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EKKO_Project™ Core

Ground Penetrating Radar Software

User Guide

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EKKO_Project™ Core is included in the following bundles:

- EKKO_Project™ Examine
- EKKO_Project™ Reveal
- EKKO_Project™ 3D Reveal
- EKKO_Project™ Suite
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1 Introduction

EKKO_Project was designed to simplify the display, editing, processing, and interpretation of Ground Penetrating Radar (GPR) data.

EKKO_Project increases productivity by giving you more time to view and interpret data and less time spent organizing it.

Use EKKO_Project to display project (.gpz) files (compressed files containing GPR linesets and grid data) intuitively in the Project Explorer window. The Properties tabs display GPR line details such as acquisition parameters and attached files.

The Line Preview window automatically displays the first line in the project with the automatic view settings to optimize the GPR data image. The user can display other lines by clicking on the line name in Project Explorer or using the arrow keys.

The MapView window displays the position of grids in the project space coordinate system. If GPR data was collected with GPS or, if the relationship between the project coordinate system and the global coordinate system (Latitude-Longitude or UTM) is defined by the user, grids and the GPS path of GPR lines are displayed in MapView.

Depth slices processed in the field using the data acquisition software or using the optional SliceView module (see below) are also displayed in the MapView window. The user can scroll vertically through the depth slices using the scroll bar on the edge of the MapView window.

If the user sees a linear reflector in a depth slice, they can draw a MapView Interpretation along the top of the reflector, so the object's position and orientation can be extracted from the GPR data into a Project Report CSV file and displayed in 3D the optional third-party, Voxler® software.

The optional LineView module allows you to display one or more GPR lines and modify the view settings to use different color palettes, gains, fonts, axes, etc. See the **LineView User's Guide** for more details.

The optional Interpretation module in LineView is used to create interpretations of Points, Polylines, Boxes, and Annotations, view them in GPR lines, and then output your interpretations as Reports. Interpretations are also displayed in MapView and the optional third-party, Voxler® software. See the **LineView User's Guide** for more details.

The optional SliceView module allows GPR data with 2-dimensional positioning, such as GPS or XY, to be processed and displayed as a series of depth slices. SliceView-Grid is used to process grid data into depth slices while SliceView-Line processes or one or more GPR lines into depth slices. Depth slices enhance interpretations at complex sites by providing a powerful way of visualizing the spatial relationships between targets seen in multiple GPR lines. SliceView also allows grid data to be exported in a 3D format and displayed in 3D the optional third-party, Voxler® software. See the SliceView manual for more details.

The optional Processing module allows you to edit and process data, including cropping data, time filters, migration, and gain. You can then save processing streams as Recipes that you can apply to other GPR projects. See the **Processing Module User's Guide** for more details.

The optional Bridge Deck Condition Report module allows you to process point interpretations on the rebar in a bridge deck or other concrete structure and output a PDF report with an amplitude map image and statistics about the rebar in the structure.

The optional Pavement Structure Report module allows you to process polyline interpretations on subsurface layers and output a PDF report with cross-sections of and layer statistics.

2 Getting Started

EKKO_Project works with GPR project files called GPZ files. Each project file contains one or more GPR line data files and may contain information from other related files such as GPS files that were saved as the GPR data was collected.

New generation Sensors & Software GPR devices automatically create Project files however, GPR data collected using older Sensors & Software GPR systems can easily be added to a new EKKO_Project project file following the Creating a New Project procedure.

2.1 Project (GPZ) File Size Limits

Project (GPZ) files are limited to a maximum size of 2 GB. This includes the GPR data plus all the attachments (see Attachments Tab). If you try to save a project file and get an error message that the project file is too large to save, consider deleting large attachments.

2.2 Opening a Project

When you open EKKO_Project, the **Getting Started** dialog box automatically opens to help you open or create a new project based on the data file format you select.

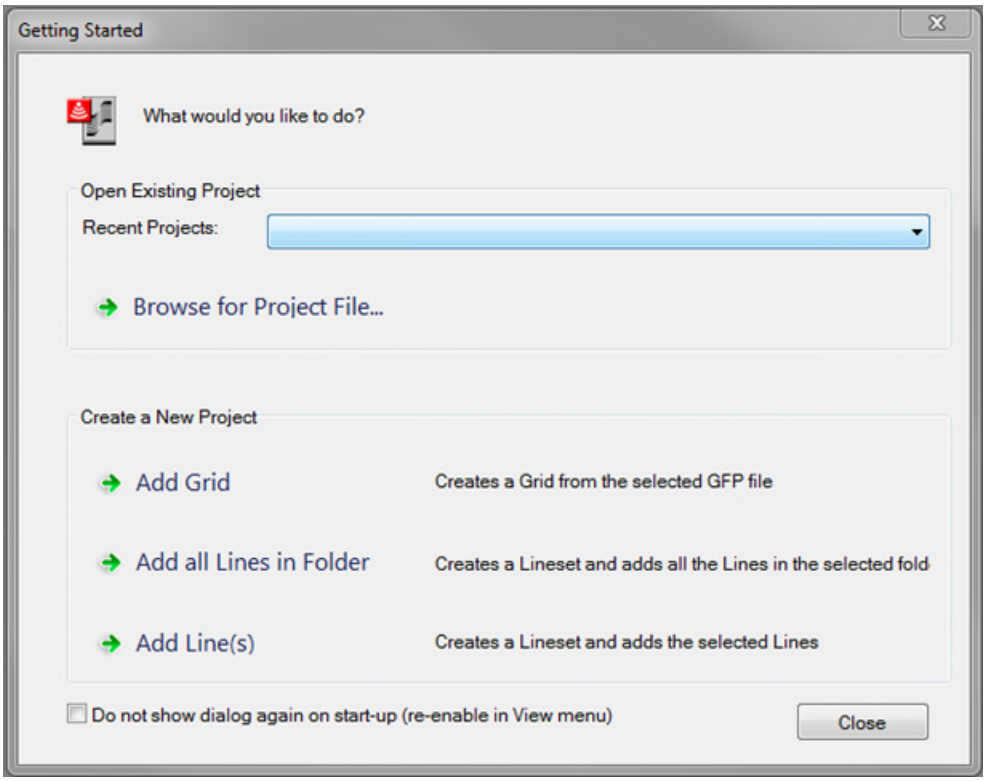
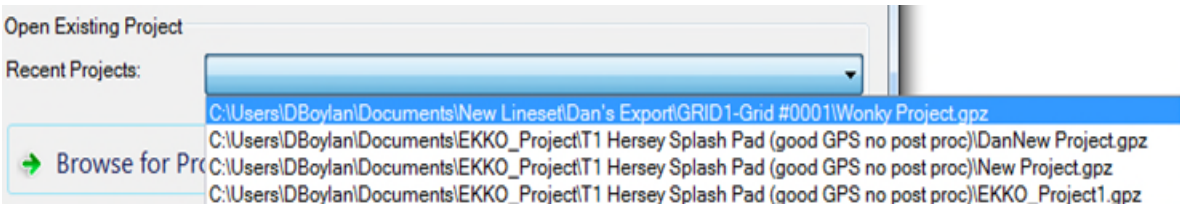


Figure 1: *The Getting Started dialog box*

2.2.1 Open a Recent EKKO_Project File

1. In the **Getting Started** dialog box **Open Existing Project** pane, click the **Recent Projects** drop-down list.

2. In the drop-down list, click the project file you want to open.



2.2.2 Open an Existing EKKO_Project File

1. In the **Getting Started** dialog box **Open Existing Project** pane, click
   Browse for Project File...

2. In the **Open** dialog, navigate to the folder and select the project file you want to work in.

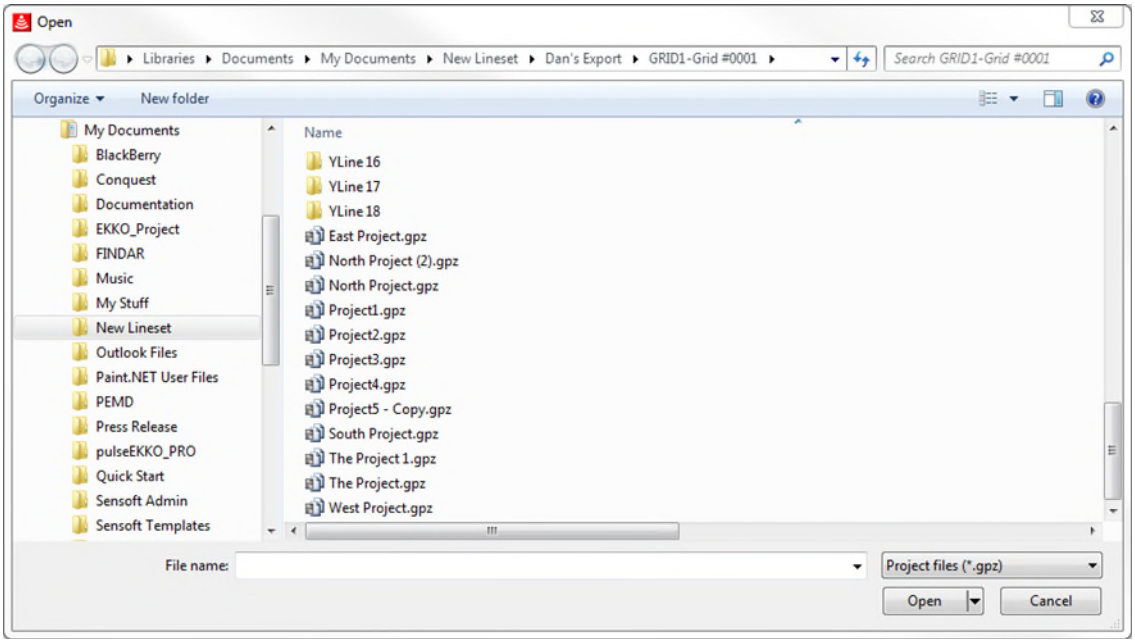


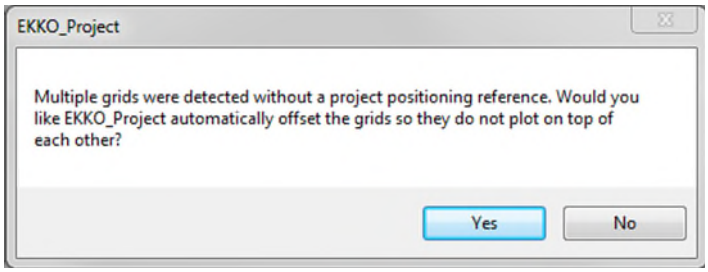
***Figure 2**: Open Dialog*

Only files with a .gpz extension are listed.

3. Select the project you want to work with and then click **Open**.

   The project contents are displayed in the Project Explorer and, if positioning information is available, the GPR lines are displayed in MapView.

   If the project file contains grids that don't have a global position reference such as GPS, a message appears:



Answering Yes will tile the grids so they are not all plotted at the origin of the project coordinate system in MapView.

Grids can be manually repositioned using the Grid Position Relationship in the Tools menu.

2.3 Creating a New Project

To create a new EKKO_Project file (typically for older GPR systems that do not automatically generate project (.gpz) files), in the **Create a New Project** pane, select one of the following options:

- Add Grid
- Add all Lines in Folder
- Add Line(s)

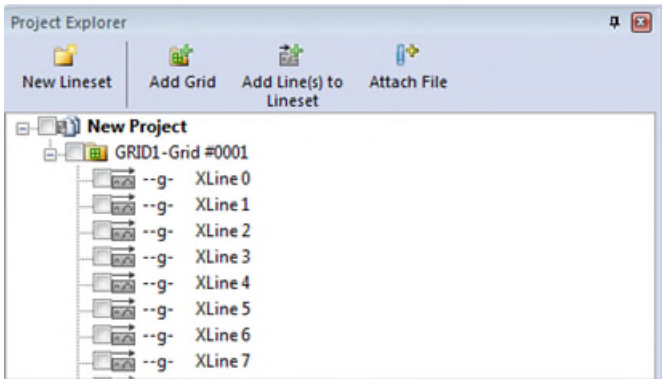
A project file can contain multiple grids and line sets.

2.3.1 Adding a Grid

1. In the **Getting Started** dialog box **Create a New Project** pane, click Add Grid.
2. In the **Open** dialog box, navigate to and then select a grid (.gfp) file.

   Only files with a .gfp extension are listed. For more details about GFP files, see Add Grid.
3. Click **Open**.

   The grid is displayed in the Project Explorer and indicated with the small green grid on the folder.



2.3.2 Adding all Lines in Folder

1. In the **Getting Started** dialog box Create a New Project pane, click Add all Lines in Folder.
2. In the **Select folder to import lines from** dialog box, navigate to and then select a folder containing GPR lines.
3. Click **Select Folder**.

   The new project folders will be displayed in the Project Explorer

2.3.3 Adding Line(s)

1. Click Add Line(s).
2. In the **Open** dialog box, navigate to and then select one or more GPR (.hd) Lines.

   Only GPR files with an .hd extension are listed.

> **Note**: although only .hd files are listed and selected, the folder must also contain the associated .dt1 file(s).

3. Click **Open**. The Line(s) are displayed in the Project Explorer

3 EKKO_Project Interface Overview

When a project file is open, EKKO_Project is populated with information about the GPR data in the Project file.

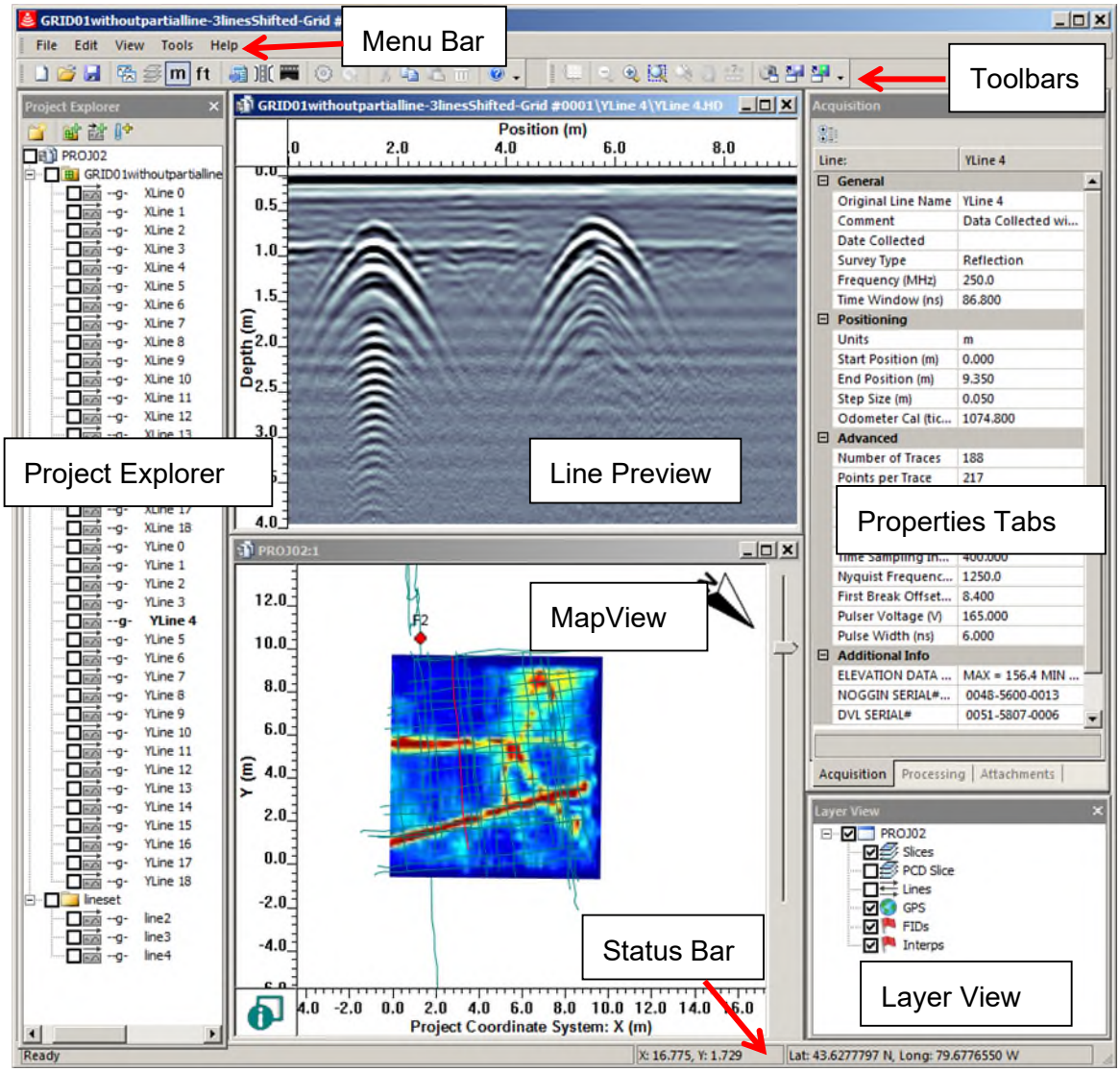


***Figure 3**: The EKKO_Project interface*

The main EKKO_Project window consists of a Menu Bar, Toolbars, Project Explorer, Line Preview, MapView, Layer View, Status Bar and Properties tabs.

All windows can be moved and resized. The tabs that make up the Properties window can be separated into individual windows (to learn more, see Window Operations).

When a project file containing grid data is opened, the 3D Preview window is available to display the grid data in a 3D format with one depth slice and two GPR cross-sections (lines) visible at the same time.

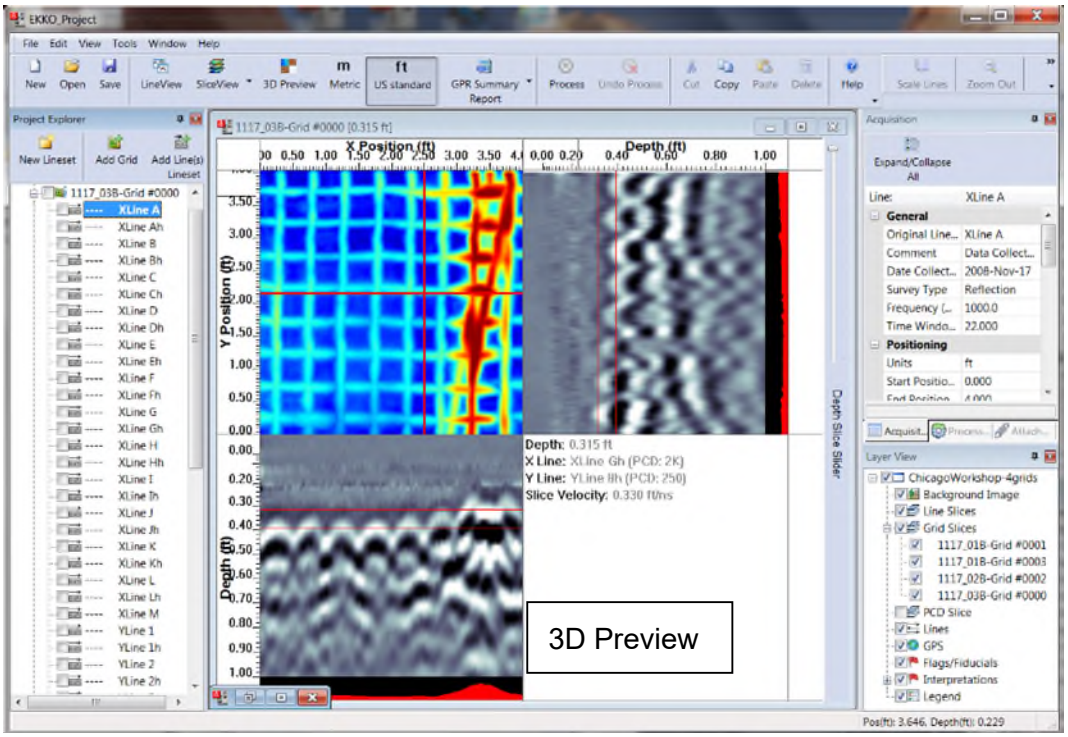


***Figure 4**: The EKKO_Project interface showing the 3D Preview window for grid data; in this example, a Conquest concrete grid scan data rebar.*

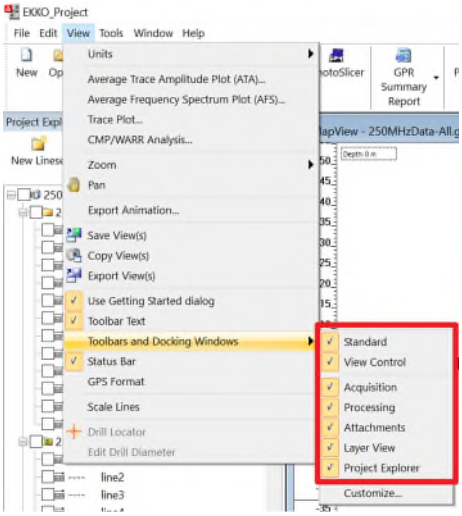
The GPR lines are oriented parallel to the cross-hair lines on the depth slice.

For the details of the 3D Preview window, see 3D Preview.

3.1 Missing Windows or Toolbars

If, when running EKKO_Project, you cannot find some of the windows and tabs that are supposed to be visible, such as the Layer View, Acquisition tab, Processing tab and Attachments tab, do the following:

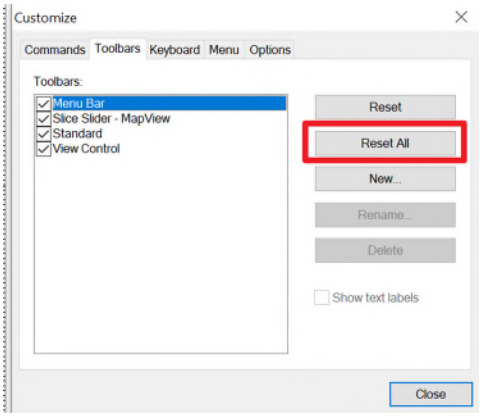
1) Go to **View > Toolbars and Docking Windows** and make sure the window is checked on.



2) Go to **Help > Restore Factory Defaults**. This should make all the windows visible.

3) If the windows are still not visible, go into **View > Toolbars and Windows > Customize**.

   Under the **Toolbars** tab, **Reset All**. Under the **Keyboard** tab, **Reset All**. Under the **Menu** tab, **Reset**.



3.2 Active Window

EKKO_Project typically displays up to three data display windows at a time: Line Preview, MapView and 3D Preview. Only one window can be active and accept changes at a time. The active window is the window that was last selected by clicking in it with the mouse cursor and is usually identified by its darker title banner.

To make changes in a particular window, first ensure it is the active window.

Trying to edit a window makes it the active window, for example, selecting a GPR line in the Project Explorer by clicking on it makes the Line Preview window the active window.

4 Project Explorer

Project, folders, and files are displayed in the Project Explorer which is similar to Windows Explorer. In Project Explorer, grids and linesets are used just like folders in Windows, and GPR lines are similar to files.

To display all GPR Lines associated with a project folder, click the plus sign (+) beside the grid or lineset name

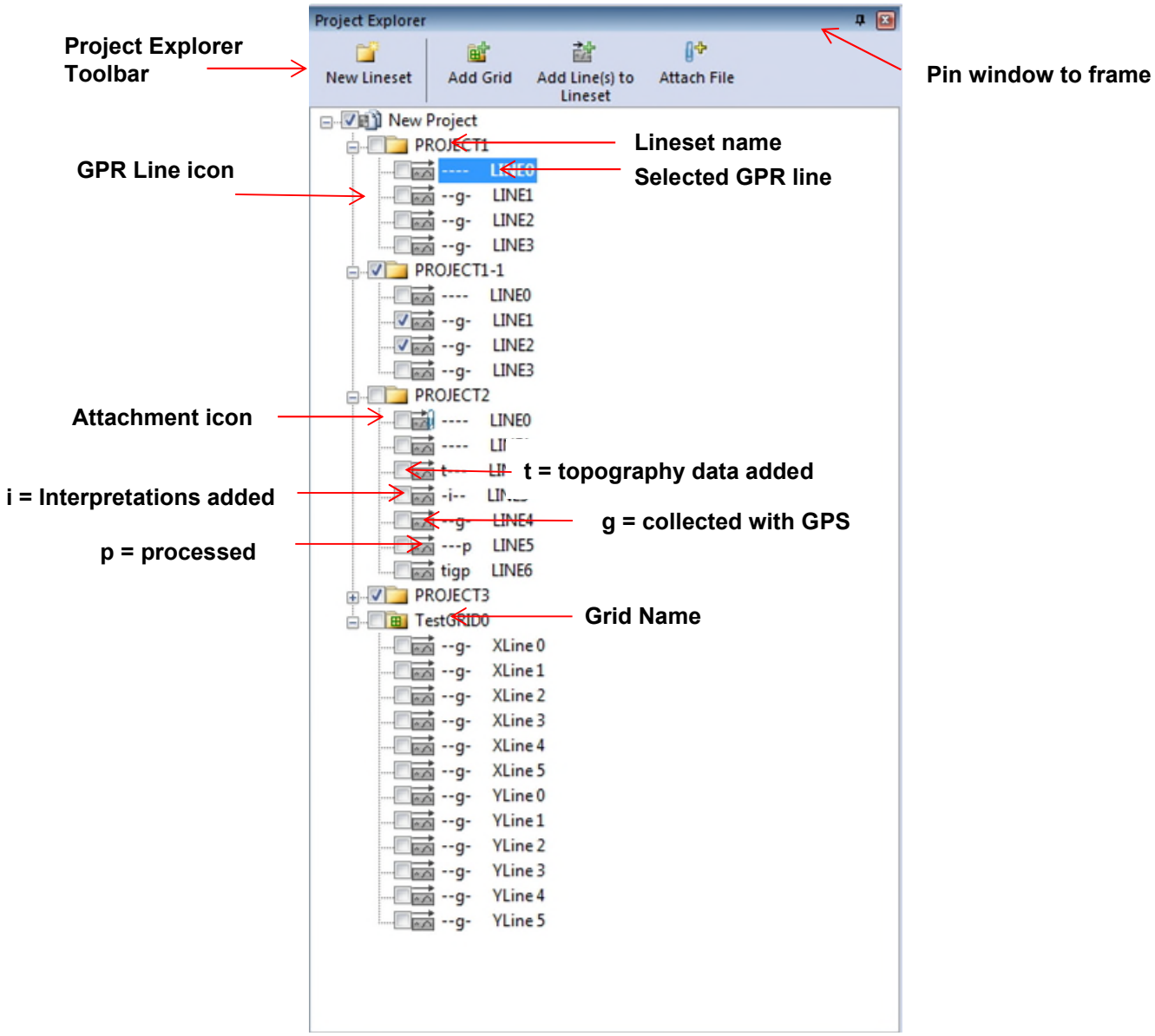


Figure 5: *Project Explorer pane displaying open data folders listing the GPR lines.*

The names of all the GPR data files in the grid and/or linesets are listed. The line icon ( ) indicates which files are GPR lines. If other files associated with the line (photos, videos, field notes, etc.) have been attached, the line icon displays a paperclip icon (to learn more, see Attach a File).

4.1 Data Collections Linesets vs. Grids

Data collections in EKKO_Project are composed of either linesets or grids.

Grids are, by definition, a complete collection of GPR lines related to one another spatially and run parallel and/or orthogonally (right angles) to one another; they cannot run at angles other than right angles.

In Project Explorer, a folder containing grid data has a small green grid drawn on it: 

To edit a grid by adding, deleting, moving, or changing the direction of lines, use the **Tools > Grid Tools >** Grid Tools menu option or by right-clicking on the grid name in Project Explorer and selecting Edit Selected Grid from the menu. However, individual GPR lines in a grid can be copied from a grid and added to a lineset.

Linesets are collections of GPR lines that may or may not relate to one another spatially.

In Project Explorer, a Lineset folder looks like this: 

Linesets can be edited to add or delete GPR lines using the Right Click menu. GPR lines in linesets can also be cut and/or copied and pasted into other linesets.

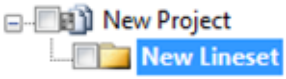
4.2 Selecting vs. Checking GPR Lines

GPR lines, linesets, grids, and projects can be selected in two different ways:

4.2.1 Clicking the Item Name

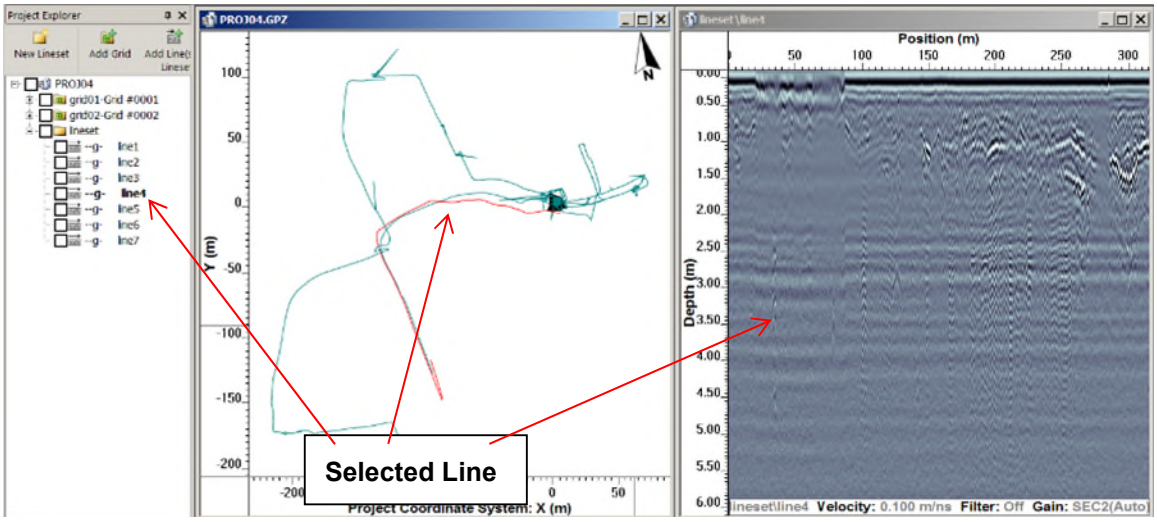
To select the name of a GPR line, lineset, grid, or project, click the item name.

Once an item is selected, it is highlighted blue and you can only apply Right Click menu operations to the item.



If the GPR line is displayed in MapView, it turns red to indicate it has been selected. For example, if a single GPR line collected with GPS is selected, the GPS path in MapView turns red. If a grid is selected, all the grid lines turn red.

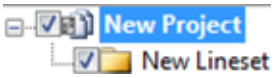
When a GPR line is selected in Project Explorer, it is displayed in the Line Preview window.



4.2.2 Clicking the Item Checkbox

To access copy, cut, paste, delete, and process operations from the Standard Toolbar or the Edit Menu, click the checkbox beside the GPR Line, lineset, grid, or project name.

> **Note**: When a GPR Line is checked, the GPR collection (lineset or grid) and the project name are also checked. This feature enables you to identify when GPR Lines in the collection are checked even if the GPR collection is collapsed (click the minus sign [-]).



4.3 Associated Data Files

An icon is displayed next to the line name in Project Explorer to indicate whether any of the following file types are attached to the GPR line:

4.3.1 GPS

If a GPS is connected to the GPR system during data collection, GPS files with the same name as the GPR line are saved to the Project file and/or data folder. When the GPR data is opened in EKKO_Project, GPS positions are automatically integrated with the GPR lines. This is indicated by the letter "g," see the example in the Project Explorer.

GPS integration means Latitude-Longitude and UTM coordinates are displayed on the Status Bar when viewing the GPR line in LineView and listed in Reports.

The name of the GPS file is listed under the Attachments tab.

4.3.2 Topography

When a topography (.top) file with elevation information is attached to a GPR line, it is indicated by the letter "t," see the example in the Project Explorer.

Integrating topography information means that the GPR line can be plotted with an elevation axis in LineView, rather than the default depth axis. Elevations of interpretations and fiducial markers are also listed in Reports.

The topography file name is listed in the Attachments tab.

Topography files with the same name and in the same folder as the GPR line are automatically attached. Topography files with a different name can be manually attached; see the Attachments tab.

GPS files also contain elevation information; see GPS Files for more information about GPS elevations and how EKKO_Project decides whether to use Topography file or GPS file elevations.

4.3.3 Interpretations

Interpretations added to the file using the optional Interpretation module in LineView are identified by the letter "i," see the example in the Project Explorer. Interpretations are points of interest (points, polylines, boxes, and annotations) added to GPR lines. This is similar to adding a flag/fiducial during data collection.

4.3.4 Processing

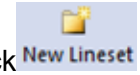
GPR data that has been processed using the optional Processing module is identified by the letter "p," see the example in the Project Explorer. See the **Processing Module User's Guide** for more details.

5 Project Explorer Toolbar

The Project Explorer toolbar displays four icons representing features that enable you to add GPR lines to the current project:



5.1 Add a New Lineset

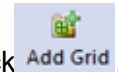
1. To add a new lineset folder to the current project file, in the menu bar click 

.

   A  **New Lineset** folder opens in the Project Explorer.

2. To rename the new lineset, right-click **New Lineset.**
3. In the drop-down list, click **Rename**.

5.2 Add a Grid

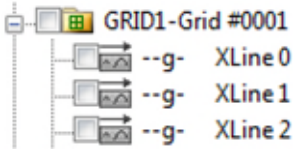
1. To add a grid (.gfp) file to the current project, in the menu bar click 

.
2. In the **Open** dialog box, navigate to the folder and click the grid file you want to open.

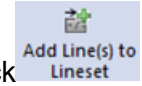
   Only files with a .gfp extension are listed.

3. Click **Open**.

   The new grid is displayed in the Project Explorer:



5.3 Add Lines to Lineset

1. To add lines to the selected lineset, in the menu bar, click 

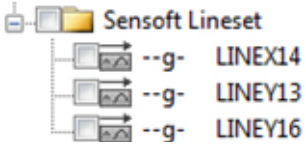
.
2. In the **Open File** dialog box, navigate the file folder and then select one or more GPR (.hd) Lines.

   The GPR lines are added to the current Lineset. If the highlighted item is not contained in a lineset, a new lineset will be created in the project.

Note: GPR lines cannot be added to a grid.

3. Click **Open**.

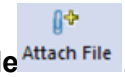
   The lines are displayed in the Project Explorer:



5.4 Attach a File

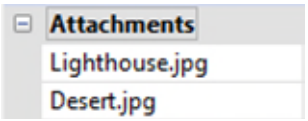
The Attach File feature enables you to attach any file to the selected GPR line, lineset, grid, or project.

> **Note**: any item with the same name as the line is automatically attached when the line is added to the project (for example, a picture of the site could be renamed as LineX0.jpg so it is automatically attached to the project when the LineX0 data is added).

1. To add an attachment to a file, in the menu bar click **Attach File** 

.
2. In the **Open File** dialog box, navigate to the folder and then select the file you want to attach.
3. Click **Open**.

   The files are displayed in the Attachments pane:



> **Note**: if you attach multiple topography (.top) or GPS (.gps or .gp2) files, the last file attached is the one that is used.

5.5 LineView Module (Optional)

Double-clicking on a GPR Line name in Project Explorer displays it in the optional LineView module. For more details, see LineView or the **LineView User's Guide**.

5.6 SliceView Module (Optional)

The SliceView module processes grids or lines into a series of depth slices.

SliceView-Grid processes a grid into depth slices.

SliceView-Lines processes one or more lines with 2D positioning (such as GPS or project XY) into depth slices.

5.6.1 SliceView-Grid

Use one of the following methods to process a grid in SliceView-Grid:

1) Double-click on a GPR grid name in Project Explorer.
2) Select or check the grid name in Project Explorer and then select **Tools > SliceView-Grid.**

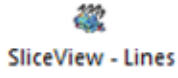
3) Select or check the grid name in Project Explorer and then click the **SliceView-Grid** button 

on the toolbar.
4) Right click on the grid name in Project Explorer and select SliceView-Grid from the sub-menu.

For more details, see SliceView-Grid or the **SliceView User's Guide**.

5.6.2 SliceView-Lines

Use one of the following methods to process a single GPR line in SliceView-Lines:

1) Select or check the line(s) in Project Explorer and then select **Tools > SliceView-Lines**.
2) Select or check the line(s) in Project Explorer and then click the **SliceView-Lines** button 

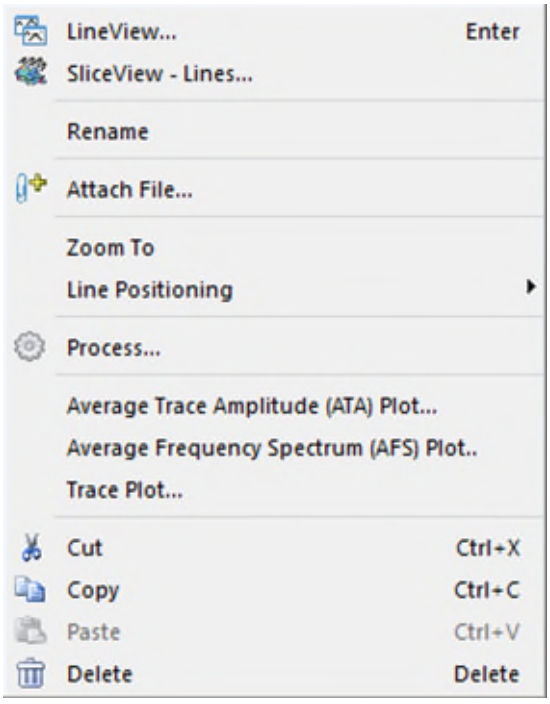
on the toolbar.
3) Right click on the GPR line name in Project Explorer and select **SliceView-Lines** from the sub-menu.

For more details, see SliceView-Lines or the **SliceView User's Guide**.

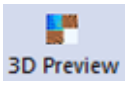
5.7 Right Click Menu

When you right-click in Project Explorer, a context-sensitive menu opens. Menu items vary depending on whether the project name, a grid, lineset, or GPR line was right clicked on.

Menu items in the right-click menu only operate on the item that was selected. The checked items in the Project Explorer are ignored.



Use the following table as a guide to working with the Project Explorer Right Click menu features:

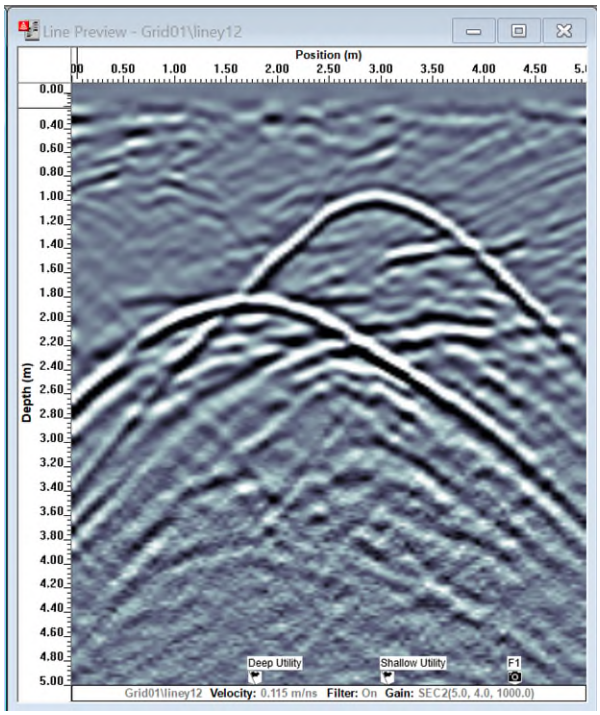
Menu Option	Description
LineView 	Click LineView to open and display project GPR lines in the optional LineView module. To learn more, see the **LineView User's Guide**. The LineView button is only visible if the LineView module was purchased.
SliceView-Grid 	Click SliceView-Grid to process and display the grid as a series of depth slices in the optional SliceView module. To learn more, see the **SliceView User's Guide**. The SliceView button is only visible if the SliceView module was purchased.
SliceView-Lines 	Click SliceView-Lines to process and display the checked lines with 2D positioning as a series of depth slices in the optional SliceView module. To learn more, see the **SliceView User's Guide**. The SliceView button is only visible if the SliceView module was purchased.
3D Preview 	With a Conquest grid selected in the Project Explorer, click to open and display the grid as a depth slice flanked with an X and Y line. To learn more, see 3D Preview.
Rename	Change the name of the project, grid, lineset, or GPR line in a lineset. **Note**: A GPR grid line grid **cannot** be renamed.
Edit Selected Grid	Edit the selected grid. See Edit Selected Grid.
Create Grid from Checked Lines	Create a new grid using the checked lines in Project Explorer. See Create Grid from Checked Lines.
Attach File	To attach any file to the currently selected GPR data line, lineset, grid, or project, click  Attach File. The file is then displayed in the Attachments tab.
Zoom To	Zoom to the currently selected GPR line or grid in MapView. The GPR line or grid must be plotted in MapView so only grid lines or lines with GPS are eligible or this option is greyed out and not accessible.
Grid Position Relationship	If a grid is selected, the grid-to-project position relationship is edited (see Grid Wizard) – useful for moving a grid in the project XY coordinate system.
Line Positioning	If a line is selected, the line-to-project position relationship is edited (see Line Positioning) – useful for defining or placing a line in the Project, Latitude/Longitude or UTM coordinate system. **Note:** the position of individual grid lines cannot be edited with this option; the options are greyed out and not accessible. The positions of grid lines are edited using the Edit Selected Grid tool.

Menu Option	Description
Process	To open the Processing dialog box, click  Process. This feature enables you to edit and process selected GPR line using repositioning, temporal and spatial filters, and migration features. See the **Processing Module User's Guide** for more details.
Undo Process	To reset the selected GPR line to its original format before processing was applied, click  For more details, see the Processing module. Undo Process. Copied GPR lines are reset to the any processing they had at the point they were copied. When processing is undone to an item, the small letter "p" beside the file name indicating that it was a processed file disappears. See the **Processing Module User's Guide** for more details.
Average Trace Amplitude (ATA) Plot	Average Trace Amplitude (ATA) plots display the average signal amplitudes (in millivolts) for the selected GPR line. ATA plots display how quickly signal amplitude decays from the peak value of the transmit pulse to the background noise level, providing an indication of the maximum penetration in the survey area. See Average Trace Amplitude.
Average Frequency Spectrum (AFS) Plot	Average Frequency Spectrum (AFS) plots the average frequency spectrum of the selected GPR line. Select AFS to determine the frequency content and bandwidth of the GPR line to decide if filtering is required. See Average Frequency Spectrum.
Trace Plot	Trace Plot is used to display individual traces from the selected GPR line; this allows the user to check the first break is correct, see subtle signals on traces or view the effect of different editing and processing types on individual traces. See Trace Plot.
Cut	Use the  Cut feature to remove the selected GPR line, lineset or grid from the project. This enables you to remove a GPR line from a lineset and paste it into a different lineset. **Note**: a GPR line cannot be cut from a grid.
Copy	Use the  Copy feature to: • Copy the selected GPR line so it can be pasted into the same or a different lineset in the project • Copy the selected lineset or grid so it can be pasted back into the project **Note**: You can copy GPR lines from a grid and paste then into a lineset, but you cannot be paste them into a grid.

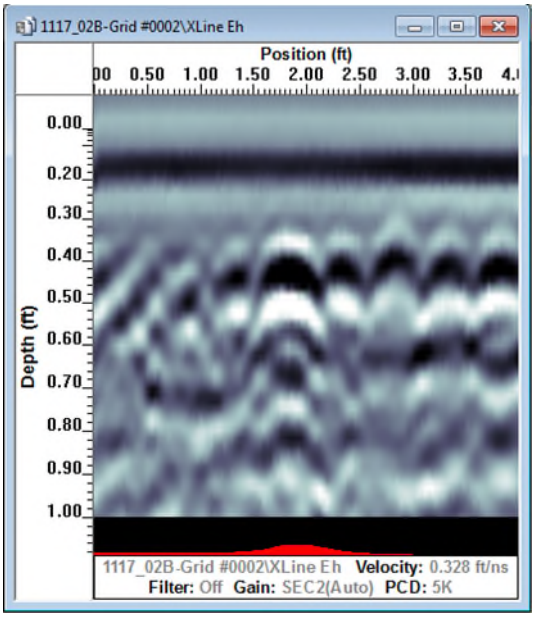
Menu Option	Description
Paste	Use the  Paste feature to: • Paste a copied or cut GPR line into the same or a different lineset in the project • Paste a copied or cut lineset or grid back into the project **Note**: You can copy GPR lines from a grid and paste them into a lineset, but you cannot paste them into a grid.
Delete	To Delete the selected grid or lineset from a project, click  **Delete**. You can also delete a GPR line from the Lineset in the project. **Note**: GPR lines cannot be deleted from a grid. .

6 Line Preview

The Line Preview window displays the GPR line currently selected in Project Explorer. When EKKO_Project first opens, Line Preview automatically displays the first GPR line listed in the project.



If the GPR line is a Conquest line that includes PCD data, the PCD response is plotted as a red graph under the line image. The maximum value of the PCD scale is displayed in the Line Preview Legend.



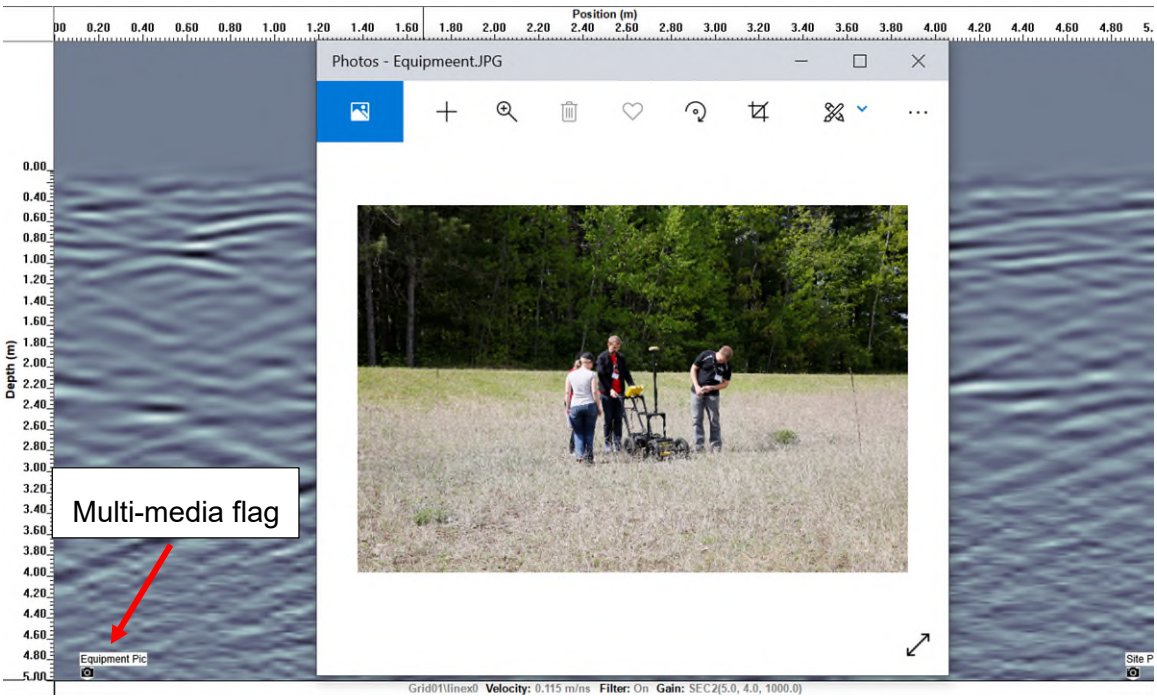
The user can change the Line Preview display to another GPR line in the project by:

1) Clicking on another line name in Project Explorer, or

2) After clicking in the Project Explorer window to make it the Active Window, using the up and down arrow keys on the keyboard to move to a new GPR line name.

Both options provide fast switching between lines to quickly review all the lines in a project.

Any Flags or Field Interpretations added to the GPR line during data collection or interpretations added to the GPR line using the optional Interpretation module are visible in the Line Preview plot. Clicking on a multi-media flag (one with a media icon such as a photo, audio or video) opens the file attached to the flag.



On the bottom of the GPR line is a simple legend listing the file path and line name, the velocity used to calculate the depth axis and the View Settings (gain and filter).

After selecting the Line Preview window, use the zoom options to zoom in, out or to a user-specified zoom window using the buttons on the View Control Toolbar or the **View > Zoom** menu options.

After zooming in, plot the whole GPR line to the Line Preview window by selecting the **Fit to Window** button on the View Control Toolbar or the **View > Zoom** menu option.

GPR lines plotted in Line Preview use an Auto gain and the color table and filter from the GPR system's data logger (DVL or Display Unit).

The View Settings can be changed by plotting the GPR line(s) in the optional LineView module and changing the View Settings there. After exiting LineView, the Line Preview settings for that GPR line are updated.

Use Measure to measure distances between objects on a GPR images displayed in LineView. The Measure tool includes the vertical component of the distance so be careful of the vertical exaggeration that is often a part of GPR data displays.

Line Preview will not plot GPR traces in wiggle mode and GPR lines cannot be plotted with an elevation axis with the traces shifted for topography – these advanced display options are available in the LineView module.

If the Line Preview window is closed, open it by selecting **Window > Open Line Preview**.

7 MapView

The MapView window shows a plan map image of GPR lines and grids. It also displays flags/fiducials, field interpretations, interpretations and depth slices added to the GPR data in the field or by using EKKO_Project. The Layer View window controls which items are visible in MapView.

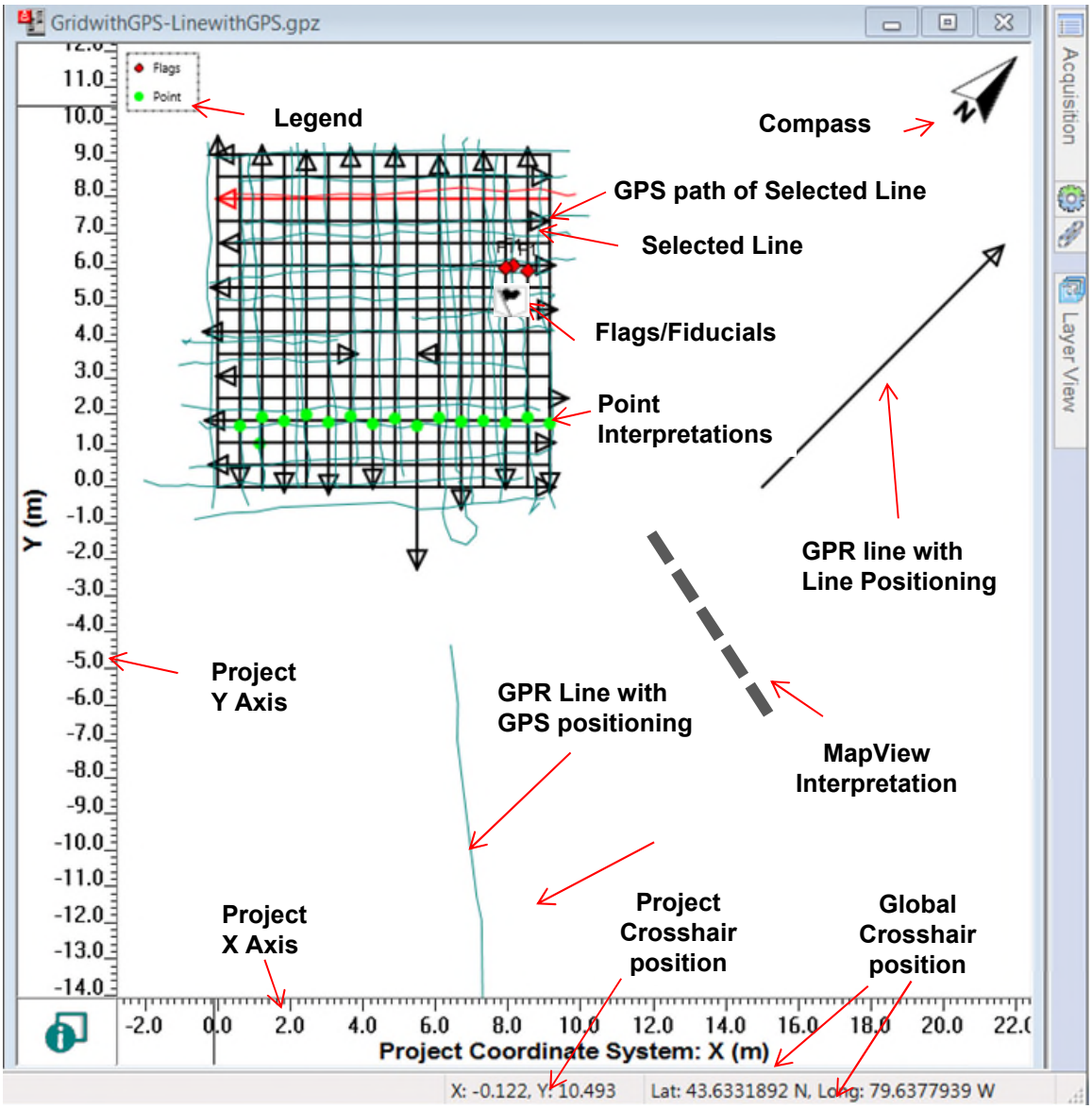


***Figure 6**: MapView Window*

If the GPR project does not contain any grids and none of the GPR lines were collected with GPS or positioned using Line Positioning, then the MapView window will not be open as there is nothing to plot.

When one or more GPR lines are selected in the Project Explorer, they appear in red in MapView. If the file has an associated GPS file, the GPS path also appears in red.

Flags always appear as a flag icon with text nearby. Flags that have had a photo, audio or video file attached to them, called multi-media flags, appear with an appropriate icon with text nearby. Clicking on the icon opens the attached file.

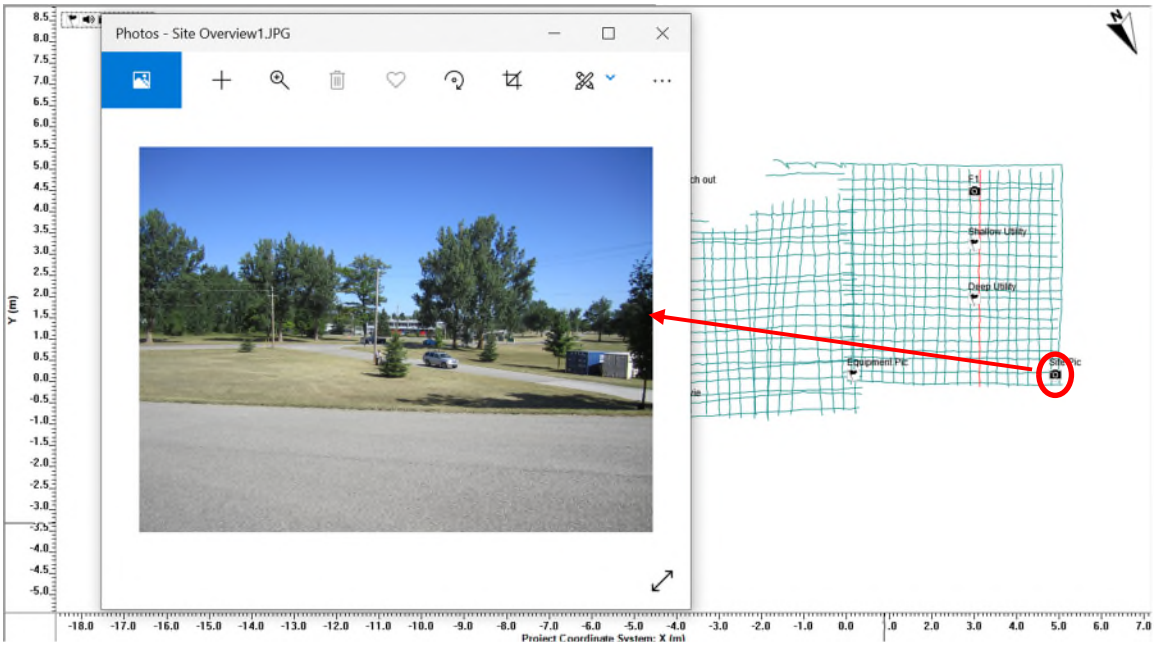


***Figure 7**: Clicking on a multi-media flag in MapView, opens the file attached to the flag.*

Interpretations appear in the color and shape they were defined with.

MapView Interpretations are dash lines drawn on the MapView window. Typically, they are drawn on features seen in depth slices. To draw MapView Interpretations, select **Tools > MapView Interpretations > Add**. (see MapView Interpretations).

Depth slices can be plotted in MapView. For more information, see below.

7.1 Project (XY) Coordinates

MapView displays GPR data in project (XY) coordinates. The horizontal axis is the project X position, and the vertical axis is the Project Y position. The units are either meters or feet, determined by the selected Units.

GPR lines are displayed in MapView as black lines with arrows. Lines collected as part of a grid are automatically displayed in MapView. Individual GPR lines are displayed in MapView if they have project (XY) positioning added to them (see Line Positioning).

Move the mouse cursor over the MapView image to display the project (XY) coordinates the Status Bar along the bottom of the EKKO_Project screen.

7.2 Global Coordinates

To show GPR data in global coordinates, such as Latitude-Longitude or UTM, the relationship between the project (XY) and global coordinates must be defined. If GPR data were collected with GPS, this relationship is automatically defined.

If a grid was collected with GPS, the grid lines are displayed as black arrowed lines, and the GPS paths are displayed as dark green lines (see **Figure 6**). Due to the variable accuracy of GPS units, the GPS lines will not typically correspond exactly with the GPR grid lines. MapView calculates the best fit of the grid to the GPS to position the grid and establish the project – global relationship.

To manually define the Project to Global relationship, use the Tools > Project Position Relationship > Wizard (see Wizard).

Once the Project to Global relationship has been defined, move the mouse cursor over the MapView image to display the Latitude-Longitude and UTM coordinates in the Status Bar along the bottom of the EKKO_Project screen.

A compass icon 

pointing to geographic North is displayed if the World-Project relationship is defined. This relationship is calculated automatically if the GPR data were collected with GPS. If this relationship is not defined, the Status Bar displays “GPS relationship not defined”.

Global coordinates are also used in output reports (see Project Report (CSV)).

If the GPS and grid lines are out by 45 degrees, it may indicate a problem with the grid definition of “X” and “Y” lines when the grid was collected in the field. To correct, see Editing Grid Line Orientation.

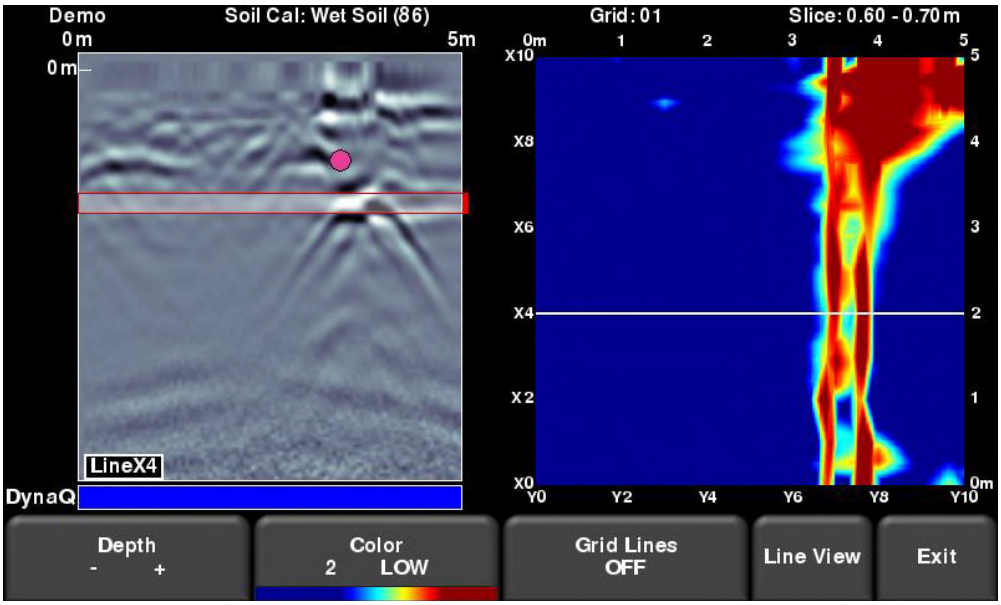
Use the following table as a guide to working with MapView:

Item	Description
Cross-hair position	As you move the cursor over an area in the Grid Map, the position of the mouse crosshair is displayed in XY and global coordinates GPS (if present) at the bottom right of the screen.
Flags/Fiducials	Flags/Fiducials are markers added during data collection at specific trace positions along the line. Flags/Fiducials can be repositioned and the labels edited if the Interpretation module was purchased (see the **LineView User's Guide** for more details).
Interpretations	Interpretations added to the file using the optional Interpretation module in LineView. Interpretations represent points of interest (points, polylines, boxes, and annotations) added to the line. To learn more, see Interpretations..
Field Interpretations	Some GPR systems such as the LMX200 have the capability of adding point interpretations in the field. These are just like the interpretations added with the Interpretation module and are displayed in MapView.
MapView Interpretations	MapView Interpretations are straight line drawn onto the MapView window. They are typically drawn on targets found while scrolling through depth slices. To learn more, see MapView Interpretations.
Selected Line	The line selected in the Project Explorer is highlighted red in the plan Map. The details of the selected line are displayed in the Properties Pane.
Compass	When the project-global position relationship is defined, a North arrow is displayed in MapView. North is not necessarily vertically upwards; if a grid is opened, MapView displays it with the Y-axis pointing vertically, which may not be North so the North arrow will then point in another direction. To rotate the MapView display so North is up, use the Reset to North function.

7.3 Depth Slices in MapView

Depth slice images can be plotted to MapView. Depth slices are generated in two ways:

1) Using the optional SliceView module or
2) For some GPR systems, depth slices can be generated on the Display Unit or DVL during data collection out in the field. For example, when using recent Noggin, LMX200, LMX150 FINDAR or Conquest systems, depth slices from grid data can be generated on the DVL.



Depth Slice generated and displayed on a Digital Video Logger. These images are saved to the GPZ file when the data is copied to a USB-memory stick and available to display in EKKO_Project.

Depth slices generated in the field are saved when the data is transferred from the DVL to the GPZ file on the USB-memory stick. These depth slices are available to plot in MapView when the GPZ file is opened in EKKO_Project.

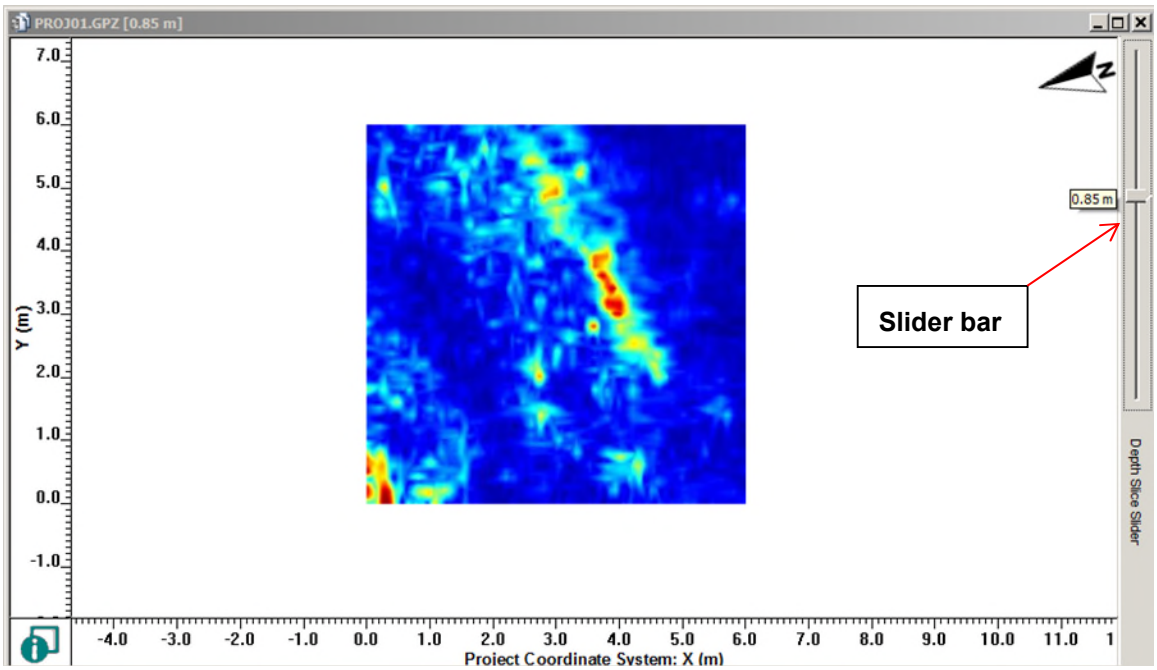
The SliceView module can generate depth slices from:

1. grid data (SliceView-Grid)
2. GPR line data (SliceView-Lines) collected with GPS
3. GPR line data (SliceView-Lines) that has XY positioning added each line in post-processing using Line Positioning.
4. GPR Lines made into a grid (Create Grid from Checked Lines).

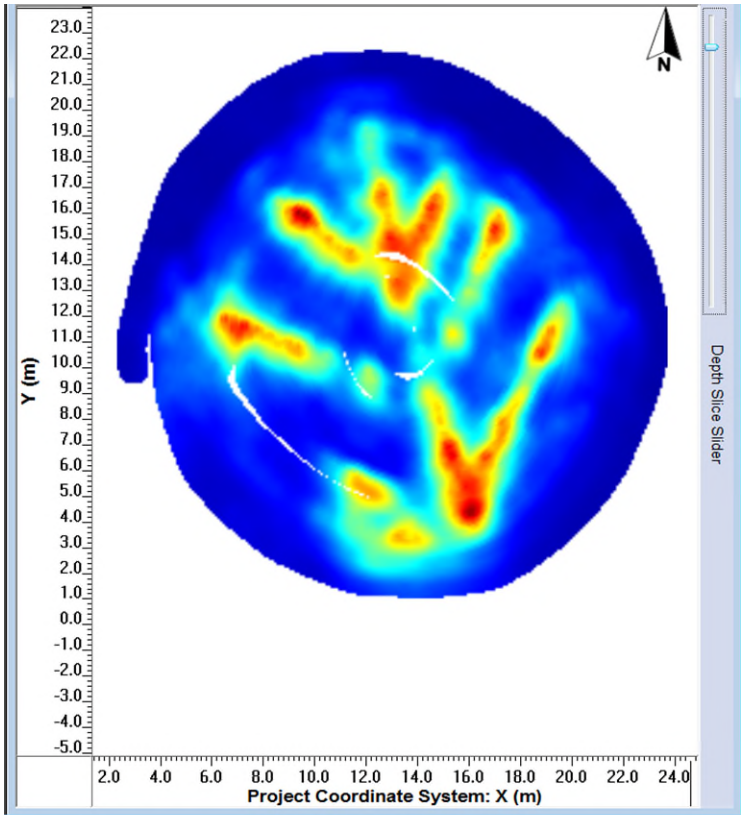
Depth slices are only displayed in MapView if they have been checked in the Layer View.

Use the depth slice slider bar on the top right of the MapView window, to scroll through the depth slices. You can also use the mouse-wheel to smoothly scroll through the depth slices, after selecting the MapView window to make it the Active Window.

The current slice depth is displayed next to the slider bar, the window title and the MapView legend in the top left corner.



Depth Slice at 0.85 m generated from a grid and displayed in MapView.

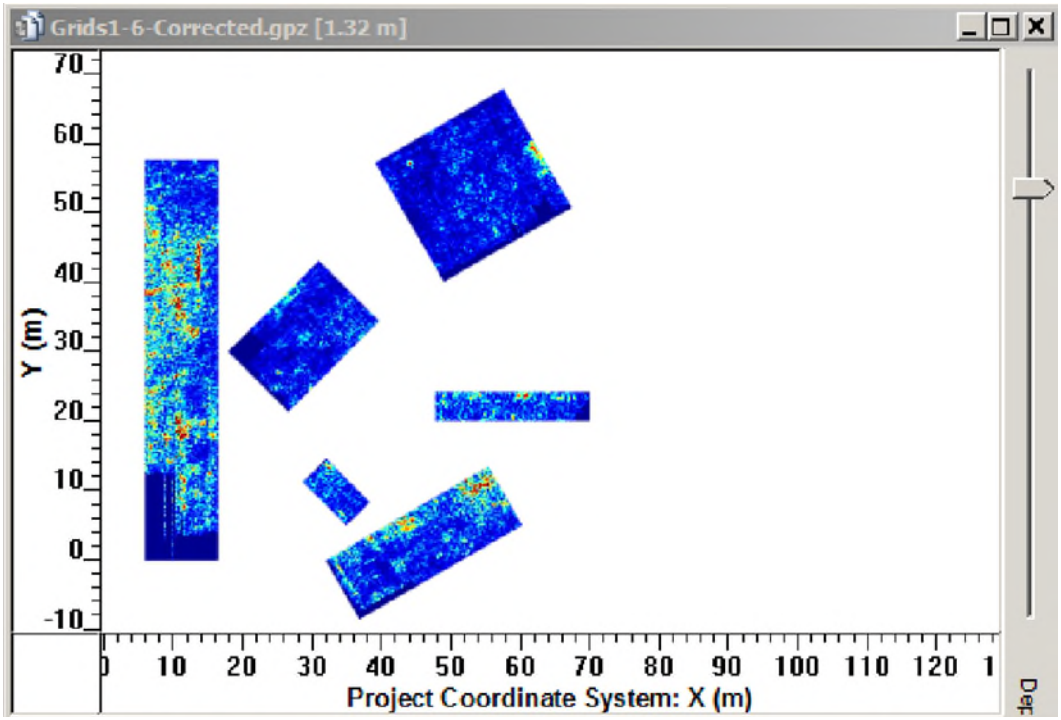


Depth Slice generated from one or more GPR lines and displayed in MapView.

For multiple grids, slice through all of them simultaneously, even if:

- they are at different angles to one another,
- they were collected with different GPR systems with different center antenna frequencies,
- they were collected with different depth slice processing (slice thickness, amplitude equalization gain, background subtraction filter, resolution, etc.).

For example, if depth slices were processed using a different slice thickness value, the depth slices shown in MapView are the depth slices closest to the current depth value.



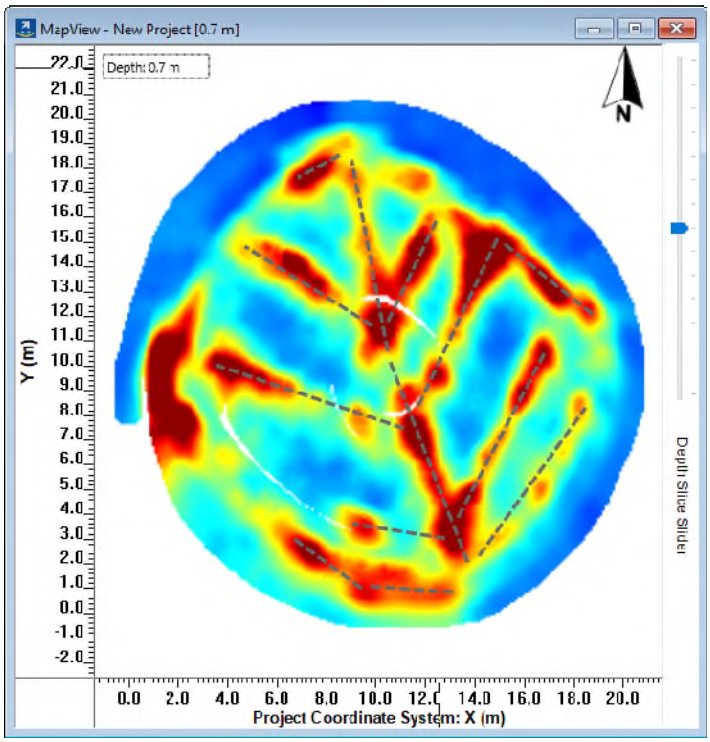
7.4 MapView Interpretations

MapView Interpretations are lines drawn in the MapView window by the user. They are typically drawn on targets found while scrolling up and down through depth slices.

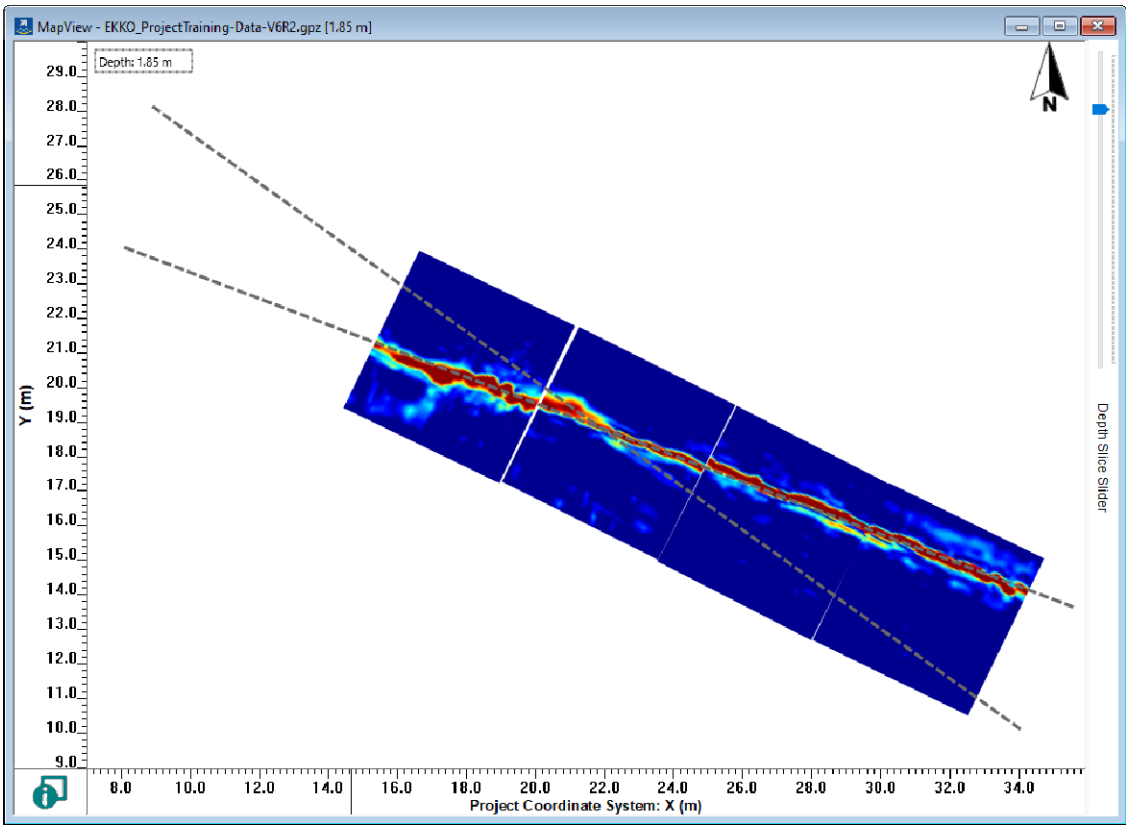
To draw one or more MapView Interpretations, go to **Tools > MapView Interpretations > Add**. Notice that when the mouse cursor is in the MapView window, it turns to crosshairs.

To draw a MapView Interpretation, click and drag the mouse cursor along the desired path. To end the line, release the mouse button.

MapView Interpretations save the depth of the depth slice they were drawn on. All MapView Interpretations are plotted in MapView, regardless of what depth they were drawn.

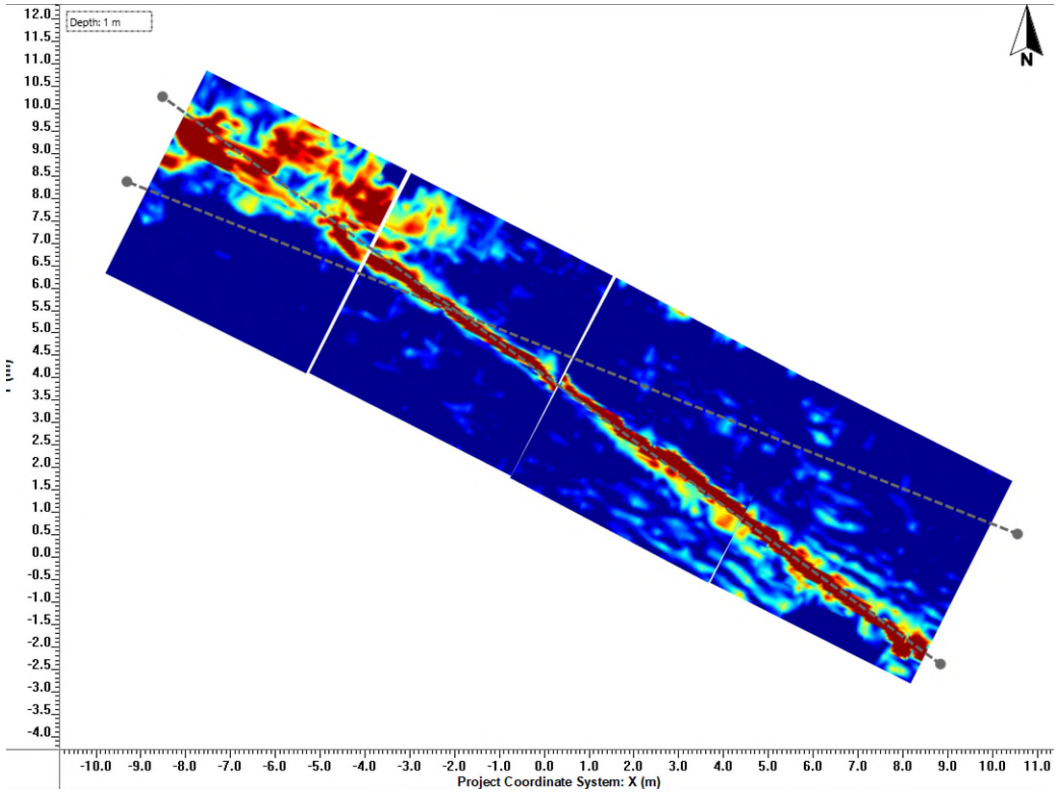


Depth Slice shown above with MapView Interpretations added along strong, red reflectors.



Depth Slice of utility data with MapView Interpretations added along red, linear reflections interpreted as utilities. Note that MapView Interpretations save the depth of the depth slice they were drawn on; the second MapView Interpretation was drawn on a different depth slice.

To delete one or more MapView Interpretations, go to **Tools > MapView Interpretations > Delete**. Notice that all MapView Interpretations have small circles added to their ends. Also notice that when the mouse cursor is in the MapView window, it turns to garbage can. Move the mouse cursor to the circle on either end of the MapView Interpretation and click to delete it.



The positions (local XYZ, Latitude-Longitude-Depth, UTM Easting-Northing-Depth) of all MapView Interpretations can be exported to GPR Project (CSV) files (see Project Report (CSV)).

When exported to a CSV, points can be interpolated between the start and end points of the MapView Interpretation. The default interpolation interval is zero (0) which means that there is no interpolation of points – only the start and end points of the MapView Interpretation are saved. If a different interpolation interval distance is entered, for example 0.1 meters or 0.333 feet, points are interpolated every 0.1m or 0.333 feet between the start and end positions of the MapView Interpretation and saved to the CSV file.

After saving the CSV file, all the Point Interpretations, including the points in MapView Interpretations are optionally plotted in 3D Voxler® (see Project Report (CSV)).

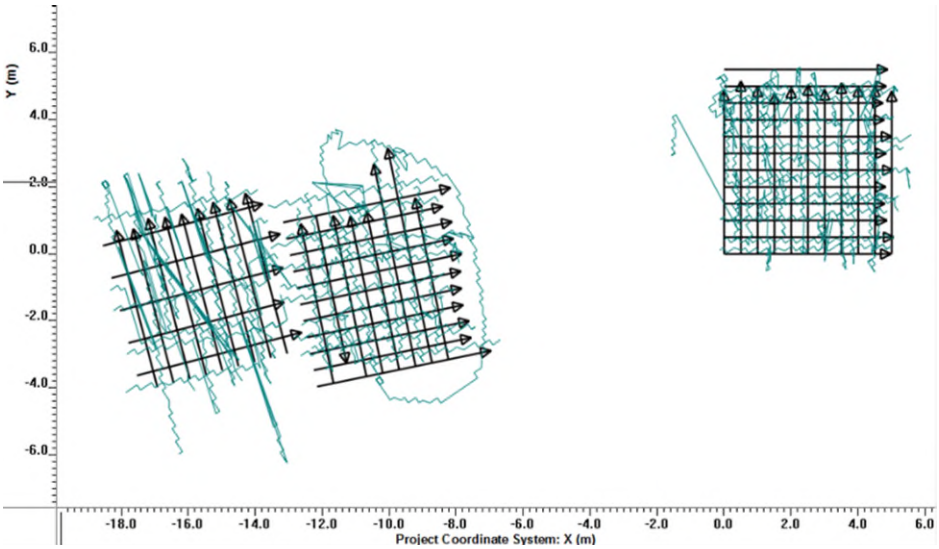
7.5 Saving MapView Depth Slices as GIF Animation Files

If the MapView window is the Active Window, select **View > Export Animation** to the depth slices to a GIF animation file. The Export Animation dialog box allows the user to set the frame speed of the animation. For more details, see Export Animation.

7.6 Displaying Multiple Grids with GPS

Many GPR surveys are made up of multiple grids. EKKO_Project can display more than one grid to confirm targets within the grids.

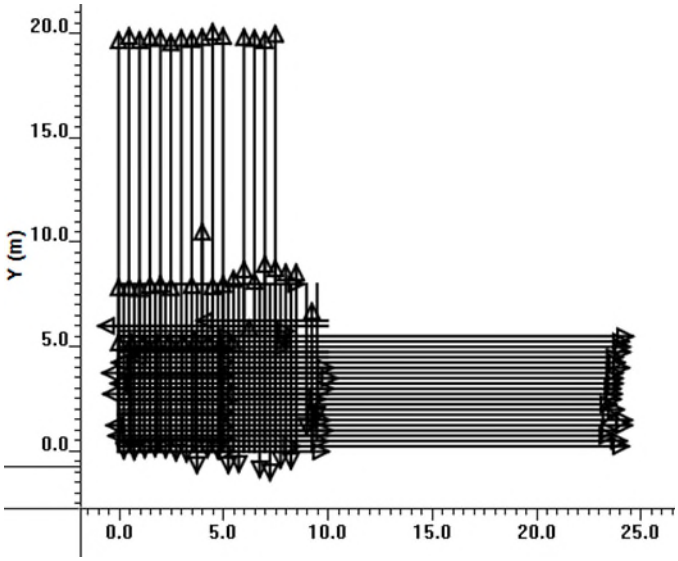
Multiple grids collected using GPS are automatically arranged within the MapView window.



7.7 Repositioning Grids

Multiple grids collected without GPS all have their X=0, Y=0 corner corresponding with the X=0, Y=0 of the Project coordinate system. When a project file containing more than one grid without GPS is opened, the user is asked if they would like the grids arranged so they are spread out and do not overlap.

Answering “No” will leave all the grids “stacked” at the X=0, Y=0 position (see figure below below).



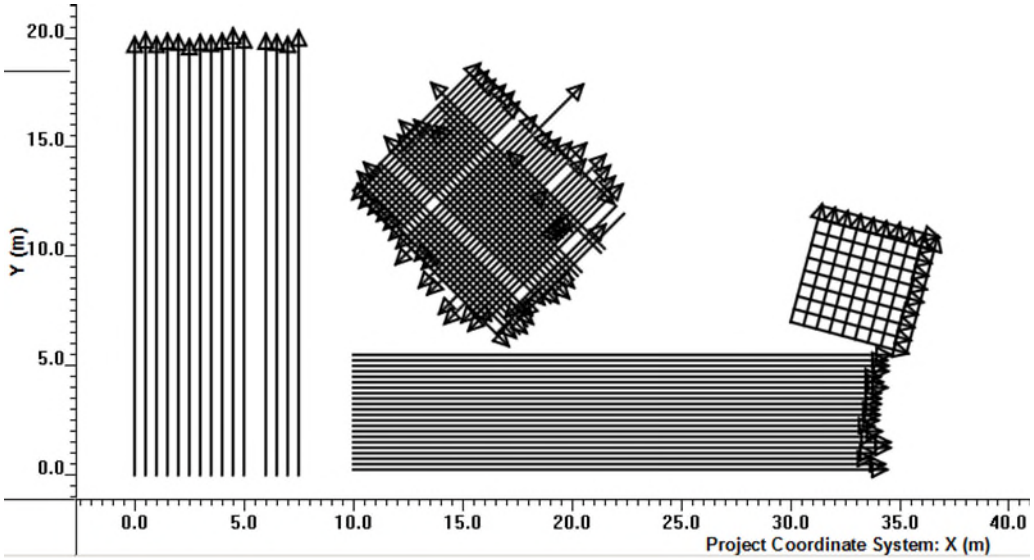
Answering “Yes” automatically shifts the grids so there is a gap between each one. In other words, the origin of all grids after the first grid is set to a value other than X=0, Y=0.

Regardless of the position of a grid in MapView, it can move to a new position. To move a grid within the project coordinate system, select the grid in Project Explorer and then:

1) right-click to open the menu and select **Position Relationship > Wizard** or,
2) select **Tools > Grid Position Relationship > Wizard**

and follow the directions (see Grid Position Wizard).

For example, the image below shows grids after each one was repositioned within the Project coordinate system.



7.8 Editing and Merging Multiple Grids

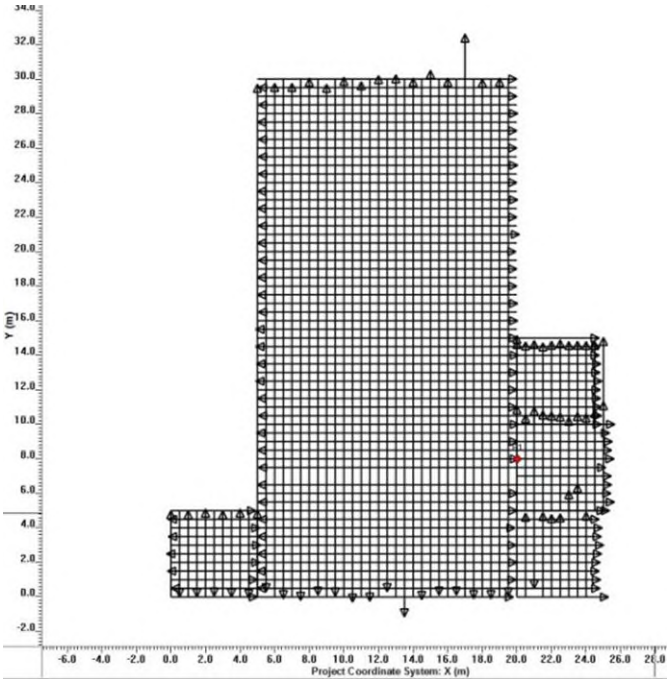
Use the Tools > Grid Tools to create grids from lines, edit grids, add lines to a grid or merge two grids together to create one large grid.

The key advantage of using the Grid Tools to merge multiple grids together is that then all grid data are processed together in SliceView, so filters such as Background Subtraction use all the data in their calculations.

Merging grids in Grid Tools requires the grid lines for all grids to be parallel or orthogonal (90 degrees) to one another. You cannot merge grids if grid lines are oriented at other angles, for example, 45 degrees.

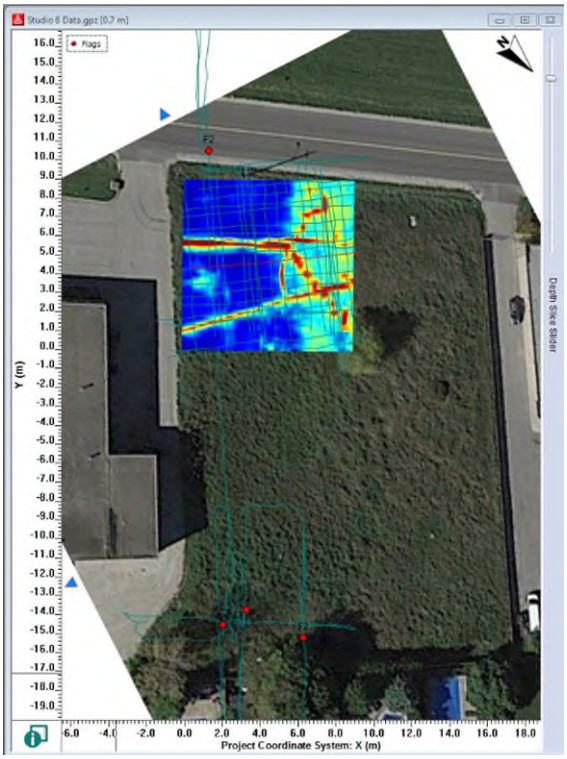
As well, all the grids being merged must have consistent settings such as antenna frequency, temporal sampling interval, antenna separation, etc. If any key settings differ between grids, they cannot be merged. In this case where there are differences, it is better to plot the grids separately as shown in the sections above.

For more details, see Adding a Grid to a Grid.



7.9 Background Images

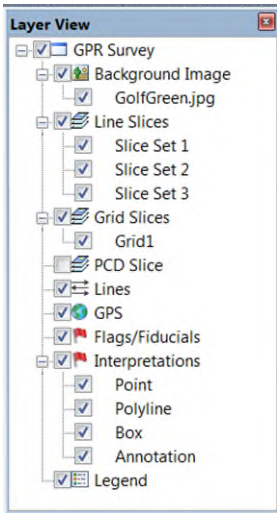
A powerful way to visualize and present data is by adding a background image to MapView.



For details, see [Add Background Image to MapView].

8 Layer View

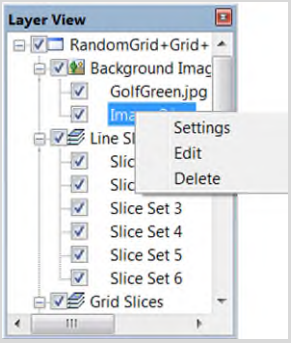
The Layer View window allows the user to specify which items to display in MapView and Line Preview windows.

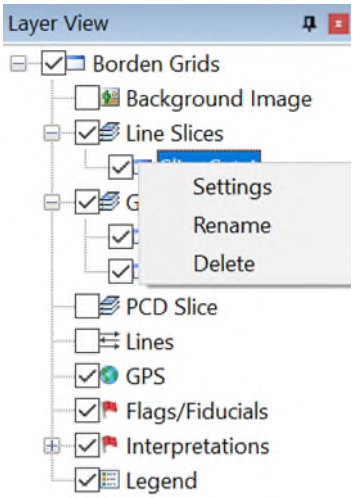


Checked items are displayed in MapView and Line Preview.

The checked status of Line Slices, Grid Slices, Lines, GPS, Flags/Fiducials and Interpretations are used to determine which elements to include in the Google Earth™ Report KMZ file (Google Earth (KMZ)).

Use the following table as a guide when working with the Layer View window:

Layer	Description
Background Image	Display the background image in MapView. It is possible to display more than one background image, so they can be stacked on top of one another or spread out to different areas of MapView. Individual images can be turned off or on using the checkbox. When multiple images are displayed, the first image loaded is on the bottom and later images are displayed above. If the image has a percentage of transparency, images underneath it will be partially visible. Right-clicking on a background image item opens a sub-menu.  Selecting **Settings** opens the Add Background Image dialog (Add Background Images to MapView) Selecting **Edit** puts handles on the image to resize or rotate it and selecting **Delete** deletes the background image.

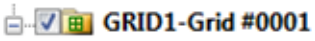
Line Slices	Plot depth slices generated with the SliceView module using the SliceView-Lines program. It is possible to display more than one Line Slice at the same time. If Line Slices overlap, they are displayed in alphabetical order from the bottom up, for example, Line Slice names that start with, say “z”, on top of ones that start with, say “a”. Right-clicking on a Line Slice item opens a sub-menu.  Selecting **Settings** opens the SliceView-Lines dialog to allow the settings for that Line Slice to be modified and the depth slices regenerated. Selecting **Rename** opens a dialog to rename the Line Slice. Selecting **Delete** deletes the Line Slice image.
Grid Slices	Plot depth slices generated with the SliceView module. Depth slices generated with the SliceView-Grid program or, for some GPR systems, in the field with the data acquisition program. For example, the Conquest, LMX200 and Noggin systems generate depth slices in the field. For Conquest users, the PDC image is always plotted on top of depth slices so ensure Grid Slices is not checked when viewing grid slices. It is possible to display more than one Grid Slice at the same time. If Grid Slices overlap, they are displayed in alphabetical order with ones that start with, say “z”, on top of ones that start with, say “a”..
PCD Slice	Plot Power Cable Detector (PCD) image in MapView. Only available for grid data collected with a Conquest GPR system. The PCD image is always plotted on top of depth slices so ensure PCD Slice is not checked when viewing the grid slices.
Lines	Plot GPR grid lines and GPR lines with project (XY) positioning in the MapView window. Grid lines plot on top of depth slices so turning the grid lines off makes the depth slices more visible.
GPS	GPS paths for lines and grids collected with a GPS in the MapView window.

Flags/Fiducials	Markers added to GPR lines in the field during data collection. When selected, Flags/Fiducials are displayed in both the Line Preview and MapView windows. Flags/Fiducials are indicated by a flag icon and a label such as F1, F2 etc. If the flag had a media file attached to it, it appears as a multi-media flag (see Line Preview and MapView). Flags/Fiducials can be repositioned, and the labels edited if the optional Interpretation module was purchased (see the **LineView User's Guide** for more details).
Interpretations	Display interpretations in MapView and Line Preview. Interpretations are added to GPR lines while analyzing the data using the optional Interpretation module in LineView. Interpretations are points of interest (points, polylines, boxes, and annotations) added to GPR lines. GPR systems with the DVL 500 data logger, such as the LMX200, newer Noggins and pulseEKKOs have the capability of adding point interpretations in the field. These are just like the interpretations added with the Interpretation module.
Legend	Display the Legend in the MapView window, defining the Flags and interpretations added to the data in the field or while analyzing the GPR data in EKKO_Project using the Interpretation module in LineView. The legend also displays the current depth of depth slices. If the Legend is covering data, it can be moved by clicking and dragging it to a new location in the MapView window.

9 3D Preview for Grid Data

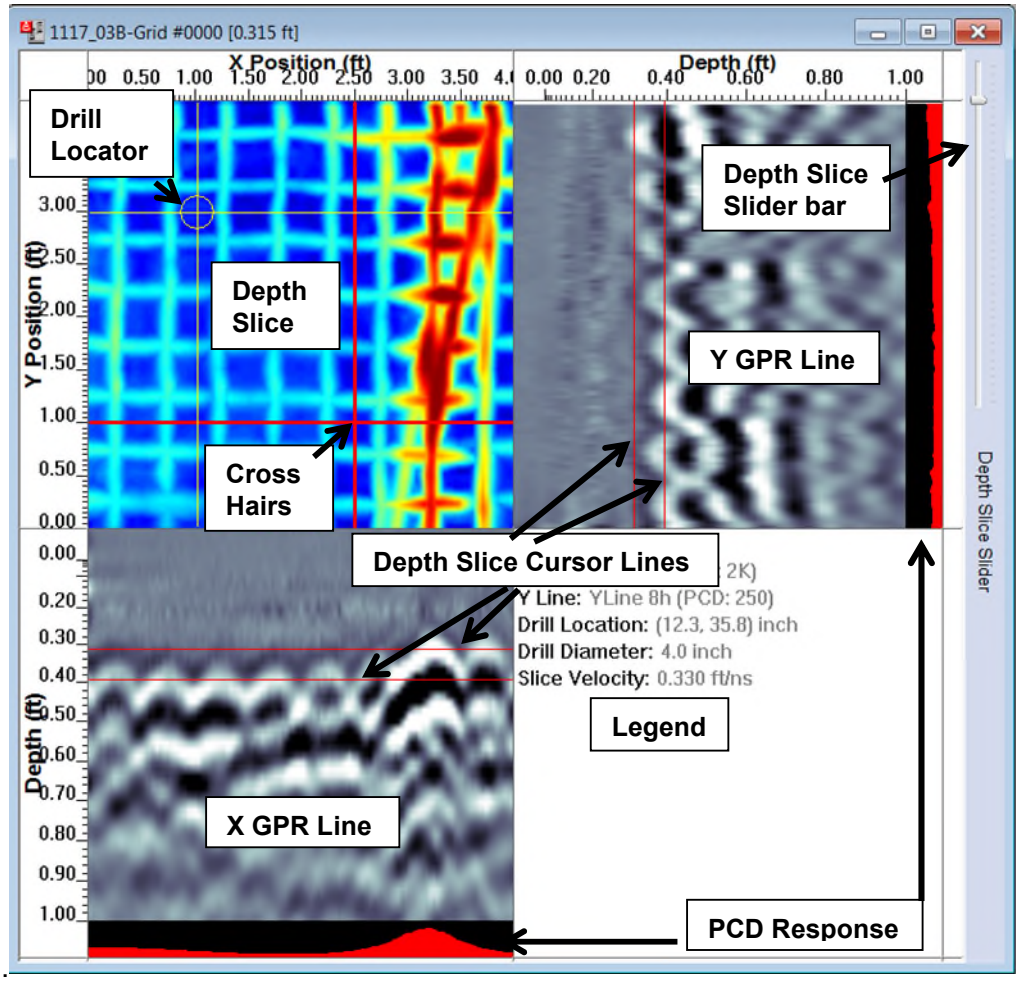
The 3D Preview window shows a depth slice image from a grid on the upper left, a GPR X line on the bottom left and a GPR Y line on the upper right.

1. To display a grid in 3D Preview check or select a grid in Project Explorer.



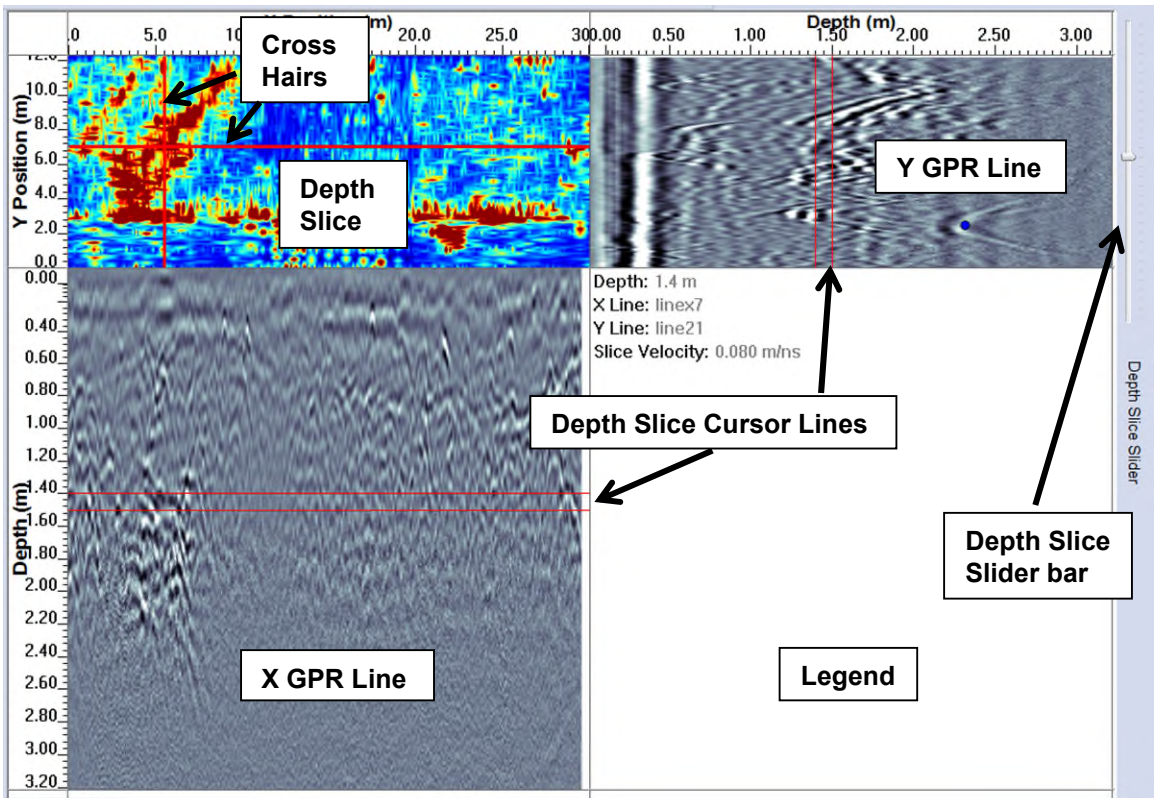
2. Click **Window > Open 3D Preview**.
3. **3D Preview** can also be opened from the Project Explorer right click menu

Here is an example of a 4x4 foot grid on concrete floor collected with a Conquest system.



Images of the 3D Preview window can be saved to the project and used in the GPR Summary Report or exported to the clipboard or an image file. They can also be saved as a GIF animation files (Export Animation)

Here is an example of a 12x30-meter archaeological grid collected with a Noggin 250 system.



For help with interpreting concrete, utility and geological data displayed in 3D Preview see Interpreting Grids in 3D Preview.

The 3D Preview window is only available if the grid data has been processed into depth slices. The depth slice processing is typically done using the SliceView-Grid function in the SliceView module. However, GPR systems with the DVL 500 data logger can process depth slices right on the display unit out in the field, specifically the Conquest 100, LMX200, Noggin and pulseEKKO have this capability. These depth slices are saved with the GPZ file when it is transferred from the display unit and copied to a computer.

9.1 Depth Slices

The depth slice image displayed is controlled by the vertical slider bar beside the window, mouse wheel or **Page Up** and **Page Down** keys, and is locked to the same slice displayed in the MapView window.

The red Depth Slice Cursor Lines indicate the depth slice thickness and the depth range of data used to calculate the current depth slice.

Clicking in the depth slice image moves the crosshairs to the nearest X and Y lines.

The Depth Slice images can be modified with different gains and color palettes by:

1) Reprocessing the grid data in SliceView-Grids after changing the slice gain, data processing and/or the slice settings.

2) Changing the settings and reprocessing the grid data on the Conquest 100, LMX200, Noggin or pulseEKKO Display Unit, exporting the new project file to a PC and opening it again in EKKO_Project,

9.2 GPR Lines

The GPR lines are displayed parallel to the crosshairs on the depth slice. The Y line is rotated so it is parallel to the vertical crosshair.

Change the current X line by pressing the **Up Arrow** and **Down Arrow** on the keyboard. Change the current Y line by pressing the **Left Arrow** and **Right Arrow** on the keyboard.

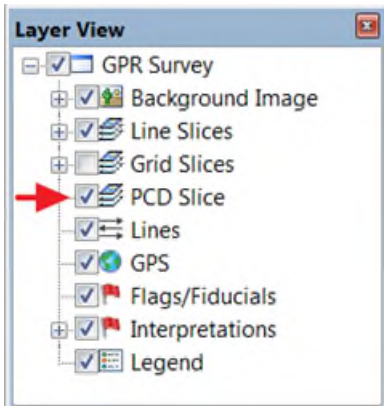
As you move the cursor over the GPR Line images, the position and depth of the mouse crosshair is displayed at the bottom right of the screen.

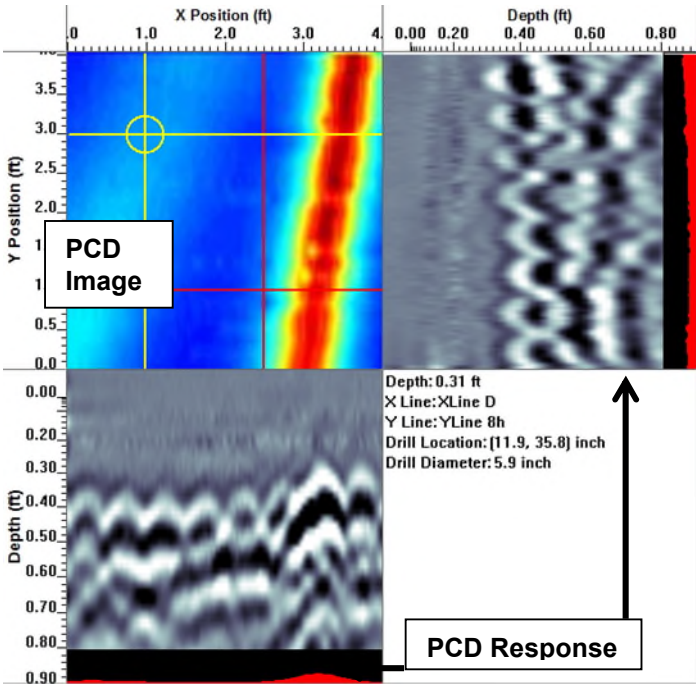
The GPR Line images can be modified with different gains, color palettes, depth, etc. by:

1) Changing the Line settings in SliceView-Grids, saving the new settings and exiting.
2) Changing the View Settings in the Conquest 100, LMX200, Noggin or pulseEKKO Display Unit, exporting the new project file to a PC and opening it again in EKKO_Project,

9.3 PCD

If displaying Conquest 100 data in 3D Preview, the PCD image replaces the current depth slice in 3D Preview by selecting it in the Layer View window:



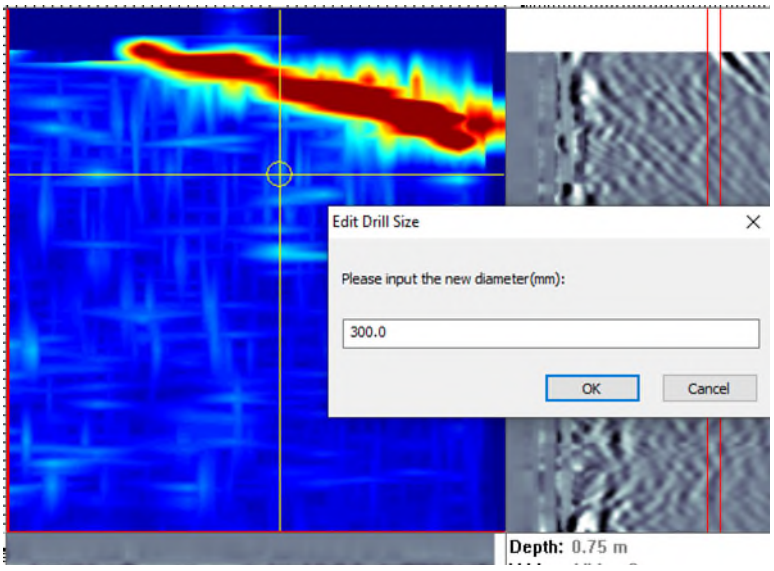


9.4 Drill Locator

The Drill Locator is displayed on the depth slice by selecting the Drill Locator button from the **View >** **Drill Locator** menu option or right-clicking on the 3D preview depth slice and selecting it from the menu.

The Drill Locator is a set of movable crosshairs and a resizable circle displayed on the depth slice to determine the XY coordinates of a suitable location to drill.

The diameter of the circle is set by the user with the **View >** **Edit Drill Diameter** menu option or by right-clicking on the 3D preview depth slice and selecting it from the sub-menu:



Enter a custom size of the drill diameter up to 36 inches or 1000mm.

9.5 Legend

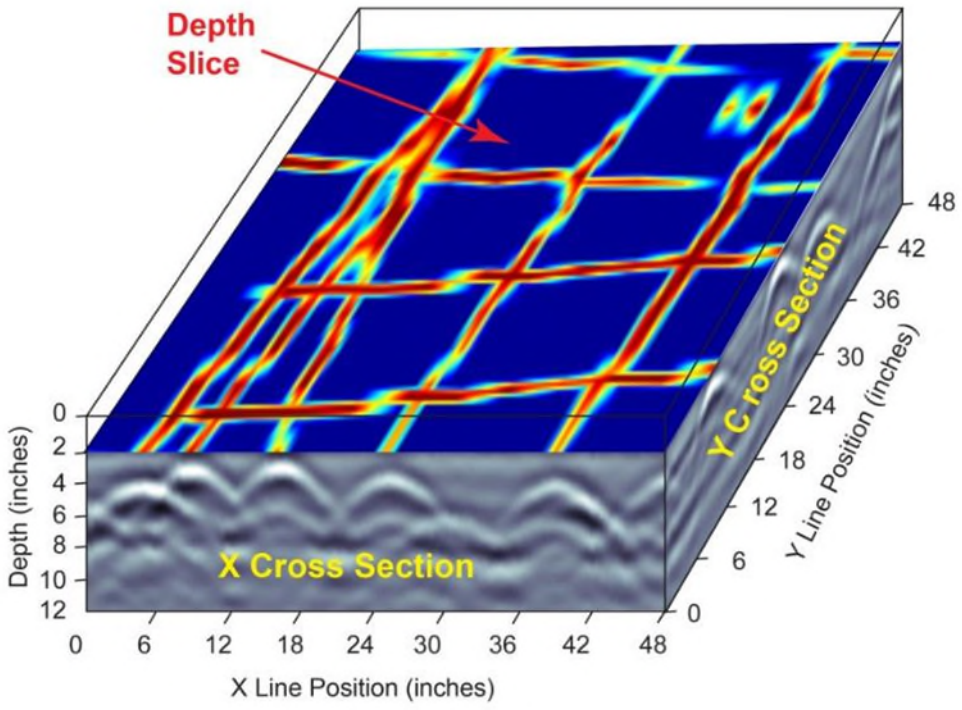
The Legend is in the lower right of the 3D Preview window. It displays the depth of the displayed depth slice, the names of the displayed X and Y lines and drill locator XY position and diameter (if displayed).

9.6 Saving 3D Preview GIF Animation

If the 3D Preview window is the Active Window, select **View > Export Animation** to save it to a GIF animation file. The Export Animation dialog box allows the user to select whether the depth, X lines or Y lines will animate while the other two are fixed on the currently selected image. For more details, see Export Animation.

9.7 Interpreting Grids in 3D Preview

When interpreting data in 3D Preview it helps to remember that the images are 3 sides of a cube of data. The conceptual grid image displays the relationship between depth slice images and X and Y GPR lines.



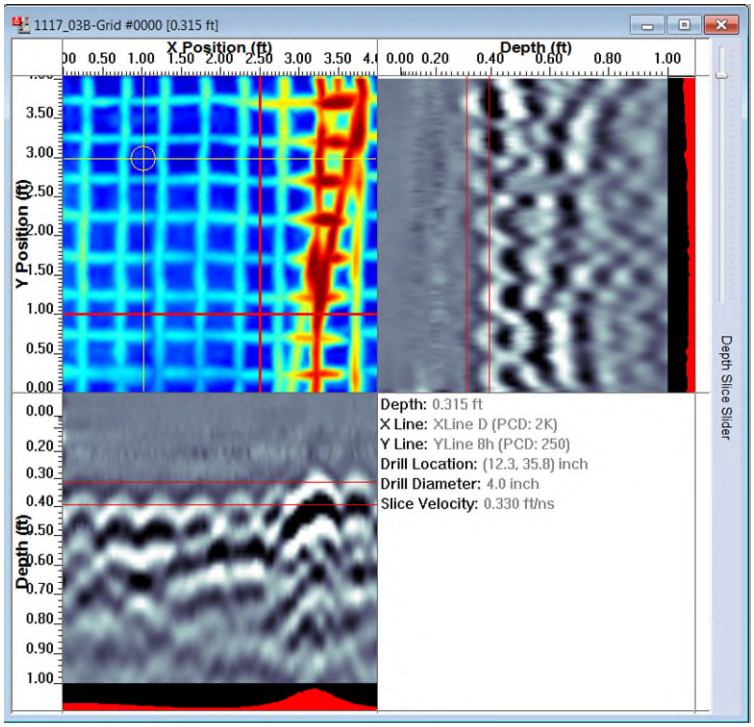
Use the following tips to help interpret grid data shown in 3D Preview for Grid Data:

1) If the grid was collected with only lines in one direction, only one set of X or Y GPR lines will appear.
2) The position of the Y line within the grid is indicated by the vertical cross-hair on the depth slice.
3) The position of the X line within the grid is indicated by the horizontal cross-hair on the depth slice.
4) The depth slice image shows an average of all the GPR signals between the two red depth slice cursor lines displayed in both the X GPR line and Y GPR line. Stronger colors usually indicate a stronger reflection and therefore, a higher contrast between the host material and the object.
5) To change the depth slice to a shallower or deeper one, use the Depth Slice Slider bar on the right side of the window. Notice how the Depth Slice Cursor Lines on the X and Y GPR lines move together.
6) Use the Measure tool to measure the distance between objects in the depth slice or the GPR lines.

9.7.1 Concrete 3D Preview Example

For the concrete grid shown in and below, the following observations can be made:

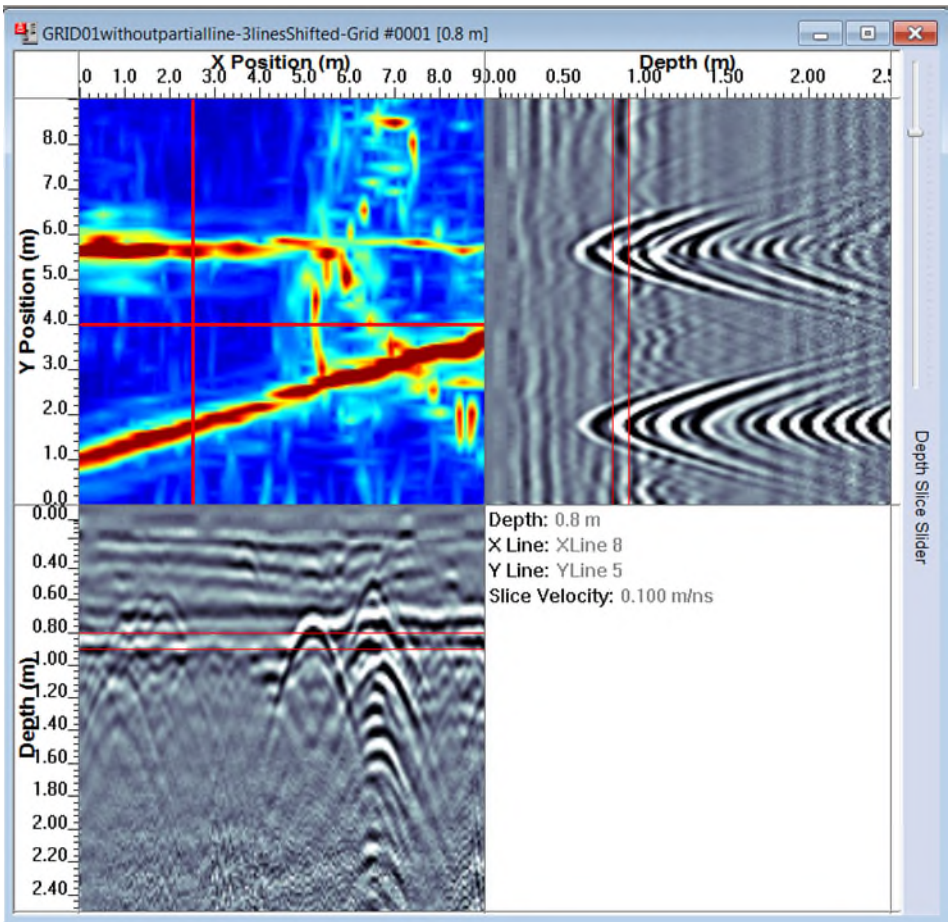
1) The current depth slice shows a rebar or wire mesh at a depth of about 0.3 feet (using the depth scale on the X and Y Lines).
2) The rebar is at a spacing of 6 inches (using Measure).
3) A conduit with current flowing in it is visible in the depth slice, the X GPR Line and the PCD response.



9.7.2 Utility 3D Preview Example

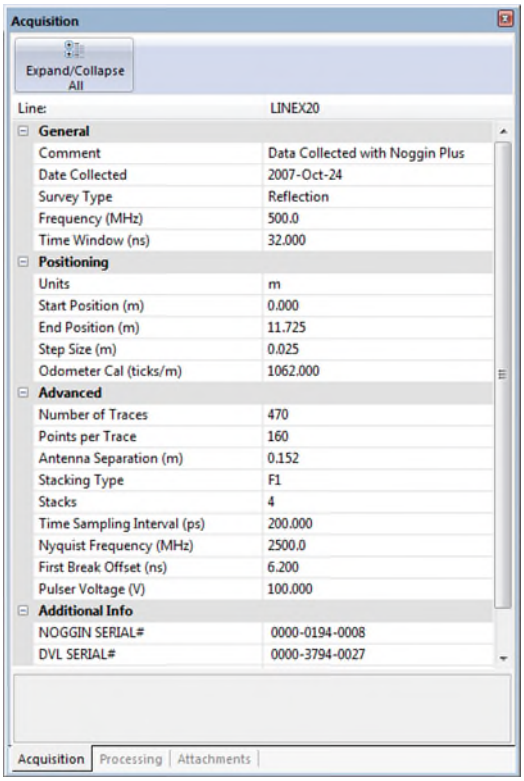
For the utility grid shown in and below, the following observations can be made:

1) The current depth slice shows two obvious utilities at a depth of about 0.5 meters (using the depth scale on the Y Line).
2) The orientation of the utilities can be seen in the depth slice.
3) Slicing through the depth slices shows other utilities at other depths and orientations.



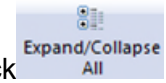
10 Properties Tabs

The Properties pane is a series of tabs that display information about the selected GPR line. The Properties pane can usually be found on the right side of the EKKO_Project screen; the tabs are displayed at the bottom of the pane.

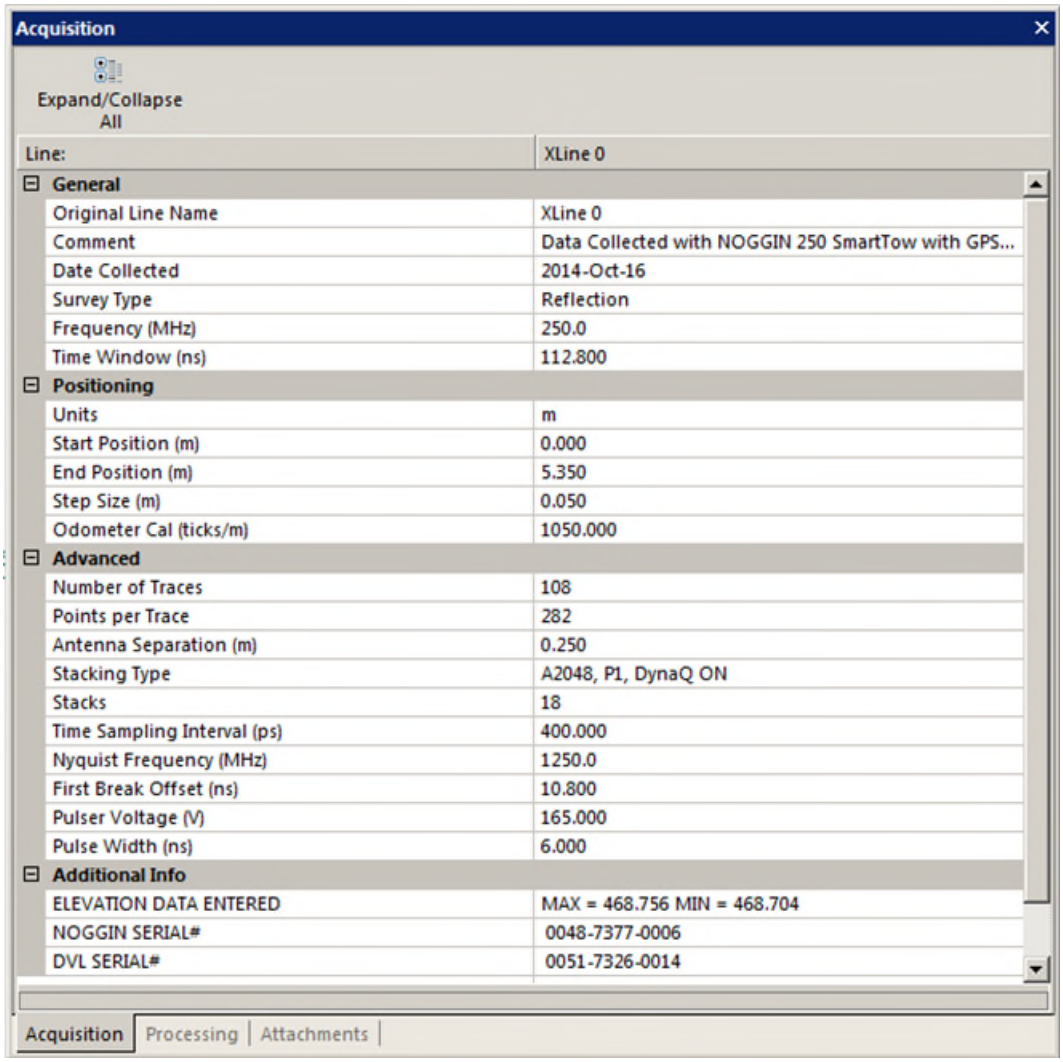


10.1 Acquisition Tab

The Acquisition tab displays information about how the GPR line was acquired. It lists the survey parameters under four headings: General, Positioning, Advanced, and Additional Info. You may need to click the plus (+) sign to view the details under a heading.

To quickly open or close all the headings, click 

.



Use the following tables to guide you through working with the Acquisition tab.

The **General** pane displays the following basic survey parameters:

Field	Description
Original Line Name	The name of the GPR line when first opened in EKKO_Project.
Comment	Comment about the system used to acquire the data.
Date Collected	The date of data collection.
Survey Type	GPR survey type: reflection, CMP/WARR, or transillumination.
Frequency (MHz)	The antenna center frequency
Time Window (ns)	The length of the time window in nanoseconds (ns).

The **Positioning** pane displays the following parameters related to the positioning of the GPR line:

Field	Description
Units	Meters or feet
Start Position	The initial position of the GPR system along the line, generally will be zero, but could be different if an offset was used, or if the line was collected as part of a forward/reverse grid.
End Position	The ending position of the GPR system along the line
Step Size	The distance interval along the surface between GPR data traces
Odometer Cal.	The calibration value of the odometer wheel (if applicable)

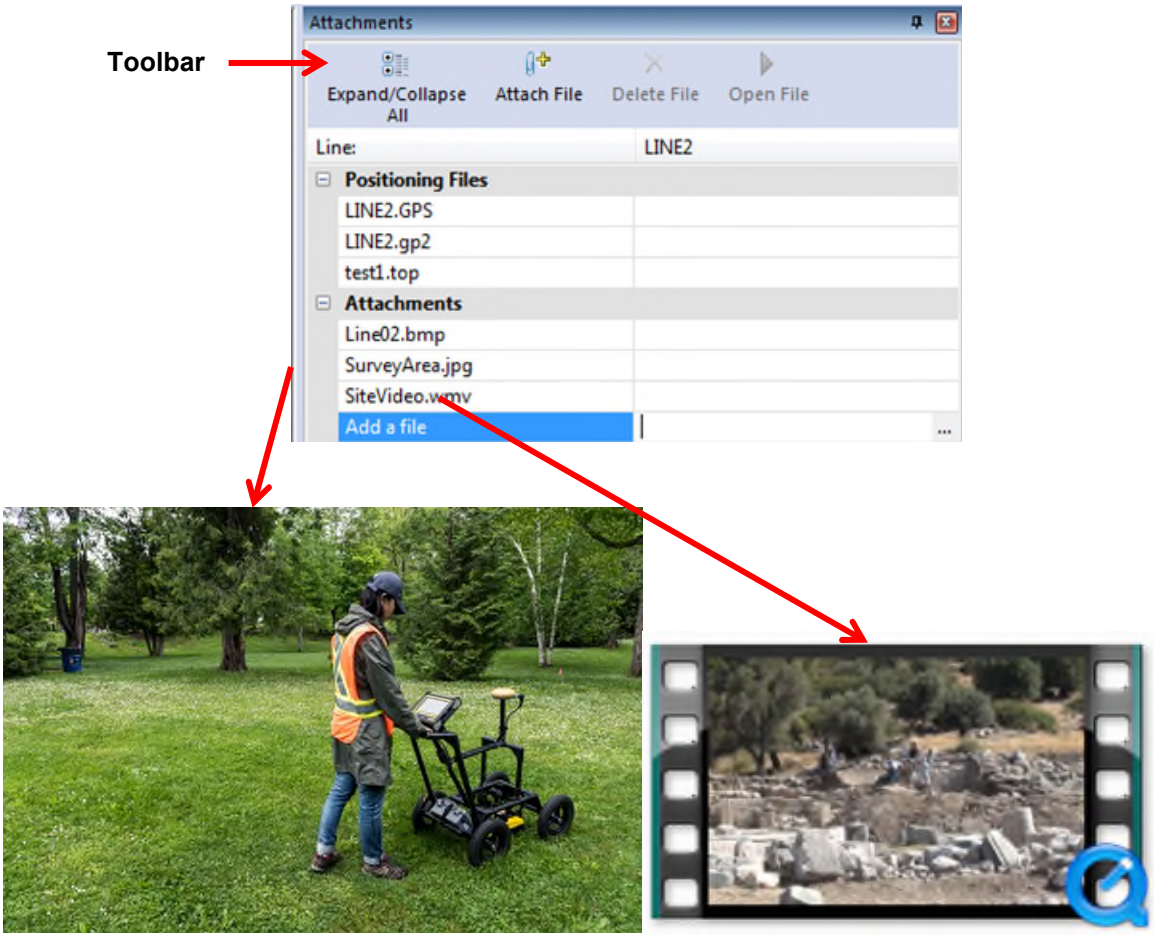
The Advanced pane displays the following advanced survey parameters:

Field	Description
Number of Traces	Total number of traces
Points per Trace	The number of sample points per trace
Antenna Separation	Spacing between transmitting and receiving antennas
Stacking Type	• **DynaQ ON**: indicates automatic stacking • **P**: number of point stacks • **S**: number of trace stacks • **A**: maximum number of stacks
Stacks	Number of repeated measurements averaged to get resulting measurements
Time Sample Interval (ps)	The time period in picoseconds at which the GPR signal is sampled. Often set automatically by the system based on GPR frequency.
First Break Offset (ns)	The number of nanoseconds from the start of the trace to the first break
Transmitter Voltage	The voltage of the transmitter
Pulse Width (ns)	The width of the GPR pulse in nanoseconds. Varies with antenna center frequency.
GPS Latency (s)	The GPS latency in seconds (only listed if a non-zero value applied)
GPS X Offset	X direction offset between GPR and GPS (only listed if non-zero value applied)
GPS Y Offset	Y direction offset between GPR and GPS (only listed if non-zero value applied)
GPS Z Offset	Z direction offset between GPR and GPS (only listed if non-zero value applied)

The **Additional Information** pane may include the serial numbers of the GPR system and the Digital Video Logger (DVL), as well as any processing done prior to importing the data.

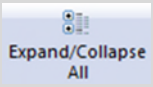
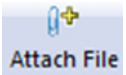
10.2 Attachments Tab

The Attachment tab lists all files attached to the current GPR line, project, grid, or lineset such as GPS files, topography files, photos, documents, videos or voice recordings of information relevant to the GPR line.



10.2.1 Attachments Toolbar

Use the following table as a guide to working with the Attachments pane toolbar:

Item	Description
	Click to display or hide the list of attached files.
	This feature enables you to attach a file to the GPR line. 1 Click **Attach File**. 2 In the Attach File(s) dialog box, navigate to and select the file you want to attach. 3 Click **Open**.

	1 In the **Attachments** tab, select the item you want to delete. 2 Click **Delete File**. 3 In the message box, click Yes. **Note**: Positioning files (GPS, Topography) cannot be deleted.
	1 In the **Attachments** tab, select the item you want to open. 2 Click **Open**. **Note**: if there is no application associated with the selected file type, Windows will prompt you to select one from a list.

10.2.2 Positioning Files

GPS and Topography files are special files called “Positioning Files”; they are always listed first in the Attachments list. When attached, either automatically or manually, they cannot be deleted, only replaced by another GPS or topography file.

If another GPS or topography file is attached, the user is prompted whether to replace the current file. If they answer “Yes”, the new file is added to the list and the old GPS or topography file is appended with the extension .BAK and kept as an attachment for record-keeping but is not used for positioning.

GPS and topography files both contain elevation information, but the topography file takes precedence. Therefore, if both a GPS and topography file are attached, the topography file elevations are used when plotting the data.

The GPS and topography file names must always match the name of the GPR line. If a GPS or topography file with a different name is manually attached to a GPR line, the name is changed to match the name of the GPR line. Further, these attached files will be automatically renamed when the GPR line name is changed. Other attachments do not follow this requirement.

10.2.2.1 GPS Files

Attaching a GPS file adds Latitude, Longitude, UTM coordinates, and GPS elevation to every trace in the GPR line.

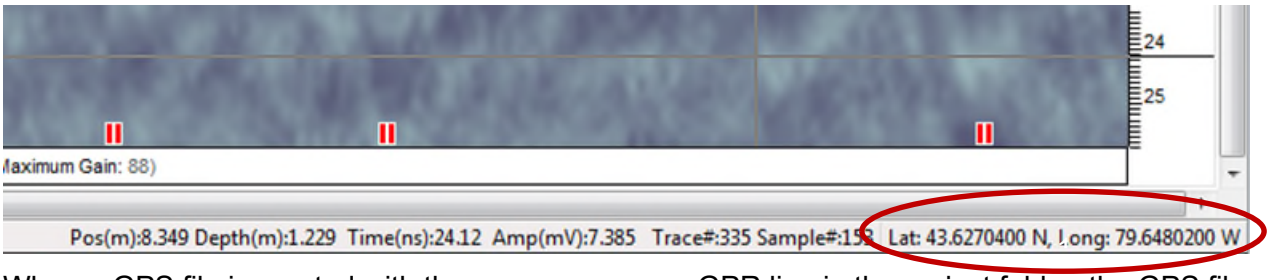
A GPS file is created by attaching a GPS system to the GPR system during data collection. GPS files contain lines of standard GPS positional output text (called NMEA strings) and the associated GPR trace number. When the GPS (or GP2) file is attached to a GPR line, latitude, longitude, and GPS elevations for every GPR trace are calculated and saved into the GPR line.

Some later GPR systems also save GP2 files, which contain GPS data in a different format than the GPS file.

Note: EKKO_Project automatically creates a GP2 file from an existing GPS file.

GPS and GP2 files formats are defined in Appendix B – File Formats.

When GPS information is available, GPR lines plotted in LineView display the GPS position of the current mouse cursor location on the Status Bar along the bottom of the screen.



When a GPS file is created with the same name as a GPR line in the project folder, the GPS file is automatically attached to the GPR line. GPS files, even those with different names, can also be attached manually. In this case the GPS file is copied, renamed to the same name as the GPR line and attached.

A GPR line with integrated GPS is indicated by a small letter “g” beside the GPR line name in Project Explorer.

10.2.2.2 GPS Elevations

GPS data contains an elevation value that is integrated with the GPR line. However, be aware that if you are using a lower-end GPS system the elevation data may not be very accurate; plotting the GPR line with an elevation axis in LineView usually provides poor results with large vertical shifts in the data image. High-end GPS systems can provide accurate elevation values that work well when the GPR line is plotted with an elevation axis in LineView.

10.2.2.3 Topography Files

A topography file is a text file containing GPR line positions and the elevations at those positions. When a topography file is attached to a GPR line, elevations for every GPR trace are saved into the elevation field of the GPR trace header.

When elevation information is available, GPR lines can be plotted in the LineView module with an elevation axis. This type of display can be invaluable for understanding the proper spatial positioning of GPR reflections.

- Each line of text must contain a pair of numbers representing position and elevation.

Topography file example:

0.0	935.8
10.1	933.9
22.7	930.3
30.5	932.7
34.6	936.5

The Topography file format is defined in Appendix B – File Formats.

> **Note**: Topographic files (.top) are stored in the same units that the data was collected in (meters or feet); however, the file could be viewed in a different unit. The units used during collection are displayed in the Acquisition tab **Positioning Pane**.

When a topography (.top) file is available with the same name as a GPR line in the folder, it is automatically attached to the GPR line. Topography files, even those with different names, can

also be attached manually. In this case the topography file is copied, renamed to the same name as the GPR line and attached.

A GPR line with integrated topography is indicated by a small letter “t” beside the GPR line name in Project Explorer.

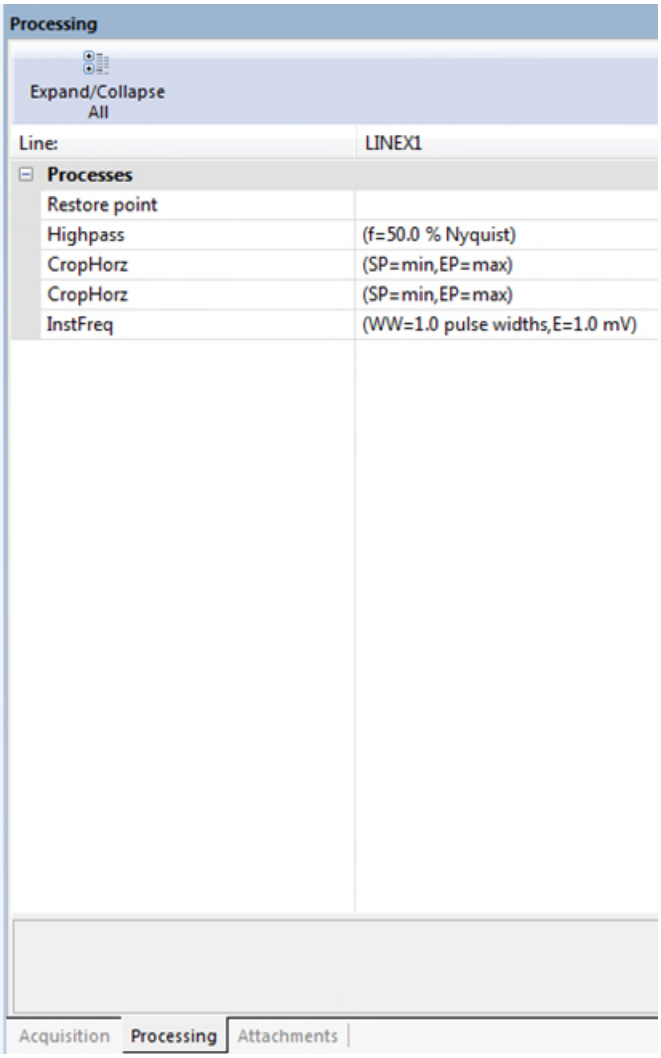
If a topography file is attached *after* a GPS file is attached, the user is prompted to confirm whether they would like to replace the GPS elevations with the elevations from the topography file. If the answer is “Yes”, the topography file is attached. If the answer is “No”, the topography file is not attached. In other words, if a Topography file has been attached, it is used for elevations.

10.3 Processing Tab

If GPR lines have been processed using the optional Processing module, the processing details, including the name of the processes, the order the processes were applied, and the details of the process parameters are listed in the Processes tab.

Only processed GPR lines are identified by a small letter “p” in the Project Explorer will list processing information in the Processes tab.

To learn more, see the **Processing Module User’s Guide**.



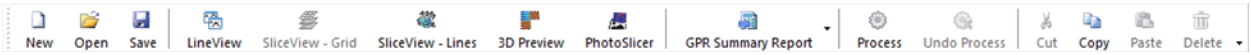
Note: Distance units (m/ft.) listed in the processes tab are always displayed in the format the GPR line was collected in, even if the Units have been changed in EKKO_Project.

11 Toolbars

To manage how toolbars are displayed ion EKKO_Project, in the menu bar, click the View Menu.

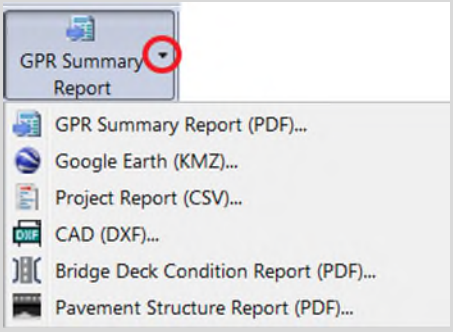
11.1 Standard Toolbar

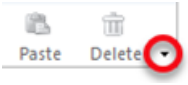
The EKKO_Project Standard toolbar displays icons or text that represents features that allow you to work with GPR data.



Use the following table as guide to work with the Standard Toolbar:

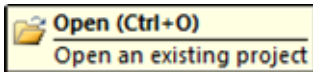
Toolbar Option	Description
New	Click New to create a New project.
Open	Click Open to Open an existing project.
Save	Click Save to Save the current project
LineView	Select an item(s) in Project Explorer and then click LineView to display the items in the optional LineView.module. The LineView button is only visible if a license for the LineView module was purchased.
SliceView-Grid	Select a grid in Project Explorer and then click SliceView - Grid to process and display the grid as depth slices using the optional SliceView module.
SliceView-Lines	Select one or more Lines with GPS positioning in Project Explorer and then click SliceView - Lines to process and display the lines as depth slices using the optional SliceView module.
3D Preview	Select a grid in Project Explorer and then click 3D Preview to display the grid as a depth slice flanked with an X and Y line in 3D Preview.
PhotoSlicer	Click the PhotoSlicer button PhotoSlicer to open a photo and select the depth slices to superimpose onto the photo. See PhotoSlicer.

Toolbar Option	Description
Report	Button to generate a report. The Report button defaults to the GPR Summary Report but changes; remembering the last type of report selected. To generate a different report than the one indicated by the button, use the dropdown menu (small down arrow) on the side of the button.  The reporting options are: GPR Summary Report Google Earth (KMZ) Project Report (CSV) CAD (DXF) Bridge Deck Condition Report Pavement Structure Report.
Process	Click Process to open the Processing dialog box. The Process button is only visible if a license for the Processing module was purchased. See the **Processing Module User's Guide** for more details.
Undo Process	Click Undo Process to Undo Processing applied to the checked GPR lines. The Undo Process button is only visible if a license for the Processing module was purchased. See the **Processing Module User's Guide** for more details.
Cut	Click Cut to Cut the selected or checked item(s) and place them on the clipboard. This enables you to remove a GPR line from a lineset and paste it into a different lineset. **Note**: a GPR line cannot be cut from a grid.
Copy	Click Copy to Copy the selected or checked GPR line(s), lineset, or grid, and place them on the clipboard.

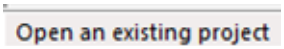
Toolbar Option	Description
Paste	Click  to Paste the cut or copied GPR line(s), lineset, or grid from the clipboard into the project.
Delete	Click  to Delete the selected GPR line, lineset, or grid from the project.
Add or Remove Buttons	Click the small drop-down arrow to the right of the Delete button  to add or remove buttons from the Standard toolbar. To learn more, see Add or Remove Buttons.

To display a brief description of the icon's function, hold your mouse cursor over the icon on the toolbar.

If a keyboard shortcut is associated with the toolbar item, it is displayed with the tool tip

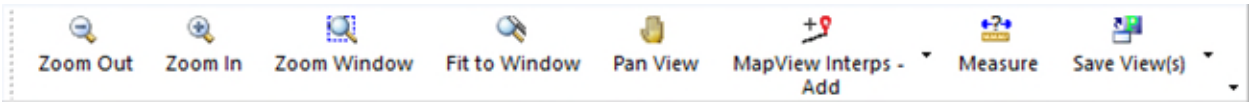


A description also appears on the Status Bar at the bottom of the screen:

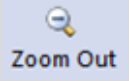


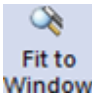
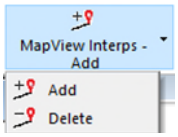
11.2 View Control Toolbar

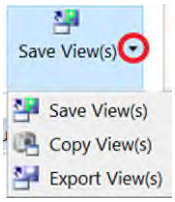
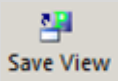
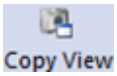
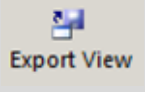
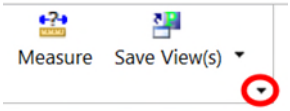
The EKKO_Project **View Control** toolbar allows you to manage how to display images in MapView and Line Preview.



Use the following table as a guide to working with the View Control toolbar:

Field	Description
Zoom Out	Click  to display 1.5 times more of the MapView image. For Line Preview, Zoom out shows more horizontal data in the window. To learn more, see Zoom Out.
Zoom In	Click  to magnify the MapView image by 1.5 times. For Line Preview, Zoom in shows less horizontal data in the window. To learn more, see Zoom In.

Field	Description
Zoom Window	 Click to magnify a selected area within MapView or Line Preview. To learn more, see Zoom Window.
Fit to Window	 Click to automatically zoom to fit all data in the MapView or Line Preview windows. To learn more, see Fit to Window.
Pan View	 Click to pan the Display area (drag and drop) in MapView. Not available for Line Preview. To learn more, see Pan View.
MapView Interpretations	 Click to add MapView Interpretations in the MapView window. Once in **Add** mode, click the desired start point of the line and drag to the desired end point, releasing the mouse. Continue to add as many MapView Interpretations as desired. When finished, exit **Add** mode by clicking on the MapView Interps button again. To delete MapView Interpretations, use the dropdown menu (small down arrow) on the side of the MapView Interps button and select **Delete**:  Once in **Delete** mode, click the small circles at the start or end of the MapView Interpretation to delete it. Continue to delete as many MapView Interpretations as desired. When finished, exit **Delete** mode by clicking on the MapView Interps button again. To learn more, see MapView Interpretations
Measure	 Click to measure distance in the MapView, Line Preview and 3D Preview windows. To learn more, see Measure.

Field	Description
View(s)	Buttons to Save, Copy or Export the current image (see below). The View(s) button visible on the toolbar defaults to Save View(s) but changes; remembering the last type of View(s) selected. To select a View(s) option other than the one indicated by the button, use the dropdown menu (small down arrow) on the side of the button: 
Save View	Click  to save the Active Window or all open windows as an image file and attach it to the project file. This image can be included in the GPR Summary Report. To learn more, see Save View.
Copy View	Click  to copy the Active Window or both the MapView and Line Preview windows to the clipboard. To learn more, see Copy View.
Export View	Click  to export the Active Window or both the MapView and Line Preview windows as a graphics image file (jpg, bmp, png etc.) To learn more, see.Export View.
Add or Remove Button	Click the small drop-down arrow beside the **Save View(s)** button to add or remove buttons from the View Control toolbar.  To learn more, see Add or Remove Buttons.

11.2.1 Measure

To measure distance within the MapView, Line Preview or 3D preview windows, click .

Click and drag the ruler icon () to span two points within the MapView that you want to measure.

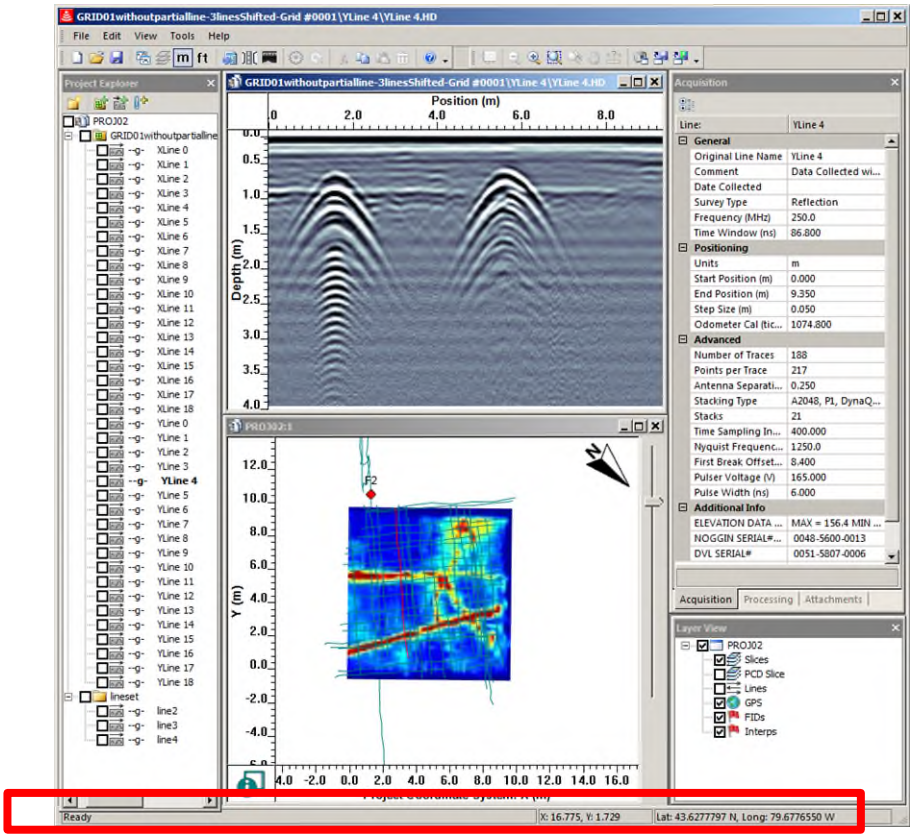
The measured distance is displayed in the Status Bar on the bottom left:



The first value indicates the straight-line distance between the two points. The values displayed in brackets represent the distance along the X-axis and Y-axis respectively.

12 Status Bar

The Status Bar is displayed along the bottom edge of the EKKO_Project window:



As the mouse cursor moves around the various windows and toolbars, relevant information is constantly displayed on the Status Bar including:

Toolbars

- Description of the function of the button
- Measurement distance when the Measure button is selected (see Measure)

Line Preview window:

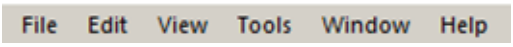
- Position along the GPR line
- Depth
- Trace number
- Time

MapView window:

- Positional information in Project X,Y coordinates
- Latitude/Longitude and UTM positions (see GPS Format) providing a Project-to-Global position relationship has been defined (see Project Position Relationship)

13 Menu Bar Overview

The EKKO_Project menu bar displays several options that allow you to create, save, manipulate, and export GPR data.



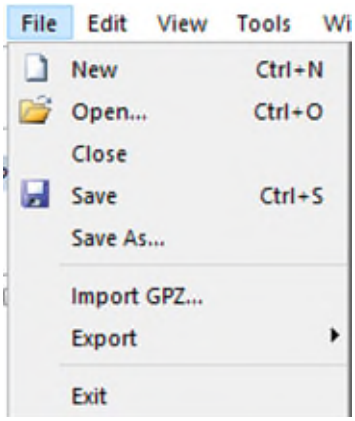
Use the following table as a guide to working with the EKKO_Project menu bar:

Field	Description
File	Create a **New** project, or **Open, Close, Save, Report, Export,** or **Exit** existing projects. To learn more, see the File menu.
Edit	Update your project - add lines, linesets, or grids, rename files, or attach files. To learn more, see the Edit menu.
View	Display units in meters or feet, view data in **Average Amplitude Spectrum, Average Trace Amplitude** or **Trace Plot** graphs, or define how the toolbars are displayed. Perform **CMP/WARR Analysis**. To learn more, see the View menu.
Tools	Access LineView (optional), SliceView-Grid and SliceView-Lines (optional), modify Project or Grid Position Relationships, Add Positioning to Lines, Processing (optional) and GPS routines. Add background image to MapView and Edit grids with the X and Y lines mixed up. To learn more, see the Tools menu.
Window	To open the Line Preview or MapView windows or tile the Line Preview and MapView windows horizontally or vertically. To learn more, see the Window menu.
Help	Display information about EKKO_Project, a PDF version of this manual, the About dialog, and the EKKO_Project Registration. See Help.

14 File Menu

Use the File menu to create a New project, Open, or Save files, create Reports, Export lines, or **Exit** the EKKO_Project.

To open the file menu drop-down list, click **File**:



The following sections describe the File menu features:

14.1 New

1. To create a new project file, In the EKKO_Project menu bar, click **File** > **New**.

   Alternatively, in the Standard Toolbar, click 

.
2. In the **Getting Started** dialog box (**Figure 1**), in the C**reate a New Project** pane select one of the three data type options to add GPR data to a new project file:

   - Add Grid
   - Add all Lines in Folder
   - Add Line(s)

Note: Project files can contain multiple grids and linesets.

To learn how to add more data to the current project file, see the Edit menu.

14.2 Open

1. To open an existing project (.gpz) file in EKKO_Project, click **File > Open**.

   Alternatively, in the Standard Toolbar, click 

.
2. In the **Open** dialog (Figure 2), navigate to and then select the project you want to open.
3. Click **Open**.

14.3 Close

1. To close the current project click **File > Close**
2. In the message box, to close the project and save your changes, click **Yes**.

   To close the project without saving your changes, click **No**.

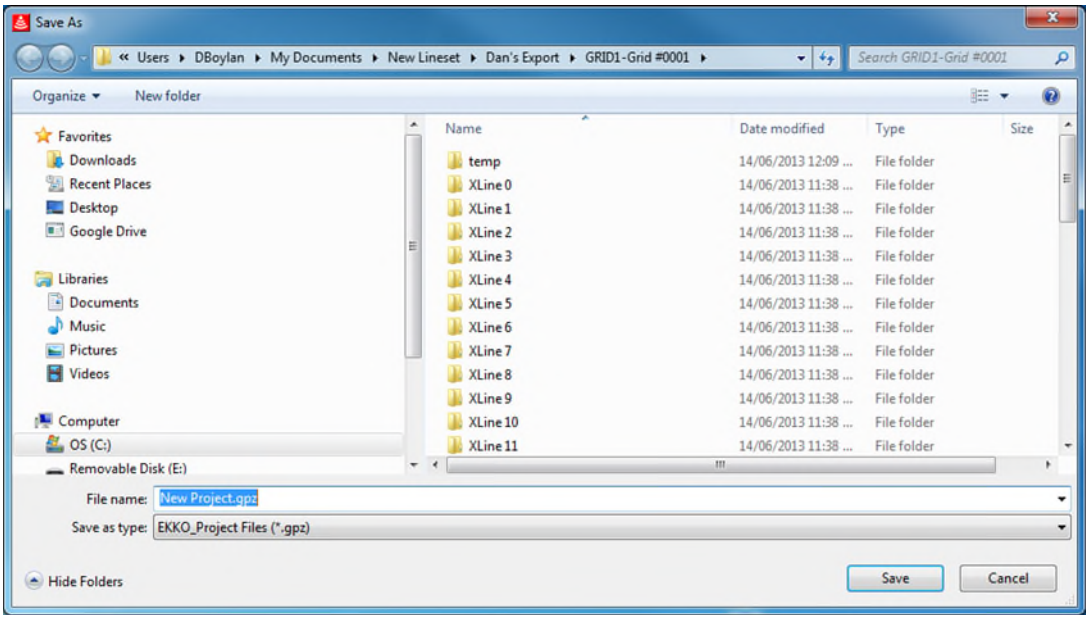


***Figure 8**: Save As dialog box*

3. In the **Save As** dialog box, navigate to the folder you want to save the project to.
4. Click **Save**.

14.4 Save

1. To save the current project to a .gpz file, click **File > Save**.

   Alternatively, in the Standard Toolbar, click Save.

2. In the **Save As** dialog box, navigate to the folder you want to save the project to.
3. Click **Save**.

   When a new project is saved, the .dt1, .hd, and all other ancillary files such as GPS and topographic files are saved to a compressed .gpz project file.

14.5 Save As

1. To save the current project to a different folder and/or name, click **File > Save As.**
2. In the **Save As** dialog box, navigate to the folder you want to the project to.

   To save the project with a different file name, in the **File name** field enter the new project name.

3. Click **Save**.

14.6 Import GPZ

1. To merge the data from an existing project (GPZ) file with the current project in EKKO_Project (if a project file is already open), click **File > Import GPZ**.
2. In the **Open** dialog (Figure 2), navigate to and then select one or more projects (GPZ files) you want to import and merge into the current project.
3. Click **Open**.
4. Data folders and grids in the imported project files are added to the current project file.

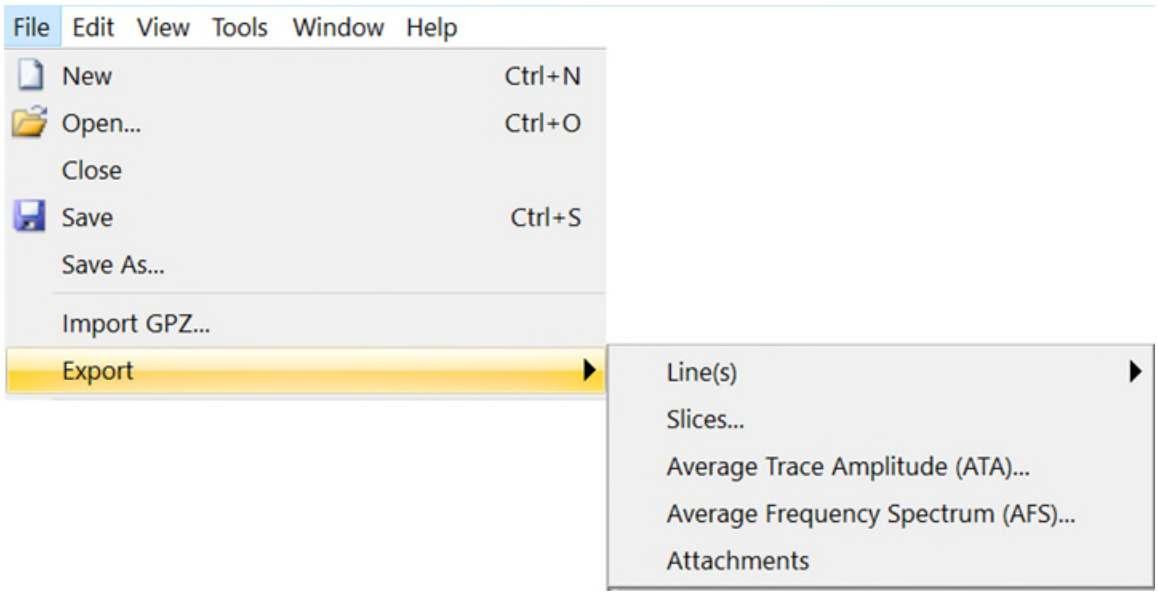
Note that no interpretations are imported from the project file into the current project. It is best to import and merge all the project files **before** adding interpretations or processing data.

14.7 Export

Select **Export** to extract data files from a project and save them as GPR Line(s).

If the optional Processing module is available, Export also allows GPR lines to be exported as Slices, Average Trace Amplitude (ATA) plots, and Average Frequency Spectrum (AFS) plots.

1. To export data files, click **Export**.

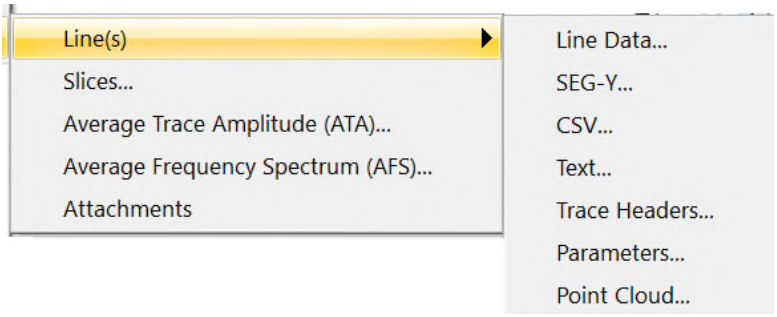


2. In the drop-down list, click the format you want to save the file as.

14.7.1 Lines

Select **Line(s)** to extract data from a project file and save them to a separate folder as Line Data, CSV, or Text.

1. Click the **Line(s)** drop-down list to select the format you want to export line data to:

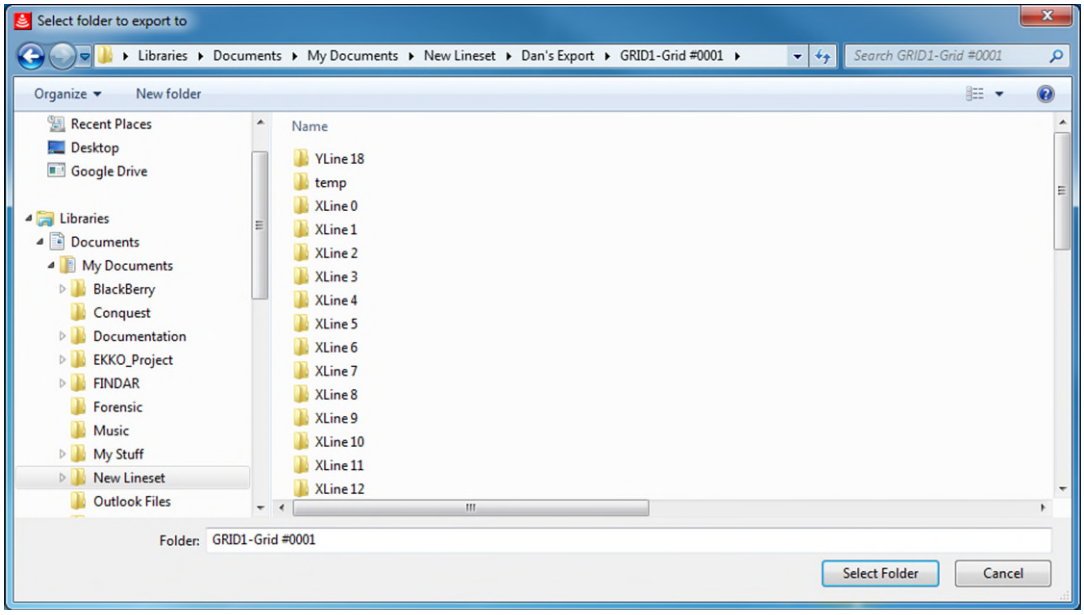


2. In the drop-down list, click the format you want to save the file in.

14.7.1.1 Line Data

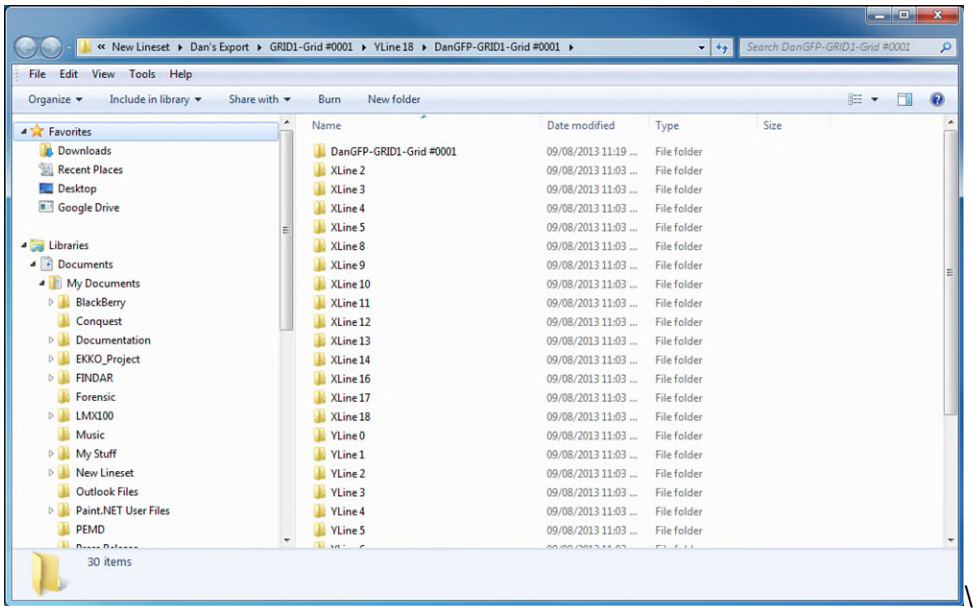
Select **Line Data** to export selected GPR lines (.dt1 or .hd) and any files attached to that data (such as GPS, topography, photos, etc.).

1. To export GPR lines from the project (.gpz) file to a different folder location click **File > Export > Line(s) >Line Data**.



2. In the **Select folder to export** to dialog box, navigate to and then select the folder you want to export the files to.
3. Click **Select Folder**.

   A dialog box opens displaying the exported lines.



Note: Interpretations are not saved when GPR lines are exported.

The DT1 and HD file formats are defined in Appendix B – File Formats.

14.7.1.2 SEG-Y

Select **SEG-Y** to export GPR lines to a SEG-Y, a format commonly used for seismic data. Selected GPR lines are converted to a file with the same name as the original file(s) appended with a .sgy extension,

1. Click **File > Export > Line(s) > SEG-Y.**
2. In the **Select folder to export** to dialog box, navigate to and select the folder you want to export the file to.
3. Click **Select Folder**.

   A dialog box opens to display the folder that the .sgy lines were saved to.

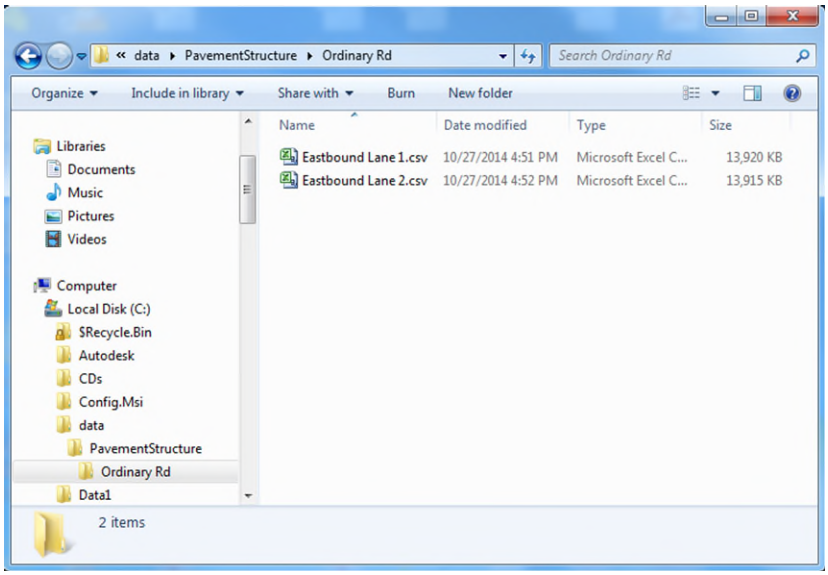
The SEG-Y format is defined in Appendix B – File Formats.

14.7.1.3 CSV

Select **CSV** to export GPR lines to a comma separated value (CSV) file. This feature converts selected GPR lines to a single file with the same name as the original file(s) appended with a .csv extension,

4. Click **File > Export > Line(s) > CSV.**
5. In the **Select folder to export** to dialog box, navigate to and select the folder you want to export the file to.
6. Click **Select Folder**.

   A dialog box opens to display the folder that the .csv lines were saved to.



7. To open a .csv file, navigate to the folder you saved the lines in and then click the .csv file.

   The CSV files can be read by spreadsheet software such as Microsoft® Excel® and GIS software.

   The new file lists the data in a table that displays point amplitudes from each trace in separate columns with trace numbers and position values at the top of each column and point numbers and time values at the beginning of each row.

	TRACE	1	2	3	4	5	6	7	8	9	10
	Position (m)	1	1.05	1.1	1.15	1.2	1.25	1.3	1.35	1.4	1.45
Point	Time (ns)										
1	-11.2179	-63	-39	-67	-59	-35	-64	-67	-70	-64	-70
2	-10.4167	-58	-63	-63	-63	-43	-71	-75	-79	-68	-76
3	-9.61538	-66	-67	-59	-54	-55	-75	-82	-64	-87	-79
4	-8.8141	-54	-67	-63	-63	-62	-71	-84	-51	-76	-52
5	-8.01282	-68	-76	-59	-62	-82	-71	-62	-79	-68	-72
6	-7.21154	-48	-68	-78	-80	-79	-85	-88	-79	-90	-75
7	-6.41026	-58	-71	-92	-88	-72	-89	-94	-74	-81	-60
8	-5.60897	-72	-72	-86	-90	-63	-74	-67	-79	-84	-79
9	-4.80769	-87	-95	-82	-86	-67	-79	-94	-81	-108	-81
10	-4.00641	-80	-89	-89	-90	-90	-104	-106	-74	-84	-89
11	-3.20513	-95	-67	-74	-85	-100	-103	-80	-96	-114	-87
12	-2.40385	-84	-78	-92	-95	-62	-71	-100	-95	-92	-94
13	-1.60256	-79	-64	-79	-79	-79	-90	-74	-87	-98	-95
14	-0.801282	-96	-78	-80	-71	-68	-67	-85	-96	-72	-81
15	0	-72	-85	-88	-81	-75	-85	-84	-72	-78	-76
16	0.801282	-95	-64	-89	-104	-89	-82	-93	-105	-86	-105
17	1.60256	-168	-162	-177	-181	-170	-170	-174	-190	-134	-160
18	2.40385	-319	-188	-257	-296	-390	-259	-372	-334	-254	-225
19	3.20513	-550	-654	-595	-531	-765	-582	-750	-606	-602	-591
20	4.00641	-977	-1039	-633	-829	-1041	-1116	-1139	-964	-962	-781
21	4.80769	-95	247	-633	-488	1336	413	-1095	-809	-390	-592
22	5.60897	3171	5875	5931	2228	6845	3724	3889	4820	5397	4700
23	6.41026	14598	18501	16181	13723	16706	16393	16985	16911	14282	15368
24	7.21154	28652	28583	28015	28171	30727	27429	28763	28139	28666	24952
25	8.01282	32527	32556	32752	32752	32752	32387	32561	32535	32752	32505
26	8.8141	32752	32752	32752	32752	32752	32752	32752	32752	32752	32752
27	9.61538	32752	32752	32752	32752	32752	32752	32752	32752	32752	32752
28	10.4167	32752	32752	32752	32752	32752	32752	32752	32752	32752	32752
29	11.2179	32752	32752	32752	32752	32752	32752	32752	32752	32752	32752
30	12.0192	32752	32572	32603	32752	32573	32752	32094	32752	32752	32752
31	12.8205	31422	32285	31184	31625	29620	32012	30352	32440	31116	32359
32	13.6218	25666	17666	13981	22071	15361	15412	21748	24947	17647	26989
33	14.4231	592	-20493	-15565	-4700	-9915	-11535	-3172	-11154	-10237	-2856

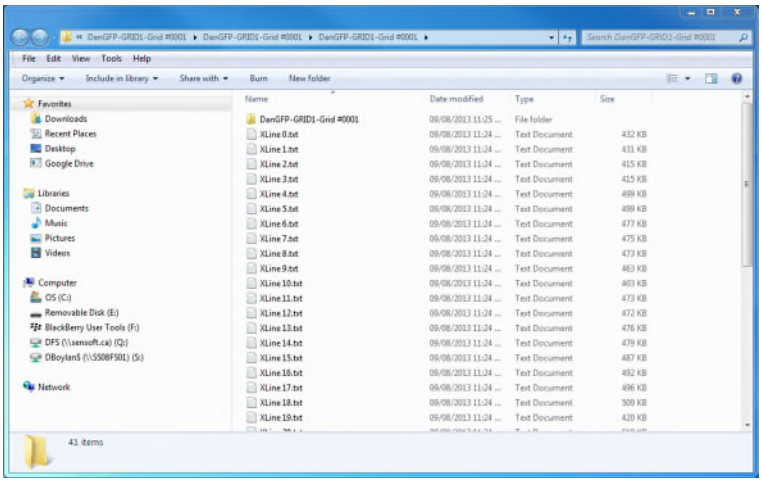
Amplitude values are expressed as 2-byte integers ranging from -32767 to +32767 and can be converted to millivolts by multiplying by 50/32767 = 0.0015259.

14.7.1.4 Text

Select **Text** to export GPR lines to a text file. This feature converts GPR lines to a single text file with the same name as the original file(s) appended with a .txt extension.

1. Click **File > Export > Line(s) > Text**
2. In the **Select folder to export** to dialog box, navigate to and select the folder you want to export the file to.
3. Click **Select Folder.**

   A dialog box opens to display the folder that the .txt lines were saved to.



4. To open a .txt file, navigate to the folder you saved the lines in and then click the .txt file.

   This format can be read by spreadsheet software, such as Microsoft® Excel®, word processing software such as Windows® Notepad, and Microsoft® Word®.

   The text file lists data in a table that displays point amplitudes from each trace in separate columns with position values at the top of each column and time values at the beginning of each row.

-999	0.000	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500
-6.00	-66	-58	-55	-55	-58	-58	-55	-55	-55	-55	-58
-5.60	-67	-59	-62	-62	-59	-55	-59	-59	-63	-59	-55
-5.20	-79	-62	-59	-59	-63	-63	-59	-58	-63	-63	-63
-4.80	-74	-59	-55	-63	-58	-59	-59	-59	-55	-62	-59
-4.40	-74	-55	-55	-55	-54	-55	-55	-55	-55	-55	-54
-4.00	-46	-55	-51	-55	-55	-51	-51	-54	-50	-54	-58
-3.60	-62	-58	-55	-55	-51	-55	-55	-51	-59	-58	-58
-3.20	-55	-59	-58	-58	-63	-55	-62	-59	-55	-55	-58
-2.80	-79	-63	-55	-59	-63	-59	-59	-59	-58	-59	-63
-2.40	-59	-62	-59	-58	-59	-63	-62	-59	-59	-62	-63
-2.00	-63	-59	-59	-59	-59	-58	-54	-63	-62	-59	-59
-1.60	-54	-59	-59	-63	-55	-58	-58	-55	-59	-59	-55
-1.20	-51	-59	-59	-62	-63	-58	-59	-58	-59	-63	-59
-0.80	-63	-59	-59	-62	-59	-59	-59	-59	-55	-63	-59
-0.40	-50	-50	-43	-43	-43	-47	-42	-37	-39	-47	-47
0.00	103	81	88	92	88	95	88	92	95	85	86
0.40	1297	924	919	936	957	962	983	924	947	977	949
0.80	2930	2925	2996	2981	3040	2987	3016	3007	3143	3054	3032
1.20	6403	5963	5941	6171	6012	6089	6139	6143	6101	6282	6110
1.60	11010	10621	10735	10801	10847	10908	10991	11032	11054	11064	11171
2.00	13821	13680	13728	13805	13925	14067	14182	14230	14207	14194	14082
2.40	9461	9567	9622	9763	9789	9769	10223	10136	9657	9888	9514
2.80	-1049	-646	-631	-375	-381	-509	12	-159	-737	-528	-1041
3.20	-11975	-11743	-11597	-11441	-11389	-11389	-11300	-11456	-11995	-11679	-12070
3.60	-18546	-18382	-18097	-18019	-18034	-18087	-18062	-18177	-18515	-18423	-18604
4.00	-20711	-19783	-21380	-21564	-21599	-21806	-21542	-21341	-21067	-20811	-20946
4.40	-10897	-8028	-11225	-11871	-11861	-11878	-11228	-10010	-9249	-9173	-8908
4.80	1954	3287	-582	-928	-1203	-847	261	1873	2826	3102	3662
5.20	4421	4802	4534	4351	4148	4198	4886	5515	6001	6491	6653
5.60	23	-519	3027	3671	3338	2754	1909	1433	995	865	806
6.00	-409	-587	2961	4116	4575	4169	2652	673	-791	-1628	-1595
6.40	3433	3683	4220	5010	5587	5731	4696	2703	1571	1690	2084
6.80	5574	6318	4986	4927	4682	4655	4733	4947	5370	6081	6864
7.20	7174	7257	5710	5070	4597	4258	5476	7618	8990	9536	10200
7.60	7208	6608	5857	5593	5516	5487	6606	8041	9240	9608	9141
8.00	4944	4515	5640	5711	5718	6035	6064	5929	6016	5543	3970
8.40	3870	3032	4365	4357	4802	5295	4466	3140	2098	673	-1108
8.80	2184	1172	1402	1315	2339	2867	1925	167	-1791	-3340	-4292
9.20	-248	-1638	-2169	-2379	-1933	-1715	-2226	-3652	-5035	-5664	-5210
9.60	-3282	-4055	-4381	-5059	-5432	-5511	-4921	-4454	-4772	-4689	-3349
10.00	-2993	-3757	-3809	-4423	-5006	-4805	-3338	-1760	-1049	-660	103
10.40	-1648	-2068	-1908	-2283	-2774	-2292	-936	495	1576	2124	2099
10.80	-407	-610	-331	-441	-721	-657	-316	555	1586	2098	1638
11.20	206	42	422	509	426	-321	-1195	-821	280	847	551

The first value in this file is a placeholder and is always set to -999.

Amplitude values are expressed as 2-byte integers ranging from -32767 to +32767 and can be converted to millivolts by multiplying by 50/32767 = 0.0015259.

14.7.1.5 Trace Headers

Every time a GPR data trace is collected, as well as saving the trace amplitude information, other parameters associated with that trace are saved to the “trace header” in the data file.

The trace header consists of 25 floating point numbers. Parameters such as the trace number, trace position, elevation data, Transmitter X, Y and Z positions, Receiver X, Y and Z positions, GPS X, Y and Z positions and the time of day in seconds past midnight when the trace data were collected, are saved to the trace header.

If the GPR line was collected with a pulseEKKO system with a DVL-500, the 3-dimensional orientation of the transmitter and receiver (Yaw, Pitch and Roll) are also listed.

Exporting the trace headers allows the user to see the values of these parameters from every trace header in the GPR line.

Select **Trace Headers** to export the GPR tracer header information to a CSV. The selected GPR lines are converted to a file with the same name as the original file(s) appended with a .csv extension,

1. Click **File > Export > Line(s) > Trace Headers.**
2. In the **Select folder to export** to dialog box, navigate to and select the folder you want to export the file to.
3. Click **Select Folder**.

A dialog box opens to display the folder that the .csv lines were saved to. The CSV file format allows the trace header information to be exported to programs like Microsoft® Excel®.

Trace Number	Position	Number of points per trace	Elevation data	Total odometer ticks	# bytes/ point	Time Window	# of stacks	GPS X Position	GPS Y Position	GPS Z Position	Receiver X Position	Receiver Y Position	Receiver Z Position	Transmitter X Position	Transmitter Y Position	Transmitter Z Position	Timezero adjustment	Zero Trace Flag	Time of Day	Comment flag
1	0	100	0	0	2	10	1	-79.734419	43.6333983	0	0	0	0	0	0	0	0	0x0	0	0
2	0.03	100	0	19	2	10	1	-79.7344193	43.6333982	0	0	0	0	0	0	0	0	0x0	0	0
3	0.06	100	0	38	2	10	1	-79.7344197	43.633398	0	0	0	0	0	0	0	0	0x0	0	0
4	0.09	100	0	57	2	10	1	-79.73442	43.6333979	0	0	0	0	0	0	0	0	0x0	0	0
5	0.12	100	0	76	2	10	1	-79.7344203	43.6333978	0	0	0	0	0	0	0	0	0x0	0	0
6	0.15	100	0	94	2	10	1	-79.7344206	43.6333976	0	0	0	0	0	0	0	0	0x0	0	0
7	0.18	100	0	113	2	10	1	-79.734421	43.6333975	0	0	0	0	0	0	0	0	0x0	0	0
8	0.21	100	0	132	2	10	1	-79.7344213	43.6333973	0	0	0	0	0	0	0	0	0x0	0	0
9	0.24	100	0	151	2	10	1	-79.7344216	43.6333972	0	0	0	0	0	0	0	0	0x0	0	0
10	0.27	100	0	170	2	10	1	-79.7344219	43.6333971	0	0	0	0	0	0	0	0	0x0	0	0
11	0.3	100	0	189	2	10	1	-79.7344223	43.6333969	0	0	0	0	0	0	0	0	0x0	0	0
12	0.33	100	0	208	2	10	1	-79.7344226	43.6333968	0	0	0	0	0	0	0	0	0x0	0	0
13	0.36	100	0	227	2	10	1	-79.7344229	43.6333966	0	0	0	0	0	0	0	0	0x0	0	0
14	0.39	100	0	246	2	10	1	-79.7344232	43.6333965	0	0	0	0	0	0	0	0	0x0	0	0
15	0.42	100	0	265	2	10	1	-79.7344236	43.6333964	0	0	0	0	0	0	0	0	0x0	0	0
16	0.45	100	0	283	2	10	1	-79.7344239	43.6333962	0	0	0	0	0	0	0	0	0x0	0	0
17	0.48	100	0	302	2	10	1	-79.7344242	43.6333961	0	0	0	0	0	0	0	0	0x0	0	0
18	0.51	100	0	321	2	10	1	-79.7344245	43.633396	0	0	0	0	0	0	0	0	0x0	0	0
19	0.54	100	0	340	2	10	1	-79.7344249	43.6333958	0	0	0	0	0	0	0	0	0x0	0	0
20	0.57	100	0	359	2	10	1	-79.7344252	43.6333957	0	0	0	0	0	0	0	0	0x0	0	0
21	0.6	100	0	378	2	10	1	-79.7344255	43.6333955	0	0	0	0	0	0	0	0	0x0	0	0

14.7.1.6 Parameters

Select **Parameters** to export the GPR Acquisition parameters for all the checked GPR lines to a CSV file. The CSV file defaults to the name Line Parameters.

1. Click **File > Export > Line(s) > Parameters.**
2. In the **Save As** dialog box, navigate to the folder you want to save the CSV file of parameter data to.
3. Modify the default file name if desired.
4. Click **Save**.

A dialog box opens to display the folder that the .csv lines were saved to. The CSV file format allows the data acquisition parameters to be exported to programs like Microsoft® Excel®.

Line	Start Positions (m)	End Positions (m)	Length (m)	Frequency (MHz)	Time Window (ns)	Collection Date	GPS Start Lat	GPS Start Long	GPS End Lat	GPS End Long
LINE00	0	1021.4	1021.4	500	50	2014-Apr-07	-122.3150603	37.49791711	-122.3029686	37.49357323
LINE01	0	1023.4	1023.4	500	50	2014-Apr-07	-122.3029958	37.4935491	-122.3150999	37.4978935
LINE02	0	1021.9	1021.9	500	50	2014-Apr-07	-122.315068	37.49791712	-122.3029683	37.4935725
LINE03	0	1022.6	1022.6	500	50	2014-Apr-07	-122.3029952	37.49355314	-122.3150923	37.4978929
LINE04	0	1021.1	1021.1	500	50	2014-Apr-07	-122.3150641	37.497912	-122.302973	37.49357154
LINE05	0	1041	1041	500	50	2014-Apr-07	-122.3029954	37.49355482	-122.3150352	37.49789708
LINE06	0	1021.5	1021.5	500	50	2014-Apr-07	-122.3150713	37.49791342	-122.3029715	37.49357036
LINE07	0	1021.9	1021.9	500	50	2014-Apr-07	-122.3029918	37.49355642	-122.3150848	37.49789596
LINE08	0	1021.8	1021.8	500	50	2014-Apr-07	-122.3150728	37.49791222	-122.3029721	37.49356782
LINE09	0	1022	1022	500	50	2014-Apr-07	-122.3029915	37.49355865	-122.3150874	37.49789813
LINE10	0	1021.4	1021.4	500	50	2014-Apr-07	-122.3150754	37.49790947	-122.3029734	37.4935653
LINE11	0	1021.8	1021.8	500	50	2014-Apr-07	-122.3029907	37.49356111	-122.3150857	37.4979009
LINE12	0	1021.8	1021.8	500	50	2014-Apr-07	-122.315076	37.49790743	-122.3029761	37.4935648
LINE14	0	1021.5	1021.5	500	50	2014-Apr-07	-122.3029666	37.49357703	-122.3150744	37.49790916
LINE15	0	1022.5	1022.5	500	50	2014-Apr-07	-122.3150722	37.49790828	-122.3029652	37.49355727
LINE16	0	1022.2	1022.2	500	50	2014-Apr-07	-122.3029879	37.49356466	-122.3150881	37.49790619

14.7.1.7 Point Cloud

Third-party point-cloud software can be used for plotting very large scientific data sets. Originally developed for LiDAR, 3D Laser scans and photogrammetry, point cloud visualization software can be a useful tool for visualizing GPR data collected with GPS.

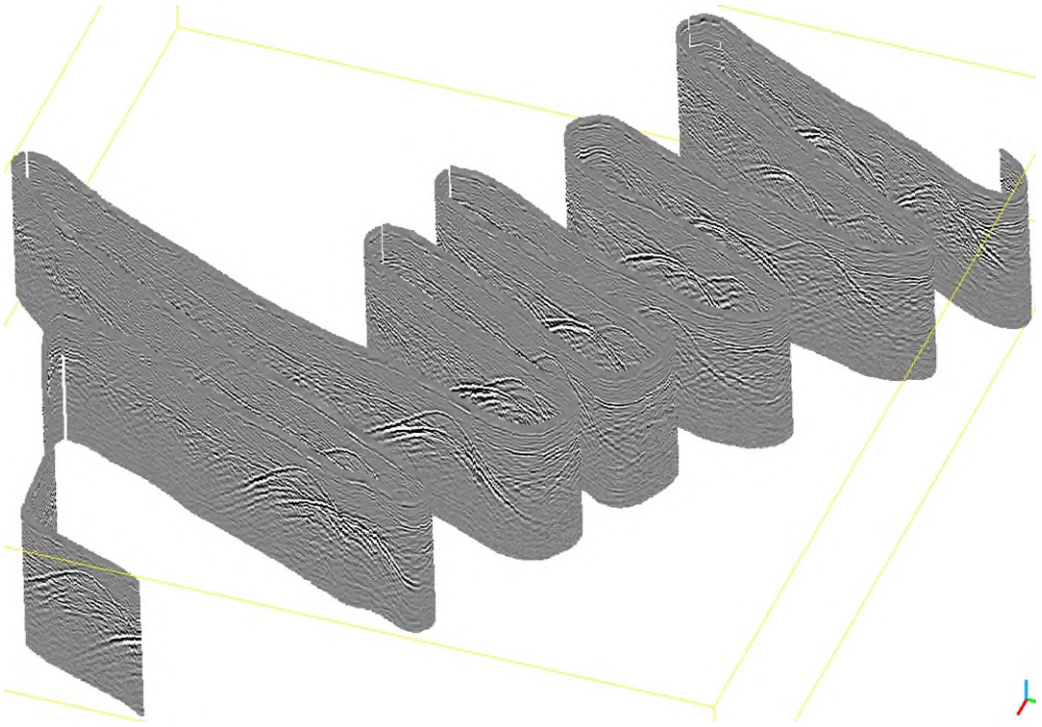
Select **Point Cloud** to export the all the checked GPR lines to a point cloud CSV file. The CSV file defaults to the name Line Parameters.

1. Click **File > Export > Line(s) > Point Cloud**
2. In the **Save As** dialog box, navigate to the folder you want to save the CSV file of parameter data to.
3. Modify the default file name if desired.
4. Click **Save**.

A dialog box opens to display the folder that the .CSV lines were saved to.

Easting (17T)	Northing (17T)	Elevation (m)	Amplitude (mV)
588805.3853	4903156.9	222.0259	0.5066072
588805.3853	4903156.9	222.0259	0.4791406
588805.3853	4903156.9	222.0259	0.553911
588805.3853	4903156.9	222.0259	0.5981628
588805.3853	4903156.9	222.0259	0.8896145
588805.3853	4903156.9	222.0259	2.0722067
588805.3853	4903156.9	221.9889652	4.0803246
588805.3853	4903156.9	221.9694978	10.3793449
588805.3853	4903156.9	221.9538013	21.5903187
588805.3853	4903156.9	221.9397881	34.8765526
588805.3853	4903156.9	221.9267422	48.3977776
588805.3853	4903156.9	221.9143236	50
588805.3853	4903156.9	221.902343	50
588805.3853	4903156.9	221.8906841	40.5529938
588805.3853	4903156.9	221.8792699	-14.1697435
588805.3853	4903156.9	221.8680475	-45.979187
588805.3853	4903156.9	221.8569786	-50.0015259

The CSV file format allows the GPR data to be imported into point cloud software such as CloudCompare™ and Voxler®. For example, the figure below shows a GPR line zigzagging over two utilities (indicated by hyperbolas) plotted in CloudCompare™, free 3D point cloud processing software.



GPR line data plotted in third-party point cloud software called CloudCompare™.

14.7.2 Slices

Use the Slices feature to export Average Trace Amplitudes for one or more intervals from all the traces in the selected lines to a comma separated (.csv) file. Slices are compatible with 2D plotting software applications such as Golden Software's Surfer®.

This is an old menu option that has largely been replaced by the CSV file outputs of SliceView-Grid and SliceView-Lines.

14.7.3 Average Trace Amplitude

Select **Average Trace Amplitude (ATA)** plot to display the average rectified signal amplitudes (in microvolts) for one or more GPR lines.

For more details, see Export Average Trace Amplitude Values.

14.7.4 Average Frequency Spectrum

This option requires the optional Processing module.

Select **Average Frequency Spectrum (AFS)** to display the average frequency spectrum of the selected GPR line(s).

For more details, see Export Average Frequency Spectrum Values.

14.7.5 Attachments

Select **Attachments** to export all the files attached to the project (GPZ) file.

1. Click **File > Export > Attachments.**
2. In the **Select folder to export** dialog box, navigate to and select the folder you want to export the file to.
3. Click **Select Folder**.
4. A dialog box opens to display the folder that the attachments were saved to.

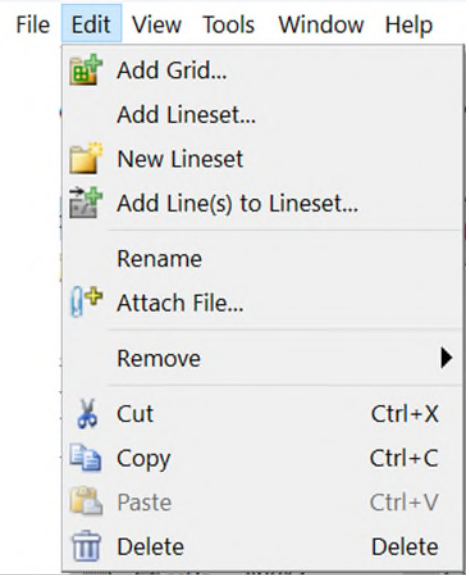
14.8 Exit

1. Click **File > Exit** to close all windows that are open as part of the current EKKO_Project session and exit the application.
2. In the message box, click **Yes** to save the project file.

15 Edit Menu

The EKKO_Project menu bar Edit menu contains many features that allow you to add and update GPR project files.

To open the edit menu drop-down list, click **Edit**:



The following sections describe the Edit menu features:

15.1 Add Grid

1. To add a grid to the current project file, click **Edit > Add Grid**.
2. In the **Open** dialog box, navigate to and then click the grid file you want to add.
3. Click **Open**.

   The project file grid name defaults to the same name as the .gfp file.

15.2 Add Lineset

A Lineset represents a number of GPR lines grouped into a single folder. Select **Add Lineset** to create and then populate a lineset folder.

1. Click Edit > Add Lineset.
2. In the **Select folder to import Lines From** dialog box, navigate to and then select the folder you want to add.
3. Click **Select Folder**.

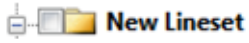
   The lineset and lines are displayed in Project Explorer.

15.3 New Lineset

Select **New Lineset** to create a New Lineset folder in the current project file.

1. Click **Edit > New Lineset.**

   The lineset name appears in the Project Explorer window.



15.4 Add Line(s) to Lineset

Select **Add Line(s) to Lineset** to add lines to a Lineset in a project.

1. Click **Edit** > **Add Lines to Lineset**.
2. In the **Open** dialog, navigate to and then select one or more GPR (.hd) lines.
3. Click **Open**.

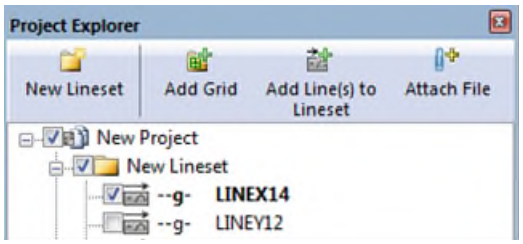
   The data files are added to the Lineset and are displayed in the Project Explorer.

15.5 Rename

Select **Rename** to change the name of the project, grid, lineset, or GPR line in a lineset.

Note: A GPR line name in a grid cannot be renamed.

1. To rename an item, in Project Explorer, select the item you want to rename.



2. In the menu bar, click **Edit** > **Rename**.



   A box appears around the item name signifying that the name is now editable.

3. Type the new item name and then press **Enter**.

Note: Certain characters, such as periods and slashes are not valid in names. If you enter one of these characters, it will be automatically replaced with an underscore.

15.6 Attach File

Select **Attach File** to attach GPS files, topography files, photos of the line location, videos of the area, or voice recordings of information relevant to the GPR project, grid, lineset, or line.

1. To attach a file to the selected GPR data line, lineset, grid, or project, click **Edit** > **Attach File**.
2. In the **Attach Files** dialog box, to navigate to and then select the file you want to attach.

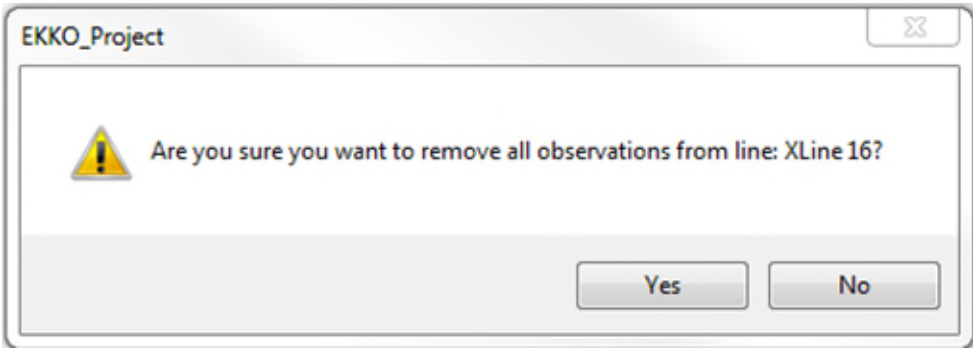
   The file is listed in the Attachments tab. To learn more, see Attachments Tab.

15.7 Remove

Use **Remove > Interpretation Observations** to remove interpretations from MapView and LinePreview. For example, since interpretations are included when a GPR line is copied, you may want to remove interpretations from the copied line.

1. To remove interpretations from GPR line, lineset, or grid, click **Edit > Remove > interpretation Observations.**





2. To remove the observation, in the message box, click **Yes**.

15.8 Cut

To remove the selected GPR line, lineset or grid from the project, click **Edit > Cut**.

This enables you to remove a GPR line from a lineset and paste it into a different lineset.

> **Note**: a GPR line cannot be cut from a grid.

15.9 Copy

To copy an item, click **Edit** > **Copy**.

Use the **Copy** feature to:

- Copy a GPR line, lineset, or grid and display it in LineView or Process the item differently than the original.
- Copy and then paste the selected lineset or grid back into the project.

> **Note**: GPR lines in a grid can be copied, but they must be pasted into a lineset; they cannot be pasted into a grid.

15.10 Paste

Select **Paste** to add a GPR line from one lineset to a different lineset.

To paste an item, click **Edit** > **Paste**

Use the **Paste** feature to:

- Paste a copy of a GPR line, lineset, or grid into LineView, or Process the item differently than the original.
- Paste a copied or cut lineset or grid back into the project.

> **Note**: copied GPR lines must be pasted into a lineset; they cannot be pasted into a grid.

15.11 Delete

To remove a grid or lineset from a project, or delete a GPR line from the lineset in the project, click **Edit** > **Delete**.

> **Note**: GPR lines cannot be deleted from a grid.

To delete a line or lines from a grid, use the GFP_Edit utility program that accompanies SliceView.

> **Caution**: Removing a GPR line from the project file may result in the total loss of the GPR data line, interpretations, and associated files (.gps, .top, and .ini) unless a separate copy of the original data files exists.

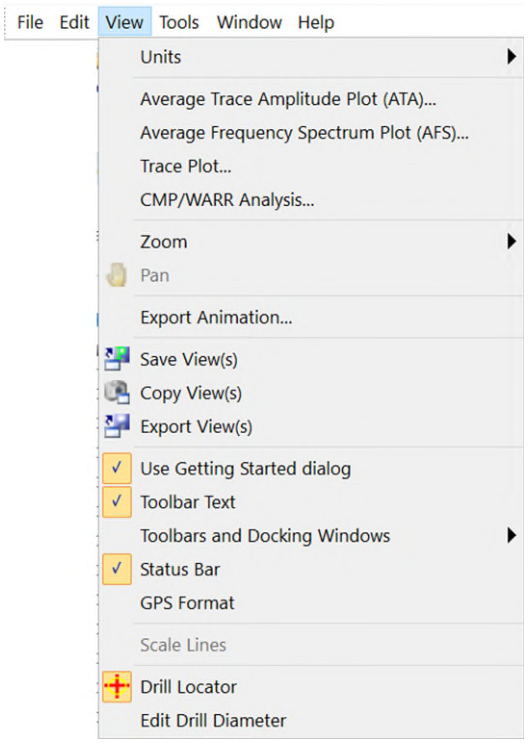
The original data files may exist if the GPR lines were added to the project file rather than being embedded in the project (.gpz) file.

If the project (.gpz) file was generated by the Sensors & Software GPR system, a copy of the GPR line(s) can be made clicking **File** > **Export** > **Lines;** this saves the original .dt1 and .hd files, and not the interpretations**.**

16 View Menu

The EKKO_Project View menu contains many features that allow you to change the way information is displayed in EKKO_Project.

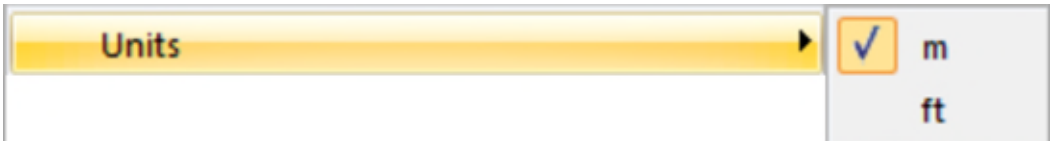
To open the view menu, click **View**:



The following sections describe how to work with the View menu features:

16.1 Units

1. To display units of measurement in EKKO_Project in meters or feet, click **Units.**
2. In the drop-down list, click **m** (metric) or **ft.** (US standard).



Changes in units of measurement affects the following EKKO_Project features:

- Line Preview
- MapView
- LineView
- Reports (including Bridge Deck Condition and Pavement Structure Reports)
- Processing

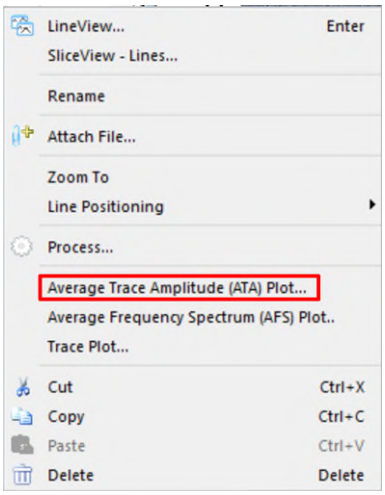
16.2 Average Trace Amplitude

Average Trace Amplitude (ATA) plots display the average signal amplitudes (in millivolts) for one or more selected GPR lines.

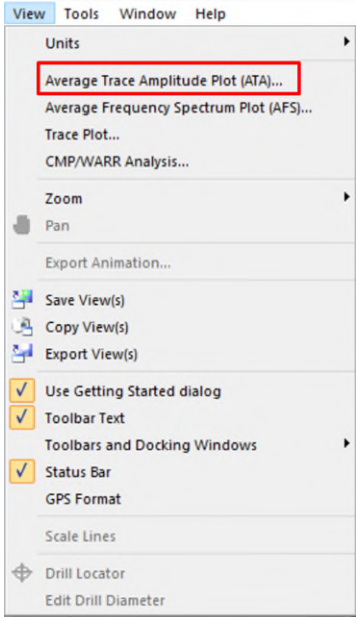
ATA plots display how quickly signal amplitude decays from the peak value of the transmit pulse to the background noise level, providing an indication of the maximum penetration in the survey area.

Data is Dewowed and Rectified before being displayed but Dewow can be turned off (see Appendix).

1. **One GPR Line:** To display the ONE currently selected GPR line in Project Explorer, right click with the mouse cursor on the Project Explorer window and then, from the right click menu, select **Average Trace Amplitude Plot (ATA).**



2. **Multiple GPR Lines:** To display ALL the GPR lines currently CHECKED in Project Explorer, click **View > Average Trace Amplitude Plot (ATA).**



The ATA plot is greyed out if no lines are selected in the Project Explorer window.

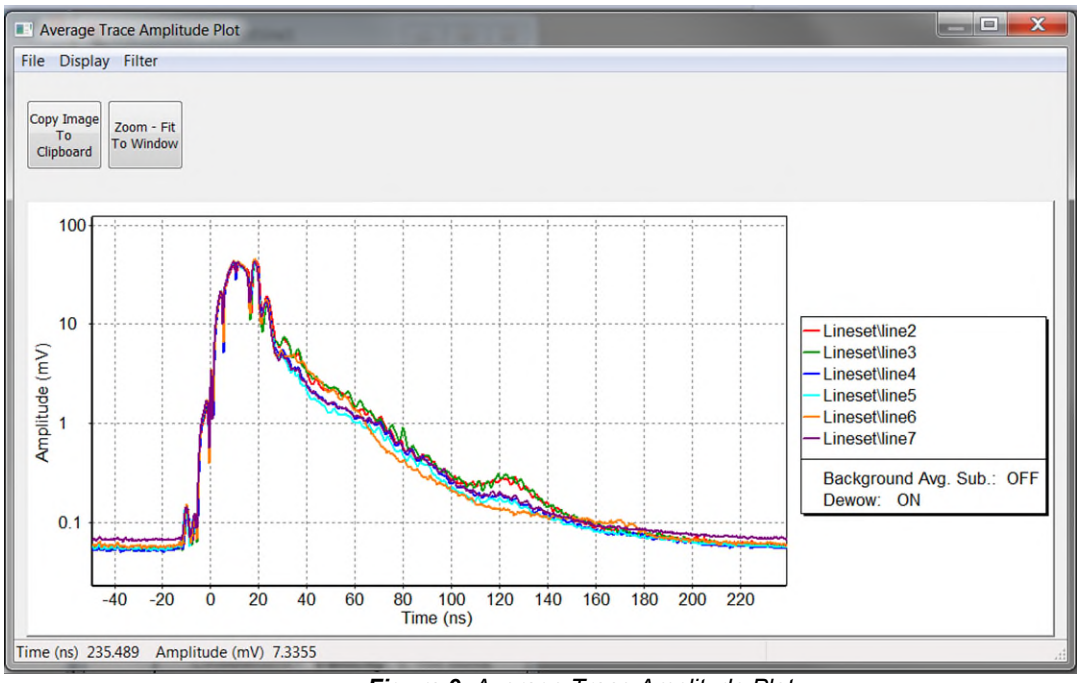


***Figure 9**: Average Trace Amplitude Plot*

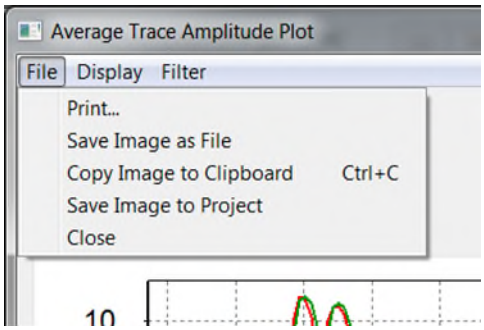
Use the following table as a guide to working with the Average Trace Amplitude Plot:

Item	Description
Resize Window	Drag and drop a corner or edge of the window to resize it. The Window can also be maximized using the Maximize button in the top right.
Pan View	Hold the **right**-click button and drag the mouse in the direction you want to move the image.
Copy Image to Clipboard	Click the Copy Image to Clipboard to copy the image to paste it in another document.
Default View Limits	Click **Zoom - Fit to Window** button to return to the original plot display.
Zoom	Click the image to define the top left corner of the zoom box 1 Hold the left-click button and drag the mouse to the bottom right corner of the zoom box. 2 Release the mouse button and the image zooms to the box
Amplitude (mV) – Y Axis	The GPR signal amplitude in millivolts (mV). Move the mouse cursor along the time axis to display the time and GPR signal amplitude on the status bar at the bottom of the window. The signal amplitude typically starts at the background noise level on the left. At zero time, a strong amplitude signal occurs when the GPR system fires its transmitter. At later times, the GPR signal slowly decays back to the background noise level (providing the recording time window is long enough). The steepness of the slope depends on the material being surveyed.

Item	Description
Time (ns) – X Axis	The time in nanoseconds from the start of the recording window. Time before zero time is displayed as a negative value. The time at which the signal level drops back to the background noise level is the maximum penetration time. This can be converted to the average maximum depth of penetration if the GPR velocity for the material is known.

16.2.1 File

Click the File menu to see the following sub-menu:

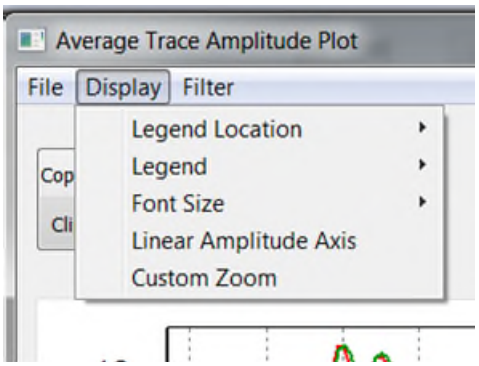


Use the following table as a guide to working with the **File** menu:

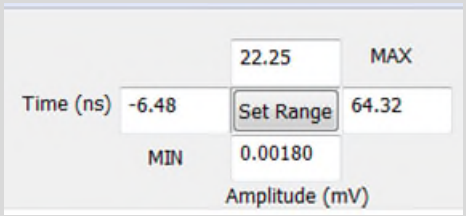
Item	Description
Print	To print the ATA plot, click **Print**.
Save Image as File	To save the ATA plot as an image, click **Save Image as File**. 1 In the **Save As** dialog box, use the dropdown at the bottom to select the type of graphics image file (jpg, bmp, gif or png). 2 Navigate to the folder to save the file to. 3 Click **Save**.
Copy Image to Clipboard	To copy an ATA plot image to paste to a document, click **Copy Image to Clipboard**.
Save Image to Project	To attach the ATA image to the project so it is included in GPR Summary Reports, click **Save Image to Project**.
Close	To close the ATA plot, click **Close**.

16.2.2 Display

Click the Display menu to see the following sub-menu:

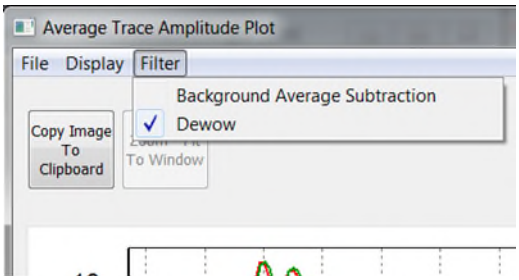


Use the following table as a guide to working with the **Display** menu:

Item	Description
Legend Location	To define the location of the legend on the ATA plot, click **Legend Location**. In the drop-down list click **Top, Bottom, Left, Right**, or **Hide**.
Legend	Select the items to include on the Legend: **Filters** and **GPR Line names**.
Font Size	Choose a font size of **Small**, **Medium** or **Large**.
Linear Amplitude Axis	Check this option to change the Amplitude Axis from the default Logarithmic scale to a linear scale.
Custom Zoom	Allows the user to specify **Min** and **Max Times** in nanoseconds (ns) and **Min** and **Max Amplitudes** in millivolts (mV) to display. 

16.2.3 Filter

Click the Filter menu to see the following sub-menu:



Check **Background Average Subtraction** to apply an Average background subtraction filter with a filter length equal to the length of the GPR line before plotting the ATA plot. Defaults to OFF.

Check **Dewow** to apply a high pass temporal filter called Dewow to the GPR line before plotting the ATA plot. Defaults to ON.

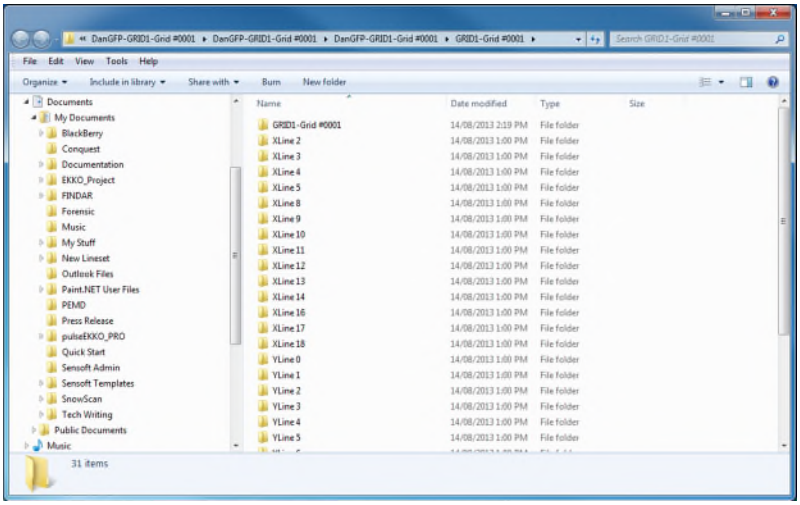
For more information on Filtering, see Dewow and Background Average Subtraction in the **Processing Module User's Guide**.

16.2.4 Export Average Trace Amplitude Values

Exporting the Average Trace Amplitude values requires the optional Processing module.

To export the average rectified trace amplitudes for all the traces in the selected GPR line(s) to comma separated value (.csv) files:

1. Click **File > Export > Average Trace Amplitude (ATA)**.
2. In the **Select target folder for the ATA report** dialog box, navigate to and then select a target folder.
3. Click **Select Folder**
   A dialog box opens to display the folder containing the reports in Windows Explorer.



Note that the exported ATA data has the Dewow filter applied.

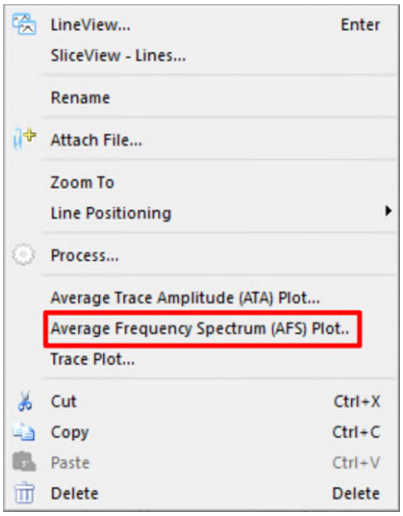
16.3 Average Frequency Spectrum

Average Frequency Spectrum (AFS) plots the average frequency spectrum of the selected GPR line(s).

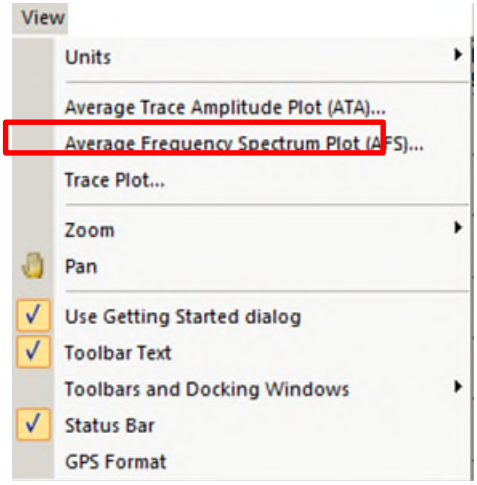
Plot the AFS to determine the frequency content of GPR lines to decide if filtering is required to remove unwanted frequencies like high frequency noise. If so, lowpass, highpass, or bandpass filtering can be applied (see Filters – Time in the **Processing Module User's Guide**).

Data is Dewowed and Rectified before being displayed but Dewow can be turned off (see Appendix).

1. **One GPR Line:** To display the ONE currently selected GPR line in Project Explorer, right click with the mouse cursor on the Project Explorer window and then, from the right click menu, select **Average Frequency Spectrum (AFS) Plot.**



2. **Multiple GPR Lines:** To display ALL the GPR lines currently CHECKED in Project Explorer click **View > Average Frequency Spectrum Plot (AFS).**



The AFS plot is greyed out if no lines are selected.

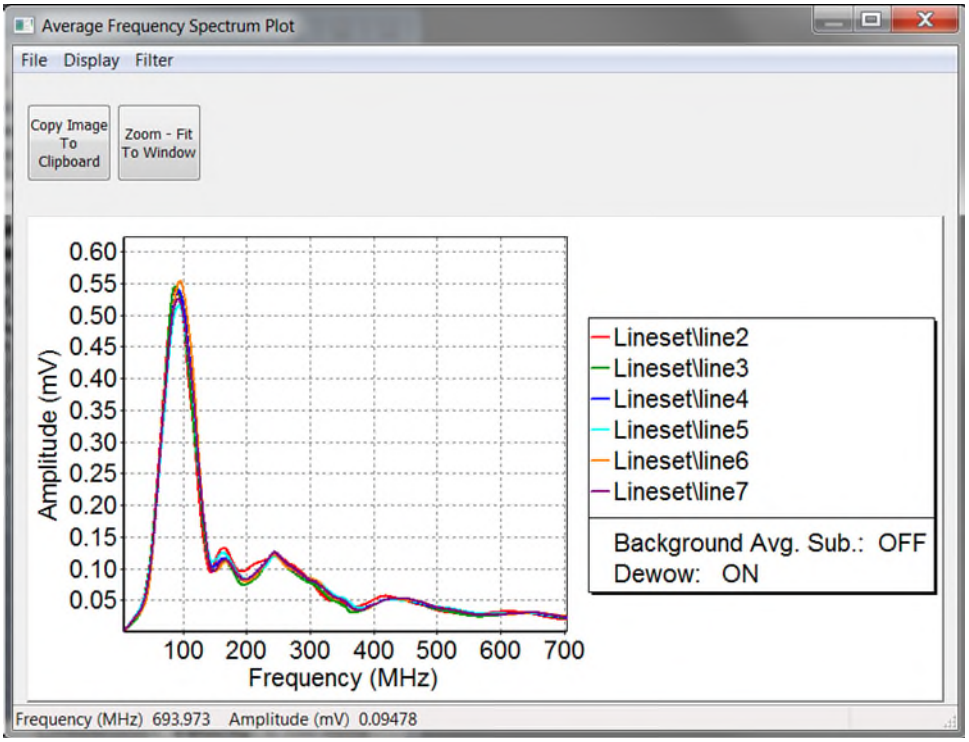


***Figure 10**: Average Frequency Spectrum Plot*

Use the following table as a guide to working with the Average Frequency Spectrum Plot:

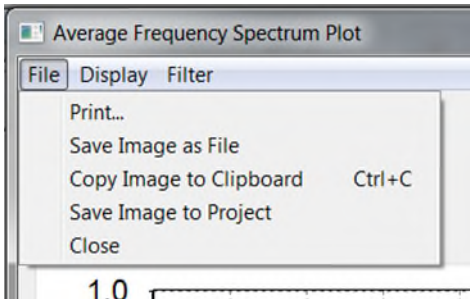
Item	Description
Resize Window	Drag and drop a corner or edge of the window to resize it. The Window can also be maximized using the Maximize button in the top right.
Pan View	Hold the **right**-click button and drag the mouse in the direction you want to move the image.
Copy Image to Clipboard	Click the Copy Image to Clipboard to copy the image to paste it in another document.
Default View Limits	Click **Zoom - Fit to Window** button to return to the original plot display.
Zoom	Click the image to define the top left corner of the zoom box 1 Hold the left-click button and drag the mouse to the bottom right corner of the zoom box. 2 Release the mouse button and the image zooms to the box
Amplitude (mV) – Y Axis	The GPR signal amplitude in millivolts (mV). Move the mouse cursor along the time axis to display the time and GPR signal amplitude on the status bar at the bottom of the window.

Frequency (MHz) – X Axis	The Frequency in megahertz (MHz). The displayed frequency range defaults to zero to the Nyquist frequency (calculated from the temporal sampling interval for the GPR line).

Note: Sensors & Software antennas center frequency is measured in air. For example, 100 MHz antennas produce a center frequency of about 100 MHz when data is collected in air. The center frequency of data from antennas placed on the ground will be lower in frequency than the stated frequency of the antenna. For example, the center frequency of data collected with 100 MHz antennas is often 60 to 70 MHz.

16.3.1 File

4. Click the File menu to see the following sub-menu:

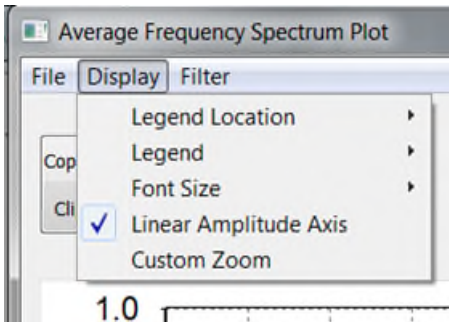


Use the following table as a guide to working with the **File** menu:

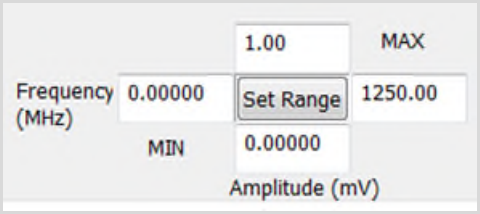
Item	Description
Print	To print the AFS plot, click **Print**.
Save Image as File	To save the AFS plot as an image, click **Save Image as File**. 1 In the **Save As** dialog box, use the dropdown at the bottom to select the type of graphics image file (jpg, bmp, gif or png). 2 Navigate to the folder to save the file to. 3 Click **Save**.
Copy Image to Clipboard	To copy an AFS plot image to paste to a document, click **Copy Image to Clipboard**.
Save Image to Project	To attach the AFS image to the project so it is included in GPR Summary Reports, click **Save Image to Project**.
Close	To close the AFS plot, click **Close**.

16.3.2 Display

5. Click the Display menu to see the following sub-menu:

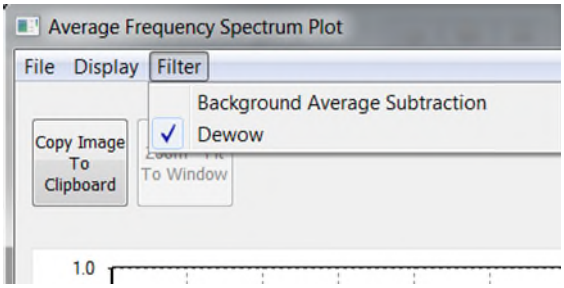


Use the following table as a guide to working with the **Display** menu:

Item	Description
Legend Location	To define the location of the legend on the AFS plot, click **Legend Location**. In the drop-down list click **Top, Bottom, Left, Right**, or **Hide**.
Legend	Select the items to include on the Legend: **Filters** and **GPR Line names**.
Font Size	Choose a font size of **Small**, **Medium** or **Large**.
Linear Amplitude Axis	Uncheck this option to change the Amplitude Axis from the default Linear scale to a logarithmic scale.
Custom Zoom	Allows the user to specify **Min** and **Max Frequency** in megahertz (MHz) and **Min** and **Max Amplitudes** in millivolts (mV) to display. 

16.3.3 Filter

Click the Filter menu to see the following sub-menu:



Check **Background Average Subtraction** to apply an Average background subtraction filter with a filter length equal to the length of the GPR line before plotting the AFS plot. Defaults to OFF.

Check **Dewow** to apply a high pass temporal filter called Dewow to the GPR line before plotting the AFS plot. Defaults to ON.

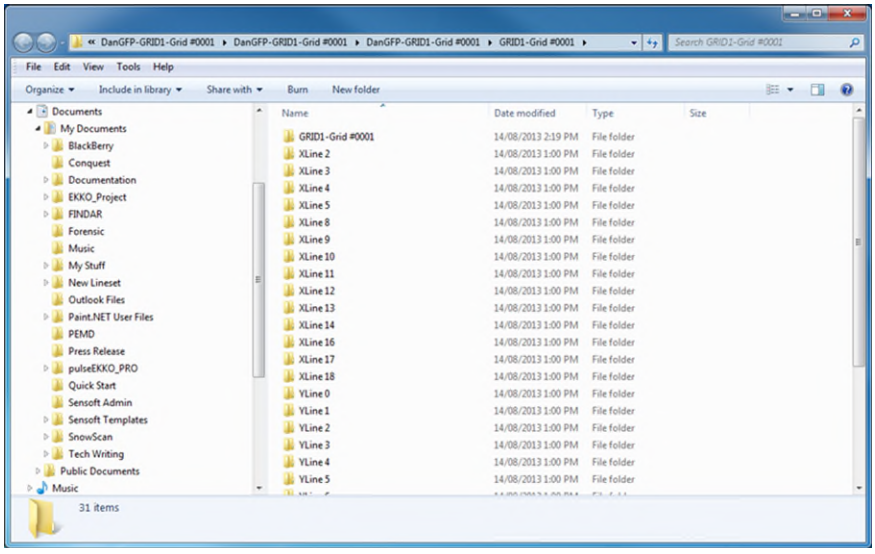
For more information, see Dewow and Background Average Subtraction in the **Processing Module User's Guide**.

16.3.4 Export Average Frequency Spectrum Values

Exporting the Average Frequency Spectrum values requires the optional Processing module.

To export the average frequency spectrum for all the traces in the selected GPR line(s) to comma separated value (.csv) files:

1. Click **File > Export > Average Frequency Spectrum (AFS)**.
2. In the **Select target folder for the AFS report** dialog box, navigate to and then select a target folder.
3. Click **Select Folder**
   A dialog box opens to display the folder containing the reports in Windows Explorer.

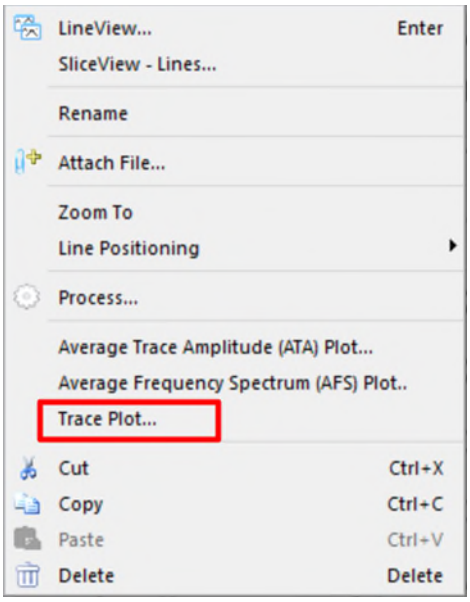


16.4 Trace Plot

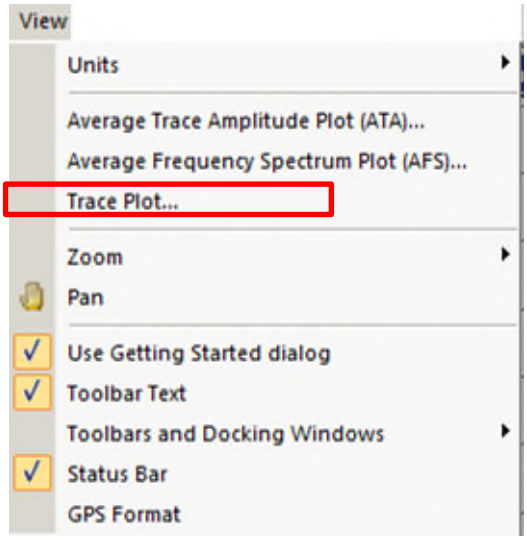
Trace Plot is used to display individual traces from one or more GPR lines; this allows the user to see subtle signals on traces or view the effect of different editing and processing types on individual traces.

Viewing traces can also help you determine if the first break offset needs to be edited. Normally the first break should occur at the first large deflection in the signal. If not, time scales and depth scales on section plots will be inaccurate.

1. **One GPR Line:** To display the traces of the ONE currently selected GPR line in Project Explorer, right click with the mouse cursor on the Project Explorer window and then, from the right click menu, select **Trace Plot.**



2. **Multiple GPR Lines:** To display the traces of ALL the GPR lines currently CHECKED in Project Explorer, click **View > Trace Plot.**



The Trace plot is greyed out if no GPR lines are selected.

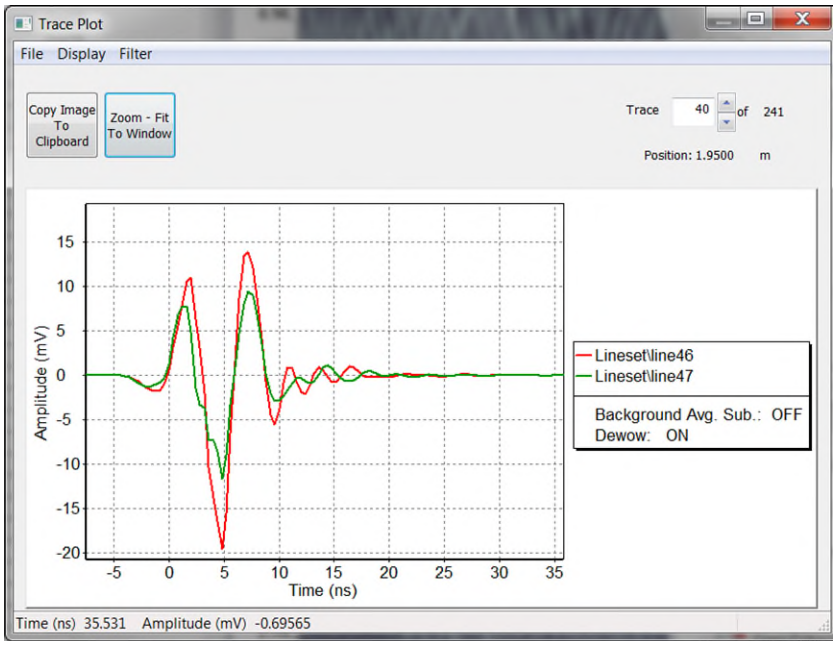


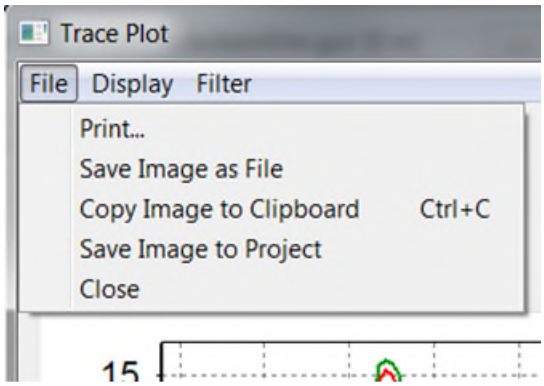
***Figure 11**: View Traces Plot*

Use the following table as a guide to working with the Trace Plot:

Item	Description
Resize Window	Drag and drop a corner or edge of the window to resize it. The Window can also be maximized using the Maximize button in the top right.
Pan View	Hold the **right**-click button and drag the mouse in the direction you want to move the image.
Copy Image to Clipboard	Click the Copy Image to Clipboard to copy the image to paste it in another document.
Default View Limits	Click **Zoom - Fit to Window** button to return to the original plot display.
Zoom	1 Click the image to define the top left corner of the zoom box 2 Hold the left-click button and drag the mouse to the bottom right corner of the zoom box. 3 Release the mouse button and the image zooms to the box
Amplitude (mV) – Y Axis	The GPR signal amplitude in millivolts (mV). Move the mouse cursor along the time axis to display the time and GPR signal amplitude on the status bar at the bottom of the window.
Time (ns)	The time in nanoseconds from the start of the recording window. Time before zero time is displayed as a negative value.
Trace	The displayed trace. Click the up and down arrows to display other traces.
Position	The position of the displayed trace on the GPR line. The position is based on the trace number and the step size

16.4.1 File

3. Click the File menu to see the following sub-menu:

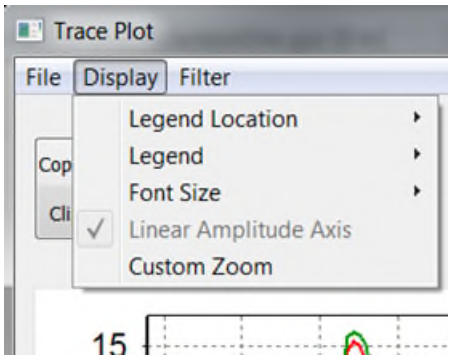


Use the following table as a guide to working with the **File** menu:

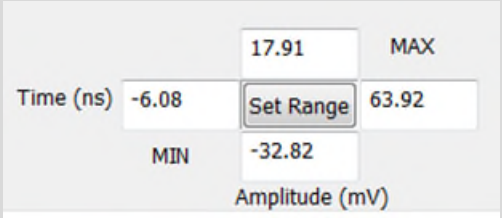
Item	Description
Print	To print the Trace plot, click **Print**.
Save Image as File	To save the Trace plot as an image, click **Save Image as File**. 1 In the **Save As** dialog box, use the dropdown at the bottom to select the type of graphics image file (jpg, bmp, gif or png). 2 Navigate to the folder to save the file to. 3 Click **Save**.
Copy Image to Clipboard	To copy a Trace plot image to paste into a document, click **Copy Image to Clipboard**.
Save Image to Project	To attach the Trace image to the project so it is included in GPR Summary Reports, click **Save Image to Project**.
Close	To close the Trace plot, click **Close**.

16.4.2 Display

4. Click the Display menu to see the following sub-menu:

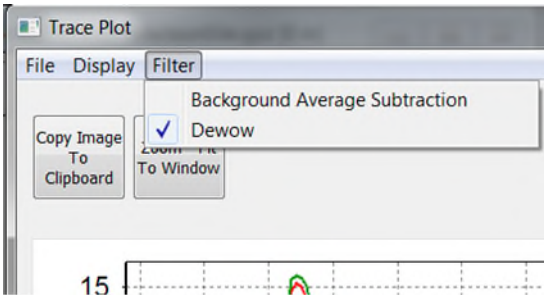


Use the following table as a guide to working with the **Display** menu:

Item	Description
Legend Location	To define the location of the legend on the Trace plot, click **Legend Location**. In the drop-down list click **Top, Bottom, Left, Right**, or **Hide**.
Legend	Select the items to include on the Legend: **Filters** and **GPR Line names**.
Font Size	Choose a font size of **Small**, **Medium,** or **Large**.
Linear Amplitude Axis	Not available.
Custom Zoom	Allows the user to specify **Min** and **Max Time** in nanoseconds (ns) and **Min** and **Max Amplitudes** in millivolts (mV) to display. 

16.4.3 Filter

Click the Filter menu to see the following sub-menu:



Check **Background Average Subtraction** to apply an Average background subtraction filter with a filter length equal to the length of the GPR line before plotting the Trace plot. Defaults to OFF.

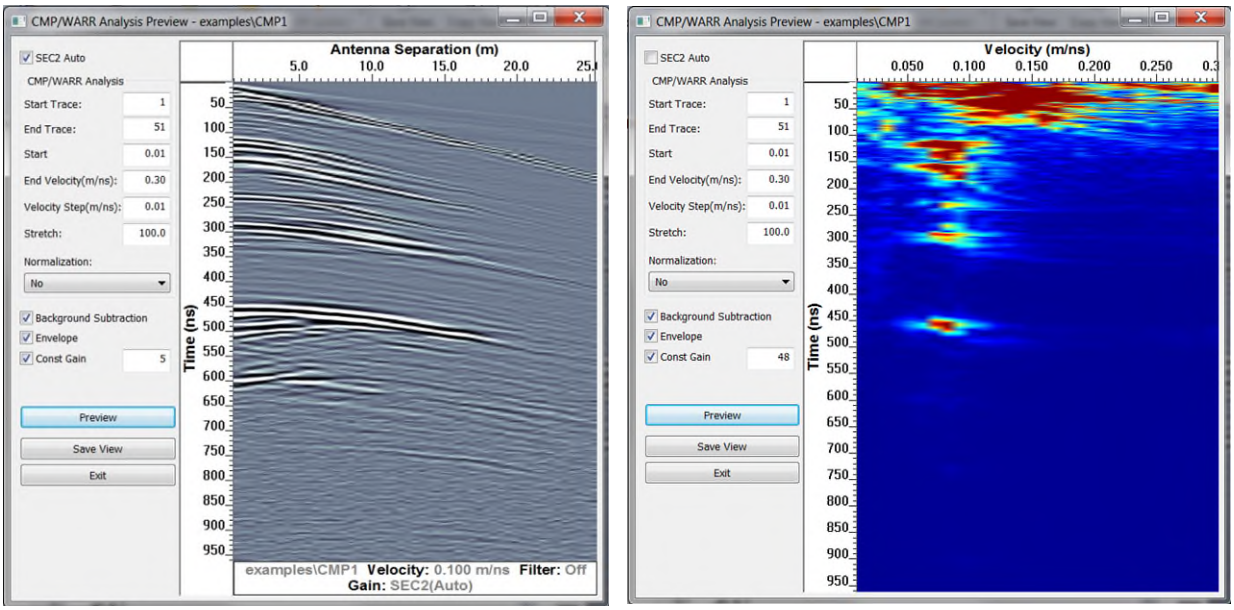
Check **Dewow** to apply a high pass temporal filter called Dewow to the GPR line before plotting the Trace plot. Defaults to ON.

For more information, see Dewow and Background Average Subtraction in the **Processing Module User's Guide**.

16.5 CMP/WARR Analysis

This option requires the optional Processing module.

Analyze Common Mid-Point (CMP) or Wide-Angle Reflection and Refraction (WARR) survey data (left) and analyze it using semblance analysis to extract velocity information (right):



For more details, see the **Processing Module User's Guide**.

16.6 Zoom

16.6.1 Zoom Out

To decrease the magnification of the MapView or Line Preview image by a factor of 1.5 times, click **View** > **Zoom** > **Out**.

16.6.2 Zoom In

To increase the magnification of the MapView or Line Preview image by a factor of 1.5 times, click **View** > **Zoom** > **In**.

When you zoom in to display a portion of the project data, an icon appears in the lower left corner of MapView to indicate that data exists outside the current view (see Pan).

16.6.3 Zoom Window

To magnify a selected area of MapView or Line Preview windows, click **View** > **Zoom** > **Zoom Window** and then click and drag a rectangle around the area of interest.

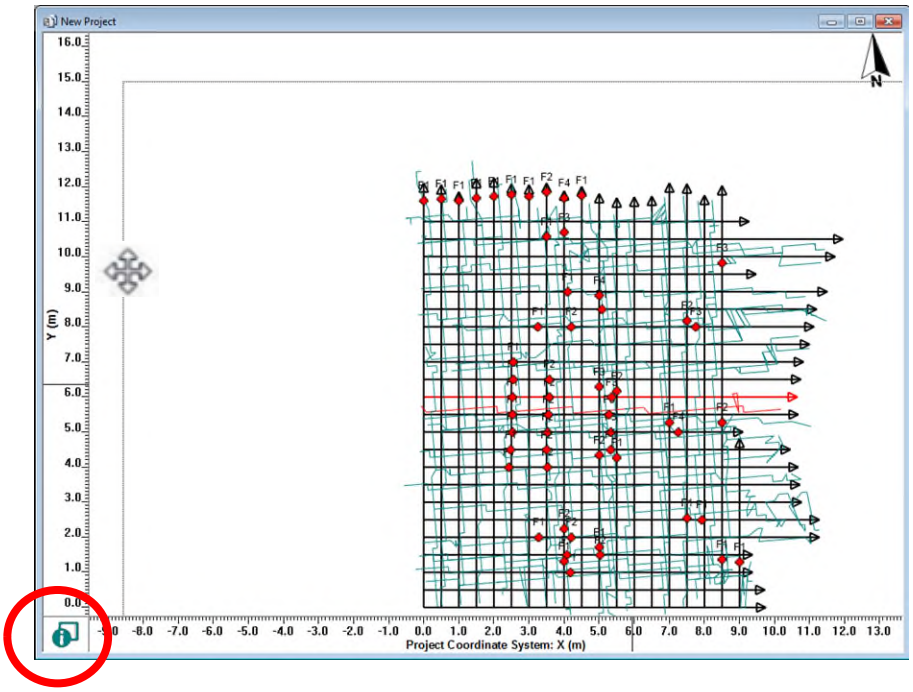
16.6.4 Fit to Window

To adjust the zoom to fit all the data in the MapView or Line Preview windows, click **View** > **Zoom** > **Fit to Window**.

16.7 Pan

To reposition the MapView or the Line Preview, click **View** > **Pan**.

Click and drag the cursor ( ) to move the MapView or Line Preview within the window.



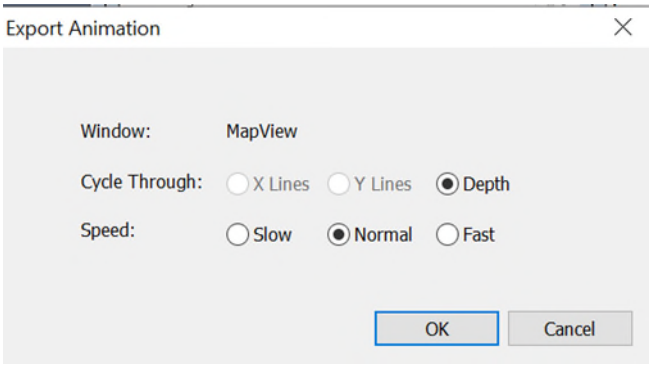
Panning or zooming images within MapView may prompt the following icons to be displayed in the bottom left corner:

Indicates that some of the data is outside the current window.

Indicates that all the data is outside the current window. Click **View** > **Zoom** > **Fit to Window** to see all the data in the project in the MapView window.

16.8 Export Animation

If the MapView or 3D Preview window is currently the Active Window, it can be saved to a GIF animation file by selecting **View > Export Animation**. The following dialog box opens:



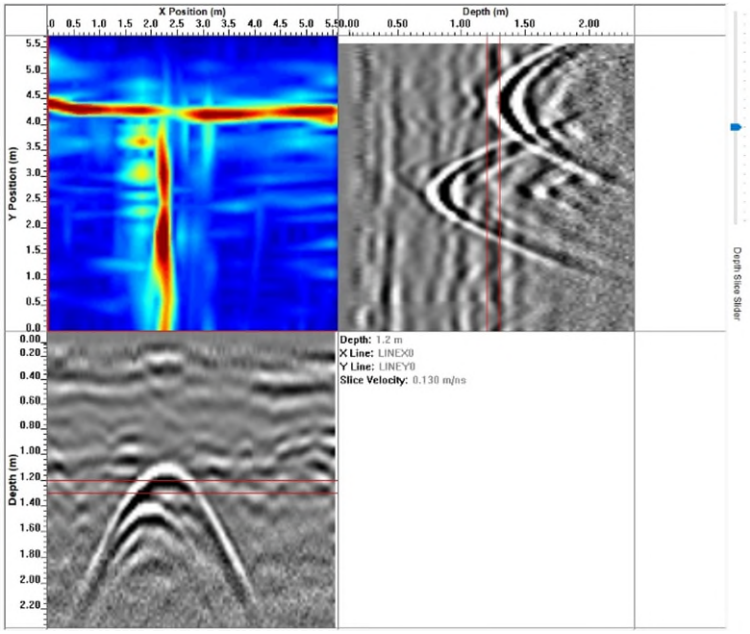
Window displays the name of the window to be animated (MapView or 3D Preview).

Cycle Through displays what images will animate. If Window is MapView, it is only possible to animate the Depth Slices. If the Window is 3D Preview, the user can select either the X Lines, Y Lines, or depth slices to animate.

Speed determines the speed of the animation; the number of frames per second (fps). Slow is 1 fps, Normal is 2 fps and Fast is 3 fps.

After pressing OK, the user is prompted to navigate to the folder to save the GIF file into and can edit the default name for the GIF file.

After exporting the GIF animation file, the folder opens, to see the GIF file and play it, if desired.



16.9 Save View

To save the MapView or Line Preview window image to the GPR Summary Report (PDF), select that window so it is the Active Window and then select **View > Save View**.

1. A message opens, asking if you would like to save the currently selected window or all open windows.
2. A dialog for naming the image. The default name is based on what window is being saved (Line Preview or MapView).
    - For Line Preview images, the default image name includes the Line name.
    - For 3D preview, the default name includes the grid name and depth slice.
    - For MapView images, the default image name will include:
        - the depth of the slice being shown (if Slices are turned on in Layer View).
        - PCD, (if PCD is turned on in Layer View).
3. Click **Save**.

When the GPR Summary Report is selected, the user can select from the images attached to project to appear in the report.

To see a list of the images currently saved and available for the GPR Summary Report, select the project item in Project Explorer and then open the Attachments Tab.

Images saved to the Project (GPZ) file can be exported using the File > Export > Attachments menu option.

16.10 Copy View

To copy the MapView or Line Preview window image to the clipboard, select that window so it is the Active Window and then select **View > Copy View**.

A message opens, asking if you would like to save the currently selected window or all open windows.

This feature enables you to copy and paste the image to a document or image editor.

16.11 Export View

To export the MapView or Line Preview image to a graphics image file, select that window so it is the Active Window and then select **View > Export View**.

1. A message opens, asking if you would like to save the currently selected window or all open windows.
2. In the **Save As** dialog box, navigate to, and select the folder you want to save this image in.
3. Use the **Save as Type** dropdown to select the file format (jpg, bmp, gif, png or tiff)
4. Click **Save**.

16.12 Use Getting Started dialog

When a new project is created, the Getting Started dialog (Figure 1) automatically opens to guide you through creating a project file.

To disable this feature, click **View** and then uncheck **Use Getting Started dialog**.

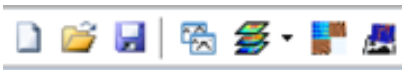
16.13 Toolbar Text

EKKO_Project enables you to display/hide the text that appears below each toolbar icon.

Select **View** > **Toolbar Text** to display text below each icon:

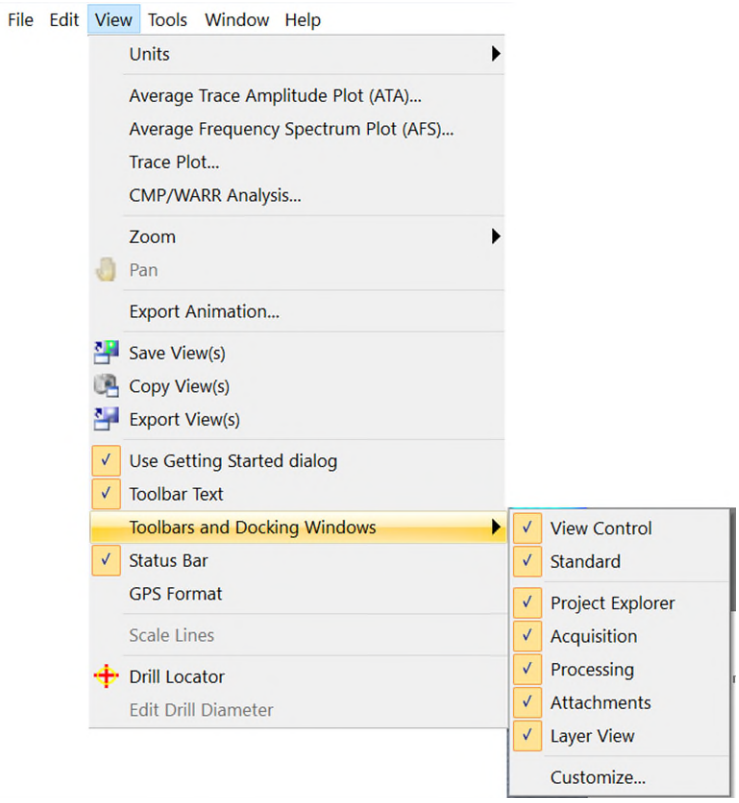


To display the toolbar icons without text, reducing the size of the toolbar, select **View** and then uncheck **Toolbar Text.**



16.14 Toolbars and Docking Windows

Select **View** > **Toolbars and Docking Windows** to view or hide the following features:



- Standard Toolbar
- View Control Toolbar
- Acquisition Tab
- Processing Tab
- Attachments Tab
- Project Explorer
- Layer View

16.14.1 Customize

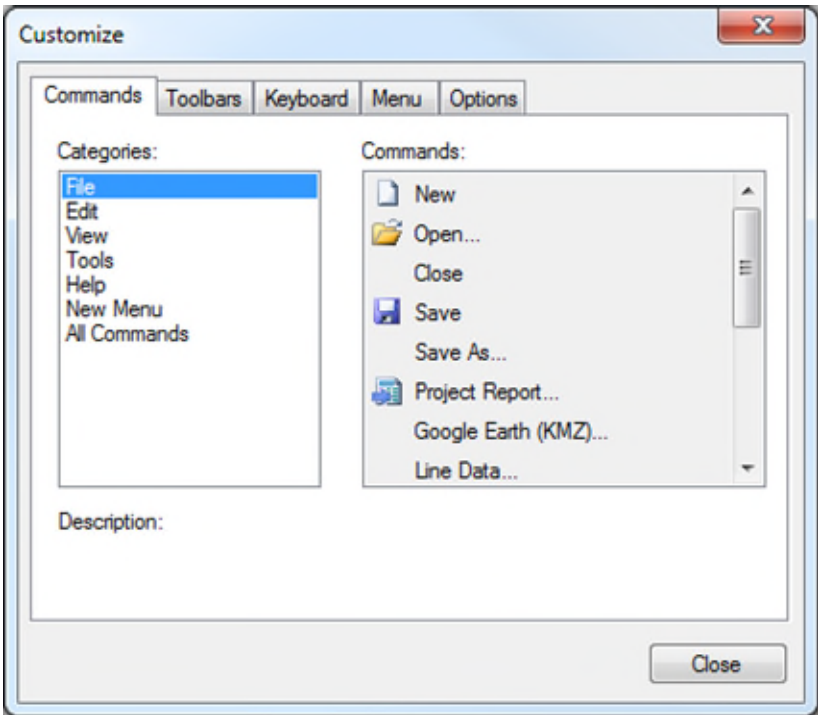
Customize is standard Microsoft® functionality; for more details see Microsoft® documentation.

To modify the Commands, Toolbars, Keyboard, Menus, and other Options in EKKO_Project, click **View** > **Toolbars and Docking Windows** > **Customize**.

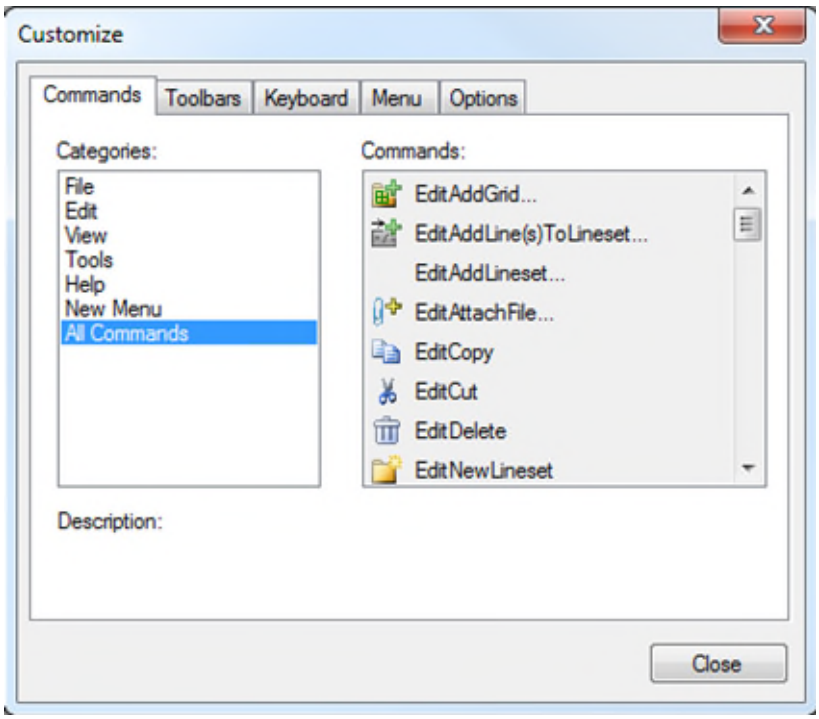
16.14.1.1 The Commands Tab

Use **t**he Commands tab to display all commands available to add to a toolbar.

1. The Commands tab lets you see all the commands available to add to a custom or existing toolbar. To determine which commands will be displayed in the menu bar, click the item in the **Categories** pane.



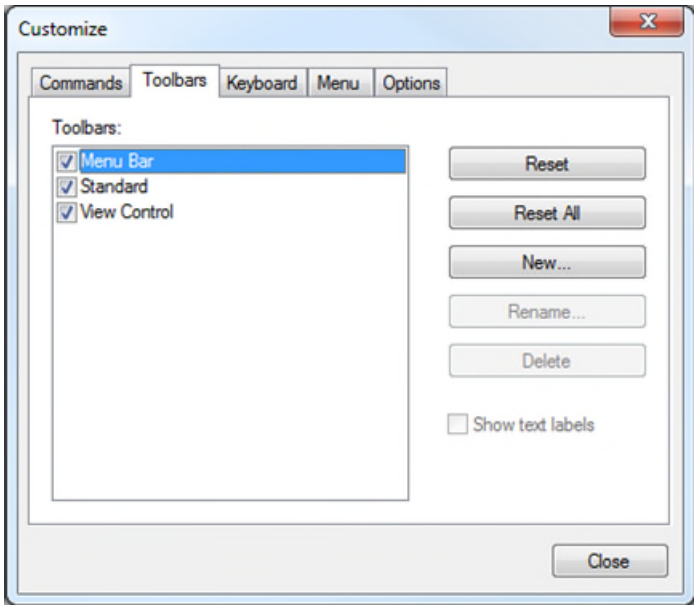
2. To display a description of the command, click a menu item in the **Commands** pane.



3. To exit the Customize window, click **Close** or click another tab to view more information.

16.14.1.2 Toolbars Tab

1. To display the available Toolbar options, click the **Toolbars** tab.



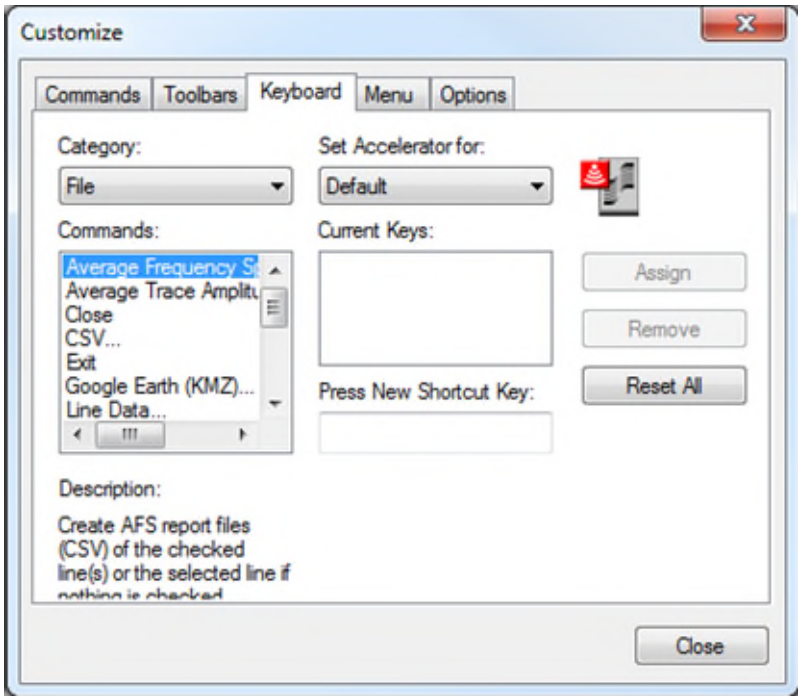
2. Use the following table as a guide to working in the Toolbars tab:

Field	Description
Toolbars	The Toolbars field displays the available menu bars. To display or hide a toolbar in EKKO_Project, select/deselect the checkbox next to the toolbar name.
Reset	In the Toolbars field, select the menu bar(s) that you want to return to the default setting and then click **Reset**.
Reset All	To return all toolbars to their default view, click **Reset All**.
New	1 To add a new toolbar to EKKO_Project, click **New**. 2 In the Toolbar Name field, type the name of the new toolbar. The new toolbar is displayed in the Toolbars field.
Rename	To Rename a toolbar that you have added to EKKO_Project: 3 In the Toolbars pane, select the toolbar you want to rename. 4 Click **Rename**. 5 In the **Toolbar Name** dialog box, type the new toolbar name. 6 Click **OK**.
Delete	To Delete a toolbar that you have added to EKKO_Project: 1 In the Toolbars pane, select the toolbar you want to rename. 2 Click **Delete**. 3 In the confirmation dialog box, click **Yes**.
Show text labels	To display text descriptions with the toolbar icons, click the **Show text labels** checkbox

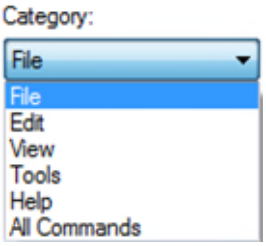
16.14.1.3 Keyboard

To manage how your keyboard interacts with EKKO_Project, click the **Keyboard** tab.

Use the Keyboard tab to assign keyboard shortcuts to any feature in the **File**, **Edit**, **View**, **Tools**, **Help**, or **All Commands**.



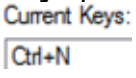
1. To create a new keyboard shortcut, in the **Category** drop-down list, click one of the following options:



Note: Each Category displays a different list of commands.

2. In the **Commands** pane, click the command that you want to apply a hotkey shortcut to.

   A brief description of the command is displayed in the **Description** area.
   Any existing shortcuts associated with the selected command are displayed in the **Current Keys** pane.



3. In the **Set Accelerator for** drop-down list, click an option.
4. To create a new hotkey shortcut, select the **Press New Shortcut Key** field and then press a shortcut combination on your keyboard.

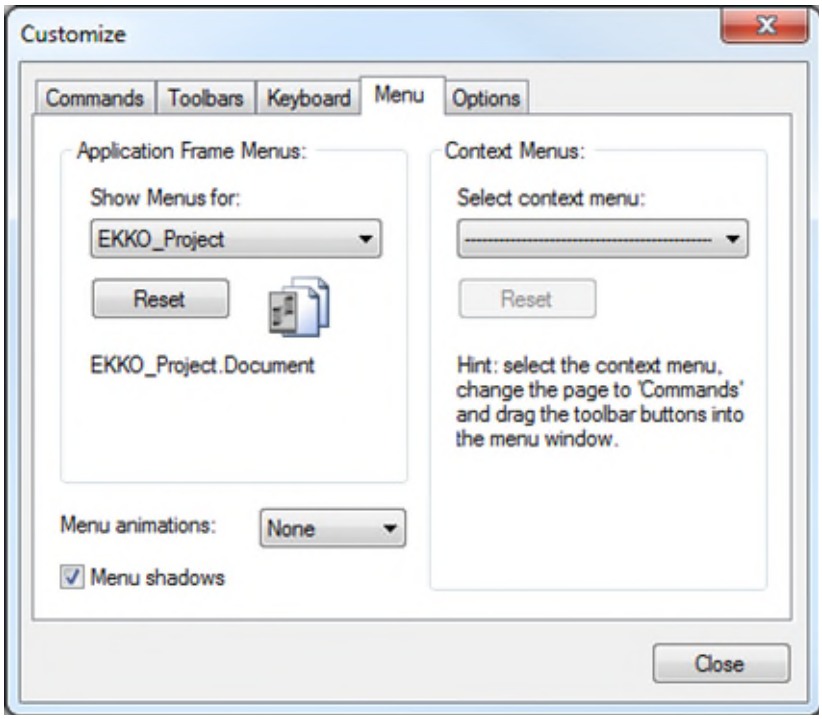
   The shortcut is displayed in the **Press New Shortcut Key** field.

5. Click **Assign** to assign the shortcut to the selected command.

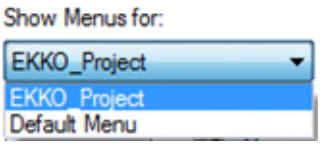
Press **Remove** to remove a shortcut from a command.
Press **Reset All** to remove all shortcuts.

16.14.1.4 Menu

1. To change the items displayed in the menu bar, click the **Menu** tab.

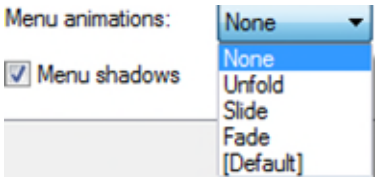


2. In the **Application Frame Menus** pane, click the **Show Menus for** drop-down list.
3. Click one of the following options:



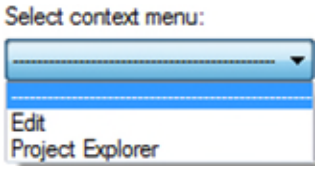
Click **Reset** to abandon your changes.

4. To apply animations to the menu, click the **Menu animations** drop-down list and select one of the following options:
5.



6. To apply shadows to the menu items, select the **Menu shadows** option.

7. To allow context menus to be displayed, in the Context Menus pane, click the **Select context menu** drop-down list to select one of the following:

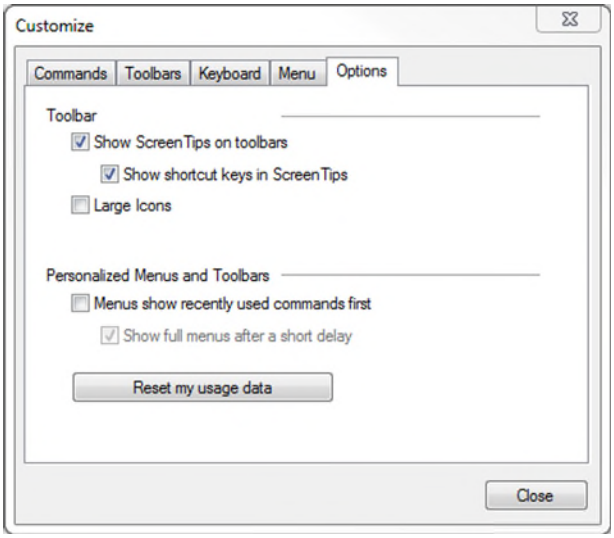


   Click **Reset** to abandon all your changes.

8. Click **Close** to close the window.

16.14.1.5 Options

1. To define your toolbar and menu options, click the **Options** tab.



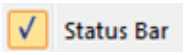
2. Use the following table as a guide to working with the **Options** tab:

Field	Description
Toolbar	
Show Screen Tips on toolbars	Select this option to display text screen tips when you hold your mouse over the toolbar icon.
Show shortcut keys in Screen Tips	Select this option to display text keyboard shortcuts when you hold your mouse over the toolbar icon.
Large Icons	Select this option to display the large toolbar icons.
Personalized Menus and Toolbars	
Menus show recently used commands first	Select this option to place the commands you most recently used at the top of the drop-down list. Click the arrow (>) to display other menu options,
Show full menus after a short delay	Select this option to first display only the most recent commands and then display the full menu after a few seconds.
Reset my usage data	Select this option to reset the recently used order.

3. Click **Close** to close the window.

16.15 Status Bar

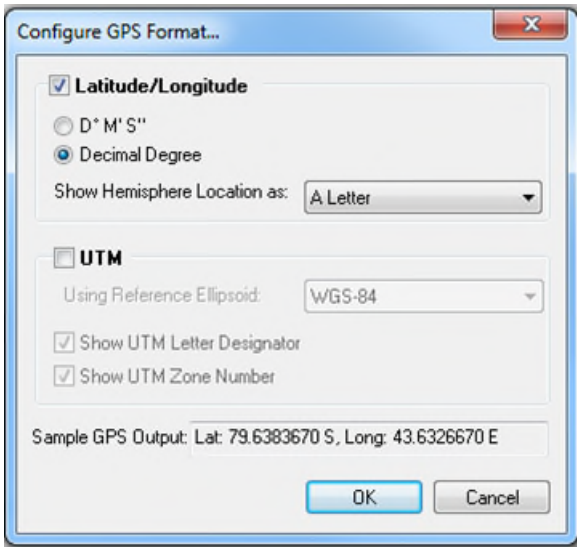
To display information in the Status Bar at the bottom of the EKKO_Project window (Status Bar) in the menu bar, click **View** > **Status Bar**.



To not display information in the status bar, de-select the Status Bar option.

16.16 GPS Format

To modify the format of the GPS information in the Status Bar at the bottom of the EKKO_Project window, in the menu bar click **View** > **GPS Format**.



16.16.1 Latitude/Longitude

If Latitude/Longitude is selected with the checkbox, the display options are:

1) **Degrees Minutes Seconds**

2) **Decimal Degrees**

The options for the Hemisphere are:

1) **Do not show**

2) Show as a **Positive** (+) or **Negative** (-) sign. A plus (+) sign if Latitude is in the Northern hemisphere or Longitude is in the Eastern Hemisphere and a minus (-) sign if Latitude is in the Southern hemisphere or Longitude is in the Western Hemisphere.

3) **Letter**: For latitude, “N” for North or “S” for South. For Longitude, “E” for East or “W” for West.

4) **Word**: For latitude, “North” or “South”. For Longitude, “East” or “West”.

A sample of the current GPS output is shown at the bottom of the dialog box.

16.16.2 UTM

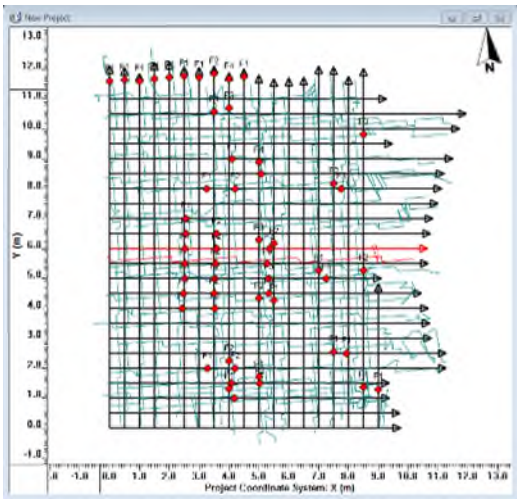
If UTM is selected with the checkbox, the Reference Ellipsoid can be selected from the drop-down list. The default is WGS-84.

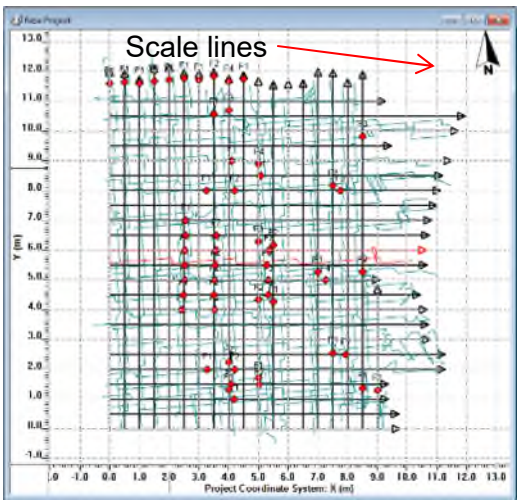
To display the UTM Zone Number and/or the UTM Letter Designator, select those options.

A sample of the current GPS output is shown at the bottom of the dialog box.

16.17 Scale Lines

Scale lines are dashed lines that correspond to the X and Y axes label increment. They can assist in determining an accurate XY position within the project data.





16.18 Drill Locator

See Drill Locator.

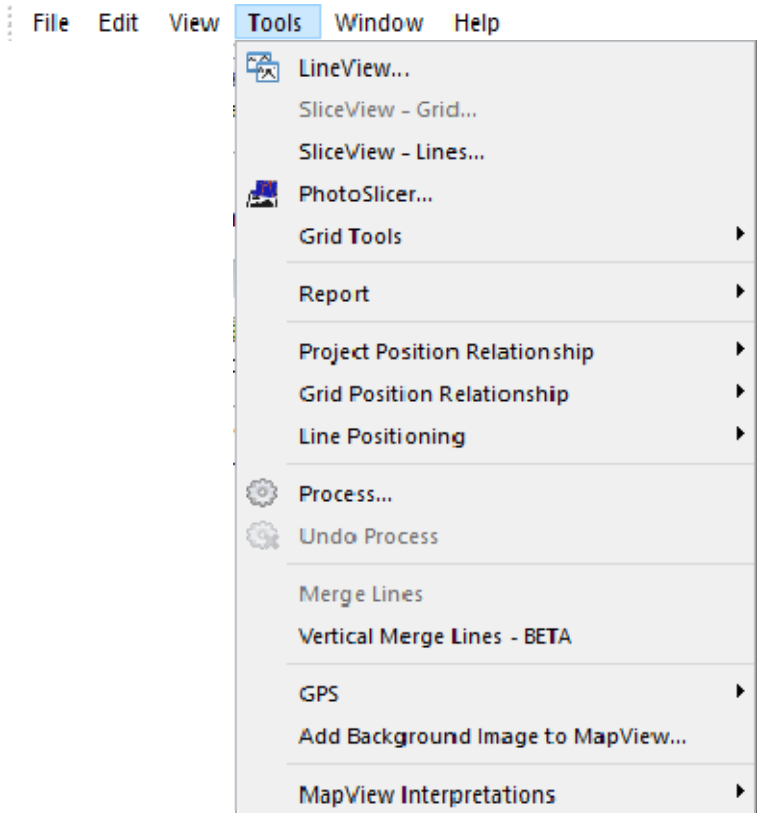
16.19 Edit Drill Diameter

See Drill Locator.

17 Tools Menu

The EKKO_Project Tools menu contains many features that allow you work in 3D Preview and the optional LineView, SliceView, and Process modules within EKKO_Project. The Tools menu is also used to add or modify positioning, add background images to MapView and produce various reports from the GPR data and images in the project.

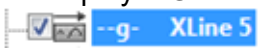
To open the tools menu drop-down list, click **Tools**:



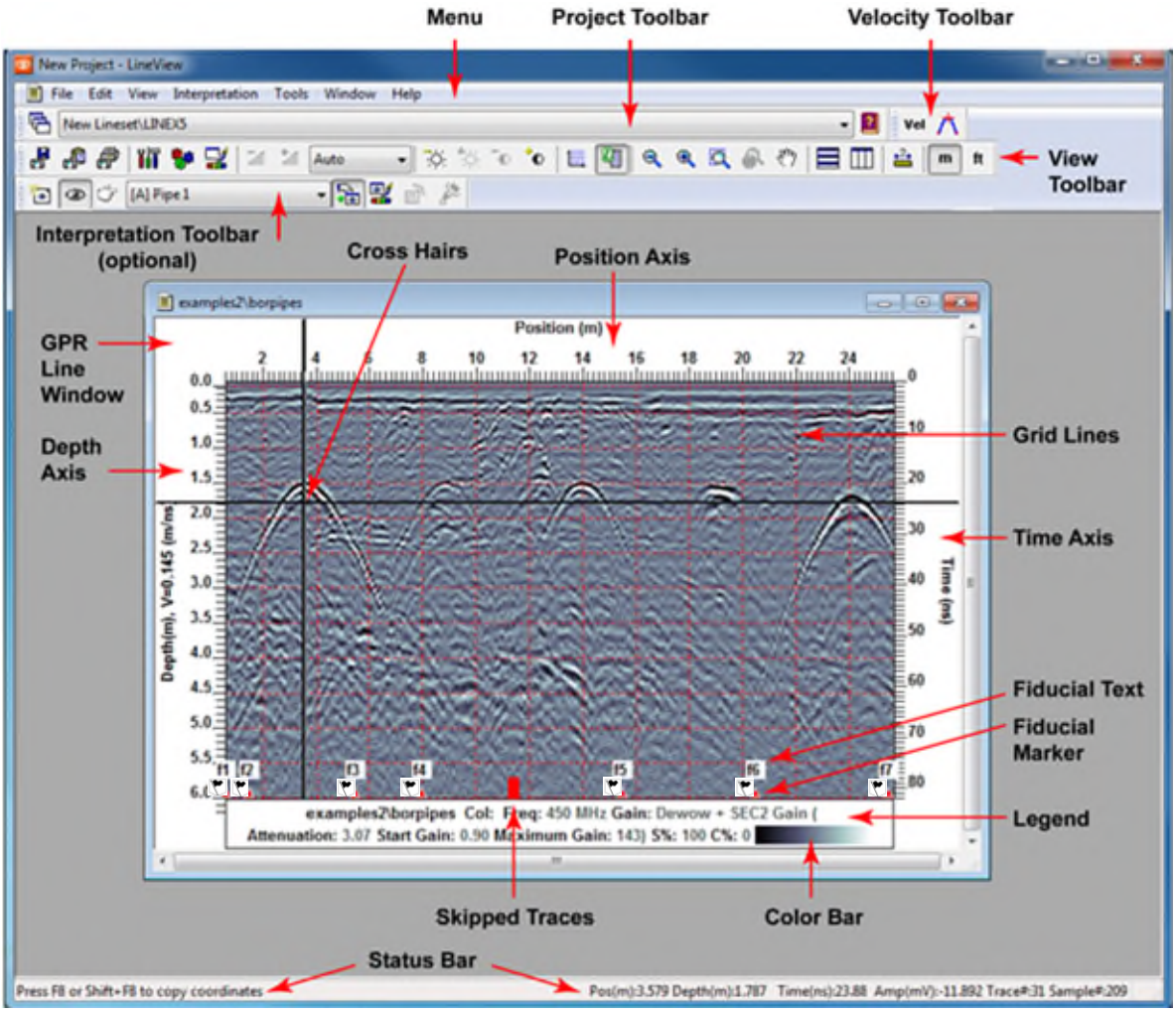
The following sections describe how to work with the Tool menu features:

17.1 LineView

The optional LineView module displays cross-sectional views of GPR lines; you can change the display settings such as color table, gain, and axes.

1. To display a GPR Line name in the LineView module, in Project Explorer, select a line.


2. Click **Tools** > **LineView**.



Use LineView to add interpretations such as, Points, Polylines, Boxes, Annotations and Flags to the GPR Line. Interpretations can be displayed in MapView and listed in the Project Report (CSV).

Only the selected GPR Line or those checked in to Project Explorer are displayed in LineView, however all GPR Lines in the project can be displayed using the LineView toolbar Project List drop-down.

To learn more about using LineView to display GPR lines and add Interpretations, see the **LineView User's Guide**.

17.2 SliceView

The SliceView module is used to process a grid or line(s) of GPR data collected in an area into a series of map view images called depth slices. Depth slices provide highly detailed subsurface information that can enhance GPR data interpretation and presentation. Users can see the spatial correlation of targets, making interpretation easier as they can differentiate real targets from targets of no interest. For example, responses from utilities tend to produce linear targets while local targets, such as rocks, appear as point targets. This type of display is especially useful for interpreting large data volumes.

Depth Slices can be generated two ways:

1) SliceView-Grid
2) SliceView-Lines

Both modules have the following features:

- Analyze GPR data collected in an area (grid or pseudo-grid) by viewing depth slices at increasing depths
- Reprocess data using different velocities and background subtraction filter lengths
- Process depth slices to plot in the MapView window in EKKO_Project Core
- Save depth slices as images such as JPG, BMP or PNG
- Save depth slice images to include in the GPR Summary Report (PDF)
- For data collected with GPS or with a Project Position Relationship:
    - generate KMZ files of depth slices to display in Google Earth™
    - generate Geotiff files of depth slices to display in GIS software
- Export depth slice data to CSV or GRD files for further analysis in third-party software, such as Golden Software's Surfer®

SliceView-Grid has the following additional feature:

- Export grid data to 3D data files and plot using the optional Voxler® 3D visualization software (by Golden Software)

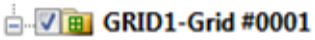
The SliceView module is described in more detail below.

17.2.1 SliceView-Grid

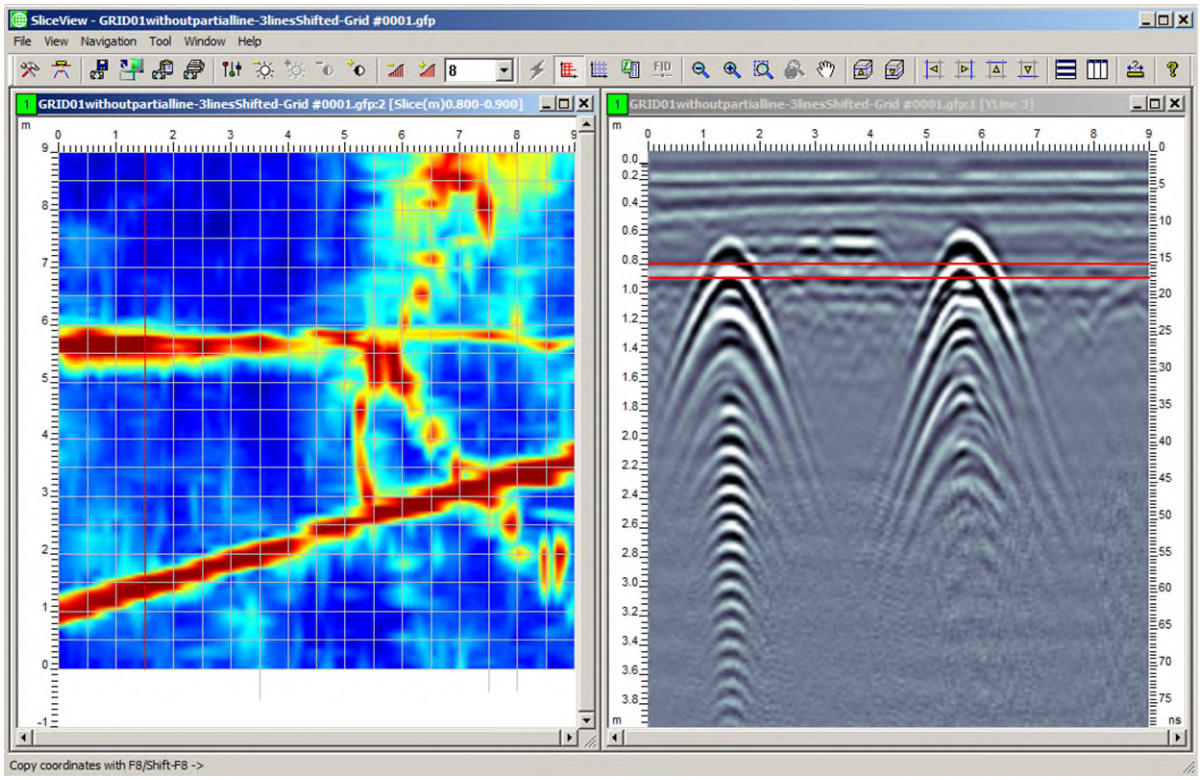
SliceView-Grid is used to process GPR data collected in a grid into depth slices.

The SliceView module contains a function called SliceView-Grids to generate depth slices of GPR data collected in a grid.

1. To display a grid in SliceView, in Project Explorer, select a grid.

2. Click **Tools** > **SliceView-Grid**. This opens the SliceView-Grid function, processes the grid data into depth slices and displays them along with the GPR grid lines like the example below.

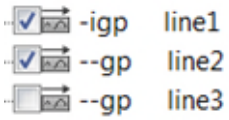


To learn more about using SliceView-Grid to display depth slices, see the **SliceView User's Guide**.

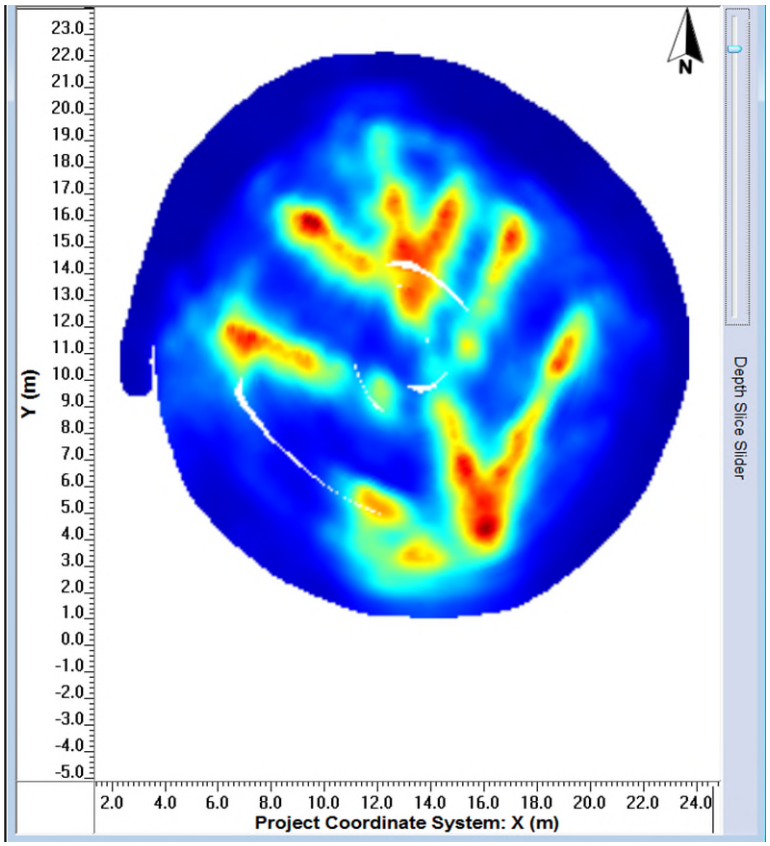
17.2.2 SliceView-Lines

SliceView-Lines is used to process one or more GPR lines with positioning information into depth slices. This means the GPR lines must have been collected with GPS or had line positioning added to the lines in post-processing (see Line Positioning).

1. To process GPR line data using SliceView-Lines, in Project Explorer, select one or more lines.



2. Click **Tools** > **SliceView-Lines.** This opens the SliceView-Lines function, processes the grid data into depth slices and displays them in the MapView window like the example below.



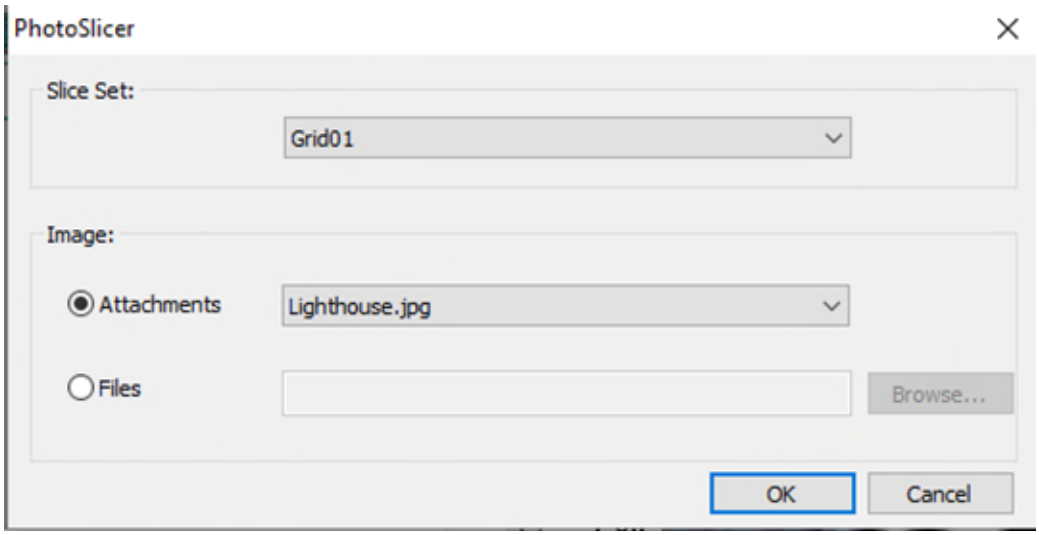
To learn more about using SliceView-Lines to display depth slices, see the **SliceView User's Guide**.

17.3 PhotoSlicer

PhotoSlicer allows the user to overlay GPR depth slices onto a photograph. Depth slices generated on the Display Unit in the field or from EKKO_Project's SliceView module are added to a photo and can be stretched or squeezed to fit onto the photo in the proper position and with the proper perspective. Photos with depth slices are an excellent way to convey the position of objects found with GPR in the context of the survey site.

PhotoSlicer images can be saved for external reports and presentations. They can also be attached to the project file so they can appear in the GPR Summary Report.

Select PhotoSlicer from the Toolbar button or by selecting the **Tools > PhotoSlicer** menu option. The following dialog box opens:



Slice Set is the name of the depth slices to overlay on the photo.

The user selects the depth slice from the dropdown that lists all the depth slices available in the project; depth slices generated by SliceView-Grid and SliceView-Lines.

Image is the image the slice will be overlayed on. While a photograph of the surveyed area is typically used, any image file is can be selected.

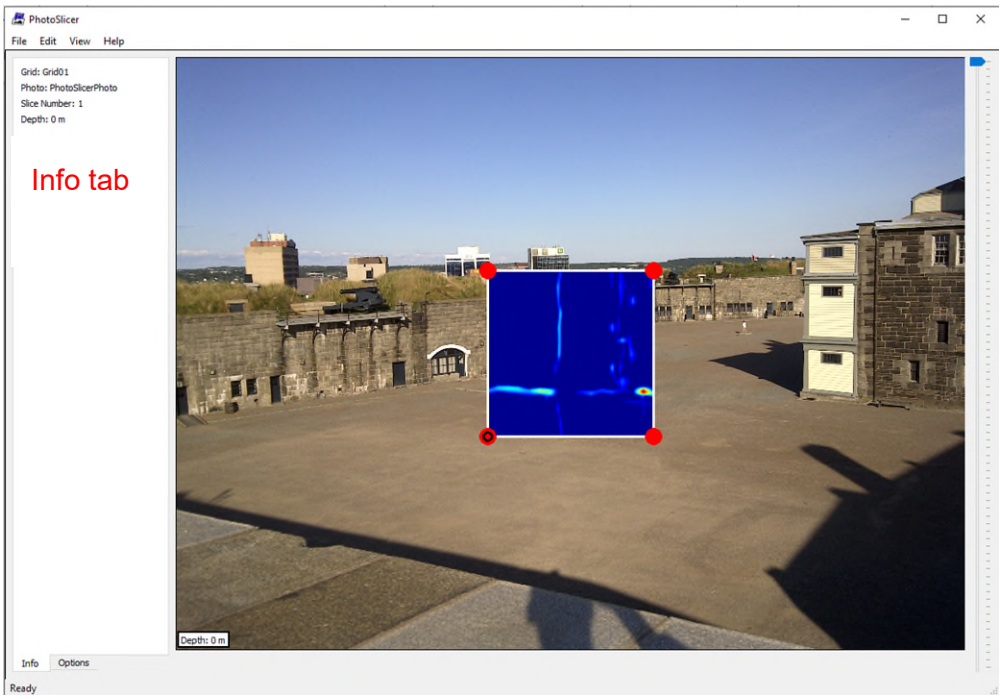
If the desired photo has already been attached to the GPR project (GPZ) file or any Lineset, Grid or GPR line in the project (see Attachments Tab), the user clicks on the **Attachments** button and then uses the dropdown list to select the name of the image.

PhotoSlicer supports the following image formats: BMP, JPEG, JPG, PNG, TIF and TIFF.

If the desired photo is elsewhere on the computer, select the **Files** button and then use the **Browse** button to navigate to the folder and select the name of the image.

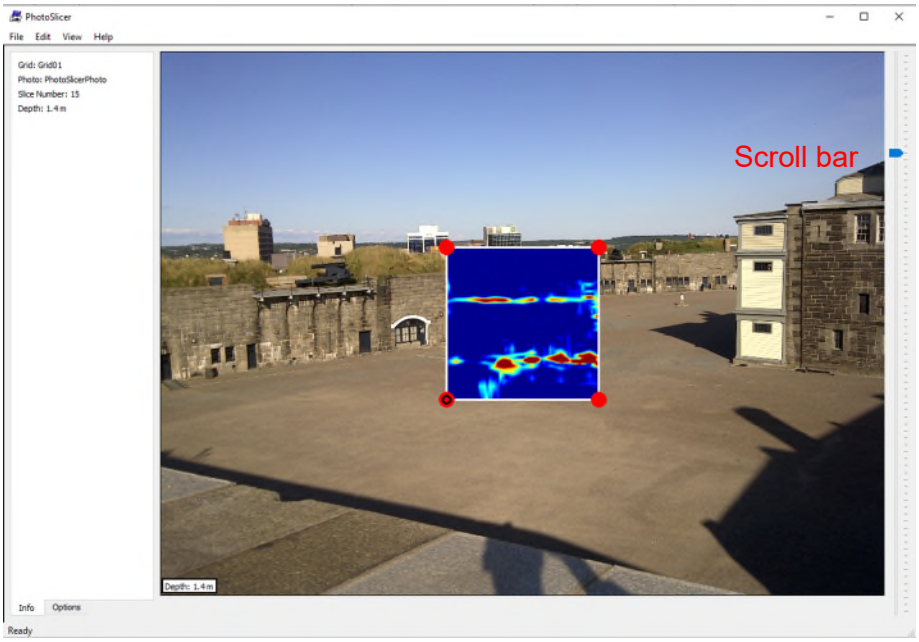
Once the Slice Set and Image are selected, press OK.

A new window opens with the image in the background and the top depth slice overlayed on the image. The Info tab on the left lists the name of the Slice Set, name of the image.



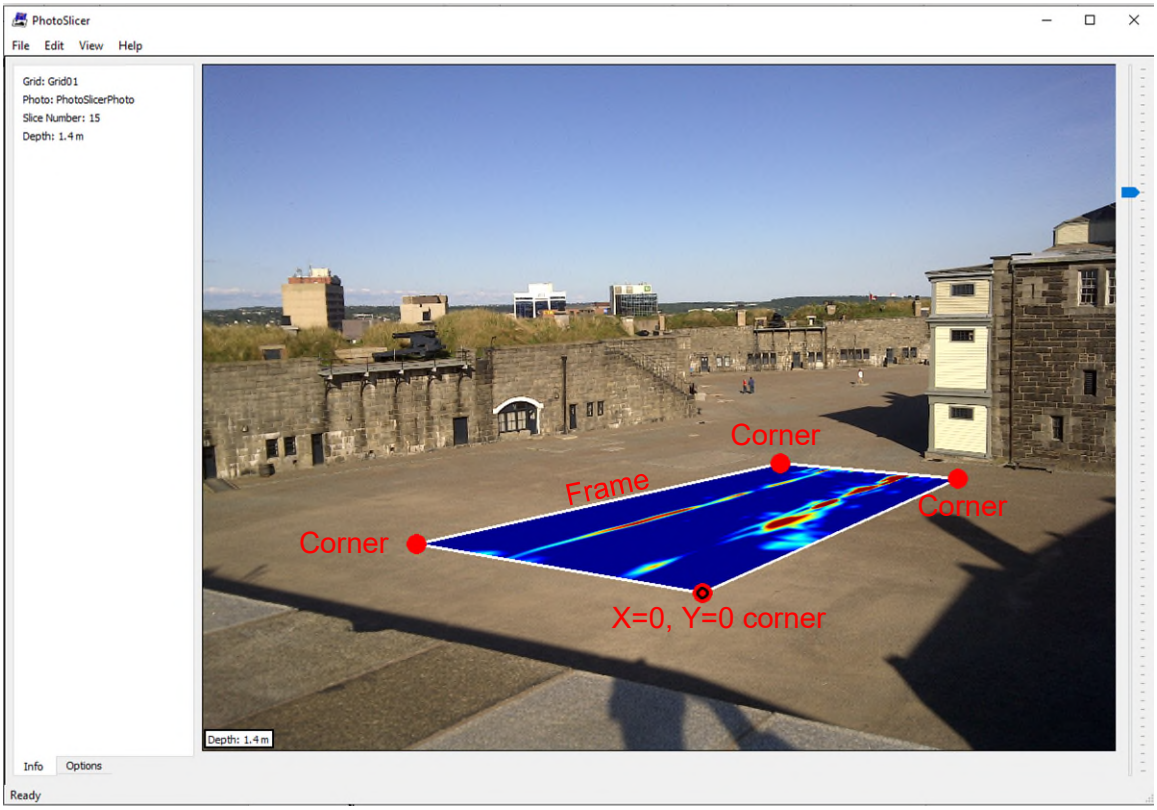
If necessary, the photo can be rotated 90 degrees clockwise using the **View > Rotate Image** menu option.

The depth of the current depth slice is displayed in the bottom left corner of the image. Use the mouse scroll wheel or the scroll bar on the right to scroll through the depth slices and select the desired one.

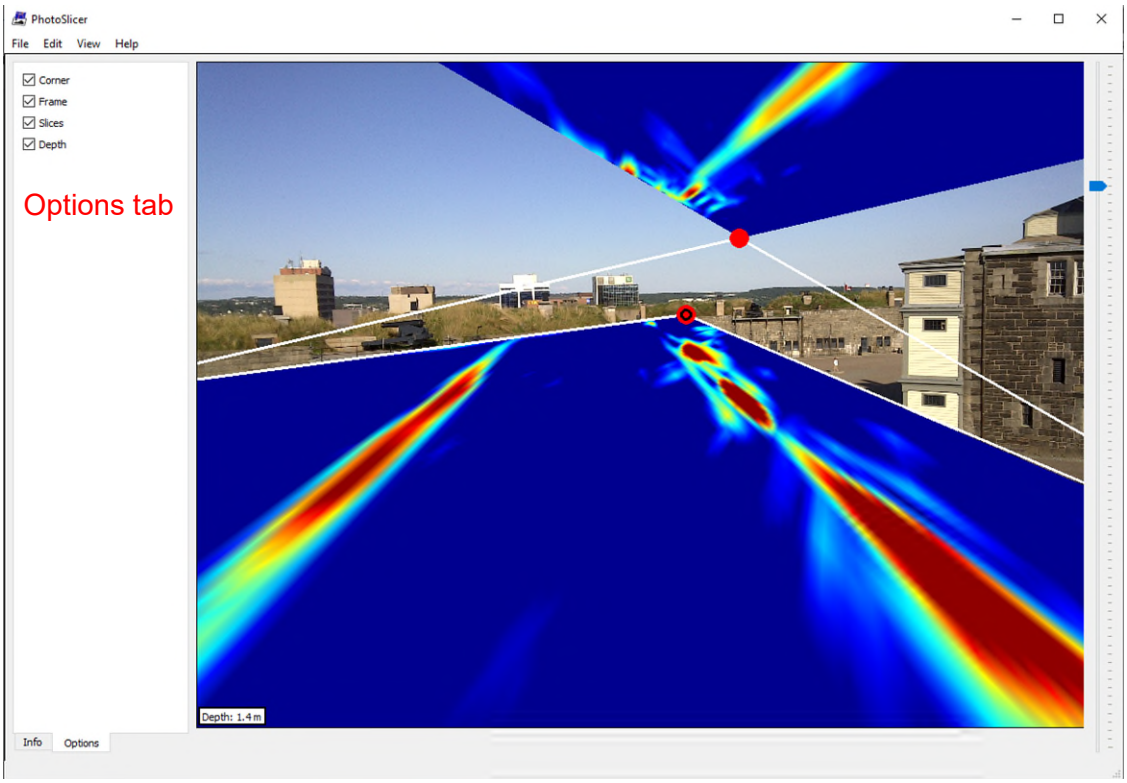


The depth slice has a frame and red corners that cab be clicked and dragged to stretch, squeeze, rotate and change the shape to place it at the desired location on the photo. The X=0, Y=0 corner of the depth slice is indicated by the black zero (0) on one of the red corners.

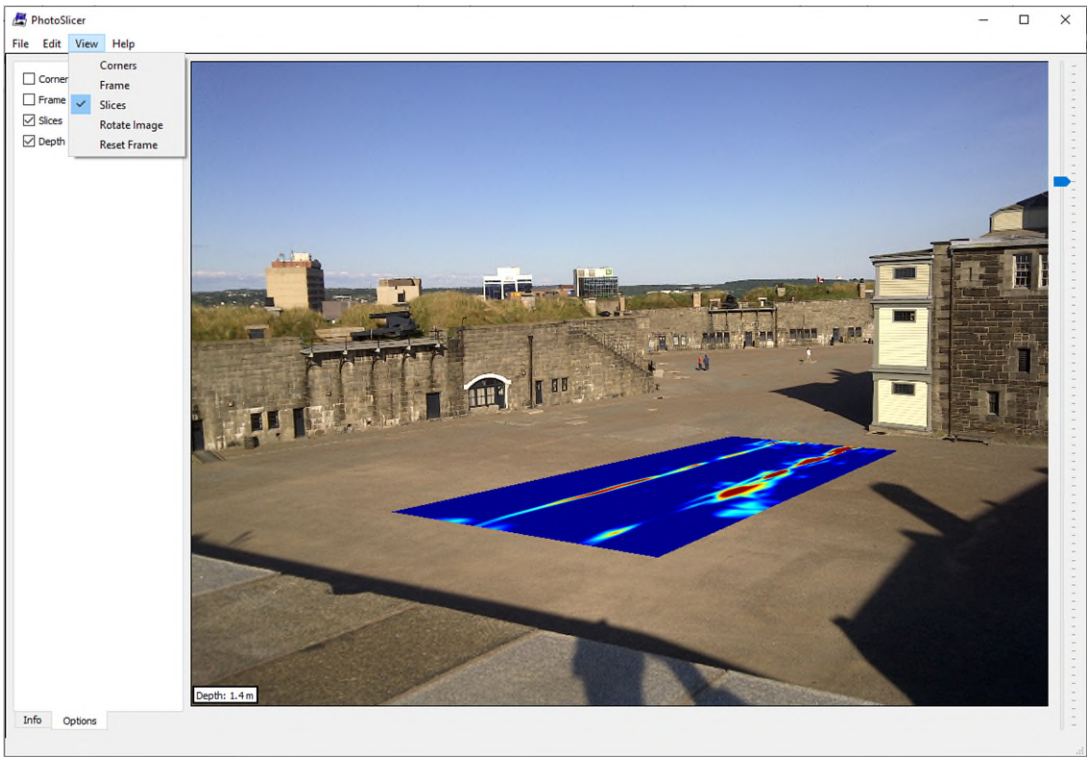
If the photo is of the grid collected with GPR, position the depth slice by placing the four corners of the depth slice onto the four corners of the grid in the photo.



It is possible to move the corners of the depth slice off the edges of the photograph. This is sometimes necessary to position the depth slice in the correct position but be aware that once you “drop” the corner, you will no longer have access to it to move it again. In this situation and if the depth slice image gets twisted and distorted, it may be necessary to reset the depth slice image to the original starting point and try again. Do this by selecting **View > Reset Frame**.



Once the depth slice has been placed, the red corners, frame and depth slices can be turned off using the option in the **View** menu or by selecting the **Options** tab in the bottom left corner and unchecking the appropriate boxes. The depth slice can still be moved without the corners or frame.



Once the photo and depth slice are positioned correctly, you can save images:

1) Save the image to the clipboard by going to **Edit > Copy to Clipboard.** The image can then be pasted into another document such as a Microsoft® Word® document.
2) Save the image to a JPG graphics image file by going to **File > Export PhotoSlice**
3) Save all the images to JPG graphics image files by going to **File > Export All PhotoSlices**

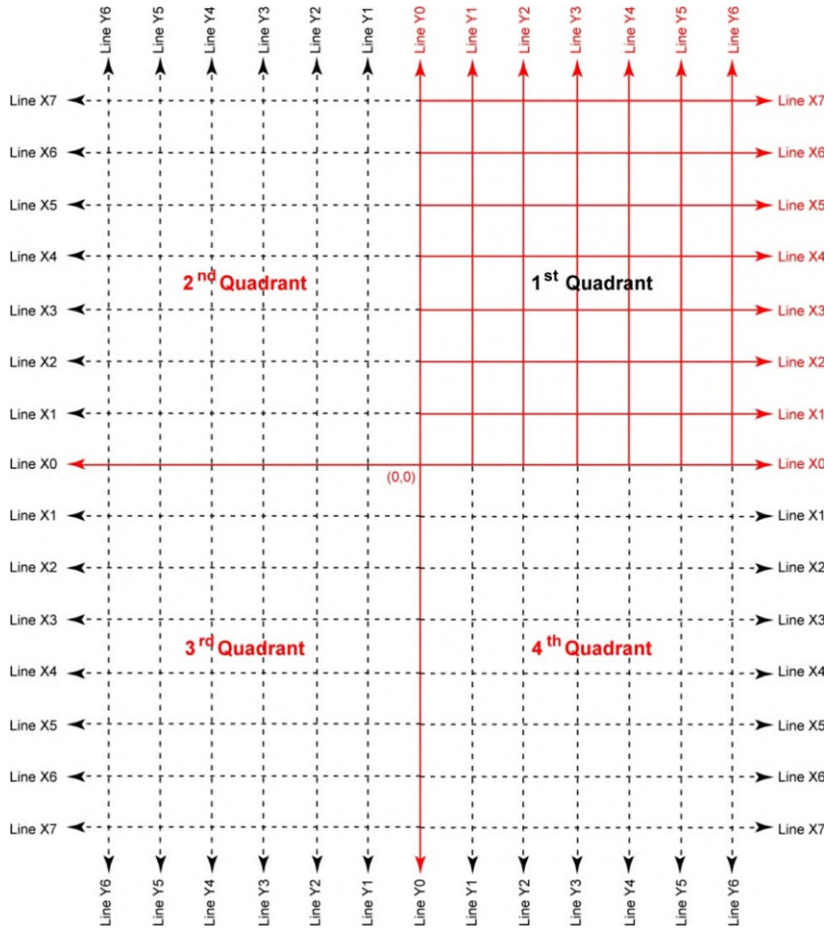
When you save a JPG graphics file image, the **Save As** dialog opens allowing you to navigate to the desired folder and name the JPG file. Once the file has been saved, the folder opens to show the saved file.

To exit from PhotoSlicer, go to **File > Close** or click on the **X** in the top-right corner.

17.4 Grid Tools

17.4.1 Grid Conventions

By convention, grids are always supposed to be collected in the “First Quadrant” with the X axis increasing from left to the right and the Y axis increasing upwards.

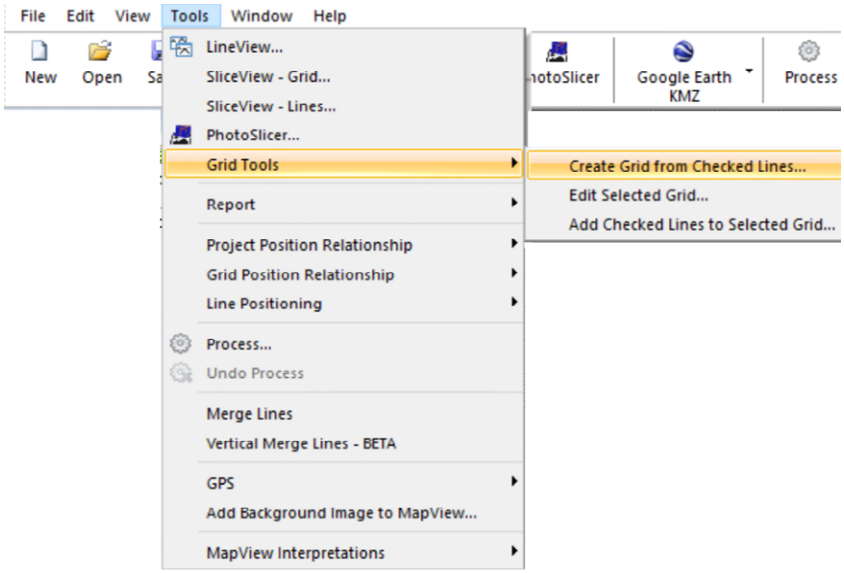


As well, “X Lines” are defined as the grid lines collected in the X direction of the grid and “Y

Lines" are defined as grid lines in the Y direction of the grid.

Grid Tools are used to create grids from GPR lines and edit grids, so the grid lines are positioned as if they were collected in the first quadrant. This ensures that depth slices or 3D volumes created from the data are correctly oriented and not mirror image or off at right angles.

17.4.2 Create Grid from Checked Lines

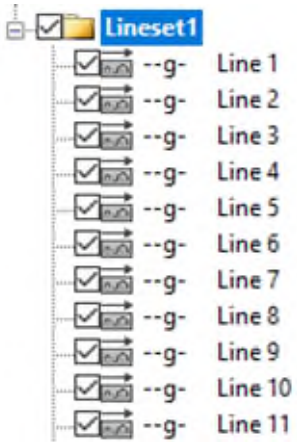


Sometimes GPR Line Scans are collected in a grid pattern (either parallel lines or lines in the both the X and Y directions) and the user wants to add them to a grid so it can be processed into depth slices using the SliceView-Grid module. This is done by using the GFP_Edit utility program to create a GFP file for that group of lines, which is the file that defines the position, direction, and length of every GPR line in the grid.

Note that grid line names must be unique, so it is not possible to create a grid with more than one line named Line1 or Line2, etc. This could happen by checking lines with the same name but in different linesets in Project Explorer, for example, \Lineset1\Line1 and Lineset2\Line1

17.4.2.1 Creating a Grid with All GPR Lines in One Direction

From Project Explorer, check all the GPR lines.

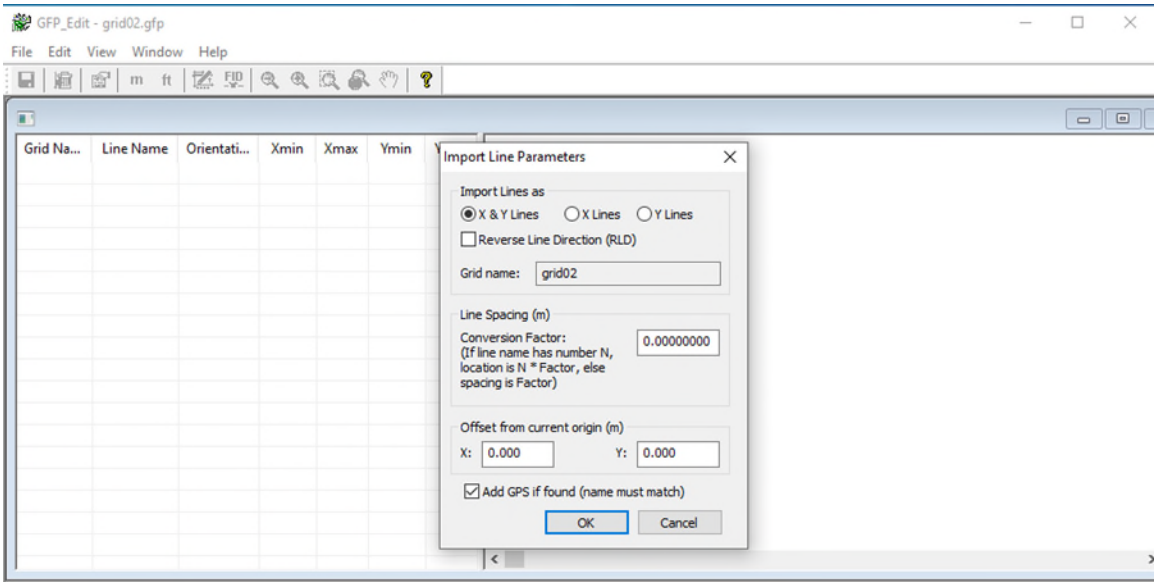


Select **Create Grid from Checked Lines**, either by:

1) right- clicking on the Lineset name in Project Explorer and selecting it from the menu or

2) clicking on the Lineset name in Project Explorer and selecting it from the **Tools > Grid Tools** menu.

The GFP_Edit utility program opens:



Import Lines as: Select X Lines or Y Lines (see Grid Conventions).

Reverse Line Direction: Leave unchecked unless you want all the lines to be reversed.

Grid Name: Defined as the Lineset Name in Project Explorer. The name is not editable in this dialog.

Line Spacing: Enter the distance between lines.

Offset from Current Origin: To set this value properly, understand that GFP_Edit uses the number at the end of the line name and the **Line Spacing** value to calculate the position of each line in the grid.

For example, if lines are in the X direction, spaced 0.5 meters apart and the first line name ends with “1”, for example Line1, it is positioned at:

Y Position = Line number * Line Spacing = 1 x 0.5 = 0.5 meters

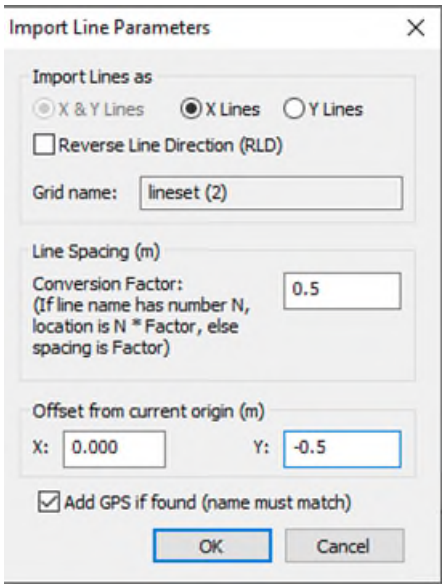
It is usually desired that the first grid line is positioned at zero (0). There are two ways to position the first line at position zero (0):

1) Set the **Offset from Current Origin** value in the other direction to the line direction to:

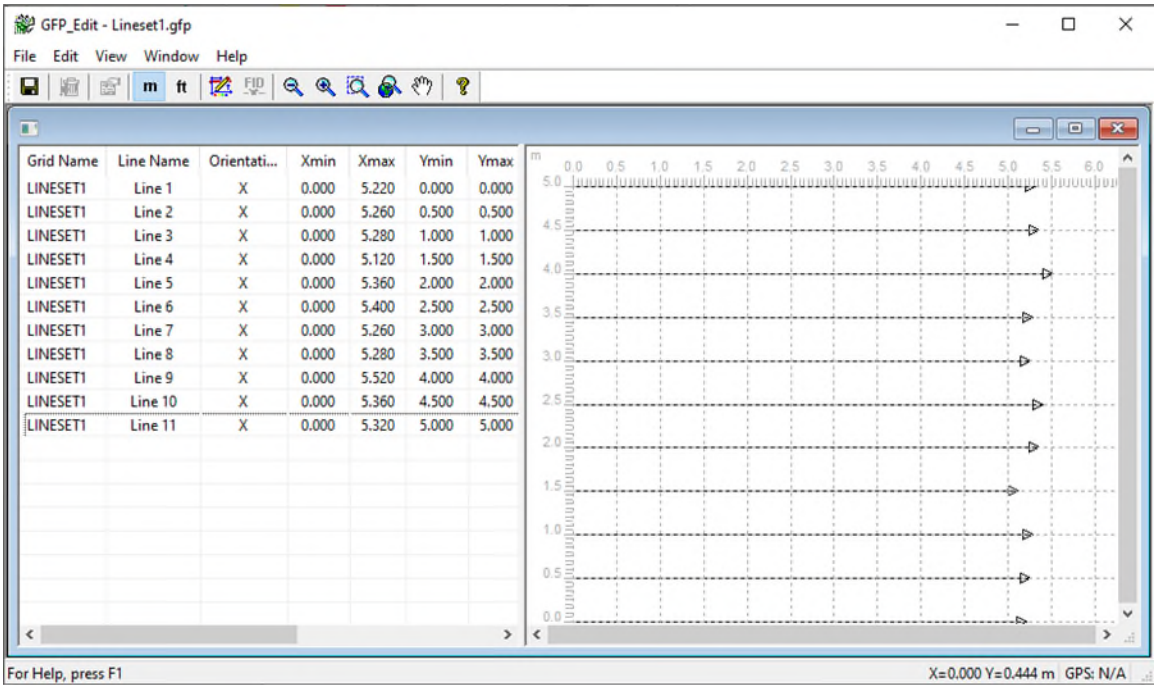
   Y = -(First Line Number x Line Spacing)

   In the example above, Y = -(1 x 0.5) = -0.5.

2) Exit from GFP_Edit and follow the directions below in Creating a Grid with GPR Lines in Both X and Y Directions to rename the lines, but only for the one line direction.



Once the fields are filled in, press OK. This opens a map view showing the position of all the lines in the grid:



From this screen, if necessary, modify the grid line positions and directions by using the editing tools described in Edit Selected Grid. When finished exit from GFP_Edit using the X in the corner or from the File menu.

17.4.2.2 Creating a Grid with GPR Lines in Both X and Y Directions

If you want to create a grid from GPR lines that go in both the X and Y directions, the easiest way is, before selecting the **Create Grid from Checked Lines** option, to rename the lines in Project Explorer adding an X and an incrementing number starting at 0 to the lines in the X direction and a Y and an incrementing number starting at 0 to the lines in the Y direction.

For example: if there are 10 GPR lines, and Lines 1-5 were collected in the X direction and Lines 6-10 were collected in the Y direction, rename them as follows:"

Original Line Name	Renamed Line to Create Grid
Line1	Line1-X0
Line2	Line2-X1
Line3	Line3-X2
Line4	Line4-X3
Line5	Line5-X4
Line6	Line6-Y0
Line7	Line7-Y1
Line8	Line8-Y2
Line9	Line9-Y3
Line10	Line10-Y4

If your grid is large an contains so many lines that renaming them all is not feasible, see Creating Large Grids with GPR Lines in Both X and Y Directions.

After renaming the GPR lines in Project Explorer, check all the lines to include in the grid. Select **Create Grid from Checked Lines**, either by

1) right-clicking on the Lineset name in Project Explorer and selecting it from the menu or
2) clicking on the Lineset name in Project Explorer and selecting it from the **Tools > Grid Tools** menu.

The GFP_Edit utility program opens with a dialog with the following settings:

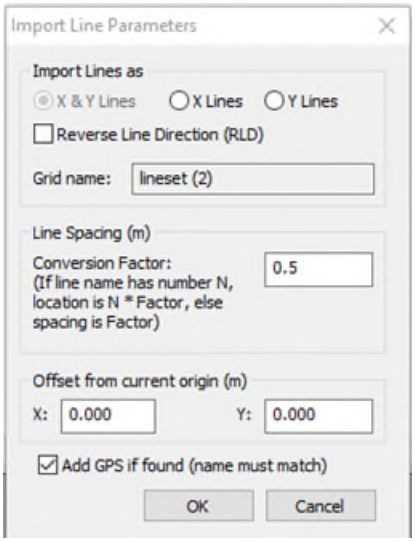
Import Lines as: Leave it set the default value of X & Y Lines.

Reverse Line Direction: Leave unchecked unless you want all the lines to be reversed.

Grid Name: Defined as the checked Lineset Name in Project Explorer. The name is not editable in this dialog.

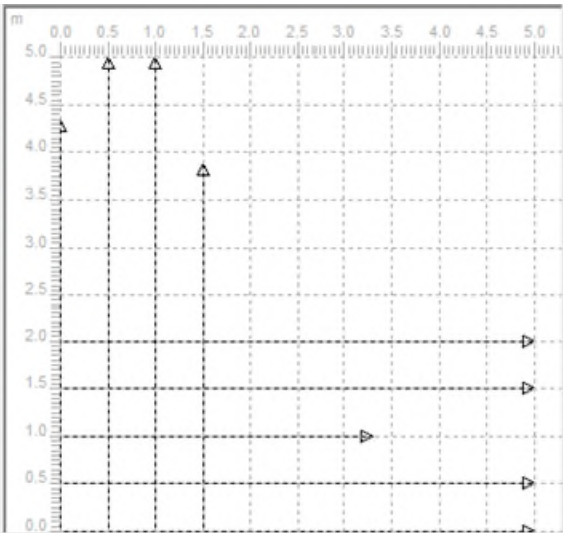
Line Spacing: Enter the distance between lines.

Offset from Current Origin: Leave values at the default values of X=0 and Y=0.



Once the fields are filled in, press OK. This opens a map view showing the position of all the lines in the grid:

Grid Na...	Line Name	Orientati...	Xmin	Xmax	Ymin	Ymax
LINESET	line1-X0	X	0.000	5.000	0.000	0.000
LINESET	line2-X1	X	0.000	5.000	0.500	0.500
LINESET	line3-X2	X	0.000	3.300	1.000	1.000
LINESET	line4-X3	X	0.000	5.000	1.500	1.500
LINESET	line5-X4	X	0.000	5.000	2.000	2.000
LINESET	line6-Y0	Y	0.000	0.000	0.000	4.340
LINESET	line7-Y1	Y	0.500	0.500	0.000	5.000
LINESET	line8-Y2	Y	1.000	1.000	0.000	5.000
LINESET	line9-Y3	Y	1.500	1.500	0.000	3.880



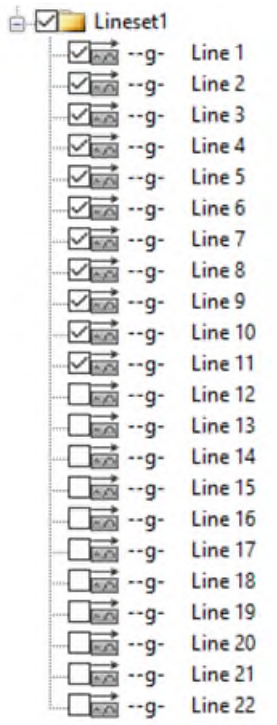
From this screen, if necessary, modify the grid line positions and directions by using the editing tools described in Edit Selected Grid. When finished exit from GFP_Edit using the X in the corner or from the file menu.

17.4.2.3 Creating Large Grids with GPR Lines in Both X and Y Directions

If you have too many lines that renaming is infeasible, we recommend creating a grid with only the X Lines, then adding the Y Lines. Here is an example of this method.

Adding X Lines to a Large Grid

From Project Explorer, check all the GPR lines that go in the X direction, in this example Line1= 1 to Line 11.



Select **Create Grid from Checked Lines**, either by:

1) right-clicking on the Lineset name in Project Explorer and selecting it from the menu or
2) clicking the Lineset name in Project Explorer and then selecting it from the **Tools > Grid Tools** menu.

The GFP_Edit utility program opens with a dialog with the following settings:

Import Lines as: Set to X Lines (see Grid Conventions).

Reverse Line Direction: Leave unchecked unless you want all the lines to be reversed.

Grid Name: Defined as the checked Lineset Name in Project Explorer. The name is not editable in this dialog.

Line Spacing: Enter the distance between the X grid lines.

Offset from Current Origin: To set this value properly, it is important to understand that GFP_Edit uses the number at the end of the line name and the **Line Spacing** value to calculate the position of each line in the grid.

For example, if lines are spaced 0.5 meters apart and the first line name ends with “1”, for example Line1, it is positioned at:

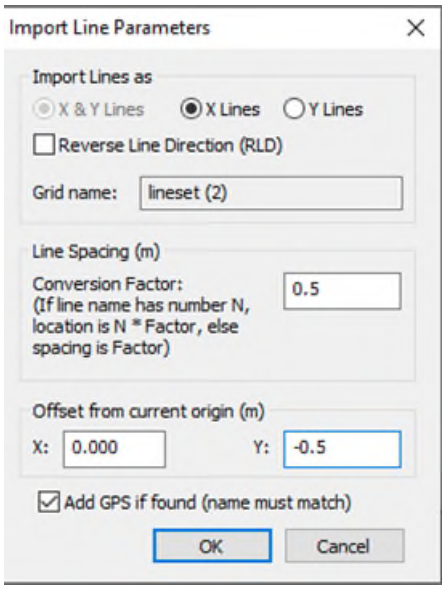
Y Position = Line number * Line Spacing

Y Position = 1 x 0.5 = 0.5 meters

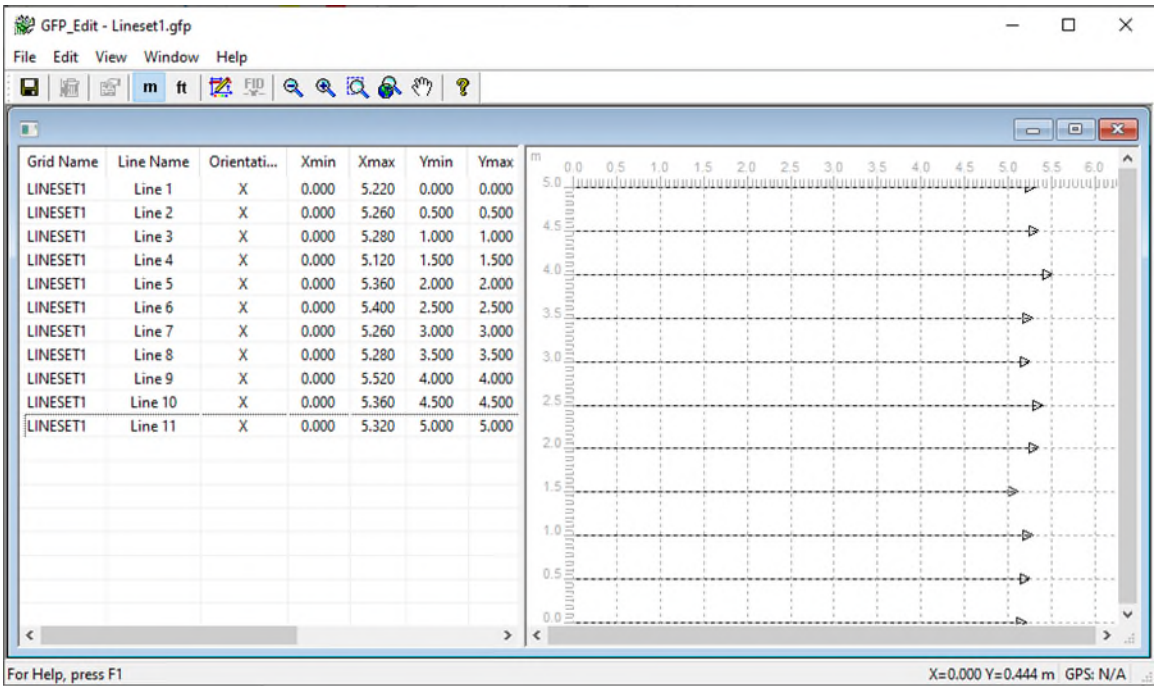
Since it is usually desired that the first line in the grid is positioned at zero (0). To do this, set the **Offset from Current Origin** value in the Y direction to:

-(Line Number x Line Spacing)

In the example above, Y = -0.5.



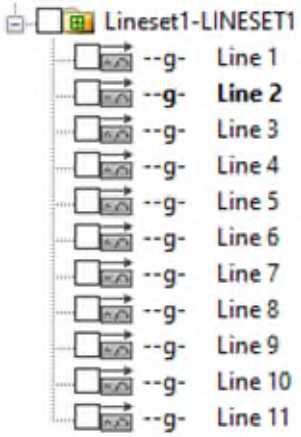
Once the fields are filled in, press OK. This opens a map view showing the position of all the lines in the grid:



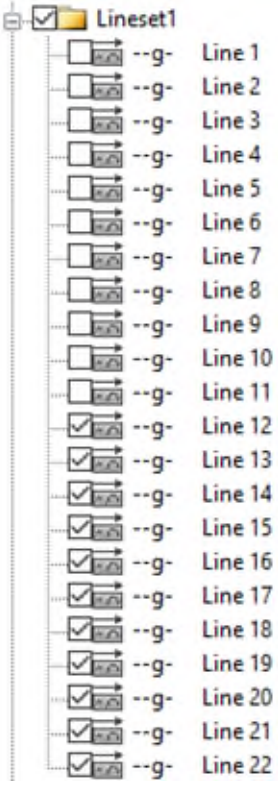
To save the new grid with the X lines, exit from GFP_Edit by clicking the X in the top right corner or using the File menu.

Adding Y Lines to a Large Grid

From Project Explorer, notice the new grid folder containing the X lines.



To add the Y Lines to the new grid, go back to the original Lineset and check all the GPR lines that go in the Y direction, in this example, Line 12 to Line 22.



Select **Add Checked Lines to Selected Grid**, either by:

1) right-clicking on the new Grid name in Project Explorer and selecting it from the menu or
2) clicking on the new grid name and then selecting it from the **Tools > Grid Tools** menu.

The GFP_Edit utility program opens with a dialog with the following settings:

Import Lines as: Select Y direction (see Grid Conventions).

Reverse Line Direction: Leave unchecked unless you want all the lines to be reversed.

Grid Name: Defined as the selected Lineset Name in Project Explorer. The name is not editable in this dialog.

Line Spacing: Enter the distance between Y grid lines.

To set the **Offset from Current Origin**, it is important to understand that GFP_Edit uses the number at the end of the line name and the **Line Spacing** value to calculate the position of each line in the grid.

For example, if Y lines are spaced 0.5 meters apart and the first line name ends with “12”, for example Line12, it is positioned at:

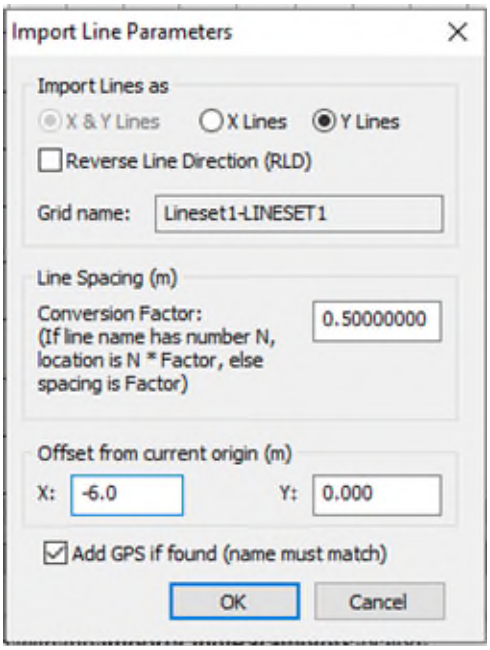
Y Position = Line number * Line Spacing

Y Position = 12 x 0.5 = 6.0 meters

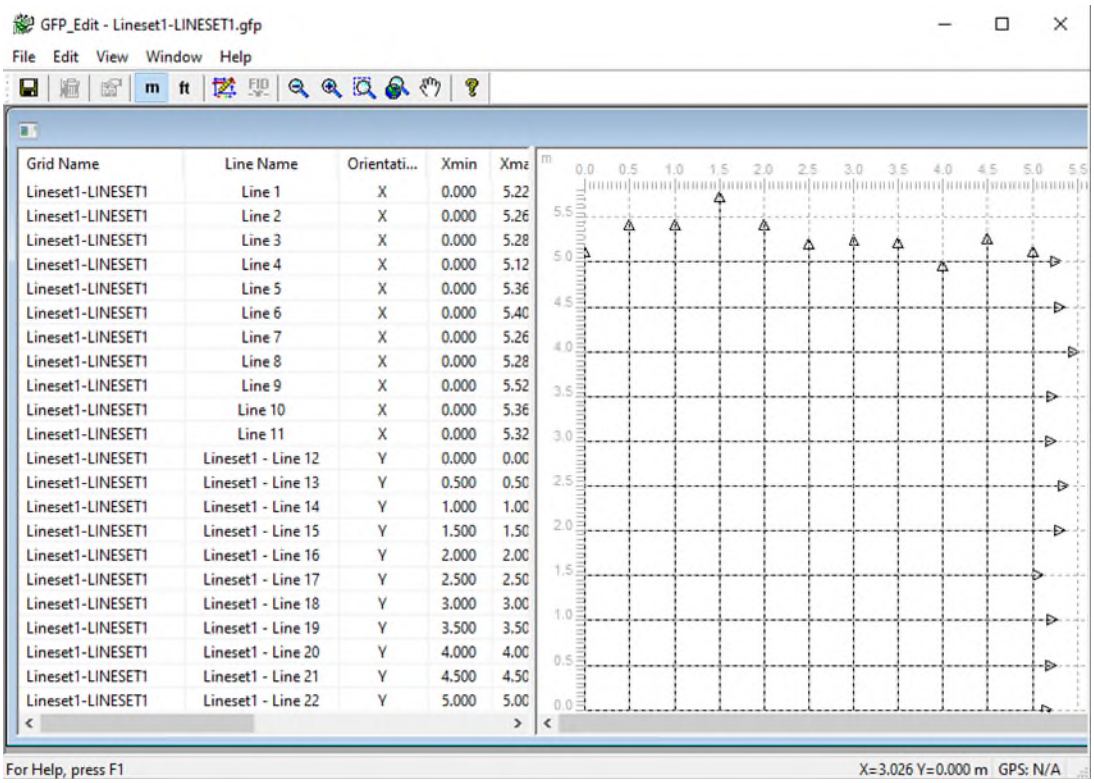
It is usually desired that the grid first line is positioned at zero (0). To do this, set the **Offset from Current Origin** value in the X direction to:

-(Line Number x Line Spacing)

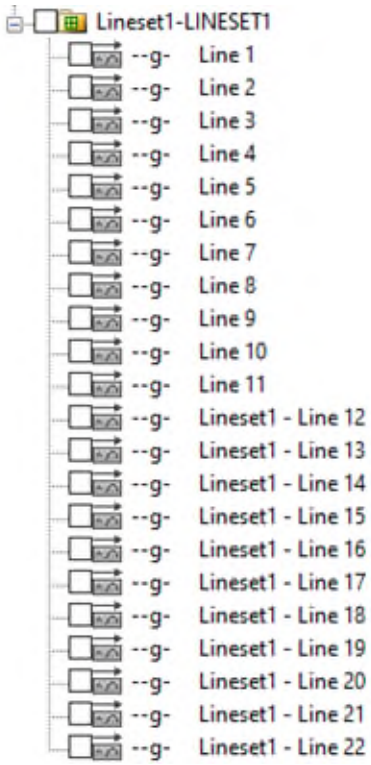
In the example above, X = -6.0.



Once the fields are filled in, press OK. This opens a map view showing the position of the Y lines added to the grid:



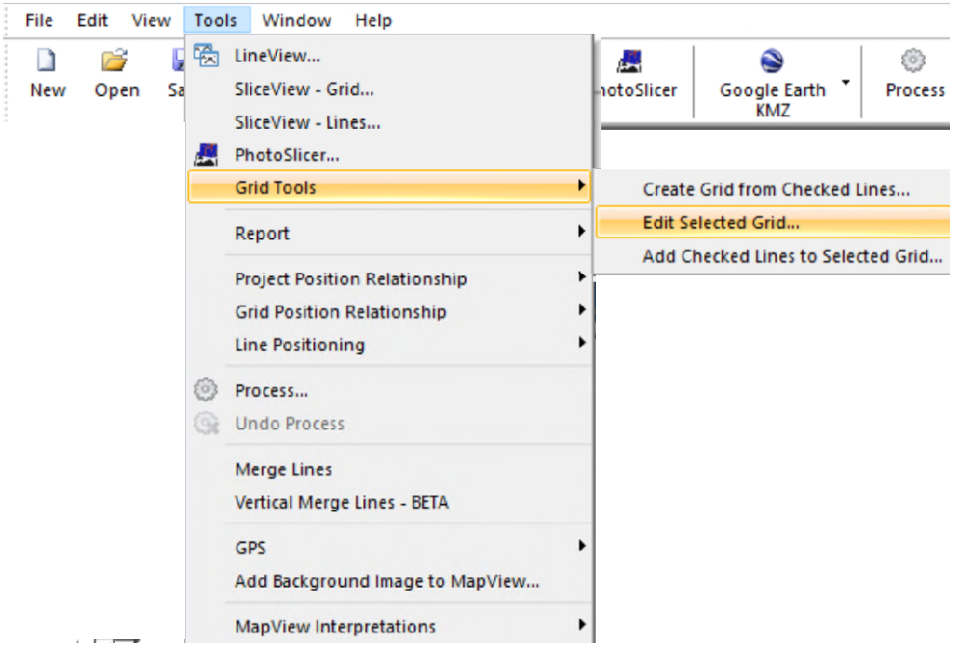
Exit from GFP_Edit to save the new grid with the both the X and Y lines into Project Explorer. You will see a grid folder in Project Explorer similar to this one:



17.4.3 Edit Selected Grid

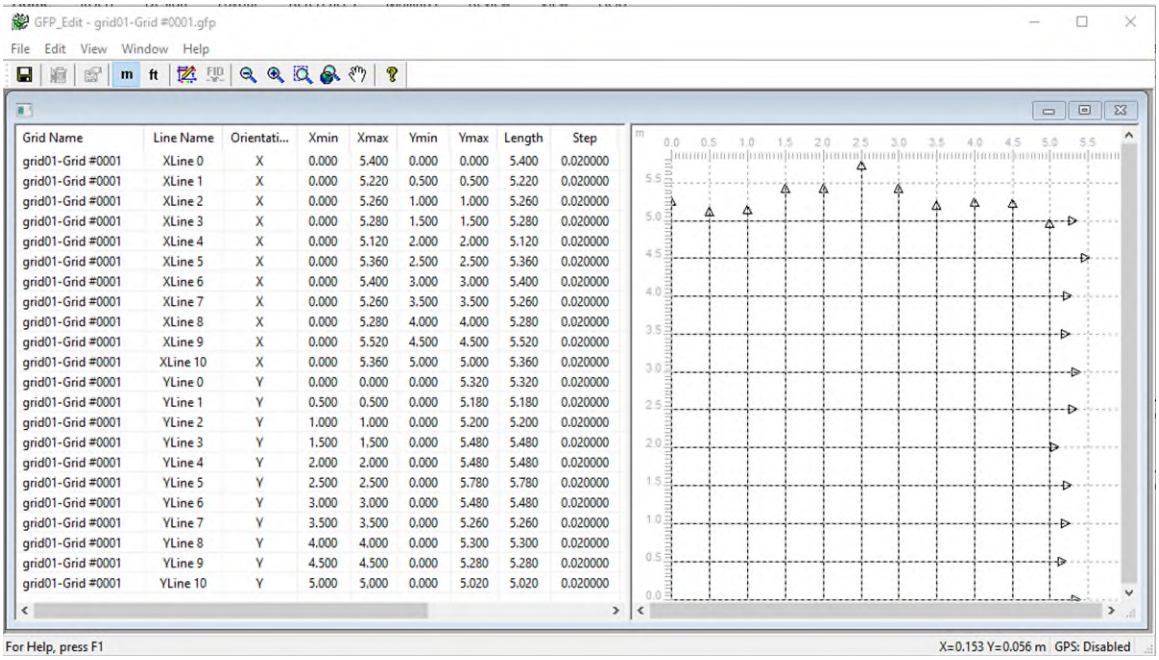
To edit a grid, select it in Project Explorer and then select **Edit Selected Grid** by:

1) right-clicking on the grid name in Project Explorer and selecting it from the menu, or
2) clicking the grid name in Project Explorer and then selecting it from the **Tools > Grid Tools** menu.



The GFP_Edit utility program opens:

After making the desired modifications to the grid, close GFP_Edit using the X in the top right corner or from the file menu. EKKO_Project will show the modified grid.

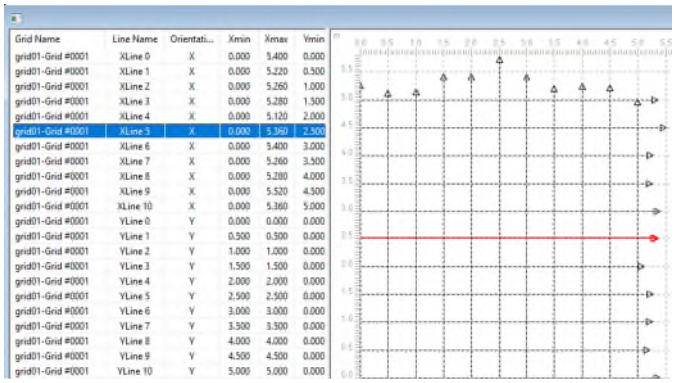


Grid Name	Line Name	Orientati...	Xmin	Xmax	Ymin	Ymax	Length	Step
grid01-Grid #0001	XLine 0	X	0.000	5.400	0.000	0.000	5.400	0.020000
grid01-Grid #0001	XLine 1	X	0.000	5.220	0.500	0.500	5.220	0.020000
grid01-Grid #0001	XLine 2	X	0.000	5.260	1.000	1.000	5.260	0.020000
grid01-Grid #0001	XLine 3	X	0.000	5.280	1.500	1.500	5.280	0.020000
grid01-Grid #0001	XLine 4	X	0.000	5.120	2.000	2.000	5.120	0.020000
grid01-Grid #0001	XLine 5	X	0.000	5.360	2.500	2.500	5.360	0.020000
grid01-Grid #0001	XLine 6	X	0.000	5.400	3.000	3.000	5.400	0.020000
grid01-Grid #0001	XLine 7	X	0.000	5.260	3.500	3.500	5.260	0.020000
grid01-Grid #0001	XLine 8	X	0.000	5.280	4.000	4.000	5.280	0.020000
grid01-Grid #0001	XLine 9	X	0.000	5.520	4.500	4.500	5.520	0.020000
grid01-Grid #0001	XLine 10	X	0.000	5.360	5.000	5.000	5.360	0.020000
grid01-Grid #0001	YLine 0	Y	0.000	0.000	0.000	5.320	5.320	0.020000
grid01-Grid #0001	YLine 1	Y	0.500	0.500	0.000	5.180	5.180	0.020000
grid01-Grid #0001	YLine 2	Y	1.000	1.000	0.000	5.200	5.200	0.020000
grid01-Grid #0001	YLine 3	Y	1.500	1.500	0.000	5.480	5.480	0.020000
grid01-Grid #0001	YLine 4	Y	2.000	2.000	0.000	5.480	5.480	0.020000
grid01-Grid #0001	YLine 5	Y	2.500	2.500	0.000	5.780	5.780	0.020000
grid01-Grid #0001	YLine 6	Y	3.000	3.000	0.000	5.480	5.480	0.020000
grid01-Grid #0001	YLine 7	Y	3.500	3.500	0.000	5.260	5.260	0.020000
grid01-Grid #0001	YLine 8	Y	4.000	4.000	0.000	5.300	5.300	0.020000
grid01-Grid #0001	YLine 9	Y	4.500	4.500	0.000	5.280	5.280	0.020000
grid01-Grid #0001	YLine 10	Y	5.000	5.000	0.000	5.020	5.020	0.020000

17.4.3.1 Selecting Grid Lines

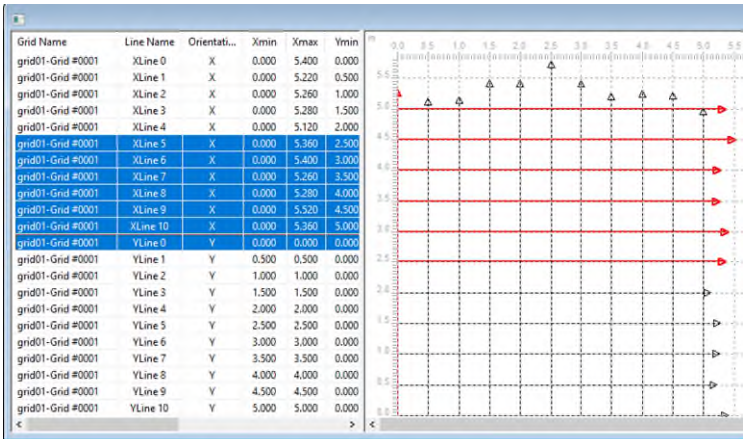
The grid lines to edit must be selected. Grid lines are selected in the following ways:

1) Select a single grid line by clicking on it in the table on the left or the map on the right.

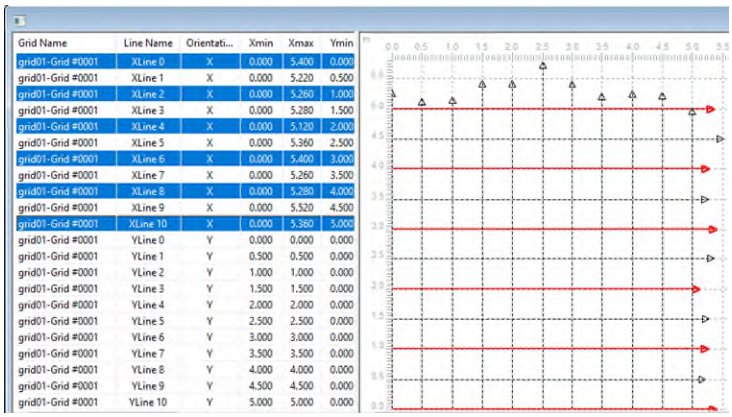


2) Select multiple grid lines by:

   a. Clicking on the first line name you want to select in the table and then pressing and holding the **Shift** key on your keyboard and clicking on the last line name you want to select in the table. All the lines between the first and last are selected.

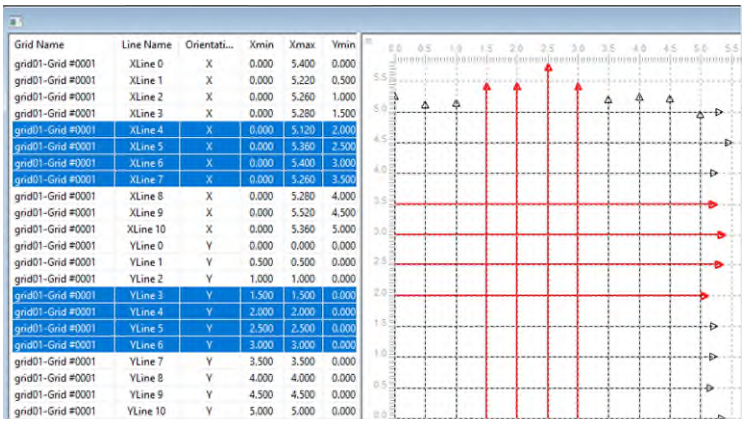


   b. Clicking a grid line name in the table (or the line on the map), and then pressing and holding the **Ctrl** key on your keyboard as you click on other lines names. This allows you to, for example, select every second line in the grid.



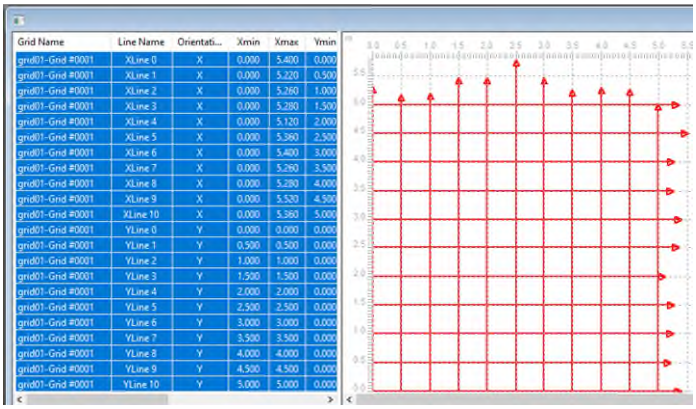
Grid Name	Line Name	Orientati...	Xmin	Xmax	Ymin
grid01-Grid #0001	XLine 0	X	0.000	5.400	0.000
grid01-Grid #0001	XLine 1	X	0.000	5.220	0.500
grid01-Grid #0001	XLine 2	X	0.000	5.260	1.000
grid01-Grid #0001	XLine 3	X	0.000	5.280	1.500
grid01-Grid #0001	XLine 4	X	0.000	5.120	2.000
grid01-Grid #0001	XLine 5	X	0.000	5.360	2.500
grid01-Grid #0001	XLine 6	X	0.000	5.400	3.000
grid01-Grid #0001	XLine 7	X	0.000	5.260	3.500
grid01-Grid #0001	XLine 8	X	0.000	5.280	4.000
grid01-Grid #0001	XLine 9	X	0.000	5.520	4.500
grid01-Grid #0001	XLine 10	X	0.000	5.360	5.000
grid01-Grid #0001	YLine 0	Y	0.000	0.000	0.000
grid01-Grid #0001	YLine 1	Y	0.500	0.500	0.000
grid01-Grid #0001	YLine 2	Y	1.000	1.000	0.000
grid01-Grid #0001	YLine 3	Y	1.500	1.500	0.000
grid01-Grid #0001	YLine 4	Y	2.000	2.000	0.000
grid01-Grid #0001	YLine 5	Y	2.500	2.500	0.000
grid01-Grid #0001	YLine 6	Y	3.000	3.000	0.000
grid01-Grid #0001	YLine 7	Y	3.500	3.500	0.000
grid01-Grid #0001	YLine 8	Y	4.000	4.000	0.000
grid01-Grid #0001	YLine 9	Y	4.500	4.500	0.000
grid01-Grid #0001	YLine 10	Y	5.000	5.000	0.000

c. Drawing a box in the map window by dragging and dropping the mouse cursor. Any grid lines touched by the box are selected and appear in red.



Grid Name	Line Name	Orientati...	Xmin	Xmax	Ymin
grid01-Grid #0001	XLine 0	X	0.000	5.400	0.000
grid01-Grid #0001	XLine 1	X	0.000	5.220	0.500
grid01-Grid #0001	XLine 2	X	0.000	5.260	1.000
grid01-Grid #0001	XLine 3	X	0.000	5.280	1.500
grid01-Grid #0001	XLine 4	X	0.000	5.120	2.000
grid01-Grid #0001	XLine 5	X	0.000	5.360	2.500
grid01-Grid #0001	XLine 6	X	0.000	5.400	3.000
grid01-Grid #0001	XLine 7	X	0.000	5.260	3.500
grid01-Grid #0001	XLine 8	X	0.000	5.280	4.000
grid01-Grid #0001	XLine 9	X	0.000	5.520	4.500
grid01-Grid #0001	XLine 10	X	0.000	5.360	5.000
grid01-Grid #0001	YLine 0	Y	0.000	0.000	0.000
grid01-Grid #0001	YLine 1	Y	0.500	0.500	0.000
grid01-Grid #0001	YLine 2	Y	1.000	1.000	0.000
grid01-Grid #0001	YLine 3	Y	1.500	1.500	0.000
grid01-Grid #0001	YLine 4	Y	2.000	2.000	0.000
grid01-Grid #0001	YLine 5	Y	2.500	2.500	0.000
grid01-Grid #0001	YLine 6	Y	3.000	3.000	0.000
grid01-Grid #0001	YLine 7	Y	3.500	3.500	0.000
grid01-Grid #0001	YLine 8	Y	4.000	4.000	0.000
grid01-Grid #0001	YLine 9	Y	4.500	4.500	0.000
grid01-Grid #0001	YLine 10	Y	5.000	5.000	0.000

3) Select all Grid Lines using **Edit > Select All Lines** menu option or pressing the **Ctrl-A**.



Grid Name	Line Name	Orientati...	Xmin	Xmax	Ymin
grid01-Grid #0001	XLine 0	X	0.000	5.400	0.000
grid01-Grid #0001	XLine 1	X	0.000	5.220	0.500
grid01-Grid #0001	XLine 2	X	0.000	5.260	1.000
grid01-Grid #0001	XLine 3	X	0.000	5.280	1.500
grid01-Grid #0001	XLine 4	X	0.000	5.120	2.000
grid01-Grid #0001	XLine 5	X	0.000	5.360	2.500
grid01-Grid #0001	XLine 6	X	0.000	5.400	3.000
grid01-Grid #0001	XLine 7	X	0.000	5.260	3.500
grid01-Grid #0001	XLine 8	X	0.000	5.280	4.000
grid01-Grid #0001	XLine 9	X	0.000	5.520	4.500
grid01-Grid #0001	XLine 10	X	0.000	5.360	5.000
grid01-Grid #0001	YLine 0	Y	0.000	0.000	0.000
grid01-Grid #0001	YLine 1	Y	0.500	0.500	0.000
grid01-Grid #0001	YLine 2	Y	1.000	1.000	0.000
grid01-Grid #0001	YLine 3	Y	1.500	1.500	0.000
grid01-Grid #0001	YLine 4	Y	2.000	2.000	0.000
grid01-Grid #0001	YLine 5	Y	2.500	2.500	0.000
grid01-Grid #0001	YLine 6	Y	3.000	3.000	0.000
grid01-Grid #0001	YLine 7	Y	3.500	3.500	0.000
grid01-Grid #0001	YLine 8	Y	4.000	4.000	0.000
grid01-Grid #0001	YLine 9	Y	4.500	4.500	0.000
grid01-Grid #0001	YLine 10	Y	5.000	5.000	0.000

Grids can be edited in various ways described in the sections below:

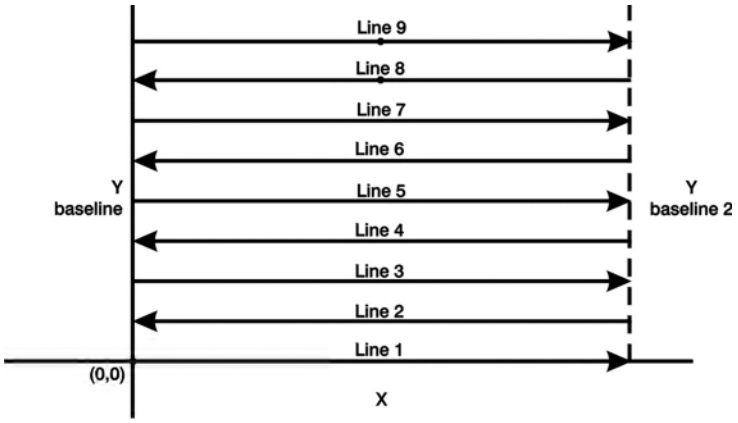
17.4.3.2 Deleting Grid Lines

1) Select the grid lines to delete (see Selecting Grid Lines).
2) Press the **Delete** key on the keyboard or select **Edit > Delete Line(s)** menu option.

Note there is no warning message before the lines are deleted and there is no undo.

17.4.3.3 Reversing Line Direction

The option to reverse the line direction is used when grid lines were collected in a zigzag but either the user collected them as Line Scans, or they collected them as a Grid Scan but forgot to set the data collection pattern to Forward/Reverse.

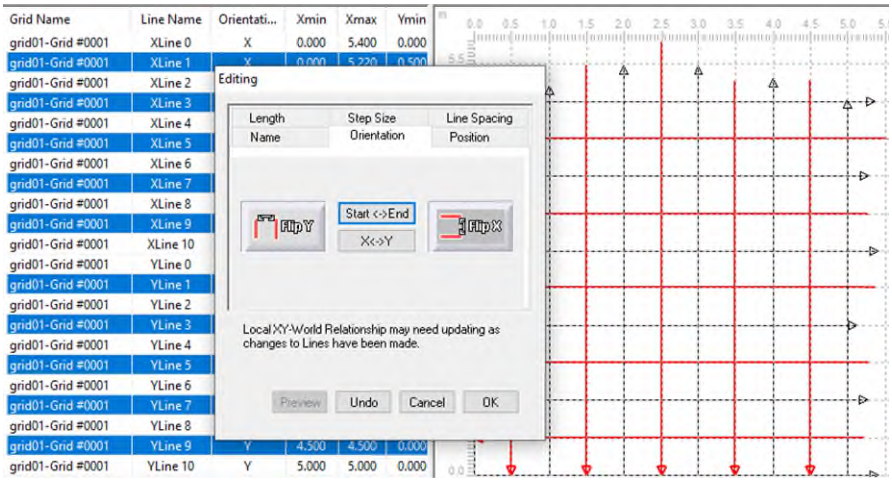


Viewing the grid as a depth slice or a 3D view displays the lines in incorrect spatial positions, resulting in erroneous and un-interpretable data views.

To remedy this situation:

1) Select the grid lines collected in the reverse line direction (see Selecting Grid Lines).

2) Select **Edit > Edit GFP File** or the **Edit Selected Lines** button on the Toolbar and go to the **Orientation** tab click the **Start<->End** button:



Do not use Reverse Line Direction when grid lines were collected with a Noggin system in Grid mode with the Survey Format set to Forward/Reverse; the line positioning is correct without any editing of the line direction.

17.4.3.4 Moving Grid Lines

1. Select the line to reposition in the grid (see Selecting Grid Lines).
2. Select:

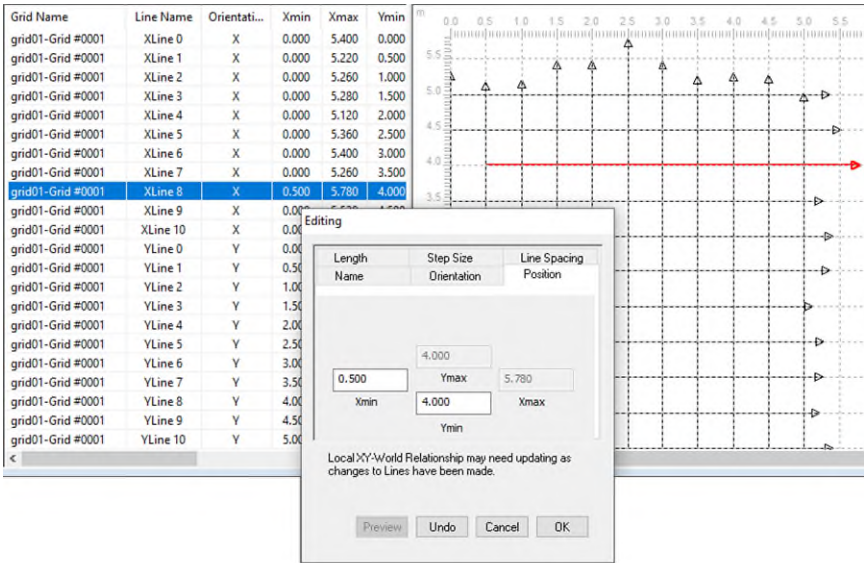
    a. **Edit > Edit GFP File** or

    b. the **Edit Selected Lines** button  on the Toolbar

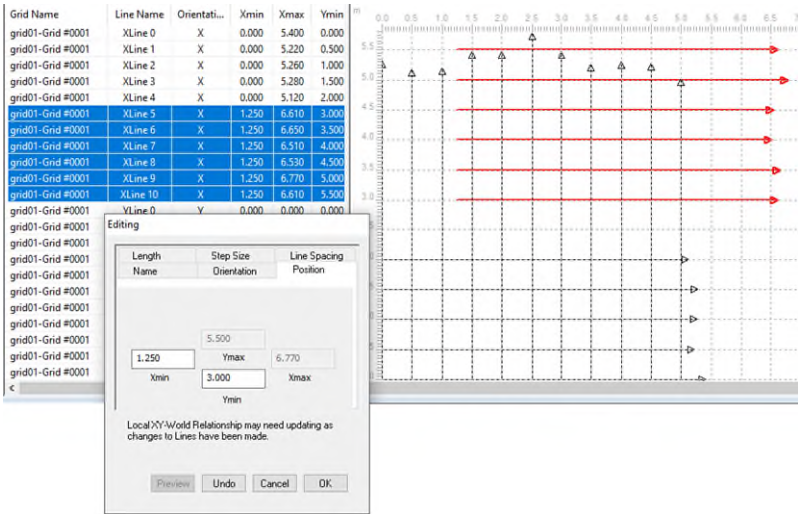
    c. Right -click on the line

and go to the **Position** tab.

3. Input the new XY position for the start of the line and press OK.



It is possible to move multiple grid lines at once. When multiple lines are selected, Xmin and Ymin define the minimum X and Y values. If a rectangle was drawn from all selected lines, Xmin and Ymin define the position of the lower left corner. In the example below, 6 lines were moved +1.25m in the X direction and +0.5m in the Y direction.



Lines can be moved to negative X or Y values but afterward, it may be necessary to redraw the map using the Fit to Window button  or by going to the **View > Zoom > Fit to Window** menu option.

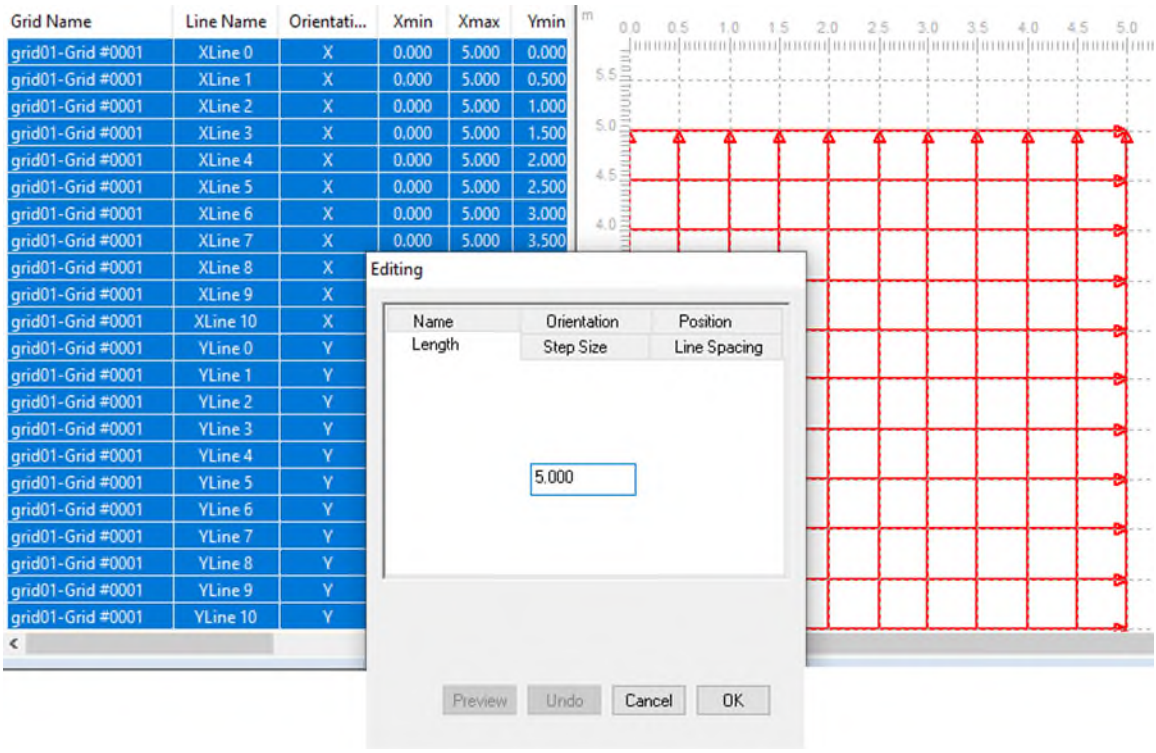
17.4.3.5 Changing Grid Line Length

The most common reason for changing the length of lines in a grid is to make all the lines in one direction of a rectangular grid or the all the lines in a square grid the same length. Although grid lines may have been stopped at the same position at the far side of the grid, especially if the terrain is rough, the odometer wheel can skip and slide, resulting in lines that differ slightly in length. Another reason is if the odometer calibration is off.

1) Select the grid line(s) to change the length of (see Selecting Grid Lines).
2) Select
   a. **Edit > Edit GFP File** or
   b. the **Edit Selected Lines** button  on the Toolbar
   c. Right -click on the line

   and go to the **Length** tab.
3) If more than one line is selected, the length of the longest line is displayed.
4) Enter the new length for the line(s) and press OK.

In the following example, the length of all the lines in the square grid are edited to be 5m long:



The line length is changed by recalculating the Step Size (the distance between traces). No traces are added to or deleted from the data file, only the position of each trace changes.

17.4.3.6 Editing Grid Line Spacing

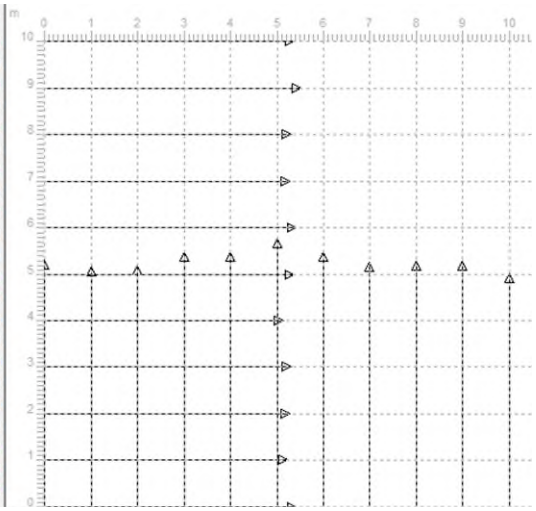
If the distance between grid lines is incorrect, it can be edited, and the lines repositioned.

1) Select the grid lines to change the Line Spacing between (see Selecting Grid Lines).
2) Select
   a. **Edit > Edit GFP File** or
   b. the **Edit Selected Lines** button  on the Toolbar

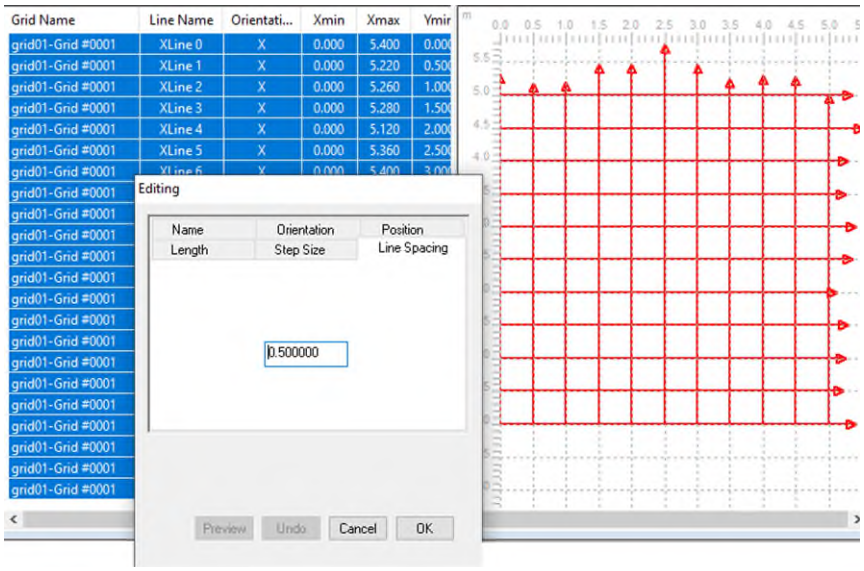
   and go to the **Line Spacing** tab.
3) Enter the new Line Spacing for the line(s) and press OK.

The following 5x5m grid was collected with the incorrect line spacing (1m instead of the correct 0.5m).

Grid Name	Line Name	Orientati...	Xmin	Xmax	Ymir
grid01-Grid #0001	XLine 0	X	0.000	5.400	0.00(
grid01-Grid #0001	XLine 1	X	0.000	5.220	1.00(
grid01-Grid #0001	XLine 2	X	0.000	5.260	2.00(
grid01-Grid #0001	XLine 3	X	0.000	5.280	3.00(
grid01-Grid #0001	XLine 4	X	0.000	5.120	4.00(
grid01-Grid #0001	XLine 5	X	0.000	5.360	5.00(
grid01-Grid #0001	XLine 6	X	0.000	5.400	6.00(
grid01-Grid #0001	XLine 7	X	0.000	5.260	7.00(
grid01-Grid #0001	XLine 8	X	0.000	5.280	8.00(
grid01-Grid #0001	XLine 9	X	0.000	5.520	9.00(
grid01-Grid #0001	XLine 10	X	0.000	5.360	10.00
grid01-Grid #0001	YLine 0	Y	0.000	0.000	0.00(
grid01-Grid #0001	YLine 1	Y	1.000	1.000	0.00(
grid01-Grid #0001	YLine 2	Y	2.000	2.000	0.00(
grid01-Grid #0001	YLine 3	Y	3.000	3.000	0.00(
grid01-Grid #0001	YLine 4	Y	4.000	4.000	0.00(
grid01-Grid #0001	YLine 5	Y	5.000	5.000	0.00(
grid01-Grid #0001	YLine 6	Y	6.000	6.000	0.00(
grid01-Grid #0001	YLine 7	Y	7.000	7.000	0.00(
grid01-Grid #0001	YLine 8	Y	8.000	8.000	0.00(
grid01-Grid #0001	YLine 9	Y	9.000	9.000	0.00(
grid01-Grid #0001	YLine 10	Y	10.000	10.000	0.00(



Same, after correcting the Line Spacing to 0.5m.



17.4.3.7 Editing Grid Line Orientation

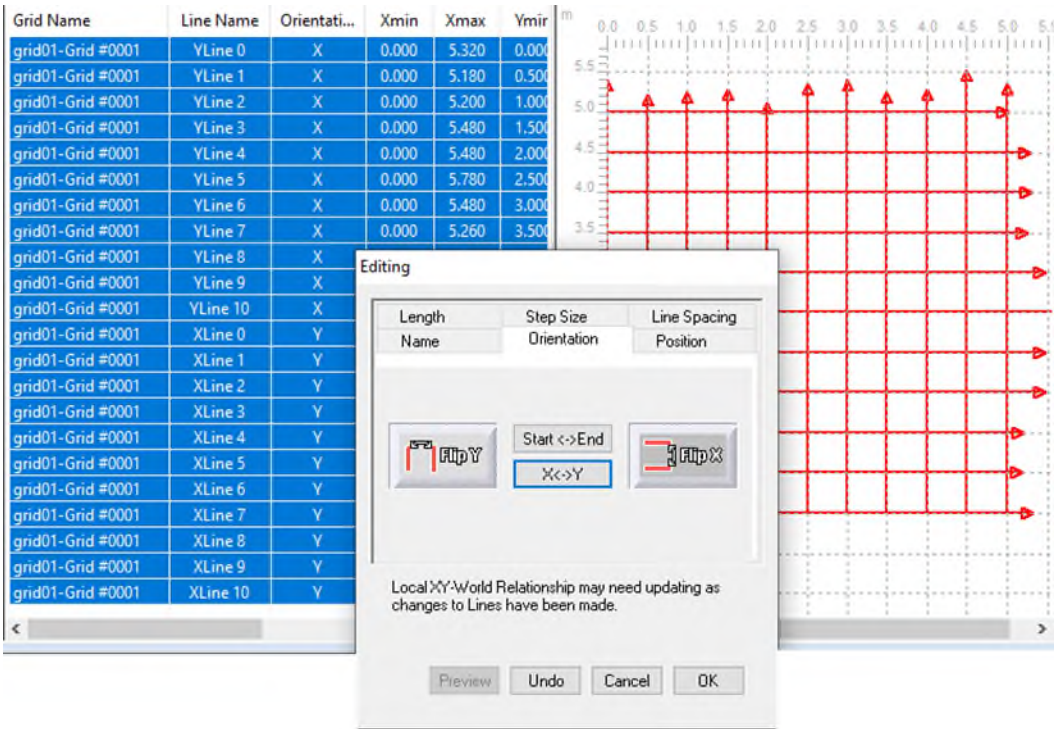
A common mistake is to collect with the X and Y lines swapped or in a different quadrant.

The **Orientation** tab is used to correct these sorts of mistakes, so the grid lines are positioned as if they were collected in the first quadrant. This ensures that depth slices or 3D volumes created from the data are correctly oriented and not mirror image or off at right angles.

Flip X and **Flip Y** tools are most commonly used to re-orient lines collected in a different quadrant than the first quadrant.

Swapping X and Y Lines

1) Select all the grid lines (see Selecting Grid Lines).
2) Select **Edit > Edit GFP File** or the **Edit Selected Lines** button  on the Toolbar and go to the **Orientation** tab.
3) Click the **X<->Y** button to change the X lines to Y lines and the Y lines to X lines.

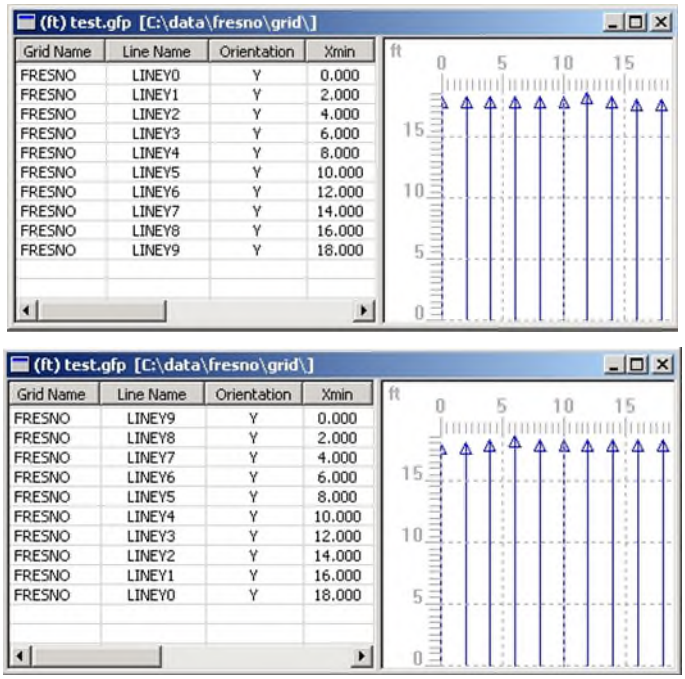


Flipping Y Lines

1) Select all the Y lines (see Selecting Grid Lines).

2) Select **Edit > Edit GFP File** or the **Edit Selected Lines** button  on the Toolbar and go to the **Orientation** tab.

3) Click the **Flip Y** button to reverse the order of the Y lines. For example, if Y lines are numbered 0 to 9 from left to right on the map image, clicking Flip Y changes the order to 9 to 0 from left to right.



Flipping X Lines

1) Select all the X lines (see Selecting Grid Lines).

2) Select **Edit > Edit GFP File** or the **Edit Selected Lines** button  on the Toolbar and go to the **Orientation** tab.

3) Click the **Flip X** button to reverse the order of the X lines. For example, if X lines are numbered 0 to 9 from bottom to top on the map image, clicking Flip Y changes the order to 9 to 0 from bottom to top.

17.4.3.8 Changing the Step Size

Changing the Step Size, the distance between traces, is another way of changing the length of the grid lines.

1) Select the grid line(s) to change the step size of (see Selecting Grid Lines).

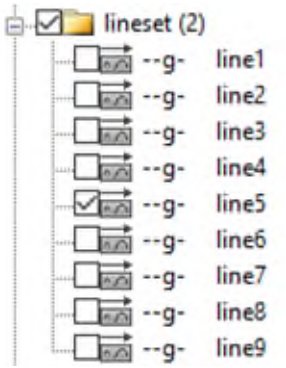
2) Select **Edit > Edit GFP File** or the **Edit Selected Lines** button  on the Toolbar and go to the **Step Size** tab.

3) Enter the new step size for the line(s) and press OK.

17.4.4 Add Checked Lines to Selected Grid

17.4.4.1 Adding One Line to a Grid

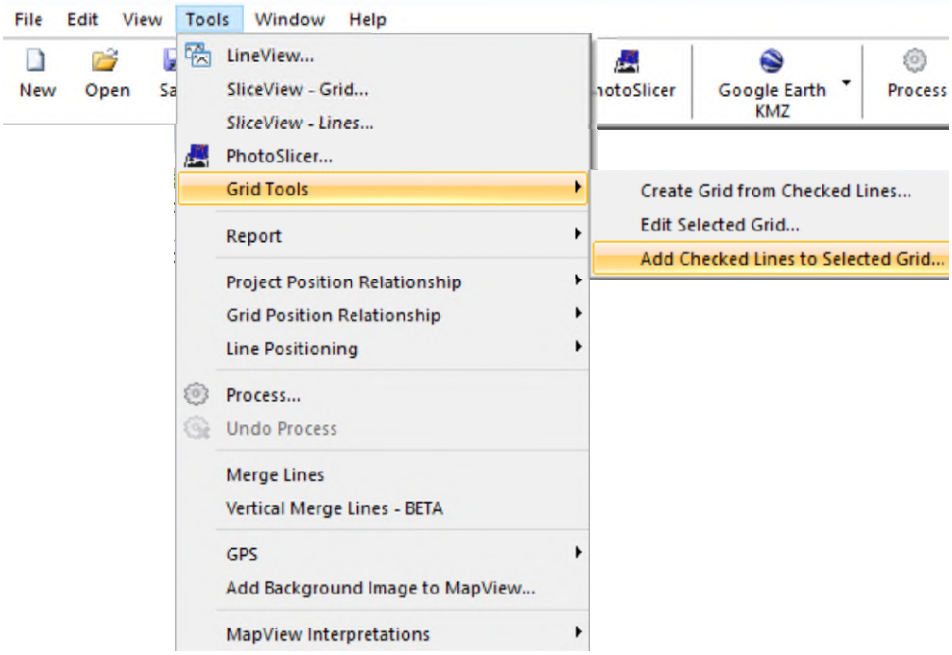
From Project Explorer, check the GPR line to add to a grid.



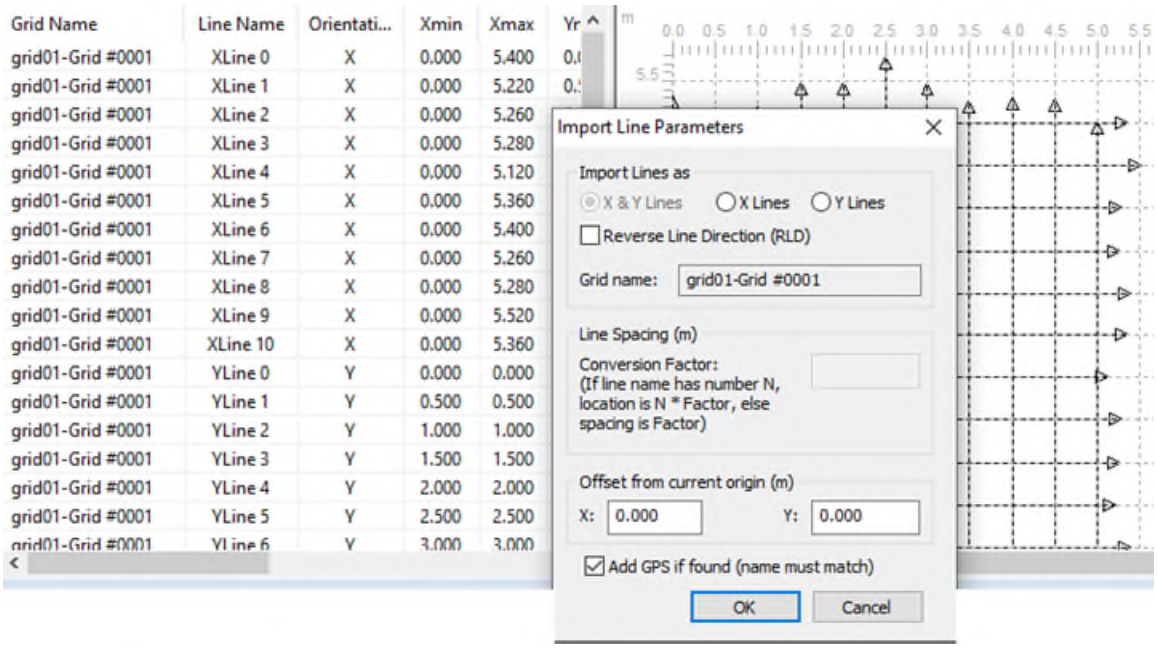
In Project Explorer, select the grid to add the checked GPR line to.

Select **Add Checked Lines to Selected Grid** by**:**

1) right-clicking on the Grid name in Project Explorer and selecting it from the menu or
2) Clicking on the Grid name in Project Explorer and then selecting it from the **Tools > Grid Tools** menu.



The GFP_Edit utility program opens with a dialog with the following settings:



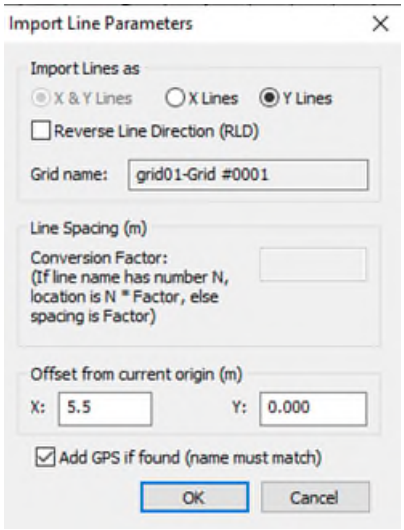
Import Lines as: Set to X Lines or Y Lines depending on the line direction of the line being added to the grid.

Reverse Line Direction: Leave unchecked unless you want all the lines to be reversed.

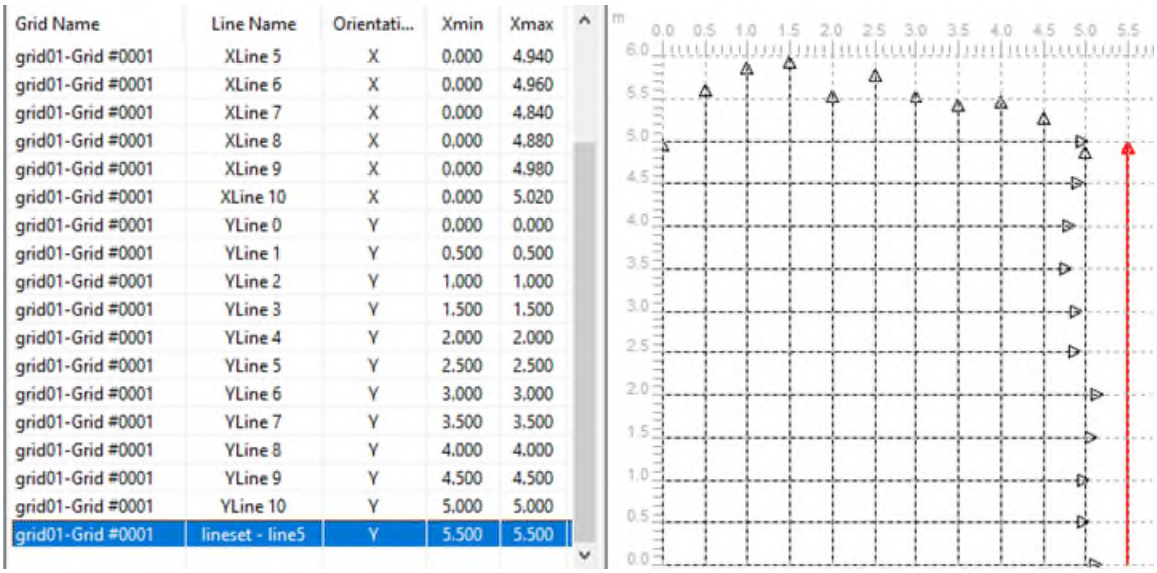
Grid Name: Defined as “selected Grid Name - Lineset Name of checked lines” in Project Explorer. The name is not editable in this dialog.

Offset from Current Origin: Set the X and Y values to the starting position of the line to add to the grid.

For example, if the line being added to the grid is a Y line that continues at the same line spacing as the grid (0.5m in this case), the last Y line is at X = 5.0, so the desired X position of the new line is X = 5.5.



Once the fields are filled in, press OK. This opens a map view showing the position of the new line added to the grid in red:



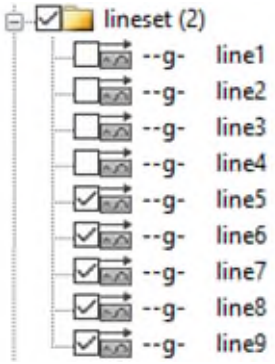
Grid Name	Line Name	Orientati...	Xmin	Xmax
grid01-Grid #0001	XLine 5	X	0.000	4.940
grid01-Grid #0001	XLine 6	X	0.000	4.960
grid01-Grid #0001	XLine 7	X	0.000	4.840
grid01-Grid #0001	XLine 8	X	0.000	4.880
grid01-Grid #0001	XLine 9	X	0.000	4.980
grid01-Grid #0001	XLine 10	X	0.000	5.020
grid01-Grid #0001	YLine 0	Y	0.000	0.000
grid01-Grid #0001	YLine 1	Y	0.500	0.500
grid01-Grid #0001	YLine 2	Y	1.000	1.000
grid01-Grid #0001	YLine 3	Y	1.500	1.500
grid01-Grid #0001	YLine 4	Y	2.000	2.000
grid01-Grid #0001	YLine 5	Y	2.500	2.500
grid01-Grid #0001	YLine 6	Y	3.000	3.000
grid01-Grid #0001	YLine 7	Y	3.500	3.500
grid01-Grid #0001	YLine 8	Y	4.000	4.000
grid01-Grid #0001	YLine 9	Y	4.500	4.500
grid01-Grid #0001	YLine 10	Y	5.000	5.000
grid01-Grid #0001	lineset - line5	Y	5.500	5.500

Note that previous Grid name/lineset name is added to the beginning of the line name.

After making the desired modifications to the grid, close GFP_Edit using the X in the top right corner or from the file menu. EKKO_Project will show the modified grid with the new Y line.

17.4.4.2 Adding Multiple Lines to a Grid

From Project Explorer, check all the GPR lines to add to a grid.

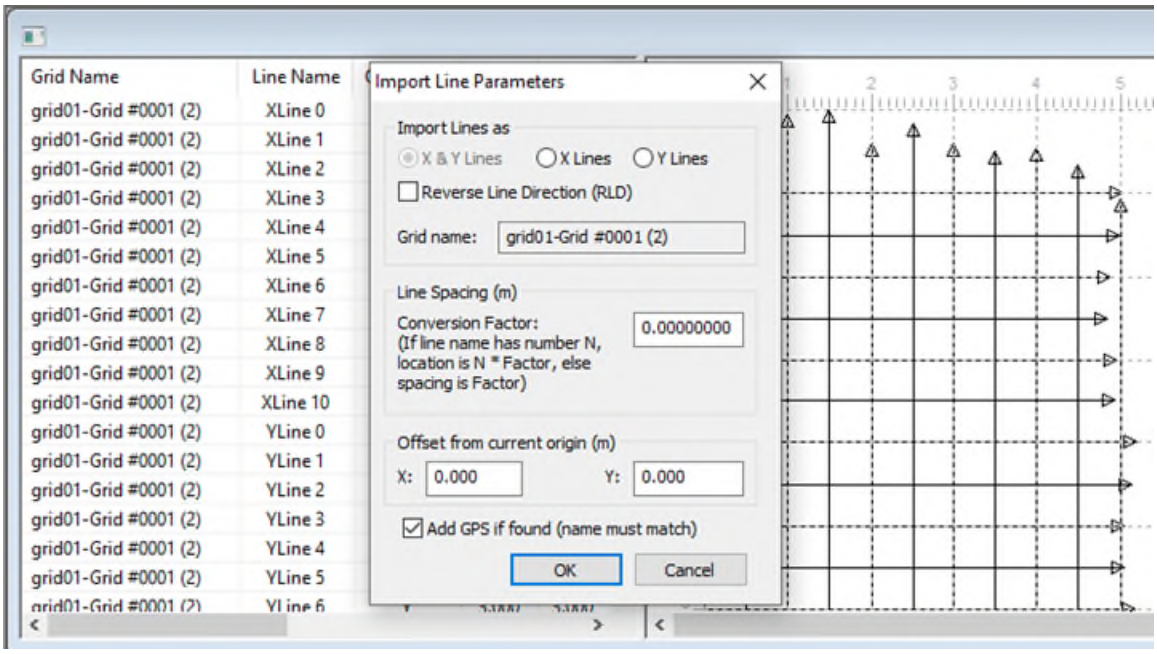


In Project Explorer, select the grid to add the checked GPR lines to.

Select **Add Checked Lines to Selected Grid**, either by:

1) right- clicking on the Grid name in Project Explorer and selecting it from the menu or
2) clicking on the Grid name in Project Explorer and selecting it from the **Tools > Grid Tools** menu.

The GFP_Edit utility program opens with a dialog with the following settings:



Import Lines as: Set to X Lines or Y Lines depending on the line direction of the lines being added to the grid (see Grid Conventions).

Reverse Line Direction: Leave unchecked unless you want all the lines to be reversed.

Line Spacing: Enter the distance between the new grid lines.

Offset from Current Origin: To set this value properly, it is important to understand that GFP_Edit uses the number at the end of the line name and the **Line Spacing** value to calculate the position of each line in the grid.

For example, if lines are spaced 0.5 meters apart and the first line to add to the grid has a name that ends with “5”, for example Line5, as above, the calculated position is:

Y Position = Line number * Line Spacing = 5 x 0.5 = 2.5 meters

This calculated distance is *in addition to* the X or Y offset set in this field.

In the example above, the last Y line is at X=5.0m. If the lines being added to the grid are Y lines that continue at the same line spacing as the grid (0.5m in this case), the desired X position of each line is:

Line5 at 5.5m

Line6 at 6.0m

Line7 at 6.5m

Line8 at 7.0m

Line9 at 7.5m

Line5 at 8.0m

The achieve this, the X value for the **Offset from Current Origin** must be set to:

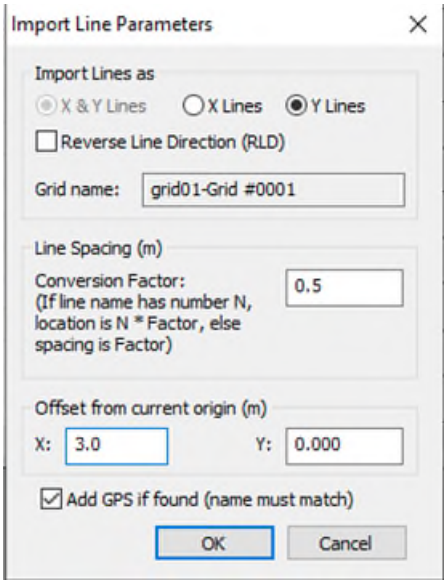
X = ((Desired X Position of first numbered line / Line Spacing) – First numbered Line Number) X Line Spacing

In this example:

X = ((5.5 / 0.5) - 5) X 0.5

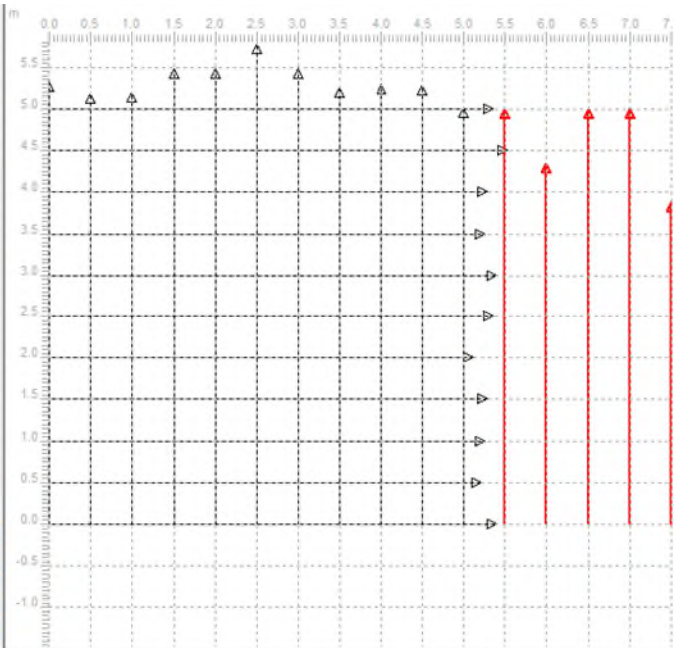
X = (11 – 5) X 0.5

X = 3.0m



Once the fields are filled in, press OK. This opens a map view showing the position of all the lines in the grid:

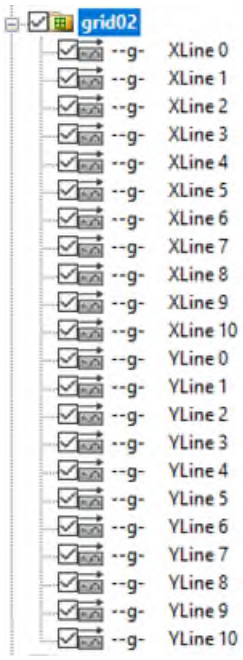
Grid Name	Line Name	Orientati...	Xmin	Xmax
grid01-Grid #0001	XLine 0	X	0.000	5.400
grid01-Grid #0001	XLine 1	X	0.000	5.220
grid01-Grid #0001	XLine 2	X	0.000	5.260
grid01-Grid #0001	XLine 3	X	0.000	5.280
grid01-Grid #0001	XLine 4	X	0.000	5.120
grid01-Grid #0001	XLine 5	X	0.000	5.360
grid01-Grid #0001	XLine 6	X	0.000	5.400
grid01-Grid #0001	XLine 7	X	0.000	5.260
grid01-Grid #0001	XLine 8	X	0.000	5.280
grid01-Grid #0001	XLine 9	X	0.000	5.520
grid01-Grid #0001	XLine 10	X	0.000	5.360
grid01-Grid #0001	YLine 0	Y	0.000	0.000
grid01-Grid #0001	YLine 1	Y	0.500	0.500
grid01-Grid #0001	YLine 2	Y	1.000	1.000
grid01-Grid #0001	YLine 3	Y	1.500	1.500
grid01-Grid #0001	YLine 4	Y	2.000	2.000
grid01-Grid #0001	YLine 5	Y	2.500	2.500
grid01-Grid #0001	YLine 6	Y	3.000	3.000
grid01-Grid #0001	YLine 7	Y	3.500	3.500
grid01-Grid #0001	YLine 8	Y	4.000	4.000
grid01-Grid #0001	YLine 9	Y	4.500	4.500
grid01-Grid #0001	YLine 10	Y	5.000	5.000
grid01-Grid #0001	lineset (2) - line5	Y	5.500	5.500
grid01-Grid #0001	lineset (2) - line6	Y	6.000	6.000
grid01-Grid #0001	lineset (2) - line7	Y	6.500	6.500
grid01-Grid #0001	lineset (2) - line8	Y	7.000	7.000
grid01-Grid #0001	lineset (2) - line9	Y	7.500	7.500



After making the desired modifications to the grid, close GFP_Edit using the X in the top right corner or from the file menu. EKKO_Project will show the modified grid with the Y lines.

17.4.4.3 Adding a Grid to a Grid

From Project Explorer, check the GPR grid to add to a grid.

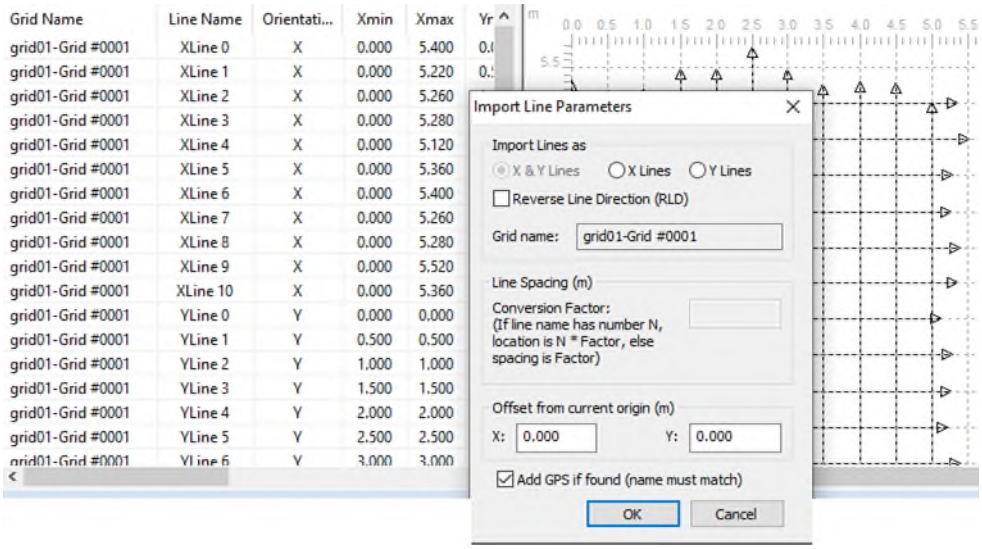


In Project Explorer, select the grid to add the checked GPR lines to.

Select **Add Checked Lines to Selected Grid**, either by:

1) right- clicking on the Grid name in Project Explorer and selecting it from the menu or
2) clicking on the Grid name in Project Explorer and selecting it from the **Tools > Grid Tools** menu.

The GFP_Edit utility program opens with a dialog with the following settings:



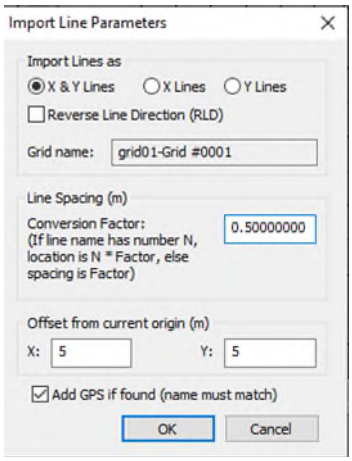
Import Lines as: Leave it at the default **X Lines & Y Lines** setting.

Reverse Line Direction: Leave unchecked unless you want all the lines to be reversed.

Line Spacing: Enter the distance between the grid in the checked grid.

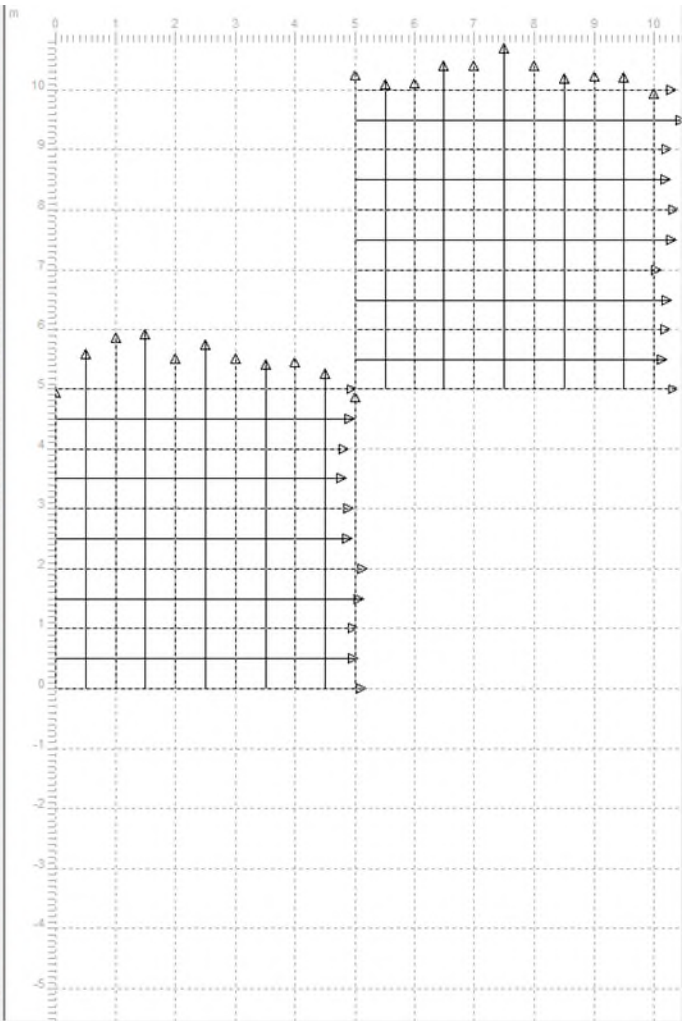
Offset from Current Origin: Set the X and Y values to the X=0, Y=0 corner of the checked grid to add to the selected grid.

For example, to add the checked grid to X=5, Y=5, set these values in the Offset from current origin fields:



Once the fields are filled in, press OK. This opens a map view showing the position of all the lines in the grid:

Grid Name	Line Name	Orientati...	Xmin	Xmax
grid01-Grid #0001	XLine 0	X	0.000	5.180
grid01-Grid #0001	XLine 1	X	0.000	5.040
grid01-Grid #0001	XLine 2	X	0.000	5.040
grid01-Grid #0001	XLine 3	X	0.000	5.140
grid01-Grid #0001	XLine 4	X	0.000	5.200
grid01-Grid #0001	XLine 5	X	0.000	4.940
grid01-Grid #0001	XLine 6	X	0.000	4.960
grid01-Grid #0001	XLine 7	X	0.000	4.840
grid01-Grid #0001	XLine 8	X	0.000	4.880
grid01-Grid #0001	XLine 9	X	0.000	4.980
grid01-Grid #0001	XLine 10	X	0.000	5.020
grid01-Grid #0001	grid02 - XLine 0	X	5.000	10.400
grid01-Grid #0001	grid02 - XLine 1	X	5.000	10.220
grid01-Grid #0001	grid02 - XLine 2	X	5.000	10.260
grid01-Grid #0001	grid02 - XLine 3	X	5.000	10.280
grid01-Grid #0001	grid02 - XLine 4	X	5.000	10.120
grid01-Grid #0001	grid02 - XLine 5	X	5.000	10.360
grid01-Grid #0001	grid02 - XLine 6	X	5.000	10.400
grid01-Grid #0001	grid02 - XLine 7	X	5.000	10.260
grid01-Grid #0001	grid02 - XLine 8	X	5.000	10.280
grid01-Grid #0001	grid02 - XLine 9	X	5.000	10.520
grid01-Grid #0001	grid02 - XLine 10	X	5.000	10.360
grid01-Grid #0001	YLine 0	Y	0.000	0.000
grid01-Grid #0001	YLine 1	Y	0.500	0.500
grid01-Grid #0001	YLine 2	Y	1.000	1.000
grid01-Grid #0001	YLine 3	Y	1.500	1.500
grid01-Grid #0001	YLine 4	Y	2.000	2.000
grid01-Grid #0001	YLine 5	Y	2.500	2.500
grid01-Grid #0001	YLine 6	Y	3.000	3.000
grid01-Grid #0001	YLine 7	Y	3.500	3.500
grid01-Grid #0001	YLine 8	Y	4.000	4.000
grid01-Grid #0001	YLine 9	Y	4.500	4.500
grid01-Grid #0001	YLine 10	Y	5.000	5.000
grid01-Grid #0001	grid02 - YLine 0	Y	5.000	5.000
grid01-Grid #0001	grid02 - YLine 1	Y	5.500	5.500
grid01-Grid #0001	grid02 - YLine 2	Y	6.000	6.000
grid01-Grid #0001	grid02 - YLine 3	Y	6.500	6.500
grid01-Grid #0001	grid02 - YLine 4	Y	7.000	7.000
grid01-Grid #0001	grid02 - YLine 5	Y	7.500	7.500
grid01-Grid #0001	grid02 - YLine 6	Y	8.000	8.000
grid01-Grid #0001	grid02 - YLine 7	Y	8.500	8.500
grid01-Grid #0001	grid02 - YLine 8	Y	9.000	9.000
grid01-Grid #0001	grid02 - YLine 9	Y	9.500	9.500
grid01-Grid #0001	grid02 - YLine 10	Y	10.000	10.000

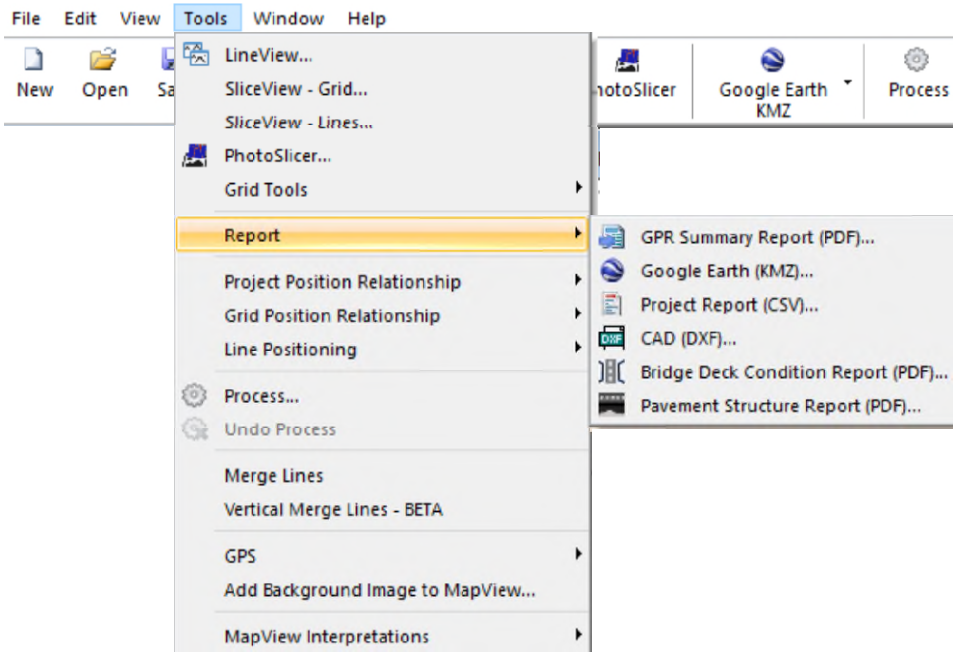


Exit from GFP_Edit by clicking the X in the top right corner or from the File menu to save the new grid that combines both grids.

17.5 Report

EKKO_Project can generate several reports from data at fiducial markers and interpretations added to the project data. Reports are output in several formats including Adobe Acrobat (.pdf), Google Earth™ (.kmz), Comma Separated Values (.csv), and AutoCAD (.dxf) files.

1. Click **Tools > Report**.



2. In the drop-down list, select a report format:

- GPR Summary Report (PDF)
- Google Earth (KMZ)
- Project Report (CSV)
- CAD (DXF)
- Bridge Deck Condition Report (PDF)
- Pavement Structure Report (PDF)

17.5.1 GPR Summary Report (PDF)

The GPR Summary Report allows users to take data images saved of EKKO_Project windows, their own photographs and images and include them in a PDF report.

Images saved from EKKO_Project windows include the Line Preview and MapView windows (see Save View) as well as images of windows from the optional LineView and SliceView modules.

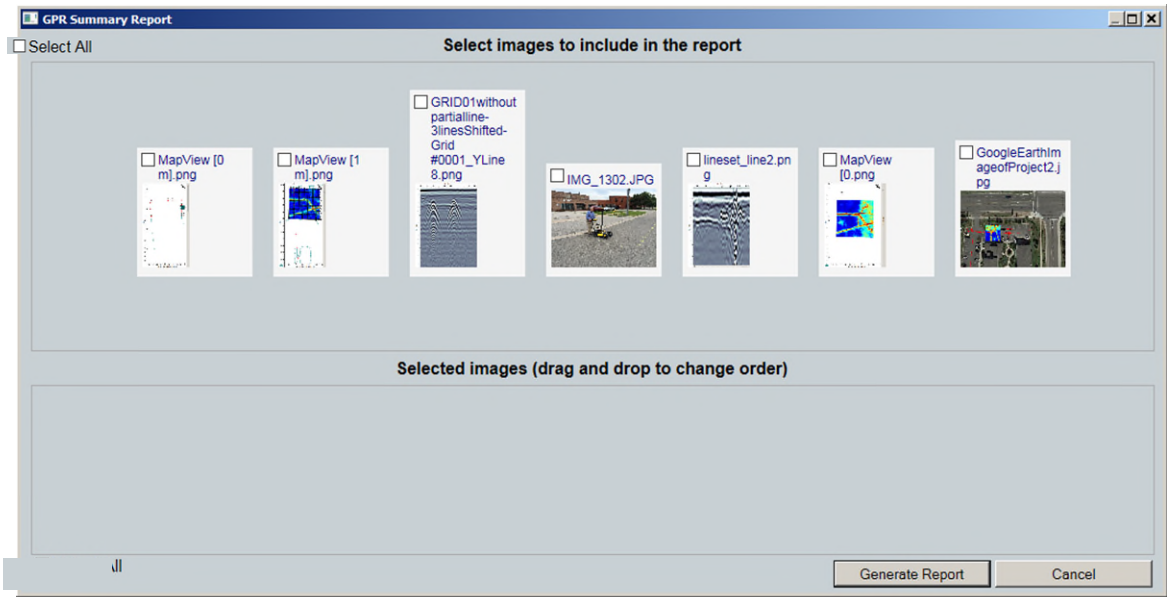
As well, screen captures saved in the field (by pressing the camera button) are also saved in the project file and are available for inclusion in the GPR Summary Report.

To see a list of window images currently saved and available for the GPR Summary Report, select the project item in Project Explorer and then open the Attachments Tab.

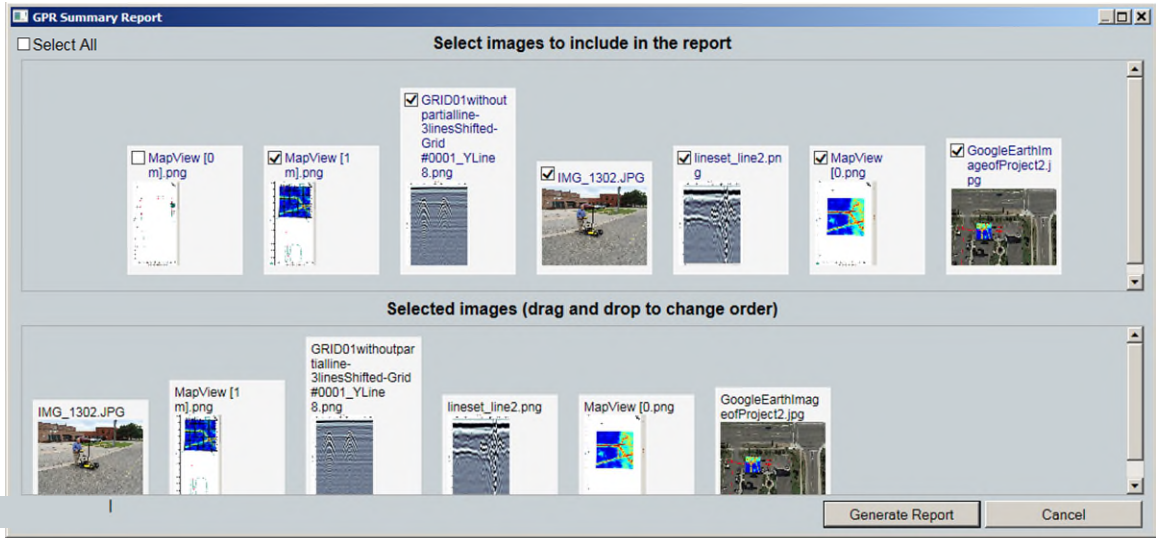
Photographs and other images attached to the project file, grid folder, lineset folder or individual GPR line in the project are available to include in the report. For details on attaching a file, see Attachments Tab.

1. To generate a GPR Summary Report (pdf) click **Tools > Report > GPR Summary Report.**

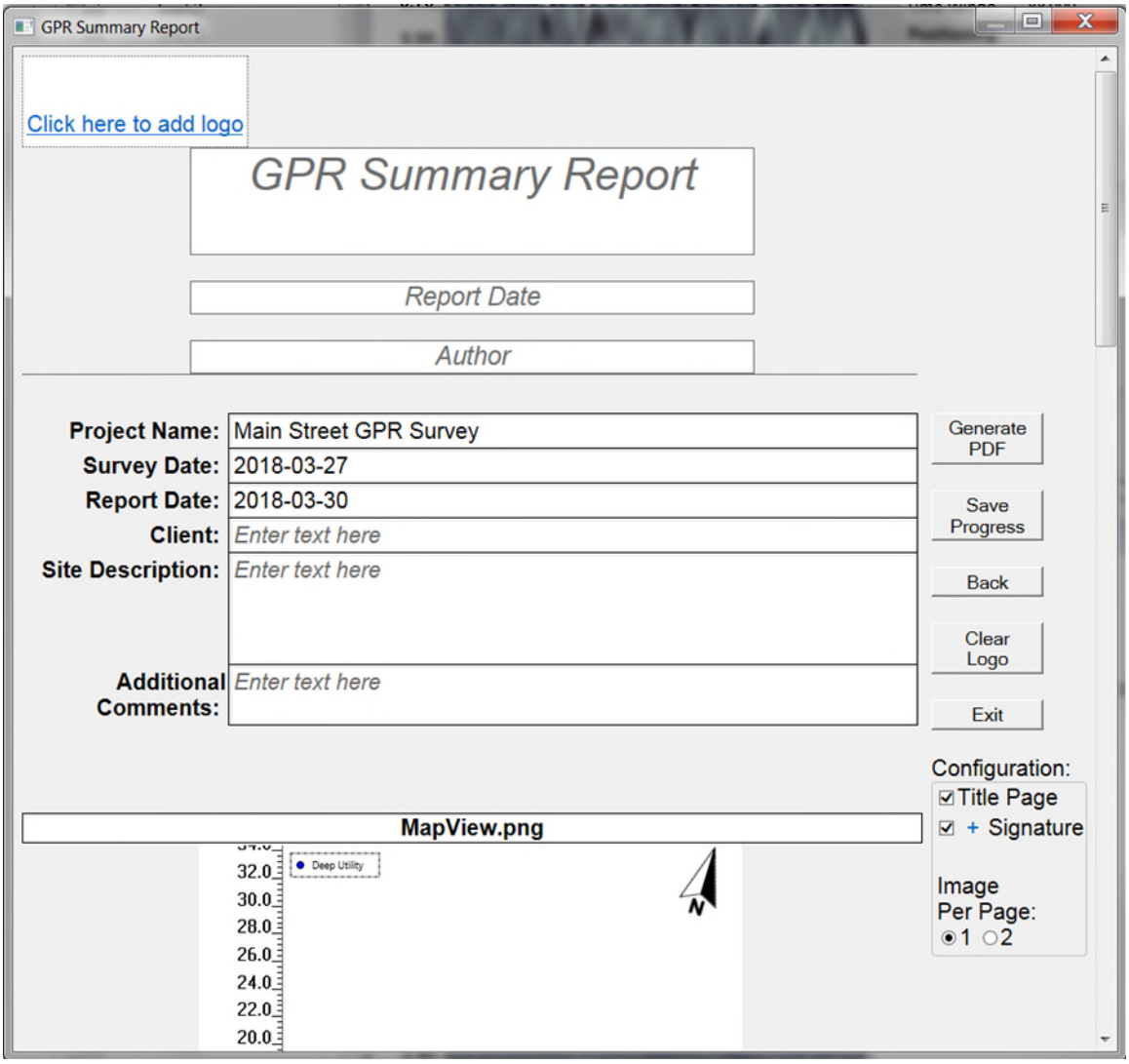
2. A dialog opens, displaying all the data images available to include in the report. Click on the images to include or click on the Select All checkbox in the bottom left corner to quickly include all the images.



3. Once the desired images are selected, they appear in the bottom of the dialog. Change the order of the images by dragging and dropping them in the desired order for the report.



4. Select **Generate Report** button. A preview of the report appears.



5. The Report preview is editable, with several fields automatically filled-in. Users can modify or add to the text fields. The **Site Description** and **Additional Comments** fields allow pages of text to be added. The title of each image can be edited from the default name and caption text added. The caption text can multiple pages long.

6. To add a Title Page to the report, select the **Title Page** checkbox.

7. The report defaults to displaying one image per page. If you'd like to display 2 images per page, select 2 under Image Per Page.

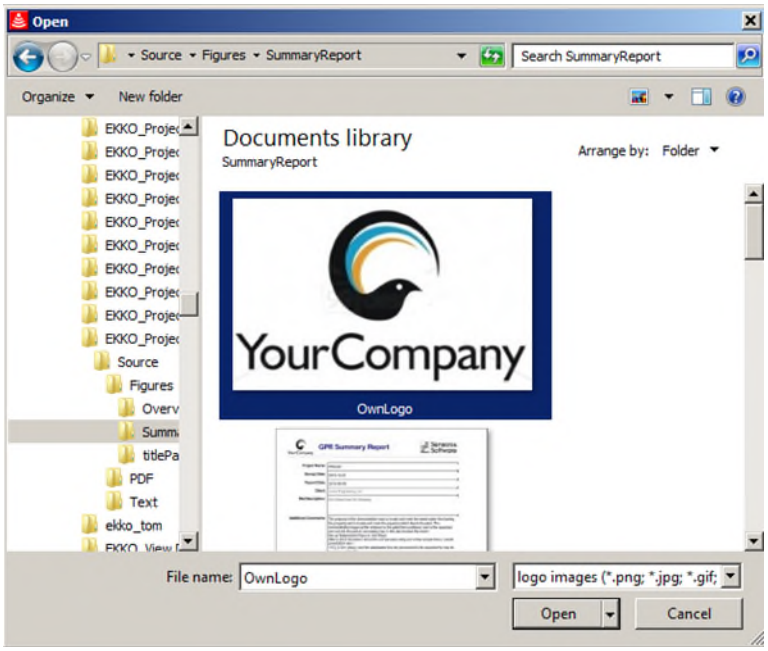
8. To add space for a Signature at the end of the report, check the **Signature** checkbox. To add more than one signature, press the + button next to the Signature checkbox.

9. If you want to make changes to the images in the report, select the **Back** button to move back to the previous screen. Text entered in text boxes before pressing **Back** is saved.

10. To save the current report and come back later to modify and finish it, press the **Save Progress** button.

11. Scroll down to the end of the document to add text to the **Conclusions** section that appears on a separate page at the end. If the Conclusion field is left blank, the PDF document will not include a conclusion page.

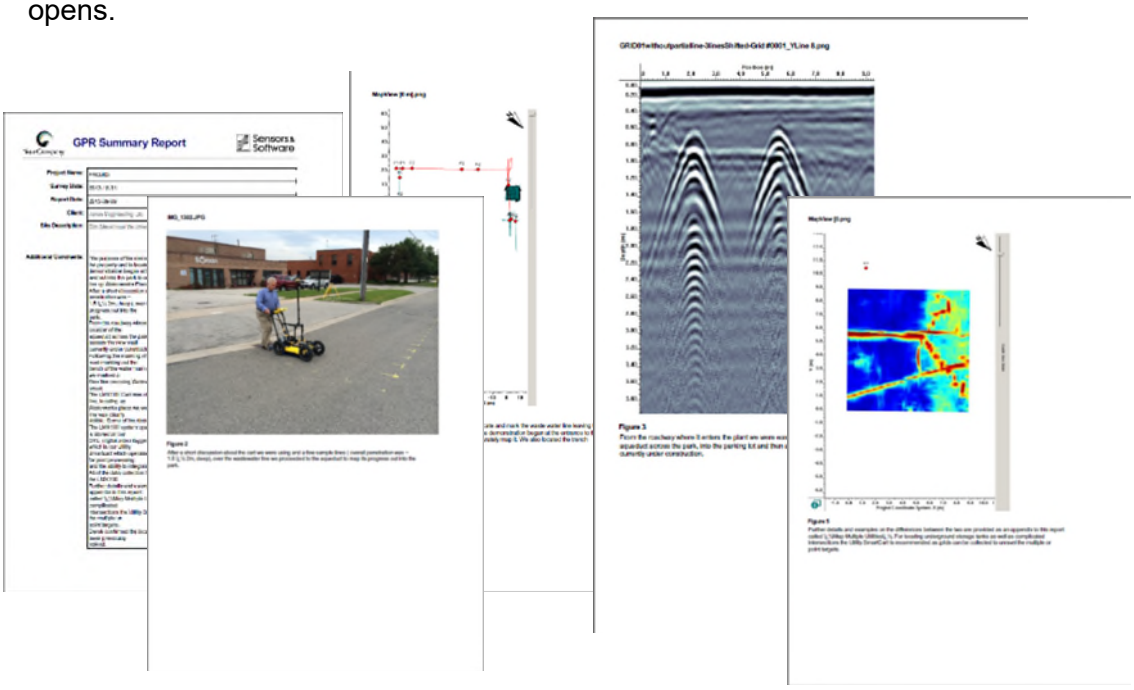
12. The user can add their own logo to the top left-hand corner of the report by clicking on the "Click here to add logo" link and selecting an image file.



The logo image is automatically remembered for that installation of EKKO_Project, so the logo file only must be selected once.

To clear the current logo image, select the **Clear Logo** button.

13. When the editing of the report is complete, save the report as a PDF document by clicking the **Generate PDF** button. Providing the computer has PDF reader software installed (it may be necessary to install Adobe Acrobat Reader from www.adobe.com), the PDF file opens.



17.5.2 Google Earth™ (KMZ)

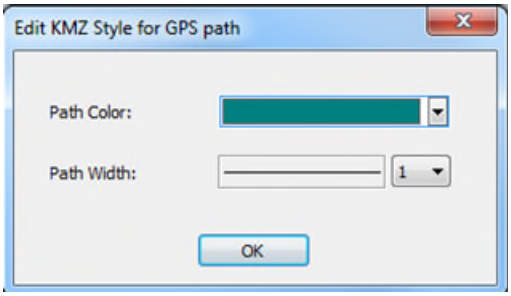
Projects containing GPR lines and grids collected using GPS can be written to a Google Earth™ (.kmz) report file and displayed in Google Earth™. The following items can be written to the kmz file and displayed in Google Earth™:

- GPS path of GPR lines,
- grids lines,
- depth slices (both Line Slices and Grid Slices),
- flags/fiducial markers added during data collection
- field interpretations added during data collection,
- Interpretations added in post-processing using the optional Interpretations Module in LineView).

The elements written to the kmz file are determined by the items checked in Layer View.

The items included in the Google Earth™ kmz file can enabled or disabled using the check-boxes in the Google Earth™ Places window.

1. To generate a Google Earth™ (.kmz) report file for GPR lines in the project (.gpz) file with GPS, click **Tools > Report > Google Earth.**
2. A dialog opens to define the color and thickness of the GPS path when plotted on Google Earth™:



Use the dropdowns to select a new color or width.

3. In the **Save As** folder, navigate to the folder you want to save the file to.
4. Click **Save**.

Google Earth™ opens to display a satellite image of the data collection site.

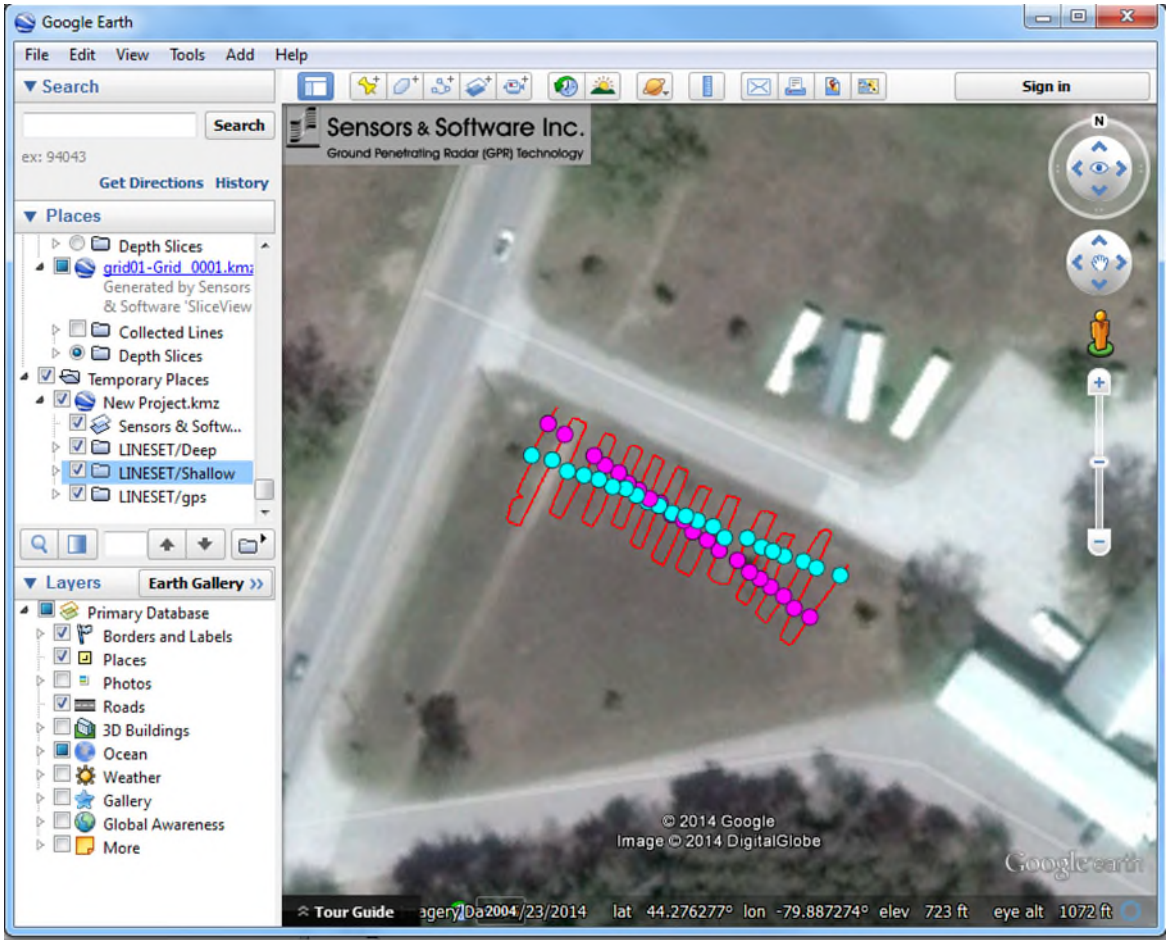


***Figure 12**: Google Earth™ image of the data collection site with the GPR line survey path in red and utility point interpretations as pink and light blue dots.*

17.5.3 Project Report (CSV)

The Project Report exports information added to the GPR data during data collection and in post-processing. Specifically, the information about the following items is saved to the Project Report CSV file:

1. Flags/Fiducial markers
2. Field Interpretations are added to the data during data collection and
3. Interpretations added to GPR lines in post-processing using the optional Interpretation module in LineView.
4. MapView Interpretations added to the MapView window.

Exporting the flags/fiducial markers and interpretations to spreadsheet-type files (.csv) allows you to transfer the information to third-party software applications such as Microsoft® Excel® and Geographical Information Systems (GIS).

Before adding interpretations, decide whether to plot data with a depth axis or an elevation axis.

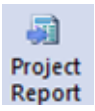
To include observation values in the report by elevation rather than depth, add the Interpretations **after** one of the following:

- the GPR line has topographic data added that will not be changed
- the GPR line is plotted with an elevation axis using a velocity value that will not be changed

> **Note**: Changing either of these conditions after adding interpretations shifts the vertical positions of the interpretations and is not recommended.

Changing the depth or elevation axis velocity in LineView changes the depth and elevation values.

1. To generate a Project Report, click **Tools > Report > Project Report**.

   Alternatively, from the Standard Toolbar, click 

.

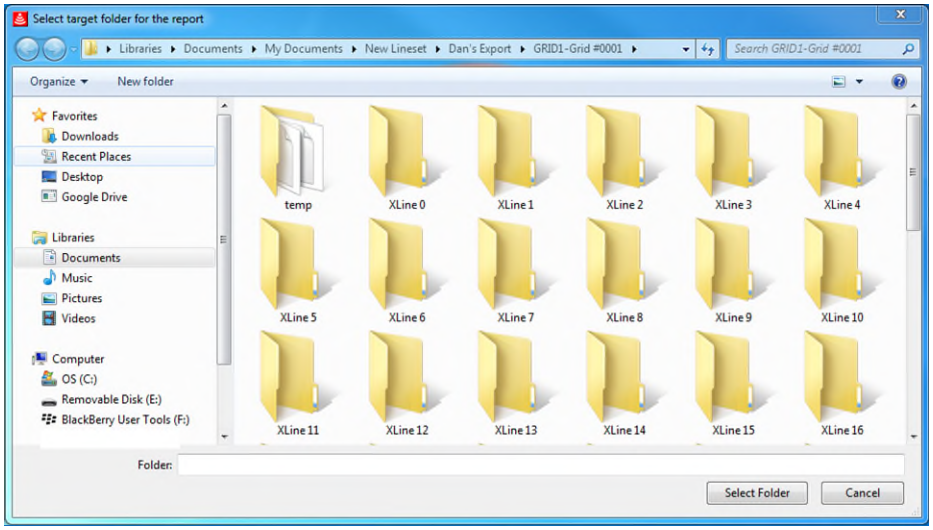
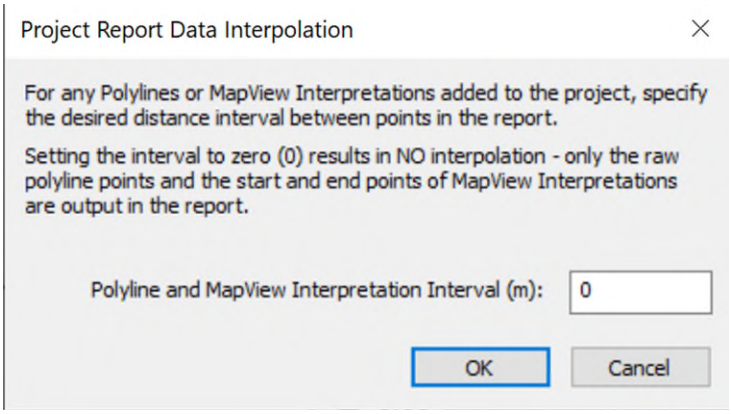


***Figure 13**: Select target folder for export*

2. In the **Select target folder for the report** dialog box, navigate to and then click the folder to save the report files to
3. Click **Select Folder**.
4. In the **Report** dialog box, enter the Polyline Output Interval (the horizontal distance between points on any polylines and MapView Interpretations in the project).

   The default value is zero (0) which means that there is no interpolation of points – only the points added are saved.



   If you want to use a specific value rather than the default, be realistic for the interval. Very small values with respect to the size of your project area will result in MANY points being written to the Project Report CSV file. For example, if your project area is 100 meters across, setting the Polyline and MapView Interpretation Interval to 0.01 meters will result in 10,000 rows of points saved. Using a value of 0.1 to 1.0 meters is more realistic in this example.

   A good rule of thumb to produce continuous looking lines in visualization software such as GIS software, Google Earth™ and Voxler® is about 1/500th of the size of your project area.

   For 100m, interval = 0.2m
   For 10m, interval = 0.02m
   For 1m, interval = 0.002m

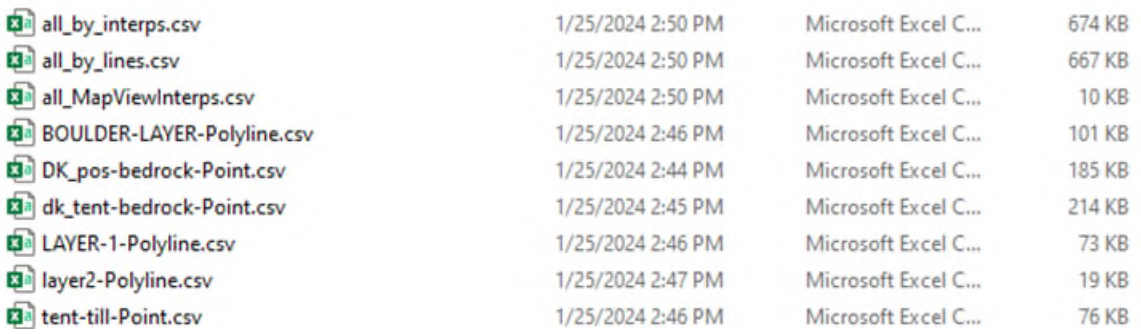
   For 500 feet, interval = 1 foot
   For 50 feet, interval = 0.2 feet
   For 5 feet, interval = 0.02 feet

   The finer the interval, the longer it will take to write the Project Report CSV file.

   The Project Report Options dialog box opens whether polyline and MapView Interpretations were added or not - if you do not have any polyline or MapView Interpretations in your project, click OK to ignore the dialog and continue.

5. Click **OK**.

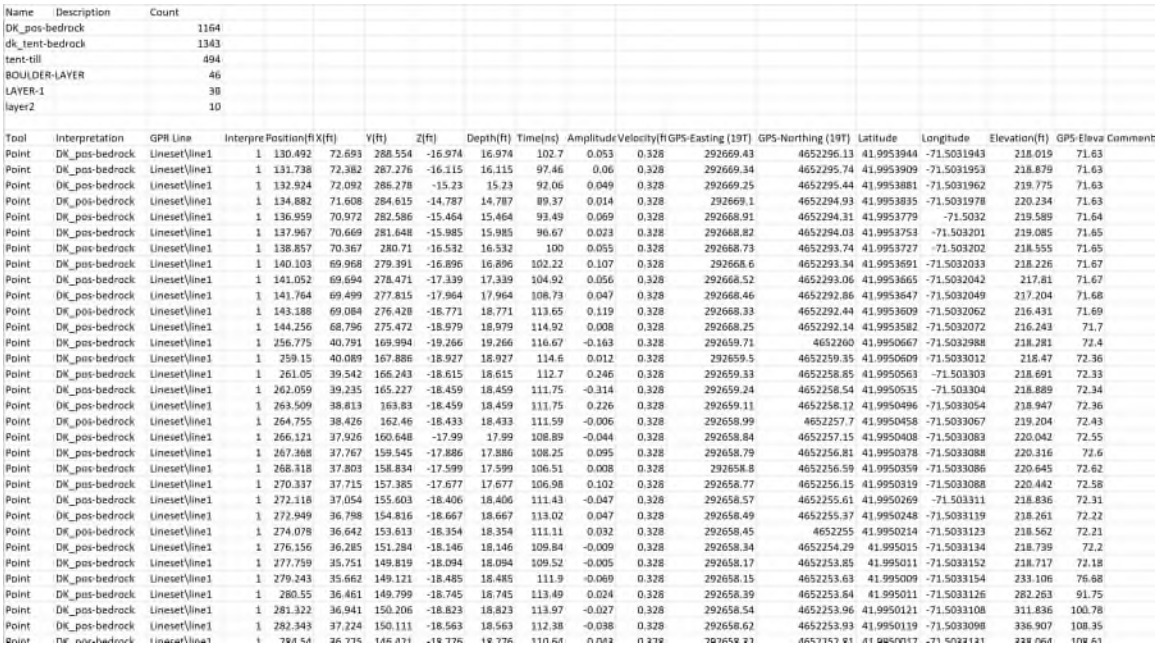
A dialog box opens to display the folder that the .csv lines were saved to.



all_by_interps.csv	1/25/2024 2:50 PM	Microsoft Excel C...	674 KB
all_by_lines.csv	1/25/2024 2:50 PM	Microsoft Excel C...	667 KB
all_MapViewInterps.csv	1/25/2024 2:50 PM	Microsoft Excel C...	10 KB
BOULDER-LAYER-Polyline.csv	1/25/2024 2:46 PM	Microsoft Excel C...	101 KB
DK_pos-bedrock-Point.csv	1/25/2024 2:44 PM	Microsoft Excel C...	185 KB
dk_tent-bedrock-Point.csv	1/25/2024 2:45 PM	Microsoft Excel C...	214 KB
LAYER-1-Polyline.csv	1/25/2024 2:46 PM	Microsoft Excel C...	73 KB
layer2-Polyline.csv	1/25/2024 2:47 PM	Microsoft Excel C...	19 KB
tent-till-Point.csv	1/25/2024 2:46 PM	Microsoft Excel C...	76 KB

The types of .csv files generated are:

- A .CSV file for each interpretation. Each file has the name of the interpretation followed by the interpretation type (point, polyline, box, or annotation) appended to the end.
- A .CSV file for each GPR line with all interpretations on that line.
- Flags_Fiducials.csv for all the flags/fiducials in the GPZ project file.
- all_MapViewInterps.csv containing all the MapView Interpretations.
- all_by_interps.csv file containing all interpretations and flags/fiducials sorted by interpretations.
- all_by_lines.csv file containing all interpretations sorted by GPR line.



Name	Description	Count
DK_pos-bedrock		1164
dk_tent-bedrock		1343
tent-till		494
BOULDER-LAYER		46
LAYER-1		38
layer2		10

Tool	Interpretation	GPR Line	Interpre	Position(fi	X(ft)	Y(ft)	Z(ft)	Depth(ft)	Time(ns)	Amplitude	Velocity(fi	GPS-Easting (19T)	GPS-Northing (19T)	Latitude	Longitude	Elevation(ft)	GPS-Eleva	Comment
Point	DK_pos-bedrock	Lineset\line1	1	130.492	72.693	288.554	-16.974	16.974	102.7	0.053	0.328	292669.43	4652296.13	41.9953944	-71.5031943	218.019	71.63	
Point	DK_pos-bedrock	Lineset\line1	1	131.738	72.382	287.276	-16.115	16.115	97.46	0.06	0.328	292669.34	4652295.74	41.9953909	-71.5031953	218.879	71.63	
Point	DK_pos-bedrock	Lineset\line1	1	132.924	72.092	286.278	-15.23	15.23	92.06	0.049	0.328	292669.25	4652295.44	41.9953881	-71.5031962	219.775	71.63	
Point	DK_pos-bedrock	Lineset\line1	1	134.882	71.608	284.615	-14.787	14.787	89.37	0.014	0.328	292669.1	4652294.93	41.9953835	-71.5031978	220.234	71.63	
Point	DK_pos-bedrock	Lineset\line1	1	136.959	70.972	282.586	-15.464	15.464	93.49	0.069	0.328	292668.91	4652294.31	41.9953779	-71.5032	219.589	71.64	
Point	DK_pos-bedrock	Lineset\line1	1	137.967	70.669	281.648	-15.985	15.985	96.67	0.023	0.328	292668.82	4652294.03	41.9953753	-71.503201	219.085	71.65	
Point	DK_pos-bedrock	Lineset\line1	1	138.857	70.367	280.71	-16.532	16.532	100	0.055	0.328	292668.73	4652293.74	41.9953727	-71.503202	218.555	71.65	
Point	DK_pos-bedrock	Lineset\line1	1	140.103	69.968	279.391	-16.896	16.896	102.22	0.107	0.328	292668.6	4652293.34	41.9953691	-71.5032033	218.226	71.67	
Point	DK_pos-bedrock	Lineset\line1	1	141.052	69.694	278.471	-17.339	17.339	104.92	0.056	0.328	292668.52	4652293.06	41.9953665	-71.5032042	217.81	71.67	
Point	DK_pos-bedrock	Lineset\line1	1	141.764	69.499	277.815	-17.964	17.964	108.73	0.047	0.328	292668.46	4652292.86	41.9953647	-71.5032049	217.204	71.68	
Point	DK_pos-bedrock	Lineset\line1	1	143.188	69.084	276.428	-18.771	18.771	113.65	0.119	0.328	292668.33	4652292.44	41.9953609	-71.5032062	216.431	71.69	
Point	DK_pos-bedrock	Lineset\line1	1	144.256	68.796	275.472	-18.979	18.979	114.92	0.008	0.328	292668.25	4652292.14	41.9953582	-71.5032072	216.243	71.7	
Point	DK_pos-bedrock	Lineset\line1	1	256.775	40.791	169.994	-19.266	19.266	116.67	-0.163	0.328	292659.71	4652260	41.9950667	-71.5032988	218.281	72.4	
Point	DK_pos-bedrock	Lineset\line1	1	259.15	40.089	167.886	-18.927	18.927	114.6	0.012	0.328	292659.5	4652259.35	41.9950609	-71.5033012	218.47	72.36	
Point	DK_pos-bedrock	Lineset\line1	1	261.05	39.542	166.243	-18.615	18.615	112.7	0.246	0.328	292659.33	4652258.85	41.9950563	-71.503303	218.691	72.33	
Point	DK_pos-bedrock	Lineset\line1	1	262.059	39.235	165.227	-18.459	18.459	111.75	-0.314	0.328	292659.24	4652258.54	41.9950535	-71.503304	218.889	72.34	
Point	DK_pos-bedrock	Lineset\line1	1	263.509	38.813	163.83	-18.459	18.459	111.75	0.226	0.328	292659.11	4652258.12	41.9950496	-71.5033054	218.947	72.36	
Point	DK_pos-bedrock	Lineset\line1	1	264.755	38.426	162.46	-18.433	18.433	111.59	-0.006	0.328	292658.99	4652257.7	41.9950458	-71.5033067	219.204	72.43	
Point	DK_pos-bedrock	Lineset\line1	1	266.121	37.926	160.648	-17.99	17.99	108.89	-0.044	0.328	292658.84	4652257.15	41.9950408	-71.5033083	220.042	72.55	
Point	DK_pos-bedrock	Lineset\line1	1	267.368	37.767	159.545	-17.886	17.886	108.25	0.095	0.328	292658.79	4652256.81	41.9950378	-71.5033088	220.316	72.6	
Point	DK_pos-bedrock	Lineset\line1	1	268.818	37.803	158.834	-17.599	17.599	106.51	0.008	0.328	292658.8	4652256.59	41.9950359	-71.5033086	220.645	72.62	
Point	DK_pos-bedrock	Lineset\line1	1	270.337	37.715	157.385	-17.677	17.677	106.98	0.102	0.328	292658.77	4652256.15	41.9950319	-71.5033088	220.442	72.58	
Point	DK_pos-bedrock	Lineset\line1	1	272.118	37.054	155.603	-18.406	18.406	111.43	-0.047	0.328	292658.57	4652255.61	41.9950269	-71.503311	218.836	72.31	
Point	DK_pos-bedrock	Lineset\line1	1	272.949	36.788	154.816	-18.667	18.667	113.02	0.047	0.328	292658.49	4652255.37	41.9950248	-71.5033119	218.261	72.22	
Point	DK_pos-bedrock	Lineset\line1	1	274.078	36.642	153.613	-18.354	18.354	111.11	0.032	0.328	292658.45	4652255	41.9950214	-71.5033123	218.562	72.21	
Point	DK_pos-bedrock	Lineset\line1	1	276.156	36.285	151.284	-18.146	18.146	109.84	-0.009	0.328	292658.34	4652254.29	41.995015	-71.5033134	218.739	72.2	
Point	DK_pos-bedrock	Lineset\line1	1	277.759	35.751	149.819	-18.094	18.094	109.52	-0.005	0.328	292658.17	4652253.85	41.995011	-71.5033152	218.717	72.18	
Point	DK_pos-bedrock	Lineset\line1	1	279.243	35.662	149.121	-18.485	18.485	111.9	-0.069	0.328	292658.15	4652253.63	41.995009	-71.5033154	233.106	76.68	
Point	DK_pos-bedrock	Lineset\line1	1	280.55	36.461	149.799	-18.745	18.745	113.49	0.024	0.328	292658.39	4652253.64	41.995011	-71.5033126	282.263	91.75	
Point	DK_pos-bedrock	Lineset\line1	1	281.322	36.941	150.206	-18.823	18.823	113.97	-0.027	0.328	292658.54	4652253.96	41.9950121	-71.5033108	311.836	100.78	
Point	DK_pos-bedrock	Lineset\line1	1	282.343	37.224	150.111	-18.563	18.563	112.38	-0.038	0.328	292658.62	4652253.93	41.9950119	-71.5033098	336.907	108.35	
Point	DK_pos-bedrock	Lineset\line1	1	284.54	36.775	148.421	-18.776	18.776	110.64	0.043	0.328	292658.33	4652252.81	41.9950017	-71.5033131	338.064	108.61	

***Figure 14**: Example of Project Report CSV file*

6. After the Project Report CSV files are generated, a message opens asking if you would like to plot all the points (point, polyline, and MapView Interpretations) in 3D in the Voxler® software. The optional Voxler® software must be installed on your computer.

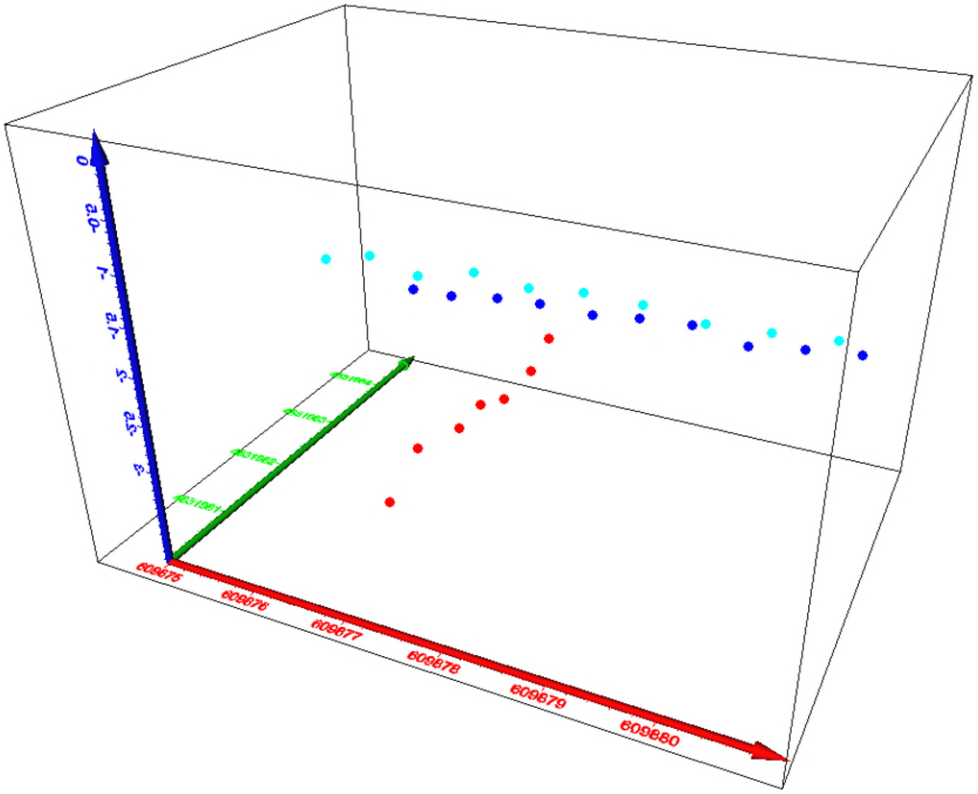


***Figure 15**: 3D Voxler® plot of point interpretations on utilities at different depths.*

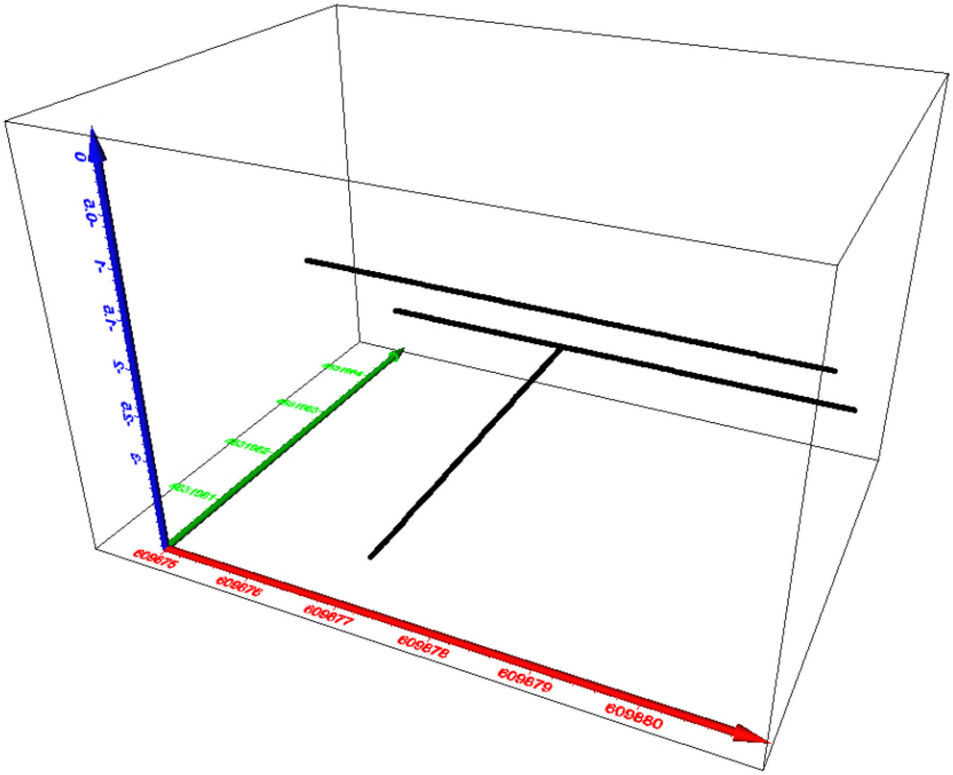


***Figure 16**: 3D Voxler® plot of MapView Interpretations interpolated at 0.04 feet (about 1/500th of the long dimension of the survey area).*

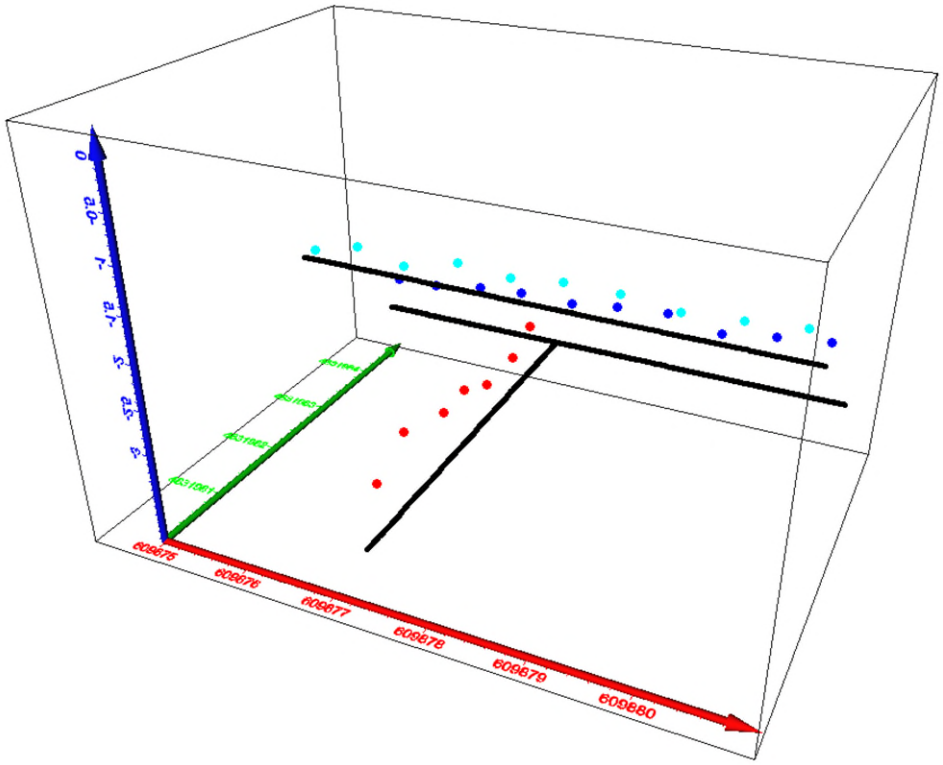


***Figure 17**: 3D Voxler® plot of point and MapView Interpretations plotted together.*

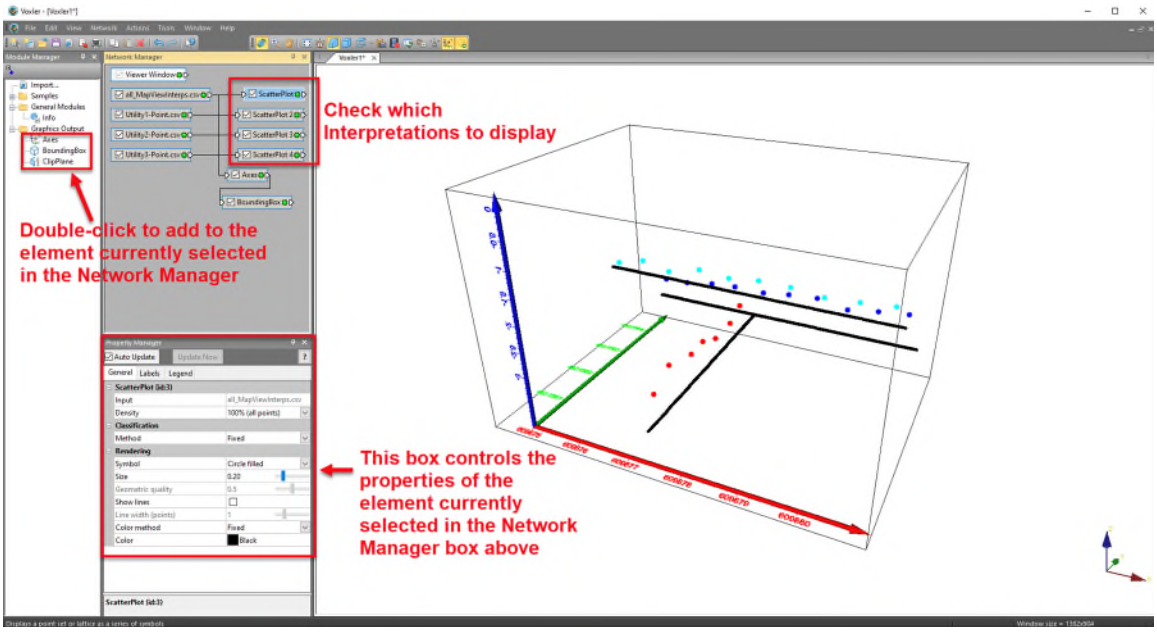


***Figure 18**: How to control interpretations plotted in Voxler®.*

CSV files can also be opened in third-party software such as Geographical Information Systems (GIS) software. The image below shows GPR utility interpretations plotted in GIS software with a Google Road image in behind.

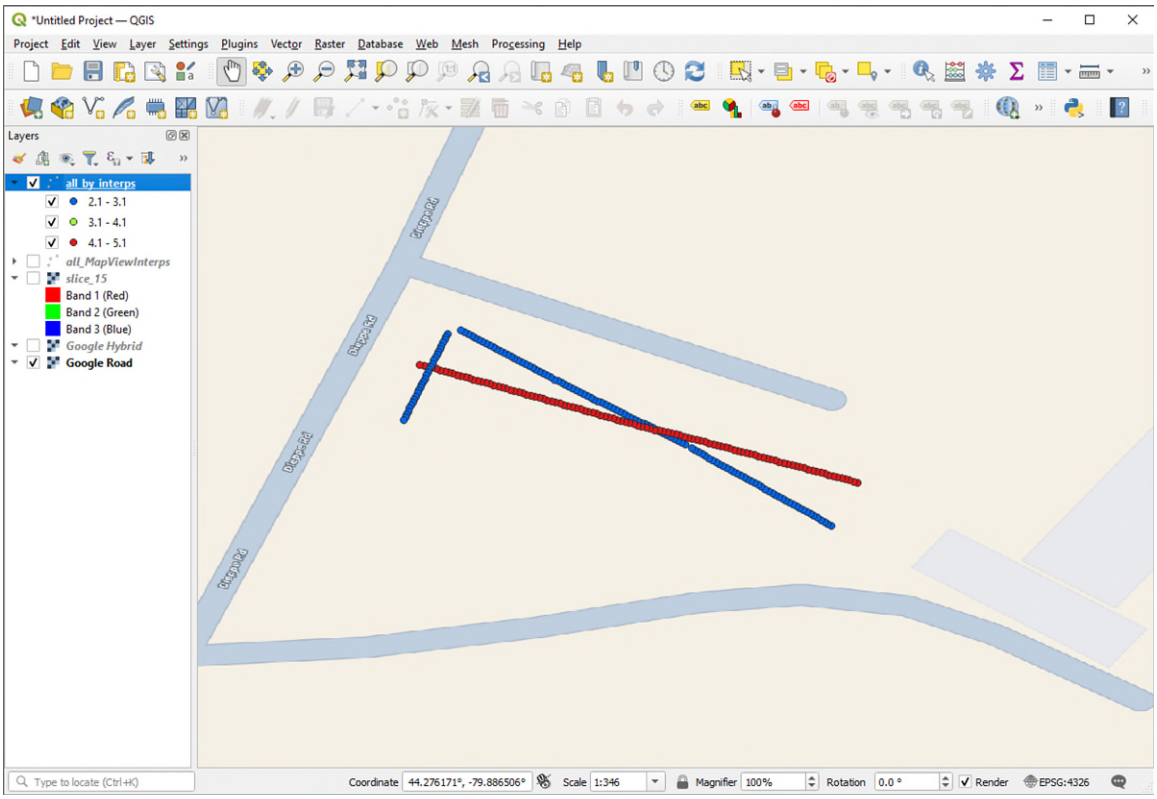


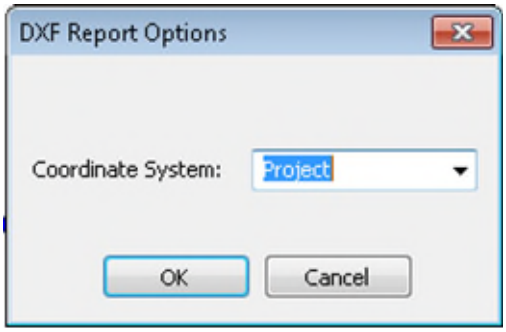
***Figure 19**: EKKO_Project LineView Interpretations plotted in GIS software.*

17.5.4 CAD (DXF)

Projects can be written to a CAD report (dxf) file. The path of the GPR grid lines, the GPS path for GPR lines collected with GPS, fiducial markers added during data collection, and post-processing point interpretations (using the Interpretation Module) are saved as layers in the DXF file.

Exporting this information to a .dxf file allows you to transfer the information to third-party CAD programs. The Voxler® software, if available, reads .dxf files. If necessary, free CAD (.dxf) file viewers can be found on-line.

1. To generate a CAD (dxf) report file, **click Tools > Report > CAD (DXF)**.
2. Use the dropdown box in the dialog box to select the coordinate system to save with the DXF file:



The options are Project (Local X, Y), or, if a local-global coordinate relationship has been established (usually by GPS data), UTM and Latitude-Longitude options are also available.

UTM is usually selected to open the GPR report in AutoCAD programs while Latitude-Longitude is the choice for GIS programs. When UTM or Latitude-Longitude is selected, a projection file (.prj) is generated that lists the projection details. It is important to keep this file with the .dxf file when importing the data into third-party programs such as ArcGIS.

The projection file always uses the WGS84 reference ellipsoid for UTM and latitude/longitude outputs.

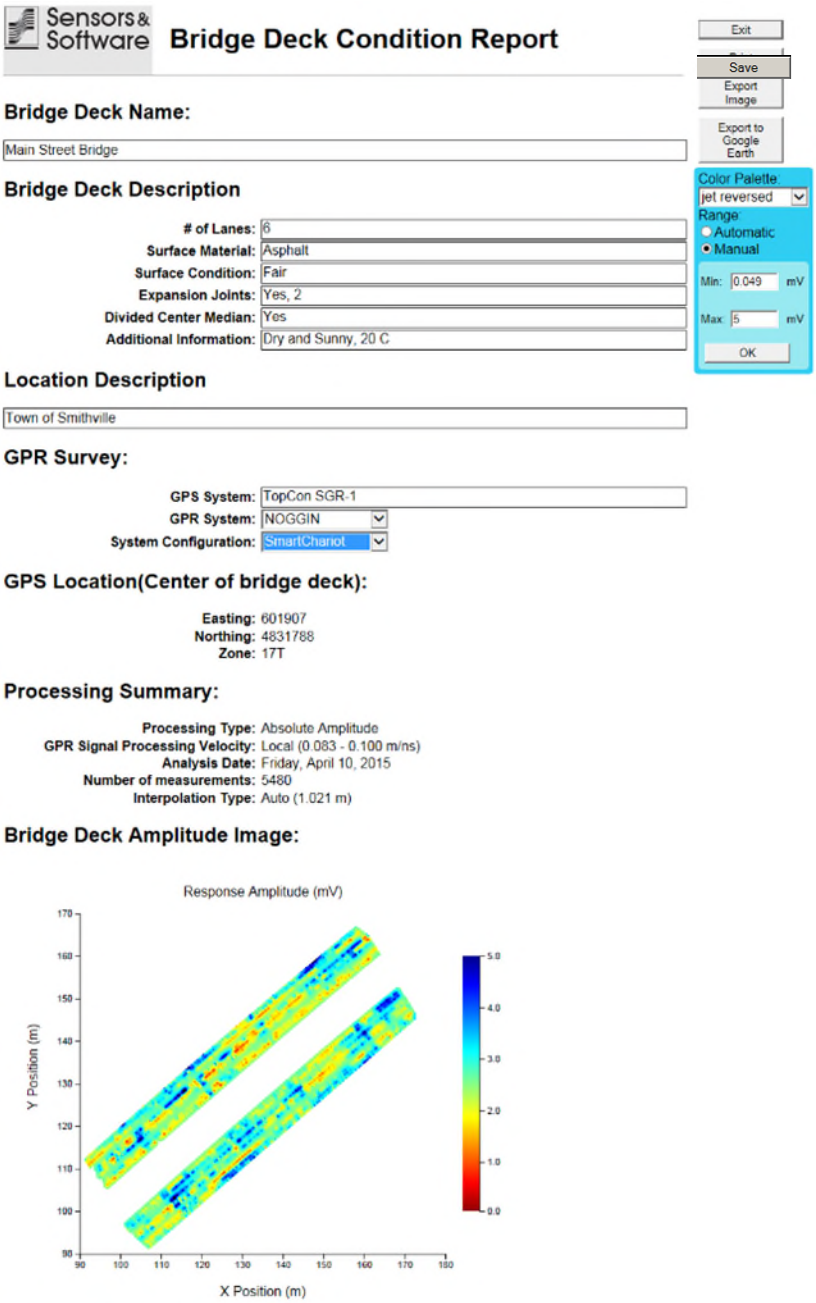
3. In the **Save As** folder, navigate to the folder you want to save the file to.

4. Click **Save**.

17.5.5 Bridge Deck Condition Report (PDF)

If the optional Bridge Deck Condition Report module is enabled, projects containing GPR lines collected using GPS or grids where point interpretations have been added to rebar responses are processed to generate a Bridge Deck Condition Report.

See the **Bridge Deck Condition Report Module User's Guide** for more details.



Sensors & Software **Bridge Deck Condition Report**

Exit | Save | Export Image | Export to Google Earth

Color Palette: jet reversed
Range: Automatic / Manual
Min: 0.049 mV
Max: 5 mV
OK

Bridge Deck Name:

Main Street Bridge

Bridge Deck Description

# of Lanes:	6
Surface Material:	Asphalt
Surface Condition:	Fair
Expansion Joints:	Yes, 2
Divided Center Median:	Yes
Additional Information:	Dry and Sunny, 20 C

Location Description

Town of Smithville

GPR Survey:

GPS System:	TopCon SGR-1
GPR System:	NOGGIN
System Configuration:	SmartChariot

GPS Location(Center of bridge deck):

Easting:	601907
Northing:	4831788
Zone:	17T

Processing Summary:

Processing Type:	Absolute Amplitude
GPR Signal Processing Velocity:	Local (0.083 - 0.100 m/ns)
Analysis Date:	Friday, April 10, 2015
Number of measurements:	5480
Interpolation Type:	Auto (1.021 m)

Bridge Deck Amplitude Image:

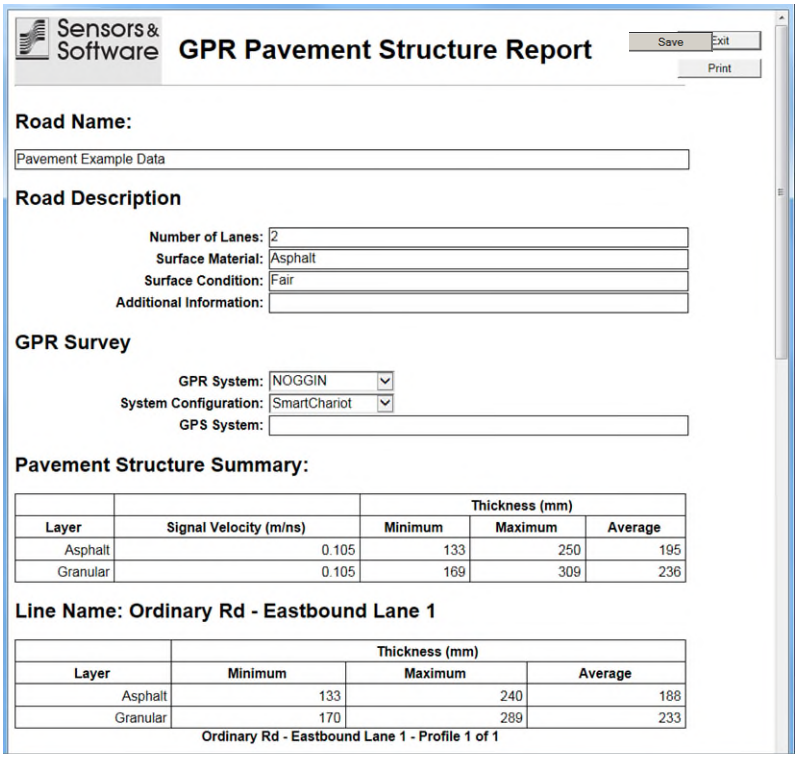
Statistical Summary:

	GPR Amplitude (mV)	Reinforcement Depth (m)	Reinforcement Spacing (m)
Minimum	0.049	0.120	0.147
Maximum	7.923	0.206	2.010
Average	2.634	0.164	0.255

17.5.6 Pavement Structure Report (PDF)

If the optional Pavement Structure Report module is enabled, Projects containing GPR lines where polyline interpretations have been added are processed to generate a Pavement Structure Report.

See the **Pavement Structure Report Module User's Guide** for more details.



Sensors & Software **GPR Pavement Structure Report** Save Exit Print

Road Name:

Pavement Example Data

Road Description

Number of Lanes: 2
Surface Material: Asphalt
Surface Condition: Fair
Additional Information:

GPR Survey

GPR System: NOGGIN
System Configuration: SmartChariot
GPS System:

Pavement Structure Summary:

		Thickness (mm)		
Layer	Signal Velocity (m/ns)	Minimum	Maximum	Average
Asphalt	0.105	133	250	195
Granular	0.105	169	309	236

Line Name: Ordinary Rd - Eastbound Lane 1

	Thickness (mm)		
Layer	Minimum	Maximum	Average
Asphalt	133	240	188
Granular	170	289	233

Ordinary Rd - Eastbound Lane 1 - Profile 1 of 1



Line Name: Ordinary Rd - Eastbound Lane 2

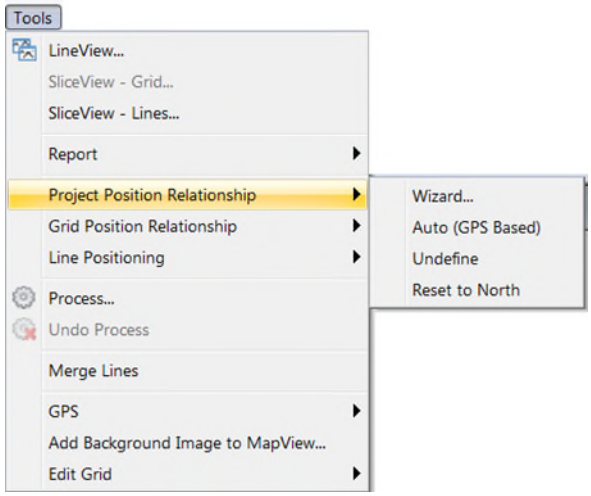
	Thickness (mm)		
Layer	Minimum	Maximum	Average
Asphalt	170	250	202
Granular	169	309	240

Ordinary Rd - Eastbound Lane 2 - Profile 1 of 1

17.6 Project Position Relationship

The Project Position Relationship defines the relationship between the project coordinates and a global coordinate system.

The Project Position Relationship menu has several options:



This menu is also available in the Project Explorer Right Click menu.

The **Wizard** takes the user step by step through manually adding global coordinates to a GPR project data.

Note: The position of individual GPR lines or grid lines within the project cannot be modified by this Wizard. For positioning individual GPR lines, use the Line Positioning routine.

Auto (GPS based) defines the project-to-global relationship using the GPS files generated during data collection or manually created and attached.

Undefine removes any previously defined project-to-global relationship.

Reset to North rotates the image so the North Arrow points up in MapView.

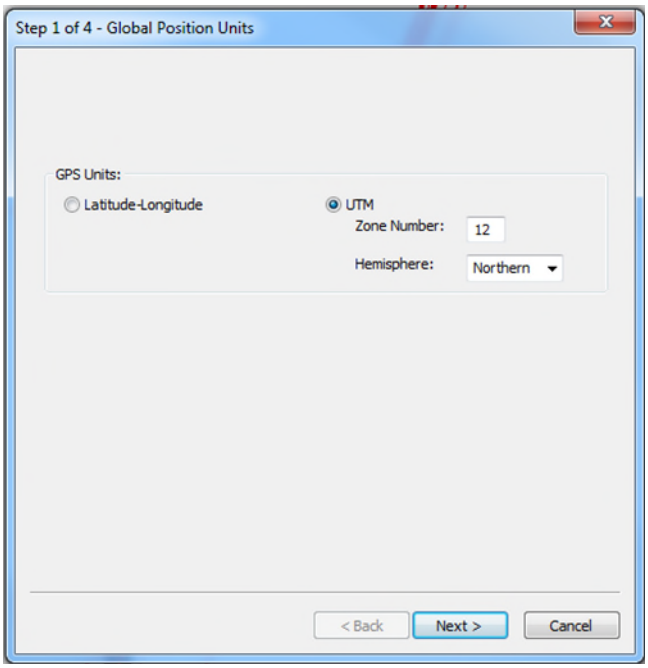
17.6.1 Wizard

Use the Wizard option to manually define the relationship between the project (X, Y) coordinates and the global coordinates (Latitude-Longitude or UTM) of the GPR project data.

Use the Wizard if:

- GPS data were not collected for a GPR data grid but one or two GPS positions in the grid area are known; GPS positions for the entire grid can be calculated.
- The automatic positioning of the grid using GPS files generated during data collection does not provide an accurate fit to the GPR data grid so you would like to manually enter GPS positions reference points to provide better positioning of the grid.

Step 1- Global Position Units

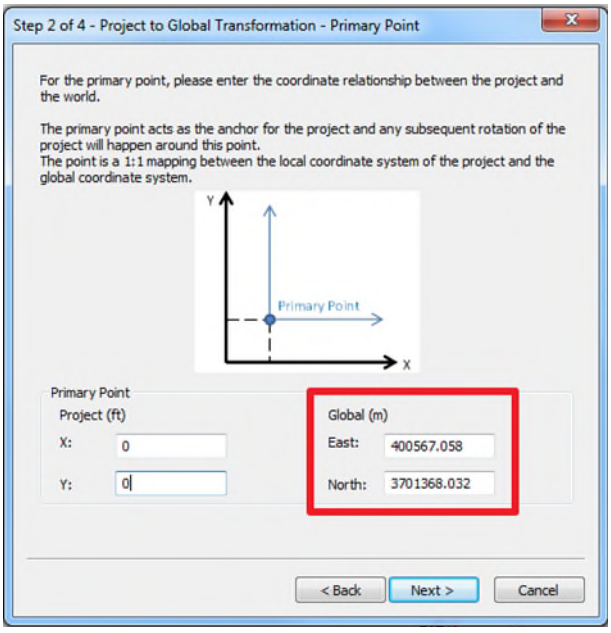


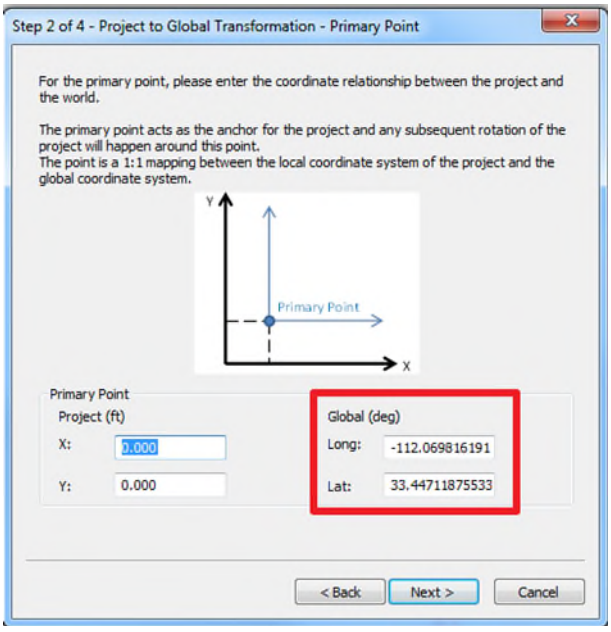
Global Position Units are defined as Latitude-Longitude or UTM (Universal Transverse Mercator).

1. Select **Latitude-Longitude** or **UTM**. UTM is the default.
2. If UTM is selected, update the **Zone Number** field.
3. If UTM is selected, in the **Hemisphere** drop-down list, click **Northern** or **Southern**.
4. Select **Next**.

Step 2 – Project to Global Transformation – Primary Point

Define a primary X, Y position in the Project coordinate system with a known global position in UTM or Latitude-Longitude.





1. In the Primary Point fields, enter the project X, Y coordinates for the point where the global position is known.

   The first time you select this option, the Project X, Y position defaults to the center of all the GPR grid data; this could be the center of one grid or several grids. If the user manually defines the project X, Y position, the wizard remembers these values the next time the Wizard is run. Any X, Y point in the project coordinate system can be entered; X=0, Y=0 is popular.

2. In the **Global East** or **Long** field enter the **Easting** or **Longitude** Global coordinates.

   In the **Global North** or **Lat** field enter the **Northing** or **Latitude** Global coordinates.

UTM Northing and Easting values are always entered in meters and can be positive or negative.

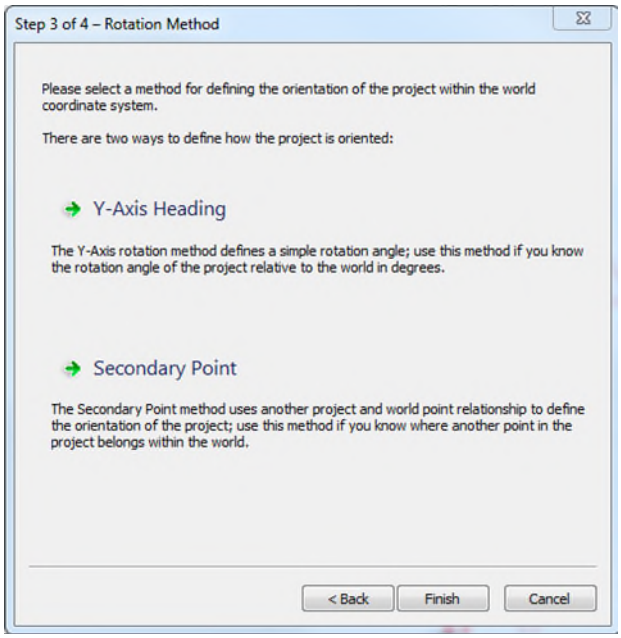
For example, the UTM values above position the X=0, Y=0 project coordinate point at Easting = 400567.058 meters and Northing = 3701368.032 in Zone 12 in the Northern hemisphere.

Latitude and Longitude values are always entered in decimal degrees. Latitudes north of the Equator are positive (+) values and south are negative (-) values. Longitudes east of the Prime Meridian (Greenwich) are positive (+) and west are negative (-).

Step 3 – Rotation Method

The orientation of the project-to-global coordinate relationship can be set in two ways:

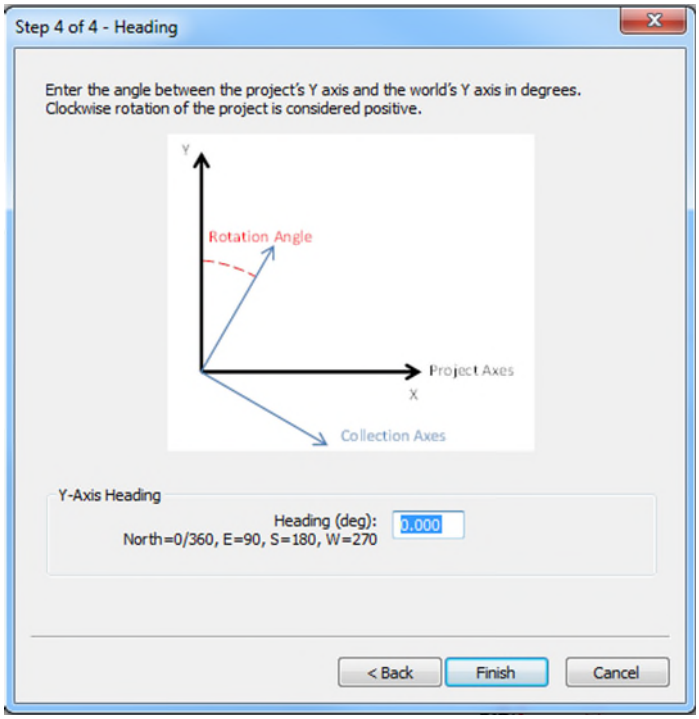
1. Rotating using a Y-Axis heading, or
2. Defining the global position of a second point in the project.



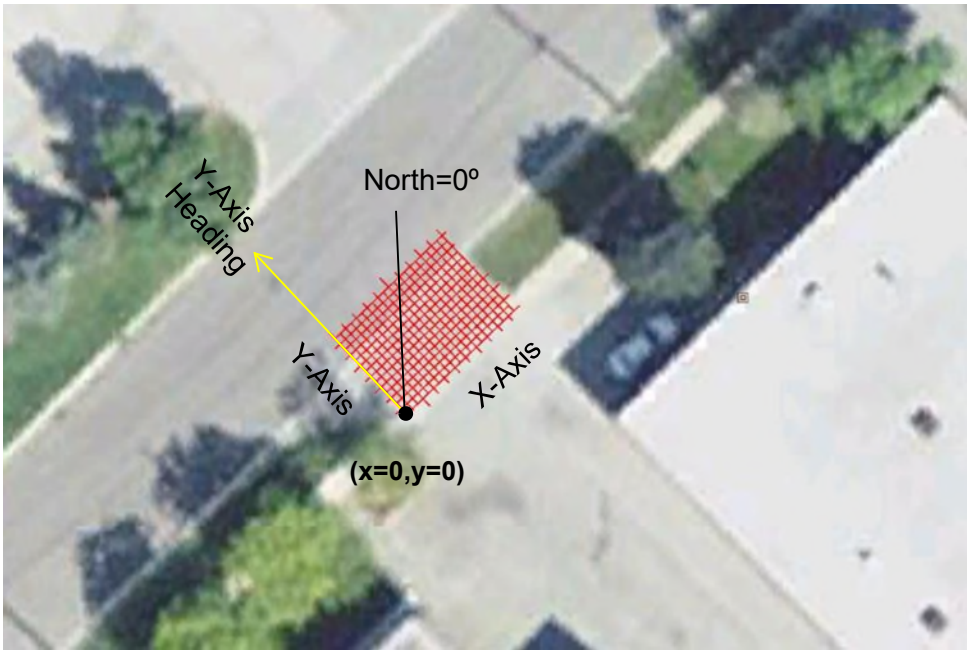
Note: if you are simply moving the Primary Point to a new location and not changing the orientation, select the **Finish** but before selecting either of the rotation methods listed.

Step 4a – Y-Axis Heading

Enter the Y-Axis Heading in degrees from 0 (zero) to 360 degrees. Angles are defined positive in the clockwise direction, for example, East is 90, South is 180, and West is 270 degrees.

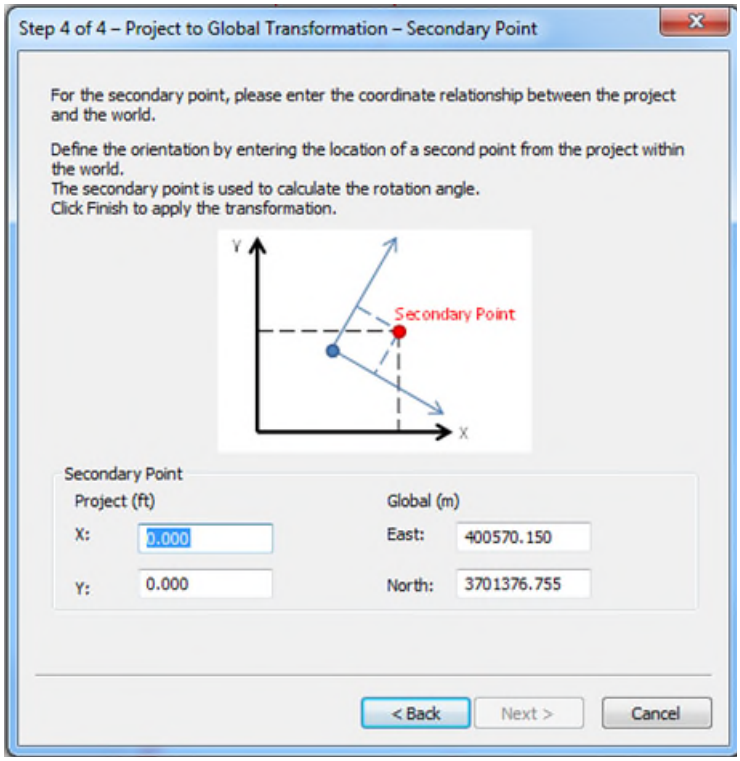


If the project-to-global coordinate relationship is acceptable, click **Finish** to save the new settings and exit the dialog.



Step 4b – Secondary Point

Define a secondary X, Y position in the Project coordinate system with a known global position in UTM or Latitude-Longitude.



1. In the Secondary Point fields, enter the project X, Y coordinates for a second point where the global position is known.

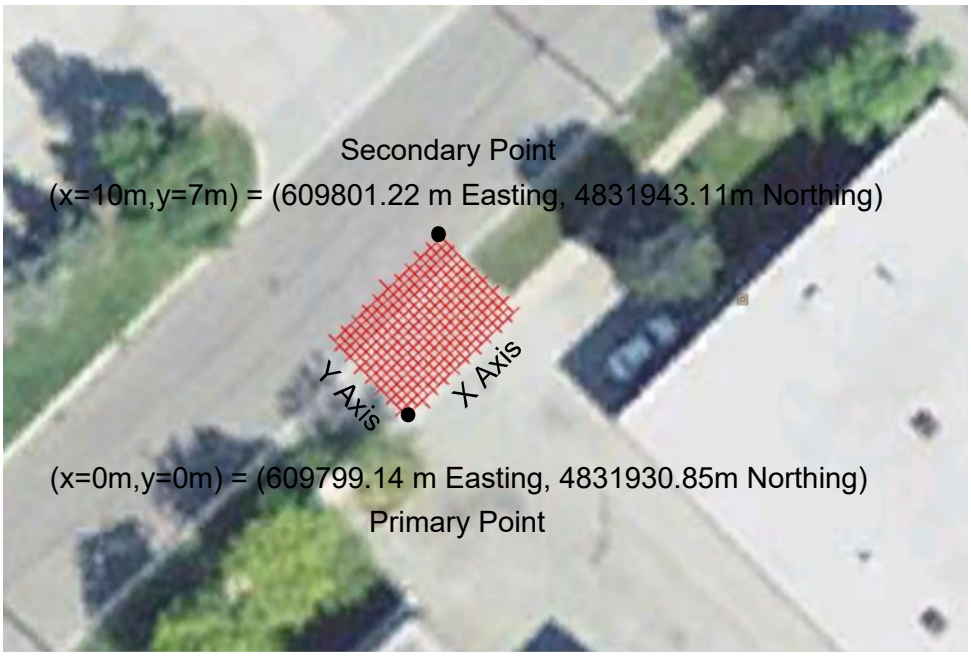
   The first time you select this option, the Project position defaults to X=0, Y=0 but any X, Y point in the project coordinate system can be entered.

2. In the **Global East** or **Long** field enter the **Easting** or **Longitude** Global coordinates.

   In the **Global North** or **Lat** field enter the **Northing** or **Latitude** Global coordinates.

UTM Northing and Easting values are always entered in meters and can be positive or negative.

For example, the UTM values above position the X=0, Y=0 project coordinate point at Easting = 400570.150 meters and Northing = 3701376.755 in Zone 12 in the Northern hemisphere.



Latitude and Longitude values are always entered in decimal degrees. Latitudes north of the Equator are positive (+) values and south are negative (-) values. Longitudes east of the Prime Meridian (Greenwich) are positive (+) and west are negative (-).

Note: The Primary and Secondary points are used to determine the heading only; the GPR data does not expand or contract to fit the data from the project coordinates to the global coordinates. The Primary Point, the heading from Primary to Secondary Point and the local positioning method used for the survey, typically an odometer, are used to position the grid in global coordinates.

The Secondary point method is commonly used when GPS positions using a handheld GPS for two corners of the grid are collected out in the field.

17.6.1.1 Using GPS Positions from Third-Party Sources

Google Earth™ is a third-party source to obtain Global positions for the Primary and/or Secondary Points in the area of your grid. Find the location of the GPR grid in Google Earth™ and then use the mouse cursor to find the GPS position for a particular point near or within the grid. As the mouse cursor is moved around on the image, the global position is listed on bottom edge.

To obtain better accuracy for points, use the **Ruler** option in Google Earth™ to change the mouse cursor from the default hand to crosshairs.

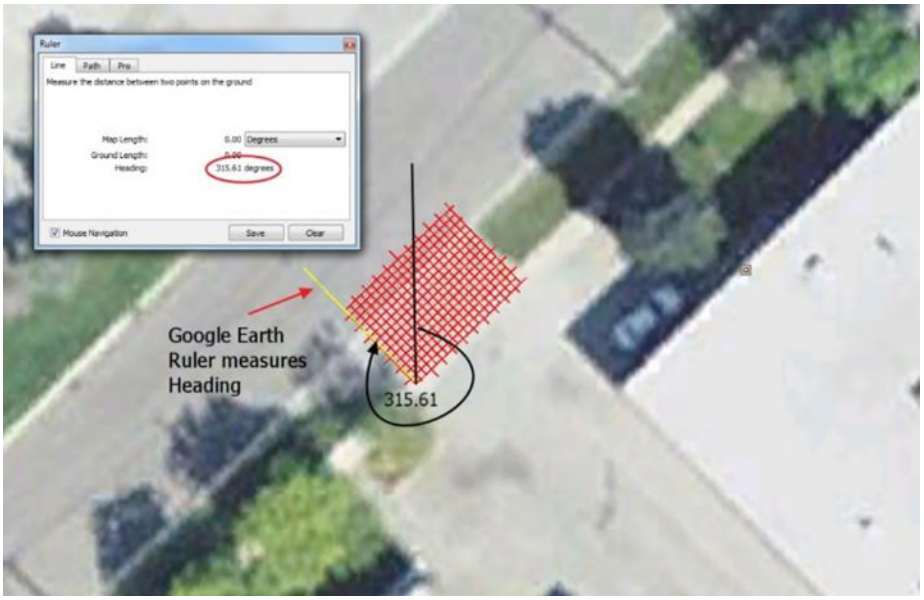


Global positions are entered as UTM or Latitude-Longitude in decimal degrees. Google Earth™ usually displays in degrees-minutes-seconds, but you can change the Google Earth™ display to decimal degrees or UTM under **Tools > Options** > **3D View Tab** > **Show Lat/Long**.

Extracting global positions from Google Earth™ is useful when a GPR grid was collected along a visible feature such as the edge of a sidewalk, building or road.

Note: while this method ensures the data align with features visible in Google Earth™, the absolute accuracy of the GPS coordinates is only as good as the Google Earth™ imagery placement, which can be several meters in some places.

The Google Earth™ Ruler can also be used to help determine the Y Axis Heading. If the Ruler function is set to degrees, it displays the Heading in degrees that the Heading dialog requires.



17.6.2 Auto (GPS-based)

Auto calculates the Project-to-Global coordinate relationship using GPS files in the project file.

The Auto menu option is most commonly used to restore the original Project-to-Global relationship after altering it using the Wizard.

Note: it is not recommended to have data in a project widely separated in space. A warning is displayed if GPS files from different UTM zones are found because the positional accuracy decreases with increasing separation.

Grids

If a grid of GPR lines were collected with GPS, the Project-to-Global coordinate relationship is calculated by finding the "best fit" between the known positions of the grid lines and the GPS positions for those lines. This calculation was automatically done when the project was opened or the grid was imported into EKKO_Project.

The best-fit calculation minimizes the error between the grid lines and GPS but depending on the GPS accuracy and the correlation with the grid lines, a manual adjustment may be necessary in some cases. Use the Wizard option to do this.

GPR Lines

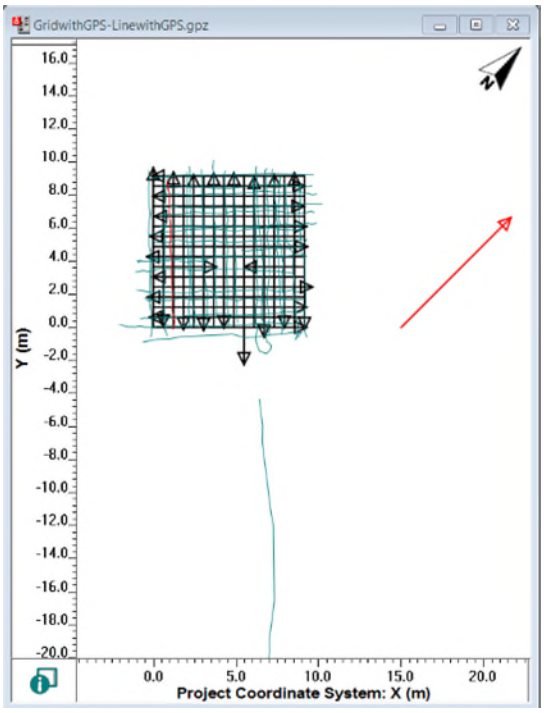
When individual GPR lines in a Lineset are collected with GPS, the raw GPS positions are used to calculate the Project-to-Global coordinate relationship.

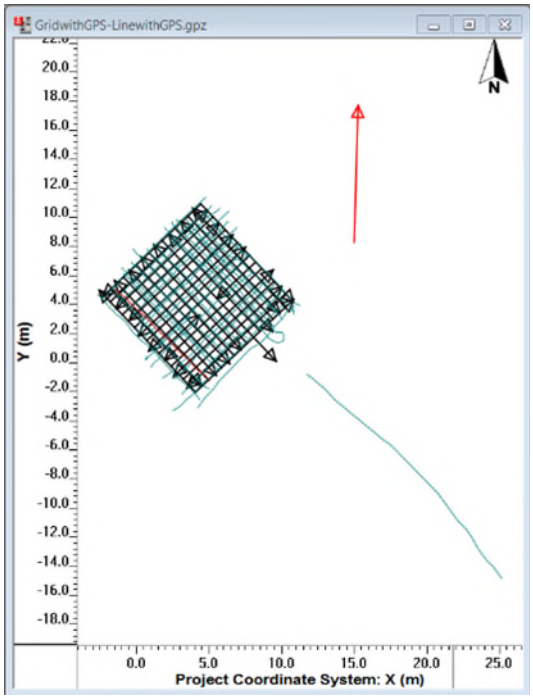
17.6.3 Undefine

Undefine removes any previously defined Project-to-Global coordinate relationship.
When the Project-to-Global relationship is undefined, GPS coordinates are not displayed on the MapView Status Bar and you cannot generate Google Earth™ (KMZ) export slice images to KMZ files for display in Google Earth™ (to learn more, see the **SliceView User's Guide**).

17.6.4 Reset to North

If the Compass Arrow in MapView (see MapView) is not set to North pointing upwards, selecting Reset to North rotates the data items in the MapView window so that North is upwards.

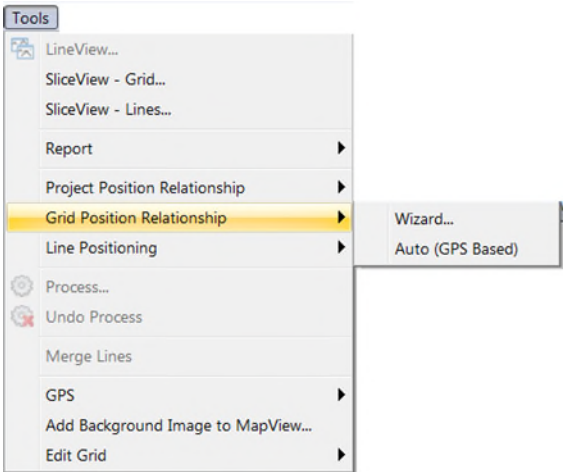




17.7 Grid Position Relationship

The Grid Position Relationship defines the relationship between the project coordinates and grids in the project.

The Project Position Relationship menu has 2 options:



This menu is also available in the Project Explorer Right Click menu.

The **Wizard** takes the user step by step through manually defining the relationship between the project coordinate and the grid coordinate systems.

Note: The position of Linesets, individual GPR lines or grid lines within the project cannot be modified by this Wizard. For individual GPR lines, use the Line Positioning routine (see Line Positioning).

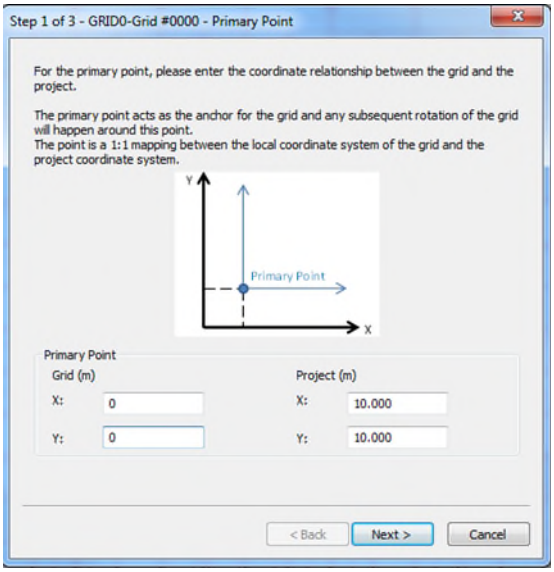
Auto (GPS based) defines the grid-to-project relationship using the GPS files generated during data collection or manually created and attached. It is not accessible if there is no Project-to-Global relationship defined.

17.7.1 Wizard

Use the Wizard option to manually position a grid in the project coordinate system.

Step 1 – Primary Point

Define a primary X, Y position in the grid coordinate system to define in the Project coordinate system.



1. In the Primary Point fields, enter the project **X**, **Y** coordinates for the grid point. Select a grid point with the realization that any possible rotation of the grid is about this point.

   The Project position defaults to the XY position of the center of the grid if a Project-to-Global relationship has been defined by GPS files; otherwise, it defaults to X=0, Y=0. Any X, Y point in the grid coordinate system can be entered.

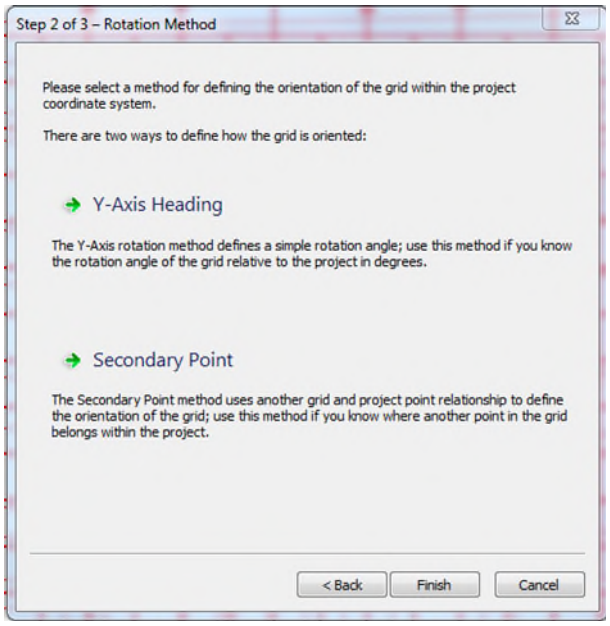
2. In the Project Points field, enter the project X, Y coordinates for the primary point.

For example, the values above position the X=0, Y=0 grid coordinate point at project coordinate X=10, Y=10.

Step 2 – Rotation Method

The orientation of the grid can be set in two ways:

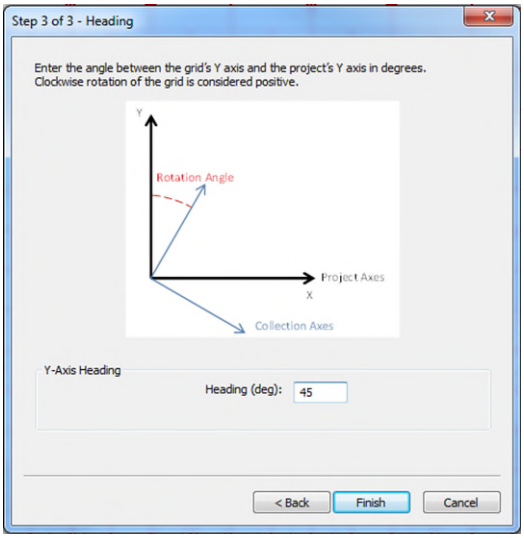
1. Rotating using a Y-Axis heading, or
2. Defining the project position of a second point in the grid.



Note: if you are simply moving the Primary Point to a new location and not changing the orientation, select the **Finish** but before selecting either of the rotation methods listed.

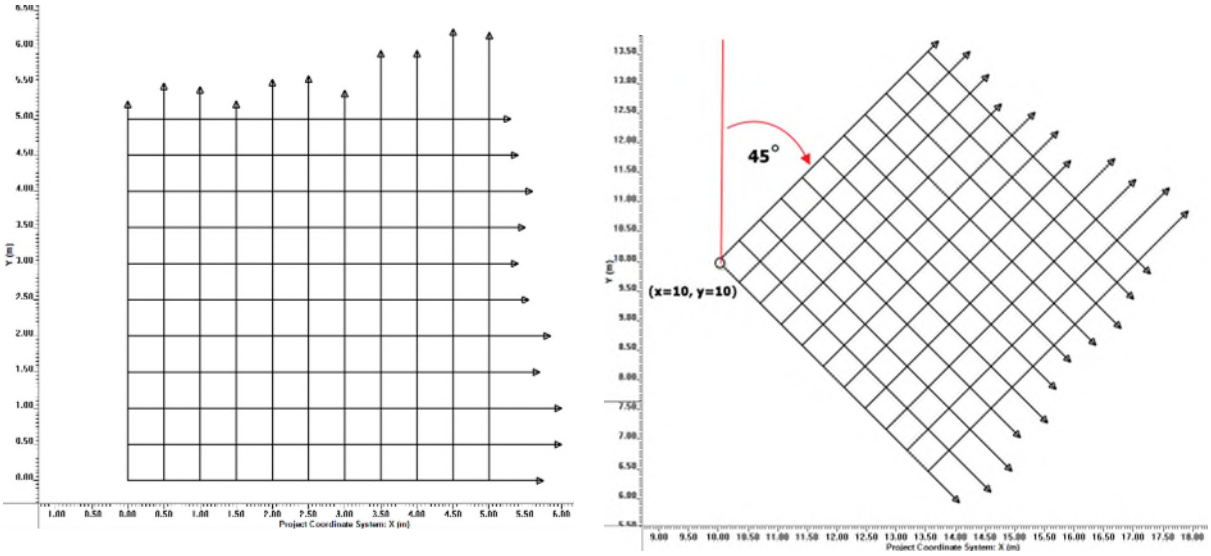
Step 3a – Y-Axis Heading

Enter the Y-Axis Heading in degrees from 0 (zero) to 360 degrees. Angles are defined positive in the clockwise direction, for example, East is 90, South is 180, and West is 270 degrees.



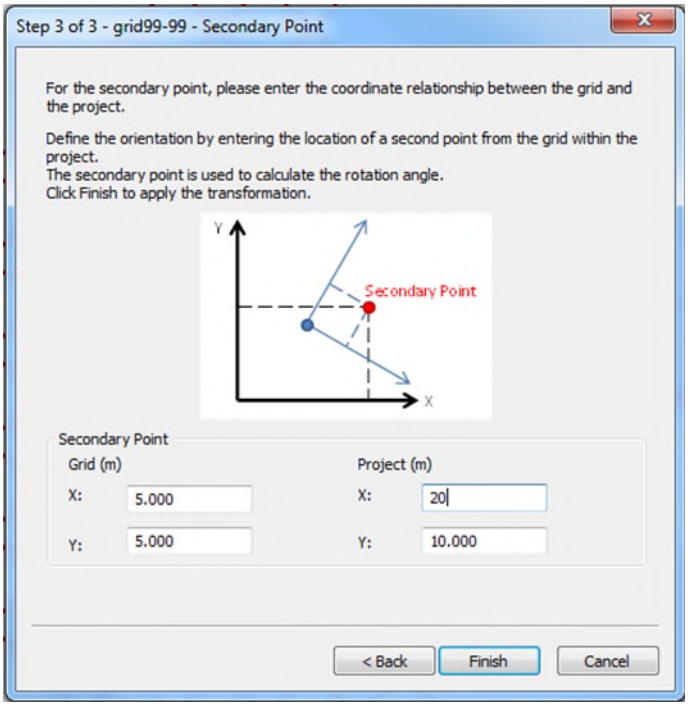
Enter the rotation angle and click **Finish** to save the new settings and exit the dialog.

For example, the two steps above moves the x=0, y=0 point of the grid to project position x=10, y=10 and the grid is rotated 45 degrees clockwise around the x=10, y=10 point.



Step 3b – Secondary Point

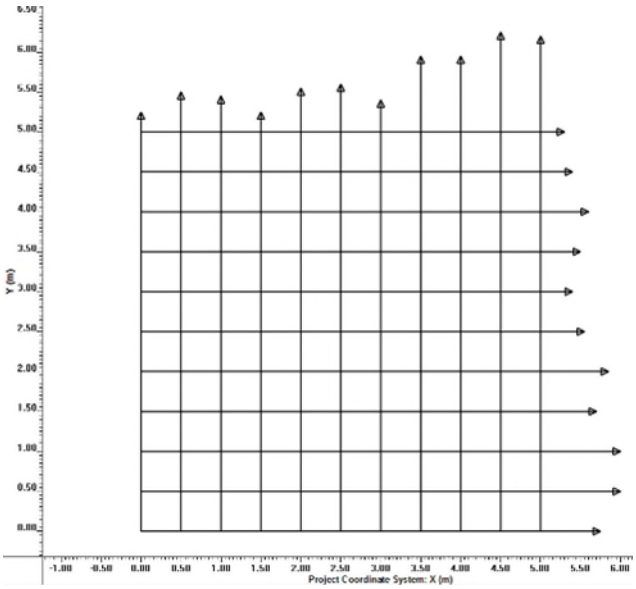
Another way of rotating the grid is by defining the project position of a second point in the grid.

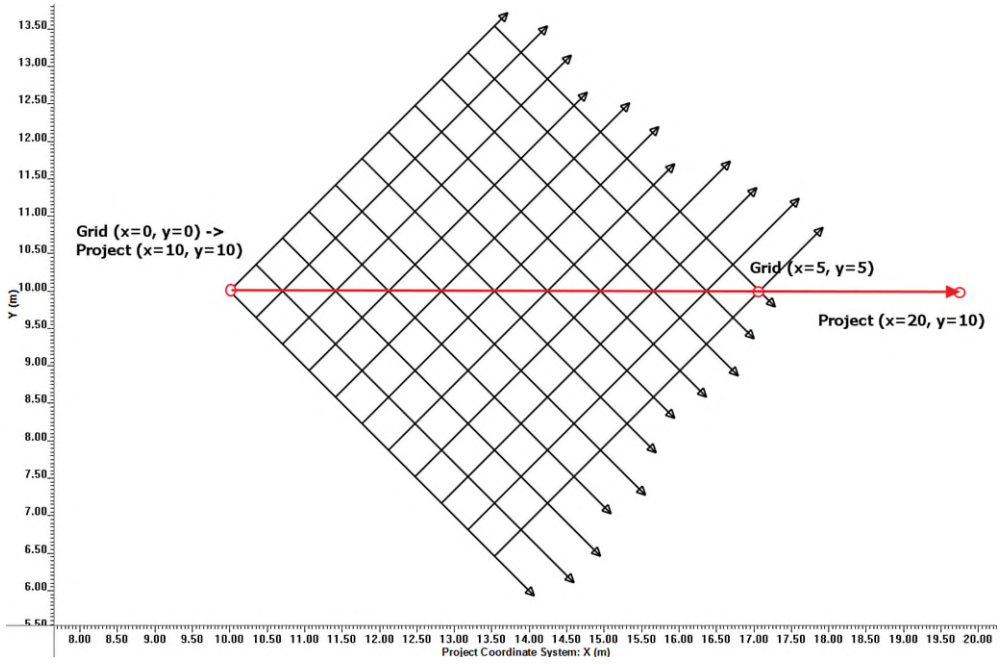


1. In the Secondary Point fields, enter the project **X**, **Y** coordinates for the grid point. Select a point with the realization that the grid will rotate based on the direction from the first point to the second point. Any X, Y point in the grid coordinate system can be entered.
2. In the Project Points field, enter the project X, Y coordinates for the secondary point.

Click **Finish** to save the new settings and exit the dialog.

For example, the two steps above moves the x=0, y=0 point of the grid to project position x=10, y=10 and the grid is rotated based on secondary grid point x=5, y=5 moving in the direction of project position x=20, y=10.

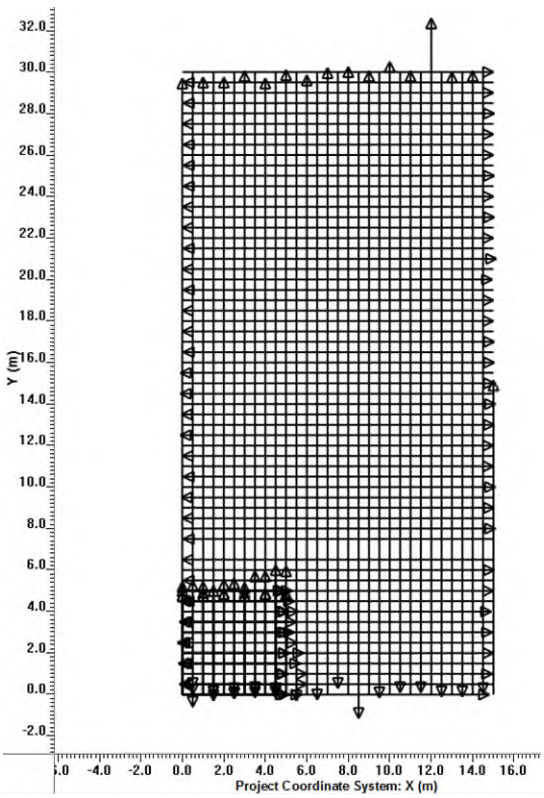


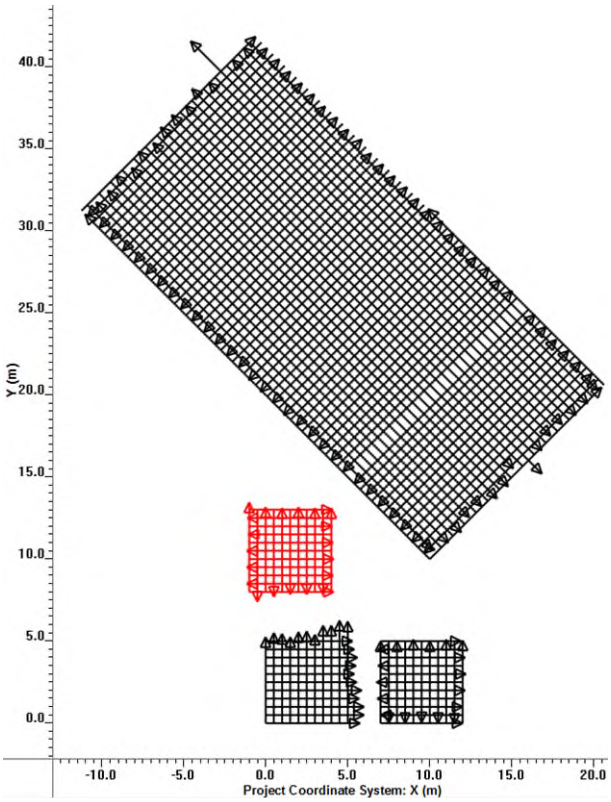


Note: The Primary and Secondary points are used to determine the heading only; the GPR grid does not expand or contract to fit the data from the grid coordinates to the project coordinates. The Primary Point, the heading from Primary to Secondary Point and the local positioning method used for the survey, typically an odometer, are used to position the grid in project coordinates.

Positioning Multiple Grids

The grid positioning methods shown above can be used to place more than one grid into the correct spatial location in the project space.





17.7.2 Auto (GPS-based)

Auto calculates the Grid-to- Project coordinate relationship using GPS files in the project file.

The Auto menu option is most commonly used to restore the original Grid-to- Project relationship after altering it using the Wizard.

Auto is only accessible if a Project-to-Global relationship has been defined by GPS files.

Note: it is not recommended to have data in a project widely separated in space. A warning is displayed if GPS files from different UTM zones are found because the positional accuracy decreases with increasing separation.

Grids

If a grid of GPR lines were collected with GPS, the Grid-to- Project coordinate relationship is calculated by finding the “best fit” between the known positions of the grid lines and the GPS positions for those lines. This calculation was automatically done when the project was opened or the grid was imported into EKKO_Project.

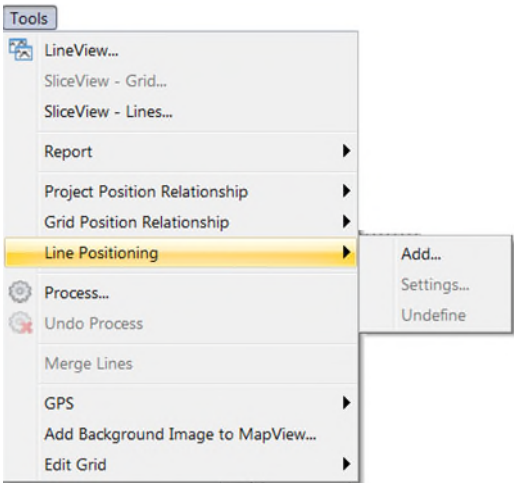
The best-fit calculation minimizes the error between the grid lines and GPS but depending on the GPS accuracy and the correlation with the grid lines, a manual adjustment may be necessary in some cases. Use the Grid Position Relationship Wizard option to do this.

17.8 Line Positioning

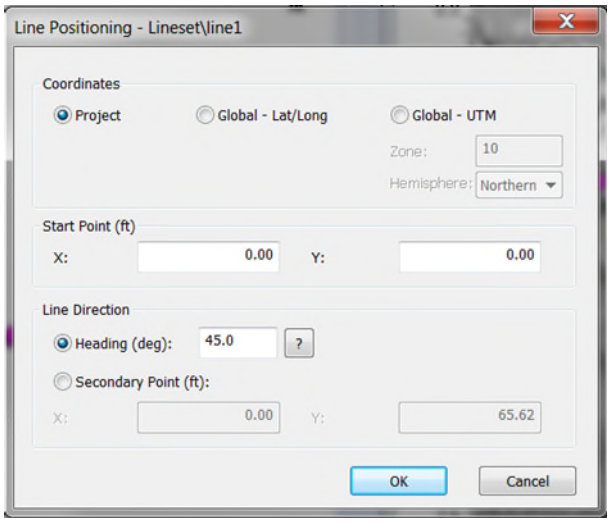
Line Positioning defines the relationship between the project XY, Latitude/Longitude or UTM coordinates and a GPR line in the project.

This menu is also available in the Project Explorer Right Click menu under **Position Relationship**.

The Line Positioning menu has 3 options:



Add opens a dialog to enter the position and direction of the selected GPR line. The user can select to position the GPR line using project (XY), Latitude/Longitude or UTM coordinates.



The **Settings** option is available for a GPR line that has previously had Line Positioning added to it and allows the position to be modified.

The **Undefine** option is available for GPR lines that have had Line Positioning added to them.

Using GPS Positions from Third-Party Sources

Google Earth™ is a third-party source to obtain Global positions for the Primary and/or Secondary Points for GPR lines. See Using GPS Positions from Third-Party Sources for more information about Google Earth™ positions for Line Positioning.

17.9 Process

Requires the optional Processing module.

Use the optional Processing module to edit and process GPR lines using various functions including repositioning, temporal and spatial filters, and migration.

For more details, see the Processing module.

17.10 Undo Process

Requires the optional Processing module.

Undo Process resets processed GPR lines to their original state before processing was applied to them. For more details, see the Processing module.

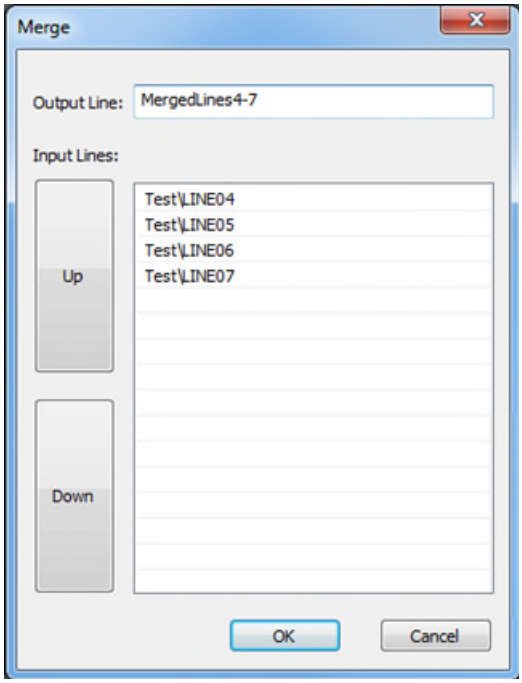
17.11 Merge Lines

Sometimes during data acquisition, a long, continuous GPR survey line is broken up into two or more pieces and saved as separate lines. Merge Lines is used to combine the data from two or more GPR lines into a single, separate line.

In Project Explorer, check the GPR lines to be merged and then select **Tools > Merge Lines**.

A dialog allows the merge order of the lines to be changed by selecting the line name and pressing the Up or Down buttons to move the line in the list.

The name of the merged line defaults but can be edited.



Press OK to create the new merged line. If all the lines came from the same folder, the new, merged line is saved to that folder. If the lines came from different folders, the new, merged line is saved in a new lineset folder.

If the merged line name conflicts with a line name already in the project, the new line is automatically appended with (2), (3) etc.

Some of the restrictions/features of Merge Lines are:

1. Lines cannot be merged together if any of the following survey parameters differ:
    a. Survey Type
    b. Frequency
    c. Time Sampling Interval
    d. Step Size
    e. Antenna Separation
2. If the lines differ in Time Window length the merges the lines using the longest time window, padding data onto the bottom of lines with shorter time windows so no data is ever lost.
3. If lines have a different First Break point number the largest first break point number from all the lines is used and other lines are padded at the top so that no data is lost during the merge operation.
4. Traces are not shifted for differences in the First Break values between lines. It is best to run repick the First Break after merging the lines together so the first break is consistent.
5. The Start Position of the new merged line is the same as the Start Position of the first line in the merge list.
6. The number of Stacks of the new merged line is the same as the number of Stacks of the first line in the merge list.
7. Lines with interpretations can be merged.

A list of lines used to create a merged line can be seen by selecting the line in the **Project Explorer**, and then selecting the **Acquisition tab** and expanding **Additional Info**.

17.12 Vertical Merge Lines (Beta)

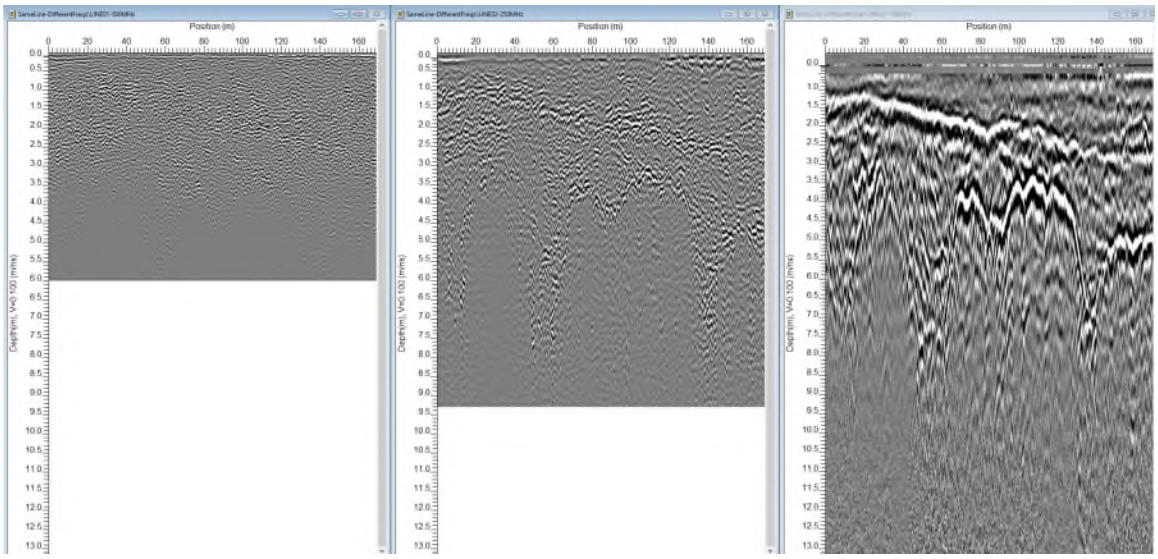
Vertical Merge is used to merge GPR lines of different frequencies, collected along the same path, together into one merged line. The highest frequency data is at the top of the GPR line, and the lowest frequency is at the bottom of the GPR line.

1) In Project Explorer, check two or more GPR lines collected with different frequencies, along the same path.

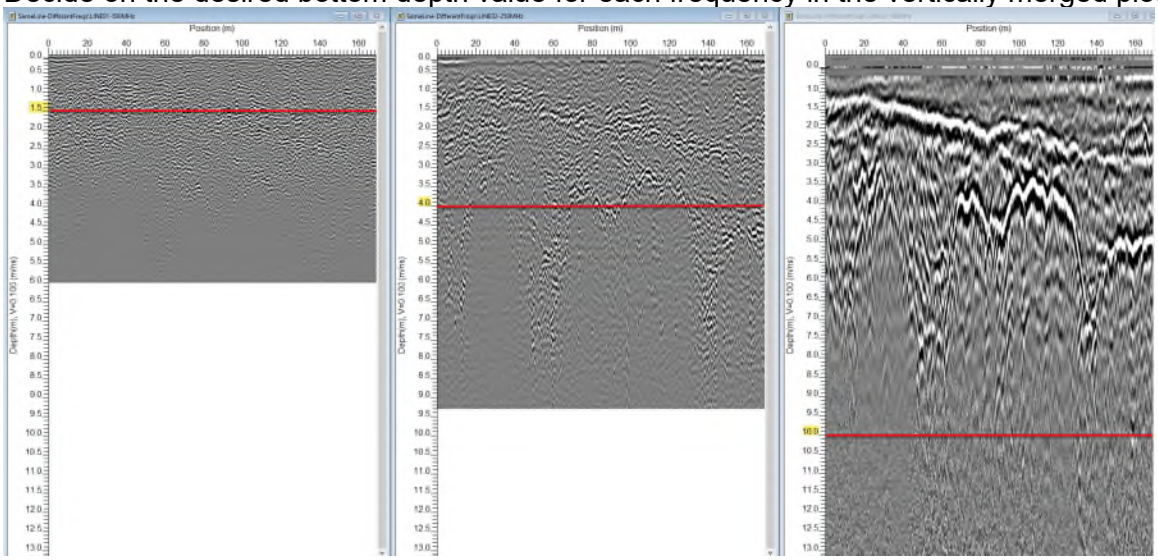
2) Open the lines in LineView and determine the best overall velocity to use for all the lines.

3) In LineView, tile the lines vertically, and arrange the lines with the highest frequency on the left and the lowest frequency on the right.

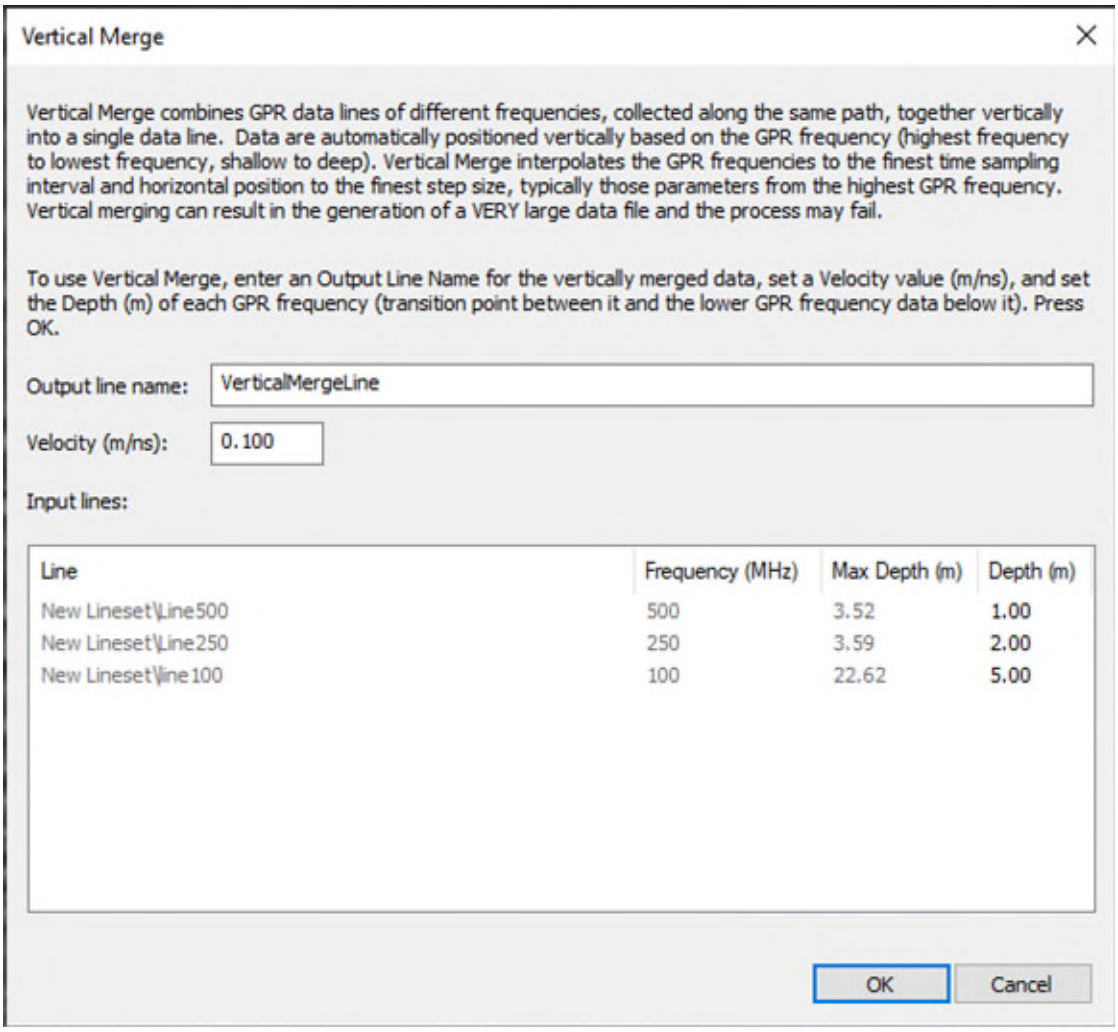
4) Click on the lowest frequency line on the right to give it the focus and then select **View > Link View Position and Time/Depth Ranges**. This plots all the lines with the same vertical (depth) axis.



5) Decide on the desired bottom depth value for each frequency in the vertically merged plot.



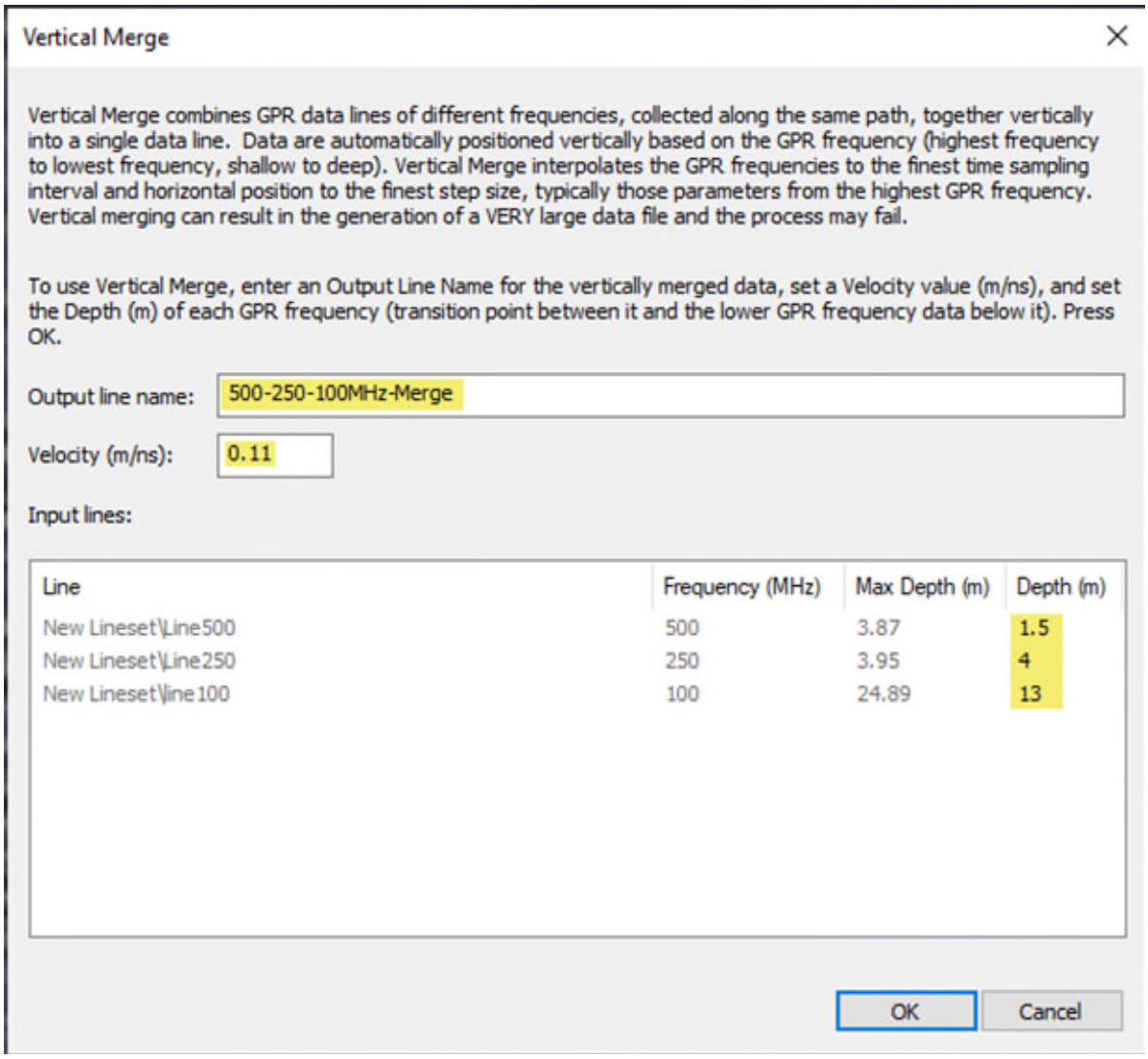
6) Exit LineView and with the data lines still checked in Project Explorer, click **Tools > Vertical Merge** Lines:



7) If desired, rename the **Output line name** for the vertically merged line.

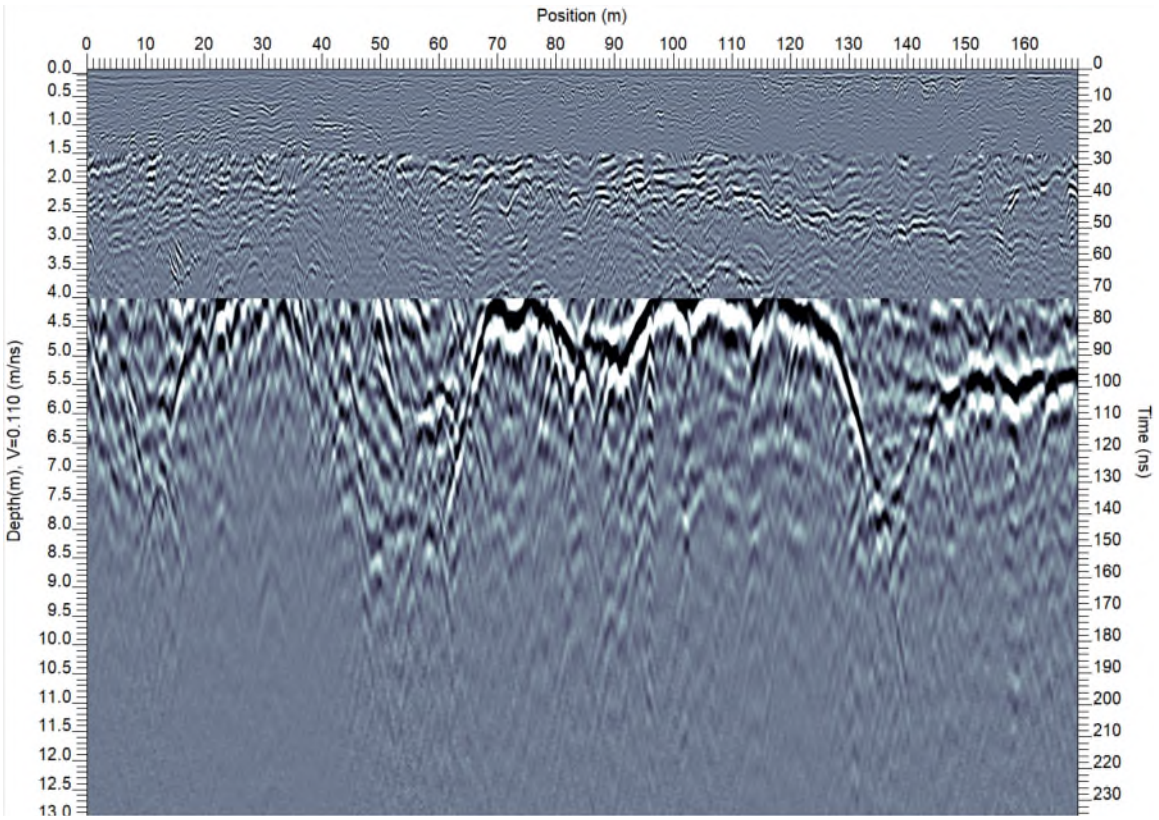
8) Enter the desired **Velocity** value in the velocity field.

9) Enter each of the transition depths in the **Depth** column. The Depth field indicates the depth at which that frequency of data will end in the vertically merged line. These depths were determined in Step 5 above.



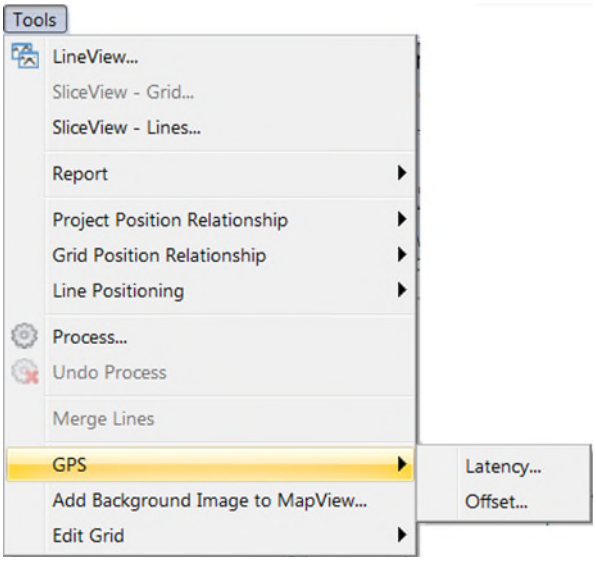
10) In the example above, the vertically merged file will include 500 MHz data from 0-1.5 meters, 250MHz data from 1.00-2.00 meters, and 100MHz data from 2.00-5.00 meters.

11) After pressing OK, the vertically merged line appears in Project Explorer and can be plotted in Line Preview and LineView.



17.13 GPS

The GPS menu has 3 options:



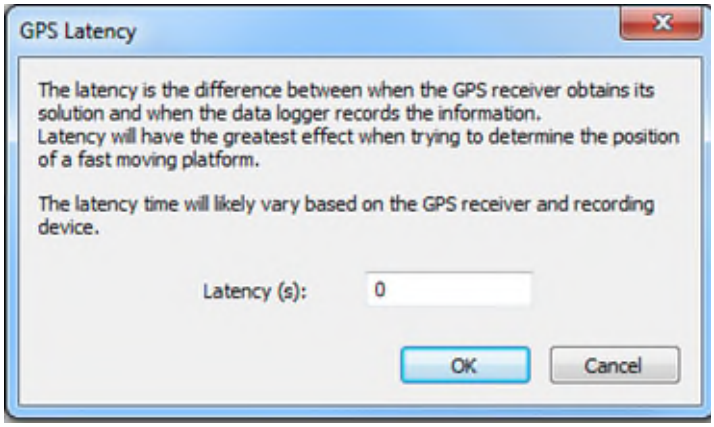
The Survey Line Offset and Latency time are used to determine which trace of the GPR line correlates to a given GPS position.

17.13.1 GPS Latency

The GPS latency time is the time difference between when the GPS receiver obtains its position and when it logged by the DVL. If GPS latency time is not corrected for, the GPS position of targets and features of interest in the GPR line is less accurate.

GPS latency is not a large problem when GPR data are collected on slow-moving platforms such as the SmartCart or SmartTow; it has the largest effect when trying to determine the true position of a fast-moving platform such as the SmartChariot.

For example, at 25 kph, you are moving 6.94m per second. If the GPS has 1.00 second latency, your data position would be off by 6.94m. Further, if you also collect data in opposite direction (i.e. north and south adjacent lanes) the positional offset on a linear target such as a buried utility that spans both lanes would be off by 6.94 x 2 = almost 14m.

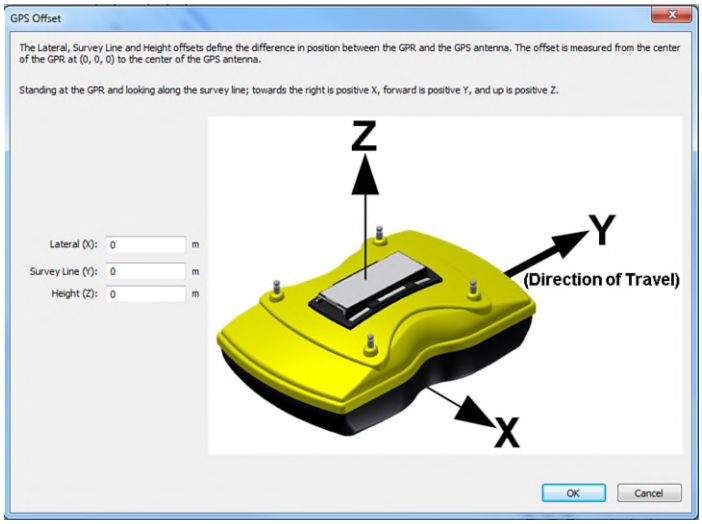


The latency time will vary by GPS, and data logger hardware/software and can be calculated and input in this dialog.

See Appendix C: GPS Latency Procedure for calculating the GPS latency time for your system.

17.13.2 GPS Offset

Offset defines the X, Y and Z offset distances between the center of the GPR system (or antennas, if using a low frequency) and the GPS. These distances are necessary to correct the position of the GPS if it is offset from the GPR.



This option displays a diagram that defines the co-ordinate system for the GPS X, Y and Z offset values.

Lateral (X)

X (or Lateral) is the distance, left or right of the survey line direction, from the GPR to the GPS Antenna. Looking in the survey line direction, the distance is positive if the GPS receiver is to the right of the GPR and negative if it is to the left of the GPR.

Survey Line (Y)

Y (or Survey Line) is the distance from the GPR to the GPS receiver in the survey line direction. The distance is positive if the GPS receiver is ahead of the GPR and negative if it is behind the GPR.

Height (Z)

Z (or Height) is the height of the GPS receiver above the GPR.

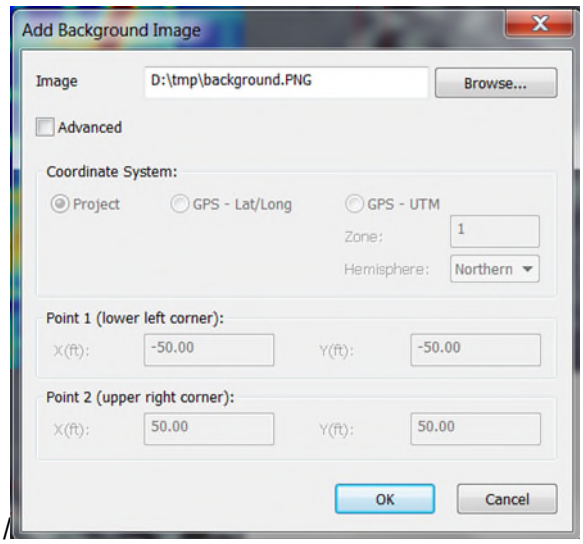
Example

When a GPR system collects data using a SmartChariot, the GPS is offset +0.50 meters in the Survey Line (Y) direction and +0.50 meters in height (Z).

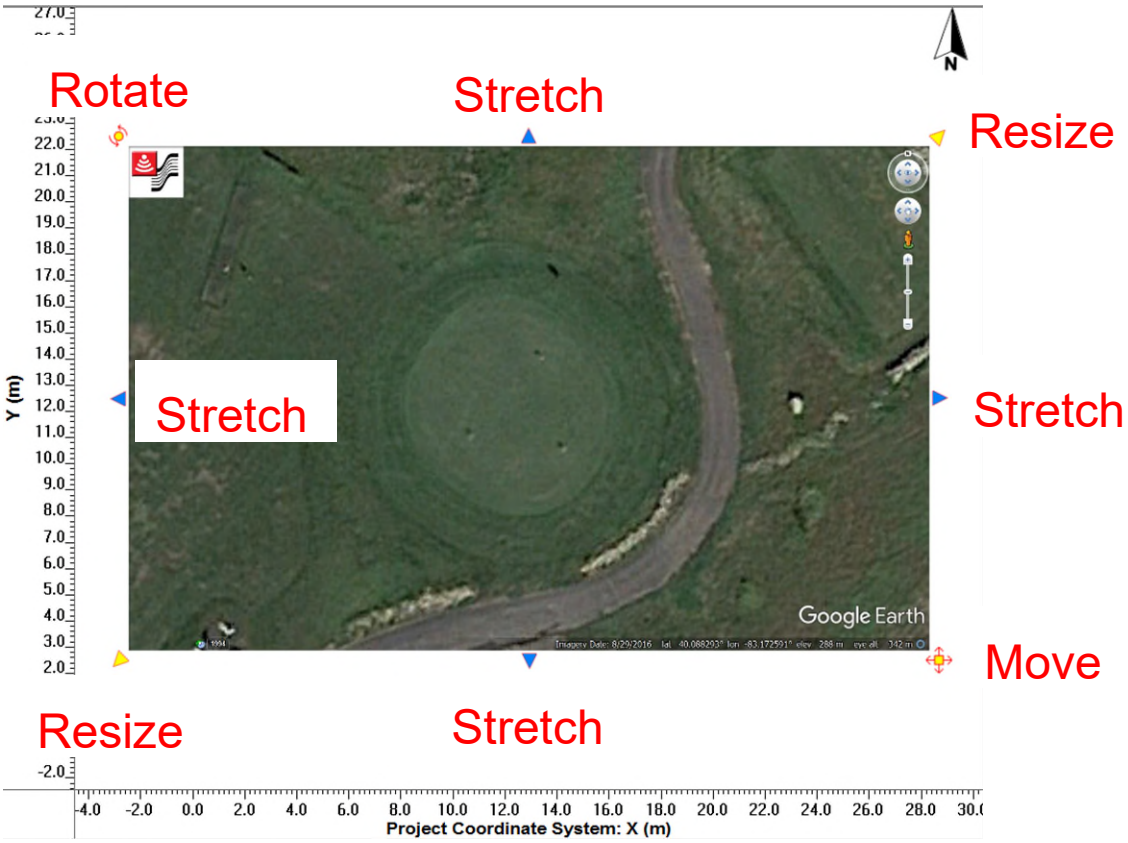


17.14 Add Background Images to MapView

To add a background image to MapView, select **Tools > Add background image to MapView**. The dialog below appears.

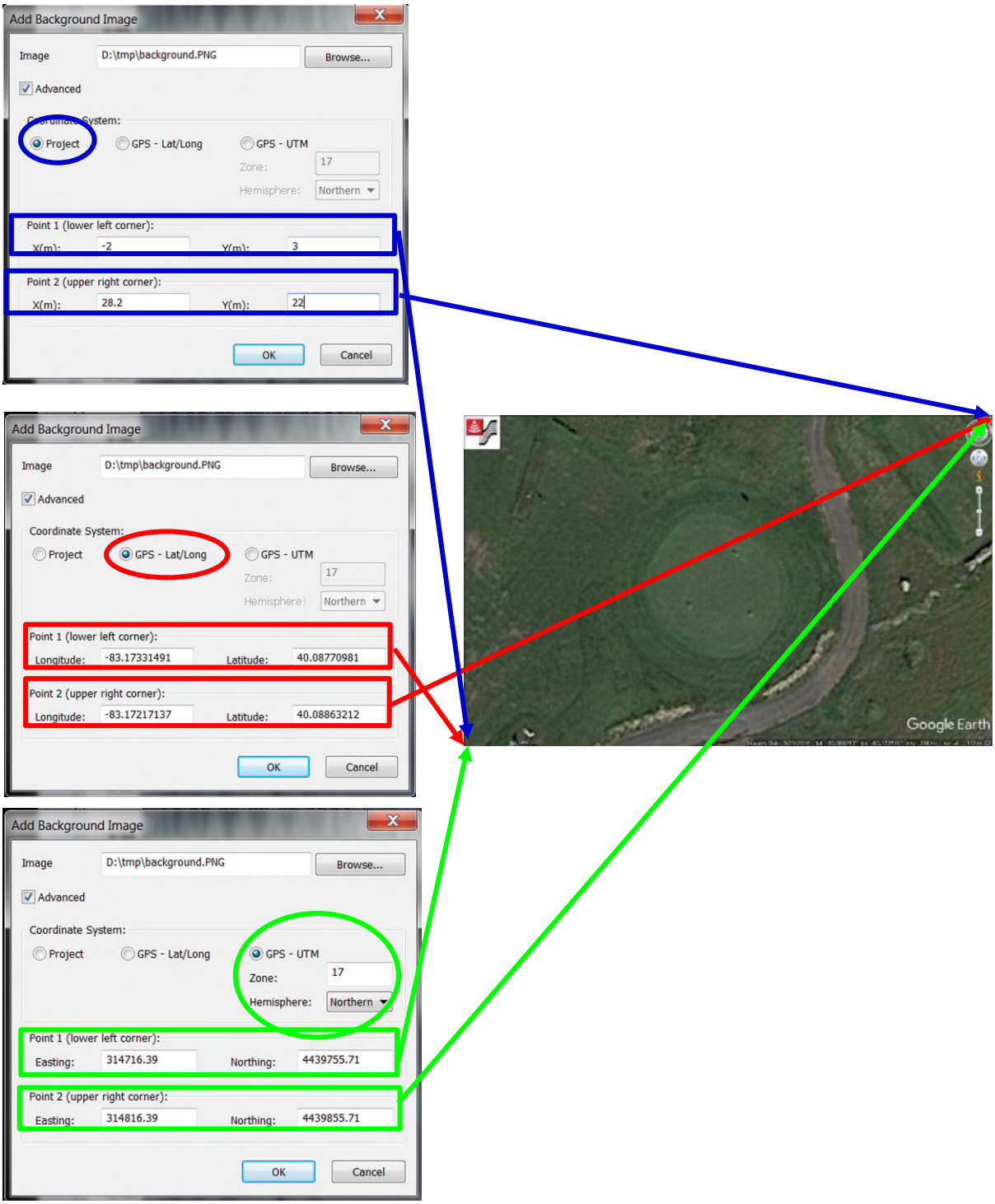


The simplest way to add a background image to MapView is to navigate to and select the image and press OK. The image appears in MapView with a handle in the top left corner to rotate it, a handle on the bottom right corner to move it, handles in the bottom left and top right corners to resize it and handles along the four sides to stretch it in any direction.



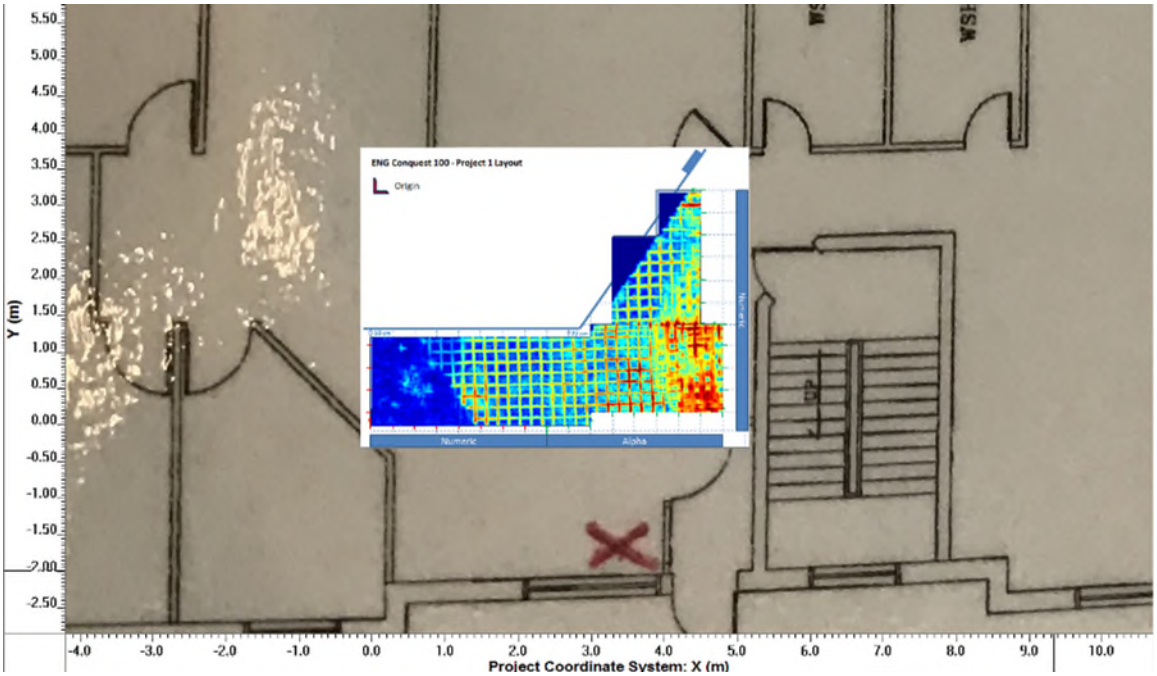
There are also more advanced ways to add the background image. Check the **Advanced** checkbox to add the image using Project, Latitude/Longitude or UTM coordinates.

After selecting the type of coordinates (Project, Latitude/Longitude or UTM), input the values for the lower left and upper right corners of the image:



Note that more than one background image can be added. This allows images to be stacked on top of one another or spread out to different areas of MapView. Use the checkboxes in the Layer View window to select which images to display in MapView.

When multiple images are displayed, the images are ordered alphabetically with the last image plotted on top. In other words, if an image called “zoo” plots on top of an image called “apple”. Use the Layer View > Background Image right-click menu (Layer View) to edit the image names to plot them in a particular order.



If the image has a percentage of transparency, images underneath it will be partially visible.

17.15 MapView Interpretations

See MapView Interpretations.

18 Window Menu

To open the Window menu drop-down list, click **Window**:

18.1 Open Line Preview

If the Line Preview window was closed, it can be opened by selecting **Window > Open Line Preview**.

18.2 Open MapView

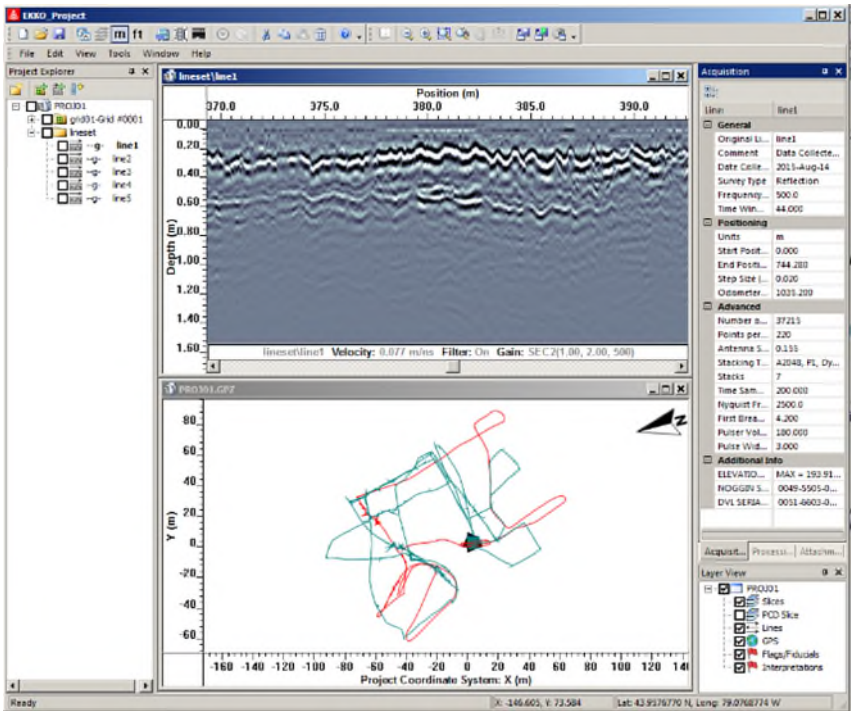
If the MapView window was closed, it can be opened by selecting **Window > Open MapView**.

18.3 3D Preview

If the 3D Preview window was closed, select a grid in Project Explorer and then select **Window > Open 3D Preview**.

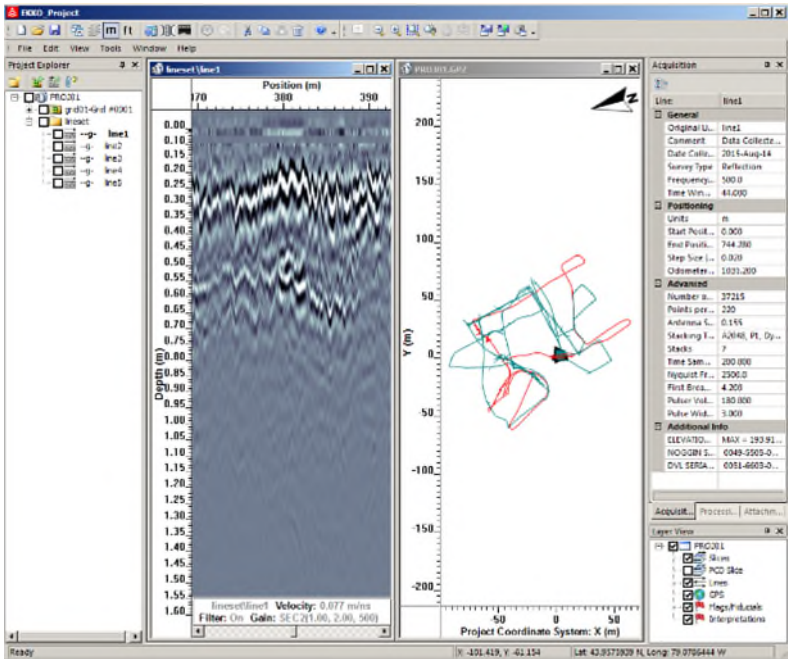
18.4 Tile Horizontally

Selecting **Window > Tile Horizontally** will arrange the Line Preview and MapView windows (and the 3D Preview window, if displaying Conquest grid data) so they are tiled horizontally in the space between the other windows open on the screen.



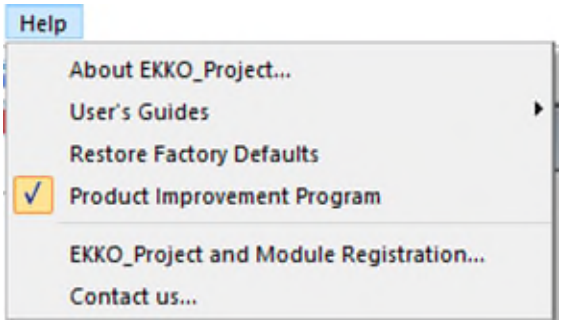
18.5 Tile Vertically

Selecting **Window > Tile Vertically** will arrange the Line Preview and MapView windows (and the 3D Preview window, if displaying Conquest grid data) so they are tiled horizontally in the space between the other windows open on the screen.



19 Help Menu

To open the Help menu drop-down list, click **Help**:

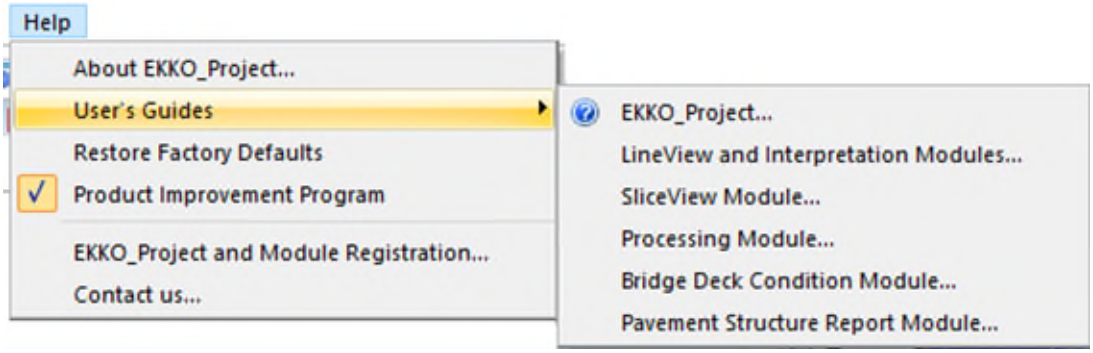


19.1 About EKKO_Project

This option displays the EKKO_Project version number, a description, and ownership information.

19.2 User's Guides

Select this option to open the PDF document for EKKO_Project or one of the EKKO_Project Modules.



Adobe Acrobat Reader must be installed on your PC to open this document. If not, you can download it from the Adobe website.

All user's guides can be opened, even if the optional module was not purchased.

19.3 Restore Factory Defaults

Click **Restore Factory Defaults** to reset all the windows, dockable windows, menus, and toolbars to their default values.

> **Note**: Restoring automatically closes EKKO_Project, so you must save your project first, and then re-open EP for the restoration to take effect

19.4 Product Improvement Program

You can help us improve EKKO_Project by participating in our Product Improvement Program. To help us understand how our customers use our products, we collect statistics on which features are used. Any information collected is completely anonymous - no information that could identify the user is collected.

To help our development team improve our software programs, we collect usage data, and that data is stored within our private and secure databases.

The data we collect provides statistics on which features are used (or not used). This helps us better understand the needs of our users so we can build better applications.

The information is completely anonymous – it is not traceable to any individual, project or organization, and does not contain any personal information. Participation is voluntary, and you can enable or disable this at any time under the Help menu in EKKO_Project.

19.5 EKKO_Project and Module Registration

The Product Registration dialog allows you to enter an EKKO_Project Serial Number, request a trial of EKKO_Project or Return a Serial Number to upgrade EKKO_Project or transfer a License to a different computer.

For more details see the **System Documentation and Software Installation** document.

19.6 Contact Us

Displays contact information for Sensors & Software including mailing address, email addresses, website, and phone and fax numbers.

20 Window Operations

EKKO_Project can display multiple panes on the main screen, but only one pane can be active and accept changes at one time.

20.1 Resizing the EKKO_Project Window

If an EKKO_Project pane is not maximized (full screen), you can resize it by clicking and dragging any frame or corner to the size you require.

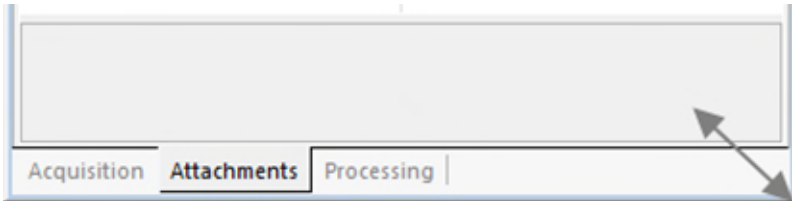


***Figure 20**: Click and drag a Project Explorer or Properties window to change its dimensions.*

> **Note**: As the size of the window changes, the information in the window will distort to fit the window size. If the window is made too small, the pane may close completely; click and drag the frame to re-open it.

20.2 Undocking and Docking Windows

1. To undock the Project Explorer and Properties panes from the edge of the screen, click and drag the window's title banner.
2. Drop the window at any location, or dock it on any edge of EKKO_Project.

   Arrow icons () appear on the screen to indicate where (top, bottom, left, or right edge) the pane can be docked.
3. Drag the title banner to the icon and drop the window to dock it in the indicated position.

Note: It is a best practice to dock windows.

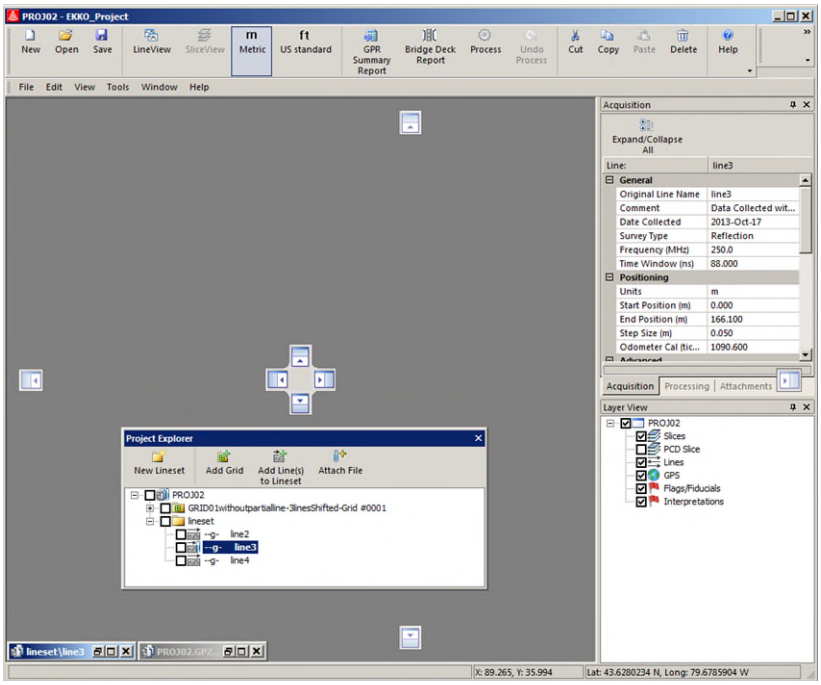


***Figure 21**: Example of moving the Project Explorer. Note the docking arrows.*

20.3 Pinning Windows

To pin a docked Project Explorer or Properties pane to the side of EKKO_Project, in the pane's title bar, click the **Pin** icon ( ).

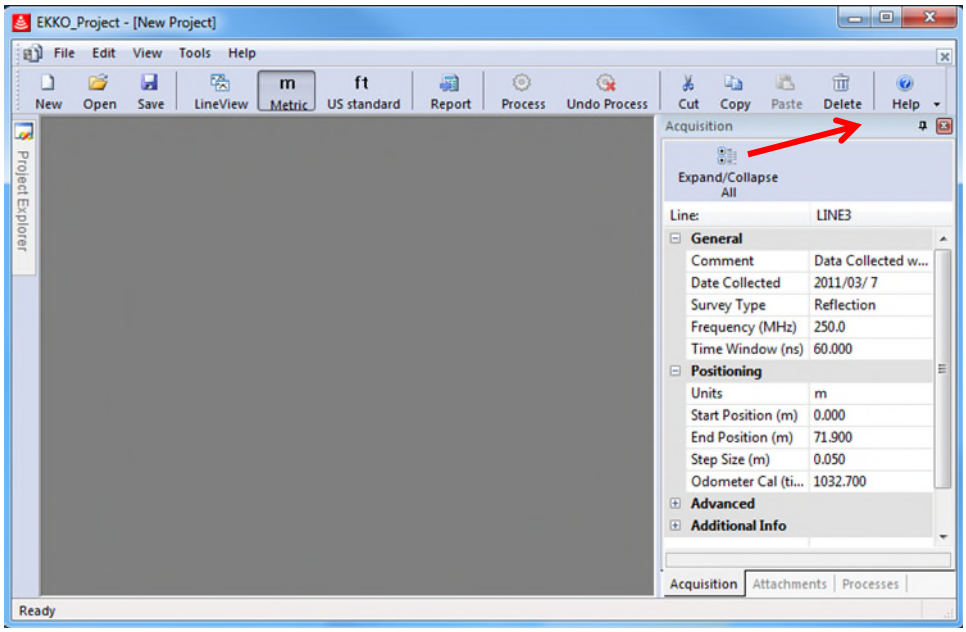


***Figure 22**: Example of pinning a window*

- To expand these panes to their original size, click the pane and then click the pin icon to pin the window back into position.

20.4 Closing a Window

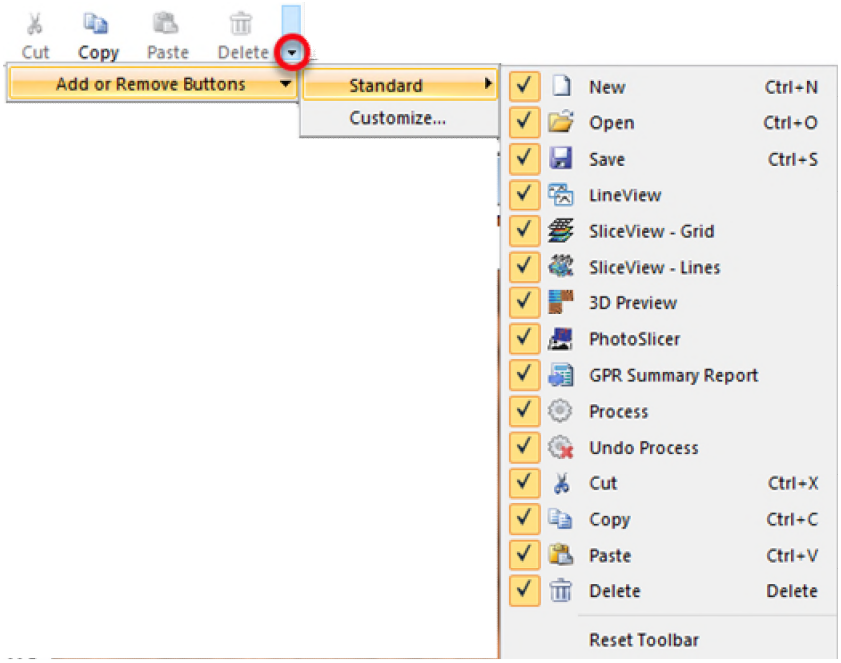
- To close a window, press close ( )
- To reopen a closed window, in the menu bar, click **View** > Toolbars and Docking Windows

20.5 Adding or Removing Buttons from Toolbars

Use the Add and Remove buttons to edit the toolbars.

20.5.1 Standard Toolbar

To manage the buttons that appear in the Standard toolbar, click the drop-down arrow beside the Delete button and click **Add** or **Remove Buttons > Standard**.



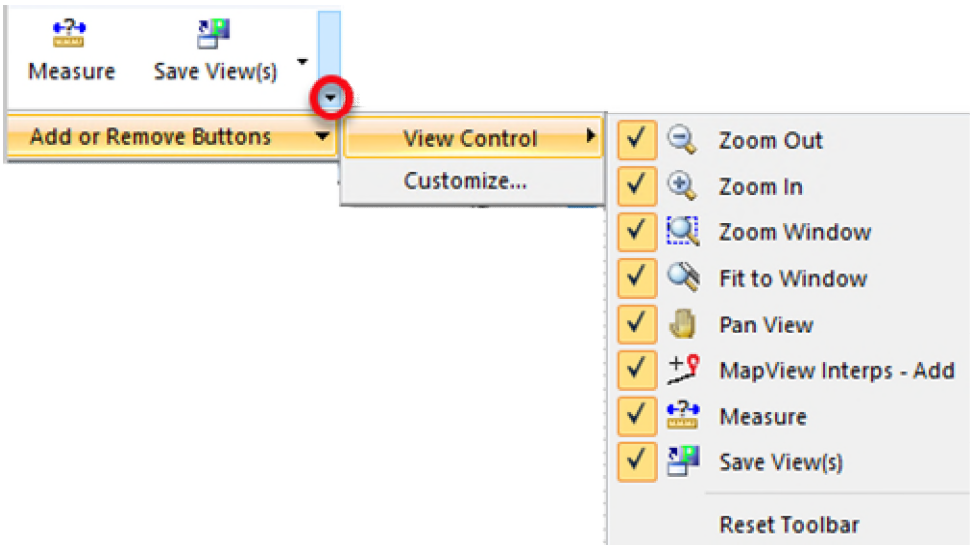
To display the button in the **Standard** toolbar, make sure it is checked.

To restore the Standard toolbar to the factory default settings, click **Reset Toolbar**.

To tailor the Standard toolbar to better suit your need, click **Customize** > **Toolbars** tab.

20.5.2 View Control Toolbar

To manage the buttons that appear in the View Control toolbar, click the drop-down arrow beside the **Save View(s)** button and click **Add or Remove Buttons > View Control**



To display a button on the View Control toolbar, make sure it is checked.

To restore the View Control toolbar to the factory default settings, click **Reset Toolbar**.

To tailor the View Control toolbar to better suit your need, click **Customize** > **Toolbars** tab.

Appendix A File Formats

1. Interpretation Reports

The following information is written to the Interpretation Report:

- Header: lists the Interpretation Names and count of observations for each interpretation
- Drawing Tool
- Interpretation Name
- GPR Line Name
- Position along Line (m or ft.)
- X Position (m or ft.)
- Y Position (if grid data)
- Depth (m or ft.)
- Time (ns)
- Elevation (if available, m or ft.)
- Signal Amplitude (millivolts)
- Velocity (ft/ns or m/ns): Velocity is used to calculate depth and elevation.
- UTM Easting with Zone
- UTM Northing with Zone
- Latitude (degrees and decimal degrees; + = North, - = South)
- Longitude (degrees and decimal degrees; + = East, - = West)
- GPS Elevation of the GPS receiver
- Comments

Name	Description	Count
Annotation1		1
Box1		1
Airwave		1
Pipe1		2
Shallow Metal		1
Horizon1		2
Fiducial		5

Tool	Interpretation	GPR Line	Position(m)	X(m)	Y(m)	Depth(m)	Time(ns)	Elevation(m)	Amplitude(mV)	Velocity(m/ns)	GPS-Easting (17T)	GPS-Northing (17T)	Latitude	Longtitude	GPS-Elevation	Comment
Annotation	Annotation1	PROJECT0\LINE00	26.057	26.057	0	1.679	38.77	111.137	-0.017	0.085	609817.58	4831949.53	43.6324321	-79.6386439	112.82	Air wave from overhead power line
Box	Box1	PROJECT0\LINE00	12.113	12.113	0	0.223	5.19	112.877	16.242	0.085	609807.68	4831939.71	43.6323453	-79.6387686	113.1	
Box	Box1	PROJECT0\LINE00	18.354	18.354	0	0.706	16.04	112.294	0.092	0.085	609812.11	4831944.11	43.6323841	-79.6387128	113	
Point	Airwave	PROJECT0\LINE00	25.607	25.607	0	1.665	38.46	111.219	-0.005	0.085	609817.27	4831949.21	43.6324293	-79.6386479	112.88	
Point	Pipe1	PROJECT0\LINE00	27.407	27.407	0	0.649	14.71	111.951	-2.905	0.085	609818.54	4831950.48	43.6324406	-79.6386318	112.6	
Point	Pipe1	PROJECT0\LINE00	39.214	39.214	0	0.669	15.18	112.231	4.84	0.085	609826.93	4831958.79	43.6325141	-79.6385262	112.9	
Point	Shallow Metal	PROJECT0\LINE00	82.451	82.451	0	0.239	5.51	113.061	4.595	0.085	609857.64	4831989.22	43.6327835	-79.6381394	113.3	
Polyline	Horizon1	PROJECT0\LINE00	23.808	23.808	0	0.522	11.8	112.478	3.638	0.085	609815.99	4831947.95	43.6324181	-79.638664	113	
Polyline	Horizon1	PROJECT0\LINE00	24.427	24.427	0	0.501	11.33	112.499	6.72	0.085	609816.43	4831948.38	43.632422	-79.6386585	113	
Polyline	Horizon1	PROJECT0\LINE00	24.933	24.933	0	0.47	10.62	112.514	6.632	0.085	609816.79	4831948.74	43.6324251	-79.638654	112.98	
Polyline	Horizon1	PROJECT0\LINE00	26.001	26.001	0	0.536	12.11	112.287	2.828	0.085	609817.54	4831949.49	43.6324318	-79.6386444	112.82	
Polyline	Horizon1	PROJECT0\LINE00	26.451	26.451	0	0.495	11.17	112.305	1.306	0.085	609817.86	4831949.81	43.6324346	-79.6386404	112.8	
Fiducial	Fiducial	PROJECT0\LINE00	15.4	15.4	0	0	N/A	N/A	N/A	0.085	609810.01	4831942.03	43.6323657	-79.6387392	113	F1
Fiducial	Fiducial	PROJECT0\LINE00	21.4	21.4	0	0	N/A	N/A	N/A	0.085	609814.28	4831946.25	43.6324031	-79.6386856	113	F2
Fiducial	Fiducial	PROJECT0\LINE00	27.4	27.4	0	0	N/A	N/A	N/A	0.085	609818.54	4831950.47	43.6324405	-79.6386319	112.6	F3
Fiducial	Fiducial	PROJECT0\LINE00	39.25	39.25	0	0	N/A	N/A	N/A	0.085	609826.96	4831958.81	43.6325143	-79.6385259	112.9	F4
Fiducial	Fiducial	PROJECT0\LINE00	82.4	82.4	0	0	N/A	N/A	N/A	0.085	609857.61	4831989.19	43.6327832	-79.6381398	113.3	F5

In a box interpretation, the positions of the upper-left and bottom-right corners are listed.

2. Global Positioning Files

The Global Positioning System (GPS) uses special satellites around the Earth to determine the position of a GPS receiver located at any position on the surface of the Earth. GPS receivers can be purchased from a number of manufacturers.

Sensors & Software GPR systems have a serial port for attaching a GPS receiver to record the position of the GPR unit. This port will accommodate any GPS receiver that has a standard serial port output.

The GPS receiver sends one or more types of data strings to the GPR. These strings, called NMEA-0183 strings, contain positional and other information in specific formats. Each type of string is specified by a 5-character prefix. There are numerous NMEA strings but to integrate the GPS data into the GPR data, the GPS receiver must be sending the GPGGA string. This may require reprogramming the GPS receiver; most systems come with PC-based utility software.

3. GPS

The .GPS file format consists of a line listing the GPR trace number and the position based on the odometer and the step size, followed by one or more NMEA strings. The GPGGA string must be included in this list.
Depending on the version of the embedded data acquisition software, the trace number lines may have every trace, every nth trace or a somewhat random interval between trace numbers.

```
Trace #2 at position 0.050000
$GPGGA,185721.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-35.1,M,,138*68
$GPGSA,A,3,15,05,18,21,26,29,51,02,08,,,,2.3,1.2,1.9*32
$GPVTG,0.0,T,,,0.0,N,0.0,K*2D
Trace #3 at position 0.100000
$GPGGA,185731.00,4337.9926,N,07938.2534,W,2,09,1.2,110.3,M,-35.1,M,,138*6F
$GPGSA,A,3,26,18,05,21,15,29,08,02,51,,,,2.3,1.2,1.9*32
$GPVTG,0.0,T,,,0.0,N,0.0,K*2D
Trace #4 at position 0.150000
$GPGGA,185732.00,4337.9926,N,07938.2534,W,2,09,1.2,110.4,M,-35.1,M,,138*6B
$GPGSA,A,3,21,15,26,29,18,05,51,02,08,,,,2.3,1.2,1.9*32
$GPVTG,0.0,T,,,0.0,N,0.0,K*2D
Trace #5 at position 0.200000
$GPGGA,185733.00,4337.9926,N,07938.2534,W,2,09,1.2,110.4,M,-35.1,M,,138*6A
$GPGSA,A,3,21,51,26,29,15,18,05,02,08,,,,2.3,1.2,1.9*32
$GPVTG,0.0,T,,,0.0,N,0.0,K*2D
Trace #8 at position 0.350000
$GPGGA,185734.00,4337.9926,N,07938.2534,W,2,09,1.2,110.4,M,-35.1,M,1,138*5C
$GPGSA,A,3,21,15,26,29,51,18,05,02,08,,,,2.3,1.2,1.9*32
$GPVTG,0.0,T,,,0.0,N,0.0,K*2D
Trace #12 at position 0.550000
```

4. GP2

The .GP2 file format consists of 5 header lines, then a line that defines the parameters listed on each line for the rest of the file:

Trace number
Number of odometer ticks
GPR line position (based on odometer ticks, odometer calibration value and step size)
Time elapsed in seconds since the start of the data collection
GPS NMEA string in quotes

Any NMEA strings output by the GPS receiver are listed. The GPGGA string is required to be in the list.

```
;GPS@@@
;Ver=1.1.0
;DIP=2009-00152-00
;Date=2012-Jan-09 13:56:16.0
;-----------------------------------------------
traces,odo_tick,pos(m),time_elapsed(s),GPS
1,0,0.000,0.00,"$GPGGA,185713.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,,138*69"
1,0,0.000,0.00,"$GPGSA,A,3,15,21,29,51,26,18,08,02,05,,,,2.3,1.2,1.9*32"
1,0,0.000,0.00,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,1,0.001,0.60,"$GPGGA,185714.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,,138*6E"
1,1,0.001,0.60,"$GPGSA,A,3,15,29,21,26,18,05,08,02,51,,,,2.3,1.2,1.9*32"
1,1,0.001,0.60,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,3,0.003,1.59,"$GPGGA,185715.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,,138*6F"
1,3,0.003,1.59,"$GPGSA,A,3,18,21,05,26,29,15,08,02,51,,,,2.3,1.2,1.9*32"
1,3,0.003,1.59,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,2,0.002,2.58,"$GPGGA,185716.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,1,138*5D"
1,2,0.002,2.58,"$GPGSA,A,3,05,21,15,18,26,29,08,02,51,,,,2.3,1.2,1.9*32"
1,2,0.002,2.58,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,3,0.003,3.63,"$GPGGA,185717.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,2,138*5F"
1,3,0.003,3.63,"$GPGSA,A,3,21,26,15,29,18,05,08,02,51,,,,2.3,1.2,1.9*32"
1,3,0.003,3.63,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,5,0.005,4.61,"$GPGGA,185718.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,3,138*51"
1,5,0.005,4.61,"$GPGSA,A,3,18,21,26,29,05,15,08,02,51,,,,2.3,1.2,1.9*32"
1,5,0.005,4.61,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,6,0.006,5.60,"$GPGGA,185719.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,,138*63"
1,6,0.006,5.60,"$GPGSA,A,3,21,18,15,05,29,26,08,02,51,,,,2.3,1.2,1.9*32"
1,6,0.006,5.60,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,10,0.009,6.59,"$GPGGA,185720.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,,138*69"
1,10,0.009,6.59,"$GPGSA,A,3,18,21,15,05,26,29,08,02,51,,,,2.3,1.2,1.9*32"
1,10,0.009,6.59,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"
1,20,0.019,7.58,"$GPGGA,185721.00,4337.9926,N,07938.2533,W,2,09,1.2,110.2,M,-
35.1,M,,138*68"
```

1,20,0.019,7.58,"$GPGSA,A,3,15,05,18,21,26,29,51,02,08,,,,2.3,1.2,1.9*32"
1,20,0.019,7.58,"$GPVTG,0.0,T,,,0.0,N,0.0,K*2D"

The last characters (before the quote symbol) in the NMEA string is the checksum. The checksum is the xor of each byte between the $ and *. NMEA lines with a failed checksum are assumed to be corrupt and not recorded.

5. DT1 and HD

Sensors & Software GPR data lines consist of two files, a Header file and a Data file. The files have the same name but different extensions. The format details of these files are given below.

Header (.HD) File:

The header file, identified by the file extension .HD, is an ASCII file. An example is shown below. The heading identifies what each piece of information represents.

```
1234

Data Collected with Noggin Plus
12/10/2000
NUMBER OF TRACES   = 220
NUMBER OF PTS/TRC  = 156
TIMEZERO AT POINT  = 31
TOTAL TIME WINDOW  = 62
STARTING POSITION  = 0.0000
FINAL POSITION     = 10.9500
STEP SIZE USED     = 0.0500
POSITION UNITS     = m
NOMINAL FREQUENCY  = 250.00
ANTENNA SEPARATION = 0.3048
PULSER VOLTAGE (V) = 100
NUMBER OF STACKS   = 4
SURVEY MODE        = Reflection
```

This file can be read and/or printed using any word processor.

Data (.DT1) File:

The data file contains as many records as there are traces. Each record in turn consists of a header section and a data section. The header section consists of an array of 25 real*4 numbers and a string of 28 characters which is used for annotation. The 25-element real array contains the following information:

Item #	Description
1	Trace number
2	Position
3	Number of points per trace
4	Topographic data, if available
5	(not used)

6	# bytes/point (always 2 for Rev 3 firmware)
7	Time Window
8	# of stacks
9-10	reserved for GPS X position (double*8 number)
11-12	reserved for GPS Y position (double*8 number)
13-14	reserved for GPS Z position (double*8 number)
15	reserved for receiver x position
16	reserved for receiver y position
17	reserved for receiver z position
18	reserved for transmitter x position
19	reserved for transmitter y position
20	reserved for transmitter z position
21	timezero adjustment where:point(x)= point(x+adjustment)
22	Zero flag: 0 = data okay, 1=zero data
23	(not used)
24	Time of day data collected in seconds past midnight.
25	Comment flag: 1 = comment attached.
26 - 32	Comment

The data section consists of an array of two-byte integers, one value for every data point.

6. SEG-Y

The following describes in detail which variables are loaded in the SEG-Y conversion program.

Reel Identification Header - ASCII Portion

The reel identification header is first loaded with the GPR header file (*.HD).
This file is copied directly into the ASCII portion.

Reel Identification Header - Binary Portion

The following lists the variables used in the binary portion.

Bytes	**Description**
3201-3204	Set to zero.
3205-3208	Set to zero.
3209-3212	Set to zero.
3213-3214	Set to one for REFLECTION data.
Set to # of	offsets for CDP data.
3215-3216	Set to zero.
3217-3218	Sample interval down trace in psec.
3219-3220	Sample interval down trace in psec.
3221-3222	Number of points in trace.

3223-3224	Number of points in trace.
3225-3226	Set to three (fixed point 2 bytes).
3227-3228	CDP fold. Set to zero for REFLECTION data. Set to # offsets for CDP data.
3229-3230	Trace Sorting Code. Set to three for single fold data. Set to one for multifold data.
3231-3250	Not used.
3251-3252	Set to two (no binary gain recovery).
3253-3254	Set to one (no amplitude recovery method).
3255-3256	Set to 1 or 2 depending on units used.
3257-3258	Not used.
3259-3260	Not used.
3261-3600	Not used or NON STANDARD (see the following).

Non-Standard

Bytes	**Description**
3261-3262	Number of traces (I*2)
3401-3410	Job number (CHAR*10)
3411-3480	Title 1 (CHAR*70)
3481-3550	Title 2 (CHAR*70)
3551-3570	Date (CHAR*20)
3571-3572	Number of stacks (I*2)
3573-3574	Pulser voltage (I*2)
3575-3594	Survey mode (CHAR*20)
3595-3598	Frequency (R*4)
3599-3600	Dewow (I*2) (0-NOT DONE 1-DONE)

The following lists the variables used in the binary portion.

Bytes	**Description**
1-4	Trace number from 1 to number of traces.
5-8	Trace number from 1 to number of traces.
9-12	Tape record number 1 to number of traces.
13-16	Set to one.
17-20	Not used.
21-24	CDP ensemble number.
25-28	Trace # within CDP. (one for REFLECTION data)
29-30	Set to one.
31-32	Set to one.
33-34	Set to one.
35-36	Set to one.
37-40	Antenna sep. times 1000. (Not official SEG-Y format)
41-44	Receiver Elevation data times 1000.
45-48	Transmitter Elevation data times 1000.
49-68	Set to zero.
69-70	Set to -1000.
71-72	Set to -1000.
73-76	Transmitter x-coord times 1000.
77-80	Transmitter y-coord (set to zero).

81-84	Receiver x-coord times 1000.
85-88	Receiver y-coord (set to zero).
89-104	Not used.
105-106	Timezero in ns.
107-114	Not used.
115-116	Number of points in trace.
117-118	Sample interval in psec.
119-120	Set to one.
121-240	Not used.

7. Topography Files

- Each line of text must contain a pair of numbers representing position along the GPR line and elevation.
- These numbers can be separated by a space or a tab.
- The range of topographic information does not have to correspond exactly to the range of positions in the GPR line. Positions lying outside the range of available topographic data will be assigned to the elevation of the nearest endpoint.
- Since linear interpolation is used to obtain the elevation at each trace position it is not necessary to have an elevation for every trace in the file. Topographic data can be added to a GPR line with as little as two position and elevation pairs (in the case of a constant slope). The more data points entered, the more detail there will be in the topographic correction.
- Topographic files must have a .top extension.

0.0	935.8
10.1	933.9
22.7	930.3
30.5	932.7
34.6	936.5

Topography files are text files that are easily created using Windows® Notepad, which defaults to a .txt file extension

To change the Windows® Notepad default to a .top extension:

1. In Windows® Notepad click **File** > **Save As**.
2. In the **Save as** dialog box in the **Save as type** drop-down list, click **All Files**.
3. In the **File name** text box, typing file name and append it with the .top extension.

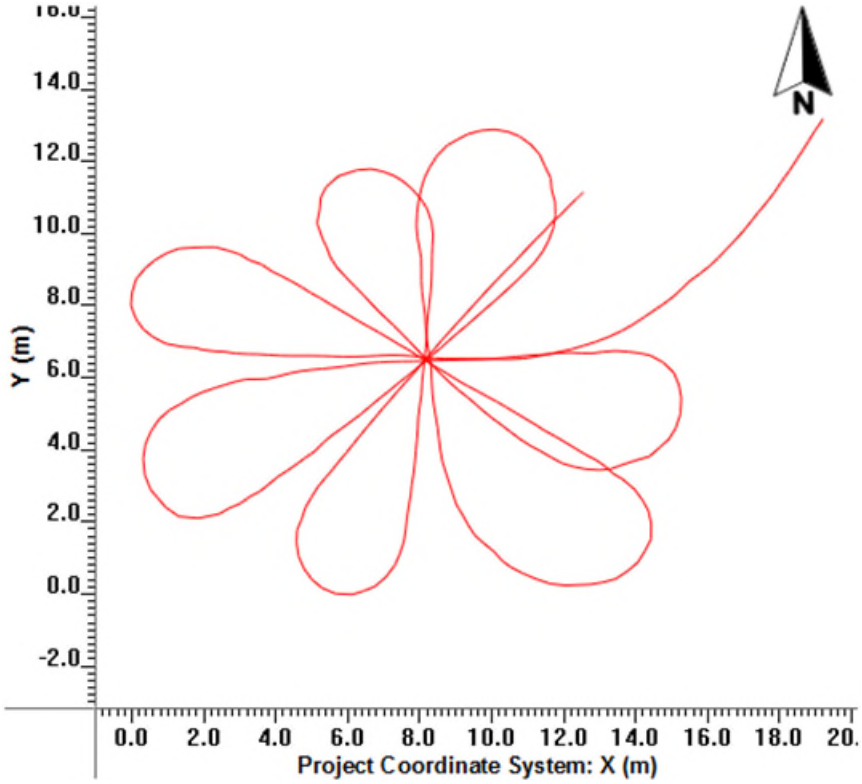
   For example, `Line87.top`.

Appendix B Calculating GPS Latency

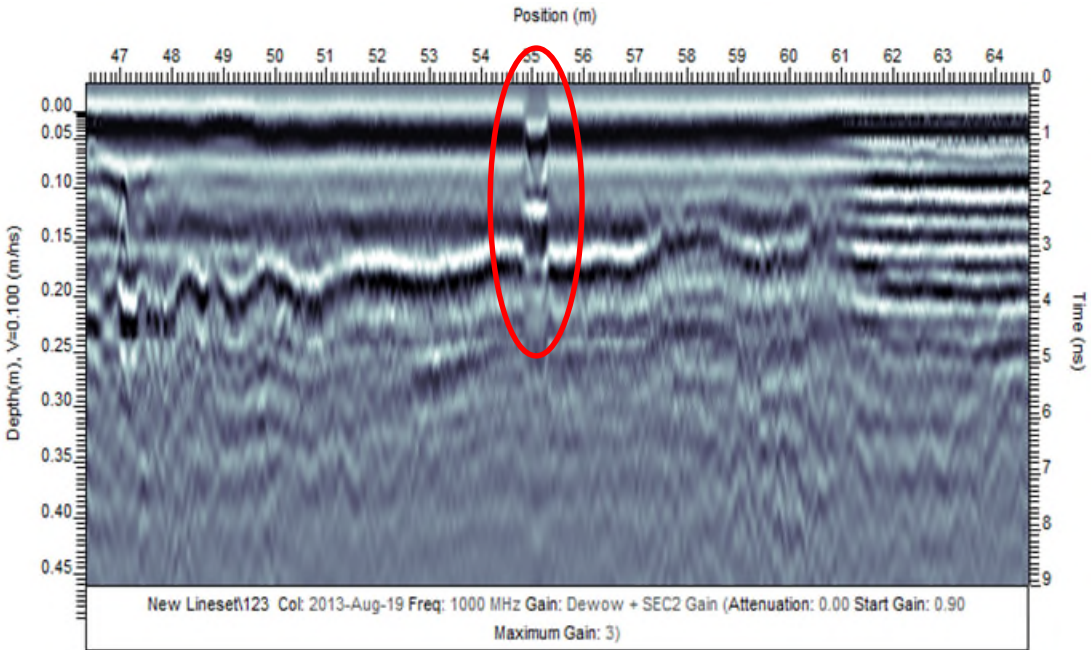
1. Choose a large outdoor area with a clear view of the sky, like a parking lot.
2. In the center of the area, place a metallic disk, roughly 1 ft in diameter. You can use a foil covered piece of cardboard. It is advised that the disk be taped down so that it does not move.
3. Set up your GPR to collect GPS data as well. Make sure that the GPS is centered directly over top of the GPR unit (as shown below).
4. Set GPR recording Depth to 0.50m (10.1ns) so that data can be collected quickly without skipping traces.
5. Start a new line and collect data running over the disk in a flower pattern (see figure below). Try to run over the disk in as many different directions and as many different speeds as you can. The faster the data are collected over the plate, the more accurate the latency value will be.
   *Make sure no traces are skipped.



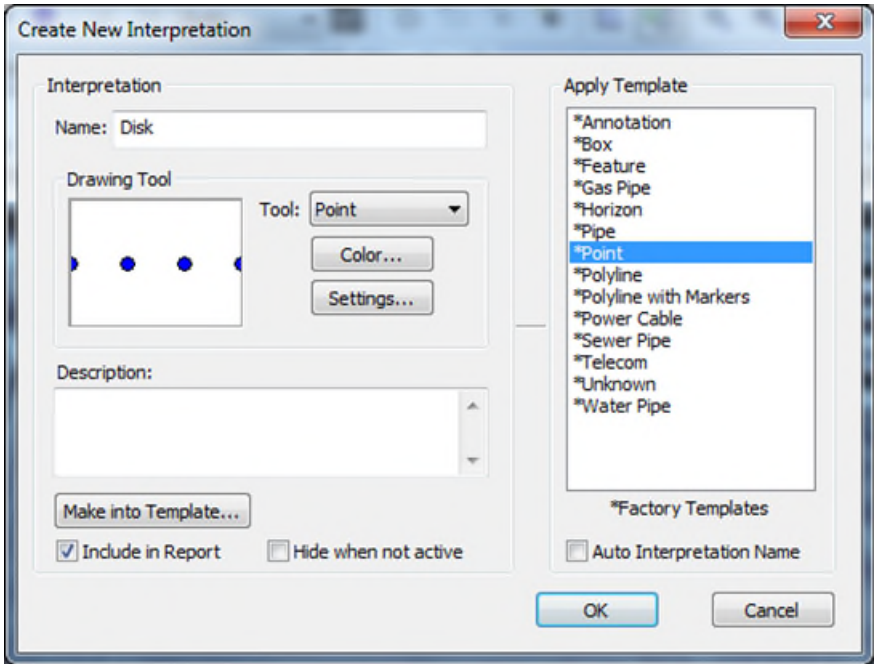
6. Export the GPZ data from the flash memory card and open it in the EKKO_Project software. MapView should display your GPS path like this:



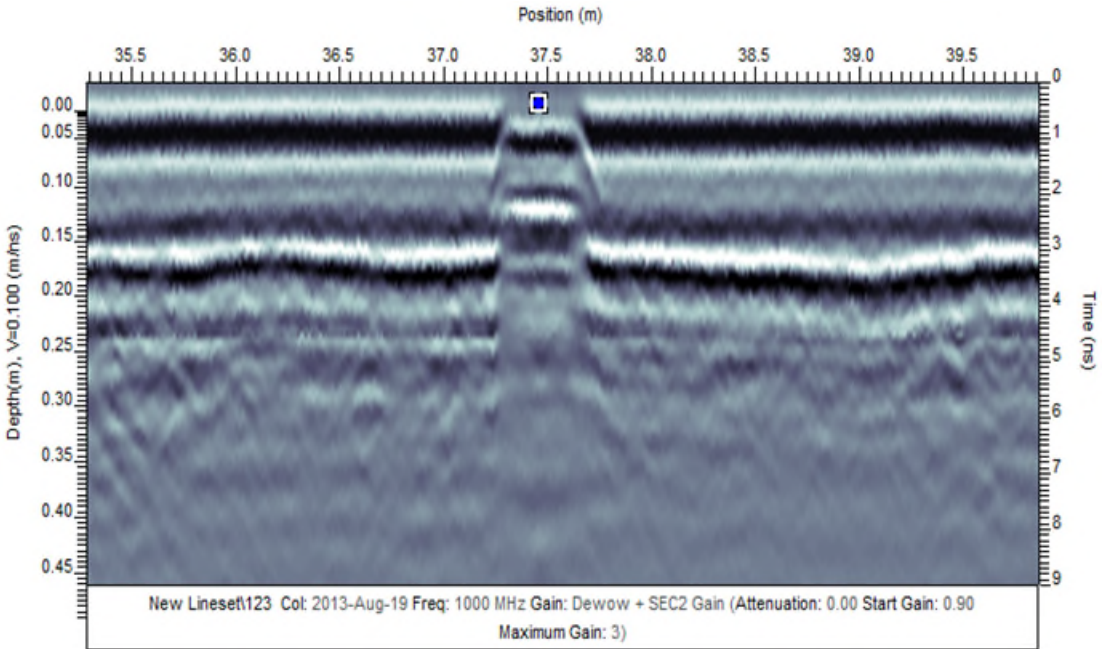
7. Double click the line name in the Project Explorer to open in LineView. Each time you ran over the disk you should see a disturbance in the direct wave like this:



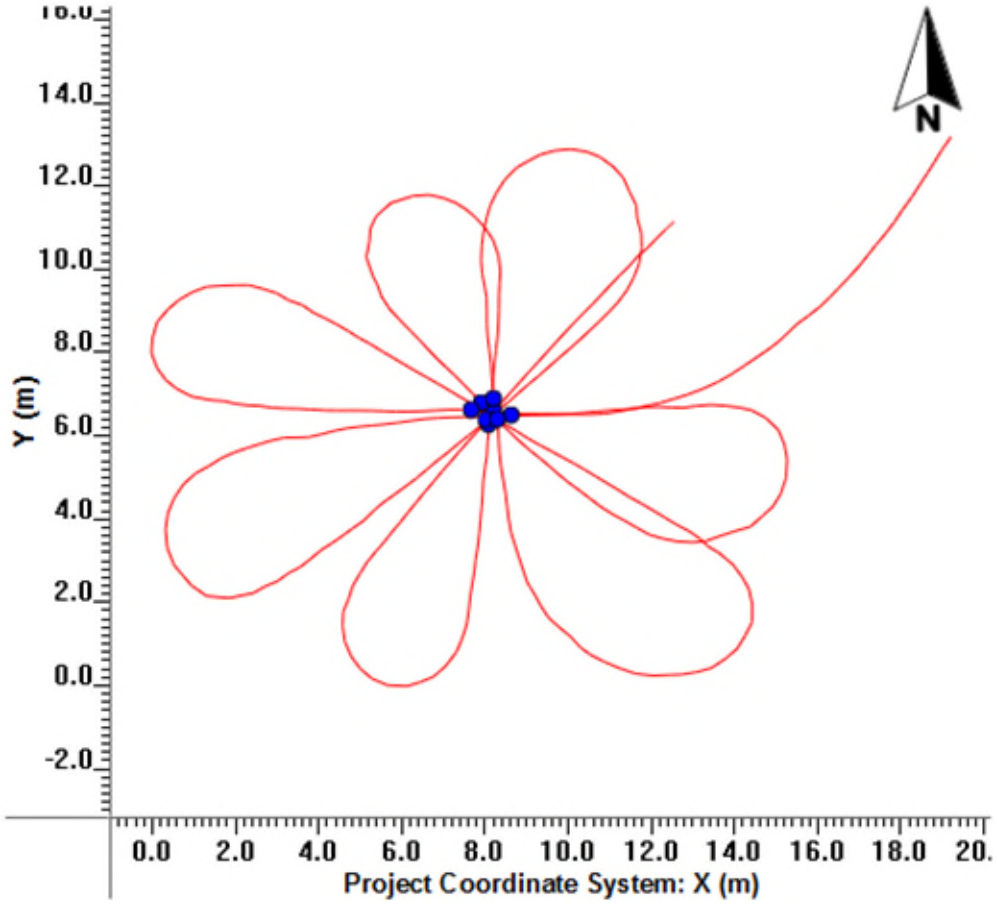
8. Create a new Point type interpretation.
   Note: If the Interpretation module is not enabled, use the mouse cursor and the F8 key for steps 8 to 13. Pressing the F8 key with the mouse cursor on the disk response in the GPR line saves the position information to the Clipboard. Copy the position information of each disturbance to a csv file.



9. Scroll through the line and enter and add an observation at the center of each of the disturbances. The vertical placement of the observation is not important.



10. Close LineView. Now you should see all of the observations clustered near the center of the flower pattern in MapView.



11. Run the Project Report under **File > Report > Project Report**, make a new folder called **0s_latency** and save the report inside.
12. Go to **Tools > GPS > Latency** and set it to 1 second, click **OK**.
13. Run the Project Report again under **File > Report > Project Report**, make a new folder called **1s_latency** and save the report inside.

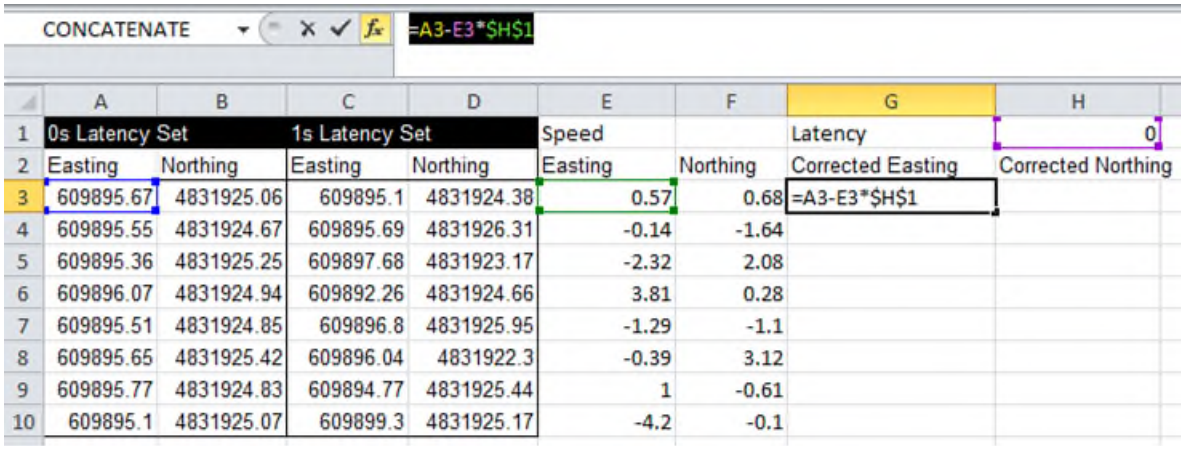
14. Open a new spreadsheet in Excel™. Copy and paste the UTM coordinates from the two project reports into the columns of the new spreadsheet.

0s Latency Set		1s Latency Set	
Easting	Northing	Easting	Northing
609895.67	4831925.06	609895.1	4831924.38
609895.55	4831924.67	609895.69	4831926.31
609895.36	4831925.25	609897.68	4831923.17
609896.07	4831924.94	609892.26	4831924.66
609895.51	4831924.85	609896.8	4831925.95
609895.65	4831925.42	609896.04	4831922.3
609895.77	4831924.83	609894.77	4831925.44
609895.1	4831925.07	609899.3	4831925.17

15. In the column to the right, calculate the speed in each axis by differencing the Eastings and the Northings. So Speed in Easting is Easting at 0s latency – Easting at 1s latency

0s Latency Set		1s Latency Set		Speed	
Easting	Northing	Easting	Northing	Easting	Northing
609895.67	4831925.06	609895.1	4831924.38	0.57	0.68
609895.55	4831924.67	609895.69	4831926.31	-0.14	-1.64
609895.36	4831925.25	609897.68	4831923.17	-2.32	2.08
609896.07	4831924.94	609892.26	4831924.66	3.81	0.28
609895.51	4831924.85	609896.8	4831925.95	-1.29	-1.1
609895.65	4831925.42	609896.04	4831922.3	-0.39	3.12
609895.77	4831924.83	609894.77	4831925.44	1	-0.61
609895.1	4831925.07	609899.3	4831925.17	-4.2	-0.1

16. In the next two columns calculate a corrected Easting and Northing based on some defined latency value. So the Corrected Easting is Easting at 0s latency – Speed_Easting * Latency_s (0s,1s)



	A	B	C	D	E	F	G	H
1	0s Latency Set		1s Latency Set		Speed		Latency	0
2	Easting	Northing	Easting	Northing	Easting	Northing	Corrected Easting	Corrected Northing
3	609895.67	4831925.06	609895.1	4831924.38	0.57	0.68	=A3-E3*H1	
4	609895.55	4831924.67	609895.69	4831926.31	-0.14	-1.64		
5	609895.36	4831925.25	609897.68	4831923.17	-2.32	2.08		
6	609896.07	4831924.94	609892.26	4831924.66	3.81	0.28		
7	609895.51	4831924.85	609896.8	4831925.95	-1.29	-1.1		
8	609895.65	4831925.42	609896.04	4831922.3	-0.39	3.12		
9	609895.77	4831924.83	609894.77	4831925.44	1	-0.61		
10	609895.1	4831925.07	609899.3	4831925.17	-4.2	-0.1		

17. Calculate the standard deviation of each of the corrected axes (Easting and Northing) and then calculate the average standard deviation:

0s Latency Set		1s Latency Set		Speed		Latency	0
Easting	Northing	Easting	Northing	Easting	Northing	Corrected Easting	Corrected Northing
609895.67	4831925.06	609895.1	4831924.38	0.57	0.68	609895.67	4831925.06
609895.55	4831924.67	609895.69	4831926.31	-0.14	-1.64	609895.55	4831924.67
609895.36	4831925.25	609897.68	4831923.17	-2.32	2.08	609895.36	4831925.25
609896.07	4831924.94	609892.26	4831924.66	3.81	0.28	609896.07	4831924.94
609895.51	4831924.85	609896.8	4831925.95	-1.29	-1.1	609895.51	4831924.85
609895.65	4831925.42	609896.04	4831922.3	-0.39	3.12	609895.65	4831925.42
609895.77	4831924.83	609894.77	4831925.44	1	-0.61	609895.77	4831924.83
609895.1	4831925.07	609899.3	4831925.17	-4.2	-0.1	609895.1	4831925.07
				Standard Deviation:		0.286256628	0.242100186
				Avg Standard Deviation:		0.264178407	

18. Now adjust the Latency value (in red) to minimize the Avg Standard Deviation

0s Latency Set		1s Latency Set		Speed		Latency	0.125
Easting	Northing	Easting	Northing	Easting	Northing	Corrected Easting	Corrected Northing
609895.67	4831925.06	609895.1	4831924.38	0.57	0.68	609895.5988	4831924.975
609895.55	4831924.67	609895.69	4831926.31	-0.14	-1.64	609895.5675	4831924.875
609895.36	4831925.25	609897.68	4831923.17	-2.32	2.08	609895.65	4831924.99
609896.07	4831924.94	609892.26	4831924.66	3.81	0.28	609895.5938	4831924.905
609895.51	4831924.85	609896.8	4831925.95	-1.29	-1.1	609895.6713	4831924.988
609895.65	4831925.42	609896.04	4831922.3	-0.39	3.12	609895.6988	4831925.03
609895.77	4831924.83	609894.77	4831925.44	1	-0.61	609895.645	4831924.906
609895.1	4831925.07	609899.3	4831925.17	-4.2	-0.1	609895.625	4831925.083
				Standard Deviation:		0.043527495	0.069991828

Avg Standard Deviation:	0.056759662

19. Once you have found the minimum Average Standard Deviation, this is the latency value to use for this GPS unit.

Appendix C Glossary

1. Definitions

Term	Description
Attenuation	Represents the radar wave attenuation given in decibels/meter. The higher the attenuation value, the faster the exponential function rises the more gain applied at earlier times on the GPR Line.
Attributes	Characteristics derived from original data. Examples are the average amplitude of the dominant frequency between two times or depths.
Automatic Gain Control (AGC)	The Automatic Gain Control (AGC) gain attempts to equalize the amplitudes of all GPR signals by applying a gain which is inversely proportional to the signal strength. This type of gain is most useful for defining continuity of reflecting events.
Average Frequency Spectrum (AFS)	Use AFS plots to determine the frequency of a signal on which to base processing and filtering, similar to band-pass.
Average Trace Amplitude (ATA)	The Average Trace Amplitude (ATA) plot displays the average signal amplitudes (in microvolts) for an entire data file. This plot is a good way to display how rapidly the signal amplitude decays to the background level, giving you an idea of the maximum penetration for the data file.
Background Average Subtraction (BAS)	Use BAS to subtract the average trace of the entire GPR line from every trace in the line. This process enhances dipping events (such as hyperbolas from point targets) and removes horizontal responses common to all traces in the line. It is also used to remove the direct air and direct ground waves (transmit pulse) visible at the top of the line. BAS also removes horizontal bands in the data present throughout the length of the line.
Background Subtraction	Use Background Subtraction to apply a running-average background subtraction to the data set. This process enhances dipping events (such as hyperbolas from point targets) and suppresses or completely removes horizontal responses. This can be very useful for removing localized flat-lying events.
Bandpass Filter	Use bandpass filtering when the GPR signal is contained in a defined band of frequencies and there is "noise" energy in the remainder of the spectrum. Applying bandpass filtering enhances the desired signals at the expense of the out-of-band noise (Dewow). Bandpass is based on Fourier transform filtering concepts.
Dewow	The process of removing a very low frequency component from GPR data. These low frequency data components are associated with either inductive phenomena or possible instrumentation dynamic range limitations.

Term	Description
DynaQ	DynaQ is an advanced, patented technology that dynamically adjusts stacking as system speed varies. In most situations, moving the system at a comfortable speed stacks enough to generate good quality data.
Enveloping	Enveloping converts a trace from a wavelet with both positive and negative components to a monopulse wavelet with all positive components. The process removes the oscillatory nature of the radar wavelet and shows the data in its true resolution. Enveloping can also simplify radar section display making it easier to interpret.
Filter Type	Dictates the weighting the traces on the edges of the Filter Width have on the average trace calculation.
First Break Offset	The number of nanoseconds from the start of the trace to the first break.
GPS Files	Attaching a GPS file adds Latitude and Longitude, UTM coordinates, and GPS elevation to every trace in the GPR line. A GPS file is created by attaching a GPS system to the GPR system during data collection. GPS files contain lines of standard GPS positional output text (called NMEA strings) and the associated GPR trace number. When the GPS file is attached, latitude, longitude, and GPS elevations for every GPR trace are saved into the GPR file.
GPZ Files	Compressed files containing GPR lineset and grid data
Grid	A square or rectilinear set of straight lines which cover an area. Acquiring data on a grid means acquiring data along each line forming the grid. Acquiring data on a grid is a pre-requisite for creating depth or time slice images. Conventional notation is to use a Cartesian coordinate system with X and Y axes.
Highpass Filter	Removes frequencies below a cut-off frequency. Used for removing low frequency content in the GPR data; sometimes used instead of the Dewow filter. High Pass is a recursive filter designed for filtering GPR lines in the time domain. It is an infinite impulse response zero phase filter.
Interpretation Module	Interpretation module in LineView to create interpretations of Points, Polylines, Boxes, and Annotations, view them in GPR lines, and then output the interpretational information in reports.
KMZ Files	The KMZ files generated by a Noggin contain GPS information describing the path travelled during line collection. These files can be configured to display depth measurements along the line, making the data easier to interpret. Noggin enables you to export KMZ files which can be opened in Google Earth™.
Lineset	All GPR lines in a project contained in one folder; collections of GPR lines that may or may not be related to one another. Linesets can be edited to add or delete GPR lines. GPR lines in linesets can also be cut and/or copied and pasted into other linesets.

Term	Description
LineView	Shows GPR line data cross sections. Uses EKKO_View/Interp application modified to work with and get launched from EKKO_Project.
Lowpass Filter	Removes frequencies above a cut-off frequency - useful for removing high frequency noise in GPR data. Low pass is a recursive filter designed for filtering GPR lines in the time domain. It is an infinite impulse response zero phase filter.
Migration	The migration process applies a synthetic aperture image reconstruction process to the GPR line.
nanosecond	A nanosecond is 10^{-9} seconds (one billionth of a second).
Overlap	Overlap (% of slice thickness) between the adjacent depth/time slices.
picosecond	A picosecond is 10^{-12} seconds (one trillionth of a second).
Polylines	A polyline is a list of points, where line segments are drawn between consecutive points.
Polyline Output Interval	The horizontal distance (meters or feet) between points on any polylines in the project. To interpolate and list more points than just the input observation points, enter them text box. A common interval is the step size for the GPR line
Project Explorer	The Project Explorer is similar to Windows Explorer, which lists folders and files. In Project Explorer, grids and linesets are used just like folders in Windows, and GPR lines are similar to Window Explorer files.
Processing Module	The optional Processing module allows you to edit and process data, including cropping data, time filters, migration and gain. Popular processing streams can be saved as Recipes and applied to other GPR projects.
Properties Window	Displays details of each GPR line including acquisition parameters and associated files
Slice	Describes the GPR data in a depth slice when the data is displayed as a computer generated image. Normally shortened to slice.
SliceView (EKKO_Mapper)	SliceView creates and displays GPR depth slice maps quickly and easily. Using the systematic grid data acquisition process common to pulseEKKO PRO, Noggin, or Conquest systems, images at multiple depths are generated in minutes.
Spatial Filter	Spatial filters act on radar data in the spatial (or positional) direction. These filters use adjacent traces during the filtering procedure and alter the shape of the trace through various mathematical manipulations designed to enhance or eliminate certain features.
Spreading & Exponential Calibrated Compensation (SEC2)	SEC2 gain is a composite of a linear time gain and an exponential time gain which attempts to compensate for the spherical spreading losses and the exponential ohmic dissipation of energy in the GPR Line.

Term	Description
Time Window	The maximum time selected for viewing, processing or data acquisition along a line. The length of the time window in nanoseconds (ns).
Time Sampling Interval	The time in picoseconds at which the GPR signal is sampled. Often set automatically by the system based on GPR frequency.
Topography Files	A topography file is a text file containing GPR line positions and the elevations at those positions. When a topography file is attached to a GPR line, elevations for every GPR position are saved into the elevation field of the GPR trace header.
Trace Plot	View Traces when you want to display subtle features in the data file or view the effect of different editing and processing types have on individual traces. Viewing traces can help you determine whether time-zero point needs to be edited. Normally the time-zero point should occur at the first large deflection in the signal. If not, time scales and depth scales on section plots will be inaccurate.
Universal Transverse Mercator (UTM)	UTM is a geographic coordinate system that uses a 2-dimensional Cartesian coordinate system to give locations on the surface of the Earth. It is a horizontal position representation, i.e. it is used to identify locations on the Earth independently of vertical position, but differs from the traditional method of latitude and longitude in several respects.
UTM Zone	The UTM system divides the Earth between 80°S and 84°N latitude into 60 zones, each 6° of longitude in width.
UTM Zone Number	Zone 1 covers longitude 180° to 174° W; zone numbering increases eastward to zone 60 that covers longitude 174 to 180 East.
UTM Letter	Each zone is segmented into 20 latitude bands. Each latitude band is 8 degrees high, and is lettered starting from "C" at 80°S, increasing up the English alphabet until "X", omitting the letters "I" and "O" (because of their similarity to the numerals one and zero). The last latitude band, "X", is extended an extra 4 degrees, so it ends at 84°N latitude, thus covering the northernmost land on Earth. Latitude bands "A" and "B" do exist, as do bands "Y" and "Z". They cover the western and eastern sides of the Antarctic and Arctic regions respectively.
Velocity	Speed at which GPR signals travel. Velocity is a critical parameter when creating depth slice images and estimating target depth since velocity is used to convert travel-time to depth.
Vertical Filter	Applies a running average filter vertically (down the trace) to a GPR line. The signal is averaged by replacing the data value at a given point by the average data value over a window centered about that point. Its primary purpose is to reduce random or high frequency noise by acting as a low pass temporal filter.

2. Abbreviations

Abbreviation	Full Phrase
AFS	Average Frequency Spectrum
ATA	Average Trace Amplitude
AGC	Automatic Gain Control
BAS	Background Average Subtraction
GPR	Ground Penetrating Radar
GPZ	GPR Project Zip file
MAPI	Messaging Application Programming Interface
MHz	Megahertz
ns	nanoseconds
ps	picoseconds
SEC2	Spreading & Exponential Calibrated Compensation
UTM	Universal Transverse Mercator

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