# BEANE SOLAR FARM

## Flood Risk Assessment and Sustainable Drainage Strategy

HLEF85532
Beane Solar Farm
3
October 2024

## Quality Management

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## Approval for issue

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| Jonathan Morley | 8 October 2024 |



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# 1 INTRODUCTION

1.1.1 RPS Consulting Services Ltd (RPS) was commissioned to prepare a Flood Risk Assessment (FRA) and conceptual drainage strategy to support the planning application for the proposed Beane Solar Farm and Battery Energy Storage System (BESS) development (the Proposed Development) at *land west of the A507, SG9 9PU*.

1.1.2 The aim of the FRA is to outline the potential for the site to be impacted by flooding, the impacts of the proposed development on flooding in the vicinity of the site, and the proposed measures which could be incorporated into the development to mitigate the identified risk. The report has been produced in accordance with the guidance detailed in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance (PPG). Reference has also been made to the CIRIA SuDS manual (C753), East Hertfordshire District Council, Hertfordshire County Council Strategic Flood Risk Assessment (SFRA) and Preliminary Flood Risk Assessment (PFRA).

1.1.3 This report has been produced in consultation with the Environment Agency (EA) and the Lead Local Flood Authority (LLFA). The site is not located within an Internal Drainage Board (IDB) District.

1.1.4 The desk study was undertaken by reference to information provided / published by the following bodies:

- British Geological Survey (BGS);
- East Hertfordshire District Council (EHDC);
- EA;
- Hertfordshire County Council (HCC);
- Multi-Agency Geographic Information Systems (MAGIC);
- Ordnance Survey (OS); and
- Thames Water (TW).

# 2 PLANNING POLICY CONTEXT

## 2.1 National Planning Policy

2.1.1 The NPPF was released in March 2012 and was updated in December 2023. The document advises of the requirements for a site-specific FRA for any of the following cases (Planning and Flood Risk paragraph 174 (footnote 60)):

- All proposals (including minor development and change of use) located within the EA designated floodplain, recognised as either Flood Zone 2 (medium probability) or Flood Zone 3 (high probability);
- All proposals of 1 hectare (ha) or greater in an area located in Flood Zone 1 (low probability);
- All proposals within an area which has critical drainage problems (as notified to the Local Planning Authority by the EA);
- Land identified in a strategic flood risk assessment as being at increased flood risk in future; and
- Where proposed development may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

2.1.2 Paragraph 173 of the updated NPPF identifies that major developments (developments on sites of more than 1 hectare (ha)) should incorporate Sustainable Drainage Systems (SuDS) unless there is clear evidence that this would be inappropriate. The systems used should:

- Take account of advice from the LLFA;
- Have appropriate proposed minimum operational standards;
- Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
- Where possible, provide multifunctional benefits.

2.1.3 Defra published their ‘Non-statutory technical standards for sustainable drainage systems’ in March 2015. These are supported by the revised NPPF.

### Planning Practice Guidance

2.1.4 Planning Practice Guidance (PPG) ID7 Flood Risk and Coastal Change provides guidance to ensure the effective implementation of the NPPF planning policy for development in areas at risk of flooding.

2.1.5 PPG ID7 states that a site-specific FRA is required for all proposals for new development in Flood Zones 2 and 3 and for any proposal of 1 ha or greater in Flood Zone 1.  A FRA should consider vulnerability to flooding from other sources as well as from river and sea flooding, and also the potential for any increased risk of flooding elsewhere resulting from a development.

## 2.2 Local Planning Policy

2.2.1 The Site falls within the East Hertfordshire District Council, which is under the Hertfordshire County Council. The Hertfordshire County Council is the LLFA for the area.

### Local Plan

2.2.2 The East Hertfordshire Local Plan was adopted for the period of 2011 to 2033and contains the following Policies relating to flood risk and drainage:

***"Policy WAT1 Flood Risk Management***

*The functional floodplain will be protected from inappropriate development and where possible developed flood plain should be returned to Greenfield status with an enhanced level of biodiversity. II. Development proposals should neither increase the likelihood or intensity of any form of flooding, nor increase the risk to people, property, crops or livestock from such events, both on site and to neighbouring land or further downstream. III. Development should take into account the impacts of climate change and should build in long term resilience against increased water levels. Therefore, appropriate distances and buffers between water courses and built development should be maintained in accordance with Environment Agency guidelines. IV. In order to steer new development to areas with the lowest probability of flooding, the Sequential Test will be used. In exceptional circumstances, if developments are proposed which are required to pass the NPPF Exceptions Test, they will need to address flood resilient design and emergency planning by demonstrating that: (a) The development will remain safe and operational under flood conditions; (b) A strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions; (c) Key services will continue to be provided under flood conditions; and (d) Buildings are designed for quick recovery following a flood."*

***"Policy WAT3 Water Quality and the Water Environment***

*Development proposals will be required to preserve or enhance the water environment, ensuring improvements in surface water quality and the ecological value of watercourses and their margins and the protection of groundwater. II. Unless there is clear justification for not doing so, an undeveloped buffer strip at least 8 metres wide should be maintained alongside all main rivers, and an appropriate buffer strip should be maintained at ordinary watercourses. Any development proposals should include an appropriate management scheme for buffer strips. III. Opportunities for removal of culverts, river restoration and naturalisation should be considered as part of any development adjacent to a watercourse. Additional culverting and development of river corridors will be resisted."*

***"Policy WAT5 Sustainable Drainage***

*Development must utilise the most sustainable forms of drainage systems in accordance with the SUDS hierarchy, unless there are practical engineering reasons for not doing so. II. Development should aim to achieve Greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. III. Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation. The provision of balancing ponds as part of an area of public open space for recreation or wildlife should be designed to ensure the safety of other users of the space. Where SUDs are provided as part of a development, applicants should detail how it will be maintained in the long term. IV. Where practicable, SUDS should be designed to ensure the sustainable drainage networks have the additional capacity required to cope with infrequent adverse weather conditions and therefore reduce flood risk."*

### Strategic Flood Risk Assessment

2.2.3 The East Hertfordshire District Council Level 1 and 2 identifies and maps flood risk from all sources within the boroughs, as well as providing guidance on producing site specific FRAs. Relevant information from the SFRA has been referenced throughout this FRA report.

## 2.3 Climate Change Allowances

2.3.1 The NPPF and supporting planning practice guidance on Flood Risk and Coastal Change explain when and how flood risk assessments should be used. This includes demonstrating how flood risk will be managed now and over the development's lifetime, taking climate change into account.

### Peak River Flow Allowances

2.3.2 In May 2022, the EA last updated advice on climate change allowances to support the NPPF. Peak river flow allowances show the anticipated changes to peak flow by management catchment. Management catchments are sub-catchments of river basin districts. Peak River Flow Allowances should be considered for locations that are currently in Flood Zone 1 but might be in Flood Zone 2 or 3 in the future.

2.3.3 EA guidance on the application of climate changes allowance is dependent on the proposed developments vulnerability. As the development is to be a solar farm and associated BESS facility this application is deemed as Essential Infrastructure. The EA require that for Essential Infrastructure developments located in Flood Zones 2, 3a or 3b, the higher central allowance should be used to assess climate change.

2.3.4 The Proposed Development will have a lifetime of 40 years. Construction will aim to commence in with connection in of the development in 2028 and remaining operational until 2068. The 2080s epoch will be assessed to be conservative. The proposed Site is located within the Upper Lee Management catchment, for which the following peak river flow allowances are applicable.

**Table 2.1. Peak River Flow Allowances (use 1961 to 1990 baseline)**

| Thames River Basin District | Allowance Category | Total potential change anticipated for '2020s' (2015-39) | Total potential change anticipated for '2050s' (2040-2069) | Total potential change anticipated for the '2080s' (2070-2115) |
|---|---|---|---|---|
| Upper Lee Management Catchment | Central | 3% | 9% | 23% |
| | Higher Central | -1% | 7% | **27%** |
| | Upper End | 10% | 22% | 59% |

2.3.5 Based on the lifetime of the development and the vulnerability classification, an allowance of 27% is appropriate. Comment will be made on this in Section 6.

### Peak Rainfall Allowances

2.3.6 Peak Rainfall Allowances are used to consider how increased rainfall affects surface water flood risk and the design of drainage systems to manage the increased rainfall.

2.3.7 New guidance requires that for developments with a lifetime of between 2061 and 2100, Flood Risk Assessments and Strategic Flood Risk Assessments should assess the central allowances for the 2070s epoch for both the 1% and 3.3% annual exceedance probability events.

2.3.8 The proposed Site is located within the Upper Lee Management Catchment for which the following Peak Rainfall Allowances are applicable.

**Table 2.2. Change to Extreme Rainfall Intensity Compared to a 1961 to 1990 Baseline**

| Applies across Upper Lee Management Catchment | Total potential change anticipated for '2050s' (2040- 2069) | Total potential change anticipated for the '2070s' (2070-2115) |
|---|---|---|
| | **3.3% AEP** | |
| **Upper Estimate** | 20% | 35% |
| **Central Estimate** | 20% | 35% |
| | **1% AEP** | |
| **Applies across Upper Lee Management Catchment** | **Total potential change anticipated for '2050s' (2040- 2069)** | **Total potential change anticipated for the '2070s' (2070-2115)** |

| | | |
|---|---|---|
| **Upper Estimate** | 20% | 40% |
| **Central Estimate** | 25% | **40%** |

2.3.9 As the development has a lifetime of 40 years, the central estimate 2070s epoch should be assessed to be conservative. Therefore, the 40% peak rainfall intensity allowance should be used.

# 3 CONSULTATION

## 3.1 Environment Agency

3.1.1 The FRA has been produced in consultation with the Partnership and Strategic Overview Team at the EA for Hertfordshire and North London area, due to part of the Site being located in Flood Zone 3. The EA do not hold any detailed modelling for the Site and wider River Beane. Please see **Appendix A** for the full response.

## 3.2 Thames Water

3.2.1 Thames Water operate the public drainage system in the Site area. Due to the agricultural nature of the Site, it is considered there are no public sewer mains in the vicinity and therefore Thames Water were not consulted as a part of the preparation of this report.

## 3.3 Internal Drainage Board

3.3.1 The Site is not located within an IDB District.

# 4 SITE DESCRIPTION

## 4.1 Site Description

4.1.1 The Site is located west of the village of Cottered at National Grid Reference TL 31134 29292 and occupies an area of approximately 79.45 ha. The Site location is presented in Figure 4-1.

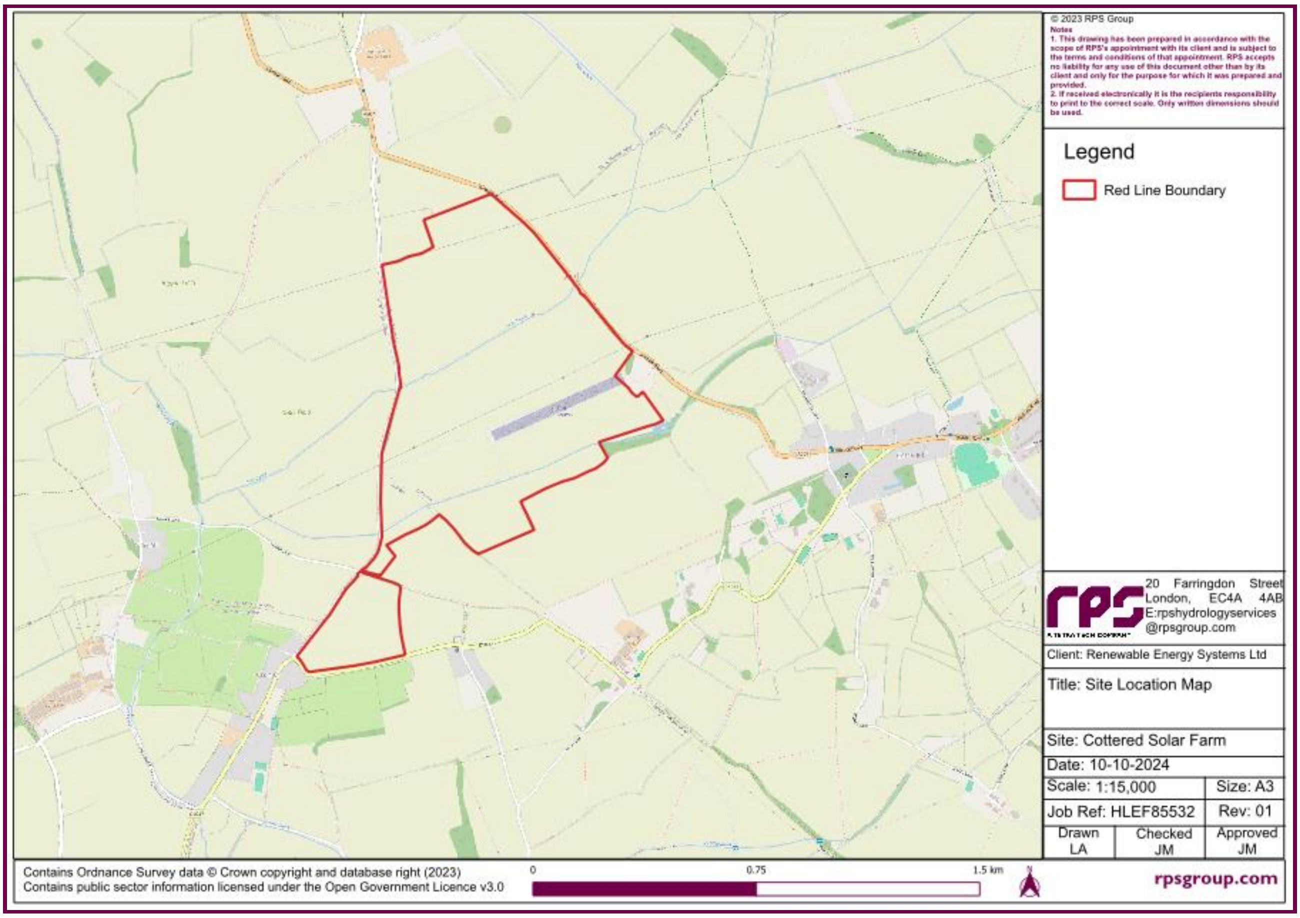




**Figure 4-1. Site Location**

4.1.2 The Site is currently comprised of agricultural land, part of which is utilised as a grass runway known as Cottered Airfield. Two watercourses intersect the Site in the north and south and flow in a westerly direction. The northern watercourse is the River Beane, the southern watercourse is an unnamed ordinary watercourse.

## 4.2 Surrounding Land Uses

4.2.1 Surrounding land uses are immediately agricultural on the northern and southern boundary of the Site. The eastern Site boundary is defined by the A507 (Baldock Road). Cromer Heath road borders the Site to the west / northwest. The B1037 is adjacent to the southern border of the Site. Located approximately 400m to the south-east of the Site is the village of Cottered. To the south-west of the southern Site section is the hamlet of Cromer. The hamlet contains a mixture of residential, agricultural and few commercial properties. The hamlet of Hare Street is a short distance to the southeast. The town of Stevenage. Is located approximately 4km southwest.

4.2.2 There are no designated sensitive areas (e.g. Special Area of Conservation (SAC), Special Protection Area (SPA) or Site of Special Scientific Interest (SSSI)) within close proximity to the site.

## 4.3 Topography

4.3.1 A topographic survey was completed by Infomap in August, 2023, reference: ISM/COTTERED SOLAR FARM TOPOGRAPHICAL SURVEY.

4.3.2 This indicates that the Site slopes from the north and south to the northern and southern watercourses. In the north the levels are approximately 127.5m AOD, in the south west the levels are approximately 118.5m AOD. The northern watercourse sits at an elevation of approximately 95.9m AOD. The southern watercourse sits at an approximate location of 101.0m AOD.

4.3.3 The topographic survey is located in **Appendix B.**

## 4.4 Site Visit

4.4.1 A Site visit was undertaken in May 2023, details of which are included in **Appendix C**. The Site visit identified an area of ponding water to the northwest of the ordinary watercourse.

4.4.2 An existing bridge crosses the River Beane within the Site, and is approximately 3m wide with a 6m span. An existing bridge crosses the ordinary watercourse which is noted as being in poor condition.

# 5 PROPOSED DEVELOPMENT

## 5.1 Overview

5.1.1 The Proposed Development is for the installation of a renewable energy generating station comprising solar arrays together with BESS facility and associated ancillary infrastructure. a substation compound, site accesses, security measures, access gates, other ancillary infrastructure and landscaping.

5.1.2 In summary, the proposed development will comprise:

- A Solar Farm with a capacity of up to 49.9MW;
- Inverter and Energy Storage Areas;
- Electrical Substation Compound;
- On-site cabling;
- Internal Tracks;
- New site accesses;
- Associated infrastructure including CCTV and Security Fencing;
- Temporary construction compounds (x2);
- Associated Landscaping; and
- Biodiversity Enhancement.

5.1.3 The Proposed Development will connect to the National Grid via 132kV overhead lines which pass over the site.

5.1.4 The Proposed Development is temporary and reversible, and the land can be restored to its present state at the end of its operational life which is 40 years following construction/commission. When operational there will be a dual use on the site as it will also be utilised for agriculture in the form of sheep grazing.

5.1.5 The Proposed Development is classified as “Essential Infrastructure” within the PPG.

5.1.6 A not to scale copy of the drawings which form part of the planning application pack are included as **Appendix D.**

## 5.2 Solar Panels and Mounting Frames

5.2.1 The panels would be composed of photovoltaic cells and would be designed to maximise the absorbency of the sun’s rays and minimise solar glare. Each string of panels would be mounted on a rack comprising metal poles anchored to the ground using pile driven foundations. There is no concrete required to facilitate this process.

5.2.2 Between each string of panels there would be a distance of up to 3m.

5.2.3 The panels would be tilted at 10 to 30 degrees from the horizontal and would be orientated to face south towards the sun. The lowest leading edge of the panels is unknown at this stage, typically panels are raised 0.8m from the ground at the lowest point (the southern edge). The maximum height of the panels will be 3.5m (the northern edge). The lowest leading edge of solar panels within the floodplain would be raised above the flood level, discussed in section 7. A typical PV module for the Site is illustrated in drawing reference: 05003-RES-SOL-DR-PT-001, provided in **Appendix D.**

## 5.3 Substation Compound

5.3.1 A substation would be required as part of the Proposed Development to act as a single connection point for the Site. It will accommodate all necessary equipment to enable the solar farm's electrical system to be controlled, monitored, metered and connected to the local electrical distribution.

5.3.2 The substation will not occupy the entire proposed area on the plans. The substation will be comprised of compacted Type 1 aggregate or single sized crushed rock. This is conservatively considered as impermeable in nature.

5.3.3 The building will not be permanently occupied but will be periodically visited by maintenance personnel.

5.3.4 The total compound area is taken as 2,764m$^2$.

## 5.4 Inverter Substations

5.4.1 Inverter substations are located within compounds that are strategically placed throughout the site as shown on the site layout drawing included as Appendix D. There are proposed to be 12 inverters in total. Inverters are small cabin-like buildings constructed on a concrete base/plinth with footprint dimensions of 5m x 3m x 3m high, and a transformer typically 4m x 3 x 3m high .Inverter stations convert the Direct Current (DC) electricity generated by the solar panels into Alternating Current (AC) electricity which is appropriate to be fed into the primary substation and then onward to the local electricity grid network.

## 5.5 Energy Storage

5.5.1 In order to optimise the benefits of the solar generation, it is proposed that the facility will include energy storage to help increase the flexibility and generation opportunities of the site. The inclusion of battery storage will allow for the storage of electricity to be fed into the grid during times of peak demand.

5.5.2 Proposed BESS facilities are co-located throughout the site next to inverters and within the same compounds. In total there are 24 BESS enclosures grouped in 12 pairs, one pair within each compound. Each pair of battery enclosure units measures 12.2m x 2.4m x 2.9m high. They are set atop concrete foundations.

5.5.3 As stated previously, energy stored in the units will be fed via underground cable to the onsite substation.

## 5.6 Inverter & Storage Compound

5.6.1 As referenced previously, singular inverter substations and pairs of battery storage enclosures are co-located within 12 compounds which are located across the site. Compounds measure c.27m x 22m.

5.6.2 Each compound also contains DC/DC units which convert the voltage of the energy created on site to facilitate transfer from the Inverters to the Battery Units, as well as an area of hardstanding to facilitate HGV / Crane movements during operation, in the unlikely event they are required. The area of hardstanding measures approximately 66m$^2$.

5.2 Otherwise, the remainder of the compounds are finished in permeable stone.

## 5.7 Spares Containers

5.7.1 2no. spares containers are situated adjacent to the substation compound. The spares containers would comprise containerised units of approximately 12.3 length (L) and 2.5m width (W).

5.7.2 Each unit would be approximately 31m$^2$.

## 5.8 Access Tracks

5.8.1 The main access to the Site will be provided via the A507 to the east. Additional access is via Cromer Heath road to the west. In addition temporary access will be constructed to the central west of the site via Cromer Heath road.

5.8.2 Internal tracks would provide access to the entire Site and the finish will be permeable. The constructed tracks would be used during construction and operation of the Proposed Development.

# 6 FLOOD RISK SETTING

## 6.1 Hydrological Setting

### Nearby Watercourses

6.1.1 The nearest surface EA Designated Main River is the River Bean which is located in the centre of the Site and flows in a westerly direction.

6.1.2 OS Mapping indicates that Weston Tributary is located approximately 800m to the west of the Site, it is a designated EA River and flows in a southerly direction joining the River Beane to the south-west of the Site. Ardeley Brook is located approximately 1.4km to the south-east of the Site and is also a designated EA Main River flowing in a westerly then northern direction before joining the River Beane.

6.1.3 Located in the southern section of the Site, is an unnamed ordinary water course which flows in a south-eastern direction and joins with the River Beane.

6.1.4 No significant artificial watercourses / features (e.g. canals, reservoirs) have been identified within 1km of the Site.

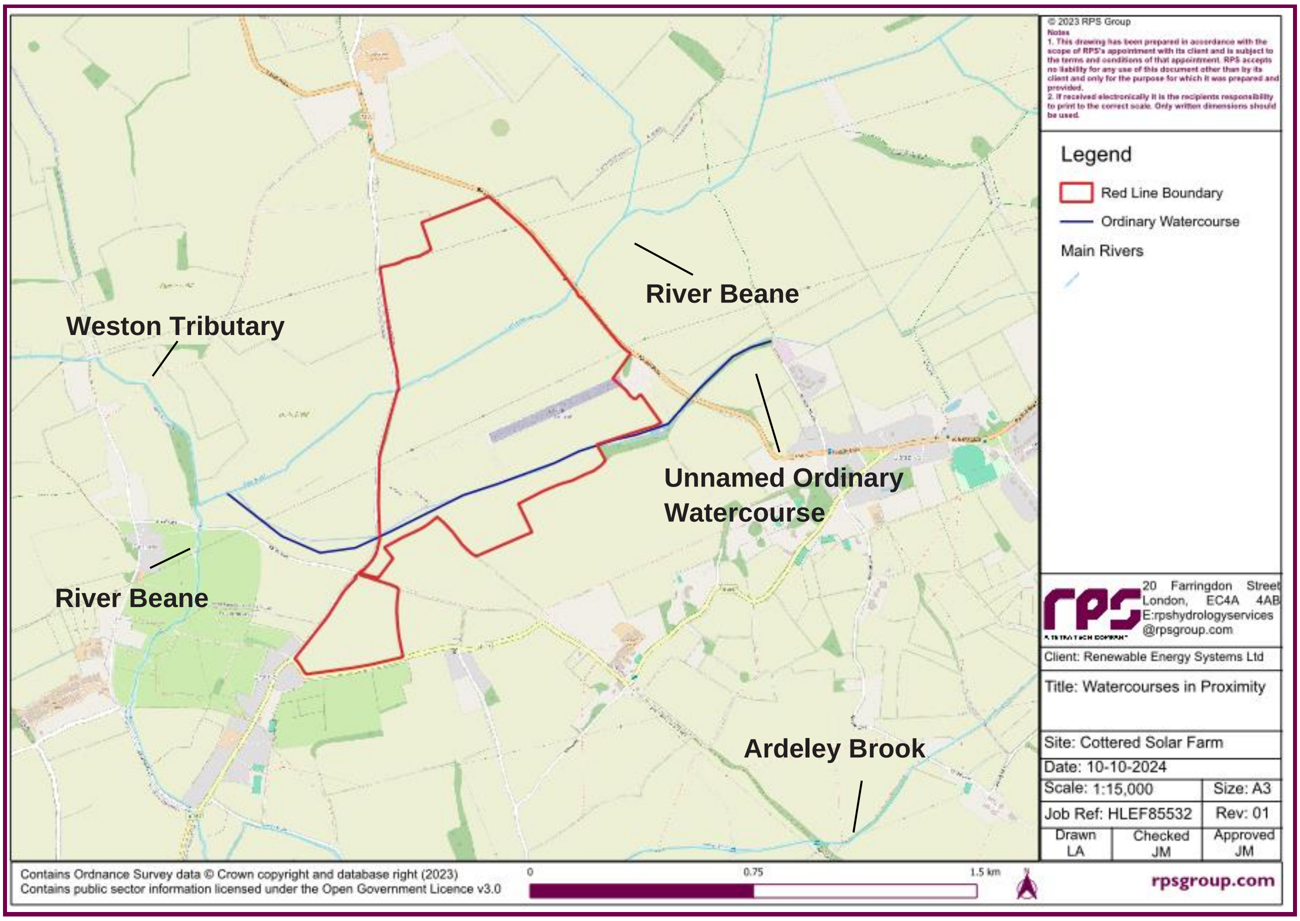




**Figure 6-1. Hydrological Watercourses**

## Fluvial / Tidal Flood Risk Classification

6.1.5 The EA Flood Map for Planning (available online) indicates that the majority of the Site (80%) is located within Flood Zone 1. However, in the central area of the Site is a section located in Flood Zone 2 and 3 which is associated with the River Beane. There is also an area in the southern section of the Site located in Flood Zone 2. The annual probability from fluvial or tidal sources is classified as the following:

- **Flood Zone 1**: land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (0.1%).
- **Flood Zone 2**: land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.
- **Flood Zone 3**: land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
- The EA Flood Map is provided as Figure 6-2.

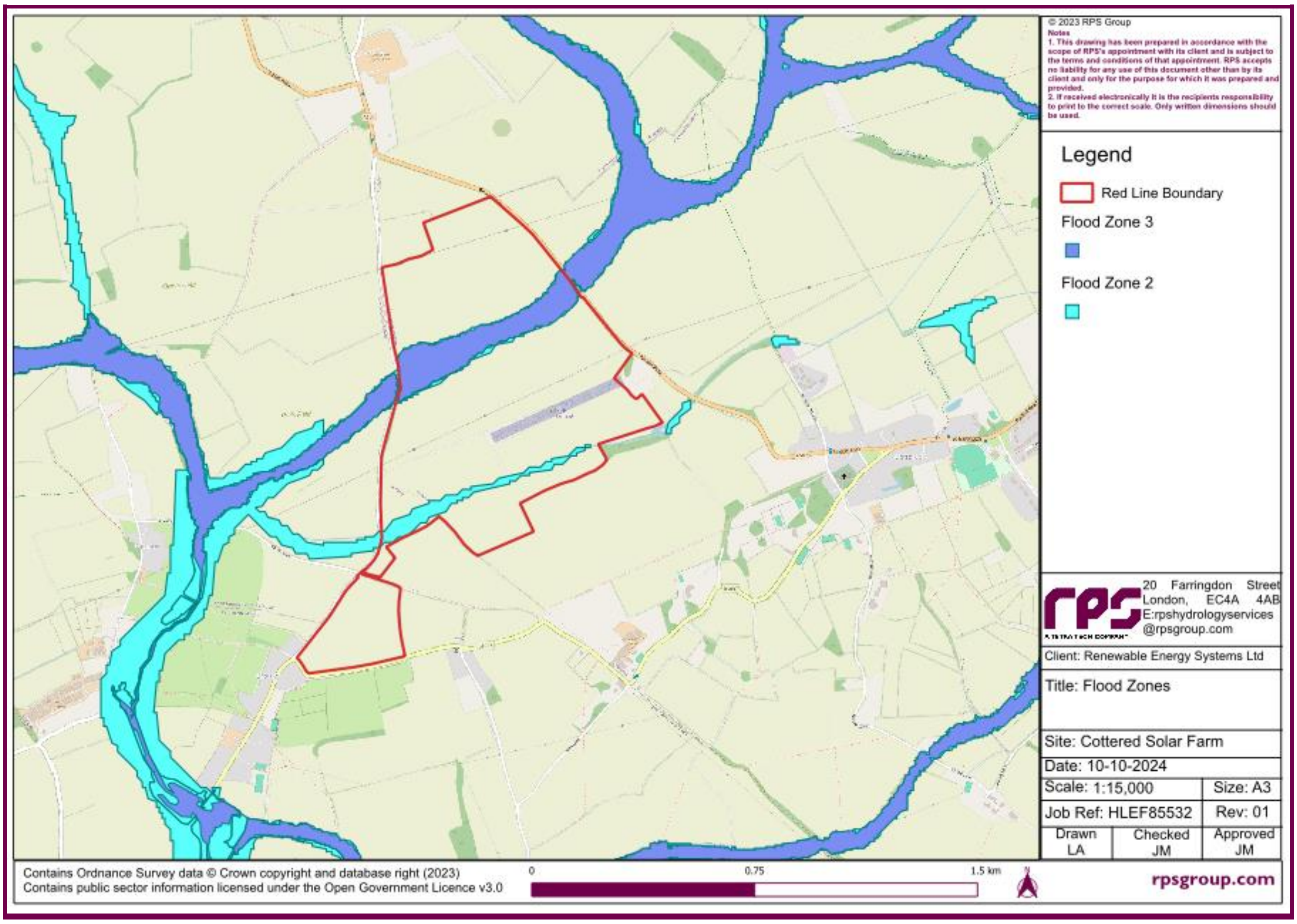




**Figure 6-2. EA Flood Map for Planning**

## Detailed Flood Data

6.1.6 Product 4 data was requested from the EA Strategic Partnership and Overview Team. The EA hold no flood level or flood data information for the Site. Their response is included in **Appendix A.**

6.1.7 *"We have not carried out any detailed flood modelling in the area you have requested. We are not able to confirm your flood levels without any modelling in place. Our Flood Map in this area is formed of national generalised modelling which was used in 2004 to create fluvial floodplain maps on a national scale. This data was later improved using a more detailed terrain model for the area. This modelling is not a detailed local assessment; it is used to give an indication of areas at risk from flooding. In the future we may carry out detailed modelling in this area, but we do not currently have any plans to do so."*

6.1.8 In the absence of EA modelled flood depth and/or level data the EA Flood Zone 2 and 3 extents have been overlaid on to a site-specific topographic survey. Cross-section information has been extracted for the main river, the River Beane in the north and using the flood extents the depths can be determined. This is included in **Appendix E**.

6.1.9 The Flood Zone 2 extent (1 in 1000-year fluvial flood extent) is used as a conservative proxy to account for climate change in the absence of any provided climate change data.

6.1.10 According to the Long-Term flood risk map for Rivers and the Sea, the only high risk is restricted to within the River Beane and the unnamed ordinary watercourse. Adjacent to the Beane is areas classified as medium to high risk. Adjacent to the unnamed ordinary watercourse is classified as low risk. The classification of the risk is based on the following:

- **High risk**: The area has a chance of flooding of greater than 1 in 30 (3.3%) each year.
- **Medium risk**: The area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%) each year.
- **Low risk**: The area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%) each year.
- **Very low risk**: The area has a chance of flooding of less than 1 in 1000 (0.1%) each year.

6.1.11 The map is presented in Figure 6-3 below.

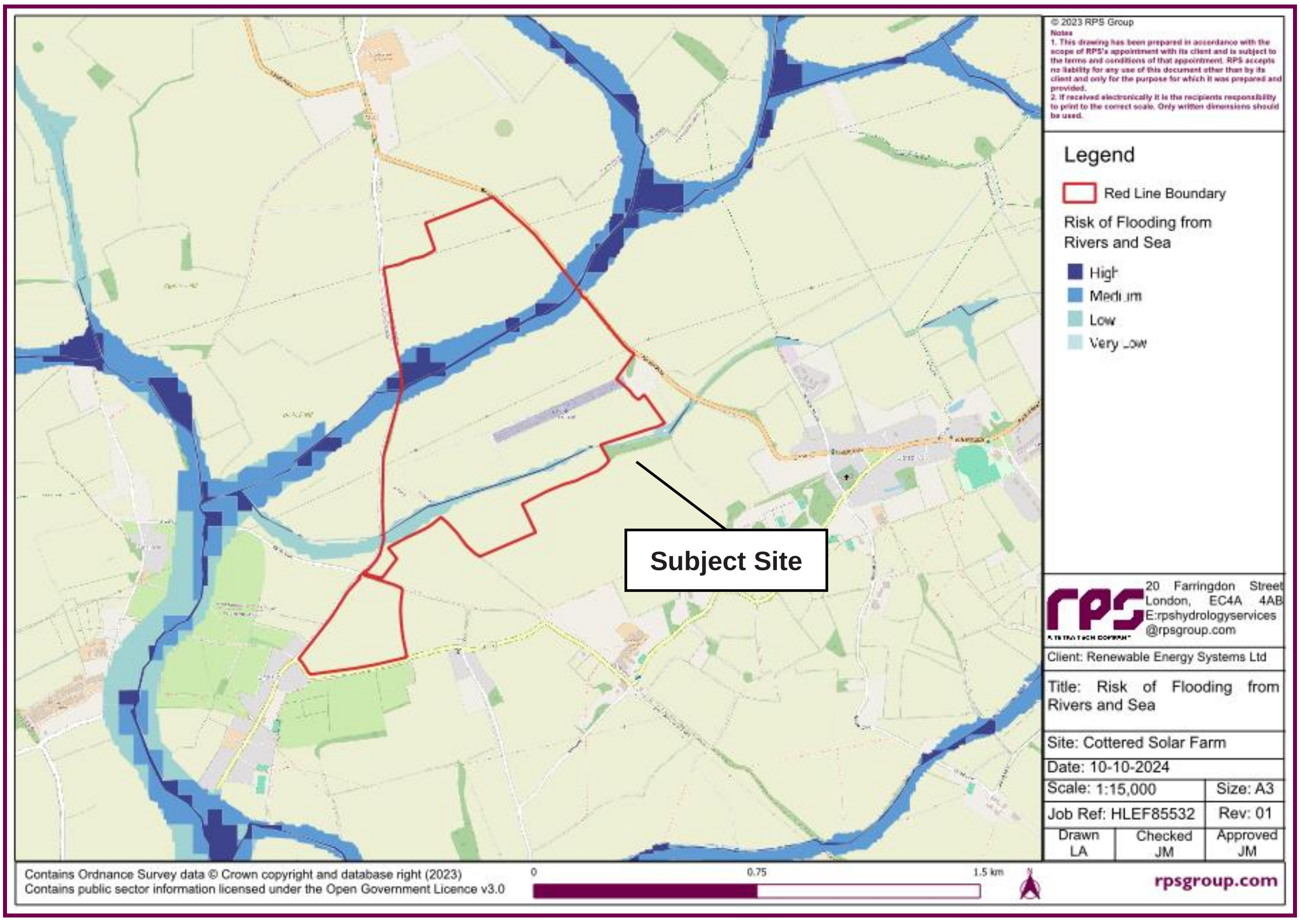




**Figure 6-3. EA Long Term Flood Risk Map for Rivers and Sea**

6.1.12 As set out above, cross sections using the floodplain extent have been prepared to estimate flood depths. Using this information, it indicates that depths in the floodplain may reach up to c.1.22m. Directly adjacent to the channel depths could reach up to 1.050m. It is worth noting that the depths will not be as high across the entire floodplain and would dissipate towards the edge of the extents.

6.1.13 At the southern drainage channel/ditch depths may reach up to 1m within the channel, with out of bank depths in the floodplain reaching up to 0.5m adjacent to the drainage channel.

## 6.2 Surface Water Flood Risk Classification

6.2.1 The EA long-term flood risk map for Surface Water, which is available online, identifies areas at risk of surface water flooding. The classification of the risk is based on the following:

- **High risk**: The area has a chance of flooding of greater than 1 in 30 (3.3%) each year.
- **Medium risk**: The area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%) each year.
- **Low risk**: The area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%) each year.
- **Very low risk**: The area has a chance of flooding of less than 1 in 1000 (0.1%) each year.

6.2.2 The EA long-term flood risk map for Surface Water indicates that the majority of the Site is classified as having a ‘very low’ risk of surface water flooding. However, there are two horizontal bands across the Site, at ‘high risk’ of surface water. The northern band high risk is associated with the River Beane and has an overland flow route feeding into the river located towards the western boundary of the Site. The southern band high risk is associated with the unnamed ordinary watercourse. The updated Flood Map for Surface Water is provided in Figure 6-4.

6.2.3 During a ‘low risk’ event the flood risk depths are expected to remain below 900mm. During a ‘medium risk’ event majority of the depths will remain below 300mm but there are some areas between 300 to 900mm. During a high-risk event the water depths are expected to remain below 300mm.

6.2.4 In all risk scenarios the water velocity is expected to exceed 0.25m/s and flows in a westerly direction.

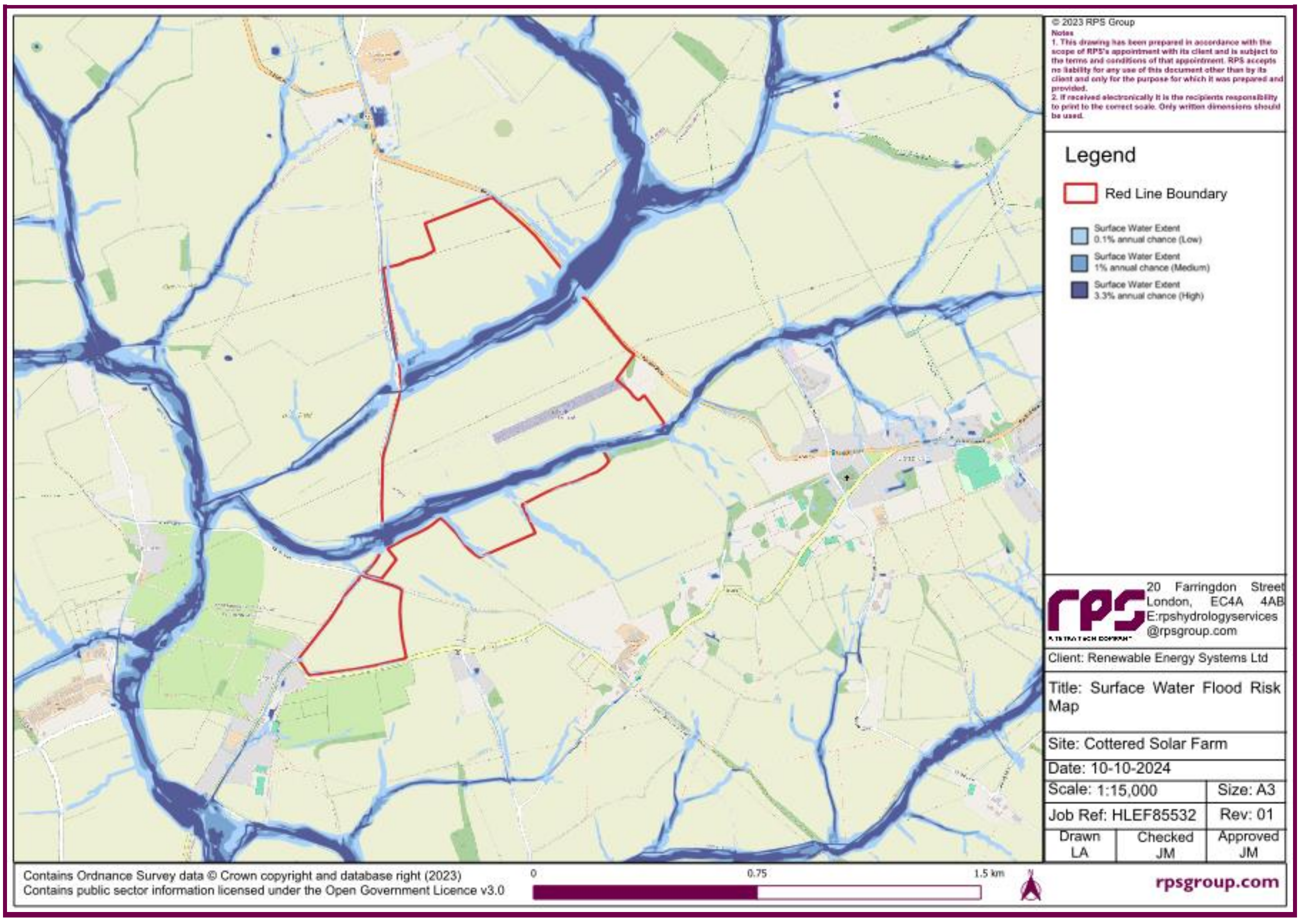




**Figure 6-4. Updated Flood Map for Surface Water**

## 6.3 High/Rising Groundwater Flood Risk

### Geological Setting

6.3.1 British Geological Survey (BGS) online mapping (1:50,000 scale) indicates that majority of the Site is not situated on superficial deposits. In the centre of the Site there is superficial deposits of Alluvium consisting of Clay, silt, sand and gravel, these deposits are associated with the River Beane. In the southern section of the Site there is superficial deposits of Head which is formed of Clay, silt, sand and gravel, which is associated with the unnamed ordinary watercourse crossing the Site. On the eastern and southern boundary of the Site is the superficial deposit of Clay-with-flints Formation which consists of Clay, silt, sand and gravel. On the northern boundary of the Site is the Lowestoft Formation which consists of Diamicton. In the southern area of the Site there are Glaciofluvial Deposits, Mid Pleistocene deposits.

6.3.2 The Site is underlain by a bedrock geology of Lewes Nodular Chalk Formation and Seaford Chalk Formation consisting of chalk. The River Beane is underlain by an area of Chalk Rock Member also consisting of chalk.

6.3.3 BGS GeoIndex indicated that there is no BGS borehole data located within the vicinity of the Site. The nearest borehole is located approximately 50m south of the southern boundary of the southern section of the Site, reference TL32NW1. The borehole consists of bolder clay from 8m below the ground, from 9m to 42m bgl the strata consisted of chalk.

6.3.4 The soils at the Site are described as ‘Lime-rich loamy and clayey soils with impeded drainage’, by the National Soils Research Institute.

### Aquifer Designation

6.3.5 According to the EA’s Aquifer Designation Mapping, the bedrock strata at the surface are classified as a Principal Aquifer. These formations provide a high level of water storage and may support water supply and / or river base flow on a strategic scale.

6.3.6 Where the River Beane travels through the Site, there is superficial deposits associated with the riverbanks deemed to be a Secondary A aquifer. These formations are formed of permeable layers capable of supporting water supplies at a local scale, in some cases forming an important source of base flow to rivers.

### Source Protection Zones

6.3.7 EA online groundwater Source Protection Zone (SPZ) mapping indicates that the Site is located within a groundwater SPZ. It is located within Zone III total catchment zone.

## 6.4 Reservoir Flood Risk Classification

6.4.1 EA mapping also indicates that the Site is not located within an area potentially at risk from reservoir flooding.

## 6.5 Local Authority Flooding Documents

6.5.1 The East Hertfordshire District Council Level 1 and Level 2 Strategic Flood Risk Assessment was published in August 2016. It provides an overview of the flood risk from with the district. Information relevant to this assessment is summarised below:

- SFRA indicated that the Site is underlain by Principle bedrock formation (layers of rock or drift deposits with high permeability and, therefore, provide a high level of water storage)
- SFRA indicated that the Site is underlain by Secondary undifferentiated superficial deposits (rock types where it is not possible to attribute either category Secondary A or Secondary B.
- The SFRA indicated that Cottered has historic record of surface water flooding in 1993, 2006 (not site-specific information).
- A tributary of the River Beane, the Ardeley Brook rises south east of Cottered, flowing in a predominantly westerly direction, before joining the River Bean south of Cromer at TL 29519 27756 approximately 800m from the Site.
- The DG5 register is a a record of properties that have experienced sewer flooding or are at risk of flooding more than once every 20 years. The register indicates that there are 13 recorded flood incidents for the post code area SG9 9 which the Site is located within.
- The SFRA indicates that the River Beane has recorded historical flood events in May 1947, Sep 1968, July 1987, Oct 1993, Dec 1995, May 2008, Feb 2009, Feb 2014. However, this is not site specific.

- SFRA indicates that the Site is located within Groundwater SPZ zone 3 (total catchment), which is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

# 7 ASSESSMENT OF FLOOD RISK

## 7.1 Flood Risk from Rivers and the Sea

7.1.1 EA mapping indicates that most of the Site is in Flood Zone 1, defined as having a 'low probability' (less than 1 in 1,000 years) of annual flooding. However, adjacent to the River Beane is ian area of Flood Zone 3 lands and there is a southern section located within Flood Zone 2 adjacent to the unnamed ordinary watercourse. These flood zones are associated with the River Beane and the unnamed ordinary watercourse, respectively.

7.1.2 In the absence of EA modelled flood depth and/or level data, the Flood Zone 2 extent (1 in 1000-year fluvial flood extent) is used as a conservative proxy to account for climate change. At the River Beane flood depths within the floodplain may reach up to 1.050m. It is recommended that solar panels be raised 0.3m above the maximum calculated flood level. The flood level should be taken from the extracted cross-sections across the watercourses and associated Flood Zones. The Above Ground Levels (AGL's) for the lowest leading edge of the panels are presented in **Appendix F.**

7.1.3 Depths associated with the southern unnamed ordinary watercourse may reach up to 1 m within the channel, with out of bank floodplain depths reaching up to 0.5m adjacent to the drainage channel. Therefore, the lowest leading edge of solar panels should be set to 0.8m above surrounding ground levels which incorporates a 300mm freeboard.

## 7.2 Surface Water Flooding (Overland Flow)

7.2.1 The EA long-term flood risk map indicates that whilst the majority of the Site is not at risk of surface water flooding, a limited number of solar arrays will be installed within parts of the Site with surface water flood risk. The risk is restricted to the watercourses and immediate surrounding land and remains below 300mm.

7.2.2 The surface water flood risk to the proposed development can be considered low to moderate.

## 7.3 Other Sources

7.3.1 The risk of flooding associated with reservoirs, canals and other artificial structures is considered to be low given the absence of any such structures in the Site vicinity. EA mapping shows the Site is outside the reservoir flood extent.

7.3.2 Overall, the risk associated with other sources is considered to be low.

## 7.4 Proposed Mitigation

7.4.1 The Local Plan, detailed in section 2 notes that hard surfaces are generally not accepted within 10m of any watercourses. Therefore, it is proposed to restrict all development including solar panels to 10m from the banks of the River Beane and the ordinary watercourse.

7.4.2 As solar panels are proposed within the 1 in 1000-year fluvial flood extents, depths out of bank (excluding the 10m easement) reach a maximum depth of 1.050m. It is proposed to raise solar panels 300 mm above predicted flood levels to limit the obstruction of water. It is advised that all solar panels within Flood Zone 2 will be raised at their lowest leading edge above the calculated flood level with a 300mm freeboard. The required FFL is presented in **Appendix F** for different areas of the Site**.**

7.4.3 The lowest leading edge of the solar panels adjacent to the ordinary watercourse in the south will be set a minimum of 0.8m above the surrounding ground level. The maximum flood depth is 0.5m and this therefore, provides adequate freeboard above any flood level.

7.4.4 As such by nature of design the solar panels will have appropriate mitigation against fluvial and surface water flooding.

7.4.5 No land raising activities are proposed with development and as such the levels at which solar panels will be set will reflect undulating Site topography. As no land raising is proposed, the Proposed Development will not interfere with the existing surface water runoff and flows paths currently present within the undeveloped Site and will remain unaltered with Proposed Development.

7.4.6 A summary of the Proposed Development is provided within Section 5 of this Report. Other than the framework upon which the panels are fixed, no other parts of the Proposed Development will be located within areas identified as being subject to flood risk. The panels themselves are watertight and meant to be exposed to the elements.

# 8 SEQUENTIAL AND EXCEPTION TEST

## 8.1 Vulnerability Classification

8.1.1 In accordance with the Flood Risk Vulnerability Classification in Table 3 of the Planning and Practice Guidance (PPG) Flood Risk and Coastal Change, solar farm developments are classified as “Essential Infrastructure”.

## 8.2 Overview

8.2.1 The NPPF sets out the requirements of the Sequential Test. A standalone Flood Risk Sequential Test has been prepared and is submitted alongside this Report as part of the planning application pack.

Development should not be allocated or permitted if there are reasonably available sites appropriate for the development in areas with a lower risk of flooding. If it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the Exception Test may have to be applied. The need for the Exception Test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification. Table 8-1 below reproduces the flood risk vulnerability and flood zone compatibility, as set out in Table 2 of the PPG.

8.2.2 For the Exception Test to be passed:

8.2.3 It must be demonstrated that the Project provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared;

a) A site-specific flood risk assessment must demonstrate that the Project will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

**Table 8.1. Flood Risk Vulnerability and Zone Compatibility**

| | Development Vulnerability | | | | |
|---|---|---|---|---|---|
| **Flood Zone** | **Essential Infrastructure** | **Highly Vulnerable** | **More Vulnerable** | **Less Vulnerable** | **Water Compatible** |
| Zone 1 | Yes | Yes | Yes | Yes | Yes |
| Zone 2 | Yes | Exception test required | Yes | Yes | Yes |
| Zone 3a | Exception test required | No | Exception test required | Yes | Yes |
| Zone 3b (Functional Floodplain) | Exception test required | No | No | No | Yes |

## 8.3 Exception Test

8.3.1 The Site is located in Flood Zone 1, 2 and 3. The PPG stipulates that Essential Infrastructure is acceptable within Flood Zone 3 provided an Exception Test is undertaken.

8.3.2 With reference to Part a) of the exception test, the Project will contribute towards meeting the UK Government’s targets for generating energy from a renewable energy source; it will generate employment during its construction and operation. It will also provide wider sustainability benefits to the local community and beyond.

8.3.3 Therefore, part a) of the exceptions test is considered to be satisfied.

8.3.4 With reference to Part b) Section 7 of this FRA provides details of the measures that will be employed to ensure that the development will be safe for its lifetime takin into account the vulnerability of its users.

8.3.5 The FRA considers the potential impact of the Project on the flood risk elsewhere and describes the measures to be included in the Project to reduce the flood risk overall. Embedded mitigation measures and a Surface Water Drainage Strategy, detailed in Section 10 will be implemented in order to ensure that the scheme is safe for its lifetime and that there will be no increases in flooding elsewhere.

8.3.6 Therefore, part b) of the exceptions test is considered to be satisfied.

# 9 POTENTIAL IMPACTS

## 9.1 Potential New Impermeable Surfaces

### Solar Arrays

9.1.1 The majority of the Beane Solar Farm developed area will be occupied by solar arrays. Although arrays have a large land take, the actual ground impact is negligible. The only intrusion will be from the pile-driven posts. There will be one post for about 6-7 panels, so likely to be 6-7m between each post. Posts are made of galvanized steel and are not solid poles. Traditional fixed solar arrays have surface area ground impact in the range of 0.0012 $m^2$ - 0.0014 $m^2$.

9.1.2 The number of the modules in this solar farm is subject to change. The estimated total number of modules at this stage is 4,131, with panel width of 4.7m. Assuming that there will be posts every 6 m the total number of estimated posts would be 3,236.

9.1.3 Based on this, if the 0.0014 $m^2$ per post is assumed, the total solar farm ground impact would be approximately 5 $m^2$ across a 79.45 ha (794,500 $m^2$) Site. This means that what covers the majority of the land as "development" will have a ground impact on 0.001% of the Site. Any alteration to the total modules will have a minimal impact on this number and will remain less than 0.1% given the nature of these raised features.

### Access Tracks

9.1.4 Where new access tracks are required, these will be placed across the Site. Internal access tracks will be finished within a permeable material.

9.1.5 Please see **Appendix D** which shows the indicative plans of access tracks (05003-RES-ERW-DR-PT-001).

9.1.6 The plans note the addition of drainage swales (if required) which will be explored further at detailed design stage.

### Ancillary Buildings

#### Substation Compound

9.1.7 The substation could potentially give rise to up to 2,764 $m^2$ of new impermeable surface.

9.1.8 The FRA takes a conservative approach and suggests that the entire compound area entails impermeable surfaces.

#### Inverter and Storage Compound

9.1.9 As per the project description summary included at Section 5 of this Report, singular inverter substations and pairs of BESS enclosures are co-located within 12 compounds which are located across the site. Each compound also contains four DC/DC units which convert the voltage of energy created on site.

9.1.10 The DC/DC converters measure 1.8m x 1.2m in area. The inverter substations and the associated transformers measure 5m x 3m and 4.1m x 3m in area respectively. The pairs of BESS enclosures together measure 12.2 x 2.44m in area. The remainder of the compound in which these facilities are located is has a permeable finish.

9.1.11 Each of the compounds will give rise to approximately 66$m^2$ of new impermeable surface. Across the 12 areas this will comprise a total impact of 792$m^2$

### Spares Containers

9.1.12 Two spares containers are proposed. Each container will give rise to 30.8m$^2$ of new impermeable surface at each of the 2 units. The total impact is 62m$^2$.

## 9.2 Summary

9.2.1 The new actual/potential impermeable surface area at the 79.45ha/ 74500 m$^2$ Site will be from the following:

**Table 9.1. Impermeable areas**

| Development | Area (m$^2$) |
|---|---|
| Solar Arrays | 5 |
| Substation Compound | 3130 |
| Inverter and Storage Compound Areas | 2,764 |
| Spares Containers | 62 |
| Potential Total | 5,961 m$^2$ |

# 10 SURFACE WATER MANAGEMENT

## 10.1 Introduction

10.1.1 New potential impermeable areas within the Site are equivalent to 5,961m$^2$/0.75% of the total Site area.

10.1.2 The sustainable management of surface water is an essential element of reducing future flood risk to the Site and its surroundings. Legislation and guidance relating to sustainable drainage systems are presented within Section 2, planning policy context.

10.1.3 Undeveloped sites generally rely on natural drainage to convey or absorb rainfall, with water infiltrating into the ground or coalescing across the surface towards watercourses.

10.1.4 Modelling work (Cook and McCuen, 2013) shows that solar panels themselves do not have a significant effect on runoff volumes, peak flows or times to peak. However, where design decisions or lack of maintenance lead to bare ground then the peak discharge may increase requiring storm water management.

10.1.5 Ancillary features are expected to increase limited areas of hardstanding within the Site. Without specific measures to manage surface water the volume of water and peak flow rate are likely to increase. Inadequate surface water drainage arrangements can threaten the Project itself and increase the risk of flooding to others.

10.1.6 Surface water arising from a developed site should as far as is practicable be managed in a sustainable manner to mimic the natural hydrology of the site while reducing the risk of flooding and elsewhere, taking climate change into account.

10.1.7 The development will have a design life of 40 years. Therefore, for the purposes of this assessment, taking into account climate change allowances a 40 % increase in peak rainfall intensity has been included as climate change allowance, which caters up to 2125.

## 10.2 Greenfield Runoff Rate

10.2.1 The Site is currently undeveloped farmland and therefore the runoff rate is considered to be greenfield runoff rate. As such the equivalent greenfield runoff rate for the proposed impermeable areas have been calculated assessing the greenfield runoff rate. This has been done using the HR Wallingford UK SuDS Greenfield runoff tool as the Site is over 50ha.

- Area: 1ha
- Standard-period Average Annual Rainfall: 620 mm/yr
- BFI/HOST: 0.349
- Hydrological Regime: 6

10.2.2 The greenfield rates are presented in Table 10.1 below. The calculations are also included in **Appendix G.**

**Table 10.1. Greenfield Runoff Rates (l/s) for 1 ha**

| Return Period (years) | Runoff Rate for 1 hr storm event (l/s/ha) |
|---|---|
| 1 in 1 | 2.98 |
| QBAR | 3.5 |

| | |
|---|---|
| 1 in 30 | 8.06 |
| 1 in 100 | 11.18 |

l/s = litres per second

## 10.3 Consideration of Drainage Hierarchy

10.3.1 The PPG advises of the following hierarchy for the disposal of surface water;

1. Infiltration;
2. To a surface water body;
3. To a surface water sewer, highway drain or another drainage system; or
4. To a combined sewer.

10.3.2 The drainage hierarchy has been considered as follows.

**Infiltration**

10.3.3 BGS bedrock geology mapping records indicate that the majority of the Site is not on superficial deposits. Isolated areas of the Site have the following superficial deposits:

- River Beane -alluvium (clay, silt, sand and gravel)
- Southern ordinary watercourse – head (clay silt sand and gravel)
- South west and north – Lowestoft formation (diamicton)

10.3.4 The LandIS mapping shows soils at the Site to be classified as Soilscape 9; Lime-rich loamy and clayey soils with impeded drainage. The Site corresponds with SOIL index 3 'Well drained, permeable sandy or loamy soils wand shallow analogues over highly permeable limestone, chalk, sandstone or related drifts' (mapping information from UK Suds Tool / Flood Studies Report (NERC, 1975)).

10.3.5 The CIRIA SuDS Manual C753 Table 25.1 'Typical infiltration coefficients based on soil texture (after Bettes, 1996) has been used to advise regarding indicative infiltration rates expected to be found on-Site. As per table 25.1 of the SuDS manual therefore we classify soils within the Site as 'sandy loam'. Based on this table, soil within the local area is classified to have typical infiltration coefficients of between $1*10_{-7}$ – $1*10_{-5}$. A best-case infiltration rate of 0.036m/hr has been assumed within the surface water calculations.

**To a Surface Water Body**

10.3.6 If discharge to the ground is not feasible, discharging to a surface water body is considered the next feasible option. Two watercourses are located on Site; the River Beane and an unnamed ordinary watercourse.

10.3.7 Given their dispersed nature, Inverter and Storage compounds would require significant pipe networking to connect to on-Site watercourses. This is not in keeping with SuDS and will prevent the site being effectively retuned to agricultural use post decommissioning of the Site. Therefore, this has not been considered further.

10.3.8 The substation compound could be connected following the topography to the River Beane in the north.

10.3.9 Appropriate discharge consents from the LLFA and EA will be required prior to construction.

## 10.4 Proposed Development Conceptual Drainage Strategy

10.4.1 A conceptual drainage approach based on the Proposed Development Layout is presented below. The discharge location and method of surface water flows is to be determined at detailed design stage, following soakaway testing.

### Solar Panels

10.4.2 It is expected precipitation would be intercepted by between 25% to 40% of the surface of the Site typically over-sailed by solar PV modules. A potential concern is the risk of water "sheeting" off a solar array façade. As stated, it is estimated that between 25% and 40% of rainfall will be intercepted by the surface of the arrays before reaching ground level. Intercepted rainfall will either run down the face of the panels and drip onto the ground below or will be lost due to evaporation from the face of the panels. Without mitigation there is a risk of erosion of the ground on which rainwater drips. This could then result in the formation of rivulets which could increase the speed at which runoff discharges from the Site.

10.4.3 However, the potential for erosion to occur as a result of the 'drip effect' is appropriately mitigated by features of the solar arrays themselves, typical solar arrays are constructed with gaps between each panel which allows surface water to fall between panels to the vegetated ground beneath.

10.4.4 Solar PV modules will have a 10 to 30-degree pitch on the horizontal plane. Between each panel array there will be a separation distance of up to 3m. This will reduce the flow velocity of run-off landing on the solar PV modules, resulting in run-off to drip down through gaps between individual panels and thus reducing the risk of water sheeting and run-off from the lower edge of the modules. A typical PV module for the Site is illustrated in drawing reference: 05003-RES-SOL-DR-PT-001, provided in **Appendix D.**

10.4.5 Within the plan the underside of a typical array is shown providing a helpful visual aid to show what the gaps are like.

10.4.6 Nevertheless the energy of the flow which drains from PV Arrays will be greater than that of baseline conditions. As set out above, this could result in erosion under the driplines.. Over time, as stated previously , intensification of the runoff from panels, along the 'drip line', could form into rivulets, creating small channels.

10.4.7 To prevent this PV Arrays have been proposed to be in alignment with the topography. The area under the 'drip line' will have appropriate grass seeding in line with the Landscape Strategy. This will prevent rivulets forming and prevent an increase in surface water runoff rates. Water will infiltrate from where it falls at the 'drip lines' any additional runoff will runoff to the drier land beneath the panels and be absorbed from here. As such the runoff eventually reaching the on-Site watercourses through the topography will not be increased.

10.4.8 It is expected grassed areas will be managed through quarterly mowing where possible, especially in the early years while the newly operational solar farm is "bedding in" with the natural environ. Year-round ground coverage is an improvement with respect to surface water infiltration compared to existing arable use where the ground is regularly bare following crop harvest.

### Ancillary Buildings

10.4.9 DC/DC converters measure 1.8m x 1.2m in area. The inverter substations and the associated transformers measure 5m x 3m and 4.1m x 3m in area respectively. The pairs of BESS enclosures together measure 12.2 x 2.44m in area. The Inverter substations, associated transformers, BESS enclosures, DC/DC converters and spares containers are not intended as permanent buildings as the Site will require full reinstatement of the land to agricultural use at the end of the Site's operational life.

10.4.10 The ancillary units should have a floor level that is off the ground by at least 100mm and they are typically located on plinths or blocks 100-500mm off the ground.

10.4.11 The buildings will require hardstanding under their footprint. However, for the remainder of the identified inverter and storage compound areas, and spares containers is proposed a 100mm – 350mm deep gravel subbase.

10.4.12 Each gravel-filled infiltration blanket is filled with a 30% void ratio to provide surface water attenuation. The gravel base will not alter the underlying condition beyond the topsoil; what would otherwise be topsoil will be replaced by gravel, which has 30% more porosity and storage capacity than the existing topsoil would have.

10.4.13 Conceptual drainage calculations have been undertaken using the industry standard Causeway Flow software to assess indicative dimensions of the gravel bases to accommodate attenuation requirements for the 1 in 100-year critical storm event plus a 40% climate change uplift. The bases formed by gravel will provide storage of surface water runoff prior to infiltration, providing a betterment to current conditions.

10.4.14 Temporary construction compounds are to be in place during the development of the site, for less than 2 years. These will be placed on hardstanding consisting of compacted stone over a layer of geotextile to provide a clean, firm, level and free draining surface suitable for cabins and heavy traffic.

## Substation Compound

10.4.15 The proposed substation compound could potentially give rise to up to 2764$m^2$ of new impermeable surfaces.

10.4.16 The required attenuation has been modelled in Causeway Flow as being c.256 $m^3$ to accommodate flows from the 1 in 100 critical storm event, with an 40% uplift to account for climate change. **Appendix H** provides full calculations for a singular substation compound. Based on the size of the unit, and it being situated on a 350 mm deep subbase with a 30% porosity ratio, this will provide 290 $m^3$. As such, the provided attenuation is greater than required.

10.4.17 Any transformers within the substation compound will be appropriately bunded to prevent contaminants i.e., oils infiltrating into the ground. Details of this will be provided at detailed design stage.

## Inverter and Storage Compounds

10.4.18 There are 12 proposed Inverter and Storage Compounds located across the site. As set out in Para 9.1.10 each compound will contain four DC/DC converters, an inverter substation and associated transformers and a pair of BESS enclosures. The remainder of the compound in which these facilities are located has a permeable finish. Collectively therefore the 12 compounds at the Site could potentially give rise to 792 $m^2$ of new impermeable surfaces (66$m^2$ each). Each area is considered individually due to the dispersed nature across the Site.

10.4.19 The required attenuation has been modelled in Causeway Flow as being c.2.5 $m^3$ to accommodate flows from the 1 in 100 critical storm event, with an 40% uplift to account for climate change. **Appendix H** provides full calculations for an Inverter and Storage Compound. Based on the size of the unit, and it being situated on a 200 mm deep subbase with a 30% porosity ratio, this will provide 5.9 $m^3$. As such, the provided attenuation is greater than required.

### Spare Containers

10.4.20 There are 2 proposed spare container units at the site and these could potentially give rise to 62 $m^2$ of new impermeable surfaces (30.8 $m^2$ each). Each area is considered individually due to the dispersed nature across the site.

10.4.21 The required attenuation has been modelled in Causeway Flow as being c.0.79 $m^3$ to accommodate flows from the 1 in 100 critical storm event, with an 40% uplift to account for climate change. **Appendix H** provides full calculations for a Spares Container unit. Based on the size of the unit, and it being situated on a 100 mm deep subbase with a 30% porosity ratio, this will provide 2.77 $m^3$. As such, the provided attenuation is greater than required.

## 10.5 SuDS Maintenance

10.5.1 Table 10.2 below shows the typical drainage maintenance plan suitable for gravel bases (extracted from SuDS Manual C753).

**Table 10.2 Gravel base maintenance**

| Maintenance schedule | Required Action | Typical Frequency |
|---|---|---|
| **Regular maintenance** | Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices | Monthly, or as required |
| | Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage | Monthly |
| | Inspect gravel for silt accumulation, and establish appropriate silt removal frequencies | Six monthly |
| | Remove sediment from gravel | Six monthly, or as required |
| **Occasional maintenance** | Remove or control tree roots where they are encroaching the sides of the gravel (if applicable), using recommended methods (eg NJUG, 2007 or BS 3998:2010) | As required |

## 10.1 Water Quality

10.1.1 Compared to agricultural (arable) use, the solar aspects are likely to create an overall betterment in surface water drainage than a continuation of the existing use.

10.1.2 The primary reason for this is the significant advantage from full year-round organically managed vegetated ground cover on within solar PV module areas compared with intensive arable uses. Research undertaken by Cook and McCuen (2013) found that provided full vegetation cover beneath the solar modules is maintained, the change in run-off characteristics from solar PV module areas is likely to be insignificant and that ground cover has a much more important control over runoff.

10.1.3 A second environmental benefit of solar PV modules are soil quality improvement from cessation of intensive arable use and organic management of the land. It is expected that soil health will be improved through increase in soil organic matter, increase in the diversity of soil flora, fauna and microbes, and improved soil structure. The ceasing of intensive agricultural practices during operation of the solar farm will likely result in an improvement in the quality of surface water runoff generated within the Site as a result of reduced sediment loadings, phosphorous and nutrients.

10.1.4 When the operational phase ends, the Proposed Development will be decommissioned. The development lifetime is 40 years. Solar PV modules, mounting structures, cabling, inverters and transformers will be removed from the Site and recycled or disposed of in accordance with good practice and market conditions at that time. All of the elements of solar PV modules can be removed with minimal topsoil disturbance which should leave the improved and enriched soil as a benefit for the return to arable use.

10.1.5 As the land will be returned to full agricultural after the expiration of the solar farm and battery consent, Sustainable drainage system features that require a straightforward restoration to existing agricultural use with minimal ground disturbance or disruption to new and improved ecological features.

## 10.2 Event Exceedance

10.2.1 The proposed surface water drainage strategy caters for the 1 in 100 year plus 40% climate change event. In the event the attenuation measures reach capacity excess water will overtop and be conveyed by gravity across the fields mimicking the existing Site runoff characteristics. This approach will aid in managing flood flows, whilst at the same time ensuring that the vegetated ground cover and existing and new boundary vegetation receive suitable hydration.

10.2.2 Solar farm components are not vulnerable in the event of exceedances. There is no need to mitigate a risk that does not exist, or for infiltration testing when there is no reason to expect a negative impact on the current baseline and every reason to expect at least modest betterment from gravel storage vs. topsoil storage.

10.2.3 Without introducing new unnatural SuDS within the majority of the Site, there will be betterment from full year-round vegetated ground cover compared existing intensive arable use. Aforementioned Cook and McCuen (2013) research advises that vegetated ground should be provided under and around arrays and maintained to avoid bare earth, but as long as this is done a solar farm has no impact on runoff characteristics.

10.2.4 The SuDS scheme for the project will therefore prioritise nature-based solutions for flood risk mitigation as opposed to unnatural elements that might compromise the multifunctional benefits of the cessation of arable farming and green infrastructure enhancement. Beyond attenuation for the ancillary units the remainder of the SuDS will be the natural filter strips between rows, the vegetated ground under arrays and the existing plus new landscape planting boundary treatments.

10.2.5 In support of this strategy overland flow, a pre-development and post-development exceedance flow plan drawing has been produced and is presented within **Appendix I**, the Exceedance Flow Plan drawing.

10.2.6 Detailed event exceedance planning will be undertaken as part of the final design process. Suitable mitigation measures will be incorporated into the development to ensure water is retained on-Site should surcharging of on-Site drains occur during extreme rainfall events.

## 10.3 Fire Water

10.3.1 An on-Site fire containment strategy will be incorporated into the overall Site drainage design at detailed design stage.

10.3.2 During a highly unlikely fire event in one of the BESS enclosure units, it is considered that the fire would remain isolated due to the dispersed nature and location of the units across the Site. Therefore, there is not a requirement to include consideration of fire water within the design of the attenuation of water at the Site.

## 10.4 Construction Stage Drainage

10.4.1 During construction of the development, the building contractor will be responsible for management and disposal of rainwater runoff generated from the site in its temporary condition.

10.4.2 The contractor shall develop a formal Site management plan, which will address pollution management and control in relation to Site plant and vehicles, raw materials storage and waste generation, to ensure that all surface water runoff generated in the temporary condition will be free of contamination.

10.4.3 Where required the contractor shall provide temporary drainage measures to contain runoff within the development Site boundary ensuring that this is sized appropriately, and that means to remove excess surface water are available for use at all times.

10.4.4 Where construction has resulted in soil compaction, the areas between panel rows would be tilled / scarified to an appropriate depth.

# 11 FOUL DRAINAGE

## 11.1 Substation Compound

11.1 Detailed plans of welfare stations within the substation have yet to be confirmed. It is not anticipated that the substation will be permanently manned, but toilet facilities may be provided within the control building. If this is the case, it is anticipated that any foul water flows from the Site will drain to a septic tank or package treatment plant prior to discharge to ground or a nearby watercourse. The discharge method of flows will be determined at the detailed design stage.

# 12 SUMMARY AND CONCLUSIONS

## Summary

12.1.1 A site-specific FRA following the guidance of the NPPF and PPG has been prepared for the Beane Solar Farm Site located south of *land west of A507, SG9 9PU.*

## Flood Risk

12.1.2 EA mapping shows that the majority of the Site is located in Flood Zone 1 with areas of Flood Zone 2 and 3 extending from the on-Site unnamed ordinary watercourse and the River Beane, which also runs through the Site.

12.1.3 The solar panels will be raised to 300mm above the flood level at the River Beane and unnamed ordinary watercourse flood extent.

12.1.4 There are also areas of overland flow/surface water flooding along the watercourses. The solar panels will be raised off the ground and as such, the development is unlikely to cause an obstruction to the flow paths/ponding.

12.1.5 Flooding from groundwater, reservoir and sewer sources is also considered to be low.

## Hydrological Appraisal

12.1.6 The incorporation of appropriate management techniques will mitigate the potential increase in runoff from the Proposed Development.

12.1.7 The design of the development, as well as surface water and soil management measures outlined in Section 10, will ensure that there is negligible alteration to local drainage patterns and flow directions and manage suspended sediments for entering the drainage channels.

## Surface Water and Soil Management Measures

12.1.8 SuDS techniques shall be incorporated into the design, when and where required, and will work in conjunction with existing field drainage to manage the discharge of any excess water from the Site.

12.1.9 Where construction has resulted in soil compaction, the areas between panel rows would be tilled / scarified to an appropriate depth and the receded with an appropriate vegetation cover.

12.1.10 All areas of the Site, where appropriate, will have vegetation cover at all times.

12.1.11 Any existing field drainage system will be restored.

12.1.12 Access tracks finish will be permeable. be . Appropriate swales will be used where required and this will be explored at detailed design stage.

12.1.13 The panels will elevated above the defined floodplain and will not cause any blockage overland flow routes.

12.1.14 Gravel subbases will be provided for ancillary infrastructure to attenuate up to the 1 in 100-year plus 40% climate change rainfall extent.

## Conclusions

12.1.15 This FRA demonstrates:

- The Proposed Development would neither exacerbate existing flooding problems nor increase the risk of flooding on Site or elsewhere;

- Surface water runoff will be mitigated by maintenance of a vegetation cover and gravel subbases;
- With appropriate surface water and soil management techniques, there is negligible alteration to local drainage patterns and directions within the Site;

12.1.16 In summary, the Proposed Development is at ‘low’ to ‘moderate’ risk of flooding from all sources assessed, and with appropriate surface water and soil management measures, would cause negligible effects on the existing hydrological regimes.

# APPENDICES

# Appendix A

## EA Response

# Appendix B

## Topographic Survey

# Appendix C

## Site Visit

# Appendix D

## Development Plans

# Appendix E

## Flood Levels and Cross-Sections

# Appendix F Finished Floor Levels of Solar Panels

# Appendix G

## MicroDrianage Greefield Runoff Rates

# Appendix H

## MicroDrainage Attenuation Calculations

# Appendix I Pre- and Post- Development Surface Water Runoff Rates