PROPOSED DEVELOPMENT AT ROMAN ROAD,

MOULTON CHAPEL

DRAINAGE STRATEGY

Page 2 - 4	Introduction design and proposals.
Page 5	Plan of surface water disposal of roof water.
Page 6	Plan of surface water disposal from roads.
Pages 7-10	Calculations of Rainfall volumes and attenuation volumes
Page 11	Results if Initial Percolation Test
Page 12	Calculation of Soil Infiltration Rate

S M Hemmings B Sc C Eng MICE MIWEM,
69 Charlotte Way,
Peterborough,
PE3 9ER

E mail: **stuart.hemmings@btinternet.com**

Telephone: **01733 263700**
Mobile: **07804 189365**

Introduction

A planning application is due to be submitted to South Holland District Council to construct approximately 78 dwellings and associated access roads off Roman Road, Moulton Chapel, near Spalding. The planning authority requires a drainage strategy to be submitted with the application.

For all large developments (more than 10 dwellings) there is a requirement to apply sustainable drainage principles (SuDS) to the disposal of surface water from the site.

The CIRIA SuDS Manual 2015 explains the philosophy of SuDS in Chapter 1 of the manual as follows:

> The philosophy of sustainable drainage systems is about maximising the benefits and minimising the negative impacts of surface water runoff from developed areas.
>
> The SuDS approach involves slowing down and reducing the quantity of surface water runoff from a developed area to manage downstream flood risk, and reducing the risk of that runoff causing pollution. This is achieved by harvesting, infiltrating, slowing, storing, conveying and treating runoff on site and, where possible, on the surface rather than underground. Water then becomes a much more visible and tangible part of the built environment, which can be enjoyed by everyone.

The Technical Standards for Sustainable Drainage produced by the Local Authority SuDS Officer Organisation (LASOO) states that generally the aim for should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

1) Into the ground (infiltration).
2) To a surface water body.
3) To a surface water sewer or highway drain.
4) To a combined sewer.

Site Investigation

A 1.8 metre deep trial hole was excavated on the site on the 11th July 2016 and this found the subsoil to be silt, and ground water was found at a depth of 1.75 metres. A second hole was excavated to a depth of 930mm and a percolation test was carried out and the rate of fall of the water in the trial pit was very small. On 30th September 2016 a second hole was excavated 1.0 metre in depth and a second percolation test was carried out which produced very similar results to the first test. The infiltration rate was calculated using methods in BRE Digest 365 and the results are shown in Appendix A. The percolation rate was calculated to be 2.09×10^{-6} m/sec.

Design of Surface Water Disposal

It is concluded that because of the low percolation rate it would be difficult to design suitable soakaways to dispose of the rainwater from the roofs of the proposed buildings on the development. The soakaways would not conform to all aspects of

BRE365, particularly the clause requiring the water level in a soakaway to have reduced by 50% within 24 hours.

With regard to the drainage of the roads on the development, in order to comply with SuDS recommendations the option of using permeable block paving with surface water infiltration into the soil beneath the sub base was first considered. However because of the very low infiltration rates LCC would be unlikely to adopt the roads if this method of construction was used.

The following methods of disposal of the surface water are proposed:-

a) The surface water from the roofs of the houses will discharge into a surface water system which will outfall directly into a storage dyke to be formed on the southern boundary of the development. As can be seen from the schematic plan on page 5 there are four discharge points proposed along the new dyke. This storage dyke will discharge into the existing north – south dyke on the eastern boundary of the development site through a flow restrictor which will limit the flow to 4.9 litres / second, which is equivalent to 1.4 cumecs/1000ha.

b) It is proposed to construct on the site with impermeable asphalt surfacing. The roads immediately surrounding the public spaces will be cambered towards either a French drain or swales which will discharge into two storage facilities constructed with plastic modular cells. These storage facilities will discharge through pipework into the storage dyke on the southern boundary.

   The section of roadway on the eastern side of the development will drain into traditional gullies which will discharge into the same surface water system under the road which transfers the roof water into the storage dyke.

   The road on the southern side of the development will be cambered so that surface water flows directly into the storage dyke adjacent to it.

   Details of the road drainage is shown on page 6.

Sufficient storage capacity will be provided so that the volume of rainfall from a 1 in 100 year event with a 30% increase for climate change can be retained in the system and then discharged into the watercourse on the eastern boundary at a rate of 5.0 litres/second. This will then comply with the SuDS manuals and guidances that recommend that the surface water should be reduced as much as possible to manage downstream flood risk.

South Holland IDB have been consulted on the proposed discharge into the dyke on the eastern boundary of the proposed development. The Board has stated that there are no objections to the principal of discharging into the dyke on the eastern boundary at the rate proposed subject to the following:

a) The developer applies for discharge consent and pays the Board a development contribution.
b) The developer may need to gain consent from the Riparian owners downstream if it is demonstrated that the flows into the dyke will be increased.

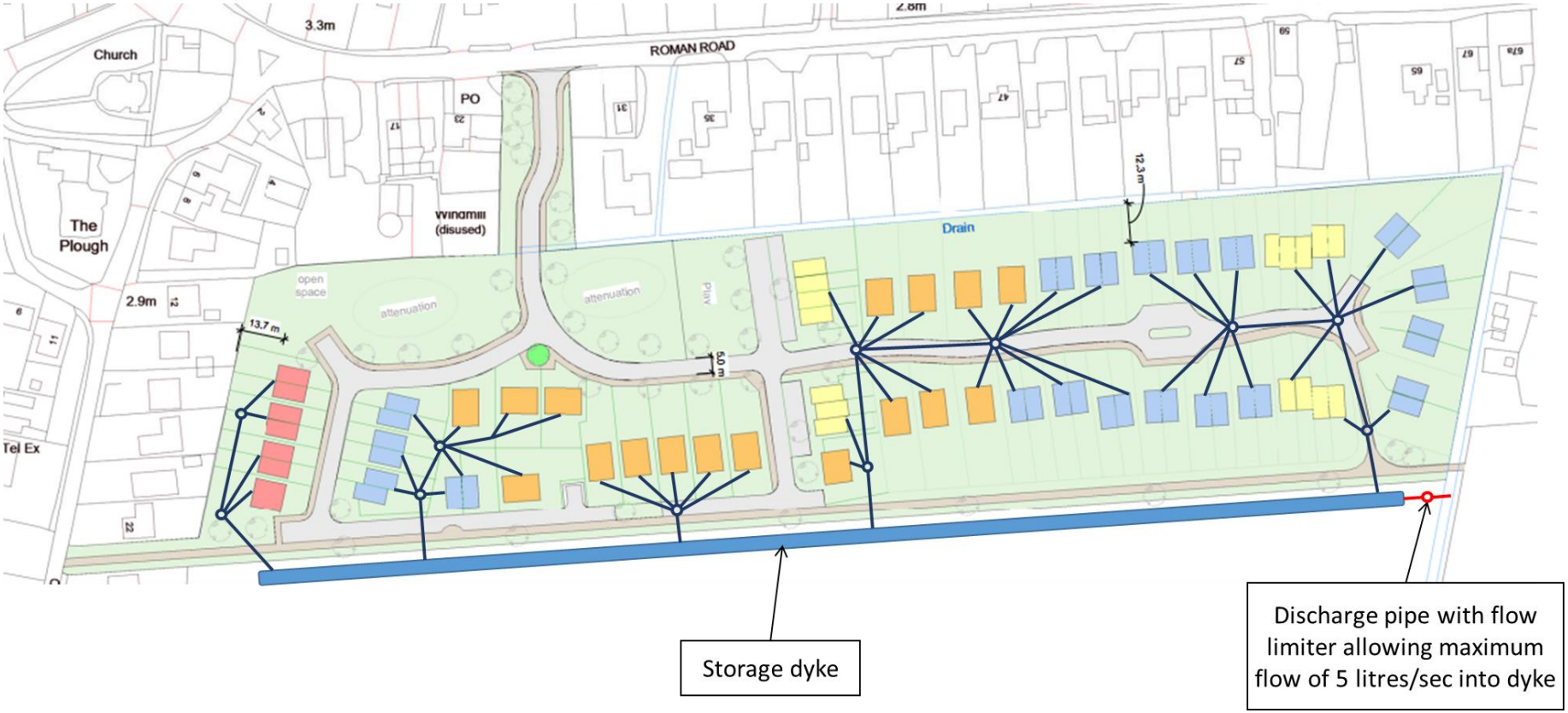
c) As an alternative to (b) above the developer may wish submit a proposal for the IDB to take over the length of the dyke as far as the existing IDB drain to allow the discharge to be made into a watercourse maintained by the Board, and the developer would need to pay the Board's costs to enmain this section of watercourse.

A schematic layout of this is shown on page 5 and 6 of this report, and initial calculations are shown on pages 7 to 10.

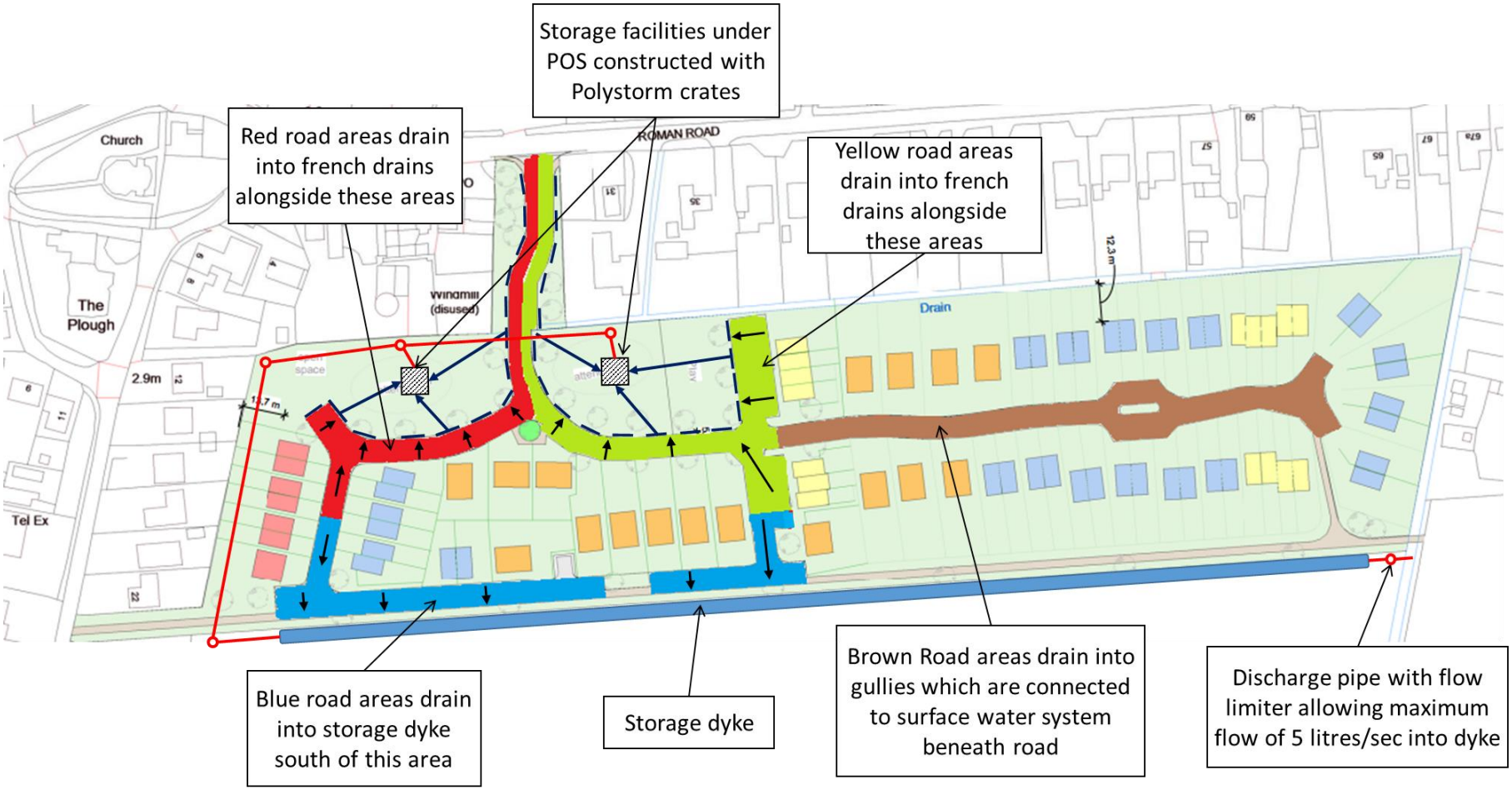
Foul Water

It is assumed the foul water sewer will be located under the new site road which will connect into the existing Anglian Water system in Moulton Chapel.

SCHEMATIC PLAN OF SURFACE WATER DISPOSAL OF ROOF WATER



SCHEMATIC PLAN OF SURFACE WATER DISPOSAL OF SURFACE WATER FROM ROADS



CALCULATION OF VOLUMES OF ATTENUATION SCHEME

Total area of site = 3.75ha.

The IDB allow for an outfall equivalent to 1.4 cumecs/1000ha from agricultural fields.

Therefore existing design outfall of surface water from the site = 3.75 x 1.4 / 1000

= 0.0049 cumecs or 4.9 litres/sec

The impermeable areas from which rainfall needs to be disposed are:

Roofs of 78 No buildings …… 4648 sq m

Impermeable Roads …….. 5636 sq m

Total impermeable area …… 10284 sq m

The volumes of rainfall in a 1 in 100 year event in 2115, with 30% increase for climate change can be calculated as follows:

Duration	M5_60min	Z1	M5-D	Z2	M100-D	Intensity mm/hour	Areal Factor	Areal Intensity mm/hour	Area (ha)	Volume cum/hr	Vol + 30% climate Change cum/hr	Total Volume cu m climate	Total Volume cu m	Volume litres/sec
15	24	0.64	15.36	1.98	30.41	121.65	0.94	114.35	1.029	1176.683	1529.69	382.4	294.17	326.856
30	24	0.81	19.44	1.97	38.30	76.59	0.95	72.76	1.029	748.741	973.36	486.7	374.37	207.984
60	24	1	24	1.93	46.32	46.32	0.96	44.47	1.029	457.567	594.84	594.8	457.57	127.102
120	24	1.2	28.8	1.89	54.43	27.22	0.97	26.40	1.029	271.651	353.15	706.3	543.30	75.459
240	24	1.42	34.08	1.86	63.39	15.85	0.97	15.37	1.029	158.176	205.63	822.5	632.70	43.938
360	24	1.57	37.68	1.83	68.95	11.49	0.98	11.26	1.029	115.892	150.66	904.0	695.35	32.192
600	24	1.74	41.76	1.81	75.59	7.56	0.98	7.41	1.029	76.222	99.09	990.9	762.22	21.173
1440	24	2.16	51.84	1.81	93.83	3.91	0.98	3.83	1.029	39.425	51.25	1230.1	946.20	10.951
2880	24	2.5	60	1.81	108.60	2.26	0.98	2.22	1.029	22.816	29.66	1423.7	1095.14	6.338

If an outflow from the system of 4.9 litres/sec is taken then the volume of attenuation required can be calculated as follows:

Duration mins	Total Rainfall in Duration mm	Total Rainfall Volume cu m into storage facility	Outflow into IDB Drain at 4.9 litres/sec	Total Storage Required	Total Time to empty Soakaway hours
15	1529.7	382.42	4.41	378.01	42.49
30	973.4	486.68	8.82	477.86	54.08
60	594.8	594.84	17.64	577.20	66.09
120	353.1	706.29	35.28	671.01	78.48
240	205.6	822.51	70.56	751.95	91.39
360	150.7	903.95	105.84	798.11	100.44
600	99.1	990.89	176.40	814.49	110.10
1440	51.3	1230.07	423.36	806.71	136.67
2880	29.7	1423.69	846.72	576.97	158.19

Therefore from the above table it can be seen that a total storage volume of 815 cu metres is required to store the total surface water drainage outfall from the impervious roads and roofs of in a 1 in 100 year event with 30% increase for climate change.

The surface water will be designed in the following way:

a) Surface water drainage from the road adjacent to the public open space (POS) in the north western corner of the site will be collected by a French drain located on the side of the north and west side of the road, and this will be connected to a storage facility constructed under the POS with plastic modular cells. The area of road is shown in red on the plan on page 6, and is an area of 945 square metres.

b) Surface water drainage from the road adjacent to the public open space (POS) east of the access road will be collected by a French drain located on the north and east side of the road, and this will be connected to a storage facility constructed under the POS with plastic modular cells. The area of road is shown in light green on the plan on page 6, and is an area of 1,500 square metres.

c) Surface water drainage from the central road on the east side of the development will be collected by gullies and will flow in a surface water system eastwards then southwards and discharge into the storage dyke on the southern boundary. The area of road is shown in brown on the plan on page 6.

d) Surface water drainage from the road on the south side of the development will flow directly into the storage dyke on the southern boundary. The area of road is shown in light blue on the plan on page 6.

e) Surface water from the roofs will be discharged into a surface water system as detailed on page 5. This is discharged into the storage dyke on the southern boundary of the site.

The required size of the storage facility in the north west corner of the site can be sized as follows:

Duration mins	Total Rainfall in Duration mm	Total Rainfall Volume cu m into storage facility	Outflow into Storage Dyke at 2.0 litres/sec	Total Storage Required	Total Time to empty Soakaway hours
15	140.5	35.12	1.80	33.32	3.90
30	89.4	44.70	3.60	41.10	4.97
60	54.6	54.63	7.20	47.43	6.07
120	32.4	64.86	14.40	50.46	7.21
240	18.9	75.54	28.80	46.74	8.39
360	13.8	83.02	43.20	39.82	9.22
600	9.1	91.00	72.00	19.00	10.11
1440	4.7	112.97	172.80	-59.83	12.55
2880	2.7	130.75	345.60	-214.85	14.53

It can be seen that the required volume of storage is 50.46 cu metres.

A plastic modular cell (eg Polystorm cell) is 500mm x 1000mm x 400mm deep and each one is capable of storing 0.19 cu m of water. Therefore 264 units will be provided which will store 50.16 cu metres of water. Therefore the units should be constructed 800mm deep and 11.0 metres x 6.0 metres.

The required size of the storage facility on the north east corner of the site can be sized as follows:

Duration mins	Total Rainfall in Duration mm	Total Rainfall Volume cu m into storage facility	Outflow into Storage Dyke at 2.0 litres/sec	Total Storage Required	Total Time to empty Soakaway hours
15	223.0	55.75	1.80	53.95	6.19
30	141.9	70.94	3.60	67.34	7.88
60	86.7	86.71	7.20	79.51	9.63
120	51.5	102.96	14.40	88.56	11.44
240	30.0	119.90	28.80	91.10	13.32
360	22.0	131.77	43.20	88.57	14.64
600	14.4	144.44	72.00	72.44	16.05
1440	7.5	179.31	172.80	6.51	19.92
2880	4.3	207.53	345.60	-138.07	23.06

It can be seen that the required volume of storage is 91.1 cu metres.

A plastic modular cell is 500mm x 1000mm x 400mm deep and each one is capable of storing 0.19 cu m of water. Therefore 480 units will be provided which will store 91.2 cu metres of water. Therefore the storage facility should be 800mm deep and 12.0 metres x 10.0 metres should be provided.

Both of these storage facilities will discharge through a 100mm dia pipeline into the storage dyke on the southern boundary of the site.

The storage dyke will be required to store 675 cu metres, which is 815 (total volume) – 50.5 (volume of attenuation under POS) – 91.1 (volume of attenuation under POS).

This storage dyke will be 350 metres in length, 1.0 metres deep with a top width of 4.5 metres and a bed width of 1.0 metres. The total volume of the dyke will be 962.5 cu metres when full.

ADDITIONAL INFORMATION

1) Water will soakaway from both the attenuation facilities under the POS, and into the ground on either side of the storage dyke. This has not been allowed for in the calculations and provides an extra factor of safety for the design.

2) The level of the public open space should if possible be 150mm below the level of the roads around this area to act as an emergency storage area in the event of an extreme storm.

RESULTS OF PERCOLATION TESTS

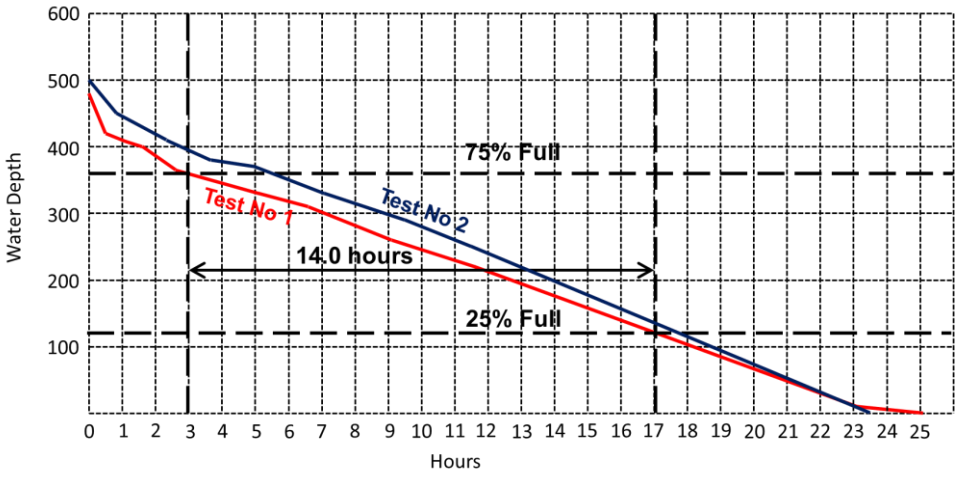
Results of test No 1 on

Hours	Time	Measurement mm	Water Depth
0.00	9.55am	450	480
0.50	10.25am	510	420
1.10	11.00am	522	408
1.60	11.30am	530	400
2.60	12.30pm	565	365
5.10	3.00pm	600	330
6.60	4.30pm	620	310
9.10	7.00pm	670	260
11.60	9.30pm	710	220
23.10	9.00am	920	10
25.10	11.00am	930	0

Results of test No 2 on

Hours	Time	Measurement mm	Water Depth
0.00	8.55am	500	500
0.50	9.45am	550	450
1.10	11.15am	590	410
1.60	12.35pm	620	380
2.60	1.55pm	630	370
5.10	4.00pm	670	330
6.60	6.25pm	710	290
9.10	8.25pm	750	250
25.10	8.30am	1000	0

Graph of Water Level and Time



CALCULATION OF SOIL INFILTRATION RATE

On 11th July 2016 a trial hole was excavated to assess the depth of the ground water table on the site. This was excavated to a depth of 1.8 metres when ground water started to enter the hole. The whole depth of the soil was found to be silty soil. On the same day a percolation tests was carried out on the site. In this test a 1.0m long x 600mm wide hole was excavated 930mm deep. This hole was filled to a depth of 480mm and water soaked away completely in 25 hours. Referring to the graph of the results the time taken to drain between 75% and 25% of the depth filled was 14 hours.

A second hole was excavated on 30th September 2016. This was also 1.0m long x 600mm wide and was 1000mm deep. This hole was filled to a depth of 500mm and water soaked away completely in 23 hours. This gave results similar to the first test.

The soil infiltration rate will be calculated as follows:

$$\text{Soil Infiltration Rate} = \frac{V_{p75-25}}{A_{p50} \times t_{p75-25}}$$

Volume outflowing between 75% and 25% effective depth:

$V_{p75-25} = (0.36 - 0.12) \times 1.0 \times 0.6 = \underline{0.144 \text{ cu m}}$

The mean surface area through which the outflow occurs, taken to be the pit sides to 50% effective depth and including the base of the pit:

$A_{p50} = (1.0 \times 0.24 \times 2) + (0.6 \times 0.24 \times 2) + (1.0 \times 0.6) = \underline{1.368 \text{ s m}}$

The time of outflow between 75% and 25% effective depth

$t_{p75-25} = 14 \times 60 \times 60 = \underline{50{,}400}$

$$\text{Soil Infiltration Rate} = \frac{0.144}{1.368 \times 50{,}400} = \underline{2.09 \times 10^{-6} \text{ m/sec}}$$

S M HEMMINGS B Sc C Eng MICE MIWEM

stuart.hemmings@btinternet.com

5th December 2016