FLOOD RISK AND DRAINAGE ASSESSMENT

STATERA PELHAM SOLAR FARM

Flood Risk Assessment & Drainage

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1 INTRODUCTION

1.1 RPS Consulting Services Ltd (RPS) have been commissioned by Statera Energy Limited to prepare a Flood Risk Assessment (FRA) to support the proposed Solar Farm development (the Proposed Development) at Pelham Farm, Pelham, approximately 700 metres (m) south-west of Berden in Essex (the Site).

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 Proposed Development to mitigate the identified risk. This report has been produced in accordance with the guidance detailed in the National Planning Policy Framework (NPPF) and accompanying Planning Practice Guidance (PPG). Reference has also been made to the Mid Essex Strategic Flood Risk Assessment (SFRA) and Essex County Council Local Flood Risk Management Strategy.

1.3 This report has been produced in consultation with the Environment Agency (EA) and Essex County Council (ECC) who act as the Lead Local Flood Authority (LLFA).

1.4 A desk study has been undertaken with reference to information provided / published by the following bodies:

- The EA;
- The ECC;
- British Geological Survey (BGS);
- MAGIC (Multi Agency Geographic Information for the Countryside);
- Ordnance Survey (OS); and
- Anglian Water (AW).

2 PLANNING POLICY CONTEXT

National Planning Policy

2.1 The National Planning Policy Framework (NPPF) was released in March 2012 and was updated in July 2021. The document advises of the requirements for a site-specific Flood Risk Assessment (FRA) for any of the following cases (Planning and Flood Risk paragraph 167 (footnote 55)):

- 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.

2.2 Paragraph 169 of the updated NPPF identifies that major developments (developments of 10 homes or more and to major commercial development) should incorporate Sustainable Drainage Systems unless there is clear evidence that this would be inappropriate. The systems used should:

a. Take account of advice from the Lead Local Flood Authority;

b. Have appropriate proposed minimum operational standards;

c. Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and

d. Where possible, provide multifunctional benefits.

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

Local Planning Policy

2.4 The Site falls within the District Council of Uttlesford, which is under the Essex County Council (ECC). The ECC is the LLFA for the area.

2.5 Currently a policy vacuum persists in this district. Uttlesford is without a Local Plan following withdrawal of its previous draft from examination last year. The council is at an early stage of preparing a new Plan, with an initial consultation and call for sites ongoing until 21 April. Following confirmation of a substantial 5-year housing land supply deficit, the council is under pressure to approve proposals for sustainable development on unallocated sites to help boost supply.

2.6 Following the withdrawal of the emerging Local Plan last year, Uttlesford District Council is implementing a fresh approach to the new Plan’s process and governance arrangements. The council is consulting on its Call for Sites and first stage consultation until April. The Local Development Scheme, approved by the council’s cabinet in October, forecasts adoption of the new Plan in mid-2024. In February, the council approved an interim set of policies to show how new developments in the district should take on board measures to address climate change. While these are not legally binding planning policies, they do make clear what the council expects to see in all new developments moving forward.

2.7 The **Interim Policies** relevant to this study are:

Interim Policy 3*: Development should be designed to minimise consumption of water, and should make adequate and appropriate provision for water recycling. Development should also protect and enhance local water quality including measures to support improvement to a water body's Water Framework Directive status. A condition on all planning permissions for the erection of new residential development will be imposed to trigger the optional requirement under Part G of the Building Regulations for the maximum potential consumption of wholesome water of 110 litres per person per day.*

Interim Policy 4: *Development should be designed to provide adequate mitigation through sustainable means against flood risk and to embed suitable water recycling, waste water and waste management so as not to cause contamination of groundwater, particularly in recognised protection zones, of surface water or run-off to river catchments. Where there is the potential for contamination, effective safeguards should be put in place to prevent any deterioration in current standards.*

Interim Policy 6: *Developers should demonstrate how their proposals prioritise nature and how they would result in a biodiversity net gain according to the latest best practice thinking on sustainability.*

Interim Policy 9: *Where relevant to the scale of the development, developers should demonstrate what opportunities have been taken at a neighbourhood level to design-in renewable energy infrastructure as an integral part of the development, how they have been incorporated, or why they have been rejected.*

2.8 The Uttlesford Strategic Flood Risk Assessment (SFRA) identifies and maps flood risk from all sources at a borough-wide scale as well as providing guidance on producing site specific FRAs. Relevant information from the SFRA has been referenced throughout this FRA report.

Climate Change

2.9 To ensure future development can provide a safe and secure living and /or working environment throughout its lifetime, national planning policy requires proposals in areas of high flood risk to be accompanied by an assessment of flood risk to and from the development, taking into account the impacts of climate change.

2.10 In July 2021 the EA released revised climate change allowances, which updates the 2020 and 2011 version of 'Adapting to Climate Change: Advice to Flood & Coastal Risk Management. The EA have used the UKCP19 projections to update the peak river flow allowances and have based them on management catchments instead of river basin districts.

2.11 The guidance on how to apply peak river flow allowances has also been changed. The following allowances must be used:

(a) the central allowance for all assessments except for essential infrastructure, where you use the higher central allowance,

(b) the upper end for 'credible maximum scenario' assessments, and

(c) the central allowance to calculate flood storage compensation, except for where essential infrastructure is affected, where you use the higher central allowance.

2.12 The document provides a central and upper estimate for increases in rainfall intensity as a consequence of climate change. Tables 1 below presents the anticipated increase in peak river flows for the Upper Lee catchment management in the Thames River Basin District, and Table 2 presents the expected change to Extreme Rainfall Intensity.

Table 1 - Peak River Flow Allowances by River Basin District (use 1961 to 1990 baseline)

River Basin District	Management Catchment	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)
Thames	Upper Lee	Upper Estimate	23%	27%	59%
		Central Estimate	3%	-1%	10%

Table 2 - Change to Extreme Rainfall Intensity Compared to a 1961-90 Baseline

Change to Extreme Rainfall Intensity			
Applies across all of England	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 Estimate	10%	20%	40%
Central Estimate	5%	10%	20%

2.13 Runoff and attenuation calculation for any development design would have to take into account the above change in climate change policy.

2.14 Both the central and upper end allowances should be assessed to understand the range of impact. As a minimum, proposals should be assessed against the central allowance to inform design levels. It is recommended that the 2080s changes are used when considering any time beyond 2115.

3 CONSULTATION

Environment Agency

3.1 According to the EA online Flood Map for Planning, the entire site is shown to be located within Flood Zone 1 whereby the risk of fluvial flooding is considered to be low. Therefore, the EA have not been consulted for the purpose of this study.

Local Authority

3.2 Consultations were undertaken with the ECC regarding any specific requirements related to the surface water management at the Site. The ECC drainage officer has responded that RPS should apply for a formal planning advice and this option was not pursued at this stage.

4 EXISTING SITE

Site Description and Surrounding Land Use

4.1 The Site is located between the settlements of Berden and Stocking Pelham in Essex, with centred grid reference TL461292. Site Location Plan is included as Figure 1.

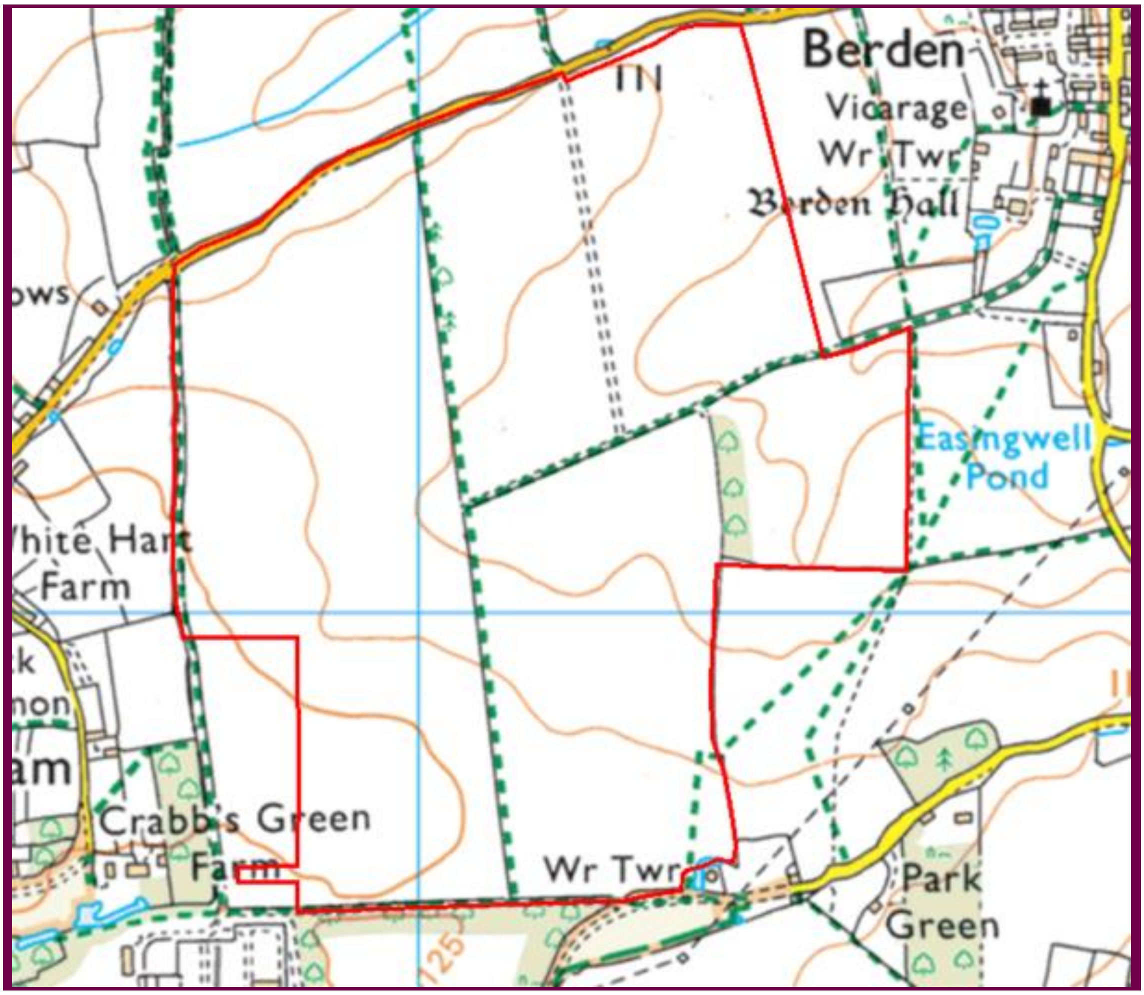


Figure 1 - Site Location Plan

4.2 The Site comprises a number of parcels of land which extent to approximately 64.3 hectares (ha) in total. The Site is located within an area of existing agricultural farmland.

4.3 The main vehicular access to the Site is provided via an established farm access off Ginns Road from the north. Additional access options would be available from a local road to Park House Farm from the south and from the local road running along the western boundary of the site.

4.4 There are no Sites of Special Scientific Interest (SSSI), or a Special Area of Conservation (SAC) close to the Site.

Topography

4.5 A Topographic Survey of the Site was not available at the time of writing this report. A review of the OS mapping indicates that the Site is sloping generally from south west to north east.

4.6 The ground levels along the western boundary are between 127m AOD and 120m AOD dropping down to109m AOD along the eastern perimeter.

4.7 In the north the level is approximately 115m AOD and to the south it is approximately125m AOD.

5 PROPOSED DEVELOPMENT

Overview

5.1 The Proposed Development is for the installation of free-standing, static solar photovoltaic (PV) panels. The Proposed Development will comprise six main elements with supporting assets (see Figure 1, including:

1. Solar PV panels set out in rows (known as strings);
2. Associated cabling and inverters/transformers;
3. Substation compound;
4. Storage facility;
5. CCTV cameras mounted on poles facing into the site;
6. Perimeter security fencing; and
7. Access and maintenance tracks.

5.2 The Proposed Development will feed directly into the National Grid, however a point of connection has yet to be determined at this time.

5.3 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 estimated to be 40 years following construction/commission. The Site development plan is provided in Appendix A.

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

Solar Panels and Mounting Frames

5.5 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. The use of these footings would ensure that there is no impact on subsurface features. Between each string of panels there would be a distance of between 3 m and 6 m to avoid inter-panel shading, depending on the topography with less space required on steeper slopes. The panels would be tilted at typically 15 to 25 degrees from the horizontal and would be orientated to face south towards the sun. The panels would be mounted at approximately 0.9m from the ground at the lowest point (the southern edge) rising to approximately 2.5 m at the highest point (the northern edge), although the anticipated maximum height could be up to 3 m.

Central Inverters

5.6 10 no. inverters would be located within the site which would appear as containerised units similar to shipping containers. Each unit would be placed on a concrete base with skid size approximately 7 m by 2.5 m.

Substation Control Building

5.7 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. The substation would measure up to approximately 12 m long, 9.5 m wide and would be placed on a concrete base.

5.8 The building will not be permanently occupied but will be periodically visited by maintenance personnel. As such, a small permeable hardstanding area will be provided outside the building with parking for approximately two vehicles.

Tracks

5.9 The main access to the Site will be provided via the existing road from Ginns Road.

5.10 Internal tracks would provide access to the entire site. Where possible, existing farm access tracks would be used. Where new internal tracks are needed, these would mainly run adjacent to existing field boundaries with minimum buffers applied to minimise encroachment into hedgerows and other landscape features. The tracks would be constructed from stone (or equivalent) and would be used during construction and operation of the Proposed Development.

6 HYDROLOGICAL SETTING

Hydrological Overview

6.1 OS Mapping indicates that there are no watercourses flowing through or adjacent to the site. The headwater of unnamed tributary to River Stort originates some 100m to the north of the site and flows in easterly direction.

Fluvial/Tidal Flooding

6.2 The EA Flood Map for Planning, presented in Figure 2, indicates the entire Site is located within FZ1, whereby the land is having an annual probability of fluvial and tidal flooding of less than 1 in 1,000.

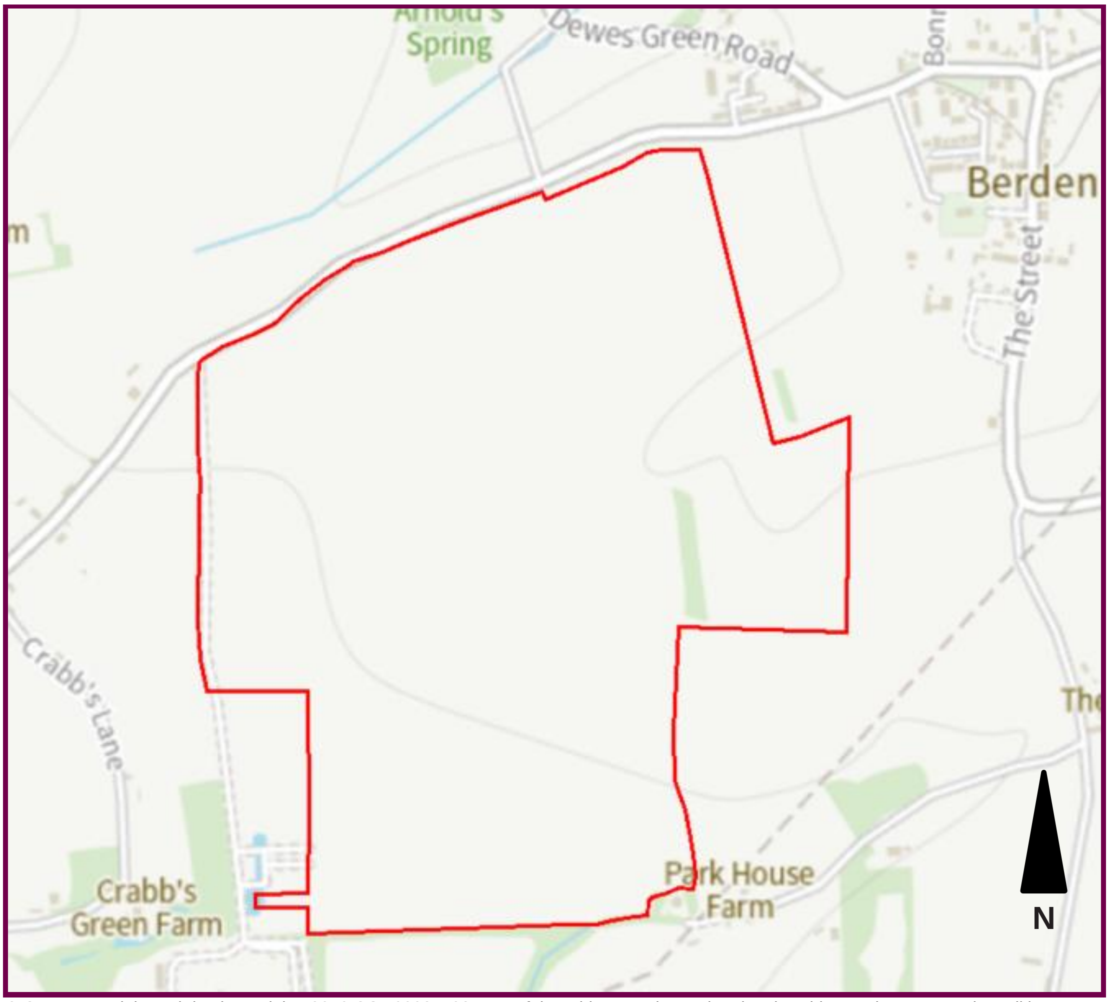


Figure 2 - Flood Map for Planning

Flooding from Rising / High Groundwater

6.3 Reference to BGS online mapping (1:50,000 scale) indicates superficial deposits in the area of the Site are of Lowestoft Formation - Diamicton.

6.4 BGS mapping indicates the Site is wholly underlain by bedrock deposits Lewes Nodular Chalk Formation And Seaford Chalk Formation (undifferentiated) - Chalk.

6.5 The BGS Hydrogeology 1: 625,000 scale online map indicates that there are several boreholes in the area surrounding the Site. Two of the borehole logs were examined, ref.TL42NE11 and TL42NE7. They both indicate that the rest level of ground water is between 30 and 55m below the ground level. Based on that, the potential for groundwater flooding is considered to be low.

6.6 The site is located in a Zone III – Total Catchment Source Protection Zone. The MAGIC Groundwater Vulnerability Map indicates that the site has a Medium Vulnerability to Ground Water Flooding. The Aquifer Designation Map indicates that the site is underlaid by a Principal Aquifer. The soils are classified as Lime-rich loamy and clayey soils with impeded drainage.

Reservoir Flooding

6.7 Reference to the EA’s Reservoir Flood Map indicates that the site is not at risk of flooding from reservoirs failure.

Surface Water Flooding

6.8 Surface water flooding is caused when the volume of rainwater falling does not drain away through the existing drainage systems or soak into the ground and lies on or flows over the ground instead.

6.9 Reference to the EA’s Surface Water Flood Map (Figure 3) indicates that most of the Site is at ‘Very Low’ risk of flooding, where the annual chance of surface water flooding is less than 0.1%. Limited linear areas within the Site are defined as being at ‘Low’, ‘Medium’ and ‘High’ risk of surface water flooding, corresponding to annual chance of flooding of between 0.1% and 1%, between 1% and 3.3% and greater that 3.3% respectively. The location of the areas at risk of surface water flooding appear to coincide with topographical lows in the terrain.

6.10 The EA Flood Risk of Surface Water map provides a tool to look at the velocity and direction of flow that is likely to occur from any areas of identified surface water flood risk. According to the map, there are two defined flow paths across the Site. These flow pathways appear to follow small depressions in the land. One flow path appears to originate within the centre of the Site flowing from west to east, and eventually discharging into a culverted drain running under Berden. The other flow paths is smaller, runs from south-west to north-east and joins the first flow path just outside the site boundary.

6.11 The depth of surface water flooding during both the 1 in 100 year and 1 in 1,000 year event is shown to be below 300 millimetres (mm).

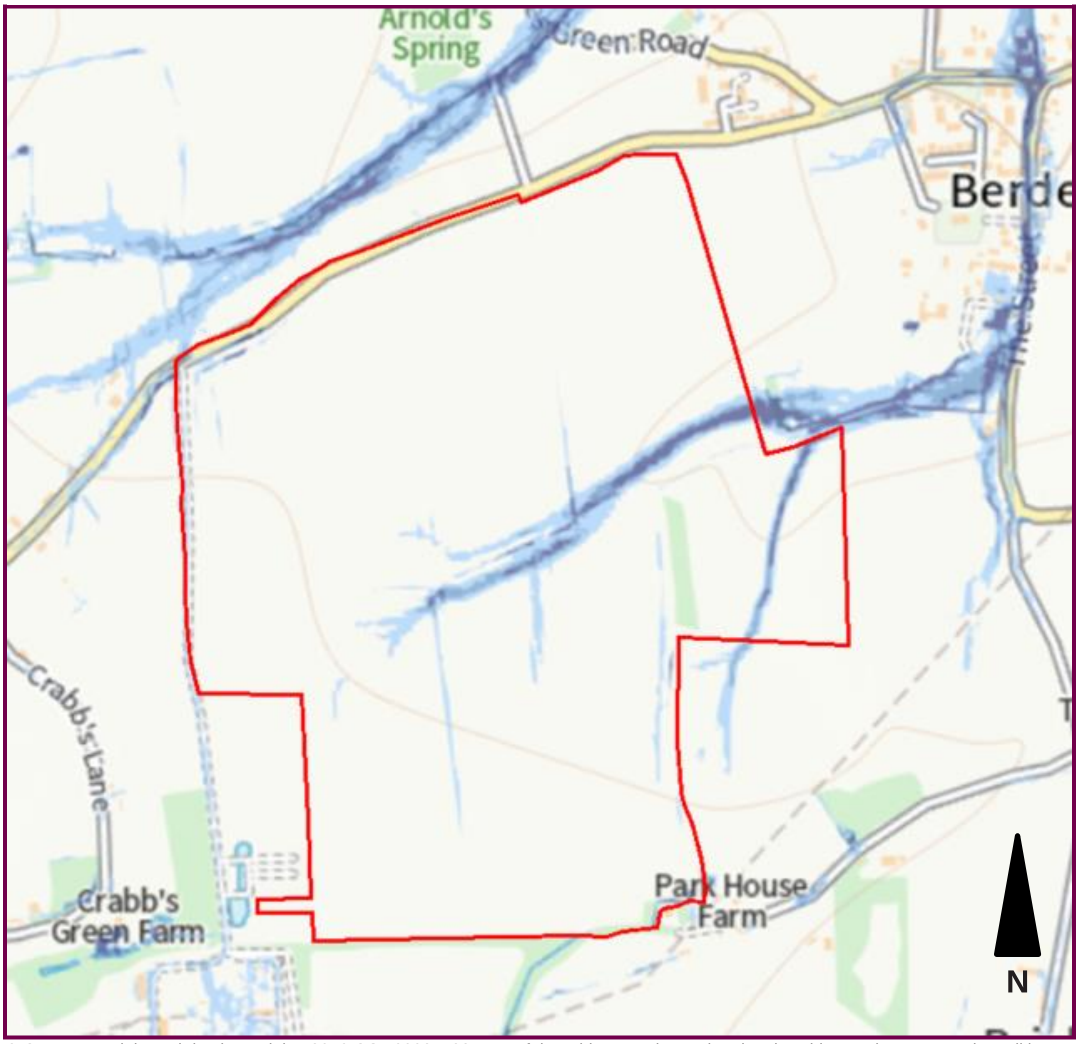


Figure 3 - Surface water flood Map

Historical Flood Events

6.12 The Uttlesford SFRA was published in May 2016 and provides an overview of flood risk from various sources within the District. The SFRA states that:

6.13 […] *The region is prone to localised flooding, with the main source of flooding from fluvial and surface water sources. Within recent years the February 2014 and October 2001 events have been the most serious, leading to widespread flooding across the District. There is a reasonably good record of historical flooding within the District. The SFRA presents a summary of the areas affected and impacts of the major recorded flood events.* […]

6.14 The records state that on 23 November 2014 the stream along the main road into Berden has burst its banks and flooded the road. However, there are no records of flooding at the site.

Assessment of Flood Risk

6.15 The OS map shows that there are no Main Rivers or ordinary watercourses within the site boundary or in close proximity to the site. Consequently, the EA mapping indicates that the site is in FZ1, defined as having a ‘low probability’ (less than 1 in 1,000 years) of annual flooding.

6.16 The EA surface water flood mapping indicates that most of the Site is at ‘Very Low’ risk of flooding. Limited areas within the Site are defined as being at ‘Low’ to ‘High’ risk of surface water flooding. These areas appear to be associated with depression in the topography which appears to form a land drain path. The maximum predicted depth of the surface water ponding along this flow path at 300mm. It is noted that some of the solar panels are proposed to be located within the boundaries of the surface water flow path route. Considering that the solar panels are waterproof and raised to a minimum of 900 mm above the ground, they would not be affected by flooding, nor will they displace flood volume from the floodplain or obstruct the flow paths..

Flood risk vulnerability classification

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

6.18 The majority of the Site is located in FZ1. Table 3 of Planning Practice Guidance reproduced in Table 1 below indicates that “Essential Infrastructure’’ developments are acceptable within Flood Zones 1, and an Exception test is not required.

Table 1 - Flood Risk Vulnerability and Zone Compatibility

Flood Risk Vulnerability and Zone Compatibility					
Flood Risk Vulnerability classification (see Table 3 of Planning Practice Guidance)	**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

6.19 Whilst the Site is in FZ1 and not at risk of fluvial flooding, there are areas with “high risk” from surface water flooding and it is reasonable to provide reassurance as to the lack of a solar farm’s vulnerability to flooding.

6.20 The only elements with vulnerability are ancillary buildings with electrical equipment. These buildings are primarily pre-fabricated container units. They can be raised off the ground so there is a void between the ground and floor level of the unit, with internal electrical equipment therein also not situated directly on the floor of the unit.

6.21 Although it is not always the case, and these buildings can be installed in areas at flood risk flood risk, optimal design will site these units outside of the flood risk areas. Where this is not possible, they can be raised higher off the ground and/or propose a less vulnerable construction for the housing structure.

6.22 The majority of a site is occupied by solar arrays; banks of panels on a pile-driven (like a fence post) mounting frame. Arrays cannot be damaged by flooding. Framework posts are driven into the ground to a depth of 2- 2.5m. They do not require concrete foundations, digging, or other earth moving to install.

6.23 Arrays are designed for existing topographic undulations and the solar farm will not change existing contours. The solar arrays will respond to the land rather than changing the land for the solar. When viewed straight down a row, if there are elevation changes, the arrays may look higher (taller) or shorter (lower) in some areas of a row. This is because framework will give the panels a consistent distance off the ground at the lower end and higher end. So, if the ground is higher the panels will look higher even though their max height from ground level at the lower and higher end is the same. Although this may not always be the case, and it is reasonable for the LLFA to seek assurances, at Pelham Sollar Farm there will be no ground-levelling or earth moving to a uniform surface or change existing topography.

6.24 Solar PV modules are mounted on the array framework, often but not always stacked in a portrait or landscape layout. The panels themselves are watertight and meant to be exposed to the elements. The photovoltaic energy generation process is passive and does not require moving parts. The only element of a solar panel that could be impacted by water is the “junction box” in the middle (on the rear of) each panel. These allow each panel to connect to the other in ‘strings’. The lowest any junction box would be to ground level is approx. 1.4m. Junction boxes are rated to either IP67 or IP68 meaning they would be able to withstand immersion in up to 1m of water. Therefore, for the solar panels to be potentially at risk from flooding, water would need to be at least 2.4m deep to impact PV output. Even if this occurs, the panels themselves would remain operational, however, junction boxes would potentially be compromised and could require minor electrical works to replace once flood waters had subsided. As such, solar arrays themselves should not be considered vulnerable to flood risk.

7 DEVELOPMENT IMPACTS

Introduction

7.1 Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites identifies that development and construction has the potential to detrimentally change a soil's physical, chemical and biological properties including drainage characteristics.

7.2 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.

Effects of solar panel arrays on runoff

7.3 Compared to agricultural (arable & livestock) use, a solar farm is likely to be inherently better for surface water drainage than a continuation of the existing use. If a solar farm proposal avoids the creation of new hardstanding, includes mitigation for ancillary buildings, and will not alter existing landforms (e.g. levelling or bunds), a solar farm will not change existing characteristics and should be a positive improvement even with no additional SuDS measures.

7.4 The primary reason for this is the significant advantage from full year-round organically managed vegetated ground cover on a solar farm compared with intensive arable or livestock grazing uses. Research undertaken by Cook and McCuen (2013) found that providing full vegetation cover beneath the solar panels is maintained, the change in runoff characteristics from solar farm sites is likely to be insignificant and that ground cover has a much more important control over runoff.

7.5 A solar farm already includes designed-in surface water flood risk mitigation. This is something solar PV planning applications do not always effectively communicate. It can be helpful to clarifying some of the ways that surface water flood risk is addressed without adding-in new features.

7.6 The "requirement" for SuDS on a 'major' development is set out in Paragraph 169 of the NPPF (2021) which states:

169. Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- a) *take account of advice from the lead local flood authority;*
- b) *have appropriate proposed minimum operational standards;*
- c) *have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- d) *where possible, provide multifunctional benefits.*

7.7 The requirement for SuDS is a "should", not a "must". It is our view that the lack of risk at the Pelham Site, coupled with the temporary nature of the development, and a requirement for full reinstatement of the land, makes a case that SuDS beyond the minimum would be inappropriate.

7.8 The solar farm is a temporary development and would not be considered "major" development if only its actual ground area impact were considered. Because the land will be returned to full agricultural after the expiration of the temporary solar farm consent, SuDS that would require new intrusive or otherwise unnatural elements (e.g. pipework or tanks) or land shaping (e.g. swales) should only be required as a last resort to enable easy restoration to existing agricultural use with minimal ground disturbance or disruption to new and improved ecological features.

7.9 If pipework or tanks are installed these would have to be ripped out of the ground to allow arable farming to resume. Likewise, while swales can be non-problematic on pastureland, they are less conducive to the resumption of arable farming and could compromise the quality of the land and soil (non-uniform wetness vs dryness).

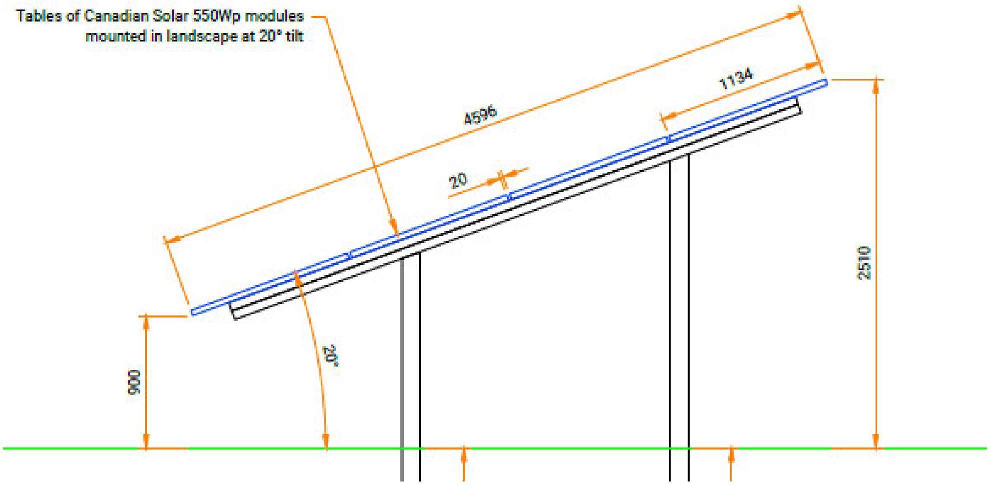
7.10 One of the multifunctional environmental benefits of a solar farm is soil quality improvement from cessation of intensive arable use and organic management of the land. It is expected that soil health will be improved through increase in soil organic matter, increase in the diversity of soil flora, fauna and microbes, and improved soil structure. All of the elements of a solar farm can be removed very easily with minimal topsoil disturbance which should leave the improved and enriched soil as a benefit for the return to arable use. Significant works to remove filter drains or level out swales that are not complimentary to a return to arable farming would undermine this benefit.

7.11 This could also lead to more problems elsewhere. Although a solar farm is a temporary consent that does not change the greenfield land classification, its 30-year lifetime is not short. Temporary land drainage measures that might unnaturally change the existing baseline could subsequently be relied off-site as part of the wider ecosystem services network. When the solar farm is decommissioned and these are removed/reverse, there is a risk of adverse “downstream” impacts for those who have relied on the SuDS. Therefore, although SuDS are intended to contribute to flood risk resilience, the nature of a solar farm and its whole-life context needs to be carefully considered so that the sustainable development can be implemented in a sustainable manner and with an eye on the future restoration to existing conditions and the resumption of arable use.

Panel Runoff

7.12 The nature of the Proposed Development means that precipitation would be intercepted by between 25% to 40% of the surface of the Site that is typically over-sailed by solar panels. A known concern is the risk of water “sheeting” off a solar array façade, running off at speed onto the same ground, pooling, and over time creating erosion and runoff channels alter existing surface water flows. This issue can arise due to simplified drawings typically submitted with planning applications. These show what looks to be a solid façade when, in actuality, a typical solar array has gaps between each panel on an array which allows surface water to fall off in many locations on to fully vegetated ground beneath.

7.13 The first image below is an extract from an elevation plan for a typical (fixed) array and highlights the gaps between the panels making up the solar array. The approx. 20 degree pitch means water is less likely to run down with velocity that helps it to “jump” the gaps. Rather, water runs off at a reduced speed due to the pitch, and drips down through the gaps. There is no actual risk of water sheeting down in one area at the lower edge of the arrays. The image that follows is from the underside of an array providing a helpful visual aid to show what the gaps are like.



7.14 The above images are provided for context and comparison only.

7.15 As result of the construction of the solar panels, some 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. As mentioned in section 7.12, 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. However, the potential for erosion to occur as a result of the 'drip effect' is appropriately mitigated by features of the solar arrays themselves, as per the images above. In addition, several mitigation techniques have been suggested as described in the following sections.

Vegetated Ground

7.16 In addition to the above, appropriate seeded vegetation will be provide below and between rows of the solar panels to act as a level spreader/energy dissipater to promote low erosivity sheet flow during operation of the solar farm. The vegetation will be managed organically and will either be mowed or used for light grazing. The grassland will not only grow between array gaps, but it includes all ground under the arrays as well. This means that excluding the access tracks and ancillary buildings most of the Site will be fully vegetated species rich pastoral grassland. The exception is areas targeted for different cover like the areas proposed for wildflower meadow planting, screen planting and new calcareous grassland.

7.17 This full year-round coverage will be a positive improvement compared to existing arable and intensive grazing use. Without any additional development being required the gaps between the arrays are natural filter strips (SuDS).

7.18 The following photos are from UK solar farms where grazing is used for grounds management. Although land may also be managed through quarterly mowing, especially in the early years while the newly operational solar farm is “bedding in”, you can see that the ground coverage is good even under arrays. Some of these images includes arrays at a steeper pitch and there is nothing to suggest that water pools and creates surface water erosion channels. The solar farm with year-round ground coverage is an improvement with respect to surface water infiltration compared to the existing agricultural use where the ground is regularly bare or with only patchy vegetation.

7.19 The key takeaway is that the majority of the Site has mitigation and SuDS inherently designed-in. The arrays are designed to avoid sheeting/pooling/erosion. Water drips off at multiple points onto vegetated ground below, and there is significant space between rows (at Pelham Site it is at minimum 7.9m) to act as natural filter strips with vegetated ground that slows the movement of surface water.

Potential New Impermeable Surfaces

Solar Arrays

7.20 The majority of the Pelham 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 $0.0012m^2$ - $0.0014m^2$.

7.21 The number of the modules in this solar farm would be 100,368, with panel width of 1.122m. Assuming that there will be posts ever 6m the total number of posts would be 18,769.

7.22 Based on this, if the 0.0014 m^2 per post is assumed, the total solar farm ground impact would be $26.28m^2$ on a 64.3 ha ($643,000m^2$) Site. This means that what covers the majority of the land as “development” will have a ground impact on 0.004% of the Site.

Access Tracks

7.23 It is proposed that the internal access tracks will be fully permeable with no tarmac or other hardstanding type surface. Most will follow existing farm tracks so would not even be new access routes. As such they will have no impact with respect to surface water drainage. Geotextile membrane layers will help to secure the aggregate to prevent it sinking into the soil and this will help prevent ground compaction.

7.24 After the construction of the solar farm the heaviest vehicles likely to use the tracks are occasional van or 4x4 type vehicles. There will be less intensive traffic around the site compared to existing farm use. This means there is low risk of over-use causing compaction that could compromise permeability. Despite this, it will be reasonable to include monitoring and maintenance of the internal accesses over the lifetime of the solar farm.

7.1.1 In construction there will be no HGVs using the internal access tracks around the Site except from the highway into the Site. All HGVs making deliveries to the site for construction will drop off in temporary construction compounds at the access point. Materials will then be delivered around the site by tractor-trailer type vehicles which are the same as vehicles that currently use these routes around the working farm. This means there is low risk of traffic/vehicles causing excess soil compaction either in construction or during operation which could limit the efficacy of the tracks' permeability.

Ancillary Buildings

Inverter and Transformer Blocks

7.25 There will be 10 Inverter and Transformer blocks on the Site. Each inverter unit would be placed on a concrete base with skid size approximately 9m x 2.5m x 2.2m (area of 22.5m^2). The transformer unit will be placed on a concrete base with approximate size 2.70m x 2.50m (area of 6.75m^2) with additional unit next to the transformer compound with area of 4m^2. Therefore, the total area of these blocks will be 33.25m^2 and 10 blocks across the Site could potentially give rise to 332.5m^2 of new impermeable surface.

7.26 The FRA takes a conservative approach and suggests that the ancillary buildings on site will entail new hardstanding. However, this is not entirely accurate. The Transformer units are pre-fabricated containers. They are not intended as permanent buildings. The Site will require full reinstatement of the land to agricultural use at the end of the solar farm's operational life. Therefore, there is no interest in creating any kind of permanent foundation for the temporary ancillary buildings. No poured concrete or other non-permeable foundation will be used.

7.27 The containers must have a floor level that is off the ground by at least 100mm and they are typically on plinths or blocks 100-500mm off the ground. At Pelham the transformers will sit atop a 300mm deep gravel base with a 500mm void between the floor level of the unit and the permeable foundation beneath. Therefore, the only impermeable surface would be the area of blocks that stabilise the transformers on the gravel base.

7.28 Lack of hardstanding beneath the building, the permeable foundation, and the void between the building and ground means that although the transformer units would have a total top-down area impact of 332.5m^2 this will not have the same effect as if these were creating 332.5m^2 of new impermeable surface. Instead, the bases formed by gravel will provide storage of surface water runoff prior to infiltration.

7.29 As the 332.5m^2 of inverter and transformer blocks are dispersed across a 643,000m^2 Site they only represent a 0.05% impact based on a top-down view that assumes they create new impermeable surface.

Substation Control Building

7.30 The substation Control Building would measure up to approximately 12 m long and 9.5 m wide. This could potentially give rise to 114m^2 of new impermeable surface. The FRA takes a conservative approach and suggests that the building entails new impermeable surfaces. It is proposed to construct a French drain around the building which will have enough capacity to attenuate the runoff from the building during the 1 in 100 plus Climate Change event (40%).

7.31 114m^2 of substation control building is dispersed across the 643,000m^2 Site and represent a 0.02% impact based on a top-down view that assumes they create new impermeable surface.

8 IMPACT POTENTIAL CONCLUSIONS

8.1 The total new actual/potential impermeable surface area at the 64.3ha / 643,000m^2 site will be from the following:

Development	M^2 Area
Solar Arrays	26.3
Inverter and transformer blocks	332.5
Substation Control Building	114.0
Potential Total	**472.8 m^2**

8.2 This equates to 446.5m^2 from buildings + 26.3m^2 from solar arrays which means the total potential new impermeable surfaces are 472.8m^2. This equals to 0.07% of the Site.

8.3 This is a “major development” because it is >1ha. A new building with a floorspace of more than 1000m^2 would also be ‘major’’. If Pelham Solar Farm sought planning consent for a building with a footprint of 472.8 m^2, it would not be classed as major development. And, here, the potential new “hardstanding” is not concentrated in one area, but is dispersed across a large area, so would have significantly less potential impact on surface water than a single building that would not be classed as major development.

8.4 This is a Site with no identified flood risk conditions. Infiltration testing is unnecessary because there is nothing that would be vulnerable should the geo-hydrological conditions mean that the 300mm area is not always sufficient and may sometimes exceed the storage capacity provided by the gravel base.

8.5 The new buildings on a permeable gravel base are not changing any underlying conditions beyond the topsoil. What would otherwise be topsoil is being replaced by gravel which has 30% more porosity and storage capacity than the existing topsoil would have. This means even if the gravel base is insufficient for storage and infiltration, the resulting conditions are no different than they would be on the as-is farmland, except that the extra storage capacity of the gravel base is a betterment compared to the topsoil in the event that underlying conditions are not supporting effective infiltration.

8.6 Even a conservative assumption of 472.8m^2 is much less than what would trigger “major development” classification in an ordinary planning context. Furthermore, the dispersed new impermeable areas are surrounded by year-round vegetated ground and wholly undeveloped natural “filter strips” between arrays. Although solar farm land-take makes it “major”, this is a box-ticking fact and not an accurate representation of impact with respect to flood risk. Inherent mitigation and SuDS incorporated into a solar farm means nil-low risk and more likely a positive improvement compared to arable use.

Surface Water Drainage Strategy

8.7 The Site is currently undeveloped farmland and therefore the runoff rate is considered to be greenfield runoff rate. The existing runoff rate has been estimated using the Wallingford Rational Method and is given in full in Appendix B. The rainfall used to derive the surface water runoff rates and volumes was obtained from the Flood Estimation Handbook (FEH) Web Service, depth-duration-frequency model. The existing greenfield rate for the whole area and per hectare for selected return periods is summarised in Table 2.

Table 2 - Existing/Greenfield Runoff Rates

Return Period (years)	Runoff Rate for 1 hr storm event (l/s/ha)	Runoff Rate for 1 hr storm event (l/s) for 64.3ha
1 in 1	7.7	497.5
1 in 30	25.7	1651.1
1 in 100	33.4	2145.9
1 in 100 + 40%CC*	46.7	3004.3

**CC – Climate Change Allowance*
l/s/ha = litres per second per hectare
l/s = litres per second

8.8 As mentioned in Section 8.2 above the presence of solar panels and associated ancillary buildings will result in total potential new impermeable surfaces are of 472.8m^2, which equals 0.07% of the Site. If a conservative approach is adopted and assumed that the ancillary buildings on site will entail new hardstanding, the runoff rates from the site post development would be as presented in Table 3 below.

Table 3 – Proposed Development Runoff Rates

Return Period (years)	Runoff Rate for 1 hr storm event (l/s/ha)	Runoff Rate for 1 hr storm event (l/s) for 64.3ha
1 in 1	7.6	498.3
1 in 30	25.7	1654.0
1 in 100	33.4	2149.6
1 in 100 + 40%CC*	46.8	3009.4

**CC – Climate Change Allowance*
l/s/ha = litres per second per hectare
l/s = litres per second

8.9 The figures above demonstrate that the difference in the runoff rates is negligible. However, as discussed earlier in this report, this is not entirely accurate. The SuDS strategy proposes that the transformers and inverters as part of the design, incorporate a 300mm deep subbase which will be constructed out of suitable material to provide a 30% ratio. This can provide sufficient attenuation storage for a worst-case 1 in 100 year storm event plus an appropriate allowance for climate change (40%). If it is conservatively assumed that the sub-station building entails new impermeable surfaces, it is proposed to construct a French drain around the building which will have enough capacity to attenuate the runoff from the building during the 1 in 100 plus Climate Change event (40%).

8.10 The drainage system will ensure that the surface run off is intercepted and discharged in a controlled manner from the Site, therefore reducing flood risk.

8.11 An overland flow pathway is present within the centre of the Site, and a minor flow path is present in the south east part of the Site. The areas of the flow paths, where the panels potentially will be located, are predicted to have depth of less than 300 mm. As the panels will be raised to a minimum of 900 mm above ground level, the solar panels will not cause any blockage of the existing flow pathway.

9 OFFSITE IMPACTS AND RESIDUAL RISK

9.1 Incorporation of one or more runoff management techniques as outlined in Section 8, will have a positive impact upon field drainage and there will be limited impacts on off-site surface water receptors.

9.2 The Proposed Development would maintain the existing rates of runoff, not block any overland flow pathway, reduce the risk of nutrient or pesticide wash off on soil particulates thereby improving water quality in the receiving watercourse, and also contribute to maintenance of the natural drainage regime.

9.3 For extreme events, the Site's topography will convey exceedance flows overland in south east and north east direction. This will potentially be along field lines in line with current natural drainage patterns.

9.4 In summary, providing suitable soil management measures and monitoring of the Site during operation and, if required, SuDS techniques incorporated into the design, the Proposed Development would have negligible effect on flood risk onsite or elsewhere and would preserve the Site's natural drainage regime.

10 SUMMARY AND CONCLUSIONS

Summary

10.1 A site-specific FRA following the guidance of the NPPF guidance has been prepared for the Pelham Power Solar Farm and ancillary development located at Pelham, approximately 700 metres (m) south-west of Berden in Essex.

Flood Risk

10.2 The EA map for planning shows that the Site is located in FZ1, where the probability of fluvial or tidal flooding is low.

10.3 The EA map for Surface Water Flooding indicates that most of the Site is at 'Very Low' risk of flooding, Limited linear areas within the Site are defined as being at 'Low', 'Medium' and 'High' risk of surface water flooding. The location of the areas at risk of surface water flooding appear to coincide with topographical lows in the terrain which form a land drain path.

10.4 The susceptibility to groundwater flooding is low.

10.5 The risk of flooding from reservoir failure has been assessed as low.

Hydrological Appraisal

10.6 The percentage increase in impermeable area is negligible and ordinarily would not require any surface water management scheme. The incorporation of appropriate management techniques will mitigate potential increase in runoff from the Proposed Development.

10.7 The Proposed Development design, as well as surface water and soil management measures outlined in Section 8, will ensure that there is negligible alteration to local drainage patterns and flow directions and manage suspended sediments from entering the drainage channels.

Surface Water and Soil Management Measures

10.8 SuDS techniques will 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.

10.9 Where construction has resulted in soil compaction, the areas between panel rows would be tilled / scarified to an appropriate depth and then re-seeded with an appropriate vegetation cover.

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

10.11 Any existing field or tile drainage system will be restored, where affected by construction will be maintained by the Applicant for the life of the Proposed Development.

10.12 Access tracks will be constructed out of permeable materials (crushed stone or reinforced grass).

10.13 The solar panels will be raised to a minimum height of 900 mm. The panels will be located away from the defined floodplain and will not cause any blockage of the overland flow route.

Conclusion

10.14 This FRA demonstrates:

- The Site is at low risk of flooding from fluvial and/or tidal flooding;
- It 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
- With appropriate surface water and soil management measures there is negligible alteration to local drainage patterns direction within the Site.

10.15 In summary, the Proposed Development is at 'Low' risk of flooding and with appropriate surface water and soil management measures would cause negligible effects on the hydrological regimes.

APPENDICES

Appendix A

Development Plan

Site boundary	Existing woodland and hedges	New community woodland
Proposed solar panels	New woodland and hedges	For further discussion with land owner
Public Right of Way	Proposed stone access tracks	New permissive footpath
2m high post and wire deer fence	Transformer substation (10 no. total)	

STATERA ENERGY

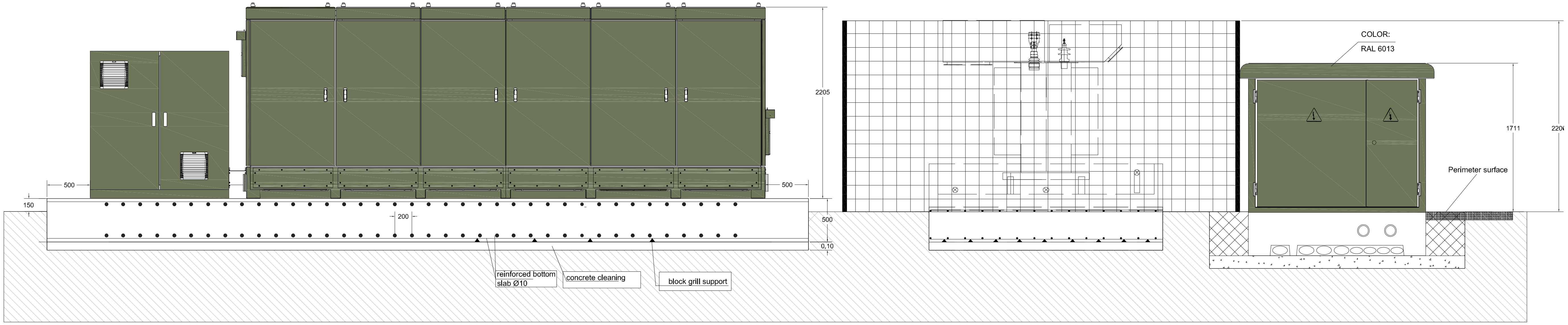
Revision	Date	Comment
–	–	–

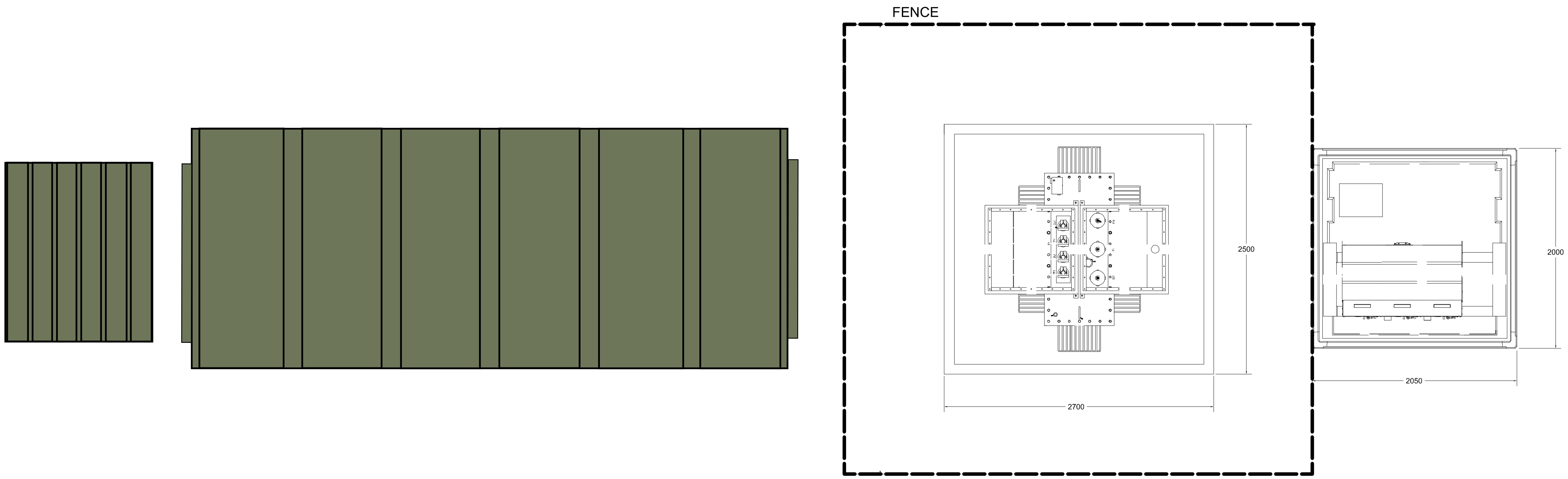
ON BEHALF
Pelham Solar

PROJECT
Proposed Solar Farm,
Stocking Pelham, Essex

DATE 28th January 2022
SCALE 1 : 2,500 @ A1
DWG No 375_MP_03
APPROVED CMcD

TITLE
Block Plan





Date: 13.02.22

Scale: 1:50 @ A3

DWG No: 458_ITU_10

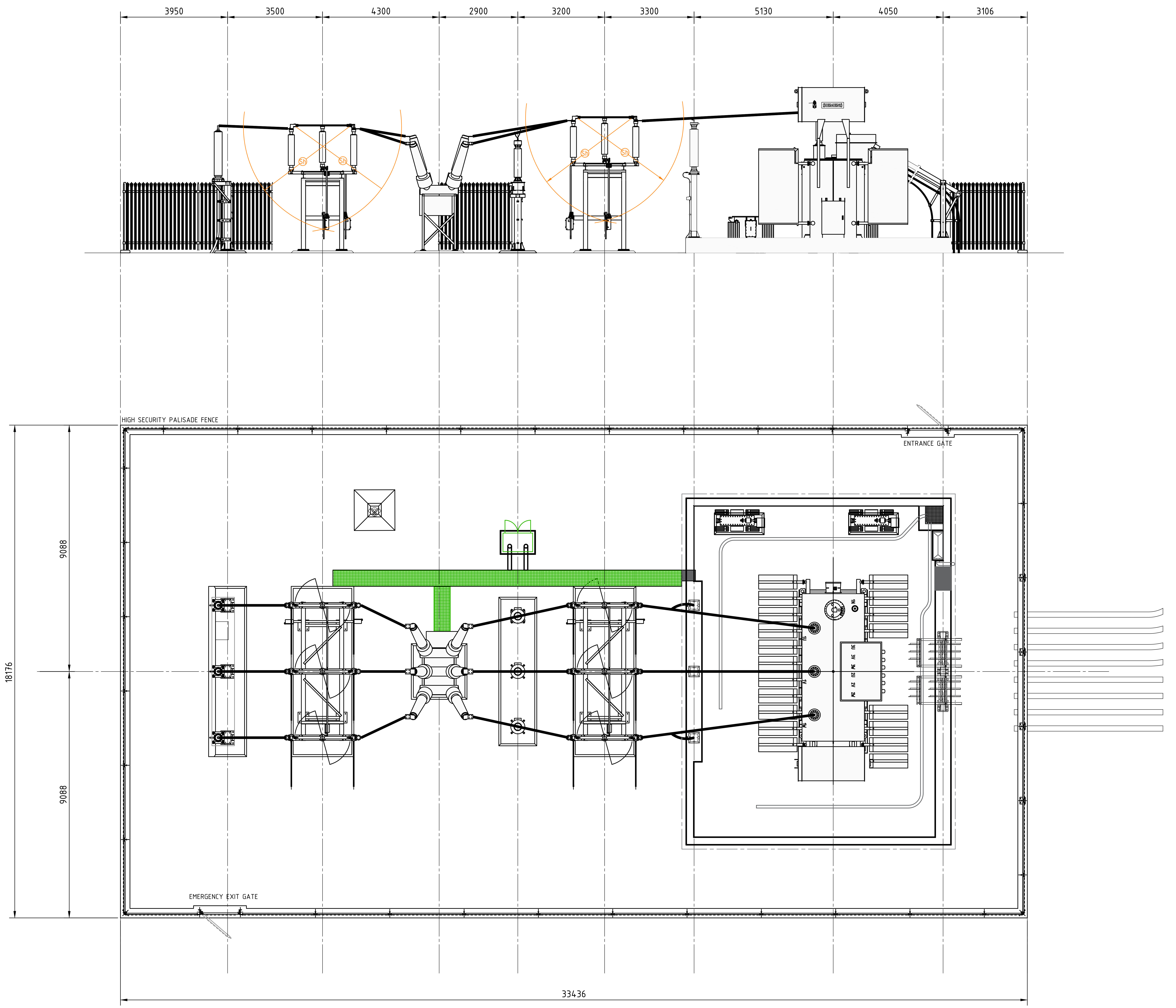
Revision	Date	Comment

0 1 2 3 4 5M

Client: Pelham Solar Ltd

Project: Solar Farm near Stocking Pelham

Title: Inverter and Transformer Block



Rev	Date	Description	Drn	Chk	App
P4	02.12.19	BASE CO-ORDINATES ADJUSTED	MI	MP	DG
P3	05.11.19	BASE POSITIONS ADJUSTED	MI	MP	DG
P2	22.10.19	GRP CONTROL ROOM REMOVED	MI	MP	DG
P1	09.04.19	PRELIMINARY	MI	MP	DG

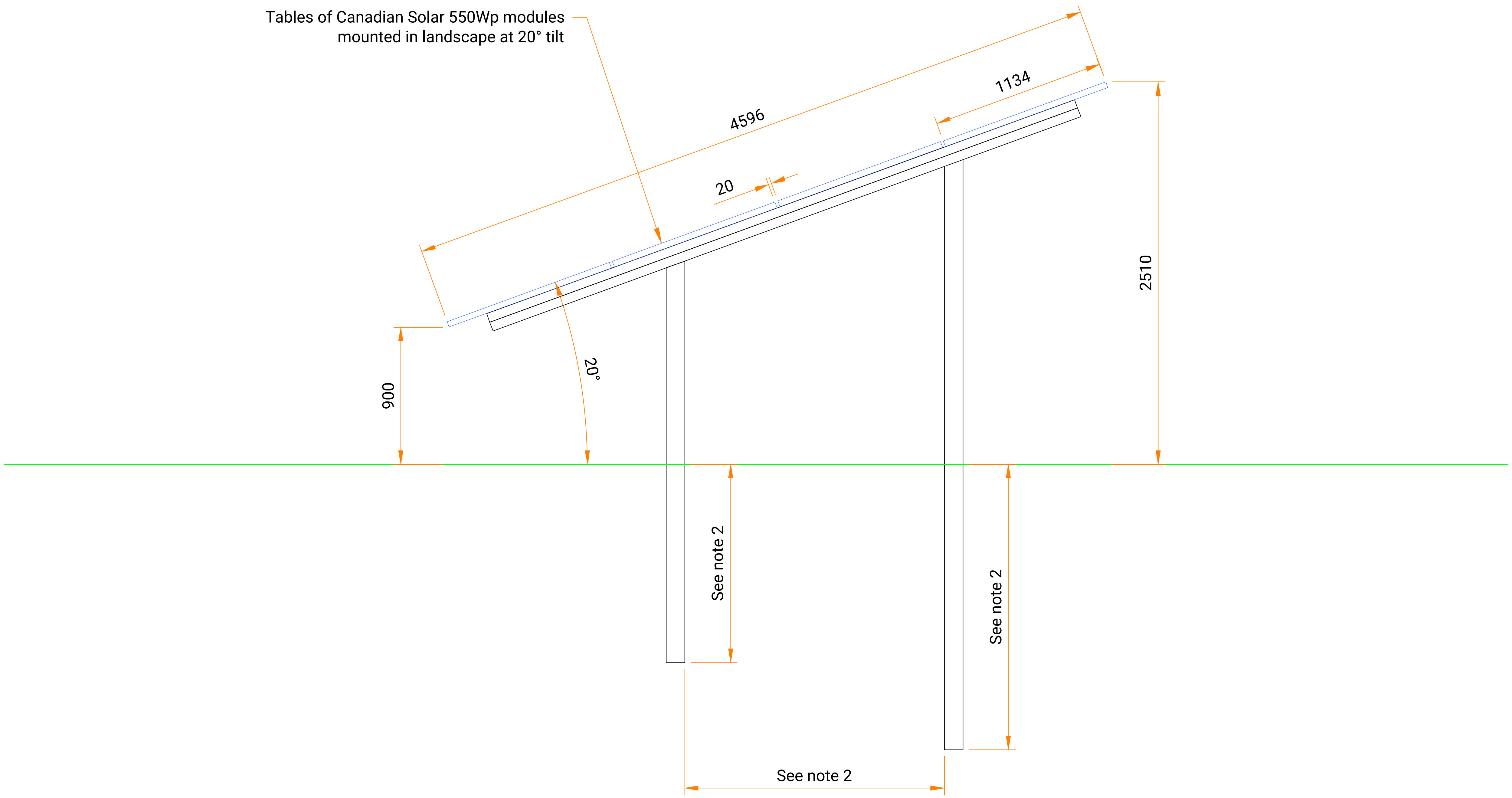
DUNAMIS
A FULCRUM GROUP COMPANY

Unit 2, The Wheelwrights, Lower Green, Higham, Bury St. Edmunds, IP28 6NL.
Telephone Number: 08447 400 076 - [redacted]

Description:

CUSTOMER
132/11/11kV TRANSFORMER
SUBSTATION LAYOUT

Project Name: SALTHOLME
Customer: STATERA
Status: PRELIMINARY
Project Number: 500889 Scale: 1:100 Size: A2
Drawing Number: 1001 Revision: P4



Notes:

1. All details are indicative only.
2. Dependent on framework design and geotechnical results - by others.

REVISIONS				
REV	DATE	COMMENTS	BY	CHKD
-	06.01.22	First issue	SS	KC

CLIENT	Statera Energy
PROJECT	Pelham Solar Farm
LOCATION	Stocking Pelham, East Hertfordshire
TITLE	Indicative Table Section Detail
DWG NO	SE-PELHAM-SD-01
REV	-

HELIOWORKS

Appendix B

Pre and Post development Runoff rates

PRE- & POST-DEVELOPMENT RUNOFF RATES

Design Rainfall

The rainfall used to derive the surface water runoff rates and volumes was obtained from the Flood Estimation Handbook (FEH) Web Service, depth-duration-frequency model. This provides design rainfall intensities for a range of return periods and storm durations, which are presented in Table A.

Table A. Design rainfall intensities

Intensity (mm/hr)									
	0.25	**0.5**	**1**	**2**	**3**	**5**	**12**	**24**	**48**
1	24	15.02	9.21	7.11	5.75	4.17	2.17	1.26	0.74
2	34.68	21.88	13.24	9.56	7.52	5.33	2.71	1.55	0.90
5	49.24	30.88	18.82	12.82	9.88	6.86	3.42	1.92	1.10
10	60.8	38.34	23.23	15.35	11.67	8.02	3.95	2.20	1.25
30	78.48	50.2	30.57	19.58	14.72	9.99	4.85	2.67	1.50
50	87.6	56.1	34.21	21.77	16.31	11.04	5.35	2.94	1.63
100	101.2	65.02	39.73	25.22	18.93	12.88	6.25	3.41	1.86
100+5%	106.26	68.271	41.7165	26.48	19.88	13.52	6.56	3.58	1.96
100+10%	111.32	71.522	43.703	27.74	20.82	14.16	6.88	3.75	2.05
100+20%	121.44	78.024	47.676	30.26	22.72	15.45	7.50	4.10	2.24
100+30%	131.56	84.526	51.649	32.78	24.61	16.74	8.13	4.44	2.42
100+40%	141.68	91.028	55.622	35.30	26.50	18.03	8.75	4.78	2.61

Surface Water Runoff Rates

The Wallingford Modified Rational Method has been used to estimate the surface water runoff generated during peak rainfall events based on the nature of the ground surface (hard standing, vegetation, etc) and rainfall depth, duration and frequency information for the immediate area. A runoff coefficient of 1 and 0.3 was applied for the impermeable and the permeable areas in line with best practise for surface water runoff estimation.

The Site is currently undeveloped farmland and therefore the runoff rate is considered to be greenfield runoff rate. The pre-development greenfield runoff rates from the whole site for a range of return periods, including climate change are presented in Table B below.

The presence of solar panels and associated ancillary buildings will result in total potential new impermeable surfaces are of 472.8m2, which equals 0.07% of the Site. If a conservative approach is adopted and assumed that the ancillary buildings on site will entail new hardstanding, the runoff rates from the site post development would be as presented in Table C below.

Table B. Pre -development runoff rates for the whole site (64.3ha)

Surface Water Runoff Rates (l/s)									
	0.25	0.5	1	2	3	5	12	24	48
1	1296.3	811.3	497.5	383.8	310.4	225.1	117.2	67.8	40.0
2	1873.1	1181.8	715.1	516.1	406.4	287.7	146.6	83.6	48.5
5	2659.6	1667.9	1016.5	692.2	533.5	370.5	184.8	103.7	59.4
10	3283.9	2070.8	1254.7	828.8	630.1	433.0	213.3	118.8	67.4
30	4238.9	2711.4	1651.1	1057.6	795.1	539.7	262.0	144.3	80.9
50	4731.5	3030.1	1847.8	1175.6	880.9	596.5	289.1	158.5	88.1
100	5466.0	3511.9	2145.9	1361.9	1022.4	695.5	337.6	184.3	100.7
100+5%	5739.3	3687.5	2253.2	1430.0	1073.6	730.2	354.5	193.6	105.7
100+10%	6012.6	3863.0	2360.5	1498.1	1124.7	765.0	371.4	202.8	110.8
100+20%	6559.2	4214.2	2575.1	1634.3	1226.9	834.6	405.1	221.2	120.8
100+30%	7105.8	4565.4	2789.7	1770.5	1329.2	904.1	438.9	239.6	130.9
100+40%	7652.4	4916.6	3004.3	1906.7	1431.4	973.6	472.7	258.1	141.0

Table C. Post -development runoff rates whole site (64.3ha)

Surface Water Runoff Rates (l/s)									
	0.25	0.5	1	2	3	5	12	24	48
1	1298.5	812.6	498.3	384.4	310.9	225.5	117.4	67.9	40.0
2	1876.3	1183.8	716.3	517.0	407.0	288.2	146.8	83.7	48.6
5	2664.1	1670.7	1018.2	693.3	534.4	371.2	185.1	103.9	59.5
10	3289.5	2074.4	1256.8	830.2	631.2	433.7	213.7	119.0	67.6
30	4246.1	2716.0	1654.0	1059.4	796.4	540.6	262.5	144.5	81.0
50	4739.5	3035.2	1850.9	1177.6	882.4	597.5	289.5	158.8	88.3
100	5475.3	3517.8	2149.6	1364.2	1024.2	696.6	338.2	184.7	100.9
100+5%	5749.1	3693.7	2257.0	1432.4	1075.4	731.5	355.1	193.9	105.9
100+10%	6022.9	3869.6	2364.5	1500.7	1126.6	766.3	372.0	203.1	110.9
100+20%	6570.4	4221.4	2579.5	1637.1	1229.0	836.0	405.8	221.6	121.0
100+30%	7117.9	4573.2	2794.4	1773.5	1331.4	905.6	439.7	240.0	131.1
100+40%	7665.5	4925.0	3009.4	1909.9	1433.9	975.3	473.5	258.5	141.2