# Module 10 GUARDRAILS Using InRoads

Introduction

Guardrail modeling in InRoads is another detailed modeling element that is sometimes given a lower priority than is warranted. This topic is introduced in the 2012 ODOT Highway Design Manual, Chapter 16, 3D Roadway Design, section 16.3.4.1, GUARDRAIL. Reference to modeling guardrails is also touched on in numerous places in the ODOT InRoads V8i User Guide, dated June 2014.
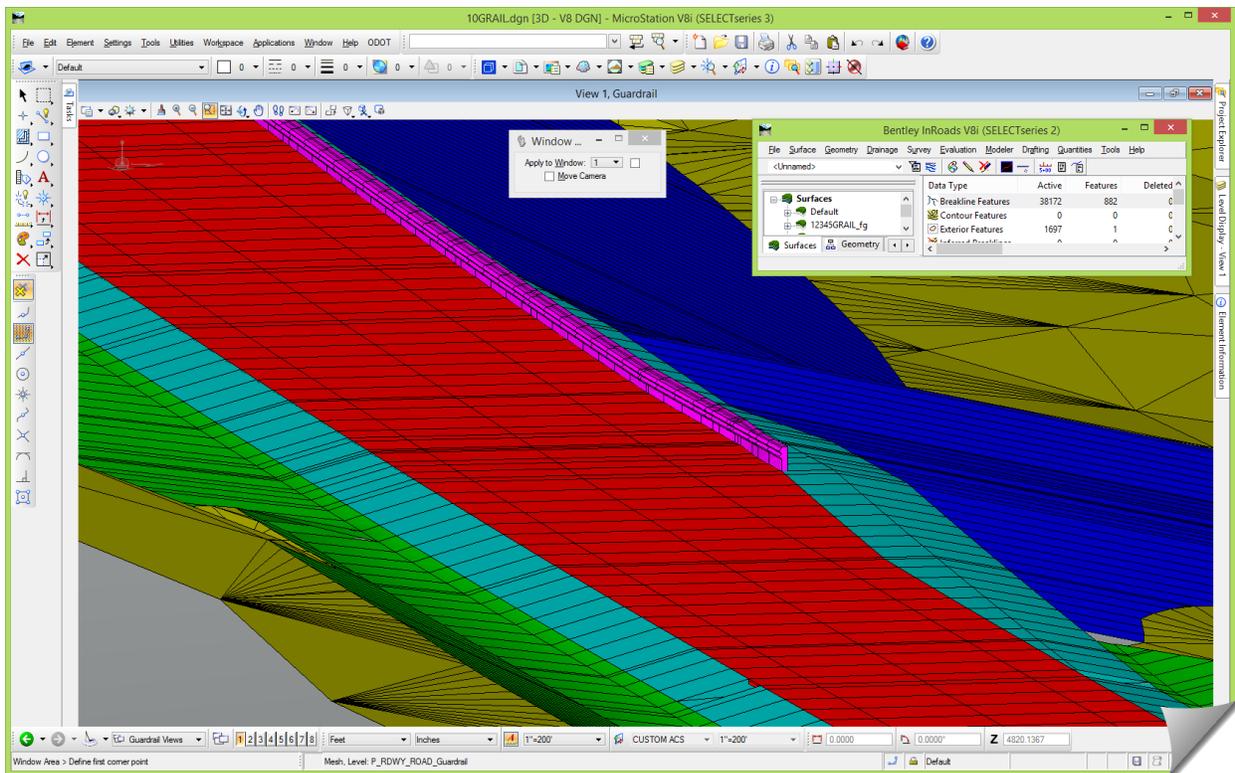
This module will approach this modeling from a template 'component' approach and its integration into the project sections through the **ROADWAY DESIGNER**.

Purpose of this Module

The purpose of this module is to show the use of **PARAMETRIC CONSTRAINTS** to model the location of guardrail, edge of paved shoulder, edge of widened embankment, and edge of subgrade at a terminal per ODOT standards using standard ODOT template components.

Objectives of this Module

By the end of this module, you will be able to use InRoads to layout project specific guardrail and terminals per ODOT standards using a template methodology.

Definition of Audience for future Modules

Please note that this module assumes that you have a certain level of competency with the software tools and will be asking you to execute some commands with very little instruction. This module was designed with a certain technical audience in mind, so ensure that you have the proper prerequisites.

Skill Level / Prerequisites:

The prerequisites for this module are the following:

- Module 1 – Introduction to the Training Modules
- Module 2 – Visualization
- MicroStation Basics
- InRoads Level 1
- InRoads Level 2

Module Files and Folders

Training Folders

You will be working on your own hard drive during this training. The module instructions will expect the training files and folders to be set up as shown here in order to align with the module directions.

You should have the **10_Guardrail** training folder and files on your local drive. The module folder and related files should be placed under the **C:\WORK\Train** folder, and look like this:
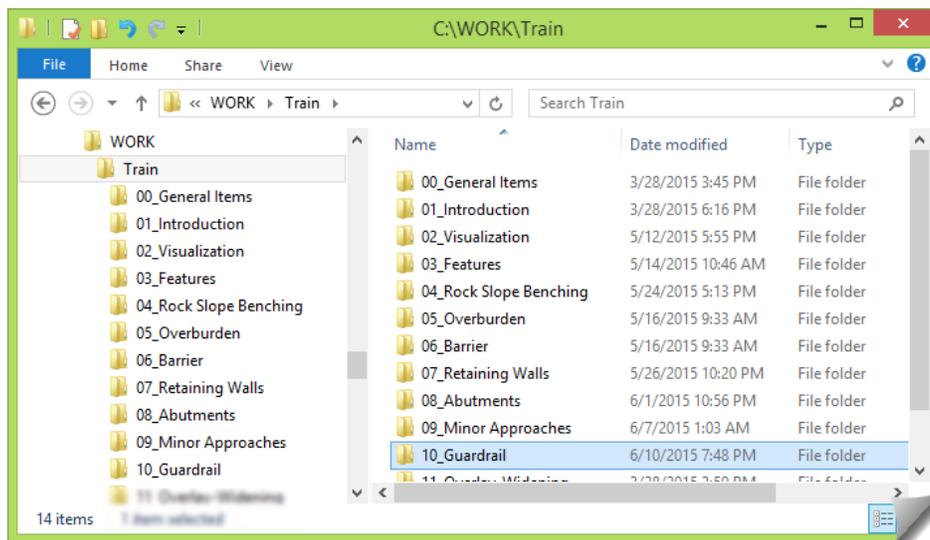
Training Files

The module folder contains all the files that will be used in these exercises including:

- **10GRAIL.dgn**, the initial MicroStation file used at the start of the exercises
- **10GRAIL.xin**, the InRoads configuration file for this work

There is an **RWK** file included in the module folder to assist in opening the InRoads files.

In this module folder, you should have these files:
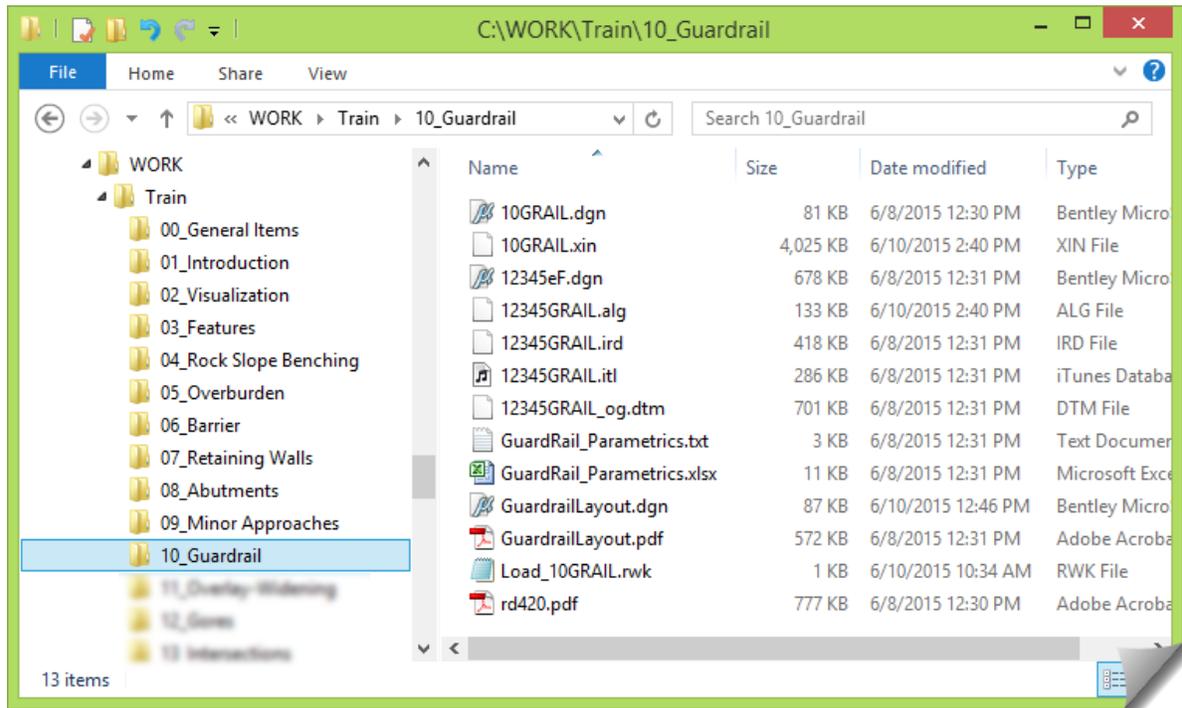
A few other notable files that are included for your reference in the module folder are:

- **rd420.pdf**, an ODOT standard drawing for an energy-absorbing terminal that will be used with this module, included here for reference.
- **GuardrailLayout**, included as both a DGN, as well as a PDF export from the drawing file, showing various layout parameters that illustrate how the InRoads template develops the guardrail terminal modeling.
- **Guardrail_Parametrics**, included as both a text file and an Excel file and will be referred to later when the specific **PARAMETRIC CONSTRAINTS** for the guardrail are covered. The text file is an InRoads file used to either save **Corridor PARAMETRIC CONSTRAINTS**, or as an input file to create them. The XLSX file is simply a reformatting of the text file that can be opened in Excel.

Technical Content of Training:

Project Orientation

REVIEW WORK AREA

The OG surface, as well as the mainline alignment, are already created. The focus of the modeling work, as shown here, will be the area of the guardrail.
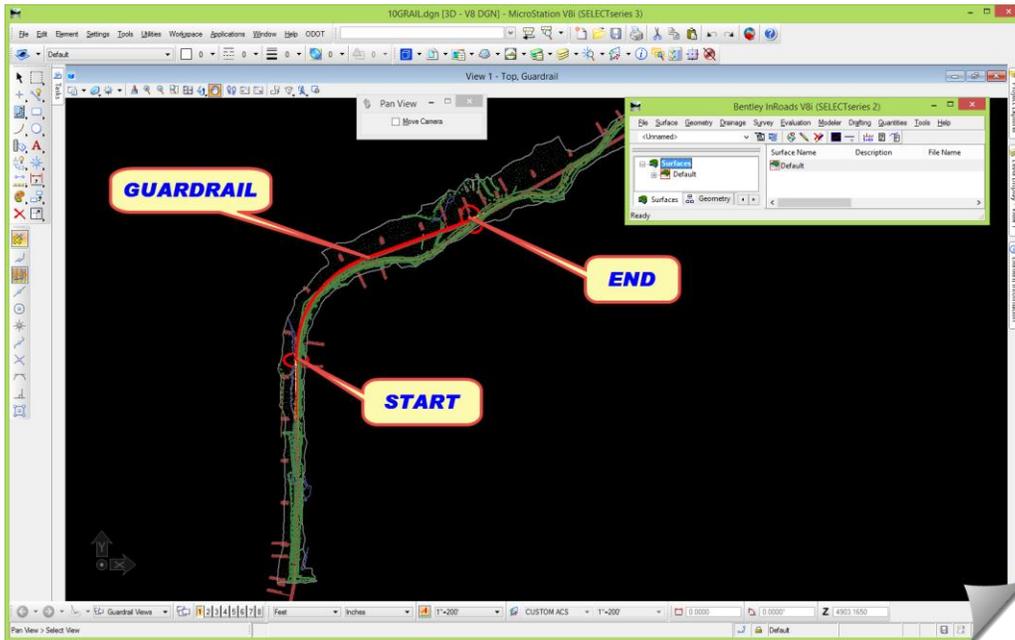
PREPARE MICROSTATION / INROADS DATA & FILES

This section will get you into the DGN, load the module-specific XIN and other data files.

1) Launch InRoads

    Use whatever mechanism you are familiar with to get the software started.

2) When the **MICROSTATION MANAGER** opens, set the **User** and **Interface** to **ODOT**.

3) Browse *C:\WORK\Train\10_Guardrail*, select **10GRAIL.dgn**, and [**Open**].
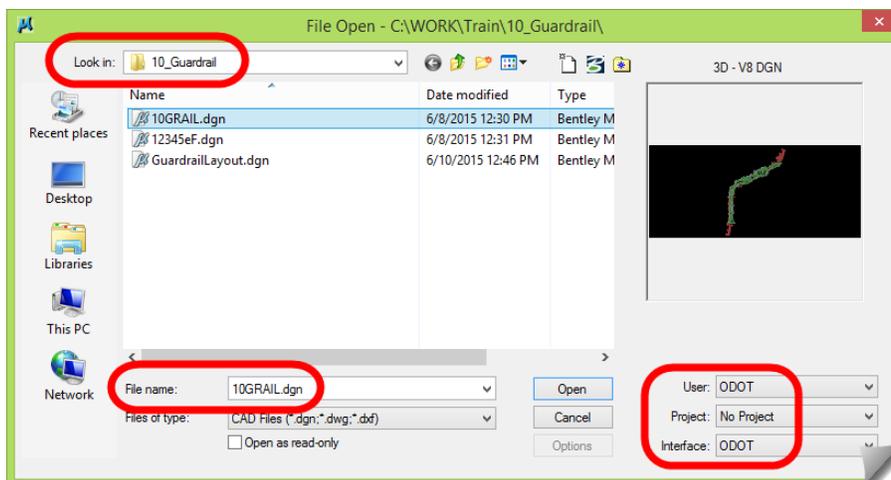
4) When the drawing opens, you'll see that it is has some content.
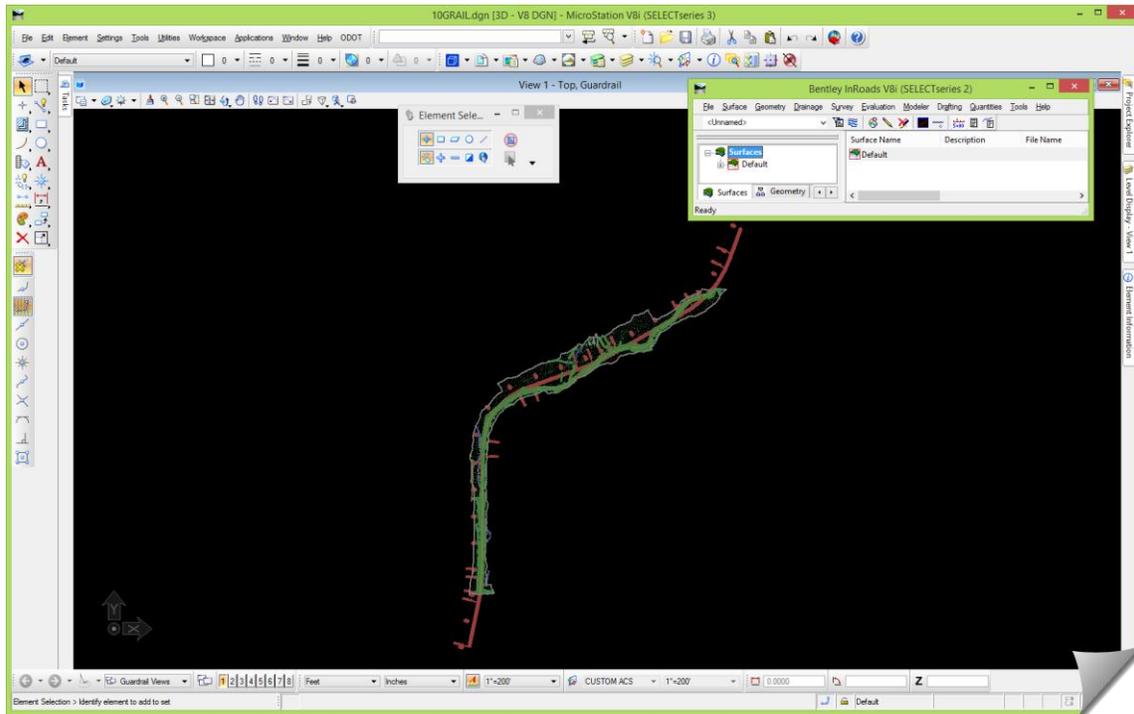
5) Open Windows **File Explorer** and browse to the `10_Guardrail` folder.

6) Drag & drop `Load_10GRAIL.rwk` into the InRoads interface to open the InRoads files.

7) Verify inside InRoads that the following files have been opened:
   - `10GRAIL.xin`
   - `12345GRAIL_og.dtm`
   - `12345GRAIL.alg`
   - `12345GRAIL.itl`
   - `12345GRAIL.ird`

8) Feel free to review the project data just opened.

9) Review the MicroStation models and reference files that are attached to this drawing so that you are oriented to the DGN file that is open.
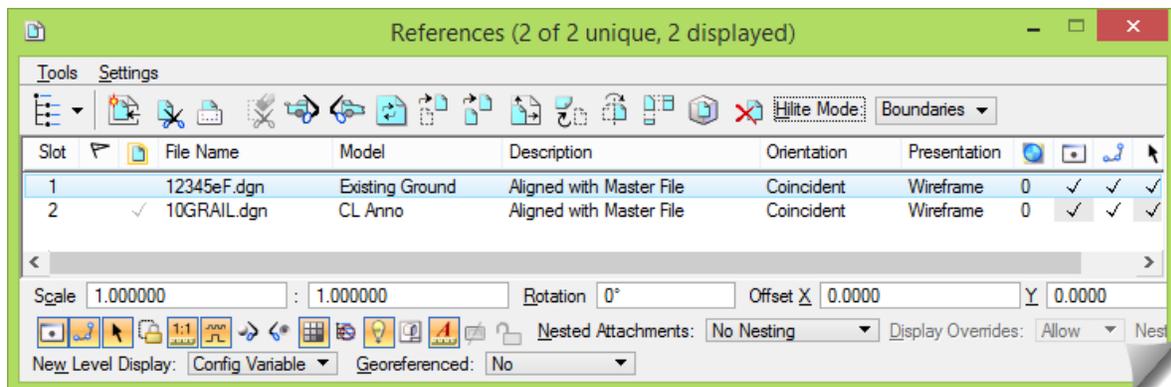
10) Move forward into the study portion of this module. Feel free to interact with the software as needed during your study in order to solidify any of the items under discussion.

Theory – Study

In this module, the project layout (geometry, templates and corridor) is already completed, and the main activity will be reviewing the sample project. With that said, the majority of the ability to model guardrail will derive from understanding exactly how the components are constructed and controlled.

PROCESS OVERVIEW

Things to Consider

Guardrail Design Criteria

The design criteria for the guardrail terminal feature locations are driven by the various ODOT Standard Drawings. In this module, the focus will be on the **RD420** non-flared option, as illustrated below. (Refer to the `rd420.pdf` in the module folder as needed for clarity and additional details.)
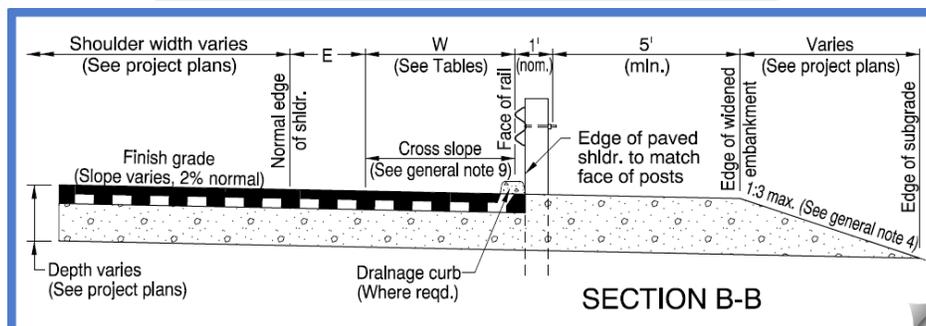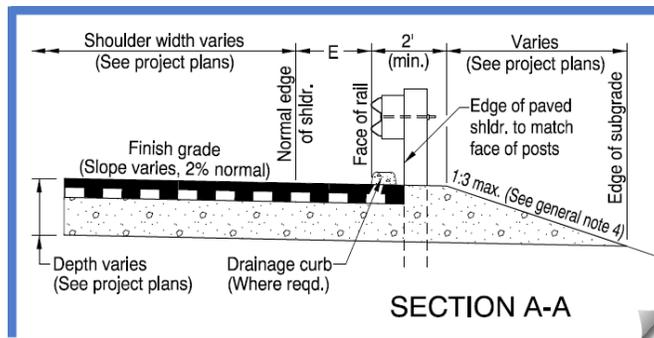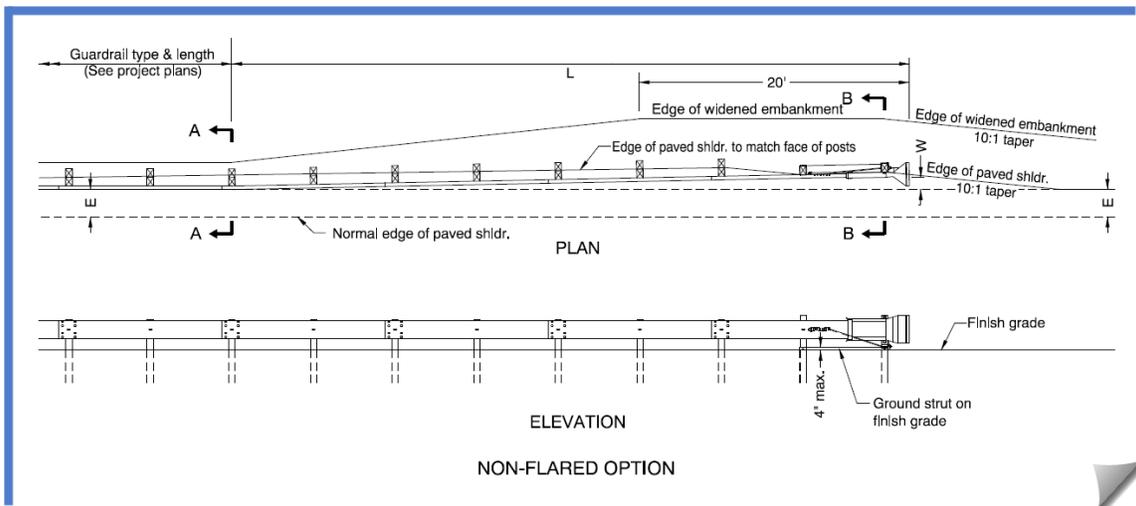
Guardrail Modeling Overview

As an overall orientation, guardrail modeling has this general outline:

a. Set up the model for the main roadway as ordinarily done.

b. If the general locations of guardrail are known (as in approaching a bridge, running close to a river, where steep slopes exist, or in areas where existing rail will be replaced), those locations can be added to the initial model.

c. Model the corridor with all of the 'known' design criteria.

d. View the modeling results, create cross sections and evaluate the design. Based on the results, identify locations for any additional guardrail using the guidance provided in the Roadside Design Guide.

e. Once the locations for additional guardrail have been identified, return to the templates and add the guardrail modeling components to those areas.

f. Define the **PARAMETRIC CONSTRAINTS** in the design corridor that control the layout of the guardrail components in the terminal locations.

g. Rerun the design corridor and evaluate the results. Verify that the road widening due to the addition of the guardrail widening didn't introduce anything unexpected or undesirable.

h. Once the guardrail locations are verified to be producing acceptable results, check the actual length of the guardrail.

> **TIP**: The total length of rail should be multiples of the 12.5' standard guardrail element length. The centerline stationing cannot be used to determine the final length of guardrail due to vertical grades, alignment curvature and tapers. One way to determine the actual length of rail is to measure the length of a feature representing the face of rail on the guardrail component (**GrF1** or **GrF2**).

i. Return to the **ROADWAY DESIGNER**, making any necessary station adjustments on the template drops, or changes to the constraint values to produce a more accurate final guardrail length.

j. As needed, create another design model, verify the lengths of guardrail, and return to the **ROADWAY DESIGNER** to make any necessary adjustments in order to fine-tune the rail lengths.

k. Produce the final design model.

> **ALERT**: The specific locations of the template drops and/or changes (constraint values) may need to be adjusted if the terminal falls on the inside or outside of a curve. The first and second post spacing and the terminal length are all measured along the rail, not on centerline. As a result, the centerline station locations need to be adjusted to achieve the correct dimensions along the rail.

> **TIP**: Using **PARAMETRIC CONSTRAINTS** works well with linear features and transitions. However, they cannot be used to model a parabolic flare terminal (RD425) very well. In some instances, **POINT CONTROLS** with a **Feature** that accurately represents the terminal flare should be used.

Techniques and Tools

There are a few key items when it comes to guardrail terminal modeling:

- **Guardrail Location Identification** – this involves defining where guardrail is needed.
- **Strategic Template Drops** – this comprises knowing where to place the template drops along the design corridor so that the berm widening and introduction of the guardrail can take place at the correct station locations to comply with layout criteria.
- **Guardrail Component Integration** – this consists of adding the necessary berm and guardrail components to the main roadway templates themselves so that the modeling toward, during, and after the guardrail terminal can take place.
- **Parametric Constraint Values** – this involves fluency with the guardrail components, their related constraints, and the associated labels on their values, so that they can be correctly entered in the ROADWAY DESIGNER to produce the intended guardrail model.

Guardrail Location Identification

This was mentioned earlier in the Guardrail Modeling Overview, and is beyond the scope of this document. Your reference for this section is the AASHTO Roadside Design Guide.

Strategic Template Drops

Three templates are required to introduce a guardrail into the design model.

a. The initial roadway template (Example that will be used in this module shown below).
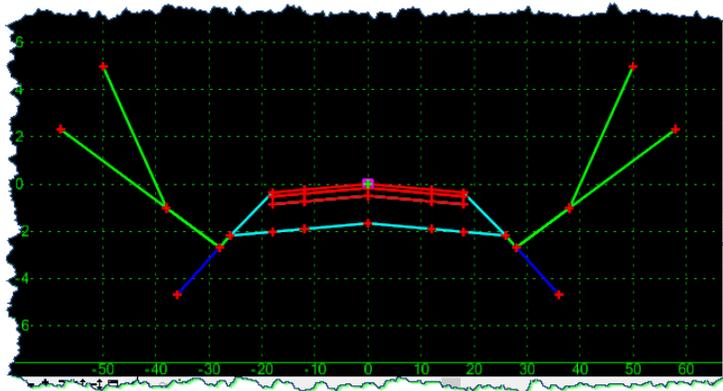
b. The initial roadway template with the addition of a new shoulder component (`Guardrail Rock Shoulder` in the ODOT template library `Barrier` folder).
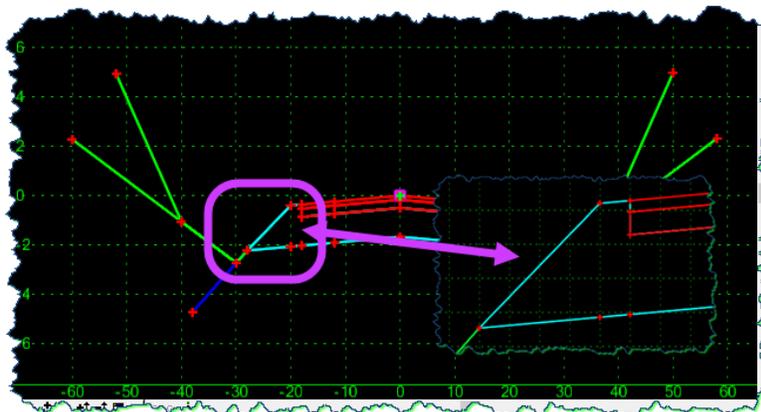
c. The initial roadway template with the addition of the guardrail component (`Guardrail` in the template library, `Roadbed Components > Multi-Layer Sections` folder).
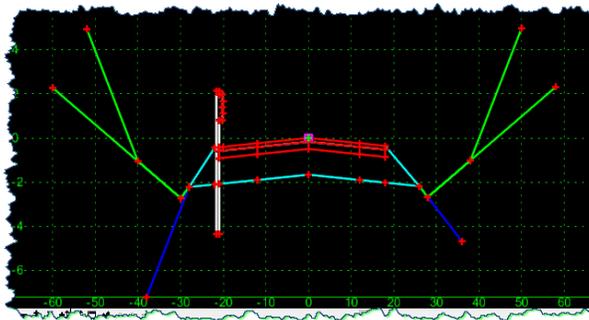
Each of these templates, once constructed, will be placed at strategically determined station locations, referenced from the start of the guardrail terminal.

These station locations will be discussed shortly.

Guardrail Component Integration

Adding the components to the templates defining the main body of the roadway modeling is nothing more than template manipulation. This type of template modification is always performed on roadway projects with variations in typical sections.

This will be discussed in more detail in the hands-on portion of this module, and a technique will be presented as an approach to adding these guardrail components on this sample project. The important part of adding these components is maintaining the constraint requirements built into the original component parts.

Parametric Constraints

The constraints that are parametrically controlled within the **ROADWAY DESIGNER** play a critical role in developing the widening associated with the introduction of a guardrail run. The component construction introduces these parametric labels. This is the focus in this section.

Five specific **Parametric Constraints** will be introduced in this modeling:

- **BlockWidth** – Assigned to and controlling template point **BlockTB**
- **PavedShldrWidth** – Assigned to and controlling template points **GrF** and **EP**
- **RockShldrWidth** – Assigned to and controlling template point **ERk**
- **RockSlopeWidth** – Assigned to and controlling template point **SGSh**
- **FillSlope** – Assigned to and controlling template points **SSF1to2** and **SSF1to4**

Two of these **Labels**, **EP** and the **SSF1to~**, are not unique to the guardrail components, but are never the less an integral part of controlling the template to produce the required roadway sections per **RD420**.
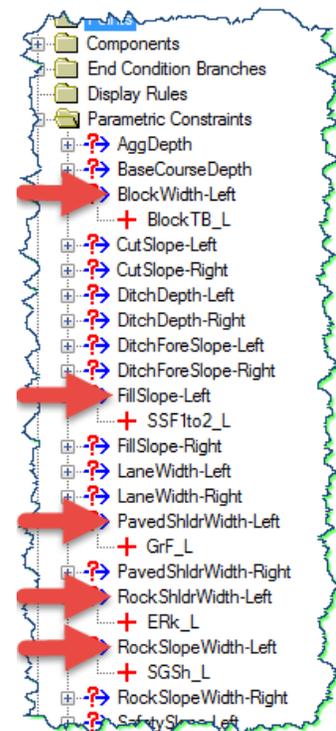
Later you will have an opportunity to review each of the components and completed templates, and take a closer look at where they are used.

Master Modeling Illustration

The next page contains an illustration that identifies and defines many of the items discussed earlier. This diagram will be invaluable when developing the guardrail modeling as it:

a. Schematically illustrates the modeling and the overall arrangement of the requirements

b. Shows where specific templates need to be placed

c. Defines the strategic station location using the start of the guardrail terminal as a reference

d. Catalogs the parametric **Labels** and their **Values** within the various station ranges

e. Provides a layer of explanation about the critical station locations

Study the next page and refer back to it as necessary throughout this module activity. This diagram is also available in PDF format, as well as a DGN, in the module folder.

STA 1668+00.00

Start of Rail + 100'

100' is somewhat arbitrary.
It needs to be a reasonable distance
for transitioning from recoverable slope.

"RockSlopeWidth" = 8' to 6'
"FillSlope" = 1:4 to 1:2
(or as conditions require)

STA 1667+75.00

SoR + 75'

End of recoverable area
described in HDM 4.6.11.2

STA 1667+37.50

SoR + 37.5' (or 50')
Terminal length

"RockShldrWidth" = 6' to 2'
"RockSlopeWidth" = 8'

STA 1667+20.00

SoR + 20'

SoR + 12.5'
"BlockWidth" = 0 to 8"

SoR + 6.25'
"BlockWidth" = 8"

The GR template will run
until the guardrail ends

Start GR Template
STA 1667+00.00

"PavedShldrWidth" = 10' to 8'
"RockShldrWidth" = 6'

STA 1666+99.99
End GRBerm Template

"PavedShldrWidth" = 6' to 10.27'
"RockShldrWidth" = 5.73'

"FillSlope" = 1:4 or flatter

Start of Rail (SoR)
At start of rail, switch to measuring to/from
the face of rail rather than the e.p. to
simplify measuring rock shoulder widths.

STA 1666+57.29

SoR - 42.71'

This is 10 x the change in
pavement width, typically 4.271':
E=2', W=2', rail thickness=0.271'
(Rail dimension from RD415)

This is 10 x the change in rock
shoulder offset, typically 10'
when E=2' and W=2'

"RockShldrWidth" = 0 to 5.73'

SoR - 100'
Start GRBerm Template
STA 1666+00.00

STA 1665+99.99
End 2Lane Template

Normal edge of shldr. paving

Edge paved shldr.
10:1 taper

Edge of widened embankment
10:1 taper

* These dimensions are based on:
normal shoulder width of 6'; rock slope of 1:4 nom.;
and surfacing depth of 21".
Adjust these to match project-specific dimensions.

Practical Application – Hands On Lab Exercises

UNDERSTANDING THE DETAILS

The next section will provide an opportunity to review the project data, focusing mainly on the components, templates and ROADWAY DESIGNER corridor configuration. The end goal for this section is that you fully understand how this sample project is set up, and why it is set up as it is. This 'review' activity is intended to reinforce the illustration on the previous page, which should be referenced frequently throughout this section.

Here are a few introductory notes:

- We will use the Standard Drawing **RD420**, Non-flared option. Other Standard Drawings that have some reference to this are **RD400**, **RD405**, and **RD415**. These additional drawings primarily show the posts and rail details, not the layout of the guardrail.
- It has been determined, through several iterations that the guardrail for this module begins at **Station 1667+00.00**.
- Based on the procedure described earlier, the end station for the guardrail was determined to be approximately **Station 1695+98.30**.

⚠️ **ALERT**: This exercise uses a two-way, two-lane highway as an example. Therefore, both ends of the guardrail run have terminals. On a one-way or multi-lane facility not exposed to opposing traffic, a trailing end piece is used instead. The template drop locations and parametric constraint values will need to be adjusted to model a trailing end piece.

Review any relevant project data

At this point, you should be in the **10GRAIL.dgn** file and have loaded the InRoads RWK data.

1) Select any graphics you may have displayed and delete them from the MicroStation file.

Start with a clean MicroStation file, free of graphics, for future display work that you may do.

Review Template Information

In this section, you will review at your own pace, the components and templates that were used in this module. The templates are specific to this sample project, whereas the components will be used for any future guardrail modeling that you may do.
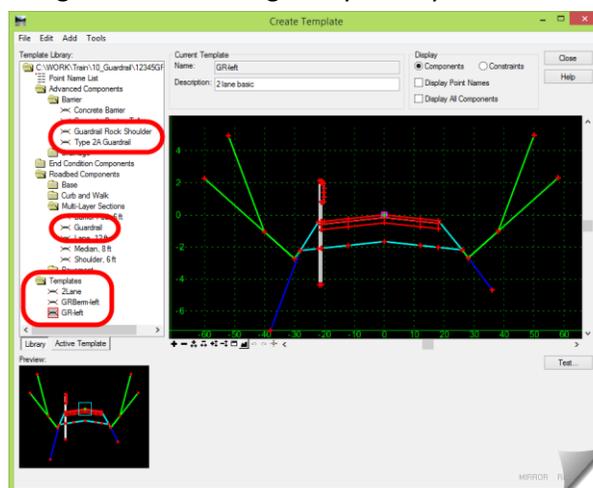
Component Review

As you explore these components and templates, pay particular attention to where the following constraint **Labels** are used and what the **Parent** template points are. In addition to that, take note of the default values of those points that have constraint **Label**s assigned to them. In the earlier illustration, when a **Label** is not being applied, the component retains its default **Value**.

- **BlockWidth**
- **PavedShldrWidth**
- **RockShldrWidth**
- **RockSlopeWidth**
- **FillSlope**

2) Open the TEMPLATE LIBRARY, browse to the **Barrier** folder under **Advanced Components**, and review the component **Guardrail Rock Shoulder**.

This component is used to create the benching that transitions from the normal roadway template to the guardrail template.

3) Notice the **GrF** template point indicating the guardrail usage.
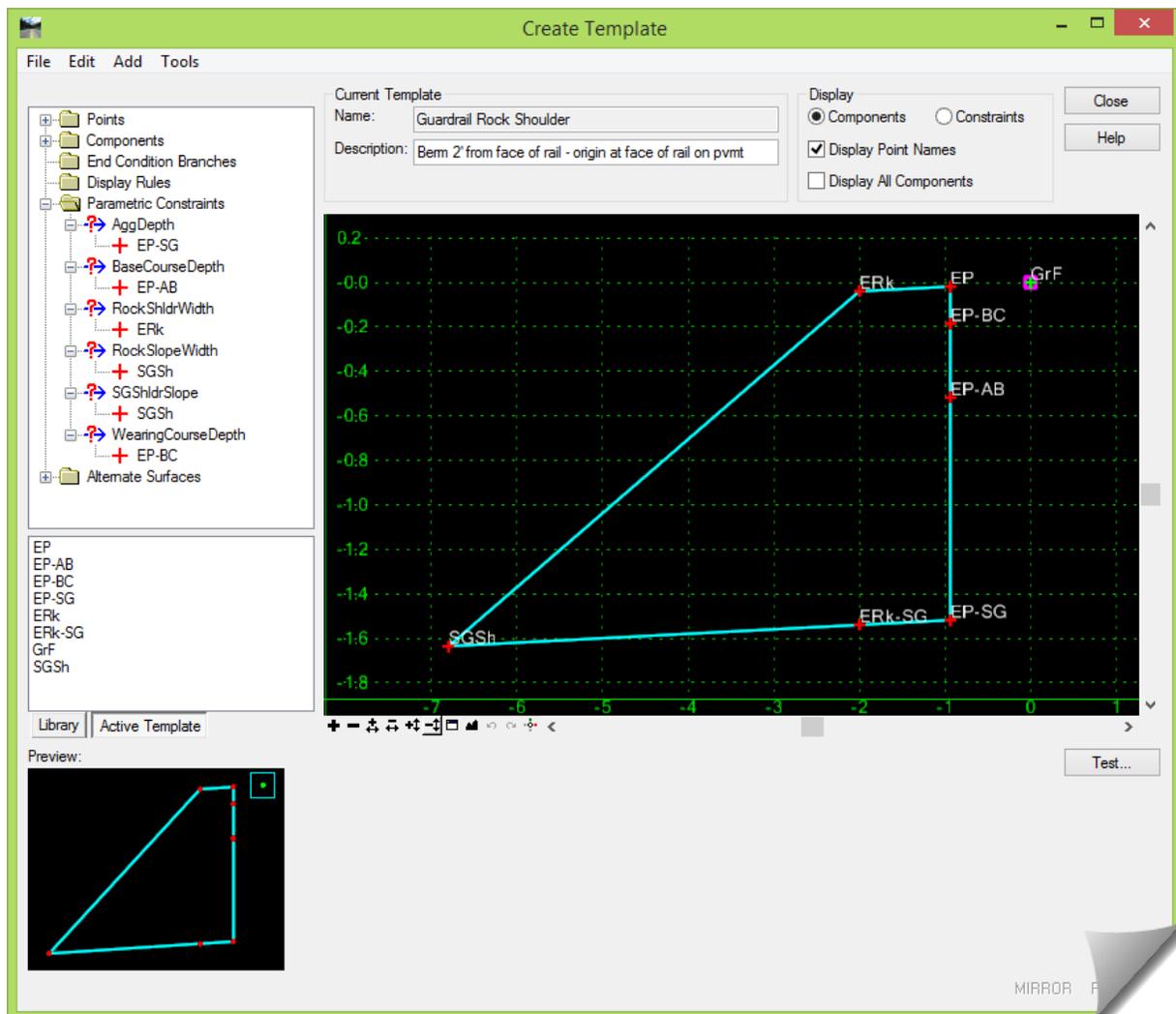
4) Now review the component details for `Type 2A Guardrail` in that same folder.
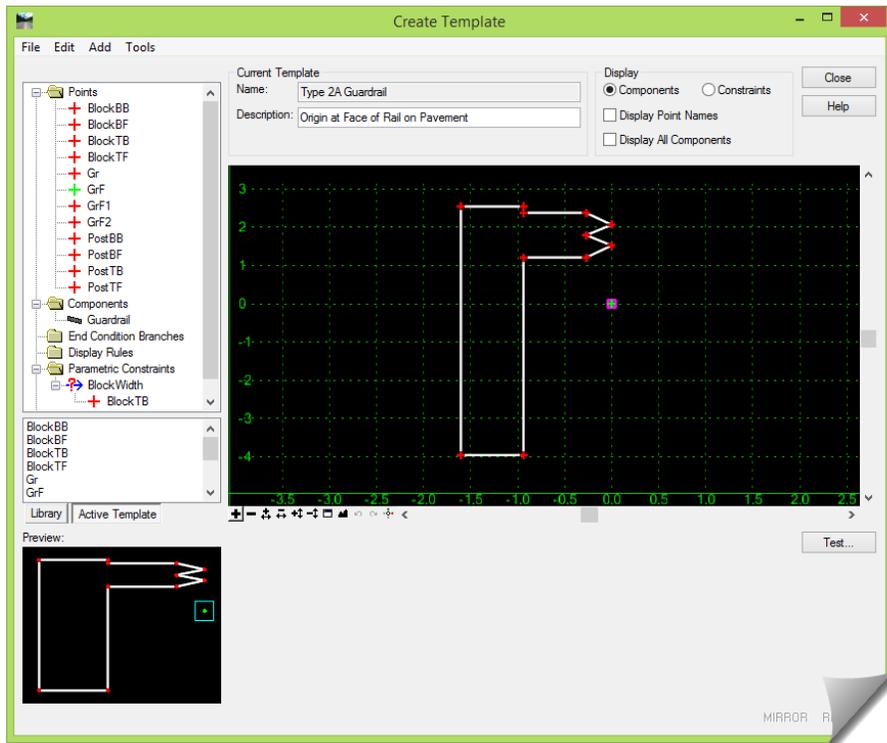
5) When you are complete with that review, browse to the **Multi-Layer Sections** folder under the **Roadbed Components** and review the `Guardrail` component.

This is an enhanced combination of the two previous components.
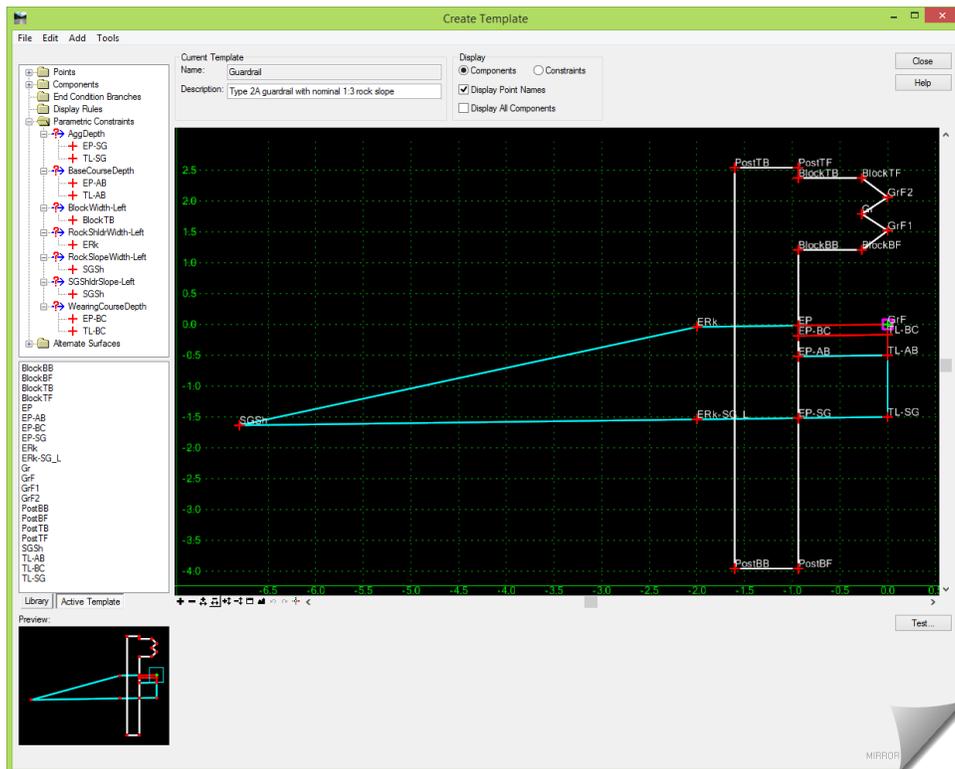
Template Review

Next will be the review of the templates used on this sample project that have the previously reviewed components already integrated into them.

1) Browse to the **Templates** and look at the basic roadway template used here, **2Lane**.
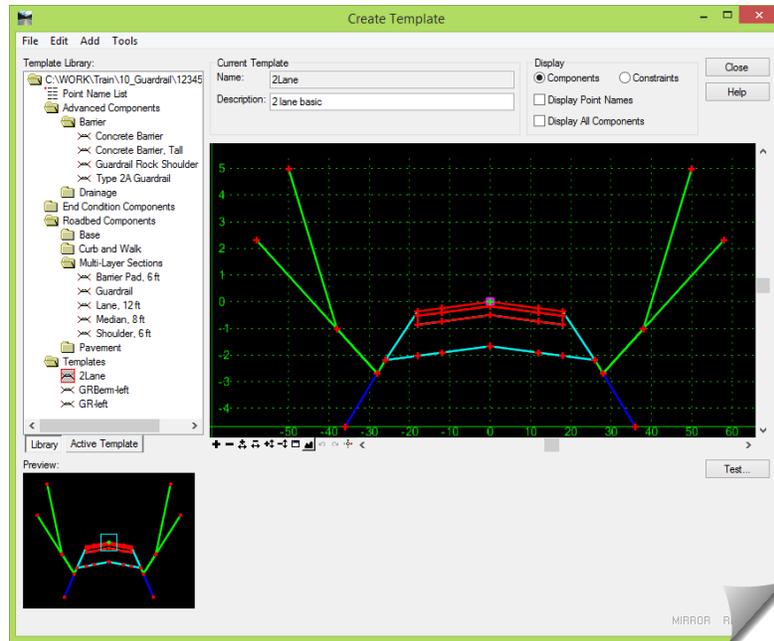
2) When you are complete with that, review the **GRBerm-left** template.

Remember to refer back to the earlier diagram to see what station these templates are placed.
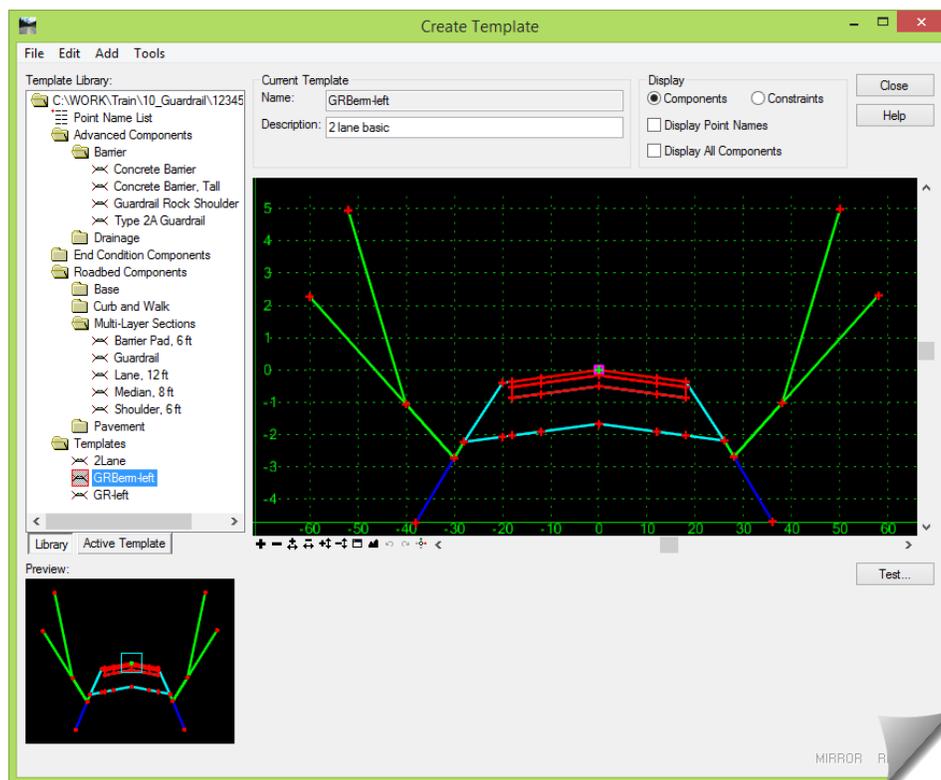
3) Take particular note of the constraint **Labels** on this template.
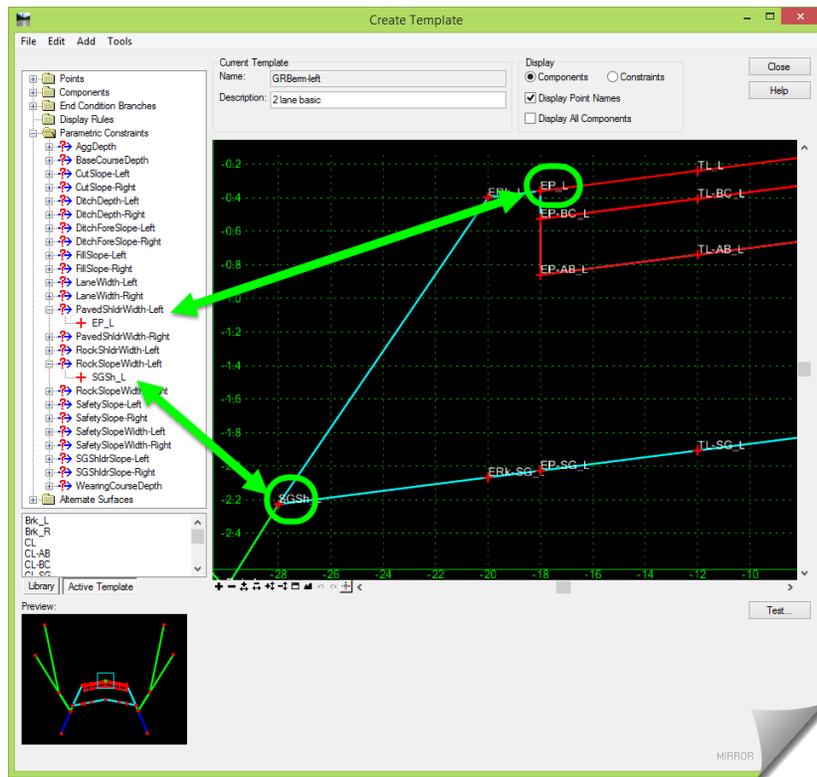
4) Finally, review the `GR-left` template.
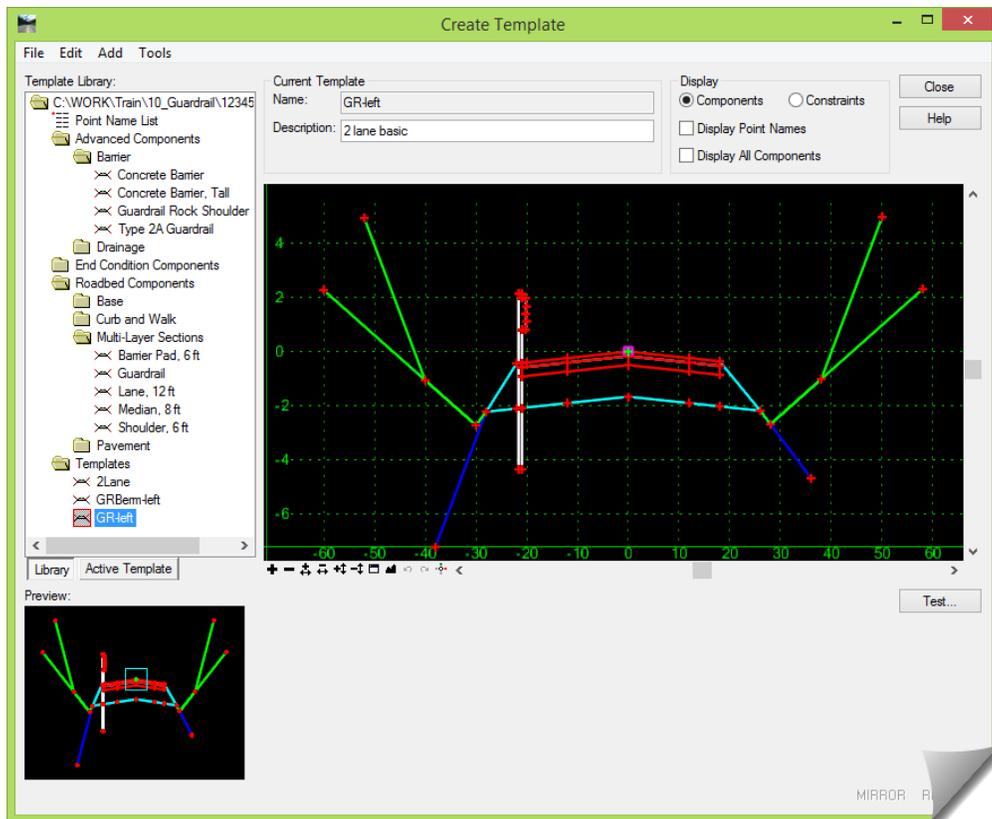
5) Similar to `GRBerm-left`, take particular note of the constraint **Labels** on `GR-left`.
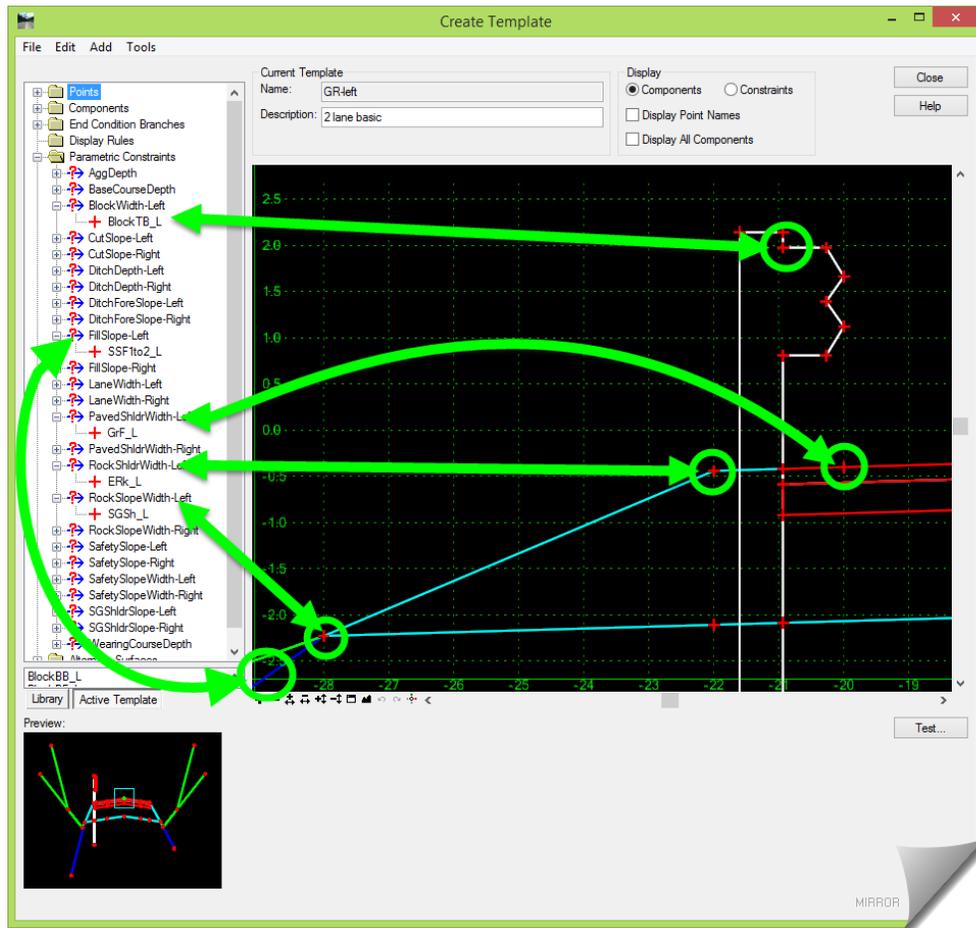
These three templates will be used in the Roadway Designer, which will be reviewed next.

6) [**Close**] the CREATE TEMPLATE tool when your review is complete.

Review Roadway Designer Corridor

Let's look at the TEMPLATE DROPS in the ROADWAY DESIGNER, as well as the PARAMETRIC CONSTRAINTS.

1) In the ROADWAY DESIGNER, look at the MANAGE CORRIDORS entry noting the modeling **Limits**.
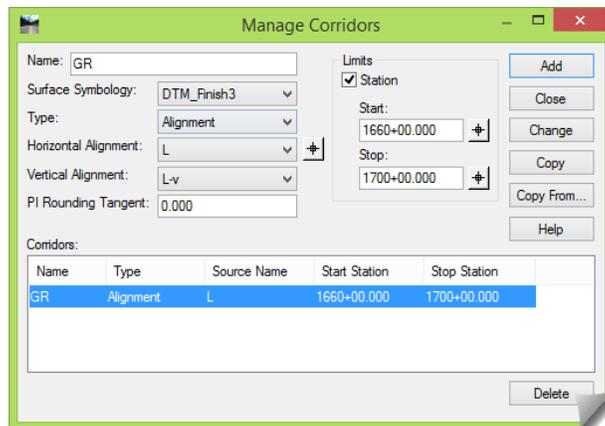
This **Corridor** is only modeling a portion of the project to illustrate the guardrail layout.

2) Review the **TEMPLATE DROPS**, study the entries, and compare them to the earlier illustration.

Do not move off this step until you fully understand the actual template drops at each station and can correlate them with the earlier diagram.
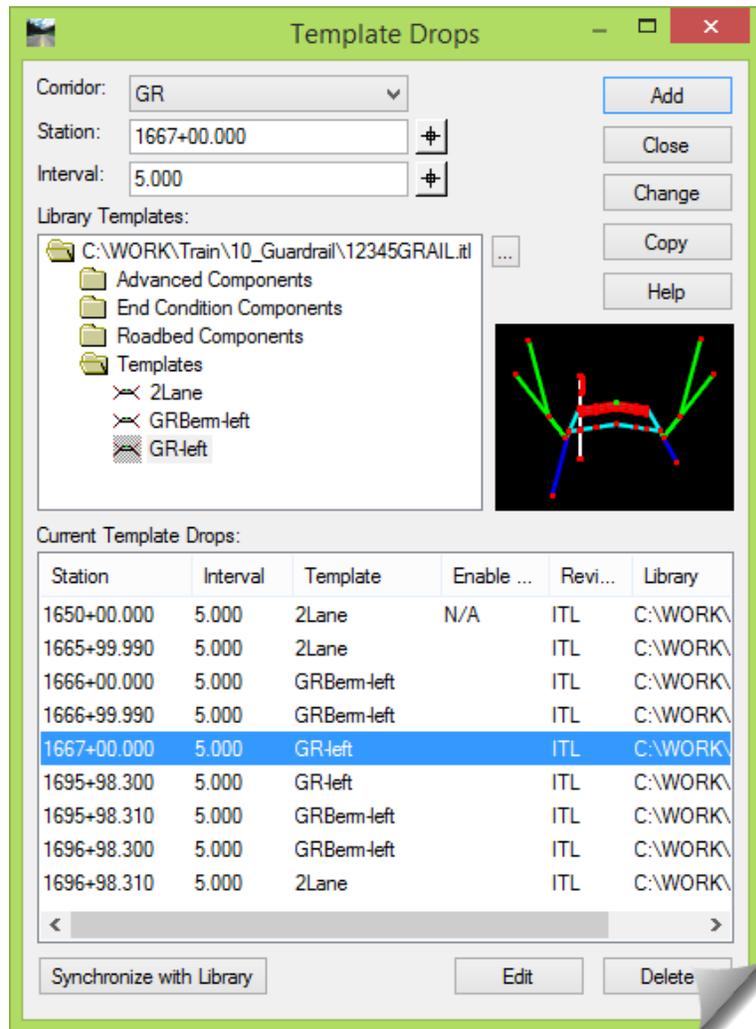

The template drops above show the guardrail being introduced as well as ending. The earlier illustration only shows the introduction of the guardrail. The reverse stationing development has to be applied at the end of the guardrail run as well, assuming it also uses a terminal. If not, then the values will need to be modified. Make sure that you challenge yourself to verify the settings in the **TEMPLATE DROPS** above with your station calculations for the end of the guardrail flare.

TIP: Templates can transition from one section to another when **Enabled** in the **TEMPLATE DROPS** dialog box. When transitions are not enabled, templates will still transition. However, the transition length becomes defined by the distance of the modeling **Interval**. A trick that has existed for a long time is to add a template drop within a tenth or hundredth of the earlier one. This forces the transition to occur more or less instantly and abruptly.

The last vital element in this workflow is the establishment of the **PARAMETRIC CONSTRAINTS** and the addition of the **Values** and **Start / Stop Station Limits**.

3) Go to the **PARAMETRIC CONSTRAINTS**, and note the five guardrail-related **Labels** and their corresponding information. Review this information by using the method described here:

   a. Choose one of the five key **Labels** listed here: (Note that **−Left** / **−Right** suffixes should be added to allow for guardrail control on each side of the roadway as needed.)

      ● **BlockWidth**
      ● **PavedShldrWidth**
      ● **RockShldrWidth**
      ● **RockSlopeWidth**
      ● **FillSlope**

   b. Find that Label on the earlier modeling layout illustration.

   c. Using the illustration, work out the **Start / Stop Station** range and **Start / Stop Values**.

   d. Verify that it exists like that in the **PARAMETRIC CONSTRAINTS** dialog box.

   e. Systematically check and verify that all the entries that *should* be there are *indeed* there.

   f. Now, in reverse, look at the **PARAMETRIC CONSTRAINT** entries for the end of the rail.

   g. Verify how those entries would fit into the earlier illustration and confirm their accuracy.

Parametric Constraints dialog box.

Corridor: GR
Constraint Label: RockShldrWidth-Left
Start Value: -0.000
Stop Value: -5.729
Station Limits — Start: 1666+00.000 — Stop: 1666+57.290

Override Values:

Enabled	Name	Start Value	Stop Value	Start Station	Stop Station
X	RockShldrWidth-Left	-0.000	-5.729	1666+00.000	1666+57.290
X	RockShldrWidth-Left	-5.729	-5.729	1666+57.290	1666+99.990
X	PavedShldrWidth-Left	-6.000	-10.271	1666+57.290	1666+99.990
X	RockShldrWidth-Left	-6.000	-6.000	1667+00.000	1667+20.000
X	RockSlopeWidth-Left	-8.000	-8.000	1667+00.000	1667+75.000
X	BlockWidth-Left	-0.000	0.000	1667+00.000	1667+06.250
X	PavedShldrWidth-Left	-10.000	-8.000	1667+00.000	1667+37.500
X	FillSlope-Left	0.250	0.250	1667+00.000	1667+75.000
X	BlockWidth-Left	-0.000	-0.667	1667+06.250	1667+12.500
X	RockShldrWidth-Left	-6.000	-2.000	1667+20.000	1667+37.500
X	RockSlopeWidth-Left	-8.000	-6.000	1667+75.000	1668+00.000
X	FillSlope-Left	0.250	0.500	1667+75.000	1668+00.000
X	FillSlope-Left	0.500	0.500	1668+00.000	1694+98.300
X	FillSlope-Left	0.500	0.250	1694+98.300	1695+23.300
X	RockSlopeWidth-Left	-6.000	-8.000	1694+98.300	1695+23.300
X	RockSlopeWidth-Left	-8.000	-8.000	1695+23.300	1695+98.300
X	FillSlope-Left	0.250	0.250	1695+23.310	1695+98.300
X	RockShldrWidth-Left	-2.000	-6.000	1695+60.800	1695+78.300
X	PavedShldrWidth-Left	-8.000	-10.000	1695+60.800	1695+98.300
X	RockShldrWidth-Left	-6.000	-6.000	1695+78.300	1695+98.300
X	BlockWidth-Left	-0.667	0.000	1695+85.800	1695+92.050
X	BlockWidth-Left	-0.000	0.000	1695+92.050	1695+98.300
X	PavedShldrWidth-Left	-10.271	-6.000	1695+98.310	1696+41.010
X	RockShldrWidth-Left	-5.729	-5.729	1695+98.310	1696+41.010
X	RockShldrWidth-Left	-5.729	0.000	1696+41.010	1696+98.300

Buttons: Add, Close, Change, Help, Export..., Import..., Delete

> 💡 **TIP**: The PARAMETRIC CONSTRAINTS dialog has an **Export…** and **Import…** button in the lower left. This provides the ability to create a file, like `GuardRail_Parametrics.txt` in the module folder. This file can be edited and then re-imported to develop the **Override Values**.

4) Now review the Plan, Profile and Cross Sectional views of the ROADWAY DESIGNER and verify that everything is modeling as expected.
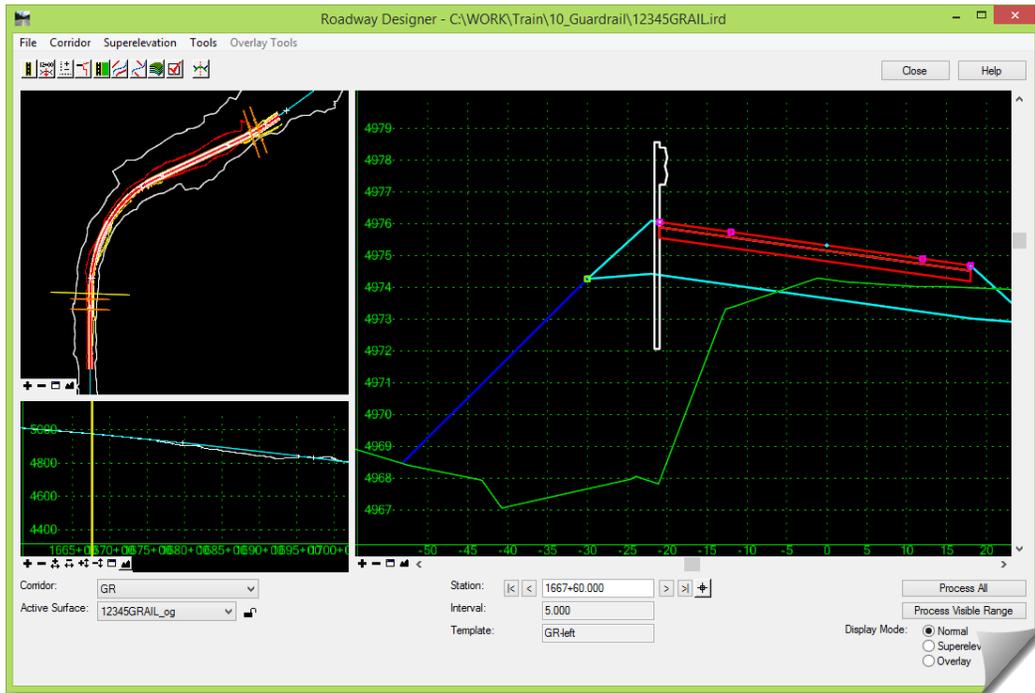
5) Feel free to create a surface and view the results in Plan or Cross Section.
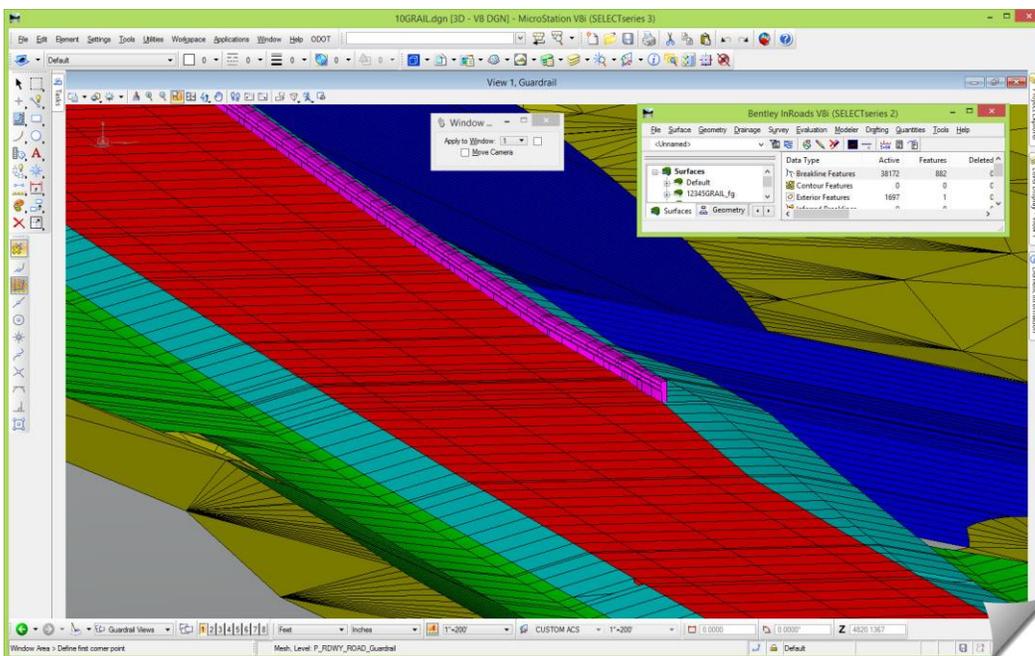
GUARDRAIL MODELING - TEMPLATE CONSTRUCTION

From the earlier material in this module, you should now know:

- Exactly where to place additional template drops along the design corridor in order to integrate the guardrail and its associated modeling into your design
- What specific **Labels** correspond to the additional parametric constraints for the guardrail and associated components
- What the **Start** and **Stop Values** are for each of the guardrail modeling constraint **Labels**
- What **Start** and **Stop Stations** are needed to control the guardrail modeling constraints
- That not all constraints require newly added **Values** in the **ROADWAY DESIGNER**, since at certain locations the *default* template **Value** is the value that should be applied

Adding Guardrail Components

The last topic to be covered in this portion of the module was earlier called "**Guardrail Component Integration**". This was described as adding the necessary berm and guardrail components to the main roadway templates themselves so that the modeling toward, during, and after the guardrail can take place.

This section will start with the **2Lane** template and show an example of adding the components needed to complete the guardrail modeling. This is only a suggested workflow, and you may have other methods to accomplish the same result.
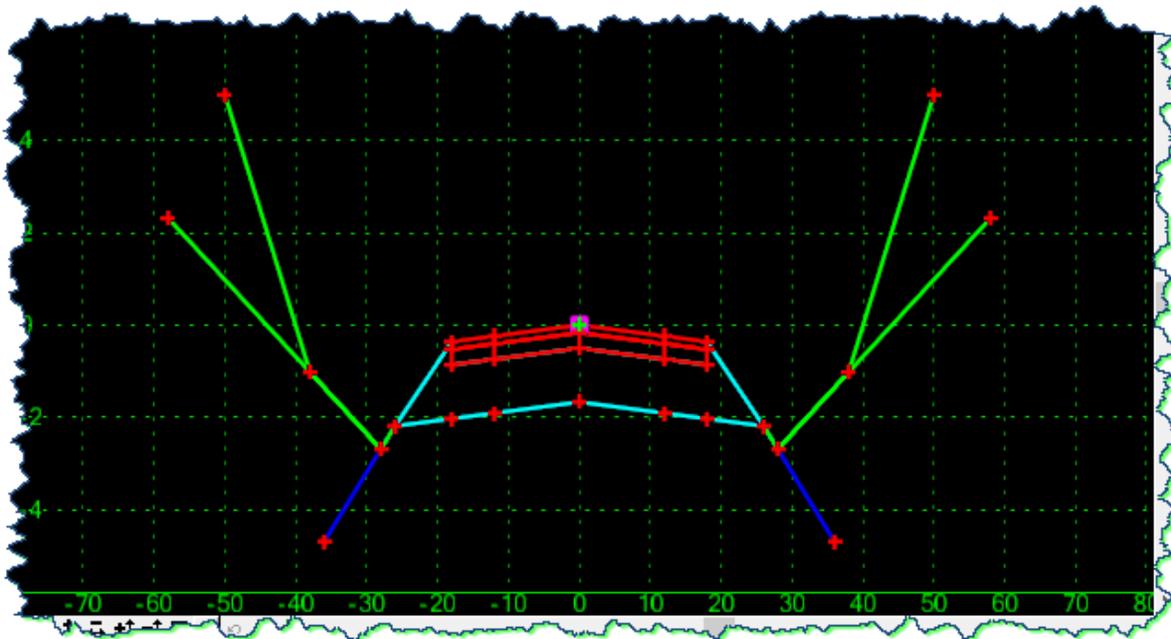
This section will not cover adding these sections to the **ROADWAY DESIGNER** as **TEMPLATE DROPS** since that has already been reviewed, and should be understood by anyone working through this module. This work will retain its focus on the **CREATE TEMPLATE** tool and only cover template modification and construction.

Note that this module is not concerning itself with any **_L** or **_R**, or **–left** or **–right** designators, and is presenting this material in *generic* terms. It is expected that you will follow the ODOT naming conventions for any work that you create whether it's template points, components, component names or templates.

The goal will be to produce the following templates:

- **GRBerm** – a template that has all of the characteristics of the **2Lane** 'base' template, but also contains the **Guardrail Rock Shoulder** component found in the **Barrier** subfolder under the **Advanced Components** folder.
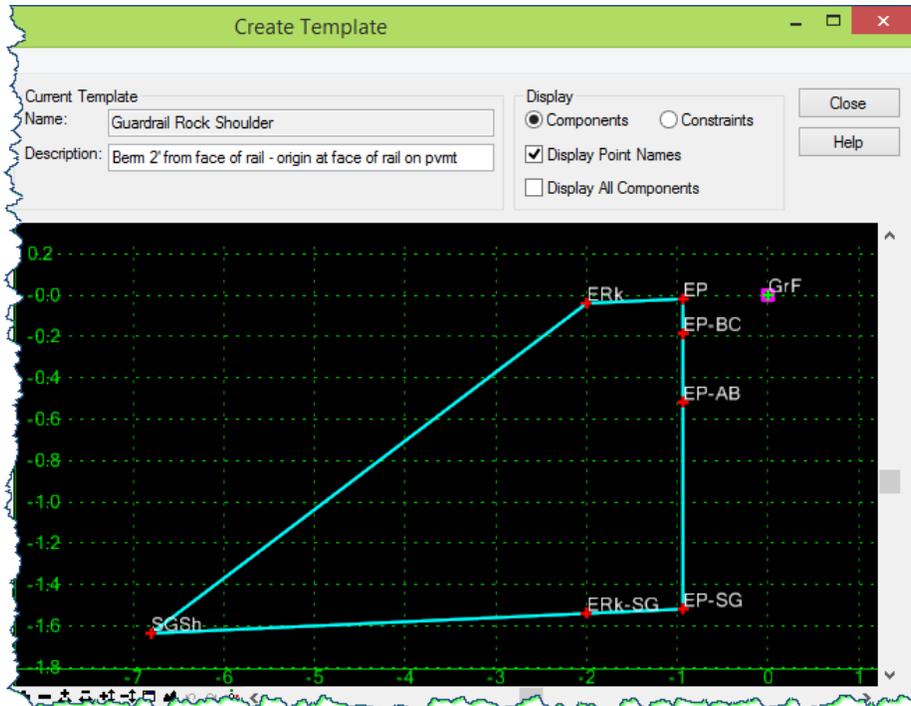
- **GR** – a template that has all of the characteristics of the **2Lane** 'base' template, but also contains the **Guardrail** component found in the **Multi-Layer Sections** subfolder under the **Roadway Components** folder.
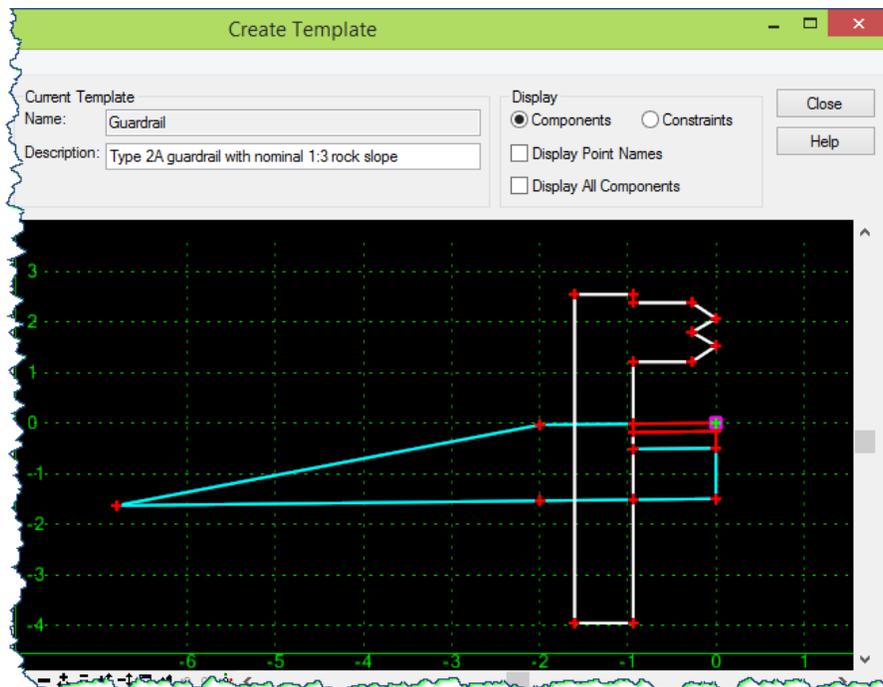
6) Open the TEMPLATE LIBRARY and browse to the **Templates** folder.
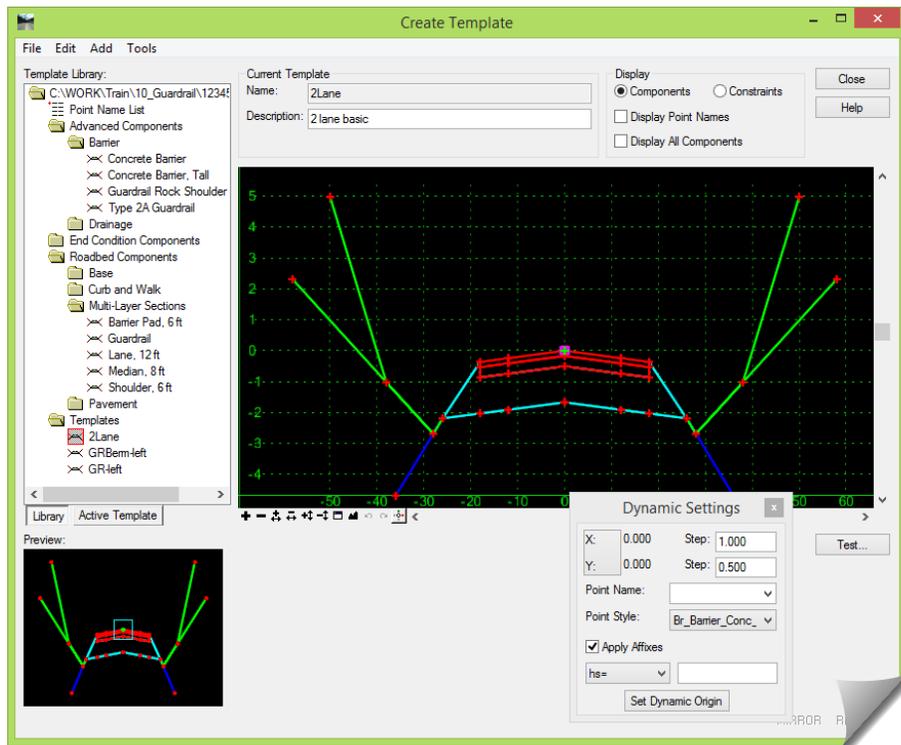
We will create two new templates in this folder, and to avoid a naming conflict, they will be using generic names just for this module. The other completed templates can be used for reference.

7) [**Copy**] the `2Lane` template in the same folder and call it `GRBerm` and make it active.
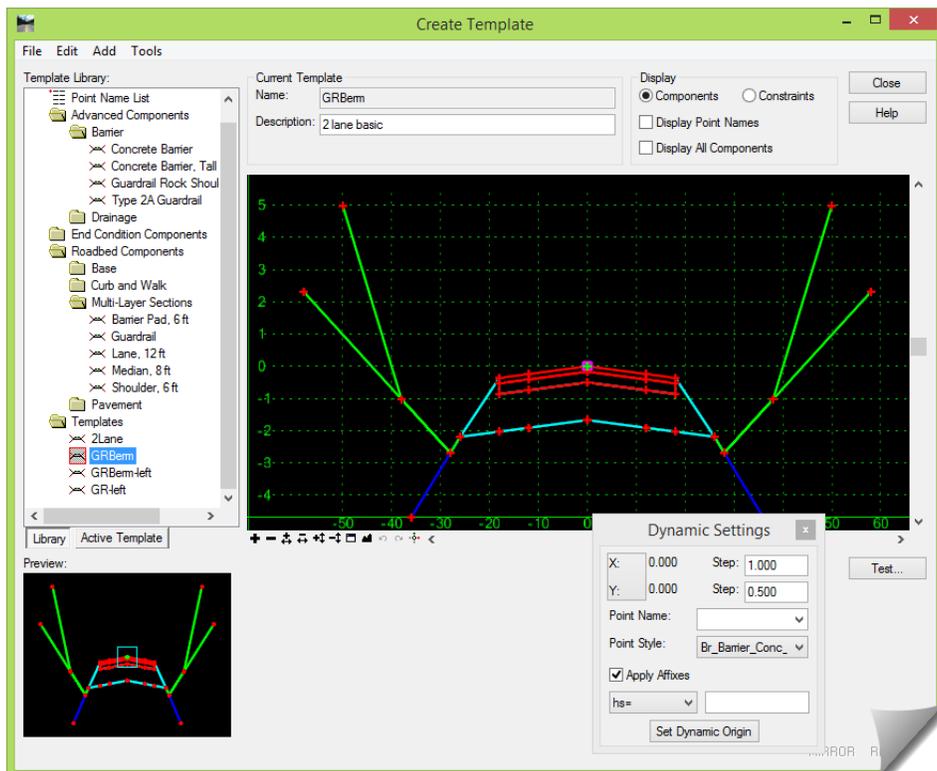
8) Reviewing both the **2Lane** template and the **Guardrail Rock Shoulder**, there are only two additional points.
    - **ERk** – the edge of rock on the surface next to the **EP**
    - **ERk_SG** – the edge of rock at the subgrade next to the **EP-SG**

Additionally, with the introduction of those two points:
    - **SGSh** is now constrained to the **ERk** instead of the **EP**
    - **ERk** and **ERk-SG** have added constraint ties
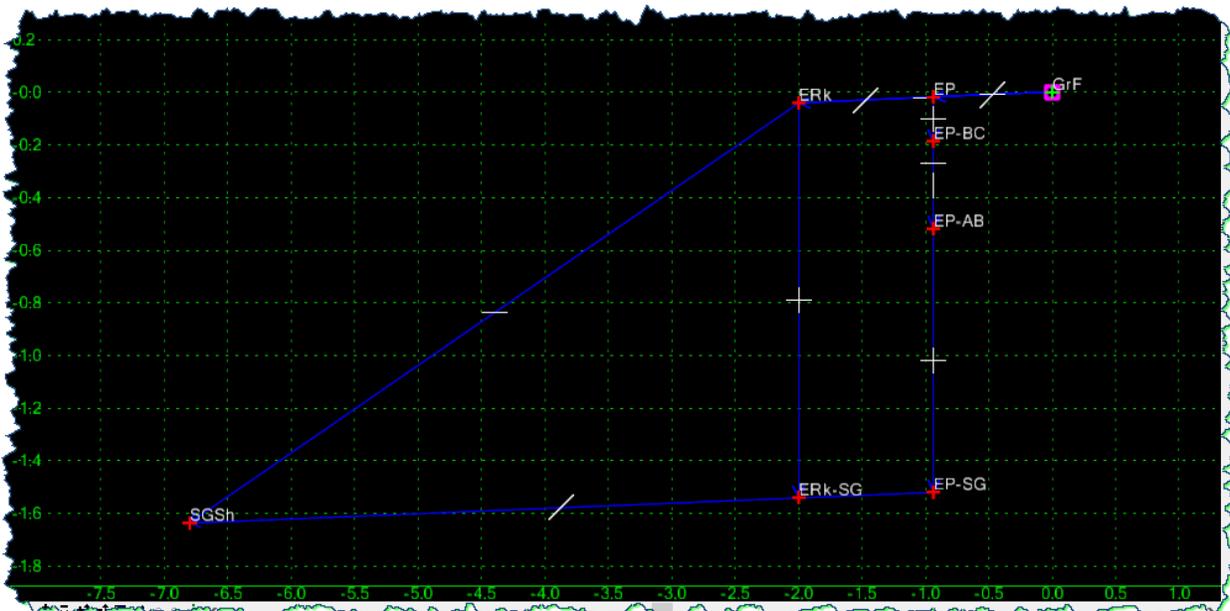
Feel free to either follow along with the steps below, or take your own personal approach to the construction of this first template. Whichever way you approach this first template modification, use the **GRBerm-left** to check your results against.

Adding the Rock Shoulder:

The first thing that will be done is to adjust the depth of the **Guardrail Rock Shoulder** component because the location of the **EP-SG** is at a different depth than the template section used in this sample project.
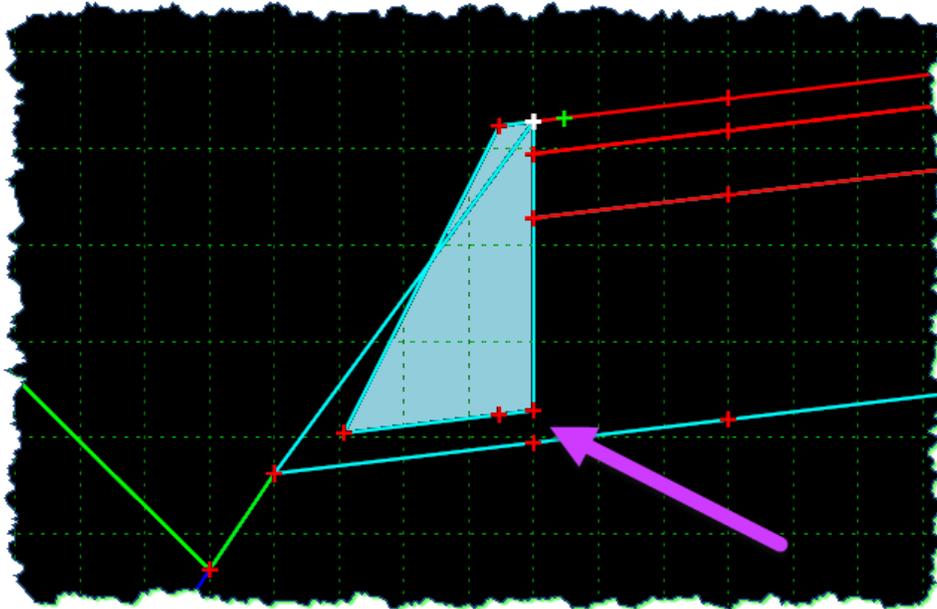
Reviewing the **2Lane** roadway template, the **EP-SG** has its **Vertical** location calculated by a formula, with the default point location equal to **-1.1667** from **EP-AB**.

This change will be made in the **Guardrail Rock Shoulder** component before adding it to the new template. This can be done later, or using other techniques. This workflow will do it to the component before it's used.
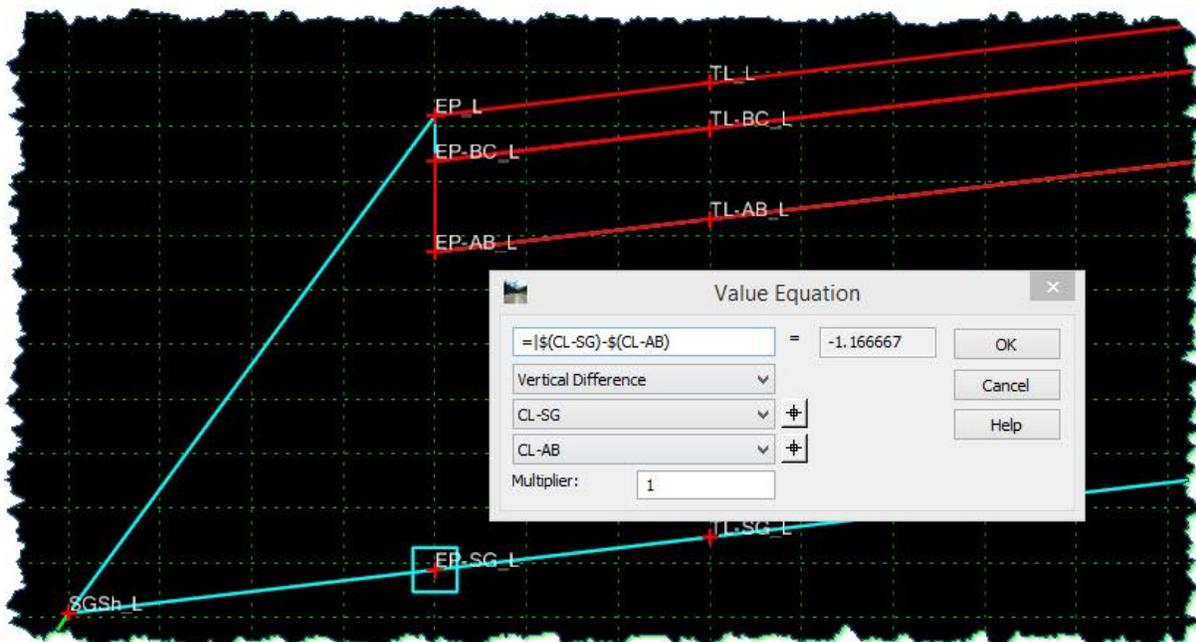
1) [**Copy**] the `Guardrail Rock Shoulder` to `GRS M10`, for Module 10.

2) Edit the template point `EP-SG` and change the **Vertical** constraint **Value** to **−1.166667**
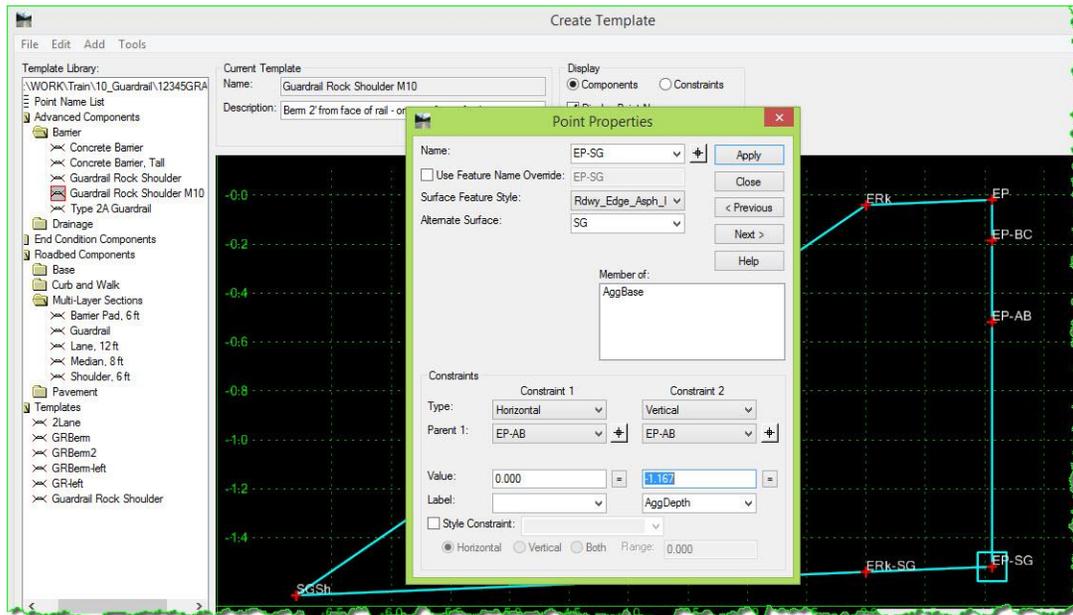
> **TIP**: All numeric fields in an InRoads dialog box has mathematical functionality built into it for adding, subtracting, dividing and even unit conversions. In the instance above, instead of entering a decimal number with an undefined amount of digits, the math can be entered like this: **−1' −2"** and then select <**TAB**> on the keyboard to perform the calculation.

3) Make sure you have the **ODOT Preference** loaded under *Tools > Options* so the affixes are applied properly.

4) Drag and drop the modified `GRS_M10` component onto the new `GRBerm` template. From the preview window grab the `EP` as the drag out / drop point.
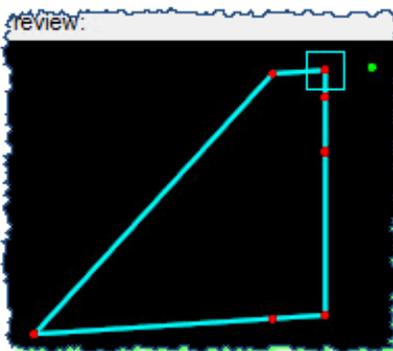
> **TIP**: Components are typically 'grabbed' from their construction origin point, but this is not a requirement when placing a component onto a template. Although not very common, any point can be selected to position the component, and sometimes it provides improved placement control to select a different point.

5) Drop it onto the **EP_L** point of the **GRBerm** template.
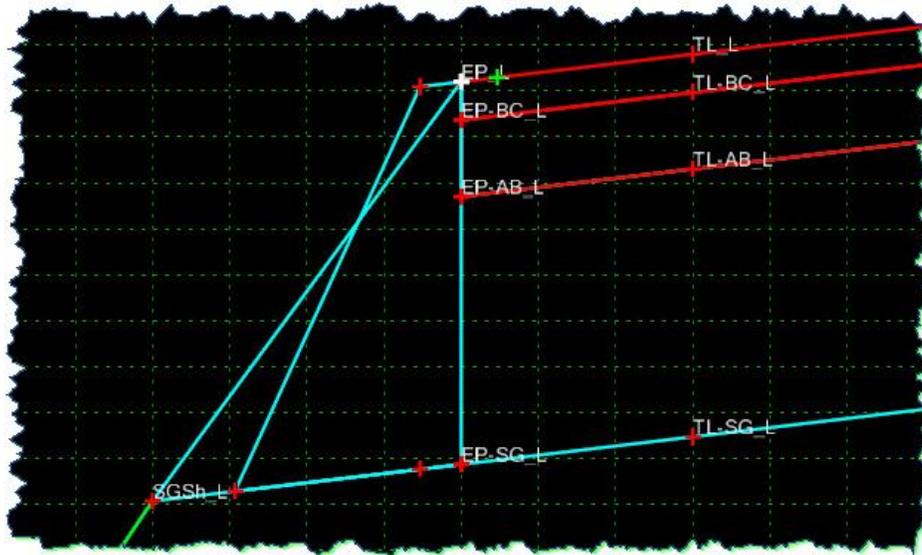
At this point, and you can easily verify this, there are two **AggBase** components in this template. The objective here is to be able to use the points that exist in the original template where needed and eventually be able to merge this new rock shoulder component with the current **AggBase** component.

6) Move the **GrF** point onto the **EP** point

In this template, the guardrail face does not exist so it will be merged with the edge of pavement.
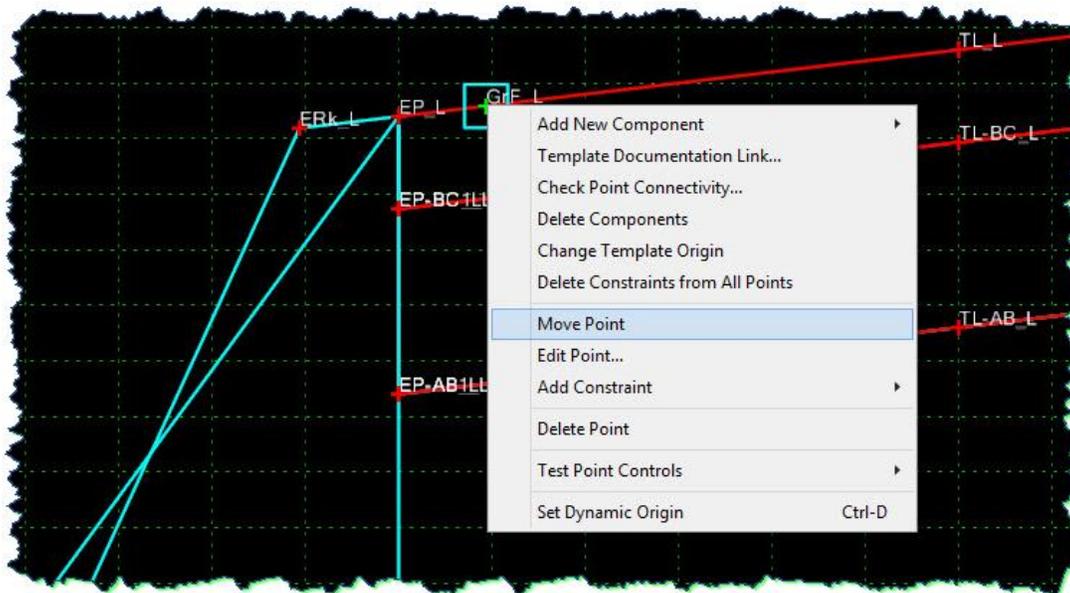
7) After that is done, **Merge** those two points, deleting the **GrF** point.
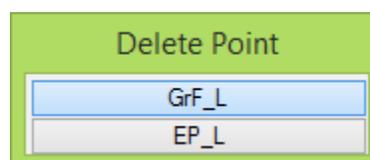
The result should be a clean **EP** point.
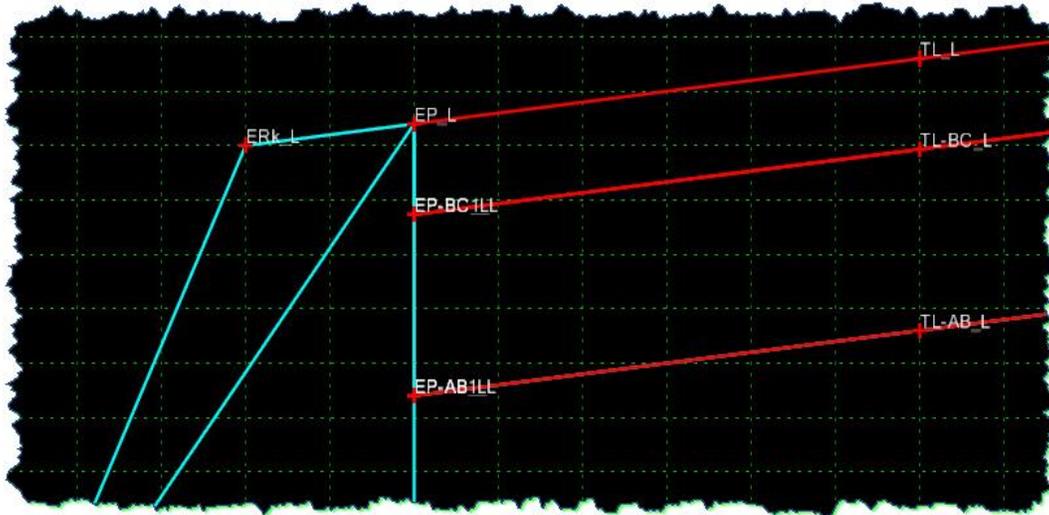
8) Now **Merge** the two points below the **EP**, retaining the point that was there, and deleting the new point.

Make sure you are merging the points, not deleting them. If you just go straight to deleting them, you will lose the shape integrity of that rock shoulder component. The graphics below are not showing the right-click and **Merge** selection, only the secondary step asking which component point should be removed.
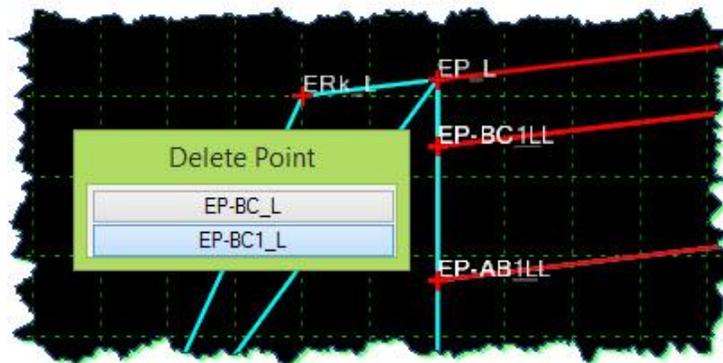
9) Then the two points below that point.
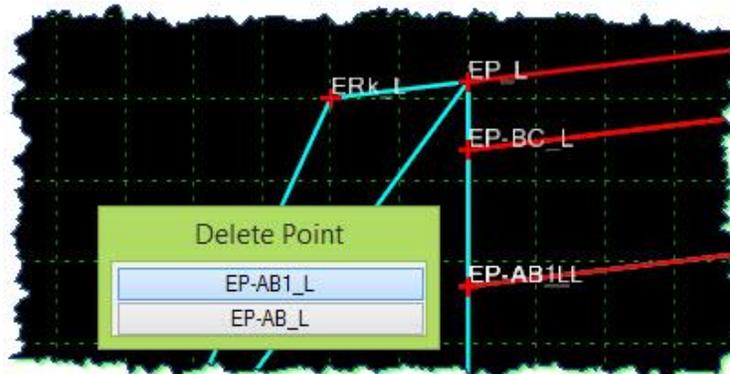
10) Then **Merge** the bottom point in that `EP` column.
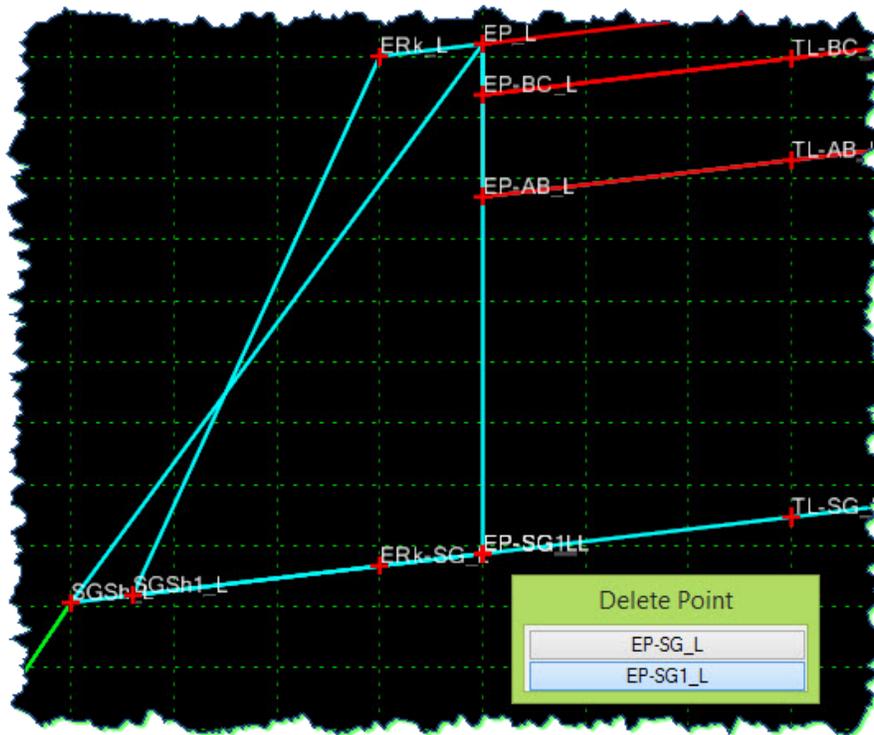
11) Reviewing the components for a continuing clarification of where you are at shows the two `AggBase` components – the one that was there in the original template and the one added by the drag & drop of the rock shoulder component.
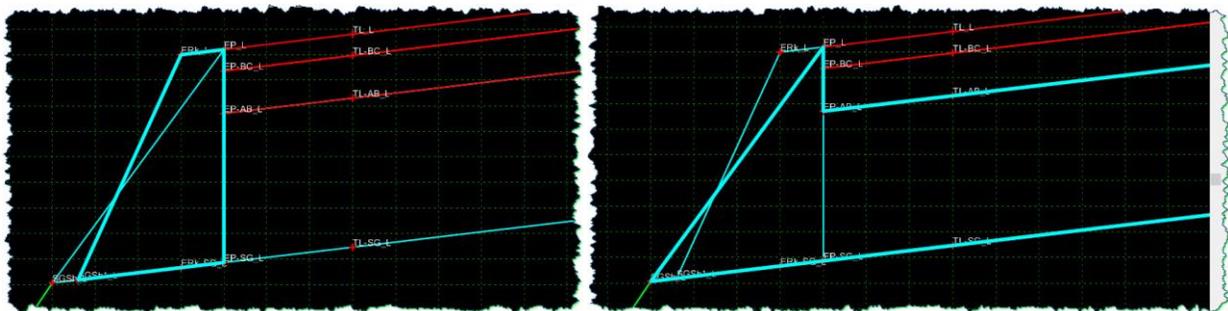
We're going to remove some of the points and modify both components so they can be merged.

TIP: When templates are constructed from individual component 'parts', common materials are very often merged into a single component for visual and quantity reasons. Merging components requires that those components have a common edge with common points along that edge in order for the merging process to be performed.

12) Delete the **EP** point from the **AggBase** component.
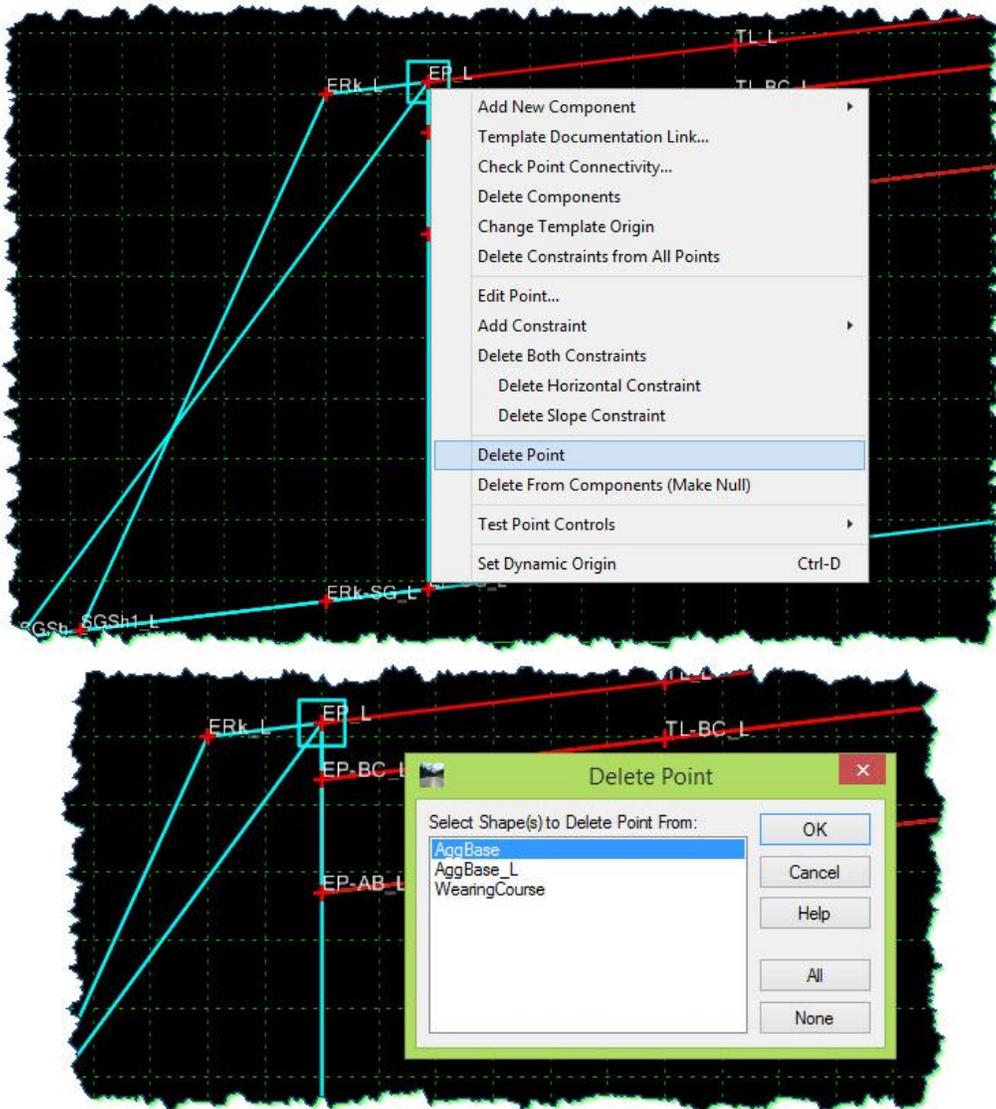
13) **Delete** the **EP-BC** and **SGSh** points from the **AggBase** component as well.
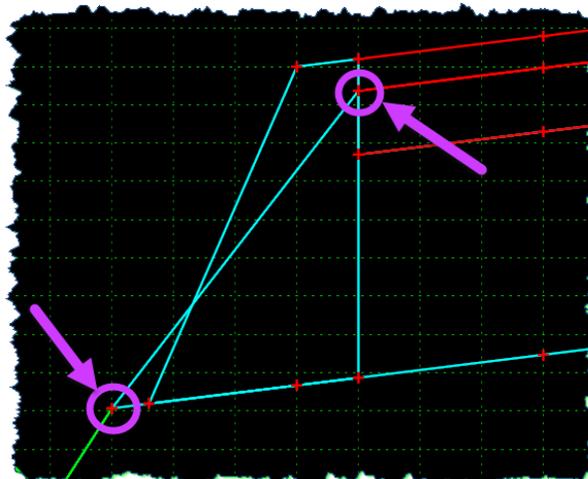
Now there are two distinct **AggBase** components that have these shapes:
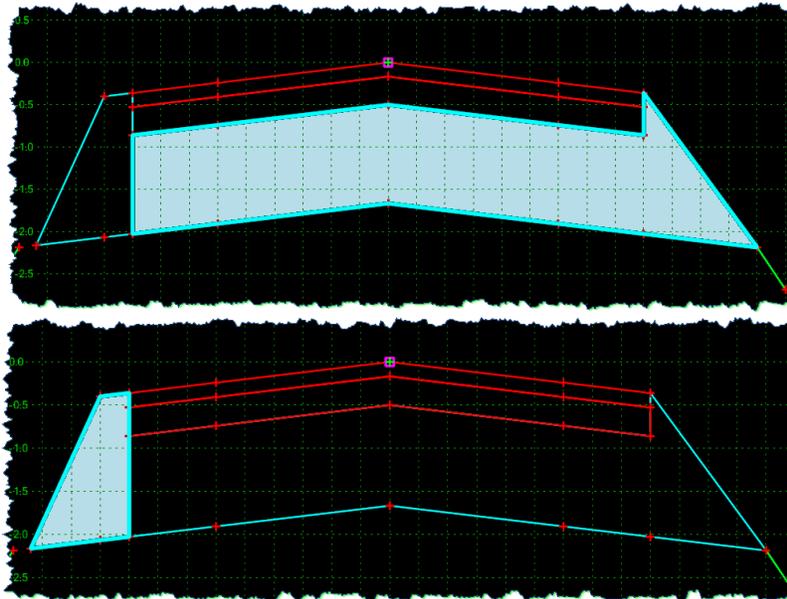

14) **Merge** the two **AggBase** components into one.
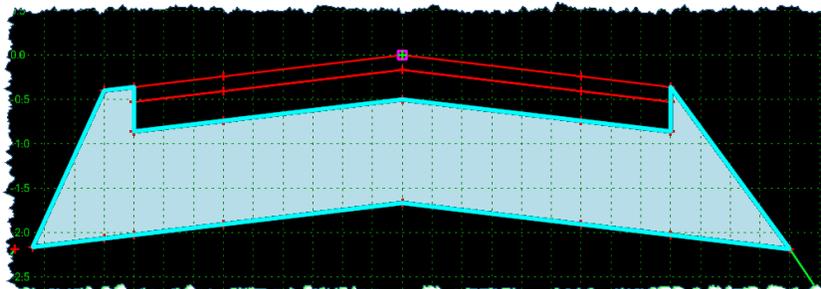
Now that the backbone of the template is formed, some additional checking and clean-up will be done, as well as addressing the hanging EC component.

15) Reviewing the SGSh point on the **AggBase** shows that it is currently **-4.8** horizontally from the rock shoulder edge. From the guardrail-modeling layout, the *default* value is **-8**.
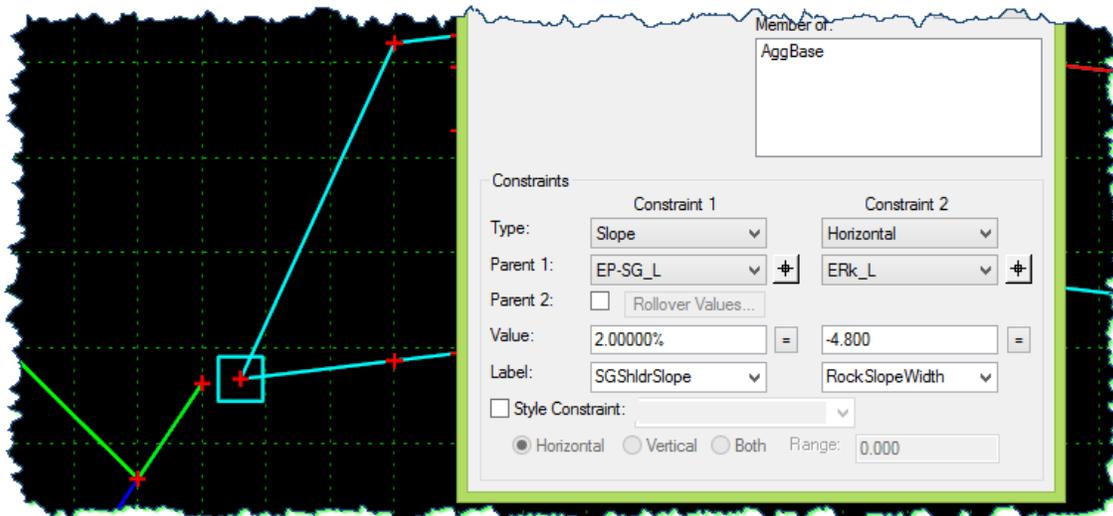
16) Change the **Value** of that **Horizontal Constraint** to **–8.00**.

17) Now the `SGSh` that was originally there and left hanging is -8.00, but from the `EP`.
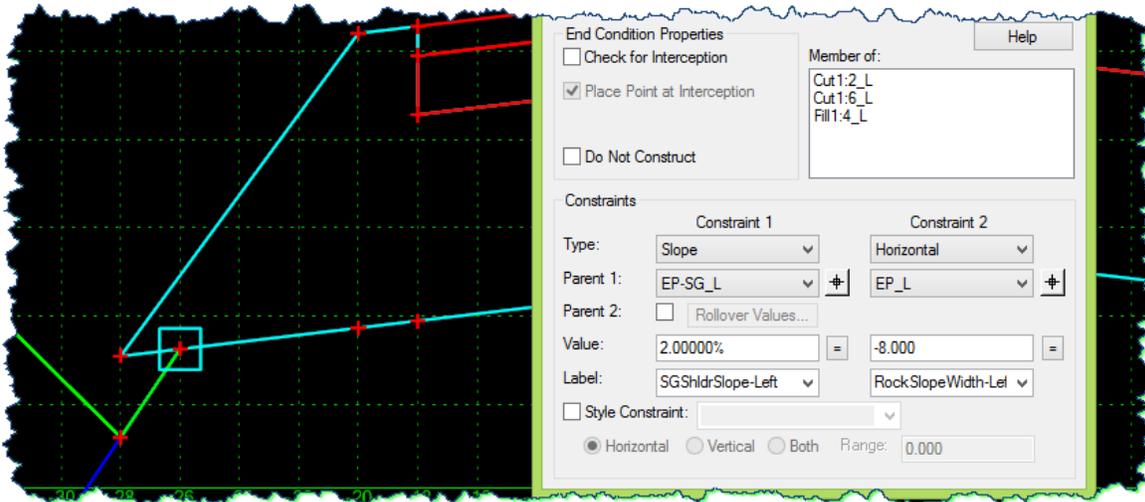

18) Change the **Parent** point of the original `SGSh` Horizontal Constraint (the parent of the end condition components) to the edge of rock, and set the **Value** to **–8.00**.

   Doing this should cause these points to coincide.
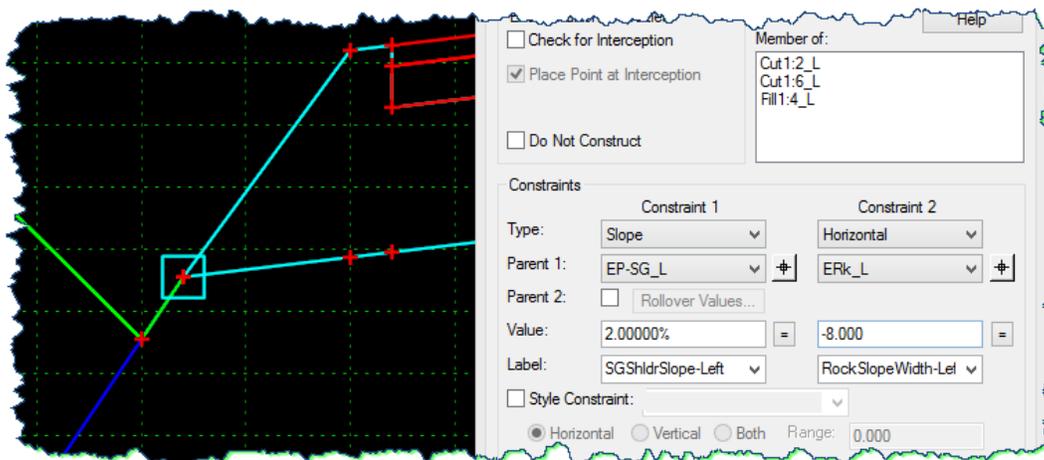
19) Merge the two `SGSh` points and select `SGSh1` for deletion.
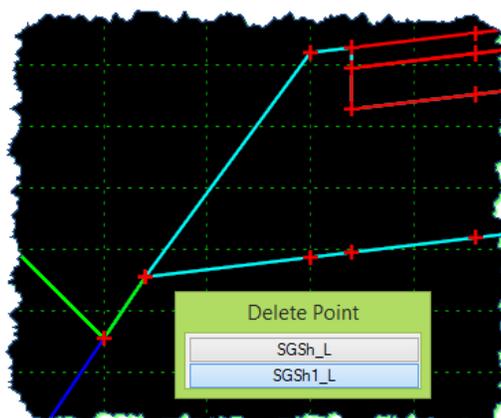
20) One last item on the **SGSh** point is to tie the **Slope** constraint to the edge of rock subgrade, **ERk-SG**, instead of the **EP-SG** that it is currently using as a **Parent**.
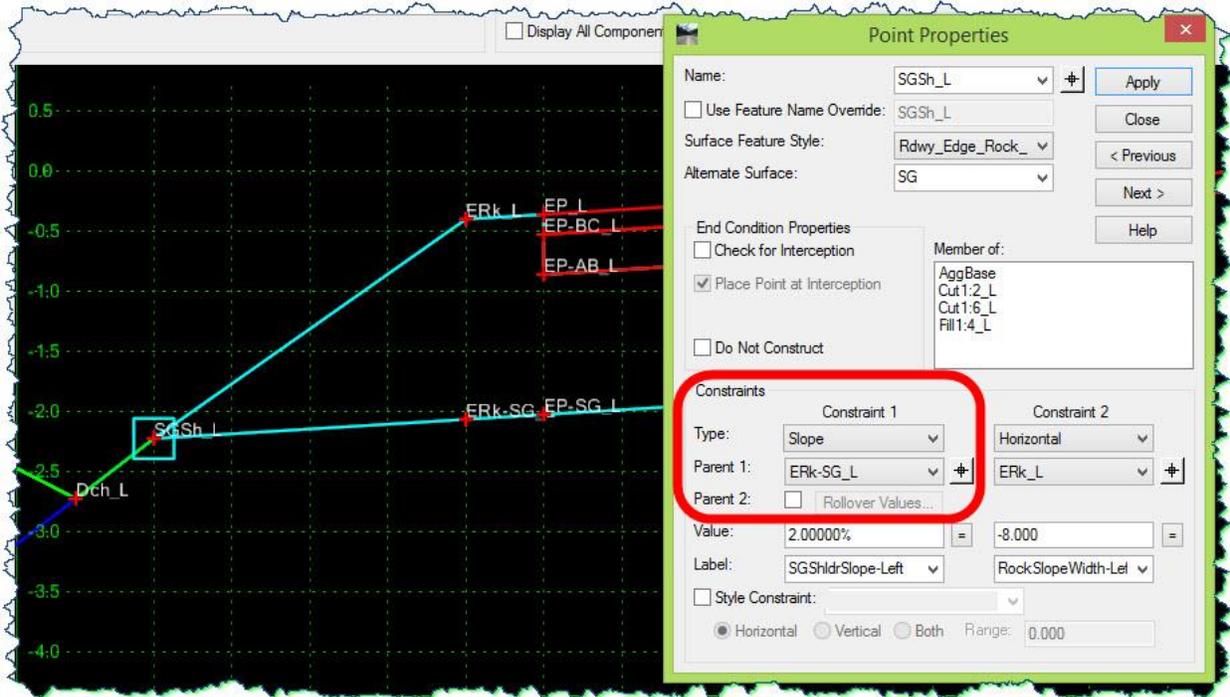

21) A few other items to check:
   a. Make sure the **Rollover** is toggled *on* and set up for the edge of rock, **ERk** point. (But only if it's applicable.)
   b. When complete, verify that the constraint **Labels** have the correct **–Left** and **–Right** suffix designators on them, or else assigning the **PARAMETRIC CONSTRAINTS** on them in the **ROADWAY DESIGNER** will be difficult. These can be easily reviewed in the **Active Template** details tab.

22) That should do it for this template.
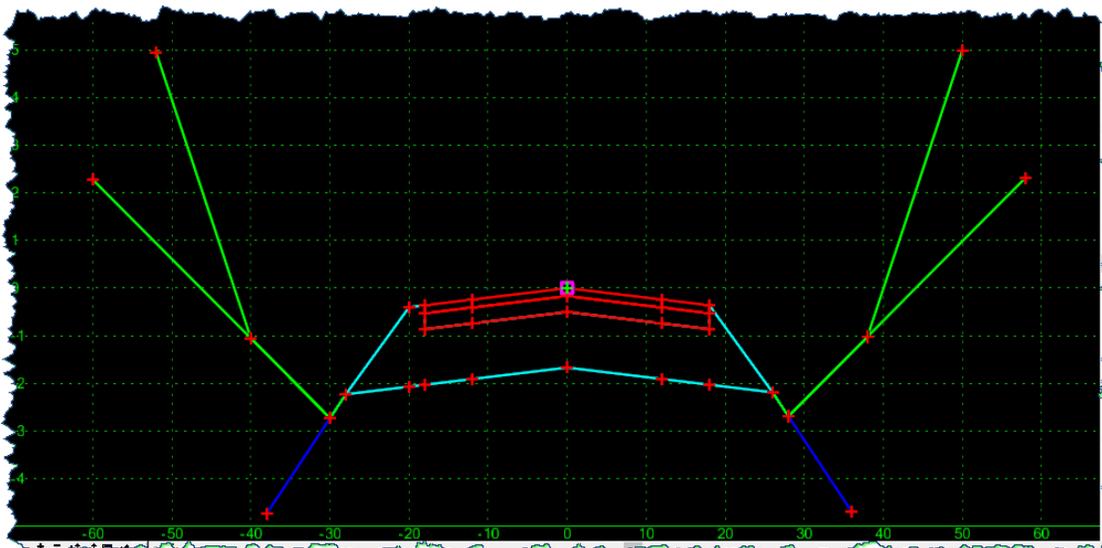
Adding the Guardrail:

The last template, which can be named **GR**, has all of the characteristics of the **2Lane** 'base' template, but also contains the **Guardrail** component found in the **Multi-Layer Sections** subfolder under the **Roadway Components** folder.
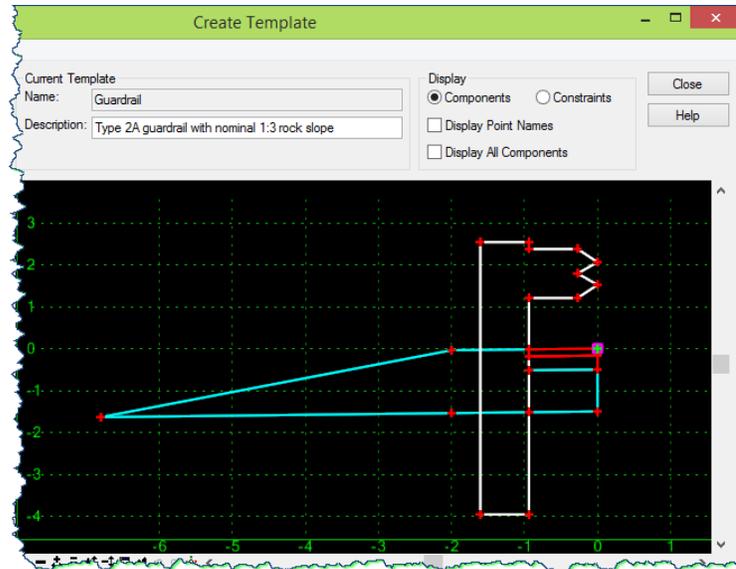
Put your template construction skills to the test and construct this template. Use the template named **GR-left** as a reference if you need it, as well as a check once yours is complete.

1) Using any techniques that you are comfortable with, construct this template.
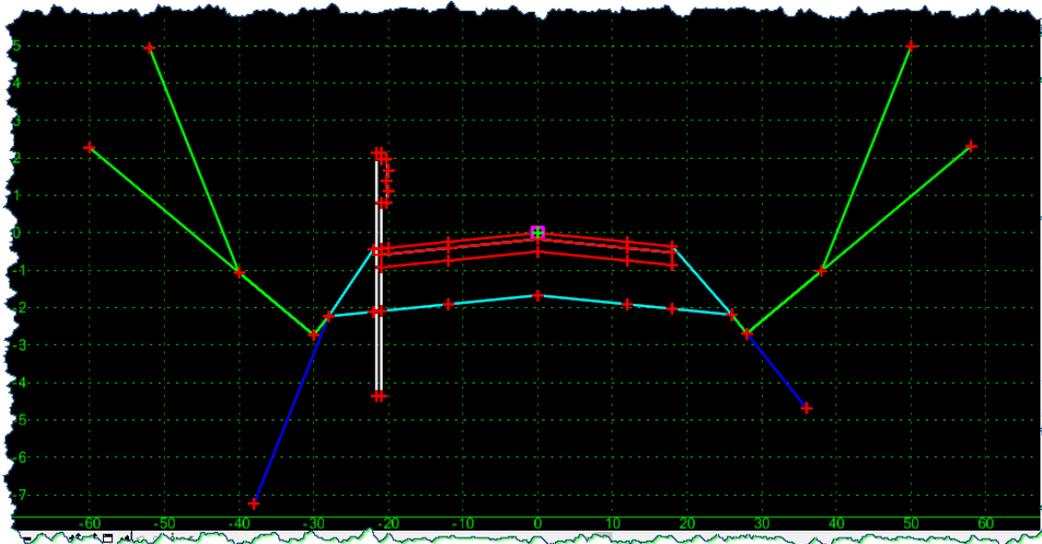
At this point, you should have the capability to add a guardrail to the roadway template used on your project.

GUARDRAIL MODELING CONCLUSION

You should be able to:

- Understand the guardrail components and how they relate to the ODOT guardrail standard drawings
- Create required templates for guardrail modeling
- Create a corridor with strategically dropped templates
- Assign **PARAMETRIC CONSTRAINTS** to control the guardrail and terminal modeling

Final Exercise

This subject matter is not necessarily a straightforward procedure. For this reason, it is highly recommended that you perform some additional work in this module as follows:

a. Take a few moments, review the sample project information for this module, and develop your own location and criteria for a guardrail location somewhere along this roadway.
   - Guardrail on one side of the road
   - Guardrail on both sides of the road

b. Either use the templates just created, or develop a new template of your own.
   - Template without berm & guardrail
   - Template with only berm
   - Template with berm & guardrail

c. Create a new **Corridor** in the **ROADWAY DESIGNER** using your templates.
   - Use the horizontal and vertical alignment supplied with this module
   - Use the existing surface supplied with this module

d. Assign the necessary **PARAMETRIC CONSTRAINTS** to control the guardrail, shoulder, rock and ECs appropriately.

e. As an alternative activity, create a non-linear horizontal alignment or surface feature to use as a **POINT CONTROL** to assign to the guardrail terminal modeling.

f. Create and view the design surface.

Refer back to the **Guardrail Modeling Overview** on page seven as well as other portions of this module for more details and direction.

Conclusion

Congratulations, you have completed the Guardrail module and have gained yet another specific skill that can be used toward the development of a more complete design model with InRoads.

We leave you with our encouraging final thought – Do these modules with an attitude of application. Study them with the viewpoint that you are going to apply these new skills on your current or future project. Look into and beyond the exercise steps and motivate yourself to momentarily pause and consider past, present and future projects and how this information could be put into practice.