Drainage Design Report for the

Proposed

Industrial Development

off

Benner Road, Pinchbeck,

Spalding, Lincolnshire

PE11 3TZ

Prepared for

Neil Brown Engineering Ltd

Issue 01

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George Shuttleworth Ltd

Consulting Engineers

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CONTENTS

1.0	INTRODUCTION	2
2.0	SUSTAINABLE DRAINAGE SYSTEMS	2
3.0	PROPOSED SURFACE WATER DRAINAGE SYSTEM	3
4.0	FUTURE MANAGEMENT & MAINTENANCE	6
5.0	FOUL SEWERAGE	7
6.0	APPENDIX 1 SUPPORTING INFORMATION	8

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1.0 INTRODUCTION

1.1. A Planning Application has been submitted to South Holland District Council for the construction of 11 Industrial units and associated access roads and parking. The Planning Application Reference is H14--0221-21.

1.2. A Flood Risk & Drainage Assessment Report was submitted with the planning application. The report contained an outline design of the proposed surface water drainage system. The outline design contained a number of options for providing the required attenuation storage. It was intended that the selection of the preferred option would be made prior to final approval when commercial considerations could be taken into account.

1.3. A consultation response was received from Lincolnshire County Council as Lead Local Flood Authority (LLFA) requesting further details be submitted on the proposed surface water drainage scheme.

1.4. This Supplement to the Flood Risk and Drainage Assessment Report has been prepared with the intention of supplying the additional information requested by the LLFA.

2.0 SUSTAINABLE DRAINAGE SYSTEMS

2.1. Sustainable Drainage Systems (SuDS) have been considered for this development.

2.2. Following the preferred hierarchy of drainage stated in Part H of the Building Regulations and The Suds Manual the following disposal routes were considered

a) Disposal via Infiltration
b) Disposal to a Watercourse
c) Disposal to Surface Water Sewer

2.3. No site specific site investigation information is available for the site but a Desktop Geotechnical Study was undertaken.

Disposal via Infiltration - Desktop Geotechnical Study

2.4. The British Geological Society web-site was checked for records of boreholes within the vicinity of the site. There are four boreholes within 150m of the western boundary of the site,

2.5. The boreholes generally indicate that a clayey layer exists to around 1.5m depth. A sandy gravely layer is present below the clay but the standing ground water level was generally up to the underside of the clay layer.

2.6. Copies of the borehole records are presented in Appendix 1.

2.7. The presence of the watercourse on the eastern boundary also indicates that vertical drainage may be restricted.

2.8. Taking into account the existing borehole records and in the absence of site specific geotechnical investigation reports, it is concluded that the site is unlikely to be suitable for surface water disposal via infiltration systems.

Disposal to a Watercourse

2.9. Following the hierarchy of Suds, a surface water drainage discharge to an open watercourse is the next preferred option. Therefore, it is proposed that the attenuated surface water run-off is discharged to the watercourse running along the eastern boundary and part of the northern boundary of the site before being piped under Wardentree Lane.

2.10. Welland & Deepings IDB has been contacted regarding the discharge of surface water. They have stated that their normal maximum discharge is 1.4/l/s/ha but for small sites they would be prepared to accept a discharge of 5.0l/s, subject to the payment of a charge

2.11. They have also stated that they would prefer the point of discharge to be as close to Wardentree Lane as practical. Therefore, a discharge opposite the pipe under Wardentree Lane is proposed.

2.12. The gross site area is 0.75ha so the a maximum discharge of 1.05l/s would be required to comply with the IDB's discharge rate of 1.4l/s/ha. It is generally accepted practice that, to avoid unnecessary blockages, the minimum practical flow rate for a discharge control device is 5.0 l/s. Therefore, a maximum discharge of 5.0 l/s is proposed.

3.0 PROPOSED SURFACE WATER DRAINAGE SYSTEM

3.1. The intention of this report is to demonstrate that it is practical to provide a surface water drainage system that meets the requirements of the LLFA. The detailed design of the system will need to be undertaken before Building Regulations submission stage and follow the principles contained in this report.

Attenuation Required

3.2. In the original FR&DAR the attenuation volume to restrict flows to 5.0l/s for storms up to and including the 1 in 100 year plus climate chamber event was estimated at 313m3.

3.3. The figure was calculated using average rainfall intensities and an average discharge.

3.4. Since production of the original report, the proposed layout has altered slightly and the connected impermeable area has reduced from 4926m2 to 4576m2. This reduces the initial estimate of storage volume down to 284m3

Provision of the Required Attenuation Volume

3.5. As previously mentioned the water level in the adjacent watercourse is between 1.44m and 1.97m and existing ground levels vary between 3.05 and 3.50m.

3.6. The proposed outfall will be at the northern end where the water level is at the lower value

3.7. Considering the minimum floor level of the units of 3.45m, the access road surface would be at around 3.15m. This equates to around only 1.55m for the hydraulic gradient across the site, the storage depth and cover to the storage units.

3.8. Due to HGV loading in the access road and the lack of cover, the installation of cellular crates under the access road has not been considered further.

3.9. However, it is proposed to install cellular crates under the parking bays, as they should not be subjected to HGV loading and for areas where HGV access is possible it would be practical to provide a protective concrete slab.

3.10. The area of the parking bays is 578m2 and with one layer of crates, 0.4m deep, would provide 220m3 of the storage required.

3.11. It is proposed to install the remainder of the attenuation volume in the permeable sub-base under the access road.

3.12. Both the cellular crates and permeable sub-base would we installed within an impermeable membrane.

3.13. The access road and parking bays will have permeable surfaces.

3.14. Due to potential problems with the future installation or repair of services, it is proposed to provide a 2.0m service strip within the road, which will not have a membrane, and normal road construction can be used.

3.15. In addition, due to the raised floor level of the units a ramp will be required for vehicular access. It is proposed that they and the adjacent footpaths are constructed in impermeable construction and drain back to the permeable access road.

Roof Drainage and Piped Drainage System

3.16. The proposed buildings have mono pitched roofs falling to the rear.

3.17. A piped system is proposed to serve the buildings. The pipes have been designed to meet the Building Regulations requirement of not surcharging under a discharge of 0.014l/s/m2.

3.18. The peak flow off all the roofs at 0.014l/s/m2 is 33.3 l/s, which requires a 225mm pipe laid at 1 in 225. Although the discharge control device will restrict the discharge to 5.0 l/s, sizing the pipes for the peak flow will allow the run-off to discharge freely to the proposed attenuation storage.

3.19. The pipes serving the two southern units will run under the permeable access road. It is proposed that the pipes under the access road are half perforated to allow excess flows in and out of the permeable sub-base via the under drain.

3.20. Half perforated pipe with the perforations at the top will convey any silt discharged off the roofs to the outfall and prevent contamination of the underdrain

3.21. The cellular crates under the car parking, being the lowest in elevation, will have 150mm sealed pipe connections to the underdrain to allow flow in and out of each storage area.

3.22. Although half perforated pipe is proposed due to the gradient of the pipe the underdrain will be able to drain almost fully to the lower end of the pipe. At the lower end of the underdrain, a small length of 100mm pipe will be connected into the manhole to fully empty the underdrain.

3.23. Details are shown of Drawings 733-001 contained in Appendix 1.

3.24. With the proposed drainage system, any flows from the southern units and access road in excess of 5.0 l/s will over flow the half perforated pipe and begin filling the storage. Flows from the northern unit will flow to the discharge control chamber and flows in excess of 5.0 l/s will reverse flow in the pipe under the access road and flow into the storage.

3.25. Sizing the pipes for the Building Regulations peak flow means that there will be no restriction to flow entering the storage provided.

Hydraulic Calculations and Simulation

3.26. As previously stated the storage volume required to attenuate the 1 in 100 year plus climate change event to a peak discharge of 5.0 l/s is 284m3. The peak storage volume is for a 6.0 hour storm.

3.27. Further hydraulic calculations and simulations have been undertaken for both the 75% winter and 50% 6 hour 1 in 100 year storms including the climate change allowance.

3.28. The storage provided has been calculated on a level basis and using a head discharge curve for a commercially available vortex control device.

3.29. The simulation calculations are presented in Appendix 1.

3.30. The calculations show that for the 75% winter storm, the storage fills to 1.147m above the invert of the discharge control device, which is 2.71m (1.563m+1.147m). This equates to 83% of the storage available

3.31. The calculations show that for the 50% summer storm, the storage fills to 1.178m above the invert of the discharge control device, which is 2.741m (1.563m+1.178m). This equates to 87% of the storage available. The peak discharge is 4.71 l/s

3.32. It should be noted that conservatively the above simulations use a Cv of 1.0 whereas the Microdrainage default values are 0.84 and 0.75 for the winter and summer storms respectively.

3.33. Also conservatively, the pipework from the northern unit roof drainage has been ignored along storage in the permeable sub-base above the cellular crates above the level of the top of the permeable sub-base under the access road.

Water Quality and Suds Treatment

3.34. All the areas subject to vehicle loading will discharge surface water through permeable pavement. The permeable blocks, sand and sub-base will provide sufficient treatment of the run-off

Construction Considerations

3.35. Following the guidance in the Interpave Permeable Pavement Design Guide, Load Category 5 has been assumed.

3.36. For a Type C (tanked) permeable pavement a construction thickness of 200mm of hydraulically bound coarse graded aggregate (HBCGA) on top of 150mm of coarse graded coarse aggregate (CGA) on 150mm of capping. The above depths are based on an assumed CBR of 5%.

3.37. As 300mm of CGA is required to provide the necessary storage, it is proposed to replace the capping with a further 150mm of CGA above the membrane.

3.38. If subsequent geo-technical investigations reveal lower CBR values then the design will need to be reviewed.

3.39. With the use of permeable sub-bases, it is essential that it is protected from contamination with mud during construction. It should either, be protected with a asphalt layer, nominally 130mm thick, which is drilled afterwards or the permeable sub-base is only installed after the majority of construction is complete and the risk of contamination has gone.

3.40. The asphalt layer can replace an equivalent thickness of HBCGA. As 200mm of HBCGA is required for Load Category 5 it is recommended that if a layer of asphalt is installed to protect the sub-base then it should be the full 200mm depth of the HBCGA.

3.41. As such the layer of HBCGA has not been counted in the attenuation volume calculation

3.42. Due to the depth of the discharge to the dyke some of the pipes in the access road will need a protective concrete slab. The concrete slab should not restrict flow in/out of layer of permeable sub-base. One method of avoiding this is to provide the concrete slab at the same level as the layer of HBCGA or DMB.

3.43. If a protective asphalt layer is installed it is also essential that some temporary drainage and storage is installed that keeps the permeable sub-base free of contaminated surface water.

4.0 FUTURE MANAGEMENT & MAINTENANCE

4.1. It is understood that the access road remain in private ownership and not be put forward for adoption.

4.2. The ownership of the access road will be in a single ownership, possibly with all the unit owners as shareholders of the company owning the access road.

4.3. Maintenance of the surface water drainage system will be the responsibility of the access road owner/

4.4. The system will require little maintenance, typically an annual inspection of the discharge control device. The permeable surfaces may require jet washing and cleaning at 5-10 yearly intervals.

4.5. It is assumed that a private contractor would be hired in to undertake these maintenance tasks.

5.0 FOUL SEWERAGE

5.1. A copy of the sewer records has been obtained from Anglian Water and is presented in Appendix 1

5.2. There is a foul sewer located in Benner Road that crosses the entrance to the site. MH4901 is located in the entrance. According to the sewer records the has a depth of 2.71m.

5.3. Using assumed soil stack locations and outline foul sewerage system has been shown on the Drawing 733-001 which demonstrates that a gravity drainage system, complying with the minimum gradients in Building Regulations should be possible.

5.4. A Section 106 application will need to be made to Anglian Water for the connection to the foul sewer. It is recommended that the application includes as a minimum, the adoption of the lateral and a demarcation chamber at the boundary. Should adoption of the full system from where it serves two curtilages be required a Section 104 application will also be required.

5.5. Anglian Water is unlikely to adopt a foul sewerage system within a tanked permeable pavement. For this reason, the proposed foul sewer route shown on drawing 733-001 is located outside the tanked permeable paving areas

5.6. With many similar industrial estates connections fro the drainage infrastructure were made into the plots within the industrial estate. Further investigation may reveal an existing sewer connection to MH4901. However, even if a connection exists a Section 106 application for an indirect connection will still be required.

6.0 APPENDIX 1 SUPPORTING INFORMATION

a) Borehole Scans

b) Impermeable Area Calculations

c) Simplified Run-off Analysis to determine critical storm

d) Options for providing attenuation

e) Calculation of Storage Provided by Depth.

f) Details of Proposed Vortex Control Device

g) Flow Depth Curve for Proposed Discharge Control Device

h) Simulation for 75% Winter and 50% Summer Critical Storms

i) Anglian Water Sewer Record Drawings

j) Drawing 733-001 – Drainage Layout Plan & Sections

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Record of Trial Pit TP2

Easting		Start date	11/04/2000
Northing		End date	11/04/2000
Ground level		Backfill date	11/04/2000
Final depth	3.20	Page	1 of 1

Job No. : C10430 **Equipment:** Jcb Type

Site Name : Wm. Morrision - Spalding

Samples & Testing								
Water	Cu kN/m2	Depths From	Depths To	Type	Legend	Depth (Thickness)	Strata Descriptions	Level	Inst/ Back fill
						(0.20) 0.20	MADE GROUND - Grass overlying brown sandy soil.		
		0.40	0.60	B		(0.50) 0.70	MADE GROUND - Medium brown very sandy soily clay with some fragments of brick, metal and plastic.		
						(0.75) 1.45	Generally firm to stiff medium brown very sandy CLAY. With high silt content and occasional cobblestones. Odour of fuel noted around 1.40m.		
		1.70	1.90	B		(1.45) 2.90	Visually moist light grey/occasionally dark grey very sandy SILT/CLAY, with bands of clayey sand. Odour of fuel throughout.		
		3.00	3.20	B		(0.30) 3.20	Visually moist dark grey very sandy SILT/CLAY, with bands of clayey sand. Slight odour of fuel.		
							End of Trial Pit		

General remarks

Slight collapse of trial pit below 2.30m.

Trial pit moist although no actual water ingress/strike.

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Record of Trial Pit TP1

Easting		Start date	11/04/2000
Northing		End date	11/04/2000
Ground level		Backfill date	11/04/2000
Final depth	3.00	Page	1 of 1

Job No. : C10430 Equipment: Jcb Type

Site Name : Wm. Morrision - Spalding

Samples & Testing

Water	Cu kN/m2	Depths From	Depths To	Type	Legend	Depth (Thickness)	Strata Descriptions	Level	Inst/ Back fill
						(0.10) 0.10	MADE GROUND - Grass overlying brown soil with occasional brick fragments.		
		0.30	0.50	B		(0.50)	MADE GROUND - Medium brown/occasionally dark brown soily sand with occasional cobbles, bricks and clay intrusions.		
						0.60			
	118.00	0.90				(0.60)	Stiff medium brown/grey mottled sandy CLAY. With high silt content.		
						1.20			
						(1.30)	Medium to dark brown/orange/grey very moist very silty SAND. With ocasional clayey intrusions/lenses.		
		2.50	2.70	B		2.50			
						(0.50)	Dark brown/dark grey sandy SILT. With occasional high clay content.		
						3.00	End of Trial Pit		

General remarks

Water ingress at 2.60m. Collapse of trial pit below 1.20m.

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[illegible] OF BOREHOLE / SPLUVIUS.

BORING: STARTED 3.11.77 TF 22 NE/26
BORING: FINISHED 3.11.77 257 AD
HOLE SIZE 350 mm x DIA TO 6.00 m

GROUND LEVEL O.D. TF22NE/26

SAMPLE OR TEST		CHANGE OF STRATA			
DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	DESCRIPTION
.50	D1		0.7		TOPSOIL.
1.00 - 1.45	U(4)1				Firm grey and brown mottled silty sandy CLAY.
1.50	D2		1.9		
2.65 - 2.95	S(21)		2.8		Medium dense brown clayey silty fine SAND.
3.00	D3				Medium dense grey/brown silty fine SAND. Slightly clayey with organic traces in the upper horizons.
3.50	W1				
4.15 - 4.45	S(17)				
4.50	D4				
5.65 - 5.95	S(29)		6.0		
6.00	D5				

REMARKS Groundwater entered the borehole at a depth of 3.5 m.
Standing water level on completion of boring 1.8 m.

KEY: D — DISTURBED SAMPLE
B — BULK DISTURBED SAMPLE
W — WATER SAMPLE
U — UNDISTURBED SAMPLE
B ( ) STANDARD PENETRATION TEST
C ( ) CONE PENETRATION TEST
NO. OF BLOWS FOR 300 mm PENETRATION IN BRACKETS

SOILS ENGINEERING LIMITED, PETERBOROUGH

BOREHOLE No. 1 SHEET No.

BORING FINISHED 3.11.77 TF22NE/20 254,250

GROUND LEVEL O.D. TF22NE/26 HOLE SIZE 150 mm x DIA TO 6.00 m

SAMPLE OR TEST		CHANGE OF STRATA			
DEPTH	TYPE	LEGEND	DEPTH	O.D. LEVEL	DESCRIPTION
			0.6		TOPSOIL.
0.50	D1				Firm brown slightly laminated silty sandy CLAY with thin grey bands and layers of fine brown sand.
1.00 - 1.45	U(4)1				
			1.8		
1.50	D2				Loose to medium dense brown silty fine SAND.
			2.75		
2.65 - 2.95	S(12)				Medium dense grey/brown silty fine SAND.
3.00	D3				
3.50	W1				
4.15 - 4.45	S(20)				
4.50	D4				
5.65 - 5.95	S(32)				
			6.0		
6.00	D5				

REMARKS Groundwater entered the borehole at a depth of 3.5 m.
Standing water level on completion 1.8 m.

KEY: D — DISTURBED SAMPLE
B — BULK DISTURBED SAMPLE
W — WATER SAMPLE
U — UNDISTURBED SAMPLE
S ( ) STANDARD PENETRATION TEST
C ( ) CONE PENETRATION TEST
NO. OF BLOWS FOR 300 mm PENETRATION IN BRACKETS

SOILS ENGINEERING LIMITED PETERBOROUGH

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Ref No: 733
Project: Benner Rd Pinchbeck
Date: 07/06/2021
Engineer: GS

ARTIFICIAL AREAS

				Flow at 0.014
Building Roofs				
Northern Block	1	650	650	9.1
Southern Blocks	2	865	1730	24.22
			2380	33.32
Car Parking Bays			578	
Loading Bays and adjacent Footpath			714	
Access Road				
Permeable Surface			904	
Sealed Surface to Benner Lane			130	
2.0m wide Service Strip			311	
Total Access Road			1345	
Total Artificial Surfaces			4576	
Total Site Area			7500	
PIMP (% Impermeable)			61	

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ATTENUATION & DISCHARGE TO DYKE- ALL ARTIFICIAL SURFACES

Calculation of Rain Profiles

M5-60	20							
r	0.4							
D (mins)	15	30	60	120	240	360	720	1440
Z1	0.64	0.81	1	1.21	1.4	1.62	1.8	2.2
M5-D	12.8	16.2	20.0	24.2	28.0	32.4	36.0	44.0
Z2(100)	1.94	1.99	2.03	2.02	2.01	1.95	1.92	1.86
Z2(30)	1.50	1.52	1.53	1.54	1.53	1.51	1.49	1.45
Z2(2)	0.80	0.80	0.81	0.82	0.83	0.83	0.84	0.85
Z2(1)	0.62	0.62	0.64	0.65	0.67	0.68	0.69	0.71
MT-D(100)	24.83	32.24	40.60	48.88	56.28	63.18	69.12	81.84
MT-D(30)	19.20	24.62	30.60	37.15	42.84	48.92	53.64	63.80
MT-D(2)	10.24	12.96	16.20	19.84	23.24	26.89	30.24	37.40
MT-D(1)	7.87	10.04	12.70	15.73	18.76	22.03	24.84	31.24
I(100)	99.33	64.48	40.60	24.44	14.07	10.53	5.76	3.41
I(30)	76.80	49.25	30.60	18.57	10.71	8.15	4.47	2.66
I(2)	40.96	25.92	16.20	9.92	5.81	4.48	2.52	1.56
I(1)	31.49	20.09	12.70	7.87	4.69	3.67	2.07	1.30

Note: Intensity I() limited to 100mm/hr

Calculation of Flows and Volumes

Contributing Impermeable Area = 4576 m2
Climate Change of 30%
Flows (l/s) = 2.78 x I x A(ha) x Global warming

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	164.27	106.63	67.14	40.42	23.27	17.41	9.53	5.64
1 in 30 yr	127.01	81.44	50.61	30.72	17.71	13.48	7.39	4.40
2 in 30 yr	67.74	42.87	26.79	16.41	9.61	7.41	4.17	2.58
1 in 1 yr	52.07	33.22	21.00	13.01	7.76	6.07	3.42	2.15

Volume (m3) = Cv x A(ha) x I x D/60 Cv= 1.00

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	147.72	191.78	241.52	290.80	334.80	375.85	411.18	486.85
1 in 30 yr	114.22	146.48	182.03	220.98	254.85	291.04	319.09	379.53
1 in 2 yr	60.92	77.10	96.37	118.05	138.25	159.98	179.89	222.49
1 in 1 yr	46.83	59.75	75.55	93.57	111.60	131.06	147.77	185.84

Initial Estimate of Balancing Volume Required

For Peak Discharge of 5.00 l/s Av Discharge Factor= 0.85 Av Qout = **4.25** l/s

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	143.90	184.13	226.22	260.20	273.60	284.05	227.58	119.65
1 in 30 yr	110.39	138.83	166.73	190.38	193.65	199.24	135.49	12.33
1 in 2 yr	57.09	69.45	81.07	87.45	77.05	68.18	0.00	0.00
1 in 1 yr	43.00	52.10	60.25	62.97	50.40	39.26	0.00	0.00

Storage required for 1 in 30 yr storm **199** m3
Storage required for 1 in 100 yr storm **284** m3

OPTIONS FOR PROVIDING ATTENUATION VOLUME REQUIRED

Attenuation Volume required			284	m3
Option 1 – All Permeable Sub-base				
Area Available, Access Rd, Parking & Ramps			2196	m2
Depth Required at 0.3 void Ratio			0.431	m
Option 2 – All Permeable Sub-base except ramps				
Area Available, Access Rd, Parking			1482	m2
Depth Required at 0.3 void Ratio			0.639	m
Option 3 Cellular Crates to Parking Bays				
Crate Depth	0.4 m	Void Ration 0.95		
Volume Under Parking Bays			220	m3
Additional Volume Req Under Access Road			64	m3
Depth of Permeable Sub-base Required under Access Road			0.177	m
Option 4 – Reduce Permeable Road Width to Provide Service Strip				
Service Strip 2.0m wide Full Length		Area	311	m2
Remaining Permeable Road Area			904	m2
Additional Volume Req Under Access Road			64	m3
Depth of Permeable Sub-base Required under Access Road			0.237	m

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Ref No: 733
Project: Benner Rd Pinchbeck
Date: 07/06/2021
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MH	Ground Level	Cover	Outlet Pipe	Invert level	Depth to IL	Distance	Grad 1 in	DS Invert Level	Connected Area (m2)	Flow (l/s0 at 0.014 l/s/m2	Capacity at Grade	Status
RWP	3.150	0.4	150	2.58	0.57	40	150	2.313	870	12.18	15	OK
S4	3.150	0.687	225	2.218	0.932	31	225	2.081	1740	24.36	35	OK
S3	3.150	0.844	225	2.061	1.089	18	225	1.981	1740	24.36	35	OK
S2	3.150	0.944	225	1.961	1.189	41	225	1.778	1740	24.36	35	OK
S1	3.150	1.147	300	1.683	1.467	30	300	1.583	1740	24.36	60	OK
FCC	3.15	1.417	150	1.563	1.587	12	150	1.483	1740	24.36	35	OK
Outfall	3.15	1.517	150	1.463	1.687							
RWP	3.150	0.25	150	2.73	0.42	40	150	2.463	870	12.18	15	OK
S5	3.150	0.537	150	2.443	0.707	6	150	2.403	870	12.18	15	OK
FCC	3.150	0.597	226	2.307	0.843							

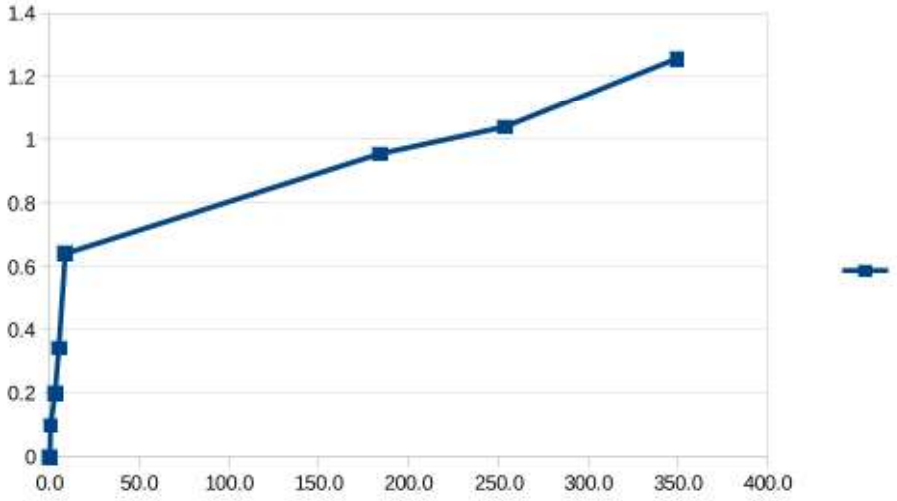
Dyke Water Level	1.44
Difference	0.0233333

IL Flow Control Device			1.563		
	300 mm pipe of length		28	1.97946 m3	
Start II	1.563 Full Soffit			1.983	0.42
	4.713 m3/mdepth				
	225 mm pipe of length		59	2.34619	
Start II	1.683 Full Soffit			1.908	0.224667
	10.44298 m3/mdepth				
	0.55 m wide underdrain	Length		59	
	Underside of Type 3		2.52		
	Lowest Drain Level		1.608		
	Highest Drain Level		1.986	0.912	
	Average Depth		0.723		
	Volume		7.038405		
	Less Pipe		0.5724		
	Nett Volume		6.466005	7.089918	
Permeable Sub base to Road					
	Top of Road		3.15		
	Surface Construction		0.13		
	DDMB/ HBCGA		0.2		
	Top of Type 3		2.82		
	Depth		0.3		
	Bottom of Type 3		2.52		
	Area		904		
	Void Ratio		0.3		
	Volume		81.36	271.2	
Cellular Crates Under Parking					
	Top of crates		2.605		
	Bottom of Crates		2.205	0.4	
	Area		578		
	Void Ratio		0.95		
	Volume		219.64	549.1	
Type 3 Above					
	Top of crates		2.605		
	Top of Sub-base in R		2.82		
	Depth		0.215		
	Volume		37.281		

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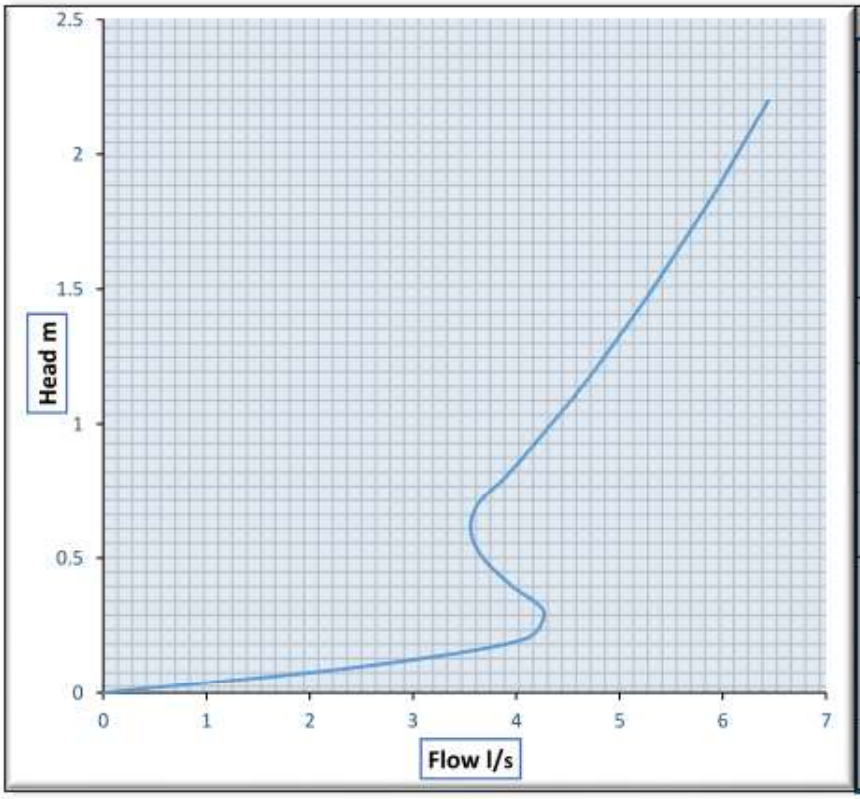
Depth	Level	300 pipe	225pipe	trench	Crates	Road	Parking	Total		
0	1.563	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
0.1	1.663	0.5	0.0	0.0	0.0	0.0	0.0	0.5		
0.2	1.763	0.9	1.0	1.1				3.1		
0.345	1.908	1.6	1.5	2.1				5.3		
0.643	2.206	2.0	2.3	4.2	0.0			8.6	13.32103	
0.957	2.52	2.0	2.3	6.5	173.0			183.8	557.9386	
1.042	2.605	2.0	2.3	6.5	219.6	23.1		253.5	820.3	
1.257	2.82	2.0	2.3	6.5	219.6	81.4	37.3	349.1	444.6	554.572



CROWN WATER Data Sheet
99 mm QR5 Type Vortex Flow Control

Job Ref : 31030621

Client Name	George Shuttleworth	Date	03/06/2021
Project Name	Benner Lane	For the attention of	George Shuttleworth



Head m	Flow l/s
0	0.000
0.1	2.510
0.2	4.070
0.3	4.270
0.4	3.950
0.5	3.680
0.6	3.560
0.7	3.630
0.8	3.890
0.9	4.120
1	4.340
1.1	4.560
1.2	4.760
1.3	4.950
1.4	5.140
1.5	5.320
1.6	5.490
1.7	5.660
1.8	5.830
1.9	5.990
2	6.140
2.1	6.290
2.2	6.440

Design Flow	5 l/s	Flush Flow	4.3 l/s
Design Head	1.325 m	At Head	0.261 m
Minimum PipePipe	150 mm	Kickback Flow	3.52 l/s
Sump Depth	300 mm	At Head	0.638 m

Note: Surface Water Only

Crown Water Ltd
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sales@crownwater.com
Company Registration Number *9514593*

ISO 9001 : 2015 REGISTERED
Cert No. 14126867

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CROWN WATER
FLOW CONTROL QUOTATION REF. 31030621

Client Name	George Shuttleworth	Date	03/06/2021
Project Name	Benner Lane	For the attention of	George Shuttleworth

Crown Water Flow Control Units

Design Flow 5 l/s Design Head 1.325 m

1 no, Crown Water 99mm QR5 Vortex Flow Control Unit with Integral Pivoting bypass door

Price £ 985 Ex VAT

Note: Surface Water Only

Scope

- All price(s) ex VAT. Quotations valid for 90 days
- Includes design, manufacture in 3mm ASI 304 Stainless Steel and UK delivery.
- Includes the required Stainless Steel Fixing Bolts and directions for installation by others

Delivery

- Delivery Normally 10 to 14 Days.

Terms

- Written Order or confirmation required
- Approved accounts: Payment within 30 days of invoice. Otherwise payment with order or pro forma prior to shipping

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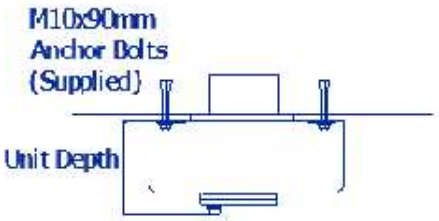
CROWN WATER

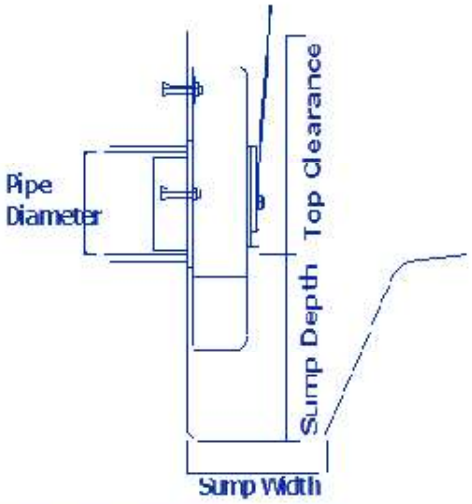
Job Ref 31030621

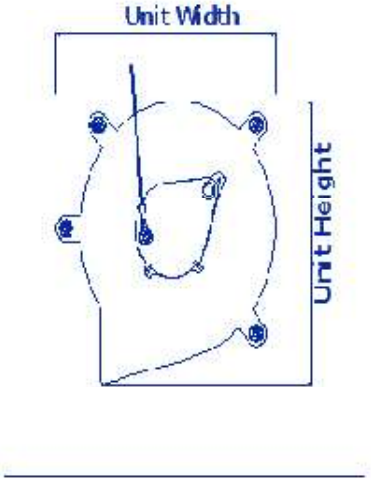
99 mm QR5 Type Vortex Flow Control

Client Name	George Shuttleworth	Date	03/06/2021
Project Name	Benner Lane	For the attention of	George Shuttleworth

Crown Water Radial Type Vortex Flow Control Unit Installation Guide







Unit Outlet Diameter	99mm	Sump Depth (Min)	300 mm
Unit Height	550 mm	Sump Width (Min)	280 mm
Unit Width	500 mm	Pipe Diameter (Min)	150mm
Unit Depth	130 mm	Top Clearance(Min)	360 mm

Note: Surface Water Only

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CROWN WATER
FLOW CONTROL QUOTATION REF. 31030621

Product Information and FAQ's

DESIGN

Individual Design.

All of our Vortex Flow Control Units are individually designed to meet the client's optimum performance criteria.

Will our Vortex Flow Control's Block?

The relatively large cross sectional areas and high internal velocities greatly reduce the risk of blockage.

How Long Will They Last?

Crown Water Vortex Flow Control Units have no moving parts to wear or fail. Made from stainless steel plate they will resist scour, degradation and chemical attack. A Vortex Flow Control should outlast the sewer in which it is installed.

MANUFACTURE

Crown Water Vortex Flow Control Units are manufactured to a high standard

- 304 Grade Stainless Steel as standard. Other material optional.
- Plate thickness 3mm as standard Thicker plate used where required.
- Pulse arc Tungsten Inert Gas Welding. All seams continuous for maximum strength.
- Emergency Bypass Door fitted as standard to allow drain down and rodding access.
- Externally regulated ISO 9001:2008 Quality Assurance System

INSTALLATION

All of our Vortex Flow Controls are purpose built to suit the specific site and to fit easily into the drainage infrastructure. Units can be specially designed for retrofitting or for installation in difficult spaces

MAINTENANCE

Vortex Flow Control units themselves require no routine maintenance. Inspection chambers require inspection & maintenance in line with current practice.

WHAT DESIGN INFORMATION DO WE NEED?

We require the following basic information to specify a Vortex Flow Control for you.

1) The design Flow - *Maximum Discharge*
2) The design Head - *Invert to Top Water Level*

From this information we will size and design the Vortex Flow Control to meet the design criteria and to suit the proposed infrastructure.

SPECIFICATION

Includes: -

1) Data Sheet showing the Head/Discharge Characteristic, both graphically and numerically.

2) Installation Guide showing the outline dimensions of the specified Vortex Flow Control and the method of fixing.

Note: Surface Water Only

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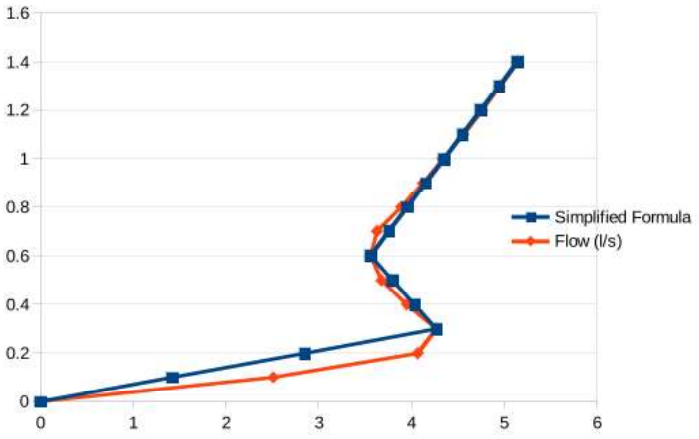
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Ref No: 733
Project: Benner Rd
Date: 07/06/2021
Engineer: GS

Discharge Control Device

Head (m)	Flow (l/s)	Simplified Formula	Difference
0	0	0	
0.1	2.51	1.423	-1.087
0.2	4.07	2.046	-1.224
0.3	4.27	4.269	-0.001
0.4	3.95	4.033	0.083
0.5	3.68	3.796	0.116
0.6	3.56	3.559	-0.001
0.7	3.63	3.7575	0.1275
0.8	3.89	3.955	0.065
0.9	4.12	4.1525	0.0325
1	4.34	4.35	0.01
1.1	4.56	4.5475	-0.0125
1.2	4.76	4.745	-0.015
1.3	4.95	4.9425	-0.0075
1.4	5.14	5.14	0

1.58
1.975



Simplified Formula

H up to 0.3	Q=H x 14.23
H 0.3 to 0.6	Q= 4.27-2.37(H-0.3)
H above 0.6	Q= 3.56+1.975(H-0.6)

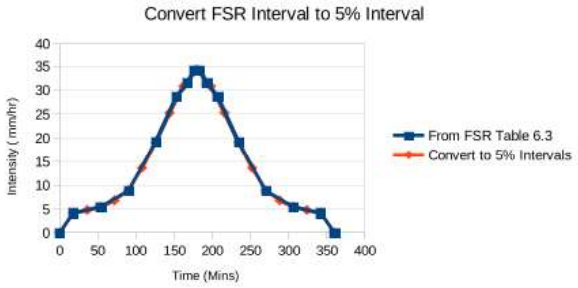
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Project: Benner Rd
Date: 07/06/2021
Engineer: GS

RAIN PROFILE 6.0 HOUR 1 IN 100 YR 75% WINTER

Critical Storm Duration	360 min
1 in 100 average Intensity	10.53 mm/hr
Cv	1.00
Climate Change	1.30

From FSR Table 6.3					Convert to 5% Intervals			
% Duration of Storm	Proportion of I	Mins from Centre	Time from Start Mins	Intensity mm/hr	%	Time Mins	Proportion	Intensity (mm/hr)
0		180	0	0	0	0.0	0	0
5	0.3	162	18	4.11	5	18.0	0.3	4.11
15	0.4	126	54	5.48	10	36.0	0.35	4.79
25	0.65	90	90	8.90	15	54.0	0.4	5.48
35	1.4	54	126	19.16	20	72.0	0.5	6.84
42.5	2.1	27	153	28.75	25	90.0	0.65	8.90
46.5	2.3	12.6	167.4	31.48	30	108.0	1	13.69
49	2.5	3.6	176.4	34.22	35	126.0	1.4	19.16
51	2.5	-3.6	183.6	34.22	40	144.0	1.85	25.32
53.5	2.3	-12.6	192.6	31.48	45	162.0	2.25	30.80
57.5	2.1	-27	207	28.75	50	180.0	2.5	34.22
65	1.4	-54	234	19.16	55	198.0	2.25	30.80
75	0.65	-90	270	8.90	60	216.0	1.85	25.32
85	0.4	-126	306	5.48	65	234.0	1.4	19.16
95	0.3	-162	342	4.11	70	252.0	1	13.69
100		-180	360	0.00	75	270.0	0.65	8.90
					80	288.0	0.5	6.84
					85	306.0	0.4	5.48
					90	324.0	0.35	4.79
					95	342.0	0.3	4.11
					100	360.0	0	0.00



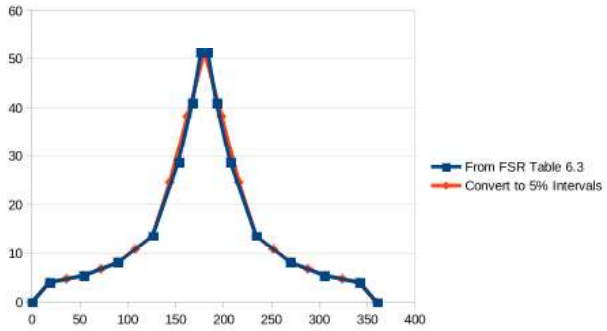
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Ref No: 733
Project: Benner Rd
Date: 07/06/2021
Engineer: GS

RAIN PROFILE 6.0 HOUR 1 IN 100 YR 75% WINTER

Critical Storm Duration	360	min
I in 100 Rainfall Intensity	10.53	mm/hr
Cv	1.00	
Climate Change	1.30	

From FSR Table 6.3					Convert to 5% Intervals			
% Duration of Storm	Proportion of I	Mins from Centre	Time from Start Mins	Intensity mm/hr	% Duration of Storm	Time from Start Mins	Proportion of I	Intensity (mm/hr)
0		180	0	0	0	0	0	0
5	0.30	162	18	4.11	5	18.0	0.3	4.11
15	0.40	126	54	5.48	10	36.0	0.35	4.79
25	0.60	90	90	8.21	15	54.0	0.4	5.48
35	1.00	54	126	13.69	20	72.0	0.5	6.84
42.5	2.10	27	153	28.75	25	90.0	0.6	8.21
46.5	3.00	12.6	167.4	41.07	30	108.0	0.8	10.95
49	3.75	3.6	176.4	51.33	35	126.0	1	13.69
51	3.75	-3.6	183.6	51.33	40	144.0	1.8	24.64
53.5	3.00	-12.6	192.6	41.07	45	162.0	2.8	38.33
57.5	2.10	-27	207	28.75	50	180.0	3.75	51.33
65	1.00	-54	234	13.69	55	198.0	2.8	38.33
75	0.60	-90	270	8.21	60	216.0	1.8	24.64
85	0.40	-126	306	5.48	65	234.0	1	13.69
95	0.30	-162	342	4.11	70	252.0	0.8	10.95
100		-180	360	0.00	75	270.0	0.6	8.21
				Totals	80	288.0	0.5	6.84
	22.3				85	306.0	0.4	5.48
					90	324.0	0.35	4.79
					95	342.0	0.3	4.11
					100	360.0	0	0.00
							20.85	



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Date: 07/06/2021
Engineer: GS

ATTENUATION FOR CRITICAL STORM DURATION OF 6 hrs
75% Winter Storm
Connected Area 4576 m2

Sub -base Storage
From Storage Sheet
For up to 0.643 m Volume = 13.32103 m3/m 8.565421
Above 0.643 m Volume = 554.572 m3/m

Discharge Control
From Discharge Control Sheet
H up to 0.3 Q=H x 14.23
H 0.3 to 0.6 Q= 4.27-2.37(H-.3)
H above 0.6 Q=3.56+1.975(h-0.6)

Instructions Adjust head at DCV at each interval to give checksum=0 or close to 0

Time	Rainfall				DCV	Storage		Discharge Control				Check Sum	
	Rainfall	Av Rainfall mm/hr	Vol In m3	Cum In m3	Head h	Storage Depth	Vol m3	Out-flow l/s	Av Flow Out l/s	Vol Out m3	Cum Out m3	Inflow - Storage - Out = 0	% full
0.0	0.0	0.00	0.00	0.00	0.000	0.000	0.0	0.00	0.00	0.00	0.00	0.00	0
18.0	4.1	2.05	2.82	2.82	0.135	0.135	1.798	1.92	0.96	1.04	1.04	-0.02	1
36.0	4.8	4.45	6.11	8.93	0.345	0.345	4.596	4.16	3.04	3.29	4.32	0.01	1
54.0	5.5	5.13	7.05	15.97	0.558	0.558	7.433	3.66	3.91	4.22	8.55	-0.01	2
72.0	6.8	6.16	8.46	24.43	0.649	0.649	11.893	3.66	3.66	3.95	12.50	0.04	3
90.0	8.9	7.87	10.81	35.24	0.661	0.661	18.548	3.68	3.67	3.96	16.46	0.23	5
108.0	13.7	11.29	15.50	50.74	0.682	0.682	30.194	3.72	3.70	4.00	20.46	0.09	9
126.0	19.2	16.43	22.55	73.29	0.715	0.715	48.495	3.79	3.75	4.05	24.51	0.28	14
144.0	25.3	22.24	30.54	103.83	0.763	0.763	75.114	3.88	3.83	4.14	28.65	0.06	22
162.0	30.8	28.06	38.52	142.35	0.825	0.825	109.498	4.00	3.94	4.26	32.91	-0.06	31
180.0	34.2	32.51	44.63	186.98	0.898	0.898	149.981	4.15	4.08	4.40	37.31	-0.31	43
198.0	30.8	32.51	44.63	231.61	0.970	0.970	189.910	4.29	4.22	4.56	41.87	-0.17	54
216.0	25.3	28.06	38.52	270.14	1.030	1.030	223.185	4.41	4.35	4.70	46.57	0.38	64
234.0	19.2	22.24	30.54	300.68	1.077	1.077	249.250	4.50	4.46	4.81	51.38	0.05	71
252.0	13.7	16.43	22.55	323.23	1.110	1.110	267.551	4.57	4.53	4.90	56.28	-0.60	77
270.0	8.9	11.29	15.50	338.73	1.128	1.128	277.533	4.60	4.59	4.95	61.23	-0.03	80
288.0	6.8	7.87	10.81	349.54	1.139	1.139	283.633	4.62	4.61	4.98	66.21	-0.31	81
306.0	5.5	6.16	8.46	357.99	1.145	1.145	286.961	4.64	4.63	5.00	71.21	-0.18	82
324.0	4.8	5.13	7.05	365.04	1.149	1.149	289.179	4.64	4.64	5.01	76.23	-0.36	83
342.0	4.1	4.45	6.11	371.15	1.151	1.151	290.288	4.65	4.65	5.02	81.24	-0.38	83
360.0	0.0	2.05	2.82	373.97	1.147	1.147	288.070	4.64	4.64	5.02	86.26	-0.36	83

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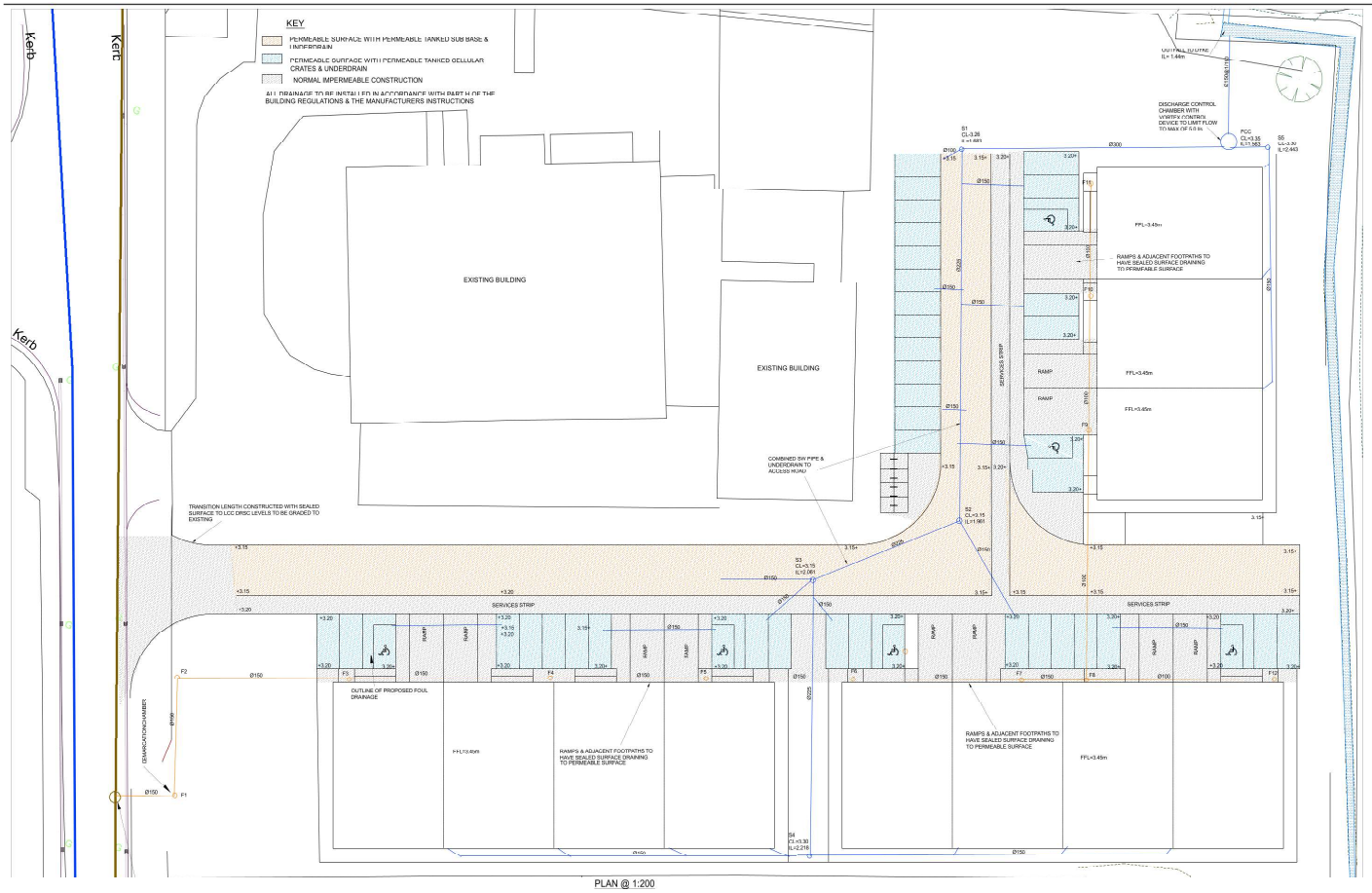
ATTENUATION FOR CRITICAL STORM DURATION OF 6 hrs
50% Summer Storm
Connected Area 4576 m2

Sub -base Storage
From Storage Sheet
For up to 0.643 m Volume = 13.32103 m3/m 8.565421
Above 0.643 m Volume = 554.572 m3/m

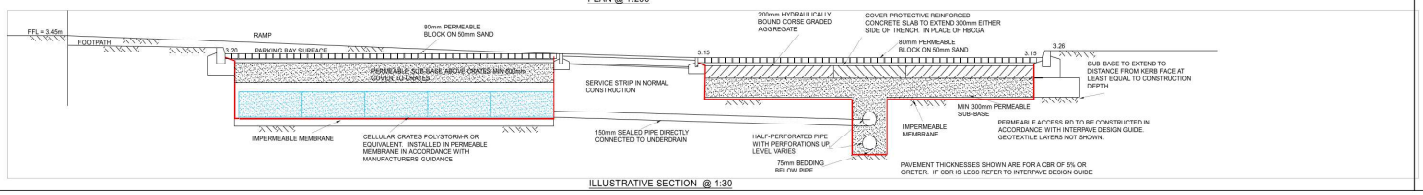
Discharge Control
From Discharge Control Sheet
H up to 0.3 Q=H x 14.23
H 0.3 to 0.6 Q= 4.27-2.37(H-.3)
H above 0.6 Q=3.56+1.975(h-0.6)

Instructions Adjust head at DCV at each interval to give checksum=0 or close to 0

Time	Rainfall				DCV	Storage		Discharge Control				Check Sum	
	Rainfall	Av Rainfall mm/hr	Vol In m3	Cum In m3	Head h	Storage Depth	Vol m3	Out-flow l/s	Av Flow Out l/s	Vol Out m3	Cum Out m3	Inflow - Storage - Out = 0	% full
0.0	0.0	0.00	0.00	0.00	0.000	0.000	0.0	0.00	0.00	0.00	0.00	0.00	0
18.0	4.1	2.05	2.82	2.82	0.135	0.135	1.798	1.92	0.96	1.04	1.04	-0.02	1
36.0	4.8	4.45	6.11	8.93	0.345	0.345	4.596	4.16	3.04	3.29	4.32	0.01	1
54.0	5.5	5.13	7.05	15.97	0.558	0.558	7.433	3.66	3.91	4.22	8.55	-0.01	2
72.0	6.8	6.16	8.46	24.43	0.649	0.649	11.893	3.66	3.66	3.95	12.50	0.04	3
90.0	8.2	7.53	10.34	34.77	0.661	0.661	18.548	3.68	3.67	3.96	16.46	-0.24	5
108.0	11.0	9.58	13.15	47.92	0.677	0.677	27.421	3.71	3.70	3.99	20.45	0.05	8
126.0	13.7	12.32	16.91	64.83	0.701	0.701	40.731	3.76	3.74	4.03	24.49	-0.38	12
144.0	24.6	19.16	26.31	91.14	0.741	0.741	62.913	3.84	3.80	4.10	28.59	-0.36	18
162.0	38.3	31.48	43.22	134.36	0.811	0.811	101.734	3.98	3.91	4.22	32.81	-0.18	29
180.0	51.3	44.83	61.54	195.91	0.914	0.914	158.854	4.18	4.08	4.40	37.21	-0.16	46
198.0	38.3	44.83	61.54	257.45	1.016	1.016	215.421	4.38	4.28	4.62	41.84	0.20	62
216.0	24.6	31.48	43.22	300.68	1.086	1.086	254.241	4.52	4.45	4.81	46.64	-0.21	73
234.0	13.7	19.16	26.31	326.99	1.124	1.124	275.315	4.59	4.56	4.92	51.57	0.11	79
252.0	11.0	12.32	16.91	343.90	1.146	1.146	287.515	4.64	4.62	4.99	56.55	-0.17	82
270.0	8.2	9.58	13.15	357.05	1.160	1.160	295.279	4.67	4.65	5.02	61.58	0.20	85
288.0	6.8	7.53	10.34	367.39	1.170	1.170	300.825	4.69	4.68	5.05	66.63	-0.06	86
306.0	5.5	6.16	8.46	375.85	1.176	1.176	304.152	4.70	4.69	5.07	71.69	0.00	87
324.0	4.8	5.13	7.05	382.89	1.180	1.180	306.371	4.71	4.70	5.08	76.77	-0.25	88
342.0	4.1	4.45	6.11	389.00	1.182	1.182	307.480	4.71	4.71	5.08	81.85	-0.33	88
360.0	0.0	2.05	2.82	391.82	1.178	1.178	305.261	4.70	4.71	5.08	86.94	-0.38	87



PLAN @ 1:200



ILLUSTRATIVE SECTION @ 1:30

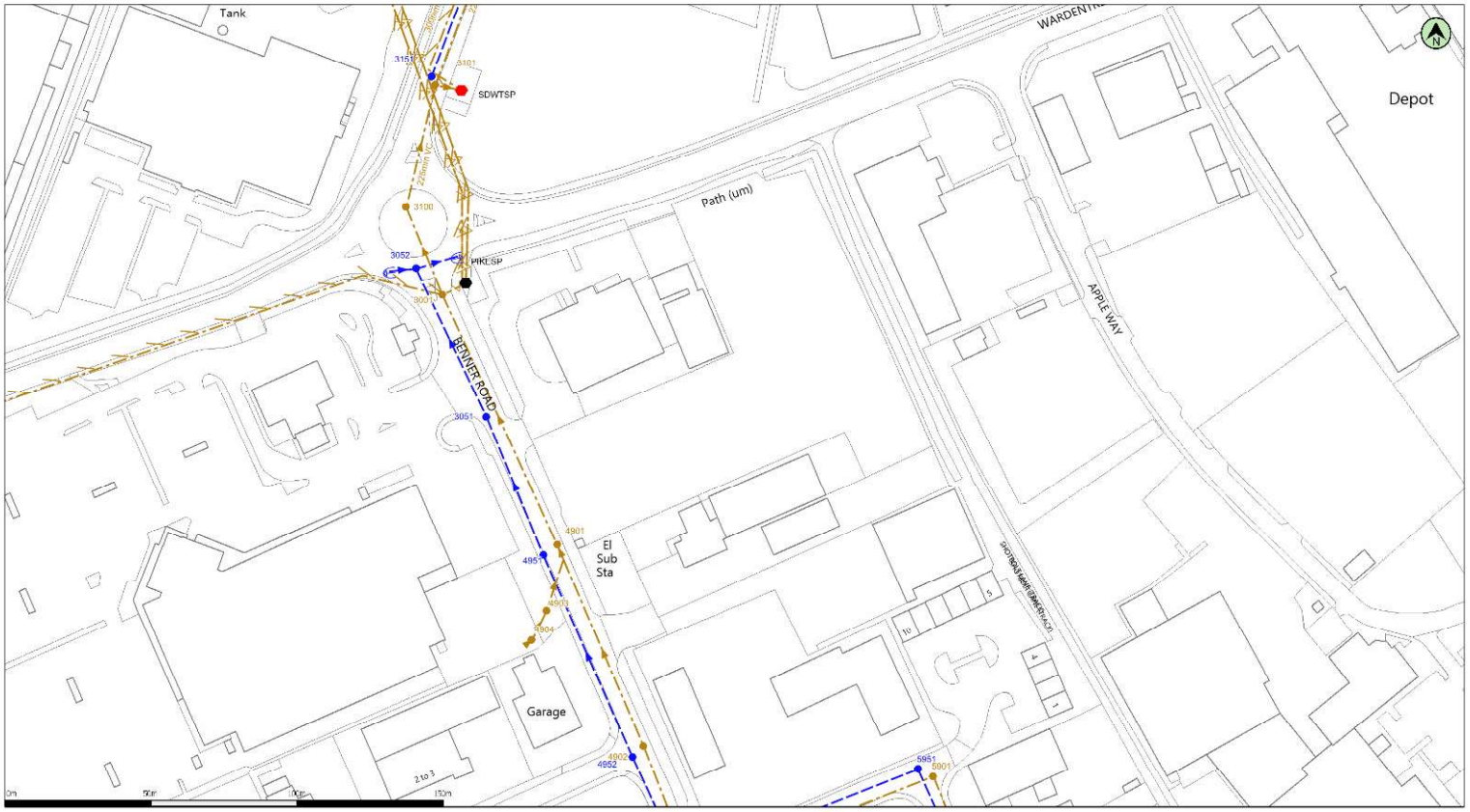
DRAINAGE DESIGN FOR PLANNING APPROVAL

PROPOSED INDUSTRIAL UNITS OFF BENNER LANE, PINCHBECK

NEIL BROWN ENGINEERING LTD

George Shuttleworth Ltd
Consulting Engineers

NOTES



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Foul Sewer
Surface Sewer
Combined Sewer
Final Effluent
Rising Main*
Private Sewer*
Decommissioned Sewer*
Outfall*
Inlet*
Manhole*
Sewage Treatment Works
Public Pumping Station
Decommissioned Pumping Station
*(Colour denotes effluent type)

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Benner Rd

love every drop
anglianwater

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
3001	F	3.06	-0.03	3.09
3100	F	-	-	-
3101	F	-	-	-
4901	F	3.09	0.379	2.711
4902	F	3.08	0.695	2.385
4903	F	-	-	-
4904	F	-	-	-
5901	F	3.139	1.449	1.69
3051	S	3.11	1.29	1.82
3052	S	3.18	1.21	1.97
3151	S	-	-	-
4951	S	3.041	1.361	1.68
4952	S	3.082	1.412	1.67
5951	S	3.06	1.79	1.27

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert