OAKLANDS FARM SOLAR PARK

Applicant: Oaklands Farm Solar Ltd

Response by the Applicant on Landscape and Visual Matters

October 2024

Document Ref: EN010122/D5/13.11

Version: Deadline 5

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This note has been prepared by LUC in relation to the concerns raised by Ms Abbott (**[REP1-043]** and **[REP4-022]**), the questions asked to date by the Inspector (**[PD-012]** and **[EV4-001]**) and further queries that were raised by the Inspector during the Issue Specific Hearing on 22nd October 2024, to provide assurance that the visualisations that supplement the Landscape and Visual Impact Assessment (LVIA) are fit for purpose and are accurate to an appropriate degree. It focuses on the two viewpoints referred to by Ms Abbott within her responses, Viewpoint 1 (Coton Road) and Viewpoint 2 (Cross Britain Way), which are the closest two viewpoints to the Proposed Development.

As set out in this note, the visualisations have been checked in two ways and the Applicant is confident there are no variations which are unusual or unexpected. The variations between the OST5 dataset and the other datasets (i.e. LiDAR and partial topographical survey of the actual site) are in line with the limitations of the OST5 dataset, and the resulting photomontages are a good representation of what the development would look like, albeit not an exact replica of reality.

<u>Landscape and Visual Impact Assessment and visualisation guidance</u>

The visualisations that supplement the LVIA follow industry standard guidance, notably:

- GLVIA3 - 3rd Edition Guidelines on Landscape and Visual Impact Assessment (GLVIA3); and
- Landscape Institute Technical Note - TGN 06/19 Visual Representation of development proposals.

Both guidance documents acknowledge that visualisations should be a good representation of what the development would look like, albeit not an exact replica of reality, as follows:

- Paragraph 8.23 of GLVIA3 states that *"Visual representations can never be the same as the real experience of the change that is to take place. They are tools designed to assist all interested parties to understand how the change proposed will affect views at particular viewpoints"*

- Paragraph 1.2.13 of TGN 06/19 states that *"Two-dimensional visualisations, however detailed and sophisticated, can never fully substitute what people would see in reality. They should, therefore, be considered an approximation of the three-dimensional visual experiences that an observer might receive in the field".*

When undertaking a LVIA, visualisations are used alongside a zone of theoretical visibility (ZTV) and field work, as visual aids, as tools and aids, but not as a means to determine the effect.

<u>Datasets and their recognised limitations</u>

Visualisations are based on digital terrain models (DTMs), which are purchased datasets. One such dataset is OST5 which, in common with most solar projects of this nature, has been used to prepare the visualisations that supplement the LVIA. A detailed explanation regarding the calibration undertaken of the digital terrain model to actual ground levels was provided in the Applicant's Supplementary Response to Q9.1.1 of ExQ2 **[AS-027]**. In simple terms, the DTM is imported into a three-dimensional (3D) environment. The terrain models are already geolocated (at the correct latitude, longitude and height) when imported. A virtual camera is placed in the scene at the same coordinates as real-world GPS coordinates which are recorded on site during photography, using a h-specification handheld GPS unit (Garmin). Identifiable features within the landscape (e.g. posts, pylons, signs, buildings etc) are located, and replicated using cylindrical 'markers' within the digital 3D scene at the correct position and height. The digital scene is overlaid onto the baseline photography and the camera position is then adjusted to ensure complete accuracy when aligning both the terrain and markers against the existing features of the landscape within the photography.

Another digital terrain model dataset is LiDAR, which has been used to cross check the accuracy of the visualisations.

The DTMs use datapoints on a grid – so heights between each datapoint are an approximation. The data looks like a series of tiles tilted at different angles, i.e. a 3D grid. The datasets include statements as to their Root Mean Square Error (RMSE)[1] – highlighting any possible variance from the true landscape height.

Further information on how these datasets are collected, along with their tolerances and limitations, is provided below.

<u>Accuracy of OST5 data</u>

OS Terrain 5 Digital Terrain Model (OST5 DTM) is produced by the Ordnance Survey (OS) and provides a high-resolution accurate model of the ground surface. It represents a bare earth scenario which does not account for the screening effects of any vegetation, buildings, or other surface objects. This dataset is commonly used as the basis for visualisations for solar farms. On the OS website, the OST5 DTM product details states "OS Terrain 5 is the height data you need to model construction projects within the wider landscape. This helps you give planners an accurate virtual view of your plans and the steps you're taking to minimise their visual impact on the surrounding area".

Accuracy:

OS T5 DTM data is considered a mid-resolution DTM, with a native resolution of 5m, and is suitably accurate for the purposes of creating a visual representation of a proposed solar farm development. The results of a comparison of OST5 to other datasets, including actual topography data obtained by survey of the Oaklands Farm site (seen in Figure 1: Topography Reference Points) show OST5 typically sits a little higher than the topographical survey, presenting a worse case scenario. The variation across the 10 spot checked heights on the site and all three datasets is between 0.01cm and 0.46m. A further breakdown of the terrain datasets used is available below.

To calculate the RSME for OST5, it is measured against several sample GPS points. It has been calculated for the following geographic areas, with greater accuracy being associated with point 1, given the main users of the dataset:

- Urban and major communication routes: 1.5m RMSE
- Rural: 2.5m RMSE
- Mountain and moorland: 2.5m RMSE

OST5 is derived from two main data sources: LiDAR (Light Detection and Ranging) and photogrammetry:

LiDAR is captured by sending laser pulses from an aircraft towards the ground. The time taken for the pulse to return to the aircraft sensor from the ground surface is used to calculate distance and thus create an accurate elevation model.

The raw data is then processed and filtered to remove points that reflect from buildings vegetation and other surface objects. This results in the creation of the bare earth DTM.

Photogrammetry captures detailed images of the ground from aerial photographs taken at a variety of angles, creating overlapping images. A 3D model of the terrain is created by calculating depth and elevation based on differences in the images' perspective.

Photogrammetry is often used in areas where LiDAR is less feasible due to cost or in regions with simpler terrain that would not require LiDAR's level of detail. While photogrammetry generally offers a

[1] RMSE – Root Mean Square Error - This is the square root of the mean of the squares of the errors between observations, such as GPS points. Definition taken from OS Terrain 5 User guide and Technical Specification.

slightly lower resolution than LiDAR, it still provides a suitable level of accuracy for the 5m resolution of OS Terrain 5 DTM.

Both sets of data are cleaned, interpolated, and undergo rigorous quality assurance (QA) to verify accuracy across different types of landscapes.

A comparison exercise has been undertaken by LUC to demonstrate any possible variance in height data seen on the site from actual surveys, using available LIDAR, OST5 and the topographical ground survey undertaken on part of the Oaklands Farm site on behalf of the Applicant by AquaTerra Consulting. The results (seen in Figure 1: Topography Reference Points) show OST5 typically sits a little higher than the topographical survey, presenting in this case a worst case scenario. The variation across the 10 spot checked heights on the site and all three datasets is between 0.01cm and 0.46m. A further breakdown of the terrain datasets used is available below.

Known limitations of OST5:

- Resolution – 5m spacing is sufficient for general analysis. If the project requires very high precision accuracy, it is unsuitable
- Terrain complexity – if the site in located within an area with complex topography, the accuracy may be less reliable. If a feature on site is smaller than the 5m grid spacing, such as a local undulation (bump or hollow), then it could be missed.
- Geographical variations - the vertical accuracy can vary based on landscape and region.
- Representation of the point - the height data is presented as a raster dataset[2] of height values, which are calculated at the centre of the pixel (square). However, no matter where the point is located within the 5m grid, this will always be an issue. It would not be possible to provide an infinite number of datapoints so there will always be a space between them.

<u>LiDAR data</u>

The principal of LiDAR data capture, as described above, applies for the Environment Agency (EA) DTM data. The main difference between EA LiDAR and OST5 is the resolution of the resulting data. Hundreds of thousands of measurements per second are made of the ground, allowing highly detailed terrain models to be generated at spatial resolutions of between 25cm and 2m.

Accuracy:

Vertical (height) - according to the EA, the absolute height error of every LiDAR survey is less than ±15cm, against at least one independent ground control. The independent control is undertaken by a field surveyor recording elevation values. Each elevation recording has a vertical accuracy of +/-0.03m. These elevations are then compared against the LiDAR survey and the RMSE is calculated.

Horizontal (planar) - the absolute spatial error in the LiDAR data is ±0.4m. For the datasets at 2m, 1m and 0.5m resolution, this error is effectively absorbed in the pixels of the raster image.

Known limitations of LiDAR:

- Weather sensitivity – LiDAR is best flown in optimal weather conditions. Conditions such as rain, fog and snow can affect the accuracy of the data.
- Line of sight requirements – LiDAR requires a clear line of sight to capture data. Consequently, it can be challenging to capture objects hidden behind another object.

[2] **Raster data** is a spatial data format representing information as a grid of cells, with each containing a value representing information, e.g. elevation. It is an effective method of storing and displaying continuous data i.e. data that changes continually across a surface.

- Dense vegetation – LiDAR can penetrate some vegetation, but where coverage is dense/thick it may result in gaps in the data or less accurate data.

<u>Topography Data from Site Surveys</u>

Exact topography can only be determined by very detailed topographical survey which would be disproportionate in this case, and require a disproportionate processing time and equipment. This is because the changes in the landscape height are typically relatively gradual, and any complexities are less significant than they may be in, for example, an urban setting. However, to demonstrate further the accuracy of the varying datasets, a sample of a topographical survey covering part of the Oaklands Farm site has been cross-checked as explained below.

As for LiDAR and OST5, a topographical survey still obtains reference height data through similar means, including photogrammetry and lidar scans. The surveyor uses the most appropriate technique for the landscape in question. Where suitable, photography for photogrammetry may be obtained from existing EA or commercial archives.

Visualisations were presented at the Issue Specific Hearing on 22nd October 2024 demonstrating any possible variance in height changes between OST5 and LIDAR terrain datasets with different coloured lines. Whilst noting that the original OST5 based visualisations are fit for purpose, and common place across the industry given this is the dataset that is typically used, the reduced RMSE for LIDAR could provide an increased level of accuracy at closer distances.

<u>Cross-checking using 'Markers'</u>

The visualisations have also been thoroughly tested by spot testing heights of all elements within the scene for the two viewpoints referred to by Ms Abbott (Viewpoints 1 and 2). This cross-check used 'markers' in a similar way to that undertaken by Ms Abbott (as set out in her response **[REP1-043]**), but with accurate measurements and positions, to confirm that new montaged elements are at the correct scale within the scene. For example, in Images 1 and 2 below, the purple markers shown alongside the PV panels on the right-hand side of the scene are confirmed as being 2.7m high.

Image 1: OST5 Sample (with purple, red and green markers)

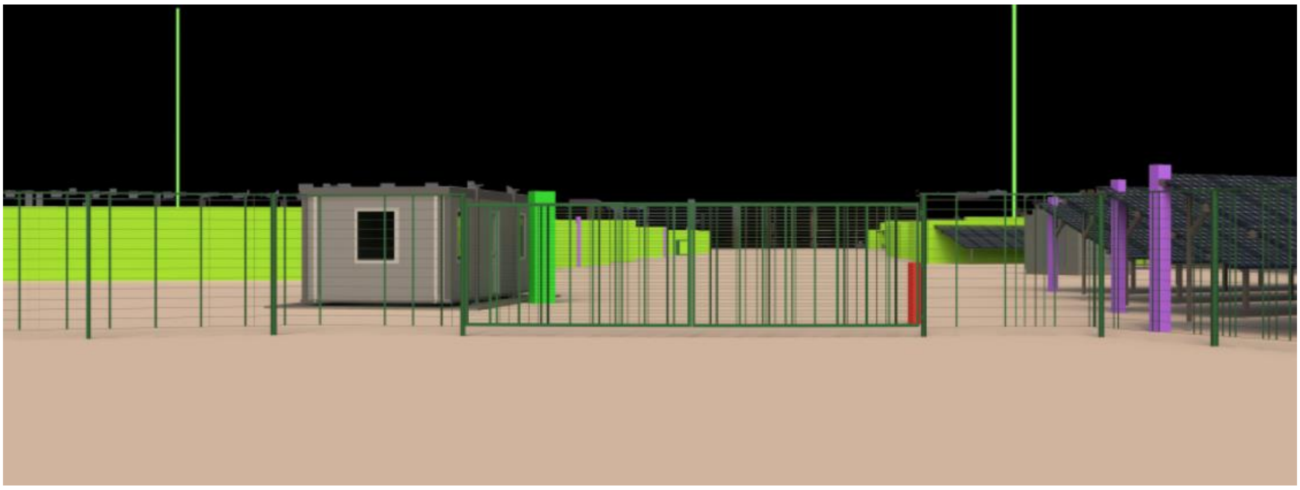
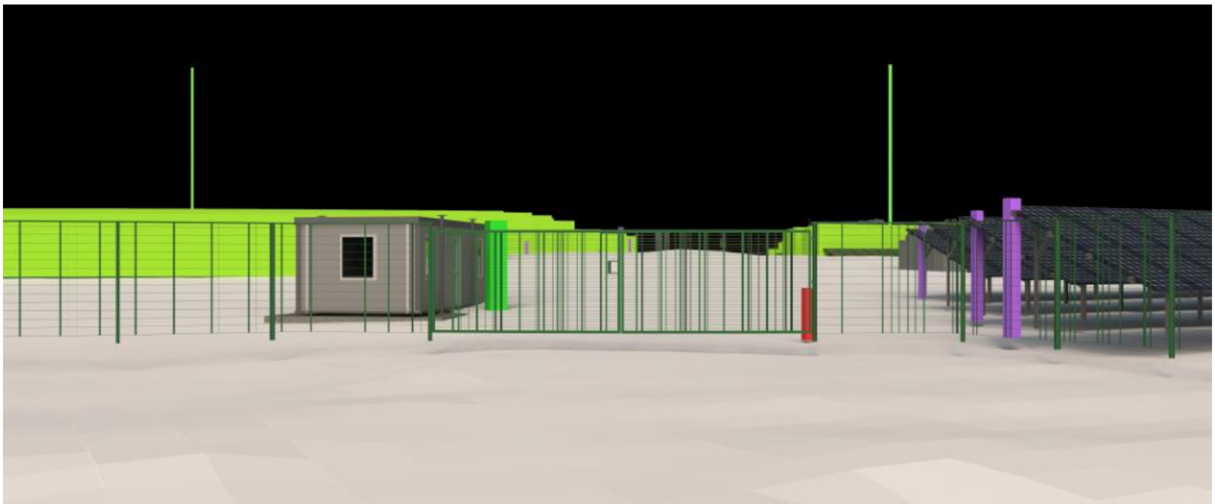


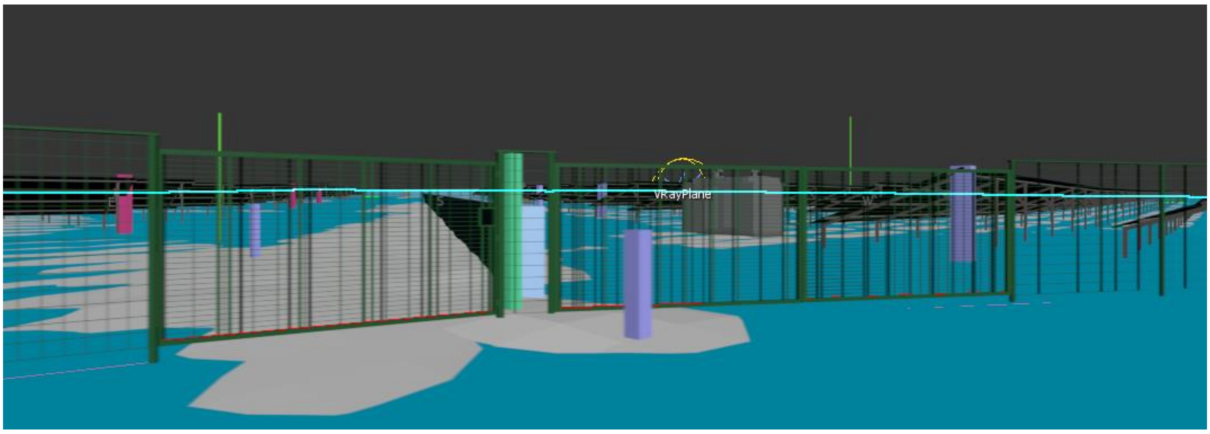
Image 2: LiDAR 1m DTM



It is apparent that the cross check undertaken by Ms Abbott has not fully taken account of perspective, as the heights of existing elements (measured by Ms Abbott) are unlikely to be at the exact same distance from the camera as the element they are being used to gauge the scale of. Note for example the existing gate (measured below in **Image 3***)* is significantly further forwards when compared to the actual position of the proposed security gate, as shown by the purple block in **Image 4**. The green block demonstrates a height of 2.2m within the scene.

Image 3 – Image taken from Summary of Written Representation from Ms Abbot of Fig 5.10j, with field measurements.

Image 4 – Comparative 3D environment used for rendering photomontage from Coton Road at the 'Twin Oak Tree' (looking roughly south) – demonstrating the green blocks at 2.2m high to cross check *heights, and the purple block at 1.1m in the position of the gate post measured in Image 3.*



Height of Proposed Development relative to hedgerows

In her Deadline 4 response **[REP4-022]**, Ms Abbott states that *"in many of the images [the Applicant] produced, the distant hedges (typically 1.5 to 2.5m tall) are not fully obscured by the 2.7m high solar panels that are immediately in front of them".* However, in response to this point it should be noted that PV panels have been set back by over 5m from the edges of fields (as part of the design strategy), and so PV panels are not immediately in front of the field boundary hedgerows as suggested.

Whilst measurement of heights within the landscape and their comparison against heights in the visualisation may appear a useful exercise, this does not account for either perspective or the manner in which a panoramic image must be distorted to allow it to be viewed in a 2D format (on screen or on paper). The visualisations and baseline photography are created using a cylindrical projection – this means that even objects of the same height and distance from the camera will reduce in size as you move further towards the top or bottom of the page, similar to the size distortion effects which are seen on typical maps of the World Essentially, presenting an image of any curved surface in a flat format on a page requires some distortion. Doubling the height of markers within the photography to provide height estimates can be misleading.

Review of LVIA judgements and conclusions

As set out in this note, the visualisations have been checked in two ways and the Applicant is confident there are no variations which are unusual or unexpected. The variations between the OST5 dataset and the other datasets (i.e. LiDAR and partial topographical survey of the actual site) are in line with the limitations of the OST5 dataset, and the resulting photomontages are a good representation of what the development would look like, albeit not an exact replica of reality. None of the differences are appreciable in terms of the landscape and visual effects that they would lead to, and none would alter the levels of effects that the assessors have reached. It can be confirmed that the levels and significance of impacts which were identified in the LVIA remain true. Landscape and visual effects are graded minor, moderate or major. At close range the effects are likely to be significant (moderate or major) and are judged as such at the two VPs concerned. The LVIA states that for users travelling along Coton Road, the change in view (as represented by Viewpoint 1) would result in a major (significant) adverse overall level effect at Year 1. The assessment is precautionary in that it considers effects to remain significant (moderate) at Year 10, reflecting the fact that planting takes a long time to fully mature. Similarly, for users of the Cross Britain Way/ National Forest Way (travelling along a localised section of the route between Walton-on-Trent and Rosliston), the LVIA assesses that the change in view (as represented by Viewpoint 2) would result in a major (significant) adverse overall level effect at Year 1, and is precautionary in that it considers effects to remain significant (moderate) at Year 10.

The comparative exercise which was undertaken at the request of the Examining Authority uses a small sample of points, and indicates that there is some minor variance between topographical datasets, both upwards and downwards, across the whole area, but it is all well within the RSME that is noted. The variances identified in the sample do not exceed around 46cm and are generally much less than this. Such variances would not alter the levels of effect that have been recorded in the LVIA.

When referencing other visualisation methodologies readily available in the public domain, there are clearly multiple examples of the use of OST5 as a baseline terrain from which the PV panels were mounted and visualisations produced, including:

- East Stour Solar Farm;
- Leaford Solar Farm; and
- Gunthorpe Road Solar Farm.

The minor variances, whilst more apparent when very close to the Proposed Development, become negligible when viewed from further away. As such there would be no perceptible difference in any of the other views should they be remodelled using a different DTM.