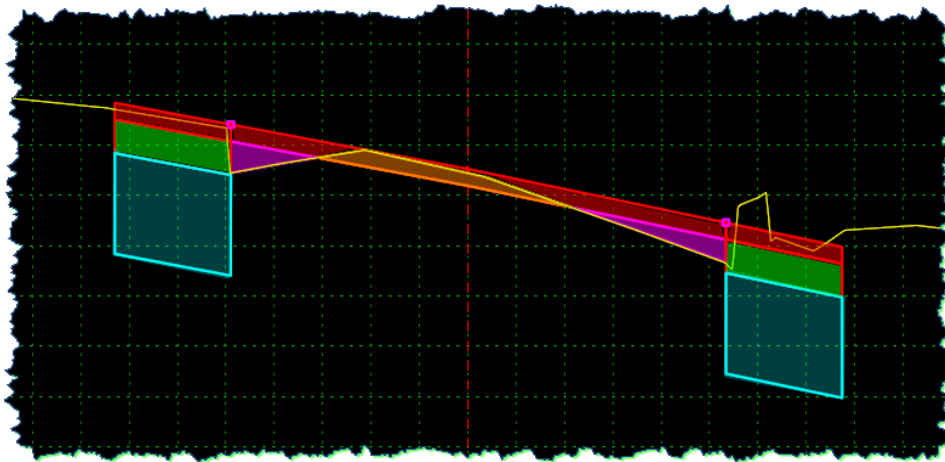# Module 11
OVERLAY TOOLS &
WIDENING Using InRoads

Introduction

Widening projects generally follow the basic workflow of corridor modeling and can be done without the use of any specialized tools. When a widening project following the existing cross slope of the road begins to produce undesirable cross slope results, then the modeling process has to be improved. Add in an extra requirement to resurface the existing roadway, and the process changes further.

Widening and resurfacing projects can contain a balance of milling (grinding) and overlay, in addition to the widening itself. This is where the InRoads **Overlay Tools** are used.

Purpose of this Module

The purpose of this module is to demonstrate modeling the addition of a new lane along an existing road with Superelevation. This module will be introducing and using the **Overlay / Stripping** component in the **CREATE TEMPLATE** tool as well as the **Overlay Tools** in the **ROADWAY DESIGNER**.

> ⚠ **ALERT**: The method shown is only suitable for projects not requiring an engineered vertical alignment. Otherwise, the vertical alignments generated by this tool should only be used for reference purposes when designing the vertical alignment.

Objectives of this Module

At the end of this module, the groundwork will be laid so that you will be able to begin using a new InRoads tool set and approach on your projects that require widening, milling (inlays) or overlays.

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 **11_Overlay-Widening** 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:
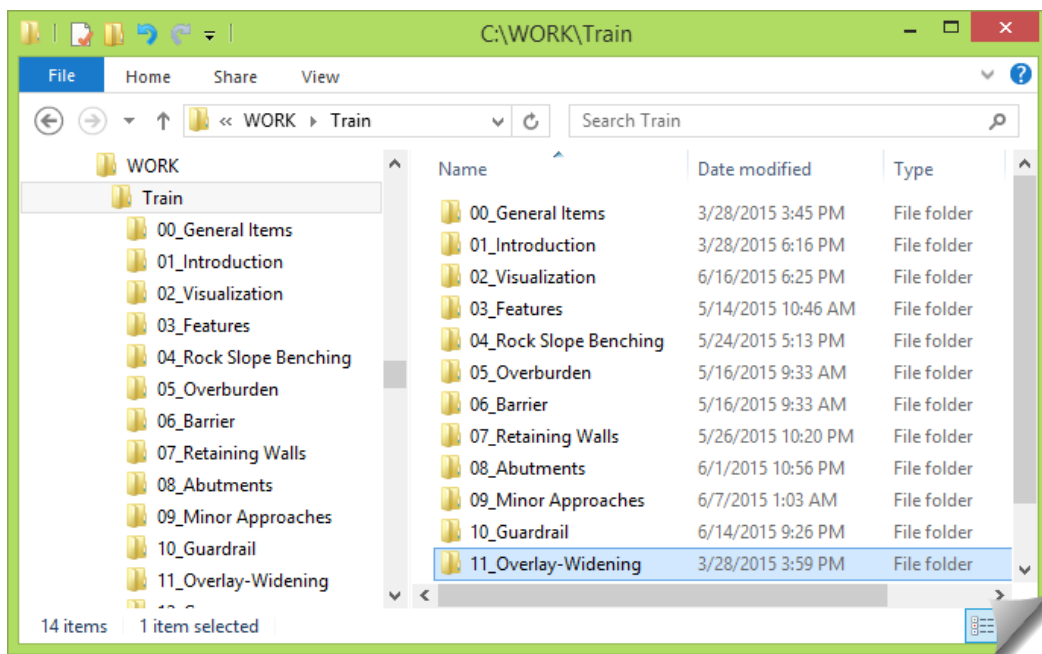

Training Files

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

- **11OWID.dgn**, the initial MicroStation file used at the start of the exercises
- **11OWID.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.

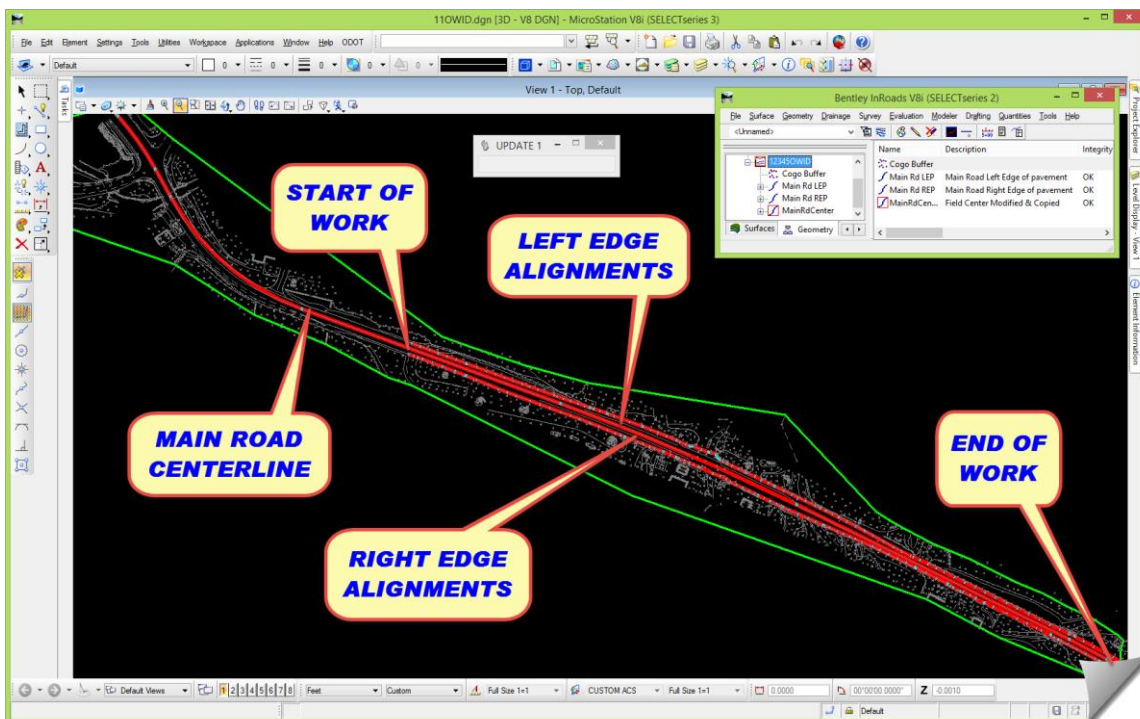In this module folder, you should have these files:
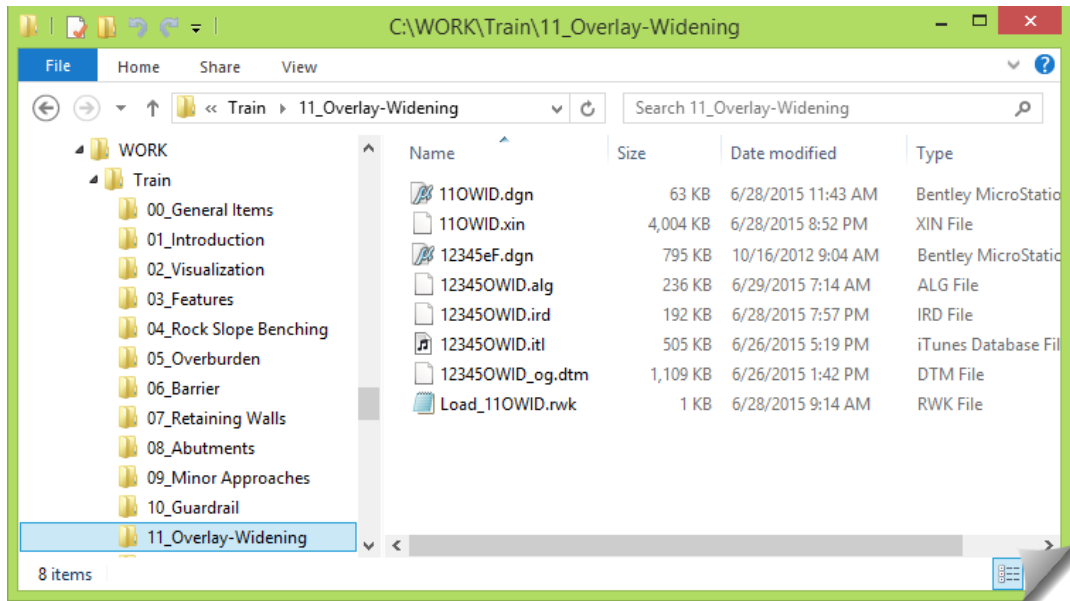
Technical Content of Training:

Project Orientation

REVIEW WORK AREA

The OG surface, as well as the mainline alignment and edges of pavement geometry, are already created. The focus of the modeling work is shown here:

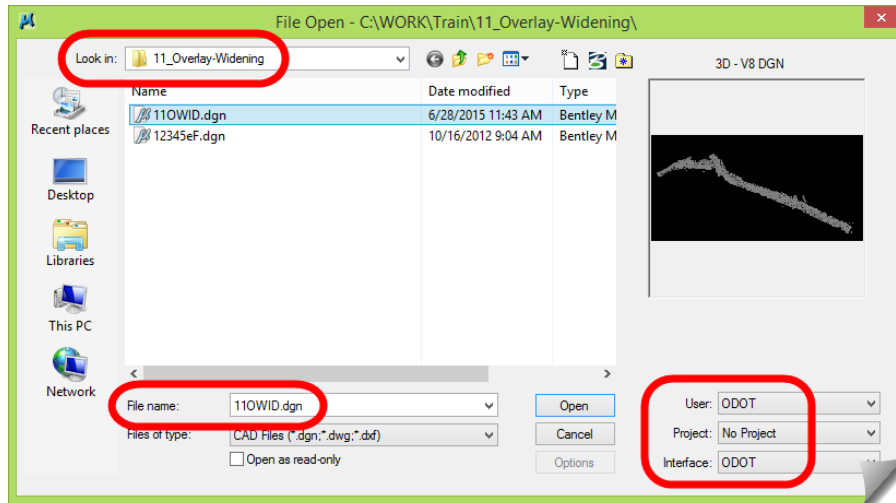## PREPARE MICROSTATION / INROADS DATA & FILES

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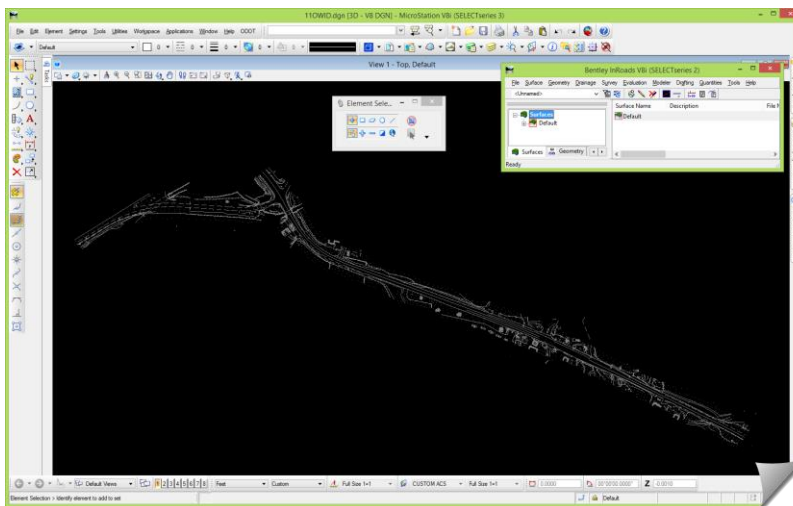
1) Launch InRoads

   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\11_Overlay-Widening*, select **11OWID.dgn**, and [**Open**].

4) When the drawing opens, you'll see that it has some content.

5) Open Windows **File Explorer** and browse to the **11_Overlay-Widening** folder.

6) Drag & drop **Load_11OWID.rwk** into the InRoads interface to open the InRoads files.

7) Verify inside InRoads that the following files have been opened:

   - **11OWID.xin**
   - **12345OWID_og.dtm**
   - **12345OWID.alg**
   - **12345OWID.itl**
   - **12345OWID.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.
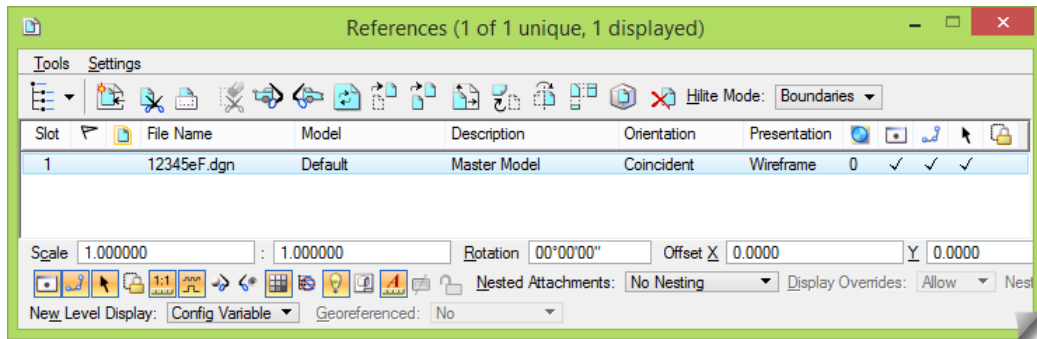
10) Move forward into the study portion of this module. Feel free to interact with the software as needed during your study in order to solidify any of the items under discussion.

Theory - Study

In this module, the project layout (geometry, templates and corridor) is already complete. This project data will act as a starting point for this module and lead into the use of the **Overlay Tools** and eventual design of the overlay and new widening work.

PROCESS OVERVIEW

Things to Consider

Overlay & Widening Defined [1]

The first step is to understand the following terms so there is no confusion about this subject.

> **Leveling** –Leveling courses (or prelevel) are initial lifts placed directly on to the existing pavement to fill low spots in the pavement. Leveling course lifts need to be as thick as the deepest low spot but not so thick that they are difficult to compact. Because it is not the final wearing course, the leveling course elevation and grade are sometimes not tightly specified or controlled.
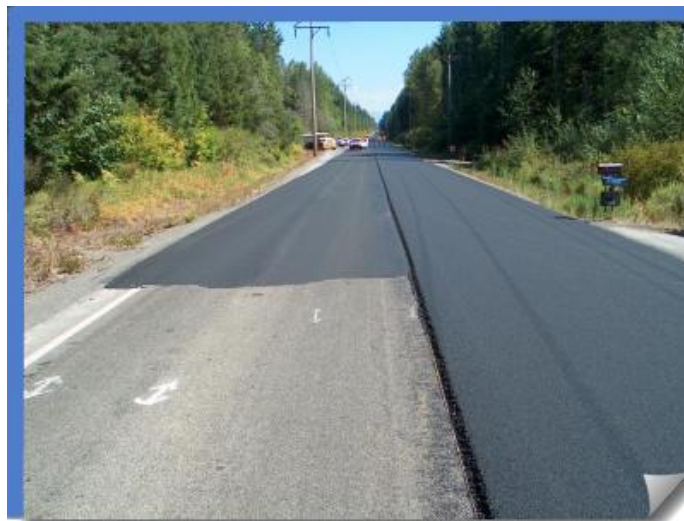

EXISTING PAVEMENT / LEVELING COURSE / FINAL COURSE

Milling / **Grinding / Stripping** – Milling (also called grinding, stripping or cold planing) can be used to smooth an existing AC pavement prior to AC or PCC overlays.

(Note: InRoads often uses the term stripping within its tools and documentation.)

Rather than filling in low spots, as a leveling course does, milling removes the high points in an existing pavement to produce a relatively smooth surface. A top layer is milled off the existing pavement to provide a relatively smooth surface on which to pave. Milling is also commonly used to remove a distressed surface layer from an existing pavement.
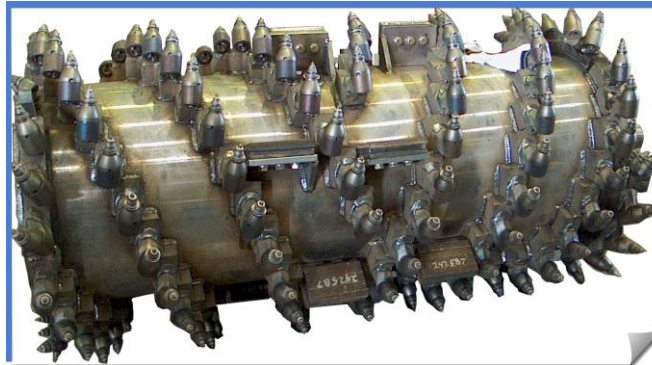
MILLING MACHINE CUTTING DRUM

Leveling Course vs. Milling – For many situations, milling may be a superior alternative to leveling. Leveling course quantities are difficult to accurately estimate and leveling course thicknesses are usually small, precluding the use of nuclear gauge density* testing. Thus, adequate mix density is difficult to achieve and measure. In some overlay projects, a combination of milling and leveling may be best.

Overlay – Generally, pavement overlays are used to restore wearing course (both AC and PCC) characteristics (such as smoothness, friction and aesthetics) or add structural support to an existing pavement.

OVERLAY PREPARATION

*A nuclear density gauge measures in-place AC density using gamma radiation. Gamma rays are emitted from the source and interact with electrons in the pavement. Pavement density is then correlated to the number of gamma rays received by the detector.

Widening Modeling Overview

The subject of modeling a road widening does not introduce any tools or techniques that are not already known by the experienced user. The only difference is the location that the template is run along. In the case of a 'standard' corridor, the modeling is done directly on the centerline. In a widening scenario, the modeling is offset some distance from the centerline, like from an existing edge of pavement or sawcut line.

Overlay−Widening Modeling Overview

Modeling a widening project has unique elements added to the workflow of corridor modeling, especially when resurfacing requirements are part of the scope. This introduces the subjects of stripping and surface preparation for the overlay material. When this is the case, the InRoads **Overlay/Stripping** components and **OVERLAY TOOLS** can be brought into the corridor modeling.

Here is an approach that can be taken:

a. Create a Template to use for this modeling

  ● This template is created using a combination of standard components for the widening portion of the section and the unique **Overlay/Stripping** components for that area of the model calling for it. The exact components that are used are determined by the design requirements and intent behind the desired results.
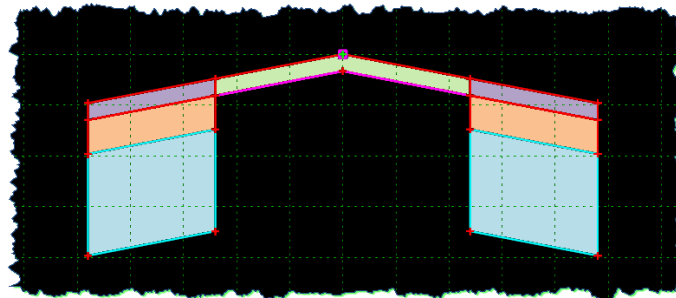

b. Create a **Corridor** in the **ROADWAY DESIGNER** as normally done

c. Add the strategically placed **TEMPLATE DROPS** as usual

d. Assign any horizontal **POINT CONTROLS** to existing pavement edges to secure their positions

e. If applicable, develop any **Superelevation** for the existing roadway for the points being controlled in the prior step

f. Set the **Display Mode** in the **ROADWAY DESIGNER** to **Overlay**. This makes the **Overlay Tools** available, and illustrates the next portion of the workflow.
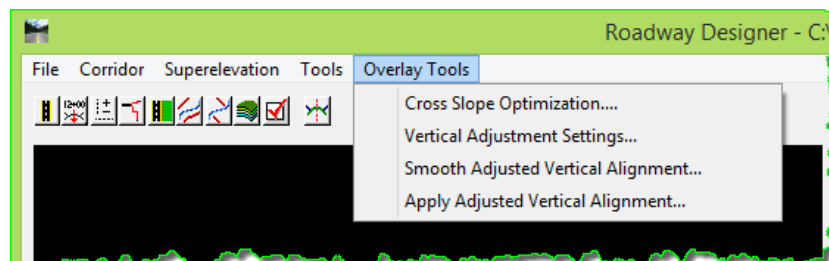
g. Use the **CROSS SLOPE OPTIMIZATION** tool to develop new cross slopes for the existing roadway that are based on 'optimized' tolerances. New **POINT CONTROLS** will be developed by this tool, replacing the previous Superelevation controls.

h. Once the cross slopes for the existing roadway are optimized, the vertical alignment at the centerline (crown location) is refined using the VERTICAL OVERLAY ADJUSTMENT SETTINGS tool. This step analyzes points along each individual modeled section to determine the ideal vertical alignment elevation based on the dialog box criteria that are defined.
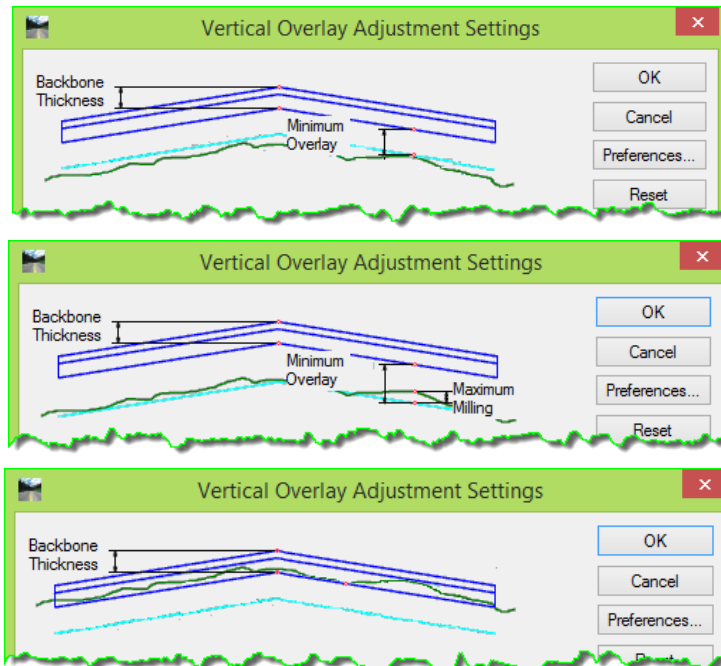
i. The vertical alignment in the previous step is temporarily created and 'raw' due to the way it was created, section-by-section, and independent of the 'whole' horizontal. The next step is to use the **Smooth Adjusted Vertical Alignment** tool to create a "smoothed" vertical alignment that can be applied to this corridor.

TIP: This tool creates a temporary best-fit vertical alignment based on the vertical overlay adjustment settings in memory. When [**Apply**] is selected, the regressed alignment is displayed in the profile along with an envelope line representing the maximum distance the regressed line can deviate from the ideal Profile Grade Line (PGL), based on the **Tolerance** value.
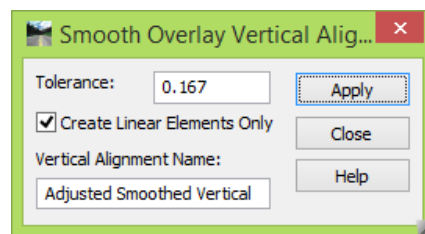

When the **Create Linear Elements Only** toggle is unchecked, the software attempts to fit parabolic curves in where possible. Non-tangential vertical curves are possible within this solution, which may be undesirable in some cases.

j. Once the new vertical alignment is created, the final step for the corridor configuration is to APPLY ADJUSTED VERTICAL ALIGNMENT, which assigns the newly created vertical to the corridor.

k. Then model review and design surface creation naturally follow.

Techniques and Tools

This type of modeling introduces only two significant items:

- **Create Template, Overlay Components** – this type of component is generally outside the experience of most users since it has a very specialized application and workflow associated with it. As a specialized component type, it has a unique set of COMPONENT PROPERTIES not found on other components. Some of these settings will be illustrated later in this module in the template review section.
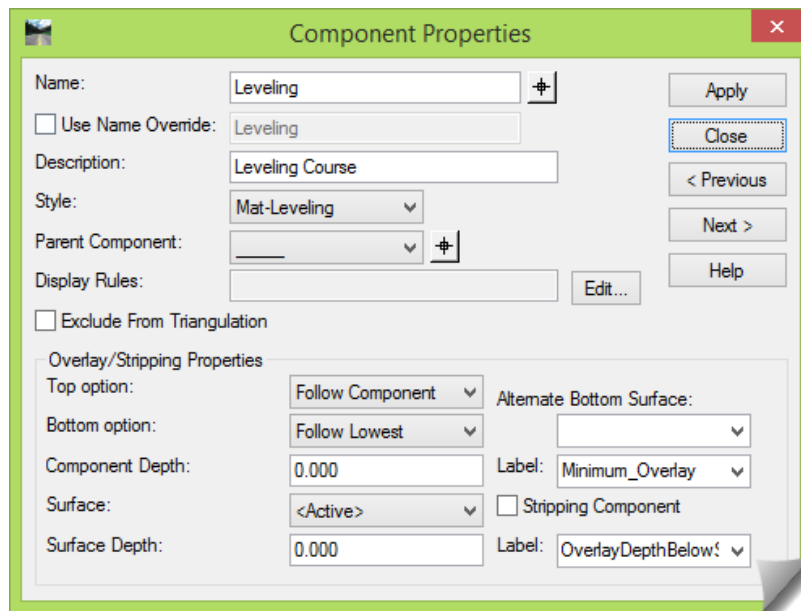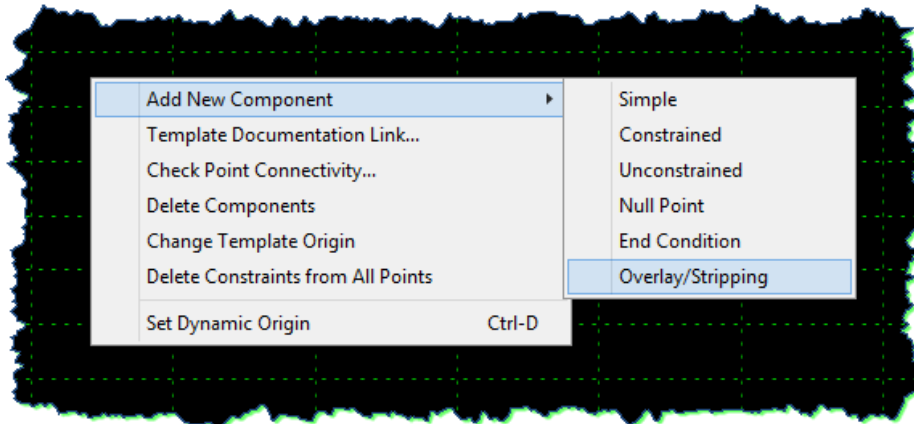
- **Roadway Designer, Overlay Tools** – as mentioned in the earlier workflow, the tools that will be used in the ROADWAY DESIGNER are the **Overlay Tools** activated by setting the **Display Mode** to **Overlay**.
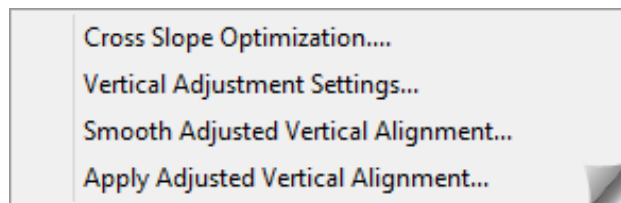
Practical Application - Hands On Lab Exercises

UNDERSTANDING THE DETAILS

The upcoming sections will not only look at the project data before starting the hands-on, it will take a closer look at the **Overlay/Stripping** components and the different ways that these components can be used in modeling.

Review any relevant project data

This module, while intending to focus on the two topics of overlay and widening, is primarily about the overlay subject. This is because the widening aspect of this work is wrapped very tightly into the overlay set up work. This statement will make more sense as you progress through this module.

At this point, you should be in the **11OWID.dgn** file and have loaded the InRoads RWK data.

Component and Template Review

This section will introduce the topic of **Overlay/Stripping** components within InRoads by reviewing several templates in the ODOT ITL that have been set up for this.

1) Open the TEMPLATE LIBRARY, browse to the **Roadbed Components > Overlay and Milling** folder and notice the three components there.

   - **Leveling**
   - **Milling**
   - **Milling and Leveling**

These specific components will not be used in this module, but are examples of the components used later in this module. They illustrate the core functionality of this component type.
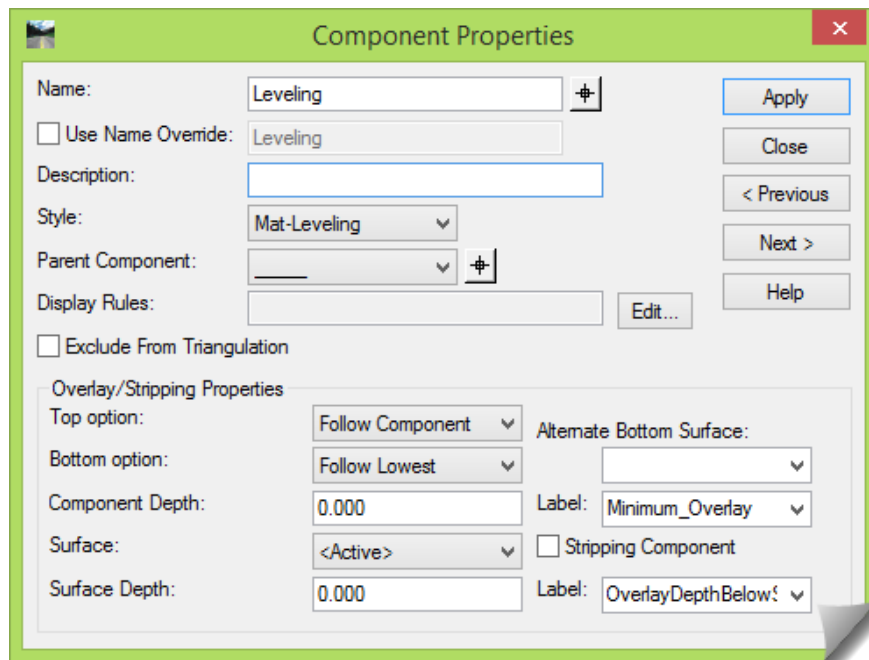
2) Make the **Leveling** component active.
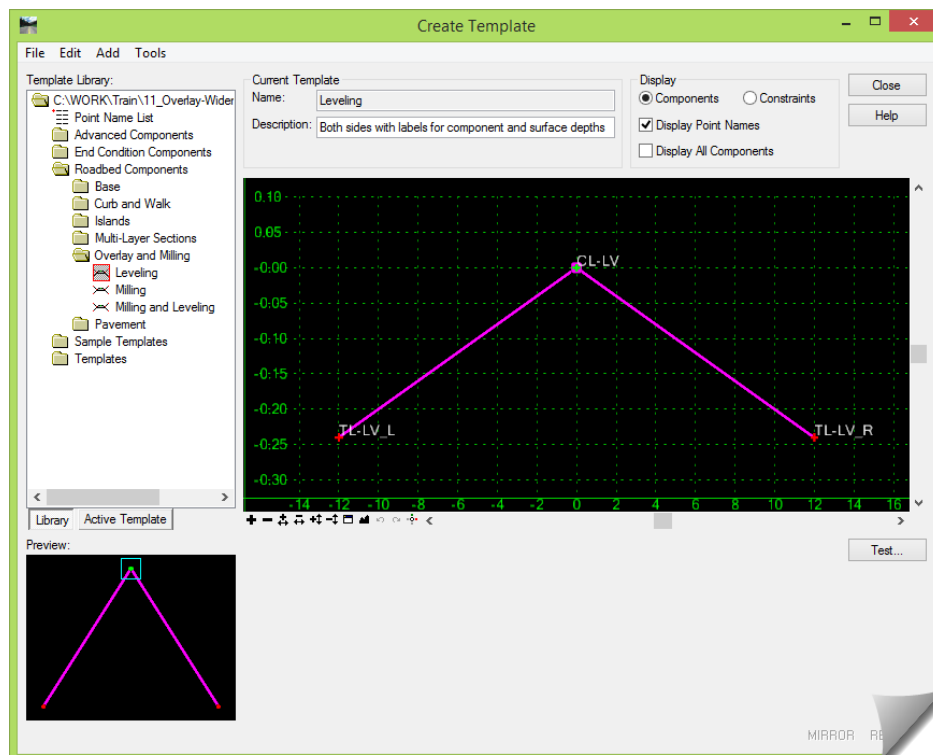
3) Start by doing a **Test** of this component and really study what is happening.

   This component consists of three points as seen by its point names.

   How can you explain its behavior based on what you are seeing as you move and reposition the simulated surface?

4) [**Close**] the **TEST END CONDITIONS** and look at the **COMPONENT PROPERTIES**.

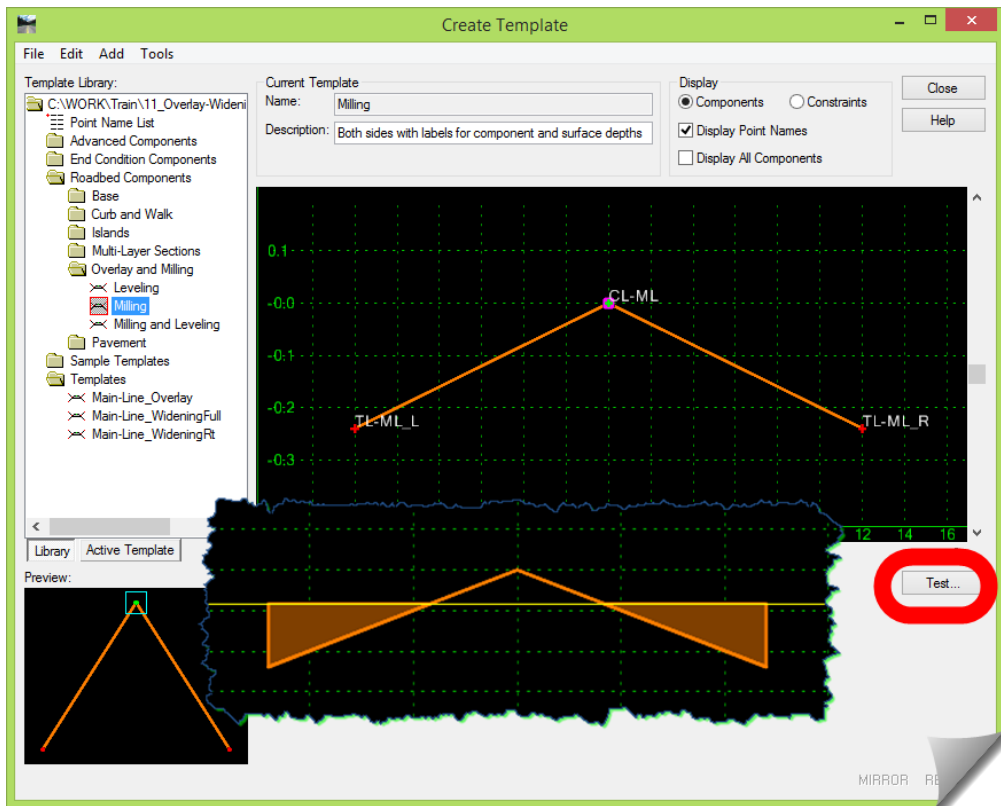   Can you correlate what you just saw in the **Test** with any of these settings?

5) Did you see the correlation with these settings?

- **Top Option** = **Follow Component**
- **Bottom Option** = **Follow Lowest**

This is the `Leveling` component. Does that behavior make sense for this activity?

A leveling component would need to rest its bottom on the existing surface, filling in any ruts or voids, while the top of the leveling should be defined as a clean, consistent edge.

6) Make the `Milling` component active and **Test** it.

7) [**Close**] the **Test End Conditions** and look at the **Component Properties**.

Can you correlate what you just saw in the **Test** with any of these settings?
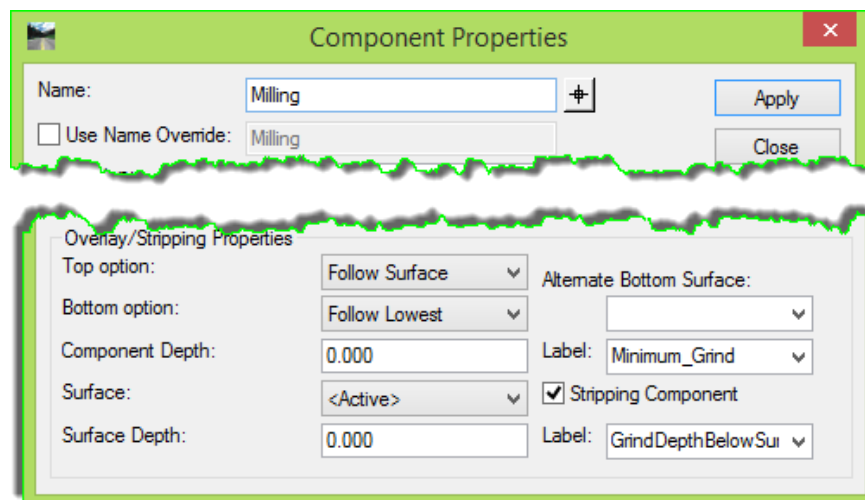
8) Did you see the correlation with these settings?
- **Top Option** = **Follow Surface**
- **Bottom Option** = **Follow Lowest** (this setting was not easily observed because it appeared to have followed the component, not the 'lowest'.)

This is the `Milling` component. Does that behavior make sense for this activity?

A milling component would create a planar uniform slope defined by the lowest point on the section that it finds to establish the cross slope 'plane'. The **Top Option** would identify the upper extents of any surface material that would need to be removed.

There is a rule about the **Bottom Option** setting that has to be considered when analyzing overlay component behavior. This is an effect of being able to define, in the **COMPONENT PROPERTIES**, how the top reacts and independently determine how the bottom reacts. The rule is that the bottom of the component will never go above the top of the component, and if the settings of the bottom instruct it to go above the top, it will simply follow the top component line.

9) Hand-sketch an example for both components on paper and fill in the solution as if you could run a **Test** with an irregular OG surface.
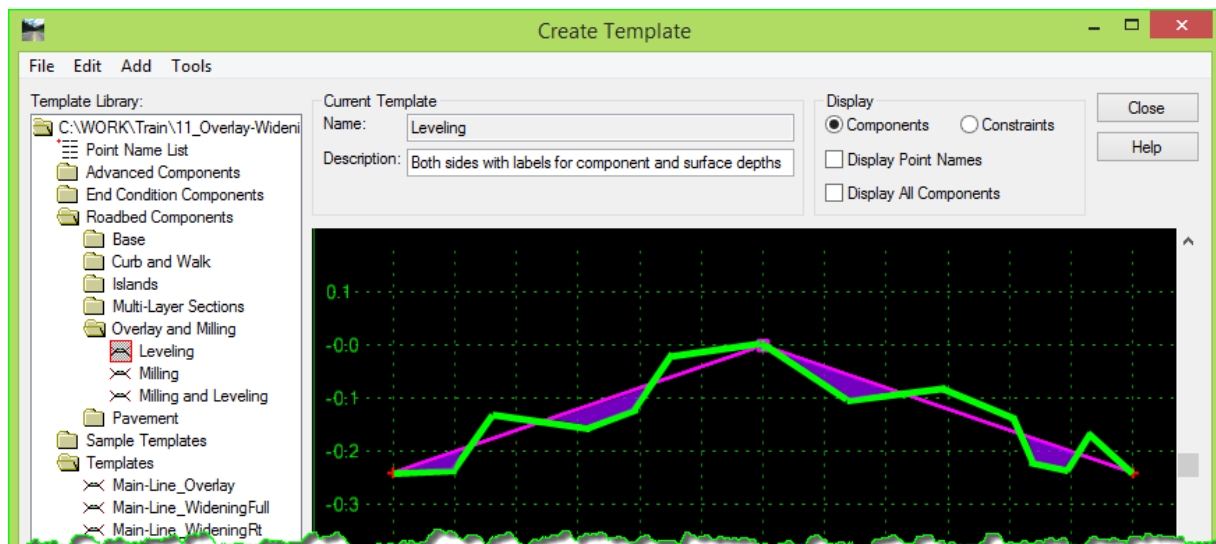
You may have drawn the conclusion that these components independently might not form a complete design solution. However, there is more to this, and these components generally do not stand alone. Additionally, these components will be impacted by the **Overlay Tools** in the ROADWAY DESIGNER later.

10) Do a thorough review of the `Milling and Leveling` component.

- **Test** it
- Analyze its behavior
- Review its components
- Review their COMPONENT PROPERTIES
- Sketch your own expanded **Test**
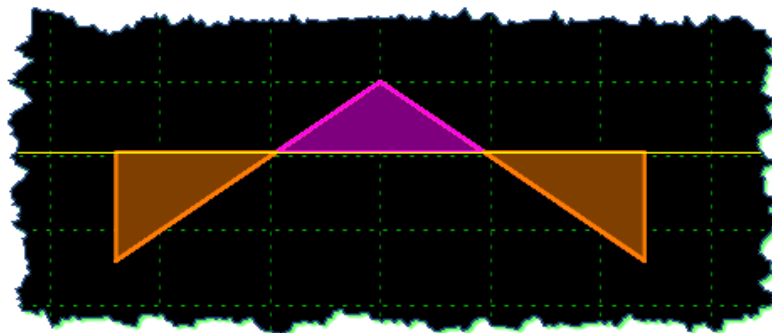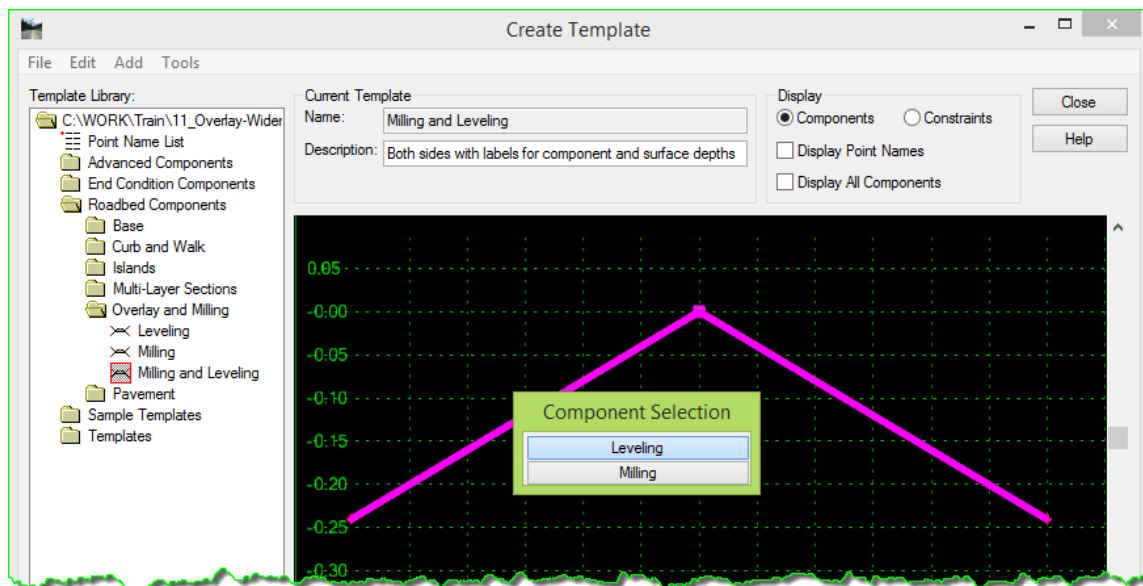
11) When that work is completed, browse to the **Sample Template** folder and set the `Widening_Mill_Level_Inlay` template as active.

12) The template to be used in this module is called **`Main-Line_WideningRt`**, in the **Template** folder. The scope of work defined for this module will be providing an overlay for the existing roadway and widening the right side. In addition for the purposes of this module, the Cut / Fill slopes will not be part of this work, as they have no additional implications in the work process.

Review the **`Main-Line_WideningRt`** template in the **Template** folder.

Take note of the **Vector-Offset** constraint on the widening component.
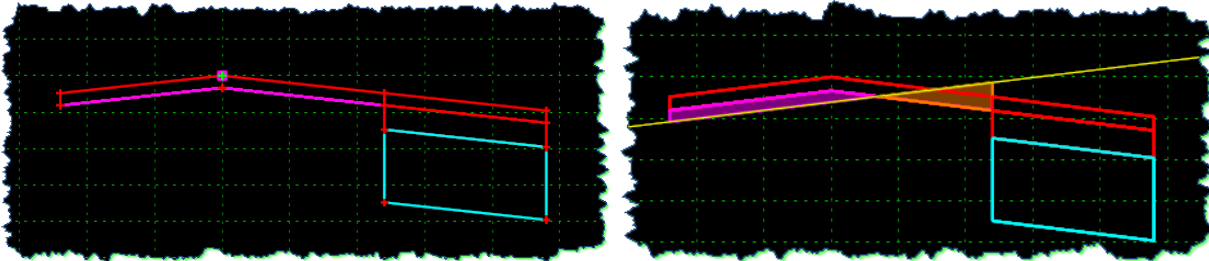
13) [**Close**] the CREATE TEMPLATE tool when your review is completed.

Final Review of Other InRoads Data

1) If you have not already, do a final review of the alignments in the Geometry Project.

- **`MainRdCenter`** – main road centerline alignment for the corridor
- **`Main Rd Sawcut_R`** – existing edge on the right from where the widening will run
- **`Main Rd Sawcut_L`** – will be used to define the left edge of the existing road
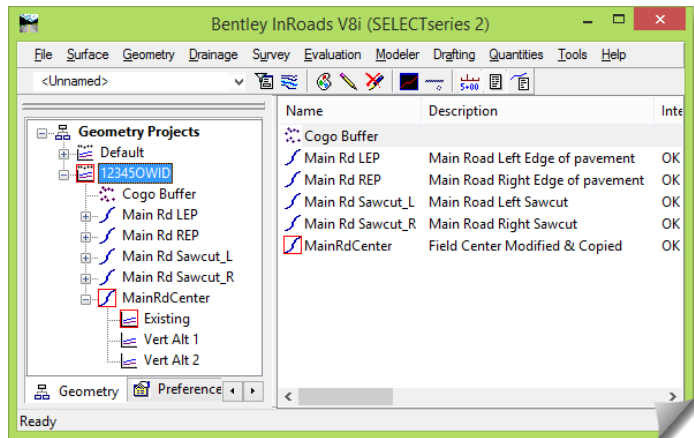
2) Lastly, review the assembly of the **`Main-Line_OWID`** corridor in the ROADWAY DESIGNER.

The majority of the work done in the module will be adding specific enhancements to this corridor in the ROADWAY DESIGNER, so the more familiar you are with the corridor the easier it will be for you to understand and make the necessary edits.

SCENARIO - OVERLAY / WIDENING MODELING

The following work will be done almost exclusively in the ROADWAY DESIGNER utilizing the **Overlay Tools**, while reviewing the templates or geometry as needed for clarification.

Relative to this design approach, here is where the work is at right now (feel free to review these items if you haven't already done so in the previous section):
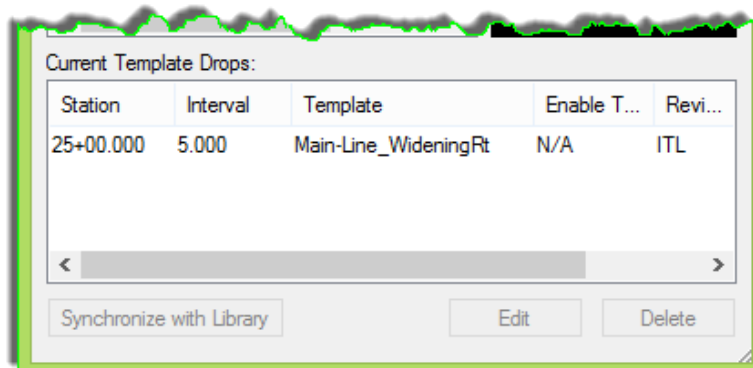
● The template has been created for this design work
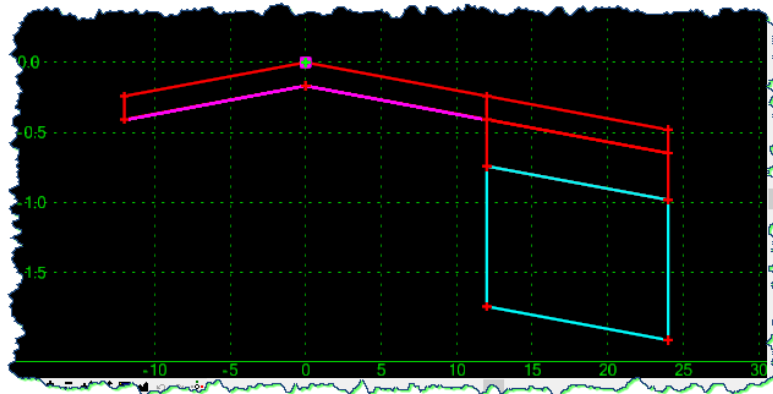
● The corridor has been created
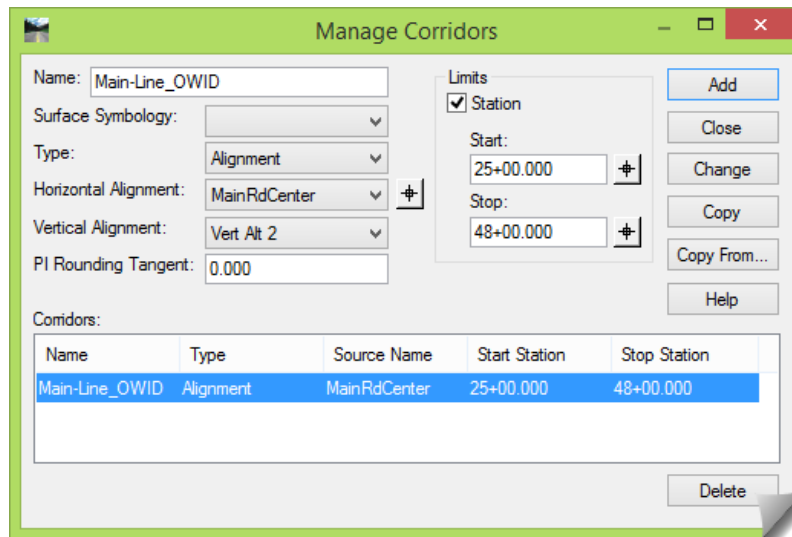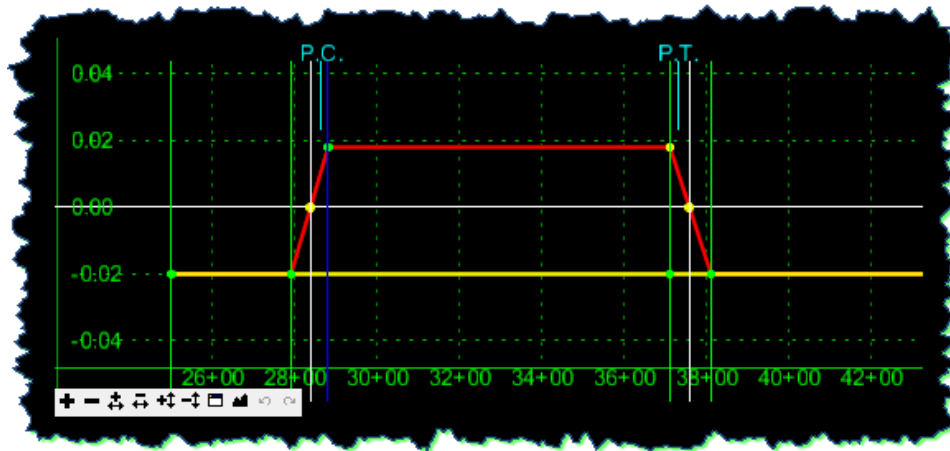

● The required template drops have been added

● **POINT CONTROLS** have been assigned to horizontally control the pavement edges

Horizontal and Vertical Controls:							
Enabled	Priority	Name	Start Station	Stop Station	Mode	Type	Control
X	1	TL_R	25+00.000	48+00.000	Horizontal	Feature	12345OWID_og:Right Sawcut
X	1	TL_L	25+00.000	48+00.000	Horizontal	Feature	12345OWID_og:Left Sawcut

● The **SUPERELEVATION** has been developed for the existing roadway using either the **SUPERELEVATION WIZARD** or manual methods. Either method will result in associated **POINT CONTROLS** that will control the Superelevation.

| Horizontal and Vertical Controls:							
Enabled	Priority	Name	Start Station	Stop Station	Mode	Type	Control
X	1	TL_L	25+00.000	44+00.000	Vertical	Superelevation	Left EP:CL
X	1	TL_R	25+00.000	44+00.000	Vertical	Superelevation	Right EP:CL

Now the rest of the process will be done primarily using the **Overlay Tools** from the main menu on the **ROADWAY DESIGNER**.
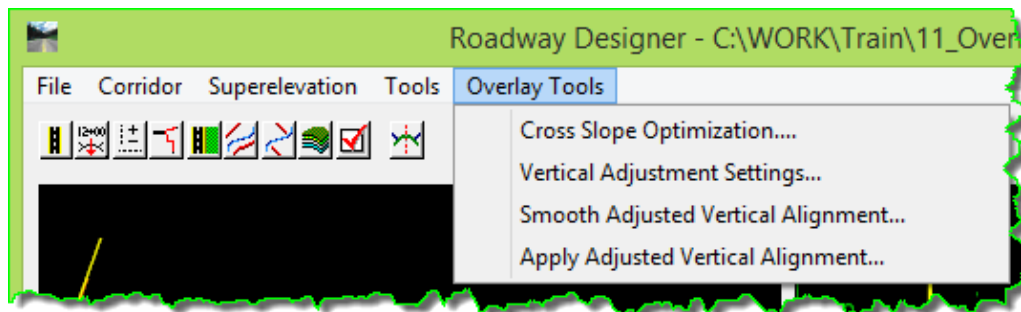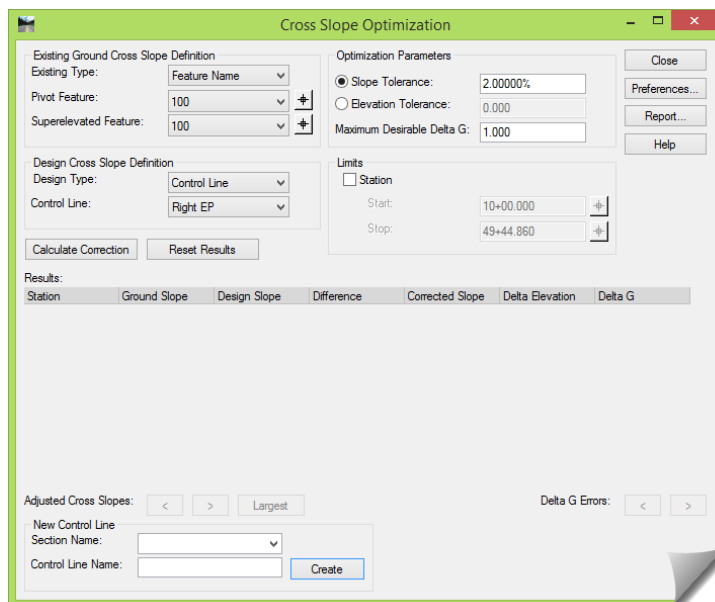
Cross Slope Optimization

This section will move into the first **Overlay Tool**.

1) Open the ROADWAY DESIGNER and verify the following:

   - **Corridor** is set to **Main-Line_OWID**
   - **Active Surface** is **12345OWID_og**

2) Set the **Display Mode** to **Overlay** and **Process All** to get a snapshot of the model as it is currently defined.
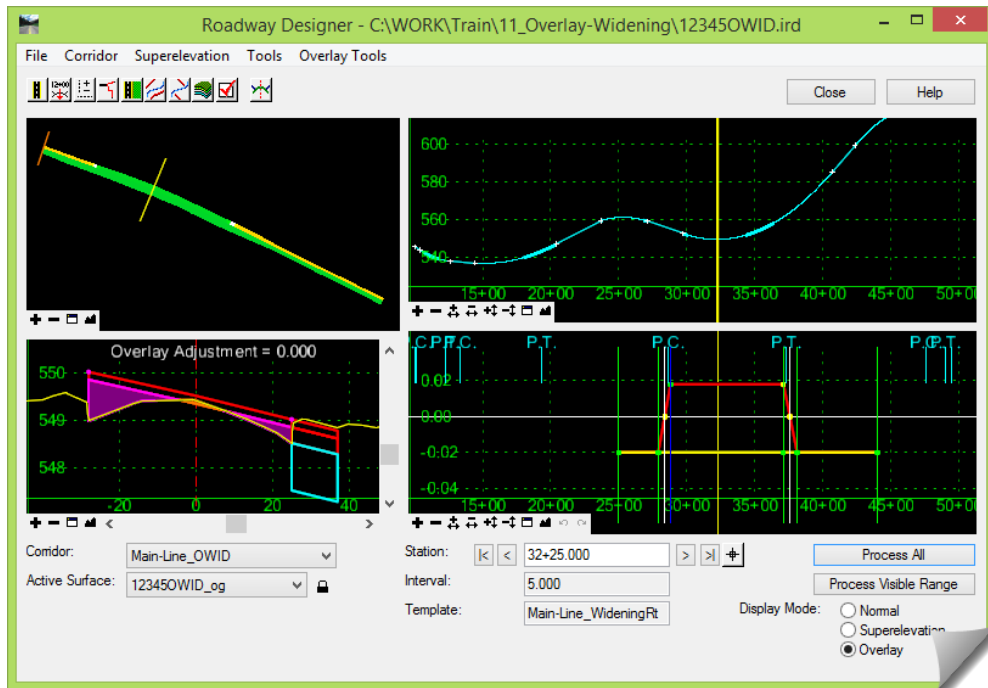
3) Open the CROSS SLOPE OPTIMIZATION command under **Overlay Tools**.

This dialog box has several distinct areas identified within the dialog box.

The object of this first tool, **CROSS SLOPE OPTIMIZATION**, is to adjust the design slope so that it will run as close to the existing road surface as possible while still running within pre-set tolerances. This tool will evaluate cross slope vertical tolerances over the length of the corridor and between the limits of the overlay.

4) Define the following settings on this dialog box:

- **Existing Type** = **Alignment**
- **Pivot Alignment** = `MainRdCenter`

> ⚠ **ALERT**: This alignment/feature represents the crown location and may not coincide with the centerline.

- **Superelevated Alignment** = `Main Rd REP`
- **Slope Tolerance** = `2.00%`
- **Maximum Desirable Delta G** = `1.000`
- **Design Type** = **Control Line**
- **Control Line** = `Right  EP`

The settings should be rather intuitive, but click the **Help** button at any time for more information.
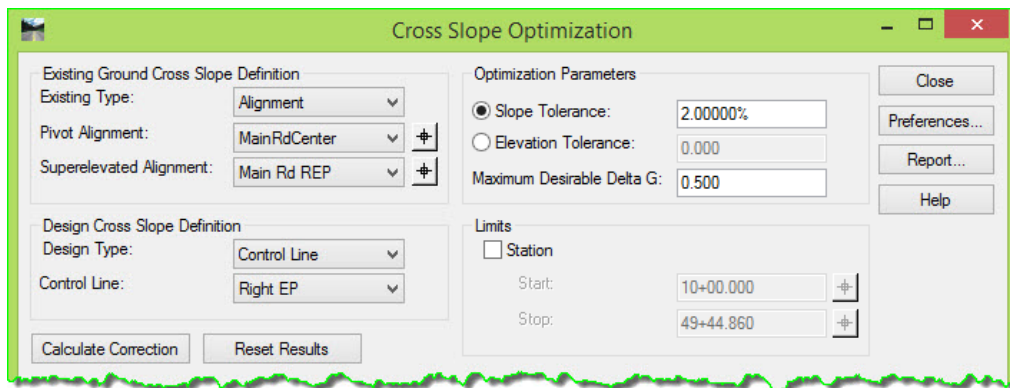

5) Now [**Calculate Correction**].
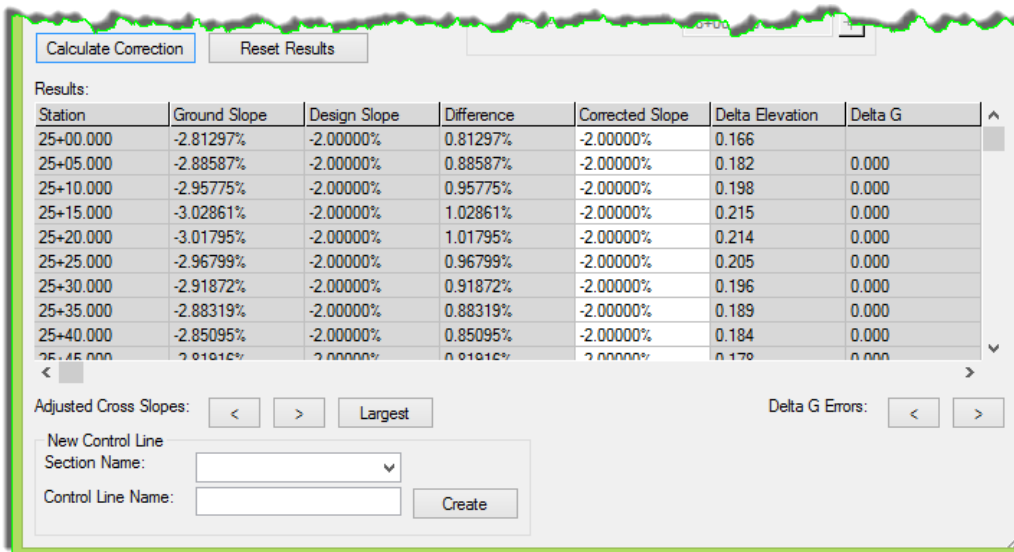
6) Scroll down and review the Results window information.

   The **Adjusted Cross Slopes** is available to toggle through along with the **Delta G Errors**.

   The red designation identifies where the tolerance specified previously is exceeded. The **Delta G Errors** are not used directly to adjust the cross slopes, but are used to report and identify stations where a longitudinal grade break in the edge of pavement (**EP**) exceeds the desirable value.

7) Notice the information in the ROADWAY DESIGNER cross section window as the sections are stepped through on the CROSS SLOPE OPTIMIZATION tool.
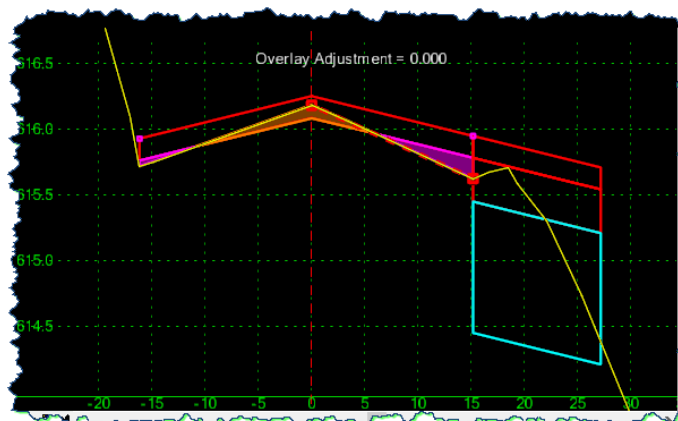

8) Notice the **Overlay** window in the lower right.
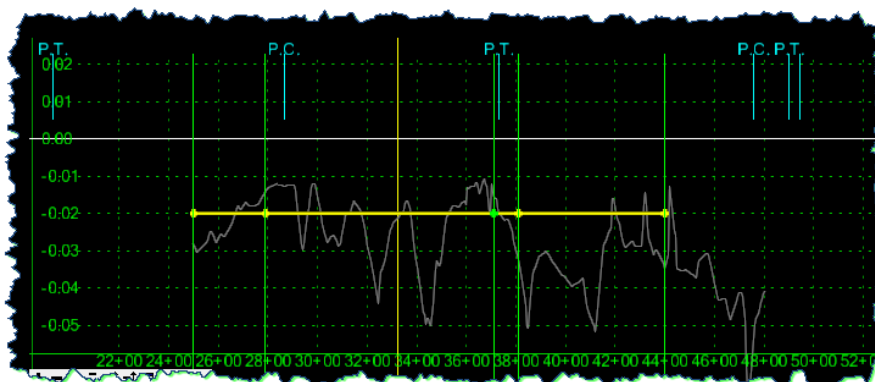
The light grey line represents the **Superelevated Alignment (Main Rd REP)** that was entered into the **Existing Ground Cross Slope Definition** while the yellow line represents the current design control line. You can see how the existing edge is quite inconsistent when compared to the design.

After reviewing the results, the corrected slope will be accepted and used as the new control line for the edge of the template, overriding the current **Superelevation POINT CONTROL**.

9) Enter a new **Name** for the **Section** and **Control Line**, then [**Create**] and [**Close**].
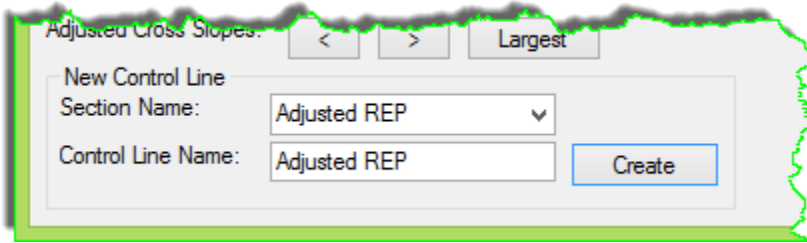
After this is done, the ground slope and the corrected slopes will match. This means that the slope defined by the new **POINT CONTROL** is forcing the cross slope on the right side to now match the existing condition.

10) Notice the change in the **Overlay** window and the addition of the newly created control.

11) Review the **POINT CONTROLS** and notice the changes.

Vertical Overlay Adjustment Settings

Once the cross slopes for the existing roadway are optimized, the vertical alignment at the centerline (crown location) is refined using the **VERTICAL OVERLAY ADJUSTMENT SETTINGS** tool. This step analyzes points along each individual modeled section to determine the ideal vertical alignment elevation based on the dialog box criteria that is defined.

1) Select the **VERTICAL ADJUSTMENT SETTINGS** from the **Overlay Tools** menu.

The picture at the top of this dialog box changes based on the settings that are selected (pictures of the various options were shown earlier).
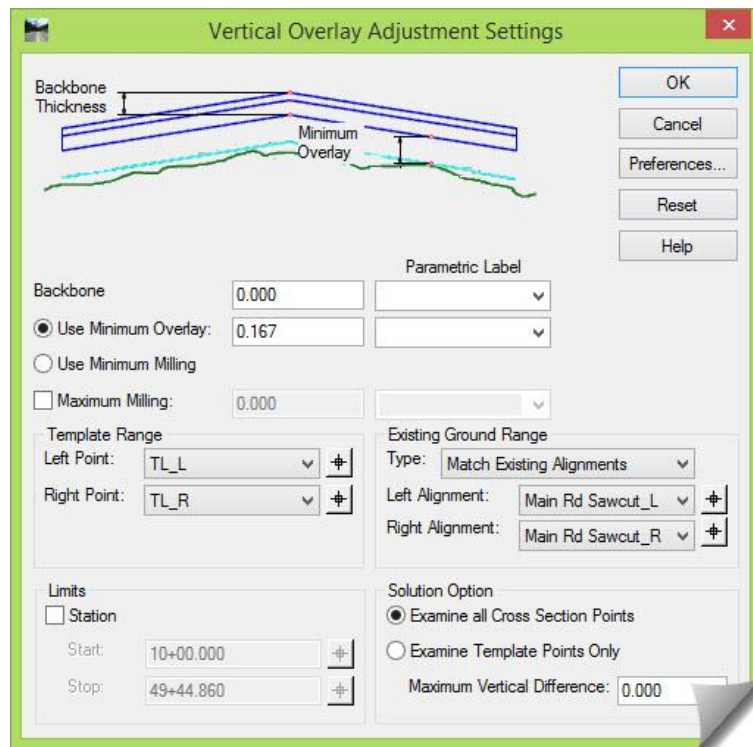
2) Define the settings for this scenario as follows:

- **Backbone**, **Use Minimum Overlay** = **2″**

The area called **Backbone** is where we identify how thick the backbone of the template is. This is from the top of the template down to the bottom of the backbone paving components (excluding the overlay and milling components).

- **Template Range**
  - **Left Point** = `TL_L`
  - **Right Point** = `TL_R`

The **Template Range** area of the dialog box identifies the range points (left and right side limits) of the design template to be used for overlay and milling.

- **Existing Ground Range**
  - **Type** = **Match Existing Alignments**
  - **Left Alignment** = `Main Rd Sawcut_L`
 - **Right Alignment** = `Main Rd Sawcut_R`

The **Existing Ground Range** does the same thing as the **Template Range** (for the existing ground limits) but allows the user a little more flexibility on exactly how the range points are determined.

- **Solution Option**
 - **Examine all Cross Section Points**

The **Solution Option** identifies which points to use within the range of a processed station. When **Examine all Cross Section Points** is selected, the vertical adjustment will be evaluated at every point on the template as well as the existing ground to determine where the vertical should be.

3) [**OK**] to save those settings and simultaneously close the dialog box.
4) [**Process All**] then zoom into the Profile view of the **ROADWAY DESIGNER** and notice the red line that has been added.

This line represents the newly created ideal vertical based on the **VERTICAL OVERLAY ADJUSTMENT SETTINGS**.
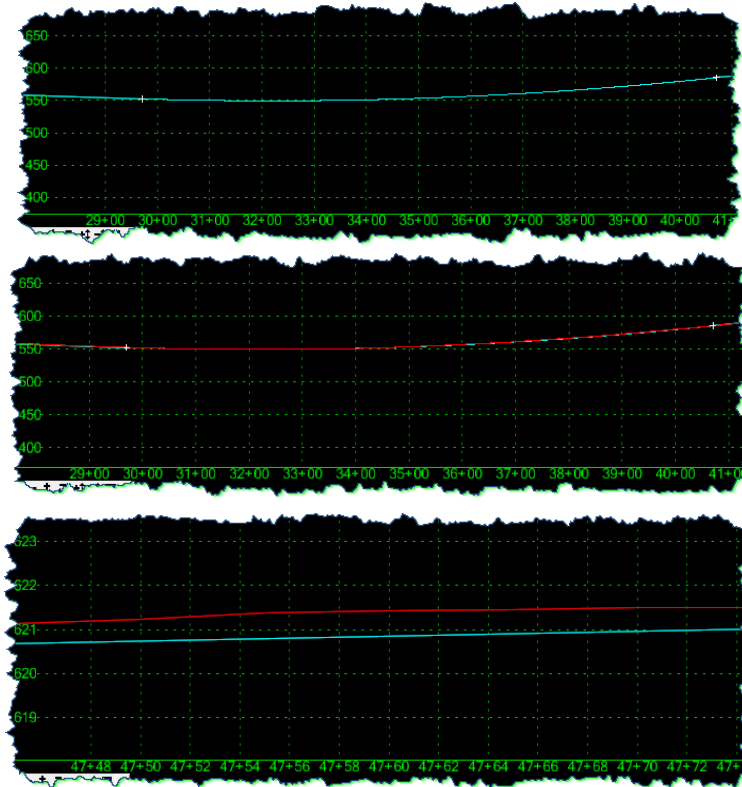
Note that, if you feel it is necessary, points can be edited in both the Profile view for the vertical, and the Overlay view for the edge **POINT CONTROL**, by right clicking on a particular point.
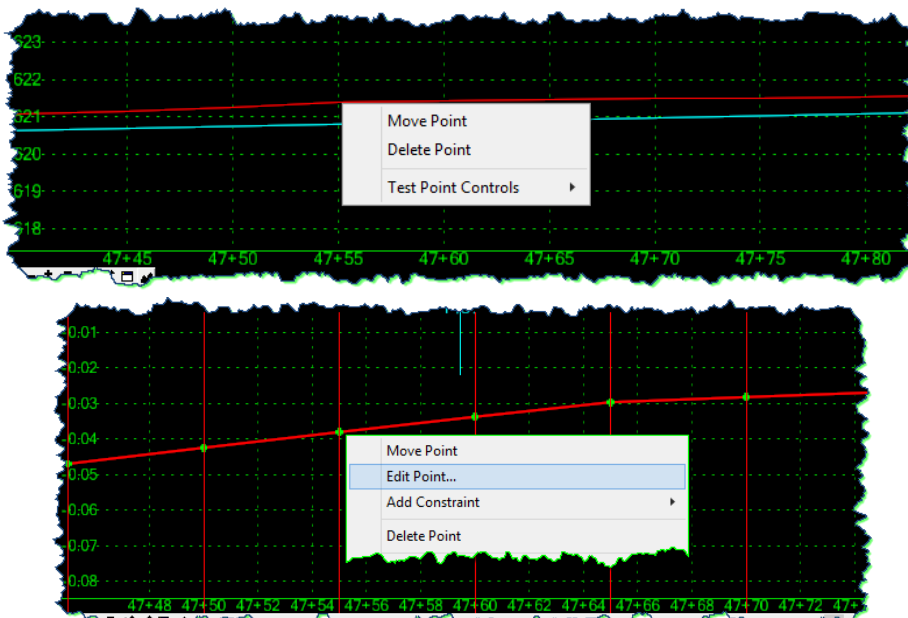
Once any review and / or editing is done, and everything looks correct, it is time to move forward.

Smooth Overlay Vertical Alignment

The **Smooth Adjusted Vertical Alignment** tool is used to clean up the new vertical alignment using a best-fit (regressed) vertical alignment.

1) Open the SMOOTH OVERLAY VERTICAL ALIGNMENT dialog box under the **Overlay Tools**.

2) Set the **Tolerance** value to <u>2"</u> to allow for a 2" envelope above or below the ideal PGL for regression purposes. Leave the **Create Linear Elements Only** toggled *on*, and enter a name in for the smoothed vertical alignment.

> ⚠ **ALERT**: Note that the naming conventions used in the module are sometimes intentionally 'descriptive', only to reinforce the activity that is being applied. On future projects, you should always use the naming convention that has been identified for that activity.
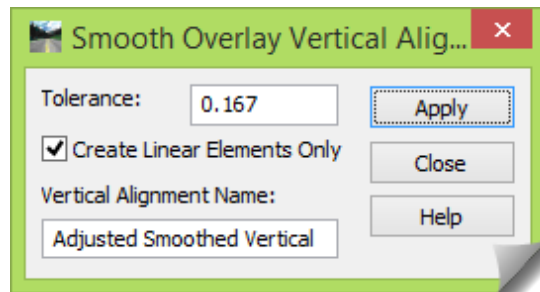
3) [**Apply**] and then [**Close**].

4) Zoom into the profile window

Notice there are two new lines, a yellow one that represents the top bounding line (the distance above is determined by the tolerance setting in previous step) and a green line that represents the regressed line.
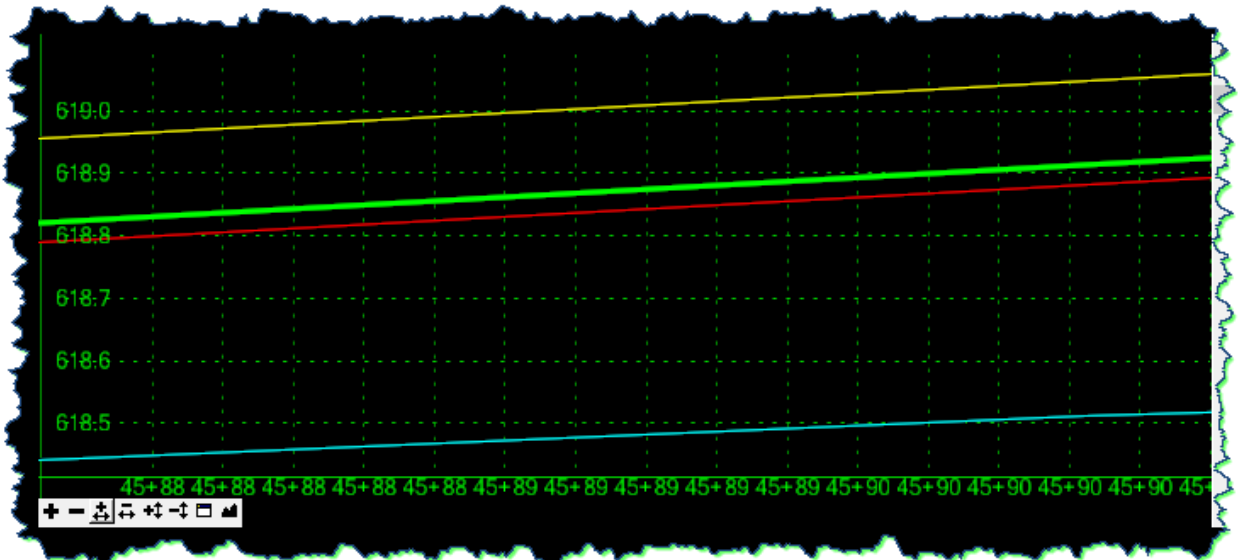

At this time, the new regressed alignment only resides in the memory, so it needs to be saved as a child of the Horizontal alignment in order to be used in our corridor.

Apply Adjusted Vertical Alignment

This section will create the vertical alignment in the active **Geometry Project**, storing it under the horizontal alignment that the corridor was built on. The tool used next will also assign the newly adjusted vertical to the corridor itself.

1) Go to the **Overlay Tools** and launch the APPLY ADJUSTED VERTICAL ALIGNMENT.

2) Check on **Apply Adjusted Vertical Alignment to Corridor** and set the **Style** appropriately.

This tool will create the vertical alignment for the centerline, but it can also create vertical alignments for the top and bottom envelopes. These can simply be used as guides for future editing. The **Create Vertical Alignment**, **Bottom** and **Top**, toggles are taking the envelope graphics that were created using the **Tolerance** setting in the **Smooth Adjusted Vertical Alignment** tool and turning them into a Vertical Alignment that could be recalled and used in the future. The current graphics are only temporary and are gone once the ROADWAY DESIGNER is closed.
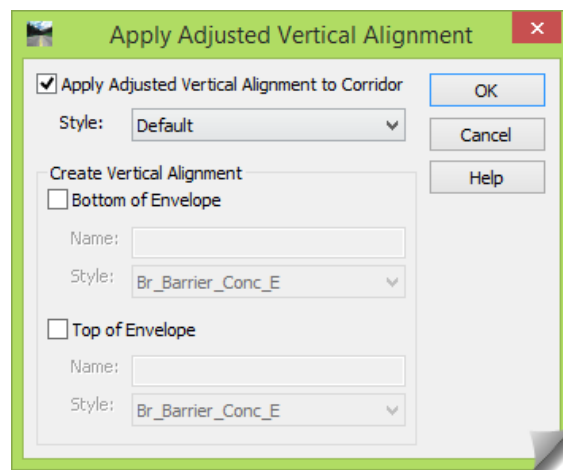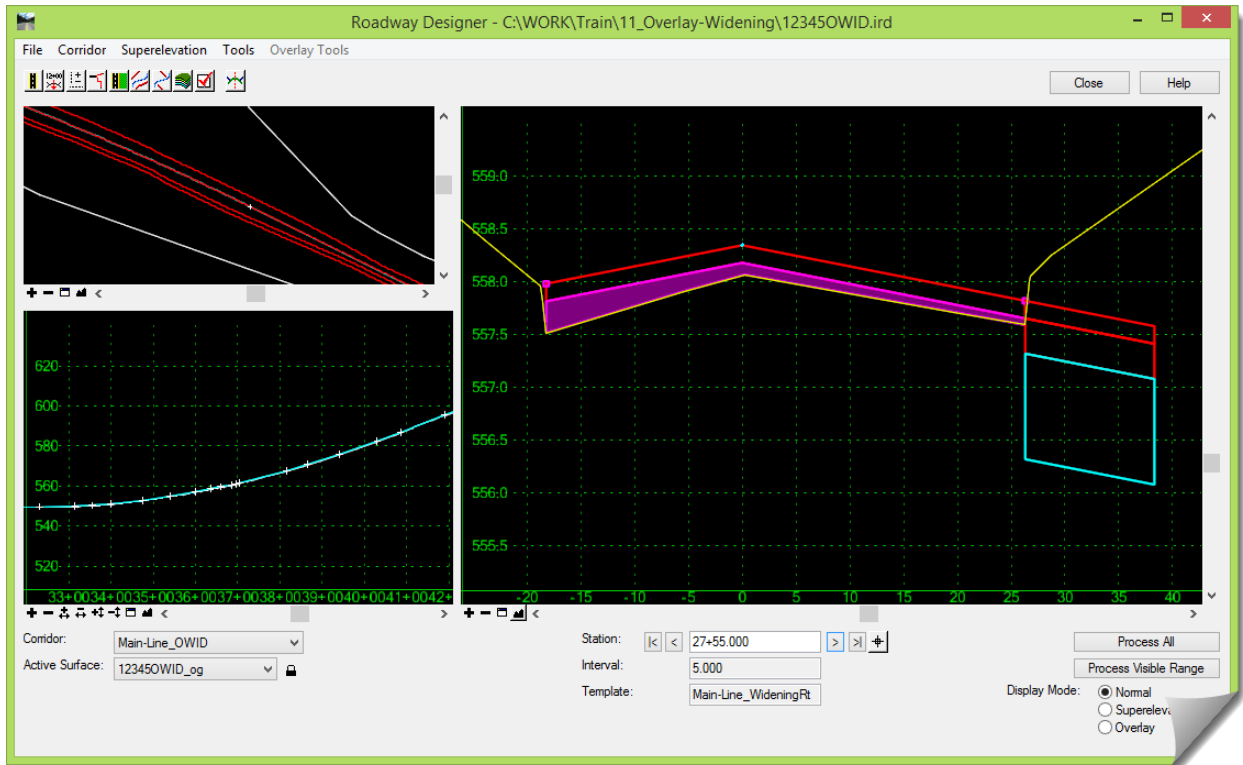

3) [**OK**] to execute this command and close.

Final Activities

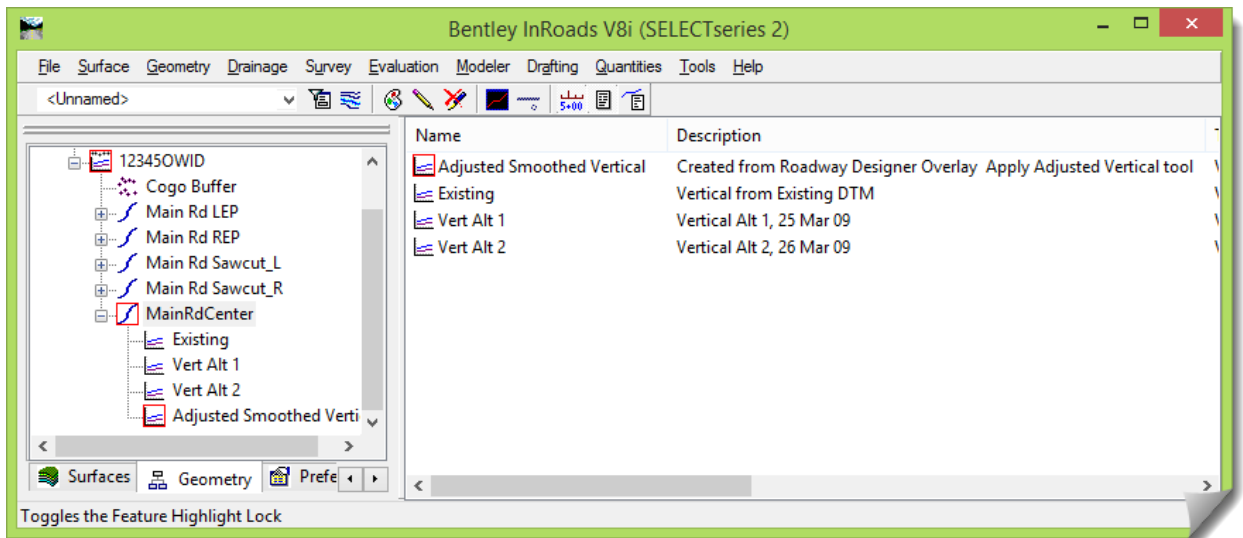1) Go to MANAGE CORRIDORS to confirm that the new alignment has been assigned.
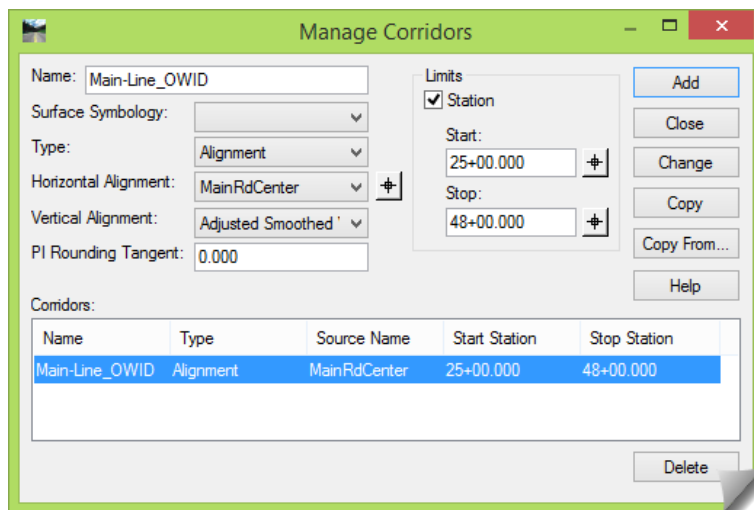
2) [**Save**] the IRD.

3) Do a review in the **ROADWAY DESIGNER** of the final results.

4) Look at the **Geometry Project** in the **Workspace Bar** and notice the new **Vertical Alignment** under the centerline.

5) [**Save**] the Geometry Project.
6) Feel free to create the design surface and do any other additional review.

Conclusion

Congratulations, you have completed the Overlay Tools & Widening module and have gained a greater insight into a specialized tool set, the **Overlay Tools**. With this information, you are continuing to expand your InRoads skills and modeling capability.

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.

References:

1. The definitions, descriptions and pictures used earlier in the *Overlay & Widening Defined* section of this module were taken from www.pavementinteractive.org , Pavement Interactive. They are an information resource for the pavement community. The content used was part of an article titled "*Existing Surface Preparation for Overlays*", published 9 July 2008.

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