BARRETT MAHONY
CIVIL & STRUCTURAL
CONSULTING ENGINEERS

LRD Planning Application
LRD6018/22-S3
Further Information Response

Project:
Carlisle Residential Development, Kimmage Road West, Kimmage, Dublin 12

Job No.
21.221

DOCUMENT CONTROL

Project: Carlisle Residential Development, Kimmage Road West, Kimmage, Dublin 12

Project No: 21.221

Document Title: LRD Planning Application LRD6018/22-S3 - Further Information Response

Document No: 21.221 – RP – 12

DOCUMENT STATUS

Issue	Date	Description	Orig.	PE	Issue Check
PL1	01.02.23	Issued for Planning FI	MS	MS	MH
PL2	03.02.23	Issued for Planning FI	MS	MS	MH

Prepared by:

BMCE
52-54 Lower Sandwith Street
Dublin 2
D02WR26

Prepared for:

1 Terenure Land Ltd
27 Merrion Square
Dublin 2
D02P297

CONTENTS

APPENDIX 1:

CST-BMD-00-ZZ-DR-C-1002	**Proposed Foul and Surface Water Drainage Layout**
CST-BMD-00-ZZ-DR-C-1015	**SUDS Layout**
CST-BMD-00-ZZ-DR-C-1021	**Surface Water Drainage Longitudinal Sections**

APPENDIX 2:
Updated 'FLOW' model results

1. INTRODUCTION

Barrett Mahony Consulting Engineers (BMCE) are appointed as Consulting Engineers by '1 Terenure Land Ltd' in relation to an LRD planning application for a proposed residential development at Carlisle Site, Kimmage Road West, Kimmage, Dublin 12 (reg ref LRD6018/22-S3).

A Further Information has been issued by Dublin City Council , specifically in relation to matters raised by DCC Engineering Department – Drainage Division

The site is located in Kimmage, Dublin 12 and consists of approximately 1.25ha total net area which is intended for use as a residential development. The site is bounded by residential settlements to the north, east and west with the Ben Dunne gym to the southwest.

Refer Figure 1.1 for a plan view of the site.

Figure 1.1 Site Location

By way of background permission was granted, under ABP 313043 on the 22/09/2022, for an SHD on the subject site comprising 208 no. apartment units in 5 no. blocks. The current proposed LRD application provides the same layout and quantum of units as this permitted development.

1.1 Proposed Development

The proposed Large Scale Residential Development will consist of the construction of 5 no. blocks of development and will range in height up to 6 storeys. This will provide 208 no. residential units (104 no. 1 beds and 104 no. 2 beds) all of which will have associated private balconies/terraces. Car, cycle and motorbike parking will be located at under croft and surface level. Vehicular/pedestrian/cyclist access is provided off Kimmage Road West via the existing Ben Dunne Gym access route. All associated site development works, open spaces, landscaping, boundary treatments, plant areas, waste management areas, and services (including ESB substations) shall be provided. A full description was set out in the statutory notices included with this application.

1.2 FI Request From DCC

The FI request from DCC, states as follows

1. Drainage

- *The applicant is requested to address the following concerns of the Drainage Division –- Drainage Division does not recommend this proposal on the basis that the design is contrary to the policies set out in the Development Plan 2022-2028 regarding surface water management, in particular SI21 Managing Surface Water Flood Risk, SI22 Sustainable Drainage Systems,SI23 Green Blue Roofs and SI25 Surface Water Management.*

- *The use of underground attenuation tanks is not in accordance with the design approach and hierarchy outlined in DCC policies. Attenuation tanks shall only be considered when all other SuDS systems have been utilised in the first instance and where alternative storage mechanisms are deemed unfeasible. Applicant is required to demonstrate this in the design. It is not clear why green areas are not being utilised as multi-functioning areas to support sustainable drainage design. The Planning Report and drawings suggest a blue roof has been incorporated into the design, but this is not substantiated by the Infrastructure Report.*

- *There are inconsistencies between the body of the Infrastructure Report and the Appendices with respect to proposed attenuation and the design criteria are not evident.*

- *The Infrastructure Report submitted with the application suggests that the required interception volumes are met however interception should be delivered at source and overprovision of interception in some areas to compensate for under provision / no provision in others should be avoided. Extent of individual surface areas and corresponding volumes should be provided.*

- *It is not evident that proposed surface water infrastructure will be constructed in accordance with the Greater Dublin Regional Code of Practice for Drainage Works. Also, the proposed management of surface water from the carpark is not acceptable. Section 20 of the Greater Dublin Regional Code of Practice for Drainage Works refers.*

- *It is not obvious from the Site Specific Flood Risk Assessment that the effect of the proposed development on neighbouring/adjacent sites and beyond the site boundary has been considered.*

1.3 BMCE Drawings

The following drawings have been revised as part of this FI response submission:

CST-BMD-00-ZZ-DR-C-1002	Proposed Foul and Surface Water Drainage Layout
CST-BMD-00-ZZ-DR-C-1015	SUDS Layout
CST-BMD-00-ZZ-DR-C-1021	Surface Water Drainage Longitudinal Sections

Refer to Appendix 1.

2. DISCUSSIONS WITH DCC DRAINAGE

2.1 Teams Call With DCC Drainage

A video call, via TEAMS, was held on Monday 23rd January 2023 to discuss the points raised in the DCC FI request. The following were in attendance:

DCC Drainage Division – Ms Niamh Fitzgerald (Senior Executive Engineer)
BMCE – Dirk Kotze, Michael Shine & Michael Hughes.

3. RESPONSE TO DCC FI COMMENTS

3.1 FI Paragraph 1

FI Comment:
'…The applicant is requested to address the following concerns of the Drainage Division –- Drainage Division does not recommend this proposal on the basis that the design is contrary to the policies set out in the Development Plan 2022-2028 regarding surface water management, in particular SI21 Managing Surface Water Flood Risk, SI22 Sustainable Drainage Systems,SI23 Green Blue Roofs and SI25 Surface Water Management….'

Response:
BMCE are of the opinion that the surface water system design is indeed compliant with the above mentioned policies, while considering the specific constraints of the subject site, and in the following sections we address the specific items raised by DCC.

3.2 FI Paragraph 2

FI Comment:
'……..The use of underground attenuation tanks is not in accordance with the design approach and hierarchy outlined in DCC policies. Attenuation tanks shall only be considered when all other SuDS systems have been utilised in the first instance and where alternative storage mechanisms are deemed unfeasible. Applicant is required to demonstrate this in the design. It is not clear why green areas are not being utilised as multi-functioning areas to support sustainable drainage design. The Planning Report and drawings suggest a blue roof has been incorporated into the design, but this is not substantiated by the Infrastructure Report…..'

Response:

SURFACE WATER STRATEGY:
The aim of any SuDS strategy is to ensure that a new development does not negatively affect the surrounding watercourse system, existing surface water network and groundwater system. This SuDS strategy for the subject development will achieve this by using a variety of SuDS measures within the site. These measures include water interception, water treatment and water attenuation. The SuDS strategy has been developed with the following steps:

- The existing run-off of the abovementioned development site has been calculated and used as the minimum benchmark for the SuDS design. Thus, the post development run-off will not exceed the predevelopment run-off.
- A set of SuDS measures has been chosen based on the DCC Development Plan 2022-2028, DCC Green & Blue Roof Guide 2021, CIRIA SuDS manual and chosen based on their applicability and usage for the site.
- A "Flow" model has been created to analyse the rainfall on the site and the effectiveness of the proposed SuDS measures (and this has been updated following discussions with DCC Drainage Department)

The use of underground tanks is not excluded by DCC policies. It is noted and understood that attenuation tanks should only be considered when all other SuDS systems have been utilised in the first instance and where alternative storage mechanisms are deemed unfeasible.

Underground tanks are proposed in the subject development, however these were only deemed necessary, following the review of what other SuDS systems and storage mechanisms could be implemented, given the specific constraints of the site. Underground tanks are not being proposed in isolation, and are part of a number of surface water management 'trains' being adopted for the site. For clarity the following SuDS measures are being used

- Extensive Green Blue Roofs
- Intensive Green Blue Roofs
- Permeable paving
- Petrol interceptors
- Underground cellular tanks.

At the start of the design process various green soft SuDS measures were considered. These included infiltration trenches, swales, detention pond / basins.

In terms of infiltration trenches, these cannot be adopted as the subsoils have insufficient infiltration characteristics. This was established via infiltration tests (to BRE 365) carried out by

Causeway Geotech Ltd in Sept 2022 (note Causeway Report Ref 21-0968 was submitted as part of the application submission). Extract of Causeway Geotech report is provided below.

> **7.3 Infiltration drainage**
>
> In infiltration test carried out in trial pit IF01-IF04, the absence of outflow precluded the calculation of any infiltration coefficients. The low-permeability fine-grained soils are therefore considered to be poor infiltration media, and would be deemed unsuitable for the implementation of infiltration drainage systems.

In terms of swales, these could not be adopted as these is insufficient space on site to implement same, given the layout of the proposed development. In particular there is insufficient separation between swales and boundary walls, buildings, foul pumping station etc.

In terms of detention pond / basins, there is insufficient space to accommodate such features in this site. In this regard, there are two areas of open space in the development.

- The first is located in the north west corner of the site. This area of the site is at the highest level and as such, from a levels perspective, is unsuitable to accommodate a pond / detention basin (such features need to be towards the lower end of the surface water system, near the outfall location.

- The second area of green space is located at the south east corner of the site. However, the area is constrained by the proximity of boundary walls, road carriageway, proposed building footprint, proposed underground foul pumping station and the fact that the area forms an important part of the landscaping provision for the development. As a result, there is insufficient space to use an open surface depression for surface water attenuation.

In the previously submitted design, the upper areas of roof (across the two buildings) were proposed to be extensive type green blue roofs. The areas of podium, at first floor level, were not proposed to be blue roofs – however following TEAMs call between BMCE and DCC on 23 January 2023, it was agreed that these first floor areas would be adopted as blue roofs also.

Previously proposed green blue roof area	=	2,822 m^2
Now proposed green blue roof area	=	4,332 m^2
Percentage increase	=	54%

This has now been reflected in the updated 'SuDS Measures' drawing attached in Appendix 1. Furthermore, an updated surface water hydraulic design model (FLOW) has been prepared, the results of which are included in Appendix 2.

<u>SURFACE WATER MANAGEMENT PLAN:</u>

The proposed Surface Water Management Plan is in line with the key requirements of the Dublin City Council Division Planning & Development Control Section. The proposed surface water drainage system takes cognisance of the Dublin City Development Plan 2022-2028 with respect to SuDS Section 9.5.4. The proposed SuDS measures provide a minimum of two stage treatment of surface water run-off. This treatment approach is in line with the CIRIA SuDS Manual C753 and is outlined below.

The proposed surface water system uses a number of SuDS components in series to provide a minimum of two-stage treatment prior to discharge into the receiving systems. A SuDS Management Train for the Development has been prepared – refer to Figure 3.1. The SuDS

Management Train describes how rainfall falling on each surface is managed and treated prior discharge and clearly demonstrates a robust train of treatment, which in most cases exceeds the minimum two-stage requirement.

Rainfall run-off will be intercepted and treated at roof levels using intensive and extensive green roofs where feasible. A multidisciplinary coordinated approach has been taken with regard to assigning the appropriate areas of roof level as intensive green roof, in an effort to accommodate other elements such as plant and photovoltaic panels. Furthermore, all podium areas (both hard and soft landscaping) will incorporate an intensive green roof drainage board above the waterproofing, to ensure greater interception of rainwater and treatment through the substrate prior to entering the pipework system.

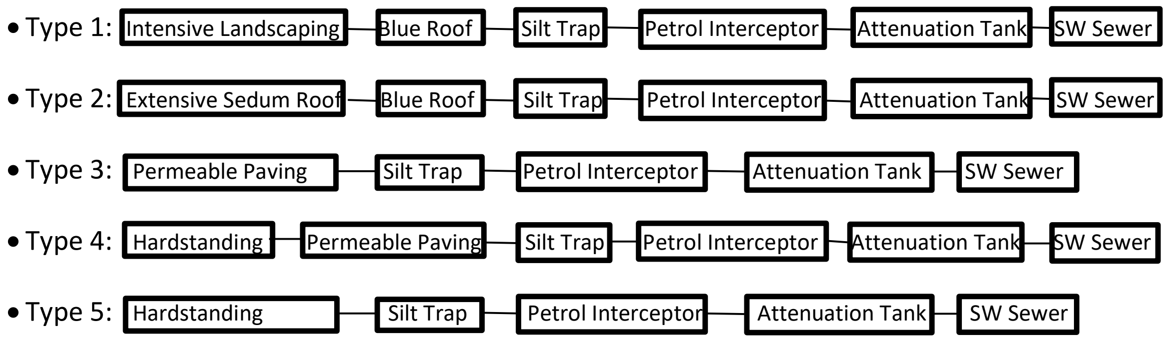


Figure 3.1 Surface Water Management Train

<u>Green Blue Roofs General:</u>

Green Blue roofs are areas of living vegetation, installed on the top of buildings. They provide water quality, water quantity, amenity and provide biodiversity benefits. Green roofs also intercept rainfall at source reducing the reliance on attenuation storage structures. The blue roof element under the traditional green roof layers provides attenuation and reduces the size requirement for attenuation tanks downstream in the surface water system. Refer to the Barrett Mahony revised drawings CST-BMD-00-ZZ-DR-C-1002 (SW Layout) and CST-BMD-00-ZZ-DR-C-1015 (SuDS Details)

<u>Green Blue Roof – Extensive:</u>

Refer to Fig 3.2 for cross section through extensive green blue roof. Extensive roofs have low substrate depths and therefore low loadings on the building structure, they are lightweight and have a low cost to maintain. These systems cover the entire roof area with hardy, slow growing, drought resistance, low maintenance plants and vegetation, such as sedums. The planting usually matures slowly, with the long-term biodiverse benefits being the sought-after results. These roofs are typically only accessed for maintenance and are usually comprised of between 20mm – 150mm overall total depth.

Extensive green roofs have the effect of providing some initial storage of rainwater, while also reducing the rate at which rainwater from heavier rainfall events will discharge to the main attenuation tank. It can also help to filter the run-off, removing any pollutants and resulting in a higher quality of water discharging to the drainage system. A typical extensive green roof system can intercept and retain over 30 litres/m² (i.e. 30 mm) depending on the build-up. Since these roofs are exposed to the Irish climate, there is a high probability that the roof will not be completely dry, and the storage capacity will be compromised on any given rainfall event. Thus, the more conservative estimate of 10 litres/m² (12mm) interception storage has been assumed. The addition of the blue roof will provide attenuation storage of 55 l/m². This will reduce the attenuation tank size required downstream and which is best practice in accordance with DCC policy SI23.

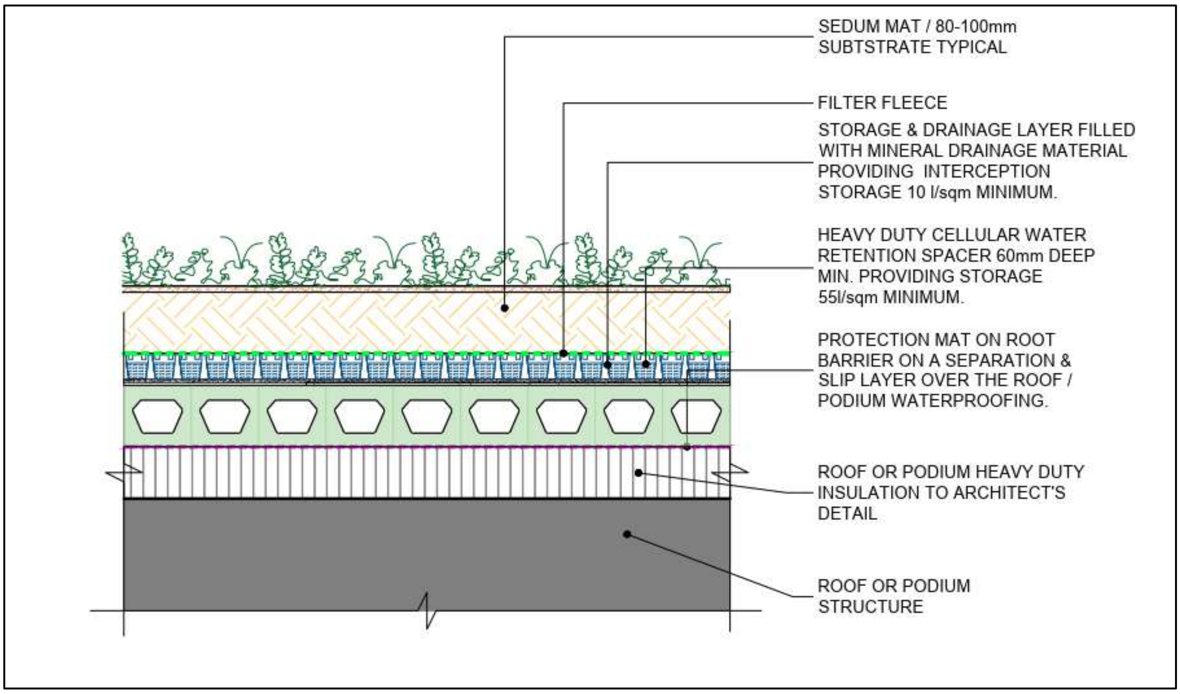


Figure 3.2 Green Roof Extensive

<u>Green Blue Roof - Intensive</u>

Refer to Fig 3.3 for typical section through intensive green blue roof. Intensive green roofs are designed to sustain more complex landscaped environments that can provide high amenity and biodiverse benefits. They are planted with a range of plants, including grasses, shrubs, trees and may also include water features, as well as hard landscape paved areas. They are designed to be accessible and normally require regular maintenance.

Intensive paved roofs will be proposed on some of the apartment blocks roofs in the public amenity areas and in some podium areas. The use of intensive of green roofs will also allow the planting of large shrubs, small trees, and small water features within the podium area. These features improve the amenity value for the residents. The build-up selected for the Intensive Green Roof on the top of the roofs will include an interception tray to capture the first 12mm of rainfall falling on each roof, providing an intercept and retain capacity of 10 litres/m² (minimum). The addition of the blue roof will provide attenuation storage of 55 l/m^2. This will reduce the attenuation tank size required downstream and which is best practice in accordance with DCC policy SI25.

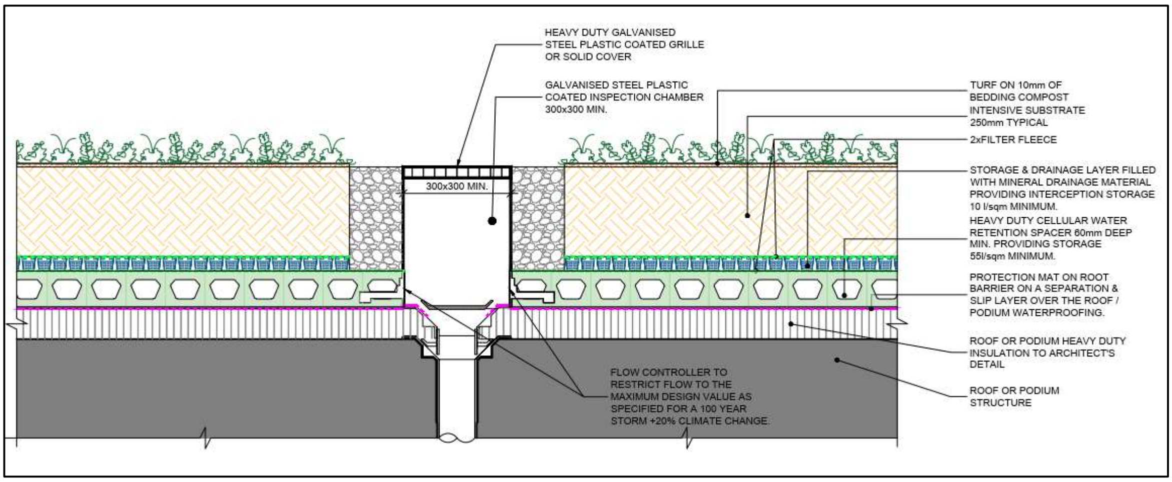


Figure 3.3 Green Blue Roof Intensive

Blue Roof Under Solar Panels

In accordance with the Green Blue Roof guide 2021, a blue roof will be installed under the section of roof in block 3 containing solar panels. It is not possible to put an intensive or extensive growing medium here. The blue roof attenuation layer will be covered in a filter fleece and gravel to mitigate dirt and debris entering the surface water system.

SUDS MEASURES LAYOUT:

Refer to Fig 3.4 for extract of updated SuDS measures drawing.

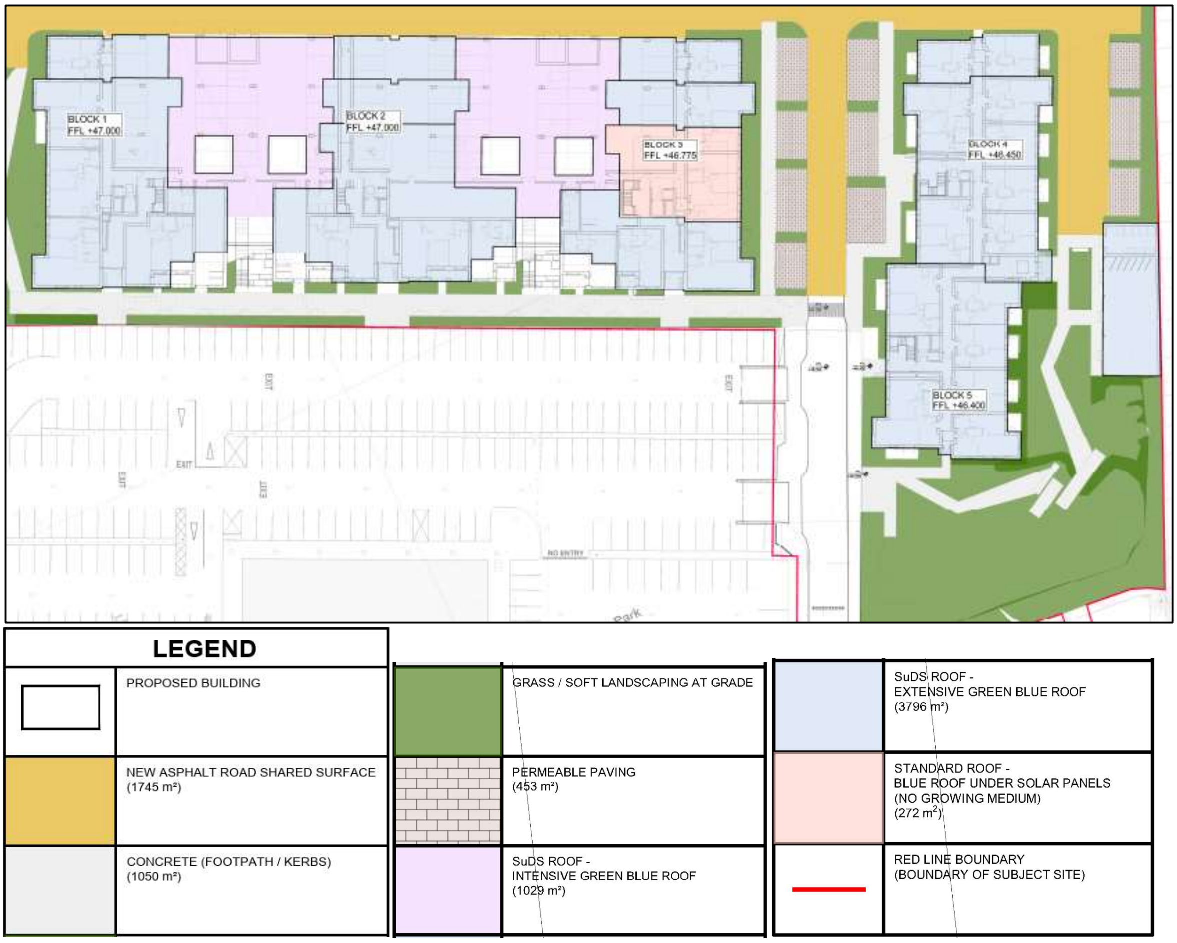


Figure 3.4 SuDS Layout

The green blue roof will provide interception of rainfall, filtration through the medium, and storage within the voids facilitating evapotranspiration. The green roofs will intercept and absorb the first 5 – 15mm of rainfall, thereby reducing the volume of run-off into the receiving systems. Rainfall run-off that is not absorbed by the green roof will filtrate through the substrate and geotextile filter fabric. A limited attenuation volume will be provided by the green roof crate layer system below the geotextile filter fabric, which will provide a time delay between the rainfall event and discharge into the system thereby reducing peak discharge rates. This will be in addition to the reduction in peak discharge rate provided by the blue roof layer below. According to the leading green roof supplier/manufacturer Bauder, up to 40% of average annual rainfall can be absorbed and released back into the atmosphere by transpiration and evaporation.

Therefore, rainfall run-off from roof areas covered by the proposed green roofs will go through a two-stage treatment train including interception and primary treatment in line with SuDS Manual C753 Table 26.7.

The proposed development contains an extensive green blue roof build up in over 70% of the inaccessible roof areas (access provided for maintenance purposes only). The remaining 30% is an allowance for parapets, access hatches and areas for solar panels. However, the section of roof containing solar panels, see figure 2.4, will contain a blue roof for attenuation, but will not contain an extensive or intensive growing medium. This complies with the Dublin City Council Development Plan 2022-2028 Appendix 11.

The proposed development contains an intensive green roof build up in over 50% of the podium (in the form of soft landscaping). This complies with the Dublin City Council Development Plan 2022-2028 Appendix 11.

<u>GROUND LEVEL SUDS MEASURES – PERMEABLE PAVING:</u>

Refer to Fig 3.5 for cross section through permeable paving. Permeable paving provides a surface suitable for pedestrian and/or vehicular traffic, while also allowing rainwater to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored beneath the overlying surface before slowly infiltrating. Permeable paving systems are an effective way of managing surface water runoff close to its source. The car parking spaces outside of the building footprint of the site will be made up of permeable paving.

By providing a raised drainage outlet above the base of the coarse graded gravel bed it is possible to achieve interception storage. Raising the invert of the drainage pipe to 100mm above the gravel bed gives 40mm interception storage @ 40% voids in the gravel.

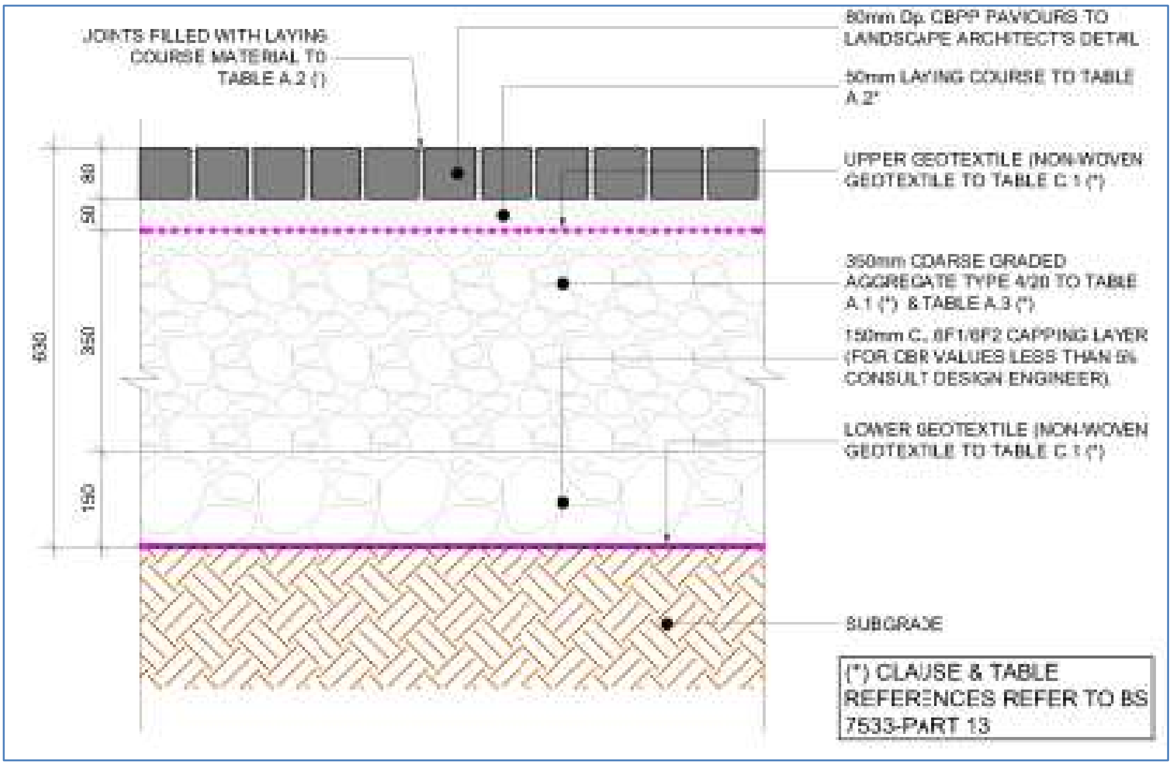


Figure 3.5 Permeable Paving Build-up

ROADWAY & HARDSTANDING AREAS:

The internal road is a hardstanding non permeable surface. The section of road adjacent to permeable parking bays will drain into the permeable paving. These permeable paving bays provide infiltration and interception storage to the rainwater flowing from the non-permeable road. This helps achieve the required interception storage as the DCC Development Plan.

It is not possible to provide adequate interception to the east – west road along the northern boundary. The proximity of the road to the boundary wall and building makes it impossible to fit in SuDS measures like tree pits, swales, or filter strips. As a result, this area will drain directly to first attention tank, and pollutants will be dealt with by way of treatment and infiltration in the underground Stormtech attenuation tank isolator row. The drainage layout has been designed in such a way that initial run off from this road will make its way to the Stormtech tank before any roof run off or excess surface water from the permeable paving, thus ensuring any infiltration will apply to the road run off first.

The car park in the under croft is a covered car park and has a hardstanding surface. Any residual rainwater that makes its way into the car park by car wheels entering the car park, or rainwater from the podium vents will drain into the foul water system, as requested by DCC. Therefore, the under croft car park area has not been considered when designing the surface water drainage and SuDS measures.

Paved footpaths in landscaped areas will be designed with fall to ensure any SW runoff soaks away into the adjacent soft landscaping areas.

INTERCEPTION STORAGE:

Soft landscaping and planted areas are conservatively taken as providing natural interception storage of 15mm. Interception storage volumes for each sub-catchment areas shown below.

Interception storage required m^3 = Total drained area (m^2) x minimum rainfall (mm)
Interception storage required = $11,500m^2 \times 0.005m = 57.5m^3$
Interception storage proposed (refer Table 2.2) = $72.4m^3$

The proposed Interception storage meets the preferred 10mm storage criteria.

Table 3.2 Interception Storage

Type of areas	Roof Areas (m^2)	Attenuation Areas (m^2)	Storage (l/m^2)	Capacity (m^3)
Green Blue Roof - Extensive	3796	3226	12	38.712
Green Blue Roof - Intensive	1029	875	12	10.5
Blue Roof (No Growing Medium)	272	231	12	2.772
Permeable Paving	453	453	45	20.385
Total	**-**	**-**	**-**	**72.4**

ATTENUATION STORAGE ROOFS

Attenuation storage is based on a 65mm deep blue roof drainage board with capacity of 55 l/m^2. This attenuation capacity does not include the buried attenuation tanks downstream on site. It is assumed that the blue roof build up will make up 85% of the roof or podium area. This is to allow for attenuation areas lost for AOVS, parapets, soil vent pipes etc.

Table 3.3 Interception Storage

Type of areas	Roof Areas (m^2)	Attenuation Areas (m^2)	Storage (l/m^2)	Capacity (m^3)
Green Blue Roof - Extensive	3796	3226	55	177.43
Green Blue Roof - Intensive	1029	875	55	48.125
Blue Roof (No Growing Medium)	272	231	55	12.705
Permeable Paving	453	453	45	20.385
Total	**-**		**-**	**258.645**

See revised SuDS Layout drawing CST-BMD-00-ZZ-DR-C-1015 submitted with this FI response for further information.

3.3 FI Paragraph 3

FI comment:

'…..There are inconsistencies between the body of the Infrastructure Report and the Appendices with respect to proposed attenuation and the design criteria are not evident…..'

Response:

Refer to the information provided at section 3.2 above, by way of further clarification. These are now fully consistent between the drawings, calculations and this report.

3.4 FI Paragraph 4

FI comment:

'….The Infrastructure Report submitted with the application suggests that the required interception volumes are met however interception should be delivered at source and overprovision of interception in some areas to compensate for under provision / no provision in others should be avoided. Extent of individual surface areas and corresponding volumes should be provided…..'

Response:

Refer to the information provided at section 3.2 above, by way of further clarification.

3.5 FI Paragraph 5

FI comment:
'……It is not evident that proposed surface water infrastructure will be constructed in accordance with the Greater Dublin Regional Code of Practice for Drainage Works. Also, the proposed management of surface water from the carpark is not acceptable. Section 20 of the Greater Dublin Regional Code of Practice for Drainage Works refers….'

Response:
We confirm that the proposed surface water infrastructure will be constructed in accordance with the Greater Dublin Regional Code of Practice for Drainage Works.

The matter of the surface water drainage to the surface level 'under croft' car park was discussed with DCC during the TEAMS call of 23 January 2023. BMCE explained that the drainage in this area was being treated as a normal external car park area, because it is at surface level (i.e. not a basement) and has a series of horizontally open vents allowing rainwater into the area. DCC noted same but stated their preference would be for the surface water in this area to be directed to the foul system. As such BMCE have amended the surface water drawing to indicate the drainage in this area being directed to the foul system. See attached updated drawing CST-BMD-00-ZZ-DR-C-1002 Proposed Foul and Surface Water Drainage Layout, in Appendix 1.

3.6 FI Paragraph 6

FI comment:
'…..It is not obvious from the Site Specific Flood Risk Assessment that the effect of the proposed development on neighbouring/adjacent sites and beyond the site boundary has been considered….'

Response:
This response should be read in tandem with the SSFRA submitted at application stage. The information contained here will address the issue of the possible impact on flooding to neighbouring sites as a result of the proposed development site and the impact of the surface water run off to the local SW network.

For clarity, the development site area refers to the total site owned '1 Terenure Land Ltd', which is subject to the proposed development, see area delineated in purple in Figure 3.6. The total area of this proposed development site is an existing green field site. The remaining area within the red line boundary but outside the purple proposed development boundary contains part of Kimmage Road and an existing access road and footpaths owned by and serving Ben Dunne Gym. It is not proposed to permanently alter or make any material change to any area outside the purple line boundary in Figure 3.6. This area is included in the red line boundary to allow for the diversion and installation of buried services (SW and FW pipes, watermain and other utilities etc.) and to provide access to the site. All red line site areas outside the purple line boundary will be reinstated to existing levels – i.e. we are not proposing to alter levels, which otherwise might in some way alter the flood risk to adjacent properties. Therefore, the proposed development will not impact any flood risk to the red line areas outside of the development site.

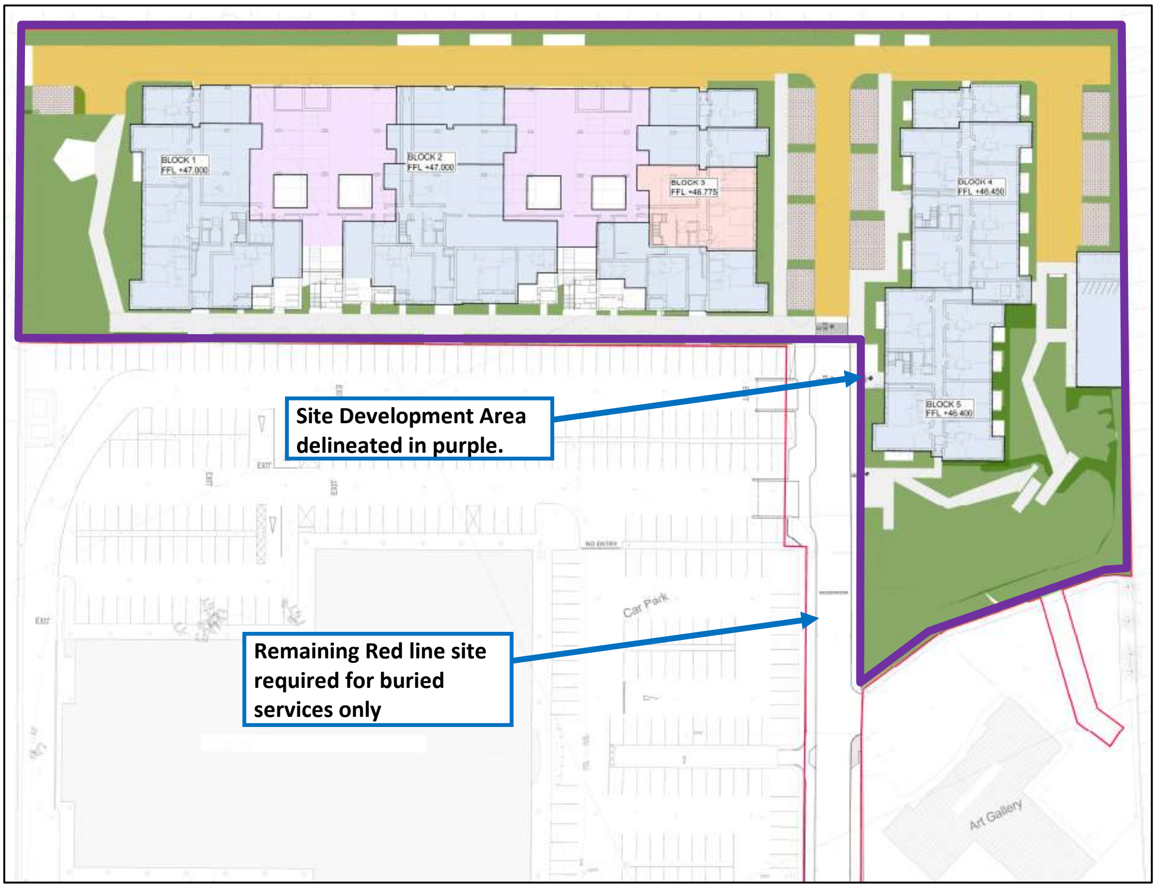


Figure 3-6 Site Development Area delineated in purple.

We refer also to the BMCE Site Specific Flood Risk Assessment submitted as part of this planning application. This SSFRA was carried out in accordance with the DEHLG guidelines for Planning 2009 and The Planning and Development Act 2000. The SSFRA concludes as follows:

- Based on available and recorded information, the site has not been subject to flooding in recent history.
- The risk of tidal flooding is considered very low as the subject site lies outside the 0.1% AEP.
- The risk of fluvial flooding in the area is considered low as the proposed site lies outside the 1% AEP.
- The risk of flooding due to ground water ingress to the proposed development is considered low.
- The risk of pluvial flooding is considered low, due to the site location and proposed measures for the development.
- Based on the flood risk identification in Stage 1, the proposed development falls in Flood Zone C. Therefore, the proposed development is deemed 'Appropriate' in accordance with the guidelines of the OPW's publication.

<u>IMPACT ON LOCAL SURFACE WATER NETWORK:</u>
The capacity of the local surface water network and any resulting flooding in the locality was taken account of when designing the site surface water network and SuDS measures. Appendix 12 of the DCC Development Plan 2022-2028 requires the maximum site discharge rate to be "QBAR or 2 l/s/ha, whichever is greater". The QBAR, or greenfield run off, for this site has been calculated as 4.46 litres per second (see section 2.3 above). The more conservative discharge value of 2.0 l/s/ha would result in a run-off rate of 2.5 l/s based on the site area of 1.25 ha.

The hydrobrake located just prior to the surface water outfall point, is designed to restrict flow to 2.0 l/s, and all surface water drainage and on-site attenuation has been designed based on this low discharge rate. This discharge rate is a 55% reduction on the current green field run off rate and 20% lower than the conservative value from the DCC Development Plan 2022-2028. Thus, increasing capacity of downstream receiving water courses.

IMPACT ON NEIGHBOURING OR ADJACENT PROPERTIES

The levels and falls withing the proposed site layout and roadway, all follow the existing topography of the site, which descends from west to east, with a minor fall from south to north. As such the proposed development layout does not alter the existing overland flow routes of the existing site, and hence poses no increased flood risk to neighbouring properties in this regard.

A linear drainage channel is proposed along the northern edge of the site road to catch surface water from the road internal east-west road, to ensure no surface water run-off from the proposed development inadvertently floes into any neighbouring property along this boundary. As the eastern portion of the site is the lowest area on the site, the road and parking bays here have been designed to fall in the opposite direction to ensure surface water run off falls away from neighbouring properties and into a drainage channel adjacent to Block 4.

As discussed above the surface water system has been designed with a large area of blue roof storage. This blue roof, along with the 2 no. underground attenuation tanks, provide significant on site storage for rainwater which can accommodate 1 in 100 year storms plus an additional 20% allowance for climate change.

As a result, there will be a significantly reduced SW discharge rate of the proposed development site, will reduce the load on the local SW network during storm events, thus reducing the flood risk to the wider area during such events.

Furthermore, given the additional green roofs which are now proposed under this FI response, technically it is possible to reduce the slightly the volume of the underground attenuation tanks. However, we have chosen not to do, and instead to maintain the tank size as previously submitted. This slight over provision of attenuation volume, acts to further mitigate flooding risk within the public system.

JUSTIFICATION TEST

During the TEAMS call of 23 January 2023 between DCC and BMCE, the matter of a justification test was discussed. BMCE pointed out that within the SSFRA submitted, and area of the existing access road is identified as being at risk of minor pluvial flooding for 1 in 100 and 1 in 1000 year rainfall event, however the area of the site where residential development is actually occurring is within Flood Zone C (i.e. at negligible risk of flooding) – hence the need for a justification test does not arise.

In the following pages, we have included extracts of the relevant flood maps for the area, from the Eastern CFRAM Flood Study, which are available online at OPW website ‘floodinfo.ie

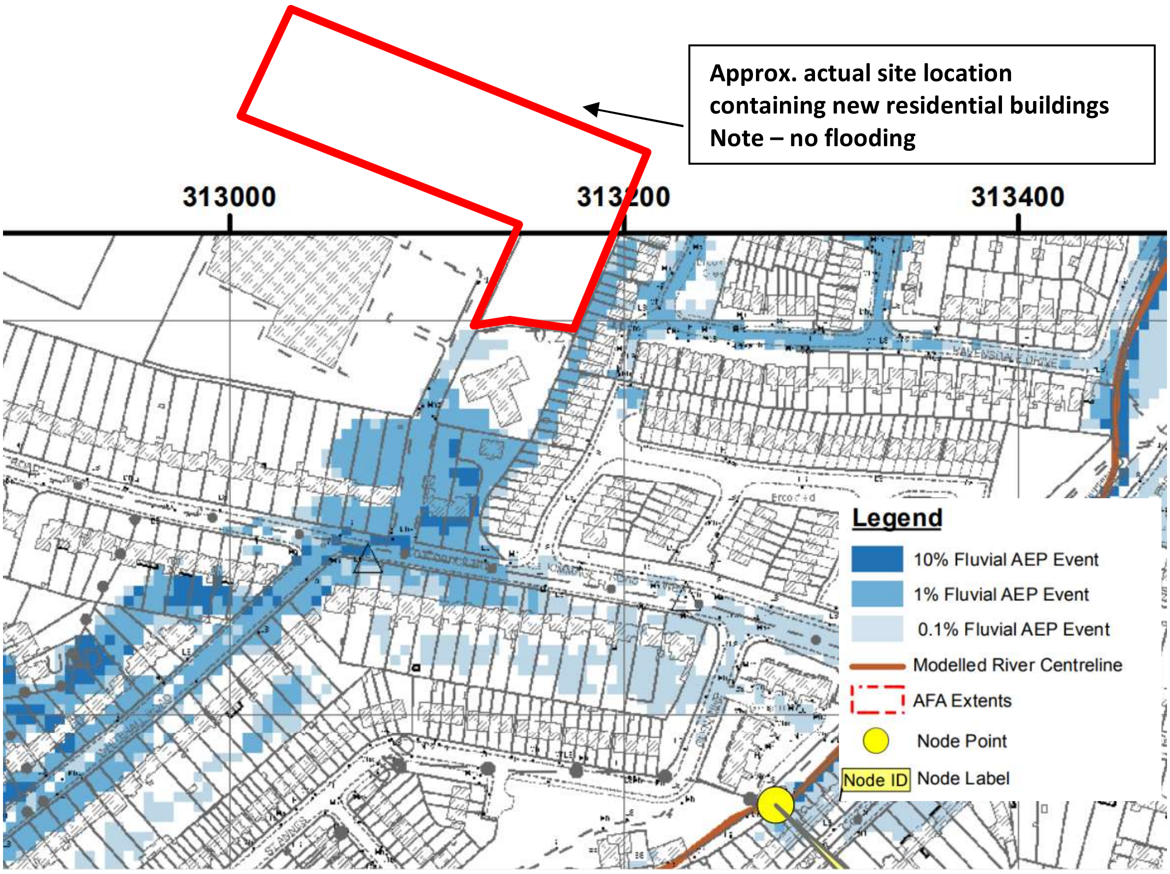


Fig 3.7 Eastern CFRAM Study – <u>Poddle River Fluvial Extents</u>
(E09POD_EXFCD_F0_03 Map 3 of 6 - note the CFRAM map 'straddles' the subject site)
(10% Fluvial AEP Event – 1 in 10 year) & (1% Fluvial AEP Event – 1 in 100 year) & (0.01% Fluvial AEP Event – 1 in 1000 year)

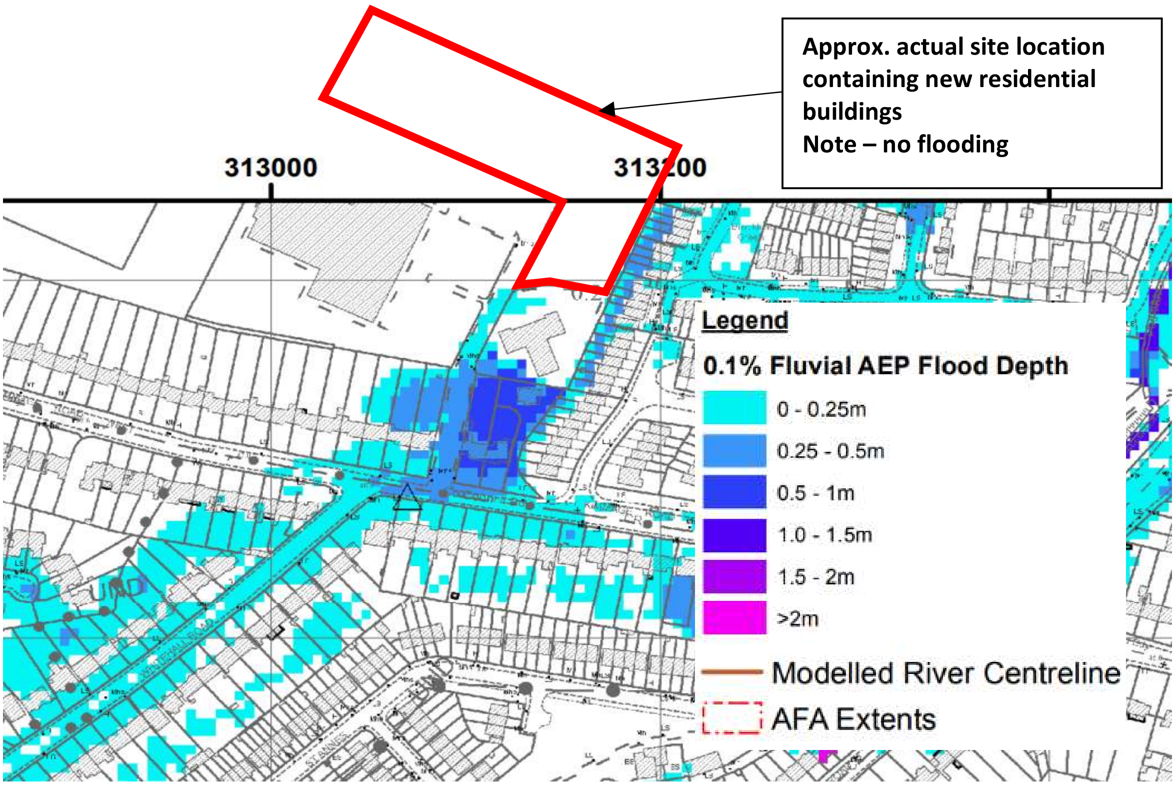


Fig 3.8 Eastern CFRAM Study – <u>Poddle River Flood Depths</u>
(E09POD_DPFCD001_F0_03 Map 3 of 6) (note the CFRAM map 'straddles' the subject site)
0.01% Fluvial AEP Event – 1 in 1000 year

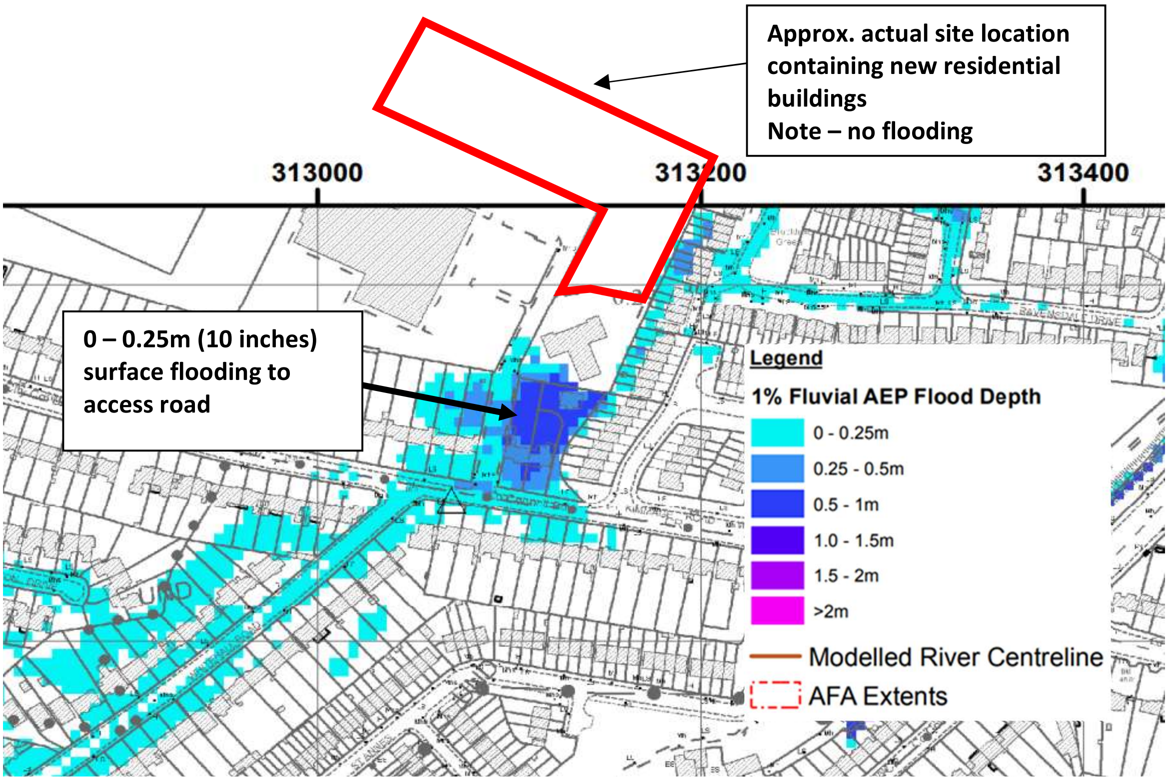


Fig 3.9 Eastern CFRAM Study – <u>Poddle River Flood Depths</u> (E09POD_DPFCD001_F0_03 Map 3 of 6)
(note the CFRAM map 'straddles' the subject site)
0.01% Fluvial AEP Event – 1 in 100 year

The above flood map extracts indicate some minor surface flooding of the existing access road, which serves the existing Gym premises. It is not proposed to change the levels of this existing access road and therefore there is no increased flooding risk to the access road or surrounding properties. Certain resurfacing works and line marking are proposed to the existing access road, and certain underground services are proposed to be installed under the existing road.

The estimated maximum depth of surface flooding in the 1 in 100 year event is estimated in region 0 – 0.25m (0 – 10 inches)

The estimated maximum depth of surface flooding in the 1 in 1000 year event is estimated in region 0 – 0.50m

In the highly unlikely scenario of a fire or medical emergency occurring in the subject development, at the same time as a 1 in 100 year flood event or a 1 in 1000 year flood, a fire tender and / or ambulance vehicle could still traverse the access road. There is no risk posed to emergency access by the predicated surface flooding of the <u>existing</u> access road.

Furthermore, the proposed <u>new</u> internal roads associated with the new development are all confined to the area immediately around the new buildings and are all in an area which is demonstrably within Flood Zone C.

Appendix 1

BMCE Drawings

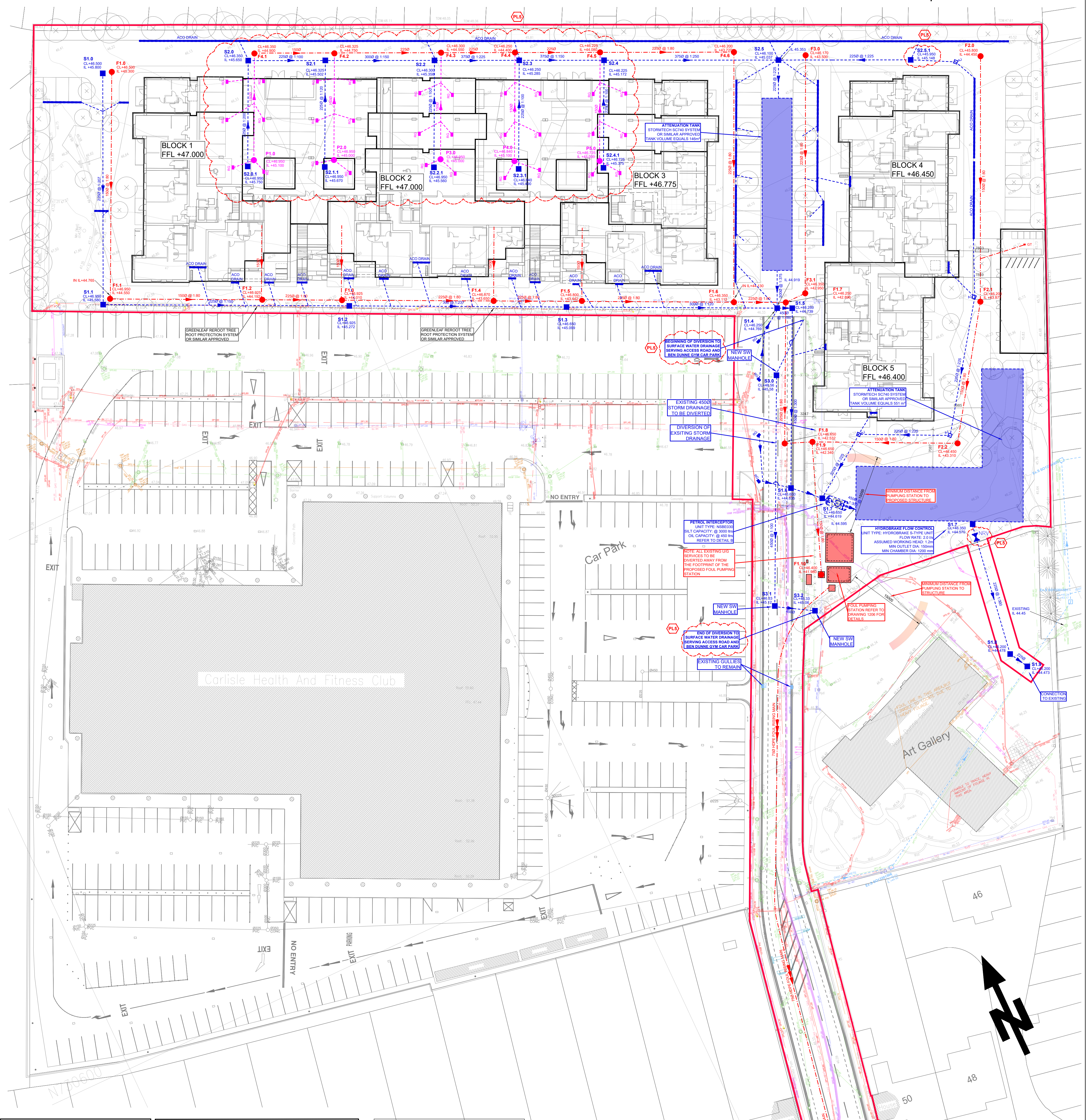
CST-BMD-00-ZZ-DR-C-1002
Proposed Foul and Surface Water Drainage Layout

CST-BMD-00-ZZ-DR-C-1015
SUDS Layout

CST-BMD-00-ZZ-DR-C-1021
Surface Water Drainage Longitudinal Sections

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS.FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - `ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.



CIVIL LEGEND

- EX. FOUL MANHOLE — Ex.F
- EX. FOUL PIPE — PIPE DESCRIPTION
- NEW FOUL MANHOLE — F
- NEW FOUL PIPE — PIPE DESCRIPTION
- EX. SURFACE WATER MANHOLE — Ex.S
- EX. SURFACE WATER PIPE — PIPE DESCRIPTION
- NEW SURFACE WATER MANHOLE — S
- NEW SURFACE WATER PIPE — PIPE DESCRIPTION
- EX. COMBINED MANHOLE — Ex.C
- EX. COMBINED PIPE — PIPE DESCRIPTION
- NEW COMBINED MANHOLE — C
- NEW COMBINED PIPE — PIPE DESCRIPTION
- NEW RISING MAIN — PIPE DESCRIPTION
- PIPE CROSSOVER
- EX. CAR PARK SURFACE WATER MANHOLE — Ex.P
- EX. CAR PARK SURFACE WATER PIPE — PIPE DESCRIPTION
- NEW CAR PARK SURFACE WATER MANHOLE — P
- NEW CAR PARK SURFACE WATER PIPE — PIPE DESCRIPTION
- DECOMMISSIONED LINE — PIPE DESCRIPTION
- FOUL ACCESS JUNCTION — AJ
- SURFACE ACCESS JUNCTION — AJ
- RAINWATER PIPE — RWP
- SOIL VENT PIPE — SVP
- ROAD GULLEY — RG
- BACK INLET GULLEY TRAP — BIGT
- FOUL RODDING EYE — RE
- SURFACE RODDING EYE — RE
- GULLEY TRAP — GT

SERVICES LEGEND

- UNDERGROUND ELECTRICITY LINE
- ELECTRICAL M/HOLE (EMH)
- OVERHEAD LINE WITH POLE (EP)
- OVERHEAD ELECTRIC
- UNDERGROUND HV ELECTRICITY LINE
- 6m HIGH STREET LIGHT (LP)
- MINI PILLAR (MP)
- EIR
- EIR CHAMBER
- OVERHEAD LINE WITH POLE (TP)
- ENET
- ENET CHAMBER
- COMMS
- COMMS CHAMBER
- VIRGIN
- VIRGIN CHAMBER
- FIBRE
- FIBRE CHAMBER
- AURORA TELECOM
- AURORA TELECOM CHAMBER
- CATV
- CATV CHAMBER
- BT
- BT CHAMBER
- ESAT
- ESAT CHAMBER
- SIRO FIBRE
- SIRO CHAMBER
- UNIDENTIFIED SERVICE (UNID)
- UNIDENTIFIED CHAMBER (UNMH)
- EARTH LINE AND RODS
- TRAFFIC SENSORS (SENSOR)
- CCTV POLE (CCTV)
- UTILITIES CABNET (UCAB)
- FOUL DRAINAGE
- FOUL MANHOLE (FMH)
- STORM DRAINAGE
- STORM DRAINAGE MANHOLE (SMH)
- COMBINED DRAINAGE
- COMBINED DRAINAGE MANHOLE (CMH)
- PRODUCT DRAINAGE
- PRODUCT DRAINAGE MANHOLE
- CHEMICAL LINE
- CHEMICAL MANHOLE (CHEMMH)
- ROAD GULLY
- GULLY TRAP
- WATER MAIN
- SLUICE VALVE (SV)
- FIRE HYDRANT (HYD)
- WATER METER (WM)
- SCOUR VALVE (ScV)
- PRESSURE RELEASE VALVE (PRV)
- AIR VALVE (AV)
- NON-RETURN VALVE (NRV)
- FUEL LINE/TANK
- GAS SV
- GAS LINE
- GAS HIGH PRESSURE LINE
- GL 00.00 — GROUND LEVEL (metres - os datum)
- CL 10.00 — COVER LEVEL (metres - os datum)
- IL 10.00 — INVERT LEVEL (metres - os datum)
- DPI.50 — DEPTH TO TOP OF SERVICE DUCT OR CABLE
- DP ON MANHOLES = INVERT LEVEL OF CHAMBER
- DP ON DRAINAGE = INVERT LEVEL OF PIPE
- UTO — UNABLE TO OPEN
- OSA — OUTSIDE SURVEY AREA
- UTT — UNABLE TO TRACE
- SURVEYED AREA

CIVIL LEGEND

DENOTES SUBJECT APPLICATION SITE FOR PCE

NOTES

1. THE CONTRACTOR SHALL CONSTRUCT ALL FOUL WATER DRAINAGE IN ACCORDANCE WITH THE LATEST IRISH WATER 'CODE OF PRACTICE FOR WASTEWATER INFRASTRUCTURE' & 'WASTEWATER INFRASTRUCTURE STANDARD DETAILS'.

2. POSITIONS OF SERVICES SHOWN ARE INDICATIVE ONLY. THE SETTING-OUT OF ALL SERVICES INDICATED IS THE RESPONSIBILITY OF THE CONTRACTOR, AND HE/SHE SHALL SATISFY THEMSELVES THAT THE REQUIRED DEPTH OF COVER AND SEPARATION DISTANCES ARE ACHIEVED IN ACCORDANCE WITH THE IRISH WATER 'CODE OF PRACTICE FOR WASTEWATER INFRASTRUCTURE' & 'WASTEWATER INFRASTRUCTURE STANDARD DETAILS".

3. THE CONTRACTOR SHALL REVIEW THE PLAN LAYOUTS PRIOR TO COMMENCEMENT HAVING REGARD TO THE REQUIREMENTS OF THE 'WASTEWATER INFRASTRUCTURE STANDARD DETAILS' PUBLISHED BY IRISH WATER. WHERE A DISCREPANCY BETWEEN BMCE PLAN LAYOUT DRAWINGS AND THE RELEVANT REQUIREMENTS OF THE 'CODE OF PRACTICE FOR WASTEWATER INFRASTRUCTURE' & 'WASTEWATER INFRASTRUCTURE STANDARD DETAILS' IS IDENTIFIED. THE CONTRACTOR MUST CONSULT BMCE, PRIOR TO COMMENCING CONSTRUCTION, SO THAT AN APPROPRIATE DESIGN AMENDMENT CAN BE MADE IF REQUIRED.

4. THE GENERAL SPECIFICATION FOR THE FOUL WATER NETWORK ON THE PROJECT SHALL BE THE 'CODE OF PRACTICE FOR WASTEWATER INFRASTRUCTURE' & 'WASTEWATER INFRASTRUCTURE STANDARD DETAILS' PUBLISHED BY IRISH WATER (LATEST EDITION). THE CONTRACTOR SHALL FAMILIARISE HIMSELF WITH ALL ASPECTS OF THIS DOCUMENT WHICH SHALL BE READ IN CONJUNCTION WITH THIS PARTICULAR SPECIFICATION.

PROPOSED FOUL AND SURFACE WATER DRAINAGE LAYOUT

SCALE @ A0: 1:250
SCALE @ A2: 1:500

ISSUE	DATE	DESCRIPTION	BY
PL5	03.02.23	ISSUED FOR PLANNING F.I.	AM
PL4	25.02.22	ISSUED TO IW	MR
PL3	04.02.22	ISSUED FOR PLANNING	MR
P3	01.02.22	ISSUED TO IW	SM
PL2	13.10.21	ISSUED FOR PLANNING	MR
PL1	08.10.21	ISSUED FOR PLANNING	MR

Project Engineer: MH | Project Director: CK

BM STAGE: **PLANNING**

BARRETT MAHONY
Dublin Office: Sandwith House, 52-54 Lower Sandwith Street, Dublin 2, Ireland. Tel: (01) 677 3200 Fax: (01) 677 3164
London Office: 12 Mill Street, London SE1 2AY, United Kingdom Tel: (0044) 20 3750 3530
Consulting Engineers, Civil . Structural . Project Management.E-mail: bmce@bmce.ie Web: www.bmce.ie

QAS INTERNATIONAL ISO 9001:2008 REGISTERED COMPANY | The Institution of Structural Engineers | ACEI | FIDIC International Federation of Consulting Engineers

CLIENT: **1 TERENURE LAND LTD.**

PROJECT TITLE: **CARLISLE SITE KIMMAGE, RESIDENTIAL DEVELOPMENT**

BM PROJECT No.: 21.221

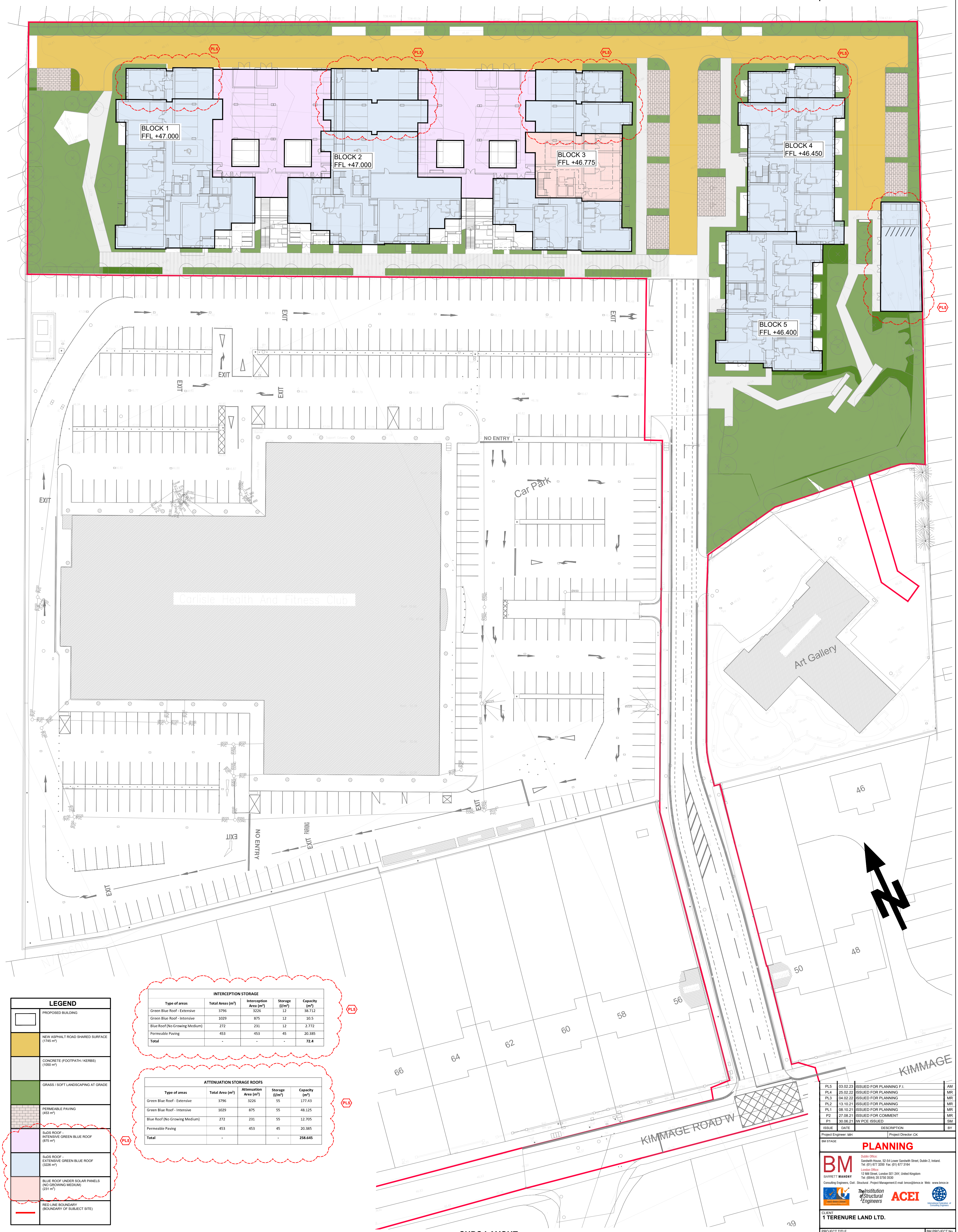
MODEL REFERENCE | SUITABILITY | REVISION

DRAWING TITLE: **PROPOSED FOUL AND SURFACE WATER DRAINAGE LAYOUT**

DWG DRAWING REFERENCE: **CST-BMD-00-ZZ-DR-C-1002** | STATUS: PL | REVISION: 5

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS.FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - `ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.



SUDS LAYOUT

SCALE @ A0: 1:250
SCALE @ A2: 1:500

INTERCEPTION STORAGE				
Type of areas	Total Areas (m^2)	Interception Area (m^2)	Storage (l/m^2)	Capacity (m^3)
Green Blue Roof - Extensive	3796	3226	12	38.712
Green Blue Roof - Intensive	1029	875	12	10.5
Blue Roof (No Growing Medium)	272	231	12	2.772
Permeable Paving	453	453	45	20.385
Total	-	-	-	**72.4**

PL5

ATTENUATION STORAGE ROOFS				
Type of areas	Total Area (m^2)	Attenuation Area (m^2)	Storage (l/m^2)	Capacity (m^3)
Green Blue Roof - Extensive	3796	3226	55	177.43
Green Blue Roof - Intensive	1029	875	55	48.125
Blue Roof (No Growing Medium)	272	231	55	12.705
Permeable Paving	453	453	45	20.385
Total	-		-	**258.645**

PL5

LEGEND	
	PROPOSED BUILDING
	NEW ASPHALT ROAD SHARED SURFACE ($1745 m^2$)
	CONCRETE (FOOTPATH / KERBS) ($1050 m^2$)
	GRASS / SOFT LANDSCAPING AT GRADE
	PERMEABLE PAVING ($453 m^2$)
	SuDS ROOF - INTENSIVE GREEN BLUE ROOF ($875 m^2$)
	SuDS ROOF - EXTENSIVE GREEN BLUE ROOF ($3226 m^2$)
	BLUE ROOF UNDER SOLAR PANELS (NO GROWING MEDIUM) ($231 m^2$)
	RED LINE BOUNDARY (BOUNDARY OF SUBJECT SITE)

PL5

ISSUE	DATE	DESCRIPTION	BY
PL5	03.02.23	ISSUED FOR PLANNING F.I.	AM
PL4	25.02.22	ISSUED FOR PLANNING	MR
PL3	04.02.22	ISSUED FOR PLANNING	MR
PL2	13.10.21	ISSUED FOR PLANNING	MR
PL1	08.10.21	ISSUED FOR PLANNING	MR
P2	27.08.21	ISSUED FOR COMMENT	MR
P1	30.06.21	IW PCE ISSUED	SM

Project Engineer: MH | Project Director: CK

BM STAGE
PLANNING

BM BARRETT MAHONY
Dublin Office:
Sandwith House, 52-54 Lower Sandwith Street, Dublin 2, Ireland.
Tel: (01) 677 3200 Fax: (01) 677 3164
London Office:
12 Mill Street, London SE1 2AY, United Kingdom
Tel: (0044) 20 3750 3530
Consulting Engineers, Civil . Structural . Project Management.E-mail: bmce@bmce.ie Web: www.bmce.ie

CLIENT
1 TERENURE LAND LTD.

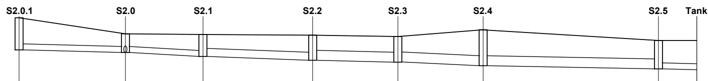
PROJECT TITLE
CARLISLE SITE KIMMAGE, RESIDENTIAL DEVELOPMENT

BM PROJECT No.
21.221

MODEL | REFERENCE | SUITABILITY | REVISION

DRAWING TITLE
SUDS LAYOUT

DWG | DRAWING REFERENCE: **CST-BMD-00-ZZ-DR-C-1015** | STATUS: **PL** | REVISION: **5**



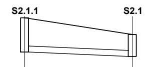
Vert exaggeration = 5.0

Datum = 42.00

Link Name		1.000		1.001		1.002		1.003		1.004		1.005		1.006
Section Type		225mm		225mm		300mm		375mm		375mm		375mm		225mm
Slope		1:200		1:100		1:150		1:225		1:150		1:250		1:225
Cover Level	46.950		46.350		46.325		46.300		46.250		45.225		46.100	
Invert Level	45.750		45.650		45.502		45.358		45.285		45.172		45.037	
Length		19.940m		14.529m		20.570m		15.964m		15.987m		32.862m		7.187m

PROPOSED SW DRAINAGE LONG SECTION - S2.0.1 TO TANK

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



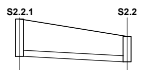
Vert exaggeration = 5.0

Datum = 42.00

Link Name		2.000	
Section Type		225mm	
Slope		1:120	
Cover Level	46.950		46.325
Invert Level	45.670		45.502
Length		20.102m	

PROPOSED SW DRAINAGE LONG SECTION - S2.1.1 TO S2.1

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



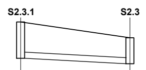
Vert exaggeration = 5.0

Datum = 42.00

Link Name		3.000	
Section Type		225mm	
Slope		1:100	
Cover Level	46.950		46.300
Invert Level	45.560		45.358
Length		20.151m	

PROPOSED SW DRAINAGE LONG SECTION - S2.2.1 TO S2.2

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



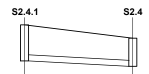
Vert exaggeration = 5.0

Datum = 42.00

Link Name		4.000	
Section Type		225mm	
Slope		1:100	
Cover Level	46.840		46.250
Invert Level	45.490		45.285
Length		20.471m	

PROPOSED SW DRAINAGE LONG SECTION - S2.3.1 TO S2.3

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



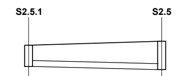
Vert exaggeration = 5.0

Datum = 42.00

Link Name		5.000	
Section Type		225mm	
Slope		1:100	
Cover Level	46.725		46.225
Invert Level	45.375		45.172
Length		20.275m	

PROPOSED SW DRAINAGE LONG SECTION - S2.4.1 TO S2.4

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



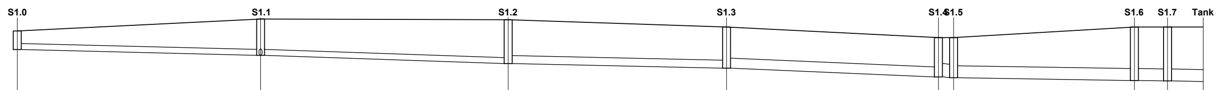
Vert exaggeration = 5.0

Datum = 42.00

Link Name		6.000	
Section Type		225mm	
Slope		1:225	
Cover Level	45.950		46.100
Invert Level	45.148		45.037
Length		24.929m	

PROPOSED SW DRAINAGE LONG SECTION - S2.5.1 TO S2.5

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



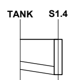
Vert exaggeration = 5.0

Datum = 42.00

Link Name		7.000		7.001		7.002		7.003		7.004		7.005		7.006		7.007	
Section Type		225mm		225mm		300mm		300mm		450mm		450mm		450mm		450mm	
Slope		1:207		1:150		1:237		1:120		1:250		1:300		1:300		1:300	
Cover Level	46.500		46.950		46.925		46.650		46.250		46.250		46.650		46.650		
Invert Level	45.800		45.580		45.272		45.099		44.769		44.739		44.635		44.619		44.595
Length		45.598m		46.389m		40.928m		39.699m		2845m		33.886m		6.214m		6.684m	

PROPOSED SW DRAINAGE LONG SECTION - S1.0 TO TANK

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



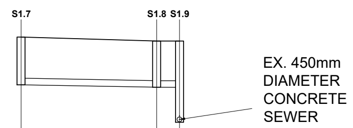
Vert exaggeration = 5.0

Datum = 42.00

Link Name		8.000	
Section Type		300mm	
Slope		1:375	
Cover Level			46.250
Invert Level			44.919
Length		7.105m	

PROPOSED SW DRAINAGE LONG SECTION - TANK TO S1.4

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V



Vert exaggeration = 5.0

Datum = 42.00

Link Name		9.000		9.001	
Section Type		225mm		225mm	
Slope		1:300		1:300	
Cover Level	46.350		46.200		46.200
Invert Level	44.570		44.478		44.473
Length		25.397m		4.286m	

PROPOSED SW DRAINAGE LONG SECTION - S1.7 TO S1.9

SCALE @ A0: 1:500 H 1:100 V
SCALE @ A2: 1:1000 H 1:200 V

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS.FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - `ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.

ISSUE	DATE	DESCRIPTION	BY
PL1	03.02.23	ISSUED FOR PLANNING	AM

Project Engineer: MH | Project Director: CK

BM STAGE

PLANNING

BARRETT MAHONY
Dublin Office:
Sandwith House, 52-54 Lower Sandwith Street, Dublin 2, Ireland.
Tel: (01) 677 3200 Fax: (01) 677 3164
London Office:
12 Mill Street, London SE1 2AY, United Kingdom
Tel: (0044) 20 3750 3530
Consulting Engineers, Civil . Structural . Project Management.E-mail: bmce@bmce.ie Web: www.bmce.ie

CLIENT
1 TERENURE LAND LTD.

PROJECT TITLE
CARLISLE SITE KIMMAGE, RESIDENTIAL DEVELOPMENT

BM PROJECT No.
21.221

MODEL | REFERENCE | SUITABILITY | REVISION

DRAWING TITLE
SURFACE WATER DRAINAGE LONGITUDINAL SECTIONS

DWG DRAWING REFERENCE	STATUS	REVISION
CST-BMD-00-ZZ-DR-C-1021	PL	1

Appendix 2

Updated ‘FLOW’ model results

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	17.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.276	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	x

Nodes

	Name	Area (ha)	T of E (mins)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
✓	S1.0	0.027	4.00	46.500	Manhole	Adoptable	1200	712974.888	730772.606	0.700
✓	S1.1	0.034	4.00	46.950	Manhole	Adoptable	1200	712956.049	730732.840	1.370
✓	S1.2	0.022	4.00	46.925	Manhole	Adoptable	1200	712998.111	730712.901	1.653
✓	S1.3	0.027	4.00	46.650	Manhole	Adoptable	1200	713037.326	730694.429	1.551
✓	S2.0.1	0.060	4.00	46.950	Manhole	Adoptable	1200	712992.063	730744.794	1.200
✓	S2.0	0.054	4.00	46.350	Manhole	Adoptable	1200	713000.638	730762.932	0.700
✓	S2.1.1	0.039	4.00	46.950	Manhole	Adoptable	1200	713005.168	730738.555	1.200
✓	S2.1	0.020	4.00	46.325	Manhole	Adoptable	1200	713013.747	730756.701	0.823
✓	S2.2.1	0.057	4.00	46.950	Manhole	Adoptable	1200	713023.787	730729.808	1.200
✓	S2.2	0.020	4.00	46.300	Manhole	Adoptable	1350	713032.379	730747.982	0.942
✓	S2.3.1	0.028	4.00	46.840	Manhole	Adoptable	1200	713038.127	730722.786	1.200
✓	S2.3	0.000		46.250	Manhole	Adoptable	1350	713046.871	730741.295	0.965
✓	S2.4.1	0.044	4.00	46.725	Manhole	Adoptable	1200	713052.705	730716.223	1.200
✓	S2.4	0.097	4.00	46.225	Manhole	Adoptable	1350	713061.358	730734.560	1.053
✓	S2.5.1	0.075	4.00	49.950	Manhole	Adoptable	1200	713128.196	730703.493	4.490
✓	S2.5	0.056	4.00	46.100	Manhole	Adoptable	1350	713098.100	730717.451	1.063
✓	S1.4A	0.071	4.00	46.100	Manhole	Adoptable	1350	713087.934	730695.975	1.169
✓	S1.4	0.133	4.00	46.250	Manhole	Adoptable	1500	713078.083	730675.168	1.481
✓	S1.5	0.026	4.00	46.250	Manhole	Adoptable	1500	713066.703	730639.883	1.511
✓	TANK	0.000	4.00	46.450	Junction			713083.105	730631.941	1.880
✓	S1.6	0.020	4.00	46.650	Manhole	Adoptable	1500	713085.103	730624.427	2.015
✓	EX.S	0.000	4.00	45.250	Manhole	Adoptable	1200	713095.251	730601.170	0.790

Links

	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
?	S1.0	S1.1	44.003	0.600	45.800	45.580	200.0	225	4.80	50.0
?	S1.1	S1.2	46.549	0.600	45.580	45.347	200.0	225	5.64	50.0
?	S1.2	S1.3	43.348	0.600	45.272	45.099	250.0	300	6.37	50.0
?	S1.3	S1.4	45.079	0.600	45.099	44.919	250.0	300	7.13	50.0
?	S2.0.1	S2.0	20.063	0.600	45.750	45.650	200.0	225	4.36	50.0

	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Pro Depth (mm)	Pro Velocity (m/s)
?	S1.0	S1.1	0.921	36.6	4.9	0.475	1.145	55	0.641
?	S1.1	S1.2	0.921	36.6	11.0	1.145	1.353	85	0.809
?	S1.2	S1.3	0.990	70.0	15.0	1.353	1.251	94	0.793
?	S1.3	S1.4	0.990	70.0	19.9	1.251	1.031	109	0.856
?	S2.0.1	S2.0	0.921	36.6	10.8	0.975	0.475	84	0.805

Links

	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
?	S2.0	S2.1	14.515	0.600	45.650	45.577	200.0	225	4.63	50.0
?	S2.1.1	S2.1	20.072	0.600	45.750	45.583	120.0	225	4.28	50.0
?	S2.1	S2.2	20.571	0.600	45.502	45.433	300.0	300	5.01	50.0
?	S2.2.1	S2.2	20.103	0.600	45.750	45.549	100.0	225	4.26	50.0
?	S2.2	S2.3	15.960	0.600	45.358	45.305	300.0	375	5.26	50.0
?	S2.3.1	S2.3	20.470	0.600	45.640	45.435	100.0	225	4.26	50.0
?	S2.3	S2.4	15.976	0.600	45.285	45.232	300.0	375	5.52	50.0
?	S2.4.1	S2.4	20.276	0.600	45.525	45.322	100.0	225	4.26	50.0
?	S2.4	S2.5	40.530	0.600	45.172	45.037	300.0	375	6.17	50.0
?	S2.5.1	S2.5	33.175	0.600	45.460	45.313	225.0	225	4.64	50.0
?	S2.5	S1.4A	23.761	0.600	45.037	44.931	225.0	375	6.50	50.0
?	S1.4A	S1.4	23.021	0.600	44.931	44.854	300.0	375	6.86	50.0
?	S1.4	S1.5	37.075	0.600	44.769	44.739	1235.8	600	8.03	50.0
?	S1.5	S1.6	24.030	0.600	44.739	44.635	231.1	600	8.28	50.0
✓	S1.6	TANK	7.775	0.600	44.635	44.609	300.0	450	8.39	50.0
?	TANK	EX.S	33.081	0.600	44.570	44.460	300.0	225	9.13	49.8
x	S2.5.1		90.047	0.600	45.900	45.600	300.0	100	7.42	50.0

	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Pro Depth (mm)	Pro Velocity (m/s)
?	S2.0	S2.1	0.921	36.6	20.6	0.475	0.523	121	0.947
?	S2.1.1	S2.1	1.192	47.4	7.0	0.975	0.517	58	0.860
?	S2.1	S2.2	0.902	63.8	31.3	0.523	0.567	148	0.897
?	S2.2.1	S2.2	1.307	52.0	10.3	0.975	0.526	68	1.026
?	S2.2	S2.3	1.041	114.9	45.2	0.567	0.570	163	0.980
?	S2.3.1	S2.3	1.307	52.0	5.1	0.975	0.590	47	0.833
?	S2.3	S2.4	1.041	114.9	50.2	0.590	0.618	173	1.007
?	S2.4.1	S2.4	1.307	52.0	8.0	0.975	0.678	59	0.952
?	S2.4	S2.5	1.041	114.9	75.7	0.678	0.688	222	1.108
?	S2.5.1	S2.5	0.867	34.5	13.6	4.265	0.562	98	0.817
?	S2.5	S1.4A	1.204	132.9	99.4	0.688	0.794	243	1.316
?	S1.4A	S1.4	1.041	114.9	112.2	0.794	1.021	301	1.179
?	S1.4	S1.5	0.684	193.4	156.1	0.881	0.911	410	0.757
?	S1.5	S1.6	1.597	451.7	160.8	0.911	1.415	246	1.468
✓	S1.6	TANK	1.168	185.8	164.4	1.565	1.391	331	1.312
?	TANK	EX.S	0.750	29.8	163.8	1.655	0.565	225	0.763
x	S2.5.1					3.950			

Simulation Settings

Rainfall Methodology	FSR
FSR Region	Scotland and Ireland
M5-60 (mm)	17.000
Ratio-R	0.276
Summer CV	1.000
Analysis Speed	Detailed

Skip Steady State	x
Drain Down Time (mins)	240
Additional Storage (m³/ha)	20.0
Check Discharge Rate(s)	x
Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	20	0	0

Node TANK Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	44.570	Product Number	CTL-SHE-0064-2000-1200-2000
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S2.0.1 Online Orifice Control

Flap Valve	x	Design Depth (m)	0.100	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	2.0		
Invert Level (m)	45.750	Diameter (m)	0.060		

Node S2.5.1 Online Orifice Control

Flap Valve	x	Design Depth (m)	0.100	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	3.5		
Invert Level (m)	45.460	Diameter (m)	0.083		

Node S2.2.1 Online Orifice Control

Flap Valve	x	Design Depth (m)	0.100	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	2.0		
Invert Level (m)	45.750	Diameter (m)	0.060		

Node S2.4.1 Online Orifice Control

Flap Valve	x	Design Depth (m)	0.100	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	2.0		
Invert Level (m)	45.525	Diameter (m)	0.060		

Node TANK Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	44.570
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	459.0	0.0	1.200	459.0	0.0	1.201	0.0	0.0

Node S2.0.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	45.750
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	720

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	866.4	0.0	0.055	866.4	0.0	0.056	0.0	0.0

Node S2.5.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	45.460
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1732.8	0.0	0.055	1732.8	0.0	0.056	0.0	0.0

Node S2.2.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	45.750
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	660

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	866.4	0.0	0.055	866.4	0.0	0.056	0.0	0.0

Node S2.4.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	45.525
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	866.4	0.0	0.055	866.4	0.0	0.056	0.0	0.0

Node S1.4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	44.769
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	182.0	0.0	0.800	182.0	0.0	0.801	0.0	0.0

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.74%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S1.0	10	45.901	0.101	15.5	0.1916	0.0000	OK
5760 minute summer	S1.1	4740	45.762	0.182	1.1	0.2960	0.0000	OK
5760 minute summer	S1.2	4740	45.762	0.490	1.5	0.6844	0.0000	SURCHARGED
5760 minute summer	S1.3	4740	45.762	0.663	2.0	0.9805	0.0000	SURCHARGED
1440 minute summer	S2.0.1	930	45.795	0.045	2.8	39.3901	0.0000	OK
15 minute summer	S2.0	11	45.882	0.232	31.0	0.6216	0.0000	SURCHARGED
15 minute summer	S2.1.1	9	45.863	0.113	22.4	0.2007	0.0000	OK
15 minute summer	S2.1	11	45.835	0.333	63.4	0.5384	0.0000	SURCHARGED
1440 minute summer	S2.2.1	930	45.793	0.043	2.6	37.4344	0.0000	OK
15 minute summer	S2.2	11	45.776	0.418	70.8	0.7750	0.0000	SURCHARGED
15 minute summer	S2.3.1	11	45.776	0.136	16.1	0.2168	0.0000	OK
5760 minute summer	S2.3	4740	45.762	0.477	4.1	0.6825	0.0000	SURCHARGED
5760 minute summer	S2.4.1	4740	45.762	0.237	1.7	48.5272	0.0000	SURCHARGED
5760 minute summer	S2.4	4740	45.762	0.590	6.1	1.9315	0.0000	SURCHARGED
5760 minute summer	S2.5.1	4740	45.762	0.302	3.8	96.6128	0.0000	SURCHARGED
5760 minute summer	S2.5	4740	45.762	0.725	7.4	1.8015	0.0000	SURCHARGED
5760 minute summer	S1.4A	4740	45.762	0.831	8.5	2.1987	0.0000	SURCHARGED
5760 minute summer	S1.4	4740	45.762	0.993	12.5	149.2288	0.0000	SURCHARGED
5760 minute summer	S1.5	4740	45.762	1.023	9.6	2.1594	0.0000	SURCHARGED
5760 minute summer	TANK	4740	45.762	1.192	9.6	547.0875	0.0000	SURCHARGED
5760 minute summer	S1.6	4740	45.762	1.127	9.7	2.2155	0.0000	SURCHARGED
15 minute summer	EX.S	1	44.460	0.000	1.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S1.0	1.000	S1.1	15.4	0.652	0.420	1.0784	
5760 minute summer	S1.1	1.001	S1.2	1.1	0.421	0.030	1.7264	
5760 minute summer	S1.2	1.002	S1.3	1.5	0.364	0.021	3.0525	
5760 minute summer	S1.3	1.003	S1.4	1.8	0.392	0.026	3.1744	
1440 minute summer	S2.0.1	Orifice	S2.0	0.9				
15 minute summer	S2.0	3.005	S2.1	29.3	0.946	0.801	0.5773	
15 minute summer	S2.1.1	8.000	S2.1	22.6	0.975	0.477	0.5678	
15 minute summer	S2.1	3.004	S2.2	59.2	1.082	0.929	1.4486	
1440 minute summer	S2.2.1	Orifice	S2.2	0.8				
15 minute summer	S2.2	3.003	S2.3	63.5	0.880	0.553	1.7603	
15 minute summer	S2.3.1	6.000	S2.3	16.1	1.015	0.310	0.6630	
5760 minute summer	S2.3	3.002	S2.4	4.1	0.515	0.035	1.7621	
5760 minute summer	S2.4.1	Orifice	S2.4	0.5				
5760 minute summer	S2.4	3.001	S2.5	6.0	0.512	0.052	4.4703	
5760 minute summer	S2.5.1	Orifice	S2.5	0.6				
5760 minute summer	S2.5	4.001	S1.4A	7.2	0.523	0.054	2.6208	
5760 minute summer	S1.4A	4.000	S1.4	8.3	0.537	0.072	2.5391	
5760 minute summer	S1.4	1.004	S1.5	9.1	0.337	0.047	10.4432	
5760 minute summer	S1.5	1.005	S1.6	9.3	0.373	0.021	6.7687	
5760 minute summer	TANK	Hydro-Brake®	EX.S	2.0				550.5
5760 minute summer	S1.6	1.006	TANK	9.6	0.397	0.052	1.2319	

Barrett Mahony Consulting Engineers

Dublin:
Sandwith House,
52-54 Lower Sandwith Street,
Dublin 2,
D02 WR26, Ireland.
Tel: +353 1 677 3200

London:
12 Mill Street,
London, SE1 2AY,
United Kingdom
Tel: +44 203 750 3530.

Sofia:
19 Yakubitsa Street,
Lozenets,
Sofia 1164,
Bulgaria
Tel: +359 2 494 9772

WWW.BMCE.IE