Broombridge-Hamilton Rainwater Management Strategy

Final Report

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Revision history

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S3-P03/02.08.2024	Updates to baseline model and recommendations	Dublin City Council
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This report describes work commissioned by Dublin City Council.

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Purpose

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Abbreviations

1D	One Dimensional (modelling)
2D	Two Dimensional (modelling)
AEP	Annual Exceedance Probability
AFA	Area for Further Assessment
CFRAM	Catchment Flood Risk Assessment and Management
DCC	Dublin City Council
DCDP	Dublin County Development Plan
DTM	Digital Terrain Model
EPA	Environmental Protection Agency
FEH	Flood Estimation Handbook
FFL	Finished Floor Level
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FRR	Flood Risk Review
FSU	Flood Studies Update
GIS	Geographical Information System
HEFS	High End Future Scenario
HPW	High Priority Watercourse
JFLOW	2-D hydraulic modelling package developed by JBA
JT	Justification Test
LA	Local Authority
MPW	Medium Priority Watercourse
MRFS	Medium Range Future Scenario
OPW	Office of Public Works
Osi	Ordnance Survey Ireland
PFRA	Preliminary Flood Risk Assessment
RSES	Regional Spatial and Economic Strategy
RMS	Rainwater Management Strategy
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems

1 Introduction

1.1 Terms of Reference

JBA Consulting Engineers & Scientists Ltd. was appointed by Dublin City Council (DCC) to prepare a Nature-based Surface Water Management Strategy for the Dublin Industrial Estate Environs. Thereafter the site is known as Broombridge-Hamilton.

1.2 Background

DCC intend to develop a Masterplan for Broombridge-Hamilton. The proposed Masterplan is located to the west of Glasnevin Cemetery, north of Cabra, south of Finglas and to the east of Pelletstown. It has an approximate area of 77 hectares. The extent of the study area is identified in Figure 1-1 below.

Figure 1-1 Broombridge-Hamilton Study Area (Source: DCC)

1.3 Aims & Objectives

The purpose of this document is to summarise the baseline stormwater and fluvial conditions that exist within the study area, and to set out an intended approach to defining the proposed nature-based surface water management strategy. This strategy aligns with the Dublin City Development Plan 2022-2028 (the Development Plan). It contains both overarching principles and a site-specific surface water management approach.

In line with Development Plan Policy SI22 (Sustainable Drainage Systems) and SI25 (Surface Water Management), sustainable drainage solutions along with a Surface Water Management Plan (SWMP) are required to be prepared as part of all new developments. This plan, which will be referred to within this document as a Rainwater Management Strategy (RMS), introduces a settlement level water sensitive urban design solution that takes a "whole of settlement" approach. This approach seeks to implement nature-based solutions to rainwater management that firstly provide controlled run-off to downstream receptors and act as part of a flood mitigation measure. The measures that provide this flood risk management are also to manage water quality in accordance with the EU Water Framework Directive and have regard to rainfall intensity and frequency increases in the context of climate change.

The RMS documents an iterative urban design process, constituting a baseline that has informed the green infrastructure strategy and urban structure across the lands. The plot development will then layer onto this green infrastructure strategy, incorporating the proposed transport routes and plot layouts into the GI layout.

1.4 Report Structure

The report follows three stages:

- An appraisal of the existing surface water network and existing fluvial conditions.
- Development of an RMS.
- Proposed site-specific measures.
- Overarching SuDS guidance (Appendix B).

2 Existing Infrastructure

2.1 Existing Surface Water Network

DCC provided several datasets related to the local surface water network in GIS format to JBA Consulting. Uisce Éireann also provided network details for their assets within the study area.

A review of the surface water network indicates that a robust dataset is available for the Broombridge-Hamilton study area. Whilst a lot of the minor surface water infrastructure elements will be replaced as part of the proposed RMS, it is key to gather information on a number of critical assets contained within the dataset. These include:

- The culvert crossing beneath the Royal Canal (Figure 2-1). This culvert is the only crossing point of the canal for the southern catchment.
- Tolka River outfalls. Though outside of the study area, these are likely to be utilised to some degree as part of the proposed infrastructure (Figure 2-2).
- Foul infrastructure network. Whilst this exercise is to appraise the existing surface water infrastructure, there is an inevitable interaction with the existing UÉ assets (Figure 2-3).

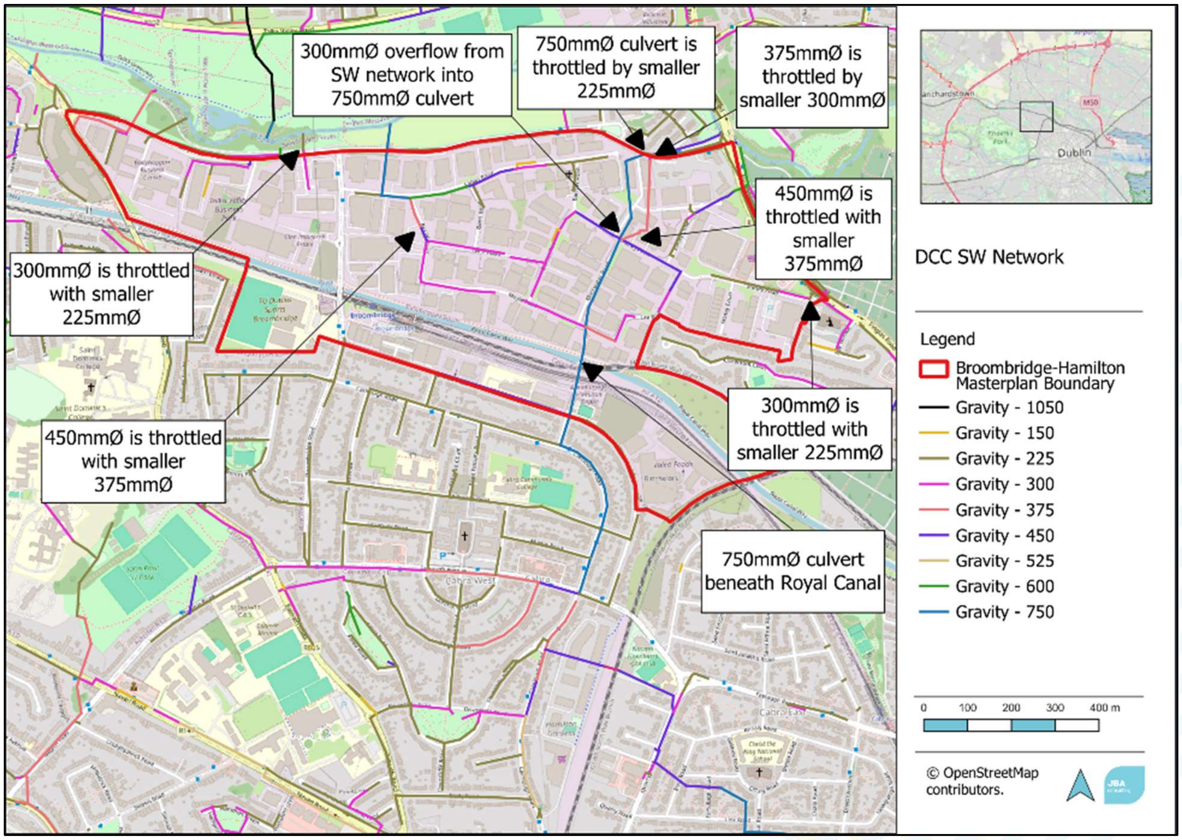

Figure 2-1 DCC Surface Water Network (Source: DCC)

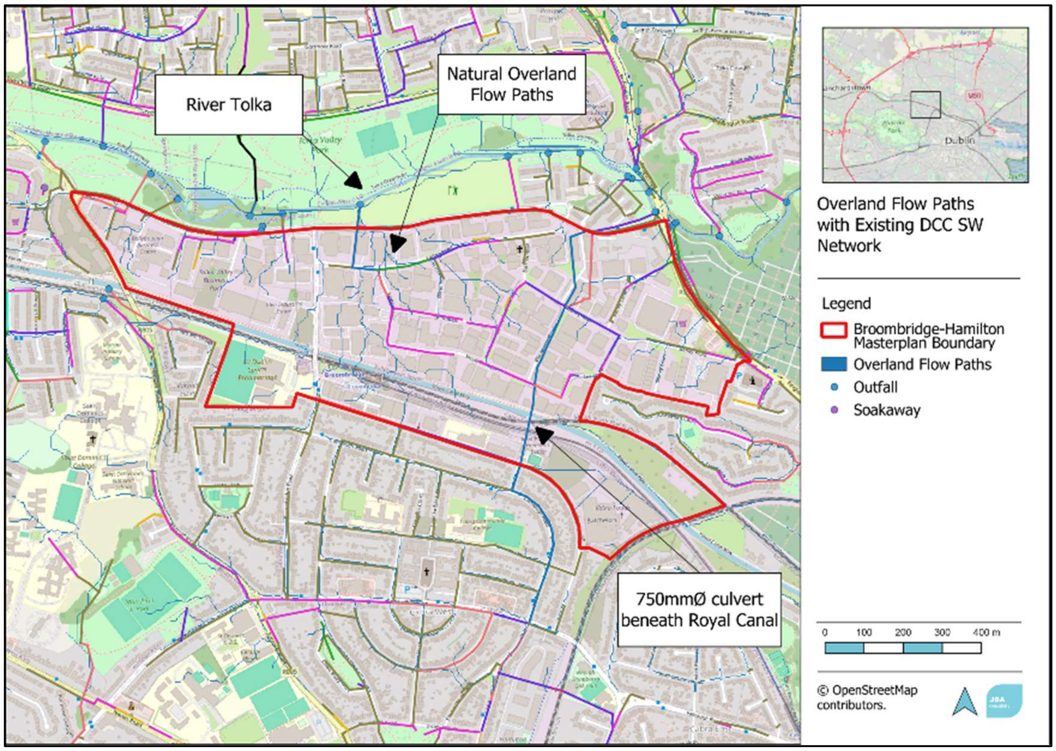

Figure 2-2 Tolka River surface water outfalls

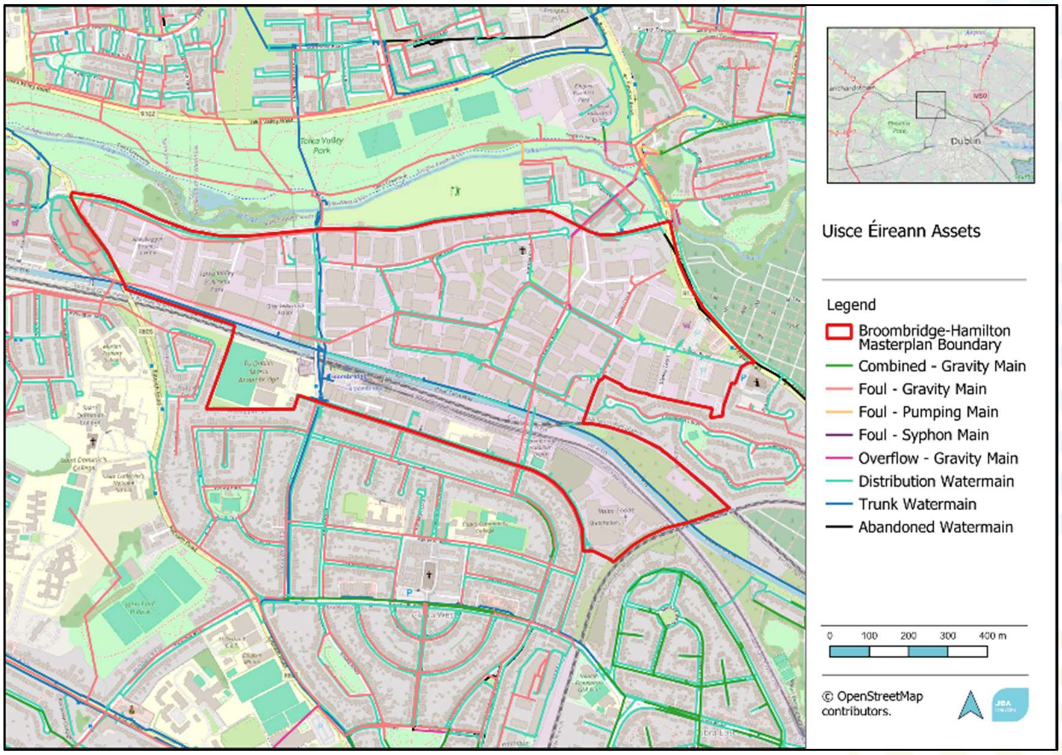

Figure 2-3 Uisce Éireann Assets

2.1.1 Royal Canal Culvert

The Royal Canal Culvert, shown in Figure 2-1, provides the only connectivity from the southern catchment (everything south of the Royal Canal within the study area) to the Tolka River downstream. Therefore, it is a critical piece of existing infrastructure.

For the majority, the culvert is 750mm dia., is throttled significantly at its downstream extents to a 225mm dia. pipe. The purpose of this is unclear, but intuitively the intention must be to retain a volume within the culvert itself and reduce the velocities that ultimately discharge to the Tolka itself. The discharge outlet was observed during a site visit by JBA Consulting on 22 March 2024, with a significant flow observed – refer to Figure 2-4 and Figure 2-5. As can be seen, there is a pair of outfalls at the Tolka Bridge on the Finglas Road with the 225mm dia. pipe most westerly of the bridge being that from the upstream 750mm dia. culvert.

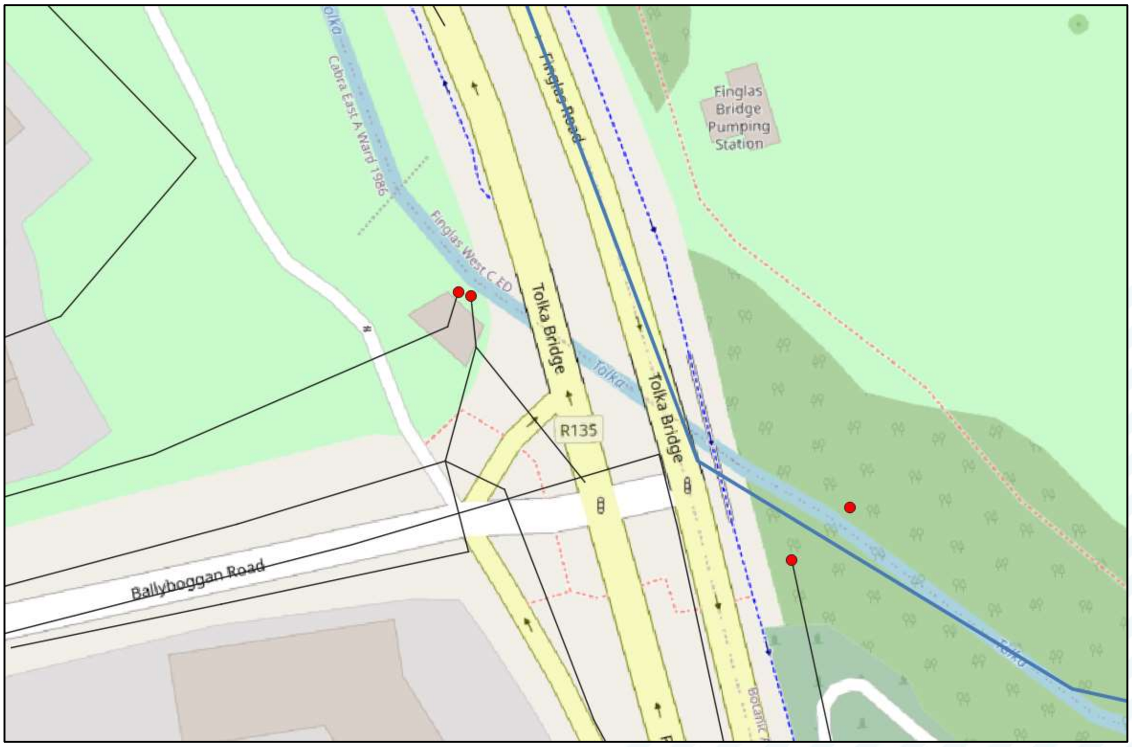

Figure 2-4 Surface water outfalls at Tolka Bridge

Figure 2-5 Outfall pair at Tolka Bridge, Note the outfall from the 750mm culvert to the right of photo with flow present

This culvert, whilst also critical for connectivity to the southern catchment, is also installed at significant depth, giving little opportunity to daylight the culvert. Taking all of this into account, the design needs to be considered with the retention of this culvert.

2.1.2 Tolka River outfalls

As Figure 2-2 shows, there are a significant number of existing surface water outfalls that discharge from the study area to the Tolka River. It is important to note that these all exist outside the current study area boundary.

It would not be the intention to retain all of these in the final design, but having this quantity available allows for numerous opportunities for surface water layouts and catchment distribution. Figure 2-6 and Figure 2-7 provide an example of the condition of the surface water outfalls present within the Tolka River.

2.1.3 Uisce Éireann Assets

As Figure 2-3 shows, the vast majority of the UÉ systems within the study area are foul only. This separation of assets makes surface water amendment proposals much more achievable. There does currently exist an overflow arrangement from the foul system into the surface water network to the north-eastern extents of the site. Any amendment to the surface water network in this region will need to take this arrangement into consideration.

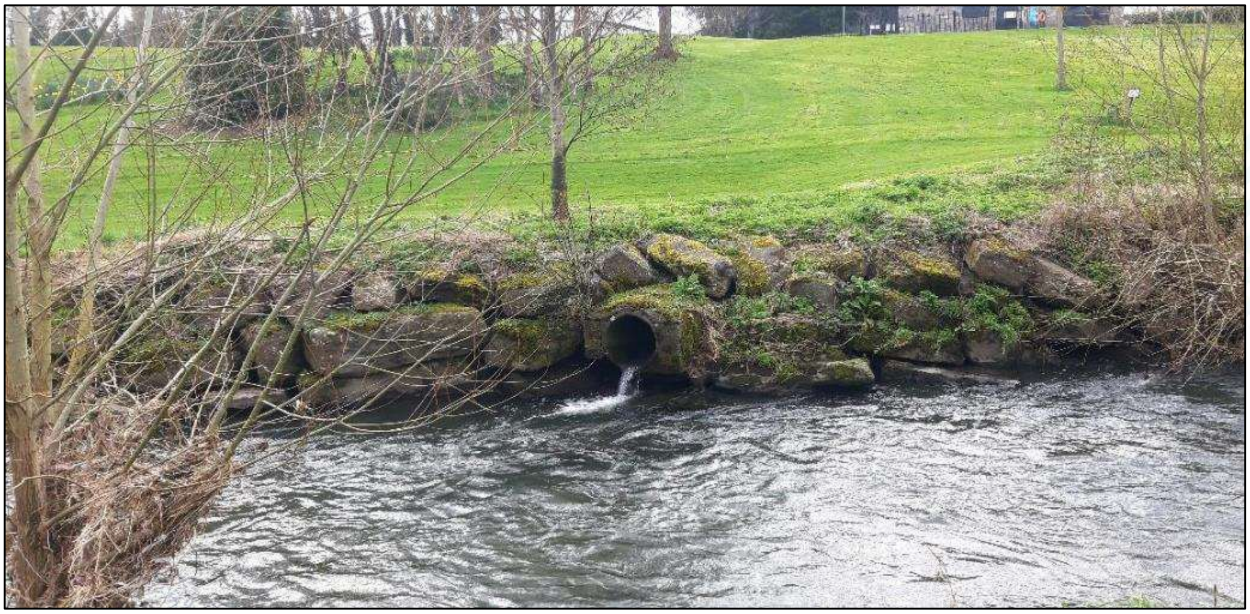

Figure 2-6 Outfall within Tolka Valley Pitch & Putt Course

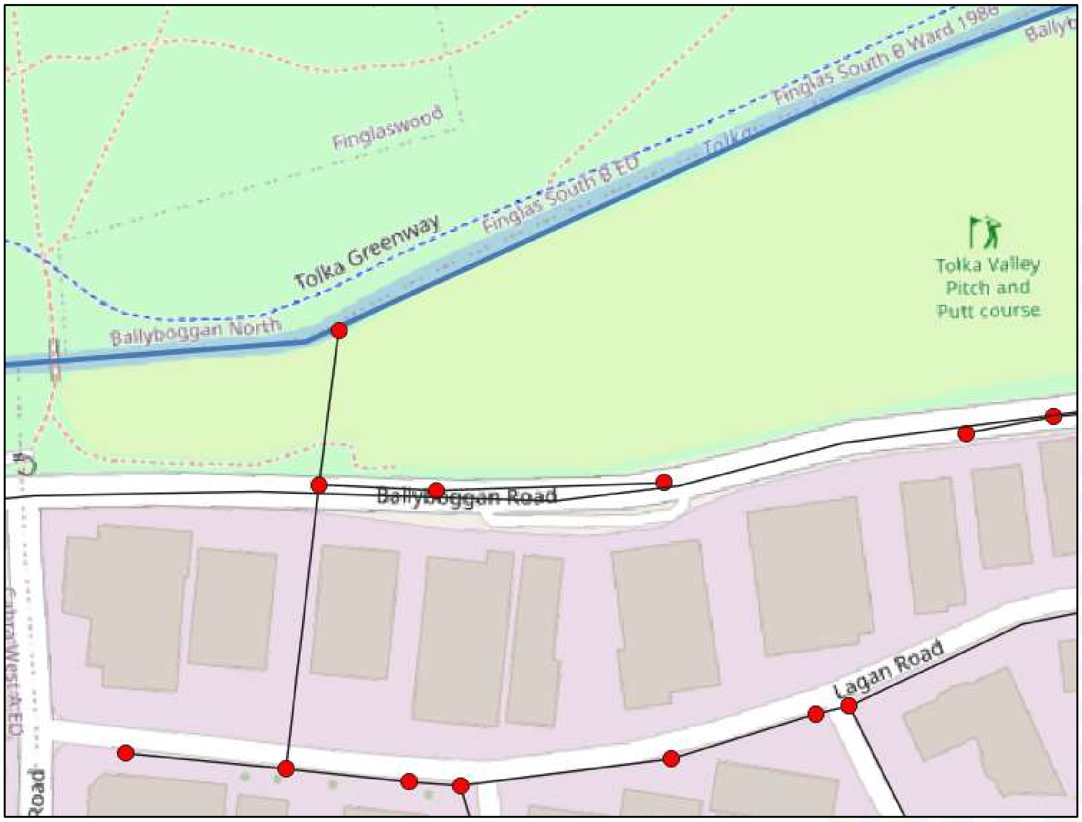

Figure 2-7 Outfall within Tolka Valley Pitch & Putt Course

2.2 Fluvial Data

2.2.1 Watercourses

The Royal Canal crosses the Masterplan boundary from northwest to southeast, paralleling the railway line. It features a series of bridges and locks along its route.

Additionally, the River Tolka follows the northern edge of the Masterplan boundary, flowing through Tolka Valley Park in a direction similar to the Royal Canal. The River Tolka passes beneath three bridges within the Masterplan boundary. The Bachelors Stream (Finglas Stream) joins the River Tolka downstream of the Masterplan boundary.

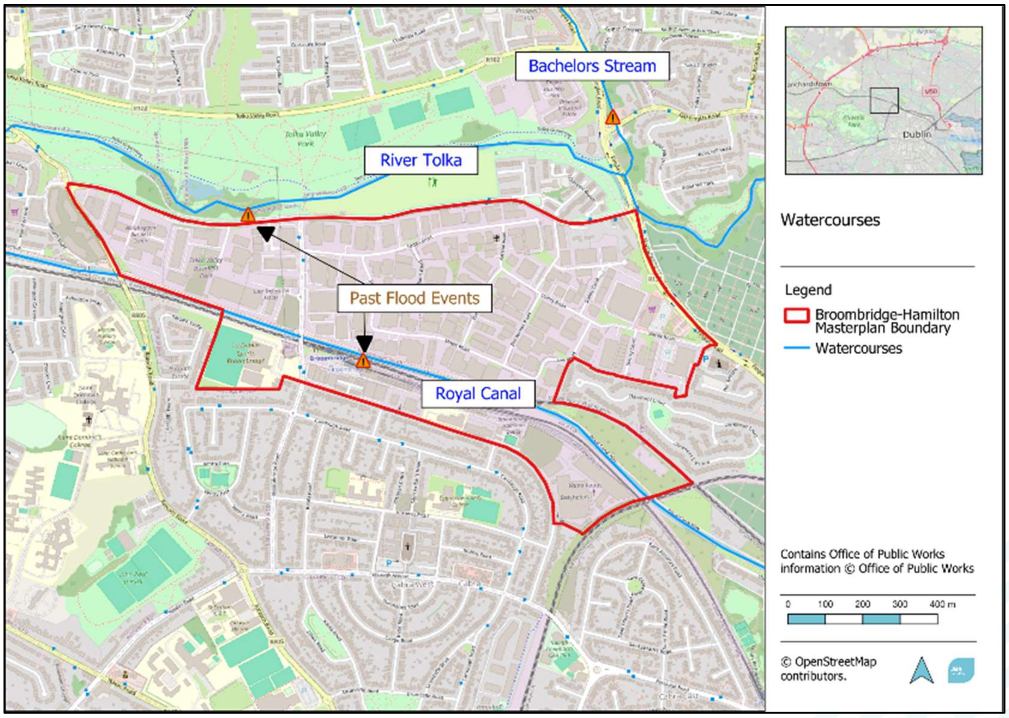

Figure 2-8: Watercourses Overview

2.2.2 Historic Flooding

Several recent past flood events occurred within or around the Masterplan boundary. Table 2-1 provides details of recent flood events that have impacted on Dublin City, arising from fluvial sources.

Table 2-1 Summary of Recent Flood Events in Dublin [1]

Date	Source of Flooding	Areas impacted
24th October 2011	Fluvial – Royal Canal	The canal overflowed which may have been due to a blockage at Glasnevin. The drainage on the road was blocked or was unable to cope with the volume of water and it flowed in to the station. The drains from the local housing estates are in the direction of the railway, which may have impacted on the flood. Sligo Intercity and Maynooth commuter services were suspended due to flooding at Broombridge Station
August 1984	Fluvial – Tolka and Finglas Rivers	Flooding at the junction between Tolka and Finglas Rivers, however a number of flood defences were put in place since the flood occured

2.2.3 Dublin FloodResilienCity Pluvial Mapping

Information on pluvial flood risk comes from the EU Interreg IVB FloodResilienCity Project. For the project, a city-wide model provided a high-level assessment of pluvial flood risk across Dublin and five Pilot Areas were identified for further detailed investigation of potential pluvial flood risk i.e. Type 2 modelling. Figure 2-9 below shows a map with the pluvial flood outlines. The mapping indicates accumulations of stormwater in many isolated pockets throughout the Masterplan boundary. The granularity of the base topographic data is coarse, and the detail of the stormwater network is also not explicitly modelled; the SWMP will provide further insight into the management of pluvial risk and the existing surface water system.

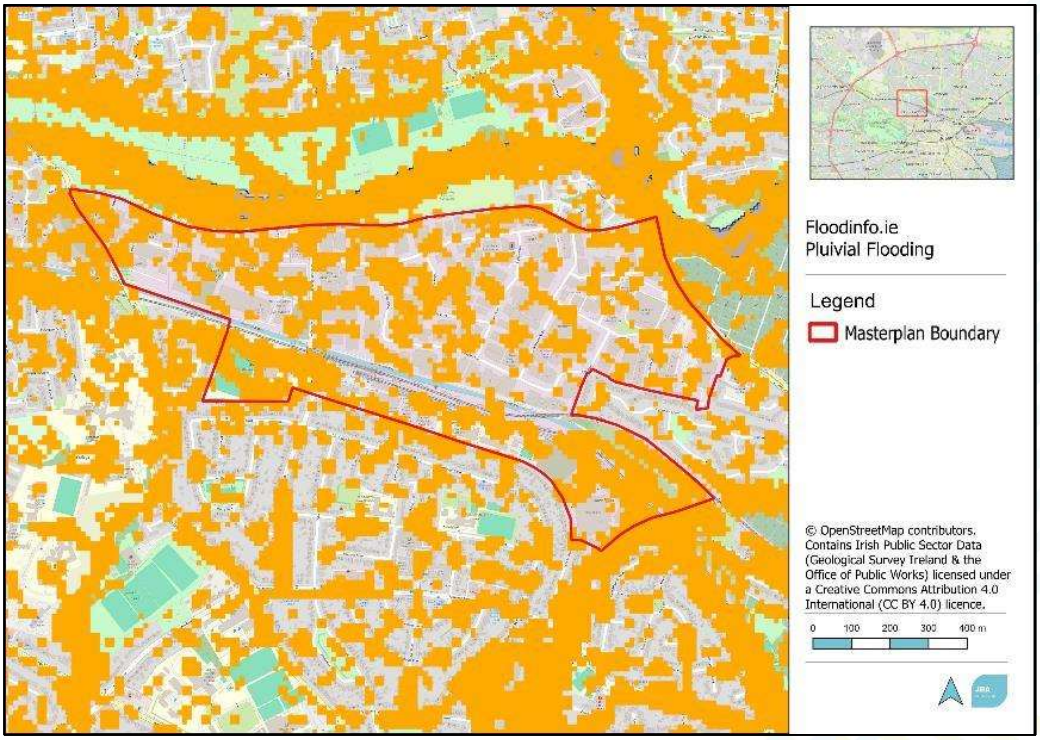

Figure 2-9 FloodResilienCity Flood Map

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[1] Source: Met Éireann Major Weather Events.

2.2.4 CFRAM

In 2011 the OPW commenced appointment of consultants to carry out a more detailed flood risk assessment on key flood risk areas. This work was undertaken under the CFRAM programme across seven river basin districts in Ireland.

The Tolka was modelled under the Eastern CFRAM, however the flood maps are under review and the results are not currently available.

2.2.5 NIFM

The National Indicative Fluvial Mapping (NIFM) was superseded by the CFRAM study. However, considering the CFRAM maps for the Tolka River are under review, the NIFM maps were consulted, and the results are presented in Figure 2-10, showing that the Flood Zones will encroach on the north-east corner of the Masterplan lands.

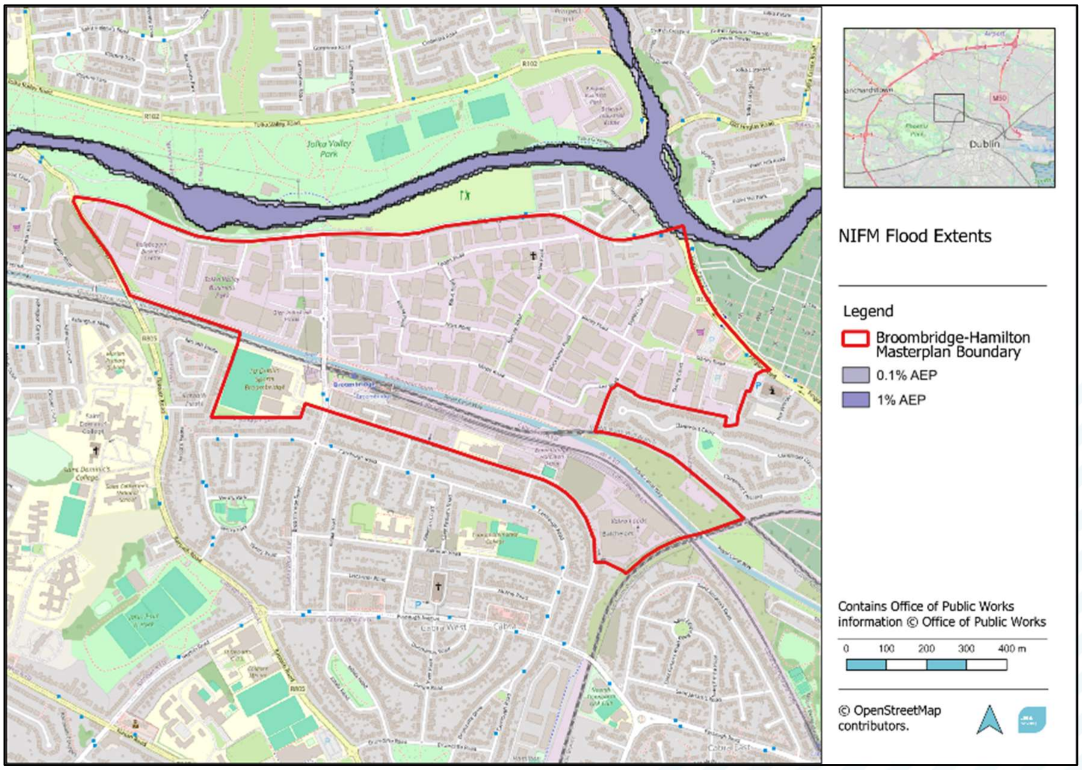

Figure 2-10 – NIFM Flood Extents

2.2.6 SFRA/Fluvial Flood Risk

The above information is appraised in greater detail within the SFRA, prepared in conjunction with this RMS.

3 Proposed RMS Approach

3.1 Process definition

At the outset, the RMS was not constrained by a proposed development layout. The RMS is intended to form the baseline, which will then inform the plot distribution of the layout. This allows the RMS to realise much more potential than when trying to be retrofitted to a fixed footprint. It allows the RMS to align fully with the green infrastructure strategy and the permeability of the site in terms of transport routes, creating a much more holistic design.

To realise this, there is a sequential approach that needs to be undertaken. This sequential approach is set out in Figure 3-1.

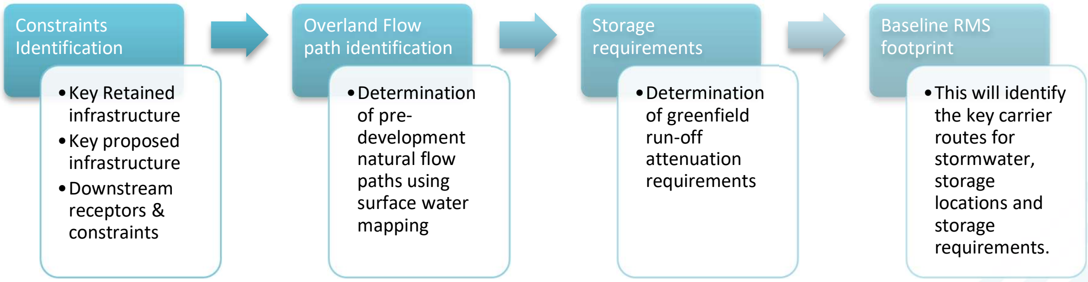

Figure 3-1 Baseline Process

3.2 Constraints Identification

The first step is to outline the restraints on any design that existing key infrastructure or proposed infrastructure elements might pose. Given the interaction with the Tolka downstream and the Royal Canal upstream, there will be certain elements of the existing surface water drainage that will be required to be retained. These constraints then form a process for defining the proposed infrastructure that can then input into the proposed masterplan layout. This ensures that the stormwater infrastructure is integral in the layout definition, as opposed to being imposed on an already agreed design.

3.2.1 Key existing drainage infrastructure

The key existing infrastructure elements that need to be considered as part of the design are as referenced in Section 2.1. These will all form constraints on the proposed layout.

The most onerous of these is the existing 750mm dia. culvert running south to north and draining the southern catchment. Due to its depth, a realignment is not preferable, and as such its footprint should be retained. This will directly define the footprint of the development.

3.2.2 Proposed infrastructure

The most significant piece of infrastructure proposed for the study area currently is the Luas Finglas Line. This will run from Broombridge Station in parallel to Broombridge Road before crossing the Tolka River. See Figure 3-2 and Figure 3-3 for the current layout.

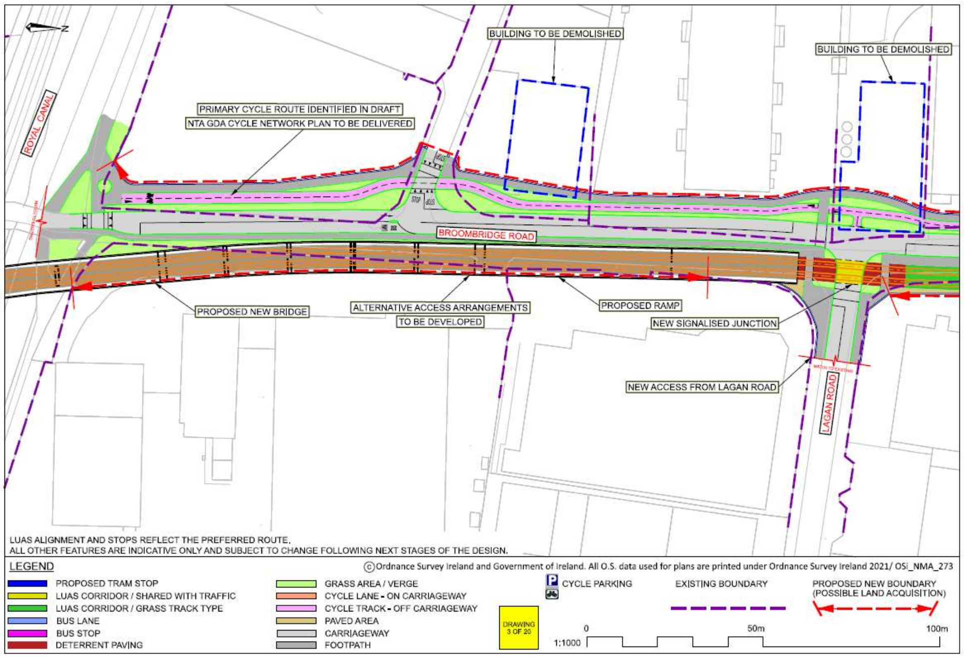

Figure 3-2 Luas Finglas from Broombridge to Tolka River

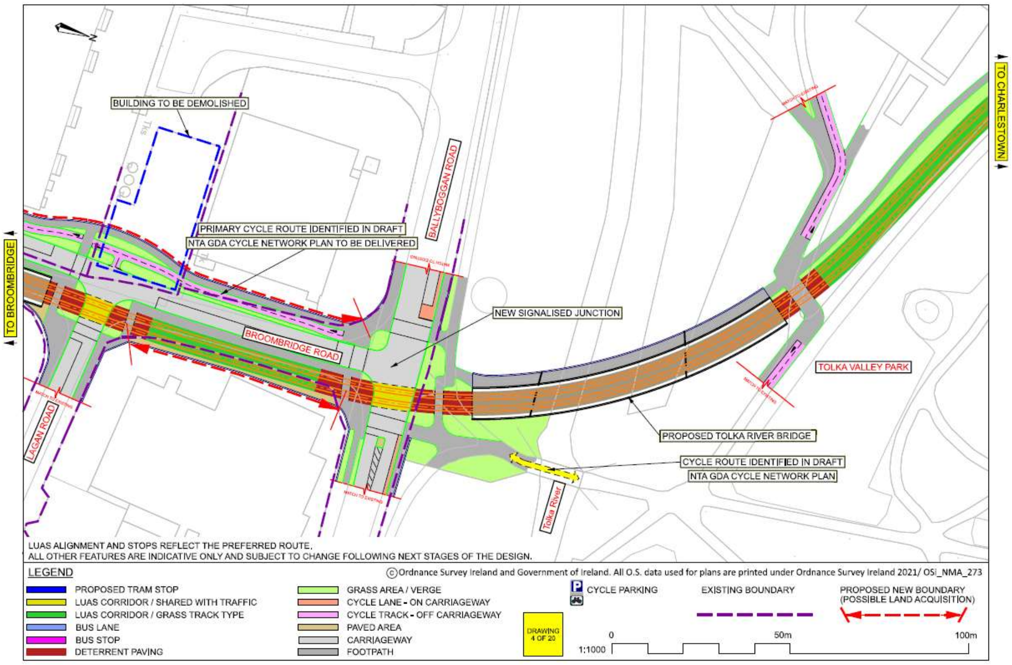

Figure 3-3 Luas Finglas Bridge over Tolka River

The Luas extension provides both constraint and opportunity. Given the timelines, the Luas Finglas line will progress in advance of the proposed green infrastructure to be included in the Broombridge-Hamilton Masterplan. Therefore, any element of the RMS that crosses beneath the Luas line will need to be considered as part of that scheme.

In terms of opportunity, it provides a new available boundary that could have the Luas corridor and adjacent cycle lanes incorporated into a SuDS proposal.

3.2.3 Downstream Receptor Constraints

The entire catchment drains to the Tolka River, through numerous outfalls as identified in Figure 2-2. Individual outfalls will not necessarily dictate the alignment so much as the topography. With the very clear north-south orientation of falls, the site's alignment begins to take on a grid like fashion in that alignment so as to complement the preferable drainage topography. A sense of the topography is seen in Figure 3-4 and this constraint is further discussed in Section 3.3.

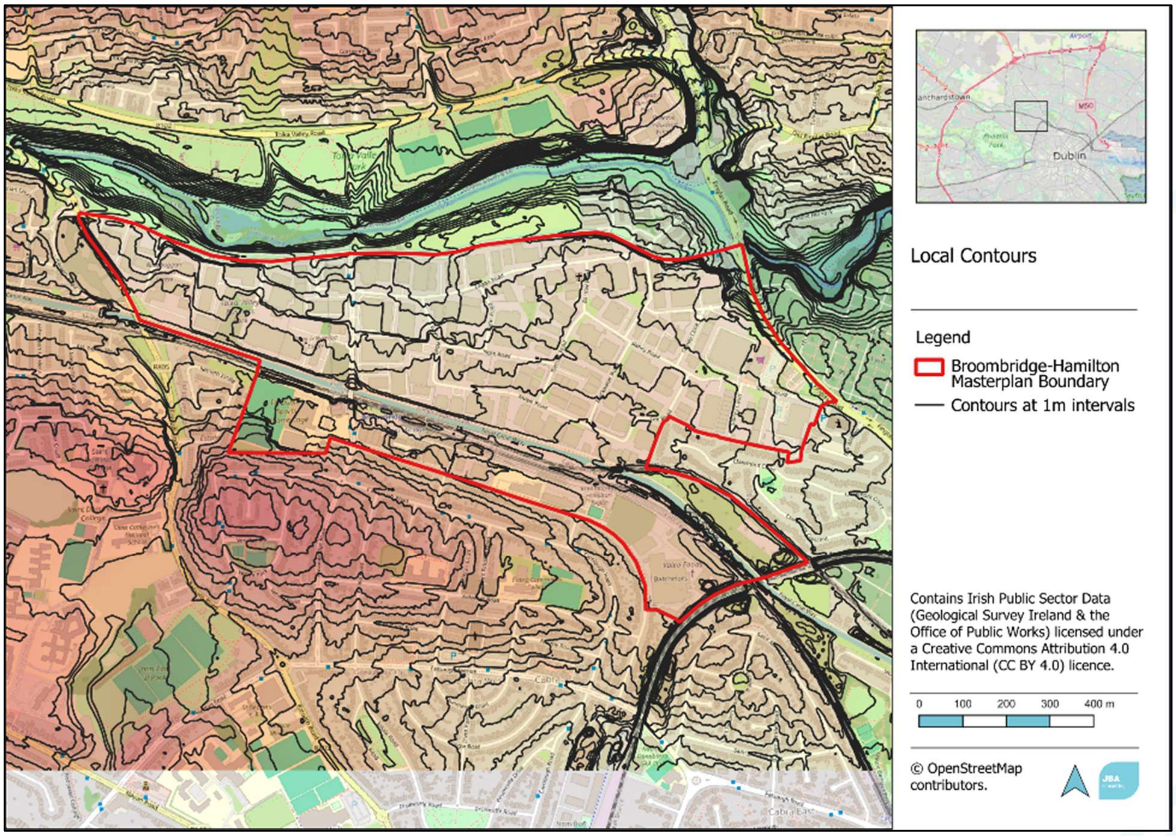

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Figure 3-4 Study Area Contours

3.3 Overland Flow Path

With no defined development footpath, it is possible to identify the most efficient surface water network based solely on the site topography. The best approach to defining this is flow path delineation.

The process towards delineating flow paths to the Tolka involved several steps carried out within a GIS application. Surface water mapping was completed using the QGIS / GRASS r. Watershed tool. This tool uses a DTM (Digital Terrain Model) to evaluate the terrain and generate surface runoff pathways, and creating a map showing flow accumulation, drainage direction, the location of streams and watershed basins. The output of this is shown in Figure 3-5.

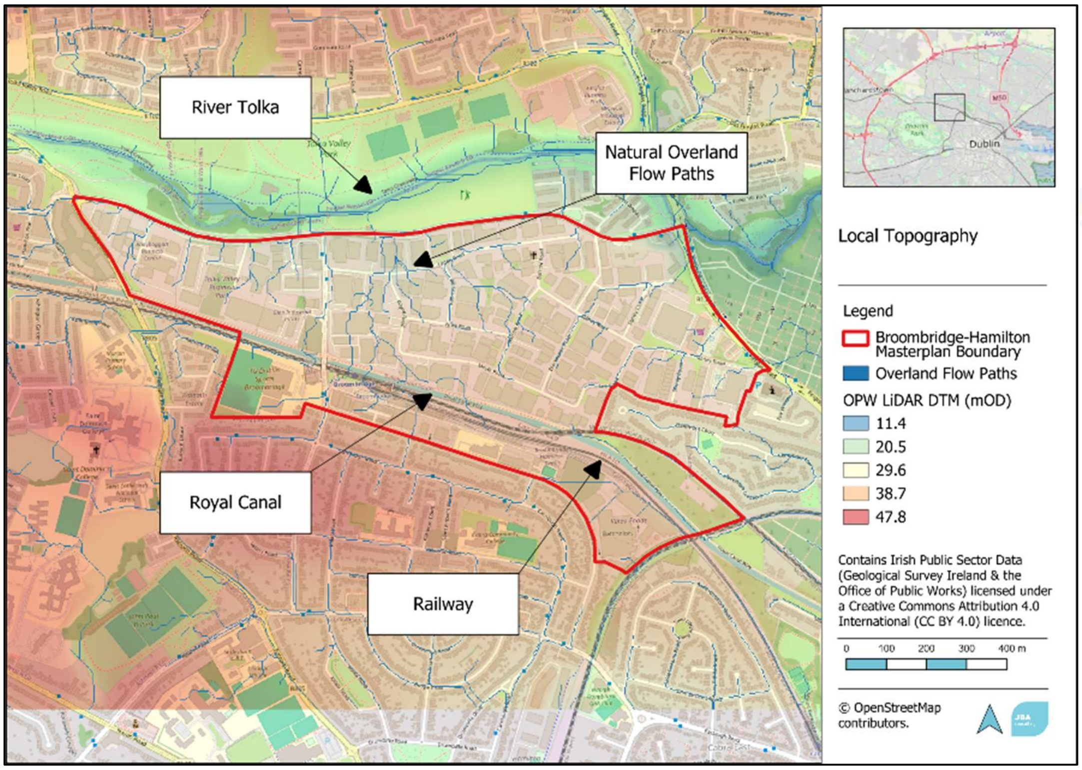

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Figure 3-5 Flow path delineation within Study Area

This is a very useful tool as it helps identify the key routes to the downstream receptors. Based on Figure 3-5, a picture has started to emerge on where the concentrated flow paths are. There is a clear concentration of flow towards the centre of the study area with numerous flow paths converging to the western boundary of the Pitch & Putt course. The flow paths to the west of Broombridge Road follow a very linear route to the Tolka. This is useful as it indicates that a hydraulic link across the Luas line may not be required, and the western catchment could standalone.

A third catchment can be defined to the east of the site where two dominant flow paths travel towards the Finglas Road. This leads itself to potentially having a carrier system on the study area boundary parallel with the Finglas Road.

Though flow paths are shown crossing the canal, it is recommended that this regime remain drained through the existing deep culvert as referenced previously.

This exercise has created four sub-catchments across the site (refer to Figure 3-6).

- Catchment A – Western extent of study area to Broombridge Road
- Catchment B – Broombridge Road to Barrow Road
- Catchment C – Barrow Road to Finglas Road
- Catchment D – Royal Canal South

With this initial delineation, we can now look at potential land-take for storage requirements.

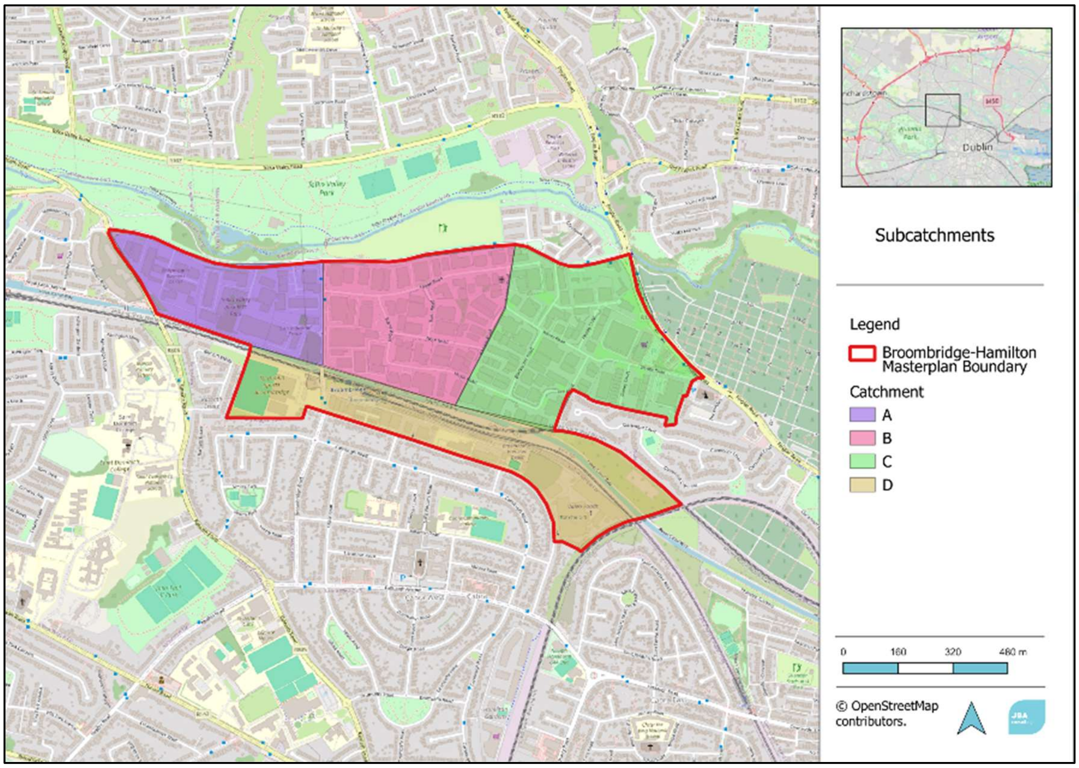


Figure 3-6 Masterplan Subcatchments

3.4 Storage Requirements

It is important to understand before layout concepts are considered as to how much land will need to be assigned to potential stormwater storage. An initial assessment has been undertaken to determine the magnitude of storage that might be needed within each of the catchments. This footprint is based on a 1m depth of storage requirement, and is a coarse calculation based on site specific rainfall intensities.

Table 3-1 Broombridge-Hamilton rainfall parameters

Broombridge-Hamilton Rainfall Parameters	
M5-60	16.3mm
SAAR	967mm
R RATIO	0.276
SPR	0.47 (Soil Type 4)

These parameters fed into a determination of permitted run-off for each of the sub-catchments and associated attenuation. These are presented in Table 3-2.

Table 3-2 Catchment Attenuation estimation

Sub-catchment	Area (Ha)	QBar (l/s)	Attenuation Estimation (m3)
Sub-catchment A	10.8	76.1	3,747
Sub-catchment B	18.6	130.95	6,442
Sub-catchment C	23.21	163.54	8,046
Sub-catchment D	19.56	137.82	6,780

These volumes, if transposed onto equivalent land-take requirements for a 1m deep detention location, equate to approximately 3.5% of the overall land within each sub-catchment.

These volumes, combined with the identified constraints and opportunities begin to form the parameters for the green infrastructure strategy. Initial green infrastructure opportunities are detailed in Section 3.5.

3.5 Green Infrastructure identification

The combination of parameters and overland flow paths give rise to several suggested green infrastructure approaches. These have been segregated into the sub-catchments for clarity and presented in Figure 3-7.

Sub-catchment A

- Flow patterns lean towards parallel green infrastrucutre corridors
- These could be tributaries of a larger carrier system running perpendicular on the Ballyboggan Road

Sub-catchment B

- Clear trend towards a central corridor. This could be incorporated into a public realm space centred around a new core stream feature.

Sub-Catchment C

- The flow paths suggest an easterly direction. A boundary swale running parallel to the Finglas Road would allow conveyance as well as SuDS and amenity benefits.

Sub-Catchment D

- Limited space for SuDS incorporation.
- Suggested greening of Bannow Road incorporating a storage feature within the current unoccupied space south of Broombridge Depot.

Figure 3-7 Green Infrastructure Opportunities

The high-level GI opportunities suggested in Figure 3-7 can be used as initial proposals for developing the footprint of the area. To test the feasibility of this, a baseline hydraulic model has been developed to begin to understand the quantum of the SuDS elements. This is detailed in Section 4.

4 Baseline Model

A baseline hydraulic model has been developed for use in sub-catchments B & C only. There is no benefit to creating a baseline hydraulic model at this time for Catchment D as there will not be any catchment-wide interventions that require hydraulic testing. The interventions here will centre around interception measures for slowing running off and improving water quality. The built-up nature restricts any large-scale intervention.

4.1 Sub-Catchment B

A proposed rainwater management strategy has been developed based to a large degree on the existing infrastructure footprint. The sub-catchment has been sub-divided into a suggested plot layout. This is shown in Figure 4-1.

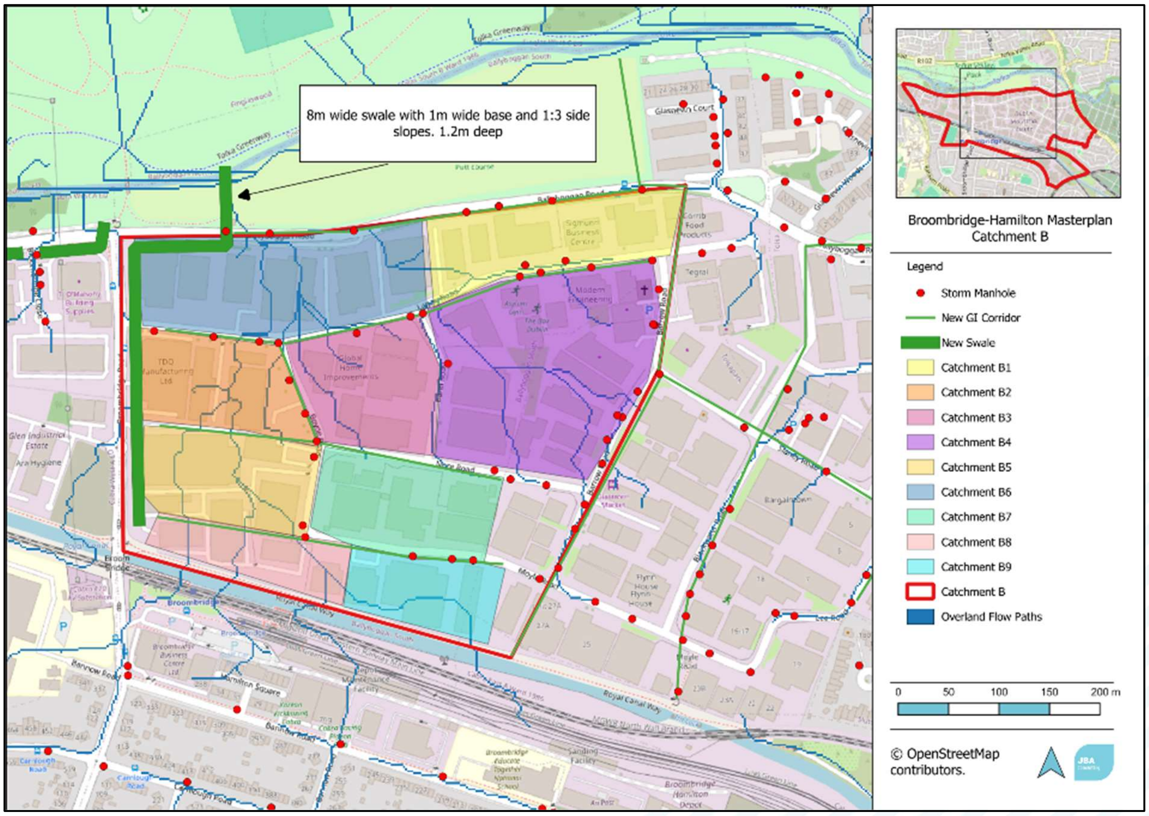


Figure 4-1 Sub-Catchment B

The key change in the hydraulic regime in this instance is a large swale located to the west of the sub-catchment. The rainwater management strategy is aligned such that the outfall from the catchment discharges towards this swale initially, before discharging towards the Tolka. A number of potential combinations were assessed in considering the swales contribution to the rainwater management strategy.

4.1.1 Sub-Catchment B Swale – No flow control

An initial size for the swale was deduced as 1.2m deep, with a 1m wide channel bed and 1:3 side slopes. This results in a total footprint of 8.2m wide. This cross-sectional area has enormous flow carrying capacity. Therefore, the initial check was to determine whether the entire catchment could be sent to the swale unattenuated, and discharge uncontrolled to the Tolka.

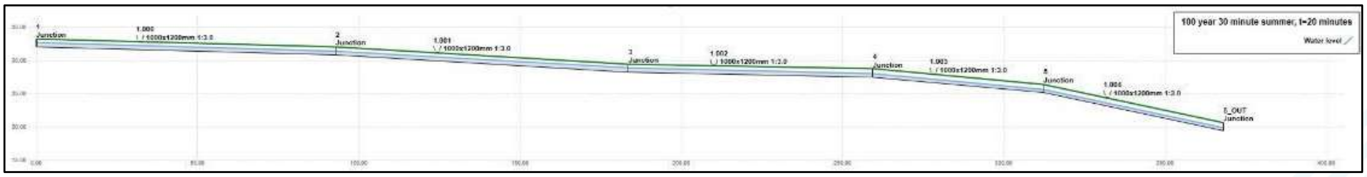


Figure 4-2 Long-section of unattenuated swale

The swale was tested for a 100-year event with 20% climate change additionally allocated to all flows. The resulting water profile is shown in the long section in Figure 4-2. The flow comfortably resides within the swale, with a flow/capacity ratio of 0.129. However, this also results in significant velocity profiles within the channel. A peak velocity of 4.24 m/s is reached during the 1% AEP event, with a peak flow rate of 3675 l/s. This approach is not recommended as it would have far-reaching consequences for downstream receptors. Therefore, a means of flow control was assessed within the swale.

4.1.2 Sub-Catchment B Swale – Flow Control

A flow control restricting the permissible discharge rate to the QBar value of 131 l/s (as per Table 3-2). This was to test whether the swale could cater for the entire storage needs of the site without any individual plot requirements.

A flow control was applied at node 5 in the model. This equates to where the swale meets the existing road parallel to the Tolka Valley Park.

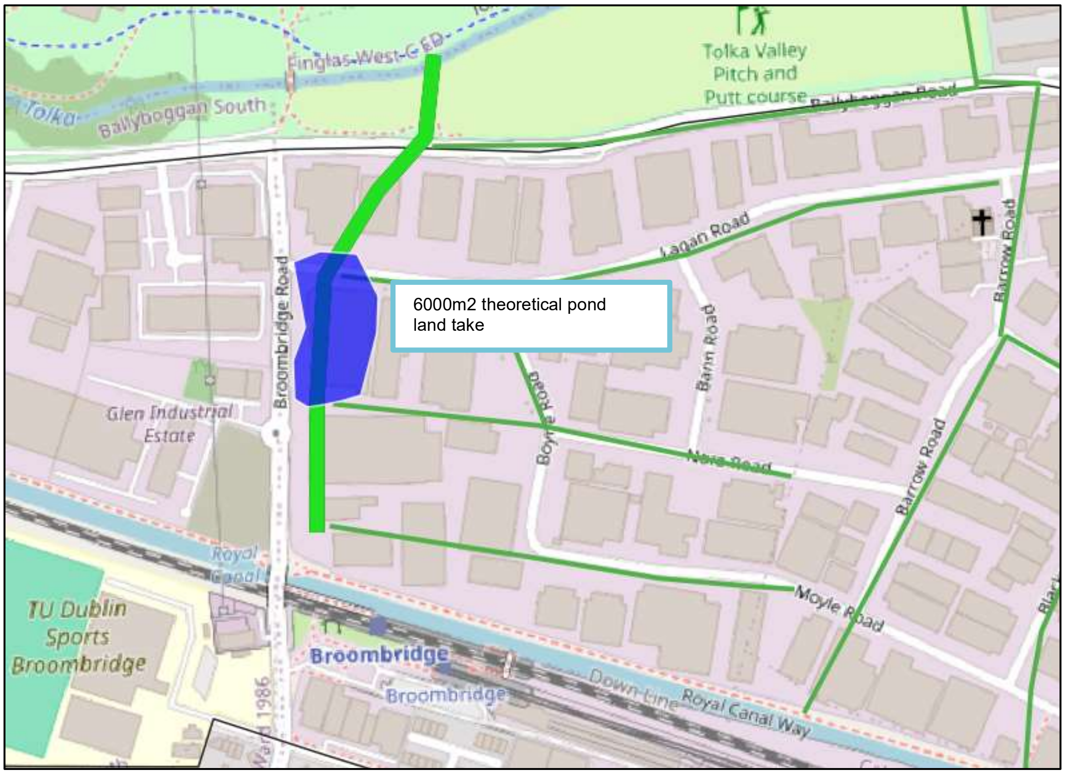
The results of this test conclude that the swale doesn't provide sufficient storage on its own, and some additional storage will be required. The reason is less to do with the swale capacity itself, and more related to the topography of the site. As is seen in the long section in Figure 4-2, there is a significant gradient in the base of the swale. Due to this, flooding in the region of 4,400m3 occurs at node 5 in this scenario. An additional test was considered where this flow control was placed at node 4, further upstream. This again resulted in flooding, in the region of 3980m3. This shows the influence of the topography on the degree of flooding but wasn't sufficient to require additional storage elsewhere. Therefore, additional in-line storage was assessed on the swale. This was considered on the basis that a pond structure could be incorporated into the footprint of the swale to allow for yet more storage.

Due to the topography of the site, it was chosen to test this storage at node 4 in the model.

4.1.3 Sub-Catchment B Swale – Flow Control plus in-line storage

A theoretical storage capacity was assigned to Node 4 combined with a flow control system. The capacity of the storage was set to 1m depth.

The resulting required storage requirement at this location was 5797m3. This is a significant volume, in the region of a 75x80m land take when considered to be storing 1m depth only. For context the scale of this storage is shown indicatively below in Figure 4-3.



6000m2 theoretical pond land take

Figure 4-3 Indicative in-line storage land take

4.1.4 Sub-Catchment B Swale – Plot level storage

Finally, a traditional plot level storage approach was considered. This effectively applies the greenfield run-off rate to the swale. This significantly underutilises the cross-section, resulting in peak water depths within the swale of only 148mm.

The consequence of this would require all plot developers to adhere to current DCC requirements in terms of attenuation volumes. Some intermediary needs to be considered to both utilise the swale as an amenity with some permanent retained volume.

A number of tests were undertaken to refine this. Initially an additional flow control measure was installed just at node 4. This applied the same discharge requirement but required a 1m head height to be achieved. This results in a disproportionate distribution of depths across the swale, as seen in Figure 4-4.

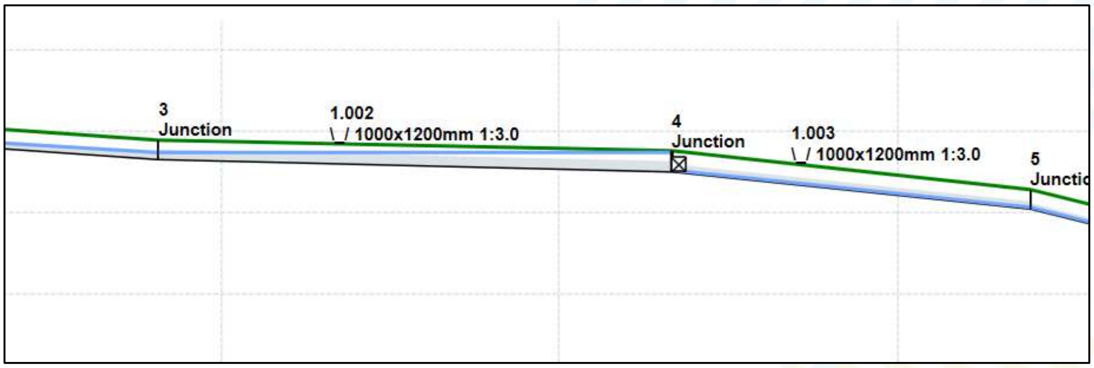


Figure 4-4 Additional flow control added at Node 4. Full bank swale results

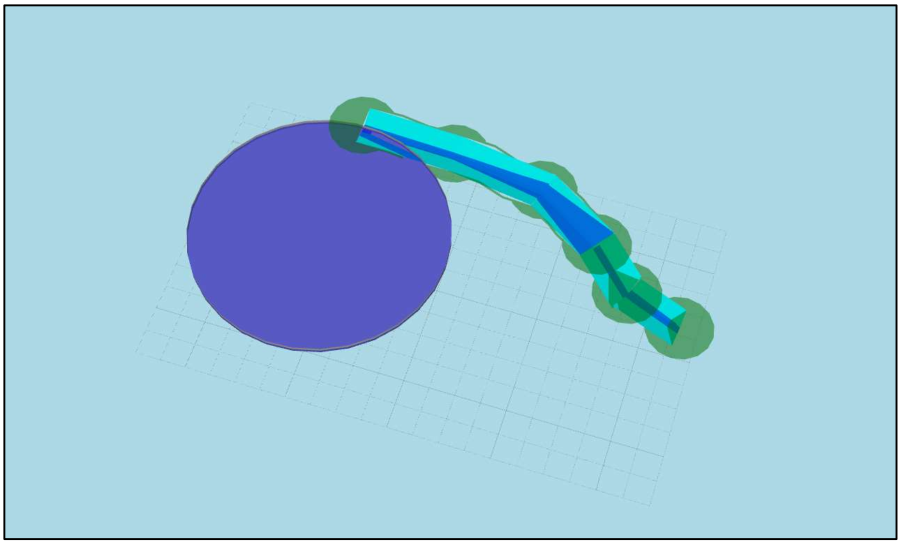


Figure 4-5 3-D isometric of swale looking south-west. The upstream storage is represented by the large storage circle at the head of the swale

An alternative to this was to test a series of weirs within the proposed swale. This would allow for a cascading flow regime and the retention of permanent volume within the swale, pending infiltration capacities. Three weirs were placed along the line of the swale.

This proved to be effective in maintaining a more consistent depth through the swale.

It is this recommendation that we propose, with plot storage incorporating source interception and attenuation strategies, coupled with weirs restricting flows to Qbar at regular intervals within the swale. This will provide a greater deal of interception, a retained water volume but done so to minimise the public amenity space land-take for storage. This approach also ensures that the swale will have a volume within outside of the infrequent design flood events.

Note, the heights of the weirs can be refined to allow for greater or shallower depths where required.

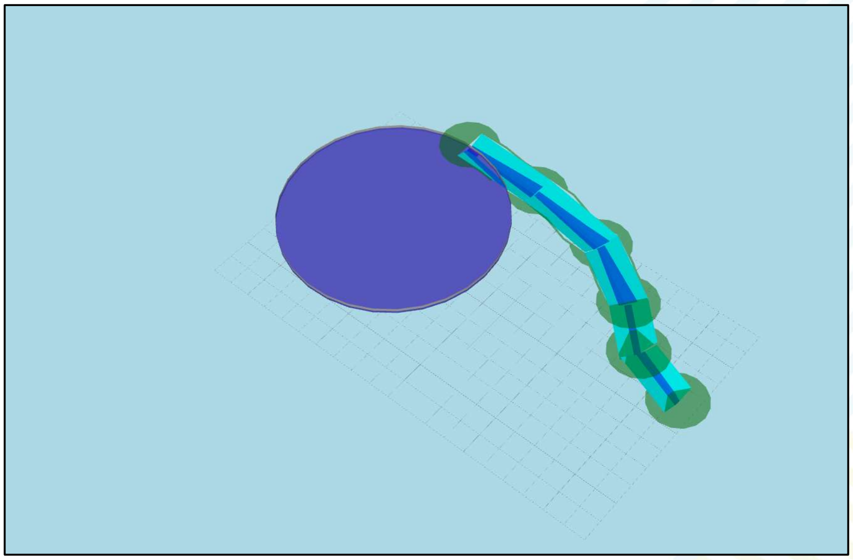


Figure 4-6 3D image of swale tested with cascading weirs

4.2 Sub-catchment C

A similar approach was taken for sub-catchment C. The green infrastructure corridors are shown in Figure 4-7 below.

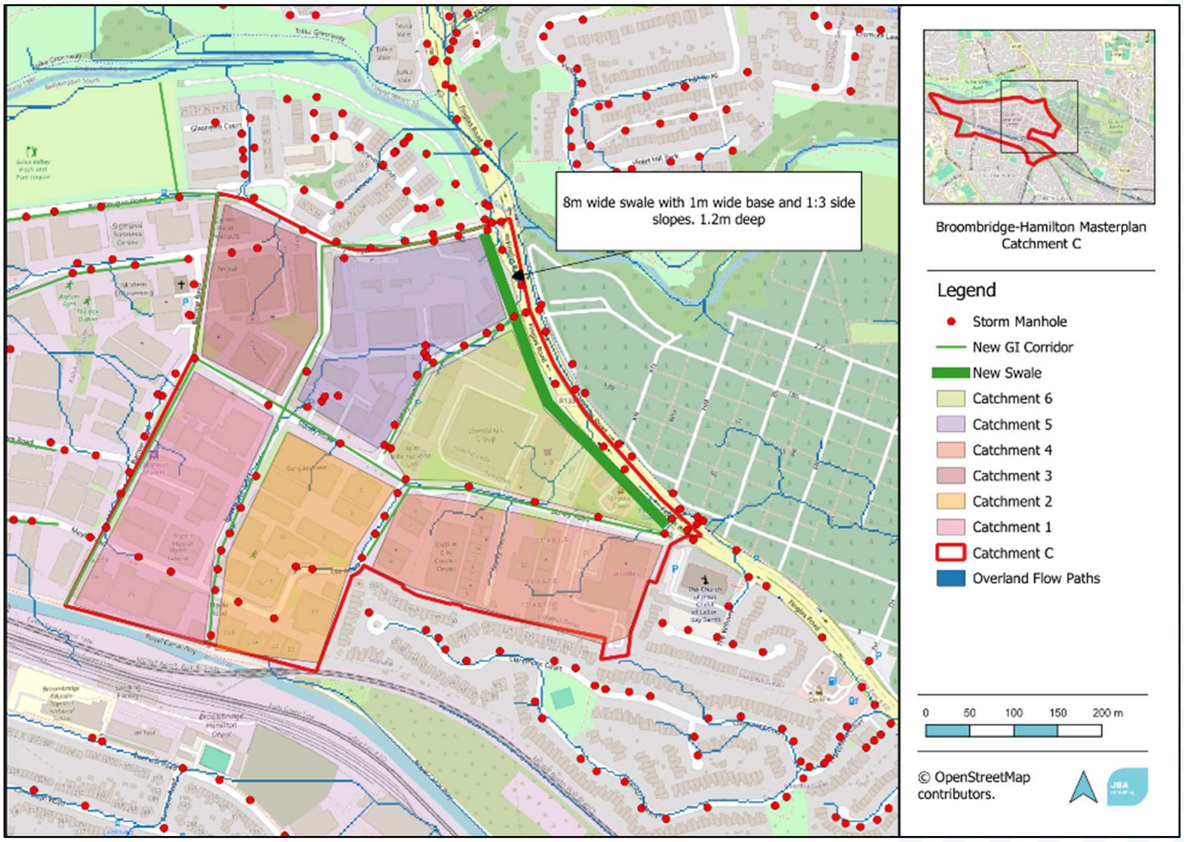


Figure 4-7 Sub-catchment C

4.2.1 Sub-catchment C – No flow control

A similar iterative approach was taken to this swale in terms of the stages of testing. One notable difference between this swale and sub-catchment B is that the longitudinal profile in C isn’t less steep for the upper portions. The longitudinal profile is shown in Figure 4-8 below. This provides more opportunity to store a volume within the swale but also reduces the flow capacity. As can be seen in Figure 4-8 below, when discharging an unattenuated flow, the upstream portion of the swale is full, which means the full 8m wide swale would be full to 1m deep. This also results in a discharge flow rate of 4,119 l/s. This is against the principles of GDSDS and DCCs own drainage policies and will therefore not be considered.

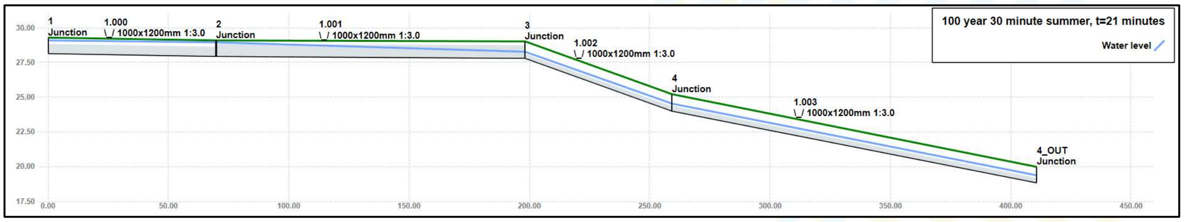


Figure 4-8 Swale long-section

4.2.2 Sub-catchment C – Flow control only

Attempting to utilise a flow control within the swale without any attenuation upstream was considered, given the favourable topography. However, the incoming flow is far too great to be attenuated, and extensive flooding resulted when tested – refer to Figure 4-9.

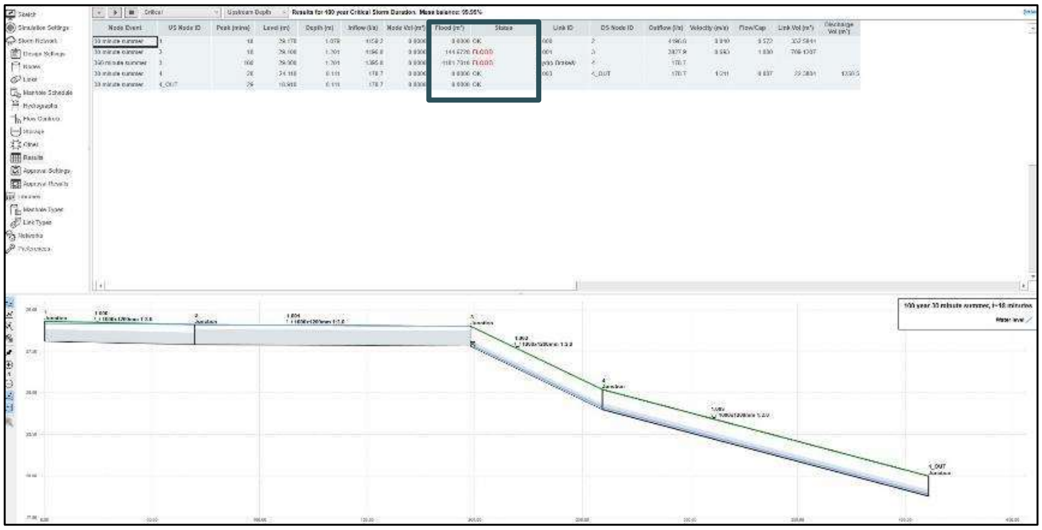


Figure 4-9 Swale SC3 flow-control results

Therefore, additional storage is required. This could be considered as in-line storage, but for the same reasons it wasn’t considered for sub-catchment B, it will not be considered here. The area required is too great, in the region of 6500m^2.

4.2.3 Sub-catchment C – Upstream storage

There will thus be a requirement for upstream storage within the catchment. An initial check was to have full plot storage. Similar to sub-catchment B, this results once again is minimal depths within the swale and doesn’t utilise it fully. Therefore, additional infrastructure is needed within the swale to create a permanent volume. Given the topography, one weir structure at node 3 would allow for a minimum 200mm depth within the swale without taking a disproportionate amount of amenity space. This is shown in Figure 4-10 below.

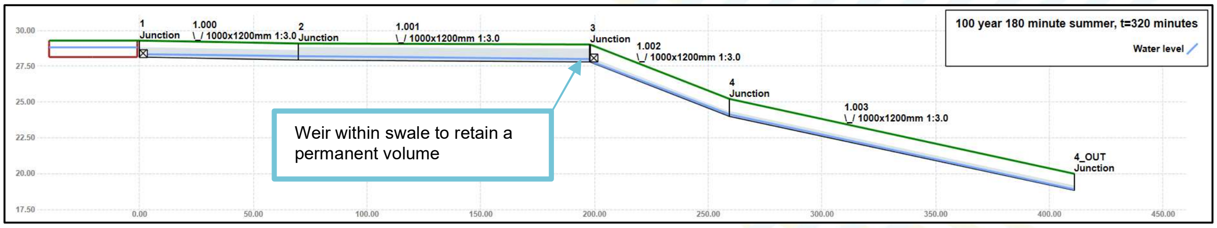


Figure 4-10 SCC Swale with 200mm weir

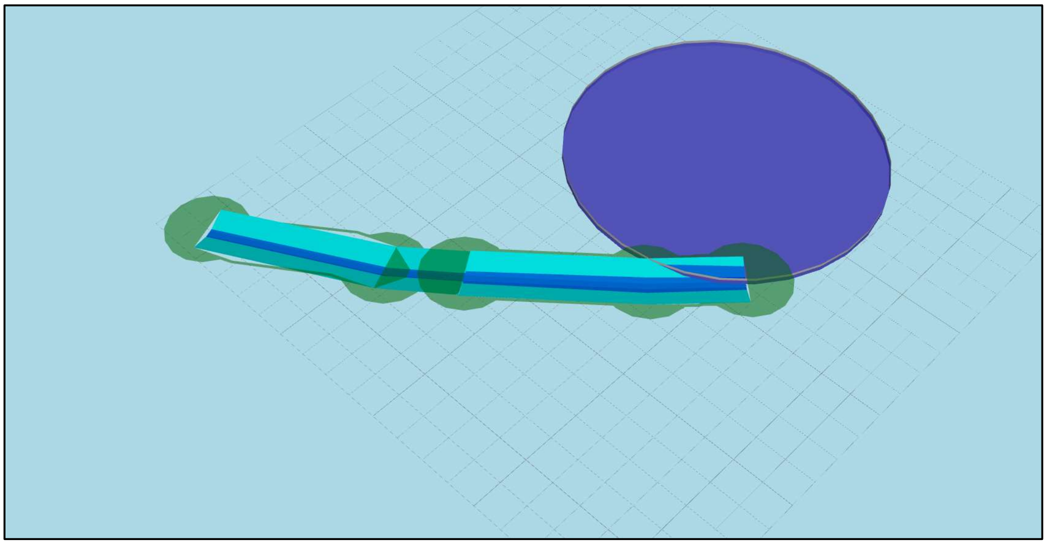


Figure 4-11 3D Render of swale (looking east) with weir in place. Extent of swale used for permanent volume is still minor given the 200mm depth

This combination of upstream storage combined with an in-stream weir/cascade structure is the preferred solution in this instance.

4.3 Sub-catchment design summary

For both sub-catchment B & C, there were identified significant opportunities for SuDS integration into the greater green infrastructure design. Two perimeter swales, form the core of the SuDS strategy. The next step is to define the context of the conveyance mechanisms from each plot to the downstream swales themselves. This is detailed in Section 5.

5 Masterplan integration

In consideration of the key SuDS proposals in Section 4, the Masterplan layout was developed. The masterplan layout is shown in Figure 5-1.

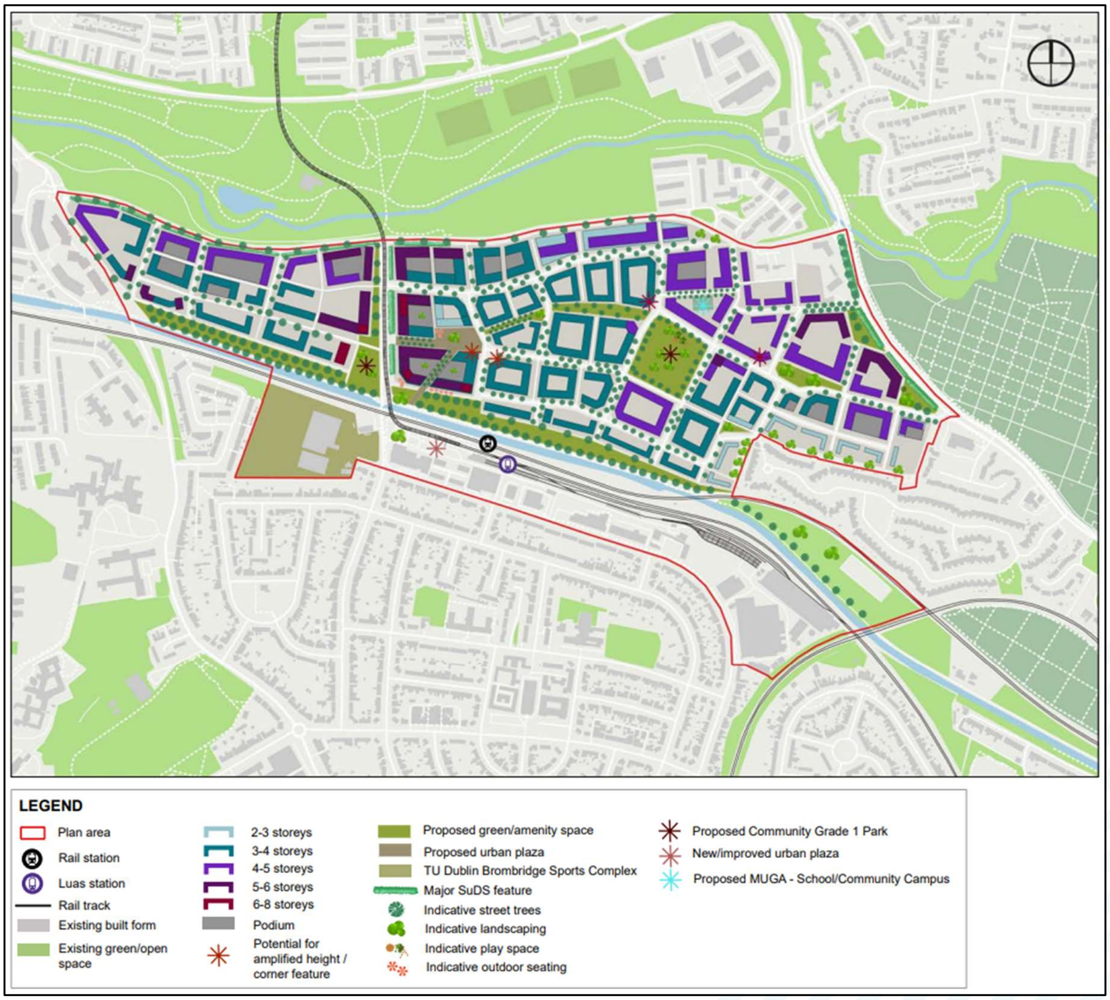


Figure 5-1 Broombridge-Hamilton Masterplan Layout (Source: DCC)

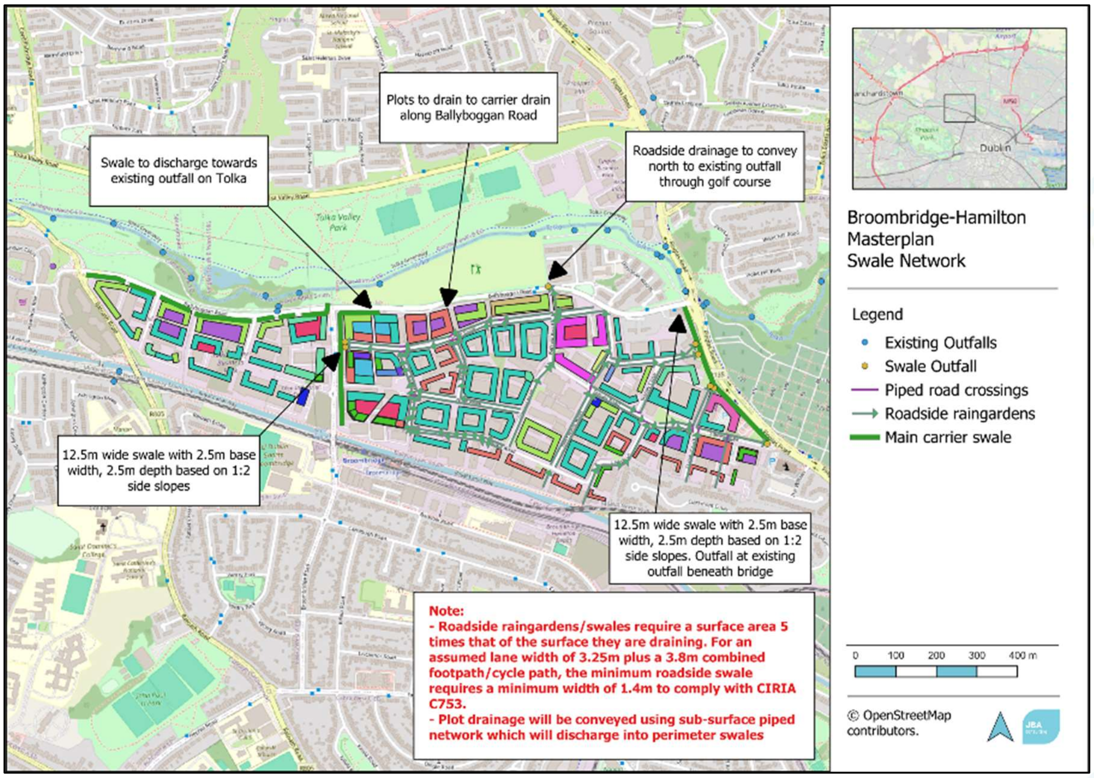
5.1 Swale refinement

Using the catchments as defined in Section 4, the baseline hydraulic model of the public realm SuDS infrastructure was further refined based on the following assumptions:

- 90% runoff from roads infrastructure
- 30% runoff from the plots
- No surcharging from the Tolka River has been assumed.
- M5-60: 16.1mm, Ratio-R: 0.277.
- Return Period: 100-years + 20% climate change

The outputs indicate no flooding during the 30-year event with only minor flooding in the 100-year event. However, such volumes could be contained throughout the swale using leaky dams, widening in certain locations. Indeed, the baseline model is conservative in its approach and therefore the flooded volume may well be an overestimation.

The configuration of the public realm infrastructure is outlined in Figure 5-2. The plots at the north of Phase 1 require their own carrier drain due to the increased land-take here.



Broombridge-Hamilton Masterplan Swale Network

Swale to discharge towards existing outfall on Tolka

Plots to drain to carrier drain along Ballyboggan Road

Roadside drainage to convey north to existing outfall through golf course

12.5m wide swale with 2.5m base width, 2.5m depth based on 1:2 side slopes

12.5m wide swale with 2.5m base width, 2.5m depth based on 1:2 side slopes. Outfall at existing outfall beneath bridge

Note:
- Roadside raingardens/swales require a surface area 5 times that of the surface they are draining. For an assumed lane width of 3.25m plus a 3.8m combined footpath/cycle path, the minimum roadside swale requires a minimum width of 1.4m to comply with CIRIA C753.
- Plot drainage will be conveyed using sub-surface piped network which will discharge into perimeter swales

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Figure 5-2 Public Realm Swale Infrastructure

5.2 Conveyance assessment

In order to convey flow through the masterplan area, roadside swales will be utilised. These will act as both conveyance and interception structures for the road runoff to the public realm swales along the peripheries. A section of the Phase 1 lands from the Luas corridor to Barrow Road was modelled to determine potential carrier drain sizes which would run beneath the roadside swales. Assuming half the width of a 6.5m road, the width of a 1.8m footpath and width of the swale itself as 2m wide, the carrier drains beneath rain in size from 225mmØ to 450mm. However, the model does not account for the various crossing points from more than one carrier pipe into the downstream pipes, which may result in increased diameters becoming necessary for conveyance purposes.

Due to the contributions of the plots being difficult to fully define (the percentage area of each plot is not known and therefore any full network design could be both under or overestimated), a different approach was taken to further assess the conveyance capability of the pipe-beneath-swale conveyance elements.

5.2.1 Road conveyance only

To test what network capacity would be needed just for the road network, the plot contributing areas from the model were removed and the only contributing areas were the road surfaces. This model resulted in 600mm max pipe diameters for 5-year + 20% allowance for climate change. No flooding occurring in 30-year and 100-year events. This suggests even with no attenuation, 600mm pipes are the maximum required to convey all public realm unattenuated flow, with it being attenuated within the perimeter swales. No allowance in this model is made for the partial attenuation within the roadside swales themselves.

5.2.2 Plot conveyance only

To determine the conveyance requirements of the plots only, the road contributing areas were removed from the model. This retained only the private development plots. To mimic a greenfield run-off rate, the impermeable area contribution was lowered to 30%.

This resulted in 750mm max diameter for 5-year + 20% climate change allowance. This 750mm is confined to just one pipe run along the Luas corridor swale towards the Tolka. Therefore, this conveyance could be refined as part of the swale as a greater conveyance mechanism. This will need to be resolved as part of a detailed design.

5.2.3 Conveyance assessment summary

The contributions from the separate land types result in an absolute maximum pipe diameter of 750mm. What this tells us is that, if combined the diameters would become quite significant at the downstream end but could potentially be incorporated into one carrier drain in the smaller and upper catchment reaches. This will limit the scale of infrastructure throughout the site. These conveyance networks should combine both where possible in the pipe-below-swale arrangement, and beyond that a separate carrier drain would need to be incorporated. This can be resolved as part of the detailed design.

Sample swale sections and locations in plan drawings are appended to this report for reference and show the potential integration of the surface water infrastructure into the public realm.

6 Recommendations & Conclusion

The intention of this document was to set out the RMS for the Broombridge-Hamilton area. The document has identified key constraints, appraised the study area's green infrastructure potential and developed initial land-take requirements for footprint development. It has then taken the intended masterplan footprint and created an integrated surface water conveyance system that complements the intentions of the green infrastructure strategy.

The plan provides both overarching SuDS guidance and site-specific infrastructure elements that complement both the intended layout and the topography and infrastructure constraints of the study area.

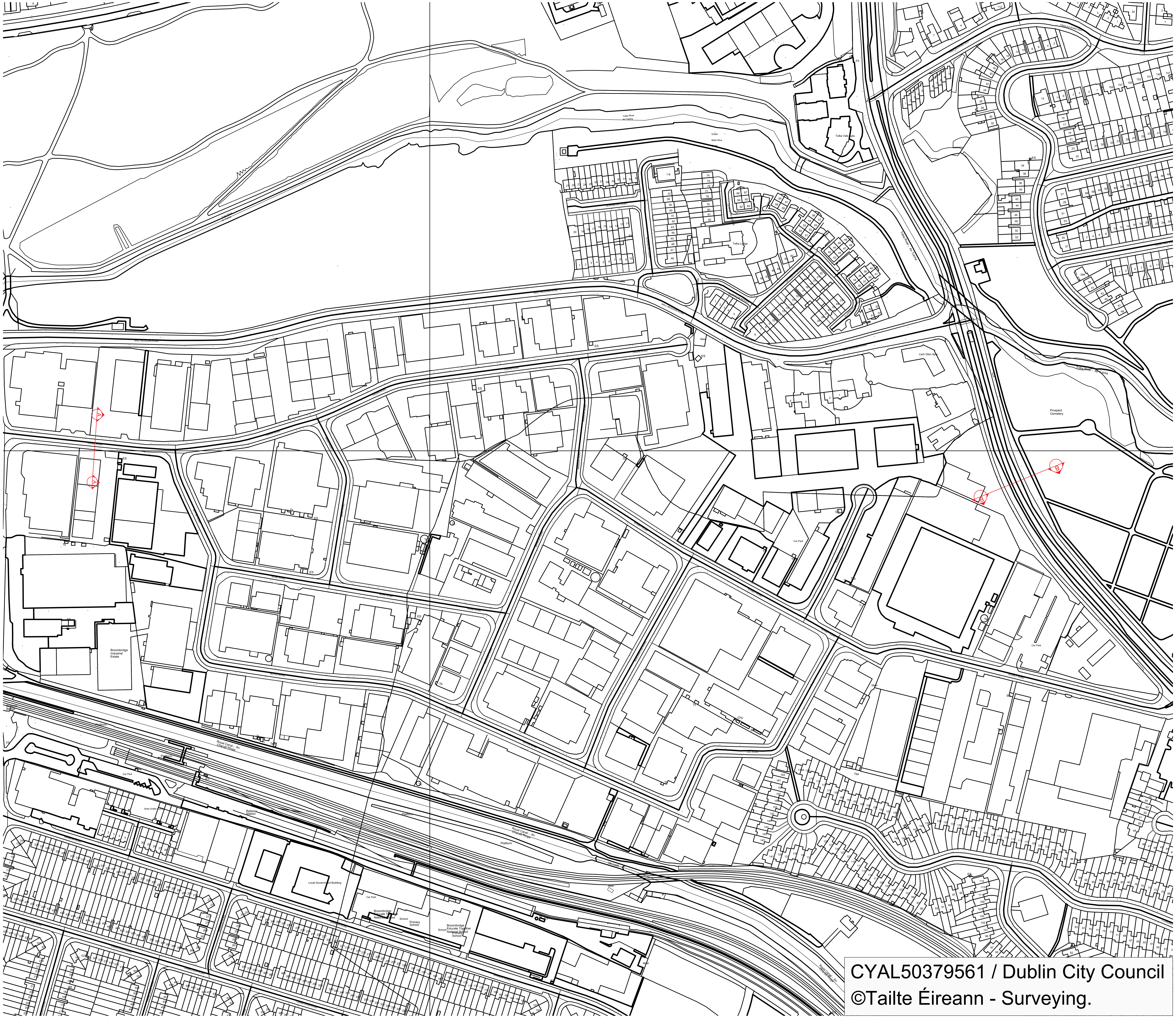
6.1 Recommendations

1. The urban framework was developed as part of an iterative process, where the consideration of integrated sustainable drainage systems into the urban design process was fundamental to refining the development strategy. The baseline hydraulic model of the public realm set out in the Masterplan indicates no flooding during the 30-year event with only minor flooding in the 100-year event. However, such volumes could be contained throughout the swale network using leaky dams, widening in certain locations.

2. This RMS sets out integrated water sensitive urban design solutions to the management of rainwater within the **public realm**. Implementing this water conveyance system will require a detailed design, to be undertaken as part of the upgrade of the street network. This can occur independently from proposals within development parcels and can occur on a phased, incremental basis, subject to detailed designs.

3. Individual development proposals within identified development parcels or on individual sites, will be required to comply with the provisions of the Development Plan, with regards to the management of surface water. This RMS does not replace existing policy requirements.

Appendix A – Drawings



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Drawing Title
Swale Plan

Client
Dublin City Council

Parent Model
MKF-JBAI-XX-XX-DR-C-0002-S3-P01-Swale_Plan.dwg

Security Classification	Scale
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Author	Designer	Checker	Approver
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Suitability	Status	Revision
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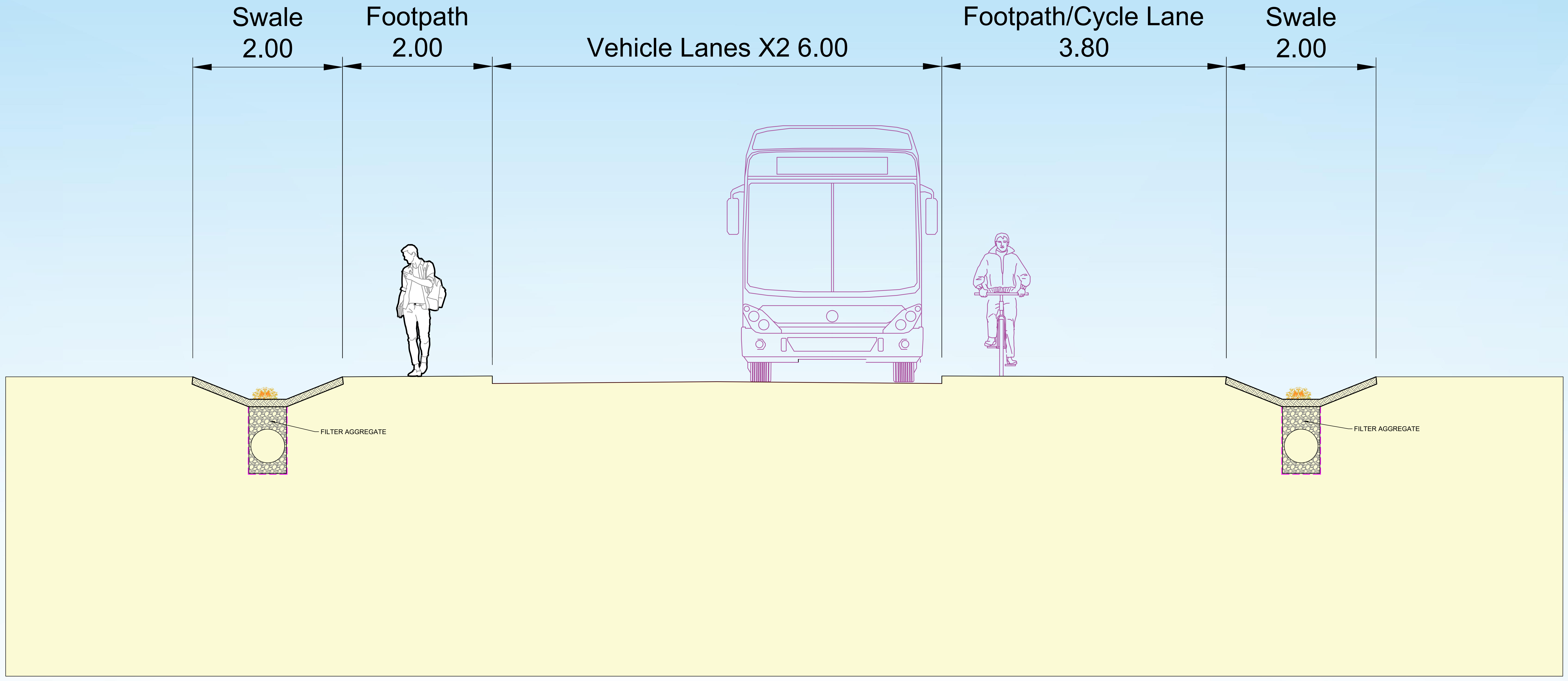
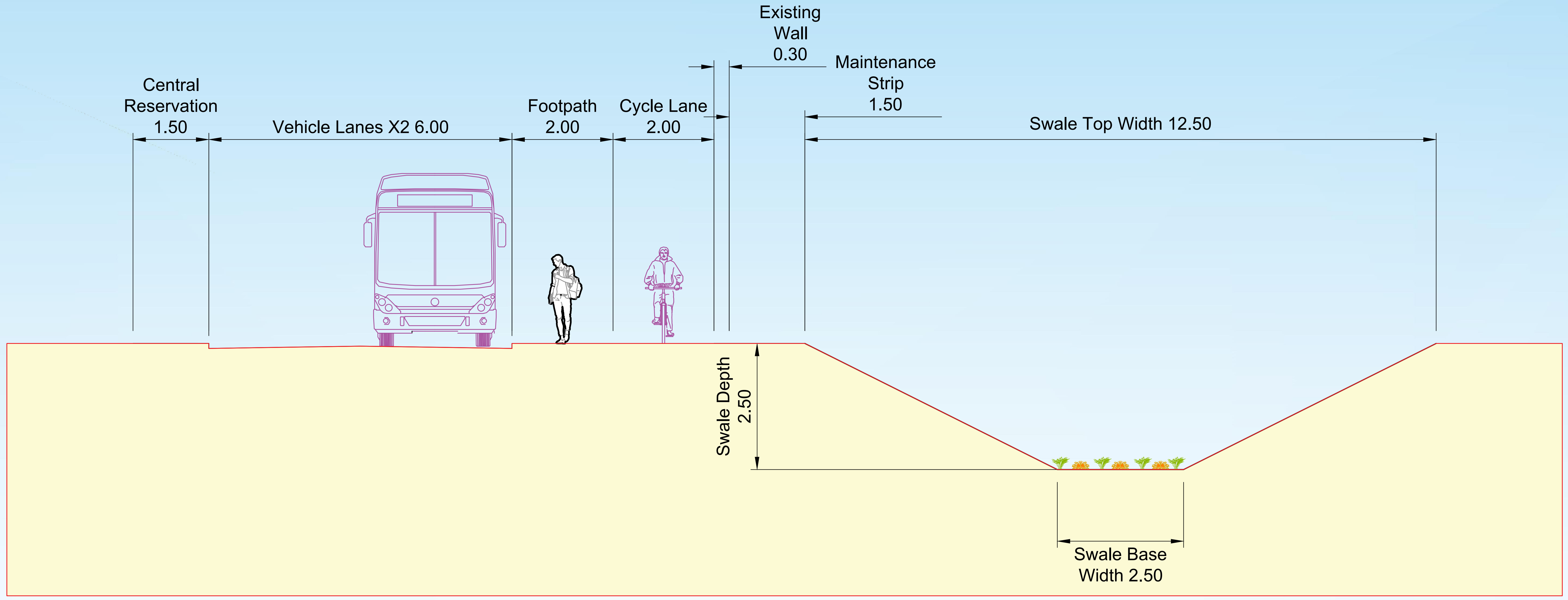


SECTION A-A TYPICAL ROADSIDE SWALE SECTION



SECTION B-B TYPICAL FINGLAS ROAD SECTION

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Project Title

SFRA & SWM - Dublin Industrial Estate

Drawing Title

Swale Sections

Client

Dublin City Council

Parent Model
MKF-JBAI-XX-XX-DR-C-0001-S3-P01-Swale_Sections.dwg

Security Classification
OFFICIAL

Scale
1:500

Author
JS

Designer
PB

Checker
MOD

Approver
MOD

Suitability
SUITABLE FOR REVIEW AND COMMENT

Status
S3

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Appendix B - Surface Water Drainage & SuDS Parameters

Urban development generally results in a high proportion of impervious surfaces, pavements, roadways, roofs etc. Adopting traditional methods of storm water runoff disposal can result in quantities of contaminated surface water run-off entering the drainage network of sewers, culverts, streams, and rivers which can cause both flooding and pollution in downstream catchments. An alternative to this is to use sustainable urban drainage systems.

Sustainable Urban Drainage Systems

The use of SuDS is a way of managing rainfall that mimics natural drainage processes and reduces the impact of development on communities and the environment. Conventional drainage seeks to convey runoff from the catchment to the downstream receptor as quickly as possible. In contrast, SuDS slow the flow and store water in both hard and soft landscape areas, thereby reducing the peak flow from the catchment, limiting the impact on the downstream boundary.

SuDS also use components individually and in series to trap silt and heavy pollution "at source". Many contaminants are broken down naturally as runoff passes from one SuDS component to the next. Multi-functional SuDS components that manage water at or near the surface can bring significant community benefits, adapting their function to the weather. The loss of aquatic habitat is reversed when using the SuDS approach. It allows flora and fauna to flourish and to connect with existing habitats.

Where SuDS are designed as an integral part of the urban fabric, they will help mitigate the contribution to flooding and the impact that development has on the natural landscape. They are also able to rehabilitate the hydrology of the urban environment through sustainable re-development and SuDS retrofit.

There are four key pillars that SUDS design should aim to incorporate. These are presented in Figure B-0-1 below.

Figure B-0-1 SUDS Pillars

Effective application of any SuDS Design must be integrated into the greater green infrastructure strategy for any development and not be considered in isolation or a late stage "add-on". The process is set out below.

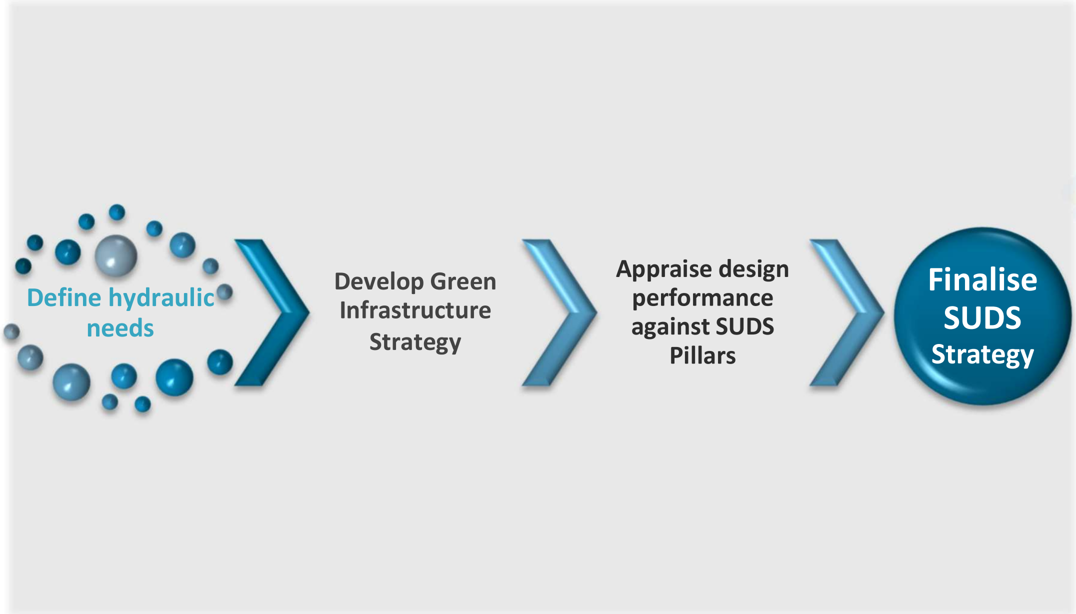


Figure B-0-2 SUDS Application Process

As can be seen, the hydraulic requirements of the SUDS strategy are the first element of the strategy. This is key as it informs the land usage and material usage in both the soft and hard landscaping.

The hydraulic parameters that are to be adhered to are presented in Table B-1. These will inform the level of attenuation and the extent of interception/treatment required, thereby defining the minimum requirements for the landscaping across any development.

This approach is to be taken as complementary to, and not a replacement for, GDSDS and DCC's own SuDS guidance documents.

Table B-1 SuDS Hydraulic Requirements

Key SUDS Pillars	Standard to be achieved	Note
Water Quality	Provide 5mm interception of rainfall using nature-based solutions at source within private development	Interception to be in compliance with Table 24.6 of CIRIA C753
Water Quality	Stormwater run-off on all public thoroughfares to pass through one interception measure prior to entering network.	Interception to be in compliance with Table 24.6 of CIRIA C753
Biodiversity	Public throughfares to incorporate open swales as stormwater carrying elements where possible to promote greater GI connectivity	
Water Quantity	Provide attenuation using green/blue roofs, detention and/or retention ponds or other suitable SuDS measures. Sub-surface attenuation may only be permitted when clear reasoning for alternatives has been provided to DCC.	
Amenity	Green roofs are a requirement for all roof areas for the following development types: Apartments; retail developments, leisure facilities; educational facilities. Where green roofs are not proposed, suitable justification must be submitted to DCC for approval prior to submitting the planning application.	
Water Quantity	Attenuation/storage of flow should be designed for the 1 in 100-year return period. Allow for 30% climate change on rainfall intensity and 10% for urban creep in all network and attenuation designs. Climate change uplift should be applied to rainfall intensity and not attenuation volume. No flooding is permitted in the 1 in 30-year return period.	
Water Quantity	Discharge rates to be restricted to the greater of QBAR or 2 l/s/ha. Flow restricting devices with an orifice of less than 50mm in diameter should be avoided where possible. Diameters of less than 50mm may be accepted by DCC on a case-by-case basis where all runoff passes through at least one SuDS measure and a robust maintenance regime is submitted, to minimise the risk of blockage.	
Water Quantity	Surface water networks are to be designed for a 5-year rainfall return period with a minimum pipe diameter of DN225 (for Taking-in-Charge).	
Biodiversity	Attenuation should be provided by means of detention or retention basins. Justification is to be provided for any departures from this requirement.	

Green Infrastructure Design

The application of SuDS will differ depending on the nature of the site, the ground conditions, topography, proposed land use and downstream receptors.

The requirements of Table B-1 apply to both public and private developments. This includes any new public realm thoroughfares (developed directly by the local authority or as part of a taken-in-charge agreement).

When developing the Green Infrastructure strategy for a development, the key parameters are providing both the minimum level of interception across the site and provide the required level of stormwater attenuation. The following measures are suggested means of achieving this, whilst also addressing the needs of the remaining SuDS pillars.

Interception

Interception is the prevention of run-off (and the associated pollution load) for the majority of small (frequent) rainfall events (or for the initial depth of rainfall for larger events). From a hydraulic perspective, interception is required to mimic greenfield hydraulic response characteristics where small rainfall events do not generally produce any runoff and thus to protect the morphology and ecology of the receiving watercourse, and the hydrological soil water balances in the catchment.

Interception provides both water quantity and water quality benefits and suggested examples are provided in Figure B-below. Each of these is expanded on further in the following section.

Figure B-2 Interception measures

Combinations of rain gardens, permeable pavements, green/blue roofs, and tree pits can usually provide sufficient opportunities for interception of the initial catchment runoff.

Rain Gardens

Bioretention systems including rain gardens collect run-off, allowing it to pond temporarily on the surface encouraging evaporation before filtering the remaining runoff through vegetation and underlying soils. Small scale rain gardens can be situated at street intersections, traffic islands and kerb extensions to create parking bays or traffic calming measures. Rain gardens are an excellent example of how SuDS can be integrated into a streetscape with limited impact on the primary purpose of an urban space.

Figure B-3 Raingarden (Source CIRIA Manual C753)

Permeable Paving

Permeable paving provides a pavement suitable for pedestrian and / or vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored beneath the overlying surface before infiltration to the ground, or controlled discharge downstream. Permeable pavements, together with their associated substructures, are an efficient means of managing surface water run-off close to its source, intercepting run-off, reducing the volume and frequency of run-off, and providing a treatment medium. Treatment processes that occur within the surface structure, the subsurface matrix and the geotextile layers include:

- Filtration
- Adsorption
- Biodegradation
- Sedimentation

Figure B-4 Permeable Paving (Source CIRIA Manual C753)

Bioretention Tree Pits

Trees can help protect and enhance the urban environment by contributing to effective surface water management strategies and adding beauty and character to the urban landscape. Trees and their planting structures provide benefits to surface water management in the following ways:

- Transpiration
- Interception
- Increased Infiltration
- Phytoremediation

Trees can be planted within a range of infiltration SuDS components (e.g., bioretention systems, detention basins, swales) to improve their performance, or they can be used as standalone features within soil-filled tree pits, tree planters or structural soils.

Tree pits can be designed to collect and attenuate run-off by providing additional storage within the underlying structure. The soils around trees can also be used to filter out pollutants from run-off directly. Tree pits are only designed to manage surface water run-off from the local area (typically a similar area that would drain to a single road gully. They should not be used to manage large volumes of water that have been collected via numerous gullies and / or channels within a large sub-catchment. Linear tree pit arrangements along roadsides provide effective interception opportunities for the immediate carriageway runoff, and should be considered where possible.

Figure B-5 Tree Pit (Source: GCL Products)

Swales

Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat, and often attenuate surface water run-off. When incorporated into site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits. They are often used to drain roads, paths, or car parks, where it is convenient to collect distributed inflows of run-off, or as a means of conveying run-off on the surface while enhancing access corridors or other open spaces. Swales can have a variety of profiles, can be uniform or non-uniform, and can incorporate a range of different planting strategies, depending upon the site characteristics and system objectives. Swales can replace conventional pipework as a means of conveying run-off, and the use of adjacent filter strips and / or flow spreaders can also remove the need for kerbs and gullies.

Figure B-6 Swale (Source: biocycle.net)

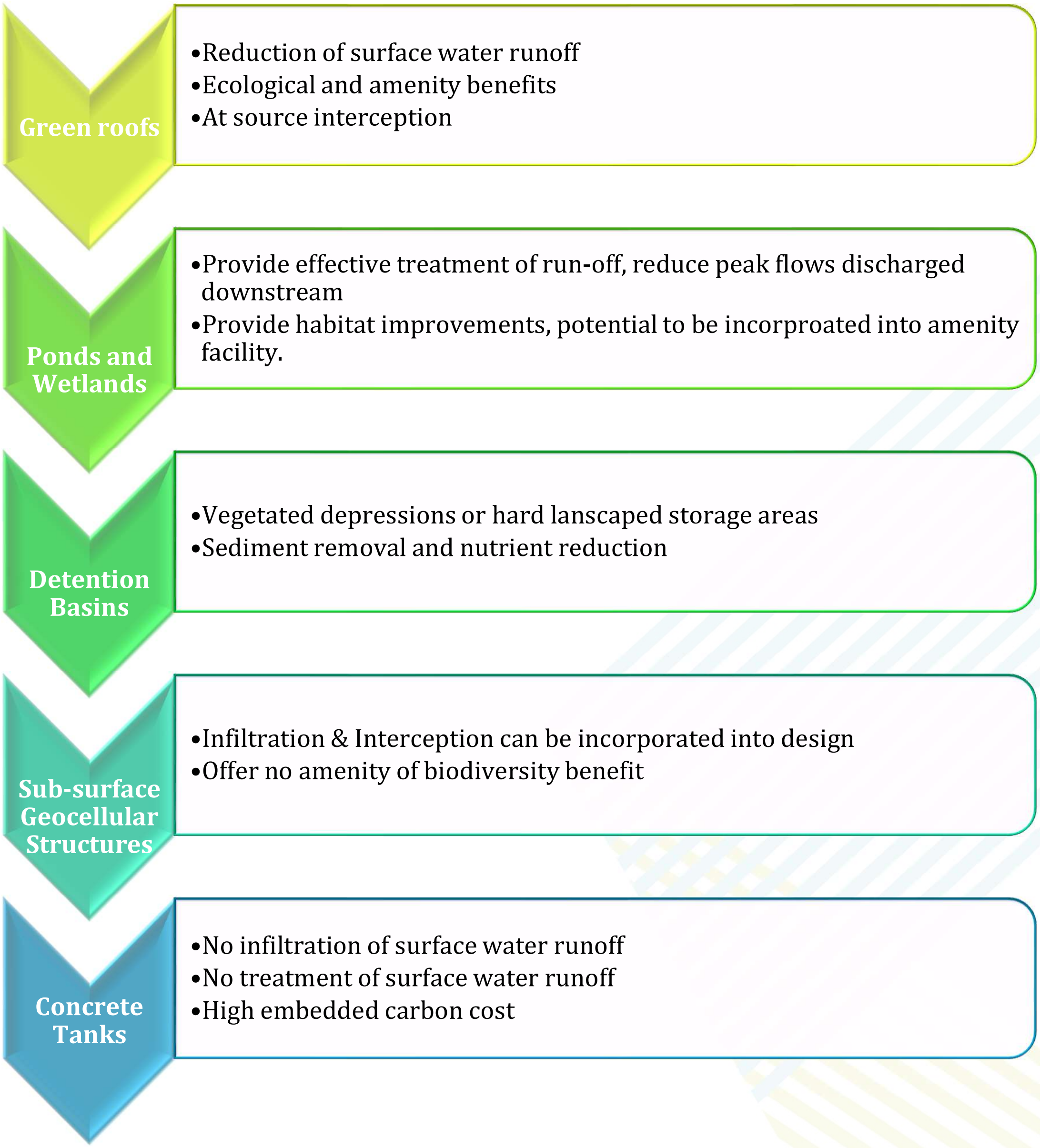
Attenuation

The following section details the measures that should be considered for providing surface attenuation within any proposed development.

Whilst green roofs provide significant interception as well as amenity benefits, they have been included here as attenuation measures. Similarly, detention basins and wetlands within each developed site will provide both interception and treatment benefits.

Attenuation Hierarchy

The graphic below details the hierarchy of attenuation measures that should be considered as part of any development. Justification for the disimissal of any of the storage measures needs to be clearly presented in any submission. This is detailed further in Section 6. The following sections detail the benefits and limitations of each of the attenuation measures referenced in Figure B-0-1.



Green roofs

- Reduction of surface water runoff
- Ecological and amenity benefits
- At source interception

Ponds and Wetlands

- Provide effective treatment of run-off, reduce peak flows discharged downstream
- Provide habitat improvements, potential to be incorproated into amenity facility.

Detention Basins

- Vegetated depressions or hard lanscaped storage areas
- Sediment removal and nutrient reduction

Sub-surface Geocellular Structures

- Infiltration & Interception can be incorporated into design
- Offer no amenity of biodiversity benefit

Concrete Tanks

- No infiltration of surface water runoff
- No treatment of surface water runoff
- High embedded carbon cost

Figure B-0-1 Attenuation Hierarchy

Surface Attenuation Measures

Green/ Blue roofs

Green roofs are areas of living vegetation, installed on the top of buildings, for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water run-off. Types of green roof can be divided into two main categories, extensive and intensive, depending on substrate depth.

Blue roofs are roof design that is explicitly intended to store water and can include open water surfaces, storage within or beneath a porous medium or below a raised decking surface or impermeable cover. Green roofs can be used together with rainwater harvesting systems although the yield from the roof will be significantly lower than a conventional roof.

Figure B-0-2 Accessible Green roof (Source CIRIA Manual C753)

Detention Basins

Detention basins are landscaped depressions that are normally dry except during and immediately following storm events. They can be on-line components where surface run-off from regular events is routed through the basin. When flows rise, because the outlet is restricted, the basin fills and provides storage of run-off and flow attenuation. Detention basins can also be off-line components into which run-off is diverted once flows reach a specified threshold. Detention basins can be vegetated depressions or hard landscaped storage areas. Where the basin is vegetated, the soil surface can absorb some run-off, so can be used to support interception. The principal water quality benefits of vegetated detention basins are associated with the removal of sediment and buoyant materials, but levels of nutrients, heavy metals, toxic materials, and oxygen demanding materials may also be significantly reduced. Water quality benefits of a vegetated detention basin increase as the detention time for an event extends. Where designed appropriately, some or all of the basin area can also be used as a recreational or other amenity facility.

Offline detention basins will normally have an alternative principal use: either as an amenity or recreational facility, or as part of urban hard landscaping. Where there is no upstream pre-treatment, on-line detention basins should include a forebay to try to contain accumulating sediments, although this can result in unusable and unattractive areas, which may not be acceptable for public open space.

Figure B-0-3 Detention Basin (Source CIRIA Manual C753)

Ponds and Wetlands

Ponds and wetlands are features with a permanent pool of water that provide both attenuation and treatment of surface water run-off. They can support emergent and submerged aquatic vegetation along their shoreline and in shallow, marshy zones, which helps enhance treatment processes and has amenity and biodiversity benefits. Dense stands of vegetation facilitate adhesion of contaminants to vegetation, aerobic decomposition of pollutants and can also help stabilise settled sediment and prevent resuspension. Wetlands tend to have greater depth variations and may include shallow islands and aquatic planting regimes. Attenuation storage is provided above the permanent pool and wetland areas. A flow control system at the outfall controls the rates of discharge for a range of water levels, causing the pond volume to fill during storm events. Run-off from each rainfall event is detained and treated in the pool.

Figure B-0-4 Wetland (Source CIRIA Manual C753)

Sub-surface Attenuation Measures

The above-surface measures should be prioritised, but where these are not suitable sub-surface attenuation solutions may be considered. Proprietary products that encourage SuDS like processes should be considered. Reinforced concrete tanks are not permitted unless agreed in advance with DCC and justification outlining how all other options have been exhausted must be provided.

Geocellular and Corrugated Arch Structures

Geocellular storage systems are modular plastic units with a high porosity that can be used to efficiently create a below ground structure for the temporary storage of surface water before controlled release or use.

Plastic corrugated arch structures comprise plastic arches which have an open bottom and are supported by integral plastic feet that are laid on a bed of aggregate. The arches are backfilled with aggregate and are usually laid in rows and are terminated at each end with end caps.

It is recommended that geocellular and corrugated arch systems are installed above the groundwater table, as groundwater pressure significantly increases lateral loads on tank walls, and even minor defects on the surrounding waterproof geomembrane or pipe joints can result in groundwater ingress filling the design storage volume.

Figure B-0-5 Geocellular storage system (Source CIRIA Manual C753)

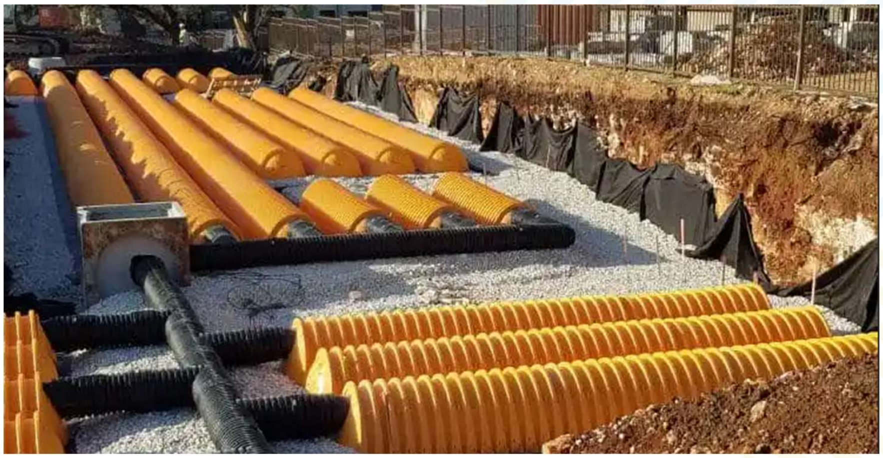


Figure B-0-6 Corrugated Arch Structure (Source CS Engineering)

Concrete Tanks

DCC are not in favour of the use of same and will only be considered in limited exceptional circumstances where clearly demonstrated through evidence-based assessment that Concrete tanks, while sub-surface, with no land take required, are a means of attenuation only. They provide no opportunity to treat surface water, contain high embedded carbon and inherit onerous health & safety maintenance regimes.

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