

# *A Co-ordinated Approach: The County Series, the National Grid and other Co-ordinate Transformation Stories*

*Ed Fielden*

Anyone who has studied the maps of Ordnance Survey's County Series will know how difficult it can be to reference positions on the maps accurately in modern-day terms. The variety of projection origins used mean that the County Series sheet lines never marry with either the National Grid or even the sheet lines of any small-scale national map series.

Study of a County Series index diagram such as the quarter-inch effort produced c.1906 by Ordnance Survey allows users to have a vague idea of the area each sheet covers. Brian Adams's work on compiling a detailed list of the projection origins of the County Series, along with his brief table of county series sheet co-ordinates,<sup>1</sup> also then allows manual calculation of County Series sheet co-ordinates in terms of feet north/south and east/west of the origin.

Now, however, an updated piece of free software allows these calculations to be made instantly, and transformed into a variety of other co-ordinate formats at the same time.

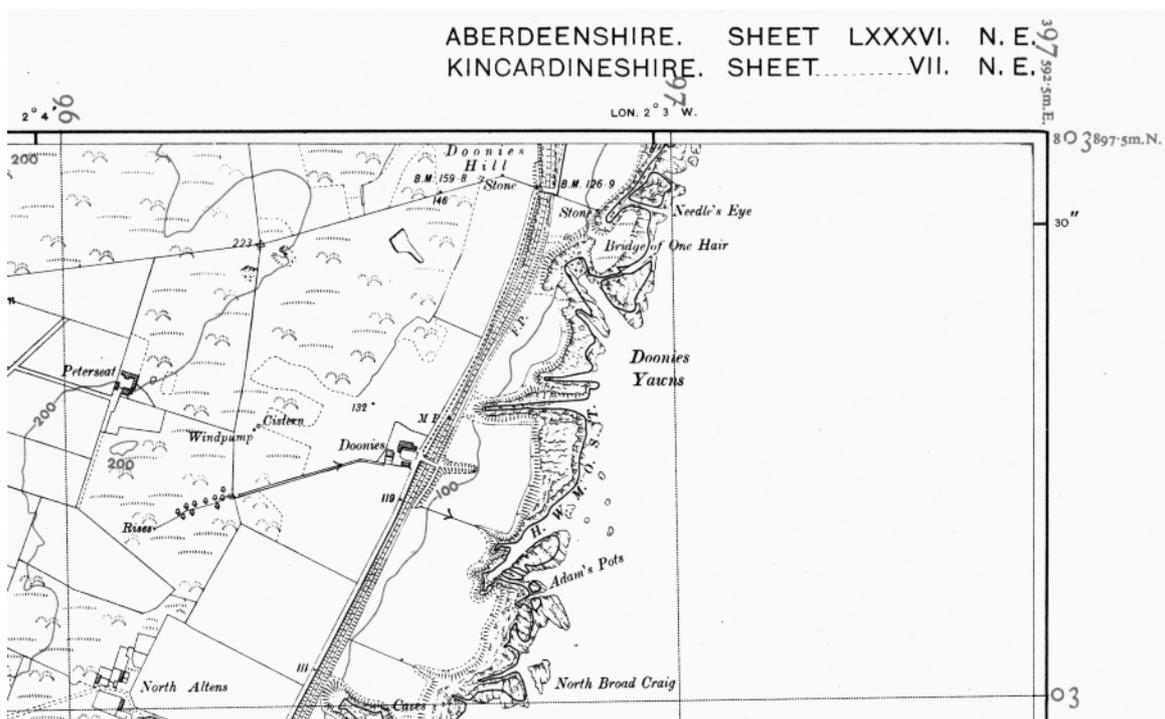


Figure 1: Extract from County Series Aberdeenshire Sheet LXXXVI N.E. / Kincardineshire Sheet VII N.E., Post-War 'Provisional Edition' A, overprinted with National Grid. [Note how the grid lines are at an angle to the sheet lines, and the sheet corners do not fall at round National Grid values.]

## *The germ of an idea*

I have no shame in admitting to being a child of the 1980s.<sup>2</sup> Even from an early age I was interested in cartography and used to study my parents' *Landranger* maps for hours at a time.

<sup>1</sup> *Projections and Origins – collected writings of Brian Adams*, Charles Close Society, 2006, 62-65 / 71-78.

<sup>2</sup> How many other members of the Charles Close Society can claim this dubious honour?

The clean lines and seeming intrinsic accuracy of the contemporary Ordnance Survey maps appealed to my technical and mathematical mind.<sup>3</sup>

The 2°W line of longitude passes exactly one mile to the west of where I have lived since age eight and I was always intrigued as to why this was the only line of longitude that appeared **exactly** vertical on all the maps I knew! I wasn't to discover why, however, until later.

Having tried to keep up-to-date editions of my local *Landranger* sheet (163, *Cheltenham & Cirencester*), I decided in November 2003 to take map collecting more seriously and began to search for sheets of my area in various other series. At this stage I still knew next to nothing about map projections, and had not even heard the word 'Cassini'.

It was not long, though, before I encountered my local sheet (104, *Swindon & Cirencester*) in GSGS 3907, the one-inch military series based on Popular Edition sheet lines. This 'discovery' intrigued me enormously. Here was a map whose sheet lines seemed to bear no relation to the National Grid, and upon which was printed a kilometre-based grid which bore no relation to either the National Grid or even the sheet lines!

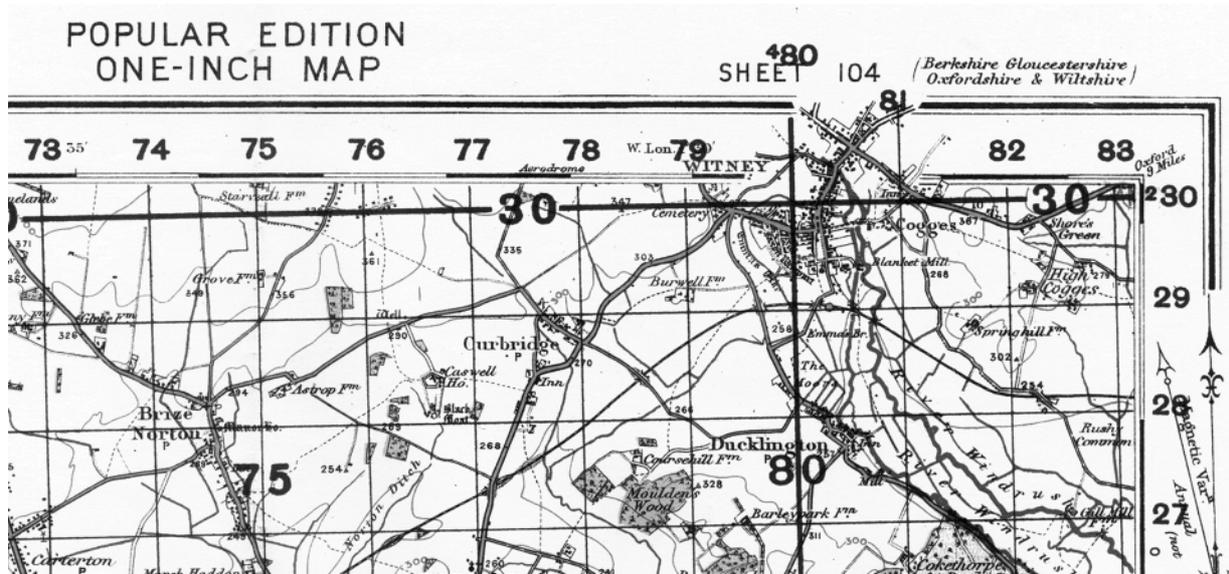


Figure 2: Extract from GSGS 3907 Sheet 104 (*Swindon & Cirencester*), print code 'W.O. 600/38. 15,500/39. C.' [1939]. The overprinted grid is the War Office Cassini Grid.

This puzzled me enough to give me the impetus to set about learning all I could about the projections, sheet lines and the history of Ordnance Survey maps of Great Britain. I joined the Charles Close Society in June 2004 and bought some of its publications – all immensely helpful in furthering my understanding.

The next logical step (in my mind, at least) was to work out how to convert between these differing projection formats, so as to be able to reference positions on old maps in terms of National Grid co-ordinates and vice versa. Through searches on the Internet and in official OS publications<sup>4</sup> I found some algorithms (which are perhaps too technical and

<sup>3</sup> The author is now a Broadcast Technician at ITV West in Bristol.

<sup>4</sup> [http://www.posc.org/Epicentre.2\\_2/DataModel/ExamplesofUsage/eu\\_cs34.html](http://www.posc.org/Epicentre.2_2/DataModel/ExamplesofUsage/eu_cs34.html)  
[http://remotesensing.org/geotiff/proj\\_list/](http://remotesensing.org/geotiff/proj_list/)

Ordnance Survey, *Projection Tables for the Transverse Mercator Projection of Great Britain*, London: HMSO, 1950 (reprinted 1967).

complex to reproduce here!) for conversion between latitude/longitude and both the Transverse Mercator and Cassini projections. Using these algorithms I decided to use my computer programming skills to make a piece of co-ordinate conversion software for my own private use. My initial aim was that I would be able to enter a set of co-ordinates in the form of one of latitude/longitude, the National Grid, or the Cassini projection on the origin of Delamere,<sup>5</sup> and the software would convert to the other two co-ordinate systems.

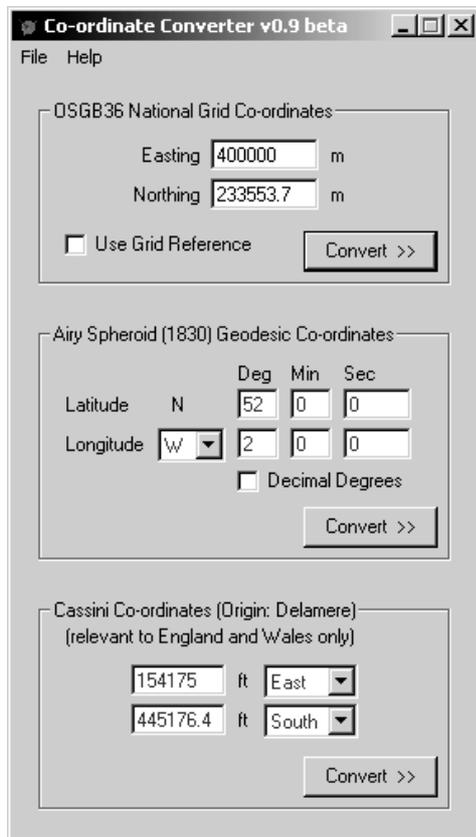


Figure 3: The 'Provisional Edition' - Co-ordinate Converter version 0.9 beta.

By early July 2004 I had completed this first aim, and 'Co-ordinate Converter' was brought into being. Feeling that others may find the converter useful, I decided to publish the software on my website as 'freeware'. In the true spirit of Ordnance Survey tradition, however, this was just a 'provisional' edition (version 0.9 beta) – it was something I wanted to improve upon later.

Over the following few months I updated the software, improving the accuracy of the transformations, adding conversions for Scottish Bonne projection co-ordinates<sup>6</sup> and the War Office Cassini Grid, and also adding a small section for conversions between the Irish National Grid and latitude/longitude. Version 1.0 was released in September 2004. (The 'Regular Edition' if you will!)

### Layers of complexity

As my map collection grew and I acquired examples from more and more series, I saw another opportunity for co-ordinate conversion – the County Series. On reading up about these maps their fragmentary history seemed rather daunting.

For those not familiar with the history of the County Series maps, allow me to paraphrase from Brian Adams's articles on the subject:<sup>7</sup>

Because of the nature of the Cassini projection – the best available at the time Ordnance Survey began large-scale mapping – the further away the mapping is from the central meridian (longitude) of the projection, the more distorted it becomes. At small scales (such as one inch to a mile) this is not too much of a problem and one projection origin (i.e. Delamere) served perfectly well for the whole of Great Britain. With large scales such as the six-inch to a mile and 1:2500 maps of the County Series, however, the distortion caused by having a single origin would have been much more noticeable and bothersome.

The solution arrived at was to create a whole array of projection origins for different counties, limiting the east-west extent of mapping on any single origin.

<sup>5</sup> Used for OS small-scale maps of England and Wales from 1850s-1940s and of Scotland from 1924-1950s.

<sup>6</sup> Used for OS small-scale maps of Scotland from 1850s to 1920s.

<sup>7</sup> *Sheetlines* 25, 3-7; *Sheetlines* 26, 15-20; *Sheetlines* 27, 3-9. Alternatively *Projections and Origins*, 53-70.

Some origins served more than one county – for instance Dunnose, on the Isle of Wight, served as the projection origin for fifteen counties: Berkshire, Buckingham, Derby, Gloucester, Hampshire/IoW, Leicester, Lincoln, Northampton, Nottingham, Oxford, Rutland, Stafford, Warwick, Wiltshire and Worcester. A contiguous sheet line system linked all these counties. Other origins served only the county in which they were situated – for instance Leith Hill Tower, near Dorking, which served as the projection origin for Surrey alone.

This obviously meant that, at the boundaries between counties mapped on differing projection origins, there was a discontinuity in the mapping. On early editions, areas of neighbouring counties on different origins were often left blank.

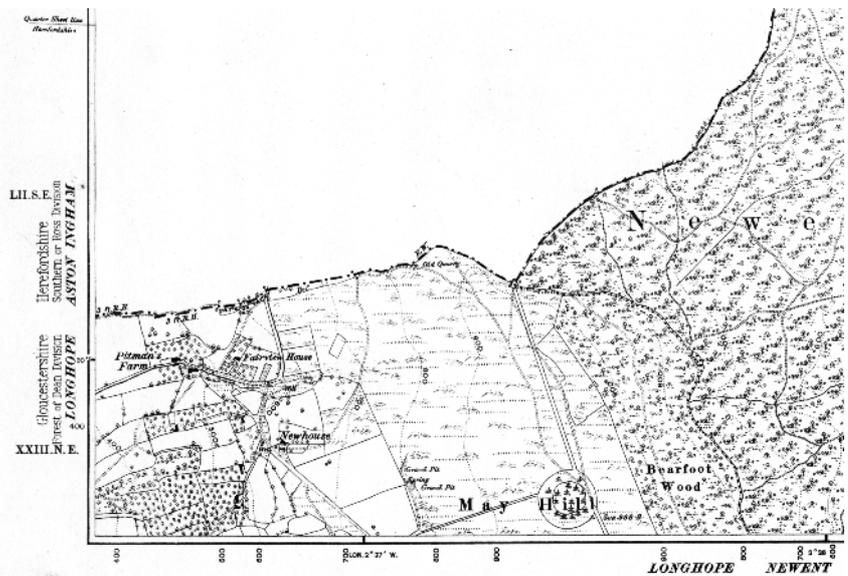
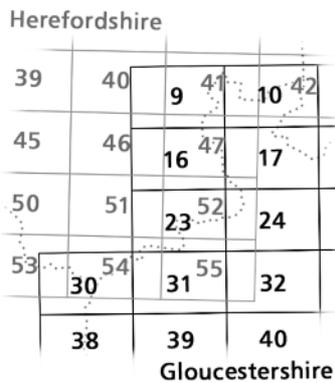


Figure 4a: Diagram of County Series sheet lines at boundary between Gloucestershire & Herefordshire.

Figure 4b: Extract from Gloucestershire sheet XXIV N.W., 1887 edition. The Herefordshire portion is left blank.

After a while it was decided that the inconvenience of the discontinuity between some counties meant that a few did not merit having projection origins of their own, and some time after their initial survey these counties were re-plotted or re-aligned on projection origins of neighbouring counties. From a historical perspective, this would seem to serve only to complicate matters still further!

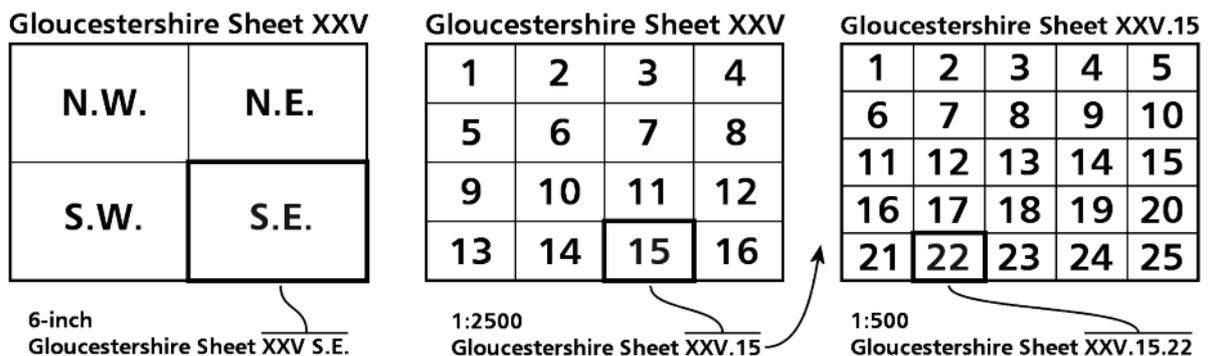


Figure 5: Diagram of County Series sheet derivatives

At this point it is worth considering the format of the County Series sheets. Each set associated with one projection origin is based on a grid of six-mile  $\times$  four-mile ‘full’ sheets. Only some editions of some six-inch sheets were issued in the full-sheet format. Within each of the ‘full’ sheets are derivative sheets such as the six-inch ‘quarter’ sheets (e.g. Gloucestershire Sheet XXV S.E.) and the 1:2500 sheets (e.g. Gloucestershire Sheet XXV.15). The County Series sheet lines were almost invariably used as the base for the large scale 1:500 town plans (e.g. Gloucestershire Sheet XXV.15.22)

### *The County Series Project: Part I*

Despite the inexorable complexities I wanted somehow to incorporate the County Series into the Co-ordinate Converter software.

Obviously there are a vast number of individual County Series sheets covering the country (almost certainly well in excess of 50,000 – I haven’t counted!). So when I embarked on the ‘County Series Project’ in summer 2006 I felt that it would be best to ease in gently by first incorporating a simple reference system for the County Series in Great Britain – in terms of feet east/west and north/south of the projection origin. Thus any point in Great Britain could be referenced in these terms **but** some manual calculation on the part of the user – along with consultation of a sheet index and Brian Adams’s tables<sup>1</sup> – would be needed to determine the relevant foot co-ordinates of the sheet one is studying.

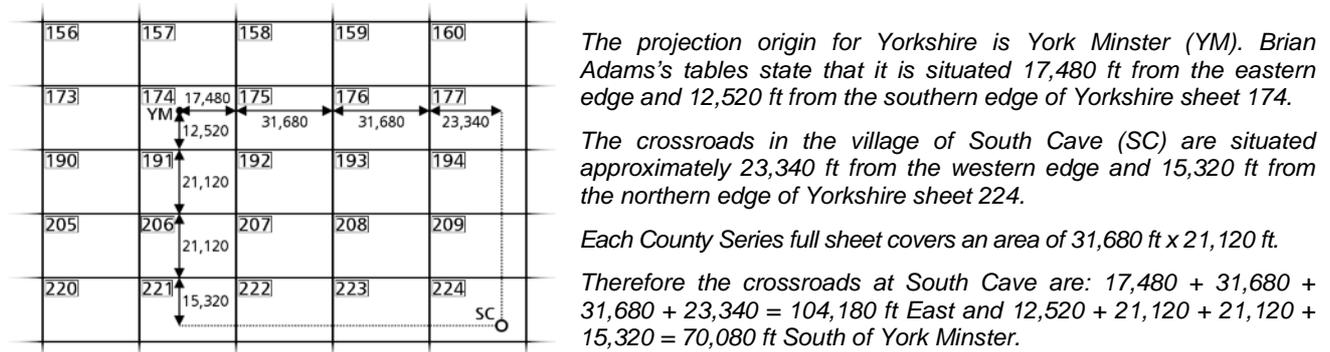


Figure 6: Example calculation of County Series foot co-ordinates for a point in Yorkshire.

For each county block it was necessary to find the precise projection origin. My starting point was the well-timed publication of Brian Adams’s detailed notes on the County Series origins<sup>1</sup> and Richard Oliver’s notes on county mapping.<sup>8</sup> In conjunction with their data I used other sources on the Internet<sup>9</sup> to find the most precise possible positions of each county origin. For each origin I took all the available data and selected the best match, in order that the positions converted would match modern-day mapping as closely as possible. Some origins have been lost on modern-day mapping, which made placing them accurately somewhat difficult. In some cases I had to settle for a rather approximate position.

I gave each origin an accuracy figure, a figure of 90% certainty referring to the accuracy of the point of origin only. Some origins I believe to have fixed to within a quarter inch, some others to within one foot, or in other cases to within ten feet or more.

In September 2006 Co-ordinate Converter version 1.1 was released, incorporating the County Series co-ordinate transformations for Great Britain. As already mentioned, however,

<sup>8</sup> Richard Oliver, *Ordnance Survey maps – A Concise Guide for Historians*, Charles Close Society, Second Edition 2005.

<sup>9</sup> <http://www.asprs.org/resources/grids/10-2003-unitedkingdom.pdf>; <http://www.magic.gov.uk>; <http://www.gps.gov.uk>.

the referencing system for the County Series required a series of manual calculations. While this may have been satisfactory for a time, the calculations needed to deduce foot co-ordinates are rather prone to human error!<sup>10</sup>

### *The County Series Project: Part II*

So it was, nearly a year later in September 2007, that I decided to take the plunge and hard-code into Co-ordinate Converter the co-ordinates of each County Series full-sheet in Great Britain and the Isle of Man, thus eliminating the need for manual calculation of sheet line foot co-ordinates. Armed with Brian Adams's tables and copies of the OS County Series indexes,<sup>11</sup> I set to work.

With a little help from a custom-made Excel spreadsheet to add/subtract six-mile and four-mile distances in feet, I computed and typed the foot co-ordinates of the south-west corners of some 6,712 full sheets (plus 250 individually-numbered 1:2500 sheets in London). Of course I then had to put the software through a fairly rigorous testing procedure to ensure that the results matched up with the sheet indexes. In addition I used some original County Series maps, and also some reprints from Alan Godfrey's series, to ensure that the results matched at large scale too.

Any point in Great Britain and the Isle of Man can be referenced in terms of scale feet east and north of the sheet edge of any six-inch or 1:2500 County Series sheet, and this point can be transformed to all other co-ordinate systems supported by Co-ordinate Converter.

I must add the caveat that the software has its limitations – it's still fairly dumb. For instance:

- A user must first select the desired county from the list before performing any transformations. In other words, the software cannot select the appropriate county by itself when presented with other co-ordinates. Several counties have more than one entry in the list, mostly encompassing differing editions of the maps themselves
- Users should enter County Series sheet numbers in Arabic numerals. Where a prefix exists (e.g. on Essex and Northumberland 'New Series' sheets) this should be omitted. Where a suffix exists (e.g. 179A) this should be entered immediately after the sheet number, without any spaces.
- No account is taken of whether all derivative sheets exist inside a full six-mile × four-mile sheet. Therefore it is still necessary to consult an index diagram to determine whether the sheet referred to in the result of a transformation does indeed exist.
- I have used indexes to derive the full sheets' positions which may not show all sheets in all editions (this is mainly true of England and Wales), although this should be limited only to areas around county boundaries.
- I have not, at present, incorporated direct sheet references for 1:500 scale maps into the software for fear of over-complicating matters. I have, however, included a diagram of how to work out the foot co-ordinates of derivative sheets such as the 1:500 scale maps.

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<sup>10</sup> With apologies and thanks to Lez Watson!

<sup>11</sup> *Indexes to the 1/2500 and 6-inch Scale Maps – England & Wales* (reprint), Kerry: David Archer, 2002.  
*Indexes to the 1/2500 and 6-inch Scale Maps – Scotland* (reprint), Kerry: David Archer, 1993.

**Co-ordinate Converter - Version 1.2**

File Help

**Great Britain** Ireland

Geodetic Co-ordinates (Airy 1830)

Deg Min Sec

Lat. N 53 46 8.7554

Lon. W 0 35 55.8766

Dec. Degrees

Great Britain National Grid

e.g. "NY 360 677"

SE 92340 31241

Grid Ref.

Cassini (Delamere) Co-ordinates

451044.38 ft East

206569.45 ft North

War Office Cassini ("WOFD") Grid

Easting 539452.777 m

Northing 450794.096 m

Grid Ref.

National Yard Grid Co-ordinates

Easting 1100984.172 yds

Northing 1580970.171 yds

Bonne Co-ordinates (Scotland)

- ft East

- ft South

County Series Co-ordinates

Yorkshire Projection Origin: York Minster Accuracy ± 0.05 ft

Explanation of county origins

Full Co-ordinates of origin

104180 ft East

70080 ft South

Sheet Co-ordinates

6-inch Full Sht. 224 scale ft from W neatline 23340 scale ft from S neatline 5800

6-inch ¼ Sht. 224 SE 7500 5800

1:2500 Sht. 224 11 7500 520

[Sheet derivatives diagram](#) Derivative sheets are not guaranteed to exist

Figure 7: Co-ordinate Converter version 1.2

Co-ordinate Converter version 1.2 was released on 6th November 2007, is free for non-commercial use, and can be found online at <http://www.fieldenmaps.info/>

Of course I would welcome any comments, error reports, general observations or ideas for improvement on Co-ordinate Converter. I will make every effort to correct mistakes notified to me and update the software accordingly.

*Anyone without access to the Internet can request copies of Co-ordinate Converter on CD from me, in writing, and in return for a small donation (minimum £1) to cover the costs of the disc and postage. If you request a copy in this way, do not forget to include your return postal address, and please let me know whether (and by what method) you would like to be kept informed of future updates to the software. My postal address is: Ed Fielden, 5 Chesterton Lane, Cirencester, Gloucestershire, GL7 1XG.*