Dublin Mountains Visitor Centre

Engineering Report for Planning
DMVC-ROD-XX-XX-RP-C-EngRpt

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ROD
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Comhairle Contae
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South Dublin County Council

Dublin Mountains Visitor Centre, Hell Fire Club, Dublin

Engineering Report for Planning

1. INTRODUCTION

This report has been prepared as part of a planning package submitted on behalf of South Dublin County Council regarding the proposed development at the Hell Fire Club (Montpelier Hill) in Dublin. This report sets out the Engineering basis for the planning stage design of the scheme in terms of surface drainage, foul drainage and water supply.

2. PROPOSED DEVELOPMENT

The development site consists of two large hillside woodland areas, the Hell Fire Woods (105 hectares) and Massy's Woods (42 hectares), located 2.5km to the south of Dublin's urban fringe, to the west and east of the R115 road respectively.

The site contains a number of protected structures including the Hell Fire Club, passage tombs, wedge tombs, standing stones and Massy's Woods walled gardens and associated ruins.

The proposed development will consist of:

- Improvements to existing entrance to the Hell Fire Woods from the R115, with provision of pedestrian footpaths. The R115 will be a two-way road, 5-6m wide with a 1.5m wide footpath. Some isolated sections will be a 3-3.5m single lane road, with traffic calming markings.

- Upgrade works to existing car park to increase parking provision from 80 no. car parking spaces to 275 no. car parking spaces and 5 no. coach parking spaces.

- Replacement of the conifer trees around the parking area that are due for felling in accordance with sustainable forest planting.

- Construction of visitor centre building at the Hell Fire Woods (Gross floor area: 966 sq. m) (Dublin Mountains Visitor Centre), to consist of two buildings side by side, situated parallel to the existing forest road, at a level of approx. 300m above sea level. They will contain basic facilities for walkers and casual visitors, a seated café for 80 no. people and an interpretation, exhibition and education facility.

- Construction of pedestrian footbridge and 'bridge house' to link the Hell Fire Woods to Massy's Woods, crossing over the R115.

- Development of new trails including a circular walkway to the summit of Montpelier Hill, encircling the Hell Fire Club (protected structure) and the Neolithic passage tombs. The circular walkway will incorporate information panels for visitor orientation and interpretation.

- General upgrading of existing trails and routes in accordance with guidelines produced by Irish Trails.

- Conservation works to the Hell Fire Club building, a protected structure. To be conserved as a ruin with minimal intervention, with discreet lighting proposed on the interior of the building as part of a long-term monitoring and management programme.

- Conservation works to Massy's Woods walled gardens, a protected structure. To be conserved as a ruin with minimal intervention through removal of overgrowth currently causing damage to the structure(s).

- Conversion of coniferous forest to northern and eastern slopes of Montpelier Hill into a permanent broadleaved/ mixed woodland landscape. Commercial forestry to the west will be retained.

- Installation of a 150mm diameter sewage pipe running under the R115 which will connect the proposed site to the existing sewer network.

- Construction of a series of six small storage ponds / wetlands across the lower areas of Montpelier Hill as part of a sustainable drainage strategy.

- Provision of discreet lighting to the car park area, along the treetop bridge and along the forest road route to the visitor centre building.

3. SITE INFORMATION

3.1 Site Location

To the north the site is bounded by the townlands of Oldcourt, Woodtown and Newtown and by the Dublin Mountains, culminating at Kippure (Co. Wicklow) in the south. The Hell Fire Woods are bounded to the west by the R114 and the Ballymorefinn Road and to the east partially by the R116, which runs into the Wicklow Way. This area is the most mountainous in Dublin and is also where the River Dodder rises, feeding into the reservoirs at Bohernabreena and giving rise to the picturesque linear parks along the Dodder Valley.

3.2 Site Topography

The site slopes steeply upwards from the east to west with a rise of approximately 41m from the existing car park entrance to the proposed visitor centre (gradient of 1:4.5). The R115 Killakee Road falls from south to north at an approximate gradient of 1:13.

3.3 Site Hydrology

Rainfall currently runs off Montpelier Hill easterly to the R115 Killakee Road and to the north of the Massy's Woods catchment area. A river runs in a northerly direction through the site, along the eastern boundary of Massy's Woods. This river is one of the headwaters of the Owendoher River, a significant river in south Dublin.

The GSI mapping website, www.gsi.ie, classifies the groundwater aquifer in the area as a locally important aquifer – bedrock which is moderately productive only in local zones. The groundwater vulnerability at the site is classified as extreme.

Refer to Appendix A for details of the GSI Maps.

3.4 Site Geology

Information obtained from the GSI website indicates that the site has predominantly shallow soils derived from non-calcareous rocks or gravels over bedrock outcrop and subcrop.

Six trial pits were undertaken at the site. Two trial pits were excavated in Massy's Woods to investigate the suitability of the area for on-site disposal of wastewater.

Two trial pits were also excavated at the location of the proposed car park and two at the location of the proposed buildings to investigate the type of soil and depth to bedrock in these locations. The trial pits undertaken indicate that rock is relatively close to the surface at the location of the proposed building. The subsoil in this area and at the location of the proposed car park consists predominantly of sand. The depth to rock at the proposed car park is approximately 1.6m. In Massy's Wood, the subsoil is predominantly clay, indicating that it will have poor infiltration rates. Bedrock was not encountered in the trial pits in Massy's Woods.

A detailed Site Investigation will be completed prior to construction to provide details of the geology of the site.

Refer to Appendix A for details of the Site Geology.

4. WATER SUPPLY

4.1 Existing Water Supply

There is no existing water supply serving the site of the proposed development.

4.2 Proposed Water Supply

A new watermain line will be required to serve the development. The closest existing public watermain is located at the intersection of the R115 (Old Military Road/Killakee Road) and the R113 (Gunny Hill).

A new connection will be required into this 4" UPVC pipe and approximately 1.5km of new 150mm diameter watermain pipe will be required along the Old Military Road/Killakee Road and up the eastern face of Montpelier Hill to bring the watermain supply to the proposed visitor centre.

The new watermain will be located a minimum of 6m away from the proposed building and will comply with the Irish Water Requirements and Standard Details for Watermains. A pre connection enquiry has been submitted to Irish Water but no response has been received at the time of writing this report.

It is estimated that visitor numbers will grow to approximately 300,000 per annum by the end of the completed developments fifth year. This equates to average weekly visitor numbers of 5,769 and average daily visitor numbers of 824.

The main features of the proposed development that will require a water supply are the restaurant and toilet facilities. The EPA Wastewater Treatment Manual for Small Communities, Business, Leisure Centres and Hotels gives daily usage estimates for each of these facilities:

- Restaurant – 15 L/day per person
- Bar drinkers - 10 L/day per person
- Bar staff - 60 L/day per person
- Toilet blocks (per use) – 5 L/day per person

Based on these values and the projected visitor numbers the future peak daily demand has been calculated as 10.678 m^3/day, refer to section 5.2.1 below.

It should be noted that an allowance has been made for the demand for drinking water for visitors. The result of this is that the incoming daily demand noted in section 4.2 is greater than the outgoing daily demand in section 5.2.1.

All watermains will be constructed in accordance with Irish Water requirements.

Refer to Appendix B for a sketch of watermain records provided by South Dublin County Council.
Refer to Appendix D for water demand calculations
Refer to Drawings DMVC-ROD-Z0-00-DR-C-0030-32 for the proposed watermain layout

5. FOUL DRAINAGE

It is proposed to provide new separate surface water and foul drainage systems to serve the proposed development. This section outlines the existing foul drainage services onsite and gives our proposals for the additional foul water drainage requirements proposed for the development.

5.1 Existing Foul Drainage

There is no existing foul drain serving the site of the proposed development.

5.2 Proposed Foul Drainage

A new foul sewer line will be required to serve the development. The closest existing public foul sewer is located at Hunters Meadow at the bottom of Gunny Hill (R113).

An option of collecting and treating the foul discharge on site was examined as part of the design process. However, due to the poor infiltration encountered in the trial holes and the shallow rock levels, the site was not deemed suitable for on-site treatment and ground discharge. Any effluent from the system would likely make its way to the Glendoo Brook and result in potential pollution. Therefore, it is proposed to construct a 150mm diameter sewer from the visitors centre to the car park entrance. This will connect into a newly constructed 150mm diameter sewer that will run below the new footpath/carriageway from the car park entrance to the intersection of the Old Military Road/Killakee Road and Gunny Hill. The sewer will follow Gunny Hill until it connects into the existing 225mm diameter foul sewer at Hunters Meadow. The new sewer line will be approximately 2.5km long.

There are concerns that the construction of a public sewer line at this location will open up the surrounding area for development and expansion of the Dublin urban area. With this in mind, the smallest allowable pipe was chosen for the design. This has greatly reduced the potential of the pipe to be used as a connection point for a large scale development.

A steep gradient is required for the sewer to suit the steep nature of the site. The sewer gradient from the visitor centre to the car park entrance is limited to a maximum of 1:10 and the gradient from the car park entrance to the proposed connection is limited to a maximum of 1:10.This is shallower than the existing surface gradient which, from the visitor centre to the car park entrance is 1:5. The gradient from the car park entrance to the proposed connection is 1:13.

This has been done to ensure that the flow in the pipe is at a speed which prevents separation of the fluids and solids. If the sewer is too steep, the fluid flows at a faster speed and the solid potion is left behind, leading to blockages. The flow velocity in the pipe has been limited to 3m/sec when flowing full in accordance with the Irish Water Code of Practice for Wastewater Infrastructure. The maximum gradient of 1 in 10 has been calculated using the Colebrook-White formula for the flow capacity of

pipeline to cater for the above velocity.To facilitate this approach backdrop manholes are required in the design.

Recessed manhole covers will be used where required within the curtilage of the site.

A pre-connection enquiry has been submitted to Irish water but no response has been received at the time of writing this report.

5.2.1 Hydraulic & Organic Loading

Daily foul discharge has been estimated based on predicted visitor and staff numbers and flow rates. Flow rates are in accordance with the EPA Wastewater Treatment Manual for Small Communities, Business, Leisure Centres and Hotels.

The projected total wastewater discharges are indicated in Table 5.1 below:

Table 5.1 - Hydraulic & Organic loading calculations

Type of Dwelling	Equivalent Persons	Flow (l/day/person)*	Hydraulic Loading (l/day)	BOD (g/day/ person)*	Organic Loading (g/day BOD_5)
Ammenity	968	10.2	9,854	12.1	11,726

* EPA Wastewater Treatment Manual for Small Communities, Business, Leisure Centres and Hotels.

Design Flow: = 9,854 litres per day

Organic Load: = 11.7 kg (BOD_5)/day

For context, the design flow for 10 average households is approximately 4,200 litres per day** and the organic load is approximately 2.1 kg (BOD_5)/day**.

** Code of Practice: Wastewater Treatment and Disposal Systems Serving Single Houses (p.e. ≤ 10) Chapter 4 recommends a daily hydraulic loading of 150 l/person be used. Table 4.1 gives a typical concentration of BOD5 as 150-500 mg/l. An average household is assumed to have 2.8 persons

All foul drainage shall be constructed in accordance with Greater Dublin Regional Code of Practice for Drainage Works and Irish Water requirements.

Refer to Appendix B for a sketch of Drainage Records provided by South Dublin County Council.
Refer to Appendix C for a copy of the Preconnection Enquiry submitted to Irish Water
Refer to Appendix D for water demand calculations
Refer to Drawings DMVC-ROD-Z0-00-DR-C-0030-32 for proposed foul drainage layout

6. SURFACE WATER DRAINAGE

It is proposed to provide new separate surface and foul drainage systems to serve the proposed development. This section outlines the existing surface water drainage services on site and gives our proposals for the additional surface water drainage requirements as part of the development.

6.1 Existing Surface Water Drainage

The site is not served by any existing surface water drainage system and rainfall currently runs off to the road to east of site, to the north of the Massy Woods catchment area.

6.2 Proposed Surface Water Drainage

It is proposed to construct a new surface water drainage system for the development to collect runoff from roads, roofs and other hardstanding areas.

Run-off from the visitor centre will be collected and outfall along a stream running north into a new man made pond (Pond A). From this the runoff will zig-zag down the hillside through a series of streams and small shallow ponds (Ponds B and C). A series of bends and natural water slowing obstacles such as rocks, small boulders and railway sleepers will be used to restrict the flow.

The new car park is comprised of three tiers of parking with 275 car spaces and 5 bus spaces. Runoff from the circulation road will flow east into swales / streams running adjacent to the parking tiers. These swales will be small scale and of a similar fashion to the stream from the visitor centre. The swales will flow into a number of small shallow ponds (Ponds F & G). The car parking spaces will be grasscrete permeable paving. This will reduce the runoff from the new car park. More details on grasscrete are contained in Section 6.2.1. A petrol interceptor will be used to capture any pollutants arising from vehicles in the car park.

A drainage ditch will run between the eastern site boundary and the lowest tier of parking. During the public consultation process, a number of local landowner reported that there can be considerable surface water run-off from the hill side at the location of the car park. While this was not observed by the design team, a stream has been provided that extends beyond the end of the proposed car parking as indicated on the drainage drawing. This stream will intercept and collect any additional water running down the hill at this location and provide an additional level of protection to the properties below.

All of the surface will flow into a larger pond located next to the entrance of the site (Pond D). This will connect to a hydrobrake manhole and will be utilised only when the outflow backs up from the hydrobrake.

A hydrobrake manhole will limit the outflow from Pond D to 2.0l/s/ha (Qbar) in accordance with the South Dublin County Council Requirements. This is considerably less than the calculated greenfield runoff rate of 5.54l/s/ha in the 1 in 100 year event. The hydrobrake will discharge through a culverted / piped connection under the existing road (R115) and flow into the Glendoo Brook in Massy's Woods.

The existing road drainage system from the car park entrance north comprises of drainage ditches to either side of the road. It is proposed to retain this system, however, where required gullies will be utilised in certain locations to increase the conductivity of surface water to the drainage ditches.

All surface water drainage shall be constructed in accordance with Greater Dublin Regional Code of Practice for Drainage Works and South Dublin County Council requirements.

Refer to Drawings DMVC-ROD-Z0-00-DR-C-0030-32 for proposed surface water drainage layout

Refer to Appendix G for typical surface water storage details taken from the C753 CIRIA SuDS Manual.

6.2.1 SUDS Approach

This should be read in conjunction with the following:

(i) Appendix E – Surface Water Storage Calculations
(ii) Drawings DMVC-ROD-Z0-00-DR-C-0030-32

As part of the development, a number of different SuDS measures are proposed to minimise the impact on water quality and quantity of the runoff and maximise the amenity and biodiversity opportunities within the site. This is in line with the Infrastructure & Environmental Quality (IE) Policy 2 Objective 1 of the South Dublin County Council Development Plan 2016 – 2022 which aims to

"*To maintain and enhance existing surface water drainage systems in the County and promote and facilitate the development of Sustainable Urban Drainage Systems (SUDS), including integrated constructed wetlands, at a local, district and County level, to control surface water outfall and protect water quality*".

Chapter 6 of the EIAR that was compiled for this development identifies three existing ponds in the area that are suitable habitats for the Common Frog and the Smooth Newt. The ponds have been selected as a Key Ecological Receptor in the EIAR. The new ponds that form the surface water drainage design will provide additional areas for these species and may have an ecological benefit to the site. The construction and operation of the proposed development will maintain a drainage neutral situation. Thus, there will be no indirect impacts on sensitive aquatic environments.

The proposed SuDS measures will include a combination of Source Control, Site Control and Regional Control measures as part of a Management Train whereby the surface water is managed locally in small sub-catchments rather than being conveyed to and managed in large systems further down the catchment. The combination of the SuDS measures outlined below will maximise the potential for surface water infiltration to the subsoil, reducing the impact on the existing surface water drainage network downstream.

It is proposed to provide the following SuDS measures:

1) Grasscrete
2) Ponds

Grasscrete

It is proposed to provide a grasscrete finish to the parking spaces. Grasscrete is a type of permeable paving which allows penetration of groundwater to the storage layers below. A total of 275 number parking spaces will be provided as part of the proposed development. A stone storage layer will be provided below the surface of the grasscrete parking spaces. This storage layer has been sized to provide storage for the surface water runoff from the parking spaces for a 1 in 100 year rainfall event including a 20% increase in rainfall depth to account for climate change. The storage layer will be a total of 500mm deep and will have a voids ratio of 30%. This storage layer will provide 475m^3 of storage which exceeds the 410m^3 required for the 1 in 100 year event. The water will make its way through the ground and via filter drains to the swales / streams.

Ponds

In total 6 ponds will be required to store the runoff. These are spread across the site and are of varying areas. It is important that the total storage capacity of the ponds meets the site outflow (ie. 792.0 cu. m). A table of the proposed pond dimensions is shown below in Table 6.1

Table 6.1 – Pond Schedule

Pond	Pond Volume (m^3)
A	187
B	38
C	38
D	326
E	0
F	66
G	137
Total Volume	792
Required Volume	792

* Pond E no longer used

The ponds will be manmade but will have a "natural feel" to suit the surrounding woodland area. It is envisaged that the runoff will flow into these ponds sequentially during rainfall. The ponds will be constructed with gently side slopes (1:3) may operate as recreational areas during dry periods, although a level of standing water may be kept if conditional. The depths of the ponds have been kept shallow to promote use during dry periods.

The total storage volume provided in the basin is 792.0 cu. m which meets the level of storage required for a 1 in 100 year rainfall event including a 10% increase in rainfall intensity to account for climate change.

Green Roofs

Green Roofs comprise a multi-layered system which covers the roof of a building with vegetation and landscaping over a drainage layer. They are designed to intercept and retain precipitation which reduces the volume and rate of surface water runoff. It is proposed to provide green roofs to a proportion of the roof area of apartment buildings. The roof area of the apartment buildings will be approximately 30% green roof. Residual runoff from the green roofs will be discharged to the surface water drainage network.

6.3 Flood Risk Assessment

The site slopes steeply to the east at an approximate gradient of 1:4.5. Although, the site receives a high volume of rainfall, the low permeability of the soil and the steep gradient of the site results in rainfall running off to the road to east of site, to the north of the Massy's Woods catchment area. The rainfall flows into the Glendoo Brook; this is an open stream that runs in a northerly direction through the site, along the eastern boundary of Massy's Woods. This river is one of the headwaters of the Owendoher River, a significant river in south Dublin.

The new visitor centre is at a level of 296m OD. The existing car park is at a level of 268m OD. The northern section of Massy's Woods is at a level of approximately 261m OD and falls to steeply approaching the Glendoo Brook.

The main construction elements of the project, the visitor centre and car park are approximately 400m from this watercourse. No works are proposed in the vicinity of the watercourse. The OPW Preliminary Flood Risk Assessment (PFRA) maps have been consulted to identify the fluvial and pluvial flood extents of the watercourse. The footprint from the *Fluvial – Indicative 1% AEP (100-yr) Event* for the Glendoo Brook was examined and as mentioned above is approximately 400m from the construction elements of the project. A *Pluvial – Indicative 1% AEP (100-yr) Event* is shown approximately 500m from the visitor centre but at a lower level.

The information provided in this section identifies that there is an extremely low risk of Fluvial or Pluvial flooding arising from this development.

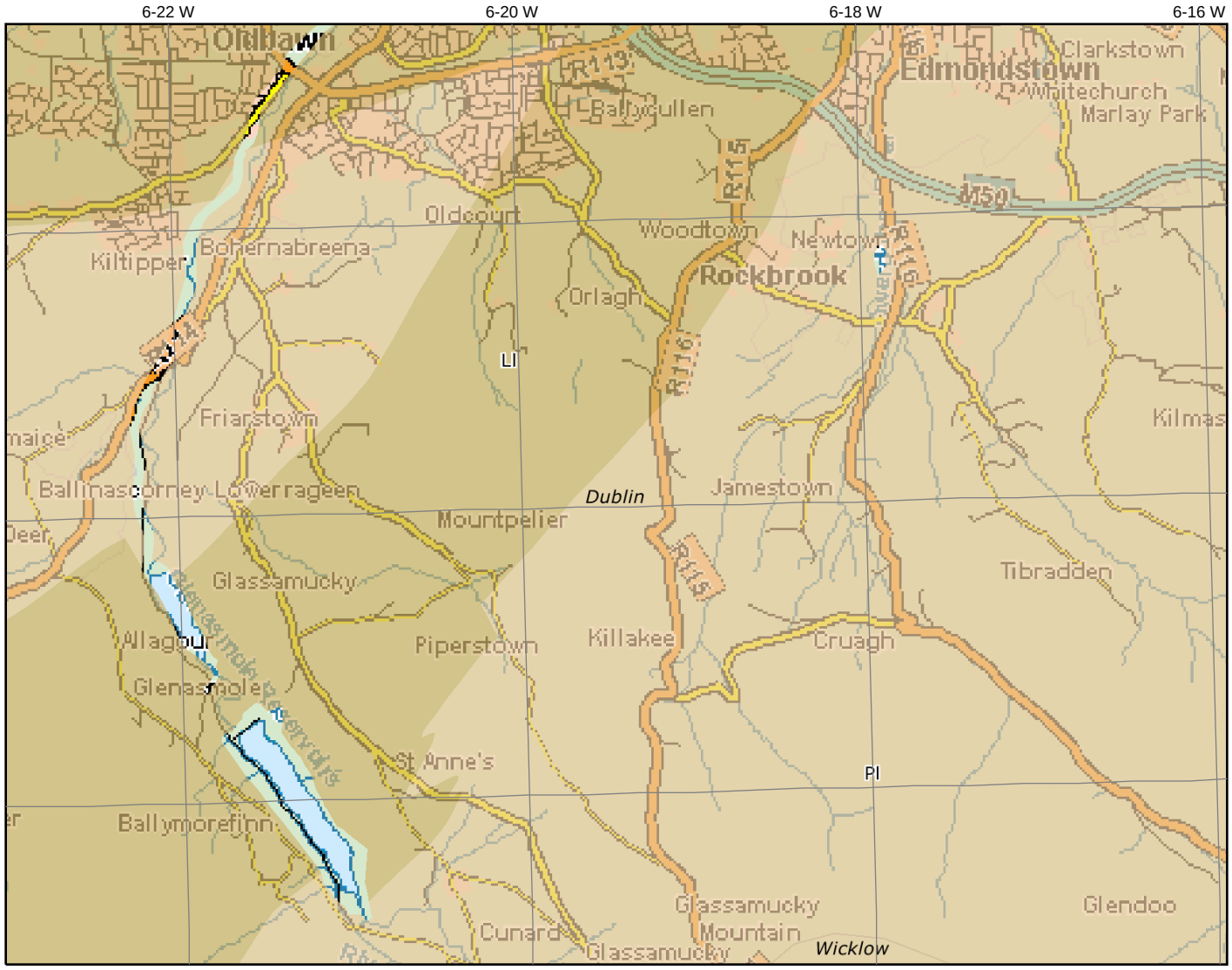
Refer to Appendix F for the OPW Preliminary Flood Risk Assessment (PFRA) maps

7. SUMMARY

- Water will be supplied to the development from the existing water supply at Stocking Lane approximately 1km from the site.
- Separate foul and surface water drainage systems will be constructed to serve the site.
- The foul network serving the site will discharge to the existing foul network at Woodstown Village approximately 2km from the site.
- The site will incorporate SuDS measures promoting treatment of surface water prior to discharge.
- Any excess surface water from the site which doesn't infiltrate to the subsoil will be collected and attenuated within the SUDS measures on site before discharging to the open stream at the east of the site.
- Storage will be provided below the grasscrete finish on the car parking spaces to attenuate the surface water runoff from the car park.

APPENDIX A
SITE GEOLOGY

Bedrock Aquifer Map



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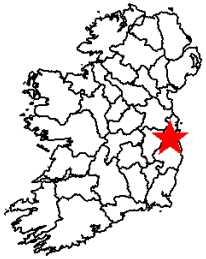


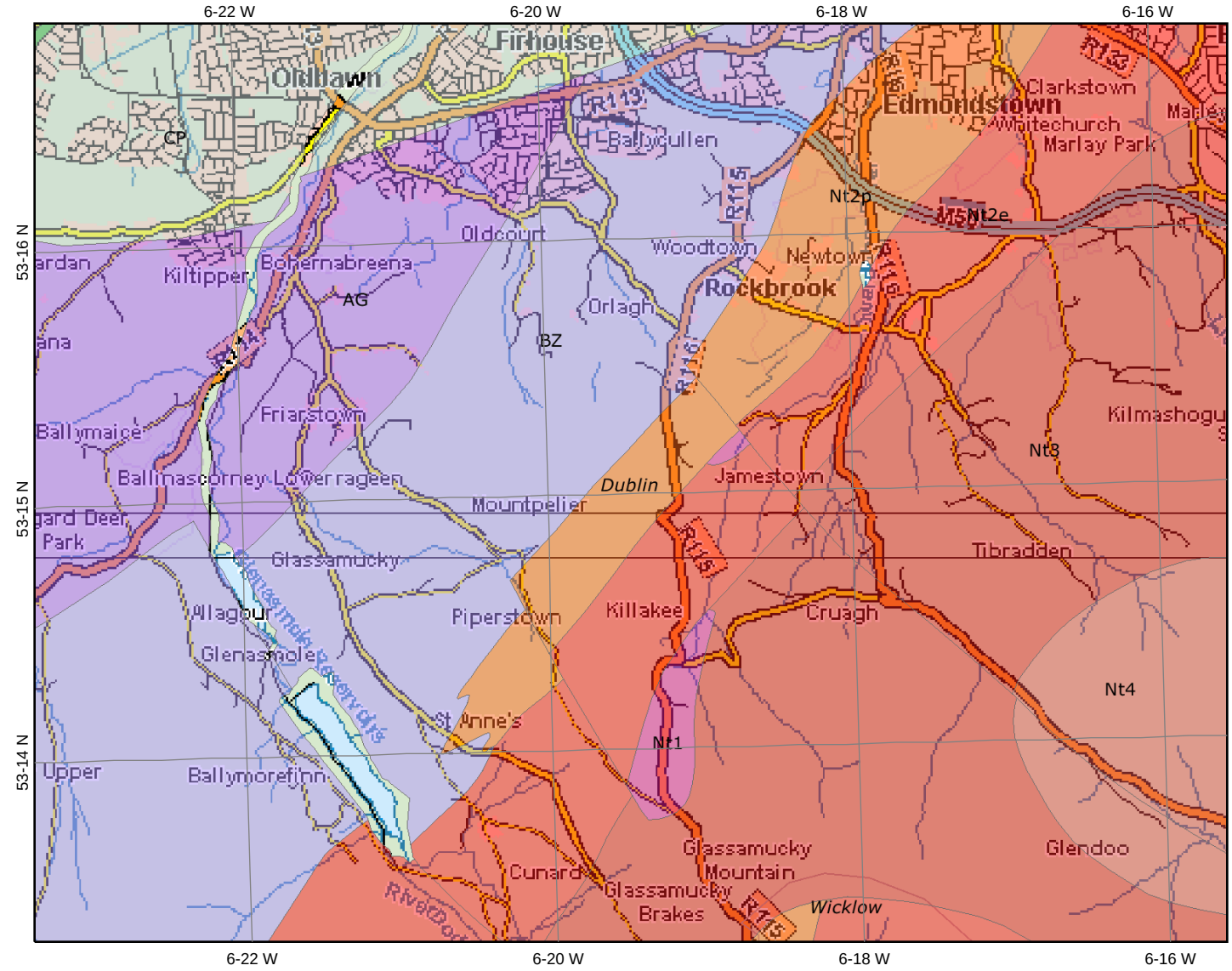
Legend

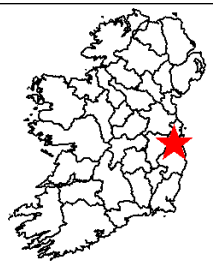
National Draft Bedrock Aquifer Map

- Rf - Regionally Important Aquifer - Fissured bedrock
- Rk - Regionally Important Aquifer - Karstified
- Rkd - Regionally Important Aquifer - Karstified (diffuse)
- Rkc - Regionally Important Aquifer - Karstified (conduit)
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Lk - Locally Important Aquifer - Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- Unclassified
- Irish National Seabed Survey Zones (50m-5000m)
- Irish Designated Seabed Zone Bathymetry

Scale: 1:42,604

Bedrock





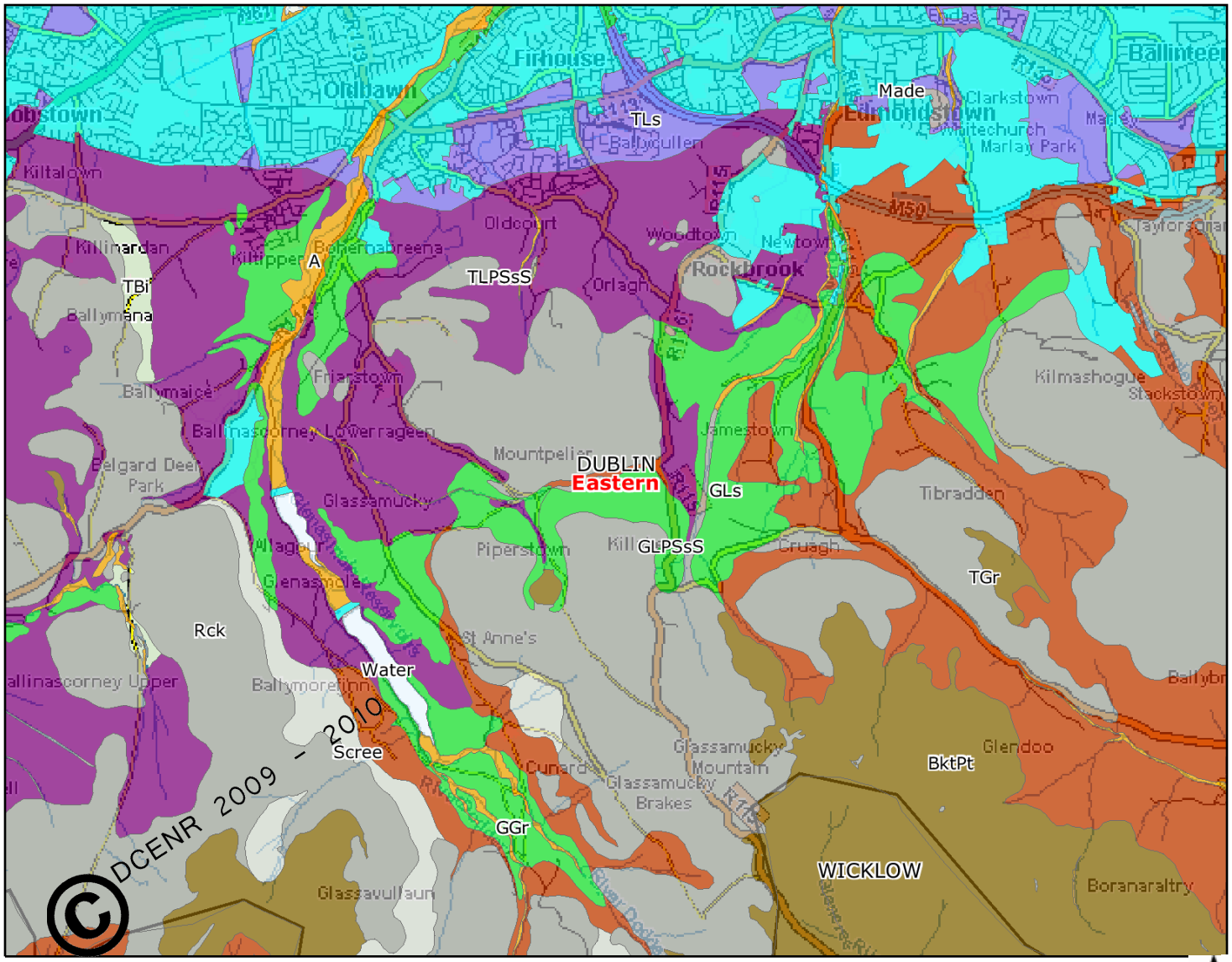
Legend

Bedrock 100k Solid Geology

- AA - Aille and Barney Fms (undifferentiated)
- AA - Allen Andesite Formation
- AAwp - Westport Oolite
- AB - South Achillbeg Formation
- ABcg - Achillbeg Conglomerate Member
- ABps - Achillbeg Lighthouse Psammite Member
- ABsl - Achillbeg School Black Slate Member
- AD - Aghaward Formation
- AD - Ardagh Shale Formation
- AD - Ardenagh Formation
- AD - Ashleam Bridge Dolomitic Formation
- AE - Aghamore Formation
- AE - Ardane Formation
- AG - Addergoole River Formation
- AG - Aghfarrell Formation
- AG - Aghmacart Formation
- AGdh - Dowery Hill Member
- AGdo - Aghmacart Formation
- AH - Achill Head Formation
- AH - Arklow Head Formation
- AHfv - in Arklow Head Formation
- Al - Aille Limestone Formation
- AK - Askingarran Formation
- AL - Altan Limestone Formation
- AL - Annascaul Formation
- AL - Argillaceous Limestones (Visean)
- ALmk - in Argillaceous Limest (Visean)
- AN - Anaffrin Formation
- AN - Annabella Formation
- ANgm - Glennamong Member
- ANrd - Old Road Member
- AP - Ards Pelite Formation
- AP - Ashleam Head Formation

Scale: 1:46,768

Teagasc Subsoil Map



Map center: 311730, 223182

Legend

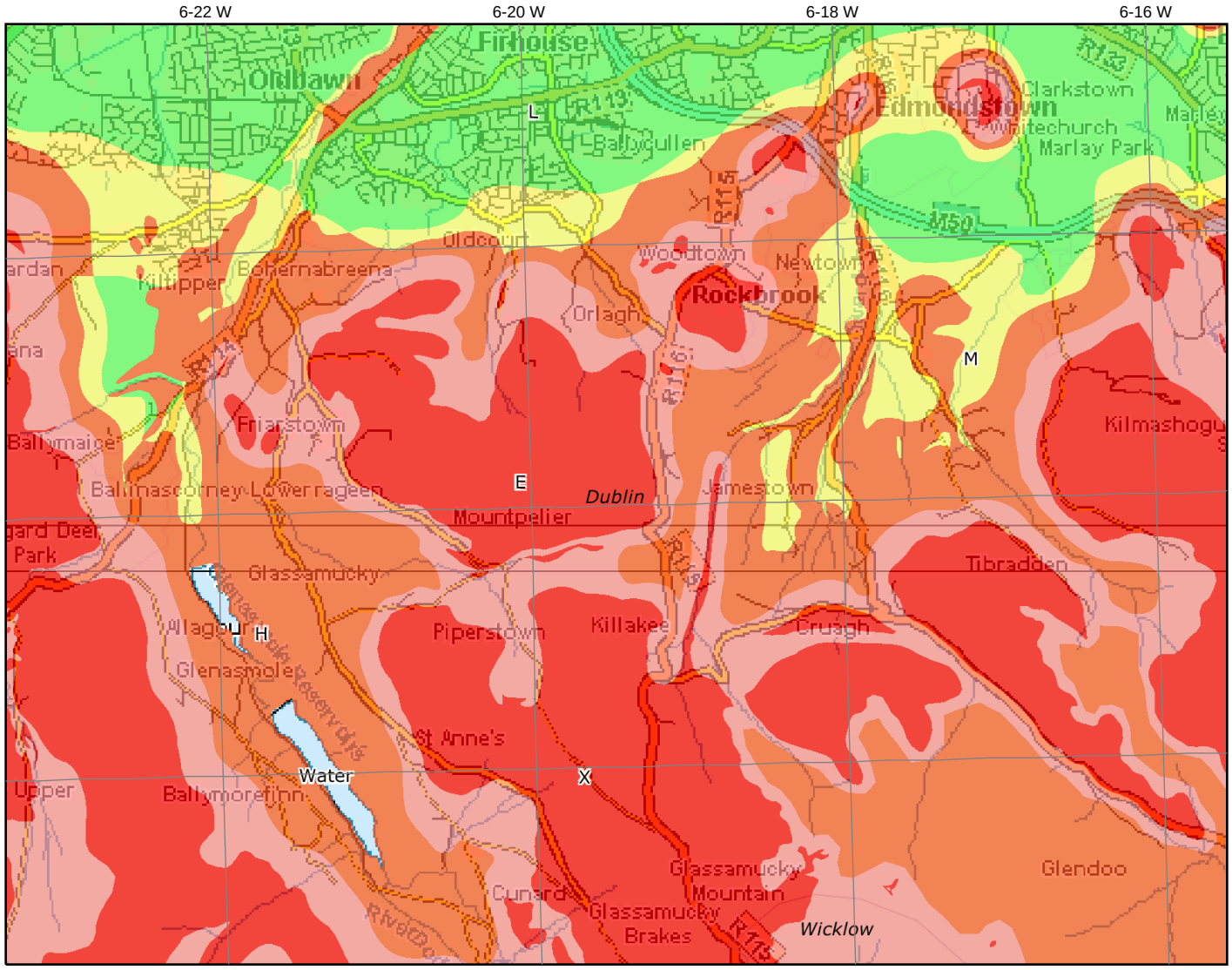
RBD Subsoils

- Alluvium
- Beach sands and gravels
- Bedrock outcrop and subcrop
- Esker sands and gravels
- Glaciofluvial sands and gravels
- Lake sediments
- Made ground
- Marine/estuarine silts and clays
- Marsh
- Peat
- Scree
- Till derived chiefly from Devonian sandstones
- Till derived chiefly from Lower Palaeozoic rocks
- Till derived chiefly from Namurian rocks
- Till derived chiefly from granite
- Till derived chiefly from limestone
- Till derived chiefly from metamorphic rocks
- Till derived from metamorphic rocks
- Till derived from mixed Devonian and Carboniferous rocks
- Water
- Windblown sands
- RBD Boundaries
- County Boundaries

Scale: 1:54,177

Snapshot Date: 23-Sep-2015

Groundwater Vulnerability



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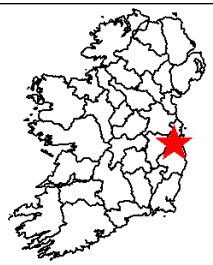

Legend

Vulnerability

- X (Rock near Surface or Karst)
- E - Extreme
- H - High
- M - Moderate
- L - Low
- Water

- Irish National Seabed Survey Zones (50m-5000m)
- Irish Designated Seabed Zone
- Bathymetry

Scale: 1:46,768

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Dublin Mountains Visitor Centre

Preliminary Ground Investigation

1. Introduction

This technical paper has been prepared to outline the preliminary ground investigations undertaken for Dublin Mountains Visitor Centre project. Six trial pits were undertaken by a contractor appointed by Coillte with visual inspections carried out by ROD on the 10th December 2015.

2. Trial Pit Log

Six trial pits in total were undertaken. Two trial pits were excavated in Massey's Wood to investigate the suitability of the area for on-site disposal of wastewater. Two trial pits were also excavated at the location of the proposed car park and two at the location of the proposed buildings to investigate the type of soil and depth to bedrock in these locations. The location of each trial pit is shown on the location plan in appendix A. Table 2.1 summarises the findings of each trial pit.

Table 2.1 – Trial Pit Summary

Trial Pit	Depth (m)	Predominant Soil Type	Comments
TP101	1.5m	Clay	Likely to have poor infiltration rates.
TP102	1.7m	Clay	Likely to have poor infiltration rates.
TP103	1.6m (rock encountered)	Sand	At proposed car park.
TP104	1.4m	Sand	At proposed car park.
TP105	1.2m (rock encountered)	Sand	At location of proposed building.
TP106	0.9m (rock encountered)	Sand	At location of proposed building.

Photographs of each trial pit, including the base of the pit, the side of the excavation and the excavated material were taken for each trial pit. Refer to Appendix B for the photographs of each trial pit.

3. Conclusions

The trial pits undertaken indicate that rock is relatively close to the surface at the location of the proposed building. The subsoil in this area and at the location of the proposed car park consists predominantly of sand. The depth to rock at the proposed car park is approximately 1.6m. In Massey's Wood, the subsoil is predominantly clay, indicating that it will have poor infiltration rates. Bedrock was not encountered in the trial pits in Massey's Wood.

David Fahey, Engineer, Roughan & O'Donovan Consulting Engineers.

Appendix A – Trial Pit Location Plan

TRIAL PIT LOCATIONS

1 HELL FIRE CLUB

2 ARCHAEOLOGY ENCLOSURE - MAKING OF THE KINGS

3 SHUTTLE DROP OFF

4 EVENTS

5 DUBLIN MOUNTAINS VISITOR CENTRE

6 BRIDGE HOUSE

7 TREETOP FOOTBRIDGE

8 ARRIVAL PROMENADE

9 UPGRADED CAR PARK

10 STEWARD'S HOUSE COMPLEX

11 MASSY'S GARDENS

12 MASSY'S FORREST KIOSK AND WORKSHOP

13 MASSY'S POTTING SHED

14 TO STOCKING LANE COACH PARK

PROJECT: DUBLIN MOUNTAINS

DRAWING: PREFERRED OPTION: MASTERPLAN

JOB NO: 1545 **DRAWING NO. :** 1545 / PO / 001 / A

SCALE: 1: 3000 **DATE :** NOV 15

PKA PAUL KEOGH ARCHITECTS

Appendix B – Trial Pit Photos

Trial Pit Ground Investigations – 10th December 2015

TP101

TP102

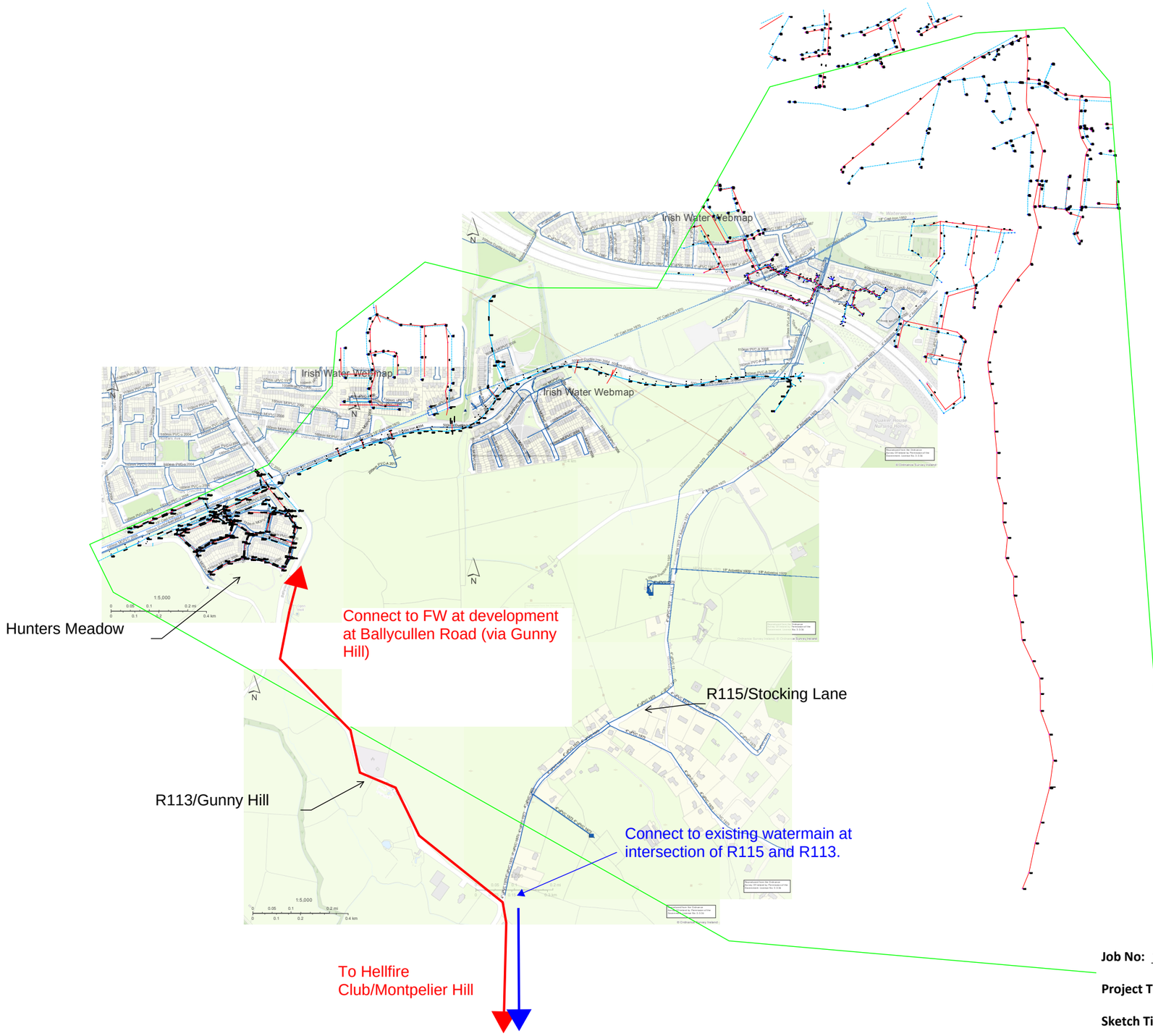
TP103

TP104

TP105

TP106

APPENDIX B
DRAINAGE AND WATERMAIN RECORDS



NOT TO SCALE - SKETCH ONLY

Job No: 15.189

Project Title: DMVC

Sketch Title: FW / Watermain Connection

Sketch No: SK 00X

By: kieran.oriordan

Date: 22/06/2017

ROD
ROUGHAN & O'DONOVAN
Consulting Engineers
Civil - Structural - Environmental
Arena House, Arena Road,
Sandyford, Dublin 18.
Tel : +353 1 2940800
e-mail : info@rod.ie
www.rod.ie

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

APPENDIX C
COPY OF PRECONNECTION ENQUIRY FORM

Pre-connection enquiry form

Industrial and commercial developments, mixed use developments, housing developments, business developments

This form is to be filled out by applicants enquiring about the feasibility of a water and/or wastewater connection to Irish Water infrastructure. If completing this form by hand, please use BLOCK CAPITALS and black ink.

Please refer to the **Guide to completing the pre-connection enquiry form** on page 12 of this document when completing the form.

Section A | Applicant details

1 **WPRN number (where available):**

2 **Applicant details:**

Registered company name (if applicable):

Trading name (if applicable):

Company registration number (if applicable):

If you are not a registered company/business, please provide the applicant's name:

SOUTH DUBLIN COUNTY COUNCIL

Contact name:

Postal address: COUNTY HALL TALLAGHT

DUBLIN 24 D24YNN5

Eircode: D24YNN5

Telephone: 014149000

Mobile:

Email: INFO@SDCC.IE

3 **Agent details (if applicable):**

Contact name: KIERAN O'SULLIVAN

Company name (if applicable): ROUGHAN O'DONOVAN

Postal address: ARENA HOUSE

ARENA ROAD

SANDYFORD DUBLIN 18

Eircode: D18V8P6

Telephone: 012940800

Email: info@rod.ie

Section C | Water connection and demand details

14 **Is there an existing connection to public water mains at the site?** Yes ☐ No ☑

15 **Is this enquiry for an additional connection to the one already installed?** Yes ☐ No ☑

16 **Is this enquiry to increase the size of an existing water connection?** Yes ☐ No ☑

17 **Is this enquiry for a new water connection?** Yes ☑ No ☐

18 **Approximate date water connection is required:** 01 / 05 / 2019

19 **Please indicate pre-development water demand (if applicable):**

Pre-development peak hour water demand	0	**l/s**
Pre-development average hour water demand	0	**l/s**

Pre-development refers to brownfield sites only. Please include calculations on the attached sheet provided.

20 **Please indicate the domestic water demand (housing developments only):**

Post-development peak hour water demand		**l/s**
Post-development average hour water demand		**l/s**

Please include calculations on the attached sheet provided.

21 **Please indicate the business water demand (shops, offices, schools, hotels, restaurants, etc.):**

Post-development peak hour water demand	0.15	**l/s**
Post-development average hour water demand	0.12.	**l/s**

Please include calculations on the attached sheet provided. Where there will be a daily/weekly/seasonal variation in the water demand profile, please provide all such details.

22 **Please indicate the industrial water demand (industry-specific water requirements):**

Post-development peak hour water demand		**l/s**
Post-development average hour water demand		**l/s**

Please include calculations on the attached sheet provided. Where there will be a daily/weekly/seasonal variation in the water demand profile, please provide all such details.

23 **What is the existing ground level at the property boundary at connection point (if known) above Malin Head Ordnance Datum?**

262 m

24 **What is the highest finished floor level of the proposed development above Malin Head Ordnance Datum?**

302 m

36 **Please indicate the industrial wastewater hydraulic load (industry-specific discharge requirements):**

Post-development peak discharge		**l/s**
Post-development average discharge		**l/s**

Please include calculations on the attached sheet provided.

37 **Wastewater organic load:**

Characteristic	Max concentration (mg/l)	Average concentration (mg/l)	Maximum daily load (kg/day)
Biochemical oxygen demand (BOD)	500	325	3202
Chemical oxygen demand (COD)			
Suspended solids (SS)	700	450	4434.3
Total nitrogen (N)	80	51	503
Total phosphorus (P)	20	12.5	123
Other			

Temperature range	
pH range	

38 **Storm water run-off will only be accepted from brownfield sites that already have a storm/surface water connection to a combined sewer. In the case of such brownfield sites, please indicate if the development intends discharging surface water to the combined wastewater collection system:**

Yes ☐ No ☒

If 'Yes', please give reason for discharge and comment on adequacy of SUDS/attenuation measures proposed.

Please submit detailed calculations on discharge volumes, peak flows and attenuation volumes with this application.

39 **Do you propose to pump the wastewater?** Yes ☐ No ☒

If 'Yes', please include justification for your pumped solution with this application.

40 **What is the existing ground level at the property boundary at connection point (if known) above Malin Head Ordnance Datum?**

262 m

41 **What is the lowest finished floor level on-site above Malin Head Ordnance Datum?** 302 m

Section F | Supporting documentation

Please provide the following additional information:

> Site location map: A site location map to a scale of 1:1000, which clearly identifies the land or structure to which the enquiry relates. The map shall include the following details:

a) The scale shall be clearly indicated on the map.

b) The boundaries shall be delineated in red.

c) The site co-ordinates shall be marked on the site location map.

> Details of planning and development exemptions (if applicable).

> Calculations (calculation sheets provided below).

> Site layout map to a scale of 1:500 showing layout of proposed development, water network and wastewater network layouts, additional water/wastewater infrastructure if proposed, connection points to Irish Water infrastructure (if known).

> All design submissions as outlined in the Irish Water Codes of Practice for Water Infrastructure and the Irish Water Codes of Practice for Wastewater Infrastructure, including the layout of all other services to be provided within the site (for example: gas, electricity, telecommunications).

> Any other information that might help Irish Water assess this pre-connection enquiry.

Section G | Declaration

I/We hereby make this application to Irish Water for a water and/or wastewater connection as detailed on this form.

I/We understand that any alterations made to this application must be declared to Irish Water.

The details that I/we have given with this application are accurate.

I/We have enclosed all the necessary supporting documentation.

Signature: [signature] Date: 22/06/2017

Your full name (in BLOCK CAPITALS):

KIERAN ORJORDAN

Irish Water will carry out a formal assessment based on the information provided on this form.
Any future connection offer made by Irish Water will be based on the information that has been provided here.

Please submit the completed form to **newconnections@water.ie** or alternatively, post to:

Irish Water
PO Box 860
South City Delivery Office
Cork City

For office use only:

Input customer number:

WATER DEMAND

Predicted Visitors

Annual Visitors	300,000
Peak Weekly use factor[1]	0.02
Peak Weekly use	5,769
Peak Day factor[2]	0.14
Peak daily use (persons)	824

Estimated person use

	Flow litres/day per person[5]	BOD5 grams/day per person[5]
Restraunt	15	15
Bar drinkers	10	10
Bar Staff	60	30
Toilet blocks (per use)	5	10

water requirement

	% of visitors using[3]	Persons using each	Flow litres/day	BOD5 grams/day
restraunt	0.4	330	4945	4945
bar	0.15	124	1236	1236
staff		20	1200	600
toilet[4]		495	2473	4945
Total Out	Total Out	968	9854	11726
Out	Out	Average (per hour)	411	489
		Normal (per hour over 8 hour period)	1232	1466
		Peak	513	611
Additional for drinking water			824	
Total In			10678	
In	In	Average (per hour)	445	
		Normal (per hour over 8 hour period)	1335	
		Peak	556	

Additional for drinking water

visitors	824
l/visitor	1
demand per day	824.18
demand per hour	103.02

1 Assume even distribution of visitors across weeks.
2 Assume even distribution of visitors across days.
3 Financial Plan - Table 4.2
4 Toilet use assumed to be - total visitors minus visitors using restraunt.
5 Waste Water Treatment Manual Table 3
6 Assume 1l per person as drinking water

AVERAGE DEMAND = 445 L/hour = 0.12 L/s

PEAK DEMAND = 556 L/hour = 0.15 L/s.

On-site storage

N/A

Fire flow requirements

~~N/A~~

STORAGE REQUIRED FOR 1 HOUR.

- ASSUME REQUIRED FLOW OF 1000 L/MINUTE = $\frac{1000}{60}$ L/s = 16.7 L/s.

⇒ STORAGE = 1000(60) = 60,000 L

TANK VOLUME = 60m^3

Flow balancing and pumping

N/A

Question 19: If the site was previously in use, please provide details of the pre-development peak hour and average hour water demand.

Question 20: Please provide calculations for domestic water demand and include your calculations on the calculation sheet provided. Demand rates (peak and average) are site specific. Average demand is the total daily volume divided by a 24-hour time period and expressed in litres per second (l/s). For design purposes, please refer to the Irish Water Codes of Practice for Water Infrastructure.

Question 21: If this connection enquiry concerns a business premises, please provide calculations for the water demand and include your calculations on the calculation sheet provided. Business premises include shops, offices, hotels, schools, etc. Demand rates (peak and average) are site specific. Average demand is the total daily volume divided by a 24-hour time period and expressed in litres per second (l/s). For design purposes, please refer to the Irish Water Codes of Practice for Water Infrastructure.

Question 22: If this connection enquiry is for an industrial premises, please calculate the water demand and include your calculations on the calculation sheet provided. Demand rates (peak and average) are site specific. Average demand is the total daily volume divided by a 24-hour time period and expressed in litres per second (l/s). The peak demand for sizing of the pipe network will be as per the specific business production requirements. For design purposes, please refer to the Irish Water Codes of Practice for Water Infrastructure.

Question 23: Please specify the ground level at the location where connection to the public water mains will be made. This is required in order to determine if there is sufficient pressure in the existing water infrastructure to serve your proposed development. Levels should be quoted in metres relative to Malin Head Ordnance Datum.

Question 24: Please specify the highest finished floor level on-site. This is required in order to determine if there is sufficient pressure in the existing water infrastructure to serve your proposed development. Levels should be quoted in metres relative to Malin Head Ordnance Datum.

Question 25: If storage is required, water storage capacity of 24-hour water demand must usually be provided at the proposed site. In some cases, 24-hour storage capacity may not be required, for example 24-hour storage for a domestic house would be provided in an attic storage tank. Please calculate the 24-hour water storage requirements and include your calculations on the attached sheet provided. Please also confirm that on-site storage is being provided by ticking the appropriate box.

Question 26: The water supply system shall be designed and constructed to reliably convey the water flows that are required of the development including fire flow requirements by the Fire Authority. The Fire Authority will provide the requirement for fire flow rates that the water supply system will have to carry. Please note that while flows in excess of your required demand may be achieved in the Irish Water network and could be utilised in the event of a fire, Irish Water cannot guarantee a flow rate to meet your fire flow requirement. To guarantee a flow to meet the Fire Authority requirements, you should provide adequate fire storage capacity within your development. Please include your calculations on the attached sheet provided, and further provide confirmation of the Fire Authority requirements.

Question 27: Please identify proposed additional water supply sources, that is, do you intend to connect to the public water mains or the public mains and supplement from other sources? If supplementing public water supply with a supply from another source, please provide details as to how the potable water supply is to be protected from cross contamination at the premises.

Section D | Wastewater connection and discharge details

Question 28: Please indicate if a wastewater connection to a public sewer already exists for this site.

Question 29: Please indicate if this enquiry relates to an additional wastewater connection to one already installed.

Question 30: Please indicate if you are proposing to upgrade the wastewater connection to facilitate an increased discharge. Irish Water will determine what impact this will have on our infrastructure.

Question 31: Please indicate if this enquiry relates to a new wastewater connection for this site.

Question 32: Please specify the approximate date that the proposed connection to the wastewater infrastructure will be required.

Question 33: If the site was previously in use, please provide details of the pre-development peak and average wastewater discharge.

Dublin Mountain Visitor Centre – Location Plan

GREEN ROOF

GRASSCRETE PARKING

STOP

CAR PARKING BAYS TO BE FUTURE PROOFED FOR ELECTRIC CHARGING POINTS

PEDESTRIAN CROSSING SIGN AS PER W140 OF THE T.S.M

FEATURE ENTRANCE SEE ARCHITECT'S DRAWINGS

60kph SPEED LIMIT SIGN RUS 042 AS PER THE T.S.M

ROAD NARROWS ON BOTH SIDES AS PER W070 OF THE T.S.M

PEDESTRIAN CROSSING

PEDESTRIAN CROSSING SIGN AS PER W140 OF THE T.S.M

CATTLE/ANIMAL CROSSING TO BE AGREED WITH LOCAL LANDOWNER

Scale 1:500 @ A1

Coordinates (Irish Grid) -
Easting - 312079
Northing - 223741

J:\2015\15189\02 Dwgs\05 Planning\DMVC-ROD-C-DR-XX-ZO-0001.dwg

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

APPENDIX D
FOUL WATER / WATERMAIN DEMAND

Predicted Visitors

Annual Visitors	300,000
Peak Weekly use factor[1]	0.02
Peak Weekly use	5,769
Peak Day factor[2]	0.14
Peak daily use (persons)	824

Estimated person use

	Flow litres/day per person [5]	BOD5 grams/day per person [5]
Restraunt	15	15
Bar drinkers	10	10
Bar Staff	60	30
Toilet blocks (per use)	5	10

water requirement

	% of visitors using[3]	Persons using each	Flow litres/day	BOD5 grams/day
restraunt	0.4	330	4945	4945
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staff		20	1200	600
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Total Out	Total Out	968	9854	11726
Out	Out	Average (per hour)	411	489
		Normal (per hour over 8 hour period)	1232	1466
		Peak per hour	513	611
Additional for drinking water			824	
Total In			10678	
In	In	Average (per hour)	445	
		Normal (per hour over 8 hour period)	1335	
		Peak hour	556	
		Average (per second)	0.12	
		Peak per second	0.15	

Additional for drinking water

visitors	824
l/visitor	1
demand per day	824.18
demand per hour	103.02

1 Assume even distribution of visitors across weeks.
2 Assume even distribution of visitors across days.
3 Financial Plan - Table 4.2
4 Toilet use assumed to be - total visitors minus visitors using restraunt.
5 Waste Water Treatment Manual Table 3
6 Assume 1l per person as drinking water

APPENDIX E
SURFACE WATER STORAGE CALCULATIONS

ROD
ROUGHAN & O'DONOVAN
Consulting Engineers
Civil - Structural - Transportation -Environmental

Job Title: Project Name	Job no: XX.XXX	Member/ Location: Location Details	Calcs by: XX Date: XX/XX/XXXX	Sheet No: X Checked by: XX Date: XX/XX/XXXX

Ref.	Calculations	Output

ALLOWABLE OUTFLOW FROM CATCHMENT

Notes:
If AREA < 50hectares, QBAR = 0.00108 x (AREA)^0.89 x (SAAR)^1.17 x (SOIL)^2.17 (Institute of Hydrology Report No. 124)
Use min AREA 50hectares (GDSDS Volume 2 Section 6.3.1.2.2)

If AREA > 50hectares, QBAR = 0.00066 x (AREA)^0.92 x (SAAR)^1.22 x (SOIL)^2.00 (Flood Studies Supplementary Report No. 6)

User input required in cells marked yellow

Area = 0.18 hectares

Catchment Area m^2	Catchment Area km^2	Catchment Area ha	SAAR mm	SOIL	QBAR m^3/sec	QBAR l/sec	Return Period years	Growth Curve Factor	Modified QBAR l/sec	Allowable Outflow per Hectare l/sec/ha
500,000	0.500	50.000	800	0.30	0.1065	106.53	1	0.85	90.55	**1.81**
500,000	0.500	50.000	800	0.30	0.1065	106.53	QBAR	1.00	106.53	**2.13**
500,000	0.500	50.000	800	0.30	0.1065	106.53	10	1.70	181.10	**3.62**
500,000	0.500	50.000	800	0.30	0.1065	106.53	30	2.09	223.11	**4.46**
500,000	0.500	50.000	800	0.30	0.1065	106.53	100	2.60	277.19	**5.54**
500,000	0.500	50.000	800	0.30	0.1065	106.53	200	2.89	308.32	**6.17**

ROD
ROUGHAN & O'DONOVAN
Consulting Engineers
Civil - Structural - Transportation -Environmental

Job Title: PROJECT TITLE

Job no: XX.XXX

Member / Location: Location Details

Sheet no: X

Calcs by: XX

Checked by: XX

Date: XX/XX/XXX

Date: XX/XX/XXX

Ref: | Calculations | Output

Surface Water Attenuation & Storage

User INPUT

Total Area to be Drained		1.850	Sq m	2 Day M5 (mm) =		101.90 mm
Impermeability Factor		1.00		Ratio 60 Minute M5/2 Day M5	r	0.21
Storm Return Period	T	100	Yrs	Impermeable Area		1850 Sq m
Allowable Discharge **per hectare**		2.13	l/s	Allowable Discharge	P	0.02 Cu m/min
Time of Concentration	TC	8.00	min	60 Minute M5		21.80 mm
				Storage Event		Maximum Event

Storage C = Q*TS - P*(TS + TC) + P^2*TC/Q

W = LN(1.06 * M5-60/(48*r))
X = LN(721/(1 + 15 * D))
Y = LN(48 * r/1.06)
Z = LN(721/16)
LN(M5-D) = LN(D) + W + (X * Y)/Z

Cr = J0 + J1 * (M5-D) + J2 * (M5-D)^2

LN((MT-D)/M5-D)) = Cr * (LN(T) - 1.5)

Time of Storm TS	Time of Storm D	Time of Concentration TC	W	X	Y	Z	LN(D)	LN(M5-D)	M5-D	Rainfall Intensity	J0	J1	J2	Cr	M100-D	Rainfall Intensity +10%	Discharge to Storage	Discharge to Storage Q	Storage Required C
Minutes	Hours	Minutes							mm	mm/hr					mm	mm/hr	l/s	Cu.m/min	Cu. m
3	0.050	8.0	0.811	6.021	2.271	3.808	-2.996	1.406	4.079	81.579	0.165	0.008	-0.000305	0.194	7.443	163.756	84.152	5.049	14.89
5	0.083	8.0	0.811	5.770	2.271	3.808	-2.485	1.767	5.852	70.225	0.165	0.008	-0.000305	0.203	10.996	145.142	74.587	4.475	22.07
7	0.117	8.0	0.811	5.569	2.271	3.808	-2.148	1.984	7.269	62.305	0.165	0.008	-0.000305	0.209	13.920	131.250	67.448	4.047	27.97
10	0.167	8.0	0.811	5.328	2.271	3.808	-1.792	2.196	8.993	53.959	0.165	0.008	-0.000305	0.215	17.537	115.742	59.479	3.569	35.26
13	0.217	8.0	0.811	5.134	2.271	3.808	-1.529	2.343	10.413	48.060	0.165	0.008	-0.000305	0.219	20.523	104.192	53.543	3.213	41.27
16	0.267	8.0	0.811	4.971	2.271	3.808	-1.322	2.454	11.632	43.621	0.165	0.008	-0.000305	0.220	23.066	95.148	48.895	2.934	46.37
20	0.333	8.0	0.811	4.789	2.271	3.808	-1.099	2.568	13.042	39.127	0.235	-0.001	-0.000017	0.222	25.978	85.729	44.055	2.643	52.21
25	0.417	8.0	0.811	4.600	2.271	3.808	-0.875	2.678	14.563	34.951	0.235	-0.001	-0.000017	0.220	28.837	76.130	39.122	2.347	57.91
30	0.500	8.0	0.811	4.441	2.271	3.808	-0.693	2.766	15.894	31.788	0.235	-0.001	-0.000017	0.218	31.305	68.871	35.392	2.124	62.81
45	0.750	8.0	0.811	4.075	2.271	3.808	-0.288	2.953	19.173	25.564	0.235	-0.001	-0.000017	0.214	37.237	54.614	28.066	1.684	74.53
60	1.000	8.0	0.811	3.808	2.271	3.808	0.000	3.082	21.800	21.800	0.235	-0.001	-0.000017	0.210	41.832	46.015	23.647	1.419	83.52
75	1.250	8.0	0.811	3.597	2.271	3.808	0.223	3.179	24.034	19.228	0.235	-0.001	-0.000017	0.206	45.623	40.148	20.632	1.238	90.88
90	1.500	8.0	0.811	3.424	2.271	3.808	0.405	3.258	26.001	17.334	0.250	-0.002	0.000012	0.204	48.923	35.877	18.437	1.106	97.24
105	1.750	8.0	0.811	3.276	2.271	3.808	0.560	3.324	27.771	15.869	0.250	-0.002	0.000012	0.201	51.837	32.583	16.744	1.005	102.82
120	2.000	8.0	0.811	3.147	2.271	3.808	0.693	3.381	29.390	14.695	0.250	-0.002	0.000012	0.199	54.469	29.958	15.395	0.924	107.82
135	2.250	8.0	0.811	3.032	2.271	3.808	0.811	3.430	30.887	13.728	0.250	-0.002	0.000012	0.197	56.878	27.807	14.290	0.857	112.37
150	2.500	8.0	0.811	2.930	2.271	3.808	0.916	3.475	32.284	12.914	0.250	-0.002	0.000012	0.195	59.106	26.007	13.364	0.802	116.55
165	2.750	8.0	0.811	2.837	2.271	3.808	1.012	3.514	33.598	12.217	0.250	-0.002	0.000012	0.193	61.183	24.473	12.577	0.755	120.42
180	3.000	8.0	0.811	2.752	2.271	3.808	1.099	3.551	34.840	11.613	0.250	-0.002	0.000012	0.191	63.133	23.149	11.896	0.714	124.04
240	4.000	8.0	0.811	2.470	2.271	3.808	1.386	3.670	39.258	9.814	0.250	-0.002	0.000012	0.186	69.967	19.241	9.888	0.593	136.52
300	5.000	8.0	0.811	2.250	2.271	3.808	1.609	3.762	43.042	8.608	0.250	-0.002	0.000012	0.182	75.717	16.658	8.560	0.514	146.81
360	6.000	8.0	0.811	2.070	2.271	3.808	1.792	3.837	46.390	7.732	0.250	-0.002	0.000012	0.178	80.742	14.803	7.607	0.456	155.62
420	7.000	8.0	0.811	1.917	2.271	3.808	1.946	3.900	49.415	7.059	0.250	-0.002	0.000012	0.176	85.245	13.396	6.884	0.413	163.36
480	8.000	8.0	0.811	1.785	2.271	3.808	2.079	3.955	52.188	6.524	0.227	-0.001	0.000003	0.173	89.340	12.284	6.313	0.379	170.28
540	9.000	8.0	0.811	1.668	2.271	3.808	2.197	4.003	54.760	6.084	0.227	-0.001	0.000003	0.171	93.097	11.379	5.847	0.351	176.51
600	10.000	8.0	0.811	1.563	2.271	3.808	2.303	4.046	57.164	5.716	0.227	-0.001	0.000003	0.169	96.572	10.623	5.459	0.328	182.16
660	11.000	8.0	0.811	1.469	2.271	3.808	2.398	4.085	59.427	5.402	0.227	-0.001	0.000003	0.167	99.810	9.981	5.129	0.308	187.33
720	12.000	8.0	0.811	1.382	2.271	3.808	2.485	4.120	61.570	5.131	0.227	-0.001	0.000003	0.165	102.847	9.428	4.845	0.291	192.09
780	13.000	8.0	0.811	1.303	2.271	3.808	2.565	4.153	63.608	4.893	0.227	-0.001	0.000003	0.164	105.712	8.945	4.597	0.276	196.50
840	14.000	8.0	0.811	1.229	2.271	3.808	2.639	4.183	65.554	4.682	0.227	-0.001	0.000003	0.162	108.425	8.519	4.378	0.263	200.61
900	15.000	8.0	0.811	1.160	2.271	3.808	2.708	4.211	67.418	4.495	0.227	-0.001	0.000003	0.161	111.006	8.140	4.183	0.251	204.44
960	16.000	8.0	0.811	1.096	2.271	3.808	2.773	4.237	69.209	4.326	0.227	-0.001	0.000003	0.159	113.469	7.801	4.009	0.241	208.04
1020	17.000	8.0	0.811	1.035	2.271	3.808	2.833	4.262	70.934	4.173	0.227	-0.001	0.000003	0.158	115.827	7.495	3.851	0.231	211.42
1080	18.000	8.0	0.811	0.979	2.271	3.808	2.890	4.285	72.599	4.033	0.227	-0.001	0.000003	0.157	118.090	7.217	3.709	0.223	214.60
1140	19.000	8.0	0.811	0.925	2.271	3.808	2.944	4.307	74.210	3.906	0.227	-0.001	0.000003	0.155	120.266	6.963	3.578	0.215	217.61
1400	23.333	8.0	0.811	0.720	2.271	3.808	3.150	4.390	80.658	3.457	0.227	-0.001	0.000003	0.151	128.873	6.075	3.122	0.187	228.98
1700	28.333	8.0	0.811	0.526	2.271	3.808	3.344	4.469	87.260	3.080	0.227	-0.001	0.000003	0.147	137.527	5.339	2.744	0.165	239.50

INCREASE TIME OF STORM TO DETERMINE MAXIMUM STORAGE EVENT

MAXIMUM STORAGE REQUIRED (Cu. M) = 239.50

ROD ROUGHAN & O'DONOVAN Consulting Engineers Civil - Structural - Transportation -Environmental	Member / Location: Location Details	Sheet no: X
Job Title: PROJECT TITLE Job no: XX.XXX		Calcs by: XX Checked by: XX Date: XX/XX/XXX Date: XX/XX/XXX

Ref:	Calculations	Output

Surface Water Attenuation & Storage

User INPUT

Total Area to be Drained		915	Sq m	2 Day M5 (mm) =		101.90 mm
Impermeability Factor		1.00		Ratio 60 Minute M5/2 Day M5	r	0.21
Storm Return Period	T	100	Yrs	Impermeable Area		915 Sq m
Allowable Discharge **per hectare**		2.13	l/s	Allowable Discharge	P	0.01 Cu m/min
Time of Concentration	TC	8.00	min	60 Minute M5		21.80 mm
				Storage Event		Maximum Event

Storage C = Q*TS - P*(TS + TC) + P^2*TC/Q

W = LN(1.06 * M5-60/(48*r))
X = LN(721/(1 + 15 * D))
Y = LN(48 * r/1.06)
Z = LN(721/16)
LN(M5-D) = LN(D) + W + (X * Y)/Z

Cr = J0 + J1 * (M5-D) + J2 * (M5-D)^2
LN((MT-D)/M5-D)) = Cr * (LN(T) - 1.5)

Time of Storm TS	Time of Storm D	Time of Concentration TC	W	X	Y	Z	LN(D)	LN(M5-D)	M5-D	Rainfall Intensity	J0	J1	J2	Cr	M100-D	Rainfall Intensity +10%	Discharge to Storage	Discharge to Storage Q	Storage Required C
Minutes	Hours	Minutes							mm	mm/hr					mm	mm/hr	l/s	Cu.m/min	Cu. m
3	0.050	8.0	0.811	6.021	2.271	3.808	-2.996	1.406	4.079	81.579	0.165	0.008	-0.000305	0.194	7.443	163.756	41.621	2.497	7.36
5	0.083	8.0	0.811	5.770	2.271	3.808	-2.485	1.767	5.852	70.225	0.165	0.008	-0.000305	0.203	10.996	145.142	36.890	2.213	10.92
7	0.117	8.0	0.811	5.569	2.271	3.808	-2.148	1.984	7.269	62.305	0.165	0.008	-0.000305	0.209	13.920	131.250	33.359	2.002	13.84
10	0.167	8.0	0.811	5.328	2.271	3.808	-1.792	2.196	8.993	53.959	0.165	0.008	-0.000305	0.215	17.537	115.742	29.418	1.765	17.44
13	0.217	8.0	0.811	5.134	2.271	3.808	-1.529	2.343	10.413	48.060	0.165	0.008	-0.000305	0.219	20.523	104.192	26.482	1.589	20.41
16	0.267	8.0	0.811	4.971	2.271	3.808	-1.322	2.454	11.632	43.621	0.165	0.008	-0.000305	0.220	23.066	95.148	24.183	1.451	22.94
20	0.333	8.0	0.811	4.789	2.271	3.808	-1.099	2.568	13.042	39.127	0.235	-0.001	-0.000017	0.222	25.978	85.729	21.789	1.307	25.82
25	0.417	8.0	0.811	4.600	2.271	3.808	-0.875	2.678	14.563	34.951	0.235	-0.001	-0.000017	0.220	28.837	76.130	19.350	1.161	28.64
30	0.500	8.0	0.811	4.441	2.271	3.808	-0.693	2.766	15.894	31.788	0.235	-0.001	-0.000017	0.218	31.305	68.871	17.505	1.050	31.06
45	0.750	8.0	0.811	4.075	2.271	3.808	-0.288	2.953	19.173	25.564	0.235	-0.001	-0.000017	0.214	37.237	54.614	13.881	0.833	36.86
60	1.000	8.0	0.811	3.808	2.271	3.808	0.000	3.082	21.800	21.800	0.235	-0.001	-0.000017	0.210	41.832	46.015	11.696	0.702	41.31
75	1.250	8.0	0.811	3.597	2.271	3.808	0.223	3.179	24.034	19.228	0.235	-0.001	-0.000017	0.206	45.623	40.148	10.204	0.612	44.95
90	1.500	8.0	0.811	3.424	2.271	3.808	0.405	3.258	26.001	17.334	0.250	-0.002	0.000012	0.204	48.923	35.877	9.119	0.547	48.10
105	1.750	8.0	0.811	3.276	2.271	3.808	0.560	3.324	27.771	15.869	0.250	-0.002	0.000012	0.201	51.837	32.583	8.282	0.497	50.85
120	2.000	8.0	0.811	3.147	2.271	3.808	0.693	3.381	29.390	14.695	0.250	-0.002	0.000012	0.199	54.469	29.958	7.614	0.457	53.33
135	2.250	8.0	0.811	3.032	2.271	3.808	0.811	3.430	30.887	13.728	0.250	-0.002	0.000012	0.197	56.878	27.807	7.068	0.424	55.58
150	2.500	8.0	0.811	2.930	2.271	3.808	0.916	3.475	32.284	12.914	0.250	-0.002	0.000012	0.195	59.106	26.007	6.610	0.397	57.64
165	2.750	8.0	0.811	2.837	2.271	3.808	1.012	3.514	33.598	12.217	0.250	-0.002	0.000012	0.193	61.183	24.473	6.220	0.373	59.56
180	3.000	8.0	0.811	2.752	2.271	3.808	1.099	3.551	34.840	11.613	0.250	-0.002	0.000012	0.191	63.133	23.149	5.884	0.353	61.35
240	4.000	8.0	0.811	2.470	2.271	3.808	1.386	3.670	39.258	9.814	0.250	-0.002	0.000012	0.186	69.967	19.241	4.890	0.293	67.52
300	5.000	8.0	0.811	2.250	2.271	3.808	1.609	3.762	43.042	8.608	0.250	-0.002	0.000012	0.182	75.717	16.658	4.234	0.254	72.61
360	6.000	8.0	0.811	2.070	2.271	3.808	1.792	3.837	46.390	7.732	0.250	-0.002	0.000012	0.178	80.742	14.803	3.762	0.226	76.97
420	7.000	8.0	0.811	1.917	2.271	3.808	1.946	3.900	49.415	7.059	0.250	-0.002	0.000012	0.176	85.245	13.396	3.405	0.204	80.80
480	8.000	8.0	0.811	1.785	2.271	3.808	2.079	3.955	52.188	6.524	0.227	-0.001	0.000003	0.173	89.340	12.284	3.122	0.187	84.22
540	9.000	8.0	0.811	1.668	2.271	3.808	2.197	4.003	54.760	6.084	0.227	-0.001	0.000003	0.171	93.097	11.379	2.892	0.174	87.30
600	10.000	8.0	0.811	1.563	2.271	3.808	2.303	4.046	57.164	5.716	0.227	-0.001	0.000003	0.169	96.572	10.623	2.700	0.162	90.09
660	11.000	8.0	0.811	1.469	2.271	3.808	2.398	4.085	59.427	5.402	0.227	-0.001	0.000003	0.167	99.810	9.981	2.537	0.152	92.65
720	12.000	8.0	0.811	1.382	2.271	3.808	2.485	4.120	61.570	5.131	0.227	-0.001	0.000003	0.165	102.847	9.428	2.396	0.144	95.01
780	13.000	8.0	0.811	1.303	2.271	3.808	2.565	4.153	63.608	4.893	0.227	-0.001	0.000003	0.164	105.712	8.945	2.273	0.136	97.19
840	14.000	8.0	0.811	1.229	2.271	3.808	2.639	4.183	65.554	4.682	0.227	-0.001	0.000003	0.162	108.425	8.519	2.165	0.130	99.22
900	15.000	8.0	0.811	1.160	2.271	3.808	2.708	4.211	67.418	4.495	0.227	-0.001	0.000003	0.161	111.006	8.140	2.069	0.124	101.12
960	16.000	8.0	0.811	1.096	2.271	3.808	2.773	4.237	69.209	4.326	0.227	-0.001	0.000003	0.159	113.469	7.801	1.983	0.119	102.89
1020	17.000	8.0	0.811	1.035	2.271	3.808	2.833	4.262	70.934	4.173	0.227	-0.001	0.000003	0.158	115.827	7.495	1.905	0.114	104.56
1080	18.000	8.0	0.811	0.979	2.271	3.808	2.890	4.285	72.599	4.033	0.227	-0.001	0.000003	0.157	118.090	7.217	1.834	0.110	106.14
1140	19.000	8.0	0.811	0.925	2.271	3.808	2.944	4.307	74.210	3.906	0.227	-0.001	0.000003	0.155	120.266	6.963	1.770	0.106	107.63
1400	23.333	8.0	0.811	0.720	2.271	3.808	3.150	4.390	80.658	3.457	0.227	-0.001	0.000003	0.151	128.873	6.075	1.544	0.093	113.25
1700	28.333	8.0	0.811	0.526	2.271	3.808	3.344	4.469	87.260	3.080	0.227	-0.001	0.000003	0.147	137.527	5.339	1.357	0.081	118.46

INCREASE TIME OF STORM TO DETERMINE MAXIMUM STORAGE EVENT

MAXIMUM STORAGE REQUIRED (Cu. M) = 118.46

ROD ROUGHAN & O'DONOVAN Consulting Engineers Civil - Structural - Transportation -Environmental	Member / Location: Location Details	Sheet no: X
Job Title: PROJECT TITLE Job no: XX.XXX		Calcs by: XX Checked by: XX Date: XX/XX/XXX Date: XX/XX/XXX

Ref: | Calculations | Output

Surface Water Attenuation & Storage

User INPUT

Total Area to be Drained		1,175	Sq m	2 Day M5 (mm) =		101.90 mm
Impermeability Factor		1.00		Ratio 60 Minute M5/2 Day M5	r	0.21
Storm Return Period	T	100	Yrs	Impermeable Area		1175 Sq m
Allowable Discharge **per hectare**		2.13	l/s	Allowable Discharge	P	0.02 Cu m/min
Time of Concentration	TC	8.00	min	60 Minute M5		21.80 mm
				Storage Event		Maximum Event

Storage C = Q*TS - P*(TS + TC) + P^2*TC/Q

W = LN(1.06 * M5-60/(48*r))
X = LN(721/(1 + 15 * D))
Y = LN(48 * r/1.06)
Z = LN(721/16)
LN(M5-D) = LN(D) + W + (X * Y)/Z

Cr = J0 + J1 * (M5-D) + J2 * (M5-D)^2
LN((MT-D)/M5-D)) = Cr * (LN(T) - 1.5)

Time of Storm TS	Time of Storm D	Time of Concentration TC	W	X	Y	Z	LN(D)	LN(M5-D)	M5-D	Rainfall Intensity	J0	J1	J2	Cr	M100-D	Rainfall Intensity +10%	Discharge to Storage	Discharge to Storage Q	Storage Required C
Minutes	Hours	Minutes							mm	mm/hr					mm	mm/hr	l/s	Cu.m/min	Cu. m
3	0.050	8.0	0.811	6.021	2.271	3.808	-2.996	1.406	4.079	81.579	0.165	0.008	-0.000305	0.194	7.443	163.756	53.448	3.207	9.46
5	0.083	8.0	0.811	5.770	2.271	3.808	-2.485	1.767	5.852	70.225	0.165	0.008	-0.000305	0.203	10.996	145.142	47.373	2.842	14.02
7	0.117	8.0	0.811	5.569	2.271	3.808	-2.148	1.984	7.269	62.305	0.165	0.008	-0.000305	0.209	13.920	131.250	42.839	2.570	17.77
10	0.167	8.0	0.811	5.328	2.271	3.808	-1.792	2.196	8.993	53.959	0.165	0.008	-0.000305	0.215	17.537	115.742	37.777	2.267	22.40
13	0.217	8.0	0.811	5.134	2.271	3.808	-1.529	2.343	10.413	48.060	0.165	0.008	-0.000305	0.219	20.523	104.192	34.007	2.040	26.21
16	0.267	8.0	0.811	4.971	2.271	3.808	-1.322	2.454	11.632	43.621	0.165	0.008	-0.000305	0.220	23.066	95.148	31.055	1.863	29.45
20	0.333	8.0	0.811	4.789	2.271	3.808	-1.099	2.568	13.042	39.127	0.235	-0.001	-0.000017	0.222	25.978	85.729	27.981	1.679	33.16
25	0.417	8.0	0.811	4.600	2.271	3.808	-0.875	2.678	14.563	34.951	0.235	-0.001	-0.000017	0.220	28.837	76.130	24.848	1.491	36.78
30	0.500	8.0	0.811	4.441	2.271	3.808	-0.693	2.766	15.894	31.788	0.235	-0.001	-0.000017	0.218	31.305	68.871	22.479	1.349	39.89
45	0.750	8.0	0.811	4.075	2.271	3.808	-0.288	2.953	19.173	25.564	0.235	-0.001	-0.000017	0.214	37.237	54.614	17.825	1.070	47.33
60	1.000	8.0	0.811	3.808	2.271	3.808	0.000	3.082	21.800	21.800	0.235	-0.001	-0.000017	0.210	41.832	46.015	15.019	0.901	53.05
75	1.250	8.0	0.811	3.597	2.271	3.808	0.223	3.179	24.034	19.228	0.235	-0.001	-0.000017	0.206	45.623	40.148	13.104	0.786	57.72
90	1.500	8.0	0.811	3.424	2.271	3.808	0.405	3.258	26.001	17.334	0.250	-0.002	0.000012	0.204	48.923	35.877	11.710	0.703	61.76
105	1.750	8.0	0.811	3.276	2.271	3.808	0.560	3.324	27.771	15.869	0.250	-0.002	0.000012	0.201	51.837	32.583	10.635	0.638	65.30
120	2.000	8.0	0.811	3.147	2.271	3.808	0.693	3.381	29.390	14.695	0.250	-0.002	0.000012	0.199	54.469	29.958	9.778	0.587	68.48
135	2.250	8.0	0.811	3.032	2.271	3.808	0.811	3.430	30.887	13.728	0.250	-0.002	0.000012	0.197	56.878	27.807	9.076	0.545	71.37
150	2.500	8.0	0.811	2.930	2.271	3.808	0.916	3.475	32.284	12.914	0.250	-0.002	0.000012	0.195	59.106	26.007	8.488	0.509	74.02
165	2.750	8.0	0.811	2.837	2.271	3.808	1.012	3.514	33.598	12.217	0.250	-0.002	0.000012	0.193	61.183	24.473	7.988	0.479	76.48
180	3.000	8.0	0.811	2.752	2.271	3.808	1.099	3.551	34.840	11.613	0.250	-0.002	0.000012	0.191	63.133	23.149	7.555	0.453	78.78
240	4.000	8.0	0.811	2.470	2.271	3.808	1.386	3.670	39.258	9.814	0.250	-0.002	0.000012	0.186	69.967	19.241	6.280	0.377	86.71
300	5.000	8.0	0.811	2.250	2.271	3.808	1.609	3.762	43.042	8.608	0.250	-0.002	0.000012	0.182	75.717	16.658	5.437	0.326	93.24
360	6.000	8.0	0.811	2.070	2.271	3.808	1.792	3.837	46.390	7.732	0.250	-0.002	0.000012	0.178	80.742	14.803	4.831	0.290	98.84
420	7.000	8.0	0.811	1.917	2.271	3.808	1.946	3.900	49.415	7.059	0.250	-0.002	0.000012	0.176	85.245	13.396	4.372	0.262	103.76
480	8.000	8.0	0.811	1.785	2.271	3.808	2.079	3.955	52.188	6.524	0.227	-0.001	0.000003	0.173	89.340	12.284	4.009	0.241	108.15
540	9.000	8.0	0.811	1.668	2.271	3.808	2.197	4.003	54.760	6.084	0.227	-0.001	0.000003	0.171	93.097	11.379	3.714	0.223	112.10
600	10.000	8.0	0.811	1.563	2.271	3.808	2.303	4.046	57.164	5.716	0.227	-0.001	0.000003	0.169	96.572	10.623	3.467	0.208	115.69
660	11.000	8.0	0.811	1.469	2.271	3.808	2.398	4.085	59.427	5.402	0.227	-0.001	0.000003	0.167	99.810	9.981	3.258	0.195	118.98
720	12.000	8.0	0.811	1.382	2.271	3.808	2.485	4.120	61.570	5.131	0.227	-0.001	0.000003	0.165	102.847	9.428	3.077	0.185	122.00
780	13.000	8.0	0.811	1.303	2.271	3.808	2.565	4.153	63.608	4.893	0.227	-0.001	0.000003	0.164	105.712	8.945	2.919	0.175	124.81
840	14.000	8.0	0.811	1.229	2.271	3.808	2.639	4.183	65.554	4.682	0.227	-0.001	0.000003	0.162	108.425	8.519	2.781	0.167	127.41
900	15.000	8.0	0.811	1.160	2.271	3.808	2.708	4.211	67.418	4.495	0.227	-0.001	0.000003	0.161	111.006	8.140	2.657	0.159	129.85
960	16.000	8.0	0.811	1.096	2.271	3.808	2.773	4.237	69.209	4.326	0.227	-0.001	0.000003	0.159	113.469	7.801	2.546	0.153	132.13
1020	17.000	8.0	0.811	1.035	2.271	3.808	2.833	4.262	70.934	4.173	0.227	-0.001	0.000003	0.158	115.827	7.495	2.446	0.147	134.28
1080	18.000	8.0	0.811	0.979	2.271	3.808	2.890	4.285	72.599	4.033	0.227	-0.001	0.000003	0.157	118.090	7.217	2.355	0.141	136.30
1140	19.000	8.0	0.811	0.925	2.271	3.808	2.944	4.307	74.210	3.906	0.227	-0.001	0.000003	0.155	120.266	6.963	2.273	0.136	138.21
1400	23.333	8.0	0.811	0.720	2.271	3.808	3.150	4.390	80.658	3.457	0.227	-0.001	0.000003	0.151	128.873	6.075	1.983	0.119	145.43
1700	28.333	8.0	0.811	0.526	2.271	3.808	3.344	4.469	87.260	3.080	0.227	-0.001	0.000003	0.147	137.527	5.339	1.743	0.105	152.12

INCREASE TIME OF STORM TO DETERMINE MAXIMUM STORAGE EVENT

MAXIMUM STORAGE REQUIRED (Cu. M) = 152.12

ROD ROUGHAN & O'DONOVAN Consulting Engineers Civil - Structural - Transportation -Environmental	Member / Location: Location Details	Sheet no: X
Job Title: PROJECT TITLE Job no: XX.XXX		Calcs by: XX Checked by: XX Date: XX/XX/XXX Date: XX/XX/XXX

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Surface Water Attenuation & Storage

User INPUT

Total Area to be Drained		1,625	Sq m	2 Day M5 (mm) =		101.90 mm
Impermeability Factor		1.00		Ratio 60 Minute M5/2 Day M5	r	0.21
Storm Return Period	T	100	Yrs	Impermeable Area		1625 Sq m
Allowable Discharge **per hectare**		2.13	l/s	Allowable Discharge	P	0.02 Cu m/min
Time of Concentration	TC	8.00	min	60 Minute M5		21.80 mm
				Storage Event		Maximum Event

Storage C = Q*TS - P*(TS + TC) + P^2*TC/Q

W = LN(1.06 * M5-60/(48*r))
X = LN(721/(1 + 15 * D))
Y = LN(48 * r/1.06)
Z = LN(721/16)
LN(M5-D) = LN(D) + W + (X * Y)/Z

Cr = J0 + J1 * (M5-D) + J2 * (M5-D)^2
LN((MT-D)/M5-D)) = Cr * (LN(T) - 1.5)

Time of Storm TS	Time of Storm D	Time of Concentration TC	W	X	Y	Z	LN(D)	LN(M5-D)	M5-D	Rainfall Intensity	J0	J1	J2	Cr	M100-D	Rainfall Intensity +10%	Discharge to Storage	Discharge to Storage Q	Storage Required C
Minutes	Hours	Minutes							mm	mm/hr					mm	mm/hr	l/s	Cu.m/min	Cu. m
3	0.050	8.0	0.811	6.021	2.271	3.808	-2.996	1.406	4.079	81.579	0.165	0.008	-0.000305	0.194	7.443	163.756	73.918	4.435	13.08
5	0.083	8.0	0.811	5.770	2.271	3.808	-2.485	1.767	5.852	70.225	0.165	0.008	-0.000305	0.203	10.996	145.142	65.516	3.931	19.39
7	0.117	8.0	0.811	5.569	2.271	3.808	-2.148	1.984	7.269	62.305	0.165	0.008	-0.000305	0.209	13.920	131.250	59.245	3.555	24.57
10	0.167	8.0	0.811	5.328	2.271	3.808	-1.792	2.196	8.993	53.959	0.165	0.008	-0.000305	0.215	17.537	115.742	52.245	3.135	30.97
13	0.217	8.0	0.811	5.134	2.271	3.808	-1.529	2.343	10.413	48.060	0.165	0.008	-0.000305	0.219	20.523	104.192	47.031	2.822	36.25
16	0.267	8.0	0.811	4.971	2.271	3.808	-1.322	2.454	11.632	43.621	0.165	0.008	-0.000305	0.220	23.066	95.148	42.949	2.577	40.73
20	0.333	8.0	0.811	4.789	2.271	3.808	-1.099	2.568	13.042	39.127	0.235	-0.001	-0.000017	0.222	25.978	85.729	38.697	2.322	45.86
25	0.417	8.0	0.811	4.600	2.271	3.808	-0.875	2.678	14.563	34.951	0.235	-0.001	-0.000017	0.220	28.837	76.130	34.364	2.062	50.86
30	0.500	8.0	0.811	4.441	2.271	3.808	-0.693	2.766	15.894	31.788	0.235	-0.001	-0.000017	0.218	31.305	68.871	31.088	1.865	55.17
45	0.750	8.0	0.811	4.075	2.271	3.808	-0.288	2.953	19.173	25.564	0.235	-0.001	-0.000017	0.214	37.237	54.614	24.652	1.479	65.46
60	1.000	8.0	0.811	3.808	2.271	3.808	0.000	3.082	21.800	21.800	0.235	-0.001	-0.000017	0.210	41.832	46.015	20.771	1.246	73.37
75	1.250	8.0	0.811	3.597	2.271	3.808	0.223	3.179	24.034	19.228	0.235	-0.001	-0.000017	0.206	45.623	40.148	18.122	1.087	79.83
90	1.500	8.0	0.811	3.424	2.271	3.808	0.405	3.258	26.001	17.334	0.250	-0.002	0.000012	0.204	48.923	35.877	16.194	0.972	85.42
105	1.750	8.0	0.811	3.276	2.271	3.808	0.560	3.324	27.771	15.869	0.250	-0.002	0.000012	0.201	51.837	32.583	14.708	0.882	90.31
120	2.000	8.0	0.811	3.147	2.271	3.808	0.693	3.381	29.390	14.695	0.250	-0.002	0.000012	0.199	54.469	29.958	13.523	0.811	94.71
135	2.250	8.0	0.811	3.032	2.271	3.808	0.811	3.430	30.887	13.728	0.250	-0.002	0.000012	0.197	56.878	27.807	12.552	0.753	98.70
150	2.500	8.0	0.811	2.930	2.271	3.808	0.916	3.475	32.284	12.914	0.250	-0.002	0.000012	0.195	59.106	26.007	11.739	0.704	102.37
165	2.750	8.0	0.811	2.837	2.271	3.808	1.012	3.514	33.598	12.217	0.250	-0.002	0.000012	0.193	61.183	24.473	11.047	0.663	105.78
180	3.000	8.0	0.811	2.752	2.271	3.808	1.099	3.551	34.840	11.613	0.250	-0.002	0.000012	0.191	63.133	23.149	10.449	0.627	108.95
240	4.000	8.0	0.811	2.470	2.271	3.808	1.386	3.670	39.258	9.814	0.250	-0.002	0.000012	0.186	69.967	19.241	8.685	0.521	119.92
300	5.000	8.0	0.811	2.250	2.271	3.808	1.609	3.762	43.042	8.608	0.250	-0.002	0.000012	0.182	75.717	16.658	7.519	0.451	128.95
360	6.000	8.0	0.811	2.070	2.271	3.808	1.792	3.837	46.390	7.732	0.250	-0.002	0.000012	0.178	80.742	14.803	6.682	0.401	136.69
420	7.000	8.0	0.811	1.917	2.271	3.808	1.946	3.900	49.415	7.059	0.250	-0.002	0.000012	0.176	85.245	13.396	6.047	0.363	143.49
480	8.000	8.0	0.811	1.785	2.271	3.808	2.079	3.955	52.188	6.524	0.227	-0.001	0.000003	0.173	89.340	12.284	5.545	0.333	149.57
540	9.000	8.0	0.811	1.668	2.271	3.808	2.197	4.003	54.760	6.084	0.227	-0.001	0.000003	0.171	93.097	11.379	5.136	0.308	155.04
600	10.000	8.0	0.811	1.563	2.271	3.808	2.303	4.046	57.164	5.716	0.227	-0.001	0.000003	0.169	96.572	10.623	4.795	0.288	160.00
660	11.000	8.0	0.811	1.469	2.271	3.808	2.398	4.085	59.427	5.402	0.227	-0.001	0.000003	0.167	99.810	9.981	4.505	0.270	164.55
720	12.000	8.0	0.811	1.382	2.271	3.808	2.485	4.120	61.570	5.131	0.227	-0.001	0.000003	0.165	102.847	9.428	4.256	0.255	168.73
780	13.000	8.0	0.811	1.303	2.271	3.808	2.565	4.153	63.608	4.893	0.227	-0.001	0.000003	0.164	105.712	8.945	4.038	0.242	172.60
840	14.000	8.0	0.811	1.229	2.271	3.808	2.639	4.183	65.554	4.682	0.227	-0.001	0.000003	0.162	108.425	8.519	3.845	0.231	176.21
900	15.000	8.0	0.811	1.160	2.271	3.808	2.708	4.211	67.418	4.495	0.227	-0.001	0.000003	0.161	111.006	8.140	3.675	0.220	179.58
960	16.000	8.0	0.811	1.096	2.271	3.808	2.773	4.237	69.209	4.326	0.227	-0.001	0.000003	0.159	113.469	7.801	3.521	0.211	182.73
1020	17.000	8.0	0.811	1.035	2.271	3.808	2.833	4.262	70.934	4.173	0.227	-0.001	0.000003	0.158	115.827	7.495	3.383	0.203	185.70
1080	18.000	8.0	0.811	0.979	2.271	3.808	2.890	4.285	72.599	4.033	0.227	-0.001	0.000003	0.157	118.090	7.217	3.257	0.195	188.50
1140	19.000	8.0	0.811	0.925	2.271	3.808	2.944	4.307	74.210	3.906	0.227	-0.001	0.000003	0.155	120.266	6.963	3.143	0.189	191.15
1400	23.333	8.0	0.811	0.720	2.271	3.808	3.150	4.390	80.658	3.457	0.227	-0.001	0.000003	0.151	128.873	6.075	2.742	0.165	201.13
1700	28.333	8.0	0.811	0.526	2.271	3.808	3.344	4.469	87.260	3.080	0.227	-0.001	0.000003	0.147	137.527	5.339	2.410	0.145	210.37

INCREASE TIME OF STORM TO DETERMINE MAXIMUM STORAGE EVENT

MAXIMUM STORAGE REQUIRED (Cu. M) = 210.37

ROD ROUGHAN & O'DONOVAN Consulting Engineers Civil - Structural - Transportation -Environmental	Member / Location: Location Details	Sheet no: X
Job Title: PROJECT TITLE Job no: XX.XXX		Calcs by: XX Checked by: XX Date: XX/XX/XXX Date: XX/XX/XXX

Ref: | Calculations | Output

Surface Water Attenuation & Storage

User INPUT

Total Area to be Drained		3,168	Sq m	2 Day M5 (mm) =		101.90 mm
Impermeability Factor		1.00		Ratio 60 Minute M5/2 Day M5	r	0.21
Storm Return Period	T	100	Yrs	Impermeable Area		3168 Sq m
Allowable Discharge **per hectare**		2.13	l/s	Allowable Discharge	P	0.04 Cu m/min
Time of Concentration	TC	8.00	min	60 Minute M5		21.80 mm
				Storage Event		Maximum Event

Storage C = Q*TS - P*(TS + TC) + P^2*TC/Q

W = LN(1.06 * M5-60/(48*r))
X = LN(721/(1 + 15 * D))
Y = LN(48 * r/1.06)
Z = LN(721/16)
LN(M5-D) = LN(D) + W + (X * Y)/Z

Cr = J0 + J1 * (M5-D) + J2 * (M5-D)^2
LN((MT-D)/M5-D)) = Cr * (LN(T) - 1.5)

Time of Storm TS	Time of Storm D	Time of Concentration TC	W	X	Y	Z	LN(D)	LN(M5-D)	M5-D	Rainfall Intensity	J0	J1	J2	Cr	M100-D	Rainfall Intensity +10%	Discharge to Storage	Discharge to Storage Q	Storage Required C
Minutes	Hours	Minutes							mm	mm/hr					mm	mm/hr	l/s	Cu.m/min	Cu. m
3	0.050	8.0	0.811	6.021	2.271	3.808	-2.996	1.406	4.079	81.579	0.165	0.008	-0.000305	0.194	7.443	163.756	144.105	8.646	25.49
5	0.083	8.0	0.811	5.770	2.271	3.808	-2.485	1.767	5.852	70.225	0.165	0.008	-0.000305	0.203	10.996	145.142	127.725	7.664	37.79
7	0.117	8.0	0.811	5.569	2.271	3.808	-2.148	1.984	7.269	62.305	0.165	0.008	-0.000305	0.209	13.920	131.250	115.500	6.930	47.90
10	0.167	8.0	0.811	5.328	2.271	3.808	-1.792	2.196	8.993	53.959	0.165	0.008	-0.000305	0.215	17.537	115.742	101.853	6.111	60.39
13	0.217	8.0	0.811	5.134	2.271	3.808	-1.529	2.343	10.413	48.060	0.165	0.008	-0.000305	0.219	20.523	104.192	91.689	5.501	70.67
16	0.267	8.0	0.811	4.971	2.271	3.808	-1.322	2.454	11.632	43.621	0.165	0.008	-0.000305	0.220	23.066	95.148	83.730	5.024	79.41
20	0.333	8.0	0.811	4.789	2.271	3.808	-1.099	2.568	13.042	39.127	0.235	-0.001	-0.000017	0.222	25.978	85.729	75.441	4.526	89.40
25	0.417	8.0	0.811	4.600	2.271	3.808	-0.875	2.678	14.563	34.951	0.235	-0.001	-0.000017	0.220	28.837	76.130	66.995	4.020	99.16
30	0.500	8.0	0.811	4.441	2.271	3.808	-0.693	2.766	15.894	31.788	0.235	-0.001	-0.000017	0.218	31.305	68.871	60.606	3.636	107.56
45	0.750	8.0	0.811	4.075	2.271	3.808	-0.288	2.953	19.173	25.564	0.235	-0.001	-0.000017	0.214	37.237	54.614	48.060	2.884	127.62
60	1.000	8.0	0.811	3.808	2.271	3.808	0.000	3.082	21.800	21.800	0.235	-0.001	-0.000017	0.210	41.832	46.015	40.494	2.430	143.03
75	1.250	8.0	0.811	3.597	2.271	3.808	0.223	3.179	24.034	19.228	0.235	-0.001	-0.000017	0.206	45.623	40.148	35.330	2.120	155.63
90	1.500	8.0	0.811	3.424	2.271	3.808	0.405	3.258	26.001	17.334	0.250	-0.002	0.000012	0.204	48.923	35.877	31.571	1.894	166.52
105	1.750	8.0	0.811	3.276	2.271	3.808	0.560	3.324	27.771	15.869	0.250	-0.002	0.000012	0.201	51.837	32.583	28.673	1.720	176.07
120	2.000	8.0	0.811	3.147	2.271	3.808	0.693	3.381	29.390	14.695	0.250	-0.002	0.000012	0.199	54.469	29.958	26.363	1.582	184.64
135	2.250	8.0	0.811	3.032	2.271	3.808	0.811	3.430	30.887	13.728	0.250	-0.002	0.000012	0.197	56.878	27.807	24.470	1.468	192.43
150	2.500	8.0	0.811	2.930	2.271	3.808	0.916	3.475	32.284	12.914	0.250	-0.002	0.000012	0.195	59.106	26.007	22.886	1.373	199.58
165	2.750	8.0	0.811	2.837	2.271	3.808	1.012	3.514	33.598	12.217	0.250	-0.002	0.000012	0.193	61.183	24.473	21.536	1.292	206.21
180	3.000	8.0	0.811	2.752	2.271	3.808	1.099	3.551	34.840	11.613	0.250	-0.002	0.000012	0.191	63.133	23.149	20.371	1.222	212.40
240	4.000	8.0	0.811	2.470	2.271	3.808	1.386	3.670	39.258	9.814	0.250	-0.002	0.000012	0.186	69.967	19.241	16.932	1.016	233.79
300	5.000	8.0	0.811	2.250	2.271	3.808	1.609	3.762	43.042	8.608	0.250	-0.002	0.000012	0.182	75.717	16.658	14.659	0.880	251.40
360	6.000	8.0	0.811	2.070	2.271	3.808	1.792	3.837	46.390	7.732	0.250	-0.002	0.000012	0.178	80.742	14.803	13.026	0.782	266.48
420	7.000	8.0	0.811	1.917	2.271	3.808	1.946	3.900	49.415	7.059	0.250	-0.002	0.000012	0.176	85.245	13.396	11.788	0.707	279.75
480	8.000	8.0	0.811	1.785	2.271	3.808	2.079	3.955	52.188	6.524	0.227	-0.001	0.000003	0.173	89.340	12.284	10.810	0.649	291.59
540	9.000	8.0	0.811	1.668	2.271	3.808	2.197	4.003	54.760	6.084	0.227	-0.001	0.000003	0.171	93.097	11.379	10.013	0.601	302.25
600	10.000	8.0	0.811	1.563	2.271	3.808	2.303	4.046	57.164	5.716	0.227	-0.001	0.000003	0.169	96.572	10.623	9.348	0.561	311.93
660	11.000	8.0	0.811	1.469	2.271	3.808	2.398	4.085	59.427	5.402	0.227	-0.001	0.000003	0.167	99.810	9.981	8.783	0.527	320.79
720	12.000	8.0	0.811	1.382	2.271	3.808	2.485	4.120	61.570	5.131	0.227	-0.001	0.000003	0.165	102.847	9.428	8.296	0.498	328.95
780	13.000	8.0	0.811	1.303	2.271	3.808	2.565	4.153	63.608	4.893	0.227	-0.001	0.000003	0.164	105.712	8.945	7.871	0.472	336.50
840	14.000	8.0	0.811	1.229	2.271	3.808	2.639	4.183	65.554	4.682	0.227	-0.001	0.000003	0.162	108.425	8.519	7.497	0.450	343.53
900	15.000	8.0	0.811	1.160	2.271	3.808	2.708	4.211	67.418	4.495	0.227	-0.001	0.000003	0.161	111.006	8.140	7.164	0.430	350.09
960	16.000	8.0	0.811	1.096	2.271	3.808	2.773	4.237	69.209	4.326	0.227	-0.001	0.000003	0.159	113.469	7.801	6.865	0.412	356.25
1020	17.000	8.0	0.811	1.035	2.271	3.808	2.833	4.262	70.934	4.173	0.227	-0.001	0.000003	0.158	115.827	7.495	6.595	0.396	362.03
1080	18.000	8.0	0.811	0.979	2.271	3.808	2.890	4.285	72.599	4.033	0.227	-0.001	0.000003	0.157	118.090	7.217	6.351	0.381	367.49
1140	19.000	8.0	0.811	0.925	2.271	3.808	2.944	4.307	74.210	3.906	0.227	-0.001	0.000003	0.155	120.266	6.963	6.127	0.368	372.65
1400	23.333	8.0	0.811	0.720	2.271	3.808	3.150	4.390	80.658	3.457	0.227	-0.001	0.000003	0.151	128.873	6.075	5.346	0.321	392.11
1700	28.333	8.0	0.811	0.526	2.271	3.808	3.344	4.469	87.260	3.080	0.227	-0.001	0.000003	0.147	137.527	5.339	4.699	0.282	410.13

INCREASE TIME OF STORM TO DETERMINE MAXIMUM STORAGE EVENT

MAXIMUM STORAGE REQUIRED (Cu. M) = 410.13

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 311871, Northing: 223676,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	3.0,	4.3,	5.0,	6.0,	6.7,	7.3,	9.2,	11.3,	12.7,	14.8,	16.6,	18.0,	20.1,	21.8,	23.3,	N/A ,
10 mins	4.1,	5.9,	6.9,	8.4,	9.4,	10.2,	12.8,	15.8,	17.7,	20.6,	23.1,	25.0,	28.1,	30.4,	32.4,	N/A ,
15 mins	4.9,	7.0,	8.1,	9.9,	11.1,	12.0,	15.0,	18.5,	20.9,	24.2,	27.1,	29.4,	33.0,	35.8,	38.1,	N/A ,
30 mins	6.6,	9.4,	11.0,	13.3,	14.9,	16.2,	20.3,	25.0,	28.1,	32.6,	36.6,	39.7,	44.5,	48.3,	51.4,	N/A ,
1 hours	8.8,	12.7,	14.8,	17.9,	20.1,	21.8,	27.3,	33.7,	37.9,	43.9,	49.3,	53.5,	60.0,	65.1,	69.3,	N/A ,
2 hours	11.9,	17.1,	19.9,	24.2,	27.1,	29.4,	36.8,	45.4,	51.1,	59.2,	66.5,	72.1,	80.9,	87.7,	93.4,	N/A ,
3 hours	14.2,	20.4,	23.7,	28.8,	32.3,	35.0,	43.9,	54.1,	60.9,	70.5,	79.2,	85.9,	96.3,	104.4,	111.2,	N/A ,
4 hours	16.1,	23.0,	26.8,	32.6,	36.5,	39.6,	49.7,	61.2,	68.9,	79.8,	89.6,	97.2,	109.0,	118.2,	125.9,	N/A ,
6 hours	19.1,	27.4,	32.0,	38.8,	43.5,	47.1,	59.2,	72.9,	82.1,	95.1,	106.7,	115.8,	129.8,	140.8,	149.9,	N/A ,
9 hours	22.8,	32.7,	38.1,	46.2,	51.8,	56.1,	70.4,	86.8,	97.8,	113.2,	127.1,	137.9,	154.6,	167.7,	178.5,	N/A ,
12 hours	25.8,	37.0,	43.1,	52.3,	58.6,	63.5,	79.7,	98.3,	110.7,	128.2,	143.9,	156.1,	175.0,	189.8,	202.1,	N/A ,
18 hours	30.7,	44.1,	51.3,	62.3,	69.8,	75.7,	95.0,	117.1,	131.8,	152.6,	171.3,	185.9,	208.4,	226.0,	240.7,	N/A ,
24 hours	34.8,	49.9,	58.1,	70.5,	79.0,	85.7,	107.5,	132.5,	149.2,	172.8,	193.9,	210.4,	235.9,	255.9,	272.4,	331.0,
2 days	44.5,	62.0,	71.3,	85.3,	94.6,	101.9,	125.6,	152.3,	169.8,	194.4,	216.2,	233.0,	258.9,	279.0,	295.6,	353.5,
3 days	52.3,	71.7,	81.9,	97.1,	107.2,	115.0,	140.3,	168.4,	186.7,	212.3,	234.8,	252.2,	278.7,	299.1,	316.0,	374.5,
4 days	59.3,	80.2,	91.2,	107.4,	118.1,	126.4,	153.0,	182.4,	201.5,	227.9,	251.2,	269.0,	296.1,	317.0,	334.2,	393.6,
6 days	71.5,	95.1,	107.4,	125.3,	137.1,	146.1,	175.0,	206.6,	227.0,	255.0,	279.5,	298.2,	326.5,	348.2,	366.0,	427.1,
8 days	82.3,	108.3,	121.6,	140.9,	153.7,	163.4,	194.2,	227.6,	249.1,	278.5,	304.1,	323.5,	353.0,	375.4,	393.8,	456.6,
10 days	92.3,	120.3,	134.6,	155.2,	168.7,	179.0,	211.5,	246.6,	269.1,	299.7,	326.3,	346.4,	376.8,	399.9,	418.8,	483.2,
12 days	101.7,	131.5,	146.7,	168.4,	182.7,	193.5,	227.5,	264.2,	287.5,	319.2,	346.7,	367.4,	398.7,	422.5,	441.8,	507.7,
16 days	119.1,	152.3,	168.9,	192.8,	208.3,	220.0,	256.8,	296.1,	321.0,	354.7,	383.7,	405.6,	438.5,	463.3,	483.5,	552.0,
20 days	135.4,	171.5,	189.5,	215.2,	231.8,	244.3,	283.5,	325.1,	351.3,	386.8,	417.2,	440.1,	474.3,	500.2,	521.2,	592.0,
25 days	154.5,	193.9,	213.4,	241.1,	259.0,	272.4,	314.3,	358.5,	386.2,	423.6,	455.5,	479.5,	515.3,	542.3,	564.1,	637.6,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
’Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin’,
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

APPENDIX F
OPW PRELIMINARY FLOOD RISK ASSESSMENT MAP

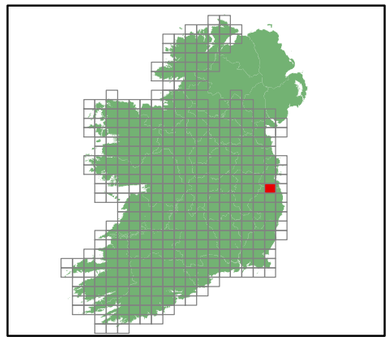
N

No Fluvial Data Available For Area

No Fluvial Data Available For Area

0.5 0.25 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 Kilometers

Location Plan :



Legend:

Flood Extents

- Fluvial - Indicative 1% AEP (100-yr) Event
- Fluvial - Extreme Event
- Coastal - Indicative 0.5% AEP (200-yr) Event
- Coastal - Extreme Event
- Pluvial - Indicative 1% AEP (100-yr) Event
- Pluvial - Extreme Event
- Groundwater Flood Extents
- Lakes / Turloughs

PFRA Outcomes

- Probable Area for Further Assesment
- Possible Area for Further Assesment

Important User Note:

The flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location. Information on the purpose, development and limitations of these maps is available in the relevant reports (see www.cfram.ie). Users should seek professional advice if they intend to rely on the maps in any way.

If you believe that the maps are inaccurate in some way please forward full details by contacting the OPW (refer to PFRA Information leaflets or 'Have Your Say' on www.cfram.ie).

Office of Public Works
Jonathon Swift Street
Trim
Co Meath
Ireland

OPW

Project :
PRELIMINARY FLOOD RISK ASSESMENT (PFRA)

Map :
PFRA Indicative extents and outcomes
- Draft for Consultation

Figure By :	PJW	Date :	July2011
Checked By :	MA	Date :	July 2011

Figure No. : 2019 / MAP / 221 / A

Revision 0

Drawing Scale : 1:50,000

Plot Scale : 1:1 @ A3

APPENDIX G
TYPICAL DETAILS FOR SURFACE WATER STORAGE

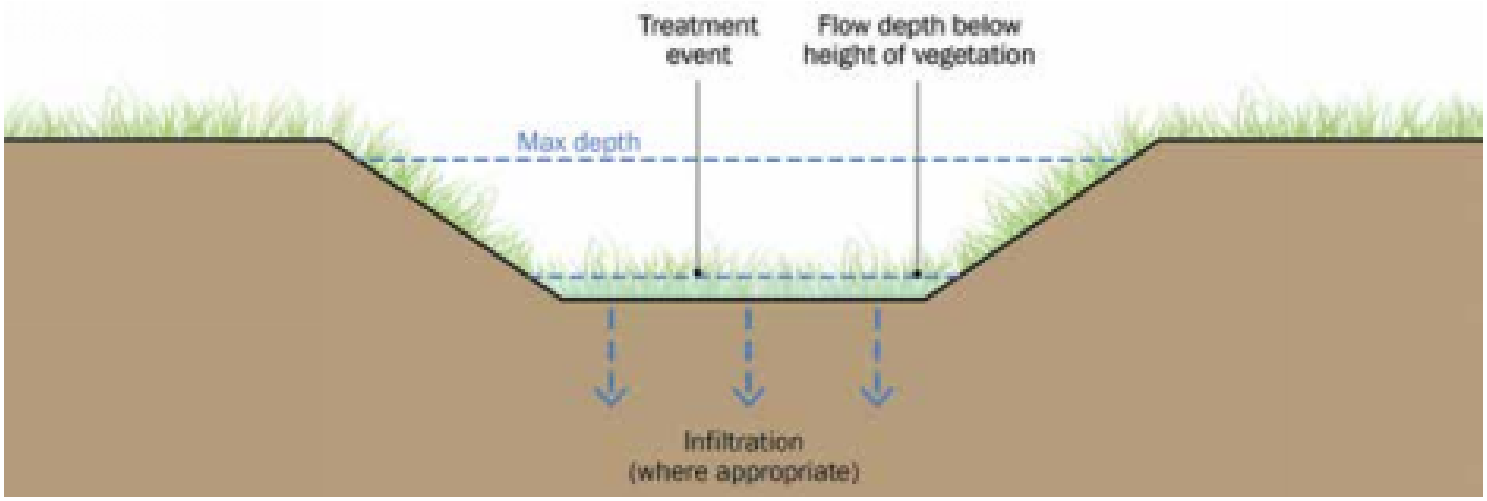


Figure G -1 : Typical attenuation swale
Taken from the CIRIA C753 SuDS Manual Figure 17.1

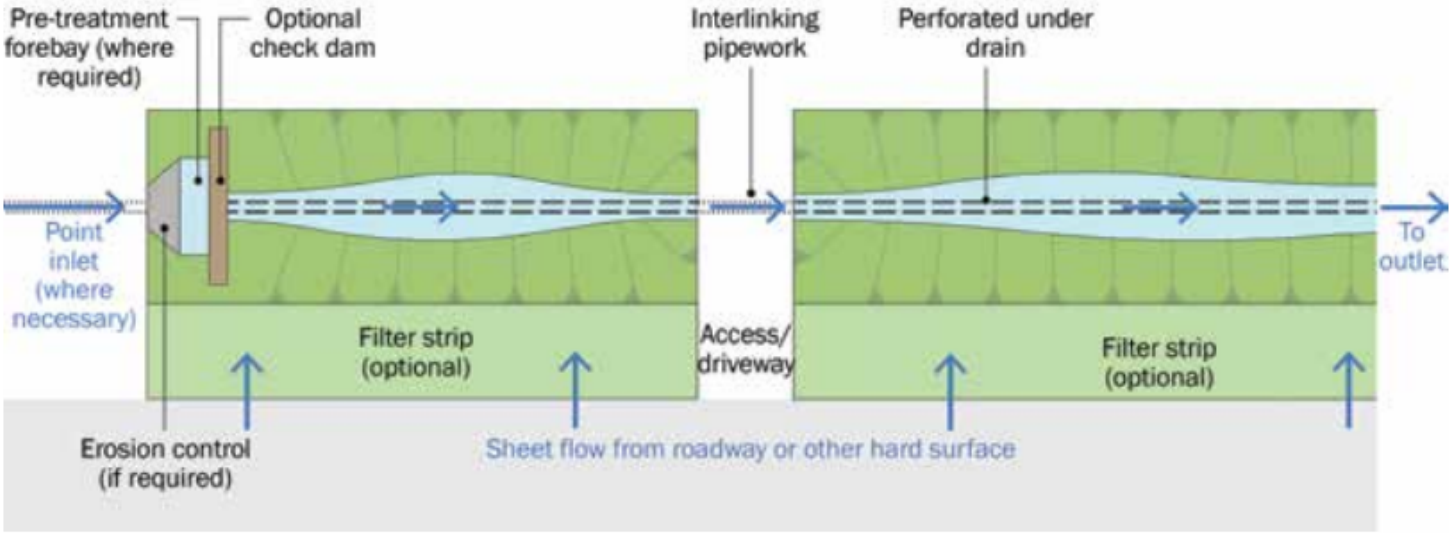


Figure G - 2 : Typical plan view of swale
Taken from the CIRIA C753 SuDS Manual Figure 17.5

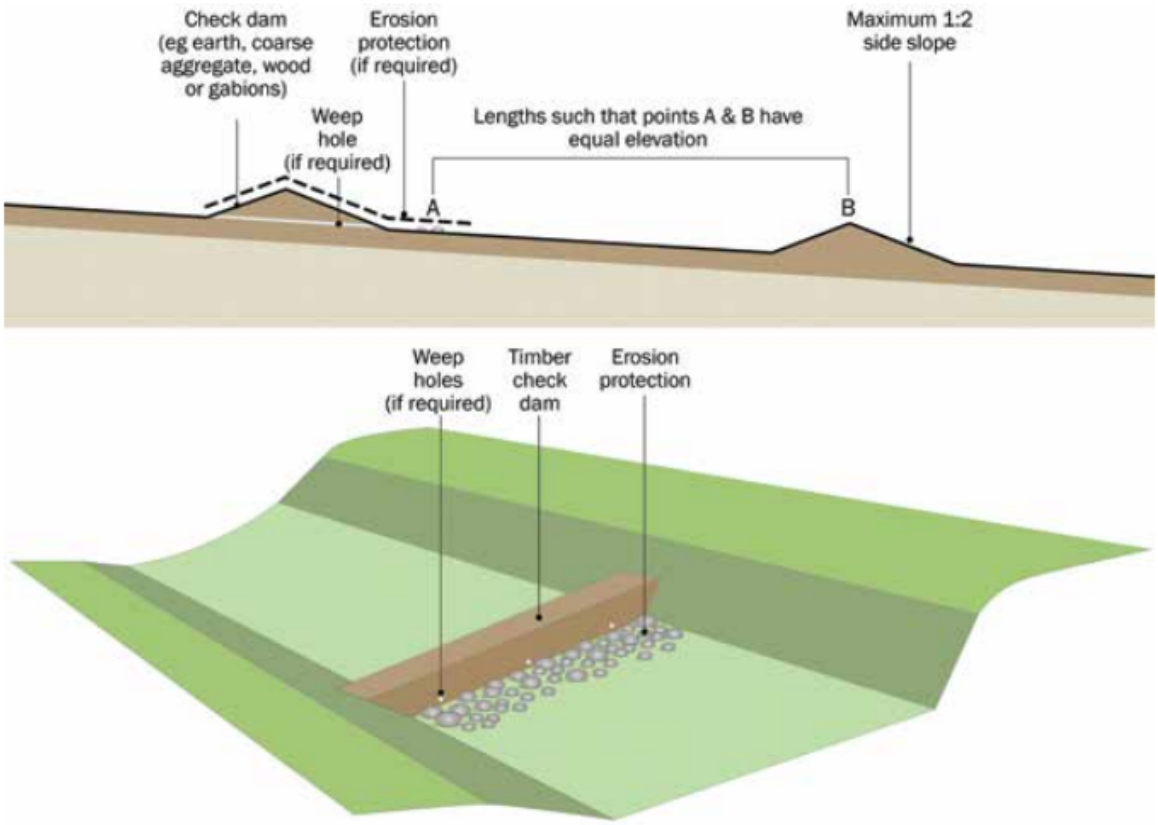


Figure G - 3 : Typical check dam details
Taken from the CIRIA C753 SuDS Manual Figure 17.13

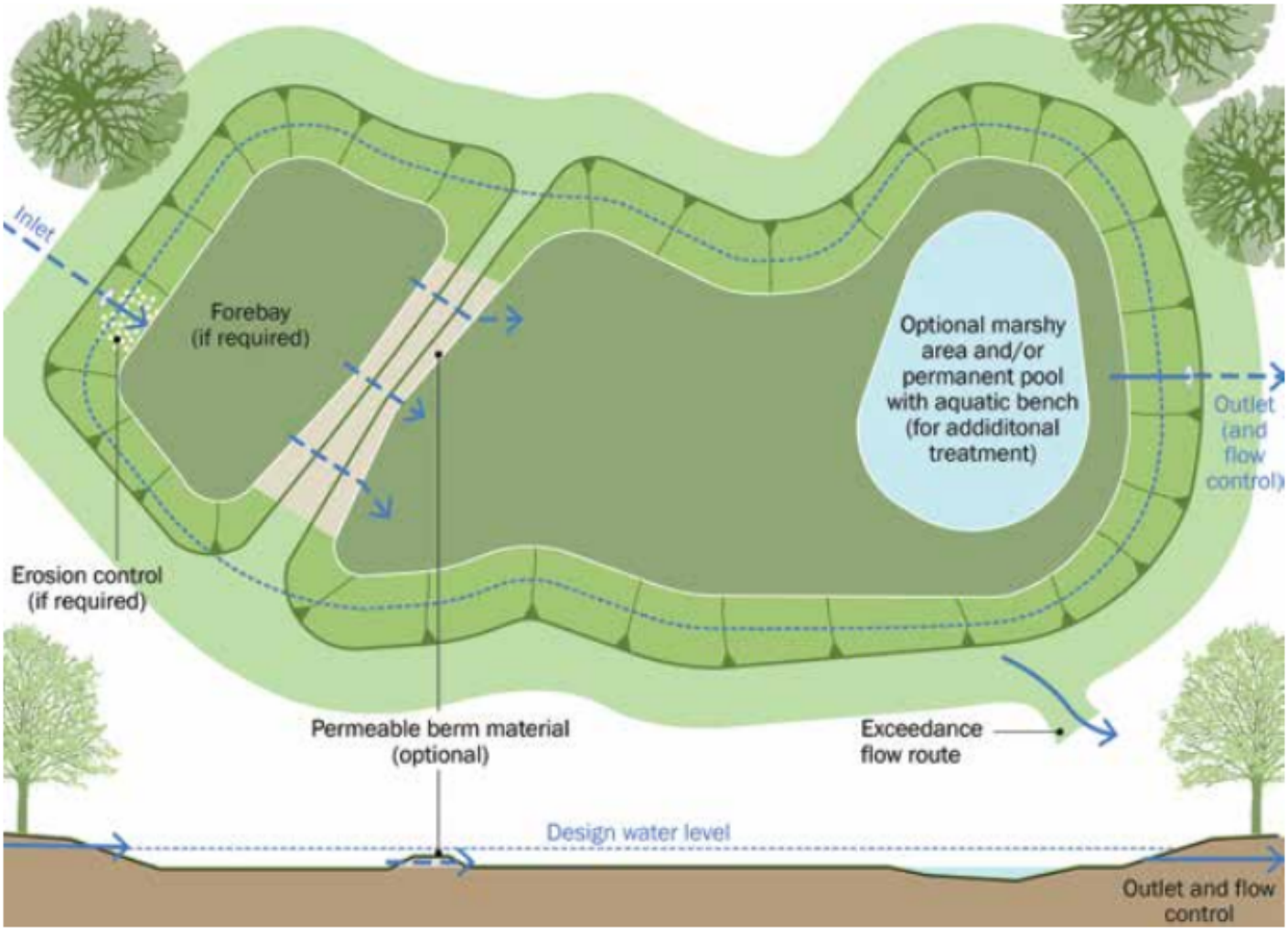


Figure G - 4 : Plan and elevation of vegetated detention basin
Taken from the CIRIA C753 SuDS Manual Figure 22.22

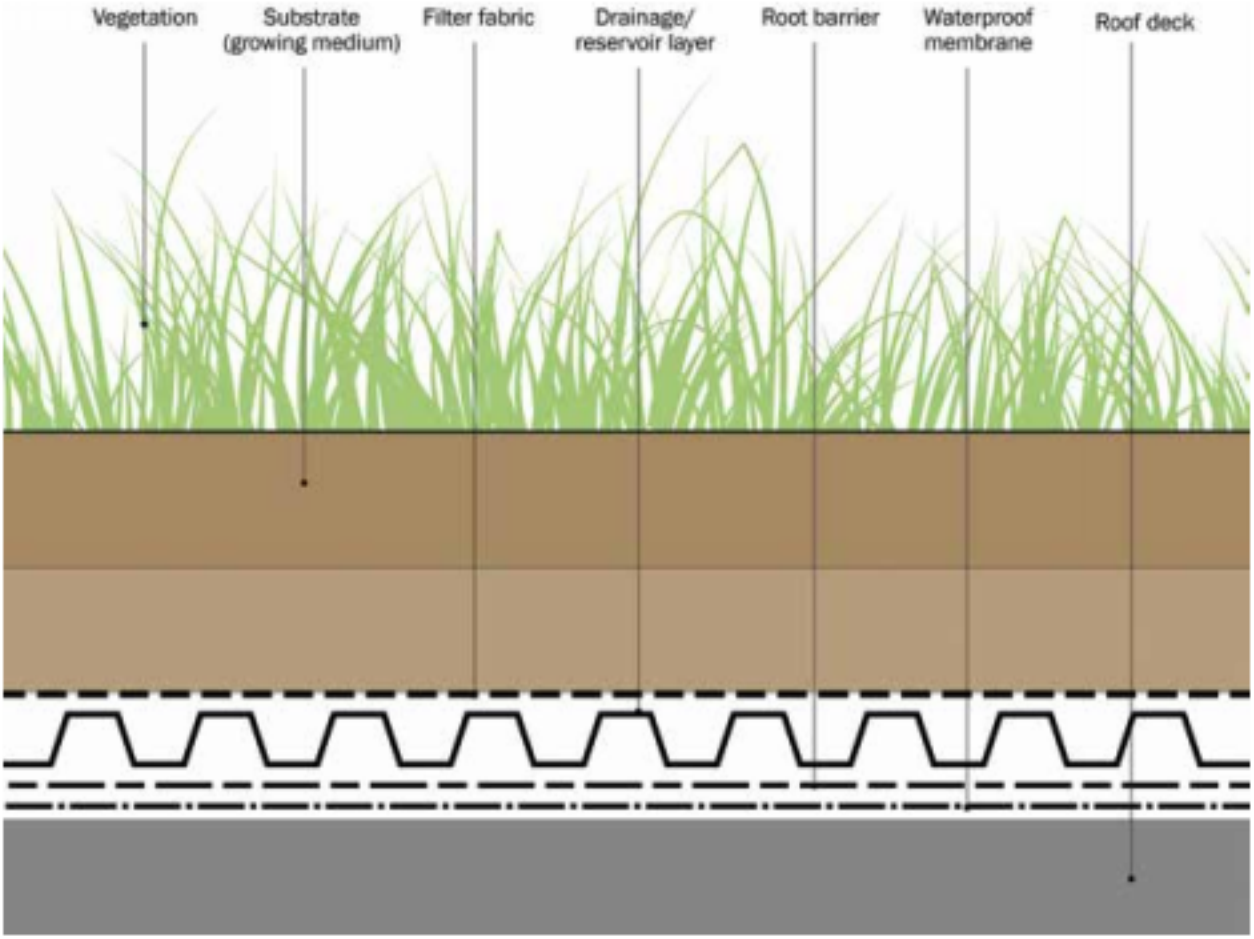


Figure G - 5 : Typical extensive green roof components
Taken from the CIRIA C753 SuDS Manual Figure 12.1

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