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GWP Report No: 250611

Our ref: cpc030625
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03 June 2025

Dear Mrs Cameron

Independent Review of Botley West Solar Farm Environmental Statement Reports with respect to Cassington Village flood-risk related Matters

Text of letter in normal style

Please find below our preliminary independent review of the flood risk assessment and hydrology sections of the Botley West Solar Farm Environmental Statement (ES) reports, submitted by the Applicant SolarFive Ltd.

For the avoidance of doubt the following reports (dated November 2024) have been reviewed:

- Volume 1 Chapter 10: Hydrology and Flood Risk
- Volume 3 Appendix 10.1: Flood Risk Assessment
- Volume 3 Appendix 10.2: Conceptual Drainage Strategy
- Volume 3 Appendix 10.3: Hydraulic Modelling Report
- Volume 3 Appendix 10.4: Hydrology Report
- Volume 3 Appendix 10.5: Surface Water Modelling Report
- Outline Code of Construction Practice
- Outline Operational Management Plan

The purpose of this letter is to present the findings of this independent review to identify potential omissions, errors and inaccuracies in the documentation of particular importance to, the village of Cassington, but also of relevance to the wider project area. This review is not a detailed critique of the flood risk related work completed by the Applicant and their consultants.

A previous similar assessment of the PEIR documentation was undertaken in July 2024. That report considered the wider project area and its impact across the surrounding countryside and was not village specific. The findings of that review are not repeated verbatim below, however the critical conclusion of the earlier assessment that storm water run-off risks had not been adequately assessed is highlighted at this time.

Qualifications and Experience – Clive Carpenter

My name is Clive Carpenter. I have a BSc (Hons) 2.1 in Geology (Bristol, 1989), an MSc in Hydrogeology and Groundwater Resources (Birmingham, 1992) and more than 30 years of post-graduate experience in water management and impact assessment projects in the UK and overseas, including technical leadership of flood risk assessments and flood alleviation strategies. I also have more than 30 years of experience in the strategic planning, feasibility and design of water management for large scale infrastructure projects globally, including on-going responsibility for construction works water management design on a £1.5 Billion transport project in the UK.

I am a fellow of the Geological Society (FGS), Chartered Geologist (CGeol), European Geologist (EurGeol) and a Chartered (C.WEM) Member (MCIWEM) of the Chartered Institute of the Water and Environmental Management. I am also an associate member of the Academy of Experts (AMAE).

I am a member of the International Association of Hydrogeologists (IAH), was an IAH British Chapter Committee Member (2005 – 2012) and have been the IAH British Chapter Secretary (2007 – 2012).

Cassington Village

The village of Cassington is located at the southern end of the Central Site Area of the proposed Botley West development. It is located approximately 500m east of the River Evenlode and 700m north of the River Thames, on the northern extent of the Thames floodplain. Cassington Parish includes the hamlet of Worton is approximately 700m to the north-east of the village.

Historically Cassington has been vulnerable to storm rainfall, with the Cassington Stream flowing through the middle of the village, fed by field drains and field storm water run-off from the field on the higher ground to the north-west of the village. Flood vulnerable areas include Elms Road, Sport Field, Foxwell Court, Foxwell End, St Peters Close, Horsemere Land, Reynold Farm and Jericho Farm. The flooding is understood to be, in part, due to flow restrictions through the village due to limited ditch and culvert flow conveyance. The village has not been historically flooded by the River Thames. This pluvial storm water overland run-off flood risk was deemed sufficiently concerning for Atkins to be commissioned by the Blenheim Estate to undertake an assessment of natural flood management options for the village.

Flood Risk Policy Framework

Flood risk policies of relevance to this proposed development exist at national, district and local level. Of specific relevance are:

National Policy Statement (NPS) EN-1 which states that development should be designed to ensure there is no increase in flood risk elsewhere. Surface water drainage arrangements for any project should be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed development.

West Oxfordshire Local Plan 2031. Policy EH7: Flood Risk which states all sources of flooding will need to be addressed and measures to manage or reduce their impacts … incorporated into the development proposal.

Vale of White Horse District Council Local Plan 2031. Core Policy 42: Flood Risk which states the need to 'Ensure development does not increase the risk of flooding elsewhere', and that all developments require a Drainage Strategy … to ensure run-off rates attenuated to greenfield run-off rates.

More broadly, flood risk is a constraint and therefore a factor in considering development planning. The Cassington Parish Council Green Infrastructure Plan contains details of past flooding and current flood risk to the village of Cassington.

Overview of Proposed Project Applicant's Flood Risk Documentation

The Applicant's documentation has not changed substantively since being reviewed as the PEIR reports in mid-2024, with the exception of the greater focus on storm water flood risk assessment around the Cassington area. Nonetheless, the concerns expressed in the July 2024 are repeated here again, to ensure it is understood these concerns remain valid.

The Botley West project involves the installation of between 1,800,000 to 2,200,000 solar panels over an area of 14 km^2 (14 million m^2) of largely rural Oxfordshire, extending 16km north-to-south, crossing the floodplains of the River Evenlode and River Thames. The development requires supporting infrastructure including 156 PCS units, 6 transformers, a primary sub-station, and kilometres of cabling.

The solar panels will cover an area of approximately 840 hectares (8.4 million m^2) of which 545 hectares (5.45 million m^2) will be in the Central Site Area, immediately north of the village of Cassington.

The hydrology and flood reports consider flood risks to the development, and flood risks caused by the development, associated with rivers (fluvial), overland storm rainfall run-off (pluvial), groundwater, field drainage and sewers.

The Applicant's submission identifies impacts on:

- Increased flood risk from impermeable areas (mostly buildings)
- Deterioration in water quality
- Increased flood risk from damage to existing flood defences
- Impact on existing field drainage

Fluvial (River) Flooding Risk

Detailed river hydraulic flood modelling of the River Evenlode pre-development has been undertaken by the Applicant, which has delineated the river flooding extents for different storm return periods. Whilst there are numerous land parcels which will be inundated by river floodwaters, it is understood there are no solar panels or other above ground infrastructure to be placed in the river flood zones. Much of the Export Cable Corridor is located in Flood Zone 2 or 3, but the proposed method statement of using trenchless technologies will largely avoid direct physical disturbance to the water courses, the floodplain and associated minor flood defences. Consequently, the potential for changes to river flood risk are considered by this review to be relatively low. For Cassington which is located outside of Flood Zone 2, changes to the flow conveyance and storage within the River Evenlode are unlikely to affect the village.

Groundwater Flooding Risk

The potential for groundwater and sewer flood risk changing is considered by this review to also be limited given the general lack of underground infrastructure in the area. Effects are expected to be localised and any disturbance of sewers will need prior permission from the wastewater utility service provider. Groundwater can be expected to be encountered in low-lying valley floors and the boundary between permeable and low permeability strata – de-watering is likely to be required for cable trenching activities in these locations. Whilst no details are provided, any such dewatering work will be regulated by the Environment Agency and should therefore follow conventional engineering best practice and impact mitigation. Given the low permeability of the strata around Cassington, and no proposed cable routes near to Cassington, changes to the groundwater flooding are considered limited.

Pluvial (overland storm rainfall runoff) Flooding Risk

The most critical issue, in our opinion, is pluvial flooding risks associated with increased overland surface storm rainfall run-off due to the proposed development. The Applicant appears to recognise the increased importance and concern around this issue in that they have now prepared a new appendix for the ES on Conceptual Drainage Strategy and undertaken numerical modelling of surface water flow risks specifically for the 350 hectares of watersheds contributing to overland storm flows into and near to Cassington. Environment Agency surface water flooding maps show significant overland flow routes through the middle of the Land Parcel immediately upslope of Cassington, as well as overland flows also leaving Land Parcels further east and flowing through nearby farms and along the eastern side of the village.

The new Cassington surface water modelling work (which does not include the eastern flow route) shows reduced areas and depths of flooding compared to the EA pluvial flood maps but still calculates flood flows passing through the village and impacting on properties. The Applicant does state however that the model is not calibrated, does not include measurements of culverts, nor include urban pipework. Nonetheless it estimates flow velocities of up to 1.0 m/s upstream of the village and up to 2.0 m/s downstream of the village, velocities that result in a very high flood hazard category (> 2.0) for the village.

The numerical modelling has been used to identify possible approaches to reducing the pluvial flood risk to Cassington eg ponds, bunds and ditch widening. But the model has not then been used to test the effectiveness of these approaches – so the extent to which they might deliver sufficient, or any, benefit is unproven. Indeed, it is possible that ditch widening could increase flooding further downstream.

The proposed drainage strategy is split into four parts: solar panels, ancillary buildings, transformers and substations. The Applicant proposes standard surface water capture, attenuation and discharge approaches and technologies for ancillary buildings, transformers and substations recognising that these all introduce impermeable hardstanding which will increase flow rates and total flow. However as per their position in the PEIR, the Applicant continues to believe the solar panels themselves will not significantly increase in run-off. We discuss this further in the next section, along with their proposed solar panel flood risk reduction measures, which by their very existence confirms the Applicant does accept solar panels will increase storm water run-off and therefore pluvial flood risk, compared to the pre-development situation.

To be clear, national, county and local policies, plans and legislation require any development to ensure that the storm run-off which leaves the development footprint must not have a greater peak flow or total volume of flow compared to the pre-development situation.

The Applicant states clearly in the latest documentation that the drainage systems have been developed as far as concept designs, but they have yet to determine the methods of surface water flow discharge, nor have they determined the locations of off-site discharges, and hence have no site-specific detailed designs, which will be left to a later detailed design stage. Furthermore, despite a 12-month period passing since the PEIR documentation became available, the Applicant still have not undertaken any infiltration testing on the site.

We therefore continue to consider the lack of infiltration testing to be a critical issue in that the Applicant has no quantitative understanding of the extent to which they will be able to infiltrate water into the ground and therefore they cannot determine with any confidence, the size of attenuation ponds they require or whether there is room for the required size of ponds where they will be required to be sited. To be clear, they have not demonstrated the feasibility or viability of their proposed drainage schemes.

If the requirement to attenuate storm water run-off was limited to solely the associated infrastructure, as the Applicant states, then the feasibility of managing storm run-off for a minor area (2.2 hectares) of the wider site might be relatively easy to demonstrate. However, as we will demonstrate in the next section, the Applicant's assumption that solar panels - which reportedly cover up to 840 hectares (60%) of the 14km^2 - do not significantly increase run-off, is fundamentally wrong.

What the Applicant does recognise is that the solar panels will increase erosion. They suggest this increase in erosion risk is mitigated by a well-managed organic vegetation grassland – although then refer in their documentation to the vegetation being managed organically (mowed or lightly grazed), which actually consequently means there will be a continuously variable and changing seasonal vegetation cover, that is to say the mitigation measures will have no design and therefore there is no confidence they will be effective in extreme storm events, up to and including the 1 in 100 Year return period storm.

Solar Panel Run-Off

As per the PEIR documentation, the Applicant continues to state that solar panels do not significantly increase run-off peak flow and volumes from solar developments. The Applicant now includes specific sections on this issue, but now refers to how the solar panel impact of increasing run-off will be reduced, eg low slope angles, gaps between arrays and panels, filter strips and permeable access tracks.

It is clear therefore that the Applicant now accepts solar panels will increase rainfall run-off but they are articulating that they are attempting to minimise this increase. It is not clear whether they consider the mitigation measures adequate to return the storm run-off flows to pre-development levels, and especially for extreme rainfall events (up to 1 in 100 Year + climate change allowance, return periods).

Whilst we do not agree that gaps between panels and arrays will reduce run-off, as the size of the panelled area installed remains the same, we do point out that lower slope angles mean a greater 'effective' hardstanding area, and as such one of their proposed mitigation measures will actually make the volume of intercepted rainfall greater.

As before to support their statement solar panels do not increase storm run-off, they refer to out-dated research by Cook and McCuen published in 2013, which they advise concluded that full vegetation cover is required beneath the modules to make changes in run-off flows insignificant. As before the Applicant goes onto dismiss research by Pisinaras (2014) and Yavari (2022) which report increases in storm run-off, considering these results as inappropriate given the semi-arid environment the work was undertaken in.

It is very noticeable however, that the Applicant does not challenge the more recent research, referenced by ourselves in our July 2024 report letter, in this technical area, which provides consistent conclusions that solar panels increase peak run-off, increase total flows and increase erosion compared to the pre-development situation. This more recent research is considered to better represent the micro-hydrology of, and the inter-relationship between, the solar panels, the below-panel shaded vegetation and the inter-panel access corridors.

For ease of the reader, the following research summaries are repeated here from our July 2024 report letter:

- Gullotta et al (2023) found that whilst there were no practical changes in run-off immediately after installation, that in the long-term, peak run-off rates increased by 20-35% due to changes to the vegetation and soils, principally: increased saturation of the access corridor due to panel run-off drip-lines; corridor soil compaction due to maintenance vehicles resulting in reduced infiltration; and lower vegetation growth under the panels due to shading. The 3 contributing factors result in faster surface water run-off, greater total run-off volumes (up to 5%) and increased velocities, which logically will result in more erosion. It should be noted, it is peak run-off which is primarily responsible for flooding.

- Galzki et al (2024) undertook research on 5 commercial solar farms in the USA over a wide range of climatic conditions. They found that run-off from a fixed panel was approximately 10 times that from the incident precipitation rate on average, and that run-off increased by 14% for widely spaced panels, to 23% for narrowly spaced panels – note this did not include soil compaction in the access corridors. Panel orientation relative to the ground slope angle was also found (as would be expected) to be important, with panel rows orientated on the landscape contours generating less run-off than those installed up and down the hillslope. Increases in soil density in the access corridors (as would be caused by maintenance vehicles) also increased storm water run-off.

- Lastly, Liu et al (2023) investigated the effects of solar farms on soil erosion. He concluded that the effects of concentrating rainfall along solar panel downslope edges and the reduction in vegetation beneath the panels (due to 67-90% less solar radiation from panel shading), increased storm run-off peak flow rates by between 7% and 73%, and annual total run-off by between 14% and 4,046%, with erosion increasing by 58% to 88%. Liu identified rainfall intensity increasing by 5 times at the drip line compared to natural rainfall intensity. Liu also highlighted that once erosion commenced, this accelerated erosion rates increase further as it further concentrates overland flow into run-off channels. Liu also highlighted the particular risks during the construction period when vegetation removal and vehicle movements are at their greatest.

Whilst the above is a rather technical discussion, the concluding point is that contrary to the Applicant's submissions, research shows that solar panels do increase storm rainfall run-off. Because the Applicant cannot demonstrate the vegetation solution has a guaranteed reliability and effectiveness up to a given design event (ie a regulator specified required 1 in 100 Year plus climate change return period), then the vegetation and filter strip mitigation measures cannot be considered to be reliable to maintain storm run-off at predevelopment levels up to and including 1 in 100 Year return period storms.

The consequence for the Applicant is that they will need to manage (capture, store and slowly release) the storm water rainfall run-off from nearly all 14km^2 (1,400 hectares) of the development that contains the 840 hectares of solar panels, as opposed to the 2.2 hectares they are proposing. This is a fundamental error on the part of the Applicant, which underestimates (if we assume hectares to be managed as a reasonable metric) surface water flood risk by almost 3 orders of magnitude. On this basis the application should be refused.

Surface water management of this scale will require considerable land take, which will need to be outside of the river flood zones in order to be effective. It is not clear whether this is achievable on the site with the number of solar panels proposed and as such this questions the feasibility of the proposed development. Conversely if the Applicant choses to reduce the number of solar panels to accommodate the necessary surface water management infrastructure, this would presumably impact the cost effectiveness of the development and may result in the financial viability of the scheme becoming problematic.

Additional Omissions and Concerns

The below omissions and concerns were identified in our letter of July 2024. The Applicant's position on these issues has not changed since the PEIR reports, and therefore they are all repeated here again as they all remain valid:

i) The wider site has at least 10 No. Ordinary Watercourses passing through the development land parcels and numerous more ancillary drainage routes. These demonstrate that surface water will also flow onto the site from land upslope of the solar panel land parcels. Such run-off will increase the amount of run-off on the site that needs to be captured and managed – thereby overwhelming any surface water management structures sized for the development area or sub-areas, unless perimeter drainage is installed to prevent off-site areas draining onto the on-site land. This issue has not been recognised by the Applicant, in large part because they do not recognise the need to manage surface water over the entire area with solar panels. It has not been demonstrated by the Applicant that all land areas draining onto the site can be routed around the development. Where they cannot, then such areas will contribute to overwhelming the on-site water management infrastructure, increasing downslope flood risk;

ii) The construction phase is recognised by the Applicant as having an adverse impact on surface water run-off flood risk. They state this will be reliant on the Code of Construction Practice (CoCP) to ensure control of surface water run-off risk. However, the Outline CoCP which is now available, does not mention surface water drainage management, and states a Flood Management Plan will only be prepared prior to construction. It is therefore not only uncertain but impossible to currently assess the adequacy of the CoCP to manage this risk;

iii) The Applicant recognises the need to not only attenuate construction phase storm run-off flows but also enable adequate treatment (most likely turbidity clarification). However, such treatment requires much slower flow rates than pre-development storm events and as such the amount of storm water retention on site during the construction phase had to be much greater than post-construction. This does not appear to have been recognised by the Applicant. No details are provided on construction phase drainage, nor pollution control measures, which they advise are to be developed under the CoCP, including a Pollution Prevention Plan. It is therefore not only uncertain but impossible to currently assess the adequacy of the CoCP to manage this risk;

iv) Accepting that the entire area containing the solar PVs needs to be managed to control its surface water management then it follows that for this development with dozens of Land Parcels each potentially flowing to more than one off-site micro-catchment that this will necessitate dozens of construction phase and operational phase retention basins and treatment facilities – each similar to those prosed for the Land Parcel adjacent to Cassington. There is no evidence to demonstrate that these issues have been adequately evaluated to confirm the construction of up to 2.2 million solar panels in a $14km^2$ area is feasible, nor that they can be adequately operated and maintained given operational phase flood risk and water quality risk management are to be detailed later in the Operational Management Plan.

Conclusions

The conclusion of this independent flood risk and drainage review of the Environmental Statement documents is not substantively different from the conclusions made in July 2024 on the PEIR documentation. The Applicant has done little to address the critical inadequacies and omissions in the earlier stage of the project design and assessment process. Specifically, the Applicant's submissions on Hydrology and Flood Risk fail to adequately consider the increase in pluvial flood risk to surrounding village communities due to storm rainfall run-off from the solar panels. Consequently, there is no consideration given to the significant water management infrastructure required to be compliant with the statutory regulatory regimes.

The additional analysis and optioneering work undertaken by the Applicant to inform pluvial storm water flood risk reduction measures for Cassington village – notwithstanding its own limitations and lack of risk reduction measure detailed design and assessed effectiveness - highlights the inadequacies of the Applicant's approach for other storm water flow routes leaving the site. Without such risk measures being put in place, the development will increase downslope and downstream flooding risks, a situation which is not permitted under planning.

Furthermore, the Applicant has not demonstrated they will be able to adequately manage surface water run-off and sediment mobilisation during the construction period, which given the size of the scheme and natural terrain geometry will cause challenges which could prevent delivering the proposed development.

Accordingly, we consider the DCO cannot be approved, and these issues should be subject to a public hearing.

Yours sincerely

[redacted]

Clive Carpenter

Partner and Head of Water Management

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