OpenRoads Designer User Manual

U.S. Department of Transportation
Federal Highway Administration

Chapter 10

SUPERELEVATION

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Chapter 10 Superelevation

This chapter covers the creation and modification of Superelevation. Before using Superelevation tools, the mainline Corridor should be created. See *Chapter 9 – Corridor*.

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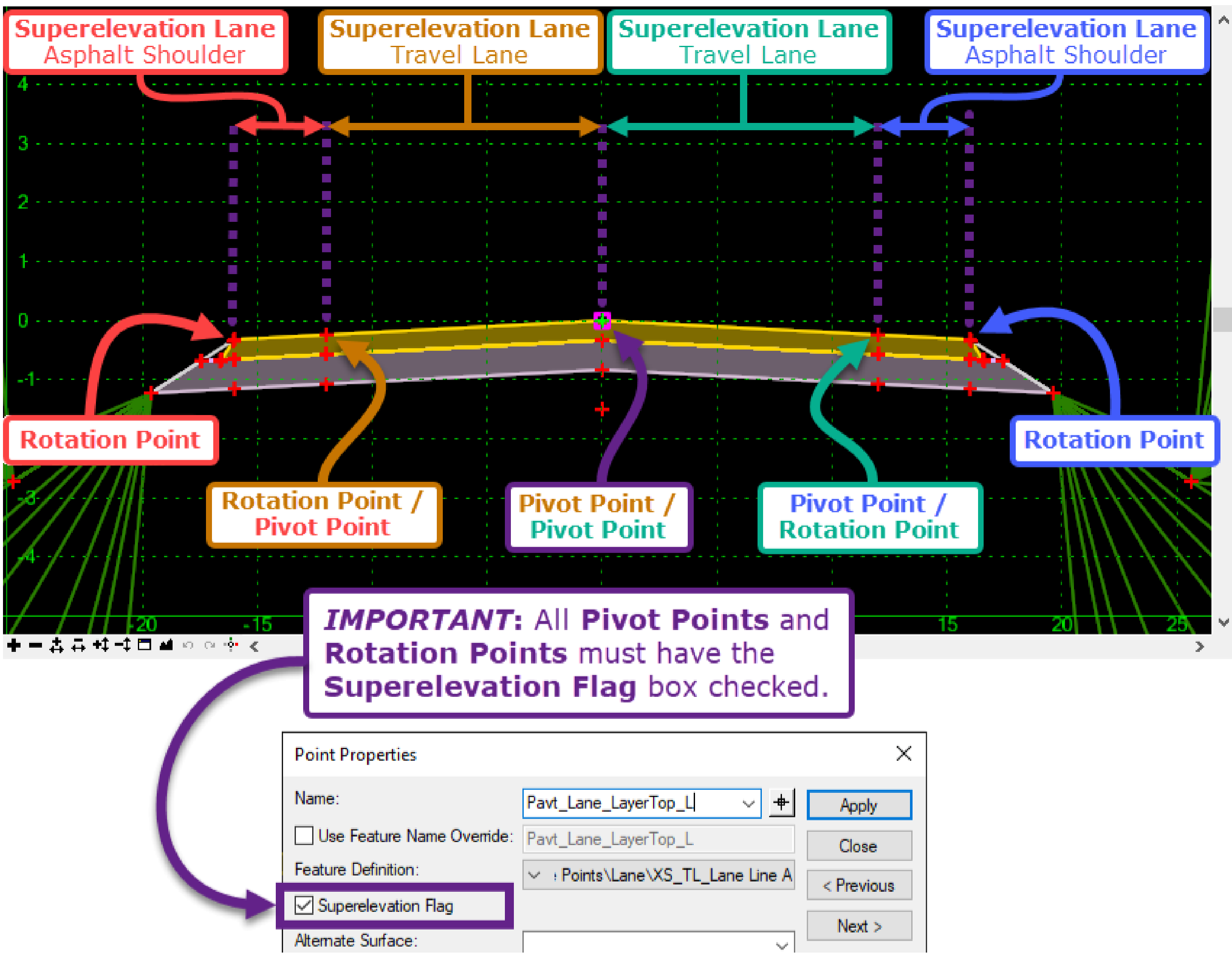
10A – INTRODUCTION TO SUPERELEVATION

Before Superelevation elements are created and applied, it necessary to create the mainline Corridor. All Corridor Templates should be reflective of project conditions. Specifically, the appropriate lane and shoulder width/configurations should be carefully considered before initiating the Superelevation process.

10A.1 Superelevation Lanes and Superelevation Flag

A *Superelevation Lane* is defined by a *Pivot Point* and a *Rotation Point*. To superelevate a roadway, the Pivot Point remains stationary while the Rotation Point is moved vertically until the Superelevation Rate (e value) is achieved. A Template will likely contain several *Superelevation Lanes*. When two *Superelevation Lanes* are directly adjacent, then a single Point will function as both the *Pivot Point* and *Rotation Point* – as shown in the graphic below.

Superelevation Lanes are defined by the User by checking the *Superelevation Flag* box found in the Template Point Properties. The *Superelevation Flag* box is found in the Template Point Properties. See *8C.3 Superelevation Flag*.

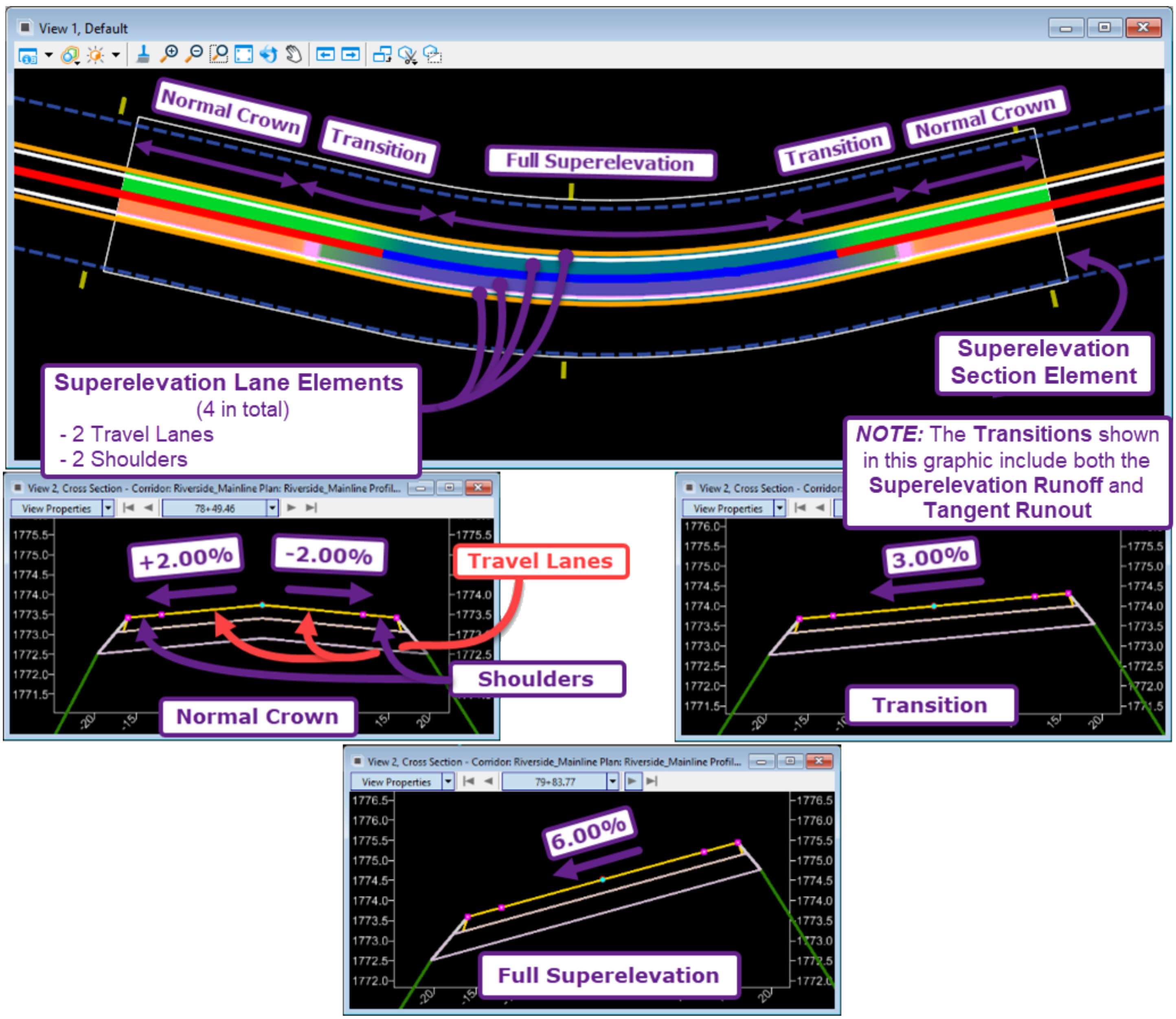


10A.2 Superelevation Elements in the 2D Design Model

In the 2D Design Model graphics, there are two Superelevation elements that the User can interact with: **Lane** elements and **Section** elements.

Superelevation Lane Elements: *Superelevation Lane* elements are shown as color-graded lanes. An individual *Superelevation Lane* element represents a portion of the road to be superelevated. The width and configuration of *Superelevation Lanes* are established by the *Pivot Point* and *Rotation Point*. The color of a *Superelevation Lane* at a given location represents the Cross-Slope value. When the color appears to be transitioning over a given length, then the cross slope is transitioning. In the graphic shown below, there are 4 *Superelevation Lanes* in total. ***NOTE:*** Each *Superelevation Lane* is given a unique name. The name is a combination of the Pivot Point and Rotation Point names – for example "Pavt_CL_LayerTop - Pavt_ETW_LayerTop_R"

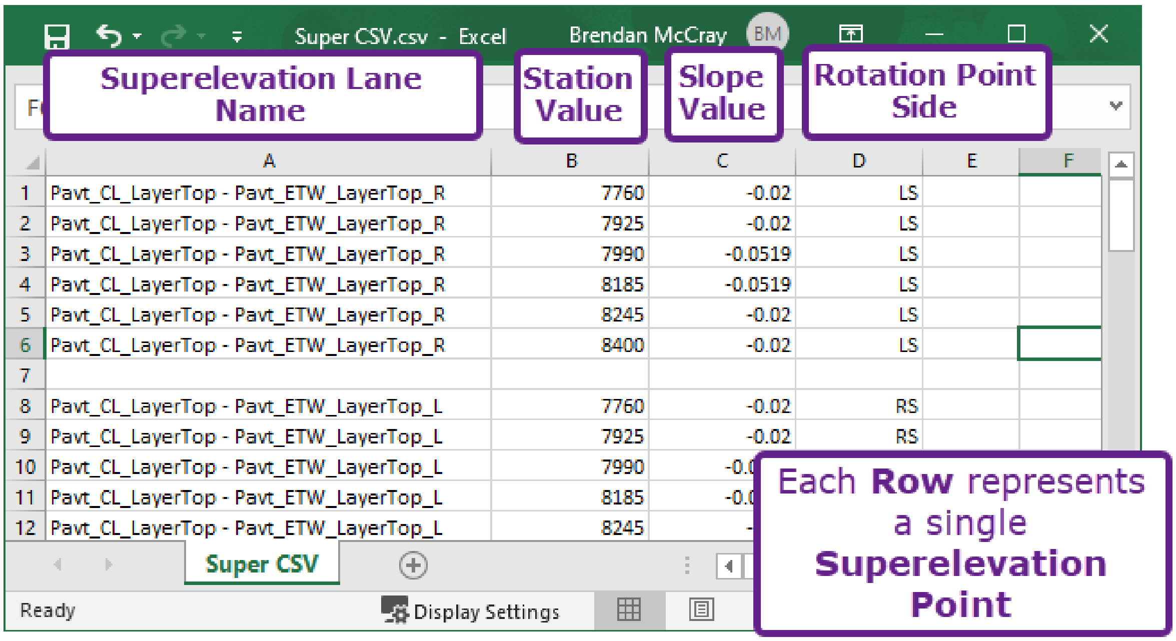
Superelevation Section Elements: *Superelevation Section* elements are responsible for the superelevation calculations and settings pertaining to *Lanes.* A *Section* element is shown as a white rectangular box All *Lanes* enveloped within a *Superelevation Section* box are controlled by that Section.



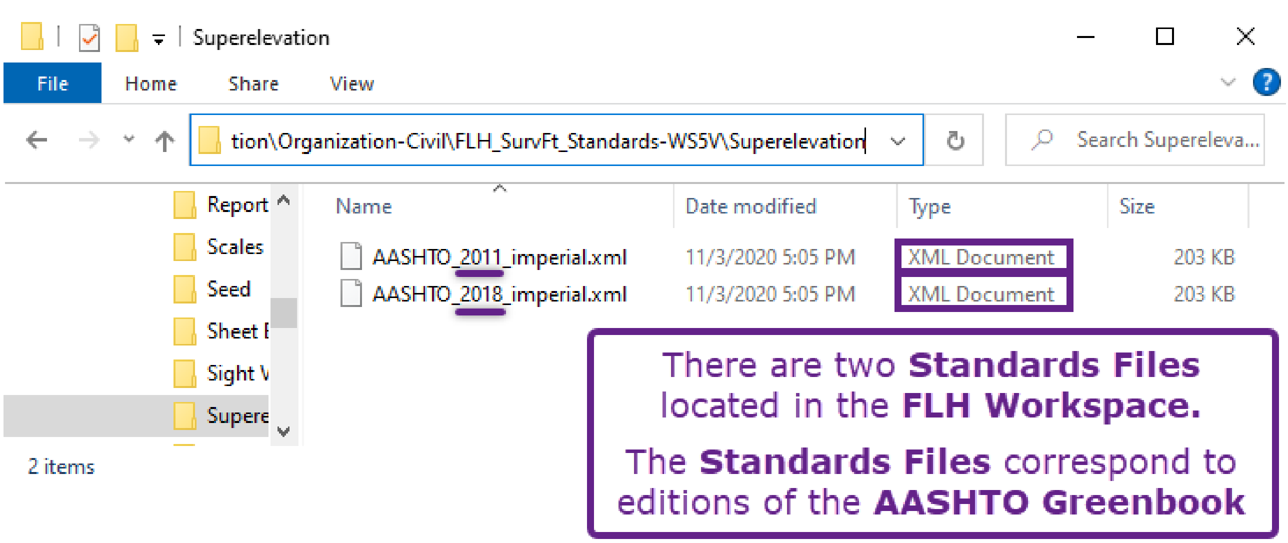
10A.3 Setting Superelevation Rates and Transitions - Overview

Superelevation rates and transition lengths can be determined manually OR calculated automatically by the software. The location where *Superelevation Lanes* changes slope is called a *Superelevation Point.*

Manually: In Microsoft Excel, the User can create a .CSV File to set superelevation rates and transitions in tabular form. Each line in the spread sheet table represents a *Superelevation Point* that belongs to a *Lane.* **This method is labor intensive**, because the User has to manually determine the superelevation rates and transition lengths for each curve. When the User is satisfied with the .CSV File table, it is imported into the ORD Software and applied to *Section* elements. See *10D.3 Use a CSV File to Set Superelevation (Import Superelevation tool)*.



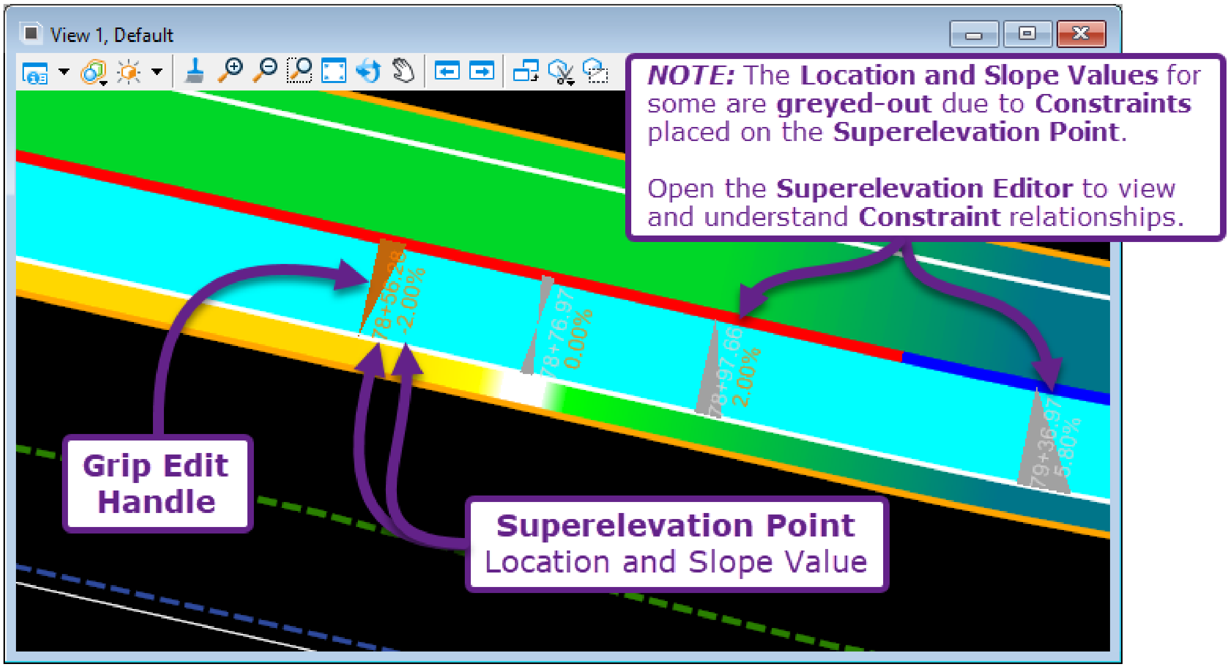
Automatically: Superelevation rates and transitions are automatically calculated from a .XML File, which is referred to as the *Standards File*. The *Standards File* (XML) contains the same Superelevation Tables found in the Greenbook. To inform the software on the correct superelevation tables to use, the User inputs the Design Speed, maximum superelevation rate (e_{max}), transition calculation methods, and other parameters relating to project conditions. *Standard Files* (XML) are located within the FLH Workspace. For a detailed explanation of how to operate the *Standards Files* (XML), see *10C.3 Calculation and Layout of Superelevation Elements*.



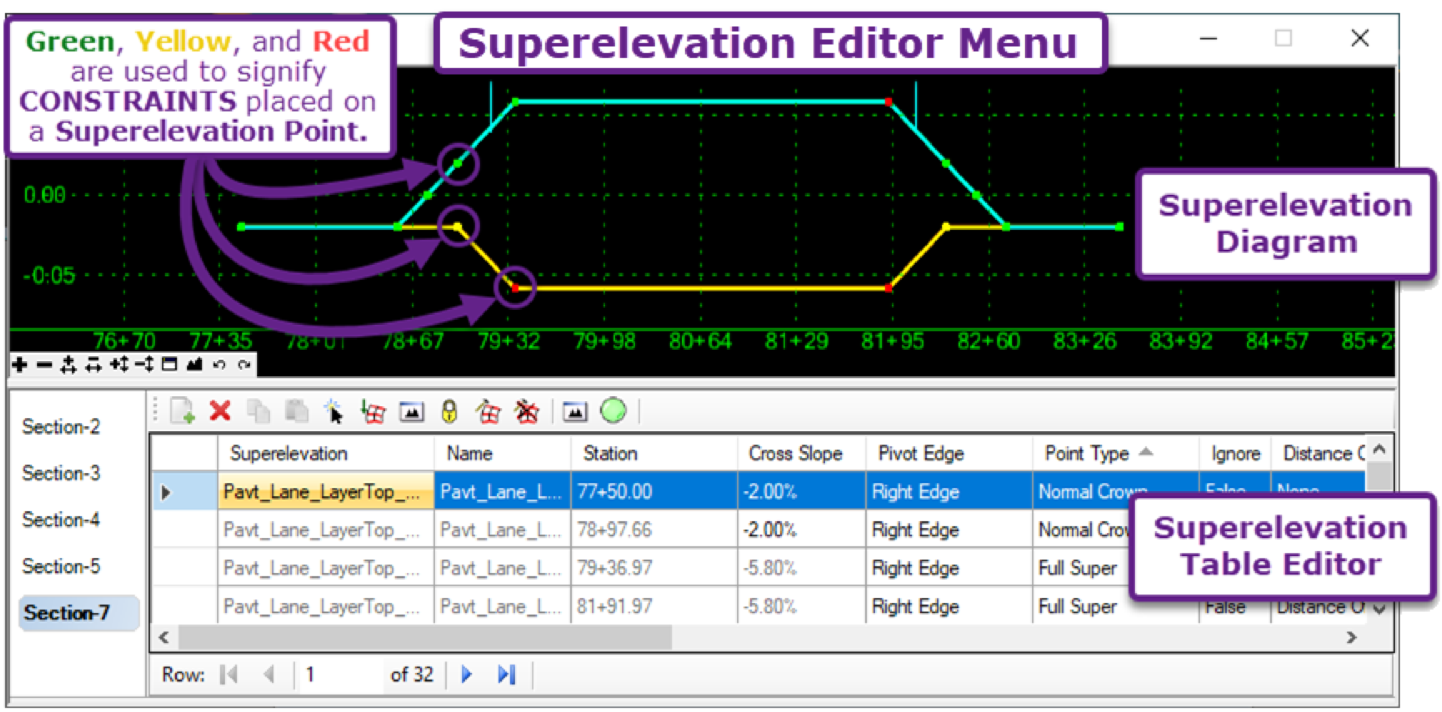
10A.4 Edit Superelevation and Viewing the Superelevation Diagram

Selecting a *Lane* element in the *2D Design Model* will reveal the Cross Slope and corresponding Station value for each Superelevation Point.

IMPORTANT: When a *Standards File* (XML) is used to automatically calculate superelevation, then the *Cross Slope* and *Station* value for some Points will be locked (grey in color). Points that are locked are subject to *Constraints Relationships* which prevents editing. Superelevation Constraints operate in the same manner as Template Point Constraints. **Constraint relationships must be understood before Superelevation Points are edited.** See *10E.2.f Constraint Relationships for a Typical Curve*.



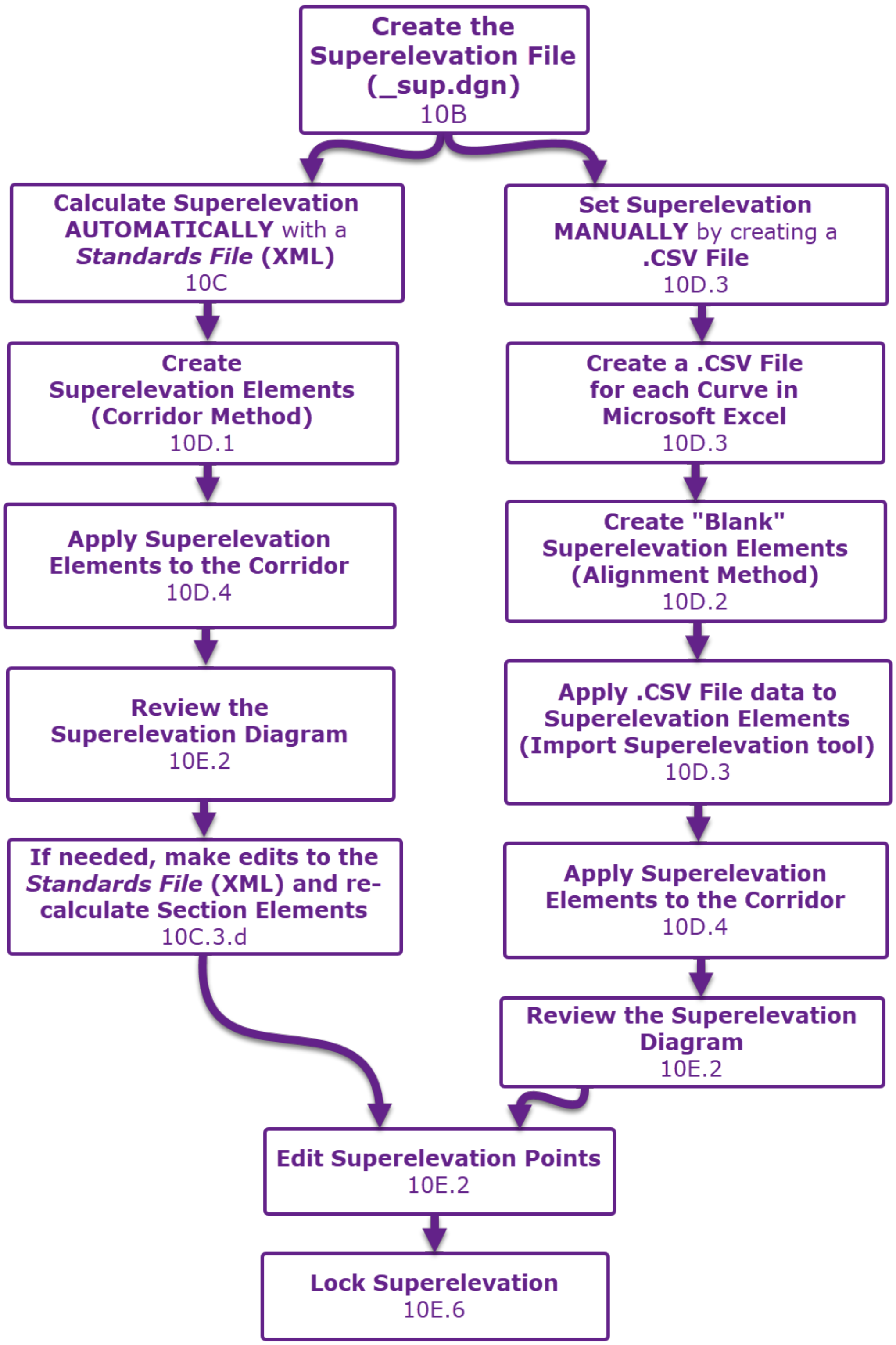
The preferred location to make edits is within the *Superelevation Editor* tool - which contains a Table that lists all Superelevation Point information and shows Constraints relationships. This tool also shows the Superelevation Diagram. See *10E.2 Superelevation Editor tool*.



10A.5 Superelevation Processes Flow Chart

The flow chart below shows the two overall workflows for creating Superelevation Elements. The Flow Chart is divided into two major branches. The left branch shows the overall workflow for creating Superelevation *automatically* – with the software calculating Superelevation Rates and Transition locations with a Standards File (.XML). The right branch shows the workflow for creating Superelevation *manually* with a User-created .CSV File.

The advantages/disadvantages and situations when to use *automatic* vs *manual* method are discussed on the next page.



10A.5.a Automatic Method (.XML) vs Manual Method (.CSV)

In general, the Automatic Method (calculation of Superelevation Rates by the ORD Software) can be more difficult to understand than the Manual Method (calculations performed by the User for each curve).

The Automatic Method has a few "behind the scenes" concepts and operations that the User needs to understand to get the desired outcome and edit Superelevation Points in a predictable manner. For example, the User needs to understand the default configuration of the Standards File (XML) and the Constraints placed on Superelevation Points. To make Superelevation calculations behave as desired, the User may need to slightly modify the Standards File (XML) and make edits to superelevation points (parent), which will automatically adjust child points through constraint relationships.

The Manual Method is conceptually easier to understand. The User will set the lane cross-slope value and station for each Superelevation Point along the transitions of a horizontal curve. The Manual Method may seem more accessible; however, it is very time consuming in both initially setup and when making adjustments in a future design iteration. This chapter explains in detail how the Automatic Method operates to accommodate Conventional Superelevation configurations for FLH Projects.

For Projects that call for a conventional Superelevation configuration, the Automatic Method is recommended over the Manual Method for the following reasons:

- With the Automatic Method, Superelevation Points are dynamic. When the Alignment is adjusted, Superelevation Points will re-calculate and re-position as necessary. With the Manual Method, Superelevation Points are static, which means the User has to manually re-position them when the Alignment is edited. For this reason, the Manual Method may not be feasible for longer Alignments with many horizontal curves.

For custom or non-conventional Superelevation configurations, it may not be possible to manipulate the Standards File (XML) to meet unique Project conditions. In these cases, it may be more time efficient to set Superelevation with the Manual Method. Please note that if the Alignment is edited and stationing is altered, then the User will have to manually adjust Superelevation Points. This can be done with the Superelevation Editor tool or by creating a new CSV and re-applying it to the Section Elements.

10B – CREATE THE SUPERELEVATION ORD FILE (_SUP.DGN)

To help with segregation of data and increase processing speeds in the Corridor ORD File, Superelevation elements (*Sections* and *Lanes*) are typically placed in a dedicated ORD File, which is referred to as the Superelevation ORD File.

The only ORD Files that need to be referenced into the Superelevation ORD File are the Alignment ORD File and the Corridor ORD File.

> ***NOTE:*** It is NOT necessary to reference the Survey ORD File into the Superelevation ORD File. Superelevation elements do NOT directly interact with the Existing Ground Terrain Model.

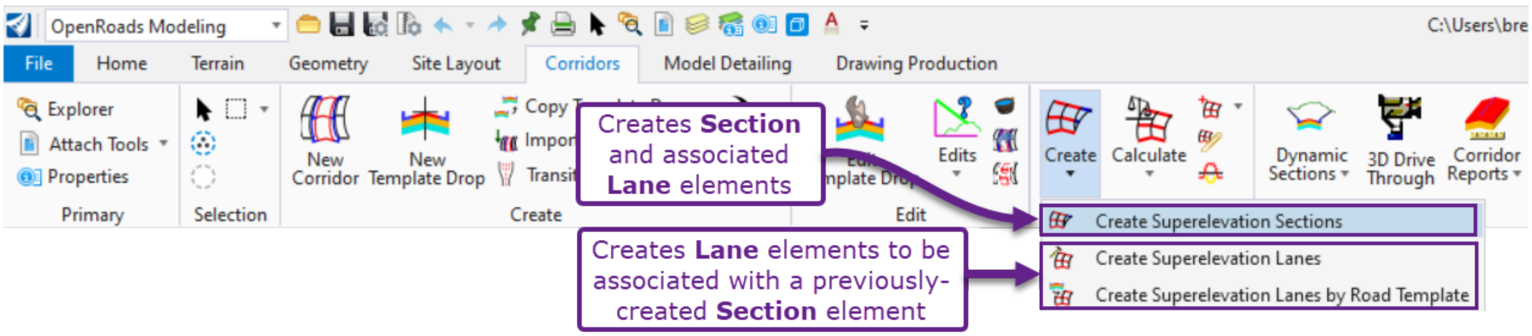
After Superelevation elements are created, the Superelevation ORD File is referenced into the Corridor ORD File. In the Corridor ORD File, the referenced Superelevation elements are applied to the Corridor model with the *Assign to Corridor* tool. See *10D.4 Apply Superelevation Elements to Corridor (Assign To Corridor tool)*.

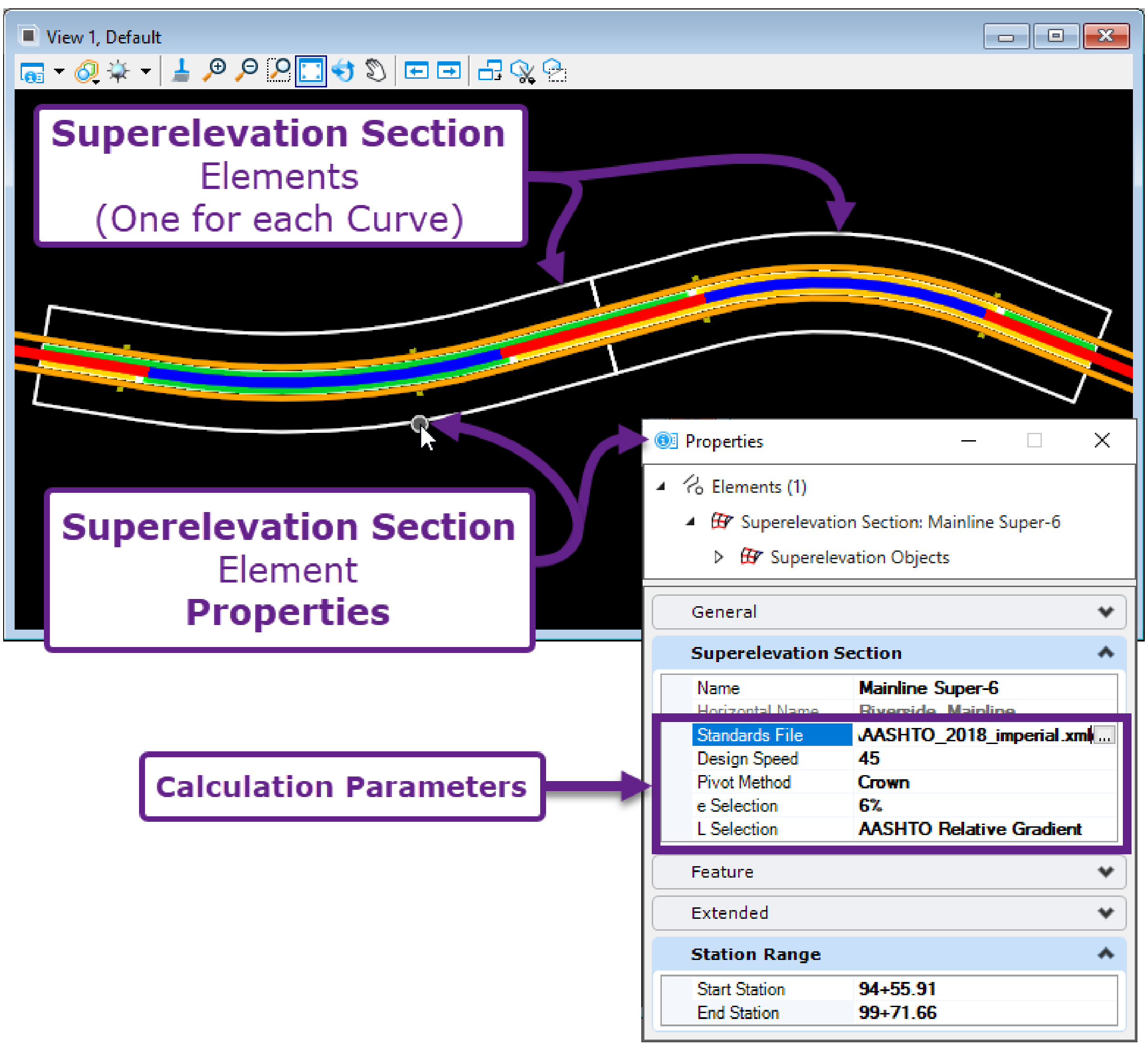
It is not necessary to reference the Superelevation ORD File into any ORD File besides the Corridor ORD File. See *2F.1 Project Organization and Referencing Map for ORD Files*.

10C – PREREQUISITE INFORMATION FOR CREATING SUPERELEVATION

10C.1 Introduction to Sections Elements

Superelevation Sections elements control the automatic calculation of superelevation. The Section element is used to set superelevation rates and transition for the *Lane* elements. When using a *Standards File* (XML) to automatically calculate rates and transitions, all Calculation Parameters are stored in the Properties box of each *Section* element. When manually setting rates and transitions with a CSV File, the CSV File is applied to the *Section* element, which in turns populates superelevation values in the *Lane* elements.



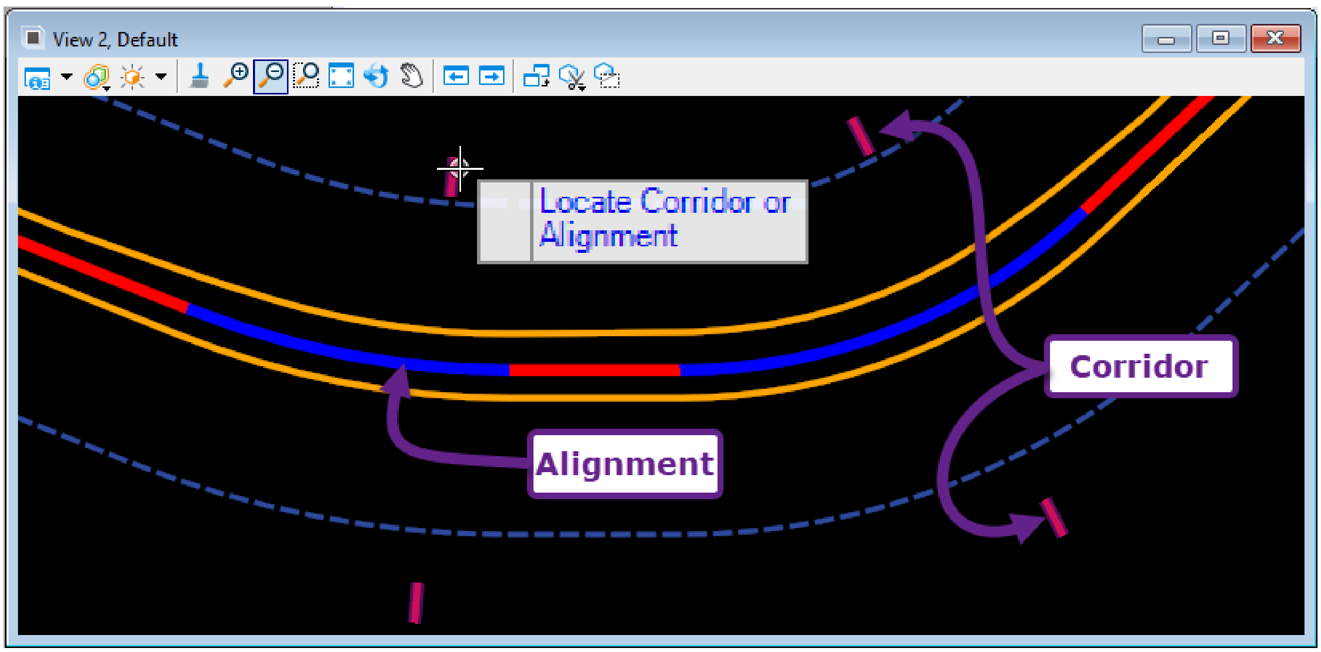


10C.1.a Corridor Method vs Alignment Method

When initially creating superelevation elements, the *Create Superelevation Sections* tool must be used. This tool can be used by selecting the Corridor OR the Alignment. When the *Corridor Method* is used, the overall process is more streamlined, but can be problematic with complex Corridors (see the ***WARNING*** on the next page). For relatively simple Corridors, the *Corridor Method* is recommended because it involves fewer steps and can be more "beginner" friendly. For advanced, complex Corridors, the *Alignment Method* should be used.

Corridor Method: Creating the *Section* elements directly from the *Corridor* is a more streamlined process. With a single use of the tool, *Section* and *Lane* elements are created. The "Corridor Method" requires a *Standards File* (XML) to be specified in creation of the *Section* elements, which means rates and transitions will be automatically calculated. With this method, *Lane* elements are automatically created by analyzing the *Superelevation Flags* in the current Corridor Templates.

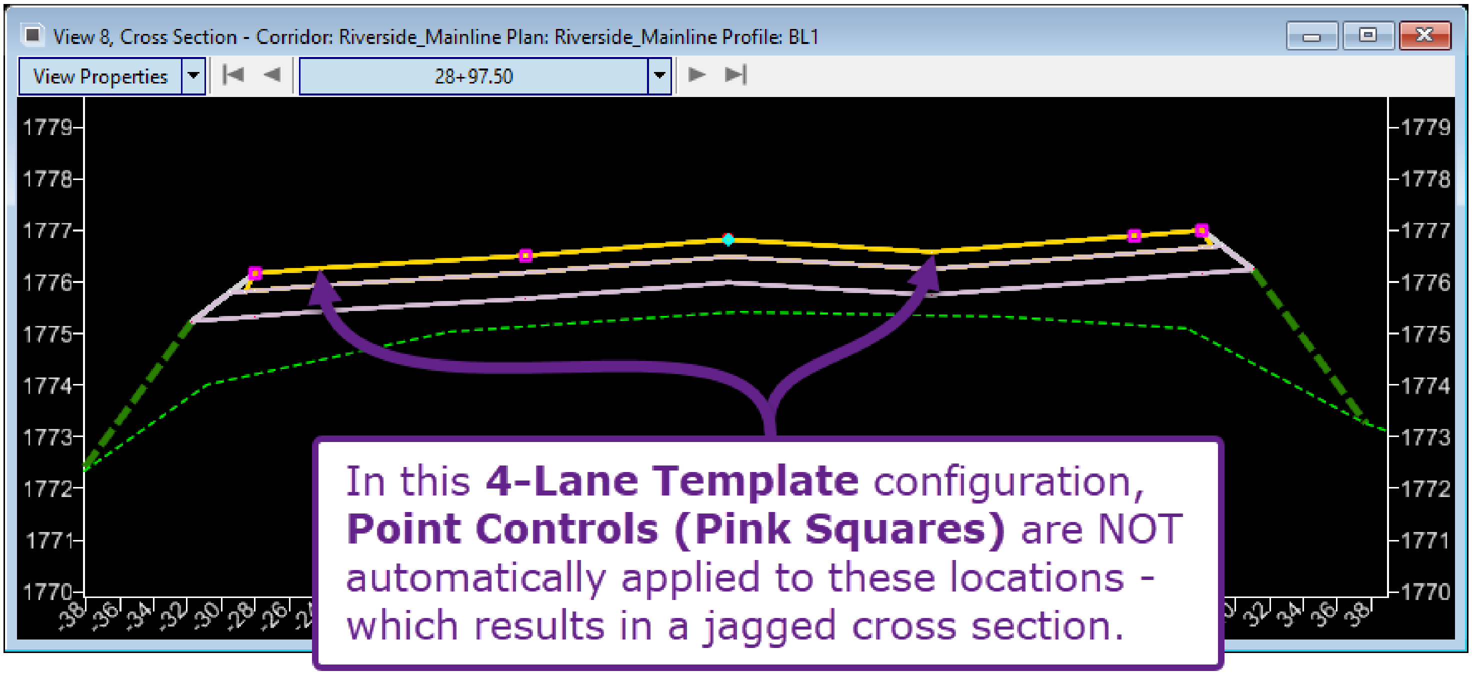
Alignment Method: Like the "Corridor Method", *Section* and *Lane* elements are created with a single use of the *Create Superelevation Section* tools. However, a *Standards File* (XML) is NOT applied to the *Section Elements*. This means the *Section* and *Lane* elements are blank. The User is required to set superelevation rates and transitions with the *Calculate Superelevation* tool (*10D.7*) or with a CSV File (*10D.3*). With "Alignment Method", the User can create *Lane* elements with either the "Template Method" or "Manual Method".



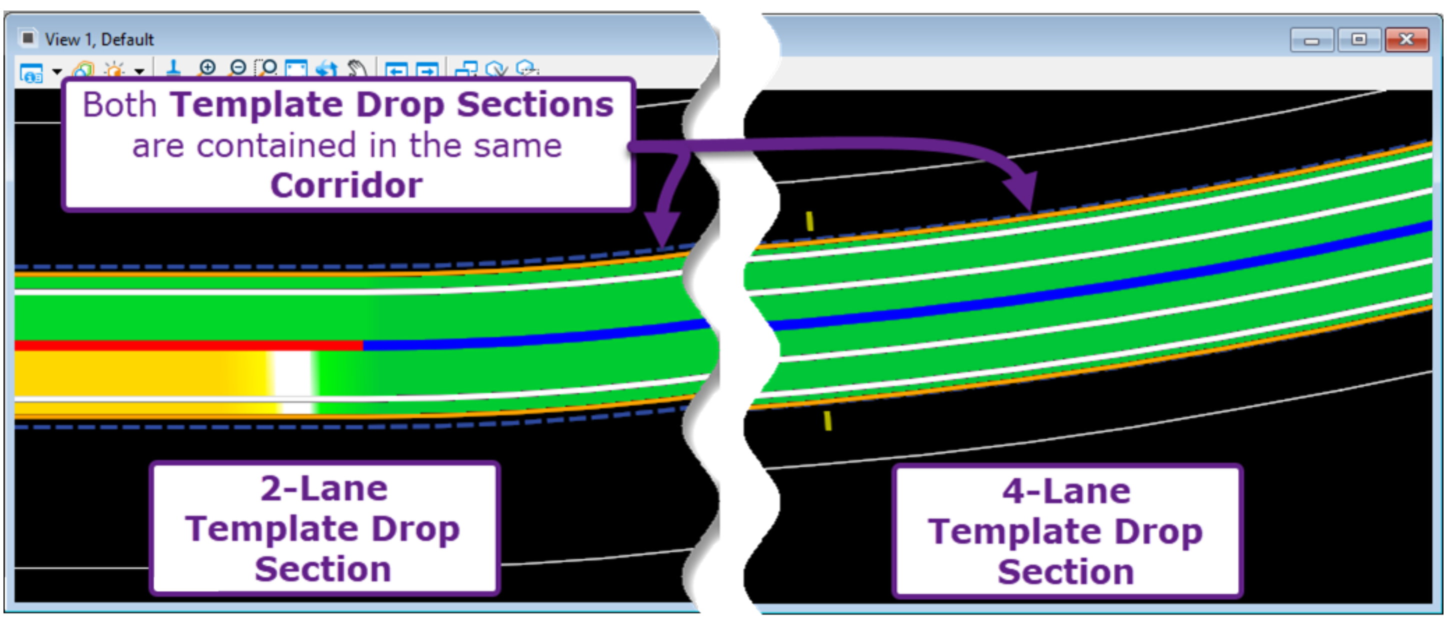
10C.1.b Corridor Method WARNING

WARNING: Do NOT use the *Corridor Method* when the Corridor contains vastly different Template Drops Sections. For example, if a Corridor contains two Templates with different lane configurations, then superelevation may be applied to one of the Templates incorrectly.

In the graphic below, the left-shoulder and right-inside lane are missing Point Control symbols (pink squares) - as a result of using the *Corridor Method* with a Corridor that contains dissimilar Templates. This is a current know defect of the software.



NOTE: The *Corridor Method* operates correctly with 4-Lane Templates. The issues shown above will arise if the 4-Lane Template is proceeded by a 2-Lane Template and both configurations are contained in the SAME Corridor.



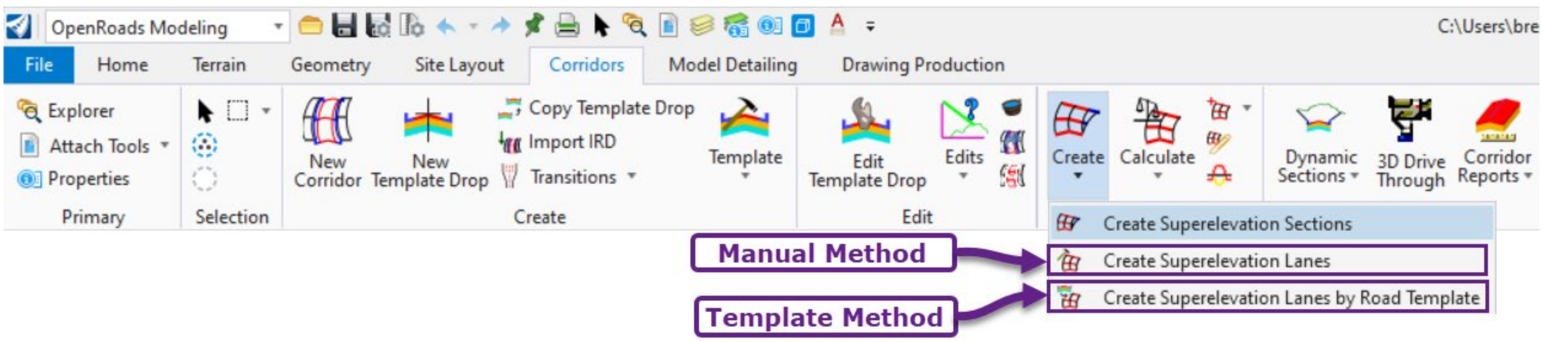
WARNING: Do NOT use the ***Corridor Method*** when the **Corridor** contains dissimilar **Templates**

10C.2 Introduction to Lane Elements

Each *Section* element will have one or more associated *Lane* elements. Superelevation rates and transitions are applied to *Lane* elements. Each *Lane* element has a superelevation diagram that can be viewed with the *Superelevation Editor* tool or the *Open Superelevation View* tool. *Lane* elements are typically created in the last few steps of the *Create Superelevation Section* tool. However, there are dedicated *Lane* creation tools as shown in the graphic below. See *10A.2 Superelevation Elements in the 2D Design Model* for a graphical distinction between *Lane Elements* and *Section Elements*.

10C.2.a Template Method vs Manual Method

Lane elements can be created manually or by analyzing a Template.



Template Method: The User specifies a road Template from the loaded Template Library. The appropriate number of *Lane* elements are created and configured automatically based on the location of *Superelevation Flags* in the Template. *Lane* parameters – such as width and Normal Crown cross-slope value are automatically set.

This method of Lane creation is used when the "Corridor Method" is used to create *Section* elements.

The Create Superelevation Lanes by Road Template tool utilizes the "Template Method". For operation of this tool, see *10D.5 Create Superelevation Lanes tool*.

Manual Method: The User creates each *Lane* manually by specifying *Lane* parameters – such as lane width, Normal Crown cross-slope value, and which side of the lane is the Pivot Point.

The Create Superelevation Lanes tool utilizes the "Manual Method". For operation of this tool, see *10D.6 Create Superelevation Lanes by Road Template tool*.

IMPORTANT: *Lane* elements are typically created in conjunction with the *Section* elements, when the *Create Superelevation Section* tool is used.

The *Lane* creation tools ONLY need to be used in two situations:

1. *Lane* elements were not created initially with the *Create Superelevation* tool. This happens when the User exits (right-clicks) from the *Create Superelevation* tool prematurely.
2. The *Lanes* elements were initially created incorrectly. The User may wish to delete the incorrect *Lane* elements and re-create them correctly with the *Lane* creation tools.

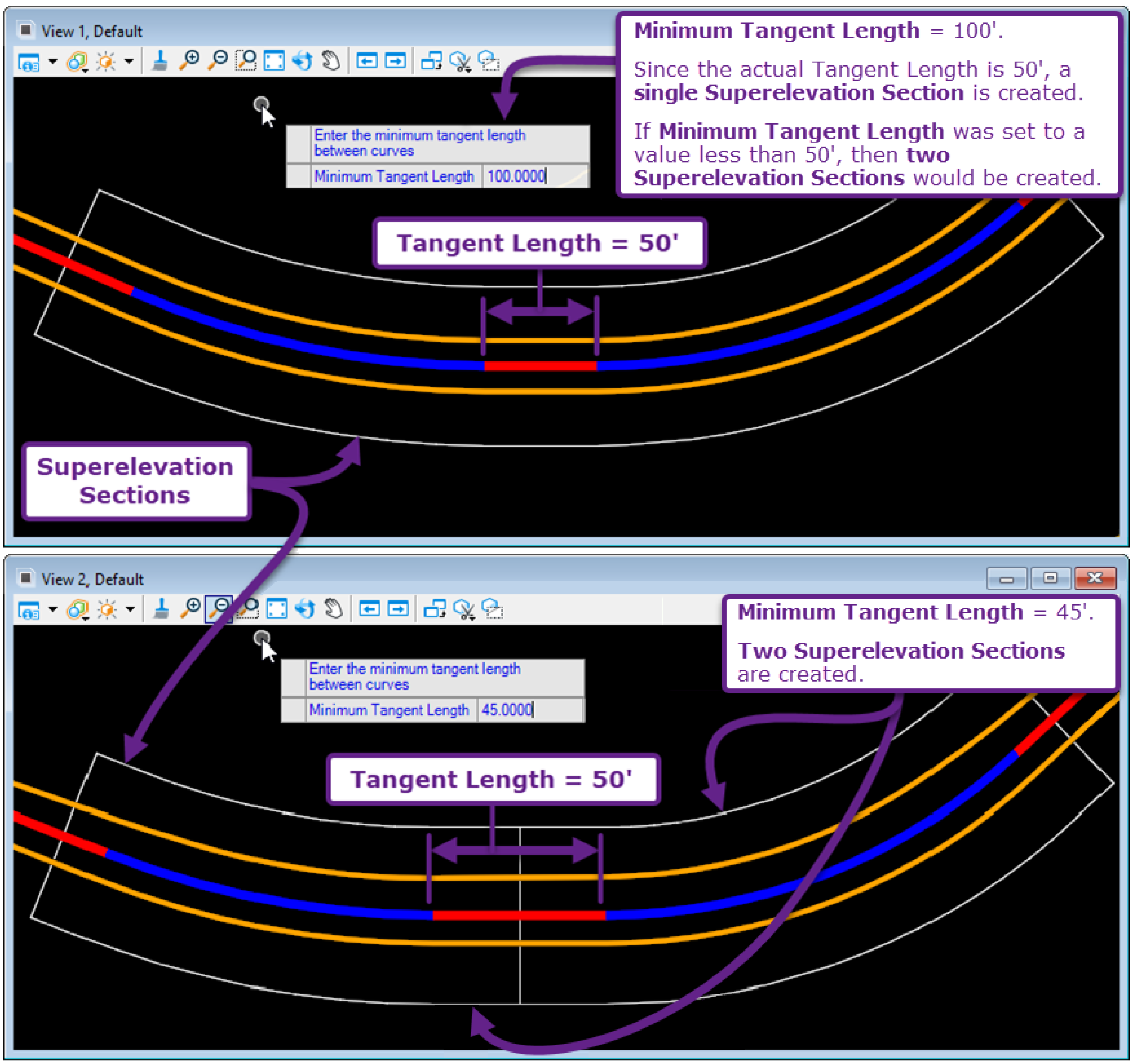
10C.3 Calculation and Layout of Superelevation Elements

10C.3.a Layout of Sections Elements (Minimum Tangent Length)

Ideally, a *Section* element is created for each curve along the mainline alignment. The exception is for close curves, such as reverse curves or compound curves. In those cases, a single *Section* element should be created to span all close curves. In general, a single *Section* should be created for two or more curves that contain overlapping runoff transitions.

The User can control the creation and layout of *Section* elements with the *Minimum Tangent Length* value. If the tangent length between two curves exceeds the *Minimum Tangent Length* value, then TWO *Section* elements are created.

BEST PRACTICE: In the case when transition segments for two curves overlap (i.e., Reverse Curves or Compound Curves), a single *Section* element should be created to span the overlapping curves. In all other cases, a single *Section* element should be created for each curve. This convention greatly improves the management and readability of the table of the *Superelevation Editor.* The table is much more organized because only the Superelevation Points for the focused curve are presented. If a single *Section* element was used to span the entire alignment, then all Superelevation Points for the project are shuffled together in the table of the *Superelevation Editor*.



10C.3.b Calculation Parameters for Superelevation Sections

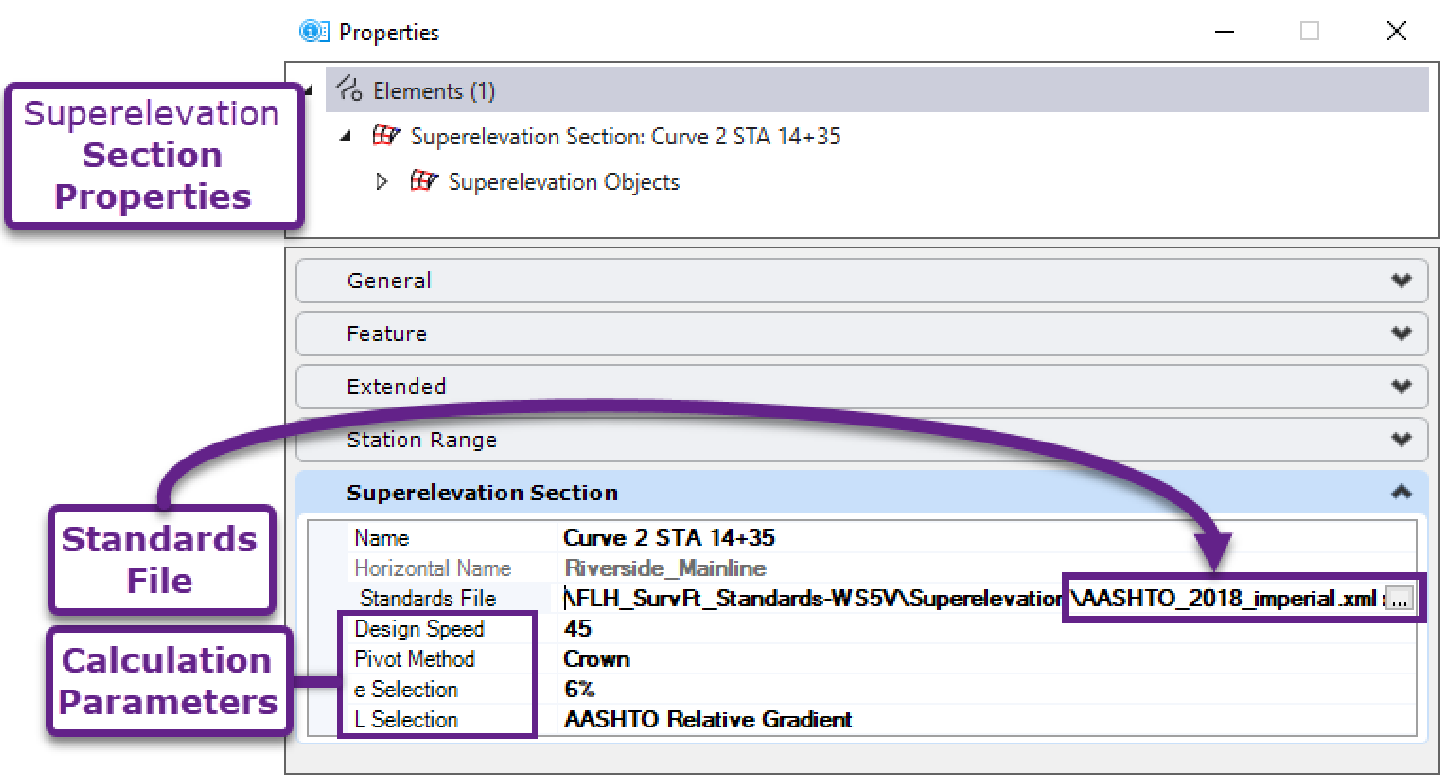
Superelevation rates and transitions are calculated from a .XML File, which is referred to as the *Standards File* (XML). The *Standards File* (XML) contains superelevation **Tables** and **Equations** found in the AASHTO Greenbook. See the next page for a more detailed explanation of each **Calculation Parameter**.

To inform the software on the correct superelevation tables or equations to use from *Standards File* (XML), the following **Calculation Parameters** need to be specified and input by the User:

- **Design Speed:** Each *Section* has a designated design speed – which is used in calculations.
- **e Selection:** Determines the maximum superelevation rate (e max) to be used. The maximum superelevation rate is only used with the radii set to the minimum radius value. Radii that are less than the minimum radius value will be set to a superelevation rate that is less than the maximum superelevation rate.
- **L Selection:** Transition length calculation method:
  - **Speed Table:** Transition lengths are *drawn* from **Table 3-16a** in the Green Book.
  - **Relative Gradient:** Transition lengths are *calculated* from **Equation 3-23** in the Green Book.
- **Pivot Method:** Determines how *Lanes* are rotated. Typically set to *Crown* if the Corridor Alignment coincides with the road crown. See *10C.3.b.i Pivot Methods*.
- **Standards File (XML):** .XML File that corresponds to the recent versions of the AASHTO Greenbook (i.e., 2014 or 2018)

The **Standards File (XML)** is found in the FLH Workspace at the following location:
…\OpenRoads Designer CE 10.10\Configuration\Organization-Civil\FLH_Stds-WS10.10.21.00V\Superelevation

NOTE: After a *Section* element has been created, the **Calculation Parameters** and **Standards File (XML)** can be changed in the Properties box. Alternatively, use the *Calculate Superelevation* tool with a *Section* element to change the calculation parameters and standard file. (See *10D.7* and *10E.1*)



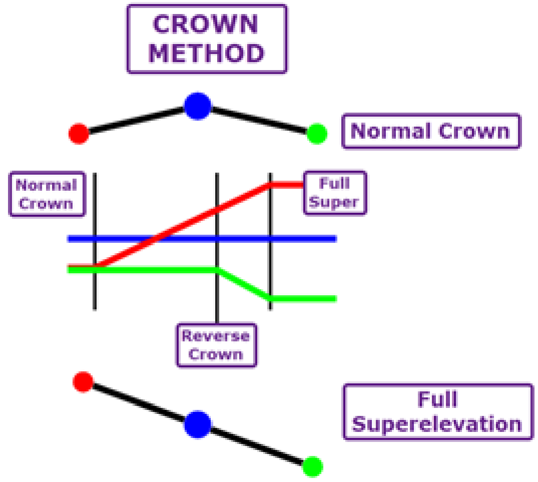
<table>
<tr><th colspan="3">Calculation Parameters</th></tr>
<tr><th>Input</th><th>Description:</th><th>Method:</th></tr>
<tr><td>Design Speed</td><td colspan="2">This input sets the Design Speed (in MPH) for the Superelevation Section. The Design Speed is used in calculations pertaining to “e Selection” and “L Selection”.</td></tr>
<tr><td>Pivot Method</td><td colspan="2">Sets the scheme for how lanes are rotated. Most roadways are rotated relative to the crown point, which corresponds with the Crown Pivot Method. For more information, see 10C.3.b.i Pivot Methods.</td></tr>
<tr><td rowspan="2">e Selection</td><td rowspan="2">This input has two purposes:
1. Sets the maximum superelevation slope value (e max) allowed on the project.
2. Specifies the method in which the superelevation slope for each curve is obtained from the Standards File (XML).</td><td>AASHTO Method 5 for 8% eMax Equation
Superelevation slope values at each curve are calculated from Equation 3-20 in the AASHTO Green Book. WARNING: This method is only appropriate if the maximum superelevation slope value (e max) for the project is specifically set to 8%.</td></tr>
<tr><td>4%, 6%, 8%, 10%, or 12% Tables
The Superelevation slope value for each curve is drawn from the appropriate superelevation table found in the AASHTO Green Book.
4% (Table 3-8)
6% (Table 3-9)
8% (Table 3-10)
10% (Table 3-11)
12% (Table 3-12)</td></tr>
<tr><td rowspan="2">L Selection</td><td rowspan="2">This input determines how the Transition Lengths. Transition Length includes both Superelevation Runoff and Tangent Runout.
For information on how the Transitions are placed, see 10C.3.c Placement of Transition Points in Relation to the PC/PT of Curves.</td><td>Speed Table
Transition lengths are drawn from Table 3-16a in the AASHTO Green Book.
WARNING: The Speed Table method is not appropriate if the Paved Shoulder (say 4’ wide) is modeled as a Superelevation Lane. The Speed Table method and Table 3-16a assumes that 12-ft lanes are used. The software automatically determines the number of lanes based on the number of Lanes elements established in the Corridor Template. The Speed Table Method will interpret a 4’ shoulder as a 12’ travel lane. This would result in longer than necessary Transition Lengths and a shallower Relative Gradient value.</td></tr>
<tr><td>AASHTO Relative Gradient
Transition Lengths are calculated from the AASHTO Relative Gradient Equation (Eq. 3-23).
With the AASHTO Relative Gradient method, the actual width of each Superelevation Lane is taken into account to achieve an exact relative gradient value Δ on the pavement edge.
NOTE: By default, the relative gradient value (Δ) is based on Design Speed. However, a custom value be used by modifying the Standards File with the Edit Superelevation Rule File tool.</td></tr>
</table>

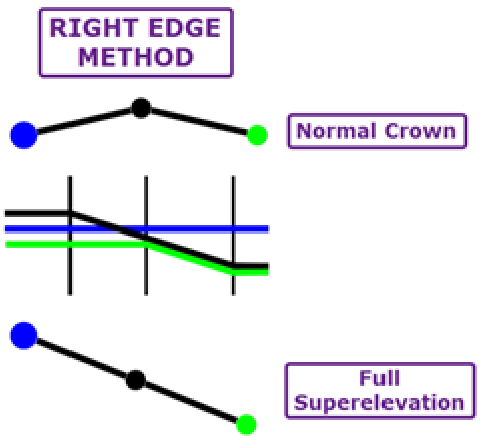
10C.3.b.i Pivot Methods

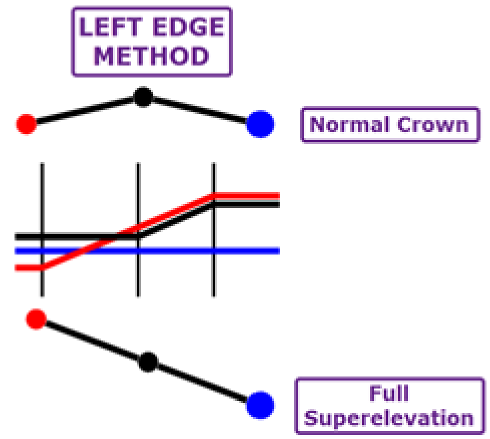
The graphic on the next page provides a visual key on how to interpret the different Pivot Methods available for *Superelevation Lanes*.

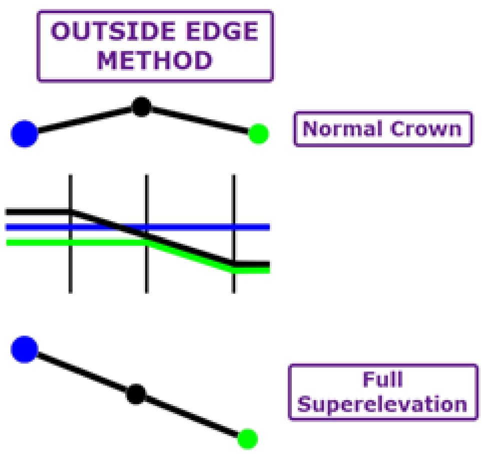
The *Crown* Pivot Method is used for most crowned roadways with the Horizontal Alignment positioned on the centerline of road.

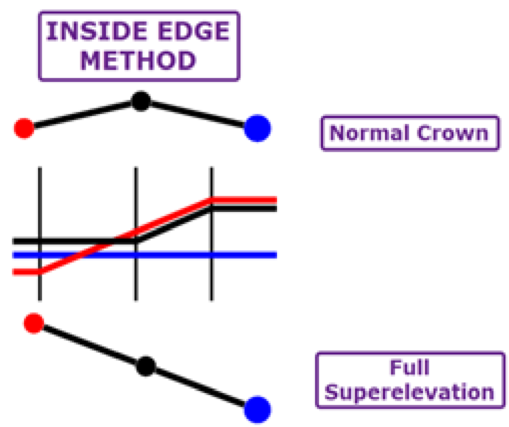
For roadways with Horizontal Alignment positioned on the edge of road, the User should choose one of the following methods: *Inside Edge*, *Outside Edge*, *Left Edge*, or *Right Edge.* If the *Inside Edge* or *Outside Edge* methods are used, then the Ultimate Pivot Point location will change to correspond with either the inside or outside edge of road. If the *Left Edge* or *Right Edge* methods are used, then the Ultimate Pivot Point location will always be on either the left or right edge of road.

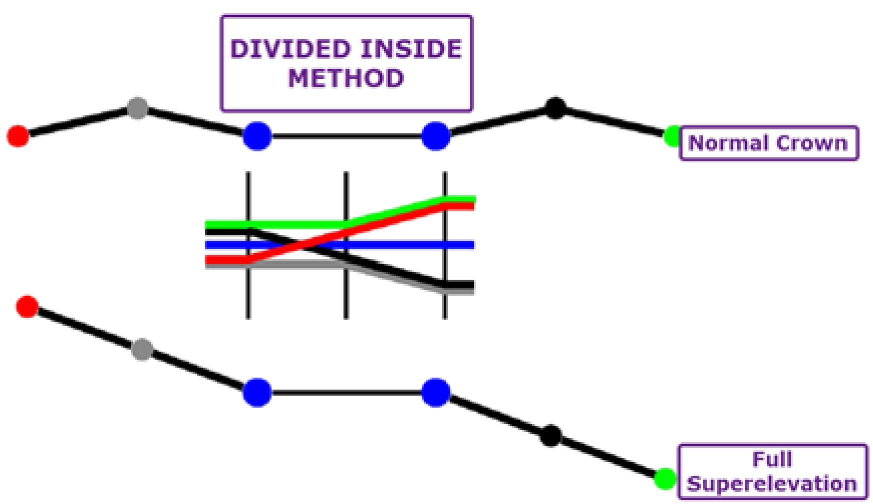

CROWN METHOD
Normal Crown
Normal Crown
Full Super
Reverse Crown
Full Superelevation


RIGHT EDGE METHOD
Normal Crown
Full Superelevation


LEFT EDGE METHOD
Normal Crown
Full Superelevation

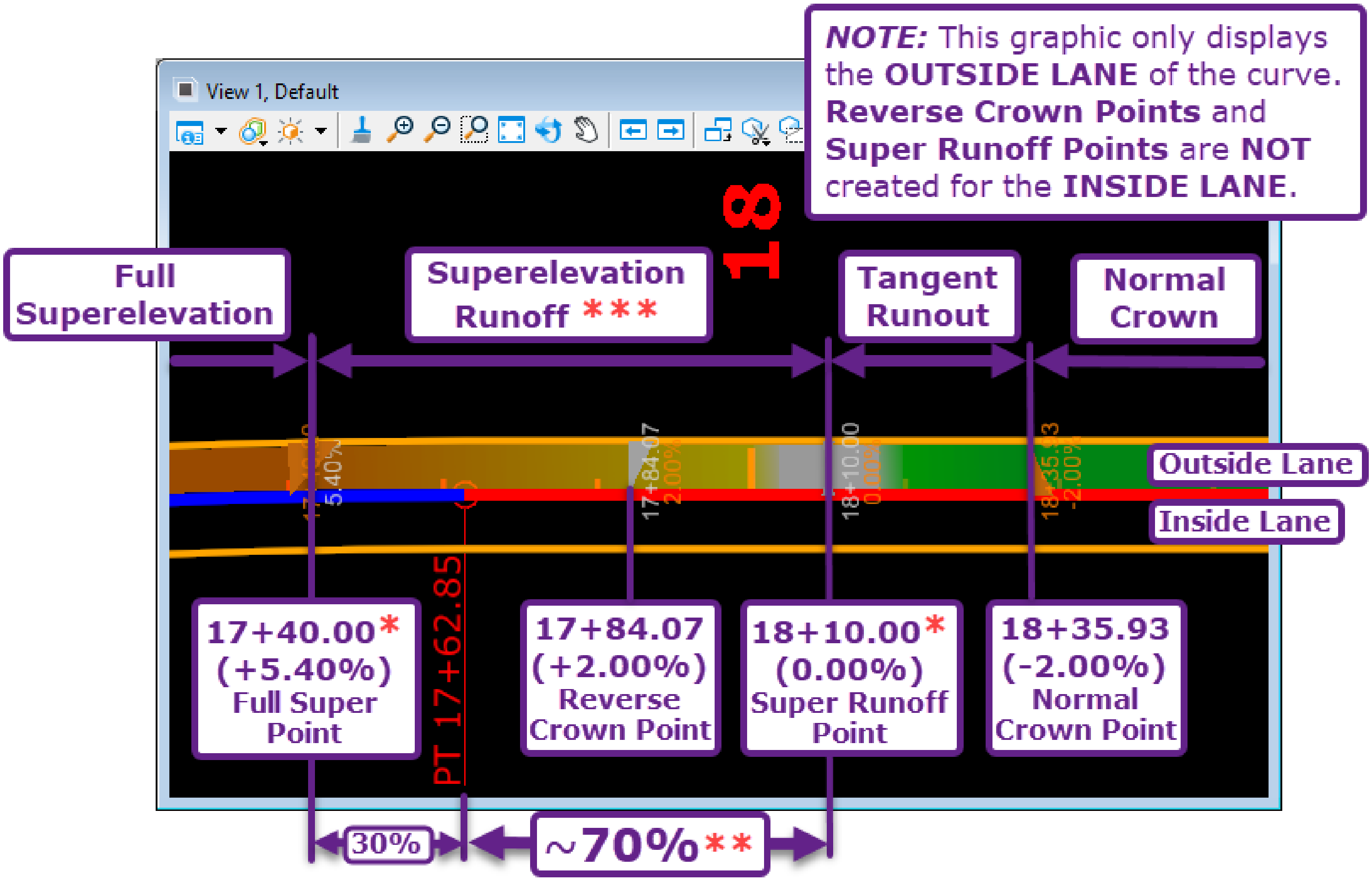

OUTSIDE EDGE METHOD
Normal Crown
Full Superelevation


INSIDE EDGE METHOD
Normal Crown
Full Superelevation


DIVIDED INSIDE METHOD
Normal Crown
Full Superelevation

10C.3.c Placement of Transitions Points in Relation to the PC/PT of Curves

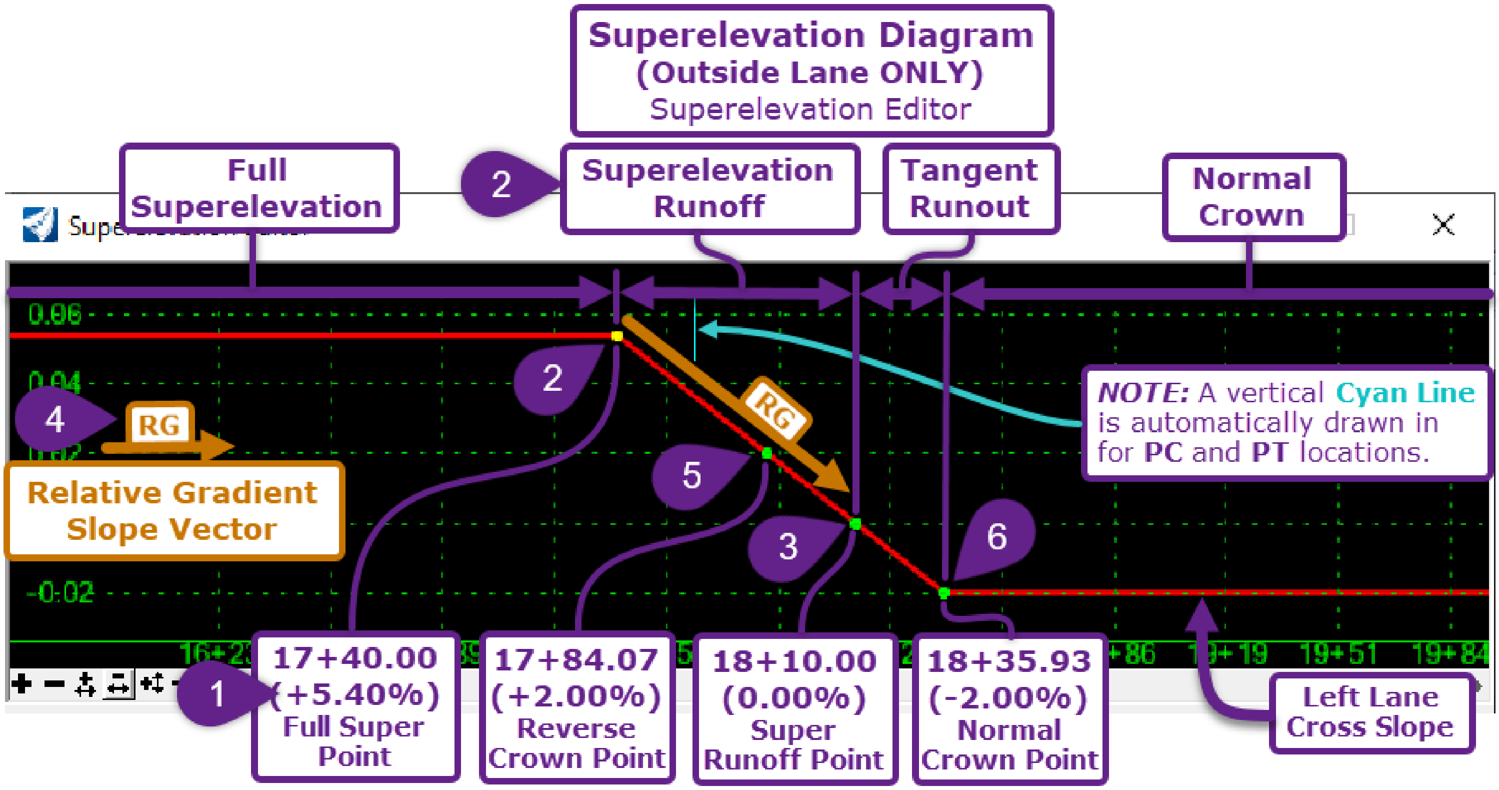
By default, transition locations are automatically placed such that 70% of the Superelevation Runoff length is placed on the tangent**. The default *Percent On Tangent* value of 70% is coded into the *Standards File* (XML), but can be changed with the *Edit Superelevation Rules File* tool. See *10C.3.d*.
NOTE: The Tangent Runoff length is NOT factored in the 70% *Percent On Tangent* calculation.



WARNING: By default, the stationing for the *Full Super Point* and *Super Runoff Point* are rounded to the nearest **5** – relative to the start station of the Alignment. For example, if the start station of the Alignment was 9+9**7.52** – then the station for *Full Super Point* and *Super Runoff Point* would end in XX+X**7.52** or XX+X**2.52**. In the example above, the start station of the Alignment is 10+00.00 – which is why *Full Super Point* and *Super Runoff Point* are placed at nice, round stations. The default *Station Rounding* of 5 is coded into the *Standards File* (XML) but can be changed with the *Edit Superelevation Rules File* tool.

****WARNING:*** If you do the math for the example shown above, only 67.36% of the *Superelevation Runoff* length is shown on the tangent. This is due to the default *Station Rounding* value of 5. The *Percent on Tangent* value is slightly altered to allow the *Full Super Point* and *Super Runoff Point* to be placed at station intervals of 5. If the *Station Rounding* value was set to 0 in the *Standards File* (XML), then EXACTLY 70% of the Superelevation Runoff length would be placed on the tangent.

*****WARNING:*** It is encouraged for the User to check the calculated *Superelevation Runoff* length (in ORD) with the corresponding tables and equations found in the AASHTO Green Book. However, the calculated lengths (in ORD) and the Green Book lengths will slightly differ by default. This is again due to the default *Station Rounding* of 5. The *Superelevation Runoff* length is slightly altered to allow for *Station Rounding*. If the *Station Rounding* was set to a value 0, then the calculated length (in ORD) will EXCACTLY match the lengths found from the tables or equations in the Green Book.



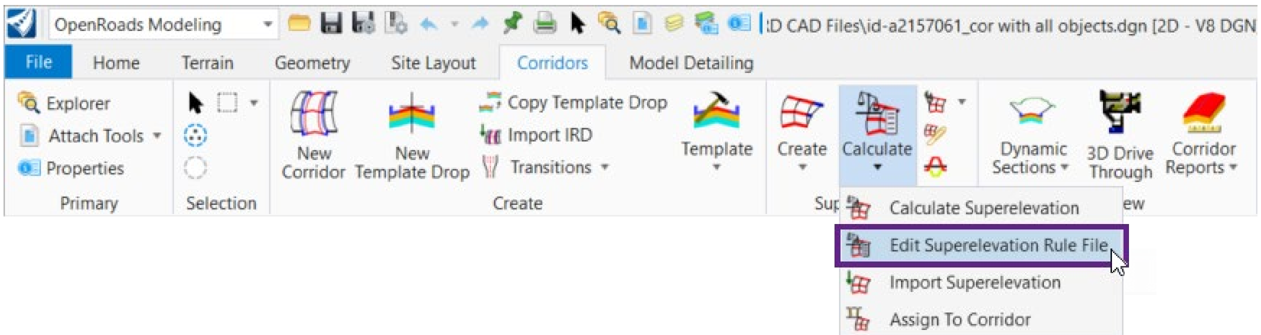
The processing and calculations for Superelevation transition points is as follows:

1	The cross-slope value for the **Full Super Point** is calculated based on the radius of the curve and the *e-Selection* method used (in this case +5.40%).
2	The **Superelevation Runoff** length is calculated based on the *L-Selection* method used. The station for the **Full Super Point** is placed along the curve at ~30% length away from PT or PC of Curve (in this case 17+40). The station is affected by the *Percent on Tangent* and *Station Rounding* values found in the *Standards File* (XML).
3	The station of the **Super Runoff Point** is placed relative to the **Full Super Point –** at a distance equaling 100% of the **Superelevation Runoff** length. ***NOTE:*** The cross-slope value of a **Super Runoff Point** is always 0.00%. The *Stationing Rounding* values influence the placement of this **Super Runoff Point**, which results in a slightly different calculated **Superelevation Runoff** length when compared with the Green Book value.
4	With **Full Super Point** and **Super Runoff Point** placed, the **Relative Gradient Slope Vector** is established between these points. See *10E.2.f Constraint Relationships for a Typical Curve*.
5	The station of the **Reverse Crown Point** (which always equals +2.00%) is *interpolated* along the **Relative Gradient Slope Vector** established by the **Full Super Point** and **Super Runoff Point** (in this case 17+84.07). ***NOTE:*** The **Reverse Crown Point** must be placed on an unround station to maintain a constant **Relative Gradient Slope Vector** through all Points in the transition.
6	The position of the **Normal Crown Point** – which always equals -2.00% - is *extrapolated* along the **Relative Gradient Slope Vector** (in this case 18+35.93). ***NOTE:*** Similarly, the **Normal Crown Point** will likely be placed on an unround station to maintain a constant **Relative Gradient Slope Vector** through the entire transition.

10C.3.d Edit the Superelevation Rule File tool

The *Edit Superelevation Rule File* tool is used to modify the *Standards File* (XML). The *Standards Files* (XML) contains all AASHTO Superelevation Tables/Equations. Additionally, a few important Calculation Parameters are set in the *Standards Files* (XML) and can be customized with this tool.

WARNING: This tool will alter the contents and coding within the .XML File. The User should make a copy of the *Standards File* (XML) before use of this tool. Alternatively, the User can perform a *Save As* of the *Standards File* from within this tool. See steps 2 and 3 of workflow *10C.3.d.ii*.

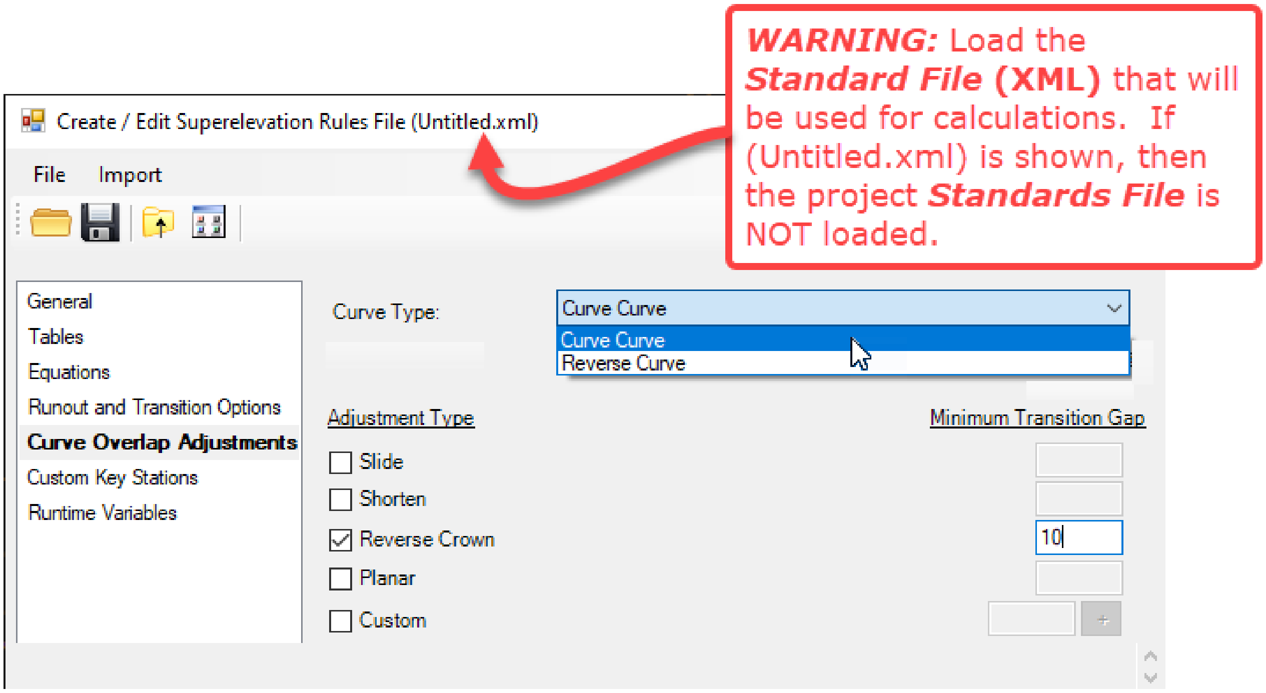


Some of the more important Calculation Parameters that are modified with this tool include:

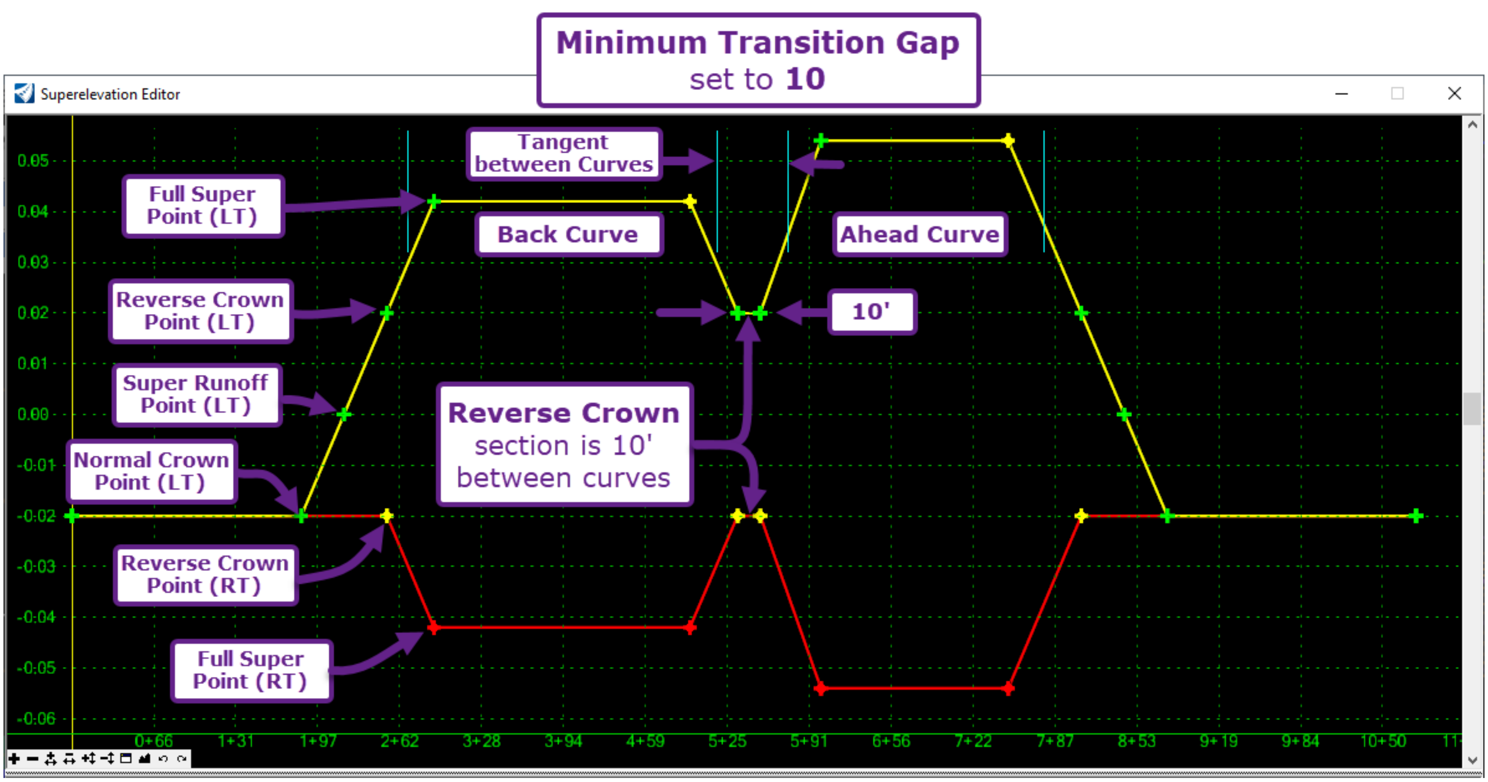
Standards File – Calculation Parameters		
Parameter	**Description**	**Default**
Station Rounding	The Station value for **Full Super** and **Super Runoff** points are rounded to the specified value – in relation to the start station of the alignment. For example, if the start station of the Alignment was 9+9**7.52** – then the station for Full Super Point and Super Runoff Point would end in XX+X**7.52** or XX+X**2.52**. Stations for **Reverse Crown Points** and **Normal Crown Points** are NOT rounded. See *10C.3.c* Placement of Transition Points in Relation to the PC/Pt of Curves.	5 ft
Cross Slope Rounding	By default, the Cross-Slope value of the Full Super point is rounded to a hundredth of a percent (0.01%). For example, if this was changed to 1.00%, then cross-slope value at each curve would be a whole number percent (i.e., 5% or 3%)	0.01%
Percent On Tangent	Controls the placement of transition points in relation to the PC or PT of the Curve. For example, if this was changed to 1.0 (100%), then the entire transition would be in the tangent and the Full Super Point is placed at the PC or PT station. ***NOTE:*** This option is found in the Runout and Transition tab.	0.7 (70%)
(Tangent) Runout Options	The Tangent Runout length for all curves can be fixed to a specified value. By default, this option is not used, and Tangent Runout lengths are calculated in the same manner as Superelevation Runoff lengths.	Not used
Use Spiral Length	If this box is checked then the Superelevation Runoff lengths will EXACTLY equal the length of the spiral – assuming a spiral is used with a curve. The Tangent Runout length will be placed entirely on the tangent. The Full Super Point is placed exactly at the PC or PT of curve. By default, this option is NOT used. When this option is NOT used, the Spiral transition is treated as part of the tangent.	Not used
Curve Overlap Adjustments	When the transitions lengths of two curves overlap – such is the case of Reverse Curves or Curve-Curve (Compound Curves), these parameters control how the transitions behave. See *10C.3.d.i Curve Overlap Adjustment Methods*.	Planar

10C.3.d.i Curve Overlap Adjustment Methods

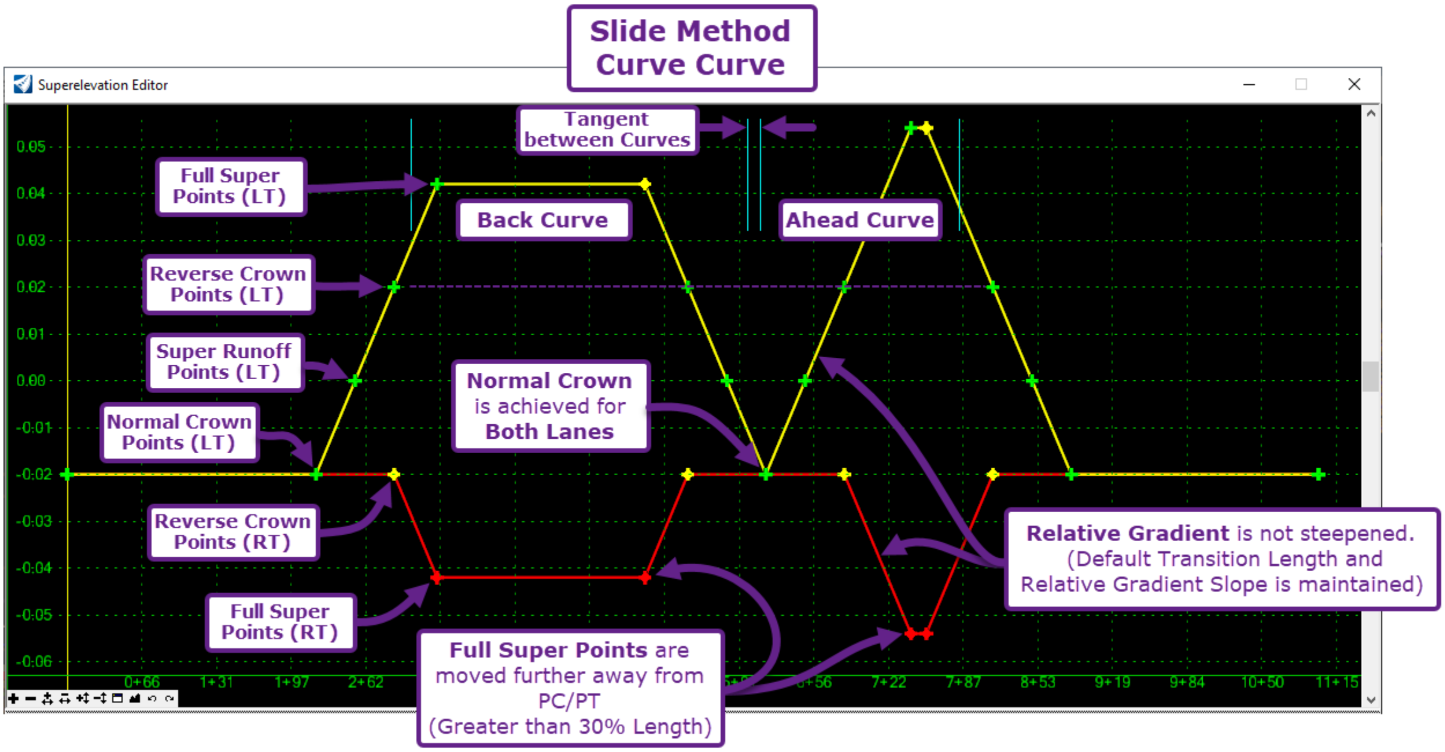
This section explains the different methods for the calculation of transitions when curves overlap. Adjustment Types are listed in the *Curve Overlap Adjustment* tab of the *Edit Superelevation Rules File* tool.

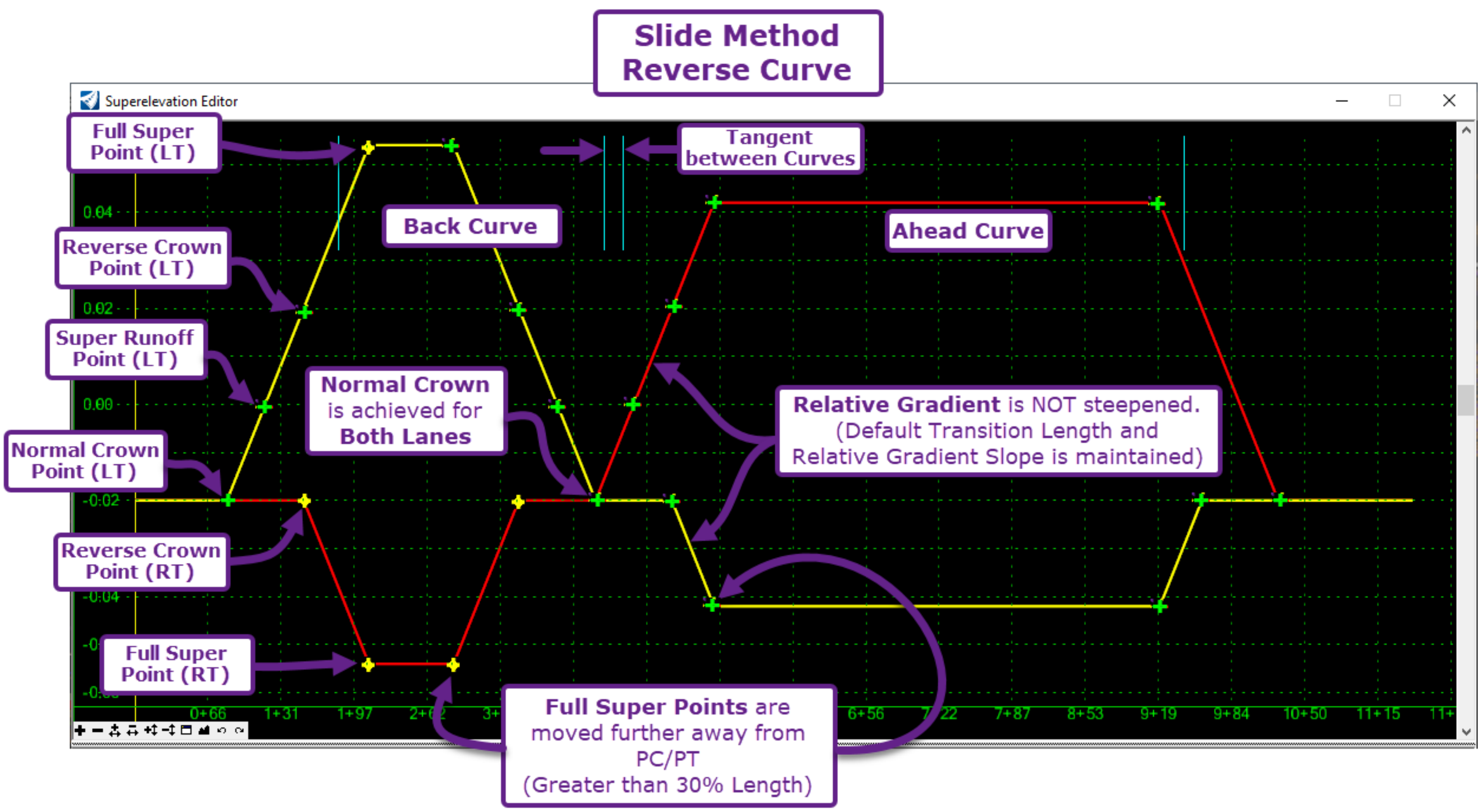


Minimum Transition Gap: A value MUST be set in this box for the *Adjustment Type* to take effect. This value sets the length for the Normal Crown or Reverse Crown section between curves. In the example graphics shown on the succeeding pages, the *Minimum Transition Gap* was set to 0.00 – which results in a Normal/Reverse Crown lane slope achieved for a single point station. If this value was set to 10, then the lanes would have a 10' Normal/Reverse Crown section before transitioning back to the Full Super point.

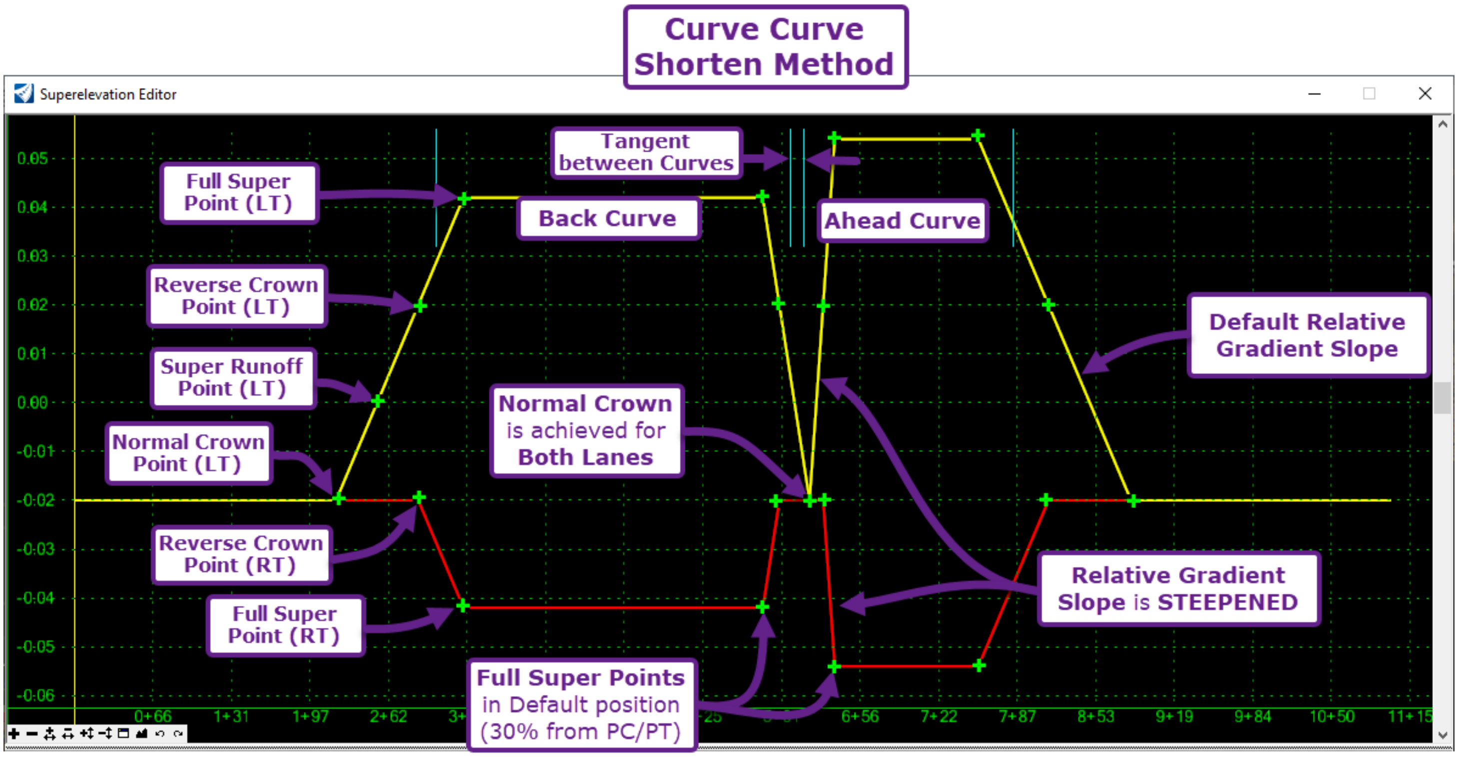


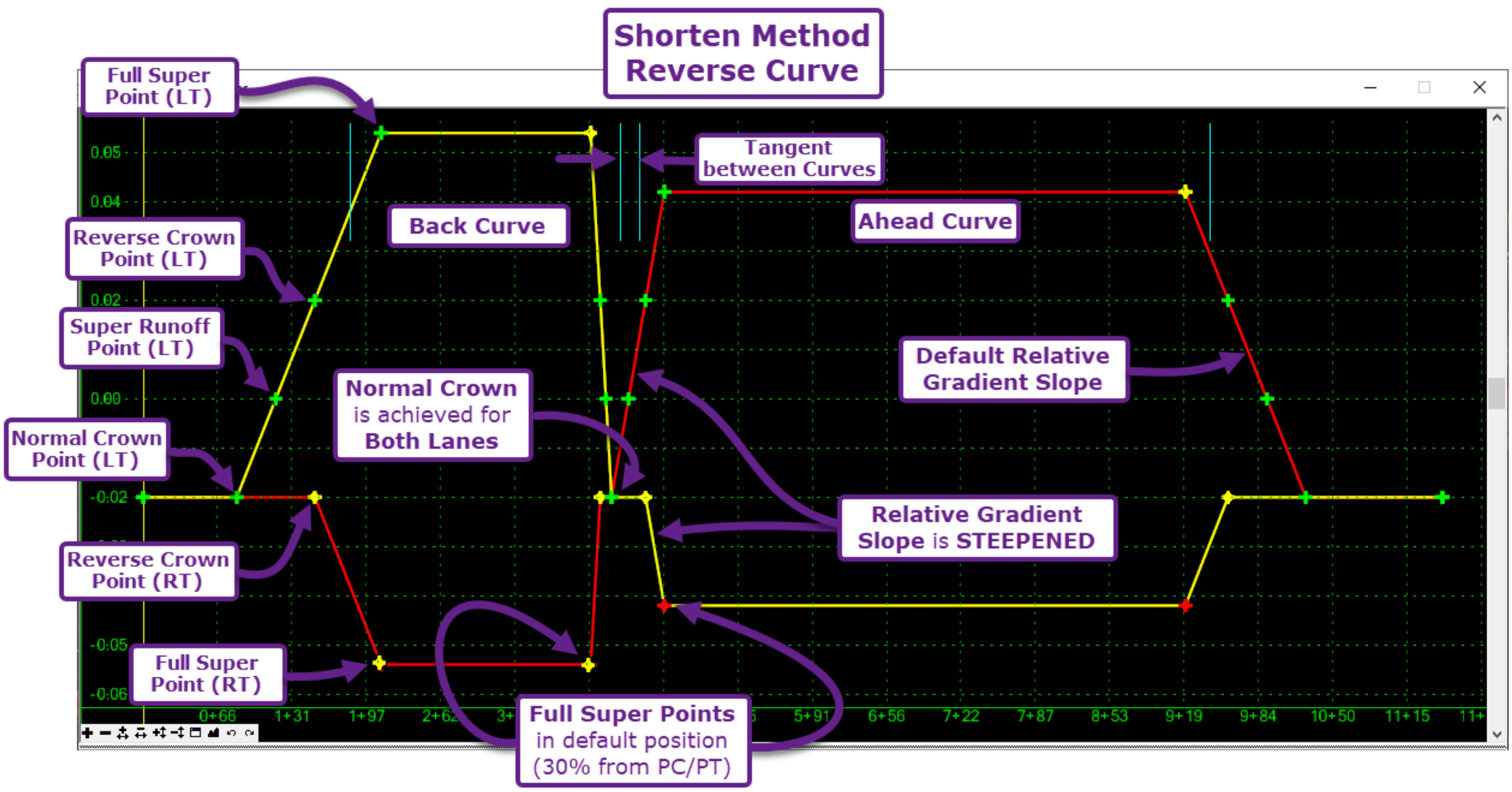
Slide: The **Full Super** points are moved away from the PC or PT of the Curves, which means the full calculated *Superelevation Runoff* lengths for the overlapping curves are not compromised. The slope of the Relative Gradient for transitions in the overlapping area is NOT steepened. In other words, the transitions are moved closer into the curves to achieve a Normal Crown for both lanes in the transition area.



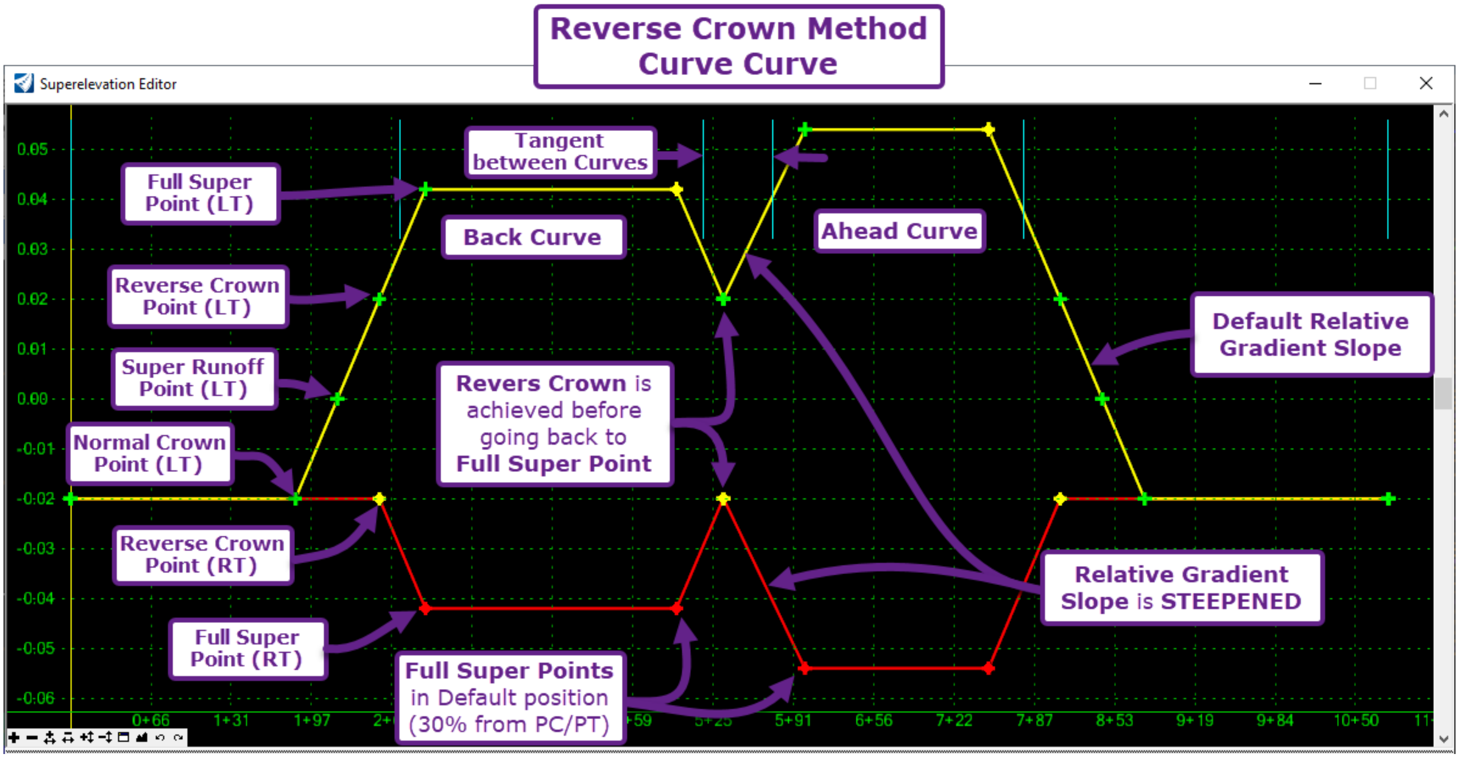


Shorten: The **Full Super** points are kept in the default positions, but the *Superelevation Runoff* lengths are shortened to achieve a *Normal Crown* between the PT and PC of the overlapping curves.

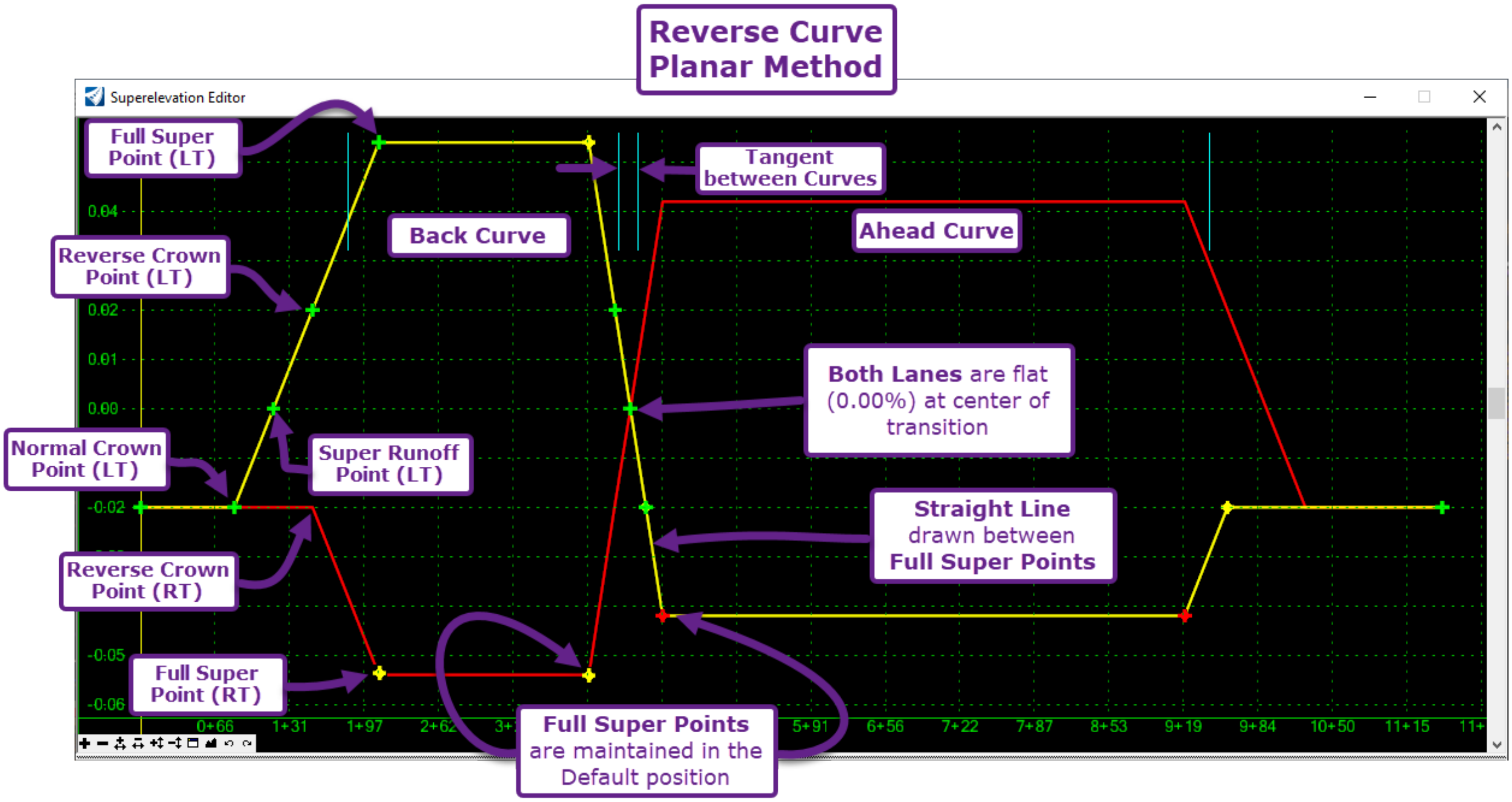


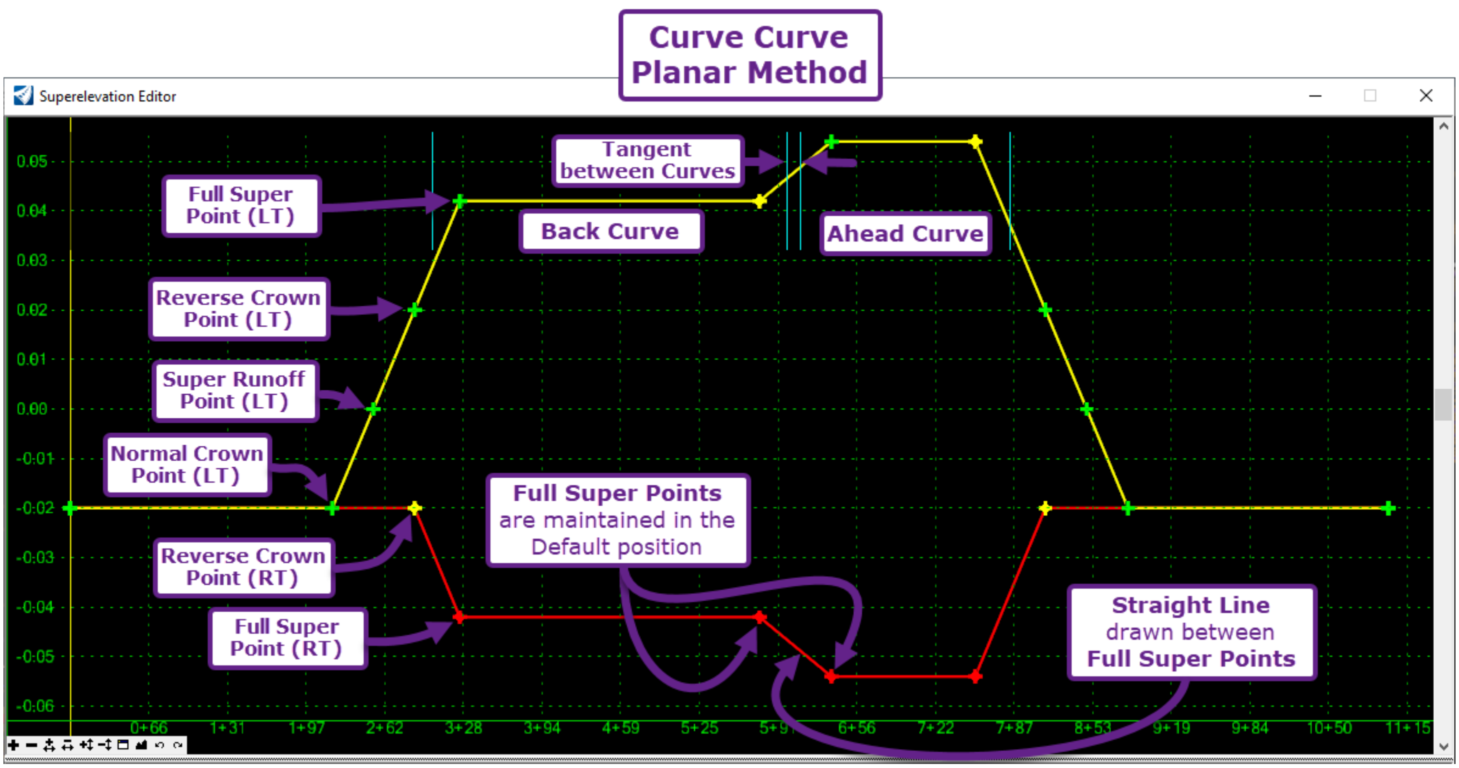


Reverse Crown: Applies to Curve-Curves only. Like the *Shorten* method, the **Full Super** points are kept in the default positions. The transition lengths are shortened as necessary to achieve a *Reverse Crown* for both lanes exactly between the PT and PC of the Compound Curve (Curve-Curve).



Planar: The **Full Super** points are kept in their default position and the cross-slope transition is constant from one curve to the next. In the Diagram, a straight line is drawn from the **Full Super** point of the Back Curve to the **Full Super** point of the Ahead Curve. In the case of Reverse Curves, both lanes are completely flat at the center of the transition – which can result in a drainage issue if the Profile grade is also flat at this station.





10C.3.d.ii Edit Calculation Parameters with the Edit Superelevation Rule File tool

In this example workflow, various *Calculation Parameters* will be changed in the *Standards File* (XML) using the *Edit Superelevation Rule File* tool. Calculation Parameters that will be changed include:

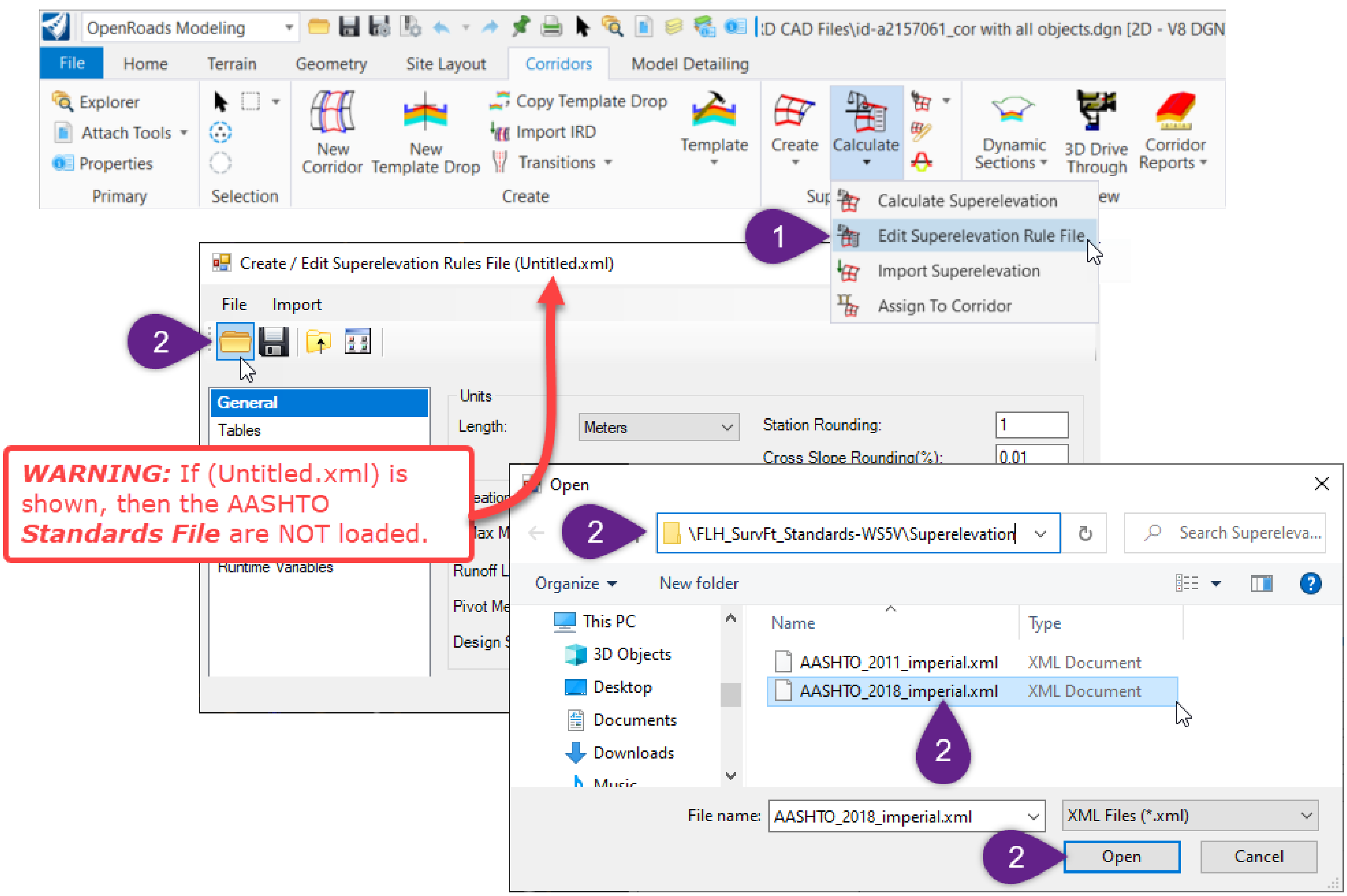
> Station Rounding, Cross Slope Rounding, Percent on Tangent, Runout Options, Use Spiral Length, Curve Overlap Adjustments

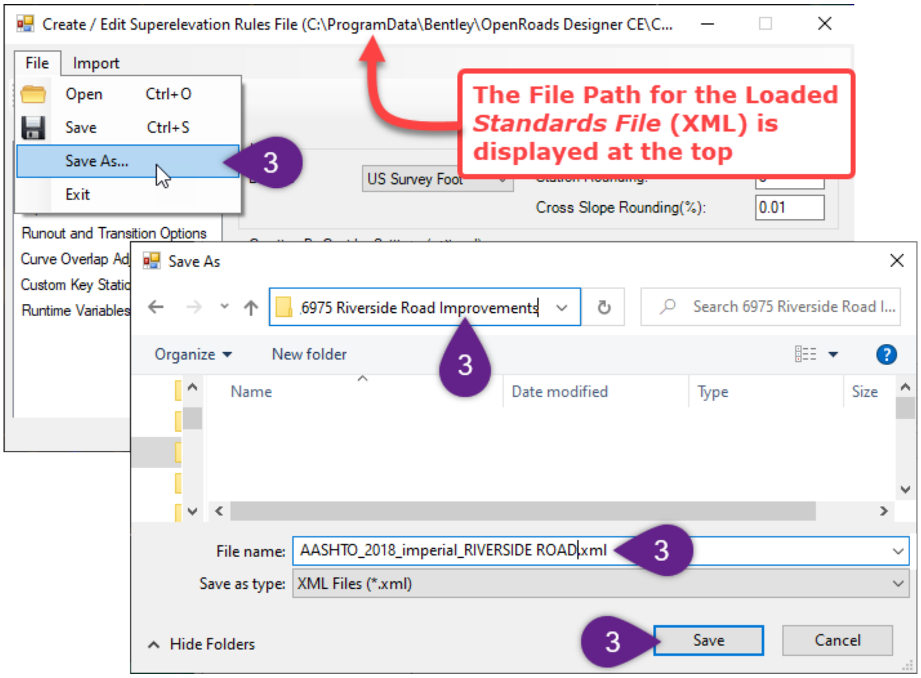
WARNING: This tool will alter the contents and coding within the .XML File. The User should make a copy of the *Standards File* (XML) before use of this tool. Alternatively, the User can perform a *Save As* of the *Standards File* – which is shown in steps 2-3 below.

1	Select the *Edit Superelevation Rule File* tool from the Ribbon. Ribbon Location: ***OpenRoads Modeling*** → ***Corridor*** → ***Superelevation***

Load the desired *Standards File* (XML) to make edits to. Before making edits, create a copy of the desired *Standards File* (XML) with the Save As tool.

2	Load the desired *Standard File* (XML) from the FLH WorkSpace. Select the *Open Folder* icon . Navigate to the Superelevation Folder in the FLH WorkSpace. Select the version of AASTHO *Standard File* that is appropriate for the project (either 2014 or 2018). *Standard File* (XML) location in the FLH WorkSpace: *…\OpenRoads Designer CE 10.10\Configuration\Organization-Civil\FLH_Stds-WS10.10.21.00V\Superelevation*

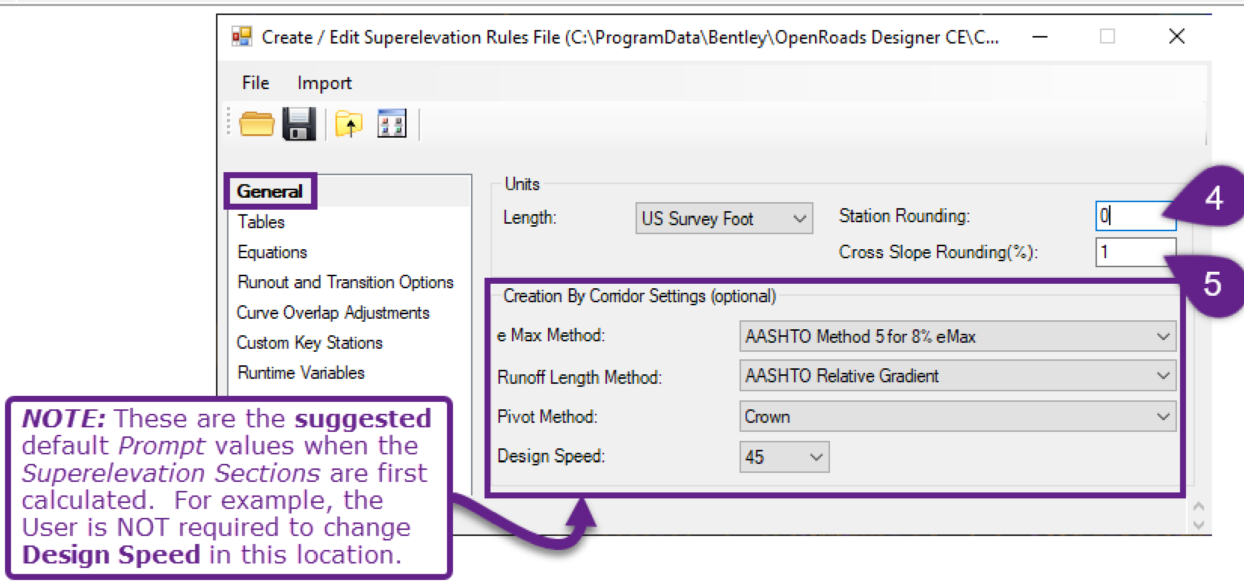


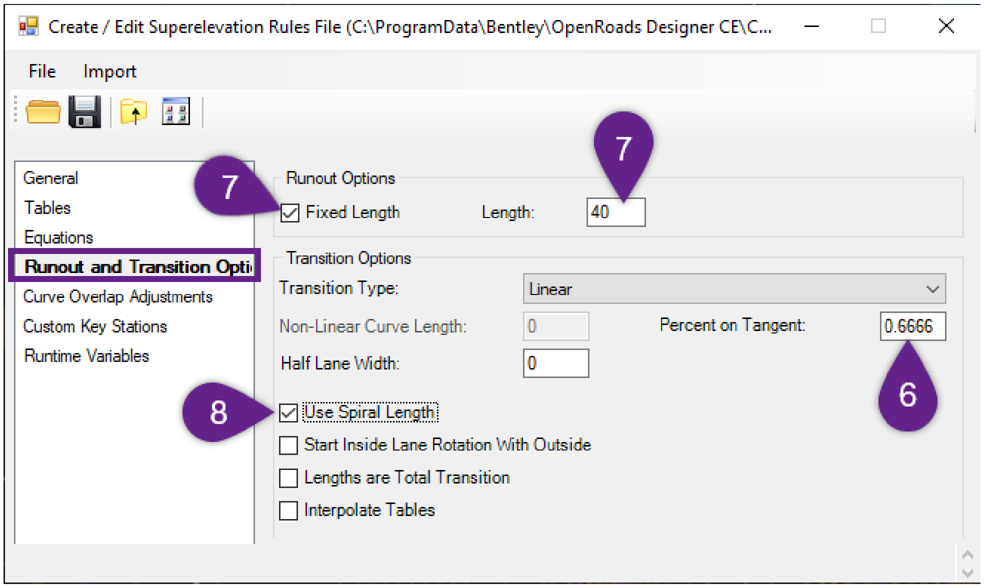


3	Make a copy of the *Standards File* (XML) to be used specifically for the project. Go to: *File* → *Save As…* Rename with an appropriate File Name and place the copied *Standards File* in a project folder.

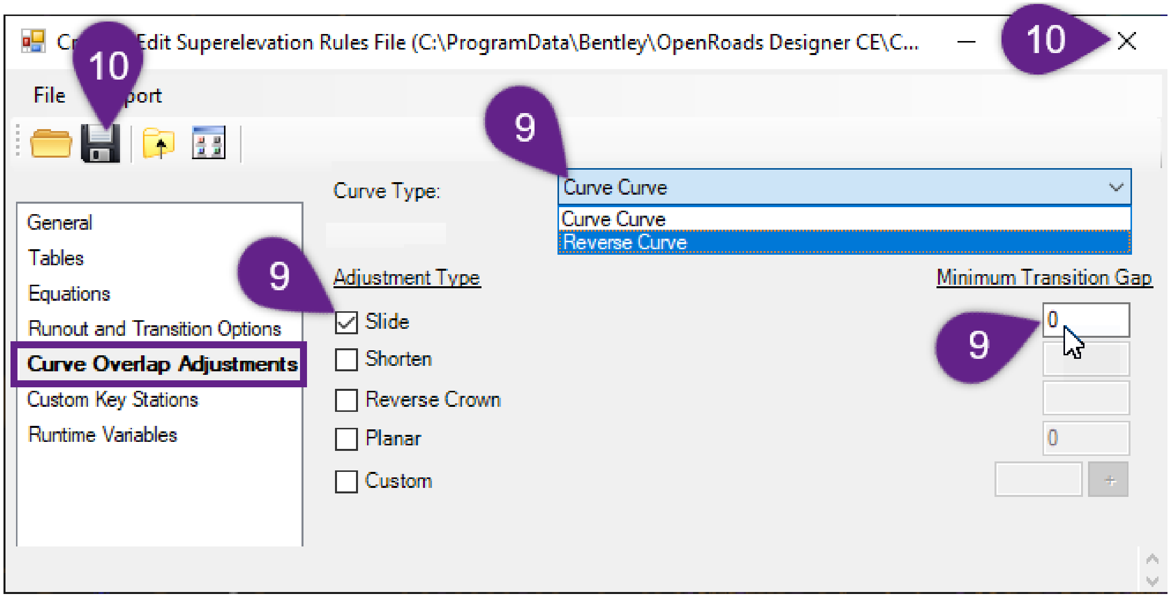
After steps 2-3 have been completed, edits can be made to the Calculation Parameters within the copied *Standards File* (XML).

4	**Edit the *Station Rounding* parameter:** In the *General* tab, change the value for *Station Rounding*. In this case, it is desired that Station Rounding is NOT used – which is achieved by entering 0.00 into the value box. (Default Value = 5’)
5	**Edit the *Cross Slope Rounding* parameter**: In the *General* tab, change the value for *Cross Slope Rounding*. In this case, it is desired that Superelevation cross-slopes are rounded to the nearest whole number – which is achieved by entering 1.00% into the value box. (Default Value = 0.01%)





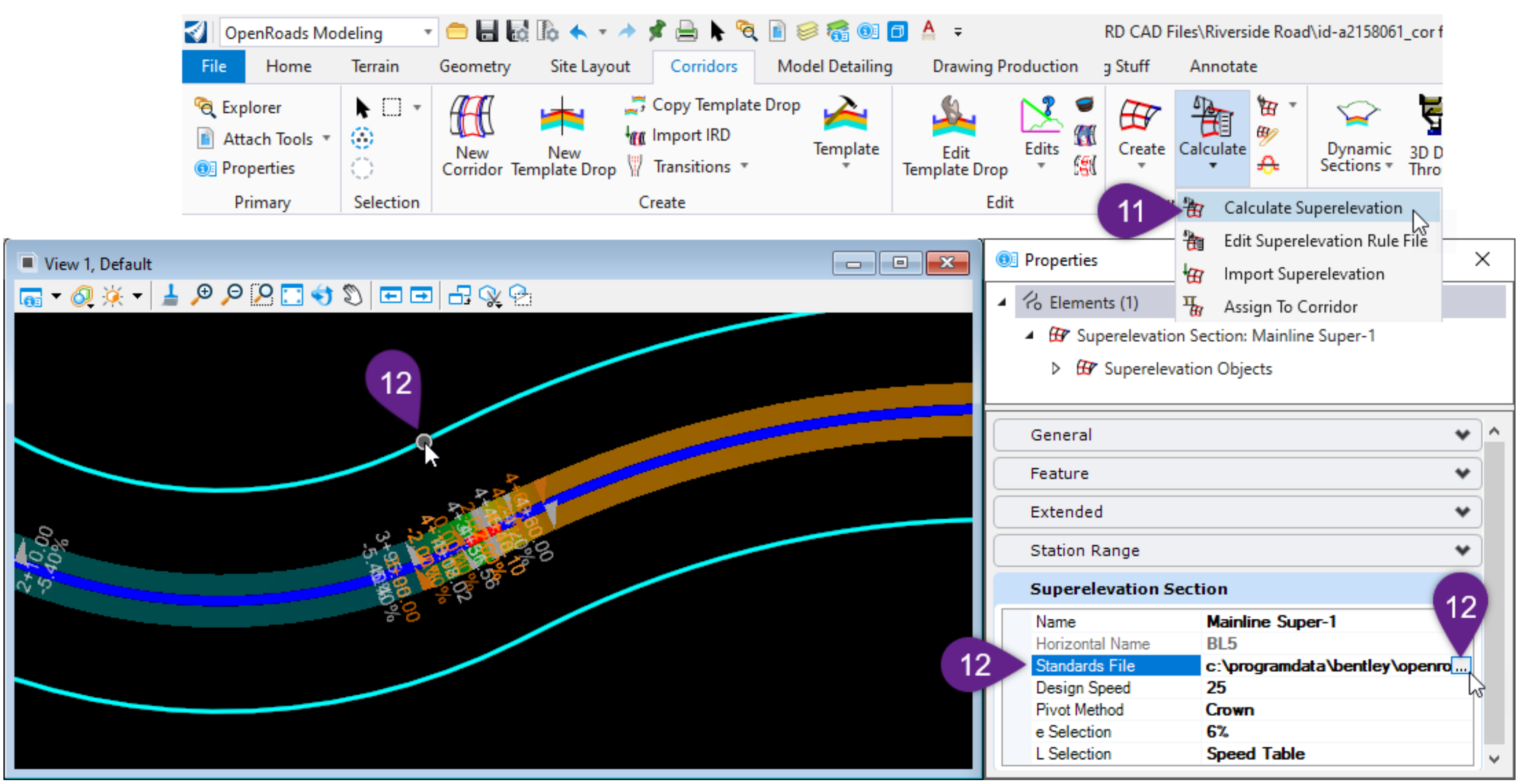
6	**Edit the *Percent on Tangent* parameter:** In the *Runout and Transition Options* tab, change the value for *Percent on Tangent*. In this case, it is desired that 66.66% of the Superelevation Runoff Length is placed on the Tangent – which is achieved by entering 0.6666 into the value box. (Default Value = 0.7 or 70%)
7	**Edit the (Tangent) *Runout Options*:** In the *Runout and Transition Options* tab, check the box for *Fixed Length*. In this case, it is desired that the Tangent Runout length to always be 40' - which is achieved by entering 40 into the value box. Tangent Runout is defined as the length to go from Normal Crown (typically -2.00%) to the Super Runoff Point (0.00% slope) for the lane on the outside of the curve
8	**Edit the *Use Spiral Length* parameter:** In the *Runout and Transition Options* tab, check the box for *Use Spiral Length*. In this case it is desired that the Superelevation Runoff lengths will EXACTLY equal the length of the spiral
9	**Edit the *Curve Overlap Adjustment* parameters:** In the *Curve Overlap Adjustments* tab, uncheck the box for *Planar.* Check the box for *Slide.* This needs to step needs to be done for both the *Curve Curve* and *Reverse Curve* types.



10	Click the *Save* icon and Exit out of the menu. If prompted to Save again, select Yes.

After Step 10, the *Standard File* (XML) is edited. However, the *Standards File* needs to be applied to the Superelevation Sections. Edits to the *Standard Files* (XML) will not take effect in the Superelevation Sections, Lanes, Corridor until manually applied by the User.

11	Apply the edited *Standard File* to the *Sections* with the *Calculate Superelevation* tool. See *10D.7 Calculate Superelevation tool*.
12	**ALTERNATIVELY,** Apply the edited *Standards File* to the *Sections* by selecting the *Section*. In the Properties Box, select the button next to the *Standard File* property. Navigate to the location specified in step 3 and select the edited *Standards File*.



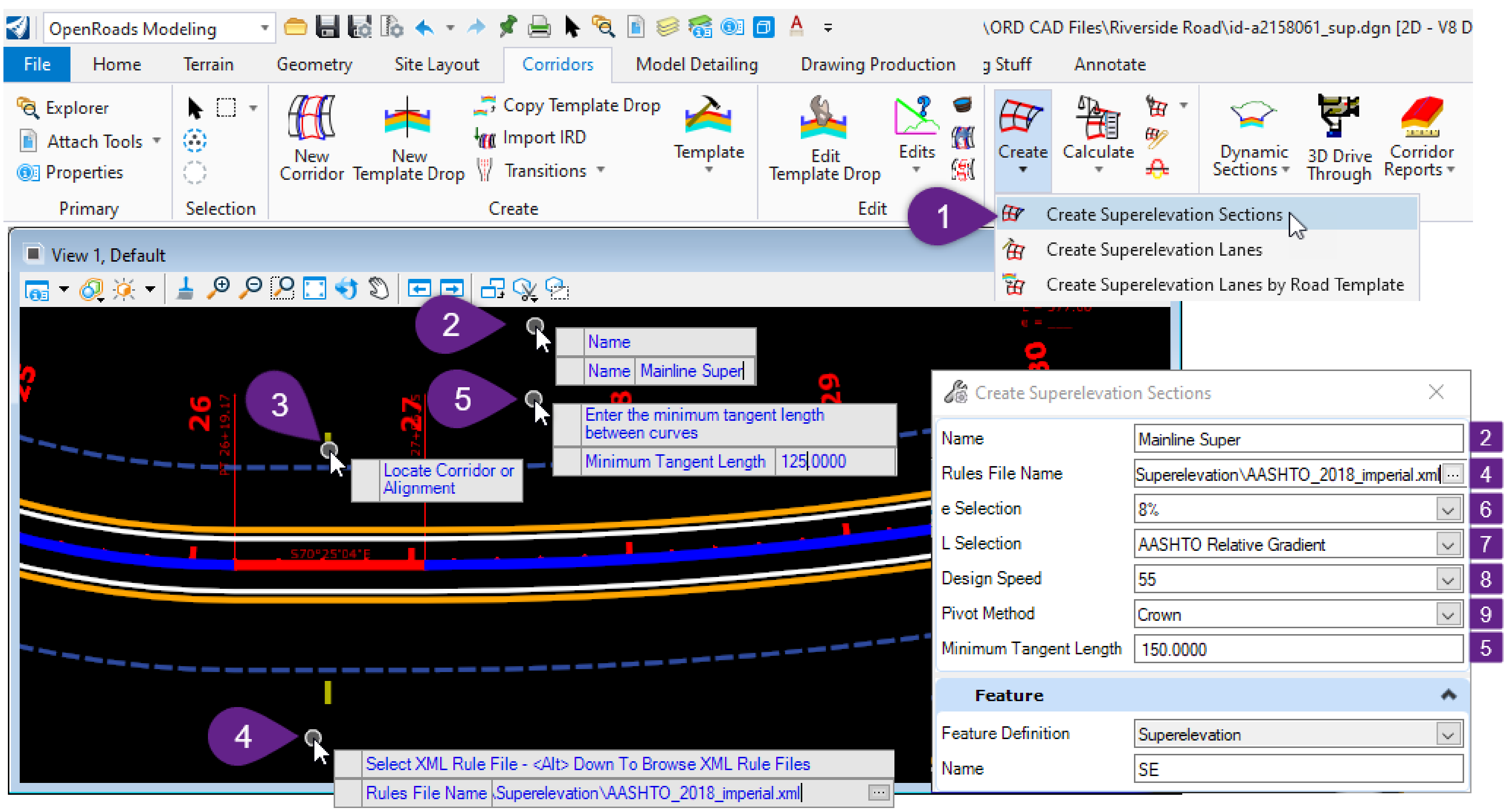
10D – CREATE SUPERELEVATION ELEMENTS

10D.1 Corridor Method

Using the Corridor method, *Sections* and *Lanes* elements will be created with one use of the *Create Superelevation Sections* tool. Superelevation rates and transition will be automatically calculated from the *Standards File* (XML)*.* After this workflow is complete, the User must apply the Superelevation elements to the Corridor with the *Assign to Corridor* tool. See *10D.4 Apply Superelevation Elements to the Corridor*.

WARNING: The *Corridor Method,* should NOT be used for Corridors that contain multiple, dissimilar Template Drop Sections. See *10C.1.b Corridor Method WARNING*. For these configurations, use the *Alignment Method*. Create unique Superelevation Sections and Lane elements for each Template configuration.

WARNING: Before this workflow is attempted, ensure that *Superelevation Flags* have been set in all Corridor Templates. If *Superelevation Flags* have NOT been set, then the *Lanes* elements will not be created – only empty Sections will be created. See *8C.3 Superelevation Flag*.



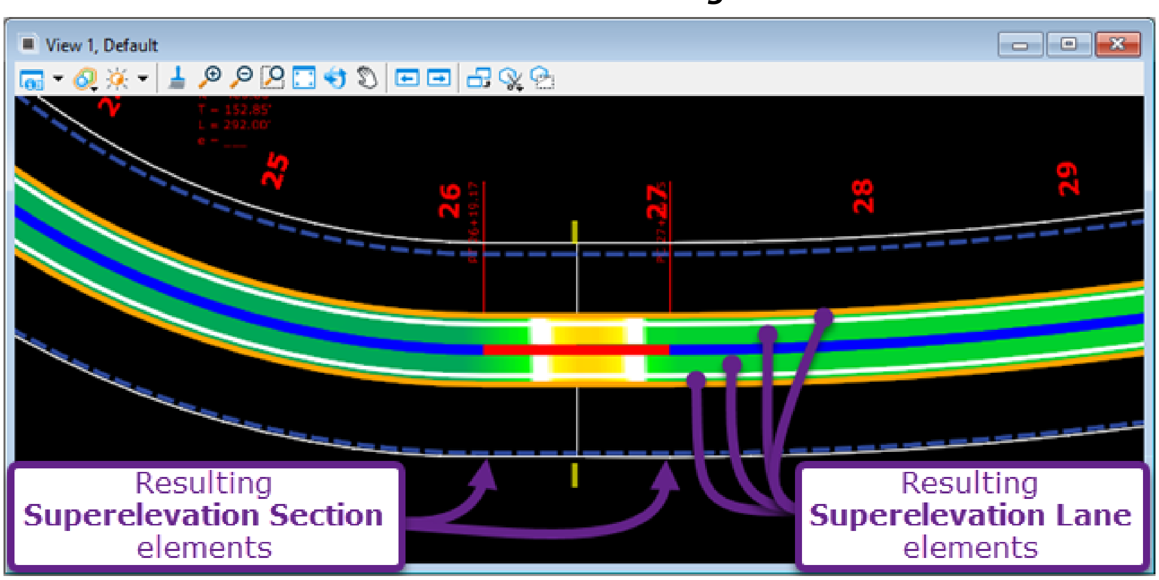
1	Select the *Create Superelevation Sections* tool from the Ribbon. Ribbon Location: ***OpenRoads Modeling*** → ***Corridor*** → ***Superelevation***
2	Prompt: Name – Assign the Superelevation Sections an appropriate Name. When multiple *Superelevation Sections* are created with this tool, subsequent *Sections* will have a suffix added to the Name "-1", "-2", "-3" etc..
3	Prompt: Locate Corridor or Alignment – Left-Click on the mainline Corridor.

4	*Prompt: Select XML Rules File - <Alt> Down To Browse XML Rule Files* – Simultaneously press the ALT and DOWN ARROW keys to navigate to the *Standards File*. The *Standards File* is used to automatically calculate superelevation slope values and transition locations. The *Standards File* is found on the FLH Workspace at the following location: *...\OpenRoads Designer CE 10.10\Configuration\Organization-Civil\FLH_Stds-WS10.10.21.00V\Superelevation*
5	Prompt: Enter the minimum tangent length between curves – This parameter determines if a single Section is created for multiple close curves. See *10C.3.a Layout of Superelevation Sections (Minimum Tangent Length)*. **RECOMMENDATION:** If unsure, set the Minimum Tangent Length between 75-150 feet. In general, the Minimum Tangent Length should get longer as the Design Speed increases. ***WARNING:*** Before accepting and preceding past the *Minimum Tangent Length* value, set the Calculation Parameters displayed in the Dialogue Box. The User will NOT be prompted by the software to set these values. **The Calculation Parameters can be changed later in the Properties Box of the *Section* element or with the *Calculate Superelevation* tool.**

There are no prompts given for Steps 6 – 9. The User must set these Calculation Parameters in the *Dialogue Box*. See Warning in Step 5.

6	**e Selection** – This input sets how the superelevation slope values for each curve (depending on the radius value) are determined. This input should correspond to the maximum superelevation value (e_{max}) used for the project. See *10C.3.b Input Parameters for the Calculation of Superelevation Sections*.
7	**L Selection** – This input determines how the transition lengths are calculated. ***WARNING:*** Do **NOT** use the **Speed Table** method if the Shoulders of the Corridor Template contain *Superelevation Flags.*
8	**Design Speed** – This input sets the Design Speed (in MPH) for the *Superelevation Section*. The Design Speed is used in calculations pertaining to "e Selection" and "L Selection".
9	**Pivot Method** – Sets the scheme for how lanes are rotated. Use the *Crown* method when the road crown corresponds with the Corridor Alignment. See *10C.3.b.i Pivot Methods*.

After the *Minimum Tangent Length* is accepted in step 5, then Superelevation Section and Lane elements will be created as shown below. To apply the superelevation cross-slopes and transitions to the Corridor, the User must enter the Corridor File (_cor.dgn) and apply the *Section* and *Lane* elements to the Corridor with the *Assign to Corridor* tool.



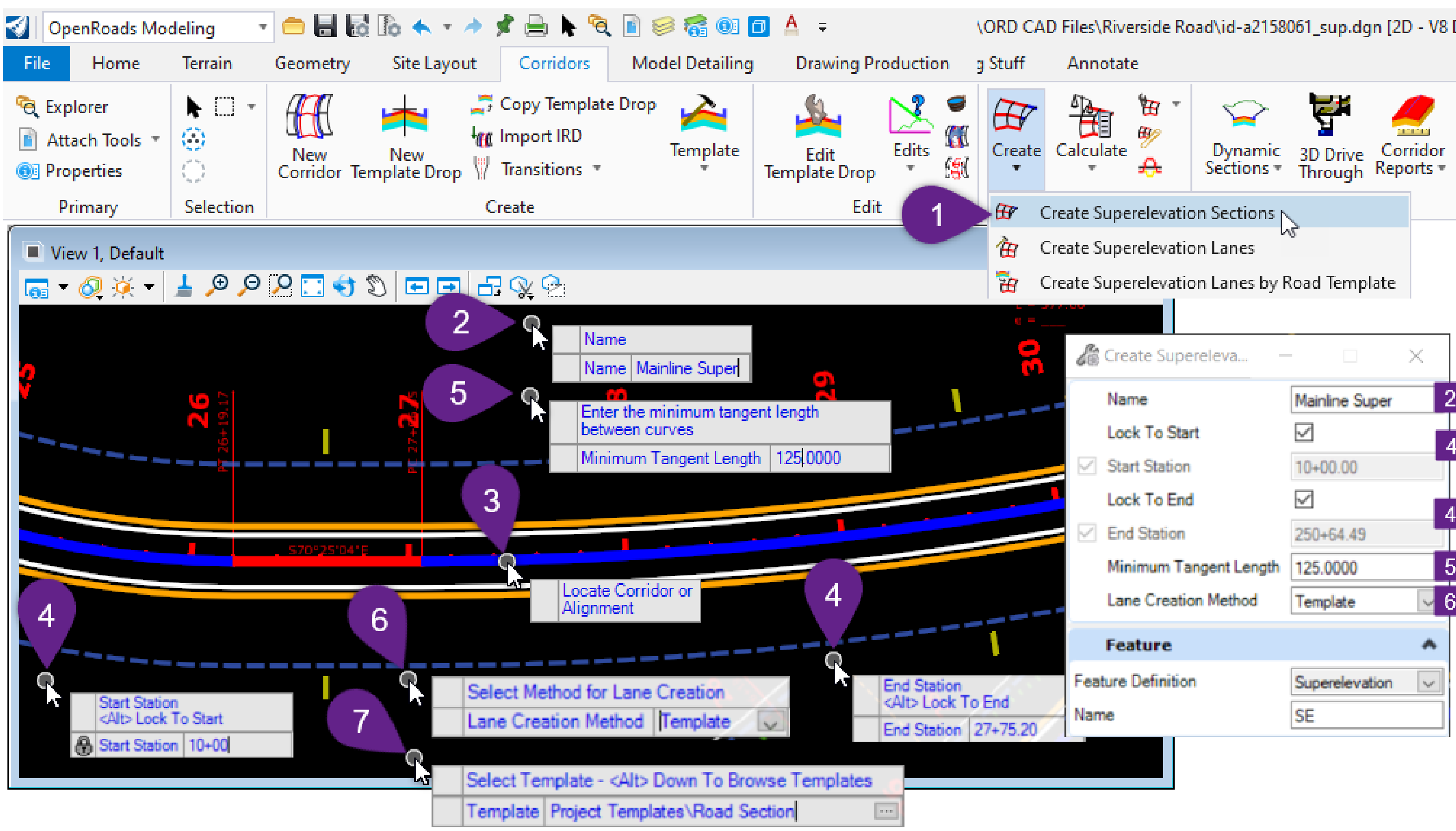
10D.2 Alignment Method

The Alignment Method is an alternate method for creating *Section* and *Lane* elements with the *Create Superelevation Section* tool. The main difference between the Alignment and Corridor Methods is that superelevation rates and transitions are not initially calculated. In other words, the resulting *Lanes* are essentially blank, meaning the Normal Crown condition is present throughout, including in curved segments. The User must use the *Calculate Superelevation* tool to attach a *Standard File* (XML) to the resulting *Section* elements. See *10D.7 Calculate Superelevation tool*.

With the Alignment Method, there are two options for creation of *Lane* elements:

Manual: The User manually specifies the Width, Normal Cross Slope, and Side of Centerline (pivot location) for each *Superelevation Lane* element. This is the same procedure used by the *Create Superelevation Lanes* tool. See *10D.5 Create Superelevation Lanes tool*.

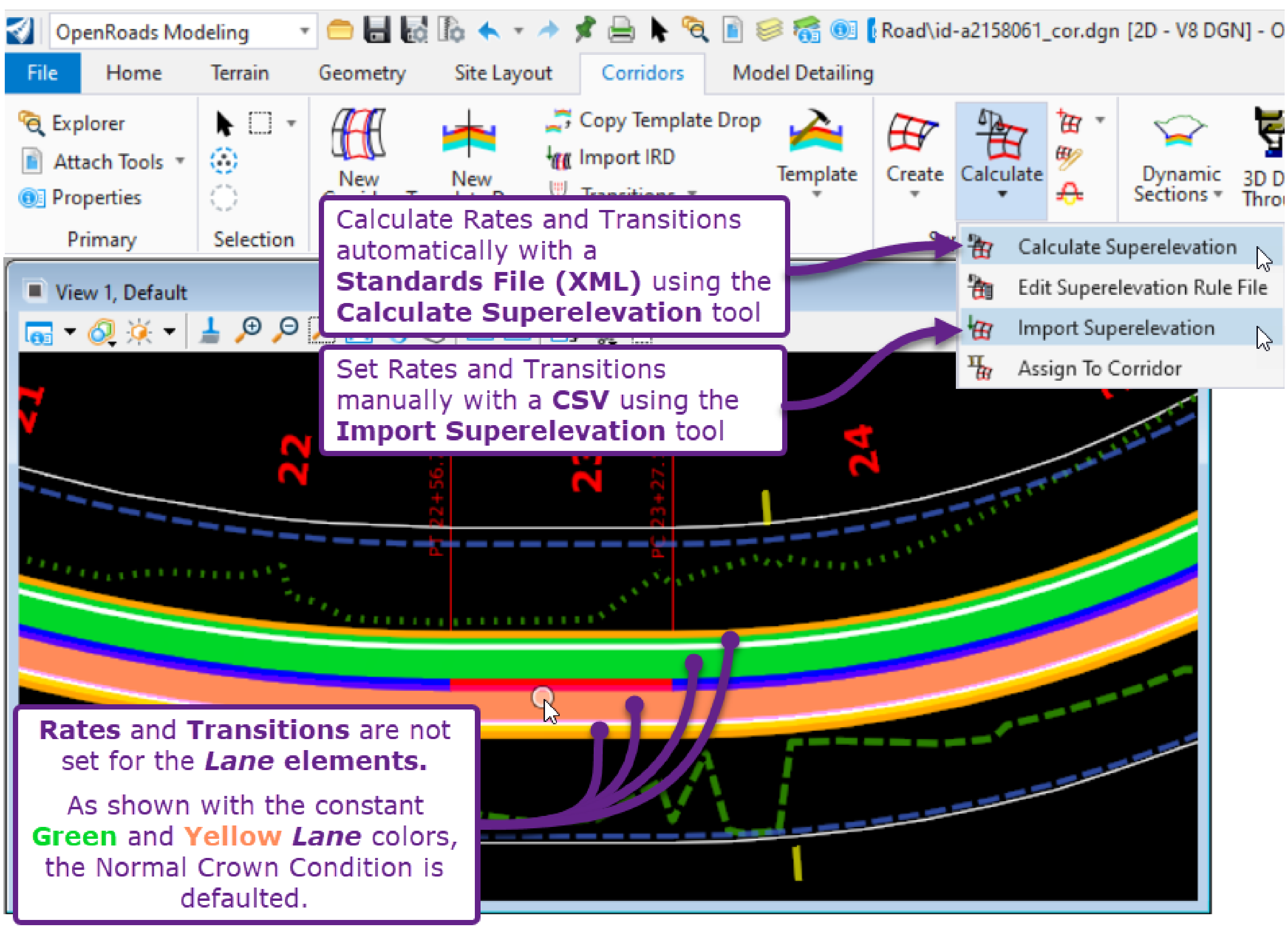
Template: The User specifies a Template from the currently loaded Library. The appropriate number and configuration of *Lane* elements are automatically created based on the *Superelevation Flag* location within the Template. This is the same procedure used by the *Create Superelevation Lanes by Road Template* tool. See *10D.6 Create Superelevation Lanes by Road Template tool*.



1	Select the *Create Superelevation Sections* tool from the Ribbon. Ribbon Location: ***OpenRoads Modeling* → *Corridor* → *Superelevation***
2	*Prompt: Name* – Assign the *Superelevation Sections* an appropriate Name. When multiple *Superelevation Sections* are created with this tool, subsequent *Sections* will have a suffix added to the Name "-1", "-2", "-3" etc..

3	*Prompt: Locate Corridor or Alignment* – Left-Click on the mainline Alignment.
4	*Prompt: Start Station* *Prompt: End Station* Set the station range for *Section* creation. *Section* elements will not be created before or beyond the station range.
5	*Prompt: Enter the minimum tangent length between curves* – this parameter determines if a single *Section* is created for multiple close curves. See *10C.3.a Layout of Superelevation Sections (Minimum Tangent Length)*. ***RECOMMENDATION:*** Set this value between 75 - 150 feet.
6	*Prompt: Select Method for Lane Creation* – Refer to the previous page for an explanation of the *Manual* and *Template* methods. In this case the *Template* method is picked.
7	*Prompt: Select Template - <ALT> Down to Browse Templates*. Press the ALT key and DOWN ARROW key simultaneously to browse Templates within the currently loaded Project Template Library. Left-Click on the desired Template and press OK. Left-Click in the *View* to advance to the next prompt. ***WARNING:*** Ensure the correct Project Template Library is loaded. If not, exit out of the corridor creation workflow. Enter the Template Editor and load the correct Project Template Library. See *8A.1 Accessing the Template Editor and Template Libraries*.

After step 7, the *Section* and *Lane* elements are created – but do not contain superelevation rates or transition. Superelevation rates and transitions can be calculated automatically with the *Calculate Superelevation* tool. ALTERNATIVELY, rates and transitions can be set manually in a .CSV file and applied to the *Sections* and *Lanes* with the *Import Superelevation* tool.



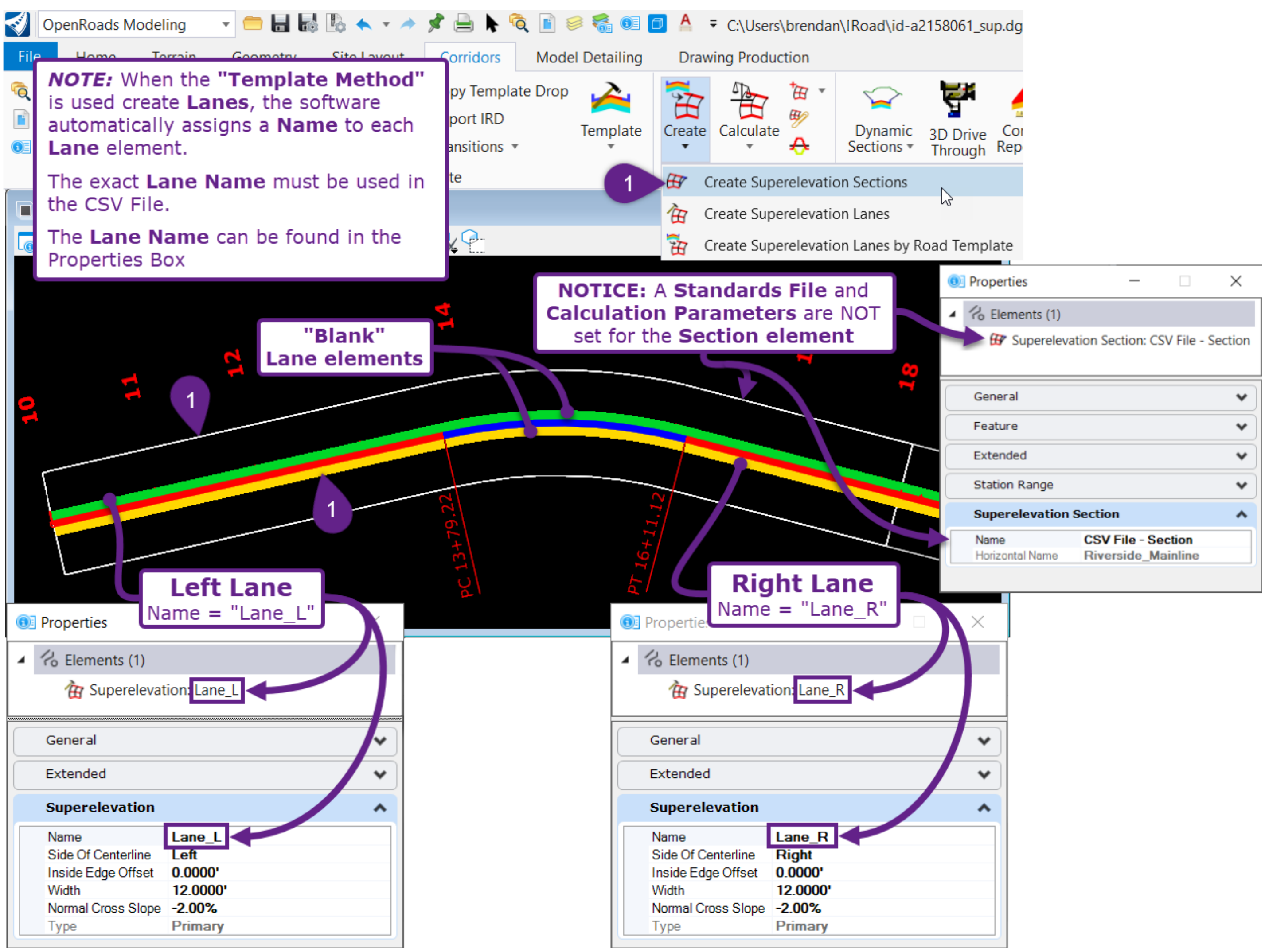
10D.3 Use a CSV File to Set Superelevation (Import Superelevation tool)

This workflow overviews the process of setting Superelevation rates and transitions from a CSV File created by the User in Microsoft Excel. ***NOTE:*** This workflow is NOT necessary if the procedures followed in *10D.1* or *10D.2* were used.

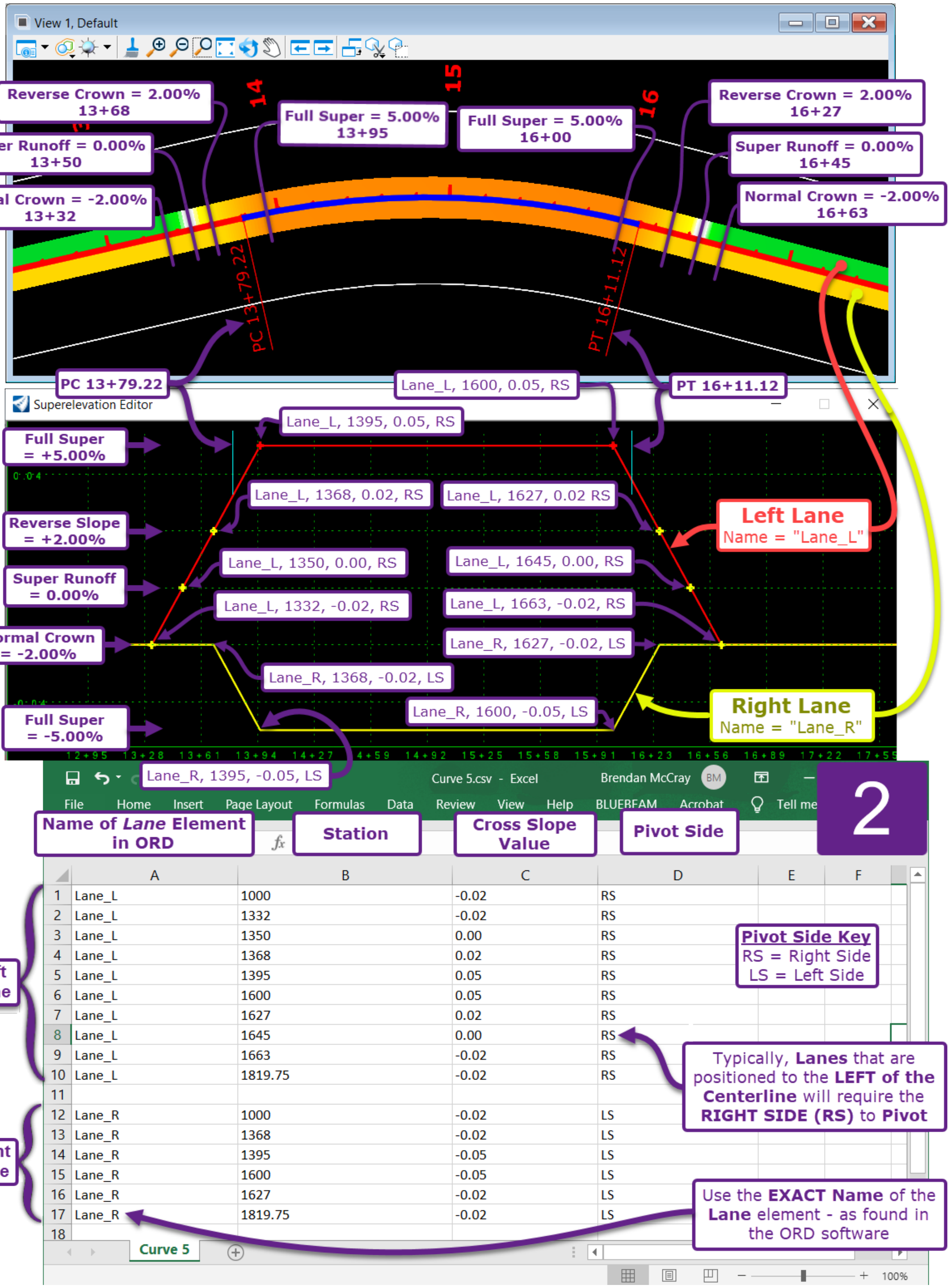
This workflow shows how to set and apply superelevation for the single curve shown below. CSV Files are applied to *Superelevation Section* elements to populate cross-slope values and transition locations for the *Lane* elements.

BEST PRACTICE: Create a *Section* element for each curve. Create a single *Section* element for Reverse Curves, Compound Curves, or curves that may have overlapping transitions lengths.

1	**Create *Superelevation Section* and *Lane* Elements:** Use the *Create Superelevation Sections* tool to create the *Section* and *Lane* elements. **Use the "Alignment Method" to create the *Section* elements.** See *10D.2*. ***WARNING:*** Using the "Corridor Method" to create Superelevation elements attaches a *Standards File* (XML) to the **Section** element. When a *Standards File* is attached to the *Section*, it is still possible to apply a CSV File; however, this configuration is problematic. If the Alignment were to be edited, then the *Section* element is automatically re-calculated according to the attached *Standards File* (XML) – which overwrites the rates and transitions applied by the CSV File. Re-calculation of *Sections* is avoided when using the "Alignment Method".

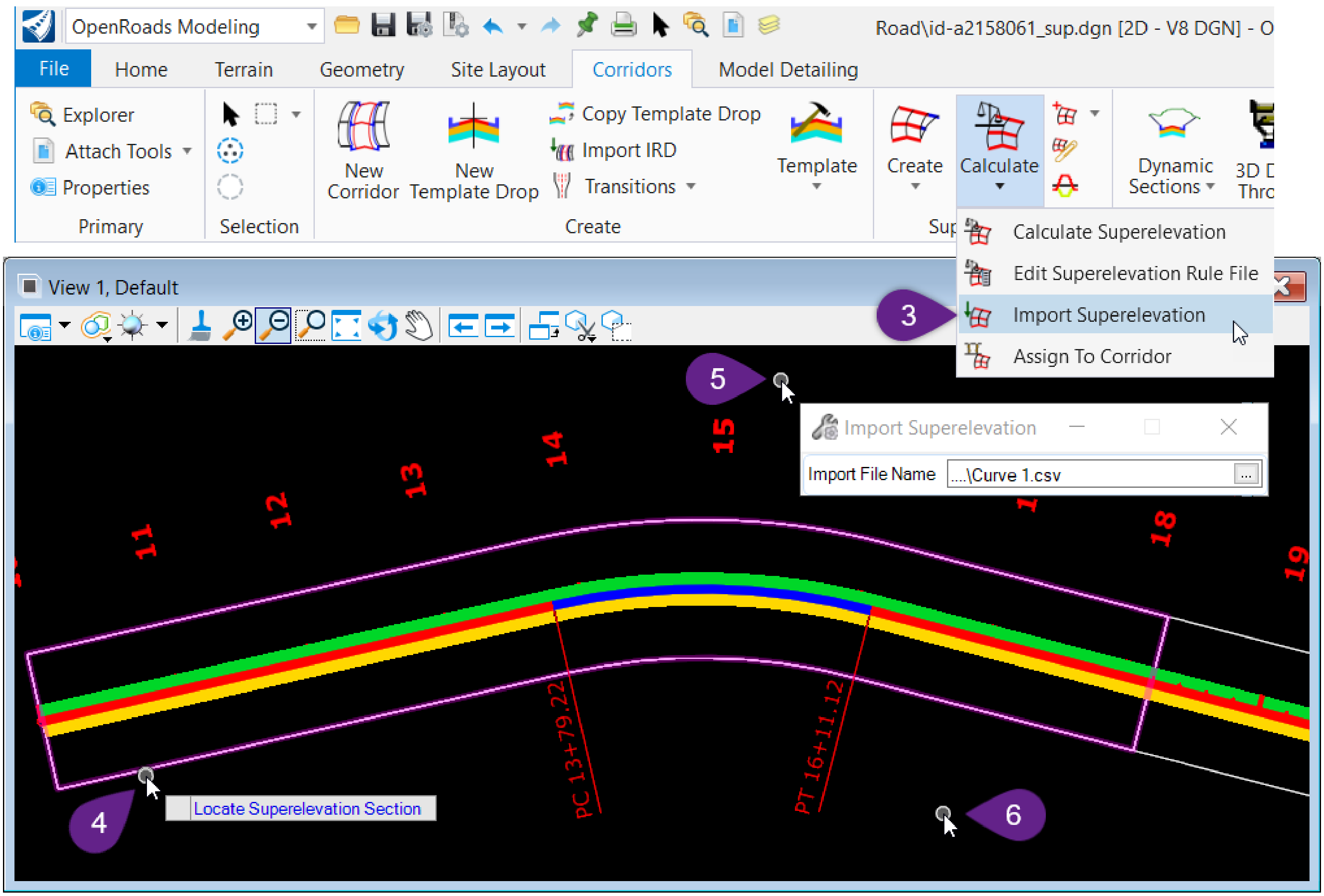


2	**Create the CSV File for each Section element:** In Microsoft Excel, open a new spreadsheet. An example spreadsheet is shown below. In the spreadsheet, the User must specify the **Lane Name, Station, Cross Slope Value,** and **Pivot Side** for each Superelevation Point. When satisfied with the Excel Spread sheet, convert it to a .CSV File by performing a *Save As...*



	A	B	C	D
1	Lane_L	1000	-0.02	RS
2	Lane_L	1332	-0.02	RS
3	Lane_L	1350	0.00	RS
4	Lane_L	1368	0.02	RS
5	Lane_L	1395	0.05	RS
6	Lane_L	1600	0.05	RS
7	Lane_L	1627	0.02	RS
8	Lane_L	1645	0.00	RS
9	Lane_L	1663	-0.02	RS
10	Lane_L	1819.75	-0.02	RS
11				
12	Lane_R	1000	-0.02	LS
13	Lane_R	1368	-0.02	LS
14	Lane_R	1395	-0.05	LS
15	Lane_R	1600	-0.05	LS
16	Lane_R	1627	-0.02	LS
17	Lane_R	1819.75	-0.02	LS
18				

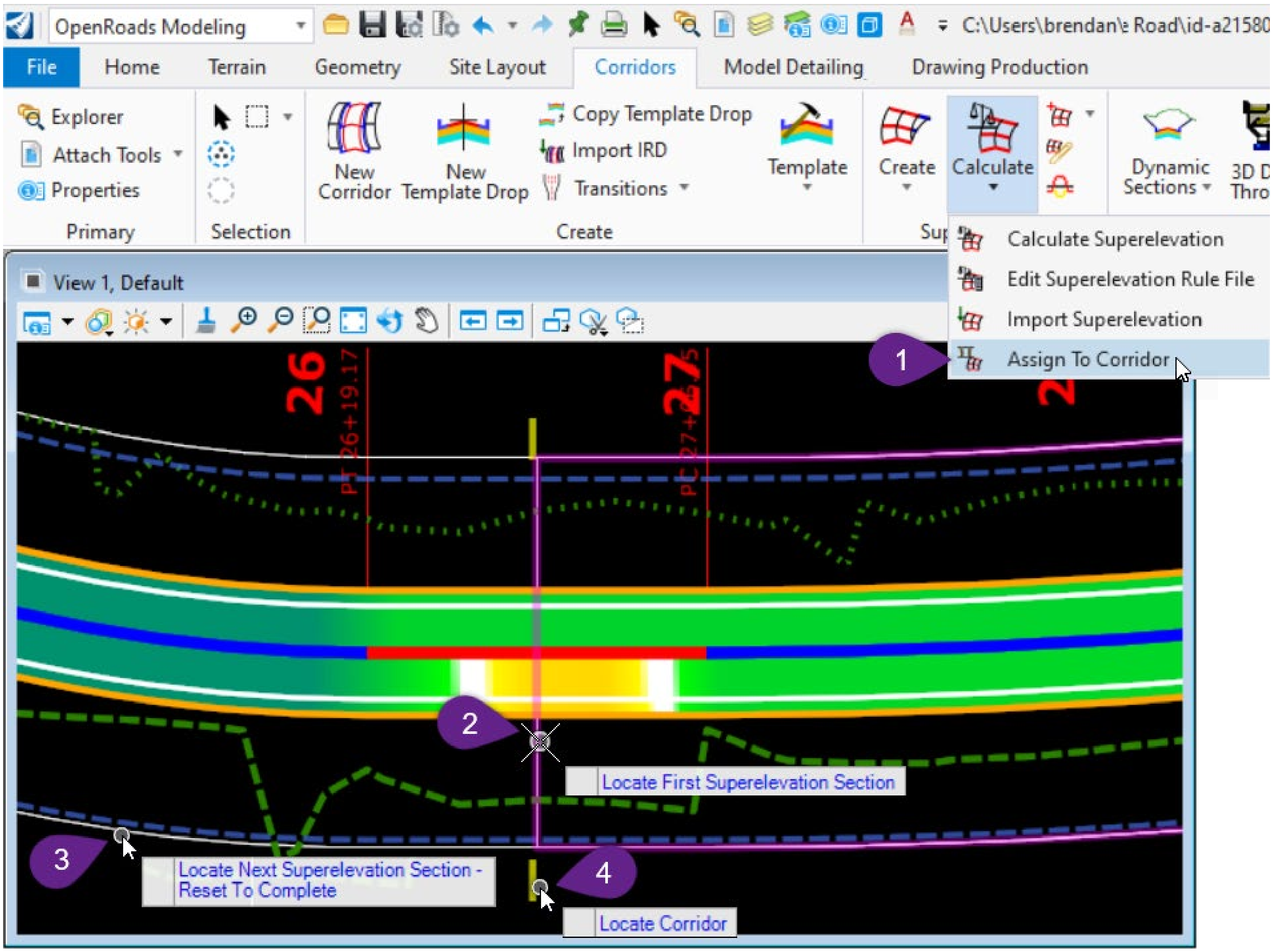
3	**Apply the CSV File to the Section Element with the *Import Superelevation* tool:** Select the Assign to Corridor tool from the Ribbon. Ribbon Location: **OpenRoads Modeling** → **Corridor** → **Superelevation**
4	Prompt: Locate Superelevation Section – Left-Click on the Section element.
5	*Prompt: Select Import File – Alt Down To Select File* - Press the ALT and DOWN ARROW keys to navigate to the CSV File location. Select the CSV File created in Step 2.
6	Left-click in the *View* to complete the command. The Lane elements should update to reflect the CSV data.



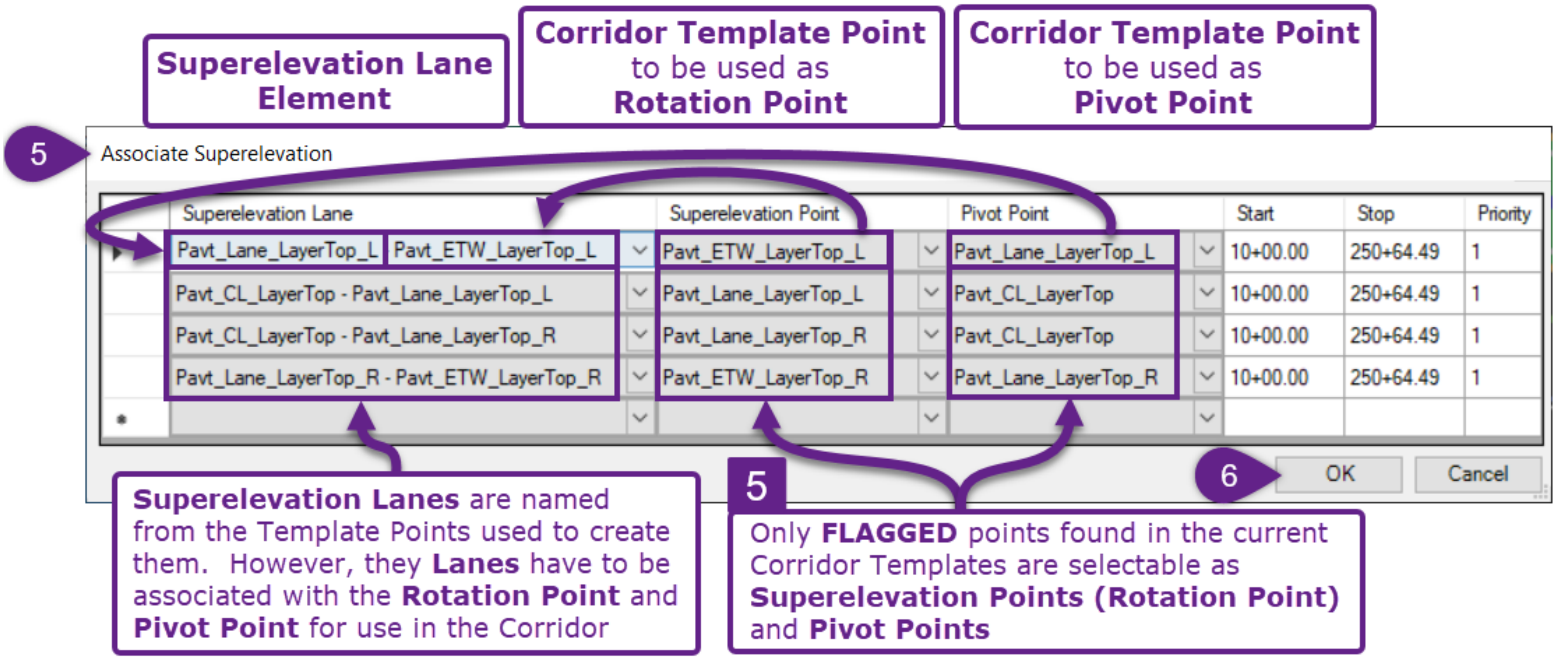
10D.4 Apply Superelevation Elements to Corridor (Assign To Corridor tool)

Superelevation elements will NOT be incorporated into the Corridor model until the *Assign to Corridor* tool is used. With this tool *Superelevation Section* elements are added to the Corridor.

The *Assign To Corridor* tool can only be successfully used from the Corridor File (_cor.dgn). The Superelevation File (_sup.dgn), which contains the *Section* and *Lane* elements must be referenced into the Corridor File (_cor.dgn) to use this tool.



1	Select the *Assign to Corridor* tool from the Ribbon. Ribbon Location: ***OpenRoads Modeling → Corridor → Superelevation***
2	*Prompt: Locate First Superelevation Section* – Left-Click on a *Section* element that will be added to the Corridor. ***NOTE:*** It is not necessary to Left-Click on the *Lane* elements. This is because each *Lane* segment belongs to a specific *Section* element.
3	*Prompt: Locate Next Superelevation Section – Reset to Complete* – Left-Click on the remaining *Section* elements to be added to the Corridor.
4	*Prompt: Locate Corridor* – Left-Click on the Corridor Handle element.



5	After step 4 is completed, the *Associate Superelevation* window will be presented. The *Associate Superelevation* window is used to inform the Corridor to which Corridor Template Points to use as the Pivot Point and Rotation Point for each *Superelevation Lane* element. If *Lane* elements were automatically created from a Template (such as with the Corridor Method or the Template Method), then the *Associate Superelevation* window is typically populated correctly and the User can simply push OK. This tool is typically intelligent enough to choose the correct Pivot and Rotation Points based off the Name of the *Lane* element. ***NOTE:*** When *Lane* elements are created automatically (i.e., from a Template), then the resulting *Lane* elements are **NAMED** by the two *Flagged* Template Points that define the *Lane* geometry. For example, the *Lane* element corresponding to the *Lane* between the centerline point and left edge of lane is named *Pavt_CL_LayerTop – Pavt_Lane_LayerTop_L.* The first part of the Lane name corresponds with the **Pivot Point** (*Pavt_CL_LayerTop*). The second part of the Lane name corresponds with the **Rotation Point** (*Pavt_Lane_LayerTop_L*). In *Manual* creation of *Lane* elements, the User should have specified a Name for each *Lane* element. The *Associate Superelevation* window will typically be blank, which means the User will have to match each *Lane* with the intended Pivot and Rotation Points. ***TIP:*** The *Name* of a *Lane* shown in the Properties Box. Select the *Lane Element* to reveal the *Name* in the Properties Box.
6	When a Rotation Point and Pivot Point has been set for each *Lane* element, then select OK. The Corridor will be reprocessed to incorporate Superelevation.

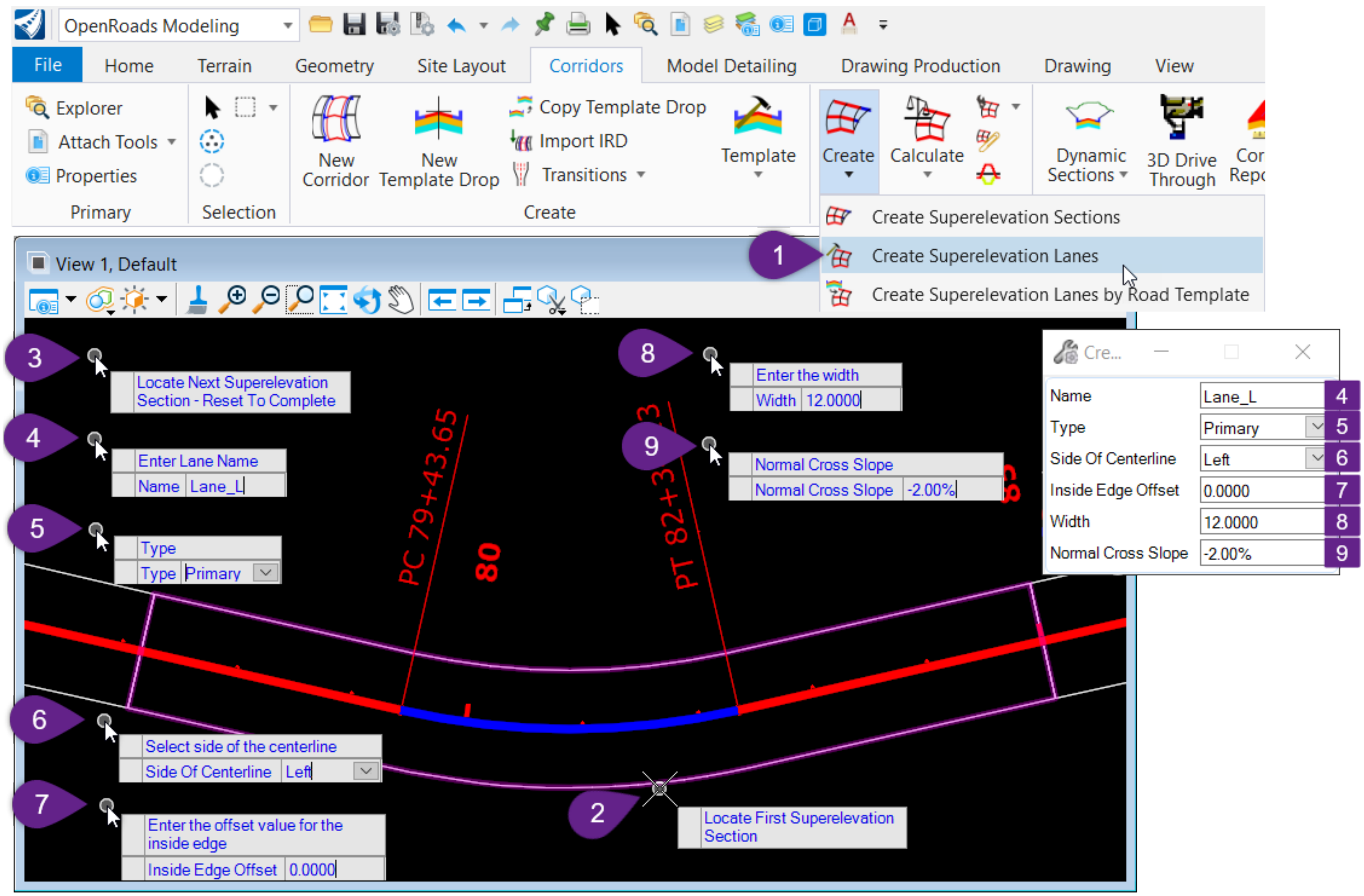
After the *Section Element* has been applied to the Corridor, the User can verify correct application by opening *Dynamic Cross Section Viewer* and scrolling through stations along the horizontal curve. The *Section Elements* have been correctly applied when Point Control indicators (pink boxes) are shown atop the *Rotation Points*.

10D.5 Create Superelevation Lanes tool

Typically, *Lane* elements are created with the *Create Superelevation Section* tool. However, this tool can create additional *Lane* elements if needed. Before this tool is used, the *Section* elements need to be created.

With this tool, *Lane* elements are created MANUALLY, meaning the width, normal cross slope, and pivot point is specified by the User.

NOTE: *Lane* elements created from this tool will be "blank". The User must use the *Calculate Superelevation* tool (automatic) or the *Import Superelevation* tool (CSV File) to set rates and transitions automatically.



1	Select the *Create Superelevation Lanes* tool from the Ribbon. Ribbon Location: ***OpenRoads Modeling*** → ***Corridor*** → ***Superelevation***
2	*Prompt: Locate First Superelevation Section* – Left-Click on a *Section* element that the *Lane* elements will be created for.
3	*Prompt: Locate Next Superelevation Section – Reset to Complete* – If desired, the User can create *Lane* elements for multiple *Sections*. Select all *Sections* that *Lane* elements will be created for. When all *Section* elements have been selected, Right-Click in the *View* to advance to text *Prompt.*

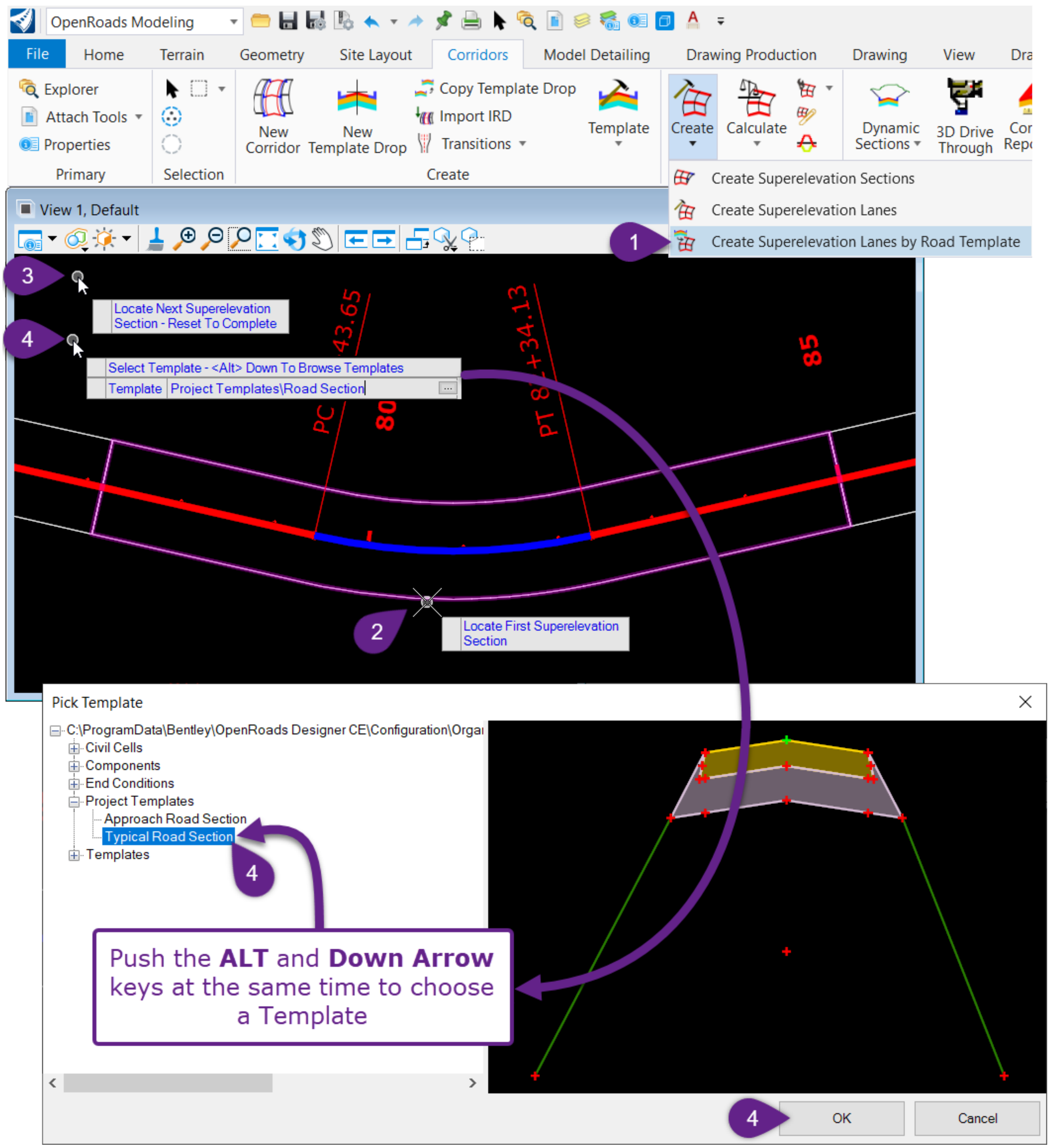
4	*Prompt: Enter Lane Name* – Enter a brief, but logical name for the *Lane* element. Left-Click in the *View* to accept.
5	*Prompt: Type* – Select the *Lane Type* to use. Typically, the *Primary* Type is used. Left-Click in the *View* to accept. The *Auxiliary* Type allows the User to specify a custom Station Range for the *Lane* element. If the *Primary* Type is used, then the length of the *Lane* element will equal the length of the *Section*.
6	*Prompt: Select side of the centerline* – Select which side of the Alignment the *Lane* will be placed. This step sets the Pivot side for the *Lane*.
7	*Prompt: Enter the offset value for the inside edge* – If the *Lane* is placed directly adjacent to the alignment, then this value should equal zero. For example, if a Paved Shoulder were to be modeled as a *Lane*, then the *Offset Value* would be equal to the Travel Lane width.
8	*Prompt: Enter the width* – Key-in the desired width for the *Lane* element. The width of the *Lane* element is factored into Superelevation rates and transition calculations.
9	*Prompt: Normal Cross Slope* – Key-in the desired Normal Cross Slope value for the *Lane* element. ***NOTE:*** For a crowned roadway, this value will be **NEGATIVE**.

10D.6 Create Superelevation Lanes by Road Template tool

Typically, *Lane* elements are created with the *Create Superelevation Section* tool. However, this tool can create additional *Lane* elements if needed. Before this tool is used, the *Section* elements need to be created. ***WARNING:*** Load the Project Template Library before using this tool.

With this tool, *Lane* elements are created from a TEMPLATE, meaning the User specifies a road Template from the Template Library. The *Lane* element parameters are automatically read from the *Superelevation Flags* set in the selected Template.

NOTE: *Lane* elements created from this tool will be "blank". The User must use the *Calculate Superelevation* tool (automatic) or the *Import Superelevation* tool (CSV File) to set rates and transitions automatically.

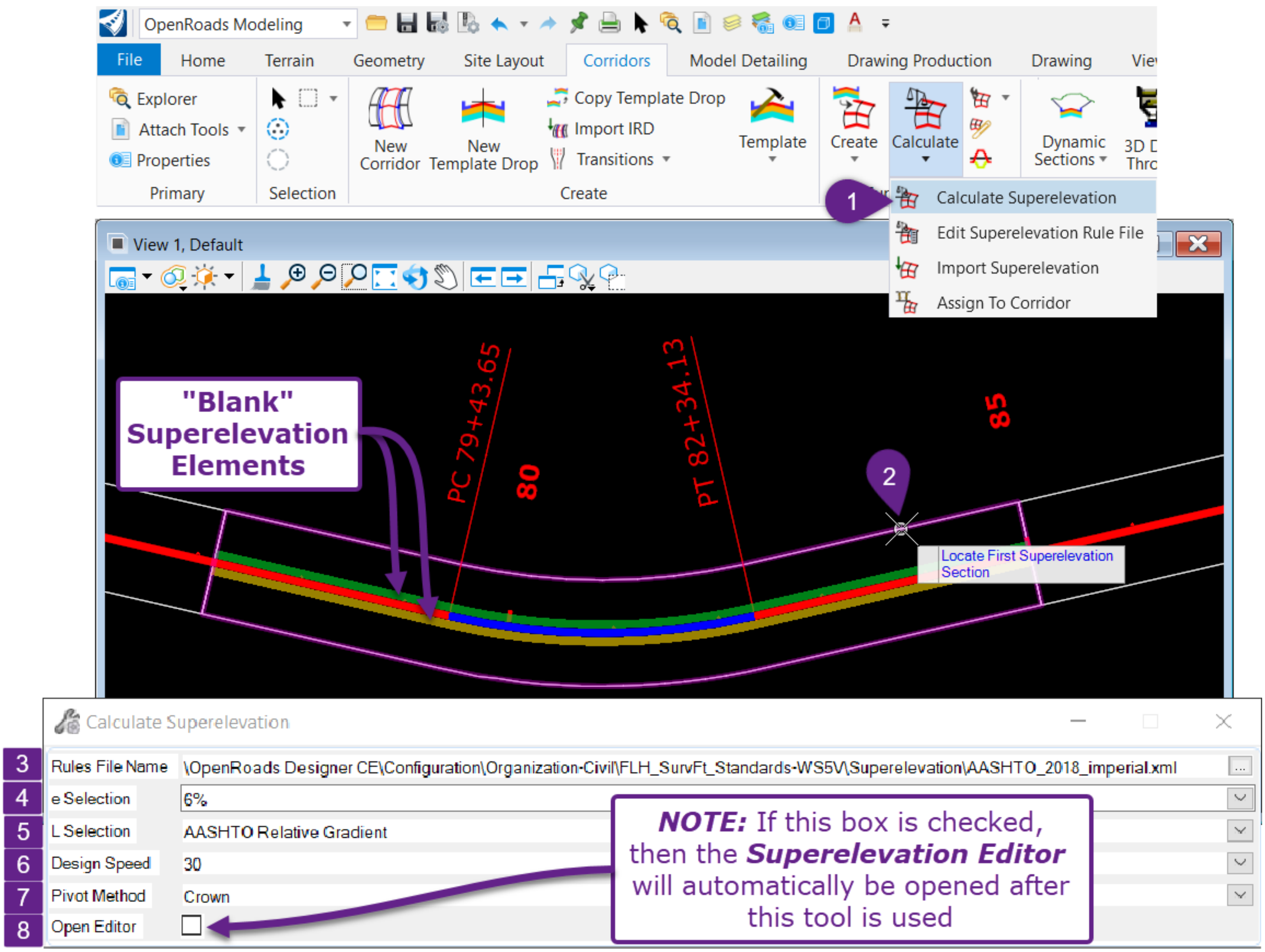


10D.7 Calculate Superelevation tool

This tool can is used to set the *Standards File* (XML) and *Calculation Parameters* for "blank" *Section* elements.

Also, this tool can be used to change the *Standards File* (XML) and/or *Calculation Parameters* for a *Section* element that has been previously calculated. ***NOTE:*** These parameters may also be changed in the Properties box of the *Section* element. See *10E.1 Switch the Standards File and Edit Calculation Parameters*.

For a detailed explanation of the *Standard File* (XML) and *Calculation Parameters*, see *10C.3 Calculation and Layout of Superelevation Elements*.

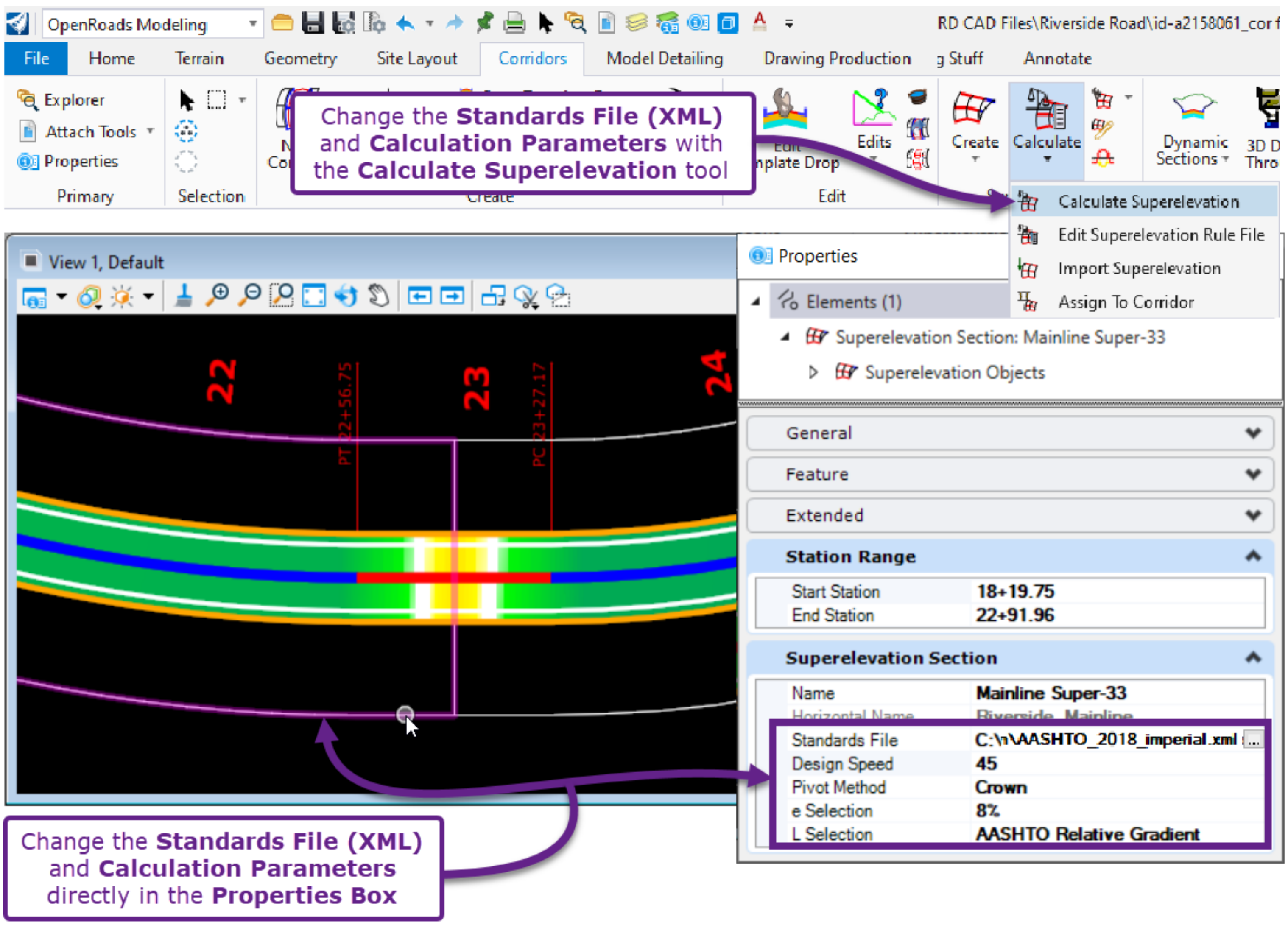


10E – EDIT SUPERELEVATION POINTS

10E.1 Switch the Standards File and Edit Calculation Parameters (Calculate Superelevation tool)

The *Standards File* (XML) and Calculation Parameters are attached to the *Section* element and can be viewed and changed in the Properties box when a *Section* element is selected. Calculations Parameters that can be modified in the Properties box include: Design Speed, Pivot Method, e Selection, and L Selection.

Alternatively, the *Calculation Superelevation* tool can be used switch the *Standards File* (XML) or change Calculation Parameters. See *10D.7 Calculate Superelevation tool*.



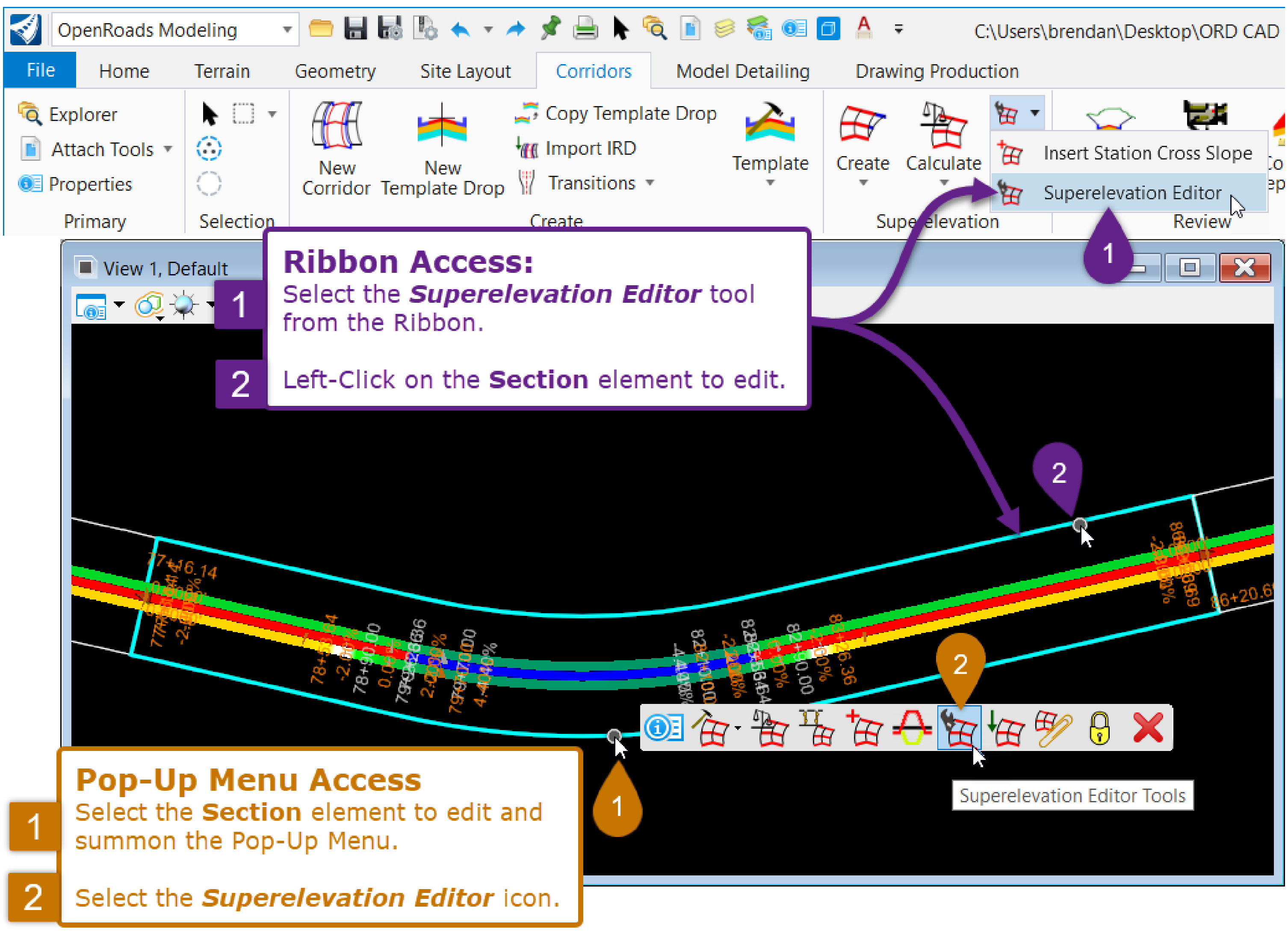
10E.2 Superelevation Editor Tool

This tool provides access to the Superelevation Table and shows the Superelevation Diagram for a single *Section* element. Each line in the Superelevation Diagram represents a specific *Lane* element.

BEST PRACTICE: Before making edits in the *Superelevation Editor* tool, the User is encouraged to manipulate the *Standards File* (XML) to make superelevation rates and transition calculations behave as desired in an automatic fashion. See *10C.3.d Edit the Superelevation Rule Tool*.

WARNING: Editing a Point in the Superelevation Table will affect the position of other Points due to *Constraint Relationships* that are present in the Diagram. Constraint Relationships are only formed when a *Standards File* (XML) is used to automatically calculate superelevation. **The User must understand Constraint Relationships for successful editing of Points in the Table.** See *10E.2.f Constraint Relationships for a Typical Curve*.

WARNING: Superelevation Points that are edited with this tool will revert back to their original position if the *Section* element is re-calculated. Re-calculation occurs if the Alignment, Profile, or any element that interacts with the Corridor is edited. See *10E.6 Recalculation of Superelevation and Locking Section Elements*.

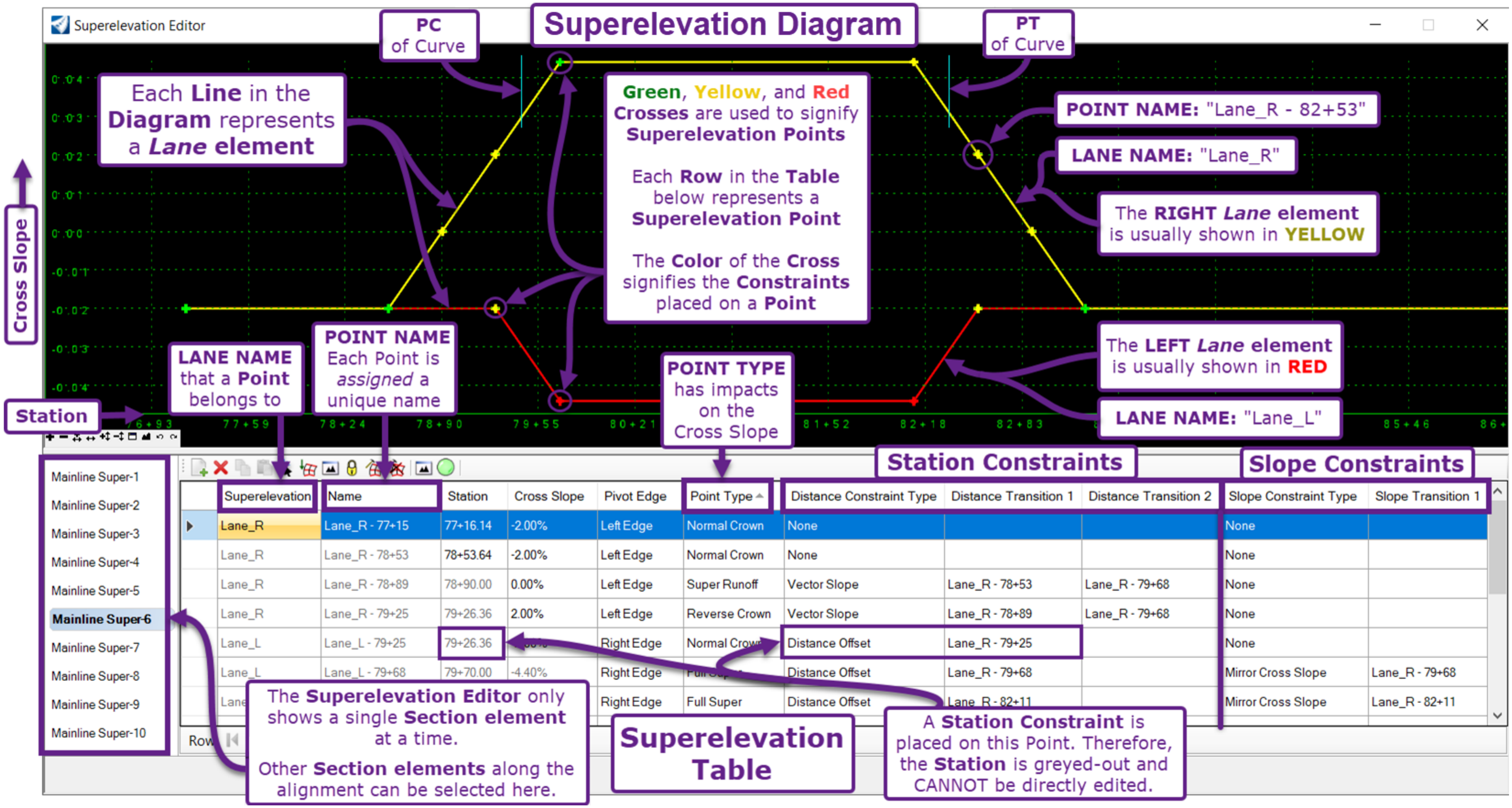


10E.2.a Superelevation Editor Overview

The graphic below overviews the *Superelevation Editor*. The *Superelevation Editor* is made up the **Superelevation Diagram** and the **Superelevation Table**.

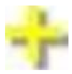
The Diagram is arranged with the Alignment **Station** representing the X-axis. The Lane **Cross Slope** value represents the Y-axis.

In the Diagram, the X and Y position for a **Superelevation Point** depends on the **Station** and **Cross Slope** value shown in the **Table**. If the **Station** and/or **Cross Slope** for a **Point** is greyed out, then a Distance and/or Slope Constraint is placed on the **Point**.



10E.2.b Superelevation Point Constraints

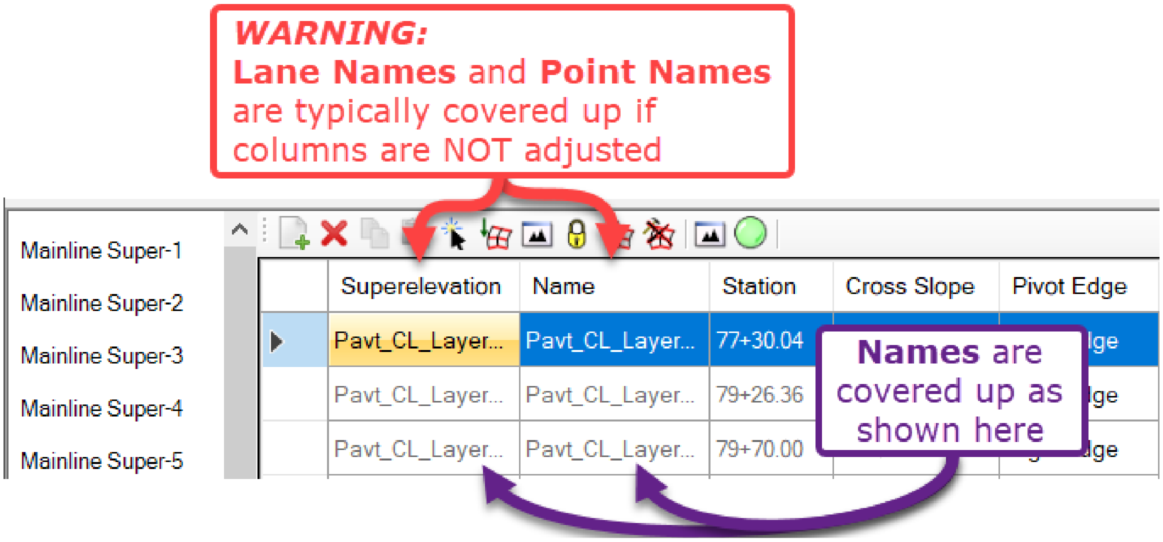
Constraints are recognized in the **Superelevation Diagram** by Red, Yellow, and Green crosses.

Superelevation Point Constraints		
Constraint Identifier:		**Description:**
Fully Constrained		• Two Constraints defined. The Station and Cross-Slope values are constrained to Parent Points. • The Station Position and Cross-Slope values for Fully Constrained Superelevation Points CANNOT be edited directly. • In 2D Design Model and Superelevation Editor, Station Position and Cross-Slope Values are greyed out.
Partially Constrained		• One Constraint defined. Either the Station or Cross-Slope Value is constrained. • The value for the unconstrained parameter can be directly edited. The value for the constrained parameter is greyed out.
Unconstrained		• No Constraints defined. • Both the Station and Cross-Slope values can be directly edited in the 2D Design Model or Superelevation Editor.

10E.2.c Point Names vs Lane Names

To interpret and recognize Constraint Relationships among Superelevation Points, the User must understand the difference between the **Lane Name** and **Point Names**.

TIP: Expand the column widths to reveal entire *Lane Name* and *Point Name*.

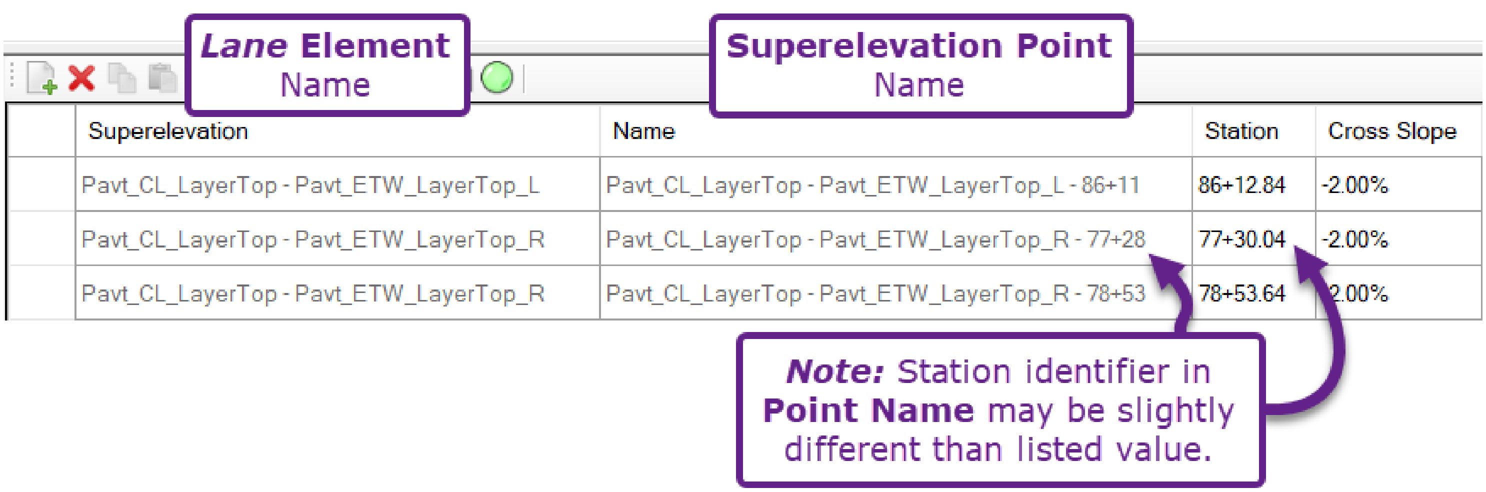


Lane Names: Unless specified in manual creation, the default Name for a *Lane* element is the combination of the two *Flagged* Template Points specified in the *Template Editor*.

An example **Lane Name** is: "Pavt_CL_LayerTop - Pavt_ETW_LayerTop_R"

Superelevation Point Names: Each row in the Superelevation Table represents a particular Superelevation Point in a *Lane* element. Every *Superelevation Point* is automatically assigned a unique Name. The **Superelevation Point Name** is the combination of the **Lane Name** ("Pavt_CL_LayerTop - Pavt_ETW_LayerTop_R") and the Station of the Point (77+28).

An example **Superelevation Point Name** is: "Pavt_CL_LayerTop - Pavt_ETW_LayerTop_R – 77+28"



TIP: When a *Lane* element is selected in the *2D Design Model*, the **Lane Name** can be changed in the Properties Box. The **Superelevation Point Name** CANNOT be changed. Changing the **Lane Name** to something brief and logical (i.e. "Lane_R" or "Lane_L") will improve the readability of the Table.

10E.2.d Point Types

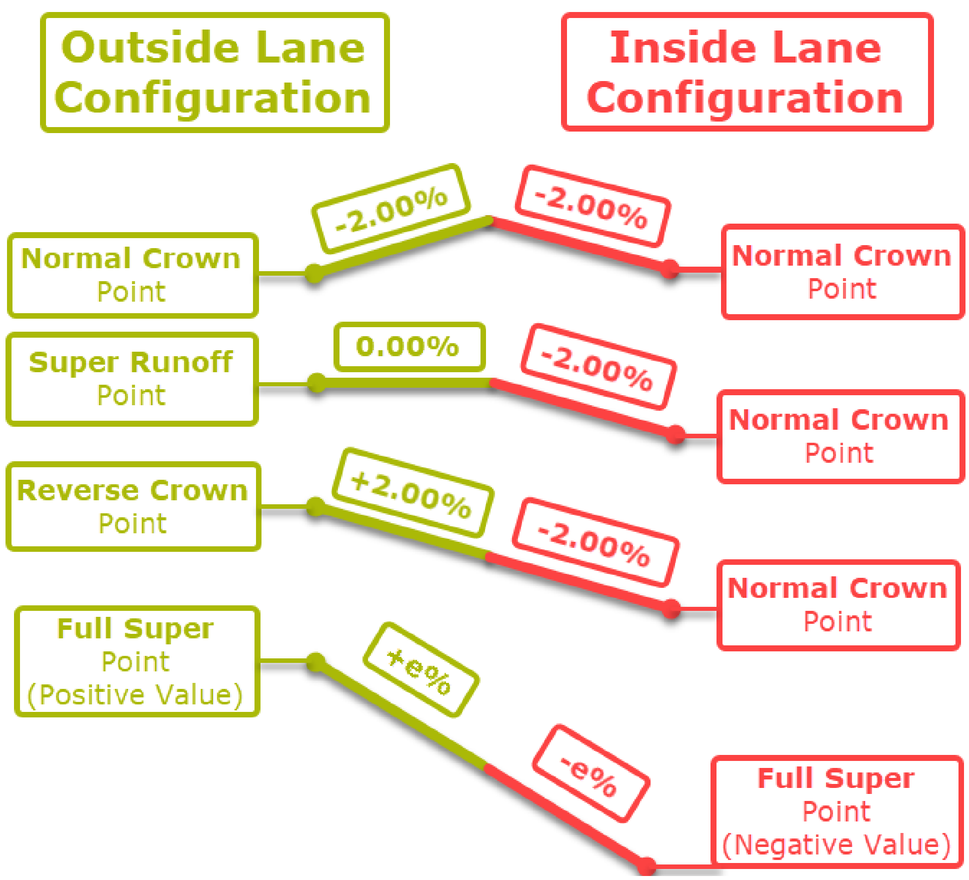
Point Type directly corresponds with the **Cross Slope** value for a Superelevation Point. The **Normal Crown**, **Super Runoff**, and **Reverse Crown** values are always the same, as discussed in the table below. The **Full Super** point depends on the radius of the curve.

Superelevation Point Types	
Point Type:	**Description:**
Normal Crown	This value is always **negative**. If a 2% crown is used, the Cross Slope value will always equal **-2.00%**.
Super Runoff	The Cross Slope value is always equal to **0.00%**. Some publications refer to this as the "Level Crown" location.
Reverse Crown	This value is always **positive.** If a 2% crown is used, the Cross Slope value will always equal **+2.00%**
Full Super	The Cross Slope value for is uniquely calculated for each curve (radius). This often referred to as the "e-value". This is calculated from the *Standard File* (XML) and Calculation Parameters set in the *Section* element Properties.

The Right and Left Lanes will undergo different transition sequences – depending on which side is positioned to the **INSIDE** or **OUTSIDE** of the Alignment through a curve.

The transition sequence for the **OUTSIDE Lane** is typically:
Normal Crown → *Super Runoff* → *Reverse Crown* → *Full Super* (Positive Value)

The transition sequence for the **INSIDE Lane** is typically:
Normal Crown → *Full Super* (Negative Value)



10E.2.e Constraint Types

When a *Standards File* (XML) is used to automatically calculate superelevation rates, *Constraints* are placed on Superelevation Points. *Constraints* for Superelevation Points work similar in concept to constraints for Template Points. *Constraints* are used to fix the **Station** or **Cross Slope** Value of a Superelevation Point in relation to a Parent Point.

NOTE: The **Parent Points** constraint for a Point is shown identified in "Slope Transitions" column.

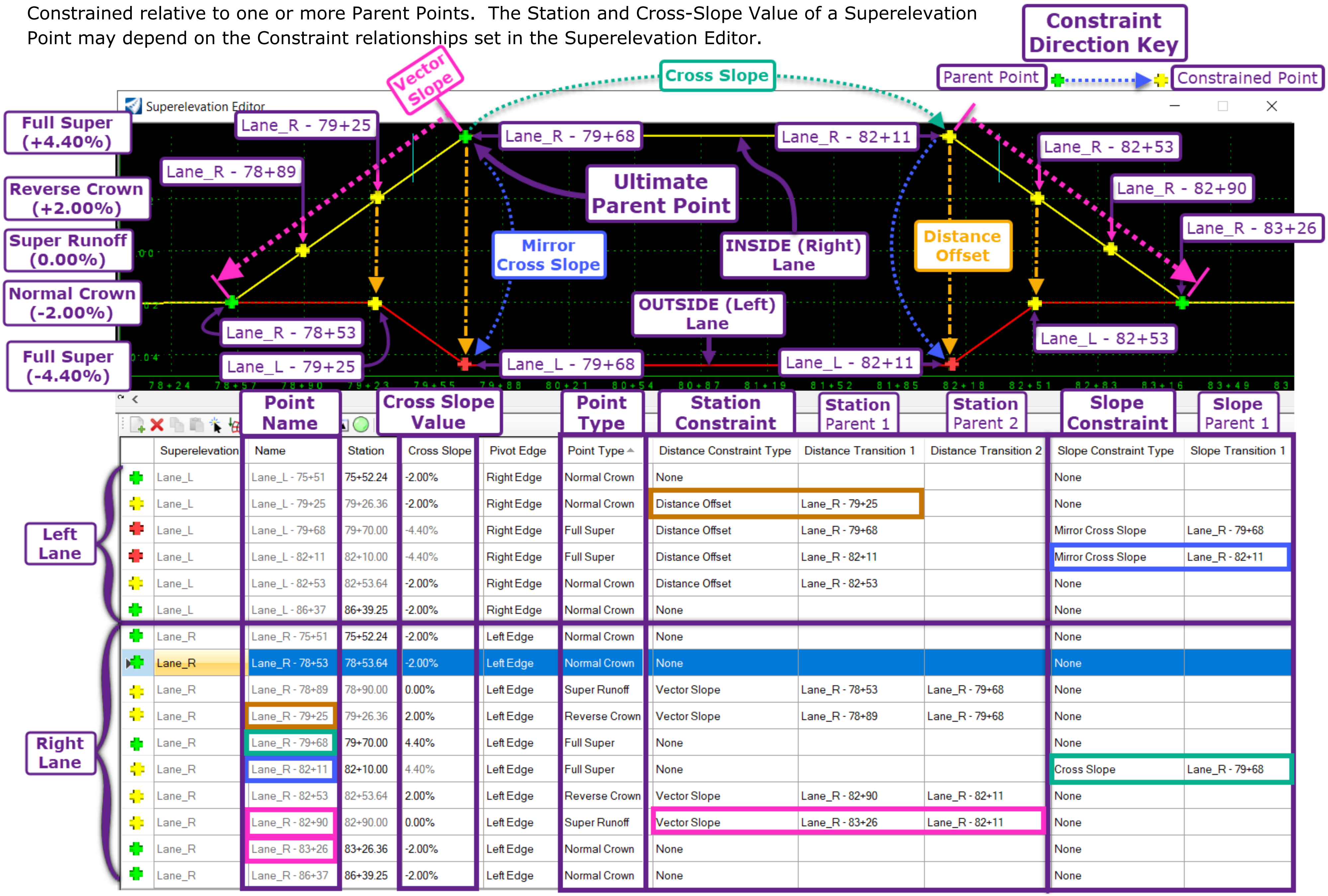
			Station Constraint	Parent Points (Station Constraint)		Cross Slope Constraint	Parent Point (Cross Slope)
Name	Cross Slope	Point Type	Distance Constraint Type	Distance Transition 1	Distance Transition 2	Slope Constraint Type	Slope Transition 1
Lane_R - 89+95	2.00%	Reverse Crown	Vector Slope	Lane_R - 89+59	Lane_R - 90+31	None	
Lane_L - 90+31	-4.00%	Full Super	Distance Offset	Lane_R - 90+31		Mirror Cross Slope	Lane_R - 90+31
Lane_R - 93+49	4.00%	Full Super	None			Cross Slope	Lane_R - 90+31

Distance Constraint Type	
Type:	**Description:**
Distance Offset	This type is used to fix the Station of a Point to the same station as the Parent Point. (Shown with an orange arrow on the next page). Typically, this constraint type is used when multiple Points should be locked to the same station. For example, the *Full Super Point* for the Left Lane and the *Full Super Point* for the Right Lane are typically placed at the same Station. This Constraint Type locks the Station position of the two Points in a Parent-Child relationship. When the Station of Parent is edited, then the Child will automatically moved.
Vector Slope	This constraint type uses TWO Parent Points. This constraint type is shown in pink on the next page. This constraint type locks in the station of a point based on the *Vector* created by the two Parent Points.

Slope Constraint Type	
Type:	**Description:**
Cross Slope	This type is used to fix the Cross Slope value of a Point to the same Cross Slope as the Parent Point. (Shown with a turquoise arrow on the next page). Typically used to constrain the Full Super Point at the PC and the Full Super Point at the PT.
Mirror Cross Slope	This type is used mirror the Cross Slope value of from a Parent to a Point. (Shown with a blue arrow on the next page). This is typically used for the Full Super Points that share the same Station but are placed on opposing *Lane* elements. These points should have equal but opposite Cross-Slope values (i.e., **+5.2%** → **-5.2%**)

10E.2.f Constraint Relationships for a Typical Curve

When a *Standards File* (XML) is used to calculate rates and transitions, most Superelevation Points are Constrained relative to one or more Parent Points. The Station and Cross-Slope Value of a Superelevation Point may depend on the Constraint relationships set in the Superelevation Editor.



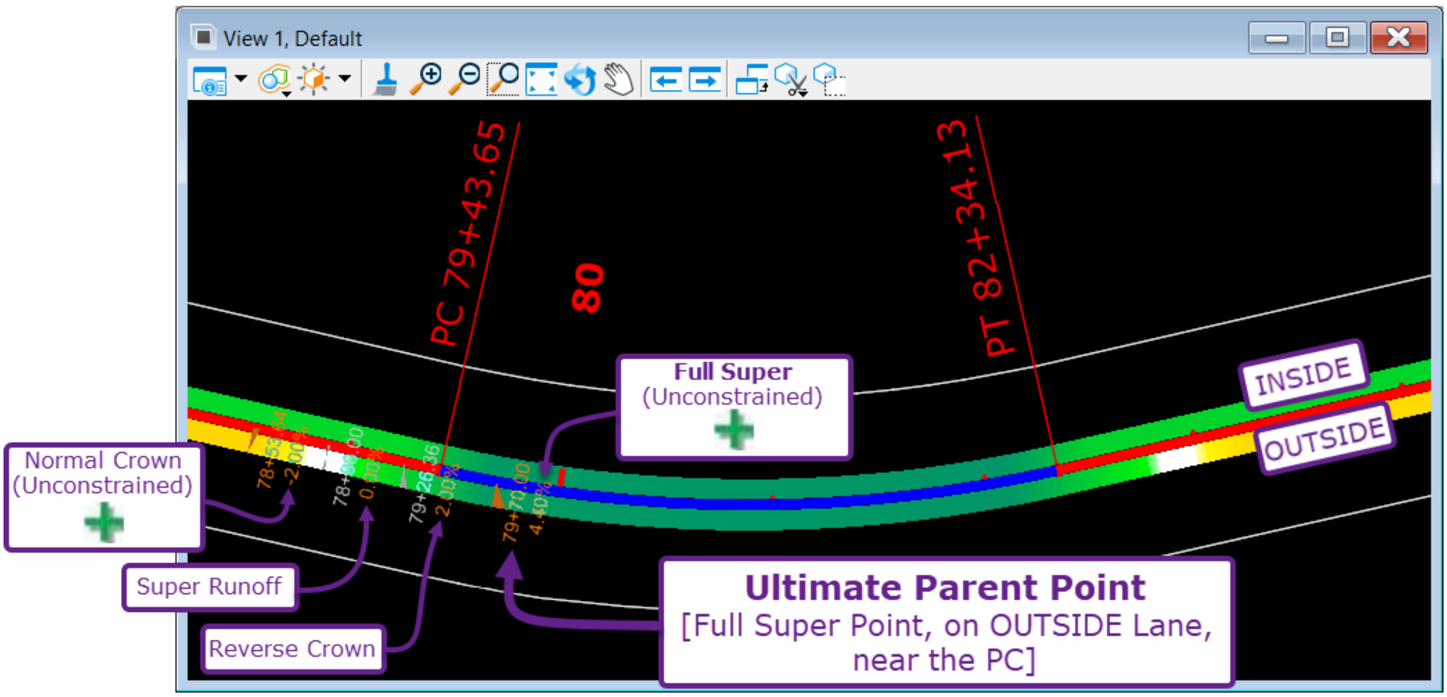
Superelevation	Name	Station	Cross Slope	Pivot Edge	Point Type	Distance Constraint Type	Distance Transition 1	Distance Transition 2	Slope Constraint Type	Slope Transition 1
Lane_L	Lane_L - 75+51	75+52.24	-2.00%	Right Edge	Normal Crown	None			None	
Lane_L	Lane_L - 79+25	79+26.36	-2.00%	Right Edge	Normal Crown	Distance Offset	Lane_R - 79+25		None	
Lane_L	Lane_L - 79+68	79+70.00	-4.40%	Right Edge	Full Super	Distance Offset	Lane_R - 79+68		Mirror Cross Slope	Lane_R - 79+68
Lane_L	Lane_L - 82+11	82+10.00	-4.40%	Right Edge	Full Super	Distance Offset	Lane_R - 82+11		Mirror Cross Slope	Lane_R - 82+11
Lane_L	Lane_L - 82+53	82+53.64	-2.00%	Right Edge	Normal Crown	Distance Offset	Lane_R - 82+53		None	
Lane_L	Lane_L - 86+37	86+39.25	-2.00%	Right Edge	Normal Crown	None			None	
Lane_R	Lane_R - 75+51	75+52.24	-2.00%	Left Edge	Normal Crown	None			None	
Lane_R	Lane_R - 78+53	78+53.64	-2.00%	Left Edge	Normal Crown	None			None	
Lane_R	Lane_R - 78+89	78+90.00	0.00%	Left Edge	Super Runoff	Vector Slope	Lane_R - 78+53	Lane_R - 79+68	None	
Lane_R	Lane_R - 79+25	79+26.36	2.00%	Left Edge	Reverse Crown	Vector Slope	Lane_R - 78+89	Lane_R - 79+68	None	
Lane_R	Lane_R - 79+68	79+70.00	4.40%	Left Edge	Full Super	None			None	
Lane_R	Lane_R - 82+11	82+10.00	4.40%	Left Edge	Full Super	None			Cross Slope	Lane_R - 79+68
Lane_R	Lane_R - 82+53	82+53.64	2.00%	Left Edge	Reverse Crown	Vector Slope	Lane_R - 82+90	Lane_R - 82+11	None	
Lane_R	Lane_R - 82+90	82+90.00	0.00%	Left Edge	Super Runoff	Vector Slope	Lane_R - 83+26	Lane_R - 82+11	None	
Lane_R	Lane_R - 83+26	83+26.36	-2.00%	Left Edge	Normal Crown	None			None	
Lane_R	Lane_R - 86+37	86+39.25	-2.00%	Left Edge	Normal Crown	None			None	

10E.2.g Ultimate Parent Point

In the graphic on the previous page, the **"Lane_R – 79+68"** point is labeled as the ***Ultimate Parent Point***. The position of the Ultimate Point will directly or indirectly affect the position of all other Points in the same curve through Constraint relationships. However, there are two minor exceptions. The two *Normal Crown* points – for the OUTSIDE Lane only – are unaffected by moving the *Ultimate Parent Point*. (In the graphic on the last page, the two *Normal Crown* points are labeled "*Lane_R – 78+53*" and "*Lane_R – 83+26*")

Ultimate Parent Point Location: The Ultimate Parent Point is the unconstrained ✚ **Full Super** point placed near the PC of Curve. It is one of the few points that can be edited freely, because it doesn't have one or two Parent Points.

> ***NOTE:*** The Full Super point can be placed on either *Lane* element. The placement depends on which *Lane* is placed to the OUTSIDE of the alignment through the curve.

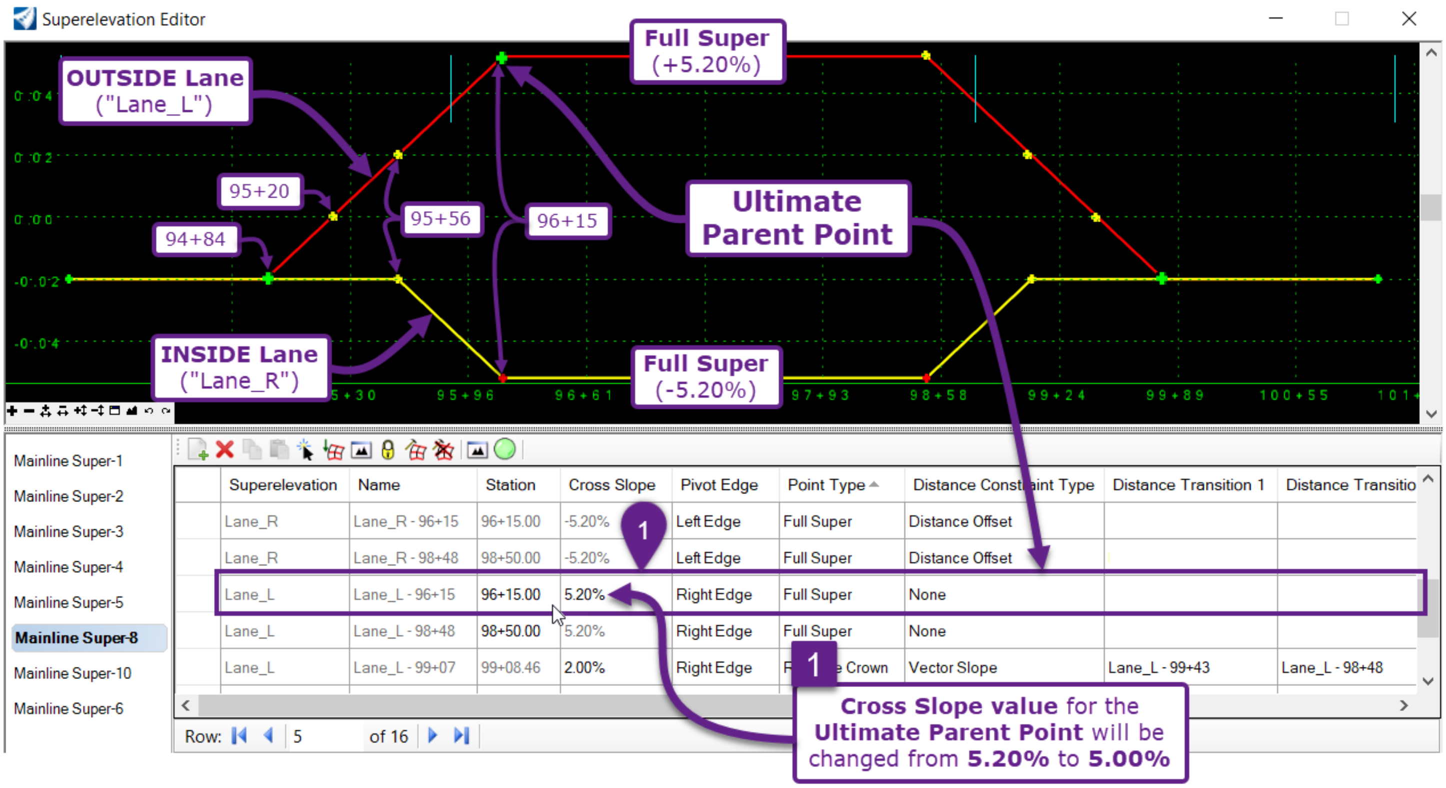


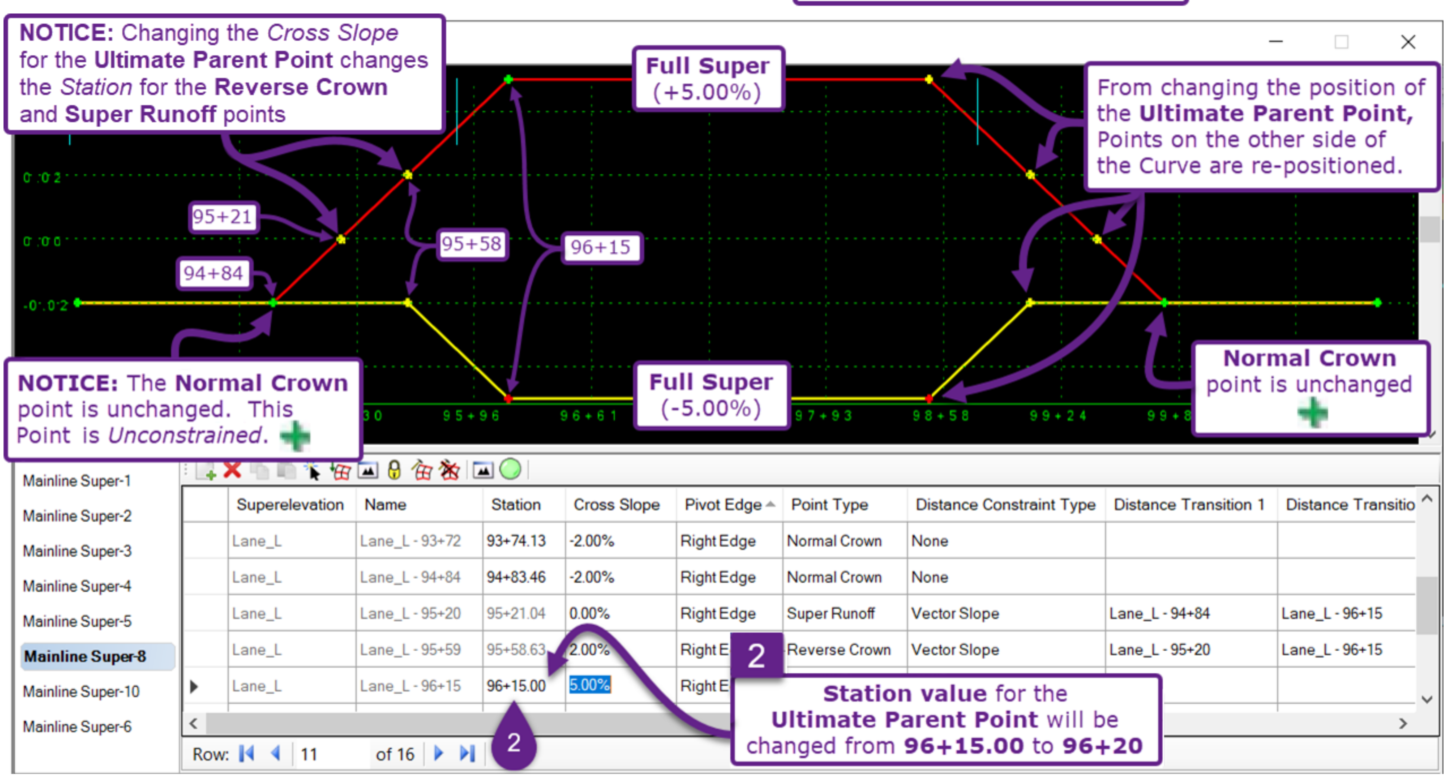
NOTE: The **Super Runoff** and **Reverse Crown** points are Constrained between the **Full Super** (Parent 1) and **Normal Crown** (Parent 2) with a **Slope Vector Constraint**

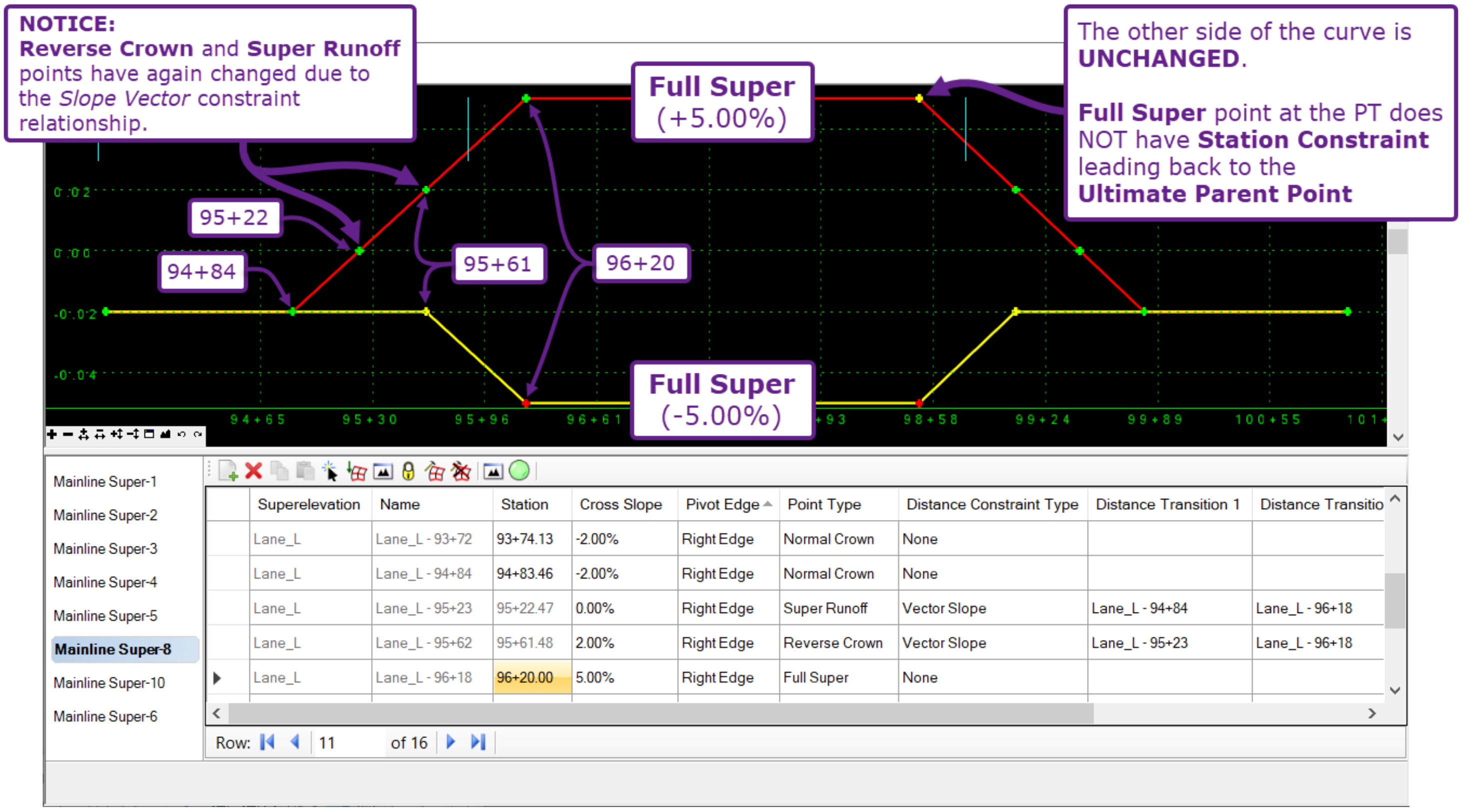
10E.3 Manipulating Constrained Points in the Superelevation Editor

In the first part of this workflow, the Station and Cross Slope value for the Full Super points will be changed by locating the *Ultimate Parent Point*. Changing the location of the *Ultimate Parent Point* will re-position all Constrained Points.

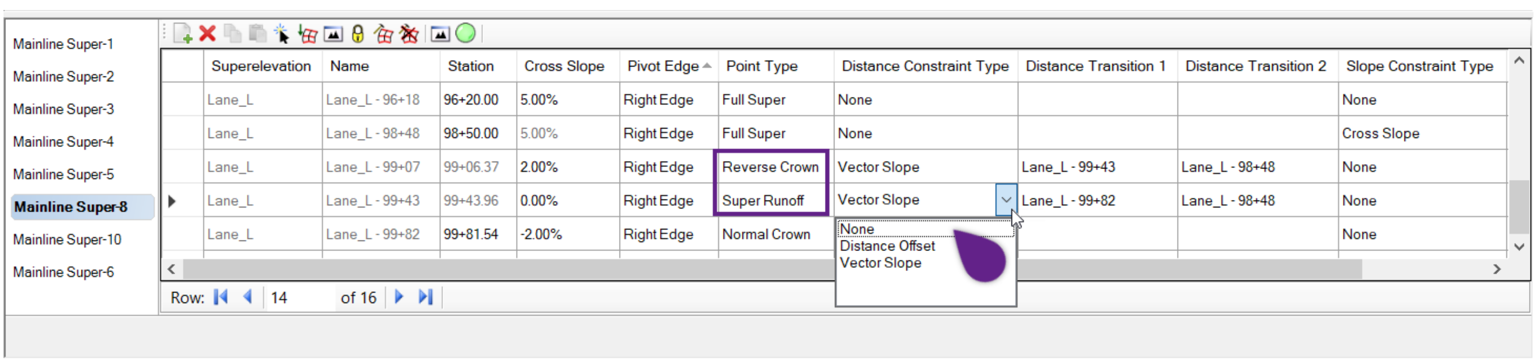
IMPORTANT: When working with Constrained Points, the User should **locate the *Ultimate Parent Point*** and consider all *Constraints* relationships that stem from it. See *10E.2.g Ultimate Parent Point* and *10E.2.f Constraint Relationships for a Typical Curve*.







TIP: The Station of the **Reverse Crown** and **Superelevation Runoff** points can be kept static by removing the *Distance* (Station) *Constraint*. Set the *Distance Constraint Type* to *None*.

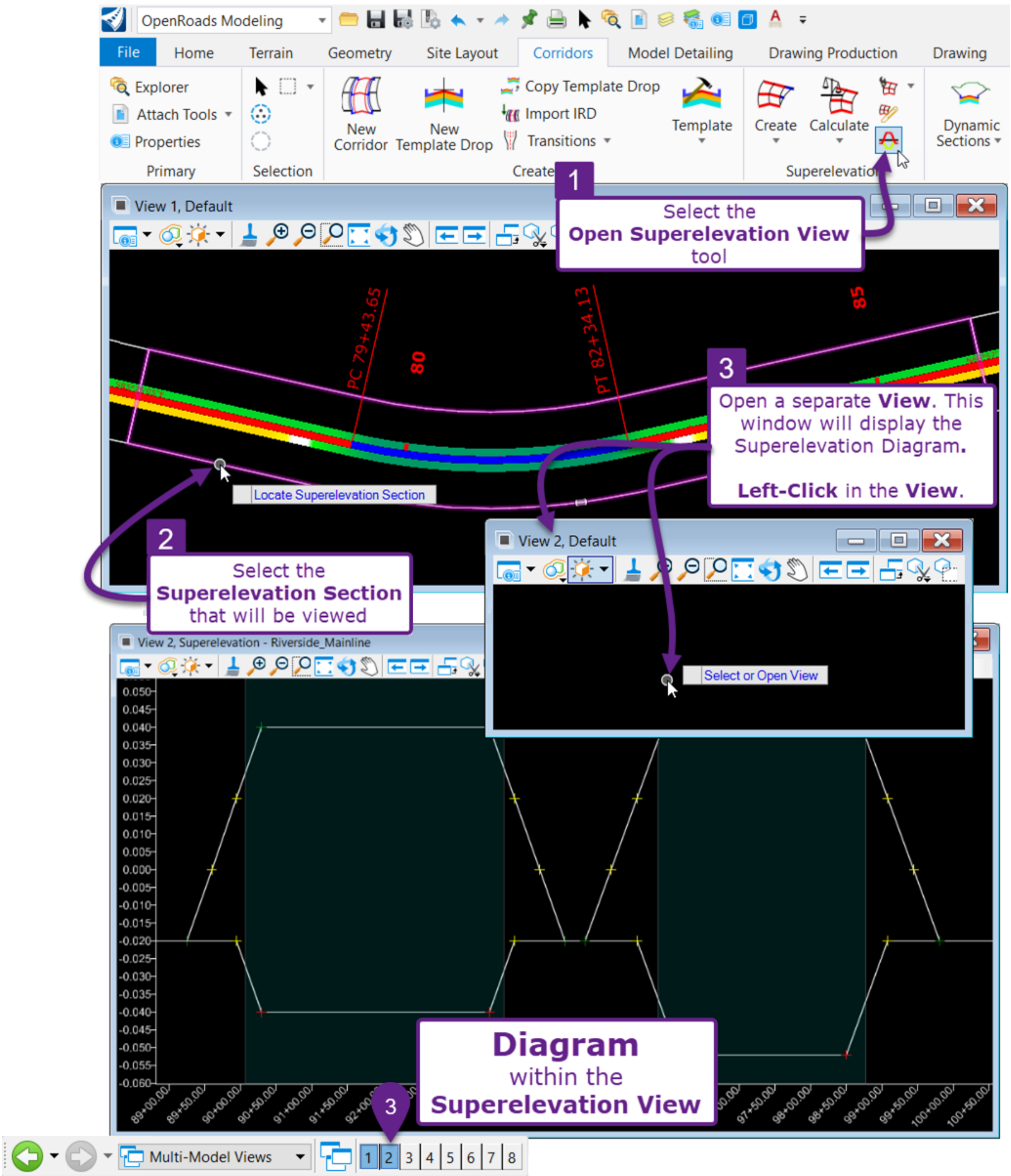


10E.4 Open the Superelevation View

The *Superelevation View* is another location to view and edit the *Superelevation Diagram*. In the Superelevation View, the User can select a Point from the Diagram and directly edit the Station or Cross-Slope value.

Within in this tool, Points will be color-coded according to Constraints placed on them. See *10E.2.b Superelevation Point Constraints*. However, the Parent Point(s) for a given Point is not listed in this location. Parent Points can only be identified and traced in the Table of the *Superelevation Editor* tool.

Another difference between this tool and the *Superelevation Editor*, is that the *Diagram* is shown for the entire Alignment length. The *Section Editor* only shown the *Diagram* for a single *Section* element at a time.

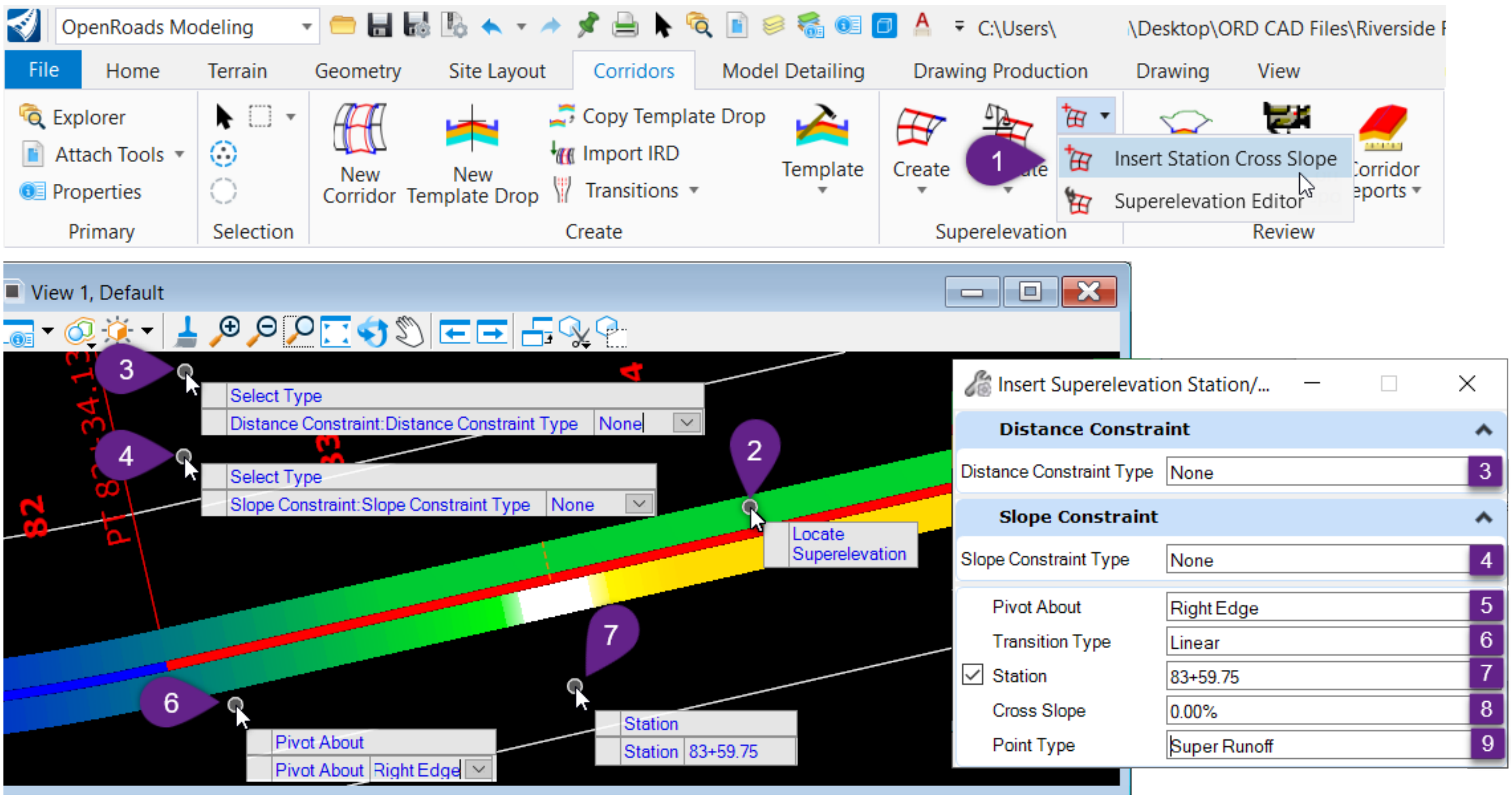


10E.5 Insert Station Cross Slope tool

This tool is used to manually add a Superelevation Point to a *Lane* element. This tool can be used directly to a *Lane* element in the *2D Design Model* or in the *Superelevation Table Editor*.

In this example a new Point will be placed in the left lane – directly opposite the Super Runoff Point (Cross Slope = 0.00%) in the right lane. The Cross Slope value of the new Point will also be 0.00%

WARNING: Superelevation Points that are created with this tool are deleted if the *Section* element is re-calculated. See *10E.6 Recalculation of Superelevation and Locking Section Elements*.



1	Select the *Insert Station Cross Slope* tool from the Ribbon. Ribbon Location: ***OpenRoads Modeling*** → ***Corridor*** → ***Superelevation***
2	*Prompt: Locate Superelevation* – Left-Click on the *Lane* element. The Superelevation Point will be added to the chosen *Superelevation Lane* element. In this case, the Left Lane is selected.
3	Prompt: Select Type: Distance Constraint Type – If desired, the User can place a Station Constraint on the new Point. See *10E.2.e Constraint Types*. A clever use of a Station Constraint would be to use the Distance Offset Type (with offset = 0.00) to constrain the Station of the new Point to the Super Runoff Point in the lane directly opposite. In this case, the *None* option is selected.
4	*Prompt: Select Type: Slope Constraint Type* - If desired, the User can place a Cross Slope *Constraint* on the new Point. See *10E.2.e Constraint Types*. A clever use of a *Cross Slope Constraint* would be to use the *Cross Slope Type* to constrain the Cross Slope of the new Point to the Super Runoff Point in the lane directly opposite. In this case, the *None* option is selected

5	*Prompt: Pivot About* – Select the side of the *Lane* that will serve as the Pivot Point. Typically, the **Right Edge** is selected for *Lane* elements placed to the **Left** of the Alignment. In this case, the Left Lane was selected in Step 2, so the *Right Edge* option is selected.
6	*Prompt: Transition Type* – If desired, non-linear transitions can be specified between Superelevation Points. In conventional highway design, the slope transition between Superelevation Points are **Linear.**
7	*Prompt: Station* – Graphically select station location or key-in the station value for the new Superelevation Point. ***NOTE:*** If a *Distance Constraint* was specified in step 3, then this *Prompt* is NOT presented.
8	*Prompt: Cross Slope* – Key-in the Cross Slope value for the new Superelevation Point and press Enter to lock. ***NOTE:*** If a *Slope Constraint* was specified in Step 4, then this *Prompt* is NOT presented. In this case 0.00% is keyed in.
9	*Prompt: Point Type* – If desired, a Point Type can be assigned to the new Superelevation Point. The main advantage of assigning a Point Type is to help organize the new Point within the *Superelevation Table Editor* tool. In this example, the point has a 0.00% cross slope – which corresponds with a **Super Runoff** Point Type.

10E.6 Recalculate Superelevation and Lock Section Elements

Superelevation is re-calculated whenever edits are made to the Alignment, Profile, Corridor, or any elements that interact with the Corridor. However, to trigger the superelevation re-calculation, the User must open the Superelevation ORD File. When the Superelevation ORD File is opened, superelevation will be re-calculated.

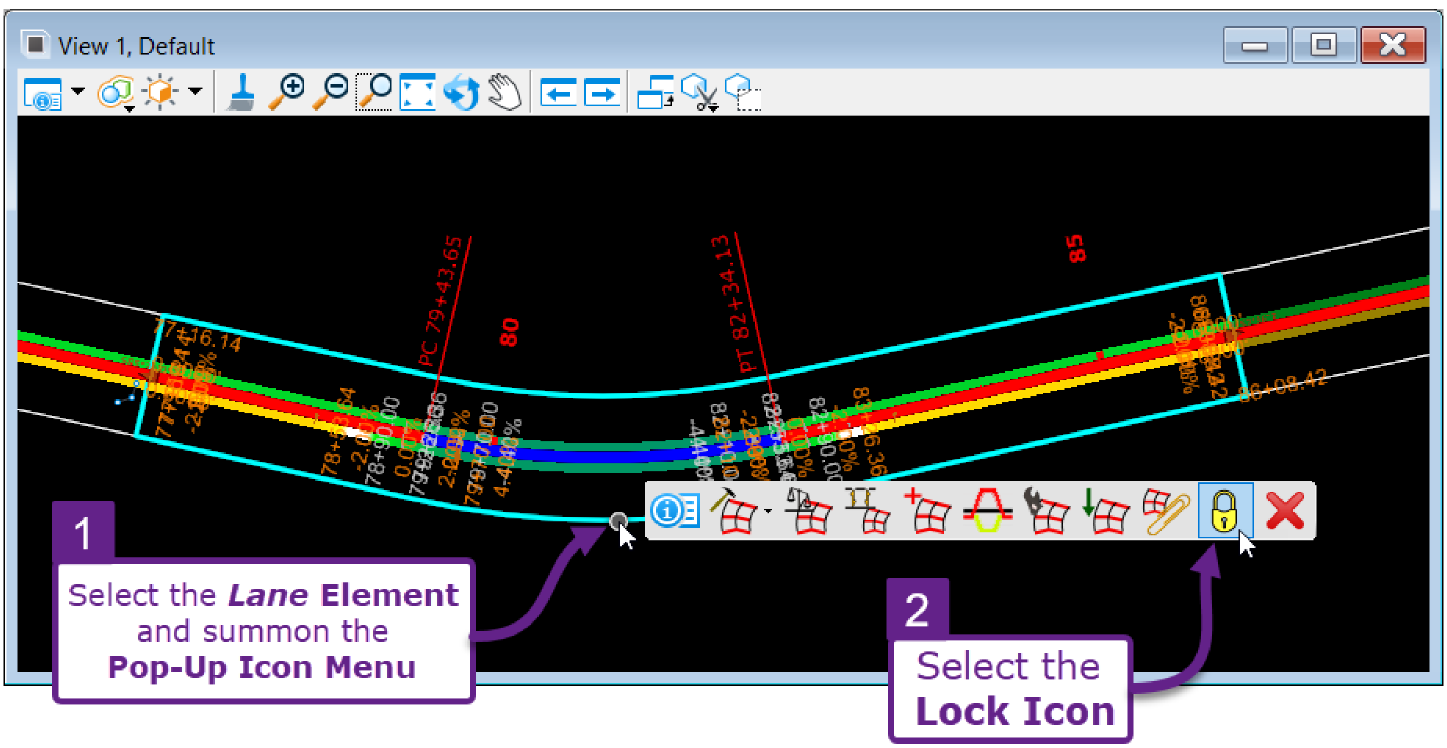
Also, re-calculation occurs when edits are made to the *Section* elements from within the Properties box.

WARNING: When a Superelevation is re-calculated, all custom edits made are lost. This includes all changes made in Superelevation Editor, Superelevation View, or Cross Slope/Station edits made directly to the *Lanes* in the *2D Design Model* .

BEST PRACTICE: To prevent re-calculation, *Lock* all *Section* elements after Superelevation has been reviewed.

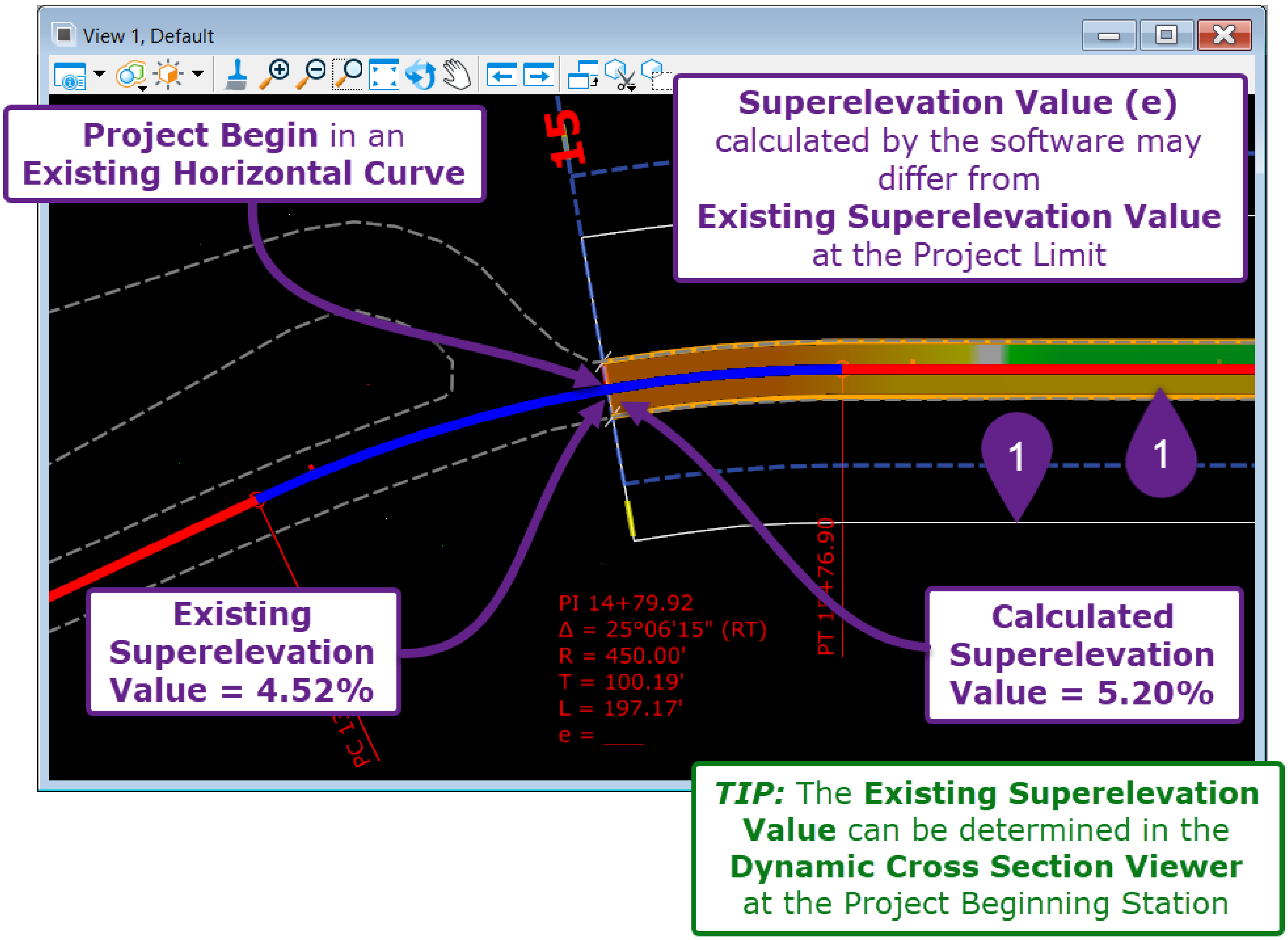
When *Section* elements are *Locked*, they will NOT re-calculate until *Unlocked* by the User.

Locking *Section* Elements: *Section* elements are locked by selecting the element and summoning the *Pop-Up Icon Menu* and selecting the **Lock** icon .



10F.1 Begin or Terminate Superelevation in an Existing Horizontal Curve

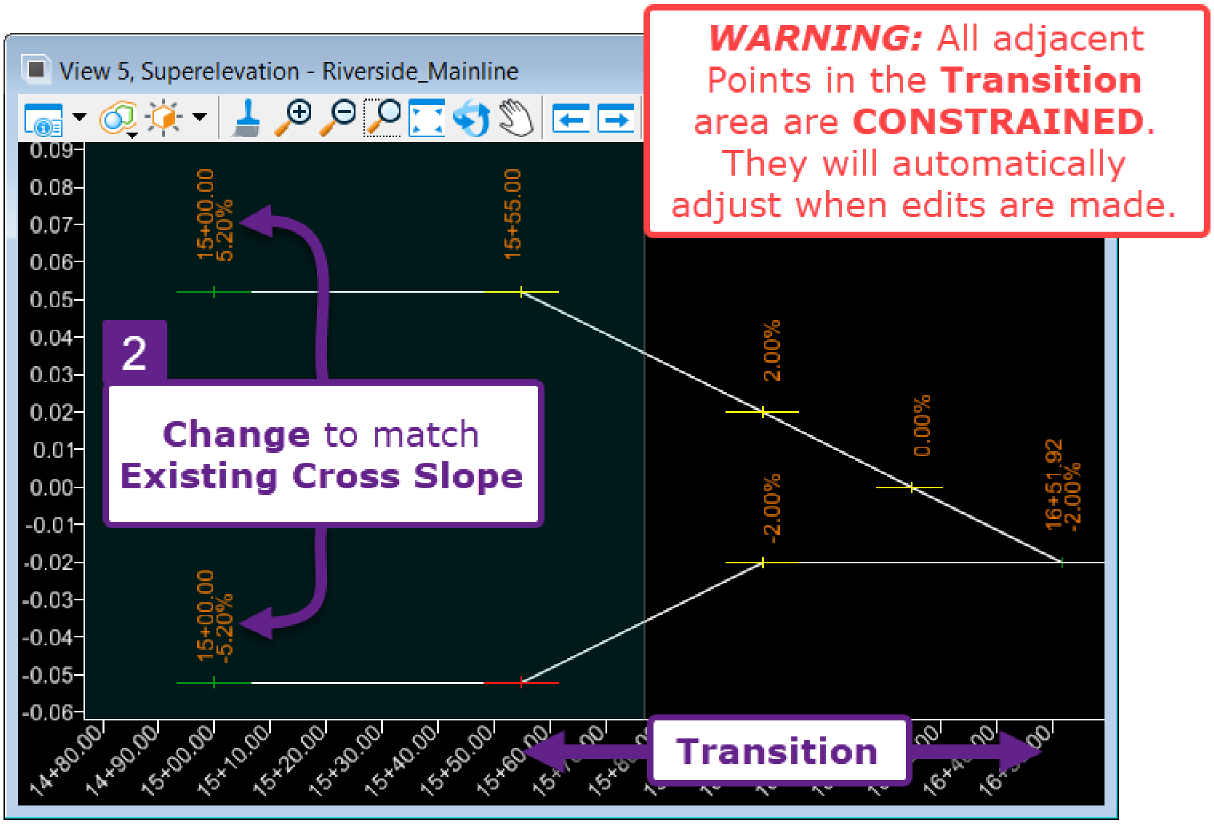
Occasionally, a project will begin or end in the middle of a horizontal curve or within the superelevation transition. This is a unique situation because the proposed design may begin or end within a full superelevation section or amid a transition. The proposed road cross slope needs to match the existing road cross slope at the project limit location. At the project limit location, the Superelevation Value (e) calculated by the software may differ from the Existing Superelevation Value – as shown in the graphic below.



To address this situation, the following workflow can be performed:

NOTE: This workflow is shown for the beginning project limit. This workflow is also applicable if the ending project limit is located within an existing horizontal curve.

1	Create and calculate Superelevation Section and Lane Elements with a method discussed in either *10D.1 Corridor Method* or *10D.2 Alignment Method*.

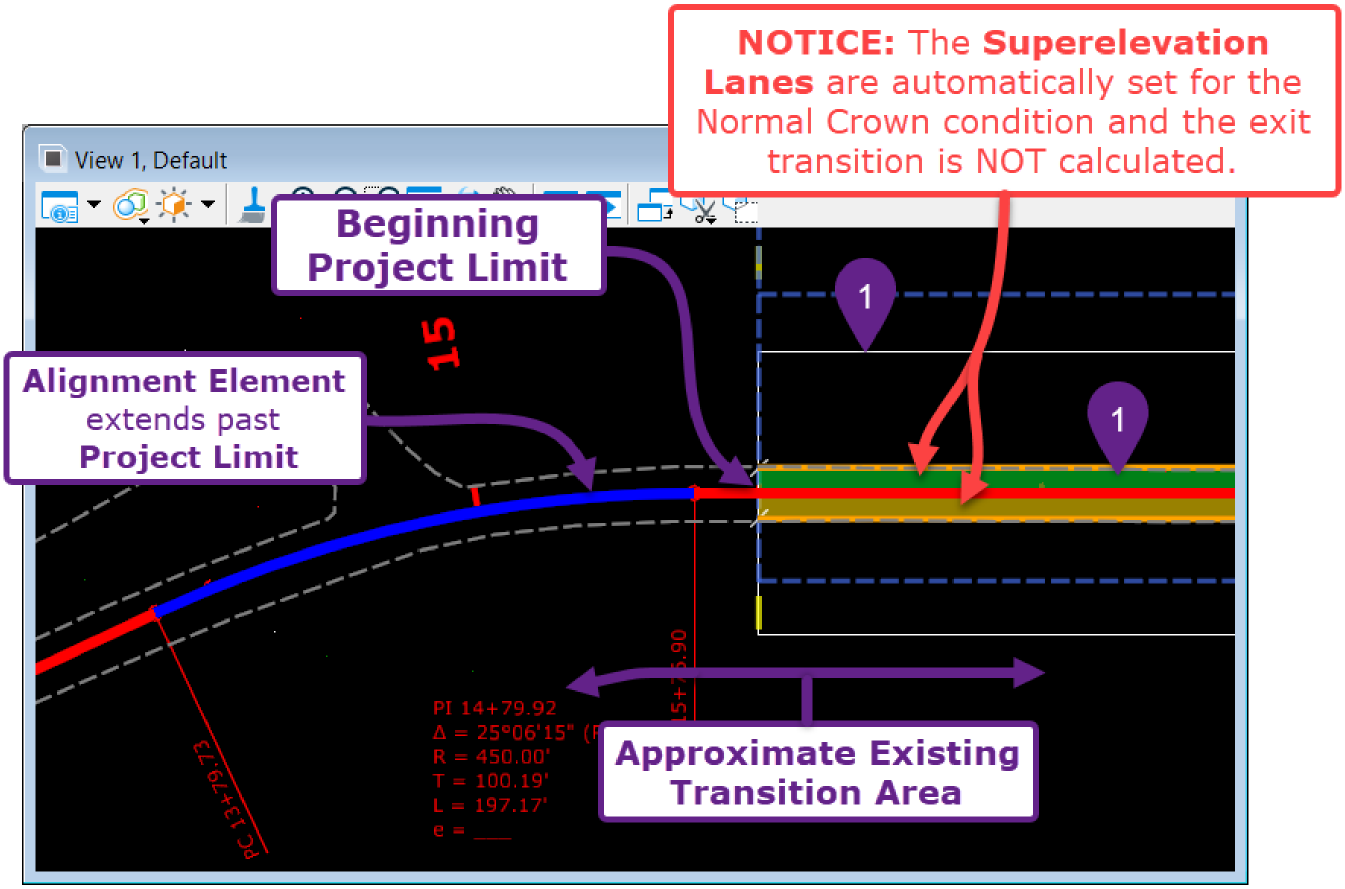


2	Manually edit the proposed Superelevation values at the project limit. The proposed Superelevation values may be edited in the Superelevation Editor (See *10E.2*) or in the Superelevation View (See *10E.4*). ***WARNING:*** When proposed Superelevation Points at project limit are edited, then the adjacent Transition Superelevation Points will be rearranged due to Constraint relationships. See *10E.2.f Constraint Relationships for a Typical Curve*.
3	Lock the Section Element. See *10E.6 Recalculation of Superelevation and Locking Section Elements*. ***WARNING:*** Section Elements must be locked after editing Superelevation Values. If not, the Section Element may re-calculate and edits performed in Step 2 will revert to default values.

10F.1.a Begin or Terminate Superelevation in an Existing Transition

If the beginning or end project limit is in an existing Superelevation Transition area, then a different procedural workflow should be performed.

NOTE: This workflow assumes that Alignment extends beyond the project limits and the existing horizontal curve. In other words, the Alignment does NOT begin or end exactly at the project limit.

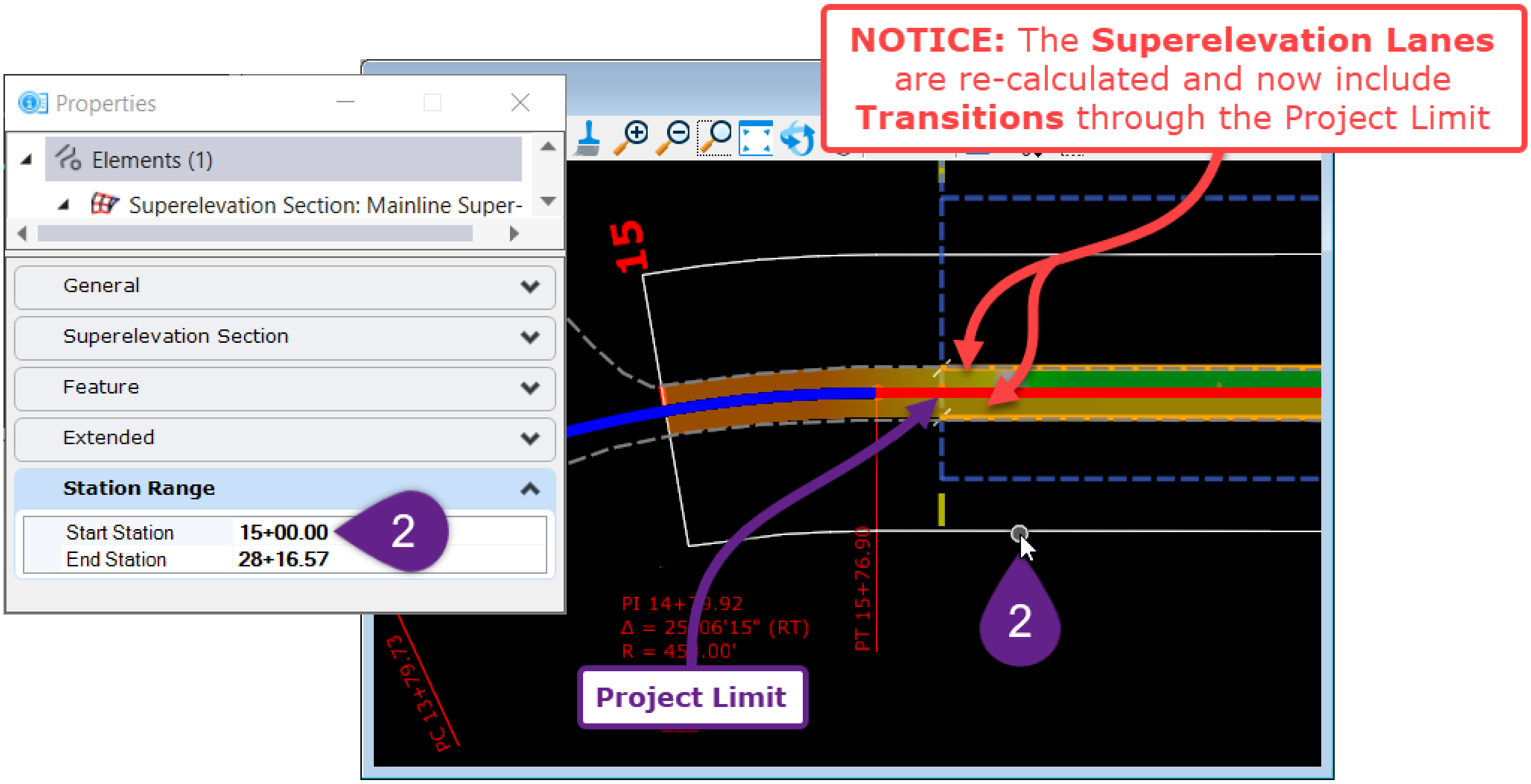


<table>
<tr><td>1</td><td>Create and calculate Superelevation Section and Lane Elements with a method discussed in either 10D.1 Corridor Method or 10D.2 Alignment Method.

In the example shown above, the Corridor Method was used – which means the Section and Lane Elements begins at the exact location where the Corridor begins. Since the Section Element is entirely located past the existing horizontal curve, the Transitions are NOT calculated and the Normal Crown condition is assumed. Since the Section Element and horizontal curve do NOT overlap, the software is NOT aware of the transition area. This is rectified by manually extending the Section Element into the horizontal curve – as shown in Step 2.

Alternative: Create Section and Lane Elements with the Alignment Method. With the Alignment Method, the User can specify a Start Station for the creation of Section and Lane Elements. Key-in a Start Station located with the horizontal curve. In the example shown above, a satisfactory Start Station would be 15+00. If the Alignment Method is used, then Step 2 can be skipped.

NOTE: It is acceptable for the Section and Lane Elements to extend beyond the Project Limit. However, the Corridors should begin exactly at the Project Limit.</td></tr>
</table>



2	Select the *Section Element*. In the Properties Box for the *Section Element*, key-in a new Start Station. The new Start Station should a station within the existing horizontal curve. The *Lane Elements* will automatically adjust to the new Start Station. The *Lane Elements* will be re-calculated with respect to the radius of the existing horizontal curve.
3	Manually edit the proposed Transition Points values to agree with the existing transition at the project limit. As discussed in *10E.2.g Ultimate Parent Point* and *10E.3 Manipulating Constrained Points in the Superelevation Editor*, transition points are linearly constrained between the Full Super Point and the Normal Crown Point. The User must adjust the Station and Cross Slop Value of the Full Super and Normal Crown Points to match the existing transition.
4	Lock the Section Element. See *10E.6 Recalculation of Superelevation and Locking Section Elements*. ***WARNING:*** Section Elements must be locked after editing Superelevation Values. If not, the Section Element may re-calculate and edits performed in Step 3 will revert to the default values.