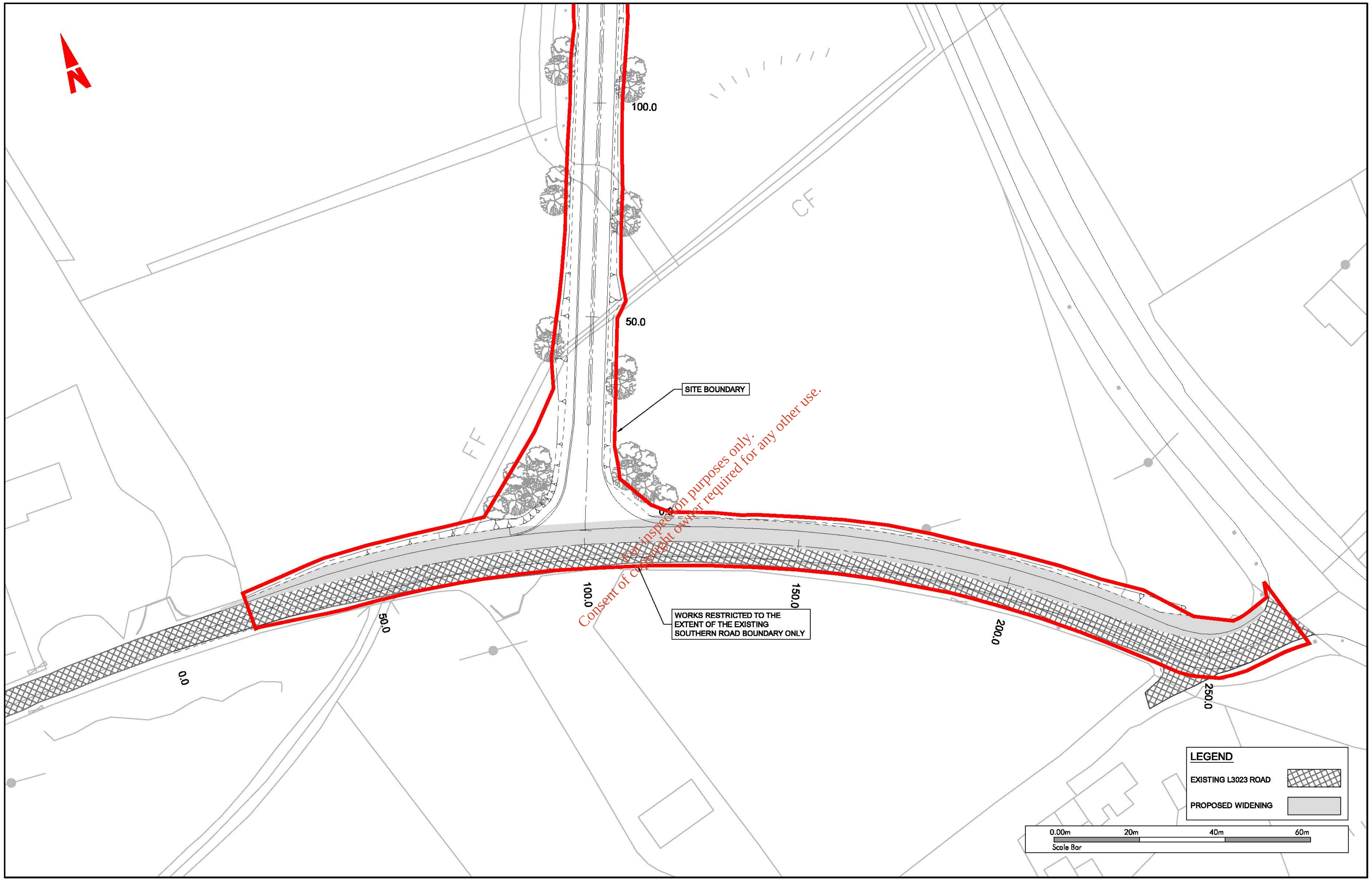

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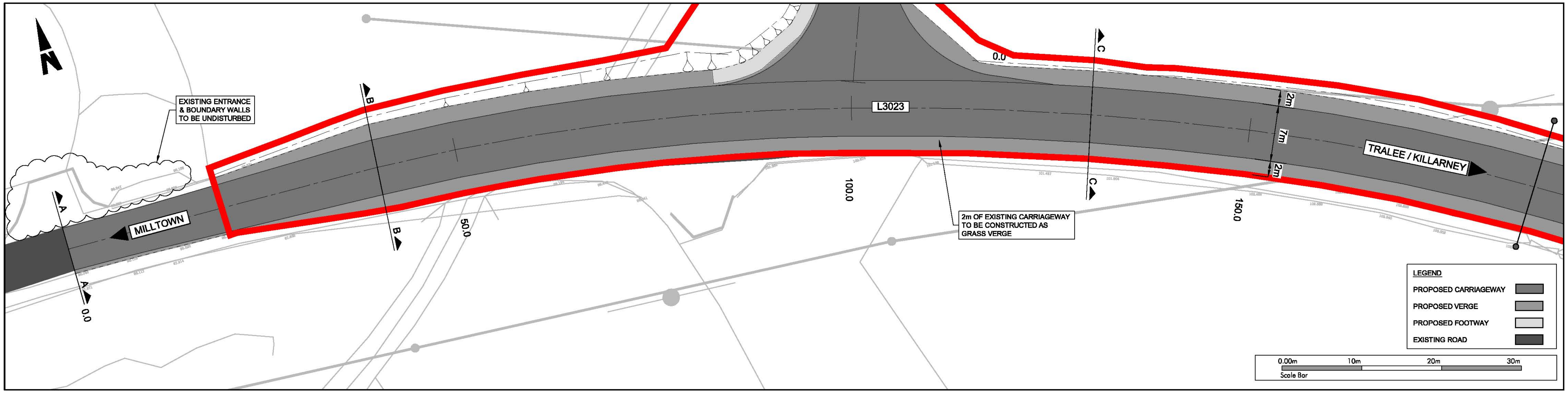
Drawing Number: DG0014/04

Rev: P01

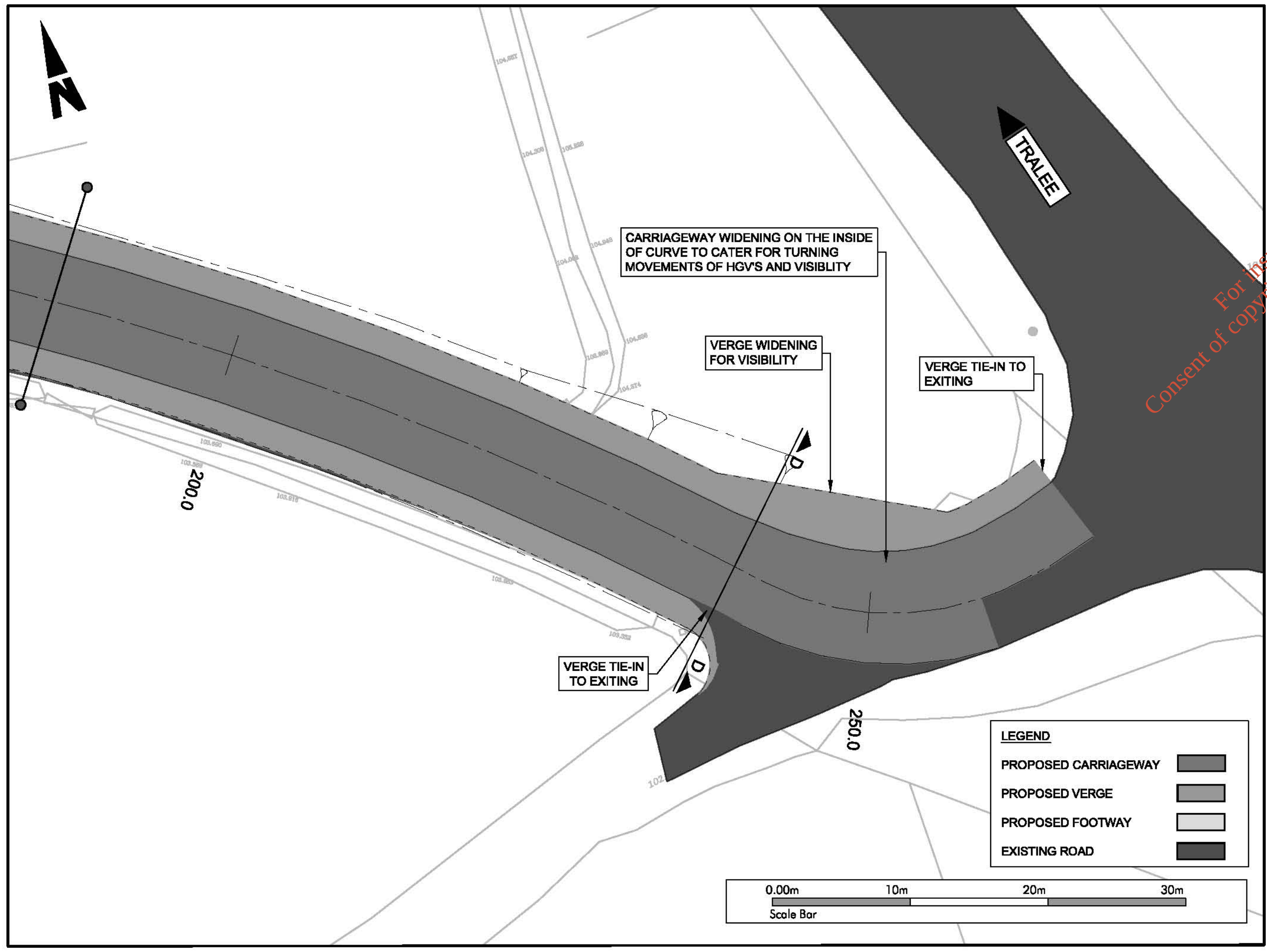
Title: **LOCAL ROAD WIDENING ON THE NORTH SIDE OF L3023**

(Sheet 4 of 6)

MGE0109DG0014.dwg



PLAN SCALE 1:250 @ A1 & 1:500 @ A3



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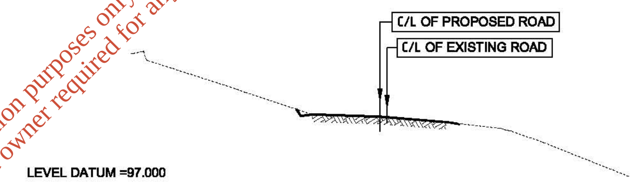
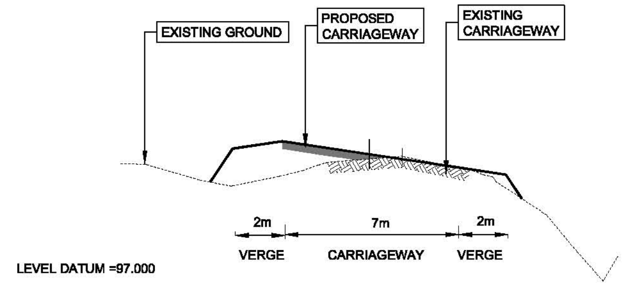
TYPICAL CROSS SECTIONS



LEVEL DATUM =97.000

PROPOSED	98.223, 98.154, 98.124, 98.048, 98.027
OFFSET	-3.363, -2.730, 0.000, 2.738, 3.183
EXISTING	98.970, 98.883, 98.494, 98.447, 98.161, 98.154, 98.146, 98.123, 98.119, 98.048, 98.027, 97.963, 97.933, 97.775, 97.321

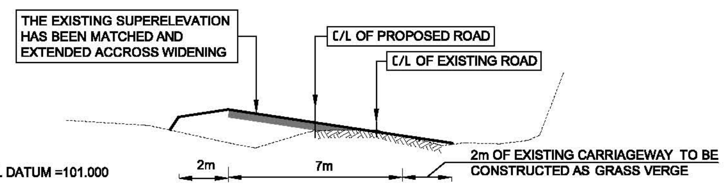
SECTION A-A
CHAINAGE = 0.000



LEVEL DATUM =97.000

PROPOSED	98.528, 98.977, 99.077, 98.902, 98.727, 98.627, 98.307
OFFSET	-6.397, -5.500, -3.500, -0.000, 3.500, 5.500, 6.140
EXISTING	98.777, 98.765, 98.553, 98.474, 98.607, 98.680, 98.792, 98.859, 98.873, 98.717, 98.688, 98.597, 98.535, 98.093, 97.590, 97.206, 97.532

SECTION B-B
CHAINAGE = 40.000



LEVEL DATUM =101.000

PROPOSED	101.936, 102.111, 102.211, 102.036, 101.861, 101.761, 101.745
OFFSET	-5.851, -5.500, -3.500, 0.000, 3.500, 5.500, 5.533
EXISTING	102.067, 102.002, 101.995, 101.760, 101.699, 101.706, 101.913, 101.926, 101.931, 101.935, 101.867, 101.755, 101.727, 101.765, 101.749, 101.798, 101.868, 102.702

SECTION C-C
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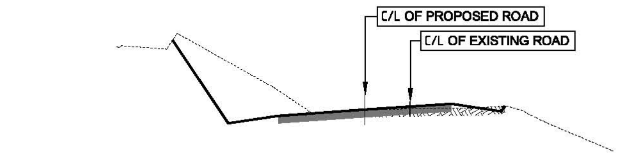

LEVEL DATUM =102.000

PROPOSED	104.358, 103.240, 103.340, 103.424, 103.501, 103.401, 103.470
OFFSET	-7.737, -5.500, -3.500, 0.000, 3.500, 5.500, 5.638
EXISTING	104.270, 104.283, 104.238, 104.448, 103.728, 103.373, 103.419, 103.449, 103.454, 103.472, 103.416, 103.251, 102.869

SECTION D-D
CHAINAGE = 240.000

PROFILE VERTICAL SCALE 1:125 @ A1 & 1:200 @ A3
HORIZONTAL SCALE 1:500 @ A1 & 1:1000 @ A3

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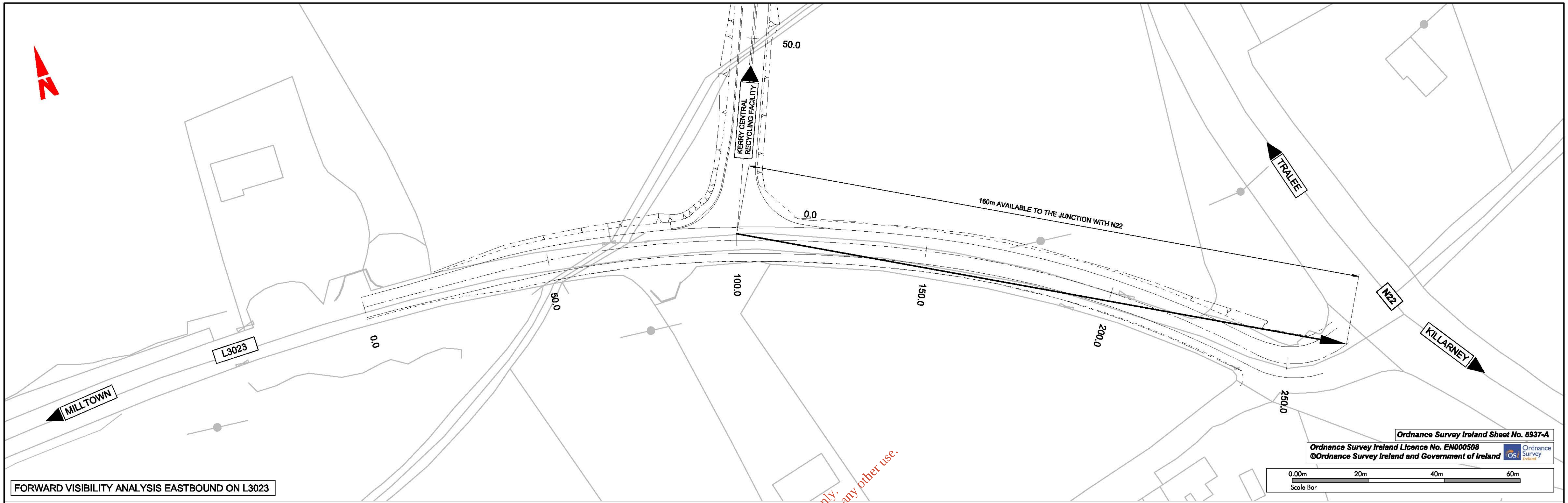
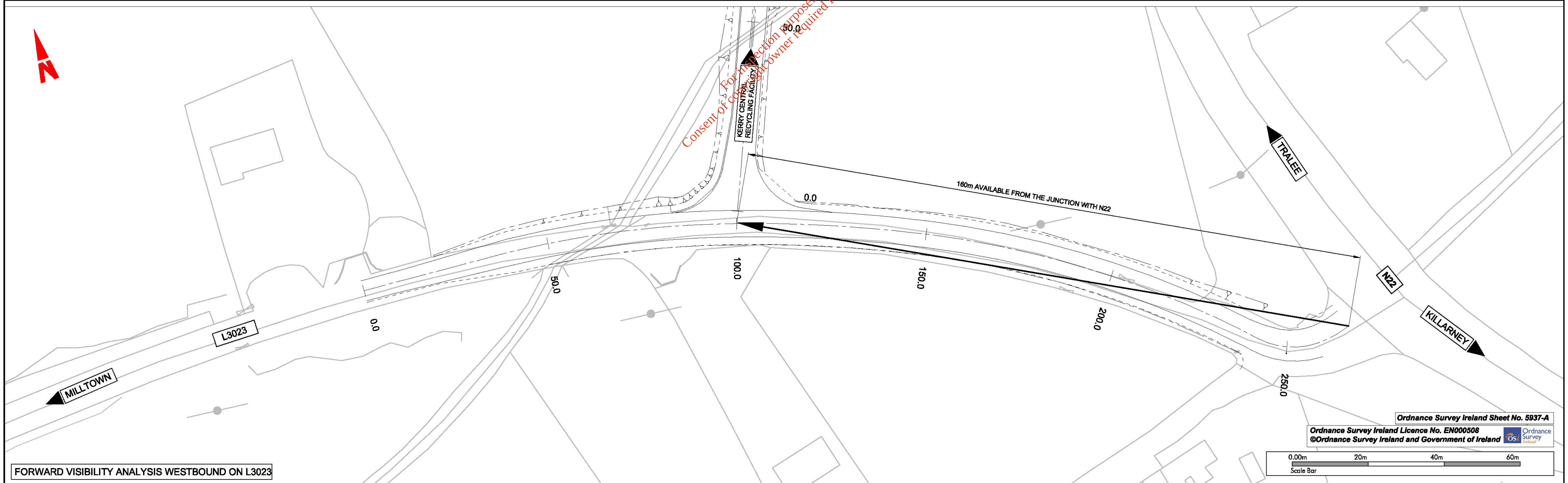
PLANNING	As Shown @ A1	As Shown @ A3

Drawing Number: DG0014/05
Rev: P01

Title: **LOCAL ROAD IMPROVEMENT PLAN & TYPICAL CROSS SECTIONS**
(Sheet 5 of 6)

MGE0109DG0014.dwg





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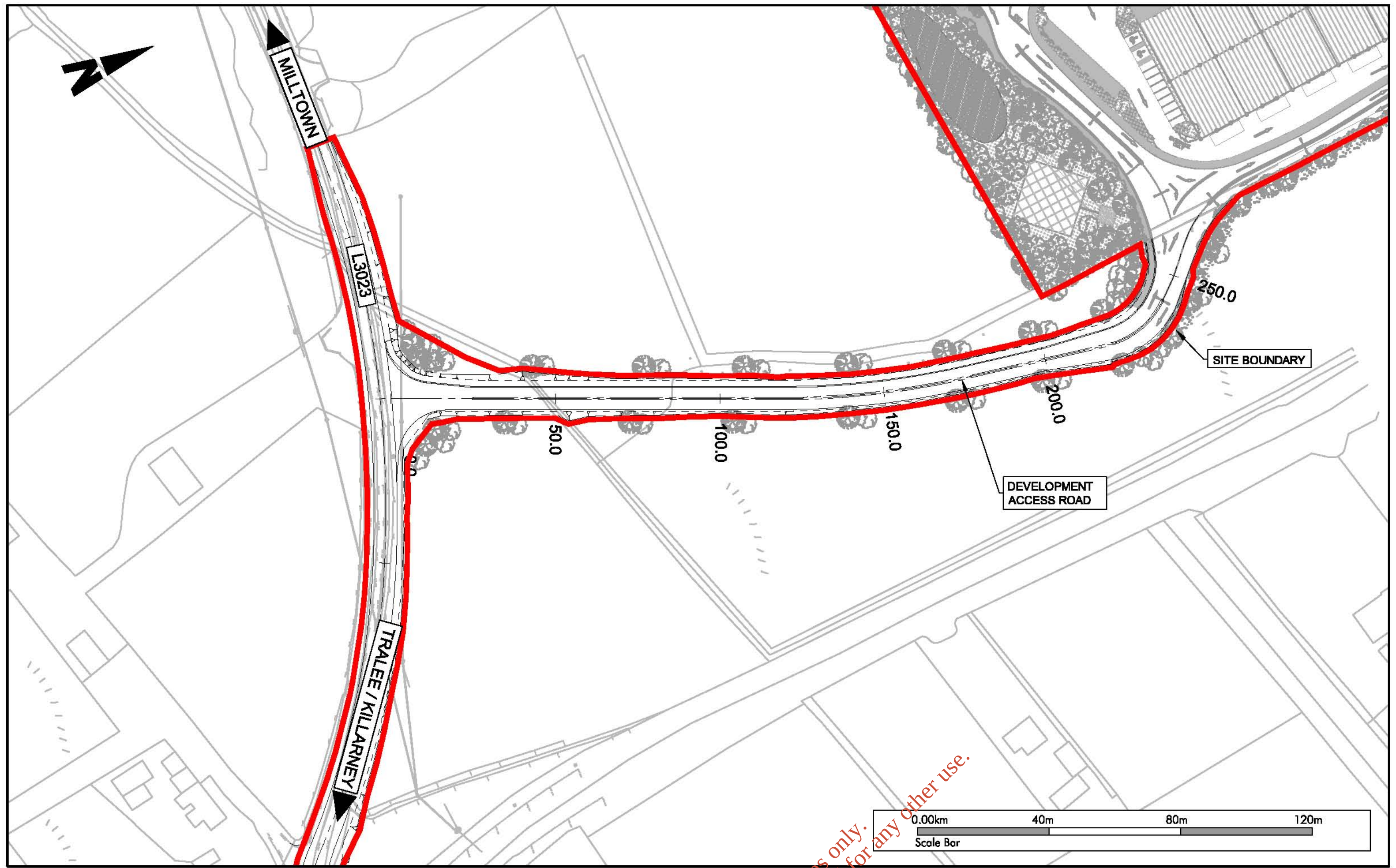
Drawing Status	Scale / Sheet Size	
PLANNING	1:500 @ A1	1:1000 @ A3

Drawing Number: DG0014/06

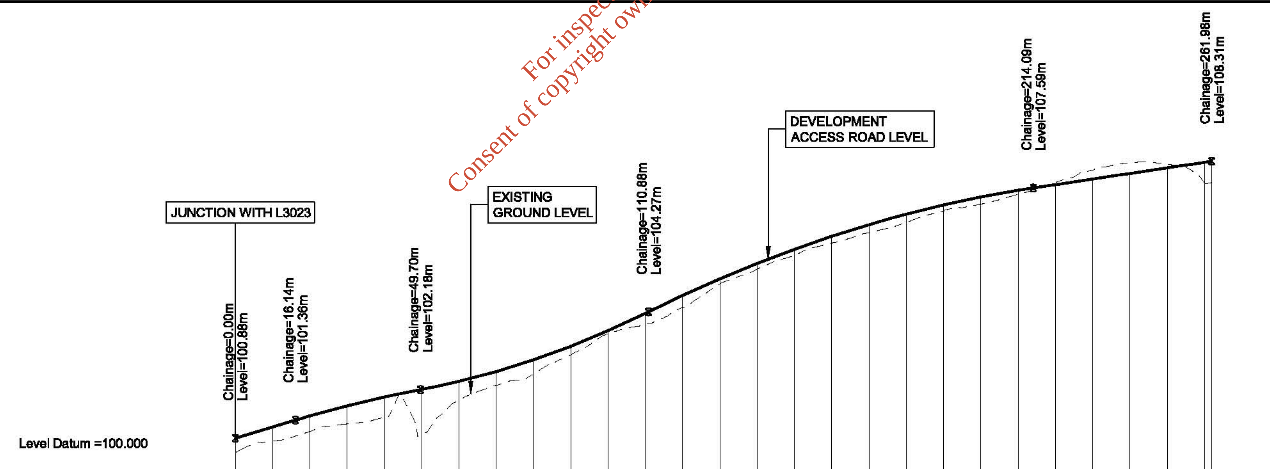
Rev: P01

Title: **STOPPING SIGHT DISTANCE ON APPROACH TO THE DEVELOPMENT ENTRANCE**
(Sheet 5 of 6)

MGE0109DG0014.dwg



PLAN HORIZONTAL SCALE 1:1000 @ A1 & 1:2000 @ A3



Level Datum =100.000

CHAINAGE	DEVELOPMENT ACCESS ROAD LEVEL	EXISTING GROUND LEVEL
0.0	100.879	100.494
10.0	101.179	100.797
20.0	101.477	101.063
30.0	101.747	101.262
40.0	101.984	101.437
50.0	102.188	100.985
60.0	102.403	101.902
70.0	102.668	102.297
80.0	102.982	102.599
90.0	103.347	103.115
100.0	103.761	103.677
110.0	104.226	103.929
120.0	104.706	104.384
130.0	105.153	105.018
140.0	105.567	105.416
150.0	105.947	105.788
160.0	106.294	106.114
170.0	106.608	106.392
180.0	106.888	106.659
190.0	107.135	106.976
200.0	107.348	107.158
210.0	107.529	107.422
220.0	107.682	107.740
230.0	107.832	108.077
240.0	107.982	108.270
250.0	108.132	108.230
260.0	108.282	107.745
262.0	108.311	107.739

HORIZONTAL SCHEMATIC: ∞ L=118.11m; R=-255.00m L=57.64m; ∞ L=43.41m; R=-25.00m L=42.82m

VERTICAL SCHEMATIC: G=3.00 L=15.03m; L=39.09m R=-3000.00m; R=2000.00m L=61.63m; L=98.35m R=-3000.00m; G=1.50 L=47.89m

PROFILE VERTICAL SCALE 1:100 @ A1 & 1:200 @ A3
HORIZONTAL SCALE 1:1000 @ A1 & 1:2000 @ A3

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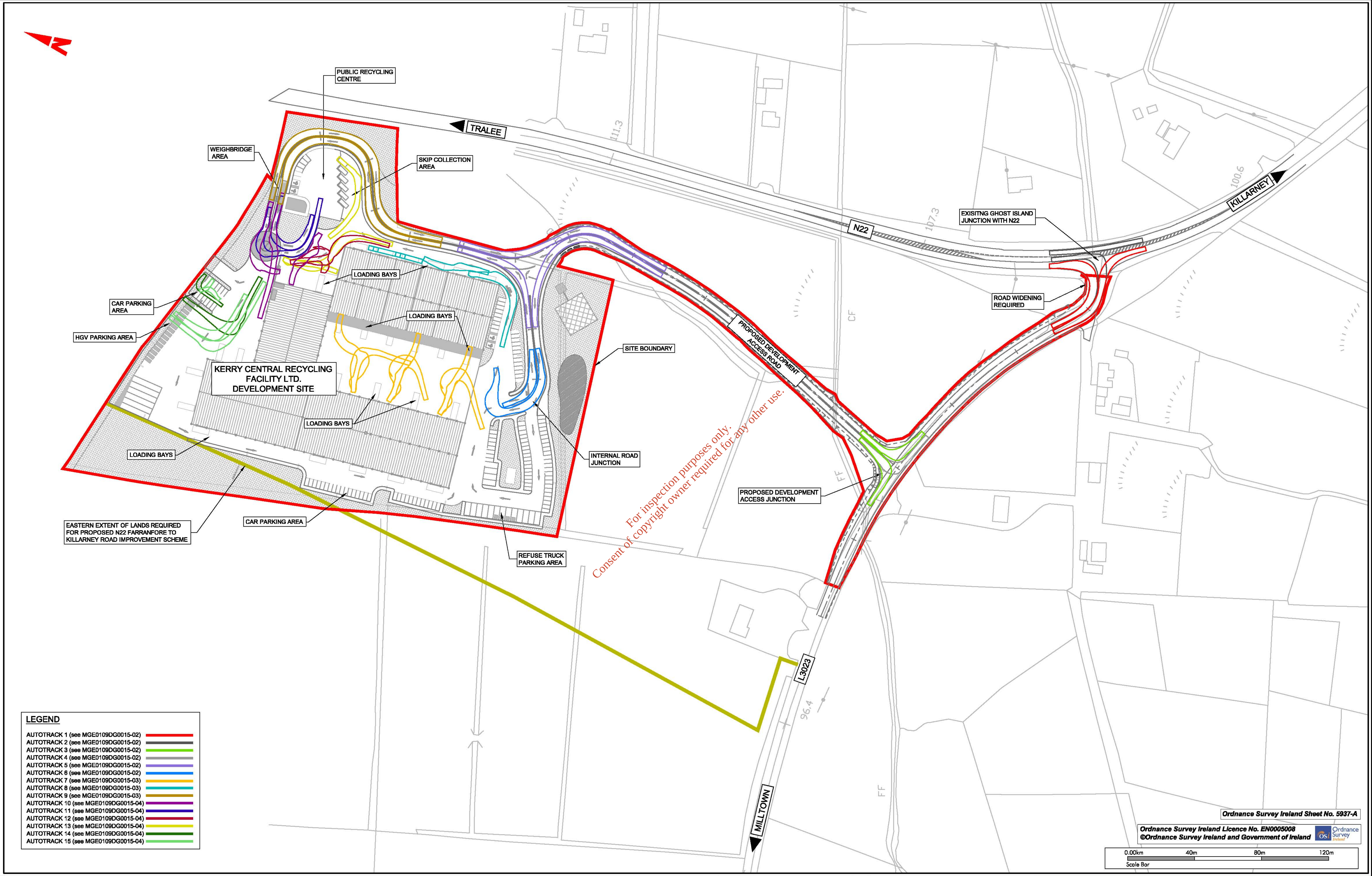
Scale / Sheet Size: As Shown @ A1 | As Shown @ A3

Drawing Number: DG0014/07
Rev: P01

Title: **DEVELOPMENT ACCESS ROAD PLAN & PROFILE**
(Sheet 6 of 6)

MGE0109DG0014.dwg



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P01	29.07.09	A.N. K.R.	PLANNING ISSUE	C.O'S.

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Drawing Number: DG0015/01
Rev: P02

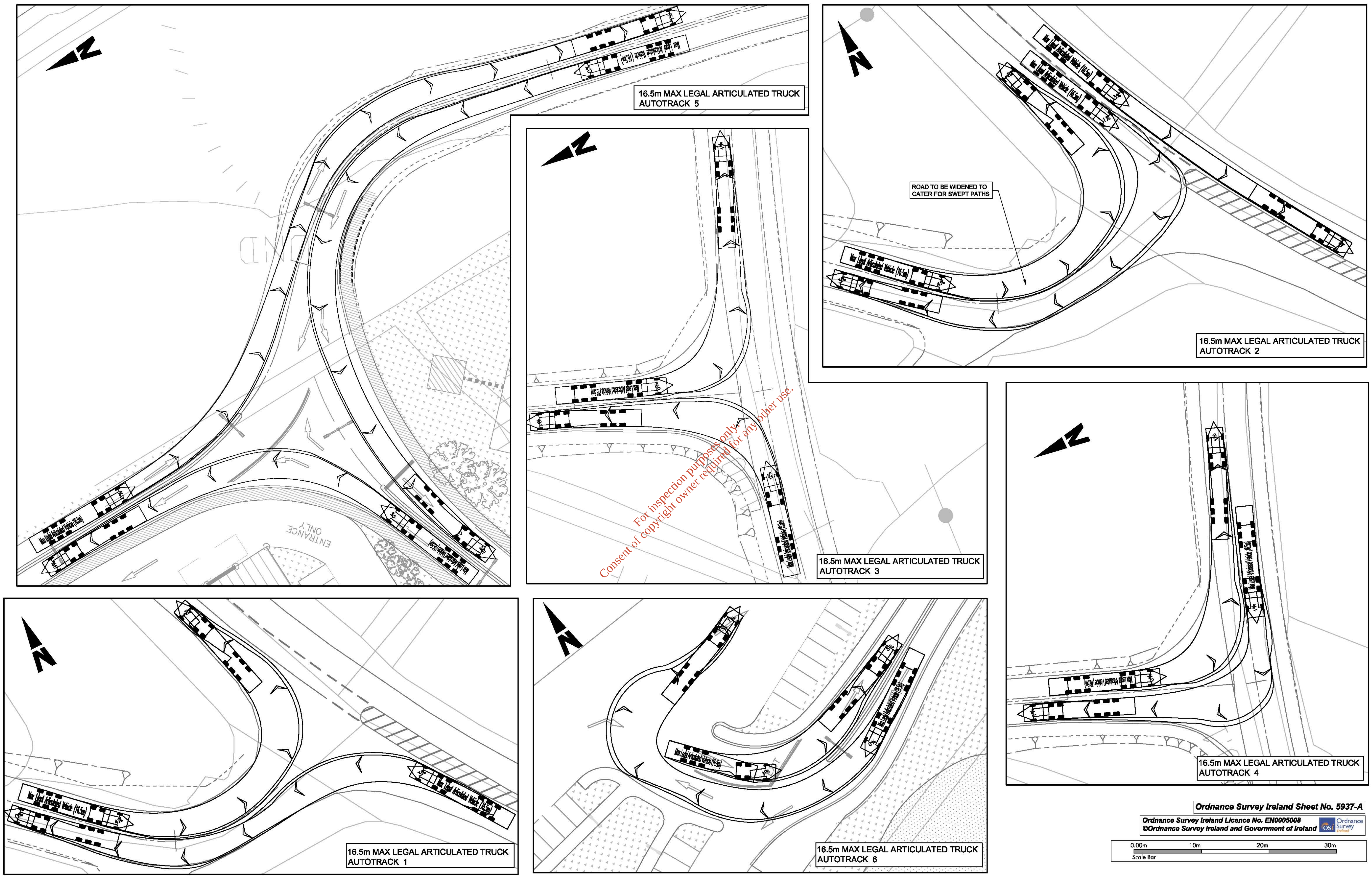
Project: KERRY CENTRAL RECYCLING FACILITY LTD. PLANNING APPLICATION

Title: **OVERALL PLAN OF AUTOTRACK ANALYSIS**

(Sheet 1 of 4)

Drawing Status	Scale / Sheet Size	
PLANNING	1:1000 @ A1	1:2000 @ A3

MGE0109DG0015.dwg



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Drawing Number: DG0015/02

Rev: P01

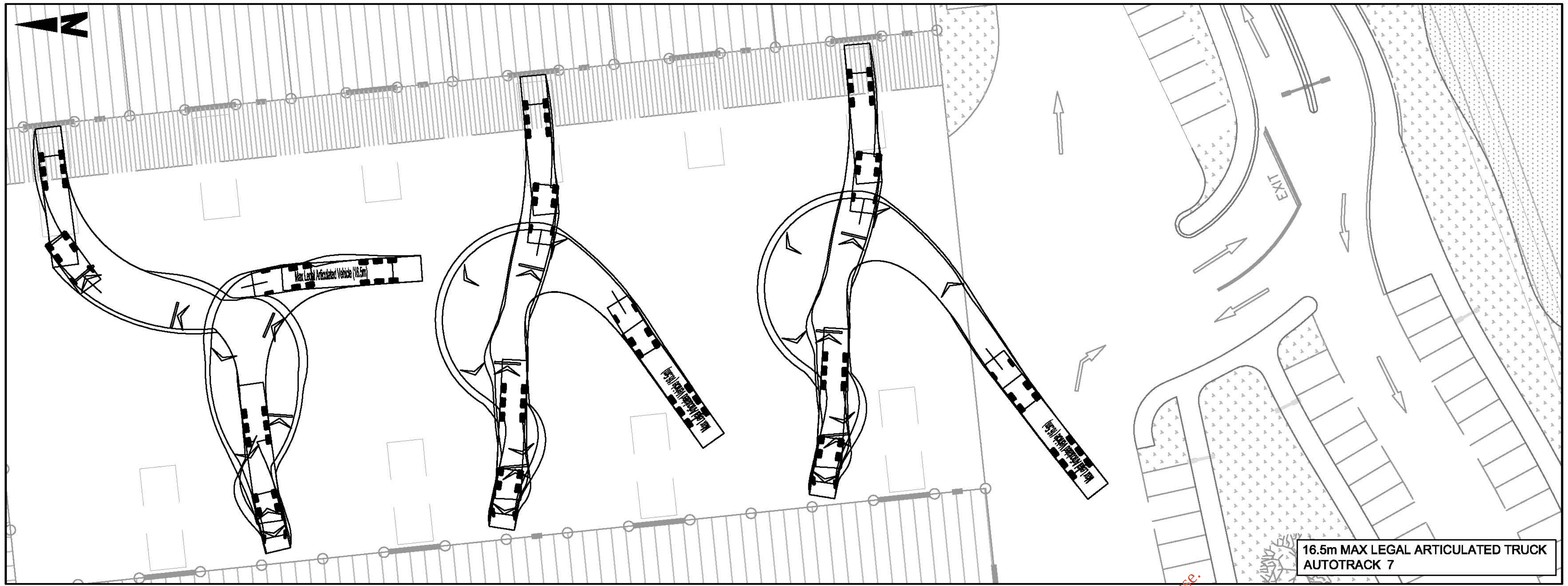
Project: KERRY CENTRAL RECYCLING FACILITY LTD. PLANNING APPLICATION

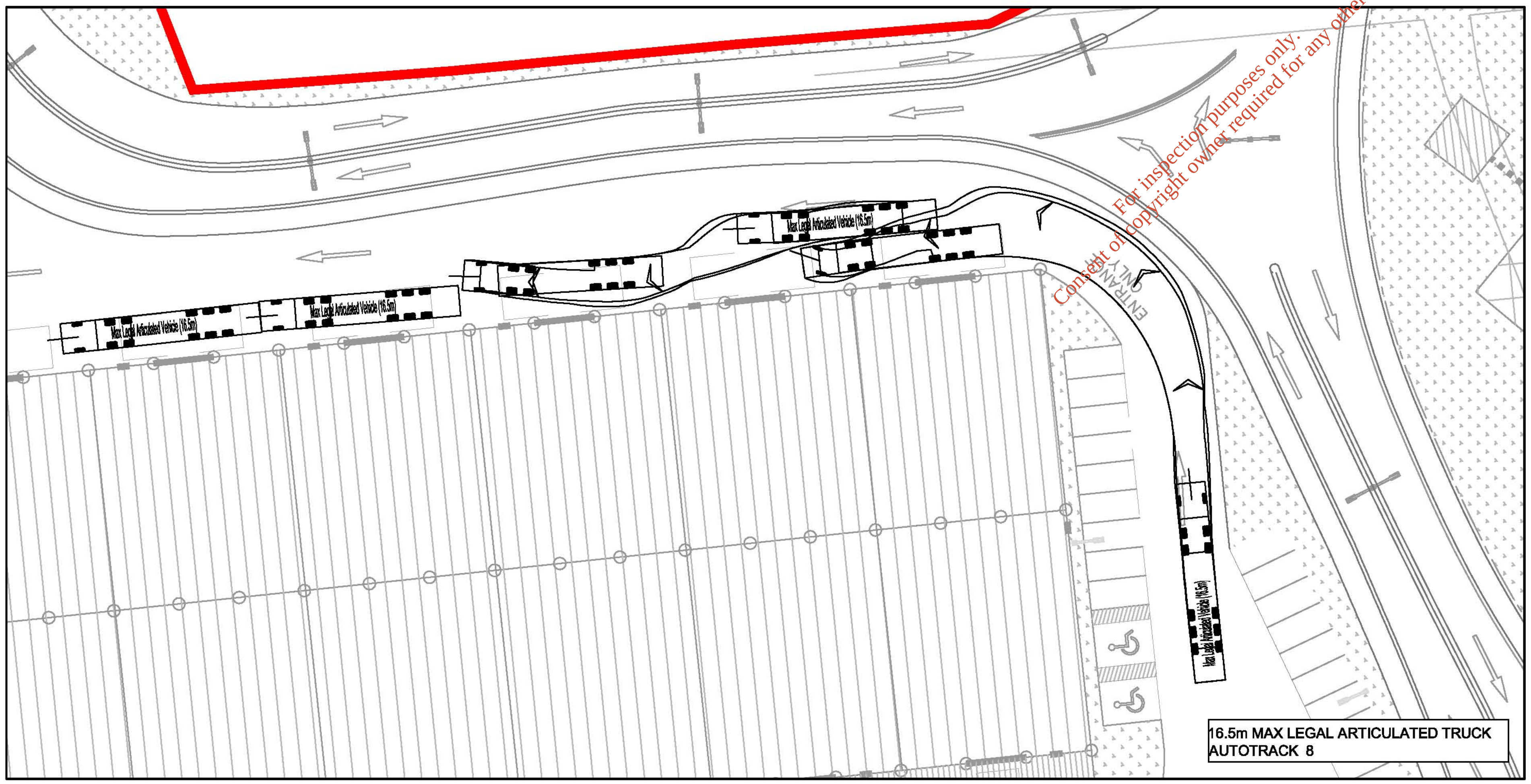
Title: AUTOTRACK ANALYSIS (1-6)

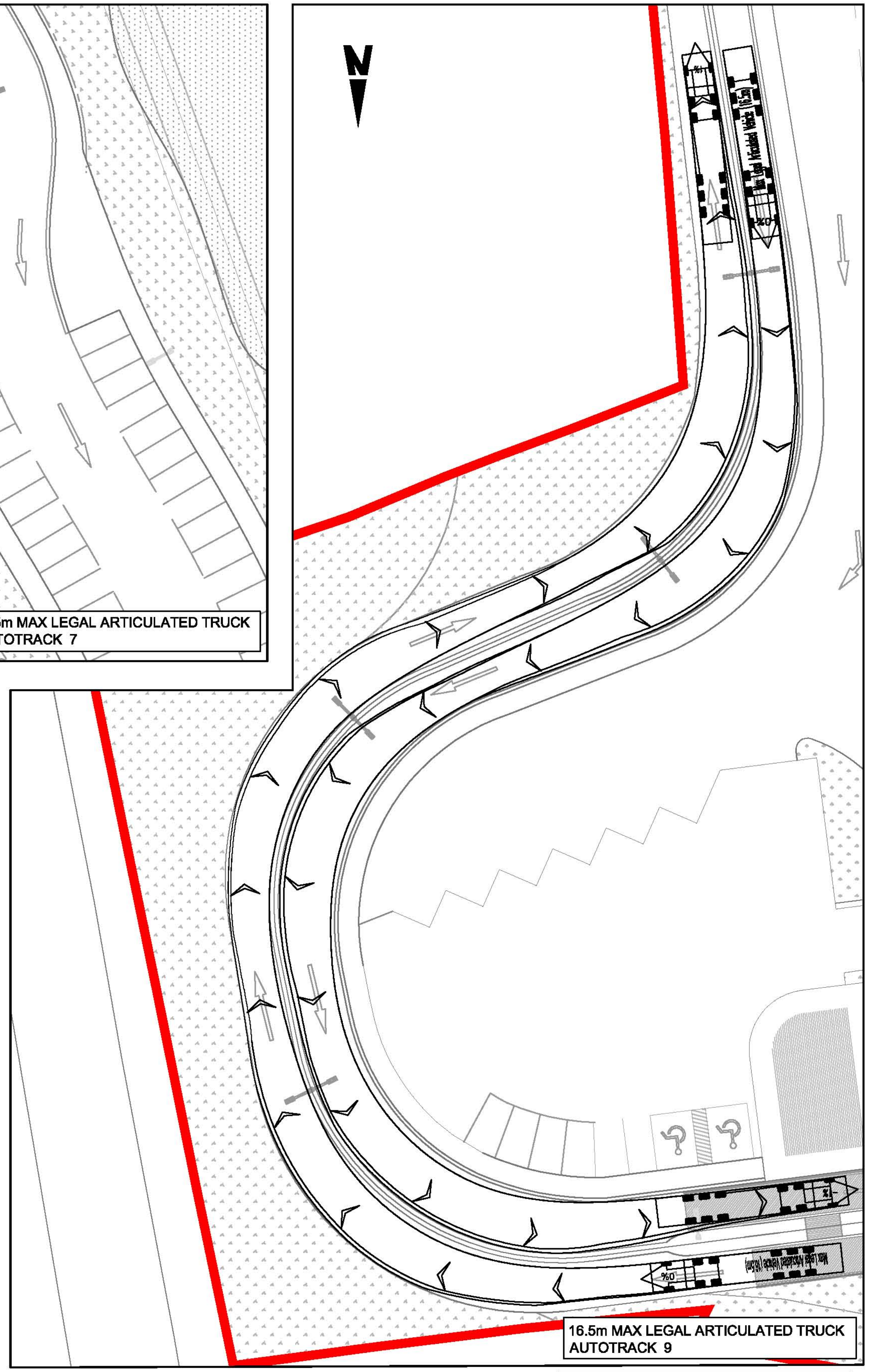
(Sheet 2 of 4)

Drawing Status	Scale / Sheet Size	
PLANNING	N.T.S. @ A1	N.T.S. @ A3

MGE0109DG0015.dwg







Ordnance Survey Ireland Sheet No. 5937-A

0.00m 10m 20m 30m
Scale Bar

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Drawing Status	Scale / Sheet Size	
PLANNING	N.T.S. @ A1	N.T.S. @ A3

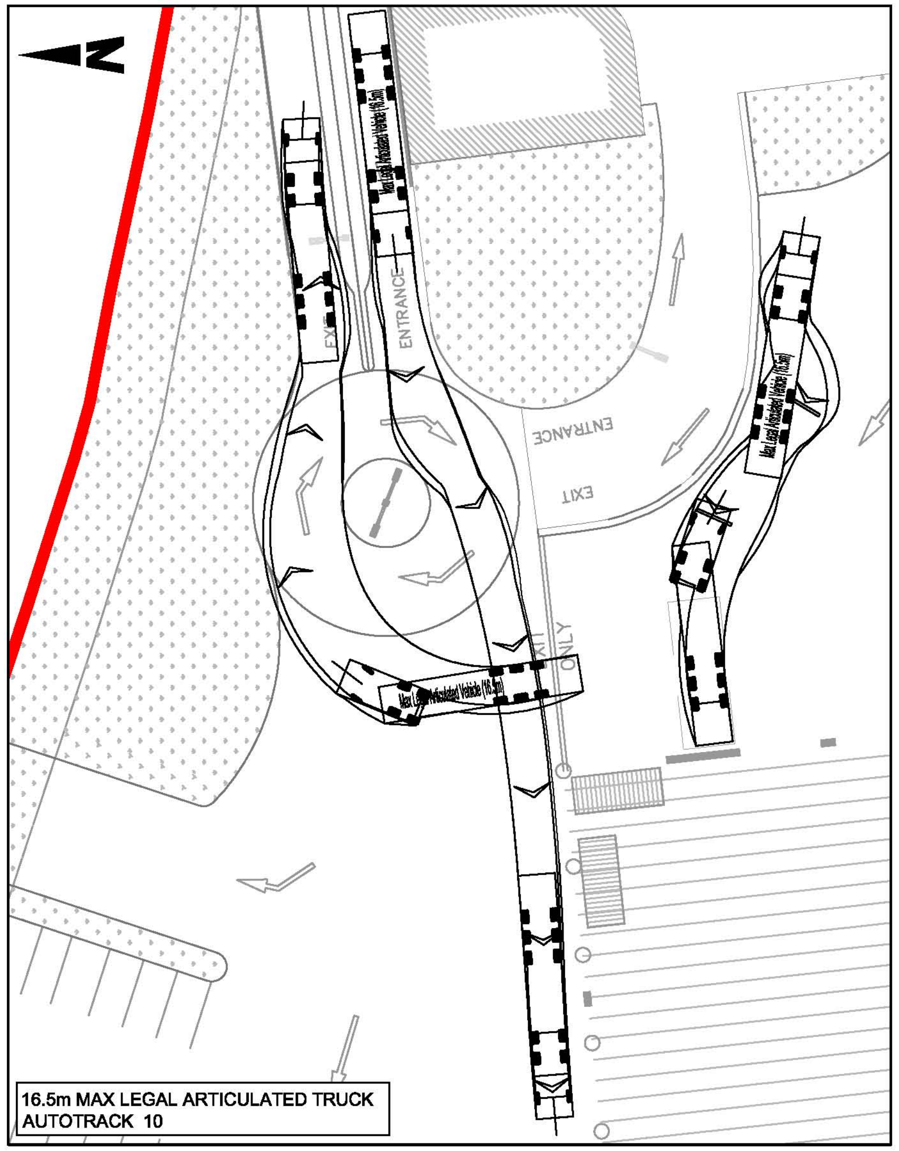
Drawing Number: DG0015/03

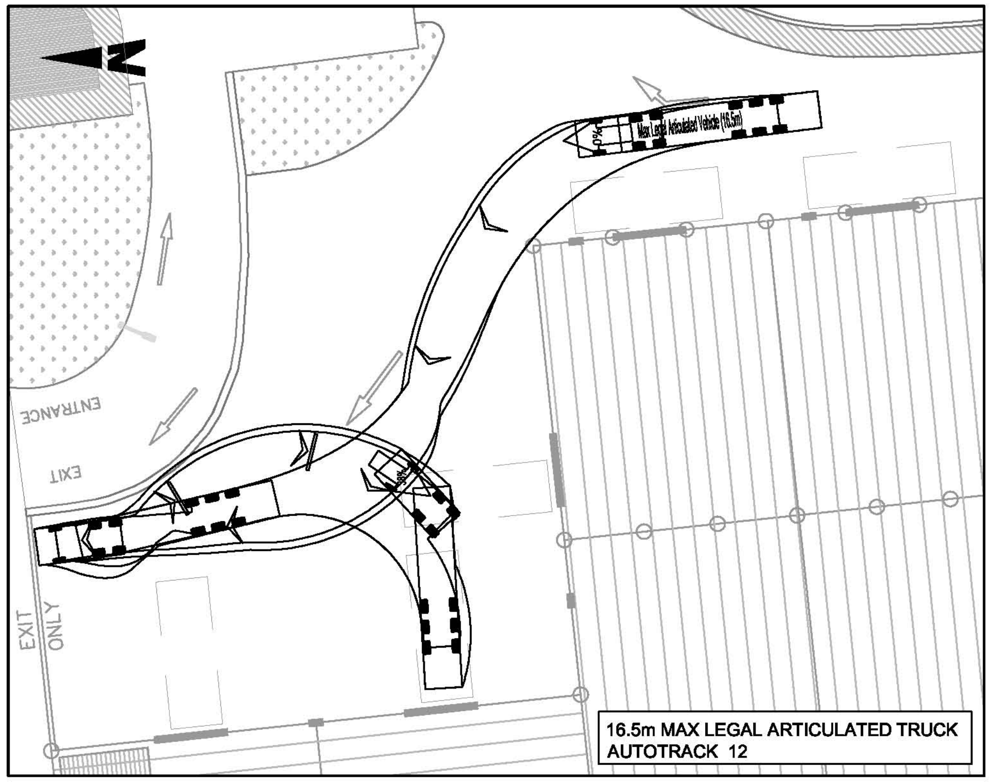
Rev: P02

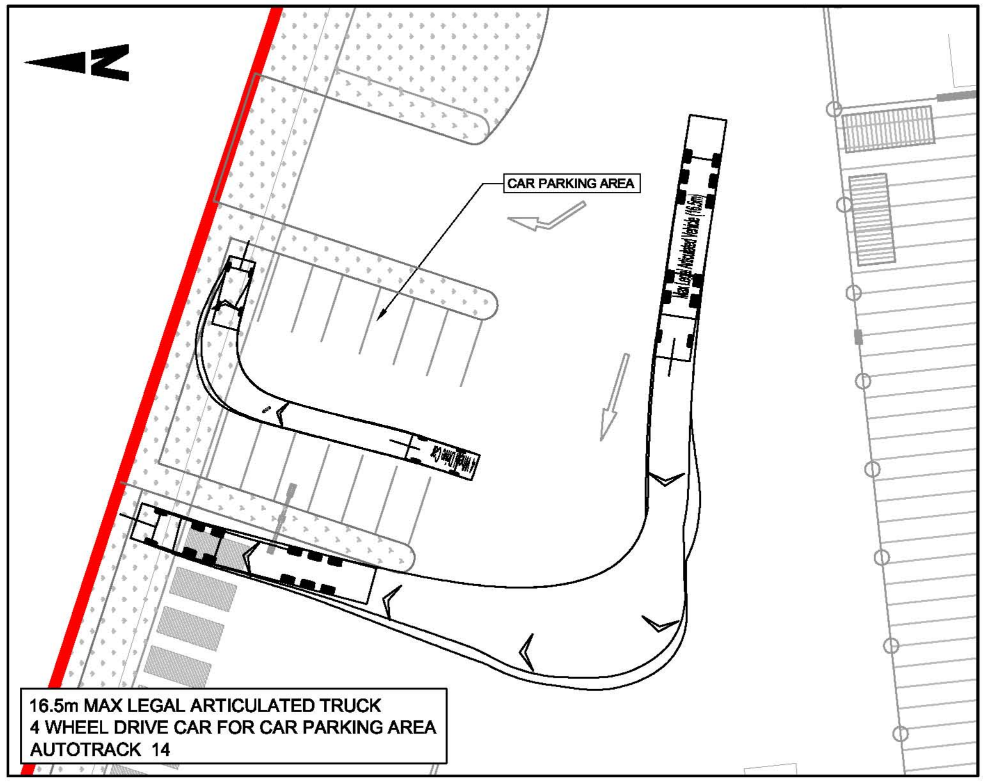
Title: AUTOTRACK ANALYSIS (7-9)

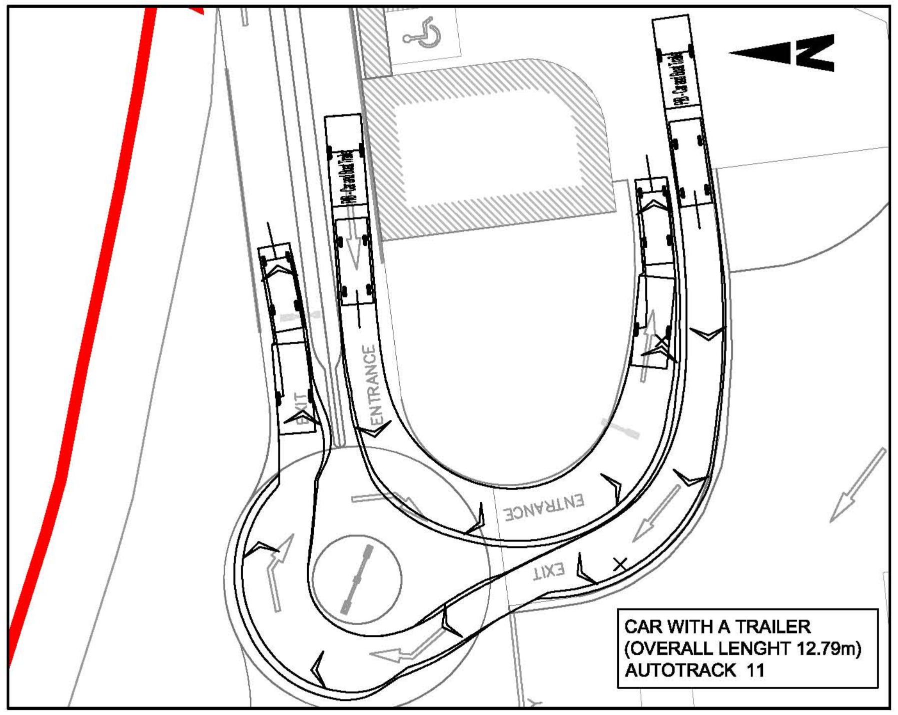
(Sheet 3 of 4)

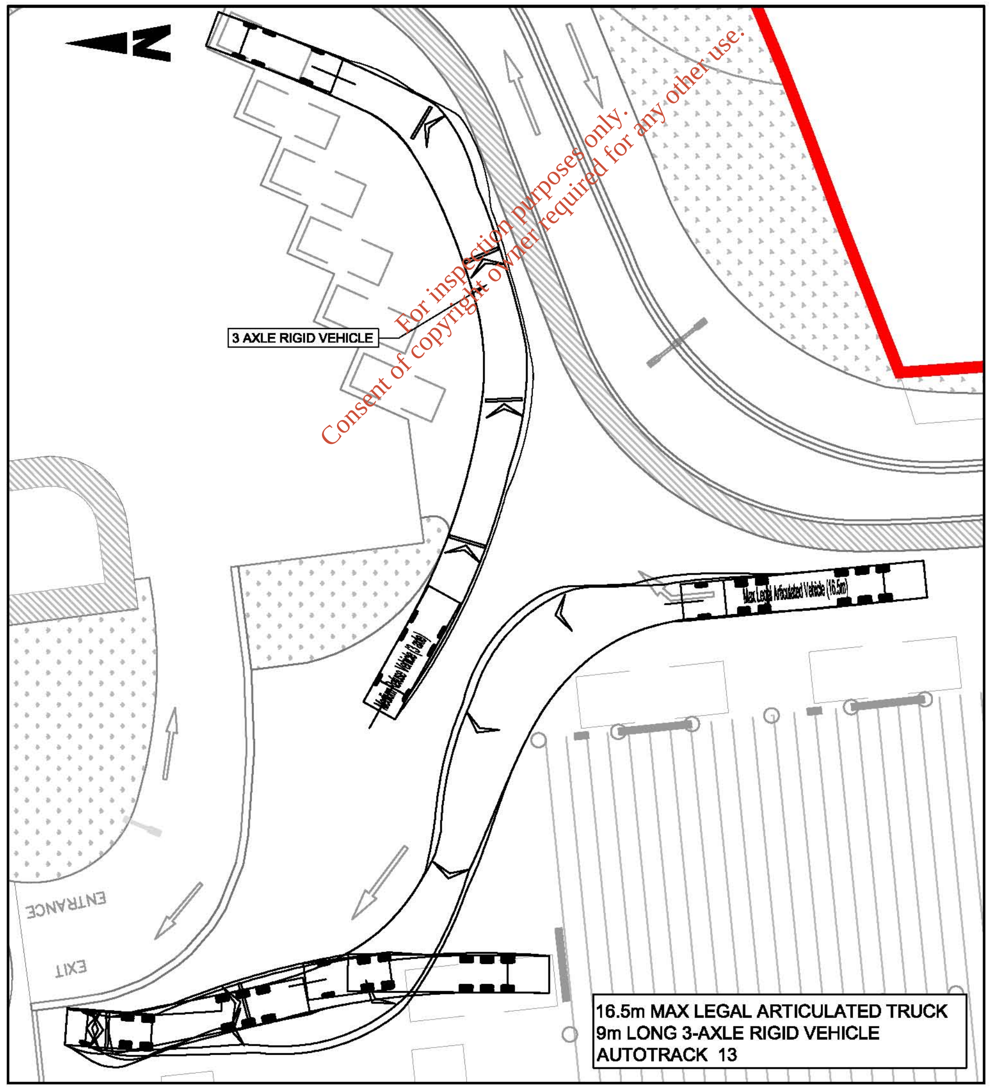
MGE0109DG0015.dwg

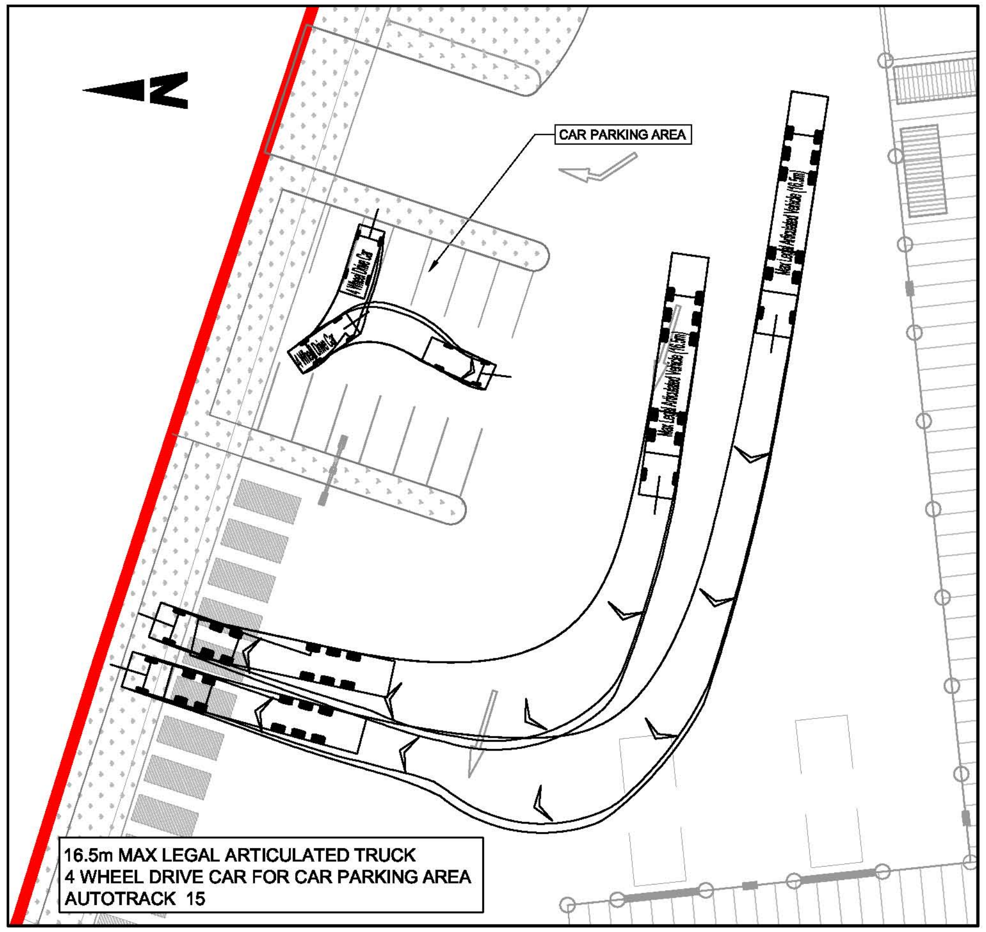












Ordnance Survey Ireland Sheet No. 5937-A

Scale Bar: 0.00m 10m 20m 30m

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Drawing Status: PLANNING
Scale / Sheet Size: N.T.S. @ A1 | N.T.S. @ A3

Drawing Number: DG0015/04
Rev: P02

Title: AUTOTRACK ANALYSIS (10-15)
(Sheet 4 of 4)

MGE0109DG0015.dwg

Kerry Central Recycling Facility Ltd

Drainage Calculations

June 2009

MGE0109CR0002

RPS

Kerry Central Recycling Facility

Drainage Calculations

DOCUMENT CONTROL SHEET

Client	Kerry Central Recycling Facility Ltd.					
Project Title	Kerry Central Recycling Facility					
Document Title	Drainage Calculations					
Document No.	MGE0109RP0009					
This Document Comprises	DCS	TOC	Text	List of Tables	List of Figures	No. of Appendices
	1	1	6	1	-	8

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
F01	Final Issue	J. O'Callaghan	P.J. Griffin	W. Madden	Galway	Oct 6th 2008
F02	Final Issue	M.C. Sheridan	P.J. Griffin	W. Madden	Galway	June 24th 2009

TABLE OF CONTENTS

APPENDICES

TABLES

1 FOUL SEWER DESIGN PROCEDURE

It is proposed to treat the foul flow from the development in a wastewater treatment system and to discharge the flow to groundwater through a raised bed soil polishing filter as shown on **Drawing No. DR0001/01**. Details of on-site test results showing the suitability of the site for the discharge of foul flows to groundwater are shown on the Site Characterisation Form in Appendix A.

The proposed foul sewer system shown on **Drawing No. DR0001/01** was designed using the Foul Module of MicroDrainage WinDes and complies with the specifications set out in the "Recommendations for Site Development Works for Housing Areas" as issued by the Department of the Environment, Heritage and Local Government.

The outputs from the program are located in Appendix B and include the following:

- Network Design Table
- Network Results Table
- Pipeline Schedules
- Manhole Schedules

Longitudinal Sections are shown on **Drawing No. DR0002/05**.

1.1 DESIGN PARAMETERS

The following parameters were used for the basis of design in the WinDes Foul Module.

Parameters	Values	Reference
Flow Rates	Non-residential buildings	As per EPA Wastewater Treatment Manual
Peak Flow	6 x Dry Weather Flow (DWF)	Site Development Works 1998
Min Velocity	0.76m/s	Site Development Works 1998
Pipe Roughness	1.50	(Colebrook/White)
Pipe Cover	1.2 minimum roads and other trafficked areas 0.9m minimum in open spaces and footpaths not adjacent to roadways	Site Development Works 1998

1.2 PIPE & MANHOLE NUMBERING

The pipe numbers define the structure of the network. The first pipe at the head of a system on the main line is numbered 1.000, the second 1.001, the third 1.002 as so on. Likewise the first pipe in a branch line is numbered 2.000 and the second 2.001. Other branches follow suit, 3.000, 4.000 etc. The manhole numbers are shown as F1, F2, F3, etc. – see **Drawing No. DR0001/01**.

1.3 FOUL LOADINGS

The foul loadings that were used in modelling of the foul network are shown in Table 1.

Table 1: Foul Loadings

Foul System Users	Number of Persons	Flow (L/p/d)	Flow (L/d)	BOD (g/p/d)	BOD (g/d)	PE Flow	PE BOD
Office & Yard Staff	50	60*	3000	30	1500	16.7	25
Drivers	15	30**	450	15	225	2.5	3.75
Totals			**3450**		**1725**	**19.2**	**28.8**

* Table 3 – EPA Wastewater Treatment Manuals, Office and/or factory with canteen
** Foul Loading due to drivers assumed to be 50% of that from office and/or factory with canteen

1.4 WASTEWATER TREATMENT PLANT

An on-site wastewater treatment plant is proposed to treat the foul effluent. The treatment plant will be located as shown on **Drawing No. DR0001/01**. The proposed treatment plant will be provided with chemical dosing facilities to reduce the phosphorus levels in the treated effluent to <0.5mg/l (Orthophosphate). This will have a minimal effect on the phosphorus levels in the stream of approximately 0.0007mg/l. Refer to Chapter 5 and Chapter 6, surface water and ecological assessment in the EIS, for further assessment on the potential impacts on water quality. Details of the proposed wastewater treatment plant are shown in Appendix C.

2 STORM SEWER DESIGN PROCEDURE

2.1 SITE INVESTIGATION

Trial holes were dug on 5th May 2008 in order to determine the existing soil infiltration rate and the soil suitability for a soakaway pit. The location of the trial holes, (ST-01 and ST-02) is shown on **Drawing No. DR0001/01**.

At the time both holes contained groundwater, therefore a BRE Soakaway Test could not be carried out and the site was deemed unsuitable for the location of a soakaway pit. It is therefore proposed to discharge surface water run-off from the site via an attenuation pond to an existing drainage ditch / stream located at the south west end of the site.

2.2 STORM SEWER DESIGN

The storm sewer system was designed using the MicroDrainage WinDes Storm Module. This system uses the Modified Rational Method of storm flow modelling. This design procedure complies with the specifications set out in the "Recommendations for Site Development Works for Housing Areas" as issued by the Department of the Environment, Heritage and Local Government.

The proposed storm sewer system is shown on **Drawing No. DR0001/01**. The system incorporates both filter and carrier pipe. The filter pipe will be used as part of the road drainage system, with the carrier pipe used to drain other hard surface areas. Calculations for the storm sewers are shown in Appendix D.

The outputs from the MicroDrainage WinDes Storm Module program include the following:

- Network Design Table
- Network Results Table
- Manhole Schedules
- Pipeline Schedules

Longitudinal Sections are shown on **Drawing No. DR0002/01**, **02**, **03** and **04**. Longitudinal Sections for the road drainage system are shown on **Drawing No. DR0006/01**.

2.3 DESIGN PARAMETERS

The following parameters were used for the basis of design in the WinDes Storm Module.

Parameters	Values	Reference
Return Period	1 Year	Wallingford Procedure

M5-60	15.3	Wallingford Procedure
Ration 'R'	0.24	Wallingford Procedure
Max Rainfall	50mm/hr	Wallingford Procedure
Global Time Entry	4 minutes	Wallingford Procedure
Minimum Velocity	0.76m/s	Site Development Works 1998
Run-Off Co-efficient	Roof = 0.95 Road and Other Hard Surface Areas = 0.8	BS 8005 (Colebrook/White)
Pipe Roughness	0.6 – Carrier Pipe 1.5 – Filter Pipe	Colebrook/White
Pipe Cover	1.2 minimum without concrete encasement 0.75 minimum with concrete encasement	Site Development Works 1998

2.4 PIPE AND MANHOLE NUMBERING

The pipe numbers define the structure of the network. The first pipe at the head of a system on the main line is numbered 1.000, the second 1.001, the third 1.002 as so on. Likewise the first pipe in a branch line is numbered 2.000, the second 2.001 and so on. Other branches follow suit, 3.000, 4.000 etc. The Manhole Numbers are shown as S1, S2, S3. etc. – see **Drawing No. DR0001/01**.

2.5 HYDROCARBON INTERCEPTOR

In accordance with the requirements of BS EN 858, 4.1 (b) '(run-off) from impervious areas, e.g. car parks, roads, factory yards areas;' the size of the separator will depend on the design, rainfall intensity and the catchment area draining to the separator.

The maximum rainwater flow rate Q_r in l/s shall be calculated using the equation below in accordance with EN 752-4:

$$Q_r = \Psi.i.A$$

where

- I is the rainfall intensity, in l/s.ha
- A is the area receiving rainfall, measured horizontally, in ha;
- Ψ is a dimensionless coefficient (usually taken as one)

Pollution prevention guidelines (PPG 3) uses a rainfall intensity equal to 65mm/hr which corresponds to the following formula for a bypass separator:

$$NSB = 0.0018 \times A$$

where

- NSB: Nominal Size of Bypass separator
- A: Catchment Area in m^2

2.5.1 Hydrocarbon Interceptor No. 1

In this case, the area draining to the bypass separator is approximately 38,600m^2 which includes all road/paved areas within the site, resulting in the following:

$$NSB = 0.0018 \times 38{,}600m^2 = 69.5 \text{ l/s}$$

As per the Specification sheet for "Klargester" Bypass Separator included in Appendix E, the appropriate unit is the NSBD72, as highlighted. This unit is capable of handling a peak flow rate of 720 l/s as shown. Surface water calculations provided in the Appendix D show a maximum flow rate of 280 l/s which is significantly lower than the capacity of the unit.

2.5.2 Hydrocarbon Interceptor No. 2

In this case, the area draining to the bypass separator is approximately 2,240m^2, resulting in the following:

$$NSB = 0.0018 \times 2{,}240m^2 = 4.032 \text{ l/s}$$

As per the Specification sheet for "Klargester" Bypass Separator included in Appendix E, the appropriate unit is the NSBD6, as highlighted. Surface water calculations provided in the Appendix D show a maximum flow rate of 21.6 l/s. This unit is capable of handling a peak flow rate of 60 l/s as shown. This is significantly higher than the actual flow rate the unit will be required to handle.

3 ATTENUATION SYSTEM DESIGN

Attenuation of storm water on-site will be provided by means of an Attenuation Pond. This Attenuation Pond was designed using the following parameters:

(i) Return Period of 30 Years

(ii) Storm duration of 1 minute to 48 hours

(iii) M5-60 = 15.8

(iv) Ratio “R” = 0.3

(v) Coefficient of Runoff from Roofs = 0.95

(vi) Coefficient of Runoff from Road and Other Trafficked Areas = 0.8

The location of the Attenuation Pond is shown on **Drawing No. DR0001/01**. Details and schematic arrangement for the Attenuation Pond are shown on **Drawing No. DR0004/01**. Detail of the flow control unit to be installed in the outlet manhole from the attenuation pond are shown in Appendix F.

An attenuation pond with a capacity of 600m^3 is required.

Calculations for the storage capacity requirements are included in Appendix G.

APPENDIX A

Site Characterisation Form

SITE CHARACTERISATION FORM

1.0 GENERAL DETAILS (From planning application)

NAME & ADDRESS OF APPLICANT:	Kerry Central Recycling Facility Ltd. Scart/Caherdean, Killarney, Co. Kerry.
SITE LOCATION AND TOWNLAND:	Scart/Caherdean, Killarney, Co. Kerry.

TELEPHONE NO:	064 32458	**FAX NO:**	064 38661	**E-MAIL:**	brian.bruton@kwd.ie
MAXIMUM NO. OF RESIDENTS:	65 staff @ 60L/p/d 32 visitors @ 5L/p/d	**NO. OF DOUBLE BEDROOMS:**	-	**NO. OF SINGLE BEDROOMS:**	-

PROPOSED WATER SUPPLY: (tick as appropriate)	**mains** √	**private well/borehole**	**group well/borehole**

2.0 DESK STUDY

SOIL TYPE	Till derived chiefly from Namurin Rocks	**Other (specify)**	**AQUIFER CATEGORY**	**Regionally Important**	**Locally Important** √	**Poor**

VULNERABILITY Interim GSI Guidelines and site information	**Extreme**	**High**	**Moderate**	**Low**	**High to Low** √	**Unknown**

BEDROCK	Namurian Undiffer-entiated	**Name of Public/Group Scheme Water Supply within 1 km**	**None**

Is there a GSI Groundwater Protection Scheme? (Y/N):	Y	**Groundwater Protection Response:**	R1	**Source Protection Area**	**SI** None	**SO** None

Presence of significant sites (archaeological, natural & historical):	N/A
Past experience in the area:	N/A

Comments:
(*Integrate the information above in order to comment on: the potential suitability of the site, potential targets at risk, and/or any potential site restrictions).*
From the above we can infer that percolation in the area would be acceptable. However, caution would have to be taken due to the under lying aquifer quality and usage and extreme vulnerability of the area.

NOTE: Only existing information available at the desk study stage should be used in this section

3.0 ON-SITE ASSESSMENT

3.1 Visual Assessment

LANDSCAPE POSITION:	N22 runs adjacent the eastern boundary of the site.	**SLOPE:**	STEEP (>1:5)	SHALLOW (1:5-1:20) √	RELATIVELY FLAT (<1:20)

SURFACE FEATURES (Distance to features should be noted in metres)		
HOUSES:	None on proposed site	
SITE BOUNDARIES:	North – Factory & Agricultural Land South – Agricultural Land	East –N22 and Drainage Ditch West – Drainage Ditch
ROADS:	N22 to East of site	
EXISTING LAND USE:	Greenfield site with conifer plantation	
OUTCROPS (ROCK AND/OR SUBSOIL):	None on site	
SURFACE WATER PONDING:	None on site	
LAKES:	None on site	
BEACHES/SHELLFISH AREAS/WETLANDS:	None on site	
KARST FEATURES:	None on site	
WATERCOURSE/STREAM*:	None on site	
DRAINAGE DITCHES*:	Running along the western and eastern boundary of the site. Internal drainage ditches will be captured in the internal drainage system.	
WELLS*:	None on site	
SPRINGS*:	None on site	
VEGETATION INDICATORS:	Grass and rushes in area of proposed percolation area	
GROUND CONDITION:	Soft and boggy	

COMMENTS:
(Integrate the information above in order to comment on: the potential suitability of the site, potential targets at risk, the suitability of the site to treat the wastewater and the location of the proposed system within the site).

Water table possibly high on site. Foul water treatment on-site could cause risk to groundwater and surface water.

* **note** water level

3.2 Trial Hole No.1

Trial Hole should be a minimum of 2.1 m deep (3m where have regionally important aquifers)

Depth of trial hole (m):	**1.8m**	**Date and time of excavation:**	**05/05/08**	**Date and time of examination:**	**06/05/08**
Depth from ground surface to bedrock (m) (if present):			**Not encountered**		
Depth from ground surface to water table (m) (if present):			**1.4m**		

	Soil/Subsoil Texture & Classification**	**Soil Structure**	**Density/ Compactness**	**Colour *****	**Preferential flowpaths**
0.1 m **0.2 m** **0.3 m** **0.4 m** **0.5 m** **0.6 m**	Peat	Blocky	Compact	Dark Brown	Grass Rootlets
0.7 m **0.8 m** **0.9 m** **1.0 m** **1.1 m** **1.2 m** **1.3 m** **1.4 m**	Blue Grey Clay with Gravel	Structureless Massive	Soft	Blue	None
					Water Table
1.5 m **1.6 m** **1.7 m** **1.8 m**					End of Dig
1.9 m **2.0 m** **2.1 m** **2.2 m** **2.3 m** **2.4 m** **2.5 m**	See next page for cross section of trial hole				

Other information

Depth of water ingress:	1.4	**Rock type (if present):**	N/A	**Plasticity and dilatancy results:**	**3 samples to be tested for each horizon and results should be entered above for each horizon**	**Likely T value: >20**

EVALUATION: Ground suitable for discharge subject to P Test results.

** See Appendix E for BS 5930 classification
*** All signs of mottling should be recorded
Note: Depth of percolation test holes should be indicated on diagram above.

Trial Hole No.1 - Cross Section

(a) Percolation ("T") Test @ Invert of Percolation Pipe or relevant subsoil layer

Percolation Test Hole	1	2
Depth from ground surface to top of hole (mm) (A)	900mm	900mm
Depth from ground surface to base of hole (mm) (B)	1.3m	1.3m
Depth of hole (mm) [B - A]	400mm	400mm
Dimensions of hole [length x breadth (mm)]	300 x 300	300 x 300
Each hole must be pre-soaked twice before the test is carried out (from 10.00 am to 5.00 pm and from 5.00 pm to next morning)		
Date of test	06/05/08	06/05/08
Date pre-soaking started	05/05/08	05/05/08
Time filled to 400 mm		
Time water level at 300 mm		

Percolation Test Hole No.	1			2		
Fill no.	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δt (min)**	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δt (min)**
1						
2						
3						
	Average Δt			**Average Δt**		

Not carried out

AverageΔt/4 = [Hole No.1] _____(t_1)

Average Δt/4 = [Hole No.2] _____(t_2)

T value* = (t_1 + t_2)/2 =_______(min/25 mm)

Result of Test : T =

COMMENTS:

- **If two very different T test results are obtained and where one of these values fails then a third test should be carried out to determine the representivity of each of the results.**

3.3 (b) Percolation ("P") Test @ Ground Level, Trial Hole No. 1

Percolation Test Hole	1	2
Depth of hole from ground surface (mm)	400	400
Dimensions of hole [length x breadth (mm)]	300x300	300x300
Each hole must be pre-soaked twice before the test is carried out (from 10.00 am to 5.00 pm and from 5.00 pm to next morning)		
Date of test	06/05/08	06/05/08
Date pre-soaking started	05/05/08	05/05/08
Time filled to 400 mm	10:27	10:32
Time water level at 300 mm	11:01	11:10

Percolation Test Hole No.	1			2		
Fill no.	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δp (min)**	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δp (min)**
1	11:01	11:39	38	11:10	11:55	45
2	11:43	12:36	53	11:57	12:50	53
3	12:38	14:42	124	12:50	14:58	128
Average Δp			72	**Average Δp**		75
AverageΔp/4 = [Hole No.1] 18 (p_1)				**Average Δp/4 = [Hole No.2] 19 (p_2)**		

P value* = (p_1 + p_2)/2 = 18.5 (min/25 mm)

Result of Test : P = 18.5

COMMENTS: The P value is 18.5, giving an infiltration rate of 20 L/m^2/day as the P value is between 5 and 20. This was lower than expected.

- **If two very different P test results are obtained and where one of these values fails then a third test should be carried out to determine the representivity of each of the results**

3.2 Trial Hole No. 2

Trial Hole should be a minimum of 2.1 m deep (3m where have regionally important aquifers)

Depth of trial hole (m):	**2m**	**Date and time of excavation:**	**05/05/08**	**Date and time of examination:**	**06/05/08**
Depth from ground surface to bedrock (m) (if present):			**Not encountered**		
Depth from ground surface to water table (m) (if present):			**1.1m**		

	Soil/Subsoil Texture & Classification**	**Soil Structure**	**Density/ Compactness**	**Colour *****	**Preferential flowpaths**
0.1 m	Peat	Blocky	Compact	Dark Brown	Grass Rootlets
0.2 m					
0.3 m					
0.4 m					
0.5 m					
0.6 m					
0.7 m	Blue Grey Clay	Structureless Massive	Soft	Blue	None
0.8 m					
0.9 m					
1.0 m					
1.1 m					Water Table
1.2 m					
1.3 m					
1.4 m					End of Dig
1.5 m	See next page for cross section of trial hole				
1.6 m					
1.7 m					
1.8 m					
1.9 m					
2.0 m					
2.1 m					
2.2 m					
2.3 m					
2.4 m					
2.5 m					

Other information

Depth of water ingress:	N/A	**Rock type (if present):**	N/A	**Plasticity and dilatancy results:**		**Likely T value:**	**>20**

EVALUATION: Ground will provide adequate treatment subject to P test results.

** See Appendix E for BS 5930 classification
*** All signs of mottling should be recorded
Note: Depth of percolation test holes should be indicated on diagram above.

Trial Hole 2 - Cross Section

(a) Percolation ("T") Test @ Invert of Percolation Pipe or relevant subsoil layer

Percolation Test Hole	1	2
Depth from ground surface to top of hole (mm) (A)	900mm	900mm
Depth from ground surface to base of hole (mm) (B)	1.3m	1.3m
Depth of hole (mm) [B - A]	400mm	400mm
Dimensions of hole [length x breadth (mm)]	300 x 300	300 x 300

Each hole must be pre-soaked twice before the test is carried out (from 10.00 am to 5.00 pm and from 5.00 pm to next morning)

Date of test	06/05/08	06/05/08
Date pre-soaking started	05/05/08	05/05/08
Time filled to 400 mm		
Time water level at 300 mm		

Percolation Test Hole No.	**1**			**2**		
Fill no.	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δt (min)**	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δt (min)**
1						
2						
3						
Average Δt				**Average Δt**		

AverageΔt/4 = [Hole No.1] _____(t_1)

Average Δt/4 = [Hole No.2] _____(t_2)

T value* = (t_1 + t_2)/2 =_______(min/25 mm)

Result of Test : T =

COMMENTS:

Not carried out

- **If two very different T test results are obtained and where one of these values fails then a third test should be carried out to determine the representivity of each of the results.**

3.3 (b) Percolation ("P") Test @ Ground Level , Trial Hole No. 2

Percolation Test Hole	1	2
Depth of hole from ground surface (mm)	400	400
Dimensions of hole [length x breadth (mm)]	300x300	300x300
Each hole must be pre-soaked twice before the test is carried out (from 10.00 am to 5.00 pm and from 5.00 pm to next morning)		
Date of test	06/05/08	06/05/08
Date pre-soaking started	05/05/08	05/05/08
Time filled to 400 mm	10:01	10:03
Time water level at 300 mm	10:43	10:46

Percolation Test Hole No.	1			2		
Fill no.	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δp (min)**	**Start Time (at 300 mm)**	**Finish Time (at 200 mm)**	**Δp (min)**
1	10:43	11:51	68	11:26	12:14	48
2	11:51	13:06	75	12:15	13:41	86
3	13:08	15:10	122	13:44	16:04	140
Average Δp			88	**Average Δp**		91
AverageΔp/4 = [Hole No.1] 22 (p_1)				**Average Δp/4 = [Hole No.2] 23 (p_2)**		

P value* = $(p_1 + p_2)/2$ = 22.5 (min/25 mm)

Result of Test : P = 22.5

COMMENTS: The P value is 22.5, giving an infiltration rate of 10 L/m^2/day as the P value is between 20 and 40. This was lower than expected but is more conservative than the P value obtained at TH-01 and will be used in the sizing of the percolation area.

- **If two very different P test results are obtained and where one of these values fails then a third test should be carried out to determine the representivity of each of the results**

Sketch of site showing measurement to Trial Hole location and Percolation Test Hole locations, wells and direction of groundwater flow (if known), proposed house (incl. distances from boundaries) adjacent houses, watercourses, significant sites and other relevant features. North point should always be included.

[A copy of the site layout drawing should be used if available]

Please see Drawing No. DR0001/01.

4.0 CONCLUSION of SITE CHARACTERISATION:

(*Integrate the information from the desk study and on-site assessment (i.e. visual assessment, trial hole and percolation tests) above and conclude the type of system(s) that is (are) appropriate. This information is also used to choose the optimum final disposal route of the treated wastewater).*

Suitable for (delete as appropriate)****:

~~(a) septic tank and soil percolation system~~

~~(b) septic tank and intermittent filter system and polishing unit; or septic tank and constructed wetlands and polishing unit~~

(c) mechanical aeration system and polishing unit

****note: ***more than one option may be suitable for a site and this should be recorded***

and

~~**SUITABLE**~~ / **UNSUITABLE** (delete as appropriate) for discharge to **surface water**[1]

SUITABLE ~~/ **UNSUITABLE**~~ (delete as appropriate) for discharge to **groundwater**

5.0 RECOMMENDATION:

Propose to install: EPS Bison Wastewater Treatment Plant followed by a raised bed soil filter and discharge to ~~surface water~~/groundwater (delete as appropriate)

Conditions (if any) e.g. special works, invert level of trench, site improvement works testing etc……….

See attached design

Signed: PJ Griffin, RPS Consulting Engineers

Address: Lyrr Building, IDA Business and Technology Park, Mervue, Galway

Qualifications/Experience: Chartered Engineer Date of Report: 12th Sept.2008

Phone: 091 534100 Fax: 091 534199 e-mail pj.griffin@rpsgroup.com

[1] A discharge of sewage effluent to "waters" (definition includes any or any part of any river, stream, lake, canal, reservoir, aquifer, pond, watercourse or other inland waters, whether natural or artificial) will require a licence under the Water Pollution Acts 1977-90

6.0 TREATMENT SYSTEM DESIGN DETAILS

<table>
<tr><td>System Type?</td><td>BAF</td><td>Proposed Discharge route?</td><td>~~Surface water~~</td><td>Groundwater</td></tr>
<tr><td>Size of Proposed Treatment System?</td><td>Primary/Septic Tank (m^3)
6.8</td><td colspan="2">Secondary Treatment System Capacity (m^3)
6.8</td><td>Percolation Area/Polishing filter (State units - m or m^2)*
345m^2 soil polishing filter</td></tr>
<tr><td>What Quality Assurance is proposed during the following?</td><td colspan="2">Installation & Commissioning
Installed and commissioned by EPS</td><td colspan="2">On-going Maintenance
On-going maintenance by EPS</td></tr>
</table>

*** the calculated percolation area or polishing filter area should be shown on site plan**

7.0 REVIEW (by Local Authority)

Site visit ☐ Date:

Inspection of Trial Hole ☐ Date:

Inspection of Percolation Test Holes ☐ Date:

COMMENTS

SIGNED: Date:

APPENDIX B

Foul Sewer Calculations

FOUL SEWERAGE DESIGN

Global Variables

Pipe Size File	C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File	C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Industrial Flow (l/s/ha)	0.00
Industrial Peak Flow Factor	0.00
Flow Per Person (l/per/day)	180.00
Persons per House	1.00
Domestic (l/s/ha)	0.00
Domestic Peak Flow Factor	6.00
O'flow Setting (*Foul only)	0
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	0.000
Min Cover Depth for Optimisation (m)	1.200
Min Vel for Auto Design Only (m/s)	0.76
Min Slope for Optimisation (1:X)	1000
Minimum Outfall Invert (m)	0.000
Ground Level at Outfall (m)	107.480
Outfall Manhole Name	WWTP
Outfall Manhole Dia/Length (mm)	0
Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Hse	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	63.51	0.690	92.0	0.000	19	0.0	1.500	o	150
1.001	80.95	0.640	126.5	0.000	0	0.0	1.500	o	150
1.002	21.08	0.170	124.0	0.000	0	0.0	1.500	o	150

Network Results Table

PN	US/IL (m)	E.Area (ha)	E.DWF (l/s)	E.Hse	Infil. (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	106.200	0.000	0.0	19	0.0	13	0.32	0.91	16.1	0.2
1.001	105.510	0.000	0.0	19	0.0	14	0.28	0.78	13.8	0.2
1.002	104.870	0.000	0.0	19	0.0	14	0.29	0.79	13.9	0.2

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	150	F1	109.830	106.200	3.480	1200
1.001	o	150	F2	107.830	105.510	2.170	1200
1.002	o	150	F3	107.480	104.870	2.460	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	63.51	92.0	F2	107.830	105.510	2.170	1200
1.001	80.95	126.5	F3	107.480	104.870	2.460	1200
1.002	21.08	124.0	WWTP	107.480	104.700	2.630	0

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
F1	109.830	3.630	1200	1.000	106.200	150			
F2	107.830	2.320	1200	1.001	105.510	150	1.000	105.510	150
F3	107.480	2.610	1200	1.002	104.870	150	1.001	104.870	150
WWTP	107.480	2.780	0		OUTFALL		1.002	104.700	150

APPENDIX C

Bison Preliminary Design Proposal for Wastewater Treatment Plant

Environmental Products Division

PRELIMINARY DESIGN PROPOSAL

FOR

WASTEWATER TREATMENT PLANT

CLIENT REPRESENTATIVE	**RPS**
ATTENTIOIN	**Mary Claire Sheridan**
DATE	**11th June 2009**
REFERENCE	**QB10159-08R**

Pumping & Treatment Systems

ISO 9001 Registered

ISO 14001 Registered

IRISH AGRÉMENT BOARD
BUILDING PRODUCT CERTIFICATION

TABLE OF CONTENTS

1. INTRODUCTION

The following report has been compiled using loading details and Population Equivalency (P.E.) supplied by RPS.
The design criteria and parameters have been calculated based on the recommended EPA loading rates as outlined in Table 2.1 below. Treatment plant selection has been based on the max loading rates based on 100% occupancy as per Table's 2.3, 2.4 and 2.5 below.

Prior to approval a site investigation and assessment will be required.

2. DESIGN PARAMETERS

Table 2.1. EPA Recommended Loading Rates

Situation	Source	Flow litres/day per person	BOD_5 grams/day per person
Industrial	Office and/or factory without canteen	30	20
	Office and/or factory with canteen Open industrial site e.g. quarry (excluding canteen)	60 40	30 25
Schools	Non-residential with cooking on-site	60	30
	Non-residential with no canteen	40	20
	Boarding school: (1). Residents (2). Day Staff (includes mid-day meal)	 180 60	 60 30
Hotels	Guests	250	75
	Guests (no meal)	180	45
	Resident staff	180	60
	Day Staff	60	30
	Conference	40	20
	Restaurant full meals: (1). Luxury Catering (2). Prepared Catering (3). Snack Bars (4). Function Rooms incl. Buffets (5). Fast Food	 25 15 10 10 10	 25 15 10 10 10
Pubs and Clubs	Residents	200	60
	Day Staff	60	30
	Bar Drinkers	10	10
	Bar Meals	10	10

Table 2.1 Continued.

Situation	Source	Flow litres/day per person	BOD_5 grams/day per person
Amenity Sites	Restaurants	15	15
	Function Rooms	10	10
	Toilet Blocks (per use)	5	10
	Toilet Blocks (long stay car parks)	10	15
	Golf Clubs	20	10
	Squash, with club house	25	15
	Swimming	10	10
	Football Club	30	20
	Caravan Sites (1). Touring (2). Static not serviced (3). Static fully serviced (4). Tent sites	 50 75 150 50	 35 35 55 35
Hospitals	Residential elderly people	250	60
	Residential elderly people plus nursing	300	65
	Nursing Homes	350	75

Table 2.2 EPA Recommended Minimum Distances from Treatment Systems

System Size P.E.	Approximate Number of Houses Served	Distance From Existing Development (m)
10 – 40	**2 – 10**	**28**
41 – 60	11 – 15	31
61 – 80	16 – 20	34
81 – 100	21 – 25	37
101 – 120	26 – 30	40
121 – 140	31 – 35	43
141 – 160	36 – 40	46
> 161	> 41	50

Table 2.3 Design Basis

Detail	Number	Unit
P.E.	**29**	P.E.
Hydraulic Loading	**180**	L/p/d
Organic Loading	**60**	gBOD/p/d
Gravity Inlet	**Assuming Yes**	Yes
Gravity Outlet	**Assuming Yes**	Yes
T-Value	**T.B.C.**	Min/25mm
Invert Level	**T.B.C.**	M
Power Supply	**T.B.C.**	Volts
Water Table	**T.B.C.**	M (BgL)

Table 2.4. Design Criteria

Parameter	Influent	Effluent	Unit
Design Flow	**3.45**	**3.45**	M^3/d
Peak Flow	**0.43**	**0.43**	M^3/hr 3DWF
BOD Load	**1.725**	**0.069**	Kg/d
T.N.	**-**		Mg/L
T.P	**-**	**<1**	Mg/L
Orthophosphates		**<0.5**	
S. Solids		**30**	Mg/L
BOD		**20**	Mg/L
Domestic/Commercial		**Domestic**	

2.5 DESIGN CALCULATIONS

E.P.S. Design Brief / Basis:

Hydraulic Loading = 3450 L/d

Organic Loading: = 1725 g/d

Total P.E (As per the Hydraulic Load) = 19.2 P.E.
Total P.E (As per the Organic Load) = 28.8 P.E.

EPS Ltd. propose 1 No. 30 P.E. SAF Treatment Plant

- SCOPE OF SUPPLY

The table below outlines all the main treatment options supplied by EPS. The items applicable to this development have been marked with a ‘Y’.

Treatment System	Y/N	Description
Primary Treatment		
Primary Settlement Tank		*See Product Selection*
Secondary Treatment		
SAF Plants - *CT* - *Concrete*	**Y**	
SBR		
CAS		
MBR		
Tertiary Treatment		
Self Cleaning Sand Filter		
In-situ Sand Filter		
Reed Bed		
Disinfection - *UV* - *EFFG System* - *LBX System*		
Nutrient Removal		
Nitrification (Ammonia)		
Denitrification (Anoxic Zone)		
Phosphate Reduction	**Y**	
Additional Plant Items		
Screening		
Grease Removal		
Disposal Options Design		
Flow Splitting Chamber		
Recirculation Chamber		
Inlet Pumping Station		
Outlet Pumping Station		
Flow Metering	**Y**	*Optional*
Remote Monitoring	**Y**	*Optional*
Sampling	**Y**	*Optional*
Operation and Maintenance		
Service Contract		
Operation and Maintenance Contract	**Y**	

Treatment System	Y/N	Description
SAF PLANTS (grp) Standard Range		
CT 25		
CT 30	Y	
CT 50		
CT 75		
CT 100		
CT 125		
CT 150		
SAF PLANTS (grp) Nitrifying Range		
CT 35-N		
CT 50-N		
CT 75-N		
CT 100-N		
M 200		
M 250		
M 300		
M 400		
M 500		
M 600		
AQUAMAX RANGE		
30 PE Concrete		
50 PE Concrete		
75 PE Concrete		
100 PE Concrete		
150 PE Concrete		
200 PE Concrete		
250 PE Concrete		
300 PE Concrete		

Treatment System	Y/N	Description
SBR *(Sequencing Batch Reactor)*		
200		
300		
400		
500		
600		
700		
800		
900		
1000		
CAS		
150		
200		
300		
400		
Duplex Systems 400 PE upwards		
MBR		
125		
250		
375		
500		
750		
1000		
1500		
2000		
2500		

4. QUOTATION

Number QB10160-08R

Date 11th June 2009

Customer RPS Group

Address Lyrr Building, IDA Business & Technology Park, Mervue, Galway.

EPS Offer

Item 1:
TREATMENT PLANT
EPS propose the installation of 30 P.E. SAF treatment unit to deal with the sewage from the proposed development. Typical effluent discharge values achieved with secondary treatment would be 20mg/l BOD and 30mg/l SS. Prices include, transport, electrical, mechanical installation and commissioning.

Price € 9, 950.00 Excluding VAT

Item 2:
FERRIC DOSING SYSTEM
To achieve the Total Phosphorous parameter, The installation of a ferric dosing system is necessary. This includes the provision of a 100 litre day tank complete dosing pump to dose ferric sulphate into the treatment plant to reduce the phosphate levels to licence standard.

Price: €1,800.00 excluding VAT

Optional Items.

Item 3:
EYE WASH FACILITY [due to presence of Ferric Sulphate on site]
Hand held hose spray and stand.
Preforated spray head provides soft spray for cleansing eyes and face. Handle stays open once the valve is squeezed

Price: €470.00 excluding VAT

Item 4:
FLOW METER:
Mag Flow Digital Flow meter (C/w Integrated Recorder)

Price: € 2,000.00 excluding VAT

Item 5:
AUTOMATIC SAMPLER
Provision of automatic sampler to operate on a flow / time basis to take samples as required.

Price: €2,850.00 excluding VAT

Item 6:
GSM DIAL OUT FACILITY
To alert the plant operator in the case of a fault via GSM Messaging.

Price: €2,200 excluding VAT

VAT @ 13.5%

Payment Terms

40%	With Order
55%	On delivery of all or part of equipment to site. (i.e.) Tanks/Equipment /Mechanical or Electrical installation.
5%	On Commissioning

NOTE:

- *Order of equipment will only take place when deposit is received.*
- *Commissioning will only take place when paid up to 95%*
- *Final and full payment must be received. Maximum 90 days from payment of initial deposit.*

Delivery
6 working weeks from date of receipt of initial deposit on order

Basis of Selection
The treatment process proposed has been designed based on the information submitted to EPS and the recommended EPA loading guidelines.
All treatment plant options are selected on domestic sewage requirements or commercial sewage requirements where applicable. The option proposed is based on 100% occupancy.
No surface water or storm water is to enter the treatment plant.
The use of an appropriately sized and maintained grease trap is a client requirement, so as to ensure that no grease enters the treatment plant.

Design
The design of the treatment plant proposed is in accordance with BS6297. The design loading rates and applicable set-back distances are as per the EPA guidelines. The design of suitable disposable systems are as per the EPA guidelines or BS6297 where applicable.

Maintenance
EPS offer a full operation and maintenance after sales service which we encourage all customers to avail of.

Cancellation
EPS do reserve the right to recover reasonable costs from any deposit monies paid should a proposed project be cancelled.

Additional Terms

- Strictly Nett Monthly.
- Title does not pass until payment has been made in full.
- All goods/services subject to our standard conditions of sale (available on request). All payments to be forwarded to Head Office.
- All purchases subject to EPS standard credit terms and delivery unless otherwise agreed in writing.
- Retention does not apply to this quotation.

I HEREBY AGREE TO THE ABOVE TERMS AND INSTRUCT EPS TO PROCEED WITH THE ORDER AS OUTLINED ABOVE.

SIGNED ______________________________

ON BEHALF OF ______________________

POSITION HELD _____________________

DATE __________________________________

5. EXCLUSIONS AND CLIENT RESPONSIBILITIES

It shall be the responsibility of the client to provide the following:

- Provision of power to EPS Control Panel
- Any excavation or backfilling
- Any additional civil works or pumping as may be required for sites with water table issues.
- Site clearance and reinstatement
- Provision of ducting
- Provision of concrete hard standing areas as required
- Connection of inlet and outlet sewer lines
- Provision of seed sludge where applicable for plant start-up
- Provision and installation of and maintenance of a suitable grease trap if not otherwise included in EPS supply.
- Provision of chemicals as required for commissioning and set-up
- Access to treatment plant site for a 40ft articulated truck to allow for placement of tanks. Any necessary crane hire is the clients responsibility unless otherwise agreed by EPS.
- Provision of and construction of disposal systems.
- Provision of pipework from pump stations to disposal systems.
- All site security and fencing.
- Provision for telephone line or connection
- Provision for on- site induction/ Safety talks that are greater than 2 hours.
- Provision for builders discount.
- Provision of rising main and connection to EPS pipework.
- Provision for dry valve chamber to sump/ tanks c/w access cover.
- Provision of ESB metering box.
- Provision of a clean accessible working environment for EPS staff.

6. TREATMENT OPTIONS

6.1 PRIMARY TREATMENT

Our range of primary settlement tanks (PST) are available in both concrete and glass reinforced plastic (grp). We offer single stage, two stage and three stage settlement options.

All primary settlement tanks are designed to reduce the gross and suspended solids loading prior to secondary treatment. Sludge storage requirements are also included in PST design. Storage periods will vary depending on the option provided but as a general rule all primary settlement tanks should be desludged every 3 months at a minimum.

A primary settlement tank requires little maintenance, as there are no moving parts or electrical parts associated. Desludging and silt removal where applicable is the main requirement for primary settlement tanks.

6.2 SECONDARY TREATMENT

6.2.1 SAF PLANTS

A submerged aerated filter normally consists of a primary settlement tank, an aerated submerged biofilm reactor and a secondary settlement tank. This type of system is a well-developed technology and is regularly used for small communities.

6.2.2 CT RANGE

Incoming sewage is separated and stored in the first section of the primary settlement tank, allowing only settled liquor to pass forward for biological treatment.

The biological treatment stage comprises of two separate zones in series, both using submerged aerated filter technology and a well known jet aeration system – the VENTFLO Inductor.

The first biological stage treats the majority of the carbonaceous stage, resulting in a low loading rate for the second stage and a subsequent high overall removal rate.

Biomass (humus stage) sloughed from the submerged media is separated in the final humus settlement stage and returned intermittently by pump to the primary stage for co-settlement.

6.2.3 CONCRETE RANGE

Incoming sewage is separated and stored in the two stage primary settlement tank(s), allowing only settled liquor to pass forward for biological treatment.

The biological treatment tank comprises of select filter media to sustain biological growth and an aeration system comprising of a duty air blower and a diffused aeration system.

The treated effluent then passes to a final settlement tank prior to discharge where any humus sludge or suspended solid material settles out. A timer operated sludge return pump returns sludge intermittently to the primary settlement tank for storage.

6.2.4 SBR – Sequencing Batch Reactor

The Sequencing Batch Reactor process is a form of activated sludge treatment in which aeration, settlement and decanting occur in a single tank.

SBR's can operate as a uni-tank or multiple tank set-up.

The process employs a five stage cycle which may be repeated a number of times per 24 hour period. The five stages include fill, aerate, settle, decant, rest.

The wastewater is pumped into the SBR during the fill stage. The contents are then aerated and mixed prior to a quite settlement phase where all of the biomass and solids settle out. The clear supernatant is then decanted from the system. Following a rest phase the cycle is repeated. Periodically excess sludge is removed from the system during the rest phase and stored prior to removal off-site for treatment and disposal.

The SBR process provides good operational flexibility and allows for the option of incorporating nitrification, denitrification and phosphorous removal. It is a simple and reliable system, ideal for the treatment of varying flow and load conditions. This type of system is of particular benefit when treating wastewater from hotels, pubs and restaurants, etc.

6.2.5 CAS PLANT

The EPS CAS plant is based on conventional activated sludge technology. Each unit is factory built complete with all necessary equipment necessary for efficient operation.

A CAS plant is of steel construction, divided into two major sections – an aeration section and a clarifier. Each unit comprises of an inlet box, aeration header with drop pipes and diffusers, roots type blower including motor, controls, drives and fittings, sludge return and storage.

Following aeration the mixed liquor of activated sludge and treated effluent passes forward to the clarifier where conditions are favourable for the separation of settled sludge and the final effluent prior to discharge. All settled solids are returned continuously to the aeration section for further treatment.

Periodically excess sludge is wasted from the system to a sludge storage tank prior to removal off-site for treatment and disposal.

Nitrification, denitrification and phosphorous removal can also be accommodated with this system.

6.2.6 MBR – Packaged Membrane Bioreactors

MBR technology is a leading edge technology for the treatment of wastewater to a very high standard. Typically a final effluent standard of 5 : 5 : 5, BOD : SS : NH_4 is achieved consistently.

Background

The development of our submerged membrane bioreactor technology was the result of a Japanese Government initiative to produce compact, high quality effluent, treatment plants.

Since producing the first pilot plant using MBR technology in 1989 and the first commercial plant in 1991, over 950 plants have been installed worldwide. These treat a wide range of wastewaters, the principal application being sewage and sludge liquors, but also including industrial and food processing wastewater, and grey water recycling for a wide range of re-use purposes.

Process Description

The process employs simple flat sheet membrane panels housed in stainless steel cases and aerated by a coarse bubble diffuser system. A series of these membranes are submerged within an activated sludge treatment tank. An advantage of this design is that the membrane panels are securely retained and cannot touch or abrade each other, while the cases also act as a flume to ensure effective tank mixing and even distribution of the biomass.

The membrane panels are manufactured with an average pore size of 0.4 microns, which in operation becomes covered by a dynamic layer of protein and cellular material. This further enhances the performance effectiveness of the filtration process by providing an effective pore size of less than 0.01 microns, which is in the ultra-filtration range.

Our membrane bioreactor treatment produces a high quality disinfected effluent. The raw sewage generally only requires screening (to 3mm) and de-gritting prior to entering the membrane bioreactor tank. The process requires no primary or secondary settlement stages and no additional tertiary treatment or UV stages to achieve quality typically better than 5 : 5 : 5 mg/l BOD : Suspended Solids : Ammonia.

The MBR system has a number of inherent advantages. It does not remove the solids by settlement, therefore the biomass can operate at very high levels of mixed liquor suspended solids (MLSS), generally in the order of 12,000-18,000 mg/l, and up to 22,000 mg/l. This high concentration enables a low tank volume and a long sludge age to be utilised, which reduces sludge production and allows a small footprint. The associated viscosity with the suspended solids will affect the cross flow over the membrane surface. It is recommended that in normal operation the MLSS does not routinely go below 10,000 mg/l and that a minimum level of 8,000 mg/l at average flow is recommended.

The maximum hydraulic flow determines the required number of membrane units. Each membrane unit may contain up to 400 flat plate membrane panels housed within a rectangular case, together with an integral aeration system in the bottom section of the unit. Treated effluent is removed from the membrane units using gravity head (typically 1 –1.2m).

The membrane air diffuser typically allows 3-6% uptake of available oxygen at 3.3m-3.5m water depth, dependent on temperature and initial dissolved oxygen levels. Higher uptake rates will be found at lower temperatures and where the influent is initially anoxic.

Aeration is continuous at all times when permeate is flowing through the membrane units. During periods of low influent flow when the permeate flow stops, the aeration blowers can be cut out and will re-start automatically upon permeate flow resuming.

Operational Experience

Operating experience of pilot and main treatment plants has consistently resulted in an effluent of high quality that has little dependence on variations in feed strength and is fully disinfected with bacteria and viruses reduced to below the limits for bathing water or recreational water standards.

By minimising the effect of fouling through controlled cross flow velocities over the membrane surface, cleaning is required typically only twice per year using a backwash of dilute sodium hypochlorite solution into each membrane unit.

The process is designed to run without supervision and by using high quality materials, including stainless steel, the membrane panels and cases have long life expectancies in the most part beyond 10 years.

6.3 TERTIARY TREATMENT

6.3.1 Self-Cleaning Mechanical Sand Filter

EPS offer a self-cleaning up-ward flow mechanical sand filter for flows varying from 2.5m^3/hr up to 45m^3/hr. The stainless steel filters are skid mounted, manufactured, assembled and tested at our workshop in Mallow prior to delivery.

The filter design operates a well known and utilised technology of moving sand with the effluent passing upwards through a downward moving sand bed. The dirty sand is in turn re-circulated through a cleaning mechanism prior to re-entry to the top of the sand bed for further filtration.

Wash water is returned to the treatment plant for solid settlement and treatment at a maximum rate of 5% of the filters overall hydraulic design.

6.3.2 In-Situ Sand Filter

An In-Situ sand filter consists of varying stratified layers of sand and gravel. The treated effluent is distributed evenly over the entire filter area by a gravity distribution system or a pumped distribution system. It then passes down through the various layers of sand and gravel where it is further polished and filtered prior to entering the ground water or surface water.

6.3.3 Reed Bed System

A typically designed reed bed system for tertiary treatment can further improve the quality of an effluent prior to discharge or disposal. A reed bed system will lead to enhanced removal of BOD, COD and suspended solids, as well as ammonia, nitrates and phosphorous, if specifically designed for same.

A reed bed system can operate as a horizontal flow or vertical flow system.

The system comprises of an inlet and outlet and layer of gravel. The surface is planted with reeds known as *Phragmites Australis*, which ensures oxygen transfer down into the gravel bed through the rhizomes.

6.3.4 Disinfection: Ultra Violet (UV)

UV disinfection of a treated effluent prior to disposal is a necessary requirement for many sites. UV light is effective for disinfection as it ruptures the genetic structure of harmful bacteria leading to instantaneous destruction.

EPS offer two ranges of disinfection systems for varying flows and applications. EPS offer the EEFG range for flows of $1m^3$/hr to $40m^3$/hr and the LBX range for flows from 3 to $1000m^3$/hr. Both systems incorporate a reliable self-cleaning mechanism to prevent fouling of lamps during use.

6.4 NUTRIENT REMOVAL

6.4.1 Nitrification

Nitrification is the conversion of ammonium in wastewater to nitrate under aerobic conditions. Within the aeration tank the ammonium is converted firstly to nitrite and then nitrate through the action of autotrophic nitrifying bacteria. These nitrifying bacteria are recycled through the process to maintain high levels of nitrification. Because nitrifying bacteria are slower to reproduce than other heterotrophic bacteria long aeration periods are required to achieve sufficient growth.

6.4.2 Denitrification

Denitrification is the conversion of nitrate to nitrogen gas using suitable heterotrophic bacteria under anoxic conditions. In the absence of a readily available oxygen source the bacteria can use the oxygen available in the NO_3 for cell synthesis thus reducing the NO_3 to N_2. To help with the denitrification process sludge is returned from the end of the aeration system and also from the final settlement tank. This sludge, which is both high in nitrate and biomass, is essential for achieving good denitrification levels.

6.4.3 Phosphate Reduction

To reduce the soluble orthophosphate levels in the treated effluent, ferric sulphate is dosed into the primary settlement tank or the aeration tank. The ferric precipitates out the soluble phosphate and thus reduces the phosphorous levels. Typical P values achieved with dosing would be <2mg/L Total P.

6.5 ADDITIONAL OPTIONS

6.5.1 Screening

EPS offer a range of stainless steel screens for 3mm or 5mm requirements. All screens offered come with washing and compaction if required.

6.5.2 Grease Removal

The entrance of fats, oils and greases (Fogs) into any treatment plant is prohibited. It is imperative that any Fogs are removed by a suitable grease trap prior to entering the waste stream to any plant. Depending on the application and the potential loads of Fogs a number of grease traps are available for selection.

The use of enzyme type grease emulsifiers is not acceptable for the removal of Fogs from waste streams entering a treatment plant.

EPS encourage the use of undersink type systems and three chamber type interceptors that are sufficiently sized, suitably located and regularly maintained and emptied. The entrance of grease to a treatment plant will lead to inefficient operation and mal odours and it is for this reason that effective grease systems are installed.

6.5.3 Flow Splitting Chamber

For applications where duplex systems are proposed, EPS also offer factory assembled flow splitting chambers.

6.5.4 Recirculation Chamber

In applications where denitrification is required, recirculation chambers are available for splitting the final effluent stream and the diversion of a portion of same back to the front end of the treatment plant to an anoxic tank. This ensures that the nitrate is converted to nitrogen gas and water prior to subsequent discharge.

6.5.5 Inlet Pumping Station

Depending on varying site conditions and process selection an inlet pumping station may be required. EPS offer a range of pumping solutions to cater for same and offer a variety of pump type and make as well as sumps in steel or pre-cast concrete.

6.5.6 Outlet Pumping Station

Many applications require that the final treated effluent is pumped to a higher discharge point or onto a pressurised dispersion system (sand filter, etc). EPS offer a number of solutions for this requirement, with each site requiring a specific and individual design.

6.6 INSTRUMENTATION

For additional control and monitoring of treatment plants once installed, EPS offer a range of items that aid in meeting the operational and monitoring requirements of all discharge licences.

- Flow Metering (Inlet and Outlet)
- Remote Monitoring (gsm Dial Out Unit)
- Automatic Sampling
- Datalogging and trending of flows

6.7 OPERATION AND MAINTENANCE

EPS offer both Service Contracts and Full Operation and Maintenance Contracts for plants installed by us or by other companies.

Our operation and maintenance staff offer a service, which includes the following:

- Mechanical and Electrical Maintenance
- Process Operation
- Chemical Supply and Set-Up
- Desludging
- Preventative Maintenance
- Production of Operational Reports for Discharge Licence Requirements
- Trouble-shooting for Existing Plants
- Holiday Cover / Weekend Cover, etc.

6.8 DESIGN OF DISPOSAL SYSTEMS

EPS offer design recommendations for disposal systems for all sites as required. EPS require that a detailed site assessment be carried out. A subsequent site assessment report will then be utilised to design a suitable percolation area, soil polishing filter or sand polishing filter as required.

All recommendations will be in accordance with EPA guidelines and Risk Assessment in accordance with GSI/DOE guidelines.

EPS do not install disposal systems and cannot accept any liability for disposal systems once installed. Disposal systems should at all times be installed in accordance with EPA guidelines or BS6297 which ever is deemed appropriate.

APPENDIX D

Storm Sewer Calculations

STORM SEWER DESIGN by the Modified Rational Method

Global Variables

Pipe Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Location - Scotland & Ireland

Return Period (years)	1
M5-60 (mm)	17.900
Ratio R	0.250
Maximum Rainfall (mm/hr)	50
Foul Sewage (l/s/ha)	0.00
O'flow Setting (*Foul only)	0
Volumetric Runoff Coeff.	0.75
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.000
Min Cover Depth for Optimisation (m)	1.200
Min Vel for Auto Design Only (m/s)	0.76
Min Slope for Optimisation (1:X)	1000
Minimum Outfall Invert (m)	0.000
Ground Level at Outfall (m)	106.830
Outfall Manhole Name	Att. Pond
Outfall Manhole Dia/Length (mm)	0
Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	31.68	0.310	102.2	0.064	4.00	0.0	0.600	o	225
1.001	42.74	0.147	290.8	0.082	0.00	162.9	0.600	o	600
2.000	19.27	0.100	192.7	0.183	4.00	0.0	0.600	o	450
1.002	23.05	0.050	461.0	0.030	0.00	0.0	0.600	o	600
3.000	35.87	0.150	239.1	0.128	4.00	0.0	0.600	o	300
3.001	58.63	0.248	236.4	0.397	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	43.7	4.4	106.500	0.064	0.0	0.0	0.0	1.29	51.4	7.6
1.001	42.2	4.9	105.330	0.146	162.9	0.0	0.0	1.42	402.3	179.6
2.000	44.4	4.2	106.180	0.183	0.0	0.0	0.0	1.46	232.4	22.0
1.002	41.2	5.2	105.183	0.359	162.9	0.0	0.0	1.13	318.8	202.9
3.000	43.1	4.6	106.400	0.128	0.0	0.0	0.0	1.01	71.6	14.9
3.001	40.4	5.6	106.250	0.525	0.0	0.0	0.0	1.02	72.0	57.4

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
4.000	47.74	0.420	113.7	0.087	4.00	0.0	0.600	o	225
1.003	25.11	0.045	558.0	0.032	0.00	0.0	0.600	o	675
5.000	18.86	0.187	100.9	0.004	4.00	0.0	1.500	o	225
5.001	14.94	0.066	226.9	0.012	0.00	0.0	1.500	o	225
5.002	33.10	0.146	226.9	0.014	0.00	0.0	1.500	o	225
5.003	19.97	0.088	226.9	0.018	0.00	0.0	1.500	o	225
5.004	66.59	0.293	226.9	0.021	0.00	0.0	1.500	o	225
5.005	22.02	0.097	226.9	0.019	0.00	0.0	1.500	o	225
5.006	59.54	0.415	143.5	0.014	0.00	0.0	1.500	o	225
6.000	68.32	0.490	139.4	0.095	4.00	0.0	0.600	o	225
1.004	10.15	0.087	116.7	0.009	0.00	0.0	0.600	o	675
7.000	18.84	0.186	101.3	0.004	4.00	0.0	1.500	o	225
7.001	18.28	0.082	223.6	0.003	0.00	0.0	1.500	o	225
7.002	41.51	0.186	223.6	0.008	0.00	0.0	1.500	o	225
7.003	13.23	0.059	223.6	0.012	0.00	0.0	1.500	o	225
7.004	62.68	0.280	223.6	0.022	0.00	0.0	1.500	o	225
7.005	24.33	0.085	287.2	0.014	0.00	0.0	0.600	o	225
7.006	15.87	0.055	287.2	0.017	0.00	0.0	0.600	o	225
7.007	56.69	0.446	127.0	0.018	0.00	0.0	1.500	o	225

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
4.000	42.9	4.6	106.455	0.087	0.0	0.0	0.0	1.23	48.7	10.1
1.003	39.4	5.9	105.058	1.003	162.9	0.0	0.0	1.10	394.5	270.0
5.000	44.2	4.3	106.755	0.004	0.0	0.0	0.0	1.14	45.4	0.5
5.001	43.1	4.6	106.568	0.016	0.0	0.0	0.0	0.76	30.2	1.9
5.002	41.0	5.3	106.502	0.030	0.0	0.0	0.0	0.76	30.2	3.3
5.003	39.8	5.8	106.356	0.048	0.0	0.0	0.0	0.76	30.2	5.2
5.004	36.5	7.2	106.268	0.069	0.0	0.0	0.0	0.76	30.2	6.8
5.005	35.6	7.7	105.975	0.088	0.0	0.0	0.0	0.76	30.2	8.5
5.006	33.8	8.7	105.878	0.102	0.0	0.0	0.0	0.96	38.1	9.3
6.000	41.8	5.0	106.251	0.095	0.0	0.0	0.0	1.11	43.9	10.8
1.004	33.7	8.8	105.013	1.209	162.9	0.0	0.0	2.43	868.0	273.1
7.000	44.2	4.3	106.755	0.004	0.0	0.0	0.0	1.14	45.3	0.5
7.001	42.9	4.7	106.569	0.007	0.0	0.0	0.0	0.77	30.5	0.8
7.002	40.3	5.6	106.487	0.015	0.0	0.0	0.0	0.77	30.5	1.6
7.003	39.6	5.9	106.302	0.027	0.0	0.0	0.0	0.77	30.5	2.9
7.004	36.5	7.2	106.243	0.049	0.0	0.0	0.0	0.77	30.5	4.8
7.005	35.5	7.8	105.962	0.063	0.0	0.0	0.0	0.77	30.5	6.1
7.006	34.9	8.1	105.878	0.080	0.0	0.0	0.0	0.77	30.5	7.6
7.007	33.3	9.0	105.822	0.098	0.0	0.0	0.0	1.02	40.5	8.8

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.005	7.31	0.009	847.7	0.000	0.00	0.0	0.600	o	675

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.005	33.1	9.2	104.926	1.307	162.9	0.0	0.0	0.89	319.2	280.0

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	225	S18	108.130	106.500	1.405	1050
1.001	o	600	S17	108.130	105.330	2.200	1500
2.000	o	450	RW Tank	108.130	106.180	1.500	1350
1.002	o	600	S20	108.130	105.183	2.347	1500
3.000	o	300	S21	108.130	106.400	1.430	1050
3.001	o	300	S22	108.130	106.250	1.580	1200
4.000	o	225	S23	108.130	106.455	1.450	1050
1.003	o	675	S24	108.130	105.058	2.397	1500
5.000	o	225	S25	108.180	106.755	1.200	1050
5.001	o	225	S26	108.130	106.568	1.337	1050
5.002	o	225	S27	108.080	106.502	1.353	1050
5.003	o	225	S28	107.930	106.356	1.349	1050
5.004	o	225	S29	107.830	106.268	1.337	1050
5.005	o	225	S30	107.530	105.975	1.330	1050
5.006	o	225	S31	107.380	105.878	1.277	1050
6.000	o	225	S32	108.130	106.251	1.654	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	31.68	102.2	S17	108.130	106.190	1.715	1500
1.001	42.74	290.8	S20	108.130	105.183	2.347	1500
2.000	19.27	192.7	S20	108.130	106.080	1.600	1500
1.002	23.05	461.0	S24	108.130	105.133	2.397	1500
3.000	35.87	239.1	S22	108.130	106.250	1.580	1200
3.001	58.63	236.4	S24	108.130	106.002	1.828	1500
4.000	47.74	113.7	S24	108.130	106.035	1.870	1500
1.003	25.11	558.0	S33	107.190	105.013	1.502	1500
5.000	18.86	100.9	S26	108.130	106.568	1.337	1050
5.001	14.94	226.9	S27	108.080	106.502	1.353	1050
5.002	33.10	226.9	S28	107.930	106.356	1.349	1050
5.003	19.97	226.9	S29	107.830	106.268	1.337	1050
5.004	66.59	226.9	S30	107.530	105.975	1.330	1050
5.005	22.02	226.9	S31	107.380	105.878	1.277	1050
5.006	59.54	143.5	S33	107.190	105.463	1.502	1500
6.000	68.32	139.4	S33	107.190	105.761	1.204	1500

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.004	o	675	S33	107.190	105.013	1.502	1500
7.000	o	225	S34	108.180	106.755	1.200	1050
7.001	o	225	S35	108.130	106.569	1.336	1050
7.002	o	225	S36	108.080	106.487	1.368	1050
7.003	o	225	S37	107.830	106.302	1.303	1050
7.004	o	225	S38	107.830	106.243	1.362	1050
7.005	o	225	S39	107.530	105.962	1.343	1050
7.006	o	225	S40	107.380	105.878	1.277	1050
7.007	o	225	S41	107.380	105.822	1.333	1050
1.005	o	675	S42	107.090	104.926	1.489	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.004	10.15	116.7	S42	107.090	104.926	1.489	1500
7.000	18.84	101.3	S35	108.130	106.569	1.336	1050
7.001	18.28	223.6	S36	108.080	106.487	1.368	1050
7.002	41.51	223.6	S37	107.830	106.302	1.303	1050
7.003	13.23	223.6	S38	107.830	106.243	1.362	1050
7.004	62.68	223.6	S39	107.530	105.962	1.343	1050
7.005	24.33	287.2	S40	107.380	105.878	1.277	1050
7.006	15.87	287.2	S41	107.380	105.822	1.333	1050
7.007	56.69	127.0	S42	107.090	105.376	1.489	1500
1.005	7.31	847.7	Att. Pond	106.830	104.917	1.238	0

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL. (m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL. (m)	Pipes In D (mm)
S18	108.130	1.630	1050	1.000	106.500	225			
S17	108.130	2.800	1500	1.001	105.330	600	1.000	106.190	225
RW Tank	108.130	1.950	1350	2.000	106.180	450			
S20	108.130	2.947	1500	1.002	105.183	600	1.001 2.000	105.183 106.080	600 450
S21	108.130	1.730	1050	3.000	106.400	300			
S22	108.130	1.880	1200	3.001	106.250	300	3.000	106.250	300
S23	108.130	1.675	1050	4.000	106.455	225			
S24	108.130	3.072	1500	1.003	105.058	675	1.002 3.001 4.000	105.133 106.002 106.035	600 300 225
S25	108.180	1.425	1050	5.000	106.755	225			
S26	108.130	1.562	1050	5.001	106.568	225	5.000	106.568	225
S27	108.080	1.578	1050	5.002	106.502	225	5.001	106.502	225
S28	107.930	1.574	1050	5.003	106.356	225	5.002	106.356	225
S29	107.830	1.562	1050	5.004	106.268	225	5.003	106.268	225
S30	107.530	1.555	1050	5.005	105.975	225	5.004	105.975	225
S31	107.380	1.502	1050	5.006	105.878	225	5.005	105.878	225
S32	108.130	1.879	1200	6.000	106.251	225			
S33	107.190	2.177	1500	1.004	105.013	675	1.003 5.006 6.000	105.013 105.463 105.761	675 225 225
S34	108.180	1.425	1050	7.000	106.755	225			
S35	108.130	1.561	1050	7.001	106.569	225	7.000	106.569	225
S36	108.080	1.593	1050	7.002	106.487	225	7.001	106.487	225
S37	107.830	1.528	1050	7.003	106.302	225	7.002	106.302	225
S38	107.830	1.587	1050	7.004	106.243	225	7.003	106.243	225
S39	107.530	1.568	1050	7.005	105.962	225	7.004	105.962	225
S40	107.380	1.502	1050	7.006	105.878	225	7.005	105.878	225
S41	107.380	1.558	1050	7.007	105.822	225	7.006	105.822	225
S42	107.090	2.164	1500	1.005	104.926	675	1.004 7.007	104.926 105.376	675 225

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
Att. Pond	106.830	1.913	0		OUTFALL		1.005	104.917	675

STORM SEWER DESIGN by the Modified Rational Method

Global Variables

Pipe Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Location - Scotland & Ireland

Return Period (years)	1
M5-60 (mm)	17.900
Ratio R	0.250
Maximum Rainfall (mm/hr)	50
Foul Sewage (l/s/ha)	0.00
O'flow Setting (*Foul only)	0
Volumetric Runoff Coeff.	0.75
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.000
Min Cover Depth for Optimisation (m)	1.200
Min Vel for Auto Design Only (m/s)	0.76
Min Slope for Optimisation (1:X)	1000
Minimum Outfall Invert (m)	0.000
Ground Level at Outfall (m)	108.130
Outfall Manhole Name	S18
Outfall Manhole Dia/Length (mm)	0
Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	50.01	0.172	290.8	0.060	4.00	0.0	0.600	o	225
1.001	23.43	0.081	289.3	0.238	0.00	0.0	0.600	o	300
2.000	54.46	0.900	60.5	0.307	4.00	0.0	0.600	o	225
3.000	18.30	0.453	40.4	0.051	4.00	0.0	0.600	o	225
1.002	23.32	0.042	555.4	0.021	0.00	0.0	0.600	o	375

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	41.6	5.1	106.505	0.060	0.0	0.0	0.0	0.76	30.3	6.8
1.001	40.5	5.5	106.258	0.298	0.0	0.0	0.0	0.92	65.0	32.6
2.000	43.3	4.5	107.800	0.307	0.0	0.0	0.0	1.68	67.0	36.0
3.000	44.6	4.1	106.705	0.051	0.0	0.0	0.0	2.06	82.1	6.1
1.002	39.2	6.0	106.102	0.677	0.0	0.0	0.0	0.76	84.1	71.8

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
4.000	53.41	0.295	181.0	0.051	4.00	0.0	0.600	o	225
1.003	31.51	0.107	294.5	0.077	0.00	0.0	0.600	o	450
1.004	34.90	0.133	262.4	0.066	0.00	0.0	0.600	o	450
5.000	22.56	0.660	34.2	0.487	4.00	0.0	0.600	o	225
6.000	16.95	0.735	23.1	0.050	4.00	0.0	0.600	o	225
1.005	29.99	0.043	692.6	0.039	0.00	0.0	0.600	o	525
7.000	17.59	0.778	22.6	0.046	4.00	0.0	0.600	o	225
1.006	27.07	0.032	848.9	0.223	0.00	0.0	0.600	o	600
8.000	25.32	0.810	31.3	0.050	4.00	0.0	0.600	o	225
1.007	90.00	0.106	849.1	0.114	0.00	0.0	0.600	o	600
1.008	90.00	0.106	849.1	0.141	0.00	0.0	0.600	o	600

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
4.000	42.1	4.9	106.505	0.051	0.0	0.0	0.0	0.97	38.5	5.8
1.003	38.1	6.5	105.985	0.805	0.0	0.0	0.0	1.18	187.6	83.1
1.004	37.1	6.9	105.878	0.871	0.0	0.0	0.0	1.25	198.8	87.5
5.000	44.5	4.2	106.630	0.487	0.0	0.0	0.0	2.25	89.3	58.7
6.000	44.8	4.1	106.705	0.050	0.0	0.0	0.0	2.74	108.8	6.1
1.005	35.9	7.5	105.670	1.447	0.0	0.0	0.0	0.84	182.6	140.7
7.000	44.7	4.1	106.705	0.046	0.0	0.0	0.0	2.76	109.9	5.5
1.006	34.9	8.1	105.552	1.715	0.0	0.0	0.0	0.83	234.0	162.1
8.000	44.5	4.2	106.705	0.050	0.0	0.0	0.0	2.35	93.4	6.0
1.007	32.0	9.9	105.520	1.879	0.0	0.0	0.0	0.83	234.0	162.9
1.008	29.7	11.7	105.414	2.020	0.0	0.0	0.0	0.83	234.0	162.9

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	225	S1	107.930	106.505	1.200	1050
1.001	o	300	S2	108.130	106.258	1.572	1200
2.000	o	225	S3	109.830	107.800	1.805	1200
3.000	o	225	S4	108.130	106.705	1.200	1050
1.002	o	375	S5	108.830	106.102	2.353	1350
4.000	o	225	S6	108.230	106.505	1.500	1200
1.003	o	450	S7	108.330	105.985	1.895	1350
1.004	o	450	S8	108.130	105.878	1.802	1350
5.000	o	225	S9	108.130	106.630	1.275	1050
6.000	o	225	S10	108.130	106.705	1.200	1050
1.005	o	525	S11	108.130	105.670	1.935	1500
7.000	o	225	S12	108.130	106.705	1.200	1050
1.006	o	600	S13	108.130	105.552	1.978	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	50.01	290.8	S2	108.130	106.333	1.572	1200
1.001	23.43	289.3	S5	108.830	106.177	2.353	1350
2.000	54.46	60.5	S5	108.830	106.900	1.705	1350
3.000	18.30	40.4	S5	108.830	106.252	2.353	1350
1.002	23.32	555.4	S7	108.330	106.060	1.895	1350
4.000	53.41	181.0	S7	108.330	106.210	1.895	1350
1.003	31.51	294.5	S8	108.130	105.878	1.802	1350
1.004	34.90	262.4	S11	108.130	105.745	1.935	1500
5.000	22.56	34.2	S11	108.130	105.970	1.935	1500
6.000	16.95	23.1	S11	108.130	105.970	1.935	1500
1.005	29.99	692.6	S13	108.130	105.627	1.978	1500
7.000	17.59	22.6	S13	108.130	105.927	1.978	1500
1.006	27.07	848.9	S15	108.130	105.520	2.010	1500

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
8.000	o	225	S14	108.130	106.705	1.200	1050
1.007	o	600	S15	108.130	105.520	2.010	1500
1.008	o	600	S16	108.130	105.414	2.116	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
8.000	25.32	31.3	S15	108.130	105.895	2.010	1500
1.007	90.00	849.1	S16	108.130	105.414	2.116	1500
1.008	90.00	849.1	S18	108.130	105.308	2.222	0

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL. (m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL. (m)	Pipes In D (mm)
S1	107.930	1.425	1050	1.000	106.505	225			
S2	108.130	1.872	1200	1.001	106.258	300	1.000	106.333	225
S3	109.830	2.030	1200	2.000	107.800	225			
S4	108.130	1.425	1050	3.000	106.705	225			
S5	108.830	2.728	1350	1.002	106.102	375	1.001	106.177	300
							2.000	106.900	225
							3.000	106.252	225
S6	108.230	1.725	1200	4.000	106.505	225			
S7	108.330	2.345	1350	1.003	105.985	450	1.002	106.060	375
							4.000	106.210	225
S8	108.130	2.252	1350	1.004	105.878	450	1.003	105.878	450
S9	108.130	1.500	1050	5.000	106.630	225			
S10	108.130	1.425	1050	6.000	106.705	225			
S11	108.130	2.460	1500	1.005	105.670	525	1.004	105.745	450
							5.000	105.970	225
							6.000	105.970	225
S12	108.130	1.425	1050	7.000	106.705	225			
S13	108.130	2.578	1500	1.006	105.552	600	1.005	105.627	525
							7.000	105.927	225
S14	108.130	1.425	1050	8.000	106.705	225			
S15	108.130	2.610	1500	1.007	105.520	600	1.006	105.520	600
							8.000	105.895	225
S16	108.130	2.716	1500	1.008	105.414	600	1.007	105.414	600
S18	108.130	2.822	0		OUTFALL		1.008	105.308	600

STORM SEWER DESIGN by the Modified Rational Method

Global Variables

Pipe Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Location - Scotland & Ireland

Return Period (years)	1
M5-60 (mm)	16.800
Ratio R	0.250
Maximum Rainfall (mm/hr)	50
Foul Sewage (l/s/ha)	0.00
O'flow Setting (*Foul only)	0
Volumetric Runoff Coeff.	0.75
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.000
Min Cover Depth for Optimisation (m)	1.200
Min Vel for Auto Design Only (m/s)	0.76
Min Slope for Optimisation (1:X)	1000
Minimum Outfall Invert (m)	0.000
Ground Level at Outfall (m)	100.700
Outfall Manhole Name	
Outfall Manhole Dia/Length (mm)	0
Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	14.53	0.191	76.1	0.010	4.00	0.0	1.500	o	225
1.001	14.12	0.062	226.9	0.005	0.00	0.0	1.500	o	225
1.002	23.63	0.437	54.1	0.008	0.00	0.0	1.500	o	225
1.003	44.72	1.585	28.2	0.015	0.00	0.0	1.500	o	225
1.004	49.18	1.855	26.5	0.024	0.00	0.0	1.500	o	225
1.005	60.08	2.100	28.6	0.030	0.00	0.0	1.500	o	225
1.006	33.35	0.343	97.3	0.016	0.00	0.0	1.500	o	225
2.000	32.53	0.428	76.1	0.020	4.00	0.0	1.500	o	225

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	41.7	4.2	106.055	0.010	0.0	0.0	0.0	1.32	52.4	1.1
1.001	40.8	4.5	105.864	0.015	0.0	0.0	0.0	0.76	30.2	1.7
1.002	40.0	4.7	105.802	0.023	0.0	0.0	0.0	1.56	62.1	2.5
1.003	39.0	5.1	105.365	0.038	0.0	0.0	0.0	2.17	86.1	4.0
1.004	38.1	5.5	103.780	0.062	0.0	0.0	0.0	2.23	88.8	6.4
1.005	37.0	5.9	101.925	0.092	0.0	0.0	0.0	2.15	85.5	9.2
1.006	35.9	6.4	99.825	0.108	0.0	0.0	0.0	1.16	46.3	10.5
2.000	41.0	4.4	106.055	0.020	0.0	0.0	0.0	1.32	52.4	2.2

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
2.001	15.89	0.070	226.3	0.006	0.00	0.0	1.500	o	225
2.002	67.08	1.777	37.8	0.022	0.00	0.0	1.500	o	225
2.003	50.28	1.855	27.1	0.023	0.00	0.0	1.500	o	225
2.004	53.58	1.855	28.9	0.023	0.00	0.0	1.500	o	225
2.005	37.88	0.565	67.1	0.014	0.00	0.0	1.500	o	225
2.006	6.67	0.023	291.4	0.012	0.00	0.0	0.600	o	225
1.007	8.51	0.207	41.1	0.000	0.00	0.0	1.500	o	225

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
2.001	40.0	4.8	105.627	0.026	0.0	0.0	0.0	0.76	30.3	2.8
2.002	38.3	5.4	105.557	0.048	0.0	0.0	0.0	1.87	74.4	5.0
2.003	37.4	5.7	103.780	0.071	0.0	0.0	0.0	2.21	87.9	7.2
2.004	36.4	6.2	101.925	0.094	0.0	0.0	0.0	2.14	85.1	9.3
2.005	35.5	6.6	100.070	0.108	0.0	0.0	0.0	1.40	55.8	10.4
2.006	35.2	6.7	99.505	0.120	0.0	0.0	0.0	0.76	30.3	11.4
1.007	35.0	6.8	99.482	0.228	0.0	0.0	0.0	1.79	71.3	21.6

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	225	S1	107.480	106.055	1.200	1050
1.001	o	225	S2	107.480	105.864	1.391	1050
1.002	o	225	S3	107.400	105.802	1.373	1050
1.003	o	225	S4	106.790	105.365	1.200	1050
1.004	o	225	S5	105.205	103.780	1.200	1050
1.005	o	225	S6	103.350	101.925	1.200	1050
1.006	o	225	S7	101.250	99.825	1.200	1050
2.000	o	225	S8	107.480	106.055	1.200	1050
2.001	o	225	S9	107.480	105.627	1.628	1200
2.002	o	225	S10	107.400	105.557	1.618	1200
2.003	o	225	S11	105.205	103.780	1.200	1050
2.004	o	225	S12	103.350	101.925	1.200	1050
2.005	o	225	S13	101.495	100.070	1.200	1050
2.006	o	225	S14	100.930	99.505	1.200	1050
1.007	o	225	S15	100.920	99.482	1.213	1050

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	14.53	76.1	S2	107.480	105.864	1.391	1050
1.001	14.12	226.9	S3	107.400	105.802	1.373	1050
1.002	23.63	54.1	S4	106.790	105.365	1.200	1050
1.003	44.72	28.2	S5	105.205	103.780	1.200	1050
1.004	49.18	26.5	S6	103.350	101.925	1.200	1050
1.005	60.08	28.6	S7	101.250	99.825	1.200	1050
1.006	33.35	97.3	S15	100.920	99.482	1.213	1050
2.000	32.53	76.1	S9	107.480	105.627	1.628	1200
2.001	15.89	226.3	S10	107.400	105.557	1.618	1200
2.002	67.08	37.8	S11	105.205	103.780	1.200	1050
2.003	50.28	27.1	S12	103.350	101.925	1.200	1050
2.004	53.58	28.9	S13	101.495	100.070	1.200	1050
2.005	37.88	67.1	S14	100.930	99.505	1.200	1050
2.006	6.67	291.4	S15	100.920	99.482	1.213	1050
1.007	8.51	41.1		100.700	99.275	1.200	0

MANHOLE SCHEDULES

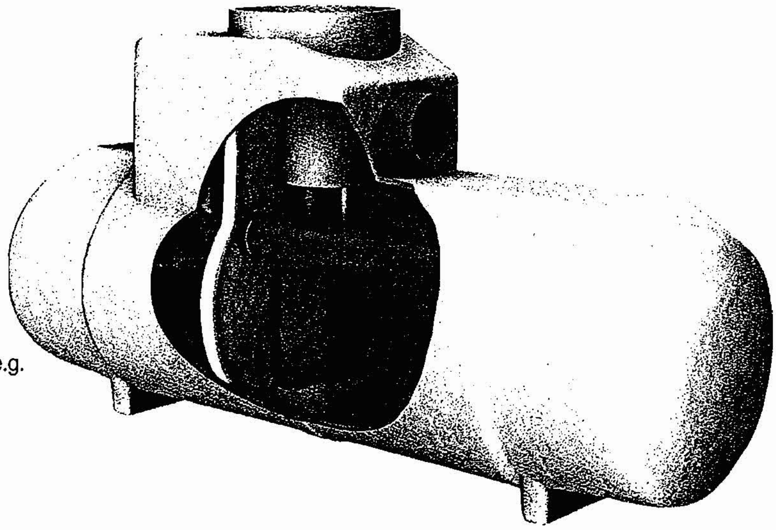
M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
S1	107.480	1.425	1050	1.000	106.055	225			
S2	107.480	1.616	1050	1.001	105.864	225	1.000	105.864	225
S3	107.400	1.598	1050	1.002	105.802	225	1.001	105.802	225
S4	106.790	1.425	1050	1.003	105.365	225	1.002	105.365	225
S5	105.205	1.425	1050	1.004	103.780	225	1.003	103.780	225
S6	103.350	1.425	1050	1.005	101.925	225	1.004	101.925	225
S7	101.250	1.425	1050	1.006	99.825	225	1.005	99.825	225
S8	107.480	1.425	1050	2.000	106.055	225			
S9	107.480	1.853	1200	2.001	105.627	225	2.000	105.627	225
S10	107.400	1.843	1200	2.002	105.557	225	2.001	105.557	225
S11	105.205	1.425	1050	2.003	103.780	225	2.002	103.780	225
S12	103.350	1.425	1050	2.004	101.925	225	2.003	101.925	225
S13	101.495	1.425	1050	2.005	100.070	225	2.004	100.070	225
S14	100.930	1.425	1050	2.006	99.505	225	2.005	99.505	225
S15	100.920	1.438	1050	1.007	99.482	225	1.006 2.006	99.482 99.482	225 225
	100.700	1.425	0		OUTFALL		1.007	99.275	225

APPENDIX E

Bypass Separator Specification Sheet

Bypass Separator

NSBD Range



Application

Bypass separators are used when it is considered an acceptable risk not to provide full treatment, for very high flows, and are used, for example, where the risk of a large spillage and heavy rainfall occurring at the same time is small, e.g.

- Surface car parks
- Roadways
- Lightly contaminated commercial areas

Performance

Klargester are the first UK manufacturer to have separators tested to EN 858-1. Klargester have now added the NSBD bypass range to their portfolio of certified and tested models. The NSBD number denotes the maximum flow at which the separator treats liquids. The British Standards Institute (BSI) tested the required range of Klargester full retention separators and certified their performance in relation to their flow and process performance assessing the effluent qualities to the requirements of BS EN 858-1. Klargester bypass separator designs follow the parameters determined during the testing of the required range of bypass separators.

Each bypass separator design includes the necessary volume requirements for:

- Oil separation capacity
- Oil storage volume
- Silt storage capacity
- Coalescer

The unit is designed to treat 10% of peak flow. The calculated drainage areas served by each separator are indicated according to the formula given by PPG3 NSBD = 0.0018A(m^2). Flows generated by higher rainfall rates will pass through part of the separator and bypass the main separation chamber.

Class I separators are designed to achieve a concentration of 5mg/litre of oil under standard test conditions.

Class II separators are designed to achieve a concentration of 100mg/litre of oil under standard test conditions.

Features

- Light and easy to install
- Class I and Class II designs
- Inclusive of silt storage volume
- Fitted inlet/outlet connectors
- Vent points within necks
- Oil alarm system available (required by BS EN 858-1 and PPG3)
- Extension access shafts for deep inverts
- Maintenance from ground level

To specify a nominal size Bypass Separator, the following information is needed:-

- The calculated flow rate for the drainage area served. Our designs are based on the assumption that any interconnecting pipework fitted elsewhere on site does not impede flow into or out of the separator and that the flow is not pumped
- The required discharge standard. This will decide whether a Class I or Class II unit is required
- The drain invert inlet depth
- Pipework type, size and orientation

Sizes & Specifications:

Nominal Size	Flow (l/s)	Peak Flow Rate (l/s)	Drainage Area (m²) PPG3 (0.0018)	Silt Storage Capacity Litres	Oil Storage Capacity Litres	Length	Dia.	Access Shaft Diameter	Base to Inlet	Base to Outlet Invert	Standard Fall Across Unit	Min. Inlet Invert	Standard Pipework Diameter
NSBD3	3	30	1670	300	45	1765	1225	750	1450	1350	100	500	160
NSBD4	4.5	45	2500	450	68	1765	1225	750	1450	1350	100	500	200
NSBD6	6	60	3335	600	90	1765	1225	750	1450	1350	100	500	200
NSBD8	8	80	4445	800	120	3065	1225	750	1450	1350	100	500	250
NSBD10	10	100	5560	1000	150	3065	1225	750	1450	1350	100	500	315
NSBD12	12	120	6670	1200	180	3915	1225	750	1450	1350	100	500	315
NSBD15	15	150	8335	1500	225	3915	1225	750	1450	1350	100	500	315
NSBD18	18	180	10000	1800	270	3200	2012	600	2110	2010	100	1000	375
NSBD24	24	240	13340	2400	360	3200	2012	600	2110	2010	100	1000	375
NSBD30	30	300	16670	3000	450	3915	2012	600	2110	2010	100	1000	450
NSBD36	36	360	20000	3600	540	3915	2012	600	2110	2010	100	1000	525
NSBD55	55	550	30560	5500	825	5085	2820	600	2310	2060	250	1000	600
NSBD72	72	720	40000	7200	1080	5820	2820	600	2310	2060	250	1000	675
NSBD84	84	840	46670	8400	1260	6200	2820	600	2310	2010	300	1000	750
NSBD96	96	960	53340	9600	1440	7375	2820	600	2310	2010	300	1000	825
NSBD110	110	1100	61110	11000	1650	7925	2820	600	2360	2010	350	1000	825
NSBD130	130	1300	72225	13000	1950	8725	2820	600	2360	2010	350	1000	825

APPENDIX F

Flow Control Unit

Hydro-Valve
Vortex Flow Control

Storm Water Flow Control

The Hydro-Valve is a vortex flow control device for controlling stormwater flow to a specific rate before discharge into a local storm drain or water course. Sizes are available between 1 –200 l/s depending on head height.

Design

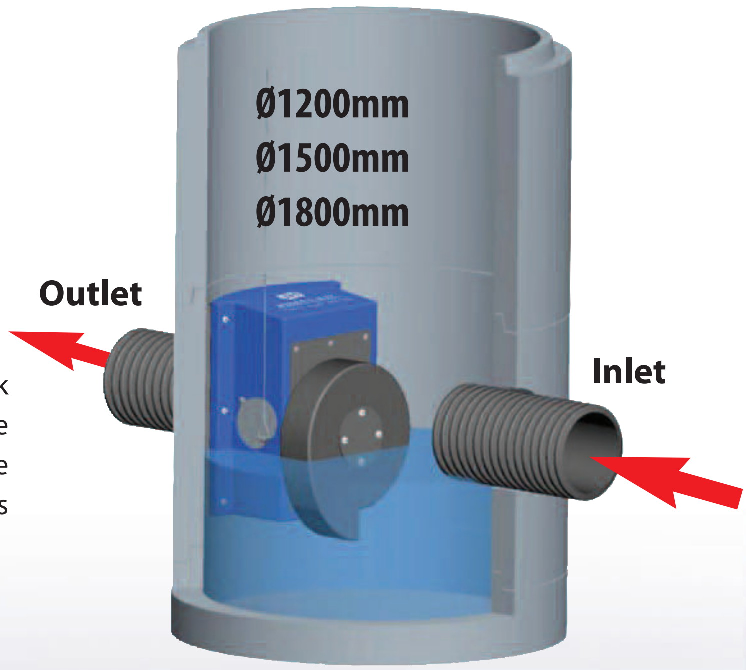
JFC Hydro-Valves are manufactured to customer specifications. They are custom designed to achieve a specified design flow rate at a given head height. The units are designed to fit into one of the following manhole types depending on specification

- Ø1200mm
- Ø1500mm
- Ø1800mm
- Rectangular Manhole

- Customised Specification
- No Moving Parts
- Self Activating
- Self Cleansing
- Manual By-Pass
- Easy Installation
- 3-6 Times Greater Orifice CSA
- Hydraulic Data Available

Quality Assurance

JFC Hydro-Valves are manufactured to ISO 9001:2000 quality assurance system.



Installation

JFC Hydro-Valves unique patented design allows for quick and easy installation onto various types of manholes (see above). The unit is fixed to the inside wall of the manhole with a number of steel stud anchors. A manual by-pass is also incorporated in the valve for remote operation in the unlikely event of a blockage.

APPENDIX G

Attenuation Requirements

Extreme Rainfall Return Periods

Location: Tralee
Average Annual Rainfall: 1224

Maximum rainfall (mm) of indicated duration expected in the indicated return period.

	Return Period (years)								
Duration	1/2	1	2	5	10	20	50	100	30
1 min				1.6	1.8	2.1	2.5	2.9	2.3
2 min				2.7	3.1	3.6	4.4	5.0	3.9
5 min				4.8	5.5	6.5	8.0	9.1	7.1
10 min				6.9	8.0	9.4	11.8	13.5	10.4
15 min	4.5	5.6	6.2	8.3	10.1	12.0	15.1	18	13.3
30 min	6.3	7.7	8.6	11.4	13.7	16.2	20	23	17.9
60 min	8.6	10.4	11.6	15.3	18.2	22	27	31	24
2 hour	11.5	14.0	15.4	19.8	23	27	33	38	29
4 hour	16.7	19.9	21.6	27	32	36	43	49	39
6 hour	20.5	24.2	26	33	38	43	51	58	46
12 hour	27.5	32	35	44	50	57	66	75	61
24 hour	34	40	44	54	61	69	80	90	74
48 hour	43	51	55	67	75	85	98	110	90

Notes: Larger margins of error for 1, 2 ,5 and 10 minute values and for 100 year return periods
M560: 15.3 M52d: 63 M560/m52d: 0.24

Project Name: Development at Scart Cross, Farranfore
Project No.: MGE0109 - Attenuation Pond

INPUT PARAMETERS:

Total Impermeable Area :	3.86 ha			
Total Area :	4.86 ha			
Greenfield Runoff:	23.51 l/s/ha			
Greenfield runoff rate:	90.66 l/s			
Additional runoff (base flow):	0.00 l/s			
Volume Out (Greenfield+baseflow):	90.66 l/s	=	0.0907	cu.m/s

STORAGE VOLUME CALCULATION

Storm Duration		10 Year RP				20 Year RP				30 Year RP			
Min.	Second	Rainfall (mm)	V_{iN} (m^3)	V_{Out} (m^3)	Storage (m^3)	Rainfall (mm)	V_{iN} (m^3)	V_{Out} (m^3)	Storage (m^3)	Rainfall (mm)	V_{iN} (m^3)	V_{out} (m^3)	Storage (m^3)
1 min	60	1.8	69.05	5.44	63.61	2.1	80.43	5.44	74.99	2.3	87.78	5.44	82.34
2 min	120	3.1	118.38	10.88	107.50	3.6	138.38	10.88	127.50	3.9	151.34	10.88	140.46
5 min	300	5.5	213.01	27.20	185.81	6.5	250.26	27.20	223.06	7.1	274.48	27.20	247.28
10 min	600	8.0	306.96	54.40	252.57	9.4	363.77	54.40	309.37	10.4	400.95	54.40	346.55
15 min	900	10.1	388.09	81.59	306.50	12.0	463.23	81.59	381.64	13.3	512.69	81.59	431.10
30 min	1800	13.7	526.86	163.19	363.68	16.2	625.85	163.19	462.66	17.9	688.81	163.19	525.63
60 min	3600	18.2	701.39	326.37	375.02	21.5	829.77	326.37	503.40	23.6	910.06	326.37	583.68
2 hour	7200	23.3	896.69	652.75	243.94	27.0	1,040.84	652.75	388.09	29.4	1,133.21	652.75	480.47
4 hour	14400	31.6	1,218.58	1,305.49	-86.92	36.0	1,386.83	1,305.49	81.34	38.9	1,500.76	1,305.49	195.27
6 hour	21600	37.8	1,459.24	1,958.24	-499.00	43.1	1,662.48	1,958.24	-295.76	46.4	1,789.85	1,958.24	-168.40
12 hour	43200	49.6	1,913.92	3,916.48	-2002.56	56.5	2,180.67	3,916.48	-1735.81	60.6	2,336.26	3,916.48	-1580.22
24 hour	86400	60.8	2,346.47	7,832.96	-5486.49	68.8	2,654.26	7,832.96	-5178.71	73.6	2,837.37	7,832.96	-4995.59
48 hour	172800	75.4	2,908.40	15,665.92	-12757.52	84.7	3,265.83	15,665.92	-12400.09	90.3	3,483.20	15,665.92	-12182.72