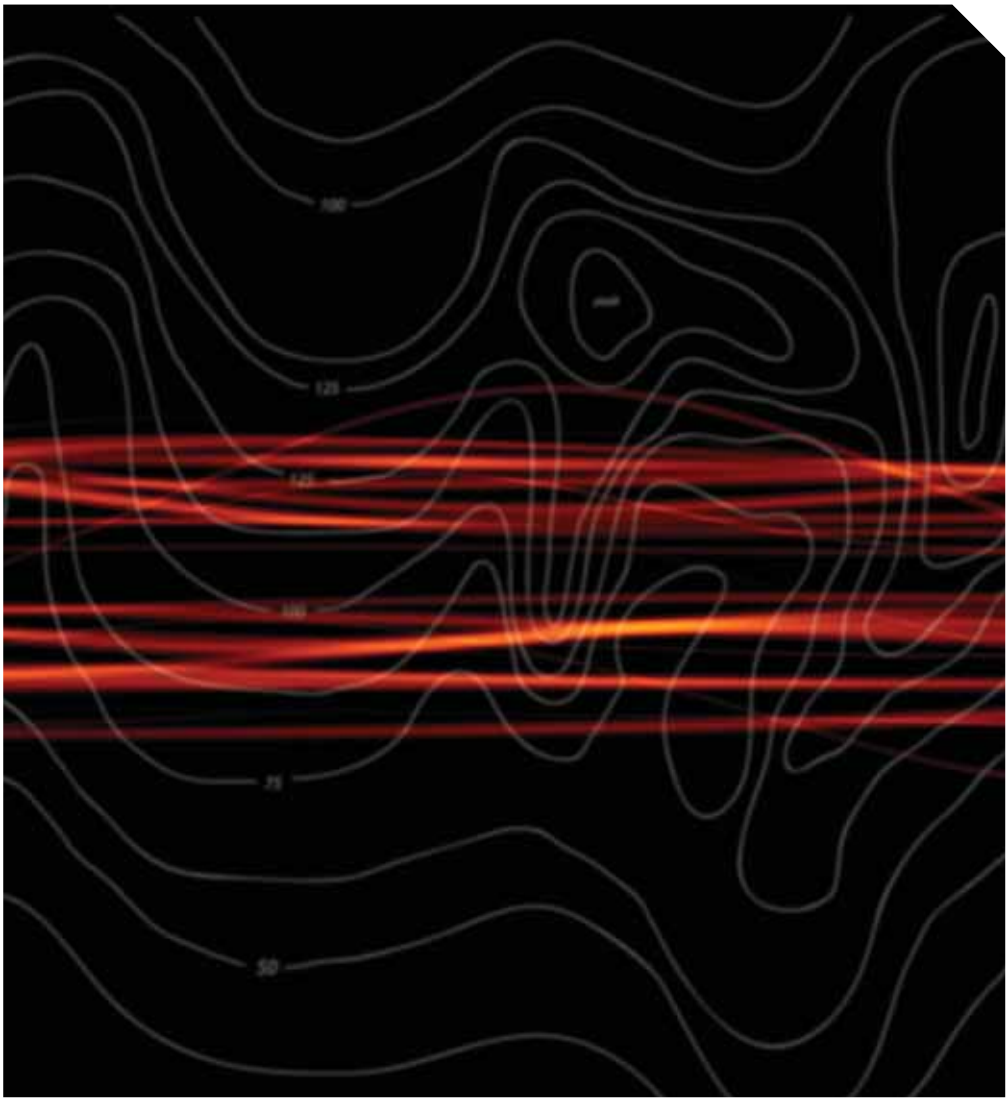
Virtually level

A useful guide from RICS and Ordnance Survey® on the transition from the familiar bench mark to heighting using GPS.



RICS

Ordnance Survey®

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An overview on the how, why and wherefore

Although specific to the British Isles the text of this leaflet is relevant to those countries where similar transitions are taking place.

Remember bench marks?

Life used to be simple and most people associated with architecture, civil engineering, or property were familiar with Ordnance Survey bench marks (BMs) cut into buildings and other structures. Each bench mark was at a known height above mean sea level, as measured at Newlyn in Cornwall (Ordnance Datum Newlyn or ODN), for mainland Britain or local datums for some outlying islands.

Ordnance Survey showed the bench marks on their large-scale maps and published bench mark lists containing the altitudes and descriptions. National mapping agencies in other countries adopted similar policies.

Up until recently users took these bench marks on trust. If in doubt it was simple to check one bench mark against a neighbouring one, using a level and staff.

The beauty of the BM network was that it gave straight forward physical altitudes above Ordnance Survey datum. You could transfer a height from any BM to find the altitude of features on a site using simple level and staff technology.

The old adage is still true: If it ain't broken, don't fix it. However, eventually everything starts to wear out and not perform as required. The point has been reached where the cost of restoring the bench mark network cannot be justified when compared with the benefits obtainable from modern technology.

Why change?

Ordnance Survey has not field-checked the bench marks for many years, but the half-million strong network is still of good quality in most places. There has been variable ground movement in some regions throughout Great Britain to the point where bench mark have become unreliable, especially in old mining areas. The main problem with continuing to maintain the bench mark network is the massive cost involved.

Bench mark values are being withdrawn from Ordnance Survey's OS MasterMap® product and bench mark lists are now no longer for sale.
Bench mark information is however now available free of charge from www.ordnancesurvey.co.uk/benchmarks Whilst bench mark information is useful for checking purposes and for historical comparison, GPS has developed sufficiently to provide a better consistency and absolute heighting accuracy across the country.

Relating altitude to the mean sea level at ODN has traditionally been by means of the BM system, which provided bench marks with a defined value for public use. This has now been replaced by a height transformation model for the entire country which relates mean sea level altitudes to GPS observations. However, it is no longer a case of just taking a value supplied by Ordnance Survey; users now have to have a reasonable understanding of how to use the software and hardware associated with precise GPS observation.

GPS is a fundamentally new approach to the heighting problem, which will help achieve a nationwide consistency. This leaflet should assist you to understand it better.

What do you need to do?

You can establish GPS-based heights by one of two methods. Both use a survey-grade GPS receiver and only work reliably when it is set up in a location with an unobstructed view of the sky.

The first method is suitable for any construction work where it is essential to establish a physical bench mark so you have a fixed reference point on the ground to which subsequent work relates. Set a tripod mounted GPS receiver over a suitable ground point and collect data from the GPS satellites for several hours. As a rule, the longer the observation period, the more accurate the result should be. GPS data for the same period should be downloaded from the Ordnance Survey website for a minimum of three OS Net® GPS Active stations, and the two datasets post processed together. With care, the resulting height of the bench mark will be correct to better than a centimetre or two. Higher accuracies can be obtained by observing over several days. (The RICS publication: Guidelines for the use of GPS in Surveying and Mapping includes full details.)

The second method is to observe heighted points in real time using a Networked Real Time Kinematic (RTK) system. Using a GPS receiver fitted with a mobile phone SIM card you can go to site, collect the network correction via the mobile telephone link and determine coordinates to an accuracy of a few centimetres within seconds. Use of this technique is best limited to those with a thorough understanding as it is a rapidly developing technology.
(See: Virtually Right – RICS Guide to Networked GPS for more information.)

How does it work?

There are over 90 permanently operating GPS stations in the OS Net® network. Their positions and altitudes are monitored continuously. These are effectively high-technology bench marks.

The system works by comparing the satellite data being received by your site receiver with the data being received at the OS Net® stations. From this, it calculates the coordinates of your receiver in the European Terrestrial Reference System 1989 (ETRS89). To convert the height component of these coordinates to altitude above ODN, Ordnance Survey publishes a correction surface, currently OSGM02, which should be included with the receiver/processing software. (For more information on these techniques visit www.ordnancesurvey.co.uk/oswebsite/gps/)

And the pitfalls?

GPS measures the altitude at a moment in time. Every time you measure a point you are effectively re-levelling it, so each reading will reflect the system inaccuracies present, seasonal and long-term ground movements. Really precise observational methods can determine long term ground movement to within a few centimetres.

Compared with conventional levelling, GPS has a very high absolute accuracy with respect to the National Datum but low relative accuracy over short distances. For this reason, GPS should be used to bring an Ordnance Survey height into a site and then spirit levelling used to transfer that height around the site.

GPS is black-box technology. It is easy to obtain an answer but not so easy to check its reliability. In areas where there has been no ground subsidence, levels derived from bench marks agree with GPS-derived levels to within 0.1m. Levelling GPS bench marks from traditional bench marks is a useful check against gross error.

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Further information available on GPS:

RICS specification
Guidelines for the use of GPS in Surveying and Mapping
ISBN 1842190938

RICS Geomatics guidance leaflet
Virtually right – a guide to Networked GPS

Other RICS information:

RICS Geomatics guidance leaflets
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