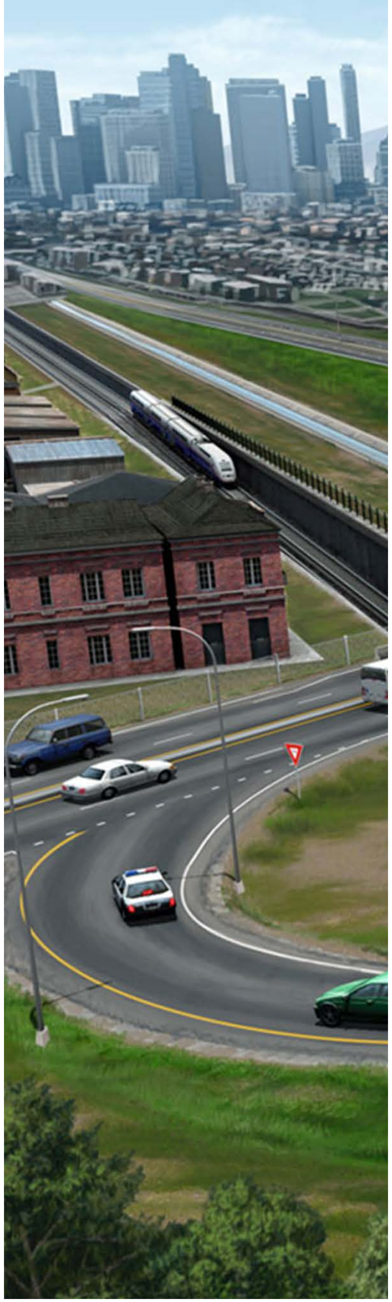


Overlay, Stripping and Widening

This course is for the **2024 Release 2** *version of:*

OpenRoads Designer CONNECT Edition

OpenRail Designer CONNECT Edition

About this Practice Workbook...

- This workbook is designed for use in Live instructor-led training and for OnDemand self study. OnDemand videos for this course are available on **learning.bentley.com**
- This PDF file includes bookmarks providing an overview of the document. Click on a bookmark to quickly jump to any section in the file.
- Both Imperial and Metric files are included in the dataset. Throughout this practice workbook Imperial values are specified first and the metric values second with the metric values enclosed in square brackets.
  For example: *12.0’ [3.4m]*.
- This course workbook uses the *Training and Examples* WorkSpace and the *Training-Imperial* or *Training-Metric* WorkSet delivered with the software.
- The terms “Left-click”, “Click”, “Select” and “Data” are used interchangeably to represent pressing the left mouse button. The terms “Right-click” and “Reset” are also used interchangeably to represent pressing the right mouse button. If your mouse buttons are assigned differently, such as for left-handed use, you will need to adjust accordingly.

Have a Question? Need Help?

If you have questions while taking this course, you can submit questions to the *Civil Design Forum* on Bentley Communities where peers and Bentley subject matter experts are available to help.

Bentley Institute

Edition: **06-01**

Course Level: **Intermediate**

Course Overview

This course teaches tools and techniques that can be used for Overlay, Milling and Widening projects.

Skills Taught:

- Create a Template with an Overlay Component
- Create and Review an “Overlay Only” Corridor
- Review the Results in the Corridor
- Creating a Template with a Milling/Stripping Component
- Create an Overlay and Milling Template
- Evaluate the Cost of a Corridor
- Compute the Pavement Quantities Along a Corridor
- Analyze Corridor Cost Based On Adjusted Profiles
- Create a Template that Contains Multiple Overlay Components
- Create a Overlay, Milling and Widening Template
- Vertical Adjustment Tool using the Minimum Milling Mode
- Limit the Depth of Milling with the Use Maximum Milling Option
- Vertical Adjustment tool using the Minimum Overlay Mode
- Vertical Adjustment tool using the Minimum Overlay Thickness Option

Exercise 1: Creating an Overlay Template

Description

In this exercise you will learn how to create and use a template that incorporates an overlay component.

Skills Taught

- Creating a Template with an Overlay Component
- Create and Review an “Overlay Only” Corridor
- Review the Results in the Corridor

Tools used in the Overlay and Milling Workflow

Many construction projects today are rehabilitation projects requiring overlay, milling, stripping, and/or widening. The overlay tools provide the ability to better streamline the process and easily try different scenarios to minimize cost.

There are two tool sets of tools that are used for overlay/milling solutions:

- Overlay/Stripping Components
- Vertical Adjustments

Template components and vertical adjustments are relatively independent of one another in the software, they are tightly related in providing a valid engineering solution.

- Quantities are calculated from template components; Overlay/Stripping components are obligatory for accurate quantities.
- Vertical Adjustments are used to calculate, define and refine a vertical alignment that optimally meets the design or cost criteria.

Overlay and Stripping (milling) Components

Overlay and Stripping Components are different from other template components in that they are not limited to simple geometric constraints. Overlay and stripping component edges can follow a surface.

Two end results of creating Corridors with Overlay/Stripping Components is detailed Cross Sections and accurate component End Area Volumes. Overlay/ Stripping components behave identically whether the Corridor Vertical Control is a defined Vertical Alignment or “live” Vertical Adjustment settings. If running from the Vertical Adjustment tool, those settings must be set properly and ultimately archived as an alignment for reuse.

Overlay and Stripping Components are not limited to use in road rehabilitation applications. Other uses include Vegetative Stripping and excavation quantities.

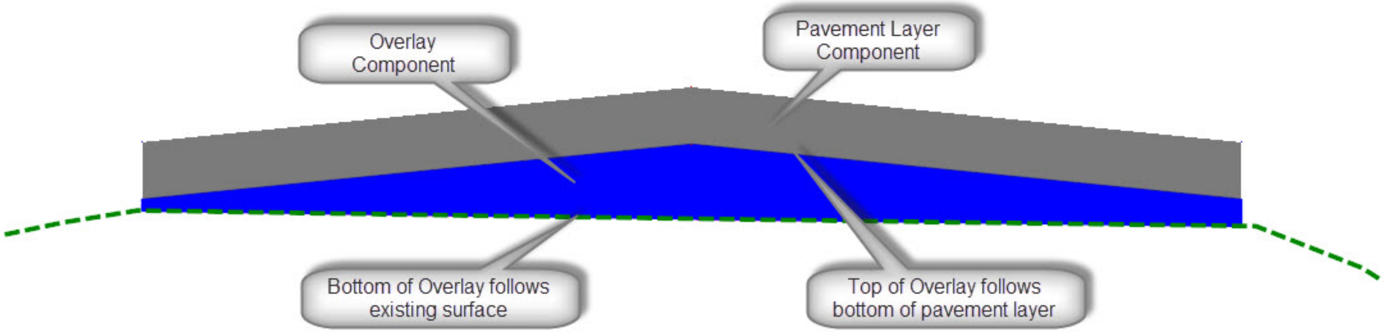
Vertical Adjustments

Vertical Adjustments read the top of the template and the existing ground to move the template vertically to optimize the amount of overlay and stripping.

The Adjustment methodology pays no attention to the types of components making up the template. The adjustments are identical regardless of whether Overlay or Stripping components are used. Proper quantities, however, do require Overlay and Stripping components.

Overlay Component

An overlay/stripping component is defined in the template as a line string with a Top and Bottom boundary. When the corridor is processed the Top and Bottom options determine the boundaries that define the overlay component as a closed shape. *When used for an overlay application the component is commonly bound along the top by a pavement layer (another component) and along the bottom by the existing surface.* The overlay component is the closed area between the new pavement layer and the existing surface.



When an overlay/stripping component is used for an stripping application the top and bottom boundaries will be different as we will learn in a later exercise. For maximum flexibility in how overlay/stripping components can be used the following top and bottom options are available.

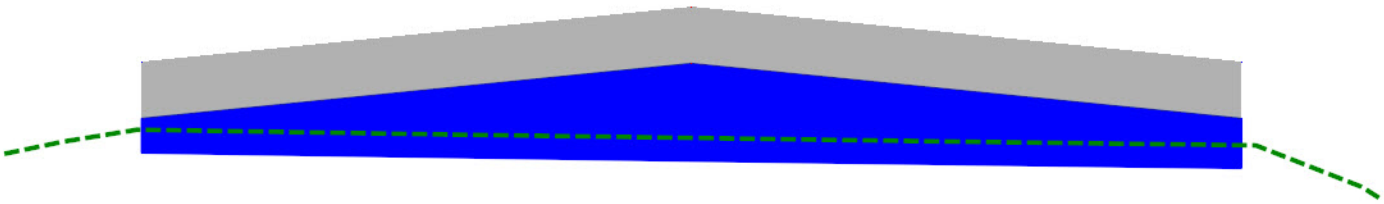
The Top of the component has 3 options:

- Follow Surface - The top of the component will be draped along the top of the target surface.
- Follow Component - The top of the component will follow the overlay/stripping component line string.
- Follow Highest - The top of the component will follow the higher of the surface or the overlay/stripping component line string.

The Bottom of the component has 4 options:

- Follow Surface - The bottom of the component will follow the target surface at a distance below the surface as defined by the Surface Depth.
- Follow Component - The bottom of the component will follow the component spine at distance below it as defined by the Component Depth.
- Follow Lowest - The bottom of the component will follow the lower of the surface line or the overlay/stripping component line string minus the Component Depth.
- Follow Highest - The bottom of the component will follow the higher of the surface line or the overlay/stripping component line string at the specified depths.

The *Component Depth* and *Surface Depth* options define the minimum depth the overlay or stripping component will extend below the component or surface. For example, what if a project required a minimum of **4”** *[100mm]* of existing material be removed before the overlay. In the illustration on the previous page the overlay material stops when it intersects the existing surface because the minimum depth was specified as zero. If however we specified a minimum Surface Depth of **4”** *[100mm]* the resulting design would resemble the following illustration. Notice that the overlay material extends **4”** *[100mm]* below the existing surface. For proper quantities we would also need a milling component to calculate this **4”** *[100mm]* of milling. We will learn how to include milling the later in this course.



The Bottom Option determines which or if both of these depth options is used. If the Bottom Option is set to Follow Surface, any value in the Component Depth is ignored. Likewise if the Bottom Option is set to Follow Component any value in the Surface Depth is ignore.

By definition, the bottom of the component will never go above the top of the component. If the Rules dictate that the bottom should go across the top, the bottom will simple start to follow the top of component line. In cross sections, these areas of zero thickness are not drawn, but when the component is displayed as a 3D mesh element, the zero thickness areas are created for integrity.

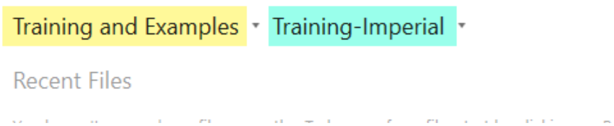
Create an Overlay Template

1. Start the software.
2. Set the WorkSpace and WorkSet

   The WorkSpace and WorkSet define standards that are used by the software. The WorkSpace and WorkSet used for this training are installed during the software installation.

   a. Select **Training and Examples** from the *WorkSpace* menu.

   b. Select **Training-Imperial** *[Training-Metric]* from the *WorkSet* menu.



3. Browse to the folder where you unzipped the dataset files and select the file **Overlay and Stripping - Template.dgn** *[Metric - Overlay and Stripping - Template.dgn]*.

   The geometry and terrain are already referenced into this drawing.

4. Create a 2 lane overlay only template.

   a. From the ribbon menu select *Corridors > Create > Template >* **Create Template**

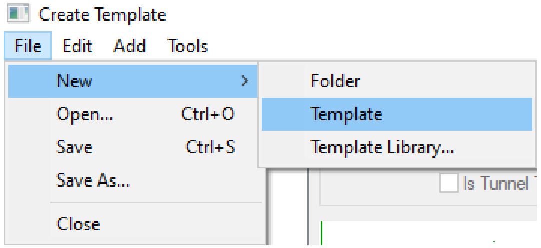
   The *Create Template* dialog opens the Template Library designated by the CIVIL_ROADWAY_TEMPLATE_LIBRARY variable. In production, this is typically set to the office, client or project standard library.

   b. From the *File* option on the *Create Template* window select **Open**.

   c. Browse to *C:\Bentley Training\Overlay Stripping and Widening* or other folder where you unzipped the dataset files.

   d. **Open** the **Overlay.Itl** file *[Metric-Overlay.itl]*

e. Select *File > New >* **Template**.



f. Name the new template **Overlay Only**

5. Ensure *Affixes* are set:

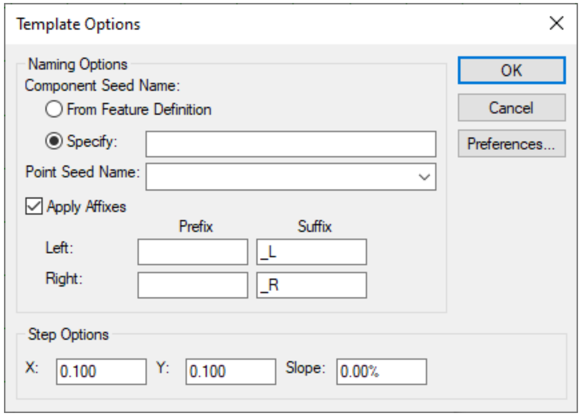
a. Select *Tools >* **Options**

b. Select **Apply Affixes** check box.

c. On the Template Options dialog set:

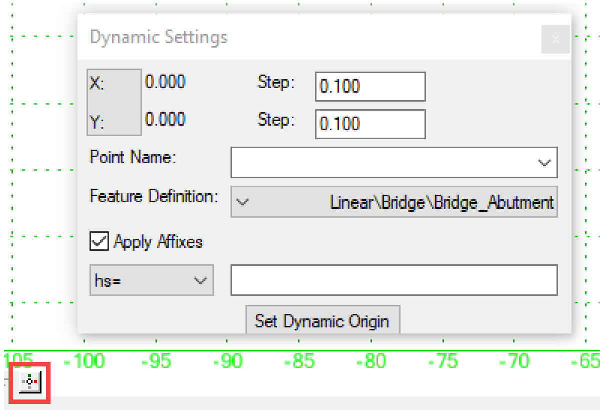
- *Left Suffix:* **_L**
- *Right Suffix:* **_R**

d. Select **OK**



6. Set the Step increments.

a. **Open** the *Dynamic Settings* window.



b. Set the *Step* increments. The *Step* settings define a snap grid in the template dialog making it easier to precisely locate points and components.

c. Set both of the *X* and *Y Step* settings to **0.1, 0.1** *[0.1, 0.1]*

7. Create the overlay only component. The component will be made of 3 points: **EOP_L**, **CL** and **EOP_R.** The top of the component will be defined with a slope of -2%. The bottom of the component will be designed to follow existing ground terrain surface.

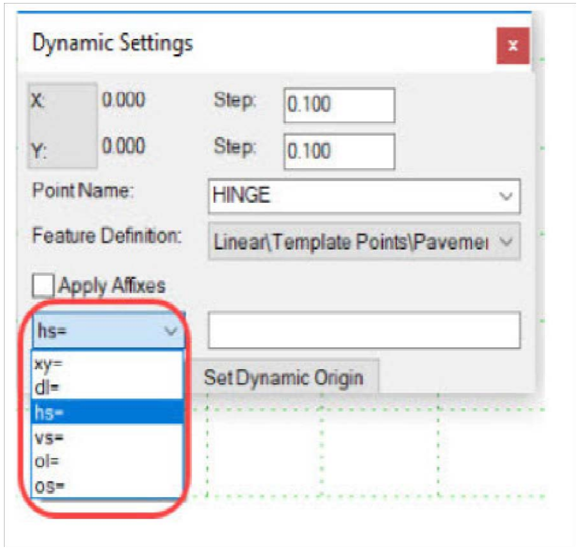
   a. *Right-click* in the *Current Template* view, then select *Add New Component >* **Overlay/Stripping**

   b. Set the following values in the *Current Component* properties:

   - *Name*: **Overlay**
   - *Feature*: **Mesh\ Asphalt\ TC_Asph Overlay** *[TC_Asph Cold Milling]*
   - *Top Option*: **Follow Component**
   - *Bottom Option*: **Follow Surface**
   - *Component Depth*: **0.00** *Surface*: **<Active>**
   - *Surface Depth*: **0.00**

   c. Create the **EOP_L** point.

   - Set the *Dynamic Settings* dialog as follows:
   - *Point Name*: **EOP** (select this from the Point Name list)
   - Set *Feature Definition: Linear\ Template Points\ Pavement* **TL_Edge of Pavt.**
   - Check on *Apply Affixes.*
   - *Precision Input*: **hs = -12, 2** *[-3.6, 2]*
   - Press: **Enter**

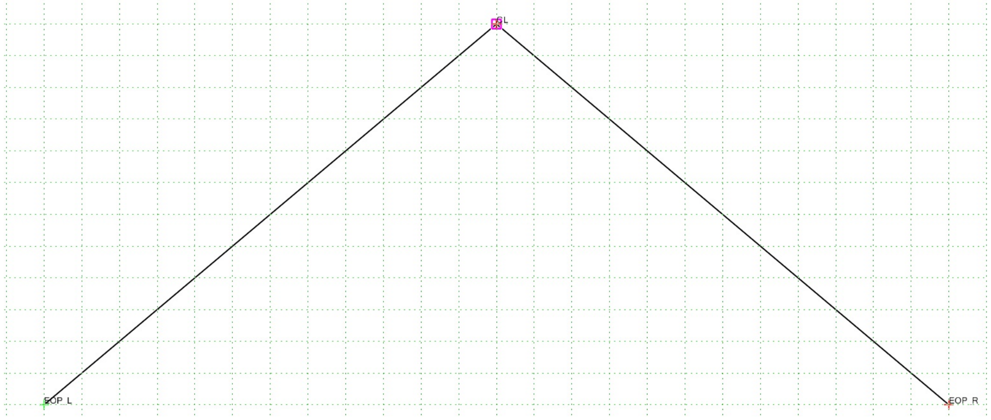


d. Create the **CL** point.

- Set the *Dynamic Settings* dialog as follows:
- *Point Name*: **CL** (select this from the Point Name list)
- Set Feature Definition: *Linear\ Template Points\ Pavement* **TL_Centerline**
- *Precision Input*: **xy = 0, 0**
- Press: **Enter**

e. Create the **EOP_R** point.

- Set the *Dynamic Settings* dialog as follows:
- *Point Name*: **EOP**
- Set Feature Definition: *Linear\ Template Points\ Pavement* **TL_Edge of Pavt.**
- *Precision Input*: **hs = 12, -2** *[3.6, -2]*
- Press: **Enter**
- *Right Click* and select **Finish**

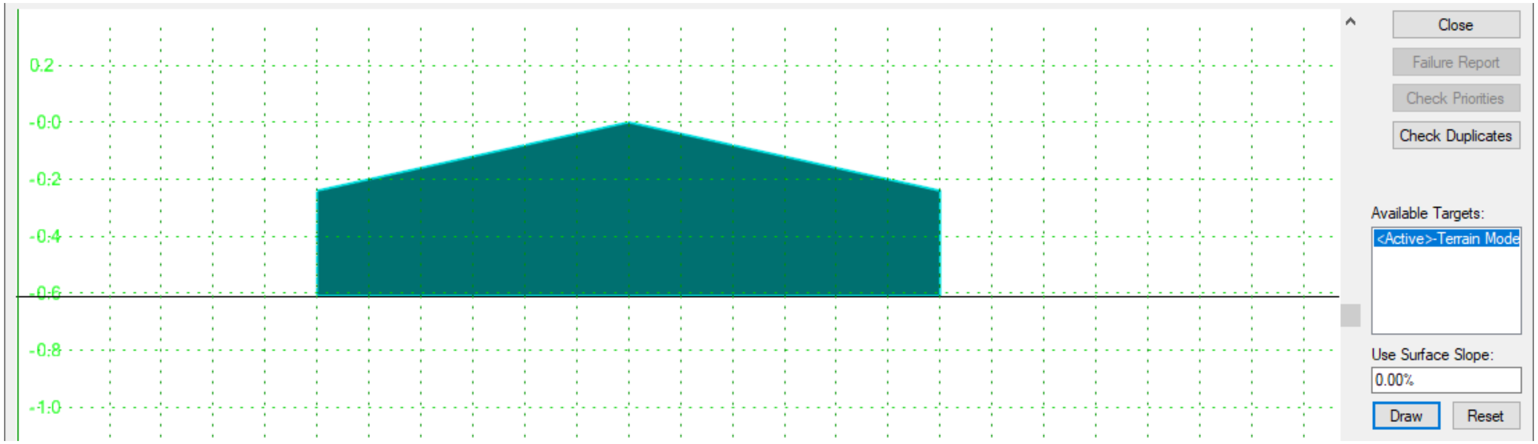


8. Test the template.

a. Select the **Test** button.

b. Select the **<Active>-Terrain Model** target and then select **Draw** to test the overlay template.

Notice the overlay area is computed from the between the overlay/stripping component on the top and the surface on the bottom.



c. Close the **Test End Conditions** dialog.

9. Adjust the template point constraints for *EOP_L* and *CL*, typically you want the *CL* point to fully unconstrained and the *EOP* points to be defined with a horizontal and slope constraint.

a. Select the **CL** point and then right click

b. Select *Delete Both Constraints*.

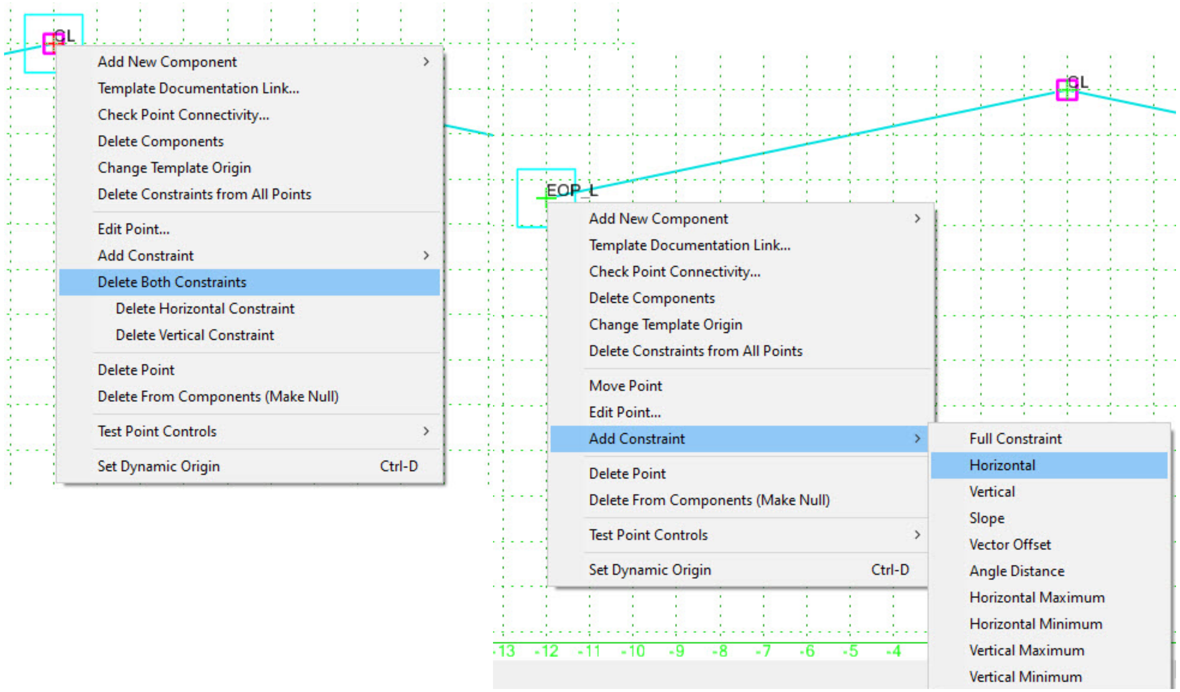
c. Select the **EOP_L** point, right click

d. Select *Add Constraint >* **Horizontal**

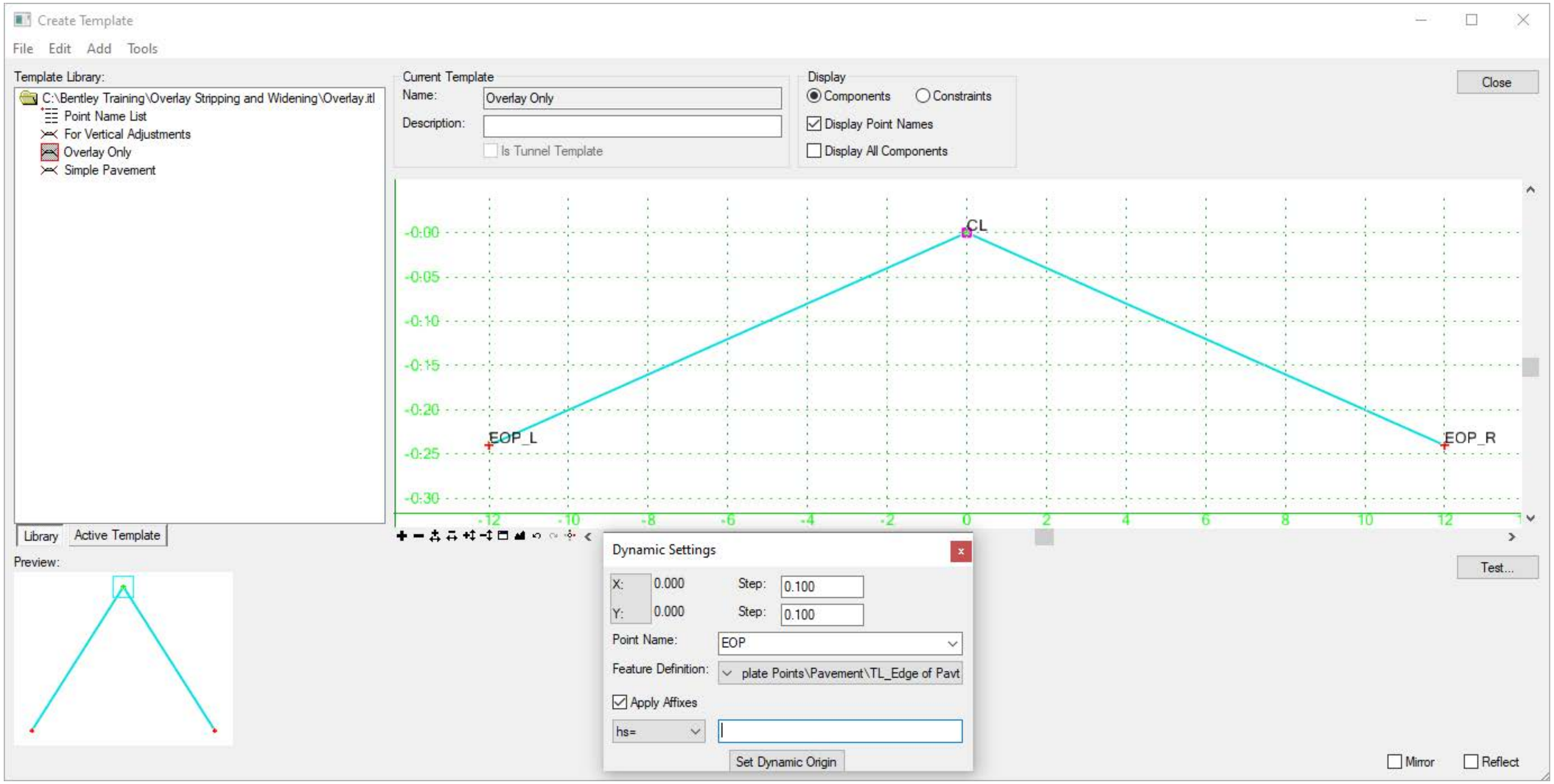
e. Pick the **CL** point and click OK

f. Select *Add Constraint >* **Slope**

g. Pick the **CL** point and click OK



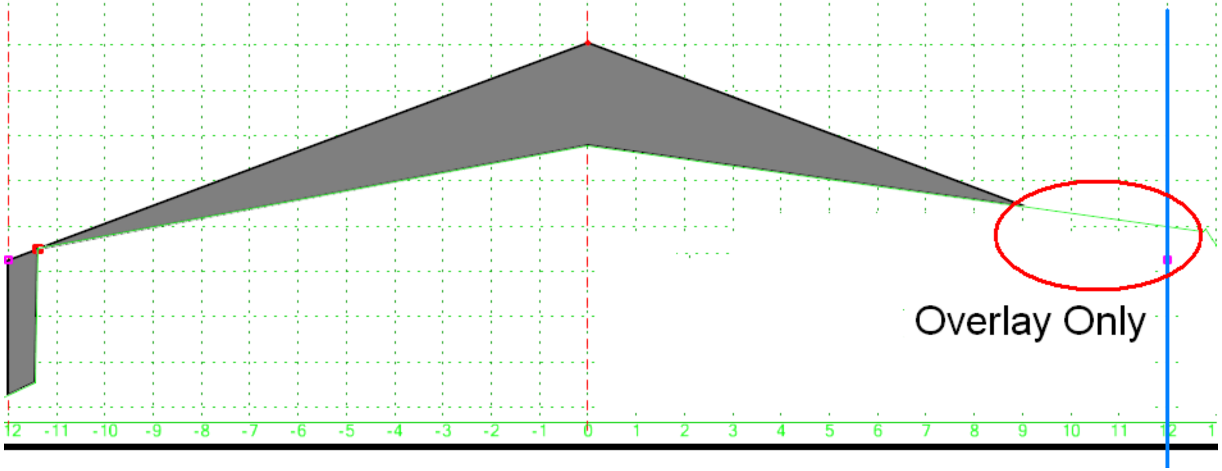
h. **Save** the Template Library.



i. **Close** the *Create Template* window.

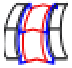
Create and Review an "Overlay Only" Corridor

An Overlay/Stripping component will stop where it intersects the bottom boundary such as the existing surface. This can result in an overlay that is less than the full width of the template. In the image below the right side is truncated before the full **12'** *[3.6m]* width.



The exercise dgn file is setup with three views for your convenience. Starting in the upper left and moving clockwise the views show the plan, profile, and cross section.

1. *Click* anywhere in *View 1*, to make this the Active View.



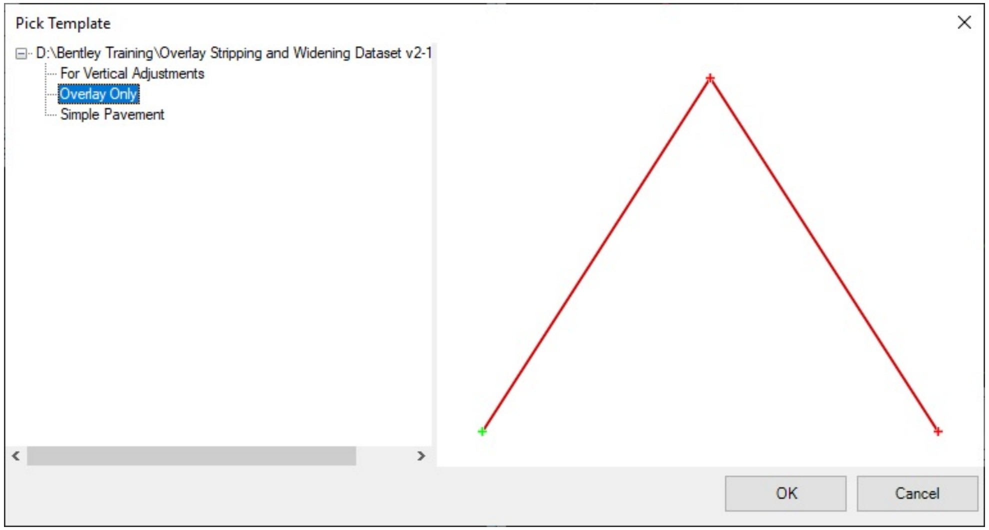
2. From the ribbon menu select: *Corridors > Create >* **New Corridor**
   a. Select > **Highway** (centerline geometry)
   b. Set the *Feature Definition >* **Final** on the *Create Corridor* dialog.
   c. In the *Name* field > **Overlay-Highway**
   d. *Right Click* to accept the **Active Profile**
   e. *Left Click* to accept and Create the Corridor

3. Add a template drop to the corridor.

a. Following the heads up prompts. press **ALT** and the **Down Arrow** on your keyboard to browse the templates in the template library.

b. The *Pick Template* window will appear

c. In the *Pick Template* window, select the template: **Overlay Only**



d. *Click OK and Left Click to accept.*

e. Follow the heads up prompts to accept the values below:

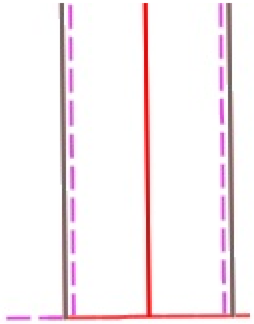
- *Start Station:* **Press ALT to lock to the Start**
- *End Station:* **Press ALT to lock to the End**
- *Interval:* **10** *[5]*

The template drop has now been assigned and the Corridor has now been created.

Review the Results in the Corridor

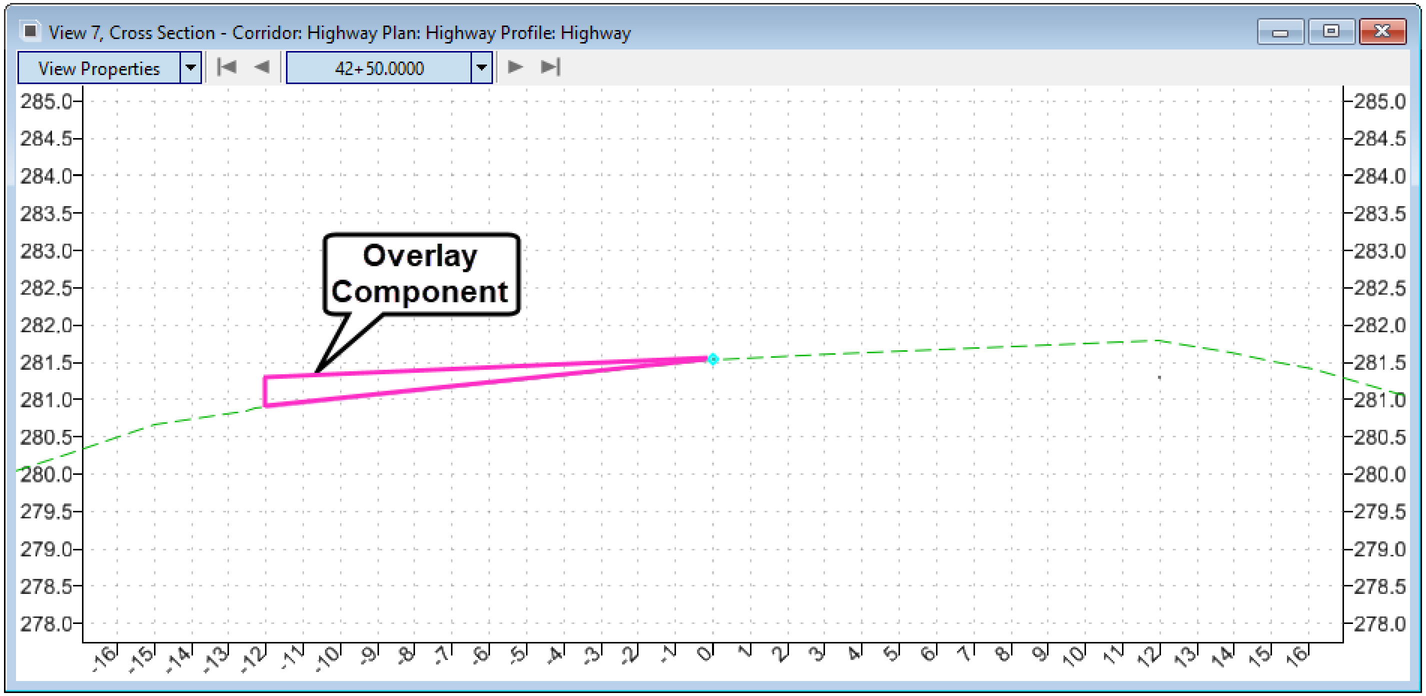
To review the results, we will create dynamic cross sections of the corridor.

1. Select the **Element Selection** tool.
2. From the ribbon menu select *Corridors >Review >Dynamic Sections >* **Open Cross Section View**
   a. In **View** 1, locate and select the **Overlay-Highway** corridor.



   b. If not already open, Open **View 7** by selecting the view 7 button from the bottom of the screen. **View 7** will appear.
   c. Select the down arrow next to *View Properties* at the top of the window.
   d. Set the *Vertical Exaggeration* to **5**
   e. Click the *left* and *right* arrow icons at the top of the window to scroll through the cross sections. A light blue line in the plan view indicates the location of the cross section currently being displayed.

Note that the component width and depth of the proposed solution varies depending on the geometry and surface at each station. For example, at about station **42+50** *[1+300]* our model requires significant overlay on the left side of the template.

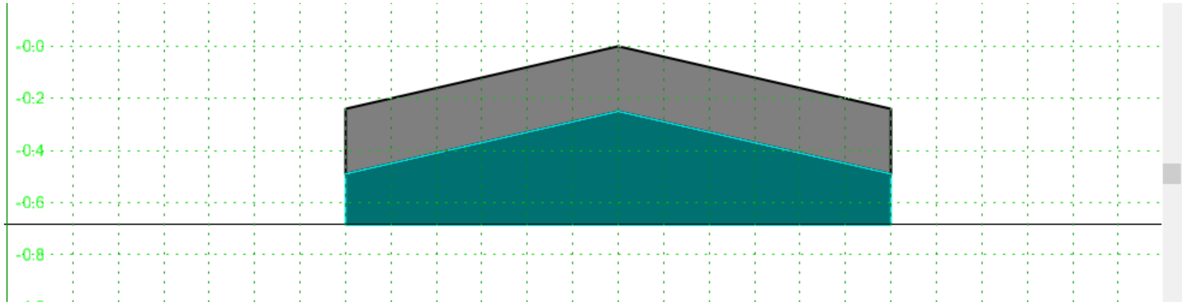


Modify the Overlay Template

To force the Overlay/Stripping component to provide design and calculations to the full width of the template we will also include a pavement component in the template.

1. Select *Corridors > Template >* **Create Template**
   a. *Right-click* on the **Simple Pavement** template and select **Copy**
   b. Paste the new template into the root of the template library by right-clicking on the *Overlay.itl [Metric - Overlay.itl]* name and then selecting **Paste**
   c. *Right-click* on the new *Simple Pavement1* template and select **Rename**
   d. Rename the new template to **Pavement with Overlay**
   e. *Double-click* the **Pavement with Overlay** template to make it active.
   f. With the *Pavement with Overlay* template active, drag the **Overlay Only** template into it and drop it at the **bottom** of the pavement layer. Make sure the overlay points merge with the points defining the bottom of the pavement layer.
   g. **Test** the new *Pavement with Overlay* template.

   The overlay component behaves just as it did before but the template now also has a fixed pavement layer.

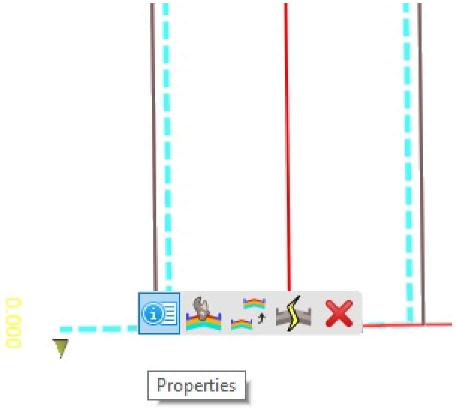


   h. **Close** the Test dialog
   i. **Save** the Template Library
   j. **Close** the *Create Template* window.

Review the Results in the Corridor

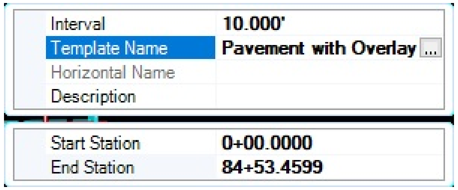
We will replace the *Overlay Only* template with the new *Pavement with Overlay* template within the corridor.

1. Select the **Element Selection** tool.
2. Select the **Template Drop Handle** for the corridor. The Template Drop Handle is on the left (looking up station) at the beginning of the corridor.



   a. Select the **Properties** button from the context menu.

   b. Change the corridor's template from *Overlay Only* to **Pavement with Overlay**.

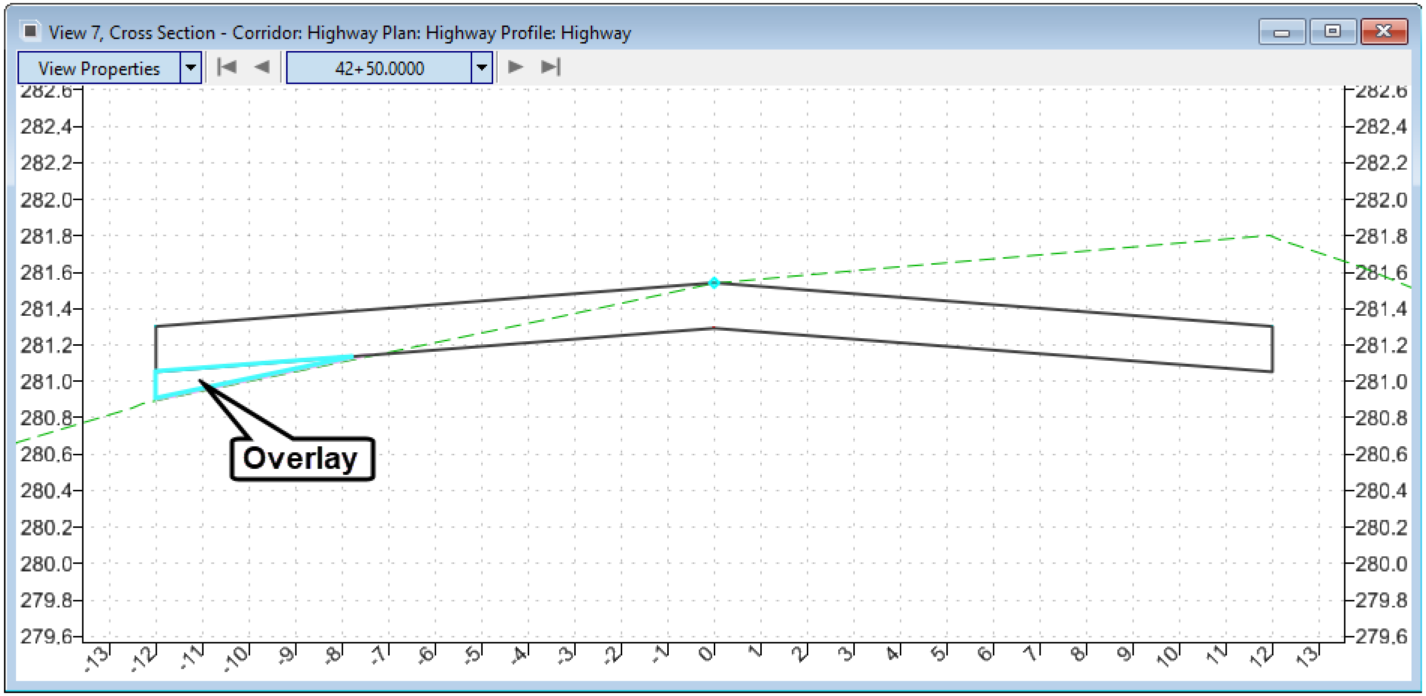


Interval	10.000'
Template Name	Pavement with Overlay
Horizontal Name	
Description	
Start Station	0+00.0000
End Station	84+53.4599

The corridor is automatically reprocessed using the new template and the dynamic cross sections updated.

3. Review the updated corridor and cross sections.

The overlay component is created across the full width of the template. On the left the overlay component shape defines the fill between the pavement layer and the existing surface. On the right no overlay is required because the existing surface is above the bottom of the pavement layer. Here the overlay component has a depth of zero.



Exercise 2: Creating a Milling/Stripping Template

Description

In this exercise you will learn how to create and utilize a template that incorporates a stripping/milling component. You will also learn how to combine the overlay and milling components.

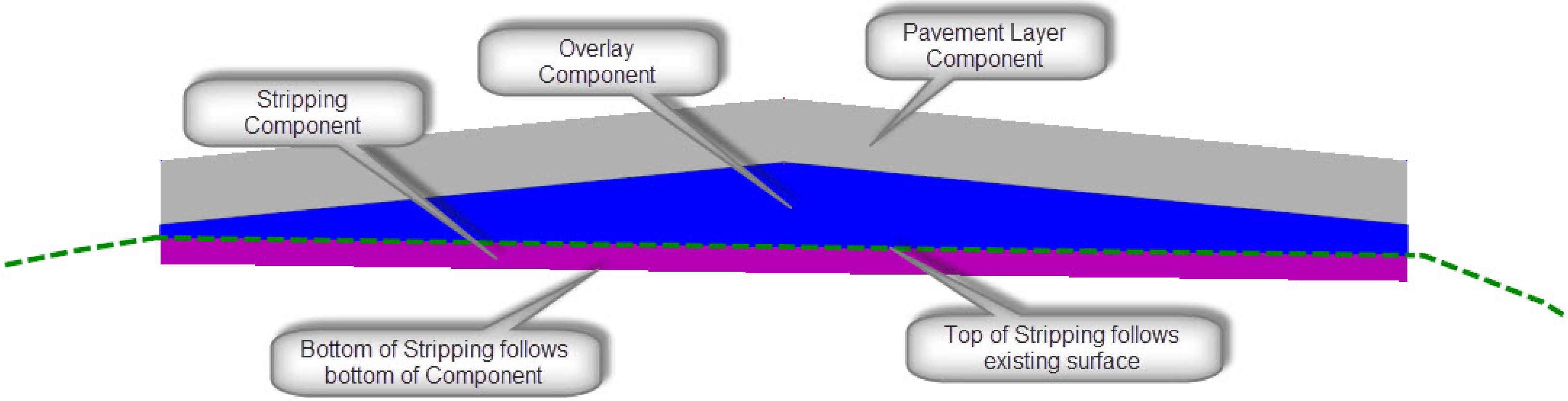
Skills Taught

- Creating a Template with a Milling/Stripping Component
- Create an Overlay and Milling Template
- Review the Results in the Corridor

Stripping Component (Milling)

There is really no difference between an overlay and an stripping component. The difference is how the Top and Bottom boundaries are defined. For an overlay application the top is bound by a pavement layer (another component) and the bottom is bound by the existing surface. *For a stripping or milling application the boundaries are reversed. The top boundary will typically be the existing surface and the bottom the overlay/stripping component.*

The following illustration shows a stripping component (purple), an overlay component (blue) and a pavement layer (gray).



The *Stripping Component* check box defines that the volume from the component is included in the Milling Report.

Create a Milling/Stripping Template

1. Open the *Overlay.itl [Metric - Overlay.itl]* Template Library.
2. Copy the *Simple Pavement* template to a new template named **Pavement with Milling**
   a. *Double-click* the **Pavement with Milling** template to make it active.
3. Add the Milling component
   a. *Right-click* in the Template view, select *Add New Component >* **Overlay/Stripping**.
   b. Set the following values in the Component Properties.
      - *Name*: **Milling**
      - *Feature Definition*: **Mesh \ Asphalt \ TC_Asph Milling** *[TC_Asph Cold Milling]*
      - *Top Option*: **Follow Surface**
      - *Bottom Option*: **Follow Component**
      - *Component Depth*: **0.00**
      - *Surface*: **<Active>**
      - *Surface Depth*: **0.00**
      - *Stripping Component* check box: **Enabled**
      - *Label:* **Mill**
4. Create the milling component along the **bottom** of the pavement component.
   a. Snap the points of the milling component to the 3 points on the bottom of the Pavement Component.
      - **L_EOP_Bot, CL_Bot** and **R_EOP_Bot**.
   a. **Test** the *Pavement with Milling* template.
   b. **Save** the template and **Close** the Create Template window.

Review the Results in the Corridor

Replace the *Pavement with Overlay* template with the new *Pavement with Milling* template within the corridor. The milling component is bound by the active surface on the top and the bottom of the Milling component line string on the bottom.

1. Change the template assigned to the corridor from *Pavement with Overlay* to **Pavement with Milling**

   a. Select the **Element Selection** tool.

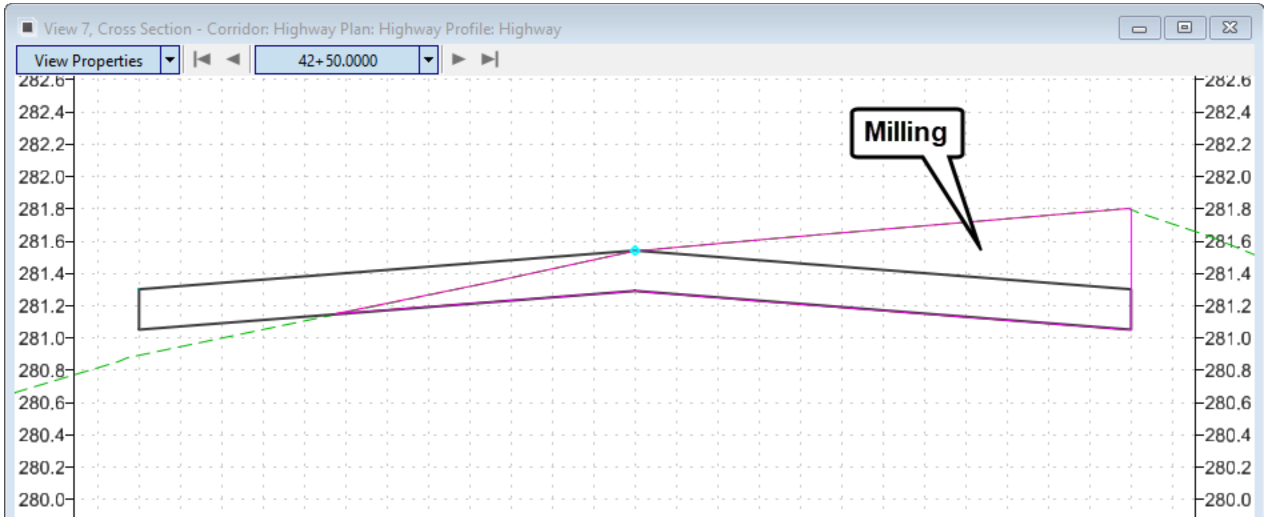
   b. Select the **Template Drop Handle** for the corridor. The Template Drop Handle is on the left (looking up station) at the beginning of the corridor.

   c. Select the **Properties** button from the context menu.

   d. Set the *Template Name* to **Pavement with Milling**

2. Review the updated corridor and cross sections.

   The stripping component is created across the full width of the template. On the right the stripping component shape defines the milling between the bottom of the pavement layer and the existing surface which is very near the top of the proposed pavement layer. On the left no stripping is required because the existing surface is below the bottom of the pavement layer. Here the stripping component has a depth of zero.



Create an Overlay and Milling Template

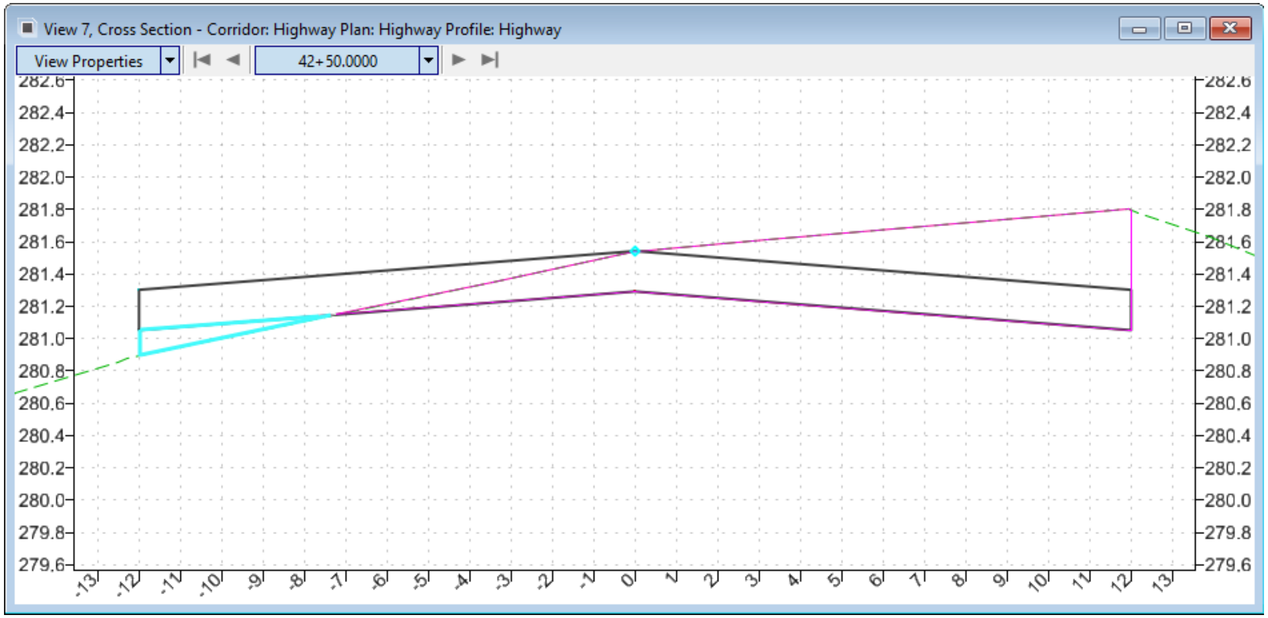
1. Open the *Overlay.itl [Metric - Overlay.itl]* template library.
2. Copy the *Pavement with Overlay* template to a new template named **Pavement with Overlay and Milling**
3. *Double-click* the **Pavement with Overlay and Milling** template to make it active.
4. Add the Milling component
   a. *Right-click* in the Template view, select *Add New Component >* **Overlay/Stripping**
   b. Set the following values in the *Component Properties*.
      - *Name*: **Milling**
      - *Feature*: **Mesh\ Asphalt\ TC_Asph Milling** *[TC_Asph Cold Milling]*
      - *Top Option*: **Follow Surface**
      - *Bottom Option*: **Follow Component**
      - *Component Depth*: **0.00**
      - *Surface*: **<Active>**
      - *Surface Depth*: **0.00**
      - *Stripping Component* check box: **Enabled**
      - *Label:* **Mill**
5. Create the milling component along the **bottom** of the pavement component.
   a. Snap the points of the milling component to the 3 points on the bottom of the Pavement Component (**L_EOP_Bot, CL_Bot** and **R_EOP_Bot**).
6. **Test** the *Pavement with Overlay and Milling* template.
7. **Save** and **Close** the Template Library.

Review the Results in the Corridor

We will replace the *Pavement with Milling* template with the new *Pavement with Overlay and Milling* template within the corridor.

1. Change the template assigned to the corridor from *Pavement with Milling* to **Pavement with Overlay and Milling**.
2. Review the updated corridor and cross sections.

   Both the overlay and the stripping component are created across the full width of the template. On the right the stripping component shape defines the milling between the bottom of the pavement layer and the existing surface which is very near the top of the proposed pavement layer. On the left the overlay component shape defines the fill between the bottom of the pavement layer and the existing surface.



Exercise 3: Evaluating the Cost of a Corridor

Description

In this exercise we will compute component quantities to evaluate the corridor's cost.

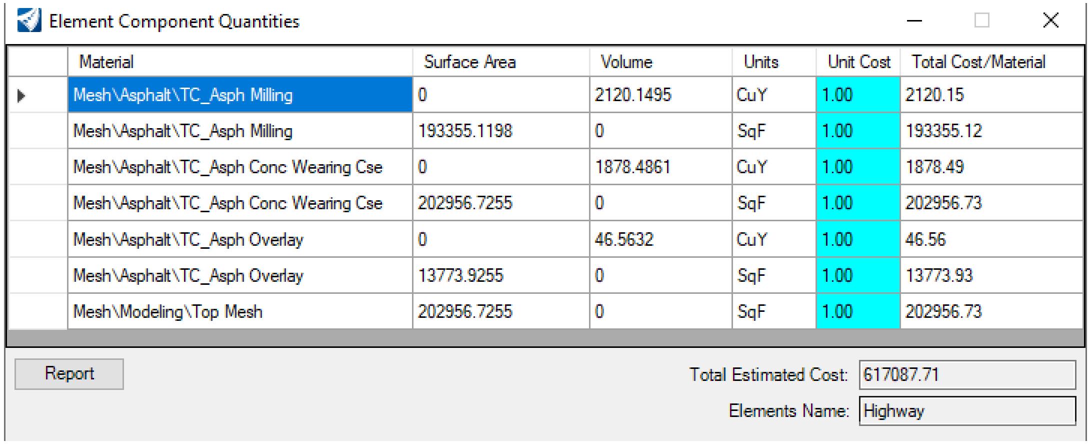
Skills Taught

- Compute the Element Component Quantities Along a Corridor
- Analyze Corridor Cost Based On Adjusted Profiles

Corridor Element Component Quantities

The Element Components Quantities tool provides volume/surface area quantities of closed-shape components directly for the corridor/3D model. This tool provides reasonable quantity estimates quickly for making engineering decisions such as evaluating the effects of changing overlay and milling depths.

All Materials have a user-definable Unit Cost field that will calculate the Total Cost/Material and the total estimate cost.



Element Component Quantities

Material	Surface Area	Volume	Units	Unit Cost	Total Cost/Material
Mesh\Asphalt\TC_Asph Milling	0	2120.1495	CuY	1.00	2120.15
Mesh\Asphalt\TC_Asph Milling	193355.1198	0	SqF	1.00	193355.12
Mesh\Asphalt\TC_Asph Conc Wearing Cse	0	1878.4861	CuY	1.00	1878.49
Mesh\Asphalt\TC_Asph Conc Wearing Cse	202956.7255	0	SqF	1.00	202956.73
Mesh\Asphalt\TC_Asph Overlay	0	46.5632	CuY	1.00	46.56
Mesh\Asphalt\TC_Asph Overlay	13773.9255	0	SqF	1.00	13773.93
Mesh\Modeling\Top Mesh	202956.7255	0	SqF	1.00	202956.73

Report

Total Estimated Cost: 617087.71

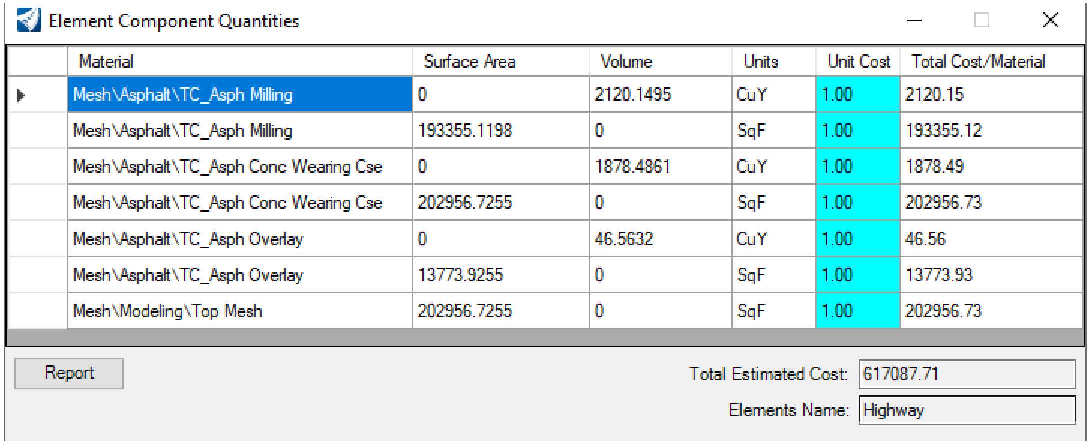
Elements Name: Highway

Note: For the purposes of this course we are only evaluating pavement quantities.

Review Element Component Quantities

1. Select *Home > Model Analysis and Reporting > Civil Analysis >* **Element Component Quantities**
2. Select the **Corridor** and *right click* to complete.

   The Element Component Quantities dialog appears. Notice the quantities are reported by surface area and volume for each material type. The *Material* name is defined by the component feature definition.



Element Component Quantities

Material	Surface Area	Volume	Units	Unit Cost	Total Cost/Material
Mesh\Asphalt\TC_Asph Milling	0	2120.1495	CuY	1.00	2120.15
Mesh\Asphalt\TC_Asph Milling	193355.1198	0	SqF	1.00	193355.12
Mesh\Asphalt\TC_Asph Conc Wearing Cse	0	1878.4861	CuY	1.00	1878.49
Mesh\Asphalt\TC_Asph Conc Wearing Cse	202956.7255	0	SqF	1.00	202956.73
Mesh\Asphalt\TC_Asph Overlay	0	46.5632	CuY	1.00	46.56
Mesh\Asphalt\TC_Asph Overlay	13773.9255	0	SqF	1.00	13773.93
Mesh\Modeling\Top Mesh	202956.7255	0	SqF	1.00	202956.73

Report

Total Estimated Cost: 617087.71

Elements Name: Highway

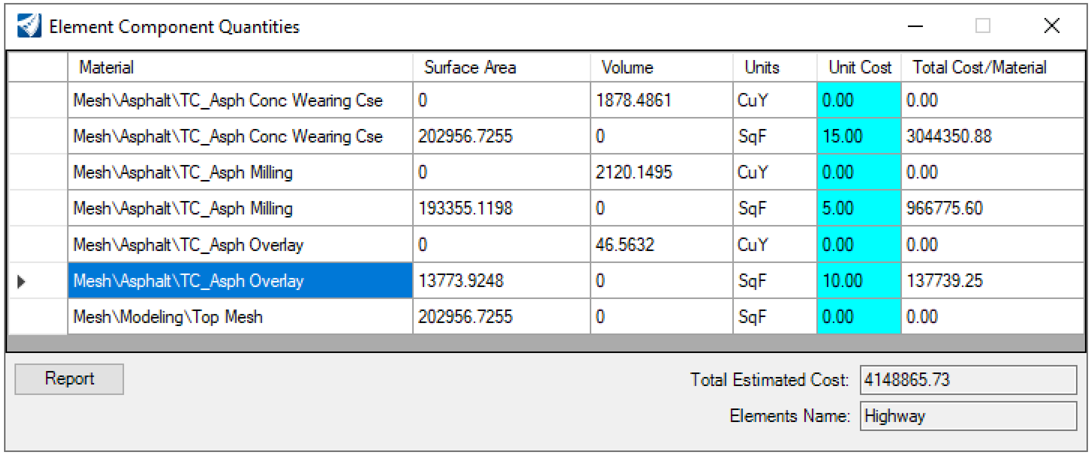
Generate a Cost Based Quantities Report

1. Define unit costs for the pavement materials.

   A lot of times pavement quantities are reported as an *Area* so lets assign appropriate unit costs to the pavement components *Surface Area.* If you prefer to estimate pavement volumes, assign unit costs for the volumes.

   - Set the *TC_Asph Milling* unit cost to **5**
   - Set the *TC_Asph Overlay* unit cost to **10**
   - Set the *TC_Asph Conc Wearing Course* unit cost to **15**

2. Since we only want area to be considered for cost, be sure to set all Unit costs for volume unit costs to **zero**.



Material	Surface Area	Volume	Units	Unit Cost	Total Cost/Material
Mesh\Asphalt\TC_Asph Conc Wearing Cse	0	1878.4861	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Conc Wearing Cse	202956.7255	0	SqF	15.00	3044350.88
Mesh\Asphalt\TC_Asph Milling	0	2120.1495	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Milling	193355.1198	0	SqF	5.00	966775.60
Mesh\Asphalt\TC_Asph Overlay	0	46.5632	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Overlay	13773.9248	0	SqF	10.00	137739.25
Mesh\Modeling\Top Mesh	202956.7255	0	SqF	0.00	0.00

   a. Select the *Report* button to view the quantities report.

   b. Review the report.

   c. **Close** the *Report Browser*.

   d. **Close** the *Component Quantities* window.

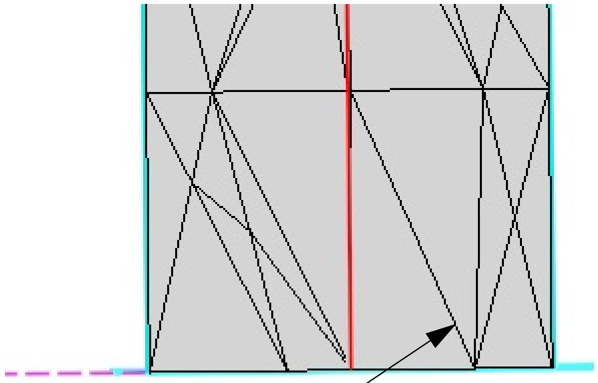
Finding a Cost Effective Solution

Changing the profile will affect the amount of overlay leveling and milling required on the project which in turn affects the total estimated cost.

1. Change the active profile of the corridor to **Alternate 1**
   a. Select the **Element Selection** tool.
   b. In *View 1*, select the *corridor mesh*
   c. Select the **Properties** button from the context menu.
   d. Set *Use Active Profile* to **False**.
   e. Set the *Profile Name* to **Alternate 1**

   The corridor is reprocessed automatically.

   The model and dynamic cross sections are updated to the new corridor.



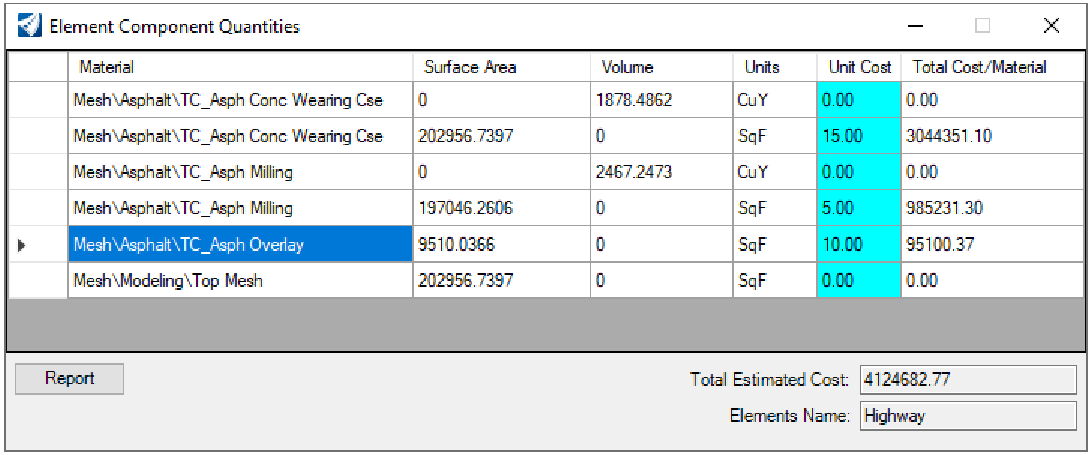
Corridor mesh

Feature Name	Overlay
Feature Definition	Final

Name	Overlay
Horizontal Name	Highway
Use Active Profile	False
Profile Name	Alternate 1

2. Select *Home > Model Analysis and Reporting >* **Element Component Quantities**
3. Select > *Highway Corridor*

4. Adjust the Unit Costs as shown in the image below.



Element Component Quantities

Material	Surface Area	Volume	Units	Unit Cost	Total Cost/Material
Mesh\Asphalt\TC_Asph Conc Wearing Cse	0	1878.4862	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Conc Wearing Cse	202956.7397	0	SqF	15.00	3044351.10
Mesh\Asphalt\TC_Asph Milling	0	2467.2473	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Milling	197046.2606	0	SqF	5.00	985231.30
Mesh\Asphalt\TC_Asph Overlay	9510.0366	0	SqF	10.00	95100.37
Mesh\Modeling\Top Mesh	202956.7397	0	SqF	0.00	0.00

Report

Total Estimated Cost: 4124682.77

Elements Name: Highway

5. Review the total estimated cost and note the amount for this solution using the *Alternate 1* profile. It is less than the *Existing Profile*.

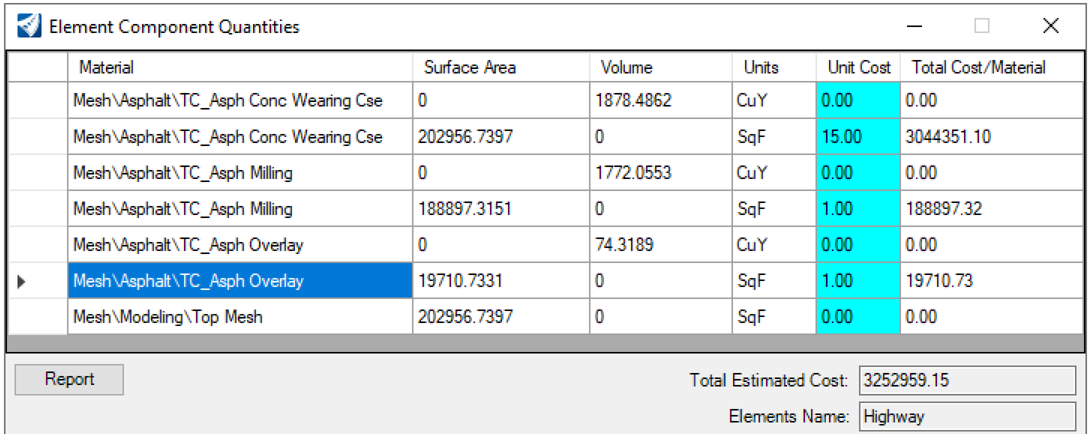
   The *Alternate 1* profile is **3”** *[75mm]* lower than the *Existing profile*.

6. Change the active profile of the corridor to **Alternate 2**

7. Select the **Corridor Component Quantities** tool.

8. Review the *Total Estimated Cost* and note the amount for this solution using the *Alternate 2* profile.

   The *Alternate 2* profile is three inches higher than the Existing profile.



Element Component Quantities

Material	Surface Area	Volume	Units	Unit Cost	Total Cost/Material
Mesh\Asphalt\TC_Asph Conc Wearing Cse	0	1878.4862	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Conc Wearing Cse	202956.7397	0	SqF	15.00	3044351.10
Mesh\Asphalt\TC_Asph Milling	0	1772.0553	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Milling	188897.3151	0	SqF	1.00	188897.32
Mesh\Asphalt\TC_Asph Overlay	0	74.3189	CuY	0.00	0.00
Mesh\Asphalt\TC_Asph Overlay	19710.7331	0	SqF	1.00	19710.73
Mesh\Modeling\Top Mesh	202956.7397	0	SqF	0.00	0.00

Report

Total Estimated Cost: 3252959.15

Elements Name: Highway

9. Which profile results in the most cost effective solution in terms of Milling?

Milling Report

Often milling costs are estimated based on the planar area to be milled. The Element Component Quantities tool provides milling quantities by volume and surface area. The previous exercise estimated the milling cost based on an assumed average milling. To get true planar area quantities for milling, use the Roadway Design Milling Reports tool.

1. Select the **Element Selection** tool.
2. Select the corridor border.
3. Select the **Corridor Reports** tool.
4. From the drop-down menu, select **Milling Report**.

   The report browser opens displaying the report.

   This report provides station-based area values and can be sent to Microsoft Excel for data manipulation by right-clicking in the report and selecting Export to Microsoft Excel.

Roadway Design Milling Report

Report Created: Monday, July 13, 2020
Time: 11:25:22 AM

Station	Left Offset/ Elevation	Right Offset/ Elevation	Planar Area
0+00.000	-12.000 291.290	12.000 291.290	0.000
0+10.000	-12.000 291.038	12.000 291.038	240.000
0+20.000	-12.000 290.786	12.000 290.786	240.000
0+30.000	-12.000 290.534	12.000 290.534	240.000
0+40.000	-12.000 290.283	12.000 290.283	240.000
0+50.000	-12.000	12.000	240.000

Exercise 4: Creating a Multi-Layer Overlay Template

Description

In this exercise we will create and utilize a template with multiple overlay layers within a single project. Multiple overlay layers are useful when different materials are required for structural integrity or cost effectiveness. Money can be saved on deep overlays, by setting a maximum depth for a premium overlay layer and filling any additional overlay with a cheaper binder.

Skills Taught

- Creating a Template that Contains Multiple Overlay Components
- Review the Results in the Corridor

Build the Maximum-Depth Layer

1. Leave the Profile as **Alternative 2**
2. Open the *Overlay.itl* *[Metric - Overlay.itl]*
3. Copy the *Simple Pavement* template to a new template named **Multi-Layer Overlay**

   a. *Double-click* the **Multi-Layer Overlay** template to make it active.

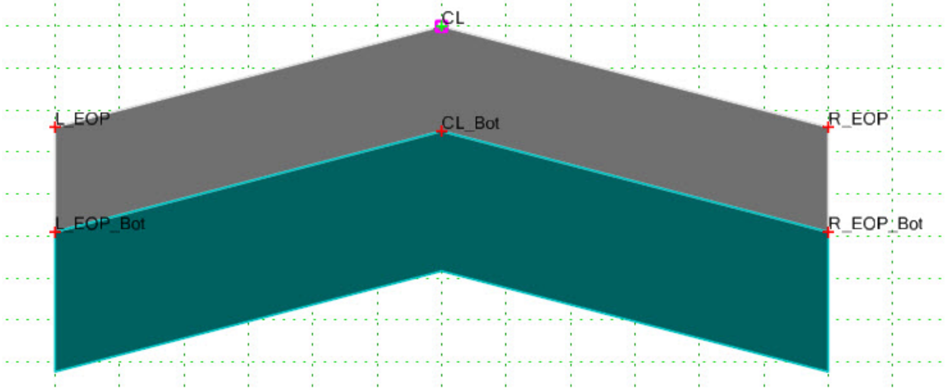
   b. *Right-click* in the Template view, select *Add New Component >* **Overlay/Stripping**

   c. Set the following values in the Component Properties.

   - *Name*: **Premium Overlay**
   - *Feature Definition:* **Mesh\ Asphalt\ TC_Asph Overlay** *[TC_Asph Cold Milling]*
   - *Top Option*: **Follow Component**
   - *Bottom Option*: **Follow Highest**
   - In the previous exercises the bottom of the overlay followed the existing surface. The bottom of this Premium Overlay component will be **0.33 ft** *[0.1m]* (defined by the Component Depth) deep or until it intersects the existing surface which ever is higher. The result is a premium overlay layer that is never thicker than **0.33 ft** *[0.1m]*.
   - *Component Depth*: **0.333** *[0.1]*
   - *Surface*: **<Active>**
   - *Surface Depth*: **0.00**

   d. On the *Dynamic Settings*: Set *Feature Definition >* **Linear\ Template Points \Pavement\ TL_Edge of Pavt**

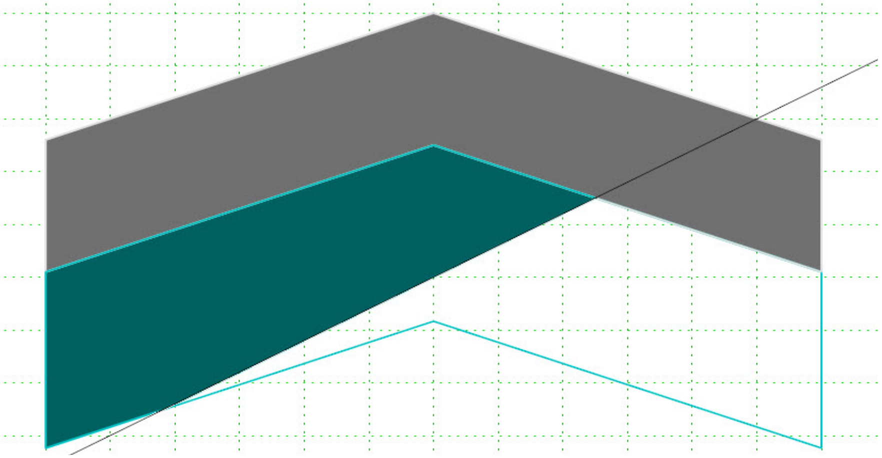
e. Set the points coincident with the *L_EOP_Bot, CL_Bot, and R_EOP_Bot* points



f. *Right Click* and select **Finish**

g. *Test* the template

Hint: Set the Surface Slope to *3.0%* to see the effect of a sloped existing surface.



Recognize that the overlay component follows the higher of the component bottom and the existing ground across the template. On the left edge of the illustration above the surface is below the **0.33ft** *[0.1m]* component depth so the overlay stops at the component. Across most of the rest of the section the surface is higher than the component and defines the bottom of the overlay shape.

h. **Close** the *Test End Conditions* window.

Build the Economic Bottom Overlay Layer

1. *Right-click* in the template view, select *Add New Component >* **Overlay/Stripping**
   a. Set the following values in the Component Properties.
      - *Name*: **Economy Overlay**
      - *Feature*: **Mesh\ Asphalt\ TC_Asph_Binder** *[TC_Asph Cold Milling]*
      - *Top Option*: **Follow Component**
      - *Bottom Option*: **Follow Surface**
      - The top of this overlay component is bound by the bottom of the Premium Overlay and the bottom is bound by the existing surface. There is no limit on the depth of the overlay.
      - *Component Depth*: **0.0**
      - *Surface*: **<Active>**
      - *Surface Depth*: **0.0**
2. Set the points near bottom points of the *Premium Overlay* component.

   Note that the bottom of the Overlay component does not actually have any points to snap to. Just get close in this step. We will adjust the points to their accurate position next.

   a. Set the *Dynamic Settings* dialog as follows:
   b. Clear: *Apply Affixes.*
   c. *Point Name*: **L_EOP_EO**
   d. Set Feature Definition: *Linear\ Template Points\ Pavement* **TL_Edge of Pavt.**

      Place Point under the bottom of the Premium Overlay layer about 0.1 below
   e. *Point Name*: **CL_EO**
   f. Set Feature Definition: *Linear\ Template Points\ Pavement* **TL_Centerline**

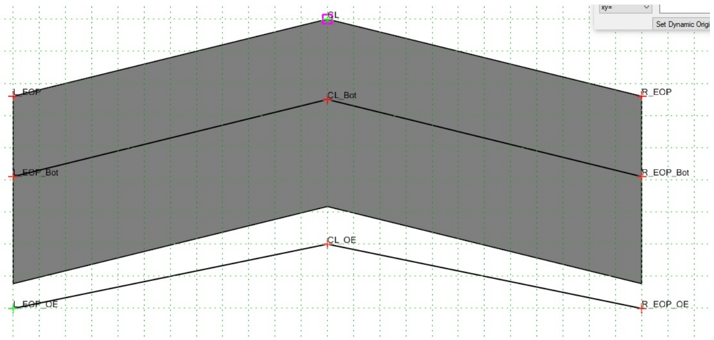
Place Point under the bottom of the Premium Overlay layer.

g. *Point Name*: **R_EOP_EO**

h. Set Feature Definition: *Linear\ Template Points\ Pavement* **TL_Edge of Pavt**

Place Point under the bottom of the Premium Overlay layer.

i. *Right Click* > **Finish**



The Template should look like the above.

3. Constrain the new points to **-0.333'** *[-0.1m]* below the *L_EOP_Bot, PGL_Bot, and R_EOP_Bot* points.

a. *Double Click* on Point **L_EOP_EO**

Point Properties dialog will now appear.

b. Set Constraint 1 as follows:

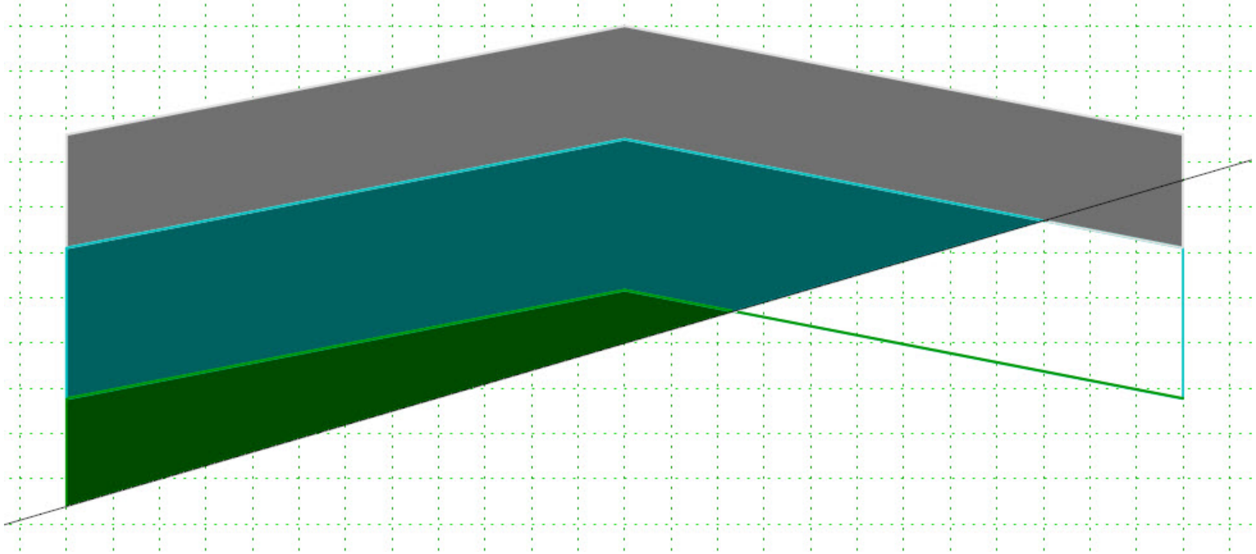
- Set Type: *Horizontal*
- Parent 1: *L_EOP_Bot*
- Value: **0** *[0]*
- Click **Apply**

c. Set Constraint 2 as follows:

- Set Type: *Vertical.*
- Parent 1: *L_EOP_Bot*
- Value: -**0.333** *[-0.1]*
- Click **Apply**
- Close *Point Properties* dialog.

4. Repeat the Process for points **CL_EO** and **R_EOP_EO**, using the appropriate Parent Points.

a. **Test** the template



When overlay is required, the premium layer (blue) is created for a maximum depth of **0.333 ft** *[0.1 m]*. The economic binder layer is then created for any additional fill depth that is required.

b. **Save** the Template Library

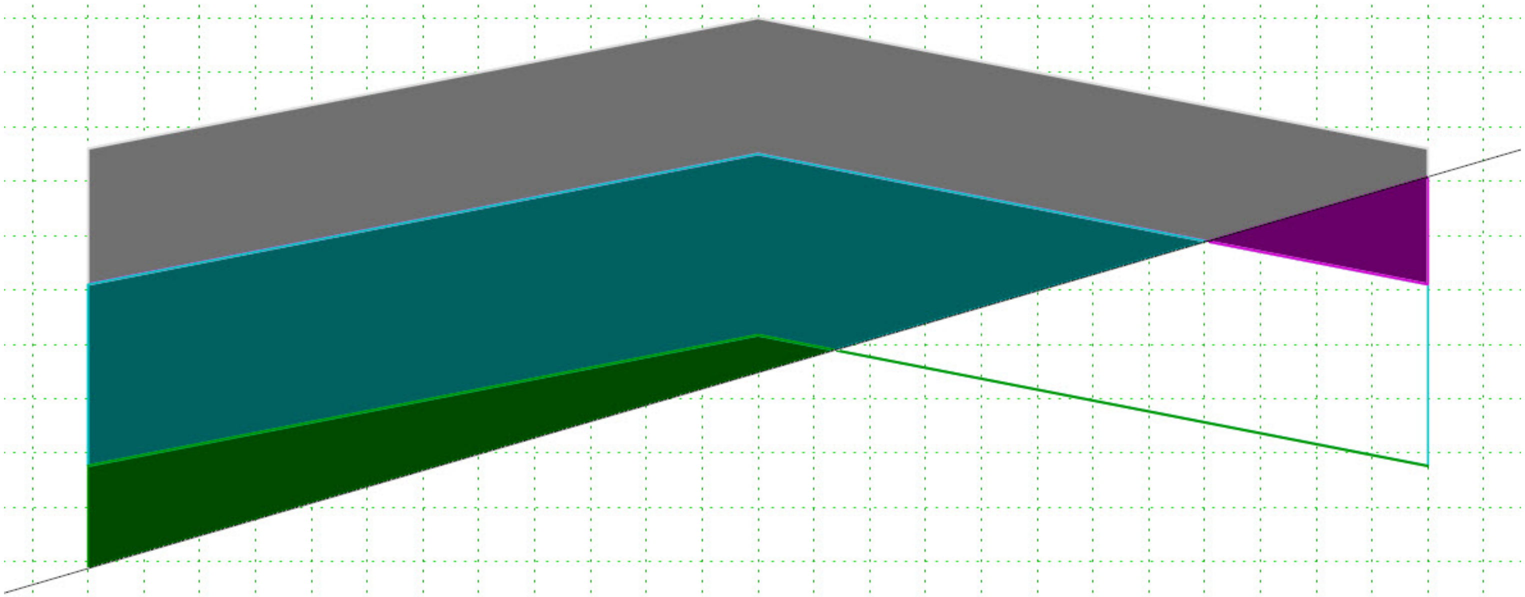
Build the Milling Layer

1. Set the *Dynamic Settings* dialog as follows:

   a. Clear: *Point Name:*

2. Right-click in the Template view, select *Add New Component* > **Overlay/Stripping**
3. Set the following values in the Component Properties.
   - *Name*: **Milling**
   - *Feature*: **Mesh\ Asphalt\ TC_Asph_Milling** *[TC_Asph Cold Milling]*
   - *Top Option*: **Follow Surface**
   - *Bottom Option*: **Follow Component**
   - *Component Depth*: **0.0**
   - *Surface*: **<Active>**
   - *Surface Depth*: **0.0**
   - *Stripping Component*: **Enabled**
   - *Label:* **Mill**
4. Set the points at the *L_EOP_Bot, CL_Bot, and R_EOP_Bot* points.

5. **Test** the template.



The existing surface is milled to the bottom of the pavement layer.

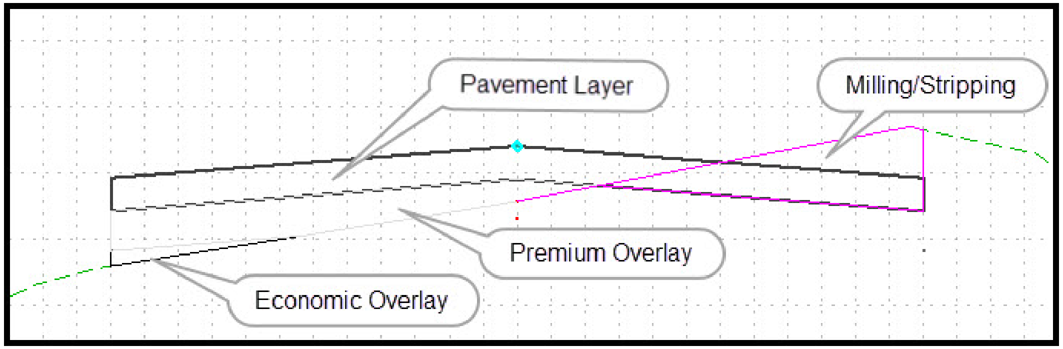
6. **Save** and **Close** the template library.

Review the Results in the Corridor

We will edit the corridor to utilize the new multi-layer template and review the results.

1. Change the template assigned to the corridor from *Pavement with Overlay and Milling* to **Multi Layer Overlay**
2. Change the active profile of the corridor to **Overlay_Under**
   a. Select the **Element Selection** tool.
   b. In *View 1*, select the corridor meshing.
   c. Select the **Properties** button from the context menu.
   d. Set *Use Active Profile* to **False**.
   e. Set the *Profile Name* to **Overlay_Under**.

   The corridor is reprocessed automatically.
3. Review the updated corridor and its cross sections.



All of the components are being utilized and that the results vary along the corridor. Also note that the results will change based on the active profile. Inspect near station 51+00 *[1+480]* where all components are used on a single cross section.

Exercise 5: Creating a Widening Template

Description

Additional components can be added to make more complex templates. For example, a project may require widening in addition to rebuilding the existing pavement with overlay and stripping.

Skills Taught

- Create a Widening Template
- Review the Results in the Corridor

Creating a Widening Template

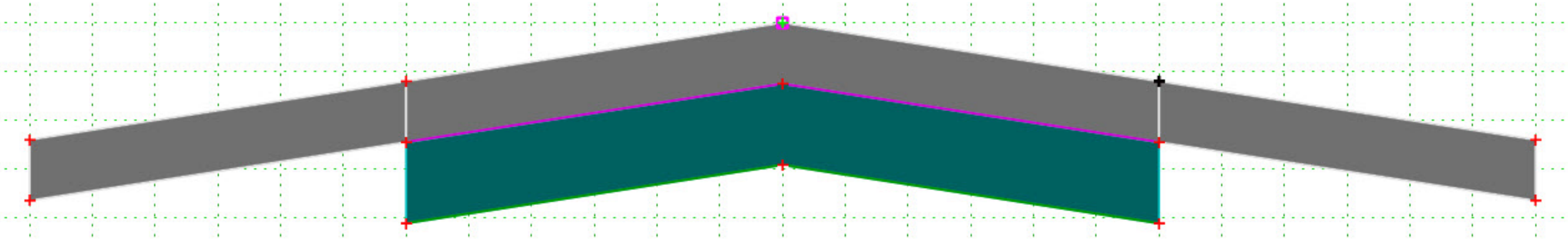
1. Open the *Overlay.itl [Metric - Overlay.itl]* Template Library (If not already Open).
2. Copy the *Multi Layer Overlay* template to a new template named **Multi Layer Overlay and Widening**
3. Double-click the **Multi Layer Overlay and Widening** template to make it active.
4. Define the first layer of the widening.

   This first layer of asphalt is the same thickness as the pavement layer in the reconstructed section of road. From a construction perspective it will be paved full width all at once.

5. Open the **Dynamic Settings** dialog.
   a. Check on **Apply Affixes**.
   b. Ensure that **Affixes** have been set to *_L* and *_R* in *Tools* > **Options**
   c. Set both *X* and *Y step* to **0.1, 0.1**
   d. Set the Point name to **SHDR**
   e. Set the *Feature Definition* > **Linear\ Template Points\ Pavement\ TL_Edge of Shld**
6. *Right-click* in the Template view, select *Add New Component* > **Simple**
   a. Set the following values in the Component Properties
      - *Name*: **Widening Pavement**
      - *Feature*: **Mesh\ Asphalt\ TC_Asph Conc Wearing Cse**
      - *Slope*: **-2.00%**
      - *Thickness*: **0.25** *[0.1]*
      - *Width*: **12** *[3.6]*

   b. *Right click* in the *Create Template* view and select **Mirror** if the component is not already being mirrored.

c. Place the new pavement at the *EOP* of the existing template.



7. Define the second layer of the widening.

This second layer of pavement is for strength. It will be constructed along with the overlays to create a uniform base for the top layer of pavement.

a. Set the Point name to **SHDR_BOT**

b. Set the *Feature Definition* > **Linear\ Template Points\ Pavement\ TL_Edge of Shld**

c. *Right-click* in the Template view, select *Add New Component* > **Simple**

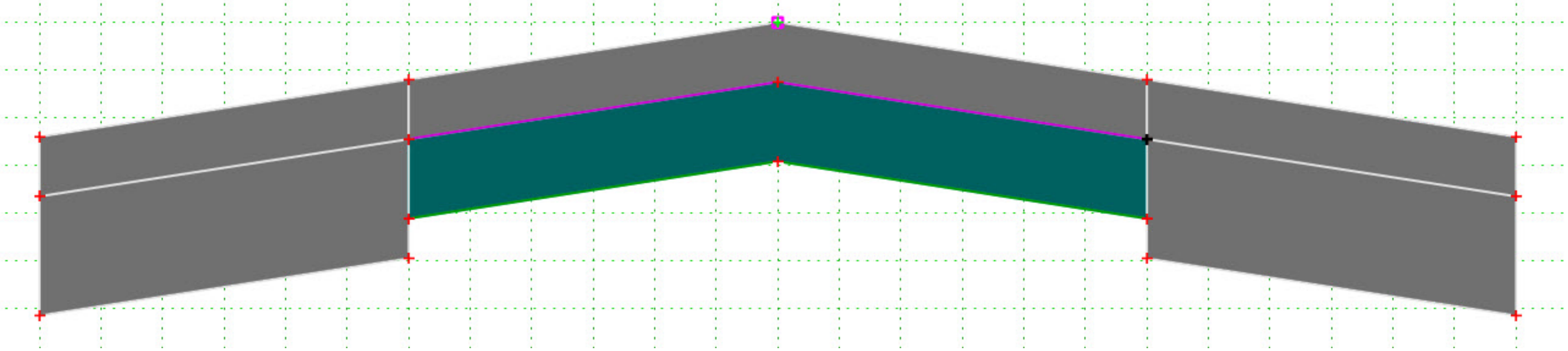
d. Leave Dynamic Settings as they are.

e. Set the following values in the Component Properties

- *Name*: **Widening Pavement Structural**
- *Feature*: **Mesh\ Asphalt\ TC_Asph Conc Intermediate Cse**
- *Slope*: **-2.00%**
- *Thickness*: **0.50** *[0.15]*
- *Width*: **12** *[3.6]*

f. *Right click* in the create template view and select **Mirror** if the component is not already being mirrored.

g. Place the new pavement directly below the top pavement widening pavement layer.



8. Define the third layer of the widening.

   This third layer is the base below the pavement.

   a. *Right-click* in the Template view, select *Add New Component* > **Simple**

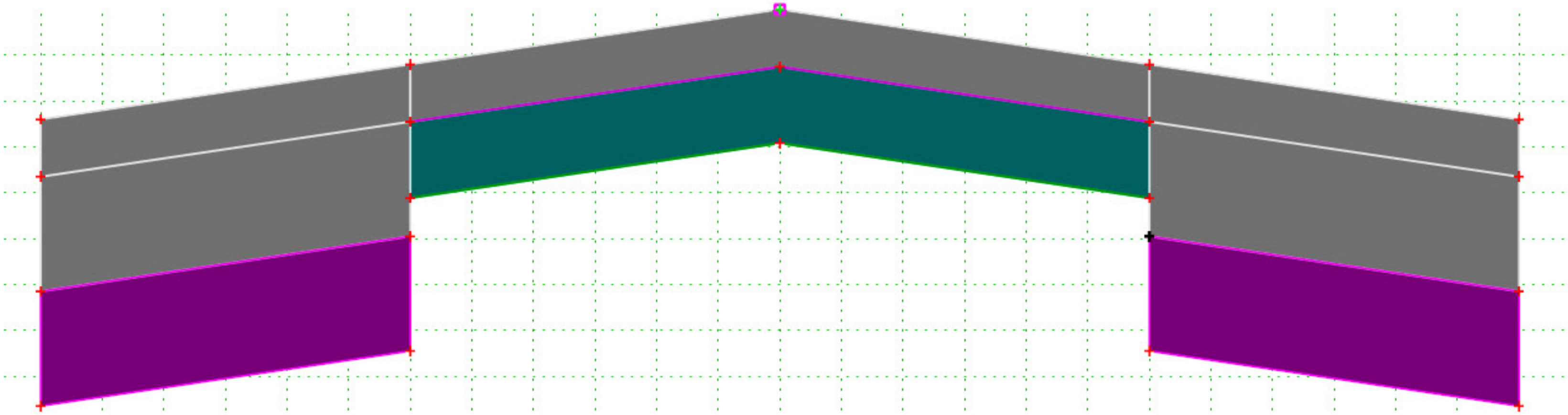
   b. Set the Point name to **SHDR_BASE**

   c. Set the following values in the Component Properties

      - *Name*: **Widening Base**
      - *Feature*: **Mesh\ Asphalt\ TC_Asph Conc Base Cse**
      - *Slope*: **-2.00%**
      - *Thickness*: **0.50** *[0.15]*
      - *Width*: **12** *[3.6]*

   d. *Right click* in the create template view and select **Mirror** if the component is not already being mirrored.

   e. Place the base below the widening pavement layers.

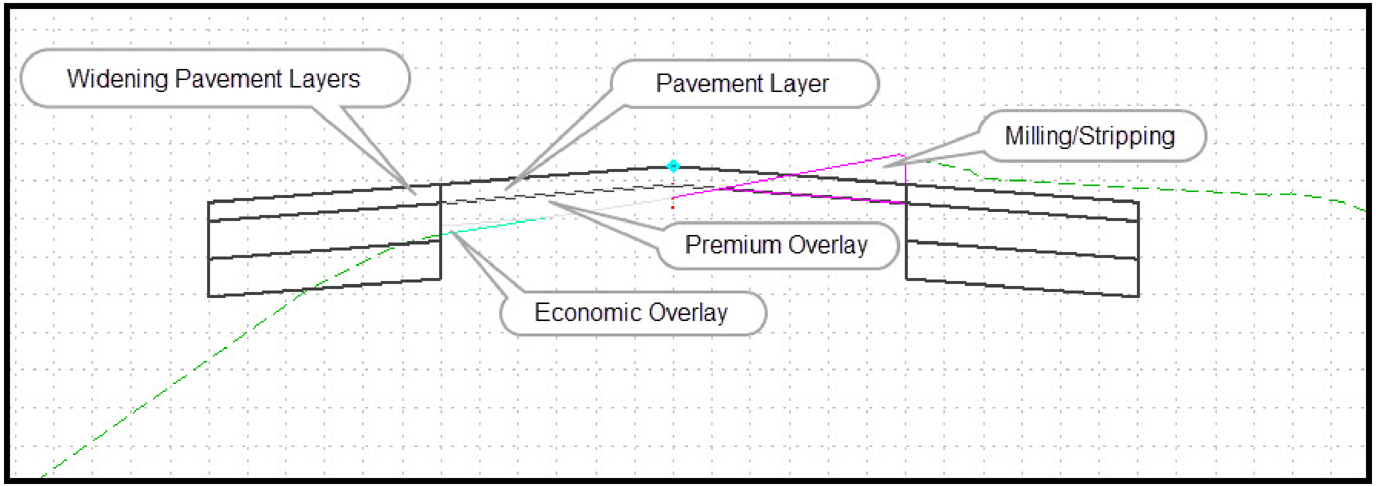


9. **Save** and **Close** the template library.

Review the Results in the Corridor

We will edit the corridor to utilize the new multi-layer overlay and widening template and review the results.

1. Change the template assigned to the corridor from *Multi Layer Overlay* to **Multi Layer Overlay and Widening**
   a. Select the **Element Selection** tool.
   b. Select the **Template Drop Handle** for the corridor. The Template Drop Handle is on the left (looking up station) at the beginning of the corridor.
   c. Select the **Properties** button from the context menu.
   d. Set the *Template Name* to **Multi Layer Overlay and Widening**
2. Review the updated corridor and its cross sections.



The interior of the roadway is being reconstructed with multiple overlay layers to build up low spots and stripping to remove high spots in the existing surface. Widening on both sides of the roadway is all new construction. There is no overlay or stripping in the widening areas. The existing ground (dirt) that needs to be cut or filled to construct the widening components is part of the standard earthwork and not affected by overlay or stripping components. The overlay and stripping components calculate removal and replacement of asphalt materials, not dirt.

To make this a complete design end conditions should be added to the template so that the earthwork (dirt) volumes can be computed.

Exercise 6: Vertical Adjustment - Milling

Description

Earlier we learned how different profiles can affect the milling and stripping volumes and thus the construction cost. In this exercise we will lean to use the Vertical Adjustment tool to assist in creating new vertical alignments to perform milling that will result in a full width uniform surface. The first alignment will allow any depth of milling to achieve a full width milling. Next you will create additional milling options that limit the amount of milling but that may result in a more economical or a better engineered solution.

Skills Taught

- Vertical Adjustment Tool using the Minimum Milling Mode
- Limit the Depth of Milling with the Use Maximum Milling Option
- Review the Results in the Corridor

Vertical Adjustment

This Vertical Adjustment tool evaluates the existing surface and calculates the elevation of the PGL necessary to minimize overlay above or minimize milling below the surface. The tool can be used in either a *Minimum Overlay* or a *Minimum Milling* mode.

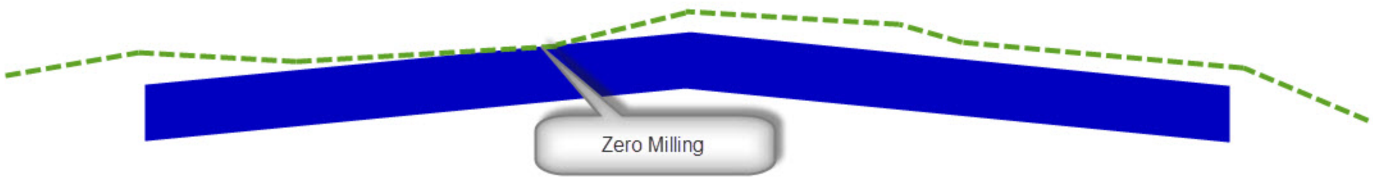
The elevation differences between the template and the existing surface can be evaluated at all cross section points or only at the template points. The *Examine All Cross Section Points* method is useful when you need potholes or other existing surface irregularities to be taken into consideration.

Important: The geometry and the corridor must be in the same DGN when using this tool because it creates a vertical alignment and the corridor must reprocess to determine criteria for the vertical alignment.

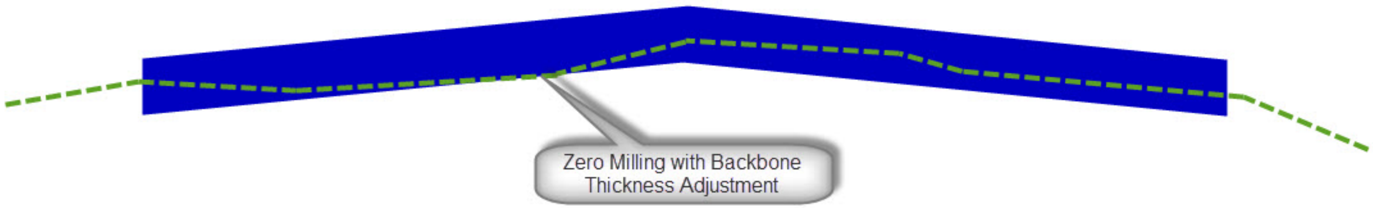
Design Stage is also important when running this tool because it processes data at each cross section. The Template Drop Interval Multiplier could cause unexpected results if set to a value other than 1. It is recommended the corridor use a Design State such as Final that has a multiplier of 1 when calculating vertical adjustments.

Minimum Milling Mode

Using the *Minimum Milling* mode the elevation of the PGL is calculated by adjusting the **TOP** of the template until it is completely below, and just touching, the existing surface.



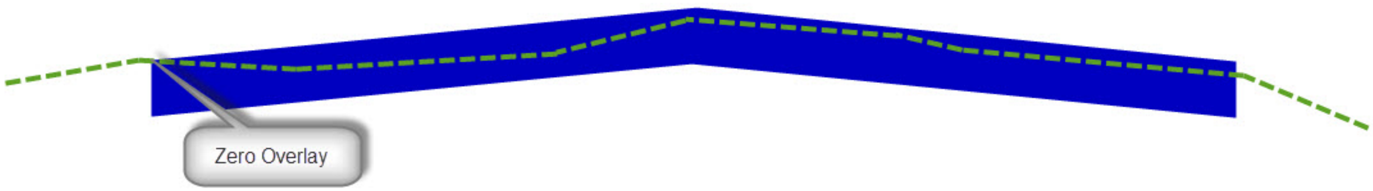
The elevation of the PGL is adjusted upward by the *Backbone Thickness* which compensates for the thickness of the template and effectively calculates the zero milling elevation on the bottom of the template.



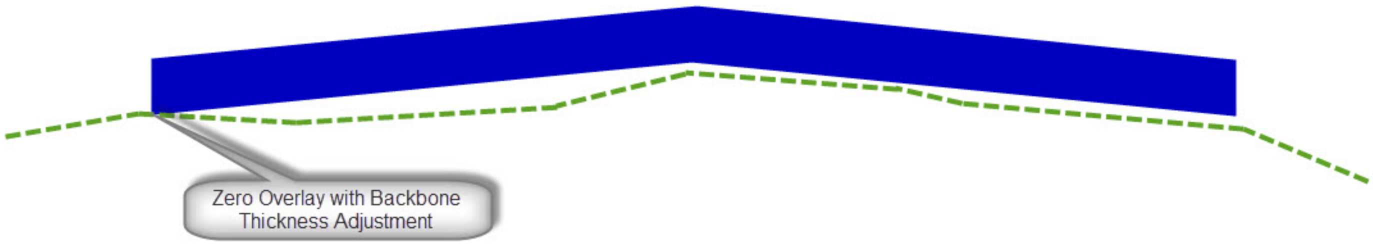
When the *Use Maximum Milling* check box is disabled the milling can be any depth. When this option is enabled the PGL is adjusted upward to limit the milling thickness to the value specified by the *Maximum Milling Thickness*.

Minimum Overlay Mode

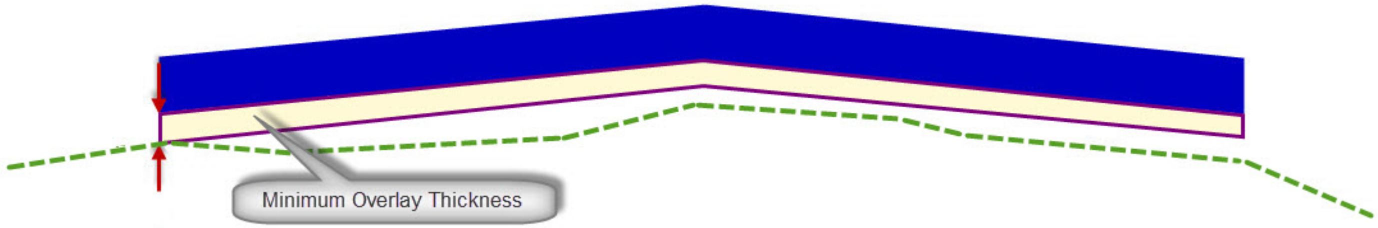
Using the *Minimum Overlay* mode the elevation of the PGL is calculated by adjusting the **TOP** of the template until it is completely above, and just touches the existing surface.



The elevation of the PGL is adjusted upward by the *Backbone Thickness* which compensates for the thickness of the template and effectively calculates the zero overlay elevation on the bottom of the template. The result is an overlay of exactly zero at the critical point.

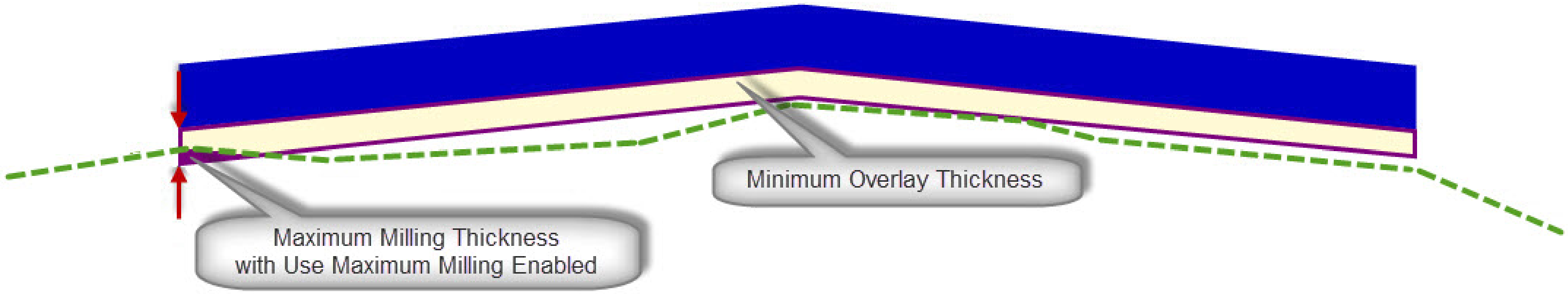


When it is necessary to ensure a minimum depth of overlay material the *Minimum Overlay Thickness* value is set. The PGL is adjusted upward by the *Minimum Overlay Thickness*. In the following illustration the minimum overlay thickness is identified by the two red arrows. Notice how the template has been shifted upward ensuring a minimum overlay.



A minimum depth of overlay material can also be achieved without adjusting the PGL upward as much by milling into the existing pavement. When the *Use Maximum Milling* check box is enabled the PGL is adjusted downward such that the maximum depth of milling is equal to the *Maximum Milling Thickness* value.

The template milling component must have a depth to force milling to occur when the bottom of the pavement layer is above the existing surface.



Create Vertical Alignment for Minimum Milling

In this exercise you will define a new vertical alignment adjusted so the full pavement layer will be constructed without a need for overlay material.

1. Open the **Vertical Adjustment - Milling.dgn** *[Metric - Vertical Adjustment - Milling.dgn]* file.

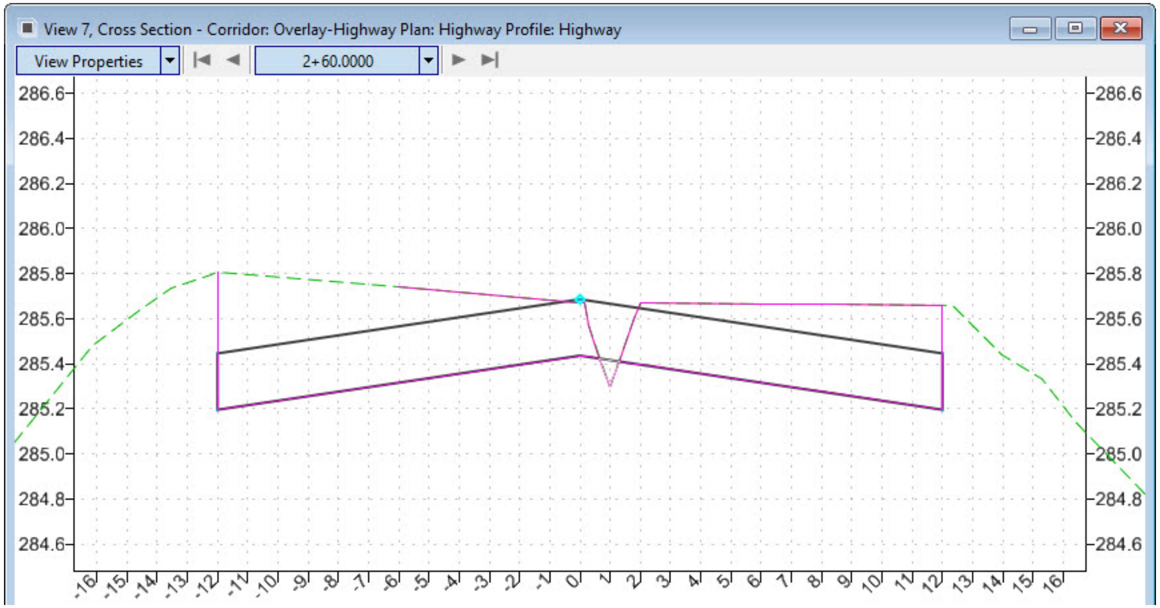
   In the Cross Section view the dark gray shape represents the pavement layer and the magenta shape represents the milling.

   The current model is based on the alignment being at the existing ground elevation.

2. In the Cross Section view, set the active cross section to **2+60** *[80.000]*.

   This cross section shows the amount of milling required to construct the new pavement layer at the same elevation centerline elevation as the existing pavement.

   However, observe the low point in the existing ground just right of the centerline. At its lowest point it is below the bottom of the new pavement layer so this small area would have to be filled, or overlayed, to bring it up to the bottom of the proposed pavement layer. Our requirement is no overlay material so we will have to lower the template slightly, and mill out a bit more material, so that the bottom of the new pavement layer is at this low point.



3. Calculate a vertical alignment so that the full pavement thickness will be constructed with no overlay material and the minimum amount of milling possible. **Note:** <u>You must be in the geometry file for the Overlay Vertical Adjustment tool to work properly.</u>

a. From *File > Open* select *Browse* and select **Geometry.dgn** *[Metric-Geometry.dgn]*

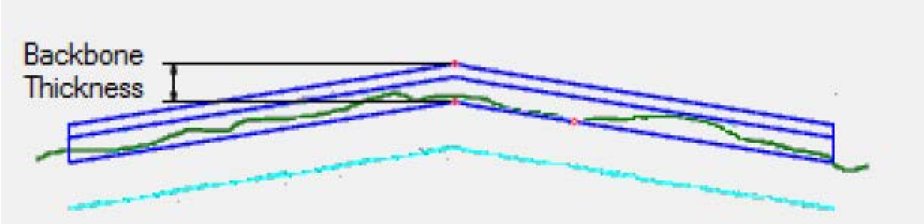
b. Select *Home > Primary > Attach Tools > References >* **Attach**

c. Select the *File >* **Vertical Adjustment - Milling.dgn** *[Metric-Vertical Adjustment - Milling.dgn.]*

d. Set up **View 4** to display the Dynamic Cross Sections for the corridor. Go to *Corridors > Review > Dynamic Sections >* **Open Cross Section View**

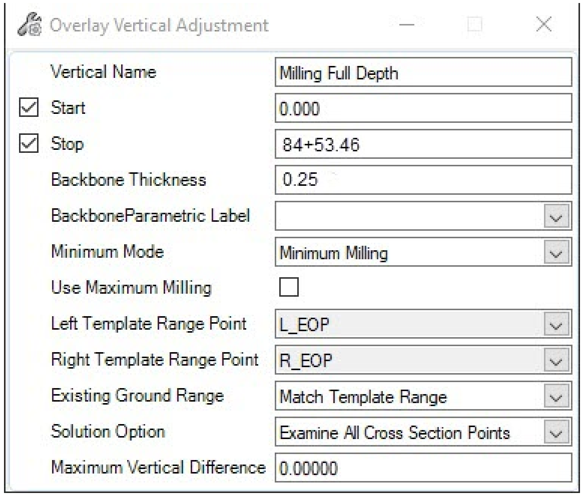
e. Now go to *Corridors > Miscellaneous >* **Overlay Vertical Adjustment**

f. Following the on screen prompts, set the following values.



- *Locate Corridor*: Select the **Overlay-Highway** corridor.
- *Vertical Name*: **Milling Full Depth**
- *Start Station*: **0+00**
- *Stop Station*: **84+53.46** *[2+576.62]*
- *Backbone Thickness*: **0.25** *[0.1]*

This is the thickness from the profile grade line to the bottom of the template. Assuming the profile grade line is at the finished grade this is the thickness of the pavement layers.

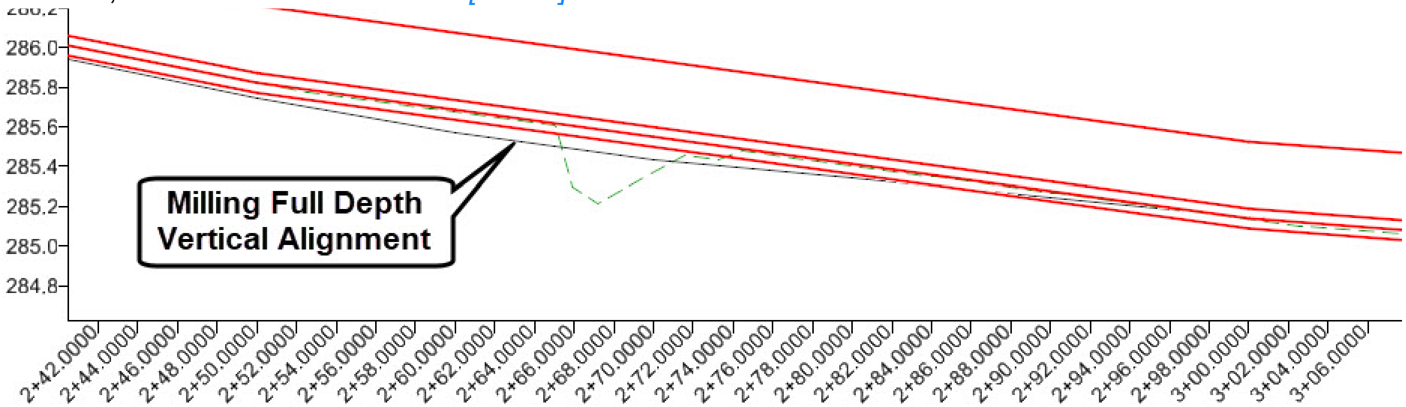


- *Backbone Parametric Label*: {Blank}
- *Minimum Mode*: **Minimum Milling**
- *Use Maximum Milling*: **No**
- *Left Template Range Point*: **L_EOP**
- *Right Template Range Point*: **R_EOP**
- *Existing Ground Range*: **Match Template Range**
- *Solution Option*: **Examine All Cross Section Points**
- *Maximum Vertical Difference*: **0.00**

It may take a few minutes to calculate the new vertical alignment. Watch the progress bar in the lower right corner of the screen. Once complete, a new vertical alignment is created and displayed in the profile view. Review new minimum milling vertical alignment.

g. Open a Profile View (if one is not open)

h. In the Profile view, zoom in near station **2+60** *[0+080]*.



Note: The current version of the software does not automatically apply a *Feature Definition* to the newly created vertical alignment. The user can do this manually via the *Properties* or the *Set Feature Definition* tool.

4. Now we need to apply this new vertical alignment to the corridor.

a. From *File > Open* select *Browse* and select **Vertical Adjustment - Milling.dgn** *[Metric-Vertical Adjustment - Milling.dgn].*

b. Change the active profile of the corridor to **Milling Full Depth**

c. Select the **Element Selection** tool.

d. In *View 1*, select the *Corridor Mesh*

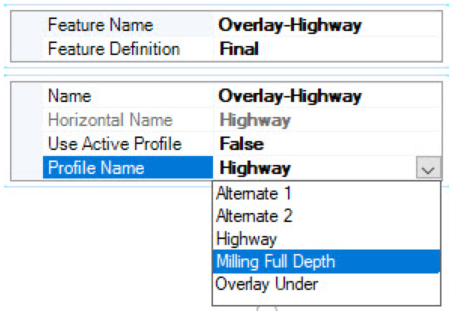
e. Select the **Properties** button from the context menu.

f. Set *Use Active Profile* to **False**.

g. Set the *Profile Name* to **Milling Full Depth**

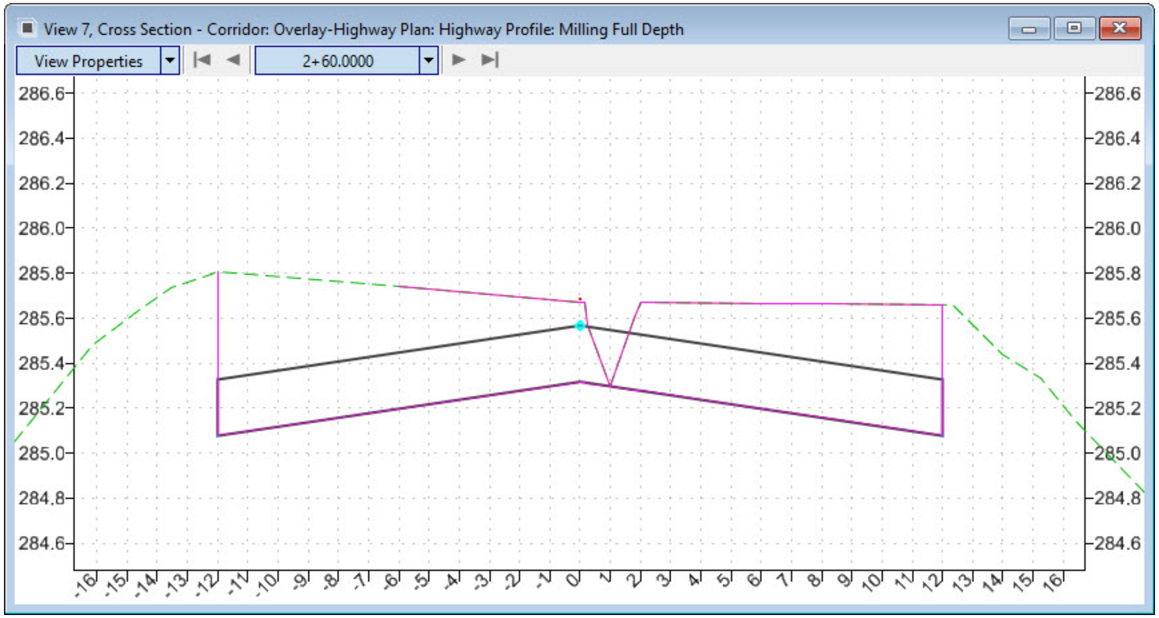
The corridor is reprocessed automatically.

The model and dynamic cross sections are updated to the new corridor.



5. Review the cross section at station **2+60** *[0+080]*.

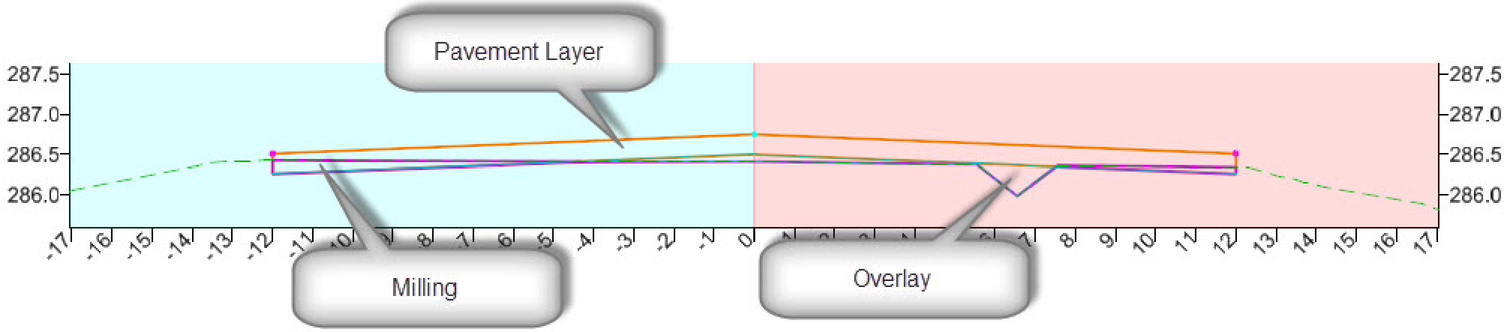
The bottom of the pavement layer has shifted downward to be at the same elevation as the lowest point on the existing pavement which requires zero overlay.



Limit Milling Depth to a Maximum Depth

In the previous exercise the vertical alignment was computed with a restriction that there could be no overlay. The minimum depth of milling to meet this condition was calculated. If the existing pavement has many high and low spots this approach can result in significant milling that may be expensive and may be so thick in some areas that it compromises the structural integrity of the remaining existing pavement. From an engineering and cost standpoint it may be desirable to limit the amount of milling with the *Use Maximum Milling* option.

In the next exercise you will define a new vertical alignment where the milling is limited to a **2”** *[50mm]* depth. The result is milling that does not go to the lowest point in the existing pavement and will require some overlay material in the low spots as shown below.



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1. Calculate a vertical alignment so that the full pavement thickness will be constructed with a maximum of **2”** *[50mm]* of milling.

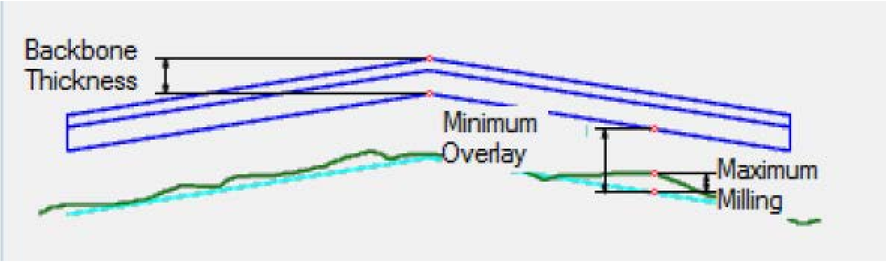
   a. From *File > Open* select *Browse* and select **Geometry.dgn** *[Metric-Geometry.dgn].*

   b. From the *Ribbon* menu select *Corridors > Miscellaneous >* **Overlay Vertical Adjustments**

   c. Following the on screen prompts, set the following values.

   - *Locate Corridor:* **Overlay-Highway**
   - *Vertical Name*: **Milling Limited Depth**
   - *Start Station*: **0+00**
   - *Stop Station*: **84+53.46** *[2+576.62]*
   - *Backbone Thickness*: **0.25** *[0.1]*

This is the thickness from the profile grade line to the bottom of the template. Assuming the profile grade line is at the finished grade this is the thickness of the pavement layers.



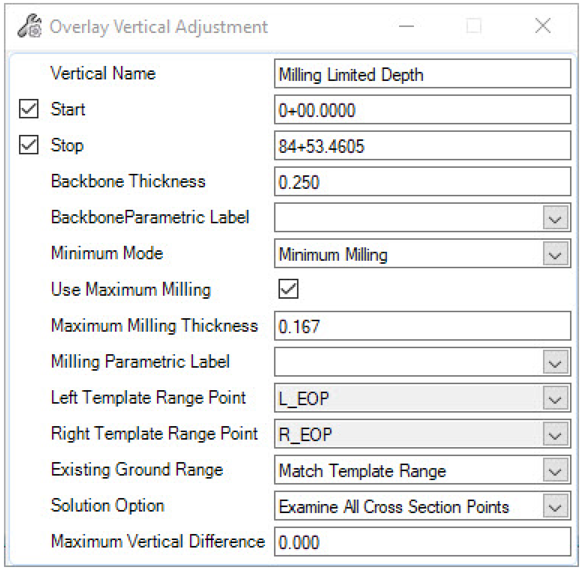
- *Backbone Parametric Label*: **{Blank}**
- *Minimum Mode*: **Minimum Milling**
- *Use Maximum Milling*: **Yes**

Note: The Use Maximum Milling setting being enabled is the difference from the previous exercise. It limits the amount of milling.

- *Maximum Milling Thickness*: **0.167** *[0.05]*

This defines the maximum thickness of the milling.

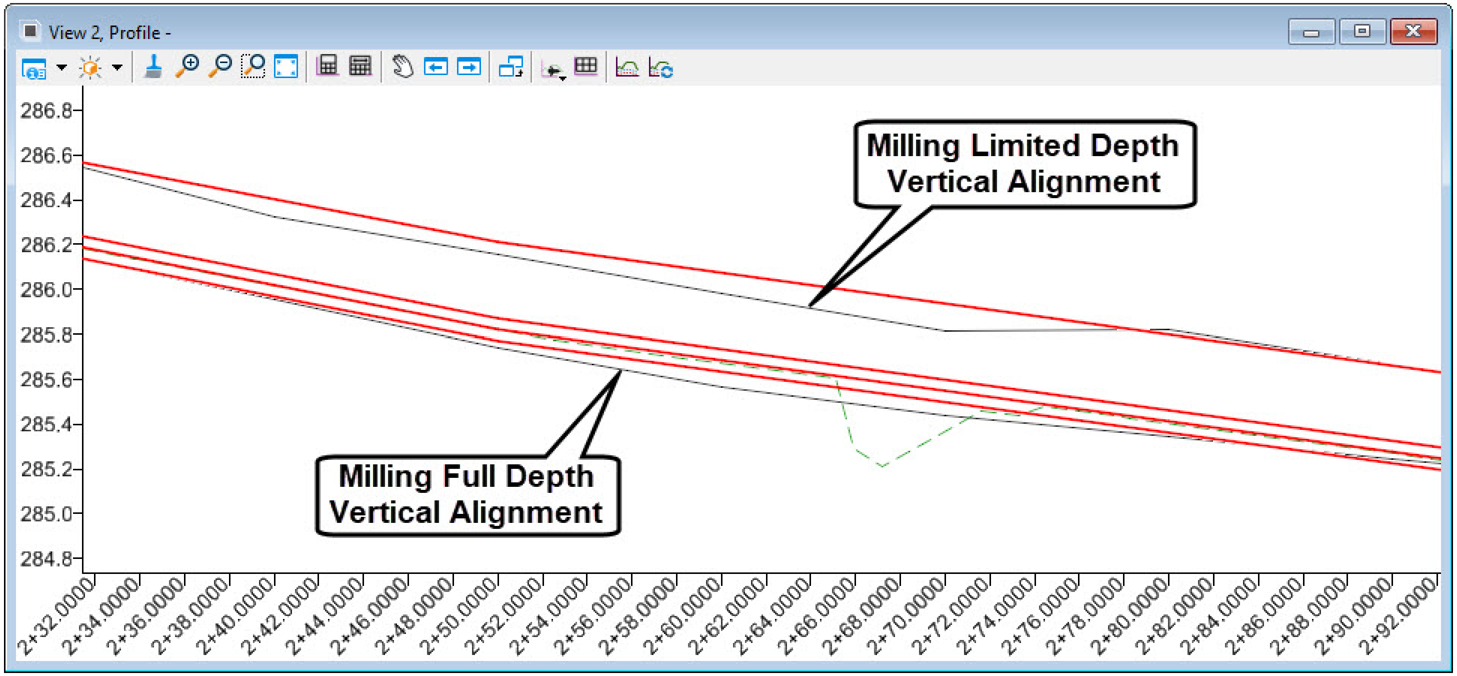
- *Milling Parametric Label*: **{Blank}**
- *Left Template Range Point*: **L_EOP**
- *Right Template Range Point*: **R_EOP**
- *Existing Ground Range*: **Match Template Range**
- *Solution Option*: **Examine All Cross Section Points**
- *Maximum Vertical Difference*: **0.00**


Overlay Vertical Adjustment

Vertical Name	Milling Limited Depth
☑ Start	0+00.0000
☑ Stop	84+53.4605
Backbone Thickness	0.250
BackboneParametric Label	
Minimum Mode	Minimum Milling
Use Maximum Milling	☑
Maximum Milling Thickness	0.167
Milling Parametric Label	
Left Template Range Point	L_EOP
Right Template Range Point	R_EOP
Existing Ground Range	Match Template Range
Solution Option	Examine All Cross Section Points
Maximum Vertical Difference	0.000

2. Review new minimum milling vertical alignment.

a. In the Profile view, zoom in near station **2+60** *[0+080]*.



3. Apply new vertical alignment to the corridor.

a. From *File > Open* select *Browse* and select **Vertical Adjustment - Milling.dgn** *[Metric-Vertical Adjustment - Milling.dgn].*

b. Change the active profile of the corridor to **Milling Limited Depth**

c. Select the **Element Selection** tool.

d. In *View 1*, select the corridor meshing.

e. Select the **Properties** button from the context menu.

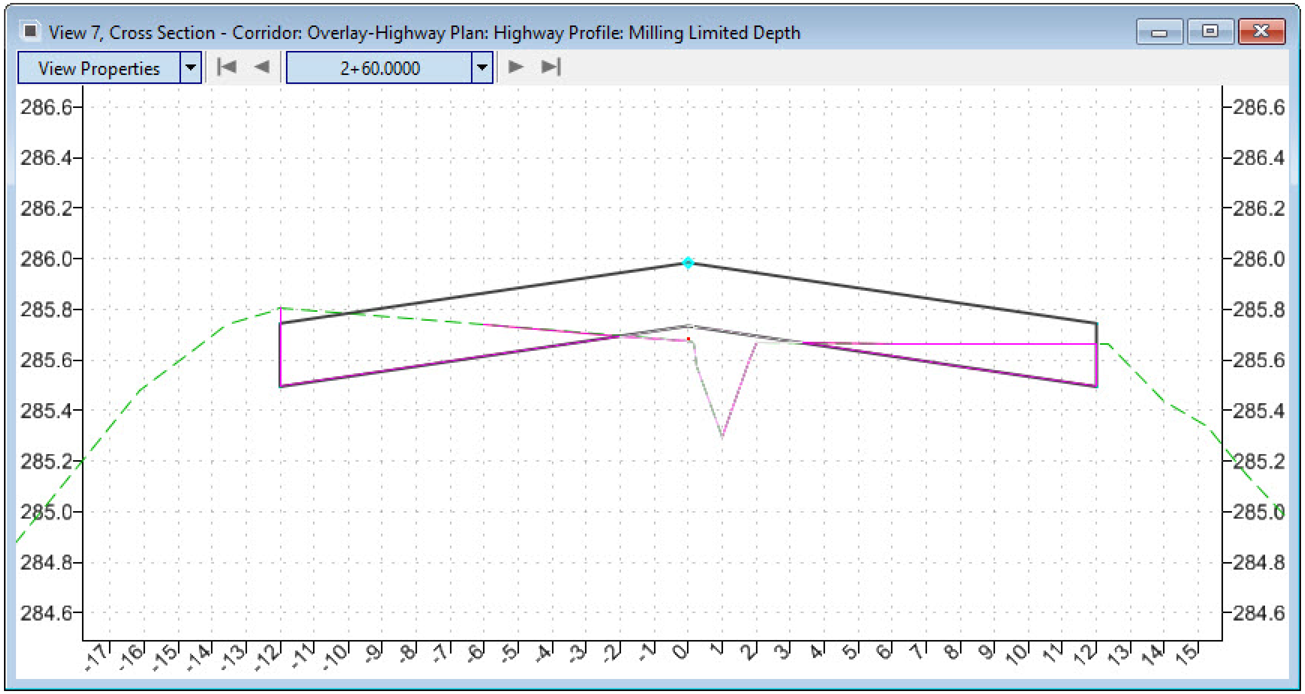
f. Set *Use Active Profile* to **False**.

g. Set the *Profile Name* to **Milling Limited Depth**

The corridor is reprocessed automatically.

The model and dynamic cross sections are updated to the new corridor.

4. Review the cross section at station **2+60** *[0+080]*.



Exercise 7: Vertical Adjustment - Overlay

Description

In this exercise we will create several vertical alignments that result in different depths of overlay and milling.

Skills Taught

- Vertical Adjustment tool using the Minimum Overlay Mode
- Vertical Adjustment tool using the Minimum Overlay Thickness Option
- Review the Results in the Corridor

Create Vertical Alignment for Minimum Overlay

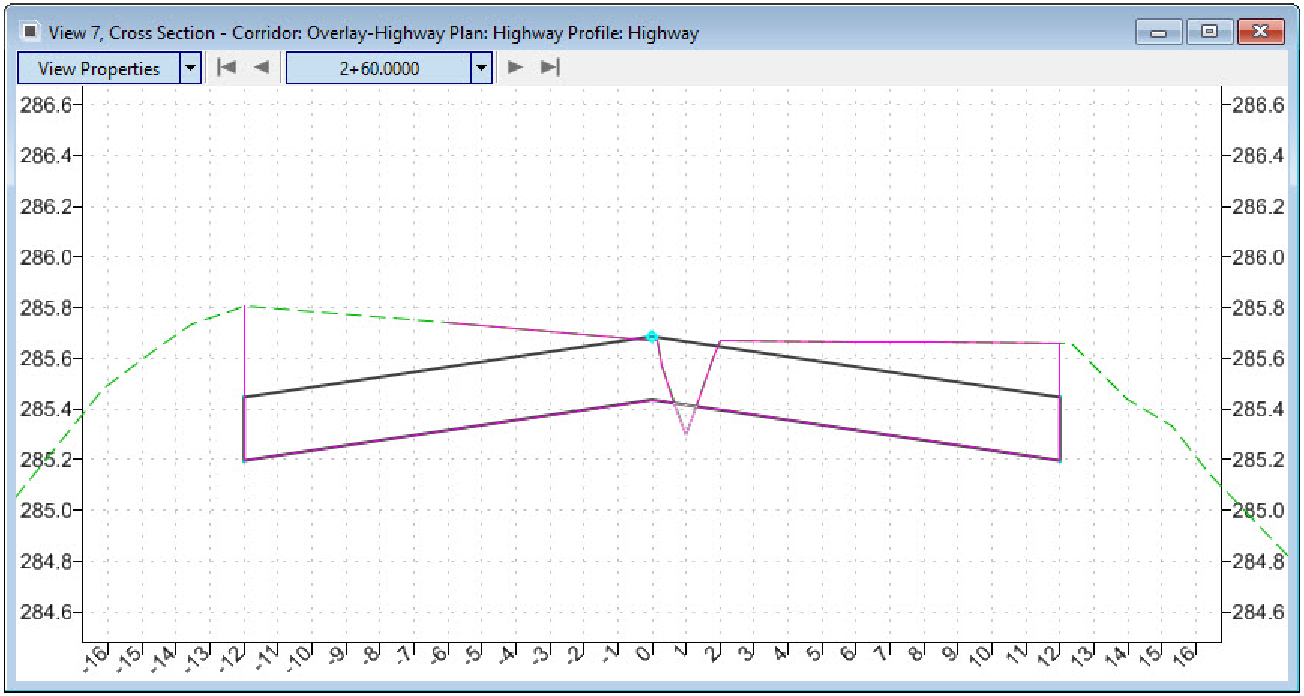
In this exercise you will define a new vertical alignment adjusted so the bottom of the pavement layer is positioned for the minimum depth of overlay required to achieve a uniform full width existing pavement surface.

1. Open the **Vertical Adjustment - Overlay.dgn** *[Metric - Vertical Adjustment - Overlay.dgn]* file.

   In the Cross Section view the dark gray shape represents the pavement layer and the magenta shape represents the milling.

   The current model is based on the corridors vertical alignment being at the existing ground elevation.

2. In the Cross Section view, set the active cross section to **2+60** *[0+080]*. Observe the dip in the existing ground just right of the centerline and notice that at its lowest point it is below the bottom of the pavement layer.



3. Calculate minimum overlay vertical alignment.

a. From *File > Open* select *Browse* and select **Geometry.dgn** *[Metric-Geometry.dgn].*

b. From the *Ribbon* menu select *Home > Primary > Attach Tools >* **References**

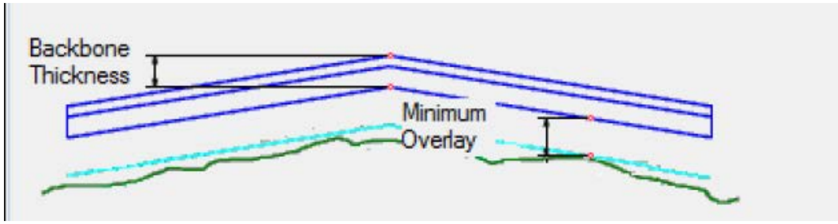
c. In the *Reference* dialog select the file **Vertical-Adjustment Milling.dgn** *[Metric-Vertical Adjustment Milling.dgn],* and right click select **Detach**

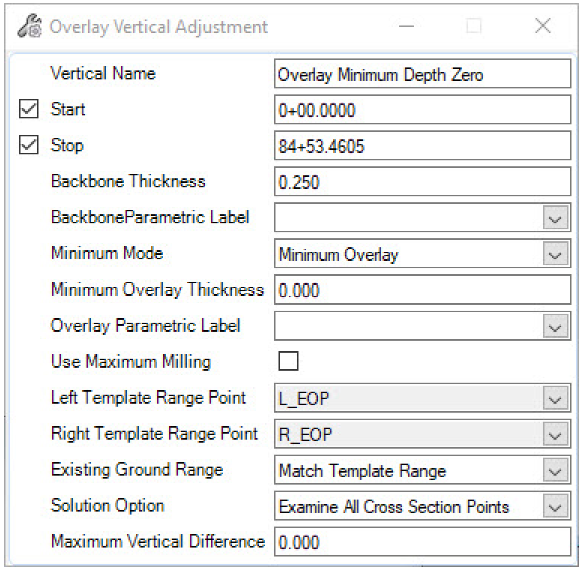
d. Then Select *Tools >* **Attach**, select **Vertical-Adjustment Overlay.dgn** *[Metric-Vertical Adjustment Overlay.dgn].*

e. On the reference attachment dialog click **OK**

f. From the *Ribbon* menu select *Corridors > Miscellaneous >* **Overlay Vertical Adjustments**

g. Following the on screen prompts, set the following values.





- *Locate Corridor*: **Overlay-Highway**
- *Vertical Name*: **Overlay Minimum Depth Zero**
- *Start Station*: **0+00**
- *Stop Station*: **84+53.46** *[2+576.62]*
- *Backbone Thickness*: **0.25** *[0.1]*
- *Backbone Parametric Label*: {Blank}
- *Minimum Mode*: **Minimum Overlay**
- *Minimum Overlay Thickness:* **0.00**

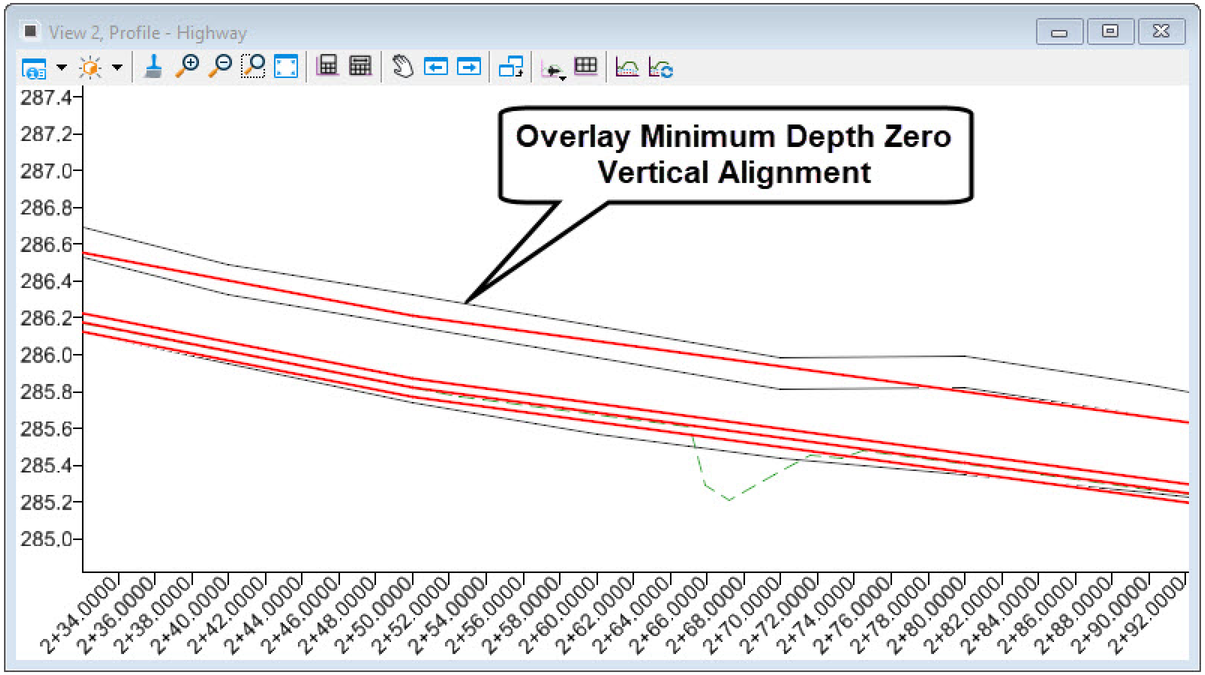
  This is the minimum distance from the bottom of the pavement layer to the existing ground.

- *Overlay Parametric Label:* {Blank}
- *Use Maximum Milling*: **No**
- *Left Template Range Point*: **L_EOP**
- *Right Template Range Point*: **R_EOP**

- *Existing Ground Range*: **Match Template Range**
- *Solution Option*: **Examine All Cross Section Points**
- *Maximum Vertical Difference*: **0.00**

4. Review new minimum overlay vertical alignment.

   a. In the Profile view, zoom in near station **2+60** *[0+080]*.



5. Apply new vertical alignment to the corridor.

   a. From *File > Open* select *Browse* and select **Vertical Adjustment - Overlay.dgn** *[Metric-Vertical Adjustment - Overlay.dgn].*

   b. Change the active profile of the corridor to **Overlay Minimum Depth Zero**

   c. Select the **Element Selection** tool.

   d. In *View 1*, select the corridor.

   e. Select the **Properties** button from the context menu.

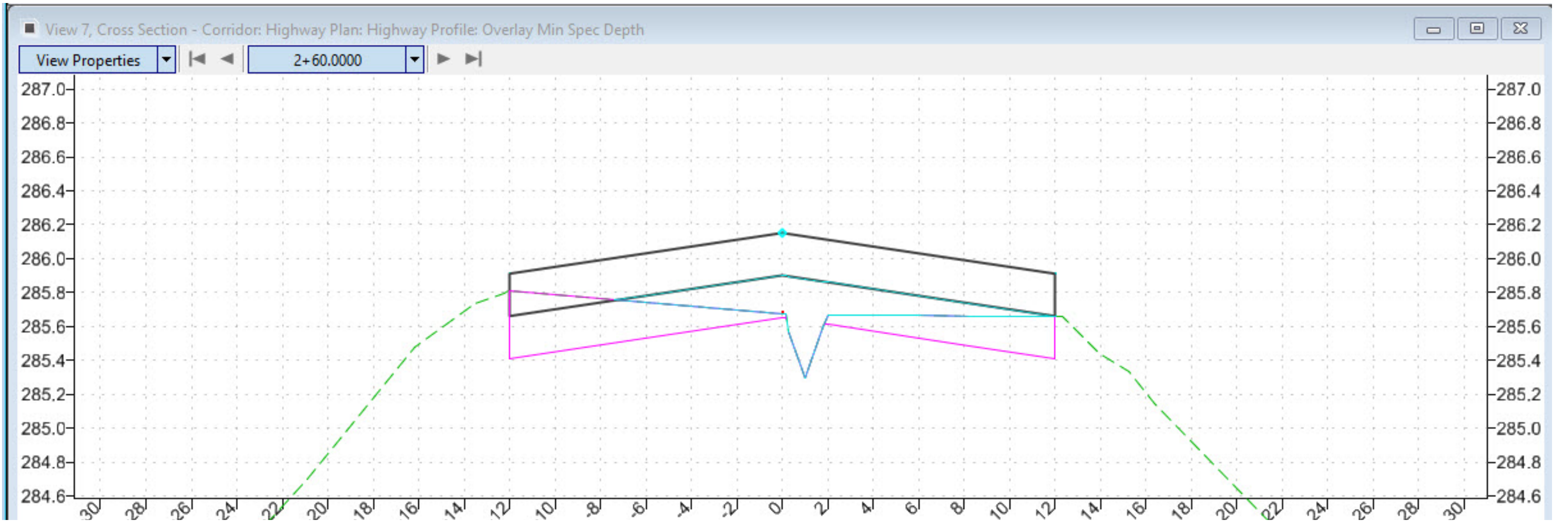
   f. Set *Use Active Profile* to **False**

   g. Set the *Profile Name* to **Overlay Minimum Depth Zero**

   The corridor is reprocessed automatically.

   The model and dynamic cross sections are updated to the new corridor

6. Review the cross section at station **2+60** *[0+080]*. The bottom of the pavement layer has shifted upward so the minimum overlay between the existing ground and the bottom of the pavement layer is zero.



If you are constructing this overlay in a single lift a zero overlay may be appropriate because it still ensures a minimum pavement thickness. However, if your construction process will be to first pave the overlay to produce a uniform pavement before placing the **0.25 ft** *[100mm]* final pavement layer you may need a minimum overlay greater than 0. For our exercise lets assume the minimum overlay that can be constructed is **3”** *[75mm]*.

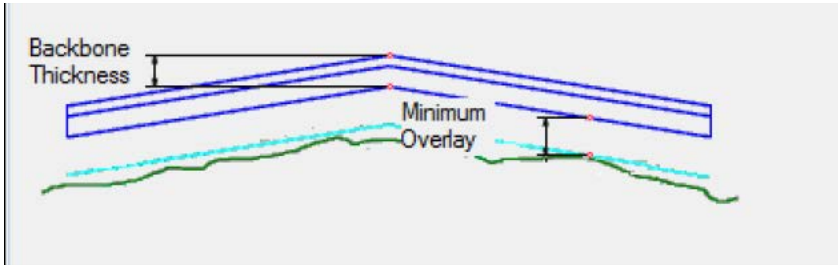
Create Vertical Alignment for Minimum 3” [75mm] Overlay

In this exercise you will define a new vertical alignment adjusted so the bottom of the pavement layer is position for a minimum overlay depth of **3”** *[75mm]*.

1. From *File > Open* select *Browse* and select **Geometry.dgn** *[Metric-Geometry.dgn]*
2. Calculate vertical alignment for a minimum **3”** *[75mm]* overlay.

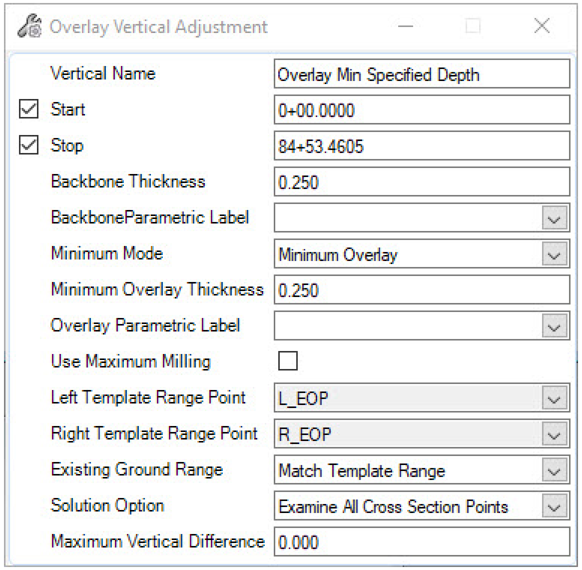
   a. From the *Ribbon* menu select *Corridors > Miscellaneous >* **Overlay Vertical Adjustments**

   b. Following the on screen prompts, set the following values.



   - *Vertical Name*: **Overlay Min Specified Depth**
   - *Start Station*: **0+00**
   - *Stop Station*: **84+53.46** *[2+576.62]*
   - *Backbone Thickness*: **0.25** *[0.1]*
   - *Backbone Parametric Label*: {Blank}
   - *Minimum Mode*: **Minimum Overlay**
   - *Minimum Overlay Thickness:* **0.25** *[0.1]*

   This defines a minimum **3”** *[75 mm]* overlay between the existing pavement and the proposed pavement layer.

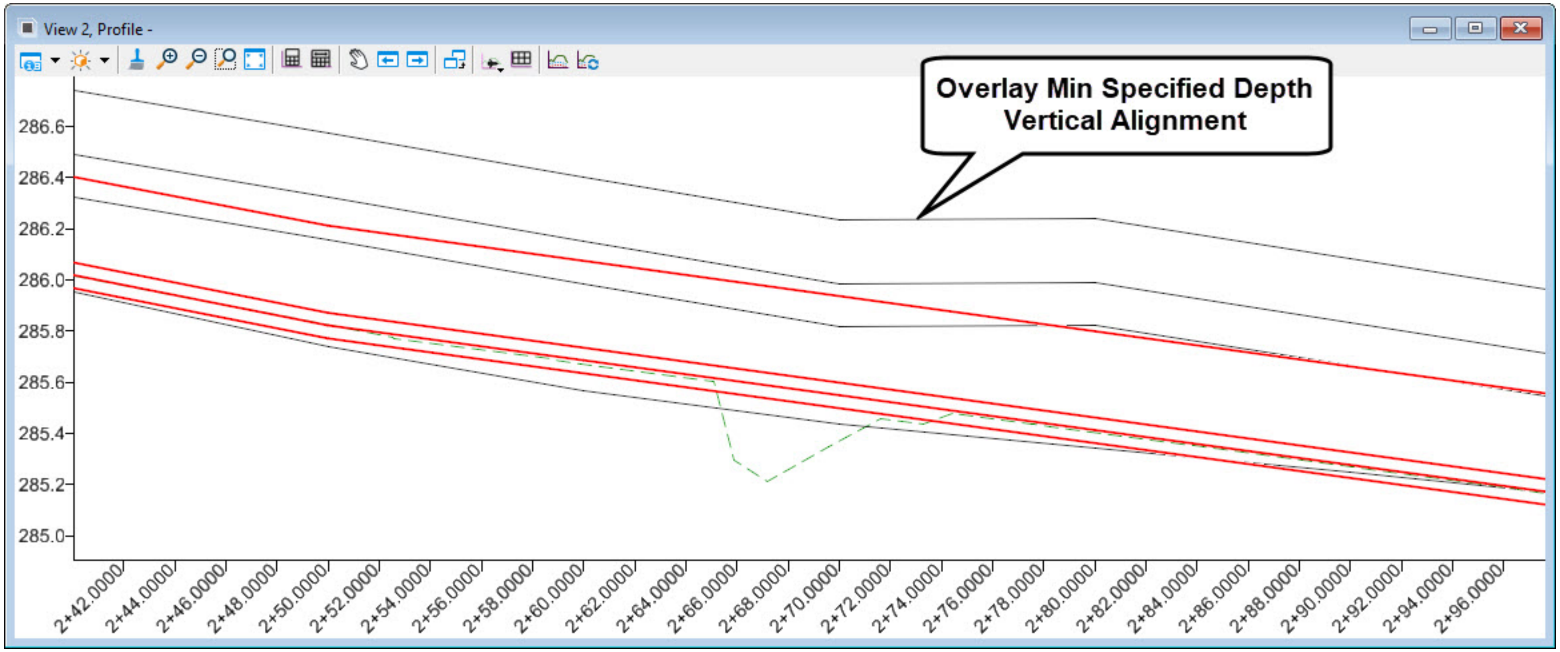


   - *Overlay Parametric Label:* {Blank}
   - *Use Maximum Milling*: **No**
   - *Left Template Range Point*: **L_EOP**
   - *Right Template Range Point*: **R_EOP**
   - *Existing Ground Range*: **Match Template Range**

- *Solution Option*: **Examine All Cross Section Points**
- *Maximum Vertical Difference*: **0.00**

3. Review new minimum overlay vertical alignment.

   a. In the Profile view, zoom in near station **2+60** *[0+080]*.



4. Apply new vertical alignment to the corridor.

   a. From *File > Open* select *Browse* and select **Vertical Adjustment - Overlay.dgn** *[Metric-Vertical Adjustment - Overlay.dgn].*

   b. Change the active profile of the corridor to **Overlay Min Specified Depth**

   c. Select the **Element Selection** tool.

   d. In *View 1*, select the corridor.

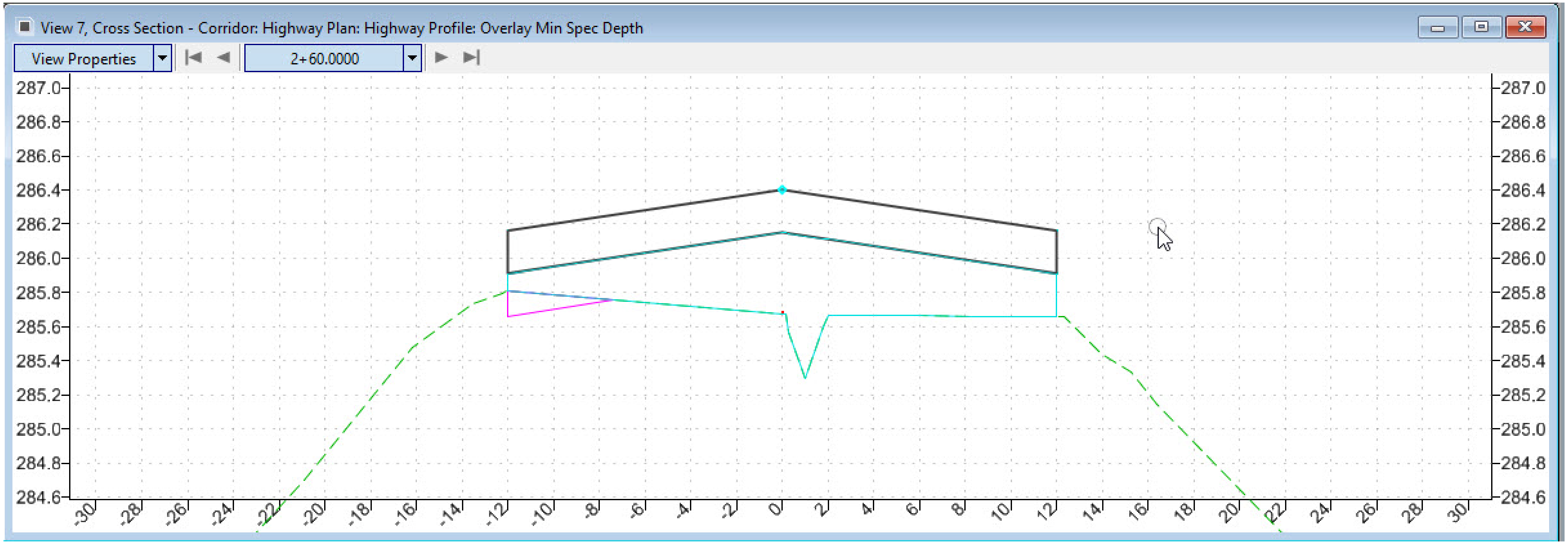
   e. Select the **Properties** button from the context menu.

   f. Set *Use Active Profile* to **False**.

   g. Set the *Profile Name* to **Overlay Min Specified Depth**

   The corridor is reprocessed automatically.

5. Review the cross section at station **2+60** *[0+080]*. The bottom of the pavement layer has shifted upward so the minimum overlay between the existing ground and the bottom of the pavement layer is **2”** *[50mm]*.



Skills Assessment

The questions below will test your retention of the skills covered in this course.

1. There are two tool sets that can be used for overlay soltuions: Overlay/Striping components and Vertical Adjustments
    a. True
    b. False
2. Overlay/Stripping Components and the vertical adjustment tool are relatively independent of one another in the software.
    a. True
    b. False
3. The Element Component Quantities tool can be used for estimating the pavement cost of the corridor.
    a. True
    b. False
4. The Vertical Adjustment tool reads the top of the template and the existing ground to move the template vertically to optimize the amount of overlay and stripping.
    a. True
    b. False
5. The Vertical Adjustment tool creates vertical geometry based on user defined overlay and milling design criteria.
    a. True
    b. False

Skills Assessment - Answers

The answers to the skills assessment questions are highlighted below.

1. There are two tool sets that can be used for overlay soltuions: Overlay/Striping components and Vertical Adjustments
   a. **True**
   b. False
2. Overlay/Stripping Components and the vertical adjustment tool are relatively independent of one another in the software.
   a. **True**
   b. False
3. The Element Component Quantities tool can be used for estimating the pavement cost of the corridor.
   a. **True**
   b. False
4. The Vertical Adjustment tool reads the top of the template and the existing ground to move the template vertically to optimize the amount of overlay and stripping.
   a. **True**
   b. False
5. The Vertical Adjustment tool creates vertical geometry based on user defined overlay and milling design criteria.
   a. **True**
   b. False

Summary

In this course you have learned various tools and techniques that can be used for Overlay, Stripping and Widening projects.

You have learned how to:

- Create a Template with an Overlay Component
- Create and Review an “Overlay Only” Corridor
- Review the Results in the Corridor
- Creating a Template with a Milling/Stripping Component
- Create an Overlay and Milling Template
- Evaluate the Cost of a Corridor
- Compute the Pavement Quantities Along a Corridor
- Analyze Corridor Cost Based On Adjusted Profiles
- Create a Template that Contains Multiple Overlay Components
- Create a Overlay, Milling and Widening Template
- Use the Vertical Adjustment Tool using the Minimum Milling Mode
- Limit the Depth of Milling with the Use Maximum Milling Option
- Use the Vertical Adjustment tool with the Minimum Overlay Mode
- Use the Vertical Adjustment tool with the Minimum Overlay Thickness Option