TERRASURVEYOR64

TERRASURVEYOR64FLD

TERRASURVEYOR64LT

User Manual

Program version 4.1.12

DW Consulting

Manual version 22

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This application has been developed using Borland Delphi version 11.

TerraSurveyor64 makes extensive use of the following components and programs:

- TMS Components (www.tmssoftware.com)
- LMD tools (www.lmdinnovative.com)
- JEDI components (www.delphi-jedi.org)
- SDL Component Suite (www.lohninger.com)
- Matrix Software Protection System (www.matrixlock.de)
- Enigma Protector (www.enigmaprotector.com)
- SurGe Data Interpolation system (www.mujweb.atlas.cz/www/SurGe)

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1 INTRODUCTION

1.1 OVERVIEW

TerraSurveyor64 is the successor to TerraSurveyor. Details of the changes from the old 32 bit version can be found in section 16 of this manual.

TerraSurveyor64 is specifically designed to acquire, assemble, process and visualize 2 dimensional archaeological data gathered with Geophysical Instruments such as Resistivity Meters and Magnetometers. It is designed for use with Windows 10 and subsequent versions but will work with most older versions of Windows. Because TerraSurveyor64 makes use of a number of internal and external extensions that are only available for Windows, Mac and Linux versions of the program are not feasible (though Mac users have reported some success using a Windows emulator).

This manual covers 3 versions of the program: TerraSurveyor64, TerraSurveyor64LT (Lite) & TerraSurveyor64FLD (Field). TS64LT is only for use with the Handheld version of the Bartington Grad601 magnetometer. TS64FLD is intended for field use only in conjunction with a full TS64 license. Both the Lite & Field versions have reduced functionality compared to the full version. Unavailable features will be marked as such in this manual.

1.2 SITES

TerraSurveyor64 primarily uses a 'site' based metaphor for arranging and storing the data collected and generated. Normally each site is stored within a dedicated folder, containing specific sub-folders for surveys (composites), grids, graphics, etc. The user is free to store any other files related to that site or survey in the site folder. However, this structure is intended for ease of use and is not a hard requirement. All files can be stored in any location with no particular structure required. See *Folders and Files* below for details.

1.3 GRIDS AND COMPOSITES

Data can be downloaded or logged either directly from a variety of Geophysics instruments or imported from a range of common and special formats. TerraSurveyor64 recognizes three main categories of data: Grids, Gridded Composites and GPS Composites. However the data from all three is stored in the same XML file format with only a few minor differences. Because all the data types use the same file format, some terms used to describe internal structures are generic. All files contain a header section containing general information about the surveyed area. It then contains a Layer structure consisting of one or more TrackGroups. A TrackGroup is equivalent to a Grid in previous versions of TerraSurveyor. Each TrackGroup will contain a number of Tracks which in turn contain a number of Points. Full details of the file structure can be found in Appendix 2.

Grids are relatively small blocks of data points typically collected by hand-held instruments in a very structured manner. All datapoints in the grid are an exact interval apart in both X & Y axes. The grids are then assembled into a larger Composite, still using the same X & Y intervals.

More modern or automated instruments may gather all the data in one dataset using GPS to position the datapoints, this type of data does not need to be assembled. TerraSurveyor64 is therefore able to import these datasets directly to Composites. The original format of the GPS positioned source data is maintained in the file.

In all cases, the data is converted into an XML based format specific to TerraSurveyor64 and stored in the Grids or Comps folder of a Site. The format contains the actual source data, either copied from the grids or the source file, references to all source data as applicable and a complete record of all processes applied to the data.

1.4 PROCESSES

A wide range of Processes are provided, allowing the data to be manipulated to produce the best possible interpretation. TerraSurveyor64 always keeps the source data as the 'Base layer' and then applies each

process in turn to a complete copy of the previous layer. This allows the sequence and parameters of any process to be changed as any stage while manipulating the survey. The survey is always saved as the source data and a list of processes thus ensuring the history and integrity of the data is always maintained.

1.5 VIEWS

Previous versions of TerraSurveyor used a number of views to display the data in different formats (Shade, Trace, Spreadsheet, Publish, etc). This is no longer the case in TerraSurveyor64, all 'views' of the data are visible in the main view of the data and can even be combined.

The main view will initially contain just an image of the survey but can also be displayed with many additional items. All of these items can be connected to the survey or the data used to create the survey so that the item (depending on it's type) will be changed when the survey data is changed, either by applying or modifying a process or by changing the actual source data. These items are:

- Ground Scale (in local or source distance units)
- Vertical Scale (for Trace views only)
- Palette / Histogram (these are seen as just vertical or horizontal versions of the same item)
- Text (any text can contain links to attributes of the survey which will show the actual value applicable at the time)
- Images
- Shapes (Rectangles, Ellipses, Polygons, etc.)
- Lines (plain or with Arrowheads)

1.6 FILES

The native format for TerraSurveyor64's data is an XML file with the .XA4 extension. TerraSurveyor64 can also read (but not write) the .XCP and .XGD formats used by older version of TerraSurveyor. Data can also be saved in a wide variety of other text and image formats.

2 Folders and Files

2.1 Naming conventions

The term "Composite" is used in TerraSurveyor64 to refer to the file type used to process and display a surveyed area. The name evolved in the days when all surveys were carried out with hand-held instruments that generated grids that then had to be merged into a single composite. Nowadays many modern surveying systems gather data in a single, large file which is converted straight into a composite. Thus "Gridded Composite" is used in TerraSurveyor64 to refer to a set of grid files assembled into a single unit. A "GPS Composite" is imported from a single, complete survey dataset. In the case of grids, they are assembled in their correct relative positions in the Grid Assembly window.

2.2 Sites

When Strict Site Structure is enabled in Preferences, TerraSurveyor64 stores all related data in a single folder. This folder is referred to within the program and this manual as a Site. This is intended to reflect the traditional archaeological site which is seen as the most common way data will be grouped. When first started, the default installation will show 2 example sites in the TerraSurveyor folder (C:\Program Files\ TerraSurveyor). This is only an example and need not be where you keep your own data. The example sites can also be deleted if you wish.

A Site is best created using the New Site button on the NavBar. Clicking this button will open a dialog box where the site name is specified. The site folder and it's standard subfolders will then be created. The site folder on creation contains just one special file called *Site.ini*. TerraSurveyor64 uses this file to recognize the folder as being a site. The 3 standard subfolders are named \Grids, \Comps and \Graphics. These are where TerraSurveyor64 stores the grid files, the generated composites and any graphics that are created. Additionally a 4th folder named \Export may be present. This is where exported data - either from grids or composites - will normally be stored. This folder is created the first time data is exported.

The \Grids folder may also contain subfolders. These folders can be created during the download or import process. They can be used for 2 purposes. The first is if grids of different sizes are being used on the same site. The Assemble Grids window can display and assemble grids that are not the same size, but this is not recommended. Ideally only grids of the same size should be stored in a folder (i.e. the Grid length, width, traverse interval and measurement interval are all the same). If they are not, perhaps because different instruments are being used on the same site or because certain areas are being surveyed at a different resolution to the rest of the site, sub folders should be created to separate the different grid types.

This facility can also be used to separate grids into different areas of a site. For example, perhaps a site consists of a North field and a South field. By creating 2 subfolders called North and South, the grids for these areas can be easily administered. However, note that only grids within the same folder can be combined into a single composite.

The Site folder is a normal Windows folder and can be used to hold any other folders or files of your choosing. For example, a \Source folder could be added to store the source files for imported data, survey reports could be kept in the site folder itself or a \Maps folder could hold AutoCAD drawing files. You can do anything you like as long as the SITE.INI file is present.

Note: Site folders cannot not contain other site folders, if this does occur (perhaps because site folders have been moved or created by other means) TerraSurveyor64 will be unable to see or navigate to the lower level site.

Composite files can be opened even when not contained in a site structure. Just double-click on the composite file in File Explorer and it will be opened in TerraSurveyor64. Note that if the composite being opened is not in a site structure, some facilities such as modify grids will not be available as the program does not know where the grids are.

2.3 Files

TerraSurveyor64 uses the same file type and structure to store all file types: Grid, Gridded Composite and GPS Composite. However, for clarity this manual and, to some extent, the program itself will differentiate between the types.

The term "Grid" is used in this manual to refer to the data measured within a rectangular area on a Site. Internally the grid is referred to as a TrackGroup.

"Gridded Composite" refers to a set of Grids which have been combined into a single file with all the data from those grids positioned like tiles on a floor.

A "GPS Composite" is generally imported from a single file collected by a GPS positioned instrument in one session. As such, it consists of a single TrackGroup.

2.3.1 Grids

The grid file is generated either by directly downloading data from an instrument or by importing the data from a plain text file generated by some other means. Either process creates an XML file containing the basic data from the surveyed area, plus some additional information. This extra information is extracted either directly from the instrument during the download process or from user- supplied data filled in prior to the download/import being started. The grid files can then be assembled into a Composite to recreate the full data set from the surveyed area.

2.3.2 Composites

When saved as a file, a composite contains just the source data from all the grids or source file, some metadata (names, dates, comments, etc), a list of applied processes and (optionally) all the 'view' settings active when the file was saved (Grids showing and intervals, Relief & sun position, Contours, etc.). Once the file is loaded into TerraSurveyor64 the list of processes is used to re-create a set of layers, each layer containing a copy of the previous layer but modified by the applicable process. In this way, any layer can be displayed at any time and processes can be modified, have their sequence changed, be deleted or added to. The view settings re-create the appearance and layout of the survey as last saved.

2.3.3

All file types are saved as plain ASCII XML files with the extension .XA4.

The XML files use a plain ASCII format and so can be viewed (and even edited or created) in any text editor. This provides a level of retrieval security in that even if TerraSurveyor64 is not available for some reason, the data can still be recovered. The downside is that the data can be changed very easily – perhaps making it unreadable to TerraSurveyor64. The program expects certain elements and attributes (the names for the structures in an XML file) to be present and with certain values. If these are not present, are in different positions or have unexpected content, the read process will probably fail.

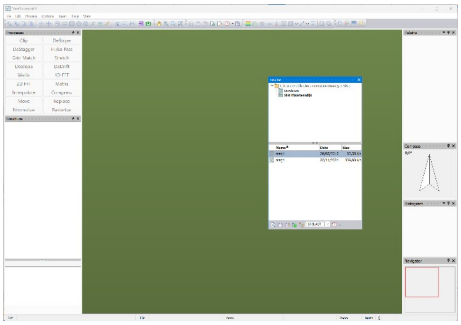
In order to make the file as future-proof as possible, all parameters in the XML file consist of 3 fields; Name, Val and Type. The Val field is always a clear indication of the parameter's intended value. For example, a DeStripe parameter with a name of "Method" will have a Value of "Mean" or "Median", not just "0" or "1".

3 User Interface

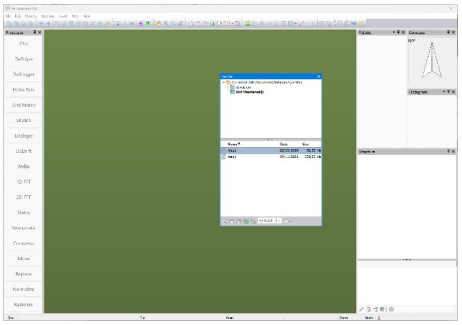
The TerraSurveyor64 program comprises one main window in which a survey is displayed surrounded or overlaid by a number of docking panels. These docking panels contain information about the survey or give access to additional functions to manipulate the survey. There is also a menu bar and tool bar at the top of the main window which provide access to additional functions.

3.1 Docking Panels

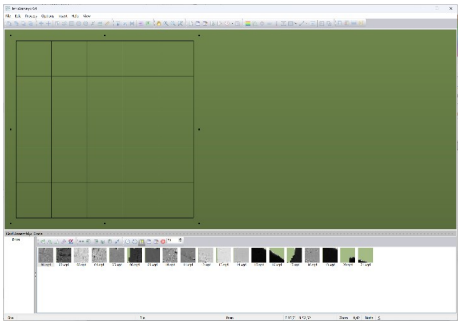
On installation TerraSurveyor64 will create four default screen layout templates, two for general use when processing data and two for assembling grids. The layout, size and position of the panels on these templates are tailored to the current screen size and resolution. The two general layouts can be extensively customised with changes saved to the original template or as a new template. The two Grid templates are more limited as they have a specific function which would be compromised by excessive customisation. A template and the options available can be selected from the main menu > View menu.



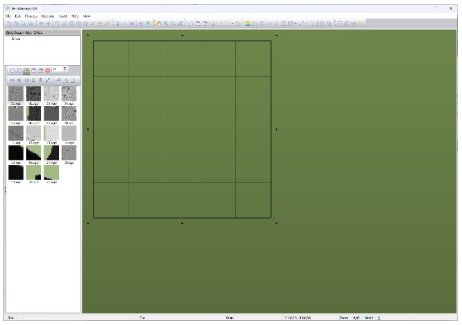
Standard Composite screen layout



Alternate Composite screen layout



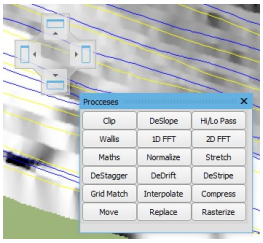
Standard Grid Assembly screen layout

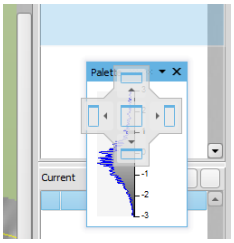


Alternate Grid Assembly screen layout

The original four templates can be restored at any time from the View menu. Note that restoring the templates will delete all existing templates.

The User Interface allows all panels, with the exception of the main survey view, to be moved anywhere on the screen and be either docked to an edge or remain floating. Click & Drag a panel by it's header bar. When being dragged 'ghosted' indicators will show where the panel will dock to.





Panels can be hidden or shown by using the Main menu View list. Panels can also be hidden by clicking the X in the top-right corner.

3.2 TOOLBAR

The main tool bar at the top of the screen contains 7 blocks of buttons, each block having a particular set of functions:

-  Open / Save: Open, Save, Save As, New, Open Grid Assy, Recent Files, Save detail.
-  Zoom: Turn off Zoom, Zoom in, Zoom out, Zoom to full extent of survey.
-  Input/Output: Export, Save image, Print, Import, Download.
-  Select Area: Grids, Track, Shapes, Cross Section & Ruler.
-  Viewing modes (plus toggle Navbar when Strict Site Structure is active)
-  Insert scenery items
-  Arrange survey and scenery items Front / Back

These blocks can be rearranged on the toolbar and their positions are automatically saved on exiting the program.

3.3 MAIN MENU

The main menu provides access to all functions covered by the toolbar and other visual controls. It also has a number of functions that are not available by any other means. These are mainly ancillary functions such as:

- Preferences
- Themes
- Desktop panel views and layouts
- Composite & Site management
- Help, Registration and Updates

3.3.1 THEMES & LAYOUTS

Themes allows the user to choose between 2 Light and 2 Dark themes.

The View list shows all the available panels and allows them to be hidden or displayed. The NavBar has it's own dedicated button on the toolbar to show or hide it as this a frequently used operation.

The View > Desktop allows the user to save the current positioning of all the panels as a user defined layout. This can then be used as the user's default layout when TerraSurveyor64 is started or selected at any time when the program is running. The menu also has options to reset the main and Grid Assembly layouts to their defaults. This can be necessary if different size or resolution screens are used as the panel positions are stored in pixels and so can end up being off-screen and so can no longer be repositioned.

3.3.2 COMPOSITE & SITE MANAGEMENT

Provides some useful utilities for managing and manipulating composite files and complete sites. Most are self explanatory however:

3.3.2.1 MERGE

Allows 2 or more GPS based composites to be merged into one file. All files must use the same absolute positioning system (i.e. GPS based data where all datapoints have Lat/Long or UTM positions)

3.3.2.2 CONVERT SITES TO TS64

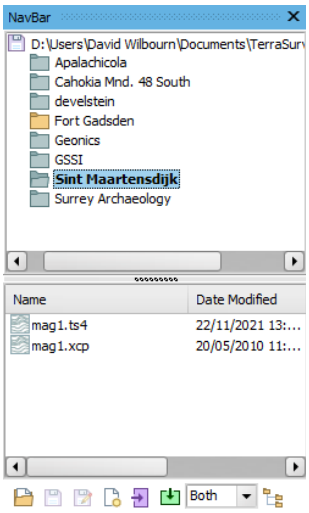
Allows a range of existing TerraSurveyor (32bit) site folders to be selected and converted to TerraSurveyor64 files. The conversion can be done in one of three ways:

- **Replace:** Convert all the .XCP & .XGD files in the site folder to .TS4 files then delete the old .XCP & .XGD files.

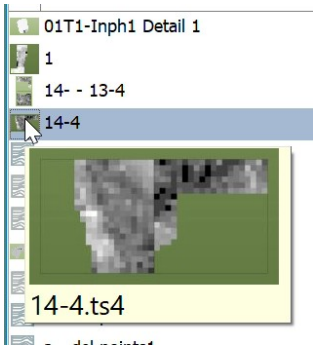
- **Replace & Archive:** Convert all the .XCP & .XGD files in the site folder to .TS4 files then move all the old .XCP & .XGD files to a zip file (one zip file for each folder containing .XCP or .XGD files).
- **Duplicate:** Copy the entire site folder to a new site folder (named [oldname]-TS64) then perform the Replace & delete on the new folder

3.4 Navigation

When Strict Site Structure is active a docking panel titled **NavBar** will be visible. This consists of two lists with a small toolbar of buttons at the bottom.



The top list shows all the folders in the currently selected root folder. Those folders that are marked as TerraSurveyor Sites are color coded in grey-green , all others are shown in yellow. The name of the currently selected site folder is shown bold. Yellow , non-site folders can contain subfolders that can be site folders however site folders cannot be nested. The root folder is initially set to C:\Program Data\TerraSurveyor however it can be set to any folder using the Folder tree button in the toolbar at the bottom of the panel. The last selected site folder will be reopened when TerraSurveyor64 is reopened.



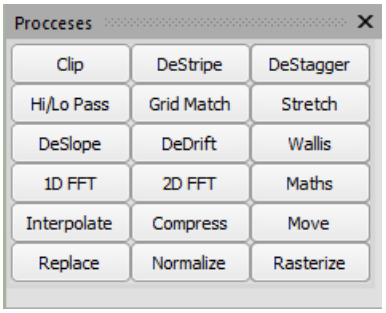
Below the folder list is a list of Composite files available in the selected Site folder (these are the files in the Comps subfolder of the Site). This list will show either .XA4, .XCP or both types depending on what is set in the toolbar at the bottom of the panel. The list can be sorted by Name, Date or Size by clicking on appropriate section in the header row. The icon next to the filename will be changed to a (very) small thumbnail image of the survey after it has been opened. The thumbnail is created when any survey is closed so will show the last state of the survey. A much larger version of the thumbnail will be shown when the mouse hovers over the small icon.

A selected composite can be opened by double-clicking it or by clicking the Open button . Once a composite has been opened it can be saved using the Save or Save As button.

New (blank) surveys can be created from the tool bar and data download or import also initiated here.

The Nav Bar, like all the panels can be hidden by clicking the X in the top corner and re-displayed from the View menu. However there is also a dedicated button on the toolbar to hide and show the Nav Bar.

3.5 Process Panel



The processes available to the user to modify the survey data are all shown on this panel. The panel itself can be positioned and as required, the buttons will re-arrange themselves to fit the size and shape of the panel. Selecting a process open a dialog box specific to that process. Once the appropriate settings have been made, a new layer will be added to the survey to contain the results of that process. Each process is described in full in section 10.

TS64Fld: This panel is reduced to just the Clip and DeStripe process

3.6 Structure Tree

The Structure Tree panel is the main means of controlling the view of the current survey. The top half gives access to the major parts of the view and the bottom half lists the parameters applicable to that part. At the very bottom is a small toolbar that provides various functions depending on the part of the view selected.

3.6.1 TREE

The tree at the top of the panel is divided into 5 sections.

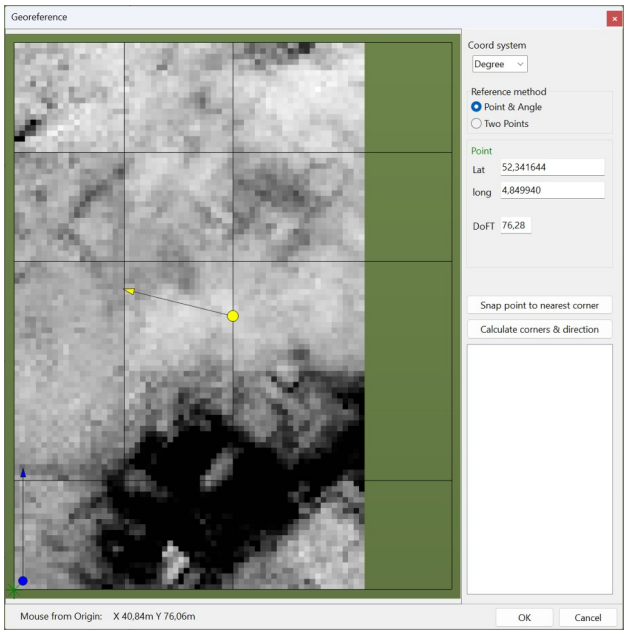
3.6.1.1 SITE

Selecting the first section will show a list of top level parameters associated with the survey such as Origin, Description, Dates, Grid size & Interval, etc. Where applicable, these parameters can be edited or changed from the parameter list.

Most of these are straight-forward and require no explanation however three deserve some attention:

3.6.1.1.1 GeoReference

Only applicable to Gridded data.



Gridded data is not inherently geo-referenced, the data is positioned relative to some arbitrary point not defined in the actual data. This can be corrected by supplying an Origin for the bottom-left corner of the survey and Direction of First Traverse for the data. Clicking the Set button opens a dialog that aids in correctly setting these values. The dialog shows the survey with one or two position crosses (depending on the reference method).

Referencing can be done by specifying either a point and angle or any two points. These points can be anywhere within the survey. First position the point marker(s) at the correct location over the survey. The markers are a green and red 'asterisk'. Once positioned, enter the true location of these points in the corresponding fields on the right of the dialog. The locations can be in any of the supported Coordinate Unit systems listed in the dropdown list at the top (UTM, Lat Long, etc.). Click **Calculate corners & direction** to see the results of calculating the true Origin and direction from the supplied points and their values. These will be then saved with the survey.

3.6.1.1.2 Survey Orientation

Only applicable to Gridded data.

Normally the survey will be shown **Vertical**, with traverses running bottom to top. However the survey can be rotated so that all tracks are drawn **Horizontal** across the screen or with the survey rotated to it's **True** orientation, i.e. to the DoFT, in which case North will be up. The main use for the horizontal orientation is to show the traces in their 'normal' orientation, i.e. the 'x' axis is distance and the 'y' axis is value. This simulates the display normally seen in previous versions of TerraSurveyor.

3.6.1.1.3 Display Map System

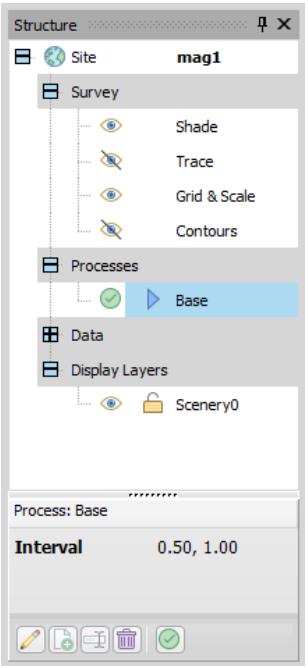
The position of the cursor over the survey will be shown in the status bar at the bottom of the screen. This will be formatted based on the selected Display Map System. This position can also be shown adjacent to the cursor by toggling the Show Position button on the main toolbar.

3.6.1.2 SURVEY

This section has 4 entries; Shade, Trace, Grid & Scale, Contours. Each represents a major layer used to build up the image. These layers can be turned on or off by clicking the 'eye' symbol. When an entry is selected a list of parameters associated with this layer will be shown, these can be used to change the appearance of the layer.

3.6.1.3 PROCESSES

List all the processes applied to the survey. The first item will always be the Base layer. Subsequent processes will listed below the base layer, The 'top' layer will therefore be the bottom item in the list. Clicking on a process will re-draw the survey to display the survey with all processes applied up to that point in the list.



A process can be temporarily disabled by clicking on the green checkmark next to it's name. When disabled the survey will be re-calculated omitting that process from all calculations.

The order in which processes are applied can be changed by dragging a process to a new position in the list.

The parameters for the process will be listed however as there is often more to selecting or changing a parameter value than just changing a number, these cannot be changed directly from the list. The edit button in the small toolbar at the bottom of the list will open the dialog box associated with that process to allow it's parameters to be modified.

For small surveys the survey will be re-calculated and re-drawn whenever a process is moved or modified. For larger surveys (anything above 50,000 datapoints – though this threshold can be changed in Preferences), changes will be prepared but not applied until the Green checkmark button in the toolbar is clicked. A warning will be shown after the first change when this is in effect and the background color of the survey area will be changed as a reminder.

A Process can be deleted by clicking the Trashcan button.

The currently active process is highlighted with a blue arrowhead next to it's name.

3.6.1.4 DATA

Only available in the full TS64

This provides a list of Trackgroups (Grids) in the survey. The parameter list shows the data applicable to that trackgroup and the trackgroup can be hidden/shown by clicking on the eye symbol.

3.6.1.5 DISPLAY LAYERS

Only available in the full TS64

A number of 'scenery' items can be displayed on or around the survey. These are added using the buttons on the main toolbar at the top of the screen. Once added, their parameters can be set by selecting the item from the list in this section. Initially there is always one default layer available for these items called Scenery0. More drawing layers can be added and renamed as required. Items can be assigned to any drawing layer and the layers can be hidden/shown using the eye symbol.

More details of the types of items available and their use can be found in section 8.

3.6.2 DELTA

Only available in the full TS64

Once one or more processes have been applied to the survey, the effect of those processes on the data can be displayed by selecting the two processes in the Process section. Click on any process then Ctrl-click on the second process. The survey will change to show the difference between the two selected processes.

The background color will be changed as a reminder that this is a Delta image and not the actual survey. The parameter list will allow the color palette to be changed and clipping or a compression algorithm to be applied to the difference data.

This view is specifically designed to highlight possible over-processing of the data. By comparing 2 layers, the result of a process or set of processes can be seen. It is often easier in this way to see when processing may be too aggressive and archaeology is being removed by a process or setting.

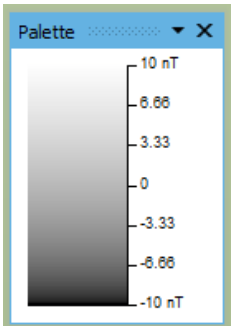
Note: Although the Delta of all processes can be determined, some processes such as Move, Interpolate or Rasterize will affect the underlying geometry of the data so making a direct comparison of the data at every point difficult or invalid.

3.7 PALETTE & HISTOGRAM

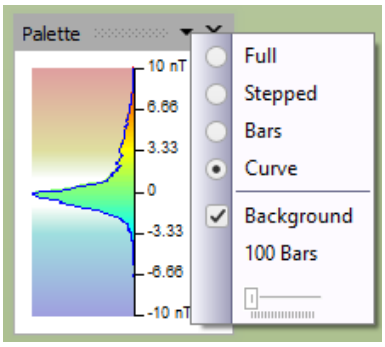
The Palette and Histogram panels are very similar in nature, the main difference is the orientation of the colour bands and graphics (if used). The actual palette to display is set from the Shade panel on the Site Structure tree.

3.7.1 PALETTE

The primary purpose of the Palette is to display the range of colours used in the Shade view to indicate the magnitude of the reading at any point on the survey. The palette is generated from any suitable image that is stored in the program's AppData\Palettes folder (see below for details of the image requirements). A number of palettes are provided with TerraSurveyor64 however the user is free to create and use any palette they wish. There are also two special greyscale palettes supplied: Gamma Corrected & Pseudogrey. See below for details.



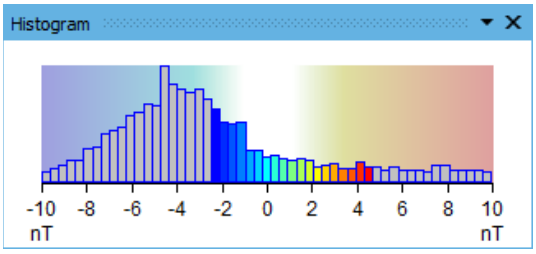
The basic palette panel will show the colours in a rectangle with a scale on the right side showing what the colours equate to in the survey values. The unit of measurement (such as nT or Ohms) if set for the survey will be displayed next to the top & bottom values.



By right-clicking on the header bar down arrow, a menu with some other options will be shown. The default layout of Full will show only the palette for the full width of the panels drawing area. Stepped, Bars and Curve will show the full palette colours to the right of a histogram representation of the data. If Background is checked, the area behind the histogram will be shown as a muted, pastel version of the palette (this option is not available for greyscale palettes). Finally the number of bars or divisions in the histogram can be set. TerraSurveyor64 will attempt to determine the best number of steps to show however this can result in odd spikes in the graph when there are relatively few discrete values in the survey.

3.7.2 HISTOGRAM

The histogram panel is fundamentally the same as the Palette except it is presented as a horizontal graph.



As with the Palette, the graph can be shown as as Curve, Stepped or Bars (shown here). The background can be plain or a pastel version of the current palette of colours. The example shown here also illustrates the effect of using the Clip Display setting in the Structure Shade panel. Because the survey image (not the actual data) has been clipped +/- 1SD, the outlying values, below about -2.5nT and above +4.5nT in this case, are all grouped together and shown as blue or red (with this palette). The remaining data between -2.5 and +4.5 nT then share out the remaining colours in the palette. The number of bars has also been reduced to 50 to improve the appearance. Note that the Display Clip is centered on the Mean value of the survey.

3.7.3 FILES

Palette Image requirements The palette image must be a BMP or PNG and the bands of colour must run across the short axis of the image. TerraSurveyor64 will take the center pixel of each row or column (whichever is shorter) to form the palette. The palette can therefore be any length though in practice 200 – 300 colours are usually enough. For best results each pixel along the long axis of the image should have a unique colour. The basic greyscale palettes have 255 shades from white through grey to black. True, full

black is not available as this is used to enable transparency in some situations. A selection of example palettes is provided with TerraSurveyor64 however the user is free to add or remove any palette images they wish. The images are all stored in the Palettes folder within the TerraSurveyor Program folder, this will usually be found at *C:\Program Files (x86)\DWC\TerraSurveyor64*. A large selection of suitable (and unsuitable) palette images can be found here: *http://soliton.vm.bytemark.co.uk/pub/cpt-city*

Gamma Corrected uses a non-linear scale that takes into account the human eye's non-linear perception of colour and darkness. Using this palette will usually give better perception of the relative differences between shades.

A more detailed explanation can be found here: *https://en.wikipedia.org/wiki/Gamma_correction*

Pseudogrey uses a simple trick to create a palette that looks like it is just greys but actually contains many more actual colours: 1776 in this implementation. As each shade of grey is actually the three primary colours (Red, Green & Blue) at the same level, a normal sequence of greys will increment all the colours by one for each shade of grey. The pseudogrey method uses a combination of all the primary colours incremented by just one to generate extra intermediate colours that are indistinguishable from grey for the human eye but are for a computer. Using this method an image saved using this palette can contain about 7 times as much detail about the source values than a plain greyscale image. This method has no real advantage for general use but can be used to transfer more detail of the values to a GIS or other data manipulation program.

More information about this technique can be found here: *https://patdavid.net/2012/06/true-pseudogrey-in-gimp/*

3.8 Selection

Only available in the full TS64

The selection system allows most processes to be only applied to pre-defined areas of a survey. The selection area can be any combination of Grids (for a grid based survey), Tracks, rectangles, circles and polygons. A polyline can also be selected but this is only for use with the DeSlope process. The selection can be applied to either everything within the selection or everything outside the selection. The selection will stay in effect for all layers until specifically deleted.

Note: Some processes do not support the selection system because of their nature. The Periphery Grid Matching process for example always works on the entire survey and the other Grid Matching methods only allow Grid selections.

3.8.1 Detail Survey

A selection can also be saved as a new survey. To do this, select the are to be saved then click the Save Detail  button. The selected area and layer will be saved as a new ts4 file. The default name for the file will be Detailx.ts4 but any name can be used.

3.8.2 Selection Tools

The selection system is accessed via the main toolbar Selection panel.

Clicking one of the available selection type buttons will allow the user to draw the shape on the survey. The selected area will be shown as a green (or other selected colour) cross-hatched area. Selected areas can overlap but clicking on an area again will delete it.

The Selection panel will be shown whenever a selection is made. The panel lists the areas currently selected. By default, all the selections shown in this list will be applied to the next process to be applied to the survey, i.e. only the areas within the selection will be changed by the next process. The Selection panel,

with the current selection, will remain visible and active after a process has been applied. The same selection will therefore be applied to subsequent processes until the Selection panel is explicitly closed.

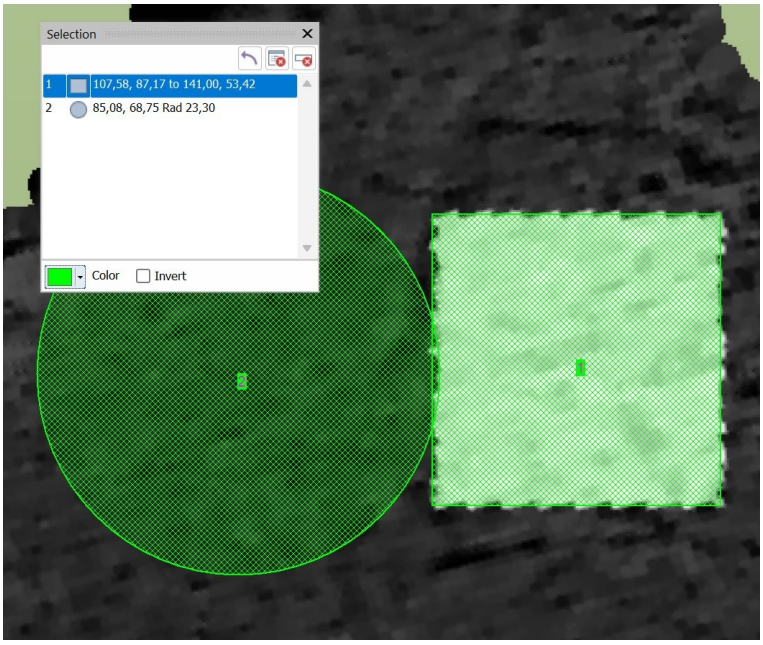
The list shows a brief description of each area's size, position and shape. The buttons above the list will delete a single selection area or all of them. Closing the Selection panel will clear any pending selection areas.

The selection of an existing process can be modified or created by selecting the process then either adding or deleting selection areas to the list. Once the modifications are complete click the Apply to Current button.

Normally the selection will modify only those points within the selection area. This can be changed to modify only the points outside the selection area by setting the Invert checkbox. When set the selection will be drawn in the inverse colour to the normal selection area. The colour of the normal selection method can be set to any colour, this can be helpful when the default green colour does not contrast with a colour palette.

The selection list and area highlighting can be turned on for layers which have a selection by clicking the **Show Selection** button in the Process parameters list.

The Selection panel is normally a floating panel, i.e. it will behave like an ordinary dialog box, only appearing when making or viewing a selection and can be moved to any location on the screen. However the panel can be docked to any edge of the screen in which case it will remain visible at all times but the list will be empty when the current layer has no selection.



3.9 COMPASS & NAVIGATOR

These two minor panels are a Compass arrow and the Navigator which shows an overview of the survey area.

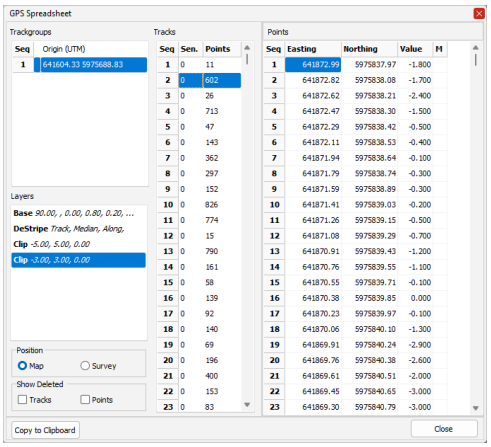
The compass arrow indicates the direction of North relative to the survey. In many cases this will be superfluous as North is always 'up' for GPS surveys. However it may be useful for gridded data as there is no specific need for grid tracks to be oriented North-South. The arrow is repeated in a miniature version on the status bar at the bottom of the screen.

The navigator panel is simply a white area which is the full extent of the survey, including any extra scenery such as a palette, scales, annotations, etc. The red box inside the white area is what is currently visible on the screen.

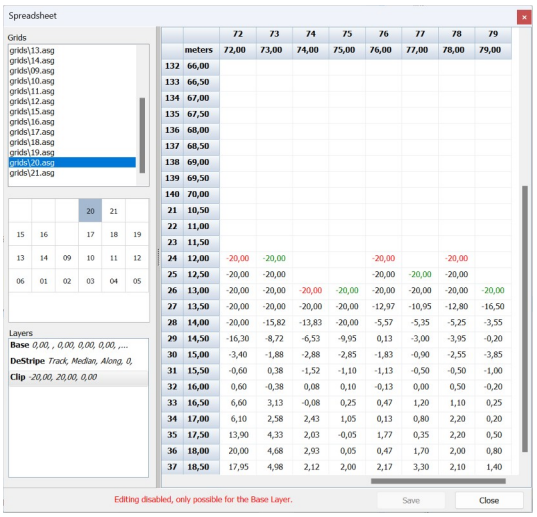
3.10 SPREADSHEET

This view of the data can be opened in a separate window from this button on the main toolbar. The layout of the window will be different depending on the type of data. Gridded data will be an actual spreadsheet layout where either the whole survey or individual grids can be selected and viewed as rows and columns.

The GPS spreadsheet window allows each track to be selected and the data for that track is then shown as 3 columns for easting, northing and value. The Track Cross-section dialog can be opened to give a visual overview of the currently selected track. The current selection can be copied to the clipboard as plain text for use elsewhere. The processing layer can also be selected to change the values shown in the window.



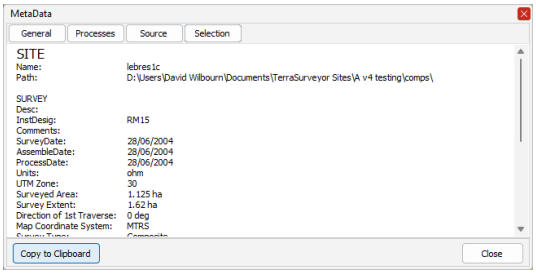
The Grid spreadsheet window provides more functionality; in addition to copying a survey, grid or selection to the clipboard, it can actually edit the survey. Individual values can be changed and selected areas can be cut, copied and pasted to different locations. This is done as in any normal spreadsheet using the Ctrl-C, Ctrl-X & Ctrl-V keys. Note that this can only be done when the base layer is selected and, unlike the Move process, actually changes the source data. The start and end of each track is highlighted by coloring the first value in each track green and the last value red.



A small visual representation of the survey is also provided on this window. A Grid can be selected for editing or inspection from either the top list or the grid panel.

3.11 METADATA

The Metadata window is opened with this button on the main toolbar. It shows all the metadata such as filenames, dates, track & point counts, area and other statistics stored with or derived from the survey data as plain text. Any of the four sections (General, Processes, Source & Selection) can be copied to the clipboard.



4 Main View

The main Survey view displays a graphical representation of the survey data. Various methods can be used to display that data in a manner suited to the type of data and the user's preferences.

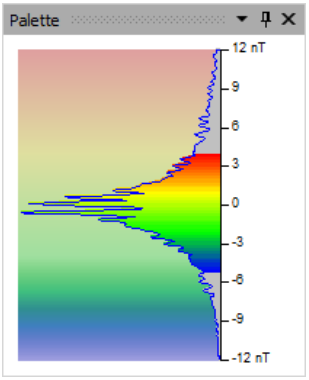
4.1 Shade

Generally considered the primary display method for survey data. It presents the data as a 'shaded map' of the survey area using colours or greyscales to indicate the relative strength of the signal at each measurement point.

Various options are available to modify the way in which the Shade plot is calculated and displayed. These can be set in the Structure Tree by selecting Survey > Shade.

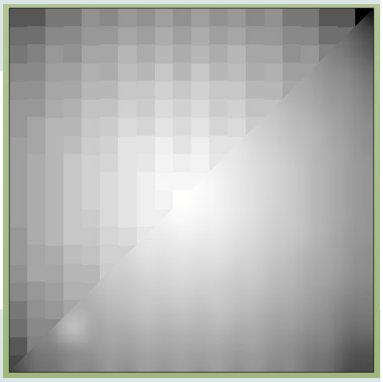
4.1.1 Clip Display

Clips the visual display to the Mean of the layer +/- 1 or 3 SD. This does not affect the actual data in any way, it is intended to be just a quick way to assess the data prior to the appropriate processing being applied. When active the Palette panel will show values outside the clipping range in grey



4.1.2 Graduated Shade

Note: Only available for Gridded data, GPS data sets it's interpolation level explicitly via the Interval parameter.



Interpolate the image (not the data) to produce smooth shading to the pixel level.

Graduated shade calculates a continuously interpolated value for every pixel. Each pixel value is calculated by generating cubic spline curves from all the data points in both the X and Y axes. This mode also allows the generation of accurate contour lines.

Note: Graduated Shading is very processor intensive. Generating this view, especially at high magnifications, can be slow. Enabling the Contour option will also add considerably to the time.

Remember that Graduated Shading is just a view of the data, it does not change or 'improve' the accuracy of the underlying data in any way.

4.1.3 Value Scaling Method

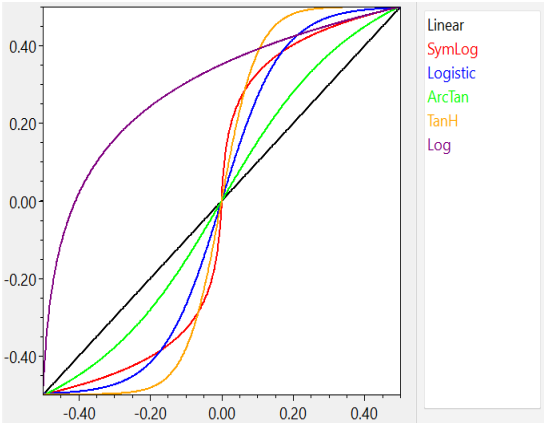
Note: this feature replaces and includes the Band Weight Equalisation method.

Note: This is a **display only** function. It does not modify the actual data values.

This drop-down option list applies one of a range of redistribution methods to the current data, In most cases this is a Sigmoid function which compresses the values at the high and low end of the scale and expands the values in the center, thus highlighting the detail that will normally be seen around the center values of the dataset.

When applied, only the Shade view colours, contours, Palette & Histogram scales are affected.

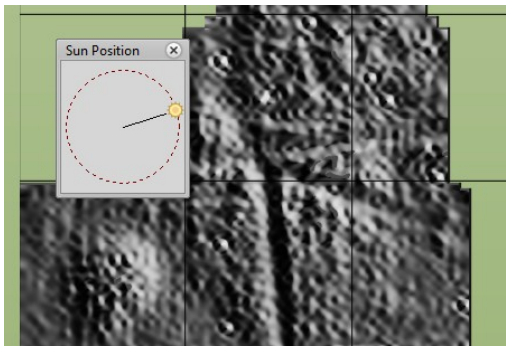
The list (currently) comprises:



- Linear – the default with no change to the data
- SymLog – Symmetrical Logarithmic: this uses two Logarithmic curves that are modified to simulate a sigmoid 'S'. They are both shifted in to start at zero instead of 1 and the 'lower' curve is inverted.
- Band Weight Eq. - redistributes the data so that each colour has the same number of datapoints assigned (this option has no effect on the contours or Palette and Histogram scales).
- Log – applies a Logarithmic curve to the data from the Min to Max values, this curve is also shifted to start at zero instead of 1. This curve is not centered on zero and is not symmetrical.
- Logistic, ArcTan, TanH – Simple, or pure mathematical Sigmoid functions, results are very similar.

All methods modify the data so that the current range is maintained. For example, if the source data is clipped to -3 / +3 then any datapoints at -3 will remain at -3, zero will remain at zero, 3 will remain at 3 but all other values will be 'pushed out' towards the limits.

4.1.4 Relief



Displays the survey as if it was a 3D surface lit from an angle. This presentation can be effective for highlighting features in a survey which has a changing background signal level or 'slope'.

Set the position of the 'sun' by clicking and dragging the sun symbol around in the box. The view will be updated when the sun is released.

4.1.5 Palette

Select the colour palette to be used to shade the survey image.

4.1.6 Transparency

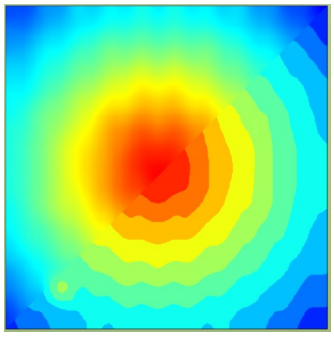
Set the transparency of the shade image. Transparency can be set to 0 (none / solid colour) to 10 (fully transparent / invisible).

4.1.7 Flip Palette

Invert the palette so that the 'low value' colour becomes the 'high value' colour and visa-versa. If you find yourself using this option often then you should consider editing the actual palette image.

4.1.8 Palette Bands

Convert the palette into a set of solid colour bands. The number of bands can be set to any value.



4.1.9 TRIM TO TRACKS

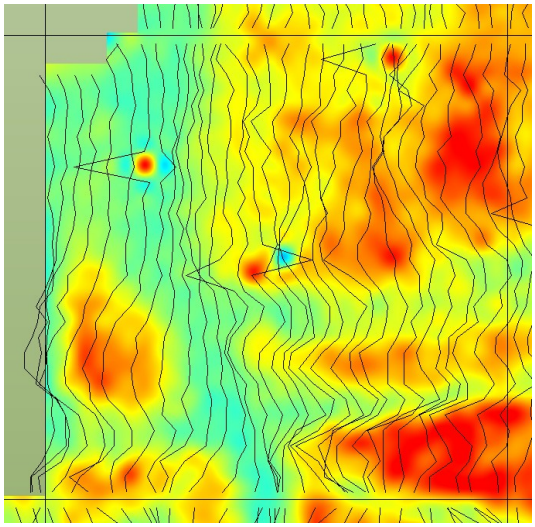
Only applicable to GPS data.

Trims the displayed Shade view to follow the outermost tracks. This option has no effect on the data, it only eliminates the pixels of the Shade image which fall outside a concave hull generated from the survey points. Because of the way the hull is generated there may be some corners cut off or other small mismatches between the tracks and the hull. Only the outer edge of the survey is trimmed, internal blank areas are not affected.

4.2 TRACE

The alternate main display method for the data. It presents the data as a trace or graph line for each track.

4.2.1 GRIDDED DATA



Each track is displaced across the screen by a distance proportional to the value at that point. The value is centered on the Median value of the Layer. This provides a 3D- like visualisation of the survey area. However this displacement does mean that there is no obvious link between the trace and the value's position on the survey.

Traces are drawn point to point and so start and end in the center of an interval square, not at the edge of each grid.

4.2.2 GPS DATA

The track just follows the path of the data, there is no displacement as the path is not normally straight and so any displacement would be meaningless or just confusing. Each track is drawn as a combination of the points and/or track line. The first and last point of each track are highlighted with green and red circles to aid in identification.

XY Traverses (or Pseudo-traces) can be generated for GPS data, these appear identical to the traces seen for gridded data but are generated from the interpolated data. They can be in either the horizontal or vertical direction and the interval in both axes is set to the same interval set for the Shade view.

The following parameters can be set for the Trace lines:

4.2.3 VERTICAL SCALE FACTOR

Only applicable to Gridded data (or GPS data when XY Traverses are on)

Set the displacement factor for Gridded data. A factor of 0 will draw straight lines over the grid.

4.2.4 SHOW

Only applicable to GPS Data

A dropdown list with the options: Track, Points or Track & Points. Track will draw the lines between the points, Points will draw small circles at the X/Y location of the datapoint.

4.2.5 SHOW 1 TRACK IN...

Only applicable to Gridded data

Reduce the number of tracks drawn. This can be useful on large, dense surveys where too much information may make it difficult or impossible to discern any features.

4.2.6 LINE WIDTH

Sets the width of the line drawn.

4.2.7 LINE COLOR MODE

A dropdown list with these options:

Mono: draw all the tracks in a single colour set in preferences, default is Black

Alternating: Each Track is an alternating colour, default is Blue and Yellow. The prime colour can be set in Preferences, the alternate colour is derived automatically from that.

Palette: Each line segment is set to a colour based on the value of the point the line originates in.

4.2.8 XY Traverses

Only applicable to GPS data

Simulate traces from the interpolated data. A Drop-down list of either None (normal tracks) Horizontal (E-W) or Vertical (N-S) traces.

4.2.9 Highlight Tracks

Highlight a track as the mouse moves over it.

Note that for gridded data, the actual trace line is usually not drawn over the track as it's position (left to right) is determined relative to the median value for the survey. So a point with a value exactly equal to the Layer median will be centered over the 'parent' track, values greater then the median will be to the left of the track and values below the median to the right.

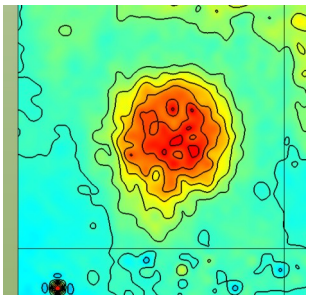
4.2.10 Mark Start/End

Show the green & red dots at the ends of tracks and traces.

4.2.11 Show Deleted

Show deleted tracks & traces, can be useful when 'cleaning up' GPS data.

4.3 CONTOURS



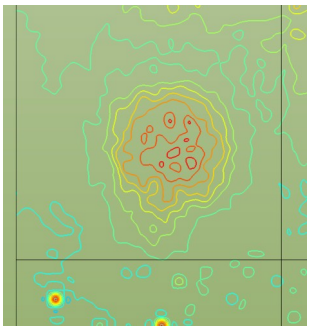
Draw contour lines on the survey. The lines will be equally spaced across the range of the current layer's value range. The lines are actually simulated by drawing any pixel that is bordered by two colours that straddle a contour value in the contour colour.

The following parameters can be set:

4.3.1 LEVELS

The number of contour lines to be drawn on the survey. A maximum of 20 contour levels can be drawn.

4.3.2 IN PALETTE COLOR



If set, the survey colours will be inverted so that the contour is drawn in the palette colour applicable to the contour level and the remainder of the survey will be in the colour normally used for the contour line. If the contour colour is Black when this option is set, the background will be drawn transparent.

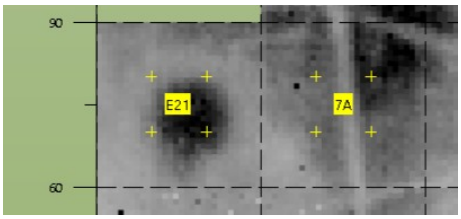
4.3.3 COLOR

Set the colour for the contour line. If In Palette Color is active this becomes the background colour of the survey.

4.4 GRID & SCALE

A number of ancillary items can be drawn on the survey to aid in identifying and locating features. By default only the Grid lines will be turned on for Gridded data, nothing will be shown for GPS data.

The colours and some other attributes of the following parameters can be set in Preferences.



4.4.1 GRID LINES

Delinieate the grids in the survey. Indicates the basic grid rows and columns of the survey area. It does not allow for Grids that have been moved within the survey. With GPS data the Grid lines are arbitrary and have no significance relative to the data, they are only provided to aid in locating the position of features on the ground. When GPS data is shown the size of the grid squares can be set in the Structure Tree parameters, for Gridded data the size is set by the data.

4.4.2 GRID LINE STYLE

The Grid Lines can be Solid, Dashed, Dots, Dash-Dot or Dash-Dot-Dot.

4.4.3 SUB GRIDS

Further divide the grids into smaller sections. Set the number of Sub Grids to more than zero to display them.

4.4.4 GRID SCALES

Draw a ground distance scale along the left & bottom edges of the survey. The scale is labelled at each grid division with the distance from the origin corner.

For GPS data the Scales will be offset from the Grid squares by a small amount. This distance allows for the radius of the survey points. The scale will be based on the western-most and southern-most point in the survey but the outer edge of the survey image will be extended left and down by the radius specified in the Base layer settings. This does not happen with Gridded data as the points are already indented from the edges by half the X & Y interval and all points are drawn as rectangles, not circles.

4.4.5 GRID LINE INTERVAL

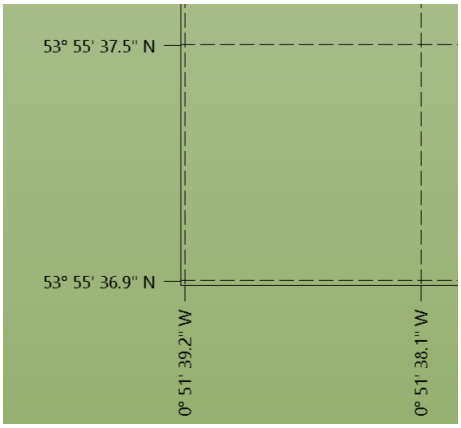
The size of the 'grid squares' when displaying GPS data. This value cannot be changed for Gridded data as it is set by the data.

4.4.6 SOURCE MAP SYSTEM

For reference only, the mapping system used by the source data.

4.4.7 DISPLAY MAP SYSTEM

This option will only be shown if the source map system is not Meters (i.e. the maps can be georeferenced). The units of measurement used for the Grid Scale labels. The label can be formatted as Meters (from zero), UTM (or OSGB/OSTN/etc) or Lat/Long (Deg, Deg.Min, Deg.Min.Sec).



4.4.8 GRID NAMES

Show the name of the source file for that grid square. Only applicable to, and shown for, Gridded data.

5 Download

Data can be downloaded directly from many common Geophysics instruments. TerraSurveyor64 can communicate directly with a range of instruments allowing data to be read directly into it's own Grid format.

Instruments currently supported are:

- Bartington Grad 601 & 601-2 Magnetometer (single & dual sensor pairs)
- GeoScan FM-36 & FM-256 Magnetometer
- GeoScan RM-15 Resistivity meter + MPX15 multiplexer
- GeoScan RM-85 Resistivity meter
- TR/CIA Resistivity meter

TS64Lt: Only supports download from the Bartington Grad 601 & 601-2 Magnetometer

First, connect the instrument to the computer using the cable supplied by the instrument manufacturer.

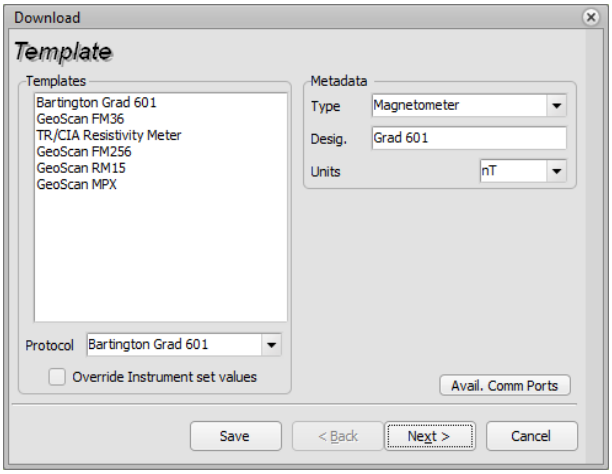
Select Download from the File menu or the NavBar.

The download system uses a 'Wizard'. Each step of the download is covered by a dialog page. Once the necessary data has been entered on each page, press the Next> button to move on. The download process consists of up to 6 pages, however only those pages relevant to the selected protocol are shown so that for most instruments, there will be less pages to go through. For many instruments this will be just the Template, Output Files and Progress pages.

Note: TerraSurveyor64 provides download processes for a wide variety of data formats generated by the different instruments. Each of which must have it's own specific process. This makes it impractical to provide comprehensive error checking and handling for all instruments and conditions. We therefore suggest that you maintain the download software supplied by the manufacturer of the instruments alongside TerraSurveyor64. In case of problems, use the manufacturer's software to download the data, export it to a standard format and then import it into TerraSurveyor64.

5.1 TEMPLATE

Select the applicable template from the List. Each Instrument type may have more that one entry in the list when that instrument can have different settings, such as Grid Size or Intervals. The basic instrument for a template must be selected from the Protocol list at the bottom.



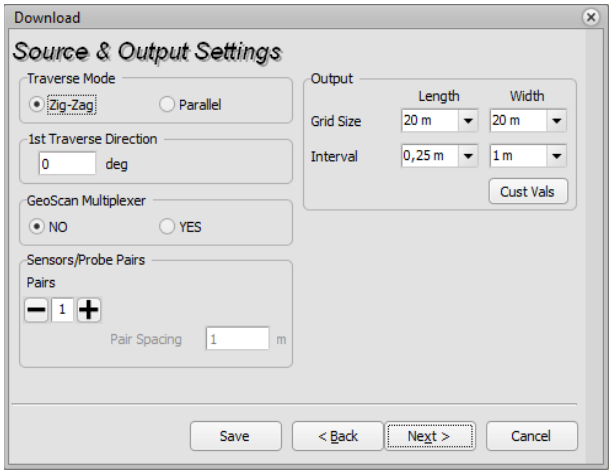
Many instruments provide all necessary sizes, intervals, etc. within the header of the downloaded data. In these cases, the download process omits the pages that allow you to set these values. However it may be that the you have used different values (for the grid size perhaps) than those recorded in the header. In these cases, you can choose to show all the pages and override the header values manually. This is done by by checking the Override Instrument set values checkbox.

If a new template is needed, select the most similar template available for that instrument, make the necessary changes in the other pages and then click Save. You can also change an existing template by the same means. All the settings on all pages will be saved with the template. A template can be deleted by selecting it and then clicking the Delete key.

Set the Metadata applicable to the instrument. This data is for reference only. It is stored with the Grids and Composite created from the grids and can be seen in the Metadata view.

5.2 SOURCE & OUTPUT SETTINGS

This page will normally only be displayed for instruments that do not supply header data in the download, primarily the GeoScan instruments.



Traverse mode describes the method used to walk the grid. Zig-zag means that each traverse starts at the end that the previous one ended. Parallel means that all traverses start from the same side of the grid.

Direction of 1st traverse in degrees. This sets the direction of the North arrow on the main display.

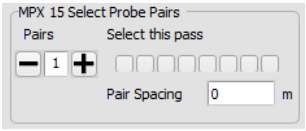
Sensors/Probe Pairs. The sensor count is used by some processes, such as DeStagger and Stretch Traverse, to correctly modify the data. This setting is only applicable to systems that generate multiple readings at each interval such as a Bartington Grad 601-2 or GeoScan RM15 + MPX15 multi-probe array. For all other systems this value should be left at 1.

Notes:
For a gradiometer, one sensor is a pair of magnetometers (i.e. A single Bartington Grad 601 or FM36 is considered one sensor for the purposes of downloading).

The spacing value is for reference only and is not used in any computations. Use it to record the horizontal distance between probes for a resistivity system or the vertical separation for gradiometers.

The presence and contents of the last panel on this page will depend on the instrument selected. For most instruments there will be no other panel showing.

For the GeoScan FM36/256 a checkbox for Drift Correction will be shown.



For the MPX15 / RM85 a panel giving control of the probe configurations will show in place of the Sensor/Probe Pairs panel:

MPX 15 Selected Probe pairs. The MPX15 (and RM85) allows you to log data from a number of probes, connected in various configurations. Each probe pair reading may therefore be at a different spacing (equating to different depths). However, to fit the TerraSurveyor64 method of handling data, each spacing must be downloaded into a separate grid. To do this TerraSurveyor64 allows you to set the number of probe pairs read at each measurement point and then specify which readings taken at that point are to be recorded. By doing multiple downloads of the same data but selecting different readings from the datastream each time, each spacing set can be read into different grids.

For example:

If you have 4 probes on the frame at 0.5m spacings you could define the MPX15 configuration as 2 x 0.5m readings in parallel (probe 1 & 2 + probe 3 & 4) + 1 x 1.5m reading (probe 1 & 4). This would output 3 values at each measurement point. To download this data you would do two complete downloads from the instrument, each download creating a different grid from the logged data. The downloads would use the following settings:

- Sensor Probe Pairs: 2 @ 0.5m, Selected Probes : 3 with checkboxes 1 & 2 checked.
- Sensor Probe Pairs: 1 @ 1.5m, Selected Probes : 3 with checkbox 3 checked.

Remember that the Grid Size & Intervals must also be set differently for each download and that each set of grids should be saved in separate grid subfolders.

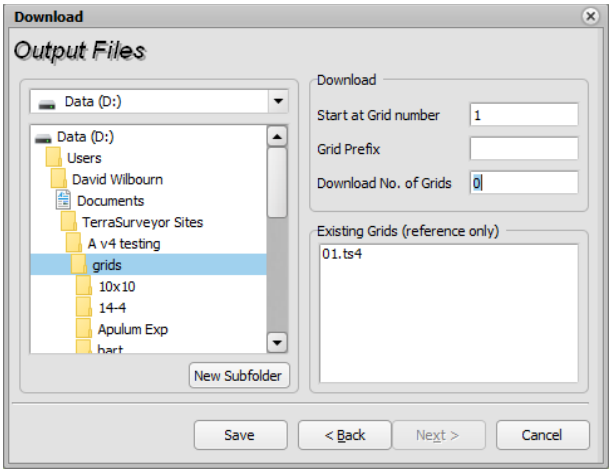
Each setup can be saved as a different template.

The Output panel on the right covers the parameters of the grids to be created. Set the Grid Size, and Intervals to the appropriate values. Non-standard sizes can be set using the Cust Vals button. This will turn all 4 drop-down lists into edit boxes. In this case, all 4 values will have to be entered by hand.

The Length is is the length of each track or interval on the track and will be the axis going up and down the screen in normal use. The Width is the distance between each track or the width of the grid and will go across of the screen.

5.3 OUTPUT FILES

The output path is shown for reference. If Strict Site Structure is enabled, it is set at the pre-defined \Grids folder of the site, however additional subfolders may be created within the \Grids folder (click New Folder). This is useful for separating Grids, for example by instrument or area within a site. Note that Grids of different size (or X/Y Intervals) should not be mixed in a subfolder. The Grid Assembly window can show and assemble Grids with different sizes, however this is not recommended (the thumbnail height and width will be set to the largest dimension of all the grids in the folder).



Set the Start at Grid Number and Grid Prefix if required. Start at Grid Number can be any whole number. Grid Prefix can be any string. Use these fields to differentiate between grids downloaded on different days, site areas, etc.

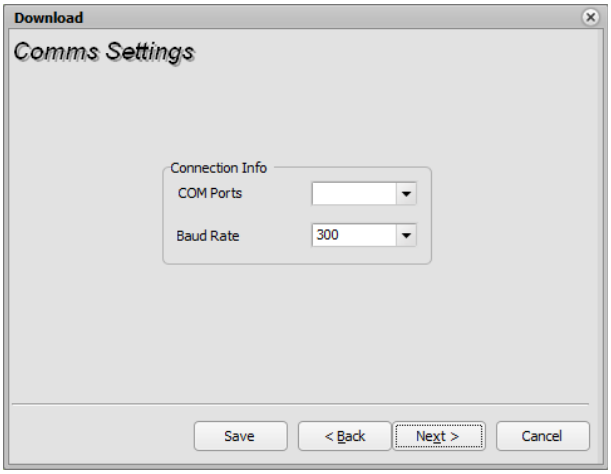
The Start at Grid Number will be added to the download sequence of the grid. Sequence numbers below 10 are padded with a leading zero (i.e. 01, 02, etc.). Most instruments number all grids in their memory from 1. Please note that it does not affect which grids are downloaded, only the names created for them.

By using a Grid Prefix string, grids could be renumbered A01, A02, A03 on day 1; B01, B02, B03 on day 2 etc. Similarly, using a different Start at Grid Number value could create grids 01, 02, 03 on day 1; 04, 05, 06 on day 2, etc.

For GeoScan instruments, set the Download No. of Grids to the appropriate value. All other instruments will determine this value from information in the downloaded data and so this field is disabled for them. For GeoScan downloads, the Next> button will be disabled until a number of grids to download has been specified.

5.4 COMMS SETTINGS

All downloads are carried out using serial cables. Many modern computers - especially laptops - do not have a serial port (also known as an RS232 port). In this case you can use a USB to Serial adapter cable/box to connect the two. If this method is used, the COM port should not be set in Preferences because the port number is assigned dynamically, depending on the other units connected to the USB ports. The download process will therefore scan all the available serial ports in turn and attempt to establish communications with the instrument. Once the instrument has been found, the download will automatically start.



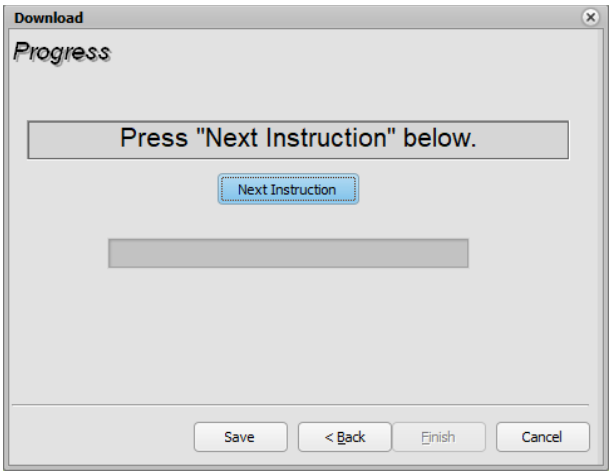
However, this does not work for a few instruments, notably the GeoScan machines, which do not wait for TerraSurveyor to initiate the download. In the case of these machines the COM port must be set on this page. The list shows all the currently active COM ports and is continually refreshed. The best way to determine which port the cable is connected to is therefore to leave the cable unplugged. When this page is reached make a note of the listed COM ports then plug the cable in. Wait a moment (it may take the PC a second or two to recognize the cable) then select the new entry on the list.

There is one other circumstance which may cause problems: when other serial devices are also sending signals to the PC. The most common of these is a GPS receiver. As TerraSurveyor only checks for the presence of data - any data - on a COM port, a GPS receiver (which generates data continuously) connected to a port number lower than that used by the Instrument will be assumed to be the download instrument. In this case, either turn off the device or determine the COM port the instrument is connected to and set the COM port explicitly in Preferences.

The Baud Rate can be changed from that specified in the Template for those instruments that support different baud rates (currently only the GeoScan machines)

5.5 PROGRESS

Follow the directions given on the large panel at the top of this page. The messages are specific to each Instrument. Click on the Next Instruction button to advance to the next message and finally start the actual download procedure.



Progress or Error messages appropriate to the Instrument and the data it provides will be displayed in the large panel and a bar will show progress (when this can be computed).

Once downloading has been successfully completed, a message box will show the number of grids created. Click OK and then Finish to continue to the Grid Assembly Window.

6 IMPORT

TS64Lt: Does not support this function.

Data can be imported from a range of standard format data files generated by software such as that supplied with many Geophysics instruments. A number of special formats created by specific instruments or software programs are also supported.

Generic Formats:

- XYZ
- Z
- Spreadsheet
- Irregular Interval
- Gridded GPS
- Irregular X & Y

Special Formats:

- Bartington Grad601 (Handheld only)
- GSSI Profiler
- Surfer ASCII, version 6 & 7 binary
- Scintrex
- GeoPlot binary Grid & Composites
- Geonics G38
- GeoMetrics G858
- Foerster Ferex Dataline / Data2Line
- UXO (GPS & Grid based)
- SenSys ASCII
- Frobisher
- GeoMar MLgrad13 (Bartington cart)
- CMD Conductivity
- InSite Grids & Grid assemblies (limited)
- Snuffler
- Blank Composite

Data is normally imported into grids the same as those created by the download process. However data can also be imported directly to a composite when the layout dictates.

6.1 GENERIC FORMATS

TerraSurveyor can read the following generic ASCII formats:

6.1.1 XYZ (GRIDDED)

In this format each line of the file represents a single cell in the grid (or composite). The line must contain at least 3 entries; the column (X), row (Y) and value (Z). Any column may be selected from the file to fill each of these values, the column order and method used to select them is defined in the File Layout page.

Empty values may be omitted, entries that exceed the range specified in the import dialog will be ignored. Lines that do not yield valid numbers in all three specified columns or do not start with digits will also be ignored.

6.1.2 Z

Each line of the file contains just a single entry for the value. The position of each value is assumed from it's sequence. The first value is typically placed in the top-left corner cell of the grid, the second in the cell to it's right and so on. The file must therefore contain a value for every cell in the grid, empty values must be represented by the dummy value. The traverses is always assumed to go from left to right (as viewed from the startpoint of a grid when gathering the data). The position of the origin (corner of the first value) can be set to any corner.

6.1.3 SPREADSHEET

Each line of the file represents a complete row of the grid (or composite). Values may be separated by a tab, space or comma. As with the XYZ format, care must be taken when using data with PCs that use the comma as the decimal separator. Empty values may be omitted as long as the separator is present.

TerraSurveyor assumes by default that all imported data is arranged with the origin (position 0,0) in the Top-Left corner. The position of the origin can however be set to any corner.

6.1.4 IRREGULAR Y

Note: Because of the fundamental change in the concept of direction between the old TerraSurveyor and TerraSurveyor64, this import method's name has been changed from Irregular X to Irregular Y.

The basic layout of the file must be similar to the basic XYZ file (i.e. at least 3 columns, containing the X distance, Y distance and Z measurement value). However, this format allows the points along the track – the length – to be irregularly spaced. The irregular spacing will be converted into regular intervals (at a spacing set in the import dialog) by an interpolation process.

As the format name implies, the interpolated axis will always be the Y axis when displayed in TerraSurveyor64. This may seem to imply that the format cannot be used for certain files. However, the column used for the Y axis does not have to be called the Y axis by the file. Simply specify whatever column contains the irregularly spaced data as the Y axis and then rotate of flip the resulting data as necessary to re-orientate the final data.

Note that any data rows with values outside the range specified by the import dialogs will be ignored, as will any lines in the file that do not contain valid numbers in the defined columns.

6.1.5 IRREGULAR X & Y

This format is typically intended for use with data gathered with GPS positioning data. Using this method, the data does not need to conform to a classic grid system. However, for best coverage and results from the available GPS processes, it is suggested that a regular, grid-like approach is used when gathering data: the lines need not be oriented in any particular direction but they should be fairly straight, parallel and regularly spaced.

The basic layout of the file must be similar to the basic XYZ file (i.e. an ASCII file of at least 3 columns, containing the X distance, Y distance and Z measurement value). Each row may contain multiple X, Y & Z sets. The source values will be interpolated to generate appropriate values at the closest regular grid points. The interpolation process can use any interval for the X & Y axis. Interpolated points will be generated for a specified radius around each point. This is to ensure that complete ground coverage is provided for each traverse or track of source data – and also limit the interpolation to a statistically valid distance from the available data.

Because of the nature of the data, grids have no meaning. Therefore Irregular X & Y data is always interpolated straight to a composite. The composite will be sized to fit the full extent of the source data, plus allowing for the radius of the track as specified in the Irregular X & Y panel.

To import more than one file to a single composite, join the source files into a single text file (using an external text editor or word processor) prior to importing. Alternatively the files can be imported separately and them merged using the specific Merge function, see the main menu | Merge.

The source data can contain markers to define the start and end of traverses. The markers can be almost any text embedded in the file. The import process uses either (user defined) Regular Expressions to recognize the marker (see Format Settings for details) or a value in a specific column that changes to trigger a new traverse. The regular expression can be a separate line of text in the file or a particular string within a line of data, the trigger column must be part of a normal row in the data. The regular expressions or Change column will be saved in the template.

Alternatively, Track breaks can be based on either the time or distance gap between 2 adjacent data rows. Use the On Pause and On Jump methods to introduce Start and End markers.

If both start and end markers are present, data between each start and end mark will not be used in the interpolation process (nor will datapoints before the first start and after the last end). Just start markers can also be used.

X & Y positions can be in either Lat/Long, Deg/Min/Sec format (or variations on this) or UTM meters. In the case of the former, the data will be stored in the composite file using the source format but will be converted to UTM values when opened. Lat/Long positions are signed, i.e. positions south of the equator or west of the prime meridian are negative. If the file uses 'S' or 'W' to indicate the hemisphere this will be recognised and converted. However this will only work if the 'S' or 'W' are appended directly to the Lat/Long value (e.g. 0123.4567W) or in the column directly after the Lat/Long position. If the data is imported from UTM, a UTM zone can be specified however this is not required. If the data is not geo-referenced then the UTM format should be used. A geoid can also be specified for GPS data, this will be stored in the composite. If no Geoid is selected, the Geoid set in Preferences will be used.

Note that any lines in the file that do not contain valid numbers in all the defined columns will be ignored.

Survey systems are increasingly mounting multiple sensors together on a single machine such as towed cart. Some of the dataloggers associated with such systems output each sensor's position and value as a single line of data, however some place all the data for all the sensors at a single measurement event on the same line. TerraSurveyor64 can handle either file layout. If multiple sensors are defined in each row, the X, Y & Z for each sensor must be a separate column in the file. The file will be read repeatedly from beginning to end for each sensor specified and the data for that sensor appended to the end of the composite.

Latitude & Longitude is a very ancient format and as a result can have a wide range of layouts. TerraSurveyor supports a number of these layouts, though probably not all. All layouts are based on a single numerical value with one decimal marker, the layout will determine how the digits around the decimal are interpreted:

- Degree or Ddd: The digits before the decimal are whole degrees, those after are decimal degrees.
- Degree Minute or DMm: The digits before the decimal are whole degrees. The first 2 digits after the decimal are interpreted as whole minutes, subsequent digits are decimal minutes.
- Degree Minute Second or DMS: The digits before the decimal are whole degrees. The first 2 digits after the decimal are whole minutes, the next 2 digits are whole seconds and subsequent digits are decimal seconds.

More complex layouts with multiple separators such as 12°34,56012345 or 12°34'56.012345" are not supported. Normally the dot '.' will be expected as the decimal, even in computers that use the local settings of ',' for a decimal. Where a special file format defines the decimal character in a header etc. that will used instead.

6.2 Proprietary Formats

A number of proprietary or special formats can also be imported or created. These formats are usually specific to particular instruments or software packages. By providing direct import facilities, full advantage can be taken of the special processing abilities provided by TerraSurveyor64.

6.2.1 Bartington Grad601

Import the grid files created by the Bartington Datalog utility program. These are either a pair of .dat & .hdr ASCII files for each grid or a single .dat file for each grid, either version can be imported. Only the .dat files will be listed in the Wizard, TerraSurveyor64 will find the associated .hdr file for each grid. The only setting required after selecting the files to be imported is the Dummy value. This should be 32702 however this can be set by the user when downloading using the Datalog program so may be different.

Note: The Datalog program should default to 32702 for the dummy however this does not seem to be always the case. In practice it is common to see the dummy set to zero. If this occurs the dummy values will be indistinguishable from any actual values of 0 resulting in apparently poor grids and composites.

Check the Dummy value in Datalog before commencing the download.

6.2.2 GSSI PROFILER

An ASCII format created by the GSSI Profiler datalogger. The data file (extension *.emi) contains some standard header lines followed by data in a comma separated XYZ format. The data lines may also contain GPS positioning data if the datalogger is suitably equipped (and the appropriate logging mode is selected). If GPS data is present the file is imported directly to composites, non-GPS data is imported as grids that can then be assembled into composites. The import process reads the header data in the .emi file and sets all the appropriate parameters accordingly. Thus there are almost no settings to be made in the import dialogs apart from the source file to be imported and destination. The only settings that can be filled in are Direction of First Traverse (this is not available in the header data and is not required for GPS based data) and for GPS based data: Track Radius, Interval and Use GPS. Track Radius determines the number of interpolated datapoints that are kept around every source point. This ensures that interpolated data is only shown within a statistically valid range of the source data. Interval sets the density of interpolated data points. Both these values can be changed after import. The Use GPS switch allows the GPS data to be ignored in which case all data will imported to grids.

6.2.3 SURFER

TerraSurveyor64 can handle three types of files created by the program “Surfer” from Golden Software: the plain ASCII files and the version 6 & 7 binary files.

In Surfer files the first line of the data represents the bottom row of the grid, the grid is therefore automatically flipped vertically during import. The X & Y Grid size and intervals are calculated from the values specified in the header.

Note that Surfer files consider datapoints to be placed at the intersection of intervals. See section Grid Measurement point position for a detailed explanation of this factor. As this results in one more column & row of data than in the equivalent sized TerraSurveyor gird or composite, there is an option to discard the First or Last Row & Column. This will result in small shift in every datapoints position but will retain the integrity of the source.

The size of the Grid/Composite specified in the Import wizard will override the size defined in the Surfer file header. Data outside the specified area will be ignored. The size should therefore be set to a value equal to, or greater than the actual size to ensure data is not lost.

6.2.4 SCINTREX

An ASCII format produced by the Scintrex SmartMag or NavMag software. TerraSurveyor can import grids gathered from instruments used in both the vertical and horizontal orientations. Grids gathered in the vertical mode can be imported as either Upper, Lower (total field) or Gradiometer (difference between upper and lower). By selecting the sensor mode “Twin”, grids can be imported where the Field 1 column becomes the even-numbered rows and Field 2 the odd-numbered rows (assuming the first row is number zero). When used in this mode, ensure that the instrument is not rotated at the end of rows and that the correct sensor is on the left/right.

Because of the way Scintrex grid data is collected, there is no fixed sampling interval (this is equivalent to the Irregular Y format described above). The import function creates fixed intervals by interpolating between the variable Scintrex Y intervals. The TerraSurveyor sampling interval can therefore be set to any value, we would suggest that a value close to the average Scintrex sampling value be selected. The actual interpolated value is taken from the mid-point of the interval, e.g. With a Y interval of 0.5m, the data is interpolated at 0.25, 0.75, 1.25, etc.

It would appear that there is also a significant delay inherent in the Scintrex datalogging system so De-stagger always has to be applied to the grid. However, the datalogger has the advantage of being able to log data both before the start and after the end of a line. This enables the import function to apply the de-stagger during import and fill the line ends with true, recorded data instead of the adjacent averages as used in the Main view De-stagger process. However, it can only be done during the import process; if not done correctly the whole import process will have to be repeated to correct it. To take full advantage of this facility, the operator should ensure that logging starts and ends at least 1m either side of the row. The de-stagger values can be set in Intervals or centimetres (or a combination of both). Negative values pull the data back towards the start of the line (normally the required correction).

The Scintrex import function expects the NavMag data to be in 7 (space and sometimes comma separated) columns:

```
   0      -4.85294  48826.67  48828.95  10.748667  0    -4.55
```

```
SmartMag data is in this form:
```

```
   0.00000,          *, 48255.33, 48255.15,   -0.00,  10.78000
```

In the case of SmartMag data, the X position (column 2) will be interpolated between available "Marker" lines or the start and end of the row (based on changes in the Y position in column 1). Lines beginning with a '/' character will be ignored.

6.2.5 GeoPlot

TerraSurveyor can import the grid and composite files created by the program "GeoPlot" from GeoScan Research. The grids and composites are actually stored in pairs of files: Grids as a xxx.grd and xxx.dat pair and composites as a xxx.cmd and xxx.cmp pair (where xxx is the 'name' of the grid or composite). The grd and cmd files are ASCII header files describe the grid or composite's size, shape, etc. The dat and cmp files are the actual values in binary format. The import process will only show the header files but the pair of files must be present in the same folder in order for the import to work. All data regarding the size and shape will be extracted from the header file, therefore the Source and Output Settings pages of the Import wizard are not shown. Grids will be converted to TerraSurveyor grid files and composites to TerraSurveyor composites.

6.2.6 Geonics

The Geonics format is a common file format created by the Geonics Mapper software after downloading data from their EM31 & EM38 instruments. Both Gridded and GPS modes are supported. Gridded covers both the Auto and Manual modes defined by Geonics. Files that use variable Y intervals will be imported in the same way as the generic Irregular Y method.

In 'Grid' mode the file uses a variant of the XYZ file layout however the X (traverse line) is only given once at the start of each block Y values. Note that the Geonics datapoints are recorded at the intersections of intervals. This difference is ignored in the import process resulting an offset of data position of ½ an interval in both axes. See Grid Measurement point position for further information.

> Note: The Geonics file format is extremely flexible, particularly in the use of line labels. In fact, it seems the line label can mean just about anything the user wishes. However there is no means of describing that meaning in the file. The import process therefore only attempts to handle the simplest and most straightforward variations. Warnings are given if more complex labels are found, however it may be that an apparently simple label is actually used in a complex and unsupported manner.

As there is no fixed value for the X & Y origin, this can be set in the Import Wizard. Set the value X & Y Origin starts at: to the value that the first X & Y value in the file will have. This value will then be subtracted from each X and Y position to match the zero-based standard in TerraSurveyor. Note that the Wizard assumes that both the X & Y axes will use the same start value and therefore the same correction.

In GPS mode, the grid based X & Y positions are still present but are virtually irrelevant, instead the X & Y position of each point is interpolated from the GPS records inserted into the file at one second intervals. The interpolation is based on a simple straight line between the last and next GPS point, using the high accuracy time to determine the distance along the line. GPS mode files always convert straight to Composites.

6.2.7 GeoMetrics G858

This import process currently only supports the G858 Grid based files, not the GPS versions.

This format is an ASCII format created by the GeoMetrics MagMapper software when used with the G858 magnetometer. The *.stn files that TerraSurveyor can read are a variation on the Irregular Y format and handled as such. This means that the (regular) Y values are interpolated from the irregular source data.

6.2.8 FOERSTER FEREX DATALINE

An ASCII spreadsheet based format produced by the Foerster Ferex Dataline software. Characterized by a short header section starting with:

```
!Institut Dr. Förster FEREX DATALINE®
![Fieldtype] STD, V3.00
```

The import process recognizes this header and will reject files that do not conform to it. The process will also transform the data to match the standard TerraSurveyor axis orientation. Foerster grid data is 'corner' based which results in the last row and column being repeated in the adjacent grids. The import process gives the user the option of discarding these rows and columns to make assembled grids form a correct composite.

6.2.9 FOERSTER FEREX DATA2LINE

An ASCII X/Y/Z based format produced by the Foerster Ferex Data2line software. Characterized by a short header section starting with:

```
[EXPORT_SOURCE]    INSTITUT DR. FOERSTER GMBH & CO. KG DATA2LINE
```

The import process recognizes this header and will reject files that do not conform to it. Though the file can contain GPS based positioning, this is ignored when reading the file, only the basic X & Y columns are read. Like the previous Foerster layout, the Foerster grid data is 'corner' based which results in the last row and column being repeated in the adjacent grids. The import process gives the user the option of discarding these rows and columns to make assembled grids form a correct composite.

6.2.10 FORSTER GPS FEREX DATALINE

An ASCII X/Y/Z based format produced by the Foerster Ferex Dataline software. Characterized by a short header section starting with:

```
!Institut Dr. Förster FEREX DATALINE®
![Fieldtype] GPS, V3.00
```

The import process recognizes this header and will reject files that do not conform to it. The GPS positions are provided in the file in both UTM and Lat / Long formats however examples indicate that the UTM values are not reliable as the easting can be outside the recommended zone for the given longtitude. The Lat / Long format is also very unusual being 'DDMM.mmm'. This is therefore converted to a more common and easier to handle 'DDD.ddd' format in the imported file.

6.2.11 UXO (GPS OR GRID)

An ASCII XYZ format common to the UXO (unexploded ordnance) community. The current import process is based on examples from Vallon & SenSys which may contain manufacturer specific features. The 2 variants are identical in layout but can have either irregularly or regularly spaced X & Y values. The type is determined by a setting in the file header. If the wrong type is selected a warning will be given as the file is read.

6.2.12 SENSYS ASC

ASCII files created by the SenSys Magneto or DLMGPS programs. Note that these programs have a range of export formats and options, it is important that you set 'Save type as' to ASCII (*.asc) and deselect 'Automatic Track Compensation' (under Options) prior to exporting the data.

6.2.13 FROBISHER

ASCII Grid files created by the Frobisher TAR-3 resistance meter. Frobisher files can contain multiple grids which are split into separate Grid files using the seq numbers given in the file for the grid name. The files do not contain 'Direction of First traverse' data, this is the only data that needs to be - and can be - entered during the import process.

6.2.14 GEOMAR MLGRAD13

ASCII files created by the GeoMar MLgrad13 program which is specifically designed for use with the Bartington cart. This is a GPS based format so data is always imported as composites. During import, a

pre-process called “Remove Tank Tracks” can be selected (see the SenSys format above for a description of this effect). This has to be done as a pre-process during import as the relationship between neighbouring tracks is not preserved in the file structure beyond this stage.

Please note that TerraSurveyor64 can only read the GeoMar .xyz files, not the .asc files.

6.2.15 CMD Conductivity – GPS or Gridded

Note: This import process has been developed on the basis of a very small set of sample files. Therefore there may be options or file contents that are not supported by this import process.

ASCII files created by the CMD Mini-Explorer. This produces 6 readings (Cond1,2,3 & Inpf1,2,3) at each measurement point. Each reading is saved to a separate grid in an automatically created sub-folder of the selected Grids folder or as Composites for GPS files. Samples seen use either UTM or Lat/Long in an unusual DDDMM.mmm format. The later are therefore converted to the more common (and easier to handle) DD.MMmmm format. There is also extensive validity testing for these files as experience indicates that they are susceptible to line level corruption. However any test cannot be exhaustive so if problems are encountered please provide samples to DWConsulting for further testing and improvements.

6.2.16 InSite Grids & Grid assemblies

InSite is another geophysical data processing program, however it is no longer generally available. A number of operators still use it and a large body of data exists in it's format.

Note: There is no published description of the InSite data format and experimentation with a variety of samples indicates that the format is at the same time both simplistic and very complicated. The grid files are simple Z files with some header lines. However the Grid assembly files which show how a set of grids are arranged, allow the grids to be oriented in a multitude of ways but the parameters that control this orientation do not seem to operate consistently between different surveys. It has therefore been impossible to develop an import process that can handle all available example files in a satisfactory manner.

Therefore it is recommended that extreme care is taken when using this import process with InSite files. We suggest contacting DW Consulting if you have any doubts about the accuracy of the process and the resulting data.

The basic Grid import process works well with all available samples and should be used as the basis for any import work. The Composite import process that reads the Grid.Inf files may succeed but more probably will only show distorted grids in their correct positions (and may fail completely). In this case, we recommend you import the grids separately and use the position information extracted from the Grid.Inf file to create a new composite from scratch.

6.2.17 Snuffler

Snuffler is a free, basic but effective download & processing program for GeoScan & Bartington Gard601 instruments. It’s native *.srd files are ASCII with some header data and then values in ‘Z’ format. Conversion is always to simple grids. Available from *http://www.sussexarch.org.uk/geophys/snuffler.html*

6.2.18 Blank Composites

One further special import format is possible which will generate blank composites - i.e. a composite where all the cells contain the Dummy value. This can then be used for a number of purposes such as inputing data by hand via the Data View.

Select the File Type Blank Composite. The Type box will be automatically set to Composite, the Composite X & Y boxes will be shown - with default values of 1. Set the values for the Grid intervals and the size of the Composite (in Grids). Specify a name for the Composite file then click on Finish. The new blank composite will be listed with all the normal composites in the site folder. Grids will be given dummy filenames in the form "B[X,Y]" where X and Y are the Column and Row.

To enter values in the Composite, see the Spreadsheet section.

Note: Composites created from a blank cannot be modified by the Open Grid Assembly window. They can however be exported as grids and then re-assembled as a new Composite.

6.3 Import Process

Select Import from the File menu or NavBar (the NavBar Import button will be disabled until a site has been opened).

The import system uses a 'Wizard'. Each step of the import is covered by a separate wizard page. Once the necessary data has been entered on each page, press the Next> button to move on. The import process consists of up to 6 pages, however only those pages relevant to the selected file format are shown so that often there will be less pages to go through. In some cases this will be just the Template, Input Files, Output Files and Progress pages.

6.3.1 Grid Measurement point position

Note: The following information is only applicable to Gridded data, GPS data is imported and stored with the exact same position values as the source.

Some gridded data formats, such as the Geonics and Surfer files, consider datapoints to be placed at the intersection of intervals. This differs from the TerraSurveyor perspective where datapoints are considered to be at the center of (half way between) each interval. This has significant implications for the import process. In the Surfer/Geonics world a grid that is 20m x 20m at 1m intervals would contain 21 rows and columns. The first row and column datapoint being measured at 0m x0m and the last at 20m x 20m. The same grid in the TerraSurveyor world would have only 20 rows and columns. It would consider the first point to be measured at 0.5m x 0.5m and the last at 19.5m x 19.5m.

The import process takes a simplistic approach to handling this offset, it ignores it. The first datapoint from the Surfer file is stored in the first datapoint of the TerraSurveyor Grid/Composite. In practice it has been found that this is sufficient for normal purposes. In most cases the offset is insignificant relative to the overall size of the survey and other sources of error such as magnetic dip. The offset can easily be corrected on the ground if required. Attempts to interpolate values for the true X & Y positions degrade the data too much. This approach also has the advantage of preserving the true measured values.

Both the Surfer and Geonics have options to drop the first or last row and column so that the grid sizes match the TerraSurveyor layout.

6.3.2 General Points

Importing Composites

When importing data that has been assembled elsewhere from grids but is now just a single composite file, some extra information has to be added to the imported version to ensure correct handling. Dummy filenames are generated for any grid that contains data in order to support the grid-oriented processes such as Stretch Traverse and De-stagger. These filenames are in the form "I[X,Y]" where X and Y are the Column and Row.

Header Files

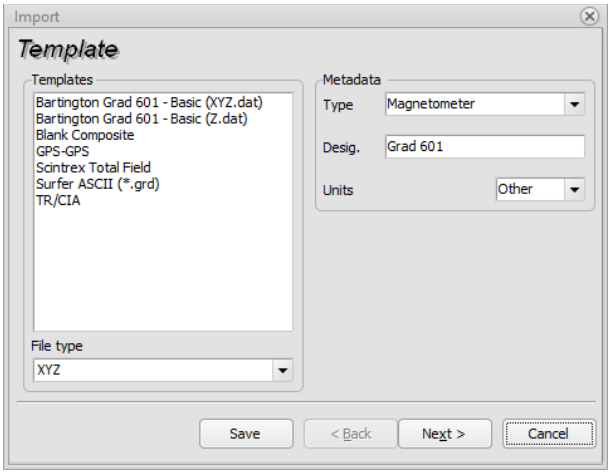
TerraSurveyor64 does not generally support generic files with “headers”, i.e. Information before the actual measured data describing instrument settings. This data should be deleted in a text editor prior to importing. However the generic import formats (XYZ, Z, Spreadsheet, Irregular X and Irregular X&Y) will ignore any lines that do not start with a number. More complex selection and filtering can be achieved in GPS files using Regular Expressions (see 6.3.6 for details). Proprietary formats such as Surfer ASCII files which specify header info in a particular layout are catered for.

Mismatched data and parameters

As many checks as possible for the specific type of data are carried out during the import process to ensure that the data matches the specified parameters. However there are situations where the correctness of the data cannot be confirmed programmatically. The most common of these occurs with XYZ data when the X and/or Y interval is set smaller than the data's actual interval. In this case the data will be imported but the grid thumbnails will appear blank as every data point is surrounded by (and in effect 'swamped' by) empty values. If this occurs, check the X and Y Intervals and re-import the data.

Another possible source of problems can occur with GPS positioned data. Latitude / Longitude can use a number of different formats that are often impossible to recognise from just the number. For example, "12.3456" could mean 12.3456 degrees or 12 degrees, 34.56 minutes or 12 degrees, 34 minutes, 56 seconds. All of these will result in a different position. TerraSurveyor64 can handle all these formats, and more, but needs to told what the format is before trying to read the data.

6.3.3 TEMPLATE:



Select the applicable template from the List. Each Instrument type may have more that one entry in the list when that instrument can have different settings, such as Grid Size or Intervals. The data format for a template must be selected from the File Type list at the bottom.

Some formats provide all necessary sizes, intervals, etc. within the header of the file. In these cases, the import process omits the pages that have you set these values.

If a new template is needed, select the most similar template available for that file type, make the necessary changes in the other pages and then click Save. You can also change an existing template by the same means. All the settings on all pages will be saved with the template. A template can be deleted by selecting it and then clicking the Delete key.

The Instrument type, Designation and Units can be set but have no effect on the actual data. The values are for reference only and are only displayed in the Metadata view (and the Palette/Vertical scale in the case of Units).

6.3.4 SOURCE FILES

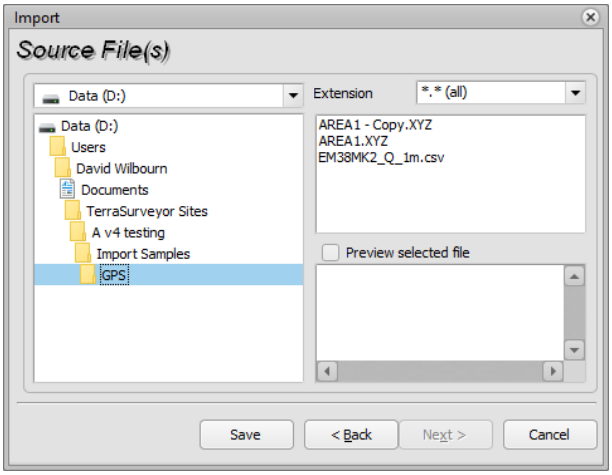
The Drive & Folder list set and show the directory the source files will be found in. The site path is shown by default. This can be changed to any folder.

Set the extension of the input file if necessary (this may have been preset by the template).

Note: Different programs may produce very different files with the same extension. Just selecting the extension in this list does not guarantee that the import process will work. In fact, this list has no effect on the import process at all, it just determines the files that will be shown in the file list.

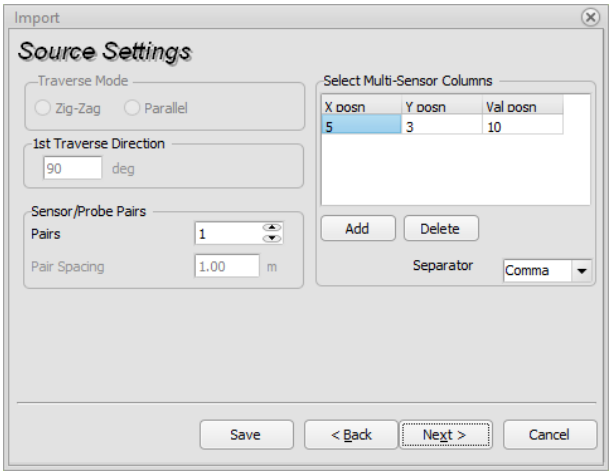
The correct import format must be set by the File Type list on the Template page.

Select the file(s) to be imported. If a composite is to be imported, only one file may be selected. By checking the Preview selected file box, the first few lines of the file can be viewed to ensure the selected file type is correct.



6.3.5 SOURCE SETTINGS

The fields shown and options available on this page of the Wizard will differ depending on the file type selected. The screenshot gives an example of what you will see. All the various fields are described below.



Set Traverse mode. This information is used by some of the processes, such as DeStagger and Stretch Traverse, to correctly modify the data and is also important when the data is in Z format (i.e. no X and Y information is supplied).

Set the Direction of 1st traverse in degrees (this may be a decimal value however in most cases just the integer value will be used in any calculations or processes).

Many of the import formats use vertical columns to store the data. The Select Columns panel controls how these columns are read and processed (Irregular X&Y data uses a slightly different panel – see below for details). Columns can be defined either in terms of absolute position or column number. In the first case you must specify the start position and width in characters of each column. In the second you must specify the column number (starting from 1) and the character used to separate each column. This can be either a space, tab, multiple tabs or comma. Commas should not be used if the PC is set to use commas as the decimal separator (such as in most European countries) as this will result in apparent extra columns. In this case use the tab or space as the column separator. Multiple spaces may be used to separate columns and may also surround commas. However only a single comma or tab character should be present between each column. The Multiple Tab option will treat tabs as spaces, i.e. a group of consecutive tabs will be treated as a single tab.

Check the X & Y Values in Intervals checkbox if the X & Y positions are given in interval counts rather that measured values (meters or ft).

For the spreadsheet format use the Ignore First Row & Col checkbox if the file uses these to show the position rather than values.

Sensors/Probe Pairs. The sensor count is used by some processes, such as DeStagger and Stretch Traverse, to correctly modify the data. This setting is only applicable to systems that generate multiple readings at each interval such as a Bartington Grad 601-2 or GeoScan RM15 + MPX15 multi-probe array. For all other systems this value should be left at 1.

> Note: For a gradiometer, one sensor is a pair of magnetometers (i.e. A single Bartington Grad 601 or FM36 is considered one sensor for the purposes of downloading).

The spacing value is for reference only and is not used in any computations. Use it to record the horizontal distance between probes for a resistivity system or the vertical separation for gradiometers.

For Scintrex files:

Set the Sensor Mode so that either the Gradient, Upper or Lower sensor data column is imported.

Set the Offset to allow for datalogger delay. Each reading's position will be corrected by the specified amount in Intervals and/or cm. Positive values 'pull back' the data by the specified amount.

For Irregular Y files:

Set Origin starts at to 0, 1, ½ Int or Lowest Values. Because TerraSurveyor uses an origin of 0,0 for all grids and composites, imported data with explicit X & Y values may need to be repositioned. This setting determines the value to be subtracted from every X & Y value. This should be set to 0 for all cases except for XYZ or Irregular Y data. If the X & Y values are in intervals and start at 1,1, select 1. If the X & Y values indicate the center of the measurement 'box' (e.g. 0.25 & 0.5 for X & Y intervals of 0.5 & 1) select ½ Int. If other values, such as Easting and Northing are used for the X & Y position, select Lowest Values. This will scan the data and subtract the lowest found value from every value.

X & Y Divisor will divide the value in the file for each position column by the given value. This can be used when the X & Y values are not recorded in the units required for the survey, for example if they are in Ft or millimetres when the survey needs to be Meters.

For Irregular X&Y files

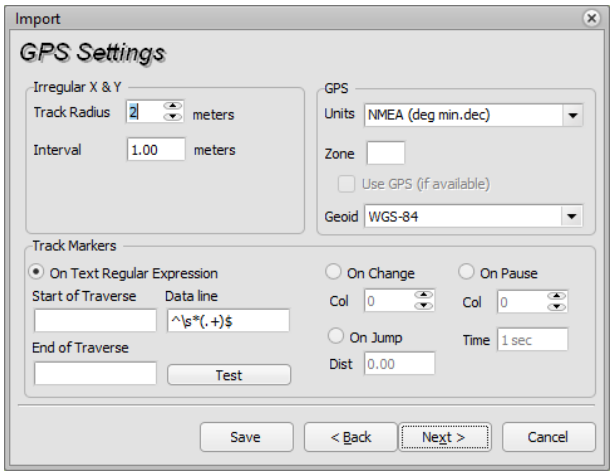
Because the Irregular X&Y format supports multiple sensors per row, the Select Columns panel for this format is different. The X, Y and Z (val) column for each sensor is listed in a short table. This table can be extended or reduced with the Add & Delete buttons. Fixed positions are not supported, positions can only be defined in terms of columns delineated by either spaces, tabs or commas.

The File options panel is also not shown with this format as all it's settings are redundant.

6.3.6 GPS SETTINGS

Note: This page is only applicable to GPS based source data.

The Track Radius determines the number of interpolated datapoints that are kept around the interpolated point closest to each source point. The value is the width of a square area, so that 7 will keep all interpolated values in a rectangle 7 'x' intervals wide by 7 'y' intervals high around the center interpolated value.



The Interval determines the level of interpolation applied to the data. Care should be taken when setting this value to avoid excessively large composites.

Both the Track radius and Interval can be changed when viewing the results.

Traverse Markers

Three different methods can be used to identify the start or end of traverses or tracks in the data:

Regular Expressions can be used to find Datalines and Traverse Start & End markers. These are set and can be tested in this panel. If nothing is entered in a field (Start, End or Data) then the whole line will be used as input (and no test for Start or End will be done). If an expression is given, only data passed on by the expression will be treated as possible X, Y & V values. *Note that the default filtering in the import process ignores any datalines that start with a non-number as that usually indicates header data or comments.*

Example 1: For a simple file that has a possible marker in the first position and 3 columns:

```
s 1234 4567 78.9
  2345 5678 89.0
e 3456 6778 12.3
```

The Start expression would be: **^s(.+)$** This translates as line start [^] followed by [s] which is discarded, followed by any characters [.], one or more [+] which are passed [()], up to the line end [$]. The end expression would be similar: ^e(.+)$. In this case the Data expression can be left empty as all other lines will be passed in full.

Example 2: XYZ data preceded by a Line number/marker.

```
L63 35.5988346 10.1589074 91 575919.7074 4939959.737 -1.784
L63 35.5988351 10.1589077 91 575919.734  4939959.793 -1.771
```

Only the Dataline need be set for this, the expression can be as simple as **^[L](.+)$**

See http://www.regular-expressions.info/reference.html for further information on Regular Expressions.

On Change: A column in the file can be monitored and a new Traverse start triggered when the value in this column changes. Note that this method only generates a Start marker on a change and so does not support gaps between the end and start of traverses.

On Jump: The distance between the current and previous X & Y position can be monitored and a new Traverse triggered if the distance is greater than the specified threshold distance. Contiguous 'jumps' will be marked as single 'End' – 'Start' pairs.

On Pause: The time between the current and previous position can be monitored and a new Traverse triggered if the time is greater than the specified threshold time (in seconds). The time must be in the format 'hh:mm:ss' and must be the only text in the column specified.

GPS

The format of the GPS position can be set to a number of common layouts:

- Deg (decimal deg)

- DMm (decimal mins)
- DMS (deg min sec)
- NMEA (deg min.dec)
- UTM (meters & zone)
- non GPS (meters)

If a country specific coordinate system (such as OSGB36 or ITM) has been selected in Preferences then that system will also be on the list.

If UTM is selected, a zone must be provided (a default for your local area can be set in Preferences).

In standard NMEA data, the Easting and Northing are each split over 2 columns – the absolute numerical position in one and the hemisphere (N/S or E/W) in the next. As the Source Settings can only specify one column per value, the import process will automatically extract the N/S or E/W sign from the adjacent column. In the composite the sign will be applied to the number ("00525.72835035,W" will become "-525.72835035"). The value will only be changed if the next column is "W" or "S".

Note that if the data lines start with text such as "$GPGGA" as seen in most NMEA data, you will have to supply a Data Line regular expression as by default the import process ignores lines that start with letters. You can use the regular expression: ^\s*[\d-](.+)$ to omit any leading letters. Note that this will mean the column numbers in the Source Settings will have to allow for the ignored column(s).

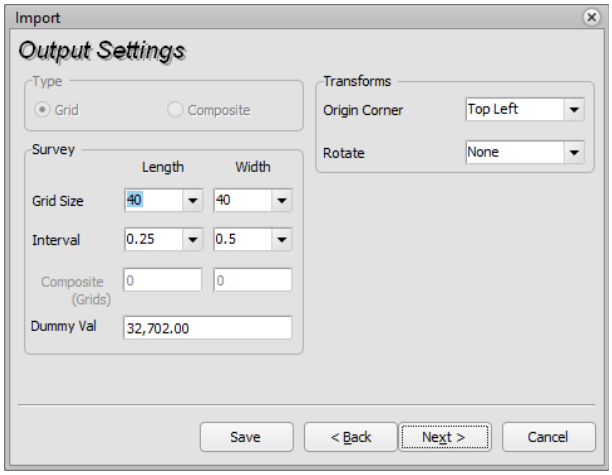
Use GPS is only applicable to GSSI data.

Set the Geoid to be used to convert the GPS Lat/Long position to Northings & Eastings.

6.3.7 OUTPUT SETTINGS

In the Type panel, select whether the files are to imported as individual Grids or a single complete Composite. This panel may be disabled if the chosen File Format does not support this option.

In the Survey panel, set the Grid Size, and Intervals. The terms 'Length' and 'Width' indicate the length of each track and the width of the track – or distance between adjacent tracks. If the correct grid size for the source data is not listed select the next bigger size. This will result in grids bigger than the original and thus give empty borders round the data. This can however be fixed later by selecting and moving the data into place. Non-standard sizes can also be entered in these fields. Remember that TerraSurveyor cannot combine different sized grids into a composite (at least, not very well). It is therefore highly recommended that you choose one grid size for all the files that will be assembled into a composite. Usually it is simpler to import different sized files into a standard big grid and move the data around later.



If the type is set to Composite, the width and height of the Composite (in Grids) must also be specified.

The Dummy Value will determine which datapoints from the imported files will be marked as non-values (e.g. Areas within a grid that could not be surveyed because of ground obstacles, etc.). All data points with this value will be discarded during import as they will not form part of any Tracks that are created.

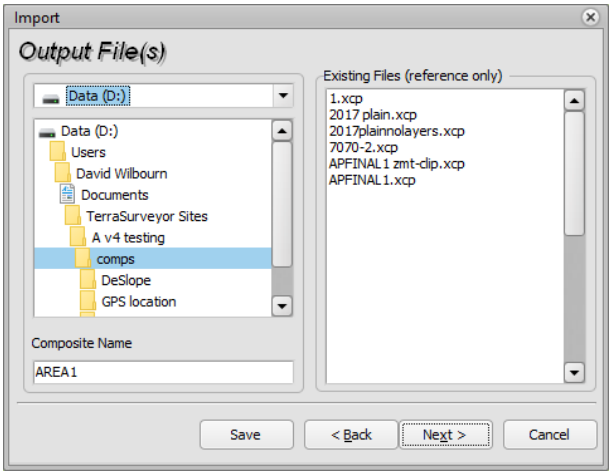
For Irregular X&Y and Gridded GPS files only the X Interval value can be set. The Composite size is set by the source file and the Y interval is always set to the same as the X.

Change the Origin corner if necessary. TerraSurveyor assumes the imported data starts (or has a 0,0 position) at the bottom-left corner. If this is not so for the imported data, the resulting images will be flipped in the X and/or Y axis. The default is Bottom-Left but any corner can be selected. Changing the corner will flip the data of each grid or the complete composite top-to-bottom and/or left-to-right prior to it being saved.

Or change the Rotation if necessary (only the origin or the rotation can be changed, not both). If the source data is not oriented the same way as is expected by TerraSurveyor, the grids can be modified automatically during import. Set the corner used by the source data as it's origin (0,0 position) to rotate the grid in 90 degree increments.

6.3.8 OUTPUT FILES

If the import Type is set to Grids, the output path can be selected in this folder list. It will default to the pre-defined \Grids folder of the site (if Strict Site Structure is enabled), however additional subfolders may be created within this folder (click New Folder). This can be useful for separating Grids, for example by instrument or area within a site.



Note that Grids of different size (or Length/Width) should not be mixed in a subfolder. The Grid Assembly window can show Grids with different sizes, however this is not recommended (the thumbnail height and width will be set to the largest dimension of all the grids in the folder).

Specify a prefix for each imported grid file name if required.

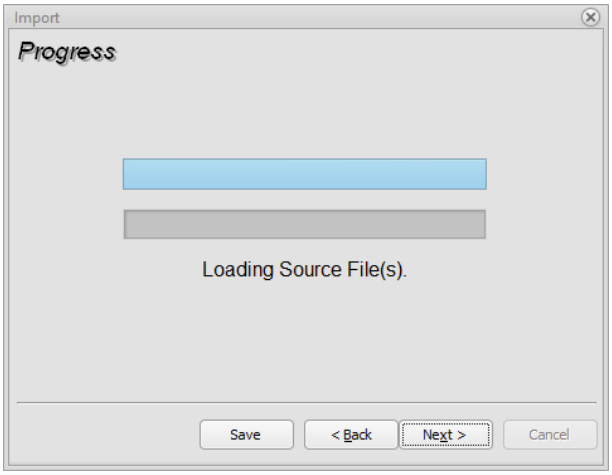
If Strict Site Structure is enabled, imported Composites will always be saved direct to the \Comps folder of the current site and so in this case the list is disabled. Otherwise this list will default to the currently selected folder but can be changed to any path. As only single composites can be imported, the Name of the new composite can be specified in the box below the Folder list. The default is the name of the source file. Clicking any existing composite name in the Existing Files list will place the name of that composite in the Composite Name box.

6.3.9 PROGRESS

Click Next to begin the actual import process. Some indication of import progress will be shown though the exact format and data shown will depend on the type and number of files to be imported.

On successful completion, a message will be displayed showing the number of imported files.

Click Finish to close the Import Wizard.

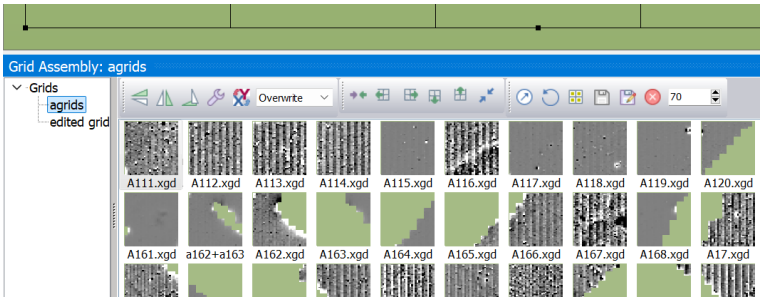


7 GRID ASSEMBLY

Data that has been downloaded or imported as grids needs to be assembled into composites before further processing can be carried out. This is done by creating an framework into which the grids are dragged.

Start by clicking on the New Blank Survey button on the main toolbar. The Grid Assembly panel will then open at the bottom of the screen and a new, empty framework will be created.

To modify an existing survey, click on the Modify Survey button on the main toolbar. The Grid Assembly panel will open and an Open File dialog will let you choose a composite to open.



The Grid Assembly panel has a list of folders on the left and it's own toolbar at the top. The main area will show thumbnails of all the grid files found in the selected folder. The panel can be resized and moved as required and the width of the folder list changed with the splitter bar.

The Folders list shows the sub-folders of the currently selected parent folder. If Strict Site Structure is used the parent folder will be the current Site, otherwise it will be the last selected folder. When Strict Site Structure is not used, the parent folder can be changed via the Browse for Folder box D:\ProgramData above the list, the Up arrow to the left of the Browse for Folder box can be used to quickly move up a level.

The Toolbar has three sections; the Framework modifiers, Transform Grid and Additional functions

Framework Modifiers allow the size of the framework to be changed. The left button switches the mode of the other buttons between expand and contract. The next four buttons will expand or contract the framework in the indicated direction by one row or column. The right button will shrink the framework to fit the currently assembled grids.

7.1 ASSEMBLE GRIDS

To assemble the composite, click and drag each thumbnail to it's the correct position on the framework. Any thumbnail can be repositioned by dragging it to another position or back to the thumbnail list. Dropping a thumbnail on top of another one on the framework will return the covered one to the list.

7.2 TRANSFORM GRID

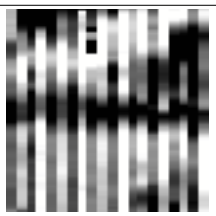
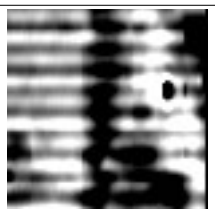
Sometimes a grid file needs to be modified before it can be assembled into a composite. This is usually because a mistake was made when collecting the data, either in the way the operator covered the grid or because of an incorrect setting in the instrument. The Transform Grid buttons allow you to fix most of these sorts of problems before assembling the composite.

Note that all Transforms and Fixes will save the modified grid file as .ts4 files.

Normally transformed files will overwrite their original version however you can also choose to keep the original and create a suffixed version of the file (e.g. a file called G11.ts4 will be joined by G11a.ts4) or the transformed file(s) can be saved to a different folder keeping the original filename.

The first three buttons Flip (top-to-bottom), Mirror (left-to-right) or Rotate (in either 90 deg or 180 deg increments) the selected grid. The Rotate function will perform a 'clean' rotation of either 90 deg (when the grid size and intervals are the same in both X & Y axes) or 180 deg if they are not. Both these rotations involve just a simple transposition of the values and so do not affect the actual data.

If the grid size is the same in both axes but the intervals are different then a rotation can be done however this will result in the data being interpolated. In this case you will be given the option of a 90 deg rotation with intervals ranging from the smallest axis to the largest axis. A mid point interval is probably the best. This method can be used to combine grids that have been surveyed in different directions however it will require that both sets of grids be interpolated to the same interval. The grids must also be square.

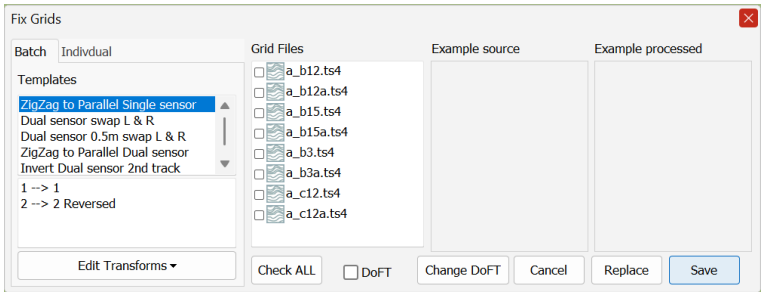
	
Example of a grid before 90deg rotation. The intervals are 1m across and 0.125 along the tracks.	*The same grid after rotation. Note that interpolation will result in considerable smoothing and blurring of detail.*

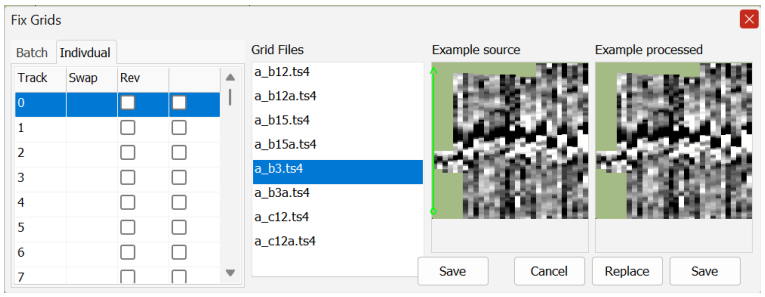
7.3 Fix Grids

For more complex transformations click on the Fix Grids button: . This will open a dialog allowing complex transformations to grids to be carried out. Two modes are available: Batch mode which will apply the same transform to all tracks in all selected grids, and Individual mode where the user can manually select tracks from a single grid to modify (either move or reverse them).

For the Batch mode, a short list of example transforms is included. More can be added by the user as required. The basis of the transform is that a repeating pattern or set of track swaps are defined. Each track can also be reversed or inverted. Reverse changes the position of every point in the track, the top is moved to the bottom and bottom to top, Invert leaves the position untouched but inverts the read order so the first point in the track becomes the last, last becomes first. Setting the Track number to zero in the transform will leave the track in the same position.

For example, a simple pattern of 1 > 2, 2 > 1 would swap each pair of lines, moving line 1 to line 2, line 2 to line 1, line 3 to line 4, line 4 to line 3, etc. The transform can be applied to any or all grids in the current folder.





All Grid functions have the option of Overwriting the original grid file, Saving the grid with a suffix (i.e. 'Grid1.ts4' will saved as 'Grid1a.ts4' next to the original) or Save to a new subfolder (default subfolder name is 'Fixed' but this can be changed in preferences).

7.4 Merge Grids

A simple merge can be performed by dragging a grid thumbnail and dropping it onto another grid thumbnail on the top panel. If the 2 grids are compatible (i.e. have the same size and intervals), a new grid will be

created that contains all the datapoints from both the dragged and dropped-on grids. This new grid will be called “name1+name2” where name1 and name2 are the names for the 2 grids.

This technique is specifically designed for those situations where an obstacle such as a wall transects a grid. Rather than trying to climb over the wall on every traverse, it is simpler to survey the grid as two grids, one for one side of the obstacle on one for the other and then merge then later.

7.5 Save Grid

The combined grids can then be saved as a composite file, which stores not only the assembled data but also details of each grid used to create the composite.

A composite can be opened at any time to add new grids or otherwise modify the layout by clicking the Modify Composite button  on the main menu. When the composite is re-opened all Processes will be re-applied to the new data and layout. Selections in Processes are (where possible) corrected to allow for changes in position.

Note: GPS based, Imported and Blank Composites cannot be opened in the Grid Assembly dialog.

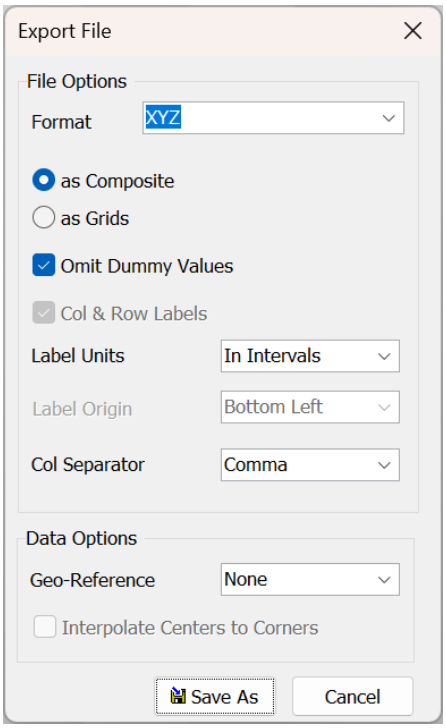
8 OUTPUT

TS64Lt & TS64Fld: Do not support this function.

The current view can be exported to a different file type, saved as an image or printed direct to paper.

8.1 EXPORT

Export the Current Layer in a variety of formats suitable for transferring data to other programs.



The Export dialog is opened via the Main menu Output button or the main File|Export menu. A number of options are provided by the dialog box. The primary one being the format. Seven major formats are supported:

- XYZ (comma, space or tab delimited)
- Z
- Spreadsheet (comma, space or tab delimited)
- Surfer (ASCII or Binary, ver 6 or 7)
- TerraSurveyor XA4 file
- ESRI ASCII Grid file (Actually exports a composite)
- TerraSurveyor Metadata XLS (the metadata for the survey in excel spreadsheet form)
- GPS (an XYZ file with user selected N & E format and Track markers)
- TerraSurveyor 3 XGD (grid) or XCP (composite) files
- TerraSurveyor64 TS4 grid or composite files

The extension to be used for the export file(s) can be selected from a list (if applicable).

Depending on the format selected, different options will be available. These include omitting dummy values and adding a border to spreadsheet data marking off columns and rows.

Geo-Reference is primarily applicable to XYZ data and can be:

- None – Data is positioned and labelled relative to 0,0
- Source – Data is the original source data but the position is modified based on the survey origin and rotation (Direction of 1st traverse)
- North – Data is interpolated from the source to produce tracks that run East-West. The position is also based on the survey origin and rotation. (only applicable to gridded data)

Label Origin can be set to any of the 4 corners (when this is not fixed by the export format). Row and column numbers will always increase from the origin corner to the opposite corner. The default origin or start corner for TerraSurveyor data is top left. The origin will either start at 0,0 or 1,1 depending on the settings of the source composite. Data is always exported by Row then Column (row 1: col 1, col 2, … col N, row 2: col 1, col 2, … col N, etc.).

Note: that this option will have a modified behaviour if the data is georeferenced. In this case the Y (Northing) values will decrease from the maximum at the top left.

Label Units will be 'In Meters' or 'In Intervals' for most formats. For the GPS format (which is only available when the source data is GPS) the available options will be 'In Meters' or 4 different Degree, Minute, Second variants. In the case of simple gridded data, the 'In Meters' option will output the data with an X & Y position defining the measurement point, not the corner of the 'box' the measurement was taken in.

When Strict Site Structure is enabled, the default is to export the data to a specially created sub-folder of the site called \Export within the current site. This would therefore appear next to the standard folders of \Grids, \Comps and \Graphics. Alternatively a specific path to export the data to can be set.

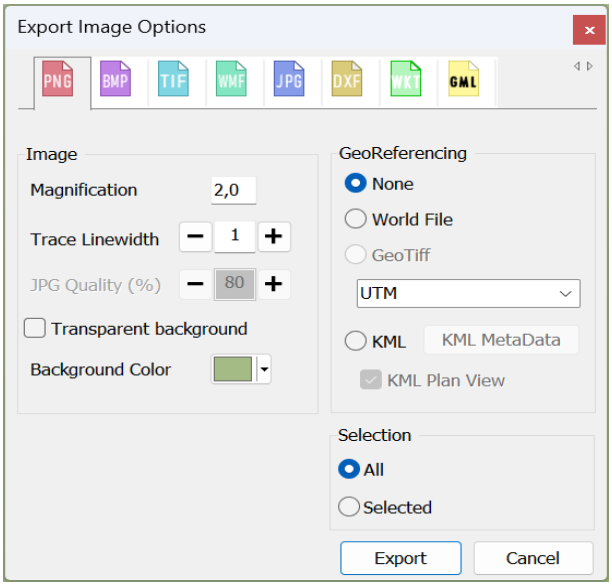
A choice can be made as to whether the data is exported as a single large composite or as individual grid files matching the source data. The exported file will be given the same name as the source composite (in the case of a single file) or each exported file will be given the name of the source grid file (for individual grids).

Exporting as TerraSurveyor3 or 4 grids may sound odd but can be useful. Surveys created in a blank composite cannot be added to, however, by exporting the composite as grids, the grids can be re-assembled with other 'real' grids. Grids can also be modified and then exported, the new grid contains the result of any processes as the new base layer. This may be useful in certain circumstances but must be used with caution as the accountability trail is lost.

XML Composite is similar to the Export TS Grids as unlike the normal XML composites, this option saves the currently selected layer, not the base layer. This means that the current layer becomes the Base layer when re-opened. It also replaces the processes with a 'History' section that details the processes in plain text form. A single, Base Layer process is included to allow TerraSurveyor64 to read the file.

The TerraSurveyor 3 export options save the Base layer as either separate XGD grid files or a single XCP file, TerraSurveyor64 generates the normal TS4 files.

8.2 Export Image



The Export Image dialog is opened via the Main menu Output button or the main File|Save Image menu. The file type to export can be selected from the tabs across the top of the dialog. Depending on the currently selected file format and in some cases, the current display settings, various options will be shown. These allow you to choose:

- Transparent background (when the file format supports it)
- Magnification (determines the size of the image and the relative thickness of the lines)
- Trace line width (when the trace view is visible)
- World File generation (only saves the Shade view)
- GeoTiff generation (only saves the Shade view)
- KML File generation
- Save as Tracks, Polygons or Polylines for WMF, DXF, GML & WKT formats.
- Selection to save.

To maintain the best possible image, BMP, PNG and TIF image formats are recommended. The BMP is an exact copy of the displayed layer but at a high resolution more suitable for printing. This does however produce extremely large files. The PNG (Portable Network Graphics) format uses a lossless compression scheme to maintain the same level of data accuracy but with much smaller files. Compressed TIFFs are also supported, as these are often suitable for import into CAD programs. JPG is also provided but as this uses a lossy compression method, a high quality value (low compression) should be used. The default is 100% (no compression).

The DXF, GML, WKT and WMF vector formats are also available though only the Tracks and Contours can be saved in these formats. DXF, GML & WKT can be georeferenced in the same way as other file types (if georeferencing data is available in the file). DXF can encode the value in each point as the line Z value and all formats allow the lines to be simplified to reduce the file size. For WMF only the Transparent

background option is available. Note that distance ticks, WLD files, etc. are not compatible with these formats and so will not be saved however any scenery contained entirely within the limits of the survey will be saved overlaid on the survey.

Once the settings applicable to the file type and displayed image have been selected, the Export button will open a normal Save As dialog. The path and filename for the survey image can be set here.

When saving or printing Shade and Trace views, no matter what portion of the layer is shown on screen, the complete survey area is saved or printed.

8.2.1 Transparent Background

When set, the area outside the survey will be set to transparent. This can be especially useful when overlaying the survey results on other maps. This option works for Shade and Trace images saved as PNG or plain TIFF files *only*. All other formats such as BMP, JPG and GeoTIFF formats do not support transparency and so will show the background in the colour used in the main view or the colour selected in the Options.

Note: Transparency in TIFF is very poorly supported by imaging applications. Although the files are valid they will in most cases generate an error of some kind. They will also be somewhat larger that TIFF without transparency as compression and transparency are incompatible in this format.

8.2.2 Magnification

To obtain clear images and text, the image saved to a file or printed often needs to be much bigger than the image seen on the screen as the screen resolution is usually lower than that of a printer. The magnification level for saved graphics can therefore be set independently of the screen magnification. However, large surveys at high magnifications can exceed the memory capacities of a PC. The actual magnification will therefore be reduced to the maximum possible for the available memory.

Increasing the magnification may also increase the number of Distance Ticks shown along the edge as the size of each Tick's text remains the same.

8.2.3 World File

The World file is a standard format used to convey GeoReferencing data about the image. Checking this box will create a small text file with the same name and path as the main graphic file but with a modified extension (*.pgw, *.tfw, *.jgw, etc). This file contains basic positioning data about the image (it does not define the Projected Coordinate System so does not give the UTM zone, etc.). It is readable by many GIS programs and aids in correctly positioning and scaling the image.

Note: This option will only be available when suitable georeferencing data is available in the file.
The file will use UTM coordinates by default. However, if a local mapping system is selected in Preferences (OSGB36 or OSTN15 for the UK, ITM for Ireland or RD for the Netherlands) this will be used. Lat/Long or Degree based referencing is not available.

This option will not save any scenery or distance ticks as the extra data around the survey image would invalidate the position information.

8.2.4 GeoTiff

A GeoTiff is a standard tiff file with full GeoReferencing data embedded with the image. This file is readable by many GIS programs and enables them to correctly position and scale the image.

Note: This option will only be available when suitable georeferencing data is available in the file.
The file will use UTM coordinates by default. However, if a local mapping system is selected in Preferences (OSGB36 or OSTN15 for the UK, ITM for Ireland or RD for the Netherlands) this will be used. Lat/Long or Degree based referencing is not available.

This option will not save any scenery or distance ticks as the extra data around the survey image would invalidate the position information.

Although the Tiff format does define support for Transparency very few applications implement it. The Tiff to GeoTiff conversion program is one of those that does not so background transparency is not available with GeoTiff or plain Tiff.

8.2.5 KML File

The KML file is used by the Google Earth application to georeference an image. Checking this box will create a small text file with the same name and path as the main graphic file with a 'kml' extension.

Note: This option will not save any scenery or distance ticks as the extra data around the survey image would invalidate the position information.

8.2.6 GML & WKT Files

Geographic Markup Language and *Well Known Text* are both ASCII text formats for georeferenced vector data. GML includes the EPSG or OGC Projected Coordinate System code is the data so are completely self-contained. WKT files contain the coordinates but not the Projected Coordinate System they refer to so this mush be separately recorded. Because it has to be vector data, only Contours and Tracks can be saved in these formats. As with the raster formats, the contours or tracks will be saved in the same form as seen on the current image. Some settings such as line color and thickness will be lost as these are not supported by the format, also the 'Z' value of tracks will probably not match the displayed image as the scale will be different (and in-fact meaningless) once viewed in a GIS.

Note: Support for both these formats have been developed based on a few sample files and testing in QGIS. For this reason there may be incompatibilities with other GIS or mis-use of data structures. Please inform us of any problems so these can be addressed.

8.2.7 Selection

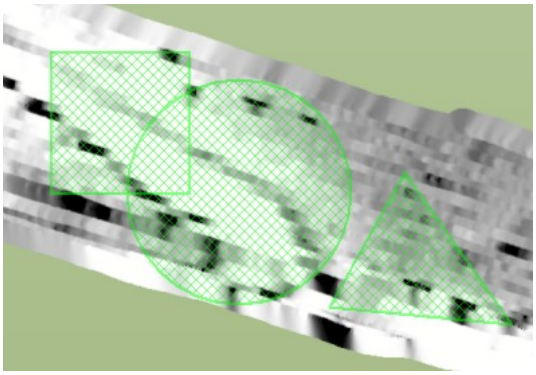
Specify what is to be saved as part of the image.

8.3 Print

The Print dialog is opened via the main toolbar Print button or the main File|Print menu. This will print the current survey exactly as displayed to a selected printer.

9 SELECTION

TS64Lt & TS64Fld: Do not support this function.



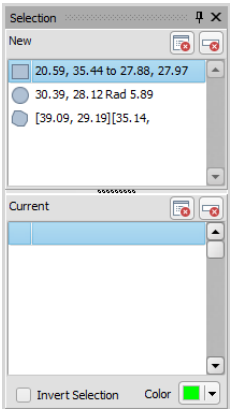
Selection allows processes to be applied only to selected areas of a survey. In most cases this is achieved by applying the process to the whole survey and then cancelling any changes made outside the areas masked by the selection. The selection mask can also be inverted so that the process is applied to everything that is not selected. Selections are applied to all processes added after the selection has been made, until the selection is removed.

Some processes, due to the manner in which they operate, such as Edge matching, either have their own variation on the selection methods or do not allow any selection.

Selections can be made by clicking one of the selection shape buttons in the main toolbar Selections section  . This allows freeform selections (Rectangle, Circle or Polygon), Grids (for grid based surveys) or Tracks. The Polyline button is only used with the DeSlope process. Click & Drag to select Rectangles and Circles. A single click will select a whole Grid, shift-click after selecting a single grid will add all grids within the rectangle defined by the two clicks. Polygons can be drawn with a single click at each corner and a double-click to close the shape. Multiple overlapping selections of different shapes can be combined into one large mask.

The selection toolbar also has buttons to activate the Cross-section dialog and ruler.

Click the Mouse pointer button to turn of the current selection mode, Cross-section or Ruler.



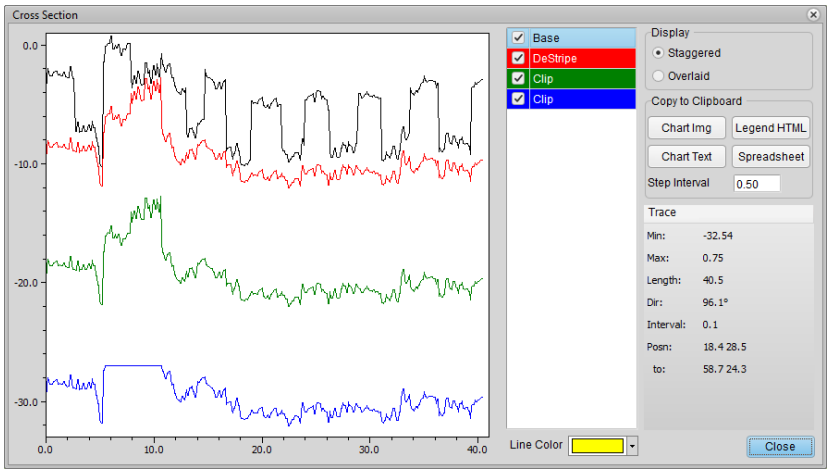
As selections are made, they are added to the top list in the Selections panel. Each selection area is listed with it's size and position parameters. Each area can be removed from the list by selecting it in the list and clicking the Delete button or by clicking on the selection on the survey. The list can cleared completely by clicking the Delete All button.

The bottom list shows the selections that are currently active.

The selection mode can be inverted by checking the box at the bottom of the panel. When checked, the selection mask will apply processes only to datapoints that are outside the mask. The colour of the mask selection lines and checkering can be set to improve visibility. This will have no effect on the selection methods.

9.1.1 CROSS SECTION

This tool displays a cross section of the survey between two points on the survey or for one whole track. Each process in the survey can be drawn either overlaid or staggered. The chart can be exported as text or an image to the clipboard.



For lines between two points, click the Cross Section tool button in the main toolbar  , click and drag across the survey in any direction. A dotted line will be drawn showing the path of the cross section. Once the mouse button is released, the

dialog box will be displayed. The final path will also be redrawn as an arrow labelled with distance and heading angle.

For complete tracks, *do not* turn on the main toolbar Cross section button, instead turn on Track Highlighting in the Track parameter list and right-click on the track. Choose Track Cross-section from the pop-up menu.

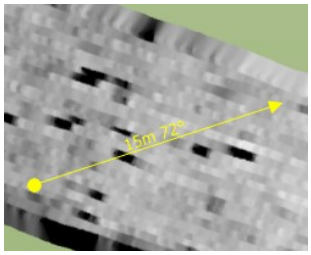
Once the dialog is displayed, new cross sections can be drawn on the survey or individual tracks selected. They will be replace the one displayed.

Note: Traces are interpolated from the closest datapoints to the path of the cross section. Inaccuracies may occur where the path is very close to – or far away from, nearest points.

Each trace represents a process layer in the survey. They are colour-coded with the base layer always being black. The traces can be overlaid or staggered for better visibility, individual traces can also be turned off. Some statistics (Min / Max value etc.) are also shown on the dialog.

9.1.2 Ruler

A simple ruler can be used to measure distance and heading between two points on the survey. Click the Ruler button on the main toolbar . Click at the start point and release the mouse at the end point.



10 Macros

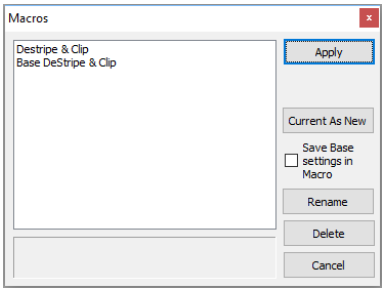
TS64Lt & TS64Fld: Do not support this function.

The Macro button allows you to save the set of processes applied to the currently selected composite. This set can then be applied to a different composite with the click of a button. This can be useful in a number of situations, for example:

When a large number of composites are created for the same site, it may be desirable to apply exactly the same processing to all of them.

For quick and simple processing in the field by inexperienced operators.

Note: Macros must be used with care and an understanding of their limitations. To obtain the best results from TerraSurveyor64, each survey should be processed individually. Full regard must be given to the features and anomalies present in the survey, the geology of the site and characteristics of the instrument.



To create a Macro, open or create a survey with the desired processes in the correct order. Open the Macro dialog by clicking the main menu Process | Macros | Manage item or the Macro button on the main toolbar. Click the Current as New button. Give the macro a simple descriptive name. Press OK and the macro will be created from the processes in the current survey. A secondary description will be created for the macro as a list of each process name in the macro. This will be shown below the list as a macro is selected.

To apply a macro, click the main menu Process | Macros item or the Macro toolbar button  . Select the required macro from the list. The processes recorded in the macro will be applied to the currently selected survey in the same order and with the same parameter values.

Notes regarding Macros:

All parameters in each process - except those indicating selections - will be stored in the macro. Any selection data will be ignored so that when the macro is applied to a different survey, the process will affect the entire survey. A warning will be given for each process that has a selection as the macro is created.

Processes that can only be applied to selections (such as Range Match and Move) cannot be included in macros and will be ignored.

Processes that apply absolute values as their parameters should be used carefully. For example the Clipping process can be applied as actual values. This may be suitable for one dataset but if applied to a dataset with a range outside these values will result in no useable data. Instead the +/- SD values should be set as the actual clipping values are then calculated from the current data.

The processes stored in the macro are simply added on top of any existing processes. This allows you to stack macros and/or individual processes. Base settings (for Turn Detection and Point Reduction) can be saved as part of a macro by checking the checkbox. In this case the base settings overwrite any existing settings. The default for this checkbox is off.

Once the macro has been applied, the processes can be edited, reordered and deleted just like any other processes. The composite does not store information regarding the macros, just the processes the macro created.

11 PROCESSES

TS64FLD Only supports the Clip & DeStripe processes, all others are disabled.

All processes are mathematical modifications applied to the top-most layer of the composite. These modifications filter, enhance or move the data in some way. They are all designed to aid you in improving the appearance of any features present in the data, however applying lots of processes will not result in better data. The best results will always be obtained from good quality source data with careful and minimal application of the right processes. Experiment with the type, sequence and parameters of processes applied. In general your aim should always be to use the least amount of processes on a dataset.

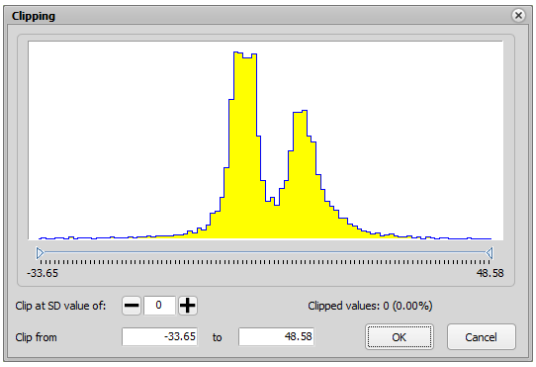
All processes (unless otherwise stated in the description) can be applied to any area, block of grids, set of tracks or the complete composite. See section 9 for full details on selecting areas, tracks and grids. If no specific selection has been made, the process will be applied to the complete composite.

11.1 GPS VS. GRIDDED DATA

TerraSurveyor64 makes no distinction between GPS and Gridded data when applying processes unless that is technically not feasible. For example, the Hi/Lo pass filter makes use of a rectangular window around each datapoint. This is not a problem for gridded data however GPS data is collected in irregular tracks that have no direct spacial relationship with their neighbours. Though the window for GPS data can have 'length', the points behind and in front of any point have an implied spacial relationship, there is no way to exactly relate the point to points in other tracks to give the window 'width'. The Hi/Lo pass filter will therefore only allow a window width of 1 for GPS derived data.

Further details of processing specific to GPS data can be found in section 12.

11.2 CLIP



Replace all values in the current layer outside a specified minimum and maximum with those values. Min and Max can be specified in absolute values or +/- SDs.

The dialog box for this process displays a histogram of the current layer's data. Use the Plus/Minus buttons next to the Clip at SD Value box to set the Min and Max cut-offs to 1,2 or 3 SDs above and below the Mean. Alternatively you can use the double sliders below the histogram to set the Min and Max to fixed values or set the values directly in the edit boxes.

11.2.1 USAGE

Use this process to remove extreme datapoint values. Extreme values will force the display to show all values in the center of the histogram in the same colour thus hiding fine details. Excluding these values will allow the details to show through.

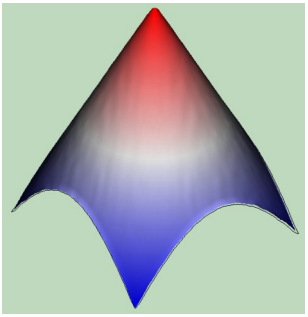
Note: Using the Band Weight Equalisation function will have a very similar effect but without actually changing the data. However, that will only be visible in the Shade view.

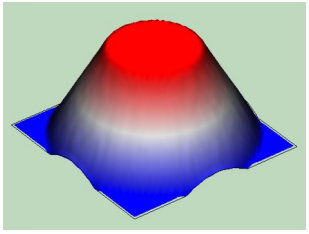
Note: The Site Structure Shade view also contains Clipping values. Those values ONLY affect the display, NOT the underlying data.

Ideally the histogram should form a 'bell curve' with no empty areas at the edges.

It is preferable to use the SD values rather that setting the limits to specific values. This is because the SD values are calculated every time the data is processed from the mean of the current data. This means that the values will be correct, even if you change the sequence of the processes or change the overall data distribution by adding more grids to the composite.

The effect of clipping on artificial data





11.3 DESLOPE

Note: This process is not a magic fix, especially when the correction is extreme. However, if used with care and appreciation for the limitations, it can be effective in salvaging portions of significantly distorted data.

Primarily intended to reduce the large disturbances seen in Magnetometer data caused by buried pipes or large metal objects etc. crossing or near a survey area. The process can be applied to single or multi-segment straight lines. The line segment(s) can be at any angle and can start and stop at any point in the survey.

A cubic curve is fitted to each row of data the selected line crosses, this curve is then subtracted from the actual data. The amount of correction applied is tapered off at the edges to ensure there are no – or at least minimal – sharp transitions from the corrected to unaffected data.

DeSlope is a selection based process. A straight line (or contiguous line segments) needs to be drawn on the survey over the pipeline or along the edge displaying the waterfall effect. The line can be at any angle on both GPS and Gridded data.

When opened, the dialog will first calculate and interpolate a rectangle defined by the start & end points of the selection line (or first segment of a line). It's width is defined by a radius either side of the line. The cubic spline for an interpolated row of data perpendicular to the selected line is then displayed in the graph, along with the source and smoothed (source minus cubic spline) data. Any cross row can be shown by moving the slider under the graph. A cross line will be displayed on the survey image to show where that cross row is located.

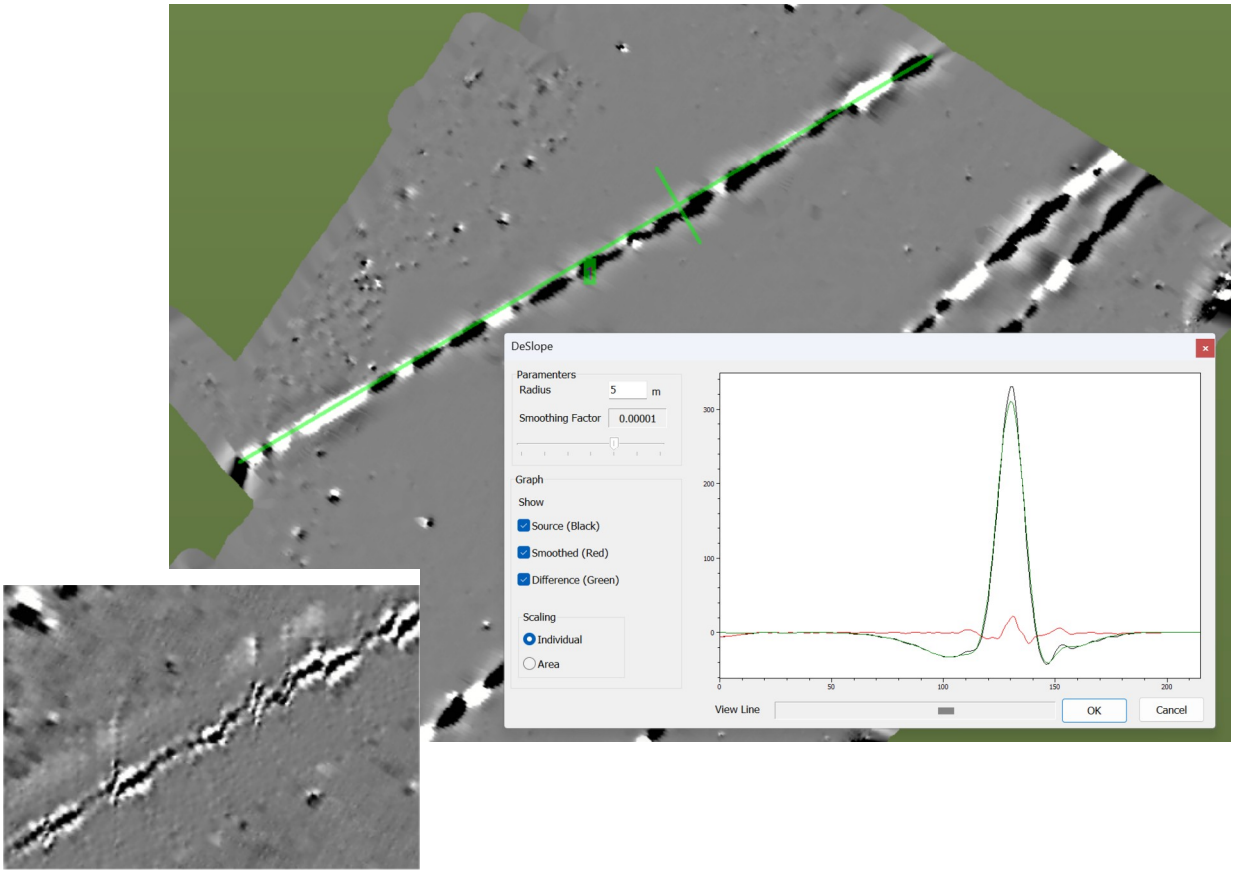
The graph can be vertically scaled to the current cross line being displayed or to the entire selection area. The black line shows the source data, the red line is the smoothed data and the green line is the correction that will be applied.

The Radius (width) of the DeSlope effect can be set, as can the Smoothing ('tightness') of the cubic spline to the source data. The smaller the smoothing value, the tighter the spline is and the flatter the resulting smoothed data will be.

Note: The cubic spline is applied to all the data in each cross line and so will smooth any features within the rectangle. Setting the Smoothing level will therefore always be a balancing act between removing as much as possible of the main disturbance without removing the underlying features.

Though the process can be applied to multi-segment lines, the process does not take into account any bends in the line. That is, each segment will be processed and corrected independently from the other segments, overlaps on the inside of a bend and gaps on the outside are not considered.

For best results this process should be applied after DeStriping but before any Clipping.



A section of the line after DeSloping

11.4 Hi/Lo Pass (incorporating DeSpike)

Applies either a uniformly or Gaussian weighted window to remove high or low frequency components in a survey. This filter also incorporates the DeSpike mode that in previous versions of TerraSurveyor was a separate filter.

Selecting High Pass calculates the mean of all the values within the specified window and subtracts this mean from the center value.

Low Pass calculates the mean of all the values within the specified window and replaces the center value with the mean.

DeSpike is very similar to a High Pass filter but with an added Threshold limit. Values that exceed this threshold in SDs (calculated from the Mean or Median of the window) will be replaced by the Mean/Median or the threshold value.

Uniform means that all values within the window are given equal weight, using either the mean or median value as the center.

Gaussian means that the weight given to each value is higher the closer it is to the center point.

The size of the window used to calculate the mean can be set using the Length and Width spin buttons. These can be set to any (odd) number between 1 and 21 (i.e. a diameter of 3 = the center point plus one datapoint either side). A value of 1 means that the filter is not applied in that axis. GPS derived data can only apply the filter along a track therefore the Width spin button is disabled for this type of data.

To aid in tuning the filter, a sample of the results are shown as either a shade survey or as a chart of one of the tracks. You can choose to show either the source, result or difference. A slider below the chart allows any track in the survey to be selected to serve as the example, the selected track is highlighted on the main view. The Shade views can be clipped (none, +/1 SD or +/- 3SD) to aid in assessing the results and difference.

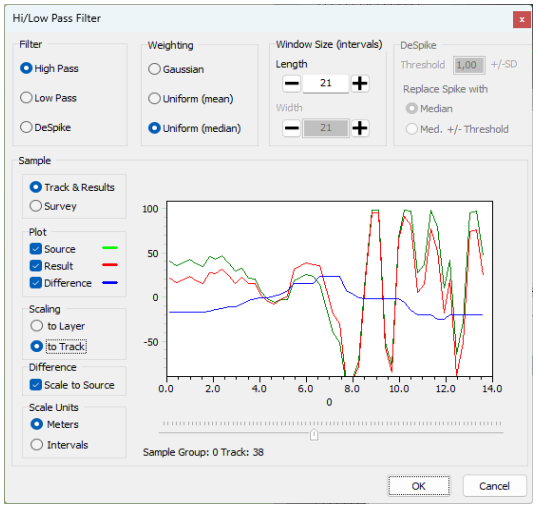


Figure 1: Hi/Lo Pass filter viewing a single GPS track

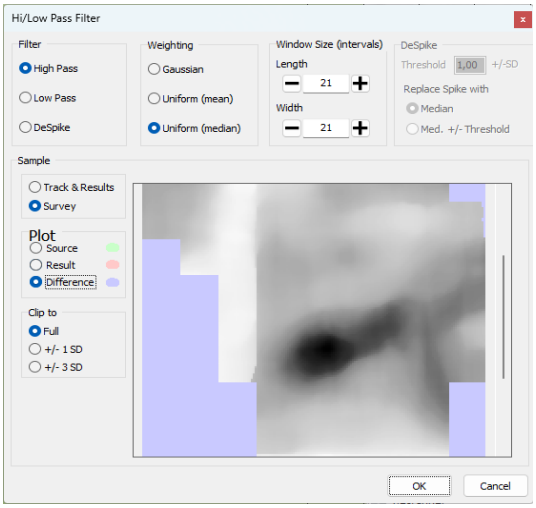
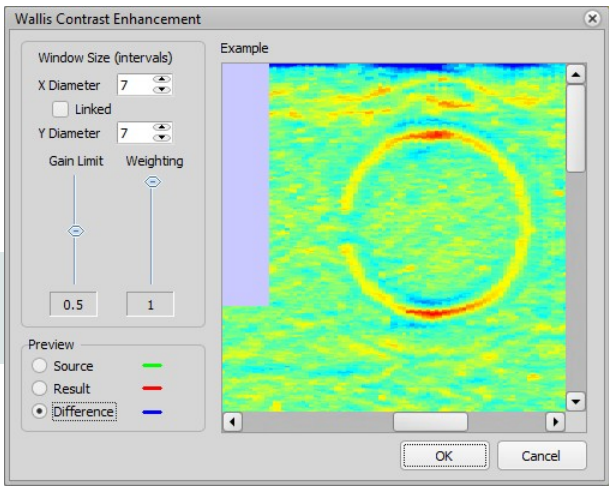


Figure 2: Hi/Lo Pass filter viewing the survey

11.5 WALLIS



A Wallis filter applies Locally Adaptive Contrast Enhancement to the layer or current selection. A preview of the effect of this process is shown as the parameters are changed to enable it to be fine-tuned.

Three values - Window Size, Weighting Factor and Gain - can be set in the filter's dialog. The window X & Y sizes can be linked so that they change in sync.

Note: This filter can only be applied to rasterized data, i.e. gridded or GPS after applying the Rasterize process.

11.5.1 USAGE:

This filter is particularly suited to surveys that display a pronounced slope across the area. This slope results in large portions of the survey being too 'dark' and other areas too 'light'. This slope can make it very difficult to further process the data without removing significant features. The Wallis Filter adjusts each datapoint so that the local mean and standard deviation (defined by the window) match the overall image mean and standard deviation. This enhancement produces good local contrast throughout the image, while reducing the overall contrast between bright and dark areas.

11.5.2 IMPLEMENTATION:

The implementation of the Wallis filter in TerraSurveyor64 is derived from *"Beyer & Baltsavias" page 104*[1]

```
R0 = (IMm * Weight) + (WINm * (1 - Weight));
R1 = (Gain * IMsd) / ((Gain * WINsd) + ((1-Gain) * IMsd));
NewV = OldV - (OldV * R1) + R0;
```

where:

Imm: mean of the whole survey

WINm: mean of the window being sampled

Imsd: standard deviation of the whole survey

WINsd: standard deviation of the window being sampled

Gain & Weight: the two parameters (both values between 0 & 1)

OldV: Old value, the value at the center point of the window being sampled

NewV:New value: the old value minus the correction defined by the equation

1 *http://www.igp.ethz.ch/photogrammetry/education/lehrveranstaltungen/RSGISFS2014/Exercises/wallis_theory.pdf*

11.6 1D FFT

> This filter was known as Notch, or Band-stop filter in previous versions of TerraSurveyor. It has again been completely re-written and expanded in version 4.1.7 of TerraSurveyor64.

The 1D FFT is used to remove or reduce a regular frequency background signal. Unlike the 2D FFT filter described elsewhere, the 1D FFT filter treats each track individually with no attention paid to direction. It's focus on one axis allows it to be far more precise in identifying and filtering errors in inherent to the data collection process than the 2D FFT can be.

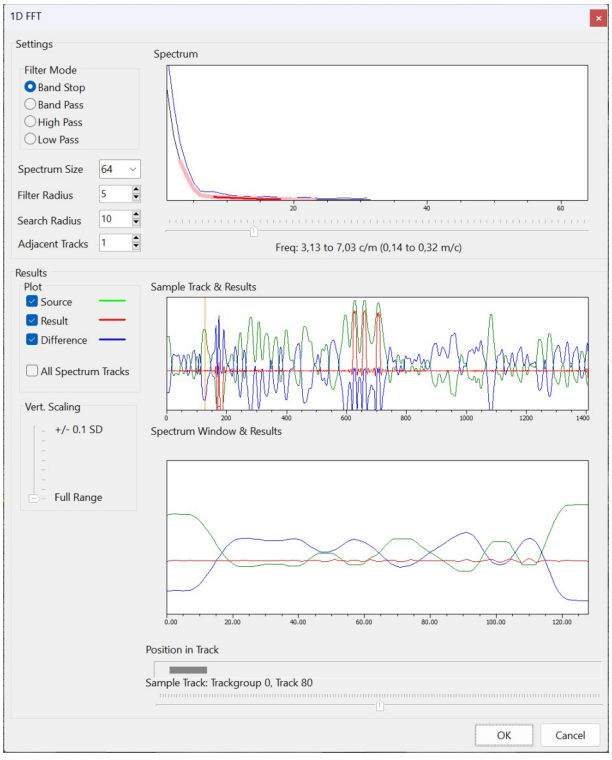
> Note: This filter can only be applied to Bi-polar data. It is therefore not normally suitable for Resistivity data.

The Filter uses Fast Fourier Transforms to calculate the strength of every frequency present in each track. A particular frequency or range of frequencies can then be selected and reduced to zero.

The filter can work in one of 4 modes:

- Band Stop (the most common use, filter out a small range of frequencies)
- Band Pass (the inverse of Band Stop – filter out everything but the selected range)
- High Pass (remove slowly changing trends such as geology)
- Low Pass (remove hast changing trends such as 'noise')

The dialog box shows the Average Spectrum of the complete survey in the top chart, an overview of a selected (example) track and a scrollable, detailed view of that selected track at the bottom. The bottom two charts show three graphs: the source data, the result of applying the 1D FFT with the current settings and the difference between the two. Any of the traces can be turned off and the vertical scaling of the charts changed.



The Band Stop and Band Pass modes use 4 parameters to improve the control over the effect of the FFT. These are the Spectrum Size, Filter Radius, Search Radius and Adjacent Tracks. The High and Low pass modes do not use the Filter and Search radius so these are disabled for these modes.

Spectrum Size: This is applicable to all the modes. It sets the size of the 'window' in datapoints used to determine the frequency spectrum of the wave. For very short tracks (less than 128 points) this will be set automatically. For longer tracks a value of 256 or 512 will usually give good results though other values can be selected. The windows are overlapped by 50% of their width and have a curved response so that the sum of any point in the overlapping areas is one.

Filter Radius: Determines the width of the band of frequencies to be removed. Generally this should be set to as small a value as possible dependant on the regularity of the repeating feature that is to be removed.

Search Radius: This value is centered on the base filtering point set by the main slider under the spectrum chart. The spectrum of each section of the track being filtered (defined by the Spectrum Size) will be individually calculated. The mid-point of the Filter Radius will then be set to the maximum value of the spectrum for that section between the limits of the Search Radius. The filtering applied to every section of every track will therefore be maximised the peak value seen in the range set by the main Frequency slider and the Search Radius.

The Search Radius is shown on the main Spectrum chart as a thick pink line, the Filter radius (for the current example track) is shown as a thinner red line.

Adjacent Tracks: When set to any value greater than 1, the values to be subtracted from each track are determined based on the spectrum of that number of tracks closest to each track. Tracks are selected based on them having the exact same number of datapoints and their start and end points being within a small distance. By basing the filtering of each track on the average of it and it's immediate neighbors, the effect of variations unique to each track (presumably from 'true' features) can be reduced and the mutual variations shared by all tracks (due to the cart's movement) can be maximised. This setting should only be used for cart based, multi-sensor systems where all the datapoints of multiple tracks will be affected equally by the motion of the cart.

The High & Low pass modes show their cut-off frequency as a vertical red line with tapering off red lines showing the direction of the filtering.

Because the signals are a product of the movement of the instrument, the frequency spectrum is shown in cycles per meter (c/m). The frequency is shown below the detail chart. The numbers on the main chart scale refer to the Spectra as defined in the FFT.

11.6.1 USAGE:

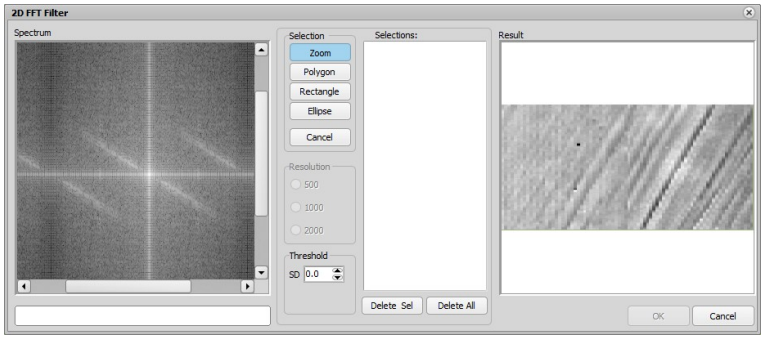
The type of error the 1D FFT filter can remove is generally limited to a regularly repeating cycle along the track. This is typically caused by a resonant bounce in a cart or the operator's walk having a constant 'beat' to it. Generally, any errors will appear as narrow peaks in the central portion of the trace. To remove the peak set the main spectrum slider to the most common frequency to be eliminated. Although the effect may be very apparent on a shade view of the data, any slight variations in frequency will cause the peak to be spread out across relatively large section of the spectrum. It may be necessary to determine the base frequency visually by finding a section of track with a prominent waveform, measuring it's length with the Ruler tool and counting the peaks along that length. Dividing one by the other will give you a good idea of the center frequency to be selected. Even with the Search radius to help automate the tuning of the filter to peak values, you may find that repeated applications of the filter, slightly offset from previous applications, are necessary.

Be aware that this filter is based on finding regular, repeating patterns in the tracks based on pure computational methods. It may well be that patterns that are 'obvious' to the human eye and brain are not truly regular and repeating so will be missed by the process. Equally, the computations may find and remove subtle underlying patterns we cannot initially see.

11.7 2D FFT

The 2 Dimensional Fast Fourier Transform converts the survey into a spectrum diagram that displays both frequency and direction. This diagram can be edited to remove certain areas. Once the diagram is converted back to a survey, the data these areas represent are removed. In this way, regularly repeating features such as plow marks can be filtered out.

Note: Unlike all other filters used in TerraSurveyor64, the 2D FFT filter manipulates an *image* of the survey rather than the underlying data. This is due to the graphical nature of the filter process. Once the filter is applied the result is converted back into a layer of data. This new layer is a good representation of the filtering process however there is no direct link between the before and after layer. This filter therefore lacks the accountability available with of all other processes. However the results achieved by this filter are potentially so useful, it is felt that this is an acceptable loss.



The dialog box for this filter has two main displays. The left-hand one is the frequency spectrum of the survey. This can be edited. The one on the right shows the result of the editing process. This is provided as an aid to the editing functions. It's appearance may be different to the main shade view, this is because the data is converted to a greyscale graduated shade image with no gridlines etc. This image is generated from the edited spectrum diagram and after editing, converted back into a data layer.

The frequency spectrum will normally consist of a dark background with a white cross in the center. In simple terms, the center of the cross contains or represents the 'real' data of the survey; the vertical arms result from the top and bottom edge of the survey and the horizontal arms are the left and right edge.

If there is a significant repeating pattern in the survey, this will normally be seen as a light coloured 'smudge' radiating out from the center of the image. The angle of a smudge to the center is at right-angles to the pattern seen on the survey. So a series of regular plough marks going from top-left to bottom-right will show as a smudge running from the center towards the top-right corner.

The length of the smudge relates to the regularity of the pattern; the more regular the pattern, the shorter and better defined the smudge will be. In severe cases 'echoes' or harmonics of the main pattern may be seen to the sides of the main smudge. This can be seen in the example above. These can be ignored as they should disappear when the main smudge is removed.

An operator induced error, such as that caused by a regular swing in the walking pattern, may show as a light spot on the horizontal arm as this arm represents the direction of travel for the operator. However, in this case it may be better to use the **1D FFT Filter** described elsewhere in this manual. This filter is specially configured to deal with this type of error.

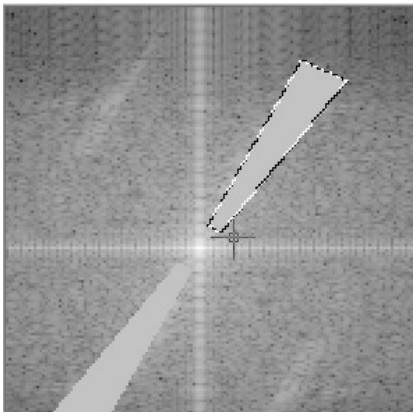
Areas of dummy values have sharp edges which would cause a faint checkerboard pattern in the spectrum. This has been avoided (to a large extent) by converting all dummy values to the survey Median. This edge effect will be very apparent with relatively small composites (single grids, etc.) as the edges of each datapoint become more significant in the overall dataset.

11.7.1 USAGE:

Both the spectrum and the survey images can be zoomed in and out. This is done by clicking (in) and right-clicking (out) on the image. For the spectrum, make sure that the Zoom button has been selected before doing this. The survey image is always in zoom mode.

To remove the patterns the smudge must be edited out. This is done by selecting an area on the spectrum with the mouse. Make sure the area to be selected is clearly visible (use the zoom function to do this). Select one of the 3 selection modes (polygon, rectangle or ellipse).

- **Polygon**: Click at the corners of an area in sequence round the area. Double-click to close the selection. For a very irregular area, you can also click and hold then draw round the area.
- **Rectangle**: Click and hold in one corner of the rectangle, drag to the opposite corner and release the mouse button.
- **Ellipse**: Click and hold at the center of the ellipse, drag outwards to the edge of the area to be selected.



When the mouse button is released, the area and the corresponding area mirrored about the center will be cleared - they will show as a plain grey. The Survey image will also be updated to deflect the result of clearing the selection. Note that this is just an indication of the result, dummy areas in particular may show features that will not appear in the final survey. If you start a selection but which to cancel it, press **Cancel Select**.

Make sure you do not clear the very center of the cross as this generally represents the 'real' data.

Multiple areas can be selected and cleared. All the deleted areas are shown in the list in the middle of the dialog box. You can delete any selection by clicking on it's entry in this list and clicking **Delete Sel**. at the bottom. All selections can be removed with the **Delete All** button.

The **Resolution** of the image used to calculate the 2D FFT can be set to a low (500x500 pixel), medium (1000x1000 pixel) or high (2000x2000 pixel) image. The default is 1000. Because the survey is converted to an image to perform the 2D FFT, some artefacts may be introduced in large or high resolution surveys. This effect can be reduced by using the high resolution image, however processing time will be increased.

A **Threshold** can be set to exclude out-lying values from the 2D FFT process. If the Threshold is set to any value greater than zero, the cut-off values will be set to the current layer median +/- the SD x the threshold value. Excluded datapoints will not be used to calculate the FFT (the cut-off value will be used instead) If the **Keep vals outside Threshold** checkbox is set, the excluded values will be used in the results layer rather than the calculated values.

Once you are satisfied with the result, click **OK** and the filter will be applied to the main composite.

11.8 MATHS

A range of basic mathematical functions can be applied to the current layer or a selection. These are:

- Addition - adds (or subtracts if negative) the specified value to every datapoint in the current layer or selection.
- Multiplication - multiplies (or divides if less than 1) every datapoint in the current layer or selection by the specified value.
- Power - raises every datapoint in the current layer or selection to the power of a specified value. Numbers less than 1 result in the root of the value (power of 0.5 is the same as the square root).
- Absolute - makes every datapoint in the new layer positive (i.e. -1 becomes 1).

Note: Power function: If the Layer contains negative values, all values are increased by the Minimum value prior to application of the Power function. The new values are then decreased by the same amount. This is necessary to prevent errors when raising negative numbers to a power.

11.9 NORMALISE / STANDARDISE

Converts all values within a survey, Grid/Trackgroup or selection to a value within a limited range. For the Normalisation method, this range will be 0 to 1 where 0 equates to the lowest value in the dataset and 1 the highest. Standardisation will center all values around the mean of the dataset and convert all values to their standard deviation from the mean.

Can be applied to Grids/Trackgroups (ignores current selection), selected area (is a selection is active) or the whole survey.

Primarily used to reduce differences between grids caused by instrument & environmental factors, most often seen with resistivity data. Particularly useful prior to the application of Periphery Matching (in which case it must be applied to Grids/Trackgroups).

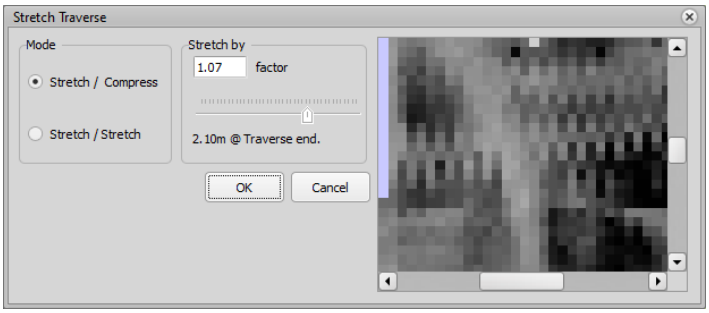
Note that once applied, the values are just numbers that fall within the range 0 to 1 or (neg) xSD to (pos) xSD . Subsequent processes may well cause datapoints to move outside this range.

11.10 STRETCH

Note: This process is only applicable to Gridded data where the position of each point on the ground is inferred from other measurements such as time.

Compensates for data collection errors caused by the instrument's physical movement over the ground not matching the movement assumed by the data logging software. This is generally caused by one of two problems:

- Handheld magnetometers that rely on the operator walking at a constant and defined speed to calculate the distance travelled when collecting gridded data.
- Cart based systems with odometers where this is not exactly accurate.



The process stretches (and/or compresses) the end point of each track by a specified factor, adjusting the value of all the points in between by a proportional amount. The process does not move the actual point but calculates a new value for the point based on the assumption that the end of the point's track had been moved by the specified amount.

This process can be applied in 2 different modes, referred to as: Stretch/Compress and Stretch/Stretch. Stretch/Compress will stretch alternating Tracks by the factor or inverse of the factor. In combination with a positive or negative correction factor, all possible combinations can be covered.

The value for Stretch determines how far the value for last datapoint in each track is shifted, either by stretching (positive) or compressing (negative). The values of all intermediate datapoints are shifted a proportional value between zero (for the first point) and the position of the end of the track times the factor. The new values for the intermediate datapoints are calculated using a cubic spline algorithm. This produces a smooth curve from the available datapoints. The selected value is just a multiplication value. So for a 20m long track, a factor of 1.05 will stretch values out by 1m or compress them by 0.95m.

Points at the end of compressed traverses are filled with values extrapolated from the preceding values in the same row. Data in adjacent rows and grids is not considered.

All tracks are stretched based on the overall size of the grid so short tracks are modified proportionally.

This process correctly allows for multiple sensor arrays. The necessary information is extracted from the grid files, assuming that the Sensor count and Zig-Zag information is set correctly when downloading/importing the data.

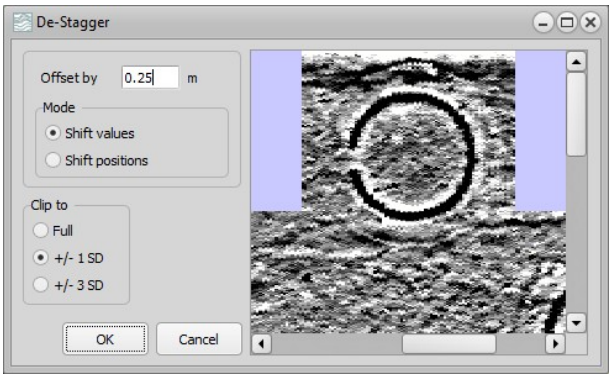
The dialog box will show a preview of the process' effect. The preview image can be zoomed with the mouse-wheel and moved about to inspect specific areas. The dialog box can itself be enlarged to show more of the preview.

Note: Because this process is dependent on sensor configuration and data collection patterns, it should be carried out prior to any interpolation.

11.11 DESTAGGER

Compensates for data collection errors where the recorded position of a track is displaced from the actual position on the ground. This is typically caused by mechanical delays in the triggering the datalogger or by electronic delays in the datalogger and GPS.

In each case, the delay will result in each track being started too soon or too late. The DeStagger process shifts each track forwards (or backwards for negative values) by a specified distance. The correction offset is applied to all tracks in the direction of travel.



The process has two modes:

Shift Values: In this mode the X/Y position of each datapoint is left unchanged. The value of each point in a track is transferred to a cubic spline curve and a new value for each point modified by the offset position is extrapolated back from the curve.

Shift Positions: In this mode the values for each datapoint are left unchanged. The X/Y position of each datapoint is moved back or forwards in the direction of travel by the offset distance. The offset direction is calculated from the current point to the next point in the track.

The dialog box will show a preview of the process' effect. The preview image can be zoomed with the mouse-wheel and moved about to inspect specific areas. The dialog box can itself be enlarged to show more of the preview. The preview can be clipped (none, +/1 SD or +/- 3SD) to aid in assessing the results of the applied shift.

Note: The preview will be applied to the whole survey, irrespective of any selections currently active. Once the process is approved ('OK' pressed), the process and selection will be applied to the survey.

Note: Although the process can be applied in either mode to both GPS and Gridded data, it is not recommended to use Shift Positions with Gridded data.

Note: The Shift Values mode will 'smear out' single point spikes (as seen in the above example). It is therefore recommended that any necessary DeSpiking (a mode in the Hi/Lo Pass process) be carried out before this process.

11.11.1 USAGE

Because of the presumed cause of this error, this process is really only applicable to Magnetometer data.

11.12 DEDRIFT

Note: DeDrift is a fully automatic process and so has no parameters.

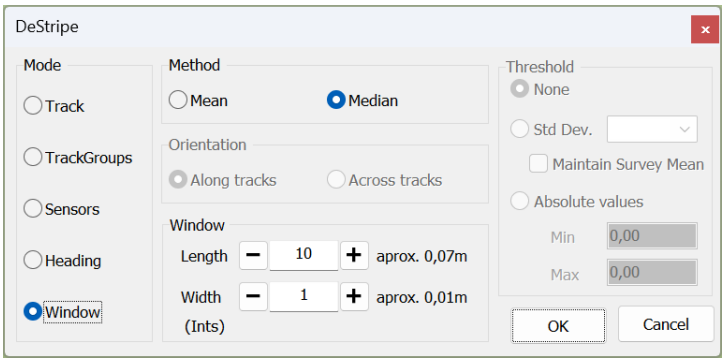
Corrects for drift over time in readings taken by an instrument. The process calculates a Linear slope for each track and then deletes that slope from the track, with the correction centered about the mid point of the track.

11.12.1 USAGE

This process is really only applicable to Magnetometer data as that is the only instrument that generally exhibits drift.

11.13 DESTRIPE

Calculates and removes an average offset from a group of points. This offset can be the result of electronic or physical differences between sensors on a multi-sensor instrument, or differing sensitivity of a sensor depending on heading. The process has a number of specialised modes which have their own methodologies (described below) but generally it calculates the Mean or Median (hereafter referred to as the average) of each Trackgroup (Grid), Track, Window, Heading sector, or Sensor within a grid. The average is then subtracted from the applicable set of datapoints.



The list of modes available will depend on the type of survey being processed.

11.13.1 TRACKGROUP (GRID)

Determine the average of all the datapoints in each trackgroup or grid and subtract that value from all the datapoints in that trackgroup or grid.

11.13.2 TRACKS

Determine the average of the datapoints in each track and subtract that value from all the datapoints in that track.

11.13.3 SENSORS

Determine the average of the datapoints for a set of tracks within a trackgroup that were recorded with the same sensor. This value is then subtracted from all those datapoints.

For Gridded data the sensor grouping is inferred from the type and configuration of the instrument specified during the download or import process. For GPS imported data this will also depend on the information that can be inferred from the file, this may not be possible for all file types.

This mode is particularly effective when linear features are present in the data that run parallel to the direction of traverse. In this case, normal Track based destriping will remove or severely reduce the linear feature as there is no way to determine that the average value of an individual traverse is due to a feature. By averaging all the tracks in a grid that were gathered with a particular sensor travelling in a particular direction, heading and sensor errors can be considered constant. The average for that set of tracks can therefore be considered the striping error value for all of them. Removing this value will destripe the data without affecting the linear features that will now form only part of the track set.

11.13.4 HEADING[2]

Note: This mode can only be applied to GPS surveys.

Specifically designed for GPS magnetometer data, this method determines the average of a set of datapoints grouped by trackgroup, sensor and heading. This value is then subtracted from all the datapoints in that group.

Because GPS tracks can curve in any direction, the heading errors can be different for every datapoint in a track making the simpler destriping methods almost useless. However, with the large point counts usually seen in GPS datasets it is possible to determine an average value for all the datapoints within the whole survey that were collected by a particular sensor while heading in a specific direction. The direction is grouped into 5° sectors to provide the best balance between accuracy and group size. As each sensor's value in all heading directions would ideally be zero, the average can be subtracted from each point with that sensor and heading to leave only local archaeological, geological or mechanical effects.

2 *The Heading DeStripe method is based on the work of Alois Hinterleitner, Wolfgang Neubauer & Immo Trinks: "Removing the influence of vehicles used in motorized magnetic prospection systems".*

11.13.5 Window

Similar to the basic Track DeStripe, the Windowed DeStripe calculates the average of a set of datapoints and subtracts that from every point in the set. The difference here is average is calculated from a moving window whose size is set by the user, the correction is only subtracted from the center value of the window. This mode is therefore functionally identical to a high pass filter.

11.13.6 Profile

Note: This application or mode emulates the Mean Profile Filter found in ArchaeoFusion, hence the rather non-intuitive name.[3]

Note: This mode can only be applied to Gridded surveys, either the whole survey or a selection of Grids.

Note: Despite extensive testing and investigation, the results of this mode never match samples generated by ArchaeoFusion's MPF. However, in our opinion, these samples do not match what should be expected from the described process either.

Unlike the more straightforward modes described above, Profile is a combination of a one dimensional low-pass and high-pass filter, the result of which is subtracted from the source layer.

The initial low-pass filter is applied to each track using the specified Length Window size. The result of this filter is then filtered using a high-pass filter at right angles to the tracks. The result of these two filters is then subtracted from the source survey. The filters can replace the value with either the Mean or Median value.

11.13.7 Settings

Note: These settings are not applicable to the Profile mode.

Optional Thresholds can be set for any mode. These can be expressed in SDs or as absolute values. The Threshold determines which values will be included in the calculation of the average value. If SDs are used, either a standard value can be selected from the list or a custom value typed over the standard value.

The Median method does not generally require thresholds as it naturally excludes extreme datapoints, however thresholds can be used if required as it may be useful for cases with extreme disturbances in the data such as that caused by pipelines.

Normally the DeStripe is applied Along the direction of the traverses. However it can sometimes be useful to apply the process across the traverses. The orientation can therefore be set to Across if required. This option is only applicable to Gridded data.

11.13.8 Usage

Normally this process will produce Bi-polar data with a center value close to zero. Because of this it is not recommended for use with Resistivity data. If the Mean is used with monopolar data – the normal state for Resistivity data, the Maintain Mean checkbox should be checked. This will add the mean of the source layer to all points in the processed layer after processing.

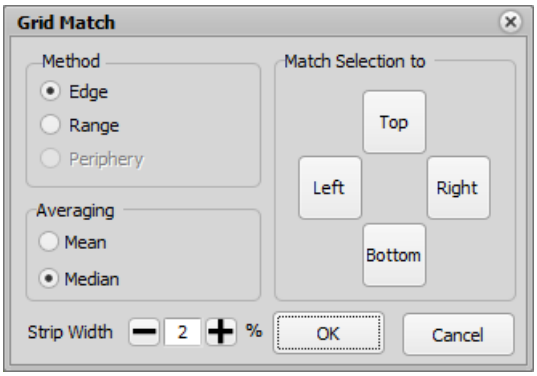
Note: Mean = average and Median = middle value (when all values are sorted in numerical sequence).

3 *http://archaeofusion.com/manual/module_4_6_7.htm*

11.14 Grid Match

Note: This process is an amalgamation of three separate processes available in previous versions of TerraSurveyor: Edge Match, Range Match & Periphery Match.

Grid Match is intended for use on Gridded data where there are differences between the average and range of adjoining grids. This will normally only occur with Resistivity data.



This process can be applied using 3 different methods: Edge, Range and Periphery.

11.14.1 Edge

Calculates the mean of the 2 lines (rows or columns) of data either side of the edge to match. It then subtracts the difference between the means from all datapoints in the selected area.

11.14.2 Range

Similar in effect to Edge Match but better able to handle widely differing data ranges and distributions. Range determines the minimum and maximum of a percentage of the (rows or columns) of data either side of the edge of the selection. It then calculates an offset and stretching factor to match the two datasets. The process then subtracts the offset from all datapoints in the selected area and multiplies them by the stretching factor. This can be particularly effective when matching resistivity grids that have been surveyed at different times.

11.14.3 Periphery

Calculates an underlying 2D surface for each grid and subtracts that surface from each value. The shape of the surface is interpolated from the grid's peripheral values averaged with their neighbours in adjacent grids. Particularity effective when grids exhibit very different averages and ranges to all their neighbours.

This method improves on the results provided by the Edge and Range methods. Though both those methods worked reasonably well when just matching two adjacent grids, problems often occur when trying to match a block of grids. Because those methods apply a single, fixed correction value in just one axis, attempts to match grids in more than one axis will often result in worse results that before matching. The Periphery Match method addresses this problem by creating a 2D correction surface for each grid. The shape of this surface is interpolated from the average peripheral values of the grid and it's neighbouring grids. Each edge is therefore corrected by ½ the difference between it and it's neighbour, datapoints further in from the edges receive a similar but reduced correction, reducing to zero at the center.

This correction is applied to whole grids and is based on the premise that each grid is corrected by ½ the difference between itself and it's neighbour. Therefore the method has no parameters or selection criteria, other than whether the correction applied to the mean or median of the grid's values. It is always applied to all the grids in the survey.

11.14.4 Application

Edge and Range can only be applied to a selection of grids and will be greyed out if no grids are selected when the process is applied. To select a grid or range of grids, click the Grids button ⊞ on the selection menu then click on a grid in the survey. Subsequent clicks will add more grids to the selection or remove them if already selected. Shift-click will add all grids bounded by a rectangle enclosing all currently selected grids and the clicked grid.

The Edge or Range process can then be applied to the selected grid relative to one of the grid's four sides.

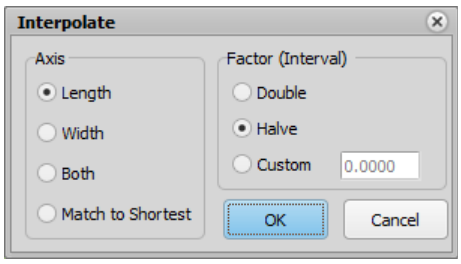
11.14.5 Usage

Typically used with Resistivity data to correct for changes in the reference probes. These changes may be due to errors in transferring the probes to new positions or when a survey is spread over a period of time

resulting in different conditions and probe locations. Because of the presumed source of this error, selections should normally be complete grids.

11.15 INTERPOLATE

Note: Interpolate cannot not be used on GPS data. The data is already interpolated, using a different method much better suited to the nature of the source. Instead, to increase the resolution of GPS based data, make the Interval distance in the GPS Base parameters smaller.



Increases or decreases the resolution of the survey. The values for the new datapoints are extrapolated using a cubic spline algorithm using data from along each track. This produces a smooth curve to fit the available source datapoints. This method is used for both increasing and decreasing the resolution.

Resolution can be changed to any value. For convenience and compatibility with previous versions of TerraSurveyor, single click 'double' and 'halve' values can also be selected. The custom factor can be any value with up to 4 decimal places. '2' and '0.5' will have the same result as the 'double' and 'halve' settings.

Remember: *Double* means 'double the interval' - i.e. double the distance between points, this *halves* the resolution.

Four axis options are available to apply the factor along the track (Length), across the track (Width) Both or Match the longest to the shortest.

Note: This process should only be used to allow different datasets to be matched, it should not be used to give the impression of enhanced data. Though it may appear to improve the data, any improvement is artificial. Excessive interpolation will eventually start to create artefacts that have no basis in the source data. Every doubling in any direction will also double the processing time for each subsequent process and prevent Delta View comparisons across the interpolated layer. Instead the view- based function Graduated Shade should be used. This produces the same (or better) result without modifying the actual data.

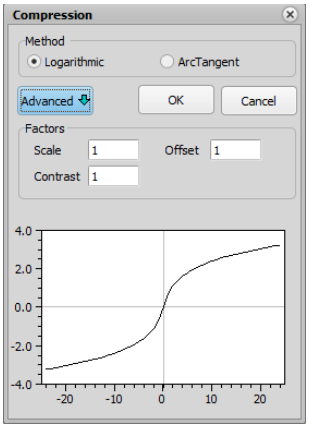
If Interpolate must be used, it should be carried out as late as possible in the sequence of processes as many processes (such as DeStagger and Stretch Traverse) depend on the original traverse data for their calculations. Interpolation also increases the amount of data that must be processed, slowing down all operations.

Decreasing the resolution may be useful when a large survey at high resolution starts to overwhelm the PC. By reducing the resolution and then exporting the survey as a new composite, a much smaller and more manageable composite can be created.

Though the process can handle any interval, artefacts may appear in the data when the start and end interval are not simple multiples of each other. This will be especially apparent when dummy value areas or the ends of tracks are involved as it may not be possible to fit the interpolated intervals exactly into the grid.

11.16 COMPRESS

Apply a compression algorithm to the current layer.



By default only the basic dialog box is shown. This allows a simple choice of Logarithmic or ArcTangent compression. The difference in effect can be seen in the plot shown at the bottom of the dialog box.

Clicking the Advanced button will show or hide the lower portion of the dialog box. Here you can vary the Factors (values) for scale, contrast and offset to tailor the curve of the algorithm to your requirements. The default values for these can be set in Preferences.

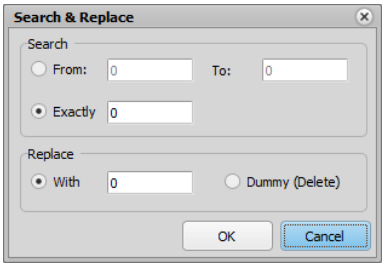
11.17 MOVE

Changes the position of every point within a selection by a distance specified in Meters. For GPS based data the distance is defined North / South and East / West, for Gridded data the distance is Forward / Backward (normally Up & Down on the screen) and Left / Right. For Zig-zag data, the move direction is independent of the direction of movement when the data was collected.

11.18 REPLACE

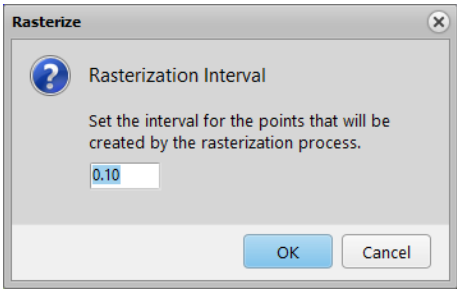
Search for, and Replace datapoint values with a specified value or delete them. Can be for the whole survey or a selection.

Two panels are provided: The Search panel allows a range of values or an exact value to be selected. In the Replace panel, a new value to replace the matching Search value or values with can be set. Checking the Delete box will mark all the matching Search values in the input range as deleted.



11.19 RASTERIZE

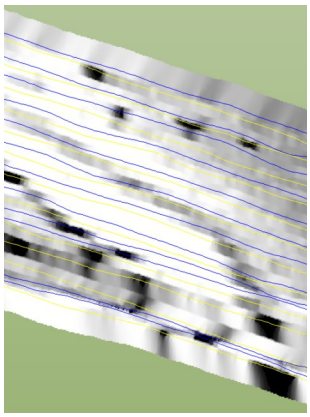
Note: This process is only applicable to GPS data.



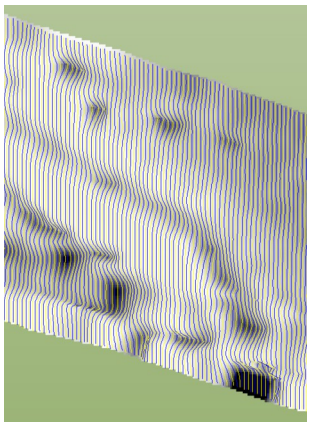
Rasterize converts the current GPS based layer into a Gridded layer. The values for the source layer are interpolated using the specified interval, the current radius and the SurgeF interpolation method (for accuracy). The resulting values are then converted into Tracks running North-South.

After applying this process subsequent layers will be treated as if they were collected as gridded data with exactly equal intervals in the X (E-W) & Y (N-S) axes. This allows some specific processes such as Hi-Lo pass filters to be applied in both directions.

The Tracks for the post-rasterized layers will be shown as for gridded data, i.e. left-right displacement will indicate the magnitude of the value and so will not be drawn exactly over the corresponding point on the ground (or shade view).



A GPS based survey showing multiple tracks with irregular spacing and orientation.



The same survey after Rasterization. The tracks and datapoints are now regularly spaced with generated tracks running N-S

12 GPS PROCESSING

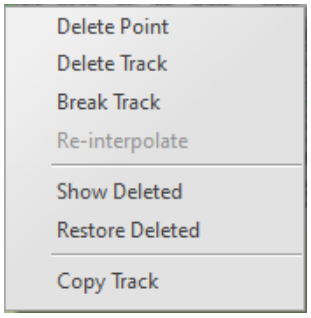
Though GPS and Gridded data is treated equally as much as possible, there are certain differences that have to be considered and dealt with. The primary difference is the way in which Tracks are collected and marked. In Gridded data this is fundamental to the format and can be easily discerned. However GPS collected data can be much harder to deal with, often there are no explicit tracks marked and a lot of 'rubbish' data can be recorded between tracks or even within tracks.

In order to make further processing of GPS data feasible and effective, a number of extra functions are available when this type of data is displayed.

12.1 GPS TRACK

Prior to making any Track selection, the Tracks must be made visible by clicking the Tracks eye icon on the Structure Tree. The Break and Delete options will only work if the Base layer is selected. Furthermore, Break Track and delete Point will only be available if the Show Track & Points option is set from the parameter list.

Tracks can then be selected by setting Track Selection on from the main toolbar. Click the button for Tracks and any track clicked on afterwards will be added to the selection. Clicking on it again will remove it from the selection. Once a selection has been made, right-clicking on the survey will pop up a menu with some track editing options.



The track based options will be applied to the point or track closest to the cursor when the menu is displayed:

Delete Point – (only when Points are displayed) Mark the point closest to the cursor as deleted. The point will then be displayed as a small X but no tracks will be drawn to or from it.

Delete Track – Mark the track closest to the cursor as deleted. Multiple Tracks can be selected prior to applying the Delete to all of them using Ctrl-Click.

Break Track – Break the track containing the point closest to the cursor. The next point (in the order recorded in the source file) will become the start of the new Track. Multiple points can be selected prior to applying the Break to all of them using Ctrl-Click.

Restore Deleted – Convert all points marked as deleted back to their original status. This option will undelete *all* points in the survey that have been marked as deleted, including those marked by automatic processes such as Discard Overlap.

Re-interpolate – With large surveys, re-interpolating the data every time a point or track is edited could be very time consuming and make the work very tedious. This is therefore postponed until explicitly called by this option or forced by other changes such as adding a new process.

Copy Track – Copy the X, Y, Value and Marker for the current track to the clipboard as a simple CSV layout to the clipboard.

12.2 GPS BASE

Only applicable to GPS datasets.

All the functions below are specified as part of the Base layer and are applied to the data in that layer. The various options are always applied to the data in this layer in the same order (if activated):

- Break on Turns *or*
- Break on Jump *(these first two are mutually exclusive)*
- Reduce Points
- Discard Overlap

12.2.1 BASE INTERPOLATION

Interval sets the X & Y interval of the interpolated data (only square intervals are supported for this type of data). This value should be kept as large as possible relative to the area of data and number of source datapoints. For example: If the source data for a 1Ha survey is recorded at 0.1m intervals but with a track spacing of 2m, the average is about 50,000 points per Ha. However by using the recorded interval as the interval for the whole survey, a composite will have 1 million points to interpolate. In this case an X&Y interval of 0.5m would still give a resolution approximately equivalent to the source average but be about 25 times faster to process.

If higher resolution is required for certain areas of the survey, a GPS Detail can be selected and extracted to a separate composite.

Track Radius sets the area around each datapoint that is included in the interpolated result.

Tracks are the lines of data gathered in one direction, they equate to the rows of data gathered by conventional griding methods. Though not essential with GPS data it is recommended that tracks be used to ensure complete and efficient coverage of a survey area. Straight, parallel tracks will also greatly enhance the effectiveness of the available GPS based processes. The distance between each track should be roughly constant and the Track Radius a little bigger than this distance. This will ensure that adjacent tracks will be displayed as a contiguous area while edges and unsurveyed areas will be displayed as transparent or the background color.

12.2.2 REDUCE POINTS

Note: Point Reduction is an irreversible process.
The survey will only contain the reduced set of datapoints after application. We recommend you save the survey with a new name after applying Point Reduction to preserve the original data.

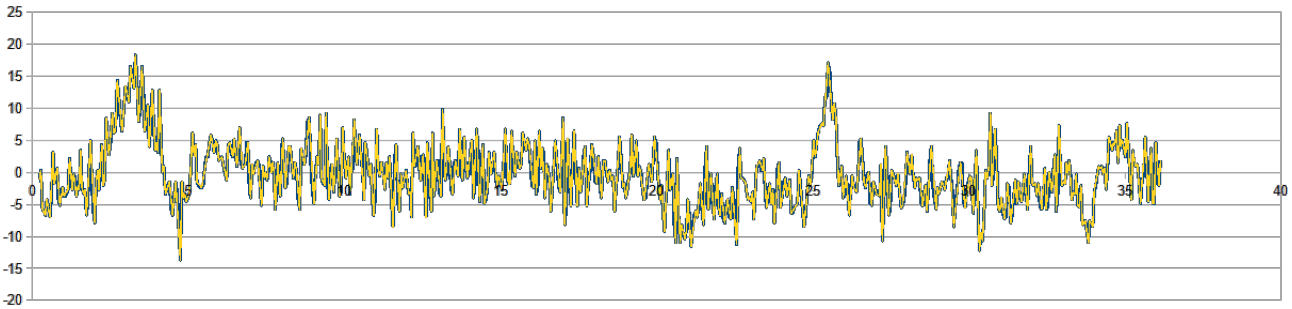
This function is primarily intended to reduce system memory requirements, it removes a portion of the source datapoints using one of two methods: Curve Match or Fixed Intervals. This reduces the amount of data that needs to be stored and processed by TerraSurveyor during subsequent processes.

12.2.2.1 CURVE MATCH

The Curve Match method uses the Douglas-Peucker polyline simplification[4] algorithm to reduce the number of datapoints passed to subsequent GPS processes. The algorithm removes points in the source data that are not necessary to creating a good representation of the overall shape of the data. The application level is expressed in percent of the + & - 1 SD range of the source data. The value used will depend on the source data, for fast changing data a value of 2% seems to provide good accuracy with a significant (70%) reduction in points. 'Flatter' data will require a much lower value, perhaps 0.1%. The default tolerance can be set in Preferences.

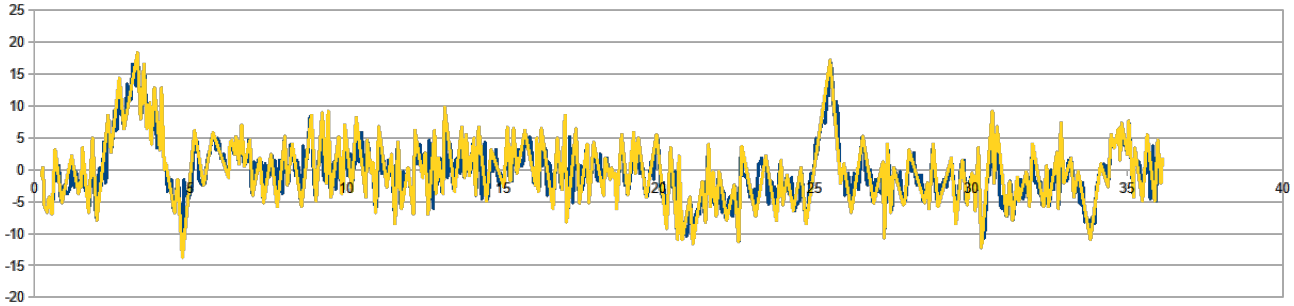
Be aware that 'flatter', or slow changing data will require far fewer datapoints to define the curve – but that this may well result in large intervals between points which will show as gaps in the shade view.

The following charts show the same sample data (40m long, 747 points) reduced with 5%, 2% and 0.5% tolerance (blue is source, yellow reduced):

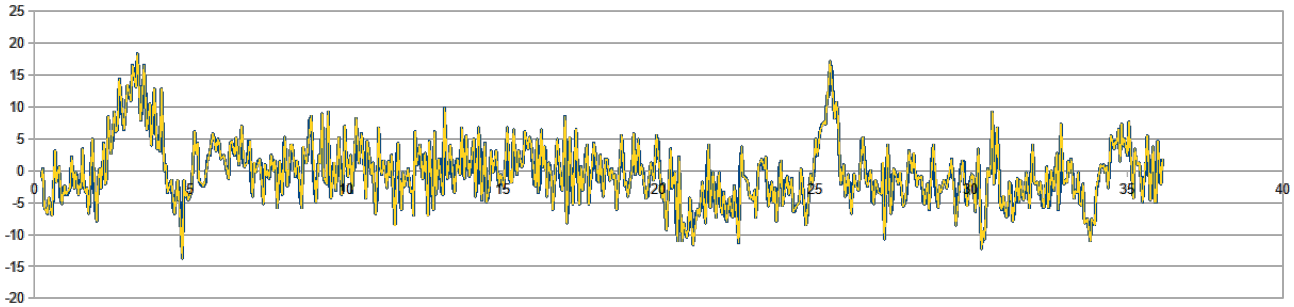


5% keeps 116 points (15%)

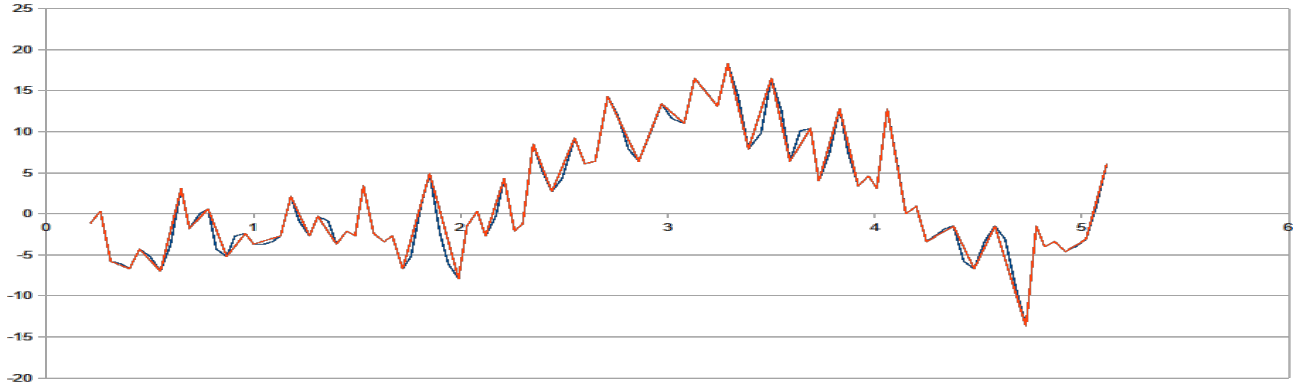
4 *en.wikipedia.org/wiki/Ramer%E2%80%93Douglas%E2%80%93Peucker_algorithm*



2% keeps 227 points (30%)



0.5% keeps 451 points (60%)



first 5m @ 0.5% tolerance in detail

12.2.2.2 Fixed Intervals

Fixed Intervals re-interpolates the source data so that all resulting datapoints are at the same interval, this interval can be smaller or greater than the average interval of the source. Obviously for the purpose of reducing the size of the source dataset, a larger interval should be chosen. The interpolation uses a simple straight line extrapolation for both the X-Y position and the value, no curve fitting to allow for trends between points is used. e.g. if the value is half way between to the two adjacent points, the resulting value will also be half way between the adjacent values.

12.2.2.3 Fixed Average

Similar to the Fixed Intervals, the Fixed Average method replaces all datapoints with new ones whose position on the ground is at fixed intervals. The value for each point is however the simple mean average of *window* points either side of new point.

12.2.3 Break on Turns

Note: A number of other methods to detect turns or Track breaks are available in the Irregular XY import processes. If the data is being imported and contains extra data not kept in the composite file, it may be better to use one of these methods rather than Break on Turns.

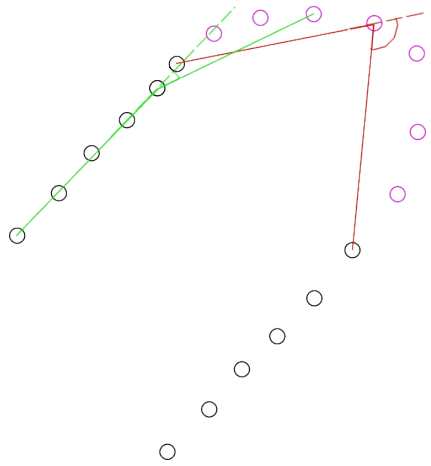
Note: Because the Reduce Points process significantly affects the spacing and number of available points, this process is, if enabled, always applied prior to the Reduce Points.

Note: Break on Turns and Break on Jump are mutually exclusive; only one or the other may be applied.

Used to cut tracks of data that do not have start and end traverse markers, such as that collected as a continuous stream with simple cart based systems. Many subsequent GPS based processes are ineffective without defined tracks (De-Stripe in particular).

As with many processes, the effectiveness of turn recognition will be influenced by many factors. Certain datasets or data collection methods may not lend themselves to turn recognition. Actions such as reversing or obstacle avoidance may well result in a turn being identified programmatically when a human would not see one. Conversely situations that appear to the user to be 'obvious' turns may not meet the process's criteria. Ultimately this process should always be seen as an aid to handling poor data, it should never be considered a standard, reliable tool for general use.

This function looks at the angle made from each point to 2 other points a fixed number ahead and behind it. If the angle is greater (i.e. away from a straight line) than the defined threshold, it is assumed a turn has been started. The test continues on each point until the angle starts to decrease at which point the function assumes the apex of the turn has been reached (or just passed) and the cut is initiated. The function cuts the track at this point and marks a specified number of points either side of the turn apex as deleted. The function has 3 parameters: Threshold angle (described above), Threshold length (the number of points in front and behind used to calculate the angle) and Cut Length (the number of meters in front and behind the apex that are marked as deleted). The Threshold may be set to any number but is internally limited to a maximum 5% of the Track length and a minimum of 2.



A simplified example illustrating a threshold length of 4. The green line shows the Threshold angle has not been reached. The red line shows that the angle has been exceeded and the apex found. The magenta points either side of the apex are then marked as deleted to break the track into 2 straight, parallel tracks.

12.2.4 Break on Jump

This function is a copy of a function also available in the Irregular XY Import process. It has been duplicated in the GPS Base functions as it may well be useful here and fits with the other Base functions.

Note: Because the Reduce Points process significantly affects the spacing and number of available points, this process is - if enabled - always applied prior to the Reduce Points.

Note: Break on Turns and Break on Jump are mutually exclusive; only one or the other may be applied.

Calculates the distance between every point and the next one in the source data. If the distance exceeds the threshold distance, the point is marked as a Track break. The default threshold is 3 times the survey interval.

12.2.5 DISCARD OVERLAP

Intended to eliminate a track (or portions of a track) that has been collected too close to another. Without this, the results of the interpolation process can be distorted as it tries to accommodate very close points with potentially differing values.

The function checks the separation of every point from it's nearest neighbour. If the point is closer to an existing neighbour (that is not in the same track) than a threshold distance, either the newest or oldest point is marked as deleted. This can break tracks into very short segments so the process then checks the length of all tracks, those that are shorter than a specified length are also deleted.

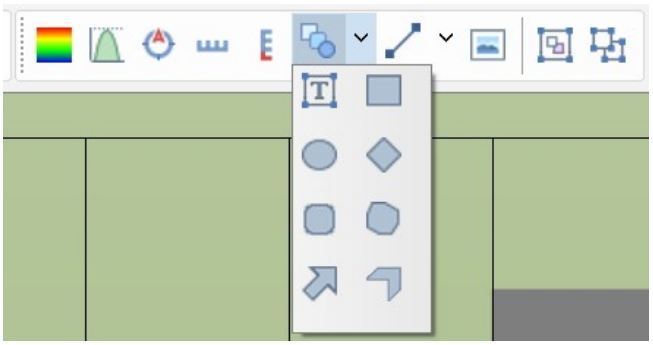
'Newest' and 'oldest' refers to the relative position of the point in the source data, 'new' being further down the file.

13 SCENERY

TS64Lt & TS64Fld: Do not support this function.

In addition to the basic Survey image, TerraSurveyor64 can display a range of 'scenery' items on and around the survey image. These items can provide additional information linked directly to the survey or can be used to highlight and annotate the survey image as required by the user. All items are linked to the survey so that if parameters or values in the survey change, the associated items will also change as appropriate for the item. For example, if the colour palette used with the survey is changed then any palette item for that survey will also change colours. Text within items can also be linked to metadata from the survey so a text block could contain references to the survey's filename, size in hectares, points count or value range.

All the Scenery items can be added from the buttons on the main toolbar. Their front to back order can be changed with the Front to Back buttons, also on the toolbar.



Any Scenery items will be listed in the Site Structure tree, clicking on the item will show all that item's parameters in the panel below. These parameters control things such as background and line colours, fonts for text elements of the item and parameters specific to the item such as the position or number of divisions to be shown in scales.

The scenery item will be set to a size based on the size initially drawn for the item, modified to suit the type of item. The North arrow will, for example, be reset to a square based on the shorter axis of the drawn rectangle.

Scenery can be assigned to different drawing layers. Note that these layers are specific to the scenery and are not related in any way to the layers created by Survey processes. All items are initially assigned to a layer called Scenery0. However any number of layers can be created and items assigned to those layers as required. Layers (and items) can be shown and hidden from the Site Structure tree by clicking their eye icon. This can be useful for creating such things as page framing elements or annotations that may not be for distribution to other parties.

Items can be locked to the Survey (check the Lock to Survey checkbox in the Structure Tree parameters). When locked, the size and position of the item relative to the main survey cannot be changed. If the survey is moved or resized, the item will be moved and resized with it.

All items can have transparent backgrounds allowing items and the survey behind them to show through. Note that a transparent background is different to Transparency. A transparent background draws solid foreground elements (text, lines, etc.) with nothing around them, Transparency will affect all elements equally and allows partial transparency.

13.1 SAVE / LOAD SCENERY

All scenery items can be saved with the survey if desired, if scenery is present then the user will be given the option to save with or discard the scenery when the file is saved. The scenery will be rebuilt along with the survey when the file is opened.

A set of scenery items can be saved as separate template for use with other surveys. This can be used to design an approved or standard layout of items such as a Title block in the page corner.

Save & Load Scenery is available fro the main menu, under File.

13.2 PALETTE

Draws a vertically oriented palette with a scale down the side. The style, colours and font of all parts of the palette can be set.

13.3 Histogram

Draws a horizontally oriented graph of the survey's data. The style, colours and font of all parts of the histogram can be set.

> Note The number steps in the histogram will be set by the global steps value taken from the Histogram panel.

13.4 Compass

Draws a square box with a north arrow in it. The arrow indicates the direction of north relative to the survey on the same layer (or 'up' if no survey is present). The arrow can be either a simple drawing (as seen with the Compass panel), a character from a font or an image. This allows the arrow to be customised to your requirements.

Any character from any font can be used - though of course this will only make sense if the character is recognisable as an arrow. A number of characters from the WingDings fonts (standard in Windows) are suitable for this purpose. There are also specific geographical fonts available that have suitable characters. ESRI North is freely downloadable and if you have installed Golden Software's Surfer you will have GSI North Arrows, both of which consist entirely of such characters. Make sure that any selected character points upwards, the character will be rotated based on this assumption.

An image can also be used to provide an even more elaborate or custom compass arrow. You may have such an image available within your organisation as clipart, alternatively you could draw one yourself in a graphic package or download something from the internet. As with the character, North must be up to get the correct rotation. Note that the image is rotated around the center point of the image – which may not be the center of the compass.

In the case of the character and image, there will be an additional property available. This scales the character or image to let you get the best fit to the background (if used). The example image shown above is scaled to 100% and so the top edge just touches the edge of the background.

13.5 Ground Scale

Draws a ground distance scale based on the size of the survey. The style of the scale and the numbers of major (numbered) and minor (unnumbered) ticks can be set. Currently 3 scale styles are defined: Zigzag, Ticks and Boxes. Though the basic style is fixed, the fonts, lines and fills for each style can be set to any value required in Properties. By default, the scale will be drawn with 4 major ticks, or 1 if the survey is only one grid wide.

Note that in order to preserve the scaling, the Ground scale cannot be resized directly. Changing the size of the survey will change the size of the scale, as will changing the number of Major Ticks in the Properties. Changing the font and font size may also affect the height and width of the scale.

13.6 Vertical Scale

Draws a vertical scale linked to the scaling of the Trace view. The height of the scale for a Trace view cannot be altered as it is derived from the range of the data in the survey and the vertical scale parameter of the Survey. The width is set by the font and the font's size.

13.7 Text box

Places text on the page. This can be plain, fixed text or can include 'entities' or links to attributes of the survey. For example the name of the site or the dimensions of the survey can be included in the text. When these attributes change the text is changed accordingly.

The text edit box has 2 main areas, the top area is where the text is entered as in any text editor. The area below that shows an example of what the plain text will look like on screen (excluding font settings), the

entities are shown in bold. To insert an entity, right-click at the insertion point and choose the required one from the displayed pop-up menu. The entities are divided into 3 lists: Site, Composite & General to aid selection.

Note: the list of available entities covers most aspects of the survey and site and is equivalent to the information available in the metadata view. However if you find a need for other entities please contact DW Consulting to discuss having them included in future versions of the program.

13.8 Shape

A number of basic shapes can be added on and around the survey to aid in annotation or for other graphic purposes. The available shapes are:

- Rectangle
- Ellipse
- Diamond
- Rounded Rectangle
- Polygon

To select and add a shape, click on the Shape button on the main Toolbar and select the basic shape required then click and drag over the area the shape is to cover. Once drawn, the shape will be added to the Site Structure tree with a default name and a list of parameters below it. All the shapes can be rotated to any angle by dragging the small circle that will be seen near the right of the shape. The colour & style of the outline and fill can be set.

Each Shape will have 4 Link points half way along each side, the link points are visible as small blue crosses when the shape is selected. These points can have lines anchored to them. The lines will move with the Link point when the shape is moved, resized or rotated.

13.9 Link Line

As with the basic shapes, a number of styles of line can be added to the survey. The available line types are:

- Straight
- Arc
- Polyline
- Sideline (one vertical and one horizontal line)
- Bezier

The line can have arrowheads at either or both ends. The Polyline allow irregular lines with as many segments as required to be drawn. The Arc and Bezier allow curved lines to be drawn. A Text label is available for the line, set the text through the Site Structure parameter list.

Lines can be free floating anywhere on the survey or be linked to one of the four link points on a shape or any point on the survey. When a line starts, ends or is moved on a survey, it is automatically linked to that particular point on the survey.

13.10 Image

Allows an image to be placed on the survey. Note that the image is not stored in the XML file and so will need not be kept in the same place as when it was first added.

14 The Software

14.1 System Requirements

TerraSurveyor64 can be installed on any Windows-based PC from XP onwards (WinXP, WinNT, Win2000, Vista, Win7). However we would recommend a Windows 10 or better PC.

A USB port is required for the registration dongle (if used).

The 3D view makes use of an imaging system called OpenGL. This will be available automatically on any Windows PC However, older PCs may not support version 1.4 – which is the recommended minimum to run the features used in the 3D view. The program checks for this at startup and will warn you if the PC does not support 1.4 or above. The speed at which the 3D view is generated and manipulated will depend on the power of the video card or on-board drivers.

14.2 Installation

The software can be downloaded from the DWConsulting.nl website as a single installation file called TS40xxxx-Setup.exe (where xxxx indicates the current version). You should log on as a User with Admin rights before installing the program. This will be necessary to allow the installation process to copy the files to the correct places and make some changes to the registry.

Start the Setup program. The installation wizard will take you through a number of steps to install the program and it's components. By default the program will be installed in C:\Program Files\DWC\ TerraSurveyor64. This is the path that will be assumed in this manual. The templates and some other support files are copied into your AppData folder and the example sites will be created in Documents\ TerraSurveyor Sites.

Once the installation is complete, you will see a new TerraSurveyor64 icon on the Desktop and an entry under Start | programs.

14.3 Registration

The initial installation of TerraSurveyor64 will give you a 30-day trial period to evaluate the program. During this period the Graphic Save functions and Direct Print will work but all images will be overprinted with the word TRIAL. After this period the program will continue to work, but ALL save, download, import and print functions will be disabled. This includes saving of Grids and Composites!

To purchase a registered copy of the program, please place an order at www.dwconsulting.nl.

Two methods are available to activate the program:

- Machine Codes
- Dongle

You will be asked to select which method you want to purchase when you place your order.

14.3.1 Machine Code

This method of registration locks a license to a particular PC. This is done by using certain serial numbers specific to the PC to form part of a digital 'key'. To create this key you will need to install the program, run it in trial mode and send the Machine Code (see Help | Registration) to us when you place the order (there are special fields for this on the order form).

Once payment for the license(s) has been received, an Unlock code for each PC will be e-mailed to you. This code should be copied and pasted into the Unlock Code box in the Registration window. If you have more than one license make sure that each Unlock code is used with the correct PC.

14.3.2 Dongle

The Dongle is a small component that plugs into any USB port on a PC. The program checks for the physical presence of the dongle on startup and when any USB device is connected or disconnected. If the dongle is

disconnected the program will revert to Trial mode, if the Trial period of 30 days has been passed ALL save, download and import functions will be disabled.

Once payment for the license(s) has been received, a dongle for each license will be sent to you in the post. TerraSurveyor can be installed on as many PCs as required but only a PC with a dongle plugged in will be able to download data, save graphics, etc.

When a license is extended or updated, such as with monthly or yearly licenses, you will be sent an update code. This is an encrypted string that when copied into the Unlock code field of the Register dialog, will update the dongle to reflect the new license.

14.3.3 Pros & Cons

Both methods have their advantages and disadvantages. The Dongles provide the greatest flexibility as they can be moved from PC to PC as required. You could, for example, have TerraSurveyor64 installed on a laptop for in the field and a PC in the office. You would however only need one dongle to operate them both (though not at the same time). Universities can invest in just a few dongles and issue them to students or faculty members as necessary for their work. Commercial companies could purchase a dongle to accompany each survey machine. You would only have to install the program on any PC that might need to use it (itself a simple matter) and plug in the dongle as required.

Disadvantages are that the dongle is a relatively small item that could be lost or stolen. Also, because it generally protrudes from the side or rear of a laptop, it is vulnerable and could be broken off or damaged.

The Machine code method is much quicker to implement - you don't have to wait for the dongle to arrive in the post. Once installed, it cannot be lost or broken but it also cannot be transferred.

We do understand that PCs are occasionally replaced and will be happy to provide new Unlock codes in this case. However, for obvious reasons this will not be done more often than once per year, per license and we reserve the right to deny the user new unlock codes if we feel that the service is being abused. Damaged dongles will be replaced for a small fee on return of the damaged unit. Lost dongles are however your responsibility!

15 XML SCHEMA

All survey files use the same basic XML file structure however there is a distinction made between the 3 main types of data: GPS, Gridded (composite) and Grid. This distinction is determined by an attribute in the Header element and only has an impact on how the program handles the file.

The basic structure is a Site, which contains just one Survey. This structure is intended for future expansion to allow support for multiple surveys wrapped within a single survey.

The Survey has a Header element which contains general information applicable to the whole survey. Where this information has a specific or unique purpose within the survey it is generally a named attribute. For more generic data, or where multiple attributes are possible, the Param element is used which has an English language name, a value and a type attribute. This should ensure that the data is always decipherable in the future.

The Header is followed by a one or more Process elements. The first Process is always of type Base and contains information about the format of the source data and some Track breaking options. Each subsequent Process defines a modification process and it's parameters. As each process has different requirements and settings, these parameters are all encoded with the Params structure mentioned above. Each parameter has an English language name to ensure transferability and all values are also in clear language. For example, an averaging mode would be given as "Mean" or "Median", not '0' or '1'.

The actual data is enclosed in a Layer wrapper element. Each layer contains nested TrackGroups (usually just one for GPS data, for gridded data each TrackGroup is equivalent to a Grid). The TrackGroup has an origin position relative to the Survey origin. The next level is the Track element which then contains the elements P(oint). The point has 3 attributes: X, Y and V. For GPS data the X & Y are in the same format as was imported or downloaded. For Gridded data the position is given relative to the TrackGroup origin. Note that Gridded data position is given in actual distance from the origin, not a position sequence. So the first point at position 0,0 would have an X & Y of 0.25, 0.5 (if the interval between readings is 0.5m x 1m). For compactness the X or Y attribute may be omitted if it is the same as the previous point's X or Y. For Gridded data this will mean that the Y is only given once at the start of each Track.

```
<xs:schema attributeFormDefault="unqualified" elementFormDefault="qualified"
xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="Site">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Survey">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Header">
                <xs:complexType>
                  <xs:sequence>
                    <xs:element name="Param" maxOccurs="unbounded" minOccurs="0">
                      <xs:complexType>
                        <xs:simpleContent>
                          <xs:extension base="xs:string">
                            <xs:attribute type="xs:string" name="Name" use="optional"/>
                            <xs:attribute type="xs:string" name="Val" use="optional"/>
                            <xs:attribute type="xs:string" name="Type" use="optional"/>
                          </xs:extension>
                        </xs:simpleContent>
                      </xs:complexType>
                    </xs:element>
                  </xs:sequence>
                </xs:complexType>
              </xs:element>
              <xs:element name="Processes">
                <xs:complexType>
                  <xs:sequence>
                    <xs:element name="Process">
                      <xs:complexType>
                        <xs:sequence>
                          <xs:element name="Param" maxOccurs="unbounded" minOccurs="0">
                            <xs:complexType>
                              <xs:simpleContent>
                                <xs:extension base="xs:string">
                                  <xs:attribute type="xs:string" name="Name" use="optional"/>
                                  <xs:attribute type="xs:string" name="Val" use="optional"/>
```

```
                              <xs:attribute type="xs:string" name="Type" use="optional"/>
                            </xs:extension>
                          </xs:simpleContent>
                        </xs:complexType>
                      </xs:element>
                    </xs:sequence>
                    <xs:attribute type="xs:string" name="Action"/>
                    <xs:attribute type="xs:string" name="IsActive"/>
                  </xs:complexType>
                </xs:element>
              </xs:sequence>
              <xs:attribute type="xs:byte" name="RC"/>
            </xs:complexType>
          </xs:element>
          <xs:element name="Layer">
            <xs:complexType>
              <xs:sequence>
                <xs:element name="TrackGroup">
                  <xs:complexType>
                    <xs:sequence>
                      <xs:element name="Track">
                        <xs:complexType>
                          <xs:sequence>
                            <xs:element name="P" maxOccurs="unbounded" minOccurs="0">
                              <xs:complexType>
                                <xs:simpleContent>
                                  <xs:extension base="xs:string">
                                    <xs:attribute type="xs:float" name="X" use="optional"/>
                                    <xs:attribute type="xs:float" name="Y" use="optional"/>
                                    <xs:attribute type="xs:byte" name="V" use="optional"/>
                                  </xs:extension>
                                </xs:simpleContent>
                              </xs:complexType>
                            </xs:element>
                          </xs:sequence>
                          <xs:attribute type="xs:byte" name="Ident"/>
                          <xs:attribute type="xs:byte" name="Sensor"/>
                          <xs:attribute type="xs:byte" name="RC"/>
                        </xs:complexType>
                      </xs:element>
                    </xs:sequence>
                    <xs:attribute type="xs:string" name="Name"/>
                    <xs:attribute type="xs:string" name="Interval"/>
                    <xs:attribute type="xs:byte" name="Ident"/>
                    <xs:attribute type="xs:byte" name="RC"/>
                  </xs:complexType>
                </xs:element>
              </xs:sequence>
              <xs:attribute type="xs:byte" name="RC"/>
              <xs:attribute type="xs:string" name="Extent"/>
            </xs:complexType>
          </xs:element>
        </xs:sequence>
        <xs:attribute type="xs:string" name="Name"/>
        <xs:attribute type="xs:string" name="Visible"/>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
  <xs:attribute type="xs:string" name="Program"/>
  <xs:attribute type="xs:string" name="ProgVer"/>
  <xs:attribute type="xs:string" name="Name"/>
 </xs:complexType>
</xs:element>
</xs:schema>
```

16 TRANSITION FROM PREVIOUS VERSION

16.1 ARCHITECTURE

The previous version of TerraSurveyor was a 32bit application. This meant that (in very simplified terms) it could only address – or hold in memory – about 2,000 million numbers. This sounds like a lot, and when used with surveys from handheld geophysics instruments that might only produce 50,000 readings in a day, it was quite sufficient. However in the last few years the development of 'GPS cart' based systems, often pulled by motorised vehicles, means that 20 million datapoints can easily be collected in a day. When you consider that each point consists of at least 3 numbers (X, Y & value) and that processing will duplicate all that data for every layer, 2,000 million does not go far.

A 64bit application can however handle many more numbers – about 9 million million million in fact. This should be sufficient for most people for a while!

It is important to realise that a 64bit app is not inherently faster than a 32 bit app. It may appear faster because it will generally be created on a newer and therefore better (I hope) compiler, run on a newer and therefore faster PC and have fewer bottlenecks when handling larger files, but the underlying processing of data, accessing files or displaying images on the screen remains the same.

16.2 FILE STRUCTURE

TerraSurveyor64 will continue to use XML files for all data storage. The old 32 bit version supported XML, compressed (zipped) XML and binary files, these are only supported in a limited way in the new version. The old XML files can be read but are not written, the compressed and binary types are not supported at all.

The structure of the XML files has been completely changed. In the old version there were 2 fundamental file types: the grid and composite. The grid (*.xgd) files used a line per value structure, each line was a separate 'record' with an X, Y and data value. The Composite actually contained one of two substructures. The original substructure for gridded data (assembled from grid files) was akin to a spreadsheet layout where each row was an array of space separated datapoints. The X & Y value was inferred from the datapoint's position in the row array. This layout, though compact, was not suitable for GPS based data so that data used the same structure as the grid files and stored the X, Y and value for each datapoint as attributes of a single line record. The header and some other details of the grid and composite files were also different.

The new structure sees no difference between a grid, a composite assembled from grids or a survey imported from a GPS cart system. All use the same structure for recording data: the line per record method previously found in grid files and GPS versions of composites. This does mean that composites that are converted to the new file structure will be much (about 10x) larger, however storage space is no longer a problem on modern PCs.

In addition all parameters for processes are now fully documented within the file. In the old version parameters were simply listed in the order they were defined internally by the code and would usually just be a number with no obvious meaning attached to that number. The new structure lists each parameter with a name that matches the equivalent parameter in the relevant dialog box and a value that describes the function of the parameter. For example, while the old system might have just contained `<Param Val="2.00"/>` as the 3rd entry in a Destripe process, the new structure will use `<Param Name="Method" Val="Median" Type="String"/>`.

16.2.1 Trackgroups, Tracks & Points

In order to harmonize the slightly different structures of gridded composites and GPS surveys, all data is arranged in three nested levels. The Trackgroup is the top level and equates to the Grid in a traditional gridded survey. There will normally be only one Trackgroup in a GPS survey though future enhancements to the program may allow this to change. The bottom level is the Point, this is a single data value with an X and Y location, the value recorded at that point and some flag data for deleted points, etc. The X and Y in the file are in any one of the formats TerraSurveyor can support (Lat-Long, UTM, OSGB, Meters, etc.). Gridded data which originally encodes it's source data with just row and column numbers is converted to absolute positions in meters. The Track is a set of Points that form a single line of data (sometimes also called a Traverse).

16.3 Folder Structure

The default operation method for TerraSurveyor remains the same as previous versions of TerraSurveyor with a Site folder containing Comps, Grid, Graphic and Export folders. However this is not a requirement any more. This method can be turned off in preferences (Interface: General: Enforce Strict Site Structure). When turned off the NavBar will be removed, files can then be opened from- and saved to- any location. The Recent Files list on the main menu and main toolbar will show either the last 10 files opened or, when Strict Site Structure is on, the last files opened in the current folder.

16.4 Interpolation

The old system used an interpolation system called SurgeF to convert GPS data into a grid of values that could be used to generate on-screen images. The method produces excellent results with far fewer artefacts and much faster than other similar methods such as Kringing. However it is still very slow when 'immediate' results after a small change are expected. The nature of GPS cart based data is such that the quality of interpolation that SurgeF produces at distances from the tracks is mostly irrelevant to us. I have therefore developed a much simpler and quicker interpolation method that, on large surveys with dense tracks and datapoints, produces results almost indistinguishable from those produced by SurgeF. The quick method is orders of magnitude faster than SurgeF, allowing an image to be displayed in seconds instead of minutes. You can switch from one method to the other at any point.

16.5 Writing Files

Files were written on a line-by-line basis in most situations by the old program. This meant that for each line the program had to find the file, open it, find the end of the text, append the line, and close the file again. The new program writes each line to a buffer in memory and then writes the whole buffer to disc in one operation. This is much more efficient and faster with large files – and GPS files can easily be 10's of megabytes.

16.6 Cosmetic

It is immediately obvious that TerraSurveyor64 has a very different interface to the old version. However all the functionality of the old program is still available in the new, just arranged differently. Some functions have been omitted but only where they no longer serve a purpose in the new program or are no longer recommend methods for Windows programs.

16.6.1 Docking Panels & MDI

MDI (Multiple Document Interface) is no longer a recommended method for Windows programs and so is not used in the new program. If you need to have multiple surveys open at the same time you should just open multiple copies of TerraSurveyor, each with a different survey. Data can be copied and pasted from one application to another (if the data is compatible with the survey it is being pasted into).

The NavBar, Settings dialog, Process panel (on the left) and Info panel (on the right) have been replaced by moveable and dockable panels. There are a number of other panels such as the Palette, Histogram and Selection panels which are also dockable. All these panels can be moved about and docked to any side of

the main window. They can also be floating panels (similar to the old NavBar and Settings). Any arrangement of panels can be saved as your preferred layout (on the main menu, View | Desktop)

16.6.2 Styles

Light, Dark and plain Windows Styles are available from the main menu, Options | Styles.

16.6.3 Button Toolbar

The button toolbar at the top of the main screen provides access to most main functions. The bar is subdivided into smaller panels each with a specific purpose:

- File operations (open, save, new, assemble composites, etc)
- Zoom
- Data (import, download, export, print)
- Selection (areas, tracks) + Cross section and Ruler
- Mode (main, grid assembly, spreadsheet, metadata)
- Publishing Shapes & Objects (drawing shapes, palettes, histograms, linked text, etc.)
- Z order (for arranging shapes & objects)

These panels can also be re-arranged as required.

16.6.4 Main View

Unlike the old TerraSurveyor, all the primary 'views' such as the Shade, Trace, Delta & Publish are now shown in a single panel. The various views can all be turned on or off as required so that virtually all these options can be combined or hidden. They are all controlled by the Structure panel, described below.

16.6.4.1 North & Traces

Another major visual change compared to the old TerraSurveyor is that 'North' is now always 'up'. Traverse or Tracks are now drawn at whatever angle they were actually surveyed. So tracks surveyed in a North-South direction will be shown running up and down the screen, East-West tracks will be shown running left to right. This applies to both Shade and Trace views, Traces will be drawn at right-angles to Track. There is an option to rotate the survey so that Tracks are horizontal.

Because GPS tracks are (almost) never straight or exactly aligned with their neighbours, GPS Tracks are only shown as single lines following the GPS path. Alternate Tracks are colour coded red and blue and the track under the cursor at any time can be highlighted in purple.

16.6.5 Structure Panel

The structure panel has two main areas, the Structure Tree at the top and the Parameter List below it. The Structure Tree has five subsections: Site, Survey, Processes, Data and Display Layers. When an item from any of these sections is selected, information associated with that item will be shown in the Parameter List. In most cases the Parameter List is 'live' – changes can be made directly in the list. In the case of Process parameters the list is for information only, changes can only be made in the dialog box specific to the process.

16.6.5.1 Site

Parameter List shows information about the whole survey such as Origin (for geo-referencing), Orientation (Gridded data only), Units of measurement, dates, comments, overall statistics.

16.6.5.2 Survey

Has four items: Shade, Trace, Grid & Scale and Contours. These items control the main layers that display the survey. At the highest level the layers can be shown or hidden by clicking on the 'eye' symbol. The parameter list for each item gives control of the appearance of each layer such as the palette for the Shade view and the display of grid lines and grid names.

16.6.5.3 Processes

Lists all processes currently applied to the survey. The list always starts at the top with the Base layer which represents the source data prior to any processing. The parameter list gives details of the settings for each process however this list is not directly editable. Though this could be possible in some cases, many processes require more complex handling than just the setting of a parameter to a different value.

Selecting a Process in this list changes the current layer displayed in the survey image. A blue arrowhead indicates the currently displayed layer.

16.6.5.4 Modify

All the functions previously available from the Modify button can now be carried out in the Process and Parameter list. A small toolbar at the bottom of the parameter list is active when a process is selected. This toolbar allows the dialog associated with the process to be opened or a process to be deleted from the list.

The order of processes can be changed by dragging the process to it's new position in the list.

When changes to the order or parameters of a process are made the changes will either be made immediately (for small surveys) or, for large surveys, will be collected but not applied until the user is finished with all changes. The user will be reminded that changes are pending by a warning message and the background colour will be changed.

Pending changes can be applied by clicking the green tickmark button in the Process toolbar.

16.6.5.5 Delta

There is no specific command to view the difference between two processes in the this version of TerraSurveyor. Instead the user just needs to select two processes in the list and the survey will be changed to a Delta of these layers. The background colour will be changed to indicate that this is a Delta image.

16.6.5.6 Data

Lists the Trackgroups in the survey, really only of interest for gridded data.

16.6.6 Display Layers

This section allows extra objects to be added to the survey image for display and interpretation purposes. These objects include such things as text (either plain text or text generated from survey parameters) palettes, histograms, arrow, lines, etc. to be shown on and around the survey. By default these objects are all assigned to an image layer called Scenery0. However extra layers can be created as required and objects can be moved to these other layers. Layers can be displayed or hidden as necessary.

As each object is selected, information related that object will be displayed in the Parameter list.

16.6.6.1 Processes Panel

This panel is virtually identical to the Process panel in the old TerraSurveyor. Clicking any of the buttons will open a dialog box to add a process and layer to the survey. This panel can be moved and resized as required.

16.6.7 NavBar

This NavBar performs the same basic tasks as in the old version. The set of buttons at the bottom has bee replaced by a smaller toolbar with just the basic functions of Open, Save, New, Import and Download. It can also list only the new TS4 files, the old XCP files or both. Other functions that were available from the NavBar can now be found on the main menu or top toolbar.

16.6.8 Palette & Histogram

These two panels replace the fly-out palette from the Settings dialog and the small histogram at the top of the right-hand information panel. They both have more extensive display options however the Palette panel does not allow the palette to be changed.

To change display options for the Palette or Histogram, right-click on the dropdown arrow at the top-right of the panel. The menu that drops down will allow you to set the style of the palette or histogram, the background colouring method and the number of divisions used to display the palette/histogram if required.

There is considerable overlap between the two displays, the only real difference is that one is vertical and the other horizontal. In recognition of this, the palette can show either just a solid rectangular palette or one shaped to the histogram of the data with a lighter version of the palette filling in the remaining rectangle. The histogram can also have the lighter background and the shape for both panels can be either Bars, Stepped or Curved.