Three Oaks, Thornholme

Flood Risk Assessment & Drainage Strategy

24th August 2022
Version 2.0
RAB: 2942FRD

Disclaimer

Published by

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Quality Control

Action	Name
Prepared	S. Bandali / T. Haskey
Checked	N. Parsons
Approved	G.M. Wilson

Revision History

Version	Date	Amendments	Issued to
1.0	03.05.2022	First issue	John Fairlie, Engena Limited
	24.08.2022	Updated in line with client comments	Richard Barker, Ridge Clean Energy

Contents

1.0 Introduction

RAB Consultants has prepared this Flood Risk Assessment (FRA) in support of the proposed development of a solar energy farm and battery storage at Three Oaks Renewable Energy Park, Thornholme, East Riding of Yorkshire.

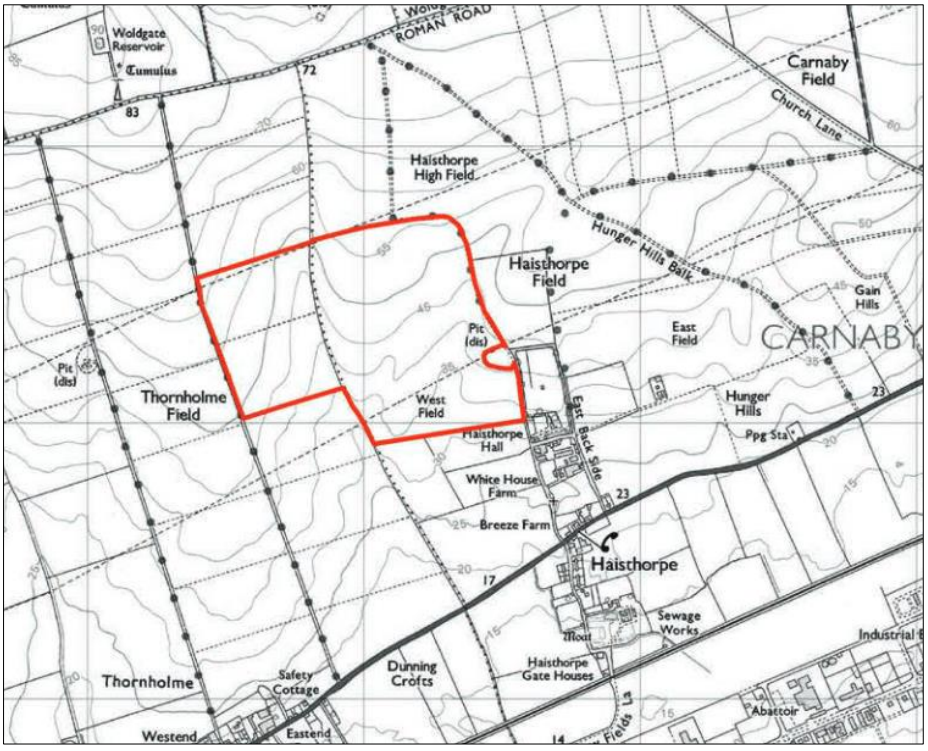
The development site is located in Flood Zone 1 according to the Environment Agency's Flood Map for Planning (Rivers and Sea). A Flood Risk Assessment for this site is required under the Planning Practice Guidance for the National Planning Policy Framework (NPPF) as it is a major development. A site-specific FRA is required to ensure that the development is safe from flooding and will not increase the risk of flooding elsewhere.

2.0 Site details

2.1 Site location

TABLE 1: SITE LOCATION

Site address:	Three Oaks Renewable Energy Park, Thornholme, East Riding of Yorkshire
Site area:	65.84 ha
Existing land use:	Arable land
OS NGR:	TA 12151 65544
Local Planning Authority:	East Riding of Yorkshire Council



2.2 Site description

The proposed site is located to the northeast of Thornholme in East Riding of Yorkshire.

The existing site comprises arable land. The surrounding environment is agricultural greenfield or agricultural land with a few residential and commercial buildings to the south. The North Sea is located 5km to the east of the site.

Access to the site is from a farm track to the west of the site.

2.3 Development proposal

A 39MW solar energy farm is proposed with solar panels, a customer cabin, customer substation, battery storage compound and transformer station (Appendix A).

New access roads within the site are also proposed. In addition, an upgraded access track is proposed to the west of the site.

3.0 Flood Risk

3.1 Sequential test

According to the Environment Agency's Flood Map for Planning the site lies in Flood Zone 1, which is described in the NPPF as land having a less than 1 in 1,000 annual probability of river or sea flooding (less than 0.1% AEP).

The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. NPPF Planning Practice Guidance (PPG) Table 2 confirms the 'Flood risk vulnerability classification' of a site, depending upon the proposed usage. This classification is subsequently applied to Table 3 'Flood risk vulnerability and flood zone compatibility' to determine whether:

- The proposed development is suitable for the flood zone in which it is located; and
- Whether an Exception Test is required for the proposed development.

The proposed development is classed as 'essential infrastructure' in accordance with NPPF PPG. The development is therefore appropriate for the Flood Zone. Neither a Sequential Test nor Exception Test are required as the development is in Flood Zone 1, the lowest risk zone.

3.2 Flood History

The map provided in the 2019 East Riding of Yorkshire Level 1 Strategic Flood Risk Assessment (SFRA) indicates that there have been no recorded flood events at the site.

The Environment Agency hold no record of flooding affecting the proposed site.

No information of floods affecting the site was found during internet searches.

3.3 Fluvial (Rivers)

The site is located in Flood Zone 1, the lowest risk zone, according to the Environment Agency's Flood Map for Planning (Figure 1). The nearest watercourse is Mill Beck located 1.80km to the southwest of the site.

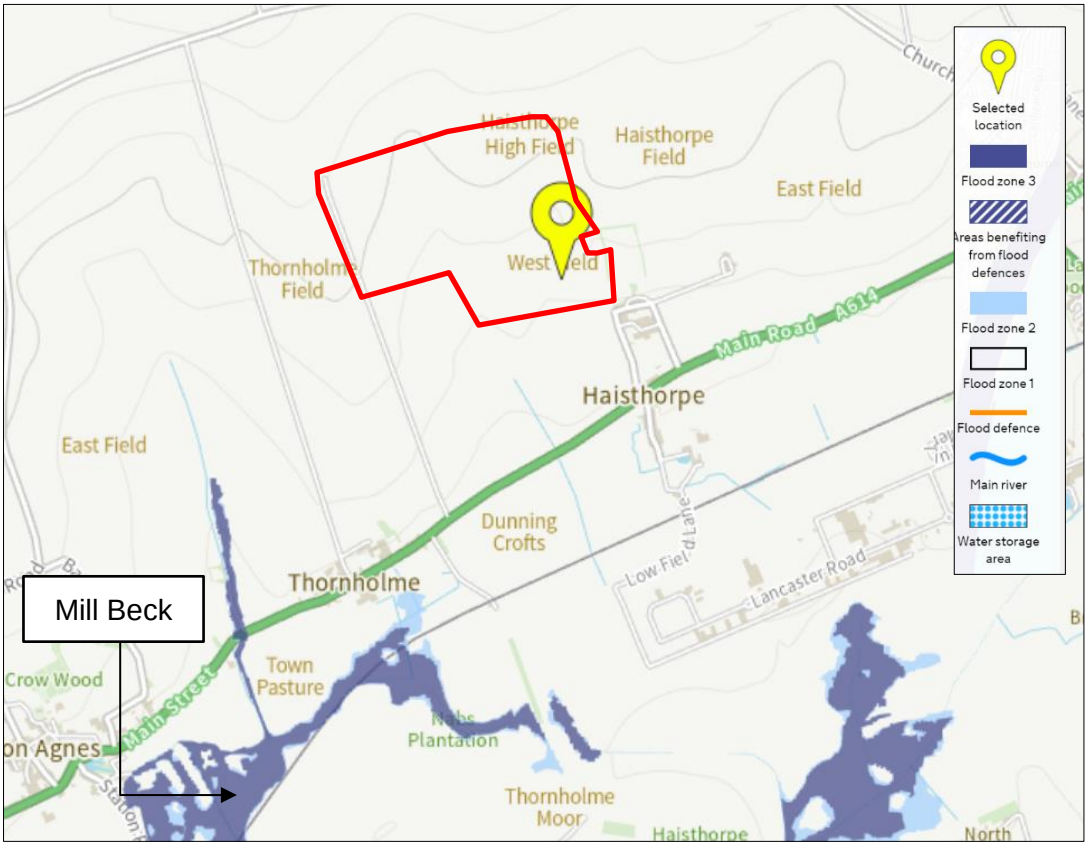


FIGURE 1: SCREEN SHOT OF THE ENVIRONMENT AGENCY'S FLOOD MAP FOR PLANNING ON 23.03.2022

3.3.1 Climate Change Impact on Fluvial Risk

The Environment Agency guidance document 'Flood risk assessments: climate change allowances' was released in February 2016 and updated in July 2021. It includes statistical increases on peak fluvial flows by Management Catchment and allowance categories based on epochs and development vulnerability classification. Referring to the NPPF PPG, the development is classified as 'essential infrastructure' and has an expected lifetime of 40 years. In this case as the site is located in Flood Zone 1 the peak river flow allowances are not applicable.

The guidance also relates to peak rainfall intensity allowance, which is relevant for surface water flooding. For the '2080s' it is recommended that both the 'Central' allowance of 20% and 'Upper End' allowance of 40% are used.

3.4 Flood defence breach or overtopping

3.4.1 Breach Risk

The site does not benefit from flood defences, so there is no breach flood risk for the site.

3.4.2 Overtopping Risk

The site does not benefit from flood defences, so there is no overtopping flood risk for the site.

3.5 Coastal/Tidal

The site is not affected by coastal or tidal flood risk.

3.6 Pluvial (Surface water)

The Environment Agency's Surface Water Flood Map (Figure 2) identifies the site and access roads to be at 'very low' risk of flooding from surface water. Figure 2 also shows that there are a few minor localised areas across the site identified as 'low' risk. These low-risk areas identified reflect very small natural valley shapes within the landscape.

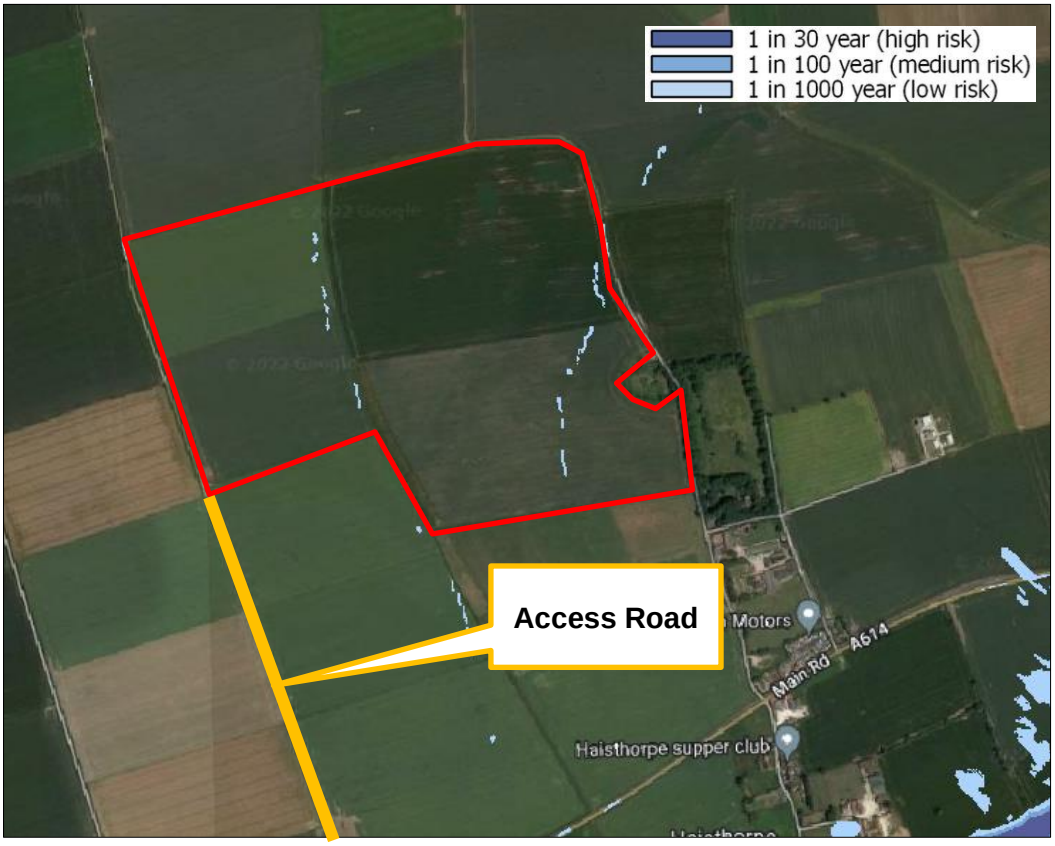


FIGURE 2: SCREEN SHOT OF THE ENVIRONMENT AGENCY'S RISK OF FLOODING FROM SURFACE WATER OVERLAYED WITH GOOGLE MAPS

Figure 3 shows the proposed scheme with the surface water risk map overlain. The map indicates that the customer cabin, customer substation battery storage compound and transformer station are not located in an area at risk from surface water flooding.

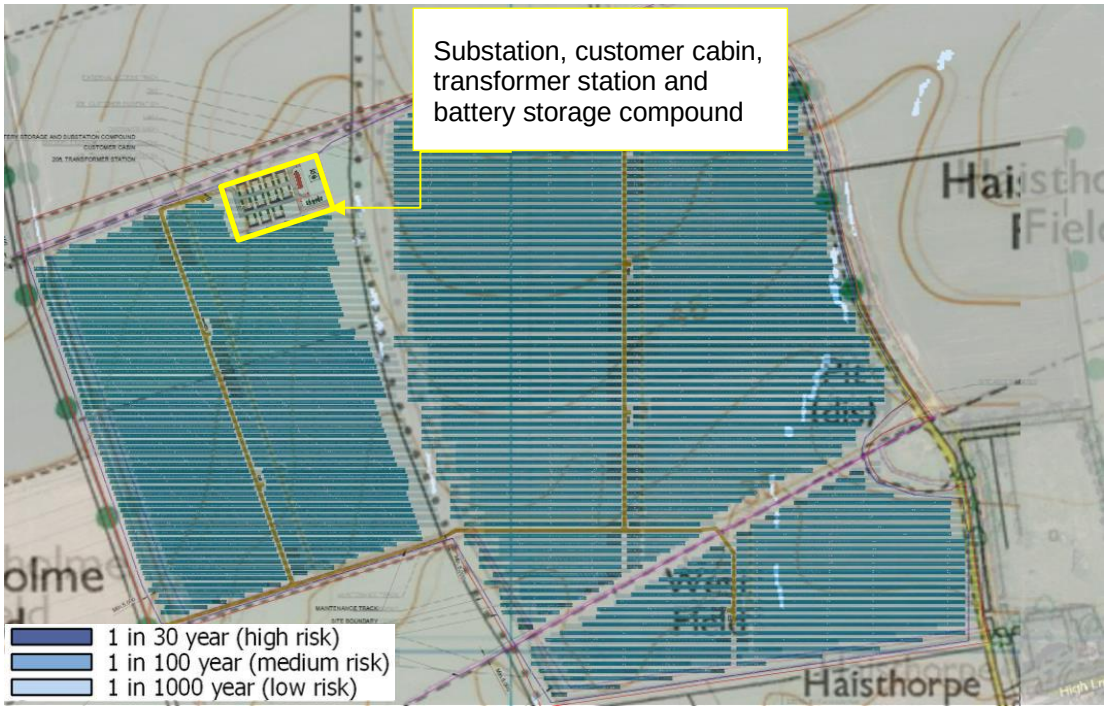


FIGURE 3: SCREEN SHOT OF THE ENVIRONMENT AGENCY'S RISK OF FLOODING FROM SURFACE WATER OVERLAYED WITH THE PROPOSED DRAWING

TABLE 2: ENVIRONMENT AGENCY SURFACE WATER RISK CATEGORIES

Surface Water Risk Category	Surface water flooding Annual Exceedance Probability
Very Low	< 0.1%
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	> 3.3% (1 in 30 years)

3.7 Artificial water bodies

The Environment Agency Reservoir Flood Map identifies that the site is not at risk of flooding from this source.

There are no canals near the site that could pose a risk.

3.8 Groundwater

The groundwater susceptibility map in the 2019 SFRA indicates that the site is located in an area classified as being >=50% <75% susceptible to groundwater flooding.

The 2019 SFRA states that a large proportion of East Riding is underlain by the Yorkshire Wolds which is a large outcrop of chalk stretching from the Humber Estuary to the coast between Bridlington and

Scarborough. According to the SFRA, *'the chalk is overlain by thin soils which, when saturated by intense rainfall can let water quickly soak through to recharge the groundwater and raise the water table*.

Based on the available data a more detailed analysis of groundwater flooding is not considered appropriate.

3.9 Sewers

The 2019 SFRA states that Yorkshire Water has undertaken work to update and improve the sewer system in East Riding since 2007. Further information on sewer flooding is not provided in the SFRA.

Given the rural nature of the proposed site, no sewers are expected to be present.

From this initial review no issue has been identified to warrant a more detailed assessment of risk from this source.

4.0 Mitigation Methods

4.1 Risk to buildings

4.1.1 Finished floor levels

The proposal includes the construction of solar panels, a customer cabin, a battery storage compound, a customer substation, a transformer station and access tracks throughout the site. As mentioned in Section 3.6, the customer cabin, customer substation, battery storage compound and transformer station are not located in an area at risk from surface water flooding.

A small number of solar panels are proposed to be located within areas at risk of surface water flooding. Depths below 0.3m and velocities of over 0.25m/s are expected.

The cross section drawing of the solar panels provided (Figure 4) shows the structures to be mounted such that the lowest edge of the panel will be a minimum of 0.9m above the ground. This is significantly higher than the expected water depths of below 0.3m. This is considered reasonable mitigation for the identified risk; however, this should be confirmed by the manufactures.

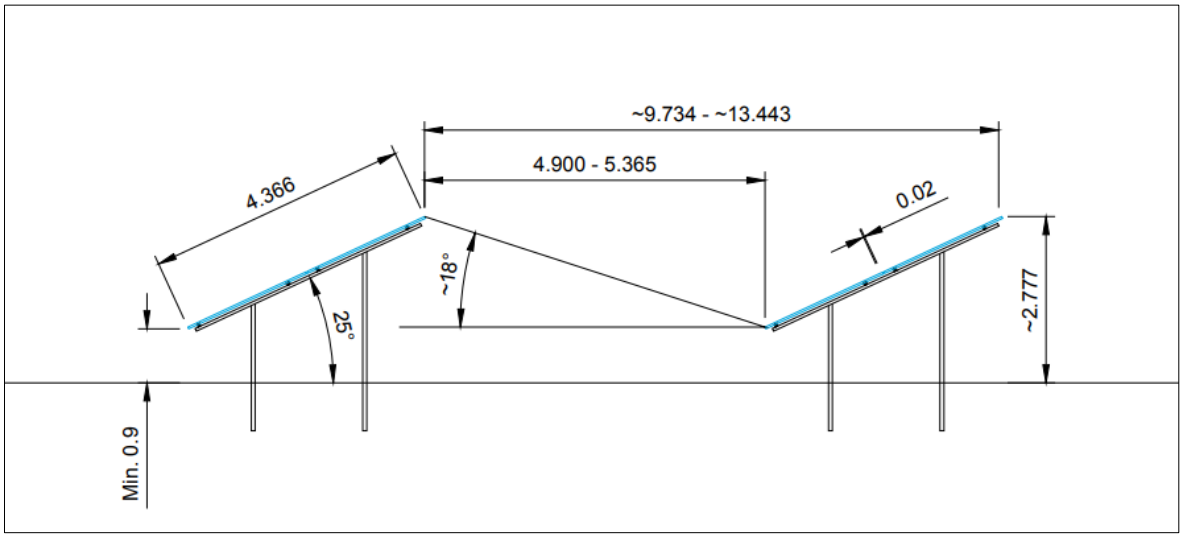


FIGURE 4: CROSS SECTION OF THE PROPOSED SOLAR PANELS

4.1.2 Flood resistance

Flood resistance is a strategy of temporary or permanent measures taken to reduce the amount of flood water that will enter buildings.

The use of flood resistance measures is not appropriate given the nature of the development and the assessed risk.

4.1.3 Flood resilience

Flood resilience measures are intended to reduce damage to a building such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment.

The use of a flood resilience strategy is not considered appropriate given the nature of the development and the assessed risk.

4.2 Risk to occupiers

4.2.1 Safe access/egress

Safe dry access and egress is expected for staff in all but the most extreme flood scenario.

4.2.2 Flood warning and evacuation plan

The Environment Agency does not provide a Flood Warning for the site. Given the assessed risk to the site, a bespoke flood warning plan is not considered necessary.

4.3 Risk to others

4.3.1 Floodplain compensation

Environment Agency guidance states there must be no loss of flood storage capacity for flooding up to the 1% AEP plus climate change event.

The site is not expected to experience flooding. The proposed development is therefore not expected to occupy existing floodplain storage volume or interact with natural flow routes, hence no impact on the floodplain is expected and therefore floodplain compensation is not required.

4.3.2 Surface water run-off

The existing site is entirely agricultural land. The development proposal, of a solar farm with battery storage, will create a large impermeable area with the potential to increase surface water runoff from the site. The scheme will however include gaps between individual panels throughout all of the arrays. This will allow water to drain direct onto the undeveloped ground below each panel section. In this way there will be negligible impact on runoff from the site.

5.0 Drainage strategy

5.1 SuDS applicable policies

The East Riding of Yorkshire Council published the Sustainable Drainage Systems (SuDS) & Surface Water Drainage Requirements for New Development Design and Maintenance Combined Planning Note

and Standing Advice in 2016. This has been used to assist with this drainage strategy, along with CIRIA's SUDS Manual and LASOO Non-Statutory Technical Standards for Sustainable Drainage, Practice Guidance.

5.2 Existing Drainage

The existing site comprises 65.84 ha of greenfield land. No topographic survey is available however, freely available LiDAR data (1m 2020 DTM) indicates that rain falling onto the site is guided to the natural valley shapes in the site (also highlighted in Figure 2), conveying runoff to the south (as shown in Figure 5 below).

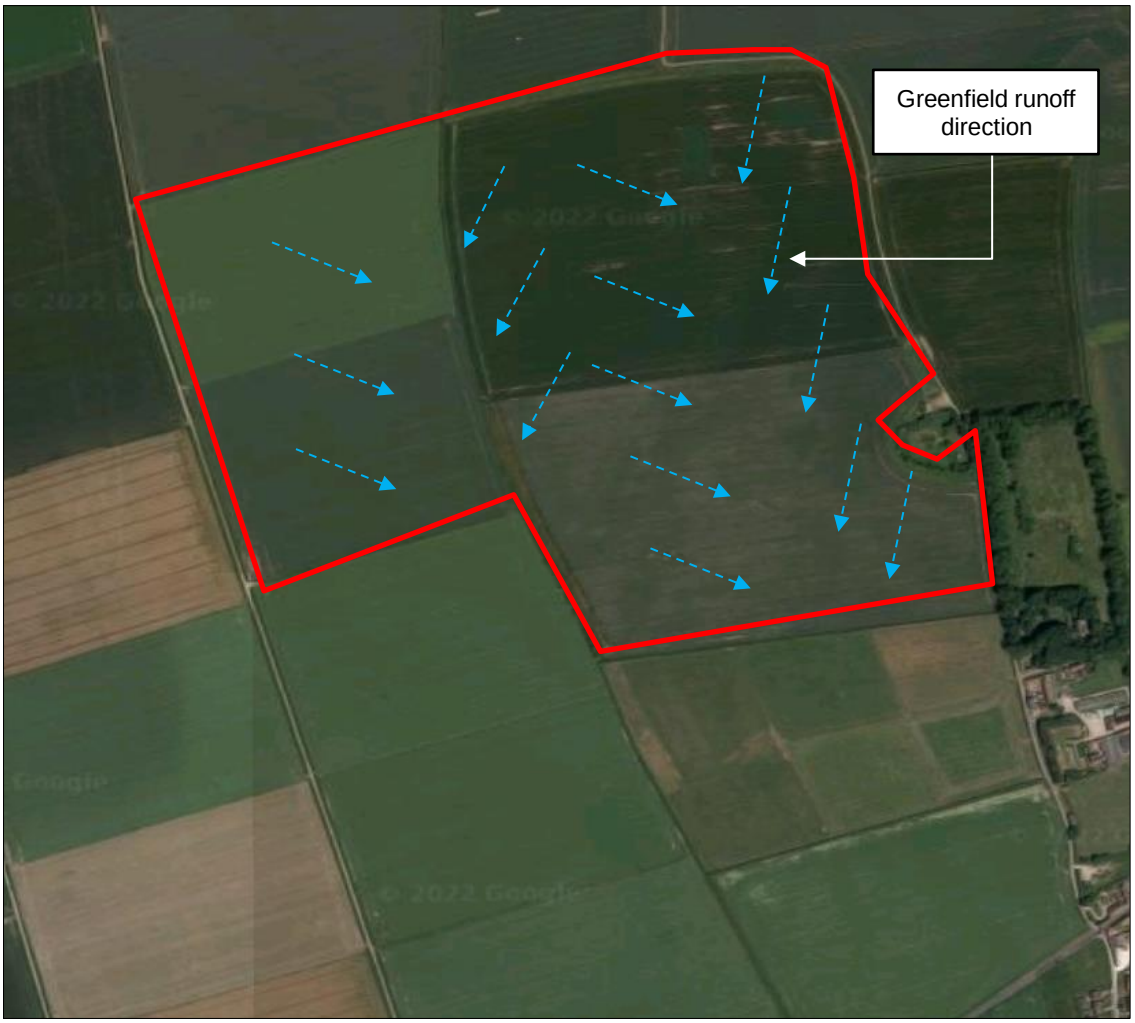


FIGURE 5: EXISTING SITE RUNOFF DIRECTION

Pre -development runoff rates have been calculated using the IH124 method (based on the interim Code of Practice of Sustainable Drainage Systems given the small site area).

IH124 parameters:

- Area = 65.84ha (total site area)
- SOIL = 0.300

- SAAR = 700mm
- Region = 3

TABLE 3: ESTIMATE OF PRE-DEVELOPMENT RUNOFF RATES

Annual Exceedance Probability (AEP)	Peak Runoff Rate
QBAR	116.4 l/s
100% (1 in 1)	100.1 l/s
3.3% (1 in 30)	204.6 l/s
1% (1 in 100)	242.1 l/s
1% (1 in 100) plus 17% climate change*	283.3 l/s

**2050s Higher Allowance for the Hull and East Riding Management Catchment*

5.3 SuDS Feasibility

The SuDS Manual (2015), discusses the SuDS approach to managing surface water runoff which is intended to mimic the natural catchment process as closely as is possible. The approach sets out the design objectives in respect of SuDS:

- Use of surface water runoff as a resource;
- Manage rainwater close to where it falls (at source);
- Manage runoff on the surface (above ground);
- Allow rainwater to soak into the ground (infiltration);
- Promote evapotranspiration;
- Slow and store runoff to mimic natural runoff rates and volumes;
- Reduce contamination of runoff through pollution prevention and by controlling the runoff at source; and
- Treat runoff to reduce the risk of urban contaminants causing environmental pollution.

Depending on the characteristics of the site and local requirements, these may be used in conjunction and to varying degrees. Table 4 presents the functions of the SuDS components (from which a management train can be created) and their feasibility in respect of the site.

TABLE 4: FEASIBILITY OF SUDS TECHNIQUES AT THE DEVELOPMENT SITE

Technique	Description	Feasibility Y / N / M (Maybe)
Good building design and rainwater harvesting	Components that capture rainwater and facilitate its use within the building or local environment.	N – There is no requirement for water to be used within the site.
Porous and pervious surface materials	Structural surfaces that allow water to penetrate, thus reducing the proportion of runoff that is conveyed to the drainage system (green roofs, pervious paving).	Y - Porous surfaces could be used on proposed access tracks constructed around the solar farm.
Infiltration Systems	Components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil.	M – There is scope to incorporate infiltration systems, however the extent to which infiltration is possible would need to be confirmed via ground testing.
Conveyance Systems	Components that convey flows to downstream storage systems (e.g. swales, watercourses).	M – There is scope to incorporate some conveyance systems into the development.
Storage Systems	Components that control the flows and, where possible, volumes of runoff being discharged from the site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff (e.g. ponds, wetlands, and detention basins).	Y –There is scope to incorporate small surface water storage features into the development.
Treatment Systems	Components that remove or facilitate the degradation of contaminants present in the runoff.	Y - There is scope to incorporate small SuDS features that would provide water treatment.

5.4 Proposed Drainage

The proposed development and drainage strategy has been split into 3 main parts:

1. The formation of the solar panel farm.
2. The Battery storage area, which will also contain the customer cabin, customer substation and transformer station.
3. The access tracks throughout the site.

(1) The proposed development primarily constitutes a matrix of permanently fixed, south facing solar panels arranged on racks with 2cm gaps between each panel. It is not proposed to formally drain the solar panels but to allow rain to simply fall onto the adjacent ground where it has opportunity to infiltrate, collect and flow overland as existing.

Given each rack has a maximum vertical capacity of three panels, rainwater will fall to the ground below in three main concentrated drip lines beneath the bottom edge of each solar panel. The proposed panel arrangement will enhance water dispersion across the site, minimising localised runoff concentration and as such is expected to reasonably mimic greenfield condition without further measures. The use of vegetation below the panels will also enhance infiltration, retention, detention and soil erosion protection, while also promoting evapotranspiration

(2) It is also not proposed to formally drain the access tracks that will be constructed around the site. They will be created with permeable materials (e.g. gravel, grass-crete) such that rain falling on these areas will act as greenfield condition.

(3) Finally, the battery storage area at the north of the site which will also contain customer cabin, customer substation and transformer station will be created using a crushed stone / gravel so that rain falling on this area will act as greenfield condition.

The soil condition and level of vegetation should be restored to pre-construction condition (or better) to mitigate the effects of soil compaction during the construction process of the solar farm. This will aid with infiltration of water through the top level of soil.

Water quantity and **quality** will be managed through enhanced infiltration, retention, detention, and evapotranspiration through the use of local source control features. **Amenity** and **Biodiversity** can be enhanced through the use of planting of wildflower / grass meadow throughout the site. Excess runoff will behave as greenfield, by following the natural topography of the land.

6.0 Conclusion

Planning permission is sought to develop a renewable energy park to the northeast of Thornholme in East Riding of Yorkshire.

The site is located in Flood Zone 1 according to the Environment Agency's Flood Map for Planning. The site is not expected to be impacted by flood water in all but the most extreme scenario.

Safe, dry access and egress is expected in all but the most extreme flood scenario.

The proposal will result in an increase to the impermeable area on the site, however this will comprise of a large number of small panels with drainage gaps, separated by surrounding undeveloped ground. The impact on site runoff will therefore be minimal. Local effects will be managed through the use of small source control features.

It is concluded that the proposed development is appropriate for the flood risk and is not expected to increase the risk of flooding elsewhere.

7.0 Recommendations

- Locate the customer cabin, customer substation, and transformer station away from the areas identified at risk from surface water flooding.

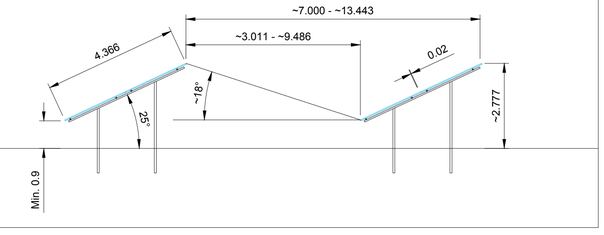
- Implement suitable post-construction decompaction and vegetation across the site and beneath solar panels to enhance local infiltration, retention and detention.
- *Construction (Design and Management) Regulations 2015*
    - *The revised CDM Regulations came into force in April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the Designer's responsibilities is to ensure that the Client organisation, in this instance Ridge Clean Energy Ltd, is made aware of their duties under the CDM Regulations.*

Appendix A – Proposed Drawings

Proposal only

BATTERY STORAGE AND SUBSTATION COMPOUND
CUSTOMER CABIN
20ft. TRANSFORMER STATION
Min. 8.000
Min.5.000
MAINTENANCE TRACK
SITE BOUNDARY
SECURITY FENCE
OVERHEAD LINE
Min.5.000
Min.8.000
SITE ACCESS GATES
110x [2P13 module frame]
1 705x [2P26 module frame]
84 734x MODULES - 53 996.8 kWp SYSTEM
Haisthorpe Field
Haisthorpe
0
100
200 m

DETAIL B | Frame side view
M 1:100@A1



Notes:

1. All dimensions to be confirmed on site prior to installation.
2. All dimensions are indicative only and in mm unless otherwise specified.
3. Drawing based on:

"OS 1 25 000 raster_- Explorer 726696 941072";
"OS_MasterMap_Imagery_Layer_728062_942568";
"OS_Terrain_5_726696_941071";
"OS_VectorMap_Local_Raster_743641_962392";
"Three Oaks Boundary.kmz".
GE Imagery date: 01/07/18.

Legend:

- Site boundary
- Perimeter fence
- Overhead line
- Maintenance track
- Customer cabin
- 20ft. transformer station

System description:

DC Power kWp:	53 996.8
AC Power kVA:	35 905 (Rated@215kVA)
No. of modules:	84 734
Module type:	Canadian Solar CS7L-590MB
Dimensions:	2173x1305x35
Substructure type:	2 modules in portrait
Tilt angle:	25°
Shading angle:	~18° / ~31.5°
Azimuth from South:	Due south
Pitch distance:	~7.000m - ~13.443m
Row to row distance:	~3.011m - ~9.486m
No. of inverters:	167
Inverter type:	Huawei SUN2000-215KTL-H0
Power ratio:	1.5 (Rated@215kVA)
No. of AC combiners:	-
No. of Transformers	6
Fence area:	~61.91 ha
Fence length:	~3 325 m
Total area:	~65.84 ha

Proposed location:

Revisions:

Rev	Date	Comments	Drawn
A	08/07/22	BESS compound added	RU

Project:	Three Oaks Renewable Energy Park
Location:	West Back Side, Haisthorpe, Driffield, YO25 4NW, UK 54°4'18.46"N 0°17'24.25"W
Title:	Figure 2 - Site Layout

Drawn:	DETRA / AP	Checked:	JF
Scale:	1:2000@A1	Date:	08/07/22
Drawing No:	ENGN1009-100	Rev:	A

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