the parapet cap. The protection mat and root barrier, are brought upwards and secured.
If in projects with high wind loads the perimeter and corner areas of the roof are to be part of the green roof, the vegetation cover must be closed immediately, e. g. by using Sedum mats. This is very often done by adding wide edge stripes of concrete or grass pavers.



Standard perimeter solution

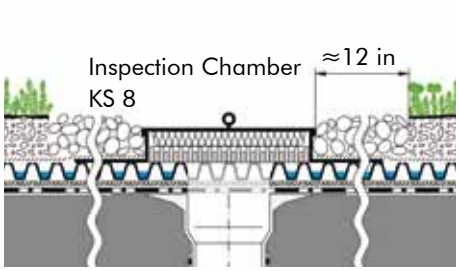


Solution for low perimeters



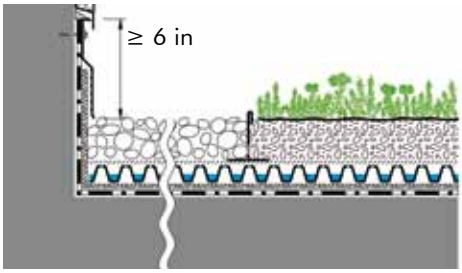
Perimeter solution for high wind loads (loose waterproofing)

Roof Drains and Inspection Chambers

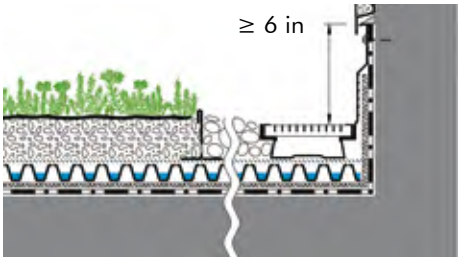


Usually, the drainage of low sloped roofs is achieved through roof drains. The quantity as well as the size of the roof drains should be designed according to laocal building codes.
Inspection chambers make sure the roof drains remain accessible and therefore can be cleaned easily.

Wall Connection



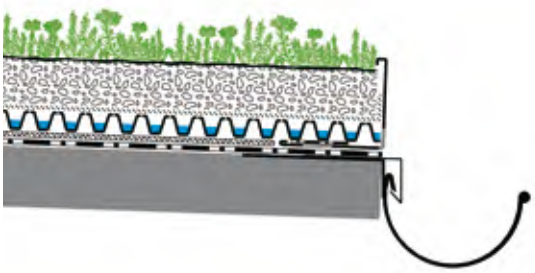
The connection to walls needs to be waterproof. Therefore the protection mat, the waterproofing and the root barrier are taken up at least 6 in above the finished surface of the green roof build-up and fixed with a protection profile. In front of facades the installation of additional drainage channels is recommanded



in order to lead rainwater directly into the drainage layer. If only little water is expected, a simple gravel strip is sufficient.

Drainage via an External Eaves Gutter

If the drainage of a green roof is to be ensured by an external gutter, the green roof build-up can be bordered by an eaves profile, which is attached to the waterproofing. Eaves profiles border the build-up but allow for unhindered water runoff due to their drainage slots.



Ecological
Green Roof Systems

This Planning Guide aims to give you a general overview of the technology involved in the various extensive green roof options.

Our technical experts will be pleased to advise you on specific solutions for your own individual building projects: from the planning phase right through to creating your specification texts.

Challenge us!

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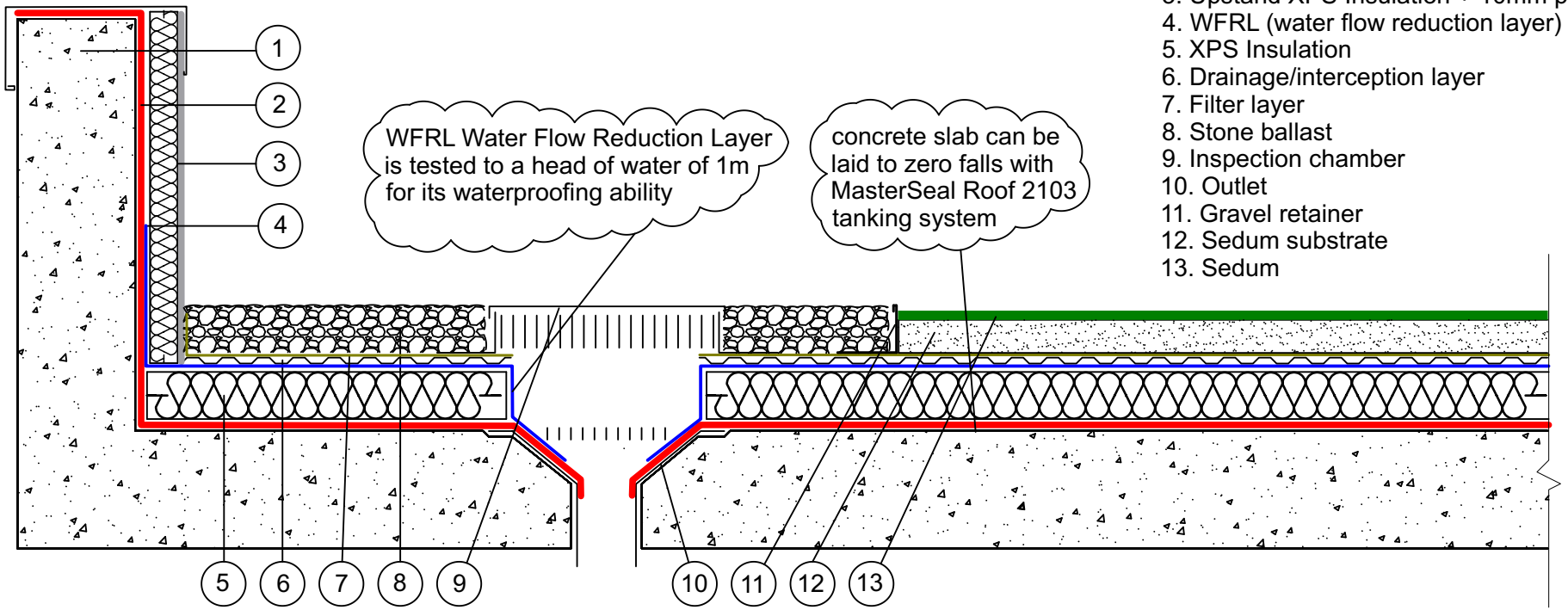
BETON Inverted Green Roof Waterproofing System



1. Concrete Substrate
2. MasterSeal Roof 2103 membrane
3. Upstand XPS Insulation + 10mm polymer
4. WFRL (water flow reduction layer)
5. XPS Insulation
6. Drainage/interception layer
7. Filter layer
8. Stone ballast
9. Inspection chamber
10. Outlet
11. Gravel retainer
12. Sedum substrate
13. Sedum

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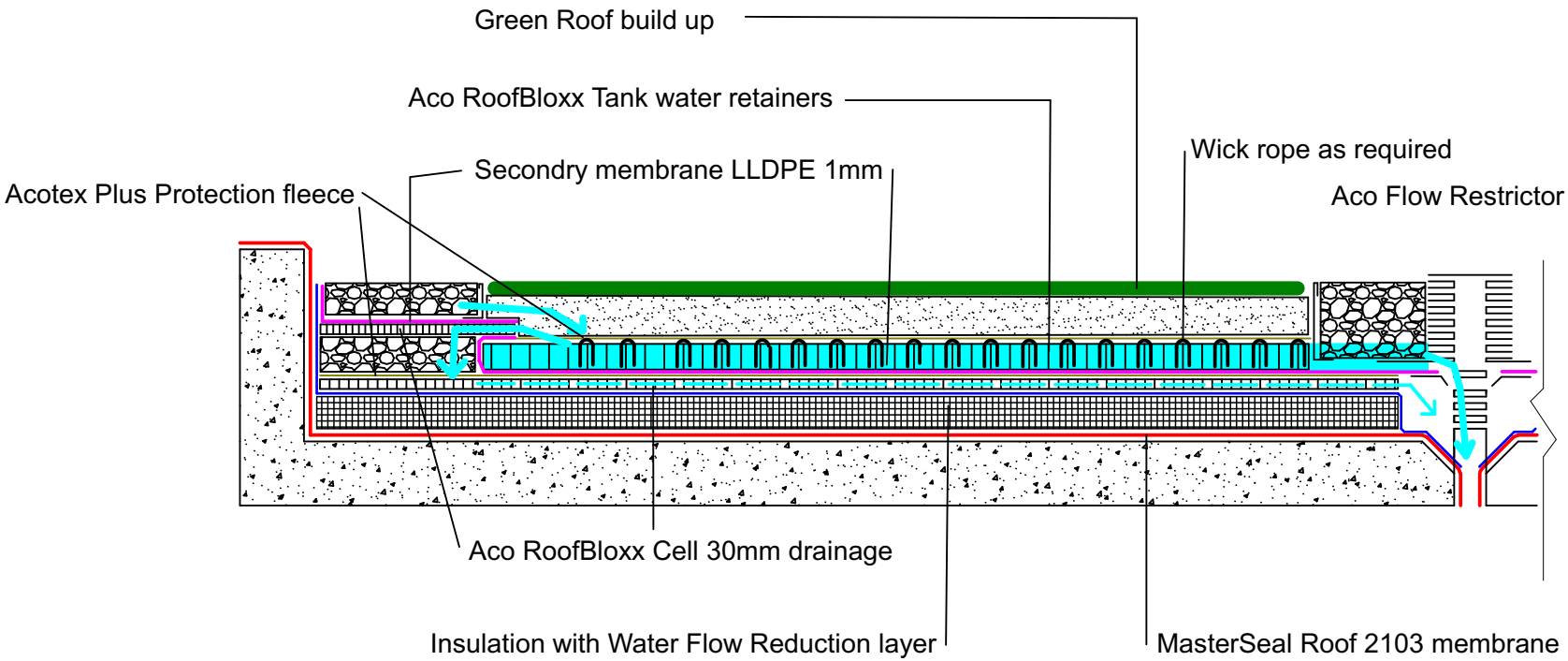
Tel: +353 1 4016402

Website: www.beton.ie
email: info@beton.ie

Date: 28/11/19
Drawing no: Beton GR2001 rev a
Title: Beton Inverted Green Roof Waterproofing system
Drawn by: DoC
Scale: Not to scale

This drawing is not a working drawing and is for illustration purposes only.

Beton Inverted Green Roof Waterproofing system with Blue roof retention



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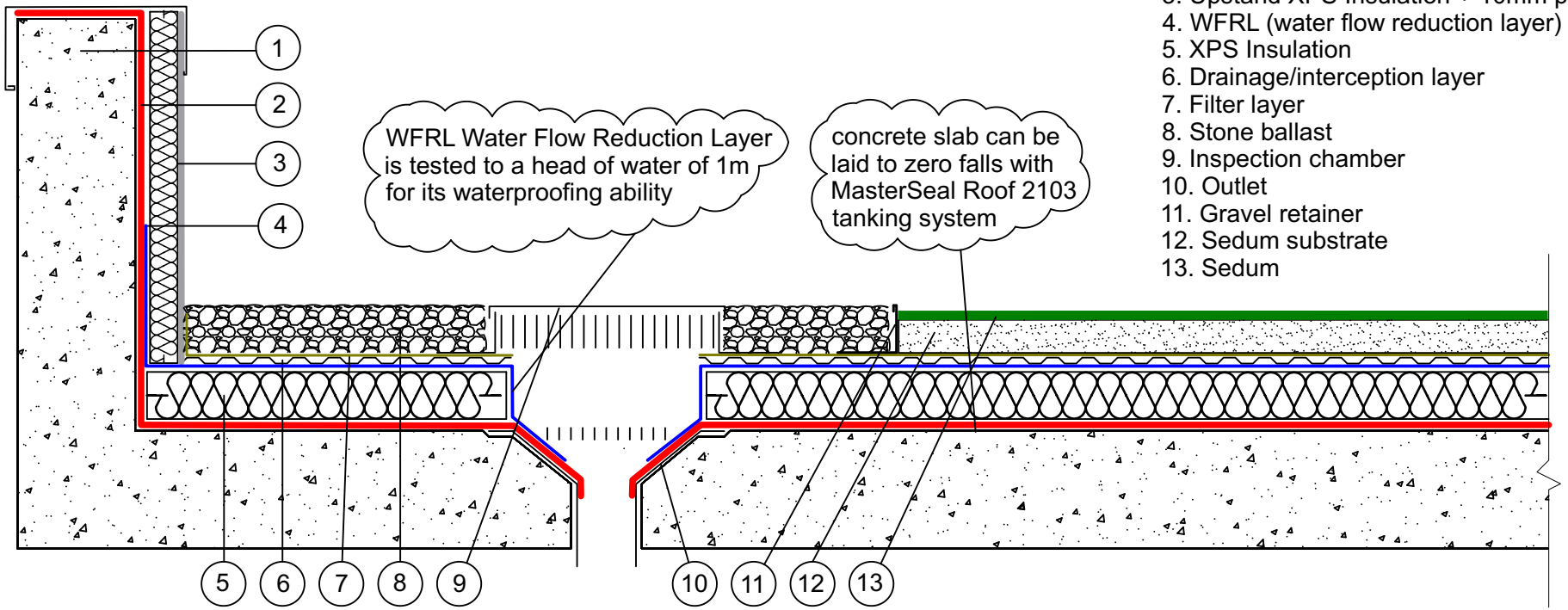
Date: 17/05/21
Drawing no: Beton ACO BR rev a
Title: Beton Inverted Green Roof Waterproofing system with Blue roof retention
Drawn by: DoC
Scale: Not to scale

This drawing is not a working drawing and is for illustration purposes only.

BETON Inverted Green Roof Waterproofing System



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Beton Construction Services Ltd

Roof rainfall outflow calculation				
Site location: Port Rd, Killarney Block J				
Met Eireann E 95739 N 91377 **Return Period Rainfall Depths**			**PIMP**	
M5-60	16.70		Green roof	
M5-2D	76.80		6cm S	45.0%
M100-60	31.50		30cm S	0.0%
			50cm S	0.0%
r	0.24		Paved	0.0%
			Ballast	9.0%
Roof elements				
Green Roof			Average pimp Factor for roof	54.0%
6cm S (m^2)	850.00			
30cm S (m^2)	0.00		**1. Sub Estimated Outflow**	**m^3**
50cm S (m^2)	0.00		M5-60 1 in 5yr 1hr	8.53
Paved (m^2)	0.00		M5-2D 1 in 5yr 48hr	39.21
Ballast (m^2)	95.00		M100-60 1 in 100yr 1hr	16.08
Sub Total (m)	945.00		Drainage layer interception l(m^2)	3.00
PIMP Factors				
Green roof				
6cm S	0.5		Deduct for drainage layer interception:	
30cm S	0.4		**2. Sub Estimated Outflow**	**m^3**
50cm S	0.4		M5-60 1 in 5yr 1hr	5.69
Paved	0.9		M5-2D 1 in 5yr 48hr	36.37
Ballast	0.9		M100-60 1 in 100yr 1hr	13.25
Add for climate change factor	10%			
Total Estimated Outflow	**m^3**			
M5-60 1 in 5yr 1hr	6.26			
M5-2D 1 in 5yr 48hr	40.01			
M100-60 1 in 100yr 1hr	14.57			

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