



- Planning Red line Boundary
- Existing vegetation within the site - to be retained
- Existing Public Right of Way (PRoW)
- Existing footpath
- Proposed shared cycle/footpath route
- Proposed shared street route
- Proposed footpath
- Existing LEAP (Locally Equipped Area for Play)
- Proposed LAP (Local Area for Play)
- Existing recreational area
- Existing school and sport field on school grounds
- Proposed LEAP (Locally Equipped Area for Play)
- Proposed LAP (Local Area for Play)
- Suggested trim trail station
- Proposed open space
- Proposed private garden
- Suggested orchard
- Indicative new trees
- Proposed attenuation basin locations (SuDS)

Land at Woodcroft Farm
on behalf of Grainger plc

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Appendix Four

Faulhaber Design ZTV Methodology



LIDAR derived ZTV analysis

Statement of Method

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Introduction

A Zone of Theoretical Visibility study (ZTV) is used for assessment of the potential visual impact of a proposed development across a large study area. Reference points representing proposed development are tested across a model of the surrounding terrain and surface objects to determine where the proposal will be visible.

The availability of detailed LIDAR data and ever-increasing computer processing power make ZTVs a far more accurate and reliable tool than they have been in the past, but they remain a theoretical exercise which is dependent on the placement of reference points and the accuracy of the surface model.

While LIDAR derived ZTV analysis can depict the predicted extent of potential visibility to a very high degree of accuracy, and careful use of multiple sets of reference points could even show, for example, how many stories of a tall building might be visible at any point, a ZTV analysis on its own cannot provide a proper assessment of visual impact. Their main use is as a guide and aid to further investigation through additional analysis, site visits, landscape assessments, receptor appraisals, and Accurate Visual Representations (AVRs).

Project Specific Details

Project name	Woodcroft Farm, Waterloooville		
Date issued	12 th January 2024		
Prepared by	Sam Henderson sam@faulhaber.co.uk		
Site centre location	468183 (Easting) :: 112274 (Northing)		
Map base size & scale	Width 4548m (1819px), Height 4265m (1706px), 1:25k, 2.5m grid		
Output scale and resolution	18.2cm x 17.1cm = 1:25000 @ 2.5m per pixel (to print at 100 px/cm)		
LIDAR capture season	2020		
Buffer min height threshold	0.5m		
Permanent buffer shading	Red		
Vegetation buffer shading	Green		
Radius of ZTV analysis	5km		
Unobstructed views shading	Purple		
Potential filtered views shading	Green		
Observer / Viewer height	1.6m		
<u>Reference Points:</u>			
Number	95	Description	Placed on a 20m grid throughout the extent of the height parameter plan and set at the appropriate height above existing ground level – either 12m or 15m (see notes)

LIDAR data – the Environment Agency National LIDAR Programme

LIDAR (Light Detection and Ranging) is an airborne remote sensing technique which uses a laser, scanner and GPS receiver to generate precise, three-dimensional information of the terrain and surface objects.

The Environment Agency (EA) has been capturing aerial LIDAR data since 1998. In 2016 the National LIDAR Programme was announced to capture high resolution data covering all of England. As of October 2022, there is now very close to complete coverage.

The data is captured between October and April each year, to ensure as much detail as possible is captured from ground and surface objects beneath deciduous tree cover, while still enabling measurement of the canopy from laser returns which bounce and split off higher branches (a laser that splits rather than simply bouncing generates “multiple returns” rather than an “only return”, with the “first return” indicating the highest obstacle struck, and the “last return” the lowest obstacle).

Bespoke algorithms are used by the EA to classify every point that is returned to the sensor as either ground or a surface object, including a distinction between vegetation and other surface objects (eg buildings).

The classified “point cloud” generated from the laser returns is then processed into various different kinds of “raster” product known as a Digital Elevation Model (DEM). DEMs are provided on a 1m grid, based on the Ordnance Survey National Grid, at an absolute vertical error of +/-15cm (with a random error of no more than +/-5cm) and an absolute horizontal error of +/-40 cm. Three different DEMs are used in the terrain, buffer and ZTV analyses.

The **Digital Surface Model (DSM)** is generated from the last (or only) return, ensuring only the most solid surface objects are included, such as buildings, vehicles and non-permeable vegetation (dense evergreen or thicket, stumps etc). The resulting grid represents all solid and non-permeable surface objects.

The **Digital Terrain Model (DTM)** is initially generated from the last (or only) return where points have been automatically classified as ground. This terrain model is then “ground checked” to ensure that large flat roofs and other similar surface features have not been mistakenly classified as ground, and that steep embankments and other similar terrain features have not been mistakenly classified as surface objects.

The **First Return Digital Surface Model (FZDSM)** is generated from the first (or only) LIDAR pulse, which ensures it includes a close estimation of the full extent of all vegetation and tree canopies, and the fullest extent of more solid surface objects such as buildings. The resulting grid represents all surface objects, including semi-permeable deciduous vegetation.

Software

Mapping software	<i>QGIS 3.20 inc. plugins</i> – used to produce mapping layers and ZTV analysis
CAD software	<i>Vectorworks 2022</i> – used to align plans & models and to position reference points
Graphics software	<i>Photoshop 2022</i> – used to compile layers into final mapping outputs

Methodology

The DTM, DSM and FZDSM data layers are compiled in mapping software and recalculated so that they match the extent and resolution of the base-mapping to be used in the final outputs – for example, this is usually a 1:25,000 OS Explorer map base, which works on a 2.5m grid.

If there are significant existing surface objects on the site which might affect the analysis, but which are to be cleared under the proposals being tested, these are removed from the DSM and FZDSM.

The DTM layer is block shaded in 5m intervals to create elevation shading layers, and an algorithm is applied to create “relief” effect layers, for use in terrain analysis plans.

The same algorithm is also applied to the FZDSM to create relief layers for use in buffer analysis plans.

The differences between LIDAR data layers are calculated to create a series of DEMs representing the relative heights of all surface objects within the study area (the “All Buffers” DEM, the “Permanent Buffers” DEM and the “Vegetation Buffers” DEM). These are filtered to eliminate features below a minimum threshold and the “Permanent Buffers” and “Vegetation Buffers” layers are used in buffer analysis plans, shaded to represent increasing relative height.

Reference points are positioned in CAD software, using scaled plans and/or 3D models, in a method appropriate to the proposals being analysed. For large buildings they might be placed on the outside edges and highest points, for more extensive proposals such as large housing schemes and solar arrays, one reference point might be placed on the highest point of each house or each panel. Where design proposals are at an early stage, reference points might be placed on a grid, or randomly, within proposed development areas, or according to height parameter plans. All reference points are allocated either an absolute height AOD or a relative height above existing ground level.

The reference points are imported into mapping software and tested against both the DSM and the FZDSM using a visibility analysis algorithm. In essence, this algorithm draws a line from each reference point, at its specified height above the DEM being tested, to a point at a specified height above every grid square in the DEM (usually set at 1.6m to represent an eye-level viewer). Each grid square reports as visible if the path between points is clear, or invisible if the path between points is blocked by intervening features on the DEM. The analysis is repeated for each reference point, and the separate outputs are then combined into a single output that reports how many of the reference points are reported as visible from each grid square.

The nature of the algorithm means that visibility is tested from a set height above every element of the DEM being analysed, which means that potential visibility is reported where a viewer standing on top of a building or tree canopy would be able to see a reference point. The All Buffers DEM and Permanent Buffers DEM are used to filter out all reported visibility from areas that are covered by existing surface objects.

Block shading is applied to all remaining areas where **at least one reference point** is reported as visible, to produce two layers showing visibility across the DSM and visibility across the FZDSM, for use in the ZTV analysis plans.

Where reference points have been placed appropriately (with some kind of demonstrably “fair” distribution, for example on a grid throughout a development area), the layer showing visibility across the FZDSM is shaded according to what percentage of the total number of reference points are visible at any one point, for use in additional ZTV analysis plans.

Outputs

While various output layers from the mapping software can be combined with base mapping in various different ways to illustrate and visualise the interaction of proposals with the surrounding terrain and surface features, certain output plans are produced as standard.

The **terrain analysis** combines black and white base mapping with elevation shading in 5m intervals and the DTM relief effect layer to illustrate the topography in the study area.

The **buffer analysis** combines black and white base mapping with the shaded Permanent Buffers and Vegetation Buffers layers and the FZDSM relief effect layer to illustrate the extent of all surface buffers in the study area. Shading of buffers increases in darkness and intensity with increased height above ground (or surface) level. This can also be combined with the elevation shading layer, to allow further interpretation of the significance of different surface buffers.

The **ZTV analysis** combines areas of predicted visibility over the two different surface models. Areas of predicted visibility over the FZDSM (which includes all vegetation) are block shaded and described as “unobstructed views” where **at least one of the reference points may be visible without any intervening obstructions**. Any additional areas of predicted visibility across the DSM (which only includes dense and evergreen vegetation) are block shaded in a different colour and described as “potential filtered views” (of at least one reference point). As the visual impact of potential filtered views will decrease with distance from the site, these areas are faded beyond 2km from the centre of the site. The centre of the site is marked with a single site marker, which does not relate directly to the placements of individual reference points, which are shown on separate drawings. Radius lines are shown from the site marker. The analysis is produced over both black and white base mapping (which is better for precisely identifying shaded areas of predicted visibility) and colour base mapping (which is better for identifying features of the base mapping that interact with areas of predicted visibility).

If appropriate (see methodology and interpretation notes) a separate **ZTV % visibility analysis** is produced. This shows all potential unobstructed views (areas of predicted visibility across the FZDSM) shaded according to what percentage of the reference point are predicted as visible. This is produced over a black and white base map to improve legibility, sometimes combined with the surface relief effect to illustrate the interaction of predicted visibility with intervening terrain and surface buffers.

General notes on interpretation

Based on the methodology set out above, there are certain aspects of exactly what it is that the analysis represents, which are worth bearing in mind when interpreting the outputs.

The **relief shading effects** that are used in some of the outputs are created by shading all slopes in a DEM according to their aspect (which way they face) and their steepness. They are used to give a 3D effect, so that terrain and surface objects can be directly visually interpreted, without referring to contour lines, map bases, or other layers. They do not provide a representation of light cast across the DEM.

The **buffer shading** in the analysis layers used in plans roughly increases in darkness and intensity with height, but interacts with other layers when generating outputs and is only intended to be used to give an overall impression.

The **ZTV analysis shading** uses a single block colour to represent all areas where at least one reference point might be visible, but makes no distinction between a theoretical glimpsed view of the top corner of a proposal and a broad view of its full height.

The **tree canopies** that are included in the FZDSM are probably the most imprecise element of the LIDAR data, due to their nature, and the most prone to change. Transitions between areas of unobstructed views and areas of potential filtered views should be treated as hazy and changeable, not stark and defined as they are shown on the outputs. It seems safe to assume however (from the nature of the data collection) that barring all other changes they are if anything slightly underestimated.

Additional interpretation and site visits are needed to analyse areas of **potential filtered views**. The deciduous vegetation buffers (present in the FZDSM but not the DSM) used to identify these areas could be anything from a street tree or scraggly hedge to a large copse or block of woodland. There is no way of indicating the depth of the intervening screening between viewer and reference point, or of determining the density of that screening, let alone seasonal changes.

Care should be taken with outputs generated using **multiple sets of reference points** to represent increasing height of development, cumulative development, etc. to be sure it is clear what is shown.

The **% visibility shading** represents another layer of precision in how the reference points and surface models interact. It doesn't take account of any visual buffering that would be provided by the proposed development itself. It can also be hard to find a 'fair' way to distribute reference points to produce a meaningful depiction of the extent to which a proposal might be visible, rather than simply whether some part of that proposal might be visible or not.

Project specific notes

reference points:



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