Tutorial for Resource Applications

Version 10

Softree Technical Systems Inc.

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1. Getting Started

This manual is formatted as a hands-on tutorial, which can be used by novice or experienced users. Step-by-step examples use prepared documents and data files to illustrate tools needed for common RoadEng® tasks. The document is set out as if you were doing a road design project from original ground survey to completed construction documents.

Installation

The tutorial files referred to in the following examples can be installed from Softree's Support web site:

- Go to the *Support-Documentation Updates* page on Softree's web site: https://support.softree.com/product-updates/Documentation-Tutorials.
- Once *SoftreeTutorials.exe* has been successfully downloaded.
- <Double-click> on the file to begin installation.

During the installation you will be prompted to select which content to install, we recommend installing all the available tutorial options.

Documents

The tutorial files (data sets) will be installed in the folder below by default:

C:\Users\Public\Documents\Softree\TrainingV10\RoadEngResource

We will refer to this folder as **<RoadEngResource>** in the examples below. It is possible to change this folder at install time; you can also copy it to a new location afterwards if you wish.

Recommendation: To make accessing files easier as you work through the tutorial, we suggest pinning the <RoadEngResource> folder to your Quick Access menu. To do so, open Windows Explorer, navigate to the folder <RoadEngResource>. Right-click on the folder, select "Pin to Quick Access". This will now make the folder available on the left-hand side of Windows Explorer (see figure below).

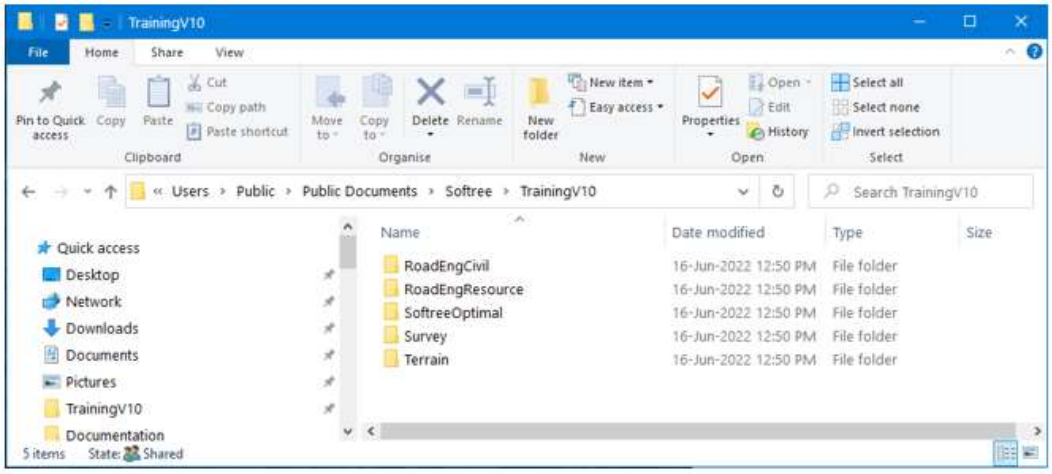


Figure 1-1: Quick Access in Windows Explorer

Don't Save Files (in most cases)

Most of the following examples end with the phrase: "… do not save changes". If you modify the tutorial files, they will no longer work with the steps in the exercise; this will prevent you, or someone else, coming back and doing the exercise again.

If a file gets modified, delete the files in the training folder. Then re-install the tutorial files (per the original steps).

C:\Users\Public\Documents\Softree\TrainingV10\RoadEngResource

Defaults and Layouts

The setup and layout files are stored the folder below by default:

C:\ProgramData\Softree\RoadEng10

It is possible to change this folder, so we will refer to it as **<Defaults and Layouts>** in the examples below. A folder containing training specific files has also been added to this location:

<Defaults and Layouts>

Note: You can always determine the actual **<Defaults and Layouts>** folder by running a module, selecting menu *Setup* | *Location Setup* | *Install* tab.

Function Groups

RoadEng® and Terrain Tools® products have certain features; we classify these optional features by *function group*.

To view the features enabled with your license:

1. Select *Setup* | *Module Setup* and click on the *General* tab.
2. Click on the *Menus…* to open the Menu Customization Dialogue box.

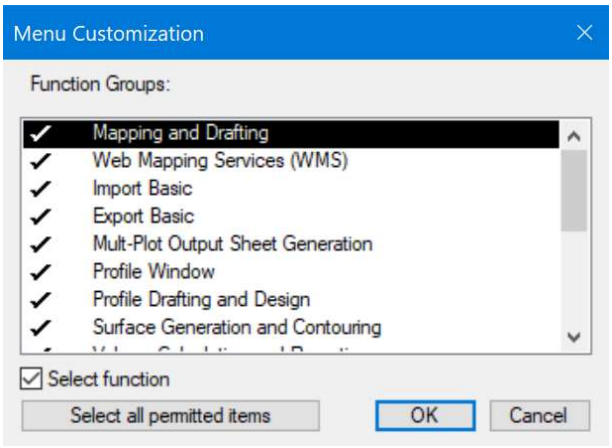


Figure 1-2 : Function Groups Displayed in the *Menu Customization* Dialogue

Note: Specific function groups are required to do certain examples

All required function groups are listed prior to each example in this manual. If you do not have permission to use all the required function groups, you may wish to skip the example. Also note that some function groups may be disabled even if *you* have permission to use them – this is so users with a lesser license can still do the example.

On-line Help

Help information is available by choosing the *Help* menu or pressing ***<F1>*** on your keyboard. The On-line Help includes detailed technical information about menus, dialogue boxes, and operation of the program. It may be useful to refer to the On-line Help while working through the examples in this manual.

Additional help is available through the Softree Knowledge Base:

https://www.support.softree.com/knowledge-base

Tutorial Units

Most examples in this tutorial are in Imperial Units (feet). To correctly follow the examples, ensure Imperial (ft) units are enabled in the *Setup* | *Setup Module Setup* | *Units* tab | Units: *Imperial (ft)*. If other units are used, they will be specified at the start of the example. The procedures and concepts described apply to all unit systems.

Screen Layouts

Screen layouts are small files that save display options (window positions, labels, scales etc). Many of the examples in this training manual include a step to retrieve a screen layout; this change provides multiple view options in one quick step.

A screen layout in Terrain Module has the file extension (.ilt). A screen layout in Location has the file extension (.dlt).

The *screen layout* drop-down control can be found in the Standard toolbar in all modules (figure below), *View* | *Screen Layout*:

Figure 1-3: Accessing *Screen Layouts* Group

With the drop-down expanded, you can:

<Right-click> on a screen layout in the *Screen Layouts* tool bar item to:

- Change Properties
- Delete
- Copy
- Save

<Right-click> on a folder (Softree or Custom) in the Screen Layouts tool bar item to:

- Change properties (only the *Custom* folder can be changed here)
- Paste a screen layout that was recently copied
- Save new layout (define name and description)

The *Custom* folder is often defined on a network drive so that the layouts are accessible to all users.

- The *Save screen layout* button allows you to save a screen layout anywhere but only those in the *Custom* or *Softree* folders will appear in the *Screen Layouts* tool bar.

- The *Retrieve screen layout* button allows you to open a screen layout file anywhere including those in the *Custom*, *Training* or *Softree* folders.

- The *Delete screen layout* button opens the screen layout folder where you can multiple layouts to delete.

- You can change the *Softree* folder from the menu *Module | Setup, Install* tab. Do not do this unless you understand the consequences; more than just screen layouts are stored in this folder. The most common change is to put *Settings and Layouts* into your *Documents* folder (private to one user only).

Note: Screen layouts were updated in Version 9. Softree recommends 'updating' any legacy user screen layouts to update their behavior. Version 9 layouts work better when moved between monitors of differing screen resolutions.

To 'Update' Screen Layouts:

If your legacy screen layout contains multi-plot information, please open your legacy screen layout in the multi-plot window first:

Select *Multi-Plot* tab | *Add New* ▼ | *Retrieve Other Layout.* Select ***Multi-Plot Old Screen Layout (.dlt)*** from the file type drop-down in the *Retrieve Screen Layout Dialog*. Select your legacy layout. Once open, press *Save Chapter* in the Multi-Plot ribbon.

Conventions

The following conventions are used throughout the manual:

- Menu functions are delimited by a line "|". *File | Open* means to click on *File* button in the corner of the menu bar and then select *Open* from the drop-down menu.
- Dialogue box control, buttons and heading names are *italicized*.
- The symbols "< >" contain keyboard functions. For example, <shift-enter> means: hold down the *Shift* key and press the *Enter* key.
- File names and path names are **bold**.

2. Functional Overview

Softree software solutions are sold as modular products. Depending on the product you have purchased, it could include up to three *modules*:

1. *Survey/Map*
2. *Terrain*
3. *Location*

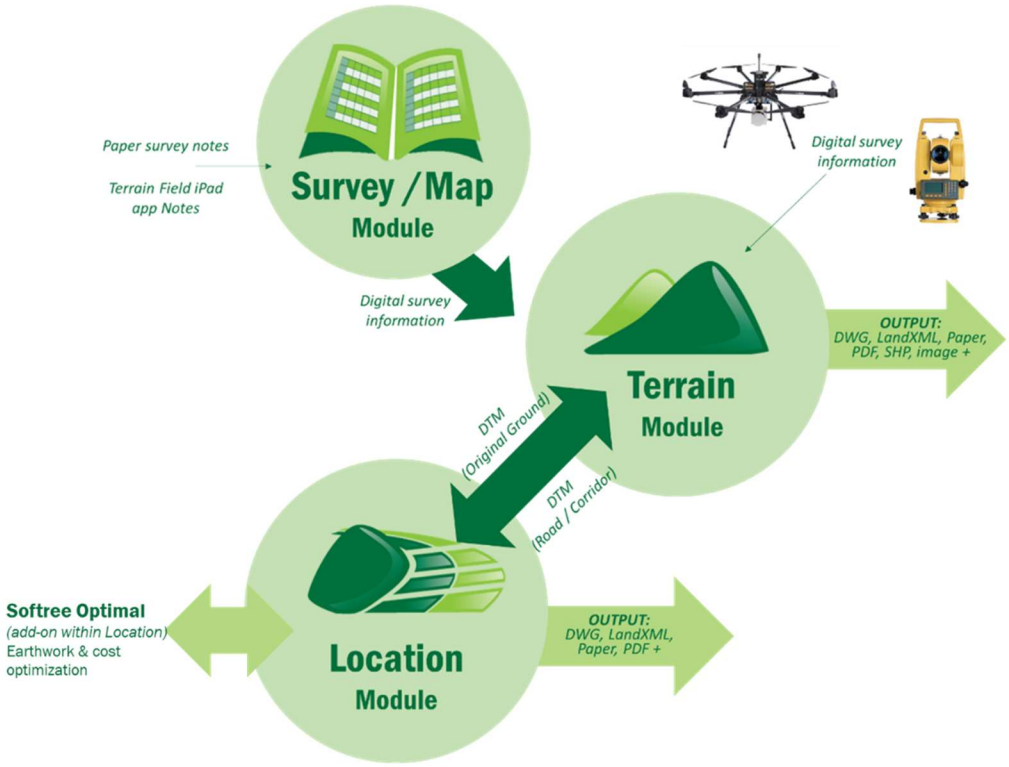


Figure 2-1: *Relationship* Between the Modules

Each of the modules can be started from the Windows Start menu, a desktop shortcut or from the *Setup* tab within either of the other modules.

Survey/Map Module

This module is used primarily to type paper survey notes into the computer. Azimuths, distances and slopes are entered and reduced to coordinates. Facilities exist to add perpendicular side shots to a traverse so that a group of terrain, suitable for a road design, can be easily captured with basic survey instruments.

Survey/Map also contains tools for adjusting traverses with respect to each other or to known coordinates.

Terrain Module

The Terrain Module provides basic CAD facilities for assembling and manipulating 2D and 3D points and features. Information can be imported from external sources like survey files, CAD files and image files. Three dimensional coordinates can be incorporated into a digital terrain model (DTM).

DTMs can be used for:

- Contour generation
- Section and profile display
- Volume calculations
- Pad, pit and site design (grading)
- 3D viewing
- Original ground for road design (Location module)

The Terrain module is also a capable mapping tool with control of line types, colors, symbols, hatching and labelling styles.

Location Module

This is the module used to design road alignments. Location requires an original ground terrain (provided by the Survey/Map and/or Terrain modules). The designer controls cross section templates, alignment location and curves. Location provides real time feedback of volumes, mass haul, road footprint, cross sections, grades, etc.

Location can also export designed surfaces back to the terrain module where they can be merged into a composite surface. This is the most common way to prepare the original ground for an intersection design.

Softree Optimal Add-on (within Location Module)

This add-on (function group) is available within the Location Module with a valid Softree Optimal license. Softree Optimal is a patented alignment optimization tool, generating the lowest cost vertical alignment based on the ground surface, the preliminary horizontal alignment, and the design parameters and constraints entered by the user.

Typical RoadEng Workflow for Designing a Road

1. The Terrain module is used to import and verify survey data of existing conditions. Possible data sources include total station (XYZ files), LiDAR, or GIS maps (shape, dwg, dgn etc.).

In the case of P-Line survey data, the workflow would begin with traverse note entry in the Survey Map module (see Chapter 3)

2. Using the Terrain module, a TIN (Triangular Irregular Network) surface representing original ground (OG) is created. The resulting linework and TIN surface is saved in a *.TERX file. NOTE: it may be useful to create several terrain files (e.g. one with the TIN model and one with planimetric linework).
3. A new design is created in the Location module, based on an OG surface (.TERX file from step 2).
4. The road cross section is created or adjusted using the Template Editor.
5. A horizontal alignment is created or adjusted using the mouse or explicitly in the Horizontal Alignment Panel.
6. A vertical alignment is created or adjusted using the mouse or explicitly in the Vertical Alignment Panel. Vertical optimization (Softree Optimal) can also be used in this step.
7. Steps 4-6 are repeated until the designer is satisfied with the result. In addition to Plan, Profile and Cross Section views, various reporting tools provide the designer with feedback. This includes volumes, mass haul diagram, and cost reporting.
8. Construction documentation is prepared using the Multi-Plot window. This documentation is printed directly or exported to Avenza .Zip file for use in the field.
9. LandXML or ASCII files can be saved for construction staking.

3. P-Line Survey Note Entry

This example illustrates how to enter in a road p-line with cross sections.

Note: See Getting Started section for file install folders (**<RoadEngResource>** and **<Defaults and Layouts>**)

Setting up Entry Options

1. Open the Survey/Map Module; select *Setup* | *Module Setup* and click on the *Units* tab. Select *Imperial (ft)* units if necessary. Press *OK*.

1. Open up a new traverse document with menu *File* | *New. Select Traverse Document*. Press *OK*.

2. You will be presented with the Starting Coordinate dialogue box shown below:

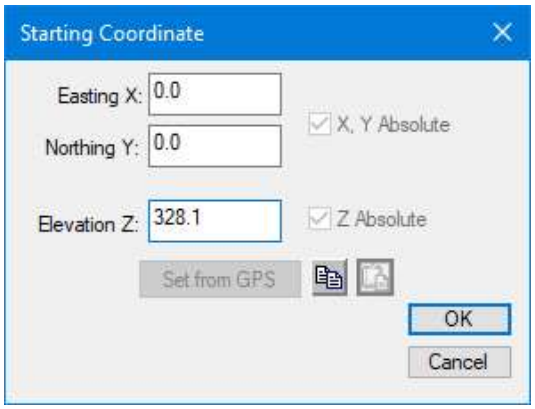


Figure 3-1: *Starting Coordinate* Dialogue

3. Set the initial *Elevation Z* to **328.1**. Press *OK*.

4. We will now use a pre-set screen layout, select *View* | *Screen Layout* group, select layout **training Normal.slt** from the training folder in the dropdown list.

Screen layout files contain window attributes (position, size, options and label formatting etc.) A screen layout file can be set up and retrieved for a particular design or task.

Note Entry

A hardcopy of the traverse notes used in this example can be found in Appendix A. To print a paper copy of the notes, go to **<RoadEngResource>\Spur Traverse Notes.pdf.**

Note: The traverse notes used in this example are entered from top down. Traverse notes can also be entered from bottom up. To change direction, select *Traverse* | *Traverse Entry Options* and disable Top down.

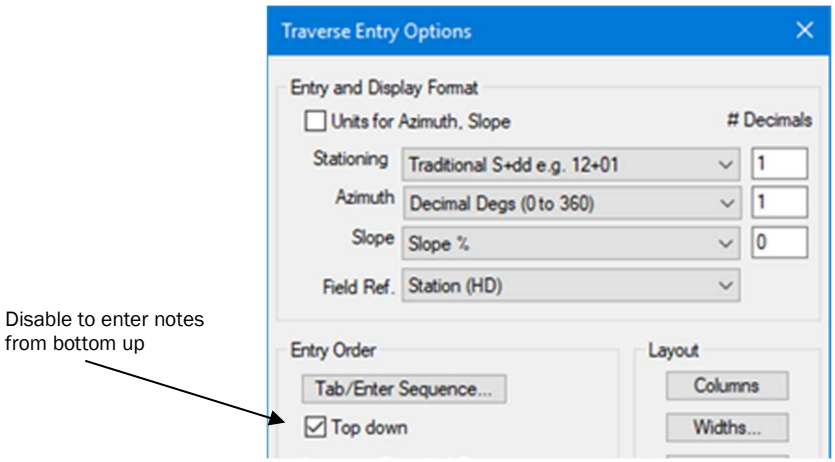


Figure 3-2: *Note Entry Direction* Options

5. <*Double-click*> on the field under the SSL column at Station 0+00.0 to open extended side shot edit dialogue box as shown below.

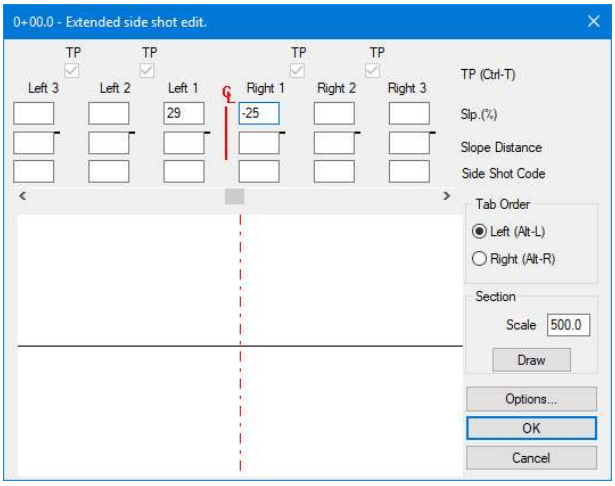


Figure 3-3: *Extended Side Shot* Edit Dialogue Box

6. Enter the slp% of **29** on the *Left 1* side as shown in the figure above. Press *Enter*. The cursor will jump to the *Right 1* side.
7. Enter the slp% of **-25** on the *Right 1* side. Press *Enter*. The extended side shot dialogue box will close and the cursor will jump into the GND column at Station 0+00.0.
8. Enter an overburden thickness of **0.5** feet over fractured rock by typing in **OB/0.5/FR**. Press *Enter*. The cursor will be in the *Type* column.
9. Leave the default of **FS** (Forward Shot) and press *Enter* again. The cursor should be in the *Fore Azim* column.
10. Enter **75.9** in the Fore Azim column. Press *Enter*. The cursor will have moved to the S.D. (Slope Distance) column.
11. Enter the S.D. of **189.0** and press *Enter*.
12. Type in the *Slp%* of **5**. Press *Enter*.

13. Type **20** in the *Left 1* Slp%. Press *Enter*. Type **-20** in the *Right 1* Slp%. Press the *Tab* button on your keyboard to the slope distance of **33.2**.
14. Press the *Tab* button again, enter the final slope of **-27.** Press *Enter*.

Note: In Survey/Map the format will appear as -20/32.2 T, -27/.. This means that the first slope is 20% for 33.2 and the second slope (Right 2) is 27%.

15. Keep entering the survey notes (from ***Appendix A***) until Station **7+26.1.** After that Station, select the **IFS** type shot. Press *Enter*.

Notice that the cursor jumps into the S.D. column instead of the Fore Azim. The reason this occurs is because IFS shots get their azimuth from the next FS shot.

Your traverse file should appear similar to the figure below:

Station	Type	Fore Az...	H.D.	S.D.	Slp....	SSL Slp.(%)/S.D.	SSR Slp.(%)/S.D.	GND	C...	Label
* 0+00.0						29/..	-25/..	OB/0.50/FR		
	FS	75.9	188.8	189.0	5					
1+88.8						20/..	-20/33.2 T,-27/..	OB/0.50/FR		
	FS	66.2	22.7	22.8	8					
2+11.4						20/..	-20/42.0 T,-29/..	OB/0.50/FR		
	FS	66.2	80.7	80.7	0					
2+92.2						20/..	-20/..	OB/0.50/FR		
	FS	52.8	35.8	35.8	4					
3+27.9						17/..	-19/..	OB/0.50/FR		
	FS	52.8	90.9	90.9	-3					
4+18.8						17/..	-17/..	OB/0.50/FR		
	FS	40.2	77.9	77.9	1					
4+96.7						17/..	-14/..	OB/0.50/FR		
	FS	40.2	42.5	42.6	4					
5+39.2						14/38.9 T,17/..	-14/63.9 T,-12/..	OB/0.50/FR		
	FS	46.8	42.7	42.7	2					
5+81.9						14/..	-14/49.9 T,-13/..	OB/0.50/FR		
	FS	65.8	40.2	40.2	-3					
6+22.1						14/39.9 T,5/..	-14/18.9 T,-13/..	OB/0.50/FR		
	FS	71.6	16.7	16.7	-4					
6+38.8						13/29.6 T,4/..	-13/..	OB/0.50/FR		
	FS	71.6	19.1	19.1	-3					
6+57.9						12/11.9 T,10/8.2 T	-12/..	OB/0.50/FR		
	FS	82.7	6.4	6.4	-5					
6+64.3						10/21.2 T,3/..	-12/..	OB/0.50/FR		
	FS	82.7	33.9	34.1	-9					
6+98.2						10/25.8 T,3/..	-10/58.8 T,-12/..	OB/0.50/FR		
	FS	75.8	27.9	28.0	-8					
7+26.1						12/27.0 T,6/..	-12/..	OB/0.50/FR		
	IFS	20.1	3.0	3.0	-2					

Figure 3-4: *Example Traverse* Data Entry

16. Continue entering the traverse notes. *Save As "your name" + spur.tr1*
17. *File | Close*.

4. Creating a DTM with Contours

In this exercise, a digital terrain model will be created and major and minor contour lines will be generated.

Note: The digital model is represented by a *Triangular Irregular Network* (TIN); for this reason, menus, documentation and help files often refer to a Digital Terrain Model as a *TIN* model.

Note: See **Error! Reference source not found.** section for file install folders (**<RoadEngResource>** and **<Defaults and Layouts>**)

1. Open the Terrain Module
2. *Setup* | *Module Setup* to open the *Terrain Setup* dialogue. Click on the *Units* tab. Select *Imperial (ft)* units if necessary. Press *OK*.
3. *Home* | *Insert File* <RoadEngResource>\Traverse**Spur.tr1**. If **spur.tr1** is not listed use the drop down menu in lower right corner and select *All Support Files(*.ascii; *.txt…)*
4. Press *Open* to load the file.

An *Import Options* dialogue box will appear.

5. Enable *Include Side Shots* and set the *Final Slope Horizontal Distance* to **40** as per figure below. Press *OK*.

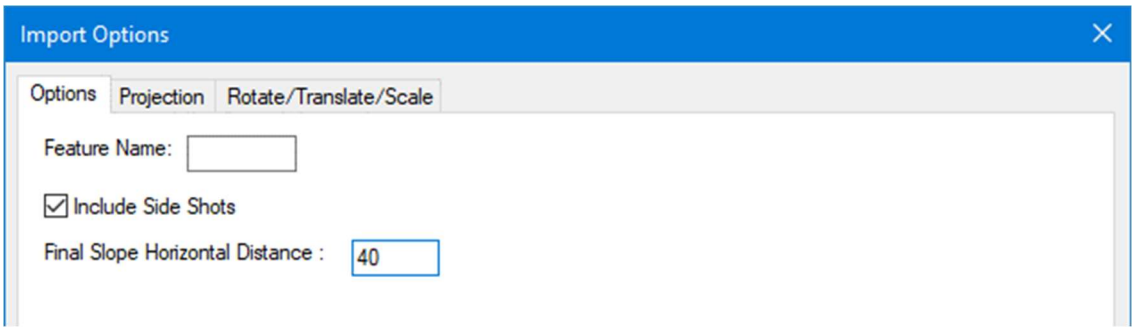


Figure 4-1: *Import Options* Dialogue Box

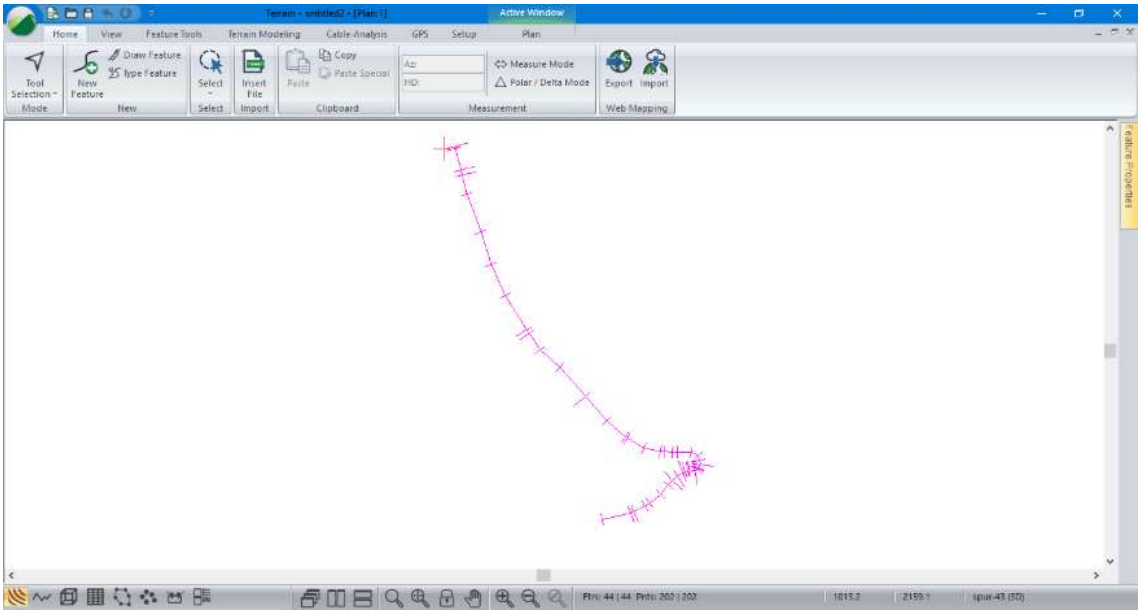


Figure 4-2: *Spur.tr1.*

Contour Specification

6. *Terrain Modeling* | *Generate TIN* to open the *Terrain Calculation* dialogue box below.

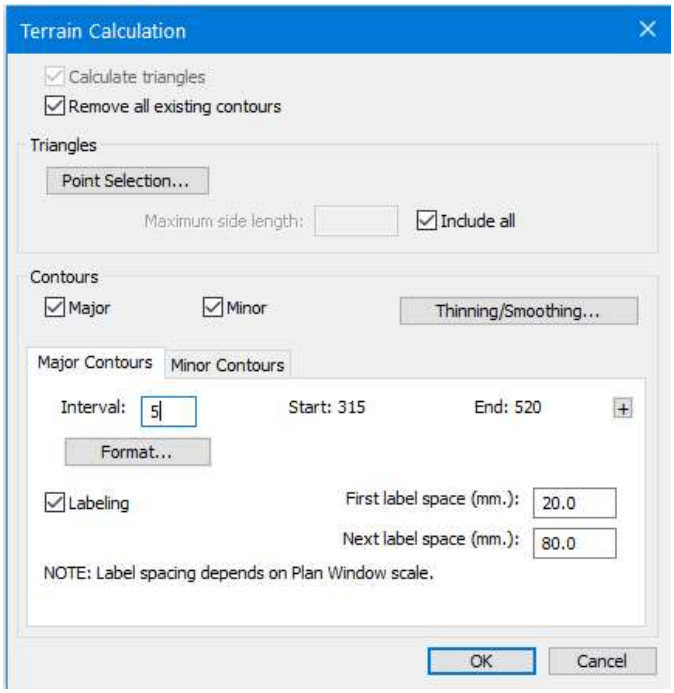


Figure 4-3: *Digital Terrain Model Calculation* Dialogue Box
Optional Contours Enabled

Set up to generate the surface and contours:

7. Make sure *Calculate Triangles* is set and also set *Include All*.

8. In the *Contours* area, make sure that *Major* and *Minor Contours* are both turned ON.

If you click on the ± button at the right side, you can change the color and line type used for the contours.

Optional, under *Thinning/Smoothing*, contour *Smoothing* (controlled by thinning distance) rounds the corners where contours cross triangle sides – smoothed contours do not match the model elevation exactly.

Note: Default contour line types and colors are stored in the **Normal.ilt** screen layout. Any changes made after a new document is created are saved with the document.

9. Click on the *Major Contours* tab
10. Set the *interval* to **5**.
11. Make sure *Labeling* is turned ON as shown above in Figure 4-3.

The *Start* elevation is detected as 315.

12. Click on the *Minor Contours* tab and set the interval to **1** and make sure *Labeling* is turned OFF.
13. Press the *OK* button to generate both TIN and contours.

The figure below shows the result.

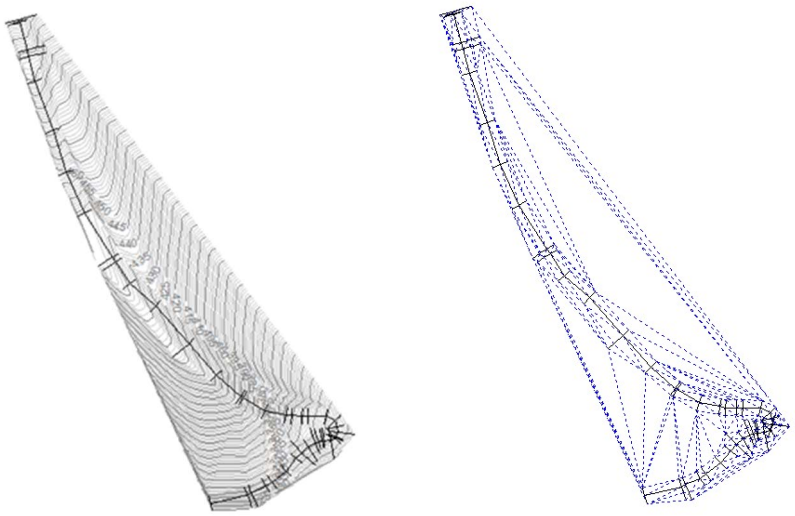


Figure 4-4: *Contours Generated* without Boundary or Length Limitation
Underlying Triangles Shown on Right

The figure above shows how a *Triangular Irregular Network* (TIN model) is created from 3D data points. Once the TIN model has been generated, contours are formed by creating a straight-line segment across each triangle (see figure below).

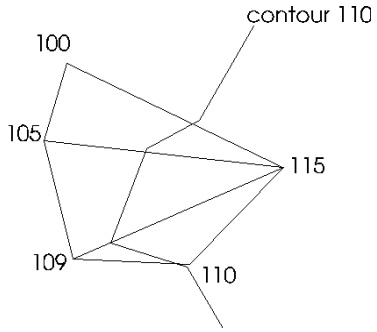


Figure 4-5: Contour Formation From *TIN Model*

Elevations between known elevation points are interpolated. If contour smoothing has been enabled, the contours will be less angular.

Limiting Triangles

The triangles (and resulting contours) on the upper right and lower left of the model (as shown in Figure 4-4) are unrealistic – elevations are being interpolated between points which are very far apart. There are two ways to prevent these unrealistic triangles:

- Create a boundary polygon (with property *TIN boundary*).
- Limit triangle length.

A boundary polygon will limit triangle formation to an area of interest; TIN boundaries will be covered in other exercises.

The following steps will demonstrate how to limit the triangle length.

14. *Terrain Modeling* | *Generate TIN* in the tool bar to re-open the *Terrain Calculation* dialogue box again.
15. Turn ON the *Calculate triangles* check box.
16. Turn OFF *Include all* and set the *Maximum side length* to **300** (see figure below).

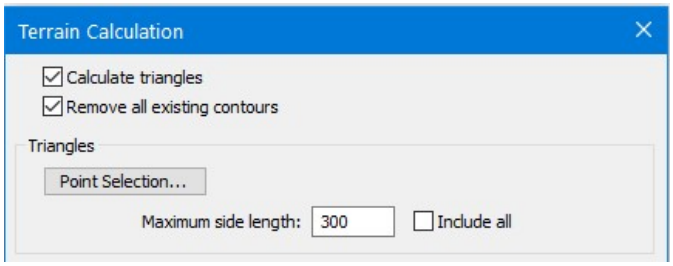


Figure 4-6: Terrain Calculation with *Triangle Maximum Side Length Limited*

Note: If you set *Maximum side length* too small, there will be holes in your model.

17. Press *OK* to recalculate triangles and contours.

The Plan Window should look similar the figure below.

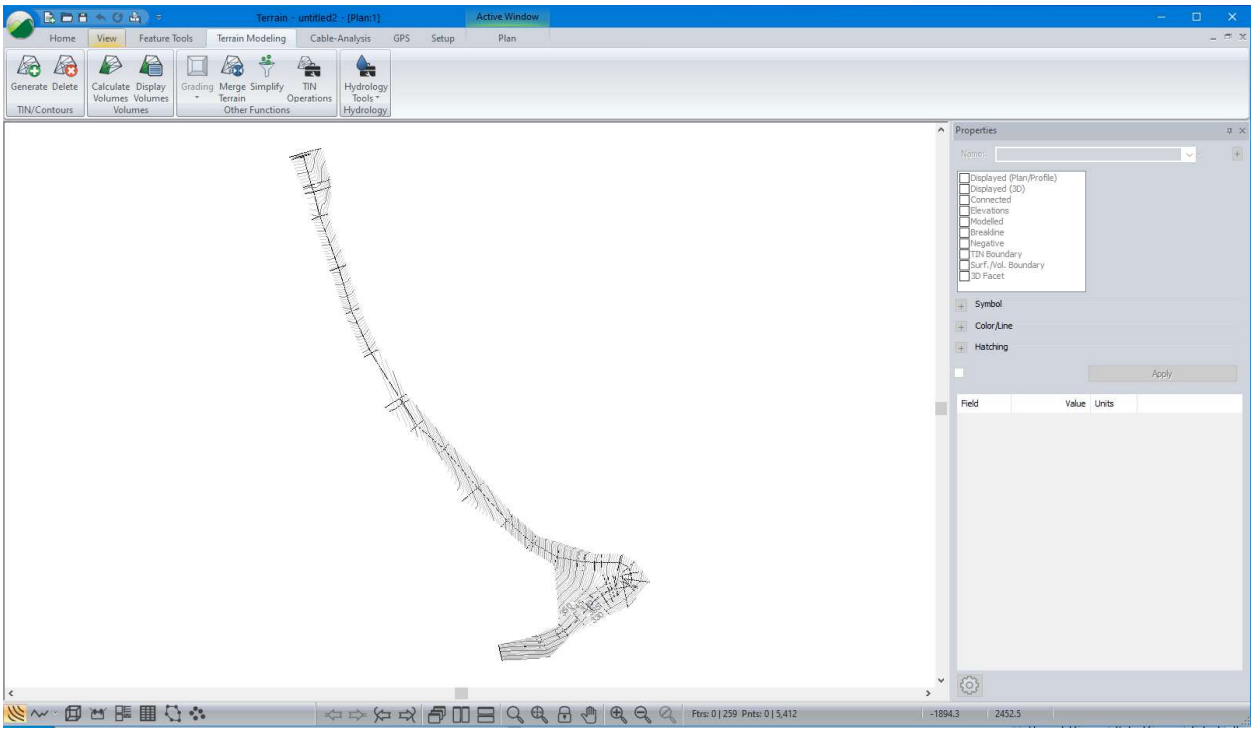


Figure 4-7: Terrain Model with *Triangles Limited to 300ft*.

At this point you may wish to experiment with some of the other options in the *Terrain Calculation* dialogue box. Once the dialogue box is open type <F1> to see detailed help information.

18. *File | New*. Do not save changes.

5. Working with LiDAR

LiDAR (**Li**ght **D**etection **A**nd **R**anging) surveys produce very large amounts of relatively accurate three dimensional point data. The data includes points representing laser light scattered from the ground (bare earth), foliage, buildings, transmission lines and other objects. This data is usually broken into tiles, each containing a few million points.

Size and Accuracy Considerations

- The 32-bit version of RoadEng® is limited to approximately 5 million points. The 64-bit version of RoadEng® can handle more points depending on the speed of the user's CPU processor and amount RAM, 10 million points is reasonable.

- Interpolating the LiDAR into regular grid format is not recommended, because this creates points by interpolation (lost accuracy). For accuracy purposes, it is better to work with the raw data points.

- When importing LiDAR data, it is very important to group points together instead of making feature for every point. Features require a significant amount of memory (much more that a point) so it is best to store thousands of points per feature.

It is not uncommon to have data sets with hundreds of millions of points (well exceeding the recommended maximum of 10 million points). This limitation is generally not a problem for most corridor projects, if points outside the area of interest are thinned. Consider a relatively large road project say 20 kilometers (~ 12 miles). Assume that your LiDAR horizontal resolution is 1 meter (3 feet) and that you have identified a corridor that is 200 meters (~656 ft.) wide along a preliminary alignment. This yields about 4 million data points.

Importing LiDAR in LAS/LAZ format

Large data sets need to be loaded in such a way that they use the least amount of memory possible. In the next section, you will load a prepared LiDAR import format from an **LAS file.**

Note: LAS or LAZ format is the preferred format for LiDAR, as it is compact and loads fast.

19. Open the Terrain module. *File* | *Open,* select **<RoadEngResource>\LiDAR\RoadNetwork.terx**.

This file contains the following:

- Several existing roads.
- Several proposed roads

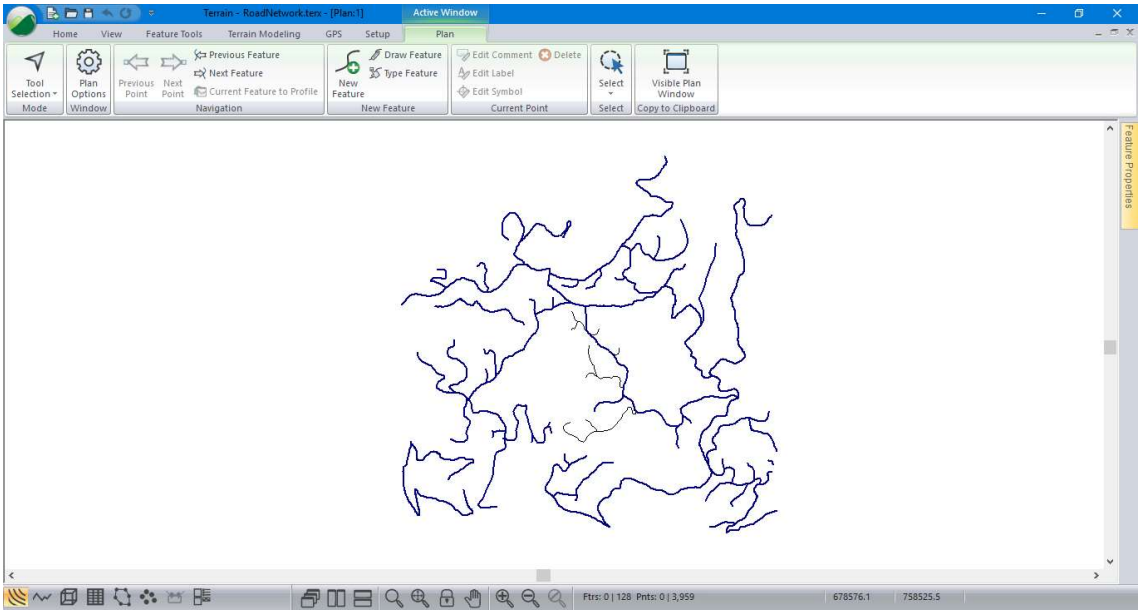


Figure 5-1: *RoadNetwork.terx*

Typically, the coverage from a LiDAR dataset is much larger than what the user would like to model, and this can cause unnecessary computation time or simply make the computations infeasible. To counter this, data can be filtered upon import by a rectangle, corridor, polygon, and combinations of all three. Note that the Default region represents the entire dataset.

Denser information is only needed around a couple of roads that will be used for this design so filtering by corridor will be the best path forward.

20. *Home* | *Insert File* and select all six .LAS files from the folder **<RoadEngResource>\LiDAR** , by holding down the control key while selecting. Press *Open*.

The *Import Options* dialogue will appear (figure below).

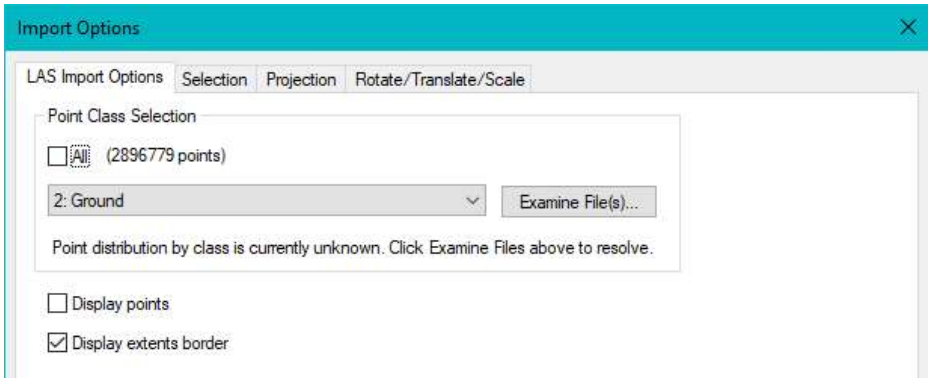


Figure 5-2: *Las Import Options*

21. Make sure that:

- ***2: Ground*** is the only *Point Class* that is imported
- *Display points* is disabled (un-checked)
- *Display extents border* is disabled.

Note: In this exercise the entire LiDAR data set is read into the Terrain module and then the data is thinned. This is not possible for very large LiDAR files; the *Selection* tab in the *Import Options* dialogue (figure above) allows you to thin your data as it is being read from files.

22. Press *OK* to proceed with importing the data in full resolution.
23. Press *Continue* if prompted by the warning message as shown below:

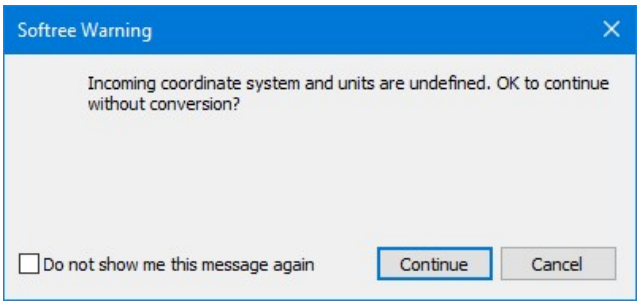


Figure 5-3 : *Warning Message* – Undefined Coordinate System

Basic Grid Simplification (fast)

In the status bar at the bottom of the window there are values for the number of features and points in the file. The imported dataset (selected points) contains 2,896,779 points. This is manageable but unnecessarily large. We will now reduce the size of the dataset.

24. Select *Terrain Modeling* | *Simplify*.

This will open the *Simplify Surface Point Data* dialogue (Figure 5-5 below).

25. Ensure the *Method* is set to *Basic Grid Simplification (Fast)*. Set the *Sample Grid Spacing* to **10.00.**

This data will be used to make an original ground surface for designing two roads. We do not want to thin our surface data in these road corridors.

26. Exclude thinning for a road corridor:

- Under *Excluded Regions*, press *Add*.

This will open the *Filtering Region* dialogue (Figure 5-5below). This allows you to specify features (rectangles, corridors or polygons) to exclude from the filtering procedure.

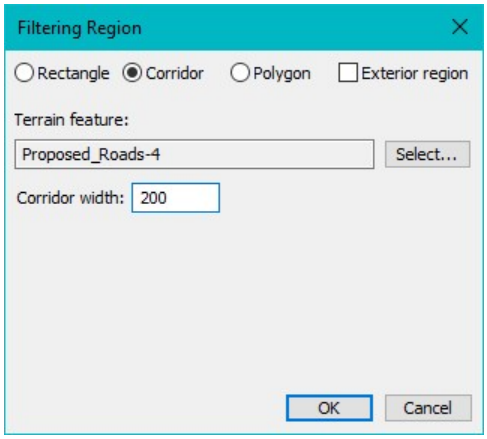


Figure 5-4 : *Filtering Region* dialogue box, corridor options.

- Select the *Corridor* option (as shown in the figure above).
- Press *Select* and <double-click> on the alignment feature "**Proposed Roads-4**" (near bottom of list). Press *OK*.
- Set the *Corridor width* to **200**. Press *OK*.

27. Repeat steps above to exclude "**Proposed Roads-6"** also.

Now there are two corridor regions excluded from our thinning: **Proposed Roads-4** and **6** (figure below).

28. Press *Calculate*.

Under *Point Counts* you will see that our settings will result in a 73.8% reduction, but the area within the two corridors will remain in full resolution.

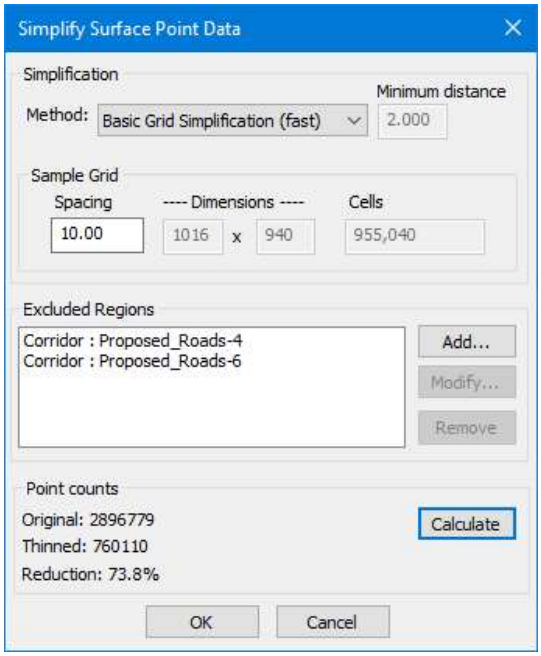


Figure 5-5: *LiDAR Thinning* : Basic Grid Simplification

29. Press *OK* to proceed with the thinning.
30. Press *OK* when prompted with the warning message: "Warning there is not enough space to UNDO this operation. Do you wish to continue?"

Zoom and Pan until you can see the two roads of interest (Figure 5-6). Note that the point density inside the two proposed road corridors has not been reduced, but the rest of the dataset is visibly sparser.

In the status bar the filtered dataset (selected points) contains 760,110 points. This is much more manageable for TIN computations.

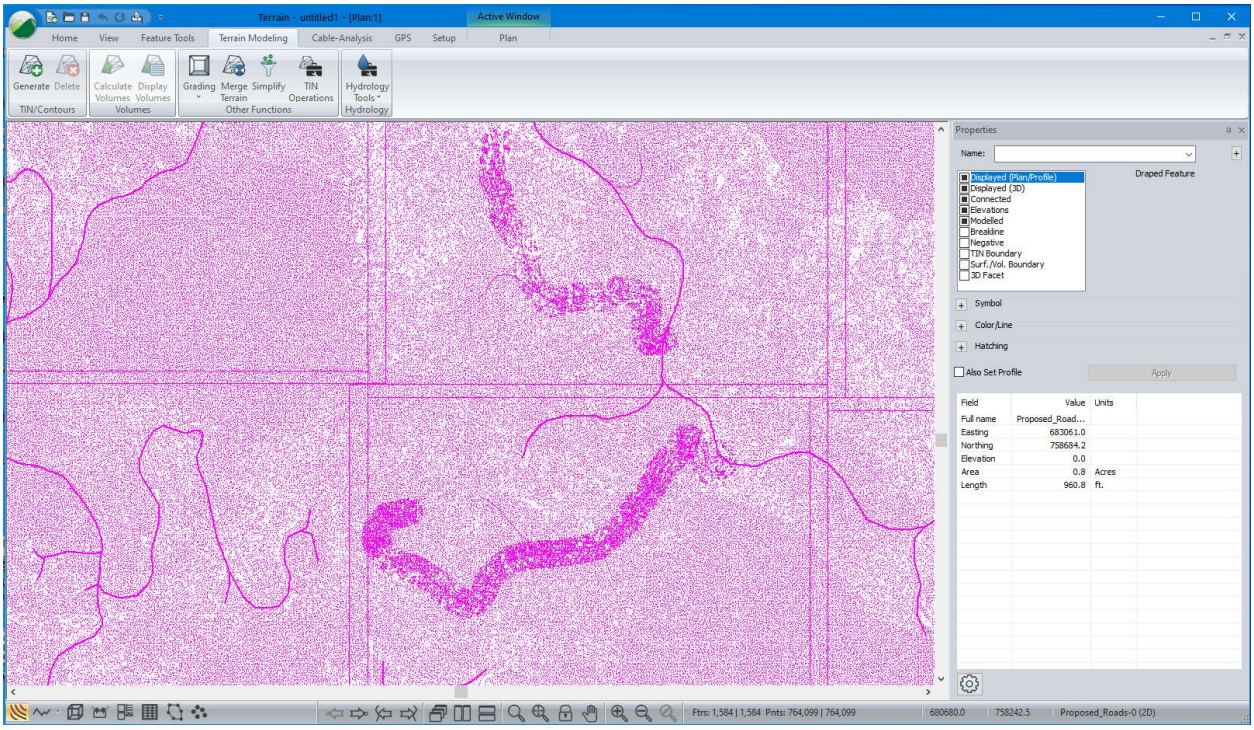


Figure 5-6: Filtered LiDAR Dataset

Generate TIN from LiDAR

31. If points are selected, deselect all points by clicking on a blank space.
32. *Terrain Modeling* | *Generate TIN*.
    - Set *major contours* to **10**.
    - Turn off *Minor Contours*.
33. Press *OK* to accept. A *warning* message will appear “Warning: Feature Extends…”, check the box to *not show the message again*, and press *OK* to continue.

The generated TIN model should look like Figure 5-7 (we’ve zoomed in a bit and set the line thickness heavier to make it more visible).

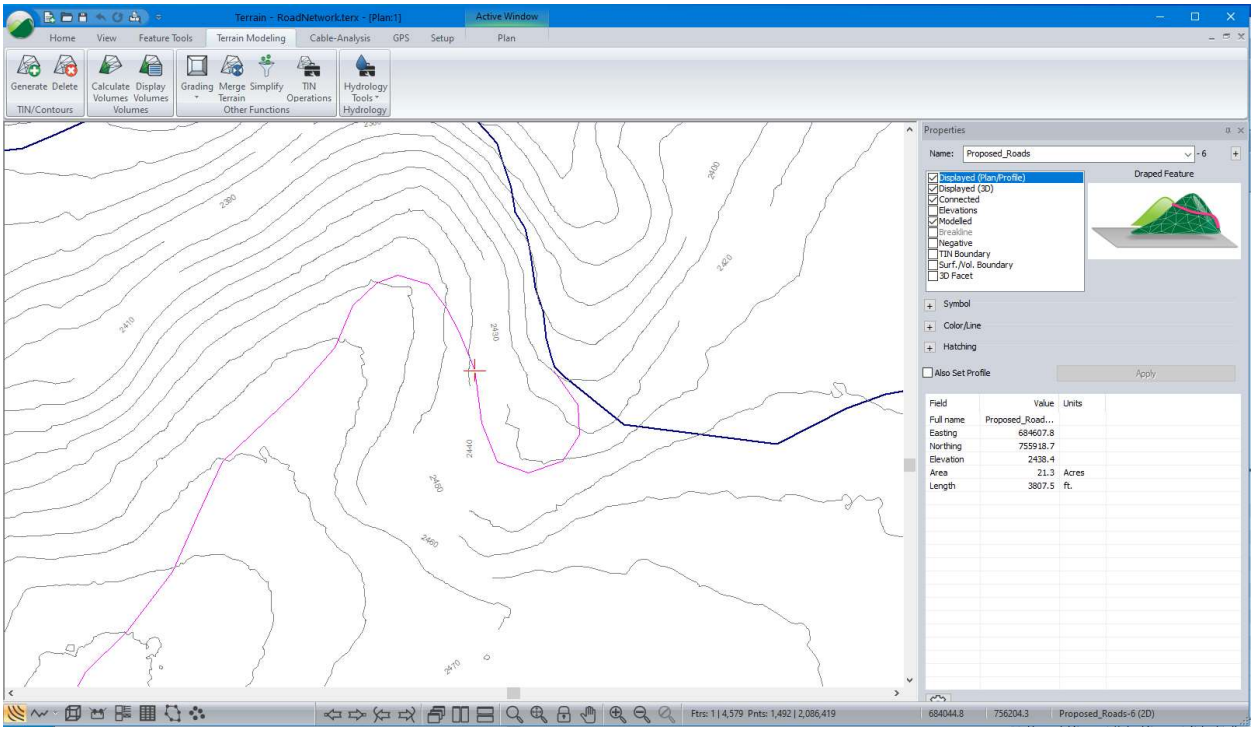


Figure 5-7: *TIN* From LiDAR

Before moving on to the next phase of our design process, the road design, we will need to save the file with the feature selected that we will base our start coordinate on.

34. Using your mouse or by *Home* | *Select* | *By Name*, select the **Proposed_Roads-6** feature as in Figure 5-7 above.
35. Use *Plan* | *Previous Point* to navigate to the start of the **Proposed_Roads-6** feature.
36. Normally, we would save this file and continue to the Location module; however, this has already been done for you in the form of **Topo.terx.**
37. *File* | *New* to continue to the next example. Do not save the changes.

6. New Location Design

There are three methods for creating a new location design:

- From a Terrain surface (ie. LiDAR) - .terx
- From a P-Line survey design - .tr1
- From another surface file (LandXML or other)

Method 1 – New Location Design from a Terrain Surface

With the LiDAR data successfully imported, and TIN model generated, the next step is to move on to the road design in the Location module. This example picks up

1. Open the Location module, or from Terrain, select *Setup* | *To Location*.

Before starting our new design, we will configure our *Location Module Setup.*

2. *Setup* | *Location Setup*. On the *Units* tab, ensure:
    - *Units* are in **Imperial (ft.)**
    - *Stationing* is in **Traditional S+dd eg. 12+01**
    - Press *OK* to close *Location Setup*

3. *File* | *New*, select *Terrain surface*, click on browse and select **<RoadEngResource>\LiDAR\Topo.terx** then press *Open.*

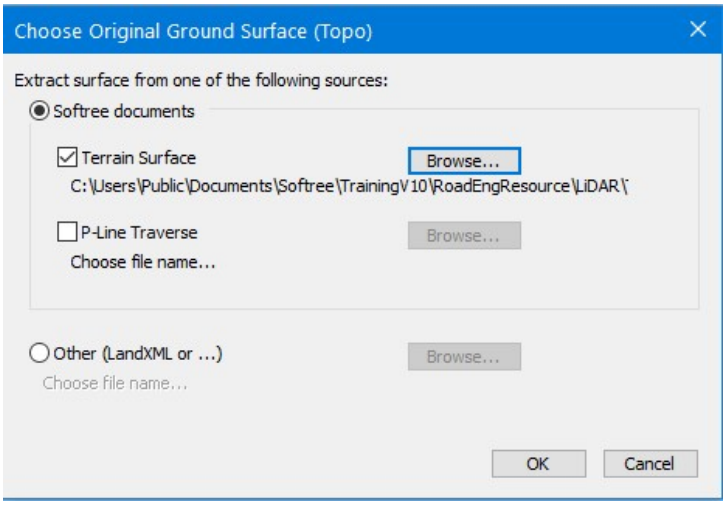


Figure 6-1: Select *Original Ground Surface (Topo)* Dialogue

4. *Initial Alignment* dialogue will appear, select *Terrain current point* for the start of alignment. Press *Next*.

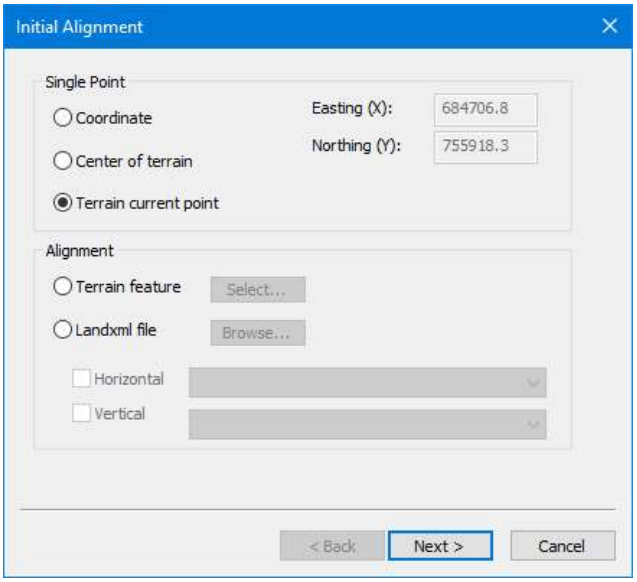


Figure 6-2: Initial Alignment from *Terrain Current Point*

5. *Initial Cross Section* dialogue will appear. Keep the default selection of *Standard Template*. Press *Finish*.

The look of your screen depends on the contents of the default *Screen Layout:* **<Defaults and Layouts>\Normal.dlt**. For this example, we will use a screen layout installed with the tutorial.

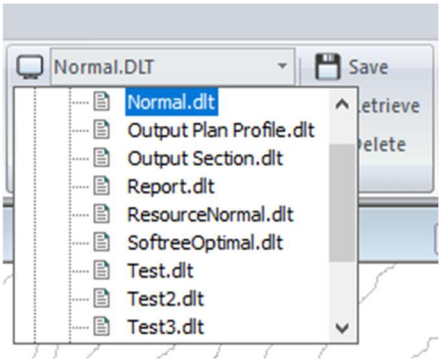


Figure 6-3: *The Screen Layout* Drop-Down.

The look of your screen depends on the contents of the default *Screen Layout:* **<Defaults and Layouts>\Normal.dlt**. For this example, we will use a screen layout installed with the tutorial.

6. Use the *Screen Layout* toolbar drop-down (figure above) to open **Training** folder, and select **training Normal.dlt**. The screen now should look similar to Figure 6-4.

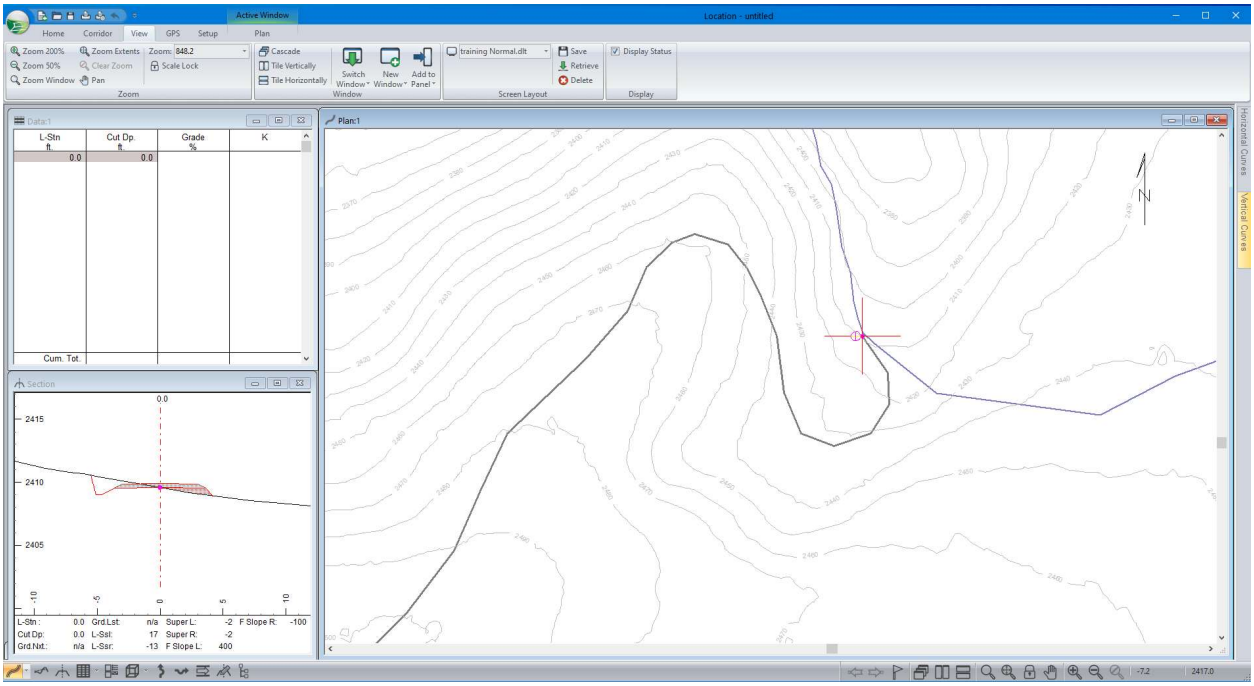


Figure 6-4: *Training Normal* Screen Layout

If you have not yet configured your default screen layout, you may wish to use the menu *View* | *Save* to over-write **Normal.dlt** with the current settings.

On your screen (Figure 6-4 above) you can see the original ground DTM in the Plan background; the line work is faded so it doesn't overwhelm the new alignment features.

The shape of your cross section depends on the contents of the default *Template table* (**<Defaults and Layouts>\Normal.tpl**). The next few steps will load templates for this exercise.

7. *Home* | *Templates*, to open the *Template Editor* shown below.

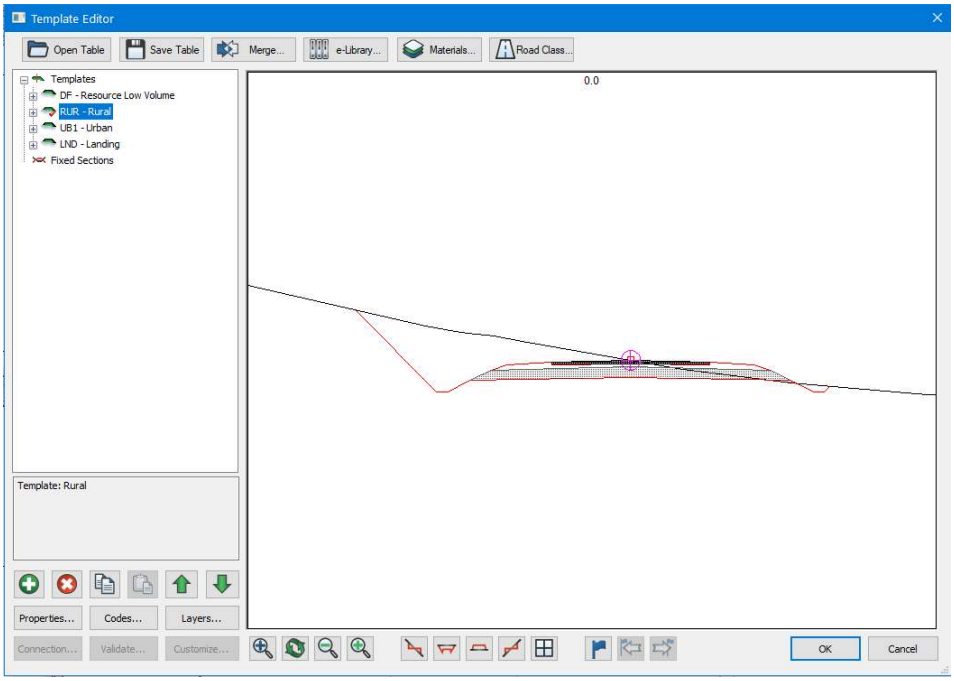


Figure 6-5: *Template Table Editor* Dialogue Box

8. Press the *Open Table* button and open <Defaults and Layouts> training\ **training_Low Volume English.tpl**.

Your screen should look like the figure below.

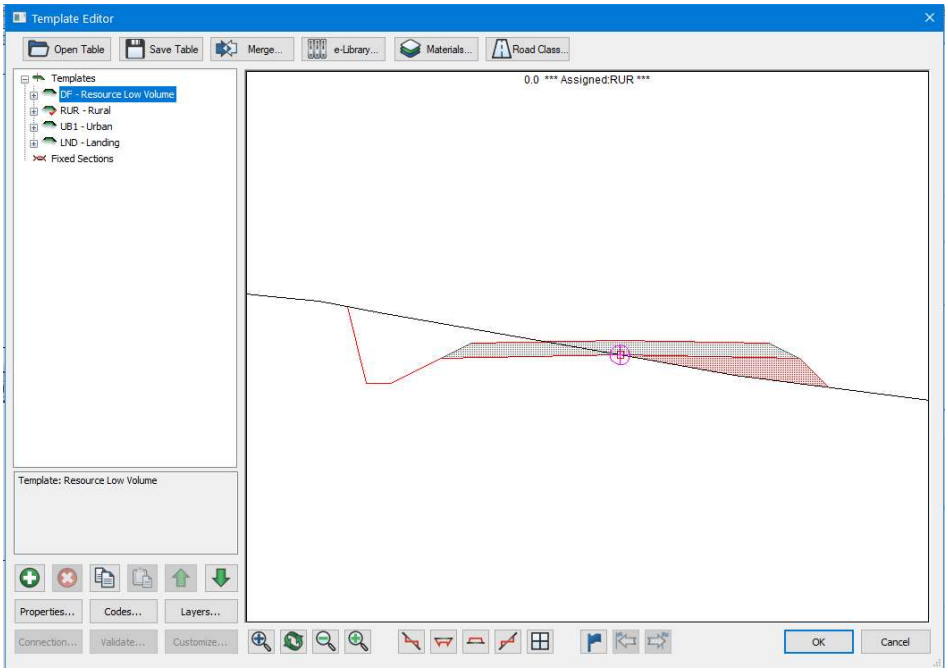


Figure 6-6 : Template Showing Training Training Low Volume English Template

Note: Templates can be saved in a library (.TPL file). This allows users to create their own customized pre-defined templates or to quickly retrieve a standard set.

If you have not yet configured your default templates, you may wish to use the *Save Table* button to over-write **Normal.tpl**. Note that templates depend on length units (feet or meters).

9. Press *OK* to close the *Template Table Editor*.
10. When prompted, press *OK* to *recalculate range*.
11. *Home | Assign by Range* to open the dialogue box, select the *Templates* tab.
12. In the *Template Name* drop-down, select **LOWV Low Volume**, and press *Add/Edit.*

Note: By leaving the *From Stn.* and *To Stn.* blank it applies the template to the full station range.

13. Press *OK* to close the *Assign Parameters by Range* dialogue.
14. When prompted, press *OK* to *recalculate range*.

The *Low Volume Template* has been applied to your full design. Templates will be discussed in more detail in upcoming chapters.

Zooming and Panning

The Zoom Tools buttons are available in the View tab ribbon (Figure 6-7), or through the bottom navigation bar (Figure 6-8).

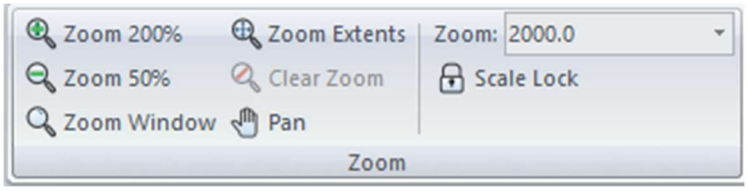


Figure 6-7: *View | Zoom Tools*

These allows you to *zoom in*, *zoom out, zoom to window, zoom extents*, *clear zoom* and *pan* respectively. There is also a function to set your *zoom scale*, and *lock your scale*.

Figure 6-8: *Zoom Tools* in the Navigation Bar

The middle roller mouse button is dedicated to zoom and pan functions.

Before we can begin creating IP's we need to adjust the scale of our Plan window to something much more appropriate for inserting IP's.

Using the middle roller ball (or a combination of the *zoom* and *pan* functions), zoom in to the red crosshairs indicating the start of the alignment (as denoted by the Roads-6 feature we selected before saving in a previous exercise).

Your scale should be similar to that shown in Figure 6-9 below.

Create a New IP

15. <Right-click> in the Plan window and select the menu *Add/Edit IP Tool* or *Home | Tool Selection | Add/Edit IP.*

The cursor will now look like a pencil ; you are ready to add intersection points.

16. Click with the pencil cursor (away from the existing point) to create a new point.

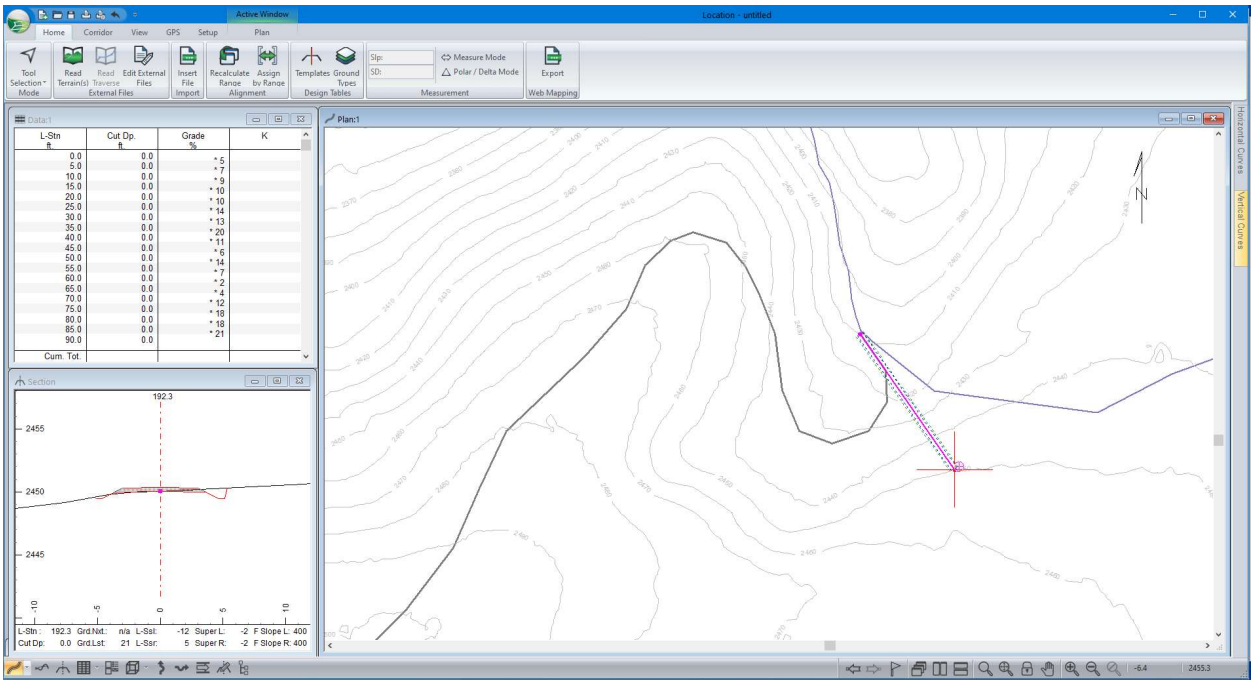


Figure 6-9: Drawing the *Horizontal Alignment*

17. Move the mouse cursor to the position shown in the figure above. Click a second time to anchor the new point.

18. Continue adding 3 more IP's at the positions shown in Figure 6-10.

The rest of the horizontal IP's have been added and saved in a design that will be used in the Adding Horizontal Curves section.

The alignment should look similar to Figure 6-10:

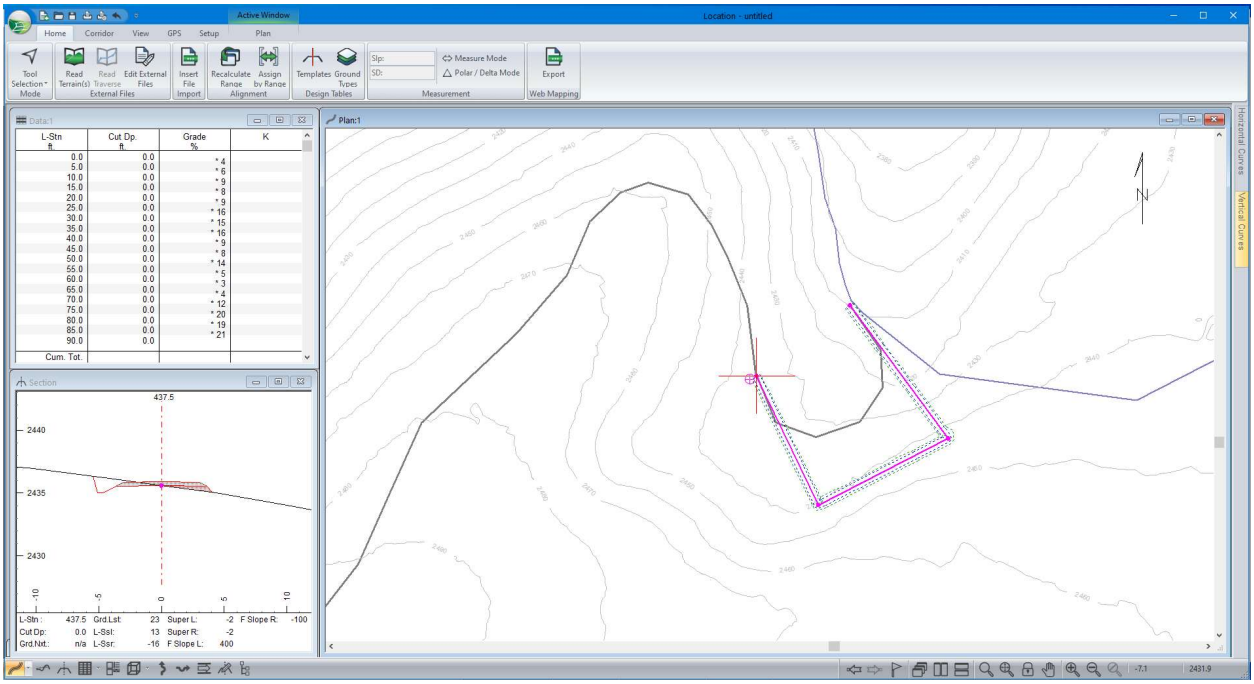


Figure 6-10 : Start of *Horizontal Alignment*

Edit an IP

19. Move your mouse over an IP; note that the cursor changes to a box ⌜ ⌝.
20. Click the mouse to capture the IP.
21. Move the mouse to a new position and click a second time to re-anchor the IP.

Insert an IP

22. Move the mouse over a segment between IPs; note that the cursor changes to a pencil with cross ↘.
23. Click the mouse to create a new IP – it should be connected to the previous and next points.
24. Move the desired position (not important) and click a second time to anchor the IP.

Delete an IP

25. Move your mouse over the IP created above; note that the cursor changes to a box ⌜ ⌝.
26. Click the mouse to capture the IP.
27. Type the <delete> key to remove the IP.

Note: Try using *Edit* | *Undo* command, <Ctrl-Z>, to undo your last edit.

28. *File* | *Close*. Do *not* save changes.

Adding Horizontal Curves

To create a horizontal curve, you first identify an IP. Then you define a curve between the tangents it defines. Horizontal curves are created and edited using the *Horizontal Curve Panel*  . The previous example has been completed for you. Continue with the steps below.

1.  *File* | *Open*, select <RoadEngResource>\ LiDAR **Road6 - 1.dsnx** then *Open*.
2. Use the *Screen Layout* toolbar drop-down to open **Training** folder, select **training Curve H.dlt**. The screen now should look similar to Figure 6-11 below.

Note: You have to turn on your background contours. *Right click* plan view | *Plan Options…* | check background box.

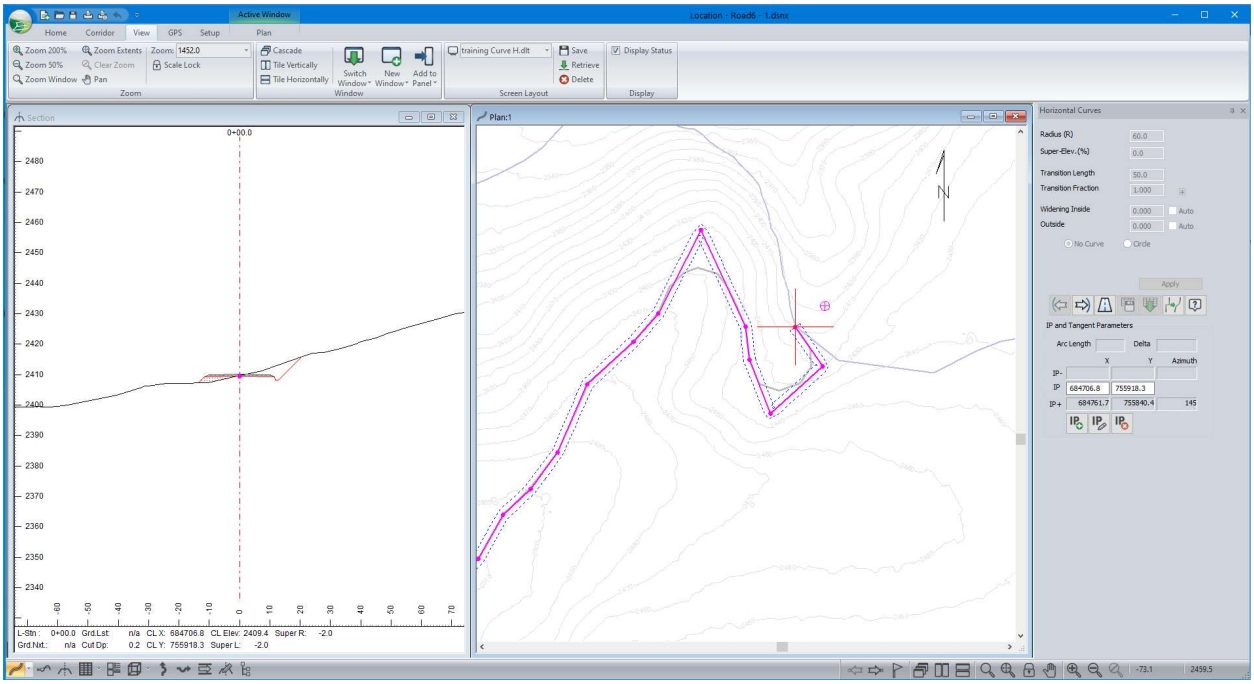


Figure 6-11 : *Horizontal Alignment* Without Curves

3. Use the *Previous IP*  or *Next IP*  buttons in the *Horizontal Curves* panel to move to the second IP in the alignment (watch the Plan window).

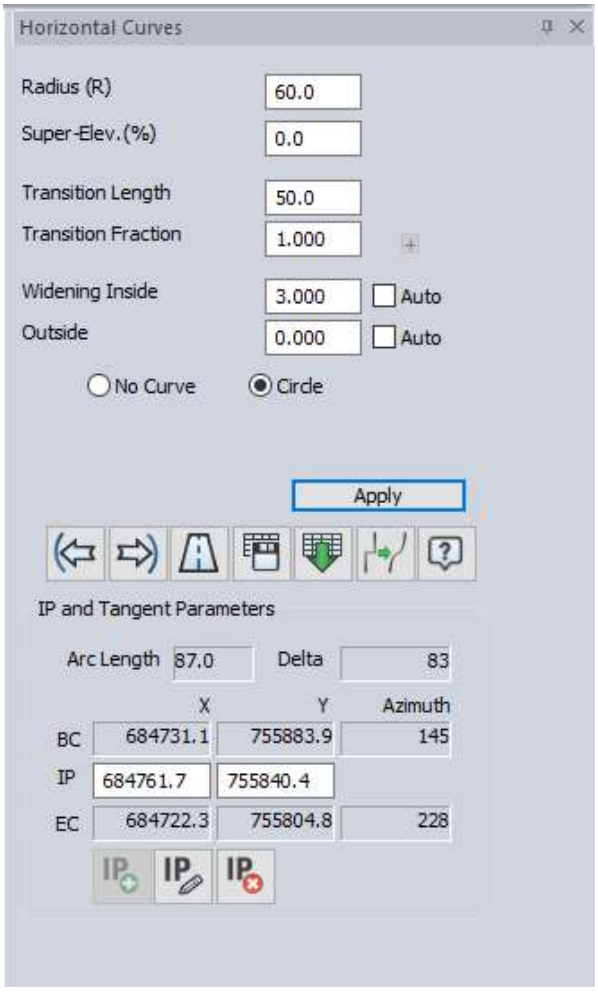


Figure 6-12: Horizontal Curve Panel

4. Press the *Get Default Curve* button to set up the parameters as shown in Figure 6-12 above.

Note: The curve panel controls are disabled until the current point is an IP between two tangents. Most of the controls are still disabled until you either select *Circle* or press the *Get Default Curve* button.

Default curves and associated tables are stored with your template table. The default template table is Normal.TPL.

5. Press the *Apply* button to create the first curve.

6. Use the *Next IP* button to move to the third IP in the alignment and repeat the steps above to create the second curve. If the curve doesn't fit, then *Edit* the IP until the curve can be applied.

Note: The current cross section is shown in the Plan window as a red cross. When you have finished editing a curve, the current cross section is the *End Curve* (EC) point.

7. Continue editing the alignment and adding curves until you are comfortable with the process Figure 6-13.

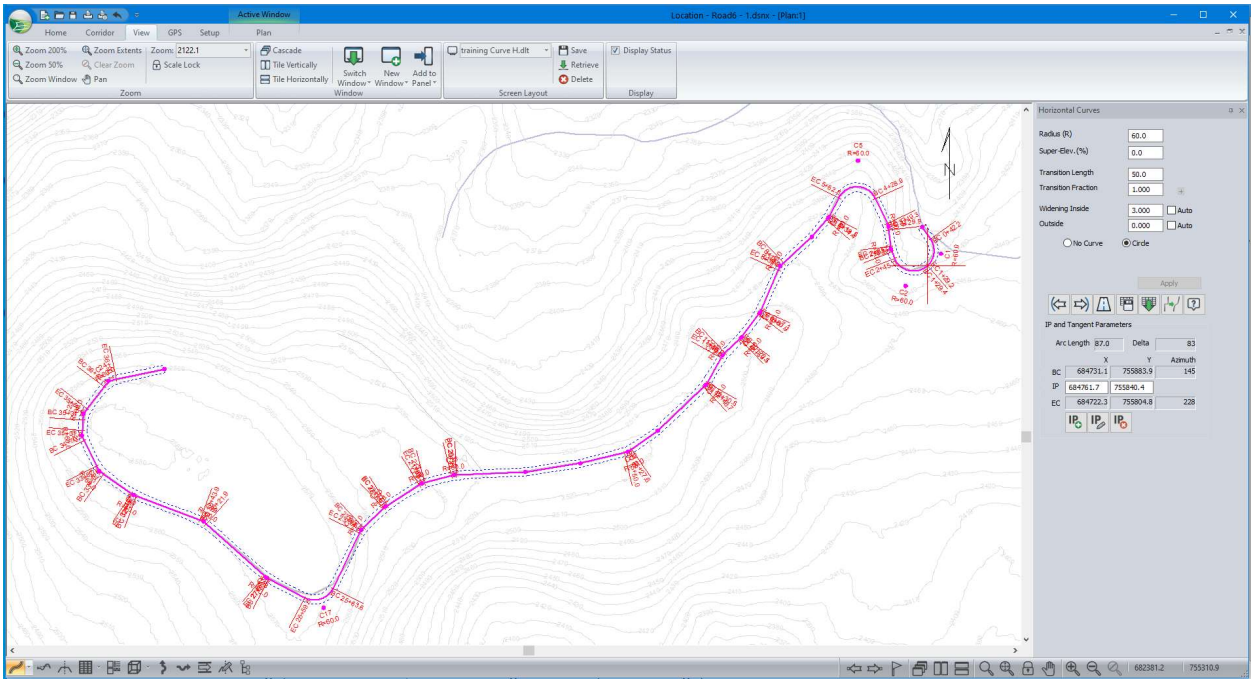


Figure 6-13: Additional *IP Placement* for Midpoint Tie-In Feature

8. *File* | *Close*. Do not save changes.

Method 2 – From a P-Line

This short exercise will demonstrate how to create a short road alignment from a P-Line traverse.

Note: See Getting Started section for file install folders (**<RoadEngResource>** and **<Defaults and Layouts>**)

1. Open the Location Module.
2. *File* | *New* to open the dialogue box below.

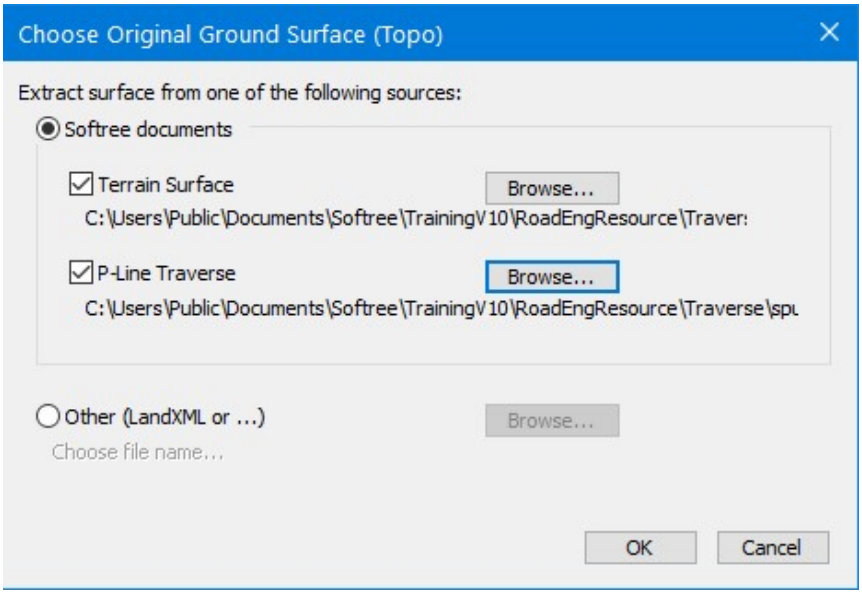


Figure 6-14: Menu *File* | *New* opens the File Open Dialogue Box

This is where you specify the original ground surface. In this example, we will open both a Survey/Map traverse (for P-Line alignment, ground type, comments, and culvert information) *and* a Terrain (for the DTM surface). Either one of these would be sufficient.

The traverse file (TR1) contains enough information in the *side shots* to define cross sections for the Location module. See ***P-Line Survey Note*** *Entry* for details on creating a traverse using Survey/Map.

The Terrain we will use was created from the Survey/Map traverse; see ***Creating a DTM with Contours***. This surface provides a better way for the Location module to interpolate cross sections between the surveyed side shots. Creating this Terrain requires a little extra work, but it allows you to detect problems in the survey and you can add additional elevation points (from other surveys perhaps) and break-lines to improve the fidelity of the surface.

3. Check *Terrain Surface*, browse to **<RoadEngResource> \Traverse\ Spur.terx.**
4. Check *P-Line Traverse,* browse to **<RoadEngResource>\Traverse \Spur.tr1.**
5. Press *OK* to create the new Location design.

The new location design has used the P-Line alignment as the basis for the initial horizontal alignment.

6. Click in the Plan Window. Use the *Pan* tool to adjust your view to look similar to the figure below.

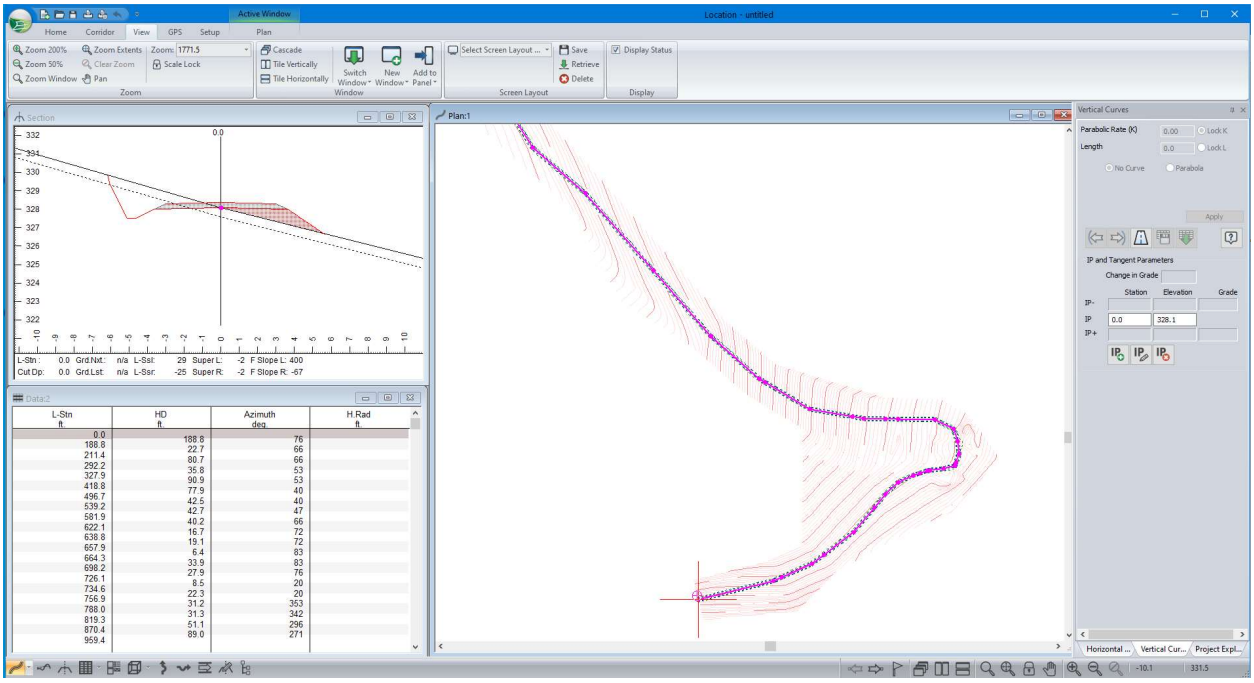


Figure 6-15: New Location Design From a *P-Line*

We can now make design changes with the *Add/Edit IP Tool* mode similar to how we did in Method 1 above.

7. *File | Close.* Do not save changes.

7. Vertical Alignment

This exercise follows on from the previous. A horizontal alignment must be created before you can create a vertical alignment.

In the following steps, you will create a vertical alignment by creating vertical intersection points (VIPs) with the mouse. VIP editing in the Profile window is very similar to IP-editing in the Plan window.

1. *File* | *Open* <RoadEngResource>**LiDAR\ Road6 - 2.dsnx**
2. Use the *Screen Layout* drop-down to open **Training** folder**,** and select **training Profile.dlt.** This will set up your screen to look like Figure 7-1 below:

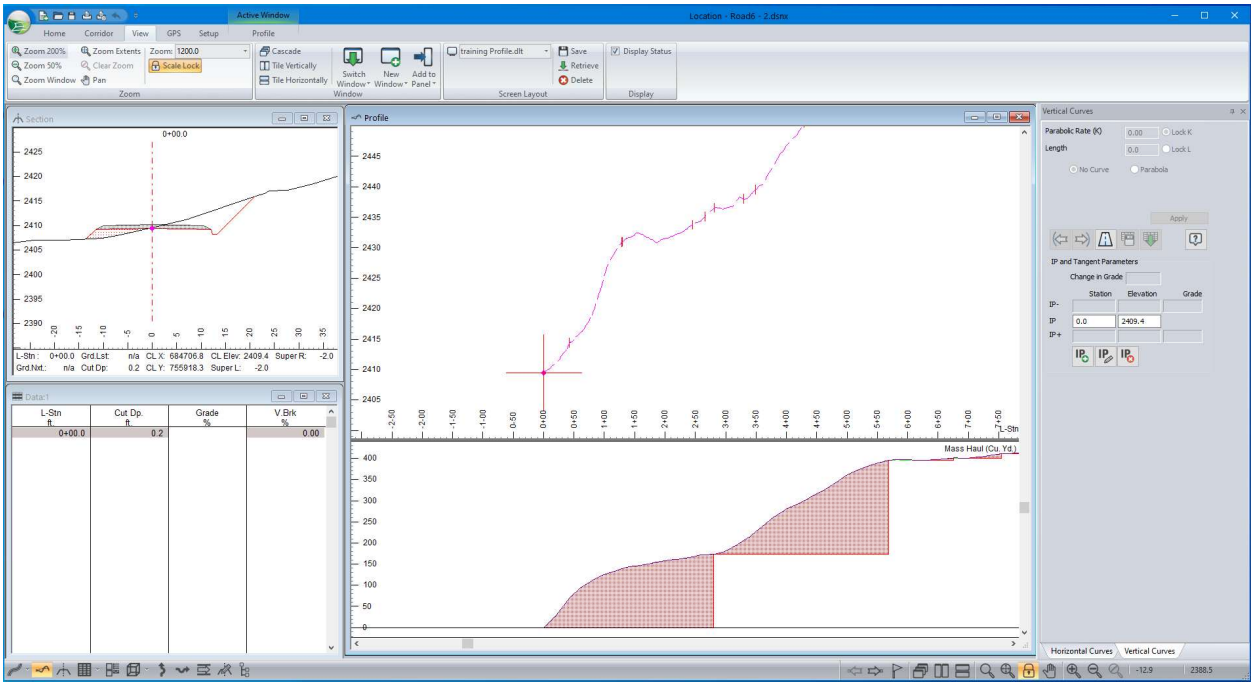


Figure 7-1: *Location Design* without Vertical Alignment

3. <Right-click> in the Profile window and select the *Add/Edit IP tool,* or Home | Tool Selection | *Add/Edit IP Tool* button .

The cursor will now look like a pencil .

4. Click with the pencil cursor anywhere to the right of station 0+00 to create a new VIP.
5. Move the captured point to a desired position and click again to anchor the point.

As in the previous exercise, use the mouse to create VIPs as close to the original ground line as possible. Make sure you practice all of the following:

- Create a new VIP at the end of the existing alignment.
- Edit an existing VIP.

- Insert a VIP between existing VIP.
- Delete a VIP.

Note: There are a few subtle differences between editing in the Plan and Profile windows:

In Profile, you can't have a backwards segment (if you insert a point between two existing VIPs, you are restricted to that station range).

In Profile, you can insert a point no matter where your mouse is. In the Plan you must mouse over a segment.

Profile editing is constrained by the length of the horizontal alignment. If you remove one end of your horizontal alignment, you will generally remove some vertical alignment.

6. Continue editing the Vertical Intersection Points until you are comfortable with the process.

Pay attention to the information available in the other windows. When you change the vertical alignment, volumes and cross sections are updated dynamically.

7. *File* | *Close*. Do not save changes.

Adding Vertical Curves

Vertical curves are like horizontal curves: you first identify a VIP, and then you define a curve between the tangents it defines. Vertical curves are created and edited using the *Vertical Curve Panel*.

1. *File* | *Open* <RoadEngResource> \ **LiDAR \Road6 – 2b.dsnx** to continue with the example.

Like all panels, *Vertical Curve Panel* can be displayed as a docked, floating or in auto-hide mode.

- In docked mode, the panel will be attached to either side of the main window.
- In auto-hide mode, the panel will be displayed as a tab on the left-side of the screen.
- In floating mode, the panel can be placed anywhere.

2. Try auto-hiding the panel by pressing the pin . Note how this hides all the active panels.

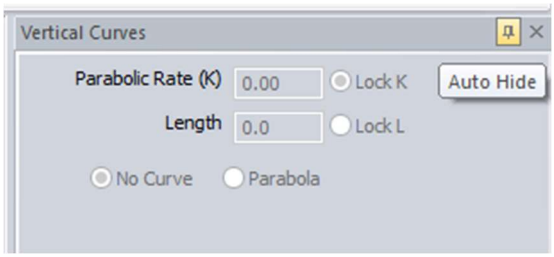


Figure 7-2: Docking Button in *Vertical Curve* Panel

3. Press the pin again to restore docked mode.
4. *Maximize* the Profile window.

Your screen should look similar to Figure 7-3 below:

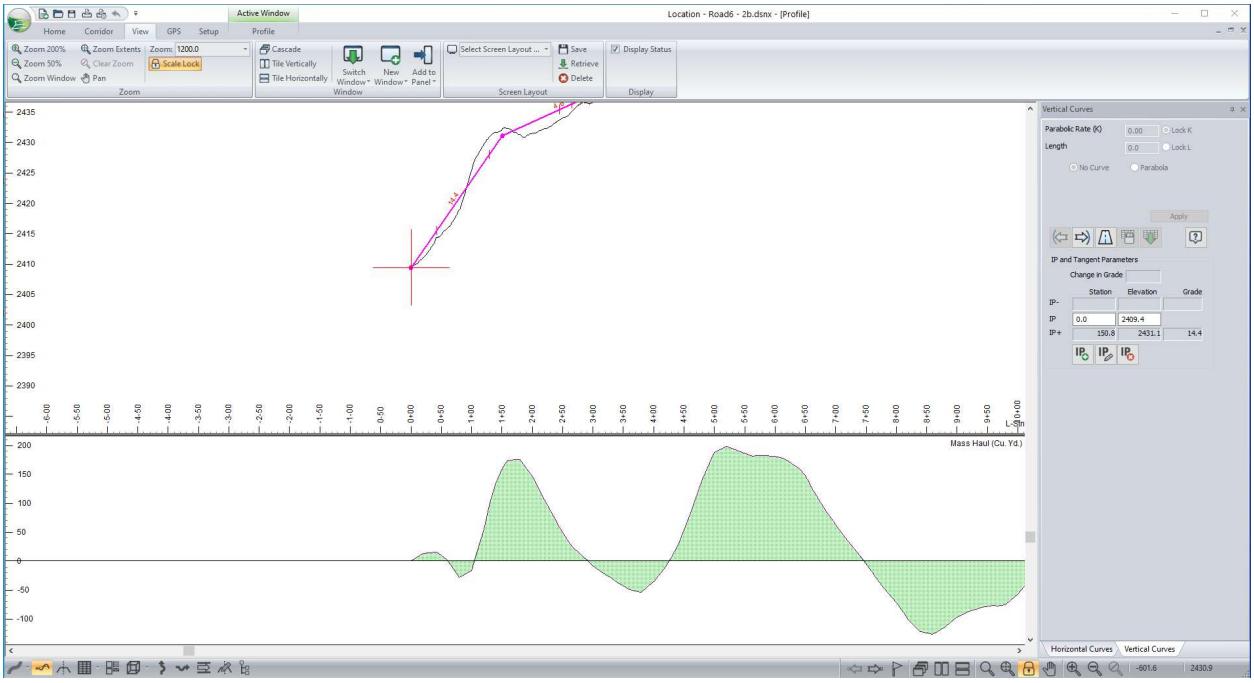


Figure 7-3: *Vertical Alignment* Without Curves

A maximized window will not cover the docked panel. The bottom panel tabs allow you to switch between multiple panels.

Add a vertical curve:

5. Use the *Previous IP* or *Next IP* buttons to move to the second Vertical IP in the alignment (watch the Profile window).
6. Press the *Get Default Curve* button and enter **20** for the *Parabolic Rate (K).*
7. Press *Apply* to create the first curve.
8. Press the *Set Default Curve* button to save this specification as the default.
9. Use the *Next IP* button to move to the third VIP in the alignment. Repeat steps 6-7 above (only change the *K* value when appropriate).

Note: When a curve does not fit tangents (vertical or horizontal), you can either:
- Shorten the curve (reduce R or K).
- Shorten the previous and/or next curve.
- Move intersection points to reduce the angle between tangents.
- Move intersection points to lengthen the tangents.

The current cross section is shown in the Profile window as a red cross. When you have finished editing a curve, the current cross section is the End Vertical Curve (EVC) point.

10. Continue editing all the VIPs until you finish adding all the curves, it should look similar to what's shown below.

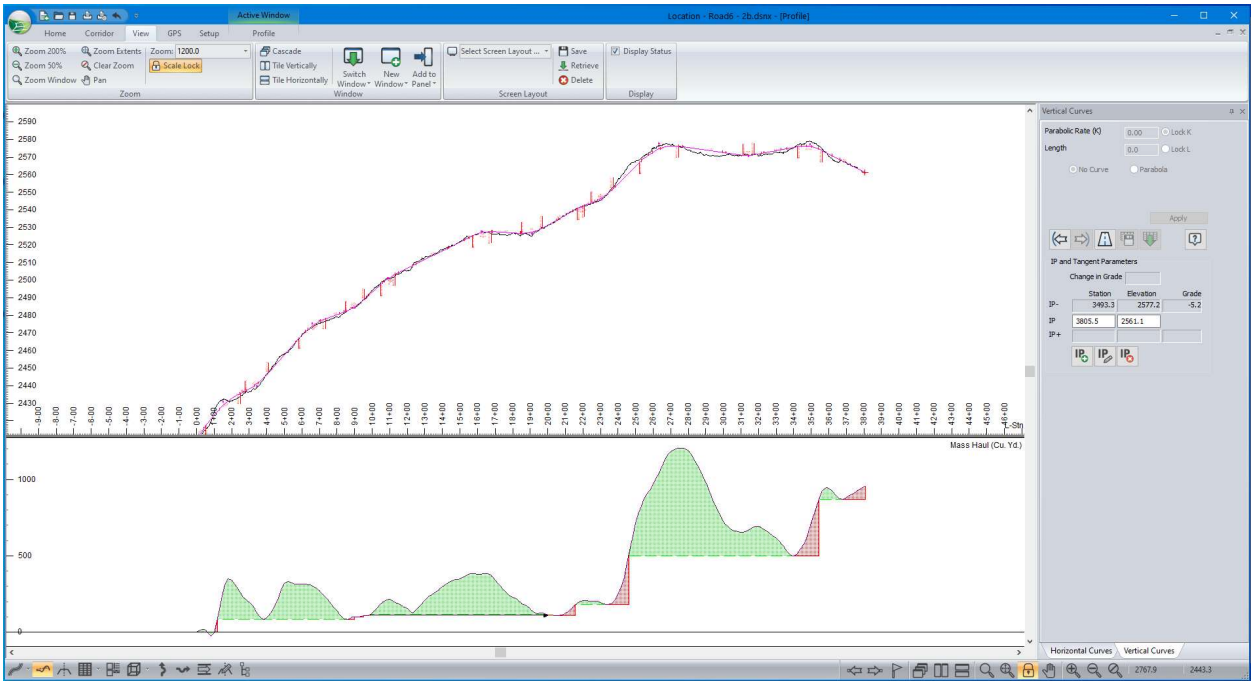


Figure 7-4: *Vertical Alignment* with Curves

11. *File* | *Close*. Do not save changes.

8. The Mass Haul Diagram

In this section, we will explore some of the RoadEng features for Alignment design and earthwork balancing.

The *Mass Haul* Diagram provides quick, qualitative information about cut and fill volumes and movements. This exercise will explore the options available for configuring this graphic.

Mass Haul is a graphic representation of accumulated volume; at any station, the value is the accumulated *cut volume* minus the accumulated *fill volume* up to that point. The difference in Mass Haul between two points indicates the volume of surplus (positive difference) or deficit (negative difference).

The default setting for mass haul includes only sub-grade material. However, it is possible to select specific materials for inclusion.

1. *File* | *Open* <RoadEngResource>\ **LiDAR \Road6 – 3.dsnx**
2. Using the *Screen Layout* drop-down menu open **Training** folder, select **training Profile only.dlt**. This will set up your screen to look like Figure 8-1 below.

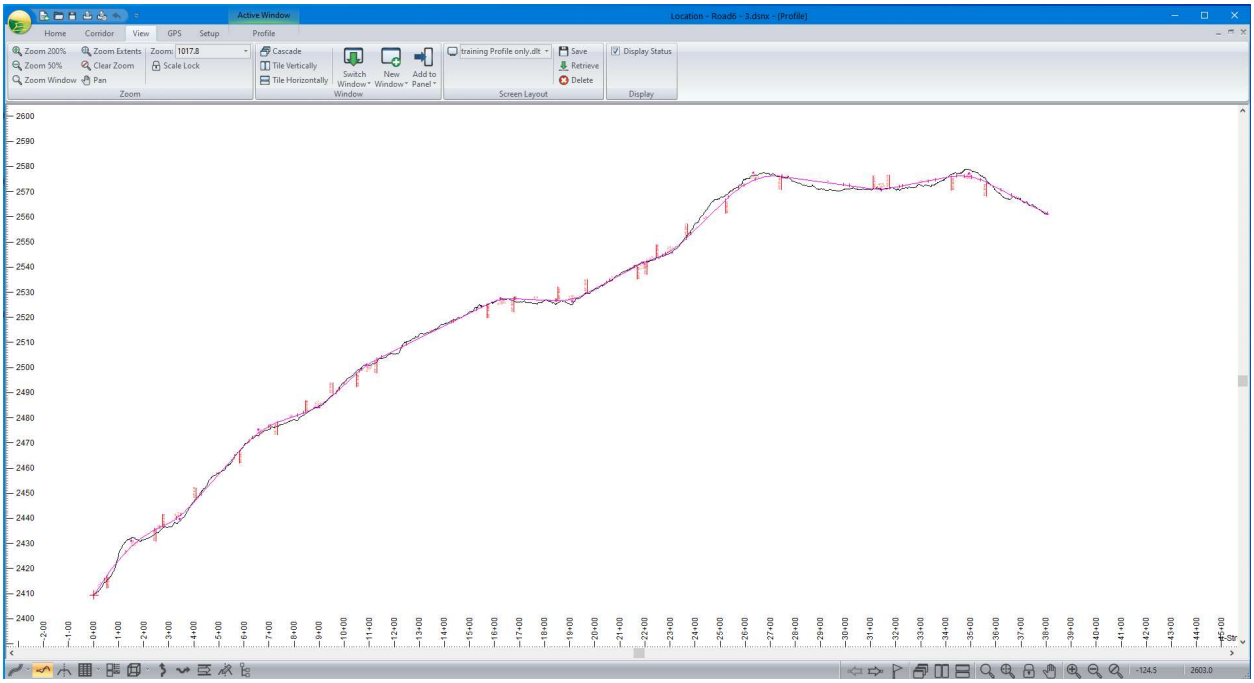


Figure 8-1: Location Design After Opening *Training Profile Only.dlt* Screen Layout

3. Add a *Mass Haul* graphic to the Profile window:
    - <Right-click> in the Profile window and select *Profile Options* to open the *Profile Windows Options* dialogue box.
    - Press the *Select* button at the bottom of the Sub-Windows area.

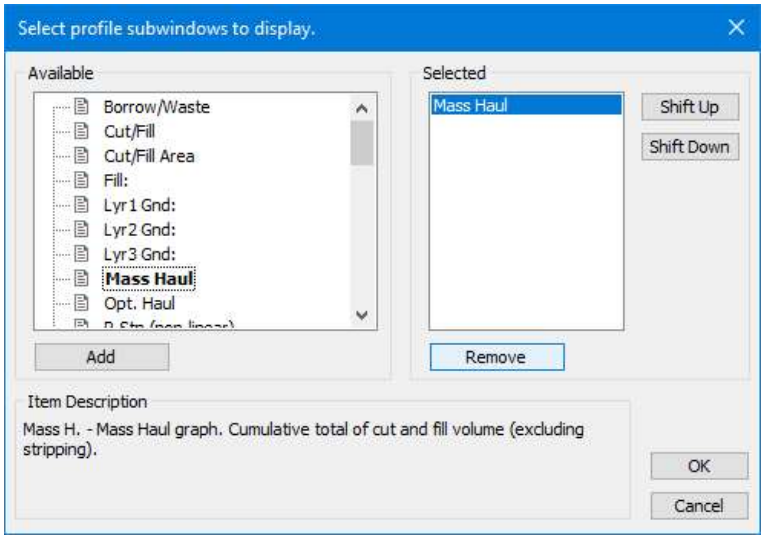


Figure 8-2: Select *Sub-Windows* For the Profile Window

- Select *Mass Haul* on the left and click *Add* (or double click) to add it to the *Selected* list on the right.

Note: The profile sub-windows area can display multiple items. All sub-windows will share the same horizontal axis (station) with the profile window.

4. Press *OK* and *OK* again to accept changes and close the dialogue boxes.

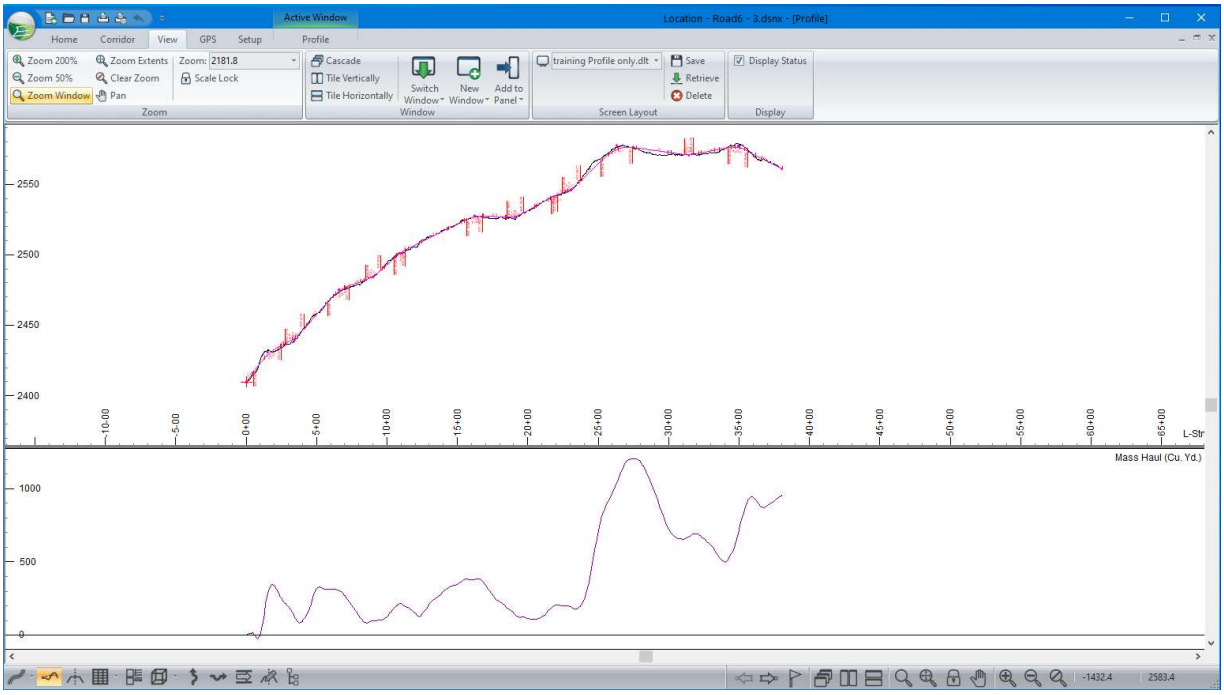


Figure 8-3: *Mass Haul* Sub-Window Displayed at the Bottom of the Profile.

5. Move your mouse over the divider between the main profile window and the mass haul; when it changes to the sizing cursor, click and drag up to make more room for the mass haul.

Now we will configure the *Mass Haul* to show hatching by haul type and to show haul direction.

6. Right-click in the *Mass Haul* window and select menu *Mass Haul Options* to open the dialogue box shown below.

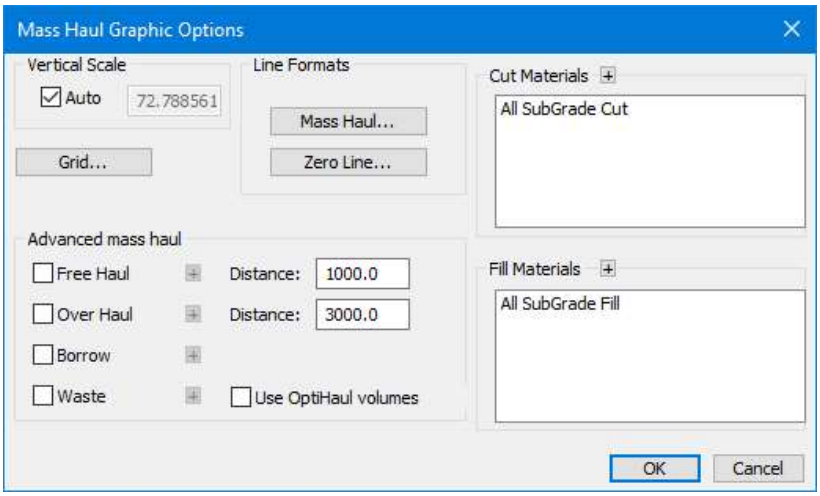


Figure 8-4: *Mass Haul* Options with All Features Enabled

Note: The concepts behind the mass haul diagram are discussed in detail in the help document. Type <F1> and read the help text if you are unfamiliar with terms such as *Free Haul*, *Over Haul*, *Borrow* and *Waste*. Close the help window when you are done.

7. Press the *Grid* button to display the common grid and axis label control.

Notice that the horizontal axis is disabled – it would be identical to the Profile axis and therefore redundant.

8. *Cancel* to close the grid options.

The *Line Formats*, *Mass Haul* and *Zero Line,* buttons allow you to control the line style and color of the basic graphic items.

9. Turn on all four *Advanced mass haul* items.

The *Free Haul Distance* and *Over Haul Distance* are controlled by the *Distance* fields to their right.

The button beside each item allows you to control the hatching style and color. Do not change the current values.

10. Press *OK* to accept changes and close the options dialogue box.

11. *Zoom out* to fit the full alignment in the profile window. Or press *Zoom Extents*. Your screen should now appear as below:

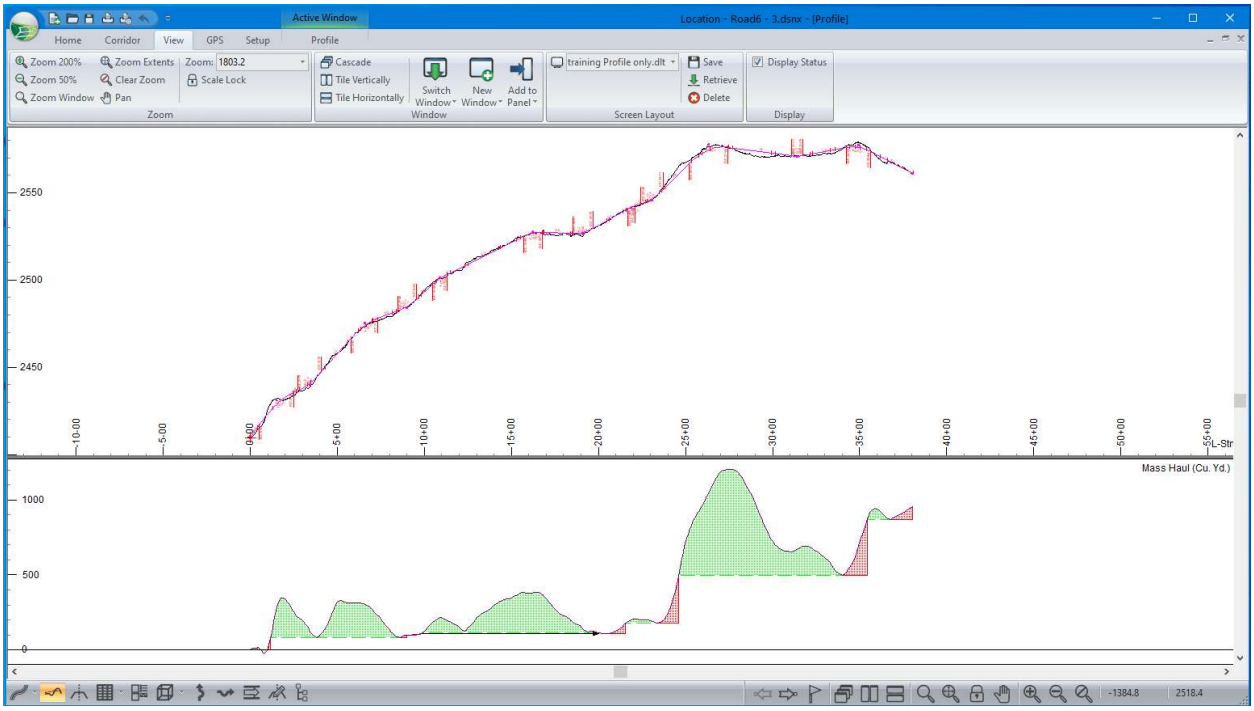


Figure 8-5: *Mass Haul* with Advanced Features Enabled

	Free Haul	Material which is pushed or pulled a distance less than the *Free Haul Distance* (100ft).
	Over Haul	Material moved beyond *Free Haul Distance* (100ft) and less than the *Overhaul Distance* (500ft).
	Borrow	Material which must be trucked in from outside the road project.
	Waste	Material which must be trucked outside the road project (End haul).

Adding a Pit

It is possible to modify the mass haul to account for borrow and waste. Will we add a waste pit at station 27+00:

12. *Home | Assign Parameters by Range.*
13. Select the *Pits* tab (as shown on the top left in the figure below).
14. Press the *Add* button to open the *Pit Access Station* dialogue box.
15. Enter **2700** for the Station and press *OK*.
16. Select Waste and enable Variable volume (smart pit).
17. Enter **1200** for *Capacity (Cu. Yd)* (see Figure 8-6 below).
18. Press *OK*.

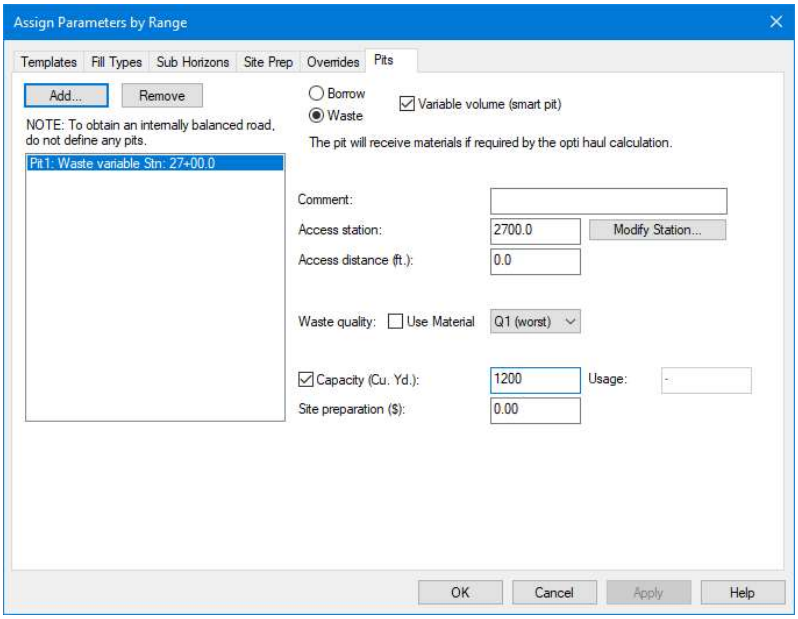


Figure 8-6: *Assign Parameters* by Range /Pits

19. Respond *OK* to *Recalculate Range*. Ensure *Re-Cost^* is checked.

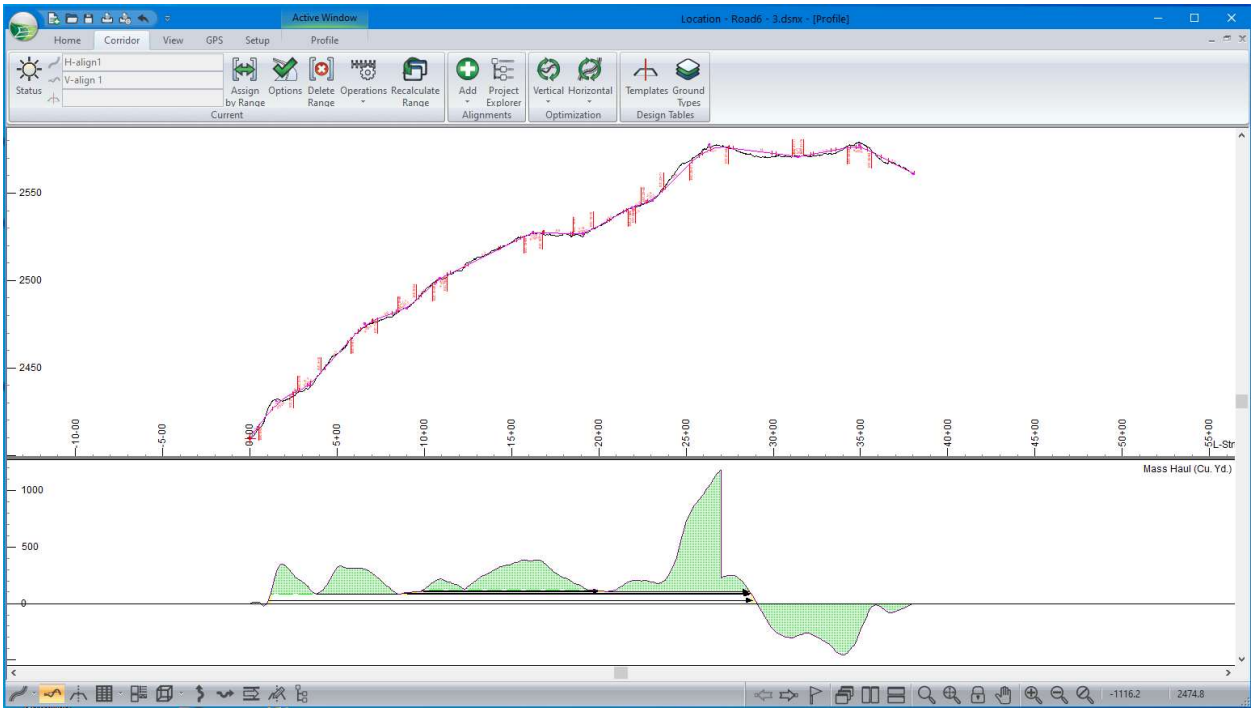


Figure 8-7: *Mass Haul* after 1,200 Cubic Yards Wasted at Station 27+00.0

The waste pit is indicated by a vertical drop at station 27+00.

We will now demonstrate how to remove a Waste Pit, as this specific waste pit will not be needed for later examples:

20. *Home | Assign Parameters by Range*.
21. Select the *Pits* tab.
22. With the Pit at station 27+00 selected, press *Remove.*
23. Press OK to close the *Assign Parameters by Range* dialogue box.
24. Respond OK to *Recalculate Range*.

Displaying Data Volumes

To display volumes related to mass haul, the Data window can be activated and configured as required.

25. *View | New Window | Data.*
26. Display Data window next to Profile window by *Window | Tile Vertically* or by pressing  in the bottom navigation bar.
27. Add data to Data window, <right-click> in the Data Window | *Data Options.* This opens the *Data Window Options dialogue.*
    - Press the *Columns…* button to configure your data fields for display.
    - In the *Available* Fields selection box, open the *L-Line* folder and select **L-Stn** and press *Add*.
    - Add **Cut V.**, **Fill V.**, and **Mass H.** from the *Volumes* folder as seen in Figure 8-8 below.

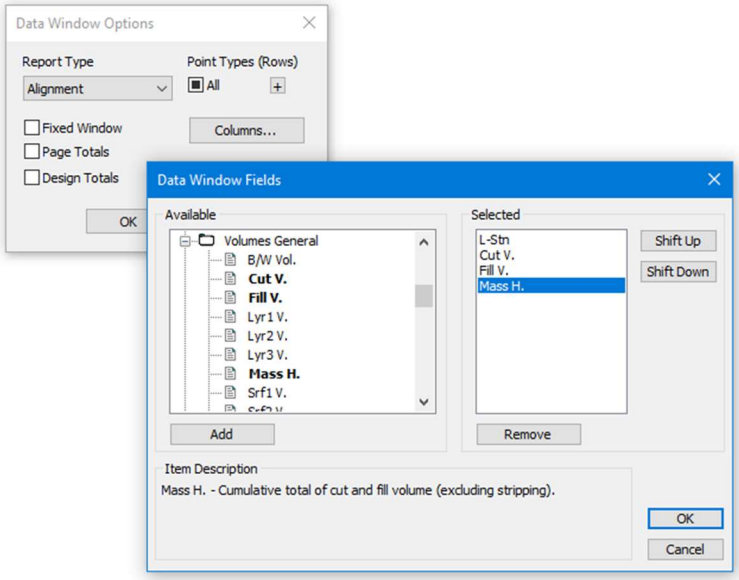


Figure 8-8: Adding *Mass Haul Information* to Data Window

28. Press *OK*, ensure the *Design Totals* checkbox is selected (checked), press *OK* again to continue to Data window.

Note: When working with the Data Window Options, you have several check box options

Fixed Window: If selected, the Data window is not moveable or sizeable.
Page Totals: If selected, totals of all rows displayed in the window are shown at the bottom.
Design Totals: If selected, totals of all rows from the beginning of the design to the bottom of the window are shown.
Point Types: defines which rows are displayed.

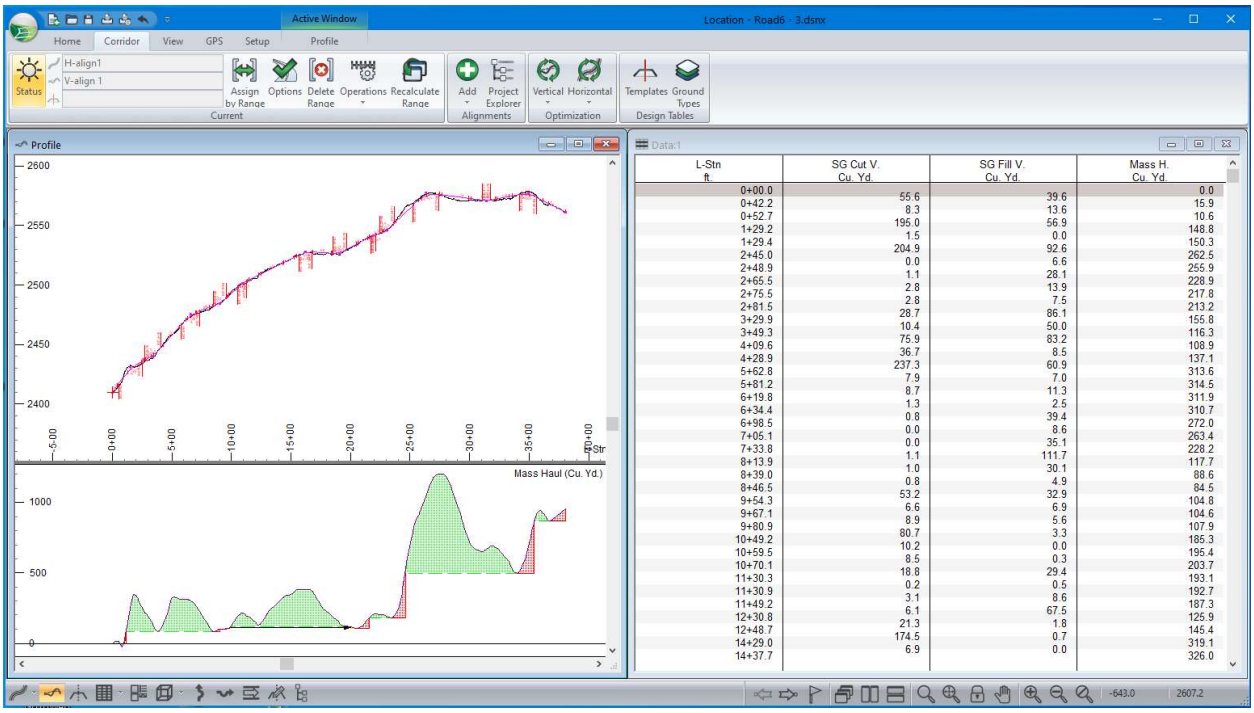


Figure 8-9: *Data Window* Complete with Mass Haul Information

Commonly, these figures in the Data window as shown in Figure 8-9 above would be activated while designing both the horizontal and vertical alignments. This example will be left unbalanced to illustrate further examples more clearly.

29. *File* | *Close*, do not save changes.

9. Softree Optimal Design Tools

RoadEng contains several features from the Softree Optimal technology. This section will briefly introduce these functions.

Complete descriptions and example tutorials are included in the *Softree Optimal* documentation (downloadable from the Support section of the Softree web www.softree.com/Support/).

The following features are available standard in a RoadEng license:

- ***Design Time Costing*** - dynamically calculates the cost of a design based on cut, fill and material movement.
- ***Optimal Haul Calculation***- determines the best (lowest cost) way to move material.
- ***Smart Pits*** - Automatically determines the pits to borrow and waste material.
- ***Quick Fit Profile*** - Quickly calculates a starting vertical alignment which matches your curvature and grade constraints.

Design Time Costing

Cost reporting and feedback is useful at all stages of design (preliminary, detailed and construction estimation).

Design Time Cost Reporting is the ability to accurately evaluate the cost of a particular design interactively before it is complete. *Softree Optimal* provides interactive and automated feedback to report earthwork costs. This functionality is extremely useful for manual design and is a prerequisite for optimization.

Earthwork cost calculations are based on material excavation, embankment, movement and borrow/waste locations.

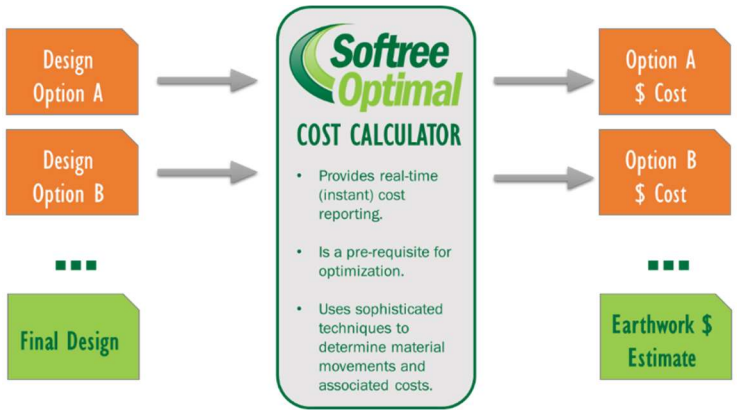


Figure 9-1: Design Time *Cost Reporting*

Optimal Haul Calculation

When *Softree Optimal* calculates the cost of an alignment, it determines the lowest cost prescription (or recipe) for moving material. We call this the *Optimal Haul*. The *Optimal Haul* is a detailed description of how material is moved along the alignment, and from/to borrow/waste pits.

Traditionally the mass haul diagram has been used to represent material movements, however it has some drawbacks. The *mass haul diagram* does not fully expose the Optimal Movement Prescription. It does not provide a detailed schedule of earth movement between stations and it does not handle the concept of material quality introduced in the case of multiple materials. The *Optimal Haul Diagram* addresses these two deficiencies.

The Optimal Haul *diagram* illustrates the Optimal Movement Prescription (as determined by Softree Optimal.)

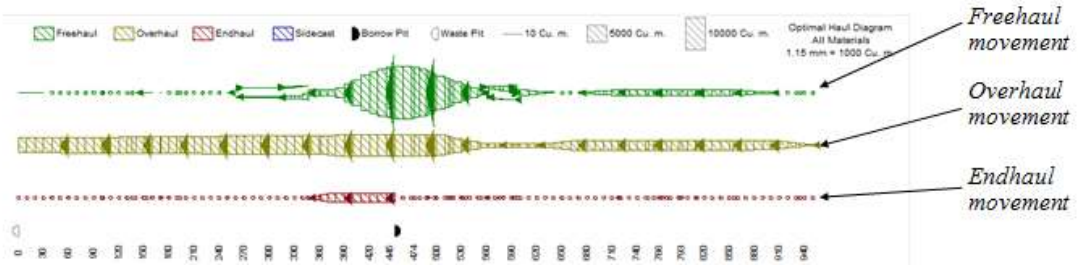


Figure 9-2: *Optimal Haul* Diagram

Smart Pits

The *smart pit* feature will allow you to determine the best location to borrow or waste material from a set of pits. Each pit has the following information:

Access station - location on the alignment from which the pit is accessed.

Distance - from access station to the borrow/waste site (sometimes called *dead-haul* distance).

Elevation – at the pit. Press the *Get from Alignment* button to assign the same elevation as at the *Access Station*.

Material - available (borrow pit only).

Excavation $ - Cost to excavate (borrow only).

Waste quality – The minimum material quality required (non-variable only).

Capacity limit - Maximum volume of borrow or waste (*variable* only).

Volume - Exact amount of borrow or waste (non-*variable* only).

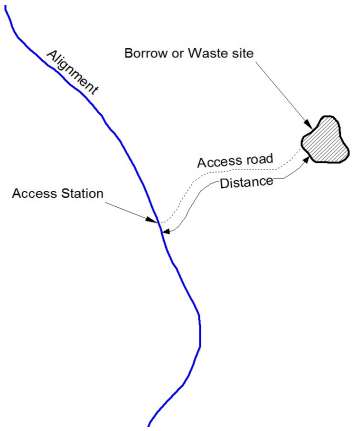


Figure 9-3: Definition of *Pit Parameters*

Quick Profile

Quick Profile generates, if possible, the closest profile to the ground considering all the geometric constraints defined by the user. The cost of this alignment will also be calculated.

The Quick Profile feature is very useful for determining if an alignment is feasible based on K values, min/max grades and predetermined control points.

10. Costing

Cost reporting and feedback is useful at all stages of design (preliminary, detailed and construction estimation).

Design Time Costing Example

In addition to being a very useful function for road design, cost calculation is a prerequisite to alignment optimization; the optimizer minimizes the cost. In this example, we will use design time costing with a hand designed road alignment.

Note: Design Time Costing is part of RoadEng® and does not require a Softree Optimal license.

Project Explorer Panel

The *Project Explorer Panel* was added to the Location module in Version 9.0 and it replaced the *Alignment Properties Panel*. The Project Explorer *Panel* was created to improve the organization of horizontal and vertical alignments and report cost and other information related to design time costing and vertical alignment optimization. The main differences from the *Project Explorer Panel* and the previous panel are that the *Project Explorer Panel* displays an organization tree that includes both Horizontal and Vertical alignments in the same window and the buttons at the top of the panel have been removed; many of these buttons have been relocated in the *Corridor* tab of the main ribbon.

We will continue with our example project, Road6.

1. *File* | *Open* <RoadEngResource>**\LiDAR\ Road6 - 4.dsnx.**
2. *View* | *Screen Layout* drop down, open Training folder, select **training costing.dlt**.

Your screen should look like Figure 10-1 below.

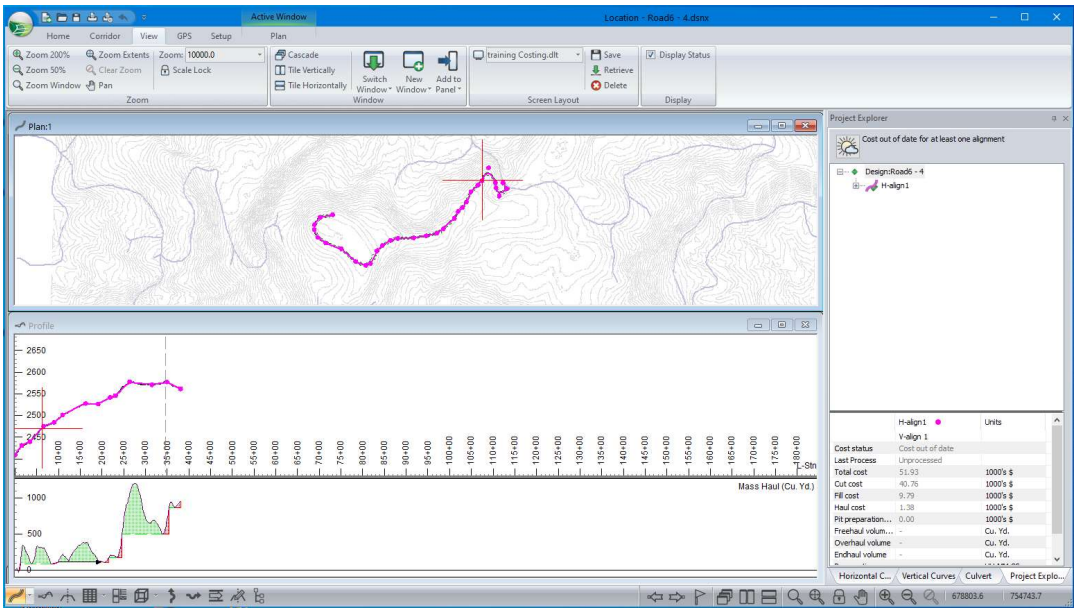


Figure 10-1: The *Location* module with *Project Explorer* Panel

Project Explorer Tree

The top part of the panel is an organization tree; the top level of the tree is the design, the level below the design is a list of horizontal alignments associated with the design, the level below that is a list of vertical alignments associated with the parent horizontal alignment, the levels below that provide the user a summary of alignment constraints, Borrow/Waste information, and results. When the screen layout is initially opened, several of the layers are not visible as the tree is not fully expanded.

3. Click the ⊞ button next to *Horizontal Alignment 1** to view the vertical alignment(s) associated with the parent Horizontal Alignment (as shown in Figure 10-2 below).

Figure 10-2: Project Explorer organization tree showing the project's design, horizontal alignment, and vertical alignment.

4. Click the ⊞ button next to *V-align 1** to expose the *Constraints, Borrow/Waste,* and *Results* levels of the tree (as shown in Figure 10-2 above).

Figure 10-3: Project Explorer organization tree with the V-align* level expanded.

The tree displays parameters that are used for cost calculations and alignment optimization. Both are closely related; however, the *Constraints* level of the tree is only applicable to optimization. In the remaining two levels (Borrow/Waste and Results) you will find information that is used for design time costing of both designs that were generated by hand and with Optimal.

5. Click the ⊞ button next to *Borrow/Waste, Results,* and the ⊞ button next to subsequent lavers to explore the remaining levels of the *Project Explorer* tree that are related to costing.

The parameters related to cost calculations are briefly outlined below.

- *Borrow/Waste*
  - ***Pits*** – Summarizes information regarding the use of pits to address material surplus (waste sites) or deficits (borrow sites) generated during the construction of the road prism. These features are located at user defined points along the alignment. The volume associated with them can be a volume assigned by you or calculated using smart pits (see below).
  - ***Sidecast*** – Summarizes information regarding the disposal of excess material along the road right-of-way. The cost to do so is assumed to be equal to the freehaul loading cost.
- *Results*
  - ***Cost Calculations*** – Provides you the status of the cost calculation.

Information Area

The bottom part of the *Project Explorer panel* is the reporting area. It displays information about the selected alignment such as volumes and costs.

The contents and order of this list is configurable. <Right-click> and *Set Report Fields*.

	H-align1 ● V-align 1	Units
Cost status	Cost out of date	
Last Process	Unprocessed	
Total cost	51.93	1000's $
Cut cost	40.76	1000's $
Fill cost	9.79	1000's $
Haul cost	1.38	1000's $
Pit preparation...	0.00	1000's $
Freehaul volum...	-	Cu. Yd.
Overhaul volume	-	Cu. Yd.
Endhaul volume	-	Cu. Yd.
Process time	-	HH:MM:SS
Opt. Gap	-	

Figure 10-4: *Reporting Area*

Cost Reporting

Now let's use the *Design Time Costing* features.

6. In the *Home* tab of the main ribbon, press the *Recalculate range* button to open the dialogue box below.

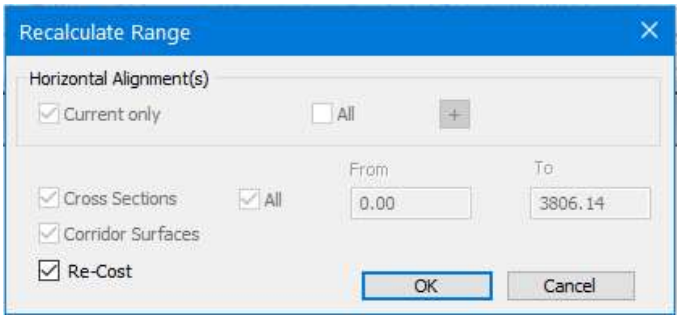


Figure 10-5: *Recalculate Range* dialogue box

7. Set the *Re-Cost* check box and press *OK*.

Note: Alternatively, the alignment can be Re-Cost by right clicking the alignment you wish to cost in the *Project Explorer* tree and selecting *Re-Cost*. Another example using this methodology is provided below.

After the calculation, you may notice the values in the reporting area of the *Project Explorer Panel* have been updated, are no longer greyed out, and appear as shown in Figure 10-6 below.

	H-align1	Units
	V-align 1	
Cost status	Determined	
Last Process	Unprocessed	
Total cost	51.83	1000's $
Cut cost	40.70	1000's $
Fill cost	9.74	1000's $
Haul cost	1.39	1000's $
Pit preparation...	0.00	1000's $
Freehaul volum...	3035.5	Cu. Yd.
Overhaul volume	355.8	Cu. Yd.
Endhaul volume	0.0	Cu. Yd.
Process time	-	HH:MM:SS
Opt. Gap	-	

Figure 10-6: The reporting area of the Project Explorer panel after the alignment was Re-Cost.

Note: You can expand the *Project Explorer* tree and it will indicate that a cost was successfully found. It also indicates that "Overflow: 948.2 Cu. Yd of excavated OB could not be wasted. Consider adding a waste pit with equal or lower quality material."

We will be looking at Smart Pits in detail in an upcoming chapter.

The next steps will demonstrate the change in cost when the vertical and horizontal alignments are adjusted.

Note: It is assumed the reader is familiar with interactive design using RoadEng®; however, even if you haven't used RoadEng® before, you can probably follow along by reading the bulleted steps.

8. In the Profile Window, change the vertical alignment slightly:
    - <Right-click> and change to the *Add/Edit IP* tool.
    - Move your mouse over a VIP (Vertical Intersection Point - square box symbol). <Left-click> to capture a point.
    - Move the point slightly and <left-click> to re-anchor the point.

Note: The information list is displayed grey after design modifications cause the costs and other items to be out of date.

9. Note the values in the reporting area of the *Project Explorer Panel* then *Re-Cost* the alignment as before.

Note that the costs are different. Now to streamline this procedure:

10. In the *Project Explorer* tree, right click *V-align 1* and select *Cost Calculations...*

The *Calculate Costs* dialogue box will appear as shown below.

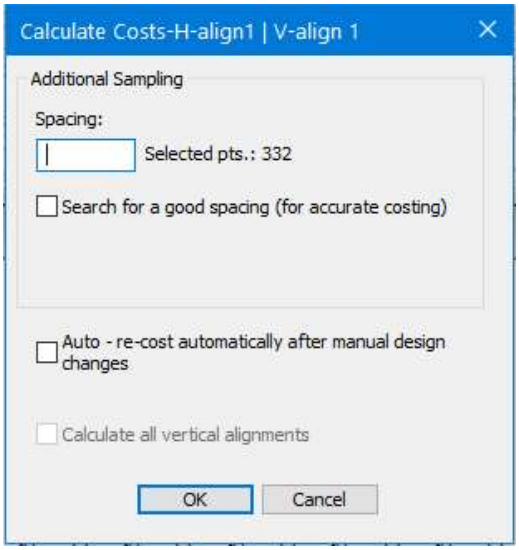


Figure 10-7: Calculate Costs dialogue box.

11. Set the *Auto* checkbox; then press *OK*.

Note: By default, the software will calculate volumes using all report points where cross sections are generated. To increase costing accuracy, additional cross sections can be sampled. This can be accomplished by specifying a spacing for additional sampling in the *Additional Sampling* section of the *Calculate Costs* dialogue box.

Now your design will automatically re-calculate the cost any time it is changed. This is only sensible for short alignments where Re-Cost doesn't take too long.

12. In the Plan window, capture and move an IP slightly and observe the updated cost.

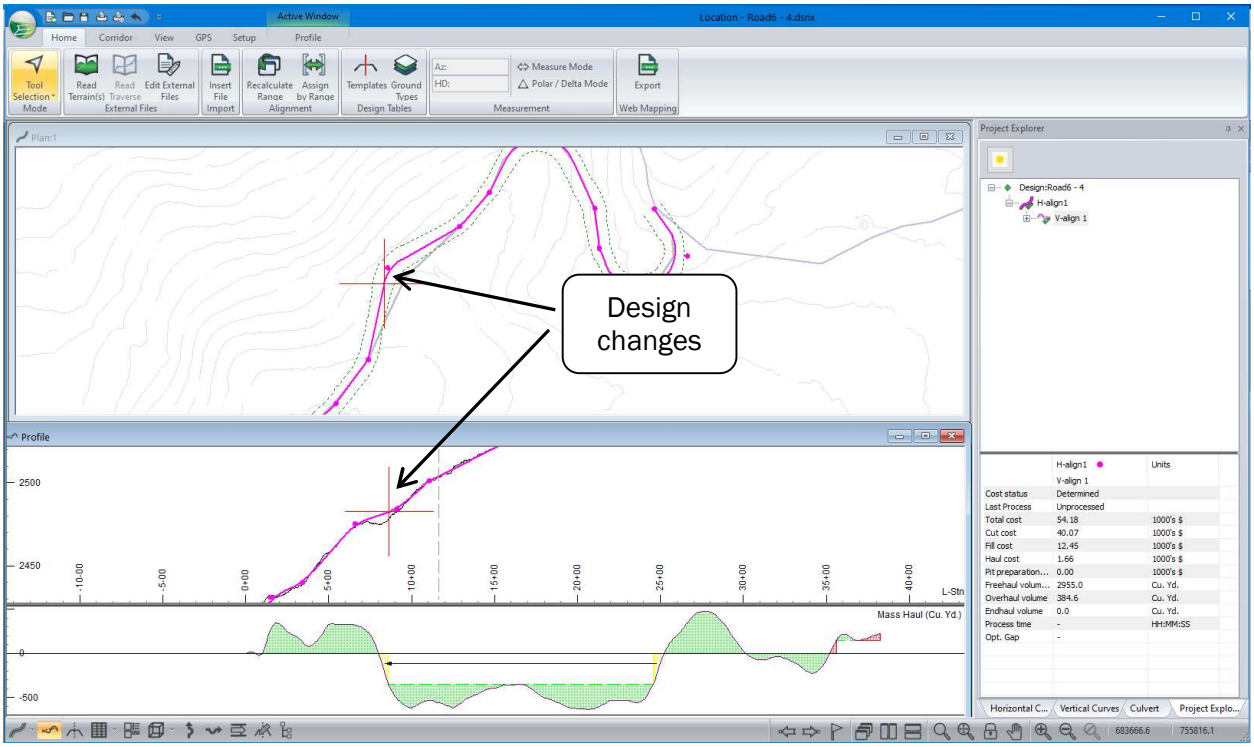


Figure 10-8: *Design Time Cost* Reporting

Note: If Auto is checked (Figure 10-5), the cost will automatically update each time the alignment is changed. In some situations, this will noticeably slow recalculation.

Cost Parameters

The earthwork cost values reported in the steps above are dependent on the volumes and types of materials excavated and embanked. RoadEng® allows you to specify what material layers are found in the ground and what materials you are using for subgrade fill. To calculate costs, you also need to provide cut/fill cost for each material and generic haul cost information.

Note: This document uses **$** for currency. You can change the currency symbol by selecting menu Module-Setup and choosing the Units tab.

13. In the *Corridor* tab of the main ribbon, click the Vertical button and select the options button.

The *Vertical Optimization Options* dialogue box will appear.

14. Then click on the *Unit Costs* tab.

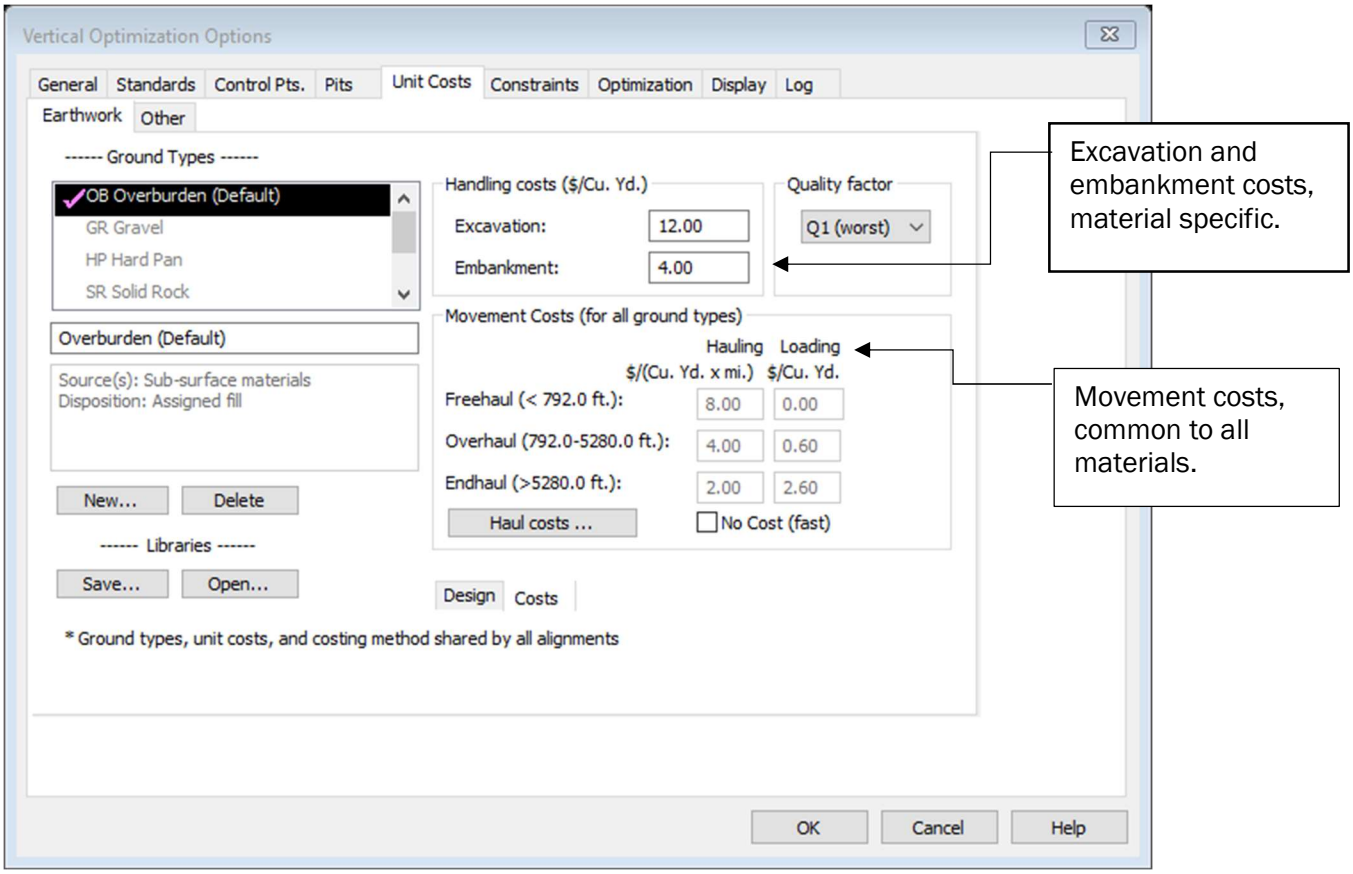


Figure 10-9: *Cost Parameters*

Handling Costs

The *Excavation* and *Embankment* (Cut/Fill) costs are dependent on material type. Unit costs are entered in $ per Cu. m (or $ per Cu. Yd.).

Quality Factor

Used to control fill operations. When fill material of a given quality is specified, any material with the same or *higher* quality can be used as fill.

Movement Costs

Are common to all material types. There are up to 3 haul categories (*Freehaul*, *Overhaul*, and *Endhaul*); this allows you to model up to 3 different types earth moving equipment (for example bulldozer, scraper and truck/excavator) the distance for each type of haul depends on the *Hauling* and *Loading* costs.

Press the *Haul costs* button to modify these values (also see note below).

- *Hauling Cost* (cost to move material) has units of $ per (Cu. m x km) or $ per (Cu. Yd. x mi).
- *Loading Cost* (cost to load material prior to moving) has units of $ per Cu. m or $ per Cu. Yd.

Movement Costs – No Cost

When the *No Cost* check box is set, your options for Movement Costs are eliminated. When this is applied, there is no cost calculated for transporting material along the alignment.

Note: For alignment optimization and comparative costing, costs don't need to be exact. The ratio between the costs is what determines the better alignment (i.e. the ratio between cut, fill and haul costs). And, even if the total $ cost is not precise; it can still be used to compare different alignments and options.

Note: You can save your ground table, including costs, to a small file (extension GDX) for use in future optimizations (Save/Open buttons).

15. Press the *Haul cost* button. This is where you can edit your movement costs.

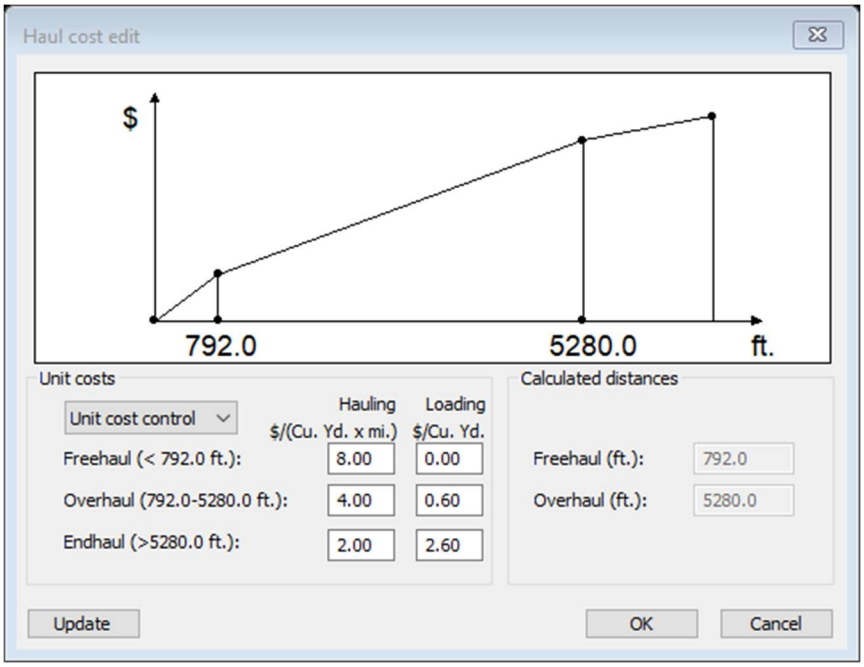


Figure 10-10: *Haul cost* edit dialogue box.

The graph above shows how the transition distances of 792 Ft and 5280 Ft are calculated in the example. Changes to the *unit costs* for *Hauling* and *Loading* will adjust the calculated distances.

Movement costs are assumed to be linear with distance; this agrees well with empirical haul equipment productivity data. The haul distance where it becomes cheaper to switch from *Freehaul* to *Overhaul* or from *Overhaul* to *Endhaul* depends on the intersection of the linear cost graph (see figure above).

The *Ground Types* dialogue contains information that is common to RoadEng®. It can be accessed from the Alignment Panel using the *Options* button; it can also be accessed from the *Edit |Edit Ground Types* menu.

The volume for each distance category is reported in the Alignment Panel as *Freehaul*, *Overhaul* and *Endhaul*.

16. Try experimenting with a few changes to the *unit costs*. Press *Update* to see how the *calculated transition distances* change.

Note: In some cases, you may only want two haul categories and you may want the transition distance to be set at an assigned distance (rather than calculated). To do that, click *Unit cost control* drop down and select *Freehaul control*. This changes the *Haul cost edit* dialogue box to appear as shown below and allows the user to specify their maximum freehaul distance.

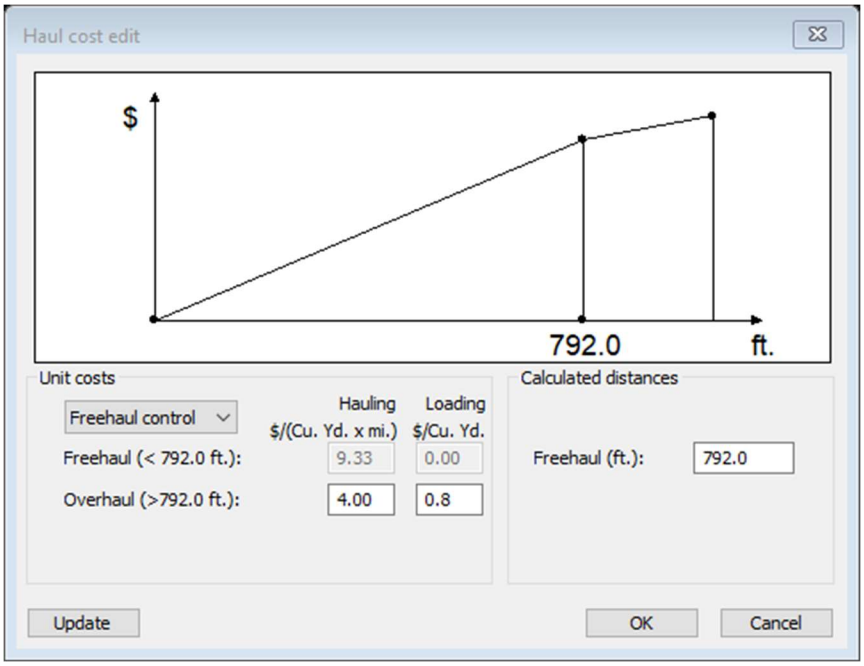


Figure 10-11: *Haul cost* edit dialogue box with Freehaul control selected.

17. Press *Cancel* to close the *Haul Costs* dialogue.
18. Press *Cancel* to close the *Vertical Optimization Options* dialog.

Optimal Haul

If you have spent any time thinking about the problem of costing road earthworks, you know that calculating the haul cost is not trivial; especially if you have multiple borrow/waste pits and different materials in the ground along the road corridor. Before reporting the haul cost, *Softree Optimal* solves an optimization problem to determine the lowest cost haul specification that balances material.

19. *File* | *Close*. Do not save changes

11. Smart Pits

This example illustrates Smart Pits and two of their pit properties: (1) Pits can have a *variable volume*; (2) Pits have a *site preparation* cost.

1. *File* | *Open* <RoadEngResource> \ **LiDAR\ Road6 - 4.dsnx.**
2. *View* | *Retrieve* the *screen layout* **training Opt Haul.dlt**. from the **Training** folder of the screen layout dropdown.
3. Activate the data window in the bottom left-hand corner.

Note: pressing the  restores the already active window. If the Data window is not activated, add a new window by selecting *Window* | *New Window* | *Data*.

---

4. Ensure that the mass haul column is added to the data window:
    - <Right-click> in the data window. Select *Data Options.*
    - Press *Columns.* This will open the *Data Window Fields* dialogue.
    - In *Available*, scroll to the *Volumes General* folder, open it and locate **Mass H.**, press *Add* (or <double-click> it).
    - Press *OK* twice to exit the dialogues.

The Mass Haul is not balanced, there is an excess of 947.8 Cu. Yds of material from having too much cut. We will add some variable Smart Pits to the project to understand their properties and to better balance the mass haul.

5. View the pit properties for the current alignment:
    - In the *Project Explorer*, <right-click> on **V-align 1**, select *Vertical Options…* and select the *Pits* tab.
    - Press *Add*, place a Waste Pit at the *start of the alignment*, ensuring the *Variable Volume (smart pit)* checkbox is checked as shown in Figure 11-1.

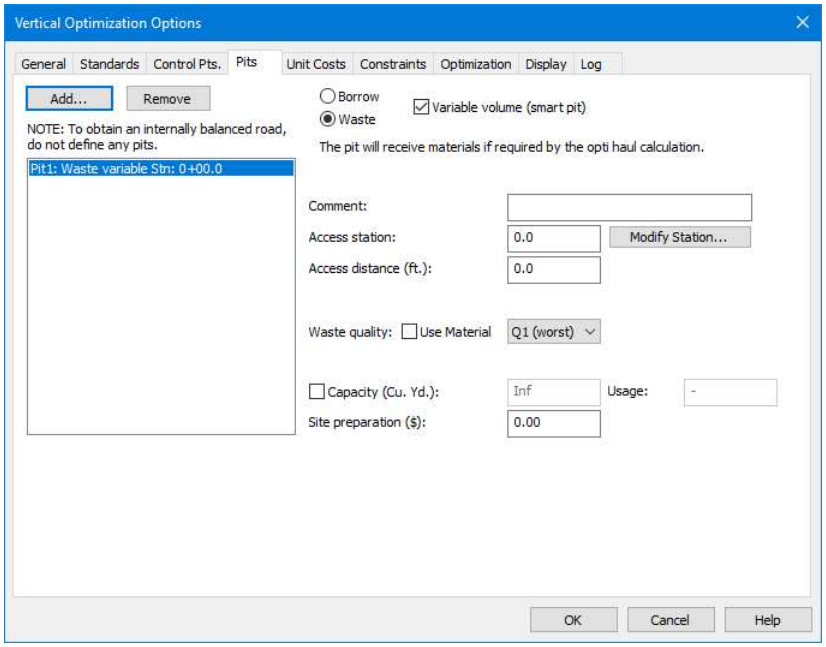


Figure 11-1: *Pits* Tab for the Selected Alignment

6. Press *OK* to close options.

Note: You can also access the *Pits* dialogue box from menu *Edit | Assign Parameters by Range*.

7. You will be prompted with the *Recalculate Range* dialogue. Check the box next to *Re-Cost*^. And press *OK*.

Alternatively, you could re-cost the current alignment by pressing the *Re-Cost* button in the Alignment panel.

Notice that the Mass Haul is now balanced; the pit volumes have been updated to balance as shown in the figure below:

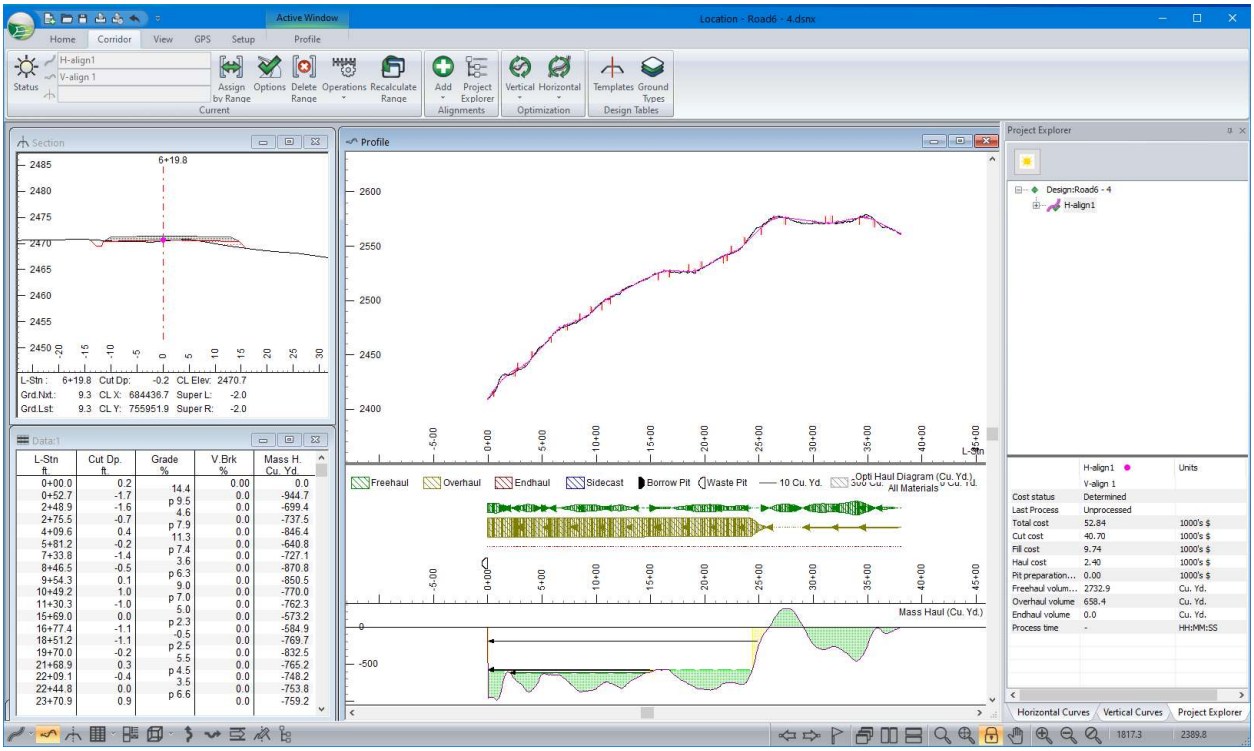


Figure 11-2 – *Balanced Mass Haul* after Addition of a *Smart Waste Pit*

The software can also decide which pit should be used if there is a choice. At this point, *Pit-1* is being used for all waste as there are no alternatives.

8. Add variable waste pit at stations **20+00**:

    - Make sure that **V-align 1** is selected.
    - In the Project Explorer, <right-click> on **V-align 1**, select Vertical Options… and select the *Pits* tab.
    - Press the *Add…* button in the Pits dialogue box.
    - Enter station **2000** in the *Pit Access Station* dialogue box, press *OK* to accept and close.
    - Make sure that *Waste* and *Variable volume (smart pit)* are set.

Notice that the *Waste quality* is **Q1 (worst)**; this means that any material can be accepted by this pit. *Capacity* is set to **inf** (infinite); you can optionally limit the size of the pit by setting this property. *Site preparation* cost is set to zero by default.

9. Press *OK* to close the options dialogue box.

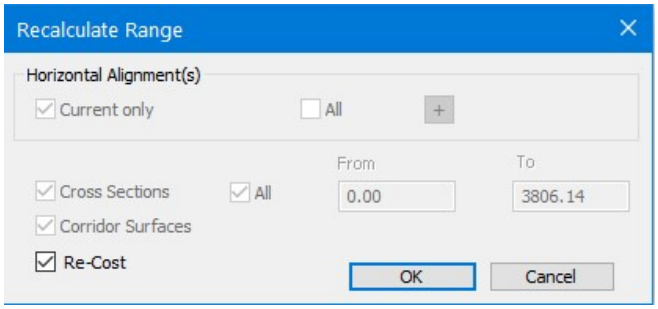


Figure 11-3: *Recalculate Range* Dialogue Box with the *Re-Cost Option* Set

10. Ensure the *Re-Cost* check box when prompted with the *Recalculate Range* dialogue box (Figure 11-3)
11. Press *OK* to recalculate and update the Optimal Haul.

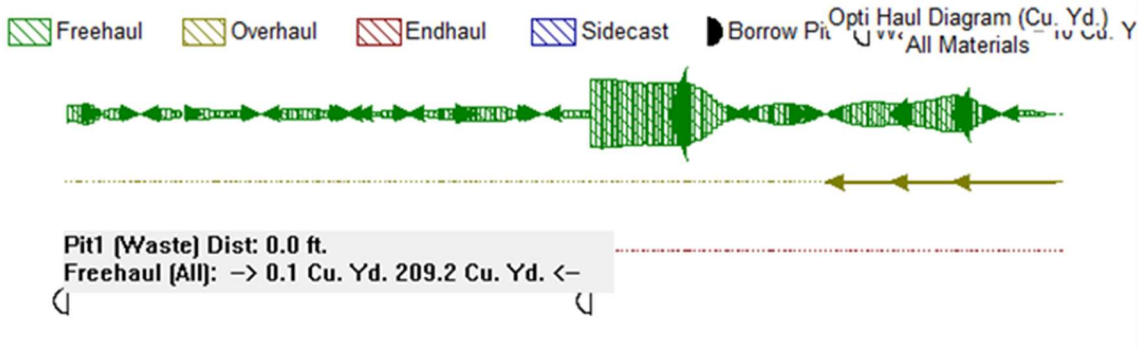


Figure 11-4: *Waste Pit Usage* at Stations 0+00 and 20+00 (half moon symbols).

You can hover over a pit, the half moon symbol, in the Opti Haul diagram to understand the volume of its use. Notice that the pit at 0+00 is only being used for 209.2 Cu. Yd. Our pit at 20+00 is being used for 738.9 Cu Yd. Smart Pits are an excellent planning tool for deciding feasibility and placement of waste and borrow pits.

12. *File* | *Close*. Do not save changes.

12. Setting Up a Screen Layout

We have used screen layouts throughout the book. This exercise demonstrates how to configure the window locations and some window options to emphasize horizontal curves (for the next exercise).

Note: See Getting Started section for file install folders (**<RoadEngResource>** and **<Defaults and Layout>**)

1. *File* | *Open* **<RoadEngResource>\ LiDAR \ Road6 - 5.dsnx.** This should look similar to your design at the end of the previous exercise.
2. Activate the Plan window by pressing in the bottom navigation bar.
3. <*Double-click*> in the Plan window *title bar* to maximize.
4. Activate the *Horizontal Curves Panel*

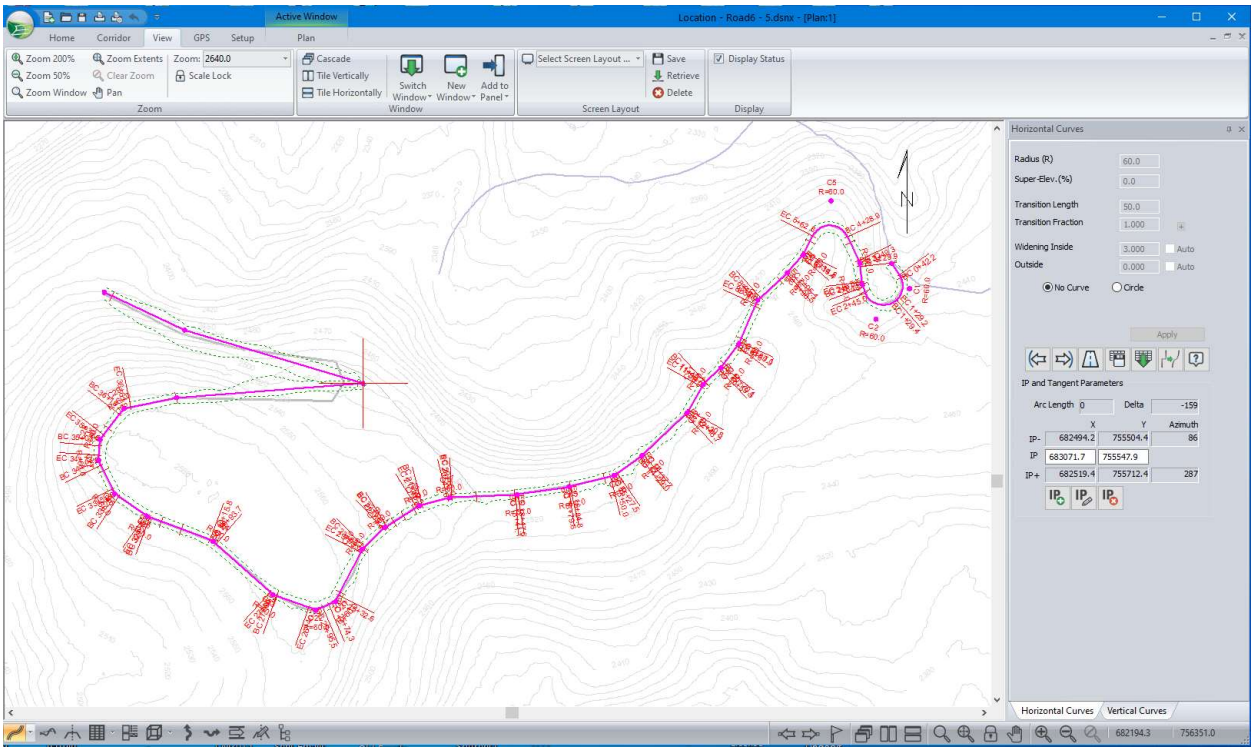


Figure 12-1: A Screen Layout with *Docked Curve Panel* and Maximized Plan Window

5. *Plan* | *Plan Options* to open the Plan window *Options* dialogue box (<right-click>, *Plan Options*).
6. Turn on *Background* display.
7. Turn on the *Road Edges*, *Slope Stakes* and *Labels*.

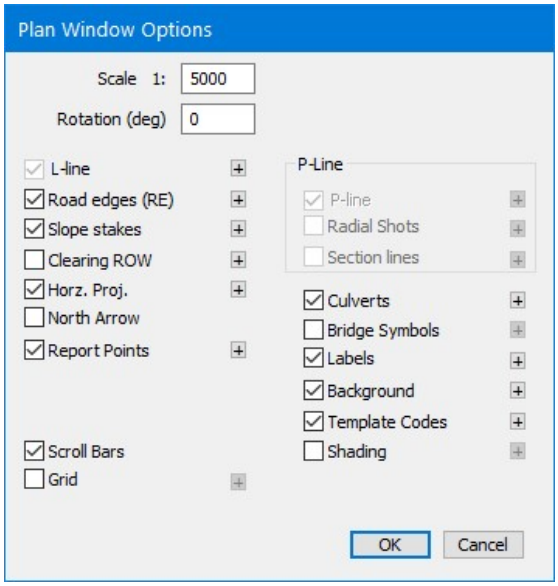


Figure 12-2: *Plan Window* Options

8. Click the + button beside *Report Points* to bring up the *Report Point Properties* dialogue box.

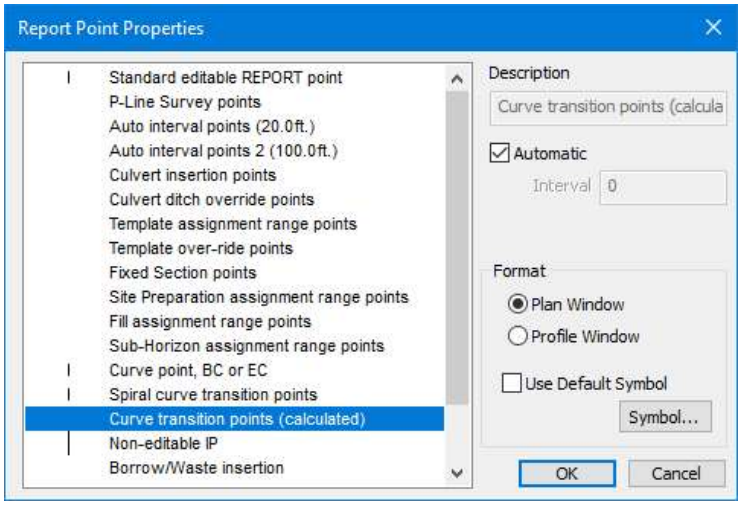


Figure 12-3: *Report Point Properties* Dialogue Box

9. Select *Curve Transition Points (calculated)* in the list and then press the *Symbol...* button.
10. Change the symbol to *Tick (Large)* and to a dark green.

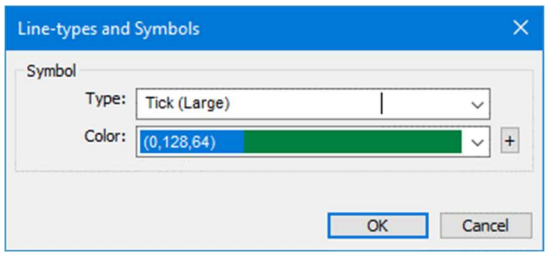


Figure 12-4: *Line Types and Symbols* Dialogue Box

11. Press *OK* twice to return to the *Plan Options dialogue.*
12. Click the + button beside *Labels* to bring up the *Label Selection and Formatting* dialogue box.
13. Turn off *Horz. IP's at Curves* (double-click).
14. Press *OK* twice to accept changes and close all dialogue boxes.

The changes made in the last few steps have changed the *look* of the screen but they have not made any changes to the actual design – no alignment or cross section changes. These changes and the rest of the *Screen Layout* can be saved to the hard drive for later use.

15. Save a new screen layout using the toolbar:
    - *View* |open the *Screen Layout Dropdown*.
    - Scroll down and <right-click> on the *Training* folder.
    - *Save New Layout* to display the dialogue box show below to the right.

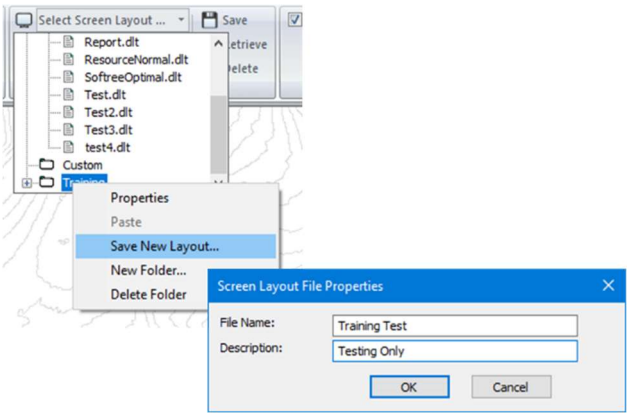


Figure 12-5: Saving a *Screen Layout* with Screen Layouts Tool *Bar*

16. Change the *File Name and Description* as in the figure above.
17. Press the *OK* button.

Alternately, the *menu View | Save Screen Layout* could have been used to save the screen layout, as shown below.

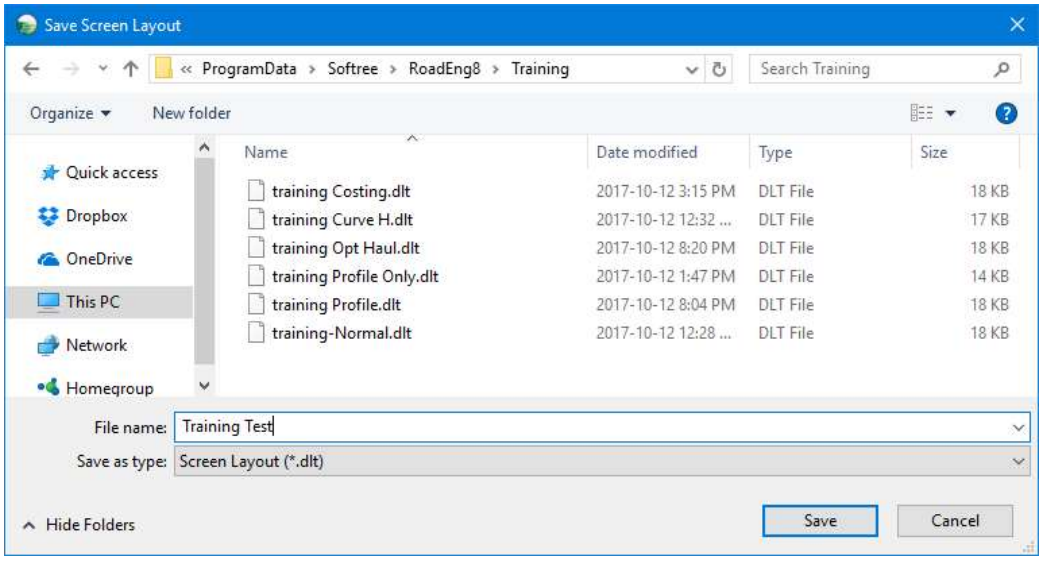


Figure 12-6: Saving *Screen Layout* Files

18. Try opening some of the other screen layouts available.

19. *File* | *Close*. Do not save changes.

13. Horizontal Curve Details

In this exercise, we will examine the *Horizontal Curve Panel* in detail. For example purposes, we have extended Road6 to include a switchback at the end.

20. *File* | *Open* <RoadEngResource>**LiDAR\Road6 – 5.dsnx.**
21. *View* | *Screen Layouts* drop-down, select **Training** folder, and then **training Curve H**.
22. If prompted by the *Recalcuate Range* dialogue. Press *OK*.
23. You can turn on the contours:
    - *right click* in plan view| *Plan Options…* | *check* background

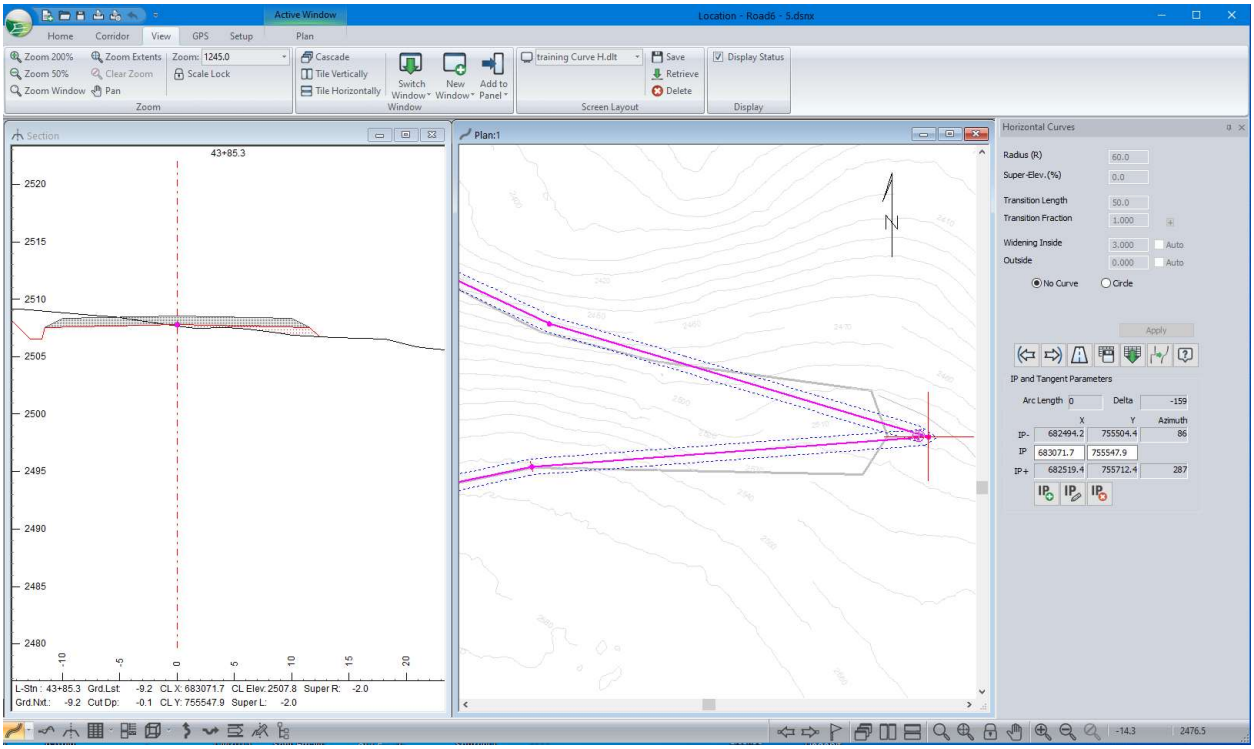


Figure 13-1: Design with *Switchback* Curve Prior to Modifications

Using Help

There are too many possible curve configurations to cover them in one exercise. More information on curves panels is found in the Help files.

If you're already familiar with the RoadEng Help documents, then skip to Designing a Switchback below.

24. For general information press the <F1> button on your keyboard.

The front page of the Help files will open with the current module highlighted, as shown below.

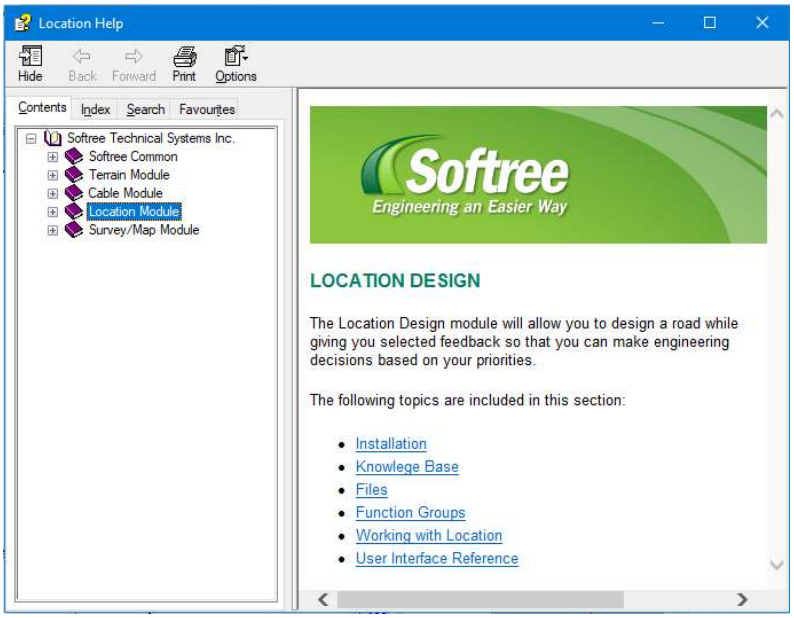


Figure 13-2: The Front Page of *Location Help*

25. For specific information on horizontal curves, select the Search tab and type “curves” into the text box and press *List Topics*. A list of topics is displayed. Highlight “Horizontal Curve Panel”. <Double-click>or press *Display*.

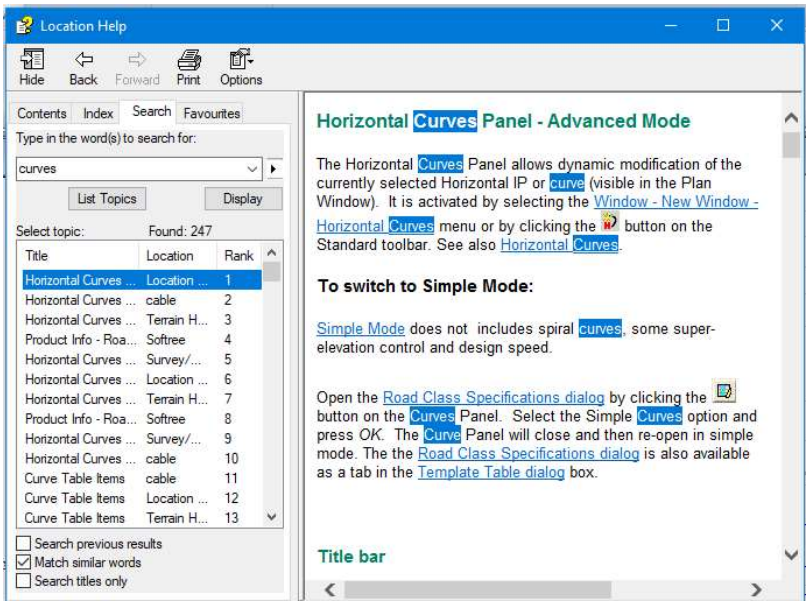


Figure 13-3: *Horizontal Curves Panel* - Advanced Mode Help Page

26. *Close* the Help window.

The easiest way to access the Help files on horizontal curves is to click on the Help Button in the *Horizontal Curve* panel.

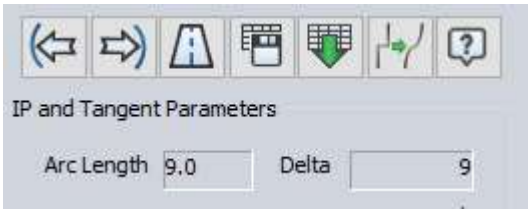


Figure 13-4: *Horizontal Curve Panel*

This page has information about all the controls in the horizontal curve panel and links to related topics.

Designing a Switchback

The most common way to design a switchback is to create two IPs and three tangents. Notice that currently there is only one IP and two tangents (Figure 13-1).

27. *Tool Selection* | *Add / Edit IP* mode.
28. Move the IP so that it is on the South side of the switch back as shown in the figure below.

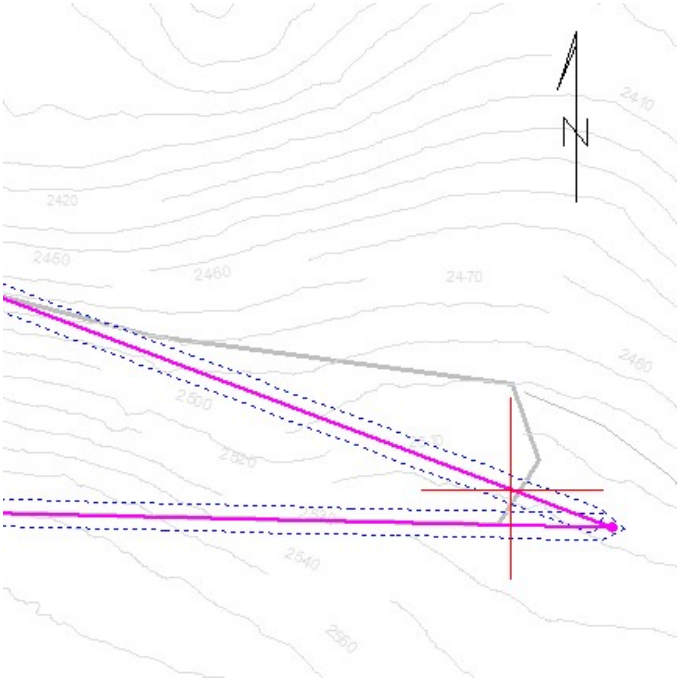


Figure 13-5: Switchback after *Moving Existing IP* to the First Half of the Switchback

29. Create two new IP's on the North side of the switchback as shown in the figure below.

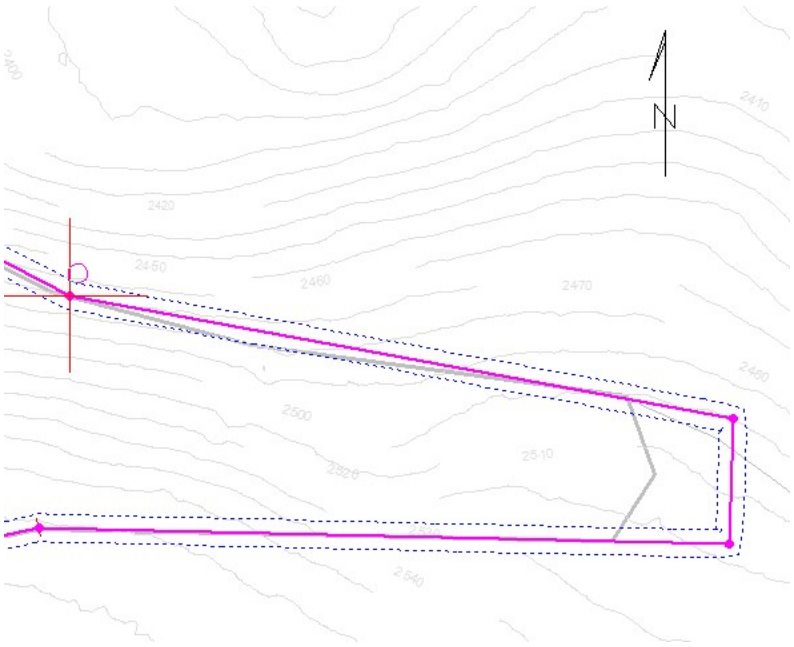


Figure 13-6: Switchback After Adding *Another IP* at the Top of the Switchback

Our switchback is about 120 feet from south leg to north leg (check it out with the *Measure Tool*). So, we a pair of curves with radius 60 feet will be perfect. After the curves are defined we will adjust the IPs to give us an almost continuous curve.

30. Horizontal curve panel, select circle and set the radius to 60 feet. Then press *Apply*.
31. Navigate to the  previous IP and repeat (twice).
32. If the curve does not fit the error message shown below will appear. In that case move the IPs around until curves with 60-foot radii fit.
33. Finally, adjust the north IP with the mouse until the curves bump into each other (figure below).

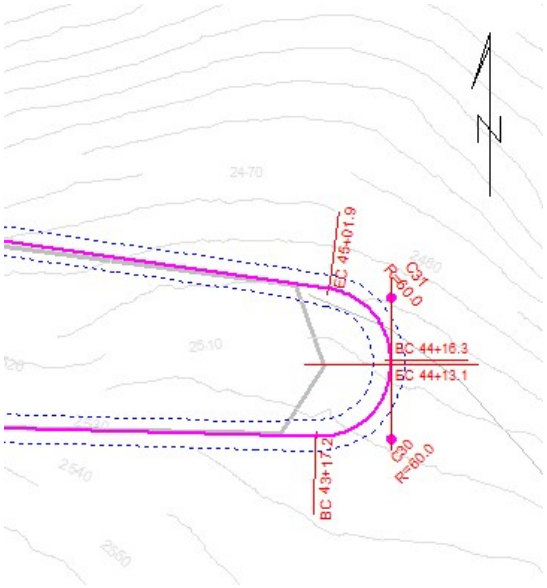


Figure 13-7: Left - IPs With Extra Room for Curves Right - Final IP Positions

Note: This example skipped the step of finding the best location for the switchback curve. Take a moment to view the profile window (figure below) and the resulting grades. Optional, try improving the position of the curves.

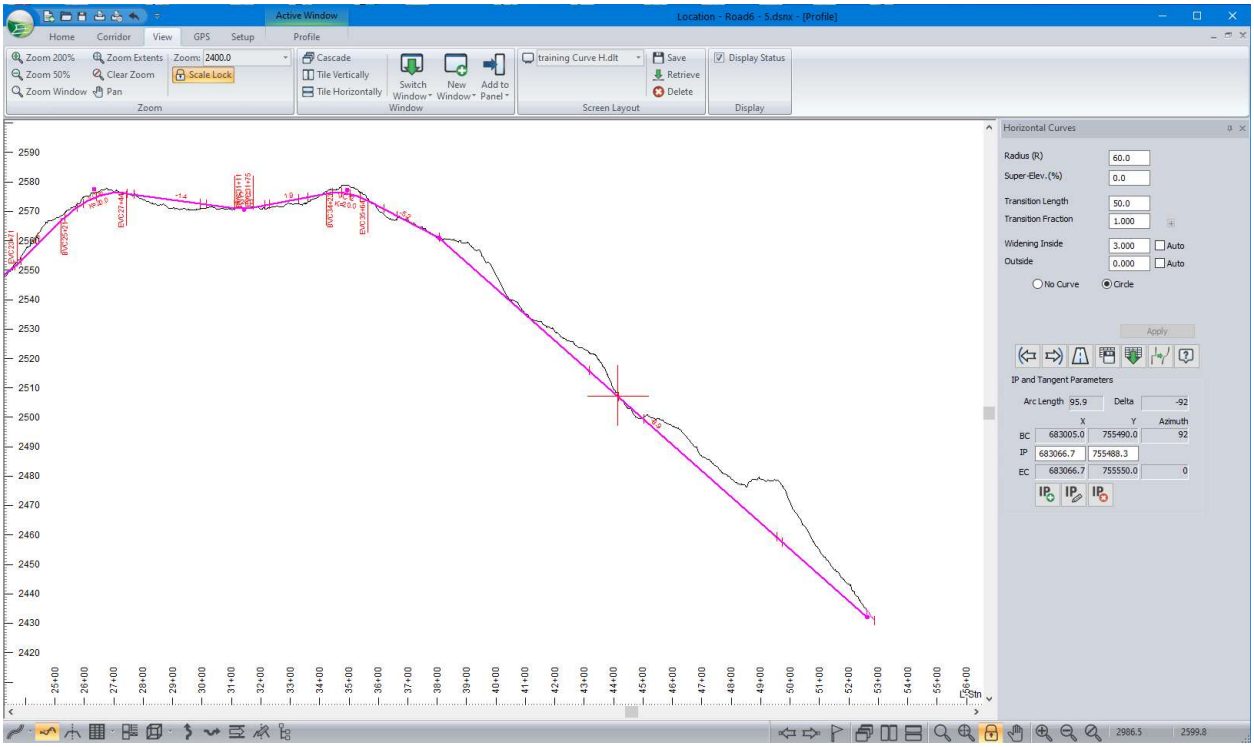


Figure 13-8: Profile View of the Switchback

Curve Widening

Small radius curves require lane widening to accommodate large vehicle off tracking. The *Widening* fields allow you to define a different widening distance for inside and outside lanes. Note that your cross section template must have curve widening built in for these values to have any effect.

As with other curve parameters, you can extract widening values from a table by setting the *Auto* check box. If time permits, you may wish to experiment with this feature. There is a widening table called **<Defaults and Layouts>\Training\WideningFeet.tbl**.

34. *File* | *Close*. Do not save changes.

14. Vertical Curve Details

In this exercise, we will examine the *Vertical Curve Panel* in detail.

Note: See Getting Started section for file install folders (**<RoadEngResource>** and **<Defaults and Layouts>**).

1. *File* | *Open* <RoadEngResource>**\LiDAR \Road6 - 6.dsnx**.
2. Using the *Screen Layouts* drop down menu, locate the **Training** folder, then find **training Curve V.dlt**. You may need to adjust your scale / zoom. Your screen should look like the figure below.

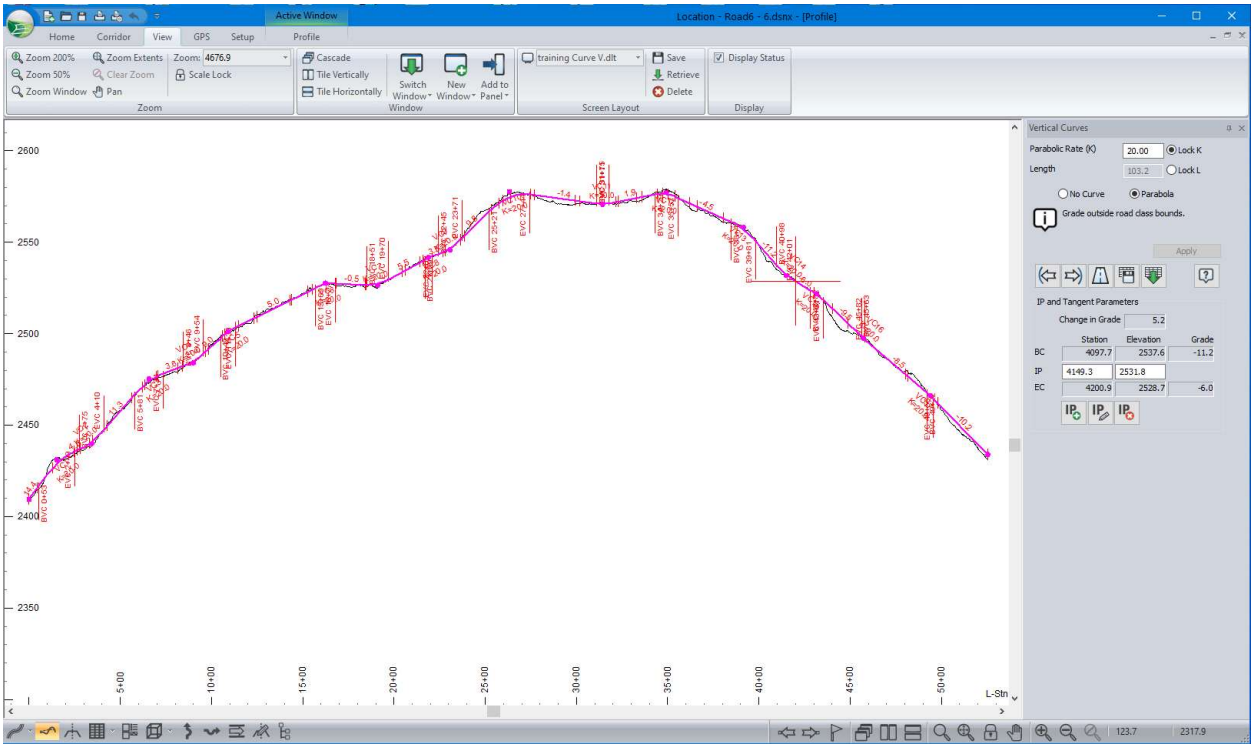


Figure 14-1: Screen Layout with *Docked Curve Panel* and Profile Window

3. Use the Previous IP  and Next IP  buttons to move to the vertical curve at stn 31+42 (the curve at the top of the plateau). This curve position can support a higher K value to be smoother.

K Value or Length of Curve

This curve has been configured to find the smallest possible curve for a forest road. K Value is defined as the length of curve divided by the change in grade.

4. Change the *K Value to* ***100.*** Notice how the length of curve increases to compensate for the higher K.

5. In the profile window *right click… | Add/Edit IP tool*. Capture the VIP point for this curve in the profile window and move it up and down.

Notice how the values in the curve panel are kept up to date. Notice how the length of curvature as well as the change in grade changes as you move the IP.

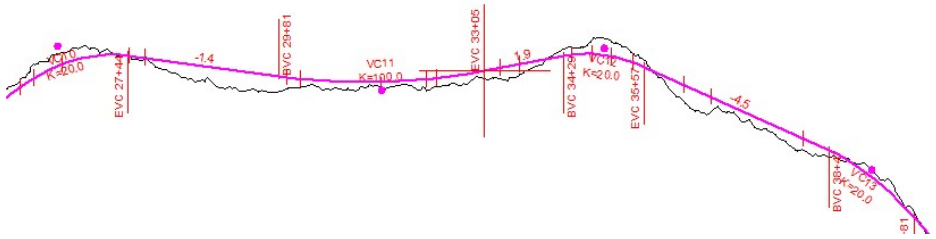


Figure 14-2 : Plateau Curve Lengthened by K=100

Locked Length

6. Select the *Lock L* radio button and *Apply* your change. Again, capture the VIP and move it with the mouse. Curves with constant length will never bump into one another when you raise or lower the VIP; however, the curvature changes dramatically.

Editing VIPs with the Curve Panel

So far, we have created and edited intersection points only with the mouse (both vertical and horizontal). The curve panels also allow you to create and edit IPs.

7. Use the Previous IP and Next IP buttons to move to the curve at IP 10+89 (VC5).
8. Change the elevation of the IP to **2502** and press *Apply*. Note how the curve moves vertically.

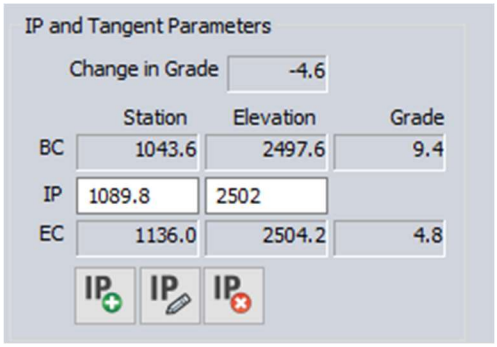


Figure 14-3: *Vertical Curve Panel* displaying IP and Tangent Parameters

Note: Alignments can be fine tuned by making small changes to the VIP *Station*, *Elevation* values.

9. Press the *Modify IP* button to open the *Modify Vertical IP* dialogue box.

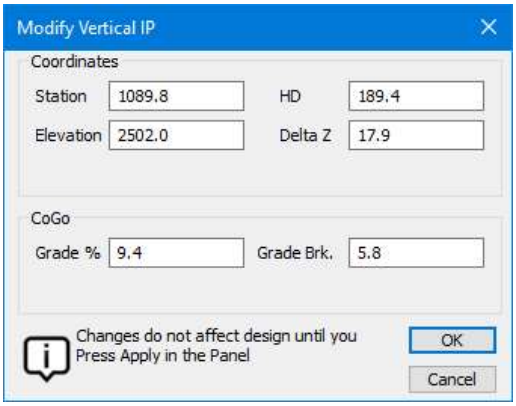


Figure 14-4: *Modify Vertical IP* Dialogue Box

The Modify Vertical IP dialogue box allows you to set the grade of the previous tangent (among other things).

10. Change *Grade %* to **9** and press *OK* to close the dialogue box. The *Elevation* value in the curve panel has been updated.
11. Press *Apply* to change the curve.

Note: You can also edit *horizontal* alignment in the *Horizontal* curve panel in a similar way.

12. *File* | *Close.* Do not save changes.

15. Materials and Stripping

So far, the design has ignored the quality of the material in the original ground. Closer inspection would reveal that all subgrade cuts and fill materials are classified as *overburden* (*OB*). This is a common practice and produces acceptable results, provided that you assign a reasonable expansion factor to *OB* so that the Mass Haul is approximately correct.

In this exercise, we will add some more realism to our design by defining materials in the original ground and in the subgrade fill.

Defining Sub-surface Layers

1. *File* | *Open* <RoadEngResource>**\LiDAR \ Road6 - 7.dsnx.**
2. On the View Tab, use the *Screen Layout* drop-down to open **Training** folder, and then **training Profile.dlt**.
3. *Home* | *Ground Types* to open the *Ground Types Editor*.

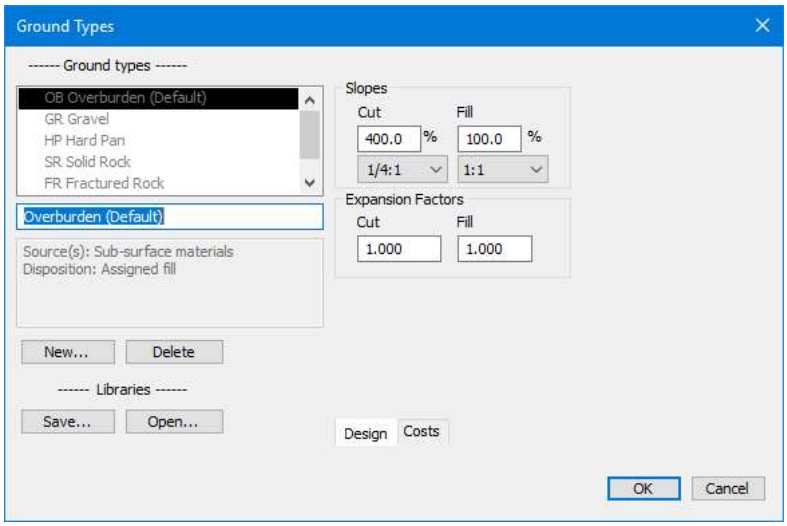


Figure 15-1: Available Ground and Subgrade Fill Materials in the *Ground Types Editor*

4. Press the *New* button and create a new material called **RR – Rip Rap**. This will be used as subgrade fill in this example.

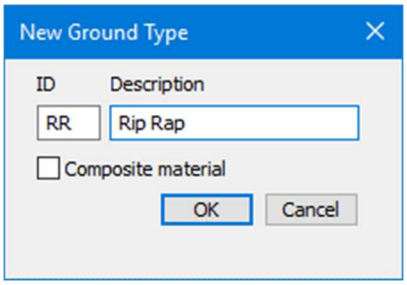


Figure 15-2: Creating *New Ground Type*

5. Press *OK* to close the *New Ground Type* dialogue box and to add our new Rip Rap material to the *Ground Types* list.

6. With *RR Rip Rap* selected in the *Ground Types* list, set both the *Fill Slope* and *Cut Slope* **to 100% (1:1).**
7. Also, create a material called Clay Silt:
    - Press the *New* button and create a new material called **CS – Clay Silt**.
    - With *CS Clay Silt* selected in the *Ground Types* list, set the *Cut Slope* to **100% (1:1).**
    - set the *Fill Slope* to **33.3% (3:1).**

If these were your default ground types, you could save the ground table as your default for easy access in future designs.

8. To do so, press the *Save* button to open the file *Save-As* dialogue box. Notice that the default folder is the <Program Data> folder. See Getting Started for more information on saving files.
9. Press *Cancel* to close the *Save-As* dialogue box. We do not want to overwrite our default with this table.

Note: The default ground table is called **Normal.GDX**.

10. Press *OK* to accept changes and close the *Ground Types* Editor.
11. Respond *Cancel* to the *Recalculate* prompt (we didn't change anything that is in use).

Now that we have created our *Ground Types*, we need to assign them to specific ranges.

12. *Home | Assign by Range* to open the *Assign Parameters by Range* dialogue box. Select the *Sub Horizons* tab.
13. Press the  button beside the *Ground Layers* field to open the *Ground Layers* dialogue box. See Figure 15-3:

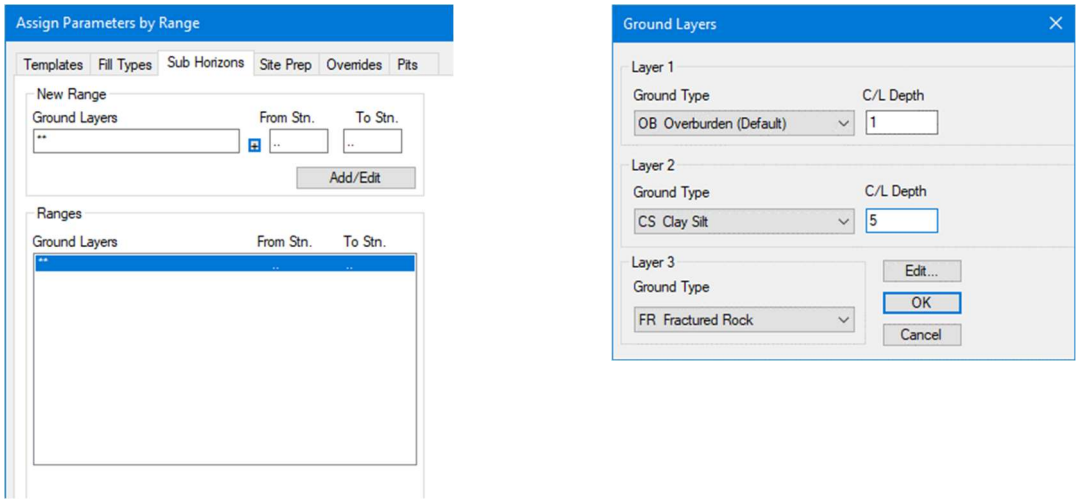


Figure 15-3: *Defining Materials* in the Original Ground

Note: Defining ground types in the Location Design Module is only required if you have not defined them in the Survey/Map Module.

14. Set up the three sub-surface *Layers* shown above (Figure 15-3, right-side) and set the *C/L Layer Depths*:
    - Set *Layer 1 Ground Type* to **OB Overburden (Default)**
    - Set *Layer 2 Ground Type* to **CS Clay Silt**
    - Set *Layer 3 Ground Type* to **FR Fractured Rock**
    - Set the OB *Depth* to **1**
    - Set the CS *Depth* to **5**

Note: You cannot define a layer depth until the next layer down has been selected.

15. Press *OK* to close the *Ground Layers* dialogue box and to return to the *Sub Horizons* tab of the *Assign Parameters by Range* dialogue.
16. Leave the *From Stn. / To Stn.* values as ".." and press the *Add/Edit* button. This will apply the new layer arrangement to the entire alignment.

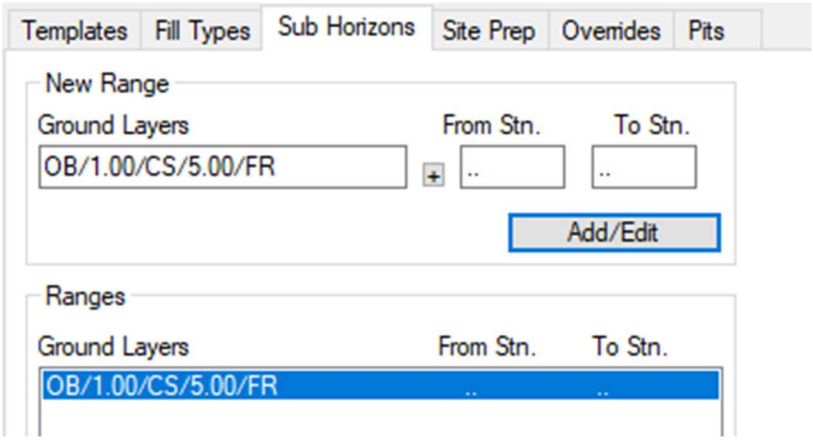


Figure 15-4: *Sub Horizons* Applied to the Entire Alignment

Note: The most common mistake made in the assignments dialogue box is to skip the *Add/Edit* step. If you Press *OK* before the ranges are updated, nothing happens.

17. Press *OK* to accept changes and close the dialogue box.
18. Respond *OK* to the *Re-calculate Range* prompt.

Look at your Section Window. Notice that the new ground layers are displayed as in the Figure 15-5.

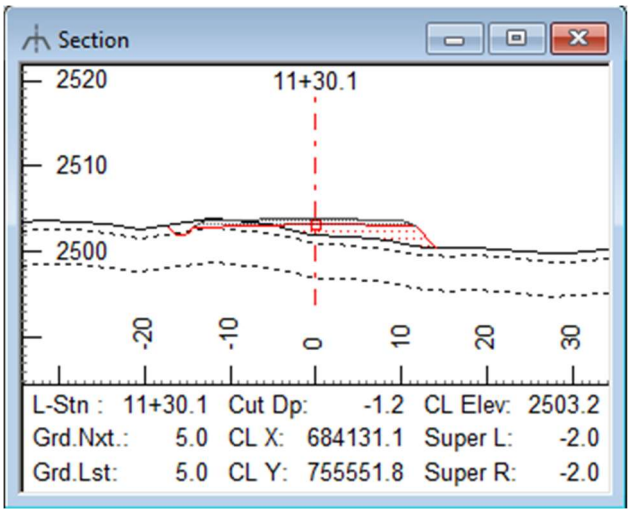


Figure 15-5: Ground Layers Depicted in the *Section Window*

The design total volumes have not changed because of the new ground layers. However, the program is now keeping track of three categories of cut volume which can be reported separately.

19. *File* | *Close*. Do not save changes

Stripping

Now, we will remove the top layer before building each cross section.

1. *File* | *Open* <RoadEngResource>**\LiDAR\Road6 - 8.dsnx.**
2. *Home* | *Assign by Range*. Select the *Site Prep* tab (figure below).

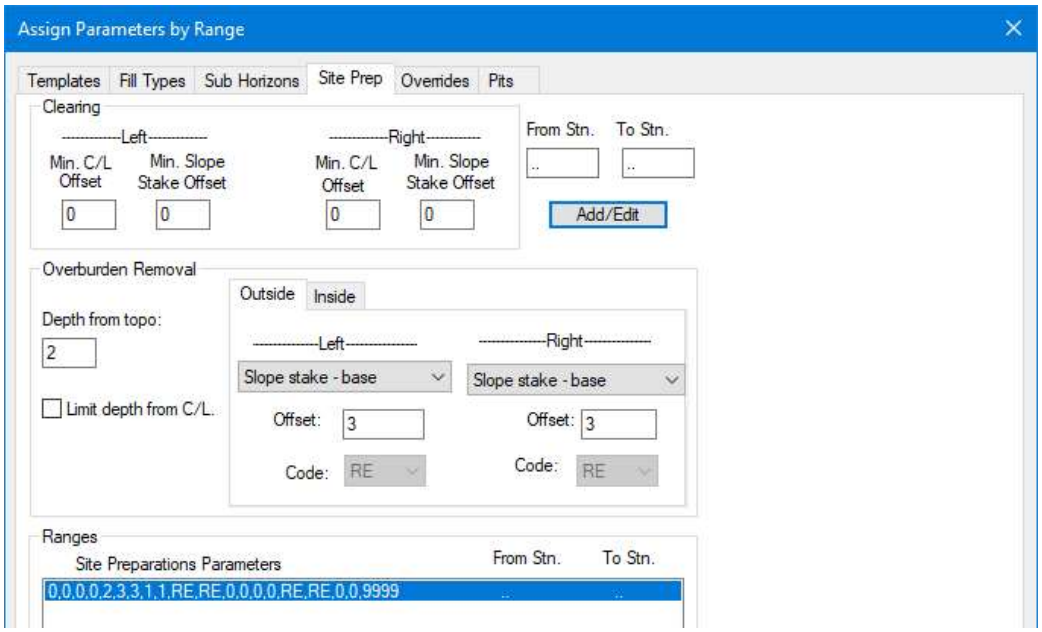


Figure 15-6: *Site Preparation Tab* set up for Stripping (Can also Control Clearing Offsets)

3. In the *Overburden Removal* area, Set the *Depth from topo* to **2** feet.

4. Leave the default 0 offsets in the *Inside* tab.
5. Set the *Outside* controls to *Slope stake – base*, **3** feet *Offset* (both sides as in the figure above). This will strip 3 feet *outside* the template footprint.
6. Press the *Add/Edit* button.
7. Press *OK* to accept changes and close the dialogue box. Respond *OK* to the *Re-calculate* prompt.
8. Zoom in on the cross section left or right-hand side. Notice that the stripping line is displayed as below.

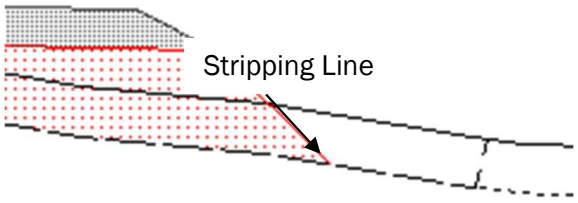


Figure 15-7: *Top Ground Layer* Stripped Off

The total volume of cut will have been reduced and fill will have increased. The OB cut volume will now be 0 and there is now a non-zero *Stripping* volume available for reporting.

Some important facts about stripping:

- Stripped material is excluded from the mass haul – it is assumed to be unsuitable for fill.
- The depth stripped will be the value assigned in the Site Prep dialogue or the top surface layer thickness, whichever is **least**. In the above example the top layer (OB) is only 1 foot thick so that is the stripped depth.
- Stripping happens before the template is applied to a cross section.

9. *File | Close.* Do not save changes.

16. Templates - Introduction

Template Concepts

Cross section templates allow you to set parameters such as road width, surfacing depths, ditches and cut/fill slopes. Templates interact with topography, super-elevation, sub-surfaces, and alignment(s) to produce final design cross sections. It is important to understand that templates are not static; they adapt to each cross section.

Users will typically create a set of standard templates for use in common design situations. *Templates*, *template components* and road *class specifications* are stored in a template table.

This example will introduce you to templates and the *Template Table Editor*.

Template Hierarchy

1. *File* | *Open* <RoadEngResource>**\LiDAR\ Road6 - 9.dsnx**.
2. *Home* | *Templates*, to open the *Template Table* editor shown in Figure 16-1.
3. Click on the button beside the template LOWV - Low Volume to view its components as shown in the figure below:

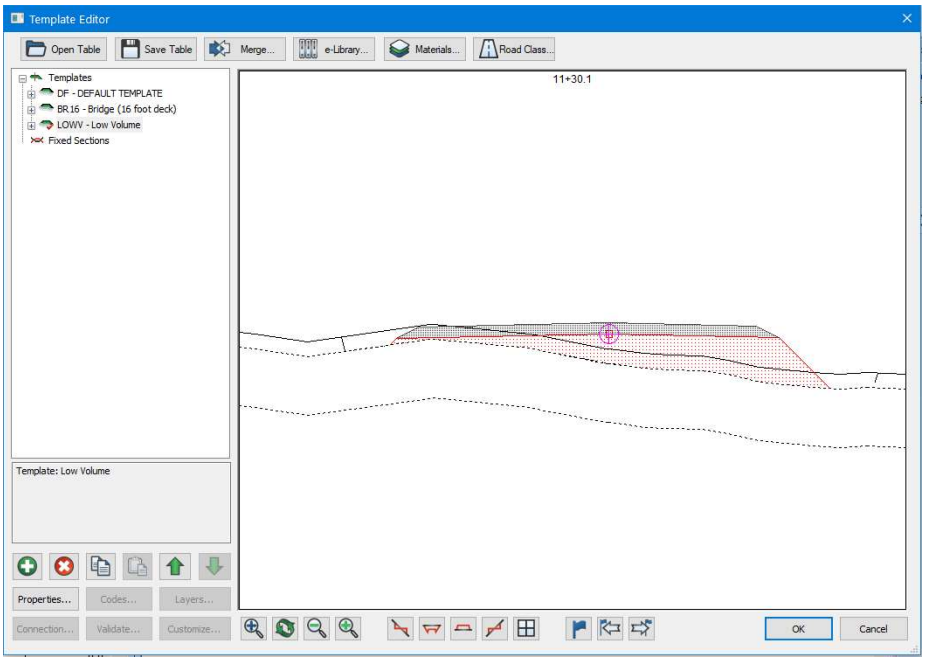


Figure 16-1: *Template Table Editor* Dialogue Box

The template editor shows you the templates contained in a table and the components contained in each template. These are the items you commonly work with.

Template Properties

4. <Right-click> on the *LOWV - Low Volume* template and choose *Properties* or <left-click> on the *LOWV - Low Volume* template and press the *Properties* Button at the lower left side of the *Template Editor* screen.

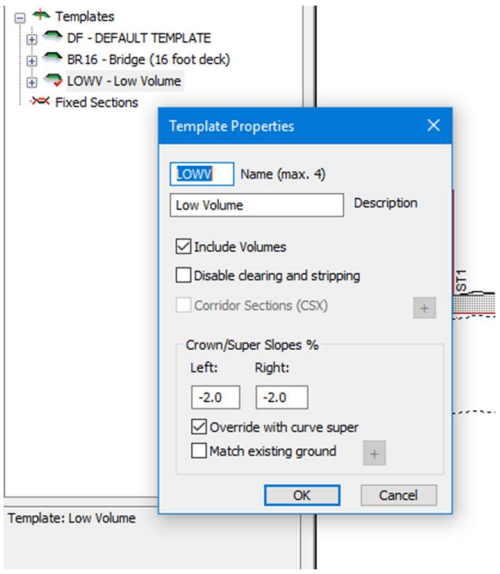


Figure 16-2: *Template Properties* Dialogue

There are relatively few controls in the *Template Properties*; most template flexibility is at the *Component* level. Aside from the template *Name* and *Description*, the most commonly used properties are the cross fall slopes.

5. Change the *Crown/Super Slopes %* to **-5%** on the *left* and **+5%** on the *right*. Press *OK*.

Notice how the Roadway component is altered by the new crown slopes – this is what happens when this template is applied inside a curve with 5% super-elevation (the template property *Override with Curve Super* must be enabled). Some components are designed to adjust themselves to the prevailing crown or super-elevation slope.

6. <Right-click> again on the template and choose *Undo Modify* to undo the above change.

Creating and Deleting Templates

Although there is an *Add* button (and context menu), you will find the most intuitive way to create a new template is to copy an existing template, paste it back into the table and then re-name and modify it.

7. <Right-click> on the *LOWV Low Volume* template and select *Copy*.
8. <Right-click> again and select *Paste* | *As New*.

The new template will appear at the bottom of the list.

9. Select the new *xx0-Low Volume* template and use the *Shift Up* button to move it up in the list.

You could also open *Template Properties* again and rename the template to **LOW2** or similar. You would also want to change at least one property or component to make the template different in a useful way.

Note: The fewer templates you have the easier it is to maintain them.

10. <Right-click> on the new *LOW2 – Low Volume* template and select *Delete* to remove it.

Template Components

There are four types of template components:

- Custom
- Roadway
- Ditches
- Slopes

Roadway, *Ditches*, and *Slopes* components are included for backward compatibility and their behavior is mostly self explanatory (and there is always <F1>). Custom components have replaced and improved upon their features. You can tell when you are looking at an old-style component – the properties dialogue box is quite different from the *Custom* components properties as shown in Figure 16-3.

In this document, we will work exclusively with *Custom* components.

Template Component Properties

Template components have parameters allowing you to configure the object for your specific design. Template parameters can be any one of the following:

User	This is the most common type of parameter. It can be a numerical value or a slope percent.
Reference Feature X Offset	Allows you to specify an optional horizontal alignment instead of a numerical offset from centerline. See *Reference Features* for more information.
Reference Feature Y Offset	Allows you to specify an optional vertical alignment instead of a numerical offset from centerline. See *Reference Features* for more information.
Reference Surface	Allows you to specify a surface (rarely used).

11. Click on the ⊞ button to the left of *LOWV- Low Volume* template or <double-click> to expose the template components.
12. <Right-click> on the *Roadway* component of the *LOWV- Low Volume* template and select *Properties* (or <double-click>) to open the Custom Component Properties dialogue box as shown in the following figure.

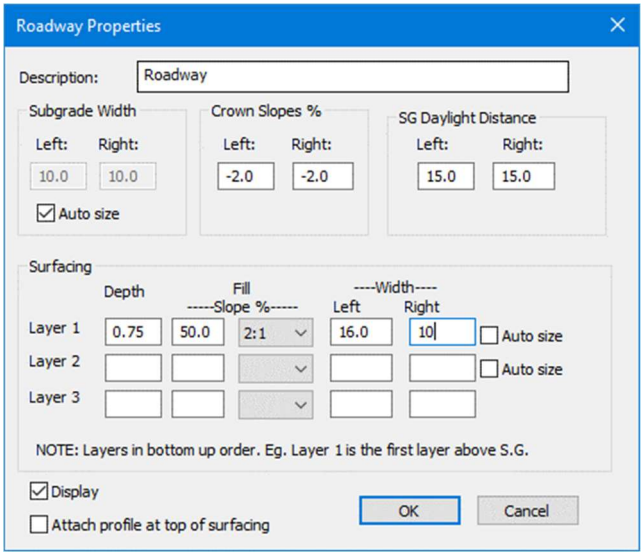


Figure 16-3: Low Volume *Roadway Properties*

This component allows you to change various parameters such as surface depth, surface width, and surface slopes.

13. Change the surface width on the *Left* by setting the *Value* to **16** as shown above.

Note: When there is a *Feature* option for a given parameter, it means that you can use a reference feature centerline offset to define the parameter instead of the default value. *Reference Features* can be defined by pressing the ⊞ button.

14. Press *OK* to accept changes and close the properties dialogue box.

Notice the road has widened on the left.

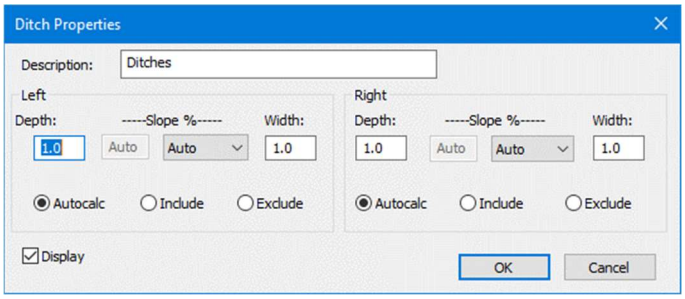


Figure 16-4: *Ditch Properties*

15. Similarly, open the *Ditch-properties* dialogue box (above). Note the available parameters and then press *Cancel* to close.

16. Open the *Slopes* properties dialogue box. Note the available parameters and then press *Cancel* to close.

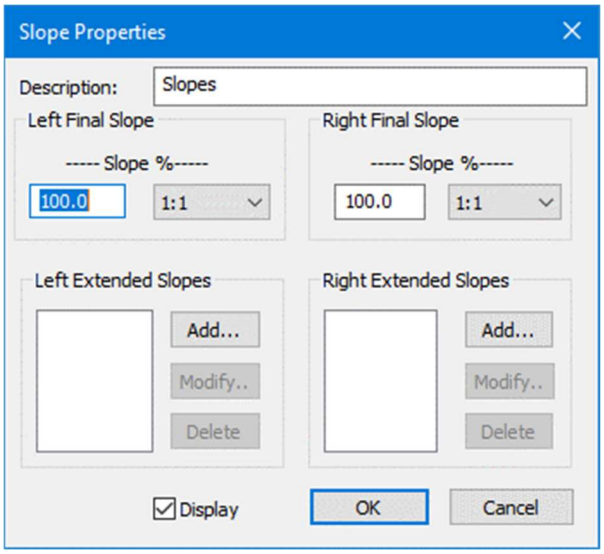


Figure 16-5: *Slope Component Properties*

The ground slope buttons (shown below) allow you to view typical cross sections:

 *Slope Right*

 *Slope Left*

 *Cut*

 *Fill*

17. Select the *Slope Left* button  . Notice how the black ground line changes and how the template accommodates.
18. <Click> and drag in the template graphic area. Note that the black ground line stays in a fixed position, but you can change the template position and see how it will behave in different situations.

Note: Since Softree added this ability to change the template position (up and down, for example) the difference between *Cut*  and *Fill*  cross sections have become irrelevant.

Note: The middle mouse pan and zoom functions work in the template graphic area.

19. Click on the *Split screen view button*  . The screen shown below will appear showing four ground situations at the same time. Each template position can be adjusted with a left mouse <click> and drag.

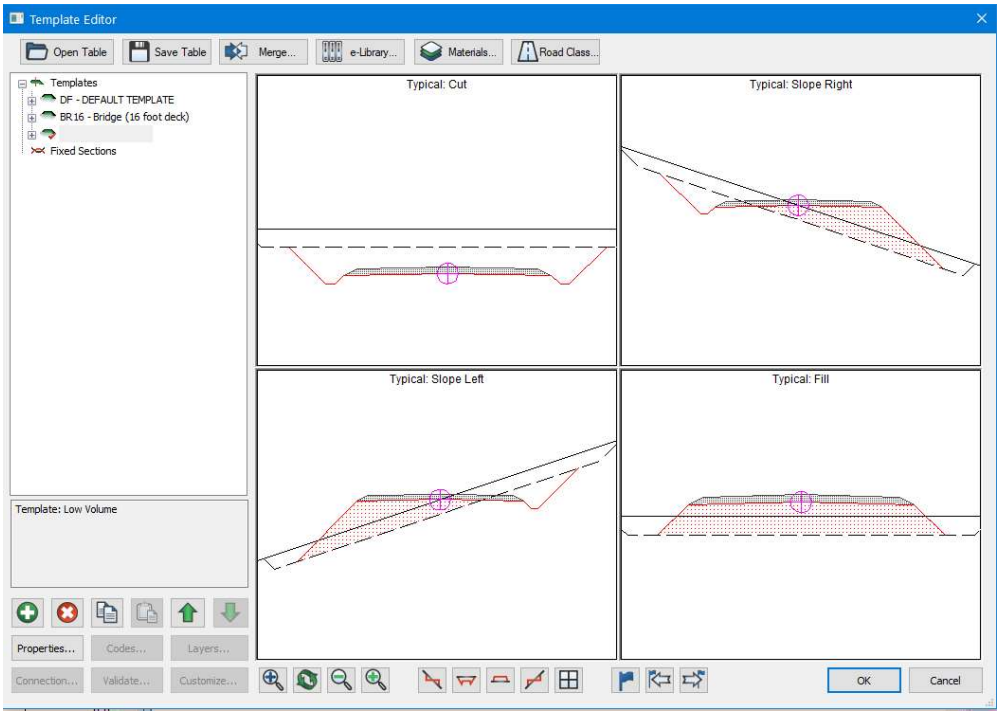


Figure 16-6: *Split Screen View* Depicting 4 Typical Sections

20. Click on the *Station* button . Change the *L-Station* to **3500**. Press *OK*.

On the screen, you will see the template applied to station 35+00 of the design. This allows you to quickly see how the template will appear before it is assigned.

21. Click on the *Slope Right* button to prepare for the following section.

Working with Components

Template *components* are interchangeable building blocks. A template table can also contain optional folders containing re-usable components.

22. Press the *e-Library* button in the top row of the *Template Editor*. This will connect to Softree's e-Library of available template components.

23. Press *Select All*. Click *OK*.

24. Open the *Slopes Components* folder by clicking on the ⊞ button beside the *Slope Components* folder or <double-clicking>.

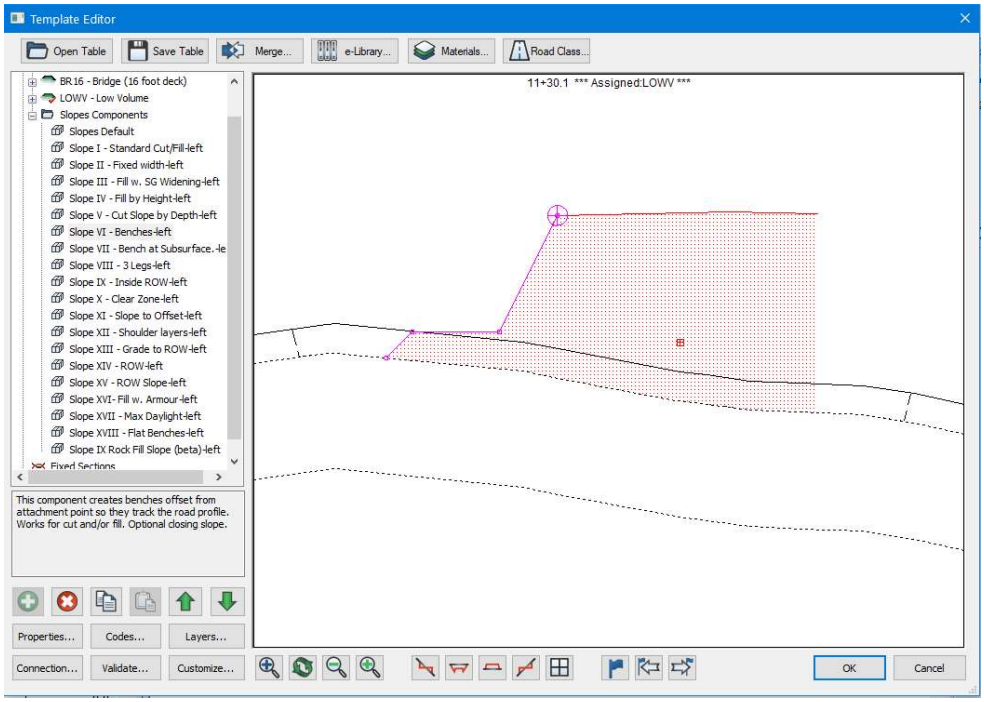


Figure 16-7: *Copying a Component* from a Folder

25. <Right-click> on the **Slope VI Benches-left** component and select *Copy*.

26. Scroll up until you can see the **LOWV- Low Volume** template again.

27. <Right-click> on the **LOWV- Low Volume** template *Slopes* component and select *Delete*.

28. <Right-click> again and choose *Paste* | *As new* as below:

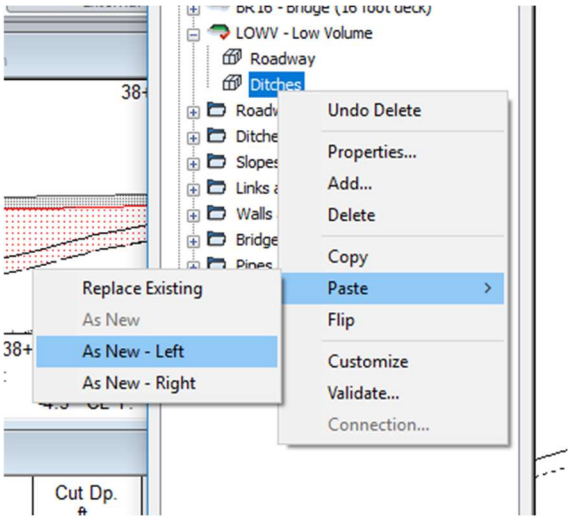


Figure 16-8: *Pasting a Component* In a Template

At this point you might want to change the new component's properties. Is the bench wide enough? Are the steps high enough?

Open the *Properties* dialogue box for the new *Slope VI Benches-left* component and:

- Change *BenchHeight* to **15**.
- Change *BenchBaseWidth* to **10.**
- Press *OK* to see the change.
- <Click> and drag your template down to create a deep cut.

Notice that the cut bench component is only on the left side as shown in the figure below. We will copy it (with its new bench height/width) to the right.

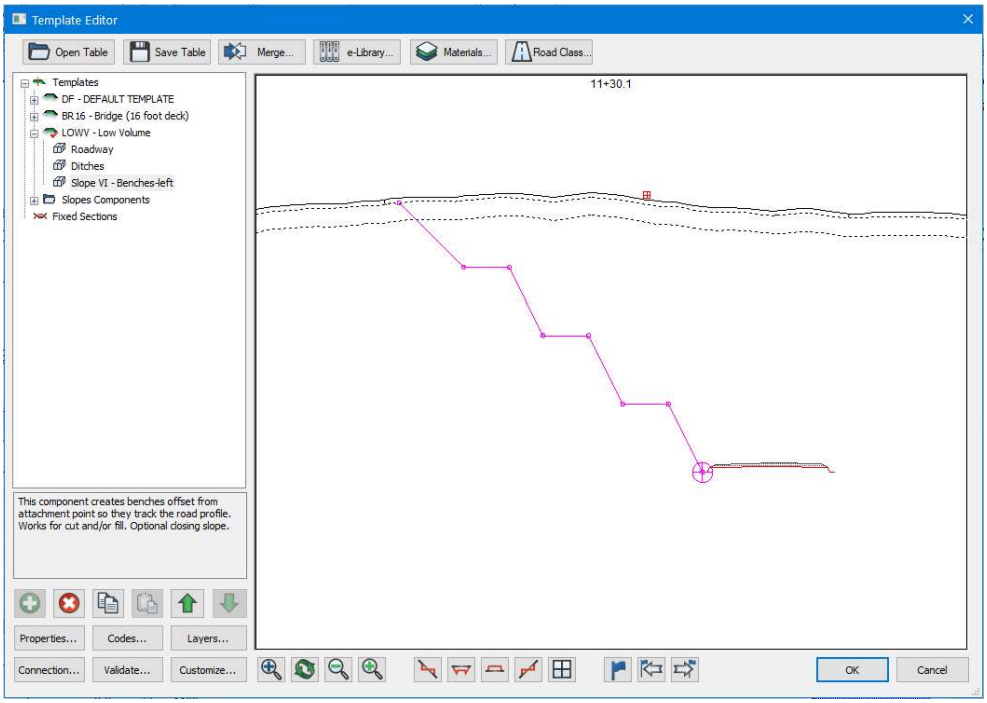


Figure 16-9: The New Slopes Component Is Only On The Left Side.

29. Under **LOWV-Low Volume**, <right-click> on **Slope VI Benches -left** and select Copy.
30. <Right-click> again and select *Paste* | *As New - Right*.
31. Use your mouse to move the typical section around (<left-click> and drag). This component creates cut or fill benches.

Note: The order of components is important; components should be arranged from the center line out. The left/right order is unimportant.

32. Use the *Shift Up* button to move one of your *Slope VI - Benches* components to the top of the list. Notice what happens to the drawing and the warning that is displayed.
33. Restore the order using the *Shift Down* button.
34. Press *Cancel* to exit the template editor.
35. *File* | *Close*. Do not save changes

17. Template Assignments

Assigning a Roadside Barrier to a Range of Stations

Templates can be assigned to a range of stations. The following example will demonstrate how this is done by adding a road side barrier to one side of a road.

Creating a New Template

1. *File* | *Open* <RoadEngResource>**\LiDAR \Road6 - 10.dsnx.**

Note: If continuing from the previous example, we removed the widening in the template. In an upcoming example, we will widen a specific area of our design.

2. *Home* | *Templates*, to open the *Template Editor*.
3. <Right-click> the LOWV-Low Volume template and select menu *Copy*.
4. <Right-click> again and select menu *Paste* | *As New* to create a new template. The new template (**xx0-LowVolume**) is highlighted and appears at the bottom of the list.
5. Use the *Shift Up* button to move the new template to just under LOWVV-Low Volume.
6. <Right-click> on **xx0-Low Volume**, select the *Properties* menu and change the *Name* of the new template to **BAR** and the Description to "**Low Volume with Barrie**r" as in the figure below. Press *OK*.

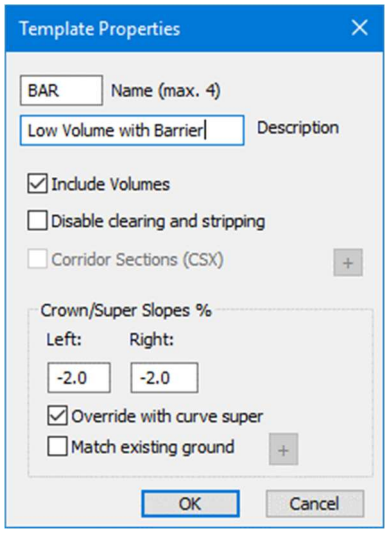


Figure 17-1: *Template Properties*

Now that you have a new template, you need to add the barrier component to it. We previously loaded the entire e-Library. If you are starting at this example, press the e-Library button to do so.

7. Open the *Walls and Barriers* folder by clicking on the button adjacent (or <double-click> on the folder).
8. Copy **Barrier II-Concrete Barrier-left.**: <Right-click> and *Copy*.

9. <Right-click> on template **BAR – Low Volume with Barrier** and choose menu *Paste* | *As New*.

The barrier will appear at the bottom of the components list and will also appear on the template graphic. Now we need to put it in the right location.

10. Put the barrier in the right location:

    - Open the *Barrier* properties (<right-click> choose *Properties*).
    - Change the *BarrierCL_Offset* parameter to **9**.
    - Press *OK* to exit the *Properties* dialogue box.

Your template should now appear as in the figure below:

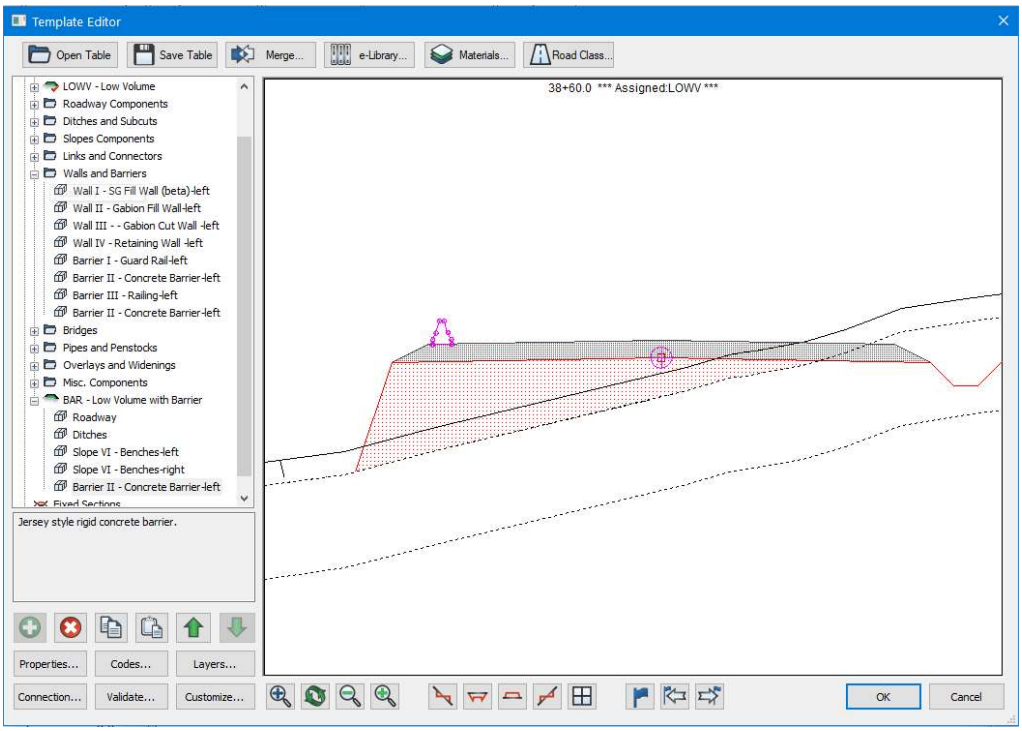


Figure 17-2: *Template* with Barrier

To make this template more useful, we will put the barrier on both sides.

11. <Right-click> on **Barrier II – Concrete Barrier-left** and *Copy* it to the clipboard.
12. <Right-click> again and select menu *Paste* | *As New- Right*.
13. Press *OK* (lower right) to accept the changes and close the *Template* editor. It is all right to respond *Cancel* to the recalculate prompt because the new template has not been assigned yet.

Assigning the Template

14. *Home* | *Assign by Range* to open the *Assign Parameters by Range* dialogue box (Figure 17-3). Select the *Templates* tab.

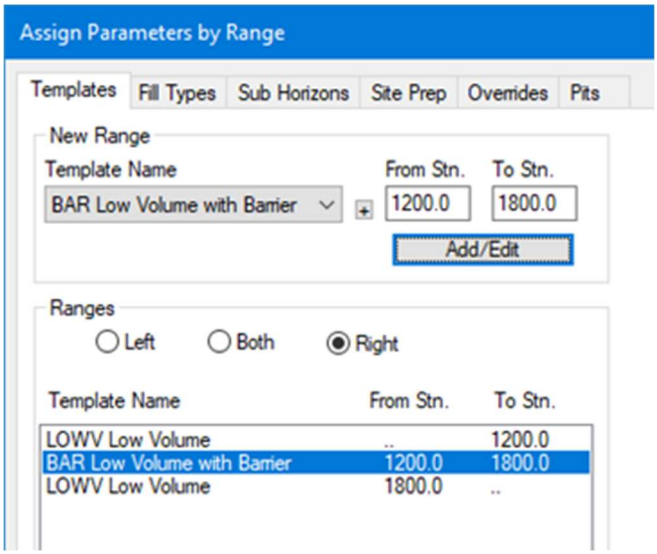


Figure 17-3: *Assigning a Template* to a Station Range

The barrier will be placed between stations 1200 and 1880 but only on the right-hand side.

15. In the Ranges area, select *Right*. Do this first because it resets the template name and range fields.
16. In the Template Name control, choose *BAR Low Volume with Barrier*. In the *From Stn*. edit box enter **1200** and in *To Stn*. enter 1**800**.
17. Press the *Add/Edit* button**.** The dialogue box should appear as in the figure above.

Note: The most common mistake made in the assignments dialogue box is to skip the *Add/Edit* step. If you Press *OK* before the ranges are updated, nothing happens.

18. Press *OK* to return to the main screen. Respond *OK* to *Recalculate* prompt.
19. Maximize the Section Window.
20. *Section* | *Jump to Station* (or <Ctrl-J>) and type station **1200**. Press *OK* to update the current section.

To remove a template assignment, assign another template over the same range.

21. Remove the barrier template assignment:
    - *Home* | *Assign by Range*
    - Select the *LOWV Low Volume* Template.
    - Adjust the *From Stn*. and *To Stn*. to be "**..**".
    - Press *Add/ Edit*.
    - This will return the range back to LOWV for the entire alignment.
22. *File* | *Close*. Do not save changes.

18. Template Parameter Overrides

Creating a Turning Lane

This example will demonstrate parameter overrides by creating a turning lane at an approach to an intersection.

1. *File* |*Open* <RoadEngResource>**\LiDAR\road6 - 10.dsnx.**
2. *Home* | *Assign by Range* dialogue box. Select the *Overrides* tab.
3. In the *Parameter* control, choose *SrfWidthL1* as shown in the figure below:

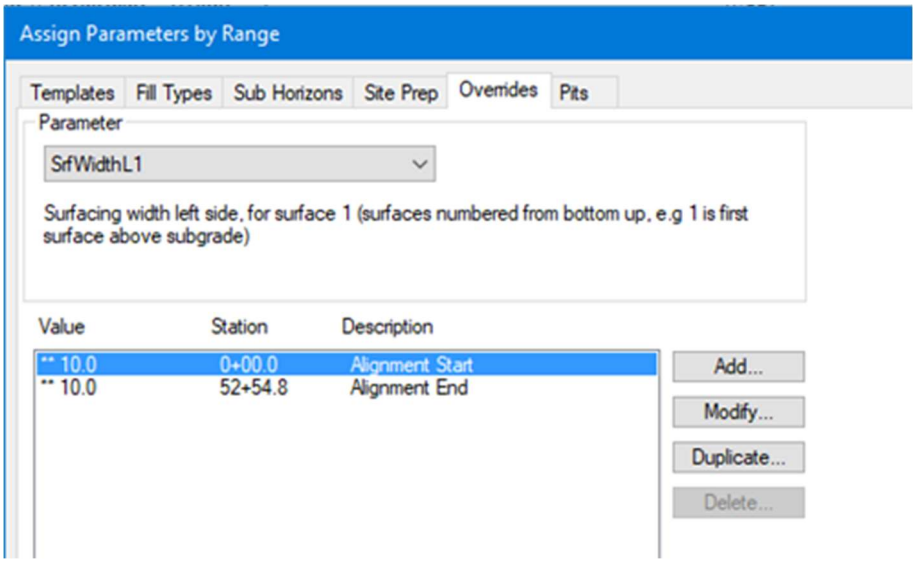


Figure 18-1: Assign Template *Overrides* Dialogue Box

4. Press the *Add…* button in the override list. Turn off *Use Default* and set the *Value* to **16 for** *Station* **9+80**. Change the description to "**Turning Lane Start**". Press *OK*.
5. Press the *Add…* button and add another *Value* of **16** at *Station* **10+50**. Also change the *Description* to read "**Turning Lane End**" (as shown below on the right). Press *OK*.

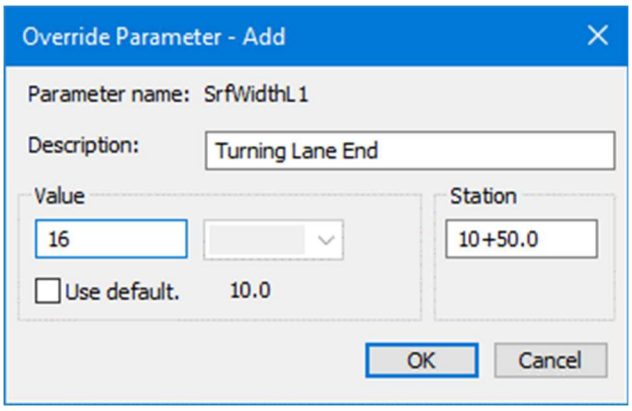


Figure 18-2: *Override Parameter* – Modify Dialogue

6. Press the *Duplicate* button and set the *Use default* check box to ON. Change the *Station* to **9+00**. Change the *Description* to **"Turning lane taper start"**. Press *OK*. Your override list should be the same as the figure below:

7. Press the *Duplicate* button again and set the *Use default* check box to ON. Change the *Station* to**11+30**. Change the *Description* to **"Turning lane taper end"**. Press *OK*. Your override list should be the same as the figure below:

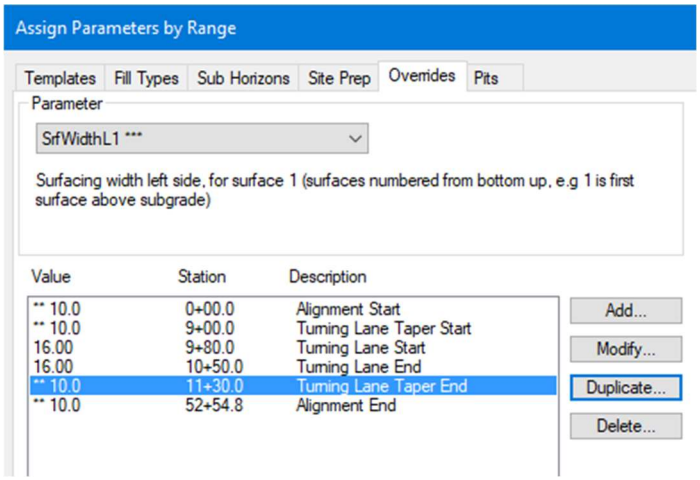


Figure 18-3: *Override Tab* for Turning Lane in Middle of Alignment

8. Press *OK* to return to the main screen. Respond *OK* to *Recalculate Range*.

9. Activate and maximize the Plan window  .

10. *Plan* | *Jump to Station*. Enter **10+00**, and press *OK*. *Zoom in*.

11. <Right-click> | *Plan Options.* Ensure *Road Edges (RE)* is checked.

Notice the road edges in blue now display the additional lane width as shown in the figure below.

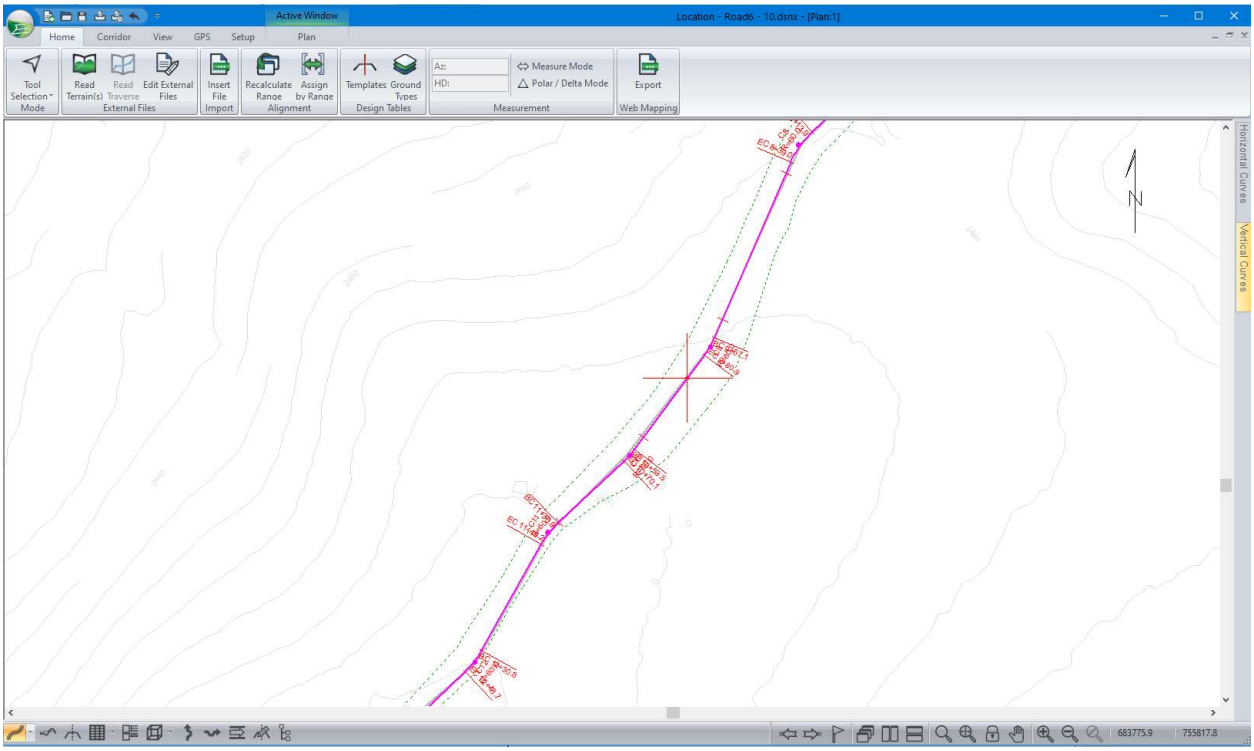


Figure 18-4: *Turning Lane* defined by Template Parameter Overrides

12. *File* | *Close*. Do not save changes.

19. Templates – Display and Reporting

Before we begin, some basic concepts and definitions are required.

Surfaces

Template surfaces are used to track and report material volumes. Each template can define up to 16 surfaces plus sub-grade. Material volumes are calculated between surfaces. Thus, we can calculate and report cut and fill volumes below the sub-grade surface and up to 16 material fill volumes.

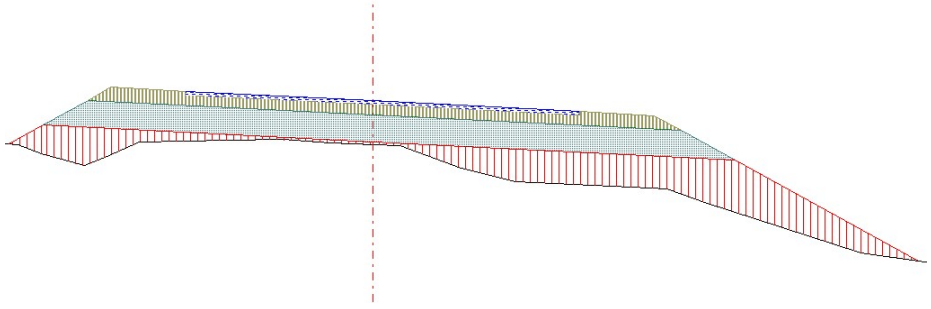


Figure 19-1: *Template Surfaces* and Enclosed Materials

Codes

Each template component has a set of pre-defined template codes. These point codes can be displayed in the Plan, Profile, Section or Data windows. In Profile and Plan the codes are connected to form linear features such as a ditch-line or sidewalk offset.

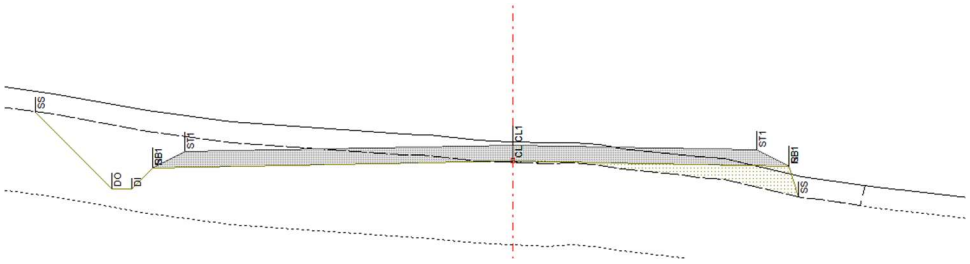


Figure 19-2: *Template Codes*

Display and Reporting of Template Layers

Formatting template layers

1. *File* | *Open* <RoadEngResource>\LiDAR\Road6 - 11.dsnx.
2. Maximize the Section window and zoom in.
3. <Right-click> in the Section window. Select *Section Options*.
4. Click on the button beside the *Template* check box to open the *Template Display Format* dialogue box.

5. Select the first item (*SG – Subgrade material*). Turn ON *Display Labels* as shown in the figure below.

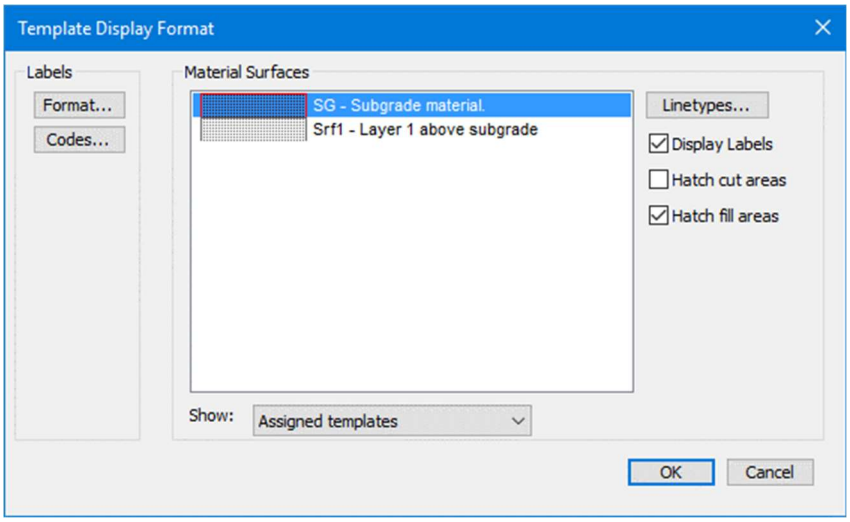


Figure 19-3: Section Window Options and the *Template Display Format* Dialogue

6. Using the *Show* drop down menu, select *All Surfaces* as shown in the figure below. Select one of the other layers. Note that *Display Labels* is not checked. Set *Show* back to *Assigned Templates*.

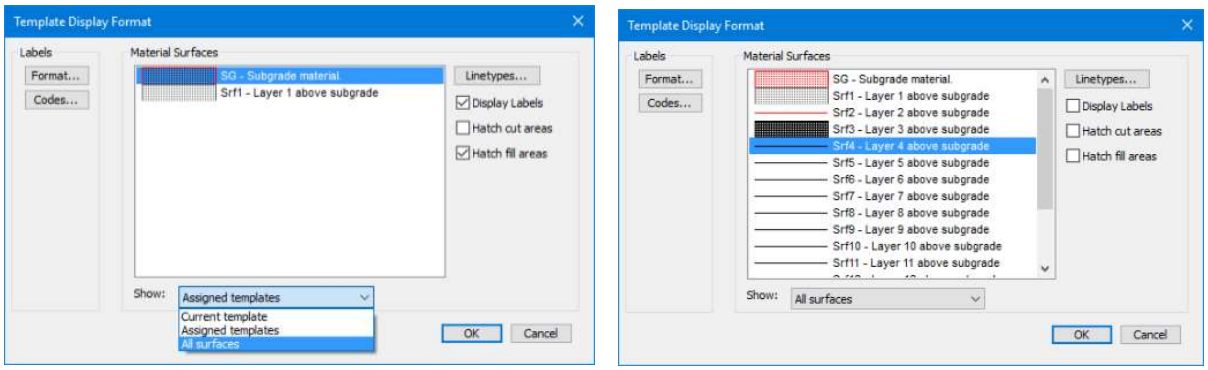


Figure 19-4: Only Template Items From the SG – Subgrade Material will Display Labels

7. With *SG – Subgrade material* selected, in the *Labels* section on the left side of the dialogue box, press the *Format...* button.

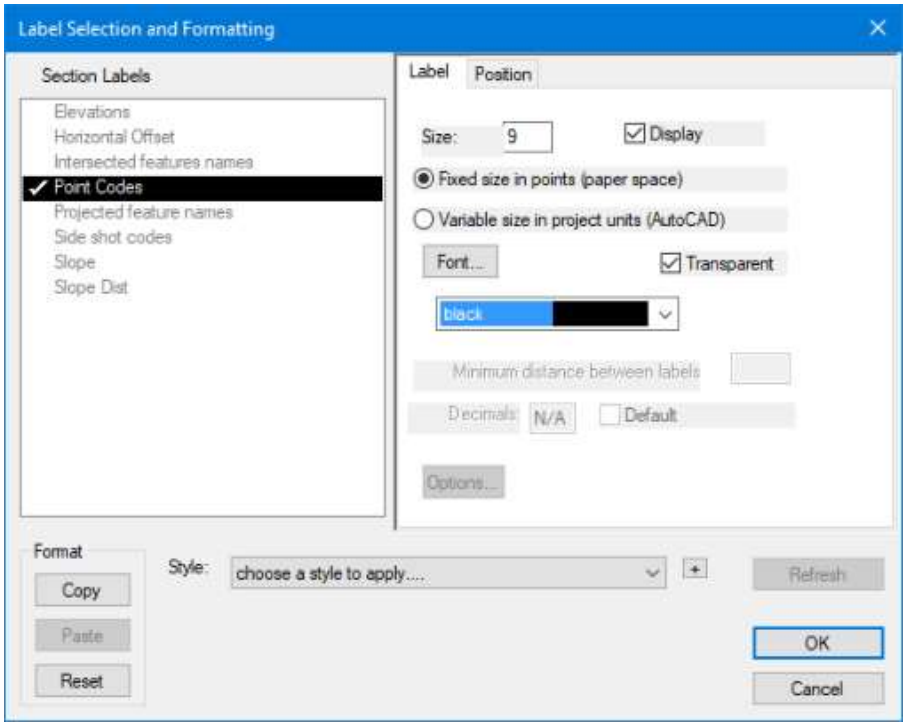


Figure 19-5: *Label Selection and Formatting* Dialogue

8. Ensure that only *Point Codes* label is selected (as shown above). <Double-click> on the label to select and de-select. You can also change label font, color and position in this dialogue box:
    - On the label tab, adjust the *label size* to **9**, *colour* to **black.**
    - On the position tab, adjust the *leader offset* (mm) to **1.0 mm.**
9. Press *OK* to close the dialogue box.
10. Back in the *Template Display Format* dialogue, press the *Linetypes* button on the upper right-hand side to open the *Line-types and Symbols* dialogue box.

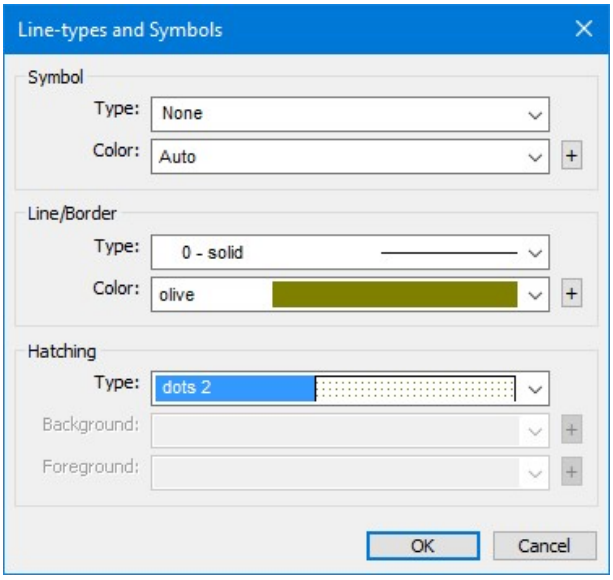


Figure 19-6: *Line-types and Symbols* Dialogue

The Line-types and Symbols dialogue box allows you to change line style (including symbols), hatch style and color.

11. Change the color of the SG -Subgrade to ***olive*** and the hatching type to ***dots 2***. As shown in the figure above. Press *OK* to accept changes and close the dialogue box.
12. Press *OK* to close the *Template Display Format* dialogue box which returns you to the *Section Window Options* dialogue box.
13. In the *Section Window Option* dialogue box, set the *Labels* check box to ON. The point code labels will not be displayed unless this master switch is turned on.
14. Press *OK* to return to the main screen. You should see the template point code labels for the subgrade surface.
15. Move your mouse over a template point that is not displayed (for example the road edge) and hold your mouse there (hover). You will see a *tool tip* displaying the point code along with some other information as in the figure below:

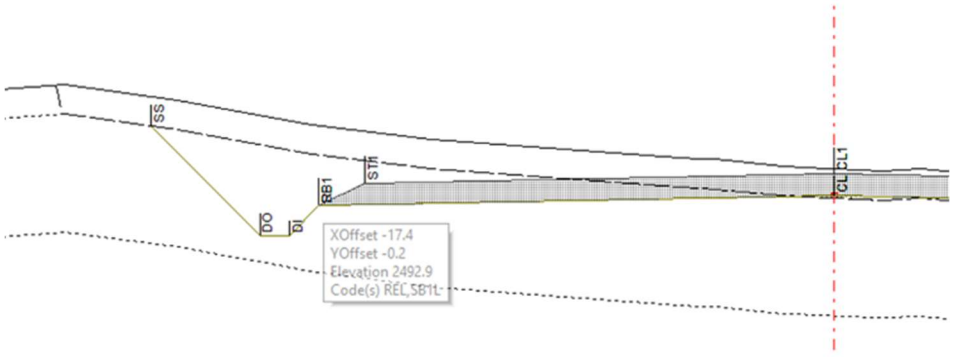


Figure 19-7: *Hover Tips* in the Section Window

16. Try hovering in other places and see what information appears in the tip. You can display:

- Mouse elevation, vertical and horizontal offsets
- Cut and fill material
- Cross sectional areas
- Template leg length and slope
- Point codes

17. *Section* | *Jump to Station*. Type **12+40**. Press *OK*.
18. <Right-click> in the ditch cut area (above the ditch bottom and below the original ground) and select *Hatch Cut Area for SG* from the menu. This shows the olive hatching you defined above.
19. <Right-click> in the same place to turn off the subgrade hatching.
20. To continue, go to step 2 in **Display and Reporting of Ditch Lines**. Or select *File* | *Close*. Do not save.

Note: The template layer formatting that we have modified in the exercise is stored in **Screen Layouts**. This includes line style, hatch style, color and label formatting for subgrade and each layer above subgrade.

Display and Reporting of Ditch Lines

Reporting Template Point Codes

In the exercise above we displayed point code labels in the section window. Point codes can also be displayed graphically in the *Plan*, *Profile* and *Section* windows. The *Data* and *Status* windows can display numeric information such as point code coordinates or centerline offsets.

The following steps will display the ditch lines in the Plan Window:

21. *File* | *Open* <RoadEngResource>**\LiDAR\Road6 – 12.dsnx**.
22. *View* | *Screen Layouts* drop-down, open **Training** folder, select **Training Normal.dlt**.
23. <Right-click> in the Plan window and select *Plan Options*.
24. Ensure that the *Template Codes* option is selected; press the button beside it to open the *Codes* dialogue box.
25. Click the *Add* button and select all the ditch point codes as shown the figure below. Press the <Ctrl> key while selecting to do a multiple select:

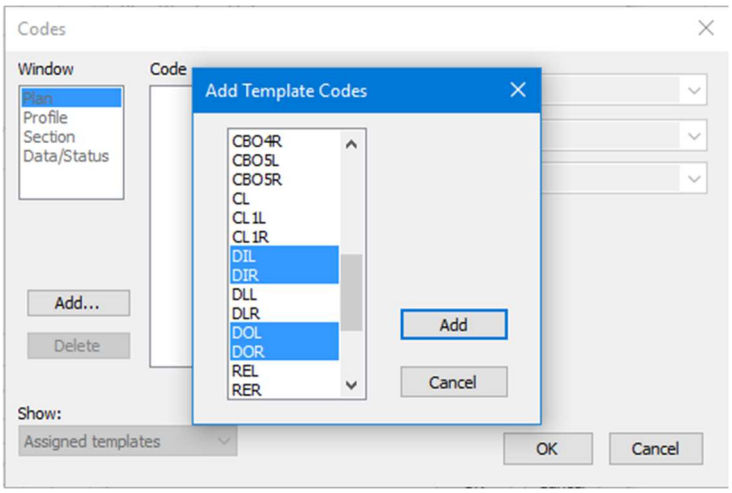


Figure 19-8: *Adding Template Codes* for Display in the Plan Window

26. Click *Add* to close the selection dialogue box.
27. With the new codes still selected, choose a *blue dash* line as shown below:

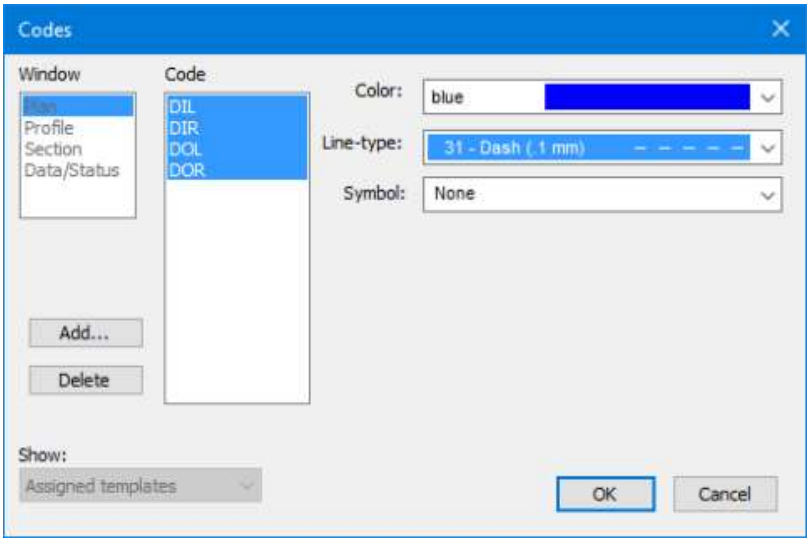


Figure 19-9: *Plan Template Codes* Format Control

28. Press *OK* to close the *Codes* dialogue box and respond *OK* to *Recalculate Range*.
29. Press *OK* again to close the *Plan Options*.
30. Adjust the Plan Window view so you can see the new ditch lines.

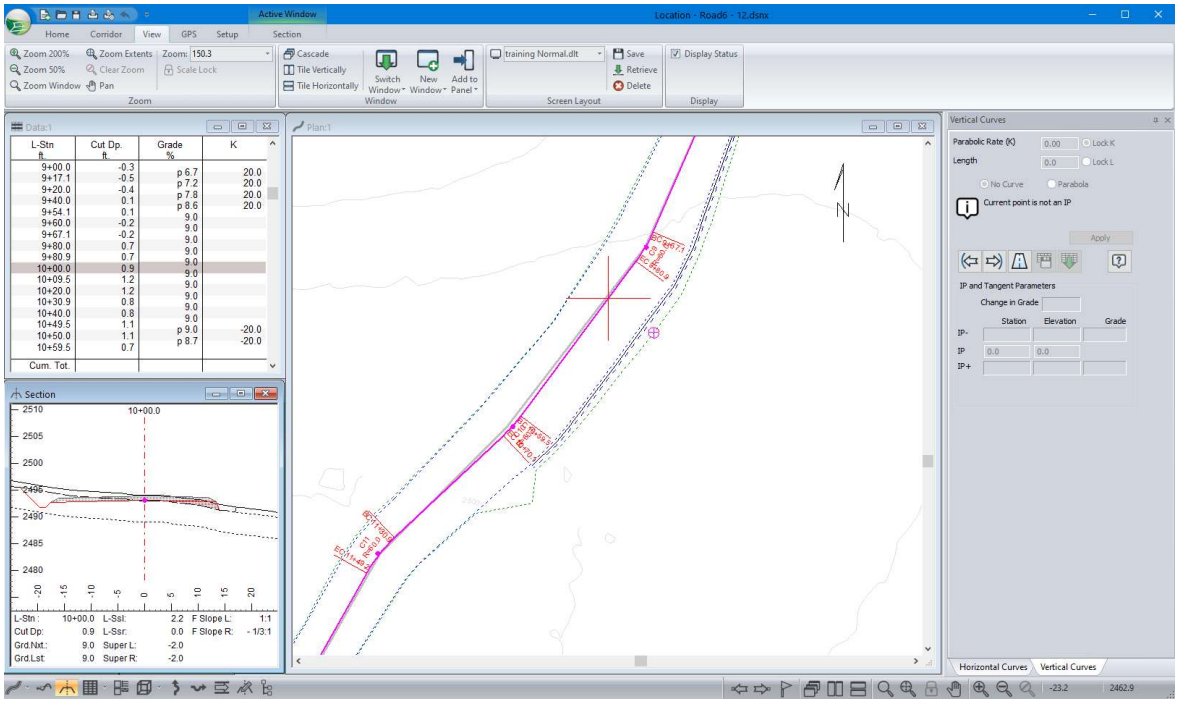


Figure 19-10: *Ditch Lines* in Plan View

Note: Template point code display options that we have changed in this exercise are saved in the **Template Table**.

The following steps will display the ditch line offsets in the Data Window.

Setting Up the Template Codes for Display

31. <Right-click> in the Data Window. Select *Data Options*. The *Data Window Options* dialogue box will appear.

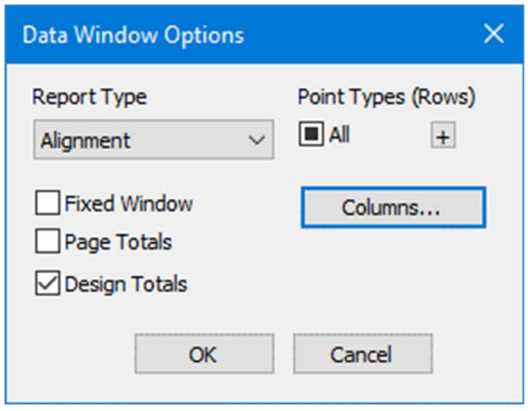


Figure 19-11: *Selecting Point Code Offsets* for Display in the Data Window

32. Press the *Columns...* button to open the *Data Window Fields* dialogue box.
33. Use the *Remove* button to delete all but the *L-Stn* item.

34. Open the *Template Codes* folder *by selecting the* button *beside the Template Codes Folder.* Then *Add* the following codes (refer to the figure below):

    - DIL-Hoff
    - DIL-VOff
    - DIR-Hoff
    - DIR-VOff
    - DOL-Hoff
    - DOL-VOff
    - DOR-Hoff
    - DOR-VOff

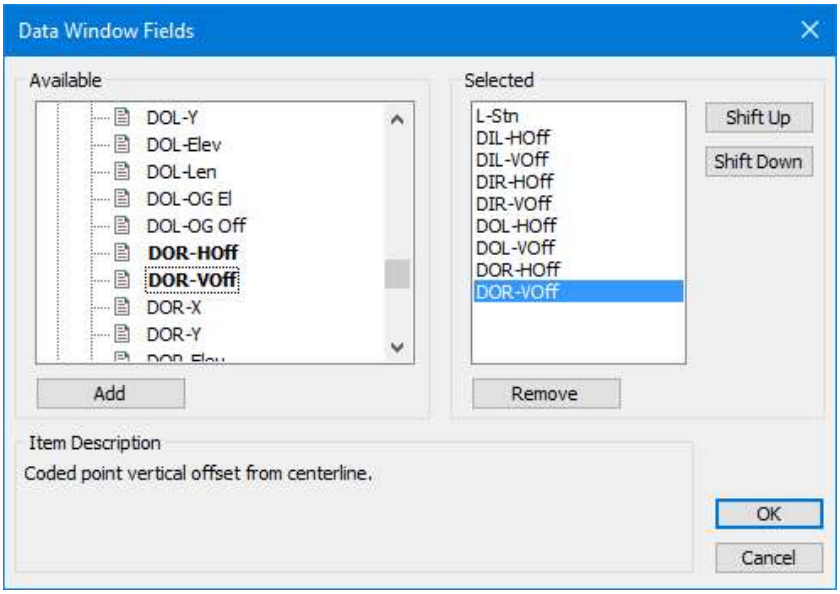


Figure 19-12: *Selecting Point Code Offsets* for Display in the Data Window

35. Press *OK* to return to the *Data Options* dialogue. Click *OK* to *Recalculate Range*.

36. To set up desired spacing of data rows, click the *Point Types* button to open the *Point Type Selection* dialogue box.

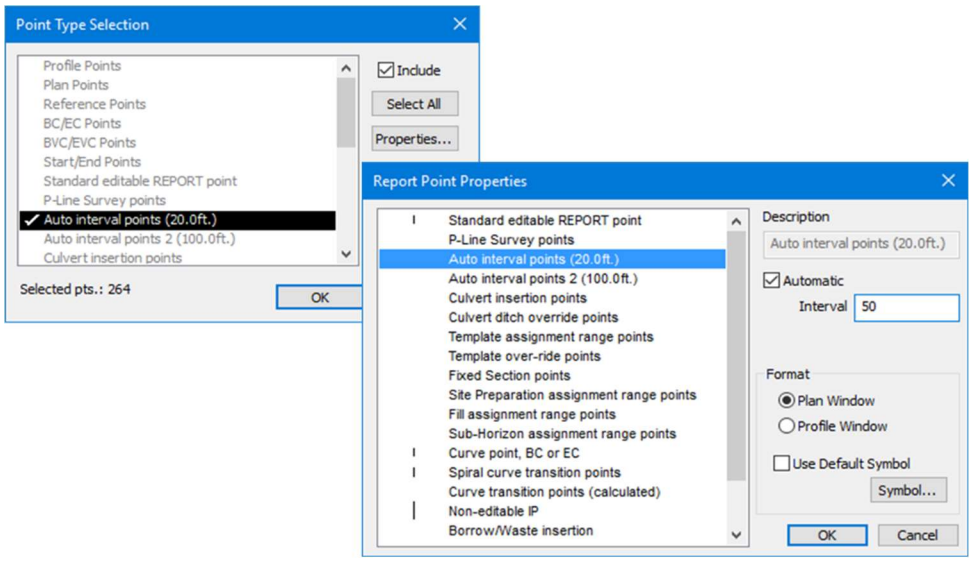


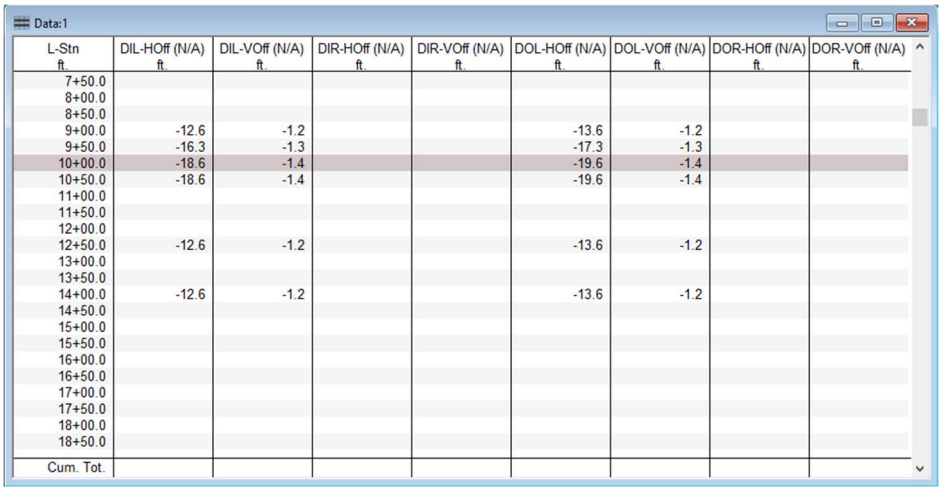
Figure 19-13: Setting the *Data Window* to Display Information every 50ft.

37. Ensure that only the *Auto Interval Points (xxx ft)* are checked for display (as in figure above left).

38. Press the *Properties* button to show the *Report Point Properties* dialogue box (figure above right). Select *Auto interval points* and set the *Automatic* check box with an *Interval* of 50.

39. Press *OK* (there will be a re-calculation). Press *OK* again to return to the *Data Window Options* dialogue box.

40. Press *OK* again to close the *Data Window Options* dialogue box and update the display (figure below).


Data:1

L-Stn ft.	DIL-HOff (N/A) ft.	DIL-VOff (N/A) ft.	DIR-HOff (N/A) ft.	DIR-VOff (N/A) ft.	DOL-HOff (N/A) ft.	DOL-VOff (N/A) ft.	DOR-HOff (N/A) ft.	DOR-VOff (N/A) ft.
7+50.0								
8+00.0								
8+50.0								
9+00.0	-12.6	-1.2			-13.6	-1.2		
9+50.0	-16.3	-1.3			-17.3	-1.3		
10+00.0	-18.6	-1.4			-19.6	-1.4		
10+50.0	-18.6	-1.4			-19.6	-1.4		
11+00.0								
11+50.0								
12+00.0								
12+50.0	-12.6	-1.2			-13.6	-1.2		
13+00.0								
13+50.0								
14+00.0	-12.6	-1.2			-13.6	-1.2		
14+50.0								
15+00.0								
15+50.0								
16+00.0								
16+50.0								
17+00.0								
17+50.0								
18+00.0								
18+50.0								
Cum. Tot.								

Figure 19-14: Data Window depicting *Point Code Offsets*

Note: The data window can be exported to a file (menu *File | Export Data to ASCII*) or the clipboard (*Edit | Copy to Clipboard | Data Window Ctrl+C*). This tabular data can be read by a spreadsheet application.

You can also add the point code offsets to your Section window *Status* area (displayed below the graphic).

41. <Right-click> in the Section window and choose *Section Options*.
42. Press the *Fields…* button in the *Status Information* area.
43. Select the  button adjacent to the *Template Codes* folder and select the desired Point Codes. Press OK, then OK again to exit in the *Section* Window. Note the addition of the Point Code offsets in the Section window *Status* area.
44.  *File* | *Close*. Do not save changes.

20. Culverts

In this exercise, you will assign a culvert to the road alignment design.

1. *File | Open* <RoadEngResource>**\LiDAR \ Road6 -13.dsnx.**
2. *View | Screen Layout* drop down**, Training** folder, select **training Culvert.dlt**. Your screen should look like the figure below.

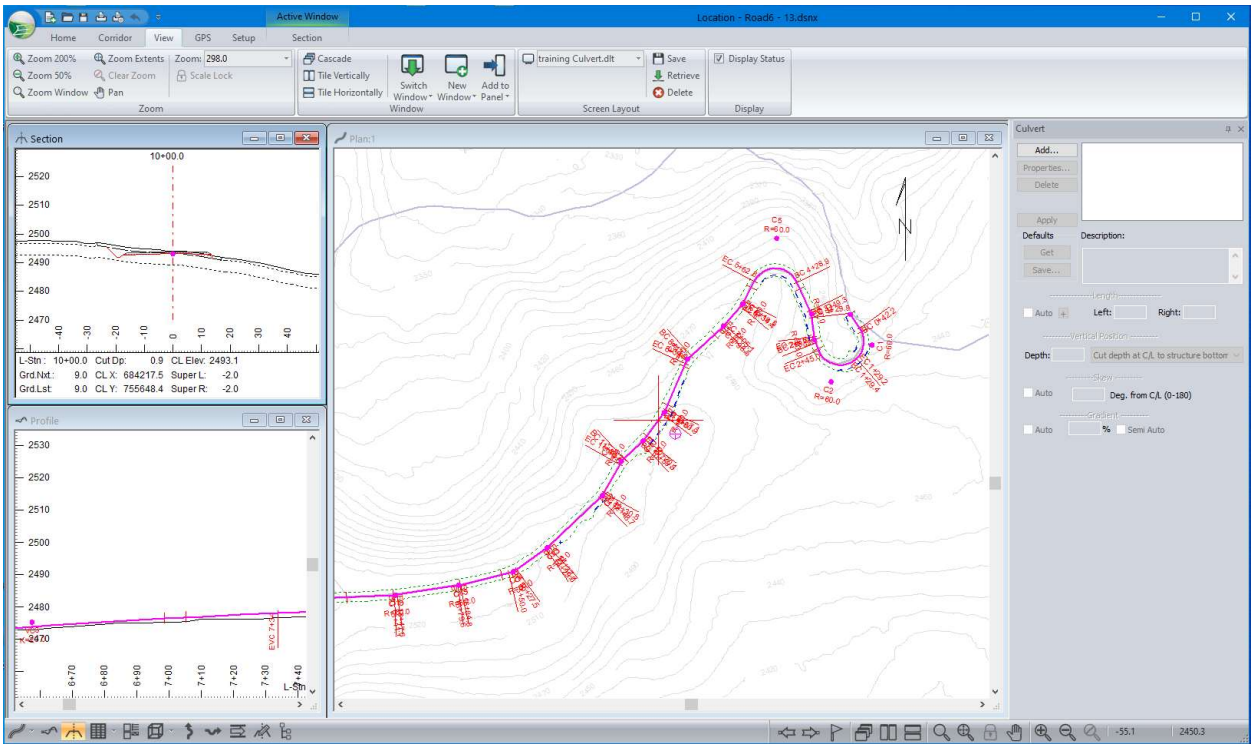


Figure 20-1: Screen Layout *training Culvert.dlt*

We are going to add a culvert at station 19+10.

3. *Zoom* in on the Plan Window.
4. Use *Plan | Jump to Station* or <Ctrl + J> to *Jump to Station* **1910**. Ensure the box is checked next to *Update cross section (add a REPORT point)*. This will add a reporting point at that station. Press *OK*.

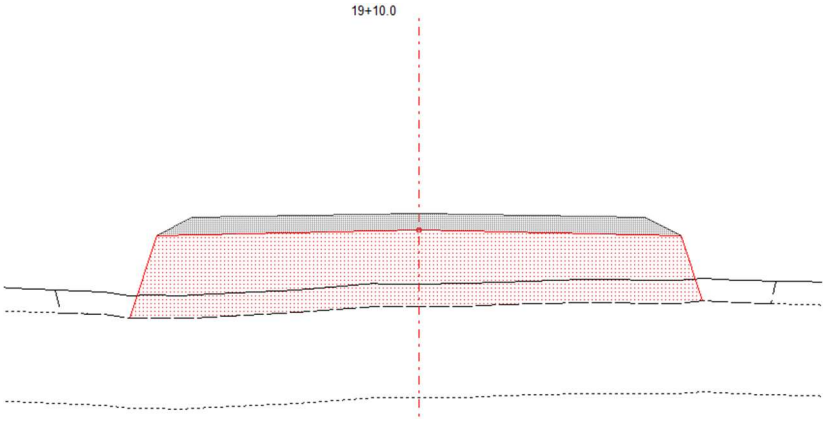


Figure 20-2: Desired *Culvert Location*

5. Press the *Add…* button in the *Culverts Editor* panel (right side of screen) to open the dialogue box shown below. Note that the *L-Line Station* defaults to the current cross section.

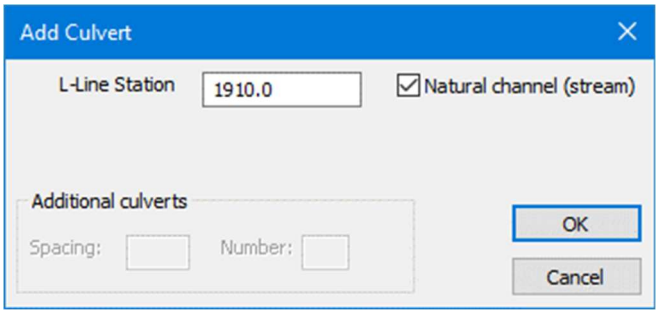


Figure 20-3: *Add Culvert* Dialogue Box

6. Set the *Natural channel (stream)* check box (the alternative is a cross drain). Press *OK* to create the culvert.

If the profile window is not showing the correct station, press *next* and then *back* buttons in the tool bar. Whenever you change the current section using the *next* and *back* buttons, all windows scroll to show the new current point.

Your culvert should be visible in the Section, Profile and Plan Windows.

7. In the *Culvert Editor*, press the *Properties* button to open the Culvert Properties dialogue box shown below.

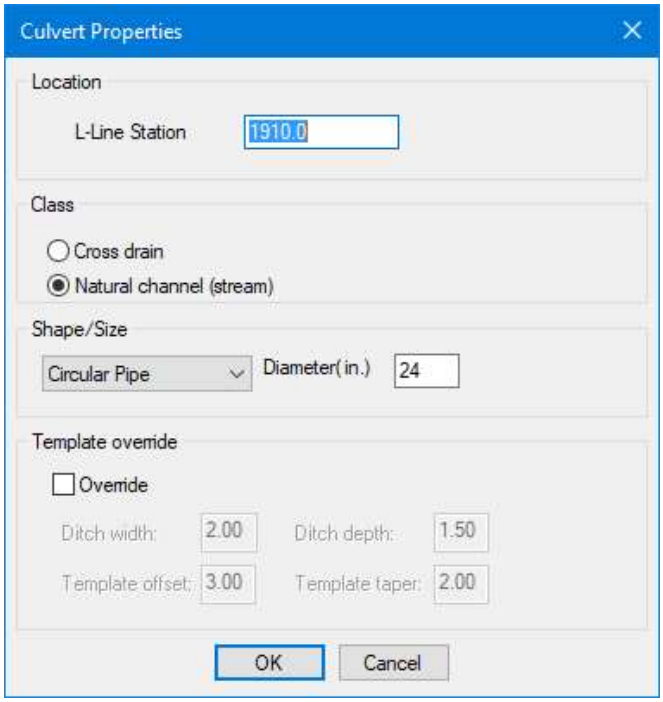


Figure 20-4: *Culvert Properties* Dialogue Box

8. The Culvert Properties dialogue box allows you to change the location, class and shape/size of a culvert.
9. Ensure the culvert *Shape/Size* is set to **Circular Pipe**. Change the *Diameter* to **24** inches and press *OK* to close the *Culvert Properties* dialogue box.
10. In the Culvert Editor panel, change the *Vertical Position* type to **Attach to upper ditch/catch point** and select *Auto* (checkbox) for the *Length*. Press *Apply* to see the changes.

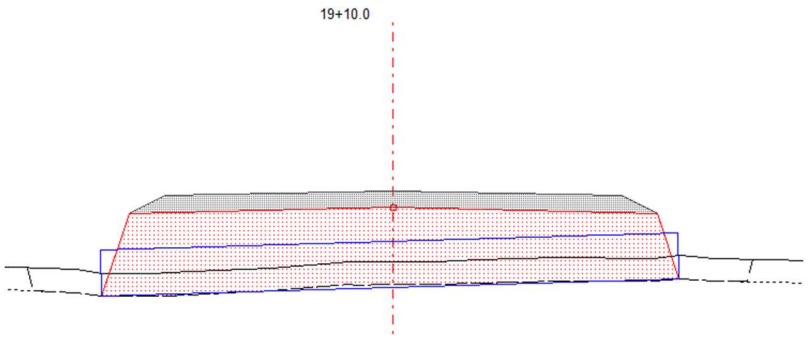


Figure 20-5: Culvert *Elevation Controlled by Catch Points*

11. In the main *Culvert Editor* window, type in a *Description* of **24" Diameter Pipe**.
12. Press the *Save* button and respond *OK* to the *Culverts Defaults* prompt. The next time you create a Natural Channel culvert, this will be the initial configuration.
13. *File | Close.* Do not save changes.

21. Labels

Annotation and labeling is available in the Plan, Profile and Section Windows. This section describes methods and procedures to control label formatting and positioning.

Label Classes

Labels are displayed according to their *Class Format* and *Point Format* (optional). The View (Plan, Profile or Section) Options menu provides access to class label formatting. The *Edit label tool* button in the toolbar allows you to modify individual labels (*point formatting*) with the mouse.

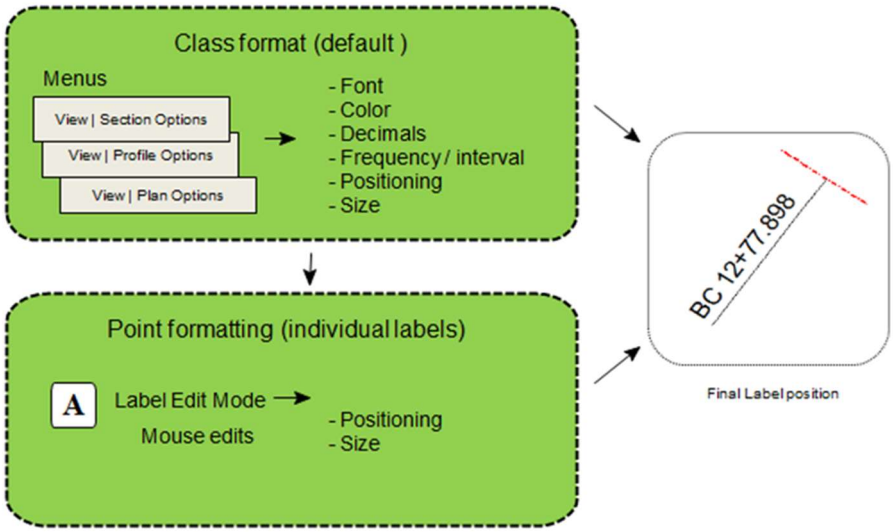


Figure 21-1: Label Rendering

The Plan Window is used in the following example but the same principles apply to the Profile and Section windows.

Class Label Formatting

1. *File* | *Open* <RoadEngResource>**\LiDAR\Road6 14.dsnx**.
2. View | *Screen layout* drop down, open **Training** folder, select **training Normal.dlt.**

Many labels can be attached to report points. The following steps show what report point types exist and how to change the spacing of *Auto Interval Points*.

3. Choose menu *Setup* | *Location Setup*, select the *Alignment* tab and then click on *Report Point Properties…* button.

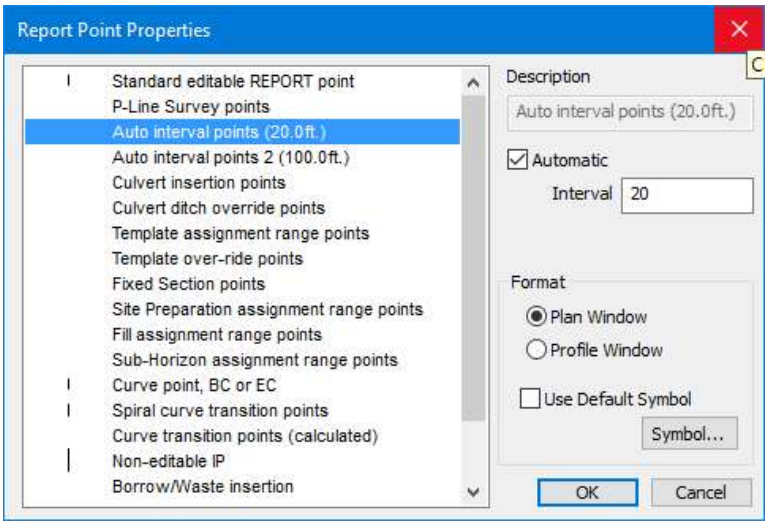


Figure 21-2: *Report Point Properties* Dialogue

4. Select *Auto Interval Points*. Notice that it is set to *automatic* and at an *interval* of **20**. This ensures that a report point exists every 20 feet.
5. Press *Cancel* twice to return to the main screen.
6. <Right-click> in the Plan window, select *Plan Options* and click on the *Labels* button.
7. Scroll down in the Plan Labels box, turn on the *LStn Report Points (Intervals)* class by double-clicking. Set the Interval spacing to **200** as shown in Figure 21-3.
8. Turn off all other labels that are currently enabled ✓ by double-clicking on each item.
9. Press *OK* twice to return to the main screen.

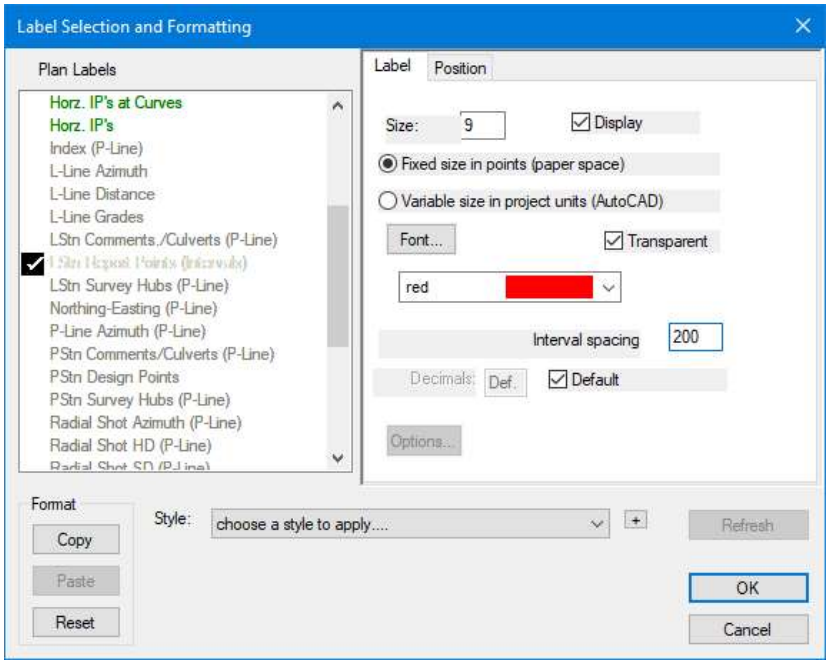


Figure 21-3: *Label Selection and Formatting*

After the Plan window refreshes the screen should appear with L-stationing report point labels every 200 feet.

Note: The format of the stationing e.g. xx+yy is controlled in *Setup* | *Location Setup* | *Units*.

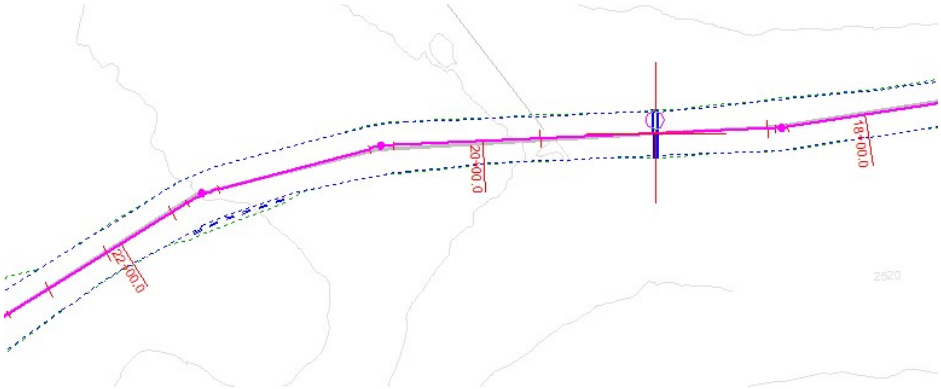


Figure 21-4: Stationing at *Fixed Intervals*

Next, horizontal curve information is added. Another option is to use the Curve Tables in Multi-Plot.

10. *Plan* | *Plan Options* and click on the ⊞ button beside *Labels*. <Double-click> on the *Horizontal IP's at Curves class* to turn on its display. Press *OK* twice to return to the main screen.

Notice the curve number and radius are displayed. Next, additional curve information will be added to the *Horizontal IP's at Curves* label class.

11. *Plan | Plan Options* and click on the button beside *Labels*. Click on the *Horizontal IP's at Curves class* and click on the *Options* button.
12. Click on the *Add Attribute* button and then add **BC Station** and **EC Station** as shown below in Figure 21-5.

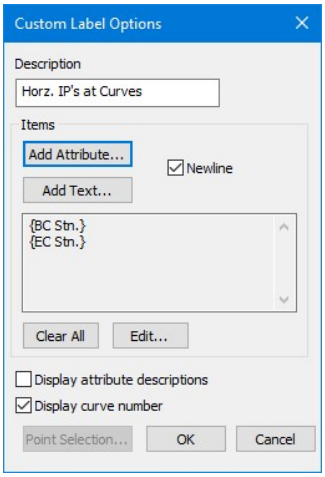


Figure 21-5: Displaying *Horizontal IP's* Labels at Curves

13. Press *OK* four times to return to the main screen.

Notice in the figure below that the additional BC/EC information is now displayed:

Figure 21-6: Curve Information Labels

User-Definable Labels

It is possible to create user definable labels and display these labels at reporting points along the alignment. User definable labels can consist of *attributes* and *static text*. The following is a list of attributes:

- L-Stn L-line stationing
- V.Brk vertical grade break
- CL X centerline X
- CL Y centerline Y

- CL Elev centerline Z
- P-Stn P-line station
- H.Brk horizontal break (change in direction)
- Gnd Elev ground elevation
- Cut Dp cut depth

The next example will demonstrate how to create a user defined label in the Plan window. In this case, we will set up a label to include centerline X, Y and our L-Stn.

14. Select *Plan | Plan Options* or right mouse click in the Plan window. Scroll down to *Plan Options*..
15. Click on the  button adjacent to the *Labels* item to activate the *label Selection and Formatting* dialogue box.
16. In the *Label Selection and Formatting* dialogue, scroll down to the first *User Defined* label class. Select it and click on the *Options...* button to activate the *Custom Label Options* Dialogue as shown in Figure 21-7.

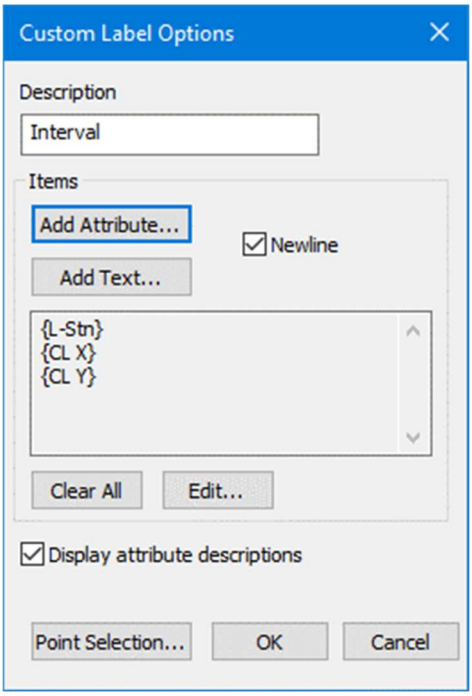


Figure 21-7: *Custom Label Options* Dialogue

17. Change the *Description* to **Interval**. If necessary, click on the *Clear All* button to remove any existing attributes and text.
18. Press the *Add Attribute* button, open the *L-Line* folder to add ***L-Stn***, ***CL X*** and ***CL Y***. Your dialogue should now look like the figure above.
19. Press *OK* to return to the *Custom Label Options* Dialogue.

We will now configure the interval for our new user defined label class:

20. Click on the *Point Selection* button.

21. Select *Auto interval points 2 (xxx ft)*. If it is not set to 200ft already, press *Properties…* and adjust the *Interval* to **200**.
22. Make sure that all other points are disabled; multiple selection is allowed.

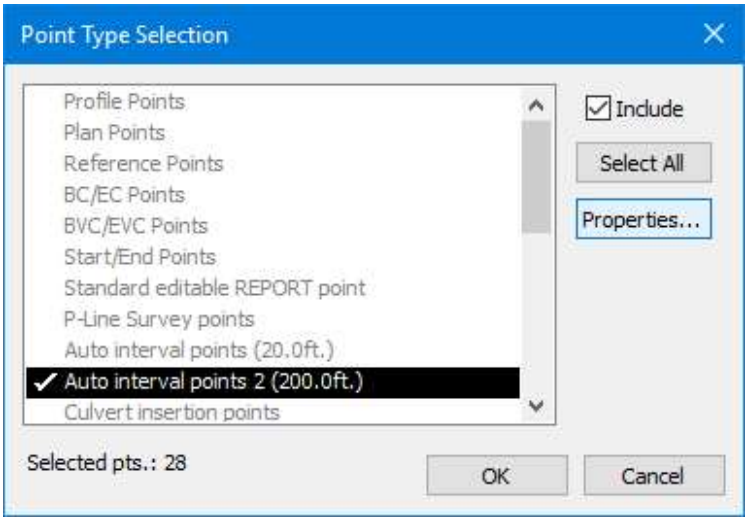


Figure 21-9: *Reporting Point* Selection

23. Press *OK* twice to return to the *Label Selection and Formatting* dialogue. Ensure that our new *Interval* (user defined) label class is activated (denoted by a check mark).
24. Press *OK* twice to return to the main screen.

Your Plan window should appear as shown below:

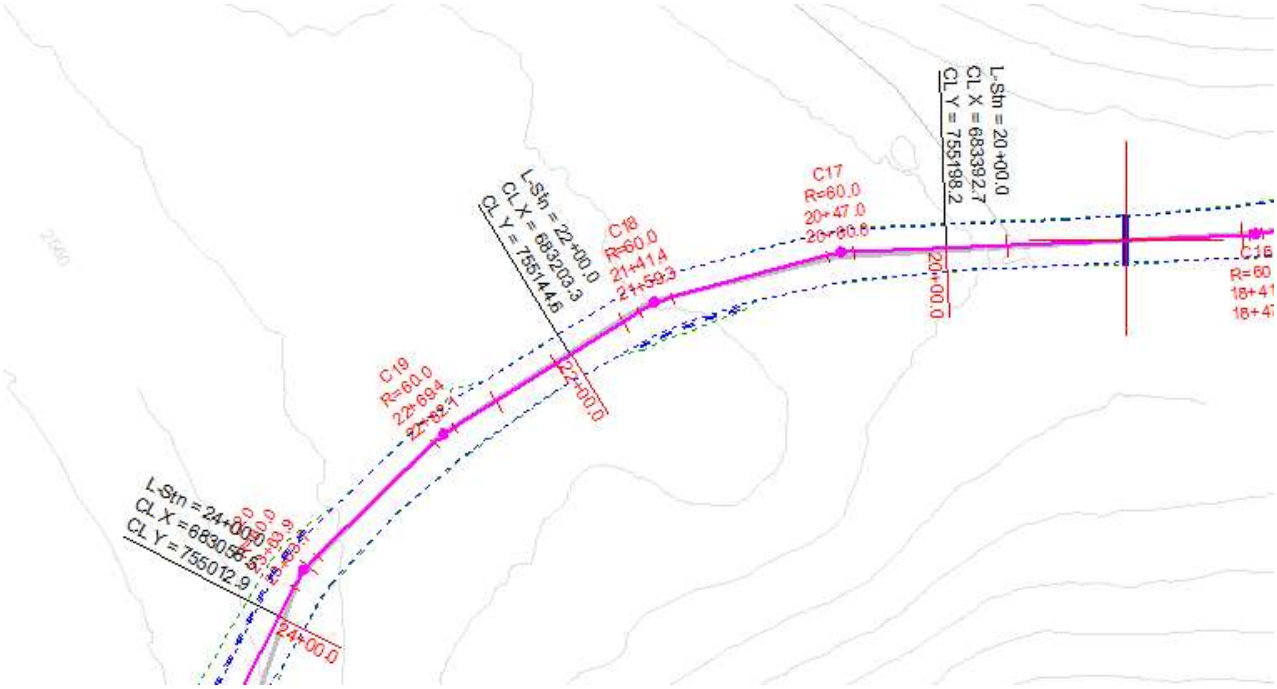


Figure 16-10: *User Defined Labels* (Stn, X, Y at 200' Spacing)

Point Label Formatting

Editing Labels with the Mouse

It is often necessary to control the position and format of individual labels. In this section, *Label Edit* mode will be used to adjust labels. We will use the Plan window in this example but the concepts apply to the Profile window also; the Section window does not support point formatting.

25. <Right-click> in the Plan window and select *Edit Label* Tool. This will change the cursor to the *Edit Label* tool cursor (alternately you could press the *Edit label* tool button in the toolbar).
26. Move your mouse cursor over the label *L-Stn=22+00*, when the cursor changes to a simple cross, <left-click> once.

The label is now selected and should look like the one in the figure below; there are two handles (small black squares) that allow you to move or rotate the label.

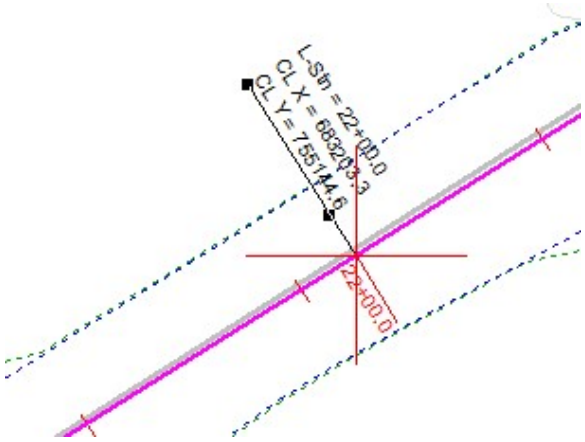


Figure 21-11: *Selected Label* with Handles Visible

27. Re-orient and re-position the label:
    - <click> and drag on the outer handle to rotate
    - <click> and drag on the text to move.
    - until it appears as shown in the figure below:

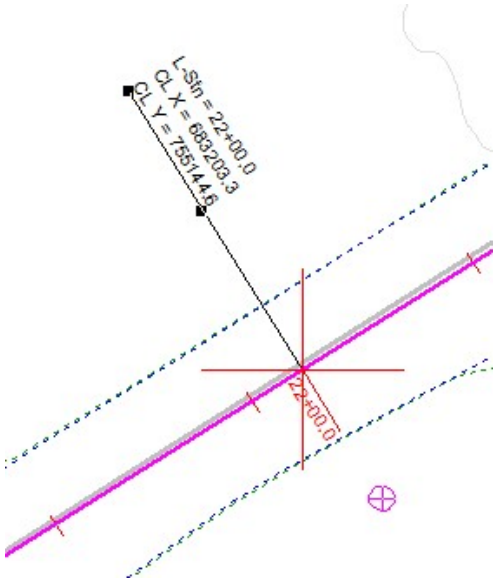


Figure 21-12: Label After *Repositioning*

Now we have a label with custom point formatting. It is also possible to change the class formatting by using mouse editing: first set up an example label the way you like it (as above) then set the class formatting to match (as below).

28. <Double-click> on the text of the label you just edited. This opens the *Label Selection and Formatting* dialogue box.

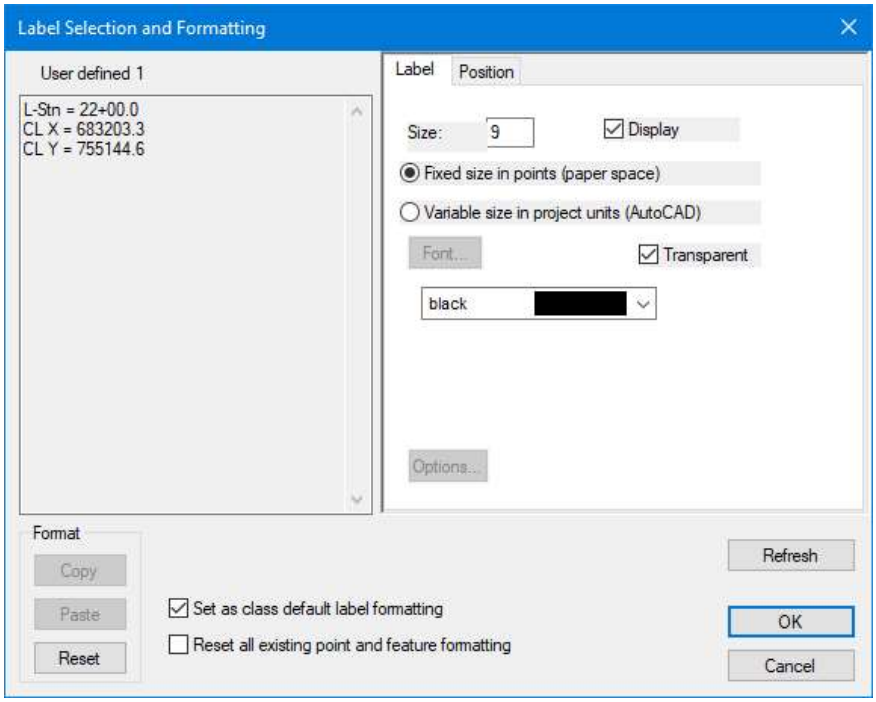


Figure 21-13: *Label Selection and Formatting* Dialogue Box

29. Select *Set as class default label formatting*. Press *OK*.

Your Plan window should now appear as shown in the figure below.

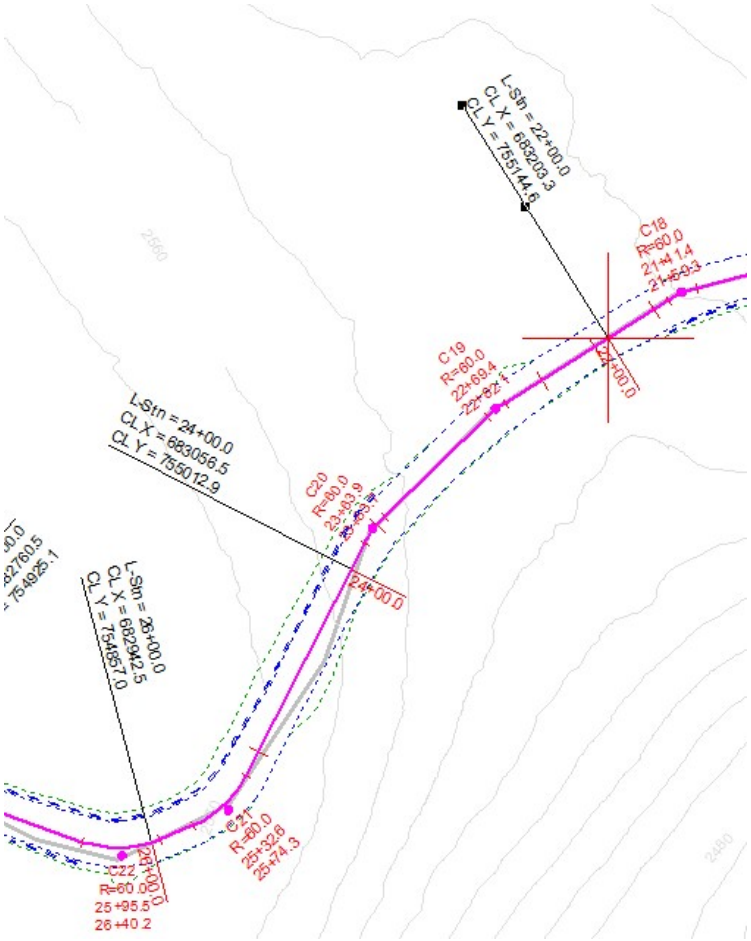


Figure 21-14: *Plan View* after Change to Class Format

We will now turn off the user-defined label we just created.

30. <Right-click> in the Plan Window, select *Plan Options*. Click on the ⊞ button adjacent to the *Labels* item to activate the *Label Selection and Formatting* dialogue box.

31. <Double-click> to uncheck the *User Defined Interval* label.

Floating Labels

Floating Labels can be added anywhere in the Plan or Profile Windows. Unlike the alignment labels explored above, *Floating Labels* can have their *anchor point* moved.

32. Turn on *Floating Labels* display:

    - <Right-click> in the Plan Window, select *Plan Options*. Click on the ⊞ button adjacent to the *Labels* item to activate the *Label Selection and Formatting* dialogue box.
    - <Double click> to turn on *Floating Labels*.
    - Press *OK* twice to return to the main screen.

33. You will be prompted with the *Label Reset Dialog* (below) because we applied some point formatting above; respond *No* unless you want to reset custom label modifications.

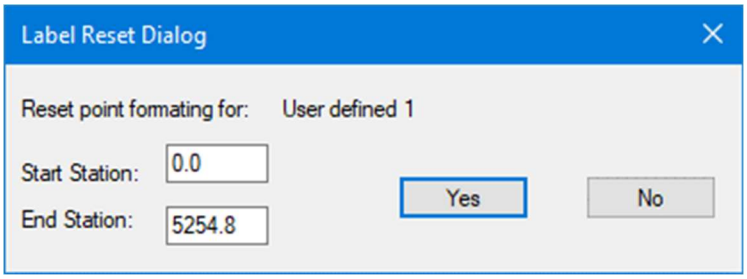


Figure 21-8 : *Label Reset* Dialogue Prompt

34. The *Edit Label* tool cursor should still be enabled. If not, <right-click> in the Plan window and select *Edit Label* Tool.
35. Navigate to the start of our alignment at Stn 0+00. You can use the *Plan | Jump to Station*.
36. Zoom with *the Edit Label* tool, click the left mouse button near the start of the proposed road in the Plan Window. Make sure you are not over an existing label. This opens the *Label Selection and Formatting* dialogue box.
    - Change "xxxxxxxx" to "**Proposed Road Tie-In Point**".
    - Click on the *Position* tab.
    - Change the *Leader* to have a **10mm** *Offset* (we can change this later with the mouse)
    - Change the *Connector* to an **Arrow**.
    - Press *OK*; the floating label will appear where you first clicked the mouse.

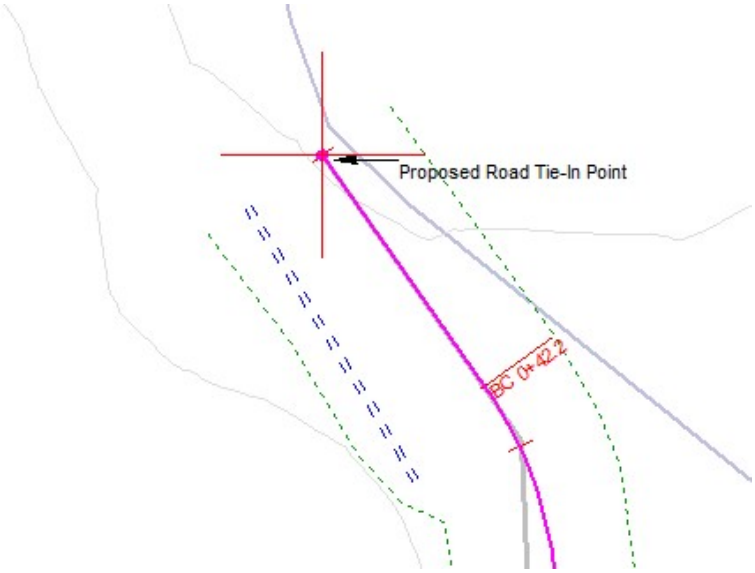


Figure 21-15: Plan Window with *Floating Label*

37. <Click> and drag the handle at the tip of the arrow to move the anchor point of the label.
38. Adjust the rotation and position of the text as we did in the previous exercise.
39. *File | Close*. Do not save changes.

Profile Sub View Labels

For presentation purposes, it is often useful to display information below the Profile. The following example will create sub-view labels for *Stn (Station)*, *FG* (final ground) and *OG (original ground).*

1. *File* | *Open* **<RoadEngResource>\LiDAR\ Road6 15.dsnx.**
2. Click on  in the bottom navigation bar, to activate the Profile Window. Maximize the Profile window.
3. <Right-click> and select *Profile Options*.
4. In the *Sub-Windows* area click on the *Select* button. Remove the Mass Haul:
    - Click on *Mass Haul* in the *Selected* area.
    - Press the *Remove* button.
5. Scroll down the *Available* list and select *Custom-Label 1* and press the *Add* button (or <double click>). *Custom Label -1* now appears in the sub windows screen.
6. Similarly add *Custom Label -2* and *Custom Label - 3*.
7. Press *OK* to return to the *Profile Options* dialogue. This should appear as in Figure 21-6 below.

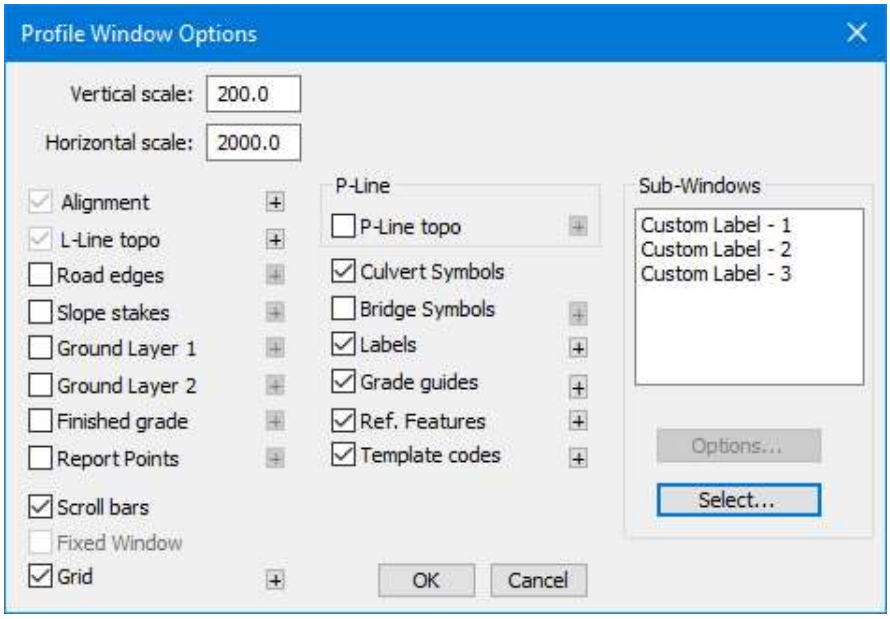


Figure 21-16: *Profile Window Options* Dialogue

We will now configure Custom Label-1:

8. In the *Sub-Windows* select Custom Label-1.
9. Press the *Options* button. The *Profile Custom Label Sub-Window* Options dialogue box appears (figure below).
    - Change the Description to **Stn**.

- Click on the *Add Attribute* button.
- Add **L-Stn** (*L-Line folder*) to the *Selected* list and press *OK*.
- Turn off *Display attribute descriptions*.
- Click on the *Point Selection* button and set the points to be **Auto Interval 2 (200' intervals)**.
- Press *OK*.

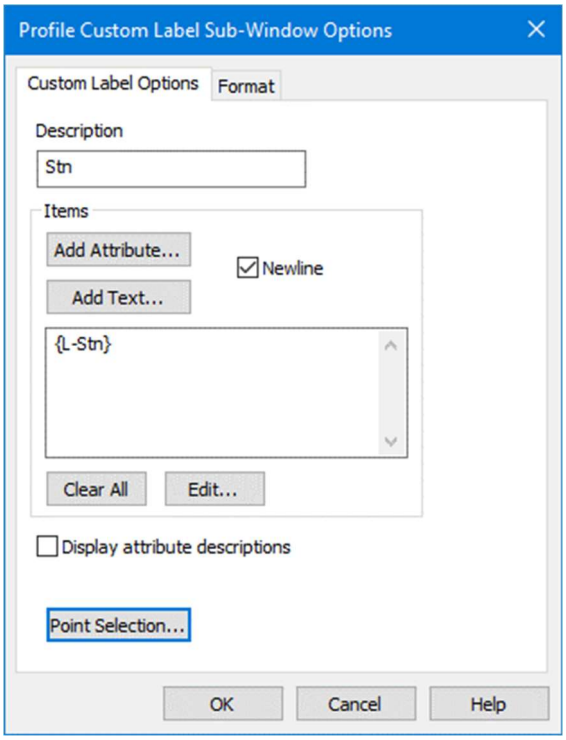


Figure 21-17: *Custom Label* Profile Sub-Window Options Dialogue

We will now do similar steps to setup labels (in *Custom Label-2* and *Custom Label-3*) for FG (final grade elevation), and OG (original ground elevation).

10. With Custom Label-2 selected:

- Click on the *Options...* button to open the *Profile Custom Label Sub-Window* dialogue box.
- Change the *Description* to **FG.**
- Click on the *Add Attribute* button.
- Add **CL-Elev** (*L-Line* folder) to the *Selected* list and press *OK*.
- Click on the *Point Selection* button and make sure the **Points to be Auto Interval 2 (200' intervals)** is set.
- Turn off *Display attribute descriptions*.
- Press OK.

11. With Custom Label-3 selected:

- Click on the *Options* button to open the *Profile Custom Label Sub-Window* dialogue box.
- Change the *Description* to **OG.**
- Click on the *Add Attribute* button.

- Add **GND-Elev** (*Ground Layers* folder) to the *Selected* list and press *OK*.
  - Click on the *Point Selection..* button and make sure the **Points to be Auto Interval 2 (200' intervals)** is set.
  - Turn off *Display attribute descriptions*.
  - Press *OK* twice to return to the main screen.

The Profile window should appear as shown in the next figure.

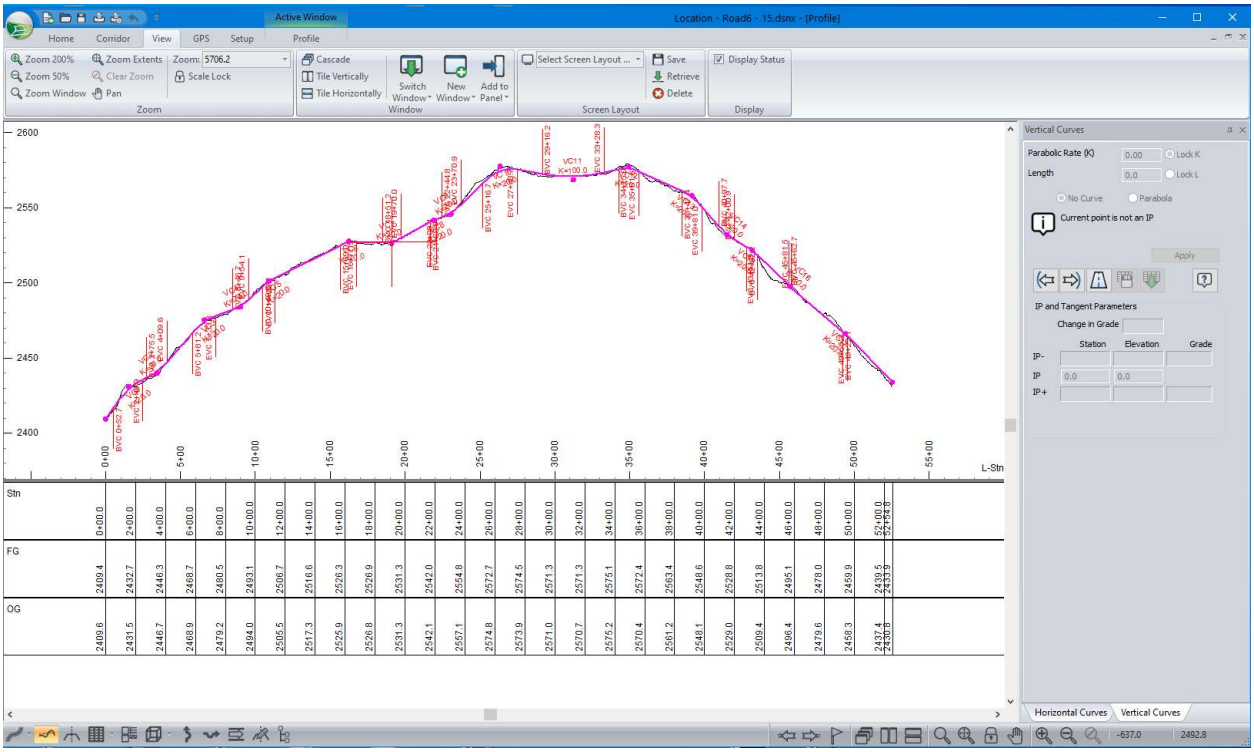


Figure 21-18: Profile *Sub-View Labels*

12. *File* | *Close*. Do *not* save changes.

22. Multi-Plot Report Builder

Multi-plot is a page layout tool for creating output. Any of the main windows (Plan, Profile, Data, and Section) can be placed on a Multi-Plot sheet with other items such as a legend, a scale bar, a bitmap graphic, a Terrain file, Curve Tables, Template assignments, or a title block.

As of Version 8, Multi-Plot layouts are no longer included in standard screen layouts. There are two unique layout file types available to Multi-Plot in the Location module:

- Book Layout file (**.blt**) – a book layout file is a collection of chapter layouts.
- Chapter Layout file (**.clt**) – a chapter layout file contains the information for a single layout type. The number pages within each chapter are defined by that Chapter's pagination settings.

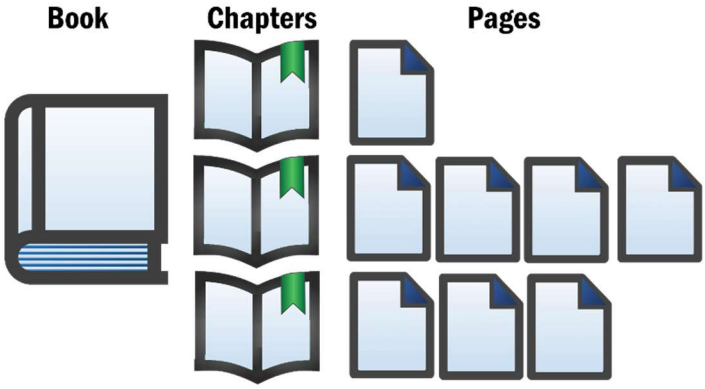


Figure 22-1: Multi-Plot Structure

In this section, you will learn how to create a Multi-Plot book with several chapters, including a title page and a standard Plan over Profile.

Multi-Plot Introduction

In this example, you will create a Multi-Plot output sheet containing Profile and Plan sub-views. Automatic pagination will also be covered.

1. *File* | *Open* <RoadEngResource>**\LiDAR\ Road6 16.dsnx.**
2. Minimize the profile window, the resulting views will appear as in the figure below.

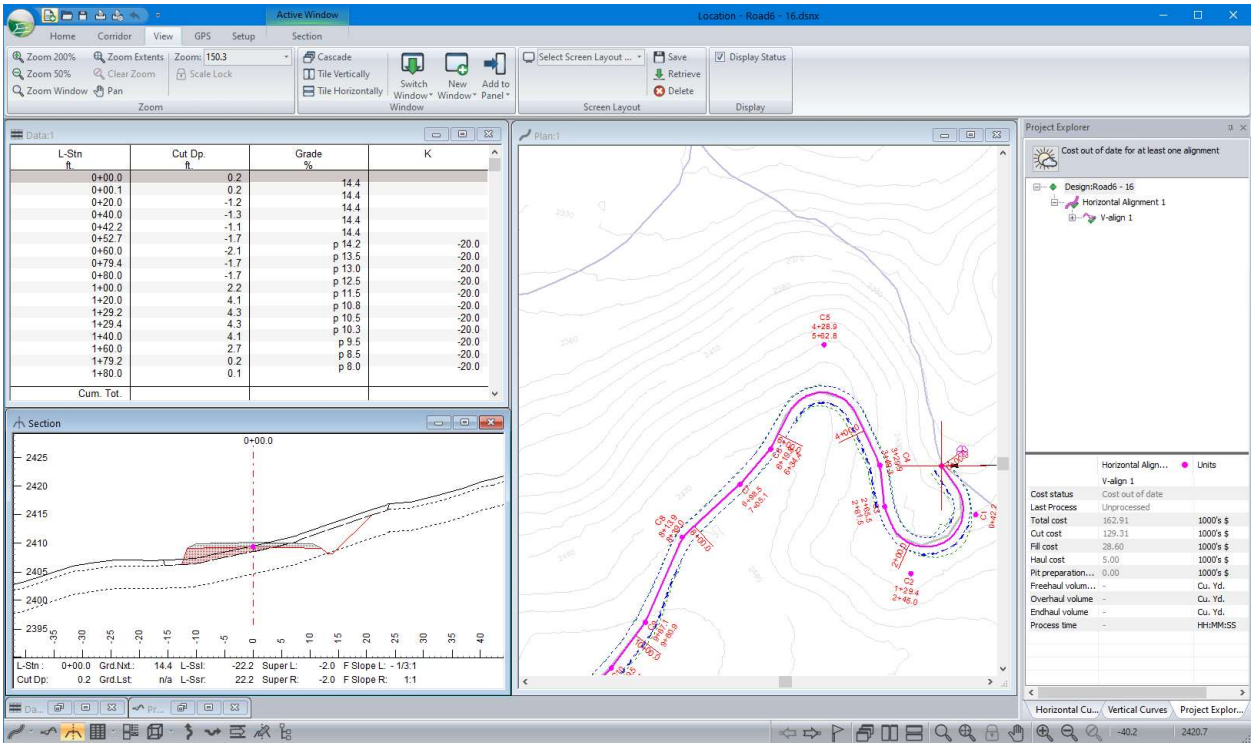


Figure 22-2: *Road6 – 16.dsnx*

For our purposes, this design is considered complete from an engineering point of view. Now we want to produce output that a contractor can use to bid on and/or build the road.

3. Press the Multi-Plot button in the bottom navigation toolbar. Alternatively, *View* | *New Window* | *Multi-Plot*. This will display the Multi-Plot Window.
4. *Maximize* the Multi-Plot window.

Configuring Your Page Size

The orientation and size of the blank sheet, within the Multi-Plot Window, defaults to 11" x 17" horizontal. Five standard engineering page sizes are available as pre-set options in the *Page Size* dialogue:

ANSI	*Size (mm)*	*Size (inches)*
ANSI A	215.9mm x 279.4 mm	8.5" x 11"
ANSI B	279.4mm x 431.8 mm	11" x 17"
ANSI C	431.8mm x 558.8 mm	17" x 22"
ANSI D	558.8mm x 863.6 mm	22" x 34"
ANSI E	863.6mm x 1117.6 mm	34" x 44"

Table 22-1: Multi-Plot *Page Size Defaults*

5. <*Right-click*> on Plan Sub-View | *Multi-Plot Options…* Set units to *Imperial*.
6. *Multi-Plot* | *Page Size* | *Custom Size* to open the Page Size dialogue box.
    - Ensure the *orientation* to **Landscape**.
    - Ensure the *Paper size* to **11" x 17"**.

- Press *OK*.

Note: the screen view is determined by the Page Size and Page Orientation controls in the ribbon toolbar. When printing, the printer setup must be confirmed to match the screen setup.

7. *File| Printer Setup* to open the *Print Setup* dialogue. Set the paper size and orientation to match our screen size and layout (11x17" and landscape). This is the paper size that governs in the print preview. This depends on the type of printer and paper size the printer can handle.

Configuring our Chapter

The first chapter we will create is a Plan over Profile layout.

8. <*Right-click*> on the *Default* chapter, this should allow you to edit its name. Change the name to **PlanProfile.**

The Location Multi-Plot Window can automatically produce as many pages as are required to show the entire design. Before we insert a Sub-View, it would be more appropriate to set the number of pages to avoid any potential rework. In this section, we will explore some of the pagination options.

9. *Multi-plot | Pagination:*

- Make sure **Fixed** is selected as *Length of road (Stations) per page*.
- Enter a value of **1250** Feet.
- Enter an *overlap* value of **10%** as seen below in Figure 22-3.
- Press *OK* to accept these *Pagination Options*.

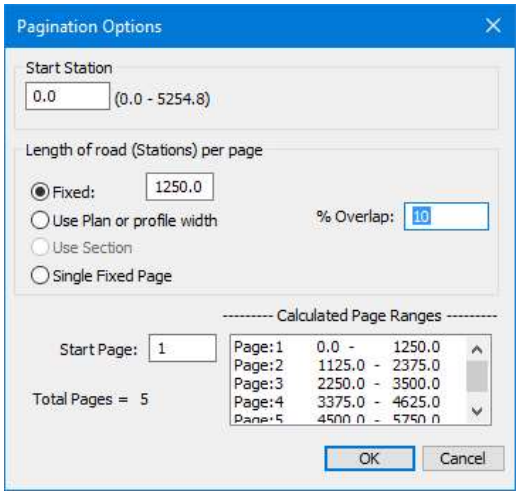


Figure 22-3: *Pagination Options*

Adding Graphic Sub-views

Now let's add some content to our page. It is recommended to always add items in Chapter-mode. This means the sub-view will be shown on all pages within that chapter.

10. With the *PlanProfile* chapter selected*, Multi-Plot | New Sub-view | Plan:1*.

A Plan Sub-view should appear in the center of your Multi-Plot Window.

Note: The Plan sub-view is an image of the main Plan window. If you don't have a Plan *window* displayed (see the Window menu) then you can't create a Plan *Sub-view*. The scale and positioning of the Plan window is controlled within Multi-Plot, and can differ from your main window.

11. <Double-click> on the Plan sub-view. Change the *Scale* to 1: **1250**. Press *OK*.
12. There are 8 handles that you can click and drag to change the size of the sub-view. Click and drag anywhere else on the sub-view ✣ to move it. The <delete> key will remove the selected sub-view(s).

Notice that the Plan is rotated automatically to best fit the rectangle with increasing stations running from left to right. In this case the Plan has been rotated automatically by approximately 180 degrees. See section: *Multi-Plot Plan Rotation.*

13. *Resize* and *reposition* ✣ the Plan sub-view to look similar to the following figure.

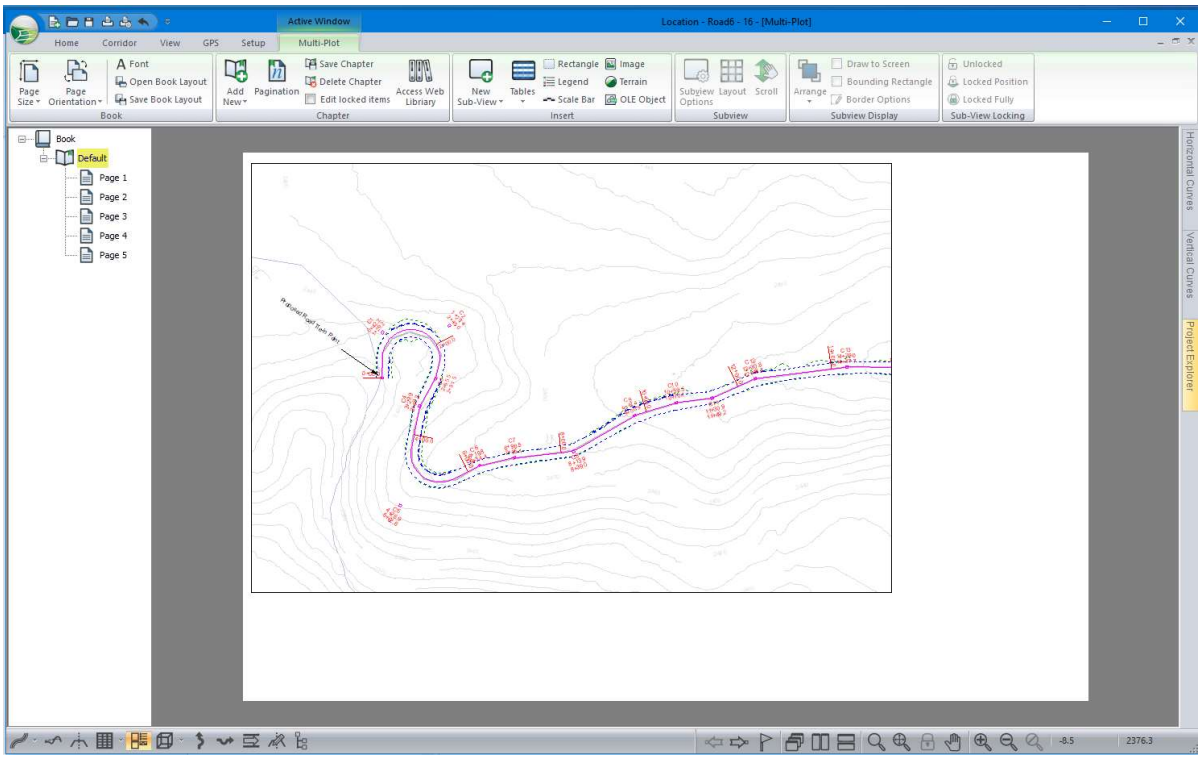


Figure 22-4: *Plan Sub-View* after Sizing and Positioning

14. *Multi-Plot* | *New Sub-view* | *Profile:1*. A Profile sub-view should appear in the center of the Multi-Plot. Adjust it to fit under the Plan sub-view (don't worry about misalignment at this point).
15. <Double-click> on the Profile Sub-view to open its options. In the *Sub-Windows* area, press *Select*. *Remove* Mass Haul from the *Selected* area. Press *OK* twice.

Note: Changing the profile sub-view options in Multi-Plot does not impact the main Profile window.

Note: A click on a sub-view will select it and deselect the previous sub-view. See also the note below.

Note: When you click outside all sub-views and drag the mouse you will create a selection rectangle. All sub-views inside or crossing the rectangle will be selected when you release the mouse. Also, <Ctrl> click allows you to select/deselect sub-views without affecting the selection state of other sub-views. Group selected sub-views can be deleted or moved together.

Grid Options

Here we turn on a grid to make it easier to align the Plan and Profile sub-views.

16. <*Right-click*> on Plan Sub-View | *Multi-Plot Options…*, enable *Show Grid*, *Snap to Grid*, and set the *Spacing* at **0.25”**, as shown in the figure below:

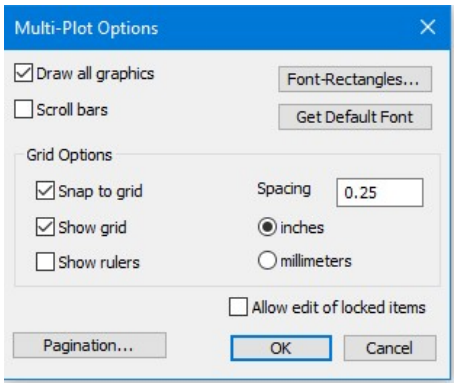


Figure 22-5: Grid Options in *Multi-Plot Options*

A dot grid will cover the entire Multi-Plot sheet.

17. Now adjust the size and position of both the Plan and Profile sub-views so they are aligned as in the figure below. Alternatively, you can also use the align tools. With both sub-views selected, click on  *Arrange* | *Align Left*.

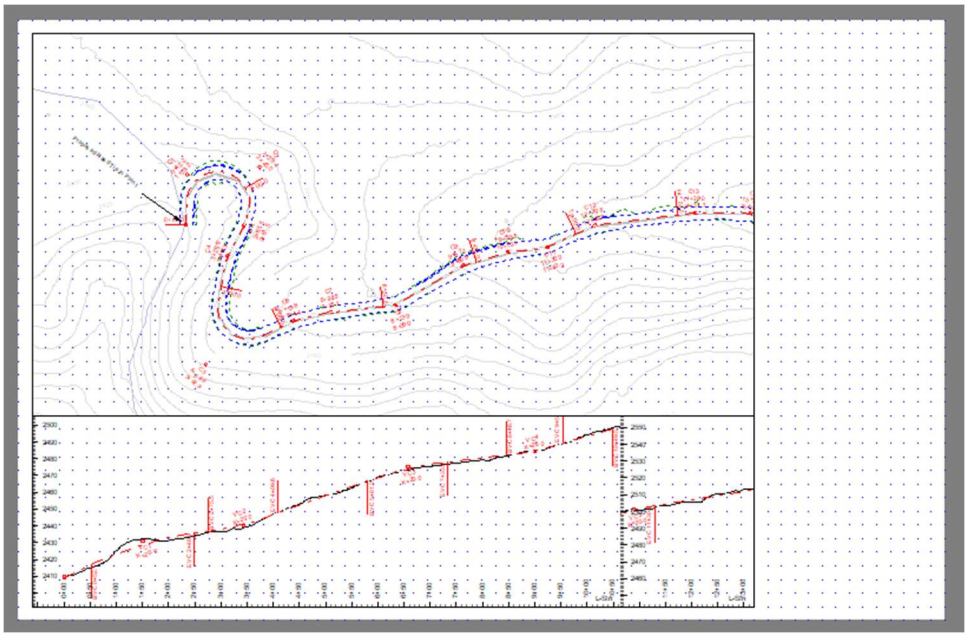


Figure 22-6: Multi-Plot after *Grid Enabled*

These two sub-views are now set-up on all 6 pages of our Plan Profile Chapter.

The scale for our new profile sub-views is not ideal. Let's adjust so the horizontal scale of the Plan and Profile is the same.

18. <Double-click> on the Profile sub-view. Change the *Horizontal Scale* to 1: **1250**. Press *OK*.

Adding a Scale Bar

19. *Multi-Plot* | *Scale Bar*. A Scale bar will appear in the middle of your sheet.
20. <Double-click> on the new scale bar to open the *Scale Bar Sub-view Options* menu.

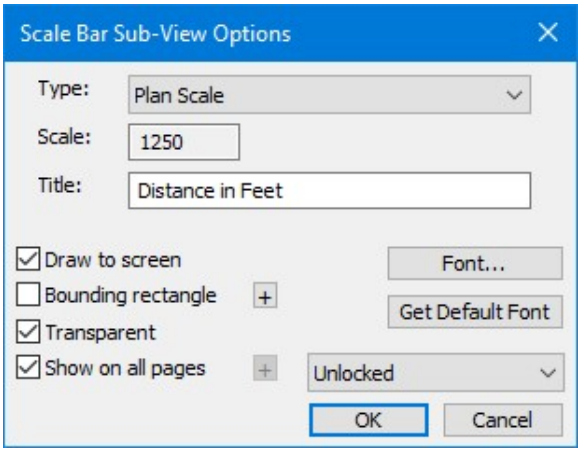


Figure 22-7: *Scale Bar Sub-View Options* Dialogue Box

21. Keep the default Plan *Scale* of 1250. Add in the optional *Title* "**Distance in Feet**". Press *OK*.
22. Resize and reposition the Scale Bar sub-view, until it appears as in the figure below.

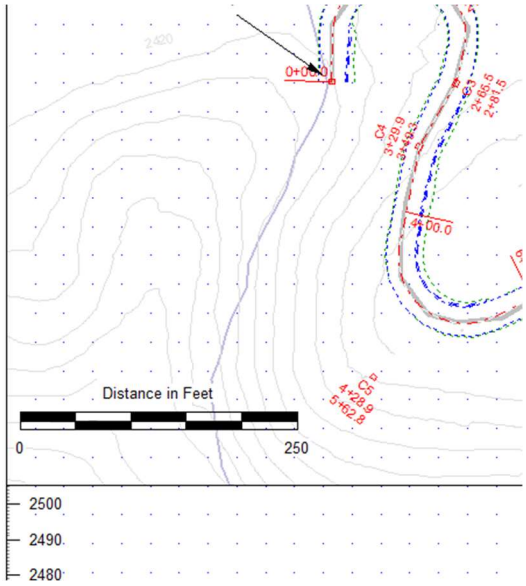


Figure 22-8: *Scale Bar* in Lower Left Corner of Plan Sub-View

Adding Rectangle Sub-View Items

Rectangles can hold typed text or many pre-defined text items.

23. *Multi-Plot* | *Insert Rectangle*. A Rectangle will appear in the middle of your sheet with the options dialogue box as shown below.

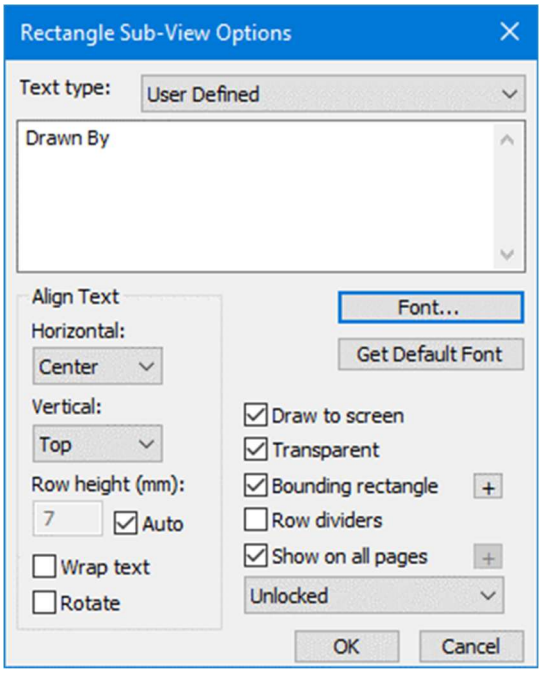


Figure 22-9: The *Rectangle Sub-View Options Dialogue*

The *Rectangle Sub-View* Options Dialogue opens automatically when you create a new rectangle, but you can also access it from a <right-click> on any rectangle sub-view and selecting *Rectangle Sub View Options* or by <double left-clicking> on the *Rectangle Sub-view.*

Note: Sometimes it is useful to use an *empty* rectangle just for its border graphic (*User Defined*, no text).

24. Type **"Drawn By"** in the text box. Multiple lines are allowed. Change *horizontal alignment* to **Center**. Check the *Wrap text* option. Click on the *Font* button and change the size to **12**. Press *OK* twice.

Arrange the new rectangle to the lower right of the page as in the figure below.

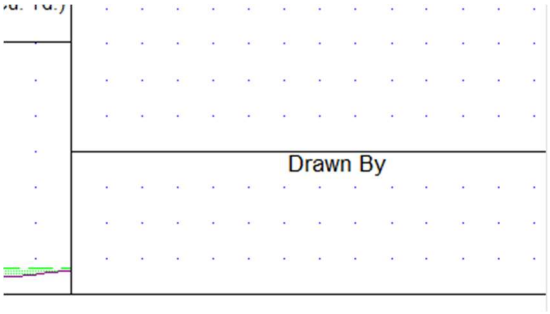


Figure 22-10: A *New Rectangle Sub-View* with Centered, Wrapped, User Defined Text in a Large Font

25. Create two more rectangles.
    - In the first, select **Print Date** from the *Text type* drop down menu.
    - In the second, select **Page X of N** from the *Text type* drop down menu.

26. Arrange the two new rectangles to fit in the first rectangle as in the figure below.

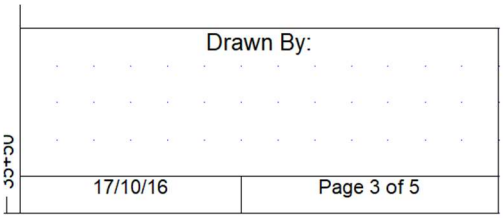


Figure 22-11: The Start of a *Title Block*

Notice how the snap to grid feature helps line up edges.

Multi-Plot Plan Rotation

In this example the Plan sub-view is acceptable on most pages. The automatic pagination puts the page start station on the left side of the Plan sub-view and the end station on the right. This approach does not always work so it is possible to set the Plan sub-view scroll position and rotation angle manually.

27. Use the *Previous Page* and *Next Page* buttons in the *Multi-Plot* ribbon to scroll through the 5 pages. Alternatively, you could also click on the pages in the navigation panel, or use <Ctrl+b> and <Ctrl +n>.

You will notice that the Plan sub-view layout on page 5 doesn't fit. We will manually scroll the position of this page.

28. Click on Page 5 in the Multi-Plot navigation.

29. Select the Plan sub-view. Click on  *Scroll* icon to open the *Sub-view Options* dialogue below.

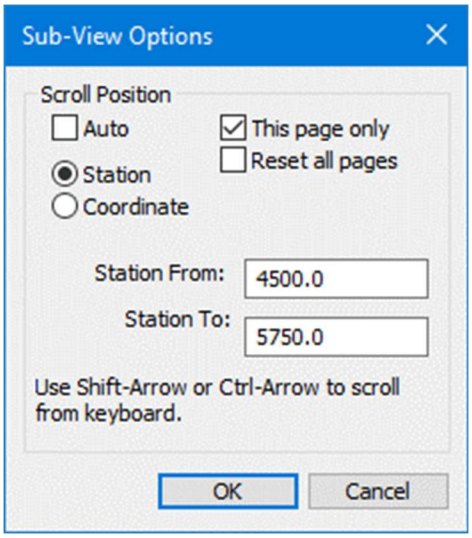


Figure 22-12: Plan *Sub-View Options* Set To Scroll Manually

30. Clear the *Auto* check box and check *This Page Only* (as above). Press *OK*.

Note the Plan position has not yet changed; we didn't change coordinates or rotation angle yet.

31. Type <Shift + arrow> to scroll. Respond OK to the manual scroll prompt.
32. Use <Shift + arrow> to adjust the Plan sub-view so that the curve is fully visible. Try to get the Plan sub-view to look like the one in the figure below.

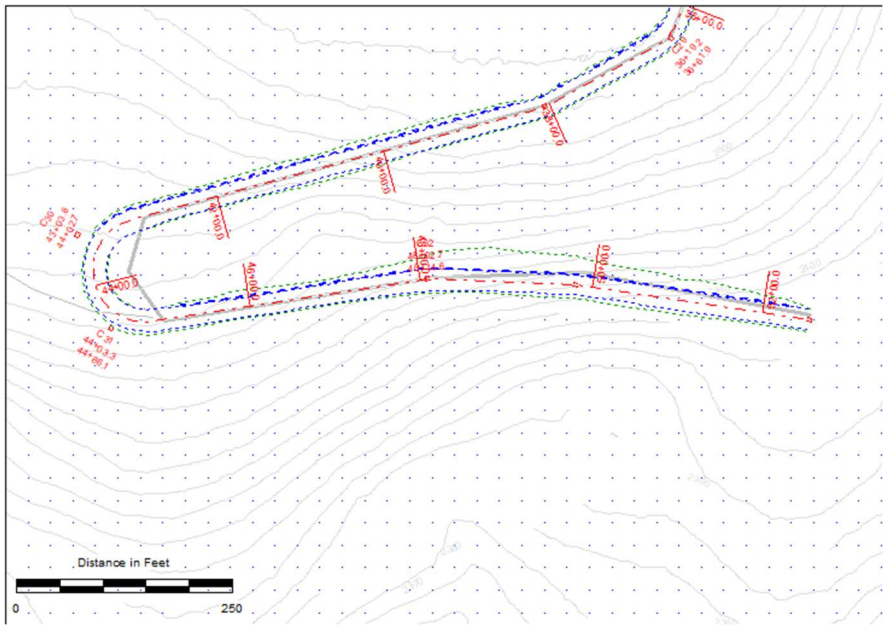


Figure 22-13: *Plan Sub-View* after Manually Scrolling and Rotating

Note: Manual alterations to the Plan or Profile position and orientation can also be done by selecting the window and then pressing <shift + arrows>. A prompt may remind you that *Your Plan/Profile sub-view is set to scroll with the current page station range. Do you wish to scroll manually instead?* This operation will disable the *Auto* check box as in step 30 above. <Shift + arrows > will scroll the plan or profile in the direction of the arrow. <Ctrl + arrows> will rotate the Plan sub-view around its center.

33. *File* | *Close*. Do not save changes.

Multi-Plot Chapters

In these exercises, we will create and retrieve Chapter layouts, copy and paste multi-plot items, explore a couple of new sub-views and save the result for future use.

Copy and Paste of Multi-Plot Items

This exercise will add a title block to a Multi-Plot sheet. We will do this by opening an additional the current Multi-Plot with a commonly used title block screen layout.

1. *File* | *Open* <RoadEngResource>**\LiDAR\ Road6 17.dsnx.**
2. Select and <delete> the existing title block items so that only the Plan and Profile remain.

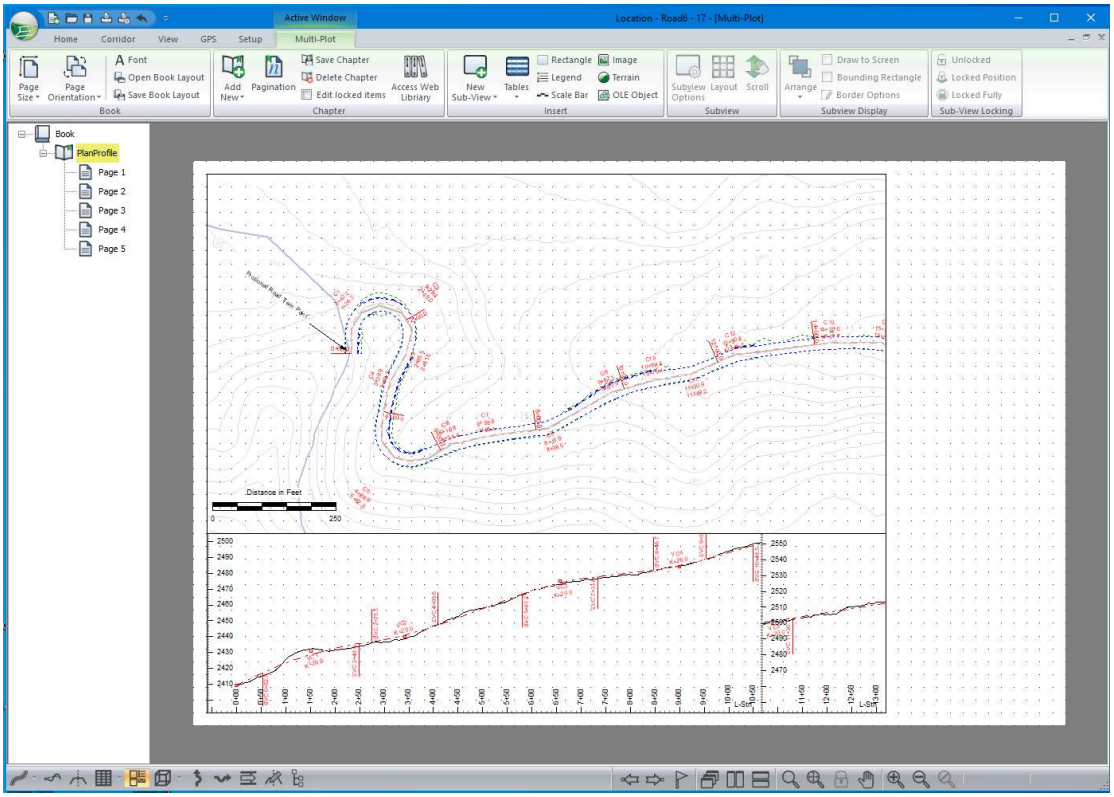


Figure 22-14: *Multi-Plot* after Loading Screen Layout and Removing Title Block Rectangles

3. *Multi-plot* | *Add New Chapter* | *Retrieve Other Layout*.
4. Select *screen layout* <Defaults and Layouts**>\Training\Title Block.clt.**

You will now have a second chapter with the title block we would like to copy.

5. Click and drag from the top right corner to select all the sub-views (rectangles in this case) of the title block as shown in Figure 22-15.
6. Type <Ctrl + C> to copy the selection to the clipboard (or use menu *Edit* | *Copy*).

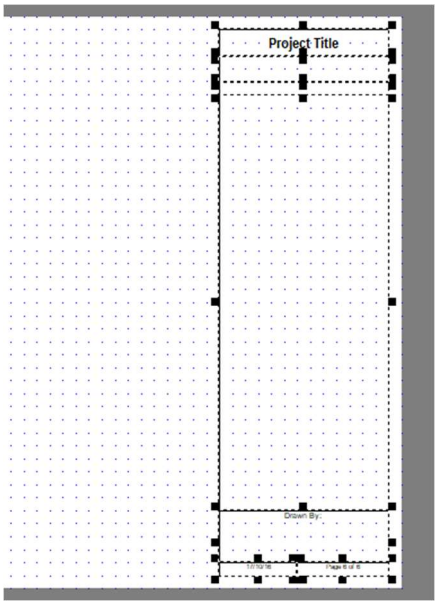


Figure 22-15: Selecting Multiple Sub-Views
(*Rectangles in this Case*) With a Mouse Click and Drag

7. Click on the PlanProfile chapter. Type <Ctrl + V> to Paste the title block on your page (or use menu *Edit* | *Paste*).

Your screen should appear as shown below:

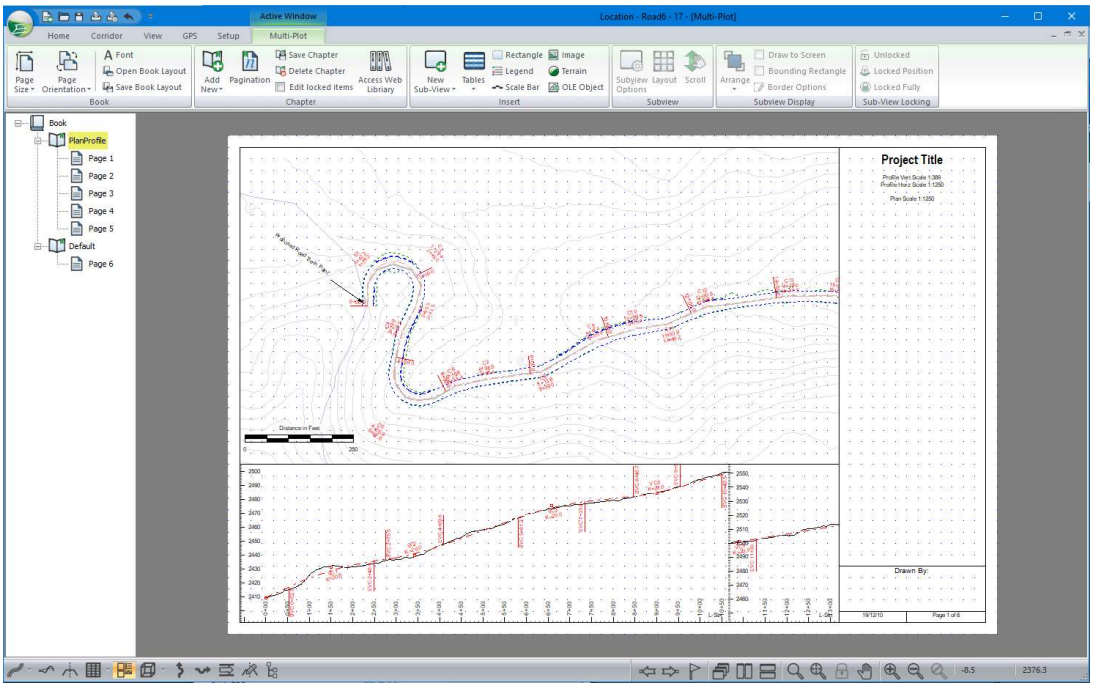


Table 22-2: Updated Title Block

8. We can save our new Plan profile chapter layout for future use: *Multi Plot* | *Save Chapter* to open the Save Chapter dialogue. (optional)

9. We no longer need the Default chapter. Click on *Default in the* navigation panel, <right-click> select *Delete Chapter*.

Add a Legend

In this section, we will create a legend sub-view item and examine some of its options.

10. With the *PlanProfile* chapter selected, select menu *Multi-Plot* | *Insert Legend* to create a legend item.

Most of the legend items created automatically need to be removed; some of those remaining will need to be renamed.

11. <Double-click> on the legend to open *Legend Sub-View Options*.
12. Click on the *Items* tab of the *Legend Sub-View* dialogue box.
13. Select and *Remove* all but the items shown below on the top. Multiple select is allowed use <Ctrl + Click> or <Shift + Click>.

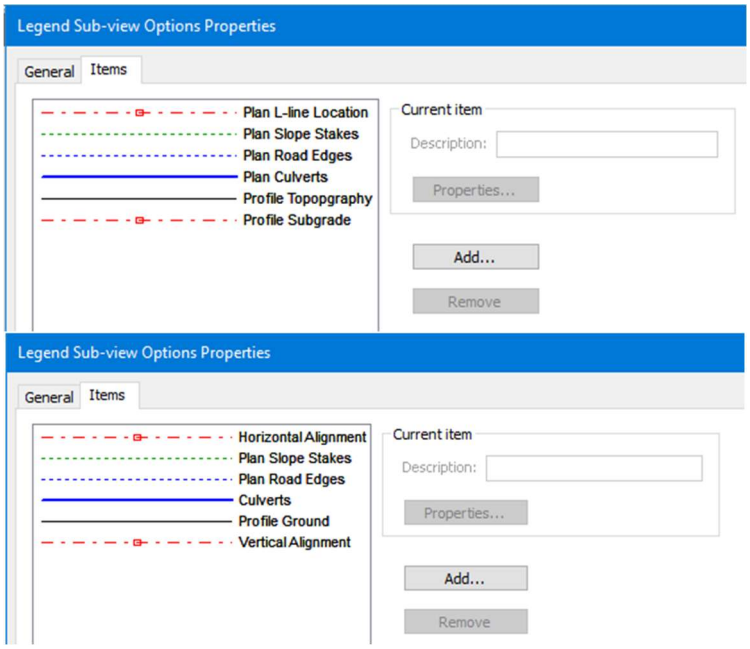


Figure 22-16: Legend with *Fewer Items* (TOP) and *New Descriptions* (BOTTOM).

14. Select items on the left one at a time and change the *Description* as in figure above on the bottom.
15. At this point you may wish to experiment with the other buttons. The *Properties* button allows you to change the line, symbol and hatching for any item.
16. Click on the *General* tab, change the *number of columns* to **1** and press *OK*.
17. Finally move and size your legend so it fits nicely on the right side of the Plan and Profile graphics. See Figure 22-17.

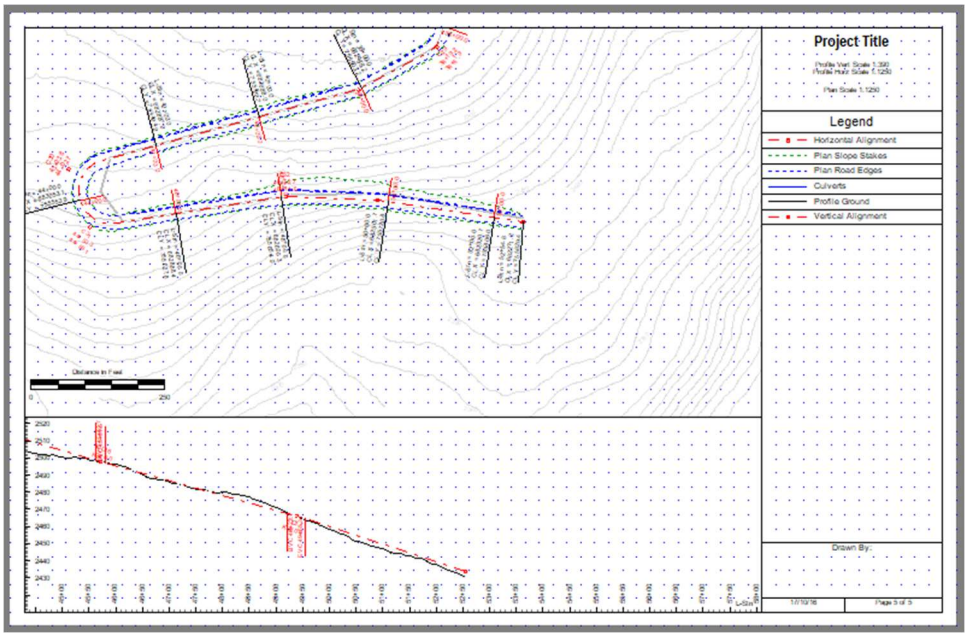


Figure 22-17: *Legend Added* to Layout

Add a Curve Table

In this section, we will create a horizontal Curve Table sub-view and examine some of its options.

18. With the *PlanProfile* chapter selected, *Multi-Plot* | *Tables* | *Horizontal Curves* to create the table.
19. Move and size the table until it fits on the right of the Plan and Profile graphics. If you go to Page 1, you will notice that the column size extends past the page boundaries. We will adjust that in a few steps.
20. <Double-click> on the *Horizontal Curve Sub-View* table to open *Curve Table Options*.
21. Change the *Column Width* to **16mm**.
22. Change the *Table Alignment* to **Vertical**.
23. Select *Design Points All* to include points of intersection (IPs) with no curve attached.
24. Press the *Add/Remove* button to open the *Curve Table Fields* dialogue box shown in the Figure below on the right.

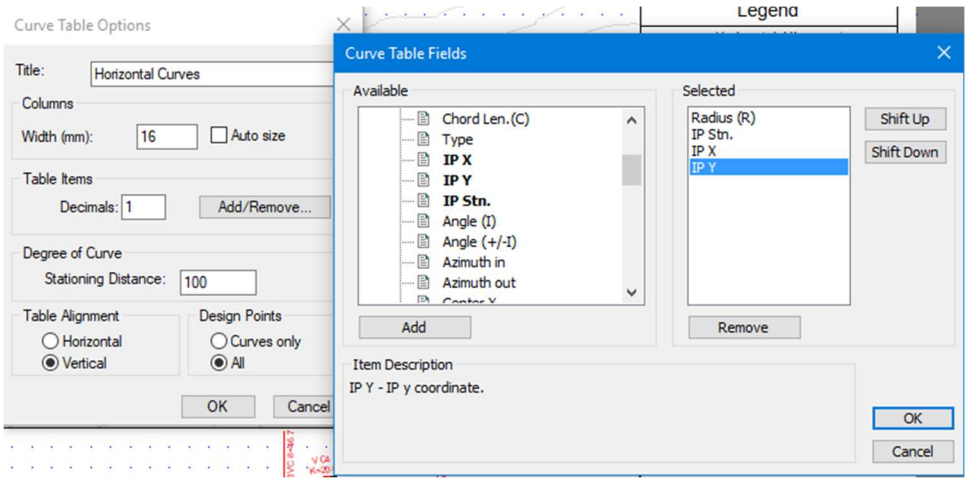
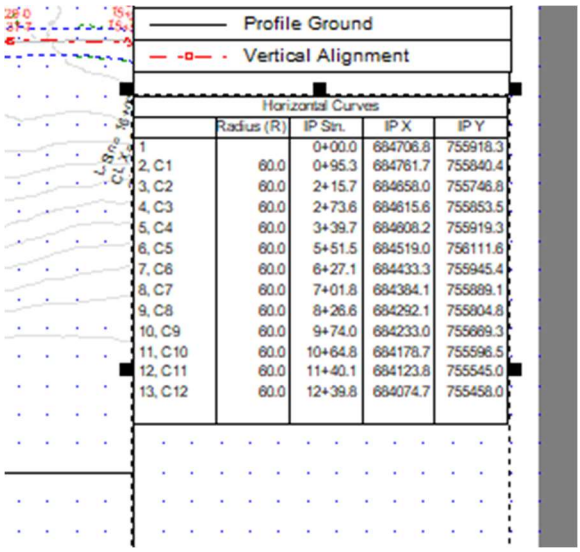


Figure 22-18: *Horizontal Curves Table Options* Dialogue Boxes

25. *Add* and *Remove* items (<double-click> works) until you have only **Radius (R)**, **IP Stn**, **IP X** and **IP Y** in the *Selected* column as in Figure 22-18.

26. Press *OK* in both dialogue boxes to see the results as shown below.



	Radius (R)	IP Stn.	IP X	IP Y
1		0+00.0	684706.8	755918.3
2, C1	60.0	0+95.3	684761.7	755840.4
3, C2	60.0	2+15.7	684658.0	755746.8
4, C3	60.0	2+73.6	684615.6	755853.5
5, C4	60.0	3+39.7	684608.2	755919.3
6, C5	60.0	5+51.5	684519.0	756111.6
7, C6	60.0	6+27.1	684433.3	755945.4
8, C7	60.0	7+01.8	684384.1	755889.1
9, C8	60.0	8+26.6	684292.1	755804.8
10, C9	60.0	9+74.0	684233.0	755669.3
11, C10	60.0	10+64.8	684178.7	755596.5
12, C11	60.0	11+40.1	684123.8	755545.0
13, C12	60.0	12+39.8	684074.7	755458.0

Figure 22-19: *Horizontal Curve Table* after Configuration

27. *File* | *Close*. Do not save changes.

23. Composite Surfaces & Drive-Through

In this section, we will export the designed surface from the Location module and merge it into the original ground surface in the Terrain module. The resulting composite surface is ideal for presentation; it could also a starting point for designing an intersecting road.

Exporting Designed Surfaces

1. Open <RoadEngResource>**\LiDAR\Road6 - 18.dsnx.**

Let's assume this design is finished. We now want to export the designed surface.

2. *File* | *Save As* to open the file save dialogue box.
3. Set the *Save as type* to Softree-Terrain File (*.terx).
4. Name the output *File Name* "***Road6***" (do not write over any example files – adjust name if neccessary).

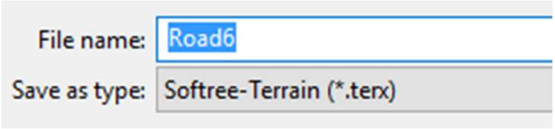


Figure 23-1: *File Save As* Dialogue Box to Export a Terrain File from the Location Module

5. Press *Save*; the *Export to Terrain* options dialogue box will open as below.

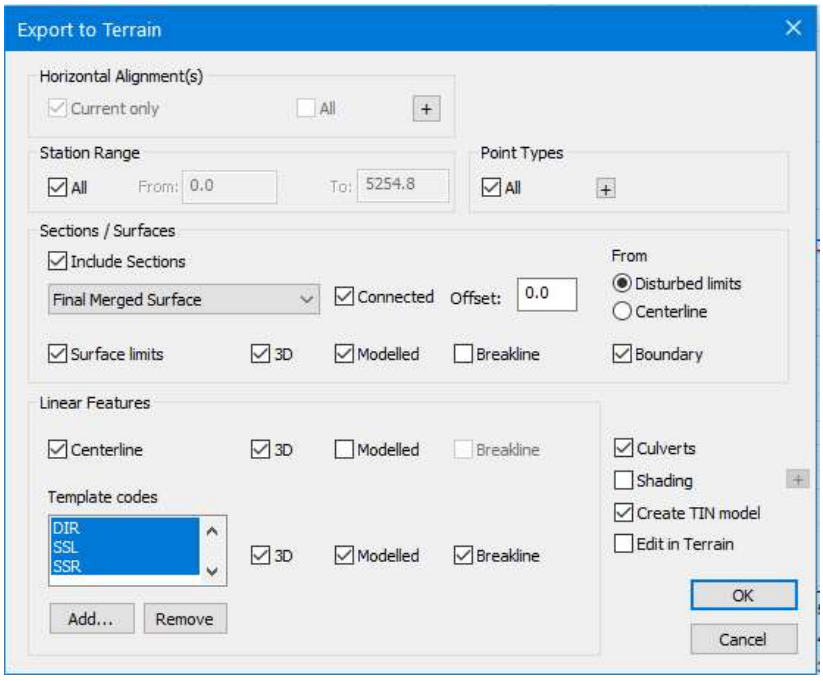


Figure 23-2: *Export to Terrain* Options Dialogue Box

The *Export to Terrain* function can be used for quite different purposes; you may wish to:

- generate a construction surface for staking or digitally controlled grading

- export alignments for use as reference features in another design
- export alignments for use as displayed features in a map or other plan drawing
- export the designed sub-grade or finished grade to create a composite designed surface

Most of the items in the dialogue box shown above are set correctly by default; we will only explicitly deal with some of the features below. Type <F1> to see a description of every control in the *Export to Terrain* dialogue box.

6. Make sure that under *Points Types*, *All* is selected. If the *Point Types* button has a grey check mark, click twice. Press *OK* to close.
7. Make sure the *Surface* selected is *Final Surface (Merged Surface)*. We want to export the surface of the road as if it were complete.
8. Make sure that *Section points* is checked and that *Offset* is **0.0** from *Disturbed Limits*. We will export data up to the slope stake lines (SS) but no further; in other words, we will export the disturbed area.
9. Make sure that the *Surface Limits* item is selected.
10. Select the *Boundary* check box to the right of it. This will limit our surface to the stay within the slope stake lines (SS).
11. Ensure that the *Create TIN model* check box is set.
12. Make sure that all important code features are added to the template codes list. Remove all existing codes and press the *Add*...button located in the bottom left corner of Export to Terrain dialogue box to open the dialogue box shown in Figure 23-3 below.

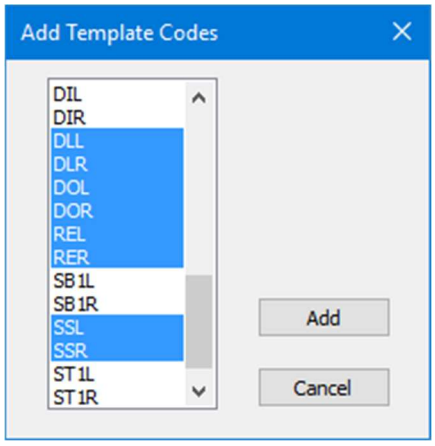


Figure 23-3: *Add Template Codes* Dialogue Box after Selecting Ditch Bottom Point Codes

13. Select the items in the figure above. To add multiple items, hold the <Ctrl> key on your keyboard while selecting the items.

Note: Template codes are defined in the template editor.

We have finished setting the options for export. It is useful to note that these options are saved with the Location design when you save it.

14. Press the *OK* button to export the Terrain file.

Merging Terrains

Now we will merge the designed surface created above with the original ground terrain to make a composite.

15. Still in our Location Design, open up the original ground file go to menu *Home* | *Edit External Files*.
16. Select **topo Road6 Extension.terx** and press the Edit button to open in the Terrain Module.

Normally you would save your Terrain with a new name at this point; you don't want to modify the original ground surface that is being referenced by you Location design.

17. Now, in the Terrain Module, choose menu *Terrain Modeling* | *Merge Terrain*. This will open the Merge Surface Dialogue box.
18. Browse for **Road6.terx.**

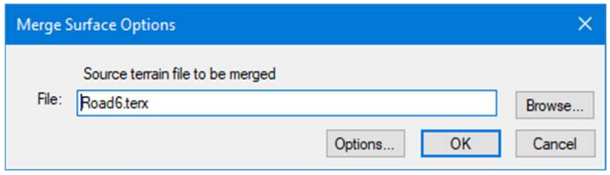


Figure 23-4: Browsing for Training*Road6.terx*.

19. Press *OK* to merge the Terrains. The following warning will appear. Respond *OK* to continue.

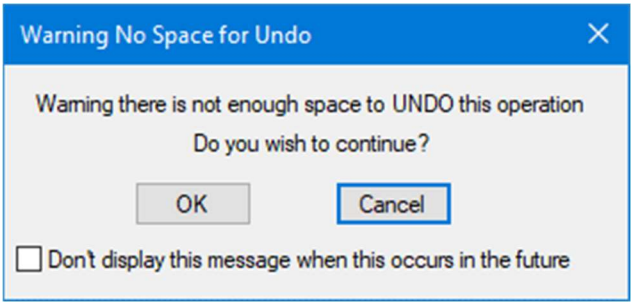


Figure 23-5: RoadEng Warning

Now we need to re-calculate the surface.

20. *Terrain Modeling* | *Generate TIN*.
21. Keep *Calculate Triangles* turned on but toggle off the calculation of *Major* and *Minor Contours* and press *OK* to recalculate the Terrain.
22. A warning message will be displayed, select "*Don't show this message again*" and press *OK* to continue.
23. *View* | *New Window* | *3D* to create a 3D view.
24. To view the Plan Window and 3D Window side by side use menu *View* | *Tile Vertically*.

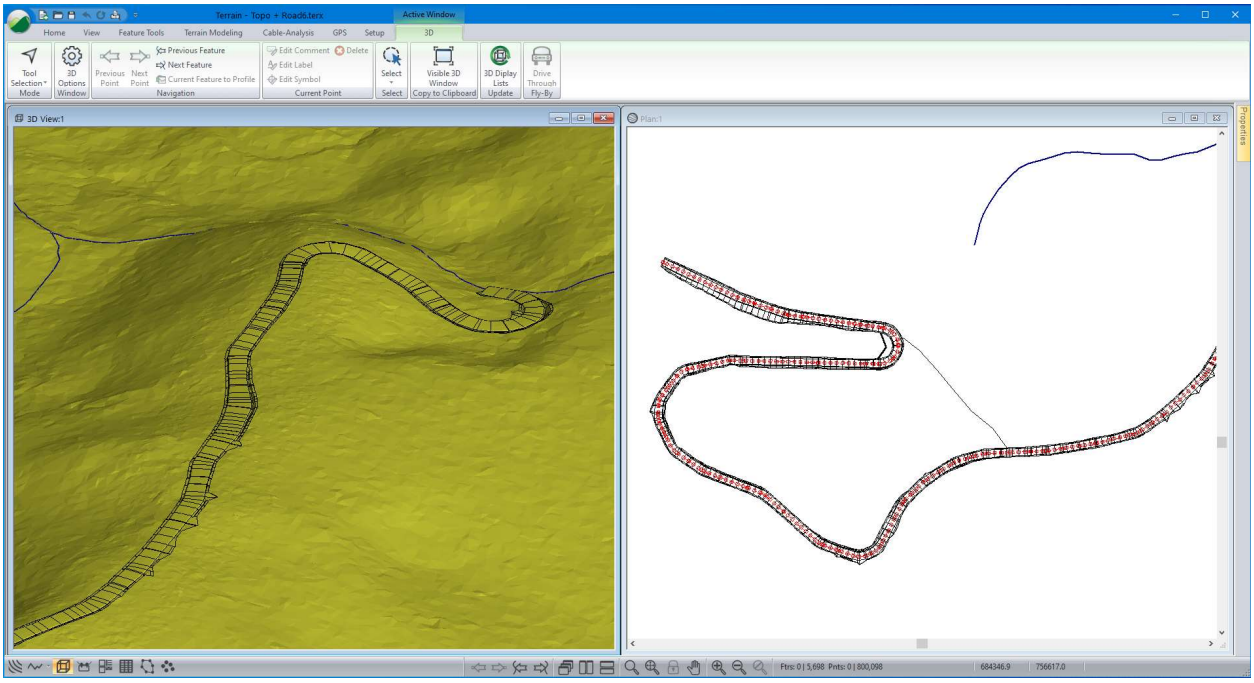


Figure 23-6: Composite Surface showing Designed Road Merged with Original Ground

25. *File* | *New*. Do not save changes.

Iterative Alignment Design

This composite surface model could now be used as the *original ground surface* for a new Location design. We might do this to design an intersecting road, driveway or overpass. This would ensure grade elevations are coincident (or grade separation in the case of an overpass) and would avoid any double counting of volumes. We might also wish to design the other direction for a divided highway.

Creating a Terrain Drive-Through

To drive through the terrain: select the feature you want to drive along in the Plan window.

1. *File* | *Open* <RoadEngResource>**\LiDAR\topo+road6.terx**
2. In the plan window, select the road centerline (*C-Line-0*).
3. Activate the 3D window (if not shown, select *View* | *New Window* |*3D*)
4. *3D* | *Drive Through* or <right-click> in the 3D window and select from the context menu to open the dialogue box below.

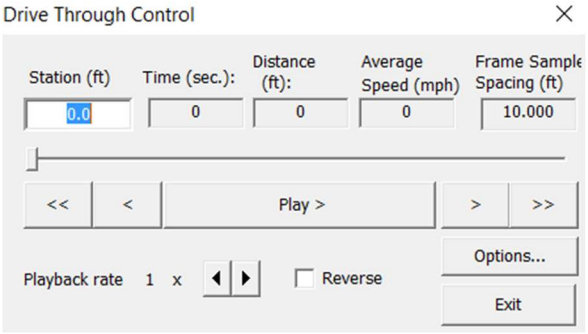


Figure 23-7: *Drive Through* Control Dialogue Box

The playback speed, start station and direction can be adjusted from here.

5. Press *Options* to bring up the *Drive Through Options* dialogue box as shown in Figure 23-8 below.

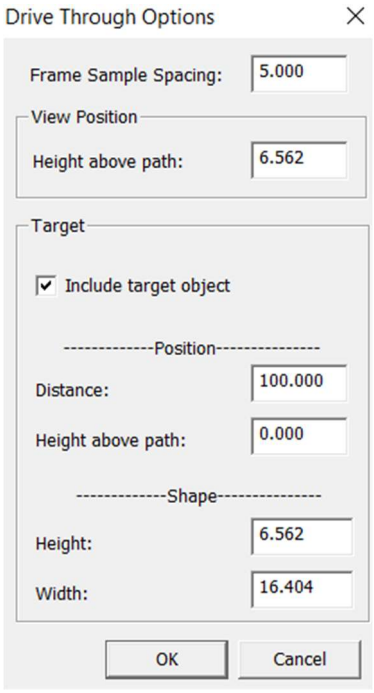


Figure 23-8: *Drive Through* Options Dialogue Box

The contents for these options are:

- *Frame Sample Spacing* - The interval at which the drive through will be sampled in the 3D view.
- *View Position* – Height Above Path: The height above the driving path where the perspective will be generated.
- *Target* - An object can be modelled in the drive through (i.e., a street sign or obstruction) by means of a position along path, height above, and the height and width of the object. Keep in mind that this object moves dynamically with the view and isn't set in a permanent location.

6. Change the *Frame Sample Spacing* to **10ft**. Press *OK* to close the *Options* Dialogue.
7. Press *Play* to begin the drive through, a sample of which can be seen below in Figure 23-9.

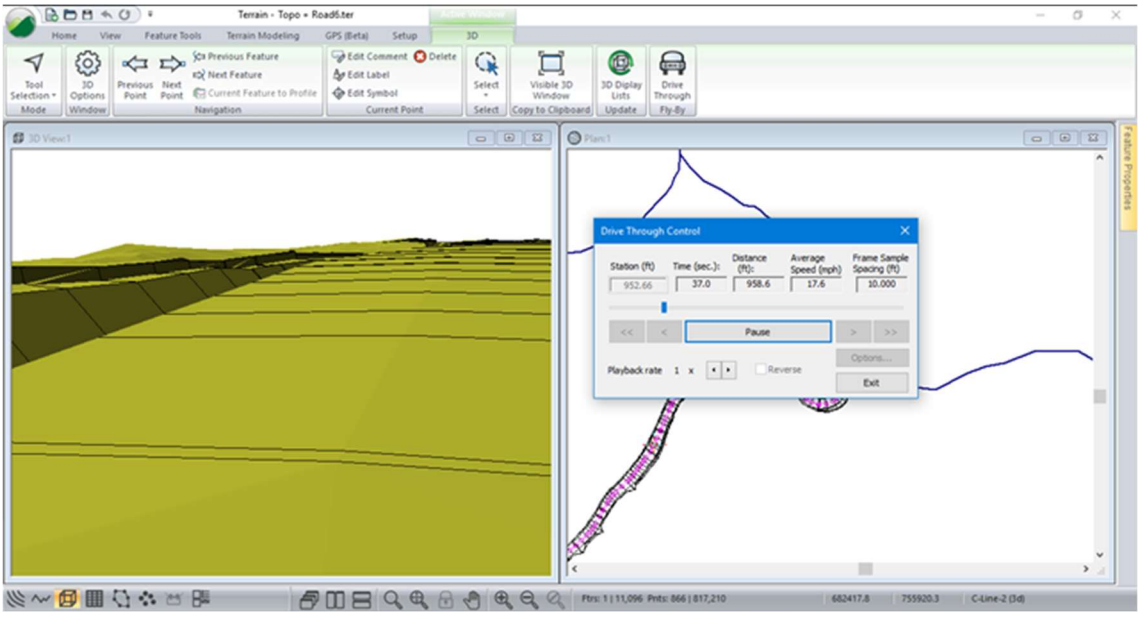


Figure 23-9: *Drive Through/Fly By Sample*

8. *File* | *New*. Do not save changes.

Appendix A – Spur Traverse Notes

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Station	Type	Fore Azi	H.D.	S.D.	Slp.(%	SSL Slp.(%)/S.D.	SSR Slp.(%)/S.D.	GND	CRK	Label
* 0+00.0						29/..	-25/..	OB/0.50/FR		
	FS	75.9	188.8	189.0	5					
1+88.8						20/..	-20/33.2 T,-27/..	OB/0.50/FR		
	FS	66.2	22.7	22.8	8					
2+11.4						20/..	-20/42.0 T,-29/..	OB/0.50/FR		
	FS	66.2	80.7	80.7	0					
2+92.2						20/..	-20/..	OB/0.50/FR		
	FS	52.8	35.8	35.8	4					
3+27.9						17/..	-19/..	OB/0.50/FR		
	FS	52.8	90.9	90.9	-3					
4+18.8						17/..	-17/..	OB/0.50/FR		
	FS	40.2	77.9	77.9	1					
4+96.7						17/..	-14/..	OB/0.50/FR		
	FS	40.2	42.5	42.6	4					
5+39.2						14/38.9 T,17/..	-14/63.9 T,-12/..	OB/0.50/FR		
	FS	46.8	42.7	42.7	2					
5+81.9						14/..	-14/49.9 T,-13/..	OB/0.50/FR		
	FS	65.8	40.2	40.2	-3					
6+22.1						14/39.9 T,5/..	-14/18.9 T,-13/..	OB/0.50/FR		
	FS	71.6	16.7	16.7	-4					
6+38.8						13/29.6 T,4/..	-13/..	OB/0.50/FR		
	FS	71.6	19.1	19.1	-3					
6+57.9						12/11.9 T,10/8.2 T,4	-12/..	OB/0.50/FR		
	FS	82.7	6.4	6.4	-5					
6+64.3						10/21.2 T,3/..	-12/..	OB/0.50/FR		
	FS	82.7	33.9	34.1	-9					
6+98.2						10/25.8 T,3/..	-10/58.8 T,-12/..	OB/0.50/FR		
	FS	75.8	27.9	28.0	-8					
7+26.1						12/27.0 T,6/..	-12/..	OB/0.50/FR		
	IFS	20.1	3.0	3.0	-2					
7+29.1						13/9.1 T,8/..	-13/..	OB/0.50/FR	24	
	FS	20.1	8.5	8.5	5					
7+34.6						8/..	-12/..	OB/0.50/FR		
	FS	20.1	22.3	22.3	-1					
7+56.9						8/..	-8/48.8 T,-11/..	OB/0.50/FR		
	FS	352.7	31.2	31.2	3					
7+88.0						7/..	-7/..	OB/0.50/FR		
	FS	342.0	31.3	31.4	5					
8+19.3						4/..	-4/..	OB/0.50/FR		
	FS	296.2	51.1	51.3	9					

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Station	Type	Fore Azi	H.D.	S.D.	Slp.(%	SSL Slp.(%)/S.D.	SSR Slp.(%)/S.D.	GND	CRK	Label
8+70.4						0/..	0/..	OB/0.50/FR		
	FS	270.8	89.0	89.3	8					
9+59.4						-2/..	2/..	OB/0.50/FR		
	FS	270.9	31.2	31.3	9					
9+90.6						-1/..	2/..	OB/0.50/FR		
	FS	270.9	52.7	53.0	10					
10+43.4						0/..	0/..	OB/0.50/FR		
	FS	280.0	28.0	28.2	11					
10+71.4						2/..	0/..	OB/0.50/FR		
	FS	280.0	105.5	106.9	16					
11+76.9						5/..	-5/..	OB/0.50/FR		
	FS	300.8	127.1	128.3	14					
13+04.0						7/..	-7/..	OB/0.50/FR		
	FS	300.8	15.4	15.6	13					
13+19.4						9/..	-9/..	OB/0.50/FR		
	FS	311.4	157.4	158.6	12					
14+76.9						9/..	-14/..	OB/0.50/FR		
	FS	318.7	212.6	212.7	3					
16+89.4						12/61.7 T,0/..	-13/..	OB/0.50/FR		
	FS	318.5	249.7	249.9	4					
19+39.2						13/..	-11/..	OB/0.50/FR		
	FS	310.7	169.4	169.7	5					
21+08.6						5/..	-10/..	OB/0.50/FR		
	FS	327.7	128.9	128.9	0					
22+37.5						9/37.0 T,5/..	-7/..	OB/0.50/FR		
	FS	327.7	28.9	29.0	5					
22+66.4						6/37.7 T,-1/7.5 T,0/..	-7/..	OB/0.50/FR		
	FS	327.7	259.4	259.4	1					
25+25.8						0/..	-4/..	OB/0.50/FR		
	FS	335.0	220.5	221.1	7					
27+46.4						-5/..	-2/..	OB/0.50/FR		
	FS	342.4	221.3	222.0	8					
29+67.7						-1/..	-5/..	OB/0.50/FR		
	FS	340.4	262.2	262.8	7					
32+29.8						-2/..	-7/..	OB/0.50/FR		
	FS	344.5	124.5	124.6	3					
33+54.3						0/..	0/40.1 T,-9/12.7 T,-11/..	OB/0.50/FR		
	FS	344.5	34.8	34.8	5					
33+89.2						0/..	2/34.3 T,-8/21.0 T,-14/..	OB/0.50/FR		
	FS	344.5	143.4	143.7	7					

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Station	Type	Fore Azi	H.D.	S.D.	Slp.(%	SSL Slp.(%)/S.D.	SSR Slp.(%)/S.D.	GND	CRK	Label
35+32.5						-2/12.4 T,-1/..	-8/..	OB/0.50/FR		
	FS	344.5	3.2	3.2	4					
35+35.7						8/0.7 T,0/0.3 T,-1/..	-8/..	OB/0.50/FR		
	FS	344.5	11.1	11.1	7					
35+46.8						8/1.7 T,0/22.1 T,-1/..	-8/56.4 T,-7/..	OB/0.50/FR		
	FS	0.0			0					

24. Index