# APPENDIX 5

SuDS Strategy

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# Killamonan / Cherryhound Local Area Plan

# SuDS Strategy

Comhairle Contae Fhine Gall
Fingal County Council

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# Control Sheet

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# Table of Contents

# 1.0 Executive Summary

This report has been prepared to define a suitable Sustainable Urban Drainage Systems (SuDS) strategy for the Killamonan / Cherryhound Local Area Plan Lands (LAP Lands). This report sets outlines the overall approach to be taken by designers and identified suitable SuDS techniques to be used.

The LAP lands are located north of the built-up area of Blanchardstown Co. Dublin. The lands are zoned for commercial and industrial uses. Currently, the area is greenfield with some residential dwellings. ESB have a substantial landholding to the southwest which includes a Substation and stores. A disused quarry is located on the eastern side of the LAP lands.

The key proposed land uses within the LAP lands are as follows

- The proposed road network.
- Gateway development - incorporating a motorway services area, office and commercial developments, and logistic uses.
- Neighbourhood centre area - retail units and small offices.
- Disused quarry - may still operate as a quarry or converted for amenity/ leisure use.

Key considerations in the provision of SuDS infrastructure in the LAP lands are:

- Protection of water quality of runoff which is ultimately conveyed to the Tolka and Broadmeadows estuaries, which are protected areas.
- Protection of groundwater quality due to the vulnerable nature of the local aquifers.
- Maintaining a runoff regime which mirrors the existing greenfield runoff

# 2.0 Brief

Clifton Scannell Emerson Associates have been appointed by Fingal County Council to prepare a sustainable Urban Drainage Strategy for the Local Area Plan Lands at Killamonan and Cherryhound as defined in the Fingal Development Plan 2011-2017.

# 3.0 Description of LAP Lands

## *3.1 Context*

The Killamonan / Cherryhound lands are located north of the built-up area of Blanchardstown, Co. Dublin. The lands are zoned objective 'GE – General Enterprise and Employment' and are the subject of a Local Area Plan (LAP) in accordance with the requirements of the Fingal County Development Plan 2011-2017.


***Figure 3.1 The Subject Lands***

Due to its strategic location within the Dublin Metropolitan Area it is the aim of the local and regional authorities to develop this area as a hub of small and large-scale enterprise as well as a significant transport corridor. The development of the Killamonan / Cherryhound lands are anticipated to create 9,000 new jobs, and has the capacity for double this amount depending on the densities achieved.

## 3.2 Proposed Local Area Plan

Proposals for the development for the area are detailed in the Killamonan / Cherryhound Local Area Plan. A map of the proposed land use is shown in Figure 3.2 below.

The land uses proposed within the LAP are summarised as follow:

- Development of the Tyrrellstown-Cherryhound Link Road.
- Gateway development, with proposals to include provision of a motorway services area near the N2, hotel, office and commercial developments, and a distribution centre for logistic uses.
- Large to small-scale industrial and commercial development.
- Neighbourhood centre area consisting of retail units serving the local area, and may include restaurants and small offices.
- Redevelopment/rejuvenation of existing quarry to Garden Centre Amenity.

Proposed development on the LAP lands aims to:

- Develop as wide a range of uses as possible within the permitted land uses
- Provide for local neighbourhood services
- Development of a Motorway Services area
- Provide an open amenity space for the area

The LAP will incorporate sustainable development objectives, including sustainable surface water drainage infrastructure, the subject of this report.

## 3.3 Hydrology within the LAP lands.

The LAP lands are located within the catchments of the Broadmeadows and Tolka Rivers. Lands in both catchments are drained by existing field drains, ditches or small streams. Appendix A  provides a map with the existing local watercourses shown.

The lands in the Broadmeadows Catchment are located in the northern portion of the lands. These lands drain to local streams, field drains and ditches which flow to the Ward river which is a tributary of the Broadmeadows River. The Broadmeadow river enters the sea at the Broadmeadows estuary at Malahide. The estuary is a SPA, cSAC, pNHA and Ramsar site.

The lands in the Tolka Catchment are located in the southern portion of the lands. These lands drain to local streams, field drains and ditches which flow to the Pinkeen river which is a tributary of the Tolka. The Tolka river enters the sea at Fairview and its estuary is part of the Tolka Estuary/Sandymount Strand Ramsar site and SPA.

As both estuaries are protected ecological areas it is essential that the water quality from the LAP lands is maintained or improved by the application of the SuDS strategy and that techniques to remove pollutants are employed.

## *3.4 Hydrogeology within the LAP lands.*

Aquifers within the southeast of the LAP lands are identified as poor, with bedrock generally unproductive except in local zones. Aquifers for the remainder of the lands are valued as locally important, with bedrock moderately productive only in local zones.

The depth to bedrock in the LAP area is generally between 3-5m. In a number of locations the depth of overlying soil is less than 1m at these locations the groundwater is classified as extremely vulnerable.

Mapping of the LAP lands from the Geological Society of Ireland (GSI) which indicates the depth to bedrock, aquifer quality and vulnerability are provided in Appendix B.

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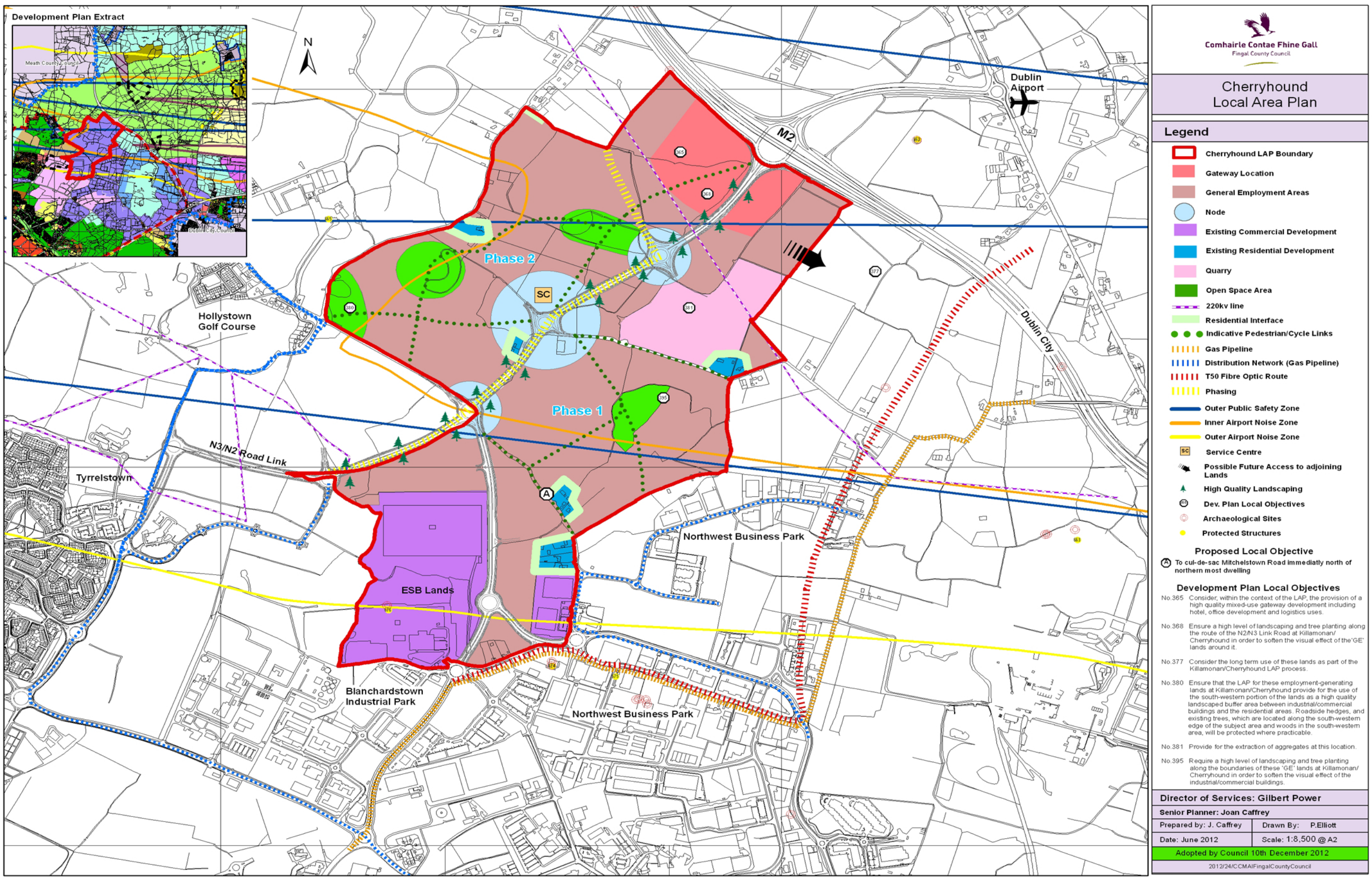


*Figure 3.2 Proposed Land Use/ Zoning (Map 8 of Killamonan/Cherryhound LAP)*

# 4.0 SuDS Background

## 4.1 Introduction to SuDS

Sustainable urban drainage is a concept that incorporates long-term environmental and social features to drainage design. It takes account of both the quality and quantity of runoff as well as the amenity value of surface water in the urban environment.

Any built up area will need to be drained to remove surface water. Traditionally this has been done using underground pipe systems designed for quantity, to prevent flooding locally by conveying the water away as quickly as possible. The alteration of natural flow patterns can lead to problems elsewhere in the catchments. More recently, water quality issues have become important, due to pollutants from urban areas being washed into rivers or the groundwater.

Drainage systems can be designed to incorporate the objectives of sustainable development. Surface water drainage methods that take account of quantity, quality and amenity issues are collectively referred to as Sustainable Urban Drainage Systems (SuDS). These systems are more sustainable than conventional drainage methods because they:

- Manage runoff flow rates, reducing the impact of urbanization on flooding quality
- Protect or enhance water quality
- Are sympathetic to the environment setting and the needs of the local community
- Provide a habitat for wildlife in urban watercourses
- Encourage natural groundwater recharge (where appropriate)

They do this by:

- Dealing with runoff close to where the rain falls
- Managing potential pollution at its source now and in the future
- Protecting water resources from point pollution (such as accidental spills) and diffuse sources.

## 4.2 SuDS impact on water quality

There are two basic mechanisms, by which SuDS remove pollutants:

- Sedimentation / filtration
- Biodegradation.

Some systems are primarily designed to capture suspended material (e.g. swales, detention basins, filter drains and grass strips). Infiltration systems provide filtration in top layers of soil/subsoil, and assume sufficiently low levels of contamination by water-soluble pollutants to rely on degradation and subsequent dilution and

dispersion. Only retention ponds and storm water wetlands have sufficient retention time to allow for breakdown of many pollutants. They also provide significant storage for persistent pollutants absorbed on deposited sediments. These ponds and wetlands also allow for storage of significant flood volumes. Biological degradation of pollutants deposited in the vegetation of swales and detention basins will also occur, but may only be a modest proportion of the influent load.

Several systems strive to prevent the generation of runoff by reducing the impervious cover within an area, thereby reducing the quantity of surface water entering the sewerage network during storm events and reducing the amount of water which requires treatment These focus on disconnecting roofs and paved areas from conventional drainage systems and conveying runoff to Soakaways, vegetated open spaces, gravel areas such as the use of gravel driveways or permeable pavement and water butts.

## *4.3 The SuDS Management Train*

In order to mimic the natural catchment processes a "management train" is required. This allows the use of varying SuDS techniques in series to incrementally reduce pollution, flow rate and volumes.

The hierarchy of techniques to be used in the management train is:

1. Prevention – The use of good site design and site housekeeping measures to prevent runoff and pollution. This should be applicable to all development. In industrial sites this may require an element of pre treatment to remove pollutants that cannot be removed by SuDS measures.

2. Source Control: - Control of runoff at or very near to its source. ie from road, roof or yard drainage.

3. Site Control: - management of water within the boundary of a site or local area.

4. Regional Control:- management of runoff from a large site or a number of sites.

Designers should place emphasis on trying to employ prevention and source control methods above those of site control or regional control. Water which can be dealt with within the confines of a site should be wherever possible rather than conveying the problem downstream. The use of different types of measure appropriate to the nature of potential pollutants must also be considered.

## 4.4 Aims of the SuDS strategy.

This SuDS Strategy has been prepared in order to ensure a sustainable approach is adopted for dealing with the surface water runoff from development within the LAP lands. The Greater Dublin Strategic Drainage Study (GDSDS) and CIRIA C697: Sustainable Urban Drainage Systems documents are the main references used.

The strategic aims for the LAP area by incorporating a SuDS strategy are

- Water Quality Protection – in receiving watercourses and groundwater.
- Stream Regime Protection – minimisation of ecological and physical impacts on receiving streams.
- Level of Service Protection – protection of site from flooding of drainage system.
- Stream Flood Protection – control of flooding of site during extreme events.
- Amenity – Ponds or wetlands can be visually attractive and adds to the character of the development.

## 4.5 SuDS Techniques

As outlined above there is a range of different stages in the management train. The techniques that are considered to be suitable for the different stages in the management train are detailed below. Information on the various SuDS techniques is provided in Appendix C.

| SuDS Group | Technique | Suitability | | | |
|---|---|---|---|---|---|
| | | Prevention | Source Control | Site Control | Regiona Control |
| Reduce Runoff | Green roof | √ | √ | | |
| | Rain water harvesting | √ | √ | | |
| | Pervious pavements | √ | √ | * | |
| | Minimise directly connected impervious areas | √ | √ | | |
| Open channels | Enhanced dry swale | | √ | √ | |
| | Enhanced wet swale | | √ | √ | |
| Infiltration | Infiltration trench | | √ | √ | |
| | Infiltration basin | | | √ | √ |
| | Soakaway | | √ | | |
| Filtration | Bio retention | | √ | √ | |
| | Filter strip | | √ | | |
| | Filter trench/ drain | | √ | * | |
| | Surface Sand filter | | | √ | * |
| | Sub-surface sand filter | | | √ | * |
| | Perimeter sand filter | | | √ | * |
| Retention | Retention Pond | | | √ | √ |
| | Subsurface Drainage | | | √ | |
| Wetland | Shallow Wetland | | | √ | √ |
| | Extended detention wetland | | | √ | √ |
| | Pond/wetland | | | √ | √ |
| | Pocket wetland | | | √ | √ |
| | Submerged gravel wetland | | | √ | √ |
| | Wetland Channel | | | √ | √ |
| Detention | Detention basin | | | √ | √ |

* Some possibilities, subject to design.

***Table 5.4 Capability of Different SuDS Techniques (Extract Table 1.7 of CIRIA C697)***

# 5.0 Killamonan / Cherryhound SuDS Strategy

## 5.1 General

As part of the detail design of the drainage systems within the Killamonan / Cherryhound LAP Lands, all surface water design and construction works shall be based on this SuDS strategy, incorporating an integrated approach to the management of runoff from each phase of development, neighbourhood and the LAP lands as a whole.

## 5.2 Key Considerations

### 5.2.1 Treatment of Runoff from the road network.

The road network is a source of pollutants that are emitted by vehicles from exhausts and oil leaks etc. When rainfall occurs after a sustained dry period the concentration of pollutants is particularly high. It is therefore important that treatment of this "first flush" is catered for adequately. Filtration techniques are effective in the removal of particulates that are carried in runoff. Filtration trenches and swales are particularly suited due to their linear nature.

### 5.2.2 Shallow depth of overlying soils on Karstic Bedrock.

Information provided (See Appendix B) by the Geological Society of Ireland (GSI) indicates that in the area of the LAP there may be limited depth of soils overlying the bedrock. Furthermore this bedrock has also been identified as being a karst limestone. Accordingly GSI has classified the local aquifer as being vulnerable contamination. to Due to the limited depth of subsoil overlying the bedrock a considerable number of SuDS techniques may not be suitable for use in portions of the lands. Site Investigation should be undertaken to determine the depth of soil and its permeability before considering the use of filtration and infiltration measures, swales and permeable pavements.

### 5.2.3 Location of Regional Control Measures.

Regional control measures by their nature require large areas of land to cater for large runoff volumes. In addition they are required to be located at the lower reaches of drainage catchments or sub-catchments. Thus the location of these structures are defined by the topography of the area under consideration and the nature of the proposed development within the catchment.

As outlined in section 3.3 of this report the LAP lands lie within the catchments of the Tolka and Ward rivers. In order to maintain the existing flow regime the lands within each catchment should continue to drain to their Thus at least two regional control measures will be required to serve the lands. These should ideally be located in areas where their amenity potential can be maximised.

## 5.3 SuDS Selection Criteria

In selecting SuDS control measures the following criteria have been considered.

- Land use characteristics;
- Site characteristics;
- Catchment characteristics;
- Quantity and quality performance requirements
- Amenity and environmental requirements.

Factors affecting the consideration of each of the above criteria are provided in Appendix D. Each of the above criteria has been assessed to determine suitability of each technique for application in the LAP Lands.

In the assessment of each technique it is either considered suitable or unsuitable with regard to land use, site characteristics, and quality performance. If deemed unsuitable for any of these criteria it is discarded as not recommended. The remaining techniques are assessed in terms of medium/high quantity & quality performance, and amenity & environmental value that are then viewed as recommended or possible.

## 5.4 Recommended SuDS Measures

Based on the above criteria (Section 5.3) each of the SuDS techniques detailed in *Table 5.4* above have been assessed for suitability for use on the LAP lands at different stages of the SuDS management train.

The majority of the lands on the Killamonan / Cherryhound LAP lands are to be used for commercial and industrial purposes. Designers should seek to incorporate between 3 to 4 treatment train measures for runoff from such sites ie prevention, source control, site control, and regional control.

### 5.4.1 Prevention

Prevention methods are to be applied wherever feasible as a way of reducing the quantity of runoff discharged and to remove pollutants from the flow that does leave the site. These measures should be incorporated into site/building design wherever possible.

The **recommended** SuDS prevention methods are:

***1. Minimise directly connected impervious areas***

This is most effective measure if applied at source or site to significantly reduce the amount of runoff that enters the drainage system. Examples of methods that can be used to include:

- Rainwater butts.
- Directing flows from hard standing areas stabilised vegetated areas.
- Disconnecting roof drains and directing flow to stabilised vegetated areas.

***2. Rainwater Harvesting***

Rainwater harvesting systems are used to collect and treat runoff locally for irrigation, washing, and sanitary purposes. This is potentially suitable for installation on commercial and residential sites. The cost of these systems is relatively low, but may require careful maintenance. Rainwater harvesting use on industrial sites must be carefully considered to ensure that the collected runoff is suitable for reuse, pre-treatment may be required.

***3. Green Roofs***

Green roofs systems can function as retention/ attenuation systems, sometimes incorporating a treatment system for runoff. These can significantly reduce the impact of runoff from buildings and developments. Green roofs are deemed to have good amenity, aesthetic, and environmental value. These are however relatively more costly, and may require careful maintenance. Green roofs are recommended for consideration on all new commercial and industrial buildings, provided that installation can be safely incorporated into the design of the building, and that the demands on maintenance and cost are not unreasonable.

Prevention methods that **may be possible:**

**1. Permeable Paving**

Permeable paving may be suitable for localised areas such as forecourts, service yards, etc. Consideration must be given to the maintenance regime to ensure that the system doesn't fail due to siltation. Detailed design will be required to take into consideration soil permeability water table level.

### 5.4.2 Source Control

The **recommended** SuDS source control methods are:

***1. Minimise directly connected impervious areas***

This is most effective measure if applied at source or site to significantly reduce the amount of runoff that enters the drainage system. Examples of methods that can be used to include:

- Rainwater butts.
- Directing flows from hard standing areas stabilised vegetated areas.
- Disconnecting roof drains and directing flow to stabilised vegetated areas.

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***4. Oil Interceptors***

Oil interceptors are required at locations where there is a risk of surface water contamination caused by grease/ oils, such as roads, carparks, loading bays, near fuel tanks, and garbage skips.

***5. Swales***

Swales are particularly useful for draining of roads due to their linear nature and ability for removal of pollutants. Where they are proposed for public roads the local authority must be consulted with regard to maintenance arrangements.

Source control methods that **may be possible**:

***1. Permeable paving***

Permeable paving may be suitable for localised areas such as forecourts, service yards, etc. Consideration must be given to the maintenance regime to ensure that the system doesn’t fail due to siltation. Detailed design will be required to take into consideration soil permeability water table level.

*2. Soakaways & Infiltration trenches – subject to ground conditions.*
Soakaways and Infiltration trenches are not suitable for industrial sites but are considered suitable for commercial sites. Infiltration trenches are relatively low cost and easy to maintain, and can be provided without much loss in amenity and aesthetics. Designers must consider the soil permeability, water table and aquifer permeability prior to incorporation into any development.

*3. Filter drains – subject to water table level.*
Filter drains are particularly useful in draining the road network. They provide some improvement of water quality and should be designed to provide attenuation. Not to be used where water table is high and may impact on the available storage capacity.

*4. Bio retention*
Bio retention areas provide for water quality improvement through the filtration of runoff through suitable soil/imported material. The flood control provision may be limited and thus consideration of how it is incorporated into the SuDS management train is important. Bio retention areas are limited to providing treatment to areas of 5 Hectares or less.

*5. Filter strips*
Filter strips can be easily incorporated into designs provided there is sufficient width of grass verge with suitable topography. They may be suited to larger industrial sites and provide limited flood provision so must be used with suitable site control that will provide adequate attenuation.

### 5.4.3 Site Control Methods

The **recommended** SuDS site control methods are:

*1. Retention Ponds – for large sites*
Retention ponds are suitable for attenuating runoff, and have good amenity & aesthetic and environmental value. These are recommended for large sites which require large volumes of water to be attenuated. Design guidance must be strictly adhered to in order to achieve the potential water quality improvements. ie minimum depth of retained water etc.

*2. Detention basins*
Detention basins provide flood control and may be sites in areas that have alternate uses outside of times of flooding ie, parkland, sports areas etc. It is important that suitable SuDS measures to provide water quality improvement are provided upstream/downstream due to the limited improvement provided by this technique.

*3. Enhanced wet swales*
Enhanced wet swales are swales that retain a shallow depth of water almost continuously and thus have a marshy base. They can be under drained where the ground is impermeable allowing discharge of retained water to the downstream drainage system in a controlled manner. They provide water quality improvement and flood control provision.

Source control methods that **may be possible**, subject to conditions:

***1. Infiltration trench – subject to local ground conditions***

These are suitable for commercial development sites of up to 2Ha. They are relatively low cost and easy to maintain, and can be provided without much loss in amenity and aesthetics. Detailed design must take into consideration high water table and provide supplementary attenuation solutions to cater to 1-in-100yr storms.

***3. Bio retention – Sites less than 5Ha.***

Bio retention areas provide for water quality improvement through the filtration of runoff through suitable soil/imported material. The flood control provision may be limited and thus consideration of how it is incorporated into the SuDS management train is important. Bio retention areas are limited to providing treatment to areas of 5 Hectares or less.

***4. Filter drains – subject to water table level.***

Filter drains are particularly useful in draining the road network. They provide some improvement of water quality and should be designed to provide attenuation. Not to be used where water table is high and may impact on the available storage capacity.

***5. Pocket wetlands***

Pocket wetlands have good amenity and environmental value, and provide habitats for some wildlife. However these require high maintenance, and may not be suitable for smaller sites. Pocket wetlands may be considered if detailed designs have been carried out to ensure that:

- these can be safely incorporated into the landscape;
- there is availability of adequate constant surface baseflow or high water table;
- a system is in place to divert high flows around the wetlands; and
- there is a supplementary attenuation system to cater to 1-in-100yr storms.

Site control methods that **are not recommended:**

***1. Subsurface drainage***

Impermeable underground storage tanks are not recommended as they do not provide any water quality improvement.

### 5.4.4 Regional Control Methods

The **recommended** SuDS regional control methods are:

***1. Retention Ponds***

Retention ponds are suitable for attenuating runoff, have good amenity and environmental value, and can be improve the aesthetics of the designated LAP landscape areas if suitably landscaped.

***2. Wetlands***

Wetlands have high amenity and environmental value, and provide a habitat for wildlife contributing to biodiversity within the LAP lands. Wetlands generally require more land and require careful maintenance. Wetlands can be considered for regional control if large areas are available, and if detailed designs have been carried out to ensure that:

- they can be safely incorporated into the landscape;
- there is availability of adequate constant surface baseflow or high water table
- a system is in place to divert high flows around the wetlands
- there is a supplementary attenuation system to cater to 1-in-100yr storms.

***2. Detention Basins***

Detention basins provide flood control and may be sites in areas that have alternate uses outside of times of flooding ie, parkland, sports areas etc. It is important that suitable SuDS measures to provide water quality improvement are provided upstream/downstream due to the limited improvement provided by this technique.

Site control methods that are **not recommended:**

***1. Infiltration Basins***

Infiltration basins are not considered suitable due to the potential issues highlighted with regard to groundwater vulnerability.

# 6.0 Conclusions & Recommendations

The drainage network for the LAP lands can be designed and constructed to provide sustainable infrastructure to ensure that the local environment and that of the receiving waters are protected from damage resulting from increased flows and pollutant loading.

The design and construction of surface water drainage within the Killamonan / Cherryhound Local Area Plan lands shall be in accordance with the Greater Dublin Strategic Drainage Study (GDSDS), CIRIA publication C697 “Sustainable Urban Drainage Systems Manual” and the recommendations set out in this drainage strategy report. Developers should also adhere to guidance provided in CIRIA publication C698 “Site Handbook for the Construction of SuDS”.

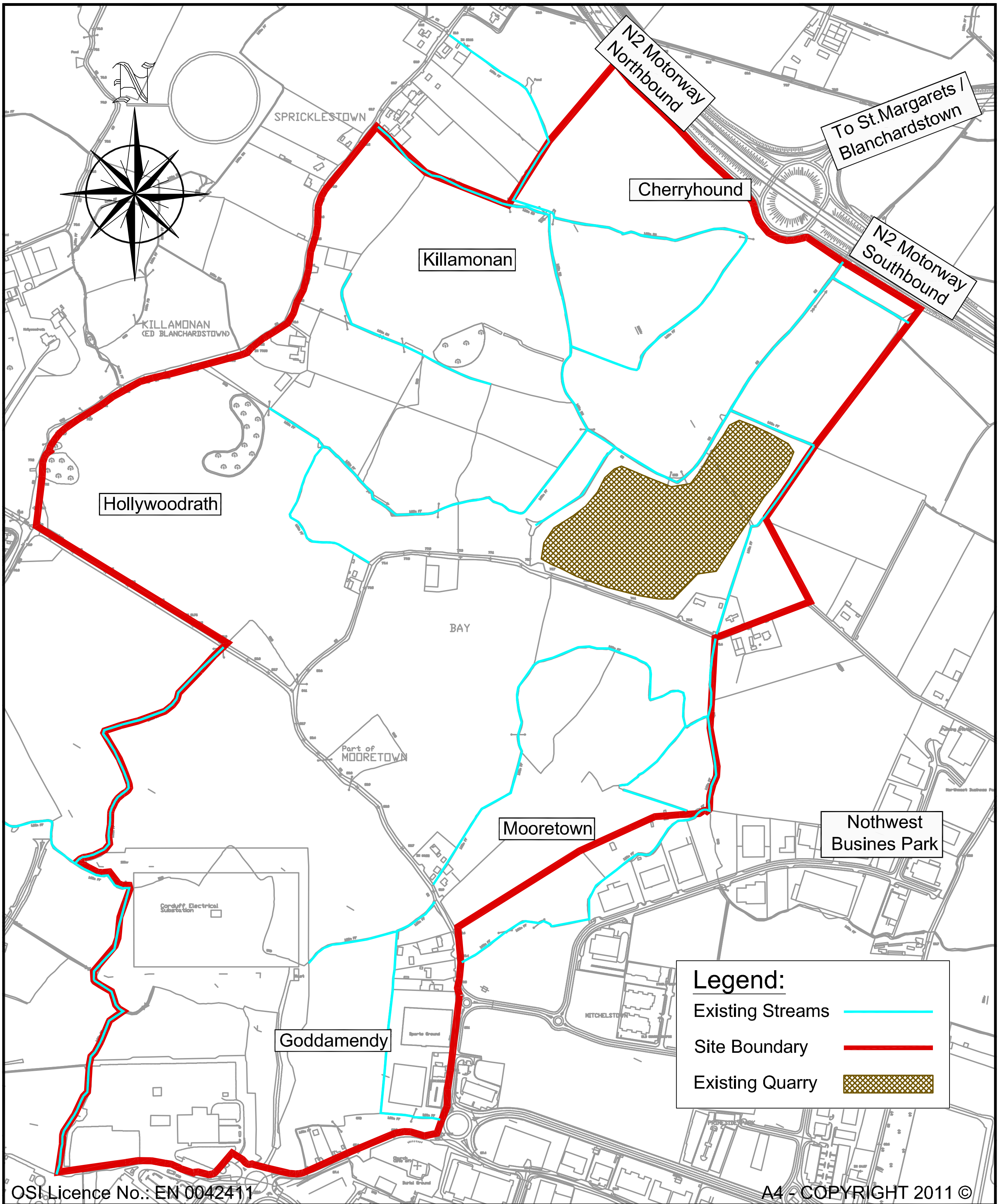
Designers must properly assess the local ground conditions to confirm the suitability of filtration and infiltration SuDS techniques prior to incorporating any such features in development proposals.

Designers must follow the SuDS management train approach for all development that will incorporate preventative, source control, site control and regional control measures. Designers must identify the techniques to address water quality and quantity. Individual site must also consider the requirement for pre treatment where particularly high pollutant loads may result from a particular development. Table D6 in Appendix D identifies the number of treatment train stages to be undertaken for different types of development.

Improvement of water quality through the incorporation of suitable SuDS measures must be provided for and this must be demonstrated to the satisfaction of the Local Authority.

Water quantity shall be maintained at greenfield rates as set down in the GDSDS and a mixture of prevention, source control, site control and region control shall achieve this. It is proposed that 40% of the volume reduction be achieved within individual site boundaries or sub catchments and the remaining 60% be achieved within regional control measures.

## *Appendix A: Existing Local Watercourses*

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| | | | | | |
|---|---|---|---|---|---|
| Project | Cherryhound LAP Suds Strategy | | | | |
| Dwg. Title | Existing Streams Within Catchment Area | | | | |
| Drawn By | DMCE | Checked by | MC | Date | August 2011 |
| Scale | NTS | Dwg. No. | Appendix B | | |

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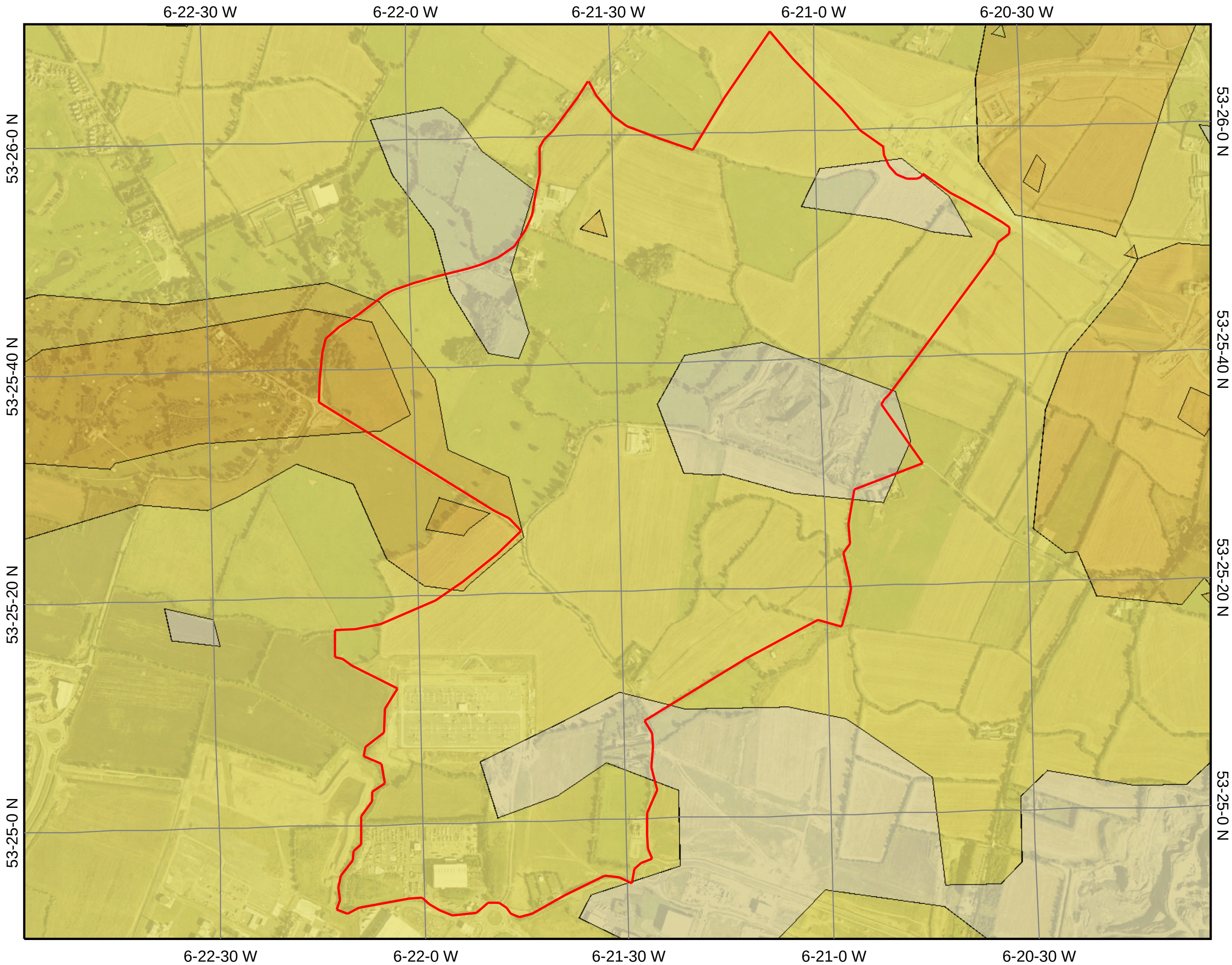
# *Appendix B: Hydro-geological Information*

Depth to Bedrock

Local Aquifer Information

Groundwater Vulnerability

# Killamonan/Cherryhound LAP - Depth to Bedrock





## Legend

**Depth to Bedrock-Dublin County**

- 0 to 1m
- 1 to 3m
- 3 to 5m
- 5 to 10m
- 10 to 15m
- 15 to 20m
- 20 to 25m
- 25 to 30m
- 30 to 45m

**Map center: 309112, 242897**

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

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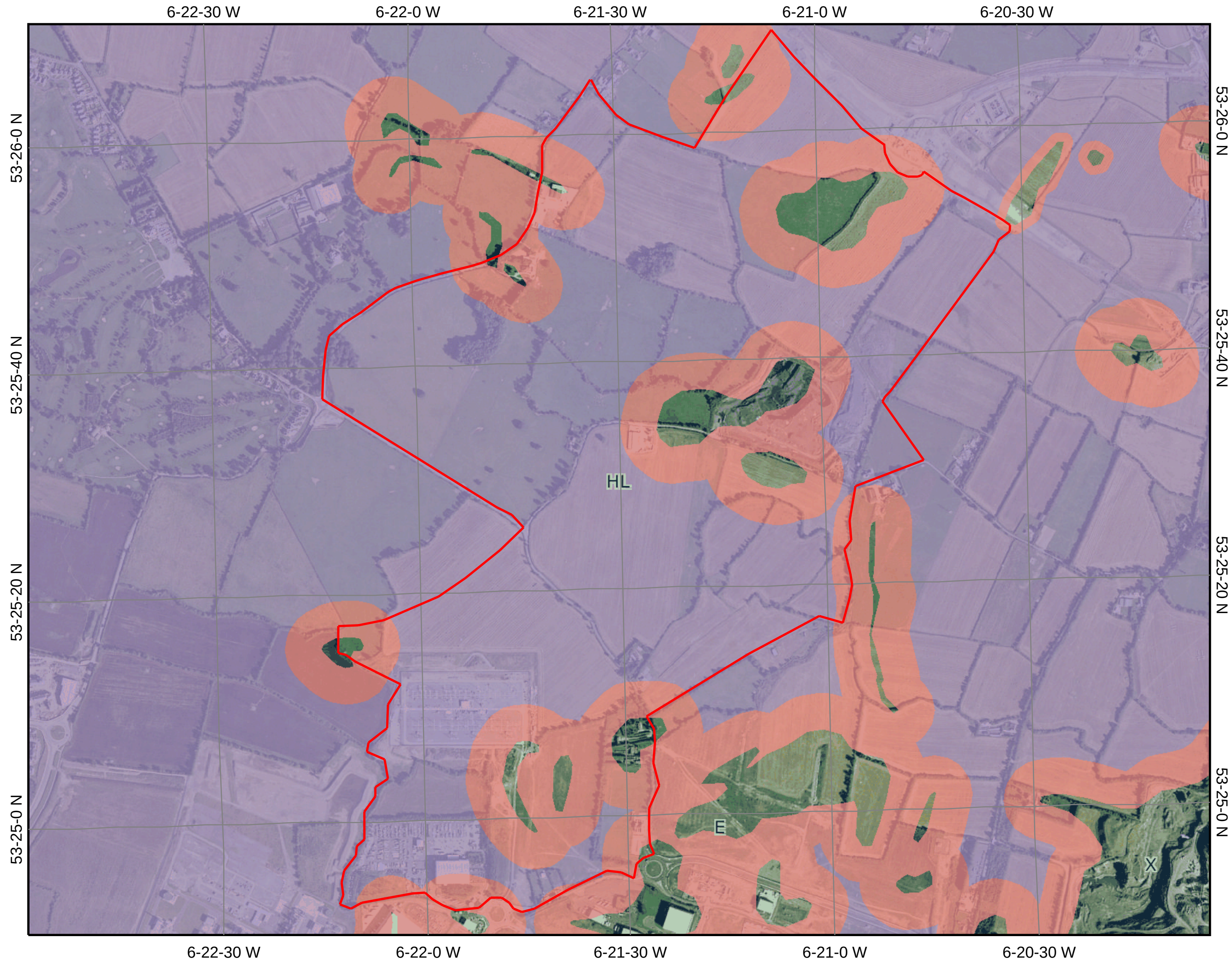
# Killamonan/Cherryhound LAP - Groundwater Vulnerability





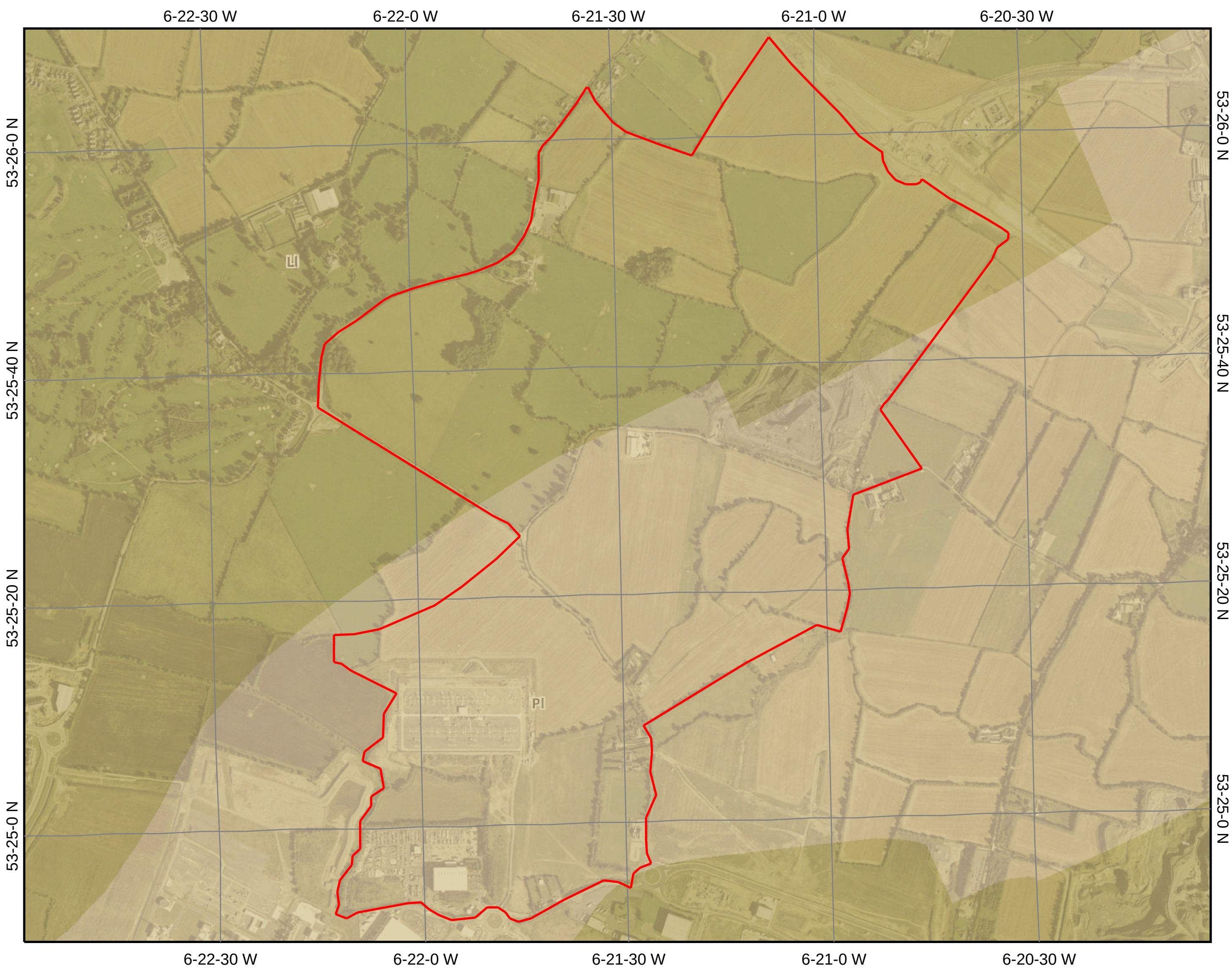
## Legend

**Eastern Interim Vulnerability**

- E (Rock near Surface or Karst)
- E - Extreme
- H - High
- M - Moderate
- L - Low
- HL - High to Low. Only an interim study took place.
- Water

**Map center: 309112, 242897**

# Killamonan/Cherryhound LAP - Aquifers





## Legend

**National Draft Bedrock Aquifer Map**

- **Rkd - Regionally Important Aquifer - Karstified (diffuse)**
- **Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive**
- **Lk - Locally Important Aquifer - Karstified**
- **Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones**
- **Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones**
- **Pu - Poor Aquifer - Bedrock which is Generally Unproductive**
- **Unclassified**

**Map center: 309112, 242897**

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# Appendix C: SuDS Techniques

Small Scale SuDS – Minimising Direct connections
Green Rooves
Rainwater Harvesting

Infiltration Trenches & Soakaways

Bioretention

Detention Basins

Filter Drains

Retention Ponds

Swales

Stormwater Wetlands

Permeable Pavements

Oil Interceptors

# SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

## SOURCE CONTROL



### DESCRIPTION

Sustainable Drainage Systems for individual buildings focus on reducing the amount of stormwater leaving a property and/or conserving water. This can be achieved by a variety of methods which are generally low cost and low maintenance, i.e.:

- Avoiding misconnections
- Minimisation of impermeable areas and diversion of run-off to infiltration/soakaway devices
- Rainwater harvesting: Water butts, Rainwater Tanks
- Greywater re-use
- Rooftop greening

### AVOIDING MISCONNECTIONS

Misconnections of stormwater to foul sewers and wastewater to storm sewers result in considerable polluting impact in receiving waters. It is the responsibility of the developer and property owner to ensure that there are no such misconnections from their development/property. Rigorous policing of connections by the local authority is required to eliminate inappropriate discharges.

### MINIMISATION OF IMPERMEABLE AREAS

### DIVERTING TO INFILTRATION/SOAKAWAY DEVICES

The minimisation of impermeable areas can be achieved through the use of permeable paving or gravelled surfaces instead of conventional paving/concrete. The diversion of stormwater, such as the first flush of roof run-off or from disconnected downpipes, to infiltration devices such as soakaways, reduces the volume of water discharge to receiving waters. Roofwater can be discharged directly to the sub-base of infiltration devices. Maintenance requirements and costs are low. See separate SuDS information sheets (Infiltration trenches & Soakaways/Permeable paving) for further details.

### WATER BUTT

A water butt is a receptacle or tank, usually covered and placed at ground level, connected to a downpipe, to provide offline attenuation of runoff from roofs. Pollutant removal improves if used in conjunction with first flush devices to divert the first 2mm of roof rainfall run-off and screens to filter out leaves and insects. Desludging is recommended on a regular (annual/bi-ennial) basis.

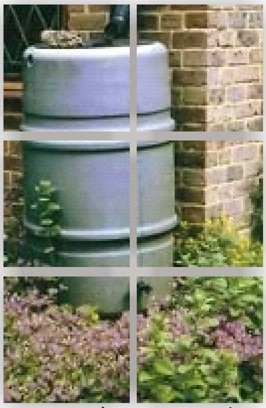
### RAINWATER TANKS

Rainwater tanks collect rainwater for re-use for car washing, gardens and firewater. Tanks can be placed on flat roofs of suitable bearing capacity or connected to downpipes and placed above or under ground. In the latter cases a pump will be required such that the water can be reused, for example, in toilet flushing.

If connecting to the toilet or washing machine a minimum level of water must be maintained by a top-up system from the mains supply. A non-return valve is required to prevent backflow from the tank to the drinking water supply.

Effluent Discharge - Dry Weather Flow

Water Butt - (source: www.blackwell-ltd.com)



Water Butt - (source:www.southern water.co.uk)

Gutter Filter
(LB Plastics Ltd.)

Leafeater
(City Rainwater Tanks Aust Pty Ltd.)

Rainwater Tank

# SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

## SOURCE CONTROL

### GREYWATER TANKS

Greywater is a term applied to all bath, dish and laundry water except toilet waste and food waste derived from garbage grinders. Greywater tanks are generally placed underground. A pump is required such that the water can be re-used, for example, in toilet flushing or for watering plants.

When properly managed, greywater is a valuable resource which horticultural and agricultural growers as well as home gardeners can benefit from. It can also be valuable to landscape planners, builders, developers and contractors. While phosphorous, potassium and nitrogen makes greywater a source of pollution for lakes, rivers and groundwater they are excellent nutrient sources for vegetation when this particular form of wastewater is made available for irrigation. Greywater irrigation has long been practiced in areas where water is in short supply.

A key to successful greywater treatment lies in its immediate processing before it turns anaerobic. The simplest, most appropriate treatment technique consists of directly introducing freshly generated greywater into an active, live topsoil environment. Pollutant removal is achieved by treating the greywater with aerobic pre-treatment or anaerobic to aerobic pre-treatment.
Refer www.clivusmultrum.com and www.greywater.com.

### International Experience

**Australia**

The Healthy Homes project on Australia's Gold Coast is an environmentally sustainable demonstration project incorporating small scale SuDS. Refer to Case Study within this document and www.oca.nsw.gov.au/resource/wramsartwork.pdf.

### ROOFTOP GREENING

Fleishman from www.ecocentre.com

### DESCRIPTION

Rooftop greening involves vegetating urban walls and rooftops as a way of gaining access to valuable open space while making urban environments healthier more attractive places in which to live and work. Rooftop greening strategies aim to:

- reduce the quantity and increase the quality of surface water run-off
- improve indoor and outdoor comfort levels for residents
- conserve indigenous biodiversity (genetic, species and ecosystem)
- reduce energy demand for heating and cooling
- encourage environmentally responsive design strategies in the City.

Rooftop Greening is moving from the fringe to the mainstream for two reasons:

1)Increasing urban densities are leading to a desire for greater access to green open space; and
2)The role of urban vegetation in producing oxygen, fixing carbon dioxide and filtering urban air and water is becoming more widely recognised.

Rooftop Gardens can function as:
***"Extensive" systems*** require little or no maintenance; are developed primarily for their environmental benefits; and normally consist of thin soils and hardy vegetation applied to large roof areas. The use of Sedum varieties is common.
***"Intensive" systems*** require high levels of maintenance; are developed primarily for aesthetic enjoyment. Extensive greening is generally a much cheaper option than intensive greening. For design considerations refer www.roofmeadows.com. Also, Grodan (www.grodan.com) produce rockwool, a lightweight substrate.

### International Experience

**Germany**

One in 10 flat roofs in German cities are of Esslingen in Germany has a by-law which requires that flat and sloping roofs (up to 15 degrees) must be vegetated. Similarly, in Mannheim, declining air quality prompted the City Council to impose a by-law in 1988 which requires all central business district buildings to be vegetated.

**Japan**

In Tokyo, guidelines encourage 20% of rooftop areas to be planted. From April 2001, companies that fail to meet these guidelines will face fines. Reductions have been implemented to fixed assets taxes for buildings with rooftop greening. These types of policies are expected to increase throughout Japan, as a consequence of revisions of city regulations.
The Takenaka Corporation have developed a "Thin Layer Rooftop Greening System," by using sedum varieties and a thin mat as a planting base, which reduces the live load on buildings and has limited maintenance requirements. Significant energy conservation has been achieved.
Refer www.takenaka.co.jp/takenaka_e/.

**America**

The award-winning Chicago City Hall green roof was installed for the Urban Heat Island Initiative project. The design includes a 3.5" deep **'extensive'** system to 24" deep **'intensive'** landscape islands. The project shows the benefit of green roofs in lowering summer temperatures within ultra-urban environments.
Refer www.cityofchicago.org .

Chicago City Hall 2002
Source www.roofmeadows.com

# INFILTRATION TRENCHES & SOAK-AWAYS

SOURCE CONTROL

Side-entry pits drain to infiltration trench in car-park

| PRIMARY CONSIDERATIONS | |
|---|---|
| Construction Cost | LOW |
| Maintenance Requirements | HIGH |
| Land Take | LOW |

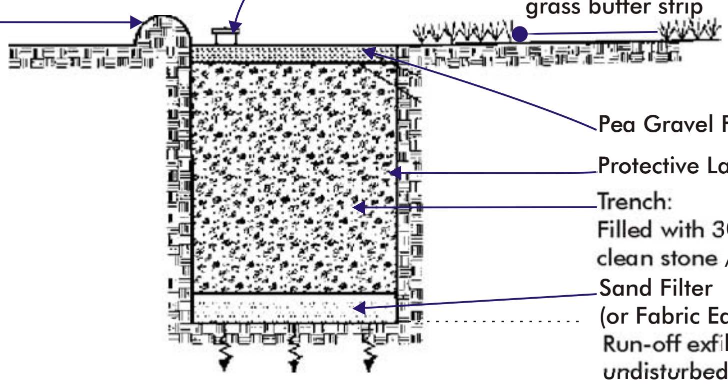
| BENEFITS | |
|---|---|
| ☑Water Quality Control | YES |
| ☑Water Quantity Control | YES |
| ☒Amenity Value | NO |
| ☒Habitat Creation Value | NO |
| ☒Biological Treatment | NO |

## DESCRIPTION

An infiltration trench is a gravel / rock-filled trench designed to infiltrate run-off to the ground. Infiltration trenches are essentially long thin soakaways (rock filled pits or large tanks structures). Run-off is stored in the voids allowing it to slowly infiltrate through the bottom into the soil matrix. This reduces the volume of water that is discharged into receiving watercourses thereby reducing some of the impacts caused by excess flows and pollutants.

## DESIGN

- Soils underlying the site should be permeable, i.e. have a clay content of less than 20% and a silt/clay content of less than 40%. (Refer BRE,1991 and CIRIA, 1996). Infiltration controls can be used on soil types 1 or 2* and where it can be demonstrated that the trench will infiltrate the design treatment volume within 12 hours under average winter rainfall (Campbell, 2000).
- A pre-treatment device such as a swale or filter strip is recommended upstream of the trench to reduce incoming velocities and coarser sediments.
- The device should be constructed at least 1.5m above the maximum groundwater level or bedrock layer and only where the groundwater classification allows.
- The trench should be filled with clean stones that can retain the required volume of water to be treated in their void space.
- The stone should be wrapped in a geo-textile. This fabric should be selected on the basis of durability with adequate opening size to resist clogging.
- The treatment volume should completely infiltrate through the trench bottom in 24 hours.
- Trenches should be under-drained, so that in the event of clogging it can act as an overflow.
- With long infiltration trenches it is advisable to provide inspection tubes at regular intervals along the trench (CIRIA, 2000).
- The maximum contributing area to infiltration trenches should be less than 5 hectares.
- The infiltration device should not be constructed within 5m of the foundations of buildings or under a road.
- Do not construct near drinking water wells, septic tanks or drainfields .
- During construction, measures to minimise sediment erosion and soil compaction should be used.
- The facility should not come into use until construction and landscaping of the site that drains to it is completed.
- Areas upstream of the trench should be stabilised.




SECTION

* Flood Studies Report, WRAP Classification

MORE OVERLEAF - 1 of 2

# INFILTRATION TRENCHES & SOAK-AWAYS



## POLLUTANT REMOVAL

Failure rates are discussed in an article published by the Centre for Watershed Protection.

Details of other studies are available from the (US) National Stormwater Best Management Practices Database. (www.bmpdatabase.org)

| Pollutant | Removal (%) |
|---|---|
| TSS | NA |
| TP | 100 |
| TN | 42 |
| NOx | 82 |

## MAINTENANCE CONSIDERATIONS

The possibility of replacing an infiltration trench once every 5 years should be considered, due to clogging.

Minimise clogging by regularly sweeping the draining area to the infiltration device.

Inspect and observe the infiltration system several times during the first year, particularly after heavy rainfall, and annually thereafter. Regular inspection can substantially help to lengthen the time interval between major rehabilitations.

## INTERNATIONAL EXPERIENCE

### Scotland

Infiltration trenches have been used extensively in Scotland. A SuDS database compiled by the Scottish Environment Protection Agency (SEPA) suggests that there were around 230 such systems in operation in Scotland by Jan. 2003. This has raised concerns, as much of Scotland is covered in clay soils which do not allow good infiltration.

Soakaways have been in existence for many years. They have been applied to highway drainage, however their use for anything other than roof water is not advised as the high sediment loads from road run-off usually causes blockage problems within 20 years. This can be avoided by routine removal and replacement of sand layers on an annual basis. However, this philosophy of high maintenance is not practiced in the UK.

### Sweden

The city of Malmo, Sweden has successfully used infiltration trenches to control run-off from the residential lots by covering the top with a grass layer. The grass layer filters the water as it passes through the soil; the trench keeps the overlying soil filter from becoming saturated.

### Germany

In Essen, Germany, a similar application has been successful. In this case an overflow for the trench is provided to carry away the excess flow generated by large storms.

### U.S.A

A study conducted in Maryland, USA (Galli, 1992), revealed that less than half of the infiltration trenches investigated were still functioning properly, and less than 1/3 still functioned properly after 5 years. Many of these practices, however, did not incorporate advanced pre-treatment (e.g., swales upstream). (Refer to USEPA Factsheets at www.epa.gov).

## ADVANTAGES

- Provides treatment of run-off through filtration, absorption & microbial decomposition.
- Reduce the volume of run-off from a drainage area.
- Can be used where space is limited.
- Relatively cheap option to install due to the limited land requirements (2%-3%).
- Minimum safety concerns.

## LIMITATIONS

- Provides no aesthetic benefits.
- Potential for underground contamination.
- Can fail, if receives high sediment loads.
- Requires frequent inspection and maintenance.
- Maintenance and replacement costsmaybehigh.
- Not suitable in areas with natural slopes greater than 15%.
- Not appropriate for areas with a lot of underground infrastructure.
- Not suitable to treat run-off from pollution hotspots such as industrial estates, unless the run-off has been treated upstream.
- Soil, geological and groundwater conditions must be such that the device does not cause pollution.
- May be ineffective for soluble pollutants such as hydrocarbons, nitrates, salts or organic compounds.
- Operational problems not always visible at the surface.

# BIO-RETENTION

## SOURCE CONTROL

An example of a Bio-retention Facility in the United States

| PRIMARY CONSIDERATIONS | |
|---|---|
| Construction Cost | MEDIUM |
| Maintenance Requirements | MEDIUM |
| Land Take | MEDIUM |

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

### DESCRIPTION

Bio-retention devices are landscaped features adapted to control run-off close to source. They are designed as depressions backfilled with a sand/soil mixture and planted with native vegetation. As the surface water passes through the vegetation it provides filtration and settlement as well as allowing for infiltration. Bio-retention facilities are typically under-drained and the filtered run-off is returned to the sewer network or to watercourses. They are most commonly used in high density urban areas in car parks, traffic islands or within small pockets in residential areas.

### Design

Each system should incorporate 5 basic design features, which are dependant on site conditions:

1) Pretreatment;
2) Treatment;
3) Conveyance;
4) Maintenance Reduction, and
5) Landscaping.

#### 1) Pretreatment:

Run-off is directed via an opening in the kerb across a grass filter strip, which reduces incoming velocities and coarser sediments. A sand or gravel sediment trap may also be incorporated into the design.

#### 2) Treatment:

The bio-retention system should be sized to be between 5 to 7% of the impervious area draining to it and should consist of a sandy soil bed with an upper mulch layer.

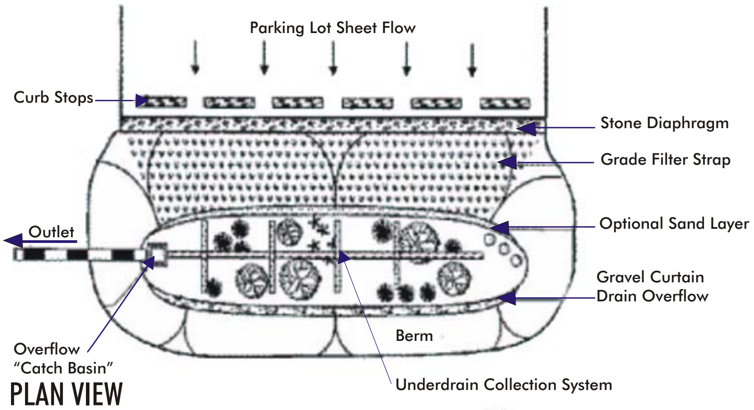
Once the sand reaches its infiltration capacity, run-off is directed into the planting bed. The sand bed keeps finer soil particles from washing out through the underdrain systems, augments the infiltration capacity of the planting bed and provides an aerobic filter. The maximum ponding depth should be between 15 and 22 cm above the filter bed.

#### 3) Conveyance:

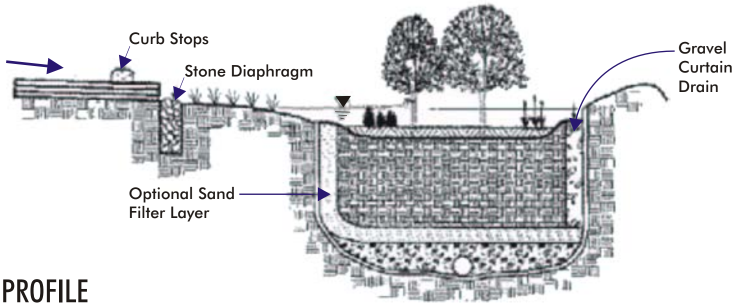
An underdrain system is used to collect the filtered run-off from the filter bed and direct it back into the sewerage network. The under drain consists of a perforated pipe in a gravel bed. An overflow system should also be incorporated into the design to allow larger storm flows to by pass the system.

#### 4) Maintenance Reduction:

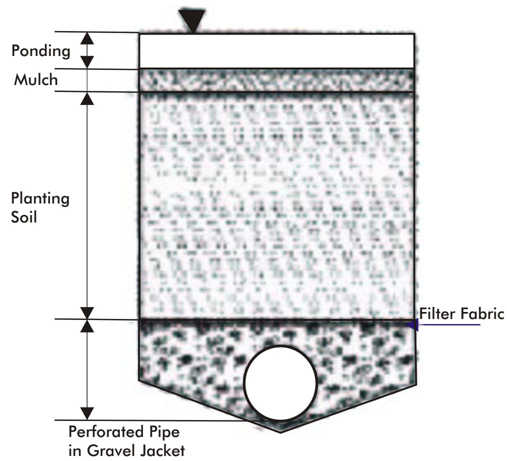
Incorporating filter strips and providing pre- treatment will minimise the maintenance requirements of the bio-retention area and will reduce the likelihood that the soil bed will clog over time.




PLAN VIEW




PROFILE




TYPICAL SECTION

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# BIO-RETENTION



## 5) Landscaping:

Native plants which can withstand the hydrological regime; tolerate stresses such as pollutants, variable soil moisture and ponding fluctuations; and that provide habitat value should be used whenever possible. Other landscaping considerations include number and sizing of plants, soil fertilitiy and plant growth. The system can incorporate trees, preserving the natural character of the land.

## 6) Other Design Considerations:

- No construction run-off should be routed through the device.
- Should be used to drain areas of 5 ha or less.
- Best applied to relatively shallow slopes (usually about 5 %). However, sufficient slope is needed at the site to ensure that water that enters the bio-retention area can be connected with the sewer network.
- Should not be used where groundwater is within 1.5m of the filter bed. The use of an impermeable liner will reduce the risk of possible ground water contamination.
- Bio-retention systems are most effective, when they are placed as close to the source of run-off as possible. Systems should be designed to fully drain in less than 72 hours.
- Can be used in stormwater hotspots, such as industrial estates, as long as an impermeable liner is incorporated into the design.

## POLLUTANT REMOVAL

- Bio-retention facilities improve water quality, vegetative filtering, sedimentation and infiltration.
- Little data have been collected on the pollutant removal effectiveness of bio-retention areas.
- The Table below shows data gathered from two studies carried out in Maryland.
- There is considerable variability in the effectiveness of bio-retention areas, and it is believed that proper design and maintenance helps to improve their performance. Details of other studies are available from the (US) National Stormwater Best Management Practices Database. (www.bmpdatabase.org)

| Pollutant | Removal (%) |
|---|---|
| Copper | 43-97 |
| Lead | 70-95 |
| Zinc | 64-95 |
| Phosphorous | 65-87 |
| TKN | 52-67 |
| NH4+ | 92 |
| $NO_3$- | 15-16 |
| Total Nitrogen (TN) | 49 |
| Calcium | 27 |

## MAINTENACE CONSIDERATIONS

- Monthly inspections are recommended until vegetation is established.
- Litter removal should occur on a monthly basis.
- Inspections should occur twice a year, after the vegetation has become established.
- Sediment can accumulate near the inlets and removal of this material should be carried out as required.
- The filter strip will require mowing during the growing season.
- Other possible tasks will include replacement of dead vegetation, erosion repair, mulch replenishment and possibly unclogging of the subsurface drain.

## INTERNATIONAL EXPERIENCE

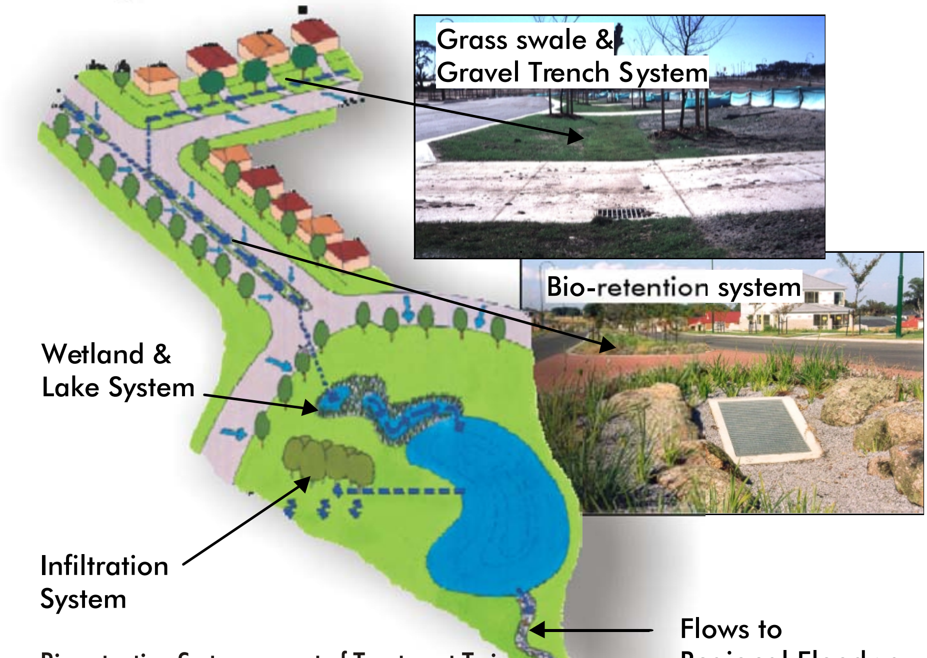
Bio-retention devices are a relatively new type of system and have been used mainly in the US and Australia.

### ADVANTAGES

- ☑Creation of micro-habitats
- ☑Improved Aesthetics
- ☑Water quality improvement
- ☑Can be applied in almost any soils or topography
- ☑Suited to high-density urban areas and industrial sites

### LIMITATIONS

- ☒Bio-retention areas provide a limited amount of flood control.
- ☒Cannot be used to drain large sites greater than 5 ha.




Bio-retention System as part of Treatment Train

FROM PREVIOUS - 2 of 2

# DETENTION BASINS
## SITE CONTROL



Grassed Detention Basin, South Dublin

**PRIMARY CONSIDERATIONS**

| | |
|---|---|
| Construction Cost | LOW |
| Maintenance Requirements | HIGH |
| Land Take | MEDIUM |

**BENEFITS**

| | |
|---|---|
| ☑ Water Quality Control | YES |
| ☑ Water Quantity Control | YES |
| +/- Amenity Value | SOMETIMES |
| ☒ Habitat Creation Value | NO |
| ☒ Biological Treatment | NO |

## Description

Detention basins are vegetated depressions designed to impound run-off in basins during large storms and gradually release it. Detention basins mainly provide runoff rate control as opposed to water quality control and are therefore best used as part of an overall treatment train approach. However, a limited amount of treatment is provided through settlement of suspended solids.

Detention Basin, Residential Area, Scotland

## Design

### Basic Design Features:

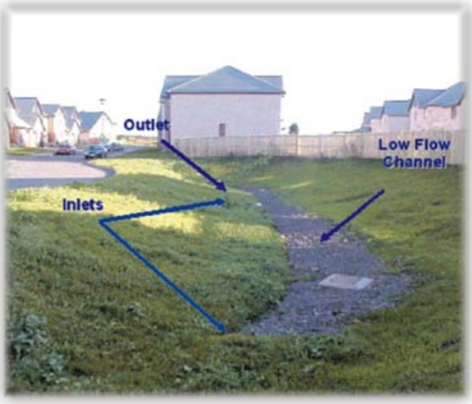
- Basins should be designed to empty within 24 hours of a storm thus not have a permanent pool of water.
- The treatment volume required for water quality control is 1 x Vt (Wallingford Pocedure).
- The maximum water depth in the basin should not exceed 3 m.
- The side slopes of the basin should ideally be terraced with an average 3:1 slope or flatter, which will minimise the potential for erosion and will allow easy access for maintenance and for safety purposes. Slope protection may be required during the construction of the basin.
- The side slopes and base should be planted with dense native vegetation which can tolerate periodic inundation and water flow. This will provide slope protection and assist sediment removal.
- The basin should have a length to width ratio greater than 3:1 to increase basin performance.

The inlet structures should be designed to incorporate energy dissipaters (such as micropools or flow spreaders) to reduce the inflow velocity and turbulence.

- The outlet device should be designed so that the facility temporarily impounds runoff in the basin during large storms, to reduce the peak rate of discharge for a given design storm to pre-development levels (e.g., 2-, 5-, 10- or 100-year storm). (Texas Nonpoint Sourcebook).
- An overflow or spillway should also be included in the basin design, to prevent the water levels from over topping the embankment.
- Design can be adjusted to suit areas of limestone topography or rapidly percolating soils such as sands.
- Impermeable liners should be incorporated where there is significant potential for seepage of pollutants to groundwater.

### Design Enhacement Options:

- Sediment forebay to assist sediment removal.
- Extended detention can provide the required treatment for certain industrial premises.
- Micro-pool (typically shallow and undrained) at the outlet to concentrate finer sediment and reduce re-suspension. Can be planted with wetland species.
- Low flow channels to prevent erosion at the inlet and to route the last remaining run-off to the outlet after the event, ensuring the basin dries completely. For Design and Operation Details, refer to the Minnesota Urban Small Sites Manual




Dry Detention Basin, South Dublin

MORE OVERLEAF - 1 of 2

# DETENTION BASINS *Site Control*

### Volumetric Design Criteria

Defined by a matrix of parameters:

1) Depth / Area Storage Relationship:

♦Largely dictated by topography and outfall levels. Volumetric allowances for vegetation of up to 25% should be provided.

2) Head / Discharge Relationship:

♦The pond/basin should be designed to a maximum discharge rate achieved, when the structure is full but consideration must be given to outfall conditions, e.g. receiving water levels.

3) Throttle Rate:

♦Throttle sizes are generally a minimum of 150mm. In smaller developments, the volumetric element of storage is likely to be achieved by other drainage components such as lined or unlined permeable pavement car parks or soak-aways.

4) Effective Contributing Area:

♦The paved and pervious catchment surfaces which contribute run-off after various losses. The relationship between contributing area and throttle rate will define the critical duration of the design rainfall events. Events will be longer for tighter throttle rates and storage volumes larger.

5) Rainfall Characteristics of the Area:

♦Ireland has been analysed for hydrological characteristics. These have been processed to enable appropriate design storm events to be produced for any location, duration and return period. This is based on the Flood Studies Report undertaken in the 1970s.

6) Level of Service:

♦Design should be for a range of return periods (up to 100 years). It is unlikely that one structure will serve the needs of the various criteria. Temporary flooding of car parks and public space areas are likely to be acceptable on occasions. The hydraulic implications for loss of volume due to sediment or vegetation should also be considered.

7.) Safety:

♦Should be considered for all stages of construction, operation, maintenance and decommissioning.

♦Appropriate design criteria should be applied to protect against overtopping in extreme events.

♦Large storage areas may have to consider not only the freeboard and wave development. The return period for such design is likely to relate to dam legislation and the downstream risk with the occurrence of a failure.

♦Blockage of the pass forward structure must be catered for and an alternative method of drawing down the storage system must be provided.

### Pollutant Removal

♦Detention basins provide moderate pollutant removal.

♦Removal efficiency is limited for soluble pollutants due to the absence of a permanent pool of run-off, although they can be effective at removing some pollutants through settling.

♦Typical removal rates, as reported by Winer (2000) are:

| Pollutant | Removal (%) |
|---|---|
| TSS | 61 ± 32[1] |
| TP | 20 ± 13 |
| TN | 31 ± 16 |
| NOx | -2 ± 23 |
| Metals | 29 - 54 |
| Bacteria | 78[2] |

1: ± values represent one standard deviation
2: Data based on less than five data points

For details of other studies, refer to the National Stormwater Best Management Practices Database. (www.bmpdatabase.org)

### Maintenace Considerations

- The basin should be inspected after severe events to check bank stability and vegetation growth.
- Twice yearly inspections will be required to check for subsidence, erosion and sediment accumulation.
- Inlet and outlet structures should be inspected for debris and erosion at least twice a year or after large storms (CIRIA , 2000). Any problems should be addressed immediately.
- Debris and litter should be removed, as required.
- Sediment should be removed from the basin, as necessary. CIRIA (2000) suggest sediment removal will be required every 7 to 10 years (up to 25 years depending upon the design and inclusion of a sediment forebay).

### International Experience

Detention Basins have been used for several years in Scotland. They were first used as part of the drainage masterplan for a development called the Dunfermline Eastern Expansion Area. This masterplan was developed using the treatment train concept, where the basins were located upstream of regional control facilities. Monitoring work carried out in Scotland, has highlighted the habitat value of such basins, when grass cutting is kept to a minimum. This research has also reinforced the importance of providing adequate vegetation cover. In several basins, planting took place at the wrong time of year leading to erosion and operational difficulties.

Vegetated Detention Basin

### Advantages

- ☑Provides for flow control.
- ☑Can limit downstream scour by reducing peak flow rate and dissipating the energy of the run-off.
- ☑Can be used as recreational areas such as football pitches.
- ☑Could be integrated into green space areas, typically found in Irish housing estates.
- ☑Limited safety concerns.
- ☑Can be used in almost all soils and geology, with minor design adjustments for regions of limestone topography or rapidly percolating soils such as sand.
- ☑Can accept run-off from stormwater hotspot such as industrial sites.
- ☑Can be used to trap construction run-off, as long as all deposited sediment is removed before normal operation begins.
- ☑Detention basins are relatively long lived facilities.
- ☑When appropriate wetland species are planted on the base, basins can provide important micro-habitats.

### Limitations

- ☒Limited pollutant removal capabilities.
- ☒Potential for clogging of outlets.
- ☒Needs a relatively large land area therefore may be limited to greenfield sites.

# FILTER DRAINS

## SOURCE CONTROL



Filter Drain

| PRIMARY CONSIDERATIONS | |
|---|---|
| Construction Cost | LOW |
| Maintenance Requirements | HIGH |
| Land Take | LOW |

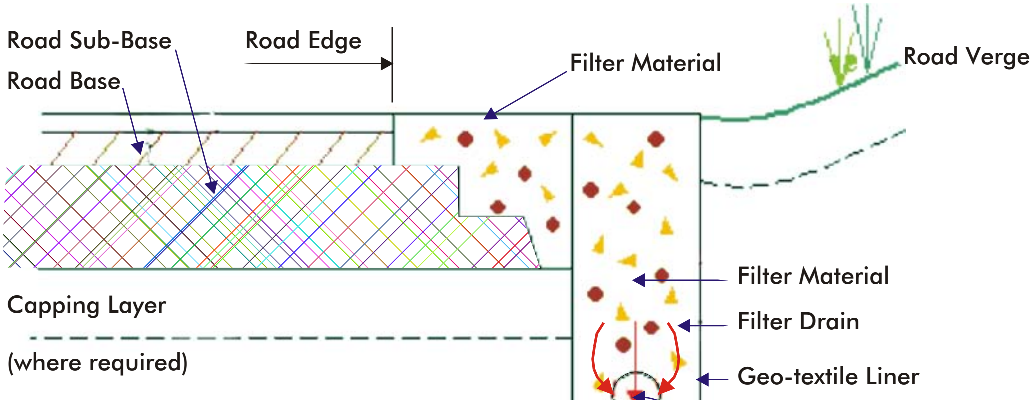
| BENEFITS | |
|---|---|
| ☑ Water Quality Control | YES |
| ☑ Water Quantity Control | YES |
| ☒ Amenity Value | NO |
| ☒ Habitat Creation Value | NO |
| ☒ Biological Treatment | NO |

### DESCRIPTION

A filter drain is a gravel filled trench, generally with a perforated pipe at the base. Run-off flows slowly through the granular material, trapping sediments and providing attenuation. Flow is then directed to a perforated pipe, which conveys run-off either back into the sewerage network or into a waterbody. Filter drains are mainly used to drain road and carpark surfaces. Ideally these systems are used as a component of a treatment train.

### DESIGN

- Filter drains are normally situated on the roadside verge or median strip. The perforated pipe is not required along the entire length of the trench, only near the end of the device.
- The trench is usually lined with geotextile to prevent ingress of soil and other material into the structure (CIRIA,2000).
- Inspection manholes should be located at regular intervals along the length of the device.
- Excess flows during extreme rainfall events may be dealt with by overland flooding passing to swales or by an overflow pipe which connects to swales or other parts of the drainage system.
- The dimensions of the trench should be selected to meet the level of reduction and attenuation of flows required, the assessment of hydraulic design performance being site specific.
- Should only be used to drain areas less than 5 hectares.
- Ideally a pre-treatment device (such as a filter strip or grassed area) should be incorporated to increase the longevity of the system.
- Construct at least 1.5m above the maximum groundwater level and only where the groundwater classification allows.
- Design to avoid flooding for 1:30 year storm event. For 100 year events, property flooding should not take place and overland flows should not pass from the site to cause flooding to other areas.
- Filter drains should not be located on common boundaries as construction of fences and hedges will destroy them.
- The minimum distance from a property should be at least three times the depth of the trench.
- Consideration of topography is important to ensure sub-surface and overland flows are directed away from properties.
- When filter drains are used to drain road surfaces, there is a possibility of the stones being scattered when vehicles leave the carriageway. This can be minimised by using crushed rock on the surface layer of the fill material (CIRIA, 2000).
- Filter drains can be used in the base of swales to provide additional attenuation and treatment.
- When using filter drains, the use of gullypots is not required and should be avoided.
- Do not construct near drinking water wells, septic tanks or drain fields, unless fully lined.




### CROSS-SECTION THROUGH A FILTER DRAIN

# FILTER DRAINS



## POLLUTANT REMOVAL

Ideally sediment should be removed in a pre-treatment device, rather than in the filter drain itself.

| Pollutant | Removal (%) |
|---|---|
| TSS | 85 |
| Total Lead | 83 |
| Total Zinc | 81 |
| Oil | 70 |
| Nutrients (N & P) | Limited |

## MAINTENANCE CONSIDERATIONS

Regular inspections are required to monitor sediment build-up.
This can involve:
- digging up sections of the trench to check for clogging;
- use of inspection manholes;
- CCTV surveys within the perforated pipe.

Remedial work will also be required at intervals to remove sediment from the device. This can be done by replacing the filter material or through cleaning and replacement.

## IRISH EXPERIENCE

These drains are used on the National Road Project serving a dual purpose of groundwater control and run-off drainage. The pipe is conservatively sized for the run-off flow assuming negligible attenuation in the media or loss to infiltration.

## INTERNATIONAL EXPERIENCE

Scotland

Many of the first filter drains used extensively in Scotland were inappropriately designed as end of pipe features and became clogged at the inlet. Filter drains are meant to be linear features designed to run parallel to the surface they are draining.

Filter drains serving trunk roads and motorways have also occasionally been problematic. Following an accident on the M74 motorway in Scotland, a quantity of fuel oil was spilled onto the road when tanks ruptured on a heavy goods vehicle and this was subsequently discharged into a nearby watercourse through filter drains. The use of above ground structures such as swales and ponds would have minimised the effects of the incident, as measures could have been taken to contain the pollutants within the structures.

Preliminary monitoring results suggest that filter drains have a finite lifespan. Many are prone to clogging due to the absence of some form of pre-treatment device. Rumble strips or other measures can be incorporated to minimise stone scattering by vehicles. They have perfomed well on major roads, but may receive higher solids in urban use areas.

A Filter Drain under Construction

## ADVANTAGES

- ☑Provides attenuation.
- ☑Provides limited treatment.
- ☑Relatively inexpensive.
- ☑Relatively low land take.
- ☑Can be used in most soil conditions provided run-off discharges into a perforated pipe rather than to soil.
- ☑Minimal safety risk.

## LIMITATIONS

- ☒No habitat or amenity value provided.
- ☒Does not provide biological treatment.
- ☒Below ground structure therefore operational problems not always visible at surface. Similarly significant pollution events are routed below ground and are difficult to identify.
- ☒Not suitable where groundwater levels are high, i.e. likely to come within 1.5m of the base of the device.
- ☒Not suitable for industrial areas unless treatment is provided upstream of the device and operates as part of a treatment train.
- ☒Regular maintenance required.

FROM PREVIOUS - 2 of 2

# RETENTION PONDS *SITE CONTROL*

City West Retention Pond

| PRIMARY CONSIDERATIONS | |
|---|---|
| Construction Cost | HIGH |
| Maintenance Requirements | LOW |
| Land Take | HIGH |

| BENEFITS | |
|---|---|
| ☑Water Quality Control | YES |
| ☑Water Quantity Control | YES |
| ☑Amenity Value | YES |
| ☑Habitat Creation Value | YES |
| ☑Biological Treatment | YES |

## DESCRIPTION

Retention ponds are permanent water bodies which hold water for a couple of weeks allowing particles to settle and biological treatment. Retention ponds are regional controls which serve large scale developments, such as industrial estates and major housing developments. They are one of the most effective storm water management installations for removing storm water pollutants. Sedimentation of solids occurs in the open water and wetland bench. Nutrients are removed in the open water by photosynthesis and by bacteria attached to wetland plants. Since retention ponds have the capability of removing soluble pollutants, they are suitable for sites where nutrient loadings are expected to be high. These systems also provide flood control, when designed to allow fluctuations in water level above the permanent pool of water.

Roadside Retention Pond, Scotland

## DESIGN

### General Design Criteria / Features

- Design to have a minimum permanent pool of 4 x Vt (Wallingford Procedure).
- Design to hold water for 14 - 21 days.
- Typically ponds are comprised of a sediment forebay, a permanent pool of open water and an outlet structure.
- Wetland and aquatic vegetation are planted mainly around a shallow benched edge.
- A minimum contributing area of 5 ha is desirable.
- The inlet should be designed to minimise the velocity of flow entering the system. The inlet and outlet should be remote from each other. The inlet should not be fully submerged at normal pool elevation.
- Pre-treatment is achieved in the sediment forebay: a small pool (typically about 10% of the volume of the permanent pool). Coarse particles should be trapped in the forebay.
- Open water in retention ponds should occupy 50-75% of the permanent pool surface area. The remaining area should be used to create a shallow bench about 3m wide (CIRIA, 2000).
- This shallow bench should be planted with appropriate native aquatic vegetation which will:
  - -enhance the removal of soluble nutrients and sediment trapping,
  - -prevent sediment re-suspension,
  - -provide a wildlife habitat,
  - -act as a safety bench to prevent children reaching deeper water,
  - -help to conceal any litter or debris which may accumulate
  - -help stabilise the soil at the edge of the pond, preventing erosion,
  - -enhance the aesthetic value of the facility, helping to make an asset to the community.
- Side slopes should be limited to 1 in 4.
- Flatter slopes also help to prevent erosion of banks, make routine bank maintenance tasks easier and provide for public safety.
- The original design volume of the pond should take into account gradual sediment accumulation.
- The average depth of water in the permanent pool should be between 1m and 2m, with a limit of 2.5m to prevent anaerobic conditions. This should also be deep enough to minimise algal blooms and re-suspension of previously settled materials.
- Some flood storage is also available above the permanent pool which is limited to 2m above the normal water level to prevent inundation of the vegetation.
- Wet ponds need a sufficient drainage area to maintain the permanent pool.
- During large flood events it may be necessary to divert runoff round the pond.
- The water should be retained in the pond for 14 to 21 days during the wettest months to allow for biological treatment and allow settlement of fine solids.
- A liner may be required to retain a permanent pool where soils are permeable.
- In pollution hotspots, such as industrial estates, ponds should be lined to prevent groundwater contamination. A liner should also be used where groundwater levels are high or require protection, to prevent interaction with the polluted run-off.
- The design should incorporate features to lengthen the flow path through the pond, such as underwater berms.
- Length to width ratio should be 5:1 preferably, with a minimum of 3:1 (Horner et al, 1994).
- The use of multiple ponds in sequence improves treatment.
- Fencing of ponds is generally not desirable but may be required in some situations.
- Signs may be posted during cold periods, to warn of the dangers of ice.

MORE OVERLEAF 

# RETENTION PONDS *SITE CONTROL*

### DESIGN

#### Habitat Enhancement

- Locate ponds near (but not directly connected to) other wetland areas e.g. (natural ponds, lakes, floodplains) to allow plants & animals to colonise.
- Create habitat mosaics with sub-basins of permanent, temporary and semi-permanent ponds, varied in size (from 1ha down to $1m^2$) and depth (1m down to 5cm).
- Maximise the area of shallow and seasonally inundated ground dominated by emergent plants which are generally more tolerant of pollutants than submerged aquatic plants.
- Create undulating 'hummocky margins' in shallow water, which mimic the natural physical diversity of semi-natural habitats. Avoid smooth finished surfaces, as they provide less physical diversity for plants & animals.
- Encourage development of open, lightly shaded and densely shaded areas or pools.
- Encourage a mosaic of marginal plants (rather than single species stands).
- Use native water plants, trees, shrubs or grass species.

### DESIGN

#### Volumetric Design Criteria

The volume required is defined by a matrix of parameters which are summarised as:

1) Depth / Area Storage Relationship:

- This is largely dictated by topography and outfall levels. Volumetric allowances for vegetation of up to 25% should be provided.

2) Head / Discharge Relationship:

- The pond/basin should be designed to a maximum discharge rate, achieved when the structure is full but consideration must be given to outfall conditions, e.g. receiving water levels.

3) Throttle Rate:

- Throttle sizes are generally a minimum of 150mm. For smaller developments, the volumetric requirement is likely to be achieved by other drainage components such as lined or unlined permeable pavement car parks or soak-aways.

4) Effective Contributing Area:

- This is the paved and pervious catchment surfaces which contribute runoff after various losses.

The relationship between contributing area and throttle rate will define the critical duration of the design rainfall events. Events will be longer for tighter throttle rates and storage volumes

5) Rainfall Characteristics of the Area:

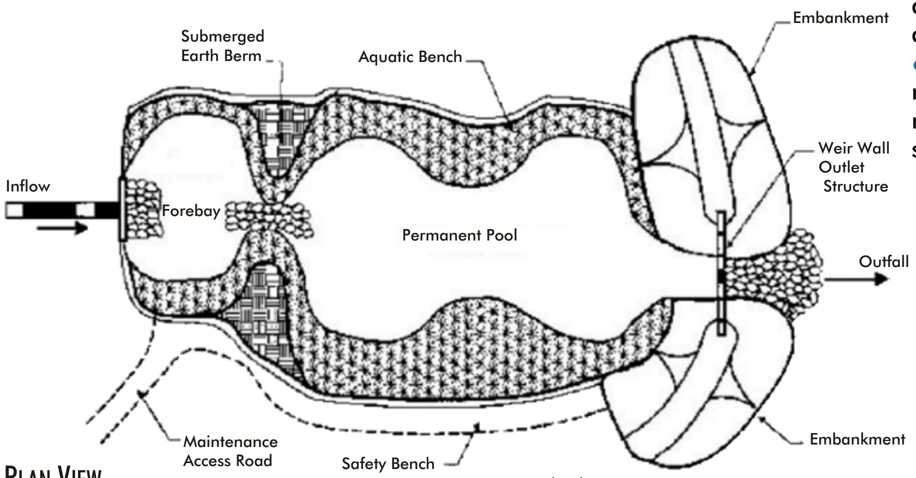
- Ireland has been analysed for hydrological characteristics. These have been processed to enable appropriate design storm events to be produced for any location, duration and return period. This is based on the Flood Studies Report undertaken in the 1970's.

6) Level of Service:

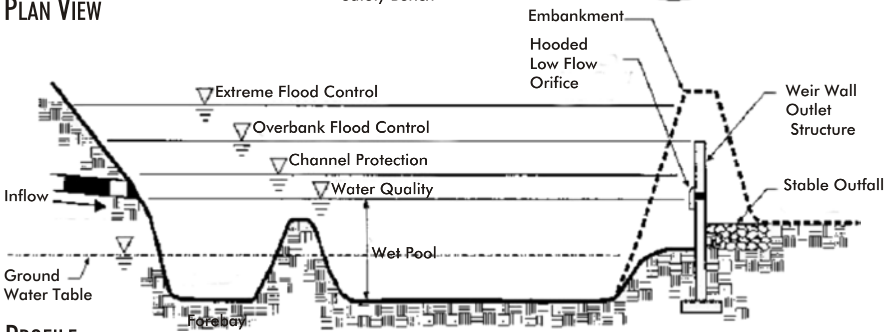
- Design should be for a range of return periods (1 to 100 years). It is unlikely that one structure will serve the needs of the various criteria. Temporary flooding of car parks and public space areas are likely to be acceptable on occasions. The hydraulic implications for loss of volume due to sediment or vegetation should also be considered.

7) Safety:

- This should be considered for all stages of construction, operation, maintenance and decommissioning.
- In the case of extreme events an appropriate design criteria should be applied to protect against overtopping.
- Large storage areas may have to consider not only the freeboard and reinforced spillway but the fetch for wave development.
- Very large storage reservoirs would have have regard to dams regulations and risk of failure should be examined in all cases.
- Blockage of the pass forward structure must be catered for and an alternative method of drawing down the storage system must be provided.




PLAN VIEW




PROFILE

Retention Pond, Scotland

FROM PREVIOUS & CONTINUES - 2 of 4

# RETENTION PONDS

*SITE CONTROL*



## POLLUTANT REMOVAL

The effectiveness of wet ponds has been estimated through a wide range of research, producing variable results. However, it is believed that proper design and maintenance may help to improve performance. Research reported by Schueler suggests the following typical removal rates (USEPA Factsheets):

| Pollutant | Removal (%) |
|---|---|
| Total Suspended Solids | 67 |
| Total Phosphorous | 48 |
| Total Nitrogen | 31 |
| Nitrate | 24 |
| Metals | 24-73 |
| Bacteria | 65 |

Details of other studies are available from the (US) National Stormwater Best Management Practices Database. (www.database.org)

A Retention Pond in Scotland

## MAINTENANCE CONSIDERATIONS

- Readily visible facilities tend to receive more and better maintenance than those less visible, more remote locations.
- Inlets and outlets should be inspected quarterly or after large storms for evidence of clogging or accumulation of debris.
- Other potential problems that should be checked include subsidence, nuisance plants, erosion and litter accumulation.
- Regular mowing can be carried out around the margins. However, this adds to the maintenance costs, reduces the habitat potential and is not always required.
- Maintenance costs may be higher in the first few years after construction, until the vegetation becomes established.
- Typically sediment may have to be removed from the forebay once every 10 years or after 50% of total forebay capacity has been lost.
- Adequate maintenance access should be provided.
- Sediment should be removed from the pond, as required, when the pool volume has become reduced significantly or the pond becomes eutrophic. US EPA factsheets suggest this is required once every 20 years.

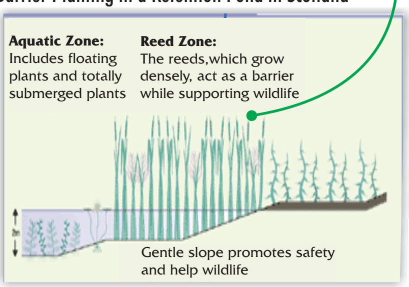
## COST CONSIDERATIONS

- Ponds are long-life facilities (typically longer than 20 years).
- The construction costs associated with these facilities vary considerably.
- In addition to the water resource protection benefits of wet ponds, evidence suggests they may provide an economic benefit by increasing property values, where they add to the overall amenity. This is supported by experience in the USA and Australia.

## OTHER CONSIDERATIONS

- Existing wetlands or natural ponds should not be used as SuDS facilities.

Barrier Planting in a Retention Pond in Scotland




## INTERNATIONAL EXPERIENCE

In Scotland, monitoring of retention ponds has highlighted the importance of bank stabilisation at an early stage. Erosion, due to wave action has been a problem in systems which are not adequately sheltered from the prevailing westerly wind. In Dunfermline, retention ponds have provided an added amenity to the local area. Recently, educational initiatives have been set up to encourage school children to make supervised visits to the ponds and assist with planting. Competitions have been held in the local press for local children to invent names for the ponds. Display boards are to be positioned around the ponds to explain their purpose.

Retention ponds have also been used to control runoff from a motorway service station on the M40 in Oxford, England. The drainage of the site is based on the treatment train concept. Permeable paving and filter drains have been used as source control measures. Regional facilities consist of retention ponds and a stormwater wetland.

Retention Pond, Scotland

# RETENTION PONDS *SITE CONTROL*

### INTERNATIONAL EXPERIENCE

U.K.

A suite of SuDS options has also been used at the Hopwood motorway service station on the M42. SuDS measures include permeable paving and retention ponds.

M42 Motorway Services

### ADVANTAGES

☑Capable of removing solid and soluble pollutants.

☑Provides biological treatment of run-off.

☑Suitable for sites where nutrient loadings are expected to be high.

☑Can be used in residential, commercial and industrial sites.

☑Can provide flood control.

☑Habitat creation.

☑Provision of an amenity to local residents.

☑Educational opportunity.

☑Can increase property values when planned and sited properly.

### LIMITATIONS

☒Safety concerns.

☒Requires relatively large land area therefore may not be suitable for high density urban areas.

☒Requires contributing area greater than 5 hectares, typically.

☒Liners may be required when soil conditions are permeable or where groundwater levels are high.

## Construction Stage...

Retention Ponds, Construction Stage, M74, Scotland

## Operational Stage

Retention Ponds, Operation Stage, M74, Scotland



Dublin City Council
Comhairle Cathrach Bhaile Átha Cliath

Dublin Drainage
A Strategic Study for Greater Dublin

# SWALES





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

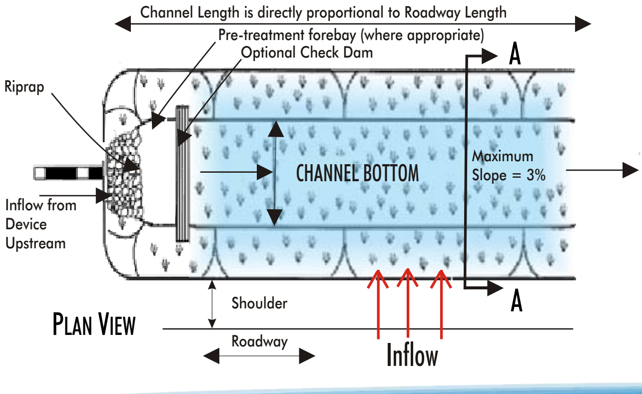
- Trapezoidal or parabolic cross section with relatively flat side slopes (less than 3:1) to maximise contact with the vegetation thus enhance treatment.
- Position along the side of the impervious area that they drain to facilitate sheet flow.
- Kerb cuts or a low earth weir may be required at the edge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

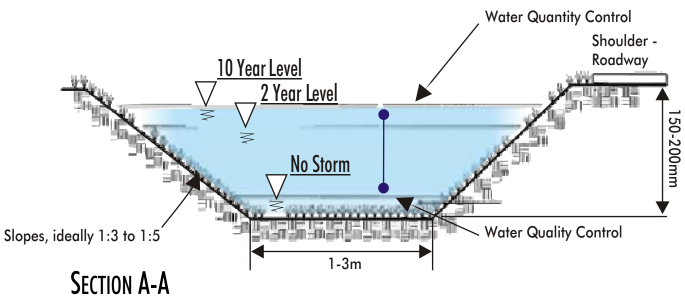
*B) High Level:* (Mini-retention basin combined with a conveyance channel); "Deep" water allows low values of conveyance velocity to be determined, which will reduce scour. Appropriate where soil conditions are relatively permeable or under drainage is provided.

*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)



Dublin City Council
Comhairle Cathrach Bhaile Átha Cliath

Dublin Drainage
A Strategic Study for Greater Dublin

# SWALES



## 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

# STORMWATER WETLANDS *Regional Control*

Stormwater Wetlands

| PRIMARY CONSIDERATIONS | |
|---|---|
| Construction Cost | HIGH |
| Maintenance Requirements | MEDIUM |
| Land Take | HIGH |

| BENEFITS | |
|---|---|
| ☑Water Quality Control | YES |
| ☑Water Quantity Control | YES |
| ☑Amenity Value | YES |
| ☑Habitat Creation Value | YES |
| ☑Biological Treatment | YES |

## Description

Stormwater wetlands are similar to retention ponds but with more emergent aquatic vegetation and a smaller open water area (less than 25% of the water surface area).

Stormwater Wetlands are shallow pools that create growing conditions suitable for the growth of marsh plants. They typically have less bio-diversity than natural wetlands. Because wetlands are heavily vegetated, they serve as a natural filter for urban run-off.

Stormwater wetlands detain urban run-off, remove pollutants through biological treatment and settlement and provide habitat and aesthetic benefits. Wetlands can be integrated into developments as a community water feature.

A Stormwater Wetland in Scotland

## Design

### General Design Criteria / Features

- Design to retain water for 14 days during the wettest months to allow for biological treatment and for settlement of solids.
- Design to have a minimum permanent pool of 3 x Vt (Wallingford Procedure).
- The simplest form of a constructed wetland comprises of a basin with a forebay and wetland vegetation area.
- An adequate water flow is required to ensure a permanent pool of water.
- Wetlands should have a length-to-width ratio of at least 5:1, which helps prevent short-circuiting (US EPA Factsheets).
- The distance between inlet and outlet should be maximised. The use of islands and peninsulas will ensure this.
- The drainage area should be greater than 5 hectares.
- Sediment forebays are recommended to decrease the velocity and sediment loading. Forebays should be a separate cell. It is suggested that they should be 2 to 3m deep and contain at least 10% of the wetland's treatment volume. Coarse particles remain trapped in the forebay and maintenance is performed in this smaller pool, eliminating the need to dredge the entire wetland. Alternatively a detention basin may be placed before the wetland, to remove settleable solids and protect the wetland from extreme fluctuations in water levels during large storms.
- Effective wetland design displays "complex microtopography"; wetlands should have zones of both very shallow and moderately shallow wetlands using underwater earth berms to create the zones. This design will provide a longer flow path through the wetland to encourage settling and plant diversity and to discourage undesirable plant monocultures.
- The average depth of the wetland should be 0.5 to 0.75m. The depth of open water should not exceed 2 metres. Water deeper than 2m inhibits rooted plant growth, thus providing areas of open water. However, wetlands can be designed for flood control by providing flood storage of up to 2m, above the level of the permanent pool.
- The open water area should be less than 25% of the water surface area.
- Shallow side slopes should be gradual (e.g. 1 in 4), as in natural wetlands and should not exceed 3:1 (Horner et al, 1994) to reduce safety hazards and enable maintenance.
- Wetlands should be constructed to have no lateral slope perpendicular to the flow path to avoid concentrating the flow in preferred channels.

### Habitat Enhancement

- A wetlands ecologist should be consulted about planting so that plants are selected which are capable of pollutant removal, adapted to saturated soil conditions, tolerant of periodic inundation by run-off and which can withstand the dry periods that naturally occur in the local area. A diverse native selection should be planted shortly after constructing the wetland. Mostly perennial species should be selected with priority to those that establish rapidly. Vegetation reduces the effect of wind which can cause short circuiting of the wetland.
- If possible, stormwater wetlands should be located close to natural waterbodies, to enhance colonisation. However, existing important habitat areas should be avoided.

# STORMWATER WETLANDS *REGIONAL CONTROL*

## DESIGN

### Volumetric Design Criteria

The volume required is defined by a matrix of parameters, which are summarised as:

1) Depth / Area Storage Relationship:

- This is largely dictated by topography and outfall levels. Volumetric allowances for vegetation of up to 25 percent should be provided.

2) Head / Discharge Relationship:

- The pond/basin should be designed to a maximum discharge rate, achieved when the structure is full. Consideration must be given to outfall conditions, e.g. receiving water levels.

3) Throttle Rate:

- Throttle sizes are generally a minimum of 150mm. For smaller developments, the volumetric requirement is likely to be achieved by other drainage components such as lined or unlined permeable pavement car parks or soak-aways.

4) Effective Contributing Area:

- This is the paved and pervious catchment surfaces, which contribute run-off after various losses.
- The relationship between contributing area and throttle rate will define the critical duration of the design rainfall events. Events will be longer for tighter throttle rates and storage volumes larger.

5) Rainfall Characteristics of the Area:

- Ireland has been analysed for hydrological characteristics. These have been processed to enable appropriate design storm events to be produced for any location, duration and return period. This is based on the Flood Studies Report work carried out in the 1970's.

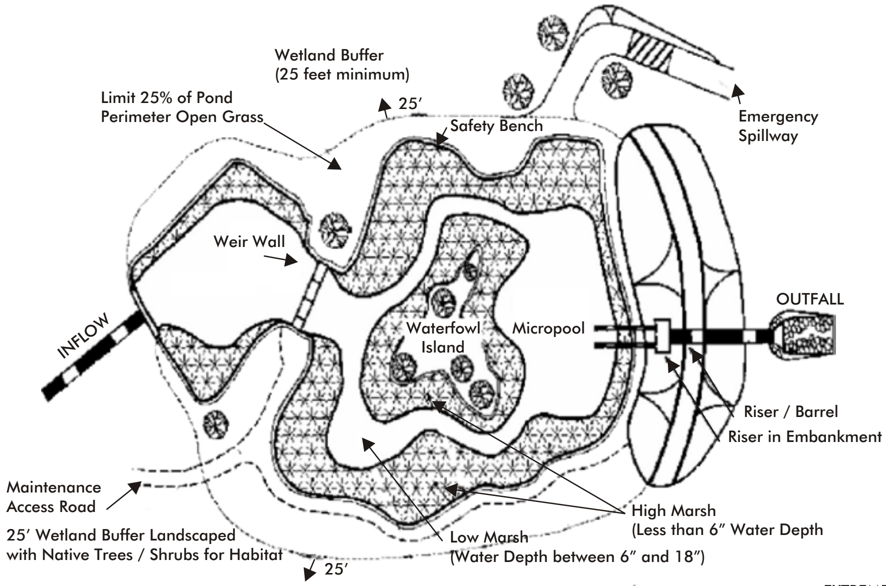
6) Level of Service:

- Design should be for a range of return periods (1 to 100 years). It is unlikely that one structure will serve the needs of the various criteria. Temporary flooding of car parks and public space areas are likely to be acceptable on occasions. The hydraulic implications for loss of volume due to sediment or vegetation should also be considered.

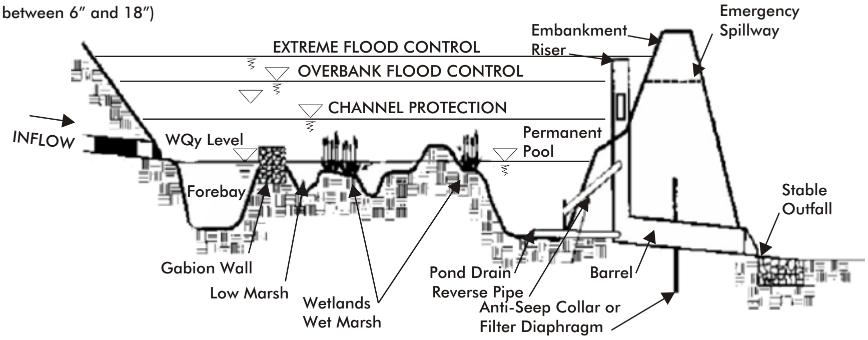
## DESIGN

### Other Design Issues

- Stormwater wetlands can accept run-off from stormwater hotspots, but need significant separation from groundwater if they will be used for this purpose. Where the potential for groundwater contamination is high, such as in industrial estates, the use of liners is required.
- Wetlands can be used in almost all soils and geology. At sites where infiltration occurs, it may be necessary to incorporate an impermeable liner into the design in order to maintain a permanent pool.
- Warning signs may be posted during cold periods, to warn of the dangers of ice.
- Stormwater wetlands are generally safer than retention ponds but deep zones may still be a hazard. Fencing of wetlands is generally not desirable but may be required in some situations. A preferred method is to manage the contours of the pond to eliminate drop-offs and other safety hazards. Barrier planting around the margins will restrict access.
- Groundwater inflows and outflows can have a significant effect on a constructed wetland system. Groundwater chemistry can affect water quality and processes such as sedimentation and vegetation growth.
- Construction run-off should be prevented from entering the constructed wetlands as the resulting sediment loading can severely degrade the performance of the system.




PLAN VIEW




PROFILE

FROM PREVIOUS & CONTINUES - 2 of 3

# STORMWATER WETLANDS *REGIONAL CONTROL*

### POLLUTANT REMOVAL

Wetlands are the most effective type of SUDS in terms of pollutant removal. As storm run-off flows through the wetland, pollutant removal is achieved through settling and biological uptake within the facility. Stormwater wetlands can provide significant reductions in sediment, nutrient, heavy metals, toxic materials, floatable materials, oxygen demanding substances, oil and grease as well as a partial reduction in bacteria and viruses.

| Pollutant | *Removal (%) |
|---|---|
| Total Suspended Solids | 60-80 |
| Oil & Grease | Detail Unknown |
| Total Phosphorous | 20-40 |
| Total Nitrogen | 20-40 |
| Bacteria | 60-80 |
| Copper | 60-80 |

*Typical Removal Rates based on National US Data Range

Details of other studies which have been carried out world-wide, are available from the National Stormwater Best Management Practices Database.

### MAINTENANCE CONSIDERATIONS

Maintenance requirements for wetlands are similar to those of retention ponds:

- Inlets and outlets should be inspected quarterly or after large storms for evidence of clogging or accumulation of debris.
- During the first two years, it is extremely important that the facilities be inspected quarterly for nuisance vegetation and that these be removed; this will insure a healthy and aesthetically pleasing facility.
- Other potential problems that should be checked include subsidence, erosion and litter accumulation. Remedial work should be carried out when required.

- Sediment may have to be removed from the forebay once every 5 to 7 years or when half of the forebay depth is filled with sediment.
- The wetlands themselves may have to be dredged once every 25 years or less.
- Stormwater wetlands require frequent maintenance in the first 3 years to establish the marsh.

Thereafter, maintenance will be that carried out as in other pond systems.

- Aquatic vegetation within the wetland should be cut back after flowering, and thinned when necessary, typically every 7 to 10 years.

### COST CONSIDERATIONS

- Wetlands have a long life span, compared to many other types of SuDS. In the US the annual cost of routine maintenance is typically estimated at about 3% to 10% of the capital cost.
- Maintenance costs may be higher in the first few years after construction, until the vegetation becomes established.
- It is anticipated that well designed wetlands, which incorporate additional aesthetic features may provide an economic benefit by increasing property values.

### INTERNATIONAL EXPERIENCE

Stormwater wetlands have been used extensively in the US. Further details are available from the National Stormwater Best Management Practices Database. (www.bmpdadabase.org)

### ADVANTAGES

- ☑ Provide high pollutant removal efficiencies.
- ☑ Require relatively low maintenance.
- ☑ Can be used in almost all soils and geology.
- ☑ Creates habitat.
- ☑ Can enhance the aesthetics of an area and provide recreational benefits.
- ☑ Can provide an economic benefit by increasing property values.

### LIMITATIONS

- ☒ Large land requirements.
- ☒ Seasonal variations in treatment and pollutant removal efficiencies.
- ☒ Wetlands require careful design and planning to ensure that wetland plants are sustained after the practice is in place.
- ☒ Delayed efficiency until plants are well established.
- ☒ Requires reliable water supply.
- ☒ Acceptance influenced by public opinion.
- ☒ Topography of the site.

# PERMEABLE PAVEMENTS

SOURCE CONTROL

Traditional road surface drain permeable parking bays

**PRIMARY CONSIDERATIONS**

| | |
|---|---|
| Construction Cost | LOW |
| Maintenance Requirements | HIGH |
| Land Take | MEDIUM |

**BENEFITS**

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

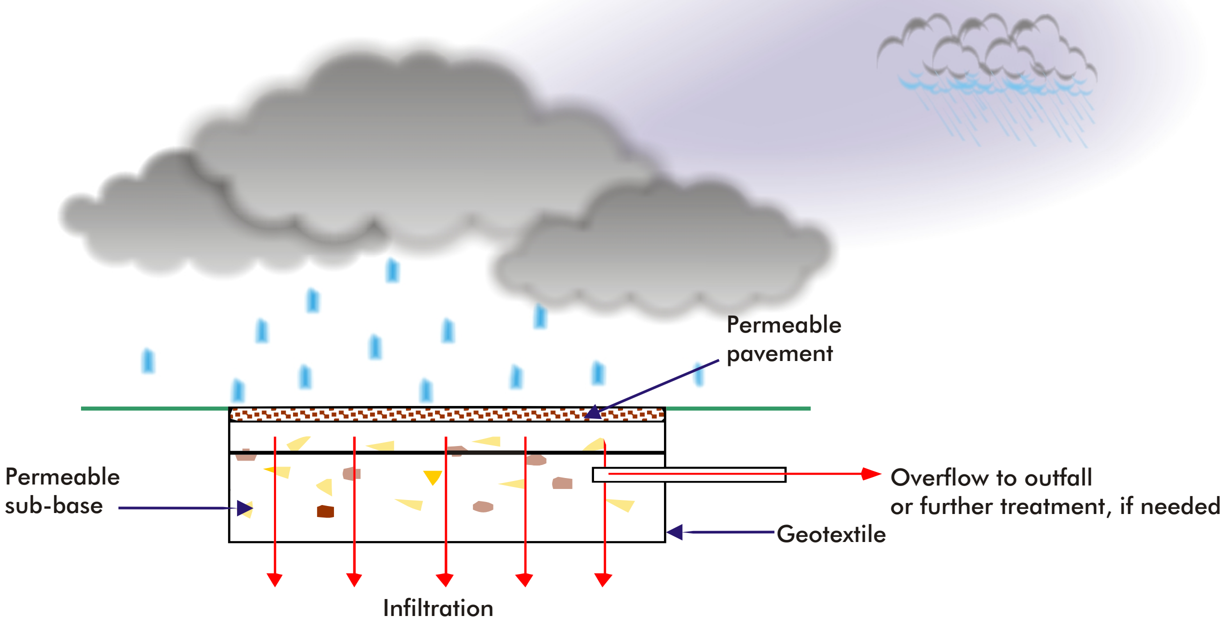
## DESCRIPTION

Permeable pavements are designed to reduce imperviousness, consequently minimizing surface run-off. They vary in type from porous asphalt, porous concrete, or modular paving (large gaps between impervious areas allows infiltration) and are suited to lightly trafficked areas.

Run-off infiltrates to an underlying stone reservoir which is capable of removing pollutants, before discharge in a controlled manner into a nearby watercourse or infiltrating directly.

## DESIGN

- The bottom of the stone reservoir should be flat to allow infiltration across the whole structure.
- The depth / volume of sub-base storage zone needs to relate to the design rainfall depth, taking into account the voids ratio of around 30 per cent.
- Appropriate geotextiles should be used to prevent the sub-base from clogging.
- Granular sub-base should be stabilised to prevent deformation under traffic loads.
- Soils should have at least moderate infiltration rates.
- Construct base of device at least 1.5m above the maximum groundwater level and only where the groundwater classification allows.
- Line the device or underdrain to discharge to sewer, where groundwater is at risk.
- Hydraulic design should avoid flooding for a "once in 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.
- Minimum carpark gradients should be used to minimise excessive loading at the lower edges of the paving / surface.
- Soil levels to be lower than the kerb level around landscaped features (avoid mounding).
- Avoid point inflows to the sub-base.
- Outfall pipe to be designed as a throttle for extreme events.
- A relief pipe is recommended to cope with excess volume (overflow).
- Blocks must be tightly packed and securely laid to prevent movement or cracking under load.




PERMEABLE PAVEMENT USED FOR INFILTRATION

# PERMEABLE PAVEMENTS



## POLLUTANT REMOVAL

Research undertaken by the University of Abertay, Scotland suggests that permeable paving is effective in attenuating flow and improving the quality of the run-off.

The Water Research Centre at the University of Australia has also carried out research which involved simulating rainfall of 580mm per annum with a loading of 200ppm silt. The results suggest that after 30 years the permeability of the surface would be reduced by about 25%.

| Pollutant | Removal |
|---|---|
| Nutrients | High |
| Heavy Metals | Unknown |
| Sediment | High |
| Bacteria & Viruses | High |
| Oxygen Demand | High |
| Toxic Materials | High |
| Floatable Material | High |
| Oil & Grease | High |

## MAINTENANCE CONSIDERATIONS

- Vacuum brushing or jetting is recommended twice a year, in Spring and in late Autumn.
- Results of research indicate clean job every seven years. Current experience suggests that permeable pavements might operate with routine maintenance for 15-20 years. After this period the pavement may become clogged with silts and toxins, so the porous surface or the inlets to the permeable pavement sub-base should be cleaned or individual areas treated. If this fails, it may be necessary to lift the surface and possibly remove and replace the bedding gravel and / or porous bricks and geotextile fabric (refer CIRIA, 2000).

Permeable paving - South Dublin

## INTERNATIONAL EXPERIENCE

### Scotland

In Scotland, system failure has occurred due to inappropriate landscaping in the surrounding area. In one case during the construction phase of the development, top soil for landscaping was stored on the surface of the permeable paving. Many local authorities have been reluctant to adopt permeable paving due to concerns over their performance. However, systems have been operating effectively in lightly trafficked private developments. Instances of failure have mainly been due to incorrect construction or inappropriate use.

### Rest of U.K.

Grasscrete has been used in other parts of the UK to drain areas such as overflow car parks. Grasscrete options include modular paving blocks or grids which have a series of gaps planted with turf grass to allow for infiltration. These systems are not appropriate for areas subjected to heavy pedestrian or vehicular traffic.

A "GRASSCRETE" Access Road in the U.K.

Attentuation levels for traditional stone filled lined permeable pavements have been tested for 100 year storm events. It was found that even in the wettest periods, the runoff rate was usually below 2l/s/ha and in general 1l/s/ha was the maximum flow rate.

## ADVANTAGES

☑Reduces peak run-off rates and volumes, i.e., recharges groundwater.

☑Retains pollutants prior to discharge to the drainage or groundwater system.

☑Reduces ponding and flooding.

☑Valuable option in spatially constrained urban sites.

☑Reduces the amount of impervious area in a development.

☑Roof water can be discharged directly into its sub-base.

☑Water available for secondary uses such as watering plants or toilet flushing (option).

☑Oil spillages can be treated in situ.

☑Minimal safety risks: sub-bases can act as a heat blanket in winter preventing ice formation on the surface.

☑Can visually enhance site.

☑Can be used to assist the successful establishment and future growth of trees in urban areas.

☑Only slightly more expensive than conventional surfaces.

☑Specially designed blocks can eliminate the need for other drainage structures such as pipes and gulleys.

## LIMITATIONS

☒No habitat or amenity value provided.

☒Risk of failure due to clogging.

☒Requires frequent maintenance (i.e. cleaning to prevent clogging).

☒Not ideal for highly trafficked areas due to high potential for sediment and pollution to clog the system and potential failure to support heavy traffic loads.

☒Groundwater contamination and low dissolved pollutant removal may occur in coarse soils unless appropriate design is incorporated.

☒Not suitable where groundwater levels are high, i.e. likely to come within 1.5m of the base of the device.

☒Limited use in industrial estates, due to the potential groundwater contamination.

☒Unsuitable in steeply sloping sites.

☒Surface is unsuitable for gritting/sanding in winter as sediment will clog surface.

FROM PREVIOUS - 2 of 2

# OIL INTERCEPTORS

**SOURCE CONTROL**

Example of an Oil Interceptor

**PRIMARY CONSIDERATIONS**

| | |
|---|---|
| Construction Cost | MEDIUM |
| Maintenance Requirements | HIGH |
| Land Take | LOW |

**BENEFITS**

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

## DESCRIPTION

Oil interceptors generally comprise three underground retention chambers designed to remove coarse sediments and retain oils. The first chamber is used for sedimentation and removal of large debris. This chamber contains a permanent pool of water and a well screened orifice which allows regulated flow into the second chamber. The second chamber is used for oil retention and also contains a permanent pool of water. An inverted elbow pipe permits regulated flow from this chamber into the third chamber. The inverted pipe collects water from deep in the permanent pool leaving oil contaminants floating on the surface until it is removed or absorbed by sediment particles when they settle. The third chamber is used to collect and disperse flow into the stormwater drain network or an infiltration basin. This chamber contains an orifice outlet which is often raised to create a third settling pool and regulate outflow.

## DESIGN

1) Run-off segregation:

Only run-off from areas which are likely to have oil contamination (e.g. filling areas for service stations) should be directed to the separator. This will reduce the size of the separator required. Appropriate use of bunding may help segregate oil contamination from 'clean' run-off.

2) High flow bypass:

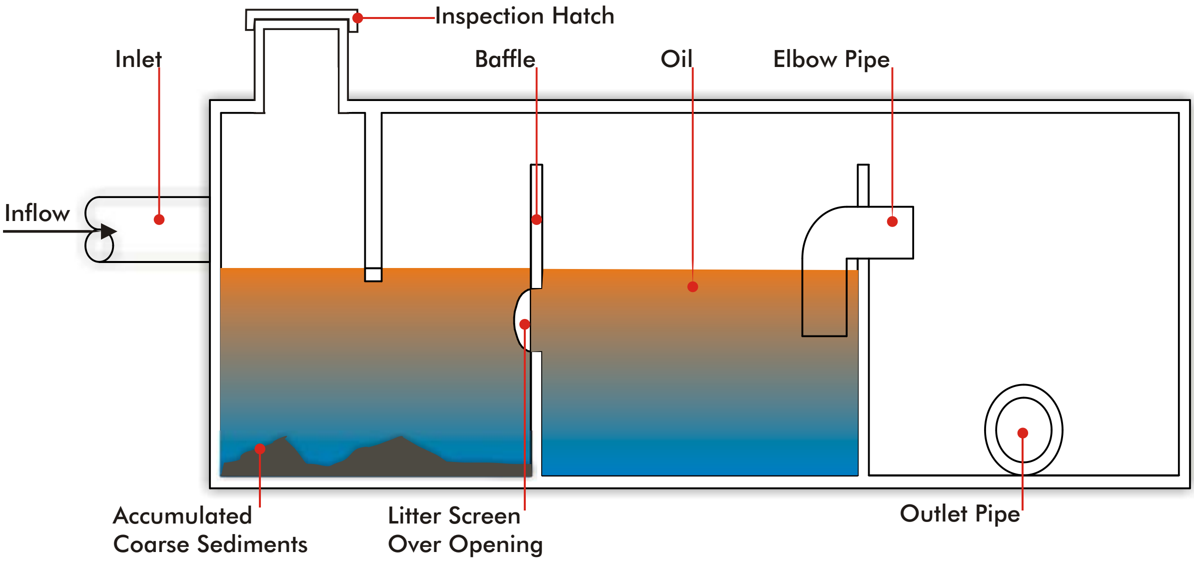
The separator should be designed to accept low flow only, with a high flow bypass installed to provide for the residual flow up to the capacity of the pipe system.

3) Interceptor chamber screening:

Ensure that the orifice between the primary and secondary chambers is effectively screened. This should generally not allow debris greater than 5 millimetres in diameter to enter the second chamber. It should be easily accessible and easily removed for cleaning.

4) Maintenance access:

Easy access is required for inspection and cleaning. Each chamber could have its own inspection entrance, with step rings leading to the bottom of the chamber.




TRIPLE INTERCEPTOR DEVICE

MORE OVERLEAF - 1 of 2

# OIL INTERCEPTORS



### POLLUTANT REMOVAL / MAINTENANCE

Triple oil interceptors have been reported to have relatively poor pollutant removal capability. This has been attributed to poor maintenance and the passage of high flows though the device (Galli, 1992). They have also been found to be expensive to operate due to their high maintenance requirements (Ontario Ministry of Environment & Energy, 1994).

| Pollutant | Removal |
|---|---|
| Gross Pollutants | Low to Medium |
| Fine Sediment | Low |
| Medium Sediment | Low to Medium |
| Coarse Sediment | Medium |
| Attached Pollutants | Low |
| Dissolved Pollutants | None |
| Oil & Grease | Medium to High |
| Floatable Material | Medium to High |

### MAINTENANCE CONSIDERATIONS

Clean once a month to keep accumulated oil and grit from escaping. A vacuum pump tanker can be used to pump out the contents of each chamber.

Without regular maintenance, the system quickly reaches capacity. Oil and solid pollutants are re-entrained into the flow, rendering the device ineffective. Regular inspections should be made to assess sediment and oil levels along with outflow oil concentrations.

### INTERNATIONAL EXPERIENCE

Oil interceptors are widely used to protect receiving waters from pollution by oil.

See Pollutant removal capacity included for documented experience of their performance.

### ADVANTAGES

- Suitable for treating stormwater from areas with significant vehicular pollution (e.g. car parks).
- Can also trap litter.
- Can treat stormwater from areas storing or handling petroleum products (e.g. service station and petroleum depots).
- Can be retrofitted into existing drainage systems.
- Minimum visual impact.

### LIMITATIONS

- Limited removal of fine sediments or soluble pollutants.
- Turbulent conditions may re-suspend particles or entrain floating oil. (A high flow by-pass can overcome this problem).
- Trapped debris is likely to have a high concentration of pollutants, possibly toxic.
- Requires regular cleaning to achieve design objectives.
- Can pose a potential safety hazard for maintenance personnel.

TRIPLE CHAMBER OIL INTERCEPTOR

FROM PREVIOUS - 2 of 2

# *Appendix D: SuDS Selection Criteria*

D1 Land use Characteristics

D2 Site Characteristics

D3 Catchment Characteristics

D4 Quantity and Quality Performance

D5 Amenity and Environmental Requirements

## D.1 Land Use Characteristics

It is important to ensure that the SuDS techniques selected are appropriate to the use of the land draining to the system. The proposed land uses within the LAP lands require the following drainage system characteristics.

| Land Use | Required Drainage System Characteristics |
|---|---|
| Very low density development Areas | These areas are likely to have lower pollution levels, and providing that they have a fully vegetated surface, lower sediment loadings compared to equivalent impervious surfaces. A full treatment train is unlikely to be necessary and a single stage should be sufficient. |
| Roads /Highways | The design criteria for roads must take into account the nature of the receiving waters and their sensitivity to pollution.<br><br>Drainage near roads should ensure not only that the road can shed water but also that the ground around the roads and paths will not become saturated. Lack of free draining soil under the road can lead to a loss of ground strength and frost heave. If drainage runs alongside roads the carriageway will need to be defined and measures taken to avoid over-running or parking on verges. |
| Commercial development (including shops, schools and offices) | Some small areas within these sites, such as fuel tanks or rubbish skips, should be treated as industrial (hotspot) sub-catchments. Unless the receiving water is particularly sensitive, two levels of treatment will typically be required. This might consist of source control followed by site or regional controls. |
| Industrial development / hotspot areas | Industrial areas pose a greater threat to the environment than other land uses. Runoff from these areas may include highly polluted runoff. Extra stages of runoff treatment are therefore required, especially for sensitive receiving waters. Pollution prevention measures are essential, eg the use of containment systems such as bunds will allow any spills to be controlled in high risk areas. Roofing over areas such as garage forecourts will allow rainfall to be directed to the drainage system without being polluted. The area subject to spills can be drained separately without having to cater for the entire volume from rainfall runoff. Even if potentially polluting areas are contained, the risk of pollution is still relatively high, so the drainage from the whole industrial site should pass through at least three treatment stages.<br><br>The following areas should be connected to the foul sewer, subject to the agreement of the local authority.<br>• permanent skip areas<br>• yard areas where chemicals and oils may be spilled<br>• delivery bays where there is a high risk of spillage<br>• designated pressure washing areas<br>• fuelling areas<br>These areas should be clearly defined and kept to a minimum to limit the volume of water discharged to the foul sewer. Discharges of trade effluent must be in accordance with consents issued under the relevant legislation. |

Table D.1 Influence of land use on SUDS selection (Extract from Table 5.1 of CIRIA document 697)

## D.2 Site Characteristics

The site characteristics that can affect the use of particular SuDS techniques are detailed in the extract from CIRIA Report 697 below.

| Site characteristic | Required drainage system characteristics |
|---|---|
| 1. Soils | The function of different SUDS is very dependent on the underlying soils. More permeable soils can enhance the operation of some practices, but adversely affect others, eg wet ponds or wetlands rely on a pool of water or saturated sub-soils to provide the basis for water quality treatment. Permeable soils will prevent the retention of a pool of water unless a liner is installed. Infiltration practices rely on the passage of water through the soil profile and more permeable soils transmit more water. |
| 2. Groundwater: minimum depth to seasonally high water table | Infiltration devices will require at least 1 m of soil depth between the base of the device and the maximum expected groundwater level. This is to ensure that the system operates efficiently during periods of exceptional wet weather and that the risk of system flooding from high groundwater levels is minimised. |
| 3. Area draining to a single SUDS component | Practices that rely on vegetative or media filtering of runoff tend to be more appropriate for smaller catchment areas, as large flows may overwhelm their ability to treat the runoff. Ponds can be appropriate for larger catchment areas although, by using effective source control and SUDS management trains, ponds will most usually feature at the bottom of a train of upstream components. It should be rare that areas >2 ha drain to a single SUDS component. |
| 4. Slope of contributing drainage area | Steeper slopes may eliminate the use of some practices, may require other practices to be modified, but may have little impact on others. Depending on the design, it is usually more difficult to achieve higher pond/basin storage volumes on sloping sites. Swales may be adapted for steeper slopes if the swales are placed along the contours rather than up or down the slope. Biofiltration and filter strips require residence times that are generally only possible with gentler slopes. Infiltration practices are also limited to gentle slopes as they must provide storage of water until the water can soak into the ground. In addition, infiltration of water into a slope may cause saturation further down which could cause slope instability or re-emergence of stormwater. |
| 5. Head | Elevation differences are needed from inflow to outflow to allow certain SUDS techniques to operate under gravity. If sufficient head is not naturally available, it can often be artificially created by excavation or by using embankments. |
| 6. Availability of space | Some techniques require more land take than others, though this is not necessarily a barrier. In England and Wales, PPG 3 (DETR, 2000) calls for higher density housing developments, but also requires all developments to provide sufficient provision for open space and playing fields where such spaces are not already adequately provided within easy access of the new housing. A pond could be included in such an area, or the area could be used for extreme flood management, being designed to flood on rare occasions and for a short time during and after extreme storm events. In some instances, ponds have been located outside the development site on adjacent land. |

*Table D.3 – Influence of site characteristics on SUDS selection (Table 5.3 of CIRIA C697)*

| SUDS group | Technique | Soils | | Area draining to a single SUDS component | | Minimum depth to water table | | Site slope | | Available head | | Available space | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Impermeable | Permeable | 0 – 2 ha | > 2 ha | 0 – 1 m | > 1 m | 0 – 5 % | > 5 % | 0 – 1 m | 1 – 2 m | Low | High |
| Retention | Retention pond | Y | Y[1] | Y | Y[5] | Y | Y | Y | Y | Y | Y | N | Y |
| | Subsurface storage | Y | Y | Y | Y[5] | Y | Y | Y | Y | Y | Y | Y | Y |
| Wetland | Shallow wetland | Y[2] | Y[4] | Y[4] | Y[6] | Y[2] | Y[2] | Y | N | Y | Y | N | Y |
| | Extended detention wetland | Y[2] | Y[4] | Y[4] | Y[6] | Y[2] | Y[2] | Y | N | Y | Y | N | Y |
| | Pond/wetland | Y[2] | Y[4] | Y[4] | Y[6] | Y[2] | Y[2] | Y | N | Y | Y | N | Y |
| | Pocket wetland | Y[2] | Y[4] | Y[4] | N | Y[2] | Y[2] | Y | N | Y | Y | Y | Y |
| | Submerged gravel wetland | Y[2] | Y[4] | Y[4] | Y[6] | Y[2] | Y[2] | Y | N | Y | Y | N | Y |
| | Wetland channel | Y[2] | Y[4] | Y[4] | Y[6] | Y[2] | Y[2] | Y | N | Y | Y | N | Y |
| Infiltration | Infiltration trench | N | Y | Y | N | N | Y | Y | Y | Y | N | Y | Y |
| | Infiltration basin | N | Y | Y | Y[5] | N | Y | Y | Y | Y | N | N | Y |
| | Soakaway | N | Y | Y | N | N | Y | Y | Y | Y | N | Y | Y |
| Filtration | Surface sand filter | Y | Y | Y | Y[5] | N | Y | Y | N | N | Y | N | Y |
| | Sub-surface sand filter | Y | Y | Y | N | N | Y | Y | N | N | Y | Y | Y |
| | Perimeter sand filter | Y | Y | Y | N | N | Y | Y | N | Y | Y | Y | Y |
| | Bioretention/filter strips | Y | Y | Y | N | N | Y | Y | N | Y | Y | N | Y |
| | Filter trench | Y | Y[1] | Y | N | N | Y | Y | N | Y | Y | Y | Y |
| Detention | Detention basin | Y | Y[1] | Y | Y[5] | N | Y | Y | Y | N | Y | N | Y |
| Open channels | Conveyance swale | Y | Y | Y | N | N | Y | Y | N[3] | Y | N | N | Y |
| | Enhanced dry swale | Y | Y | Y | N | N | Y | Y | N[3] | Y | N | N | Y |
| | Enhanced wet swale | Y[2] | Y[4] | Y | N | Y | Y | Y | N[3] | Y | N | N | Y |
| Source control | Green roof | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y |
| | Rain water harvesting | Y | Y | Y | N | Y | Y | Y | Y | Y | | | |
| | Permeable pavement | Y | Y | Y | Y | N | Y | Y | N | Y | Y | Y | Y |

=Y: Yes N: No
[1] with liner
[2] with surface baseflow
[3] unless follows contours
[4] with liner and constant surface baseflow, or high ground water table
[5] possible, but not recommended (implies appropriate management train not in place)
[6] where high flows are diverted around SUDS component.

***Table D.4 – Site characteristics selection matrix (Table 5.4 of CIRIA C697)***

The selection matrix can be used to inform the selection of control measures to be utilised in the Killamonan / Cherryhound LAP lands.

## D.3 Catchment Characteristics

The tables below describe the influence of catchment characteristics on performance requirements and the number of treatment train components required for the lands.

The northeastern area of the Killamonan / Cherryhound LAP lands is within the catchment area of Ward River, whereas the southwestern part of the lands is within the catchment of Tolka River. The Ward River meets the Broadmeadow River downstream, and ultimately discharges into the Broadmeadow Estuary, which is a designated SPA, cSAC, NHA and Ramsar site. The Tolka River discharges into the Tolka Estuary, which is a designated SPA /Ramsar site. Thus there is a requirement to ensure that the discharged water quality is improved through the use of multiple SuDS measures at different stages of control.

| Catchment characteristic | Potential issues |
|---|---|
| Freshwater fisheries, sites with an ecological designation e.g. SSSIs, SACs | There will be a need to maintain habitat quality by maintaining natural recharge, preventing bank and channel erosion, preventing blanketing by silt, preserving the natural riparian corridor, preventing pollution, and by controlling stream warming. |
| Aquifers used for public water supply (Locally important aquifers) | SuDS designs will need to prevent possible groundwater contamination by preventing infiltration of contaminated runoff. At the same time, recharge will need to be retained in areas that recharge existing public water supply wells. Groundwater protection zones are important considerations and the risk posed by infiltration techniques to groundwater needs careful evaluation. |
| Coastal/ estuarial waters | Discharge to coastal or estuarial waters will not generally require peak flow or volume control as there will be no deterioration in flood risk as a result of increased runoff. Due to the high dilution available, surface water discharges to coastal waters are generally considered low risk. The main risk is from the faecal coliforms, oil and metals which are all present in urban runoff affecting bathing and shellfish waters, and here higher levels of treatment may be required. |
| Habitat-dependent flow regime | There may be a need to retain or adapt a particular drainage regime as a result of local habitat requirements. |
| Discharges to the sewerage network | In this scenario, hydrologic criteria must be agreed with the water authority. The allowable discharge rate will depend on the headroom available in the downstream network. Sediment control is also likely to be of concern due to ongoing maintenance requirements. |

***Table D.5: Influence of Catchment Characteristics on Performance Requirements (Extract from Table 5.5 of CIRIA C697)***

| Receiving water sensitivity / Runoff catchment characteristic | Low | Medium | High |
|---|---|---|---|
| **Residential roads, parking areas, commercial zones** | 2 | 2 | 3 |
| **Refuse collection/ industrial areas/ loading bays/ lorry parks/ highways** | 3 | 3 | 4 |

***Table D.6: Number of treatment train components (assuming effective pre-treatment is in place) (Extract from Table 5.6 of CIRIA C697)***

**Note: The sensitivity of the receiving waters is considered to be high given the designations under the Birds Directive and Habitats Directive.**

## D.4 Quantity and Quality Performance

Different SuDS measures are suited to meet different hydraulic and water quality requirements. A selection matrix based on quantity and quality performance is shown in following table.

As the receiving waters of both Ward River and Tolka River are protected areas, the ability of the SuDS system for the LAP lands needs to be have a higher quality performance in terms of removal of heavy metals, nutrients, and bacteria. This will be best achieved with source and site controls.

| SUDS group | Technique | Water quality treatment potential | | | | | Hydraulic control | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Suitability for flow rate control (probability) | | |
| | | Total suspended solids removal | Heavy metals removal | Nutrient (phosphorous, nitrogen) removal | Bacteria removal (*) | Capacity to treat fine suspended sediments and dissolved pollutants | Runoff volume reduction | 0.5 (1/2 yr) | 0.1 – 0.3 (10/30 yr) | 0.01 (100 yr) |
| Retention | Retention pond | H | M | M | M | H | L | H | H | H |
| | Subsurface storage | L | L | L | L | L | L | H | H | H |
| Wetland | Shallow wetland | H | M | H | M | H | L | H | M | L |
| | Extended detention wetland | H | M | H | M | H | L | H | M | L |
| | Pond / wetland | H | M | H | M | H | L | H | M | L |
| | Pocket wetland | H | M | H | M | H | L | H | M | L |
| | Submerged gravel wetland | H | M | H | M | H | L | H | M | L |
| | Wetland channel | H | M | H | M | H | L | H | M | L |
| Infiltration | Infiltration trench | H | H | H | M | H | H | H | H | L |
| | Infiltration basin | H | H | H | M | H | H | H | H | H |
| | Soakaway | H | H | H | M | H | H | H | H | L |
| Filtration | Surface sand filter | H | H | H | M | H | L | H | M | L |
| | Sub-surface sand filter | H | H | H | M | H | L | H | M | L |
| | Perimeter sand filter | H | H | H | M | H | L | H | M | L |
| | Bioretention/filter strips | H | H | H | M | H | L | H | M | L |
| | Filter trench | H | H | H | M | H | L | H | H | L |
| Detention | Detention basin | M | M | L | L | L | L | H | H | H |
| Open channels | Conveyance swale | H | M | M | M | H | M | H | H | H |
| | Enhanced dry swale | H | H | H | M | H | M | H | H | H |
| | Enhanced wet swale | H | H | M | H | H | L | H | H | H |
| Source control | Green roof | n/a | n/a | n/a | n/a | H | H | H | H | L |
| | Rain water harvesting | M | L | L | L | n/a | M | M | H | L |
| | Permeable pavement | H | H | H | H | H | H | H | H | L |

* limited data available

n/a: non applicable

H = high potential
M = medium potential
L = low potential

*Table D.7: Quantity and Quality Performance Selection Matrix (Table 5.7 of CIRIA C697)*

## D.5 Amenity and Environmental Requirements

The main community and environmental issues relating to different SuDS measures and relevant selection matrix are shown in the following tables.

Maintenance and cost issues are generally considered an important factor in selecting the most suitable SuDS measure.

The number of residential properties within the Killamonan / Cherryhound LAP lands is relatively low and it could be considered that as the lands develop that residential development will further decrease in the area. Lands designated for green space have been provided for in the Fingal Development Plan 2011-2017, which will serve as buffers between the commercial/ industrial areas and adjoining residential areas. It is recommended that SuDS measures that have better aesthetic and community value be used at the gateway development, neighbourhood centre area, designated landscape areas, and adjacent adjoining residential developments.

| Community/ environmental factor | Influence on SUDS selection |
|---|---|
| 1. Maintenance régime | The future management of the site can influence the choice of drainage system. At sites where ground staff are employed, grass mowing and other landscaping activities will take place regularly, so swales etc may be appropriate. At other sites, it may be preferable to contract out maintenance work with less regular, but at least annual maintenance on ponds, wetlands and pavements. A commitment to the long term maintenance of the drainage system should be established at early stages in the planning process by involving the owner of the proposed drainage system in the design process. |
| 2. Community acceptability | Some SUDS techniques may not be acceptable in close proximity to property eg swales in gardens are not likely to be acceptable. Some ponds may only be acceptable providing a minimum level of operation and maintenance is ongoing, and providing the water quality is reasonable all year round. This may mean that additional treatment train components are required. Amenity considerations are site specific, but there may be opportunities to enhance/provide the following facilities for the local population:<br>• additional recreational open space<br>• opportunities for education<br>• enhanced levels of landscape maintenance<br>• improved visual impact (through integration of SUDS with local topography and site layout)<br>• water features (including water bodies and conveyance channels).<br>It should be noted that education campaigns can exert significant influence on community acceptance of sustainable drainage schemes (see Chapter 24 for additional details). |
| 3. Cost | Construction and maintenance costs can vary widely between techniques and the long term costs of SUDS should be considered at an early stage. In selecting a design from a series of options, both capital and operational costs should be considered using a whole life costing approach (see Chapter 25 for details), and a cost-benefit analysis carried out. Benefits could include water quality, amenity and ecology improvements. |
| 4. Public safety | Good design and education can help overcome concerns about safety (see Chapter 24). All drainage techniques have advantages and risks, and a balance must be struck. For example, culverts are confined spaces, whereas swales have sloping sides. The safest technique will depend on the site itself. Access to a water feature might be encouraged for education and recreation, and measures taken at particular areas to ensure this is safe. In other areas, access could be discouraged by the use of barrier planting, notices or low permanent fencing. Barrier planting has advantages over fencing as it has visual and wildlife value as well as being more of a deterrent than a challenge to unwanted visitors. Safety reviews should always be undertaken where open water systems are implemented. However, the risks associated with open water features can be minimised by community engagement and careful design – for example the use of shallow planted margins. It is recommended that RoSPA is consulted if there are specific safety concerns. |
| 5. Habitat creation | SUDS can improve wildlife habitat. Ponds and wetlands offer the greatest opportunity, with aquatic and emergent vegetation providing a habitat for fish, insects, amphibians, reptiles, birds and mammals. Grassed surfaces in filter strips, swales and infiltration basins can be integrated into general landscaping, and can be used to create green corridors, linking to wildlife habitats elsewhere. Design of SUDS should try to maximise the species diversity; local grasses, flowers and wetland vegetation should always be used and invasive species avoided. Ecological benefits are maximised where SUDS features are sited in proximity to undisturbed, natural areas or where links to these are created. |

*Table D.8 Influence of community and environmental factors on SuDS selection (Table 5.8 of CIRIA C697)*

| SUDS Group | Technique | Maintenance | Community acceptability | Cost | Habitat creation potential |
|---|---|---|---|---|---|
| Retention | Retention pond | M | H* | M | H |
| | Subsurface storage | L | H | M | L |
| Wetland | Shallow wetland | H | H* | H | H |
| | Extended detention wetland | H | H* | H | H |
| | Pond/wetland | H | H* | H | H |
| | Pocket wetland | H | M* | H | H |
| | Submerged gravel wetland | M | L | H | M |
| | Wetland channel | H | H* | H | H |
| Infiltration | Infiltration trench | L | M | L | L |
| | Infiltration basin | M | H* | L | M |
| | Soakaway | L | M | M | L |
| Filtration | Surface sand filter | M | L | H | M |
| | Sub-surface sand filter | M | L | H | L |
| | Perimeter sand filter | M | L | H | L |
| | Bioretention/filter strips | H | H | M | H |
| | Filter trench | M | M | M | L |
| Detention | Detention basin | L | H* | L | M |
| Open channels | Conveyance swale | L | M* | L | M |
| | Enhanced dry swale | L | M* | M | M |
| | Enhanced wet swale | M | M* | M | H |
| Source control | Green roof | H | H | H | H |
| | Rainwater harvesting | H | M* | H | L |
| | Permeable pavement | M | M | M | L |

H: high
M: medium
L: low

* there may be some public safety concerns associated with open water that require addressing at design stage

*Table D.9 Community and environmental factors selection matrix (Table 5.9 of CIRIA C697)*