Drainage and Civil Engineering Report

Duncannon Fort Masterplan
Wexford

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1. Introduction

Kevin McShane Ltd. have been commissioned to provide transport and civil engineering input to the detailed feasibility study for the Duncannon Fort Masterplan. This report covers the areas of the existing and proposed foul and storm water drainage, SUDS drainage and Blue and Green Infrastructure.

The proposed development comprises of the restoration of the existing Duncannon Fort site and includes the upgrade of many of the existing buildings and provision of surface water and foul drainage facilities at the site to accommodate the proposals.

A key consideration for this development will be introduction of an appropriate Sustainable Urban Drainage Systems (SUDS) and foul drainage system within the site, in accordance with the local and national guidance. SUDS is a method of treating and attenuating storm water runoff prior to discharge and are normally integrated into part of the SUDS Management Train. However, the introduction of any SUDS or underground services will need to take account of the existing constraints at the Duncannon Fort site. These constraints include the shallow underlying bedrock, archaeology, built heritage, drainage outfall routes.

Where feasible, SUDS and Blue Green infrastructure will be used to encourage and facilitate new vegetation and planting, improve water quality, foster greater Biodiversity, develop active travel pathways and reduced flood risk.

The proposed SUDS and drainage systems recommended take account of the SUDS Interim Guidance, the Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas produced by the Government of Ireland, the Blue Green Infrastructure and Nature-based Solutions Framework published by the Southern Regional Assembly, the Sustainable Drainage Explanatory, Design and Evaluation Guide, dated 2022, and published by South Dublin County Council, the Sustainable Drainage Design and Evaluation Guide 2021 published by Dublin City Council and ‘Sewers for Adoption’ published by WRC.

2. Consultations

Kevin McShane Ltd. have undertaken consultations with the Technical Departments in Wexford County Council (WCC) and with Uisce Éireann **(**Irish Water).

A joint site visit and inspection of the site was undertaken with officials from WCC on the 31 May 2023. This included a walkover survey of the site and liaison on the requirement for some limited SUDS on the site, constraints on the discharge of storm and foul water, a WCC planned upgrade of the access bridge and installation of new foul drainage scheme for the site, which is expected to commence in early 2024 (refer to plans included in Appendix 1). These include connection of foul drainage to an existing public drainage manhole located at the junction of Quay Road and Main Street which discharges via gravity to the new public waste water pumping station in Duncannon harbour.

WCC also indicated that some limited utility service corridors may be possible through part of the site, known as Zone 04, to facilitate the installation of new drainage and utility services, on the condition that these are installed under the supervision of the project archaeologist.

Uisce Éireann **(**Irish Water) have been consulted and sewer record drawings requested.

3. Existing Site and Drainage

Existing Site

The proposed site is located to the west of Duncannon and the existing site area is 1.11Ha. The current site is a brownfield site which is approximately 95% hardstanding. There are some limited open grass areas located to west and south of the site in Zone 02 (The Parade) adjacent to Building 9 (Governor's House), Building 7 (Burke's House) and Building 5 (The Officers Mess). There are also some grassed areas within the rocky areas of Zone 01 (The Seafront) and the dry moat area of Zone 03 (The Walls) and open grassland areas in Zone 04 (The Glacis). Refer to existing zone map below in Figure 3-1

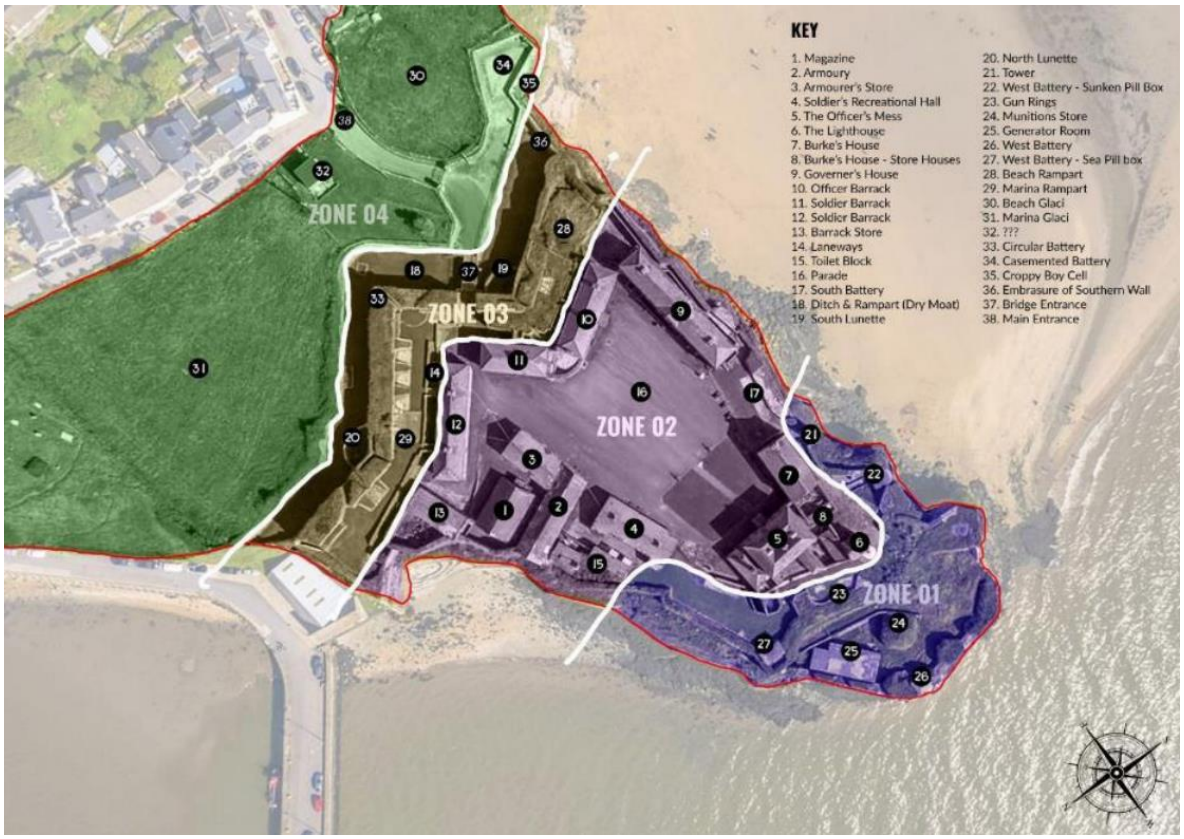

Figure 3-1: Existing Zones Within Development

Figure 3-2: Existing Central Courtyard (Zone 02)

A copy of the Topographical Survey Plan for the development site is included in Appendix 1 (to local benchmark). This plan indicates that the highest ground level within the central Zone 01 area on the site is 14.56m, located in the grassed area to the south of the site between Building 7 and Building 9. The lowest points in Zone 01 are 11.73m in the south-east corner adjacent to Building 9 and 12.65m at the main Fort access located to the east. The existing levels in the dry moat of Zone 03 (The Walls) are considerably lower than the main fort and fortifications.

The ground levels in the central courtyard area in Zone 02 fall generally from west to east towards the main fort access. There are also lower ground levels behind the existing buildings to the north and south of the site.

Existing Drainage

An existing toilet block (Building 15) is located to north of the site. There are no sewer record drawings available for the site, but it is understood that foul discharge connects to an existing chamber located in a grassed area next to the fort walls located west of the existing toilet block.

There is currently limited storm drainage within Zone 02 on the site and a small number of gullies, drainage channels and, generally, the rainwater pipes for the existing buildings discharge directly to the hardstanding surfacing. Refer to the images below in Figure 3-3 and 3-4 below and the existing drainage plan included in Figure 3-6 and copy included in Appendix 1.

Figure 3-3: Existing Building Rainwater Downpipes (Zone 02)

Figure 3-4: Existing Drainage Chamber/Channels (West of Zone 02)

Figure 3-5: Existing Drainage Outlet Channel (South-west of Zone 02)

The areas currently to the rear of the Zone 02 buildings consists of remanent drainage channels and chambers and some formalised surface outlet channels that discharge storm water to the cliff walls. Refer to images in Figures 3-4 and 3-5.

The existing levels in the dry moat of Zone 03 (The Walls) are considerably lower than the main fort and fortifications where surface water drains naturally to the existing fort walls and external drainage paths. There was no evidence of a positive drainage outlet during the site inspection.

Most of the existing surface water drainage on the site is in very poor condition and unlikely to be easily repairable. However, some of the existing drainage outlet channels located to the rear of the Zone 02 buildings currently, draining the hardstanding gravel, concrete or grass areas, may be considered for repair and reuse.

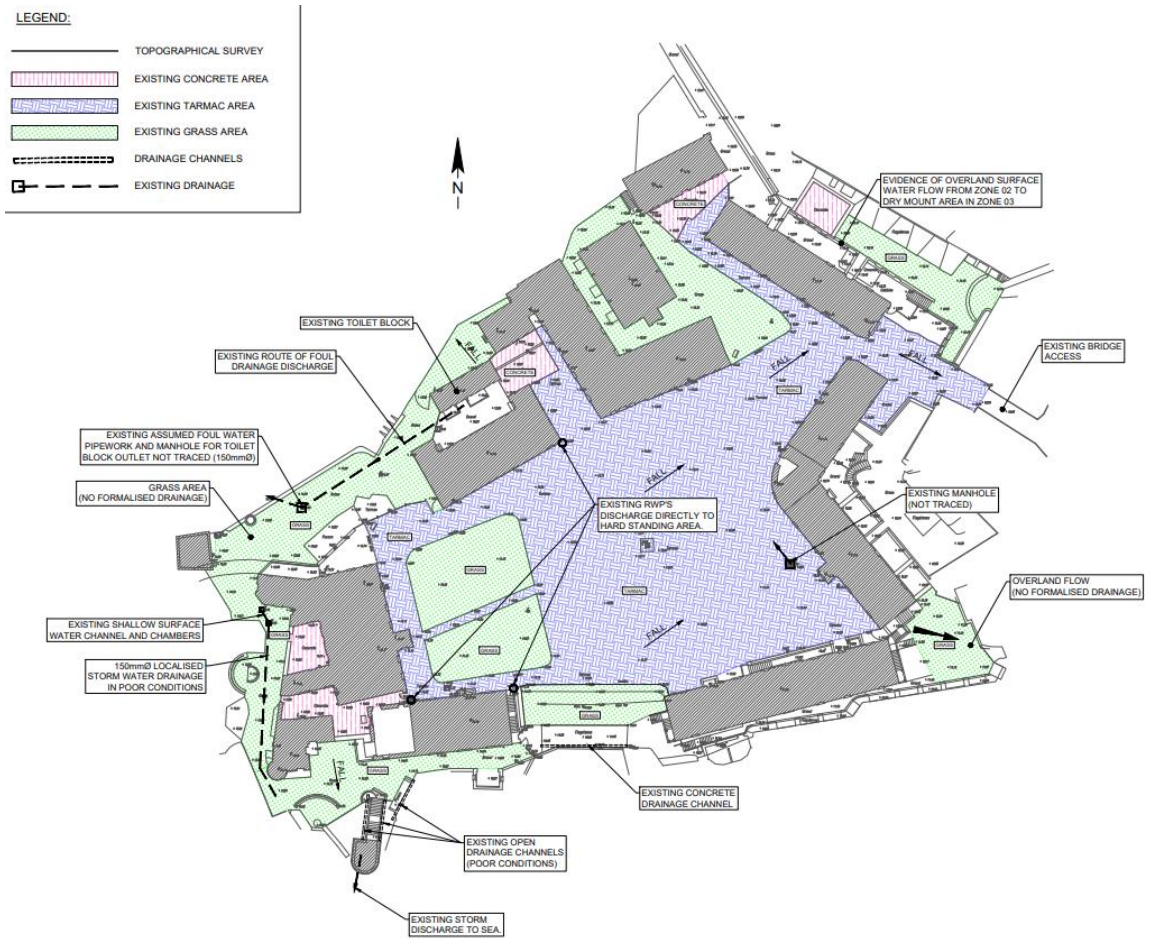

Figure 3-6: Existing Drainage Plan

Flood Risk

Floodinfo.ie online flood mapping indicate that the site is outside of both the 1 in 1000-year fluvial flood plain (present and climate change) and the 1 in 1000-year coastal (tidal) floodplain. There is also no evidence on the online flooding maps of historical flooding in the vicinity of the site. The 1 in 1000 year event is also referred to as an Annual Exceedance Probability (AEP) of 0.1% and the data shows the extent of land which might be flooded by either rivers (fluvial flooding) or from the sea (coastal or tidal flooding). An exert of the Floodinfo.ie flood map is included in Figure 3-7 below and shows the site is clear of these fluvial and coastal flooding events.

Figure 3-7: Fluvial and Coastal Flood Map (Floodinfo.ie)

4. Proposed Storm Water Drainage and Blue Green Infrastructure

Zone 01 – The Seafront

The existing seafront area of the site is remote from the main courtyard area in Zone 02 and does not appear to contain any formalised drainage structures or significant outlets. Therefore, other than the provision of some localised surface channels, SUDS rills or shallow filter trenches to drain any new pathways no further drainage works is currently proposed for this Zone 01. Details of potential SUDS trenches or rills is included later in this report.

Zone 02 – The Parade

The proposed surface water drainage system should be designed to comply with the Local Authority requirements, the SUDS Interim Guidance (Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas), the Blue Green Infrastructure and nature-based Solutions Framework, and the SDCC Sustainable Drainage Explanatory, Design and Evaluation Guide 2022.

A preliminary proposed drainage system has been designed for the site to accommodate all surface water flows below ground during the 1 in 30-year storm event in accordance with *The Sustainable Drainage Design and Evaluation Guide 2021*. However, given the historic nature of the site, sea outfall and heritage the model has also been run for a reduced 1 in 15-year storm event which may be more appropriate given the constraints at the site. For instance, the presence of shallow underlying bedrock, estimated to be approximately at a depth of 300mm, has limited the ability of the design to accommodate flows associated with the more extreme 1 in 100 year event. The design comprises of at source SUDS control and attenuation and a constrained gravity discharge to the public surface water drainage system in Quay Road.

It is proposed that storm water will be constrained to the equivalent to greenfield flow rate of 7.0 l/s and based on a factor of 10 l/s/Ha. This discharge would require to be confirmed at detailed design stage with Uisce Éireann **(**Irish Water). The calculated area of hardstanding, roads and roofs is 0.392Ha and it is proposed to drain the whole of the existing building roofs in the Zone 02 area and the hardstanding courtyard area into a new pipework system with a flow control included on the final manhole adjacent to the main fort access as shown on the preliminary drainage layout included in Appendix 2. This includes a new surface water drainage system which will drain both the front and rear of each building roof and the central courtyard area in Zone 02.

The results of a drainage model built in Causeway FLOW design software, for predominately the central Zone 01 area, is included in Appendix 3. These results indicate that a total of **60m^3** of storm water attenuation, as a worst-case scenario, would be required for the site to accommodate up to the 1 in 30-year storm event either within source control SUDS features (further SUDS details included in the next section) or enlarged underground pipes or tanks. However, given the presence of shallow bedrock and the potential significant costs of rock excavation it is recommended that at detailed design stage that either larger storm water discharge rate is agreed with Irish Water or than lower flooding return period is agreed with the Planning authorities for this site. This may include the addition of safe overland surface water routing to the east of the site and use of the dry moat located in Zone 03 (The Walls).

Sensitivity modelling was also undertaken for the 1 in 10-year storm event on the condition that this is accepted by the Planning Authority, and this resulted in a reduced storm water attenuation requirement of **37.0m^3**. The 1 in 10-year design storm event may be more appropriate given the location and historic nature of the Duncannon Fort with the inclusion of some overland flood routing to the dry moat in Zone 03 of the flood waters associated with the more severe storm events.

As a precaution it is also recommended that a series of exploratory trial pits are undertaken at the site to confirm bedrock depths, establish ground conditions and any other underground building constraints. It may also be necessary to undertake monitoring of the existing buildings during the construction phase of the works including using low impact and low vibration construction methods during the installation of new drainage.

A review of the potential types of SUDS solutions and Blue Green Infrastructure solutions for the Zone 02 area has been undertaken. These are proposed to enhance the natural environment, improve the ecosystem and biodiversity and manage and treat surface water runoff. A selection of potential SUDS solutions that could be used on this site are included in the next section.

Finally, some of the existing drainage outlet channels located to the rear of the Zone 02 buildings, currently draining hardstanding gravel or concrete or grass areas, could be repaired and upgraded to facilitate the local drainage from these areas which were excluded from the above courtyard drainage.

Zone 03 – The Walls

The grassed dry moat in Zone 03 area has limited formalised drainage at present but, from the walkover survey appears to be well drained. If this area is to be developed for future landscaping,

formalised pathways or as a market garden it is recommended that surface level SUDS drainage is installed. Outlet should be to the existing outlets at the northern and southern boundary walls, which will required to be excavated and investigated. It is recommended that these existing outlets are cleared and upgraded locally to provide surface water drainage for the longer term.

Zone 04 – The Glacis

This largely green space which is partly used for agricultural purposes forms the eastern boundary of the site. There are no formalised drainage systems included in this area at present and it is recommended that any future surface water drainage is limited to localised land drainage should this area be used for some leisure facilities in the future. Any formalised discharge should be limited to the equivalent of greenfield flow rate at approximately 10 l/s/Ha.

5. Proposed SUDS Drainage and Blue Green Infrastructure

Introduction

The Blue Green Infrastructure and Nature-based Solutions Framework states:

'Faced with global challenges effecting our environment and people such as biodiversity loss, climate change and health and wellbeing, it is now time to reconsider the place of nature and landscape in our lives and the way we plan for them.'

"Strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem service."

The Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas states:

'Sustainable urban development solutions, such as water sensitive urban design, can help to mitigate the potential for environmental degradation in the form of biodiversity loss, pollution of water bodies, and increased flood risk as the demand for urban development to accommodate a growing population continues to increase.'

The Sustainable Drainage Design and Evaluation Guide 2021 states:

'Sustainable Drainage, or SuDS, is a way of managing rainfall so that it mimics the drainage processes found in nature and addresses the issues with conventional drainage.'

'Conventional drainage seeks to remove rainfall runoff from development as quickly as possible. In contrast, SuDS slow the flow and store rainfall runoff in both hard and soft landscaping areas, thereby reducing the impact of large volumes of polluted water flowing from development.

Potential SUDS and Blue Green Infrastructure Features

The central courtyard in Zone 02 has been identified for the potential inclusion of sustainable drainage features. However, the shallow bedrock in this area, level of the existing buildings and potential to retain the historic cobble stone surface in the courtyard will impact upon the final choice of SUDS. As the general falls in ground level are from the west to the east of the courtyard there would need to be an even distribution of SuDS features across the Zone 02 area unless increased underground storage was used to replace some of the surface SuDS.

Certain SuDS features such as ponds, rain harvesting tanks, deep swales and detention areas are not considered appropriate for the Duncannon Fort site due to the ground conditions and heritage.

Option 1 – Porous Paving

The first option would be the introduction of area of permeable or porous paving in the courtyard to attenuate and treat surface water run-offs prior to discharging to a controlled gravity outlet to the existing public storm drainage system. To accommodate the estimated 60m^3 of storm water attenuation, associated with the 1 in 30-year storm event including Climate Change, a porous paving area of 875m2 (or 30m x 29m) would be required. For the design 1 in 10-year storm event this storage volume would reduce to 37m^3 and an associated porous paving area of 540m2 (or 24m x 23m) This assumes a 275mm deep layer of single size stone makeup. However, if the Planning Authority was to permit a relaxation of no flooding of the site during 1 in 30-year storm event, as detailed in Section 7.3 SUDS requirements of Hydraulic Control section of *The Sustainable Drainage Design and Evaluation Guide 2021*. A preliminary flow route analysis undertaken of the main courtyard area of Zone 02 suggests that it would be possible to introduce some flood routing to the lower dry moat in Zone 03 which would reduce the attenuation volumes required and the associated area of porous paving.

The advantages of this SUDS porous paving solution are that it could be readily sourced and installed, and a proven and effective method of storm water storage. However, its limitations are that it would not promote any biodiversity or green infrastructure and there would be little or no infiltration. The introduction of tree pits has been considered but presents issues involving potential large volumes of rock excavation and the requirement for lower and more expensive drainage outfalls. Refer typical image of a porous paving make-up in Figure 5-1 overleaf.

Porous paving could also be considered for the parking bays of any external car parks to provide attenuation and treatment prior to discharge.

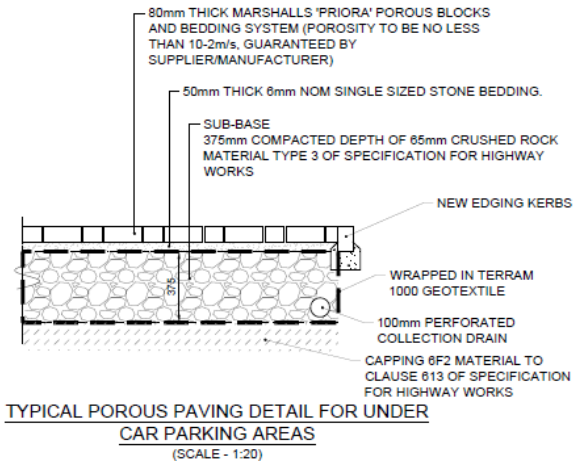

Figure 5-1: Typical Porous Paving Detail

Option 2 - Filter Strips and Bioretention Areas

Bioretention areas and filter strips could be used in conjunction with permeable paving or traditional paving within the Zone 02 courtyard. In accordance with the principles set out in the Sustainable Drainage Explanatory, Design and Evaluation Guide a filter strip will allow sheet-flow from paved areas to move freely off the pavement into a landscaped filter strip which is surrounded by flush kerbing. Refer typical image in Figure 5-2 overleaf.

As free-draining soils are not present at this site due to the underlying shallow bedrock a series of underground land drainage outlets would be required to drain each of these filter strips. These will have limited advantage in terms of storm attenuation but would improve biodiversity when used in conjunction with permeable paving or other SuDS features.

Figure 5-2: Typical Image of a Filter Strip

Option 3 – Surface Level Channels and Rills

Another potential complementary SuDS feature would be the use of surface channels and rills to attenuate and convey surface water run-off from the site. Refer typical image in Figure 5-3 below.

Figure 5-3: Typical Image of a Channel and Rill SuDS

The adoption of surface level channels to convey runoff from the rear rainwater pipes on the existing buildings to the existing courtyard would be an effective way to reduce localised flooding and reducing the depth of excavations necessary for a traditional pipework drainage system. This would be particularly cost effective given the potential shallow depth of bedrock at the site.

This SuDS feature could be used in conjunction with enlarged underground storage pipes or porous paving to provide the 60m^3 of storm water attenuation for the 1 in 30-year storm event, or 37m^3 of storm water attenuation for the 1 in 10-year storm event subject to Planning Authority and Irish Water approval.

Option 4 –Green Wall and Cliff Stabilisation

Complimentary green and blue infrastructure solutions for this site could include green walls and cliff stabilisation. Green Wall systems are multilayer system which provide sustainable solutions and enhance the natural environment, whilst helping to manage surface water runoffs. These may require specific plants for the green walls due to rock ground conditions. Cliff stabilisation measures can help reduce seafront erosion, reduce the risk of falling rocks and encourage the re-vegetation of existing slopes at the site. Refer typical images in Figure 5-4 and Figure 5-5 below.

Living sea walls is also an option for the external site areas which might be considered to encourage sea biodiversity. However, this will depend on rock type and other environmental issues.

Figure 5-4: Typical Image of Green Wall

Figure 5-5: Typical Image of Cliff Stabilisation

6. Proposed Foul Drainage

It is recommended that a separate new foul drainage system is installed within Zone 02 of the site. Foul drainage from each of the buildings will be collected in a new pipework and manhole system and will then pass under the existing reinforced bridge at the Fort access. Foul effluent will then be discharged, via gravity, to the existing public drainage system in Quay Road where it will be pumped, via the new public pumping station located at Duncannon Harbour, to the new Arthurstown WWTP.

An assessment of the estimated foul water discharge from the site has been undertaken. This assessment is based on the requirements for the proposed accommodation and buildings. Two separate assessments are included in the tables below as it was considered important to future-proof the drainage system for potential variations in the final site layout.

Option 01

Estimated Foul Water Discharge Rates					
Building No.	Name	Proposed use	Potential Person / activity	Typical Foul Loading	Foul Discharge Rate (l/s)
1	Magazine	Visitor Experience	N/A		0
2	The Armoury	Dining Hall	36 covers (x2.5)	25 l/p/day	0.026
3	Armourer's Store	Visitor Centre	7 staff	50 l/p/day	0.004
4	Recreational Hall	Community Hall	40	10 l/p/day	0.005
5	Officer's Mess	Hostel Accommodation	32 bed	150 l/p/day	0.056
6	The Lighthouse	N/A			0
7	Burke's House	Short Stay Accommodation	20 bed	150 l/p/day	0.035
8	Burke's Ho (Store)	N/A			
9	Governer's House	Museum	50	10 l/p/day	0.006
10	Officers Barracks	Retail and Cafe	66 covers (x2.5)	15 l/p/day	0.029
11	Soldier Barracks 1	Retail and 1No. Apartment	5 staff 1App x 3	50 l/p/day 150 l/p/day	0.008
12	Soldier Barracks 2	Retail and 2No. Apartments	5 staff 1App x 3 x 2	50 l/p/day 150 l/p/day	0.013
13	Barrack Store	Retail and 1No. Apartment	5 staff 1App x 3	50 l/p/day 150 l/p/day	0.008

15	Toilet Block	Toilet Block	150	10 l/p/day	0.017
Total					**0.204**

Flow Rates from British Water 'Flows and Loads - 4'

Figure 6-1: *Estimated Foul Flow Rates (Option 01)*

Based on the proposed foul drainage discharge rates for the new development, the overall site would have an estimated (mean) foul discharge rate of **0.204 l/s** or **1.2 l/s** (peak). It is considered that 150mm diameter pipe would adequately serve this development.

Option 02

Estimated Foul Water Discharge Rates					
Building No.	Name	Proposed use	Person / activity	Typical Foul Loading	Foul Discharge Rate (l/s)
1	Magazine	Visitor Experience	N/A		0
2	The Armoury	Hostel Accommodation	36 bed	150 l/p/day	0.063
3	Armourer's Store	Visitor Centre	5 staff	50 l/p/day	0.003
4	Recreational Hall	Community Hall	40	10 l/p/day	0.005
5	Officer's Mess	Café and Restaurant	30 covers (x2.5)	30 l/p/day	0.026
6	The Lighthouse	N/A			0
7	Burke's House	Short Stay Accommodation	20 bed	150 l/p/day	0.035
8	Burke's Ho (Store)	N/A			
9	Governer's House	Museum	50	10 l/p/day	0.006
10	Officers Barracks	Retail and Cafe	66 covers (x2.5)	15 l/p/day	0.029
11	Soldier Barracks 1	Retail and 1No. Apartment	10 staff 1App x 3	50 l/p/day 150 l/p/day	0.008
12	Soldier Barracks 2	Retail and 2No. Apartments	10 staff 1App x 3 x 2	50 l/p/day 150 l/p/day	0.013
13	Barrack Store	Retail and 1No. Apartment	10 staff 1App x 3	50 l/p/day 150 l/p/day	0.008
15	Toilet Block	Toilet Block	150	10 l/p/day	0.017
Total					**0.213**

Flow Rates from British Water 'Flows and Loads - 4'

Figure 6-2: *Estimated Foul Flow Rates (Option 02)*

Based on the proposed foul drainage discharge rates for this second option for the new development, the overall site would have an estimated (mean) foul discharge rate of **0.213 l/s** or **1.3 l/s** (peak). It is considered that a 150mm diameter pipe would adequately serve this development. A preliminary proposed foul drainage drawing is included in the Appendix 2 of this report.

The new public pumping station located at Duncannon Harbour (Refer to image in Figure 3 below) is understood to have included additional capacity for expansion. Therefore, subject to obtaining formal approval from Uisce Éireann **(**Irish Water) to reserve capacity for the site, it is considered that there will be capacity in the public drainage network and at the new Arthurstown WWTP to accommodate foul effluent flows from the site.

Figure 6-3: *Duncannon Harbour Waste Water Pumping Station*

Figure 6-4: Indicative Proposed Foul Drainage Plan

7. SUDS Maintenance Plan

It is recommended that any new SUDS features are included in a SUDS Maintenance Plan for the site. This plan will comprise of firstly the overriding principles below and then followed by the specific works required to be undertaken to maintain each SUD feature.

A detailed management plan should include a Schedule of Work covering the specific maintenance tasks identified, the frequency of these tasks, and any specific waste management requirements for each SUDS feature but the following provides an overview of the overriding principles and actions.

Introduction

It is proposed that regular SUDS scheme inspections will:

- Help determine future maintenance activities.
- Confirm hydraulic, water quality, amenity and ecological performance.
- Allow identification of potential system failures, e.g. blockage, poor infiltration, poor water quality etc.

During the first year of operation, inspections should ideally be carried out after every significant storm event to ensure proper functionality.

Typical routine inspection questions that will indicate when occasional or remedial maintenance activities are required, and/or when water quality requires investigation include:

- Are inlets and outlets blocked?
- Does any part of the system appear to be leaking?
- Is there evidence of sedimentation build-up?
- Is there evidence of ponding above an infiltration surface?
- Is there evidence of structural damage which requires repair?

All those responsible for maintenance should take appropriate health and safety precautions and risk assessments should always be carried out.

8. Conclusions and Recommendations

The SUDS review and Management Plan has been undertaken in accordance with best practice, with reference to the CIRIA guidance, the SDCC Sustainable Drainage Explanatory, Design and Evaluation Guide 2022 for acceptable SUDS tree pit details and the guidance set out in the Code of Practice for Wastewater Supply (July 2020) published by Uisce Éireann **(**Irish Water).

A review of the online flood mapping, included on Floodinfo.ie, indicates that the site is not at risk of either 1 in 1000 year fluvial (river) flooding or coastal (tidal) flooding. Therefore, no flooding mitigation will be required at the site.

A preliminary review of the potential types of drainage and SuDS solutions, and Blue Green Infrastructure solutions, has been undertaken. Potential SuDS are included in Section 5 of this report. It is concluded that due to the constraints on the site including the existing heritage, archaeological and underlying bedrock, SuDS should be limited to surface features such as porous paving and rills or planted areas. It is also proposed that a restricted storm water outfall to the public surface water drainage system will be provided to take runoff from roofs and hardstanding areas, subject to Irish water approval.

A new foul drainage system, pipework and manhole, will be required to service any enhanced public toilet facilities and the proposed re-development of the existing buildings and connection to the new foul pumping station location in the harbour, subject to Uisce Éireann **(**Irish Water) approval. It is proposed that foul discharge will be connected in inspection chambers adjacent to each building and connect, via gravity, to the existing public foul drainage manhole, located at the intersection of the Fort access and Quay Road. The connection treatment works would be Arthurstown WWTP.

Appendix 1: Existing Plans

Appendix 2: Preliminary Drainage Plans

Appendix 3: Preliminary Calculations