

**REDEVELOPMENT OF LAND AT
15-17 KEW GARDENS
BOGNOR REGIS
WEST SUSSEX
PO21 5RD**

SURFACE WATER DRAINAGE DESIGN REPORT

For:

Imperial Homes
Paddock View
Calcot Mount Business Park
Calcot Lane
Curdridge
Southampton
SO32 2BN

Cowan Consultancy Ltd
3 Turnberry House
4400 Parkway
Whiteley
Fareham
Hampshire
PO15 7FJ

Landguard Manor
Landguard Manor Road
Shanklin
Isle of Wight
PO37 7JB

CMW/414504/djb

3 February 2020

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1.0 INTRODUCTION

- 1.1 This report has been prepared by Cowan Consultancy Limited (CCL) for Imperial Homes, The Barn, Calcot Mount Business Park, Calcot Lane, Curdridge, Southampton, SO31 2BN.
- 1.2 This surface water drainage design has been prepared following our Surface Water Drainage Strategy 27.09.19, used for the purposes of planning approval.

2.0 GEOLOGY OF THE AREA

- 2.1.1 The site lies on OS grid reference (Eastings) 491770 (Northings) 100095 and Site GPS Coordinates 50.793167, -0.69933170.
- 2.1.2 By reference to the IGS 1 to 50000 series geological drift edition map it can be seen that the site would be expected to lie within Lambeth Group – Clay, Silt and Sand with overlying River Terrace Deposits (undifferentiated) of Sand, Silt and Clay.

3.0 SITE DESCRIPTION

- 3.1.1 The site for the proposed development consists of approximately 0.20 acres of brownfield site. Immediately to the West of the site is Bognor Regis Fire Station. The other three sides are surrounded by residential properties of Kew Gardens.
- 3.1.2 The site consists of 6no. semi-detached houses with parking to the sides and gardens to the rear.

4.0 FIELDWORK

- 4.1 The fieldwork was carried out on the 6th November 2019 comprising of three trial pits for foundation design purposes and on the 23rd January 2020 with one soakage test pit, for surface water drainage design.
- 4.2 The location of these pits are shown on Location Plan (Appendix A).
- 4.3 Trial pits referenced TP1 – TP3 and soakage test pit referenced SA1 were excavated using a mechanical excavator with a 600mm wide bucket.

5.0 TRIAL PIT GROUND CONDITIONS

- 5.1 TRIAL PIT 1 – Grass on firm moist medium to dark brown topsoil with fine roots, to 300mm BGL. Firm to stiff moist medium brown/orange/grey silty clay with fine roots, becoming softer with depth, to 1100mm BGL. Dense moist orange/grey slightly silty sand, to 1300mm BGL. Dense saturated orange/grey sand, to 1500 BGL. Water seeping into pit at 1400mm BGL, with 150mm of standing water after 45 minutes.
- 5.2 TRIAL PIT 2 – Grass on soft very moist medium brown topsoil with fine roots, to 250mm BGL. Soft very moist medium brown/orange silty clay with fine roots, becoming firmer with depth, to 1200 BGL. Water seeping into base of pit.
- 5.3 TRIAL PIT 3 – Grass on soft to firm moist medium brown topsoil with fine roots, to 200mm BGL. Firm moist medium brown/orange silty clay with large root from old tree stump at 1100mm BGL preventing excavation further. Investigations were continued with a hand auger to 1300mm BGL. Dense saturated orange/grey sand, to 1500 BGL. Water seeping into pit at 1400mm BGL, with 125mm of standing water after 5 minutes, within auger hole.

6.0 SOAKAGE TEST & RESULTS

- 6.1 Owing to the presence of struck ground water in two trial pits at 1400mm BGL and seeping water in the third trial pit at 1200mm BGL, it was decided to carry out an infiltration test within the sand layer found at 1100mm BGL. Infiltration testing was carried out in accordance with BRE Digest 365 Soakaway Design, with the soakage testing repeated three times, the results can be seen in Appendix B1.
- 6.2 The results from soakage testing were then used to calculate a soil infiltration rate (Appendix B5-B7) to be used in subsequent calculations for a soakaway design. Three soil infiltration rates have been calculated and the lowest of them has been used for the soakaway design.

7.0 SOAKAWAY DESIGN

- 7.1 For the purpose of the soakaway design it is intended that the surface water is only being collected from the roof of the proposed buildings. It has been confirmed that parking and access surfaces are to be permeable.
- 7.2 Due to presence of ground water at approximately 1400mm BGL, it has been decided to provide soakaways at a depth of 700mm below ground within grass areas to the rear of the proposed buildings. This would mean that only one layer of 400mm deep crates could be used with a minimum cover of 300mm. It has also been decided to remove the silty clay layer above the dense sand and infill with coarse gravel/sand.
- 7.3 The first set of calculations are to size a soakaway capable of containing 1 in 30 year storm + 40% climate change allowance, without flooding (Appendix C1). A factor of 1.2 has also been applied to the final storage required. As the crates are only 400mm deep, the effective depth of the soakaway will only be 300mm using a 100mm inlet pipe. It has been calculated that a soakaway storage capacity of 23.22m³ (including 1.2 FOS) will be required. Therefore a soakaway with a total size of 18.0 x 5.0 x 0.4m (24.30m³) has been proposed.
- 7.4 The second set of calculations are to see if the same size soakaway is capable of containing 1 in 100 year storm + 40% climate change allowance, without flooding (Appendix C2). In this instance the entire capacity of the soakaway crates could be used and the incoming pipes and inspection chambers could be used as additional storage. Calculations for the additional storage are shown in Appendix D.
- 7.5 The calculations show that the soakaway is slightly under size, but, the additional storage is more than provided by the incoming pipes and inspection chambers.
- 7.6 Due to the constraints of the site layout, the gardens of Plots 1, 2 & 6 can't accommodate a soakaway. Therefore the total capacity required from the site has been split into three soakaways located in the gardens of Plots 3, 4 & 5 as indicated on Drawing No. 414504/201P (Appendix C3). The soakaways are split at each plot boundary and linked with 100mm diameter pipes.

- 7.7 With regards to the proposed permeable areas, these have been considered, see calculations Appendix C4. These calculations are to establish the depth of Type 3 material below the permeable surface capable of containing 1 in 30 year storm + 40% climate change allowance, without flooding, a factor of 1.2 has also been applied to the final storage required.

8.0 DISCUSSION

- 8.1 Under normal circumstances, it is a requirement that the underside of any soakaway should be 1.0m above the established ground water level. However, if this was applied to this site, it would put the top of a soakaway above ground level, due the presence of standing ground water at around 1250mm BGL.

- 8.2 The hierarchy of SUDS drainage is:

1. Store rainwater for later use.
2. Use infiltration techniques, such as porous surfaces in non-clay areas.
3. Attenuate rainwater in ponds or open water features for gradual release.
4. Attenuate rainwater in tanks of sealed water features for gradual release.
5. Discharge rainwater direct to watercourse.
6. Discharge rainwater to a surface water sewer/drain.
7. Discharge rainwater to the combined sewer.

- 8.2.1 Item 1, is not relevant for the volume of water intended.

- 8.2.2 Item 2, is relevant to the car parking areas only.

- 8.2.3 Item 3, there are no ponds or open water features locally.

- 8.2.4 Item 5, no watercourse locally.

- 8.2.5 Item 6, the nearest surface water drain is approximately 500m away.

- 8.2.6 Item, 7, there is no combined sewer in the area.

- 8.3 Therefore, we consider that connection to a shallow soakaway (Item 4) is the only viable option for this site.

- 8.4 As mentioned previously in this report, it has been decided to place the proposed soakaway at a higher level 300mm BGL and provide a layer of coarse gravel/sand over the dense sand at 1100mm BGL. This, unfortunately, will only provide a cover of 550mm between the underside of the soakaway and the established standing ground water level at 1250mm BGL. We see this as acceptable, as there are no alternatives to this site.



Signature.....

CHRIS WYETH

For and on behalf of Cowan Consultancy Limited



Signature.....

DAVID BUTTON BSc, CEng, MICE

For and on behalf of Cowan Consultancy Limited

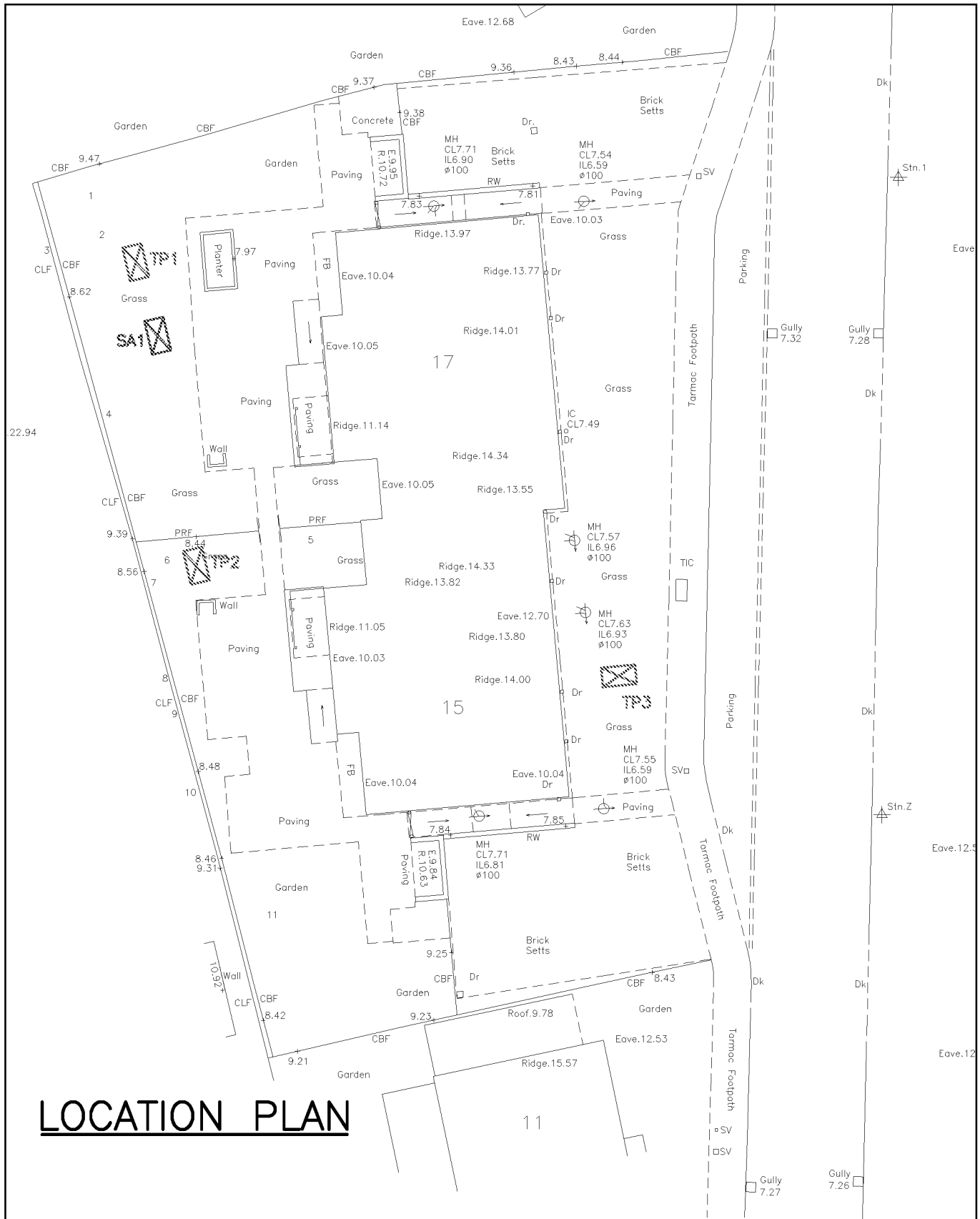
APPENDIX A

Location Plan

Drawing Sheet

Job No: 414504	Job: 15-17 Kew Gardens, Bognor Regis.	Scale: N.T.S.
Date: January 2020	Drawn: CMW	Checked:
		Drg No: Appendix A

Also at:
Landguard Manor
Landguard Manor Road
Shanklin
Isle of Wight
PO37 7JB



APPENDIX B

Soakage Test Results

SOAKAGE TEST 1 600 wd x 1000 lg x 1500 dp		Depth from ground level (mm)
Time (mins)	Water Depth (mm)	
0	700	800
20	550	950
40	445	1055
60	390	1110
80	190	1310
100	0	1500

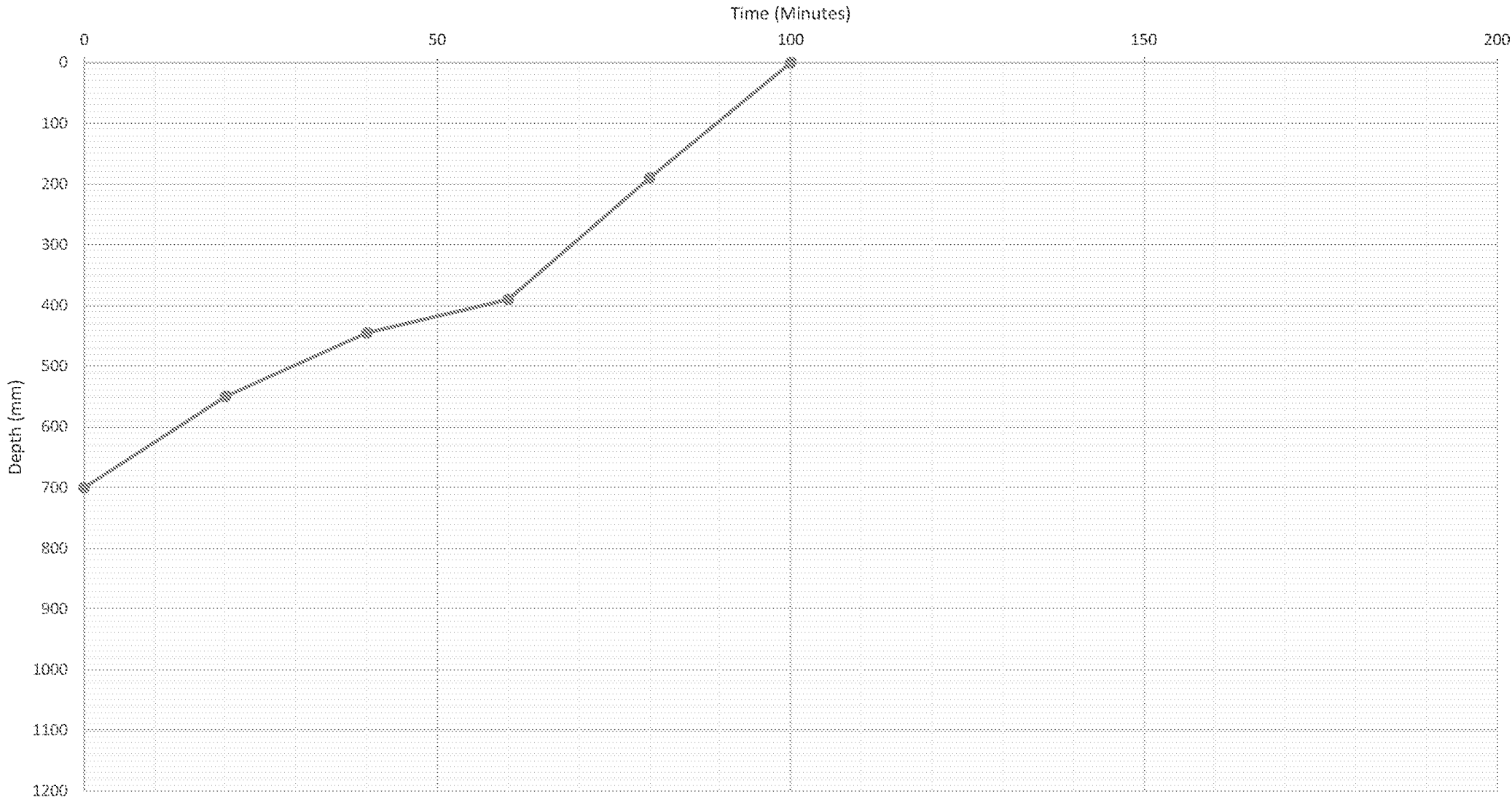
SOAKAGE TEST 2 600 wd x 1000 lg x 1500 dp		Depth from ground level (mm)
Time (mins)	Water Depth (mm)	
0	700	800
20	530	970
40	425	1075
60	375	1125
80	200	1300
100	10	1490
120	0	1500

SOAKAGE TEST 3 600 wd x 1000 lg x 1500 dp		Depth from ground level (mm)
Time (mins)	Water Depth (mm)	
0	700	800
20	560	940
40	455	1045
60	370	1130
80	195	1305
100	0	1500

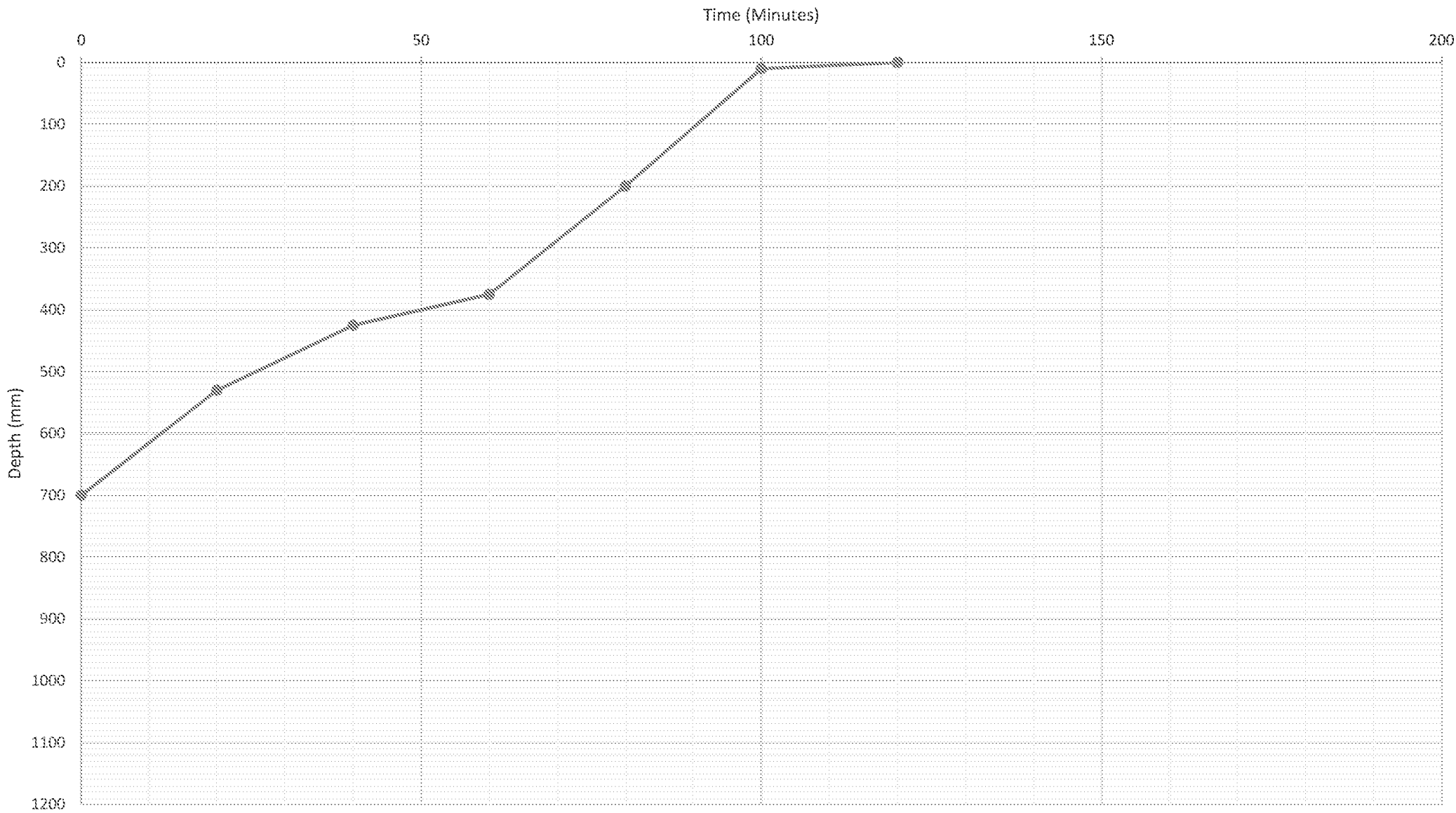
SOAKAGE TEST RESULTS

Site @ 15-17 Kew Gardens, Bognor Regis, West Sussex.

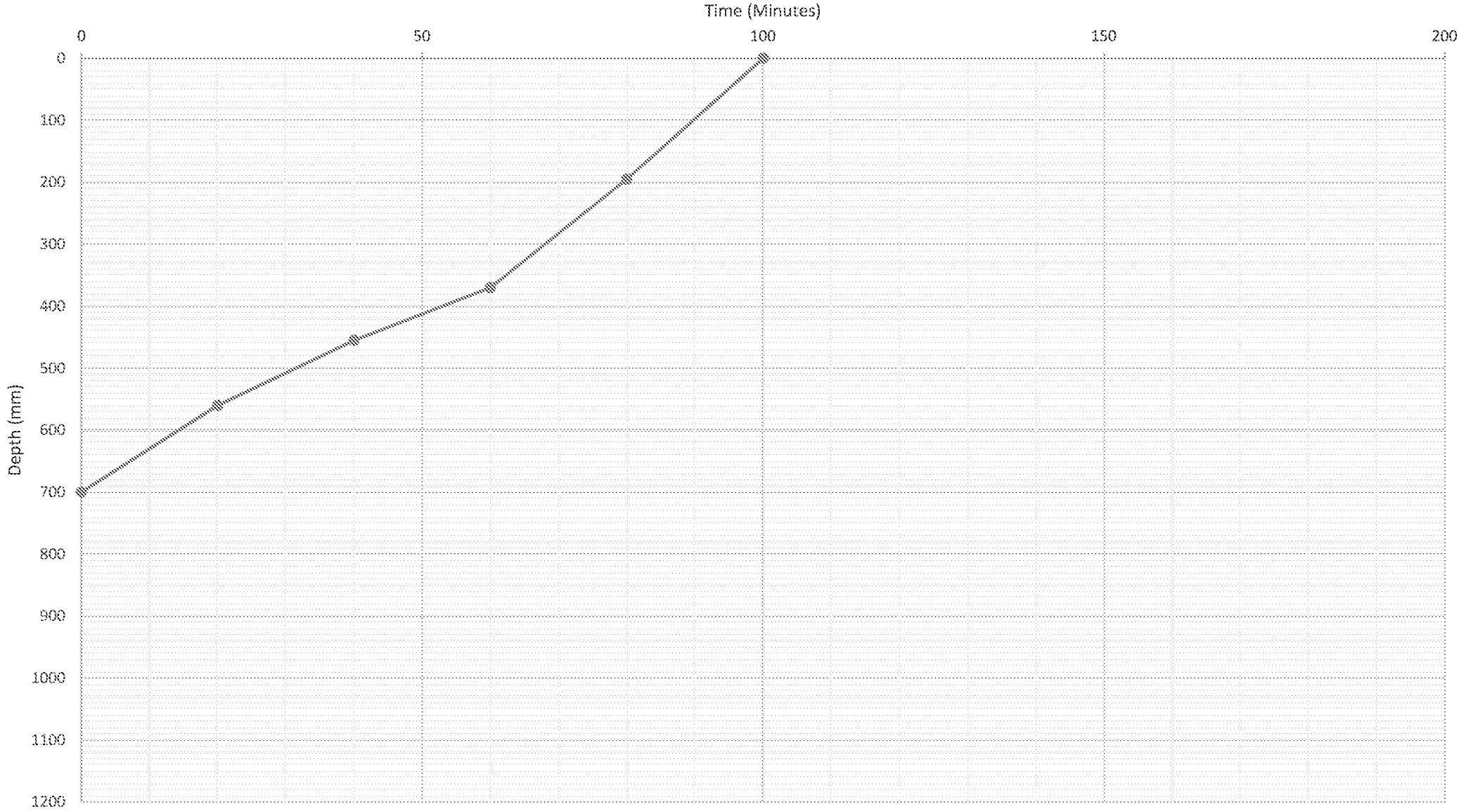
SOAKAGE TEST 1



SOAKAGE TEST 2



SOAKAGE TEST 3



Soakage Test 1	Storage volume 75% to 25%	0.60	wide	
		1.00	long	
		0.35	deep	
		Total	0.21	m3
	Surface area 50% inc. base	0.60 x 1.00	0.600	
		0.60 x 0.35	0.210	
		0.60 x 0.35	0.210	
		1.00 x 0.35	0.350	
		1.00 x 0.35	0.350	
		Total	1.720	m2
	Time for water to drop from 75% to 25%	75%	26	
		25%	81	
		Total	55	mins
			3300	secs
Soil infiltration rate			3.69979E-05	

SOIL INFILTRATION RATE CALCULATIONS

Site @ 15-17 Kew Gardens, Bognor Regis, West Sussex.

Soakage Test 2	Storage volume 75% to 25%	0.60	wide	
		1.00	long	
		0.35	deep	
		Total	0.21	m3
	Surface area 50% inc. base	0.60 x 1.00	0.600	
		0.60 x 0.35	0.210	
		0.60 x 0.35	0.210	
		1.00 x 0.35	0.350	
		1.00 x 0.35	0.350	
		Total	1.720	m2
	Time for water to drop from	75%	21	
	75% to 25%	25%	83	
		Total	62	mins
			3720	secs
	Soil infiltration rate	3.28207E-05		

SOIL INFILTRATION RATE CALCULATIONS

Site @ 15-17 Kew Gardens, Bognor Regis, West Sussex.

Soakage Test 3	Storage volume 75% to 25%	0.60	wide	
		1.00	long	
		0.35	deep	
		Total	0.21	m3
	Surface area 50% inc. base	0.60 x 1.00	0.600	
		0.60 x 0.35	0.210	
		0.60 x 0.35	0.210	
		1.00 x 0.35	0.350	
		1.00 x 0.35	0.350	
		Total	1.720	m2
	Time for water to drop from 75% to 25%	75%	27	
		25%	83	
		Total	56	mins
			3360	secs
Soil infiltration rate		3.63372E-05		

SOIL INFILTRATION RATE CALCULATIONS

Site @ 15-17 Kew Gardens, Bognor Regis, West Sussex.

APPENDIX C

Soakaway Design

Job No.	4 4504	Sheet	Date	Jan'20
Job	15-17 Kew Gardens	By CMW	Checked	TB

Soakaway Design for Proposed Building

Area 289.000 m²
Run off Coeff 1.000 m²
289.000 m²

30 year return period + 40%

R5	0.022 m	Storm duration (Min.)	5
R10	0.028 m	10	
R15	0.031 m	15	
R30	0.039 m	30	
R60	0.048 m	60	
R120	0.059 m	120	
R240	0.073 m	240	
R360	0.082 m	360	
R600	0.095 m	600	
R1440	0.123 m	1440	

Inflow to attenuation system

I5	6.38 m ³
I10	7.97 m ³
I15	9.06 m ³
I30	11.24 m ³
I60	13.89 m ³
I120	17.10 m ³
I240	21.01 m ³
I360	23.68 m ³
I600	27.50 m ³
I1440	35.48 m ³

Outflow from Tank

f 3.28E-05 m³/s

Soakaway dims:

L	18 m
W	5 m
Depth	0.3 m

As50 6.9
Void ratio 90 %

Outflow from Tank:

O5	0.0679 m ³
O10	0.1359 m ³
O15	0.2038 m ³
O30	0.4076 m ³
O60	0.8153 m ³
O120	1.6305 m ³
O240	3.2611 m ³
O360	4.8916 m ³
O600	8.1527 m ³
O1440	19.5664 m ³

Storage required:

S5	6.31 m ³
S10	7.84 m ³
S15	8.86 m ³
S30	10.83 m ³
S60	13.07 m ³
S120	15.47 m ³
S240	17.75 m ³
S360	18.78 m ³
S600	19.35 m ³
S1440	15.91 m ³

Time to half drain:

ts50	3.87 hours
ts50	4.81 hours
ts50	5.43 hours
ts50	6.64 hours
ts50	8.02 hours
ts50	9.49 hours
ts50	10.88 hours
ts50	11.52 hours
ts50	11.86 hours
ts50	9.76 hours

Storage provided 24.3 m³

Critical storm = S600
Storage required = 19.35
Time to half discharge= 11.86 Hours (Acceptable time as 1/30 year storm)

Soakaway size proposed is satisfactory

For increase from 10 year storm to 30 year storm use,
Bilhams formula $r \text{ (mm)} = (((1.25T)/N)^{(1/3.55)}) \times 25.4$
T = storm duration in hours
N = No. of storms in 10 years
0.4 10 year return period

T	N	r	0.022069124 R5	0.0087 m
0.083333	0.333333	0.015764	0.027594367 R10	0.0124 m
0.166667	0.333333	0.01971	0.031363365 R15	0.0153 m
0.25	0.333333	0.022402	0.038892614 R30	0.0196 m
0.5	0.333333	0.02778	0.048045307 R60	0.0248 m
1	0.333333	0.034318	0.059171486 R120	0.0303 m
2	0.333333	0.042265	0.072696672 R240	0.0363 m
4	0.333333	0.051926	0.081922764 R360	0.0409 m
6	0.333333	0.058516	0.095151657 R600	0.0466 m
10	0.333333	0.07	0.122758323 R1440	0.0578 m
24	0.333333	0.087685		

Job No.	414504	Sheet	Date	Jan'20
Job	15-17 Kew Gardens	By CMW	Checked	TB

Soakaway Design for Proposed Building

Area 289.000 m²
Run off Coeff 1.000 m²
289.000 m²

100 year return period + 40%

		Storm duration (Min.)
R5	0.032 m	5
R10	0.040 m	10
R15	0.045 m	15
R30	0.056 m	30
R60	0.069 m	60
R120	0.084 m	120
R240	0.103 m	240
R360	0.116 m	360
R600	0.135 m	600
R1440	0.174 m	1440

Inflow to attenuation system

I5	9.37 m ³
I10	11.61 m ³
I15	13.14 m ³
I30	16.19 m ³
I60	19.91 m ³
I120	24.42 m ³
I240	29.91 m ³
I360	33.65 m ³
I600	39.02 m ³
I1440	50.22 m ³

Outflow from Tank

f 3.28E-05 m³/s

Soakaway dims:

L	18 m
W	5 m
Depth	0.4 m

As50 9.2
Void ratio 90 %

Outflow from Tank:

O5	0.0906 m ³
O10	0.1812 m ³
O15	0.2718 m ³
O30	0.5435 m ³
O60	1.0870 m ³
O120	2.1740 m ³
O240	4.3481 m ³
O360	6.5221 m ³
O600	10.8702 m ³
O1440	26.0885 m ³

Storage required:

S5	9.28 m ³
S10	11.43 m ³
S15	12.87 m ³
S30	15.65 m ³
S60	18.82 m ³
S120	22.25 m ³
S240	25.56 m ³
S360	27.13 m ³
S600	28.15 m ³
S1440	24.13 m ³

Time to half drain:

ts50	4.27 hours
ts50	5.26 hours
ts50	5.92 hours
ts50	7.20 hours
ts50	8.66 hours
ts50	10.23 hours
ts50	11.76 hours
ts50	12.48 hours
ts50	12.95 hours
ts50	11.10 hours

Storage provided **32.4** m³

Critical storm = **S600**
Storage required = **28.15** 33.78 x 1.2
Time to half discharge= **12.95** Hours (Acceptable time as 1/100 year storm)

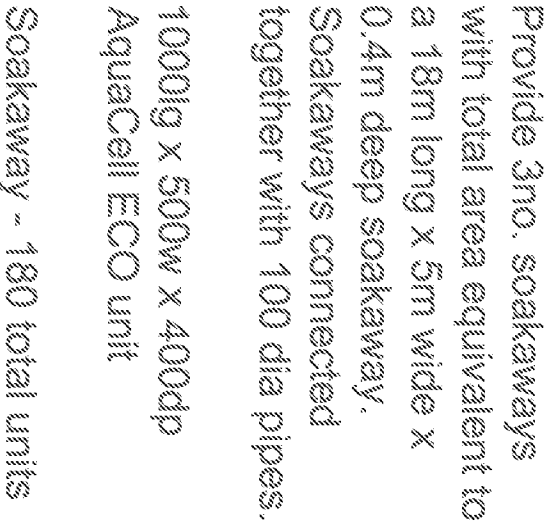
Soakaway size proposed is satisfactory

For increase from 10 year storm to 100 year storm use,
Bilhams formula $r \text{ (mm)} = (((1.25T)/N)^{(1/3.55)}) \times 25.4$

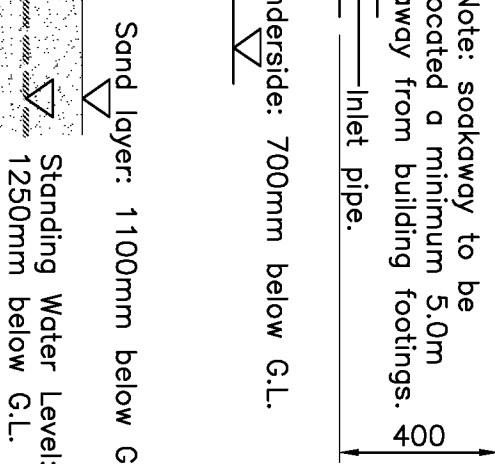
T = storm duration in hours

N = No. of storms in 10 years

T	N	r	0.4 10 year return period
0.083333	0.1	0.023154	0.03241527 R5 0.0087 m
0.166667	0.1	0.028694	0.040171329 R10 0.0124 m
0.25	0.1	0.032473	0.045462061 R15 0.0153 m
0.5	0.1	0.040022	0.056031245 R30 0.0196 m
1	0.1	0.0492	0.068879338 R60 0.0248 m
2	0.1	0.060356	0.084497712 R120 0.0303 m
4	0.1	0.073917	0.103483692 R240 0.0363 m
6	0.1	0.083168	0.116434821 R360 0.0409 m
10	0.1	0.10	0.135004879 R600 0.0466 m
24	0.1	0.124113	0.173757739 R1440 0.0578 m



1:20



Cowan
Consultancy

Also
Landguard Manor R
Landguard Manor R
Shar
Isle of W

Also
Landguard Rd
Landguard Manor
Sharn
Isle of W
PO37

NEW GARDENS,

ND

Job No.	414504	Sheet	Date	Jan'20
Job	15-17 Kew Gardens	By CMW	Checked	TB

Soakaway Design for Permeable Paving

Area 197.000 m²
Run off Coeff 1.000 m²
197.000 m²

30 year return period + 40%

		Storm duration (Min.)
R5	0.022 m	5
R10	0.028 m	10
R15	0.031 m	15
R30	0.039 m	30
R60	0.048 m	60
R120	0.059 m	120
R240	0.073 m	240
R360	0.082 m	360
R600	0.095 m	600
R1440	0.123 m	1440

Inflow to attenuation system

I5	4.35 m ³
I10	5.44 m ³
I15	6.18 m ³
I30	7.66 m ³
I60	9.46 m ³
I120	11.66 m ³
I240	14.32 m ³
I360	16.14 m ³
I600	18.74 m ³
I1440	24.18 m ³

Outflow from Tank

f 3.28E-05 m³/s

Soakaway dims:

L	19.7 m
W	10 m
Depth	0.3 m

As50 8.91
Void ratio 30 %

Outflow from Tank:

O5	0.0877 m ³
O10	0.1755 m ³
O15	0.2632 m ³
O30	0.5264 m ³
O60	1.0528 m ³
O120	2.1055 m ³
O240	4.2110 m ³
O360	6.3165 m ³
O600	10.5276 m ³
O1440	25.2662 m ³

Storage required:

S5	4.26 m ³
S10	5.26 m ³
S15	5.92 m ³
S30	7.14 m ³
S60	8.41 m ³
S120	9.55 m ³
S240	10.11 m ³
S360	9.82 m ³
S600	8.22 m ³
S1440	-1.08 m ³

Time to half drain:

ts50	2.02 hours
ts50	2.50 hours
ts50	2.81 hours
ts50	3.39 hours
ts50	4.00 hours
ts50	4.54 hours
ts50	4.80 hours
ts50	4.67 hours
ts50	3.90 hours
ts50	-0.51 hours

Storage provided 17.7 m³

Critical storm = S240

Storage required = 10.11

Time to half discharge = 4.80 Hours (Acceptable time as 1/30 year storm)

Soakaway size proposed is satisfactory

For increase from 10 year storm to 30 year storm use,

Bilham's formula $r \text{ (mm)} = (((1.25T)/N)^{(1/3.55)}) \times 25.4$

T = storm duration in hours

N = No. of storms in 10 years

T	N	r	0.4 10 year return period
0.083333	0.333333	0.015764	0.022069124 R5 0.0087 m
0.166667	0.333333	0.01971	0.027594367 R10 0.0124 m
0.25	0.333333	0.022402	0.031363365 R15 0.0153 m
0.5	0.333333	0.02778	0.038892614 R30 0.0196 m
1	0.333333	0.034318	0.048045307 R60 0.0248 m
2	0.333333	0.042265	0.059171486 R120 0.0303 m
4	0.333333	0.051926	0.072696672 R240 0.0363 m
6	0.333333	0.058516	0.081922764 R360 0.0409 m
10	0.333333	0.07	0.095151657 R600 0.0466 m
24	0.333333	0.087685	0.122758323 R1440 0.0578 m

APPENDIX D

Additional Storage Calculations

414504 - 15-17 Kew Gardens

Inspection chambers & pipework leading to poposed soakaway

Element	Dia (m)	Length (m)	Storage (m3)	
SW - I.C.01	0.450	0.600	0.382	Silt Trap
SW - I.C.02	0.450	0.600	0.382	Silt Trap
SW - I.C.03	0.450	0.600	0.382	Silt Trap
SW - I.C.04	0.450	0.600	0.382	Silt Trap
SW - I.C.05	0.450	0.600	0.382	Silt Trap
SW - I.C.06	0.450	0.300	0.191	
SW - I.C.07	0.450	0.300	0.191	
SW - I.C.08	0.450	0.300	0.191	
SW - I.C.09	0.450	0.300	0.191	
SW pipe	0.100	4.074	0.128	
SW pipe	0.100	2.798	0.088	
SW pipe	0.100	2.941	0.092	
SW pipe	0.100	3.822	0.120	
SW pipe	0.100	6.813	0.214	
SW pipe	0.100	15.844	0.498	
SW pipe	0.100	5.921	0.186	
SW pipe	0.100	5.308	0.167	
SW pipe	0.100	4.147	0.130	
SW pipe	0.100	15.915	0.500	
SW pipe	0.100	1.623	0.051	
SW pipe	0.100	7.820	0.246	
SW pipe	0.100	13.260	0.417	
SW pipe	0.100	4.862	0.153	
SW pipe	0.100	5.195	0.163	
SW pipe	0.100	1.586	0.050	
SW pipe	0.100	1.162	0.037	
Additional storage using pipes and chambers			5.911	

414504 - 15-17 Kew Gardens

Proposed soakaway for new houses

Return Period	Storage (m3) Required x 1.2	Storage (m3) Provided
1 in 30	23.220	24.300
1 in 100	33.780	32.400
Additional storage using pipes and chambers		5.911
Total storage 1 in 100		38.311