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Proposed Strategical Housing Development at St. Michaels Hospital Car Park

Stage 1 Surface Water Audit

September 2020

Document Control

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Revision	Description	Date	Prepared	Checked	Approved
R0	First Issue	29/09/2020	MC. Daly	D. Gallery	L. Brennan

Report by: _____ Date: 29th September 2020

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Checked by: _____ Date: 29th September 2020

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PUNCH Consulting Engineers

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1 Introduction

1.1 Purpose of Report

This report presents a Stage 1 Surface Water Audit carried out for a proposed residential development and associated infrastructure at St Michaels Hospital, Crofton Road, Dublin.

PUNCH Consulting Engineers have been appointed by Fitzwilliam DL Ltd. to carry out an independent Stage 1 Stormwater Audit on the proposal in line with Dún Laoghaire-Rathdown County Council (DLRCC) requirements.

1.2 Site Details

St Michaels residential development site currently consists of a carpark. The proposed development red line boundary is approx. 0.3ha in area and is bordered by Croftons Road to the north, with existing St Michaels Hospital to the south and east .

1.3 Report Details

The audit was carried out by Marie-Claire Daly and Donal Gallery on the date of September 29th.

This Stage 1 Audit has been carried out in accordance with the Dún Laoghaire-Rathdown County Council (DLRCC) Stormwater Audit Procedure Rev 0 January 2012. The auditor has examined only those issues within the design relating to surface water drainage implications of the scheme and has therefore not examined or verified the compliance of the design to any other criteria.

Appendix A contains copies of drawings and documents examined by the auditor. The drawings in Appendix B correspond to the Stage 1 Audit findings outlined in Section 2 of this report. Appendix C contains the Surface Water Audit Feedback form.

All of the findings outlined in Section 2 of this report are considered by the auditor to require action in order to improve the stormwater credentials of the scheme.

1.4 Drawings & Documents Examined as Part of Audit

- *D1855 - Engineering Planning Report*
- *D1855 - Microdrainage Surface Water Drainage Outputs*
- *D1855-C-02 Surface Water Drainage Layout*
- *D1855-C-04 Surface Water Drainage Long sections*
- *D1855-C-08 Standard Drainage Details Sheet 1*
- *D1855-C-09 Standard Drainage Details Sheet 2*
- *Building 01 Roof Plan*
- *Overall Roof Plan*

2 Stage 1 Audit Findings

The following section should be read in tandem with the drawings included in Appendix B.

2.1 Roads and ParkingSt Michaels Residential Development

2.1.1 Permeable Surfacing

Problem: It is not clear on the drawings provided what surface is proposed for the proposed road and car parking spaces. Impermeable surfaces do not allow water to infiltrate to the ground.

Recommendation: Consider inclusion of permeable surfacing for the proposed road and car parking bays – such as permeable paving and porous asphalt. The stone layer within the build-up would have a dual effect of cleaning the surface water run-off contaminants, and attenuating the flow reducing the rate at which surface water would flow from the surface areas.

2.1.2 Road Gullies/Aco Channel

Problem: There is potential to further reduce the surface water runoff and to improve runoff quality from the roads around the development and parking bays by incorporating SuDS measures in lieu of road gullies.

Recommendation: In place of connecting the proposed gullies (not already connected to a Suds system) directly into the proposed surface water network, consider connecting proposed gullies to a SuDS measure such as tree pits, infiltration trench, bio retention area etc. with an overflow to the surface water network. This will further reduce the quantity and improve the quality of surface water runoff from the site.

2.1.3 CBR Values

Problem: Californian bearing ration (CBR) varies inversely with moisture content (as the latter increases the CBR value decreases). The equilibrium CBR value is the long-term value that occurs once the pavement is constructed and the moisture content of the subgrade soil comes in to equilibrium with the suction forces within the subgrade air spaces. Carrying out CBR tests will allow for appropriate permeable paving design including capping material if and where required. This capping is typically quite impermeable when compacted.

Recommendation: CBR tests to be performed on site to allow for appropriate permeable paving design. These CBR tests are to be carried out in accordance with BS 1377-4:1990.

2.1.4 Tree Pit Systems

Problem: There is potential to reduce the surface water runoff and to improve runoff quality from the development by providing a greater amount of SuDS measures in the form of tree pit systems.

Recommendation: Consider incorporating tree pit systems in areas in close proximity to the impermeable surfaces. Connect road gullies to these systems rather than directly to the main surface water drainage system.

2.1.5 Maintenance

Problem: The report makes reference to maintenance of green roofs but does not make reference to maintenance of the remaining SuDS measures on site.

Recommendation: Set out maintenance/inspection requirements for management of the surface water system. Maintenance management to include life-span of SuDS measures, inspection/monitoring details, grass and vegetation management, litter removal and excessive sediment removal.

Ensure there are a sufficient amount of inspection chambers/manholes specified for the proposed SuDS measures in order to achieve access for maintenance including rodding, etc.

2.1.6 Sump Manholes

Problem: Silt entering the system including the attenuation tanks has the potential to cause blockages.

Recommendation: Consider additional sump manholes to capture any excess silt therefore preventing entry into the attenuation tank.

2.1.7 Attenuation Storage Tanks

Problem: There is potential to reduce surface water runoff from the development by incorporating an attenuation tank that allows for infiltration.

Recommendation: Consideration should be given to using attention tanks that permit water infiltration.

2.2 Buildings/Residential Units

2.2.1 Rainwater Harvesting Tanks

Problem: Where green roofs are not used, there is potential to install rainwater harvesting facilities for the proposed units which can be used for irrigation or for toilet flushing within the units.

Recommendation: Consider incorporating rainwater harvesting tanks.

Appendix A Drawings and Documents Examined by the Auditor

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 …. 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 outside the application red line within the public domain will be subject to the agreement of Dún Laoghaire–Rathdown County Council.

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 roof, filter drain, bioretention system 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 …. of this report.

Source of Surface Water Runoff	Total Area (m2)	Runoff (%)	Eq. Imp. Area (m2)	S Teatment Train			Receptor
				1 stage	2 stage	3 stage	
Roof	1296	100	1296	GR	GCS	PI	Storm Sewer
Footpath	651	100	651	GCS	PI	x	Storm Sewer
Road	693	100	693	FD/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); 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.

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 … 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 … 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 for Green Roofs

Extensive 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. The maintenance access for the proposed development has been provided by ladders from the floor below from the main corridor area.

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)
	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

Maintenance Schedule	Required Action	Typical Frequency
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

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

LEGEND:

- PROPOSED SURFACE WATER DRAINAGE AND MANHOLE
- EXISTING SURFACE WATER SEWER
- PROPOSED INSPECTION CHAMBER
- PROPOSED SERVICE CONNECTION
- PROPOSED PERFORATED PIPE
- PROPOSED CHANNEL DRAIN
- PROPOSED ROAD GULLY (RG)
- PROPOSED FOOTPATH GULLY (FG)
- PROPOSED ATTENUATION
- PROPOSED FILTER DRAIN
- PROPOSED BIO-RETENTION SYSTEM
- PROPOSED PETROL INTERCEPTOR (PI)

NORTH

CHARLEMONT TERRACE

PROPOSED FILTER DRAIN

S-2.001
1:14.9
USIL 9.800m
Ø150mm
DSIL9.260m

S-4
CL 11.530m
Depth (m) 0.750

S-5
CL 10.550m
Depth (m) 0.750

S-2.000
1:15.0
USIL 10.780m
Ø150mm
DSIL9.800m

S-2.002
1:16.1
USIL 9.260m
Ø150mm
DSIL8.850m

S-6
CL 10.010m
Depth (m) 0.750

S-7
CL 9.850m
Depth (m) 1.000

S-2.003
1:100.0
USIL 8.850m
Ø150mm
DSIL8.833m

S-9
CL 9.800m
Depth (m) 2.627

S-1.004
1:170.0
USIL 7.173m
Ø225mm
DSIL7.077m

S-10
CL 9.390m
Depth (m) 2.313

S-1.005
1:170.0
USIL 7.077m
Ø225mm
DSIL7.025m

S-1.006
1:100.0
USIL 7.025m
Ø225mm
DSIL 6.991m

S-15-SADDLE CONNECTION
CL 9.180m
Depth (m) 2.155

S-16
CL 9.080m
Depth (m) 2.300

PROPOSED HYDROBRAKE MANHOLE
DESIGN FLOW: 1.4l/s
DESIGN HEAD: 1.620m
ORIFICE DIAMETER: 50mm

PROPOSED KLARGESTER NSBP003
BYPASS OIL SEPARATOR OR SIMILAR APPROVED

PROPOSED CONNECTION TO EXISTING SURFACE WATER NETWORK

EXISTING 1350mm BRICK STORM

EX.SMH
CL: 9.04
IL: 5.47

S-1.007
1:170.0
USIL 6.780m
Ø225mm
DSIL6.658m

PROPOSED ATTENUATION - ESS EcoCell
GEOCELLULAR SYSTEM OR SIMILAR APPROVED
INVERT LEVEL: 7.200m
DEPTH:1.2m
TOP WATER LEVEL: 8.400m
AREA: 109m²
POROSITY: 0.95%
STORAGE VOLUME: 124m³

PROPOSED SUMP MANHOLE

BUILDING 02

BUILDING 01

S-1.003
1:170.0
USIL 7.200m
Ø225mm
DSIL7.173m

S-14
CL 9.100m
Depth (m) 1.076

S-8
CL 9.800m
Depth (m) 2.600

S-3.003
1:100.0
USIL 8.024m
Ø150mm
DSIL7.999m

S-1.002
1:100.0
USIL 6.658m
Ø225mm
DSIL6.625m

S-3
CL 9.260m
Depth (m) 1.905

S-3.001
1:100.0
USIL 8.236m
Ø150mm
DSIL8.209m

S-1.001
1:100.0
USIL 8.054m
Ø150mm
DSIL8.038m

S-12
CL 9.100m
Depth (m) 0.964

S-13
CL 9.100m
Depth (m) 0.891

S-3.000
1:100.0
USIL 8.300m
Ø150mm
DSIL8.236m

S-2
CL 9.190m
Depth (m) 1.136

S-11
CL 9.100m
Depth (m) 0.800

S-1.000
1:100.0
USIL 8.100m
Ø150mm
DSIL8.054m

S-1
CL 9.000m
Depth (m) 0.900

FG

PROPOSED BIO-RETENTION SYSTEM

OVERFLOW PIPE AT HIGH LEVEL

PROPOSED ACO CHANNEL DRAIN OR SIMILAR APPROVED

PROPOSED ACO CHANNEL DRAIN OR SIMILAR APPROVED

EXISTING 1350mm BRICK STORM

EX.SMH
CL: 9.48
IL: 6.08

S7

FINAL DRAFT

NOTES:

REVISION	DATE	DESCRIPTION	REV BY	CHK BY
X	22.09.20	DRAFT ISSUE	SC	SS

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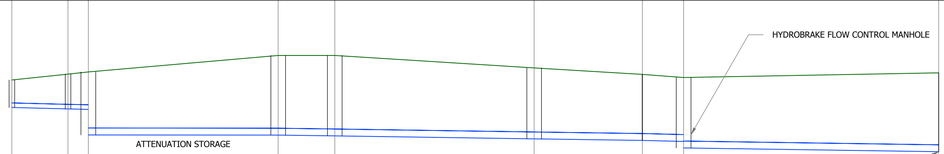
PROJECT	ST. MICHAELS DEVELOPMENT, DÚN LAOGHAIRE
CLIENT	FITZWILLIAM DL LTD
TITLE	SURFACE WATER DRAINAGE SITE LAYOUT

Director	Proj. Eng.	Drawn by	DRG. No.	REV
SOR	SS	SC	D1855-C-02	X
Scale	Checked	Date		
1:250 @A1	SS	SEP '20		

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

MH Name	S-1	S-2	S-3	S-8	S-9	S-10	S-15	S-16	OUTFALL
									
Hor Scale 250									
Ver Scale 100									
Datum (m)5.000									
Dia (mm)	150	225		225	225	225	225	225	225
PN	S-1.000	S-1.002		S-1.003	S-1.004	S-1.005	S-1.006		S-1.007
Slope (1:X)	100.0	170.0		170.0	170.0	170.0	100.0		170.0
Cover Level (m)	9.000	9.190	9.260	9.800	9.800	9.390	9.180	9.080	9.230
Invert Level (m)	8.100	8.054 8.054	8.008 7.205	7.300 7.300	7.173 7.173	7.077 7.077	7.025 7.025	6.991 6.780	6.658
Length (m)	4.582	15.495		4.618	16.273	8.839	3.362	20.817	

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	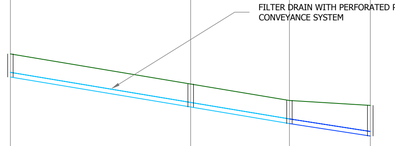			
Hor Scale 250				
Ver Scale 100				
Datum (m)7.000				
Dia (mm)	150	150	150	
PN	S-2.000	S-2.001	S-2.002	
Slope (1:X)	15.0	14.9	16.1	
Cover Level (m)	11.530	10.550	10.010	9.850
Invert Level (m)	10.780	9.800 9.800	9.760 9.260	8.850
Length (m)	14.715	8.058	6.601	

MH Name	S-11	S-12	S-13	S-14	S-15
					
Hor Scale 250					
Ver Scale 100					
Datum (m)5.000					
Dia (mm)	150		150		150
PN	S-3.000		S-3.002		S-3.003
Slope (1:X)	100.0		100.0		100.0
Cover Level (m)	9.100	9.100	9.100	9.100	9.180
Invert Level (m)	8.300	8.236 8.236	8.209 8.209	8.024 8.024	7.999
Length (m)	6.422	18.449			

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X	22.09.20	DRAFT ISSUE	FS	SS

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PROJECT	ST.MICHAELS DEVELOPMENT, DUN LAOGHAIRE
CLIENT	FITZWILLIAM DL LTD
TITLE	SURFACE WATER DRAINAGE LONGSECTIONS

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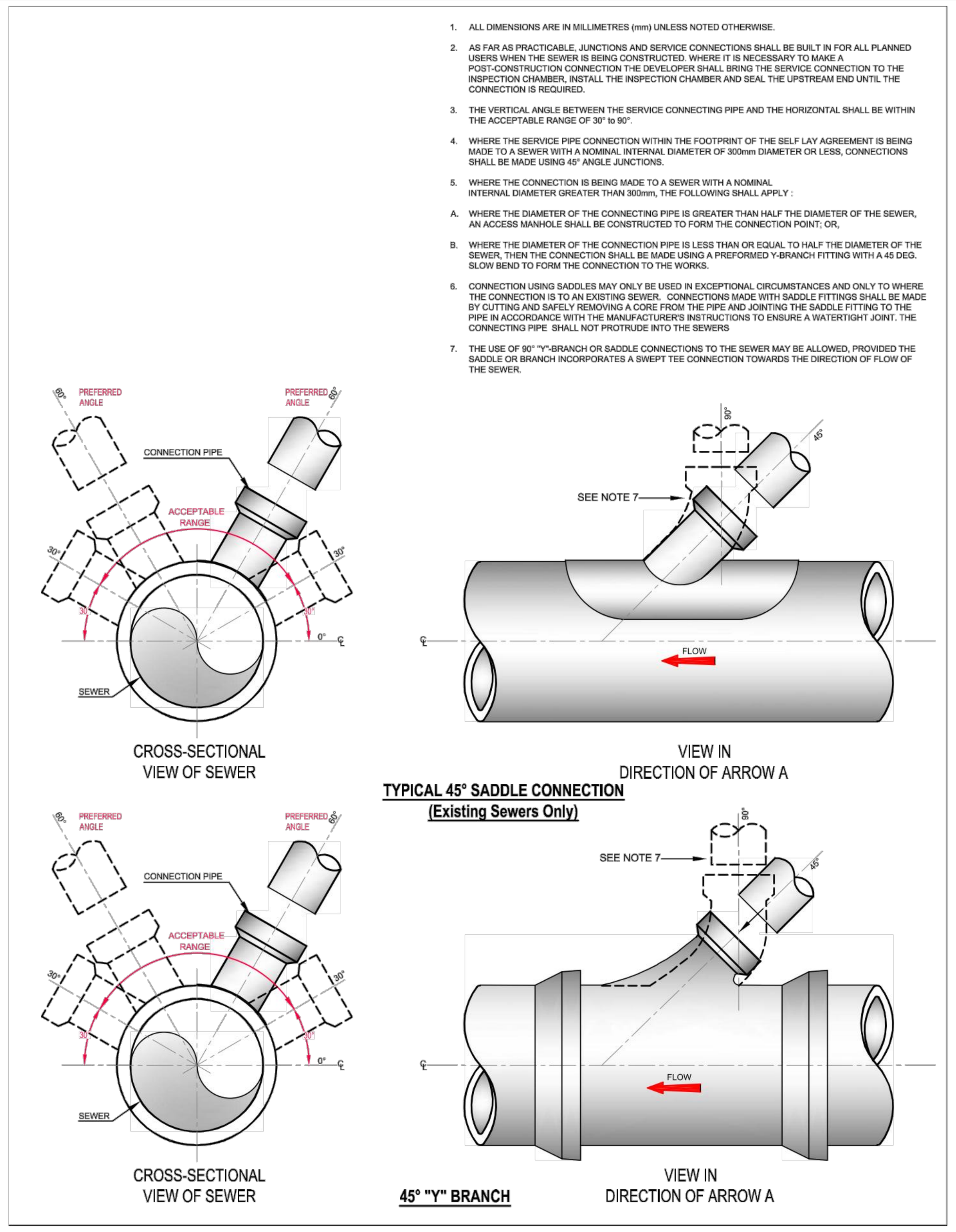
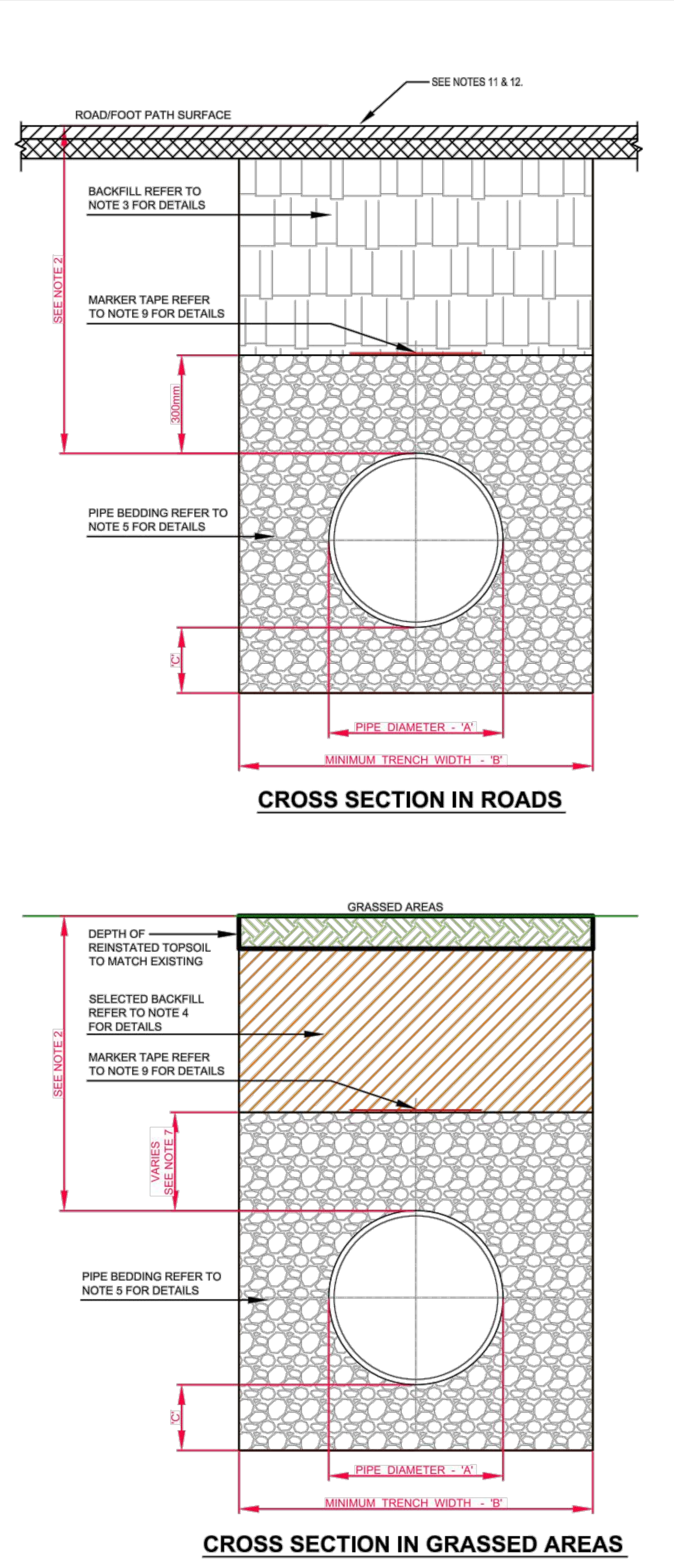


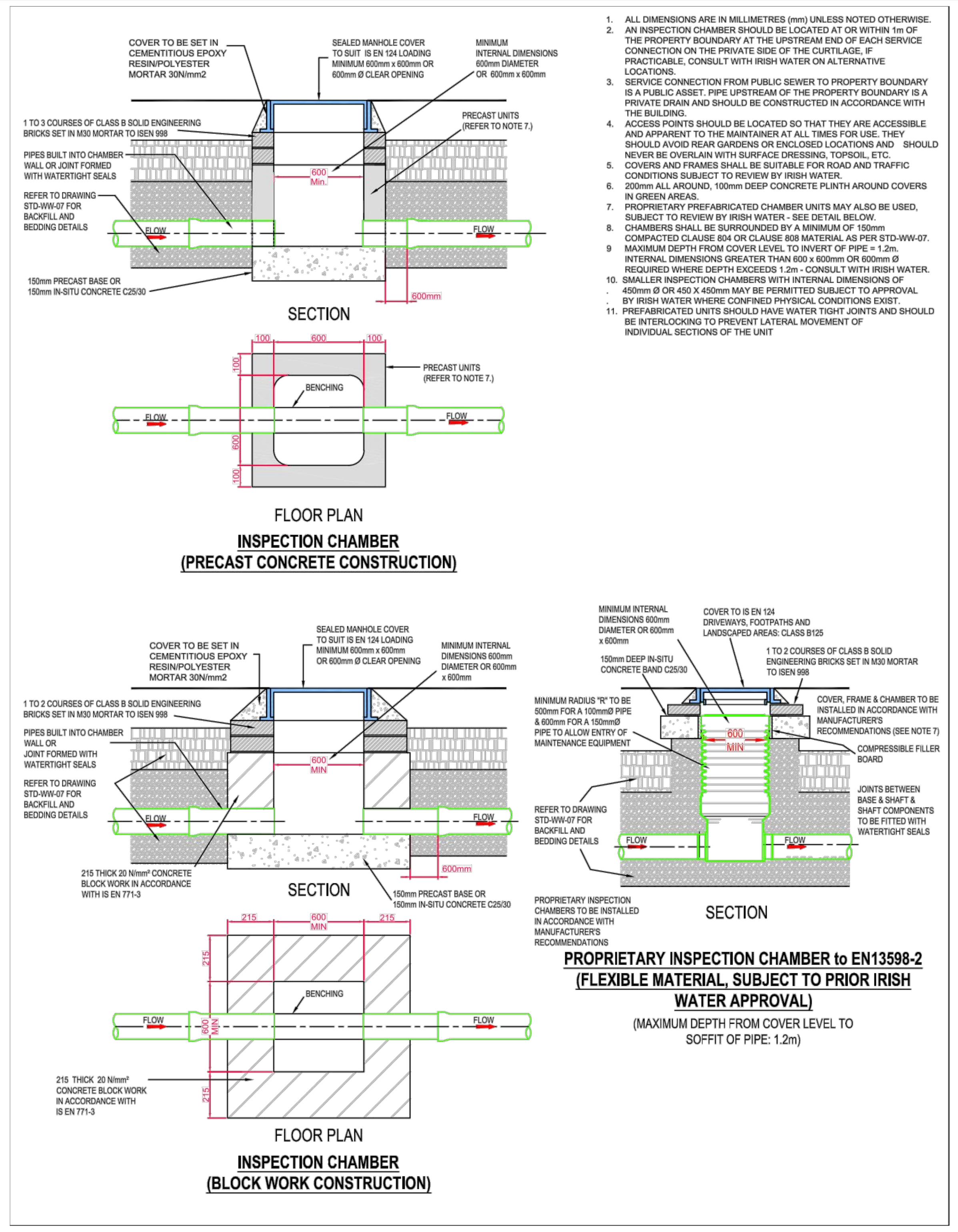
STD-WW - 04 TYPICAL SEWER/SERVICE PIPE CONNECTION



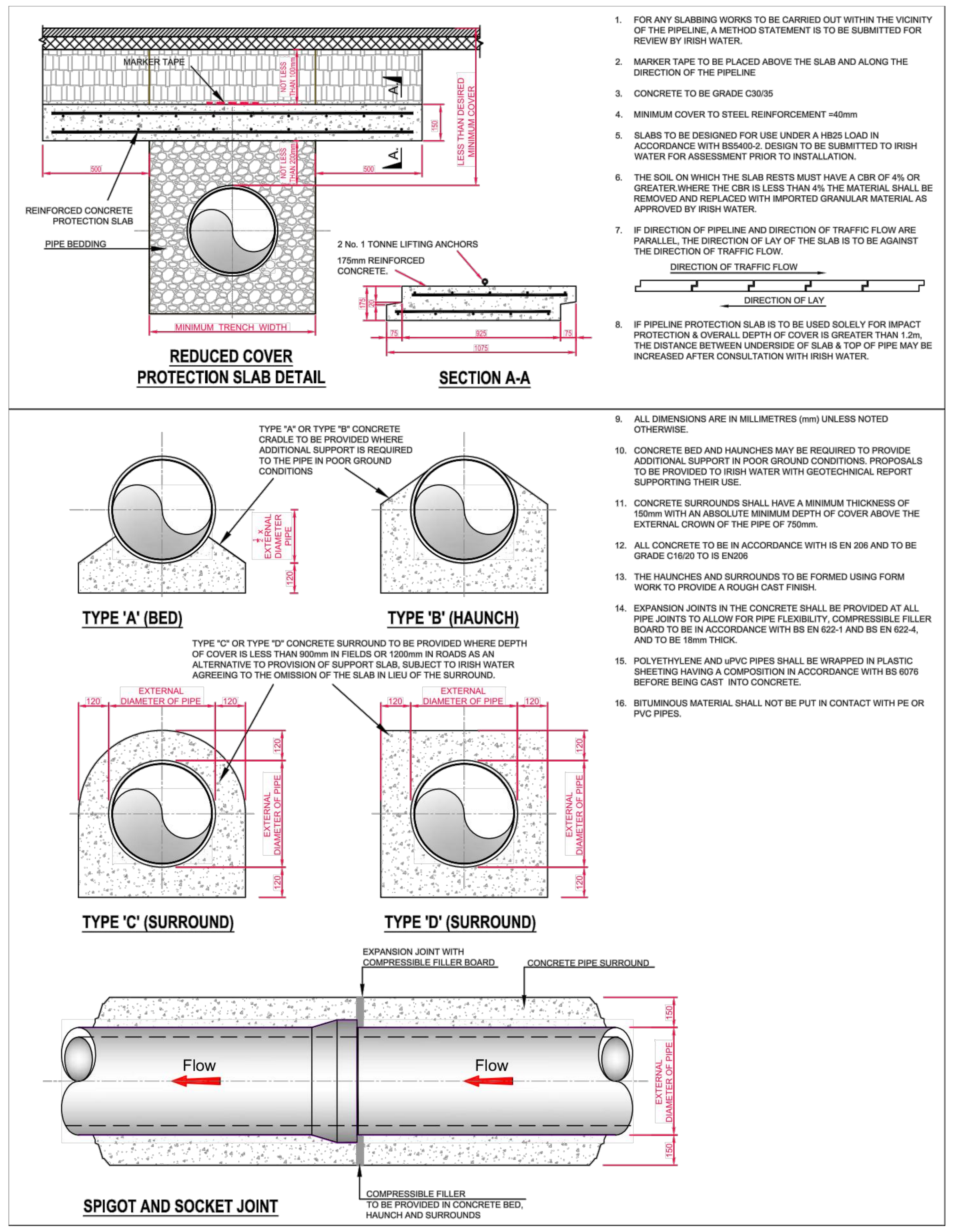
PIPE DIAMETER 'A' (mm)	TRENCH WIDTH 'B' (mm)
≤ 80 RISING MAIN	SEE NOTE 10.
100	500
150 - 200	600
>200 - 350	750
>350 - 450	900

PIPE DIAMETER 'A' (mm)	DEPTH OF BEDDING 'C' (mm)
≤100	100
150 - 450	200

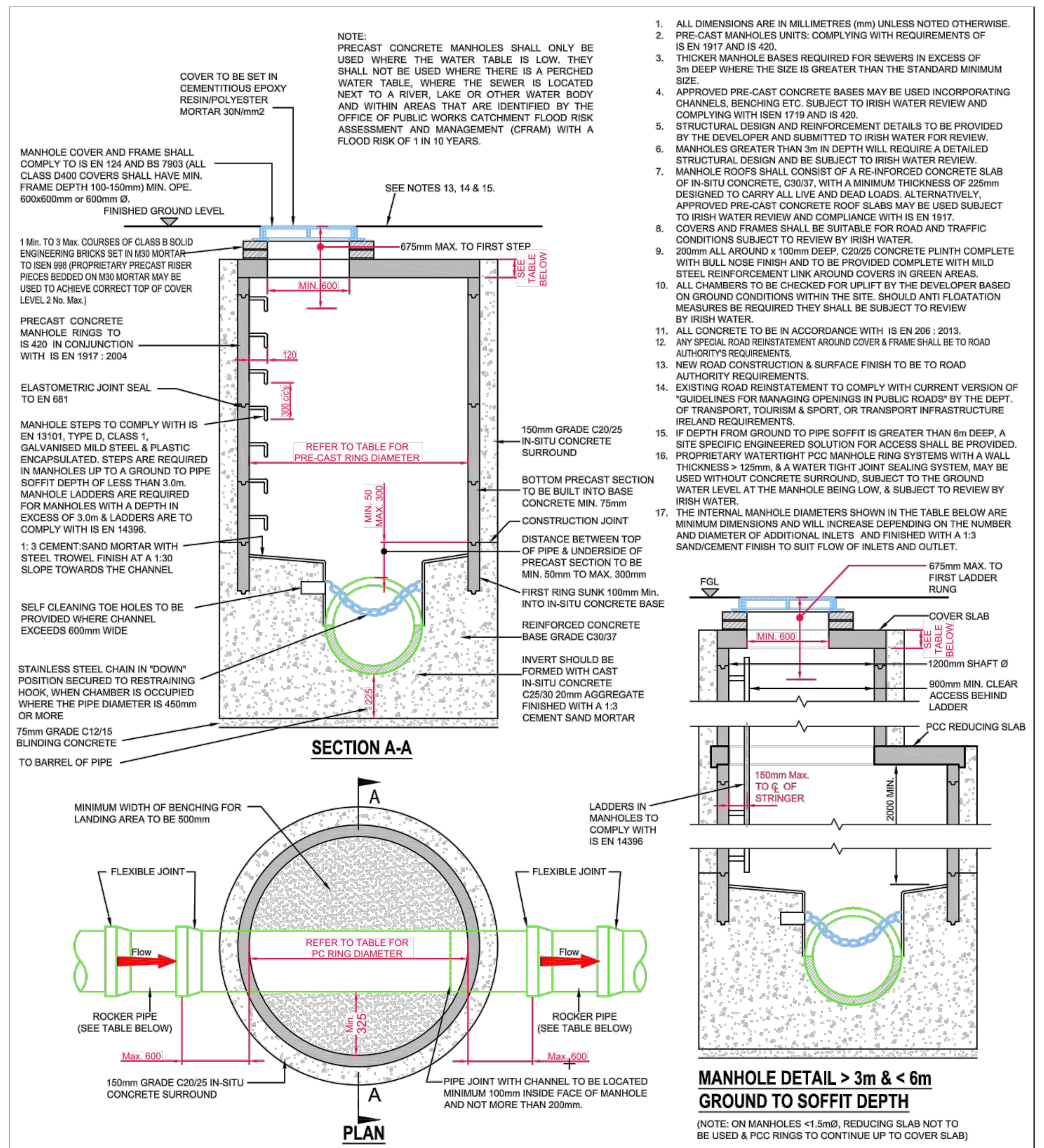
STD-WW-07 TRENCH BACKFILL AND BEDDING



STD-WW-13 PRIVATE SIDE INSPECTION CHAMBER



STD-WW-08 CONCRETE PROTECTION SLAB, BED, HAUNCH, AND SURROUND, TO WASTEWATER PIPES

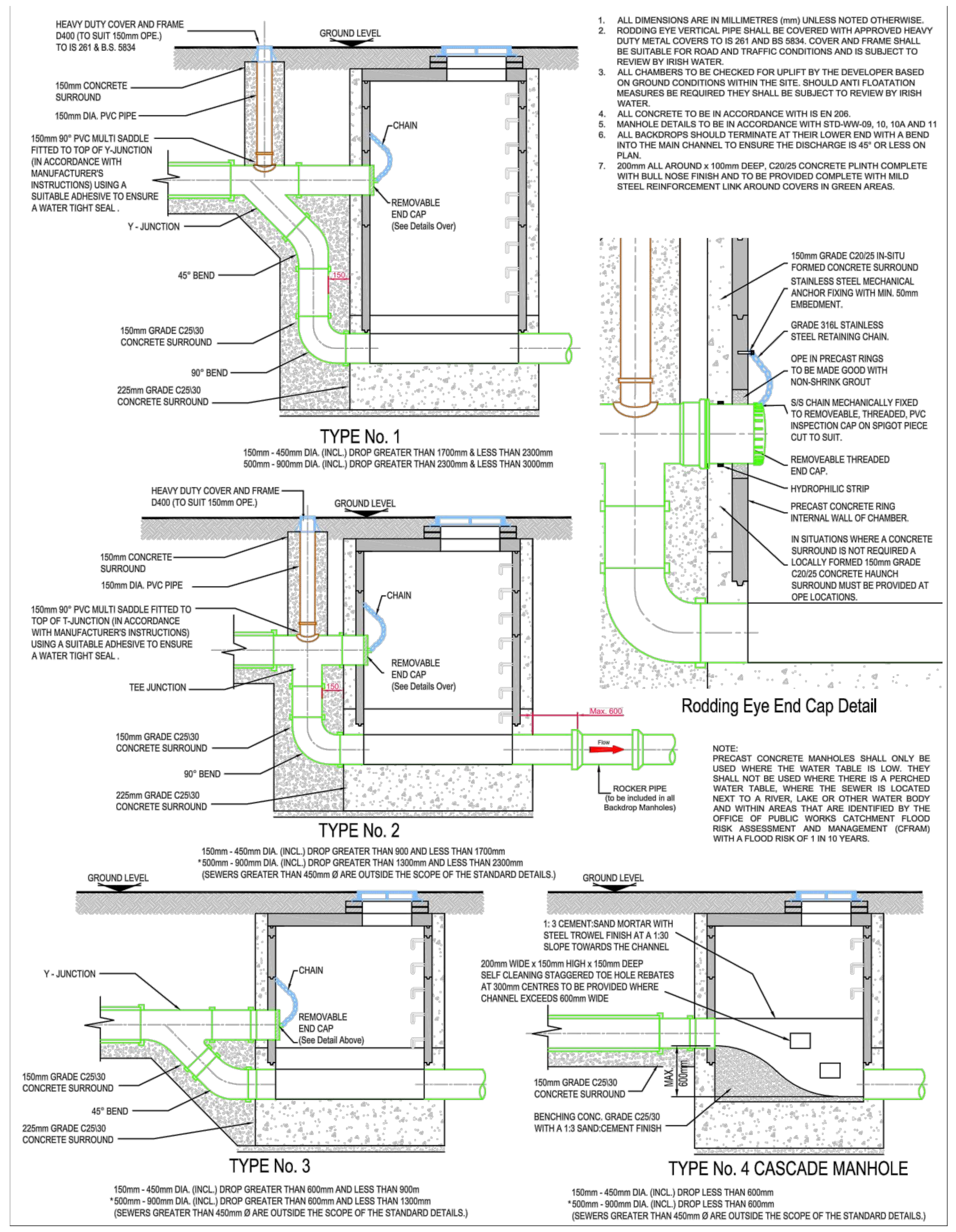


MINIMUM MANHOLE DIAMETERS			
DIAMETER OF LARGEST PIPE IN MANHOLE (mm)	INTERNAL DIAMETER OF MANHOLE (mm)	MIN. PRECAST ROOF SLAB EFFECTIVE THICKNESS (mm)	MIN. IN-SITU ROOF SLAB THICKNESS (mm)
LESS THAN 375	1200	160	225
375 TO 450	1350	160	225
500 TO 750 *	1500	170	225

ROCKER PIPE LENGTH	
PIPE DIAMETER (mm)	ROCKER PIPE LENGTH (mm)
150 TO 600	600
GREATER THAN 600 TO 750 *	1000
GREATER THAN 750 *	1250

* SEWERS GREATER THAN 450mm Ø ARE OUTSIDE THE SCOPE OF THE STANDARD DETAILS. MANHOLE SIZE OF THESE CHAMBERS MAY BE REUIRED DUE TO MULTIPLE PIPES WITHIN MANHOLE.

STD-WW-10 PRE-CAST CONCRETE MANHOLE WITH CAST IN-SITU BASE



STD-WW-12 BACKDROP AND CASCADE MANHOLES

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X	22.09.20	DRAFT ISSUE	FS	SS

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PROJECT: ST. MICHAELS DEVELOPMENT, DÚN LAOGHAIRE
CLIENT: FITZWILLIAM DL LTD
TITLE: STANDARD DRAINAGE DETAILS
SHEET 1 OF 2

Director	Proj. Eng.	Drawn by	DRG. No.	REV
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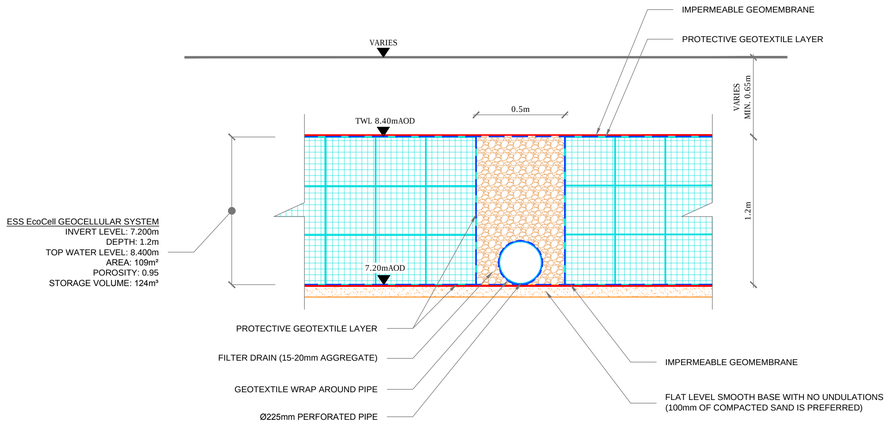
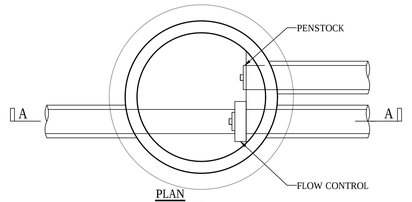
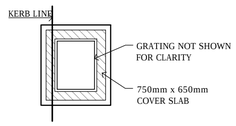
Scale: NTS @A1	Checked: SS	Date: SEP '20		



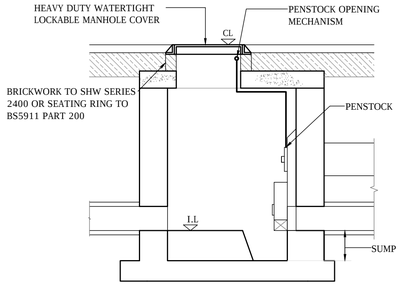
GEO-CELLULAR ATTENUATION TYPICAL CROSS SECTION



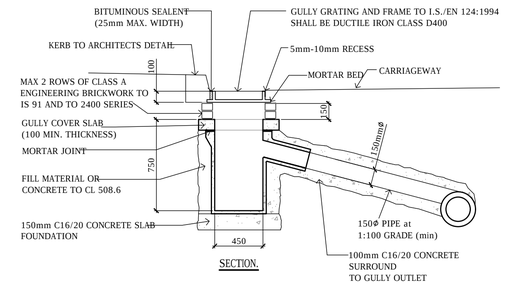
PLAN
SCALE NTS



PLAN: GULLY GRATING and FRAME

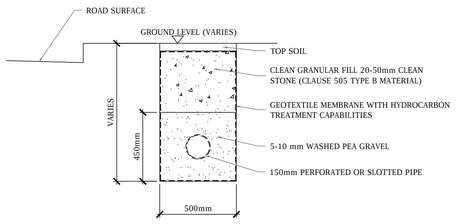


SECTION A-A
STORM WATER FLOW CONTROL MANHOLE
SCALE NTS

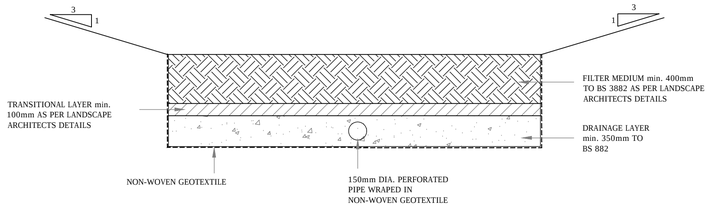


SECTION.

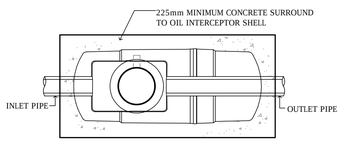
TYPICAL PRECAST ROAD GULLY



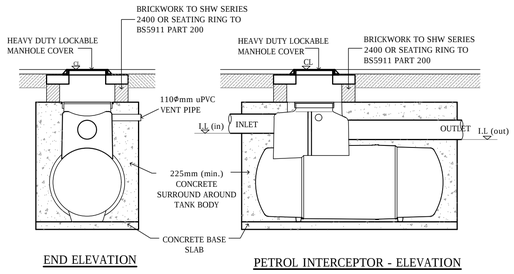
TYPICAL SECTION THROUGH FILTER DRAIN



INDICATIVE SECTION THROUGH
BIORETENTION AREA
SCALE: NTS



PLAN - PETROL INTERCEPTOR



END ELEVATION

PETROL INTERCEPTOR - ELEVATION

PLANNING

NOTES:

REVISION	DATE	DESCRIPTION	REV BY	CHK BY
X	22.09.20	ISSUED FOR PLANNING	FS	SS

Consulting Engineers
Project Managers

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PROJECT	ST. MICHAELS DEVELOPMENT, DÚN LAOGHAIRE
CLIENT	FITZWILLIAM DL LTD
TITLE	STANDARD DRAINAGE DETAILS SHEET 2 OF 2

Director	Proj. Eng.	Drawn by	DRG. No.	REV
SOR	SS	SC	D1855-C-08	X
Scale: NTS @A1	Checked: SS	Date: SEP '20		

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

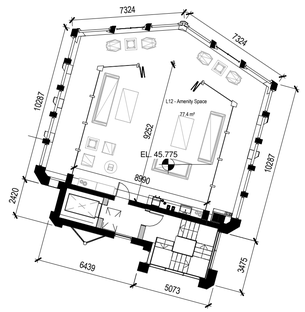
Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	20

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

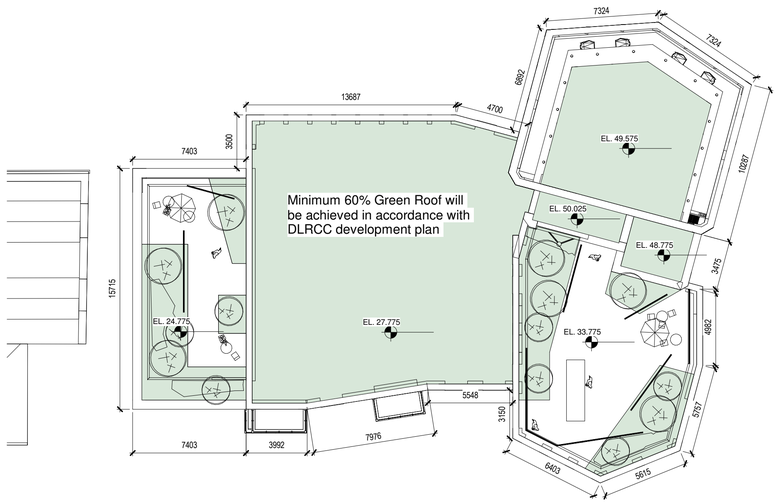
PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S-1.000	S-1	8.397	0.147	0.000	0.09			1.2	SURCHARGED
S-1.001	S-2	8.396	0.192	0.000	0.11			1.2	SURCHARGED
S-1.002	S-3	8.396	0.966	0.000	0.12	ATTENUATION	938	1.3	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	



12 Building 01 - L12 - Twelfth Floor Plan

1 : 200



R Building 01 - R01 - Roof Plan

1 : 200

Notes:

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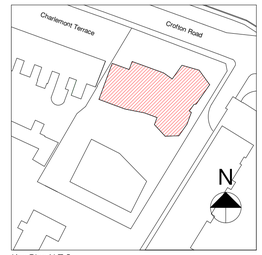
Drawing Notes:



Key Plan N.T.S.

PLANNING LEGEND	
SYMBOL	DESCRIPTION
	SITE BOUNDARY
	1 BEDROOM APARTMENT
	2 BEDROOM APARTMENT
	GREEN ROOF

Rev	Date	DRN	Description
P9	16.09.20	BF	For Information
P8	07.09.20	BF	For Information
P7	13.08.20	BF	For Information
P6	31.07.20	BF	For Information

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Fitzwilliam DL Ltd

Project Details:
Build to Rent Residential Development
St Michael's Carpark
Crofton Road
Dun Laoghaire

Drawing Title:
Building 01 - Twelfth Floor and Roof Plan

Job No	Date	Scale@A1
P18-143D	31/07/2020	As indicated
Status: Suitable For Information		Drawn By: B.Foote
Purpose: Planning		Checked By: D. McDowell

Drawing Number	Revision
P18-143D-RAU-01-ZZ-DR-A-PL1-31004	P9

1 **Overall Roof Plan**
1 : 200

Notes:
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Drawing Notes:

Green Roof Calculation

Building	Roof Area	Green Roof Area
Building One	708.8m²	521.6m²
Building Two	433.2m²	282.1m²
Total	**1,142m²**	**803.7m² (70.3%)**

Rev	Date	DRN	Description
P1	18.09.20	BF	For Information

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Client Details:
Fitzwilliam DL Ltd

Project Details:
Build to Rent Residential Development
St Michael's Carpark
Crofton Road
Dun Laoghaire

Drawing Title:
Overall Roof Plan

Job No	Date	Scale@A1
P18-143D	09/23/20	As indicated
Status: Suitable For Information		Drawn By: D.Maher
Purpose: Planning		Checked By: B.Foote

Drawing Number: P18-143D-RAU-ZZ-ZZ-DR-A-PL1-31008
Revision: P1

A1 Landscape

Appendix B Site Layout with Stage 1 Audit Findings Highlighted

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

LEGEND:

- PROPOSED SURFACE WATER DRAINAGE AND MANHOLE
- EXISTING SURFACE WATER SEWER
- PROPOSED INSPECTION CHAMBER
- PROPOSED SERVICE CONNECTION
- PROPOSED PERFORATED PIPE
- PROPOSED CHANNEL DRAIN
- PROPOSED ROAD GULLY (RG)
- PROPOSED FOOTPATH GULLY (FG)
- PROPOSED ATTENUATION
- PROPOSED FILTER DRAIN
- PROPOSED BIO-RETENTION SYSTEM
- PROPOSED PETROL INTERCEPTOR (PI)

NORTH

2.1.6 Sump Manhole

2.1.5 Maintenance

2.1.3 CBR Values

2.1.1 Permeable Surfacing

PROPOSED FILTER DRAIN

S-2.001
1:14.9
USIL 9.800m
Ø150mm
DSIL9.260m

S-4
CL 11.530m
Depth (m) 0.750

S-5
CL 10.550m
Depth (m) 0.750

S-2.000
1:15.0
USIL 9.260m
Ø150mm
DSIL9.000m

S-2.002
1:16.1
USIL 9.260m
Ø150mm
DSIL8.850m

S-6
CL 10.010m
Depth (m) 0.750

S-7
CL 9.850m
Depth (m) 1.000

S-2.003
1:100.0
USIL 8.850m
Ø150mm
DSIL8.833m

S-9
CL 9.800m
Depth (m) 2.627

S-1.004
1:170.0
USIL 7.173m
Ø225mm
DSIL7.077m

S-10
CL 9.390m
Depth (m) 2.313

S-1.005
1:170.0
USIL 7.077m
Ø225mm
DSIL7.025m

S-1.006
1:100.0
USIL 7.025m
Ø225mm
DSIL 6.991m

S-15-SADDLE CONNECTION
CL 9.150m
Depth (m) 2.155

S-16
CL 9.080m
Depth (m) 2.300

PROPOSED HYDROBRAKE MANHOLE
DESIGN FLOW: 1.4l/s
DESIGN HEAD: 1.620m
ORIFICE DIAMETER: 50mm

PROPOSED KLARGESTER NSBP003
BYPASS OIL SEPARATOR OR SIMILAR APPROVED

PROPOSED CONNECTION TO EXISTING SURFACE WATER NETWORK

EXISTING 1350mm BRICK STORM

EX.SMH
CL: 9.04
IL: 5.47

S-1.007
1:170.0
USIL 6.780m
Ø225mm
DSIL6.658m

PROPOSED ATTENUATION - ESS EcoCell
GEOCELLULAR SYSTEM OR SIMILAR APPROVED
INVERT LEVEL: 7.200m
DEPTH:1.2m
TOP WATER LEVEL: 8.400m
AREA: 109m²
POROSITY: 0.95%
STORAGE VOLUME: 124m³

2.1.7 Attenuation Storage Tank

PROPOSED SUMP MANHOLE

BUILDING 02

BUILDING 01

S-1.003
1:170.0
USIL 7.200m
Ø225mm
DSIL7.173m

S-14
CL 9.100m
Depth (m) 1.076

S-3.003
1:100.0
USIL 8.024m
Ø150mm
DSIL7.999m

S-8
CL 9.800m
Depth (m) 2.600

S-3
CL 9.260m
Depth (m) 1.905

S-3.001
1:100.0
USIL 8.238m
Ø150mm
DSIL8.209m

S-1.001
1:100.0
USIL 8.054m
Ø150mm
DSIL8.038m

S-3.000
1:100.0
USIL 8.300m
Ø150mm
DSIL8.236m

S-2
CL 9.190m
Depth (m) 1.136

S-1.000
1:100.0
USIL 8.100m
Ø150mm
DSIL8.054m

S-1
CL 9.000m
Depth (m) 0.900

S-1.002
1:100.0
USIL 8.054m
Ø150mm
DSIL8.029m

S-12
CL 9.100m
Depth (m) 0.864

S-13
CL 9.100m
Depth (m) 0.891

S-11
CL 9.100m
Depth (m) 0.800

PROPOSED BIO-RETENTION SYSTEM

OVERFLOW PIPE AT HIGH LEVEL

2.1.4 Tree Pit Systems

2.1.3 CBR Values

PROPOSED ACO CHANNEL DRAIN OR SIMILAR APPROVED

PROPOSED ACO CHANNEL DRAIN OR SIMILAR APPROVED

EXISTING 1350mm BRICK STORM

EX.SMH
CL: 9.48
IL: 6.08

2.2.1 Rainwater Harvesting Tanks

2.1.2 Road Gullies/Aco Channels

2.2.1 Rainwater Harvesting Tanks

CHARLEMONT TERRACE

ST. MICHAELS ROAD

FINAL DRAFT

NOTES:

REVISION	DATE	DESCRIPTION	REV BY	CHK BY
X	22.09.20	DRAFT ISSUE	SC	SS

Consulting Engineers
Project Managers

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MUIR ASSOCIATES

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

Director	Proj. Eng.	Drawn by	DRG. No.	REV
SOR	SS	SC	D1855-C-02	X
Scale	Checked	Date		
1:250 @A1	SS	SEP '20		

Appendix C Storm Water Audit Feedback Form

STORM WATER AUDIT FEEDBACK FORM

PUNCH Consulting Engineers

Scheme: Proposed Strategic Housing Development at St Michaels Hospital Car Park

Area:

Audit Stage: 1 **Date Audit Completed:** 29/09/2020 **Our Ref :** 202223

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.1.1	Yes	Yes		
2.1.2	Yes	Yes		
2.1.3	Yes	Yes	The CBR tests will be undertaken before the detail design stage.	
2.1.4	Yes	Yes		
2.1.5	Yes	Yes		
2.1.6	Yes	Yes		
2.1.7	Yes	No	The proposed location of the underground attenuation tank is in between two building block of significant height. Given the anticipated foundations requirements it was deemed appropriate to propose a watertight underground attenuation storage design.	

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.2.1	Yes	No	The Applicant has reservations in relation to providing rainwater harvesting systems as it is his experience that in the long term these systems become problematic given that they become a subject of an irregular maintenance.	

Signed: Slaven Šoše **Design Team Project Manager** **Date:** 01.10.2020

Please complete and return to the auditor

Auditor Signed Off: Digitally signed by Marie-Claire Daly Date: 2020.10.01 19:02:17+01'00' **Date:**