

A decorative graphic consisting of several overlapping circles and spheres. A large grey circle is in the top left. A smaller light purple circle is in the bottom right. Two red spheres with black shading are positioned on the left and bottom of the central area, connected by thin grey lines that form a circular path.

# **FLOOD RISK ASSESSMENT FOR ANAEROBIC DIGESTER AT HARVESTER FARM**

Prepared for  
AWS Power Ltd



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### I. INTRODUCTION

The development of an anaerobic digestion plant has been proposed at Harvester Farm, near Epworth (DN9 IEA). The site is approximately 2.6km south west of Epworth and approximately 2.7km north of Westwoodside. The land in the immediate vicinity is farmed organically, as is other land belonging to the estate. The farm is predominantly arable (growing vegetables), with an organic outdoor pig rearing unit. The proposed site is close to the boundary between Doncaster Metropolitan Council (DMC) and North Lincolnshire Council (NLC). The development site will fall within the NLC area. The approximate location of the farm is shown on figures 1 and 2 below.

The site is situated in a predominantly arable area, approximately 7km to the north is the M180, with the M18 11km to the west. The agricultural fields are well serviced by a network of drainage ditches and channels which ultimate discharge into the Rivers Trent and Torne. The River Trent is approximately 7.2km east of the site, with the River Torne 1.5km to the north west. The nearest identified main river, based on the EA flood mapping (see Section 2 of this report), is Folly Drain, which is less than 1km west of the site.

Assessment of the Environment Agency (EA) flood zones has confirmed that the site is within Flood Zone 3; i.e. land assessed as having a 1:100 or greater annual probability of river flooding (>1%), or a 1:200 or greater annual probability of flooding from the sea (>0.5%), in any year. Flood risk and the sources of flooding are discussed in more detail in section 2 of this assessment.

Following significant flooding in this area in 2007 and 2008, the Isle of Axholme Flood Risk Management Strategy was produced in 2012. This is still in the process of being implemented, but suggests that flood defences may be raised to achieve a 1:75 year protection, or 1:100 year protection if funding can be acquired. The nearest locations on the River Torne and Folly Drain benefit from a level of flood defences, however existing and proposed flood defences would not provide full protection for the site and are therefore ignored for the purposes of this assessment.

The development site falls within the Trent Valley Area of the North Lincolnshire SFRA, specifically within flood compartment 3F5 (Isle of Axholme), assigning a critical flood level of 4.1m AOD at this site. The site is relatively flat, with a slight slope to the south east, existing ground elevation at the development location is primarily in the range 2.4-2.8m AOD.

The proposed location and layout of the digester and associated structures are shown in appendix I of this report.

Figure 1- Location Overview

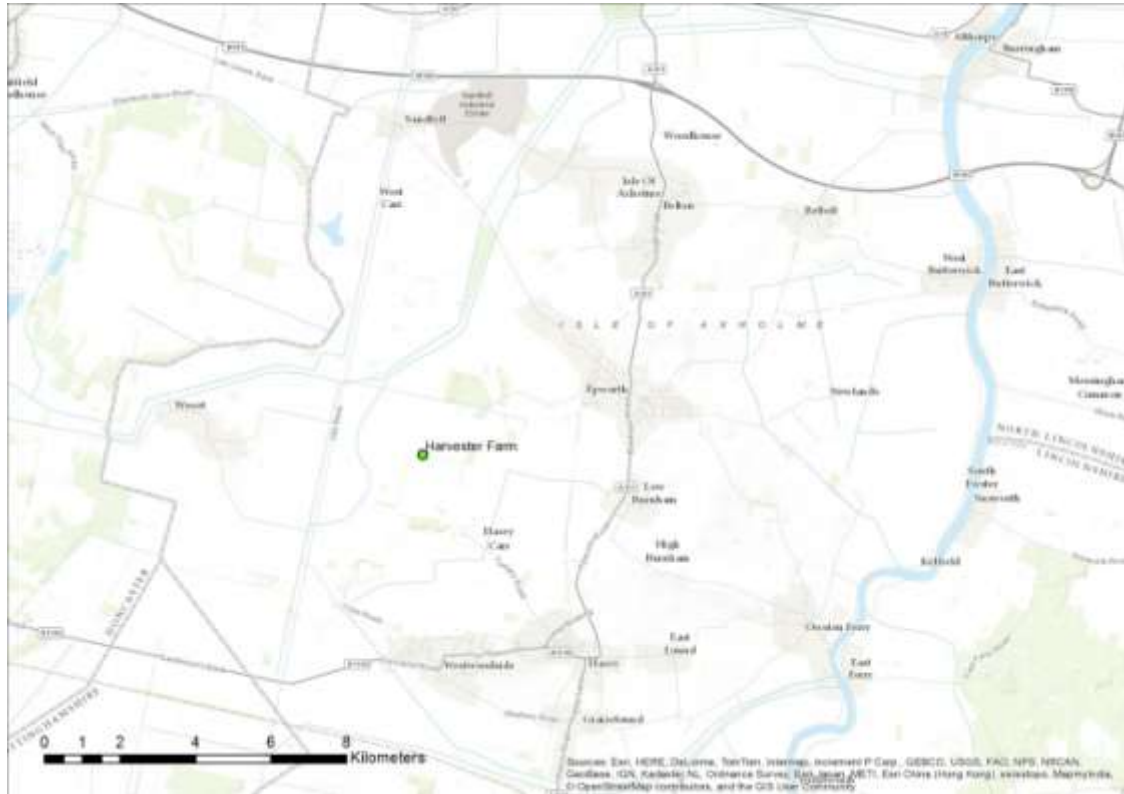


Figure 2- Site Location Plan



## 2. FLOOD RISK AT SITE

The site has been identified by the EA as being within Flood Zone 3; i.e. land assessed as having a 1:100 or greater annual probability of river flooding (>1%), or a 1:200 or greater annual probability of flooding from the sea (>0.5%), in any year. Figure 3 (below) shows the location of the development site in relation to local watercourses, and the EA's specified flood zones. As this demonstrates, there are a number of potential flood sources; these are dealt with in the following sections of this assessment.

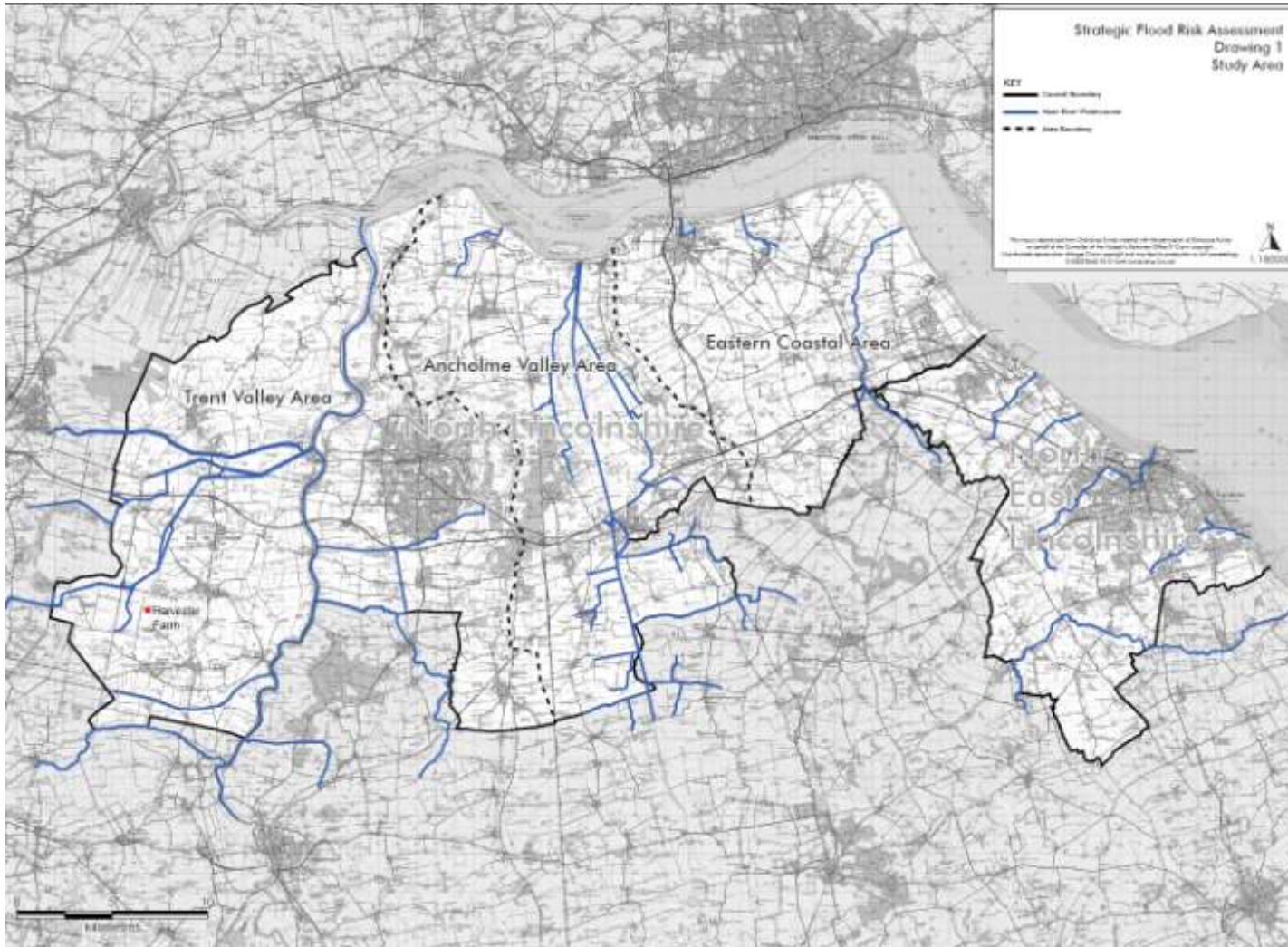
**Figure 3 – Site Flood Risk**



<Source: Environment Agency>

The site is situated within the Trent Valley area of the NLC SFRA, specifically flood compartment 3F5 (Isle of Axholme). The location of this within the wider SFRA context is shown on figure 4 below.

Figure 4: SFRA location map



<Source: NLC SFRA>

The SFRA identifies that this area was originally marshland, drained in the 16<sup>th</sup> and 17<sup>th</sup> century. A complex drainage system supplements the natural drainage to allow arable agriculture to take place across much of this fertile land, although the Isle of Axholme compartment is noted as being at a slightly higher elevation than the surrounding land in the Trent Valley area. The primary flood sources are dealt with in the following sections.

In compartment 3F5 a Level 1 Assessment only has been carried out as part of the SFRA. The resulting critical flood level is based on primarily fluvial flood risk, although land in this compartment is also potentially vulnerable to tidal flooding. Based on this, the critical flood level is based on highest water level with a 0.5% probability of occurrence (1 in 200yr), adjusted for sea level rise to 2115 to account for the potential impact of climate change. This designates a critical flood level of 4.1m AOD.

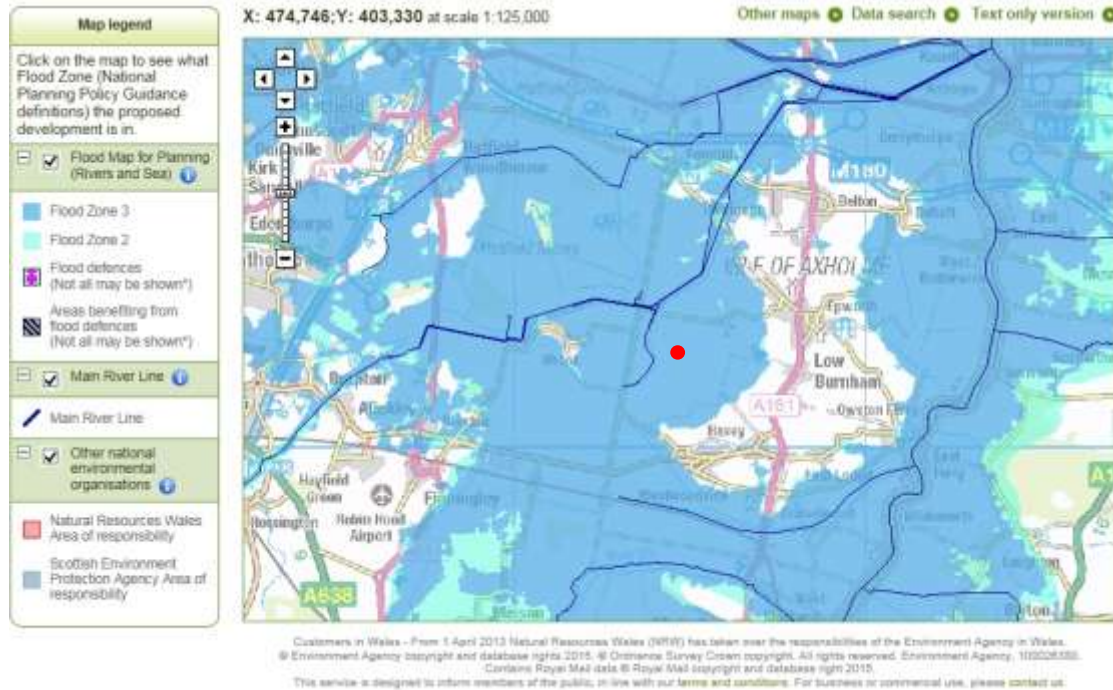
### 2.1 Fluvial Flood Risk

The two key sources of flood risk in this area are the Rivers Torne and Trent.

The River Torne is a highland carrier receiving water from the Doncaster area, across the Trent floodplain to the Keadby pumping station and ultimately discharging into the River Trent. The watercourse is assessed to provide a nominal 1:30 years standard of protection to the surrounding area by the SFRA. Therefore, in practice the flood risk from this source is low, although the impact of flood defensive is discounted in assessing flood resilience in this assessment.

The River Trent is therefore the main source of flood risk to this area. North of the M180 the flood risk from the Trent is primarily tidal, while to the south it is both tidal and fluvial. The SFRA indicates that flood risk south of the M180 is influenced by tidal conditions and by rainfall and catchment characteristics, in particular floodplain storage. It should also be noted that the land between the River Trent and the development site does rise in the Isle of Axholme, between Belton and Haxey, providing some protection from direct flooding and a 'break' in the floodplain, as shown in figure 4 below:

Figure 4 – Regional Flood Risk



<Source: Environment Agency>

The River Trent is also protected by flood defences, consisting primarily of earth embankments. The SFRA considers these to be in good to fair condition (Grades 2 and 3), with a design sufficient to prevent overtopping during events with a 0.5% (tidal) and 1.0% (fluvial) annual probability of occurrence. The River Torne embankments (also assessed by the SFRA as good to fair condition), provide flood protection from events with a 3% annual probability. However, the SFRA does note that the flat, low-lying nature of the catchment does mean that flooding during an ‘extreme’ event could be widespread and difficult to predict.

Given the distance to the River Trent, and the presence of flood defences on the River itself, it would be considered that the primary risk is linked to the drainage channels shown on figures 1 and 2. These ultimately will discharge via ground or surface water into the Rivers Torne and Trent. On this basis, flooding at the River Trent, whether fluvial or tidal sourced, may impact the ability of this drainage system to function, and may therefore prevent adequate drainage of the area. It is however, notable that during extreme events, the risk of flooding direct from the River Trent may still be significant due to the flat, low-lying nature of the area.

### 2.2 Surface and Groundwater flooding

The catchment area surrounding the development is very flat, and low-lying. Elevations for the surrounding area typically range from 1.0-3.0m AOD.

The agricultural land is well serviced by a network of drainage ditches (see figures 1 and 2), which channel the water away from the agricultural land, into the main watercourses. These are, however, under the management of the individual land owner, and the level of maintenance and care taken may vary. It is therefore unclear how effective this system would be at handling an extreme rainfall event.

However, the presence of these drainage channels will provide a preferred pathway for water flow and promote infiltration to groundwater where possible. By helping to mirror the natural flow conditions, and extending the lag time between rainfall and peak flow in the local watercourses, this can help to reduce storm surge and reduce the risk of local flooding during short, intense rainfall events.

The area is identified as naturally marshland and, coupled with the low-lying nature of the ground, this is likely to mean that groundwater level is relatively high. This may hinder the ability of the drainage channels to infiltrate rainfall to ground during longer rainfall events, creating a risk of waterlogging. This creates a risk of increased overland flow, which may lead to further flooding in the area.

It should be noted that despite the complexity of the field drainage system over this location and the wider area, and the low-lying nature of the catchment, the SFRA does not specifically discuss flood risk from groundwater flooding in either of the nearby flood compartments assessed. While this does not discount this source, it does indicate that it was not considered as significant as the potential risk from the Rivers Torne and Trent directly.

### 2.3 Flooding from Man-Made Sources

Man-made flood sources in this area are limited, with the majority of the land being under agricultural management. Urban development is limited and therefore is unlikely to have a significant impact on local conditions. The Stainforth and Keadby Canal, running to the north of the site, poses limited risk in the event of breach, however gates at either end of the canal would limit the impact area as this prevents further flow into the canal. However, this is approximately 9.3km north of the site, beyond the M180. The distance to the canal means that this is unlikely to significantly impact flood risk at the development site.

The flood risk from the field drainage system and other drainage is not considered further in this section. The flood risk from local drainage is discussed within section 2.2 above.

### **3. SEQUENTIAL AND EXCEPTION TESTING**

As shown on figures 3 and 4, the majority of the land in this area is designated as Flood Zone 3 by the Environment Agency. In addition, the nature of the development as an on-farm anaerobic digester dictates that the site needs to be close to the existing farm buildings. Locating the development elsewhere would have a significant impact both on the local area and the environment, due to the necessity to transport large quantities of feedstock from the farm into the digester on a daily basis. It is therefore not feasible to locate the digester away from the farm buildings.

On this basis it is considered that the site selection meets the criteria of the sequential test.

As the proposed development is an electricity generating station, it is considered that this could be classed as either 'essential infrastructure' or 'less vulnerable' under the National Planning Policy Framework. Based on the use as 'essential infrastructure' it is necessary to follow the requirements of the 'exception test'.

The development is considered to provide a wider sustainability benefit to the community, by helping to provide both a renewable source of energy, and improved management of slurry at the farm. In addition to this, the digestate produced will be used as a organic fertiliser, providing a nutrient benefit to the soil, allowing better soil recovery and carbon sequestration. The land area is part of the farm footprint, and therefore the land is the best, and most suitable, location for this development in the local area. No alternative sites are available and practical.

In terms of impact on flood risk, the footprint of the development is relatively small (see appendix I) and within the footprint of the existing farm buildings. The impact on flood risk in the local area would therefore be considered to be minimal, as the potential loss of floodplain storage would be an insignificant portion of the overall wider floodplain of the Rivers Trent and Torne. In addition to this, the surrounding land is primarily agricultural, and the development would not have any persons located at the site specifically. Therefore there would be no requirement to consider potential evacuation routes or islanding issues from this development.

Based on this assessment, it is considered that the site selection and the nature of the development meet the criteria of the exception test.

### 4. SUSTAINABLE DRAINAGE

Due to the nature of the proposed development, drainage is not considered a significant factor in overall flood risk in this area. A soakaway system is considered the most suitable method to accommodate rainfall on to the site. This will provide the least intrusion, and represent the most cost-effective method to mirror the pre-development drainage at this site.

To satisfy sustainable drainage requirements, the concrete base will be cambered to drain into gullies positioned suitably to minimise runoff and pooling. These will be interconnected under the base by a ring soakaway consisting of 150mm perforated pipework laid in the bedding material under the concrete base. No pipework should be placed in areas accessible to vehicles or underneath structures associated with the development. A minimum of 3 gullies should be installed, with rodding access to allow maintenance of the pipework at each gully point.

Pipework should be bedded on a minimum of 100mm graded 30-50mm granular fill in order to provide adequate pore space and capacity to allow a suitable infiltration rate direct to ground. The pipework and gravel fill will also provide a minor level of additional storage space during rainfall events. Backfilling above the pipework will be to the base of the concrete as part of the bedding for the hardstanding. The perforated pipes will be installed with a minimum of 75mm cover with a flexible filler under the covering concrete base, as per recommendations from Approved Document H. The edges of the concrete base will be bedded on natural ground for a minimum of 300mm to provide stability and reduce pressure on the pipework.

The system will not be connected to an external drainage system, and no overflow will be provided. The system will therefore entirely discharge to the ground beneath the concrete slab, with the granular bedding providing additional infiltration capacity. This will mirror the existing, natural drainage conditions and will therefore negate the impact of the increase in impermeable area.

## **5. FLOOD RESILIENT CONSTRUCTION**

The nature of the development means there will be no persons located at the site specifically, and therefore consideration of evacuation routes are not necessary. The impact of flooding to the development itself will not have a major significance when considered against the potential damage caused to the agricultural land and buildings, loss of the generation capacity would not be considered to be a high risk.

On this basis it is not considered that the raising of the development floor level to match the critical flood level of 4.1m AOD is practical or valid on a cost-benefit analysis. This action would increase the loss of flood storage due to raising ground level in the region of 1.2-1.8m locally, without any significant benefit.

The main risk would be contamination of flood waters by the release of materials from the digester and associated digestate store during a flood event. However, the digester is a sealed, anaerobic system, as required by the process for production and collection of biogas, and therefore there is no potential for ingress of flood waters or release of materials. Further details of the system are included in appendix 2 of this assessment.

Briefly, the digester stands at a height of 6.4m above ground level with an internal capacity of approximately 1,800m<sup>3</sup> (see specification in appendix 2), with the only potential inlet point situated approximately 5.5m above ground level. Local ground level is estimated at 2.5-2.9m AOD based on local spot heights, and therefore the only ingress/release point at a minimum would be 8m AOD without any modification of ground level. This significantly exceeds the 4.1m AOD critical flood level. The digester is made of a non-permeable concrete, cast in position, reinforced and insulated to be water and gas-proof. Concrete strength will be to a minimum C25/30 standard.

The multifunctional pit, providing reception pit/digestion pit function, has an open top at a height of 4m above ground level (approximately 6.4-6.6m AOD). For construction the land will be levelled and this height is will provide sufficient cover above the critical flood level to prevent ingress of flood waters or release of slurry. This will, similarly, be constructed of non-permeable concrete, reinforced and insulated to be water and gas-proof, with concrete strength to a minimum C25/30 standard.

The gas holder is a completely sealed concrete tank. As necessary for its purpose, this tank is completely water and gas-proof and no ingress of flood water is possible even if this were completely submerged.

This construction will ensure there is no flood water access, or risk of release, below the critical flood level. In addition, this will reduce the volume of slurry currently stored in the on-site open lagoon (no additional slurry or other feedstock will be imported for this

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system), therefore the potential for contamination of flood waters is significantly reduced from the present situation.

The CHP unit associated with the system will be housed in a separate container, while this will not be sealed against flood water, the system is equipped with an automatic shutdown of the electrical system via circuit breakers in the event of flooding. This would stop the plant from operating completely, but would not result in any release of materials or gas from the system.

Also associated with this development are new silage clamps, totalling approximately 40m x 60m in dimensions, with a wall height of approximately 5m (approximately 7.4m AOD). The design and build of these should be done in consultation with the Environment Agency and will need to comply with Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) Regulations (England) 2010 (amended 2013) (SSAFO). The Environment Agency will also need to be notified 14 days before construction begins. The aim of SSAFO is to control the risk of pollution from storage of silage, slurry and fuel oils on farm, compliance with this regulation should help to minimise the risk of contamination of flood waters to an acceptable level. This assessment does not review the design of the silage clamps in line with SSAFO and this should be discussed with the Environment Agency separately.

## **6. CONCLUSIONS AND RECOMMENDATIONS**

- The development site has been determined by the Environment Agency as at High Risk of flooding (Flood Zone 3). A flood risk assessment has therefore been carried out at the request of the planning authority.
- The site is situated within the Trent Valley Area of the North Lincolnshire SFRA, specifically compartment 3F5 (Isle of Axholme). The SFRA provides a critical flood level of 4.1m AOD for the development site.
- The primary sources of flooding include the Rivers Torne and Trent, and failure of the local field drainage channel network, particularly Folly Drain. The Rivers Torne and Trent may be influenced by tidal and fluvial sources, and are protected by flood defences and freeboard storage.
- The development site, and surrounding area, consists primarily of flat, low-lying agricultural land. Land in the area is in the range of 2.4-2.8m AOD.
- The size and nature of the site means that the impact of flooding on the development would not be considered significant in comparison to the wider loss of agricultural land and buildings that may potentially occur during an extreme event.
- The nature of the development, and requirement to be regularly 'fed' by farm-based feedstocks, mean that no other site is suitable for this development. In addition, the development will provide a renewable source of energy and improved soil nutrient benefit. On this basis, the development passes the sequential and exception tests.
- The primary risk during a flood event would be loss of feedstock from the digester, or from the digestate store, causing contamination of the flood waters. However, no new feedstocks are imported and these are already stored on farm, this is therefore not considered an increased risk.
- The low vulnerability of the site means that raising the floor level to the critical flood level is not practical or cost-effective. It is therefore recommended instead that the structures are made of a flood resilient construction, with no access to the digester or digestate store below the critical level of 4.1m AOD.

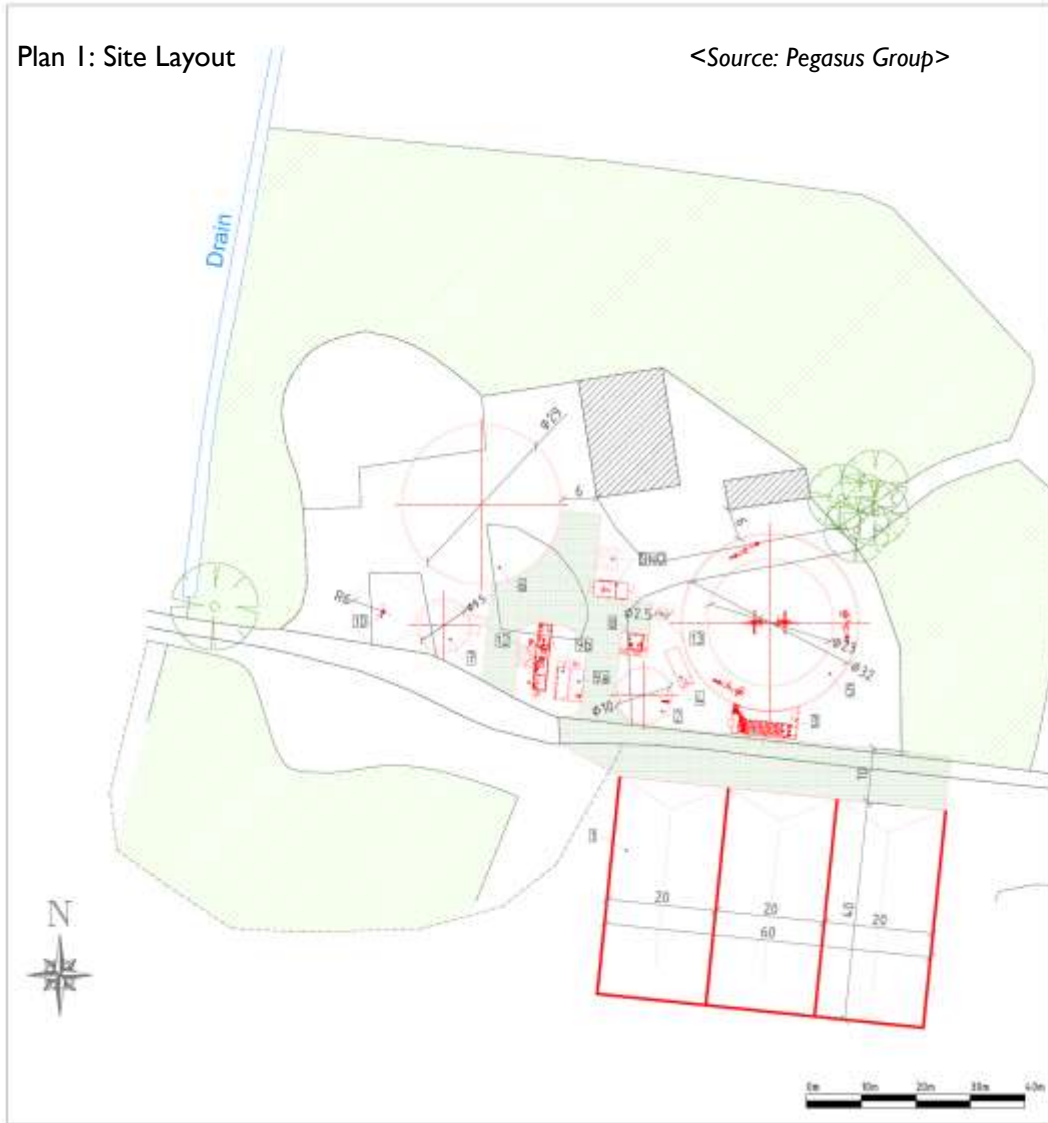
## **7. REFERENCES**

- i. National Planning Policy Framework. Department for Communities and Local Government. March 2012
- ii. Technical Guidance to the National Planning Policy Framework. Department for Communities and Local Government. March 2012
- iii. PPS25: Development and Flood Risk. December 2006
- iv. North and North East Lincolnshire SFRA. RYE Consultancy. November 2011

APPENDIX I – PROPOSED LAYOUT

Plan 1: Site Layout

<Source: Pegasus Group>



- 1) SILAGE CLAMPS
- 2) MULTI-FUNCTIONAL TANK  
(RECEPTION PIT/DIGESTION PIT/SEPARATION LIQUID PIT)  
Ø19,00m; h=4,60m; V=216m<sup>3</sup>
- 3) SUBSTRATE FEEDING SYSTEM BLDG 55m<sup>2</sup>
- 4) CENTRAL PUMPING STATION (CONTAINER)
- 5) DIGESTER - POWER RING Ø12,00m/Ø21,00m/Ø16,80m  
primary digester V<sub>usable</sub>=2.036m<sup>3</sup>  
secondary digester V<sub>usable</sub>=2.285m<sup>3</sup>
- 6) DIGESTATE TANK  
Ø20,00m/h=6,00m; V=3.963m<sup>3</sup>
- 7) GAS HOLDER Ø9,50m/h=10,00m; V<sub>max</sub>=400m<sup>3</sup>
- 8) SEPARATOR
- 9a) OFFICE & SWITCHBOARDS IN CONTAINER
- 9b) HEATING EQUIPMENT IN CONTAINER
- 10) GAS FLARE
- 12) CHP CONTAINER (500kW)
- 13) PASTEURIZATION UNIT

KEY:

- proposed development
- paved area
- trees

MODIFICATIONS

NO.	DATE	DESCRIPTION	DATE BY	DRAWN BY
01	July 11, 2011	Preparation of the first version "Project Site layout Harvester Farm 2011"	LBH	LBH
02	July 11, 2011	Initial layout plan	LBH	LBH

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PROJECT LOCATION: Duxford, England

PROJECT NAME: UK-2914-01-071-Pollyhill Farm

**NEW BUILDING OF A BIOGAS PLANT**      **PLANNING PACKAGE PROPOSED SITEPLAN**

NO. 271-1000011	Project name	01/10	Project no.	UK-2914-01-071-PP-A-01	1/1
01/10/2011	01/10/2011	01/10/2011	1:500	01/10/2011	1/1
01/10/2011	01/10/2011	01/10/2011	01/10/2011	01/10/2011	1/1







**APPENDIX 2 – SYSTEM SPECIFICATION DOCUMENT**