CATEGORY 9. BEST SCIENTIFIC ADVANCEMENT

Carrington integrated site investigation

Background to the submission

The development at Carrington, near Manchester, is an 860MW CCGT power plant on the site of the former coal-fired Carrington Power Station. The proposal includes the construction of a 600mm steel gas pipeline from the nearby National Grid site to the CCGT site over a challenging 3km route.

The pipeline route includes the former power station and a gas treatment works as well as three road crossings. The site histories suggest that the made ground cover would be complex, containing many active and relic services, buried obstructions and other features that would impact on the pipeline construction. Part of the pipeline route runs along an existing in-situ culvert, with a steeply sloping, 10m high embankment on one side and the Manchester Ship Canal on the other.

In terms of geology, Triassic Sherwood Sandstone, which is known to contain faults, underlies recent alluvial and fluvioglacial deposits and has an upper boundary made irregular by channel erosion and deposits.

RSK were commissioned by ESB International (ESBI), as owner's engineer for the Carrington Power project, to act as principal contractor on the National Grid site throughout the site works.

RSK

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ESB International

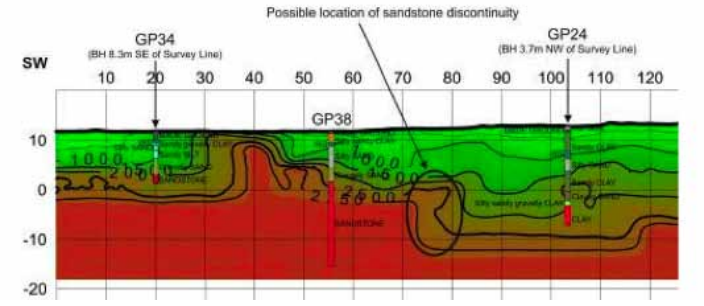
A) Innovative thinking reveals more during site investigations

RSK set out to provide a site investigation (SI) that would provide the client with a comprehensive picture of the subsurface to support a detailed engineering design of the pipeline route. The objective was to ensure that it would be possible to construct the pipeline along the proposed route, and this would be achieved by characterising complex shallow made ground and geology, and identifying all buried services and obstructions. In addition, a ground model describing the soils and geology would be developed to inform the stability of the slope and the existing culvert structure in the engineers' designs.

RSK ensured that the SI progressed collaboratively with the client. The SI included a detailed desk study and multiple complimentary geophysical surveys to develop working ground models, which were verified by targeted intrusive investigations. High-vacuum multiphase extraction was used to investigate the level of contaminants in the soil and groundwater as this minimises ground disturbance and removes the potential for releasing volatile chemicals into the environment.

The utmost importance was placed at all times on the understanding of the geotechnical issues presented by the site, and the value of the information that would be produced by a particular technique. The client's engineering objectives remained paramount, and the approach delivered the correct mix of traditional and innovative methods.

The outcome of the thorough SI was a complete record of all buried services and obstructions along the pipeline, proven using safe digging techniques.



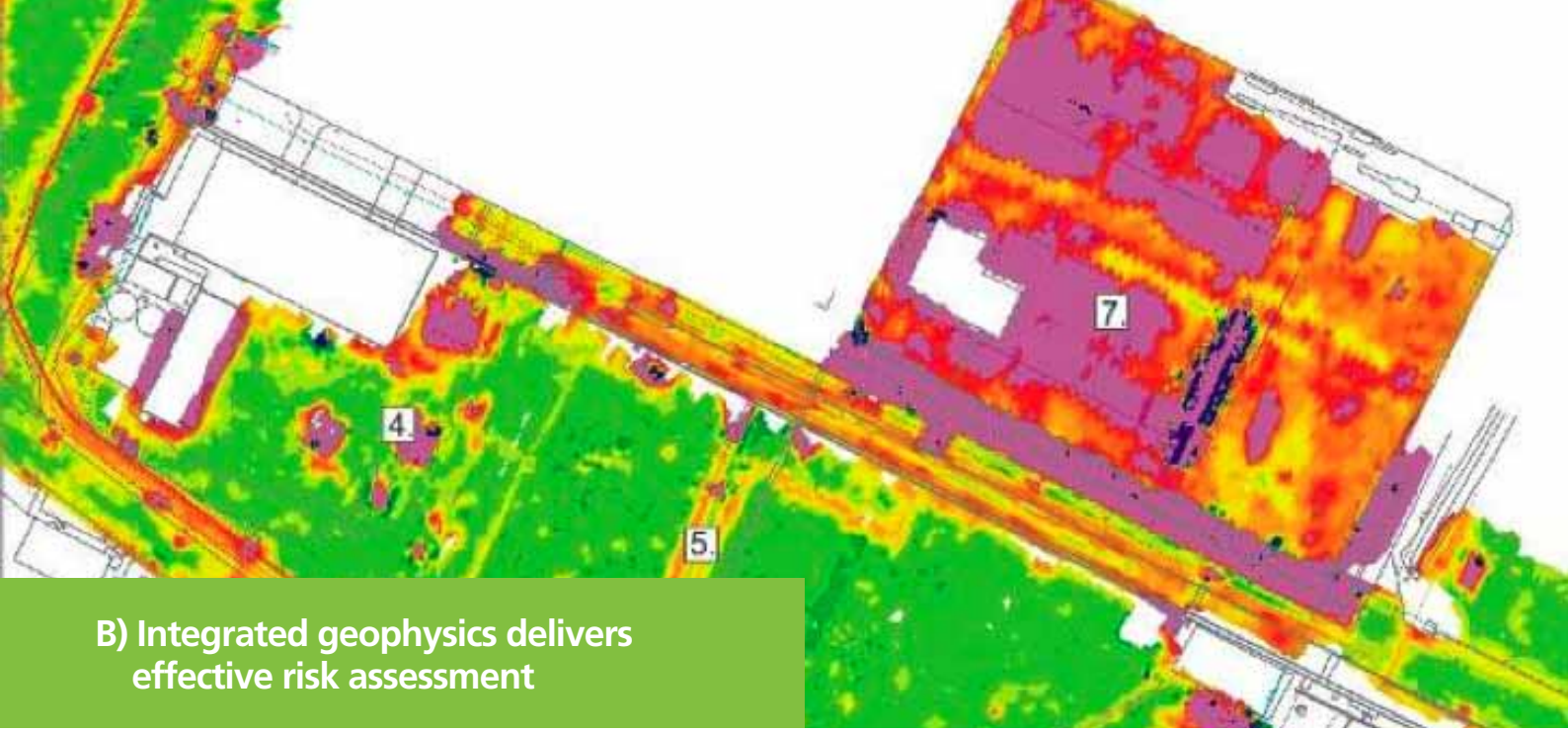
Seismic refraction data revealed variations in the bed-rock, and the properties of shallow made ground

"The works carried out for ESB International on the Carrington CCGT Power project included the investigation to locate underground services, features and sub-surface stratification including orientation of fault-like features. However, as the site was brownfield with no as-built drawings, a more demanding portion of the assignment was the innovative application of geophysical techniques to provide information on heavy substructures and, for example, investigating whether foundations were piled and to what depth.

A cooperative working environment and good joint objective focus and ownership, which was established between ESBI and RSK, resulted in the identification of naturally occurring and man made features which were not known from any available desk study information and which would have meant significant rerouting at the construction stage of the gas pipeline for the project.

RSK conducted the works in a professional manner with acute attention to the technical requirements and to Health and Safety."

Louise Lynch, ESBI project manager



Top image: EM survey data was used to map linear features (buried services) and foundations

B) Integrated geophysics delivers effective risk assessment

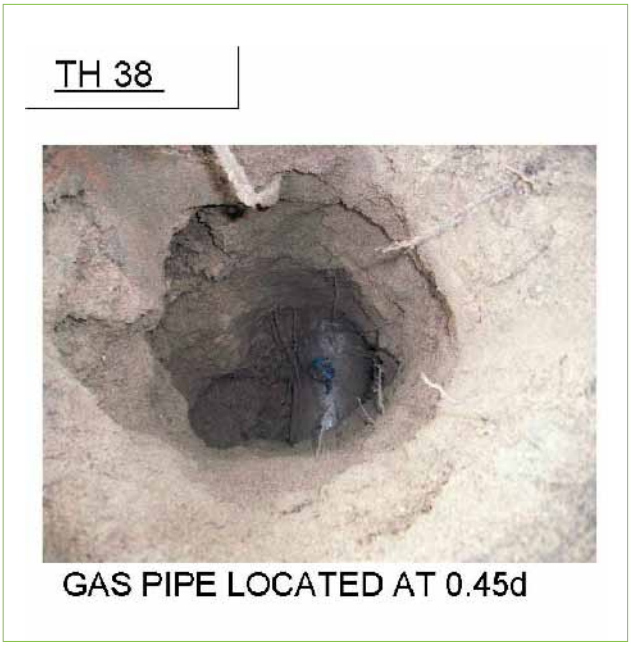
An integrated geophysical survey utilising electrical resistivity tomography, seismic refraction and surface wave ground stiffness techniques produced interpreted maps of physical properties. These were combined with targeted borehole data to develop an accurate, detailed and verified interpretation of ground characteristics.

The resulting ground model showed the depth and variation in bedrock along the route, and included the identification of the weathered zone, the presence of sand and gravel-filled palaeochannels, and a fault line that displaced the upper boundary of the bedrock by 10m.

This fault impacted on the design of a route option that would utilise horizontal directional drilling (HDD) in its construction. The possible presence of deep foundations beneath an existing structure was also critical to the HDD option. RSK developed an innovative approach that used multiple inclined boreholes and geophysical tomographic techniques to image the otherwise inaccessible volume of ground.

Within the first km of proposed route, the data also delineated a former landfill and a man-made engineered bund that formed part of the embankment. The resistivity data traced the water table along the alignment while the ground stiffness data provided values of shear modulus that fed directly into the engineer's design calculations.

For the remaining 2km of the route, the SI highlighted the location of all below-ground services, foundations and other obstructions. The scope and accuracy of traditional service mapping techniques of ground penetrating radar (GPR), radio detection and cover lifting were extended through the deployment of ground conductivity surveys using two different electromagnetic (EM) instruments.



The integrated EM survey identified all buried utilities and obstructions, including a live gas pipeline

C) Verification of survey data and industry recognition

Verification of the survey results was critical to the delivery of the project objectives. Using geophysics, however cleverly, will not provide all the answers. Equally, the level of detail and verification in the ground models produced by this project simply would not have been achieved through untargeted intrusive investigation.

The intrusive investigation designed consisted of over 80 trial holes using machine and hand pitting, and vacuum excavation. The observations verified the geophysical findings and allowed the direct measurement of service diameter, material, type, and positive identification of live or redundant services. Identified obstructions included extensive buried foundations and waste materials.

This integrated acquisition of multiple data sets, as pioneered by RSK's geophysics team, has been the subject of a subsequent collaborative research project with the University of Leeds. The results have been accepted for publication in a special joint journal issue of the European Association of Geoscience and Engineering, and the Environmental and Engineering Geophysical Society on ***Geotechnical Assessment and Geoenvironmental Engineering*** due to recognition of the 'application of new and emerging geophysical methods to imaging, characterization, and the estimation of engineering parameters'.

D) Cost-effective investigation has widespread application

Top image: Ground conductivity surveys from two different EM instruments extended the scope of GPR, radiodetection and cover lifting to reveal all buried utilities and obstructions

Comprehensive capabilities in all aspects of SI enabled RSK to provide truly unbiased recommendations on the best site investigation design, with no commercial pressure to promote one technique over another.

During the site investigation phase, RSK was acting as principal contractor for the National Grid land, and was also required to work under licence for the other land owners. RSK's project experience was used to ensure that our health and safety and logistical responsibilities were discharged effectively, and allowed the site to be investigated quickly, safely and cost effectively. The investigation used the most up-to-date geophysical methods as well as using the latest, and safest, excavation techniques to deliver one of the most comprehensive, detailed, and cost-efficient SIs ever undertaken in the UK.

Trial trenching and hand pits confirmed utilities detected by the geophysical surveys