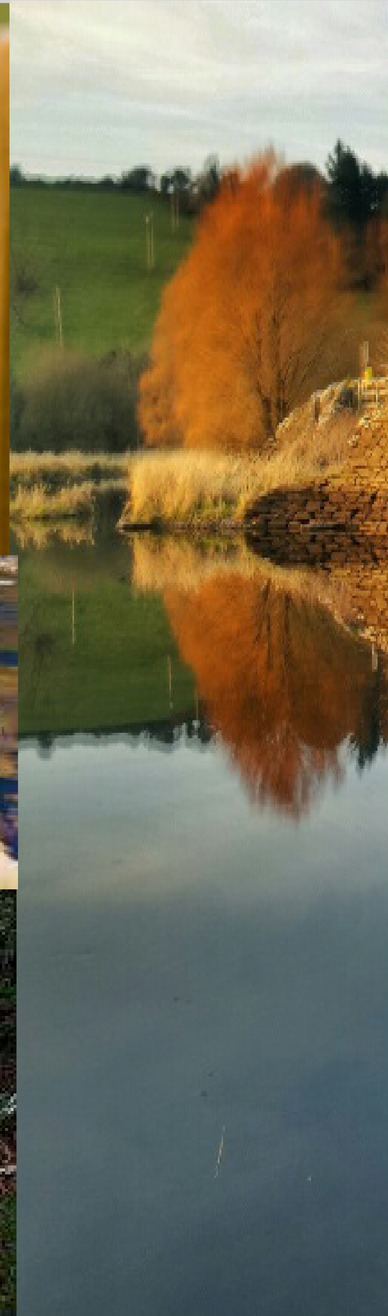
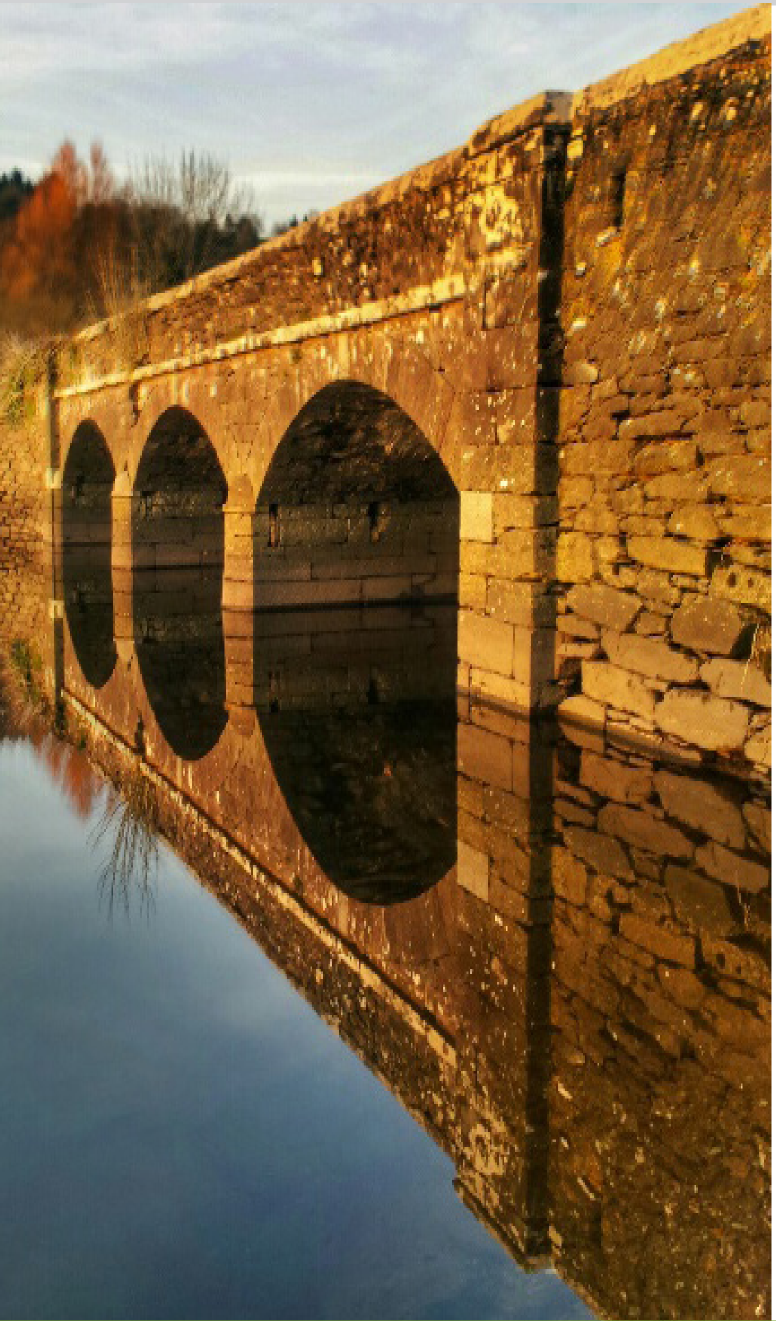
Barnhill Stormwater Management Plan

February 2019

Appendix 4

CONTENT

Barnhill Stormwater Management Plan

EXECUTIVE SUMMARY

Background

- This Stormwater Management Plan (SWMP) sets out methods that can be employed by developers within the Barnhill Local Area Plan Boundary to ensure sustainable management of stormwater.

- The main sources of stormwater were examined using a detailed watershed analysis using LiDAR survey data.

- The watershed analysis found that no significant surface water enters the study area from outside the site boundary.

Overland Flow Model

- An Overland Flow Model was developed to assess surface water runoff from within the LAP site boundary.

- The model results indicate that the main overland flow path on the site is along the line of the Barnhill stream and that runoff for most of the site drains to this stream.

Proposed SUDS Measures

Any development on the Study Area will require Sustainable Urban Drainage Systems (SUDS) to manage surface water runoff. The type of SUDS measures will depend on local ground conditions and topography. The recommended SUDS measures are as follows:

Roofs
- Rainwater butts at individual house level;
- Rainwater harvesting or the use of green roofs/ blue roofs and green walls to be provided for commercial/ large-scale buildings;
- Soakaways at individual house level if infiltration rates are suitable.

Roads, Hardstanding and Parking Areas
- Permeable paving or porous asphaltic paving;
- Bio-retention areas/ rain gardens;
- Tree pits;
- Infiltration trenches if infiltration rates permit;
- Swales and filter drains.

Site Control - Water Quantity
- Provision of retention or detention basin(s) for the site, located outside the floodplain, to attenuate peak flows from individual sub-catchments up to the 100 year design storm event;
- Use of the basin(s) as recreational areas in dry conditions where possible.

Regional Control - Water Quality
- Provision of a constructed wetland or pond in the location of the flood plain to provide water quality and ecological benefits for the overall catchment;
- Discharge of peak storm flows from the overall catchment to the existing Barnhill stream at 2l/s/ha or Qbar, whichever is the greater.

Key Recommendations

- Developers within the Barnhill LAP catchment should implement SUDS measures in line with the recommendations of this report to suit individual site layouts and local ground conditions.

- Design of SUDS Systems should be in accordance with the Grater Dublin Strategic Drainage Study (GDSDS) and the CIRIA SUDS Manual.

- SUDS measures should be located outside the predicted flood plain so that they can operate during extreme storm events. However, a constructed wetland or pond should be provided within the flood plain as a regional control to provide water quality and ecological benefits for the overall Barnhill LAP catchment.

- SUDS measures should be implemented in a management train, in that, where possible, surface water should be managed locally in small sub-catchments rather than being conveyed to and managed in large systems further down the catchment.

SECTION 1

Introduction

1. INTRODUCTION

1.1 Background

Fingal County Council has prepared a Local Area Plan (LAP) for Barnhill (lands south of the Dublin-Dunboyne Rail Line) in order to provide a statutory framework for the proper planning and sustainable development of a tract of 45.64 hectares of undeveloped land zoned Objective 'RA' Residential Area with the objective to– 'Provide for new residential communities in accordance with approved local area plans and subject to the provision of the necessary social and physical infrastructure.'

The Fingal Development Plan 2017-2023 includes important quality of life initiatives such as the Green Infrastructure Strategy and an emphasis on high quality design. The Barnhill LAP will enable these principles to be included with a strong emphasis on quality of life aspects such as neighbourhoods that support thriving communities, recreational spaces, new linkages and biodiversity. The LAP development is guided by a wide range of considerations, such as public and stakeholders consultation, key issues and needs identified by local communities and business, employment activities and opportunities, services and infrastructure, heritage and environmental issues, statutory requirements, flood risk assessment, sustainable urban development etc.

This Stormwater Management Plan (SWMP) has therefore been undertaken by Fingal County Council to ensure that sustainable stormwater management is incorporated into the Barnhill LAP. This SWMP has been prepared in accordance with national policy documents including "The Planning System and Flood Risk Management –Guidelines for Planning Authorities (OPW/DoEHLG, 2009)", the Greater Dublin Strategic Drainage Study (2005) and the CIRIA SUDS Manual (CIRIA, 2015).

1.2 Objectives of the SWMP

The Greater Dublin Strategic Drainage Study (Volume 3) contains a recommendation that “Planning and drainage authorities make the....provision of stormwater management plans a requirement of the planning approval and taking in charge process.”

A Stormwater Management Plan is a document that addresses urban and rural stormwater from a management perspective, rather than an individual development perspective, to ensure that the economic, ecological and social/ cultural values of the area are protected and enhanced and that management issues are addressed in a coordinated manner.

Stormwater Management Plans (SWMPs) are a way of helping developers/ catchment managers to recognise the impacts of activities within their site boundaries and to develop best practice management strategies to manage storm water in a sustainable way.

This Stormwater Management Plan for Barnhill is not a specific prescription for managing urban stormwater within the LAP area but describes methods and techniques that can be tailored within the study area to take account of the site specific layouts and ground conditions.

With the above objectives in mind, the key aims of this Barnhill SWMP are therefor to;

- Consider the main sources of surface water in the Study Area.
- Consider the ground conditions and topography in the Study Area and produce recommendations as to how to manage storm runoff.
- Examine the advantages and disadvantages of various SUDS systems.
- Prepare recommendations in relation to the type of SUDS systems which are appropriate for use in the Barnhill LAP catchment including preferable locations for SUDS regional controls.
- Prepare recommendations on requirements for the future design of SUDS systems.
- Assess and report on any submissions received as part of the public consultation process.

SECTION 2

Barnhill Area Stormwater Analysis

2. BARNHILL AREA STORMWATER ANALYSIS

2.1 Introduction

The Barnhill LAP site is located circa 3km from Blanchardstown Town Centre, 4.1km from Blanchardstown Main Street and 12.4 km from O'Connell Street, Dublin. It is situated directly south of Hansfield Rail Station and the Dunboyne to Clonsilla Rail Line, to the west of the Royal Canal and the Dublin-Maynooth Railway Line, to the east of the R149 road. The lands are flat, in agricultural use and characterised by field boundaries comprised of hedging and native tree species. The site location is shown in Figure 2.1 below.

Figure 2.1 Site Location

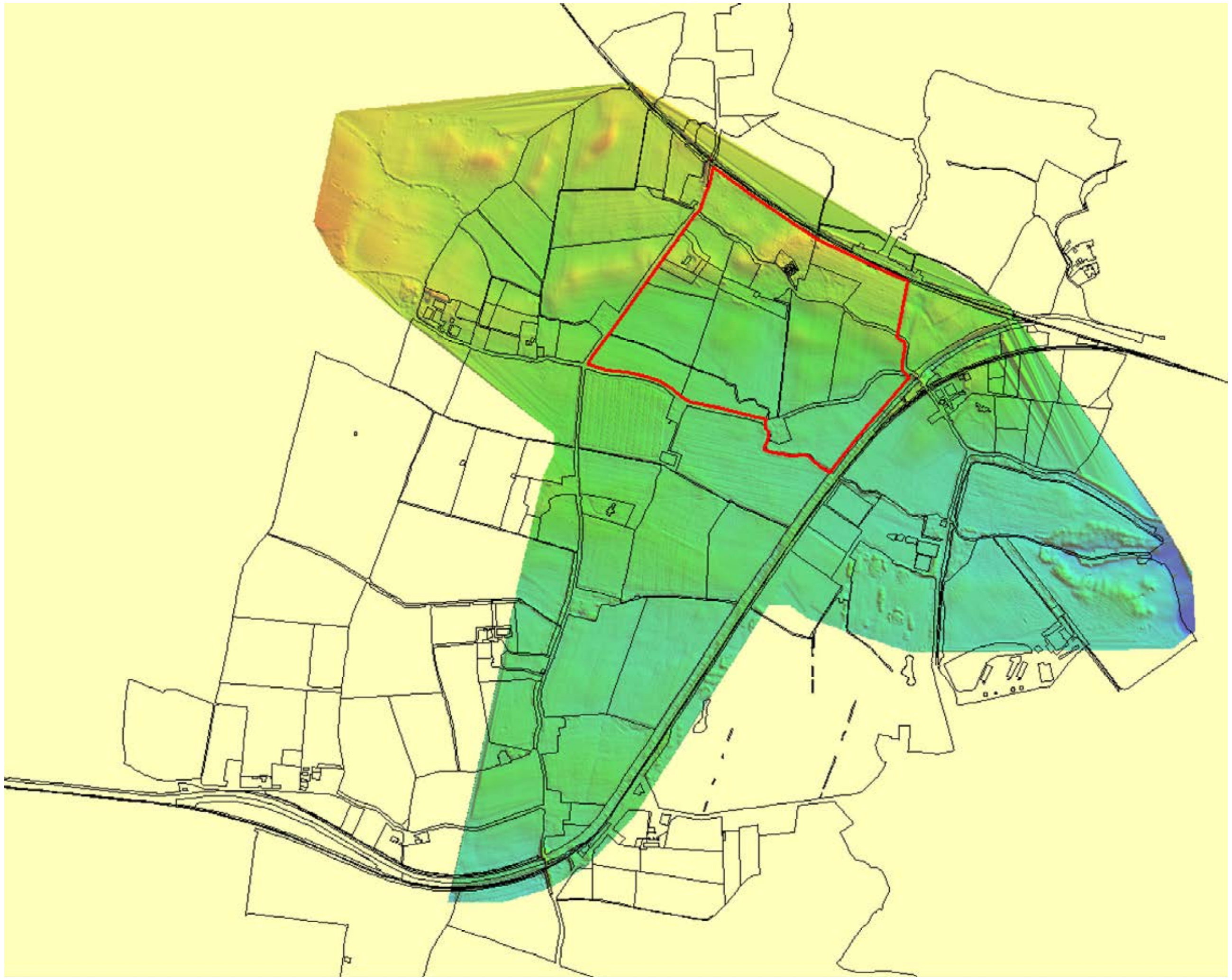


Figure 2.2 Site Boundary

2.2 Site Descrpition

The plan area of the subject site is approximately 45.64ha (hectares).

The site is bordered to the north by a railway line, to the west by a local access road, to the south by a local access road and open fields, and to the east by Royal Canal and a railway line.

The site largely consists of arable land with a farm located within the northern part and a cottage within the southern part.

An unnamed stream (referred to as the Barnhill Stream in this report for ease of reference) enters the site from the west under a local access road, runs in an open channel in a south-easterly direction through the site before entering a long culvert under the Royal Canal and railway at the eastern boundary of the site. Downstream of the railway, the stream continues to flow, in a south-easterly direction towards the River Liffey.

The unnamed stream enters the site, from the west, through three culverts; a 1.2m wide arch culvert and twin 600mm pipes located at a slightly higher level, Photo 2.3.1. The open channel of the stream in this area measures about 3m in width and 2m in depth. The stream enters a 1.2m diameter culvert and then a 1.7m wide arch culvert under the local road close to the southern boundary of the site, (Photo 2.3.2). Further downstream, it enters a long culvert under the canal and railway. The size of this culvert is believed to be 1m in diameter.

It was not possible to access the inlet of the long culvert during site walkover, due to the presence of dense vegetation, (Photo 2.3.3). However, the culvert inlet appeared to be submerged at the time of the visit, although flows in the stream were not particularly high. Downstream of the railway, the stream enters an arch culvert under local access road, Photo 2.3.4.

A Digital Terrain Model (DTM) was produced from a topographical survey of the site and surrounding areas shown shaded in Figure 2.2. The data appear to give a reasonable representation of the existing ground profile and was considered suitable for the purposes of the current assessment. Level contours based on the model are shown in Figure 2.3. Ground level within the site varies between 61m AOD in the north to 56m AOD in the south and 59m AOD in the north-east to 60m AOD in the south-west. There is an elevated area within the northern part of the site where ground levels rise to 63m AOD.

With the exception of a small northern section of the site, surface water runoff from the site drains to the Barnhill stream.

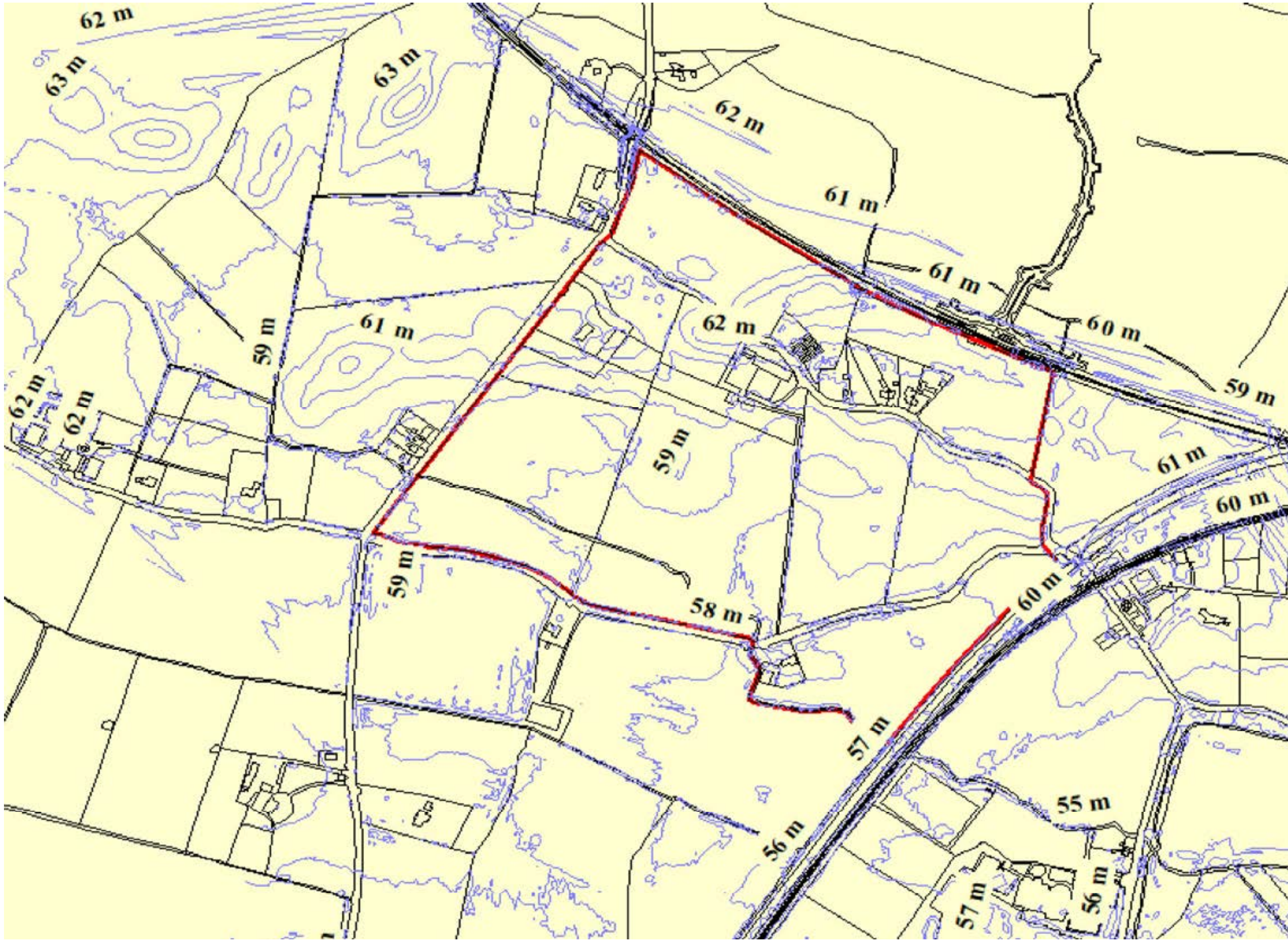


Figure 2.3 Topography based on topographic survey

Photo 2.3.1 Three culverts under the road at western boundary

Photo 2.3.2 Arch culvert under the local access road near southern boundary

Photo 3.3.3 Upstream of canal and railway culvert

Photo 3.3.4 Downstream culvert under canal and railway

2.3 Sources of Surface Water Runoff

Surface water runoff which could affect or could be affected by the proposed development can be considered in two broad categories as follow:

1. Surface water which is generated from outside the development site boundaries and which can flow towards the development site; and

2. Surface water which is generated from within the boundaries of the development site.

Surface water runoff generated from outside the site boundaries on higher land can flow towards the site, enter the site and increase the flooding risk to proposed developments. Such flows will either need to be safely routed through the development site or intercepted at the site boundary and directed to a suitable sink without affecting any properties within the development site and without increasing the risk to properties outside the site boundaries.

Surface water runoff generated within the site will need to be managed within the site drainage system. There are two parts to surface water runoff generated from within the site boundaries; those generated from hard standing areas (i.e. roofs, driveways, roads, paved areas, etc.) and those generated from soft landscaped areas.

Surface water generated from hardstanding areas is collected within the development drainage system and attenuated. Any discharges made to watercourses are limited to the greenfield runoff rate.

Surface water generated from soft landscaped areas either inflitrates into the ground or flows onto roads and enters the site drainage system.

2.4 Assessment of Surface Water Entering Study Area from Outside

A watershed analysis was carried out using available LiDAR DTM and the results are shown in Figure 2.4. This indicates that:

- Any surface water that could flow towards the site from the north would be intercepted by the railway line. Therefore, no surface water would enter the site from the north.

- Land to the east is lower than the Barnhill Site and no surface water runoff would enter the site from the east. In any case, the Royal Canal and railway would intercept any surface water to/from the east.

- The land to the south-west is generally at a higher level than the Barnhill Site, but it slopes in an easterly, south-easterly direction towards the canal and the railway, as shown by the predicted overland flow paths in Figure 2.4. Surface water runoff from this area would run east, south-east towards the canal and railway. Therefore, no significant volumes of surface water would enter the site from the south.

- The land to the west is higher than the site. However, immediately to the west of the site, the land slopes in a south-west direction away from the site (as shown by flow paths in Figure 2.4). Any surface water entering the site from the west would be through the point where the stream enters the site. Such flows are included in the stream flow. Therefore, no significant surface water runoff would enter the site from the west.

In summary, no significant surface water runoff would enter the study area from outside the site boundaries.

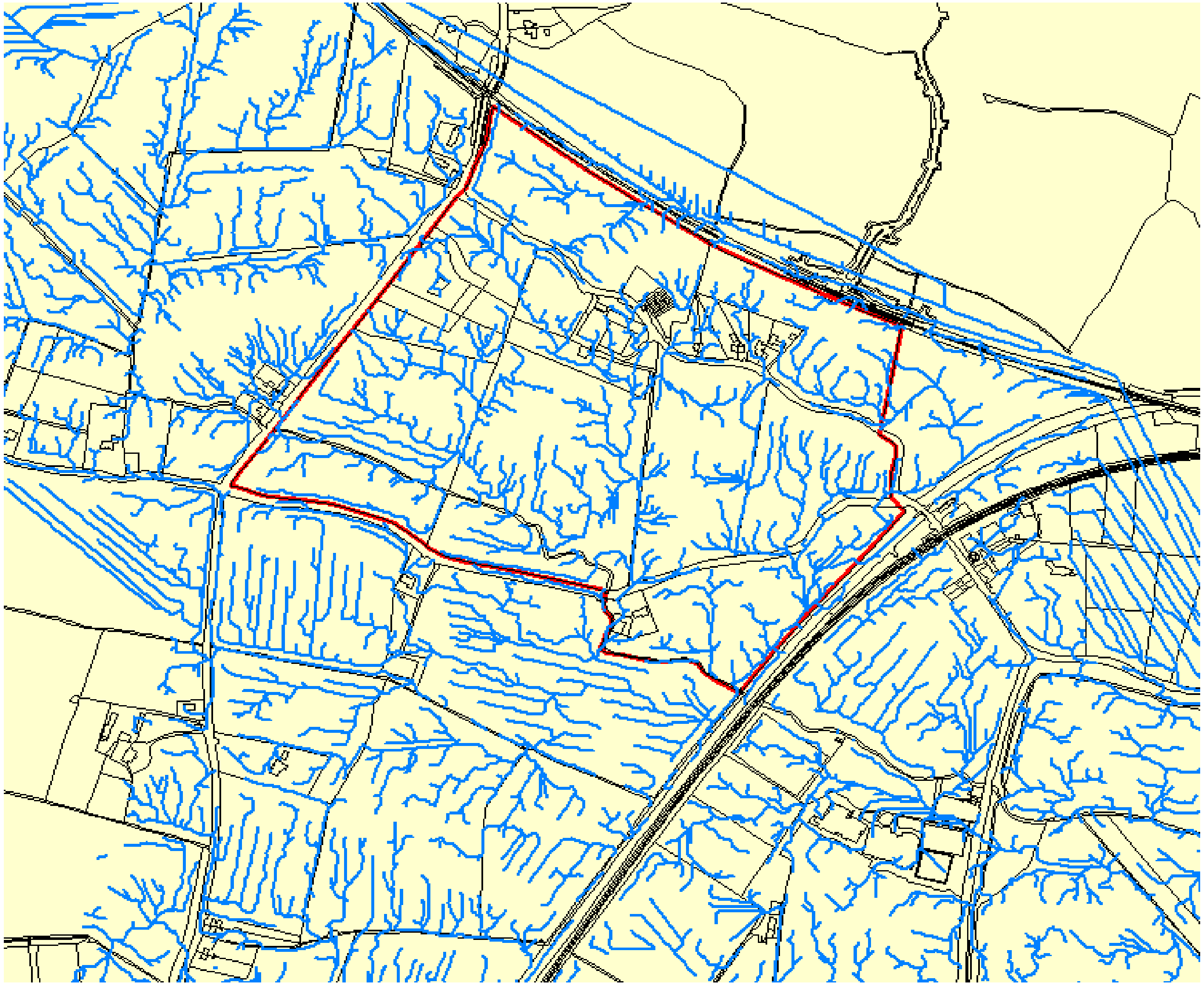


Figure 2.4 Watershed analysis showing indicative overland flow paths

2.5 Assessment of Surface Water Generated from within the Study Area

Flow paths within the site shown in Figure 2.4 indicate that surface water runoff from the entire site, with the exception of a small area at the northern tip of the site, drains to the stream. This small area which measures about 3.5ha drains north towards the railway and into the railway drainage system. Post development surface water runoff from this area should be included in the site drainage system, with discharge to the stream attenuated to the greenfield runoff rate corresponding to 96.5% of the site (i.e. the part of the site directly draining to the stream at present).

In addition to the watershed analysis outlined above, an overland flow model was also developed to assess surface water runoff. This was based on a 2D overland flow model covering the available LiDAR extent, indicated shaded in Figure 2.5.

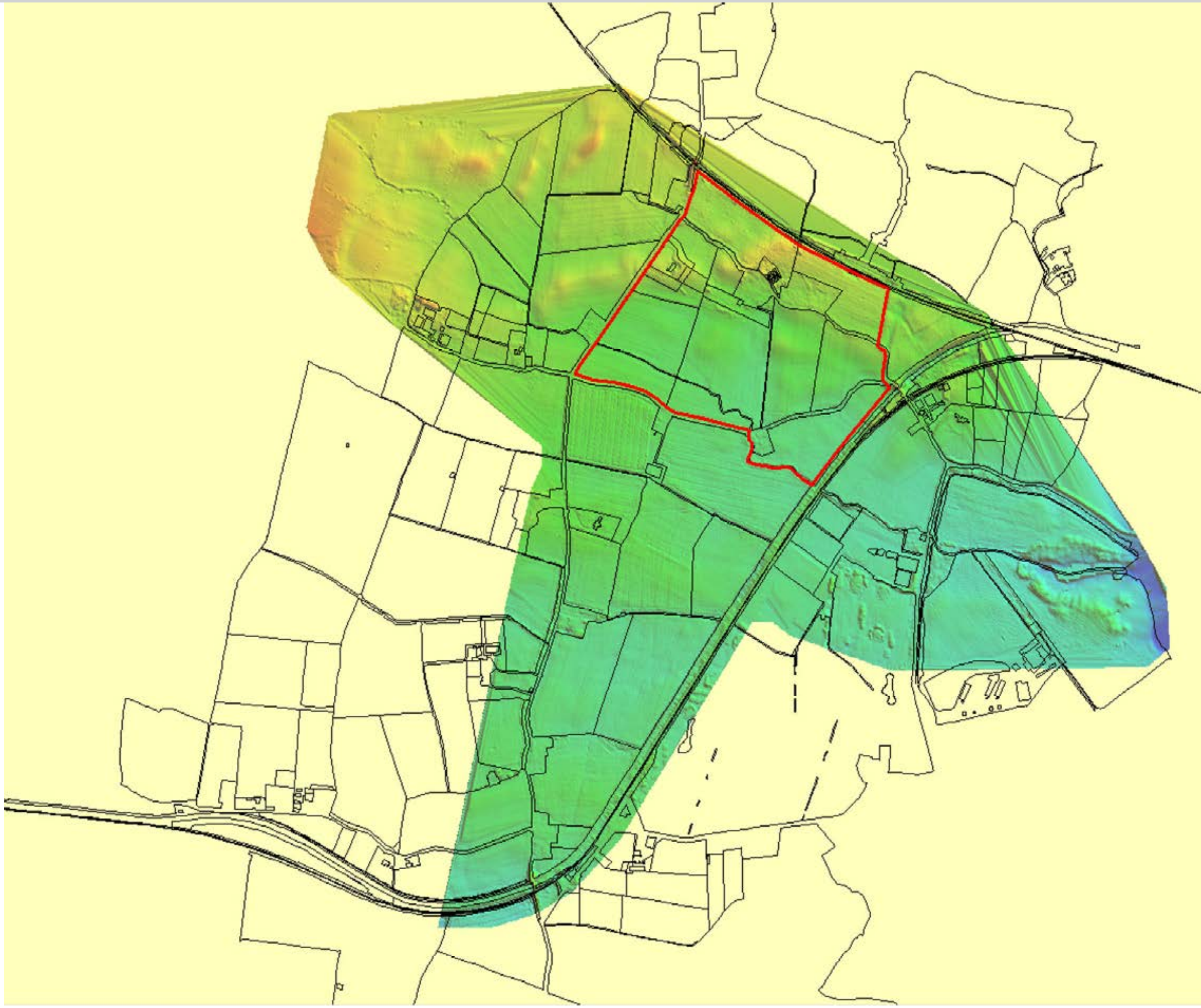


Figure 2.5 LiDAR coverage (shaded area) and development site boundary (red)

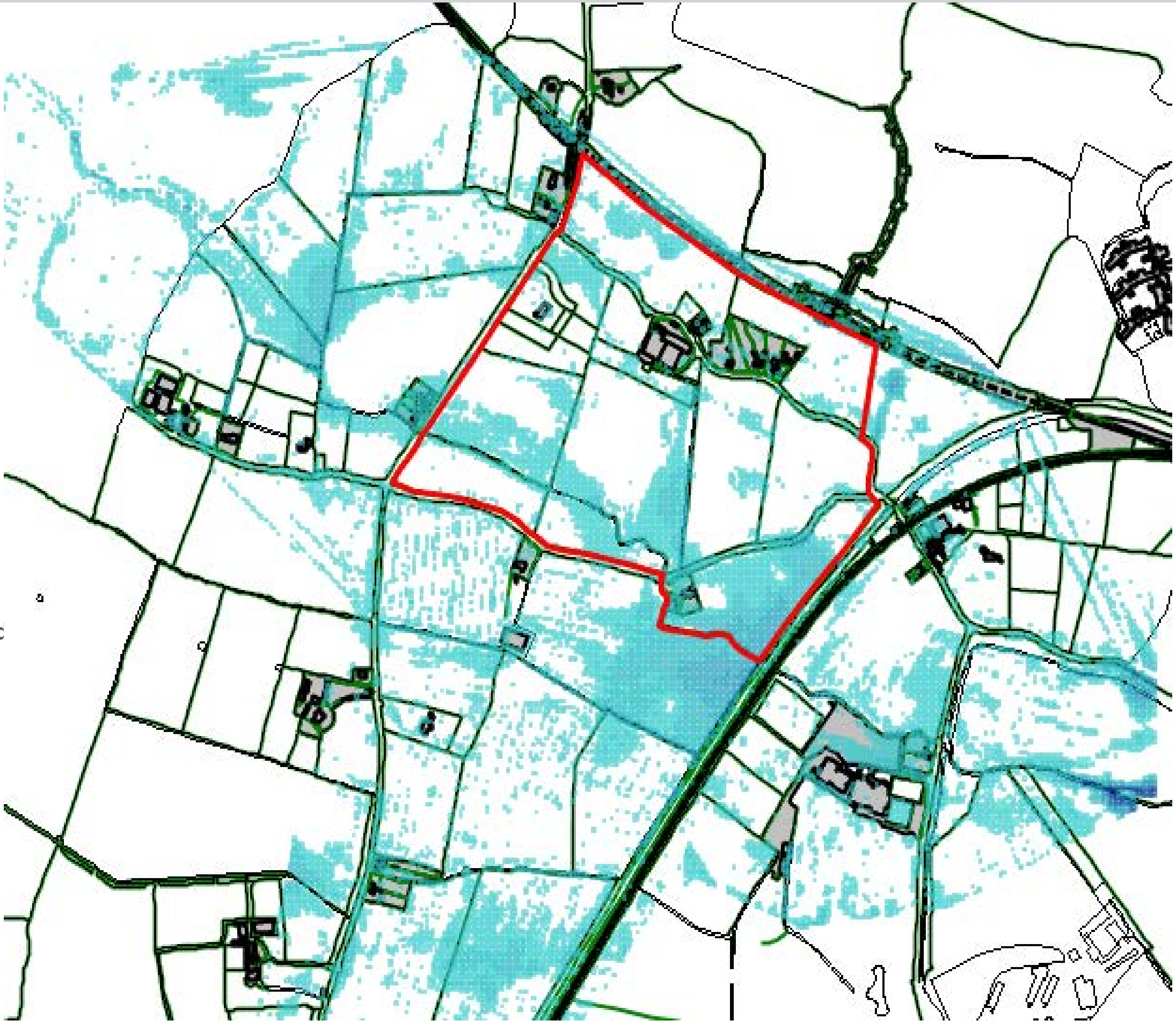


Figure 2.6 Overland flow modelling

The model is based on the Flood Modeller software package. A regular grid size of 5m was used with a time step of 1 second and global roughness (Manning's n) value of 0.07.

A uniform rainfall profile was applied to the model domain. This was derived from the OPW FSU Web Portal. In this particular case a 200 year rainfall, a summer profile and a 3 hour storm was assumed. Other storm profiles and durations indicate similar results with larger/smaller flood extent, depending on duration.

The model results are shown in Figure 2.6. The results are similar to the watershed analysis and indicate that the main overland flow path into the site is along the line of the stream and that runoff from most of the site drains to the stream. The model assumes the culvert under the Royal Canal and railway being completely blocked. Therefore, water ponds in the low-lying area, similar to fluvial flooding. In practice, rain water would not pond in this area unless fluvial flows exceed the capacity of the culvert, which was estimated to be approximately 1.5m^3/s before flood waters back up and pond upstream of the culvert. This is equivalent to a peak flow of the order of 1 in 5 year return period. However, with blockage, the culvert would back up more frequently. Based on this, assuming complete blockage of the culvert, Figures 2.6 provides a reasonable representation of the flood plain.

The Strategic Flood Risk Assessment undertaken for the development site and reported on separately indicated that large areas within the low-lying southern part of the site are at risk of flooding. The predicted floodplains for the 100 and 1000 year flows are shown in Figure 2.7a & 2.7b. These flood maps include the proposed road.

The development will require the application of sustainable urban drainage systems (SUDS) as discussed further in Chapter 3. It is good practice to locate SuDS measures outside the predicted floodplain, so that the measures can operate during extreme events and so that the risk of pollution of the watercourse is not increased. It is therefore suggested that any SUDS ponds or basins are located outside the flood plans shown in Figure 2.7 (a and b).

The use of an appropriate storm water collection network system will address the pluvial risk to LAP area extents.

Figure 2.7a Predicted flood extent for 100 and 1000 year flows with proposed road in place
a: 100 year flood extent with proposed road in place

Figure 2.7b Predicted flood extent for 100 and 1000 year flows with proposed road in place
b: 1000 year flood extent with proposed road in place

SECTION 3

Sustiable Urban Drainage System

3. SUSTAINABLE URBAN DRAINAGE SYSTEMS

3.1 SUDS Objectives and Guidance

Sustainable Drainage Systems (SUDS) are storm water drainage systems that are designed to replicate natural drainage systems. The three main objectives of implementing SUDS on a development site are to:

- minimize the quantity/ volume of run off;
- maximize the quality of run off;
- maximize amenity and biodiversity opportunities.

The following guidance documents are used in the design of SUDS systems for development;

- Greater Dublin Strategic Drainage Study (2005)
- CIRIA Suds Manual 2015 (Latest)
- BRE Digest 365 2016
- Individual Local Authority Guidance if available
- TII Design Guidance (For National Roads)

In order to enable a SuDS design to be undertaken an understanding of the ground conditions on the site and an estimation of the storm water runoff from the proposed development is required. A detailed site investigation to determine the infiltration capacity of the soils within the development area is therefore recommended.

3.2 Volume Control

Several techniques can be implemented to control the quantity/ volume of runoff from a development. Each technique presents different opportunities for stormwater control, flood risk management, water conservation and groundwater recharge, as follows;

1. **Evapotranspiration**
    - Replicates the natural hydrological process by transferring surface water from the land to the atmosphere through evaporation and transpiration from plants;
    - Reduces the amount of surface water transferred downstream.

2. **Infiltration**
    - Process by which surface water directly enters the soil.
    - Replicates the natural hydrologic process
    - The key issues which typically limit the potential for infiltration are;
        - Presence of shallow rock or karstic bedrock; High groundwater table;
        - Presence of clay or silts which have low permeability.

3. **Attenuation**
    - Slows down surface water flows before discharge downstream;
    - Usually achieved through the use of a storage volume and a constrained outlet;
    - Reduces peak flow rate but the total volume of runoff remains the same.

4. **Rainwater Harvesting/ Re-use**
   - Direct capture and reuse for domestic or landscaping purposes;
   - Contribution to quantity control depends on scale of system proposed.

The CIRIA SUDS manual and the GDSDS state that there should be no runoff discharged outside the development site for frequent rainfall (low return period events). This is known as "interception" and the GDSDS states that "Interception storage of at least 5mm, and preferably 10mm, of rainfall where runoff to the receiving water can be prevented". GDSDS also states that "Where initial runoff from at least 5mm of rainfall cannot be intercepted, treatment of runoff (treatment volume) is required. Retention pond (if used) to have minimum pool volume equivalent to 15mm rainfall."

To achieve the objective of interception the following types of SUDS systems are typically employed;

- Green roofs (allow for evaporation, evapotranspiration and attenuation)
- Permeable paving (allow for infiltration and attenuation of flows);
- Rain gardens (allow for evapotranspiration and infiltration);
- Infiltration trenches (allow for infiltration);
- Soakways (allow for infiltration).

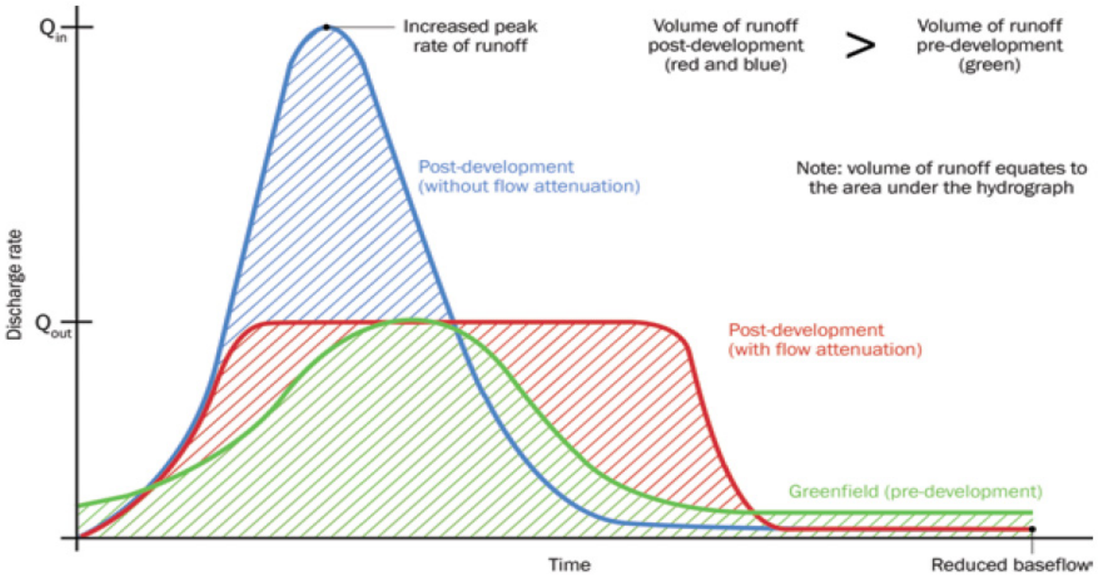


Figure 3.1 Example of a runoff hydrograph for a storm event (Source: www.ciria.org)

In addition to interception, the various SUDS guidance documents state that the volume of runoff discharged from a development should reflect the greenfield situation. To achieve this, the peak runoff discharged during extreme events (normally the 100yr return period design storm) is required to be controlled/ attenuated to ensure the post development peak flow does not exceed the pre development peak flow, as illustrated in Figure 3.1.

Most designers typically adopt the simplified approach to attenuation design for developments outlined in the CIRIA MANUAL/ GDSDS, as follows;

- Design the SUDS system to cater for the 100 yr, 6 hour design rainfall event or analyze all "design" storm hydrographs for 100yr event to identify the critical design storm duration for design;
- Design the SUDS system such that peak runoff from the 100yr event is discharged at either 2l/s/ha or Qbar (the mean annual flood), whichever is greater;
- In Ireland, Qbar is typically calculated using the IH124 method, although it is advised that this method should not be applied on sites less than 50ha in area. For sites below this size, the rational method or other appropriate method should be used to estimate the mean annual flood from the development site.

To achieve attenuation of the 100 year design storm event a variety of SUDS methodologies are typically used.

An overview of each technique and the advantages and disadvantages of each is provided in Sections 3.5 to 3.8 hereafter.

3.3 Quality of Runoff

A number of natural water quality treatment processes are employed within SUDS design, including the following;

- Sedimentation – reducing flow velocities to allow sediment particles fall out of suspension;
- Filtration & Biofiltration – trapping pollutants within the soil or aggregate matrix, on plants or on geotextile layers;
- Adsorption – attachment or binding of pollutants to the surface of soil or aggregate particles;
- Biodegradation – degradation of organic pollutants such as oils and grease;
- Volatilization – transfer of a compound from solution in water to the atmosphere;
- Nitrification – Ammonia/ ammonium ions can be oxidised by bacteria in the ground to form nitrate which readily used as a nutrient by plants;
- Photolysis – The breakdown of organic pollutants by exposure to ultraviolet light.

The level of treatment provided is dependent on the design of the SUDS system proposed, and is further described in Section 3.6.

3.4 Amenity & Biodiversity Process

SuDS systems provide opportunities to create attractive landscaping features which offer a variety of amenity, biodiversity and recreational benefits. The following are the main SUDS components offering aesthetic, amenity and ecological benefits;

- Tree Pits
- Green Roofs
- Bioretention Areas
- Ponds
- Constructed Wetlands

These are discussed further in the following section.

3.5 Proposed SuDS Strategy

3.5.1 Management Train

In order to replicate the natural drainage system and to achieve the objectives outlined above, a SUDS 'Management Train' is recommended. The SUDS Management Train is a hierarchy of SUDS techniques which should be implemented in series to achieve the following aims:

- Prevention – reduce peak runoff and pollution;
- Source Control – control runoff at or close to the source thereof;
- Site Control – manage surface water within the development site;
- Regional Control – management of surface water from a number of sites.

Various SUDS components have different capabilities that are more suited to certain stages of the Management Train outlined above. The principle of the Management Train is that wherever possible, surface water should be managed locally in small, sub-catchments rather than being conveyed to and managed in large systems further down the catchment.

The Barnhill LAP area is a gently sloping catchment falling to a stream to the south. Due to its suitable topography, without the presence of any steep slopes or overland features, a wide variety of SUDS mesures can easily be incorporated in each sub-catchment to suit the layout and localised ground conditions.

3.6 Source Controls

3.6.1 Rainwater Butts

Water Butts are small, offline storage "barrels" designed to collect runoff from roofs. They are the most common means of harvesting rainwater and have a typical capacity of less than 0.5m^3. An example of a typical installation is provided in Photo 3.6.1.

Table 3.6.1 Advantages and disadvantages of Rainwater Butts

Advantages	Disadvantages
Cheap and easy to install	Risk of blockage
Provides water for non-potable means, usually garden use	No guarantee that water will be used by residents, especially where water charges do not apply
Suitable for all developments	

Photo 3.6.1 Rainwater Butts (Source: www. Evengreener.com)

3.6.2 Rainwater Harvesting

Rainwater harvesting involves collection of rainwater from roofs and hard surfaces on a much larger scale. Collected water is typically used for non-potable purposes such as irrigation, flushing toilets and washing machines (known as grey water). The size of the harvesting tank depends on catchment area, seasonal rainfall pattern, demand pattern and retention time.

Table 3.6.2 Advantages and disadvantages of rainwater harvesting

Advantages	Disadvantages
Reduced demand on mains water	Potential health risks if not adequately maintained
Typically provides savings on large commercial and educational premises which have high greywater demands	Can be expensive to install
Can provide source control of stormwater runoff	

Photo 3.6.2 Rainwater Harvesting Schematic (Source: www.techpreviiew.org)

3.6.3 Tree Pits

Tree pit systems are porous surfacing systems which are laid around the base of trees in urban areas and replace metal grids and other systems. These porous systems allow water, air and nutrients to reach the tree roots and thereby use evapotranspiration process to reduce storm water runoff. They are designed to take water from adjacent impermeable or landscaped areas.

Table 3.6.3 Advantages and disadvantages of tree pits

Advantages	Disadvantages
Peak flow reduction used	Ongoing maintenance required
Rainwater for tree growth	
Increased amenity value	

Photo 3.6.3 Tree Pit
(Source: www.waterpave.com.au)

3.6.4 Permeable Pavements

Permeable pavements allow rainwater infiltrate through the surface and into the underlying layers where it subsequently infiltrates to the ground and/or is collected and conveyed to the drainage network. Permeable block paving is most suitable for areas with light traffic loads, whereas porous asphaltic surfaces can be used for higher traffic loads (see Photo 3.6.4). The pavement generally caters for rainwater which lands directly on its surface but in certain cases, can accept runoff from other impermeable areas.

Table 3.6.4 Advantages and disadvantages of permeable paving

Advantages	Disadvantages
Peak flow reduction	Risk of long term clogging and weed growth if not maintained
Effective in removing urban runoff pollutants	No biodiversity benefits
No additional land space requirements	
Low maintenance costs	

Photo 3.6.4 Example of a Porous Ssphaltic Surface (Duraflow ® System) at Luas Park and Ride (Source www.roadstone.ie)

3.6.5 Green Roofs

Green Roofs involve covering the roof of a building with vegetation laid over a drainage layer. They are designed to intercept and retain precipitation and therefore reduce surface water runoff, with evapotranspiration also assisting in this regard. They are particularly suited to flat or gently sloping roofs on large-scale buildings.

Table 3.6.5 Advantages and disadvantages of green roofs

Advantages	Disadvantages
No additional land take	Higher cost than conventional roof drainage system
Ecological and aesthetic benefits	Maintenance of roof vegetation required
Removal of atmospherically deposited pollutants	
Provides additional insulation - reduces energy costs	

Photo 3.6.5 A Green Roof in Ireland (Source: www.landtechsoils.ie)

3.6.6 Blue Roofs

A blue roof is a roof that is designed to store larger volumes of rainfall runoff. The water can be used for irrigation or other non-potable uses, or simply stored and discharged at a regulated rate fo the downstream collection network. They typically have had limited usage in Ireland due to their limited cost benefit. They are mostly used in highly urbanised areas where the cost of installation can be justified.

Table 3.6.6 Advantages and disadvantages of blue roofs

Advantages	Disadvantages
Use of large roof areas for storage - rainwater	Cost of installation
Reuse of water for non-potable uses	No biodiversity benefits
Reduced land take	Danger of leaks
BREAM	Increased structural costs

Photo 3.6.6 Blue Roof
(Source: www.wc3design.com)

3.6.7 Infiltration Trenches/ Soakaways

Infiltration trenches and soakaways are excavations that are filled with a void-forming material, typically rubble or stone, that allows temporary storage of water before it soaks into the ground. Soakways are typically used for individual dwellings and smaller paved areas, whereas for larger areas, infiltration trenches may be used. Infiltration trenches are essentially long narrow soakways which allow water to exfiltrate into the surrounding soils from the bottom and sides of the trench, thereby providing increased capacity. Many soakaways/ infiltration trenches for large developments are now constructed with geocelluar units which provide good overall storage capacity compared to stone fill (CIRIA, 2016). Their usage is limited to sites where the soils are suitable.

Table 3.6.7 Advantages and disadvantages of infiltration trenches/ soakaways

Advantages	Disadvantages
Infiltration can significantly reduce both runoff rates and volumes	Limited to relatively small catchments
Infiltration provides a significant reduction in the pollutant load discharged to receiving body	High historic failure rate due to poor maintenance, wrong siting or high debris input
Can be incorporated easily into site landscaping and fits well beside roads	

Photo 3.6.7 Infiltration trenches/ soakaways (source; www.sudswales.com)

3.6.8 Green Walls

Green Walls are walls that have plants growing on, or integrated within them, providing a living and self-regenerating cladding system. They are designed to intercept and retain precipitation and therefore reduce surface water runoff through evapotranspiration.

Table 3.6.8 Advantages and disadvantages of green walls

Advantages	Disadvantages
Can occupy much greater surface area than green roofs	Maintenance of vegetation required
High amenity & biodiversity benefits	Some climbers can impact structural integrity of the wall if roots penetrate small cracks
Improves thermal efficiency of building	
Good removal of atmospherically deposited pollutant	

Photo 3.6.8 Green wall on Department Store (source; www.livingwalls.ie)

3.6.9 Filter Drains

Filter drains are shallow excavations backfilled with granular material that create temporary subsurface storage for infiltration of stormwater runoff from road surfaces. Filter drains can contain a perforated pipe at the base to convey runoff to further downstream SUDS components.

Table 3.6.9 Advantages and disadvantages of filter drains

Advantages	Disadvantages
Can reduce runoff rates and volumes	High clogging potential – not suitable for sites with fine particle soils (silts / clays)
Significant reduction in pollutant load	Cost of replacing filter material should blockage occur
Easily incorporated into site landscaping	
Cost effective to install	

Photo 3.6.9 Filter Drain on M4 Motorway (Source: www.wikimedia.org)

3.7 Site Controls

3.7.1 Swales

Swales are broad, shallow, vegetated drainage channels which can be used to convey or store surface water. They are generally suited for small catchments and are typically provided along roadside verges. Swales can be designed for infiltration or detention and conveyance to another stage in the SUDS management train. Conveyance can be in the channel or in a perforated pipe within a filter bed below the base of the swale.

Table 3.7.1 Advantages and disadvantages of swales

Advantages	Disadvantages
Good removal of pollutants	Not suitable for steeply sloping sites
Easy to incorporate into landscaping	Lose their conveyance / infiltration capacity when not maintained
Peak flow reduction	Require management
Runoff volume reduction if infiltration is available	
Cost effective to construct	

Photo 3.7.1 Roadside Swale
(Source: wwtonline.co.uk)

3.7.2 Bioretention Areas/ Rain Gardens

Bioretention areas or “rain gardens” are small planted areas with stormwater controls that collect and treat stormwater runoff. The runoff is treated using soils and vegetation in shallow landscaped basins to remove pollutants. Treated runoff can be collected and conveyed further downstream and/or allowed to infiltrate into the subsoil. Part of the runoff volume is reduced by evapotranspiration from the plants/ trees.

Table 3.7.2 Advantages and disadvantages of bioretention areas/ rain gardens

Advantages	Disadvantages
Good removal of pollutants	Not suitable for steeply sloped areas
Runoff volume and peak flow reduction	Require landscaping and management
Aesthetic landscaping features	
Biodiversity benefits	

Photo 3.7.2 Bioretention Area/ Rain Garden (source: www.designingbuildings.co.uk)

3.7.3 Retention and Detention Basins

Retention and detention basins are open excavated areas that are used to retain stormwater runoff using flow control devices with infiltration to ground where possible. Detention basins are normally dry and often function as a recreational area, except during storm events. They may be constructed in such a way that surface runoff is routed through them during storm events with an outflow restriction (online), or such that runoff backs up in a network and then discharges to the basin during storm events (offline). Retention basins are 'wet' detention basins that include a permanent pool of water for water quality improvement.

Photo 3.7.3 Detention Basin (source: www.wrm.eu)

Table 3.7.3 Advantages and disadvantages of detention basins

Advantages	Disadvantages
Simple and cost effective to construct	Large area requirement
Can attenuate large event storms due to size	Retention basins have permanent pool of water so there may be perceived H&S risks
Potential for use as recreational areas	
Easy to maintain as mostly grassed areas with no planting	

Photo 3.7.3.1 Retention Basin (source: www. pennzsuppress.com)

3.7.4 Underground Attenuation Systems

Attenuation tanks are used to temporarily store stormwater for a period of time, normally until such time as the peak of a storm has passed. The water is then released to the sewer network at a controlled rate using a flow control device. There are a variety of different types of underground attenuation systems available, the most frequently used in Ireland being;

- Geocellular units;
- Concrete, GRP or other prefabricated tanks;
- Arched chambers laid in parallel (e.g. Photo 3.7.4 below)

It is the policy of Fingal County Council not to accept the use of undergound attenuation systems due to the lack of water quality, ecology and biodiversity benefits unless all other SUDS options are shown to be impractical.

Table 3.7.4 Advantages and disadvantages of underground attenuation tanks

Advantages	Disadvantages
Simple and cost effective to construct	No direct ecological or biodiversity benefits
Leaves open space above tanks free for other uses	No water quality benefits

Photo 3.7.4 A Triton™ Subsurface Attenuation System (source: www. http://terrafixgeo.com)

3.8 Regional Controls

3.8.1 Ponds and Wetlands

Ponds and wetlands are open basins which have a permanent depth of water and are generally recommended at the end of the SUDS Management Train (Regional level). Runoff which enters the pond/ wetland is detained and treated by settlement and biological uptake. Their primary objective is generally treatment, not attenuation.

Ponds should contain the following features to enhance biodiversity and improve water quality:

- Sediment Forebay – dependent on other SUDS techniques implemented upstream
- Permanent pool – a minimum volume of water (excluding losses due to infiltration and evaporation) remaining throughout the year to provide water quality treatment.
- Temporary Storage Volume – An additional storage volume within the pond to provide flood attenuation for design events.
- Aquatic Bench – A shallow zone around the perimeter of the pool to support wetland planting which provides biological treatment, ecology, amenity and safety benefits.

Table 3.8.1 Advantages and disadvantages of ponds and wetlands

Advantages	Disadvantages
Good removal of pollutants to improve water quality	High land take
Aesthetic and amenity benefits	May release nutrients during non-growing season
Can attenuate large event storms due to size	Requires baseflow
Ecological and biodiversity benefits	Perceived health and safety risks may require fencing and isolation of the pond
Limited maintenance requirements usually	

Photo 3.8.1 Dunhill Constructed Wetland, Co. Waterford (source: www.water.ie)

3.9 Recommended SUDS Measures for Barnhill LAP Area

The detailed design of any SUDS system proposed at development level shall be in accordance with the GDSDS and the CIRIA SUDS Manual 2015. Any proposed design shall be subject to detailed site investigation. The proposed design of the SUDS system, along with the overall Management Train proposals should be submitted with any planning application to Fingal County Council. The following are the recommended SUDS management measures to be implemented within the Barnhill LAP boundary;

Roofs

- Rainwater butts at individual house level;
- Rainwater harvesting or the use of green roofs/ blue roofs and green walls to be provided for commercial/ large-scale buildings;
- Soakaways at individual house level if infiltration rates are suitable.

Roads, Hardstanding and Parking Areas

- Permeable paving or porous asphaltic paving;
- Bio-retention areas/ rain gardens;
- Tree pits;
- Infiltration trenches if infiltration rates permit;
- Swales and filter drains.

Site Control - Water Quantity

- Provision of retention or detention basin(s) for the site, located outside the floodplain, to attenuate peak flows from individual catchments up to the 100 year design storm event;
- Use of the basin(s) as recreational areas in dry conditions where possible.

Regional Control - Water Quality

- Provision of a constructed wetland or pond in the location of the flood plain to provide water quality and ecological benefits for the overall catchment;
- Discharge of peak storm flows from the overall catchment to the existing Barnhill stream at 2l/s/ha or Qbar, whichever is the greater.

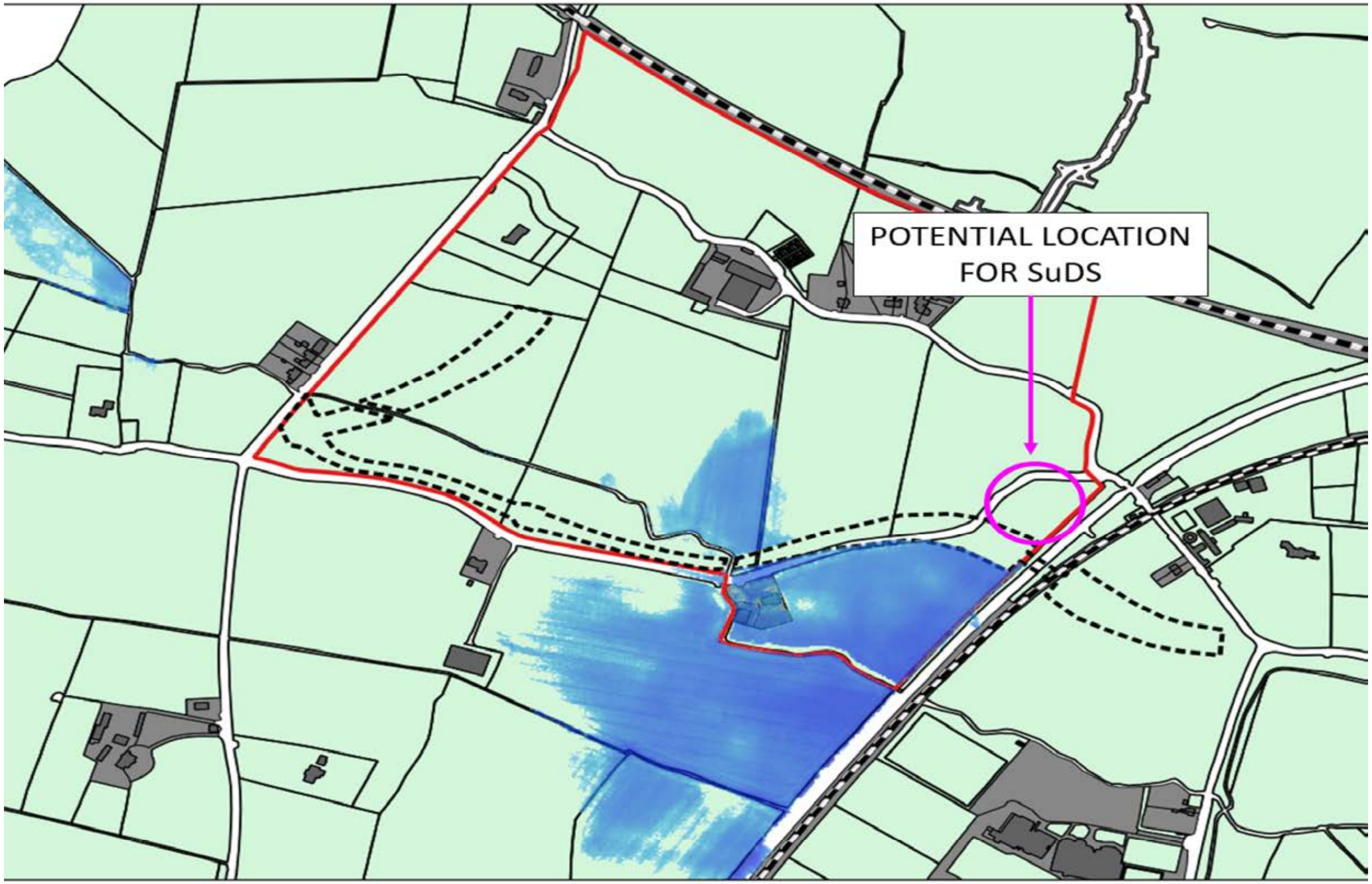


Figure 3.9 Location of possible SUDS measures

SECTION 4

Conclusions & Recommendations

CONCLUSIONS & RECOMMENDATIONS

Proposed SUDS Measures

Any development on the Study Area will require Sustainable Urban Drainage Systems (SUDS) to manage surface water runoff. The type of SUDS measures will depend on local ground conditions and topography. The recommended SUDS measures are as follows:

Roofs
- Rainwater butts at individual house level;
- Rainwater harvesting or the use of green roofs/ blue roofs and green walls to be provided for commercial/ large-scale buildings;
- Soakaways at individual house level if infiltration rates are suitable.

Roads, Hardstanding and Parking Areas
- Permeable paving or porous asphaltic paving;
- Bio-retention areas/ rain gardens;
- Tree pits;
- Infiltration trenches if infiltration rates permit;
- Swales and filter drains.

Site Control - Water Quantity
- Provision of retention or detention basin(s) for the site, located outside the floodplain, to attenuate peak flows from individual catchments up to the 100 year design storm event;
- Use of the basin(s) as recreational areas in dry conditions where possible.

Regional Control - Water Quality
- Provision of a constructed wetland or pond in the location of the flood plain to provide water quality and ecological benefits for the overall catchment;
- Discharge of peak storm flows from the overall catchment to the existing Barnhill stream at 2l/s/ha or Qbar, whichever is the greater.

Key Recommendations

- Developers within the Barnhill LAP catchment should implement SUDS measures in line with the recommendations of this report to suit individual site layouts and local ground conditions.

- Design of SUDS Systems should be in accordance with the Grater Dublin Strategic Drainage Study (GDSDS) and the CIRIA SUDS Manual.

- SUDS measures should be located outside the predicted flood plain so that they can operate during extreme storm events. However, a constructed wetland or pond should be provided within the flood plain as a regional control to provide water quality and ecological benefits for the overall Barnhill LAP catchment.

- SUDS measures should be implemented in a management train, in that where possible surface water should be managed locally in small sub-catchments rather than being conveyed to and managed in large systems further down the catchment.

GARLAND
Concepts Realised

Riverfront,
Howley's Quay,
Limerick

T 061 319708
F 061 313124
E limerick@garlandconsultancy.com