ENGINEERING PLANNING REPORT

for

A PROPOSED STRATEGIC HOUSING DEVELOPMENT

at

ST MICHAELS HOSPITAL CAR PARK, DÚN LAOGHAIRE

for

FITZWILLIAM DL LTD.

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10.12.2020	R	SS/SOR	SOR	Revised and Issued for Planning

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1. INTRODUCTION

This report has been prepared by Muir Associates Limited (MAL) to accompany a planning application for a proposed Strategic Housing Development located at St Michaels Hospital Car Park, Dún Laoghaire.

The engineering report includes sections on traffic and transportation, foul water drainage, surface water drainage and water supply. The report includes design calculations for the foul and surface water drainage together with an estimate of the water demand for the proposed development. The location of the proposed development site is shown in Figure 1.1 below:

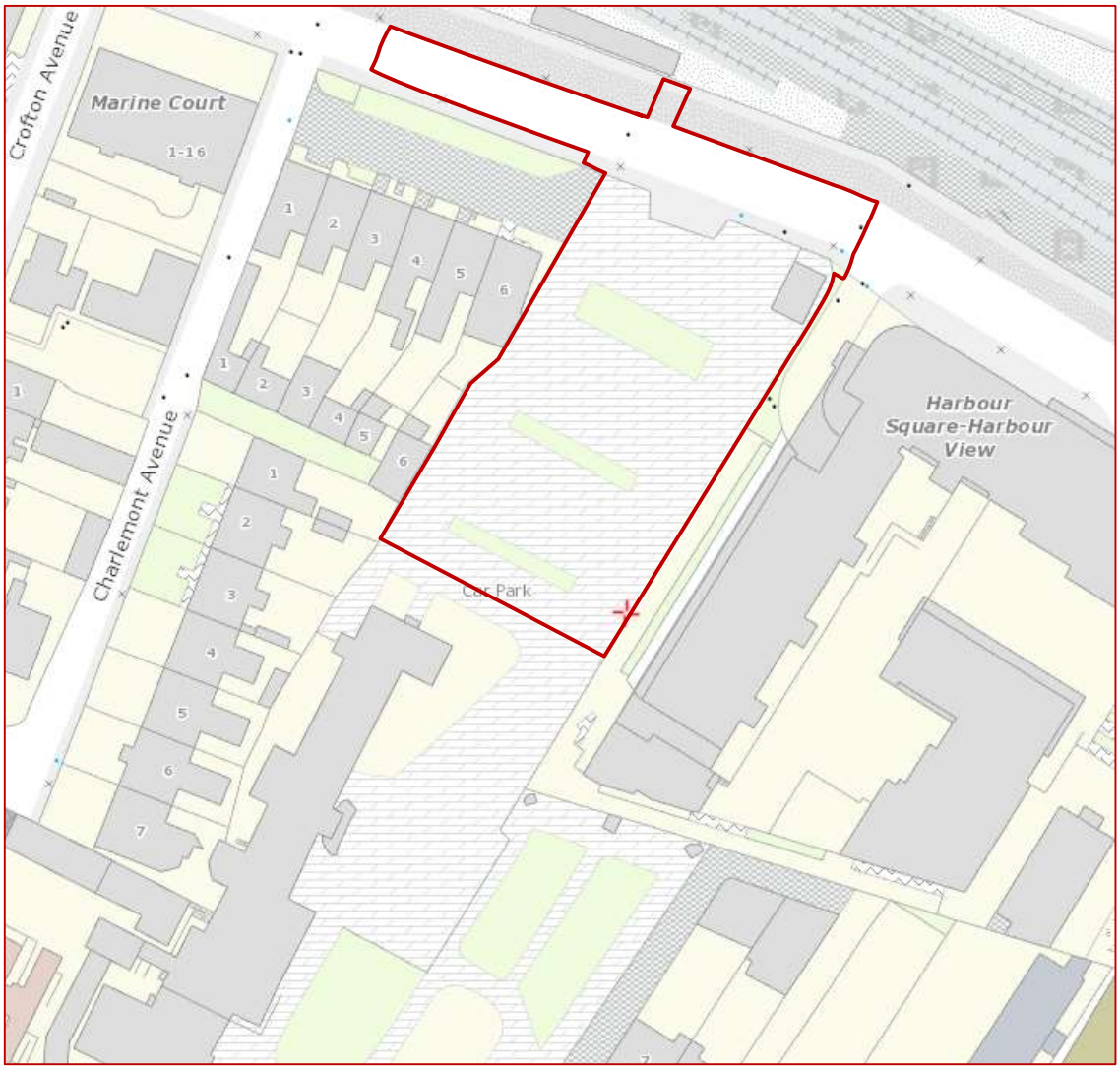


Figure 1.1: Site Location

The existing site levels fall from south to north with the levels varying from approximately 12.5mAOD to 9.0mAOD.

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The proposed development will consist of the demolition of an existing 2 No storey house on the site and the construction of 102 No build-to-rent residential apartments (80 No 1-bed and 22 No 2-bed units) across 2 No buildings (Building 01 and Building 02), along with ancillary residential amenities and a publicly accessible café on a c. 0.42ha site. Building 01 to the north extends to part 5, part 6, part 8 and part 13 No storeys in height. Building 02 to the south extends to part 8, part 9 No storeys in height, with a setback 9th storey.

Residential amenity space in the form of a reception, coworking/study space, gym, games area, lounge/kitchen area, and multi-purpose recreational space is provided at ground floor level of Building 01, alongside a reception and postal storage area. External roof terraces are included at storeys 6 and 9 at Building 01, with an enclosed glazed amenity space at 13th storey level, with external terrace. An external roof terrace is provided at 9th storey level at Building 02.

The development includes a vehicle right of way providing access to St. Michael's Hospital along the western perimeter of the site, accessed from Crofton Road. This provides access to 3 No car parking spaces (including 1 No disabled space) located between the two buildings. A secondary right of way is provided via a landscaped pedestrian route along the eastern perimeter of the site providing access to St. Michael's Hospital. A total of 150 No bicycle parking spaces are provided at the ground floor level of Building 02 (alongside a bicycle repair area), 26 No within the central courtyard and 8 No adjacent to the café at the northern perimeter.

The development also includes an ESB substation, bin store, services and drainage infrastructure, boundary treatments, access provision at Crofton and all ancillary development works necessary to facilitate the development.

A full development description is provided in the planning report which accompanies the submission.

3. TRAFFIC AND TRANSPORTATION ASSESSMENT

This section of the report deals with transportation topics namely, Vehicular Access, Pedestrian and Cycle Movements, Public Transport, Car Parking Provision, DMURS Compliance, Stage 1 Quality Audit and responses to the Transportation Planning Section comments contained in the Dún Laoghaire–Rathdown County Council opinion. Each of these topics is discussed, in turn, below. In addition, this section of the report also refers to other documents which are submitted with this application and these are listed below:

- Outline Travel Plan;
- Stage 1 Quality Audit (prepared by Bruton Consulting Engineers);

3.1 Vehicular Access

To facilitate the proposed development, it is planned to relocate the existing vehicular access to the north western edge of the site. This access will also provide continuing access for the hospital.

A copy of MAL drawing No D1855-C-01 illustrates the location of the existing site access and the relocated vehicular access to the proposed development.

The vehicular access will be a minimum of 6m wide with a maximum gradient of 1:15.

It is worth noting that the proposed development site currently accommodates of order 90 No surface car parking spaces.

The relocated vehicular access has been assessed as part of the Stage 1 Quality Audit undertaken by Bruton Consulting Engineers and a copy of the Audit is submitted as part of the application documentation.

3.2 Pedestrian Movements

The main pedestrian access to the proposed development is from Crofton Road. The proposed development includes a dedicated pedestrian access at the eastern side of the development.

The proposed development also includes improvement works to the section of footpath on Crofton Road fronting the proposed development.

3.3 Cycle Movements

Cyclists will access the proposed development from Crofton Road. Cyclists share the carriageway with vehicles on Crofton Road. A total of 184 No bicycle parking spaces are provided as part of the proposed development; 150 No bicycle parking spaces are provided at the ground floor level of Building 02 (alongside a bicycle repair area), 26 No within the central courtyard and 8 No adjacent to the café at the northern perimeter.

Extracts from the Dún Laoghaire Rathdown County Development Plan 2016-2022 illustrating the existing cycle network in the vicinity of the subject site together with the Proposed Cycle Network for the immediate area are presented in the Outline Travel Plan which is submitted with this application.

3.4 Public Transport

The existing and proposed public transport provisions are set out in detail within the Outline Travel Plan which is submitted with this application.

3.5 Car Parking Provision

The proposed development will provide a total of 3 No car parking spaces at grade between the two buildings. The car parking spaces will be fitted with electrical charging facilities.

The rationale for the parking provision is set out in the Outline Travel Plan which is submitted with this application.

3.6 Compliance with DMURS

The modifications proposed to Crofton Road as part of the proposed development together with the design of the vehicular and pedestrian access points to the proposed development have taken cognisance of the guidance provided in the Design Manual for Urban Roads and Streets (DMURS) as follows:

- By minimising, insofar as possible, the width of the vehicular access points;
- By reducing, in so far as possible, kerb radii at access points;
- By providing minimum pedestrian footpath widths of 1.8m;
- By maintaining pedestrian priority across vehicle access points;
- By providing enhanced pedestrian routes through the development at ground level;

These features are illustrated on MAL drawing No D1855-C-01 and on the architect's ground level site plan.

3.7 Stage 1 Quality Audit

A Stage 1 Quality Audit has been prepared by Bruton Consulting Engineers and is submitted as part of this application. This Audit raised a number of issues which have been addressed, where appropriate, by incorporation into the design and the issues are also documented within the Audit and are listed in the Feedback Form presented in Appendix B of the Audit Report.

3.8 Response to the Transportation Planning Section Comments Contained in the Dún Laoghaire–Rathdown County Council Section 6(4)(b) Report

The issues listed below were raised by the Transportation Planning Section and a related response to each item is also provided:

- Shared Access with Harbour View: the applicant is not in a position to deliver such a combined access;
- Boundary Wall with Charlemont Terrace: It is proposed to lower this hospital boundary wall at the entrance to improve visibility;
- Removal of Car Parking Spaces on Crofton Road: no existing car parking spaces will be impacted by the relocated access.
- Demonstrate Adequate Spaces for Cycle Parking: the architects layout drawings illustrate the locations of the cycle parking;
- Parking Provision and Electrical Charging: the parking provision is considered to be adequate and the quantum of parking is supported by the Outline Travel Plan submitted under separate cover. All car parking spaces will be fitted with electrical charging facilities;
- Cycle Parking: A total of 150 No bicycle parking spaces are provided at the ground floor level of Building 02 (alongside a bicycle repair area), 26 No within the central courtyard and 8 No adjacent to the café at the northern perimeter.

4. FOUL WATER DRAINAGE

4.1 Existing Drainage Network

The existing hospital on the site currently discharges effluent via a combined drainage network to a combined sewer on Crofton Road. The existing outfall drain currently discharges through the proposed development site. As part of the proposed development this drain will be diverted into the new vehicle access route. It is also worth noting that there are existing 450mm and 2100mm diameter combined sewers located in Crofton Road. These sewers are shown on the Irish Water records presented in Appendix B of this report and are illustrated on MAL Drawing No D1855-C-05.

4.2 Liaison with Irish Water

A Pre-Connection Enquiry was submitted to Irish Water for the proposed development and Irish Water have confirmed that subject to a valid connection agreement being put in place, the proposed connection to the Irish Water network can be facilitated. A copy of the related letter received from Irish Water is presented in Appendix C of this Report. Irish Water have also issued a Statement of Design Acceptance in respect of the foul drainage arrangements and a copy of the related Irish Water Statement is presented in Appendix C of this report.

A copy of the Irish Water records received from Dún Laoghaire–Rathdown County Council are presented in Appendix B of this report.

4.3 Proposed Scheme Design

Firstly, it is worth noting that the proposed development will have separate foul and surface water drainage networks which, in turn, will discharge off site to separate existing combined sewer and surface water sewer systems. The details of the proposed foul drainage network to serve the proposed development are described below.

It is proposed to discharge the foul effluent generated by the proposed development to the existing 450mm diameter combined sewer in Crofton Road. The details of the primary on plot drainage together with the off-plot outfall are illustrated on MAL drawing No D1855-C-05 and MAL drawing No's D1855-C-08 and D1855-C-09 illustrate the related standard drainage construction details. The works to be undertaken within Crofton Road to connect to the existing combined sewer network are indicated on MAL drawing No D1855-C-05.

The peak foul water discharge from the proposed development has been estimated at 2.88 litres per second. The design is based on Irish Water's Code of Practice for Wastewater Infrastructure of 6 x dry weather flow (DWF) and defines DWF as 2.7 persons per unit and a per capita wastewater flow of 150 litres per person per day. Calculations for the estimated foul drainage discharge together with foul drainage network information are presented in Appendix D of this Report.

The proposed foul gravity drainage system will be constructed with uPVC or concrete pipes and laid in accordance with Irish Water Code of Practice for Wastewater Infrastructure, Building Regulations (Section H) and in accordance with the selected pipe manufacturer's recommendations. A minimum pipe diameter of 225mm has been utilised on the primary foul piped drainage network. All proposed works affecting the public drainage system will be subject to detailed agreement with Dún Laoghaire–Rathdown County Council Water Services and Irish Water.

5. SURFACE WATER DRAINAGE

5.1 Existing Drainage Network

There is an existing surface water sewer located in Crofton Road which in turn discharges to the Irish Sea at the West Pier. This sewer is shown on the Irish Water record drawing presented in Appendix B of this report and is indicated on MAL drawing No D1855-C-02.

5.2 Proposed Scheme Design

The design of the surface water drainage network for the proposed development consists of a piped gravity system. It is proposed to discharge the restricted surface water runoff from the proposed development to the existing surface water sewer which

is located in Crofton Road. The layout of the proposed surface water drainage network together with the surface water drainage connection point to the public sewer is indicated on MAL drawing No D1855-C-02 and MAL drawing No's D1855-C-08 and 09 illustrate the related standard drainage construction details. The works to be undertaken within Crofton Road to connect to the existing surface water sewer network are indicated on MAL drawing No D1855-C-02.

The design of the surface water drainage network has taken cognisance of the objectives and guidance contained in the Greater Dublin Strategic Drainage Study (GDSDS) and is also informed by the site constraints. The main features of the surface water design are summarised as follows:

- Reducing the rate of run-off from the proposed development by a combination of an underground surface water attenuation tank and a flow control device with an orifice size of 50mm that in turn provides for a restricted flow of 1.4l/s;
- Using the site critical duration storm for the 1 in 100-year return period in attenuation storage volume calculations;
- Providing treatment via the use of a green roofs, filter drains, bioretention system, permeable pavement and a petrol interceptor;
- Increase in rainfall event depth by 20% to take account of climate change.

Item	Criteria
Return period for pipework	5-year check for surcharging. 100-year check for flooding
Time of entry	30 minutes
Pipe Friction (Ks):	0.6mm
Minimum Velocity	1.00m/s
Standard Average Annual Rainfall	757 mm (from Met Eireann website)
M5-60	15.7mm
Ratio r (M5-60/M5-2D):	0.272
Attenuation Storm Return Event:	100 year
Climate Change:	20% for rainfall intensities
Restricted Discharge Rate	1.4 l/s up to 100-year event
Flow Control Orifice size (diameter)	Minimum 50mm

Table 5.2.1: Design Criteria for Proposed Development;

The runoff characteristics used in the design calculations together with the treatment train are summarised in Table 5.2.2. and a copy of the related Qbar calculation is presented in Appendix E of this report.

Source of Surface Water Runoff	Total Area (m2)	Runoff (%)	Eq. Imp. Area (m2)	SuDS Treatment Train			Receptor
				1 stage	2 stage	3 stage	
Roof	1296	100	1296	GR	GCS	PI	Storm Sewer
Footpath	651	100	651	PP/GCS	PI	x	Storm Sewer
Road	693	100	693	FD/PP/BR	GCS	PI	Ground/Storm Sewer
Green Area	717	0	0	x	x	x	Ground
Total	3357	100	2640				

SuDS Component: Green Roof (GR); Geo-Cellular System (GCS); Filter Drain(FD); Bio-Retention (BR); Permeable Pavement (PP); Petrol Interceptor (PI)

Table 5.2.2 Runoff Characteristics and SuDS Treatment Train for the Proposed Development

It is also worth noting that the combined drainage runoff from the existing development upstream will be intercepted and diverted and will not enter the drainage network of the proposed development. This runoff will be delivered by diverting the existing 350mm diameter combined drainage pipe along the vehicle access route to Crofton Road. MAL drawing No D1855-C-03 illustrates this diversion.

The surface water design has been based on the criteria set out in Section 5.2 above. The discharge rate of 1.4 l/s for the runoff from the proposed development site produces a requirement for an overall attenuation storage volume of 124m^3. The attenuation storage will be provided within the underground geo-cellular attenuation storage tank. It is worth noting that the attenuation storage tank has been design as an impermeable system. However, as agreed with Drainage Planning Section of Dún Laoghaire Rathdown County Council, at detail design/construction stage an assessment will be undertaken to establish if an attenuation storage tank system that would allow for site available infiltration could be utilised.

The technical information for the proposed geo-cellular storage system together with the confirmation that the proposed geo-cellular storage system has the required load bearing capacity to support vehicular traffic loading is presented in Appendix E of this report.

The analyses of the surface water drainage network have been carried out using time-varying design rainstorms and the "Micro Drainage" simulation" software package to establish the networks capability to cater for expected summer and winter storms with return periods of up to and including 100 years. The rainfall profiles have been calculated using the Wallingford Procedure and Flood Study Methods, which are included within the software. Rainfall event depths have been increased by 20%. A copy of the surface water drainage network analysis summary together with the surface water attenuation calculations is presented in Appendix E of this Report. The pipe numbers that are predicted to experience possible surcharging for critical storm durations of varying length are highlighted in the results. The results indicate that no flooding occurs for the storm events modelled.

The proposed surface water gravity drainage system will be constructed with uPVC or concrete pipes laid in accordance with IS 6 and more particularly the Building Regulations, Section H and in accordance with the selected pipe manufacturer's recommendations. A minimum pipe diameter of 225mm has been utilised on the primary surface water piped drainage network. All proposed works affecting the public drainage system will be subject to detailed agreement with the Water Services Department of Dún Laoghaire–Rathdown County Council.

Maintenance of the surface water system will be undertaken on a biannual basis. The inspection of the system will also be undertaken on biannual basis and following any significant rainfall event.

5.3 Key Operations and Maintenance Requirements Green Roofs

Firstly, it is worth noting that the green roof layout that illustrates the areas, types and typical build-up details of the proposed green roofs is presented on architects drawing P18-143D-RAU-ZZ-ZZ-DR-A-PL1-31008 - Overall Roof Plan submitted as a part of this planning application.

Green roofs should normally only require biannual or annual visits to remove litter, check fire breaks and drains and, in some cases, remove unwanted invasive plants. The most intensive maintenance is generally required during the establishment stage, and this should usually be made the responsibility of the green roof provider. Maintenance access to each green roof area will generally be directly from internal public corridor spaces, including the main green roof of building one. Temporary ladder access from the terrace with a fall arrest system will be provided for the top level of Building Two. Access arrangement is presented in more detail on architects drawings.

The Table presented below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required.

Maintenance Schedule	Required Action	Typical Frequency
Regular Inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability.	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system.	Annually and after severe storms
	Inspect underside of roof for evidence of leakage.	Annually and after severe storms
Regular Maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth.	Six monthly and annually or as required
	During establishment, replace dead plants as required	Monthly (but usually responsibility of manufacturer)

Maintenance Schedule	Required Action	Typical Frequency
	Post establishment, replace dead plants as required (where >5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and source of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked, or moved, investigate and repair as appropriate.	As required

5.4 Key Operations and Maintenance Requirements Filter Drains

Filter drains will require regular maintenance to ensure continuing operation to design performance standards. The Table presented below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required:

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter (including leaf litter) from filter drain surface, access chambers and pre-treatment devices.	Monthly (or as required)
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage.	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies.	Six monthly
	Remove sediment from pre-treatment devices.	Six monthly, or as required
Occasional Maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (e.g. NJUG, 2007 or BS 3998:2010).	As required

Maintenance Schedule	Required Action	Typical Frequency
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium.	Five yearly, or as required
	Clear perforated pipework of blockages.	As required

5.5 Key Operations and Maintenance Requirements Pervious Paving

Regular inspection and maintenance are important for the effective operation of pervious pavements.

Pervious pavements need to be regularly cleaned of silt and other sediments to preserve their infiltration capacity. Extensive experience suggests that sweeping once per year should be sufficient to maintain an acceptable infiltration rate on most sites. However, in some instances, more or less sweeping may be required and the frequency should be adjusted to suit site-specific circumstances and should be informed by inspection reports.

The Table presented below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required

Maintenance Schedule	Required Action	Typical Frequency
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

5.6 Key Operations and Maintenance Requirements Bioretention Systems

Bioretention systems will require regular maintenance to ensure continuing operation to design performance standards.

Adequate access should be provided for all bioretention areas for inspection and maintenance, including for the appropriate equipment and vehicles.

Litter picking should be frequent, as rubbish is detrimental to the visual appearance of bioretention systems. Frequent street sweeping in the catchment area will increase the time interval between cleaning out forebays or the filter surface and will reduce the loading of fine suspended solids that can potentially clog the filter medium.

All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

The Table presented below provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required.

Maintenance Schedule	Required Action	Typical Frequency
Regular Inspections	Inspect infiltration systems for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary.	Quarterly
	Check operation of underdrains by inspection of flows after rain.	Annually
	Assess plants for disease infection, poor growth, invasive species etc and replace, as necessary.	Quarterly
	Inspect inlets and outlets for blockage.	Quarterly
Regular Maintenance	Remove letter and surface debris and weeds.	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density.	As required
	Remove sediment, litter and debris build-up from around inlets or from forebays.	Quarterly to biannually
Occasional Maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch.	As required
Remedial Actions	Remove and replace filter medium and vegetation above.	As required but likely to be >20 years

5.7 Response to the Drainage Planning Section Comments Contained in the Dún Laoghaire Rathdown County Council Section 6(4)(b) Report

Following the Section 5 Pre-Application Consultation meeting, the applicant has engaged with the Drainage Planning Section of Dún Laoghaire–Rathdown County Council and made a further submission in respect of the related comments raised in the Council's Section 6(4)(b) Report. The items raised by the Drainage Planning Section in their related report have been agreed in principle and have been addressed within the design of the surface water drainage disposal system and are reflected in this report and incorporated into the related surface water drainage detail drawings.

5.8 Storm Water Audit

A Storm Water Audit (SWA) of the proposed surface water drainage design has been undertaken by Punch Consulting and a copy of this Audit is submitted with this application. Where feasible the comments made by the approved auditor have been

taken on board and are included within the design of the surface water drainage disposal system.

6. WATER SUPPLY

6.1 Existing Water Supply

The water services records for the area have been obtained from Dún Laoghaire–Rathdown County Council and are presented in Appendix B of this report. The records indicate the watermains in the immediate vicinity of the proposed development and include a 160 mm diameter watermain located in Crofton Road. These watermains are also illustrated on MAL Drawing No D1855-C-07.

6.2 Liaison with Irish Water

A Pre-Connection Enquiry was submitted to Irish Water for the proposed development and Irish Water have confirmed that subject to a valid connection agreement being put in place, the proposed connection to the Irish Water network can be facilitated. A copy of the related letter received from Irish Water is presented in Appendix C of this Report. Irish Water have also issued a Statement of Design Acceptance in respect of the watermain design and a copy of the related Irish Water correspondence is presented in Appendix C of this report.

6.3 Proposed Scheme Design

It is proposed to provide the water supply for the proposed development by connecting to the existing 160 mm diameter watermain located in Crofton Road. This connection is illustrated on MAL drawing No D1855-C-07 and MAL drawing No's D1855-C-10 and D1855-C-11 illustrates water main standard construction details.

A bulk meter will be placed within the proposed development on the leg of the proposed 100mm diameter watermain. It is estimated that the daily peak demand required by the proposed development following full occupancy will be 3.0 l/s and an equivalent average daily water demand of 51.9 m^3.

Calculations for the estimated water demand are presented in Appendix F of this report. Water storage in accordance with the requirements of Irish Water and Dún Laoghaire–Rathdown County Council Water Services Department will be provided within the development.

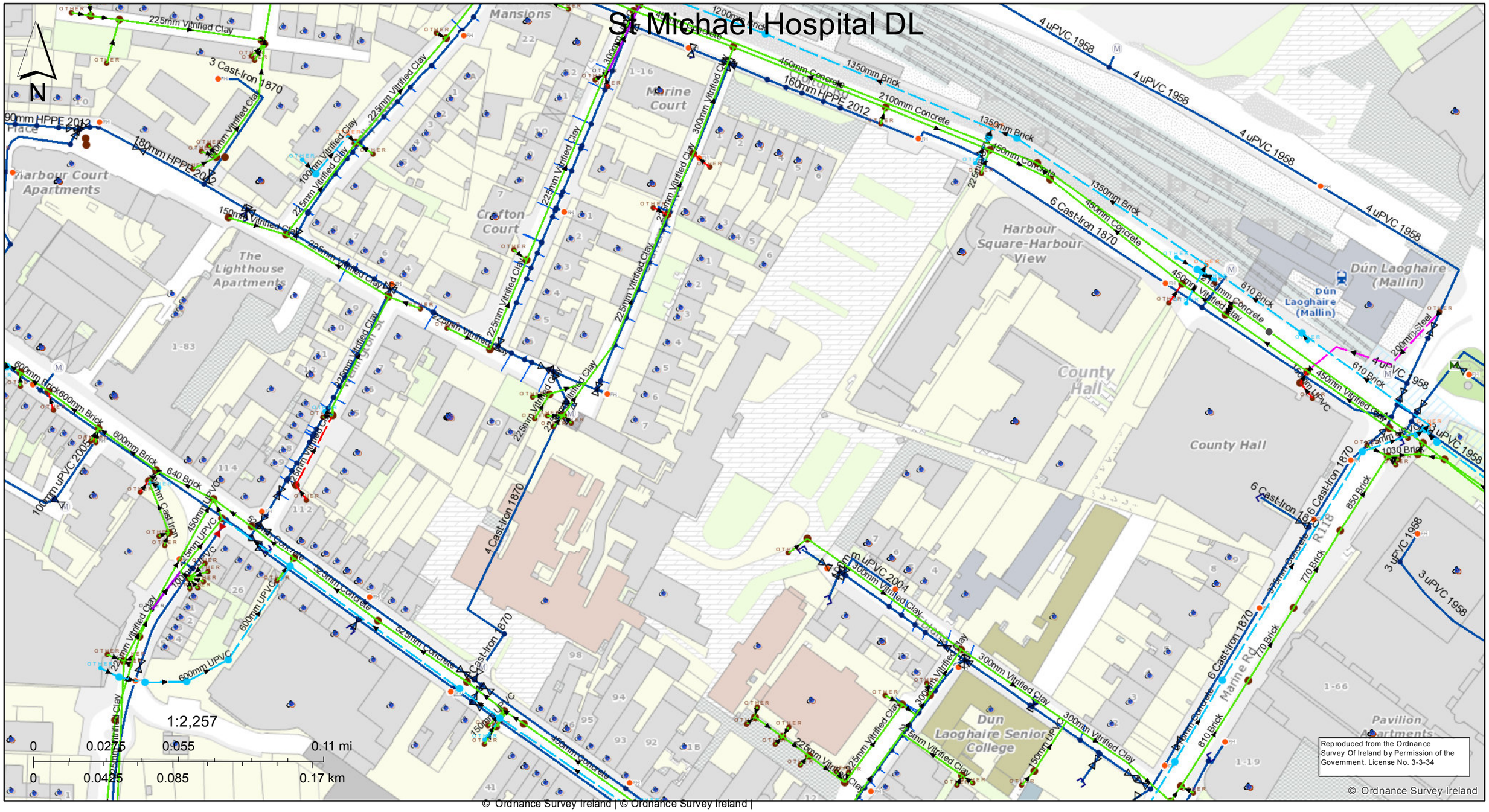
All proposed works affecting the public water supply system will be subject to detailed agreement with Irish Water and the Water Services Department of Dún Laoghaire–Rathdown County Council and the works to be undertaken within Crofton Road to connect to the existing watermain network are indicated on MAL drawing No D1855-C-07.

APPENDIX A – DRAWING LIST

Drawing No	Drawing Title
D1855-C-01	Roads Layout and Visibility Splay
D1855-C-02	Surface Water Drainage Site Layout
D1855-C-03	Diversion of Existing Combined Drain
D1855-C-04	Surface Water Drainage Longitudinal Sections
D1855-C-05	Foul Water Drainage Layout
D1855-C-06	Foul Water Drainage Longitudinal Sections
D1855-C-07	Watermain Layout
D1855-C-08	Standard Drainage Details Sheet 1 of 2
D1855-C-09	Standard Drainage Details Sheet 2 of 2
D1855-C-10	Standard Watermain Details Sheet 1 of 2
D1855-C-11	Standard Watermain Details Sheet 2 of 2
D1855-C-12	Vehicular Manoeuvres
D1855-S-01	Proposed Foundation Layout – Building 01
D1855-S-02	Proposed Foundation Layout – Building 02
D1855-S-03	Proposed Foundation Sections – Buildings 01 & 02

APPENDIX B: IRISH WATER RECORDS

St Michael Hospital DL



6/12/2018 12:12:46 PM

Legend

Stormwater Gravity Mains (Irish Water Owned)
- Surface

Stormwater Gravity Mains (Non-Irish Water Owned)
- Surface

Storm Manholes
- Cascade
- Catchpit
- Hatchbox
- Lamphole
- Standard
- Other; Unknown

Storm Inlets
- Gully
- Standard
- Other; Unknown

Storm Fittings
- Vent/Col
- Other; Unknown

Storm Discharge Points
- Outfall
- Overflow
- Soakaway
- Other; Unknown

Storm Culverts

Storm Clean Outs

Sewer Gravity Mains (Irish Water owned)
- Combined
- Foul
- Overflow
- Unknown

Sewer Gravity Mains (Non-Irish Water owned)
- Combined
- Foul
- Overflow
- Unknown

APPENDIX C: IRISH WATER CORRESPONDENCE

Fitzwilliam Real Estate Capital L
c/o Seamus O'Rourke
Marketing Network House
Argyle Square
Morehampton Road
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Éire

Irish Water
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www.water.ie

25 July 2018

Dear Sir/Madam,

Re: Customer Reference No 226188841 pre-connection enquiry - Subject to contract | Contract denied
102 unit housing development and retail unit at St Michaels Hospital, Dun Laoghaire, Dublin

Irish Water has reviewed your pre-connection enquiry in relation to water and wastewater connections at St Michaels Hospital Dun Laoghaire Dublin. Based upon the details that you have provided with your pre-connection enquiry and on the capacity currently available in the network(s), as assessed by Irish Water, we wish to advise you that, subject to a valid connection agreement being put in place, your proposed connection to the Irish Water network(s) can be facilitated.

All infrastructure should be designed and installed in accordance with the Irish Water Codes of Practice and Standard Details. A design proposal for the water and/or wastewater infrastructure should be submitted to Irish Water for assessment. Prior to submitting your planning application, you are required to submit these detailed design proposals to Irish Water for review.

You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed at a later date.

A connection agreement can be applied for by completing the connection application form available at **www.water.ie/connections**. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities.

If you have any further questions, please contact Brian O'Mahony from the design team on 022 52205 or email *bomahony@water.ie* . For further information, visit **www.water.ie/connections**

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services

Slaven Sose
MUIR ASSOCIATES LIMITED,
Consulting Engineers,
Project Managers,
Marketing Network House,
Argyle Square,
Morehampton Road,
Dublin 4,
D04 K0Y1

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

29 September 2020

Re: Design Submission for Strategical Housing Development at St. Michaels Hospital Car Park, Dun Laoghaire, Dublin (the "Development") (the "Design Submission") / Connection Reference No: 226188841

Dear Slaven Sose,

Many thanks for your recent Design Submission.

We have reviewed your proposal for the connection(s) at the Development. Based on the information provided, which included the documents outlined in Appendix A to this letter, Irish Water has no objection to your proposals.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Irish Water infrastructure. Before you can connect to our network you must sign a connection agreement with Irish Water. This can be applied for by completing the connection application form at www.water.ie/connections. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities (CRU)(https://www.cru.ie/document_group/irish-waters-water-charges-plan-2018/).

You the Customer (including any designers/contractors or other related parties appointed by you) is entirely responsible for the design and construction of all water and/or wastewater infrastructure within the Development which is necessary to facilitate connection(s) from the boundary of the Development to Irish Water's network(s) (the "**Self-Lay Works**"), as reflected in your Design Submission. Acceptance of the Design Submission by Irish Water does not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.

If you have any further questions, please contact your Irish Water representative:
Name: Alvaro Garcia
Email: agarcia@water.ie

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services

Appendix A

Document Title & Revision

- D1855-C-03 Diversion of Existing Drainage
- D1855-C-05 Foul Water Drainage Layout
- D1855-C-06 Foul Water Drainage Longsections
- D1855-C-07 Watermain Layout

*For further information, visit **www.water.ie/connections***

Notwithstanding any matters listed above, the Customer (including any appointed designers/contractors, etc.) is entirely responsible for the design and construction of the Self-Lay Works. Acceptance of the Design Submission by Irish Water will not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

NORTH

LEGEND:

- PROPOSED DIVERSION OF EXISTING COMBINED DRAINAGE
- EXISTING COMBINED DRAINAGE
- EXISTING COMBINED DRAINAGE DECOMMISSIONED
- EXISTING COMBINED SEWER
- PROPOSED MANHOLE
- PROPOSED BACKDROP MANHOLE
- EXISTING COMBINED DRAINAGE MANHOLE
- EXISTING COMBINED SEWER MANHOLE

EX. MH
CL: 8.66
IL: 6.73

CHARLEMONT TERRACE

PROPOSED DIVERSION OF EXISTING DN350mm COMBINED DRAINAGE

PROPOSED SADDLE CONNECTION TO EXISTING Φ450mm COMBINED SEWER

EXISTING DN 150mm COMBINED

EXISTING DN 150mm COMBINED

EXISTING DN 200mm COMBINED

EXISTING DN 350mm COMBINED

EXISTING DN 300mm COMBINED

EXISTING DN 150mm COMBINED

CD-1.000
1:125.0
USIL 11.780m
Ø350mm
DSIL11.650m

CD-2
CL 12.150m
Depth (m) 2.969

CD-1.001
1:100.0
USIL 9.181m
Ø350mm
DSIL8.930m

CD-3
CL 10.480m
Depth (m) 2.181

CD-1.002
1:100.0
USIL 8.298m
Ø350mm
DSIL8.180m

CD-4
CL 9.740m
Depth (m) 1.766

CD-1.003
1:100.0
USIL 7.974m
Ø350mm
DSIL7.780m

CD-5
CL 9.330m
Depth (m) 1.693

CD-1.004
1:100.0
USIL 7.637m
Ø350mm
DSIL7.510m

CD-6
CL 9.060m
Depth (m) 1.767

CD-1.005
1:100.0
USIL 7.293m
Ø350mm
DSIL7.212m

EX.MH
CL: 9.00
IL: 7.60

EX. MH
CL: 8.83
IL: 7.13
DN350 IL: 7.56

CD-1
CL 12.570m
Depth (m) 0.790

EXISTING DN350mm COMBINED
DRAINAGE TO BE DECOMMISSIONED

EX.MH
CL: 12.57
IL: 11.78

2100mm CONCRETE COMBINED

450mm CONCRETE COMBINED

EX.MH
CL: 8.97
IL: 6.89

450mm CONCRETE COMBINED

EX.MH
CL:9.14
IL:1.74

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EN 0001720 © Government of Ireland

PLANNING

NOTES:

1. LEVELS OF EXISTING INFRASTRUCTURE TO BE VERIFIED ON SITE

REVISION	DATE	DESCRIPTION	REV BY	CHK BY
A	18.09.20	ISSUED TO IRISH WATER	FS	SS

Consulting Engineers
Project Managers

Marketing Network House,
Argyle Square,
Morehampton Road,
Dublin D04 K0Y1, Ireland
Telephone: +353-1-6762788
email: info@muir.ie www.muir.ie

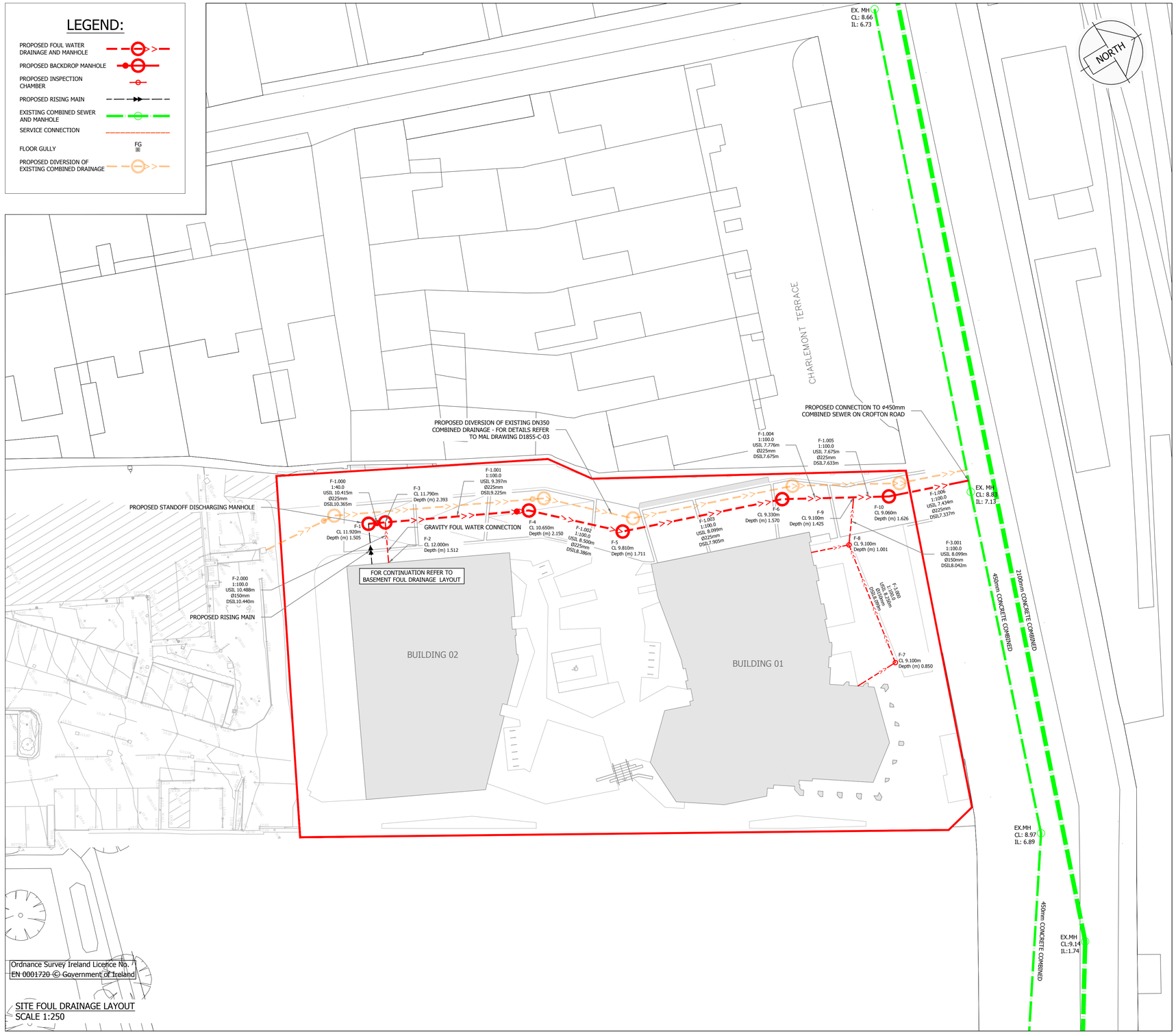
PROJECT	ST. MICHAELS DEVELOPMENT, DUN LAOGHAIRE
CLIENT	FITZWILLIAM DL LTD
TITLE	DIVERSION OF EXISTING COMBINED DRAINAGE

Director	Proj. Eng.	Drawn by	DRG. No.	REV
SOR	SS	FS	D1855-C-03	A
Scale 1:250 @A1	Checked SS	Date SEP '20		

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

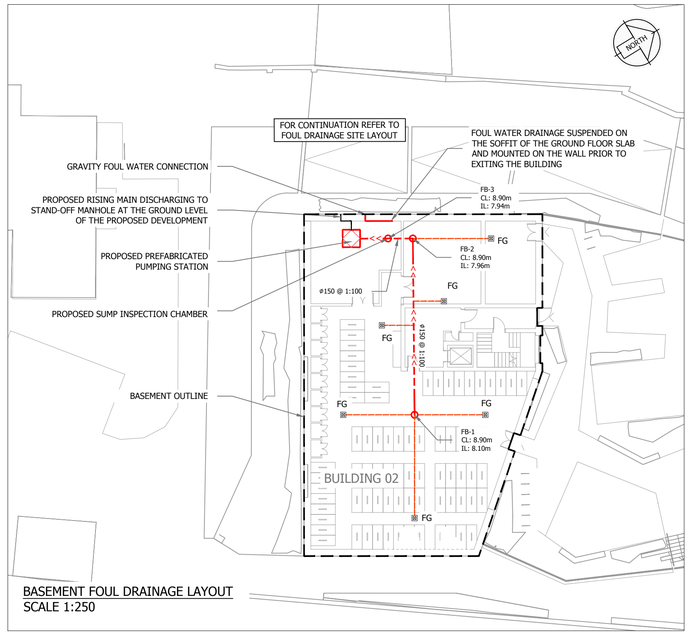
LEGEND:

- PROPOSED FOUL WATER DRAINAGE AND MANHOLE
- PROPOSED BACKDROP MANHOLE
- PROPOSED INSPECTION CHAMBER
- PROPOSED RISING MAIN
- EXISTING COMBINED SEWER AND MANHOLE
- SERVICE CONNECTION
- FLOOR GULLY (FG)
- PROPOSED DIVERSION OF EXISTING COMBINED DRAINAGE



Ordnance Survey Ireland Licence No. ?
EN 0001720 © Government of Ireland

SITE FOUL DRAINAGE LAYOUT
SCALE 1:250



BASEMENT FOUL DRAINAGE LAYOUT
SCALE 1:250

PLANNING

NOTES:

1. ALL LEVELS ARE IN METERS UNLESS NOTED OTHERWISE
2. ALL PRIMARY DRAINAGE DETAILS ARE TO COMPLY WITH THE REQUIREMENT OF IRISH WATER CODE OF PRACTICE.
3. ALL ON PLOT PRIVATE DRAINAGE TO BE IN ACCORDANCE WITH BUILDING REGULATIONS TECHNICAL GUIDANCE DOCUMENT H.
4. PIPEWORK MATERIAL uPVC AND IS TO COMPLY WITH SECTION 3.13 OF IRISH WATER CODE OF PRACTICE FOR WASTE WATER INFRASTRUCTURE.

REVISION	DATE	DESCRIPTION	REV BY	CHK BY
A	18.09.20	ISSUED TO IRISH WATER	SC	SS

Consulting Engineers
Project Managers

MUIR ASSOCIATES

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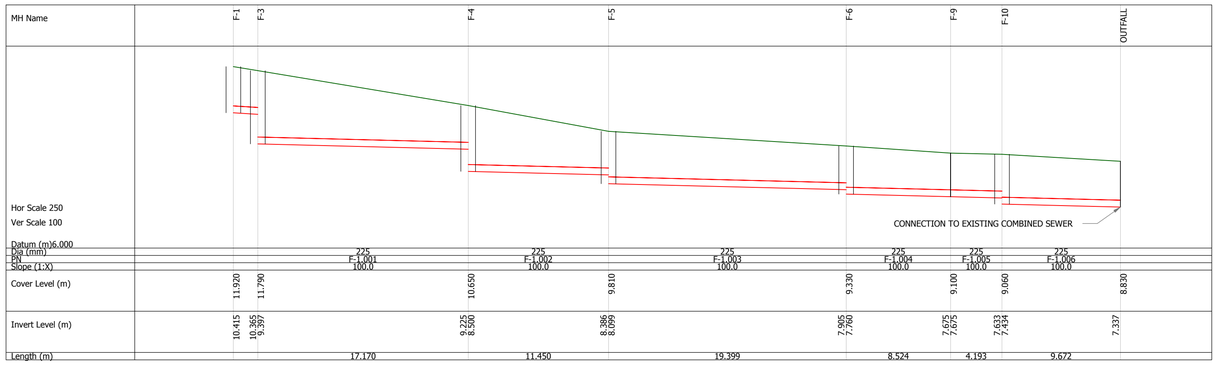
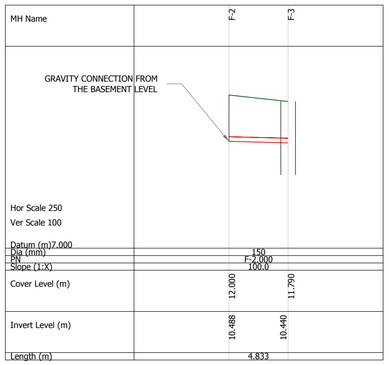
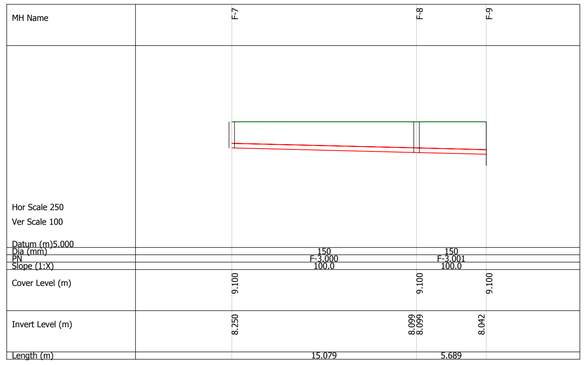
PROJECT	ST. MICHAELS DEVELOPMENT, DÚN LAOGHAIRE
CLIENT	FITZWILLIAM DL LTD
TITLE	FOUL WATER DRAINAGE LAYOUT

Director	Proj. Eng.	Drawn by	DRG. No.	REV
SOR	SS	SC	D1855-C-05	A
Scale: AS SHOWN @A1	Checked: SOR	Date: SEP '20		

DO NOT SCALE USE FIGURED DIMENSIONS ONLY







PLANNING

NOTES:

REVISION	DATE	DESCRIPTION	REV BY	CHK BY
A	18.09.20	ISSUED TO IRISH WATER	FS	SS

Consulting Engineers
Project Managers

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Argyle Square,
Morehampton Road,
Dublin D04 K0Y1, Ireland
Telephone: +353-1-6762788
email: info@muir.ie www.muir.ie

PROJECT	ST MICHAELS DEVELOPMENT, DUN LAOGHARIE
CLIENT	FITZWILLIAM DL LTD
TITLE	FOUL WATER DRAINAGE LONGSECTIONS

Director	Proj. Eng.	Drawn by	DRG. No.	REV
SOR	SS	FS	D1855-C-06	A
Scale	Checked	Date		
AS SHOWN @A1	SS	SEP '20		

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

LEGEND:

PROPOSED HDPE DN110 WATERMAIN	WM WM
EXISTING WATERMAIN	WM
SLUICE VALVE	SV
FIRE HYDRANT	FH
BULK METER	BM

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS SHOWN OTHERWISE.
2. DO NOT SCALE, USE FIGURED DIMENSIONS ONLY.
3. PIPEWORK MATERIAL IS TO BE HDPE PE-80 SDR-17 UNLESS OTHERWISE NOTED AND IS TO COMPLY WITH SECTION 3.9 OF IRISH WATER CODE OF PRACTICE FOR WATER INFRASTRUCTURE.
4. PROPOSED BULK WATER METER TO COMPLY WITH SECTION 2.6.6 OF THE IRISH WATER CODE OF PRACTICE FOR WATER INFRASTRUCTURE AND IS TO BE CHOSEN AND SUPPLIED BY IRISH WATER.
5. ALL WATERMAIN DETAILS ARE TO COMPLY WITH THE REQUIREMENTS OF IRISH WATER CODE OF PRACTICE.
6. FOR APARTMENTS A METRE WILL BE INSTALLED INTERNALLY WITHIN THE PREMISES IN ACCORDANCE WITH THE BUILDING CONTROL AUTHORITY REQUIREMENTS AND SUBJECT TO REVIEW BY IRISH WATER.

PLANNING

NOTES:

REVISION	DATE	DESCRIPTION	REV BY	CHK BY
A	18.09.20	ISSUED TO IRISH WATER	FS	SS

Consulting Engineers
Project Managers

MUIR ASSOCIATES

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PROJECT	ST. MICHAELS DEVELOPMENT, DUN LAOGHAIRE
CLIENT	FITZWILLIAM DL LTD
TITLE	WATERMAIN LAYOUT

Director	Proj. Eng.	Drawn by	DRG. No.	REV
SOR	SS	FS	D1855-C-07	A
Scale 1:250 @A1	Checked SS	Date SEP '20		

APPENDIX D: FOUL DRAINAGE DISCHARGE CALCULATIONS

Development St. Michaels

Job No: D1855

Section Wastewater Design Flow Calculations

Element	Occupancy Rate	Average Daily Flow (l/p/d)	Average Day/Peak week Flow factor	Peak Demand factor (for pipe sizing)
Domestic	2.7	150	1	6
Commercial	1 per 25m2	50	1	6

	Mean Organic Loading				
	BOD	**COD**	**SS**	**N**	**P**
mg/l	300	400	200	50	10
Total (kg/day)	12.45	16.60	8.30	2.08	0.42

Element	Unit	No of Units	Occupancy Rate (p/unit)	Total Occupancy (persons)		Daily Flow per Person* (l/p/d)	Daily Flow (l/d)	Daily Peak Flow (l/d)	Average Flow (l/s)	Factored (6) Peak Demand for pipe sizing (l/s)
Residential	Dwelling	102	2.7	275.4		150	**41,310**	**41,310**	**0.48**	**2.87**
Commercial (90m2)	Person	4	1	4		50	**200**	**200**	**0.002**	**0.01**
						Total	**41,510**	**41,510**	**0.48**	**2.88**

FOUL SEWERAGE DESIGN

Design Criteria for Foul Proposed

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	10
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.000
Flow Per Person (l/per/day)	150.00	Maximum Backdrop Height (m)	0.000
Persons per House	2.70	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul Proposed

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F-1.000	1.999	0.050	40.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F-2.000	4.833	0.048	100.0	0.000	51	0.0	1.500	o	150	Pipe/Conduit	
F-1.001	17.170	0.172	100.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F-1.002	11.450	0.115	100.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F-1.003	19.399	0.194	100.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F-1.004	8.524	0.085	100.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F-3.000	15.079	0.151	100.0	0.000	3	0.0	1.500	o	150	Pipe/Conduit	
F-3.001	5.689	0.057	100.0	0.000	51	0.0	1.500	o	150	Pipe/Conduit	
F-1.005	4.193	0.042	100.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F-1.006	9.672	0.097	100.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F-1.000	10.415	0.000	0.0	0	0.0	0	0.00	1.82	72.3	0.0
F-2.000	10.488	0.000	0.0	51	0.1	33	0.56	0.88	15.5	1.6
F-1.001	9.397	0.000	0.0	51	0.1	29	0.53	1.15	45.6	1.6
F-1.002	8.500	0.000	0.0	51	0.1	29	0.53	1.15	45.6	1.6
F-1.003	8.099	0.000	0.0	51	0.1	29	0.53	1.15	45.6	1.6
F-1.004	7.760	0.000	0.0	51	0.1	29	0.53	1.15	45.6	1.6
F-3.000	8.250	0.000	0.0	3	0.0	9	0.23	0.88	15.5	0.1
F-3.001	8.099	0.000	0.0	54	0.2	33	0.57	0.88	15.5	1.7
F-1.005	7.675	0.000	0.0	105	0.3	41	0.66	1.15	45.6	3.2
F-1.006	7.434	0.000	0.0	105	0.3	41	0.66	1.15	45.6	3.2

Free Flowing Outfall Details for Foul Proposed

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F-1.006	F-	8.830	7.337	0.000	0	0

APPENDIX E: SURFACE WATER DRAINAGE INFORMATION

Scheme	St. Michaels Development	**Page**	1
		Job No	D1855
Section	Surface Water Management	**Date**	February '20
		By	SS

MUIR

Calculations

A. Allowable Discharge

Calculations are in accordance with the Greater Dublin Strategic Drainage Study (GDSDS), Volume 2, New Developments, Flood Estimation for Small Catchments (Institute of Hydrology report No. 124)

$QBAR_{rural} = 0.00108AREA^{0.89}SAAR^{1.17}SOIL^{2.17}$

AREA =	500000	m^2	
	50	Ha	
AREA =	0.5000	km^2	
SAAR =	757	(From http://www.met.ie/climate/IE_AAR_8110_V1.txt)	
SOIL =	0.30	(From Table D1 Different Classes of Soils from GDSDS)	

$QBAR_{rural}$ = 99.86 l/s

Therefore $QBAR_{rural}$/ha is **2.00 l/s/ha**

AREA =	3193	m^2 (From Development Drawings)	
	0.3193	Ha	
AREA =	0.0032	km^2	

Therefore $QBAR_{site}$ is **0.64 l/s**

2.00 l/s/Ha

To obtain the 1 year, 30 year and 100 year throttle rates the growth curve advised for use for developments, which is shown in GDSDS Appendix C is required. Proposed values are:

1 year factor =	0.85
30 year factor =	2.10
100 year factor =	2.60

Therefore limited discharge rates are:

	GDSDS Rate				Proposed Rate			
1 year factor =	1.7	**l/s/ha**	0.5	**l/s**	**l/s/ha**	1.4	**l/s**	
30 year factor =	4.2	**l/s/ha**	1.3	**l/s**	**l/s/ha**	1.4	**l/s**	
100 year factor =	5.2	**l/s/ha**	1.7	**l/s**	**l/s/ha**	1.4	**l/s**	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm Proposed

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	15.700	Add Flow / Climate Change (%)	20
Ratio R	0.272	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm Proposed

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.000	4.582	0.046	100.0	0.035	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.001	1.659	0.017	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.002	15.495	0.005	3099.0	0.145	0.00	0.0	0.600	o	225	Pipe/Conduit	
S-2.000	14.715	0.980	15.0	0.028	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.001	8.058	0.540	14.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.002	6.601	0.410	16.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.003	1.681	0.017	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.003	4.618	0.027	170.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S-1.004	16.273	0.096	170.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.000	50.00	4.08	8.100	0.035	0.0	0.0	1.0	1.00	17.8	5.8
S-1.001	50.00	4.10	8.054	0.035	0.0	0.0	1.0	1.00	17.8	5.8
S-1.002	50.00	5.25	7.205	0.180	0.0	0.0	4.9	0.23	9.0«	29.3
S-2.000	50.00	4.09	10.780	0.028	0.0	0.0	0.8	2.61	46.2	4.6
S-2.001	50.00	4.15	9.800	0.028	0.0	0.0	0.8	2.62	46.3	4.6
S-2.002	50.00	4.19	9.260	0.028	0.0	0.0	0.8	2.52	44.6	4.6
S-2.003	50.00	4.22	8.850	0.028	0.0	0.0	0.8	1.00	17.8	4.6
S-1.003	50.00	5.32	7.200	0.208	0.0	0.0	5.6	1.00	39.8	33.8
S-1.004	50.00	5.59	7.173	0.208	0.0	0.0	5.6	1.00	39.8	33.8

Network Design Table for Storm Proposed

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.005	8.839	0.052	170.0	0.026	0.00	0.0	0.600	o	225	Pipe/Conduit	
S-3.000	6.422	0.064	100.0	0.030	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.001	2.698	0.027	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.002	18.449	0.184	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.003	2.535	0.025	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.006	3.362	0.034	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S-1.007	20.817	0.122	170.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.005	50.00	5.74	7.077	0.234	0.0	0.0	6.3	1.00	39.8	38.1
S-3.000	50.00	4.11	8.300	0.030	0.0	0.0	0.8	1.00	17.8	4.8
S-3.001	50.00	4.15	8.236	0.030	0.0	0.0	0.8	1.00	17.8	4.8
S-3.002	50.00	4.46	8.209	0.030	0.0	0.0	0.8	1.00	17.8	4.8
S-3.003	50.00	4.50	8.024	0.030	0.0	0.0	0.8	1.00	17.8	4.8
S-1.006	50.00	5.79	7.025	0.264	0.0	0.0	7.2	1.31	52.0	42.9
S-1.007	50.00	4.35	6.780	0.000	1.4	0.0	0.2	1.00	39.8	1.4

Free Flowing Outfall Details for Storm Proposed

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S-1.007	S-	9.230	6.658	0.000	0	0

Online Controls for Storm Proposed

Hydro-Brake® Optimum Manhole: S-16, DS/PN: S-1.007, Volume (m³): 2.7

Unit Reference	MD-SHE-0050-1400-1620-1400
Design Head (m)	1.620
Design Flow (l/s)	1.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	50
Invert Level (m)	6.780
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.620	1.4
Flush-Flo™	0.218	1.0
Kick-Flo®	0.443	0.8
Mean Flow over Head Range	-	1.0

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	1.2	3.000	1.9	7.000	2.7
0.200	1.0	1.400	1.3	3.500	2.0	7.500	2.8
0.300	0.9	1.600	1.4	4.000	2.1	8.000	2.9
0.400	0.9	1.800	1.5	4.500	2.2	8.500	3.0
0.500	0.8	2.000	1.5	5.000	2.3	9.000	3.1
0.600	0.9	2.200	1.6	5.500	2.5	9.500	3.2
0.800	1.0	2.400	1.7	6.000	2.6		
1.000	1.1	2.600	1.7	6.500	2.6		

Storage Structures for Storm Proposed

Cellular Storage Manhole: S-3, DS/PN: S-1.002

Invert Level (m) 7.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	108.5	0.0	1.205	0.0	0.0
1.200	108.5	0.0			

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Proposed

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.272
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	15.700	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S-1.000	S-1	960 Winter	100	+20%	100/15 Summer			
S-1.001	S-2	960 Winter	100	+20%	100/15 Summer			
S-1.002	S-3	960 Winter	100	+20%	100/15 Summer			
S-2.000	S-4	15 Winter	100	+20%				
S-2.001	S-5	15 Winter	100	+20%				
S-2.002	S-6	15 Summer	100	+20%				
S-2.003	S-7	15 Summer	100	+20%	100/15 Summer			
S-1.003	S-8	960 Winter	100	+20%	100/15 Summer			
S-1.004	S-9	960 Winter	100	+20%	100/15 Summer			
S-1.005	S-10	960 Winter	100	+20%	100/15 Summer			
S-3.000	S-11	15 Winter	100	+20%				
S-3.001	S-12	960 Winter	100	+20%	100/15 Summer			
S-3.002	S-13	960 Winter	100	+20%	100/600 Winter			
S-3.003	S-14	960 Winter	100	+20%	100/240 Winter			
S-1.006	S-15	2880 Winter	100	+20%	100/15 Summer			
S-1.007	S-16	960 Winter	100	+20%	100/15 Summer			

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm Proposed

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S-1.000	S-1	8.397	0.147	0.000	0.09			1.2	SURCHARGED
S-1.001	S-2	8.396	0.192	0.000	0.11			1.2	SURCHARGED
S-1.002	S-3	8.396	0.966	0.000	0.12		938	1.3	SURCHARGED
S-2.000	S-4	10.832	-0.098	0.000	0.26			11.0	OK
S-2.001	S-5	9.853	-0.097	0.000	0.27			11.0	OK
S-2.002	S-6	9.315	-0.095	0.000	0.29			11.0	OK
S-2.003	S-7	9.006	0.006	0.000	1.00			10.9	SURCHARGED
S-1.003	S-8	8.394	0.969	0.000	0.05			1.3	SURCHARGED
S-1.004	S-9	8.394	0.996	0.000	0.04			1.3	SURCHARGED
S-1.005	S-10	8.392	1.089	0.000	0.04			1.3	SURCHARGED
S-3.000	S-11	8.426	-0.024	0.000	0.76			11.4	OK
S-3.001	S-12	8.391	0.005	0.000	0.09			1.0	SURCHARGED
S-3.002	S-13	8.391	0.032	0.000	0.06			1.0	SURCHARGED
S-3.003	S-14	8.390	0.216	0.000	0.09			1.0	SURCHARGED
S-1.006	S-15	8.149	0.899	0.000	0.05			1.4	SURCHARGED*
S-1.007	S-16	8.390	1.385	0.000	0.04			1.4	SURCHARGED

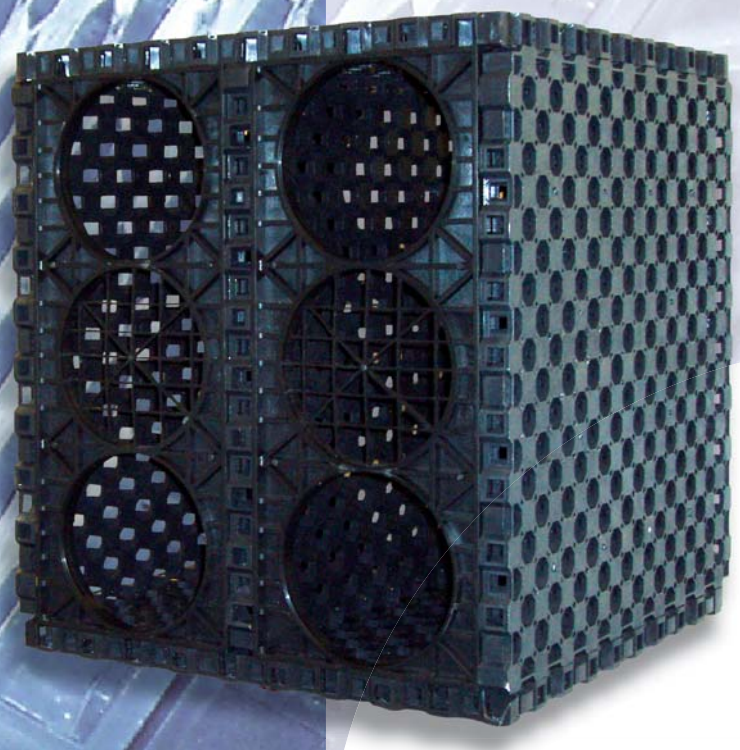
PN	US/MH Name	Level Exceeded
S-1.000	S-1	
S-1.001	S-2	
S-1.002	S-3	
S-2.000	S-4	
S-2.001	S-5	
S-2.002	S-6	
S-2.003	S-7	
S-1.003	S-8	
S-1.004	S-9	
S-1.005	S-10	
S-3.000	S-11	
S-3.001	S-12	
S-3.002	S-13	
S-3.003	S-14	
S-1.006	S-15	
S-1.007	S-16	

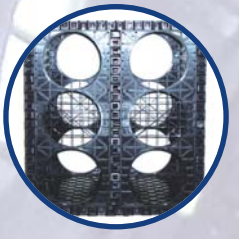
Modular Geo-Void Systems

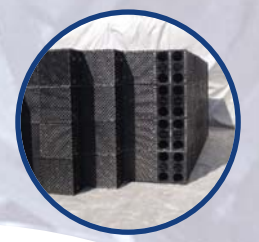
Total Water Management

Pluvial Cube

Total Linear Access Precipitation Collection System



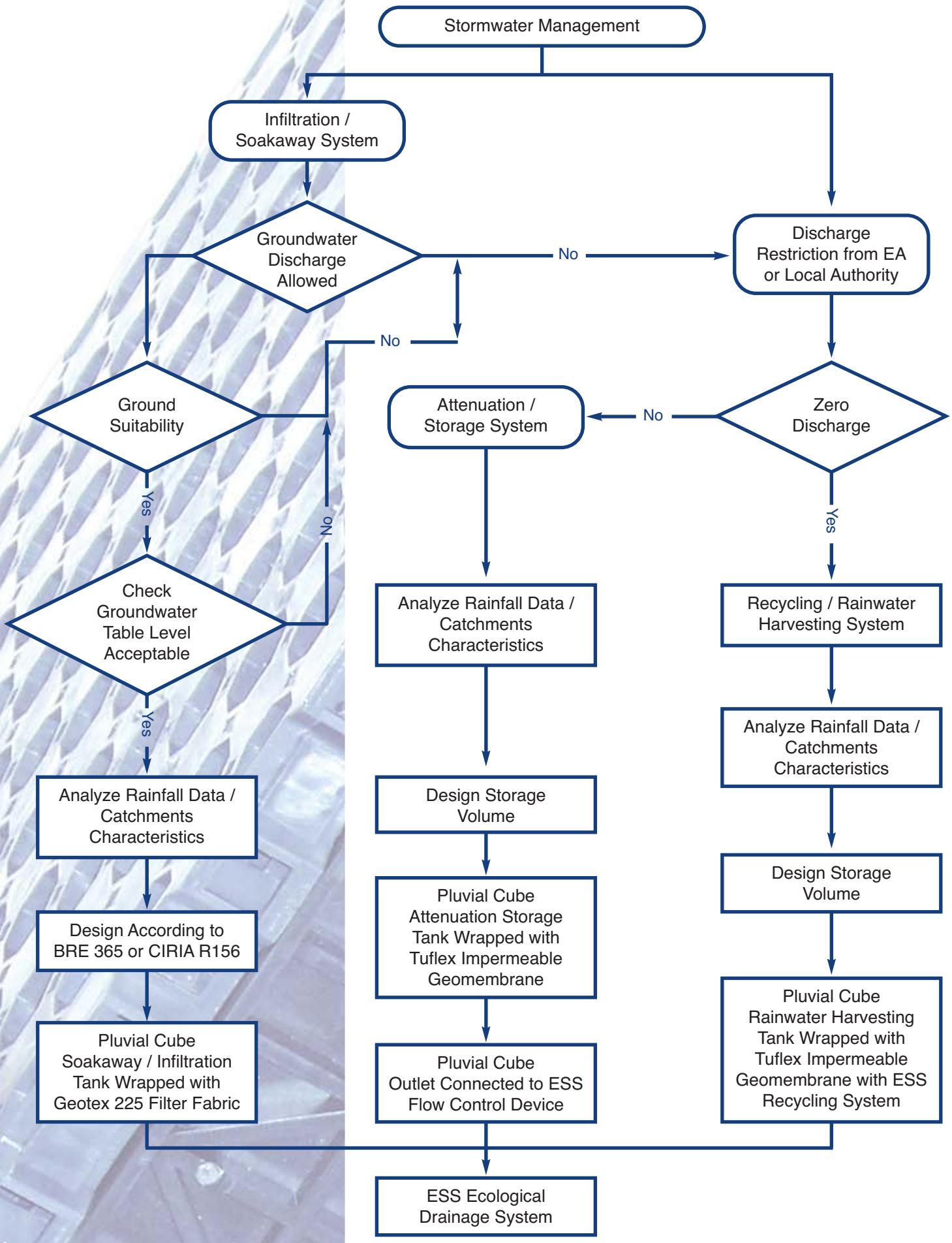




Unique Low Flow Channel System

ENVIRONMENTAL SUSTAINABLE SOLUTIONS LTD

Flow Chart


Stormwater Management
Infiltration / Soakaway System
Groundwater Discharge Allowed
No
Discharge Restriction from EA or Local Authority
No
Ground Suitability
Attenuation / Storage System
No
Zero Discharge
Yes
No
Yes
Check Groundwater Table Level Acceptable
Yes
Analyze Rainfall Data / Catchments Characteristics
Design Storage Volume
Recycling / Rainwater Harvesting System
Analyze Rainfall Data / Catchments Characteristics
Design Storage Volume
Design According to BRE 365 or CIRIA R156
Pluvial Cube Attenuation Storage Tank Wrapped with Tuflex Impermeable Geomembrane
Pluvial Cube Rainwater Harvesting Tank Wrapped with Tuflex Impermeable Geomembrane with ESS Recycling System
Pluvial Cube Soakaway / Infiltration Tank Wrapped with Geotex 225 Filter Fabric
Pluvial Cube Outlet Connected to ESS Flow Control Device
ESS Ecological Drainage System

Modular Geo-Cell Tank System

Infiltration, Detention and Re-use made easy...

Total Stormwater Management

E.S.S. Geo-Cell Modular Tank systems use surface and sub-surface infiltration techniques, resulting in clean water that can be re-used or allowed to re-enter the natural water system. E.S.S. Geo-Cell Modular Systems offer a highly efficient option for Stormwater Management in any kind of soils.

Water Quality

E.S.S. Geo-Cell Modular Tank Systems excel when there is a requirement to achieve a high water quality, particularly in the effective removal of nutrients and gross pollutants. In addition to the obvious environmental benefits, the sub-surface location of the tank system provides more usable space and an enhanced aesthetic setting compared to above ground concrete or plastic tanks.

The Modular Advantage

E.S.S. Geo-Cell Modular Tank System performance supersedes outdated aggregate trenches. The E.S.S. System provides a void space of over 90% compared to less than 20% in typical aggregate trenches. Consequently, the E.S.S. System offers a smaller footprint to achieve the same storage capacity as an aggregate trench. This saves time and money in installation and civil works costs. The lightweight design of E.S.S. Modular Tank Modules also make installation quicker, safer and cheaper. No sediment build up occurs in the E.S.S. System, unlike the clogging that is characteristic of aggregate based approaches.

System Components

Pluvial Cube Geo-Cell Tank Modules

EcoSand biologically engineered soils

E.S.S. Filtration Unit

Geotex Filtration Fabric

Tuflex Waterproofing Membrane

Geotex Protection Fleece

Ventilation Units

Preformed Pipe Connection Covers

Aquabrake Flow Control Devices and Chambers

Refer to separate data sheets

Benefits...

Complete Linear Access

Quick
Reduce site access delays

Lightweight
No cranes required

Strong
Designed for car loadings

Modular
Easily create any shape

Economical
Cheaper than concrete

Maintenance Free Tank
All debris and sediment is pre-filtered

Determinate Volume
One cubic metre of Pluvial Cube modules contain 950 litres of water

Cost Effective
Reduces excavation and disposal by two thirds compared with conventional soak wells

High Infiltration
90% void surface area

Structurally Designed
Supports shear loadings

Unique Low Flow Channels
Ensuring complete removal of any silts

Permeable Paving

Single Module

Size: 50cms x 50cms x 55cms
Units / m3: 0.1375m3
7.27 per m3

Double Module

Size: 50cms x 50cms x 107.5cms
Units / m3: 0269m3
3.72 per m3

Triple Module

Size: 50cms x 50cms x 160cms
Units / m3: 0.40m3
2.50 per m3

Clear Linear Access Through Open Subterranean Channels

Water sensitive Urban Channels

The Channel Systems are based on permeable sub-surface waterways that restore water quality and recharge the natural environment. The sub-surface E.S.S. Channel System provides a unique way of working with nature to solve the enormous problems currently associated with open concrete channels and swales.

Traditional Concrete Channels

Open concrete channels and swales are currently one of the main methods of transporting large quantities of Stormwater for discharge into streams, rivers and oceans. Open channels are used widely in the urban landscape even though they are considered unsafe. Channels are also a breeding ground for vermin and vector that endangers human health. In addition to the health and safety problem, large concrete channels take up vast areas of land and have a negative impact on the amenity of the area.

Pluvial Cube Module Dimensions* (mm)	Module Configuration	Units per m^3	Module Volume (m^3)
500 (L) x 500 (W) x 550 (D)	Single	7.27	0.1375
500 (L) x 500 (W) x 1075 (D)	Double	3.72	0.2688
500 (L) x 500 (W) x 1600 (D)	Triple	2.5	0.4

Product Data	Standard Pluvial Cube Module	Heavy Duty Pluvial Cube Module
Application	Stormwater Management	Stormwater Management
Average Weight (kg) - single module	6.05	7.05
Compressive Strength* (kN/m^2)	240	400
lateral Strength* (kN/m^2)	120	200
Long Term Creep Testing** (kN/m^2)	90	120
Void Ratio (%)	96	96
Surface Void Ratio (%)	Greater than 90	Greater than 90
Minimum Backfill Cover# (mm)	450	450
Maximum Backfill Cover (mm)	3000	4750
Material	Propylene	Propylene
Chemical Resistance	Good	Good
Bacterial Resistance	Good	Good
UV Resistance	Good	Good

Note: Other Modules with Compressive Strength more than 1500 kN/m^2 available

* Modules tested using UKAS calibrated test machine, range 0 - 60 Tons, UDL, loading rate 0.2 kN/m^2

** Modules tested for long term creep testing for 90 and 180 days

Any cover less than 450 mm - contact ESS design department

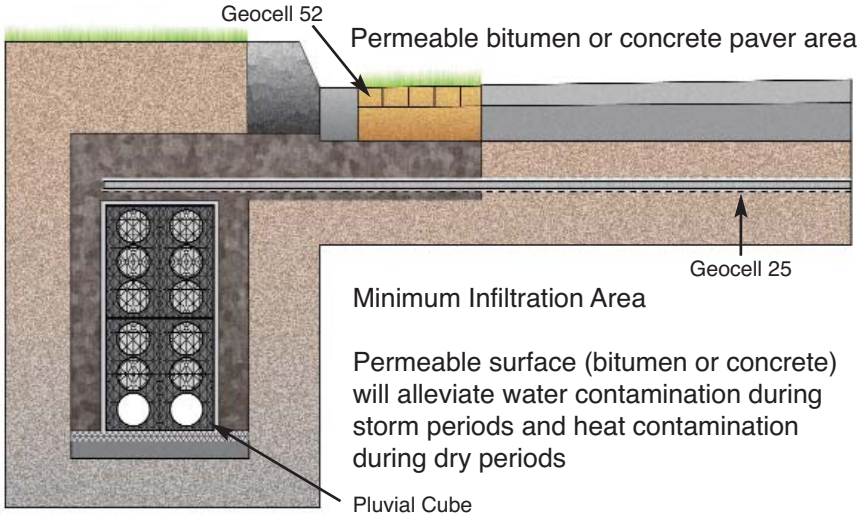
E.S.S. Channel System

E.S.S. Channels

With the E.S.S. Channel System being a sub-surface system, these problems with open concrete channels are rectified. The permeable channel system can be designed to follow the inherent contours of the landform and emulate the flow of natural waterways. The curvilinear channel design creates vertical flow, turbulence and reduces the overall flow of velocity while increasing the self cleansing capacity of the channel bed to create healthy aerobic conditions. The clear access channels allow for continual and future maintenance

Road Edge Infiltration Area.

High Traffic Areas



Filter Drain

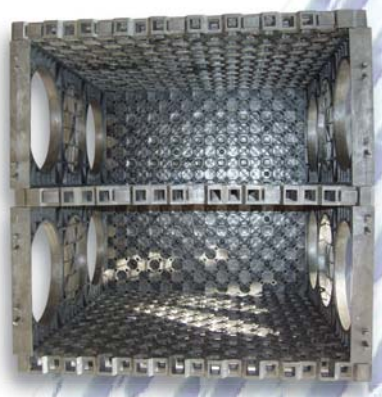
Environmental Benefits

By replacing open concrete channels or swales with E.S.S. Channel Systems, cities can now benefit from increased environmental amenities, greater recreational space and healthier conditions by using the vast tracts of land once given over to rapid flowing concrete channels.

Car Park Infiltration Area.

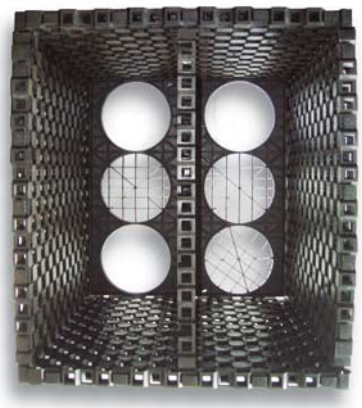
Low Flow Channel System

Self Cleaning at High Flow Velocity



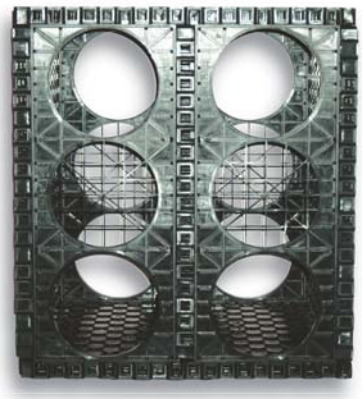
Top View
Showing Clear Channel

Provides Total Linear Access

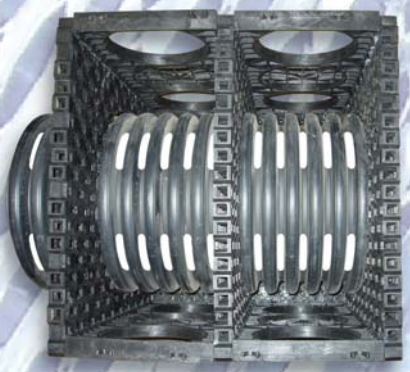


2 Clear Channels
500mm x 210mm per 0.5mt width

Controls Silt at Low Flow Velocity



4 x160mm Pipe
Access Point

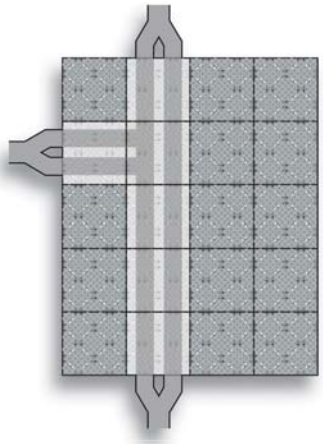


225 or 300mm
Internal Dia Channel

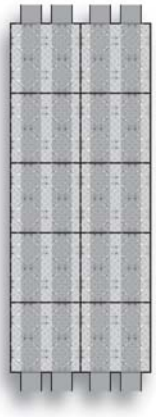
The above channels can be multi-connected using preformed connecters to larger inlet / outlet pipes

225 Low Flow Channel
(if required)

300mm Dia Low Flow Channel
(if required)



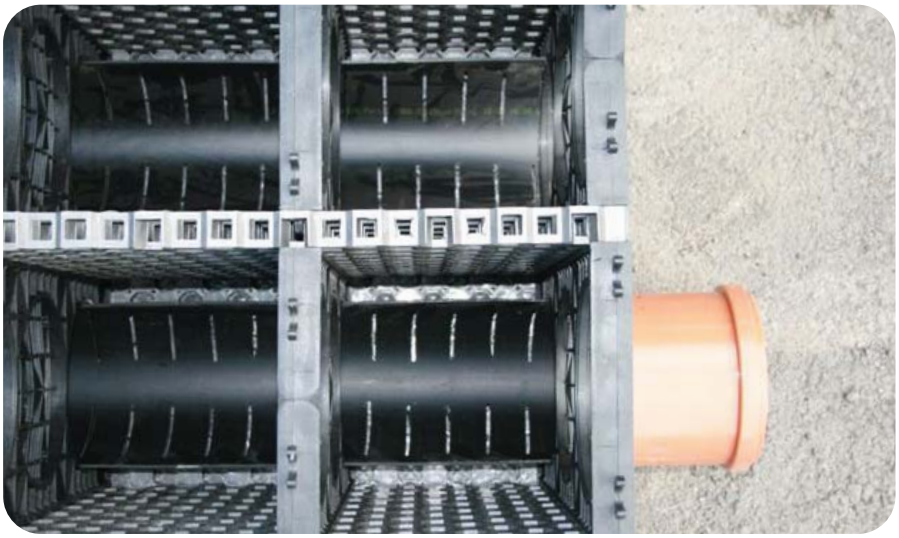
Typical Installation
Tank Format



Typical Installation Channel Format
4 Clear Access Channels x 210mm

Linear Access Channel.

With slotted low flow silt control channel installed

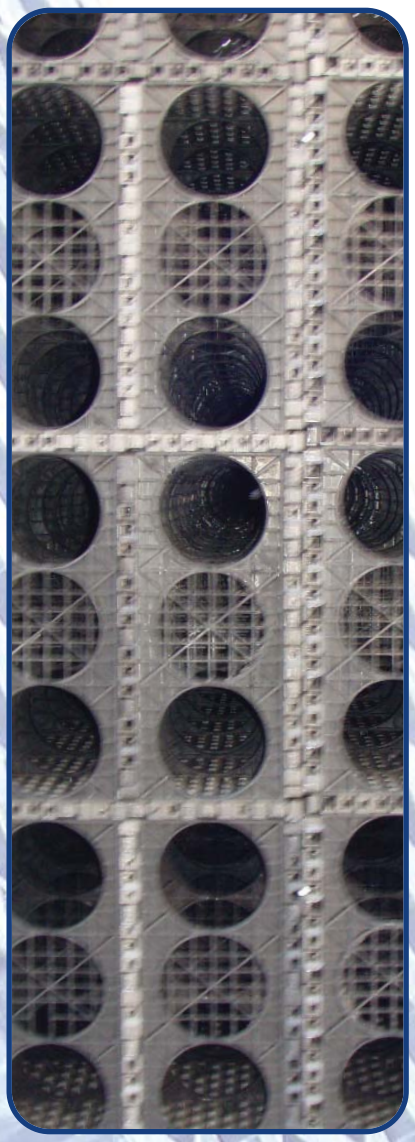


Top view showing low flow maintenance channel.

Self cleaning channels.

Connection to low flow maintenance channel at invert level.

Attenuation Tank Highlighting Number and Position of Access Points.



Cover Materials

Cover materials are an essential part of the infiltration process. E.S.S. **EcoSand** Biologically Engineered sand is designed to provide maximum permeability through optimum physical, chemical and biological characteristics. To retain infiltration performance it is essential to choose the appropriate cover material and constantly maintain pH levels between 6 and 7.5.

Type 1 - Road run off

Type 2 - Road run off

Type 3

Type 4

Type 5 - Compactable

Type 1 - Road run off

The filter sand is engineered to installation and E.A. requirements. Depending on site contaminants expected.

Trafficable Landscape - Compaction Prevention:

If a trafficable, soft landscape surface is required (i.e. grass or gravel car parks, road verges etc.), it is recommended to use **E.S.S. GeoCell 52** grass reinforcement structure. The addition of product will allow long-term permeability of the cover soil.

Loading	Minimum Cover
Pedestrian	300mm
Occasional traffic	500mm

Infiltration Tank

Attenuation Tank.

2mts deep tank with 3mts cover

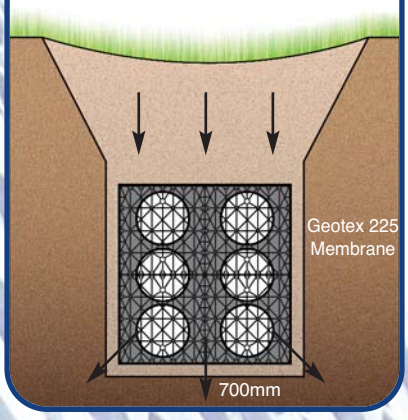
Infiltration Swales & Underground Channels

Subsurface Road Channels / Swales

Pluvial Cube Tanking System provides an efficient way of managing road stormwater runoff. It allows high infiltration areas, preventing road accidents, water ponding, and mosquito infestation Provides new accessible space

Attenuation Tank under Park and Ride Scheme showing versatility of modular system.

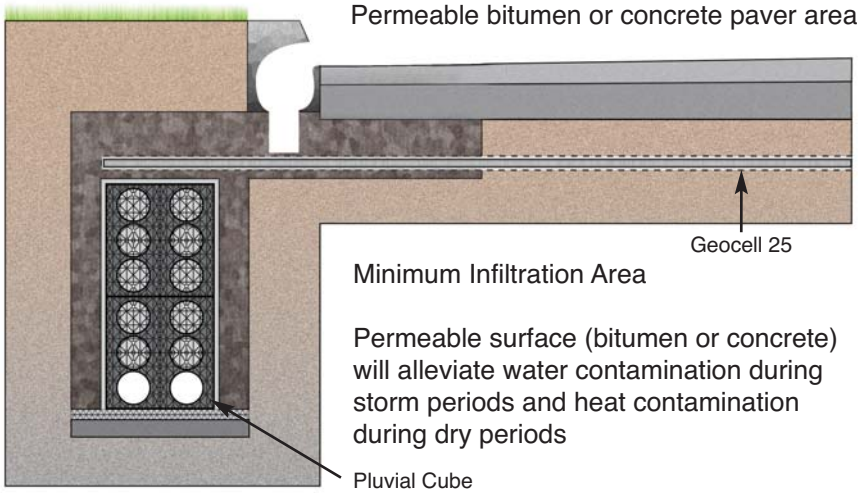
Typical Pluvial Cube Infiltration Swale Detail



High Traffic Areas

Filter Drain

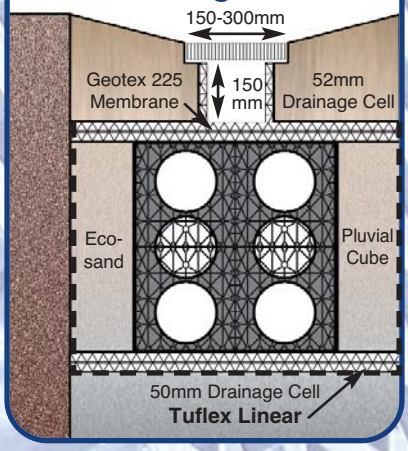
Permeable bitumen or concrete paver area



Minimum Infiltration Area

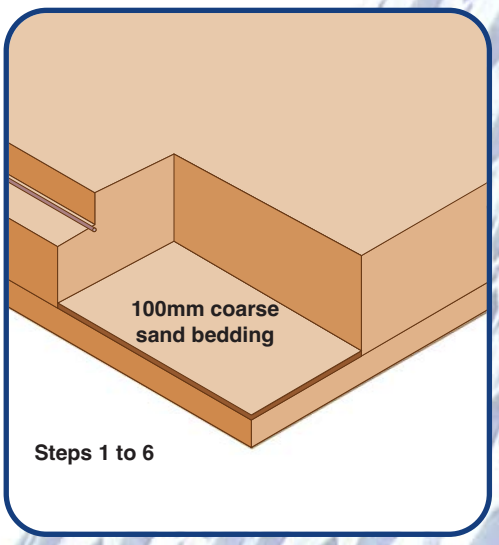
Permeable surface (bitumen or concrete) will alleviate water contamination during storm periods and heat contamination during dry periods

Typical Section Road Drainage Channel

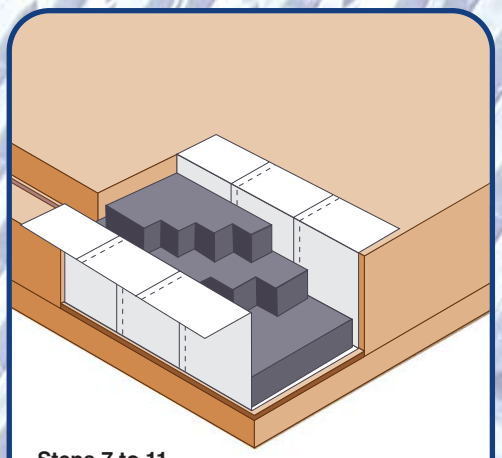


Tank 2mts deep with access channels.

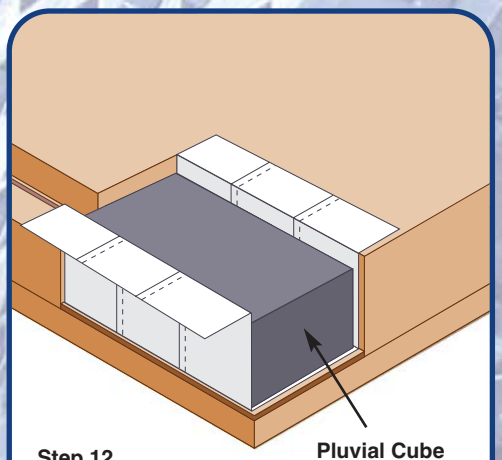
Installation Procedures



Steps 1 to 6



Steps 7 to 11



Step 12

Infiltration Tanks

Installation Steps

1. Excavate the pipe trench and lay the inlet pipe to the required fall and install silt traps in appropriate locations in the pipe run.

2. Excavate the hole or trench to the required dimensions to modular units, and any external inspection chamber(s) and / or silt trap(s).

3. Ensure that the base plan dimensions of the hole allows sufficient working space for the site operatives to manoeuvre the units and geotextile into position.

4. Ensure that the base of the excavation is flat and level, batter back the sides of the excavation to a safe angle, and ensure that the safe access is provided for the site operatives.

5. Remove any soft spots from the excavation and replace with compacted granular material.

6. **a) For Soakaway,** lay 100mm coarse sand bedding to the base of the excavation and level.
   b) For Attenuation, lay 100mm (minimum) compact solid level base (site concrete preferably).

7. **a) For Soakaway,** lay the geotextile, Geotex 225ff, over the base and up the sides of the excavation with minimum 200mm overlap joints between strips.
   b) For Attenuation, repeat procedure with Tuflex Geo Membrane.

8. Ensure there is a minimum 200mm over-run of geo-textile at the end of the modular unit.

9. Inspect geotextile for damage.
   Tuflex for Attenuation, ensuring integrity of all welded laps.

10. Assemble the module tanks to required dimensions.

    The illustrations show the correct relationships, orientation, and sequence of connection of each panel to form a basic full module tank (500 x 500 x depth).

11. Assemble the Pluvial Cube Modules in orientation as per drawing. L x W x D.

Installation Procedures

12. To receive the inlet pipe (and outlet/ inspection pipe if required). Insert tank connector and, using geotextile, form a wrap around apron of the tank connector spigot and secure using tape or jubilee clip. Ensure a minimum 50mm of spigot remains exposed. **For Attenuation tanks,** all inlets and outlets are sealed with welded preformed pipe flanges.

13. **a) For Soakaway,** Continue with the geotextile encapsulation of the Pluvial Cube tank.
b) For Attenuation, use Tuflex Geo Membranes.

14. Fold the corners of the geotextile over-run at each end of the infiltration tank as shown, welting all corners. The same method applies for Tuflex Geo Membranes ensuring all corners are welted and folded (not cut).

15. **a) For Soakaway,** Complete the encapsulation by wrapping the geotextile horizontally around the tank and tape into position.
b) For Attenuation, use Tuflex Geo Membranes.

16. Connect inlet / outlet / vent pipe and inspection chambers using appropriate adaptors.

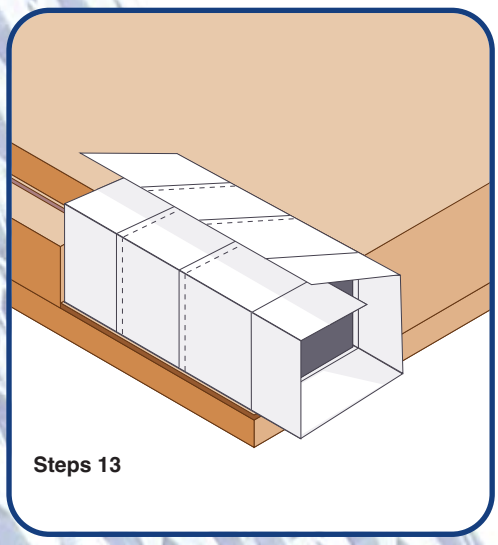
17. Backfill around excavation using type 1 or 2 sub base or selected granular material, and compact in layers of not less than 150mm. The first 500mm of any installation should be compacted by hand.

18. Use a coarse sand protection layer over the top of the Pluvial Cube tanks and geotextile and the back fill to the required depth using Type 1 or 2 sub base material. If the area is to be trafficked. Where the area is to be landscaped then as-dug material may be used provided sharp or large solid matter is removed.

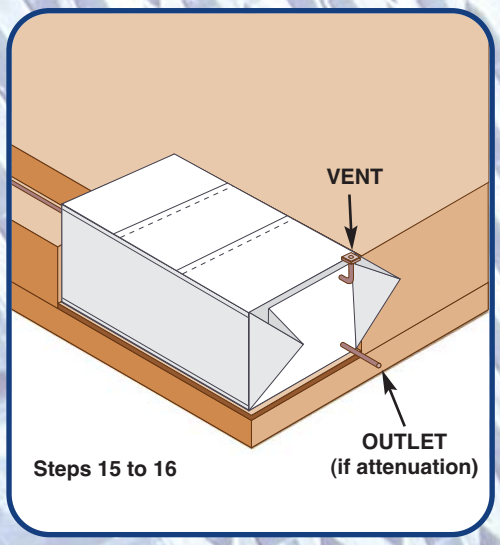
19. The area should then be compacted using suitable compaction equipment in accordance with specification for highway Works.

20. **For Attenuation tank,** steps 7-16 are also followed to encapsulate the Tuflex Geo Membranes lined tanks with Geotex 300 protection membrane prior to backfill.

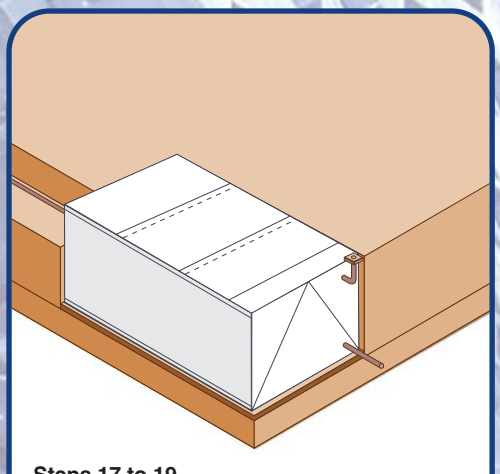
N.B. Please refer to full sequence of works data for more detailed instructions.



Steps 13



Steps 15 to 16



Steps 17 to 19

All products are manufactured to the highest quality, being subject to rigid quality control. However, the company cannot control conditions of application and use of its products, thus any warranty, written or implied, is given in good faith for materials only. ESS Ltd will not accept any responsibility for damage or injury arising from storage handling, misapplication or misuse of its products. All transactions are subject to our standard condition of sale, copies of which are available on request.

To find out more about these systems and products please contact us

Pluvial Cube

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Project					
Revision	R(1)	**Date**	15/10/2020		
Description					
Draiange Layout No.	LEVELS BY MUIR ASSOCIATES LIMITED				
Contractor					
Tank Information (m)	**Tank Depth**	**BOT**	**TOT**	**CL**	**COVER**
	1.075	7.200	8.275	9.875	1.600
				9.075	0.800
				TBC	*MIN.*

Strength of Pluvial Cube modules

Compressive Strength P_{ck} = 317 kN/m^2

Partial factor of safety for materials (Υ_m) = 2.75

Allowable load on Pluvial Cube modules **= 115 kN/m^2**

Weight of cover fill and surcharge load over Pluvial Cube module

Unit weight Backfill (Υa)	=	18	kN/m^3	
Depth of Backfill (z1)	=	1.2	m	
Depth of Backfill (z2)		0.4	m	
Unit weight stone (Υb)	=	20	kN/m^3	
Depth of stone (z3)	=	0.25	m	***(Assumed)***
Unit weight Asphalt(Υc)	=	23	kN/m^3	
Depth of Asphalt (z4)	=	0.15	m	***(Assumed)***
Load from each wheel (Q_w)	=	5.0	tons	*Vehicles up to 30,000kg GVW DIN 1072 Classification 30/30)*
	=	50	kN	

Area of applied load on Pluvial Cube modules

Considering the soil is well compacted, the load distribution to be (degrees): 26.5

Depth of cover on the modules (D_1) = 1.6 m Max.
(D_2) 0.8 m Min.

Considering the area of contact of the wheel and the road is 200 x 400 mm
(Loading Model - GVW DIN 1072 Classification 30/30)

L (m) = 0.2
B (m) = 0.4

The total area of load applied on the modules = 0.8 + 0.2 + 0.8 m
0.8 + 0.4 + 0.8 m

B` = 1.8 m
L` = 2 m

Contact area **A'** = **1.8 x 2 m**

The total area of load applied on the modules = 0.4 + 0.2 + 0.4 m
0.4 + 0.4 + 0.4 m

B` = 1 m
L` = 1.2 m

Contact area **A'** = **1 x 1.2 m**

Evaluation of Load Model GVW DIN 1072 Classification 30/30

Q_w= 50 kN

Equivalent pressure per wheel at a depth of (D_1)

$$Q`_w = \frac{Q_w}{B` \times L`}$$

$Q`_w$=
$\boldsymbol{Q`_w}$= 13.9 kN/m^2 ***Max. Cover***
$Q`_w$= 41.7 kN/m^2 ***Min. Cover***

Additional UDL = 10 kN/m^2

$$Q_{max,k} = Q_{OL} + Additiional\ UDL$$

$Q_{max,k}$ =
$\boldsymbol{Q_{max,k}}$ = 23.9 kN/m^2 ***Max. Cover***
$Q_{max,k}$ = 51.7 kN/m^2 ***Min. Cover***

Calculation of design Factors of safety

Permanent Action unfavourable loading	γ_G =	1.4
Variable Action unfavourable loading	γ_Q =	1.6
Dynamic Factor for z1	=	1
Dynamic Factor for z2	=	1

(Dynamic Factor for z1 & z2 Speed < 15mph)

Design vertical traffic loading:

$$Q_b = (\Upsilon a \times z1 \times \gamma_G) + (\Upsilon b \times z3 \times \gamma_G) + (\Upsilon c \times z4 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

$$Q_b = (\Upsilon a \times z2 \times \gamma_G) + (\Upsilon b \times z3 \times \gamma_G) + (\Upsilon c \times z3 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

Max. Cover =	**80.29**	**kN/m²**	**<**	**115.27** **kN/m²**
Min. Cover =	**104.58**	**kN/m²**	**<**	**115.27** **kN/m²**

Allowable load with F.O.S

Loading design is safe

CALCULATION OF HORIZONTAL EARTH PRESSURE LOADING (ULS)

Compressive strength of Pluvial Cube modules

Compressive Strength	P_{ck}	=	201 kN/m^2
Partial factor of safety for materials (F_m)		=	2.75

Allowable load on Pluvial Cube modules = **73.09 kN/m^2**

Horizontal earth pressure on Pluvial Cube Modules

Total horizontal pressure =

Where,
Ka - is the co-efficient of active earth pressure = (1 - sinΦ) / (1 + sinΦ)
Φ - angle of shearing resistance of soil
d - is the height of fill material till the base of the tank, m
y - is the unit weight of fill material, kN/m^3
w - water pressure
$\sigma_{surcharge\ load}$ - is the surcharge load, kN/m^2

Considering the soil is well compacted, the load distribution to be 30^0
(Soil type Assumed Loose sand and gravel - TBC confirmed by engineer)

Co-efficient of active earth pressure (Ka)	=	(1 - sinΦ) / (1 + sinΦ)		
	=	(1 - sin30^o) / (1 + sin30^o)		
	=	0.3		
Unit weight fill material (y)	=	21	kN/m^3	**Ave.**
Depth of fill till the bottom of the tank (d)	=	2.675	m Max.	
		1.875	m Min.	
Water pressure (W)	=	0	kN/m^2	
Surcharge load ($\sigma_{surcharge\ load}$)	=	10	kN/m^2	

NOTE:- Assumed No Groundwater - TBC

Partial factors applied to loading:

Permanent unfavourable loading γ_G = 1.35

Variable unfavourable loading, γ_Q = 1.5

Dynamic factor for speed < 15mph γ_{DF} = 1

Site importance factor for Class 1 site for ULS calculation γ_{SF} 1.0

Total horizontal pressure(σ_h) on module =

$$\sigma'h,a = Ka\ x\ [(\gamma\ x\ d) + \sigma surcharge\ load]$$

Including partial factors γ_{DF} , $\gamma_{SF,}$ γ_G and γ_Q

$$\sigma'h,a = Ka\ x\ \gamma_{DF}\ x\ \gamma_{SF}\ x\ [(\gamma\ x\ d\ x\ \gamma_G) + (\sigma surcharge\ x\ \gamma_Q]$$

= (0.3 x (21 x 2.675)) + 0 + (0.3 x 10)

= (0.3 x (21 x 1.875)) + 0 + (0.3 x 10)

Design load on the module =

Max. =	**27.25**	**kN/m^2**	**<**	**73.09**	**kN/m^2**
Min. =	**20.45**	**kN/m^2**	**<**	**73.09**	**kN/m^2**

Loading design is safe

APPENDIX F: WATER DEMAND CALCULATIONS

Development St. Michaels

Job No: D1855

Section Water Demand Calculations

Element	Occupancy Rate	Average Daily Demand (l/p/d)	Average Day/Peak week Demand factor	Peak Demand factor (for pipe sizing)
Domestic	2.7	150	1.25	5
Commercial	1 per 25m^2	50	1.25	5

Element	Unit	No of Units	Occupancy Rate (p/unit)	Total Occupancy (persons)	Daily Demand* (l/p/d)	Average Daily Demand (l/d) and 24 hour storage	Average Daily Peak Demand (l/d)	Average Demand (l/s)	Factored (5) Peak Demand for pipe sizing (l/s)	Fire Flow Requirements
Residential	Dwelling	102	2.7	275.4	150	**41,310**	**51,638**	**0.60**	**2.99**	TBA
Commercial (90m2)	Person	4	1	4	50	**200**	**250**	**0.003**	**0.01**	TBA
					TOTALS	**41,510**	**51,888**	**0.60**	**3.00**	