PROPOSED DEVELOPMENT AT BOSTON ROAD, GOSBERTON

DRAINAGE STRATEGY

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Revision A 2nd January 2018 Results from Lincs Lab report incorporated and proposals amended.

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Introduction

A planning application has been submitted to South Holland District Council to construct a residential development with eighteen houses and associated access roads west of Boston Road, Gosberton. 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.

Existing Drainage Systems

There is an Internal Drainage Board drain located along part of the boundary of the north western corner of the site. There is also a riparian dyke on the remaining part of the western boundary.

Site Investigations

Sidebottom Richardson Cheng Ltd (Consulting Engineers) undertook an investigation in February 2018 into the infiltration characteristics of the site. This involved excavating two pits 1.4 metres x 900mm in plan, one of the pits being excavated 1.2 metres deep and the second 1.3 metres deep. The following soil infiltration rates were calculated:

Soakaway Test No 1	7.009×10^{-6} metres/sec
Soakaway Test No 2	1.12×10^{-5} metres/sec

A second soil investigation was carried out by Lincs Laboratory in November 2018. The report stated the following conclusions:

Infiltration Rate

Infiltration rate calculations for design purposes using the test results in accordance with BRE Digest 365 [(2)] are contained in Appendix (iv). In general the trial pits revealed that there is significant variability on the site. TPs 1 & 3 showed a "*medium*" to "*high*" permeability classification with "*good*" drainage characteristics, whilst TP 4 failed to drain sufficiently in order to derive an infiltration rate. Testing was conducted at a shallow level of 0.6 m depth in all trial pits in order to assess the target zone for infiltration within the proposed swales. At this depth, the testing within TP3 gave the best infiltration rate.

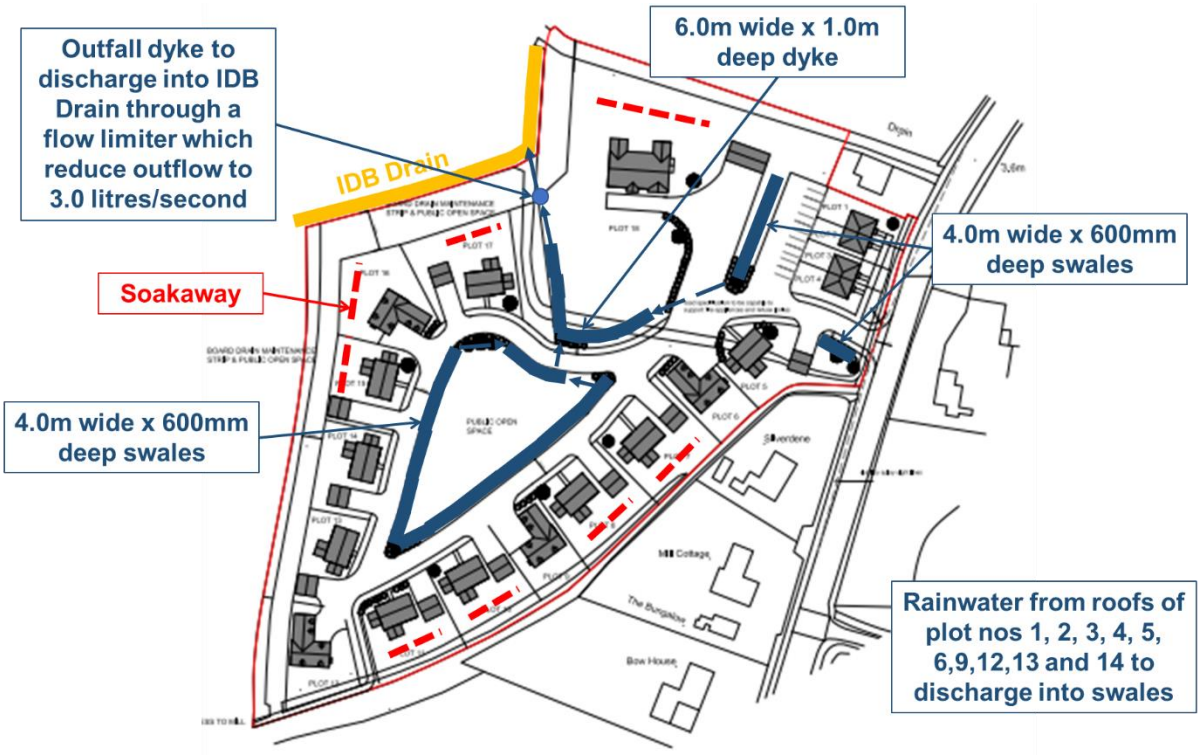
The calculated infiltration rates were:

Trial Pit	Infiltration Rates		
1	6.13×10^{-5}	2.70×10^{-5}	1.52×10^{-5}
3	8.8×10^{-4}	1.01×10^{-3}	2.37×10^{-4}

Design of Surface Water Disposal

The access roads on the proposed development will be traditional impervious construction which will be drained into swales alongside the roads and around the public open space in the centre of the development. The roads will be cambered towards the swales.

The surface water from the properties with large gardens (Plot Nos 7,8,10,11,15,16,17 and 18) will be discharged into separate soakaways. The surface water from the remaining properties will be discharged into the swales. The proposed layout is shown below.



The swales will be designed to act as soakaways and the calculations show that these should operate satisfactorily without an outfall into the IDB drain on the western side of the development. This design will then comply with the recommendation that SuD's should be incorporated into the design and that the design utilising infiltration satisfies the aim to discharge surface water runoff as high up the hierarchy of drainage options as reasonably practicable.

Due to the inconsistency of the results from the percolation tests a discharge from the swales into the IDB drain, subject to the approval of Welland and Deepings IDB, has been incorporated into the proposed drainage details for the site. The outfall from the site will be limited to 3.0 litres/ second, which is the "Greenfield Rate" calculated for the site area (2.21ha) x the greenfield rate per ha (1.4cumecs/1000ha) and is 3.09 litres/second.

The swales around the public open space and west of properties 1 - 4 will be a minimum depth of 600mm and 4.0 metres wide and be piped where accesses are required. The swale around the southern and eastern boundary of plot 18 will be 1000mm deep and 6.0 metres wide.

Calculations below will demonstrate that there will be sufficient storage capacity in the swales to provide attenuation for the rainfall from a 1 in 100 year event with a 30% increase for climate change. This will then comply with the SuDS manuals and guidance that recommend that the surface water should be reduced as much as possible to manage downstream flood risk.

Initial calculations are shown on pages 5 to 7.

A full page plan of proposal is shown on page 8.

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 Mill Road.

DESIGN OF SURFACE WATER DISPOSAL SYSTEM

The layout of the proposed swales on the development is shown on page 3 and 8.

Area of access roads = 280 x 7.2 = 2330 sq m

There is one very large house, 13 large houses with an average area of 130 sq m and 4 smaller houses with an average area of 70 square metres. The roof water from the very large house (plot no 18) and the large houses on plot Nos 7,8,10,11,15,16,17 will be disposed of into soakaways. The roof water from the large houses on plot nos 5, 6, 9, 12, 13 and 14 and the four smaller houses will be discharged into the nearest swale.

Total area of access road and roofs which are discharging into the swales

= 2330 + (130 x 6) + (70 x 4) = 3,390 sq m

The volumes of rainfall for various storm durations in a 1 in 100 year event with 30% added 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	0.339	387.654	503.95	126.0	96.91	107.682
30	24	0.81	19.44	1.97	38.30	76.59	0.95	72.76	0.339	246.670	320.67	160.3	123.33	68.519
60	24	1	24	1.93	46.32	46.32	0.96	44.47	0.339	150.744	195.97	196.0	150.74	41.873
120	24	1.2	28.8	1.89	54.43	27.22	0.97	26.40	0.339	89.494	116.34	232.7	178.99	24.860
240	24	1.42	34.08	1.86	63.39	15.85	0.97	15.37	0.339	52.110	67.74	271.0	208.44	14.475
360	24	1.57	37.68	1.83	68.95	11.49	0.98	11.26	0.339	38.180	49.63	297.8	229.08	10.606
600	24	1.74	41.76	1.81	75.59	7.56	0.98	7.41	0.339	25.111	32.64	326.4	251.11	6.975
1440	24	2.16	51.84	1.81	93.83	3.91	0.98	3.83	0.339	12.988	16.89	405.2	311.72	3.608
2880	24	2.5	60	1.81	108.60	2.26	0.98	2.22	0.339	7.516	9.77	469.0	360.79	2.088

Initially the swales will be designed to soakaway without any discharge into the IDB drain. The following areas will be used in the calculations:

Area of 6.0m wide swale per metre	2.5 sq m
Length of 6.0m wide swale	56.0 m
Area of 4.0m wide swale	1.7 sq m
Length of 4.0m wide swale	206 metres

Total soakaway area = (2.5 x 56) + (1.7 x 206) = 490.2 sq m

Although the lowest infiltration rate computed by Lincs Laboratory was 1.52×10^{-5} m/sec a more conservative value of 4.0×10^{-6} will be assumed for the calculations.

The volume that has soaked away within the time of t seconds can be worked out from:

(Soakaway area) x (Infiltration rate) x t

The tabulation of the calculations for rainfall durations of between 15 minutes and 2880 minutes (2 days) is shown on the next page:

Rainfall duration mins	Total Rainfall Volume cu m into swales	Volume that has soaked away in duration cu m	Total storage required in swales	Total time for water to soakaway in swales hours	Total time for water to soakaway in swales days
15	125.99	1.76	124.22	9.35	0.39
30	160.34	3.53	156.81	11.90	0.50
60	195.97	7.06	188.91	14.55	0.61
120	232.69	14.12	218.57	17.27	0.72
240	270.97	28.24	242.74	20.12	0.84
360	297.80	42.35	255.45	22.11	0.92
600	326.44	70.59	255.85	24.23	1.01
1440	405.24	169.41	235.83	30.08	1.25
2880	469.03	338.83	130.20	34.82	1.45

Therefore from the above table it can be seen that a total storage volume of 256 cu metres is required to store the rainfall from a 1 in 100 year event with 30% increase for climate change. The storage volume provided in the swales is:

(3.5 x 56) + (1.38 x 206) = 480.3 cu metres.

Therefore with a factor of safety of nearly 2 (nearly twice the volume provided in the swales than required) and the low infiltration rate used in the calculation this would seem to be satisfactory without any discharge into the IDB system.

An initial design for the proposed soakaways to dispose of the roof water from the large houses with a roof area of 130 sq m is shown below.

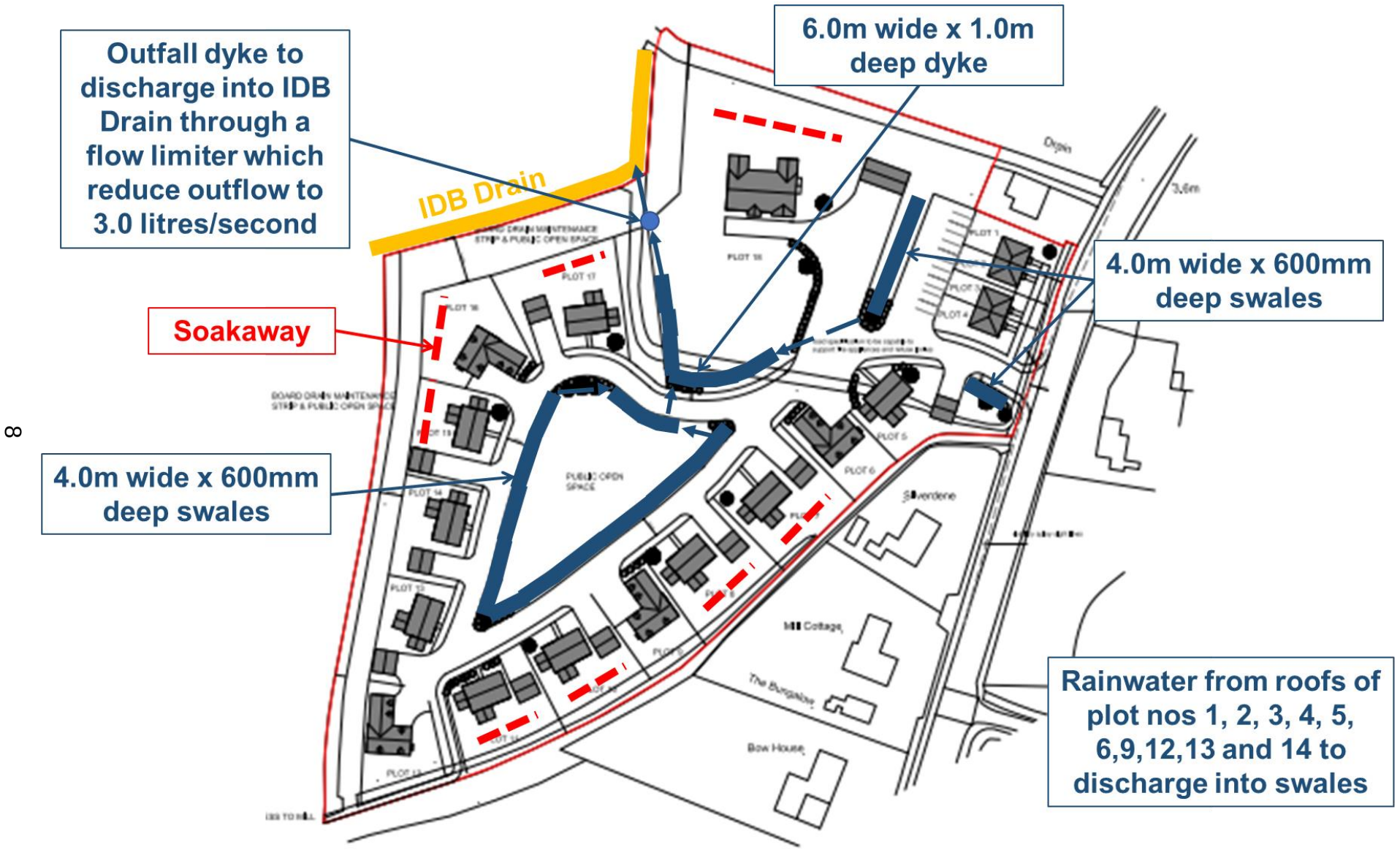
The volumes of rainfall for various storm durations in a 1 in 100 year event in 2115 with 30% added for climate change can be calculated as follows:

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	0.013	14.866	19.33	4.8	3.72	4.129
30	24	0.81	19.44	1.97	38.30	76.59	0.95	72.76	0.013	9.459	12.30	6.1	4.73	2.628
60	24	1	24	1.93	46.32	46.32	0.96	44.47	0.013	5.781	7.51	7.5	5.78	1.606
120	24	1.2	28.8	1.89	54.43	27.22	0.97	26.40	0.013	3.432	4.46	8.9	6.86	0.953
240	24	1.42	34.08	1.86	63.39	15.85	0.97	15.37	0.013	1.998	2.60	10.4	7.99	0.555
360	24	1.57	37.68	1.83	68.95	11.49	0.98	11.26	0.013	1.464	1.90	11.4	8.78	0.407
600	24	1.74	41.76	1.81	75.59	7.56	0.98	7.41	0.013	0.963	1.25	12.5	9.63	0.267
1440	24	2.16	51.84	1.81	93.83	3.91	0.98	3.83	0.013	0.498	0.65	15.5	11.95	0.138
2880	24	2.5	60	1.81	108.60	2.26	0.98	2.22	0.013	0.288	0.37	18.0	13.84	0.080

With a similar infiltration rate of 4.0×10^{-6} metres/sec the table below demonstrates that a 15.0 metre long x 1.0 metre wide x 800mm deep soakaway constructed with 60 modular geocellular units 1.0m x 500mm wide x 400mm deep is satisfactory.

Duration mins	Total Rainfall in Duration mm	Total Rainfall Volume cu m into soakaway	Volume that has soaked away in duration cu m	Total Storage Required	Total Time to empty storage pond hours	Total Time to empty storage pond days
15	503.9	4.83	0.05	4.79	26.21	1.09
30	320.7	6.15	0.09	6.06	33.36	1.39
60	196.0	7.51	0.18	7.33	40.77	1.70
120	116.3	8.92	0.37	8.55	48.41	2.02
240	67.7	10.39	0.74	9.65	56.38	2.35
360	49.6	11.42	1.11	10.31	61.96	2.58
600	32.6	12.52	1.84	10.68	67.92	2.83
1440	16.9	15.54	4.42	11.12	84.31	3.51
2880	9.8	17.99	8.85	9.14	97.58	4.07

Therefore as the soakaway provides a storage volume of 12.0 cu m the soakaway can be considered to be satisfactory.


Outfall dyke to discharge into IDB Drain through a flow limiter which reduce outflow to 3.0 litres/second
6.0m wide x 1.0m deep dyke
IDB Drain
Soakaway
4.0m wide x 600mm deep swales
4.0m wide x 600mm deep swales
Rainwater from roofs of plot nos 1, 2, 3, 4, 5, 6,9,12,13 and 14 to discharge into swales
PUBLIC OPEN SPACE
Silverdene
Mill Cottage
The Bungalow
Bow House