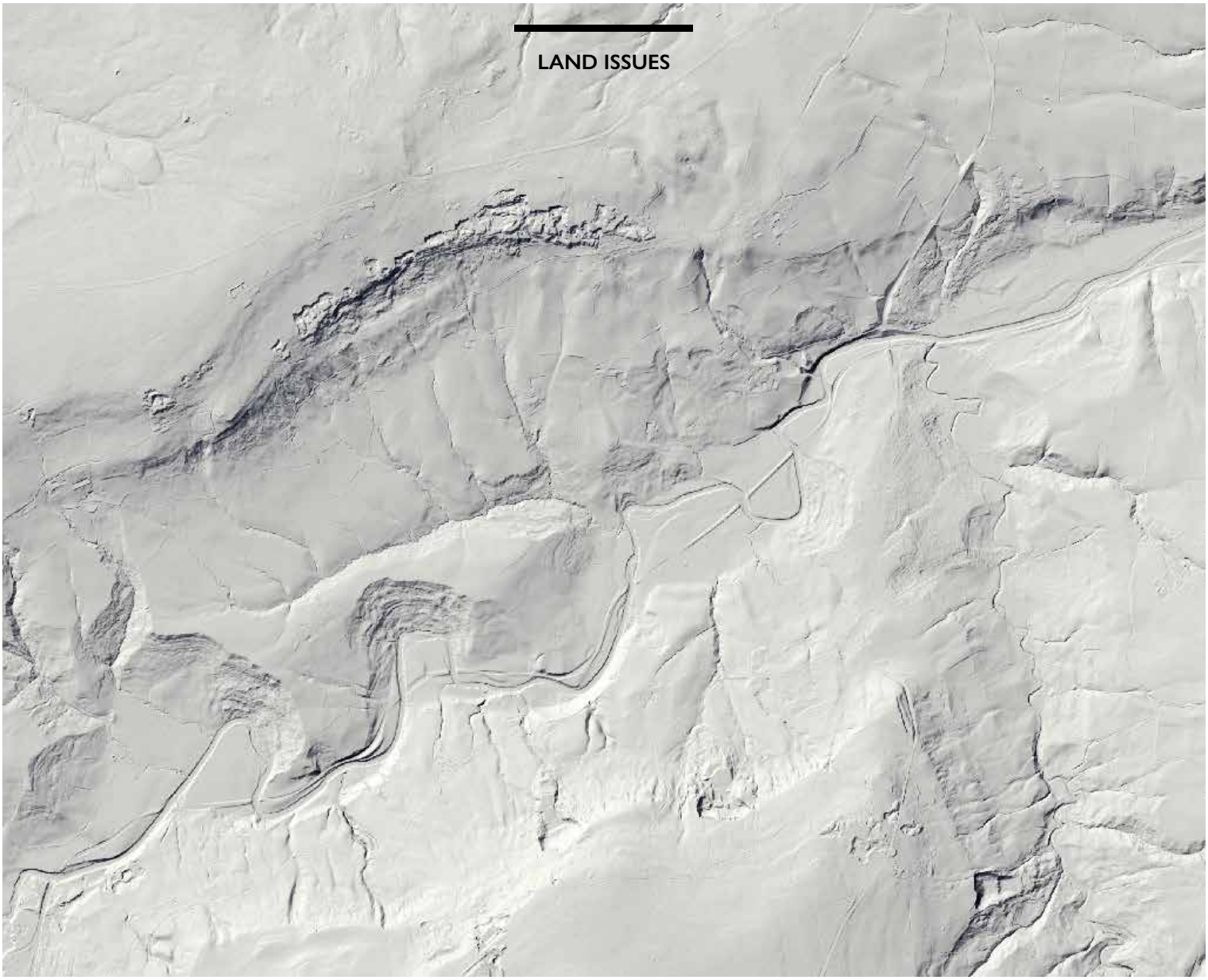


Example LiDAR image presented with Hillshade.

Avoiding third-party interference with efficient and accurate depth of cover calculations

A key means of reducing pipeline incidents due to third-party interference is ensuring sufficient depth of cover. As a globally leading provider of cutting-edge pipeline solutions, the ROSEN Group has helped develop a new methodology to achieve this goal and allow depth of cover estimates to be delivered as an additional service alongside a traditional ILI.

A UK Onshore Pipeline Operators' Association report from 2019 states that 21 per cent of all product losses incurred between 1962 and 2017 were caused by external interference. However, precise measurements of depth of cover can be hard to come by, especially for the entire length of a buried pipeline.

In a research project in conjunction with National Grid Gas Transmission, ROSEN Group has begun validating an approach that combines specialised inline inspection tools and ground elevation data. These calculations can be made to an accuracy of ±0.15 m root mean square error.

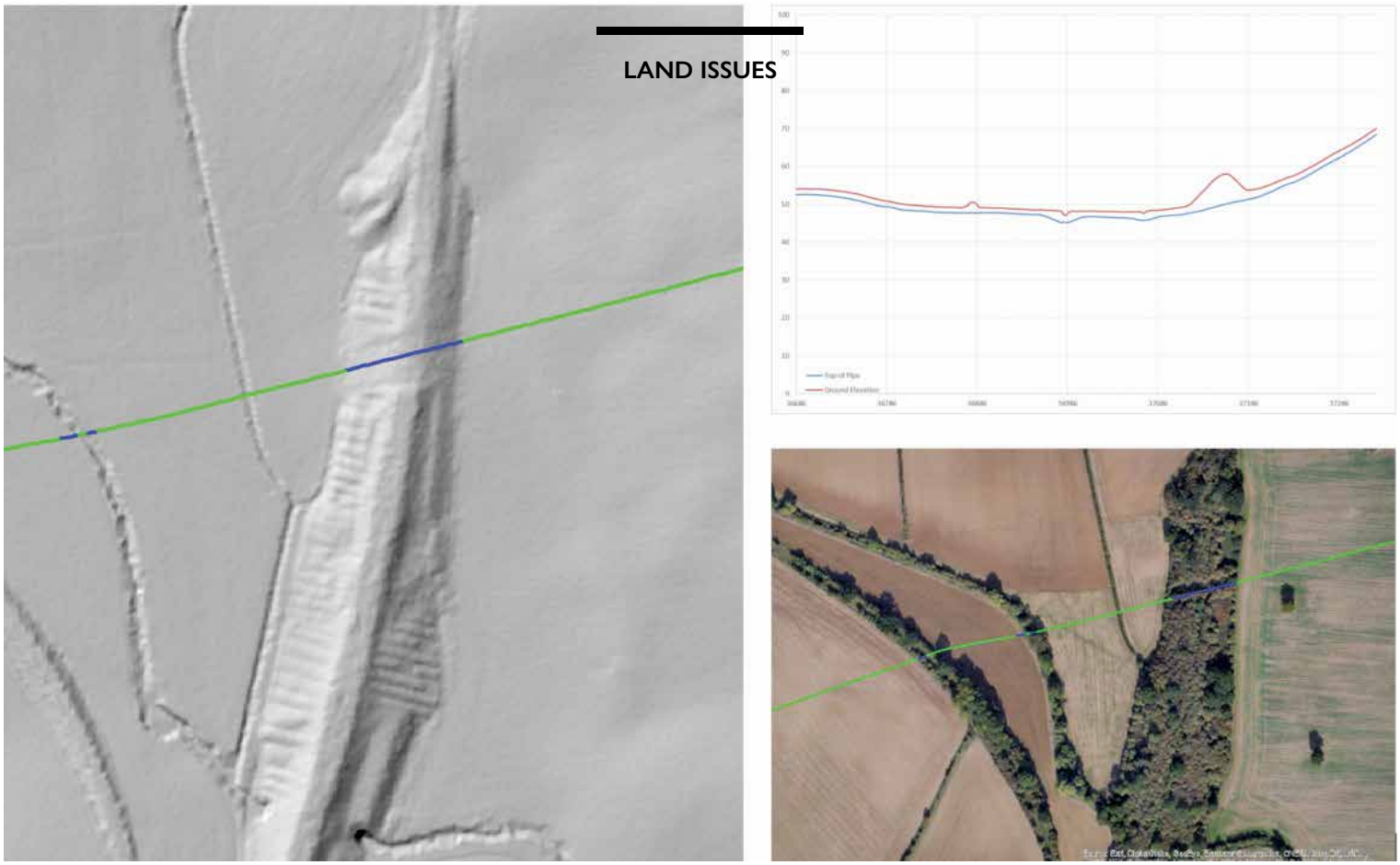
Cause of the damage

A major cause of damage to buried pipelines is third-party interference from, for example, human involvement such as construction. Pipeline depth of cover can change due to shrinkage of soils, natural erosion, human activity or failure of anti-buoyancy systems.

Apart from routine surveillance, maintaining a minimum depth of cover is a key mitigation against third-party interference. Current techniques available for measuring depth of cover on buried pipes require significant effort to produce a detailed survey for an entire pipeline.

Testing the ground

Conducted in partnership with National Grid Gas Transmission and funded by the Network Innovation Allowance scheme, ROSEN demonstrated a new methodology to estimate depth of cover over an entire pipeline. This uses



ILI and LiDAR data combined. © Environment Agency 2019. All rights reserved.

ground elevation data and high-resolution data from an inertial measurement unit (IMU).

Prior to the inline inspection of the 36 inch (914 mm), 43 km natural gas pipeline, above-ground markers (AGM) were deployed at a nominal interval of 500 m between markers. AGMs are devices placed directly over the buried pipeline to ensure the inline inspection (ILI) tool provides accurate geographical data.

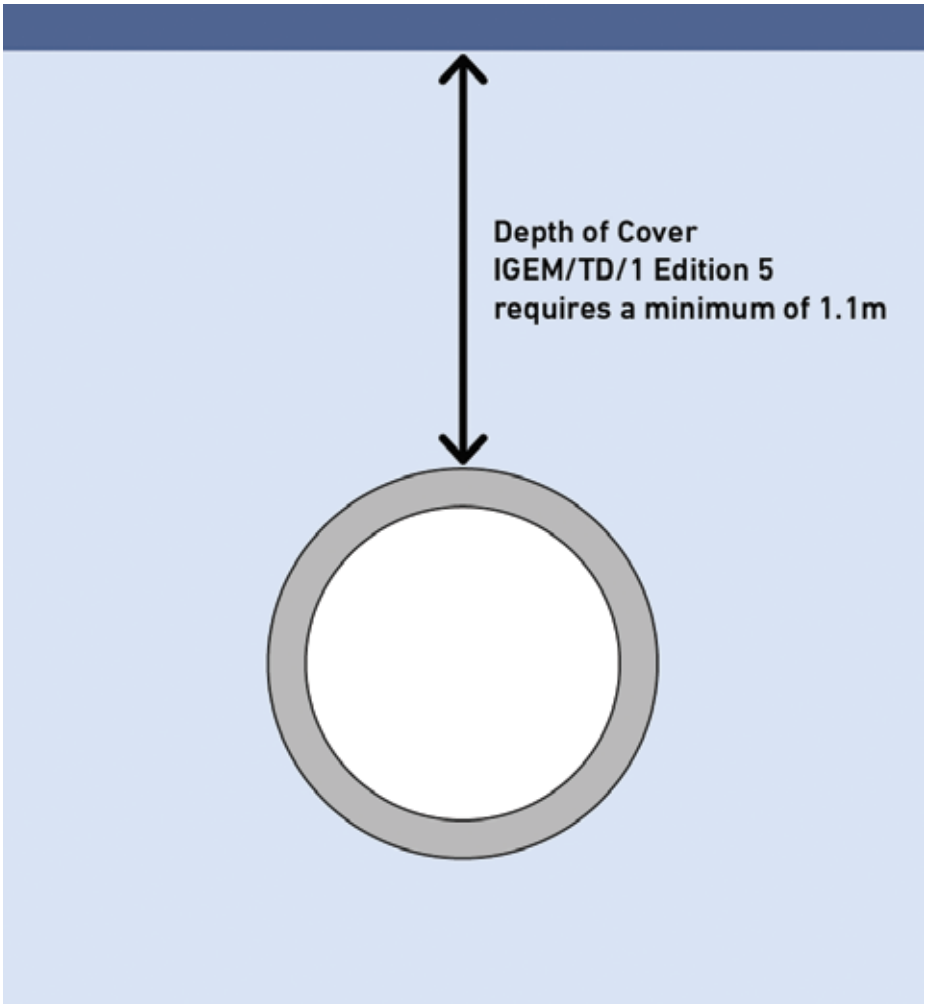
The smaller the distance between each marker, the more accurate the results. At each AGM, the pipeline position was recorded using a high-accuracy GPS system as well as a pipe and cable locator. Following deployment of the AGMs, the ILI was completed, and the results were processed by the ROSEN data analysis team to provide an accurate pipe centerline.

The data is linked to known reference locations along a pipeline route in order to provide an accurate pipe centerline as a series of X, Y and Z coordinates.

Two-element approach

Ground-elevation data collected using light detection and ranging (LiDAR) techniques was combined with the accurate pipe centerline, and an algorithm was used to calculate the depth of cover for the whole pipeline. By deploying laser light to measure distance to a target, the remote sensing method LiDAR is commonly utilised to map terrain and surface objects.

To conclude the project and verify the results, ROSEN engineers took in-field pipe depth and



Regulations require pipelines to have minimum depth of cover depending on their location.

GPS measurements, which demonstrated a depth of cover accuracy of ±0.15 m root mean square error.

The research project has shown that the methodology can provide accurate depth of cover measurement. This has enabled National Grid Gas Transmission to review the entire pipeline and identify locations that do not meet the minimum requirements.

National Grid Gas Transmission can implement measures at these locations to mitigate the potentially increased likelihood of third-party damage. Previously, pipeline technicians would have performed time-consuming survey activities in the field.

The new methodology allows accurate estimates of depth of cover to be delivered as an additional service alongside a traditional inline inspection.

Further information on the project is available from ROSEN Group. **P**

Example of a depth of cover report.