N4 Collooney to Castlebaldwin, Proposed Road Development

APPENDIX NO. 4.1

Operation Stage Drainage Information

PREPARED BY:

National Road Design, Sligo County Council,

(with additional input from CST Group, Anthony McCloy Consulting and Hydro Environmental Ltd.);



Document Control

Status	Issued For	Signed	Approved
FINAL	Publication	FM	AS

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1 Introduction

1.1 Introduction

This appendix to the EIS provides a general overview of the drainage design for the *Proposed Road Development* including information on:

- Design Flows;
- Drainage Catchments and Outfalls;
- Outfall Capacities;
- Constructed Wetland/Attenuation Pond design; and
- Culvert sizes for what are considered to be the main crossing points on the *Proposed Road Development.*

The information contained herein has been extracted and summarised from the detailed information contained within the design report.

2 Design Flows

2.1 Return Period Rainfall depths for Sliding durations

Return Period Rainfall Depths for sliding Durations

Site Location: Easting: 171052 Northing: 319356

Average Annual Rainfall (1961-1990) for Collooney: 1182mm

Table 2-1: Return Period Rainfall Depths

Average Recurrence		Return Period													
Interval	Years														
DURATION	6months	1	2	3	4	5	10	20	30	50	75	100	150	200	250
5 mins	2.5	3.5	4	4.8	5.4	5.8	7.2	8.8	9.8	11.2	12.5	13.5	15.1	16.2	17.2
10 mins	3.5	4.9	5.6	6.7	7.5	8.1	10	12.2	13.6	15.7	17.4	18.8	21	22.6	24
15 mins	4.1	5.7	6.6	7.9	8.8	9.5	11.8	14.4	16	18.4	20.5	22.2	24.7	26.6	28.2
30 mins	5.4	7.5	8.6	10.2	11.3	12.2	14.9	18.1	20.1	22.9	25.5	27.4	30.4	32.7	34.6
1 hours	7.1	9.8	11.1	13.2	14.5	15.6	18.9	22.7	25.2	28.6	31.6	33.9	37.4	40.1	42.4
2 hours	9.4	12.7	14.4	16.9	18.6	19.9	24	28.6	31.5	35.6	39.1	41.9	46	49.2	51.9
3 hours	11.1	14.9	16.8	19.6	21.5	23	27.6	32.7	35.9	40.5	44.4	47.4	52	55.5	58.4
4 hours	12.5	16.6	18.7	21.8	23.9	25.4	30.4	35.9	39.4	44.3	48.5	51.8	56.7	60.4	63.5
6 hours	14.7	19.4	21.8	25.3	27.6	29.4	35	41.1	45	50.4	55.1	58.6	64	68.1	71.5
9 hours	17.3	22.6	25.4	29.3	31.9	33.9	40.2	47	51.3	57.3	62.4	66.4	72.3	76.8	80.5
12 hours	19.4	25.3	28.3	32.6	35.4	37.5	44.3	51.7	56.3	62.7	68.3	72.5	78.8	83.6	87.6
18 hours	22.8	29.5	32.9	37.8	40.9	43.3	50.9	59.1	64.3	71.3	77.4	82	89	94.3	98.6
24 hours	25.6	33	36.6	41.9	45.4	48	56.2	65	70.6	78.1	84.7	89.6	97	102.6	107.2
2 days	34.1	42.4	46.4	52.2	55.9	58.7	67.3	76.4	82	89.6	96.1	100.9	108.1	113.6	117.9
3 days	41.3	50.4	54.8	60.9	64.9	67.8	76.8	86.2	92	99.7	106.2	111.1	118.3	123.7	128
4 days	47.9	57.7	62.3	68.8	72.9	76	85.4	95	100.9	108.8	115.4	120.3	127.6	133	137.3

NOTES:

- These values are derived from a Depth Duration Frequency (DDF) Model;
- For frequencies less than two years Average Recurrence Intervals (ARI) are used;
- For details refer to:
 - Fitzgerald D. L. (2007) Estimates of Point Rainfall Frequencies Technical Note No. 61 Met Eireann Dublin
- Available for download at <u>www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-</u> <u>Frequencies TN61.pdf</u>.

2.2 Design Surface Water Flow

Table 2-2: Rainfall Events for Design Surface Water Flow

Rainfall Events For Design Surface Water Flow						
From Table 3.2 - 100 year 1hr event	33.9	mm/hr				
Including Climate Change	40.68	mm/hr				
From Table 3.2 - 10 year 1hr event	18.9	mm/hr				
Including Climate Change	22.68	mm/hr				
NOTES:						
Apply 20% for Climate Change						

3 Drainage Catchments & Outfalls

The *Proposed Road Development* is located wholly with the Western River Basin District (WRBD), which is a largely rural area with many high quality waters and protected sites that depend on water. The WRBD is defined as the physiographical region within hydrometric areas 29-35 that drain in to the Atlantic Ocean, covers an area of 12,193km², comprises 89 river catchments with over 14,200km of river and contains the subcatchments of Unshin River, its sub-catchments and Lough Arrow. The *Proposed Road Development* is entirely located in Hydrometric Area 35 and crosses drains and streams which discharge to the Unshin River and Lough Arrow.

3.1 Outfall Locations

The following outlines the approx. location of the proposed drainage outfalls. Chapter 14 of this EIS assesses the impacts which the provision of the *Proposed Road Development* will have on these outfalls.

Outfall No. 01

Outfall number 01 is located within the townland of Rathrippin. The outfall accepts treated and attenuated road runoff from an existing attenuation pond in the townland of Toberbride, it consists of a storm water pipe which occurs 950m up-gradient of its discharge to the Owenmore River. The pipe ranges in diameter from 600mm at the inlet point to 1050mm at the outfall point to the Owenmore.

The outfall point occurs circa 950m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 02

Outfall number 02 is located within the townland of Ardcurley. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- The Markree Demesne Stream (which is on average 3.m wide (top width) and 1m deep) over circa 575m to the Unshin River.

The outfall point occurs circa 490m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 03

Outfall number 03 is located within the townland of Ardcurley. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 4.5m wide (top width) and 1m deep) over circa 280m to the Unshin River.

The outfall point occurs circa 130m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 04

Outfall number 04 is located within the townland of Doorly. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 3.2m wide (top width) and 1m deep) over circa 660m to the Turnalaydan Stream.

The outfall point occurs circa 660m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 05

Outfall number 05 is located within the townland of Knocknagroagh. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 1.7m wide (top width) and 0.7m deep) over circa 170m to the Turnalaydan Stream.

The outfall point occurs circa 170m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 06

Outfall number 06 is located within the townland of Knocknagroagh. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the:

- Turnalaydan Stream (which is on average 10m wide (top width) and 2m deep).

The outfall point occurs circa 300m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 07

Outfall number 07 is located within the townland of Drumfin. The outfall occurs in a proposed new open drain circa 280m downstream of the discharge of treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the:

- The Turnalaydan Stream (which is on average 10m wide (top width) and 2m deep).

The outfall point occurs circa 600m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 08

Outfall number 08 is located within the townland of Drumfin. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 4m wide (top width) and 1.4m deep) over circa 650m to the Turnalaydan Stream before discharging to Lough Corran which a further circa 1,130m downstream.

The outfall point occurs circa 3120m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 09

Outfall number 09 is located within the townland of Carrownagark. The outfall occurs in a proposed new open drain circa 175m downstream of the discharge of treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the:

- Drumfin River (which is on average 6m wide (top width) and 1.7m deep).

The outfall point occurs circa 1400m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 10

Outfall number 10 is located within the townland of Carrownagark. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 4.5m wide (top width) and 1.0m deep) over circa 225m; to a tributary of the Unshin River at a point which is a further distance of c. 2215m upstream from the Unshin River.

The outfall point occurs circa 2120m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 11

Outfall number 11 is located within the townland of Kingsbrook. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 3.1m wide (top width) and 0.7m deep) over circa 250m; to a tributary of the Unshin at a point which is a further distance circa c. 2920m upstream from the Unshin River.

The outfall point occurs circa 2550m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 12

Outfall number 12 is located within the townland of Aghalenane. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 2.8m wide (top width) and 1.2m deep) over circa 22m to the Ardloy Loughs (2 existing ponds in sequence). It then discharges to the Aghalenane Lough (215m

between both Loughs). The outflow from this lough discharges to a tributary of the Unshin which is circa 2700m from the Unshin River.

The outfall point occurs circa 2720m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 13

Outfall number 13 is located within the townland of Springfield. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the

- The Springfield Stream (which is on average 3.8m wide (top width) and 2m deep) which then discharges to the Swallow Hole/Turlough Complex at Tawnagh townland.

Outfall No. 14

Outfall number 14 is located within the townland of Sheerevagh. The outfall occurs in a proposed new open drain circa 160m downstream of the discharge of treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It then discharges to the:

- Lissycoyne Stream (which is on average 4.5m wide (top width) and 1.8m deep) at a point which is circa c. 1755m upstream from the Unshin River.

The outfall point occurs circa 1540m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 15

Outfall number 15 is located within the townland of Castlebaldwin. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via the:

- Drumderry Stream (which is on average 3.3m wide (top width) and 2m deep) at a point which is circa c. 2400m upstream from Lough Arrow.

The outfall point occurs circa 780m upstream from the boundary of the Lough Arrow cSAC/pNHA.

4 Outfall Capacities

4.1 Outfall Capacities

The following table demonstrates the effect which the provision of the Proposed Road Development will have on receiving watercourses. This table is also reproduced in Chapter 14 of the EIS where the effects of same are considered. Additionally; the Flood Risk Assessment contained within Appendix 4.2 (volume 4) of this EIS considers the Flood Risk associated with the Proposed Road Development on receiving watercourses.

	Without Attenuation								
Outfall ID	Existing Capacity	Existing Flow Calculated (1 in 100 Year Event)	Catchment Flow Post Road Construction	Flow From Proposed Road Surface (1 in 100 Year Event)	Required Capacity	Difference	Increase in peak flood		
	(m³/s)	(m ³ /s)	(m ³ /s)	(m³/s)	(m ³ /s)	(m³/s)	(m³/s)		
1	0.729	0.721	0	0.425	1.146	0.425	0.425		
2	3.028	1.62	2.12	0.961	3.081	1.461	1.461		
3	4.567	1.807	1.807	0.418	2.225	0.418	0.418		
4	0.698	0.916	0.916	0.179	1.095	0.179	0.179		
5	0.509	0.118	0.118	0.013	0.131	0.013	0.013		
6	40.894	18.167	18.095	1.144	19.239	1.072	1.072		
7	5.055	17.833	17.752	0.575	18.327	0.494	0.494		
8	4.560	1.685	1.500	0.381	1.881	0.196	0.196		
9	2.824	24.940	24.940	0.174	25.114	0.174	0.174		
10	0.358	0.747	0.634	0.334	0.968	0.221	0.221		
11	0.742	0.924	0.885	0.193	1.078	0.154	0.154		
12	2.097	1.232	1.232	0.043	1.275	0.043	0.043		
13	3.062	4.700	4.619	0.079	4.697	-0.003	-0.003		
14	3.083	4.129	4.056	0.675	4.731	0.602	0.602		
15	2.193	4.903	4.806	0.423	5.229	0.326	0.326		

Table 4-1:	Fxistina	and	required	outfall	capacities
1001C + 1.	Existing	unu	reguireu	outjuii	capacities

	With Attenuation								
Outfall ID	Existing Capacity	Existing Flow Calculated (1 in 100 Year Event)	Catchment Flow Post Road Construction	Attenuated Flow From Proposed Road Surface (1 in 100 Year Event)	Required Capacity	Difference	Increase in peak flood		
	(m³/s)	(m ³ /s)	(m³/s)	(m³/s)	(m³/s)	(m³/s)	(m ³ /s)		
1	0.729	0.721	0	0.024	0.024	-0.705	-0.705		
2	3.028	1.620	2.120	0.193	2.313	0.693	0.693		
3	4.567	1.807	1.807	0.082	1.888	0.082	0.082		
4	0.698	0.916	0.916	0.032	0.948	0.032	0.032		
5	0.509	0.118	0.118	0.002	0.120	0.002	0.002		
6	40.894	18.167	18.095	0.222	18.317	0.150	0.150		
7	5.055	17.833	17.752	0.115	17.867	0.033	0.033		
8	4.560	1.685	1.500	0.073	1.573	-0.112	-0.112		
9	2.824	24.940	24.940	0.030	24.970	0.030	0.030		
10	0.358	0.747	0.634	0.066	0.700	-0.047	-0.047		
11	0.742	0.924	0.885	0.033	0.918	-0.006	-0.006		
12	2.097	1.232	1.232	0.018	1.249	0.018	0.018		
13	3.062	4.700	4.619	0.014	4.633	-0.067	-0.067		
14	3.083	4.129	4.056	0.137	4.193	0.064	0.064		
15	2.193	4.903	4.806	0.085	4.891	-0.012	-0.012		

5 Constructed Wetlands/Attenuation Ponds Sizing

5.1 Introduction

The following is a brief overview of the design characteristics¹ of the various Constructed Wetlands/Attenuation Ponds proposed along the route of the Proposed Road Development. This overview is a summary of design calculations contained within the design report for the *Proposed Road Development*.

In general the ponds have been designed in accordance with the criteria set out in section 4.8.2.2.2.3 of Chapter 4 of the EIS (volume 2). That is with the exception of the existing pond at Toberbride which is being retrofitted to accept the road runoff from the Proposed Road Development and which will simply provide attenuation to the existing Greenfield Runoff Rate calculated as 8.9l/s.

The designs are generally described in analytical format with the exception of Outfall 01 which is described in descriptive format.

5.2 Outfall 1

Attenuation lagoons were constructed adjacent to the N4 / N17 roundabout at Toberbride townland in 2006.

The purpose of these lagoons was to assist in the attenuation of surface water run-off from the adjacent Toberbride business park.

Between 2006 and present only the infrastructure roads and drainage together with a minor portion of the business park has been constructed. The granted planning permission for the remainder of the business park has now lapsed. In 2006 planning for the business park was granted under 3 separate applications. Two of the three application area for the Toberbride Business Park were granted with no demand for attenuation of the surface flows, therefore the attenuation lagoon is sized to restrict to green field run-off for only a portion of the initial proposed development. The remainder of the development has the benefit of unrestricted flow from the site through the adjacent (SL Developments) business park and ultimately discharging to the Owenmore river. The industrial units that have been constructed on the Toberbride business park are included in the grant of planning that did not require attenuated discharge.

It is the intent of the roads scheme to make use of the attenuation lagoons as retention basins, thereby assisting in the removal of suspended solids from the 'first flush' wash off from the road surface. Often this first flush will also contain an element of hydrocarbons from the road surface. In order to remove these hydrocarbons from this flow an interceptor will be installed in advance of the lagoons.

The design for the storm sewer network and lagoons has been undertaken with use of the MicroDrainage WinDes software package. The default values for the design storm are a M5-60 of 18mm/hr and rainfall return factor (R) value of 0.3. The design has been undertaken by assuming a typical 2 year return period storm. This design original design for these lagoons indicated a top of bank level of 36.6m thus it is possible that the lands adjacent to the lagoon may be flooded to a depth of equivalent to 200mm of the lagoon area. It is considered that this depth/volume of water will not impact on the adjacent road network.

The lagoon during the 100 year 1440 min storm will be catering for a maximum volume of 2087m3 (including the overflow volume). Due to the restrictor on the outflow of 28.2l/sec (green field equivalent) the lagoons will empty the 1440 minute duration storm within 20.5 hrs of the storm event passing.

¹ The Design of the pond at OF 01 has been prepared by the CST Group. The remaining ponds have been design by the National Road Design Department of Sligo County Council.

5.3 Outfall 2

Pond Storage & Trea	atment Ca	lcs:	Outfal	l Number 02
Location		SOIL	Soil Type	SAAR
Ardcurley Td.		0.47	4	1182
		0.17		1102
	Catchment	Areas	1	
Element	Pavement	Verge	Grass	Unit
Catchment Areas	5.4747	2.1045	3.4539	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	5.200965	1.578375	1.72695	ha
	NTERCEPTION			
Calculate Runoff from	5mm of Rain	fall on the Develo	pment Area	
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	5.200965	1.578375	1.72695	ha
Minimum Interception Storage	260.04825	78.91875	86.3475	m ³
	TREATMENT S	TORAGE	· ·	
The Treatment Stora	age (Wet pond	l volume) needeo	for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	5.2010	1.5784	1.7270	ha
Minimum Treatment Storage m ³	780.1448	236.7563	259.0425	m ³
QBAR AND DISC	HARGE RATES	FOR PONDS/WET	LANDS	·
	QBAR Det	tails		
QBar Per Hec	tare		8.91	l/sec/ha
Actual Catchme	nt Area		11.024	ha
QBar for Actual Catc	hment Area		98.2	l/s
QBA	AR factors for F	lood Events		
[leo	d Event			Q For Catchmen
				l/s
Q 1 year (1 year throttle); FS	SR Growth curv	ve factor is 0.87.		85.47
Q 2 year (2 year throttle); FS	SR Growth curv	ve factor is 0.95.		93.33
Q 30 year (30 year throttle); I				161.11
Q 100 year (100 year throttle)	192.55			
Difference	75.64			
Difference	31.44			
Difference	in QBar - Q1			12.77
LONG TERM	/I STORAGE (Ex	tra Volume Runo	ff)	
Based on a 1 in	n 100 year sto	rm and a 6 hour e	event.	
	e Volume			

Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	425		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	1276		1276	
	River Regime Pr			
	2.1 & 2.2 "Atten			- 2 (C NI- 4)
Criterion	m3	(See Nb. 1)	-	n 2 (See Nb. 1)
For Q 1 year	693	Notes	m3 0	Notes
For Q 30 year			0	
	2,267		U	
For Q 100 year	3,470		0	
Total m3	6,430		-	
Less Long term Storage	1,397		-	
Provide Attenuation Storage	5032		0	
N/A: Del	fined at detailed	or the Site		
	fined at detailed	design phase		
		design phase		
4	fined at detailed . River Flood Pro	design phase		2 (Coo NH 4)
	fined at detailed . River Flood Pro Option 1	design phase stection (See Nb. 1)		n 2 (See Nb. 1)
4 Criterion	fined at detailed River Flood Pro Option 1 m3	design phase	Option m3	n 2 (See Nb. 1) Notes
4 Criterion Criterion 4.1 "Long Term Storage"	fined at detailed . River Flood Pro Option 1	design phase stection (See Nb. 1)	m3 -	Notes
4 Criterion Criterion 4.1 "Long Term Storage"	fined at detailed River Flood Pro Option 1 m3	design phase stection (See Nb. 1)	m3 - 693	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	Fined at detailed River Flood Pro Option 1 m3 1,397 -	design phase stection (See Nb. 1)	m3 - 693 7,400	Notes
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume	fined at detailed . River Flood Pro Option 1 m3 1,397 - 6,430	design phase stection (See Nb. 1)	m3 - 693 7,400 8,093	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	fined at detailed River Flood Pro Option 1 m3 1,397 - 6,430 693	design phase stection (See Nb. 1)	m3 - 693 7,400 8,093 693	Notes This is Q1
4	fined at detailed . River Flood Pro Option 1 m3 1,397 - 6,430	design phase stection (See Nb. 1)	m3 - 693 7,400 8,093	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	fined at detailed River Flood Pro Option 1 m3 1,397 - 6,430 693 25%	design phase stection (See Nb. 1)	m3 - - - - - - - - - - - - - - - - - - -	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption	fined at detailed . River Flood Pro 0ption 1 m3 1,397 - 6,430 693 25% 173	design phase stection (See Nb. 1)	m3 - 693 7,400 8,093 693 25% 173 8,266	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³)	fined at detailed . River Flood Pro 0 0ption 1 m3 1,397 - 6,430 693 25% 173 6,603	design phase ptection (See Nb. 1) Notes	m3 - 693 7,400 8,093 693 25% 173 8,266 8,266	Notes This is Q1 This is QBAR - Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	fined at detailed . River Flood Pro 0 0ption 1 m3 1,397 - 6,430 693 25% 173 6,603 0 0ption 1 and 2	design phase otection (See Nb. 1) Notes 2 are as defined	m3 - 693 7,400 8,093 693 25% 173 8,266 8,266 d in the exam	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	fined at detailed . River Flood Pro 0 0ption 1 m3 1,397 - 6,430 693 25% 173 6,603 0 0ption 1 and 2	design phase otection (See Nb. 1) Notes 2 are as defined dix E of the Gre	m3 - 693 7,400 8,093 693 25% 173 8,266 8,266 d in the exam	Notes This is Q1 This is QBAR - Q1

5.4 Outfall 3

Pond Storage & Tre	atment Ca	lcs:	Outfal	l Number 03
Location		SOIL	Soil Type	SAAR
Ardcurley Td.		0.47	4	1182
		0.47		1102
	Catchment	Areas	1	
Element	Pavement	Verge	Grass	Unit
Catchment Areas	2.4893	0.9799	1.2051	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	2.364835	0.734925	0.60255	ha
	INTERCEPTION			
Calculate Runoff fror	n 5mm of Rain	fall on the Develo	pment Area	1
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	2.364835	0.734925	0.60255	ha
Minimum Interception Storage	118.24175	36.74625	30.1275	m ³
	TREATMENT S	TORAGE	·	·
The Treatment Stor	age (Wet pond	l volume) needec	for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	2.3648	0.7349	0.6026	ha
Minimum Treatment Storage m ³	354.7253	110.2388	90.3825	m ³
	HARGE RATES	FOR PONDS/WET	LANDS	·
	QBAR De	tails		
QBar Per He	ctare		8.91	l/sec/ha
Actual Catchme	ent Area		4.674	ha
QBar for Actual Cate	chment Area		41.7	I/s
QB	AR factors for F	lood Events		
Flor	od Event			Q For Catchmen
				l/s
Q 1 year (1 year throttle); F				36.24
Q 2 year (2 year throttle); F	SR Growth curv	ve factor is 0.95.		39.57
Q 30 year (30 year throttle);				68.31
Q 100 year (100 year throttle	81.64			
Differenc	32.07			
Difference	13.33			
Difference	e in QBar - Q1			5.42
		tra Valume Dure	ff)	
		tra Volume Runo rm and a 6 hour e	-	
Long Term Strorag	-		630	m3
2018 1010 010			0.00	1115

Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
offerfor	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	185		0	
Criterion 1.2 "Treatment Storage" -	555		555	
Permanent Wet Pond	555		555	
2	. River Regime Pro	otection		
	1 2.1 & 2.2 "Attenu		1	
Criterion	Option 1 (Option 1 (See Nb. 1)		n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	305		0	
For Q 30 year	1,002		0	
For Q 100 year	1,523		0	
Total m3	2,829		-	
Less Long term Storage	630		_	
	030			
Provide Attenuation Storage	2199		0	
	evel of Service Fo			
	4. River Flood Pro	tection		
Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
Criterion	· · ·	See Nb. 1) Notes		n 2 (See Nb. 1) Notes
	m3	See Nb. 1) Notes	Option m3	n 2 (See Nb. 1) Notes
Criterion 4.1 "Long Term Storage"	· · ·	•	m3 _	Notes
Criterion 4.1 "Long Term Storage"	m3	•	m3 - 305	Notes This is Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	m3 630 -	•	m3 - 305 3,242	Notes This is Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume	m3 630 - 2,829	•	m3 - 305 3,242 3,547	Notes This is Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	m3 630 - 2,829 305	•	m3 - 305 3,242 3,547 305	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	m3 630 - 2,829	•	m3 - 305 3,242 3,547	Notes This is Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	m3 630 - 2,829 305 25%	•	m3 - 305 3,242 3,547 305 25%	Notes This is Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	m3 630 - 2,829 305 25% 76	•	m3 - 305 3,242 3,547 305 25% 76	Notes This is Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	m3 630 - 2,829 305 25% 76 2,905	Notes	m3 305 3,242 3,547 305 25% 76 3,623 3,623	Notes This is Q1 This is QBAR - Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption	m3 630 - 2,829 305 25% 76 2,905 Option 1 and 2	Notes	m3 - 305 3,242 3,547 305 25% 76 3,623 3,623 d in the exam	Notes This is Q1
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	m3 630 - 2,829 305 25% 76 2,905 Option 1 and 2	Notes Notes	m3 - 305 3,242 3,547 305 25% 76 3,623 3,623 d in the exam	Notes This is Q1 This is QBAR - Q1

5.5 Outfall 4

Pond Storage & Trea	atment Ca	lcs:	Outfal	Number 04
Location		SOIL	Soil Type	SAAR
Doorly Td.		0.47	4	1182
		0.47		1102
	Catchment	Areas		
Element	Pavement	Verge	Grass	Unit
Catchment Areas	1.5062	0.2187	0.1098	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.43089	0.164025	0.0549	ha
	NTERCEPTION			
Calculate Runoff from				
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.43089	0.164025	0.0549	ha
Minimum Interception Storage	71.5445	8.20125	2.745	m ³
	TREATMENT S	TORAGE		
The Treatment Stora	age (Wet pond	volume) needee	d for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	1.4309	0.1640	0.0549	ha
Minimum Treatment Storage m ³	214.6335	24.6038	8.2350	m ³
QBAR AND DISC	HARGE RATES I	OR PONDS/WET	LANDS	
	QBAR Det	ails		
QBar Per Hec			8.91	l/sec/ha
Actual Catchmer	nt Area		1.835	ha
QBar for Actual Catc			16.3	l/s
QBA	AR factors for F	lood Events		
Floor	d Event			Q For Catchmen
		<u> </u>		l/s
Q 1 year (1 year throttle); FS				14.22
Q 2 year (2 year throttle); FS				15.53
Q 30 year (30 year throttle); F Q 100 year (100 year throttle);				26.81
	FSK GIOWUI CU		0.	32.05
Difference	in Q30 - Q1			12.59
Difference i	n Q100 - Q30			5.23
Difference	in QBar - Q1			2.13
LONG TERM	1 STORAGE (Ex	tra Volume Rund	off)	
Based on a 1 in	100 year stor	m and a 6 hour	event.	
Daseu on a 1 n	Lee year stor			

Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	82		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	247		247	
2.	River Regime Pro	otection		
Criterion	2.1 & 2.2 "Attenu	uation Storage		
Criterion	Option 1 (Option 1 (See Nb. 1)		n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	149		0	
For Q 30 year	470		0	
For Q 100 year	703		0	
Total m3	1,322		-	
Less Long term Storage	316		-	
Provide Attenuation Storage	1006		0	
N/A: De	fined at detailed	design phase		
4	. River Flood Pro	tection		
4				
Criterion		tection See Nb. 1)	Option	n 2 (See Nb. 1)
			Option m3	n 2 (See Nb. 1) Notes
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (See Nb. 1)	-	
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	See Nb. 1)	-	
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	See Nb. 1)	m3 	Notes
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	Option 1 (m3	See Nb. 1)	m3 - 149	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 316 - 1,322 149	See Nb. 1)	m3 - 149 1,500 1,649 149	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 316 - 1,322 149 25%	See Nb. 1)	m3 - 149 1,500 1,649 149 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 316 - 1,322 149 25% 37	See Nb. 1)	m3 - 149 1,500 1,649 149 25% 37	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 316 - 1,322 149 25%	See Nb. 1)	m3 - 149 1,500 1,649 149 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 316 - 1,322 149 25% 37	See Nb. 1)	m3 - 149 1,500 1,649 149 25% 37	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³)	Option 1 (m3 316 - 1,322 149 25% 37 1,359	See Nb. 1) Notes	m3 - 149 1,500 1,649 149 25% 37 1,686 1,686 d in the exam	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	Option 1 (m3 316 - 1,322 149 25% 37 1,359	See Nb. 1) Notes	m3 - 149 1,500 1,649 149 25% 37 1,686 1,686 d in the exam	Notes This is Q1 This is QBAR - Q1

5.6 Outfall 5

	atment Ca	Ics:	Outfal	l Number 05
Location		SOIL	Soil Type	SAAR
Knocknagroagh Td.		0.47	4	1182
	Catchment	Areas		
Element	Pavement	Verge	Grass	Unit
Catchment Areas	0.1232	0	0	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	0.11704	0	0	ha
		STODACE		
Calculate Runoff from	NTERCEPTION		onmont Aroa	
Calculate Kullon Iron	Pavement		Grass	Unit
Rainfall	5	Verge 5	5	mm
	0.11704	0	0	ha
Equivalent Catchment Area		-	-	-
Minimum Interception Storage	5.852	0	0	m ³
	TREATMENT S	TORAGE		
The Treatment Store			d for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	0.1170	0.0000	0.0000	ha
Minimum Treatment Storage m ³	17.5560	0.0000	0.0000	m ³
QBAR AND DISC	HARGE RATES	FOR PONDS/WE	TLANDS	-
	QBAR Det	tails		
QBar Per Hec	tare		8.91	l/sec/ha
Actual Catchme	nt Area		0.123	ha
QBar for Actual Catc			1.1	l/s
QBA	AR factors for F	lood Events		
Floo	d Event			Q For Catchme
		<u> </u>		l/s
Q 1 year (1 year throttle); FS				0.96
Q 2 year (2 year throttle); FS				1.04
Q 30 year (30 year throttle);				1.80
Q 100 year (100 year throttle)	, FSK Growin C		90.	2.15
Difference	e in Q30 - Q1			0.85
	in Q100 - Q30			0.35
Difference	in QBar - Q1			0.14
			<i>(</i>)	
		the Values o Due	0++1	
LONG TERN Based on a 1 in		rm and a 6 hour		

Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	6		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	18		18	
	River Regime Pr			
	2.1 & 2.2 "Atten		1	
Criterion		(See Nb. 1)	-	n 2 (See Nb. 1)
For Q 1 year	m3	Notes	m3	Notes
For Q 1 year	11		0	
For Q 30 year	34		0	
For Q 100 year	51		0	
Total m3	95		-	
Less Long term Storage	22		-	
Provide Attenuation Storage	74		0	
N/A: Def	ined at detailed	design phase		
4.	. River Flood Pro	otection		
4.	. River Flood Pro	tection		
4. Criterion		See Nb. 1)	Option	n 2 (See Nb. 1)
			Option m3	n 2 (See Nb. 1) Notes
Criterion	Option 1	(See Nb. 1)	-	
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	(See Nb. 1)	-	
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	(See Nb. 1)	m3 -	Notes
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	Option 1 (m3	(See Nb. 1)	m3 - 11	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume	Option 1 (m3 22 -	(See Nb. 1)	m3 - 11 108	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 22 - 95 11 25%	(See Nb. 1)	m3 - 111 108 119 11 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 m3 22 - 95 11 25% 3	(See Nb. 1)	m3 - 11 108 119 11 25% 3	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 22 - 95 11 25%	(See Nb. 1)	m3 - 111 108 119 11 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 m3 22 - 95 11 25% 3	(See Nb. 1)	m3 - 11 108 119 11 25% 3	Notes This is Q1
	Option 1 (m3 22 - 95 11 25% 3 98 Option 1 and 2	(See Nb. 1) Notes	m3 11 108 119 111 25% 3 122 122 11	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	Option 1 (m3 22 - 95 11 25% 3 98 Option 1 and 2	(See Nb. 1) Notes	m3 11 108 119 111 25% 3 122 122 11	Notes This is Q1 This is QBAR - Q1

5.7 Outfall 6

Pond Storage & Tre	atment Ca	lcs:	Outfal	l Number 0
Location		SOIL	Soil Type	SAAR
Knocknagroagh Td.		0.47	4	1182
	Catchment	Areas		
Element	Pavement	Verge	Grass	Unit
Catchment Areas	1.3109	0.3174	0.3664	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.245355	0.23805	0.1832	ha
Calculate Runoff from	INTERCEPTION		opmont Aroa	
	Pavement		Grass	Unit
Rainfall	5	Verge 5	5	
	-	-	-	mm
Equivalent Catchment Area	1.245355	0.23805	0.1832	ha
Minimum Interception Storage	62.26775	11.9025	9.16	m ³
The Tweetweet Stee	TREATMENT S		d fou 1 Fuene	
The Treatment Stor				11
Equivalent Catchment Area	Pavement 1.2454	Verge 0.2381	Grass 0.1832	Unit ha
	1.2454	35.7075	27.4800	m ³
Minimum Treatment Storage m ³	180.8033	33.7073	27.4000	m*
	CHARGE RATES F	OR PONDS/WET		
•	QBAR Det			
QBar Per He	ctare		8.91	l/sec/ha
Actual Catchme	ent Area		1.995	ha
QBar for Actual Cat	chment Area		17.8	l/s
QB	AR factors for F	lood Events		-
Flor	od Event			Q For Catchme
				l/s
Q 1 year (1 year throttle); F				15.46
Q 2 year (2 year throttle); F				16.89
Q 30 year (30 year throttle);				29.15
Q 100 year (100 year throttle); FSR Growth cւ	urve factor is 1.9	06.	34.84
D:#	a in 020 01			40.00
	e in Q30 - Q1			13.69
	in Q100 - Q30 e in QBar - Q1			5.69
				2.31
LONG TER	M STORAGE (Ex	tra Volume Rund	off)	
Based on a 1	in 100 year stor	m and a 6 hour	event.	
Long Term Strorag	ge Volume		298	m3

Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	83		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	250		250	
	River Regime P			
Criterior	2.1 & 2.2 "Atter			
Criterion	Option 1 (See Nb. 1)			n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	143		0	
For Q 30 year	462		0	
For Q 100 year	696		0	
Total m3	1,300		-	
Less Long term Storage	298		-	
Provide Attenuation Storage	1002		0	
3. L	evel of Service F	or the Site		
N/A: De	efined at detailed	d design phase	-	
	4. River Flood Pro	otection		
Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
Cherton	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	298	Notes	-	Notes
Criterion 4.3 "Attenutaion & Long Term			142	This is Q1
Alternation & Long Term	-		143	
	1 200		1,480	This is QBAR - Q1
Provide Storage Volume For Q 1 year	1,300 143		1,623	
Head Discharge Assumption	25%		25%	
nead Discharge Assumption	36		36	
			1,659	
Apply Head Discharge Assumption	1,336		1,000	
	1 1			
Design Pond for Volume (m ³)	1,336	2 are as defined	1,659	nlecalculation
Design Pond for Volume (m ³)	1,336 Option 1 and		1,659 d in the exam	ple calculation trategic Drainage
Design Pond for Volume (m ³) Nb. 1	1,336 Option 1 and given in apper	idix E of the Gre	1,659 d in the exam	
Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1 C	1,336 Option 1 and	idix E of the Gre	1,659 d in the exam	

5.8 Outfall 7

Pond Storage & Tre	atment Ca	lcs:	Outfal	l Number 07
Location		SOIL	Soil Type	SAAR
Drumfin Td.		0.47	4	1182
	Catchment	Areas	-	
Element	Pavement	Verge	Grass	Unit
Catchment Areas	3.483	0.9302	2.1701	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	3.30885	0.69765	1.08505	ha
	INTERCEPTION			
Calculate Runoff from	n 5mm of Rain	fall on the Develo	pment Area	0
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	3.30885	0.69765	1.08505	ha
Minimum Interception Storage	165.4425	34.8825	54.2525	m ³
	TREATMENT S	TORAGE	·	·
The Treatment Stor	age (Wet pond	l volume) needeo	for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	3.3089	0.6977	1.0851	ha
Minimum Treatment Storage m ³	496.3275	104.6475	162.7575	m ³
-				
	HARGE RATES	FOR PONDS/WET	LANDS	
	QBAR De	tails		
QBar Per Hee	tare		8.91	l/sec/ha
Actual Catchme	nt Area		6.583	ha
QBar for Actual Cate	hment Area		58.7	I/s
QB	AR factors for F	lood Events		1
				Q For Catchmen
Floc	od Event			l/s
Q 1 year (1 year throttle); F	SR Growth curv	ve factor is 0.87.		51.04
Q 2 year (2 year throttle); F	SR Growth curv	ve factor is 0.95.		55.73
Q 30 year (30 year throttle);	FSR Growth cu	rve factor is 1.64		96.21
Q 100 year (100 year throttle)	; FSR Growth c	urve factor is 1.9	6.	114.99
Differenc	e in Q30 - Q1			45.17
	in Q100 - Q30			18.77
	e in QBar - Q1			7.63
LONG TERI	M STORAGE (Ex	tra Volume Runo	ff)	
		rm and a 6 hour e		
Long Term Strorag	-		829	m3
	-			

STORAGE REQUIRED FOR OPTION 1 AN	ID 2 (as defined Drainage St		the Greate	r Dublin Strageic
Criterion	Option 2	L (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	255		0	
Criterion 1.2 "Treatment Storage" -	764		764	
Permanent Wet Pond				
2.	River Regime I	Protection		
		nuation Storage"		
Criterion				n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	415		0	
For Q 30 year	1,359		0	
For Q 100 year	2,079		0	
•			0	
Total m3	3,852		-	
Less Long term Storage	829		-	
				1
Provide Attenuation Storage	3024		0	
	evel of Service			
	fined at detaile	ed design phase		
4		rotection		
		. (
Criterion	Option 2	L (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	829		-	
Criterion 4.3 "Attenutaion & Long Term	-		415	This is Q1
			4,432	This is QBAR - Q1
Provide Storage Volume	3,852		4,847	
For Q 1 year	415		415	
Head Discharge Assumption	25%		25%	
	104		104	
Apply Head Discharge Assumption	3,956		4,951	
-			1	
Design Pond for Volume (m ³)		-	4,951	
Nb. 1		l 2 are as defined ndix E of the Grea		ple calculation strategic Drainage
Ca	lculated Reside	ence Time		1
Total time to empty (hour's)				23:14

5.9 Outfall 8

Pond Storage & Tre	atment Ca	lcs:	Outfal	Number 08
Location		SOIL	Soil Type	SAAR
Drumfin Td.		0.47	4	1182
		0.47		1102
	Catchment	Areas		I
Element	Pavement	Verge	Grass	Unit
Catchment Areas	2.5991	0.4788	1.0789	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	2.469145	0.3591	0.53945	ha
	INTERCEPTION			
Calculate Runoff from	n 5mm of Rain	fall on the Develo	pment Area	
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	2.469145	0.3591	0.53945	ha
Minimum Interception Storage	123.45725	17.955	26.9725	m ³
	TREATMENT S	TORAGE		
The Treatment Stor	age (Wet pond	l volume) needeo	for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	2.4691	0.3591	0.5395	ha
Minimum Treatment Storage m ³	370.3718	53.8650	80.9175	m ³
OBAR AND DISC	HARGE RATES	FOR PONDS/WET	LANDS	<u> </u>
~ • • • • • • • • • • • • • • • • • • •	QBAR De			
QBar Per Hee	•		8.91	l/sec/ha
Actual Catchme			4.157	ha
QBar for Actual Cate	hment Area		37.0	l/s
	AR factors for I	lood Events		7 -
				Q For Catchment
Floc	od Event			l/s
Q 1 year (1 year throttle); F	SR Growth curv	ve factor is 0.87.		32.23
Q 2 year (2 year throttle); F	SR Growth curv	ve factor is 0.95.		35.19
Q 30 year (30 year throttle);	FSR Growth cu	rve factor is 1.64		60.75
Q 100 year (100 year throttle)	; FSR Growth c	urve factor is 1.9	6.	72.61
Differenc	e in Q30 - Q1			28.52
	in Q100 - Q30			11.85
	e in QBar - Q1			4.82
LONG TERI	M STORAGE (Ex	tra Volume Runo	off)	
		rm and a 6 hour e		
Long Term Strorag	-		576	m3
- 0	-			

Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	168		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	505		505	
2	River Regime Pro	ataction		
	2.1 & 2.2 "Atteni		1	
Criterion	Option 1 (See Nb. 1)			n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	281		0	
For Q 30 year	921		0	
For Q 100 year	1,394		0	
Total m3	2,597		-	
Less Long term Storage	576		-	
Provide Attenuation Storage	2020		0	
214	evel of Service Fo			
			1	1
4	River Flood Pro	tection		
4.	. River Flood Pro	tection		
			Ontio	n 2 (See Nh 1)
4. Criterion	Option 1 (See Nb. 1)	-	n 2 (See Nb. 1)
Criterion	Option 1 (m3		Option m3	n 2 (See Nb. 1) Notes
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (See Nb. 1)	m3 -	Notes
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	See Nb. 1)	m3 - 281	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	Option 1 (m3 576 -	See Nb. 1)	m3 - 281 2,964	Notes
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume	Option 1 (m3 576 - 2,597	See Nb. 1)	m3 - 281 2,964 3,245	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 576 - 2,597 281	See Nb. 1)	m3 - 281 2,964 3,245 281	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 576 - 2,597 281 25%	See Nb. 1)	m3 - 281 2,964 3,245 281 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 576 - 2,597 281 25% 70	See Nb. 1)	m3 - 281 2,964 3,245 281 25% 70	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 576 - 2,597 281 25%	See Nb. 1)	m3 - 281 2,964 3,245 281 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 576 - 2,597 281 25% 70	See Nb. 1)	m3 - 281 2,964 3,245 281 25% 70	Notes This is Q1
	Option 1 (m3 576 - 2,597 281 25% 70 2,667 Option 1 and 2	See Nb. 1) Notes	m3 - 281 2,964 3,245 281 25% 70 3,316 3,316 in the exam	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	Option 1 (m3 576 - 2,597 281 25% 70 2,667 Option 1 and 2 given in appendic	See Nb. 1) Notes	m3 - 281 2,964 3,245 281 25% 70 3,316 3,316 in the exam	Notes This is Q1 This is QBAR - Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	Option 1 (m3 576 - 2,597 281 25% 70 2,667 Option 1 and 2	See Nb. 1) Notes	m3 - 281 2,964 3,245 281 25% 70 3,316 3,316 in the exam	Notes This is Q1 This is QBAR - Q1

5.10 Outfall 9

Pond Storage & Tre	atment Ca	lcs:	Outfal	l Number 09
Location		SOIL	Soil Type	SAAR
Carrownagark Td.		0.47	4	1182
÷				
	Catchment	Areas		·
Element	Pavement	Verge	Grass	Unit
Catchment Areas	1.2915	0.3712	0.0712	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.226925	0.2784	0.0356	ha
	INTERCEPTION			
Calculate Runoff from	n 5mm of Rain	fall on the Devel	opment Area	Γ
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.226925	0.2784	0.0356	ha
Minimum Interception Storage	61.34625	13.92	1.78	m ³
	TREATMENT S	TORAGE		-
The Treatment Stor	age (Wet pond	l volume) neede	d for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	1.2269	0.2784	0.0356	ha
Minimum Treatment Storage m ³	184.0388	41.7600	5.3400	m ³
QBAR AND DISC	HARGE RATES	FOR PONDS/WET	FLANDS	·
	QBAR Det	tails		
QBar Per He	ctare		8.91	l/sec/ha
Actual Catchme	ent Area		1.734	ha
QBar for Actual Cate	chment Area		15.5	l/s
QB	AR factors for F	lood Events		
Floo	od Event			Q For Catchmer
				l/s
Q 1 year (1 year throttle); F				13.44
Q 2 year (2 year throttle); F				14.68
Q 30 year (30 year throttle);				25.34
Q 100 year (100 year throttle)); FSR Growth c	urve factor is 1.9	96.	30.29
Differenc	e in Q30 - Q1			11.90
Difference	in Q100 - Q30			4.94
Difference	e in QBar - Q1			2.01
		tra Volume Runo	-	
Based on a 1 i	n 100 year sto	rm and a 6 hour	event.	
Long Term Strorag			296	m3

Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	77		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	231		231	
	River Regime Pr			
	2.1 & 2.2 "Atten			
Criterion	-	(See Nb. 1)	-	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	138		0	
For Q 30 year	437		0	
For Q 100 year	654		0	
Total m3	1,230		-	
Less Long term Storage	296		-	
Provide Attenuation Storage	934		0	
N/A: Dei	fined at detailed	l design phase		
	fined at detailed			
	fined at detailed . River Flood Pro			
4	. River Flood Pro	otection		
	. River Flood Pro	otection (See Nb. 1)	-	n 2 (See Nb. 1)
4 Criterion	. River Flood Pro	otection	Optio m3	n 2 (See Nb. 1) Notes
4 Criterion Criterion 4.1 "Long Term Storage"	. River Flood Pro	otection (See Nb. 1)	m3 -	Notes
4 Criterion Criterion 4.1 "Long Term Storage"	. River Flood Pro	otection (See Nb. 1)	m3 - 138	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	. River Flood Pro	otection (See Nb. 1)	m3 - 138 1,396	Notes
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume	. River Flood Pro Option 1 m3 296 - 1,230	otection (See Nb. 1)	m3 - 138 1,396 1,534	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	River Flood Pro Option 1 m3 296 - 1,230 138	otection (See Nb. 1)	m3 - 138 1,396 1,534 138	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	River Flood Pro Option 1 m3 296 - 1,230 138 25%	otection (See Nb. 1)	m3 - 138 1,396 1,534 138 25%	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	River Flood Pro Option 1 m3 296 - 1,230 138 25% 35	otection (See Nb. 1)	m3 - 138 1,396 1,534 138 25% 35	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	River Flood Pro Option 1 m3 296 - 1,230 138 25%	otection (See Nb. 1)	m3 - 138 1,396 1,534 138 25%	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	River Flood Pro Option 1 m3 296 - 1,230 138 25% 35	otection (See Nb. 1)	m3 - 138 1,396 1,534 138 25% 35	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³)	River Flood Pro Option 1 m3 296 - 1,230 138 25% 35 1,264	(See Nb. 1) Notes	m3 - 138 1,396 1,534 138 25% 35 1,568 1,568 1,568	Notes This is Q1
4 Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	River Flood Pro Option 1 m3 296 - 1,230 138 25% 35 1,264	2 are as defined dix E of the Gre	m3 - 138 1,396 1,534 138 25% 35 1,568 1,568 1,568	Notes This is Q1 This is QBAR - Q1

5.11Outfall 10

Pond Storage & Trea	atment Ca	lcs:	Outfal	l Number 10
Location		SOIL	Soil Type	SAAR
Carrownagark/Kingsbrook To	d.	0.47	4	1182
		0.47		1102
	Catchment	Areas	1	I
Element	Pavement	Verge	Grass	Unit
Catchment Areas	2.0334	0.5533	1.2127	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.93173	0.414975	0.60635	ha
	NTERCEPTION			
Calculate Runoff from	1 5mm of Rainf	all on the Develo	opment Area	
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.93173	0.414975	0.60635	ha
Minimum Interception Storage	96.5865	20.74875	30.3175	m ³
	TREATMENT S	TORAGE		·
The Treatment Store	age (Wet pond	volume) needeo	d for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	1.9317	0.4150	0.6064	ha
Minimum Treatment Storage m ³	289.7595	62.2463	90.9525	m ³
QBAR AND DISC	HARGE RATES F	OR PONDS/WET	LANDS	
	QBAR Det	ails		
QBar Per Hec	tare		8.91	l/sec/ha
Actual Catchme	nt Area		3.799	ha
			33.9	I/s
QBA	AR factors for F	lood Events		
Flood Event				Q For Catchment I/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.				29.46
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.				32.17
Q 30 year (30 year throttle); I				55.53
Q 100 year (100 year throttle)				66.36
Difference	e in Q30 - Q1			26.07
Difference	in Q100 - Q30			10.83
Difference	in QBar - Q1			4.40
	A STORAGE (Ex	tra Volume Runc	off)	
LONG TERM				
		m and a 6 hour e	event.	

Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	148		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	443		443	
2.	River Regime Pro	otection		
	2.1 & 2.2 "Attenu		I	
Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	241		0	
For Q 30 year	790		0	
For Q 100 year	1,207		0	
Total m3	2,239		-	
Less Long term Storage	549		-	
Provide Attenuation Storage	1690		0	
N/A: De	fined at detailed	design phase	1	
4	I. River Flood Pro	tection		
Criterion	Option 1 (See Nb. 1)	Option	n 2 (See Nb. 1)
Criterion			Option m3	n 2 (See Nb. 1) Notes
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (See Nb. 1)		
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	See Nb. 1)		
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	See Nb. 1)	m3 -	Notes
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	Option 1 (m3	See Nb. 1)	m3 - 241	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 549 - 2,239 241	See Nb. 1)	m3 - 241 2,574 2,815 241	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 549 - 2,239 241 25%	See Nb. 1)	m3 - 241 2,574 2,815 241 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 549 - 2,239 241 25% 60	See Nb. 1)	m3 241 2,574 2,574 2,815 241 25% 60	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 549 - 2,239 241 25%	See Nb. 1)	m3 - 241 2,574 2,815 241 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 549 - 2,239 241 25% 60	See Nb. 1)	m3 241 2,574 2,574 2,815 241 25% 60	Notes This is Q1
	Option 1 (m3 549 - 2,239 241 25% 60 2,299	See Nb. 1) Notes	m3 - 241 2,574 2,815 241 25% 60 2,875 2,875 1 in the exam	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	Option 1 (m3 549 - 2,239 241 25% 60 2,299	See Nb. 1) Notes	m3 - 241 2,574 2,815 241 25% 60 2,875 2,875 1 in the exam	Notes This is Q1 This is QBAR - Q1

5.12 Outfall 11

Pond Storage & Trea	tment Ca	lcs:	Outfal	l Number 11	
Location		SOIL	Soil Type	SAAR	
Kingsbrook Td.		0.47	4	1182	
		0.47		1102	
	Catchment	Areas	1	1	
Element	Pavement	Verge	Grass	Unit	
Catchment Areas	1.5546	0.3105	0	ha	
Runoff coefficient	95	75	50	%	
Equivalent Catchment Area	1.47687	0.232875	0	ha	
	NTERCEPTION				
Calculate Runoff from	5mm of Rain	fall on the Develo	pment Area	1	
	Pavement	Verge	Grass	Unit	
Rainfall	5	5	5	mm	
Equivalent Catchment Area	1.47687	0.232875	0	ha	
Minimum Interception Storage	73.8435	11.64375	0	m ³	
	TREATMENT S	TORAGE			
The Treatment Stora	ge (Wet pond	l volume) needec	for 15mm		
	Pavement	Verge	Grass	Unit	
Equivalent Catchment Area	1.4769	0.2329	0.0000	ha	
Minimum Treatment Storage m ³	221.5305	34.9313	0.0000	m ³	
	HARGE RATES	FOR PONDS/WET	LANDS	•	
	QBAR De	tails			
QBar Per Hect	are		8.91	l/sec/ha	
Actual Catchmer	nt Area		1.865	ha	
QBar for Actual Catch	QBar for Actual Catchment Area			I/s	
QBA	R factors for F	lood Events	•		
<u>Floor</u>					
FIOO	Flood Event				
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.				14.46	
Q 2 year (2 year throttle); FS	Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.				
	Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.			27.26	
Q 100 year (100 year throttle);	FSR Growth c	urve factor is 1.9	6.	32.58	
Difference	in Q30 - Q1			12.80	
	n Q100 - Q30			5.32	
	in QBar - Q1			2.16	
				-	
LONG TERM	I STORAGE (Ex	tra Volume Runo	ff)		
		rm and a 6 hour e			
Long Term Strorage	-		336	m3	
5 0			. i	I	

Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection	1			
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	85		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	256		256	
2.	River Regime Pro	otection		
	2.1 & 2.2 "Attenu		I	
Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	156		0	
For Q 30 year	490		0	
For Q 100 year	732		0	
Total m3	1,379		-	
Less Long term Storage	336		-	
Drovido Attonuction Storage	1042		0	
Provide Attenuation Storage	1043		0	
3. L	evel of Service Fo	or the Site		
N/A: De	fined at detailed	design phase		
4	. River Flood Pro	tection		
Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	336		-	
Criterion 4.3 "Attenutaion & Long Term	-		156	This is Q1
			1,563	This is QBAR - Q1
	1,379		1,719	
Provide Storage Volume	1,575		450	
Provide Storage Volume For Q 1 year	156		156	
			25%	
For Q 1 year	156			
or Q 1 year lead Discharge Assumption	156 25%		25%	
or Q 1 year lead Discharge Assumption Apply Head Discharge Assumption	156 25% 39		25% 39	
For Q 1 year	156 25% 39 1,418 Option 1 and 2		25% 39 1,758 1,758 1,758	ple calculation
For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³)	156 25% 39 1,418 Option 1 and 2		25% 39 1,758 1,758 1,758	ple calculation trategic Drainage
For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	156 25% 39 1,418 Option 1 and 2	dix E of the Gre	25% 39 1,758 1,758 1,758	

5.13 Outfall 12

Pond Storage & Tre	atment Ca	lcs:	Outfal	l Number 12
Location		SOIL	Soil Type	SAAR
Aghaleneane and Ardloy To	ł.	0.47	4	1182
	Catchment	Areas	-	
Element	Pavement	Verge	Grass	Unit
Catchment Areas	0.8186	0.1249	0.0623	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	0.77767	0.093675	0.03115	ha
	INTERCEPTION	STODACE		
Calculate Runoff from			onment Area	
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	0.77767	0.093675	0.03115	ha
Minimum Interception Storage	38.8835	4.68375	1.5575	m ³
			2.007.0	
	TREATMENT S	TORAGE		<u>.</u>
The Treatment Stor	rage (Wet pond	l volume) needeo	for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	0.7777	0.0937	0.0312	ha
Minimum Treatment Storage m ³	116.6505	14.0513	4.6725	m ³
QBAR AND DISC	QBAR Det	FOR PONDS/WET	LANDS	
QBar Per He	•		8.91	l/sec/ha
Actual Catchme			1.006	ha
QBar for Actual Catchment Area			9.0	l/s
	AR factors for F	lood Events	5.0	175
				Q For Catchme
Flood Event				l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.			7.80	
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.				8.52
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.			14.70	
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.			17.57	
	e in Q30 - Q1			6.90
Difference	in Q100 - Q30			2.87
Difference	e in QBar - Q1			1.17
LONG TEP	M STORAGE (FY	tra Volume Runo	off)	
		rm and a 6 hour e		
Long Term Strorag	-		173	m3
5	-			

	Drainage Stu	udy)		r Dublin Strageic
Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	45		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	135		135	
2. F	River Regime P	rotection		
Criterion 2	2.1 & 2.2 "Atter	nuation Storage		
Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
For Q 1 year	81		0	
For Q 30 year	257		0	
For Q 100 year	384		0	
Total m3	723		-	
Less Long term Storage	173		-	
Provide Attenuation Storage	550		0	
	vel of Service I	d design phase		
4.	River Flood Pr	otection		
Criterion	Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	173		_	
Criterion 4.3 "Attenutaion & Long Term	-		81	This is Q1
<u> </u>			820	This is QBAR - Q1
Provide Storage Volume	723		901	THIS IS QUAR - QI
For Q 1 year	81		81	
Head Discharge Assumption	25%		25%	
	20		20	
Apply Head Discharge Assumption	743		922	
Design Pond for Volume (m ³)			922	
Nb. 1	Ontion 1 and	2 are as define	_	nle calculation
	-			trategic Drainage
Cal	culated Reside	nce Time		

5.14 Outfall 13

Pond Storage & Trea	atment Ca	lcs:	Outfal	l Number 13
Location		SOIL	Soil Type	SAAR
Springfield Td.		0.47	4	1182
		0.47		1102
	Catchment	Areas		
Element	Pavement	Verge	Grass	Unit
Catchment Areas	0.6261	0.1626	0	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	0.594795	0.12195	0	ha
	NTERCEPTION			
Calculate Runoff from				
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	0.594795	0.12195	0	ha
Minimum Interception Storage	29.73975	6.0975	0	m ³
	TREATMENT S	TORAGE		
The Treatment Stora	age (Wet pond	l volume) needee	d for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	0.5948	0.1220	0.0000	ha
Minimum Treatment Storage m ³	89.2193	18.2925	0.0000	m ³
QBAR AND DISC	HARGE RATES	FOR PONDS/WET	LANDS	
	QBAR Det	tails		1
QBar Per Hec			8.91	l/sec/ha
Actual Catchmer	nt Area		0.789	ha
QBar for Actual Catchment Area 7.0				I/s
QBA	AR factors for F	lood Events		
Flood Event				Q For Catchmer
				l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87. Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.				6.11
· · · · · · · · · · · · · · · · · · ·	6.68			
Q 30 year (30 year throttle); F				11.53
Q 100 year (100 year throttle);	, FSR GLOWLII C	uive lactor 15 1.9	υ.	13.78
Difference	e in Q30 - Q1			5.41
Difference	in Q100 - Q30			2.25
Difference	in QBar - Q1			0.91
LONG TERM	/I STORAGE (Ex	tra Volume Runc	off)	
		tra Volume Rund rm and a 6 hour o		

m3 m3 36 108 er Regime P & 2.2 "Atter	nuation Storage" (See Nb. 1) Notes	m3 m3 0 108	n 2 (See Nb. 1) Notes Notes Notes Notes Notes
36 108 108 er Regime P & 2.2 "Atter Option 1 m3 65 205 306 576 140 436	rotection huation Storage" (See Nb. 1) Notes	0 108 0 0 0 0 0 0 -	n 2 (See Nb. 1)
36 108 108 er Regime P & 2.2 "Atter Option 1 m3 65 205 306 576 140 436	rotection huation Storage" (See Nb. 1) Notes	0 108 0 0 0 0 0 0 -	n 2 (See Nb. 1)
108 er Regime P & 2.2 "Atter Option 1 m3 65 205 306 576 140 436	nuation Storage" (See Nb. 1) Notes	108 Option m3 0 0 0 -	
er Regime P & 2.2 "Atter Option 1 m3 65 205 306 576 140 436	nuation Storage" (See Nb. 1) Notes	Option m3 0 0 0 0 -	
er Regime P & 2.2 "Atter Option 1 m3 65 205 306 576 140 436	nuation Storage" (See Nb. 1) Notes	Option m3 0 0 0 0 -	
& 2.2 "Atter Option 1 m3 65 205 306 576 140 436	nuation Storage" (See Nb. 1) Notes	Option m3 0 0 0 0 -	
& 2.2 "Atter Option 1 m3 65 205 306 576 140 436	nuation Storage" (See Nb. 1) Notes	Option m3 0 0 0 0 -	
m3 65 205 306 576 140 436	Notes	m3 0 0 0 -	
65 205 306 576 140 436		0 0 0 -	Notes
205 306 576 140 436		0	
306 576 140 436		0	
576 140 436		-	
576 140 436	Cortho Sito	-	
140 436	Cortho Sito	- 0	
436	Cortho Sito	- 0	
436	Cortho Sito	0	
	For the fite	0	
l of Service I	For the Site		
l of Service I	Cartha Sita		
	for the site		
d at detaile	d design phase		
ver Flood Pr	otection		
Option 1	(See Nb. 1)	Optio	n 2 (See Nb. 1)
m3	Notes	m3	Notes
140		-	
-		65	This is Q1
			This is QBAR - Q1
576			
		735	
			<u> </u>
		735	
ption 1 and	2 are as defined	in the exam	plecalculation
ven in apper	ndix E of the Grea	ater Dublin S	trategic Drainage
ated Reside	nce Time		
			28:47
	140 - 576 65 25% 16 593 ption 1 and ven in appen	140 - 576 65 25% 16 593 ption 1 and 2 are as defined	140 - - 65 576 719 65 65 25% 25% 16 16 593 735 ption 1 and 2 are as defined in the exam ven in appendix E of the Greater Dublin S

5.15 Outfall 14

Pond Storage & Trea	atment Ca	lcs:	Outfal	l Number 14
Location		SOIL	Soil Type	SAAR
Sheerevagh Td.		0.47	4	1182
		0.47		1102
	Catchment	Areas		
Element	Pavement	Verge	Grass	Unit
Catchment Areas	4.0036	1.0323	2.7866	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	3.80342	0.774225	1.3933	ha
	NTERCEPTION			
Calculate Runoff fron	n 5mm of Rain	fall on the Develo	pment Area	
	Pavement	Verge	Grass	Unit
Rainfall	5	5	5	mm
Equivalent Catchment Area	3.80342	0.774225	1.3933	ha
Minimum Interception Storage	190.171	38.71125	69.665	m ³
	TREATMENT S	TORAGE		
The Treatment Stor	age (Wet pond	l volume) needed	for 15mm	
	Pavement	Verge	Grass	Unit
Equivalent Catchment Area	3.8034	0.7742	1.3933	ha
Minimum Treatment Storage m ³	570.5130	116.1338	208.9950	m ³
QBAR AND DISC	HARGE RATES	FOR PONDS/WET	LANDS	
	QBAR De	tails		
QBar Per Hec			8.91	l/sec/ha
Actual Catchme	nt Area		7.823	ha
QBar for Actual Catchment Area 69.7				l/s
QB/	AR factors for F	lood Events		1
Flood Event				Q For Catchmen
				l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.				60.65
Q 2 year (2 year throttle); F	66.22			
Q 30 year (30 year throttle);				114.33
Q 100 year (100 year throttle)	; FSR Growth c	urve factor is 1.9	b.	136.63
Difference	e in Q30 - Q1			53.68
	in Q100 - Q30			22.31
Difference	e in QBar - Q1			9.06
	1 (700 - 05 /-	1	(()	
		tra Volume Runo rm and a 6 hour e		
		ini anu a o nour e		
Long Term Strorag	evolume		953	m3

Criterion	Option 1 (See Nb. 1)	0. 1) Option 2 (See Nb. 1)	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	299		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	896		896	
	River Regime Pro			
	2.1 & 2.2 "Attenu	-		- 2 (Ca - Nh. 4)
Criterion	m3	See Nb. 1) Notes	m3	n 2 (See Nb. 1) Notes
For Q 1 year	484	Notes	0	Notes
For Q 30 year	1,581		0	
	1,301		U	
For Q 100 year	2,428		0	
Total m3	4,493		-	
Less Long term Storage	953		-	
Provide Attenuation Storage	3540		0	
N/A: De	fined at detailed	design phase		
4	. River Flood Pro			
4	. River Flood Pro			
4 Criterion			Optio	n 2 (See Nb. 1)
		tection	Option m3	n 2 (See Nb. 1) Notes
Criterion	Option 1 (tection See Nb. 1)	-	
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3	tection See Nb. 1)	-	
Criterion Criterion 4.1 "Long Term Storage"	Option 1 (m3 953	tection See Nb. 1)	m3 -	Notes
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term	Option 1 (m3 953	tection See Nb. 1)	m3 - 484	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	Option 1 (m3 953 -	tection See Nb. 1)	m3 - 484 5,180	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume	Option 1 (m3 953 - 4,493 484 25%	tection See Nb. 1)	m3 - 484 5,180 5,664 484 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 953 - 4,493 484 25% 121	tection See Nb. 1)	m3 - 484 5,180 5,664 484 25% 121	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 953 - 4,493 484 25%	tection See Nb. 1)	m3 - 484 5,180 5,664 484 25%	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	Option 1 (m3 953 - 4,493 484 25% 121 4,614	tection See Nb. 1) Notes	m3 - 484 5,180 5,664 484 25% 121 5,785 5,785	Notes This is Q1 This is QBAR - Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³)	Option 1 (m3 953 - 4,493 484 25% 121 4,614	tection See Nb. 1) Notes are as defined	m3 - 484 5,180 5,664 484 25% 121 5,785 5,785	Notes This is Q1
Criterion Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Nb. 1	Option 1 (m3 953 - 4,493 484 25% 121 4,614	tection See Nb. 1) Notes	m3 - 484 5,180 5,664 484 25% 121 5,785 5,785	Notes This is Q1 This is QBAR - Q1

5.16 Outfall 15

	SOIL	Soil Type	SAAR
	0.47	4	1182
	-		_
Catchment A	Areas		
Pavement	Verge	Grass	Unit
2.7213	0.3594	1.7766	ha
95	75	50	%
2.585235	0.26955	0.8883	ha
	700405		
		annent Area	
		-	l Incit
			Unit
_	_	-	mm
2.585235	0.26955	0.8883	ha
129.26175	13.4775	44.415	m ³
		16 47	
- F - F - F	-		
			Unit
			ha m ³
367.7655	40.4525	155.2450	m ⁻
HARGE RATES F	OR PONDS/WET	LANDS	
ctare		8.91	l/sec/ha
Actual Catchment Area			
			l/s
AR factors for Fl	ood Events		
Flood Event			
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.			
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.			
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.			70.99
); FSR Growth cu	rve factor is 1.9	96.	84.84
e in Q30 - Q1			33.33
in Q100 - Q30			13.85
e in QBar - Q1			5.63
M STORAGE (Evt	ra Volume Rung	off)	
in 100 year storr			
	Pavement2.7213952.585235INTERCEPTION Sn Smm of RainfaPavement52.585235129.26175TREATMENT STrage (Wet pondPavement2.5852387.7853CHARGE RATES FQBAR DetaCharGe RATES FCharGe RATES FCharGe RATES FCharGe RATES FCharGe RATES FCharGe RATES FCharGe RATES F<	Catchment Areas Pavement Verge 2.7213 0.3594 95 75 2.585235 0.26955 INTERCEPTION STORAGE n 5mm of Rainfall on the Develor Pavement Verge 5 5 129.26175 13.4775 TREATMENT STORAGE Trage (Wet pond volume) neede Pavement Verge 2.5852 0.26955 129.26175 13.4775 TREATMENT STORAGE Trage (Wet pond volume) neede Pavement Verge 2.5852 0.2696 387.7853 40.4325 CHARGE RATES FOR PONDS/WET QBAR Details Ctare Chment Area chment Area AR factors for Flood Events od Event SR Growth curve factor is 0.87. SR Growth curve factor is 0.95. FSR Growth curve factor is 1.64); FSR Growth curve factor is 1.9 9.5 e in Q30 - Q1 in Q100 - Q30 e in Q30 - Q1 in QBar - Q1	0.47 4 Catchment Areas Grass 2.7213 0.3594 1.7766 95 75 50 2.585235 0.26955 0.8883 INTERCEPTION STORAGE m m m Smm of Rainfall on the Development Area Pavement Verge Grass 5 5 5 5 5 2.585235 0.26955 0.8883 129.26175 13.4775 44.415 TREATMENT STORAGE rage (Wet pond volume) needed for 15mm Pavement Verge Grass 2.5852 0.2696 0.8883 387.7853 40.4325 133.2450 CHARGE RATES FOR PONDS/WETLANDS QBAR Details QBAR Details Ctare 8.91 ent Area 4.857 charea 43.3 AR factors for Flood Events SR Growth curve factor is 0.87. SR Growth curve factor is 0.95. 1.96.

Criterion	Option 1 (See Nb. 1)	Optio	n 2 (See Nb. 1)		
	m3	Notes	m3	Notes		
1. River Water Quality Protection						
· · · ·	m3	Notes	m3	Notes		
Criterion 1.1 "Interception Storage"	187		0			
Criterion 1.2 "Treatment Storage" -	561		561			
Permanent Wet Pond						
2.	River Regime Pro	otection				
	2.1 & 2.2 "Atten		ı			
Criterion	Option 1 (See Nb. 1)	Optio	Option 2 (See Nb. 1)		
	m3	Notes	m3	Notes		
For Q 1 year	305		0			
For Q 30 year	997		0			
For Q 100 year	1,526		0			
Total m3	2,828		-			
Less Long term Storage	595		_			
	555			I		
Provide Attenuation Storage	2233		0			
3. L	evel of Service Fo	or the site				
N/A: De	fined at detailed	design phase				
	I. River Flood Pro	tection				
Criterion	Option 1 (See Nb. 1)	Option 2 (See Nb. 1)			
			-			
	m3	Notes	m3	Notes		
riterion 4.1 "Long Term Storage"	m3	Notes	m3	Notes		
	m3 595	Notes	-			
		Notes	- 305	This is Q1		
Criterion 4.3 "Attenutaion & Long Term	595 -	Notes	- 305 3,255			
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume	595 - 2,828	Notes	- 305 3,255 3,560	This is Q1		
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year	595 - 2,828 305	Notes	- 305 3,255 3,560 305	This is Q1		
Provide Storage Volume For Q 1 year	595 - 2,828 305 25%	Notes	- 305 3,255 3,560 305 25%	This is Q1		
Criterion 4.1 "Long Term Storage" Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	595 - 2,828 305 25% 76	Notes	- 305 3,255 3,560 305 25% 76	This is Q1		
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	595 - 2,828 305 25%	Notes	- 305 3,255 3,560 305 25%	This is Q1		
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption	595 - 2,828 305 25% 76	Notes	- 305 3,255 3,560 305 25% 76 3,636	This is Q1		
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³)	595 2,828 305 25% 76 2,904		- 305 3,255 3,560 305 25% 76 3,636 3,636	This is Q1 This is QBAR - Q1		
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption	595 2,828 305 25% 76 2,904 Option 1 and 2	are as defined?	- 305 3,255 3,560 305 25% 76 3,636 3,636 d in the exam	This is Q1		
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume For Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³)	595 2,828 305 25% 76 2,904 Option 1 and 2	are as defined?	- 305 3,255 3,560 305 25% 76 3,636 3,636 d in the exam	This is Q1 This is QBAR - Q1		
riterion 4.3 "Attenutaion & Long Term rovide Storage Volume or Q 1 year lead Discharge Assumption apply Head Discharge Assumption Design Pond for Volume (m³) lb. 1	595 2,828 305 25% 76 2,904 Option 1 and 2	e are as defined dix E of the Gre	- 305 3,255 3,560 305 25% 76 3,636 3,636 d in the exam	This is Q1 This is QBAR - Q1		
Criterion 4.3 "Attenutaion & Long Term Provide Storage Volume for Q 1 year Head Discharge Assumption Apply Head Discharge Assumption Design Pond for Volume (m ³) Ib. 1	595 2,828 305 25% 76 2,904 Option 1 and 2 given in append	e are as defined dix E of the Gre	- 305 3,255 3,560 305 25% 76 3,636 3,636 d in the exam	This is Q1 This is QBAR - Q2 		

6 Culvert Sizes: Main Watercourses

6.1 Culvert Sizes

The Following is an overview of the main watercourse crossings on the *Proposed Road Development* and their associated sizes with the exception of the river crossings which are described in Chapter 4 of Volume 2. The following design principles apply to each crossing point:

- Bridge's or culverts are capable of passing a fluvial flood flow with a 1 % Annual Exceedance Probability or 1 in 100 year flow without significantly changing the hydraulic characteristics of the watercourse;
- Structures are capable of operating under the above design conditions while maintaining a freeboard of at least 300 mm;
- Where the land potentially affected does not include dwellings and infrastructure, culverts are capable of operating under the above design conditions while causing a hydraulic loss of no more than 300 mm (excluding the culvert gradient);
- Where the land potentially affected includes dwellings and infrastructure, it is demonstrated that those dwellings and/or infrastructure are not adversely affected by constructing the bridge or culvert;
- Culvert diameters, or height and width are not less than 900mm to facilitate maintenance access and reduce the likelihood of debris blockage.

Location (approx.)	ID	Structure Type	Maximum Design Characteristics		Comments
			Width	Height	
Ch. 500m	Open Drain	Circular Culvert	1.05m dia.		N/A
Ch. 900m	Open Drain	Circular Culvert	1.8m dia.		N/A
Ch. 1,100m	Markree Demesne Stream	Box Culvert (2no. broken sections)	3m	2.0m	The culvert will be broken between the interface of the proposed N4 and the proposed Eastern Parallel Link. This will be in the form of a plan opening of 4.5m long x 3.5m wide. The invert will be depressed by 0.5m for fish passage.
Ch. 3,550m	Open Drain to Turnalaydan Stream	Box Culvert	1.22m	1.830m	N/A
Ch. 3,700m	Open Drain to Turnalaydan Stream	Box Culvert	1.22m	1.520m	N/A
Ch. 5,300m	Open Drain to Lough Corran	Box Culvert	2.13m	2.13m	N/A
Ch. 5,620m	Open Drain to Turnalaydan Stream (u/s of Lough Corran	Box Culvert	1.52m	1.83m	N/A

Table 6-1: Main Watercourse Crossings

Location (approx.)	ID	Structure Type	Maximum Design Characteristics		Comments
			Width	Height	
Ch. 6,590m	Open Drain to Turnalaydan Stream (u/s of Lough Corran	Circular Culvert	1.35m dia.		N/A
Ch. 8,620m	Open Drain to Aghalenane Lough Outflow	Circular Culvert	0.9m dia.		N/A
Ch. 8,640m	Open Drain to Aghalenane Lough Outflow	Circular	1.2m dia.		N/A
Ch. 9,400m	Open Drain to Aghalenane Lough Outflow	Box Culvert	1.52m	1.52m	N/A
Ch. 9,650m	Open Drain to Aghalenane Lough	Box Culvert	1.05m dia.		N/A
Ch. 10,180m	Open Drain to Ardloy Lough	Box Culvert	1.52m	1.83m	N/A
Ch. 10,710m	Springfield Stream	Box Culvert	2.44m	2.13m	The invert will be depressed by 0.5m for fish passage.
	Springfield Stream	Box Culvert	2.74m	2.13m	The invert will be depressed by 0.5m for fish passage.
Ch. 10,850m	Open Drain to Springfield Stream	Circular Culvert	1.52m	1.52m	N/A
Ch. 11,320m	Open Drain to Springfield Stream	Circular Culvert	1.5m dia.		N/A
Ch. 12,250m	Lissycoyne Stream	Box Culvert	2.44m	1.830m	The invert will be depressed by 0.5m for fish passage.
Ch. 13,910m	Open Drain to Drumderry Stream	Box Culvert	1.83m	1.52m	The invert will be depressed by 0.5m for fish passage.
Ch. 14,230m	Tributary of Drumderry Stream	Bottomless Arch.	2.13m	2.13m	The invert will be depressed by 0.5m for fish passage.