OpenRoads Design: Intersection Modeling

Exercise 1: St. Peter Road Corridor

The St. Peter Road corridor model will be created in its own design file. The design files for the corridor models were created in a previous exercise. Take the following steps to prepare the 12345_KM002.dgn file for the corridor modeling process.

- ✓ Open **ProjectWise Explorer**

- ✓ Browse to the folder containing the training data. The folder location will be provided by the instructor for each class.
- ✓ Browse to the **400-Engineering\Roadway\Basemaps** folder.
- ✓ Open the file **123456_KM002.dgn**.
- ✓ From the **Home** tab, choose **Attach Tools > References** to attach the following references with a **Nest Depth** value of **0**:
    - Survey Field Book:
        - ○ 300-Survey\Basemaps\123456_FB001.dgn
        - ○ Set the survey terrain model as the active terrain model (Use the **Element Selection** tool to select the terrain boundary, allow the cursor to pause over the boundary element until the pop-up menu appears. Choose the **Set As Active Terrain** icon).
    - Geometry for proposed S.R. 185:
        - ○ 400-Engineering\Roadway\Basemaps\123456_BK001.dgn
    - Geometry for Existing St. Peter Road:
        - ○ 400-Engineering\Roadway\Basemaps\123456_BK002.dgn
    - S.R. 185 Corridor Model
        - ○ 400-Engineering\Roadway\Basemaps\123456_KM001.dgn
    - Before closing the *References* dialog, turn off the display of the self-referenced 3D model, Design-3D

The template for St. Peter Road was created in a previous exercise. Take the following steps to create the corridor model for St. Peter Road

- ✓ Use the **Element Selection** tool select the alignment for St. Peter Road. Allow the cursor to rest on the alignment element until the pop-up menu appears. Select the **Create Corridor** icon.

- ✓ Create the corridor using the settings shown below.
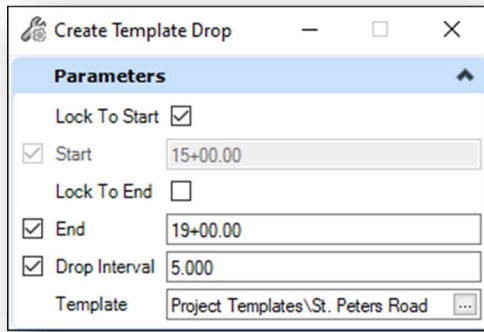
The corridor is created like the example below.
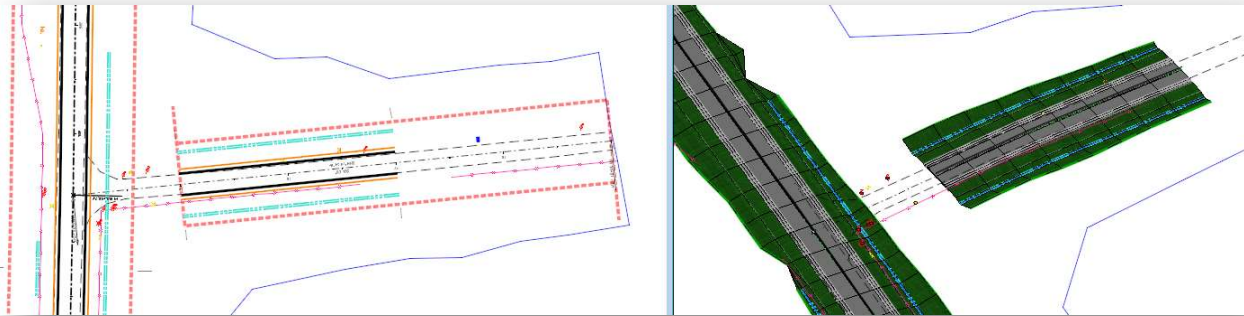
Exercise 2: St. Peter Road Intersection using a Civil Cell

This exercise will demonstrate the use of a civil cell for the intersection of St. Peter Road with S.R. 185.

Part 1: Placing the Civil Cell

With the references attached and the existing terrain active, take the following steps to place a civil cell for the St. Peter Road intersection:
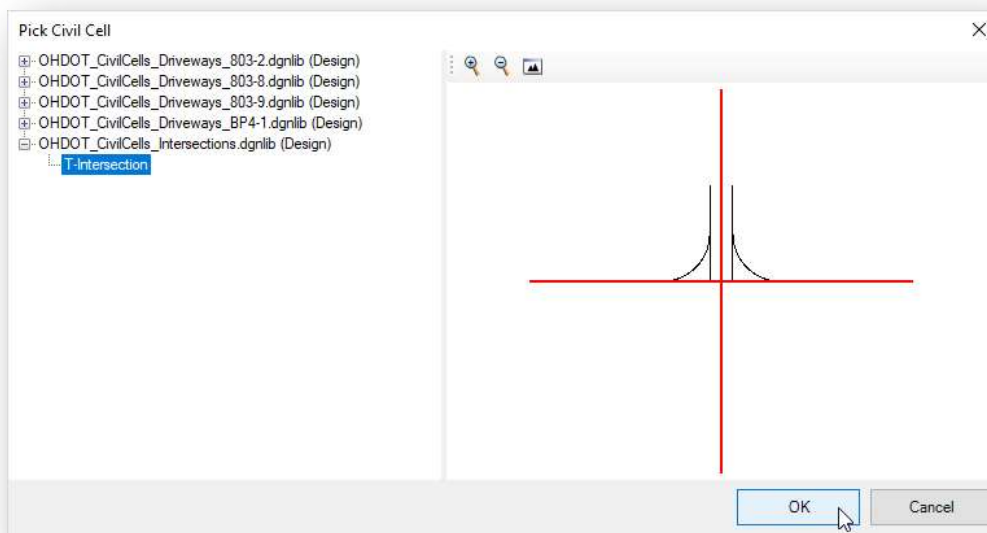
✓ From the **Model Detailing** tab, select the **Place Civil Cell** command
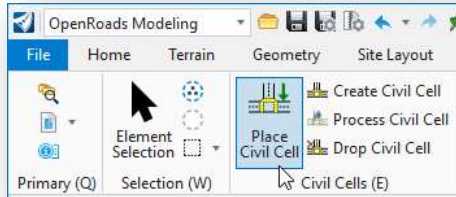
✓ Choose the **Browse** button to select the civil cell.

The ***Pick Civil Cell*** dialog is opened

- Choose the **T-Intersection** civil cell shown above and select **OK**

The civil cell requires two elements for placement: The centerline of the intersecting road and the edge of pavement of the through road.

- When prompted, select the element that represents the centerline of the intersecting road (St. Peter Road) and the through Edge of Pavement for S.R. 185.
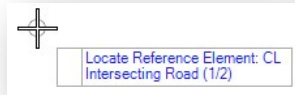

After selecting the two reference elements, the solution is displayed. Depending on the direction of the elements and how the civil cell was created, the solution may of may not appear correctly.

In the example below, the direction of the elements differs from the way the civil cell was created. This can be remedied by clicking on each of the reference elements to view different placement alternatives.
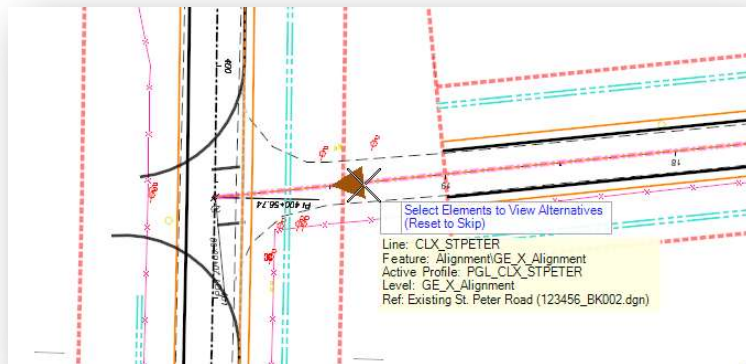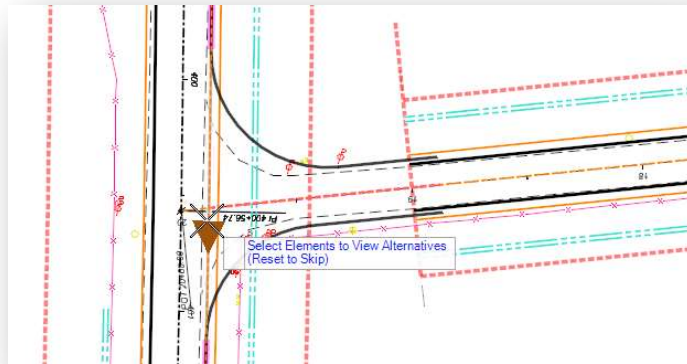

Left-clicking on the center line of St. Peter Road will reverse the direction of the element for the civil cell placement as shown below.
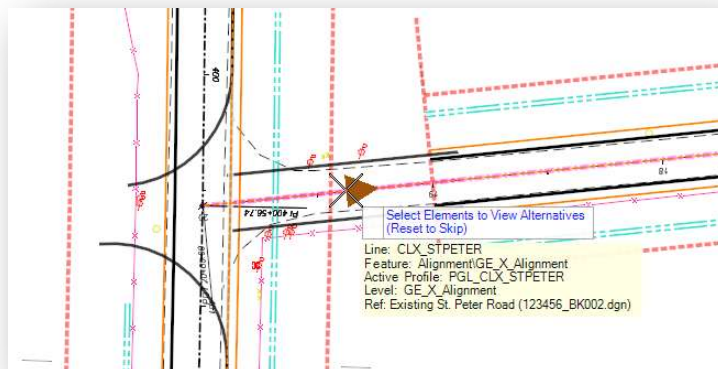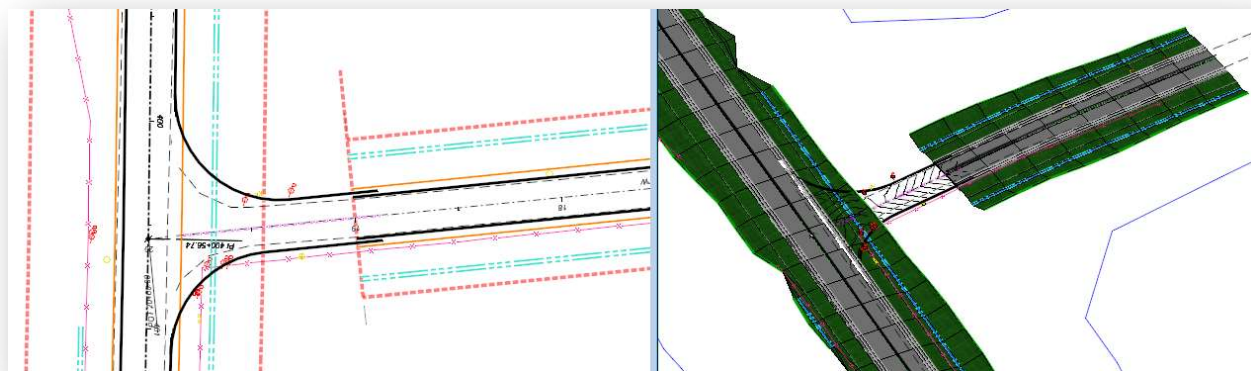
The edge of pavement element can also be reversed by left-clicking the edge of pavement line.


- ✓ When the solution appears correct, issue a reset (right-click) to skip the process of viewing alternatives

- ✓ Issue a data-point (left click) to accept the civil cell placement. 2D and 3D graphics are placed to represent the surface of the intersection.

The length of the civil cell overlaps the St. Peter Road corridor. This can be corrected either by editing the civil cell length, or my adjusting the ending location of the corridor.

✓ To adjust the corridor, select the template range graphic, and then select the arrow handle to move the ending location of the corridor. The location can be specified by snapping to the end of the civil cell as shown below.
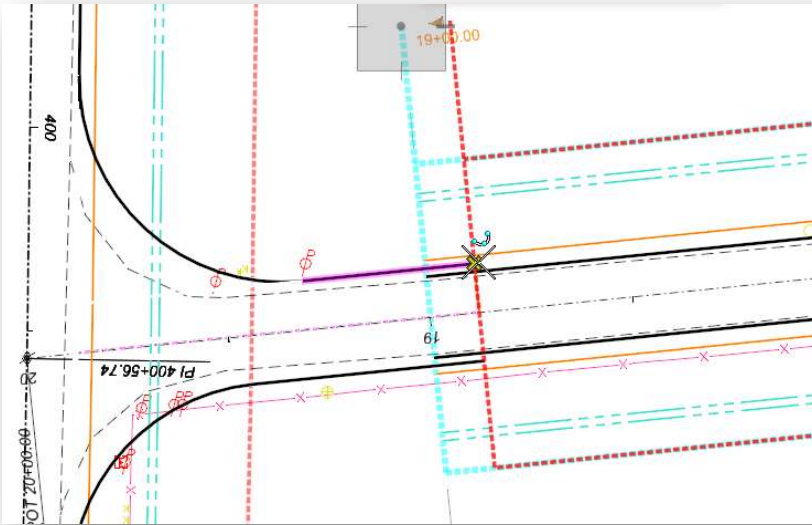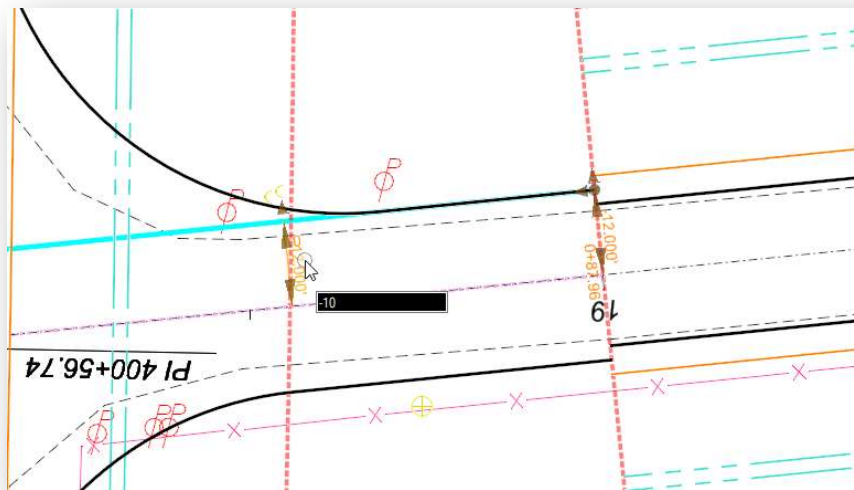

✓ To adjust the civil cell, select the civil cell element that overlays the St. Peter Road alignment. The length of the civil cell is a rule that can be edited (the value is 100.000' in the example below), or the length can be dynamically modified by choosing the left arrow at the end of the civil cell and dragging the length to the desired location.
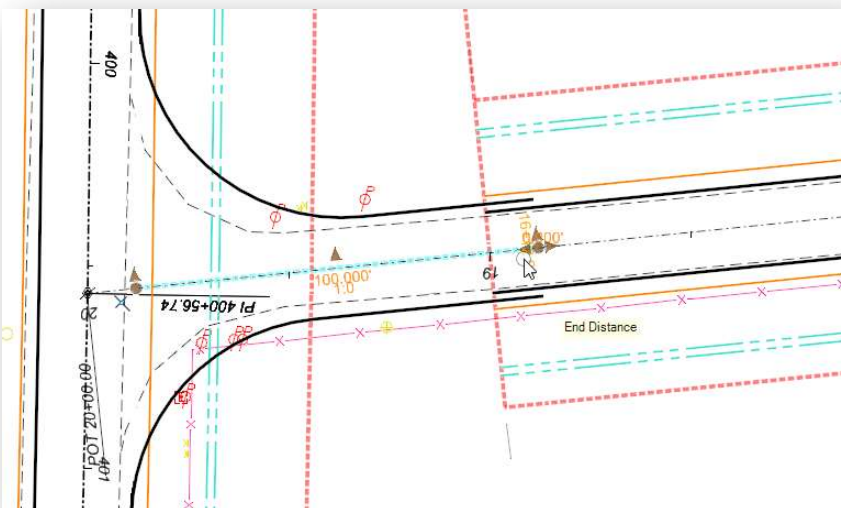
The civil cell can be edited to further meet specific project requirements. Take the following steps to edit the lane widths for the civil cell:

✓ Use the **Element Selection** command to select the edge of pavement on the north side of St. Peter Road
- The underlying rules for the element are displayed but are grey cannot be edited until the underlying element is selected.
- Right-click the element until the rules are editable
- Select the center lane width rule. Change the value to -10
- The edge of pavement is adjusted to the new value
- Repeat this process to change the lane width for the opposite side to a value of 10

✓ The same type of editing can be applied to the radius returns.
- Edit one of the radii returns to use a radius value of 40'
  - Observe the behavior of the civil cell elements. The interval displayed for the edge of pavement is automatically adjusted according to the new radius value and the surface terrain model for the civil cell is also adjusted in response to the radius change
- Change the edited radius value back to 50'

✓ Additionally, the radius returns have start and ending offset values for the tie-in with the edge of pavement lines. This is useful for meeting differing pavement widths on each side of the intersection.
- Select the radius return element on the south of St. Peter Road. The Properties dialog can be used to edit various parameters. From the **Fillet Rule** group, change the **Ahead Offset** value to **-12**. The fillet is adjusted as shown below.
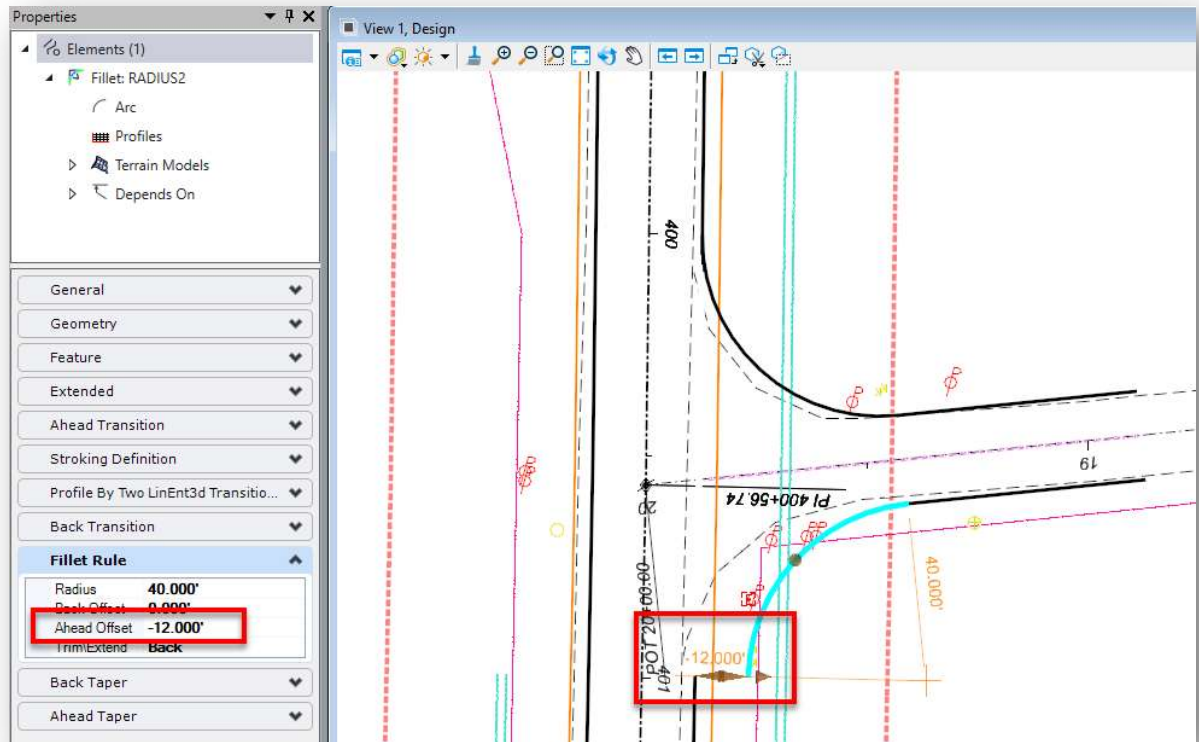
✓ Change the **Ahead Offset** parameter back to **0**

Part 2: Defining the Pavement Buildup

The pavement surface for the intersection is placed as a terrain model. The feature definition assigned to the terrain model is **P_Pavement_Surface** which is configured to display contour lines for the pavement surface at 0.1' intervals.

To complete the St. Peter Road pavement, a template will be applied to the surface terrain. Take the following steps to apply a template with the pavement buildup for St. Peter Road:
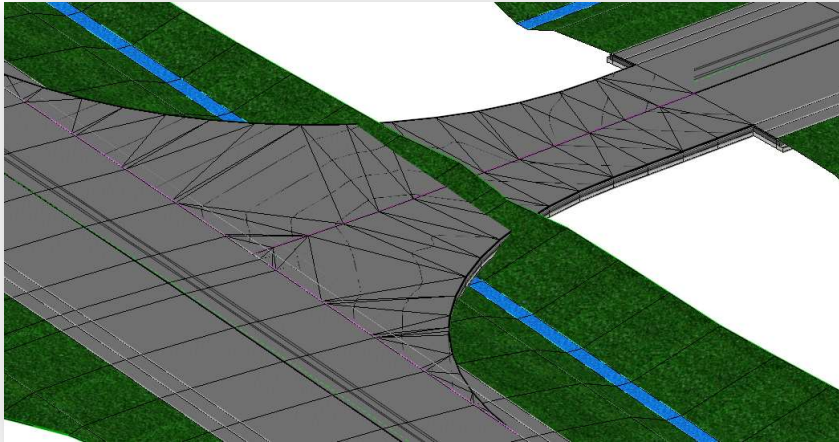
- ✓ From the **Corridors** tab, select **Template > Create Template**
  - Copy the St. Peter Road Template.
  - Paste the copy into the **Project Templates** folder.
  - Rename the copied template to St. Peter Road Pavement.
  - Double-click the St. Peter Road Pavement template to make it active.
  - Right-click in the **Current Template** window and choose the **Delete Components** command. Delete the shoulders and the side slopes on both sides of the template.
  - Delete the pavement layers for the left lane, leaving the pavement layers for the right lane in place.
  - Delete the Null points above the pavement layers (right-click on each point and choose the Delete Point command).
  - Close and save the template library.

The completed St. Peter Road Pavement template contains only the pavement as shown below. The pavement slope and width of the components is irrelevant as the terrain model for the intersection will define the slope and width.
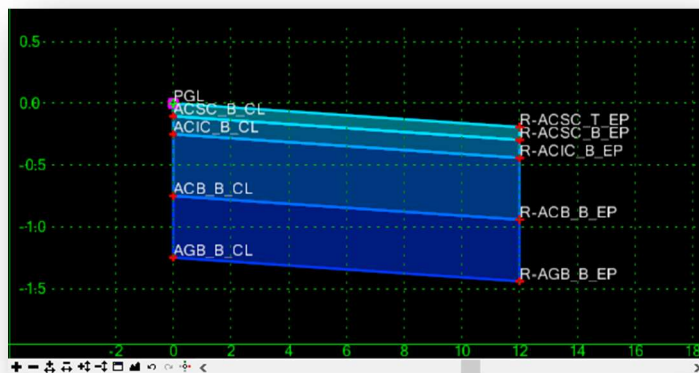
Take the following steps to assign the pavement template to the intersection terrain model.

- ✓ From the **Model Detailing** tab, select **Apply Surface Template**
  - When prompted to **Locate a Terrain Model**, select the surface terrain model for the intersection.
  - Select **No** for the **Apply Clipping Boundary** option.
  - Choose the St. Peter Road Pavement template.
  - Left click (data point) to accept the selection.
  - Data point to accept the selection. The pavement template is applied to the terrain model as shown below.

Part 3: St. Peter Road Shoulder Templates

A new template is necessary to define the pavement, shoulders, and side slopes for the St. Peter Road intersection area.

Take the following steps to create the radius return template:

- ✓ From the **Corridors** tab, select **Template > Create Template**
  - Copy the **St. Peter Road** template
  - Paste the copy into the **Project Templates** folder
  - Rename the copied template to **St. Peter Road Shoulder**
  - Double-click the **St. Peter Road Shoulder** template to make it active
  - Right-click in the **Current Template** window and choose the **Delete Components** command. Delete the pavement, the left shoulder, and end conditions on the left side. Leave the right shoulder and the right end conditions in place.
  - Delete the null points above the pavement layers (right-click on each point and choose the **Delete Point** command)

 At this point, the template should appear like the example below.
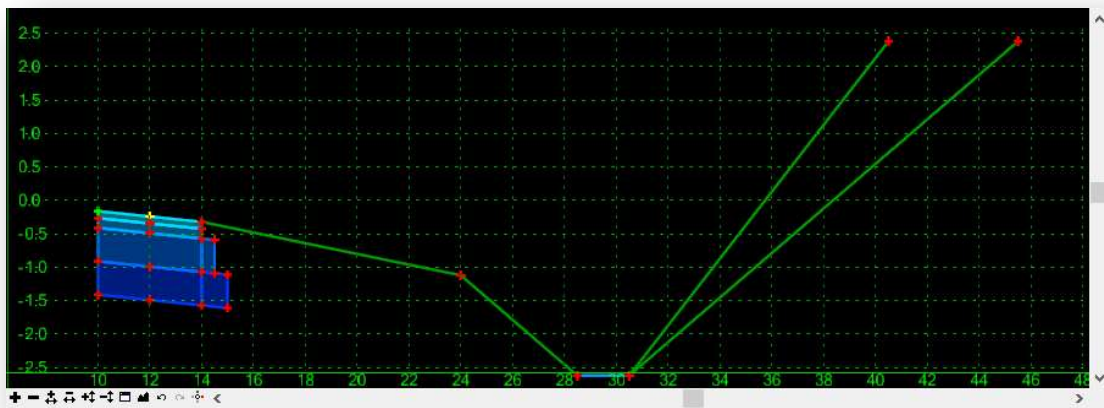
The shoulder components are currently located 10' right of the origin. The next step is to move the shoulder to the 0,0 origin in the template dialog.

- ✓ Open the *Dynamic Settings* dialog to ensure the **Step** values are defined

- ✓ Right-click on point **R-ACSC_T_EP** and choose the **Move Point** command. Move the point to the (0,0) position

Notice the point at the shoulder break is partially constrained (the point location is show with a yellow plus sign indicating that only one constraint is defined). When the pavement lane was deleted, the rule for the slope was removed since it referred to point PGL as part of the rollover lock definition. Take the following steps to define a Slope constraint for point R-ACSC_T_SB:

✓ Double-click point **R-ACSC_T_SB** to access the *Point Properties* dialog. Add a **Slope** constraint to the point with a -4.00% slope from point **R-ACSC_T_EP** as shown below.
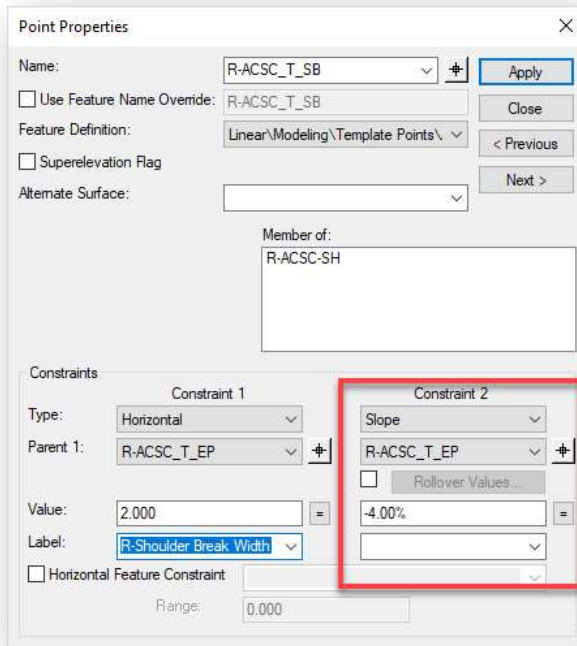
The completed template for the radius returns should appear as shown below
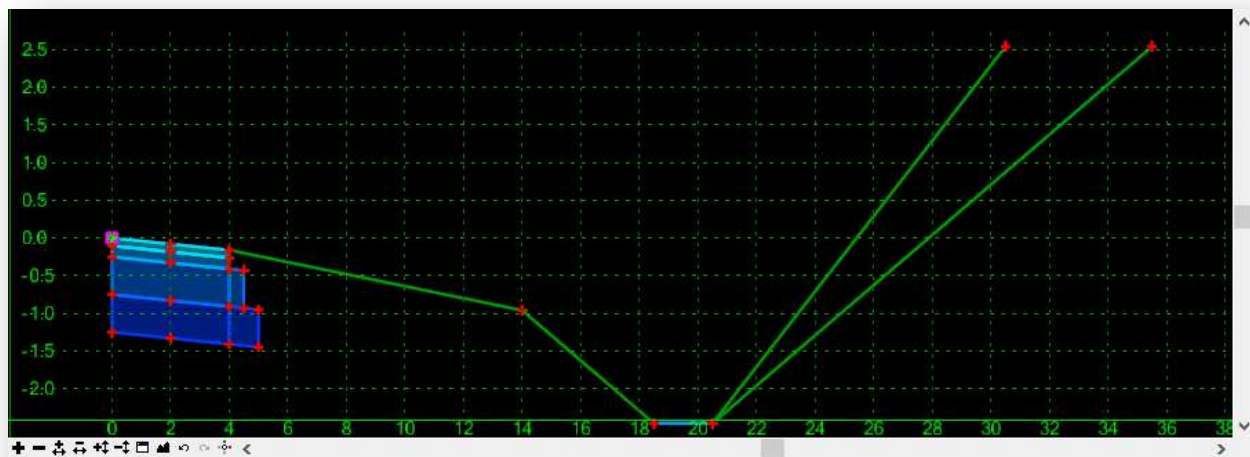
✓ Save and close the Template library.

Take the following steps to apply the St. Peter Road Shoulder template to the edge of pavement tangent lines and the radius return elements:
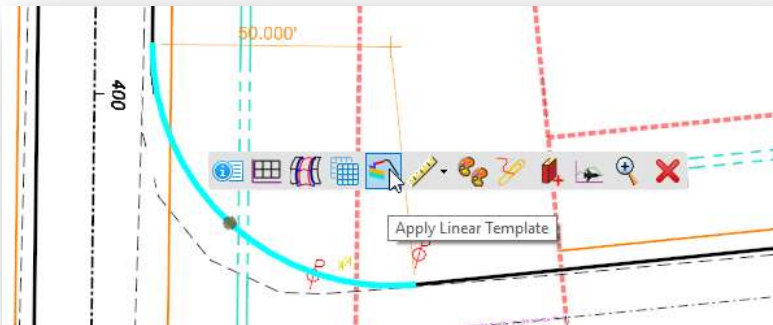
✓ Select the right radius return graphic and choose the **Apply Linear Template** command from the pop-up menu. Alternately, the **Apply Linear Template** command can be selected from the **Model Detailing** tab.

✓ Choose the **St. Peter Road Shoulder** template from the library
  - The template can be applied for a portion of the selected graphic, or the entire element. Define the **Start Station** and **End Station** to encompass the entire length of the element by using the <ALT> key
  - When applying a linear template, the template can be placed on either the left or right side of the selected element. When prompted to **Select Side – Reflect Option**, issue a data point on the side of the element that you wish to apply the template
  - Use the default **Exterior Corner Sweep Angle** value of 5 degrees

The template is applied to the radius return. Repeat the process for the remaining edge of pavement lines and radius return.

When complete, the intersection should appear like the example below.
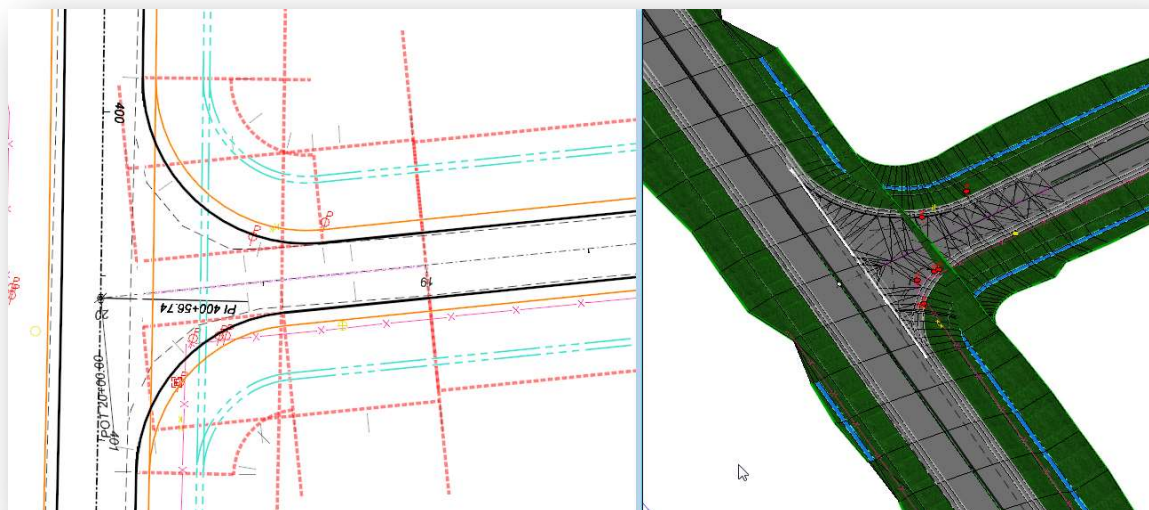
Part 4: Adjusting the S.R. 185 Corridor in the Intersection

The last step is to remove the left shoulder and end conditions on the S.R. 185 corridor through the intersection area.

The template for S.R. 185 is defined with Null Points to seek an intersection with an element in the design that defines the limits of the intersection. If the intersection graphic element is found, a display rule is used to turn off the side slopes.

Take the following steps to draw a line in the design that will be used as the intersection element the null point will seek:

- ✓ Open the design file containing the corridor model for S.R. 185
  400-Engineering\Roadway\123456_KM001.dgn

- ✓ Attach the St. Peter Road corridor as a reference
  - From the **Home** tab, select **Attach Tools > References** to attach the following file:
    400-Engineering\Roadway\123456_KM002.dgn

- ✓ From the **Geometry** tab, choose **Standards > Feature Definition Toggle Bar**
  - Set the **Feature Definition** to **Linear\Modeling > Template Points > Misc > MD_P_INTERSECTION_MATCHLINE**
  - Turn on the Use **Active Feature Definition** option
  - Turn off the **Persist Snaps and Rule** option as shown below

- ✓ From the **Geometry** tab, **Horizontal** group, select **Offsets and Tapers > Single Offset Partial**
  - When prompted to **Locate Element**, choose the S.R. 185 alignment
  - Name the element **St. Peter Match Line**
  - Create an offset line 50' to the left of S.R. 185 by snapping to the radius returns of St. Peter Road

The completed line should be like the example shown below.
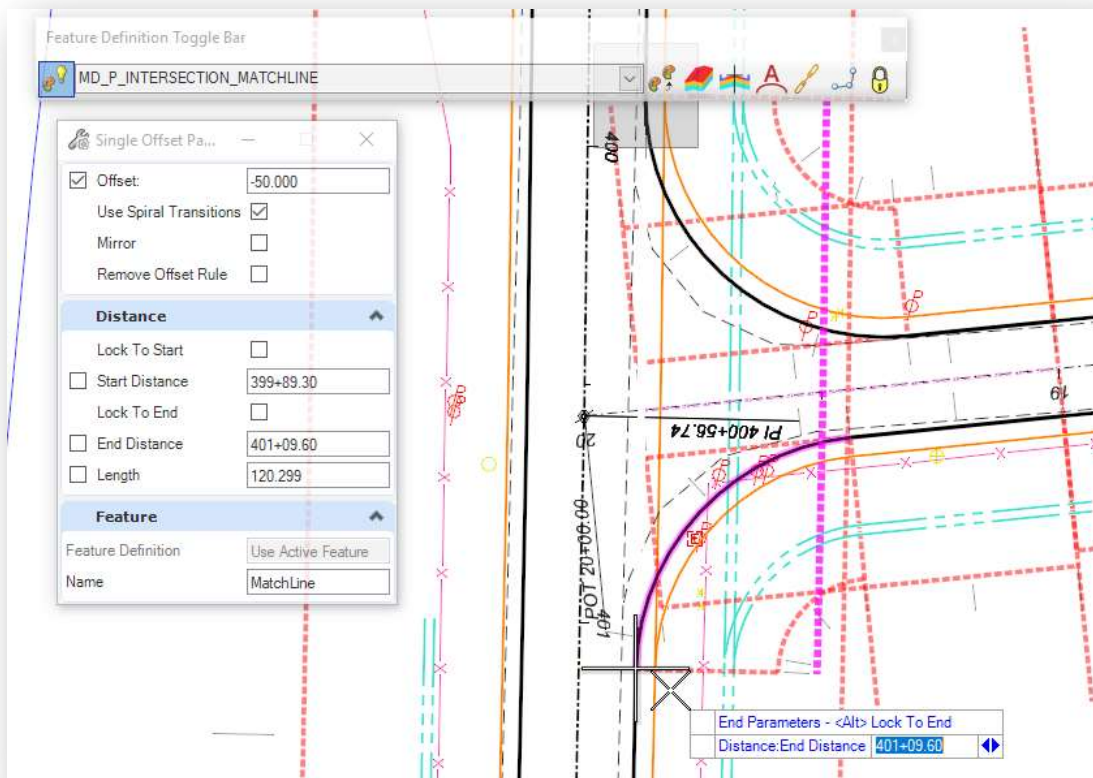
The match line element must be added as a corridor reference to the S.R. 185 corridor for the template to find the graphic. Take the following steps to add the match line element as a corridor reference:

- ✓ From the **Corridors** tab, select **Corridor References > Add Corridor Reference**
  - When prompted to **Locate Corridor**, choose the S.R. 185 corridor
  - When prompted to **Locate First Reference**, choose the match line element
  - Reset (right-click)

The element is added as a corridor reference and the corridor is reprocessed. The corridor model should appear like the example below.
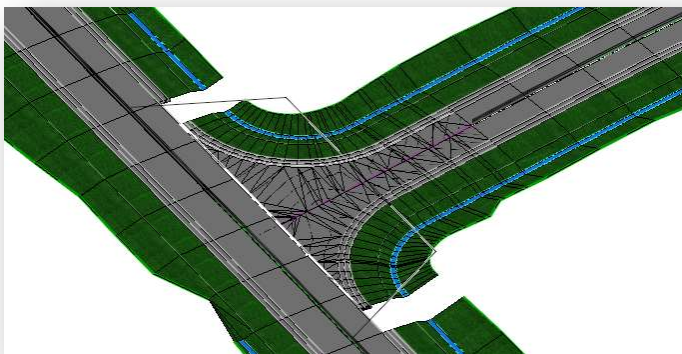
Depending on the template drop interval and the location of the radius returns, there may be a gap in the model as shown above. This can be remedied by inserting a key station on the S.R. 185 corridor to ensure that the model is processed up to the station where the radius return starts.

Take the following steps to insert a key station on the S.R. 185 corridor:

✓ From the **Corridors** tab, select **Edits > Create Key Station**
- Make sure the **Persist Snaps and Rule** option is toggled off in the Feature Definition toggle bar when adding key station locations to a corridor
- When prompted to **Locate Corridor**, choose the S.R. 185 corridor
- Identify the station by snapping to the radius return at the point where it meets the S.R. 185 edge of pavement but do not accept this location
- This function works best if you use a station value that is slightly outside of the range of the radius return. For example, if the station value is 399+89.30 at the snap point of the first radius return, key in a value of 399+89.29 that is just before the start of the radius return. For the second radius return, key in a station value that is just beyond the ending station value.

  Note: You can adjust the key-point location after it has been placed by selecting the line that is drawn at the key point location and then edit the station rule.

  The key station graphic is drawn on the level **CM_Corridor_Key_Station**

  There may be a small gap on the south end of the intersection as well. Inset another key station to close this gap.
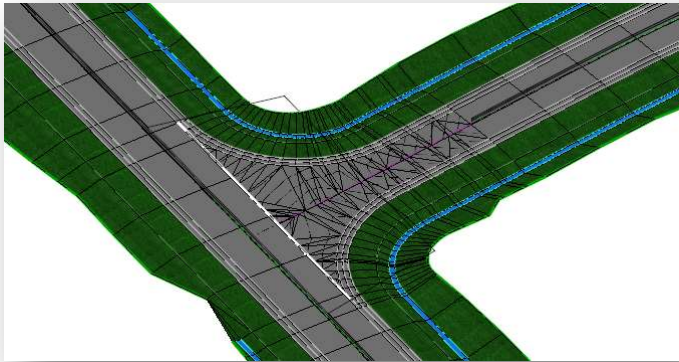
This completes this exercise.

✓ Exit OpenRoads Designer and check the file back in to ProjectWise.

Optional Exercise 3: Intersection Modeling Step-by-Step

This section will step through the process to model the intersection of S.R. 185 and St. Peter Road using the OpenRoads tools without the use of a civil cell. This exercise is used in place of Exercise 2 Part 1 above.

Process Overview

The process to model the intersection will take several steps as summarized below:

- Define the Horizontal and Vertical geometry for each road
- Create Templates for each road
- Model the mainline corridor
- Model the side road corridor
- Add radius returns to the side road and define the vertical profile for each of the radius returns
- Modify the mainline corridor to remove any side slopes through the limits of the intersection
- Adjust the side road corridor to end at the radius return
- Create a surface terrain for the pavement surface of the side road in the intersection area. The surface terrain is defined by the radius returns, the edge of pavement for the mainline corridor, and the centerline and profile of the side road corridor.
- Apply a "surface template" to the surface terrain of the intersection. This will establish the pavement buildup components beneath the pavement surface terrain.

Apply linear templates to the radius returns to model the shoulders and side slopes for the intersecting side road.

### Modeling the Intersection Pavement

The corridor for St. Peter Road was created up to station 19+25 in this example. Ending at this station will allow room for modeling the intersection with S.R. 185. The intersection will be modeled by first defining a terrain model representing the pavement surface for the intersection. Start by placing the edge of pavement lines and radius returns for the intersection.

The edge of pavement lines and the radius returns must be created using Civil Geometry tools. Take the following steps to create the edge of pavement lines:

- ✓ From the **Geometry** tab, open the *Features Definition Toggle Bar* by choosing **Standards > Feature Definition Toolbar**. Set the active feature definition to **Linear > Pavement > PV_P_Edge_of_Pavement**.

- ✓ In the *Features Definition Toggle Bar*, toggle on the **Use Active Feature Definition** option

- ✓ From the **Geometry** tab, choose **Offsets and Tapers > Single Offset Partial**. This command is used to place a civil geometry element at an offset from the selected alignment.

  - When prompted to **Locate Element**, choose the St. Peter Road alignment.
  - Enter a **Name** for the element a shown below, **R-EOP St Peter Road**.
  - Using an **Offset** of 10', define the starting point of the offset element by snapping to the edge of pavement line at the end of the corridor as shown below.
  - Enter the **End Distance** by entering the <ALT> key to lock to the end of the alignment.
  - When prompted to **Mirror** the solution, choose **Yes**.

- The mirrored line is named R-EOP St Peter Road1. Change the name to **L-EOP St Peter Road** by selecting the line element and choosing the **Properties** command from the pop-up menu.
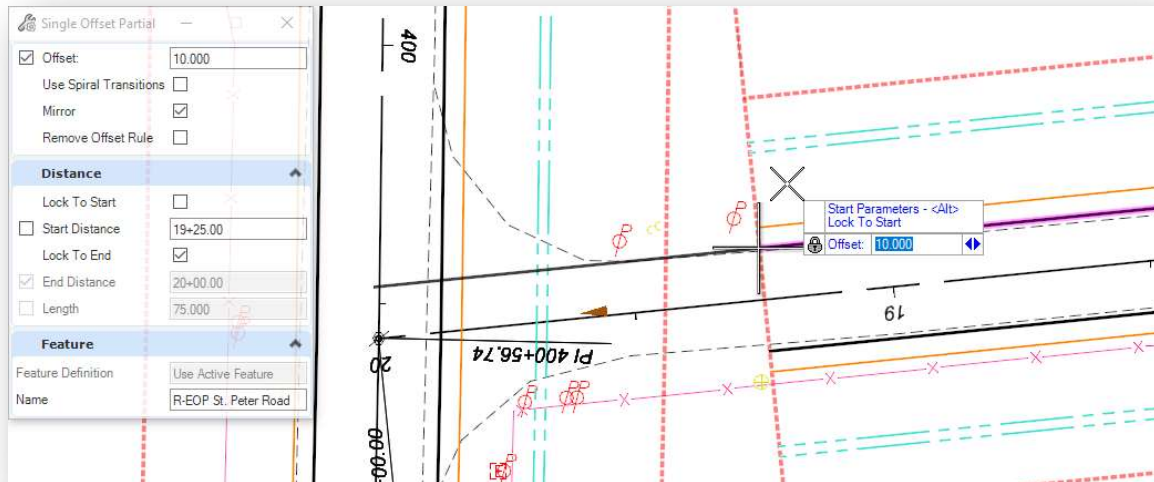
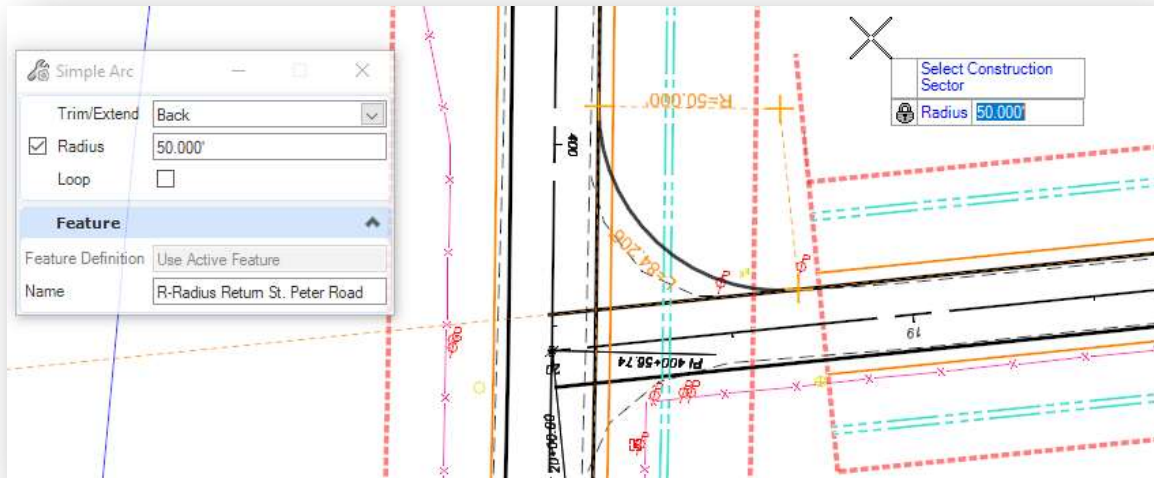Next, assign a profile to the newly created edge of pavement elements.

✓ From the **Geometry** tab, choose **Element Profiles > Profile By Slope From Element**

- When prompted to **Locate First Element to Profile**, choose one of the edges of pavement elements. Continue by choosing the other element when prompted to **Locate Next Element to Profile**. After choosing both elements, right click (reset) to end the selection process.
- Choose the centerline of St. Peter Road when prompted to **Locate Reference Element**.
- Enter a **Slope** value of -1.6%
- Choose the **Point Selection** mode **All**
- Use a **Profile Adjustment** of **None**
- Enter a **Vertical Offset** of **0**

Next, create the radius returns for the intersection.

✓ From the **Geometry** tab, select **Arcs > Arc Between Elements > Simple Arc**.

Create the first arc on the right side of St. Peter Road using a 50' radius.
- Be sure to enter a **Name** of **R-Radius St Peter Road** for the radius return element.
- Choose the **R-EOP St Peter Road** line as the first element.
- When prompted to **Trim/Extend**, choose the **Back** option.

✓ Create the second arc on the left side of St. Peter Road with a **Radius** of 50', a **Name** of **L-Radius St Peter Road**, and use the **Trim/Extend Back** option.

Next, assign a profile to the radius return elements using the **Quick Profile Transition** command.

✓ From the **Geometry** tab, select **Element Profiles > Quick Profile Transition**
  o After selecting the command, you are prompted to choose the **Quick Transition Method**. Select the **Parabolic** option.
  o When prompted to **Locate What to Define**, select one of the radii return elements. A quick profile is created for the element.
  o Repeat the procedure for the second radius return

After the profiles are assigned, the edge of pavement and radius return lines should appear in the 3D model like the example shown below.
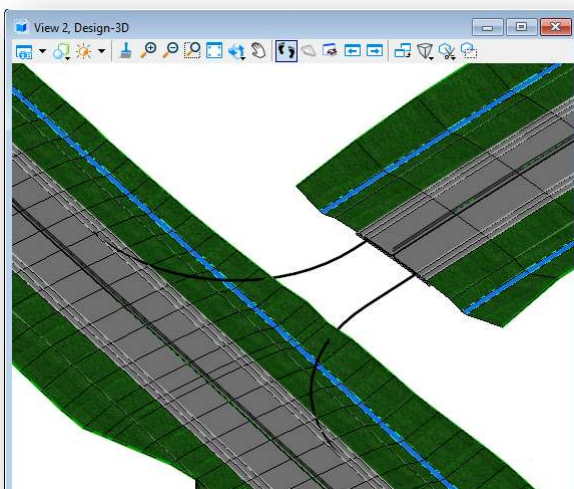
The profile for each radius return can be reviewed and edited by selecting one of the radii returns and selecting the **Open Profile Model** command. The profile for **R-Radius St Peter Road** is shown below.
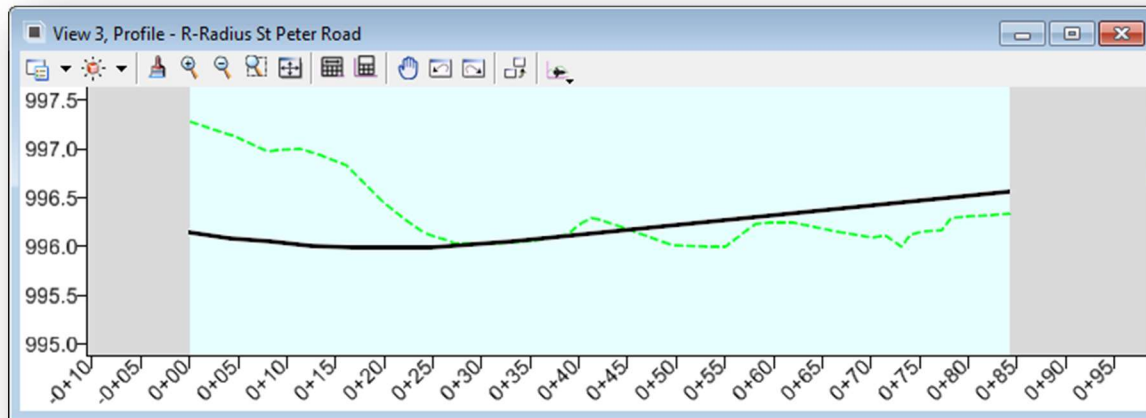
In addition to the two radius returns, it is necessary to define a line that follows the edge of pavement for S.R. 185 that extends from the ends of the radius returns. This is necessary to define the boundary of the intersection area that will be used to make the surface terrain model. We cannot use the edge of pavement line from the CLP_S185 corridor model as the line must be constrained to the limits of the radius returns.

Since this new edge of pavement line will overlap the edge of pavement lines already drawn for the CLP_S185 corridor we will use a different feature definition.

- ✓ In the *Features Definition Toggle Bar*, set the active feature definition to **Modeling > Template Points > Misc > MD_P_DNC**. The initials "DNC" stand for **Do Not Construct**. This feature definition can be used for linear elements used in the modeling process whose graphics will not be used for part of the plan production process. Graphics drawn with this feature are placed as construction elements on the level MD_P_DNC.

- ✓ From the **Geometry** tab, choose **Offsets and Tapers > Single Offset Partial**.
  - Create an offset line 12' to the left of the CLP_S185 alignment from the ends of the radius returns.
  - Because this new line is drawn on top of the edge of pavement line for S.R. 185, it is easier to temporarily turn off the reference file display of the S.R. 185 corridor model to ensure the line was drawn correctly. Open the *References* dialog and turn off the display of the 12345_KM001.dgn file.

The completed graphic should appear like the example below.
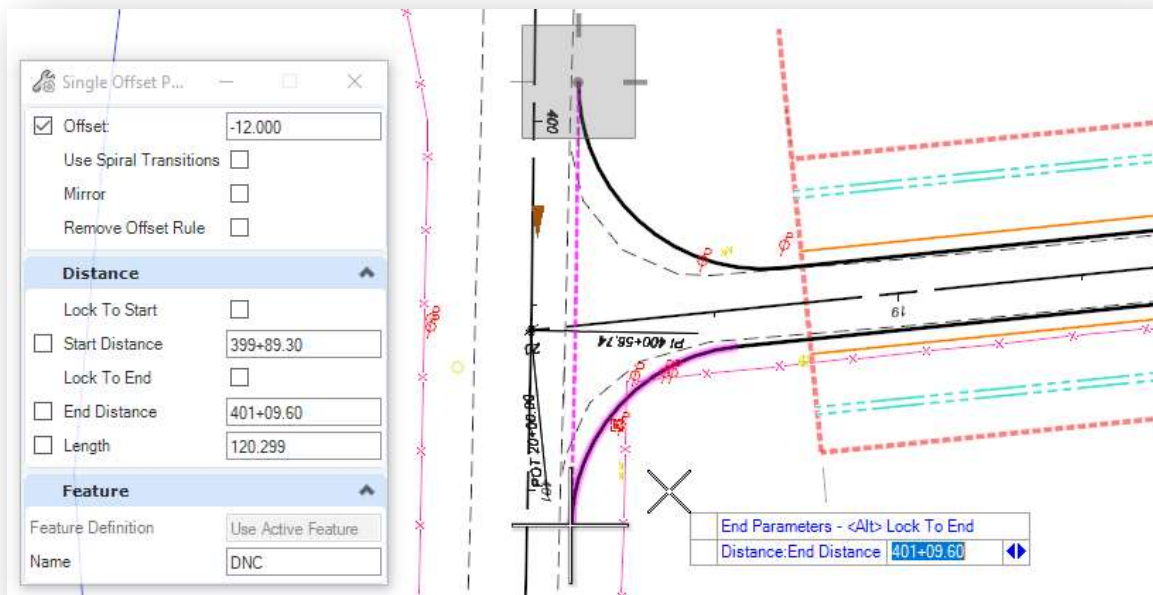
Next, assign a profile to this new DNC line.

- ✓ From **Geometry** tab, choose **Element Profiles > Profile By Slope From Element**.
  - When prompted to **Locate First Element to Profile**, choose the DNC line
  - Reset (right-click) to complete the location process
  - When prompted to Locate Reference Element, choose the S.R. 185 alignment
  - Define the profile with a -1.6% slope from the centerline of S.R. 185

The edge of pavement and radius return lines will be used to define the boundary of a terrain model for the surface of the pavement in the intersection.

- ✓ From the **Terrain** tab, choose the **From Elements** command.

  - Set the **Feature Type** to **Boundary**
  - Set the **Edge Method** to **None**
  - Set the **Feature Definition** to **Terrain > Proposed > P_Pavement Surface**. Since this is a terrain feature it cannot be selected from the *Feature Definition* tool bar.
  - Set the feature **Name** to **St Peter Road**
  - When prompted to **Locate Elements to Add**, choose the edge of pavement and radius returns for St. Peter Road as well as the DNC for S.R. 185 (five elements total – don't forget the edge of pavement lines for St. Peter Road between the radius returns and the corridor).
 - Reset when the elements are selected.
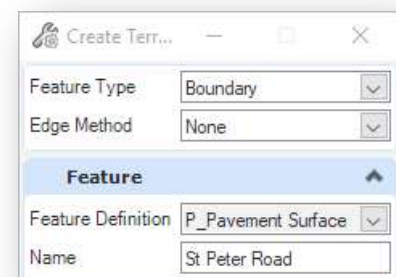
The surface is created, and contour lines are drawn as shown at right.

One more graphic is necessary to complete the pavement surface definition. The center line and profile of St. Peter Road will be added to define the crown of the pavement surface. This will be accomplished by creating one more partial offset element.

✓ In the *Features Definition Toggle Bar*, set the active feature definition to **Modeling > Template Points > Misc > MD_P_DNC**.

✓ From the **Geometry** tab, choose **Offsets and Tapers > Single Offset Partial** command.

✓ Choose the centerline of St. Peter Road when prompted to **Locate Element**.

- Start the line at the end of the St. Peter Road corridor, **Station** 19+25 with an **Offset** value of 0.
- Use the MicroStation **Intersection Snap** to end the line at the intersection of St. Peter Road with the S.R. 185 Edge of Pavement.
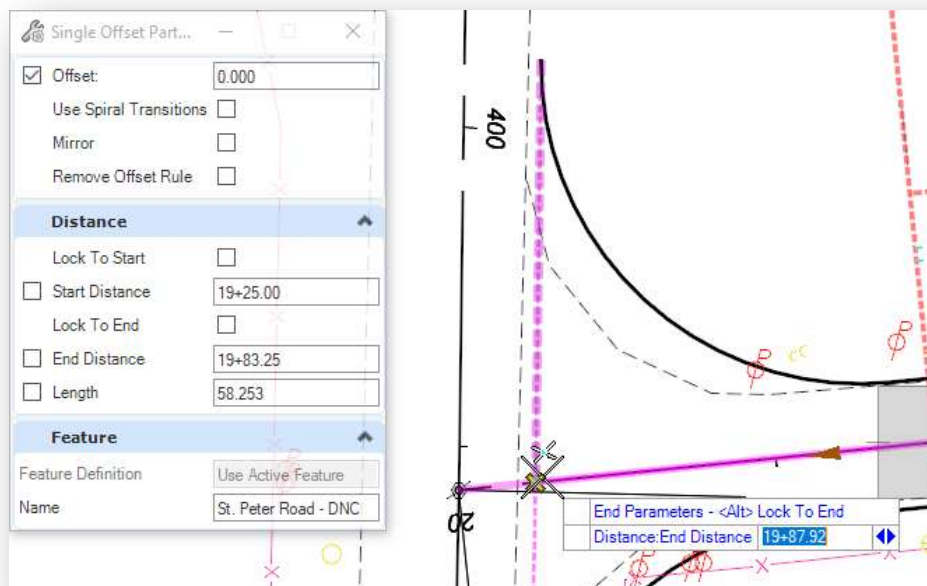
After placing the line, assign a profile to the line using the **Profile By Slope From Element** command.

✓ From the Geometry tab, select Element Profile > Profile Slope from Element
✓ The **Reference Element** is the centerline of St. Peter Road.
✓ Since the new element overlaps the centerline of St. Peter Road, use a **Slope** value of **0.0%.**

The 3d line is created as shown below.

Add this new partial offset line to the surface terrain model as a break line.

✓ From the **Terrain** tab, select **Feature Management > Add Features**.
  • When prompted to **Locate Terrain Model to Add Elements**, select the St. Peter Road pavement surface terrain model.
  • When prompted to Locate Element to Add, select the DNC line at the center of St. Peter Road.
  • Reset (right-click)
  • Set the **Feature Type** to **Break Line**

After the break line element is added, the St Peter Road terrain model should appear like the example below.
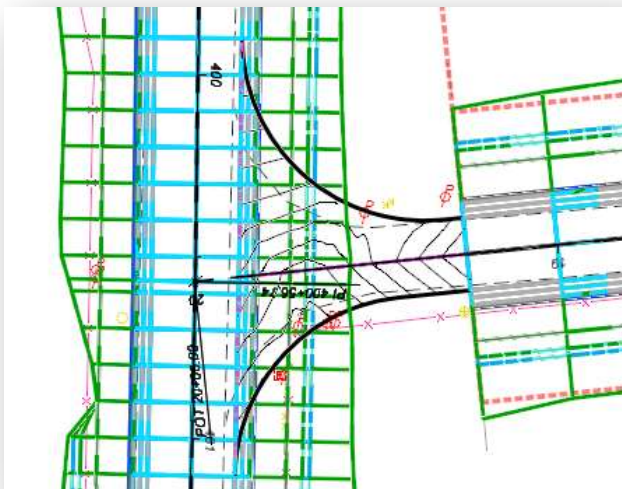
The process to define the pavement buildup, add the shoulder and side slopes, and trim the S.R. 185 corridor model through the limits of the intersection are detailed in Parts 2, 3, & 4 of Exercise 2.

This completes this exercise.

✓ Exit OpenRoads Designer and check the file back in to ProjectWise.

OpenRoads Software Version

This document was prepared using the following software version:

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OpenRoads Designer CONNECT Edition – 2022 Release 3 Update 12 – Version 10.12.02.04

Contacts

For any questions, suggestions, or problems with this document please contact the ODOT Office of CADD and Mapping Services by use of the following form on the ODOT website:

https://odot.formstack.com/forms/cadd_servicerequest