MINISTRY OF TRANSPORTATION

InRoads Typical Example 1:

New Construction of a Rural Two-Lane Undivided Highway

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1.0 Overview

This typical example illustrates the steps necessary for using InRoads in the design of a new highway construction project. It walks through the complete project design cycle from creating the project file structure to final design output. The project presented in this example is for demonstration only. The work flow reflects the specific type of highway project. The example doesn't reflect the whole range of InRoads capabilities and the methods used in the example may require modification for a specific project.

For easy identification, the directory, folder and file names are in *italics* in this document.

Project Type:

New construction of a rural, two lane, undivided highway with earth, rock and swamp treatments.

Prerequisites

AutoCAD:

- Basic View Control & Editing Command
- MTO AutoCAD Standards (IESCAD 2009)

InRoads:

User should be familiar with InRoads:

- Working Environment
- Tools
- Surfaces
- Features
- Geometry
- Template
- Roadway Designer
- Reports

It is also recommended that the user be familiar with the following:

- MTO InRoads Project Template
- MTO Customization Documentation
- MTO InRoads Standards and Preferences Manual

Highway Design:

- Design principles
- MTO Design Manuals, Guidelines, and Policies

Software Version

- AutoCAD 2009
- InRoads V8i (SELECTseries 1)

Design Data and InRoads Files

The design data used in this example project is for demonstration only. Actual projects may vary.

The length of this example project is 500m.

Proposed Design

Design Speed	80 km/h
Horizontal Curve	R = 500m
Spiral Parameter	A = 150
Spiral Length	Ls = 45m
Vertical Curve K Value	30 Sag 40 Crest
Pavement Width	2x3.50m
Shoulder Width	2.50m
Partially Paved Shoulder	0.5m
Shoulder Rounding	0.5m
Cross-fall	2% (Pavement), 6% (Shoulder)
Superelevation	4.6% (Max 6%)
Pavement	Roadway: 40mm Asphalt Top Course 50mm Asphalt Base Course 150mm Granular A 300mm Granular B (earth) 150mm Granular B (rock) Partially Paved Shoulder: 50mm Asphalt Surface Course

The files listed and described below are provided in the **Example 1** data set *Data1.zip*:

Existing Ground Surface (.dtm)
……*Data1\Surfaces\Ex1_OG.dtm*

Geometry File (.alg)
……\ *Data1\Geometry\Ex1.alg*

OG Data (.soe)
……\ *Data1\Documentation\OG.soe*

Borehole Data (.txt)
……\ *Data1\Documentation\Borings.txt*

AutoCAD Drawings (.dwg)
……\ *Data1\Drawings\Ex1.dwg*

The files listed and described below are located in ***InRoads Project Template*** directory structure (see Section 2.1):

Inroads Template Library (.itl)
……*InRoads Project Template\Standards\MTO_STD_Templates.itl*

MTO Preference File (.xin)
……\ *InRoads Project Template\Standards\ MTO_civil.xin*

AutoCAD Drawings (.dwg)
……\ *InRoads Project Template\Standards\MTO_InRoads_Template.dwg*

The following files will be created for the project design:

Projects (.rwk)

Roadway Design (.ird)

Design Surfaces (.dtm)

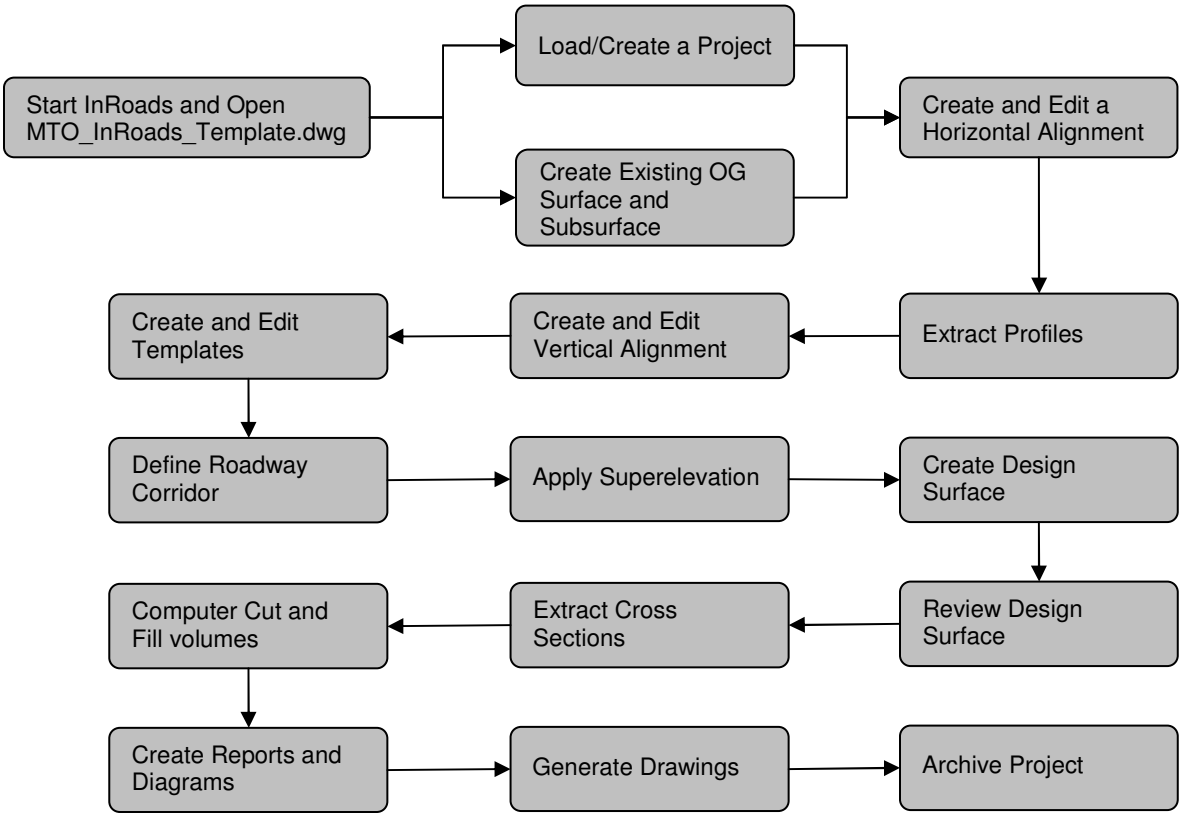
Reports (XML Data, .xml)

Design Drawings (Plan, Profile, Cross Section, .dwg)

Topics Covered:

- Setting up an InRoads Project
- Creating and Displaying Digital Terrain Models (DTMs)
- Designing a Horizontal Alignment
- Creating an Existing Ground Profile
- Designing a Vertical Alignment
- Defining a Typical Section
- Modeling a Roadway
- Applying Superelevation
- Creating Design Cross Sections and Surfaces
- Performing Quantity Computations
- Generating Design Drawings
- Producing InRoads Reports
- Exporting InRoads Data for Construction

InRoads Master Workflow



2.0 InRoads Project Setup

Note: All InRoads data files shall be as per the **MTO InRoads Project** directory structure posted on the MTO web site: http://www.xfer.mto.gov.on.ca/PTASapps/index.htm

This directory structure is mandatory for all in-house and service providers design work done with InRoads.

This section describes how to set-up the InRoads project directory and file structure.

2.1 Project Directory Set-up

Getting started

1. For this example, on your C drive create a project folder named *InRoads Projects* and then a folder named *Example1*

   The folder path should now be: C*:\InRoads Projects\Example1*

   Note: For all InRoads design work, put in the project *GWP/WP* folder a folder called *InRoads* or something similar. This is where the InRoads highway design files should be kept.

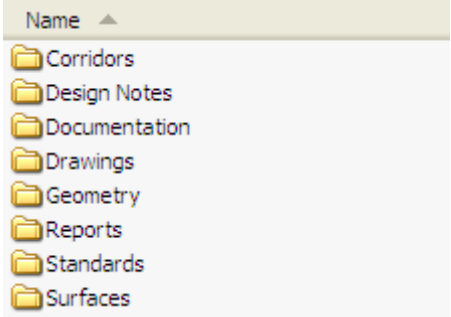
   ---

2. Go to the web site:

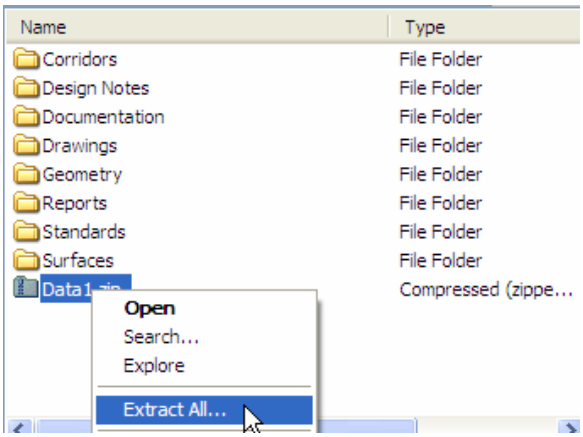
   http://www.xfer.mto.gov.on.ca/PTASapps/index.htm

   then, scroll down to find a list of InRoads files. Click on the file *InRoads Project Template.exe* and save it to the folder called *InRoads Projects* that you created in step 1. Click **Close**.
3. Install the required directory structure by going to the folder *InRoads Projects* and clicking twice on the file *InRoads Project Template.exe* to run the file. Click **Install**. Directories will be automatically set-up in the *InRoads Projects* folder in a new folder called *InRoads Project Template*
4. From the *InRoads Project Template* folder copy the following directories to the *Example1* folder:
   - Corridors
   - Design Notes
   - Documentation
   - Drawings
   - Geometry
   - Reports
   - Standards
   - Surfaces

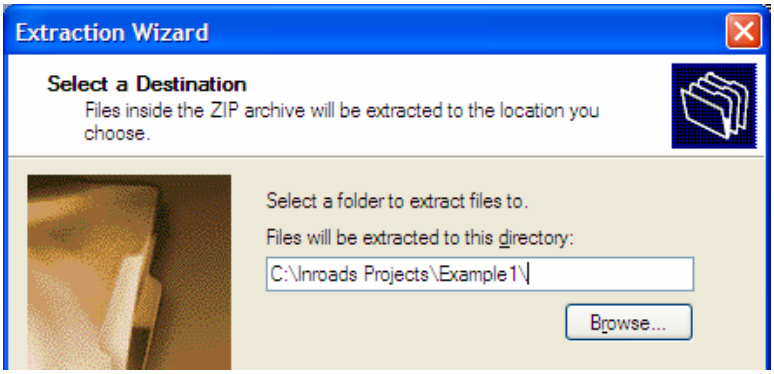
5. The folder *Example1* will now look like this:



6. Copy Example 1 data set *Data1.zip* to the folder *Example1*. Right click on the compressed file Data1.zip and select **Extract All** from the pop-up menu.



7. Follow the Extraction Wizard. When the target directory appears on the dialog, make sure the path is pointed to the folder *Example1*.



8. When finish, go through each folder to verify that files are installed properly as described under sample data set section in Section 1.

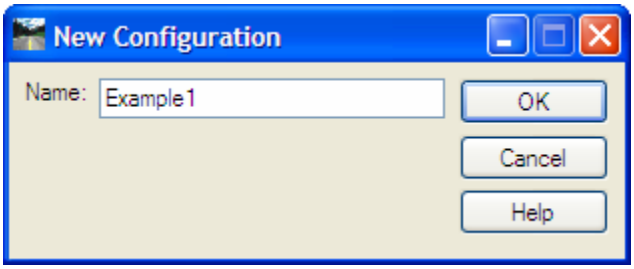
9. Start InRoads V8i (SELECTseries 1) with AutoCAD 2009.
10. Load MTO_InRoads_Template.dwg from the folder ...*Example1\Standards* into AutoCAD.
11. Click AutoCAD's **File > Save As** command to save a working drawing under …*Example1\Drawings*.

Note: MTO_InRoads_Template.dwg file contains proper layers and blocks to be used with MTO InRoads preference file as described in MTO InRoads Preference and Standards Manual.

2.2 Project Defaults

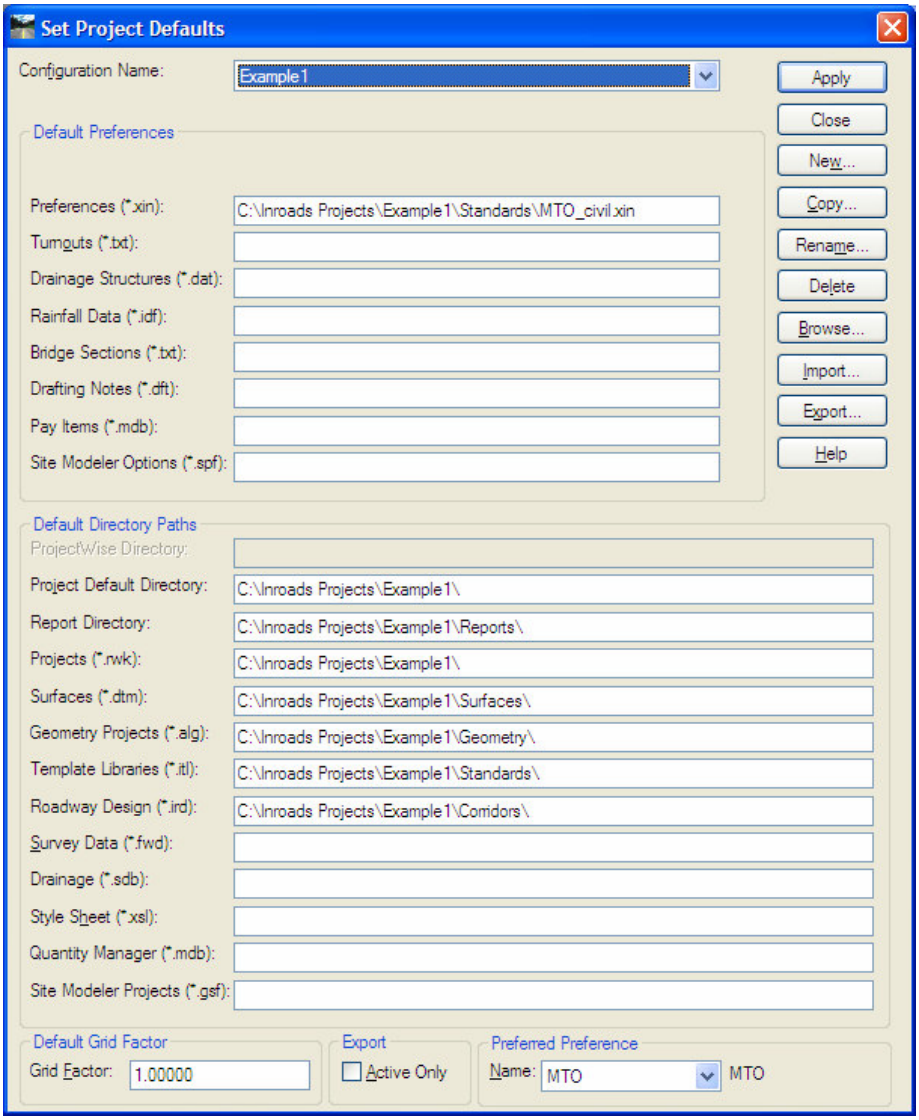
By setting up the project defaults, the user can set the default directory locations for opening/saving files for each design project to facilitate working on multiple projects. The InRoads **Project Defaults** command is used to set up default directories for all file types that can be accessed through the File/Open and File/Save As dialog boxes. These include Project (.rwk), Surface (.dtm), Geometry (.alg), Template Library (.itl), and Roadway Design (.ird). All other files, which are opened or saved throughout the program, use the Project Default Directory setting. The project default file directories are stored in the computer's registry.

1. Click to **File > Project Defaults** on the InRoads Main Menu.
2. Click on the **New** button and the New Configuration dialog box will appear.
3. Type in ***Example1*** in the Name field, click **OK** to save and close the dialog box.



4. Click in the *Preferences (*.xin)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1\Standards* folder.
5. Select *MTO_civil.xin*, and click **Open**,
6. Click in the *Project Default Directory* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1*, and Click **Open**.

7. Click in the *Report Directory* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1**Reports*, and Click **Open**.
8. Click in the *Projects (*.rwk)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1*, and Click **Open**.
9. Click in the *Surfaces (*.dtm)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1**Surfaces*, and Click **Open**.
10. Click in the *Geometry Projects (*.alg)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1**Geometry*, and Click **Open**.
11. Click in the *Template Libraries (*.itl)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1**Standards*, and Click **Open**.
12. Click in the *Roadway Design (*.ird)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example1**Corridors*, and Click **Open**.
13. The screen should now look like the picture shown below step 14.
14. Click the **Apply** button to save the configuration, and then click the **Close** button.



2.3 Project Files

InRoads allows users to create a project file for each project. With project file, the user can quickly load all files needed for a particular project. A project file is composed of a list of files with path names. To create a project file for example 1:

1. Click to **File > Open** on the InRoads Main Menu.
2. Change the *Files of type* to Surfaces (*.dtm) and select *Ex1_OG.dtm.* Click **Open**.

Note: After selecting the file type, the path will change to the folder as defined in the Project Defaults.

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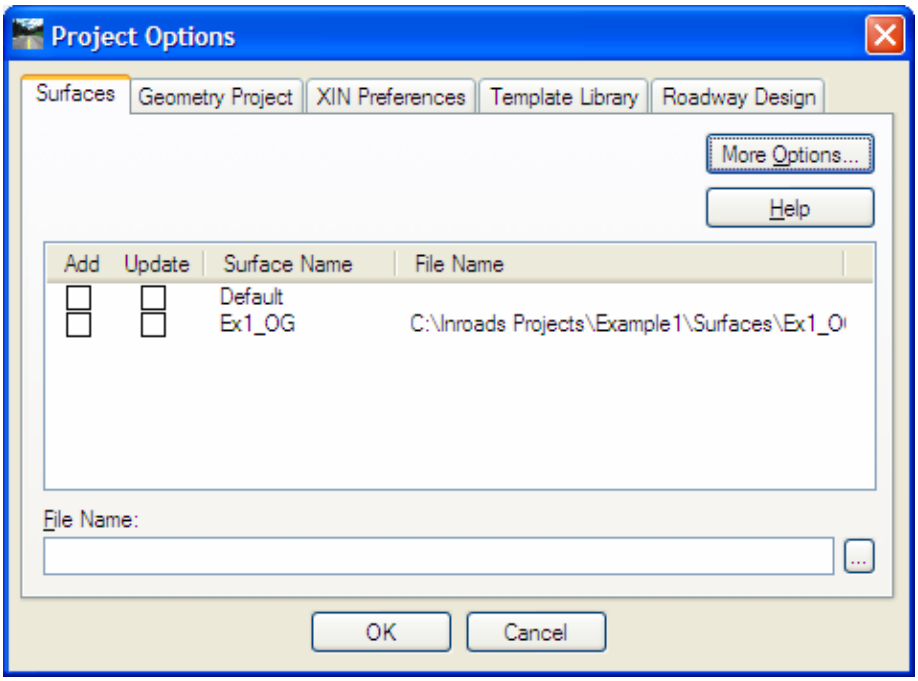
3. Change the *Files of type* to Geometry Projects (*.alg) and select *Ex1.alg*. Click **Open**.
4. Change the *Files of type* to Template Libraries (*.itl) and select *MTO_STD_Templates*. Click **Open** and then **Cancel**.
5. Create Project file (.rwk). Click to **File > Save > Project** on the InRoads Main Menu.
6. On the lower right corner of the Save As dialog box, click the **Options (…)** button. The Project Options dialog box will appear.



7. For Surfaces tab, check **Add** for the Existing surface ***Ex1_OG*** that was loaded in step 2.

Note: Proposed surfaces will be created in the design process. These files will be checked with both **Add** and **Update** options.

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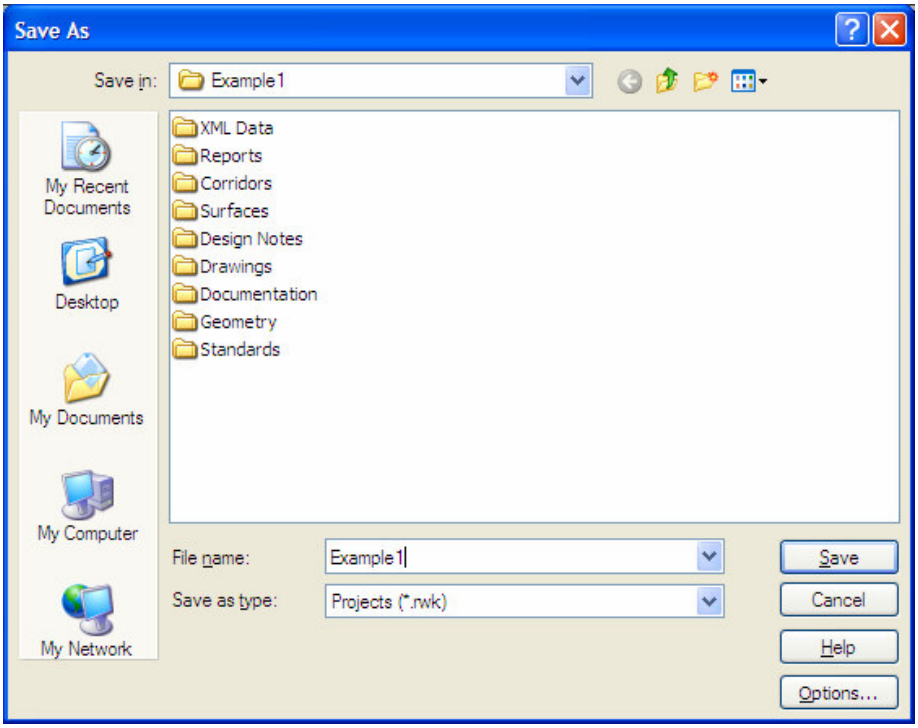
8. For the Geometry Project, XIN Preferences, and Template Library tabs, check **Add** and **Update** on each file listed under the **File Name**.
9. Click **OK** button to close the Project Options dialog box.
10. In the Save As dialog box click in the *File name* field and type in ***Example1***. Click the **Save** to complete creating the project file. Click **Cancel** to close the dialog.

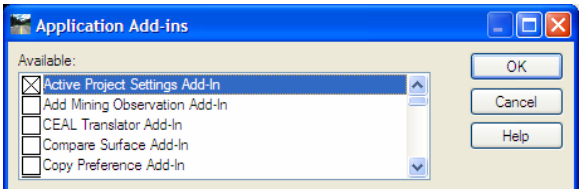


Note: Project files must be maintained and updated through the project design process. After creating subsurfaces, running Roadway Designer and creating proposed surfaces, the surfaces (.dtm) and Roadway Design (.ird) will be added to the .rwk.

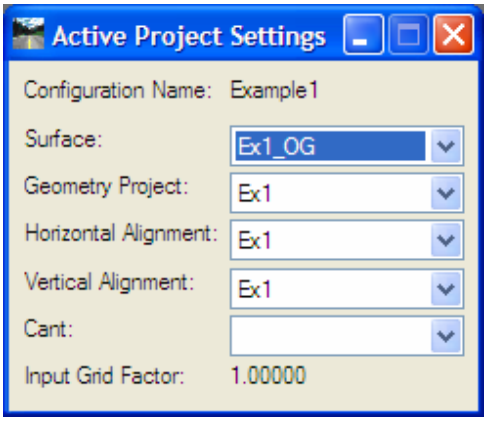
2.4 Active Project Settings

The **Active Project Settings** command displays the Active Project Settings dialog box, which gives you a single, convenient place for specifying the active surface, active geometry project, and active horizontal and vertical alignments. A change to any of the active settings is effective immediately, and other commands automatically become aware of the change.

1. Select **Tools > Application Add-ins**.
2. From the *Available* window on the Application Add-ins dialog, find and check the *Active Project Settings Add-In*.



3. Click **OK** button to close the dialog.
4. Select **Tools > Active Project Settings**.
5. The Active Project Settings dialog box should be the same as shown below. If not, make selection with the drop-down list so it matches.

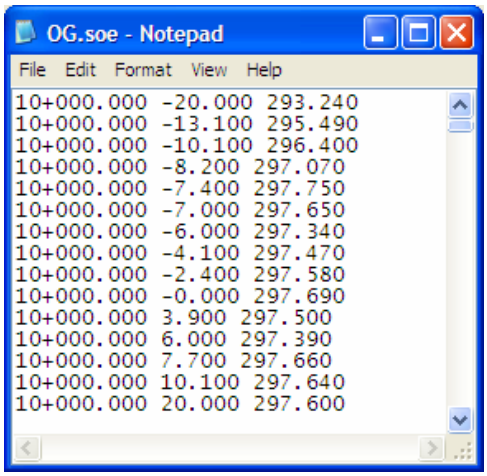


3.0 Creating Existing Conditions

3.1 Original Ground (OG) Surface

A sample existing ground surface *Ex1_OG.dtm* is provided with the sample data set. A surface can be created in several ways in InRoads. For demonstration, the InRoads *Text Import Wizard* is used to create the OG surface from an ASCII file.

The existing ground surface information is stored in an ASCII file in *Station, Offset and Elevation* format. The file can be found under: *…\Example1\Documentation\OG.soe*. Shown below is part of the file that can be viewed using Notepad:



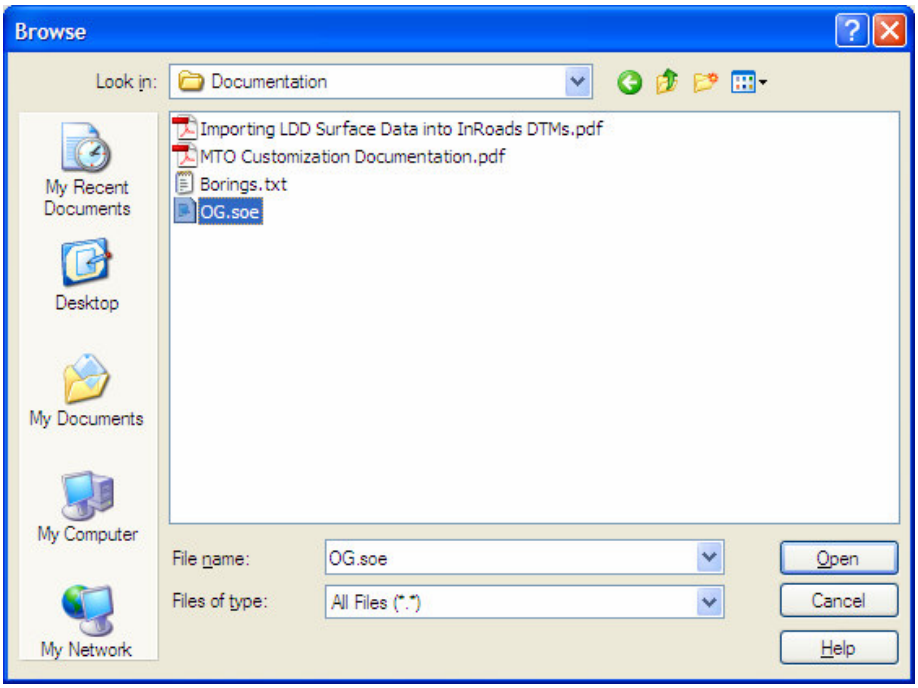
This method also needs alignment information to create the surface. The geometry project file *Ex1.alg* will be used for the surface creation.

Note: The data used to create a surface may in different format. *Northing, Easting and Elevation* is another commonly used format. InRoads *Text Import Wizard* provides the flexibility by letting you describe the format of files before you import them.

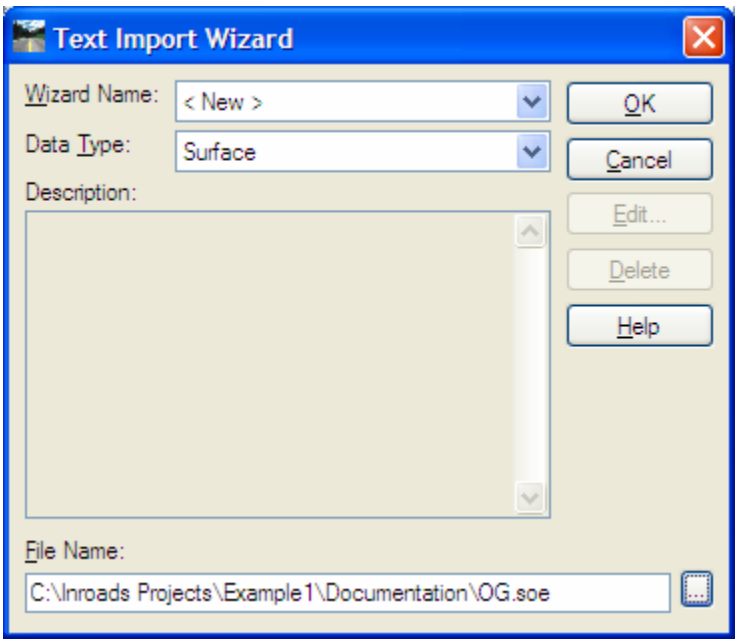
Importing OG surface

1. Before starting the process, check and make sure the alignment *Ex1* is the active alignment (See section 2.4 Active Project Settings).
2. From InRoads Main Menu select **File > Text Import Wizard**. The Text Import Wizard box will appear.
3. Select *Surface* from the *Data Type* drop-down list.

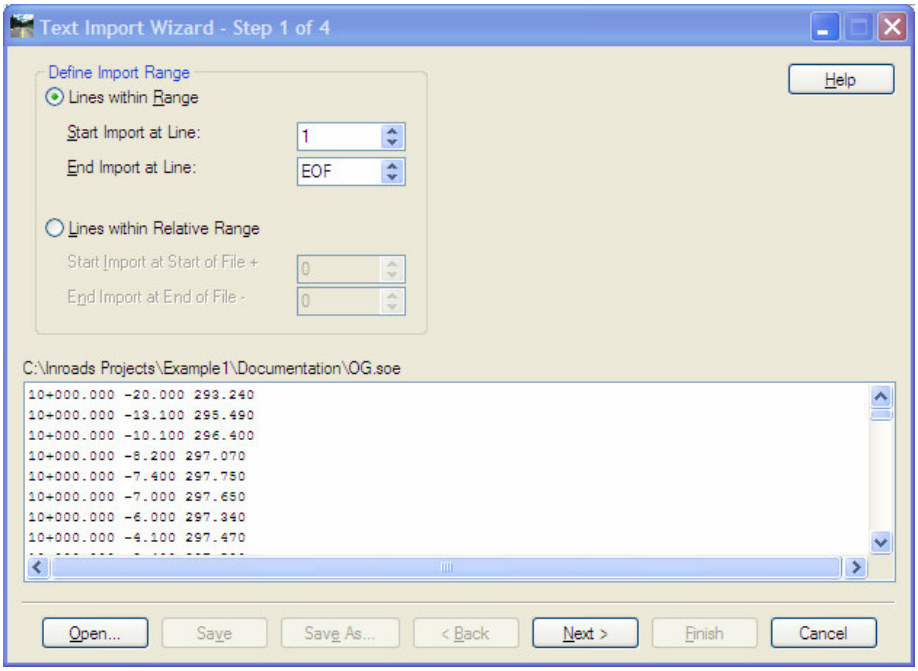
4. Click on the browse button icon on the lower right corner. The Browse dialog box will appear.
5. Browse to the *Documentation* folder under Example 1 project folder.
6. Chang *Files of type* to All Files (*.*)
7. Select the *OG.soe* file.



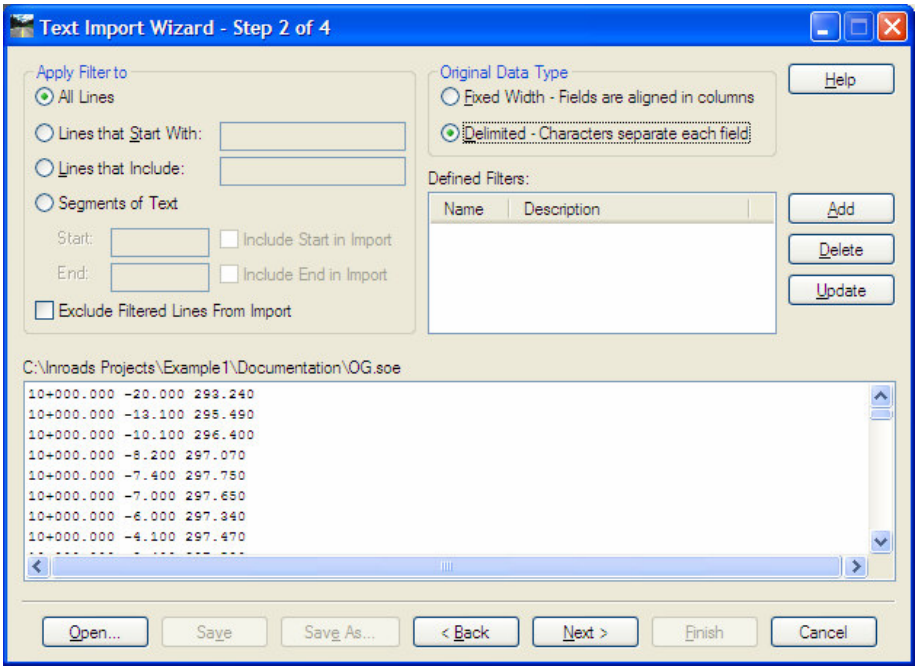
8. Click **Open** to close the Browse dialog and return to the Text Import Wizard dialog box. The file name with the path is showing in the *File Name* field now.



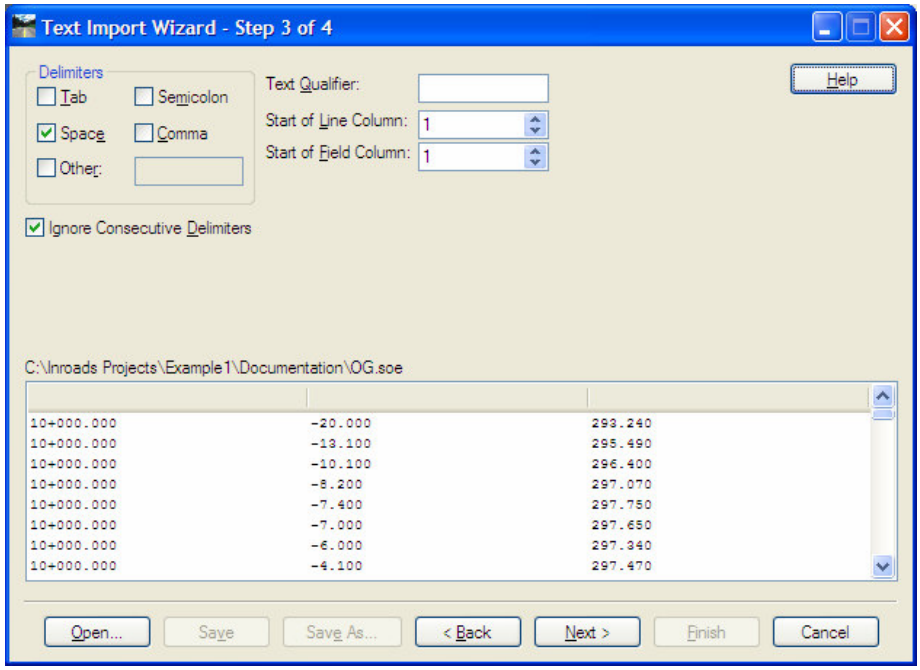
9. Click **Ok** button. The Text Import Wizard – Step 1 of 4 dialog box will appear. Keep the default settings.



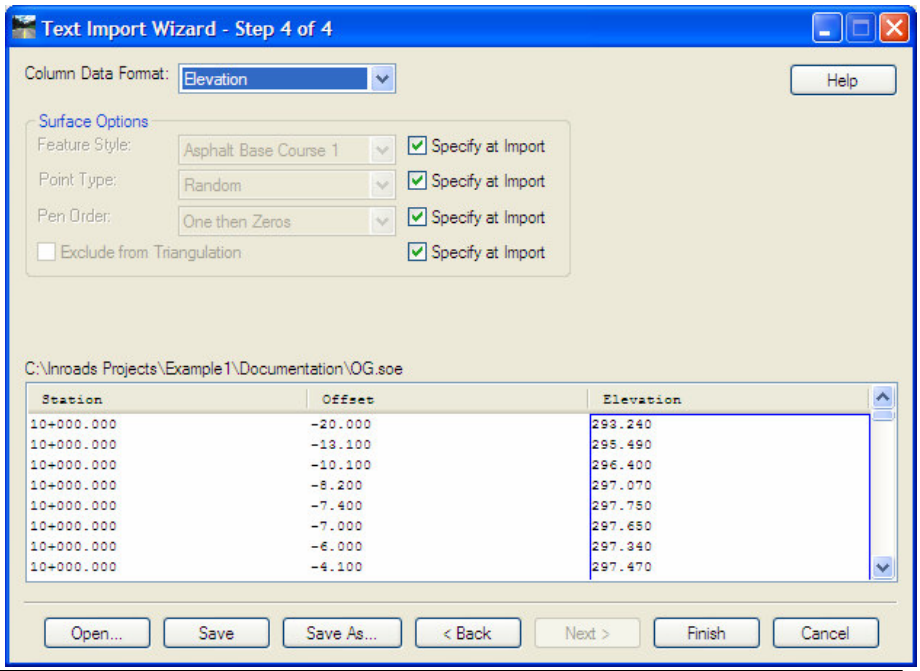
10. Click **Next >** button. In the Text Import Wizard – Step 2 of 4 dialog box, select the radio buttons *All Lines* in the *Apply Filter to* field and *Delimited – Characters separate each field* in the *Original Data Type* field.



11. Click **Next >** button. In the Text Import Wizard – Step 3 of 4 dialog box, make sure all the setting are as shown below.



12. Click **Next >** button. In the Text Import Wizard – Step 4 of 4 dialog box, click each data column and then select a *Column Data Format* for the column from the drop-down list:
    - Column 1: ***Station***
    - Column 2: ***Offset***
    - Column 3: ***Elevation***



13. Click on **Save As** to save the wizard for future use (optional). Provide a name in the Name Wizard dialog box.
14. Click **Finish** button. Surface Options dialog box will appear.

Note: If you didn't save the wizard in step 13, InRoads will ask if you want continue without saving the changes made from step 9 to 12. You can select **Yes** to continue or select **No** and return to the import wizard step 4 dialog box to save the wizard.

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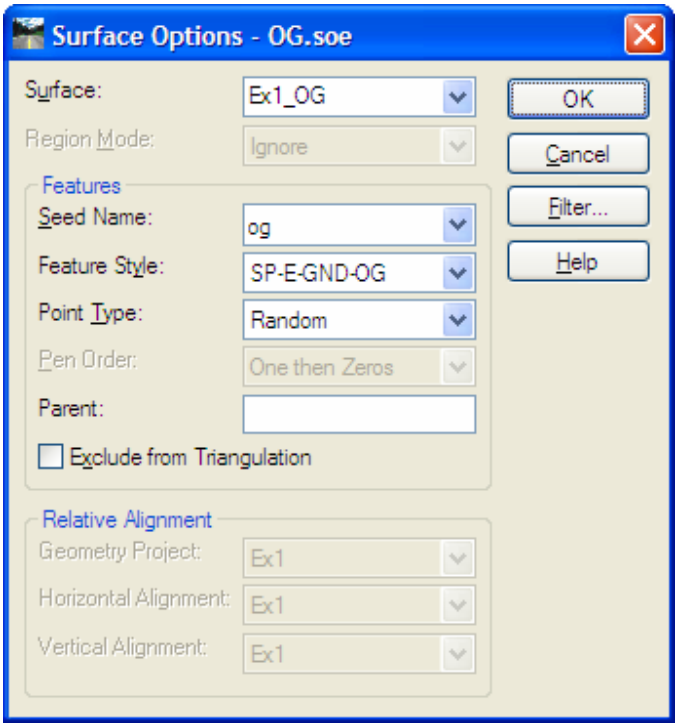
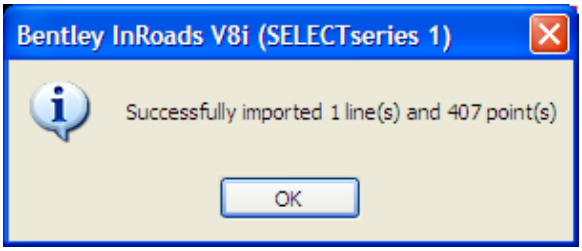
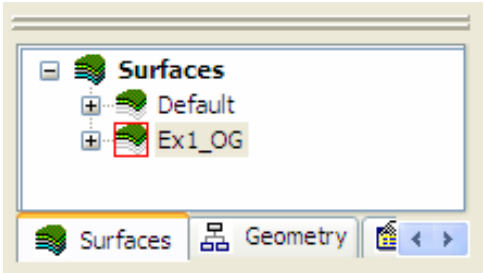
15. In the Surface Options dialog box, make or type the following selections:
    - Surface: ***Ex1_OG***
    - Seed Name: ***og***
    - Feature Style: ***SP-E-GND-OG***
    - Point_Type: ***Random***



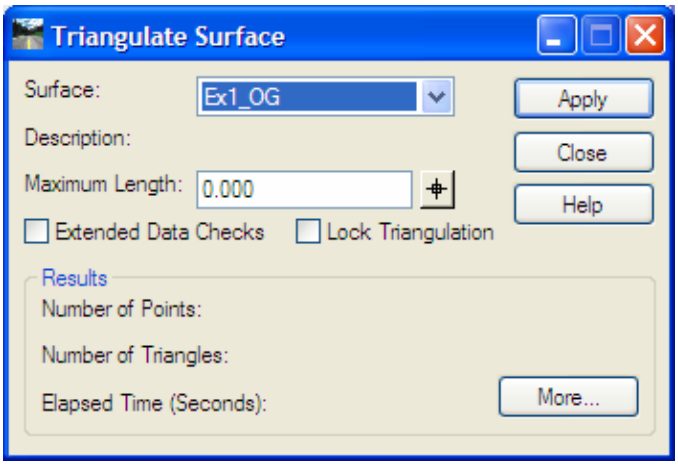
16. Click **OK** button. A dialog box will appear showing the surface is imported successfully.



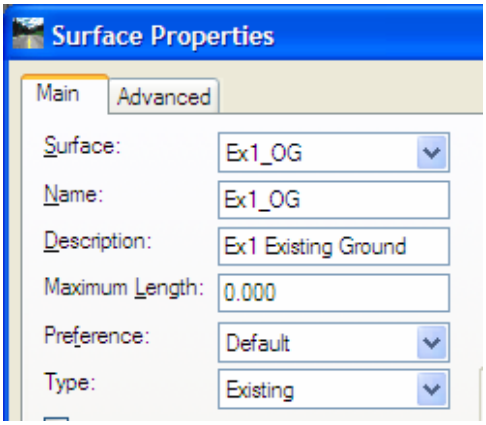
17. Click **OK** to close the dialog box. Go to InRoads Explorer. In the left pane, select *Surfaces*. A new surface *Ex1_OG* is listed under *Surfaces*.



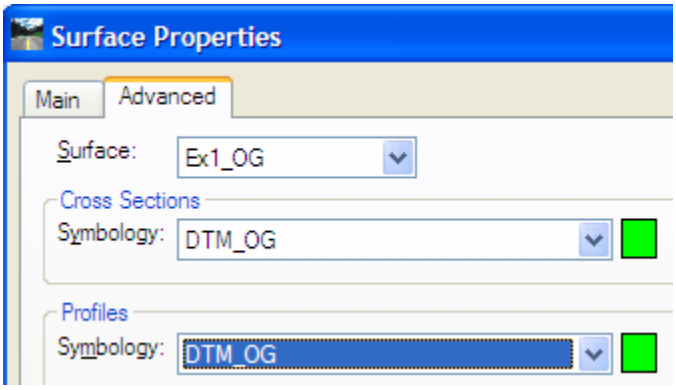
18. From InRoads Main Menu select **Surface > Triangulate Surface.**



19. Click **Apply** to triangulate selected surface.
20. Click **Close** to close the dialog box.
21. Select **Surface > Surface Properties**. On the *Main* tab, type ***Ex1 Existing Ground*** in the *Description* field.



22. On the *Advanced* tab, set *Cross Sections* and *Profiles* symbology to ***DTM_OG***.



23. Click **Apply** then **Close**.
24. Select **File > Save > Surface**. The Save As dialog box will appear and point to the folder as defined in the Project Defaults.
25. Accept the default surface name Ex1_OG and click **Save**.
26. Click **Cancel** to close the dialog box.

Viewing OG surface

InRoads provides users several viewing tools to display the surface data including the perimeter, triangles, contours and features.

1. Turn off the *Style* lock and select *Pencil* mode on the *Locks* toolbar.

Note: If the *Style* lock is on, the dialog box will not appear when you choose one of the View Surface commands.

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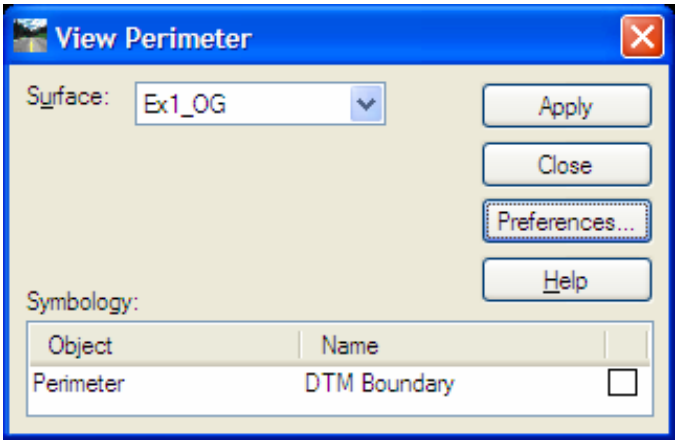
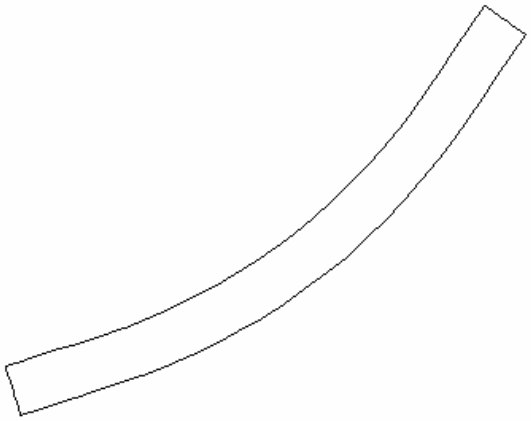
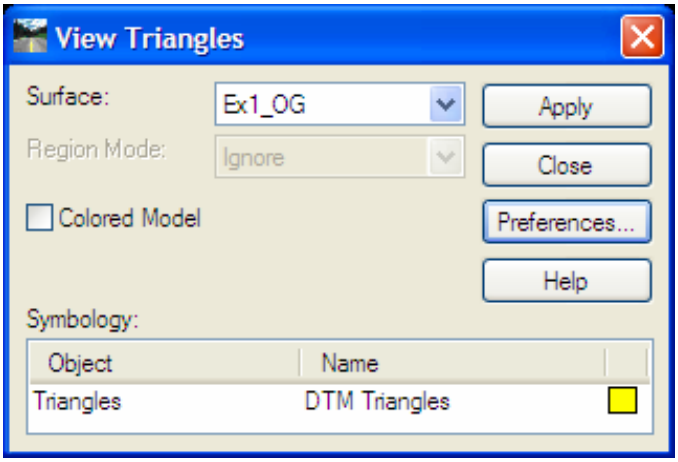
2. Select **Surface > View Surface > Perimeter**.



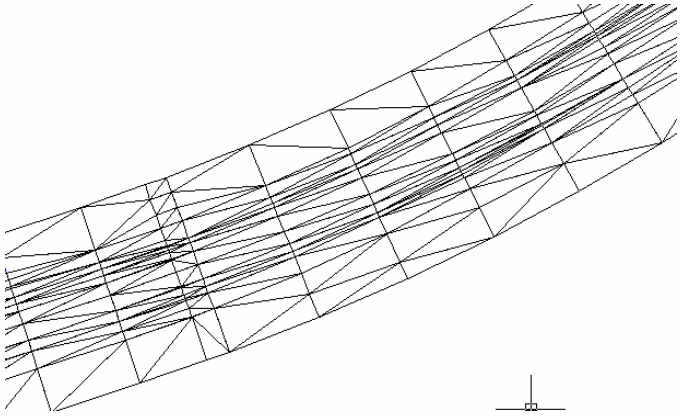
3. Click on the **Preferences** button. Make sure the preference **MTO** is selected. Close the Preference dialog.
4. Select the *Surface* ***Ex1_OG*** from the drop-down list.
5. Click on the **Apply** button and the perimeter is drawn in AutoCAD. Go to AutoCAD and zoom to the result.



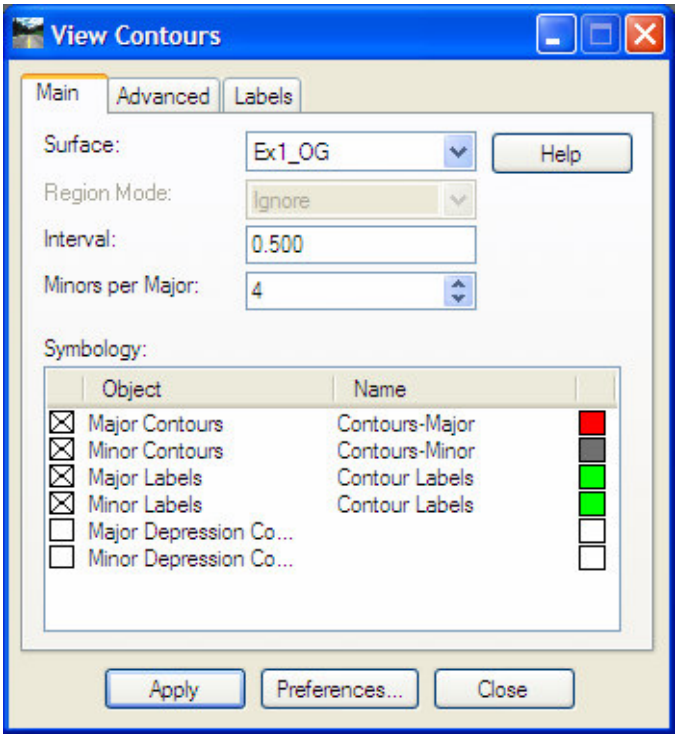
6. Click **Close**.
7. Select **Surface > View Surface > Triangles.**



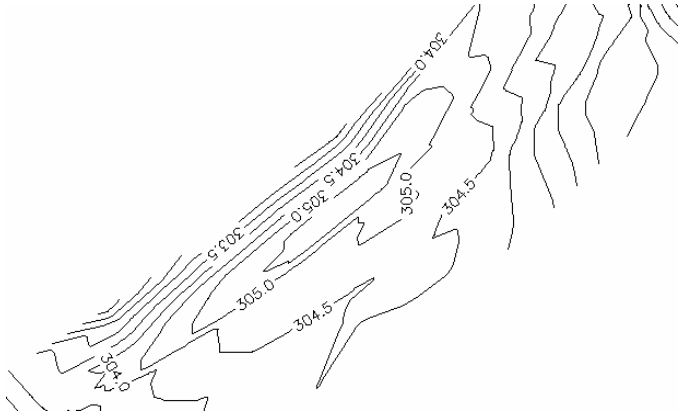
8. Click on the **Preferences** button. Make sure the preference **MTO** is selected. Close the Preference dialog.
9. Select the *Surface* ***Ex1_OG*** from the drop-down list.
10. Click on the **Apply** button and the triangles are drawn in AutoCAD.



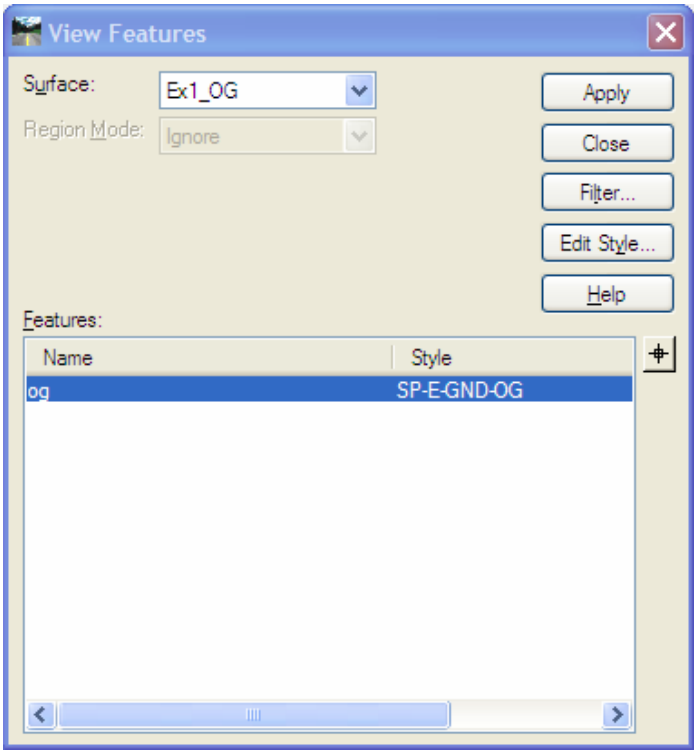
11. Click **Close**.
12. Delete the perimeter and triangles with AutoCAD delete command.
13. Select **Surface > View Surface > Contours.**



14. Click on the **Preferences** button. Select and load the preference **MTO_SP.** Close the Preference dialog.
15. Select the *Surface* ***Ex1_OG*** from the drop-down list.
16. Click on the **Apply** button and the contours are drawn in AutoCAD.



17. Click **Close**.
18. Delete the contours with AutoCAD delete command.
19. Select **Surface > View Surface > Features.**

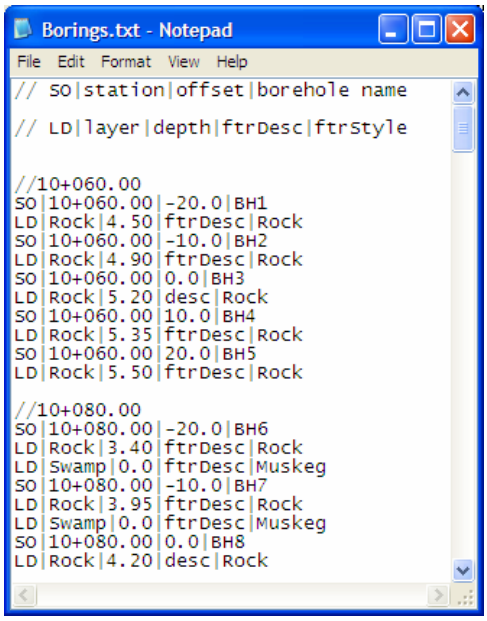


20. Select the *Surface* from the drop-down list.
21. Select the *Features* ***og*** from the feature list window.
22. Click **Apply** then **Close**.
23. Feature og is drawn with style SP-E-GND-OG in AutoCAD.

3.2 Subsurfaces (Rock and Swamp)

This example involves rock and swamp condition. The rock and swamp surfaces are created in the following task. The data file of borings containing rock and swamp information is provided with the sample data set. The file can be found at …*Example1\Documentation\borings.txt*.

The file is in ASCII format and the data format is described at the beginning of the file as shown below:



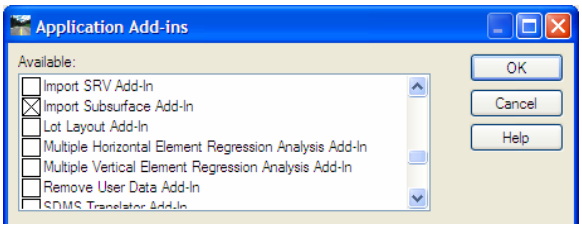
Note: InRoads *Import Subsurface* command is used in this task. Before using this command, you need:

- Create/load an existing surface
- Prepare a data file of borings with enough data to triangulate

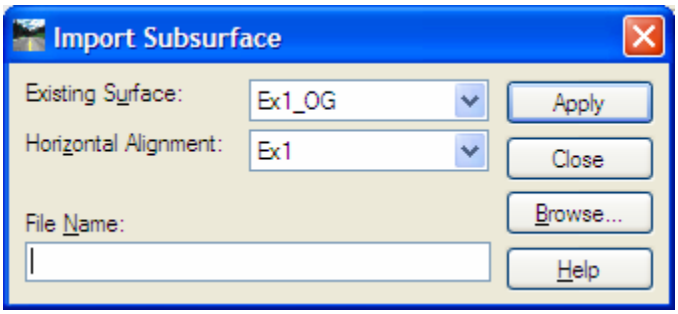
If using Station/Offset format for borehole location, you also need a horizontal alignment.

---

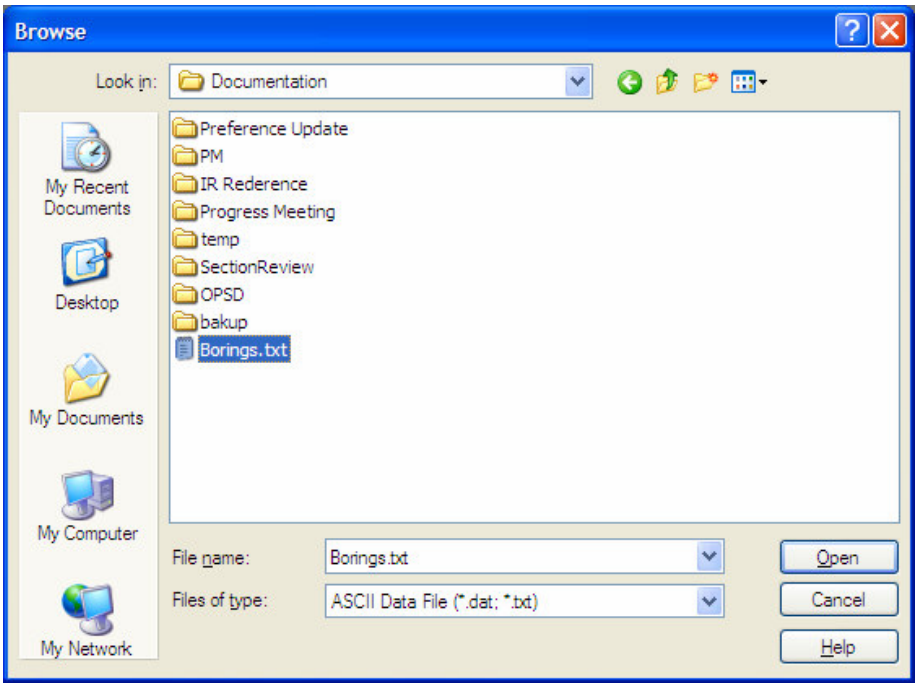
1. Select **Tools > Application Add-ins**.
2. From the *Available* window on the Application Add-ins dialog, find and check the *Import Subsurface Add-In*.



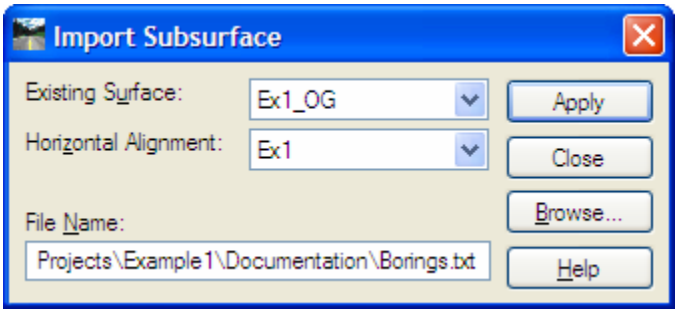
3. Click **OK** button to close the dialog.
4. Select **File > Import > Import SubSurface**.
5. Select **Ex1_OG** for *Existing Surface* and **Ex1** for *Horizontal Alignment*.



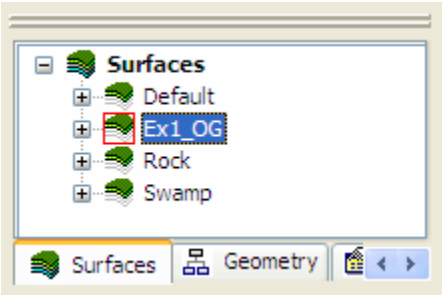
6. Click in the *File Name* field and click **Browse** button.
7. In the Browse dialog, navigate to the folder *…\Example1\Documentation* and select the file *Borings.txt*.



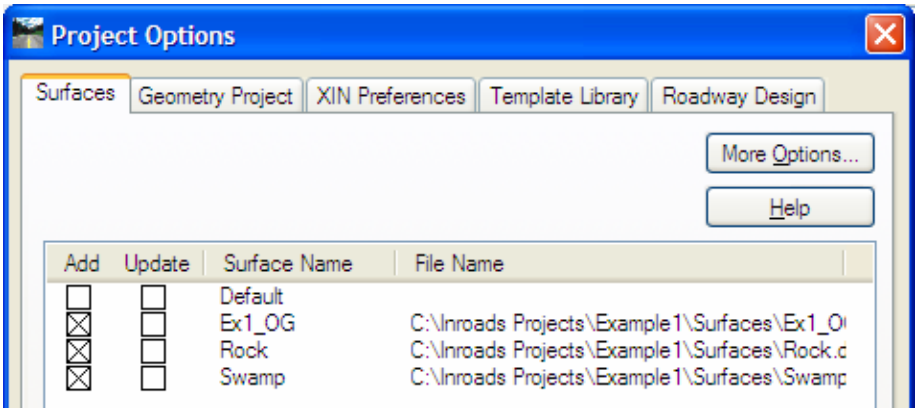
8. Click **Open** and return to the Import Subsurface dialog box. The file name with the path is showing in the *File Name* field now.



9. Click **Apply** then **Close**.
10. Go to InRoads Explorer. In the left pane, select *Surfaces*. The *Rock* and *Swamp* surfaces are created under *Surfaces*.



11. Select **Surface > Surface Properties**. Select *Rock* from the *Surface* drop-down list.
12. On the *Advanced* tab, set *Cross Sections* and *Profiles* symbology to ***DTM_Rock Survey***. Click **Apply**.
13. Select **Swamp** from the Surface drop-down list.
14. On the *Advanced* tab, set *Cross Sections* and *Profiles* symbology to ***DTM_Muskeg Survey***. Click **Apply**.
15. Click **Close** to close the Surface Properties dialog.
16. Set *Rock* surface active and save it to project folder.
17. Set *Swamp* surface active and save it to project folder.
18. Select **File > Save As** to open up the Save As dialog.
19. Change the *Save as type* to Projects (*.rwk) and select *Example1.rwk.*
20. Click the **Options (…)** button on the lower right corner of the Save As dialog box. The Project Options dialog box will appear.
21. Click *Surfaces* tab, check **Add** for Rock and Swamp surfaces.

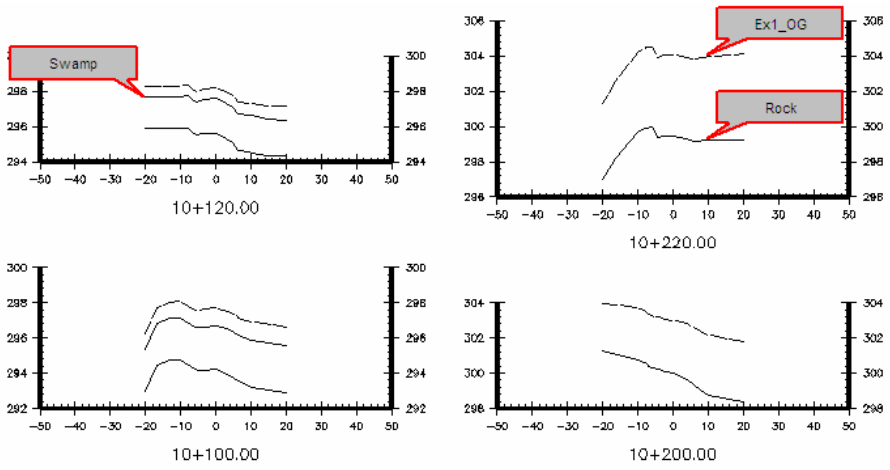


22. Click **OK** button to close the Project Options dialog box.
23. Click the **Save** button and confirm to replace existing project file.
24. Click **Cancel** to close the dialog.

3.3 View Cross Sections of the Surfaces

After defining horizontal alignment, the surfaces can be viewed in cross sections. A geometry project *Ex1.alg* is provided with the sample data set and can be used to view the surfaces.

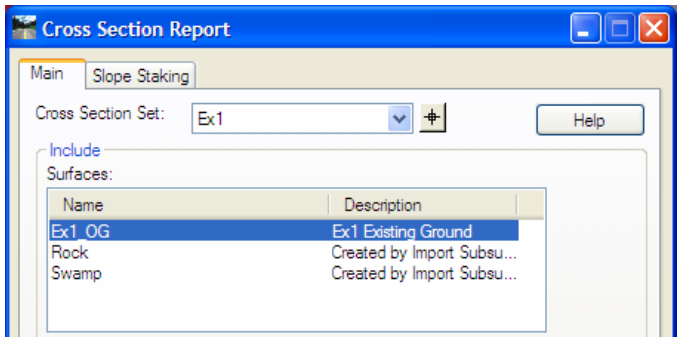
1. Make sure the geometry project *Ex1.alg* is loaded and is the active geometry project.
2. Select **Evaluation > Cross Section > Create Cross Section**.
3. Click **Preferences** button.
4. If the *Active Preference* is not **MTO**, load it. Click **Close**.
5. Select *General* leaf. Set interval to ***20*** and check surface *Ex1_OG*, *Rock* and *Swamp* in the Surfaces list window.
6. Select *Source* leaf. Make sure alignment *Ex1* is selected.
7. Click **Apply** and select an insert point in AutoCAD.



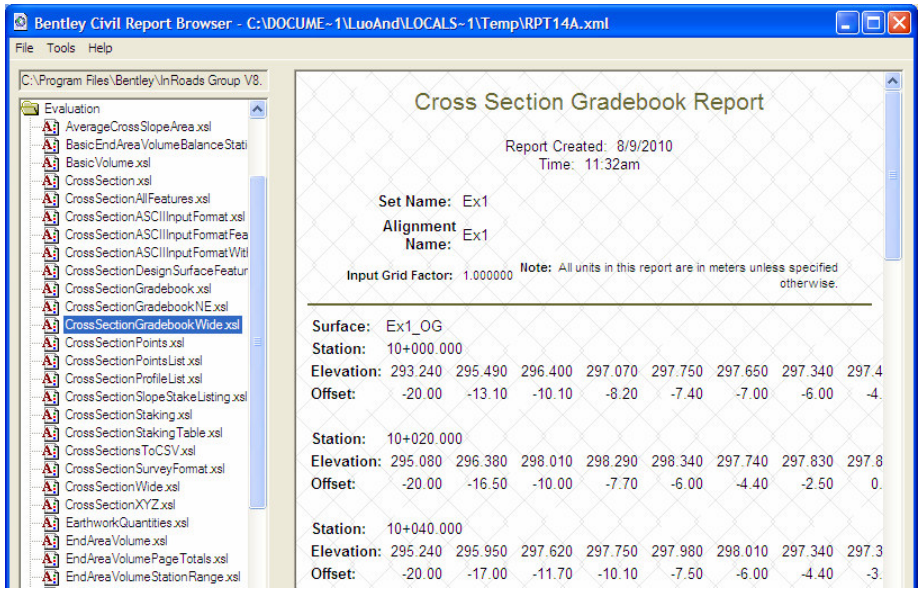
3.4 Generate Cross Section Reports

After generating the cross section set, the Cross Section Report command can be used to create station, offset, and elevation report.

1. Select **Evaluation > Cross Section > Cross Section Report**.
2. On the Cross Section Report dialog, select Cross Section Set ***EX1***.
3. Select ***Ex1_OG*** from the Include Surfaces field.



4. Click on **Apply**.
5. In InRoads Report Browser, select ***CrossSectionGradbookWide.xsl*** under Evaluation. The surface is reported in Station, Elevation, and Offset format.



6. Close the Report browser.
7. On Cross Section Report dialog, select ***Rock*** from the Include Surfaces field.
8. Click **Apply**.

Cross Section Gradebook Report

Report Created: 8/9/2010
Time: 11:34am

Set Name: Ex1
Alignment Name: Ex1
Input Grid Factor: 1.000000 **Note:** All units in this report are in meters unless specified otherwise.

Surface:	Rock							
Station:	10+060.000							
Elevation:	290.440	291.820	292.760	292.950	292.935	293.040	292.830	292.1
Offset:	-20.00	-15.00	-11.50	-10.00	-8.50	-8.00	-6.00	-4.
Station:	10+080.000							
Elevation:	291.040	293.681	293.614	292.815	292.628	292.663	292.530	292.9
Offset:	-20.00	-10.20	-10.00	-7.40	-5.90	-4.50	-2.80	0.

9. Repeat step 6 to 8 to generate Swamp report.

Cross Section Gradebook Report

Report Created: 8/9/2010
Time: 11:36am

Set Name: Ex1
Alignment Name: Ex1
Input Grid Factor: 1.000000 **Note:** All units in this report are in meters unless specified otherwise.

Surface:	Swamp							
Station:	10+080.000							
Elevation:	294.440	297.620	297.564	296.830	296.680	296.750	296.660	297.1
Offset:	-20.00	-10.20	-10.00	-7.40	-5.90	-4.50	-2.80	0.
Station:	10+100.000							
Elevation:	295.310	296.790	297.100	297.110	296.630	296.625	296.625	296.7
Offset:	-20.00	-16.70	-13.00	-10.00	-6.00	-5.00	-3.00	0.

Note: You can report each surface separately or select all the surfaces and report them in one single report.

4.0 Horizontal Alignments

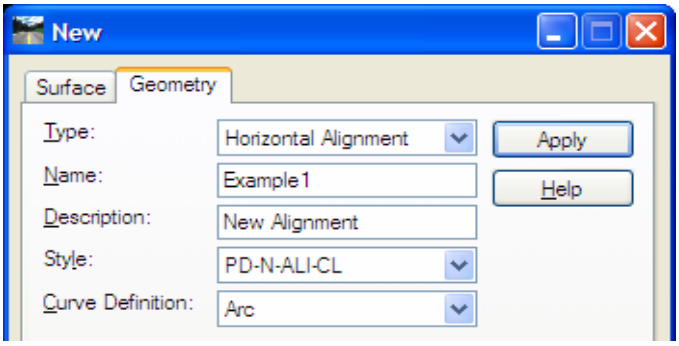
4.1 Creating Horizontal Alignment

There are various methods for creating horizontal alignments in InRoads. In this example, the PI method for the layout of horizontal geometry is used. A sample drawing *Ex1.dwg* provided with the sample data set is used as a reference with PIs to be used for the alignment.

Shown above is *Ex1.dwg*. PI-1 defines the point of beginning (POB) on the alignment, while PI-2 is a point of intersection (PI), and PI-3 is the point of ending (POE). The *Ex1.dwg* file can be found at *…\Example1\Drawings\Ex1.dwg*

The process described below will create a horizontal alignment same as provided in the geometry project *Ex1.alg*.

1. From AutoCAD, open *Ex1.dwg*.
2. In InRoads, make sure the geometry project *Ex1.alg* is loaded and it is the active geometry project.
3. Create a new horizontal alignment under geometry project *Ex1* with name ***Example1*** and style ***PD-N-ALI-CL*** (alignment style for planning and design), and the description.

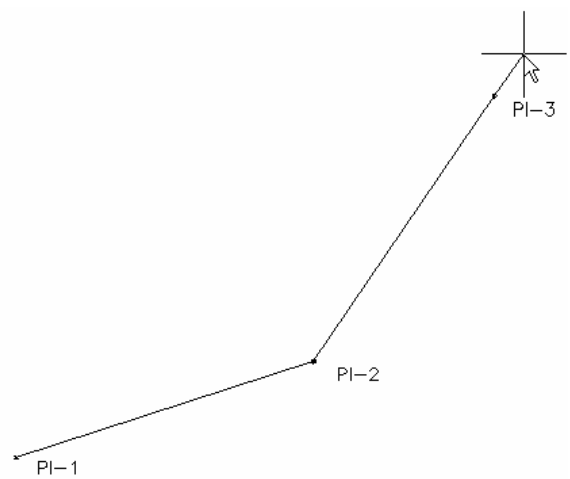


4. Click **Apply** and **Close**.
5. Select **Geometry > Horizontal Curve Set > Add PI**.
6. Click **Snap to Endpoint** icon from InRoads *Snaps* toolbar then identify the first point *PI-1*in AutoCAD as the beginning of the alignment.

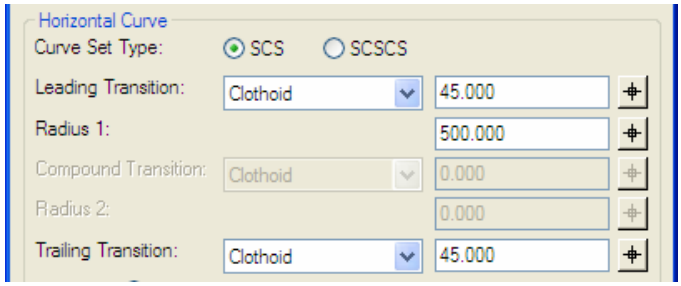
Note: Always read and follow the prompts in AutoCAD Command Line window.

---

7. Select point *PI-2* and *PI-3*.

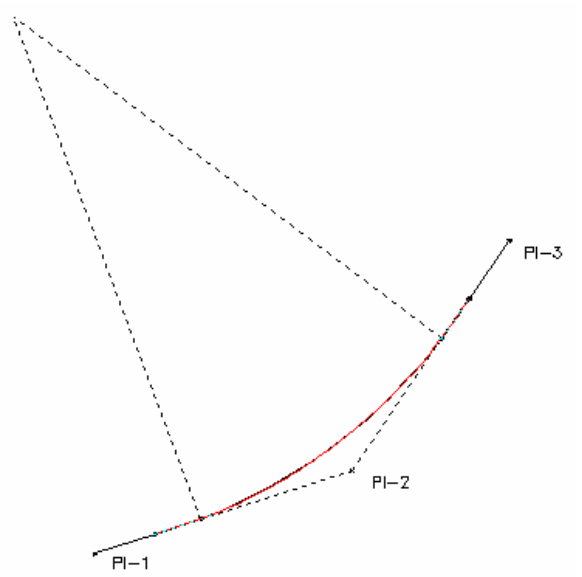


8. Right click twice, one to accept and another to end the command.
9. Delete the graphics generated by Add PI command, and then redisplay the alignment elements.
10. Select **Geometry > Horizontal Curve Set > Define Curve**.
11. In the Define Horizontal Curve Set dialog, enter the following curve information in the Horizontal Curve section: Radius is 500.00m, Spiral Length is 45.00m.

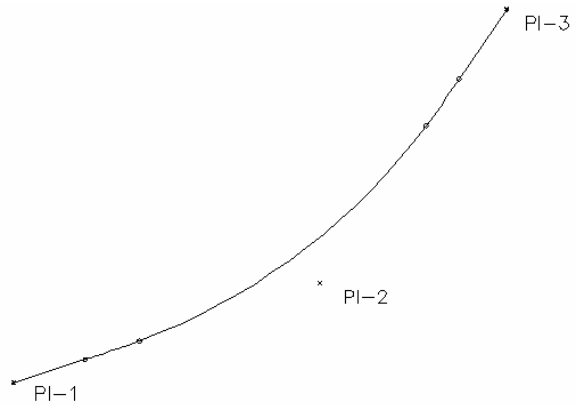


12. Click **Apply**. The curve with radius is shown in AutoCAD.

Note: If the radius is too large, InRoads will not find a solution. Adjust the parameters.



13. Click **Close** button to close the dialog.
14. The alignment is displayed in AutoCAD with the style set in step 3.



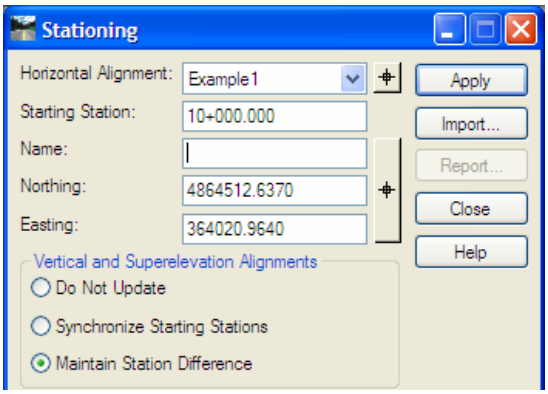
15. Save InRoads geometry project.
16. Save AutoCAD drawing to …Example1\Drawings\.

4.2 Viewing the Active Horizontal Alignment

1. Delete the graphics with AutoCAD delete command.
2. In InRoads, select **Geometry > View Geometry > Active Horizontal.** The alignment will now be shown in AutoCAD.

4.3 Setting the Starting Station

1. In InRoads, select **Geometry > Horizontal Curve Set > Stationing**.
2. In the Stationing dialog enter the station value ***10+000*** in the Starting Station field. By default, the starting point is the first PI (POB) placed in the geometry. The Vertical and Superelevation Alignments options should be set to ***Maintain Station Difference***.



3. Click **Apply** then **Close**.
4. Click **File > Save > Geometry Project**.

4.4 Reviewing Horizontal Alignments

The Review Horizontal Alignment command is used to review a selected geometry in detail.

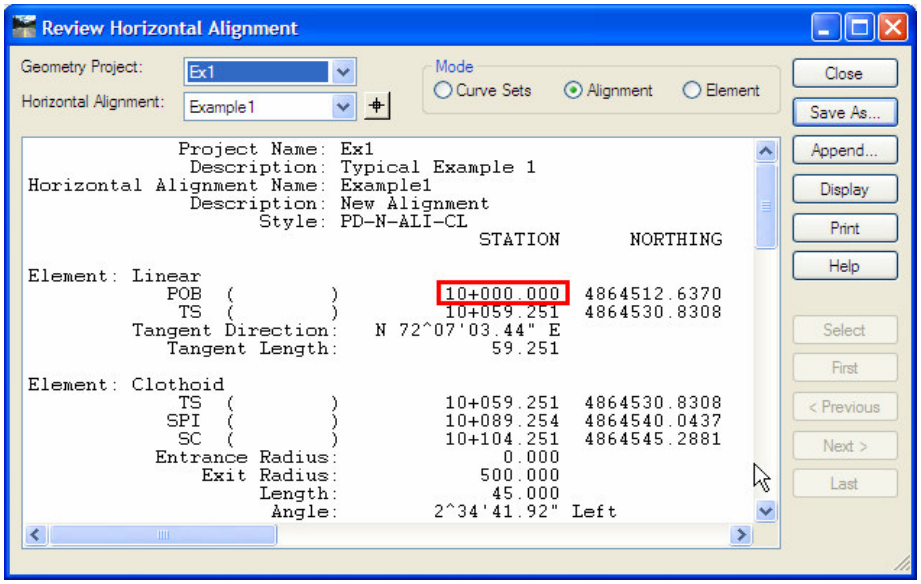
1. Select **Geometry > Review Horizontal**.
2. In the *Mode* section, select *Element*.
3. Click **Next** button to move along the alignment

Note: As you move along the alignment, the element is highlighted in AutoCAD.

---

4. In the *Mode* section, select *Alignment*. The Review Horizontal Alignment dialog displays information on all the elements in the alignment.

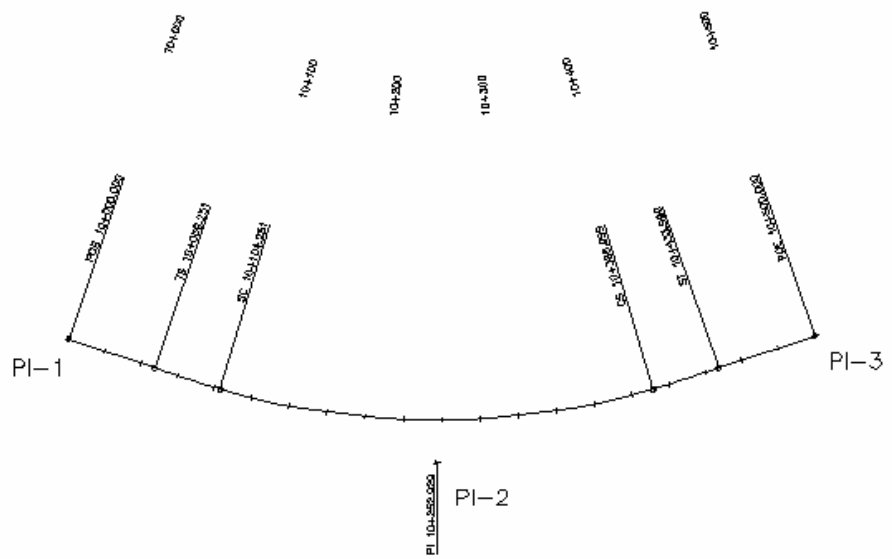
Shown below is the Review Horizontal Alignment dialog with the *Alignment* mode selected. The starting station (POB) is 10+000.000 as set in previous session. The review information can be displayed in AutoCAD using the Display button or saved as an ASCII file using the Save As button, and be used to recreate the horizontal alignment.



4.5 Displaying Stationing

The View Stationing command is used to place station annotation text along the active horizontal alignment at a specified interval.

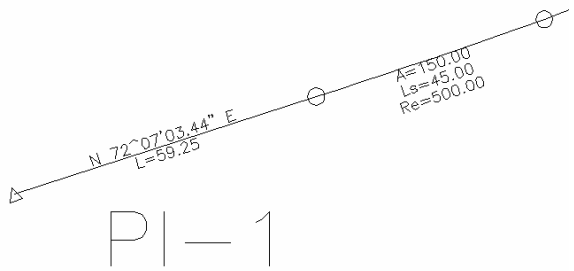
1. Select **Geometry > View Geometry > Stationing**.
2. Click on the **Preferences** button. Select and load the named preference **MTO_Alignment_P&D.** Close the Preference dialog.
3. Click **Apply** and then **Close**.
4. Stationing will be generated on the Planning and Design layer as defined in MTO AutoCAD Standards Guide.



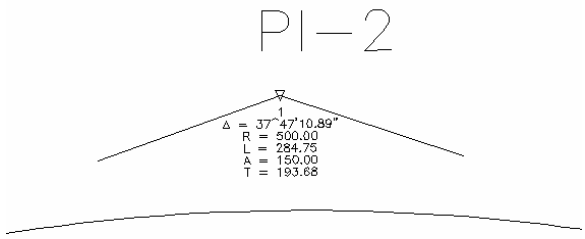
4.6 Annotating Horizontal Alignments

Horizontal Annotation command is used to display and annotate horizontal alignments, points, and elements.

1. Select **Geometry > View Geometry > Horizontal Annotation**
2. Click **Preferences** button.
3. On Preferences dialog, select ***MTO_Alignment_P&D***, click **Load > Close**.
4. Click in the Horizontal Alignments Include field.
5. Click **Filter** button.
6. On the Geometry Selection Filter dialog, select alignment ***Example1*** from the Available side.
7. Click **Add** button to put the alignment on the Selected side.
8. Click **OK** return to the View Horizontal Annotation dialog.
9. Click **Apply**. The selected alignment is displayed with element data.



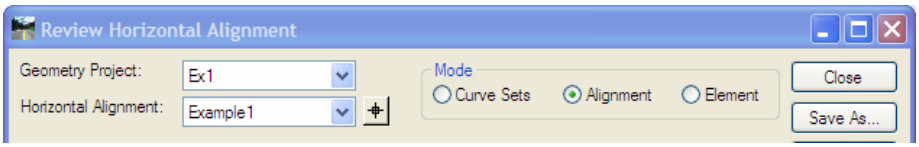
10. Click **Close**.
11. Select **Geometry > View Geometry > Curve Set Annotation**.
12. Click **Preferences** and load named preference ***MTO_Alignment_P&D***.
13. Click **Close** return to Curve Set Annotation dialog.
14. Select ***Example1*** in the Horizontal Alignment field for annotation.
15. Click **Apply** to display annotation.



4.7 Generating Horizontal Alignment Report

The Review Horizontal command can be used to report detailed information about the elements in selected horizontal alignment. The information can be displayed in AutoCAD or saved to an ASCII file. Select different *Mode* to report different parts of the alignment.

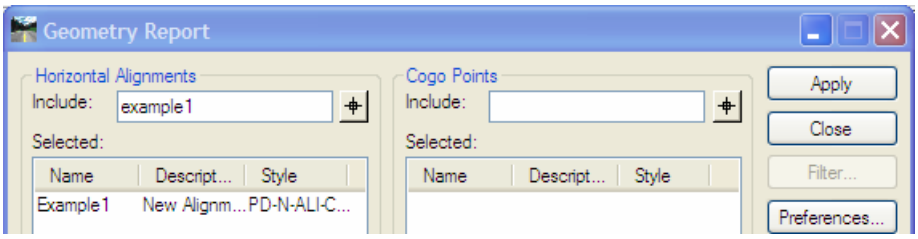
1. Select **Geometry > Review Horizontal.**
2. Select ***Ex1*** for Geometry Project and ***Example1*** for Horizontal Alignment.
3. Select *Mode* to review and report information in different format.



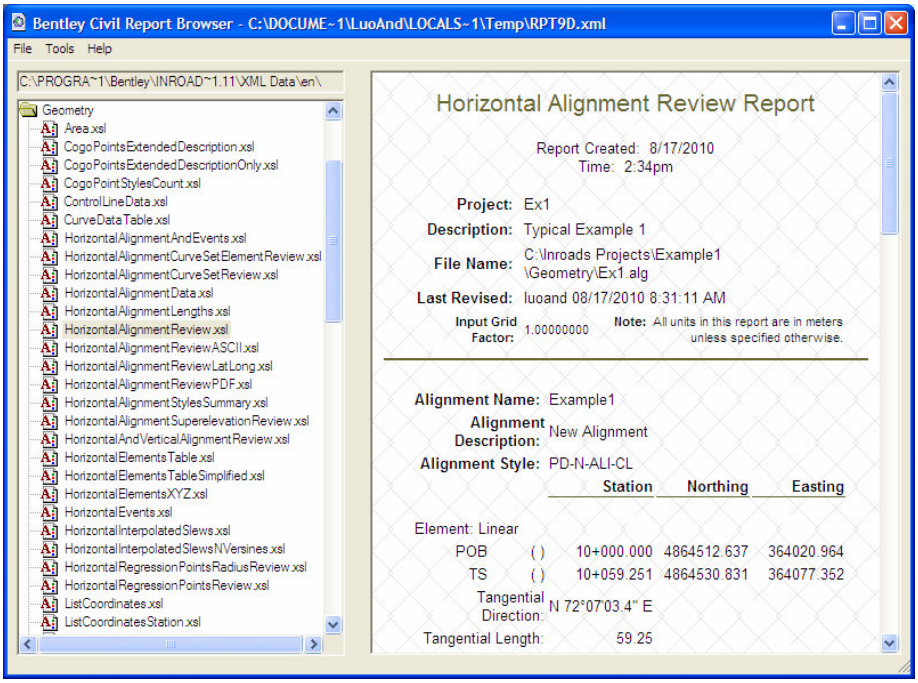
Horizontal Alignment Report also can be generated by InRoads XML Reports command and used with a large number of style sheets.

1. Select **Tools >XML Reports >Geometry**.
2. On the Geometry Report dialog, type ***Example1*** in the Horizontal Alignments Include field.
3. Press **Tab** on the keyboard. The alignment *Example1* will be listed in the Selected window.

Note: *Filter* or select button also can be used to select alignments. Use * will select all the alignments in the geometry project.



4. Click **Apply** to create the report. Bentley Civil Report Browser is displayed.
5. Select **HorizontalAlignmentReview** style sheet.



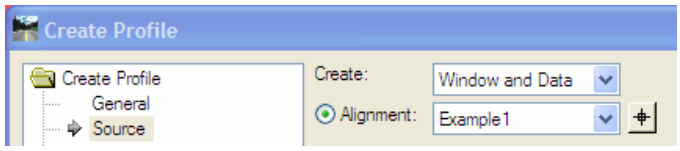
6. Select **Tools > Format Options** in the Bentley Civil Report Browser.
7. Make the desired changes to the format of the generated report.
8. Select **File > Save As** in the Bentley Civil Report Browser to save the data into file with selected file type.

5.0 Profile and Vertical Alignment

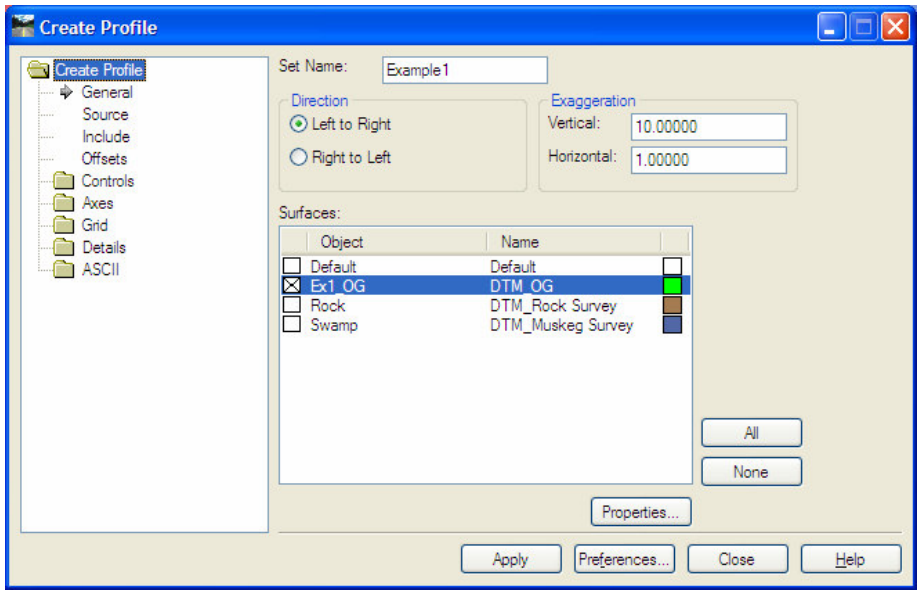
5.1 Creating Profile

Before defining the vertical geometry, the existing ground profile along the horizontal geometry needs to be extracted from selected OG surfaces.

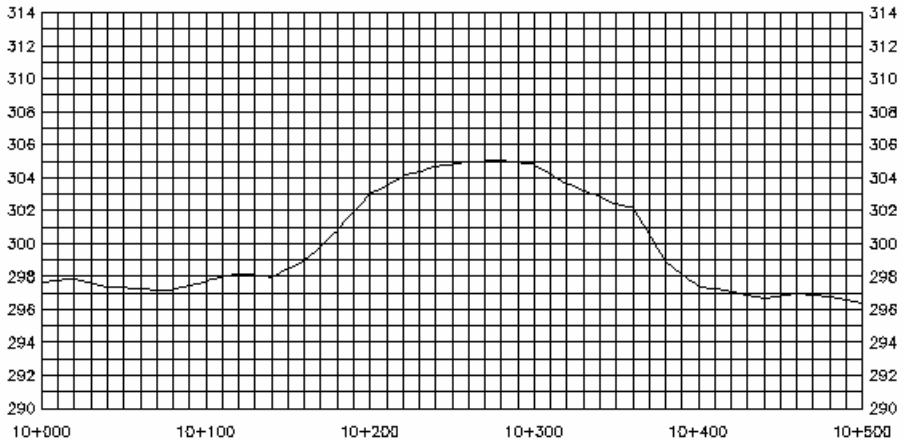
1. Select **Evaluation > Profile > Create Profile** and the Create Profile dialog will appear.
2. Click on **Preferences** button. Select and load named preference **MTO**.
3. Close the Preference dialog.
4. Click on the *Source* leaf. The *Create* field should be *Window and Data*.
5. Check and make sure the Alignment is *Example1*.



6. Click on *General* leaf. By default, the *Set Name* is set to the active horizontal alignment *Example1*.
7. Make sure surface *Ex1_OG* is checked in the *Surfaces* list window.



8. Click on *Controls* leaf. Make sure the Elevation range and Station range are not used.
9. Click **Apply** and select an insert point in AutoCAD.

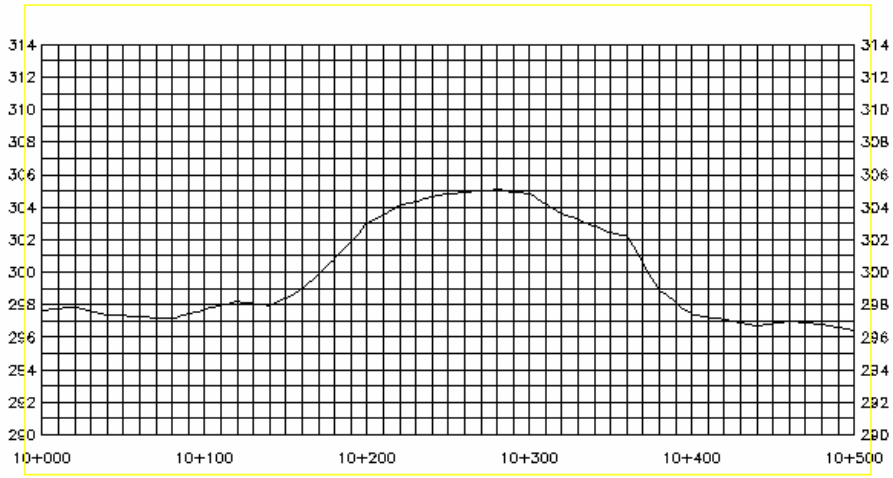


5.2 Updating Profile

After a profile is created, Update Profile command is used to add new surfaces, offsets, and features to the existing profile, or refresh surfaces, offsets, and features that have been modified in the existing profile.

The following steps will add Rock and Swamp surfaces to the profile.

1. Select **Evaluation > Profile > Update Profile**. The Update Profile dialog will appear.
2. In the *Profile Set* field, if there is more than one profile set exists in the drawing, select the most recently created set. A yellow frame will appear around the selected profile set.

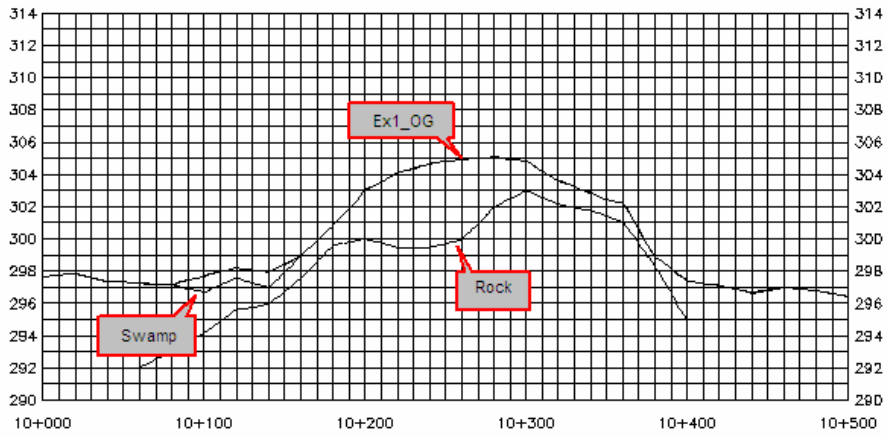


3. Click on *Surface* leaf. In the *Mode* field, select *Display On*.
4. In the available *Surfaces* list window, select ***Rock*** and ***Swamp*** surfaces.

Note:

Refresh - replaces previously displayed graphics with up-to-date data.
Display On - displays graphics not currently exist in the profile.
Display Off - removes graphics (surfaces or features) from the profile.

5. Click **Apply**.

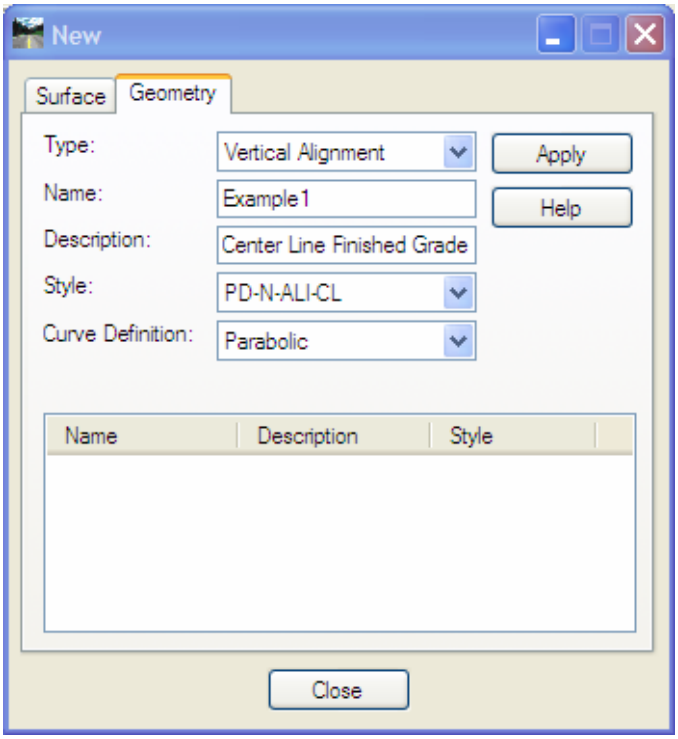


5.3 Creating Vertical Alignment

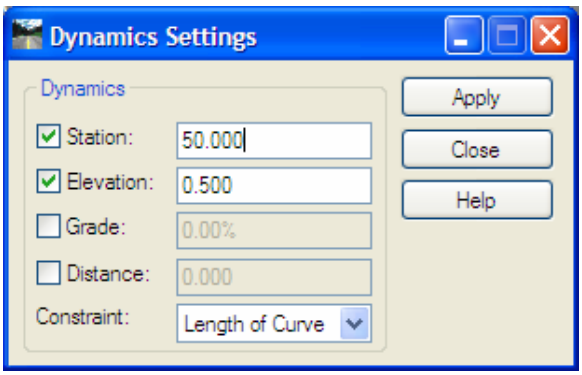
After extracting profile along the existing horizontal alignment, the vertical alignment can be defined. The following PI input will be used:

Station	**Elevation**
10+000	*296*
10+250	*303.5*
10+500	*298.5*

1. Check and make sure the horizontal alignment *Example1* is the active alignment.
2. Select **File > New**.
3. On the New dialog, select *Geometry* tab.
4. Set the dialog as following:
   - Type: ***Vertical Alignment***
   - Name: ***Example1***
   - Description: ***Center Line Finished Grade***
   - Style: ***PD-N-ALI-CL***
   - Curve: ***Parabolic***



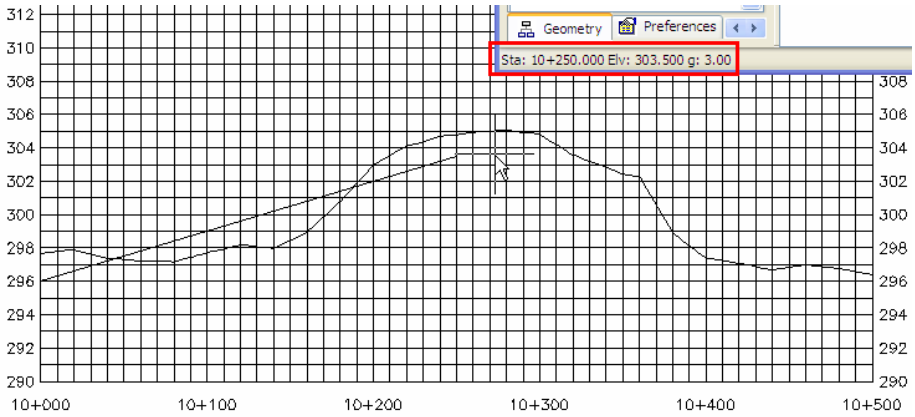
5. Click **Apply** and **Close**.
6. Check InRoads Explorer, make sure vertical alignment *Example1* is created under alignment Example1 and is active.
7. Select **Geometry > Vertical Curve Set > Dynamics Settings**.
8. On Dynamics Settings dialog, toggle on *Station* and type ***50*** in the Station input field.
9. Toggle on *Elevation* and type ***0.5*** in the Elevation input field.



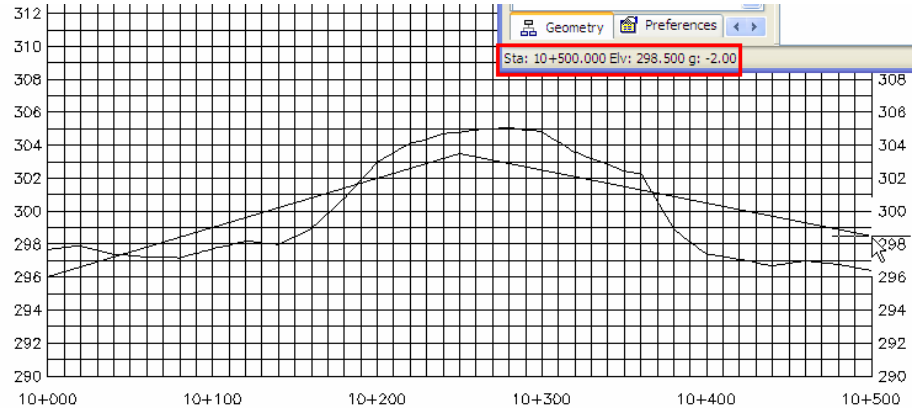
10. Click **Apply**.
11. Select **Geometry > Vertical Curve Set > Add PI**.
12. Follow the prompt in AutoCAD Command Line, pick the first point in the profile window at the profile start point station 10+000 around elevation *296*.

Note: The Station and Elevation (toggled on) are rounded up or down to the nearest value as specified in the data fields on the Dynamics Settings dialog.

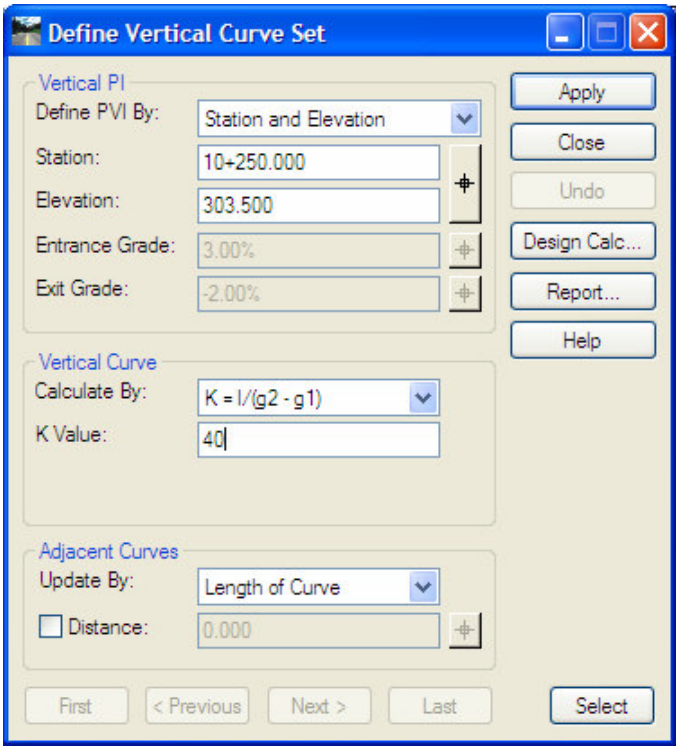
13. Follow the message in the bottom portion of InRoads Explorer window, move the cursor in the profile window to the point at station *10+250* and elevation *303.5*, then click to accept.



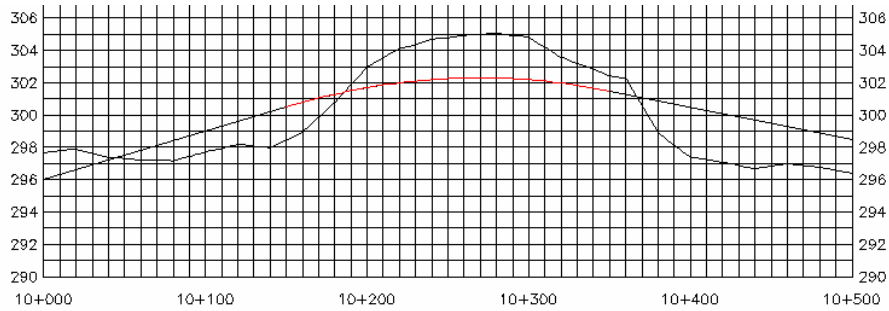
14. Move the cursor in the profile window to the profile end at station *10+500* and elevation *298.5*, and then click to accept.



15. Right click twice to end the command.
16. Close the Dynamics Settings.
17. Select **Geometry > Vertical Curve Set > Define Curve**.
18. In the *Vertical Curve* section on the Define Vertical Curve Set dialog, set *Calculate* By to ***K = l / (g2 - g1)*** and for K Value, enter ***40.***



19. Click **Apply**. The defined vertical curve is displayed and highlighted in the profile window.

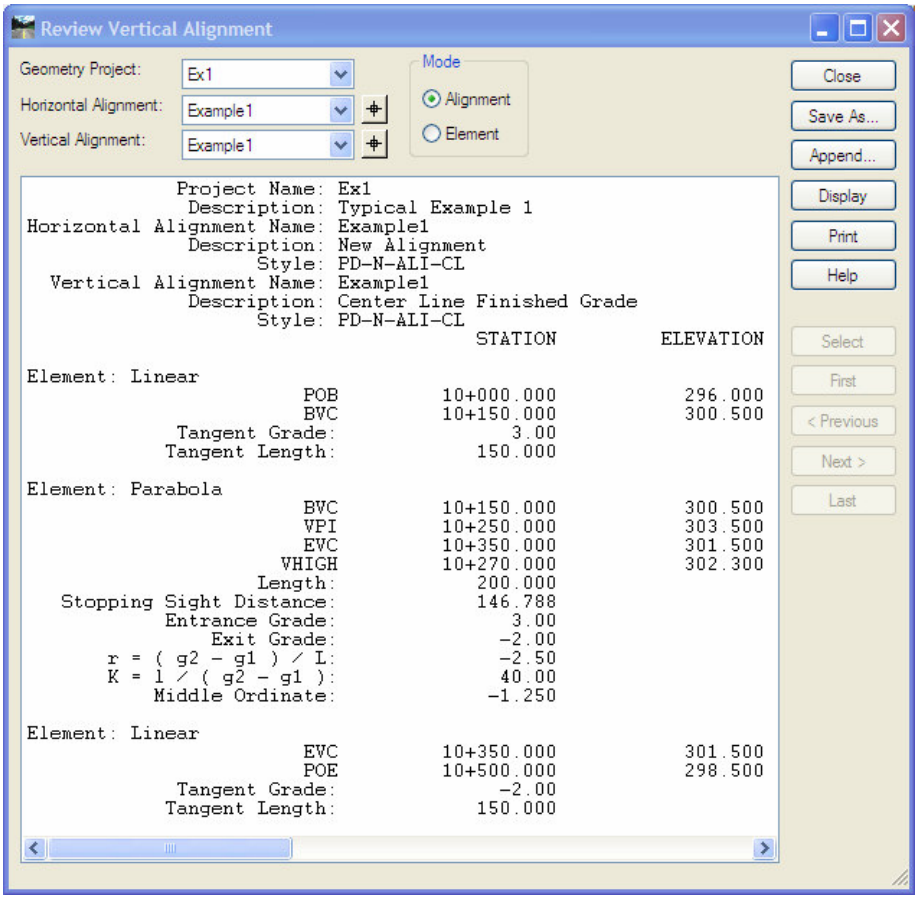


20. Click **Close** to dismiss the dialog box.
21. Save the geometry project.

5.4 Reviewing Vertical Alignment

After creating the vertical alignment, the Review Vertical Alignment command can be used to display information about the geometry of the active vertical alignment. The vertical alignment review information can be displayed in AutoCAD or saved as an ASCII file.

1. Select **Geometry > Review Vertical**.



2. In the *Mode* section, select *Element*.
3. Click **Next** button to move along the alignment.

Note: As you move along the alignment, the element is highlighted in the profile window.

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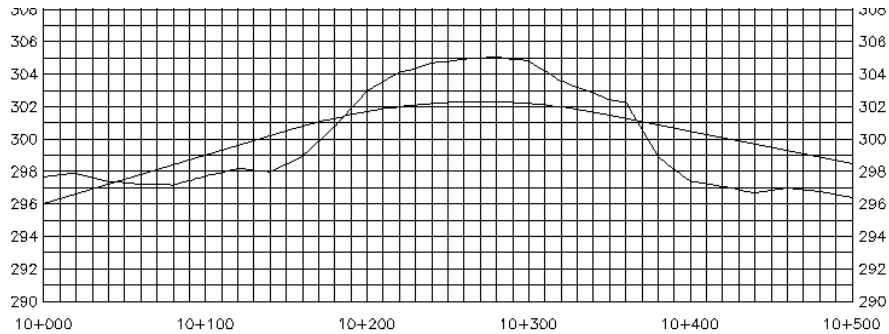
4. When finish close the dialog.

5.5 Displaying Vertical Alignment

The Active Vertical command is use to display the active vertical alignment without annotation. The geometry style associated with the alignment when they are created will be used for displaying.

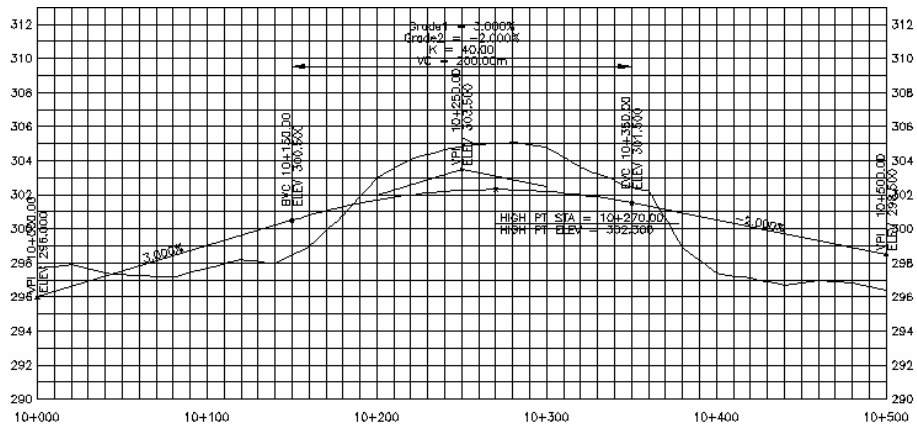
Select **Geometry > View Geometry > Active Vertical**.



5.6 Annotating Vertical Alignment

Use the Vertical Annotation command for more detailed annotation and display. Predefined preference is used to display the alignment points, tangent lines and vertical curves, and annotate the geometry.

1. Select **Geometry > View Geometry > Vertical Annotation**.
2. Make sure both the Horizontal Alignment and Vertical Alignment are *Example1*.
3. Click **Preferences**.
4. Select named preference ***MTO_Proposed*** and **Load** it.
5. Close Preferences dialog
6. Click **Apply**.



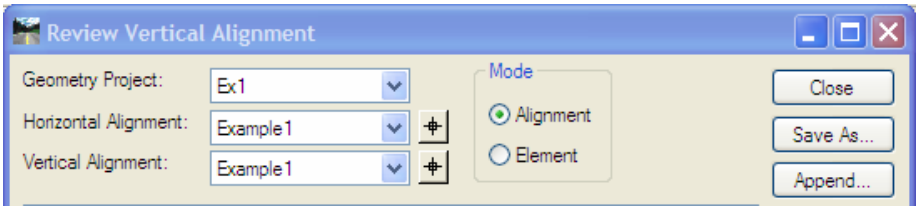
7. Use AotoCAD command to zoom in and view annotation.
8. Close the View Vertical Annotation dialog box.

5.7 Generating Vertical Alignment Report

The Review Vertical command can be used to report detailed information about the geometry of the active vertical alignment. The information can

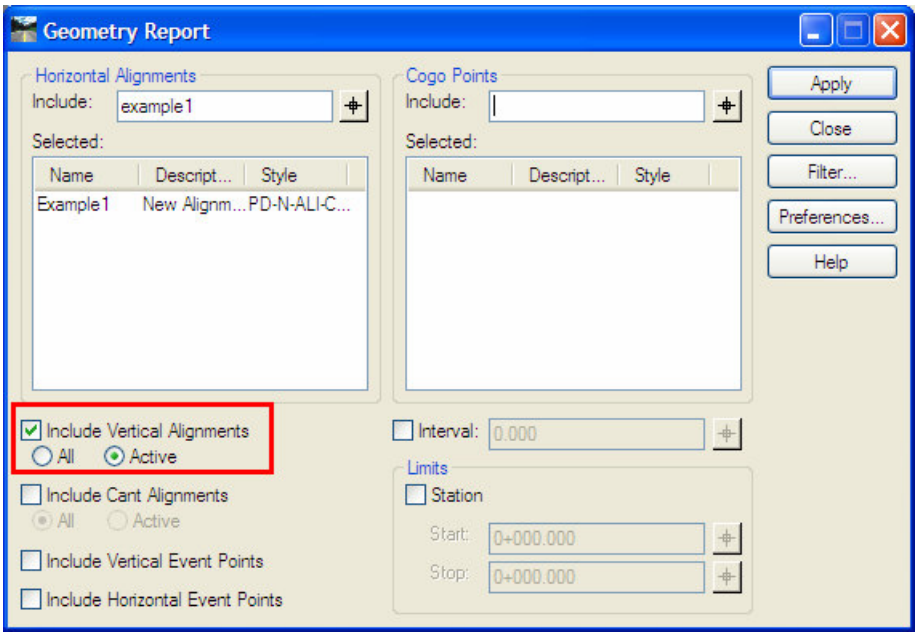
be displayed in AutoCAD or saved to an ASCII file. Select different *Mode* to review alignment or element information.

1. Select **Geometry > Review Vertical**.
2. Select ***Ex1*** for Geometry Project, ***Example1*** for Horizontal Alignment and ***Example1*** for Vertical Alignment.
3. Select *Mode* to review and report information in different format.

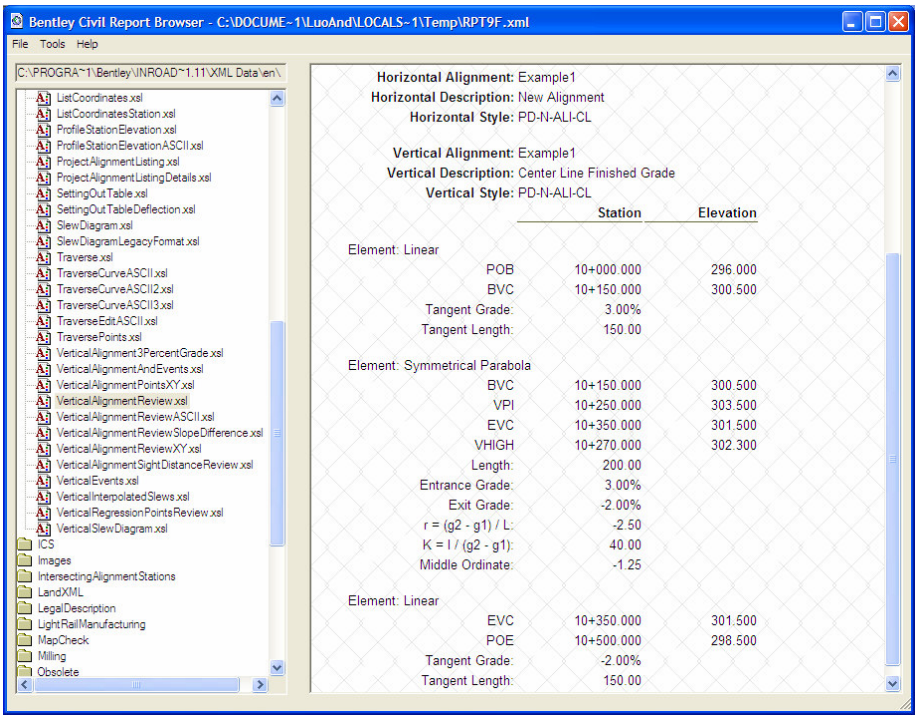


Vertical Alignment Report also can be generated by InRoads XML Reports command and used with a large number of style sheets.

1. Select **Tools >XML Reports >Geometry**.
2. On the Geometry Report dialog, type ***Example1*** in the Horizontal Alignments Include field.
3. Press **Tab** on the keyboard. The alignment *Example1* will be listed in the Selected window.
4. Check on the *Include Vertical Alignments section*.
5. Toggle on the *Active* option.



6. Click **Apply**. Bentley Civil Report Browser is displayed.
7. Select VerticalAlignmentReview style sheet



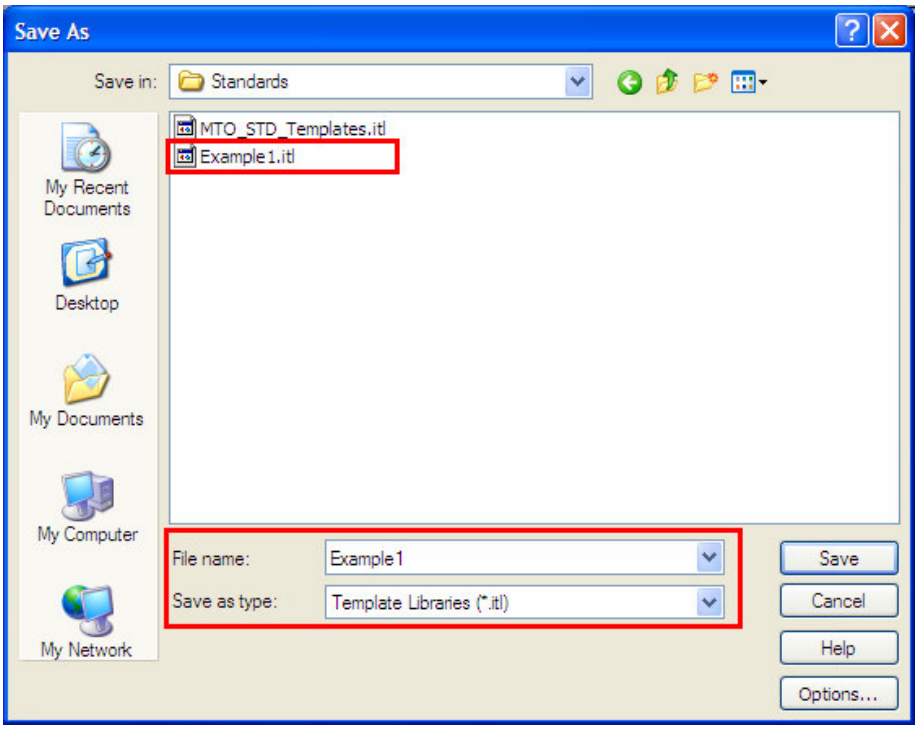
8. Select **Tools > Format Options** in the Bentley Civil Report Browser.
9. Make the desired changes to the format of the generated report.
10. Select **File > Save As** in the Bentley Civil Report Browser to save the data into file with selected file type.

6.0 Typical Sections

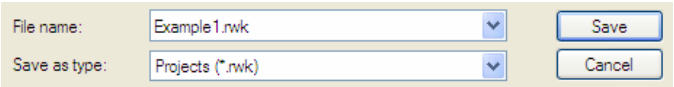
6.1 Setting Up Project Template Library

MTO standard template library contains predefined typical sections, components, and a point name list that point names are associated with MTO standard symbology. The template can be used to create project specific template library.

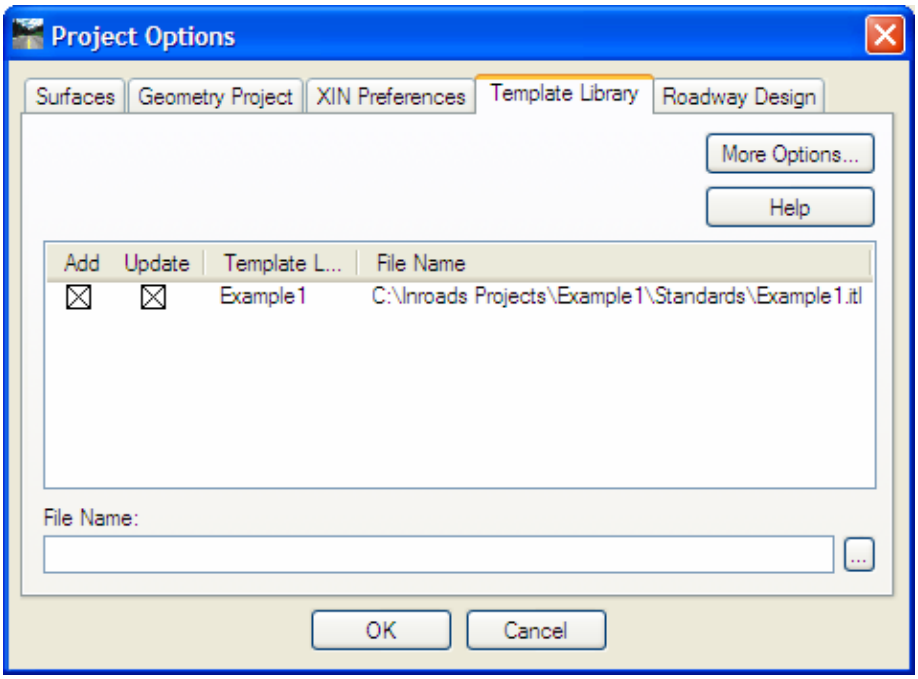
1. Select **File > Save As**.
2. On the Save As dialog, Change the *Save as type* to Template Libraries (*.itl).
3. In the *File name* field, type in ***Example1***.
4. Click **Save**. A new template library *Example1* is saved to the proper project folder as defined in project default.



5. On the Save As dialog, Change the *Save as type* to Projects (*.rwk).
6. Select *Example1.rwk* from the file list window. *Example1.rwk* will appear in the *File name* field.



7. Click **Options** then select Template *Library tab*.
8. On Project Options dialog, check both **Add** and **Update** options.



9. Click OK to close the Project Options dialog.
10. Click **Save** then **Yes** to confirm replace the existing project file.
11. Click **Cancel** to close the Save As dialog.

Note: MTO standard template library can be copied to the project template library and added to the project file as described in section 2.3.

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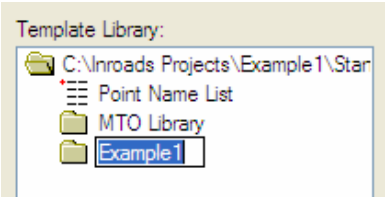
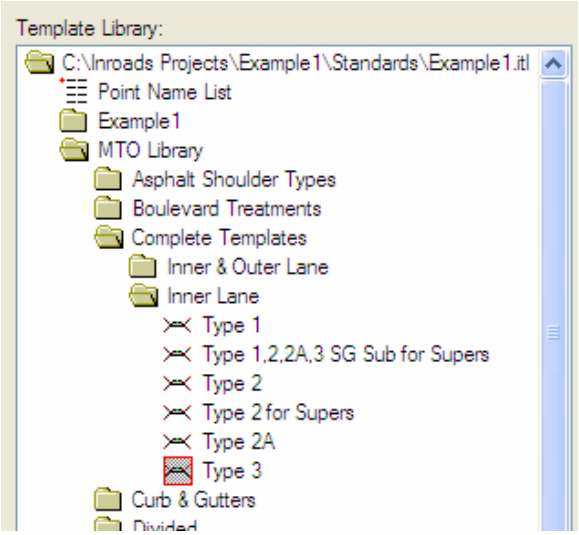
12. Select **Modeler > Create Template**. The Create Template dialog will appear.
13. Select **File > New > Folder**.
14. Type in ***Example1*** for the name of the new folder in the Template Library window.

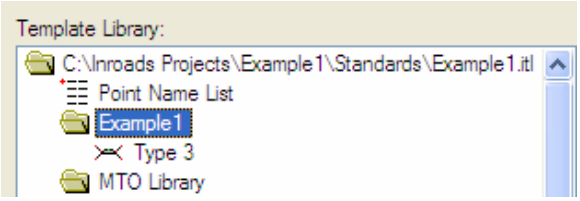


15. Double click on **MTO Library > Complete Templates > Inner Lane**.

16. Select template **Type 3**.



17. Select **Edit > Copy**.
18. Select folder *Example1*.
19. Select **Edit > Paste**.
20. Double click folder *Example1*. The standard template is copied to folder *Example1*.



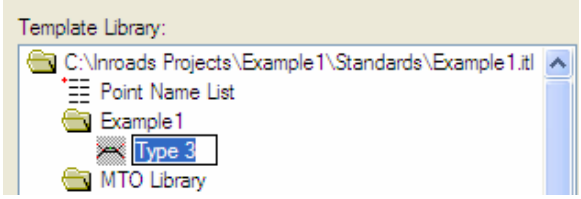
21. Click **File > Save**.

Note: Project specific templates should be created/copied and modified in the project specific folder.

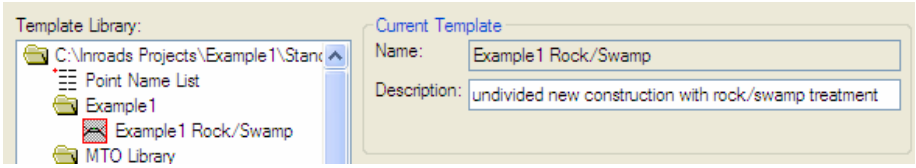
6.2 Developing Example 1 Template

In previous section, a template is selected from MTO standard templates library and copied to the project template folder. This template is going to be modified to meet the specific project requirements.

1. Select the new copied template *Type 3* in the Example1 folder.
2. Select **Edit > Rename**.



3. Type in a new name: ***Example1 Rock/Swamp***.
4. Give additional information in the *Description* field in the Current Template section.



5. Click **File > Save**.

Note: During the process of customize the project template, save the template library when the modification is worth saving.
Refer to Proposed Design in section 1 for parameters to be used in the project template.

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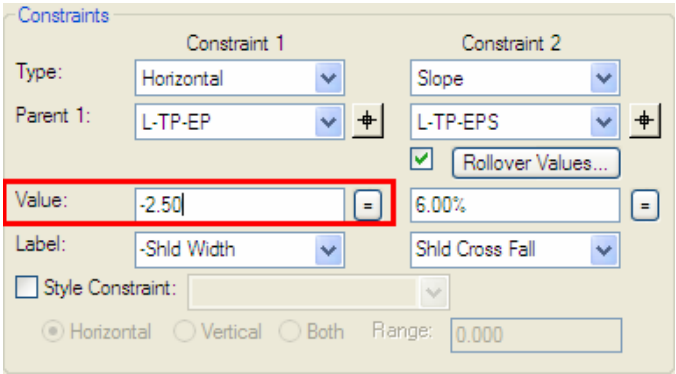
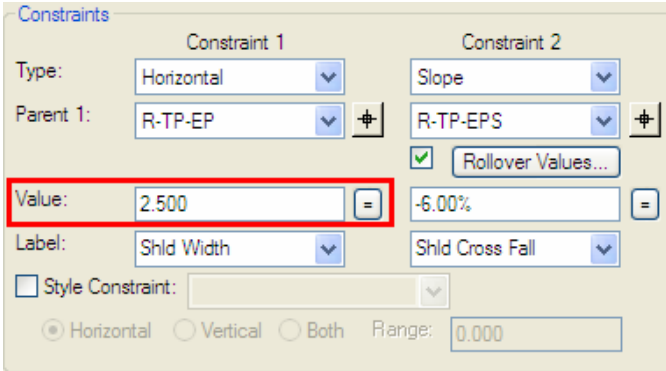
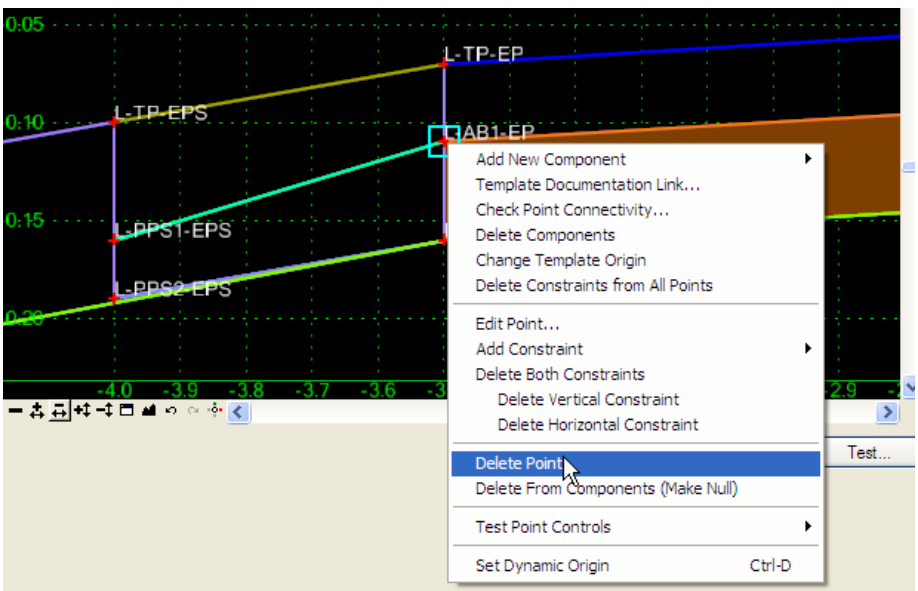
6. Change shoulder width to proposed design. In the template display window, find and double click on the point **L-TP-ES**. On the Point Properties dialog, go to *Constraints* section. Type ***-2.50*** in the *Value* field for the *Horizontal* constraint.



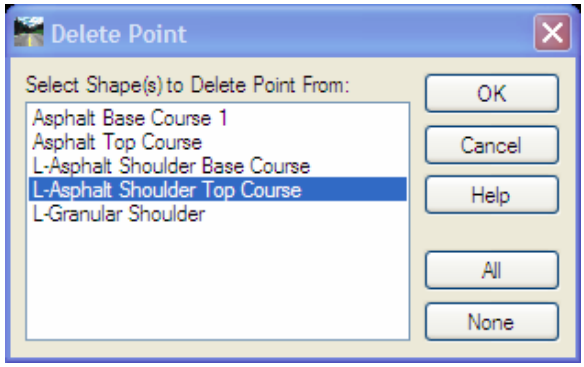
7. Click **Apply** Then **Close**.
8. Find and double click on the point R-TP-ES in the template display window. Type ***2.50*** in the *Value* field for the *Horizontal* constraint.



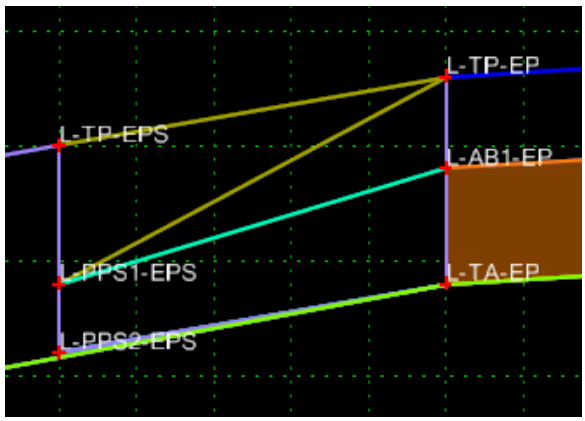
9. Similarly, for partially paved shoulder width set *Horizontal Constraint* value to ***-0.5*** for point L-TP-EPS, and ***0.5*** for R-TP-EPS.
10. Change depth of asphalt top and base courses.
    a) Set *Vertical constraint* value to ***-0.04*** for point L-AB1-EP, AB1-CL, and R-AB1-EP.
    b) Set *Vertical constraint* value to ***-0.05*** for point L-TA-EP, TA-CL, and R-TA-EP.
11. Modify the shoulder on the left side. Zoom in and right click on L-AB1-EP. Select **Delete Point** from the pop-up menu.



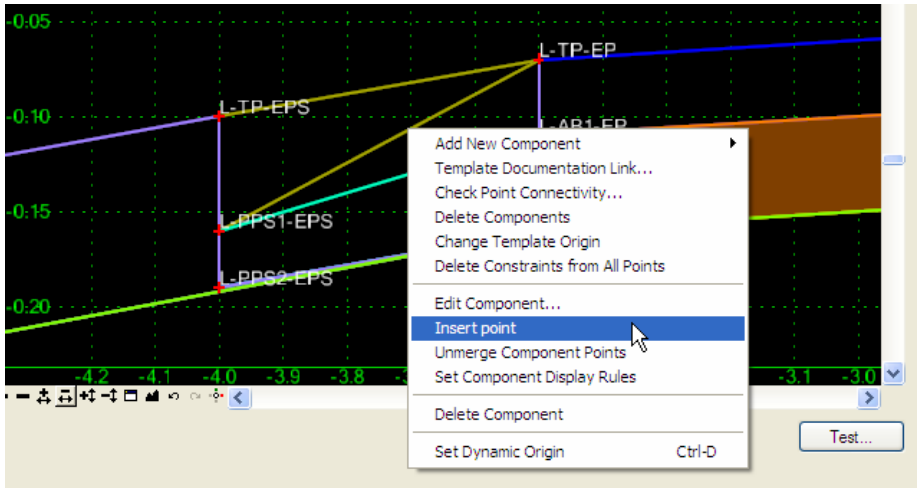
12. From the Delete Point dialog, select ***L-Asphalt Shoulder Top Course*** from the list window.



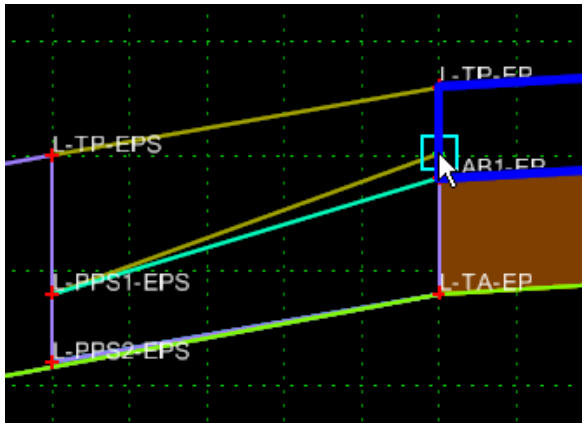
13. Click **OK.** The point L-AB1-EP is deleted from the partially paved shoulder component.



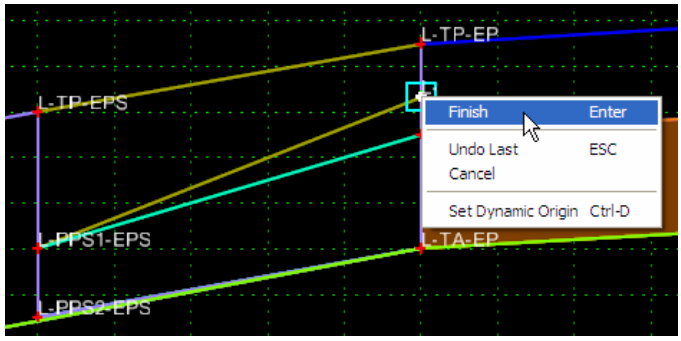
14. Right click on the line between points L-PPS1-EPS and L-TP-EP. From the pop-up menu select **Insert Point**.



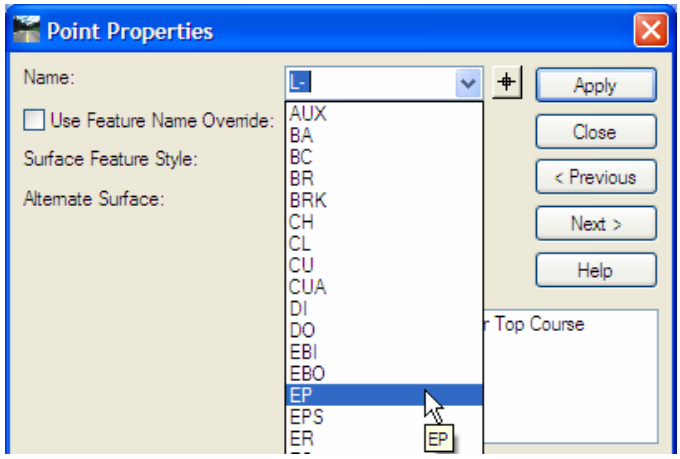
15. Move the active point curser on to the line between points L-TP-EP and L-AB1-EP, then click. A new point is added to the shoulder surface course component.



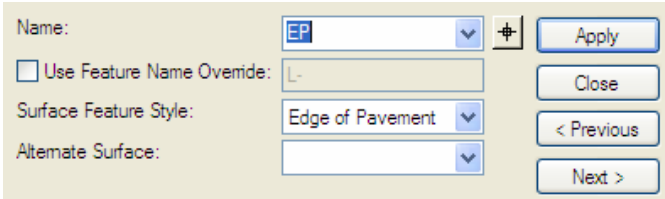
16. Right click on the point and select **Finish** from the pop-up menu.



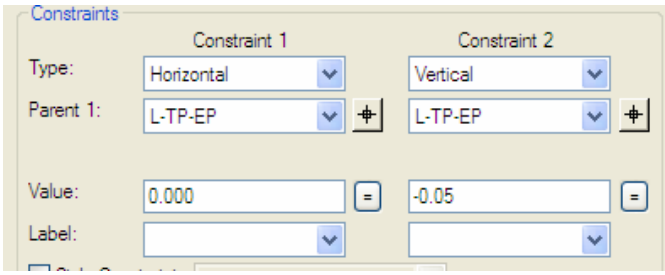
17. Double click on the newly created point. The Point Properties dialog will appear. On the Point Properties dialog, select ***EP*** from the Name drop-down list.



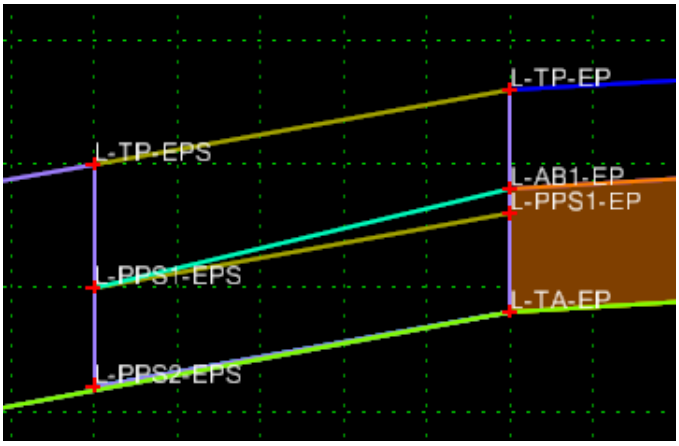
18. The Name field is populated with the selected name *EP* and the Surface Feature Style is changed to the style associated with the point name EP.



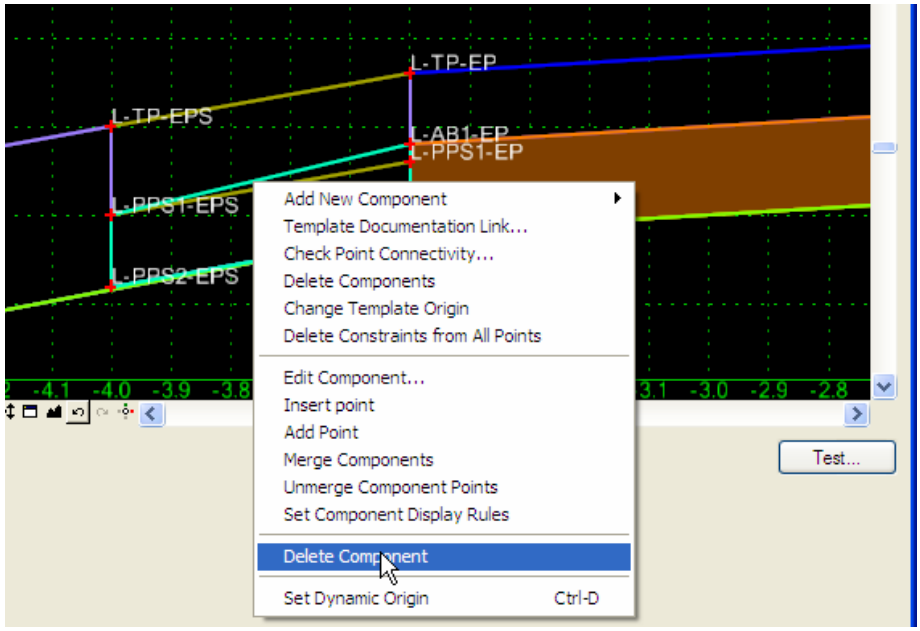
19. Rename the point name to ***L-PPS1-EP***. Click **Apply**. Set the point constraints as following.



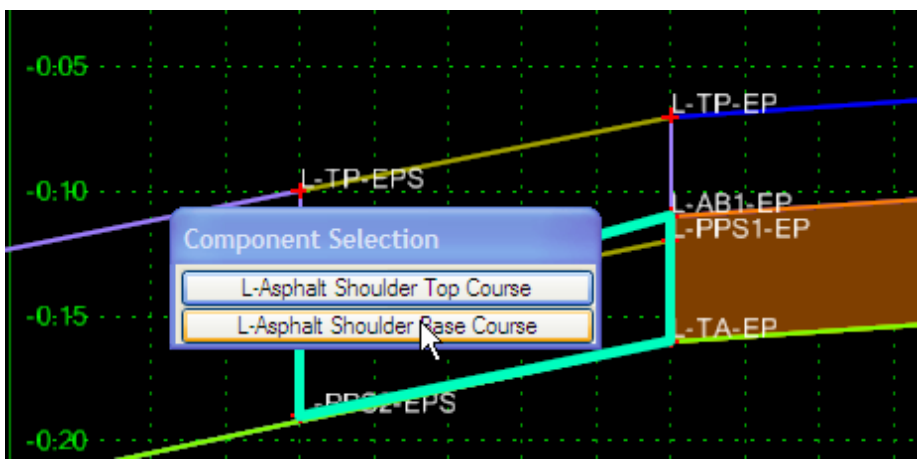
20. Click **Apply** then **Close**.



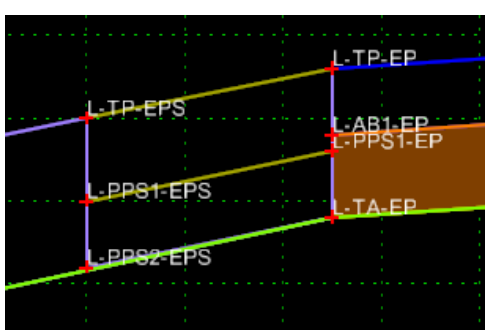
21. Set *Vertical constraint* value to ***-0.05*** for point L-PPS1-EPS.
22. Right click between the shoulder top course and base course components. Select **Delete Component** from the pop-up menu.



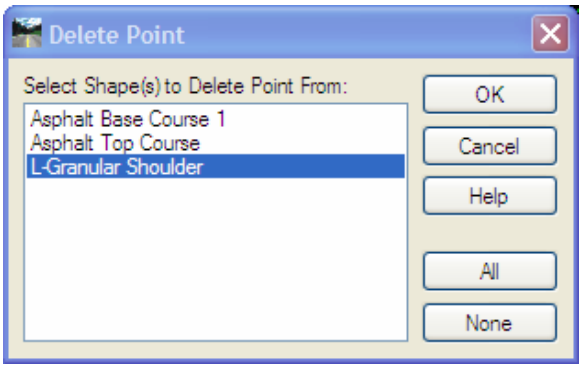
23. From Component Selection dialog, move the curser to select *L-Asphalt Shoulder Base Course* from the list. The component is highlighted in the template display window.



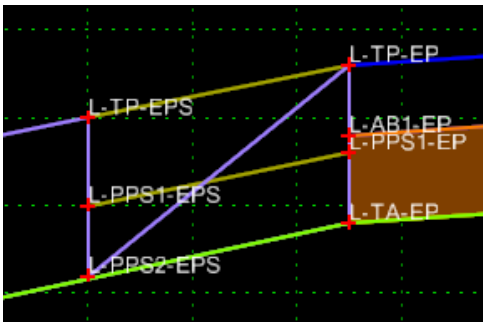
24. Click on the selected component to delete it.



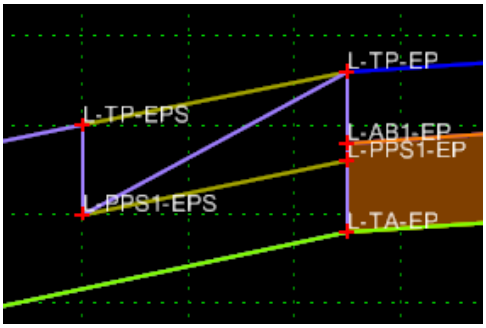
25. Right click on point L-AB1-EP and select **Delete Point**.
26. Select ***L-Granular Shoulder*** from the list then click **OK**.



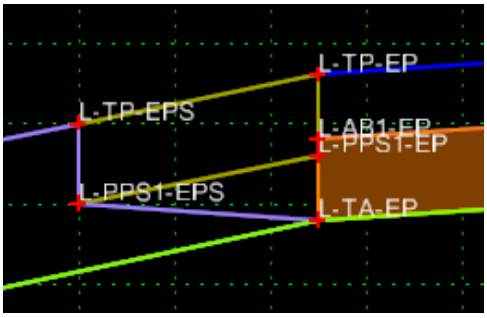
27. Right click on point L-TA-EP and select **Delete Point**.
28. Select ***L-Granular Shoulder*** from the list then click **OK**.



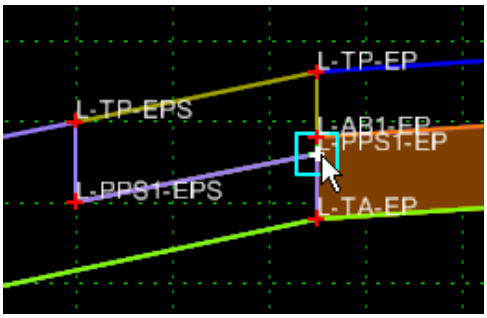
29. Right click on point L-PPS2-EPS and select **Delete Point**.



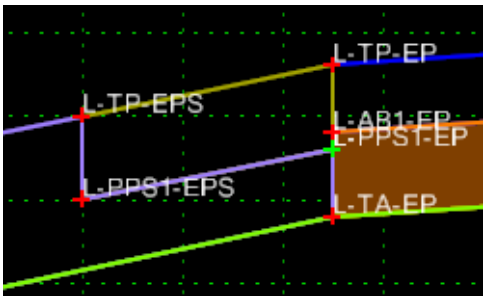
30. Right click on point L-TP-EP and select **Delete Point**.
31. Select ***L-Granular Shoulder*** from the list then click **OK**



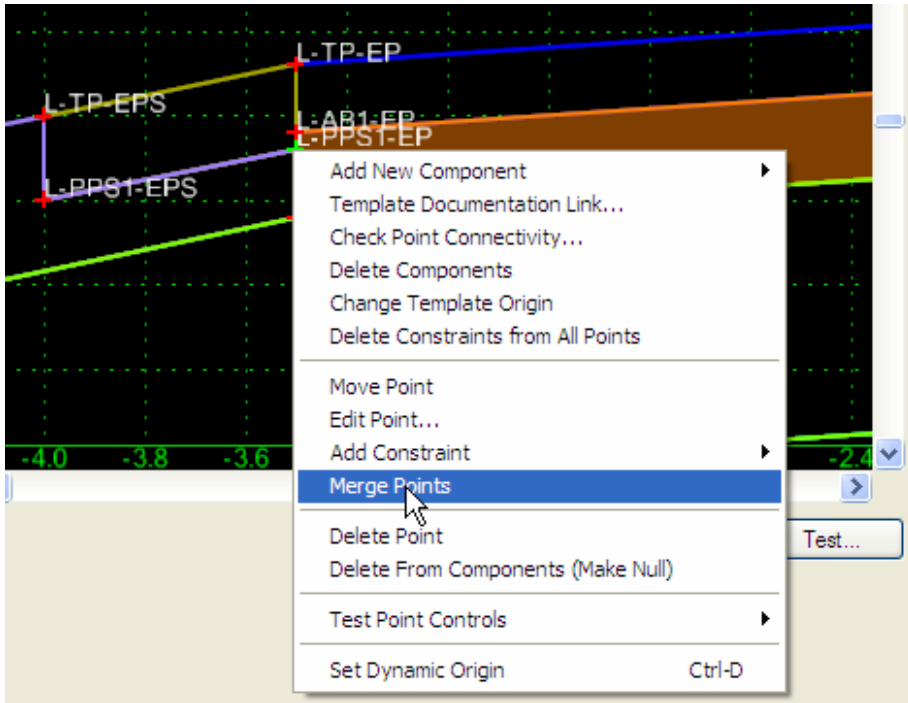
32. Right click on the line between points L-PPS1-EPS and L-TA-EP. From the pop-up menu select **Insert Point**.
33. Move the active point curser on to the point L-PPS1-EP then click. A new point is added to *L-Granular Shoulder* component at L-PPS1-EP.



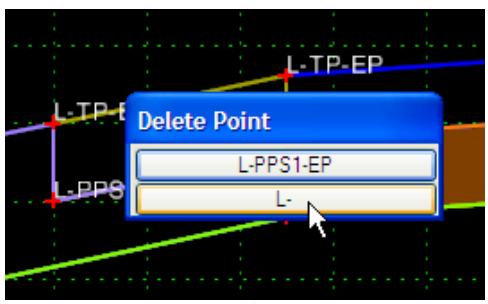
34. Right click on the point and select **Finish** from the pop-up menu. A green cross is shown on the point L-PPS1-EP.



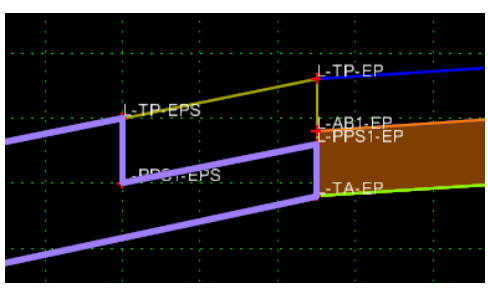
35. Right click on the point L-PPS1-EP and select **Merge Points** from the pop-up menu.



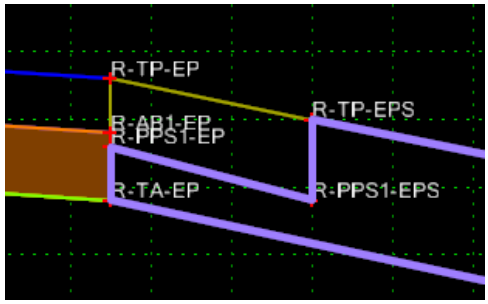
36. Select point ***L-*** From the Delete Point dialog.



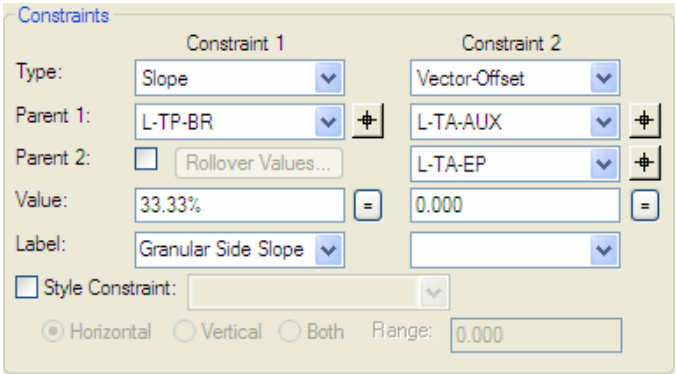
37. Click on the selected point to delete it.



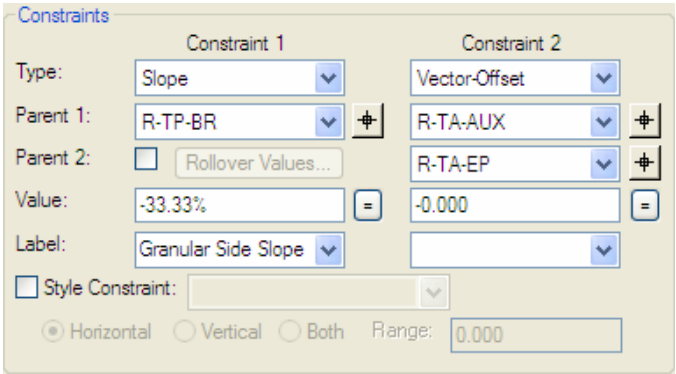
38. Repeat steps from 11 to 37 to modify the shoulder on the right side.



39. Change the *Vertical Constraint* value to -0.09 for both points L-TA-AUX and R-TA-AUX.
40. Right click on point L-TA-ER and select **Edit Point**. Set the point constraints as follow:



41. Select point R-TA-ER and set the point constraints as follow:



Note: When modify an existing templates, some point constrains may get lost because of deleting other points. Make sure proper constraints are maintained.

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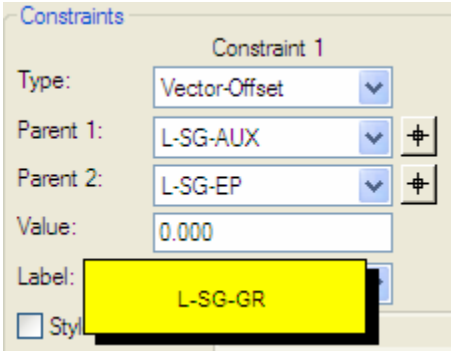
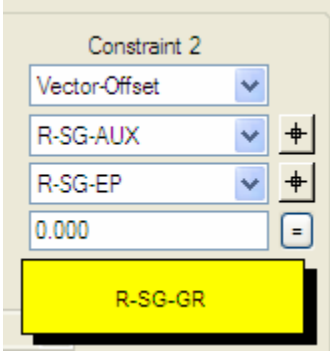
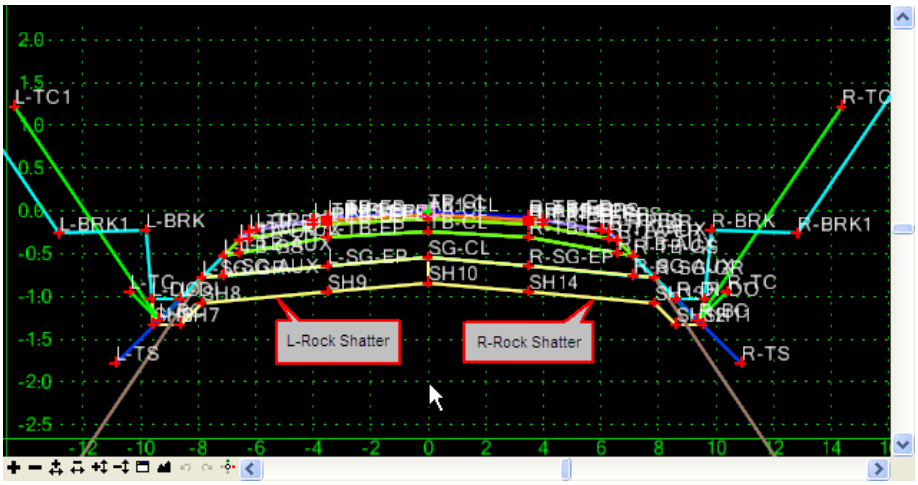
42. Verify that the *Vertical Constraint* value is 0.15 for points L-TB-EP, TB-CL, R-TB-EP.
43. Set the Vector-Offset constraints for L-SG-GR and R-SG-GR as follow:





Rock Shatter Components

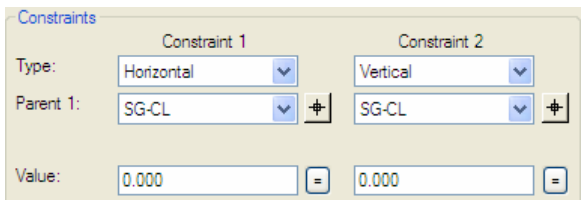
1. Delete both L-Rock Shatter and R-Rock Shatter components from the template.



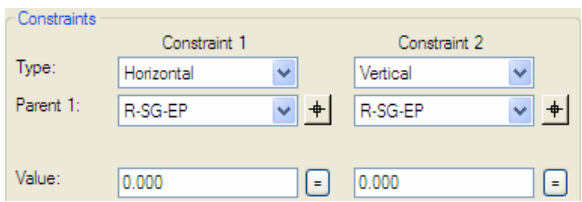
2. Insert **R-Rock Shatter** component from *End Conditions* folder in *MTO library* using the predefined component *Rock Shatter – Inner Lanes*. Drag and drop the component under Granular B component and slightly right of the centerline so the prefix "R-" is attached to the point name. Select *R-Rock Cut1* as its parent component.

3. Find points R-SH1, R-SH2, R-SH3 and R-SH4 to the right of the centerline from the component inserted in step 2, and set constraints as:

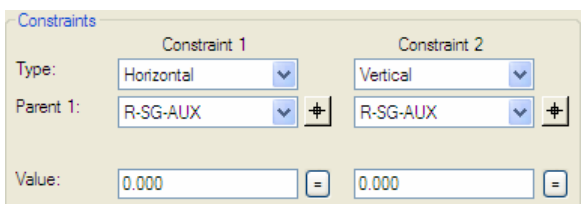
R-SH1



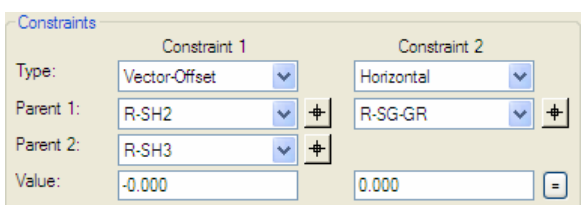
R-SH2

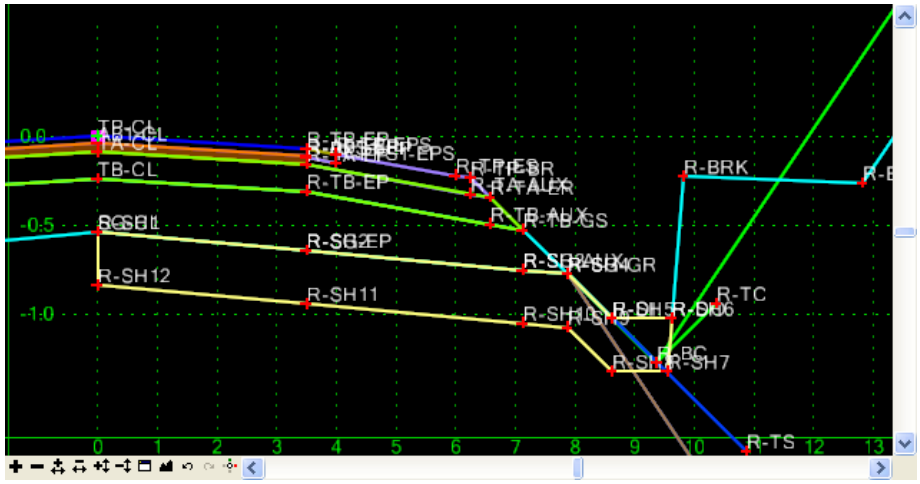


R-SH3

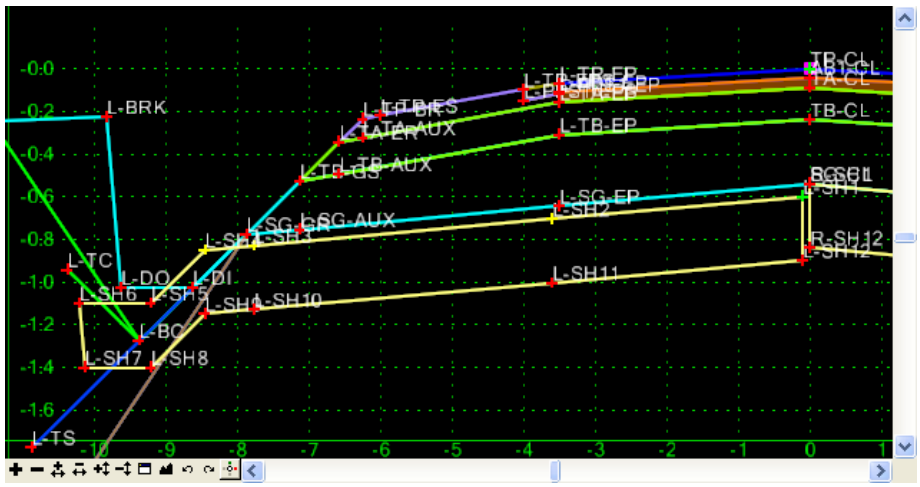


R-SH4



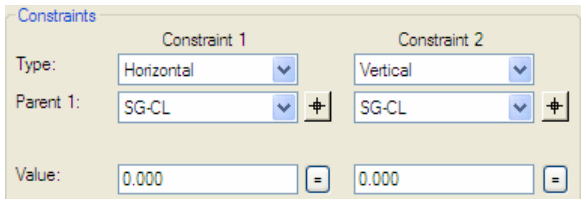


4. Insert **L-Rock Shatter** under Granular B component and slightly left of the centerline. Select *L-Rock Cut1* as its parent component. Delete points **L-SH2, L-SH3, L-SH10 and L-SH11**.

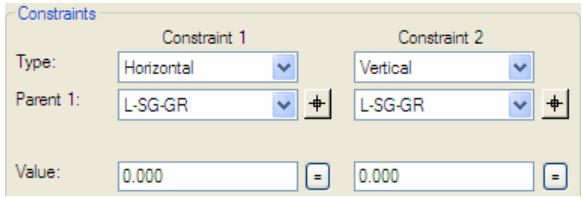


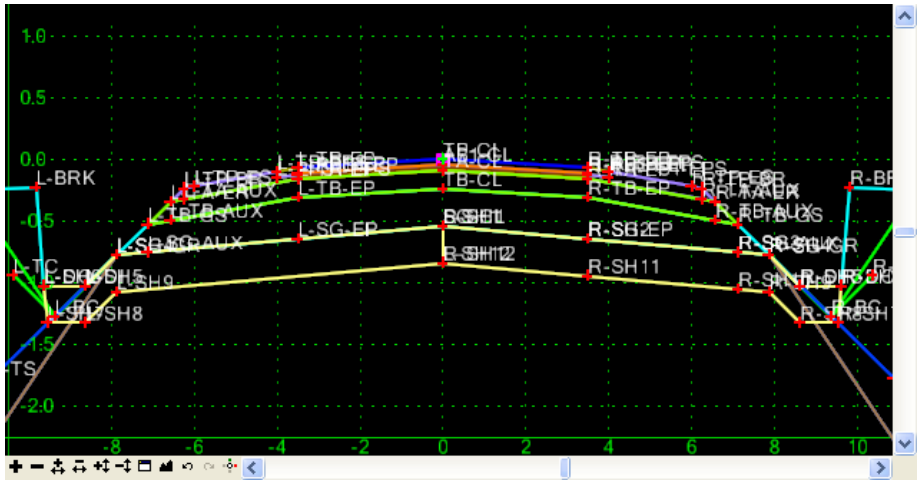
5. Set constraints for points L-SH1 and L-SH4 as:

L-SH1

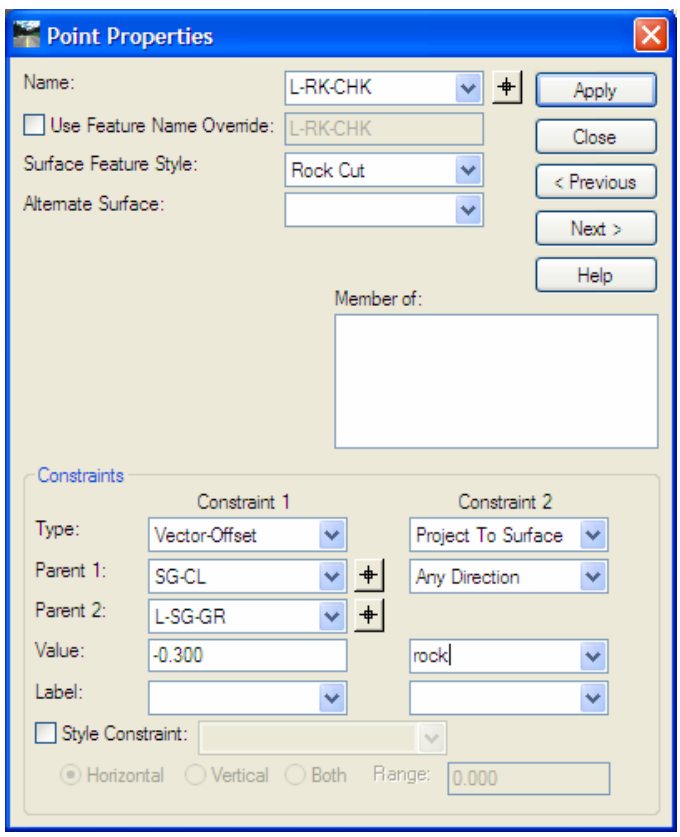


L-SH4





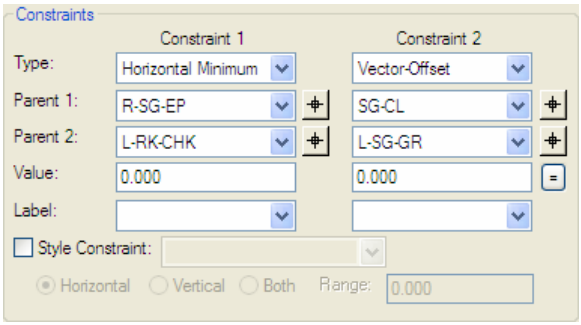
6. Add a *Null Point* to check the rock presence for component *L-Rock Shatter*. Right click in the template edit window, from the pop-up menu, select **Add New Component > Null Point**. Move the cursor to point L-SH12 and click on it. Set the newly created null point as shown below.



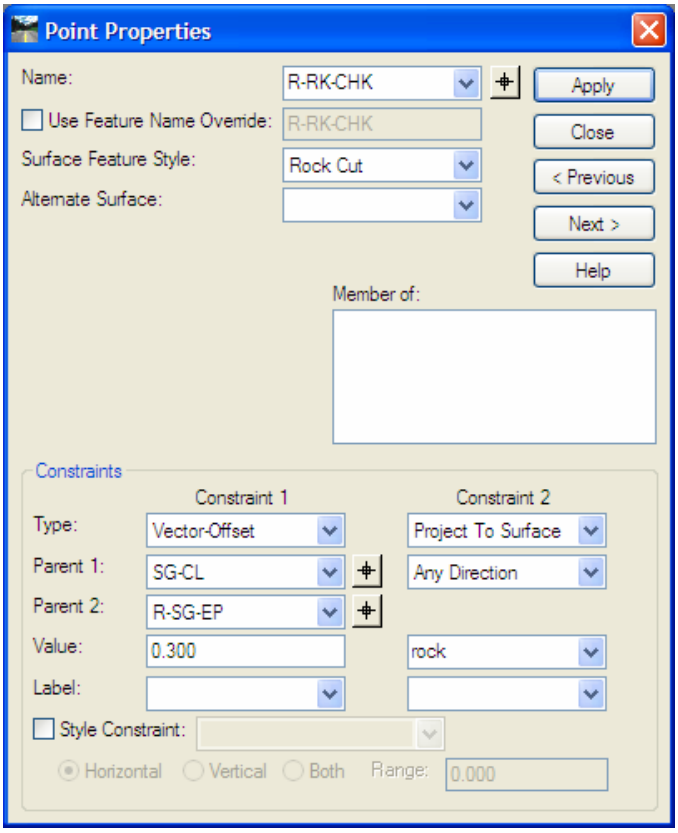
Note: The target surface name **rock** for the *Project To Surface* constraint is typed in by user and will be used as a Target Alias.

7. Click on point L-SH1 and change the constraints as follow:

L-SH1

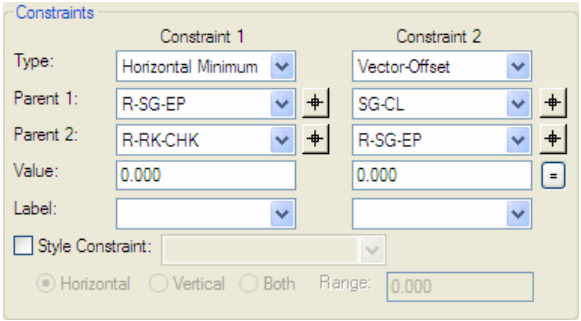


8. Right click in the template edit window, from the pop-up menu, select **Add New Component > Null Point**. Move the cursor to point R-SH12 and click on it. Set the newly created null point as shown below.

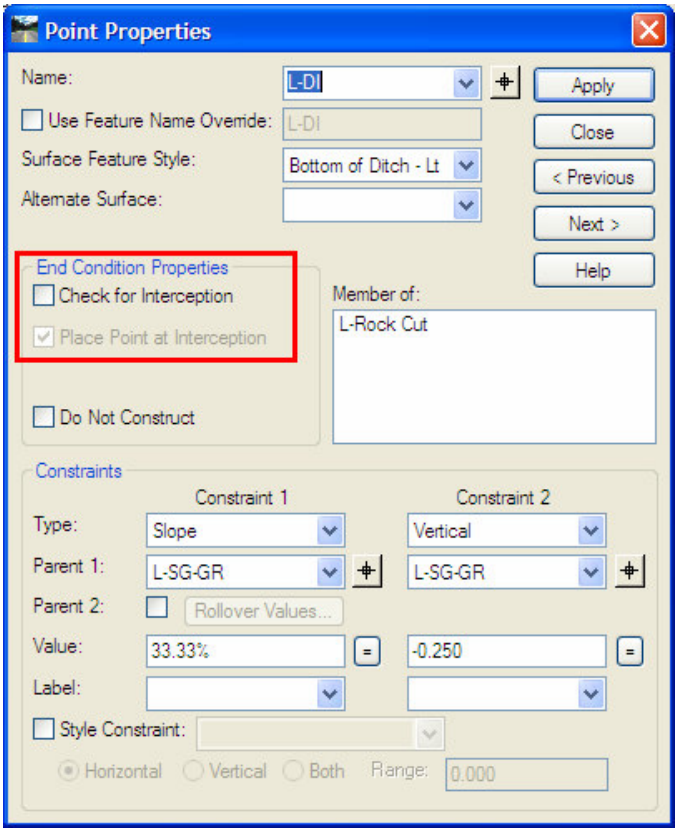


9. Click on point R-SH1 and change the constraints as follow:

R-SH1



10. Edit point properties for points L-DI, L-DO, R-DI and R-DO to turn off the **Check for Interception** option in the *End Condition Properties* field. Do not change the constraints.



11. In order to make rock shatter components (left & right) work properly, display rules need to be added to the template. Double click on the *L-Rock Shatter* component, and then click the **Edit** button. The Component Display Conditional Expression dialog appears. Click **Add** button to add following display rules.

Template Display Rules

Name	Type	Expression	Test	Value	Result
Rule1	Horizontal	L-RK-CHK - SG-CL	<=	0.000	True
Rule2	Horizontal	L-RK-CHK - L-DO	>	0.000	True
Rule3	Horizontal	R-RK-CHK - SG-CL	>	0.000	True
Rule4	Horizontal	R-RK-CHK - R-DO	<	0.000	True
Rule5	Component is Displayed	L-Rock Cut1			True
Rule6	Component is Displayed	R-Rock Cut1			True

Select rules from the *Template Display Rules* list to construct the conditional expression for ***L-Rock Shatter*** as shown below:

Conditional Expression for L-Rock Shatter Component

(Rule1 AND Rule2) OR Rule5

AND | OR | NOT | (|) | Selected Rule

Select rules from the *Template Display Rules* list to construct the conditional expression for ***R-Rock Shatter*** as shown below:

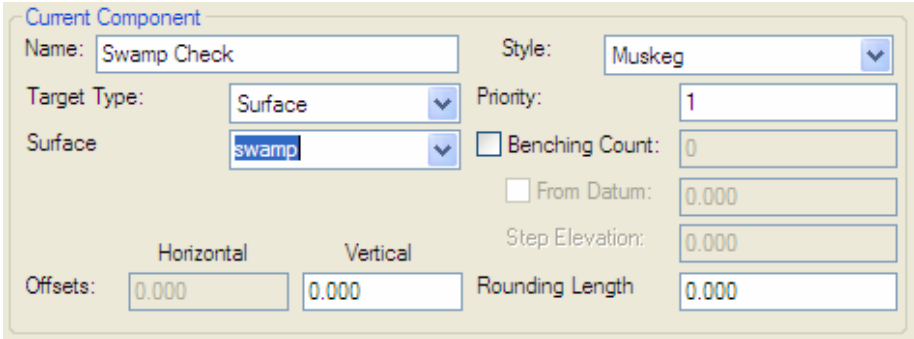
Conditional Expression for R-Rock Shatter Component

(Rule3 AND Rule4) OR Rule6

AND | OR | NOT | (|) | Selected Rule

Components Over Swamp

1. Add an End Condition to check the swamp presence. The Swamp Check component will be based off the L-SG-GR point. Zoom in to the point L-SG-GR.
2. Right click and select **Add New Component > End Condition**. Give the component a name ***Swamp Check*** and set the *Style* as ***Muskeg***. The *Target Type* set to ***Surface*** and type ***swamp*** in the *Surface* field.



Note: The target surface name **swamp** in the *Surface* field is typed in by user and will be used as a Target Alias.

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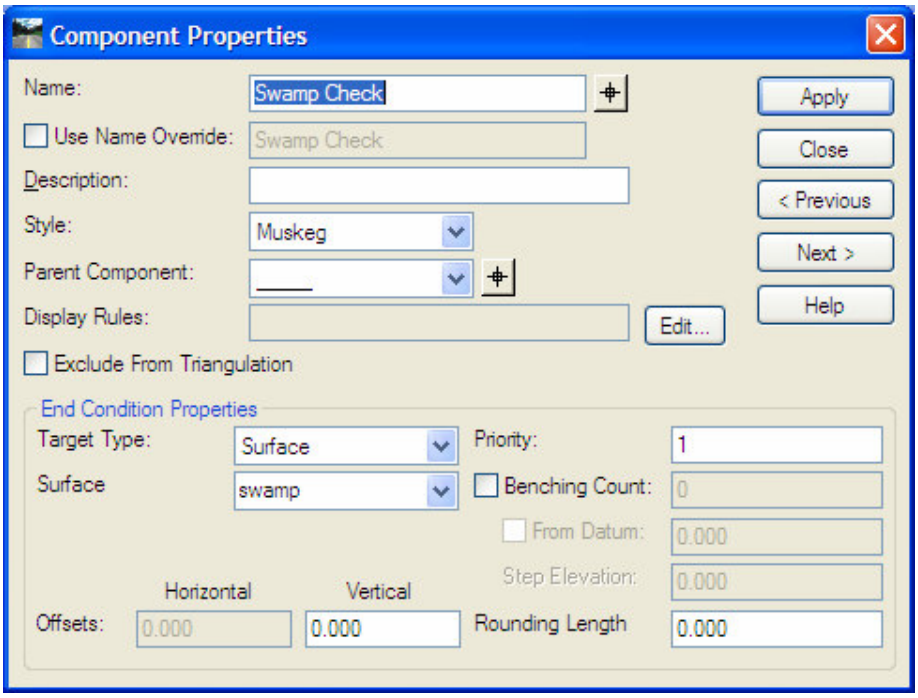
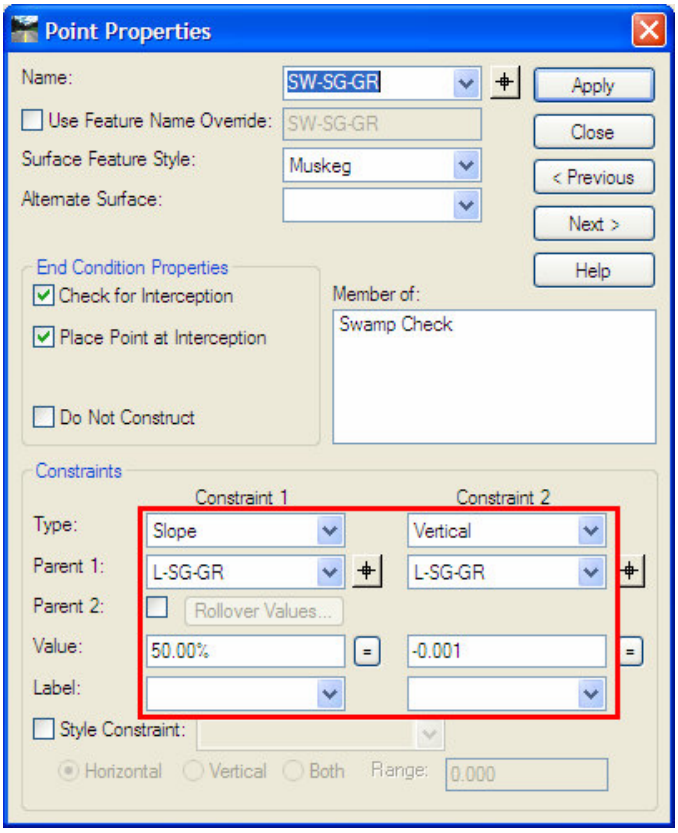
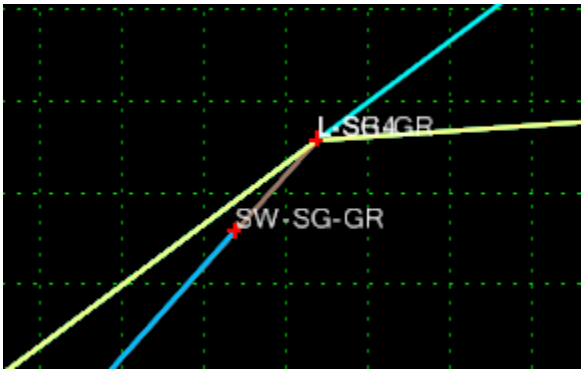
3. In the template edit window, give two points to define the end condition. Move the point curser close to the point L-SG-GR and click, then move the point curser close to the point L-TS1 and click. Right click and select **Finish** from the pop-up menu. Double click on the end condition component created just now. The component will have the following properties:

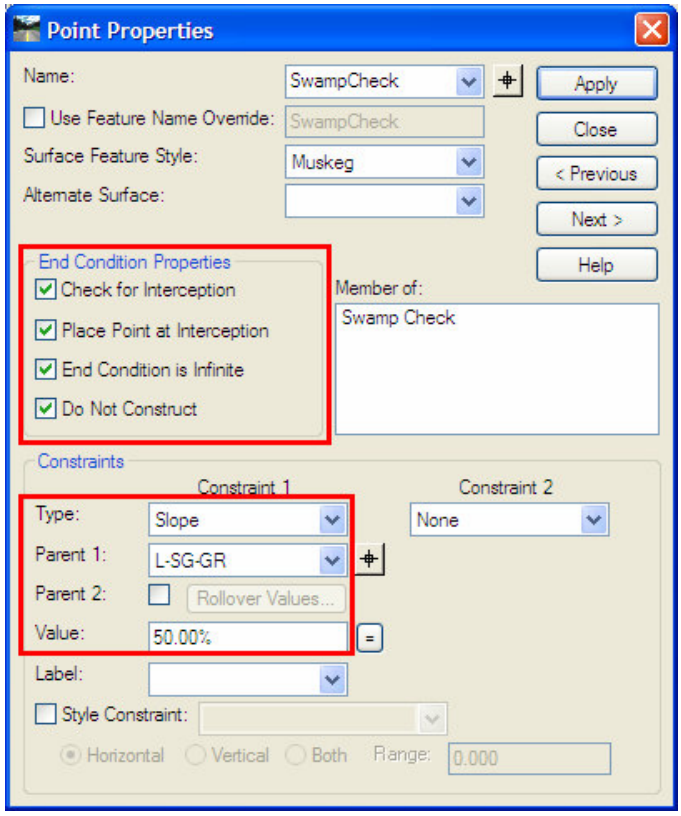


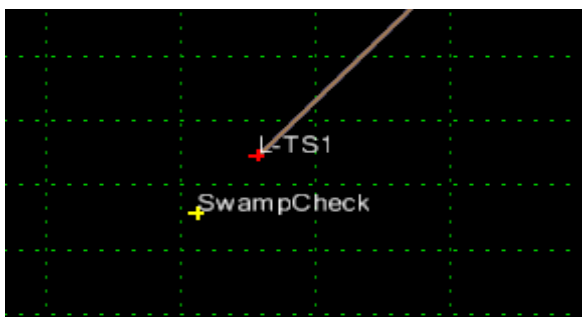
4. Edit the component points. The first will be constrained to the L-SG-GR point with 0.001 meter vertical offset. Double click on the first point and set the point name and constraints as follow:



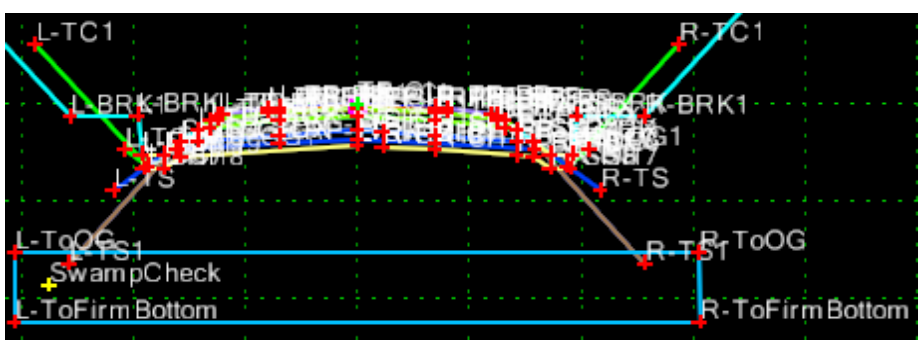


5. Double click on the second point and set the point name and constraints as shown below. The End Condition Properties should select *Check for Interception*, *End Condition is Infinite* and *Do not Construct*.



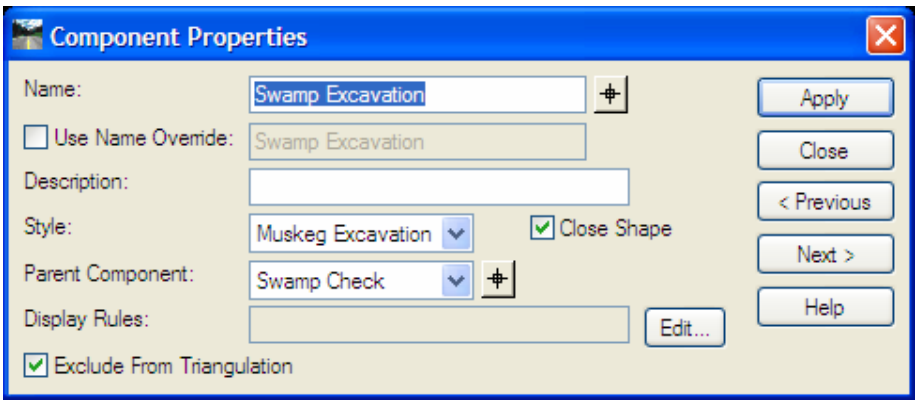


6. Right click and select **Add New Component > Constrained** (or **Unconstrained**) to create a closed shape component and name it ***Swamp Excavation***. Make this component as the child component of the *Swamp Check* component. The two lower points of this component will be called ***ToFirmBottom*** and two up points will be called ***ToOG.***

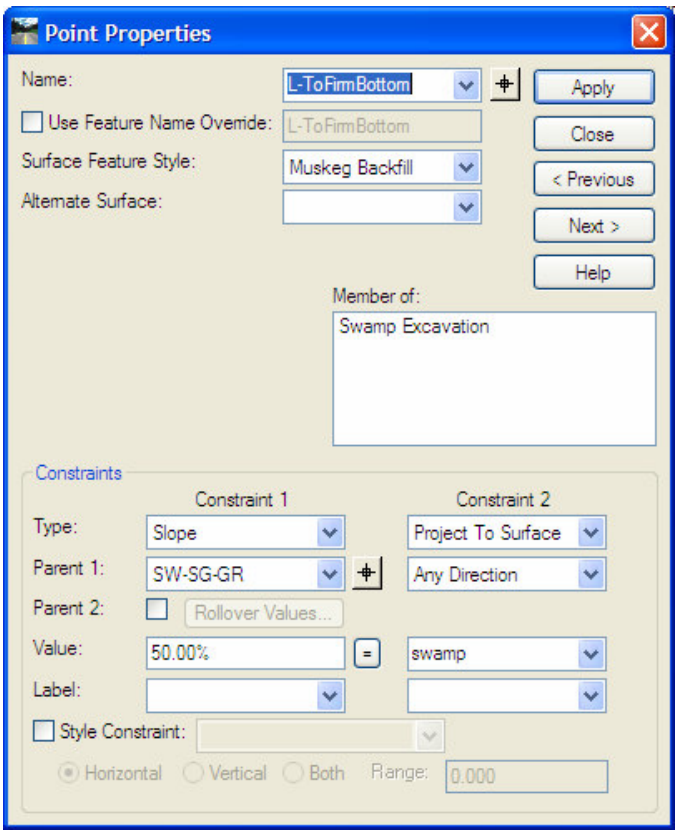


7. Set the component and point properties as follow:

Swamp Excavation

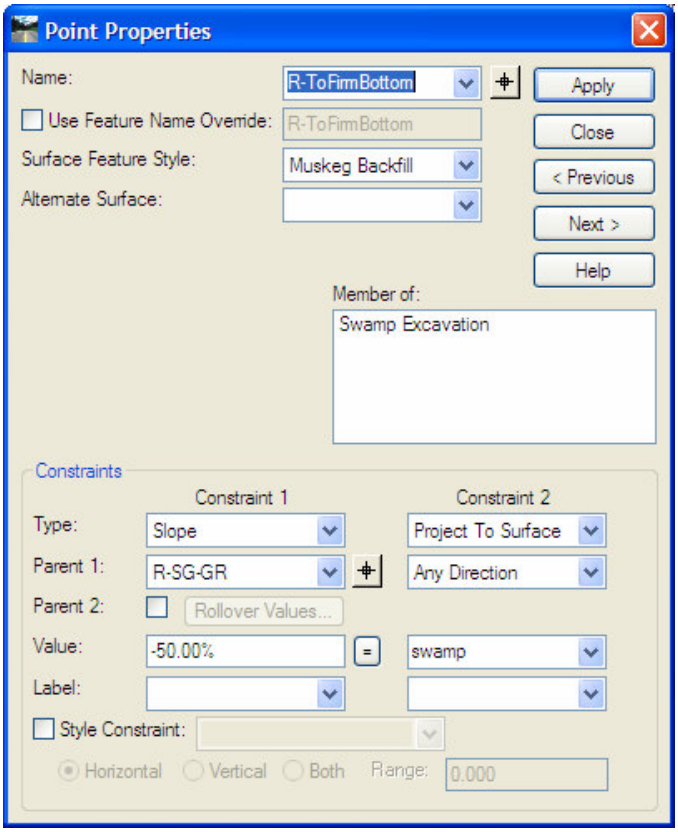


L-ToFirmBottom

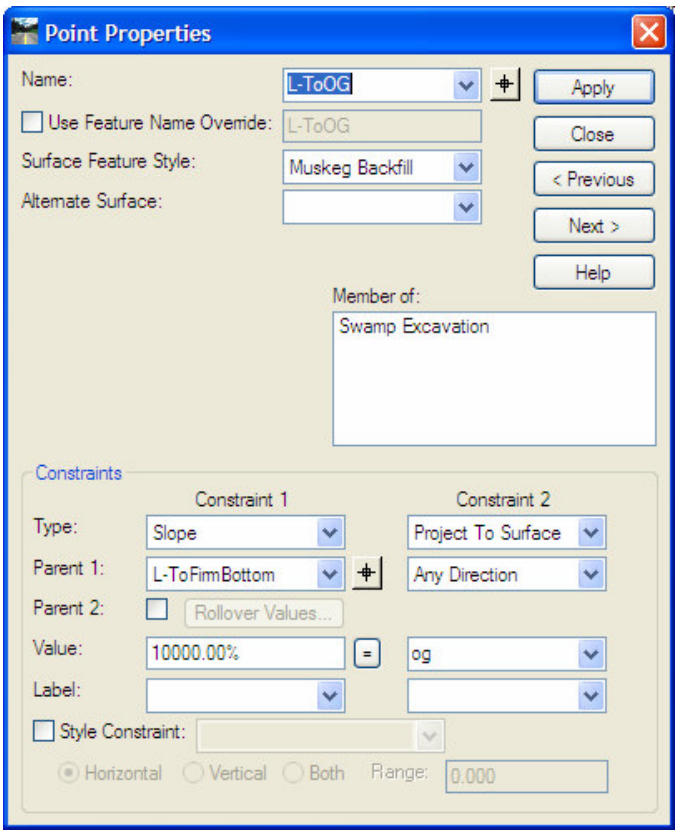


Note: If you set the *Project To Surface* constraint before the other constraint which defines the projection direction, the component may not look exactly the same as it was shown in step 6. This will not affect the component behaviour in Roadway Designer.

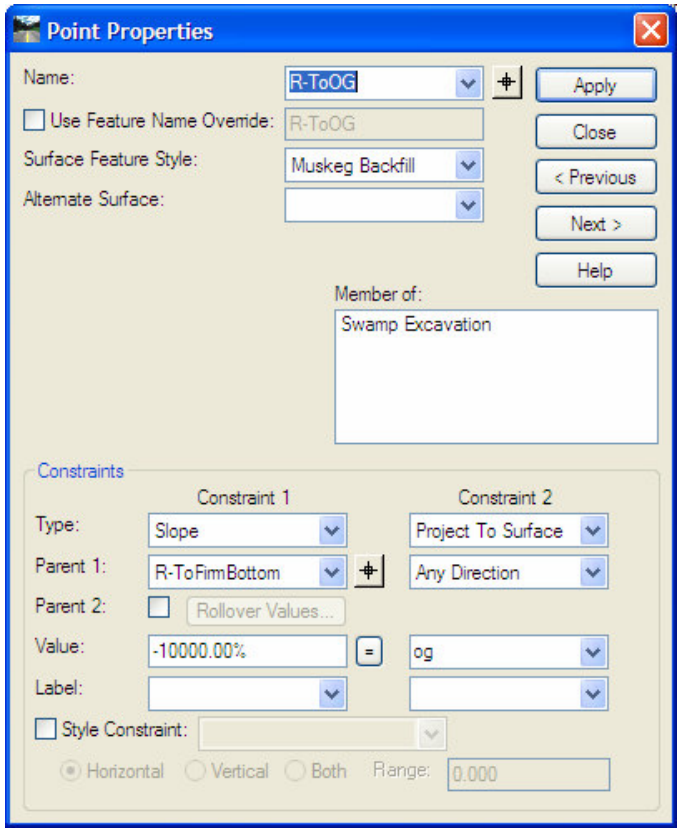
R-ToFirmBottom



L-ToOG



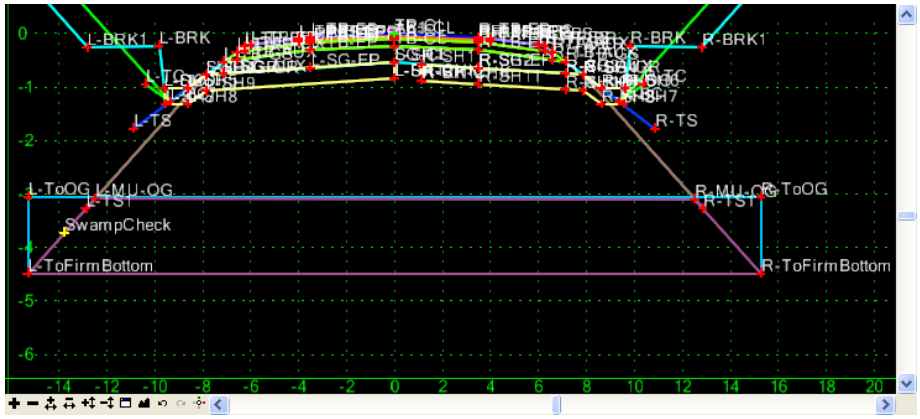
R-ToOG



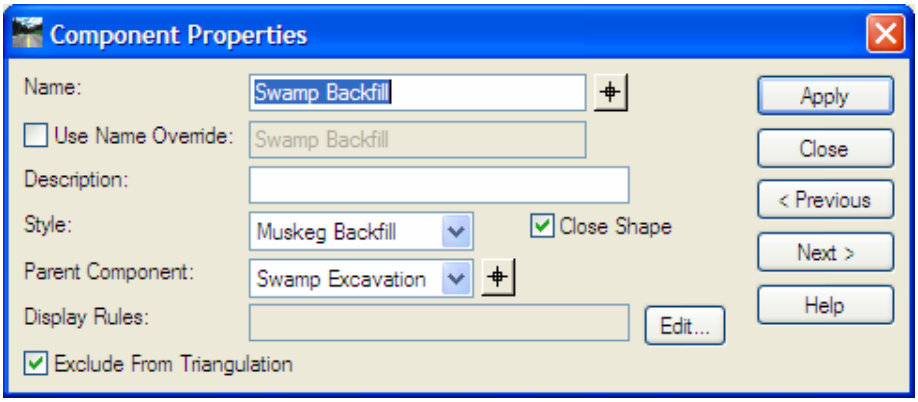
8. For Swamp Excavation, two more child components need to be created:
   - Swamp Backfill
   - Fill (Earth fill 2H: 1V)

a) Swamp Backfill component:

The two lower points will be the point *L-ToFirmBottom* and the point *R-ToFirmBottom*. Two up points ***L-MU-OG*** and ***R-MU-OG*** are constrained with 2:1 slope from *L-SG-GR* and *R-SG-GR* respective. Both points are projected to OG surface.

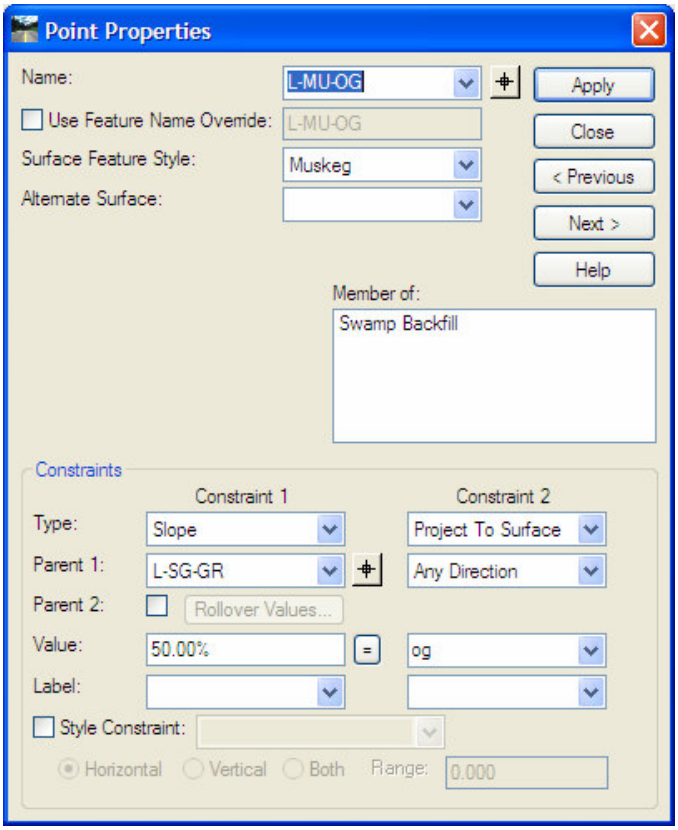


The Swamp Backfill component will have ***Muskeg Backfill*** for *Style* and ***Swamp Excavation*** for *Parent Component*.

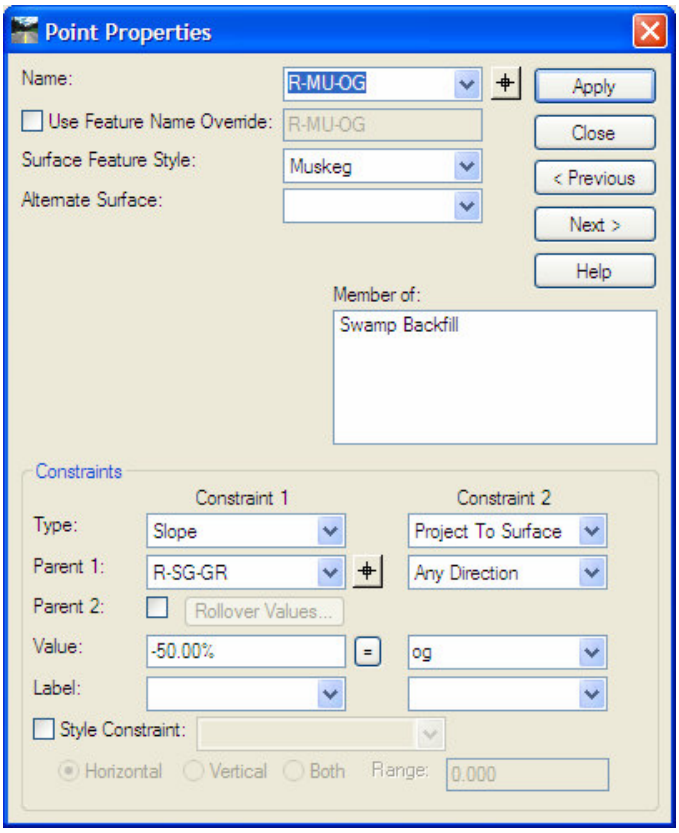


Point L-MU-OG and R-MU-OG are set as shown below. The surface name for the *Project To Surface* constraint is typed in by user and used as a Target Alias (work with multiple surfaces without having to modify the template from the template library).

L-MU-OG

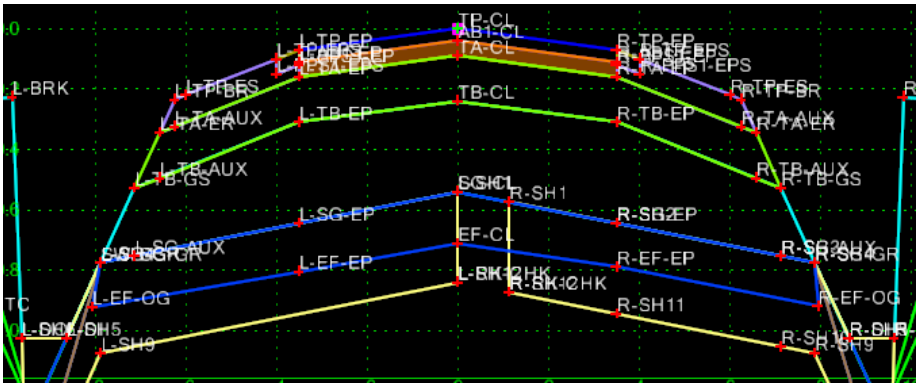


R-MU-OG

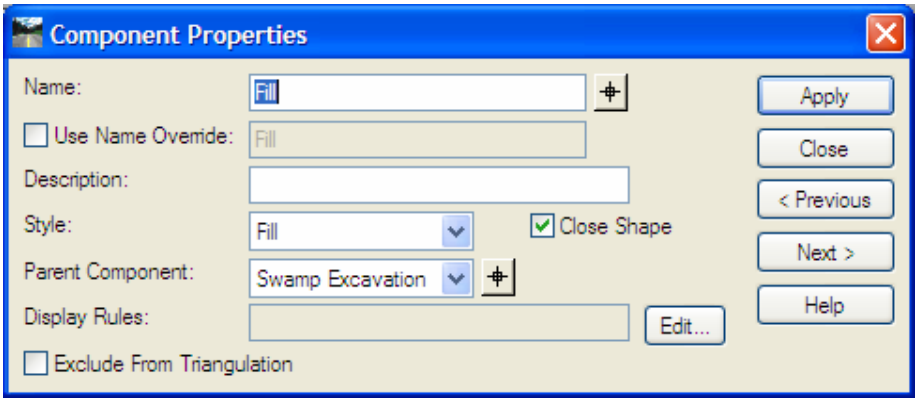


b) Fill component

Create the *Fill* component from the subgrade layer. All the points on the subgrade layer will be used as Fill component upper points. There are five lower points are added to the component. From left to right they are ***L-EF-OG, L-EF-EP, EF-CL, R-EF-EP***, and ***R-EF-OG***. All the points are projected to *OG* surface. Points ***L-EF-OG*** and ***R-EF-OG*** are constrained with 2:1 slope from *L-SG-GR* and *R-SG-GR* respective. Points ***EF-CL, L-EF-EP,*** and ***R-EF-EP*** are horizontal constrained to EP and CL points.

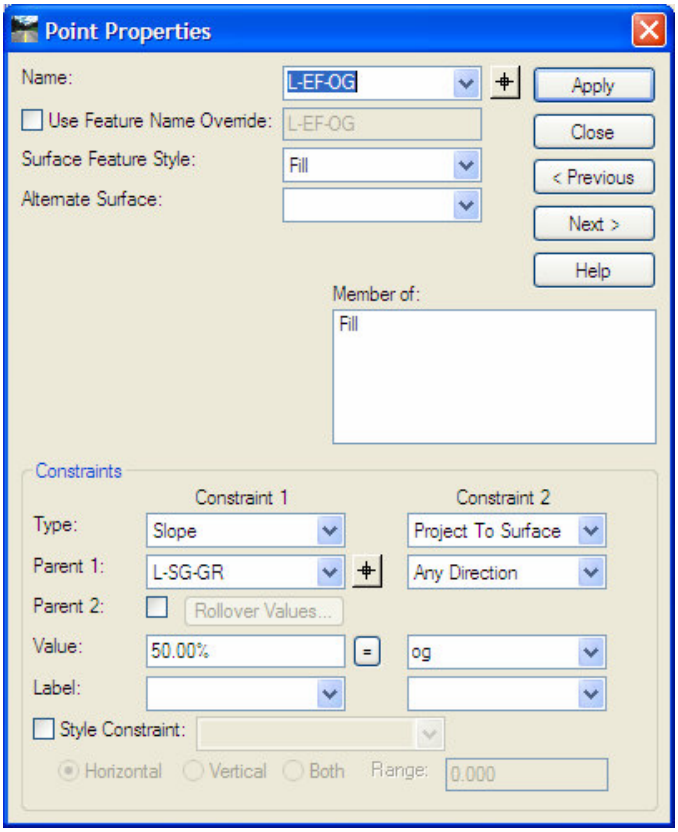


The Fill component will have ***Fill*** for *Style* and ***Swamp Excavation*** for *Parent Component*.

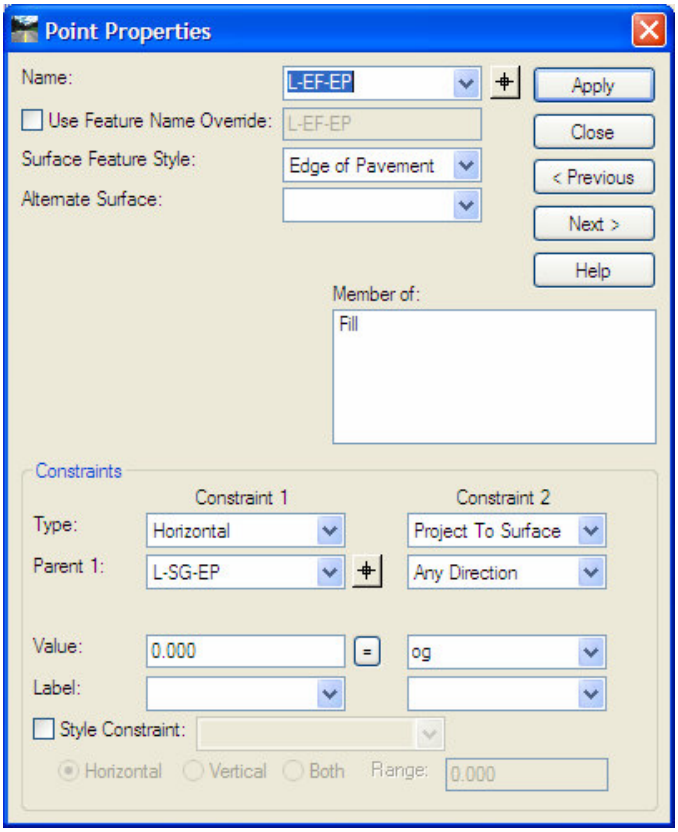


Points L-EF-OG, L-EF-EP, EF-CL, R-EF-EP, and R-EF-OG are set as shown below. The surface name for the *Project To Surface* constraint is typed in by user and used as a Target Alias

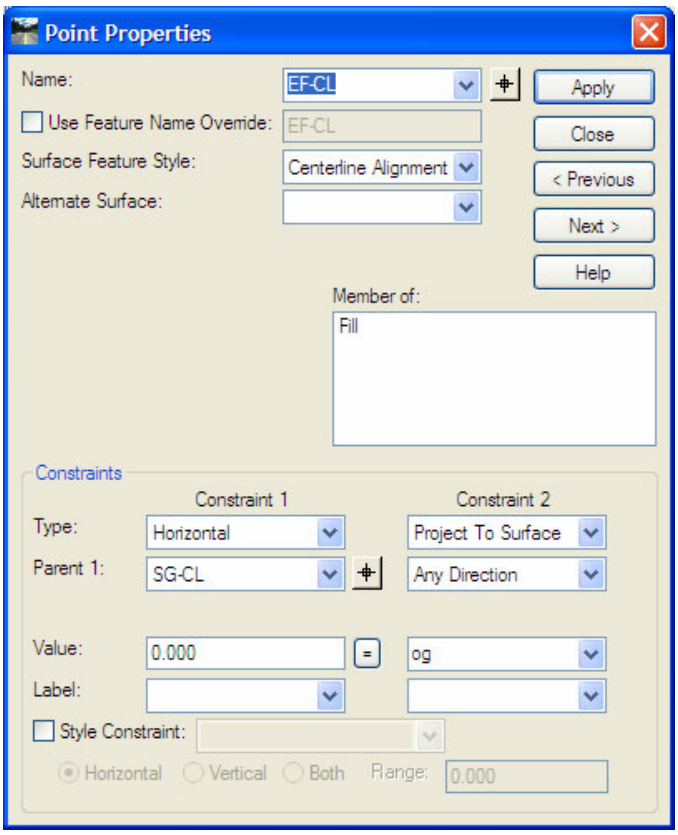
L-EF-OG



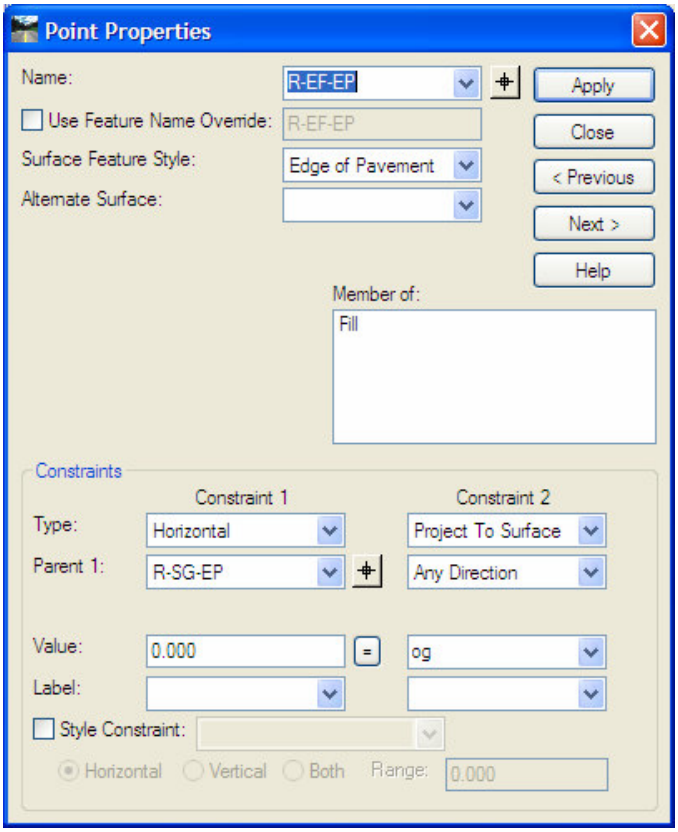
L-EF-EP


Point Properties
Name:
L-EF-EP
Use Feature Name Override:
L-EF-EP
Surface Feature Style:
Edge of Pavement
Alternate Surface:
Apply
Close
< Previous
Next >
Help
Member of:
Fill
Constraints
Constraint 1
Constraint 2
Type:
Horizontal
Project To Surface
Parent 1:
L-SG-EP
Any Direction
Value:
0.000
=
og
Label:
Style Constraint:
Horizontal
Vertical
Both
Range:
0.000

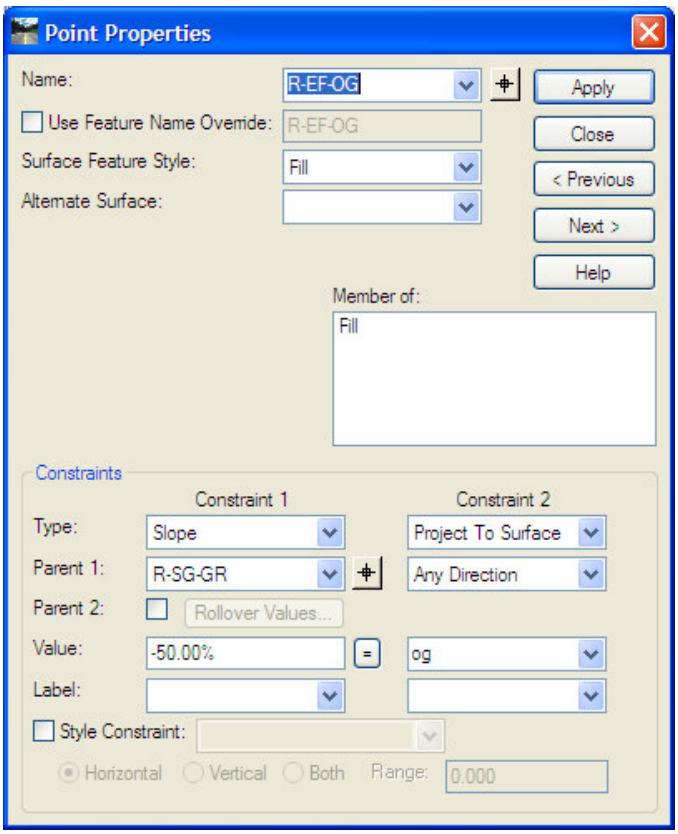
EF-CL


Point Properties
Name:
EF-CL
Use Feature Name Override:
EF-CL
Surface Feature Style:
Centerline Alignment
Alternate Surface:
Apply
Close
< Previous
Next >
Help
Member of:
Fill
Constraints
Constraint 1
Constraint 2
Type:
Horizontal
Project To Surface
Parent 1:
SG-CL
Any Direction
Value:
0.000
=
og
Label:
Style Constraint:
Horizontal
Vertical
Both
Range:
0.000

R-EF-EP


Point Properties
Name:
R-EF-EP
Use Feature Name Override:
R-EF-EP
Surface Feature Style:
Edge of Pavement
Alternate Surface:
Apply
Close
< Previous
Next >
Help
Member of:
Fill
Constraints
Constraint 1
Constraint 2
Type:
Horizontal
Project To Surface
Parent 1:
R-SG-EP
Any Direction
Value:
0.000
=
og
Label:
Style Constraint:
Horizontal
Vertical
Both
Range:
0.000

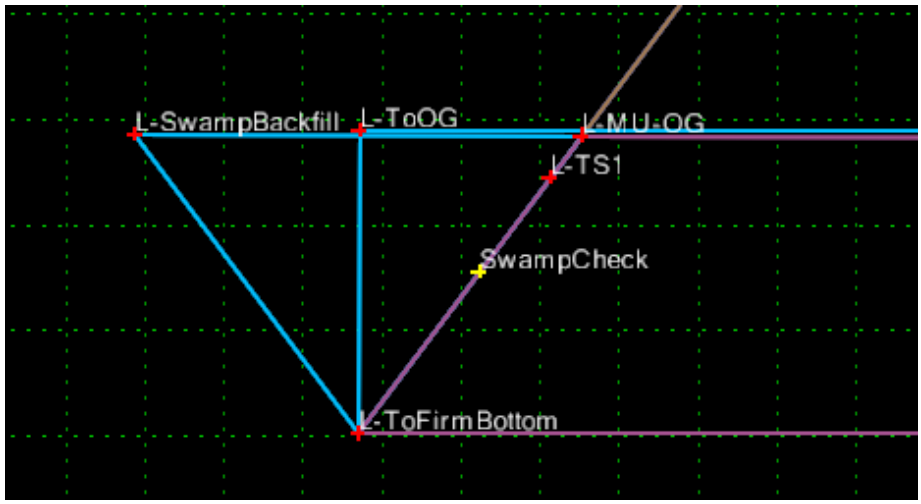
R-EF-OG


Point Properties
Name:
R-EF-OG
Use Feature Name Override:
R-EF-OG
Surface Feature Style:
Fill
Alternate Surface:
Apply
Close
< Previous
Next >
Help
Member of:
Fill
Constraints
Constraint 1
Constraint 2
Type:
Slope
Project To Surface
Parent 1:
R-SG-GR
Any Direction
Parent 2:
Rollover Values...
Value:
-50.00%
=
og
Label:
Style Constraint:
Horizontal
Vertical
Both
Range:
0.000

9. For Swamp treatment, two components for backfill with swamp material (none embankment) need to be created:
   - L-Swamp Backfill
   - R-Swamp Backfill

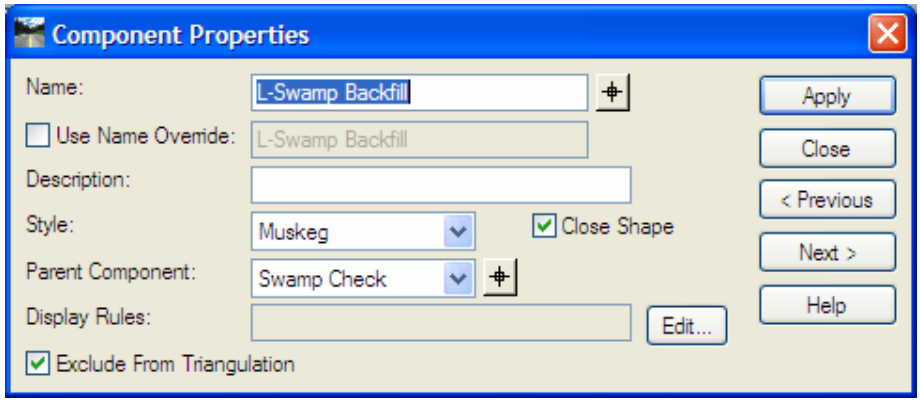
a) L-Swamp Backfill

Start from L-ToFirmBottom point, gp through the point L-MU-OG, and then go to the final point ***L-SwampBackfill***. The point L-Swampbackfill located on the left side of the point L-ToOG with 0.5:1 slope from the point L-ToFirmBottom and project to the OG surface.

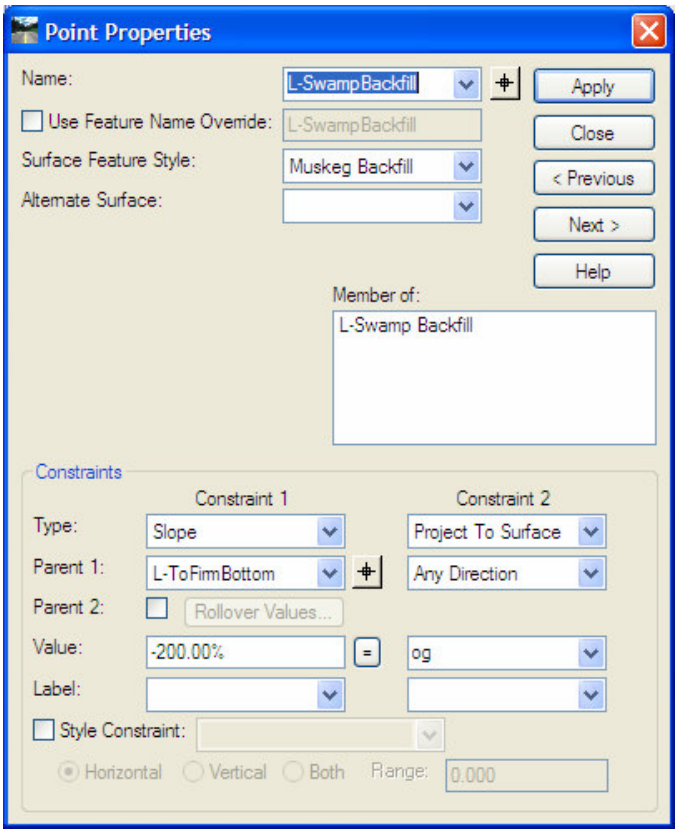


The component and the point properties are set as:

Component **L-Swamp Backfill**

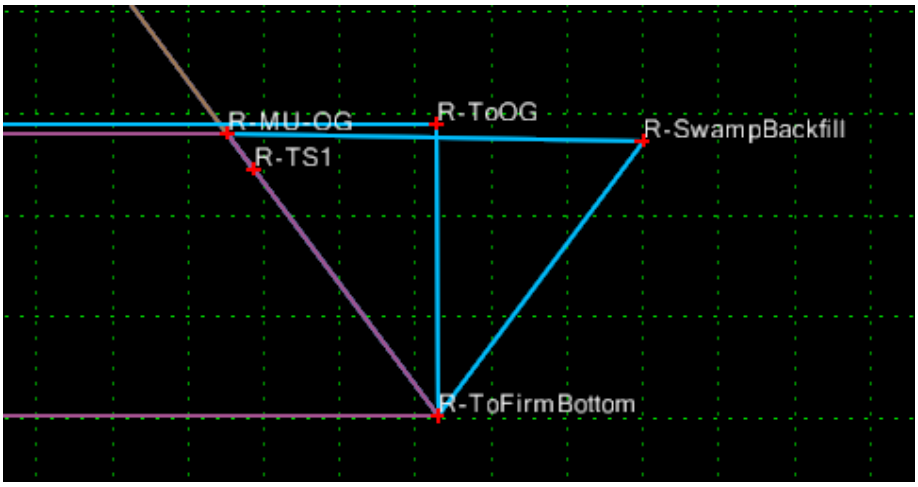


Point **L-Swamp Backfill**



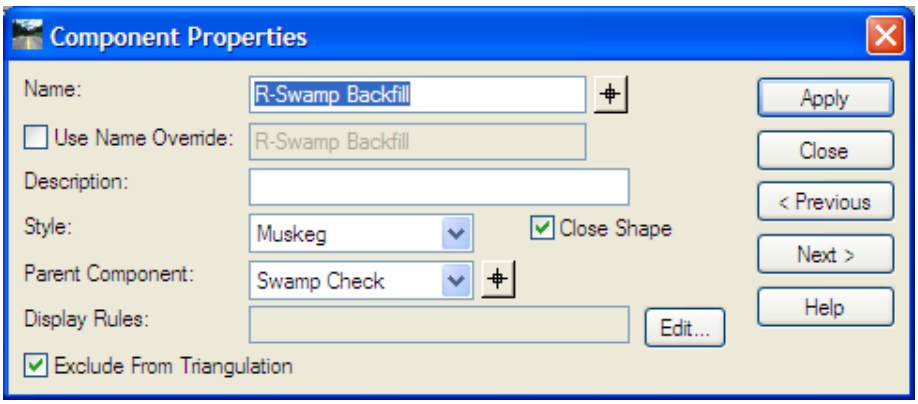
b) R-Swamp Backfill

Start from R-ToFirmBottom point, gp through the point R-MU-OG, and then go to the final point ***R-SwampBackfill***. The point R-Swampbackfill located on the right side of the point R-ToOG with 0.5:1 slope from the point R-ToFirmBottom and project to the OG surface

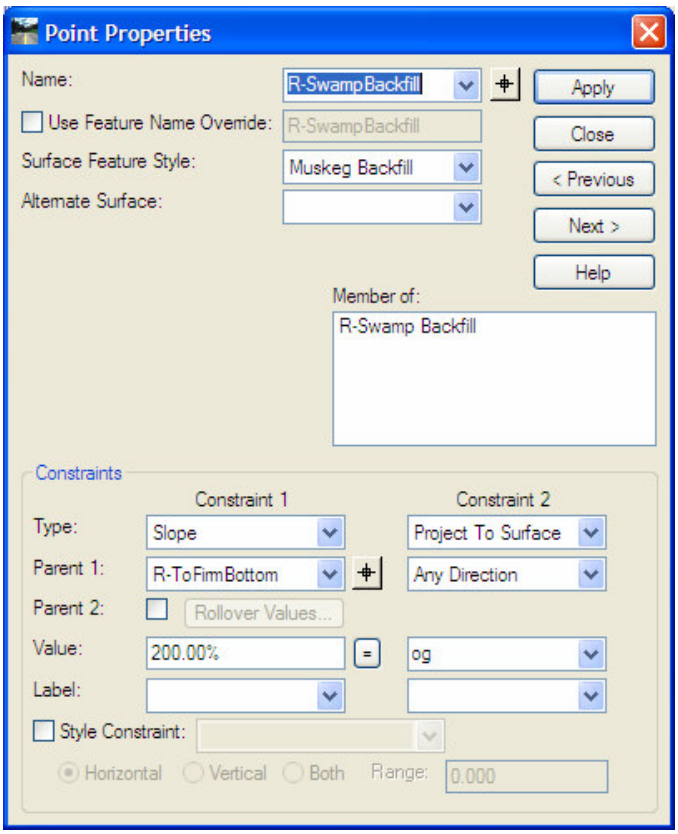


The component and the point properties are set as:

Component **R-Swamp Backfill**



Point **R-Swamp Backfill**



7.0 Roadway Modeling

7.1 Roadway Designer Overview

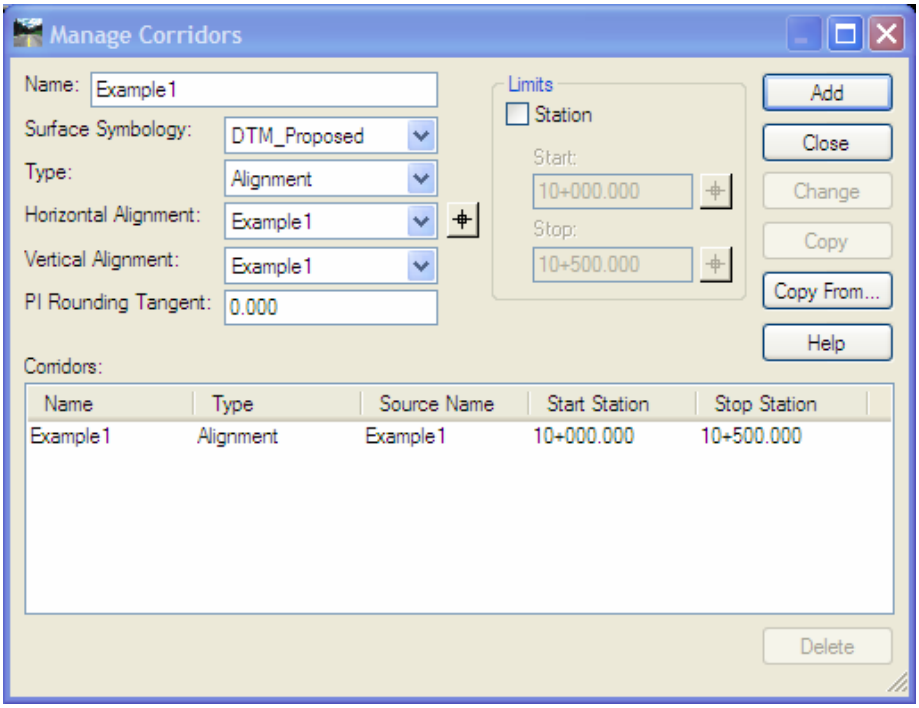
InRoads Road Designer is a highly interactive work flow that allows user to perform a majority of the road design functions. The main dialog has 3 views in standard mode and 4 views in superelevation or overlay mode. User will see the design results simultaneously in plan, profile, and the cross section at the current station. This command is also used to create new design surfaces that represent a new roadway or other type of surface.

Before running Roadway Designer, you must have:

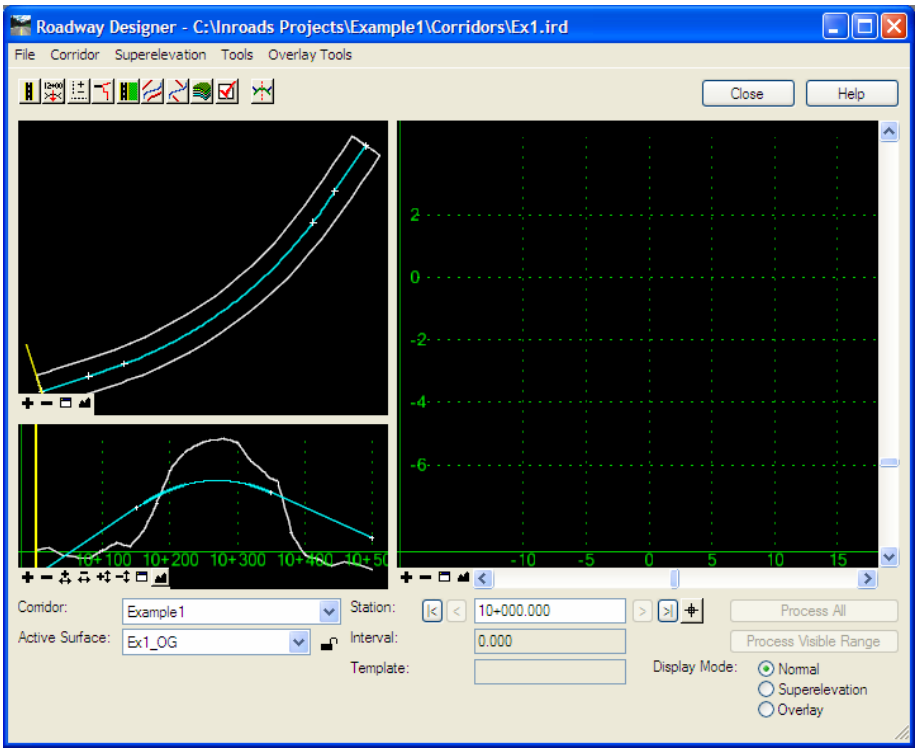
- A horizontal and vertical alignment or a surface feature that defines the location of the roadway.
- One or more existing surfaces.
- One or more templates to define the proposed typical section(s).

7.2 Creating Corridor

1. Select **Modeler > Roadway Designer**. The Roadway Designer dialog appears with three view windows.
2. Select **Corridor > Corridor Management**.
3. On the Manage Corridors dialog, type ***Example1*** in the Name field.
4. Set the Surface Symbology to ***DTM_Proposed***.
5. Set the Type to ***Alignment***.
6. Select ***Example1*** for the Horizontal Alignment.
7. Select ***Example1*** for the Vertical Alignment.
8. PI Rounding Tangent set to ***0.000***
9. Toggle off the station *Limits* for apply to the entire alignment.
10. Click **Add** to create the corridor.



11. Click **Close** to dismiss Manage Corridors dialog.



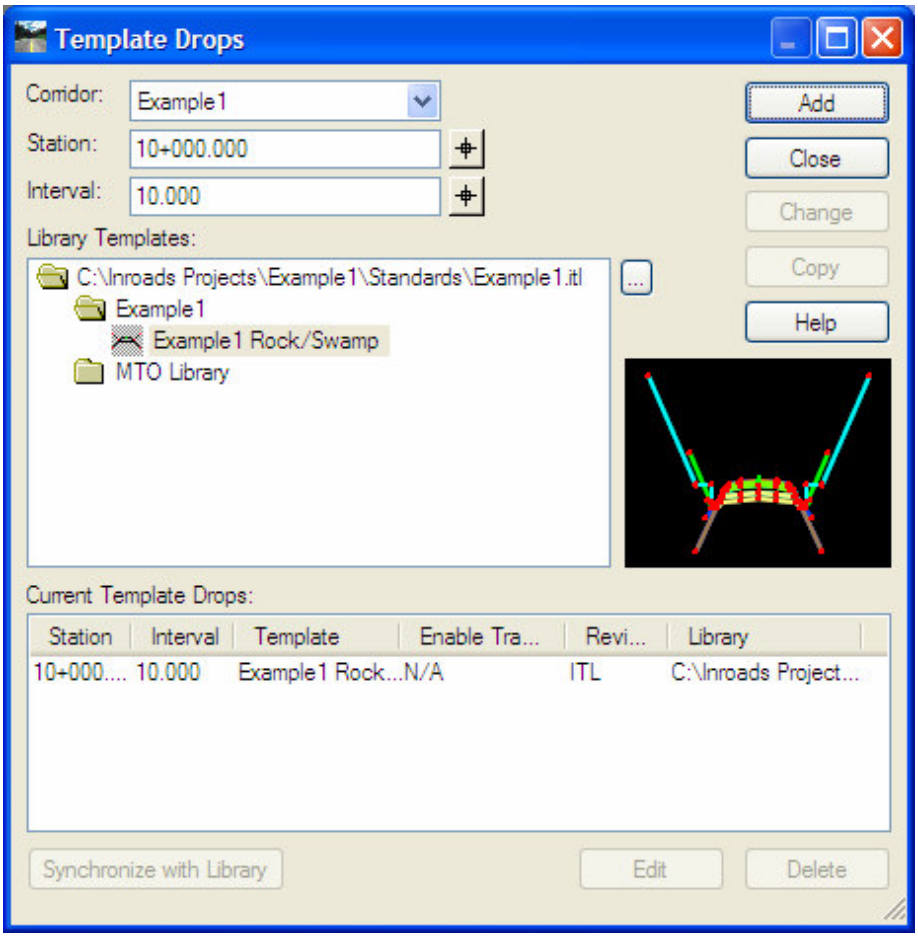
12. Click **File > Save As**. The Save Roadway Design As dialog will appear. The location will be …*Example1\Corridors* as defined in the project default.
13. For *Save as type*, select ***Roadway Design (*.ird)***.

14. For *File name*, type ***Example1***.
15. Click **Save** and close the Save As dialog.
16. Go to InRoads main menu, select **File > Save As** to update the project file with newly created Roadway Design file.

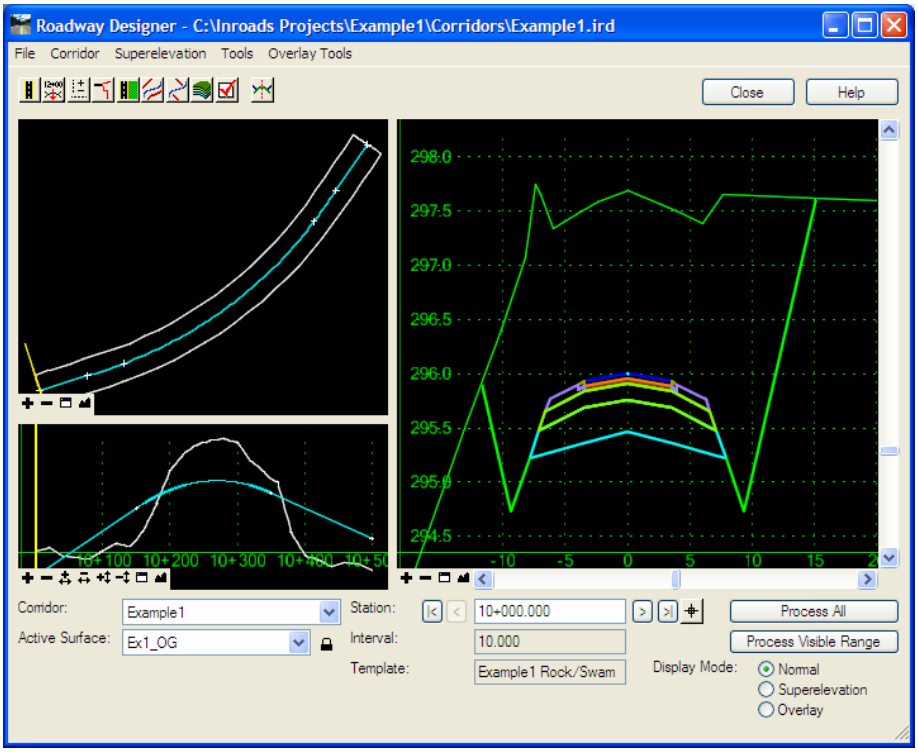
7.3 Inserting Template Drops

With an active corridor in place, the template drops can be added to the roadway design.

1. On the Roadway Designer dialog, select **Corridor > Template Drops**. The Template Drops will appear.
2. In the **Library Templates** window, select ***Example1 > Example1 Rock/Swamp***. The template that was created in section 6.2.
3. Change the *Interval* to ***10*** and the *Station* should be ***10+000.000***.
4. Click **Add**. The selected template is added to the Current Template Drops list.



5. Close the Template Drops dialog.

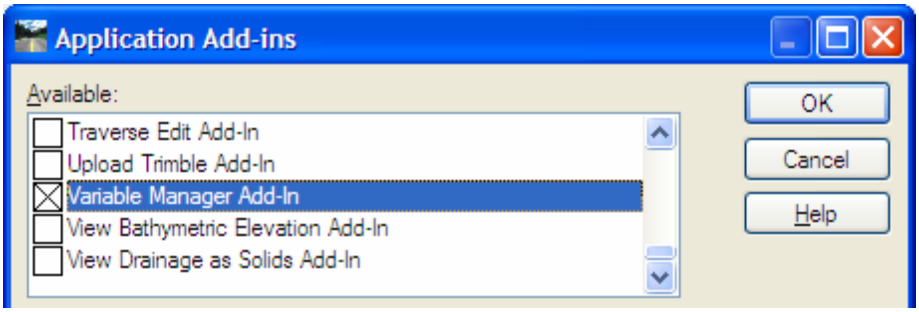


6. Click **File > Save** to save the roadway design file with template drops.

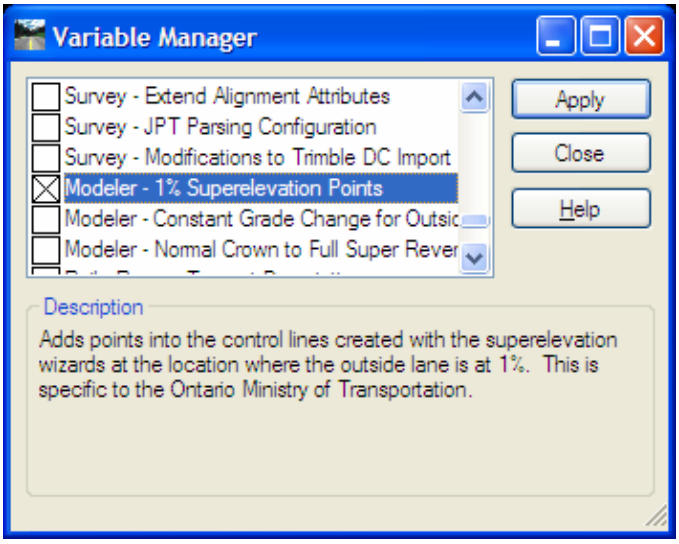
7.4 Applying Superelevation

Superelevation is used to control the control the cross-fall of roadways in areas of horizontal curves. InRoads provides tools to create, display, and report Superelevation in the roadway design process.

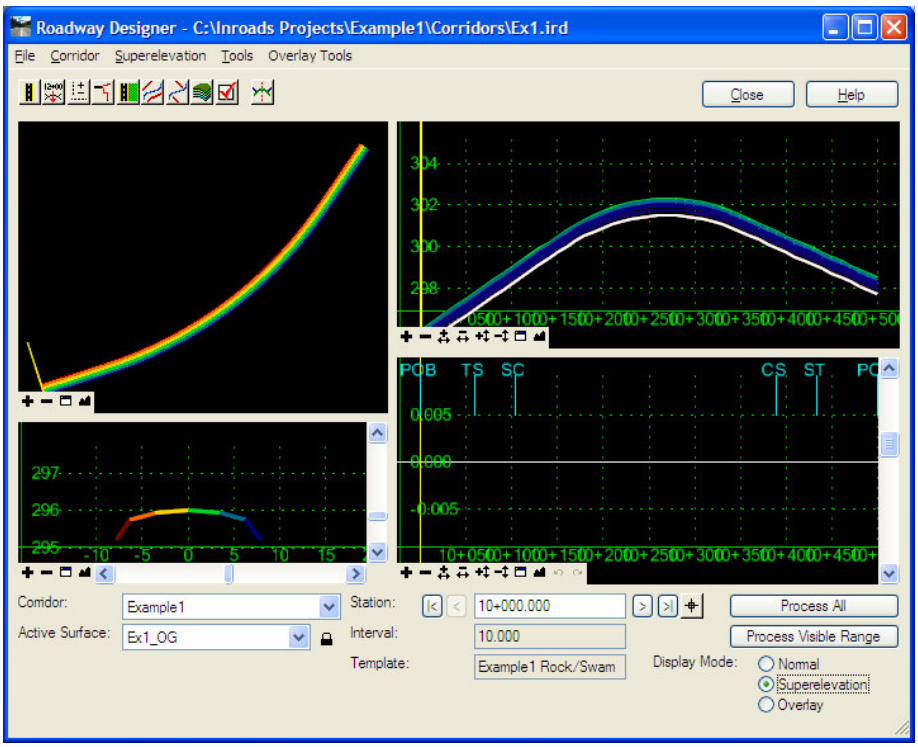
1. Select **Tools > Application Add-Ins**. From the *Available* list window on Application Add-Ins dialog, find and check the ***Variable Manager Add-In***.



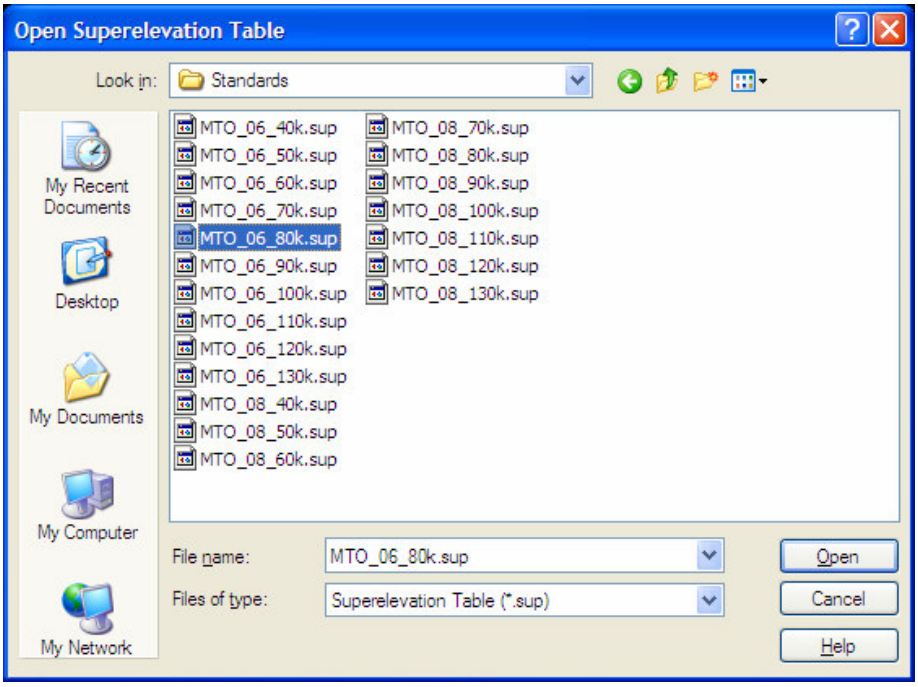
2. Select **Tools > Variable Manager**. From the Variable Manager dialog, find and turn on the ***Modeler – 1% Superelevation Points***.



3. Select **Modeler > Roadway Designer**.
4. Click on the **Process All** button and set the *Display Mode* in the lower right corner to ***Superelevation***.



5. Select **Superelevation > Create Superelevation Wizard > Table**. The Table Wizard dialog will appear.
6. Click the browse button icon ... to the right of the *Table* input field. The Open Superelevation Table dialog box will appear.
7. Navigate to …*Example1**Standards* folder. Select the superelevation table ***MTO_06_80k.sup***.



8. Click **Open**.
9. Calculate the tangent runout and enter in the *Specify Runout* input field. Tangent Runout L= 400 * 0.02 * 3.5 = 28m.

Note: 400 is the transition rate to be used for MTO standards; 0.02 is the difference between normal crown and 0% slope; 3.5m is the width of cross section to be superelevated.

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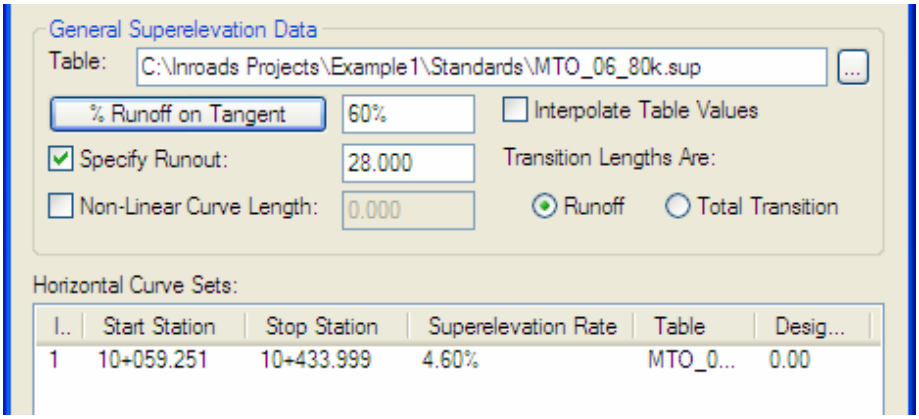
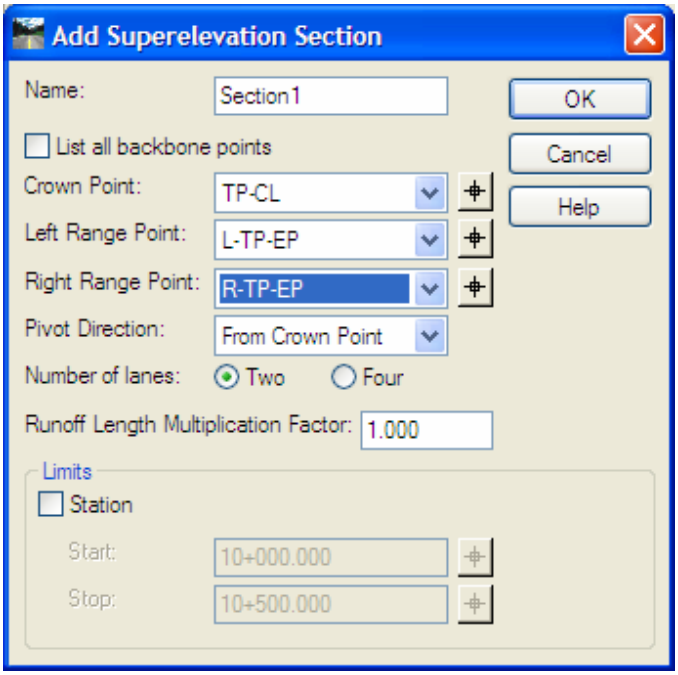
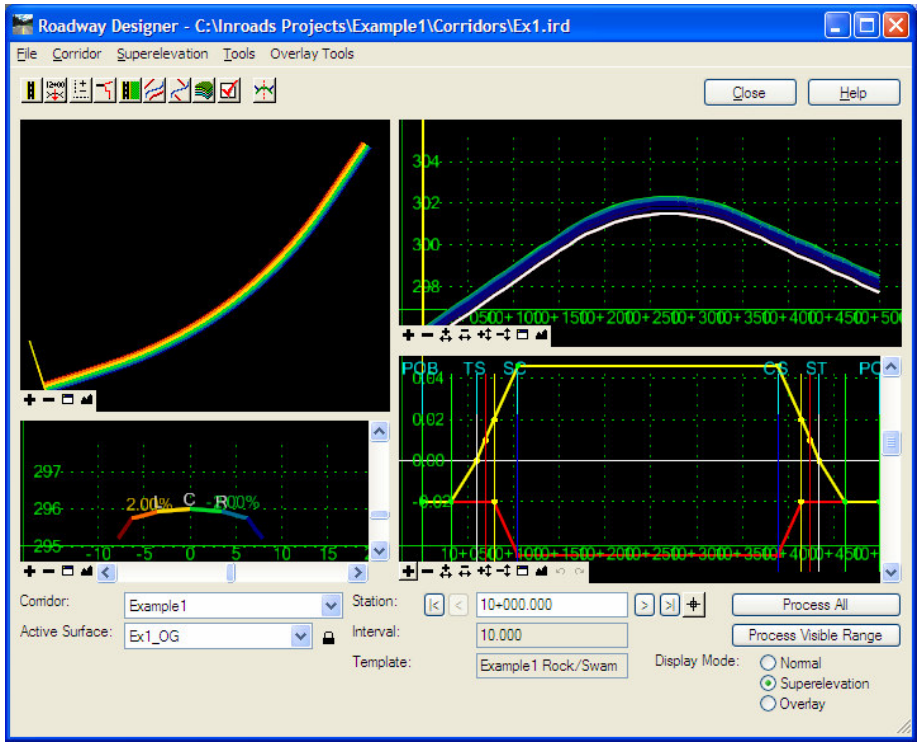
10. Click on **Load Values From Table** button. The maximum *Superelevation Rates* are read from the ASCII file specified in the Table field.



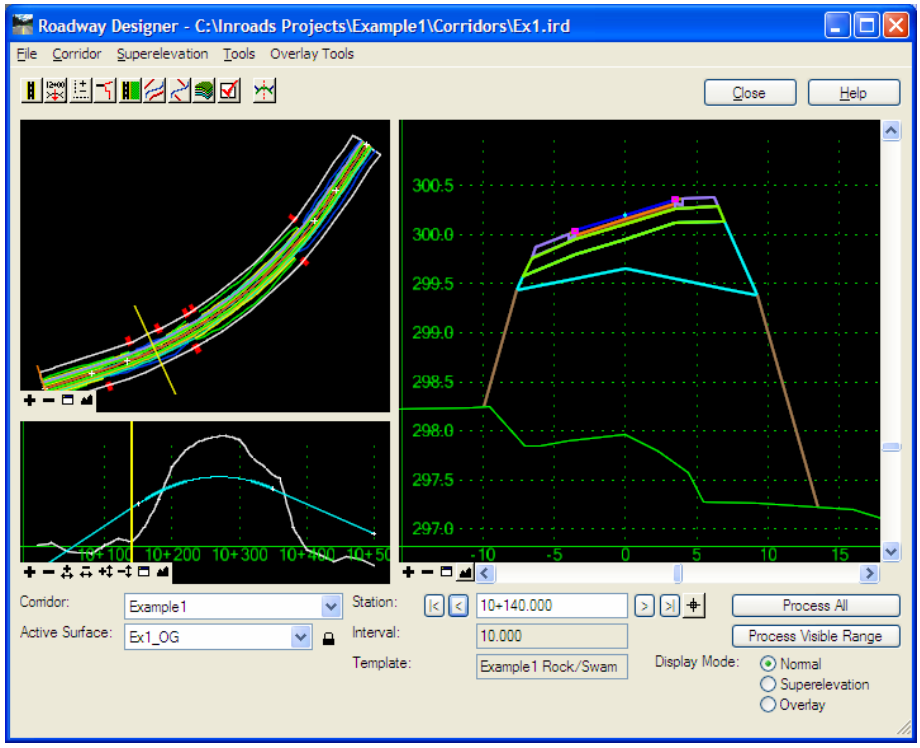
11. Click **Next**. On the Superelevation Section Definitions dialog, click **Add** button
12. On the Add Superelevation Section dialog, accept the default *Name* to be ***Section1***. Make the following selections:
    - Crown Point: ***TP-CL***
    - Left Range Point: ***L-TP-EP***
    - Right Range Point: ***R-TP-EP***



13. Click **OK** button to accept the inputs and return to Superelevation Section Definitions dialog.
14. Click **Next** button then click on the **Finish** button on the Superelevation Controls dialog. Two superelevation control lines are created for points L-TP-EP and R-TP-EP.

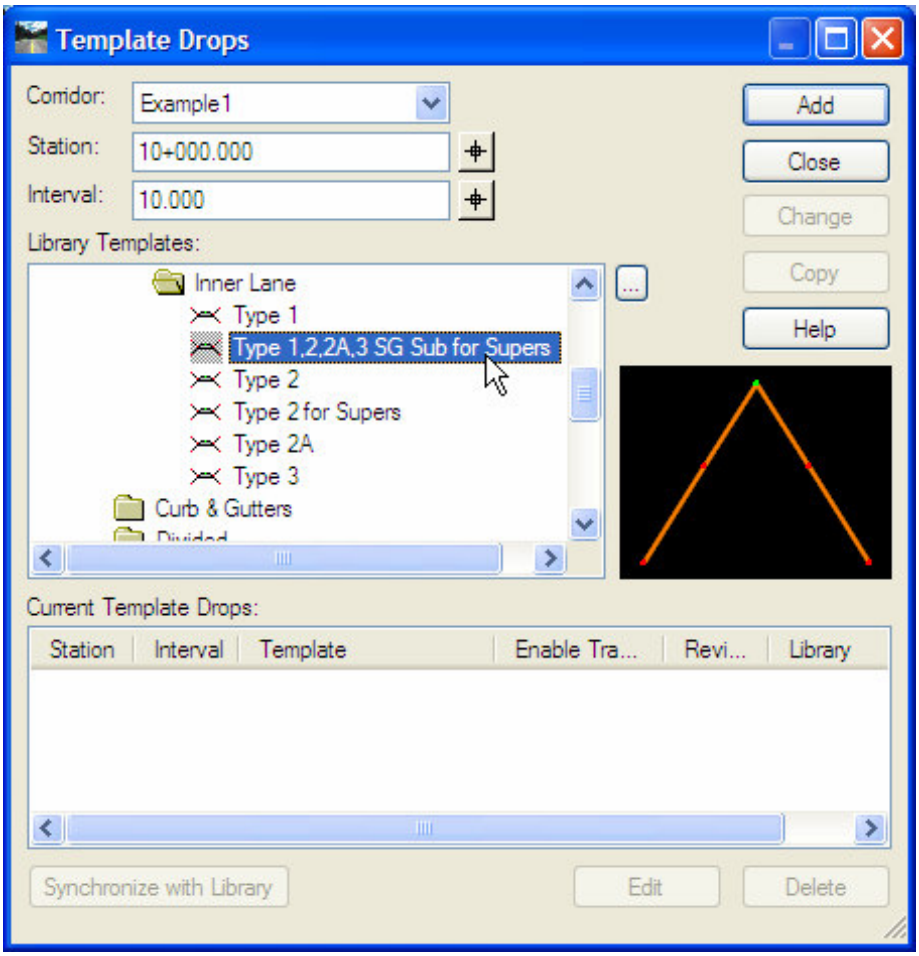


15. Set the *Display Mode* in the lower right corner to ***Normal*** to view the complete template and all layers. Review sections in both tangent and curves. All layers under pavement except for the subgrade are superelevated appropriately. The subgrade, partially paved shoulder, granular shoulder and granular A layer under shoulder will be treated separately.

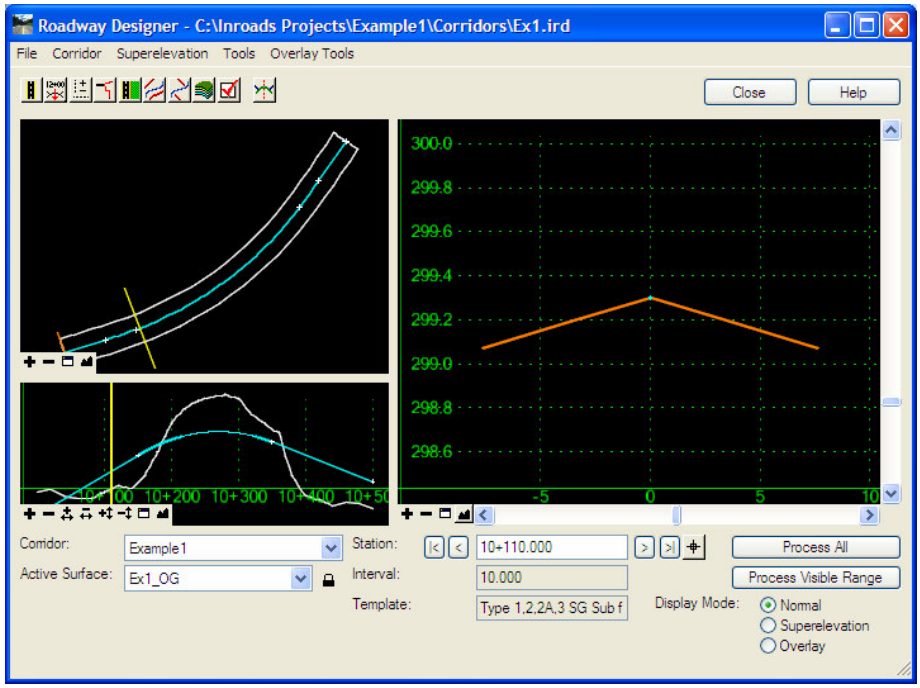


Subgrade Superelevation

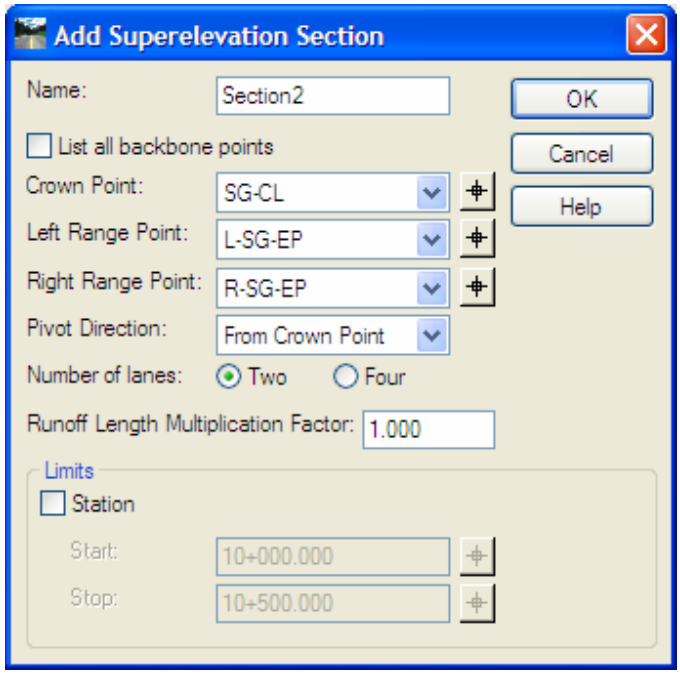
1. Select **Corridor > Template Drops**. Select ***Example1 Rock/Swamp*** under the *Current Template Drops* list and then click on the **Delete** button.
2. From the *Library Templates* window, Select ***MTO Library > Complete Templates > Inner Lane > Type 1,2,2A,3 SG Sub for Supers***. Then click **Add**.



3. Close the Template Drops dialog and return to Roadway Designer dialog. The subgrade layer is added to the current model.

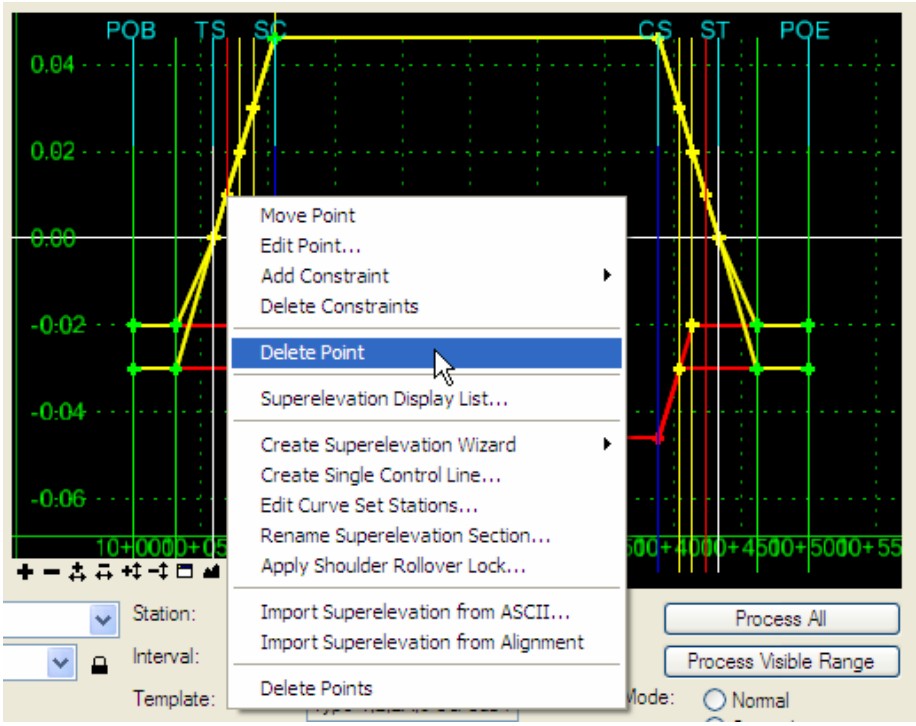


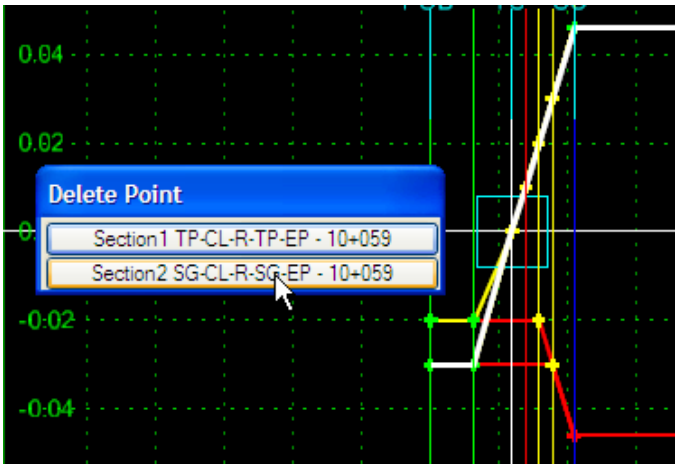
4. **Superelevation > Create Superelevation Wizard > Table**. Follow the wizard define a new section of superelevation for subgrade template using the same values used for the complete template. Set the points as shown below. Then click **OK**.



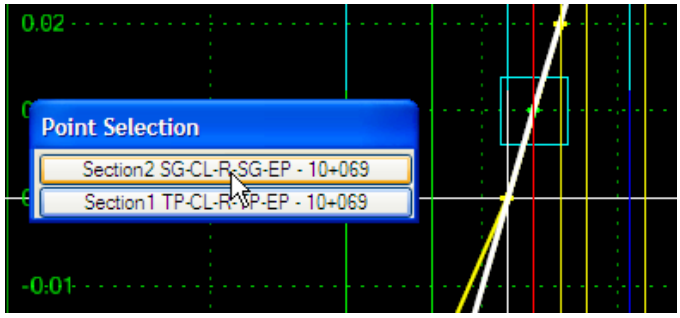
5. Click **Next** button on the Superelevation Section Definitions dialog then click **Finish** button on the Superelevation Controls dialog. The subgrade layer is now superelevated. The subgrade layer must be edited to follow MTO standards.

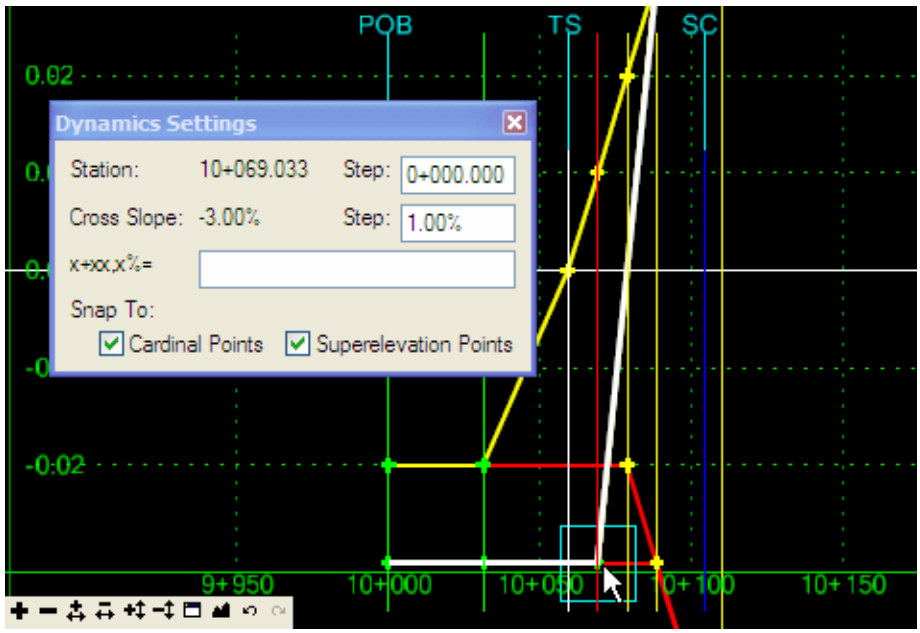
6. Switch to *Superelevation* mode. Select the superelevation diagram view. Locate the point at 0%. Right click on it. From the pop-up menu, select **Delete Point**. Then select the **Section2** line.



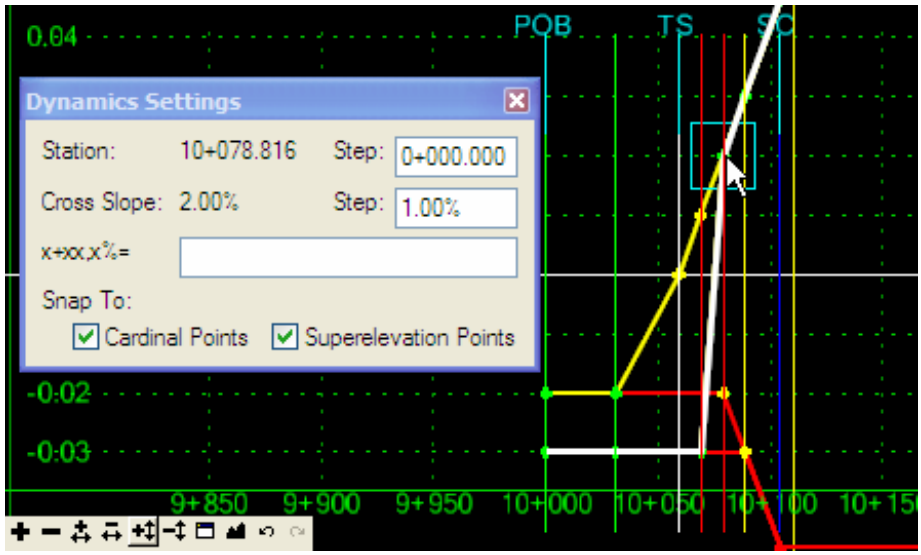


7. Right click on the 1% point and then select **Move Point** from the pop-up menu. Select the **Section2** line. The Dynamics Setting dialog will appear. Set the *Step* to ***1%*** and make sure both *Snap To* options ***Cardinal Points*** and ***Superelevation Points*** are selected. Move the cursor until the cursor hits the constant -3% value to be maintained at the 1% point from the *Section1* line.

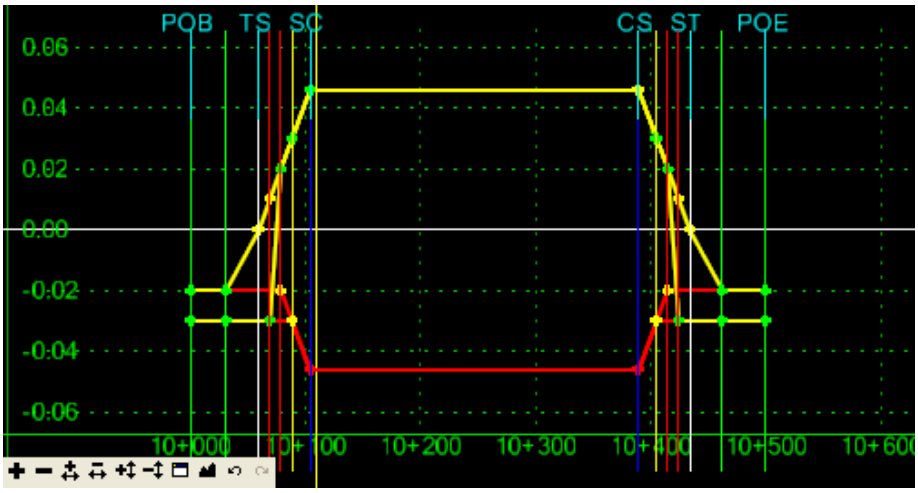




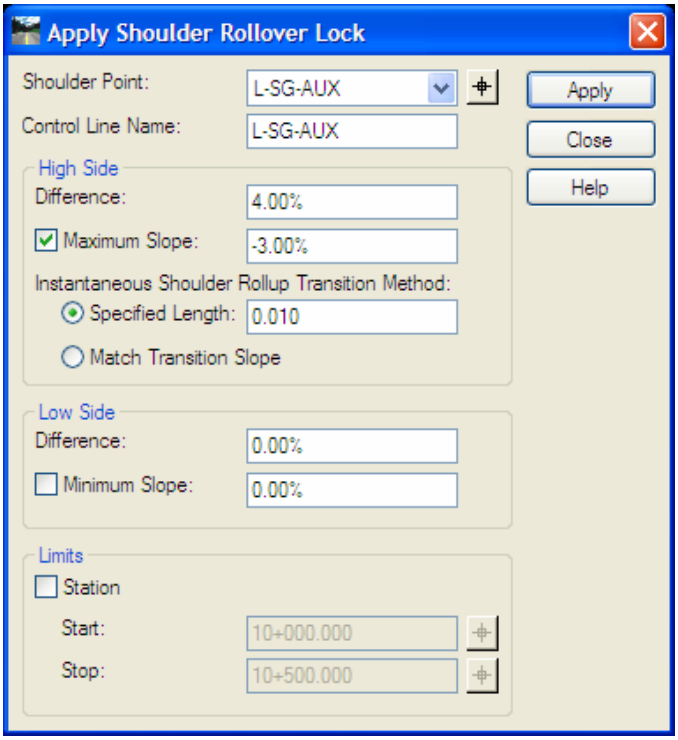
8. Right click on the Section2 line between the -3% point and 3% point. Select **Insert Point** from the pop-up menu then select the **Section2** line. Move the cursor to the 2% point from the *Section1* line.



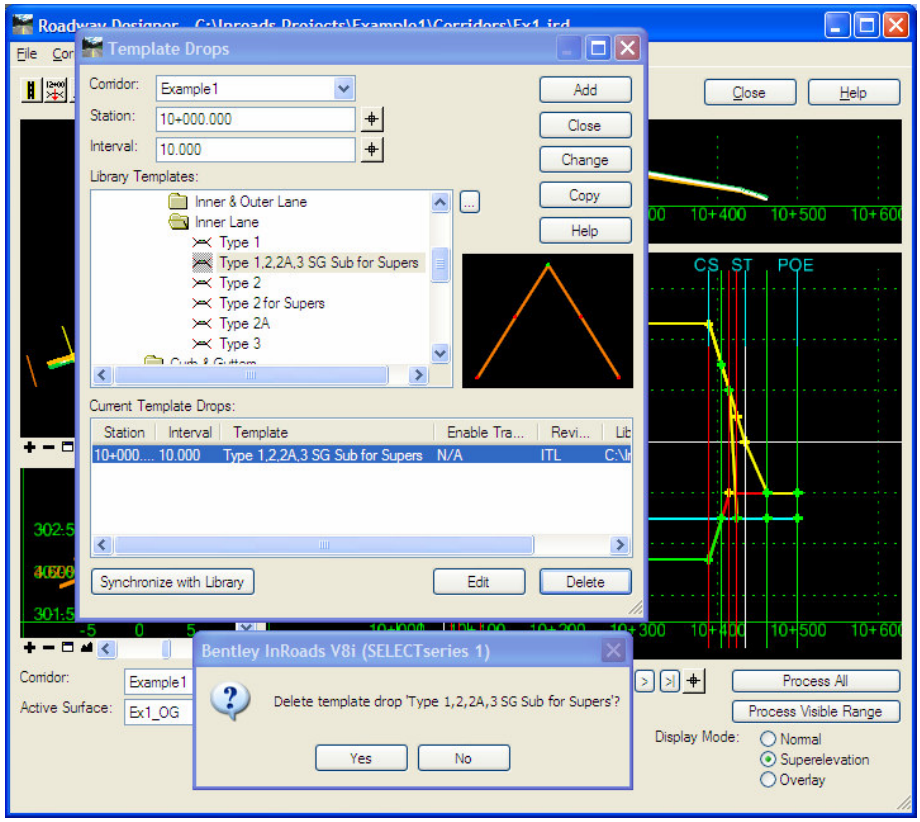
9. Repeat the same steps for the outgoing superelevation behaviour.



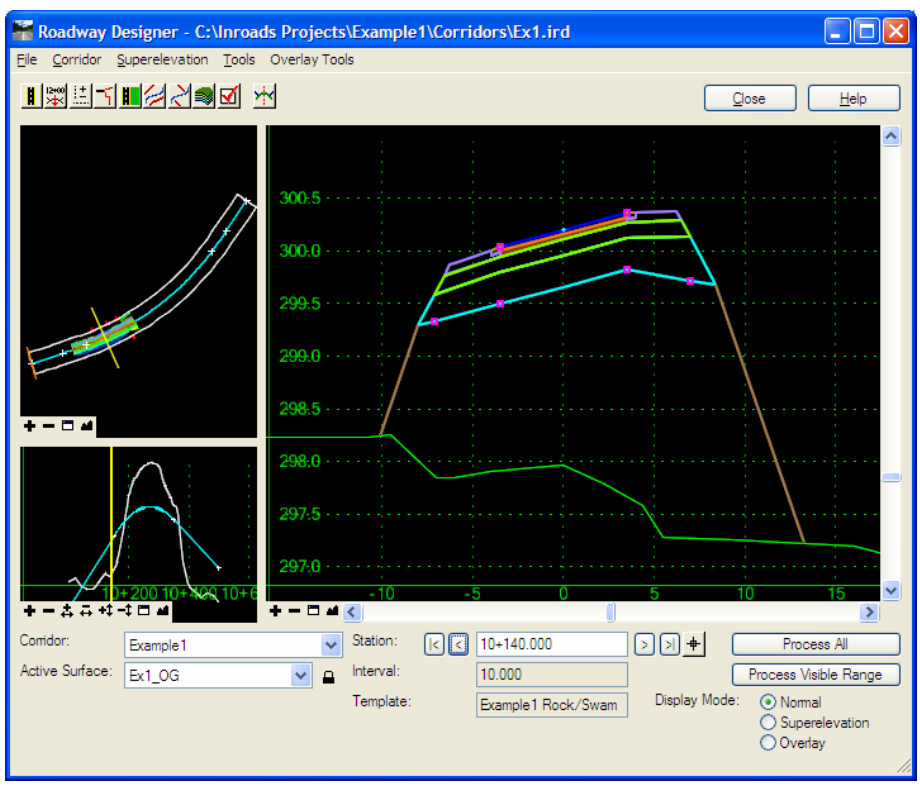
10. Select **Superelevation > Apply Shoulder Rollover Lock**. On the Apply Shoulder Rollover Lock dialog, select *Shoulder Point* ***L-SG-AUX***. Set the slope *Difference* to ***4%*** and *Maximum Slope* to ***-3%*** on the *High Side*. Set the slope *Difference* to ***0%*** on the *Low Side*. Click on **Apply**.



11. Apply the same settings to R-SG-AUX then close the dialog.
12. Set the *Display Mode* in the lower right corner to ***Normal***. Select Corridor > Template Drops and delete the current template drop from the list.

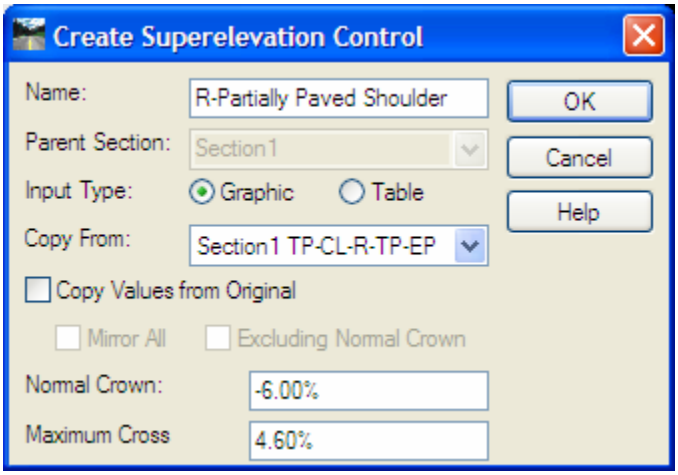


13. Select the Example1 Rock/Swamp template from the Example1 directory and then click on Add. Now the subgrade layer is superelevated appropriately.

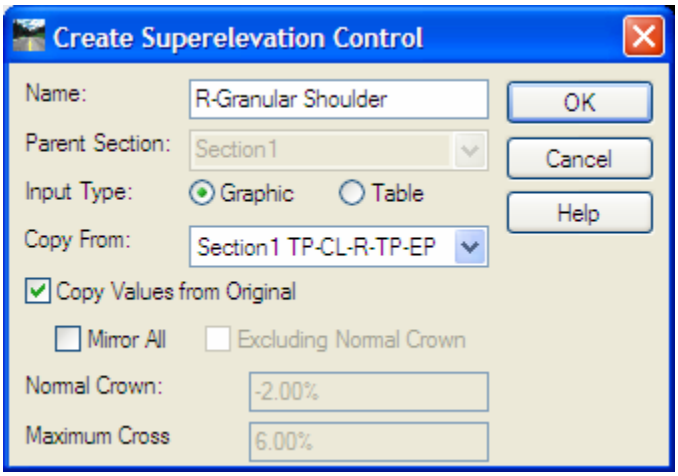


Shoulder Superelevation

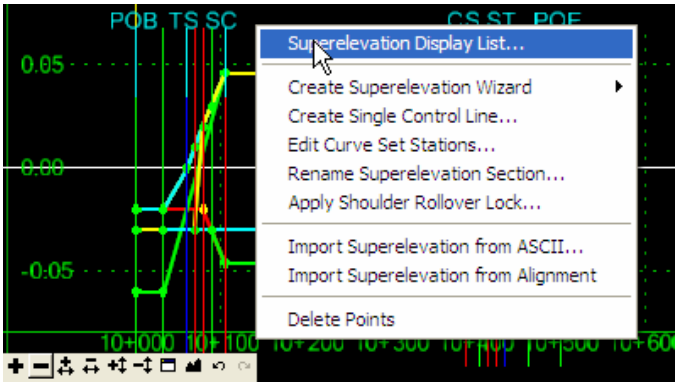
1. The partially paved shoulder, granular shoulder and granular A layer under shoulder on the high side of the superelevation must be properly superelevated to follow MTO standards. Select ***Superelevation*** Mode and then select **Superelevation > Create Single Control Line**.
2. On the Create Superelevation Control dialog, type ***R-Partially Paved Shoulder*** in the *Name* field. Select ***Section1*** as *Parent Section* (or leave blank). Select ***Section1 TP-CL-R-TP-EP*** from the *Copy From* drop-down list. Set *Normal Crown* to ***-6%*** and *Maximum Cross* to ***4.6%,*** and then click **OK**.



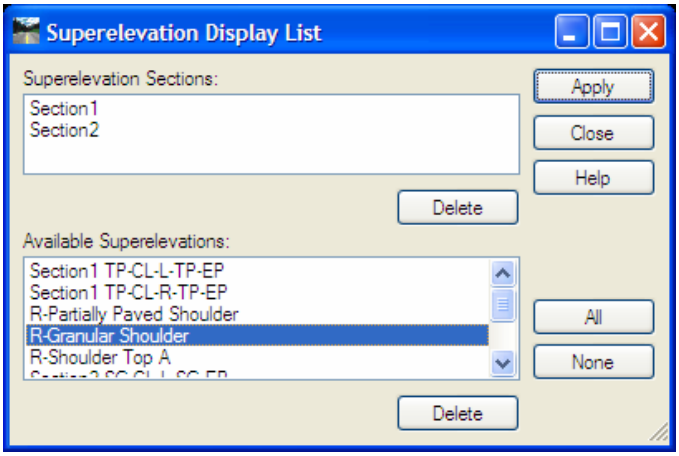
3. Select **Superelevation > Create Single Control Line**. On the Create Superelevation Control dialog, type ***R- Granular Shoulder*** in the *Name* field. Select ***Section1*** as *Parent Section* (or leave blank). Select ***Section1 TP-CL-R-TP-EP*** from the *Copy From* drop-down list. Check the ***Copy Values from Original*** option, and then click **OK**.



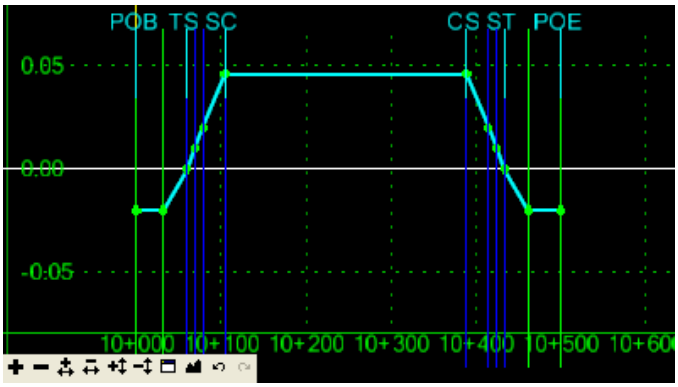
4. Right click on the superelevation diagram. Select **Superelevation Display List** from the pop-up menu.



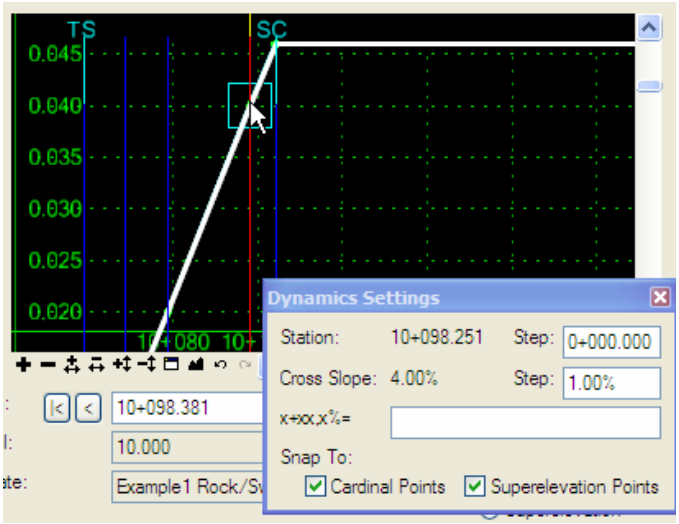
5. On the Superelevation Display List dialog, select ***R-Granular Shoulder*** from the *Available Superelevations* list. Click **Apply** and **Close**.



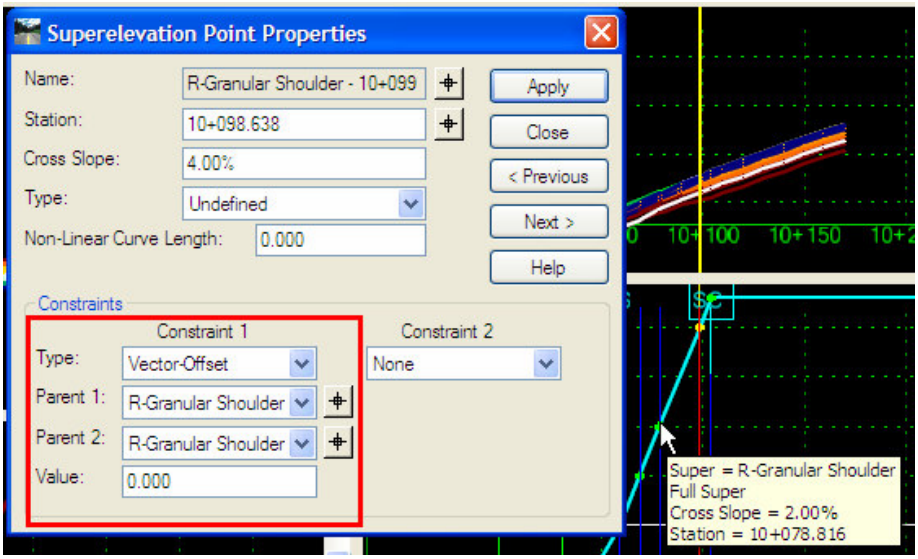
6. In the superelevation diagram view, only the selected control line *R-Granular Shoulder* is displayed. The -2%, 0%, 1%, 2% and 4.6% point are copied from the R-TP-EP control line.



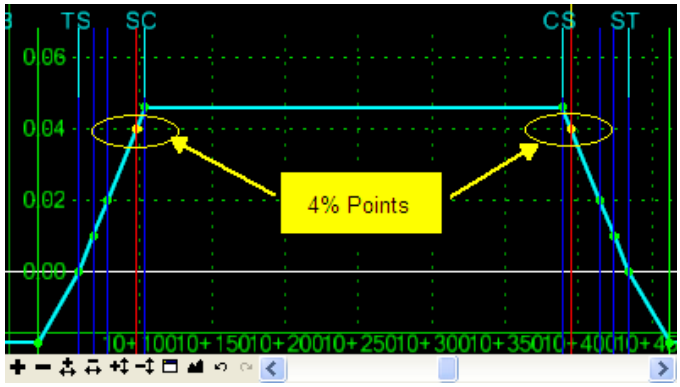
7. Right click on the line between 2% and the 4.6% point. Select **Insert Point** from the pop-up menu. Insert a point at **4%** *Cross Slope*.



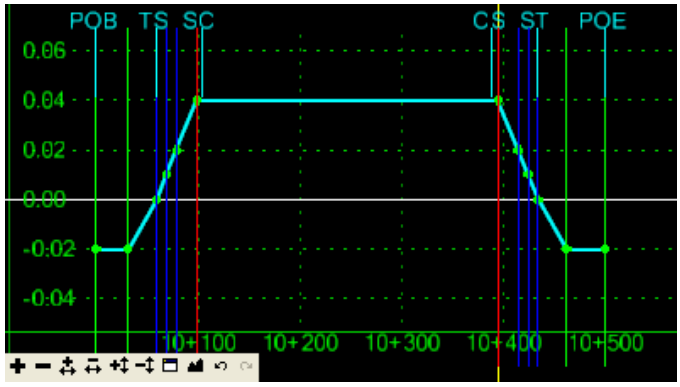
8. Right click on the newly created 4% point, then select **Edit Point**. On the Superelevation Point Properties dialog, set *Conctraint1* to ***Vector-Offset*** and select the 2% and 4.6% points as *Parent 1* and *Parent 2*. The *Value* should be ***0***. Click on **Apply**.



9. Repeat the same steps for the outgoing superelevation control points.

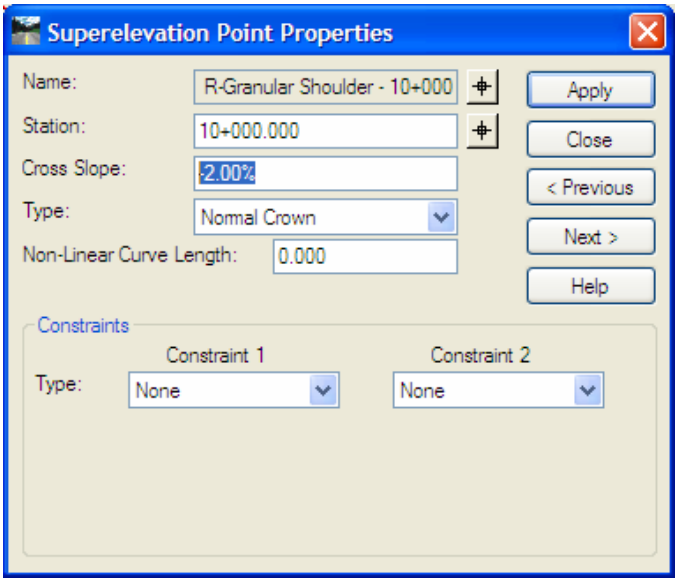


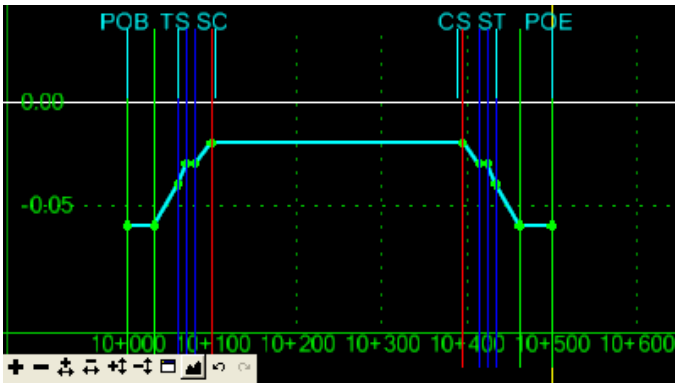
10. Delete the two 4.6% points from the control line.



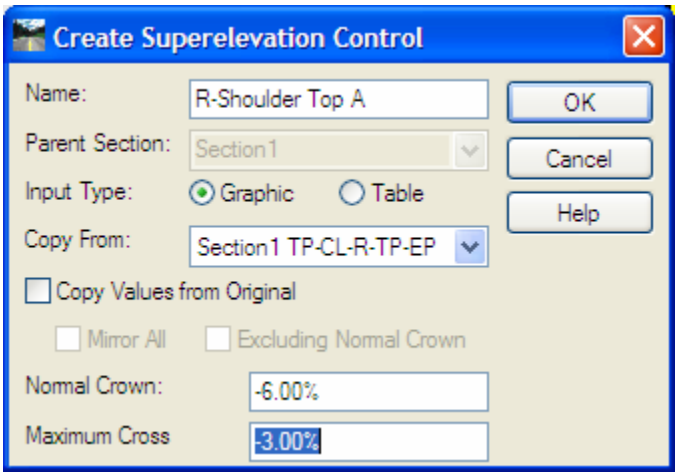
11. Right click on the first point and select **Edit Point**. The Superelevation Point Properties dialog appears. Use the **<Previous** and **Next>** button navigate through entire control line and change the *Cross Slope* value as list below:

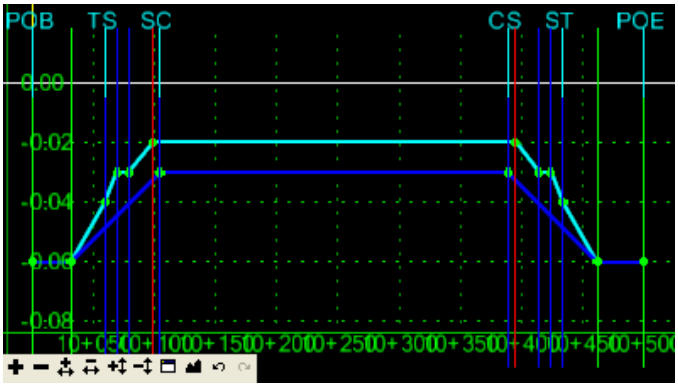
Exist Cross Slope	New Cross Slope
-2%	-6%
0%	-4%
1%	-3%
2%	-3%
4%	-2%



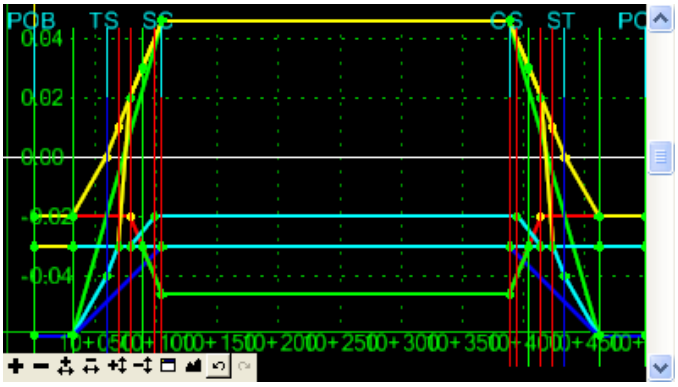


12. Select **Superelevation > Create Single Control Line.** On the Create Superelevation Control dialog, type ***R-Shoulder Top A*** in the *Name* field. Select ***Section1*** as *Parent Section* (or leave blank). Select ***Section1 TP-CL-R-TP-EP*** from the *Copy From* drop-down list. Set *Normal Crown* to ***-6%*** and *Maximum Cross* to -3***%,*** and then click **OK.**





13. Right click on the superelevation diagram. Select **Superelevation Display List** from the pop-up menu. Select **All** and click **Apply** to display all the superelevation control lines within the current mode.

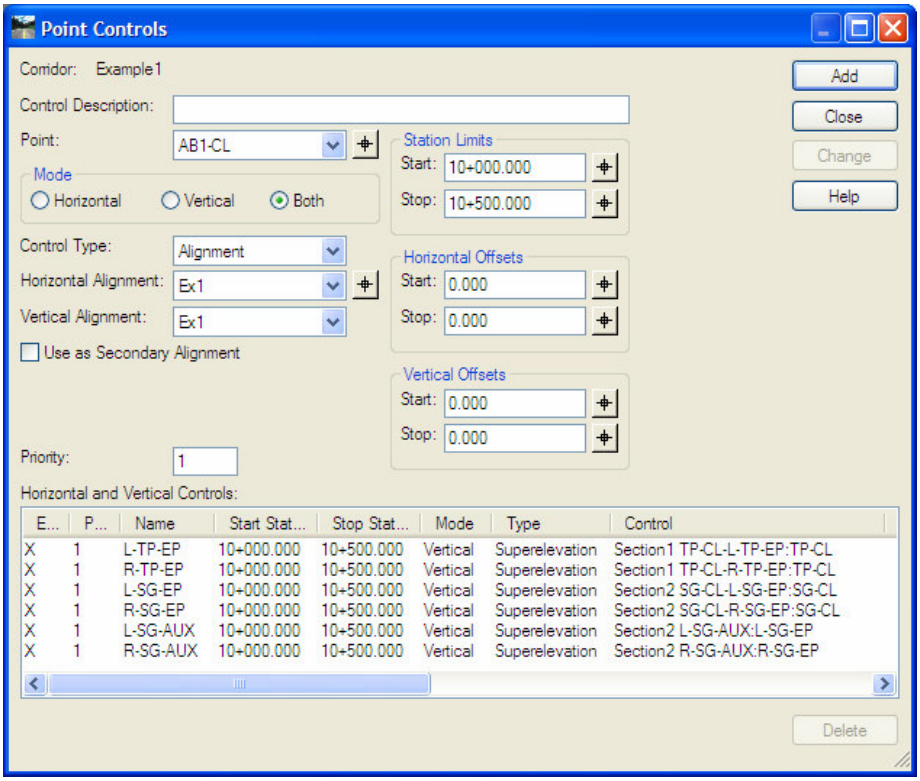


14. Switch back to *Normal* mode. All the shoulder superelevation control lines are created now. Next, proper point controls have to be set up before these controls can take effect.
15. Select **File > Save** to save changes made to the Roadway Designer file.

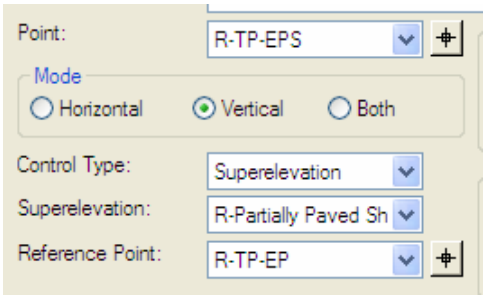
7.5 Point Controls

Point controls are used to modify the behavior of points in a template. Depending on the *Mode* selected, different control types can be applied to a point. Superelevation control lines are used as vertical point controls.

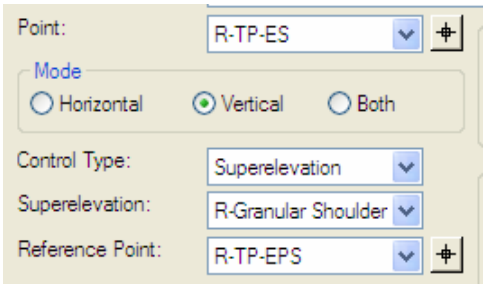
1. Select **Corridor > Point Controls**. The Point Controls dialog appears. The superelevation control lines created with the superelevation wizard in previous section are automatically added to point control list as vertical controls. See below.



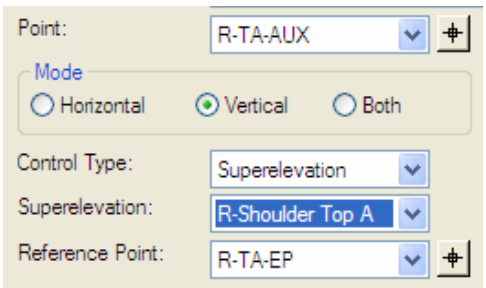
2. The superelevation control lines created with Create Single Control Line command can be used for point control through the Point Controls dialog. On the Point Controls dialog, select ***R-TP-EPS*** from the *Point* drop-down list. Set the *Mode* to ***Vertical***. Then select ***Superelevation*** for *Control Type*, ***R-Partially Paved Shoulder*** for *Superelevation*, and ***R-TP-EP*** for *Reference Point*. Click **Add**.



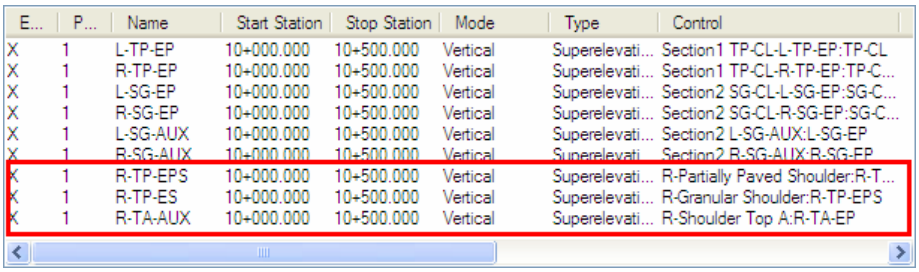
3. Select ***R-TP-ES*** from the *Point* drop-down list. Set the *Mode* to ***Vertical***. Then select ***Superelevation*** for *Control Type*, ***R-Granular Shoulder*** for *Superelevation*, and ***R-TP-EPS*** for *Reference Point*. Click **Add**.



4. Select ***R-TA-AUX*** from the *Point* drop-down list. Set the *Mode* to ***Vertical***. Then select ***Superelevation*** for *Control Type*, ***R-Shoulder Top A*** for *Superelevation*, and ***R-TA-EP*** for *Reference Point*. Click **Add**.



5. Three vertical controls for shoulder superelevation are added to the point control list.



E...	P...	Name	Start Station	Stop Station	Mode	Type	Control
X	1	L-TP-EP	10+000.000	10+500.000	Vertical	Superelevati...	Section1 TP-CL-L-TP-EP:TP-CL
X	1	R-TP-EP	10+000.000	10+500.000	Vertical	Superelevati...	Section1 TP-CL-R-TP-EP:TP-C...
X	1	L-SG-EP	10+000.000	10+500.000	Vertical	Superelevati...	Section2 SG-CL-L-SG-EP:SG-C...
X	1	R-SG-EP	10+000.000	10+500.000	Vertical	Superelevati...	Section2 SG-CL-R-SG-EP:SG-C...
X	1	L-SG-AUX	10+000.000	10+500.000	Vertical	Superelevati...	Section2 L-SG-AUX:L-SG-EP
X	1	R-SG-AUX	10+000.000	10+500.000	Vertical	Superelevati...	Section2 R-SG-AUX:R-SG-EP
X	1	R-TP-EPS	10+000.000	10+500.000	Vertical	Superelevati...	R-Partially Paved Shoulder:R-T...
X	1	R-TP-ES	10+000.000	10+500.000	Vertical	Superelevati...	R-Granular Shoulder:R-TP-EPS
X	1	R-TA-AUX	10+000.000	10+500.000	Vertical	Superelevati...	R-Shoulder Top A:R-TA-EP

Note: Additional point controls can be added for project design requirements.

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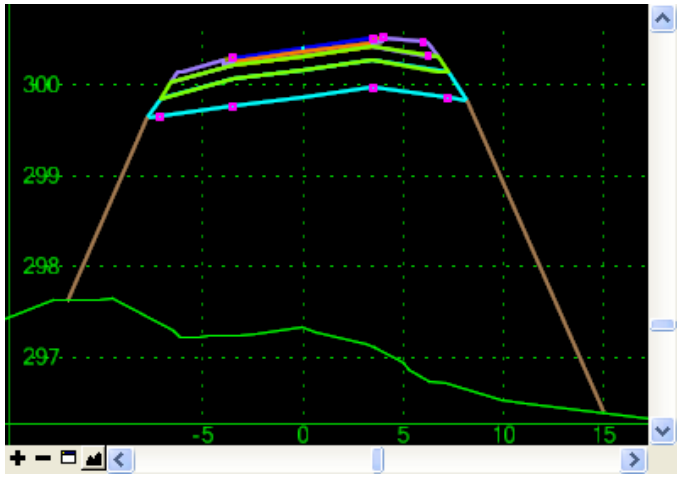
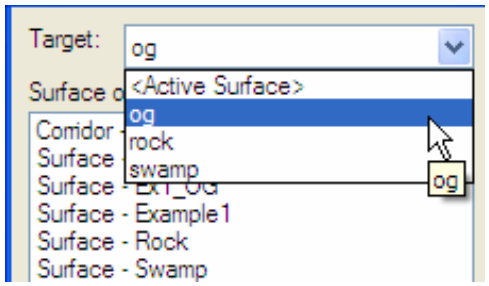
6. Close the Point Controls dialog. Select **File > Save** to save the changes.
7. View the complete template and all layers in *Normal* Display Mode. Review sections in both tangent and curves. All layers are superelevated appropriately.



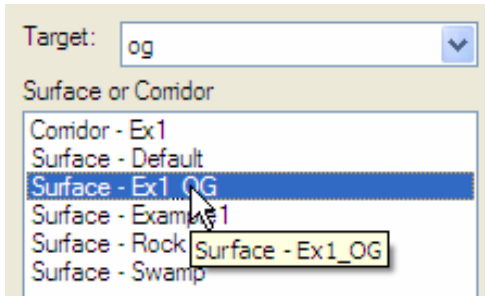
7.6 Rock and Swamp Treatments

The target surface names **og, rock** and **swamp** used for creating the template are to be used as a Target Alias.

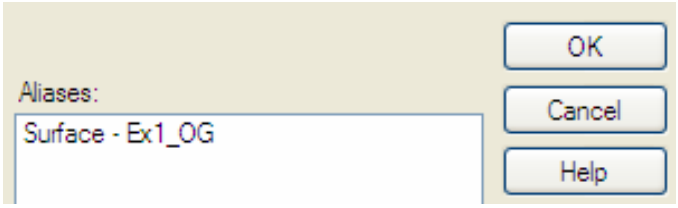
1. Select **Tools > Target Aliasing**. The Target Aliasing dialog box appears.
2. Click in the Target field, then select ***og*** from the list.



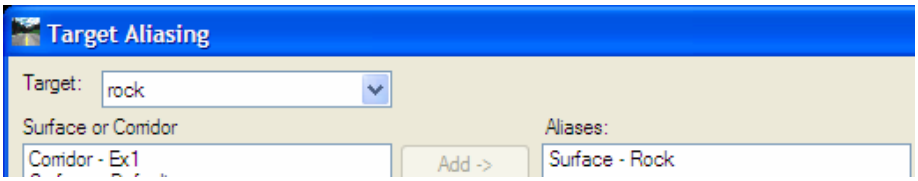
3. Select ***Surface – Ex1_OG*** form the Surface or Corridor list window on the left side of the Target Aliasing dialog.



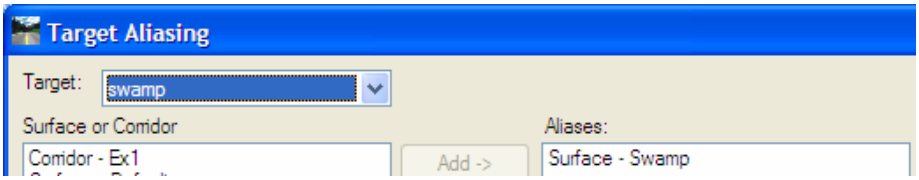
4. Click **Add** button, the selected surface will appear to the right side of the dialog in the Aliases list window.



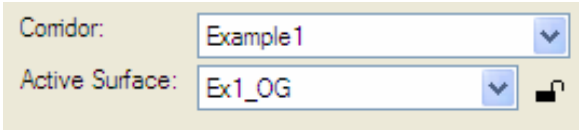
5. Click in the Target field, then select ***rock*** from the list.
6. Select ***Surface – Rock*** form the Surface or Corridor list window on the left side of the Target Aliasing dialog.
7. Click **Add** button to add the surface *Rock* to the Aliases list on the right side of the dialog.



8. Click in the Target field, then select ***swamp*** from the list.
9. Select ***Surface – Swamp*** form the Surface or Corridor list window on the left side of the Target Aliasing dialog.
10. Click **Add** button to add the surface *Swamp* to the Aliases list on the right side of the dialog.

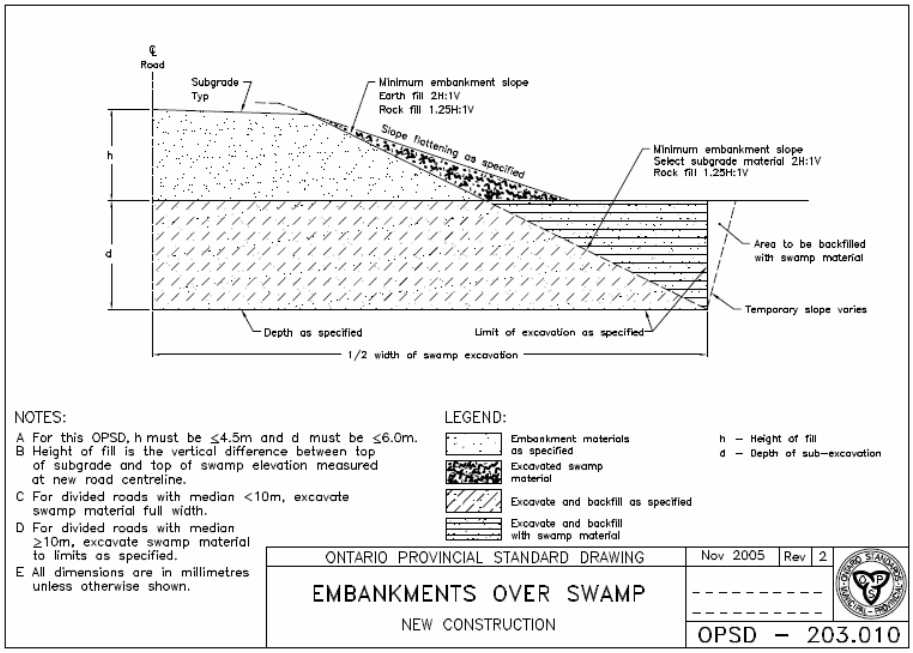


11. Click **OK** to close the dialog box.
12. In the Roadway Designer dialog, verify that the Active Surface is the existing ground surface

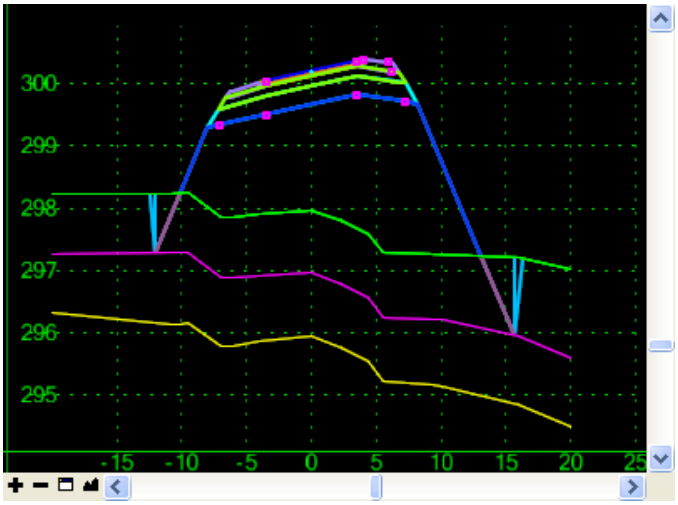


Swamp Treatment

The OPSD 203.010 Embankments Over Swamp is used for the swamp treatment. The swamp is assumed to be excavated to firm bottom.

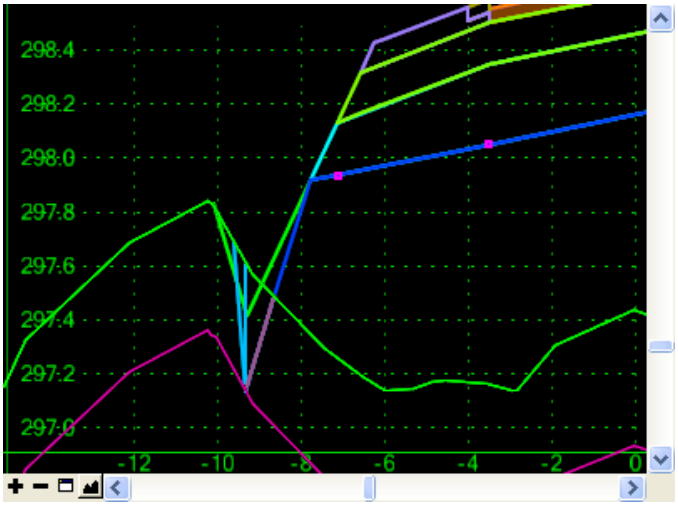


1. In the Cross Section Display window, navigate to the station range 10+080 to 10+160 where the subsurface Swamp is presented.

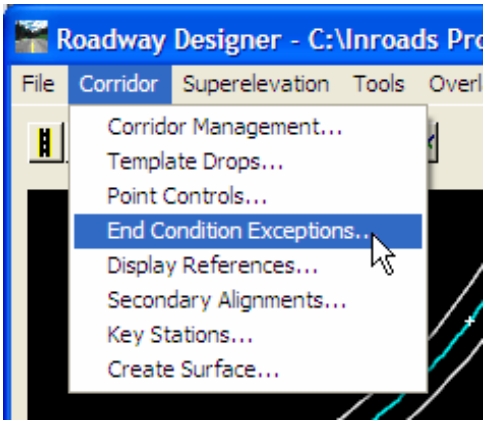


All the surfaces are shown in the cross section. The OG surface (top line) is in green, the swamp surface (middle line) is in magenta and the rock surface (bottom line) is in yellow. The swamp components (excavation, embankment, backfill etc.) are also shown in the cross section now.

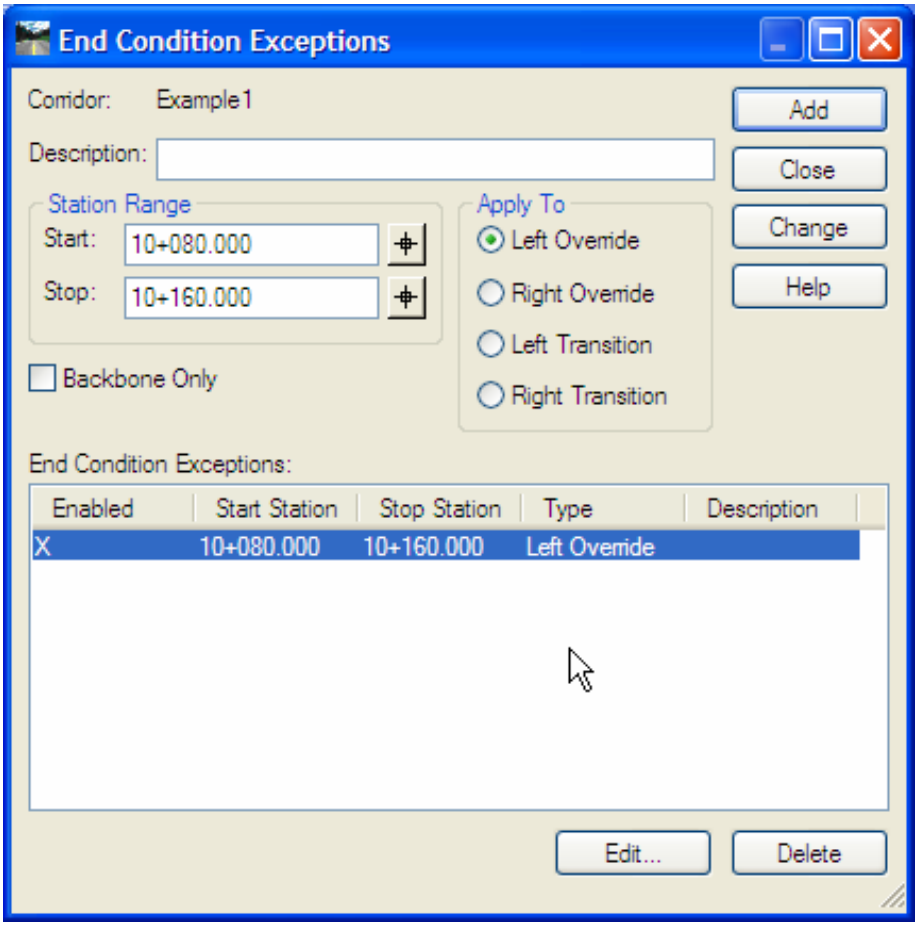
2. Go through each section that involves swamp condition. Between station 10+080 and station 10+120, left side end conditions need to be altered to reflect the embankment over swamp.



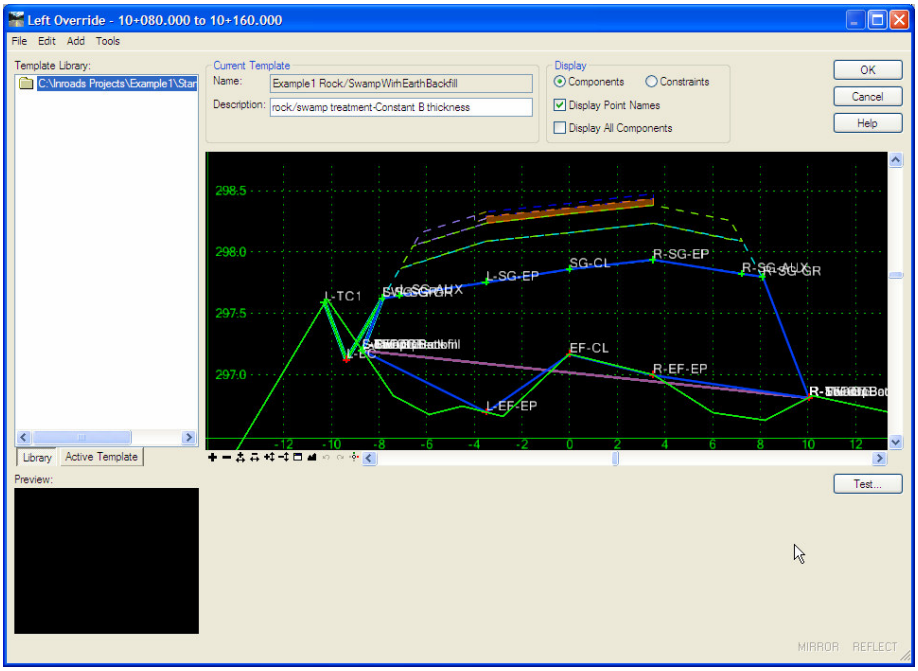
3. Record the station range then select **Corridor > End Condition Exceptions** to open the End Condition Exceptions dialog.



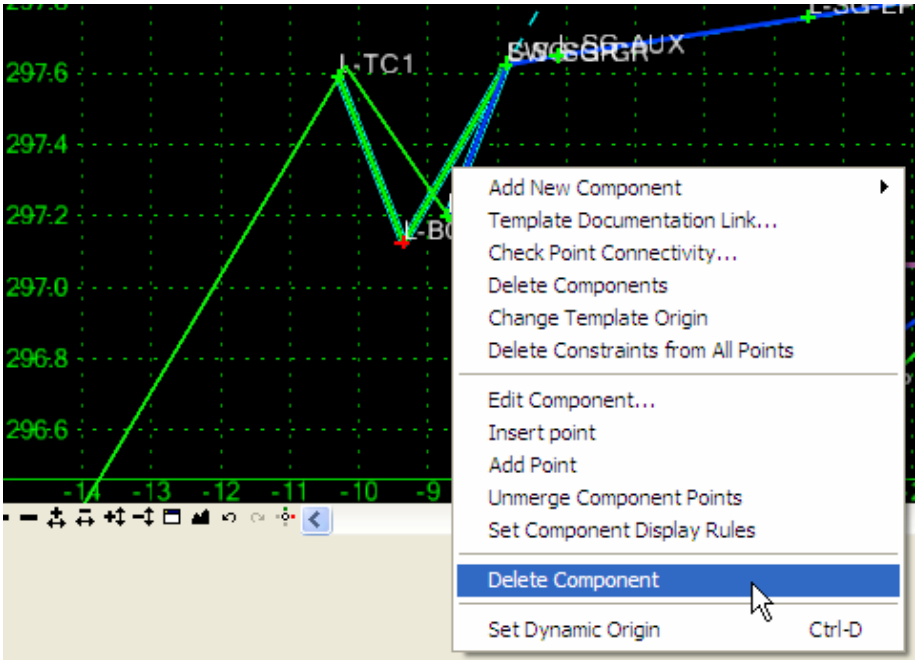
4. In the *Station Range* field of the dialog, give the *Start* station ***10+080*** and *Stop* station ***10+160*** as recorded. Select *Left Override* option in the *Apply To* field.
5. Click **Add** to create the end condition exception for the given station range.



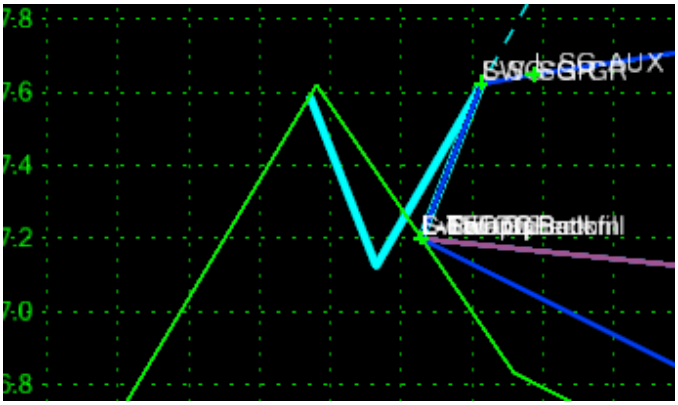
6. Click **Edit** button to open the template edit dialog.



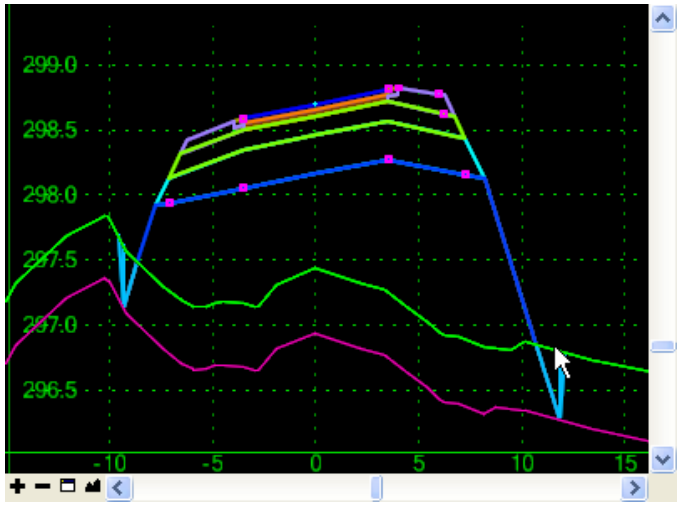
7. In the edit window, zoom in to the left side end condition. Right click on the earth cut component (in green), from the pop-up menu select **Delete Component**.



8. The selected component is deleted from the template. Click **OK** to return to the End Condition Exceptions dialog.

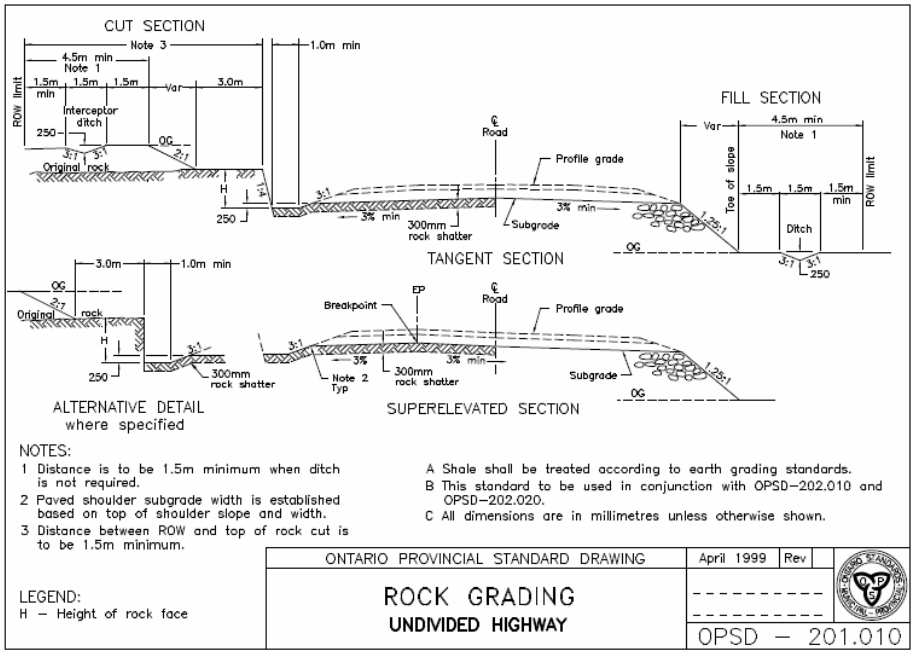


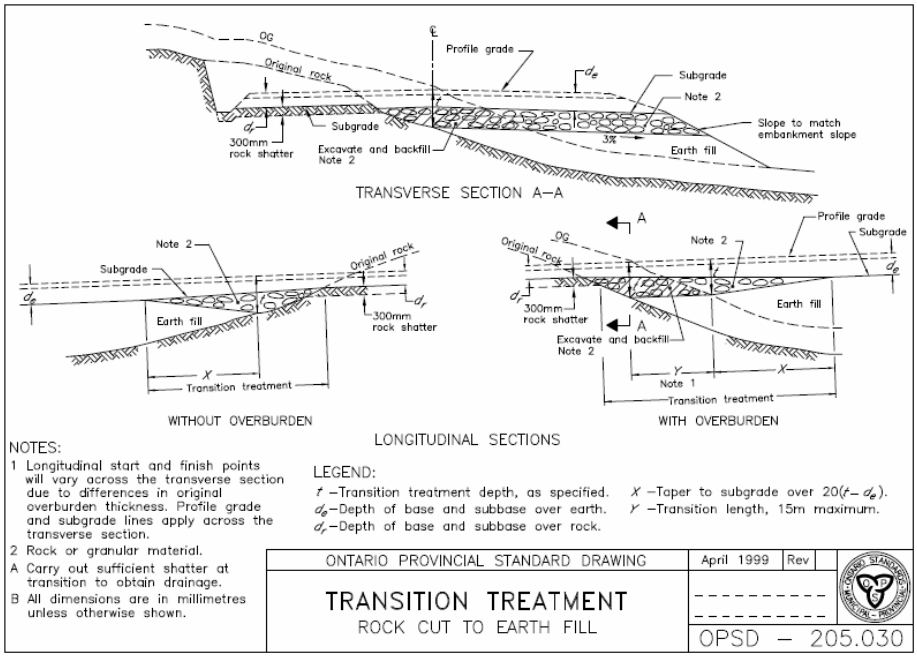
9. Click **Close** to return to Roadway Designer. Go through the swamp area again and verify the changes made to the left side end conditions.



Rock Treatment

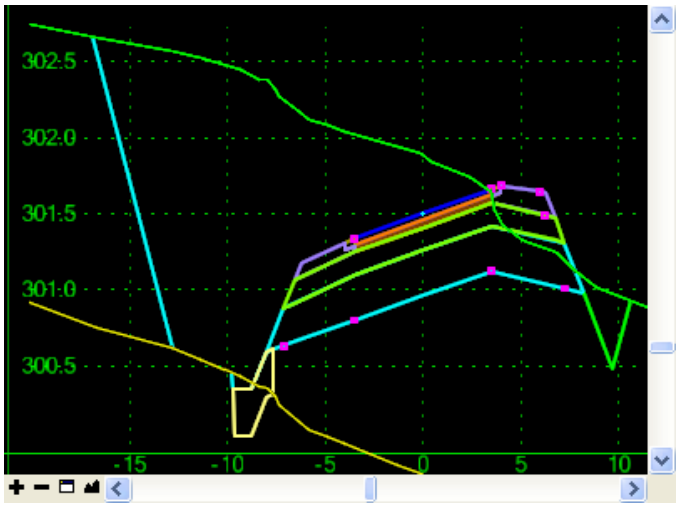
The following OPSDs are used for this example.



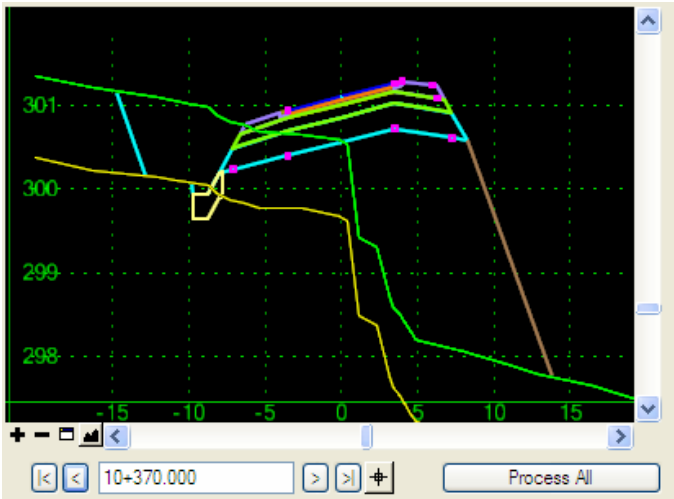


Rock in roadway cuts shall be treated. Rock treatment typically includes a uniform minimum depth of 300mm rock shatter below the theoretical rock subgrade. Granular B depth will be 150mm for rock subgrade. The transition treatment depth t, a typical frost depth 2m in MTO northeast region is used for this example.

1. In the Roadway Design, go through the cross sections. Find and record the rock cut station range.
   a) There are two sections within the corridor involve rock cut. They are from 10+180 to 10+200 and from 10+270 to 10+370.
   b) The 20m rock cut for the first section from 10+180 to 10+200 only appear within the side slope and ditch area and in short distance, no transition will be made to the sub-base (Granular B remain the same depth 300mm).

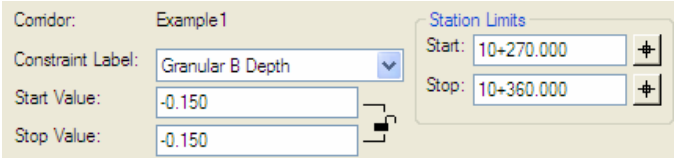


c) The last section at station 10+370 has rock cut only in side slope and ditch area, the granular B depth will remain at 300mm.



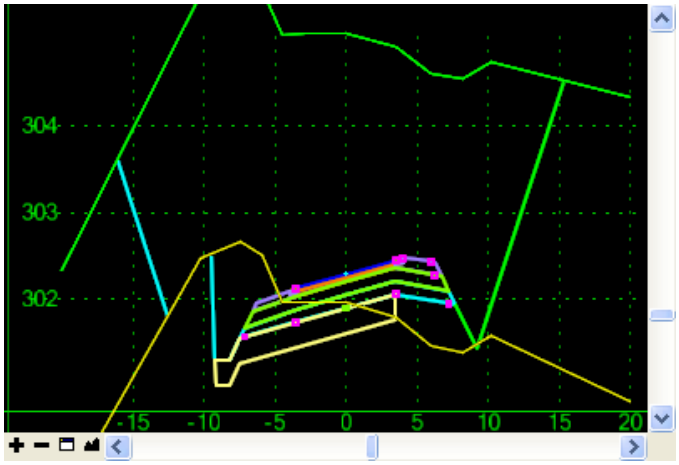
d) For the rest sections between station 10+270 and 10+360, granular B depth will change to 150mm.

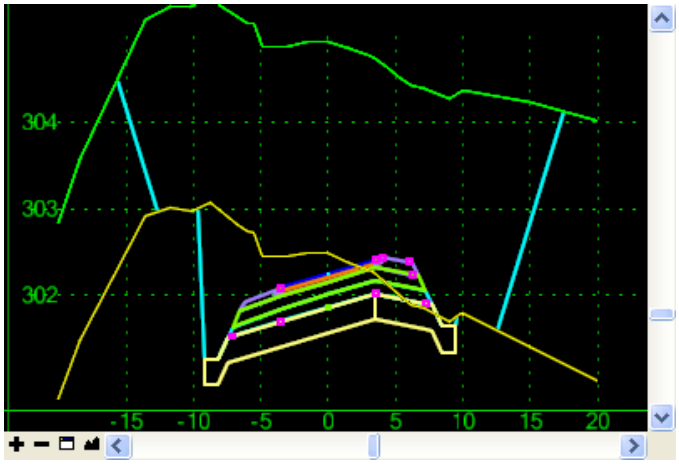
Select **Tools > Parametric Constraints**. The Parametric Constraints dialog will appear. On the dialog, set the values in the input field as following:



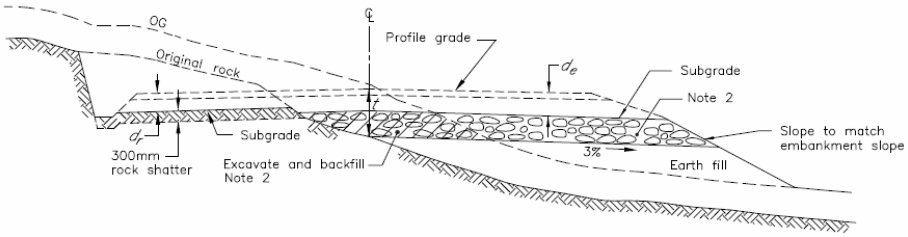
Click **Add** button on the right side to add a new entry then click close to return to roadway designer.

e) The granular B depth changed to 150mm now in the given range from 10+270 to 10+360. The rock cuts within this range involve both partial and full width rock shatter.

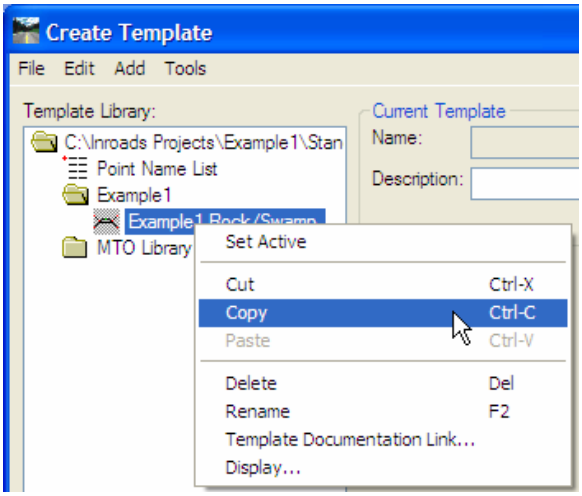




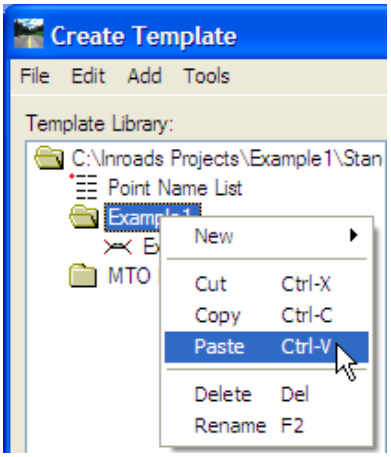
2. A new template needs to be designed to provide transition from rock to earth as per OPSD 205.030. Granular B will have different depth for rock and earth subgrade. Assume rock fill will be used for the treatment with in the depth t (2m).



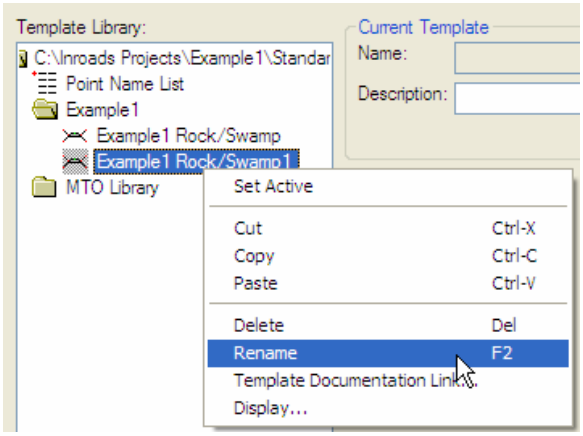
3. Close and save the Roadway Designer.
4. Select **Modeler > Create Template** to open the Create Template dialog.
5. Select the template ***Example1 Rock/Swamp*** from the Template Library on the left side of the dialog. Right click on the template then click **Copy** on the pop-up menu.



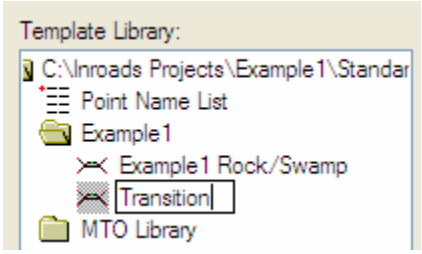
6. Right click on the folder *Example1* then click **Paste** on the pop-up menu.



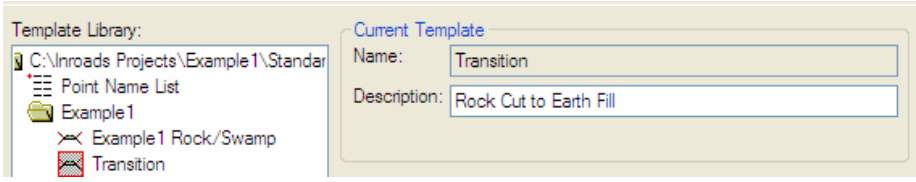
7. Right click on the newly copied template and click **Rename** on the pop-up menu.



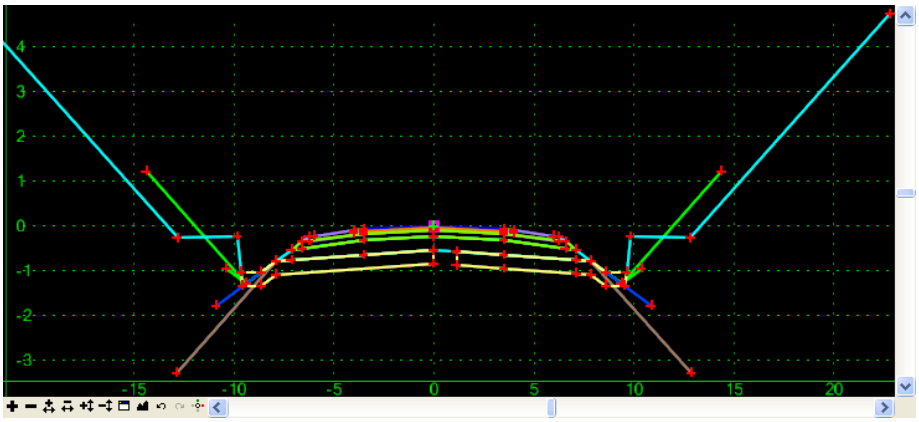
8. Type in a new name ***Transition***.



9. Give additional information in the *Description* filed for template Transition.

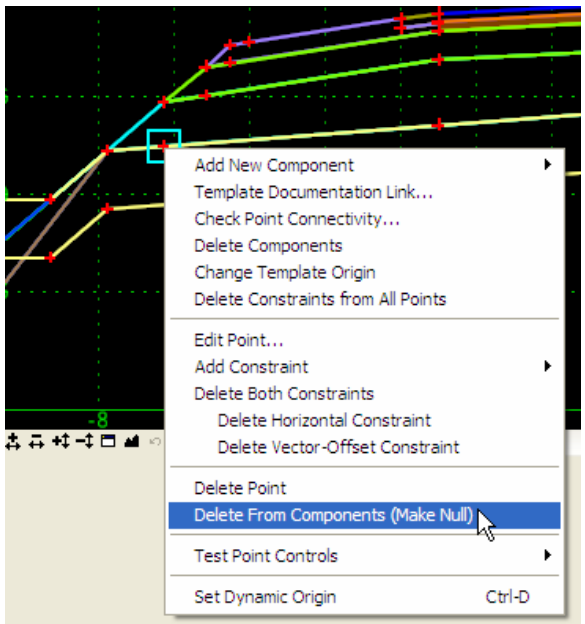


10. To make the template simple, delete all the swamp relate components (No need for this section). These include component ***Swamp Check, L-Swamp Backfill, R-Swamp Backfill, Swamp Excavation, Fill, Swamp Backfill***.

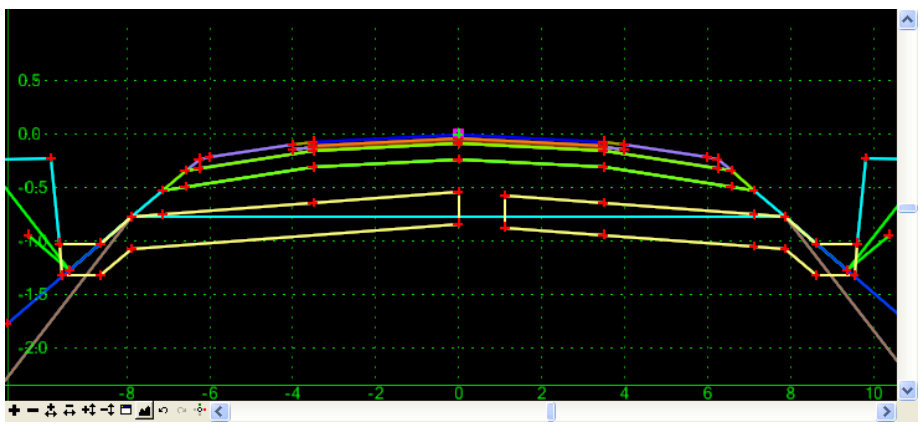


11. Since the rock cut and transitions are all within the full superelevation range, the actual Crown Point for the subgrade will be the point R-SG-EP. To accommodate the transition for granular depth from 150mm to 300mm, add two auxiliary points on each side of the crown point R-SG-EP on the subgrade layer.

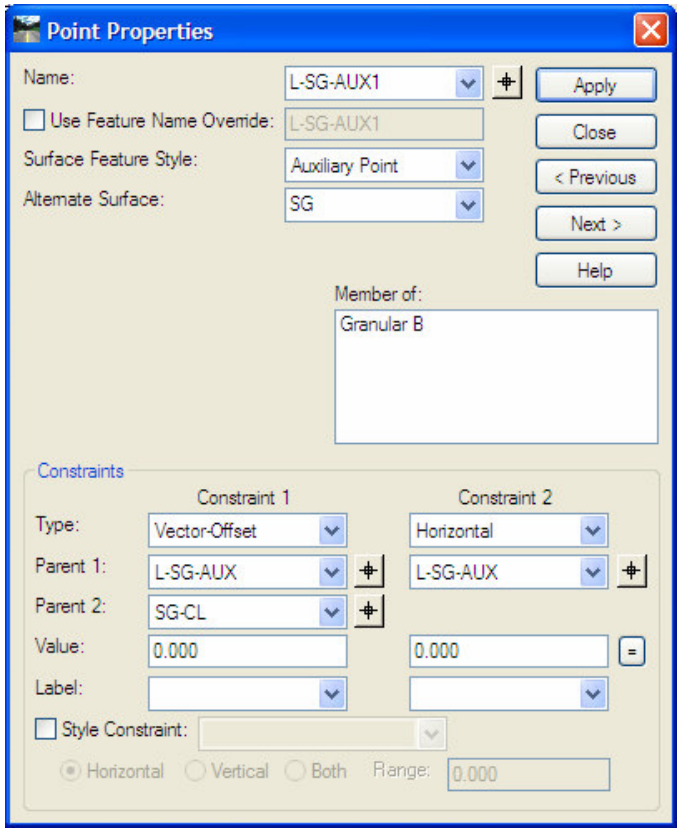
    Right click on point ***L-SG-AUX***, select **Delete From Components (Make Null)** from the pop-up menu.



Repeat the above process to make points ***L-SG-EP, SG-CL, R-SG-EP,*** and ***R-SG-AUX*** to Null points.



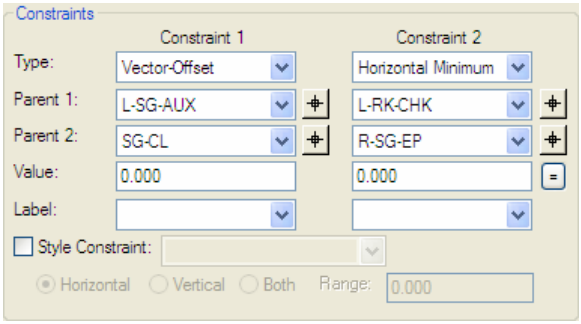
12. Add point ***L-SG-AUX1*** to component *Granular B* with Point Properties set as:



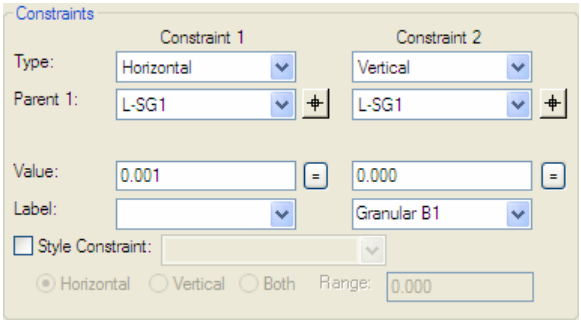
13. Add point ***L-SG1*** and ***L-SG2*** to component *Granular B* between L-SG-AUX and R-SG-EP with *Surface Feature Style* set to ***Auxiliary***. These two points are used for granular B transition on the left side of the crown point.

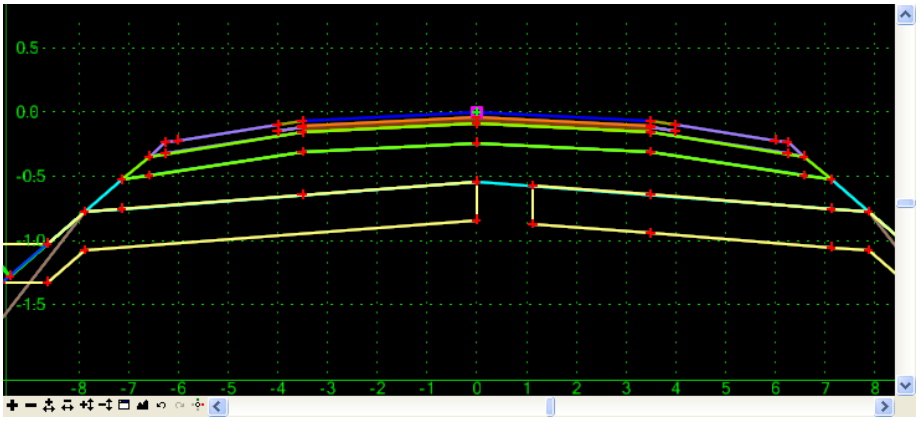
    Point *Constraints* are set as:

L-SG1



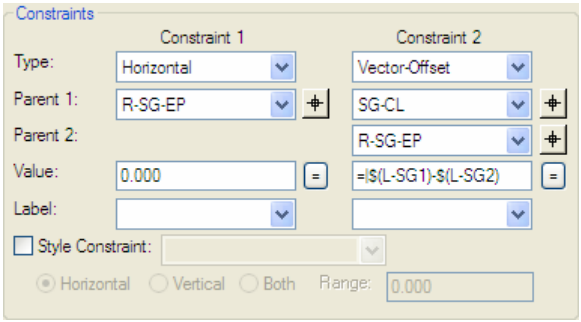
L-SG2



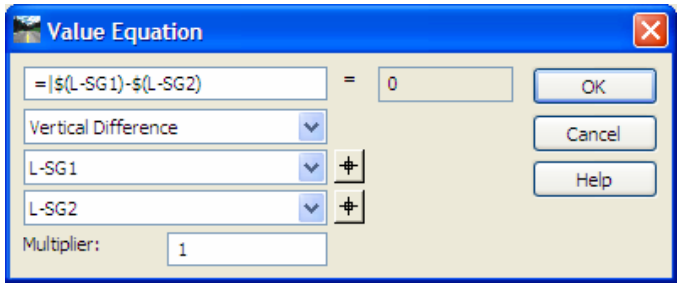


14. Insert point ***R-SG-EP1*** to component *Granular B* with *Surface Feature Style* set to ***Edge of Pavement*** and point *Constraints* set as:

R-SG-EP1

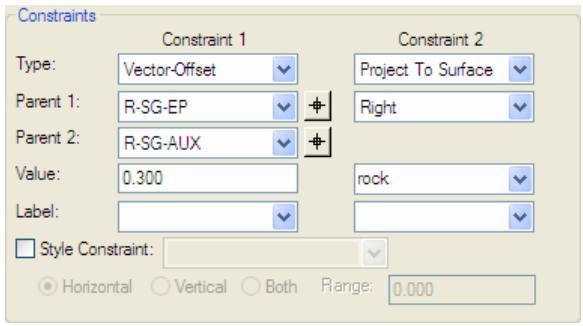


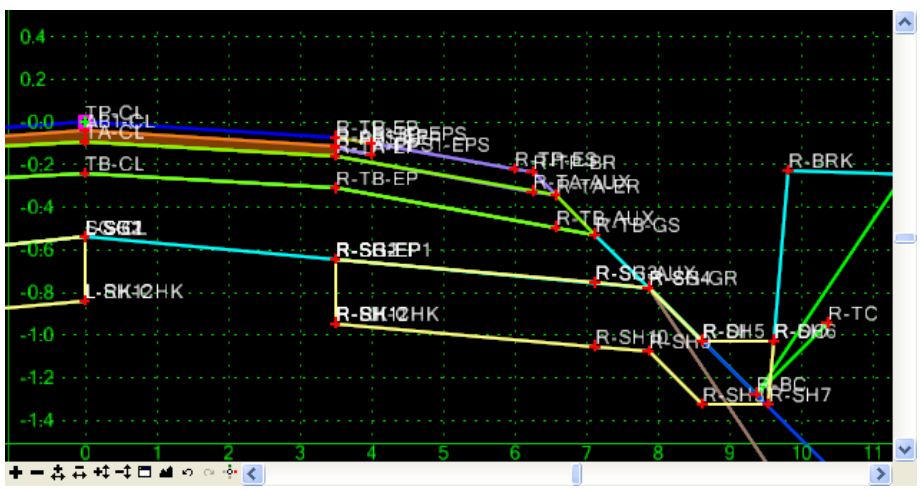
The *Vector-Offset* constraint (Constraint 2) can be input manually or set by using the Value Equation dialog. Click on the button on the right side of the input field, and then select value from the drop-down list on the Value Equation dialog.



15. Move point R-RK-CHK to the right and right under point R-SG-EP. Change the point *Constraints* as shown below:

R-SG-EP1

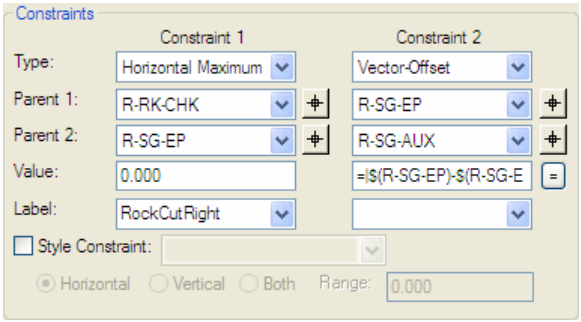




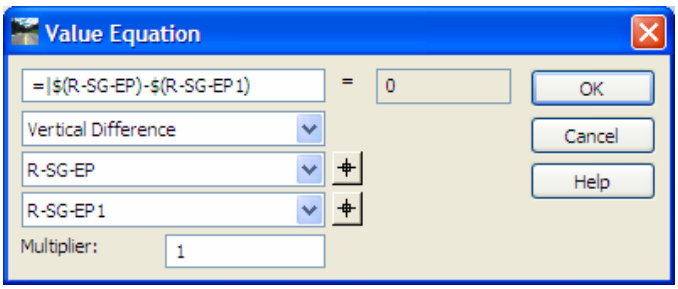
16. Add point ***R-SG1*** and ***R-SG2*** to component *Granular B* between R-SG-EP and R-SG-AUX with *Surface Feature Style* set to ***Auxiliary***. These two points are used for granular B transition on the right side of the crown point.

    Point *Constraints* are set as:

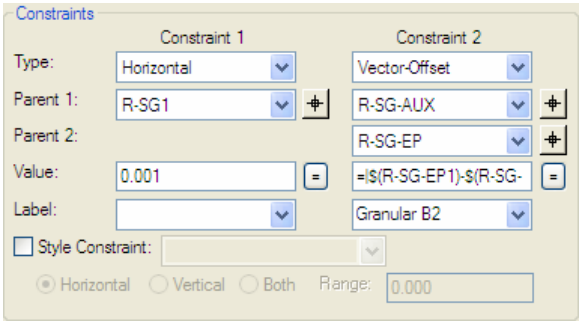
R-SG1



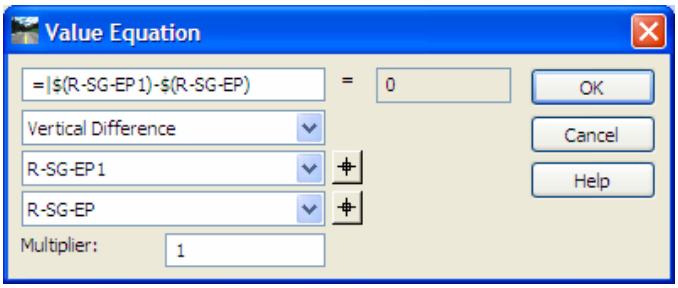
The *Vector-Offset* constraint (Constraint 2) set as:



R-SG2

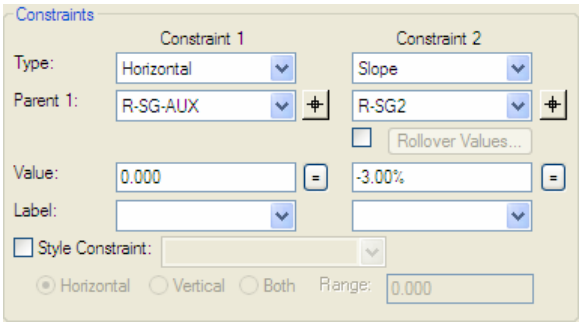


The *Vector-Offset* constraint (Constraint 2) set as:

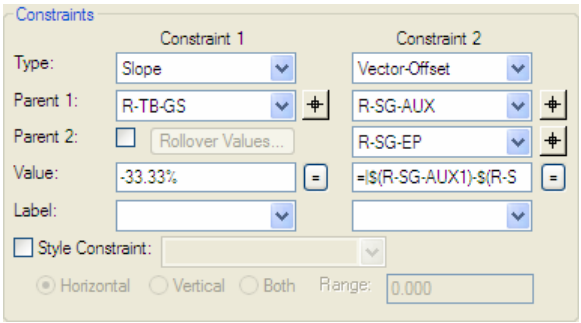


17. Insert point ***R-SG-AUX1*** to component *Granular B* with *Surface Feature Style* set to ***Auxiliary*** and point *Constraints* set as:

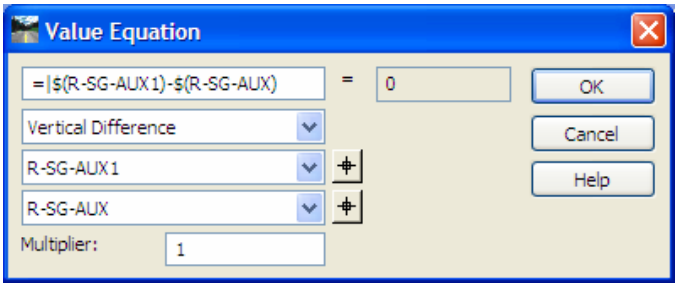
R-SG-AUX1



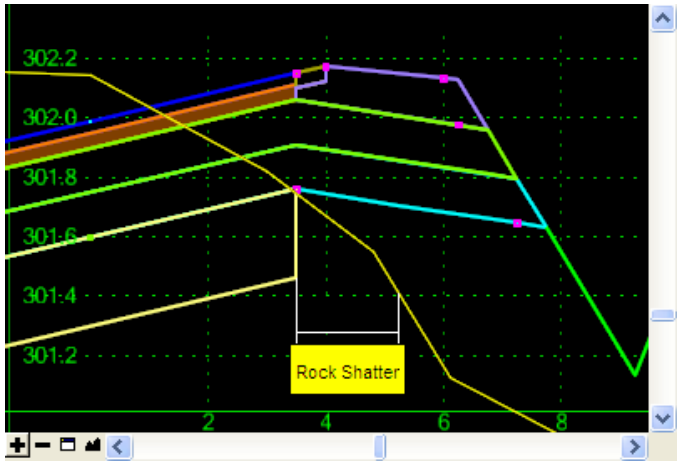
18. Change point R-SG-GR *Vector-Offset* constrain to:



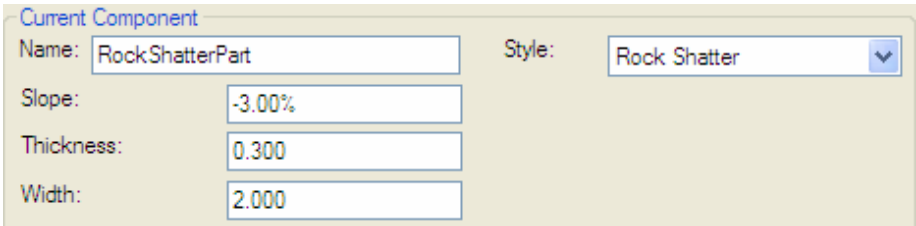
The *Vector-Offset* constraint (Constraint 2) set as:



19. A partial rock shatter component need to be added to the template to capture the rock shatter quantities when the transition falls in between points R-SG-EP and R-SG-GR.



Right click in the template edit window, select **Add New Component > Simple**. Put the following information in the *Current Component* input fields.

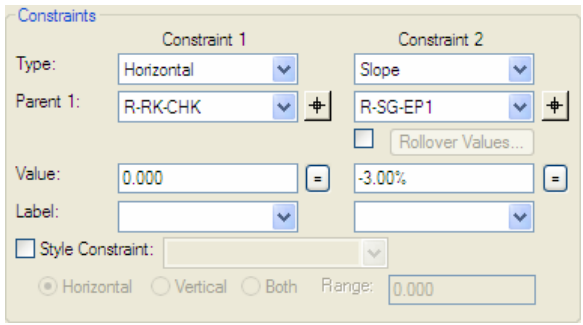


A new component RockShatterPart is added to the template with default point names.

20. Move the top left point of the newly created component to the point L-SH1 and merge with point L-SH1. Move the bottom left point of the newly created component to the point L-SH12 and merge with point L-SH12.

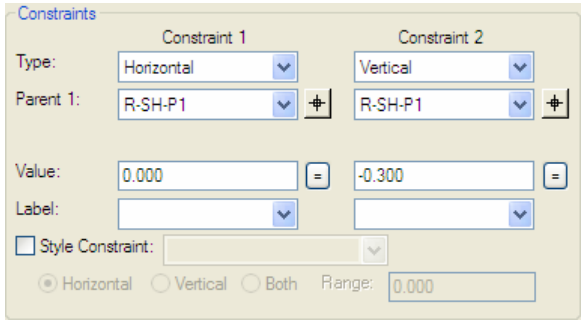
21. Rename top right point to ***R-SH-P1*** and set the point *Constraints* as:

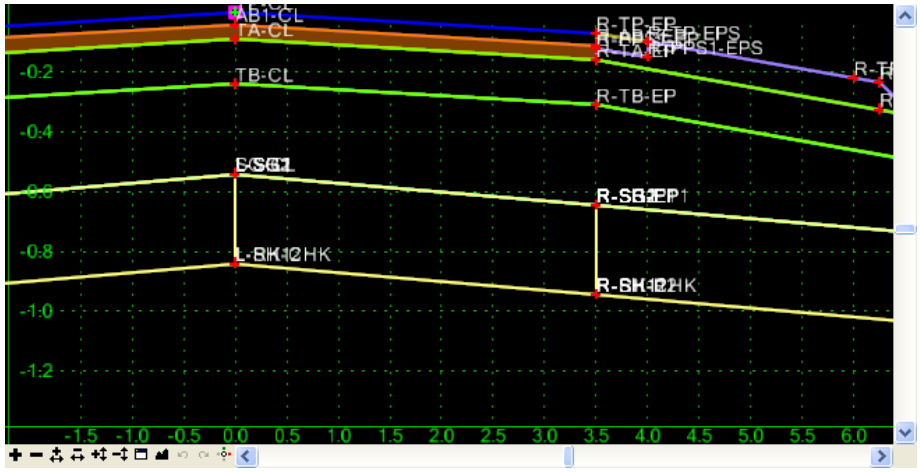
R-SH-P1



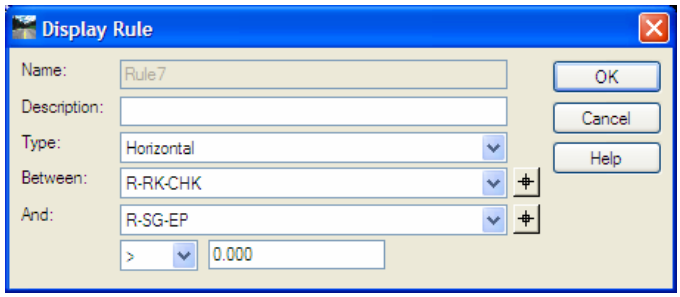
22. Rename bottom right point to ***R-SH-P2*** and set the point *Constraints* as:

R-SH-P2

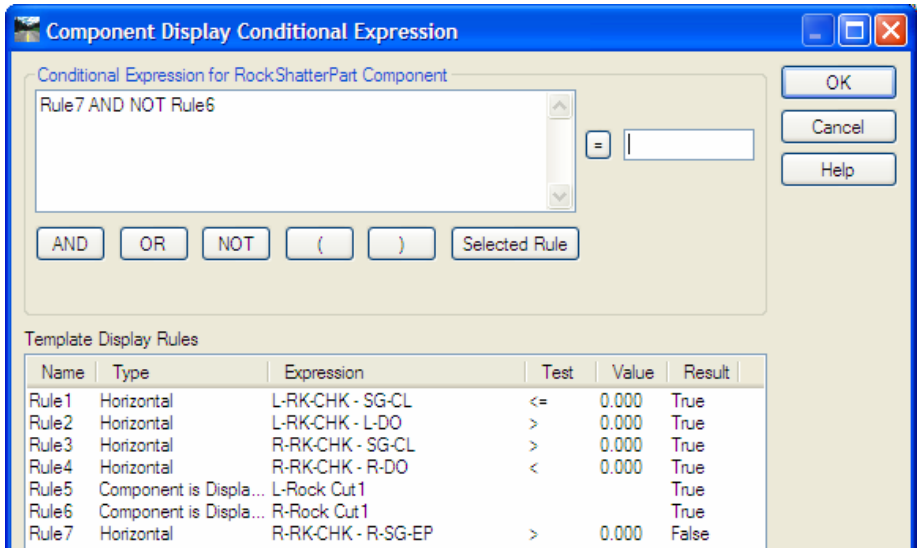




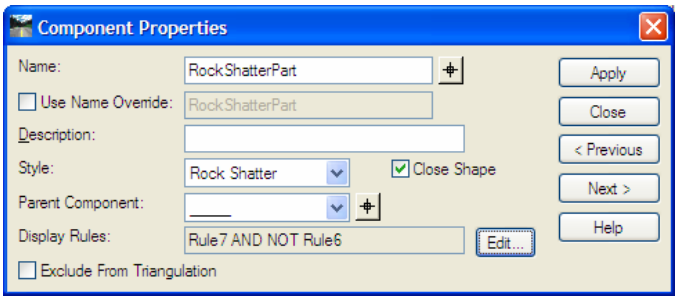
23. Add display rule to the component. Double click on the component to open up the Component Properties dialog. Click **Edit** button on the right side of the *Display Rules* field. A new dialog – Component Display Conditional Expression dialog appears. Click **Add** button and add the following rule to the template:



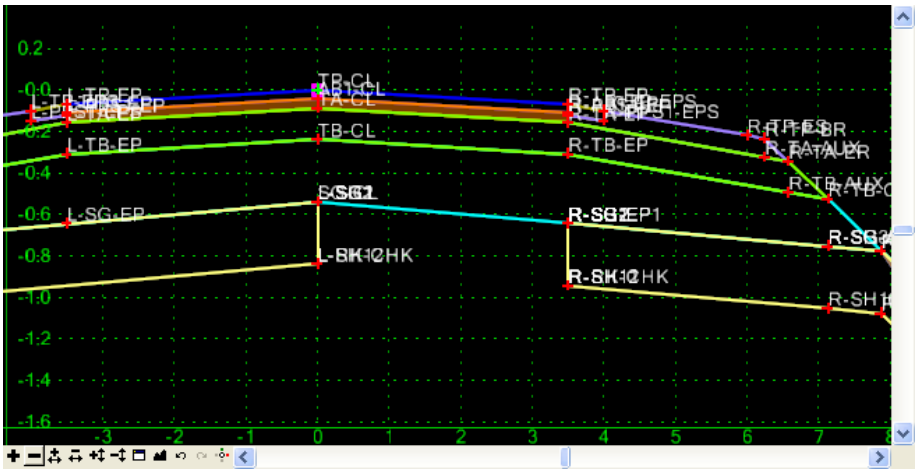
Create the conditional expression for ***RockShatterPart*** as shown below:



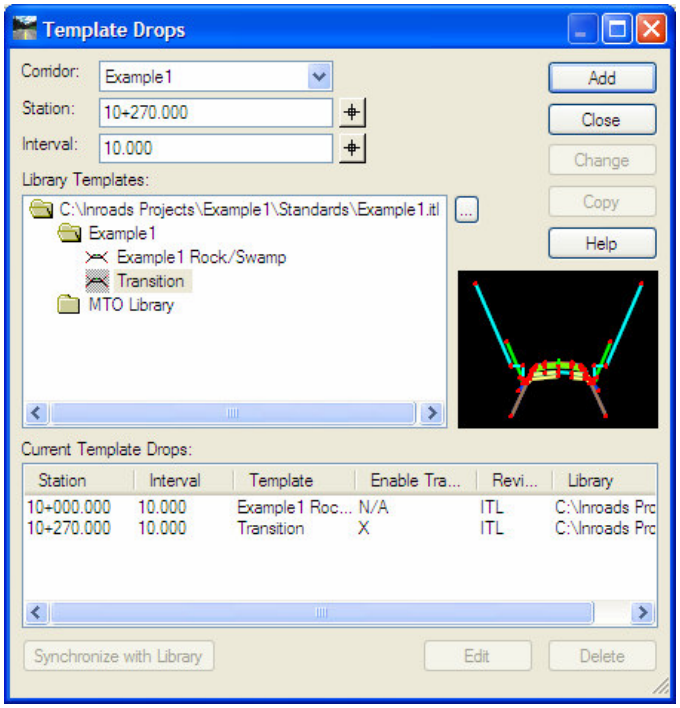
Click **OK** to return to Component Properties dialog.



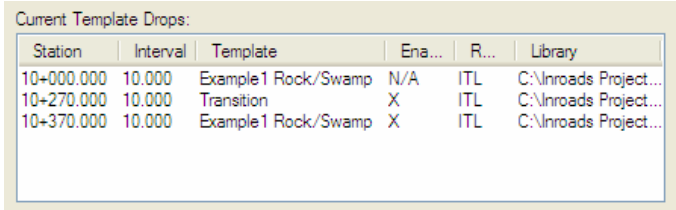
24. Click **Apply** then **Close** button to close the dialog. The component temporarily disappeared form the template.



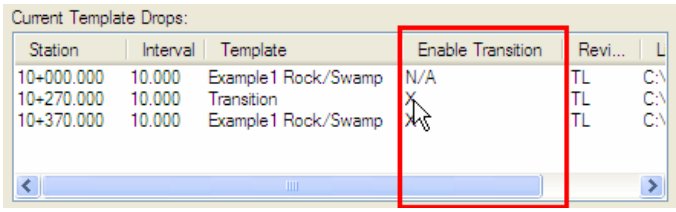
25. Save the template and close Create Template dialog. Open Roadway Designer.
26. Select **Corridor > Template Drops**. The Template Drops dialog appears.
    a) On the dialog, verify that the current Corridor is ***Example1***.
    b) Type ***10+270*** in the *Station* field and ***10*** in the *Interval* field.
    c) In the *Library Templates* window, double click on the active template library ***Example.itl***, and then double click on the folder ***Example1***.
    d) When the folder expanded, select template ***Transition*** from the library tree.
    e) Click **Add** button on the right side to add the selected template to the *Current Template Drops* list.



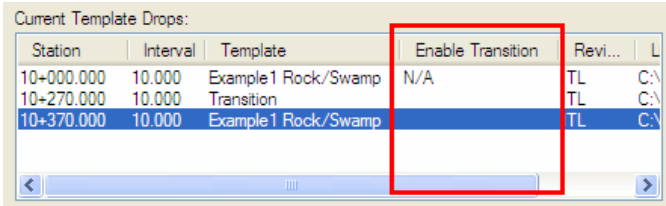
27. Add template ***Example1 Rock/Swamp*** at the end of the transition:
    a) Type ***10+370*** in the *Station* field and ***10*** in the *Interval* field.
    b) Select template ***Example1 Rock/Swamp*** from the library tree under *Example1*.
    c) Click **Add** button on the right side to add the selected template to the *Current Template Drops* list.



28. Disable template transition by clicking on the **X** in the *Enable Transition* column in the *Current Template Drops* window.

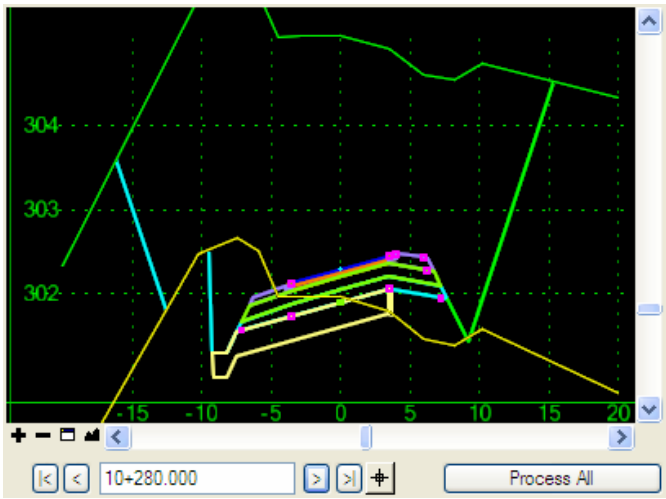


The column will show blank after the transitions have been removed between the templates.

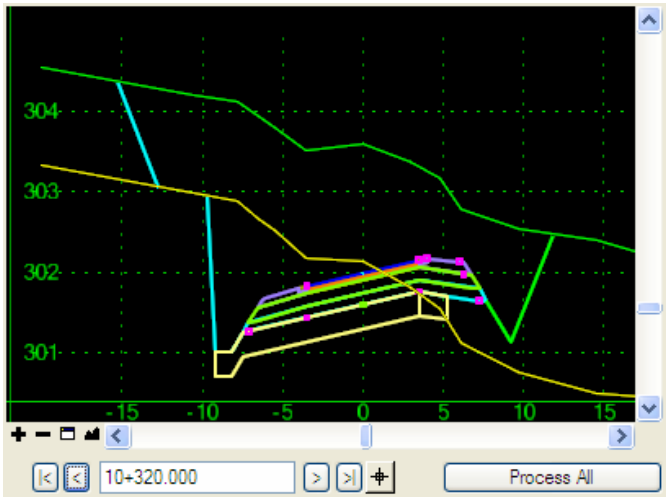


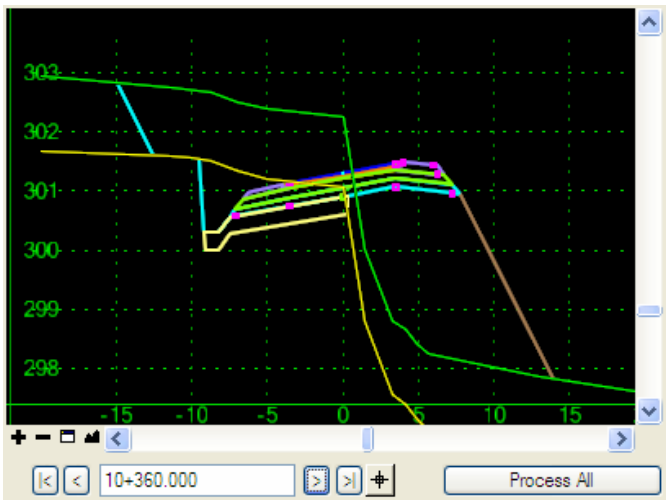
29. Click **Close** button to dismiss the dialog and return to *Roadway Designer*. Select **File > Save** to save the corridor file with new template drops.
30. Go through the cross sections between station 10+270 and station 10+360.

    For transition from partial rock shatter to full rock shatter, the rock cut edge shift from left side of point R-SG-EP at station 10+270 to the right side of the point at 10+280.



For transition from full rock shatter to partial rock shatter, the rock cut edge shift from right side of point R-SG-EP at station 10+320 to the left side of the point at 10+360.



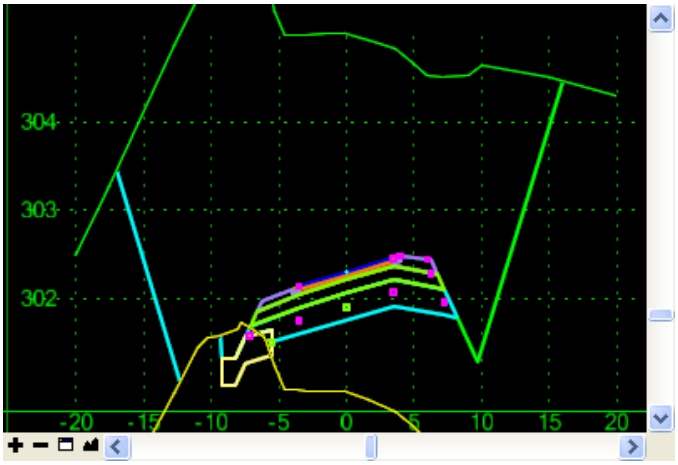


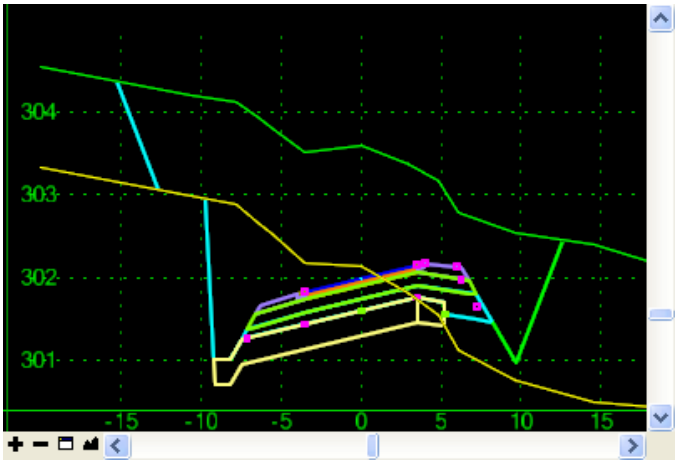
31. Record the transition range then, select **Tools > Parametric Constraints.** On the Parametric Constraints dialog, add following entries:

Override Values:

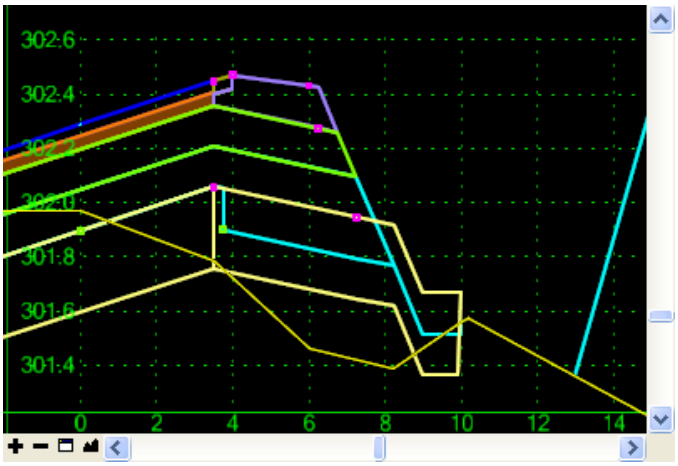
Enabled	Name	Start Value	Stop Value	Start Station	Stop Station
X	Granular B Depth	-0.150	-0.150	10+270.000	10+360.000
X	Granular B1	-0.150	-0.150	10+270.000	10+279.000
X	Granular B2	-0.150	-0.150	10+280.000	10+280.000
X	Granular B2	-0.150	-0.150	10+320.000	10+340.000
X	Granular B1	-0.150	-0.150	10+350.000	10+360.000

32. Click on **Close** to dismiss the dialog. In Roadway Designer, check the transition cross sections again. All the cross sections in the transition range now have granular B transformed from 150mm to 300mm.



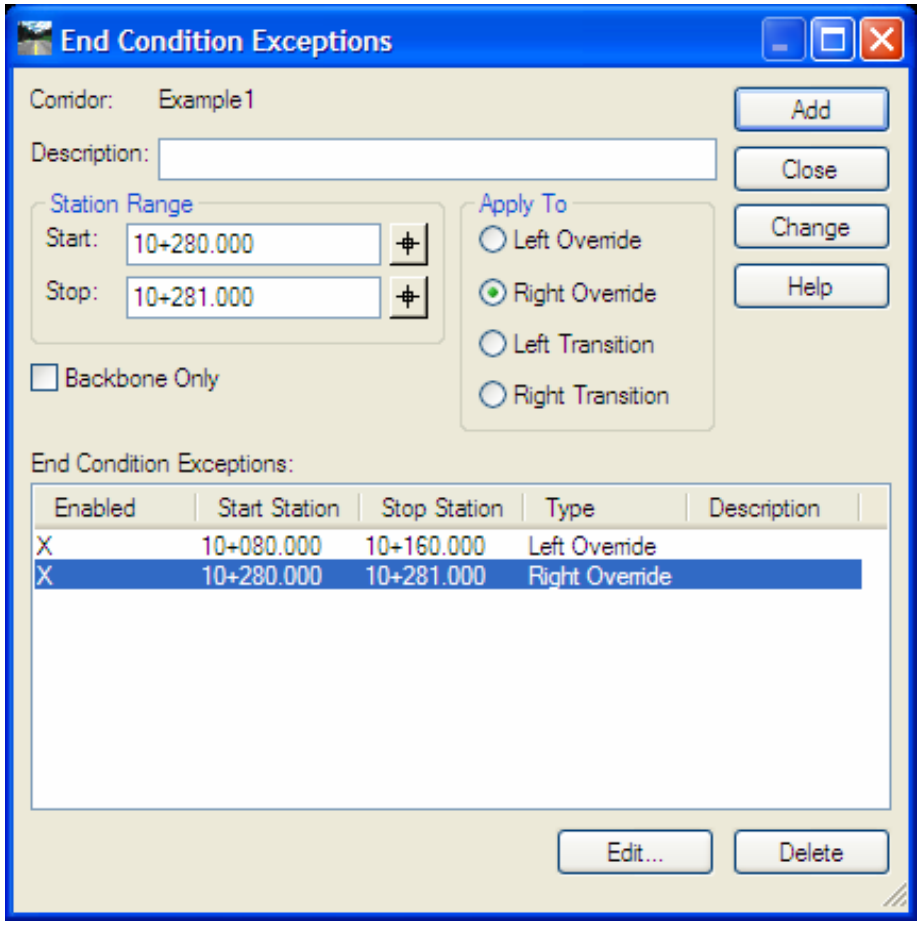


33. Because of different depth of granular B, the full range rock shatter on the right side of R-SG-EP is showing up at station 10+280 now.

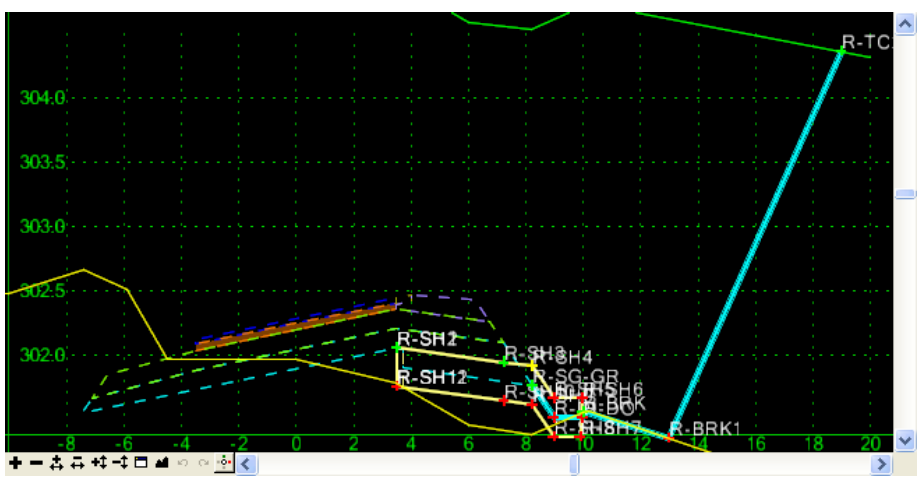


To fix this cross section, select **Corridor > End Condition Exceptions** to open the End Condition Exceptions dialog.

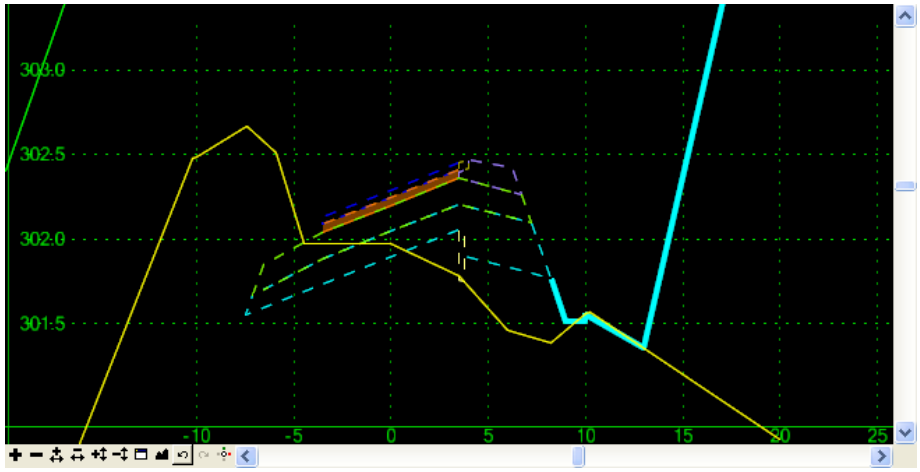
34. In the *Station Range* field of the dialog, give *Start* station ***10+280*** and *Stop* station ***10+281***. Select *Right Override* option in the *Apply To* field.
35. Click **Add** to create the end condition exception for the given station range.



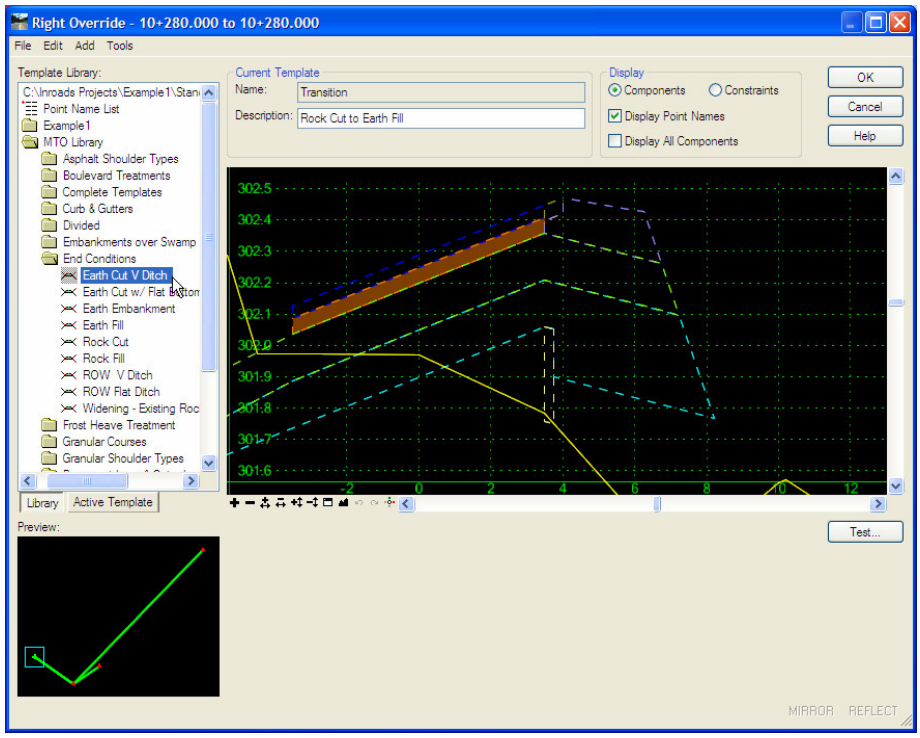
36. Click **Edit** button to open the template edit dialog.



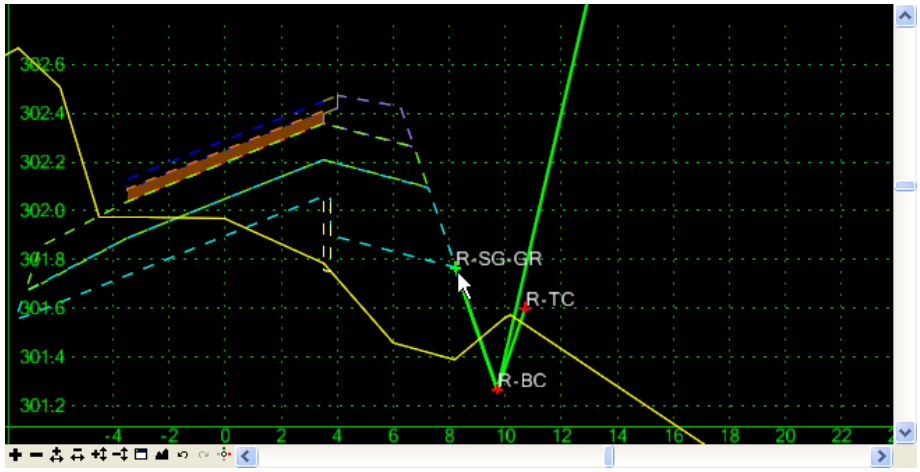
37. In the edit window, delete both ***R-Rock Cut*** and ***R-Rock Cut1*** components (in cyan).



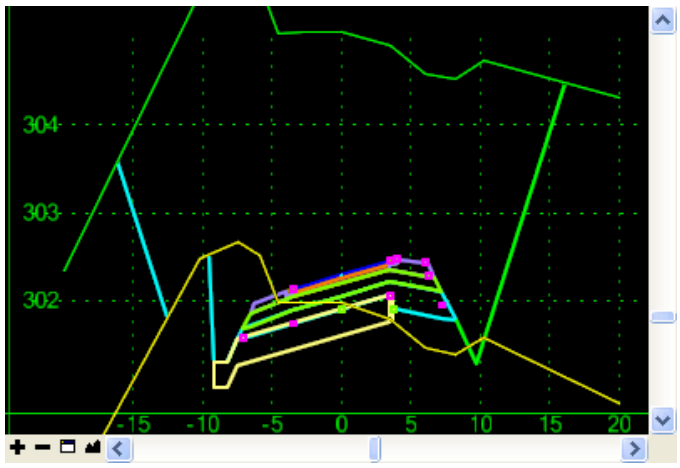
38. In the Template Library window on the left side of the dialog, expand the **MTO Library** folder. Find the end condition ***Earth Cut V Ditch*** under **End Conditions**.



Drag and drop the selected end condition to point R-SG-GR.



39. Click **OK** to return to the End Condition Exceptions dialog. Click **Close** to return to Roadway Designer.



40. The transition from rock to earth also involves rock fill as treatment within the depth of t (2m). To estimate the rock fill quantities, additional components need to be added to the template. Save and close the Roadway Designer.

Note: Rock fill will have different scenarios which include the fill depth is more or less than the treatment depth, the start point is on the left or the right side of subgrade crown point.

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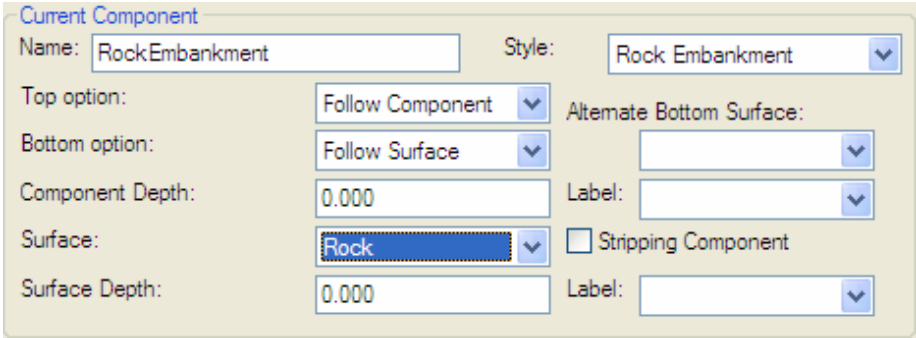
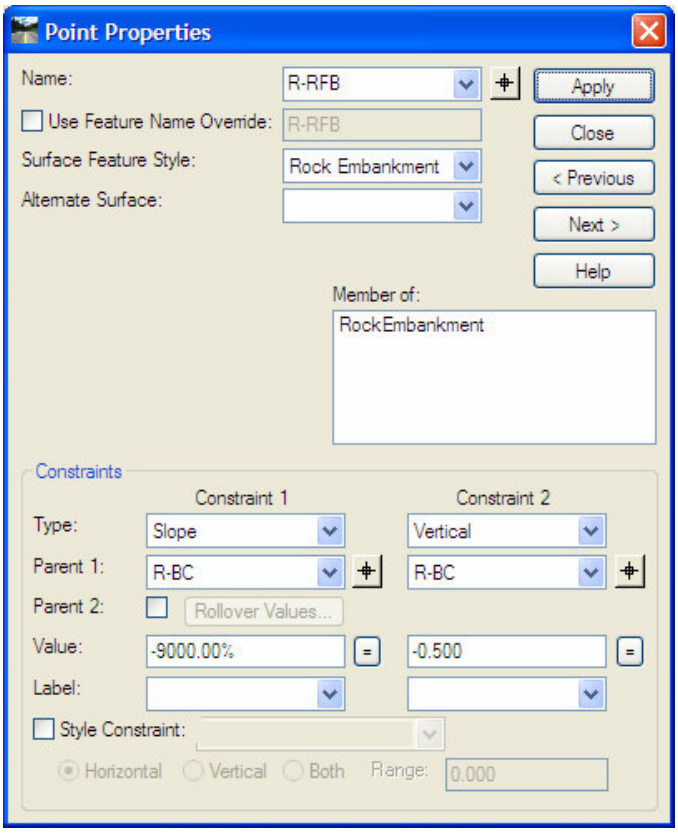
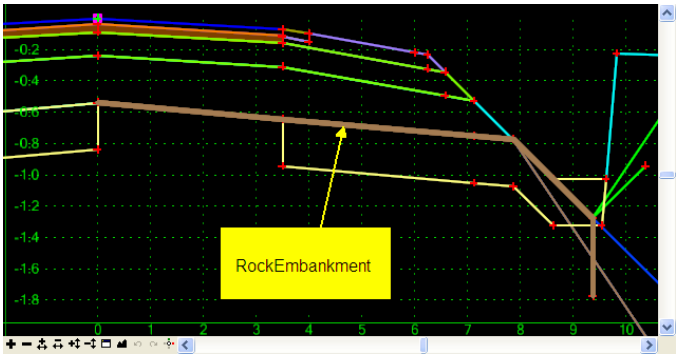
41. Open the Create Template dialog. Make the template Transition to be the active template. Right click in the template edit window, select **Add New Component > Overlay/Stripping** from the pop-up menu.
42. A *Current Component* field appears below the template edit window. Create component ***RockEmbankment*** with information input as shown bellow:

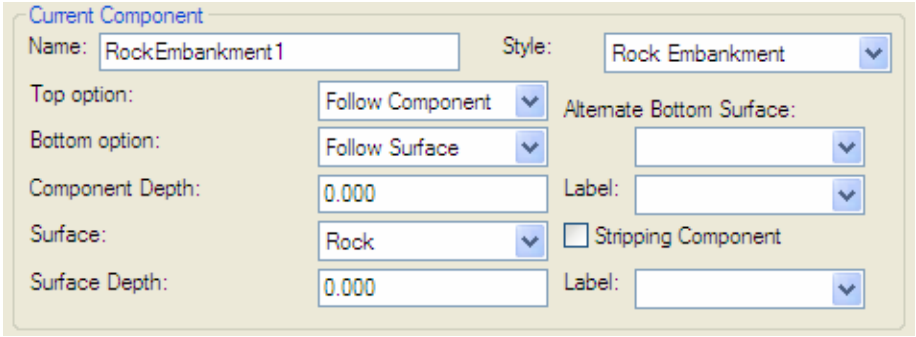


The RockEmbankment component will go through points L-SG2, R-SG-EP1, R-SG-GR, R-BC, and with the last point R-RFB set as:



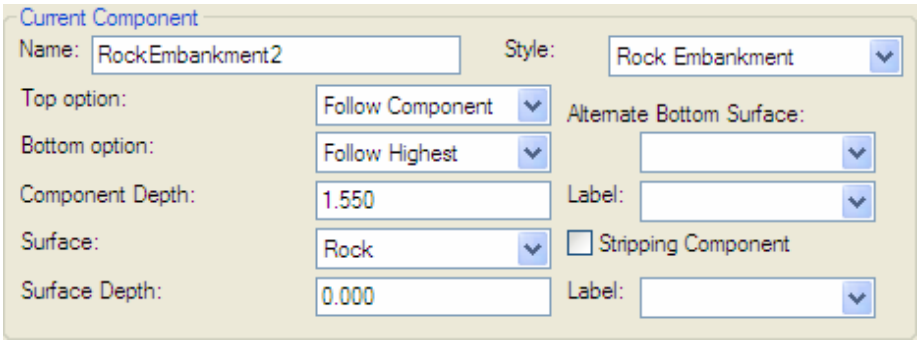


43. Right click in the template edit window and select **Add New Component > Overlay/Stripping** from the pop-up menu. Create component ***RockEmbankment1*** with information input as shown bellow:

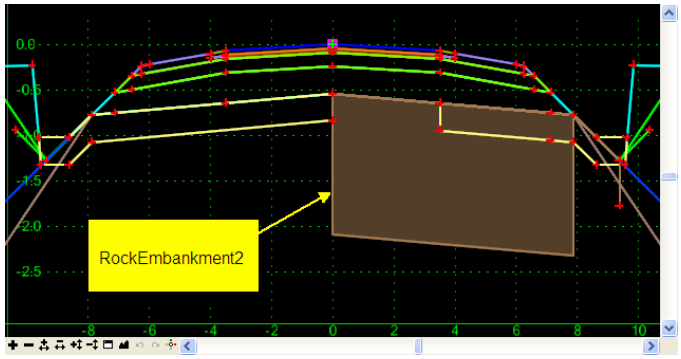


The RockEmbankment1 component will go through points R-SG2, R-SG-GR, R-BC, and point R-RFB.

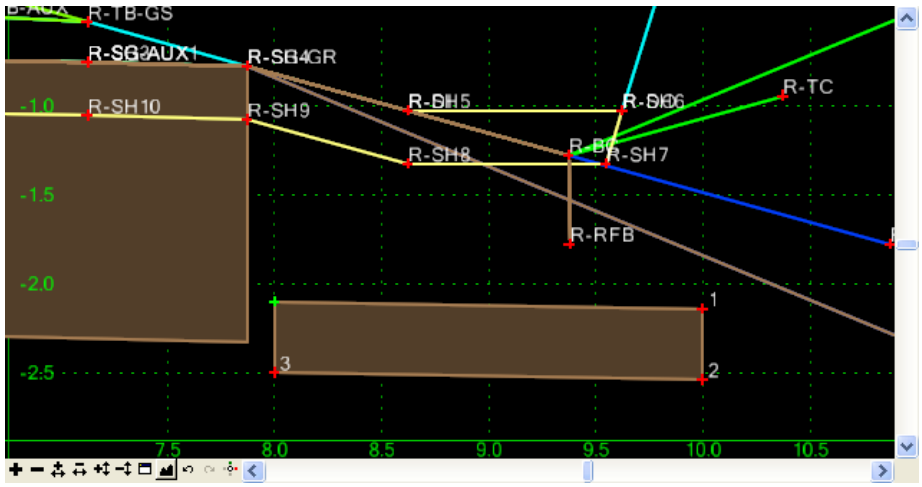
44. Right click in the template edit window and select **Add New Component > Overlay/Stripping** from the pop-up menu. Create component ***RockEmbankment2*** with information input as shown bellow:



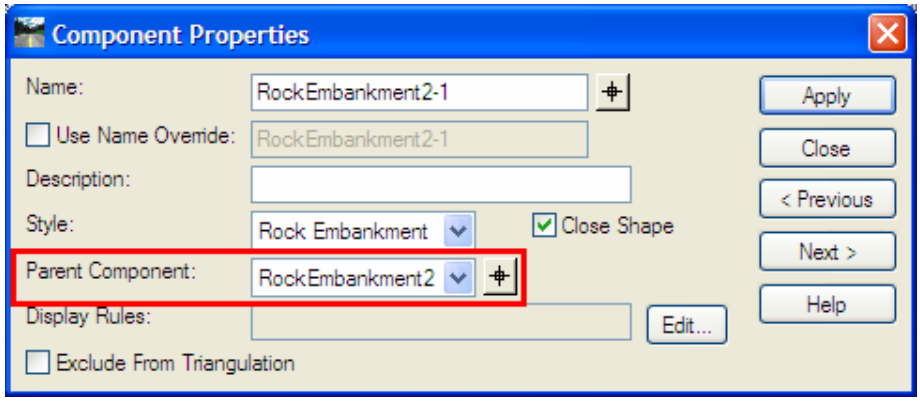
The RockEmbankment2 component will go through points L-SG2, R-SG-EP1, R-SG-GR.



45. Right click in the template edit window and select **Add New Component > Simple** from the pop-up menu to create a component ***RockEmbankment2-1*** to the right of component **RockEmbankment2**.

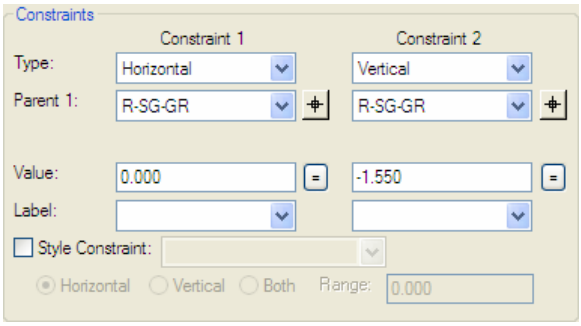


Modify component properties to make RockEmbankment2-1 to be child component of RockEmbankment2.



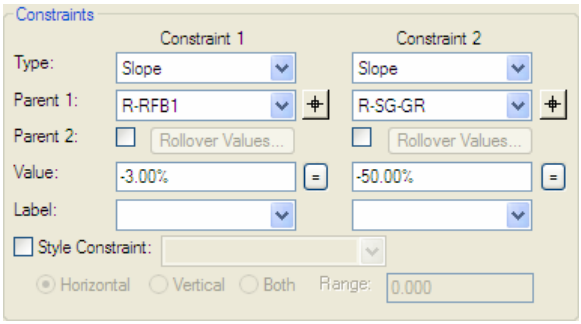
46. Move the top left point of component RockEmbankment2-1 to point R-SG-SG and merge with point R-SG-GR.
47. Rename point 3 to ***R-RFB1*** and set constraints as:

R-RFB1



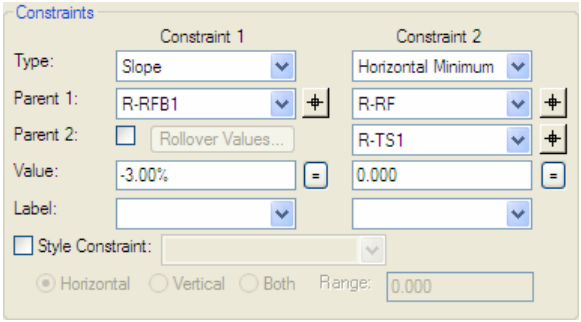
48. Right click in the template edit window and select **Add New Component > Null Point** from the pop-up menu to create a null point ***R-RF*** and set constraints as:

R-RF



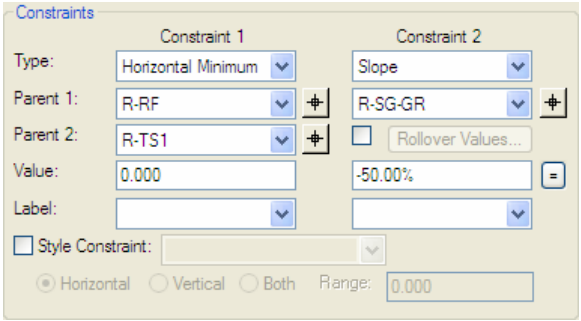
49. Rename point 2 to ***R-RFB2*** and set constraints as:

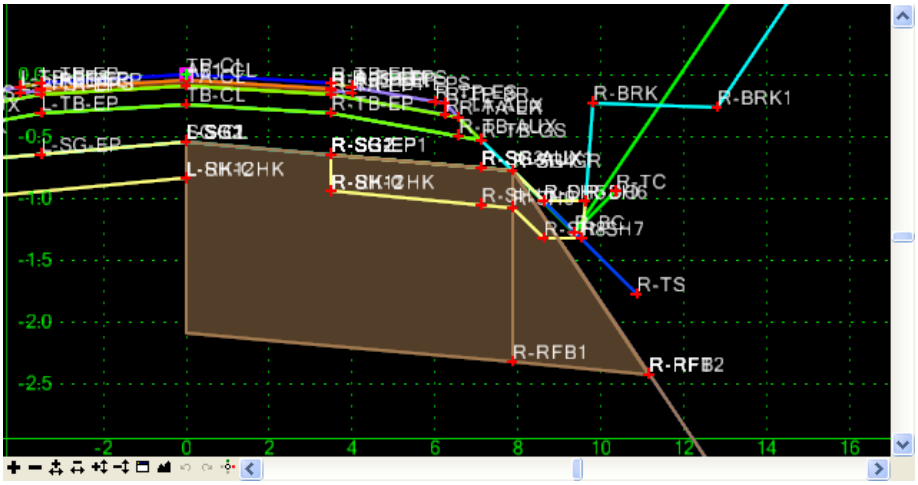
R-RFB2



50. Rename point 1 to ***R-RFT*** and set constraints as:

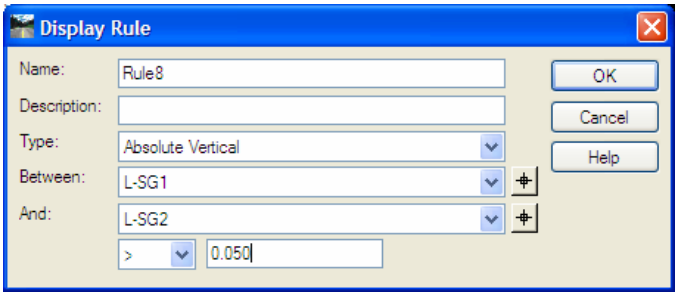
R-RFT



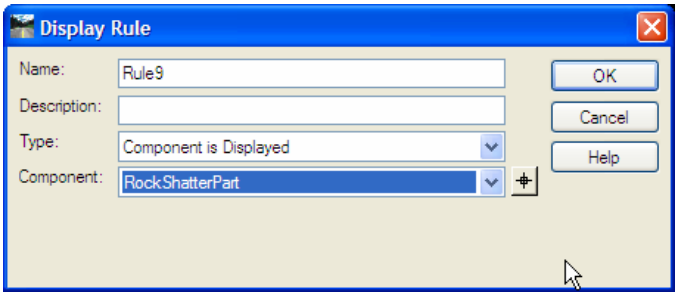


51. Set display rules for rock fill components. Double click on ***RockEmbankment*** component to open the Component Properties dialog. Click **Edit** button to the right of *Display Rules* field. Click **Add** button at the bottom of the Component Display Conditional Expression dialog. Add the following display rules to the template.

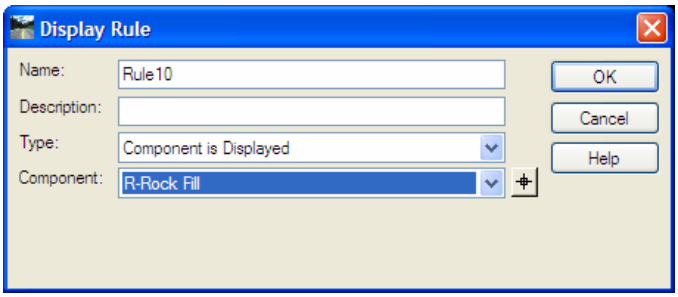
Rule8



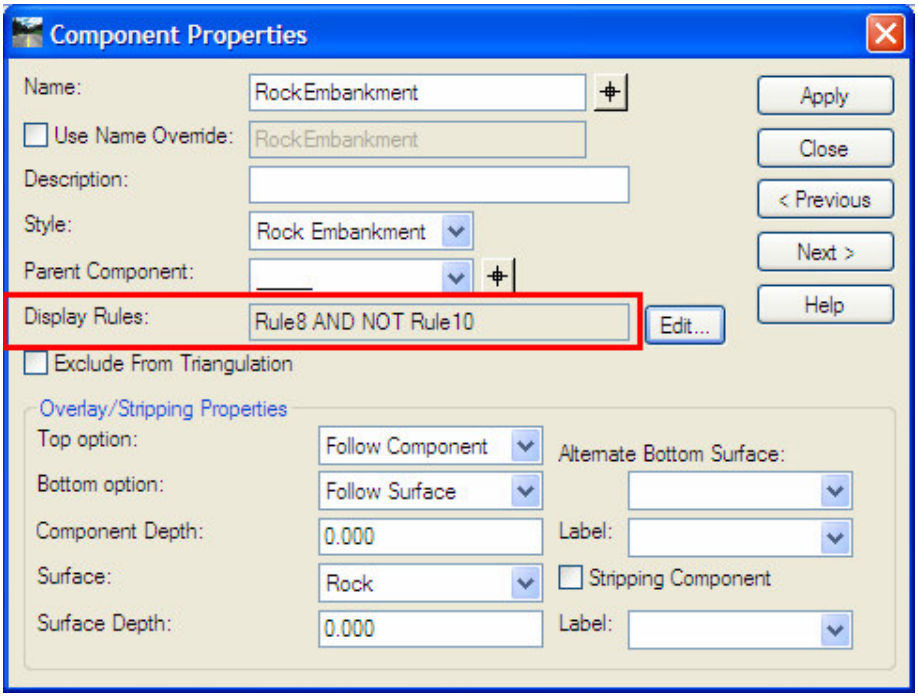
Rule9



Rule10



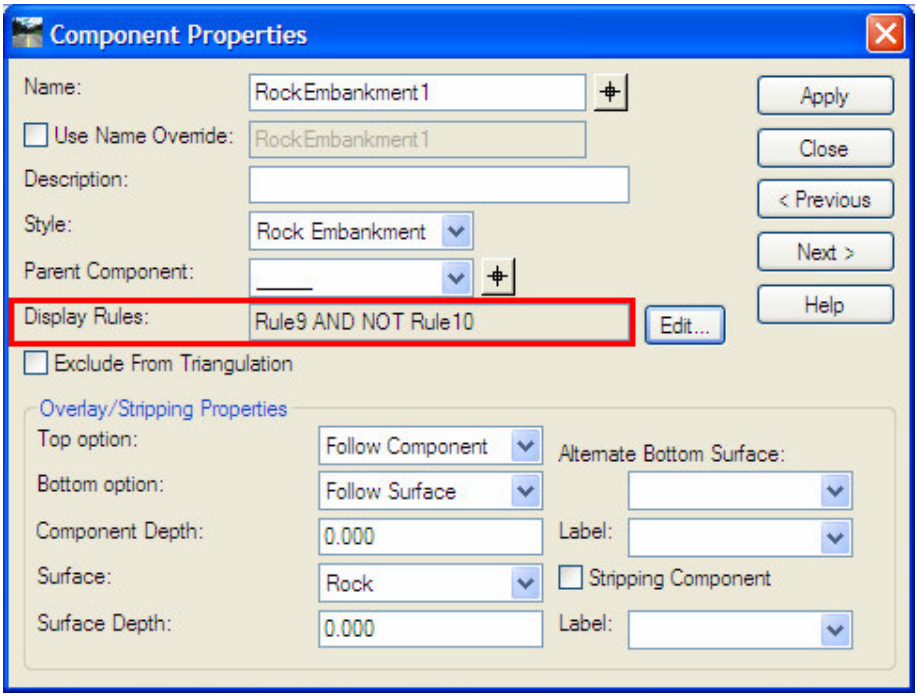
52. Create the conditional expression for ***RockEmbankment*** as shown below:



Click **Apply** then **Close**.

53. Double click on ***RockEmbankment1*** component to open the Component Properties dialog. Click **Edit** button to the right of *Display Rules* field.

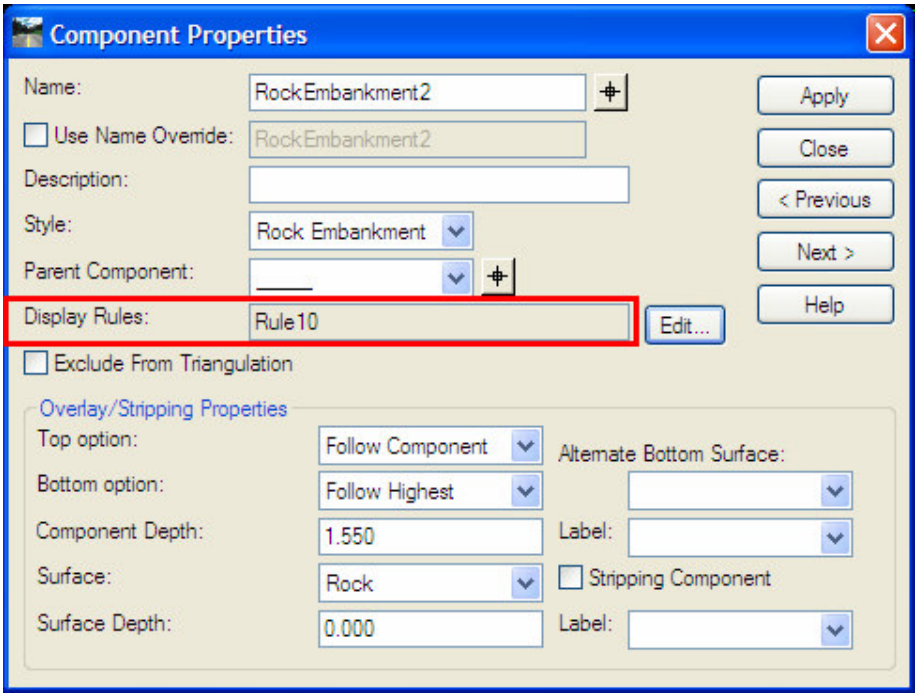
    Create the conditional expression for ***RockEmbankment1*** as shown below:



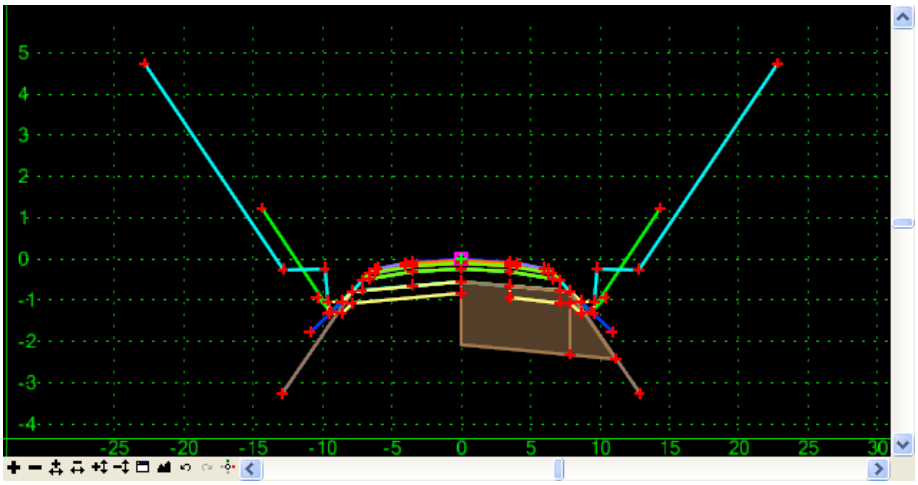
    Click **Apply** then **Close**.

54. Double click on ***RockEmbankment2*** component to open the Component Properties dialog. Click **Edit** button to the right of *Display Rules* field.

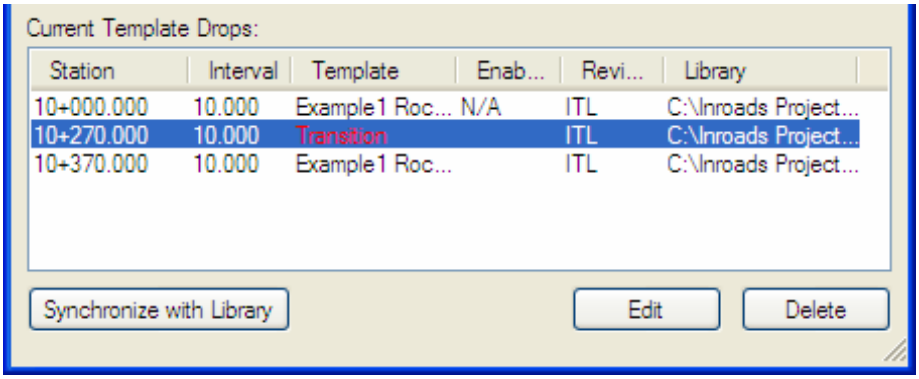
    Create the conditional expression for ***RockEmbankment2*** as shown below:



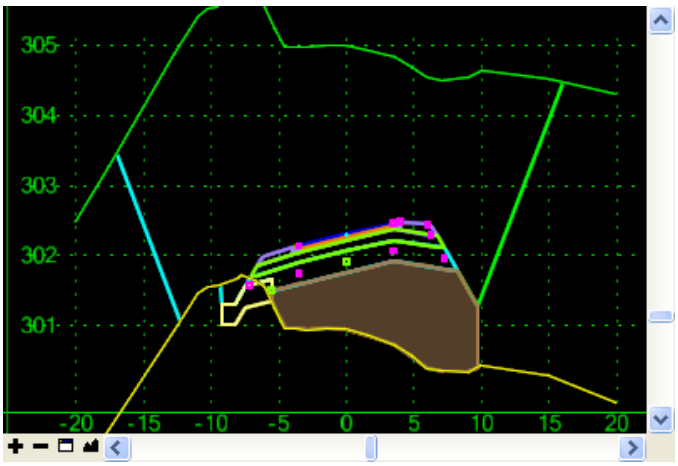
Click **Apply** then **Close**.

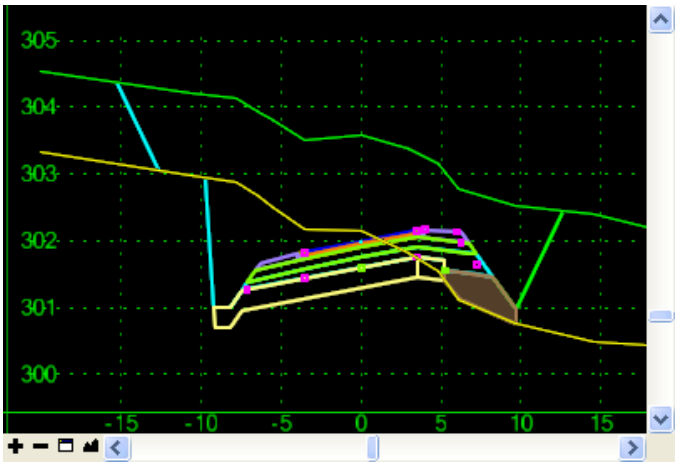


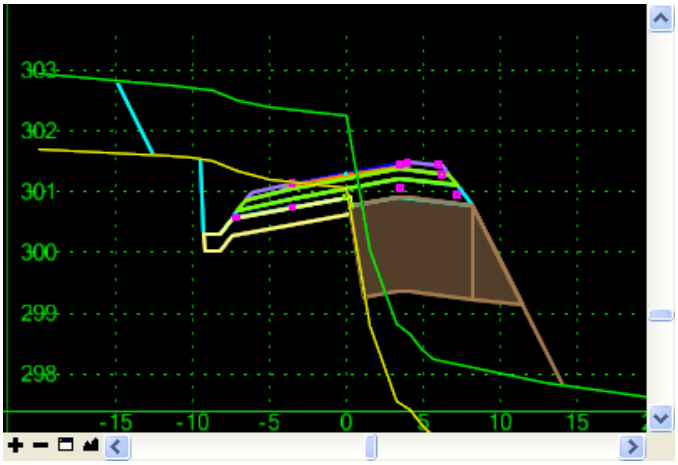
55. Save the template and close the Create Template dialog.
56. Open the Roadway Designer dialog. Select **Corridor > Template Drops**. Select the template drops at 10+270 in the *Current Template Drops list window*, then click the **Synchronize with Library** button at the bottom left of the dialog.



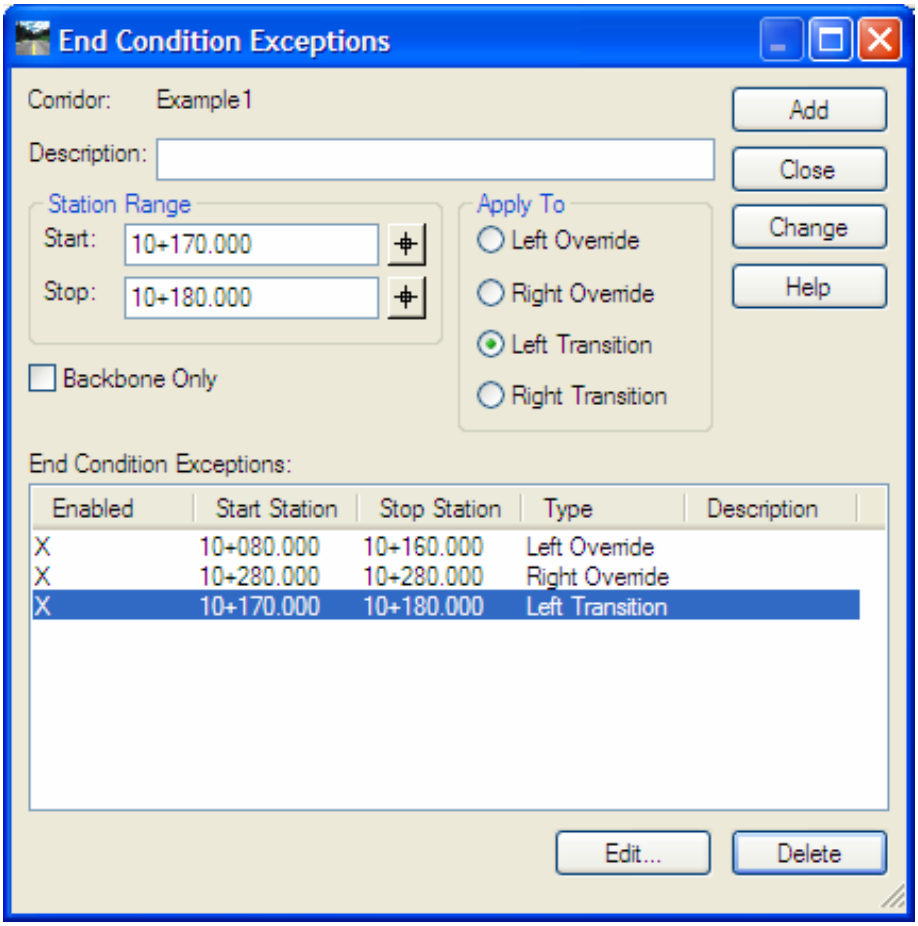
57. Check the cross section in the rock transition area. Now cross sections are shown with rock fill treatment.



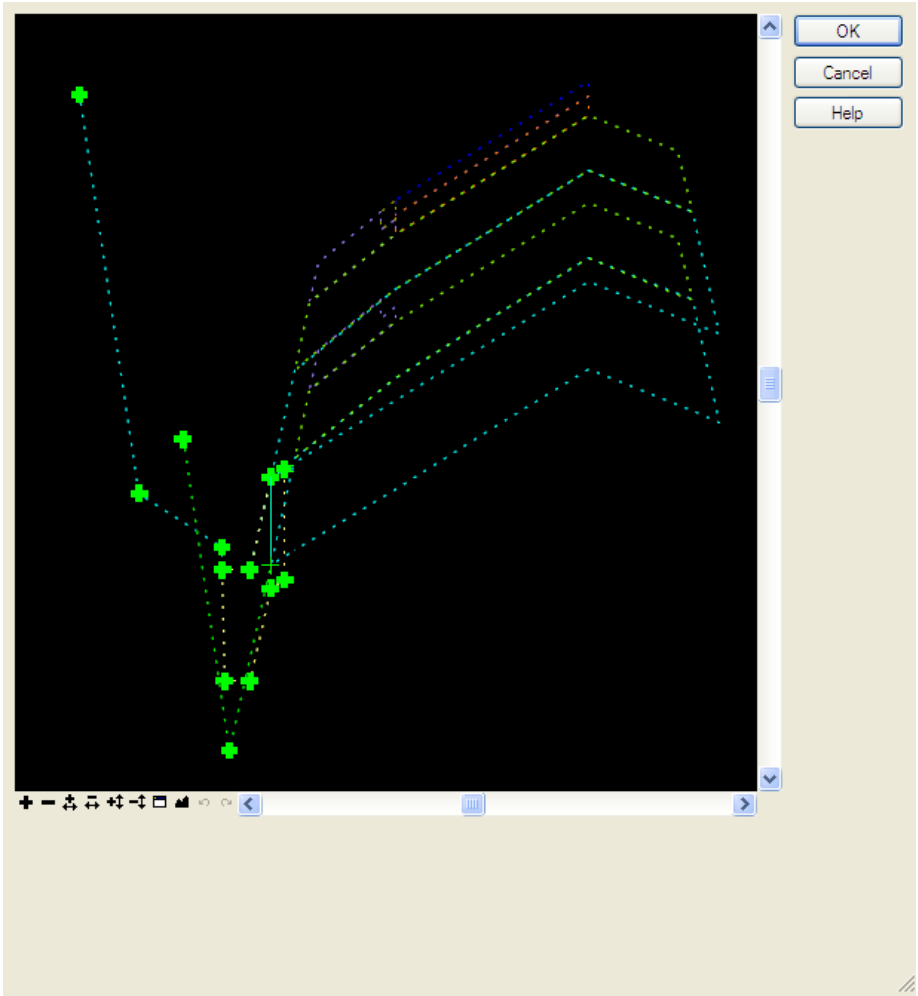




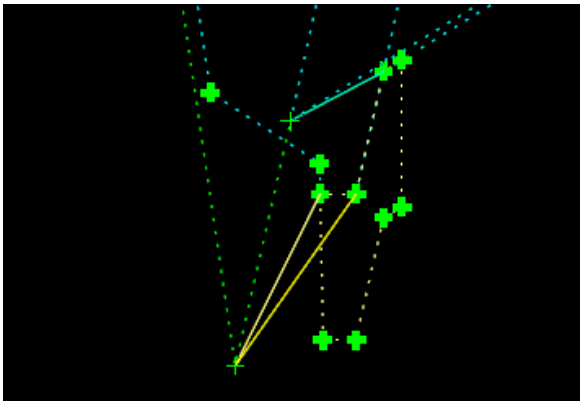
58. Set end condition transition. Select **Corridor > End Condition Exceptions** to open the End Condition Exceptions dialog. In the *Station Range* field of the dialog, give the *Start* station ***10+170*** and *Stop* station ***10+180***. Select *Left Transition* option in the *Apply To* field. Click **Add** to create the end condition exception for the given station range.



Click **Edit** button to open the Edit Transition dialog.

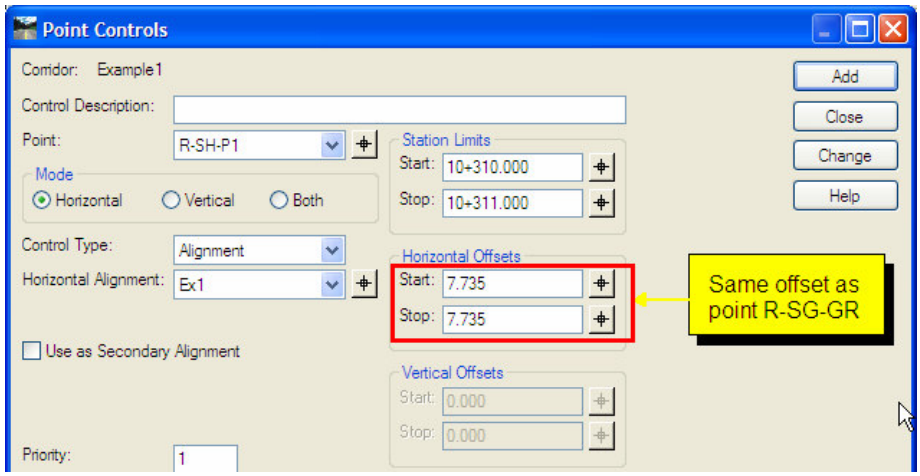


Create ditch transition from V ditch to flat bottom ditch as shown below.

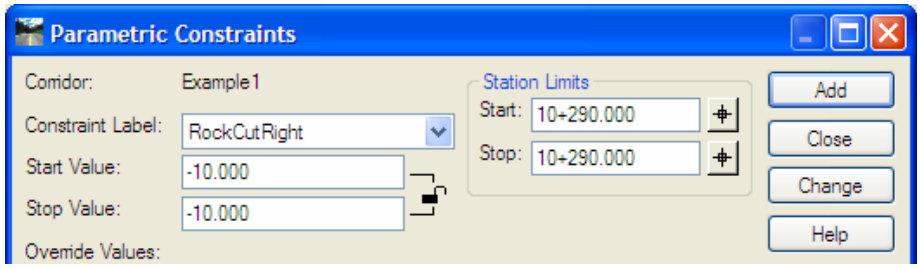


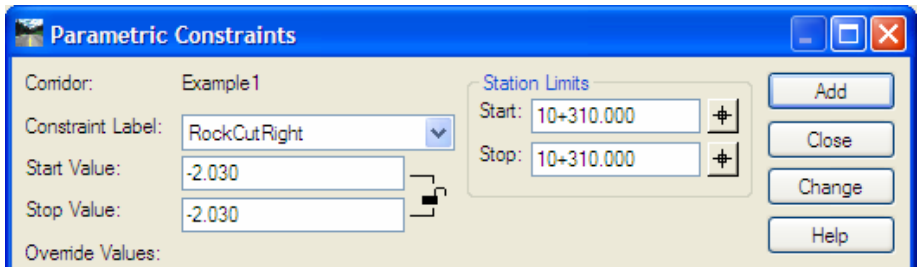
When finish, close all the dialogs and return to Roadway Designer.

59. When point R-RK-CHK goes beyond the roadway limits, additional controls need to be added to model the corridor properly. Select **Corridor > Point Controls**. Add the following point control.



60. Select **Tools > Parametric Constraints**. Add the following parametric constraints to the Roadway Designer:

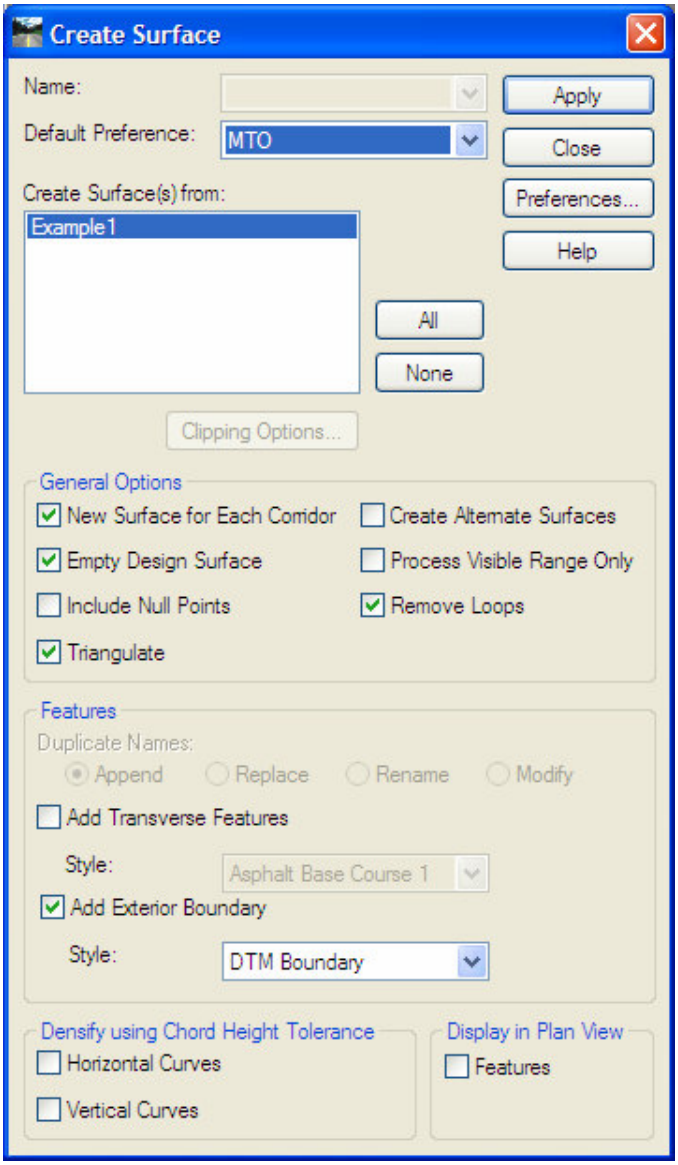




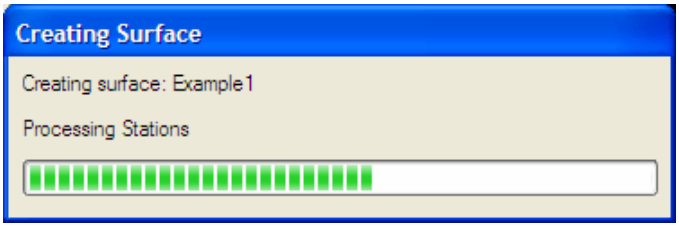
Close all dialogs and save the Roadway Designer file.

7.7 Creating Finished Surfaces

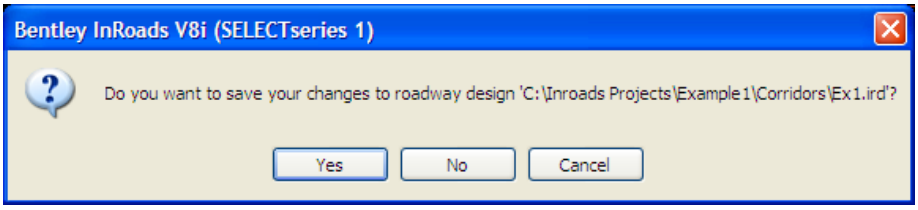
1. On the Roadway Designer dialog, select **Corridor > Create Surface**.
2. On the Create Surface dialog, verify that only corridor ***Example1*** is selected and all the options selected as shown below:



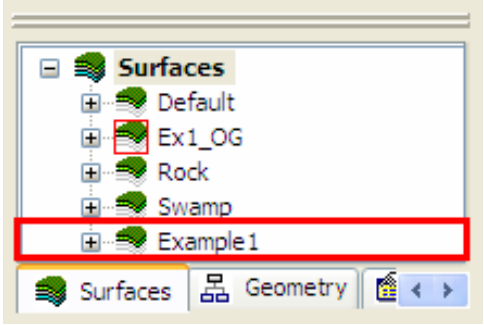
3. Click **Apply**. InRoads will process all the cross section in the selected corridor. A message window pops up to show the progress.



4. When the process finish, click **Close** to dismiss the Create Surface dialog.
5. Close Roadway Design. Save the changes when see following message.



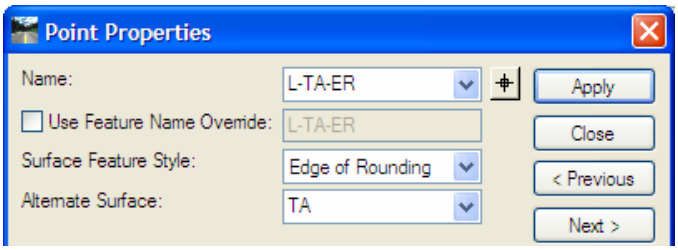
6. Go to InRoads Explorer. In the left pane, check the *Surfaces* folder. Surface *Example1* is listed under *Surfaces*.



7.8 Creating Alternate Surfaces

TA, TB and SG surfaces can be created as alternate surfaces by selecting each point on that surface and specifying the alternate surface name in the point properties window.

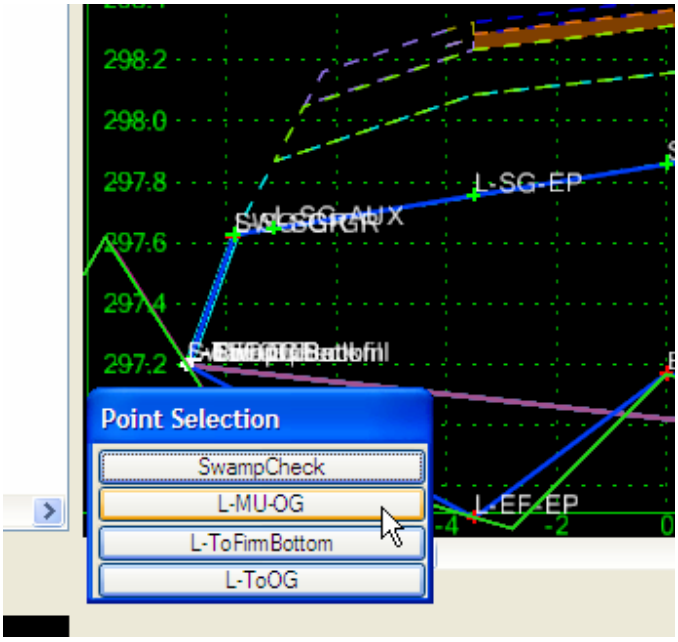
1. Select **Modeler > Create Template**.
2. On the Create Template dialog, select template ***Example1 Rock/Swamp*** from Template Library.
3. Double click on point ***L-TA-ER*** and type ***TA*** in the *Alternate Surface* field. Click **Apply** button.



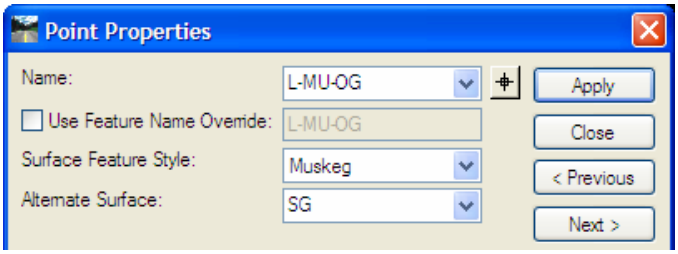
4. Repeat above process for points *L-TA-AUX, L-TA-EP, TA-CL, R-TA-EP, R-TA-AUX*, and *R-TA-ER*.
5. Give alternate surface name ***TB*** for points *L-TB-GS, L-TB-AUX, L-TB-EP, TB-CL, R-TB-EP, R-TB-AUX*, and R-*TB-GS*.
6. Give alternate surface name ***SG*** for points *L-TS, L-TS1, L-TC, L-TC1, L-BC, L-TC2, L-BRK1, L-BRK, L-DO, L-DI, L-SG-GR, L-SG-AUX, L-*

*SG-EP, SG-CL, R-SG-EP, R-SG-AUX, R-SG-GR, R-DI, R-DO, R-BRK, R-BRK1, R-TC2, R-TC1, R-TC, R-BC, R-TS1,*and *R-TS*.

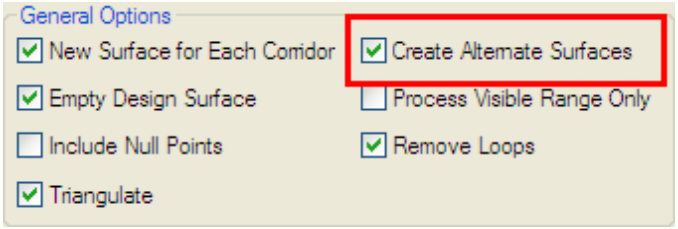
7. Select template ***Transition*** from Template Library.
8. Give alternate surface name ***TA*** for points *L-TA-ER, L-TA-AUX, L-TA-EP, TA-CL, R-TA-EP, R-TA-AUX*, and *R-TA-ER.*
9. Give alternate surface name ***TB*** for points *L-TB-GS, L-TB-AUX, L-TB-EP, TB-CL, R-TB-EP, R-TB-AUX*, and R-*TB-GS*.
10. Give alternate surface name ***SG*** for points *L-TS, L-TS1, L-TC, L-TC1, L-BC, L-TC2, L-BRK1, L-BRK, L-DO, L-DI, L-SG-GR, L-SG-AUX1, L-SG1, L-SG2, R-SG-EP1, R-SG1, R-SG2, R-SG-AUX1, R-SG-GR, R-DI, R-DO, R-BRK, R-BRK1, R-TC2, R-TC1, R-TC, R-BC, R-TS1,*and *R-TS*.
11. Save template library and close the Create Template dialog.
12. Select **Modeler > Roadway Designer.**
13. Select **Corridor > Templates Drops**.
14. Select all the template drops in red and click on the **Synchronize with Library** button. Close the dialog.
15. Select **Corridor > End Condition Exceptions.**
16. Select the LeftOverride from 10+080 to 10+160, click **Edit**.
17. Select point L-MU-OG from the template edit window.



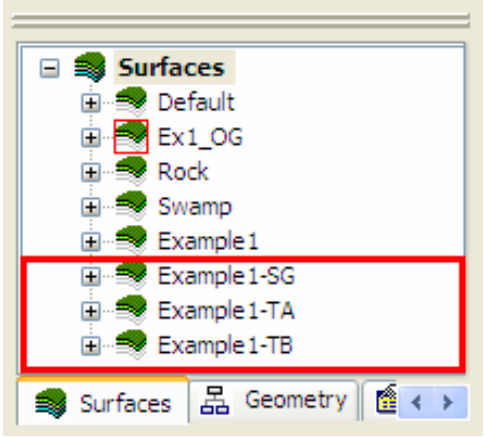
18. Type ***SG*** in the *Alternate Surface* field. Click **Apply** button.



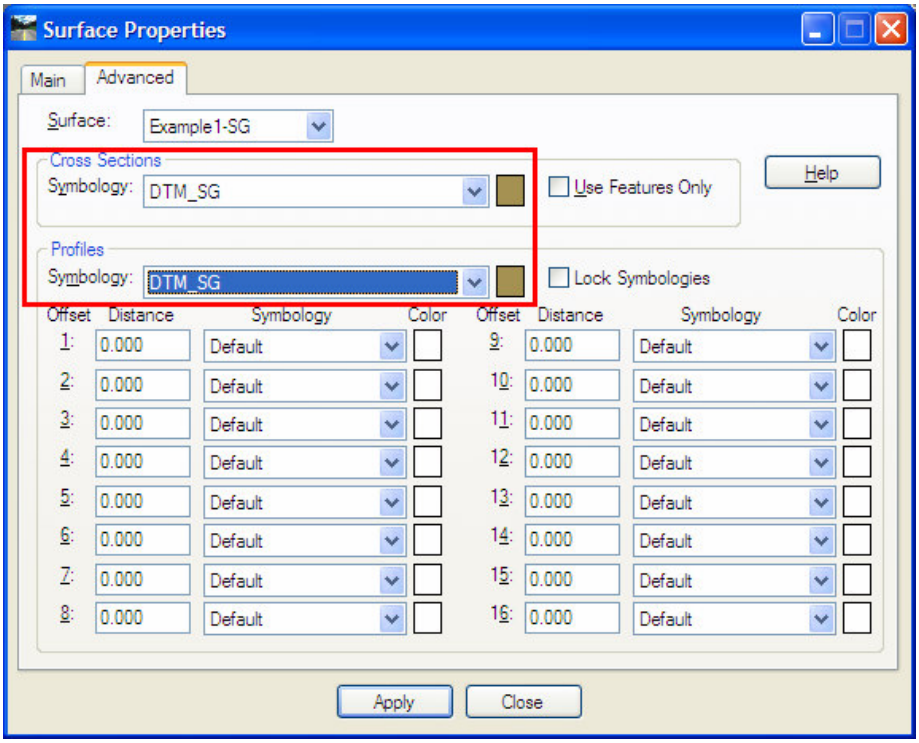
19. Close the dialog. Select the RightOverride from 10+280 to 10+281, click **Edit**.
20. Give alternate surface name ***SG*** for points *R-BC, R-TC1*, and *R-TC*. Close all the dialogs and return to Roadway Desinger.
21. Select **Corridor > Create Surface.**
22. Check the Create Alternate Surfaces option on the Create Surface dialog.



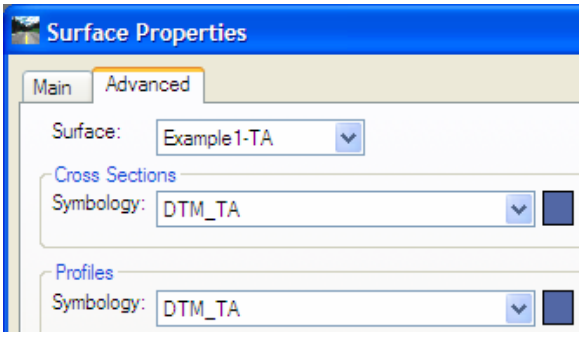
23. Click **Apply**. Save Roadway Designer and close the dialog.
24. Go to InRoads Explorer. In the left pane, check the *Surfaces* folder. Alternate surfaces are created under *Surfaces.*



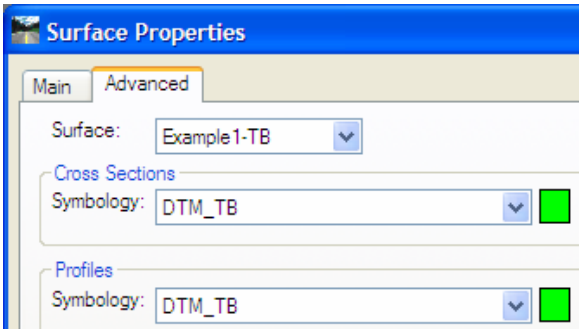
25. Right click on surface ***Example1-SG*** and select ***Properties*** from the pop-up menu.
26. Click on the **Advanced** tab on the Surface Properties dialog. Select ***DTM_SG*** from the *Symbology* drop-down list for both *Cross Sections* and *Profiles*.



27. Click **Apply > Close**.
28. Repeat the process to set symbology ***DTM_TA*** for surface ***Example1-TA***.



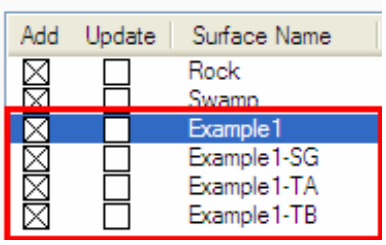
29. Set symbology ***DTM_TB*** for surface ***Example1-TB***.



30. Save surfaces Example1, Example1-TA, Example1-TB, and Example1-SG.

7.9 Updating Project File

1. Go to InRoads main menu, select **File > Save As**.
2. On the Save As dialog, verify the *Save as type* is Projects (*.rwk) and select *Example1.rwk.*
3. Click the **Options (…)** button on the lower right corner of the Save As dialog box. The Project Options dialog box will appear.
4. Click *Surfaces* tab, check **Add** for Example1, Example1-SG, Example1-TA, and Example1-TB surfaces.



Note: If the Update option is selected, the surface file(s) will be saved when you save the project.

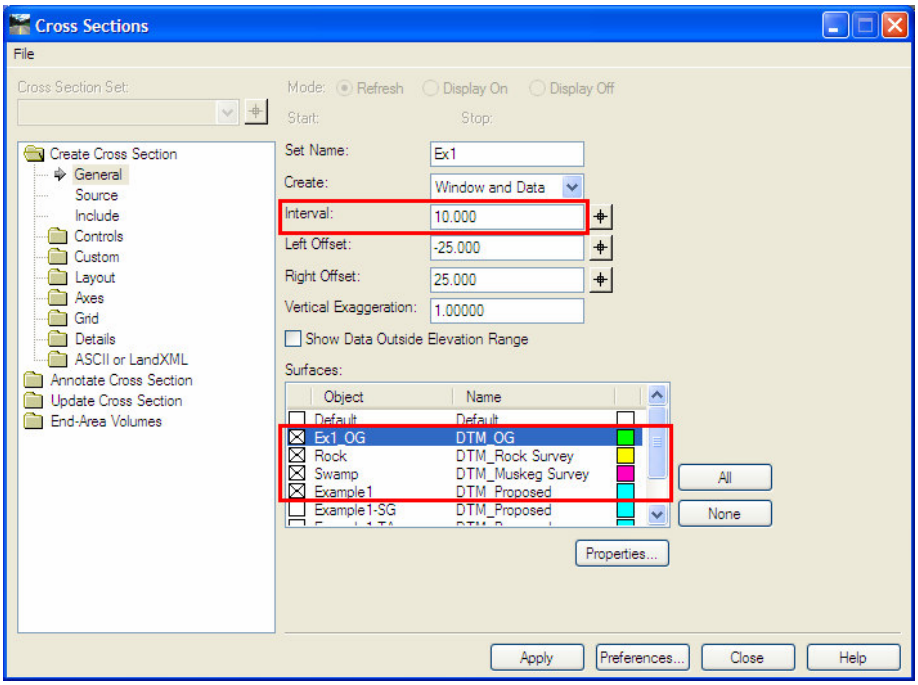
---

5. Click **OK** button to close the Project Options dialog box.
6. Click the **Save** button and confirm to replace existing project file.
7. Click **Cancel** to close the dialog.

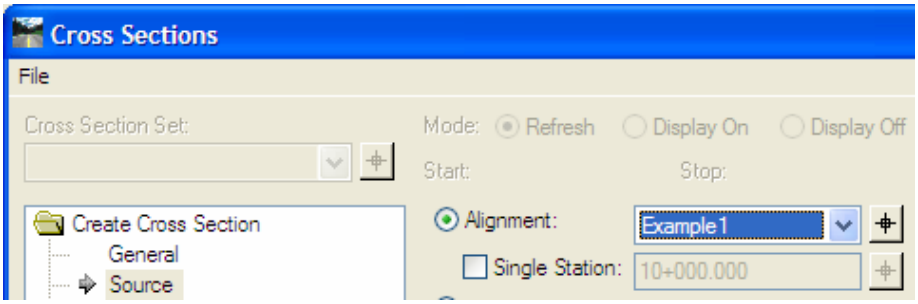
8.0 Cross Section

8.1 Creating Cross Sections

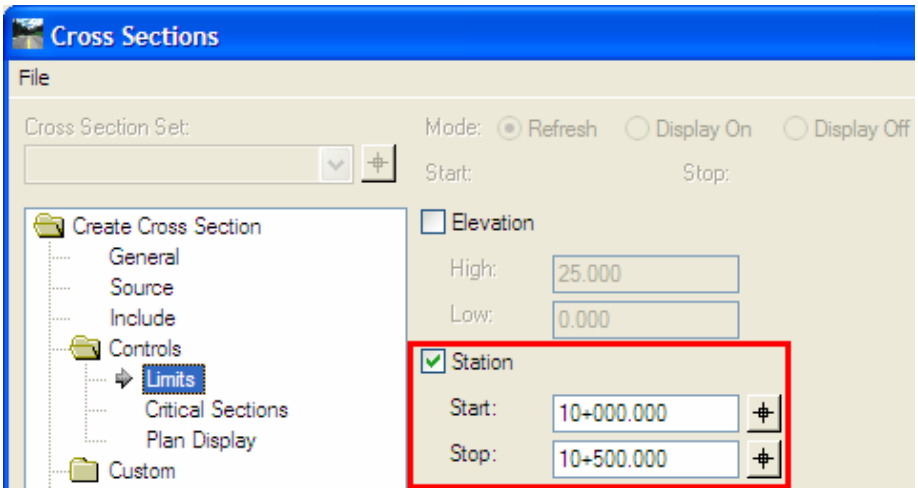
1. Load MTO_InRoads_Template.dwg from project folder...*Example1\Standards.*
2. Click AutoCAD's **File > Save As** command to save the drawing to project folder …*Example1\Drawings* with name ***CrossSections***.
3. Set the **Global Scale Factors** to 0.1.
4. Select **Evaluation > Cross Section > Cross Sections**.
5. Click **Preferences** and load named preference **MTO_Sheet(1:100).** On the dialog of *General* leaf, change the interval to ***10m***. Select surface ***Ex1_OG, Rock, Swamp***, and ***Example1*** from the *Surfaces* list.



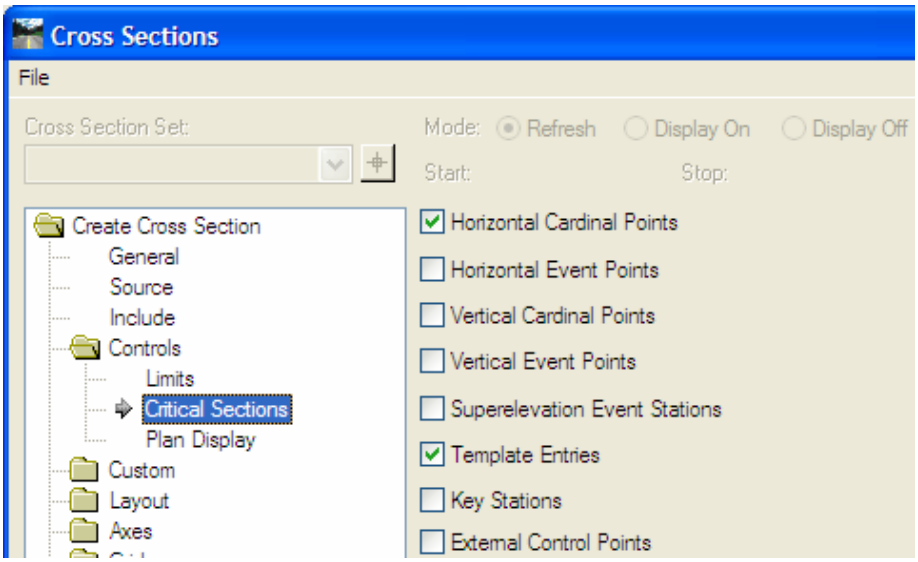
6. Click **Source** and verify that the proper alignment is show in the alignment field.



7. Click **Controls > Limits**. Verify the Station range.

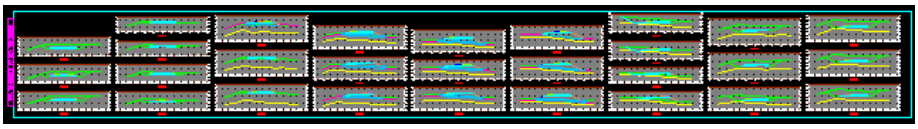


8. Click **Critical Sections** under *Controls*. Select options.

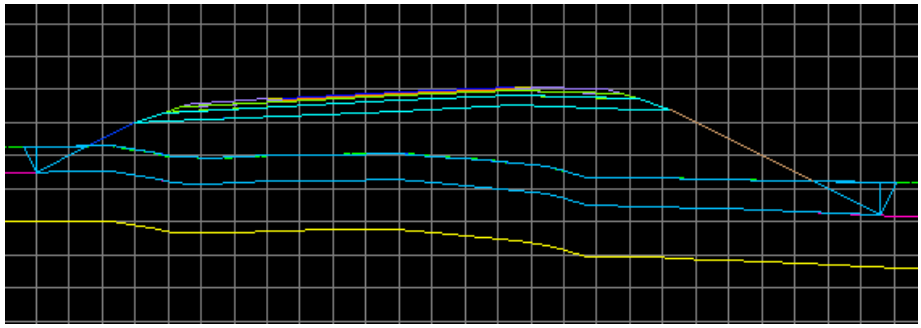


9. Click **Apply** and follow the prompt at AutoCAD command line to provide an insert point in the drawing.
10. View the cross sections that have been created.

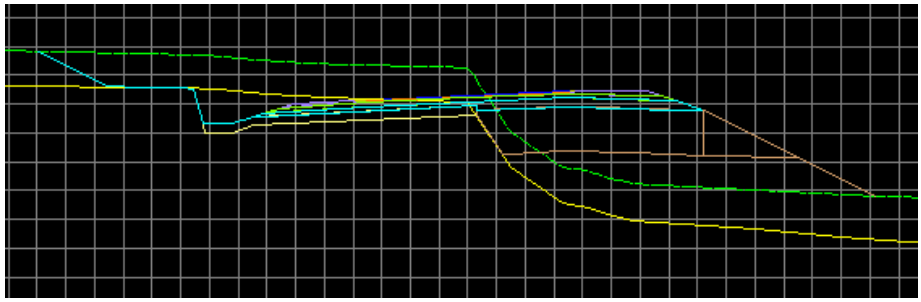
Whole Sheet:



Swamp Treatment:

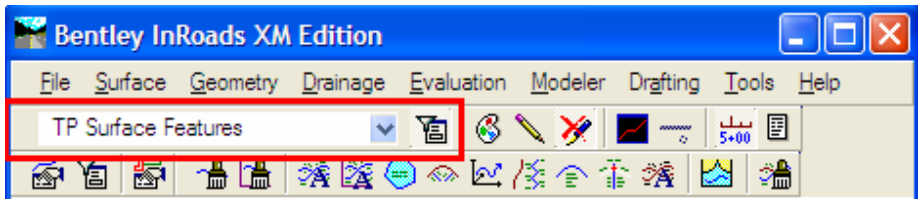


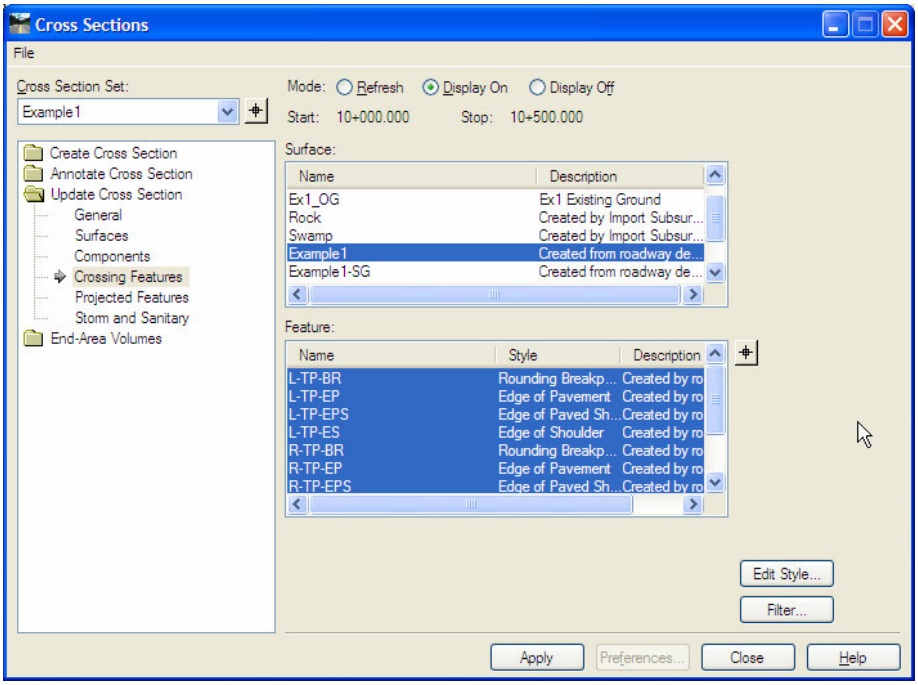
Rock Treatment:



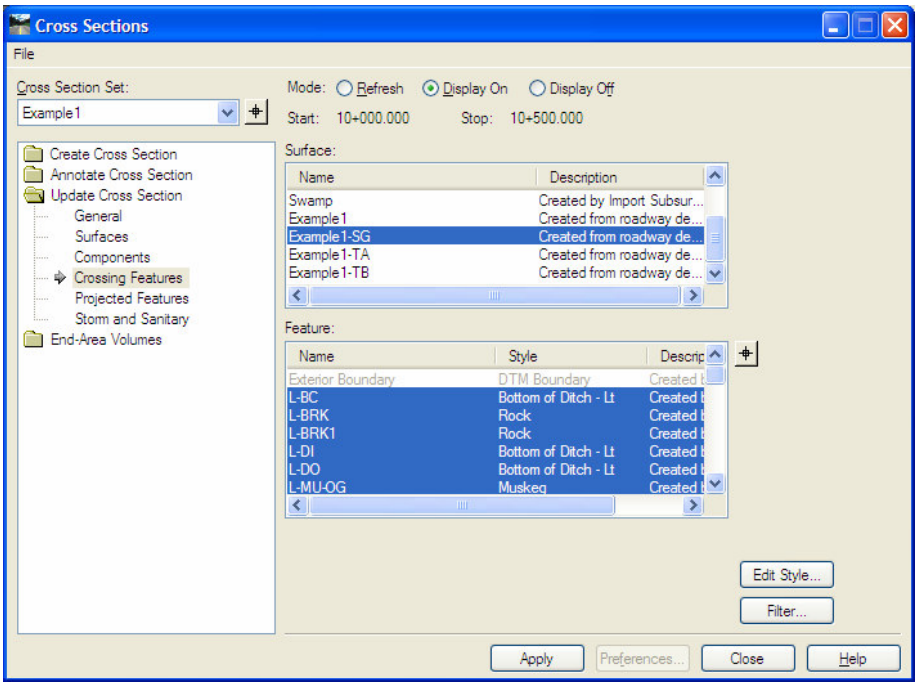
8.2 Updating Cross Section

1. Select **Evaluation > Cross Section > Cross Sections**.
2. Click on the **Update Cross Section** folder on the left pane of Cross Sections dialog.
3. Click on *Crossing Features* leaf. Toggle on the **Display On** option.
4. Select surface ***Example1*** from the Surface list.
5. Turn on the *Feature Filter Lock* and select filter ***TP Surface Features***, and then select all the features in the *Feature* list window.





6. Click **Apply**. Top surface features points will display in the cross sections.
7. Select surface ***Example1-SG*** from the Surface list.
8. Turn off the *Feature Filter Lock*, and then select all the features except in the *Feature* list window (feature Exterior Boundary is greyed out and will not be selected).



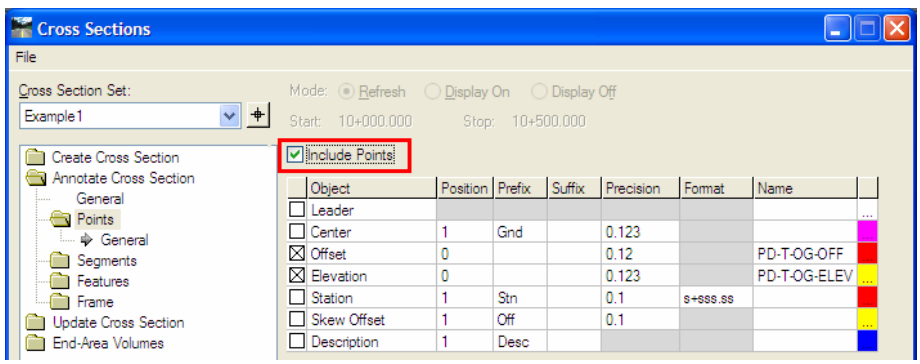
9. Click **Apply**. All the subgrade surface features points will display in the cross sections.
10. Close the dialog and save the drawing.

8.3 Annotating Cross Sections

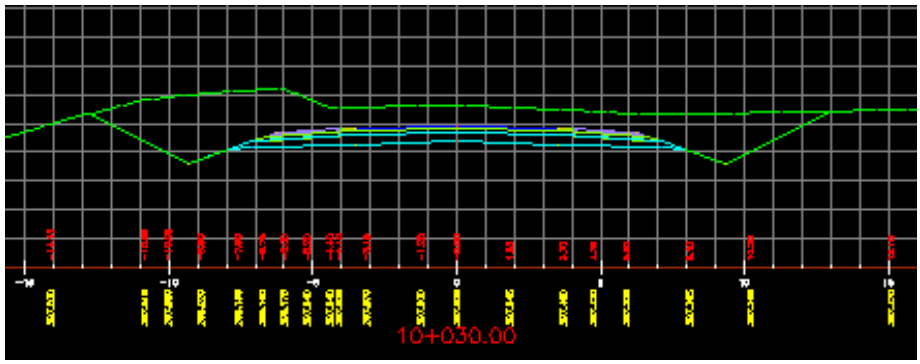
Surface or surface crossing features (if loaded) can be annotated in cross sections. Verify that the **Global Scale Factors** is set to 0.1.

OG surface

1. Select **Evaluation > Cross Section > Cross Sections**.
2. Click on the **Annotate Cross Section** folder on the left pane of Cross Sections dialog.
3. Click on **Preferences** and load named preference ***MTO_OG (1:100).***
4. Click on *General* leaf and select ***Ex1_OG*** surface.
5. Click on *Points* leaf and check **Include Points** option.

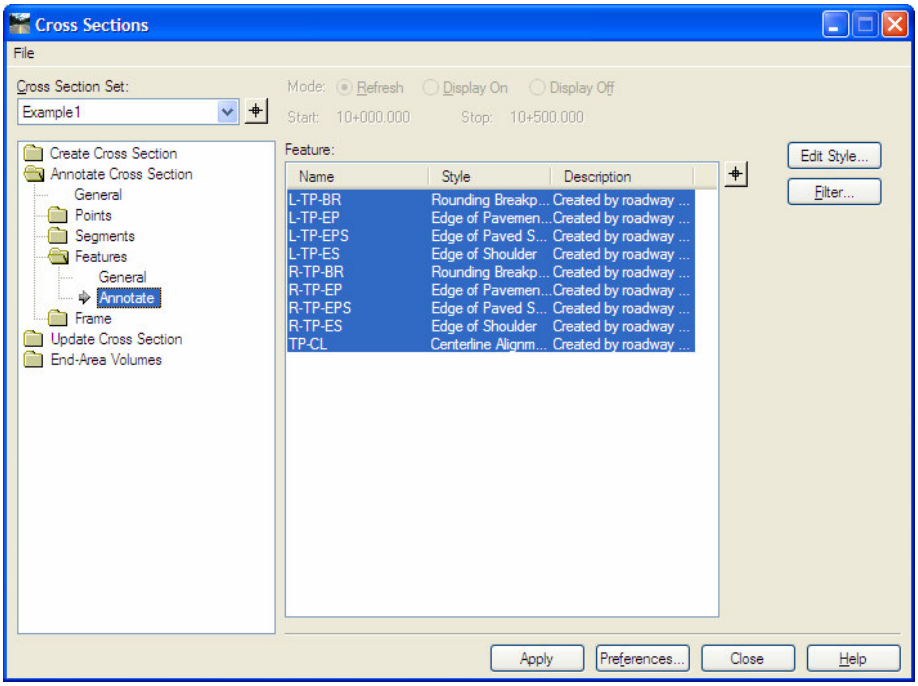


6. Click **Apply**. The OG surface is annotated in cross sections.

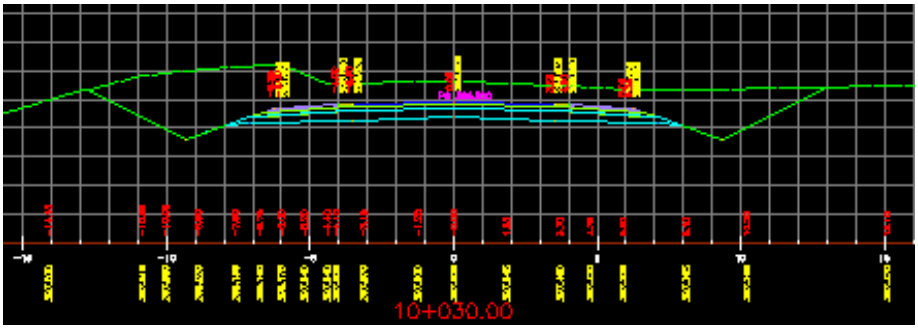


TP Surface.

1. With the Cross Sections dialog open, click on **Preferences** and load named preference ***MTO_TP (1:100)***.
2. Click on *General* leaf and select surface ***Example1***.
3. Click on *Features* leaf then click on *Annotate*. Select all the features from the features list.



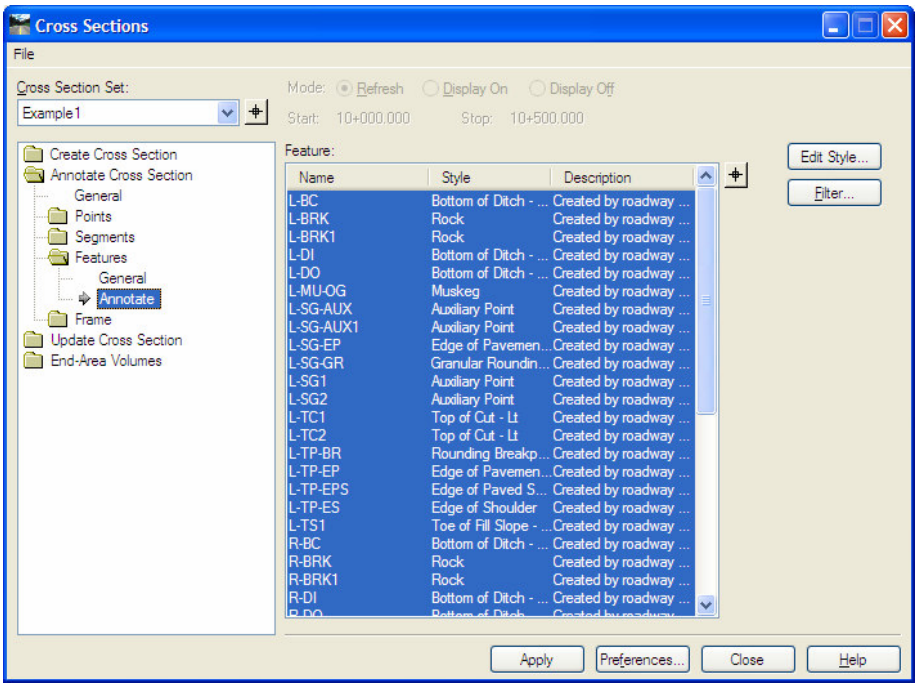
4. Click **Apply**. The top surface is annotated in cross sections.



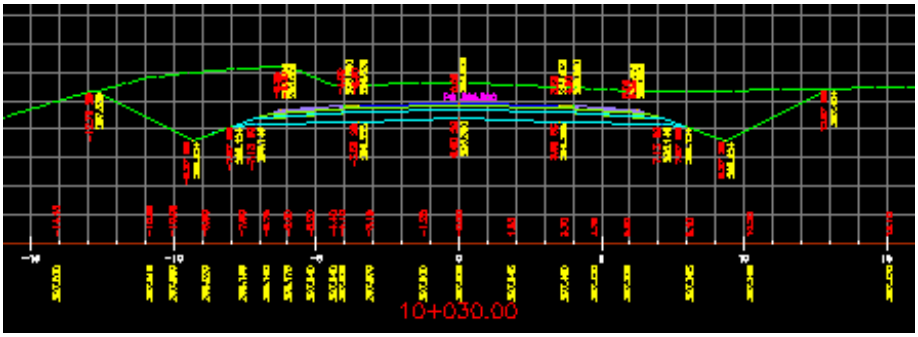
SG Surface.

1. With the Cross Sections dialog open, click on **Preferences** and load named preference ***MTO_SG (1:100).***
2. Click on *General* leaf and unselect surface ***Example1*** and select surface ***Eexample1_SG***.

3. Click on *Features* leaf then click on *Annotate*. Select all the features from the features list.



4. Click Apply. The subgrade surface is annotated in cross sections.



5. Close the Cross Sections dialog and save the AutoCAD drawing.

9.0 Volumes and Mass Haul Diagram

9.1 Calculating End-Area Volumes

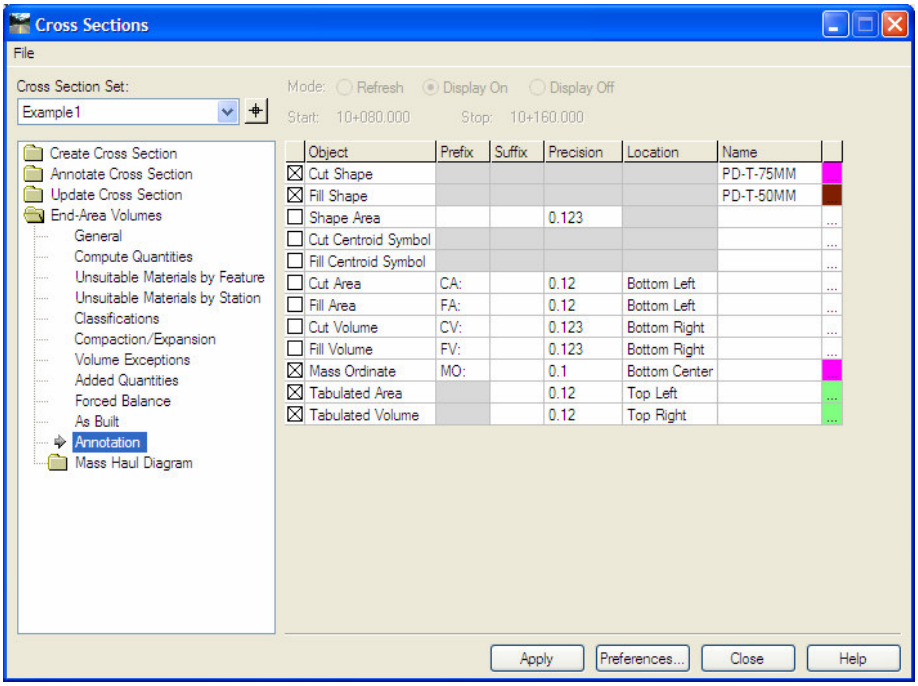
After creating cross section set, the End-Area Volumes can be used to perform the traditional end-area volume calculation to compute cut, fill, and net volumes. To compute the quantities of components, the components must be displayed in the cross section.

InRoads calculates the exact end areas at each stations. The neat volumes area calculated between stations using the average end area method. The computed volumes can be adjusted for shrinkage or expansion.

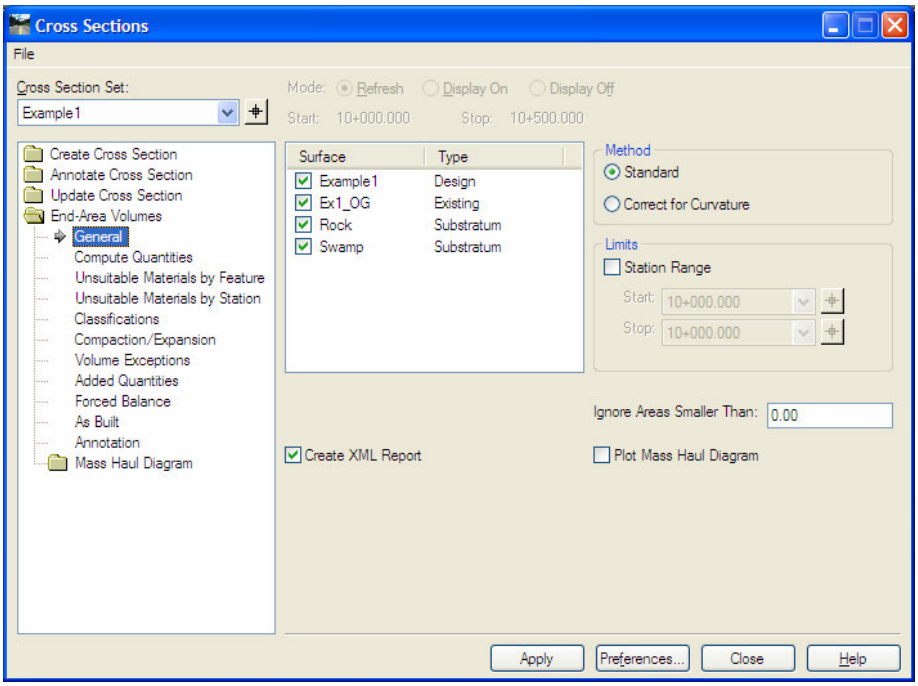
Note: The Compaction/Expansion factor and stripping depths used in this example are for demonstration only. For real projects, refer to Geotechnical Report or the Regional Geotechnical Section's recommendation.

---

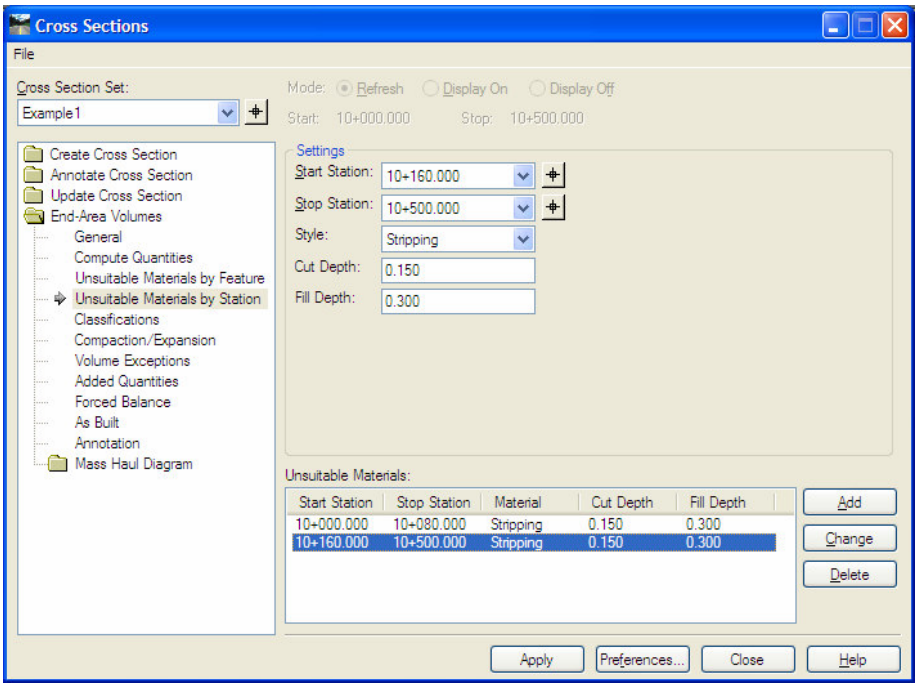
1. Verify that the cross section drawing created in previous section is the active drawing.
2. Verify that the **Global Scale Factors** is set to 0.1.
3. Select **Evaluation > Cross Section > Cross Sections**.
4. Click on the **End-Area Volumes** folder on the left pane of Cross Sections dialog.
5. Click on **Preferences** and load the named preference **MTO.**
6. Click on **Annotation**. Check the default settings of the named Preference **MTO**. Change the options as you need.



7. Click **General**. In the Surface list window, make sure all the surfaces including existing (***Ex1_OG***), designed (***Example1***), and substratum (***Rock*** and ***Swamp***) are checked. With the preference *MTO*, the volume will be calculated for whole cross section set and the *Create XML Report* option is toggled on.

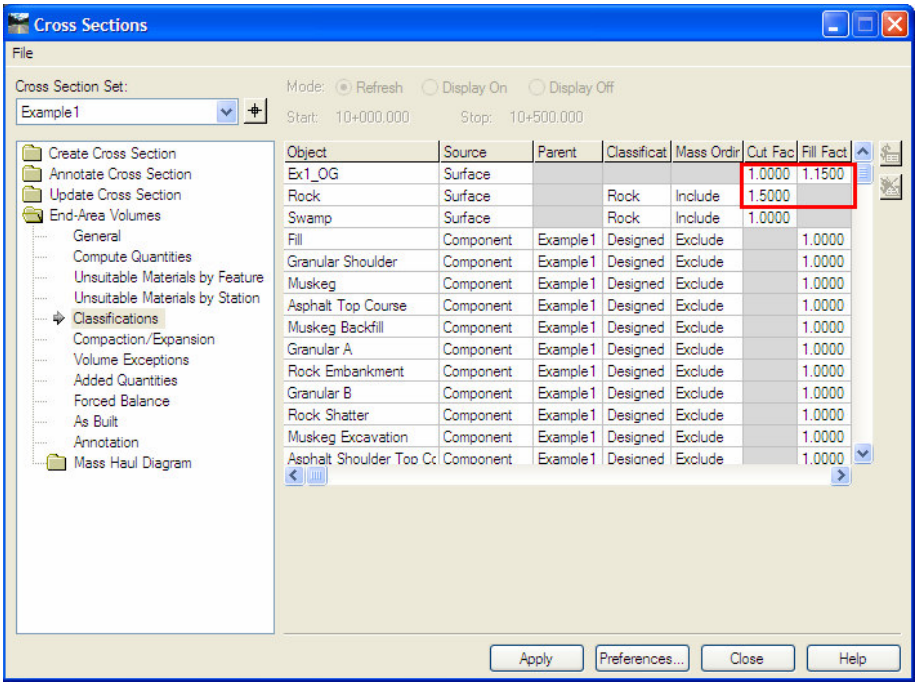


8. Click **Unsuitable Materials by Station.** For new construction, assume stripping will be across the entire cross section. Also assume the stripping depths are 0.15m in cuts and 0.30 in fills. For swamp excavation area (10+080 to 10+160), stripping is not calculated.
9. Add two stripping sections (10+000 to 10+080 and 10+160 to 10+500) to the list with the *Style* set to ***Stripping***. Both stripping section have *Cut Depth* ***0.15m*** and *Fill Depth* ***0.30m***.

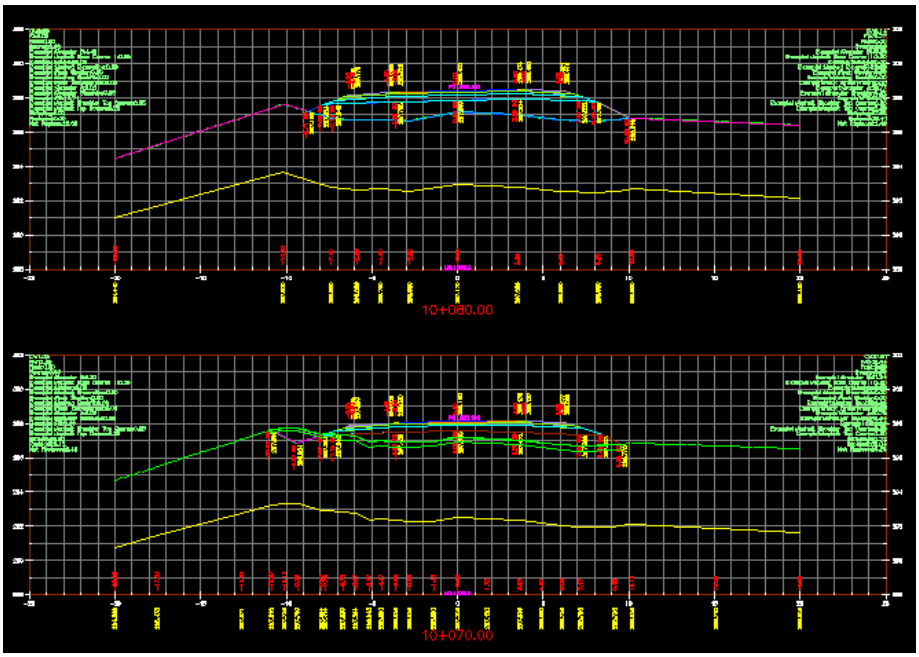


10. Click **Classification**. Use *Cut/Fill Factor* to account for any swell or shrinkage that may occur when remove/place material. Assume 15% increase for the computed earth fill quantity to compensate handing and compaction lose. Assume 50% expansion to rock cut excavation quantity for computing rock material available for fill. Edit the Cut/Fill factors in the Materials List table.

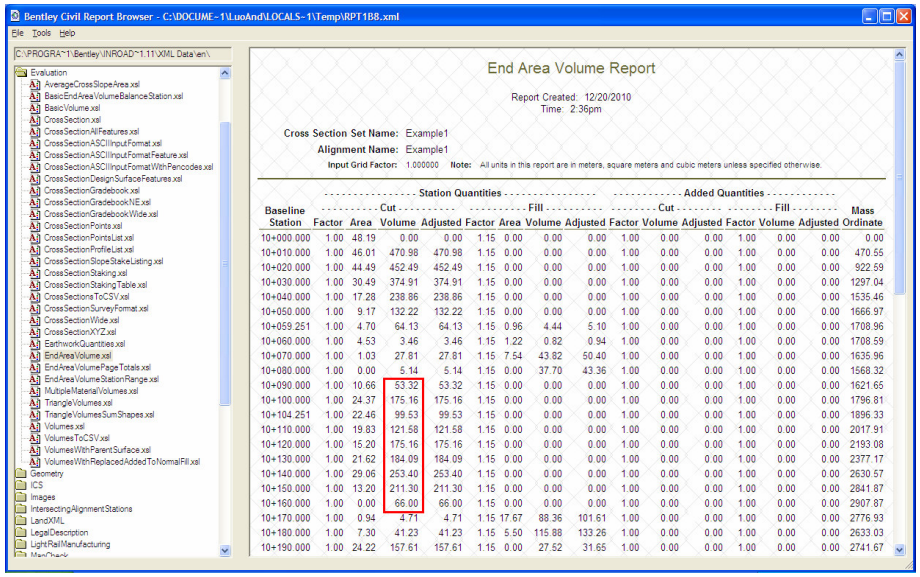
    As a component of the template, Rock Shatter doesn't have option to give the Cut Factor. However, the Rock Shatter quantity is included in the rock excavation quantity and subject to the same expansion factor as Rock Cut.



11. Click **Apply** to calculate the volumes. InRoads will annotate the cross section set based on the selections on the *Annotation* leaf.



12. With *Create XML Report* option toggled on, Bentley Civil Report Browser displayed. Select **EndAreaVolume** style sheet from the *Evaluation* folder in the left pane of the dialog.



Bentley Civil Report Browser - C:\DOCUME~1\LuoAnd\LOCALS~1\Temp\RPT1B8.xml

File Tools Help

C:\PROGRA~1\Bentley\INROAD~1.11\XML Data\en\

- Evaluation
  - AverageCrossSlopeArea.xsl
  - BasicEndAreaVolumeBalanceStation.xsl
  - BasicVolume.xsl
  - CrossSection.xsl
  - CrossSectionAllFeatures.xsl
  - CrossSectionASCIIInputFormat.xsl
  - CrossSectionASCIIInputFormatFeature.xsl
  - CrossSectionASCIIInputFormatWithPencodes.xsl
  - CrossSectionDesignSurfaceFeatures.xsl
  - CrossSectionGradebook.xsl
  - CrossSectionGradebookNE.xsl
  - CrossSectionGradebookWide.xsl
  - CrossSectionPoints.xsl
  - CrossSectionPointsList.xsl
  - CrossSectionProfileList.xsl
  - CrossSectionSlopeStakeListing.xsl
  - CrossSectionStaking.xsl
  - CrossSectionStakingTable.xsl
  - CrossSectionsToCSV.xsl
  - CrossSectionSurveyFormat.xsl
  - CrossSectionWide.xsl
  - CrossSectionXYZ.xsl
  - EarthworkQuantities.xsl
  - EndAreaVolume.xsl
  - EndAreaVolumePageTotals.xsl
  - EndAreaVolumeStationRange.xsl
  - MultipleMaterialVolumes.xsl
  - TriangleVolumes.xsl
  - TriangleVolumesSumShapes.xsl
  - Volumes.xsl
  - VolumesToCSV.xsl
  - VolumesWithParentSurface.xsl
  - VolumesWithReplacedAddedToNormalFill.xsl
- Geometry
- ICS
- Images
- IntersectingAlignmentStations
- LandXML
- LegalDescription
- LightRailManufacturing

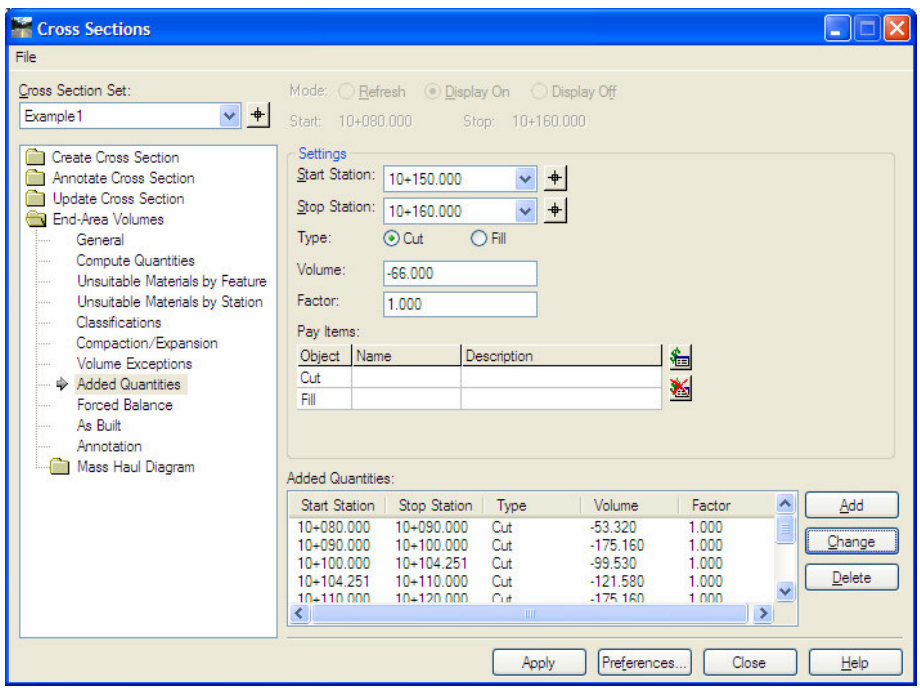
End Area Volume Report

Report Created: 12/20/2010
Time: 2:36pm

Cross Section Set Name: Example1
Alignment Name: Example1
Input Grid Factor: 1.000000 Note: All units in this report are in meters, square meters and cubic meters unless specified otherwise.

Baseline	Station Quantities								Added Quantities								Mass
	Cut				Fill				Cut				Fill				
Station	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted			Ordinate
10+000.000	1.00	48.19	0.00	0.00	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			0.00
10+010.000	1.00	46.01	470.98	470.98	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			470.55
10+020.000	1.00	44.49	452.49	452.49	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			922.59
10+030.000	1.00	30.49	374.91	374.91	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			1297.04
10+040.000	1.00	17.28	238.86	238.86	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			1535.46
10+050.000	1.00	9.17	132.22	132.22	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			1666.97
10+059.251	1.00	4.70	64.13	64.13	1.15	0.96	4.44	5.10	1.00	0.00	0.00	1.00	0.00	0.00			1708.96
10+060.000	1.00	4.53	3.46	3.46	1.15	1.22	0.82	0.94	1.00	0.00	0.00	1.00	0.00	0.00			1708.59
10+070.000	1.00	1.03	27.81	27.81	1.15	7.54	43.82	50.40	1.00	0.00	0.00	1.00	0.00	0.00			1635.96
10+080.000	1.00	0.00	5.14	5.14	1.15	0.00	37.70	43.36	1.00	0.00	0.00	1.00	0.00	0.00			1568.32
10+090.000	1.00	10.66	53.32	53.32	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			1621.65
10+100.000	1.00	24.37	175.16	175.16	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			1796.81
10+104.251	1.00	22.46	99.53	99.53	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			1896.33
10+110.000	1.00	19.83	121.58	121.58	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			2017.91
10+120.000	1.00	15.20	175.16	175.16	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			2193.08
10+130.000	1.00	21.62	184.09	184.09	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			2377.17
10+140.000	1.00	29.06	253.40	253.40	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			2630.57
10+150.000	1.00	13.20	211.30	211.30	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			2841.87
10+160.000	1.00	0.00	66.00	66.00	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00			2907.87
10+170.000	1.00	0.94	4.71	4.71	1.15	17.67	88.36	101.61	1.00	0.00	0.00	1.00	0.00	0.00			2776.93
10+180.000	1.00	7.30	41.23	41.23	1.15	5.50	115.88	133.26	1.00	0.00	0.00	1.00	0.00	0.00			2633.03
10+190.000	1.00	24.22	157.61	157.61	1.15	0.00	27.52	31.65	1.00	0.00	0.00	1.00	0.00	0.00			2741.67

13. The template used for this example has swamp related components to calculate swamp excavation and backfill. In the swamp area, the normal cut volume also includes swamp excavation volume which is duplicated and should be removed from the calculation. Record the cut volume in the volume report within the swamp area as shown above.
14. Return to Cross Sections dialog. Click on **Added Quantities**. Add the cut volume (negative for deduction) as recorded in last step for each station within the swamp area to the *Added Quantities* list.



Cross Sections

File

Cross Section Set: Example1

Mode: Refresh Display On Display Off

Start: 10+080.000 Stop: 10+160.000

- Create Cross Section
- Annotate Cross Section
- Update Cross Section
- End-Area Volumes
  - General
  - Compute Quantities
  - Unsuitable Materials by Feature
  - Unsuitable Materials by Station
  - Classifications
  - Compaction/Expansion
  - Volume Exceptions
  - Added Quantities
  - Forced Balance
  - As Built
  - Annotation
- Mass Haul Diagram

Settings

Start Station: 10+150.000

Stop Station: 10+160.000

Type: Cut Fill

Volume: -66.000

Factor: 1.000

Pay Items:

Object	Name	Description
Cut		
Fill		

Added Quantities:

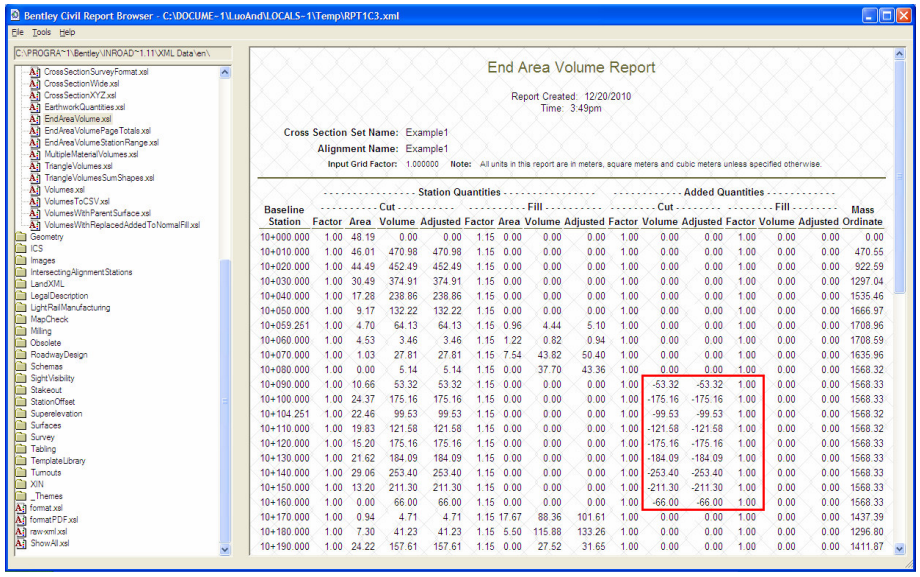
Start Station	Stop Station	Type	Volume	Factor
10+080.000	10+090.000	Cut	-53.320	1.000
10+090.000	10+100.000	Cut	-175.160	1.000
10+100.000	10+104.251	Cut	-99.530	1.000
10+104.251	10+110.000	Cut	-121.580	1.000
10+110.000	10+120.000	Cut	-175.160	1.000

Add Change Delete

Apply Preferences... Close Help

15. Click **Apply** to calculate the volume. In the Bentley Civil Report Browser, select **EndAreaVolume** style sheet to view the results. The

swamp excavation volume is now added as negative amount to the normal cut quantities.



Bentley Civil Report Browser - C:\DOCUME~1\LuoAnd\LOCALS~1\Temp\RPT1C3.xml

File Tools Help

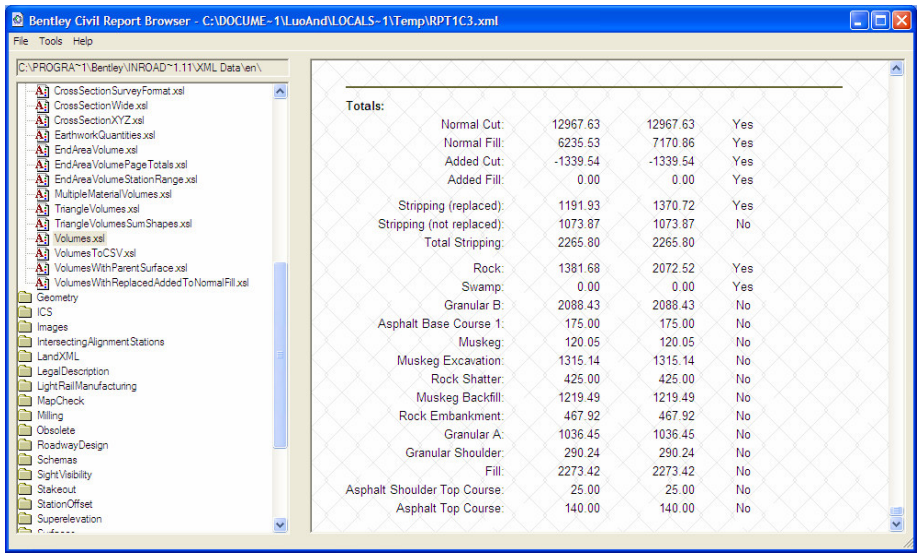
End Area Volume Report

Report Created: 12/20/2010
Time: 3:49pm

Cross Section Set Name: Example1
Alignment Name: Example1
Input Grid Factor: 1.000000 Note: All units in this report are in meters, square meters and cubic meters unless specified otherwise.

Baseline Station	Station Quantities Cut Factor	Area	Volume	Adjusted	Fill Factor	Area	Volume	Adjusted	Added Quantities Cut Factor	Volume	Adjusted	Fill Factor	Volume	Adjusted	Mass Ordinate
10+000.000	1.00	48.19	0.00	0.00	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
10+010.000	1.00	46.01	470.98	470.98	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	470.55
10+020.000	1.00	44.49	452.49	452.49	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	922.59
10+030.000	1.00	30.49	374.91	374.91	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1297.04
10+040.000	1.00	17.28	238.86	238.86	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1535.46
10+050.000	1.00	9.17	132.22	132.22	1.15	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1666.97
10+059.251	1.00	4.70	64.13	64.13	1.15	0.96	4.44	5.10	1.00	0.00	0.00	1.00	0.00	0.00	1708.96
10+060.000	1.00	4.53	3.46	3.46	1.15	1.22	0.82	0.94	1.00	0.00	0.00	1.00	0.00	0.00	1708.59
10+070.000	1.00	1.03	27.81	27.81	1.15	7.54	43.82	50.40	1.00	0.00	0.00	1.00	0.00	0.00	1635.96
10+080.000	1.00	0.00	5.14	5.14	1.15	0.00	37.70	43.36	1.00	0.00	0.00	1.00	0.00	0.00	1568.32
10+090.000	1.00	10.66	53.32	53.32	1.15	0.00	0.00	0.00	1.00	-53.32	-53.32	1.00	0.00	0.00	1568.33
10+100.000	1.00	24.37	175.16	175.16	1.15	0.00	0.00	0.00	1.00	-175.16	-175.16	1.00	0.00	0.00	1568.33
10+104.251	1.00	22.46	99.53	99.53	1.15	0.00	0.00	0.00	1.00	-99.53	-99.53	1.00	0.00	0.00	1568.32
10+110.000	1.00	19.83	121.58	121.58	1.15	0.00	0.00	0.00	1.00	-121.58	-121.58	1.00	0.00	0.00	1568.32
10+120.000	1.00	15.20	175.16	175.16	1.15	0.00	0.00	0.00	1.00	-175.16	-175.16	1.00	0.00	0.00	1568.33
10+130.000	1.00	21.62	184.09	184.09	1.15	0.00	0.00	0.00	1.00	-184.09	-184.09	1.00	0.00	0.00	1568.33
10+140.000	1.00	29.06	253.40	253.40	1.15	0.00	0.00	0.00	1.00	-253.40	-253.40	1.00	0.00	0.00	1568.33
10+150.000	1.00	13.20	211.30	211.30	1.15	0.00	0.00	0.00	1.00	-211.30	-211.30	1.00	0.00	0.00	1568.33
10+160.000	1.00	0.00	66.00	66.00	1.15	0.00	0.00	0.00	1.00	-66.00	-66.00	1.00	0.00	0.00	1568.33
10+170.000	1.00	0.94	4.71	4.71	1.15	17.67	88.36	101.61	1.00	0.00	0.00	1.00	0.00	0.00	1437.39
10+180.000	1.00	7.30	41.23	41.23	1.15	5.50	115.88	133.26	1.00	0.00	0.00	1.00	0.00	0.00	1296.80
10+190.000	1.00	24.22	157.61	157.61	1.15	0.00	27.52	31.65	1.00	0.00	0.00	1.00	0.00	0.00	1411.87

16. Select **Volumes** style sheet and go to the end of the report. A summary table of total volumes of each material is generated by InRoads. There are 4 columns in the table. From left to right they are Material (component) Name, Volume, Adjusted Volume, and if the material is included in the Mass Ordinate.



Bentley Civil Report Browser - C:\DOCUME~1\LuoAnd\LOCALS~1\Temp\RPT1C3.xml

File Tools Help

Totals:

Normal Cut:	12967.63	12967.63	Yes
Normal Fill:	6235.53	7170.86	Yes
Added Cut:	-1339.54	-1339.54	Yes
Added Fill:	0.00	0.00	Yes
Stripping (replaced):	1191.93	1370.72	Yes
Stripping (not replaced):	1073.87	1073.87	No
Total Stripping:	2265.80	2265.80	
Rock:	1381.68	2072.52	Yes
Swamp:	0.00	0.00	Yes
Granular B:	2088.43	2088.43	No
Asphalt Base Course 1:	175.00	175.00	No
Muskeg:	120.05	120.05	No
Muskeg Excavation:	1315.14	1315.14	No
Rock Shatter:	425.00	425.00	No
Muskeg Backfill:	1219.49	1219.49	No
Rock Embankment:	467.92	467.92	No
Granular A:	1036.45	1036.45	No
Granular Shoulder:	290.24	290.24	No
Fill:	2273.42	2273.42	No
Asphalt Shoulder Top Course:	25.00	25.00	No
Asphalt Top Course:	140.00	140.00	No

17. Based on the template and the input during quantity calculation, the quantity of:

    a. Earth Cut = Normal Cut + Added Cut (see step 15)
    = 12967.63 + (-1339.54)
    =11628.09 m3

b. Rock Excavation (include Rock Cut and Rock Shatter):

= Rock (from InRoads)

= 1381.68

Note: The Rock Cut is assumed 50% expansion and the Rock Shatter is subject to the same expansion factor as Rock Cut. Since the Shatter is left in place, the Available Material from Rock Shatter consists the expanded portion only.

---

c. Available Materials from Rock Excavation will be:

= Rock expanded – Rock Shatter left in place

= 1381.68 X 1.5 – 425

= 2072.52 – 425

= 1647.52

d. Muskeg Excavation is the Excavated Swamp Material volume.

e. Muskeg Backfill is the volume of embankment with specified material between the bottom of swamp excavation and the OG surface.

f. Fill is the volume of embankment with Earth Fill between the OG surface and the bottom of Granular B.

g. Muskeg is the volume for the area to be backfilled with swamp material (the area from the edge of the backfill embankment to the excavation limits).

Note: Refer to Components Over Swamp in Section 6.2 for details.

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h. Rock Embankment is the volume of rock fill treatment in the transition area.

Note: Refer to Rock Treatment in Section 7.6 for details.

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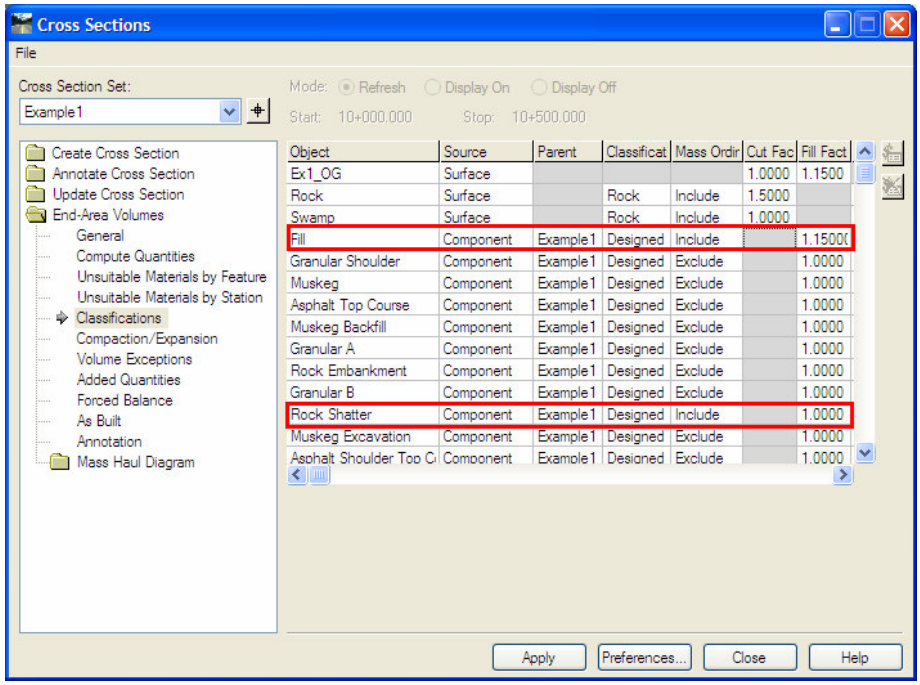
i. Granular B is the volume of granular sub-base calculated from End-Area. The volume doesn't include the expected loss in the area where granular sub-base is placed on rock subgrade. Refer to CDED manual for the application of the compensating factor.

18. Save the drawing with a different name (Cross section with end-area quantities).

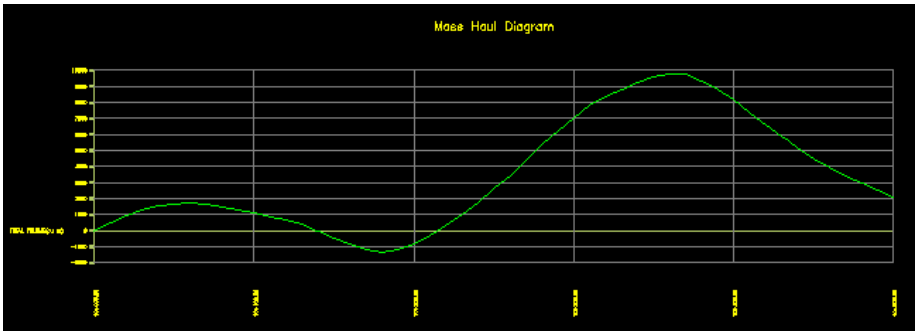
9.2 Generating Mass-Haul Diagram

InRoads uses the End-Area Volume to generate the Mass-Haul diagram that shows cumulative total of cut and fill volumes along a horizontal alignment.

1. Close the report browser and return to the Cross Sections dialog.
2. Click **Classification**. In the Materials List table, include the Fill and Rock Shatter to the Mass Ordinate. Assume 15% increase for the computed Fill (earth) quantity.



3. Click on **Mass-Haul Diagram** folder.
4. Change the **Global Scale Factors** to 1.
5. Click on **Preferences** and load the named preference **MTO_MassHaul_1000** (1000 m^3 per major grid).
6. Click **Apply**.
7. In AutoCAD, provide an insert point for the *Mass Hall Diagram*.
8. The Mass Hall Diagram will be drawn with the preset exaggeration.

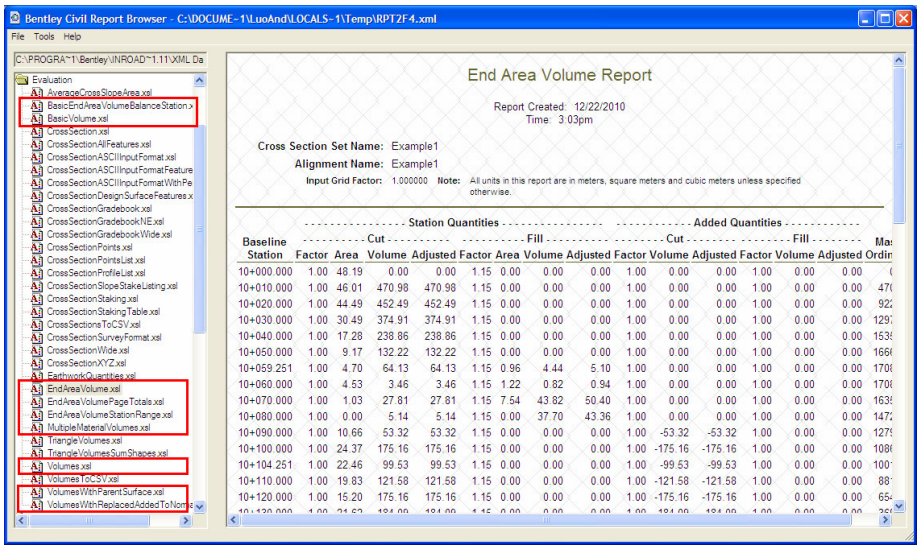


9. Save the drawing as a Mass Haul Diagram.

10.0 Reports and Data Exchange

10.1 End-Area Volume Report

The End-Area Volume Report is generated with End-Area Volumes command. Refer to Section 9.1 for details about end-area volume calculation and report generation. Once the report is generated by InRoads and the Bentley Civil Report Browser is displayed, a few style sheets from the Evaluation folder can be used to view End-Area Volume.



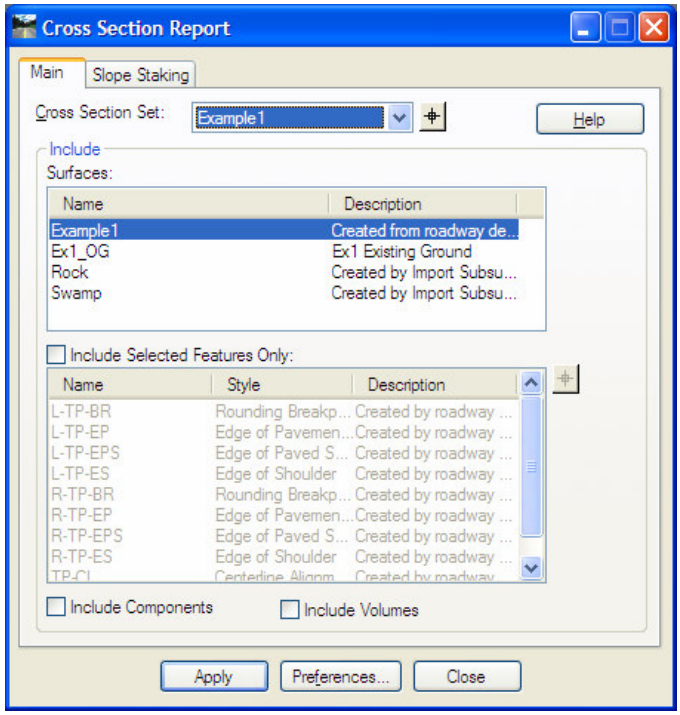
10.2 Cross Section Reports

Cross Section Report command is used to create station, offset, and elevation report for a specified cross section set. All surfaces, features, and components that you want in the report must be displayed in the cross section set.

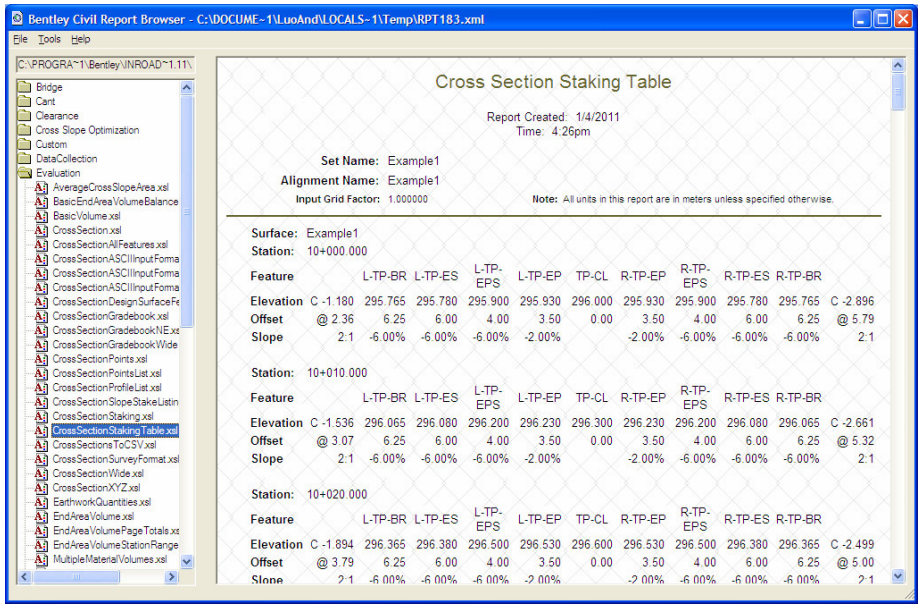
10.2.1 Top of Pavement Report

The InRoads generated design surface can be used for Top of Pavement report.

1. Open the saved cross section drawing (or you can generate a new set).
2. Select **Evaluation > Cross Section > Cross Section Report**.
3. On the Cross Section Report dialog, verify the *Cross Section Set* is ***Example1***.
4. Select surface ***Example1*** (design surface) from the Include Surfaces list.



5. Click **Apply**.
6. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionStakingTable.xsl**.

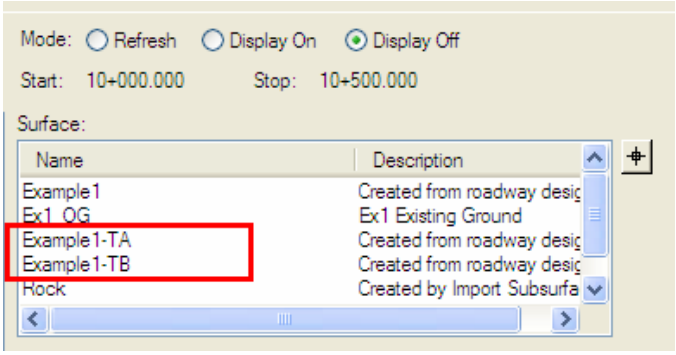


7. Save the report then close the Bentley Civil Report Browser.

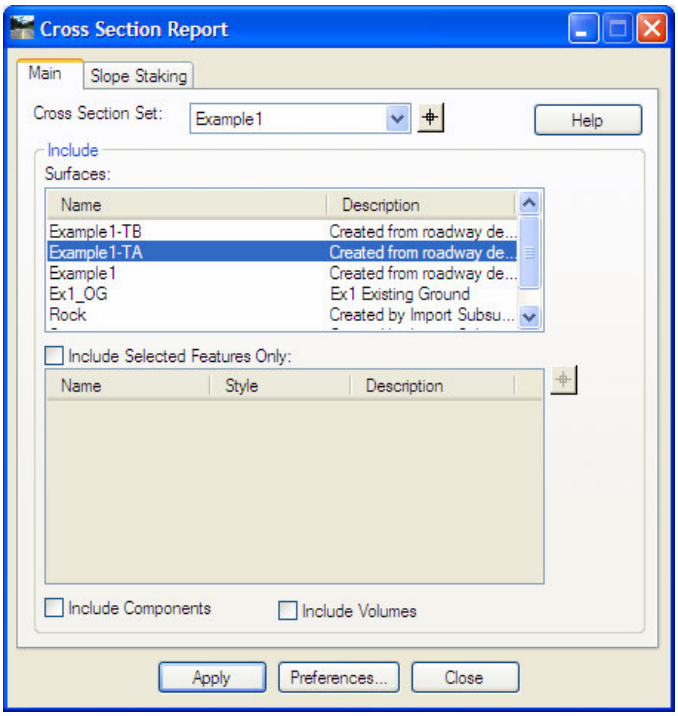
10.2.2 TA, TB Report

1. Select **Evaluation > Cross Section > Cross Sections**.

2. Click on the **Update Cross Section** folder on the left pane of Cross Sections dialog.
3. Click on Surfaces. Toggle on the **Display On** option.
4. Select surface ***Example1-TA*** from the Surface list. Click **Apply**.
5. Select surface ***Example1-TB*** from the Surface list. Click **Apply**.
6. Toggle on the **Display Off** option to make sure TA and TB surfaces have been added to the cross section set.

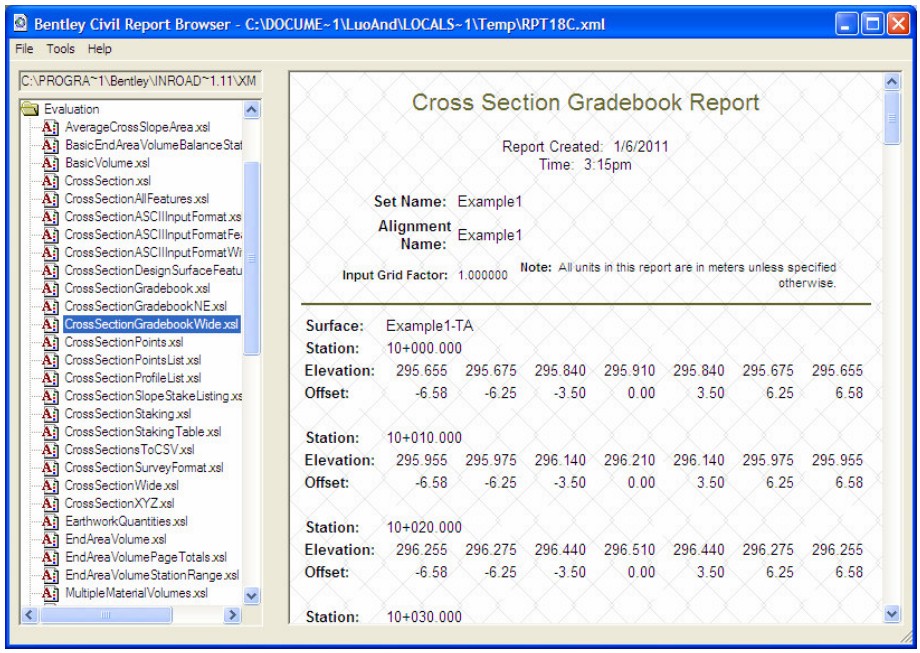


7. Close Cross Sections dialog.
8. Select **Evaluation > Cross Section > Cross Section Report**.
9. On the Cross Section Report dialog, verify the *Cross Section Set* is ***Example1***.
10. Select surface ***Example1-TA*** from the Include Surfaces list.

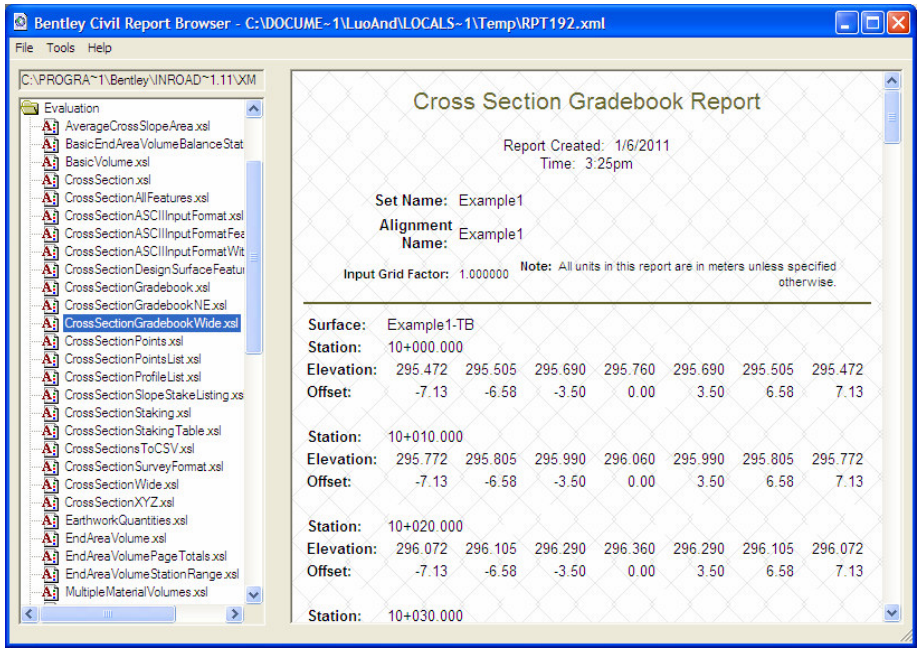


11. Click **Apply**.

12. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionGradeBookWide.xsl**.



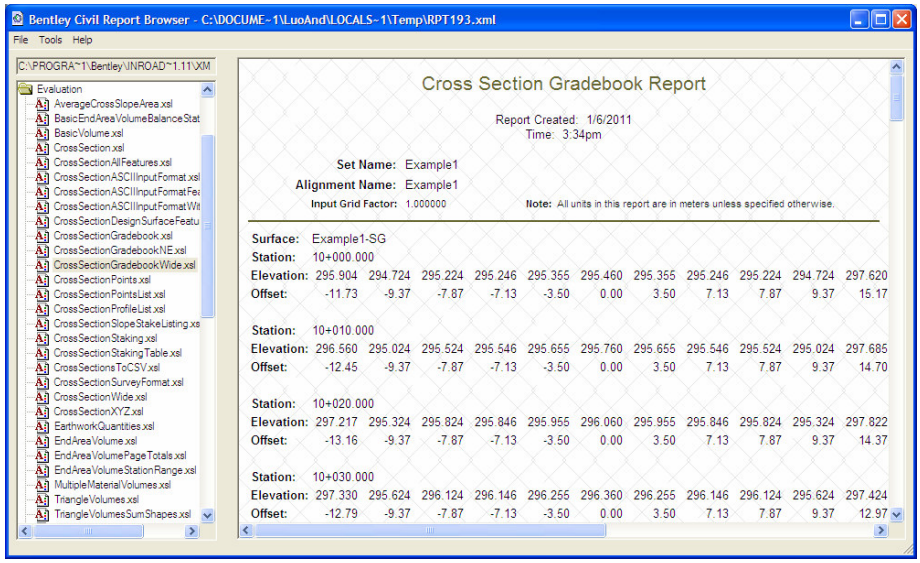
13. Save the report then close the Bentley Civil Report Browser.
14. On the Cross Section Report dialog, select surface ***Example1-TB*** from the Include Surfaces list.
15. Click **Apply**.
16. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionGradeBookWide.xsl**.



17. Save the report then close the Bentley Civil Report Browser.
18. Close the Cross Section Report dialog.

10.2.3 Subgrade Report

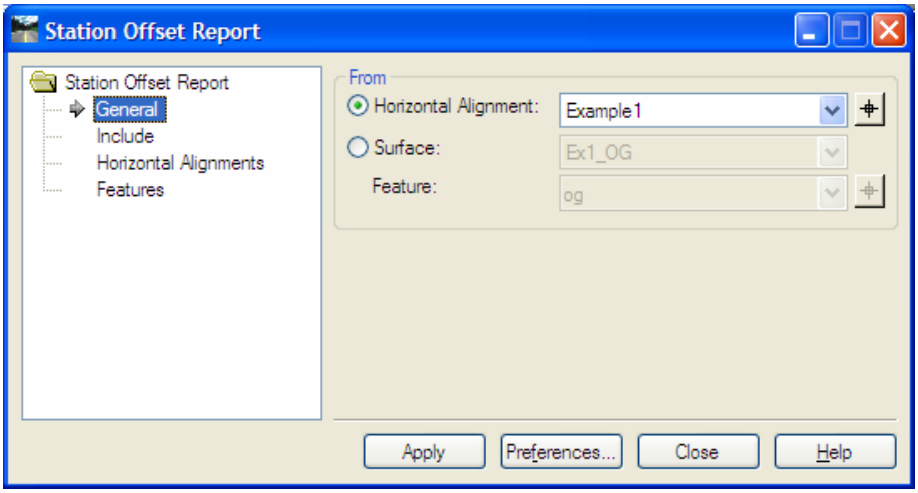
1. Repeat steps 1 to 7 in section 10.2.2 to add surface ***Example1-TB*** to the cross section set.
2. Select **Evaluation > Cross Section > Cross Section Report**.
3. On the Cross Section Report dialog, verify the *Cross Section Set* is ***Example1***.
4. Select surface ***Example1-TA*** from the Include Surfaces list.
5. Click **Apply**.
6. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionGradeBookWide.xsl**.



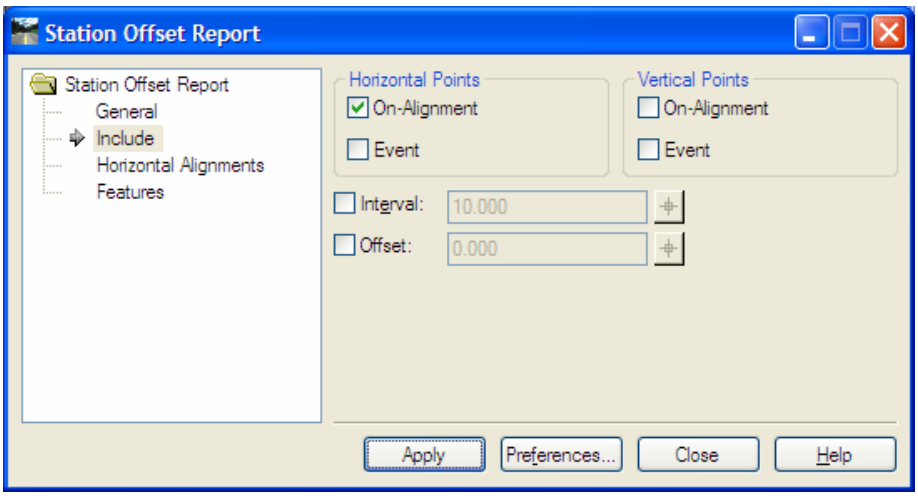
7. Save the report then close the Bentley Civil Report Browser.
8. Close the Cross Section Report dialog.

10.2.4 Rock Face Report

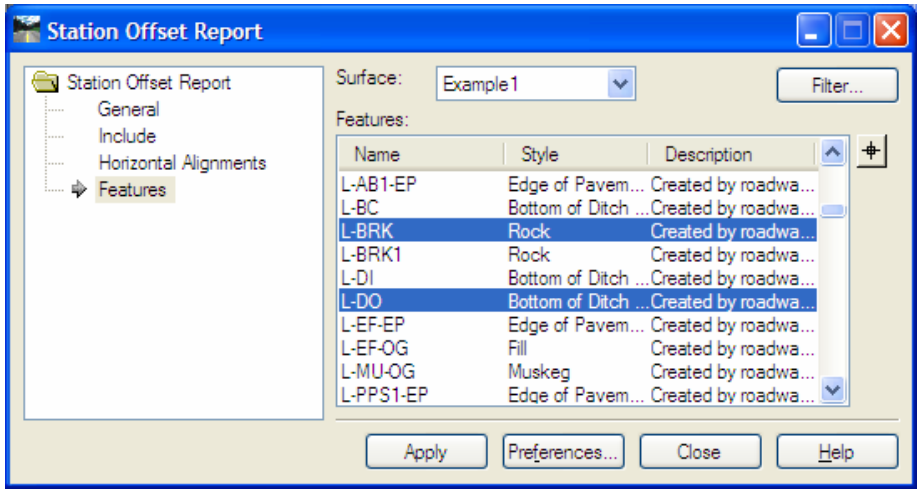
1. Select **Tools > XML Reports > Station Offset**.
2. On Station Offset Report dialog, select *General* leaf.
3. Verify the *Horizontal Alignment* is ***Example1***.



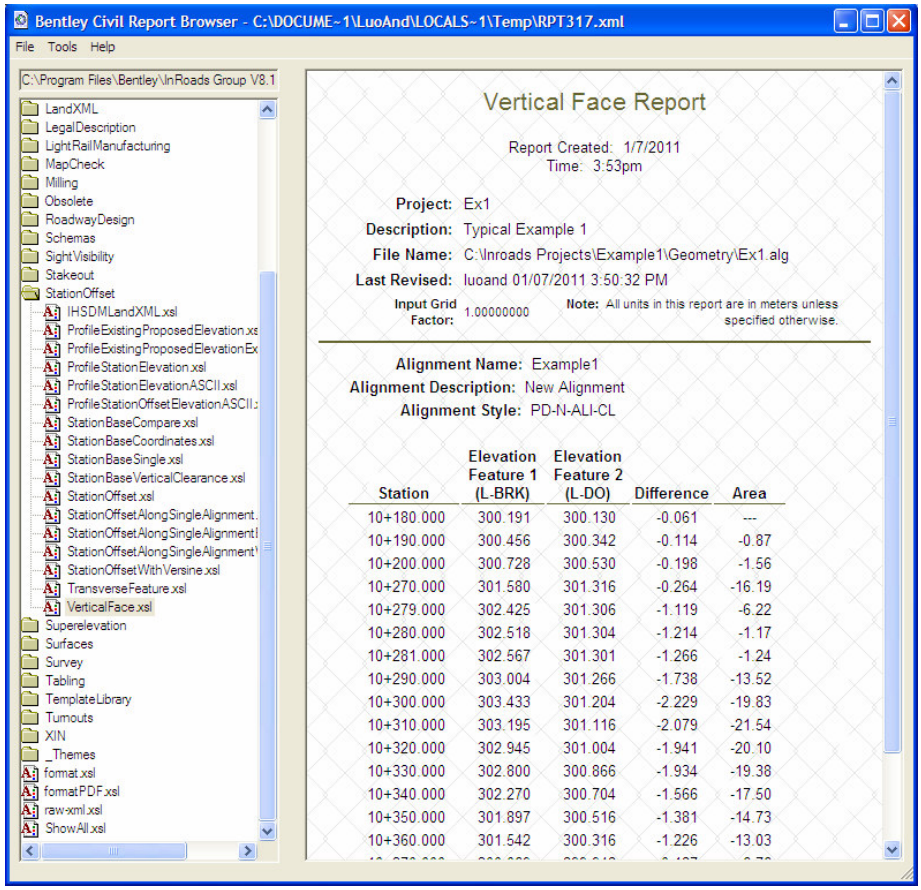
4. Select *Include* leaf. Toggle on the ***On-Alignment*** option in the Horizontal Points field.



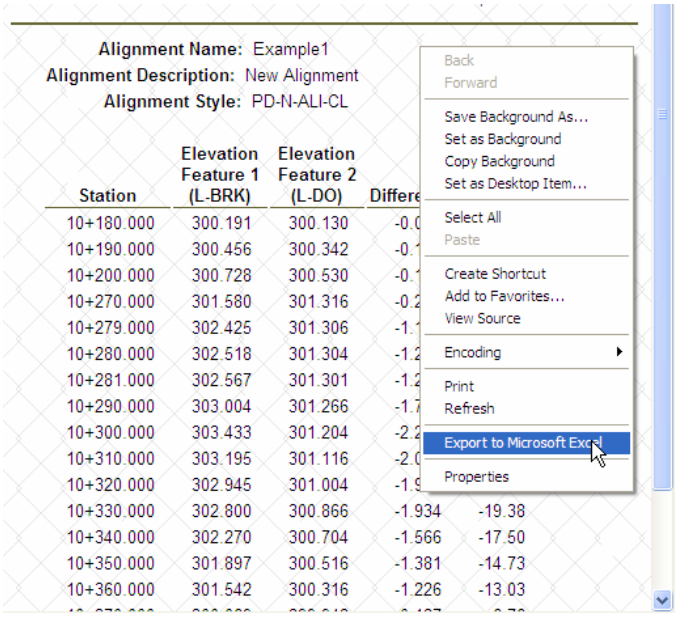
5. Select *Features* leaf.
6. Select design surface ***Example1*** for reporting from the *Surface* drop-down list.
7. In the available *Features* list window, select feature ***L-BRK*** (the top of rock face) and ***L-DO*** (the bottom of rock face). These two features are used to report left side rock face.



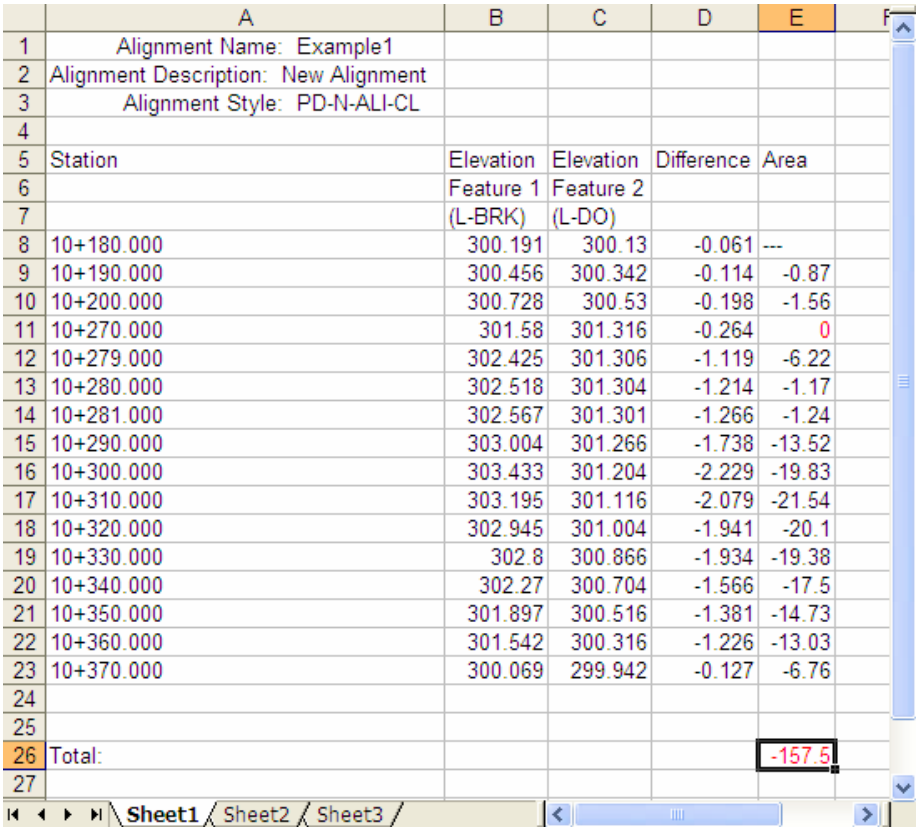
8. Click **Apply**.
9. In the Bentley Civil Report Browser, select **StationOffset > VerticalFace.xsl**.



10. Left side has two rock face sections from 10+180 to 10+200 and from 10+270 to 10+370. The area value between 10+200 and 10+270 should be removed from the report. Right click on the report and select **Export to Microsoft Excel** form the pop-up menu.



11. In Excel, type 0 in the area field at station 10+270 (start location for the second part of rock face).
12. Sum the area column for the total area of rock face on the left side.

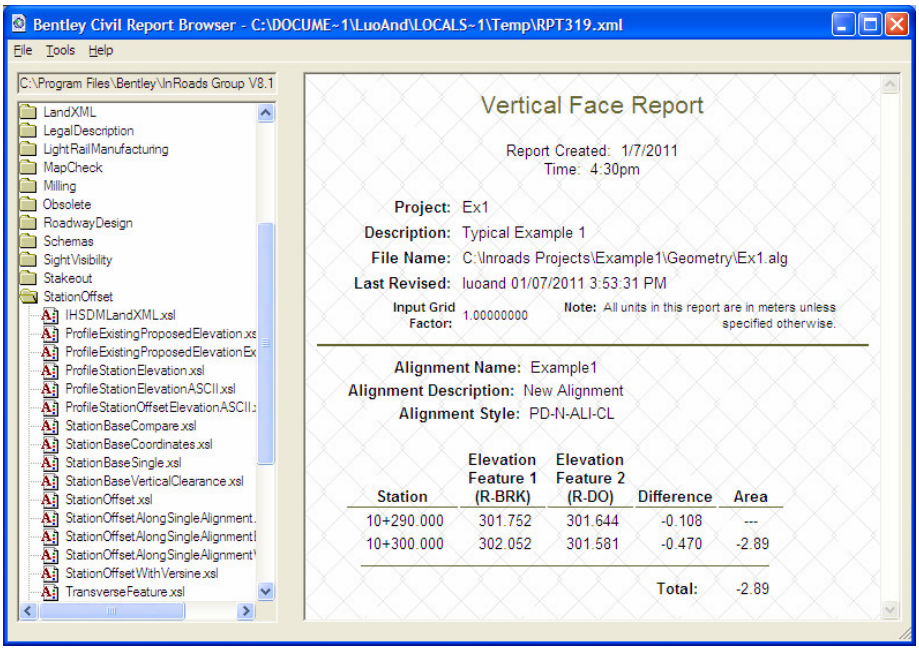


	A	B	C	D	E
1	Alignment Name: Example1				
2	Alignment Description: New Alignment				
3	Alignment Style: PD-N-ALI-CL				
4					
5	Station	Elevation	Elevation	Difference	Area
6		Feature 1	Feature 2		
7		(L-BRK)	(L-DO)		
8	10+180.000	300.191	300.13	-0.061	---
9	10+190.000	300.456	300.342	-0.114	-0.87
10	10+200.000	300.728	300.53	-0.198	-1.56
11	10+270.000	301.58	301.316	-0.264	0
12	10+279.000	302.425	301.306	-1.119	-6.22
13	10+280.000	302.518	301.304	-1.214	-1.17
14	10+281.000	302.567	301.301	-1.266	-1.24
15	10+290.000	303.004	301.266	-1.738	-13.52
16	10+300.000	303.433	301.204	-2.229	-19.83
17	10+310.000	303.195	301.116	-2.079	-21.54
18	10+320.000	302.945	301.004	-1.941	-20.1
19	10+330.000	302.8	300.866	-1.934	-19.38
20	10+340.000	302.27	300.704	-1.566	-17.5
21	10+350.000	301.897	300.516	-1.381	-14.73
22	10+360.000	301.542	300.316	-1.226	-13.03
23	10+370.000	300.069	299.942	-0.127	-6.76
24					
25					
26	Total:				-157.5
27					

Sheet1 / Sheet2 / Sheet3

13. Save the report and close Excel.

14. Return to the Station Offset Report dialog. Select Features leaf. In the available *Features* list window, select feature ***R-BRK*** (the top of rock face) and ***R-DO*** (the bottom of rock face). These two features are used to report right side rock face.
15. Click **Apply**.
16. In the Bentley Civil Report Browser, select **StationOffset > VerticalFace.xsl**.



17. Save and close the report. Close the Station Offset Report dialog.

10.3 Exporting Data

Once design is completed, the intelligent design data can be exported to contractor for construction. InRoads uses the XML industry-standard format for data exchange and outputs standard formats for Trimble and Leica for machine-controlled grading and machine guidance. Refer to the document ***Exporting InRoads Data for Construction*** located at ...\Program Files\Bentley\InRoads Group V8.11\... for details.