ABINGTON
CONSULTING ENGINEERS
CHARTERED CIVIL & STRUCTURAL ENGINEERS

Civil & Structural Engineering

Highways & Transportation

Flood Risk & Drainage

Project Management

Expert Witness

FLOOD RISK ASSESSMENT

FOR PROPOSED

ANAEROBIC DIGESTION PLANT

AT

BONBY

LINCOLNSHIRE

22nd November 2012
Revision B

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1.0 Introduction

1.1 Abington Consulting Engineers has been appointed to produce this Flood Risk Assessment and drainage report in support of a planning application for the proposed anaerobic digestion plant at Bonby in Lincolnshire.

2.0 Planning Policy & Methodology

2.1 Planning policy for flood risk is set out in the National Planning Policy Framework (NPPF) technical guidance published in March 2012. The policy document sets out key planning objectives in relation to land usage and flood risk management. The development proposals are designed to be compliant with the requirements of the National Planning Policy Framework.

2.2 A Flood Risk Assessment has been carried out to assess the effects of flooding on the development and how the development might affect flood risk elsewhere.

2.3 A drainage strategy has been developed to demonstrate that the site can be adequately drained.

3.0 Development Location & Description

3.1 The site is located to the north-east of the village of Bonby as shown on the location plan below.

Location Plan

3.2 The site area is approximately 1.68 hectares. Part of the site is an open field used for growing crops and the remainder of the site is located on an existing food and agriculture waste handling facility.

3.3 Access to the site is taken from Bonby Lane linking Bonby village to the B1218. The site is remote from other developments other than the existing waste facility and surrounded by agricultural fields.

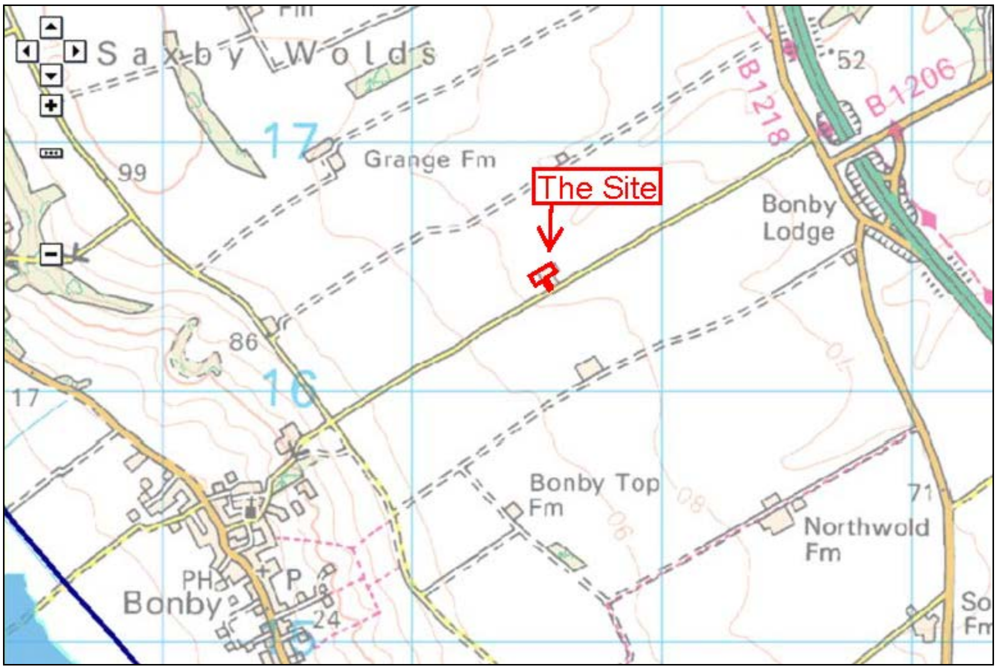
3.4 A copy of the topographical survey is presented in Appendix 1 which shows the site generally falls to the north-east at a gradient of approximately 1 in 25.

3.5 The proposed facility will be an entirely enclosed process, receiving feedstock through directly piped connections from the existing operations, into a new reception building, or receiving liquids directly from the importing tanker. The feedstock is initially pasteurised, before moving into the primary digestion tanks, where the materials are broken down and 'digested', releasing bio-methane gas. This gas is then captured, and used to power a generator. The site will generate around 3MW of electricity, for export to the local grid – sufficient for roughly 6000 homes. The remaining material – digestate – is then a completely clean product, which will be used as a direct replacement for fertiliser in the surrounding agricultural area.

4.0 Sequential Test

4.1 Table 2 in the NPPF technical guidance lists electricity generating power stations as 'Essential Infrastructure'. However, it is considered that the AD plant should be classed as 'Less Vulnerable' development based on its primary function as a waste treatment facility of non-hazardous waste. As the electricity generating is not essential to the delivery of power supply to the National Grid, it would be unrealistic to classify the plant as 'Essential Infrastructure'.

4.2 The Environment Agency's flood plain map is shown below. It shows the site falls within Flood Zone 1 which is described as having a 'low probability' of flooding as defined in Table 1 in the NPPF technical guidance.



Environment Agency Flood Plain Map

4.3 Using the Sequential Test set out in the NPPF, Less Vulnerable uses are permitted in Flood Zone 1 (refer to Table 3 below), and therefore the development site will comply with planning policy and pass the Sequential Test.

Table 3: Flood risk vulnerability and flood zone 'compatibility'

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
× Development should not be permitted.

5.0 Potential Sources of Flooding

5.1 The following mechanisms have been identified as potential sources of flooding:

- Ground water.
- Surface water run-off from the development.
- Surface water run-off from areas adjacent to the site.

5.2 There are no rivers or watercourses in the vicinity.

5.3 There are no public surface water sewers in the area (confirmed from a utility search of the area).

5.4 There are no reservoirs, canals or other artificial sources of flooding identified in the area.

6.0 Appraisal of Sources of Flooding

6.1 Groundwater

6.1.1 A report of the geology on site is presented in Appendix 2. The report shows the geology in the area is lime-rich loamy soils and the ground is freely draining. Consequently groundwater will be able to move freely within the upper strata of the soil if the water table is sufficiently high enough. A perched water table is therefore unlikely to be encountered.

6.1.2 The site is located on land with a significant gradient and consequently groundwater levels are likely to be low due to the likely absence of a perched water table and the freely draining soils.

6.1.3 There is no anecdotal evidence to suggest that groundwater is a problem on the site.

6.2 Surface water run-off from the development

6.2.1 The western half of the existing site is used for agriculture and will therefore yield rates of run-off at or close to green-field run-off. The eastern half of the site is part of the hard core yard area of the existing waste treatment facility. There is no formal drainage to this area and therefore run-off rates are expected to be slightly higher than green-field run-off.

6.2.2 A copy of the proposed development layout is shown on the proposed drainage drawing in Appendix 1. The new development will consist of large impermeable areas formed by the proposed reception building and yard area. Digester tanks will be located in the western half of the site. These will be surrounded by loose gravel surfacing with an impermeable liner located at formation level. Therefore rates of run-off from this area and other impermeable areas of the site will be high.

6.2.3 As a result of the high rates of run-off caused by the development in comparison the existing, surface water will need to be managed to prevent flood risk to adjacent land and property.

6.3 Surface water run-off from areas adjacent to the site

6.3.1 Ground levels to the north-east of the site fall away from the proposed development and therefore run-off from this area will not be a flood risk. Ground levels to the south-west fall towards the site and may result in some flooding during periods when the ground is saturated. This may need to be controlled to prevent flooding to the development.

7.0 Probability

7.1 The development site is located within a Zone 1 flood area. This is deemed to be at low risk of flooding, typically less than 1 in 1000 annual probability.

8.0 Climate Change

8.1 Table 5 in the NPPF technical guidance provides recommended allowances for increase peak rainfall intensity of 20% which should be used for any surface water drainage design.

9.0 Flood Risk Management Measures

9.1 Surface water run-off from the development has been identified as a flood risk. In order to prevent flooding to adjacent land and property this will need to be suitably managed.

9.2 An indicative drainage scheme is shown on the proposed drainage drawing in Appendix 1. As stated in Section 3 above, waste will be handled in the reception building and therefore the yard area will only be used for vehicle manoeuvring, storage of plant and empty containers. The yard will therefore be drained into the surface water drainage scheme via gullies. Run-off will pass through a class 1 bypass interceptor before discharging into the main surface water drainage system.

9.3 Roof water from the reception building will be drained directly into the main surface water drainage system without the need for any treatment.

9.4 The digester tank area will yield run-off from the top surface of the tanks which are sealed units and therefore will not contaminate the surface water. Rainwater falling onto the tanks will run-off onto the surrounding gravel areas. The gravel areas will be drained using perforated land drains which will discharge into the main surface water drainage system. These areas will only occasionally be trafficked by maintenance vehicles and pedestrians and therefore there is no risk of contamination from this area discharging into the main surface water drainage system.

9.5 Surface water will be directed to a water recycling pond at the north-eastern end of the site. The AD plant will have a demand for water usage in the processing of the waste and therefore water will be pumped from the water recycling pond to the points of usage.

9.6 Any surplus surface water will be allowed to overflow into an infiltration basin via a weir between the recycling pond and the basin. Water will then permeate into the ground and into the groundwater system.

9.7 The existing geology has been described as 'freely draining' in the geology report. Infiltration testing has been carried out on the site and the permeability '*k*' of the soil has been calculated as 2.6×10^{-3} m/s (or 9.36 m/hr used in Microdrainage).

9.8 Calculations for the preliminary sizing of the infiltration basin are presented in Appendix 3 using the following parameters:

- $k = 2.6 \times 10^{-3}$ m/s
- 100 year return period
- 20% allowance for climate change

The resulting volume requirement of the infiltration basin is $107.0m^3$. An infiltration basin with this volume based on a depth of 1.0m has been annotated on the proposed drainage drawing.

9.9 Infiltration testing has shown that the existing geology is highly permeable. Therefore the rate of surface water run-off from the higher land to the south-west of the development is likely to be low. Any run-off from this land will be intercepted by the bunding around the site and should therefore no pose a flood risk. However, as a precautionary measure it is recommended that at detailed design stage a land drain should be considered at the foot of the bunding.

10.0 Off Site Impacts and Proposed Mitigation Measures

10.1 There will be no off site impacts from the development as a result of the proposed management of surface water run-off.

11.0 Management of Residual Risks

11.1 The developer will be responsible for maintaining the proposed drainage system on site. All site drainage and will be inspected regularly for blockages, silting and functionality, and the appropriate remedial works undertaken after the inspection.

11.2 As part of the permitting requirements of the Environment Agency, the digester tank area needs to be able to contain the contents of one of the tanks if there were to be a failure. Consequently this area is fully bunded and lined with an impermeable liner.

11.3 In the unlikely event of a tank failure occurring, it is possible that some of the waste will enter the surface water drainage system via the land drains and this needs to be prevented from reaching the infiltration basin in order to prevent contamination of the groundwater system.

11.4 Each tank will have telemetry which can detect leaks and alert the plant operator. The telemetry will also be used to close an automated valve in the manhole upstream of the recycling pond in the event of a tank failure, thus preventing any waste reaching the infiltration basin.

11.5 If a tank failure occurs, there will need to be a clean-up of the site which will include the replacement of the land drains and cleaning and jetting of the drainage before the drainage system can be re-commissioned.

12.0 Foul Water Drainage

12.1 Foul water discharge from the site will be limited to domestic flows generated by the staff working at the plant. It is anticipated that there will be approximately 6 members of staff on site and therefore flows will be light.

12.2 There are no public foul sewers near the site and therefore it is proposed that a septic tank will be used to treat the sewage. As the geology has been found to be freely draining, flows from the septic tank will be irrigated into the adjacent land as shown on the proposed drainage drawing in Appendix 1.

13.0 Conclusions

13.1 The proposed development complies with the requirements of the Sequential Test set out in the NPPF technical guidance.

13.2 Surface water will drain into an infiltration basin and discharged into the groundwater system. This will prevent flood risk to adjacent land and property as a result of increased surface water run-off from the development.

13.3 Risk of contamination resulting from digester tank failure will be prevented using an automated control system.

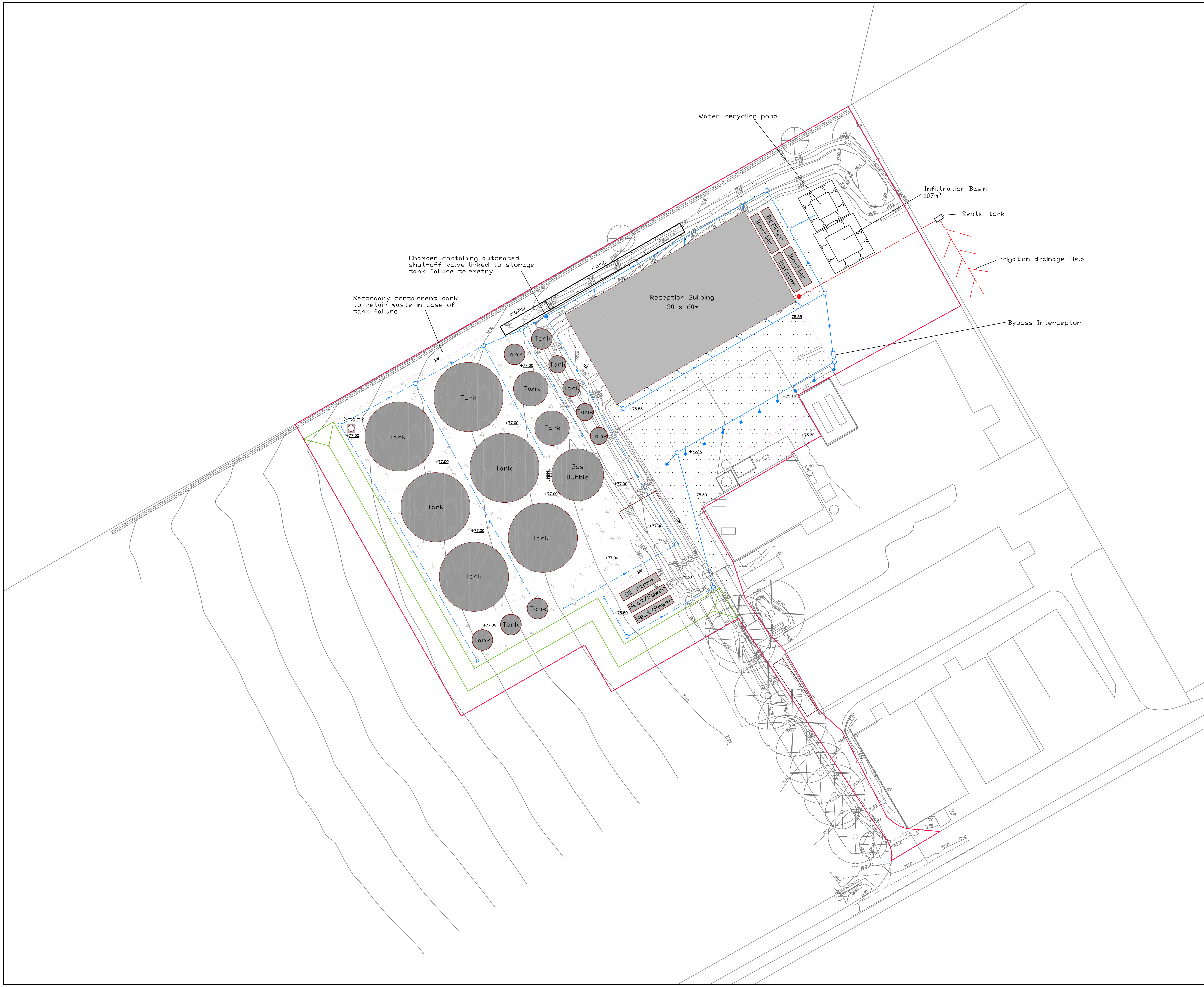
13.4 Foul drainage will be disposed of using a septic tank and irrigation system.

……………………………………………….. 22nd November 2012

Ian Brazier BEng (Hons) CEng MICE

On Behalf of Abington Consulting Engineers Limited

APPENDIX 1 – Drawings



KEY

- SWS and chamber
- Land drain and chamber
- SWS and gully
- FWS and chamber
- 62.00 — proposed finished floor level
- +62.00 — proposed ground level
- 62.75 — existing ground level contour
- impermeable hardstanding
- gravel with impermeable membrane

NOTE: Drainage scheme preliminary only and subject to detailed design

REV.	BY	REVISION DETAILS	DATE
A	IB	Layout updated.	22/11/12

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PROJECT
Bonby AD Plant

TITLE
Drainage Proposals

DRAWING NO. 12037/102 REVISION A

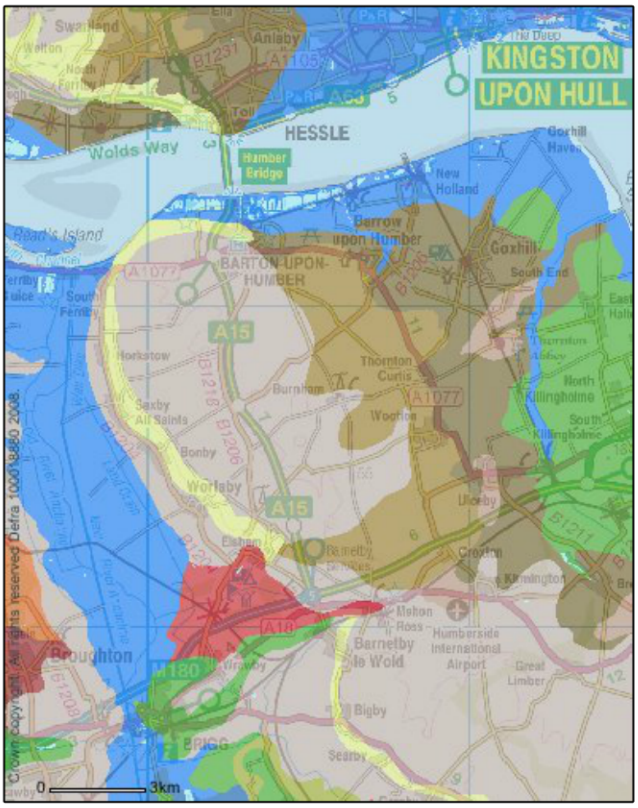
SCALE 1:500 @ A1

DRAWN EJB CHECKED IB DATE 17/10/12

APPENDIX 2 – Geology Report

Soilscapes Viewer Report

National Soil Resources Institute



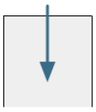
SELECTED SOILSCAPE:

Freely draining lime-rich loamy soils

HABITATS:
Herb-rich chalk and limestone pastures; lime-rich deciduous woodlands

LANDCOVER:
Arable with grassland at higher altitude

DRAINAGE:
Freely draining



FERTILITY:
Lime-rich

TEXTURE:
Loamy

COVERAGE:
England: 3.7%
Wales: 0%
E&W: 3.2%

Soilscapes is a 1:250,000 scale, simplified soils dataset covering England and Wales. It was created from the more detailed National Soil Map (NATMAPvector) with the purpose of effectively communicating a general understanding of the variations which occur between soil types, and how soils effect the environment.

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APPENDIX 3 – Calculations

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 4 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.857	0.857	248.8	93.4	Flood Risk
30 min Summer	0.877	0.877	253.0	96.6	Flood Risk
60 min Summer	0.775	0.775	231.5	81.2	Flood Risk
120 min Summer	0.561	0.561	187.7	52.4	O K
180 min Summer	0.401	0.401	156.4	34.1	O K
240 min Summer	0.282	0.282	134.0	22.2	O K
360 min Summer	0.123	0.123	104.9	8.7	O K
480 min Summer	0.049	0.049	89.5	3.2	O K
600 min Summer	0.041	0.041	74.8	2.7	O K
720 min Summer	0.036	0.036	65.3	2.4	O K
960 min Summer	0.029	0.029	52.1	1.9	O K
1440 min Summer	0.021	0.021	37.4	1.4	O K
2160 min Summer	0.016	0.016	27.5	1.0	O K
2880 min Summer	0.013	0.013	22.1	0.8	O K
4320 min Summer	0.009	0.009	16.0	0.7	O K
5760 min Summer	0.008	0.008	13.3	0.6	O K
7200 min Summer	0.007	0.007	11.6	0.5	O K
8640 min Summer	0.005	0.005	9.0	0.4	O K
10080 min Summer	0.005	0.005	9.0	0.4	O K
15 min Winter	0.942	0.942	267.0	107.0	Flood Risk
30 min Winter	0.930	0.930	264.3	104.9	Flood Risk
60 min Winter	0.753	0.753	226.8	78.0	Flood Risk

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	111.940	15
30 min Summer	73.565	23
60 min Summer	46.096	38
120 min Summer	27.939	70
180 min Summer	20.582	98
240 min Summer	16.478	128
360 min Summer	11.961	188
480 min Summer	9.535	246
600 min Summer	7.993	306
720 min Summer	6.916	362
960 min Summer	5.501	482
1440 min Summer	3.977	722
2160 min Summer	2.871	1096
2880 min Summer	2.276	1428
4320 min Summer	1.639	2184
5760 min Summer	1.296	2848
7200 min Summer	1.081	3528
8640 min Summer	0.931	4392
10080 min Summer	0.820	5000
15 min Winter	111.940	15
30 min Winter	73.565	23
60 min Winter	46.096	40

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
120 min Winter	0.457	0.457	167.3	40.3	O K
180 min Winter	0.267	0.267	131.2	20.9	O K
240 min Winter	0.140	0.140	108.0	10.0	O K
360 min Winter	0.044	0.044	80.7	2.9	O K
480 min Winter	0.036	0.036	64.3	2.4	O K
600 min Winter	0.030	0.030	54.0	2.0	O K
720 min Winter	0.027	0.027	47.5	1.8	O K
960 min Winter	0.021	0.021	37.4	1.4	O K
1440 min Winter	0.016	0.016	27.5	1.0	O K
2160 min Winter	0.012	0.012	20.4	0.8	O K
2880 min Winter	0.009	0.009	16.0	0.6	O K
4320 min Winter	0.007	0.007	11.6	0.5	O K
5760 min Winter	0.006	0.006	9.9	0.5	O K
7200 min Winter	0.005	0.005	9.0	0.4	O K
8640 min Winter	0.005	0.005	8.1	0.4	O K
10080 min Winter	0.004	0.004	7.3	0.3	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
120 min Winter	27.939	70
180 min Winter	20.582	100
240 min Winter	16.478	130
360 min Winter	11.961	180
480 min Winter	9.535	246
600 min Winter	7.993	308
720 min Winter	6.916	370
960 min Winter	5.501	480
1440 min Winter	3.977	748
2160 min Winter	2.871	1124
2880 min Winter	2.276	1520
4320 min Winter	1.639	2112
5760 min Winter	1.296	2872
7200 min Winter	1.081	3800
8640 min Winter	0.931	4448
10080 min Winter	0.820	5216

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time / Area Diagram

Total Area (ha) 1.147

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.647	4-8	0.500

Model Details

Storage is Online Cover Level (m) 1.000

Infiltration Basin Structure

Invert Level (m)	0.000	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	9.36000	Porosity	1.00
Infiltration Coefficient Side (m/hr)	9.36000		

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	64.0	1.000	169.0