

PROPOSED DEVELOPMENT AT GREEN LANE, PINCHBECK
DRAINAGE STRATEGY

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Introduction

A planning application is due to be submitted to South Holland District Council to construct a residential development with approximately forty dwellings and associated access roads south of Green Lane and west of Surfleet Road at Pinchbeck, 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.

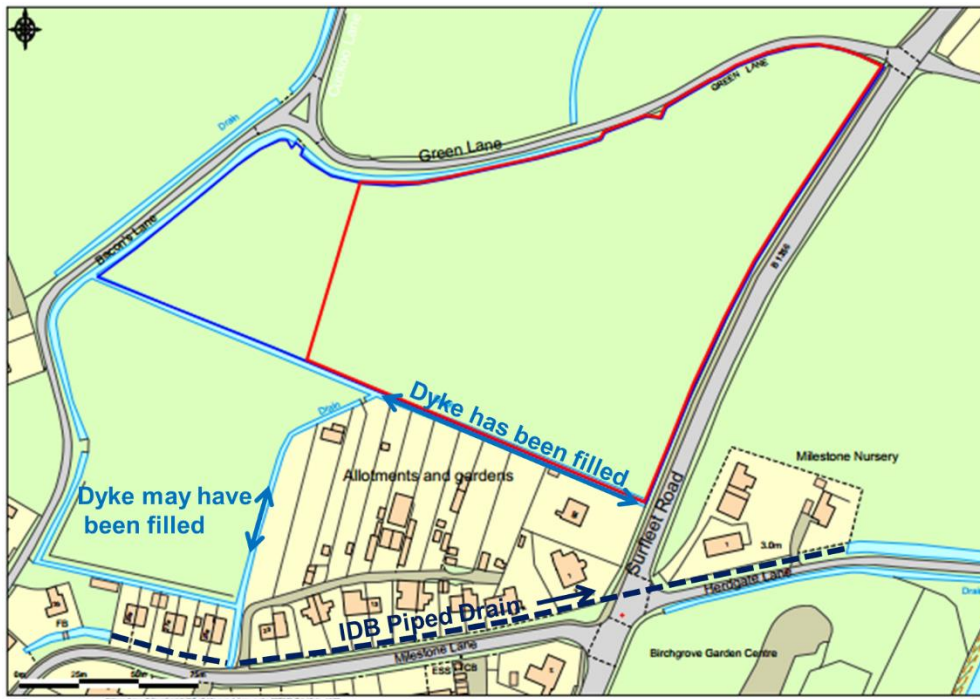
Site Investigation

A 2.0 metre deep trial hole was excavated on the site in August and this found the subsoil to be silty sand overlying clay, which was found in the bottom 200mm of the hole. No ground water was found. A percolation test was carried out on the site and the rate of fall of the water in the trial pit was very small. 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 9.0×10^{-6} m/sec.

Existing Drainage Systems

There are dykes around the site which provide drainage to the fields at present. These are not well maintained, but seem to be providing adequate drainage of the land at the present time. These are shown on the plan on the next page. It is unlikely that there are underdrains leading into the dykes as the land is free draining in this area. From

local knowledge it seems that a short length of the north south dyke which flows southwards into the IDB drain has been filled and there is no confirmation that this has been piped. However drainage from the field seems to be able to flow southwards along the dyke on the east side of Bacons Lane and then along the dyke north of property nos 25,27,29 and 33 Milestone Lane flowing eastwards to discharge into the piped IDB drain on the north side of Milestone Lane.



Design of Surface Water Disposal

The initial percolation test has shown that the rainwater from the roofs of the proposed houses can be discharged into soakaways. A typical design will be shown in the calculations for a house with a roof area of 140 square metres. The soakaways will be designed to 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.

It is proposed to construct the site access road with impermeable asphalt surfacing. The roads will be cambered towards the swales, except for the central road which will have normal gullies connected to surface water pipes which will discharge into the system of swales. The swales will flow westwards and discharge into a new dyke that will be constructed on the west side of the development. This dyke will discharge into the existing dyke through a flow limiting device and the outflow will be reduced to satisfy IDB requirements.

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 IDB watercourse at a rate of 2.5 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.

A schematic layout of this is shown below, and initial calculations are shown on pages 4 and 5.

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 Pinchbeck.

DESIGN OF ROAD DRAINAGE SYSTEM

The layout of the proposed swales on the development is shown below.



Total area of site = 2.324ha

The impermeable areas of roads..... $595 \times 7.3 = 4,345 \text{ sq m}$

The volumes of rainfall for various storm durations in a 1 in 100 year event in 2115 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	0.4345	496.9	645.9	161.5	124.2	138.0
30	24	0.81	19.44	1.97	38.30	76.59	0.95	72.76	0.4345	316.2	411.0	205.5	158.1	87.8
60	24	1	24	1.93	46.32	46.32	0.96	44.47	0.4345	193.2	251.2	251.2	193.2	53.7
120	24	1.2	28.8	1.89	54.43	27.22	0.97	26.40	0.4345	114.7	149.1	298.2	229.4	31.9
240	24	1.42	34.08	1.86	63.39	15.85	0.97	15.37	0.4345	66.8	86.8	347.3	267.2	18.6
360	24	1.57	37.68	1.83	68.95	11.49	0.98	11.26	0.4345	48.9	63.6	381.7	293.6	13.6
600	24	1.74	41.76	1.81	75.59	7.56	0.98	7.41	0.4345	32.2	41.8	418.4	321.9	8.9
1440	24	2.16	51.84	1.81	93.83	3.91	0.98	3.83	0.4345	16.6	21.6	519.4	399.5	4.6
2880	24	2.5	60	1.81	108.60	2.26	0.98	2.22	0.4345	9.6	12.5	601.2	462.4	2.7

If an outflow from the system of 2.5 litres/sec is taken then the volume of attenuation required can be calculated as follows:

Duration mins	Total Rainfall in Duration cu.m	Total Rainfall Volume cu m into storage facility	Outflow into IDB Drain at 2.5 litres/sec	Total Storage Required	Total Time to empty Soakaway hours
15	161.5	161.48	2.25	159.23	17.69
30	205.5	205.50	4.50	201.00	22.33
60	251.2	251.17	9.00	242.17	26.91
120	298.2	298.24	18.00	280.24	31.14
240	347.3	347.31	36.00	311.31	34.59
360	381.7	381.70	54.00	327.70	36.41
600	418.4	418.41	90.00	328.41	36.49
1440	519.4	519.40	216.00	303.40	33.71
2880	601.2	601.16	432.00	169.16	18.80

Therefore from the above table it can be seen that a total storage volume of 328 cu metres is required to store the rainfall from a 1 in 100 year event with 30% increase for climate change.

It is proposed to provide this storage with the swales and the dyke on the western side of the development. The swales will be approximately 600mm deep and 1.5 metres wide with a total volume of 0.54 cu metres per metre. The total length of swales shown on the initial drawing is approximately 450 metres and therefore the total volume of the swales is 243 cu metres.

Therefore if a dyke 80 metres long 1.2 metres deep with a top width of 3.0 metres is formed on the western side of the development this will have a volume of

$$80 \times 1.8 \times 1.2 = 172.8 \text{ cu metres.}$$

Therefore with this initial design a volume of $173 + 243 = 416$ cu metres will be created and therefore in a 1 in 100 year storm the system will be 75% full. This ignores any volume of water that could soak away through the sides of the swales and the dyke.

DESIGN TYPICAL SOAKAWAY FOR HOUSE

Assume a roof area of 140 square metres

Calculate Design Rainfall

The following table shows volumes of rainfall for storm durations from 15 minutes to 48 hours with a 30% allowance for climate change over 100 years.

Duration hours	Duration mins	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 climate cu m	Total Rainfall in Duration mm
0.25	15	24	0.64	15.36	1.98	30.41	121.65	0.94	114.35	0.014	16.009	20.81	5.2	28.6
0.5	30	24	0.81	19.44	1.97	38.30	76.59	0.95	72.76	0.014	10.187	13.24	6.6	36.4
1	60	24	1	24	1.93	46.32	46.32	0.96	44.47	0.014	6.225	8.09	8.1	44.5
2	120	24	1.2	28.8	1.89	54.43	27.22	0.97	26.40	0.014	3.696	4.80	9.6	52.8
4	240	24	1.42	34.08	1.86	63.39	15.85	0.97	15.37	0.014	2.152	2.80	11.2	61.5
6	360	24	1.57	37.68	1.83	68.95	11.49	0.98	11.26	0.014	1.577	2.05	12.3	67.6
10	600	24	1.74	41.76	1.81	75.59	7.56	0.98	7.41	0.014	1.037	1.35	13.5	74.1
24	1440	24	2.16	51.84	1.81	93.83	3.91	0.98	3.83	0.014	0.536	0.70	16.7	92.0
48	2880	24	2.5	60	1.81	108.60	2.26	0.98	2.22	0.014	0.310	0.40	19.4	106.4

Calculate Size of Soakaways using Polystorm units

Provide 56 No Polystorm units in an area of 14 metres x 1.0 metre wide x 800mm deep set at a depth of 1.2 metres.

Effective depth of the soakaways will be 1200mm.

The total storage volume of the Polystorm units is $0.19 \times 56 = \underline{10.64 \text{ cu metres.}}$

The design method for sizing a soakaway is based upon the the equation of volumes:

$$I - O = S$$

I = The inflow from the impermeable area draining into the soakaway

The volume from the final column in the table above will be used for this

O = The outflow infiltrating into the soil during rainfall

$$\text{The outflow } O = a_{s50} \times f \times D$$

a_{s50} = the internal surface area of the soakaway to 50% effective depth. BRE states that the base area should be assumed to clog with fine particles and become ineffective in the long term.

f = the soil infiltration rate determined by percolation tests.

D = the storm duration

The equation used for working out the outflow in the storm duration in the table below is

$$O = 0.5 \times (\text{Area of sides of soakaway}) \times f \times D.$$

$$\text{Area of sides of soakaway} = 0.8 \times 2 \times 15 = 24.0 \text{ sq.m.}$$

S = The required storage in the soakaway to balance temporarily inflow and outflow.

Therefore tabulating these figures for the storm durations above firstly using soil infiltration rate of 9×10^{-6} .

Duration mins	Total Rainfall in Duration mm	Total Rainfall Volume cu m	Area of Sides of Soakaway	Soil Infiltration Rate	Outflow in storm duration	Total Storage Required	Total Time to empty Soakaway hours
15	28.6	5.2	24.0	0.00000900	0.10	5.1	6.69
30	36.4	6.6	24.0	0.00000900	0.19	6.4	8.52
60	44.5	8.1	24.0	0.00000900	0.39	7.7	10.41
120	52.8	9.6	24.0	0.00000900	0.78	8.8	12.36
240	61.5	11.2	24.0	0.00000900	1.56	9.6	14.39
360	67.6	12.3	24.0	0.00000900	2.33	10.0	15.82
600	74.1	13.5	24.0	0.00000900	3.89	9.6	17.34
1440	92.0	16.7	24.0	0.00000900	9.33	7.4	21.52
2880	106.4	19.4	24.0	0.00000900	18.66	0.7	24.91

Therefore it can be seen that the scheme is satisfactory as the volume of storage provided is 10.64 cu metres.

The times to empty the soakaways is within the guidance set by BRE digest 365, which states that soakaways should discharge from full volume to half volume within 24 hours.

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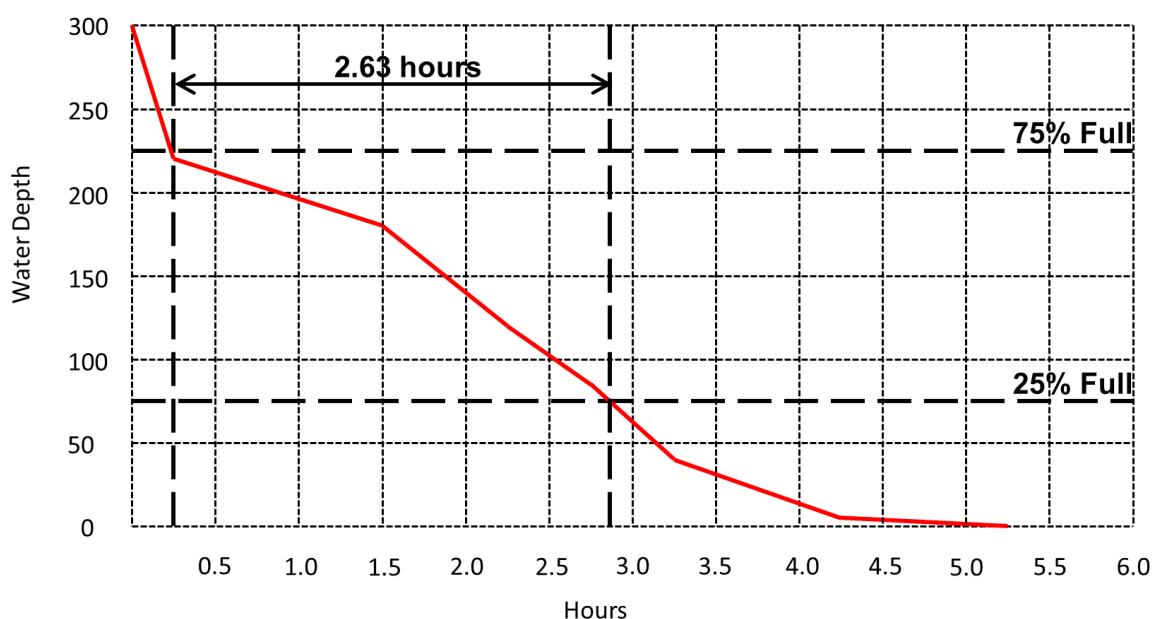
RESULTS OF PERCOLATION TEST

13th May 2017

Results

Hours	Time	Measurement	Water Depth
		mm	
0.00	8.45am	700	300
0.25	9.00am	780	220
1.50	10.15am	820	180
2.25	11.00am	880	120
2.75	11.30am	915	85
3.25	12.00	960	40
4.25	13.00	995	5
5.25	14.00	1000	0

Graph of Water Level and Time



CALCULATION OF SOIL INFILTRATION RATE

On 13th May 2017 a trial hole was excavated to assess the depth of the ground water table on the site. This was excavated to a depth of 2.0 metres when a clay layer was found, but no ground water. On the same day one percolation tests to BRE 365 was carried out on the site. In this test a 750mm long x 500mm wide hole was excavated 1.0 metre deep. This hole was

filled and water soaked away completely in 5.25 hours. Referring to the graph of the results the time taken to drain between 75% and 25% of the depth filled was 2.63 hours.

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:

$$V_{p75-25} = (0.45 - 0.15) \times 0.75 \times 0.5 = \underline{0.1125 \text{ cu m}}$$

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:

$$A_{p50} = (0.75 \times 0.3 \times 2) + (0.5 \times 0.5 \times 2) + (0.75 \times 0.5) = \underline{1.325 \text{ s m}}$$

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

$$t_{p75-25} = 2.63 \times 60 \times 60 = \underline{9,468}$$

$$\text{Soil Infiltration Rate} = \frac{0.1125}{1.325 \times 9468} = \underline{8.96 \times 10^{-6} \text{ m/sec}}$$