Grid InQuest User Manual

Version 7

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1 Introduction

Welcome to the **Grid InQuest** software manual. This document provides a complete reference for using and understanding the **Grid InQuest** package. It is intended to help you get started using **Grid InQuest** and to illustrate the methods and procedures involved in accurate coordinate conversion in Great Britain, Northern Ireland and the Republic of Ireland.

The manual is divided into two basic sections. The first section, ‘Getting Started’ teaches you the basics of the **Grid InQuest** software and how to quickly get the software up and running. The remaining sections give a detailed description of all the menu items, options and dialog boxes and how to use the software.

NB For information on the dll and DAT files, go to Programming with Grid InQuest

1.1 Overview

The Grid InQuest software provides a means for transforming coordinates between ETRS89 (WGS84) and the National coordinate systems of Great Britain, Northern Ireland and the Republic of Ireland. If necessary, it provides a fully three dimensional transformation incorporating the latest geoid model.

A coordinate may be set and retrieved as any of the following:

ETRS89 Geocentric
ETRS89 Geodetic
OSGB 1936 / British National Grid
TM75 / Irish Grid
IRENET95 / Irish Transverse Mercator
ETRS89 / UTM Zone 29N
ETRS89 / UTM Zone 30N
ETRS89 / UTM Zone 31N

In addition, depending on where the coordinates are located, it will convert between ETRS89 ellipsoidal heights and the following orthometric height datums:

Newlyn
St Marys (Scilly Isles)
Douglas02 (Isle of Man)
Stornoway (Outer Hebrides)
St Kilda
Lerwick (Shetland Isles)
Newlyn (Orkney Isles only)
Fair Isle
Flannans
North Rona
Sule Skerry
Foula
Malin Head
Belfast Lough

1.2 System Requirements

Grid InQuest will run on Windows XP, Vista and Windows 7

1.3 Installation

To Install Grid InQuest

1. Download the Grid InQuest installation file and run the exe file to install or save it onto disk and *double-click* to run. Running the exe file will start the Grid InQuest Installation Wizard.
2. Click **Next** to start the installation
3. In the **Select Installation Folder** screen you may choose a location to install Grid InQuest. Click the *Browse* button to create or choose any folder on a hard disk with at least 5 megabytes of free disk space, or accept the default location. Select whether to install Grid InQuest for a Just Me or Everyone. Click **Next** to proceed to the next step
4. Click **Next** to start the installation, and the Wizard will start copying the required files to your chosen hard disk
5. Once the setup program has finished copying all the files, click *Close.*

1.4 The Grid InQuest dll and dat files

The **Grid InQuest** DLL (GIQ60.DLL) is supplied as freeware and is available to use within third party applications at no extra cost.

Upon installation of the Grid InQuest software, the dll and dat files are automatically made available on disk.

By default, the dll file can be found in the following location:-

C:\Program Files\ Common Files\GridInQuest\Geodetics\GIQ60.dll

The DLL must be distributed with the associated data file (GIQ60.DAT).

This file is usually installed into the folder “<AllUsersAppData>\GridInQuest\GIQ60” but this path can be specified to the **Grid InQuest** DLL.

On XP this is…

C:\Documents and Settings\All Users\Application Data\GridInQuest\GIQ60.DAT

> NB. The folder **Application Data** is by default a hidden folder. To see this folder and its contents, go to **Tools > Folder Options > View** to *Show Hidden Files and Folders*

On Vista this is…

C:\Program Data

When working with the dll file, the *Unlock Code* is: **GIQ.6.0** and is detailed in the Programming Manual

1.5 Conventions used in this manual

The following terms are used in this manual:

Click	Position the cursor pointer on an item, and then quickly press and release the left hand mouse button. When you click the mouse button you should hear and feel a faint click.
Double-click	Position the cursor pointer on an item, and then quickly press and release the left hand mouse button twice. **Grid InQuest** interprets this as a single command.
Drag	Position the cursor pointer on an item, press and hold the left hand mouse button, and then move the mouse.
Choosing menu commands	For example, to choose **Open** from the **File** menu do can use either of the following: i) Using the mouse, click **File**. A listing of all the available **File** commands appears. Click the **Open** command. ii) Using the keyboard, press ALT+F (for **File**) to display the menu and type O (for **Open**).
Select	Position the cursor pointer on an item, and then click.

Specific text in the manual contains the following format:

Menu commands	Menu commands are bold-faced wherever they occur in the text
Dialog box names	Dialog box names are bold-faced wherever they occur in the text
Dialog box options	Dialog box options are in italics

1.6 Accuracy of Ordnance Survey 2d Transformations

Within Great Britain, OSTN02 is the definitive OSGB36/ETRS89 transformation. OSTN02 in combination with the ETRS89 coordinates of the active GPS Network stations, rather than the fixed triangulation network, now define the National Grid. This means that, for example, the National Grid coordinates of an existing OSGB36 point, refixed using GPS from the National GPS Network and OSTN02, will be the correct ones. The original archived OSGB36 National Grid coordinates of the point (if different) will be wrong, by definition, but the two coordinates (new and archived) will agree on average to better than 0.1m (0.1m rmse, 68% probability).

Within the Republic of Ireland and Northern Ireland the OSi/OSNI polynomial transformation is recommended for coordinate transformations between ETRS89 and the Irish Grid. Transformed ETRS89 coordinates will agree with Irish Grid coordinates derived from traditional survey control to within 0.4m (95% data).

1.7 Accuracy of OSGM02

The heights output by precise GPS positioning in the ETRS89 coordinate system are geometric distance above the WGS84 (GRS80) reference ellipsoid. Note that GPS heights are typically two to three times less precise than horizontal positions. OSGM02 converts ETRS89 ellipsoidal heights to orthometric heights above mean sea level.

In mainland Great Britain, the datum (origin point) representing mean sea level is Ordnance Datum Newlyn, defined at Newlyn in Cornwall. In the Republic of Ireland, Northern Ireland, and the islands surrounding GB, mean sea level is defined by specific independent vertical datums which are all incorporated in OSGM02 and hence OSGM02 is compatible with the products from each of the Ordnance Surveys. Other Geoid models may give 'mean sea level' heights that are incompatible with the Ordnance Surveys products.

The estimated accuracies of OSGM02 for each regional vertical datum are included in the table below. The figures quoted assume precise ellipsoidal heights are used, for lower quality GPS observations additional error budget must be included.

Regional Datum	Standard Error (m)
Great Britain	0.02
Republic of Ireland	0.03
Northern Ireland	0.02
Orkney	0.08
Shetland	0.03
Outer Hebrides	0.09
Isle of Man	0.03
St. Kilda	0.06
Scilly Isles	Single offset from Newlyn

Any discrepancy found between an Ordnance Survey levelled bench mark (OSBM) and a OSGM02 computed orthometric height is likely to be due to bench mark subsidence or uplift and, assuming precise GPS survey has been carefully carried out, the orthometric height given by OSGM02 should be considered correct in preference to archive bench mark heights.

2 Getting Started

2.1 Starting the software

Once the software has been installed correctly, Grid InQuest may be started from the start menu.

Locate and then run Grid InQuest**.** Alternatively, as part of the installation, a shortcut will be placed on the desktop. Double click the Grid InQuest shortcut and the Grid InQuest application will start...

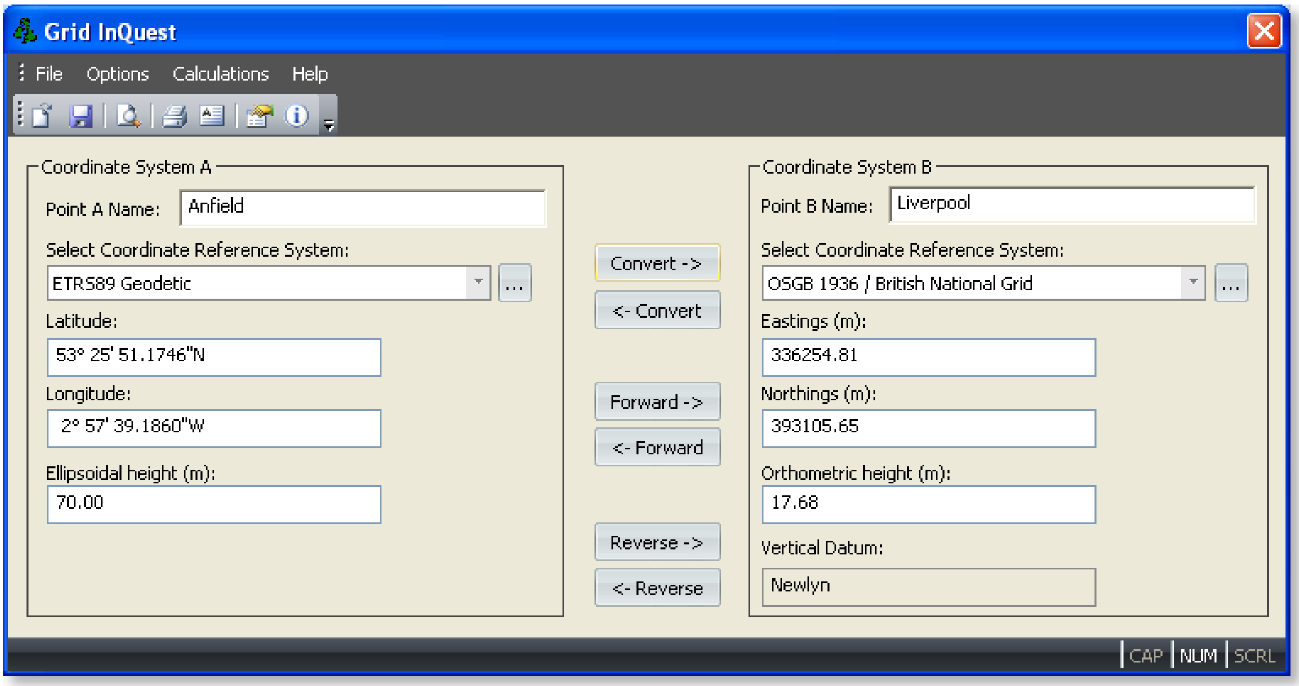


Figure 2.1: Main Grid InQuest Software

2.2 Converting a coordinate

On the left hand side of the window, for Point A, enter the details of the known coordinate. Select the coordinate type form the drop down list (eg Geocentric, Geodetic... etc). Enter the coordinate values (as either latitude, longitude and height, xyz or Eastings Northings and ellipsoidal height).

On the right hand side, for Point B, select the details to which the Point A coordinate is to be converted to. Select the coordinate type form the drop down list (eg Geocentric, Geodetic... etc). Click on the top ***Convert*** button to convert the coordinate from System A to System B. The exercise may be reversed by clicking on the lower ***Convert*** button to go from System B to System A.

2.3 Example

In this example there is a coordinate from a GPS receiver that is to be converted to the Local National Grid.

In the left hand side of the window (System A), enter the point name at the top and from the **Select Coordinate Reference System** drop down box, select ***ETRS89 Geodetic***. Enter the **Latitude, Longitude** and **Ellipsoidal Height** from the GPS receiver.

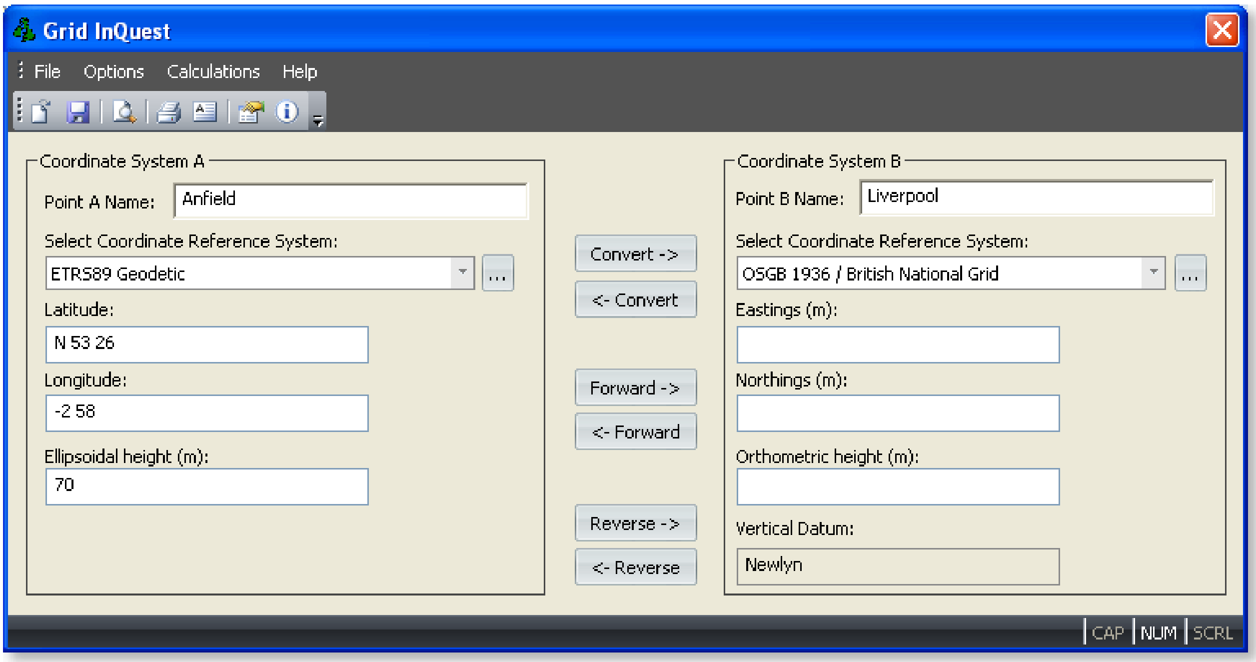


Figure 2.2: Example (Step 1)

Grid InQuest can accept most text formats for geodetic coordinates, and in the example the following has been entered:

n 53 26	to represent	53° 26’ 00.0000 N
-2 58		002° 58’ 00.000 W
70		70.00m

Select **OSGB 1936 / British National Grid** as the coordinate reference system on the right hand side (System B) since the point is inside the UK. Click on the top-most ***Convert*** button to convert the coordinate from System A (**ETRS89** GPS coordinate) to System B (**OSGB36** local grid).

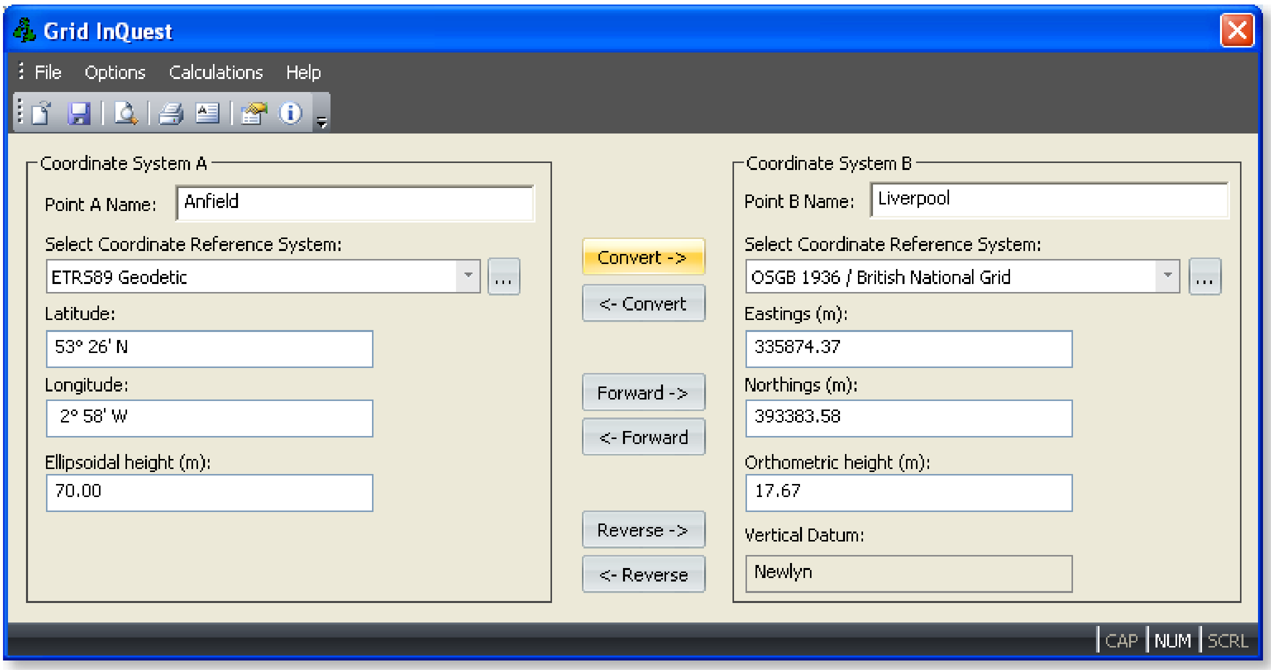


Figure 2.3: Example (Step 2)

The converted grid coordinates (Eastings and Northings) will be displayed on the right hand side:

335874.37m E

393383.58m N

17.67m Ht

The vertical datum will be automatically set to Newlyn since the coordinates we have chosen are only applicable to this vertical datum.

NB: The conversions to Ordnance Survey local datums are only valid on mainland Great Britain, Northern Ireland and the Republic of Ireland. There is a ten kilometre buffer extended from the coastline to cover near-shore transformations, however it is not valid any further offshore.

The transformations are not valid in the Channel Islands.

3 Reference

3.1 Coordinate Entry

Coordinates can be entered into the conversion software via a number of different formats.

1. ETRS89 Geodetic Coordinates

Select **ETRS89 Geodetic** as the coordinate reference system from the drop down box (1). This gives input fields for Latitude, Longitude and Ellipsoidal Height. Heights are ellipsoidal and refer to height above the GRS1980 ellipsoid.

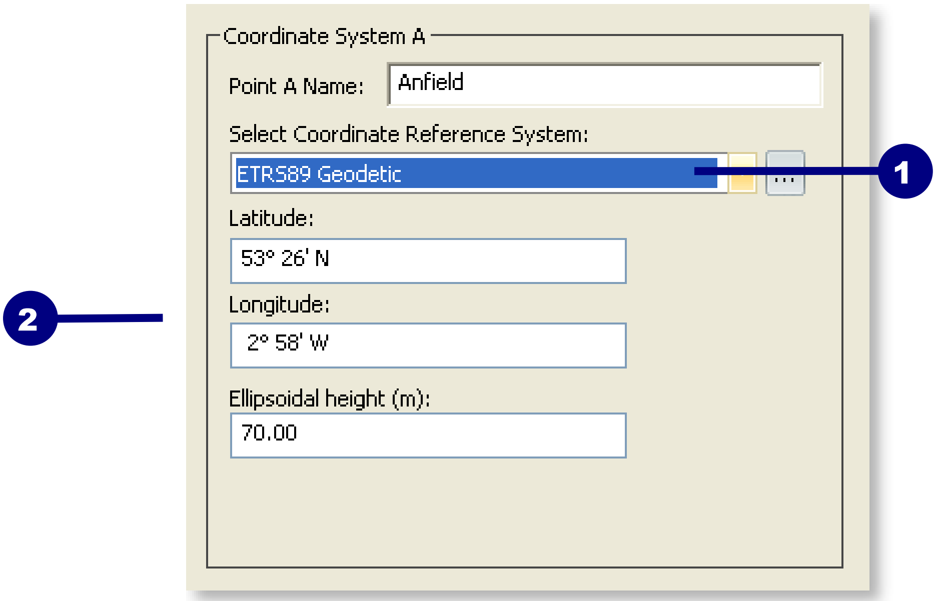


Figure 3.1: ETRS89 Geodetic Coordinate Entry

The latitude and longitude of the point can be entered into the edit boxes (2) in a variety of formats. Grid InQuest will accept decimal degrees, degrees and minutes and degrees minutes and seconds. It will accept hemisphere codes (N, S, E and W) as well as signed numbers (+ and -).

2. ETRS89 Geocentric Coordinates

Select ***ETRS89 Geocentric*** as the coordinate reference system from the drop down box (1) in Figure 3.2. This gives input fields for X Coordinate, Y Coordinate and Z Coordinate. Heights are ellipsoidal and refer to height above the GRS1980 ellipsoid.

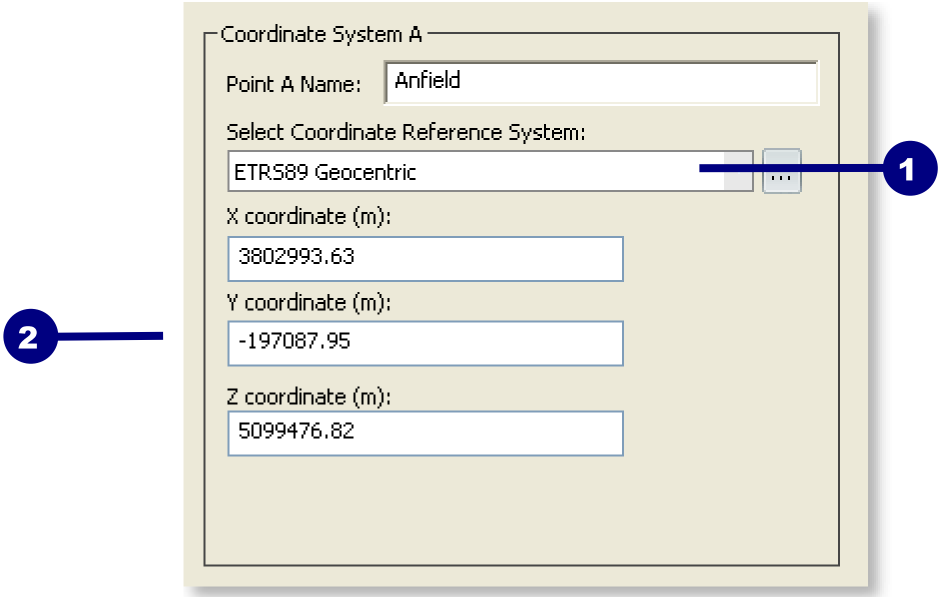


Figure 3.2: ETRS89 Geocentric Coordinate Entry

Enter the Earth centered, Earth fixed (X,Y,Z) coordinates in metres in the edit boxes (2).

3. ETRS89 UTM Coordinates

Select **ETRS89 / UTM Zone 30N** as the coordinate reference system (or 29N or 31N as appropriate) from the drop down box (1) Figure 3.3. The vertical datum will default to the appropriate one ie **Newlyn**.

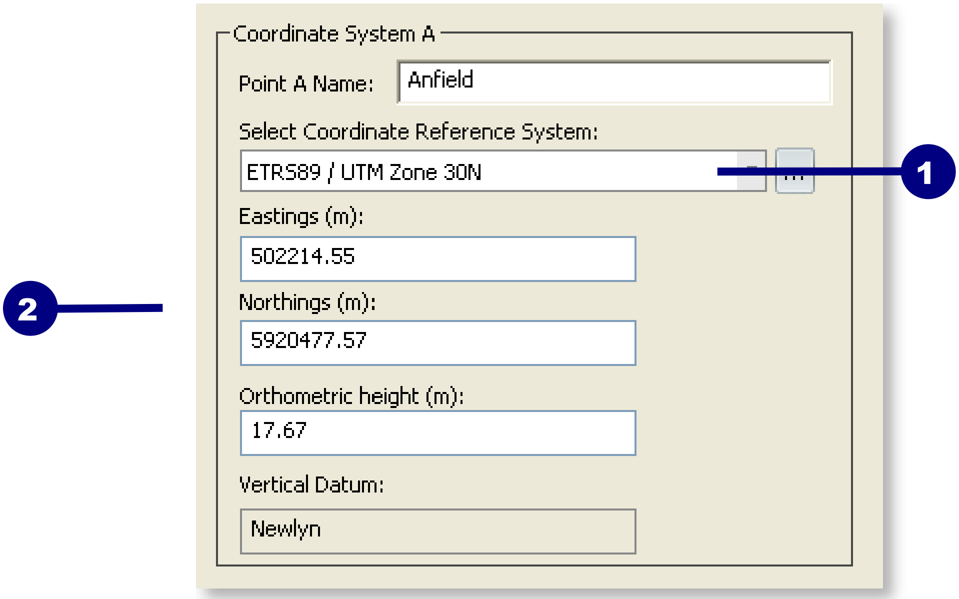


Figure 3.3: ETRS89 UTM Coordinate Entry

Enter the UTM projected Eastings and Northings in the edit boxes (2) and the orthometric height (height above mean sea level), in metres. The zones have been restricted to those applicable to the transformation, ie zones 29, 30 and 31. When working in Northern Ireland and the Republic of Ireland the zone will be fixed to 29.

4. OSGB36

When using the software in Great Britain, select ***OSGB 1936 / British National Grid*** as the coordinate Reference System from the drop down box (1), Figure 3.4.

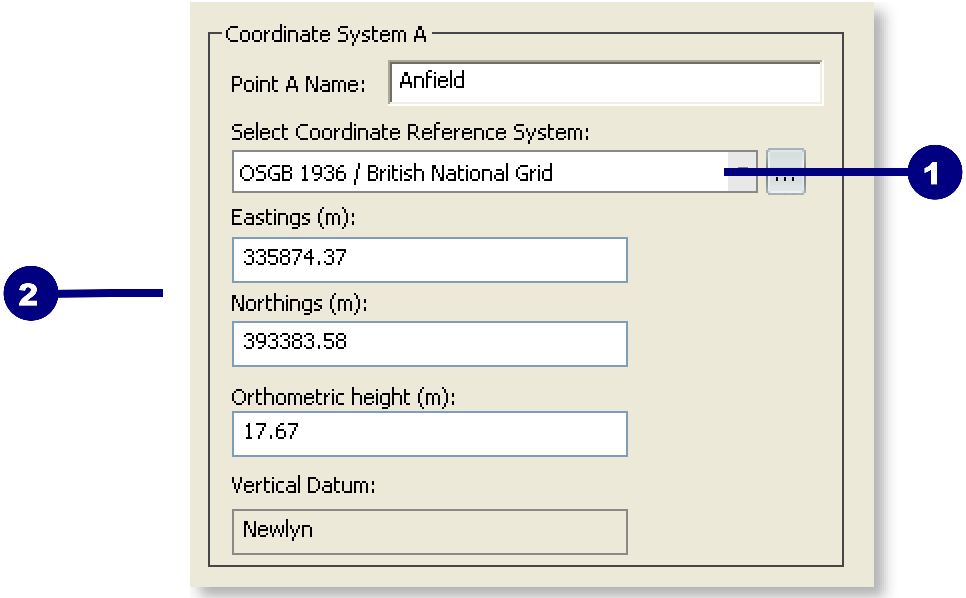


Figure 3.4: OSGB36 Coordinate Entry

Enter the OSGB36 projected Eastings and Northings, and the orthometric height (height above mean sea level) in the edit boxes (2). The vertical datum will default to the appropriate one ie **Newlyn**.

5. Irish Grid

When using the software in Ireland or Northern Ireland, select select **TM75 / Irish Grid** as the Coordinate Reference System from the drop down box (1), Figure 3.5.

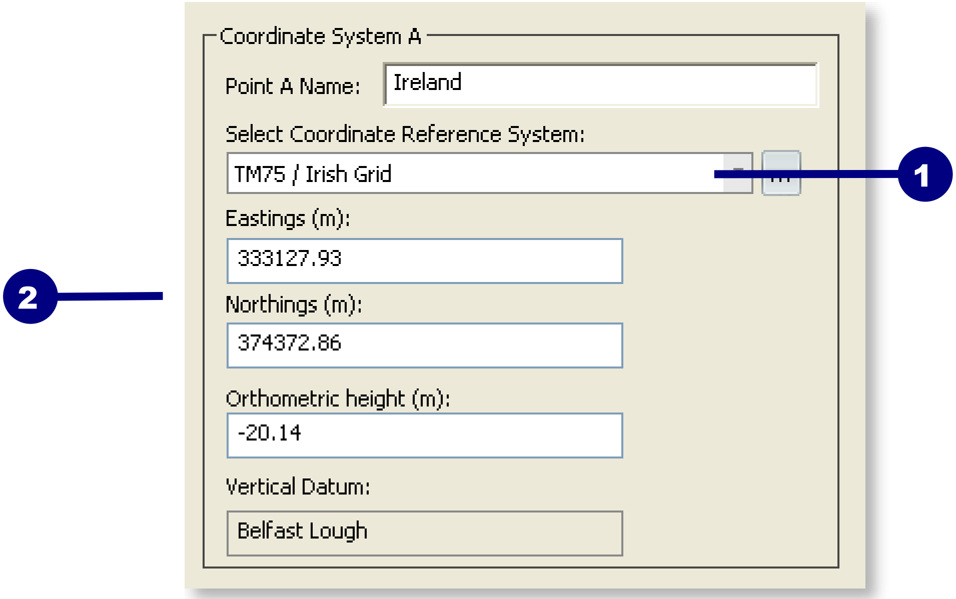


Figure 3.5: Irish Grid Coordinate Entry

Enter the Irish Grid projected Eastings and Northings, and the orthometric height (height above mean sea level) in the edit boxes (2). If the coordinates are within the Irish Grid in Northern Ireland, the vertical datum will be fixed to **Belfast Lough**. If the coordinates are within the Irish Grid in the Republic of Ireland, the vertical datum will be fixed to **Malin Head**.

6. Irish Transverse Mercator

When using the software in Ireland or Northern Ireland, select **IRENET95 / Irish Transverse Mercator**as the Coordinate Reference System from the drop down box (1), Figure 3.6.

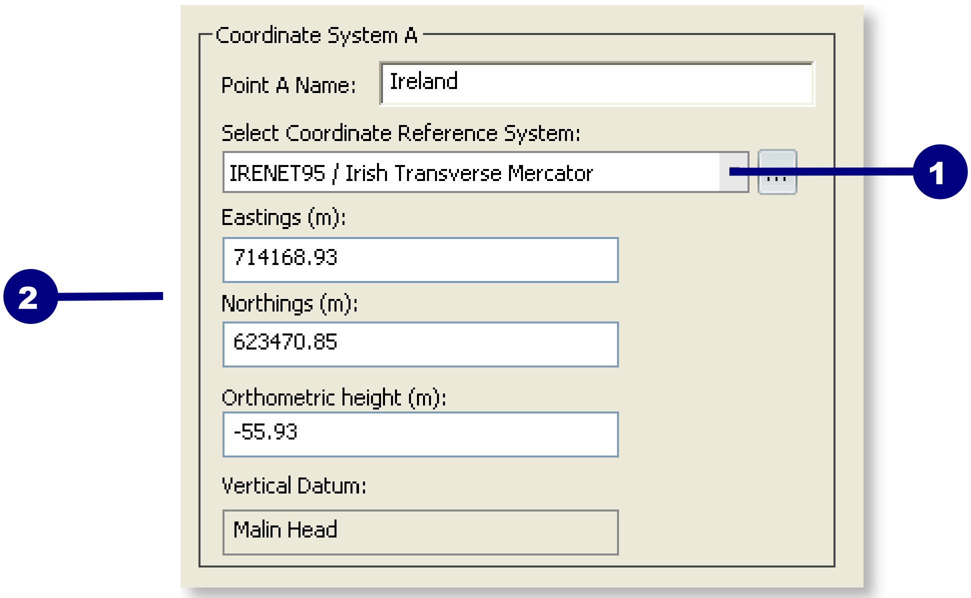


Figure 3.6: Irish Transverse Mercator Coordinate Entry

Enter the Irish Transverse Mercator projected Eastings and Northings, and the orthometric height (height above mean sea level) in teh edit boxes (2). If the coordinates are within the Irish Grid in Northern Ireland, the vertical datum will be fixed to **Belfast Lough**. If the coordinates are within the Irish Grid in the Republic of Ireland, the vertical datum will be fixed to **Malin Head**.

3.2 Coordinate Conversion

The conversion buttons in the centre of the dialog allow the coordinates to be converted to and from ETRS89 and local grid coordinates.

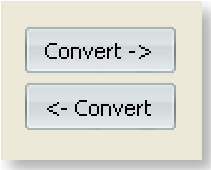


Figure 3.7: Conversion Buttons

Once the coordinates on either the left or right hand side are altered, use the conversion buttons (Figure 3.7) to convert the coordinates to and from System A to System B.

3.3 Forward and Reverse Conversion

Forward and reverse geodetic computations may also be computed using the *Forward* and *Reverse* buttons respectively. For the forward problem, to compute the coordinates of Point B a certain distance and azimuth from Point A, click on the top *Forward* button to display the dialog shown in Figure 3.8.

The forward problem may be computed using either geodetic formula (ie using a geodetic distance and azimuth on the ellipsoid) or using grid formula (ie standard Pythagoras). Select to use either geodetic or grid computations (1) and then enter the forward azimuth from Point A to Point B and the distance between Points A and B in the edit boxes. Distance must be entered in metres.

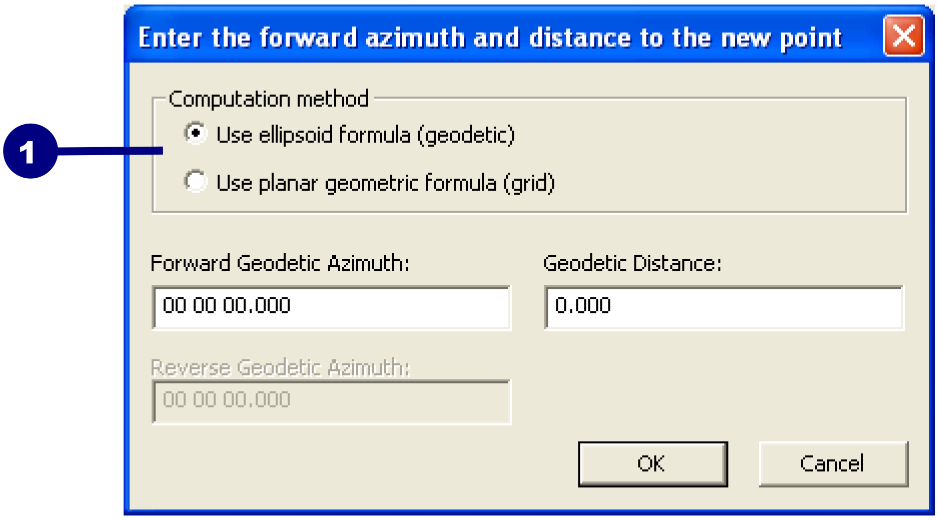


Figure 3.8: Forward Problem

For the reverse problem, to compute the azimuth and distance between Points A and B, click on one of the *Reverse* buttons to display the dialog shown in Figure 3.9. The forward and reverse azimuth and the distance between the points are displayed. Using the radio buttons (1) select if to show either the geodetic azimuth and distance between the points, or the grid distance and azimuth between the points.

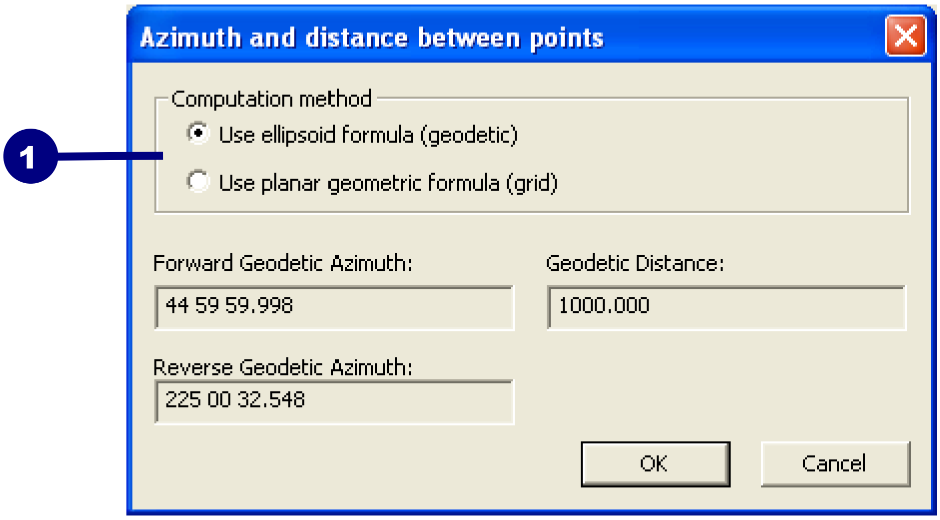


Figure 3.9: Reverse Problem

3.4 Projection Information

To view information about a specific projection's computational parameters, select the **Calculations** menu, and **Project Information**. A dialog box similar to that shown in Figure 3.10 will be displayed.

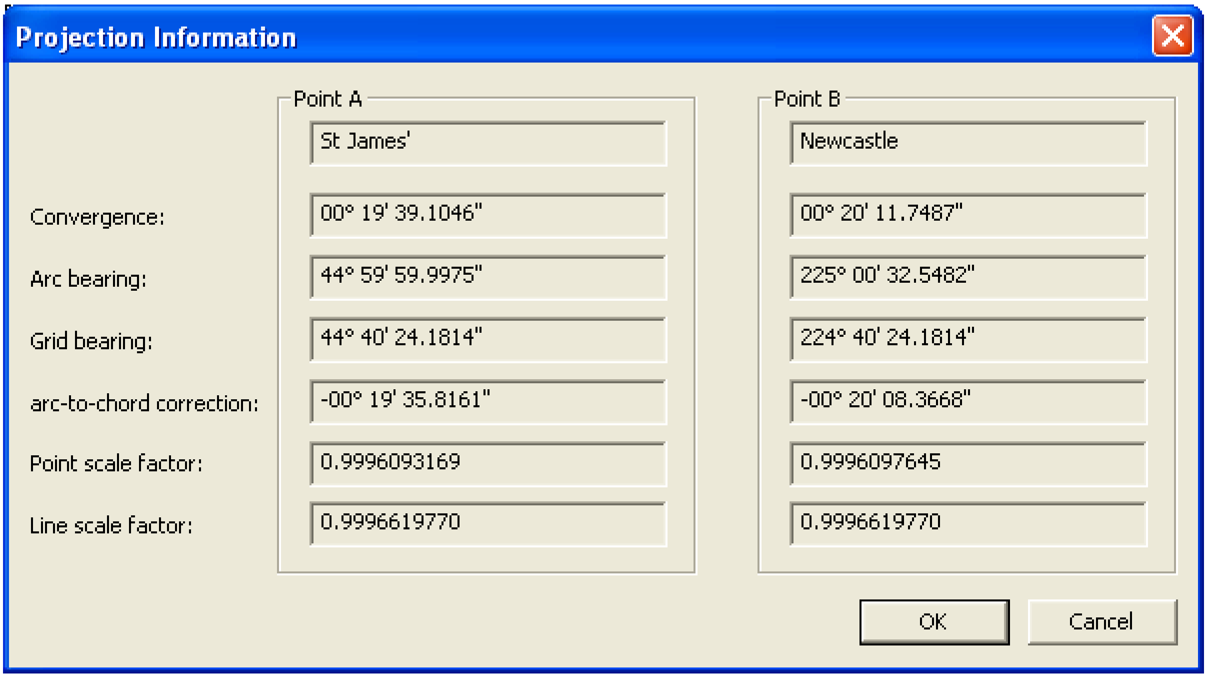


Figure 3.10: Projection Information

If both points are on the same projection and datum a certain distance apart, the dialog will display the following computed variables:

i) The convergence, γ, at a point is the angle between grid north and the projected geodetic north direction
ii) The arc bearing, T, from point A to point B is the angle between the projected geodesic and grid north
iii) The grid bearing, t, from point A to point B is the angle between the straight chord and grid north
iv) The arc-to-chord correction (t-T), is the angle between the plane bearing and the arc bearing
v) The point scale factor, m, at point A is given by the ratio between a small element of geodesic and its corresponding projected length
vi) The line scale factor, m_{ab}, is the ratio between the length of the geodesic and its projected chord length.

Depending on the chosen datum and projection of points A and B, some or all of the edit boxes will be filled with the computed variables.

3.5 Display Options

The output format of the converted coordinate may be altered by selecting ***Display Options*** from the ***Options*** menu to activate the **Display Options** dialogue box, Figure 3.11. In **Display Representation > Positions** (and **Angles**) Latitude and longitude coordinates may be entered in any format (eg degrees minutes and seconds, degrees and decimal minutes, decimal degrees...). The number of decimal places to which coordinates will be formatted to, can also be selected. The number of decimal places used can be independently set for each type of coordinate value.

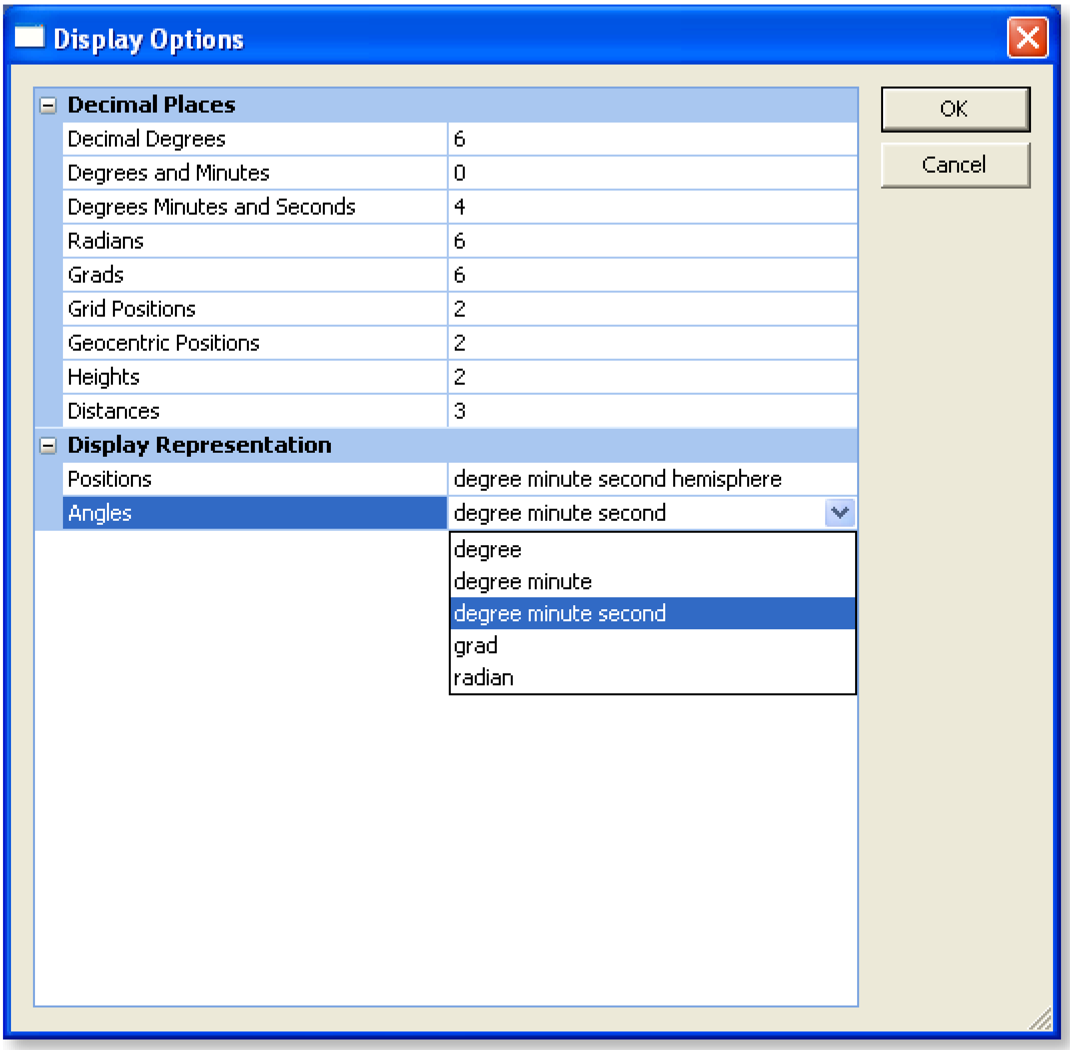


Figure 3.11: Geodetic Manager Display Options

3.6 Irish Border Options

For the areas which cross the border between Northern Ireland and the Irish Republic, it is possible to select the required border option for use of the Vertical Datum. Figure 3.12

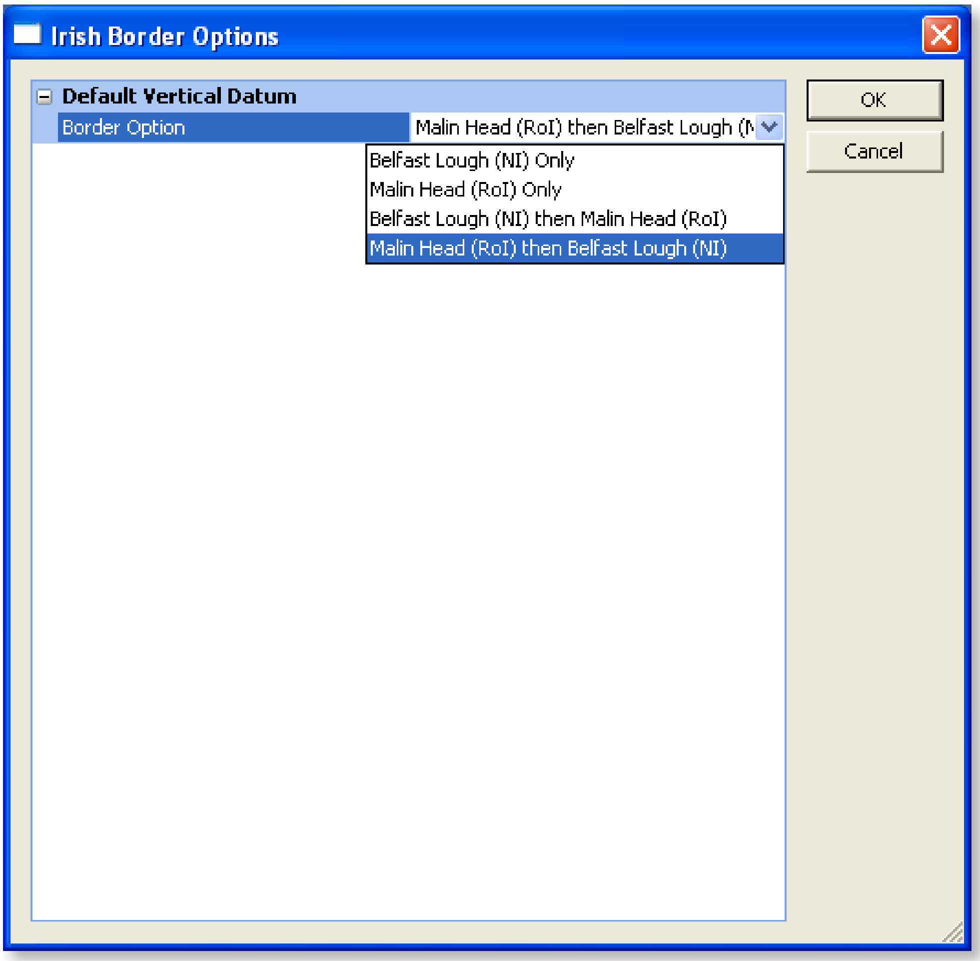


Figure 3.12: Irish Border Options

3.7 Grid InQuest Printing

The current parameters and coordinates in the dialog can be sent to a printer for future reference. From the menu select **File** and then **Print**. The standard Windows Print Dialog will be displayed. Select the required printer and click on **OK** to print a copy of the current Grid InQuest information.

3.8 Grid InQuest Report

A report on the current Grid InQuest status can be generated and saved for future reference. From the **File** menu select **Report** and a document will be created giving the current coordinates entered in the Grid InQuest software, and the appropriate geodetic parameters.

3.9 File Conversions

Grid InQuest will allow ASCII files of coordinates to be converted from one datum (and/or projection) to another. From the **File** menu select **Convert File(s)** and using the standard Windows Open dialog select the file that is to be converted. The conversion decoder will convert all delimited ASCII text files as well as Microsoft Excel files.

Selecting the ***Convert File...*** option will activate the **Text File Decoder**. This enables the user to import ASCII data files, choose how the data is represented, which coordinate system it is in and define it's appearance.

Using the Text File Decoder

On initialising the **Text File Decoder** for the first time, the **File Convert** dialogue box will be activated, Figure 3.13.

This will display the imported file in the top pane and a lower pane will display the decoded formatted version (*NB this will be automatically populated but may be incorrect and require manual decoding to correct*)...

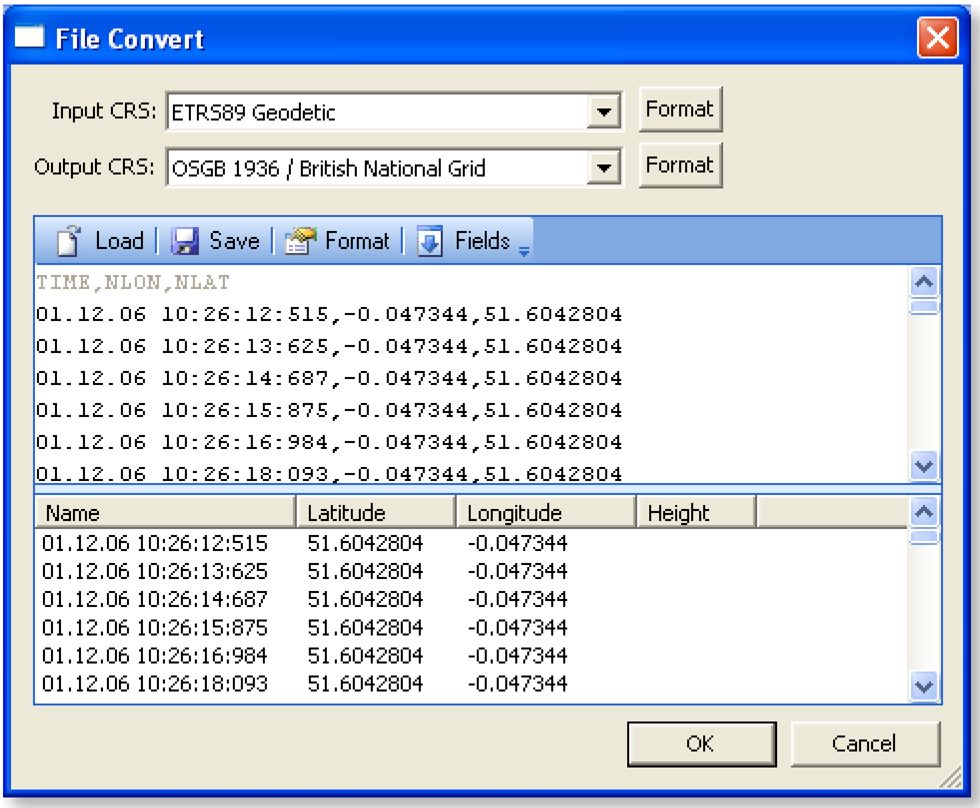


Figure 3.13: File Convert

Defining the Coordinate Reference Systems

At the top of the **File Convert** window, there are 2 fields...

Input CRS:

Output CRS:

Use the drop down list (Figure 3.14) to select the correct **CRS** (Coordinate Reference System) for both the **Input** (imported) file and the **Output** file.

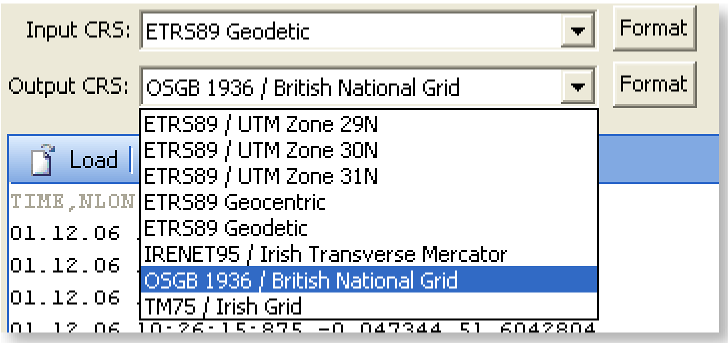


Figure 3.14: CRS selection

Use the **Format** buttons (Figure 3.14) for each **CRS**, to specify the format (ie degrees, minutes, seconds) for Geodetic coordinates (Figure 3.15) and the decimal places for Grid coordinates (Figure 3.16).

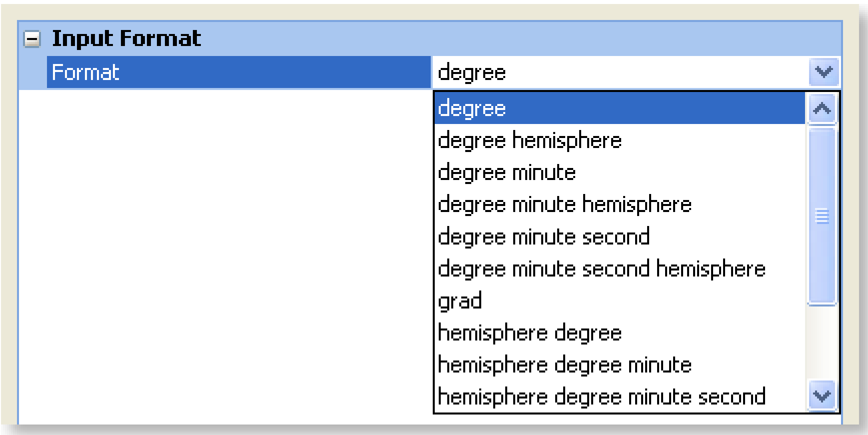


Figure 3.15: Coordinate Format Selection

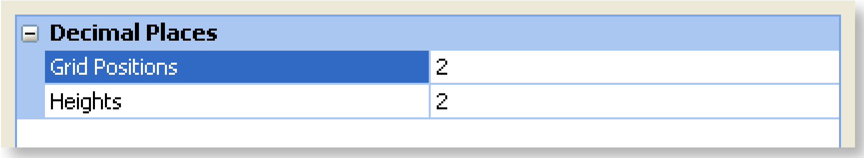


Figure 3.16: Decimal Places

Manually decoding the File

Use the series of buttons in the top pane of the **File Convert** window to correctly decode the data.

Load

Click on **Load** to import a previously saved format.

Select the appropriate **File Import Settings File (.fis)**

Save

Click on **Save** to save the current format.

This is saved as a **File Import Settings File (.fis)**

Format

Click on the **Format** button to define the file format properties. This will activate the **File Properties** dialogue box (Figure 3.17)

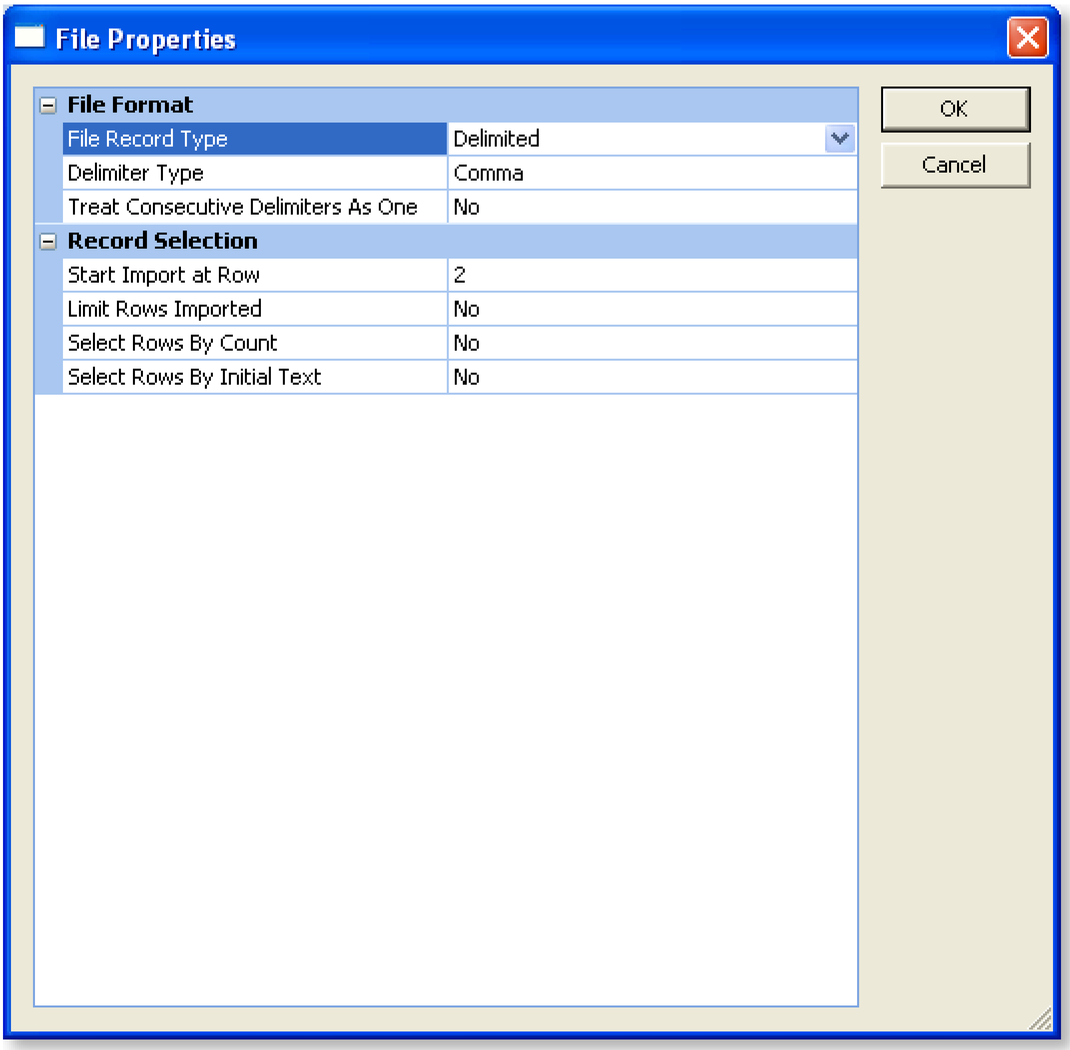


Figure 3.17: File Format Properties

These options define the format of the imported file and specify which records within the file should be used for the geodetic transformation.

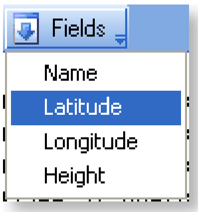
Edit the fields as appropriate and click on **OK** to view the changes in the decoded file pane.

NB. Selecting **Yes** in any of the **Record Selection** fields will activate an extra field.

Fields

Click on the **Fields** button to decode the data into the correct columns.

Select the data type eg **Latitude**...



Then select which column from the input file to use for the latitude data (Figure 3.18)

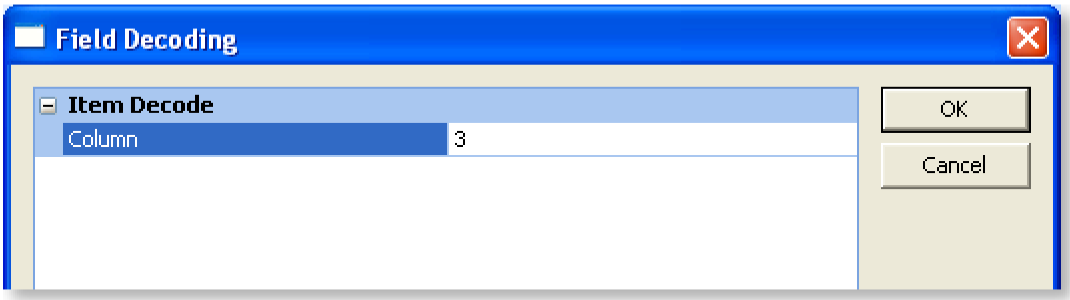


Figure 3.18: Data Field Decoding

Repeat this for all fields until the data is displayed as decoded correctly in the **File Convert** window

Running the File Transformation

When the file has been correctly decoded, select **OK**

Choose a name and location for the output file and **Save**

The File transformation will be run automatically and displays a summary window of the converted points (Figure 3.19).

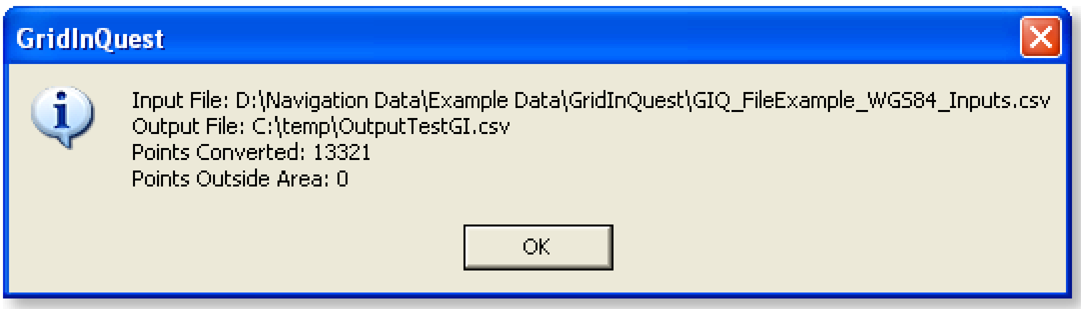


Figure 3.19: Output File Summary

4 About the Transformations

All Ordnance Survey mapping relates to a coordinate reference system. In Great Britain OSGB coordinates relate to OSGB36® (the National Grid), within Northern Ireland and the Republic of Ireland the coordinate reference system is the Irish Grid. These reference systems are traditionally realised on the earth's surface by monumented triangulation stations. The users of mapping products, in both the public and private sectors, have invested in geographical information systems (GIS) and asset management systems based on these Grid systems which have been accepted as de facto national standards.

In order to relate GPS-derived positions to the Ordnance Surveys' mapping, GPS derived coordinates need to be converted to Irish Grid or to National Grid, which requires a specialised datum transformation. For this reason the Ordnance Survey of Northern Ireland and Ordnance Survey Ireland have developed a polynomial transformation, which is the standard datum transformation for use throughout Ireland. The Ordnance Survey of Great Britain have developed OSTN02, the standard datum transformation for Great Britain.

Ordnance Survey mapping also includes height information that relates to a regional vertical datum. Height information in Great Britain refers to Ordnance Datum Newlyn (ODN), which is established from mean sea level. Although ODN is the national height datum used across mainland Great Britain there are a number of additional datums that are used on the surrounding islands, namely: Lerwick on the Shetland Islands; Stornoway on the Outer Hebrides; St. Kilda; Douglas02 on the Isle of Man and St. Marys on the Scilly Isles. The Ordnance Survey of Northern Ireland relates heights within Northern Ireland to Belfast Lough datum, and Ordnance Survey Ireland relates heights within the Republic of Ireland to the Malin Head datum. The resulting Ordnance Survey Geoid model (OSGM02) incorporates all the above vertical datums.

4.1 OSTN02

The Ordnance Survey of Great Britain has developed the horizontal transformation OSTN02. This transformation consists of a 1,250km by 700km grid of translation vectors at 1km resolution. This provides a fit between the GPS coordinate system ETRS89 and the OSGB36 National Grid. ETRS89 coordinates can be determined in Great Britain by linking a GPS survey to Active or Passive stations from the British 'National GPS Network', see www.gps.gov.uk. OSTN02 is in agreement with major triangulation stations at the level of 0.1m root mean square (RMSE).

Within Great Britain OSTN02 (the Ordnance Survey National Grid Transformation), in conjuction with the ETRS89 positions of the active GPS Network stations, is now the official definition of OSGB36 National Grid coordinate system. This means that using OSTN02 with the National GPS Network, surveyors using GPS have no need to occupy triangulation stations in order to relate GPS coordinates to National Grid coordinates.

4.2 OSi/OSNI Polynomial Transformation

Ordnance Survey Ireland and Ordnance Survey of Northern Ireland recommend the OS*i*/OSNI polynomial transformation for all horizontal transformations in the Republic of Ireland and Northern Ireland. This transformation has been developed in association with the Institute of Engineering Surveying and Space Geodesy, University of Nottingham.

The transformation is based on 183 points evenly distributed throughout Ireland and Northern Ireland. The precise ETRS89 and Irish Grid coordinates of these points ere determined by GPS and terrestrial survey methods, and a one-dimensional 3rd order polynomial individually fitted to the latitude and the longitude. The resulting polynomial allows calculation of the coordinate differences at additional points. The polynomial transformation has an accuracy of 0.4m (95% data).

4.3 Ordnance Survey Geoid Model: OSGM02

To provide the third dimension of the transformation, the Ordnance Surveys have, with others, developed the Geoid model OSGM02. The model is derived from precise gravity surveys across UK, Ireland, and surrounding waters, additionally the model includes data from the global geopotential model (EGM96). Alignment to each regional vertical datum is based on precise GPS observations at Ordnance Survey levelling marks. Within Great Britain these include the Ordnance Survey fundamental benchmark network

The Geoid model consists of a 1km grid with geoid-ellipsoid separation values covering all of Great Britain, Ireland and Northern Ireland. This model can be used with GPS determined positions to establish height above mean sea level, as defined by the respective vertical datums, to the accuracies shown in the table below. The Ordnance Surveys recommend the use of the Geoid Model OSGM02 and the active GPS network to produce orthometric height compatible with Ordnance Survey mapping.

> OSGB intend that OSGM02 is the official definition of the relationship between GPS ellipsoid heights and orthometric height in Great Britain. In the way that GPS and the transformation model OSTN02 define the horizontal coordinate system, precise GPS surveying using the OSGB active GPS Network in conjunction with the Geoid model will become the standard method of determining orthometric height.

OSTN02 covers Great Britain and the Isle of Man. The OS*i*/OSNI polynomial transformation covers the Republic of Ireland and Northern Ireland. It should be noted that the Irish Grid and the National Grid are two independent coordinate reference systems, and that Irish Grid coordinates are not directly compatible with OSGB36 coordinates.

OSGM02 covers all of Great Britain, Isle of Man, Republic of Ireland, and Northern Ireland. The Geoid model comprises of 14 patches in order to relate to mean sea level as defined by the specific vertical datum for each region. The Datum Flag which forms part of each data record specifies to which datum the geoid/ellipsoid separation value relates.

Both models have been ‘cookie-cut’ to a boundary which extends 10km offshore. Any point outside this boundary will return null values in the shift and datum flag records. It is strongly suggested that any software written to incorporate this data be capable of recognising a null value and to return an ‘outside of model boundary’ error message.

Within Ireland and Northern Ireland, OSGM02 returns orthometric heights relative to the Malin Head and Belfast Lough datums respectively. OSGM02 will return orthometric height relative to either the Malin Head or the Belfast Lough datums for points within 2km of the border between the Republic of Ireland and Northern Ireland. It is recommended that software written to incorporate this data does not extend the model beyond these limits.

5 Glossary of Terms

Accuracy The degree of closeness or conformity of an observation to its true value.

Datum The survey reference system used in a specific country or region. All geographical coordinates will be referenced to a chosen datum. Two principle datum types exist, namely global datums and astrogeodetic datums. A datum is created when a reference spheroid is tied to the earth at a particular point and coordinates are defined for that point. *See spheroid, WGS84*

Ellipsoid *See spheroid*.

ETRS89 The European Terrestrial Reference System 1989, used as the standard precise GPS coordinate system throughout Europe. In 2000, the difference between the WGS84 and ETRS89 coordinates was about 25 cm, and increasing by about 2.5 cm per year. ETRS89 has been officially adopted as a standard coordinate system for precise GPS surveying by most national mapping agencies in Europe.

Geoid A model of the level surface which is closest to MSL over the oceans. This surface is continued under the land and acts as the fundamental reference surface for height measurement, as an approximation of MSL on land.

GPS Global Positioning System. A satellite based navigation system which in the last five years has become the industry standard survey tool for positioning and navigation.

National Grid *See OSGB36*

ODN Ordnance Datum Newlyn is the national standard vertical reference system for measuring height above MSL in GB. ODN is measured relative to a value taken at Newlyn, Cornwall.

Orthometric height Height above mean sea level

OSGB36 The national standard coordinate system for topographic mapping, including all Ordnance Survey mapping, and for geographically referencing many kinds of information in relation to Ordnance Survey mapping.

OSGM02 Ordnance Survey National Geoid Model 2002. A gravimetric model used to convert from ETRS89 to ODN heights.

OSTN02 Ordnance Survey National Grid Transformation 2002. A horizontal transformation converting from ETRS89 to OSGB36 coordinates and vice versa.

Precision The degree of *repeatability or closeness* that repeated measurements of the same quantity display. Precision is used to describe the quality of data with respect to random errors. Measurements that are closely grouped are said to have a high precision because their random errors are small.

Spheroid A mathematical figure used to closely model the geoidal surface of the earth. The figure is described by the semi-major axis (a), semi-minor axis (b) and inverse flattening.

Many spheroids are used to describe the figure of the geoid on different parts of the earth. The spheroid will be intrinsically tied to the geodetic datum and once a datum is used in a particular country or region it is unlikely to be changed.

Transformation A procedure to change from one coordinate system to another

UTM Universal Transverse Mercator. Special case of the Transverse Mercator projection where by the earth is divided into 60, 6 degree zones. All the zones have identical characteristics with the exception of their central meridians which increase by a factor of 6 degrees between adjacent zones. UTM projections are used extensively in oil exploration and particularly favoured for their easy of use. One down side is that they are not preferable when mapping large extents in an east-west direction.

WGS84 The spheroid and datum used to model the geoidal surface for the entire globe. It is the principle datum for GPS since January 1987.