A66 Northern Trans-Pennine Project
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3.4 Environmental Statement Appendix 10.8 Zone of Theoretical Visibility (ZTV) and Visualisation Methodology

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The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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3.4 ENVIRONMENTAL STATEMENT APPENDIX 10.8 ZONE OF THEORETICAL VISIBILITY (ZTV) AND VISUALISATION METHODOLOGY

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10.8 Zone of Theoretical Visibility and Visualisation Methodology

10.8.1 Introduction

10.8.1.1 The purpose of this methodology is to provide an understanding of how visualisation material has been prepared to support Landscape and Visual Impact Assessment (LVIA). The methodology addresses the production of Zone of Theoretical Visibility (ZTV) mapping, viewpoint visualisations and Survey Verifiable Photomontages.

10.8.1.2 It should be recognised that production of visualisations is only one component of a LVIA. The LVIA will also consider a range of other factors when identifying and assessing changes to the landscape and to views. The use of visualisations is a useful aid when undertaking LVIA, but the assessment process is not dependent on them. LVIA may be undertaken without use of visualisation material, although for major developments the inclusion of visualisations is accepted practice.

10.8.1.3 Current good practice regarding the production of visualisations is set out in:

- *Landscape Institute and Institute for Environmental Management and Assessment (3rd edition, 2013), Guidelines for Landscape and Visual Impact Assessment (GLVIA*) (Landscape institute, 2013)[1].
- Landscape Institute (2019), *Visual Representation of Development Proposals. Technical Guidance Note 06/19 (TGN 06/19)* (Landscape institute, 2019)[2].

10.8.1.4 The remainder of this Methodology document is structured as follows.

- Section 2.1 addresses the production of the ZTV mapping that informs the LVIA.
- Details of how the Viewpoint locations were selected and which ‘Type’ of visualisation has been provided at each Viewpoint are set out in the main LVIA report. This is a requirement of the Technical Methodology specified in Appendix 10 of TGN 06/19.
- Section 3.1 gives details of how the viewpoint visualisation Types were created.
- Section 3.2 includes the Technical Methodology for Type 4 - Survey Verifiable Photomontages.

10.8.2 Zone of Theoretical Visibility

ZTV Production

10.8.2.1 ZTV maps have been generated in order to better understand the likely extent of the surrounding landscape across which the Project would be visible.

[1] Landscape institute. (2013) Guidelines for Landscape and Visual Impact Assessment 3rd Edition
[2] Landscape Institute (2019), Visual Representation of Development Proposals. Technical Guidance Note 06/19

Data sources

10.8.2.2 The 5km ZTV was produced using a commercial 2m Photogrammetric Digital Surface Model (DSM) (Bluesky International Ltd) available from National Highways. This is derived from aerial photography and takes account of screening features such as buildings and vegetation.

10.8.2.3 The DSM is based upon a 2m grid spacing. The horizontal Root Mean Square Error (RMSE) of the data is better than +/-1.5m, and the vertical RMSE is better than +/-1.5m.

10.8.2.4 The 10km ZTV was produced using a 5m Digital Terrain Model (DTM) (Bluesky International Ltd) available from National Highways. This does not take account of screening features such as buildings and vegetation as it is bare earth. However woodlands were added at a height of 7m above ordnance datum (AOD) and buildings were added using height and location data derived from OS Mastermap.

10.8.2.5 The DTM is based upon 5m grid spacing. The horizontal RMSE of the data is better than +/-1.5m, and the vertical RMSE is better than +/-1.5m

ZTV creation scenarios

10.8.2.6 The ZTV was calculated and created using GIS open-source software. The ZTV calculation process takes account of the curvature of the earth’s surface and light refraction. The eye height of the receptor in the computer model was set at 1.6m above ground level in accordance with guidance set out in the GLVIA.

10.8.2.7 The following scenarios for the 10km and 5km (more detailed ZTV) were run:

- Existing A66 (with and without vehicles, modelled at 4.7m above road level)
- Scheme (with and without vehicles, modelled at 4.7m above road level)
- The ZTV was run to 5km for DSM and 10km for DTM from the centre of the Scheme.
- The ZTV's are displayed on Figures 10.3 and 10.4 of the LVIA.

Limitations

10.8.2.8 A ZTV, as use of the term theoretical implies, is not an absolute indication of the extent of visibility but rather a computer-generated aid that utilises available relative data to indicate areas of inter-visibility and screening in relation to a specific modelled object. ZTVs are tools to assist the LVIA. The technique aims to give a better understanding of the areas where visibility is likely and unlikely but imperfections in data are such that it must only be seen as an aid to understanding. This limitation needs to be recognised when interpreting the ZTVs.

10.8.2.9 An additional caveat is that the ZTVs simply illustrate that part of a structure would be theoretically visible. As such, it makes no distinction between a clear view of all or most of a proposed feature and a view of a very small proportion of a feature (for example one corner of a building roof, or the top of a stack). This is especially relevant in the case of the project, where views from the surrounding area are often limited by vegetation cover.

10.8.2.10 The ZTV produced using the DSM reflects the presence of screening features in the landscape. However, it should be recognised that the DSM reflects a single moment in time (i.e. when the underlying aerial photography was taken). In reality, the extent and / or height of vegetation cover is dynamic and changes as vegetation inevitably increases in stature over time and / or is planted, trimmed or removed. Similarly, there is potential for buildings to have been erected, demolished or modified, subsequent to the data being captured.

10.8.2.11 Additionally, the DSM tends to assume that vegetation captured forms a solid visual barrier, when in reality views can sometimes be available through leaves and branches, especially in winter when deciduous foliage is absent. As such, the real-world visibility of the project could potentially be underestimated in places. Field work undertaken as part of the LVIA included ground truthing the DSM ZTV, confirming that it is a relatively accurate depiction of visibility, whilst recognising that glimpsed views through bare vegetation may not be modelled.

10.8.2.12 Finally, the DSM does not distinguish between the ground surface and the surface of structures and vegetation. As a consequence, the ZTV output may indicate visibility from areas known to be occupied by woodland and buildings. Whilst in theory it may be possible for people to experience the views from such locations (by climbing onto roofs, or into the tops of trees), this is not representative of typical day to day visibility, and as such there is the potential to overstate the actual visibility of the project.

10.8.3 Viewpoint visualisations

Photography

10.8.3.1 Viewpoint photography for this assessment was taken using either a Crop sensor or Full Frame Sensor digital SLR with 50mm lens and it is noted on the viewpoint photosheets as to which was used.

10.8.3.2 Photomontages were captured using a Canon EOS 6D Mark II digital single lens reflex (DSLR) camera with a full-frame sensor, using a 50mm lens on a level calibrated nodal bracket. Camera height was 1.6m above the ground.

10.8.3.3 Photographs were typically taken over a full 360 degree sweep from each viewpoint location. The precise location of each photograph was recorded using the OS mapping and refinement using aerial imagery where required, or for Type 4 productions were surveyed.

Limitations

10.8.3.4 It should be understood that photography can never provide an exact match to what is experienced in reality. Visualisations are tools in the assessment process but independent from it. They illustrate the view in the context of a specific date, time and weather conditions, that would be seen within a photograph and not as seen by the human eye. As such, visualisations need to be used in conjunction with site visits and should be considered in the context of the totality of views experienced from the viewpoint and not just focussed on the project.

10.8.3.5 Photography was taken in the summer and winter, and as such reflects visibility at those times of years. Not all viewpoints due to timescales have summer photography captured, but winter has been captured which demonstrates the worst-case scenario for visibility.

10.8.3.6 Some winter photography has not been taken in accordance with TGN 06/19 e.g. not a full frame camera and is noted as such on the relevant viewpoint photosheets.

Presentation & viewing

10.8.3.7 The viewpoint photography is inserted into a Figure template, which also includes information about the viewpoint, including the date and time of photography, and details of the camera used.

10.8.3.8 Key reference points have been labelled where required on the viewpoint photosheets.

10.8.3.9 Each sheet should be printed at the size stated on it. In some instances, this may require unconventional paper sizes (e.g. A1 width and A3 height). All printed sheets should be viewed held flat at a comfortable arm’s length.

Verified photomontage methodology

Overview

10.8.3.10 The method that was followed when preparing the verifiable computer-generated photomontages, with the aid of 3D visualisations, from an agreed range of viewpoints for the assessment.

10.8.3.11 The methodology is based upon the following documents:

- Landscape Institute (2019) – *TGN06/19*.
- Landscape Institute IEMA - *GLVIA3*
- The verifiable photomontages have been based on accurately captured and surveyed verifiable photography. Winter Photography was captured between November 2021 and March 2022.

Photography

10.8.3.12 The photographs were captured by the following method:

- Where possible, the scheme was positioned in the middle of the panorama. Photographs were taken in suitable weather conditions and ideally in clear visibility.
- The views have been photographed with a full frame digital SLR camera (Canon 6D MKII with 50mm Full Frame Sensor and is noted on the photosheets.

- The camera was mounted in portrait format on a tripod with a panoramic head attached. The lens centre (its nodal point) was set at an eye level of approximately 1.6m although the camera height may have been different if features such as fences, or hedges obscured the view.
- The camera's location was recorded using a X, Y,Z coordinate from the total station with offset to account for the lens. Camera setup levelled using levelling plate and levelling centre column.
- Camera set to manual focus; ISO100-400 with an aperture set to record an adequate depth of field (F8-F16) and white balance set appropriately to conditions.
- The camera was rotated between 10-20° to allow for a 50% overlap between each photograph.
- Images were captured in High Resolution JPEG format which includes lens distortion correction.
- The photography and surveying where required were undertaken simultaneously in order to avoid problems with markers in soft ground moving or being removed altogether.

Field of view

10.8.3.13 For the scheme under consideration each viewpoint required a panorama using stitched individual images each with a field of view of 27 degrees. The extents of the scheme and its relevant context determined the horizontal field of view required for photography and photomontage from any given viewpoint. Professional judgement based on experience of similar schemes was used to determine the required horizontal field of view to best represent the development from each viewpoint.

Verifiable surveying

10.8.3.14 The following techniques were used to verify the survey data:

- A Trimble Total Station was used by the surveyor to accurately record the camera position and also capture an array of selected survey reference points used to camera match and calibrate the photography. All survey points were captured in the British National Grid co-ordinate system, recording an X, Y and Z co-ordinate for each.
- Each camera location was surveyed together with a series of clearly defined detail points within the image (e.g. corners of road markings, features on road signs, corners of building features etc.). Where a viewpoint does not contain many or any fixed targets suitable for surveying, temporary targets were set up to allow the survey to be completed at the same time as the photography.
- Each image had a sufficient amount of clearly defined detail points taken across the width of the image and at near, mid and far distance (i.e. a balance of points across the photograph). Where possible these numbered between 8-12 points. Each detail point was given a unique number that related to the viewpoint number.

- The survey data was post-processed by the chartered surveyor to increase accuracy and then supplied in an Excel table for each set of viewpoint photography.
- A CAD file was provided containing the detail points and camera positions.

Model assembly

10.8.3.15 The following methods were used to assemble the 3D model:

- Surveyed X, Y and Z co-ordinates of reference points and the camera position were set up in 3DS Max.
- The 3D building computer model of the scheme as defined within the Scheme Description.
- The 3D computer model was georeferenced using supplied drawing data.
- Within the 3D software a virtual camera was set up using the coordinates provided by the surveyor and aligned with the reference markers.
- A lighting environment was set up within the 3D software, using the metadata stored in the image and also surveyor location data.
- A 3DS Max model file for each viewpoint was assembled before rendering. The assembled model contains the relevant scheme digital terrain model tiles and any structures, buildings or further elements (as defined above) that can be seen in the viewpoint.

Camera matching

10.8.3.16 The following describes the process of 'camera matching' to create a virtual camera:

- The process of camera matching creates a virtual camera in the same location and height and pointing in the same direction as the physical camera used on site to capture the image.
- Each viewpoint has its survey points in place and the camera was set to the required field of view and view direction. (Generally, between 75-90°).
- The process involved accurately positioning the 3D model of the scheme within each existing view. This was achieved through a process of matching the surveyed points in the digitised image with those recorded by the survey team on the existing photographs.
- The survey points and specifications of the lens type relating to each view were also entered into 3DS Max.
- The survey points of the camera position and each clearly defined detail point (relating to specified objects in the view) were then highlighted on the digitised image.
- Once the process of camera matching was completed, the 3D model of the scheme was accurately positioned within each of the views captured. This was achieved by rendering the camera matched 3D model of the scheme within 3DS Max at the same size as the digitised existing view.

- To aid in greater accuracy of real-life camera settings, the production of cylindrical projection and wide angle panoramas which match the photography stitch, a plug-in programme called Vray was used. Each of the views was rendered using the Vray Rendering Engine software.
- Individual elements were rendered out using different map channels to create masks (for example mask for the digital terrain model, earthworks, overhead line equipment, fencing, shadows etc). These masks ensured each visible element of the scheme could be independently selected when individually placed into the Adobe Photoshop file for final production.

Producing the photomontage

10.8.3.17 The following describes the process of producing of photomontage:

- The JPEGs were lens corrected and then stitched into a panorama using a cylindrical projection in Adobe Photoshop.
- At this stage panoramas were checked for acceptability by the project landscape architect.
- The renders of the 3D model were superimposed onto the existing photos in Photoshop. The foreground of the existing photos visible in front of the scheme were then carefully copied and masked to ensure the render of the 3D model sat accurately within the depth of the view. The compositing process involved digitally removing existing features such as trees that were within the extents of the scheme.
- The textured render of the 3D model was then further adjusted to match the resolution, colouring and saturation of the photograph captured to create an accurate impression of what the textures of the buildings and structures will look like.
- Soft landscaping was generated within the virtual model and rendered or added in Photoshop to reflect as accurately as possible how the scheme would look in Years 1 and 15, taking into account growth rates of any planting.

Photomontage presentation layouts

10.8.3.18 The following describes how each photomontage is presented:

- The standard Layout is A1 Landscape with a field of view generally between 75° - 90°.
- Each view is annotated with specific camera and viewpoint information and if necessary, any disclaimers.
- When printing there should be no scaling or fit to page options selected as this would alter the size of the image. A high-quality print setting with a minimum resolution of 300 dpi should be used.

10.8.4 References

Landscape institute. (2013) Guidelines for Landscape and Visual Impact Assessment 3rd Edition

Landscape Institute (2019), Visual Representation of Development Proposals. Technical Guidance Note 06/19