

# LASER FOCUSED:

## interpreting landscapes with drone LiDAR

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*ALS collection managed by Anthony Beechey, Geomatics Officer*

Archaeology has long benefited from a view from above, whether that is aerial photography from a crewed aircraft, satellite imagery or just a camera on a stick. This view is even more vital when trying to understand historic landscapes, where the interplay of topography, archaeology, modern development and conservation requirements needs to be understood. Over the past 15 years or so, uncrewed aerial vehicles (UAVs), or drones, have provided archaeologists with an affordable and rapidly deployable platform for high-quality aerial data collection on a landscape-wide scale. In addition, the variety of sensors now on offer mean that the archaeologist has immediate access to many different types of data for analysis. These include high-resolution photography, airborne laser scanning (ALS) or multispectral imaging, all captured for the primary purpose of archaeological analysis. These methods provide not only some of the most informative and visually impressive outputs, but also some of the most accessible, which can be beneficial for non-specialist audiences.

*The DJI Matrice M350 and pilot: preparing for a day of ALS at Gorhambury. Credit: Cotswold Archaeology*



The availability of such technology is highlighted in the increasing need for landscape-wide assessment in conservation management. In particular, ALS from drones allows a high-level understanding of historic landscapes to be gained in relatively short time frames, prior to targeting smaller areas for more detailed study. This offers an alternative where the deployment of crewed aircraft would not be a cost-effective option. This type of work is increasingly necessary in response to national schemes, such as Higher Tier Countryside Stewardship grants, providing funding to landowners undertaking environmentally beneficial work on their land. Of course, these landscapes often include heritage assets, some highly significant, and the ability to understand what enhancement can be made to the natural environment without unnecessary harm to the historic landscape is key, not to mention identifying opportunities for preserving and enhancing heritage assets while we're at it!

*The Gorhambury Estate 25cm DTM data, visualised to enhance archaeological feature identification. Credit: Cotswold Archaeology*



### Behind the data

UAVs have now gone far beyond just being used to take 'report cover' images for projects and we are far more likely to employ them as semi-autonomous survey tools, required to collect metrically and spatially accurate data. For most of our landscape surveys, we use a DJI Matrice 350 equipped with a DJI Zenmuse L2 LiDAR (ie, ALS) sensor payload capable of five returns and repetitive (higher accuracy, lower penetration) and non-repetitive (higher penetration, lower accuracy) scanning modes. When UAVs are used in a survey role, they are still subject to the checks and controls of a more traditional terrestrial survey. As such, all our survey flights are undertaken using either RTK (real-time kinematic) or PPK (post-processing kinematic) positioning correction, either via an RTK module onboard the UAV or through a base station. This is backed up with a network of ground control points, recorded by a survey-grade GNSS (Global Navigation Satellite System), so we can assess the 3D positional quality of the data. This means our datasets can be used as a basis for subsequent comparative flights of the same area and be integrated with other geospatial datasets.

With the introduction of the Zenmuse L2 sensor we are no longer limited to the survey dates and resolution of freely available ALS data, for example Environment Agency data. In addition, the data collected by the L2 sensor is incredibly versatile and can contribute to multiple deliverables. From a single

*The Pondyards (Scheduled Monument) and surrounding heritage assets as interpreted from the ALS data, including data from the Hertfordshire County Council HER. Credit: Cotswold Archaeology and Hertfordshire County Council HER*



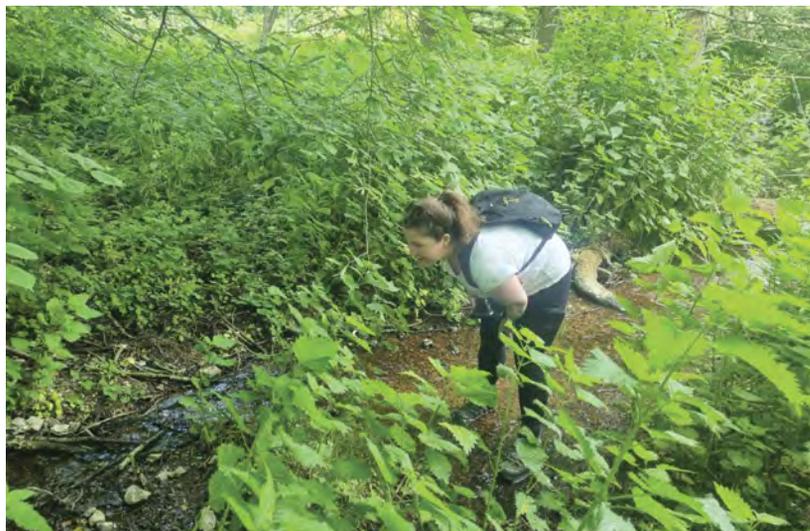
flight of an area, we can gather enough data to provide digital elevation models (DEMs), digital terrain models (DTMs), photogrammetric models, orthophotos and more!

Following the flight planning phase, where we gather appropriate permissions, information about possible restrictions and plan the flight route, we can survey an area of four hectares in around 20 minutes, with the only limiting factor being the number of available batteries. Usually flying autonomously at an altitude of around 60m above ground level and a speed of 5m/s, we can produce a point cloud of the terrain at around 1–3cm resolution, including trees and building roofs. The point cloud is then classified into ground points and non-ground points, with the option of more specific point classification if required by the project, such as structures, roads or particular monuments. The ground points are then used to create a 0.25m resolution raster DTM, retaining the height data of the points, which is suitable for use in visualisations and subsequent archaeological analysis. Additionally, DSMs (digital surface models) can also be created, combining ground and non-ground points.

### Case study

#### Gorhambury Registered Park and Garden

Gorhambury Park, situated between the city of St Albans and the M1, is a Grade II Registered Park and Garden surrounding Gorhambury House, the 18th-century seat of the Verulam family. Documentary evidence defines this as a manorial site since 1130 AD, with areas of agricultural land, wide-open pasture, ornamental gardens and woodland surrounding various phases of residences. Though the overall landscape character is not dissimilar in the present day, there have been significant changes through the centuries since the estate was established, each phase leaving traces in the landscape among hints of earlier prehistoric and Roman land use. Through high resolution ALS, we have been able to start defining these traces across the entire parkland landscape in a relatively short time frame, allowing us to identify



*Zoe following the waterflow to the east of the Pondyards. Credit: Cotswold Archaeology*

opportunities for more targeted and detailed study on potentially significant features, and offer advice on managing the historic environment alongside other environmental factors.

Our work so far has identified hundreds of individual features relating to the history of the Gorhambury estate which had not previously been clearly recorded. We were able to go some way to answering key questions about the estate's history; sites of the possible medieval manor house and the 17th-century Verulam House were identified, along with hints of their designed landscapes. We have also been able to raise new questions about the hydrology surrounding the Scheduled Pondyards water gardens in the north-east of the site, and the estate's relationship with the Roman road of Watling Street.

The outputs have been essential to the landowner's understanding of the heritage significance of their land and for identifying appropriate management measures which benefit both the natural and historic environment. In the context of a Countryside Stewardship grant application, future management will include the protection and conservation of the historic environment in balance with the natural environment.

#### Zoe Arkley

Zoe is a Senior Heritage Consultant at Cotswold Archaeology and is current Chair of the Landscape Survey Group. She has been working in heritage consultancy since 2014, applying and enhancing her landscape survey expertise in both development- and conservation-led projects with Cotswold Archaeology.



#### Tom Weavill

Tom is a Geomatics Officer at Cotswold Archaeology and has worked on archaeological sites across the country. With a focus on earthwork, landscape and building survey, he has helped to develop Cotswold Archaeology's geospatial survey capabilities within these areas, most recently in the use of UAVs.

