Module 3

Horizontal Alignment

June 2024

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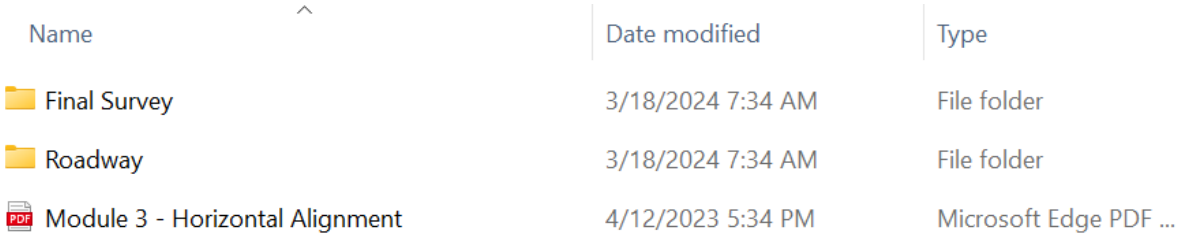
Module 3 – Horizontal Alignment

About this Practice Workbook…

- The Module 03 – Horizontal Alignment.Zip file will be provided for download.
- Exact the zip file to the root C:\
- All files are then automatically extracted here: C:\NCDOT Training\Roadway\Module 03 – Horizontal Alignment
- With these subfolders:



The Module 03 – Horizontal Alignment PDF will also be located here.

- This PDF file includes bookmarks providing an overview of the document. Click on the bookmark to quickly jump to any section in the file. You may have to turn on the bookmark function in your PDF viewer, such as Adobe Reader.

- The dataset used throughout this module uses English units and US Survey Feet.

- Each module in this series is self-contained. You can jump to any module and begin the exercises.

- The ***NCDOT_WorkSets.inp*** on your desktop should be set the following variables:
  - **NCDOT_USE_LOCAL_WORKSETS = L2**
  - **NCDOT_UNIT_TRAINING_WORKSETS = Roadway**
- This training module uses the **DOT-US North Carolina** WorkSpace, **R-2635C (Training)** WorkSet and **NCDOT_Roadway** Role. It is very important that you select the correct WorkSpace, WorkSet and Role.

- **For more information on setting up workspaces, click here.**

- The tool tips and help were copied from the Bentley Online Help. See this link for the complete list of tools and common usage.
  OpenRoads Designer CE Help (bentley.com)

- NCLUG/NCDOT Bentley ORD Open X presentations from each NCDOT Department:
  NCLUG - 2022 TECH Talks
- **This workbook was written with the release of OpenRoads Designer 10.10.XX.XX (2021)**
  OpenRoads Designer 2021 R2 update:

OpenRoads Designer Readme (bentley.com)
OpenRoads Designer 2021 Release 2 Introduction - YouTube

- **This workbook has been updated for the 2023 Release of OpenRoads Designer (23.00.00.129)**

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Overview

There are some significant changes to the process of Horizontal Alignment design and development between ORD and Geopak. There is no more GPK file for storing geometry, which is stored within the elements. There are no more input files for Open or Incomplete Alignments, the alignments are designed graphically.

When using ORD, the design of a horizontal alignment will be based on graphics and intelligent elements. These are referred to as Rule-Based elements and provide Design Intent.

Rule Based elements store all the geometry associated with that element. Elements are also Ruled by other elements. These rules are created by snapping to specific points, for example when placing a line between two points. Or selecting elements as a reference, for example placing a curve between two tangents. Rules can be created by offsetting elements or by using Civil Accudraw. The type of rule created depends on the specific design tool used to create it and how it was created.

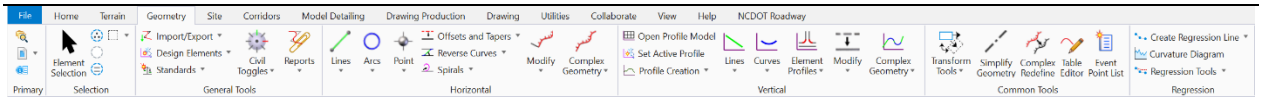
Design Intent creates associations between elements based on the rules that were established when the element was created. The purpose of Design Intent is to preserve the intention of the designer when the original elements were created. This intent is then maintained when revisions are made. A simple example is a Y line that is designed to intersect the L line at a 90^ skew, the Civil Rules that are created during that process will store that Design Intent. If a revision is made to the L alignment, the Y Line will automatically adjust to maintain the 90^ skew. This will include any elements of the Y alignment that need to adjust as well as elements based on the Y Alignment such as curbs and sidewalks.

These concepts will be featured throughout all of the training modules. This Module will focus on Horizontal Alignments and the tools required to create Horizontal Alignments.

In addition to new ways to create Horizontal Alignments the user must think about Horizontal Alignments in a new way. In Geopak a Horizontal Alignment was just a set of geometry. The elements on the screen were just representations of that geometry, they were not linked to that geometry in any way. In ORD the elements on the screen are the geometry and any manipulation of the Horizontal Alignment will change the geometry of the alignment and the design. This is one of the reasons that each Horizontal Alignment will be created and stored in an individual dgn file, the ALG file. Because Rules and Design Intent can be linked through a reference file, links between alignments can be created and maintained across separate files.

The module should provide guidance on creating individual elements of an alignment; lines and curves, creating alignments, editing elements and alignments, building rules and design intent between two alignments, stationing and annotating alignments, and creating reports for review of the alignment geometry.

Geometry Ribbon Tab



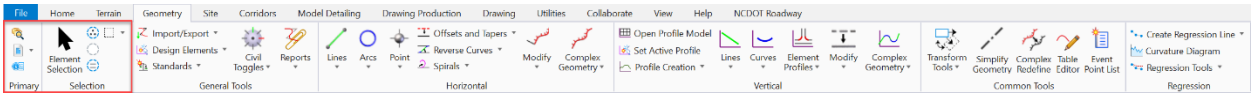
The *Geometry* Ribbon contains tools that the designer will use to create Horizontal and Vertical Geometry and plan elements that are based on Civil Geometry. The Ribbon is broken into 6 sections.

This section of the training Module will only focus on the tools used to create Horizontal alignments. These tools will include Lines, Arcs, and Points. The tools and methods used to combine individual components into a Complex Horizontal Alignment. How to create a Complex Horizontal Alignment with known PIs. How to station an alignment, report on the horizontal geometry.

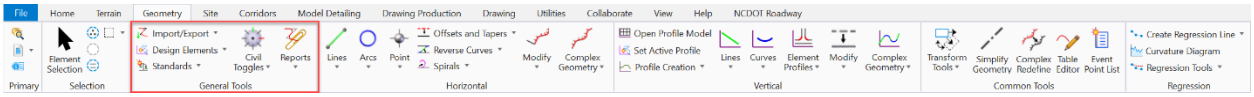
In addition to the specific tools required to create an alignment this section will also cover additional topics that are not specific to the alignment but are important concepts to understand when using CONNECT and ORD. These include Feature Definitions, Civil Rules, Design Intent and 2D and 3D models. These concepts will be covered throughout the training manual, and it is critical the user understand how these concepts work.

Primary & Selection Tool Group

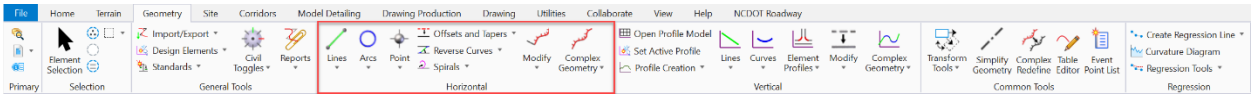
These two (2) groups are common throughout the ribbons. To see all the tools in these sections, use the Home Ribbon. The other Ribbons include a partial group of the tools included in these two sections.



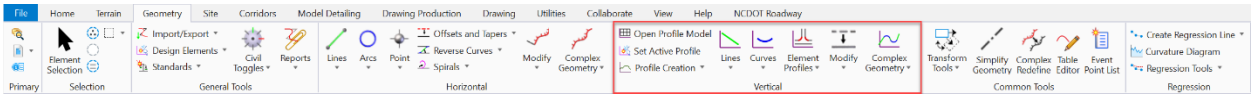
General Tool Group



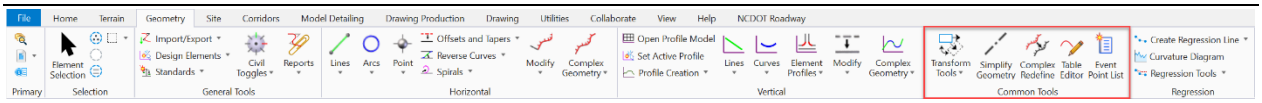
Horizontal Tool Group



Vertical Tool Group



Common Tool Group



(Table 2-1) Important Tools Used in Existing Terrain Models

 Lines	Various line placement tool (By Points, To Elements, From Elements, Between Arcs, and Chamfers).
 Arcs	Various arc placement tools (By Points, To Elements, From Elements, Between Arc, 2 Center and 3 Center and Complex Transitions).
 Modify	Stationing, Station Equations, working with Civil rules and copying civil elements.
 Complex Geometry	Creating and redefining Complex alignments, Best Fit, Offset tool (copy parallel) reverse curves, and Create Geometry by Template.
 Simplify Geometry	Tool used for removal of intervals and external referencing rules for horizontal and vertical geometries.

Feature Definition Toolbar

Before beginning with the design and drafting tools one of the concepts that will be new to the ORD user are feature definitions.

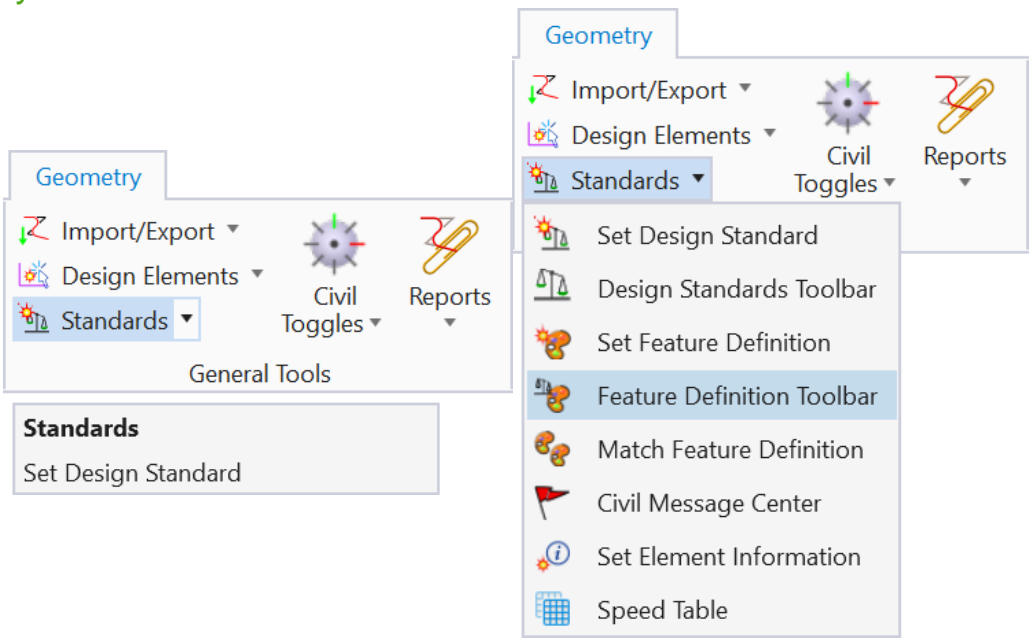
Feature Definitions are included in the NCDOT workspace. They are used to control symbology, and various other properties that are applied to the geometric elements.

The feature definitions are used to:

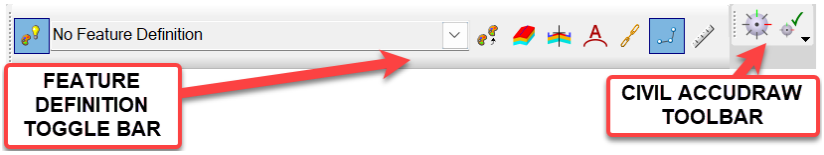
- Define what the geometric elements actually are. What is being modeled such as curb, centerline, edge of pavement, etcetera.
- Control symbology in various views, including capability to define differing symbology in plan, profile, and 3D spaces.
- Define terrain modeling attributes (spot, break line, void, etcetera)
- Define surface display characteristics annotation.

The Feature Definition Toolbar is a way to easily activate and deactivate the Feature Definition settings. Using the Feature Definition Toolbar is not a requirement, but most users will find it helpful. It is important to choose the correct Feature Definition when placing elements in the design because that Feature Definition will control the properties not only of that element during that step but also how it looks and interacts with other design elements in later steps during the design process.

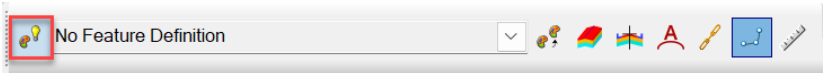
The **Feature Definition Toolbar** Toggle can be found in the *General Tools* section of the *Geometry* Ribbon.



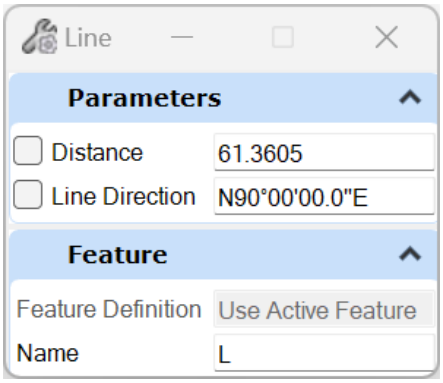
Under the *Standards* drop down menu select the **Feature Definition Toolbar**



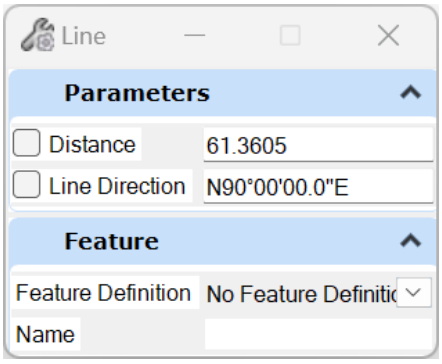
1. **Override Feature Definition**
   A. Selecting the **Override Feature Definition** icon will force the active tool to use the Feature Definition shown in the Feature Definition Toggle Bar. The user will not have to select the feature definition when placing the element.



B. This dialog for placing a line between two points will display like this with the override *ON*. Note that the Feature Definition displays *Use Active Feature* and the name has been populated.

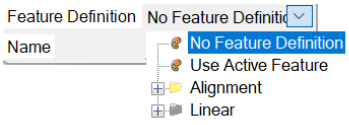


C. This dialog for placing a line between two points will display like this with the override *OFF*. Note that the Feature Definition displays *No Feature Definition* and the name field is blank.

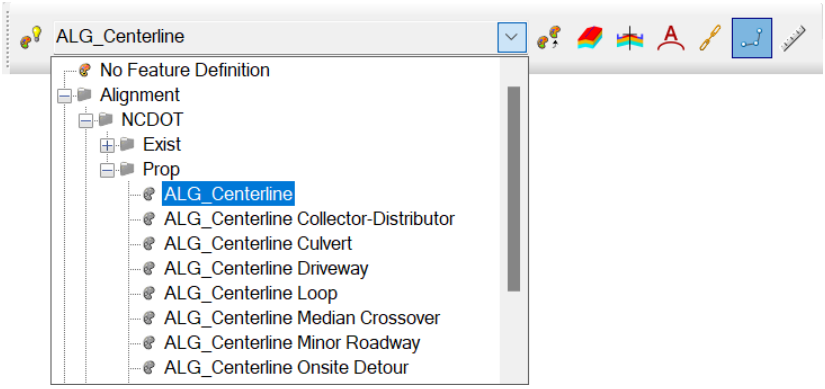


2. Feature Definition

A. Expand the Feature Definition drop down to choose from the available Feature Definitions

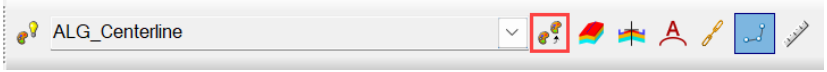


B. This example shows the available Feature Definitions for centerline alignments contained within the NCDOT workspace.



3. Match Feature

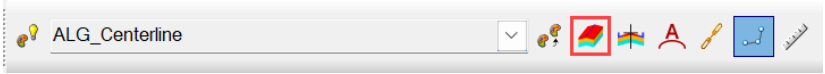
A. Use the **Match Feature Definition** tool to populate the combo box with the feature definition assigned to the selected element.



B. This tool will allow the user to match the Feature Definition of an element in the dgn file and if the **Override Feature Definition** tool is selected then the Feature Definition will be applied to the current element being placed.

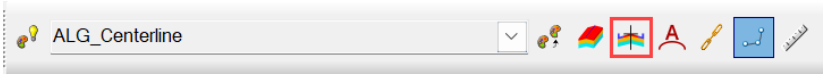
4. Create 3D Automatically.

The **Create 3D Automatically** tool will generate 3D model elements for the created elements. This tool will be covered in more detail in the Modeling sections and is not used for creating Horizontal Alignments.



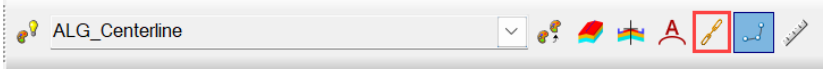
5. Feature Definition Template

The **Feature Definition Template** tool will apply a roadway template to the created element automatically. This tool will be covered in more detail in the Modeling sections and is not used for creating Horizontal Alignments.



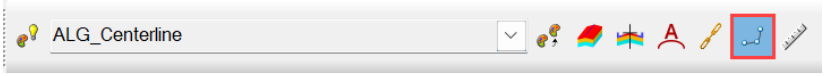
6. Chain Tools

If **Tool Chaining** is toggled on, then many tools can automatically determine base elements to use during calculations. For example, Arc Between Elements will choose the two most recent elements and set them as base elements to construct its fillet.



7. Persist Snap

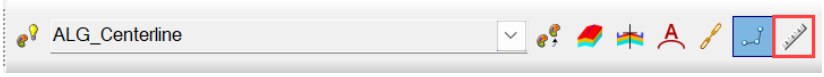
A. If **Persist Snap** toggled on, persists the snap into the geometry (default is snap on).



B. A persisted snap is a geometric rule that can be stored with the elements. For example, when placing a line between two points if the user snaps to the midpoint of an arc as the starting point a rule is created. If the length of the arc changes, and the midpoint shifts, then the beginning of the line will shift to remain at the midpoint of the arc. This is because the Midpoint Snap has been Persisted.

8. Rule Deactivation

A. If **Rule Deactivation** is toggled on, then tools create elements with rules disabled.



B. Snaps are not the only type of rules that are created when placing civil elements. Civil rules include any geometric constraint that could define the position of the element. Offset from another element, taper rate based on another element, length, bearing, radius, skew angle, etc.

This completes the overview of the Feature Definition Toolbar. All of these tools and principles will be discussed in detail during the training modules. For this section it is only important that the user has gained some basic familiarity with the toolbar, the names of the icons and a general sense of how each tool will work. Through use and practice the user will quickly understand the best practice for using each of the tools.

Horizontal Geometry Exercise – Line Tools

In the following exercises you will learn how to use the various line tools to create ruled elements. The purpose of the exercise is to become familiar with the tool and how to use it. ORD offers the user a significant amount of flexibility when placing ruled geometry.

You will see that several different tools can be used to achieve the same result.

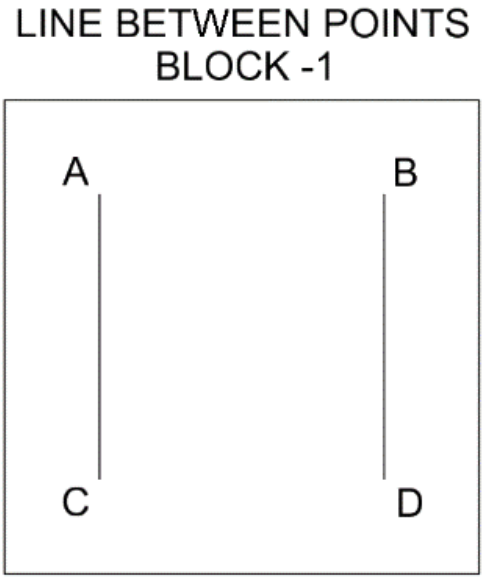
There are multiple ways to input data, through dialog boxes, at heads up prompts and dynamically.

You will see the rules associated with each element and how to edit the element using several methods.

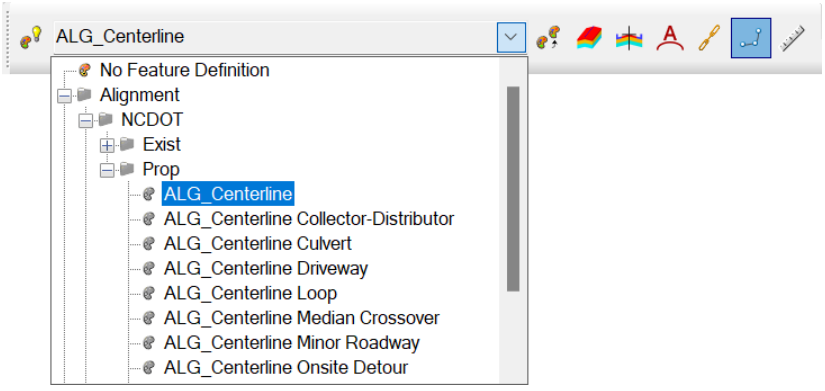
You will see the basics of design intent and how design intent is maintained throughout the design process.

Line Between Points – Precision Entry

1. **Block 1 – Precisions Entry**
   A. **Line Between Points** is one of the most basic tools that will be used during design.
   B. Path to the training directory and open the file ***R-2635C_RDY_HA_ALG_Tools.dgn***
   C. Fit view and find the box labeled Line Between Point Block -1

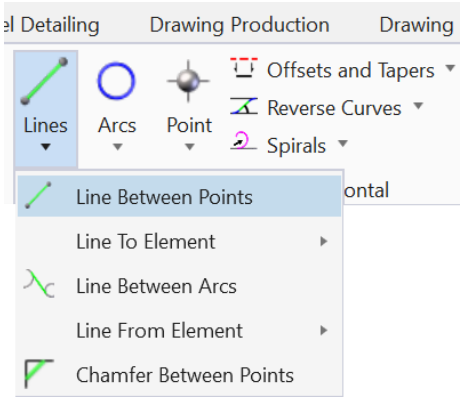


   D. If the **Feature Definition Toolbar** is not Active, then Activate it by selecting the toggle from the Standards tool group of the *General* Tools Section of the *Geometry* Ribbon
   E. Set the feature definition to *Alignment\NCDOT\Prop\ALG_Centerline*



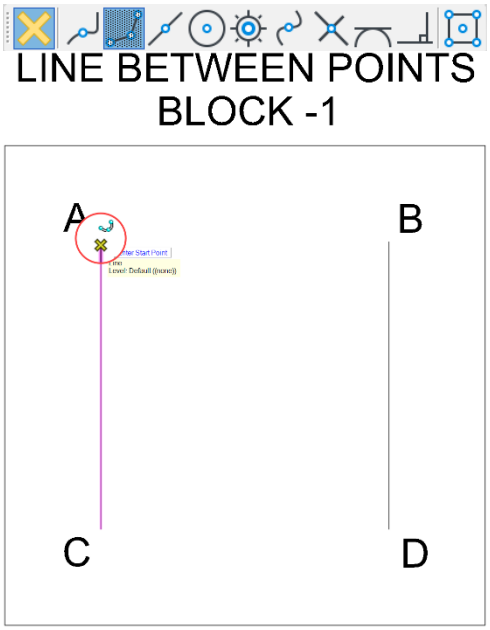
   F. Set the **Use Active Feature Definition** tool to *ON*

G. Start the tool by selecting **Line Between Points** from the *Horizontal* section of the *Geometry* Ribbon.



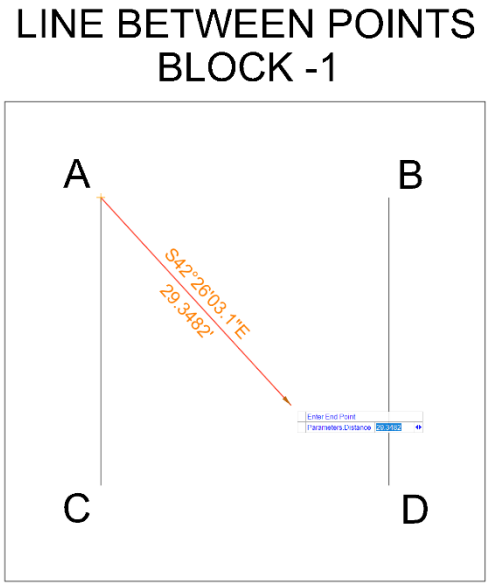
H. The Target will appear with the heads-up prompt to enter the start point

I. Using the Key Point Snap

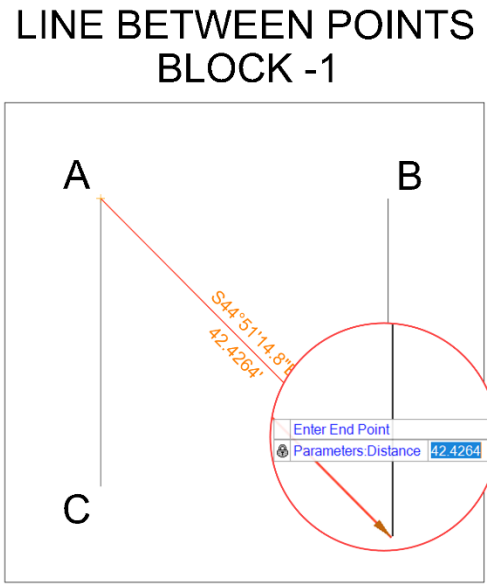


Snap to the end of the line marked ‘A’ and left click to accept the starting point.

J. At this point the user will see a partial line segment with the bearing and distance dynamically labeled, and a heads-up display for the precision input of the distance.

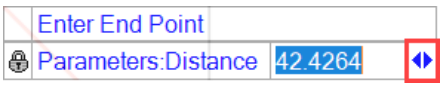


K. Enter *42.4264* for the distance, this is the distance between points 'A' and 'D'. Notice that the Parameters Distance field is blue, that indicates that a value can be entered just by beginning to type. Press ENTER and a lock will appear indicating the length of the line is now set to 42.4264'.



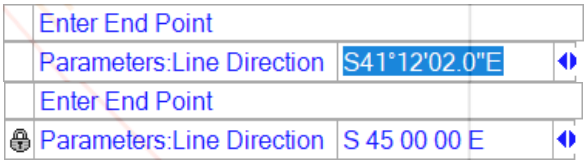
If focus has been lost from the design window click on the Border to bring it back and activate the entry field. Do Not click in the drawing field or the end point of the line will be selected.

L. Notice the blue arrows to the left of the distance value, these indicate there are additional geometry parameters that can be entered. This symbol will be common throughout many tools.

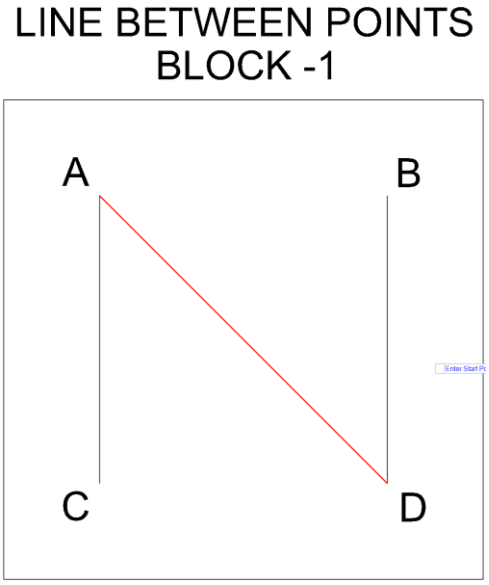


M. Press the right arrow key on the keyboard and a line direction parameter data entry will appear.

N. Enter S 45 00 00 E in a similar manner to entering the distance in the previous step. No Spaces are needed.



O. Press ENTER to lock the line direction.

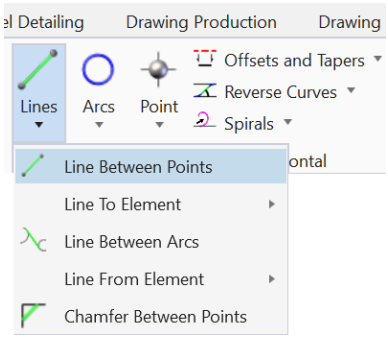


P. The screen should match the picture above with the line starting at Point A and ending at Point D. The length and bearing are shown on the line. This line has not yet been placed in the file this is a tentative location.

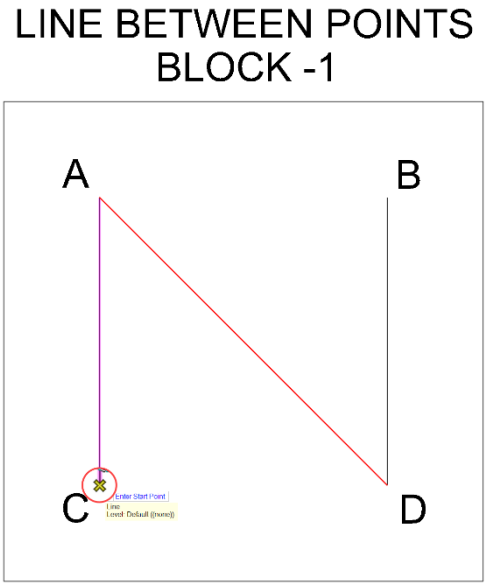
Q. Left click to accept and place the line. The Line Between Points tool will automatically restart as indicated by the Enter Start Point dialog.

Line Between Points – Snap to End Points

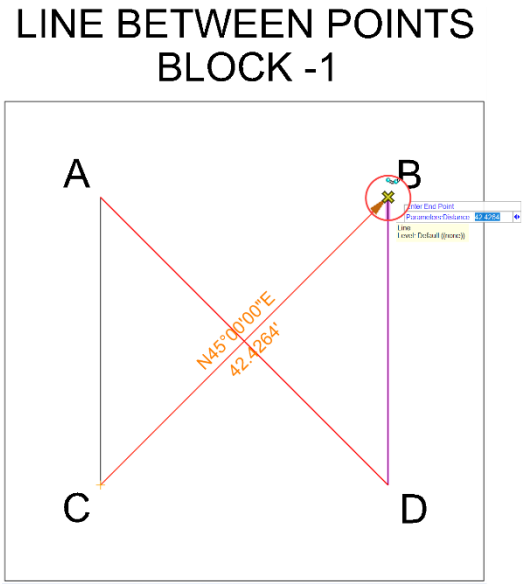
1. **Block 1 – Snap to End Points**
   A. Another common method to place a line is just snapping to the start and end point.
   B. If the toll has been reset Start the **Line Between Points Tool** from the *Horizontal* section of the *Geometry* Ribbon.



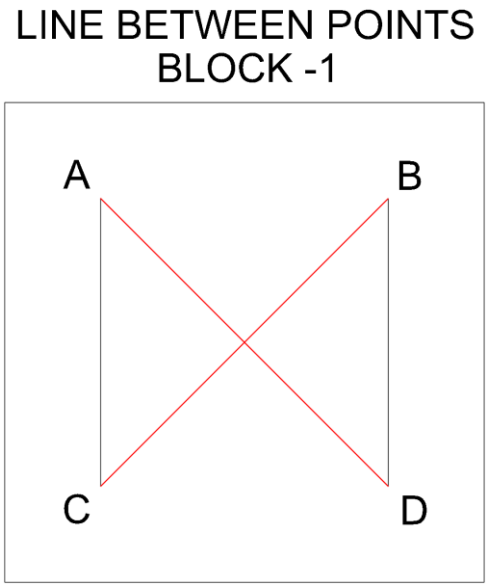
   C. Using the Key Point Snap setting snap to the end of the line at Point C to start the line.



D. Snap the end of the line at Point B to end the line. Notice that the distance is dynamically updated to match the distance that was entered in the previous exercise.



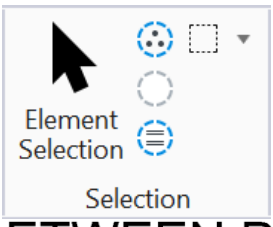
E. Left Click to accept the line.

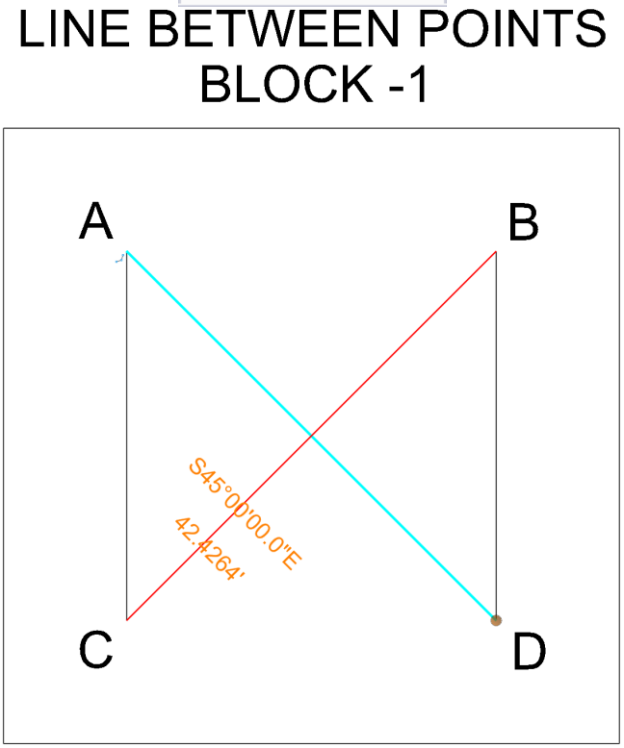


F. Block 1 should now look like the above picture.

Editing Civil Rules

1. **Block 1 – Editing Civil Rules with Text Manipulators**
   A. One of the features of ORD the user will need to become familiar with is the ability to quickly and easily edit civil geometry by changing the Civil Rules.
   B. Using the **Select** tool in the *Selection* section of the *Geometry* Ribbon, pick the line segment that was created from Point A to Point D



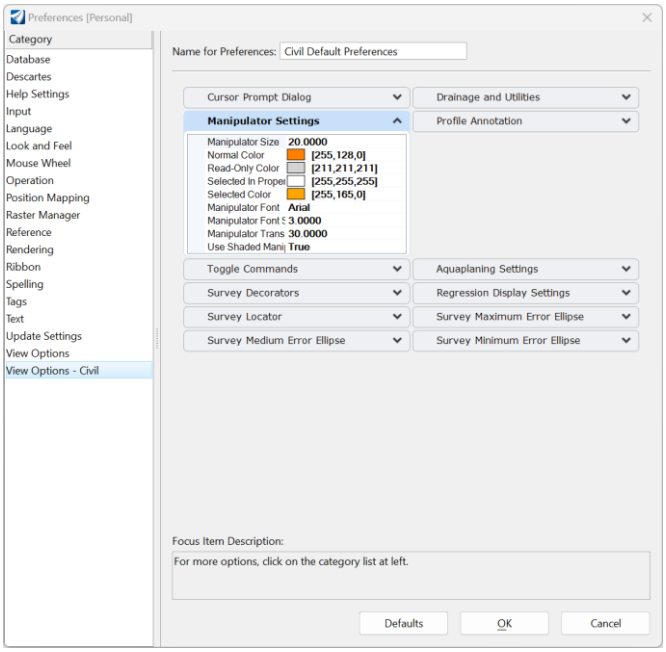


   C. Note the symbol next to the A, this indicates that a Snap Civil Rule was created for this point when the line segment was created.

D. Note the gray circle at the other end of the line, which indicates that this point is not ruled to any geometry. This symbol indicates the presence of Drag Handles.

D

E. The color of the drag handles and text manipulators can be customized by the user. For this training the color was set to gray for clarity. The color can be set under

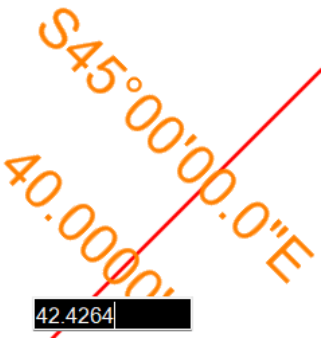


File→Settings→User→Preferences→View Options -Civil→Manipulator Settings

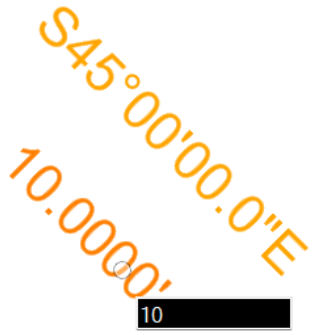
The user can also change the size and other display properties.

F. Note that the Bearing and Distance shown in the middle of the line segment are both gray, this indicates that they can be edited. These are Text Manipulators. (The gracious, powerful, and humble intern that updated these modules changed theirs to orange, as seen in previous screenshot).

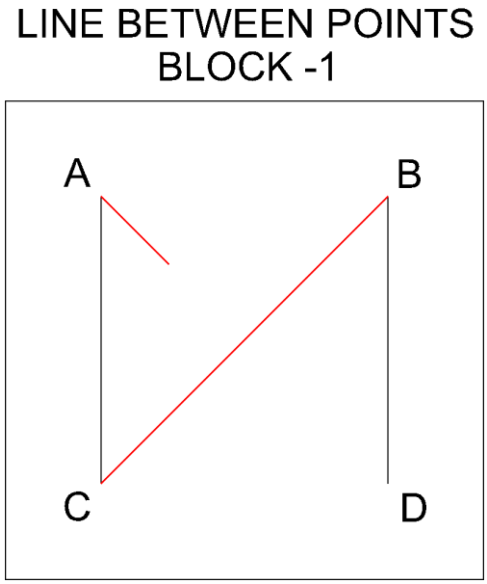
G. One way to edit the civil geometry is by editing the length and/or bearing shown in the Text Manipulators. With the line selected select the green length text at the midpoint of the line. A data entry field will appear with the current line length shown.



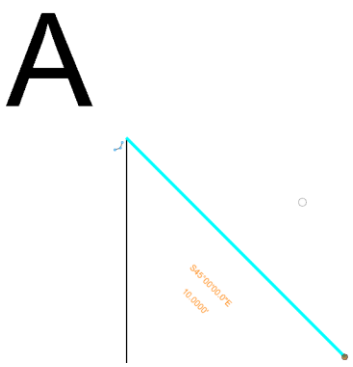
H. Change the length to *10.00'*



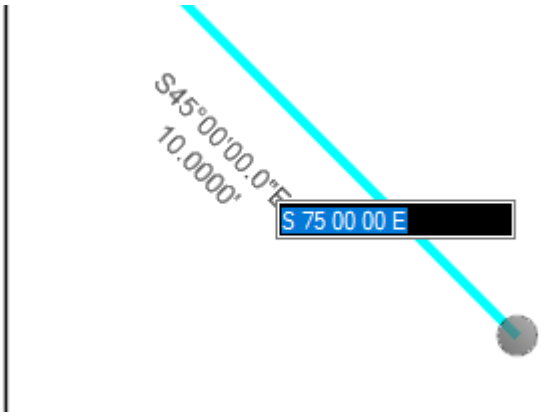
I. Left click or ENTER to accept and the length of the line will change to 10.00'



J. Reselect the line and note that the Text Manipulators and the Drag Handle dot at

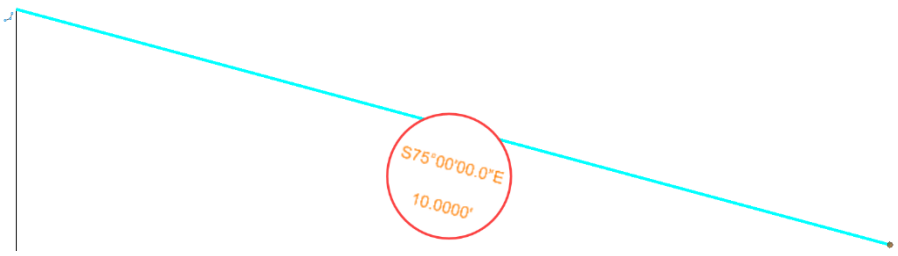


the end point of the line have both updated.

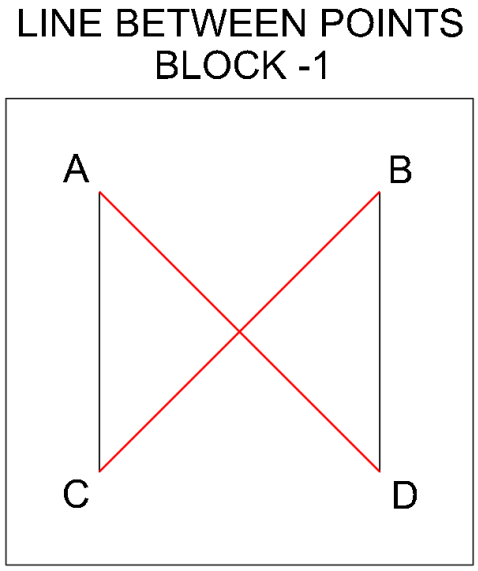


K. Select the bearing text the same way and enter S 75 00 00 E.
L. Left click or ENTER to accept and note that the direction of the line will change. Again, note that the Civil Rule parameters have updated.

M. Select Undo (Ctrl+Z) twice to undo the length and direction change to the line segment and return to the original placement.

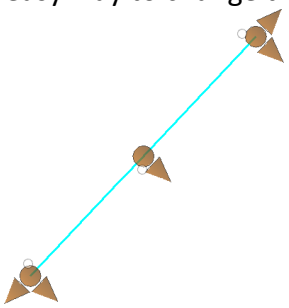


N. You should now be back to the original layout.



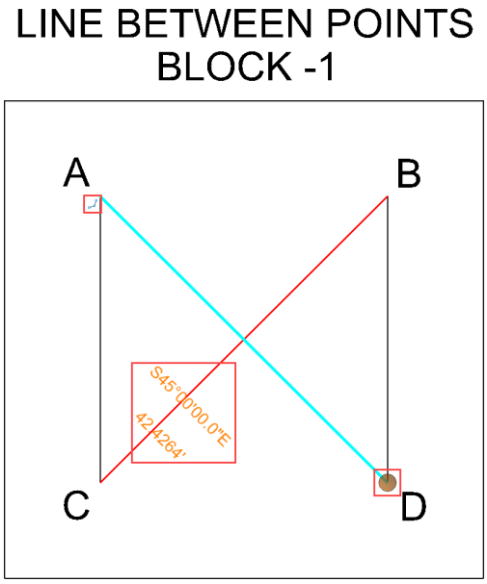
2. Block 1 – Editing Geometry with Drag Handles

A. Drag Handles are another easy way to change the Civil Rules.

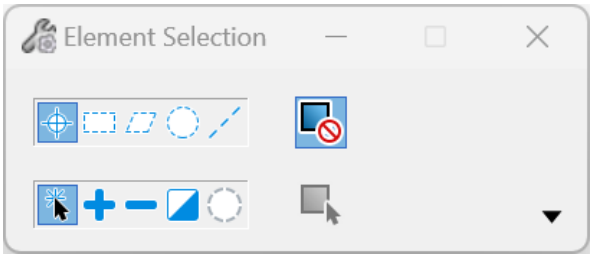


- An arrow shaped drag handle - redefines the point with one or more directions constrained. In the previous example, the parallel arrows (that are parallel to the line) are constrained to change the distance only; the arrows that are perpendicular to the line are constrained to change the direction only.
- A circular shaped drag handle moves the points without constraint.
- Drag Handles will break Civil Rules based on Snaps and care must be exercised when manipulating drag handles to avoid unwanted results. As seen in the previous example the UNDO (Ctrl+Z) command can reverse any unwanted commands.

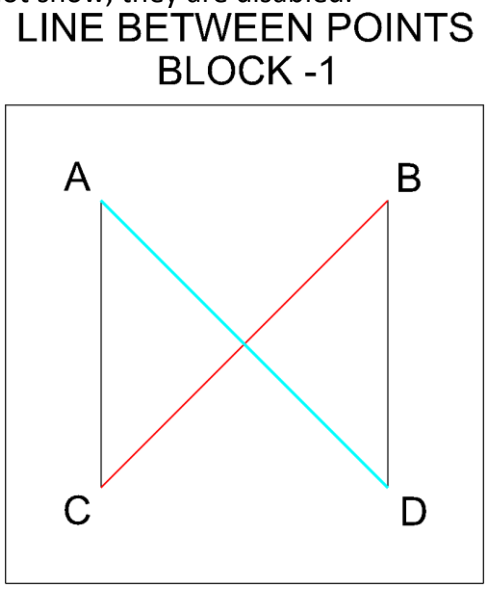
B. The **Select** tool can be configured to enable or disable handles. Activate the Select tool and pick the line segment from Point A to Point B. The snap constraint Icon will show near Point A, the Text Manipulators will show at the midpoint and the Drag Handle Icon will show near Point D. The Handles are enabled.



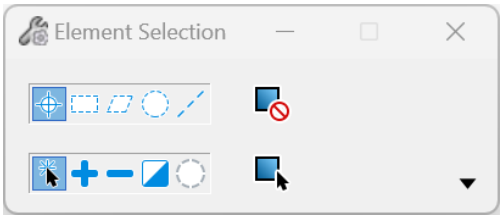
C. In the Element Selection dialog select the Disable Handles icon.



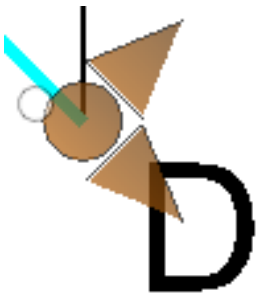
D. Select the line again and notice that the Snap Icon, the Text Manipulators and the Drag Handles do not show, they are disabled.



E. Enable the Handles by unselecting the icon in the Element Selection dialog.

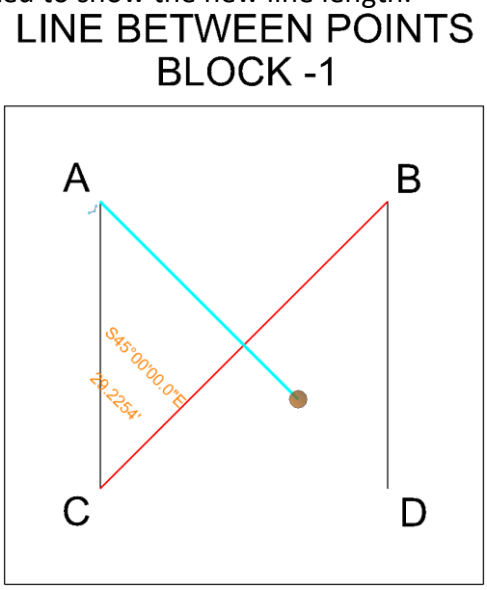


F. Reset the line in between Points A and D and place the cursor on the gray circle drag handle to display the individual drag handles, one arrow parallel to the line and one arrow perpendicular to the line.



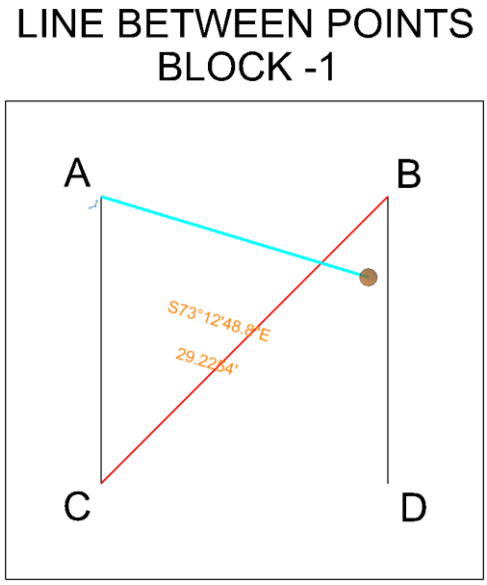
G. The drag handle that is parallel to the line will Trim or Extend the line. By left clicking to pick the arrow the user can change the length of the line.

H. Select the arrow and “drag” the end of the line back in the direction of Point A and left click to establish a new end point. The length of the line will change but the direction of the line will not. The length shown in the Text Manipulator will be dynamically updated to show the new line length.

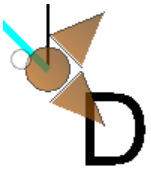


I. The drag handle that is parallel to the line will rotate the line and change the line direction.

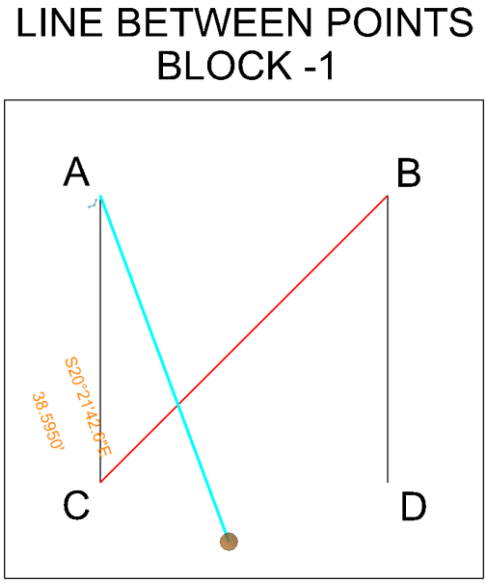
J. Select the arrow and “drag” the end of the line in the direction of Point B and left click to establish a new end point. The bearing of the line will change but the length of the line will not. The bearing shown in the Text Manipulator will be dynamically updated to show the new line direction.



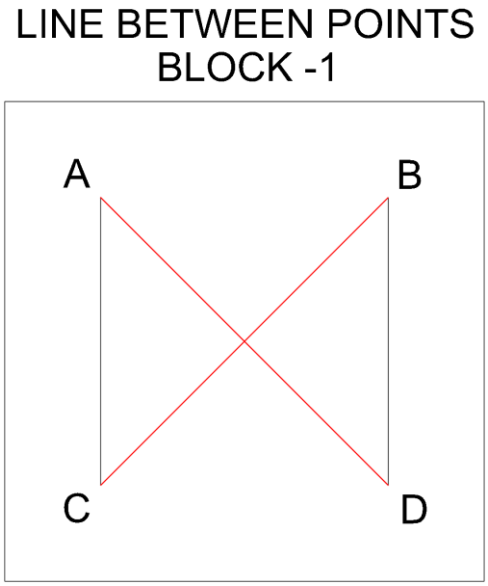
K. The circular drag handle will allow the user to change the length and direction at the same time. When selecting the circular drag handle both individual drag handles will appear.



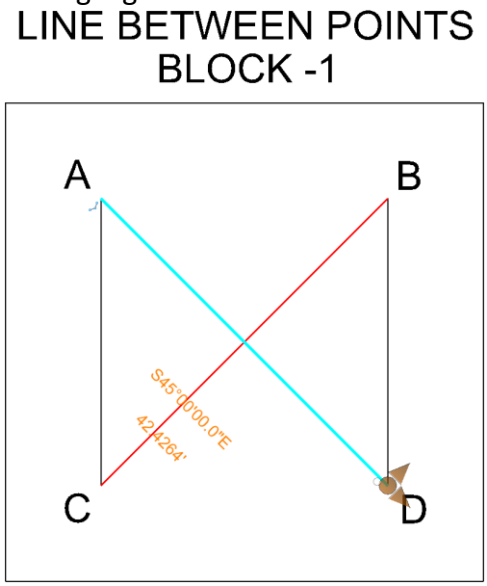
L. Select the circle and “drag” the end of the line in the direction of Point C and left click to establish a new end point. The length and bearing of the line will change but. The length and bearing shown in the Text Manipulator will be dynamically updated to show the new Civil Rules.



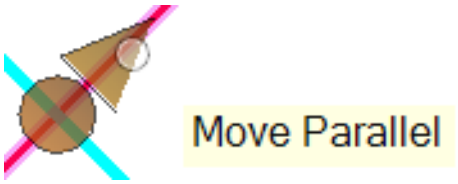
M. Select UNDO three times to undo the changes to the Civil Rules and return to the original layout.



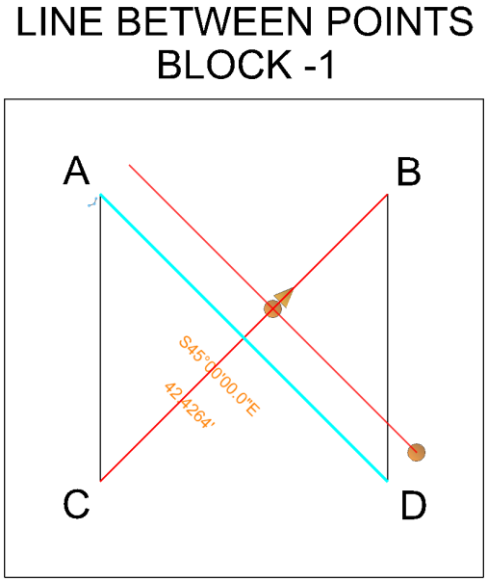
N. Use the **Select** tool to highlight the line from Point A to Point D.



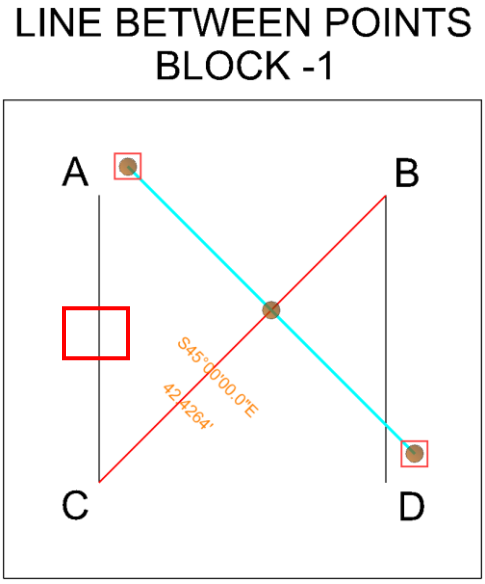
O. Move the cursor near the midpoint of the line to show the move parallel drag handle represented by the arrow.



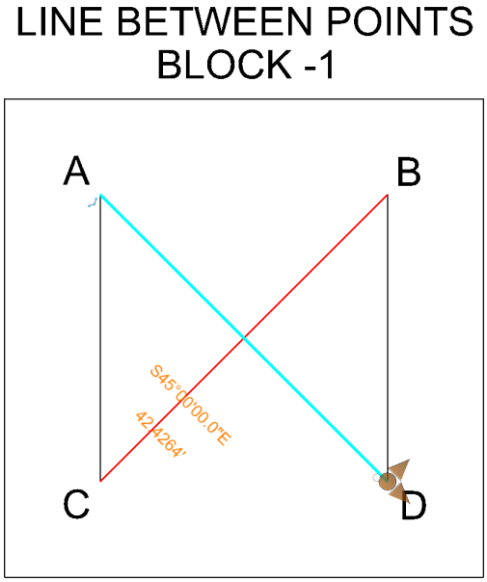
P. Select the arrow to move the line segment parallel. Left click to accept the new line location.



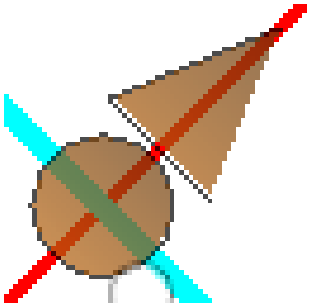
Q. If the selection was lost use the **Select** tool to reselect the line. Note that both end points show gray circles indicating the presence of drag handles.



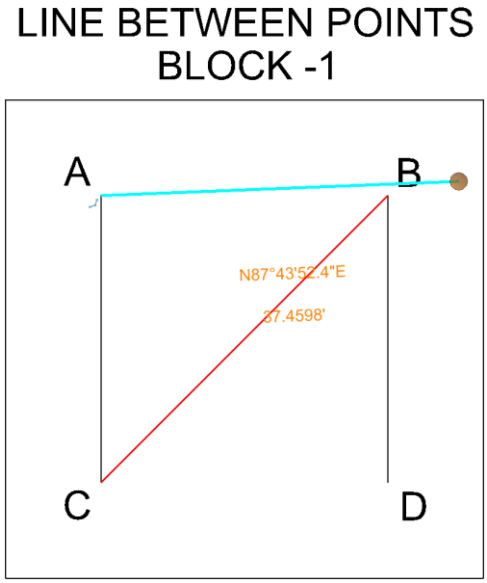
R. Previously there was a snap Civil Rule at end point A because when the initial line segment was created the user snapped to the end of the line. This created a Civil Rule. By using the midpoint drag handle the user has broken the rule. Select **UNDO** (Ctrl+Z) to undo the move, this will also undo the process of breaking the Civil Rule, it will reestablish the snap rule, indicated by the icon at Point A.



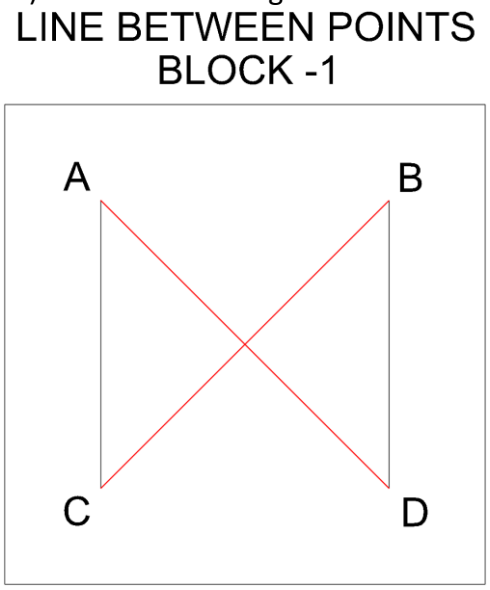
S. The line segment should still be the active element at this point. Move the cursor to the middle again to show the midpoint drag handles and grab the circle symbol. This is the Move Drag Handle.



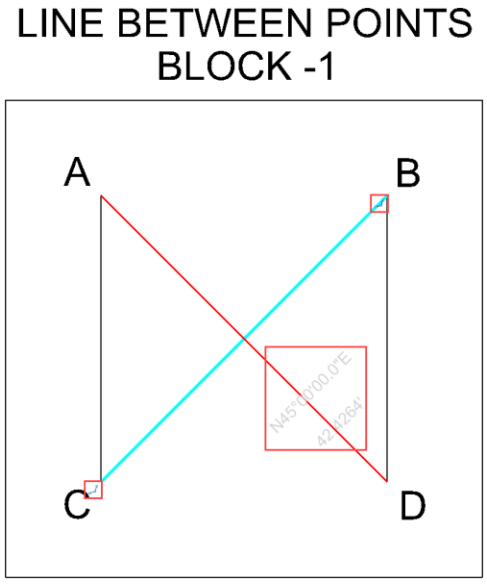
T. Move the cursor up and to the right towards Point B. This drag handle resets the midpoint of the line segment. Note that this drag handle did not break the snap Civil Rule at Point A. So, the beginning point of the line stayed in the same location, the end point moved based on the new midpoint.



U. Select **UNDO** (Ctrl+Z) to undo the change and return to the original configuration.

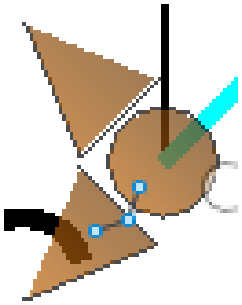


V. Use the **Select** tool to select the line segment from Point B to Point C. This line segment was created by snapping to both Point C and Point D, which created a Snap Civil Rule at the Beginning Point and End Point of the line segment. This line segment will behave differently than the line segment from Point A to Point B because of the rules.

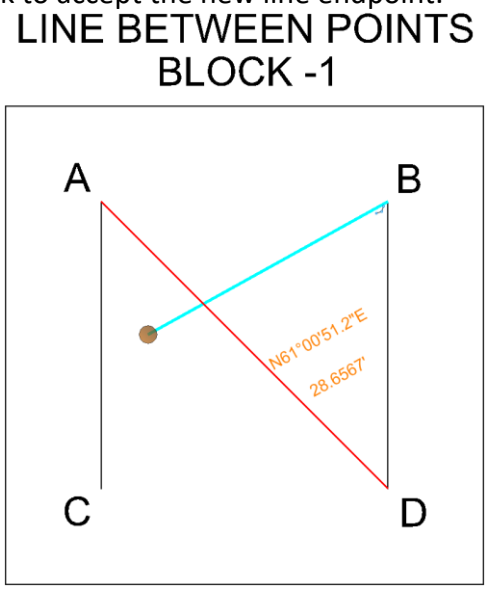


Note the snap icon at each end of the line indicating the Snap Civil Rule exists. Also note that the Text Manipulators are red and not gray, this indicates that they cannot be modified. Remember the actual color of the drag handles and text manipulators is a custom setting and they may be another color. (The gracious, powerful, and humble intern that updated these modules changed theirs to gray).

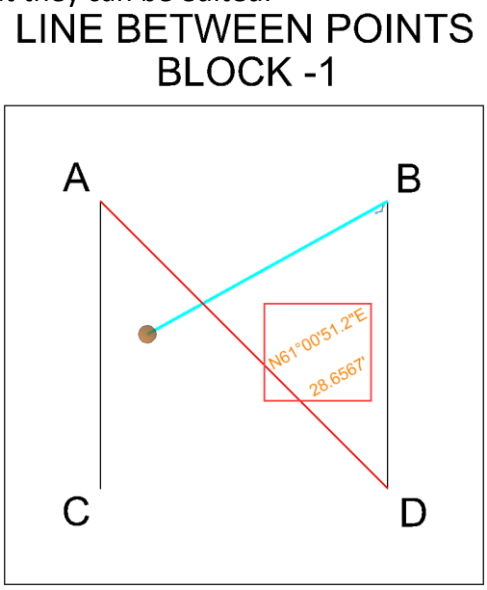
W. Remember that the drag handle can break the civil rule. With the line selected move the cursor close to the end at Point C. The gray circle will appear with the two gray arrows indicating the drag handles.



X. Select the circle and move the cursor up close to Point A. This will break the Snap Civil Rule. Left Click to accept the new line endpoint.



Y. At this point the configuration is similar to the Line from Point A to Point D, with a single drag handle and a Snap Civil Rule. Note that the text manipulators are now gray indicating that they can be edited.



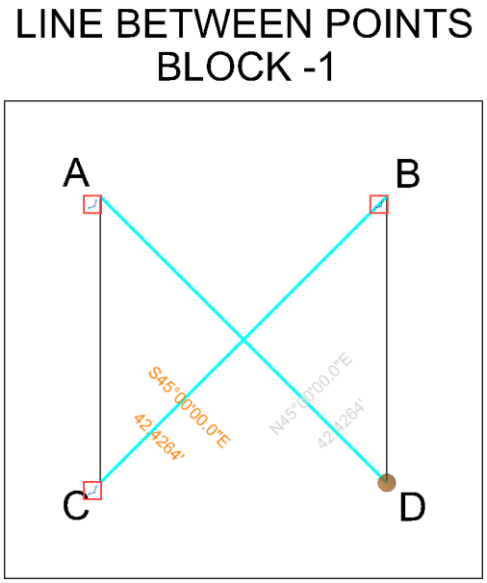
Z. Use the UNDO (Ctrl + Z) Command to undo the change and return to the original configuration. This covers the drag handle and text manipulator basics. Every geometry type will have different Text Manipulators and Drag Handles but the function will be similar across all the geometry tools, horizontal, vertical and civil.

Snap Constraints

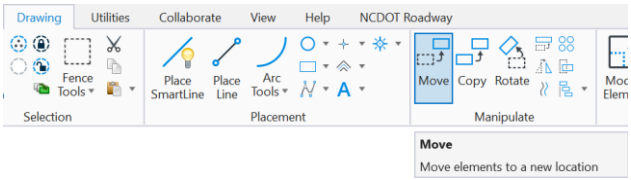
Snap Constraints are another function of CONNECT / ORD that the user will need to become familiar with to efficiently and effectively place horizontal and civil geometry elements. Snap Constraints will affect how revisions to civil elements are managed. This will be determined based on which snap was used, what was snapped to and any other constraints that may have been placed

A Snap Constraint is a geometric rule created during the element placement process. As the name indicates it is based on the snap used to create the element. The snap used can be any of the snap settings, end, middle, perpendicular etc. The snap constraint can be a useful tool when used as intended but can also cause problems for the designer if it is not created correctly. Like many other new features in ORD the proper use of this constraint should become second nature with more experience using the program.

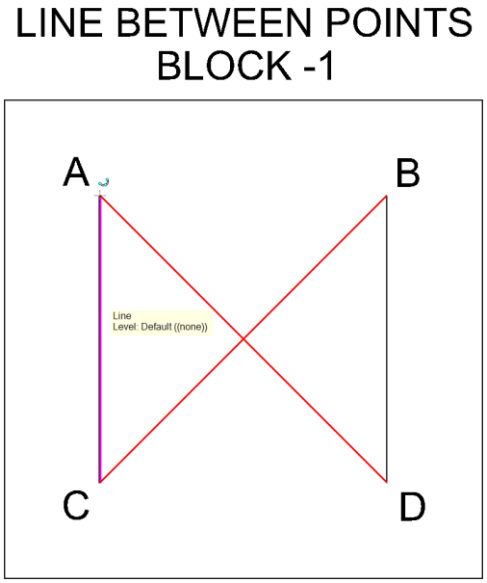
1. **Editing elements that have a snap constraint**
   C. The original layout in Block 1 has a Snap Constraint at Points A, B, and C. There is no constraint at Point D.



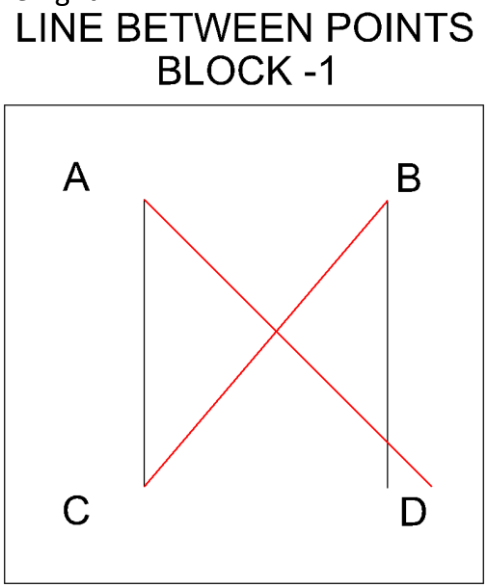
D. Select the **Move** tool in the *Manipulate* section of the *Drawing* Ribbon. Note that this is a CONNECT tool and is the same tool that has been used in MicroStation SS2, it is one of the basic CADD drafting tools. These tools can be used to manipulate ORD elements, elements that have civil geometry associated with them.



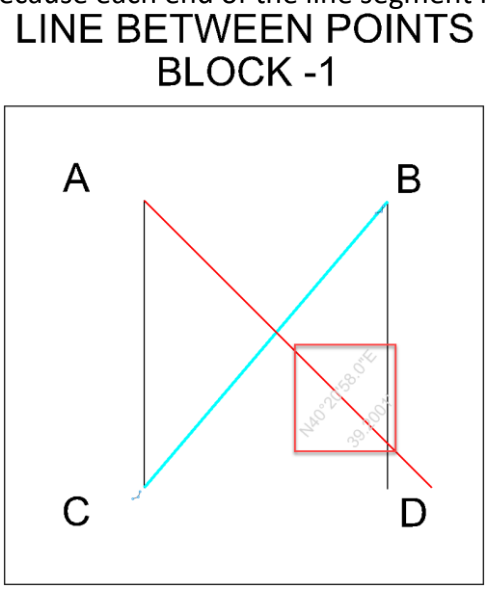
E. Left Click on the line between Points A and C to select that element to move.



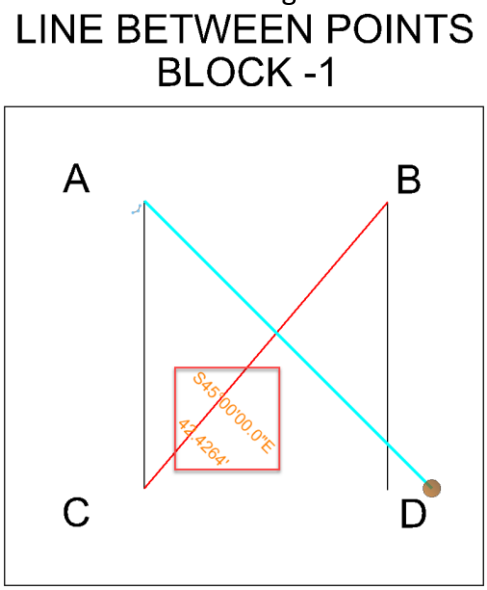
F. Move the line to the right



G. The Line from Point C to Point B was changed to match the new location of Point C. This is because each end of this line had a snap constraint. Note that the bearing and distance shown in the Text Manipulators has been updated to match the new bearing and distance from Point C to Point B. The text is also still red indicating that it is not editable because each end of the line segment has a point constraint.

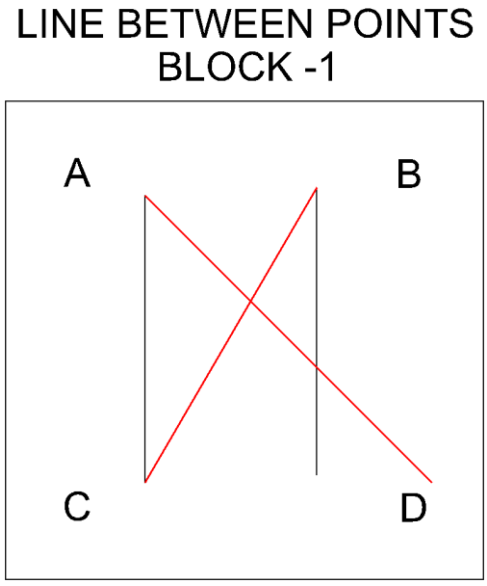


H. The line from Point A to Point D has changed in a different way. The beginning has stayed at Point A, this is where the Snap Constraint was located. The end point that was at Point D has shifted, this is because there was no constraint at that point so the line segment has maintained the original distance and bearing.

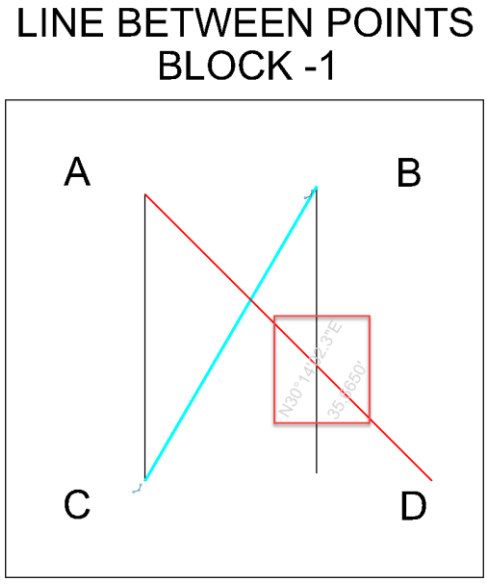


I. Use **UNDO** (Ctrl+Z) to undo the change and return to the original configuration.

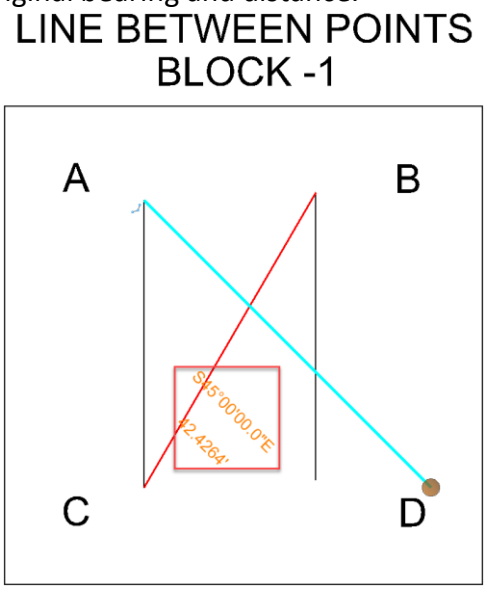
J. Select the **Move** tool in the *Manipulate* section of the *Drawing* Ribbon. Move the lie connecting Point B and Point D to the left.



K. The result will be slightly different but the concept is the same. The Line connecting Point C and Point D again changed to maintain the end points at the snap constraint location. The text manipulators also updated to show the new length and bearing.



L. The line from Point A to Point D did not change, there was no snap constraint at Point D and Point A did not move, so the line remained in the original location maintaining the original bearing and distance.

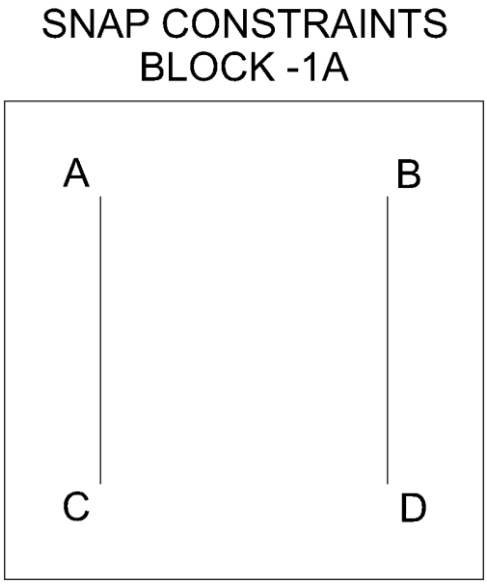


M. The proper use of snap constraints and the effects of snap constraints will become more apparent through practice and use.

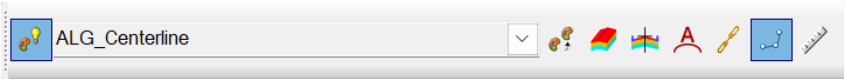
N. Select **UNDO** (Ctrl+Z) to undo the change and return to the original configuration.

2. Snap Persist

A. Open the ***R-2635C_RDY_HA_ALG_Tools.dgn*** file from the NCDOT Training directory and find the Snap Constraints Block-1A exercise.



B. Set the Feature Definition to ALG_Centerline and set the Use Active Feature Definition toggle to *ON*.

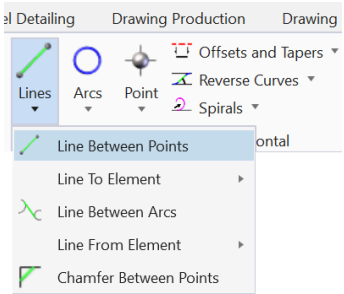


C. Make sure the Persist Snap toggle is checked to ON.

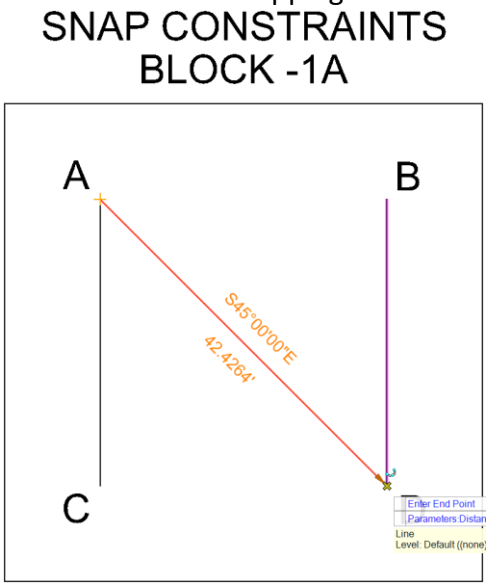
The Persist Snap toggle is a way to turn the Snap Constraints OFF and ON, there will be times when the designer does not want to use of a Snap to create a rule.

D. Set the snap mode to Key Point

E. Using the **Line Between Points** tool located in the *Horizontal* section of the *Geometry* Ribbon.

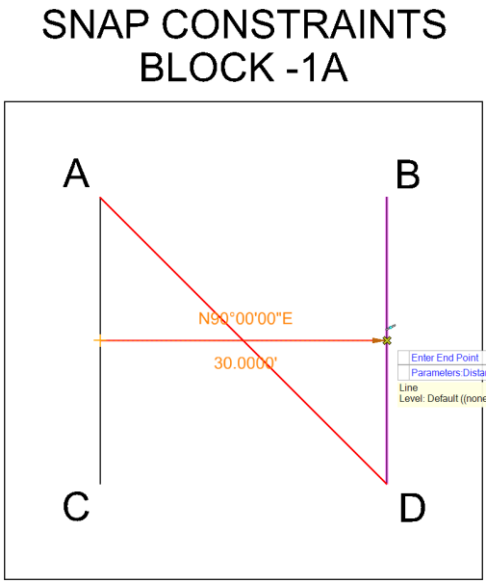


F. Draw a line from Point A to Point D snapping to the ends of the black lines.

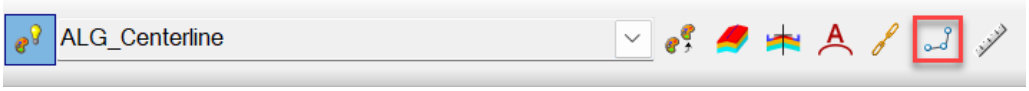


G. Change the Snap Mode to Mid Point Snap

H. Using the **Line Between Points** tool Snap to draw a line from the Mid Point of the Line between Point A and Point C to the Mid Point of the line between Point B and point D.



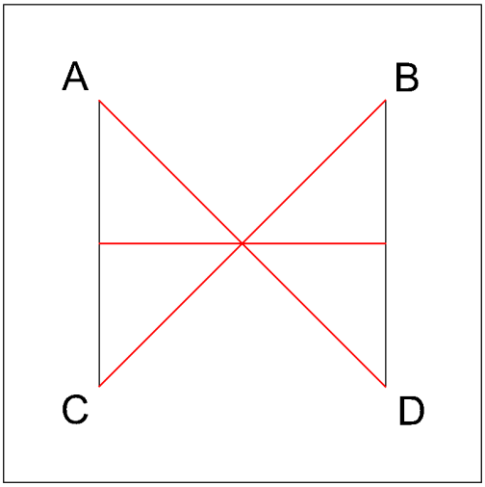
I. Locate the Feature Definition Toolbar and Toggle the Persist Snap icon to OFF



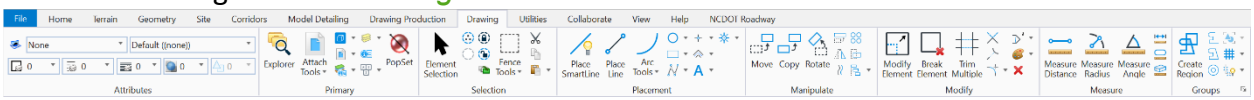
J. Set the Snap Mode to Key Point Snap

K. Using the **Line Between Points** tool Snap to draw a line from the Point C to Point B.

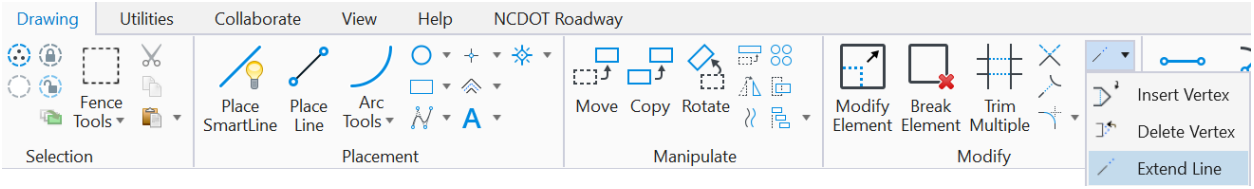
SNAP CONSTRAINTS
BLOCK -1A



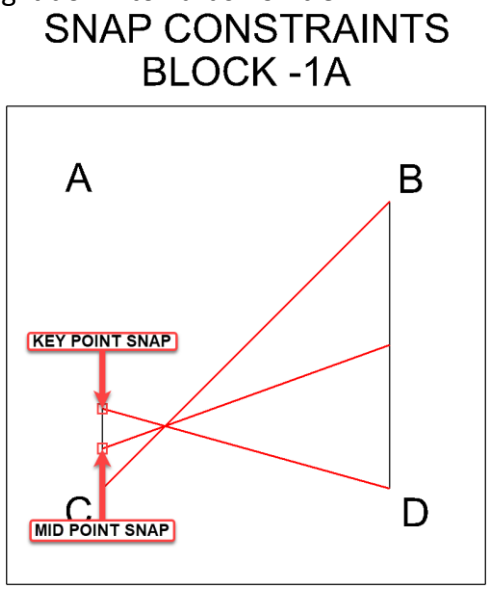
L. Change to the *Drawing* Ribbon



M. Locate the *Modify* section of the *Drawing* Ribbon and select the **Extend Line** tool.

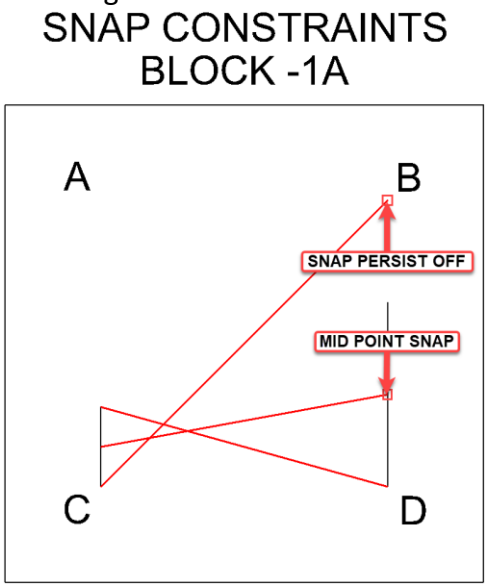


N. Select the end point of the black line between Point A and Point C and modify the end point by shifting it down towards Point C.



O. Because the Persist Snap Rule was Active when the line from A to D and the horizontal line were placed those two lines have updated to maintain the rule. The Line from A to D has maintained the Key Point Snap at the end of the reference line and the horizontal line has adjusted to maintain a snap at the Mid Point of the shortened line.

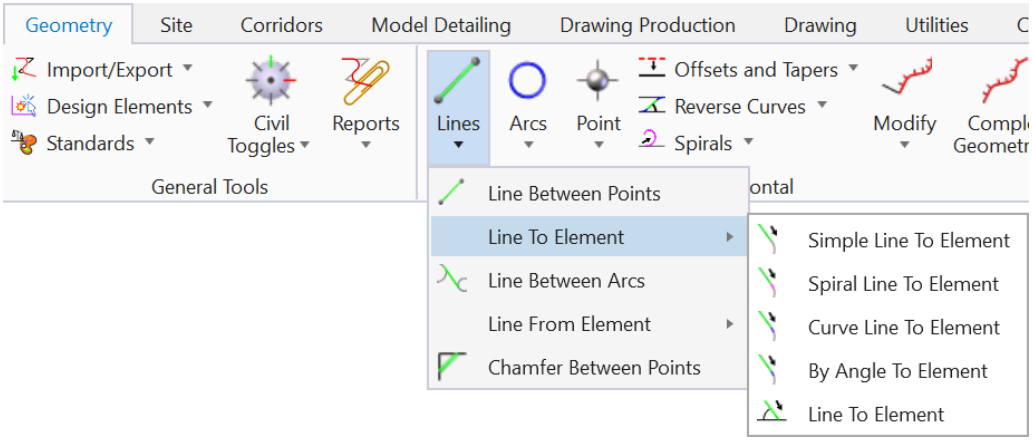
P. Use the Extend Line tool again to shorten the line from Point B to Point D.



Q. Because the Snap Persist setting was inactive when placing the line from C to D that element did not update when the change was made to line from B to D. Note that the horizontal line again updated to maintain the Mid Point Snap based on the new line length.

Line To Element Tool Group

Line to Element Tools are under the **Lines** tool group of the *Horizontal* section of the *Geometry* Ribbon<



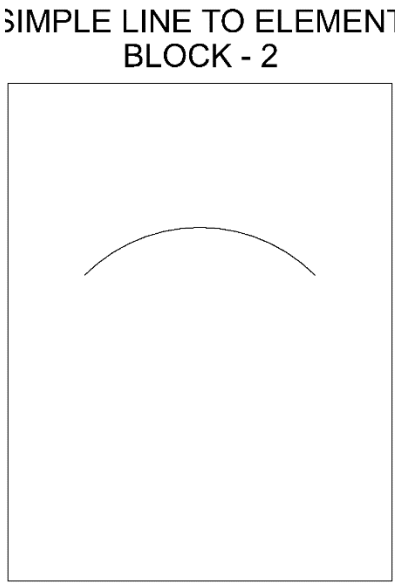
This group contains tools that will allow the user to draw a line segment that will be based on another element. These tools will be used when construction Horizontal Alignments, especially for construction Y Lines, Intersections, Ramps and Loops. Additionally this group of tool sill be used when constructing other civil geometry features that will be covered in other Modules.

This Group Contains 5 Tools

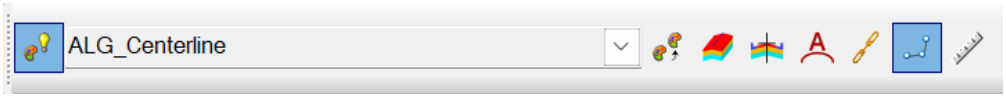
- **Simple Line to Element**
  - Creates a line without any transition to another element at zero degrees skew angle, applicable only when the To element is a curve, Offset locked at zero.
- **Spiral Line to Element**
  - Creates a line with a spiral transition to another element at zero degrees skew angle, applicable only when the To element is a curve, Offset locked at zero.
- **Curve Line to Element**
  - Creates a line with an arc transition to another element at zero degrees skew angle, applicable only when the To element is a curve, Offset locked at zero.
- **By Angle to Element**
  - Creates a line without any transition at user defined skew angle, Offset locked at zero.
- **Line to Element**
  - Constructs a line at a skew to a reference element.

1. Simple Line to Element

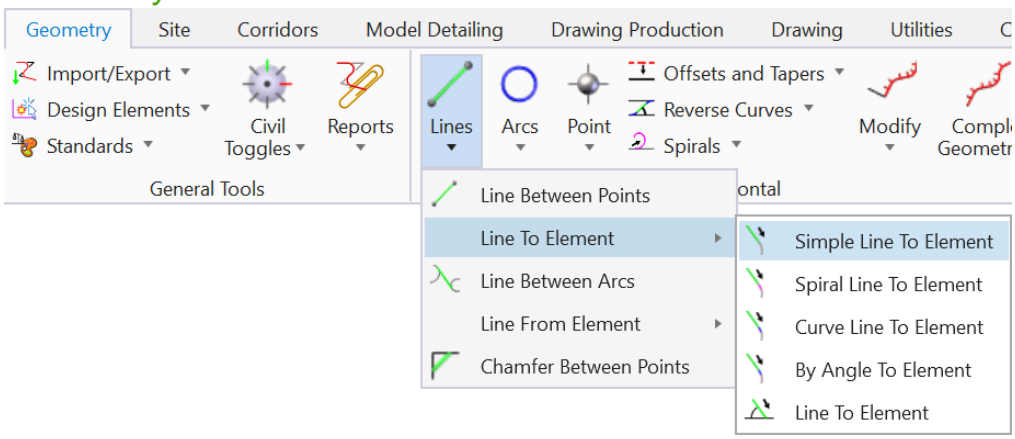
A. Locate the Simple Line to Element exercise location in Block -2. Remember this tool only work when the To Element is a curve.



B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

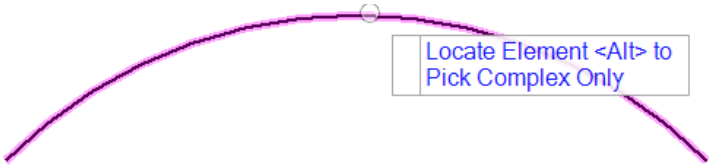


C. Select the **Simple Line to Element** tool from the *Horizontal* section of the *Geometry* Ribbon.

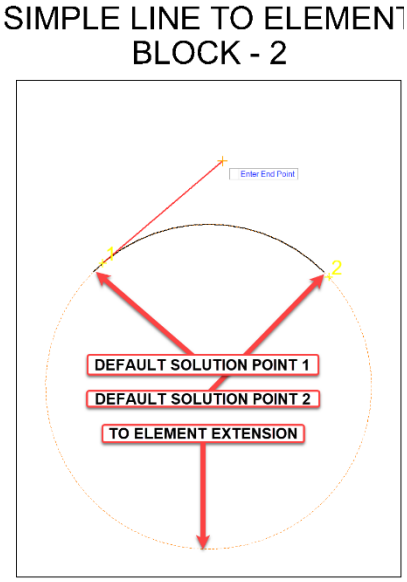


D. The heads up prompt will appear indicating Locate Element. The user will notice <Alt> to pick Complex Only. This allows the user to pick an entire complex element or an individual element within a complex element. This is a setting available in a lot of tools. This setting will not be covered during the exercises on the individual tools, it will be covered later in this Module when Alignments are discussed.

E. Left Click on the arc to select the To Element.

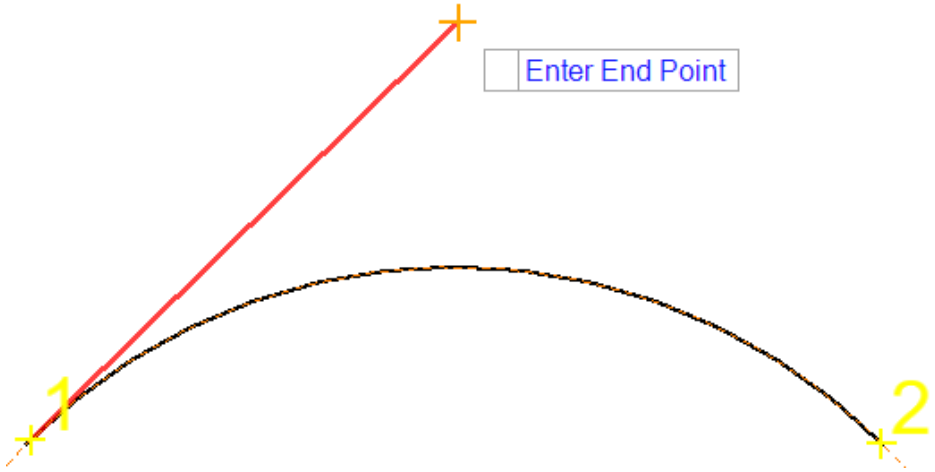


F. There are several things that will be displayed that will be helpful to the user
- A dynamic line segment will be displayed showing the possible solution.
- There is also a dashed element that displays that is an extension of the arc segment to form a circle.
- There is also an alternate solution (tie point) shown, indicated by the number .

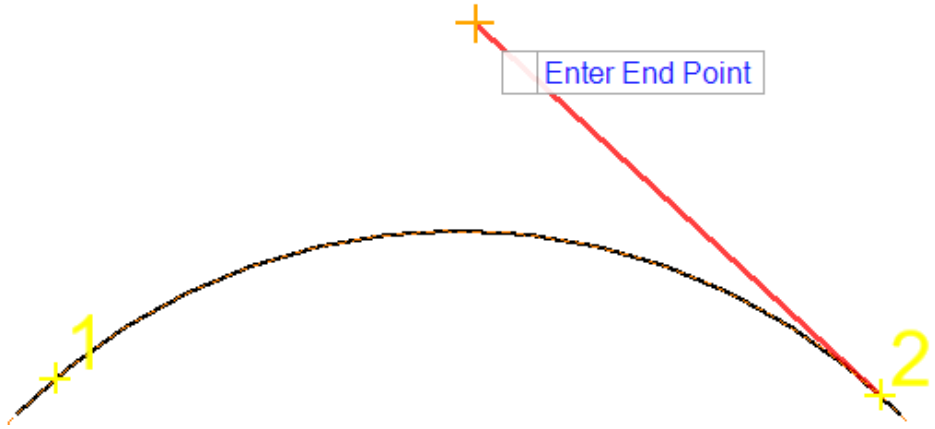


G. The first step at this point is to select the correct solution, Point 1 or Point 2. The Simple Line to Element tool is creating a line tangent to he curved element and at any location that line can solve to one of two points. The User must indicate which point to use for the solution. To change between Point 1 and Point 2 press the **<ALT>** key. This is an operation that will be required for several tools.

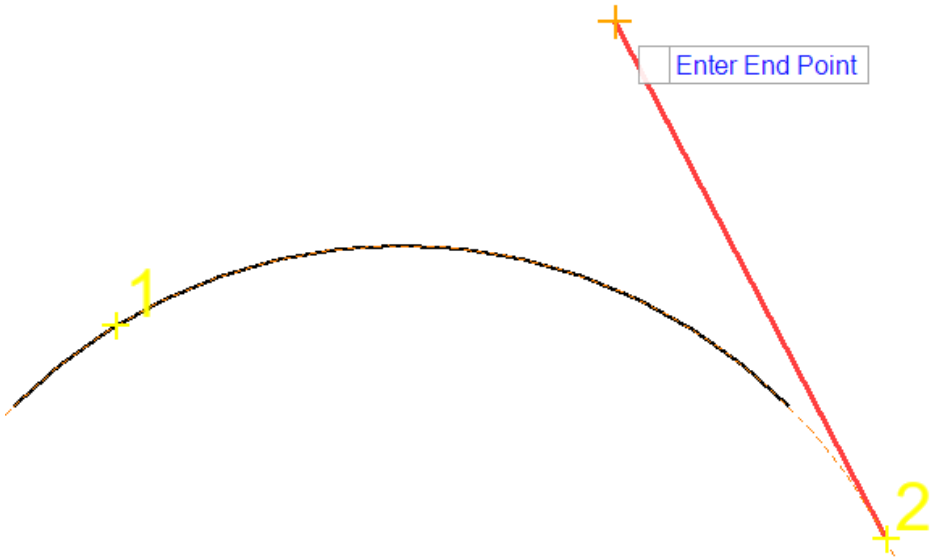
Initial default solution from Point 1



Press the **<ALT>** key to see alternate solution.

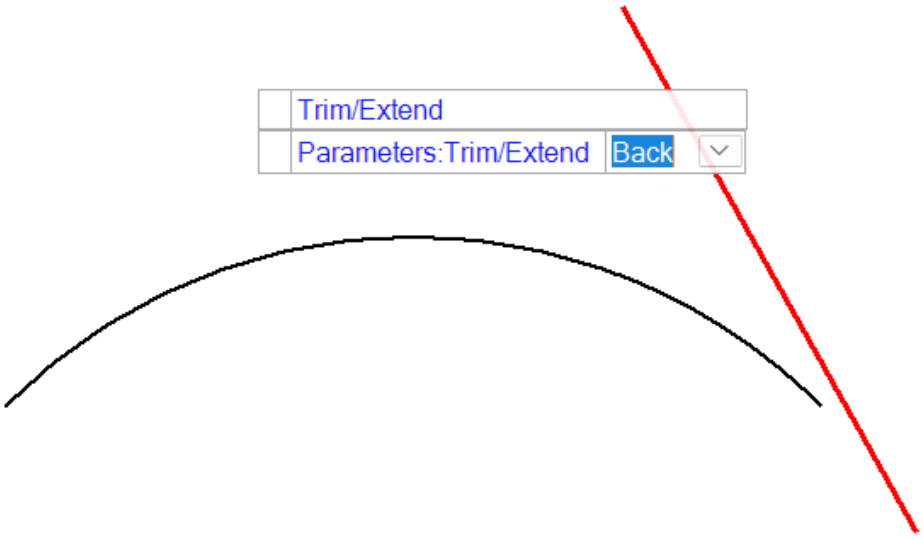


H. The next step is to select the end point by left clicking. By moving the cursor the line segment will update dynamically to show the solution. Note that it is possible to place the line segment outside the limits of the arc and onto the projected circle segment.

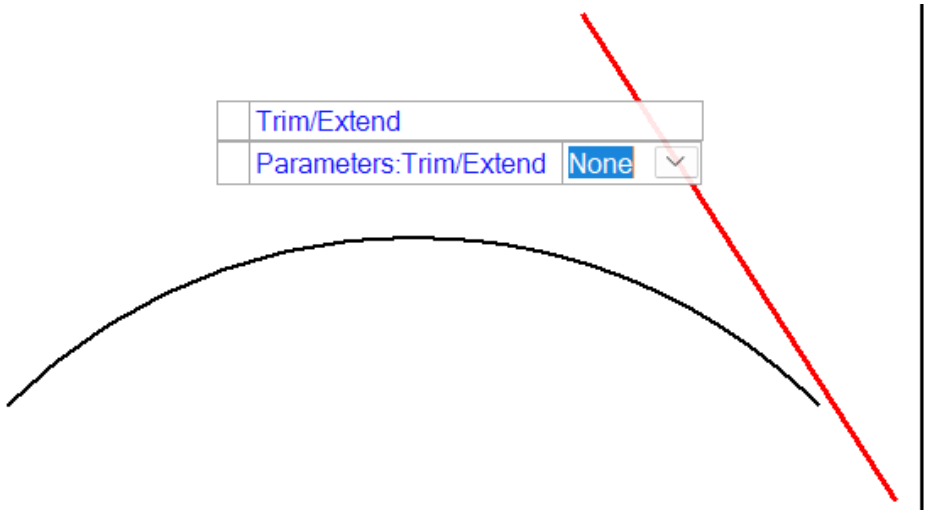


Move the cursor into a location similar to the above picture and left click to set the endpoint.

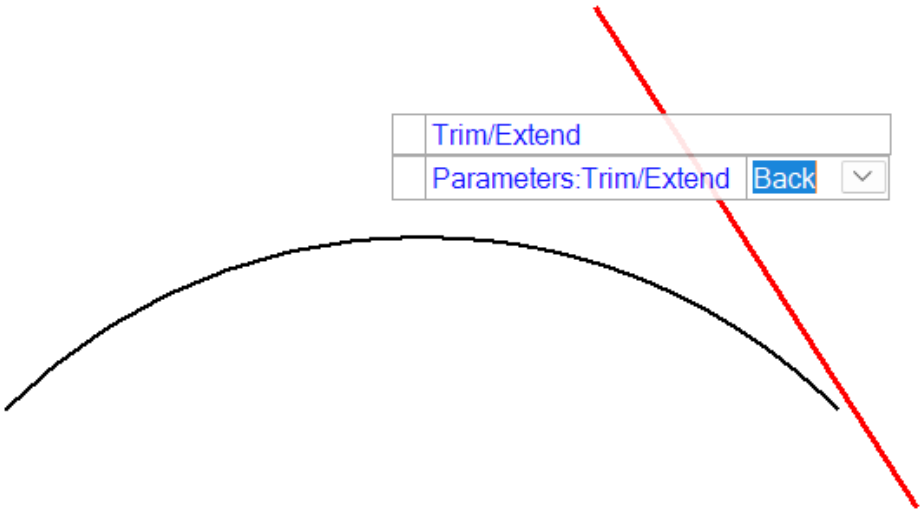
I. The line segment will be placed in the design file. The heads up prompt will ask for Trim/Extend Options.



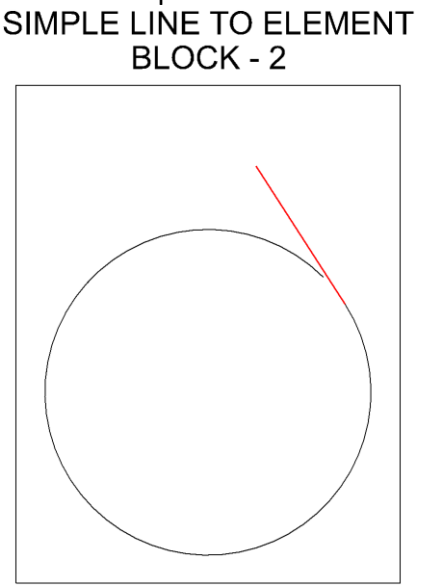
J. By using the <UP> and <DOWN> Arrows the user can toggle through the available options. Using the arrow keys to toggle through options that appear in the heads up prompt is a common procedure throughout all the tools. This tool has two option Back and None.



K. Toggle through the options until back is selected. Left Click to accept the Trim Back option. L



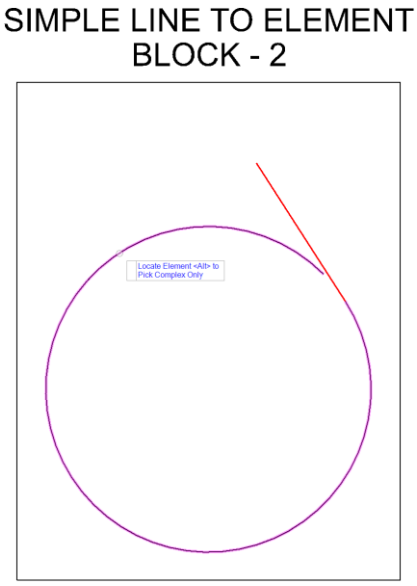
L. The solution should look like the picture below.



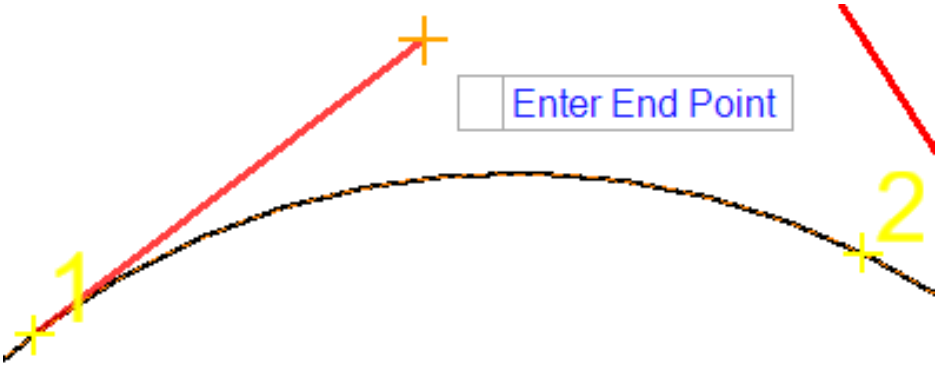
Because the Back option was selected for the Trim/Extend Option the program created a solution that extended the base Arc element around to the Line element.

One thing to note is that this tool can be used on a Civil Geometry Element that has been placed with ORD tools or just a simple arc element placed with basic drafting tools that has no civil geometry rules. If a basic Arc element is used as the To Element then the Trim/Extend Option will not modify the element to match the end point of the new line segment. The To Element has to placed with ORD tools and have geometry rules in order for the Trim/Extend Option to modify the arc to meet the line segment.

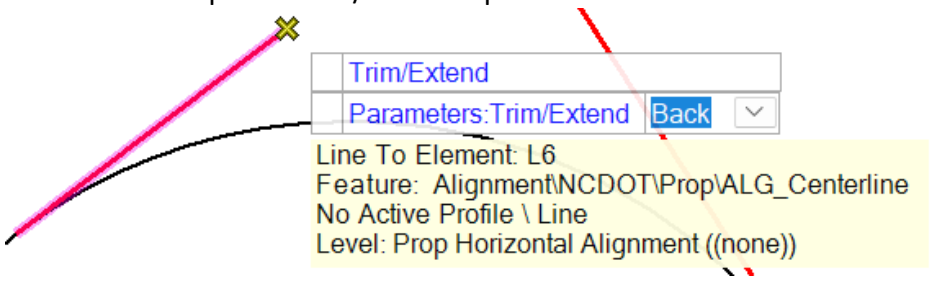
M. Restart the **Simple to Line Element** tool, and reselect the revised arc.



N. Left click to set the end point and select Point 1 as the desired solution.

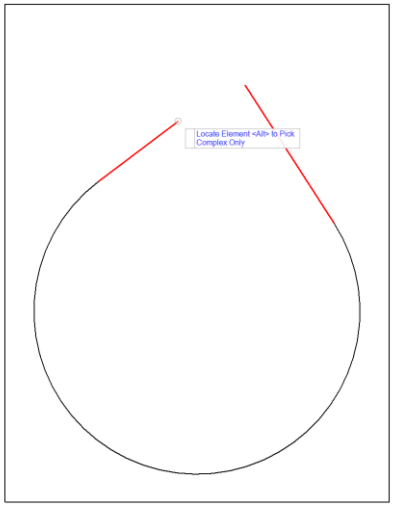


O. Left Click to accept the Trim/Extend Option Back.

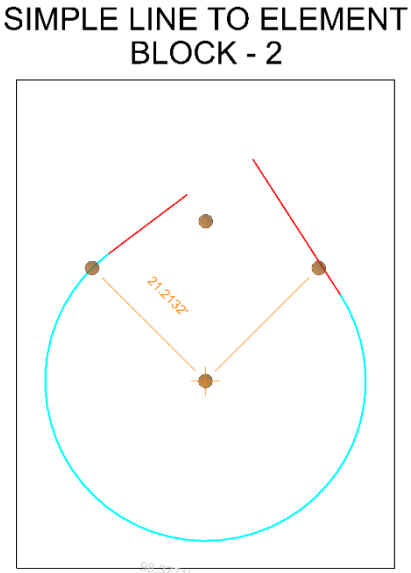


P. Note that the arc was trimmed to match the line segment. The program will trim or extend the arc in the appropriate direction to match the tangent direction of the line segment.

SIMPLE LINE TO ELEMENT
BLOCK - 2

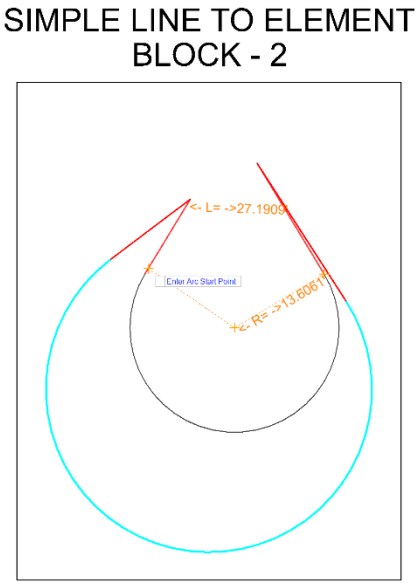


Q. The created geometry, the Arc and the Line segments all contain text manipulator and drag handles. Select the arc and note the available manipulators, they are located at the original end points of the arc and the original PI of the arc.

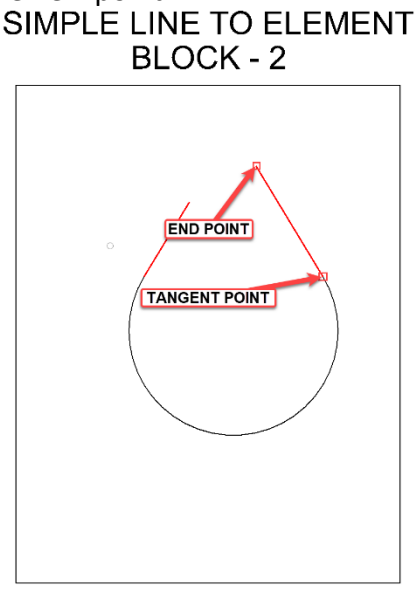


R. The radius can be adjusted by using the drag handles or the text manipulator. Note that the length 90.0761' is shown in red, this indicates that the length Text Manipulator cannot be revised, in this case that is because it would change the center location and there are no rules to tell the program how to change the center location.

S. Select the drag handle on the upper left side and move to a new location closer to the center point.

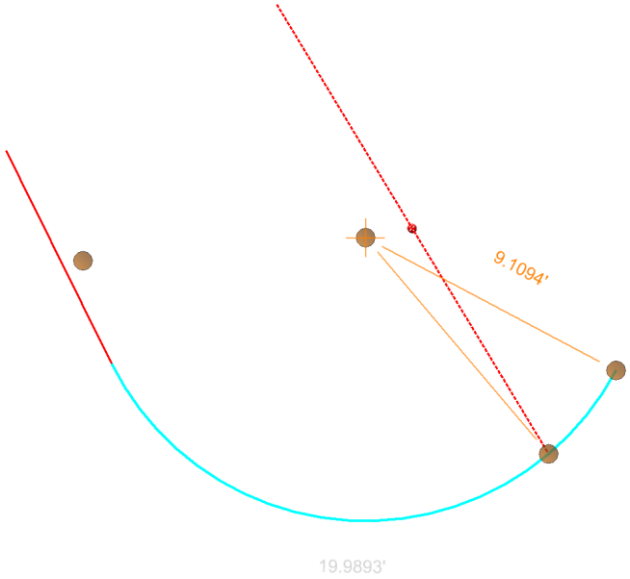


T. Left Click to accept the new point.



U. By moving the drag handle the user is changing a point on the curve, the other point on the initial arc does not change so the center of the curve is reset. This also resets the line segments by changing the tangent point. Note that the end points of the line segments that are not connected to the arc did not move. This is because of maintained Design Intent. The Design Intent of this tool is to set a Line Segment End Point and then connect a line from that End Point to an identified Arc Element. Based on the Design Intent the End Point Location is maintained and the tangent location is revised to match the revised arc element.

V. It is possible to use the drag handel and text manipulators to modify the To Element, the base Arc element, so there is no solution. In that case a dashed red element will be shown with a red circle and an 'X' that identifies the element that is causing the error.



W. In this case the easiest thing to do is to select the UNDO (Ctrl +Z) tool to undo the change.

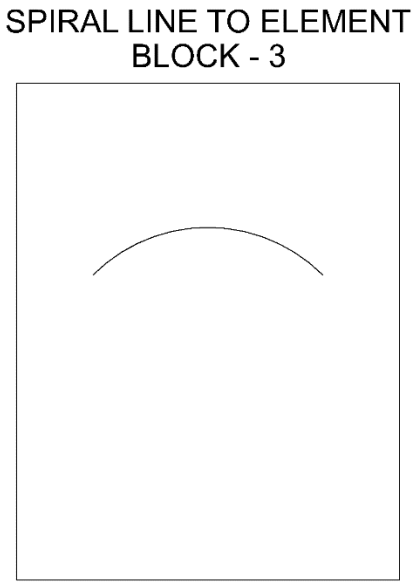
2. Spiral Line to Element

A. The **Spiral Line to Element** tool is not necessarily a tool that will be commonly used by roadway designers. This tool will draw a line segment to an element with a spiral in between. The majority of the spirals a roadway designer will design are on the ends of Arc element and will be handled in a different manner.

One possibility would be designing a ramp alignment that tied into a curve on the mainline. In this instance the roadway designer may want to have a ramp alignment that starts with a spiral and ties to a tangent that intersects the Y line.

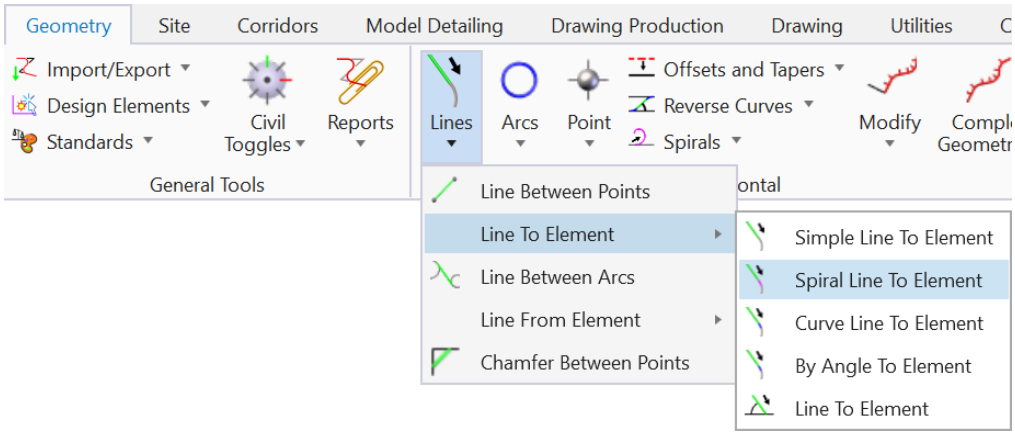
This tool is similar to the **Simple Line to Element** tool.

B. Locate the Spiral Line to Element exercise location in Block – 3. The To Element must be a curve to use this tool.



Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

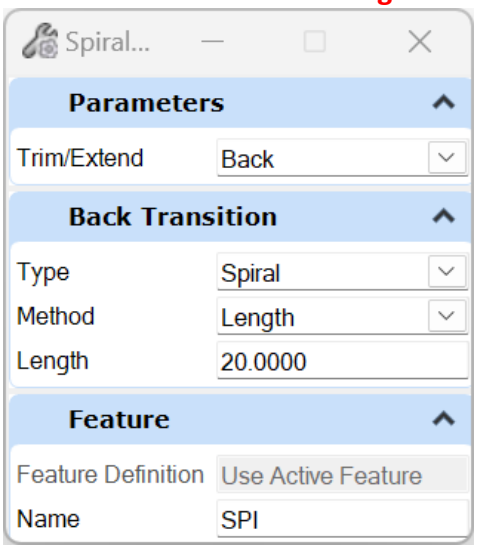
C. Select the **Spiral Line to Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



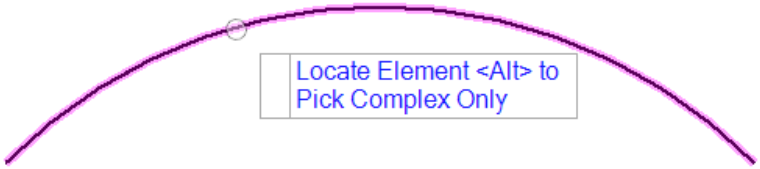
D. Note the dialog that appears on the screen. This is an alternate way to input design parameters and is available with various tools. The user can Input all the design parameters here and then simply left click at the heads up prompt to accept each input.

- Set the Trim/Extend Option to *Back* : This is the same operation that was used with the **Simple Line to Elemen**t tool.
- Set the Type to *Spiral*. Note that Curve and None are also available, if set to none this would operate as the **Simple Line to Element** tool is set to Curve this would operate as the **Curve Line to Element** tool. ORD provides a lot of flexibility with the design parameters, there will be multiple ways to design the same solution and there are multiple tools that will operate the same depending on the inputs.
- Set the Method to *Length*. The other options; A-Value, Deflection, Offset and RL-Value are not used by roadway designers>
- Set the Length to *20.00'*. This value is just for the example for a roadway design the length would be something more appropriate.
- Set the name to *SPI*. In ORD all Civil Elements are named and tracked within the dgn file. If there is already a SPI element the program will increment the name with a numerical value.

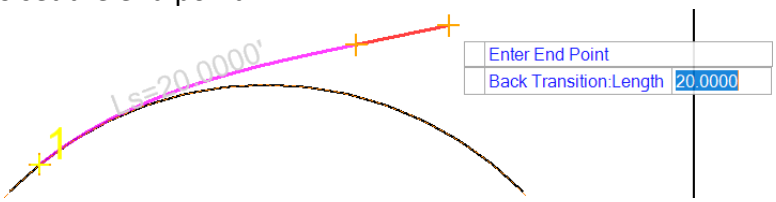
For most elements, the name is not important and not something the user need to know about. The name is critical for Alignments, it is important that the name match the alignment L, Y1, RPA1 etc. So it is important that the individual element names do not use an alignment name.



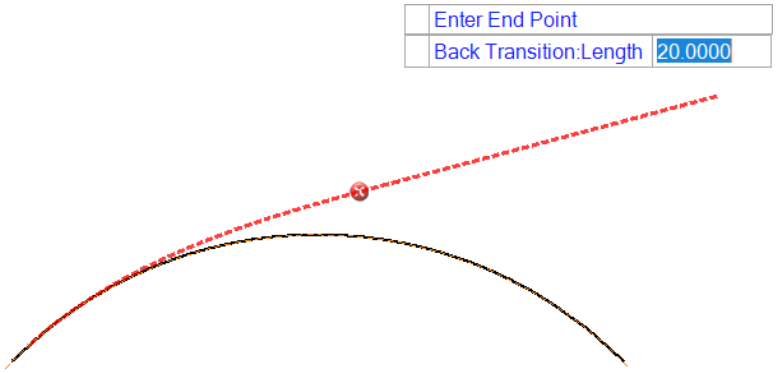
E. At this point left click to select the arc.



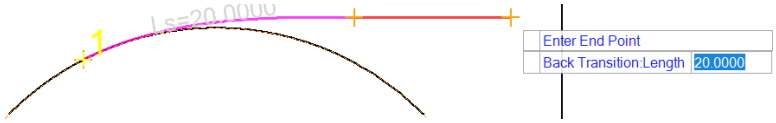
F. Left click to accept the previously entered Transition (Spiral) Length of 20.00' this will also set the end point.



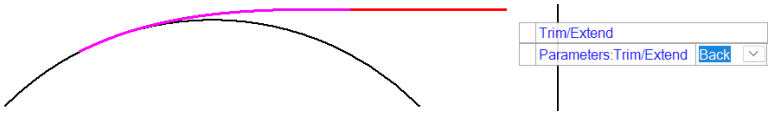
G. Note that for this tool that even though the projected circular element appears as a dashed line, similar to the **Simple Line to Element** tool that the program will not tie a Spiral to a projected arc. In this picture the end point was being set too far to the left and the line and spiral could not project within the limits of the established Arc. The red dashed line and red circle with the 'X' indicate no solution possible.



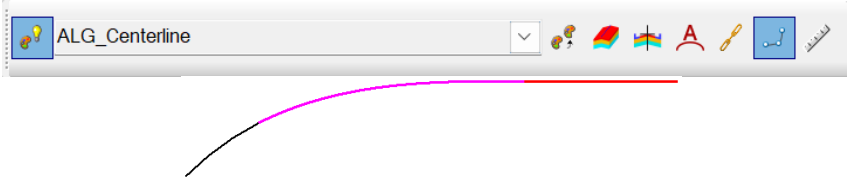
H. Left click to select an end point that has a solution as indicated by the dynamic display.



I. Left click to accept the Trim/Extend Back option.



J. The result should look like the picture below. Because the ALG_Centerline Feature Definition was selected, the spiral is shown in purple and the tangent is shown in red.

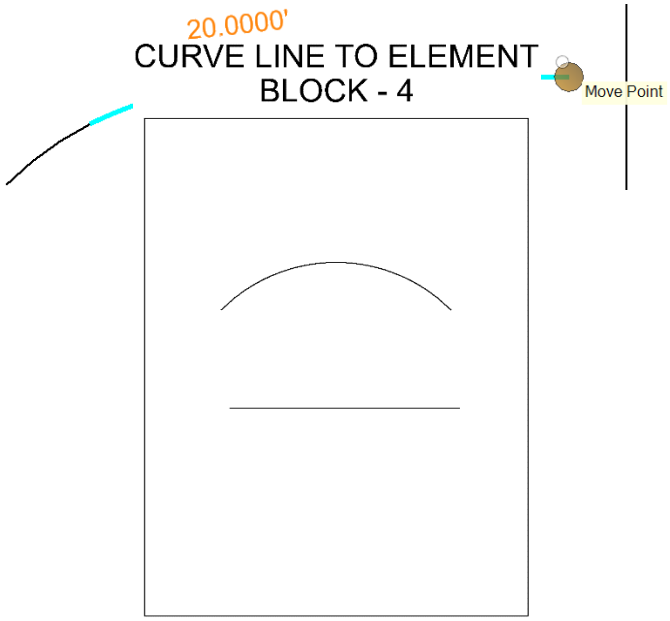


K. Left Clicking on the element will display the drag handles and the text manipulator that can be edited. This will work in a similar way to the **Simple Line to Element** tool. In this case it is only the needed point location and the length of the spiral.

3. Curve Line to Element

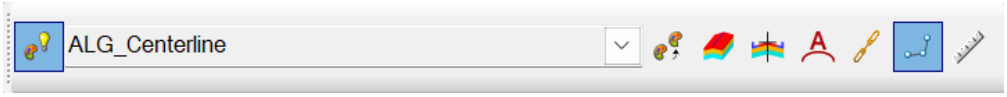
The **Curve Line to Element** tool will draw a line segment to an element with a curve in between. This tool will be useful when designing centerline alignments that tie to existing curves. This tool is similar to the **Spiral Line to Element** tool.

A. Locate the Curve Line to Element exercise location in Block – 4. When using this tool

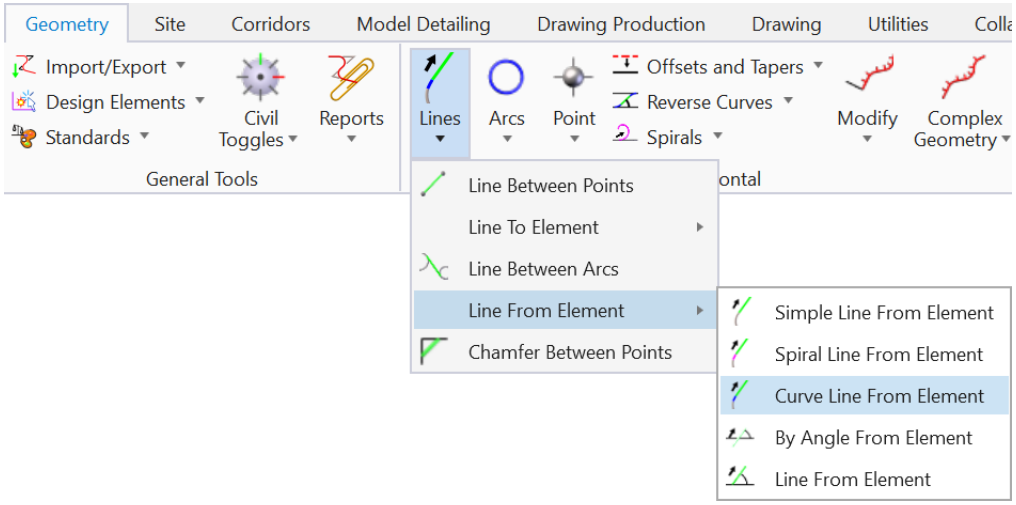


the To Element can be a line or a curve.

B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

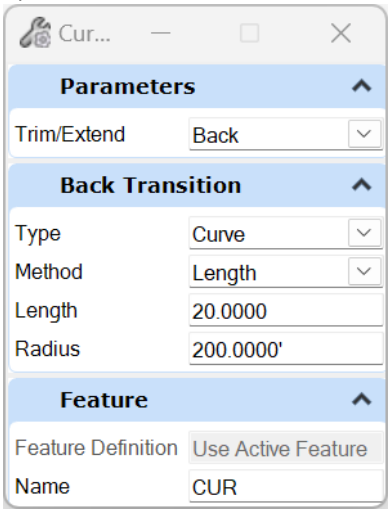


C. Select the **Curv Line to Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



D. The method to input the parameters for this tool is the same as the **Spiral Line to Element** tool using the heads up display or the dialog. Set the Dialog Box to match these parameters.

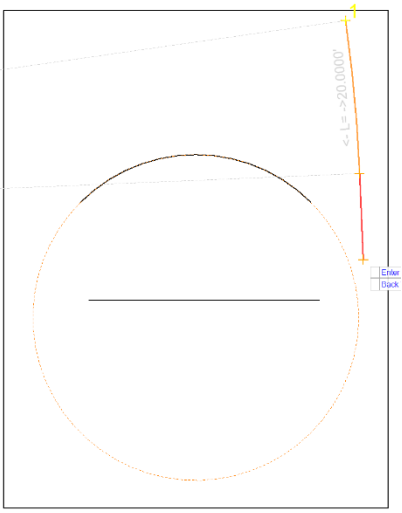
- Trim/Extend = Back
  1. Back would most likely be used when tying a proposed element to another proposed element
  2. None would most likely be used when tying a proposed element to an existing element.
- Type = Curve
  1. This uses a curve transition in between the Line and the To Element
  2. None would be effectively using **Line Between Points** or **Line to Element**
  3. Spiral would be effectively using the **Spiral Line to Element** tool
- Method = Length
  1. This defines the curve transition by the length of the curve.
  2. Deflection will define the curve by the Angle of Deflection from the Tangent Direction of the To Element
  3. Offset will define the curve by setting the end point at a defined offset from the To Element.
- Radius = 200’
  1. The sets the radius of the curve transition and will always be required
- Length = 20’
  1. This will be dependent on Method selected.
- Name = CUR
  1. This is not critical, the only important thing is to not use the name of the alignment, L, Y1, RPA etc. The user can select any other name.



E. Left click to select the curve. Note the dynamic solution will be displayed based on the position of the cursor. Because the tool can determine the solution based on the entire circular arc it is possible to find multiple solutions.

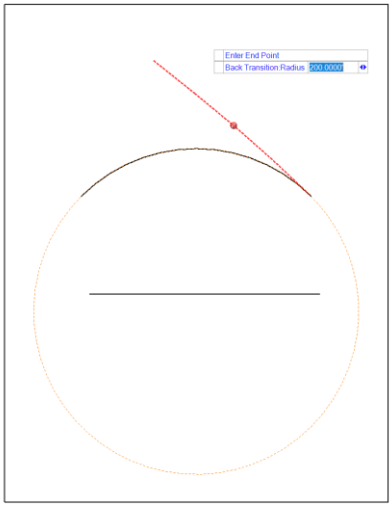
F. For this solution, if the black curve was extended counter clockwise it would be tangent to the clockwise extension of the orange curve.

CURVE LINE TO ELEMENT
BLOCK - 4

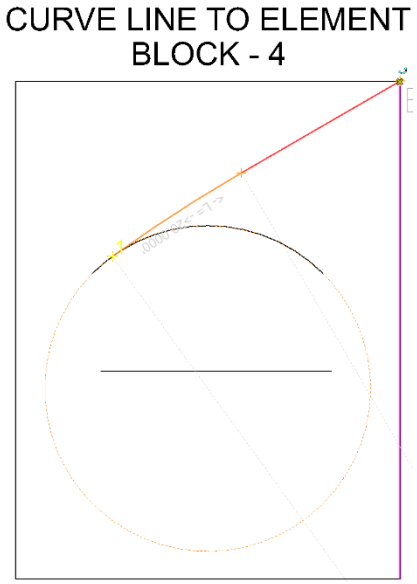


G. It is also possible to place the cursor in a position that no solution will be available, as shown by the red 'X' and the red dashed line.

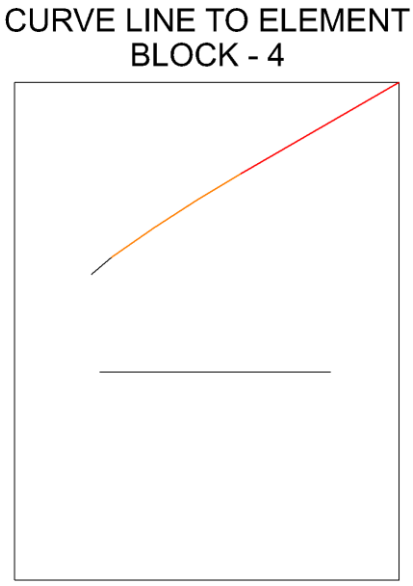
CURVE LINE TO ELEMENT
BLOCK - 4



H. By moving the cursor to the top right corner a solution will be displayed that will be more appropriate. In most cases the designer will be using a snap to place the end point of the line in a specific location.

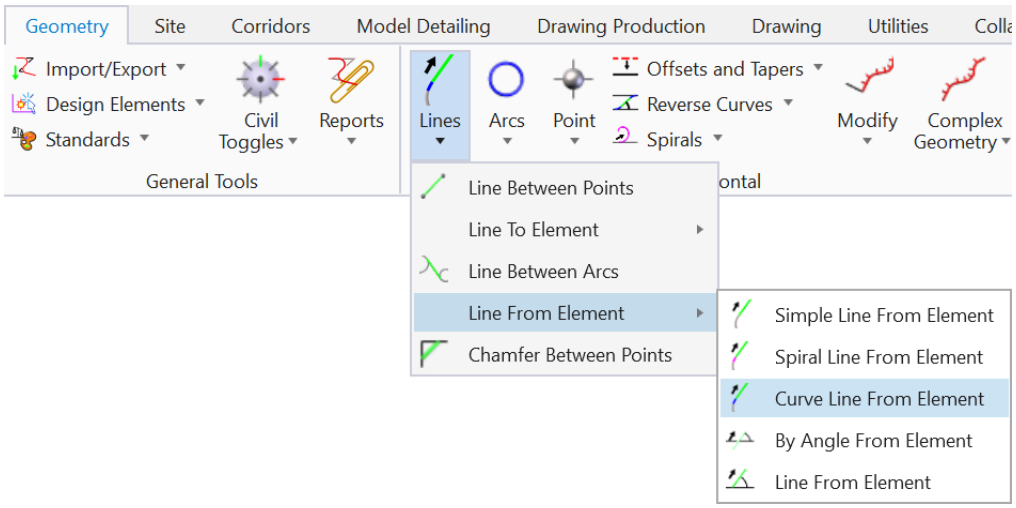


I. Note that even though the dialog box was filled out with the appropriate design data the user still has to left click through each option in the heads up display to accept the previously entered data for radius and transition.



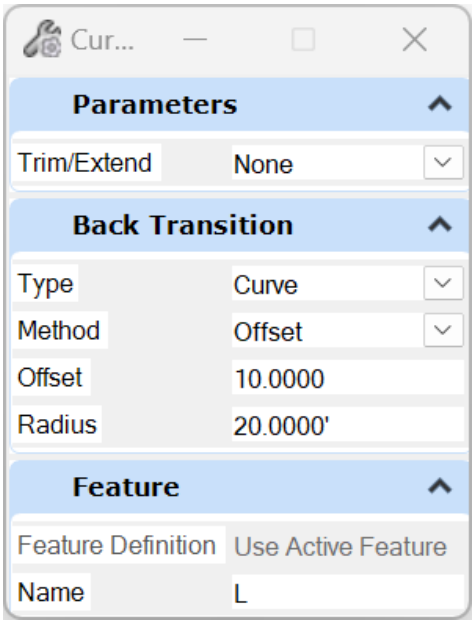
This shows the line in red, an orange curve and a transition back to the original element, the black curve.

J. Start the Curve Line to Element tool.

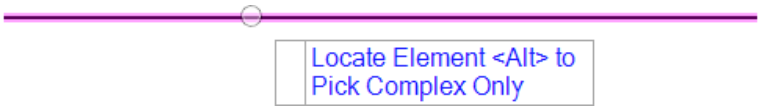


K. Set the following design parameters in the Dialog Box.

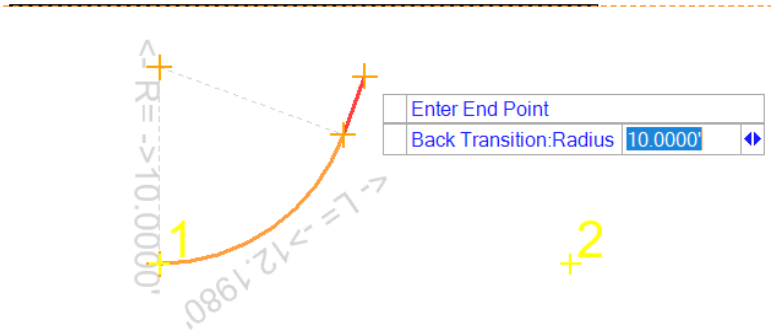
- Trim Extend = Back
- Type = Curve
- Method = Offset
- Radius = 20’
- Offset = 10’
- Name = CUR



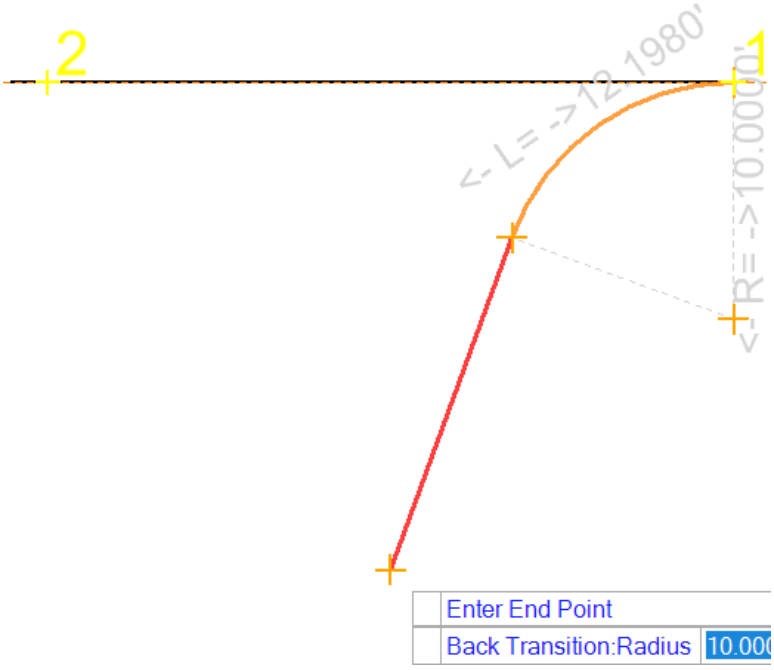
L. Select the horizontal black line.



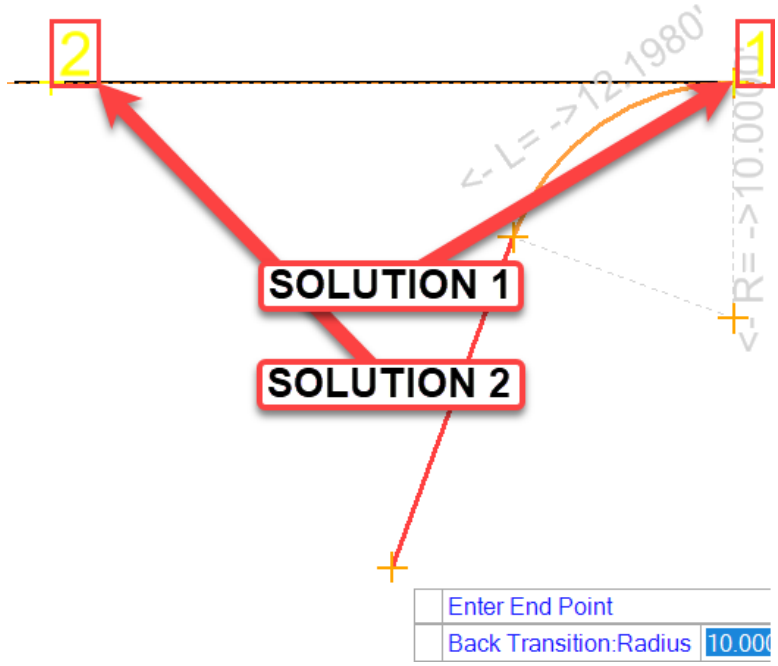
M. The program will again show the dynamic solution. In this case if the cursor is too close to the line, if it is within the offset distance of 10' the program will flip the curve to the opposite side.



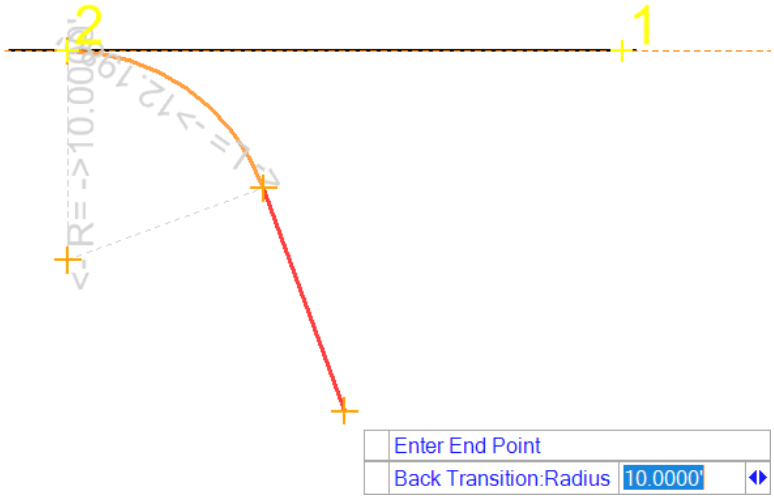
N. Move the cursor far enough away from the line to allow the curve to solve and the dynamic solution will show a curve tangent to the line.



O. Also note there are two solutions, shown with the numbers 1 and 2. These show the two possible solutions for the cursor location.

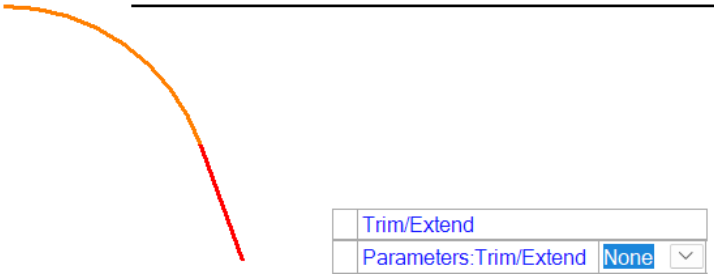


P. The user can switch between these solutions by using the **<ALT>** key. This is common across all the tools when there are multiple possible solutions. Also note that the program will use the extension of the To Element to determine a solution.



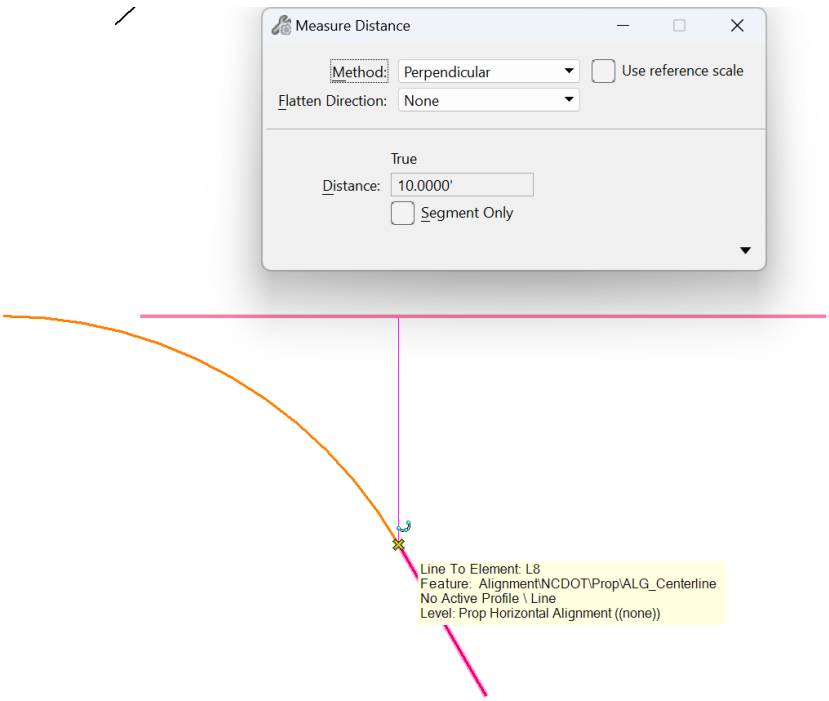
Q. Left click to accept the radius of 20'. This will also set the end point of the proposed line.

R. The original dialog was set to Trim = Back. Now that a solution has been determined the user may want to change this to Trim = None. In that case use the down arrow at this point to change between the available Trim Options.



Using the Down or Up Arrow to change between available options shown on the heads up display will be common across all the tools. This is done while left clicking through the heads up display to accept each parameter and this will override any settings that were made in the original dialog.

S. Note that the perpendicular distance from the To Element to the end of the Curve transition is 10’. This is the method and distance specified in the dialog.

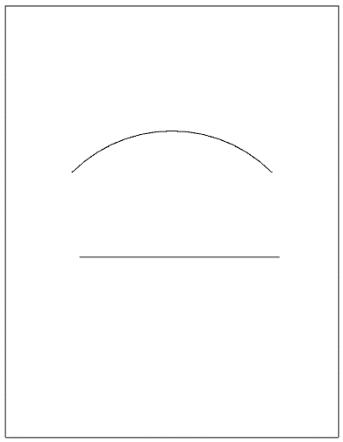


4. By Angle to Element

A. The **By Angle to Element** tool will create a line without a curve or spiral transition to another element with a defined skew angle. This tool will be useful when drawing intersecting roadways. The To Element can be an Arc or a Line.

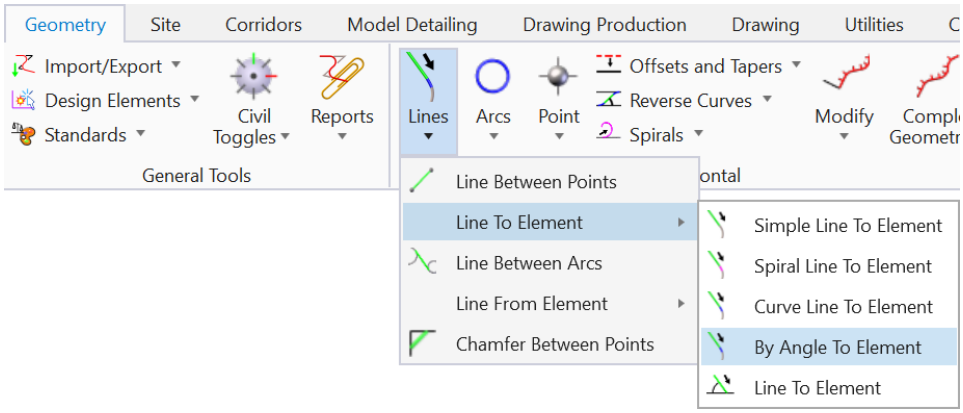
B. Locate the By Angle To Element exercise location in Block-5.

BY ANGLE TO ELEMENT
BLOCK - 5

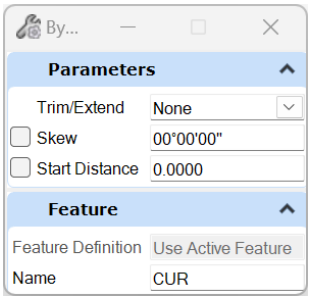


C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

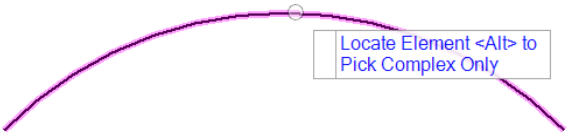
D. Start the **By Angle to Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



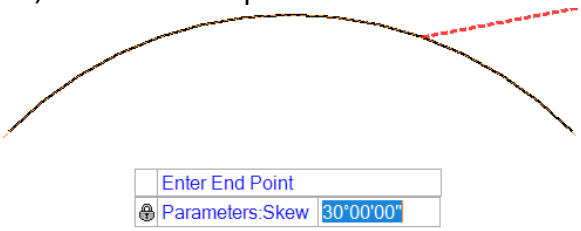
E. For this exercise we will enter all the design parameters at the heads up instead of the dialog. Uncheck the Skew and Start Distance options and the dialog box and set the name to CUR.

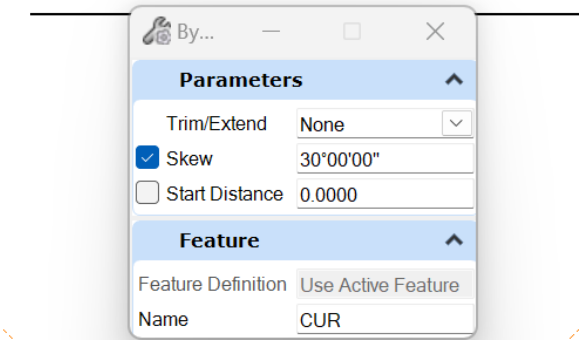


F. Left click on the Arc to start the tool and select the To Element.

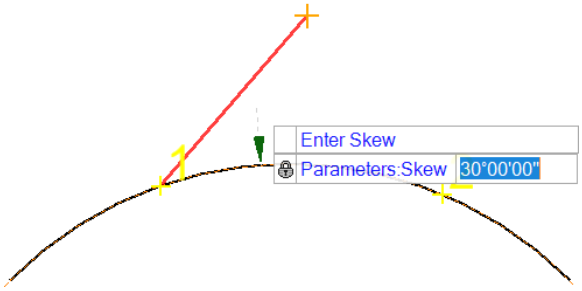


G. At the heads up prompt enter 30 for the skew. Press <ENTER> a lock symbol will appear indicating the value is locked. The dialog box will also update to show a check mark beside the Skew value. Note that multiple solutions are available, the user can toggle between these using the <ALT> key and the extension of the Arc is shown as a dashed black line, which is also a possible location for the line to solve.

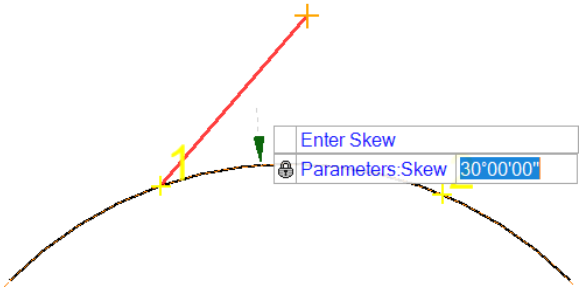




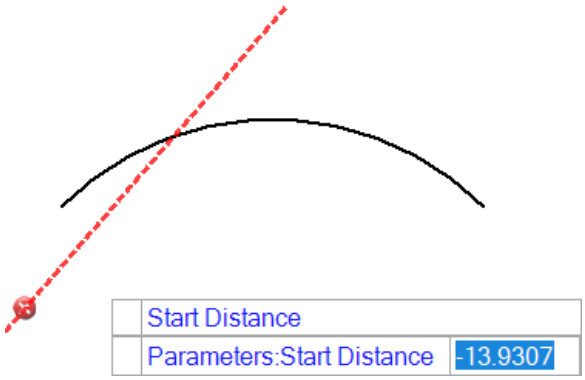
H. Left click to accept. This will set the intersection angle of the Line and the Arc at 30 degrees to the tangent. This will also place a tentative end point for the line.



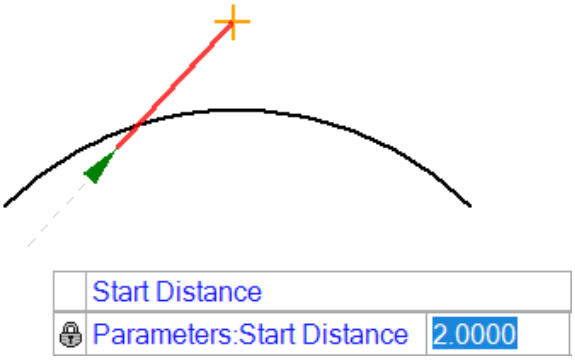
I. Left click again to accept and set the end point. When left clicking this time it is important to select a point in between the initial end point and the To Element. By Left clicking to accept the end point the user is also initializing the Start Distance.



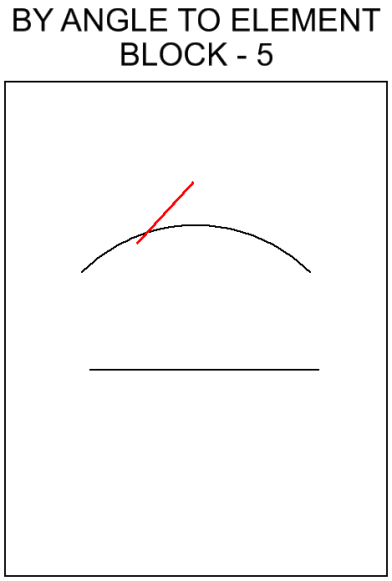
J. If the user left clicks in an area that cannot be solved the toll will end. In this case left clicking above and to the right of the initial end point will result in an error indicated by the red dashed line and the red circle with the 'X'. This can be resolved by going back to the dialog box and entering an appropriate Start Distance.



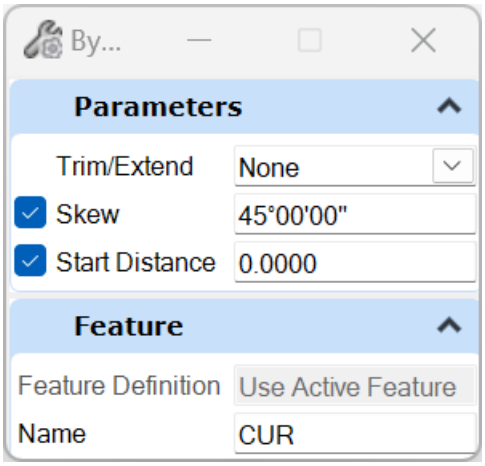
K. By left clicking in the correct location initially the user will be prompted for the start distance. This is the distance from the To Element as measured along the Proposed line where the program will place the starting point of the line. At the heads up prompt enter 2' and press the <ENTER> key.



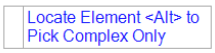
L. This will lock the value at 2’ as indicated by the lock symbol. Note that a positive value will be to the opposite side of the To Element from the end point, this is a positive extension of the line. A negative value will be to the same side of the To Element as the end point, this is a negative extension of the line. A value of 0’ would place the line on the To Element. Left click to accept this solution and place the line in the dgn file.



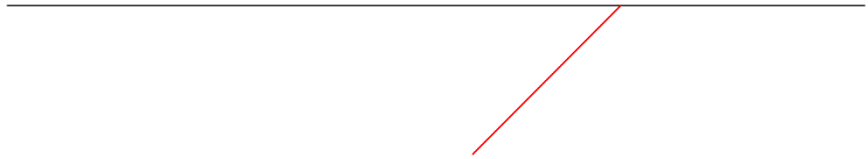
M. Restart the By Angle to Element tool. And Set the dialog Box :
- Trim/Extend = None
  Note that the Trim/Extend option is only available if the Start Distance is set to 0’
- Skew = 45 degrees
- Start Distance = 0’



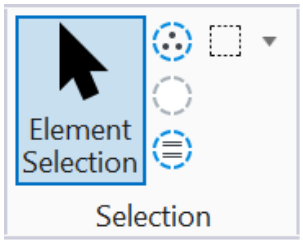
N. Left click to select the line as the To Element

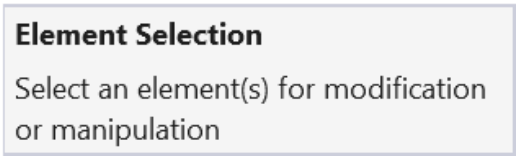


O. Left click through the heads up display to select the previously entered design parameters.

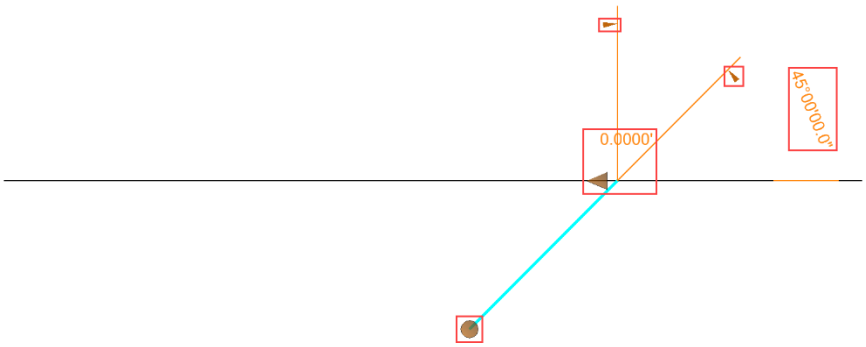


P. Start the **Element Selection** tool located in the *Selection* section of the *Geometry* ribbon. Or any ribbon for that matter (except for drawing, view, and help, but I digress). Who the heck wrote this? -humble intern

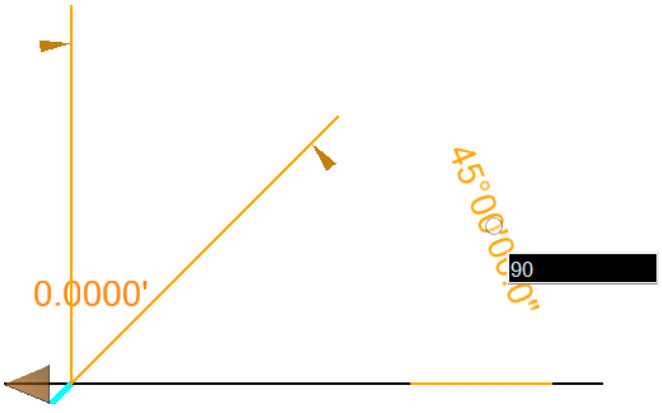




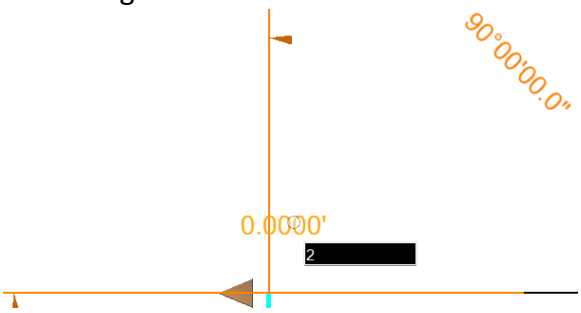
Q. Select the Line segment and notice all the Text manipulators and drag handles that are available.



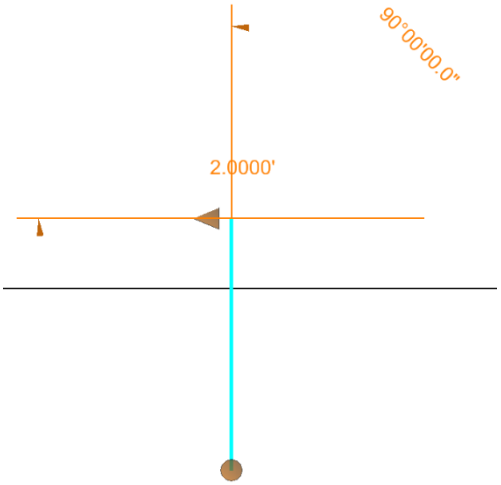
R. Select 45°00’00” and change to 90°



S. Select 0.0000’ and change to 2’



T. The line is now constructed at a 90° skew and extends 2’ past the line.



U. The ability for the user to make geometry revisions by using text manipulators and drag handles is a powerful tool provided by ORD. This ability coupled with linking various elements together through multiple layers of geometry rules and design intent allows for quick and accurate revisions to the design plans.

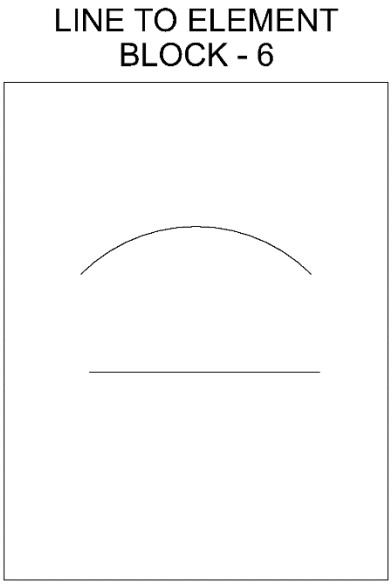
This will become evident in later training modules but if this had been a road centerline with a corridor already constructed, changing the skew angle to 90° would result in all the linked geometry updating; EOT, Curb and Gutter, Sidewalk and the corridor and sections would have updated. The vertical alignment would update based on the geometric rules of the profile and how it was constructed, and the cross sections would be updated to match the new model.

It is important for the designer to become familiar with and comfortable using all of the design tools to ensure that the model is constructed in a way that will produce the desired results.

5. Line To Element

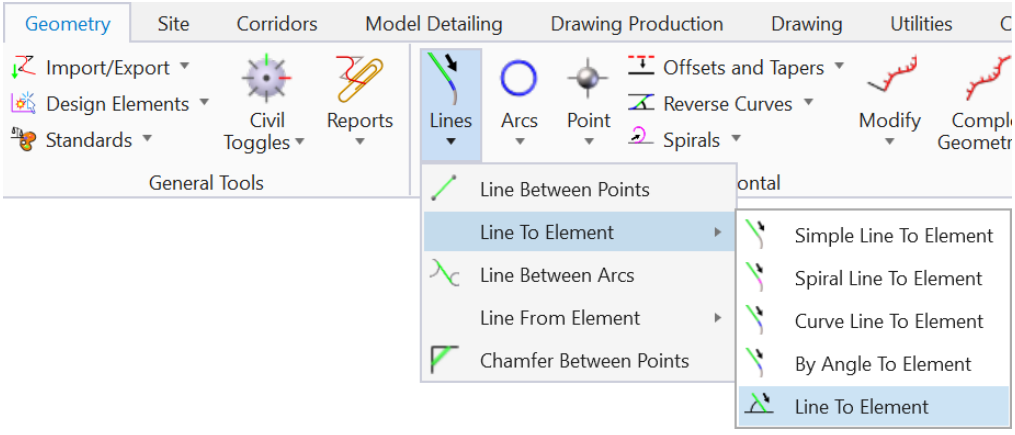
A. The **Line To Element** tool is very similar to the **By Angle To Element** tool. This tool will allow the user to draw a line at a skew to a reference element. This tool has the added functionality of allowing the user to include an initial offset from the To Element. This tool would be useful when designing a ramp for instance.

B. Locate the Line To Element exercise location in Block 6

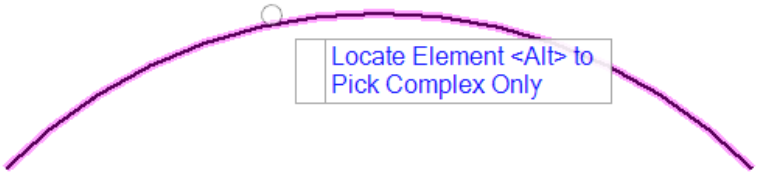


C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

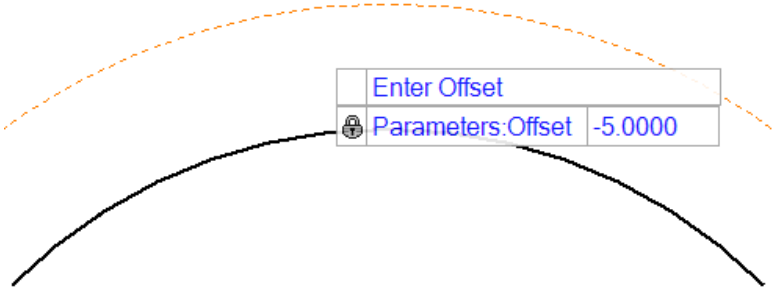
D. Start the **Line To Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



E. For this exercise we will enter all the design parameters at the heads up display. Left click on the Arc to select it as the To Element and start the tool.

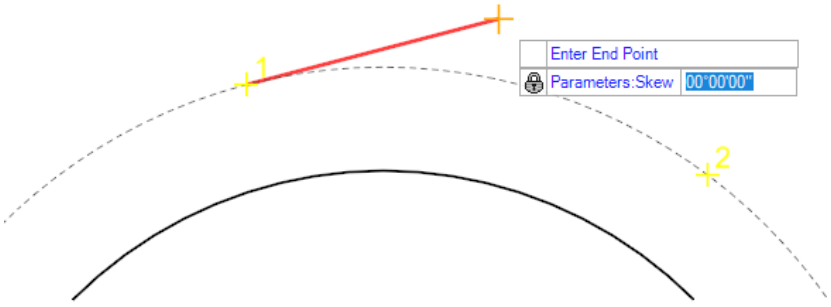


F. At the prompt enter -5.0 for the offset distance and <ENTER> to lock the value.

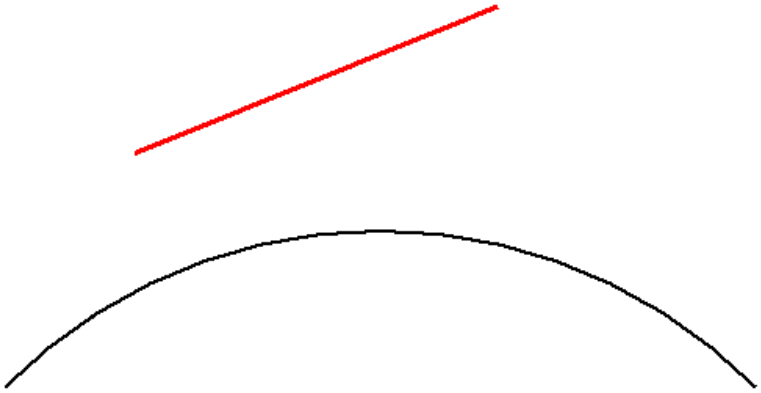


G. Left click to accept the value. For the majority of tools the user will be required to enter the value and then left click to accept the value.

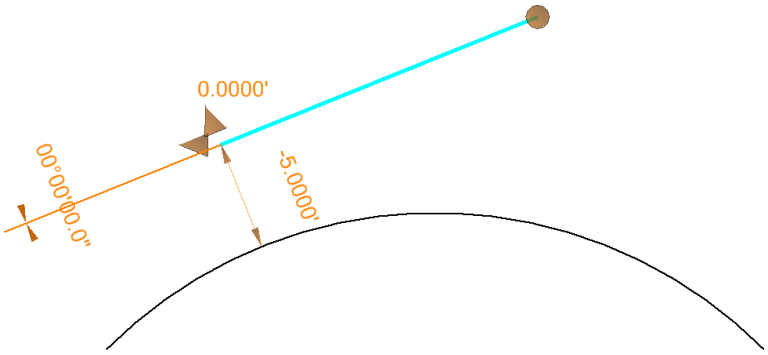
H. At the next prompt enter 0° for the Parameters Skew and <ENTER> to lock.



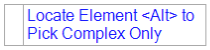
I. At this point, when left clicking to accept the skew value of 0°, the user will also set the end point of the line and complete the operation. This will create a line that is tangent to the Arc selected as the To Element at an Offset of 5.0’



J. The relevant rules and parameters can be shown by using the Element Selection tool to pick the line segment. This could be the beginning of a ramp or loop that ties to a centerline at a specified offset.



K. Restart the **Line To Element** tool, and select the line segment.

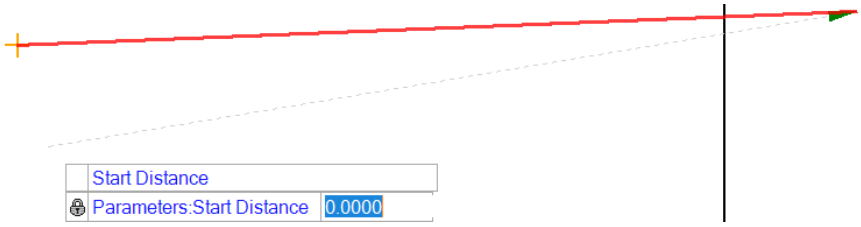


L. At the prompt enter -5.0’ and <ENTER> to lock the value.

M. Now move the cursor to a position below the line. Note that the distance stays the same but the sign changes and the value show updates to 5.0’. Left click in a location below the line and the offset will be set to the right side of the line.

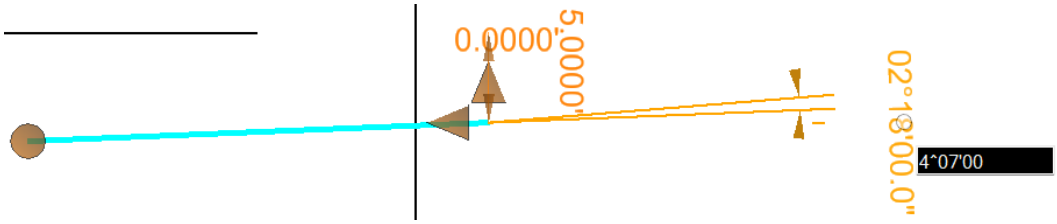
N. The parameters skew prompt will now display. Press the <ALT> key to switch to solution 2. Enter 2^18’00” (or alternate format 2..18..00) for the skew angle.

O. Because the To Element was a line there is an additional option to enter a start distance. The start distance is the distance as measured from the 5’ offset location along the line that the proposed line will start. Enter 0’ for this value to start the line at exactly 5’ offset from the To Element.

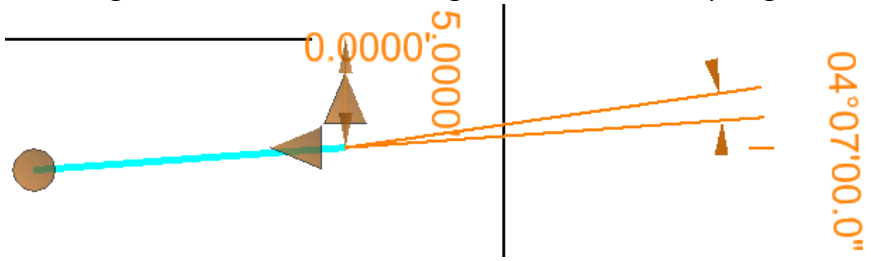


P. Left click to accept and place the line.

Q. This could be the beginning of an angular exit, set to the minimum skew angle of 2°18’00”. Use the **Select Element** tool to activate the text manipulators and change the value to 4°07’00”.



R. This is another example of how geometry rules and design intent could be used to modify a horizontal alignment. If a ramp alignment was built off of this as the initial tangent a change to the skew angle would result in modifications to all the curves, spiral and tangents to maintain the design intent of the ramp alignment.

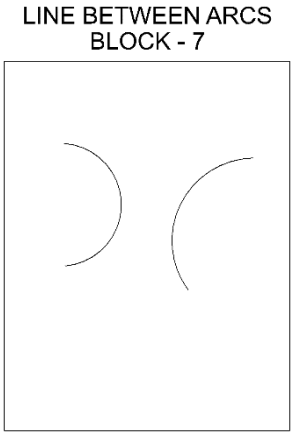


Line Between Arcs

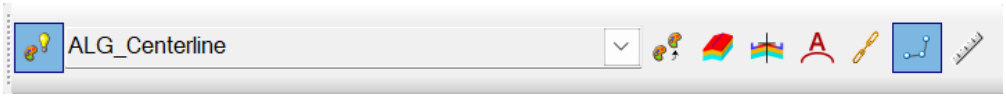
1. Line Between Arcs

A. The **Line Between Arcs** tool will draw a line between two previously placed arcs. It may seem very simple but this tool has several options that make it very useful. The user can specify an offset from either one of the previously placed arcs. The user can also specify a beginning or ending transition from the line to the previously placed arcs.

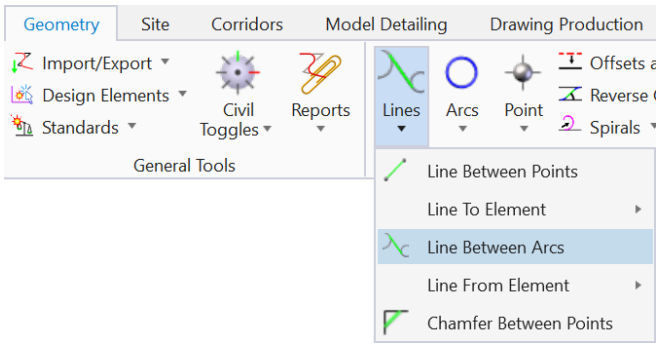
B. Locate the Line Between Arcs exercise location in Block 7.



C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

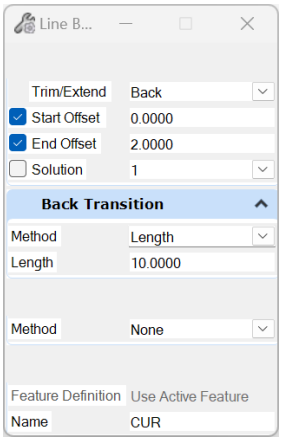


D. Strat the **Line Between Arcs** tool from the *Horizontal* section of the *Geometry* Ribbon.



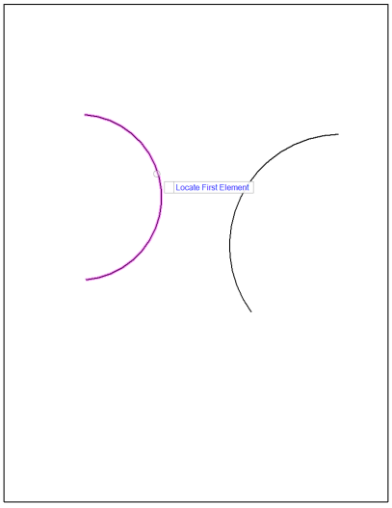
E. Set the dialog box with the following parameters.
- Trim/Extend = *Back*
  1. None = neither of the previously placed arc will be trimmed.
  2. Back = The back arc, the first arc selected will be trimmed or extended to meet the new line.
  3. Ahead = The ahead arc, the second arc selected will be trimmed or extended to meet the new line.
  4. Both = Both arcs selected will be trimmed or extended to meet the new line.
- Start Offset = *0.00'*
  1. This is the offset from the first arc where the new line will tie.
- End Offset = *2.00'*
- Solution = Leave this unchecked, this will be done during the placement process
  1. This is a way to pick a solution in advance, with this tool there will always be 4 possible solutions.
- Back Transition Method = Length
  (Note that the transition will always be a spiral)
  1. Length = Sets the transition (Spiral) by length this is the most common setting for roadway designers.
  2. A-Value = square root of RL value, **not common in roadway design**
  3. RL-Value = radius multiplied by length of spiral, **not common in roadway design**
  4. Deflection = Theta for spiral curves, **not common in roadway design**
  5. Offset = This defines the length of the spiral by solving for a tie that is the specified offset distance from the same solution without the spiral, **not common in roadway design**
  6. None= there will not be a spiral and the line will tie directly to the curve or the curve at the specified offset
- Back Transition Length = 10.00'
  1. The length of the spiral transisiton
- Ahead Transition = None
- Feature Definition = Set Feature Definition Toolbar to Use Active Feature Definition
- Name = Cur, this is not important as long as the name is not an alignment

F. The Dialog should look like the picture below

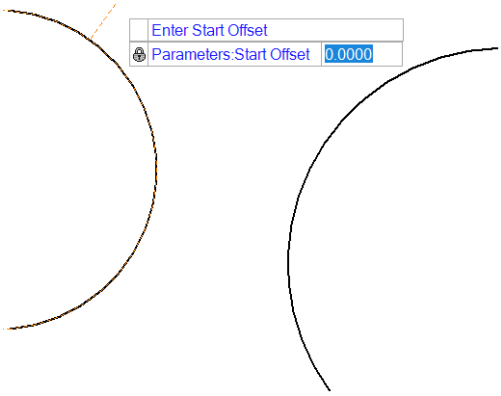


G. Left click to Locate the first element and start the tool.

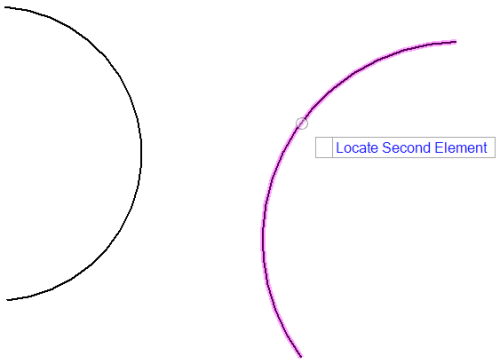
LINE BETWEEN ARCS
BLOCK - 7



H. Left click to accept the Start Offset = 0', this will already be locked because it was previously entered into the dialog box.

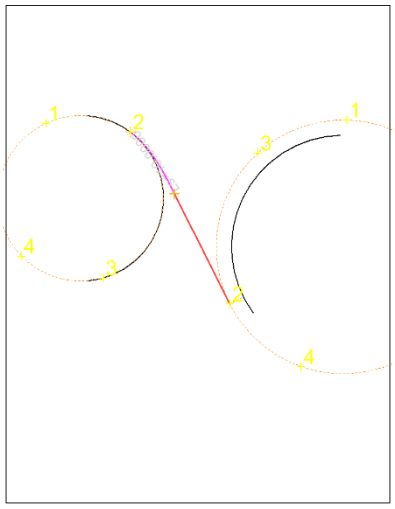


I. Left click to locate the second arc.

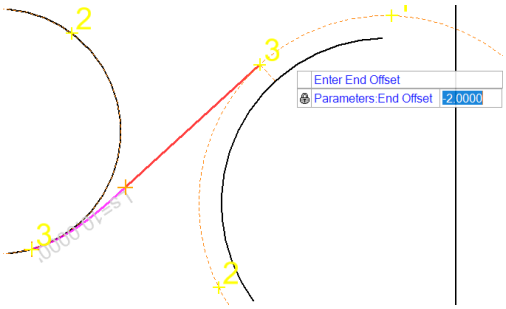


J. At this point a dynamic solution will show with location for the other possible four solutions shown. Note that like previous tools the extension of the arc can also be used to determine a solution.

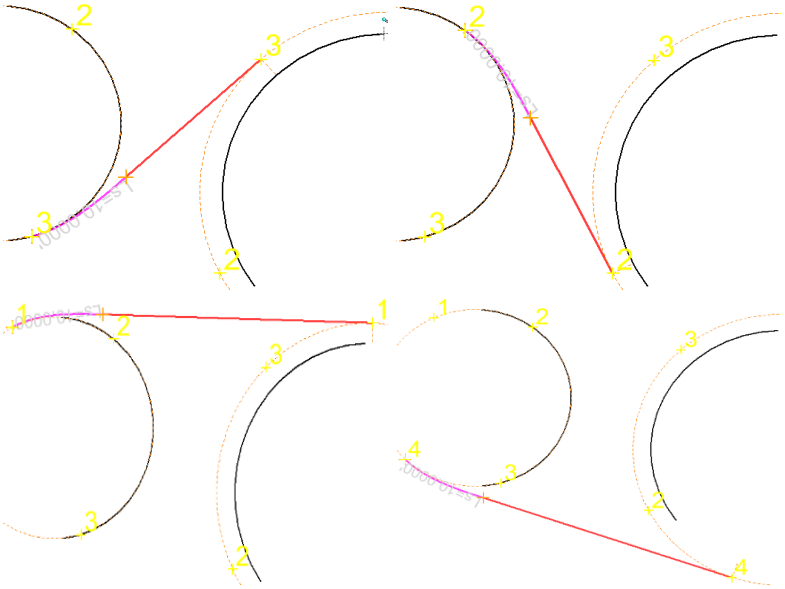
LINE BETWEEN ARCS
BLOCK - 7



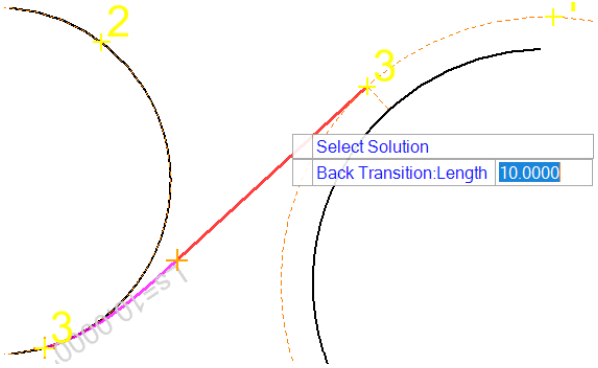
K. Left click to accept the End Offset Value = -2.00. Note that the sign updated to (-) to match the solution shown on the outside of the Arc.



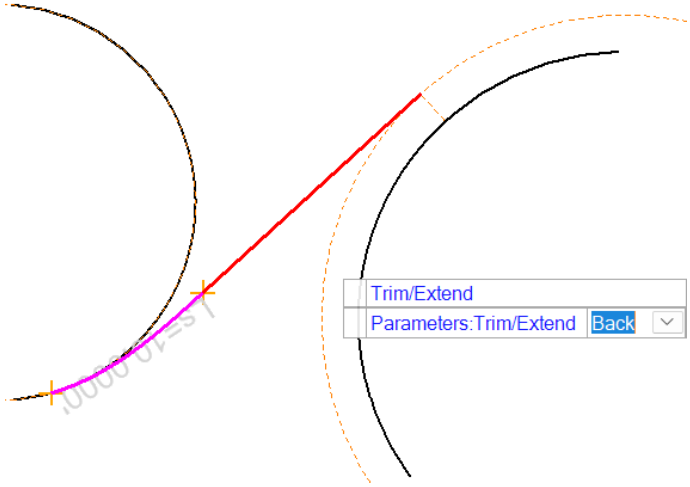
L. Because this tool always has our solutions, in addition to using the <ALT> key to select a solution the user can also select a solution by moving the cursor.



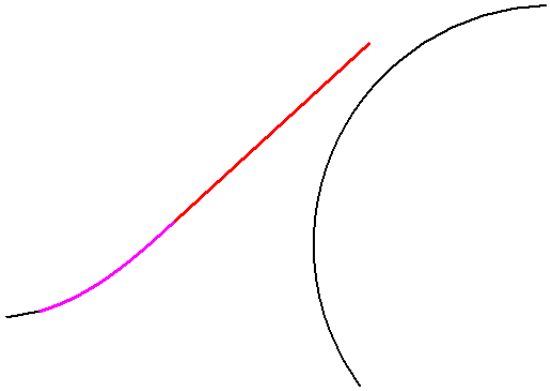
M. Left click to accept the back transition Length = 10.00. This will also set the current solution as the solution shown on the screen.



N. Left click to accept the Trim/Extend Parameter = Back. Note that the yellow numbers indicating multiple solutions are no longer visible. The previous step set solution 3 as the desired solution.

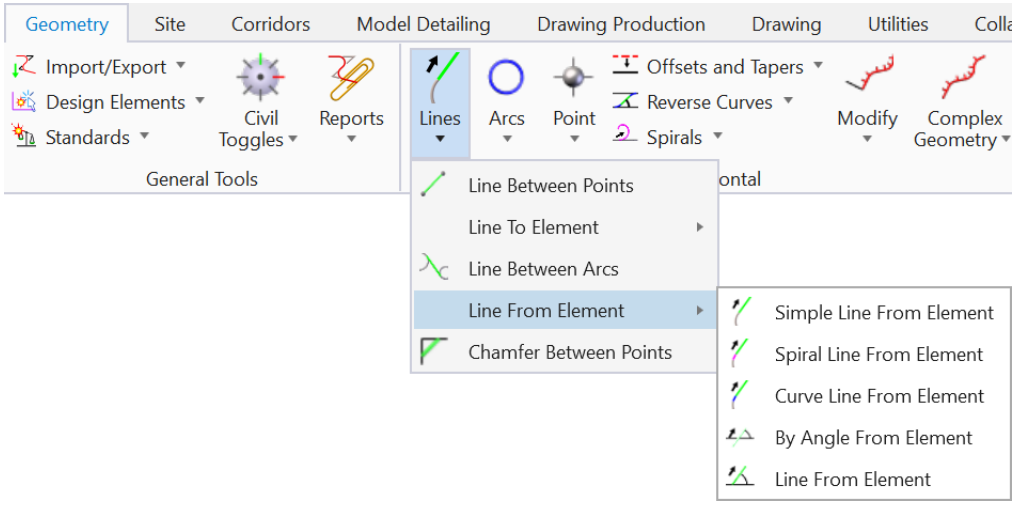


O. The ends the tool and completes the process. Note the back element was trimmed to meet the spiral transition.



Line From Element Tool Group

The Line From Element Tool Group is very similar to the Line To Element tool Group



There is a small difference in the way to the tools function.

When using the Line To Element tool group an end point to the line was specified, this was done by left clicking and setting the end point, the step this was done depended on the tool but they tolls always functioned the same. An end point was established and then the line was constructed back to the element.

When using the Line From Element tool the first part of the tool will involves establishing a point on the From Element and then the line will be constructed moving away from the element, The end point away from the element will be one of the last parts of the tools.

That is the most significant difference in the tools. If you know where in spce you want the line to end but not exactly where it ties to the reference element then use the To Element tool group. If you know exactly where on the reference element the line should tie but not exactly where in space the line should end use the From Element tool group.

This Group Contains 5 Tools

- **Simple Line From Element**
  - Creates a line without any transition from another element at zero degrees skew angle, applicable only when the From element is a curve, Offset locked at zero.
- **Spiral Line From Element**
  - Creates a line with a spiral transition from another element at zero degrees skew angle, applicable only when the From element is a curve, Offset locked at zero.
- **Curve Line From Element**

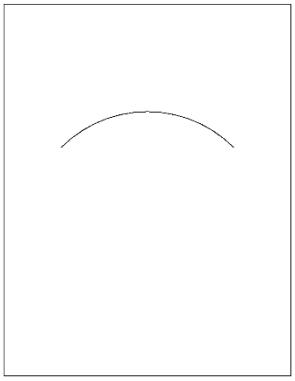
- Creates a line with an arc transition from another element at zero degrees skew angle, applicable only when the From element is a curve, Offset locked at zero.

- **By Angle From Element**
  - Creates a line without any transition from another element at user defined skew angle, Offset locked at zero.
- **Line From Element**
  - Constructs a line at a skew from a base element.

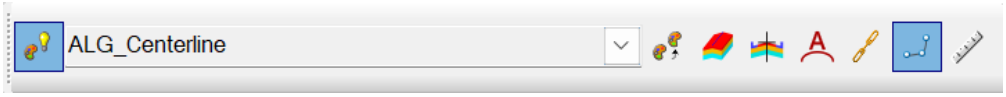
1. Simple Line from Element

A. Locate the Simple Line From Element exercise location in Block – 8. This tool only works when the From element is a curve.

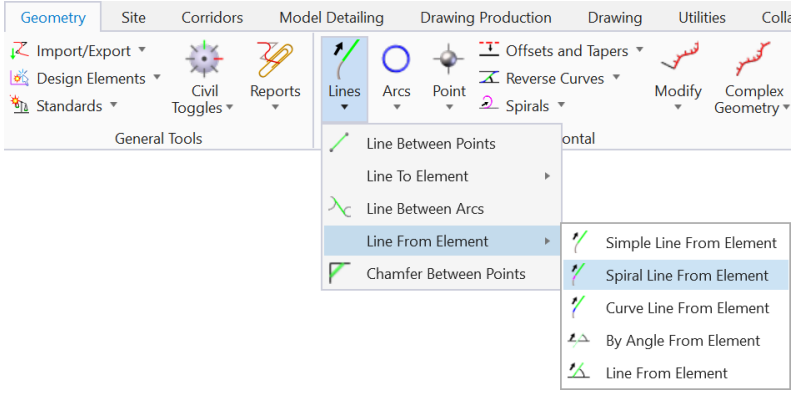
SIMPLE LINE FROM ELEMENT
BLOCK - 8



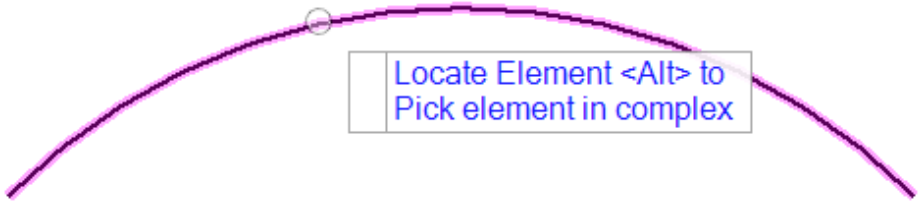
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



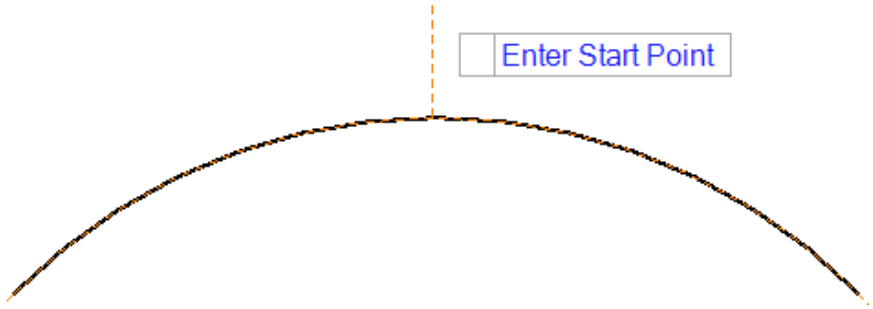
C. Select the **Simple Line From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



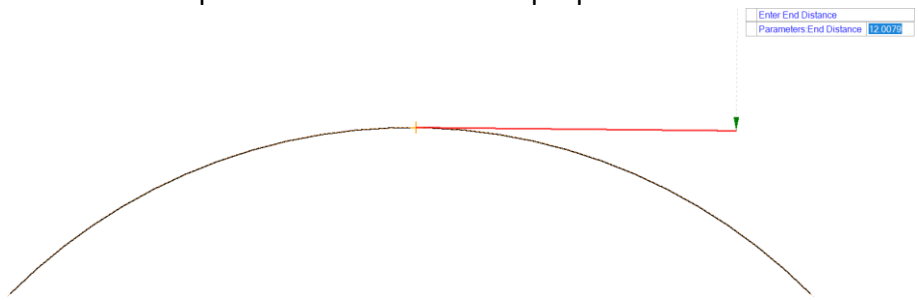
D. The heads up prompt will appear, left click to select the From element.



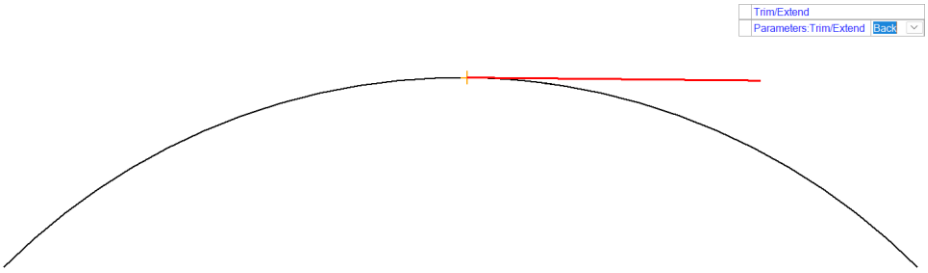
E. The user will be prompted to select a start point. The dynamic display shows two dashed elements. One dashed element represents the extension of the From element arc. The solution can be anywhere on the extension. The other dashed line represents the projection of the cursor location to the From element arc. Note that the offset is locked to 0.00’ and the proposed line will start on the element not where the cursor is located.



F. Left Click to accept a start location for the proposed line.

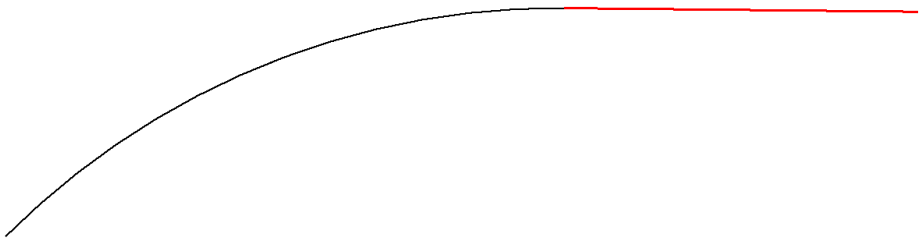


G. Enter the line length to set the end location using either positive number to set the line direction up or to the right. A negative number to set the line direction down or to the left. Or left click to accept the end location. Note that by left clicking the end point will always be a positive solution.



H. This will set the end of the line and bring up the Trim/Extend option. Use the Down Arrow to change the option to Back.

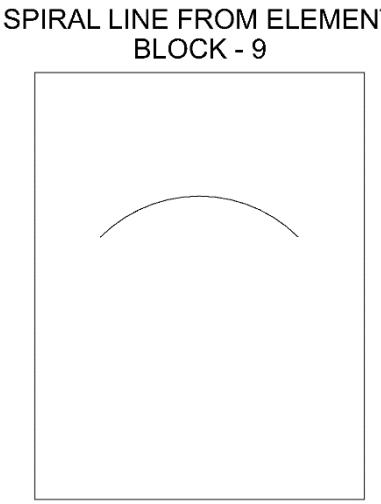
I. Left click to accept the Trim option and complete the tool.



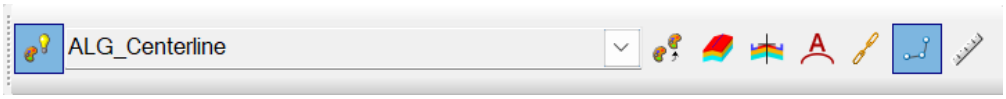
J. The difference between this tool and the **Simple Line to Element** tool is that with this tool initial point selection was located on the From element arc not in space.

2. Spiral Line From Element

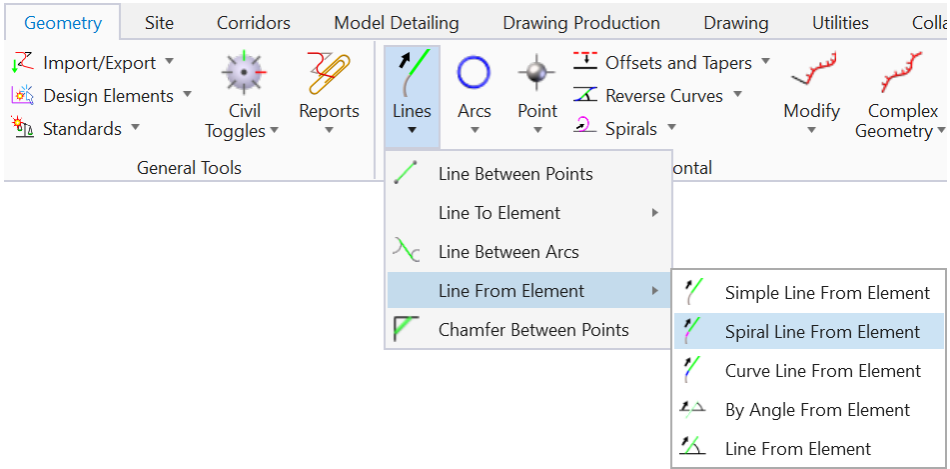
A. Locate the Spiral Line From Element exercise location in Block – 9. The From Element must be a curve to use this tool.



B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

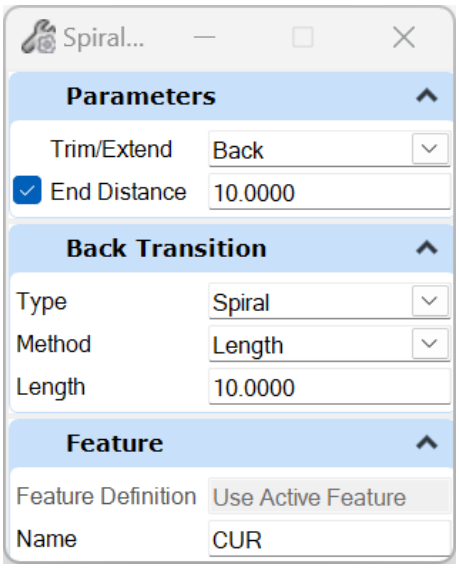


C. Select the **Spiral Line From Element** tool from the *Horizontal* section of the



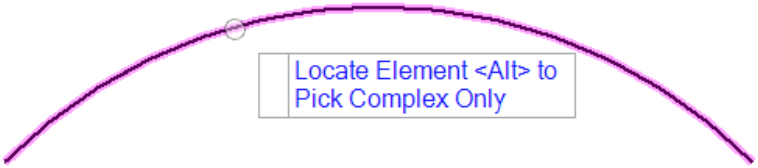
Geometry Ribbon.

D. Note that when using the Spiral Line Form Element tool the user must set the spiral parameters in the dialog box, these parameters will not be available in the heads up display.

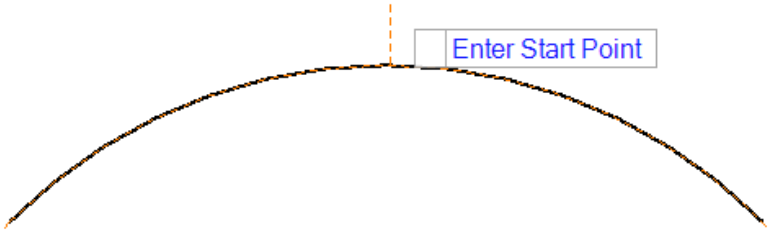


- Set Trim/Extend = Back
  1. This will trim the From Element to match the spiral transisiotn
  2. The other option is none and will not trim the From Element
- Set End Distance = 10.00'
  1. This is the length of the line, not including the spiral
- Set Back Transition Type = Spiral
  1. The None option will match the results of the **Simple Line From Element** tool
  2. The Curve option will match the results of the **Curve Line From Element** tool
- Set Method = Length
  1. The other options to define the spiral length match the options in the **Spiral Line To Element** tool. None of these other options are commonly used in NCDOT roadway design.
- Set Length = 10.00'
  1. This is the length of the spiral.
- Set Name = CUR
  1. This is the name of the element. This can be anything except for the name of the alignment.

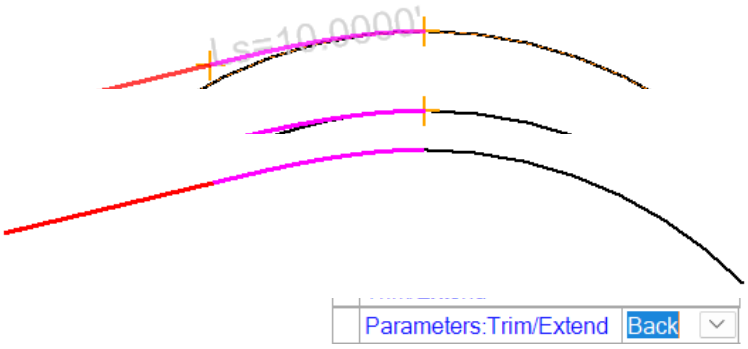
E. Left click to locate the From element arc and start the tool.



F. Left click to select the start point.



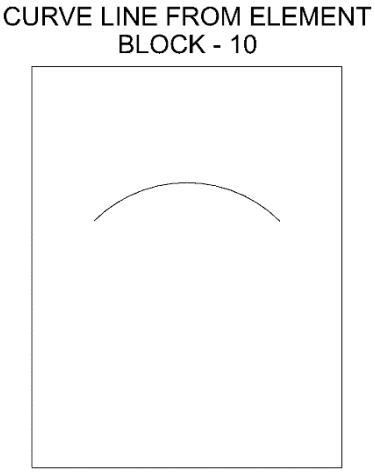
G. Left click to accept the End Distance = 10.00’
H. Left click to accept the Trim/Extend Option as Back.
I. This will trim the From element to the end of the spiral transition and complete the tool



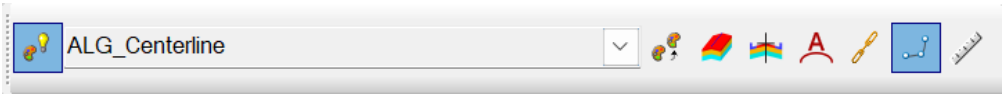
3. Curve Line From Element

The **Curve Line From Element** tool will draw a line segment from an element with a curve in between. This tool is similar to the **Curve Line to Element** tool.

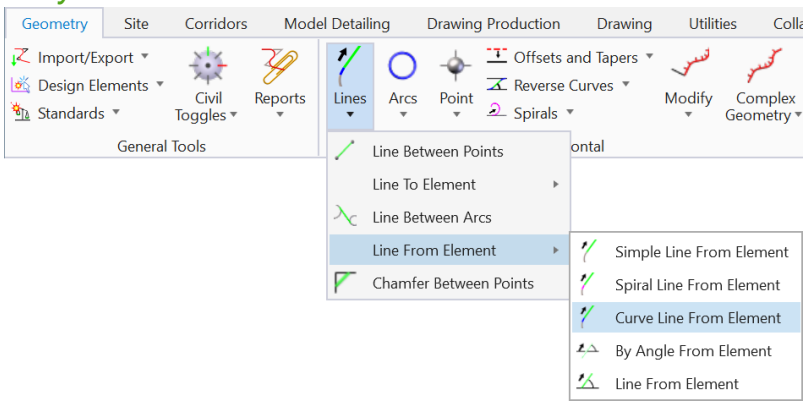
A. Locate the Curve Line From Elemnt exercise location in Block – 10. When using this tool the From Element must be a curve.



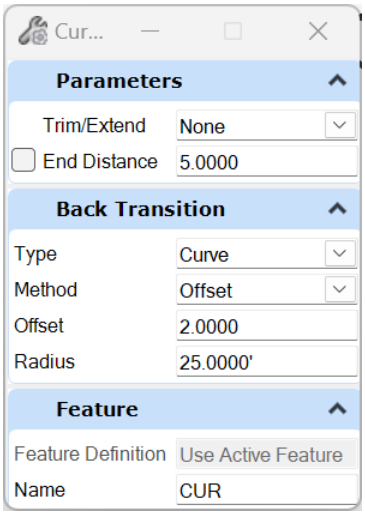
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



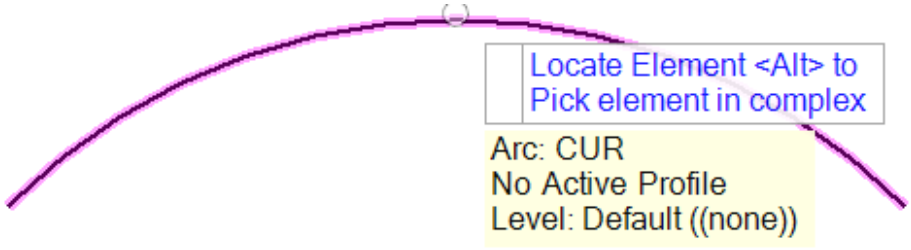
C. Select the **Curve Line From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



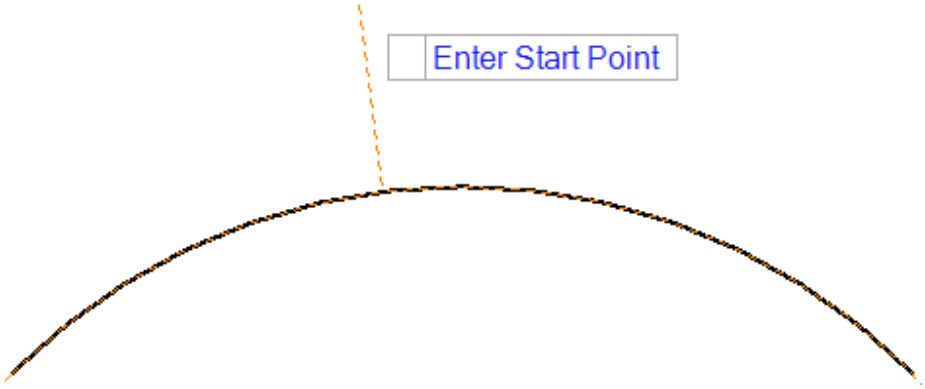
D. This tool will function like the **Spiral Line From Element** tool. Not all the design parameters will be available at the heads up display. The user will be required to input some data into the dialog box. Set the dialog box to the following parameters.
   - Trim/Extend = None
     1. None will not modify the From Element
     2. Back will trim the From Element to match the curve transition
   - End Distance = 5.00’ – leave this unchecked
     1. This is the length of the line segment and not include the curve transition
   - Type = Curve
     1. None = This functions like the Simple Line From Element tool.
     2. Spiral = This functions like the Spiral Line From Element tool.
   - Method = Offset
     1. Offset will set the curve length so that the line is offset the specified distance from a parallel tangent to the From Element
     2. Length will set the curve by the defined curve length
     3. Deflection will set the curve length based on the deflection
   - Radius = 25.00’
     1. This is the radius of the transition curve and is always required. Note that if the radius entered is too small to solve for a transisiton the program will complete the tool using only a line segment.
   - Offset = 2.00’
     1. This entry will be based on the Method selected. The offset is the distance from a tangent to the curve and the proposed line segment
   - Name = CUR
     1. This is not important as long as the name is not the alignment name



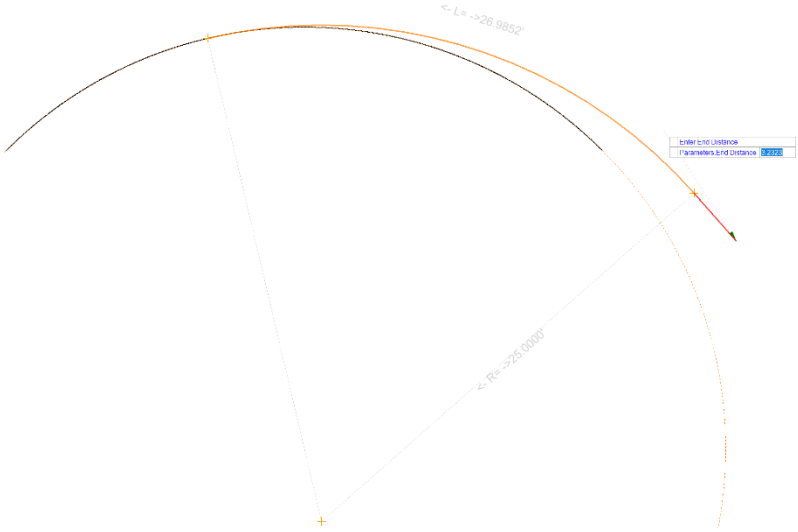
E. Left click to select the curve and start the tool.



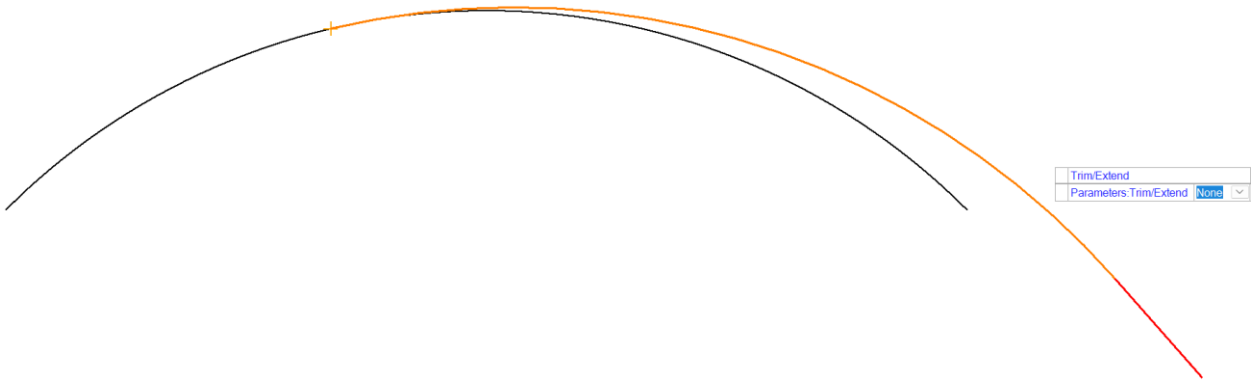
F. Left click to accept the start point. The start point will be on the From Element with an offset of 0.0'. The dashed line shows the projection from the cursor location back to the From Element. The solution can also be solved for any location along the projection of the From Element.



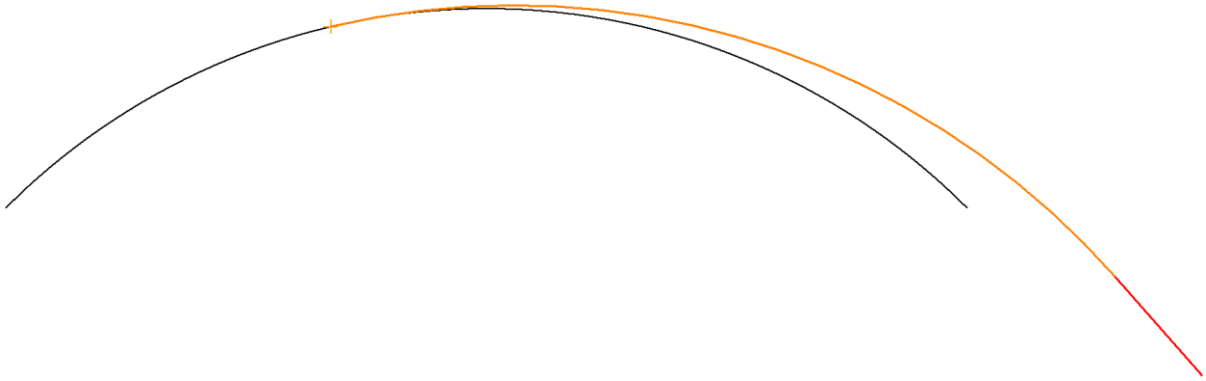
G. Because the curve parameters were set in the dialog box the curve transisiton will be created. The End Distance was entered as 5.00' but because the check box was not checked the End Distance will need to be reset. This can be done dynamically or by entering a distance at this point. Left click anywhere to dynamically set the end distance of the line segement. This can be edited after placement using the text editors or drag handles.



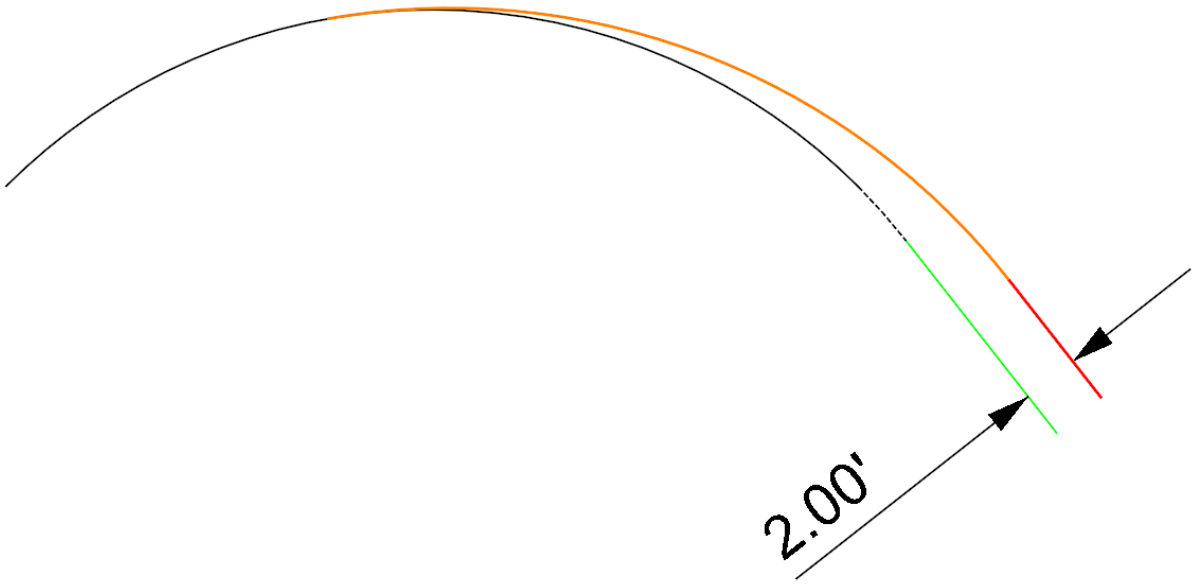
H. Left click to accept the trim option of None.



I. This will complete the placement of the line and curve transition.



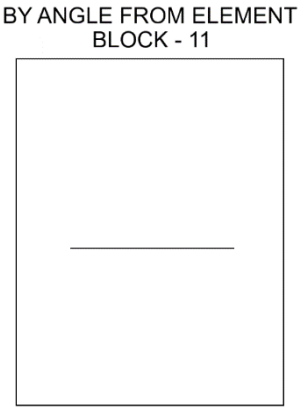
J. The offset distance specified in the dialog box is the offset from a line tangent to the From Element that is the same direction as the solution. The tangent line is shown in green below and the line placed by the toll is shown in red below. The green line is tangent to a projection of the From Element.



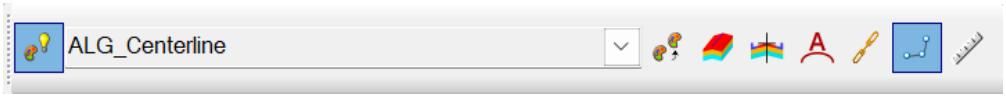
4. By Angle From Element

The **By Angle From Element** tool creates a line without any transition from another element at a defined skew angle. The start point will be locked to the element at an offset of zero, this is a point where the line will intersect/pass through the From Element. The proposed line can be extended in either direction. This tool can be used with a From Element that is a curve or a line.

A. Locate the By Angle From Element exercise location in Block – 11. This only has a line in it but this tool will work with lines or arcs.

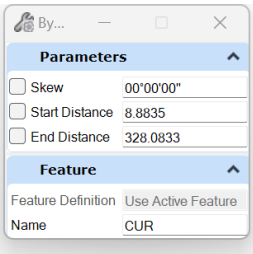


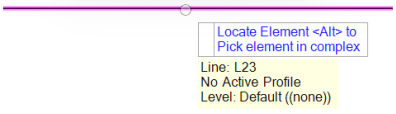
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



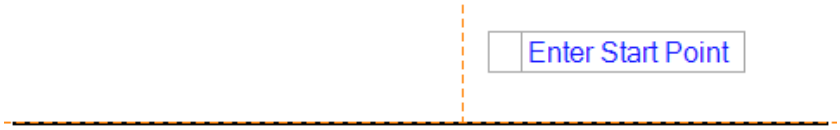
C. Select the **By Angle From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.

D. The heads up dispaly and the dialog box will appear. Do not enter any data into the dialog box, as an alternative method use the heads up display and dynamic data entry to complete the tool Left click to select the line as the From Element and initiate the tool.

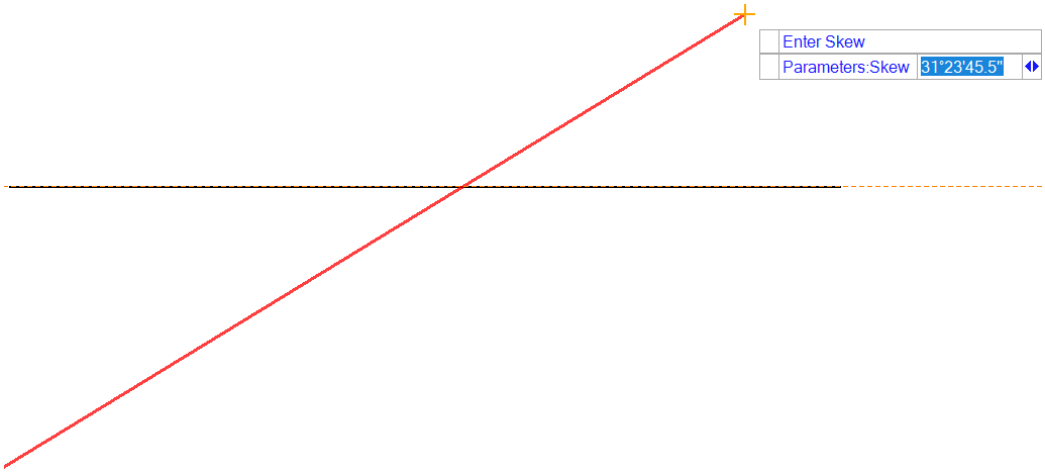




E. Left click to accept a start point. The dynamic display will show the projection back to the From Element as a dashed black line. This indicates the point on the element that the line will pass through.

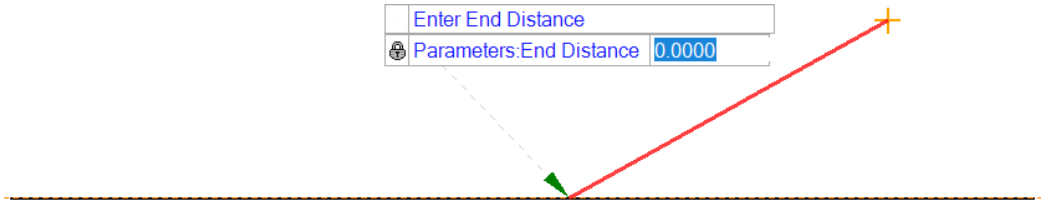


F. Left click to accept one end point of the line and to set the skew angle. At this point the skew angle could also be entered into the dialog box or entered into the heads up display. The skew will be dynamically displayed in the heads up dialog.

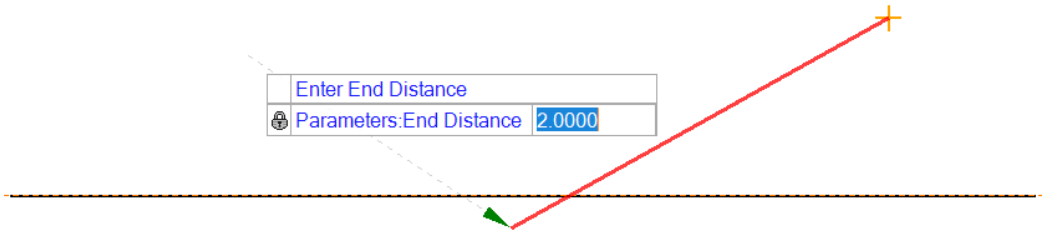


G. Left click to accept the other end point of the line. At this point a distance could also be keyed into the dialog or entered into the heads up display.

- A distance of 0.00' will place the end point on the From Element at the start point selected above

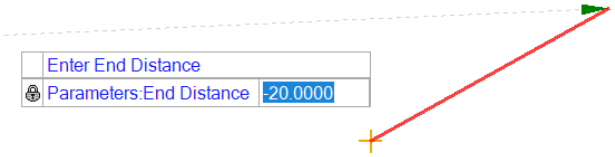


- A positive (+) Distance will place the end point on the opposite side of the From Element as the initial point selection. In this example below the line. The distance will represent the distance along the skew from the From Element.



This is a distance of (+)2.00

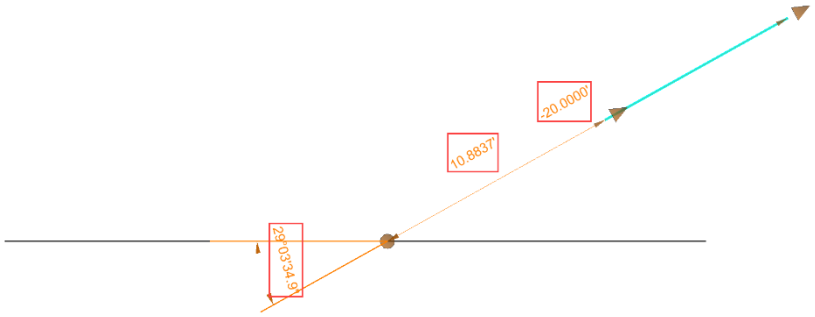
- A negative (-) Distance will place the end point on the same side of the From Element as the initial point selection. In this example above the line. The distance will be measured along the skew from the From Element. A small distance would put the point between the From Element and the initial point and a larger distance would place the point further away from the From Element than the initial Point.



This is a distance of (-)20.00’

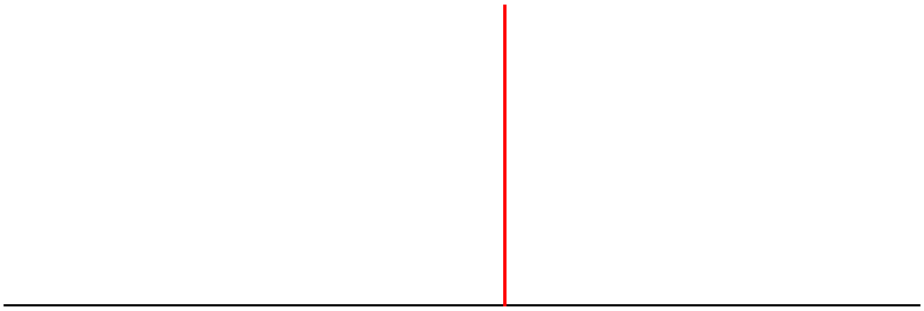
H. Left click in between the initial point and the From Element to dynamically place and accept the second end point of the line.This will complete the process of placing the element.

I. Use the Element Selection tool and pick the line. The text manipulators and drag handles will appear. These show that the line is
   - 20’ long
   - Starts 10.8637’ along the skew from the From Element
   - And is at a skew of 29°03’34.9” to the From Element

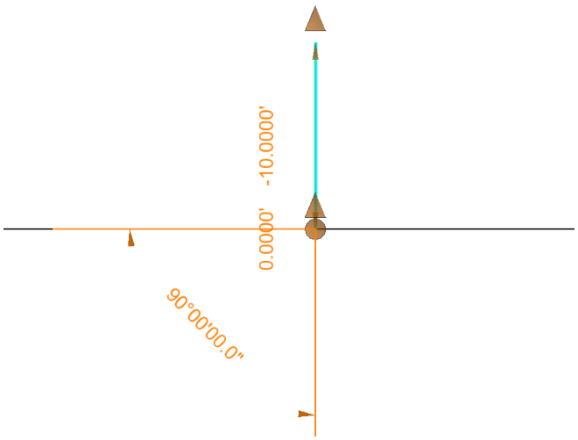


These numbers will be slightly different depending on where you placed your line.

J. While the line is selected use the Element Selection tool and left click each of the values and edit the numbers
   - Change -20’ to 10’
   - Change 10.8837’ to 0.00’
   - Change 29°03’34.9” to 90°



K. The line is now 10’ long, starts exactly on the From Element and is Perpendicular to the From Element

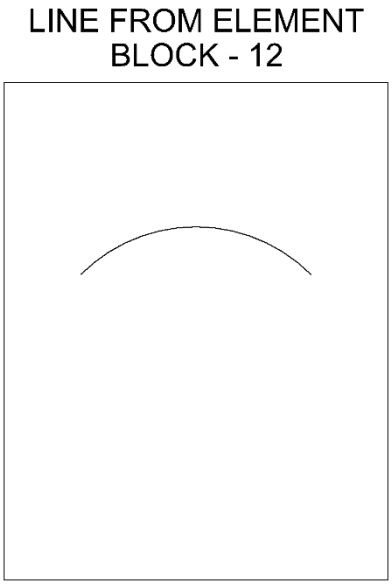


5. Line From Element

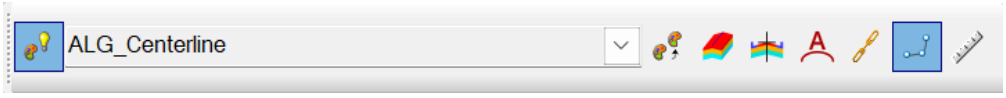
The **Line From Element** tool is very similar to the **By Angle From Element** tool. The difference is that when using the **Line From Element** tool the initial point (the Start Point) can be placed at an offset to the From Element. When using the **By Angle From Element** tool the initial point is always at a 0.00' offset.

This tool could be sued to design the initial tangent for a ramp that ties to a mainline Arc.

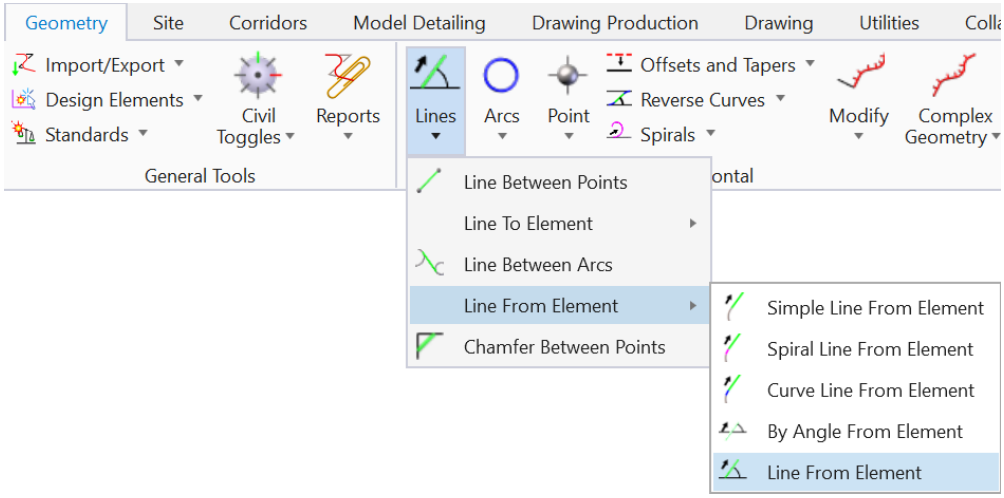
A. Locate the Line From Element exercise location in Bock – 12. This tool will work with Lines or Arcs.



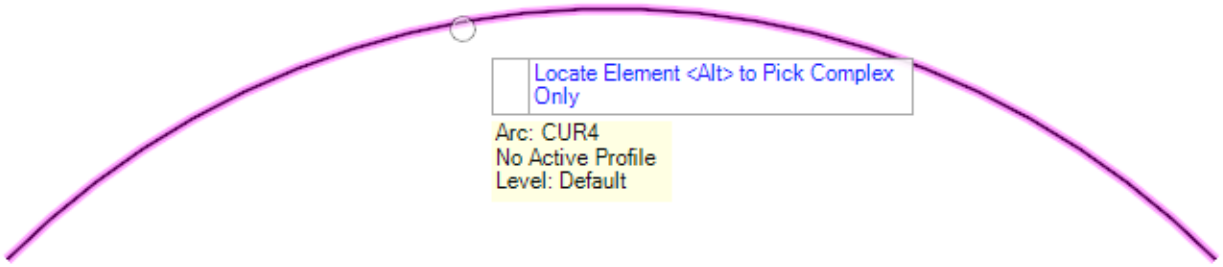
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



C. Select the **Line From Element** tool from the *Horizontal* section of the *Geomerty* Ribbon

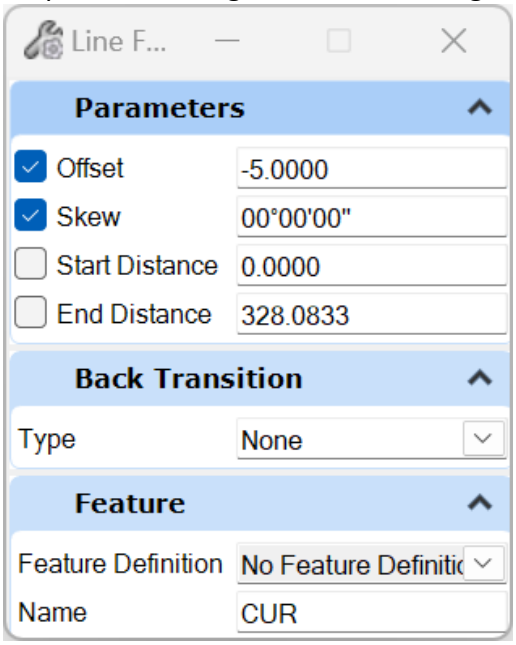


D. The heads up prompt will display, left click on the Arc to select the From Element.

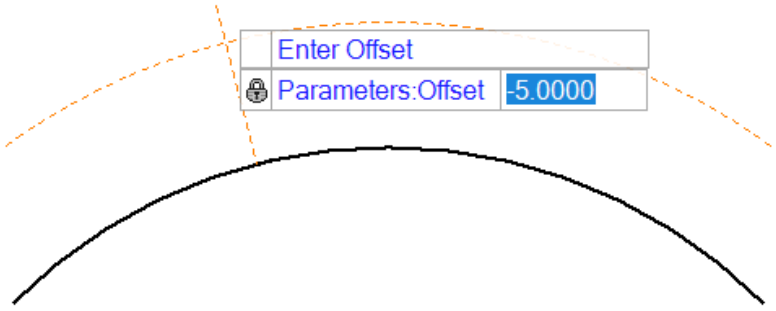


E. Use the following setting in the dialog box
- Offset = -5.00
  1. This is the offset from the From Element that the line will pass through.
  2. An offset of 0.00 will construct an element similar to the previous From Element tools.
- Skew = 0°00’00”
  1. This sets the skew to the from element, 0° will construct a line tangent to the From Element at the specified offset
- Start Distance
  1. Leave this unchecked
- End Distance
  1. Leave this unchecked
- Back Transition = None
  1. None will construct a line only
  2. Curve will use an arc transition; this will construct and element similar to the **Curve Line From Element** tool with the option of the offset distance
  3. Spiral will use a spiral transition; this will construct an element similar to the Spiral Line From Element tool with the option of the offset distance.

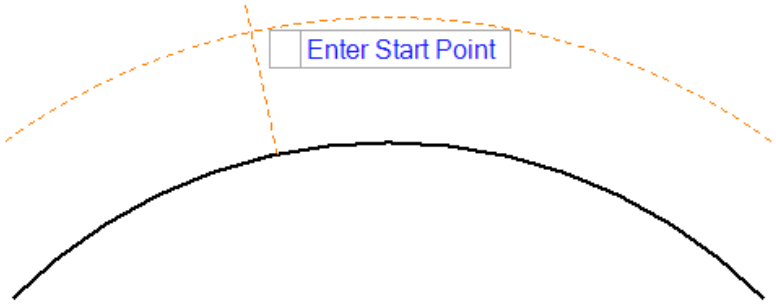
- Name = CUR
  1. This is not important as long as it is not the alignment name



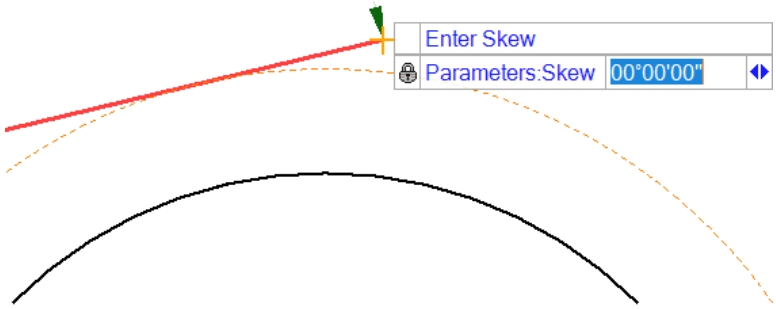
F. Left click to accept the Offset = 5.0’



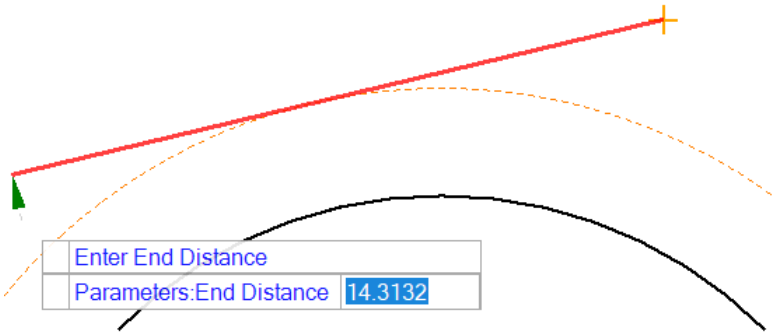
G. Left click to select the Start Point, this is not the start point of the line, this is point where the tool starts the construction of the line. The line will pass through this point. This point will be located at the specified offset from the From Element.



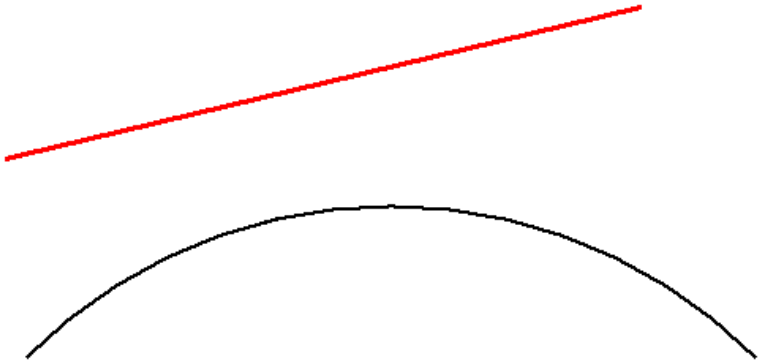
H. Left click to accept the Skew = 0°0’0” and to select one end point of the line segment.



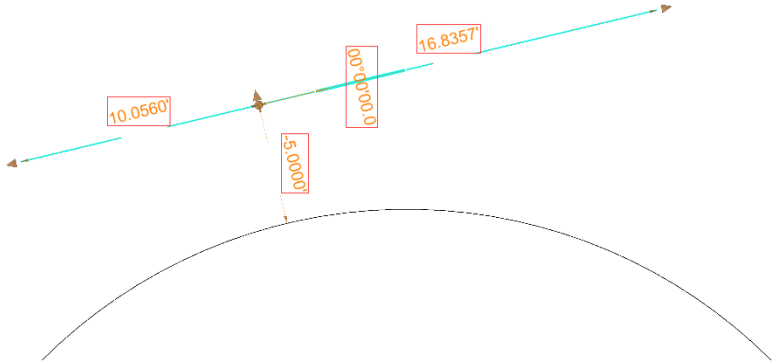
I. Left click to accept the other end point of the line



J. This will complete the tool and place the line segment.

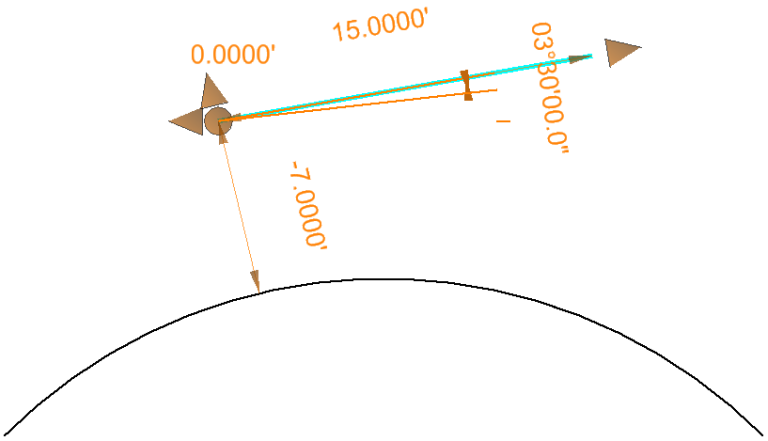


K. Use the element selection tool to highlight the line segment.



L. This shows the line is
- Offset 5.0’ from the From Element
- The Skew is 0°00’00”
- The length of the line to the right of the start point = 16.8357’
- The length of the line to the left of the start point = 10.0560’

M. Change the values to the following
   - Offset -5.00’ = -7.00’
   - Skew from 0°00’00” to 3°30’00”
   - Length of 18.6712’ to 15.00’
   - Length of 13.6985’ to 0.00’



N. This line now starts at a point 7.0’ to the left of the From Element at a skew of 3°30’00” and has a total length of 15.00’

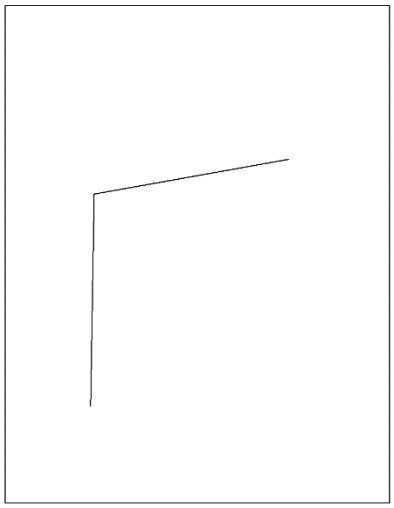
Chamfer Between Points

The Chamfer Between Points is not a tool that will be commonly used by the roadway designer. It is a simple tool to use and will place a chamfer (a corner) between two elements. The chamfer can be a simple line or include a curve on one or both ends.

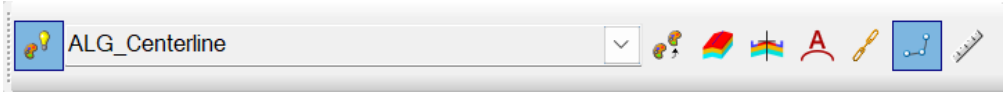
1. Chamfer Between Points

A. Locate the Chamfer Between Points exercise location in Block – 13.

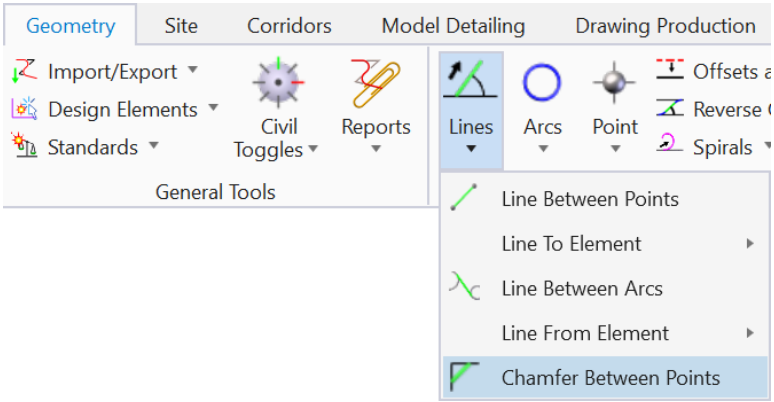
CHAMFER BETWEEN POINTS
BLOCK - 13



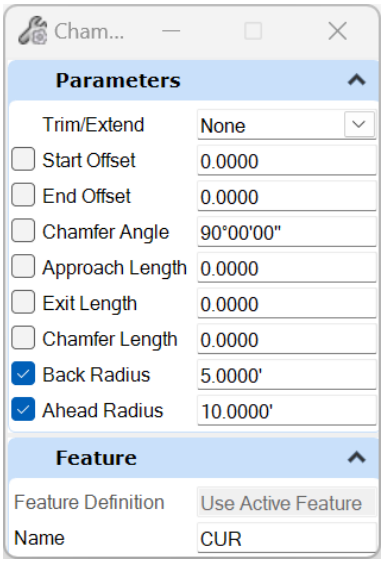
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



C. Select the **Chamfer Between Points** tool from the *Horizontal* Section of the *Geometry* Ribbon.

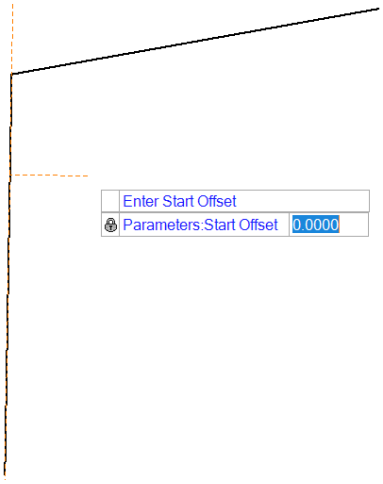


D. The heads up prompt and the dialog box will appear. Leave all boxes in the dialog unchecked except for Back Radius set to 5.00’ and Ahead Radius set to 10.00’. These will be the radius for the curve transition and they are not available for input with the heads up prompt.

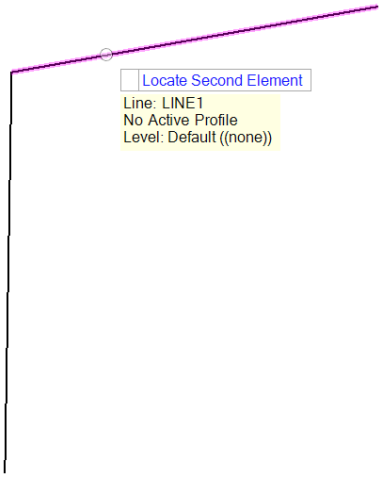


E. Left Click to select the first element

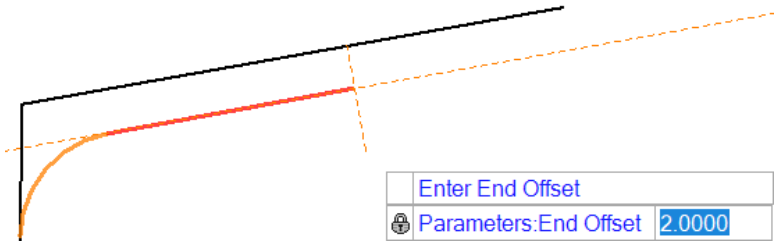
F. The next prompt is for the start offset. This is the distance offset from the first element where the chamfer construction will tie. Type in 0.00', press <ENTER> to lock the distance and then left click to accept the distance.



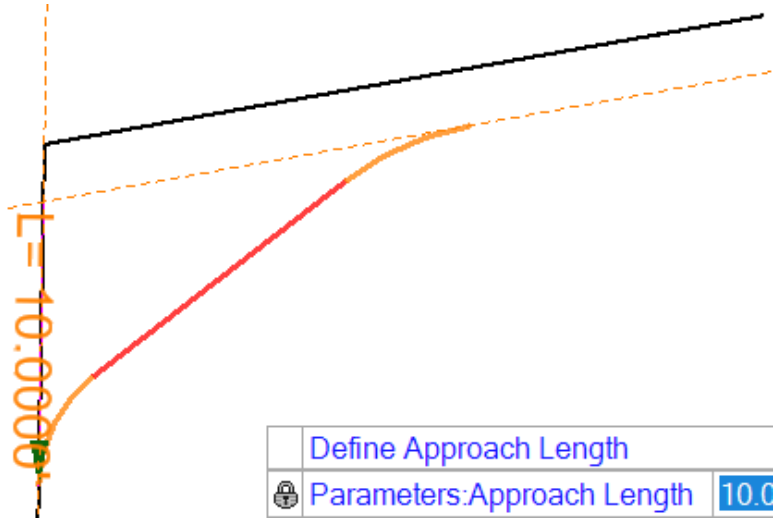
G. Left Click to locate the second element



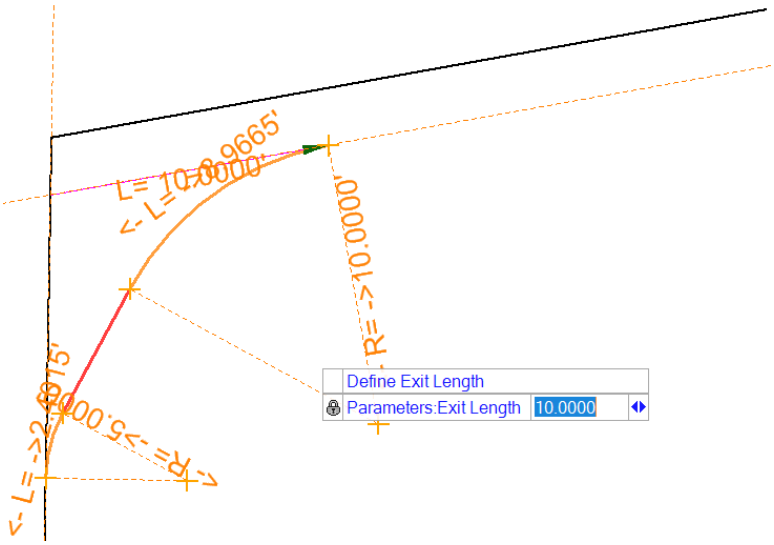
H. At the prompt enter 2.00’ for the offset from the second element, press <ENTER> to lock the selection and left click to accept the offset.



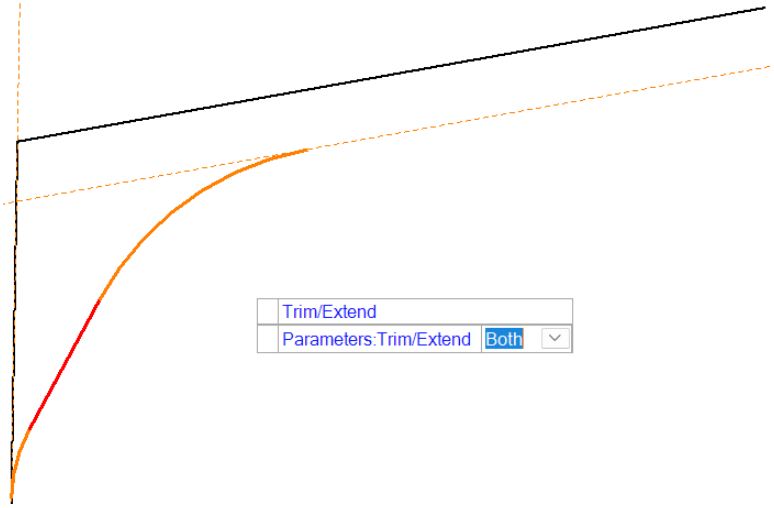
I. The next prompt is the approach length, this is the distance from the corner to the start of the chamfer along the first element. Enter 10.00’, press <ENTER> to lock the selection and left click to accept.



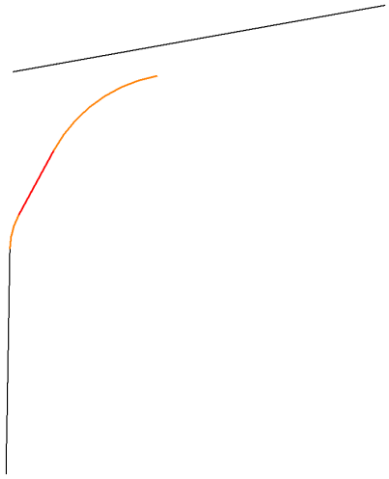
J. The next prompt is for exit length, this is the distance to the end of the chamfer measured along the second element. Enter 10.00', press <ENTER> and left click to accept.



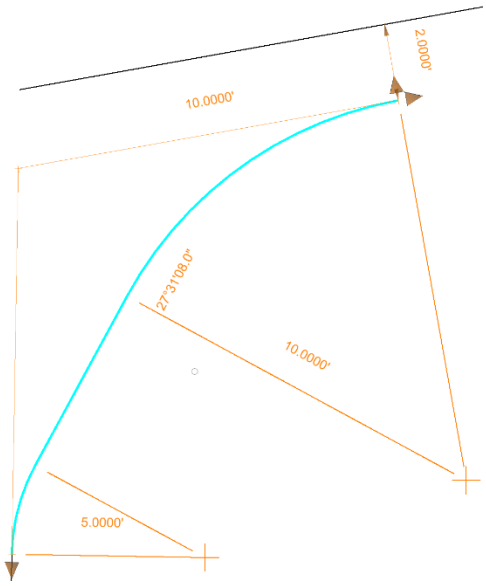
K. Use the Down arrow to change the Trim/Extend option to Both. Left Click to accept.



L. Note that the first element, the element with the 0.00’ offset was trimmed to match the curve transition. The second element was not trimmed because the curve element tied to an offset , not to the element.



M. By using the Element Selection tool and selecting the chamfer all of the text manipulators and drag handles will be visible and available for editing



N. As stated previously this will not be a common tool for the roadway designer. There are better and more flexible tools that can be used to create geometry between elements.

Horizontal Geometry Exercise – Arc Tools

In the following exercises you will learn how to use the various Arc tools to create ruled elements. The purpose of the exercise to become familiar with the tool and how to use it.

These tools will function similar to the line tools, a lot of the concepts and processes should be familiar.

One of the key concepts to understand with Arc tools will be the amount of flexibility the user has when revising and editing Arcs. After placing a simple Arc all of the following attributes are very easy to edit and revise.

- The user can edit the radius
- The user can edit the tangent direction
- The user can add and edit transitions linear transition
- The user can add and edit spiral transistiong
- The user can apply offsets and radii for multi centered curves

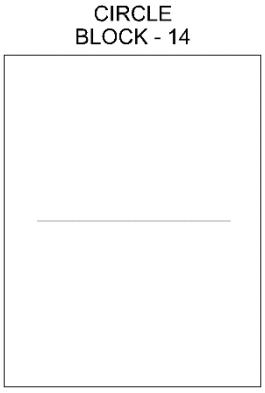
This will be a significant improvement to the way users have designed curves in the past.

Circle

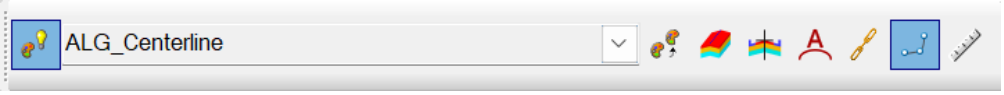
This is a very simple tool that only creates a circle. This will not be a tool that is commonly used by the roadway designer.

1. Circle

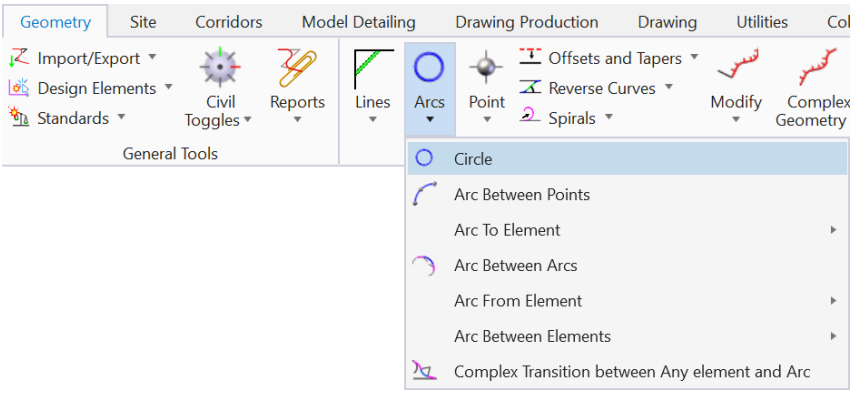
A. Locate the Circle exercise location in Block – 14.



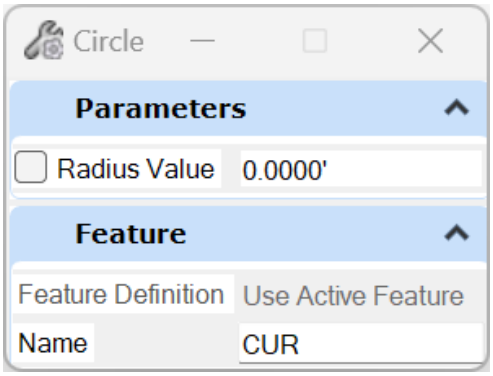
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



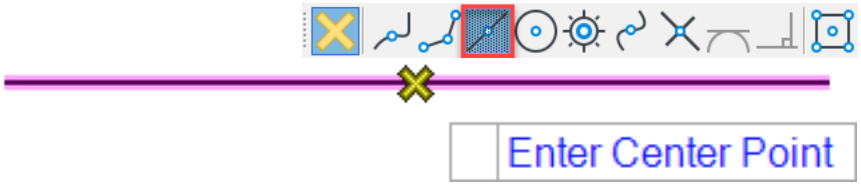
C. Select the **Circle** tool from the *Horizontal* section of the *Geometry* Ribbon.



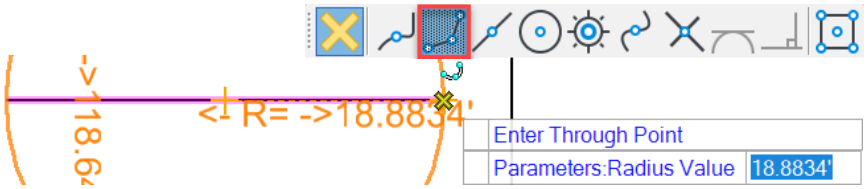
D. The dialog will appear, the only parameter is the radius value. Leave this box unchecked. Set the name to *CUR*.



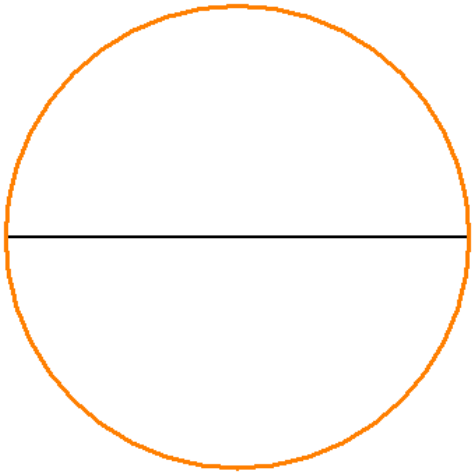
E. The heads up display will prompt for a center point. Snap to the middle of the line and left click to accept the center point. (Mid point snap helps here)



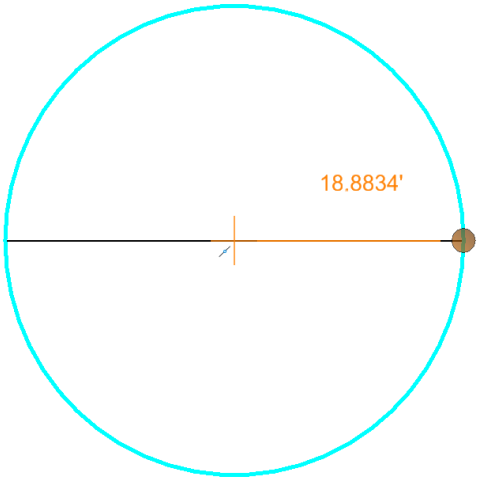
F. Snap to one end of the line to dynamically set the Radius Value. (Now back to key point snapping)



G. Left click to accept the end point and finish placing the circle.



H. Use the **Element Selection** tool to highlight the circle and see the text manipulators and drag handles. The radius should display a value of 18.8834’

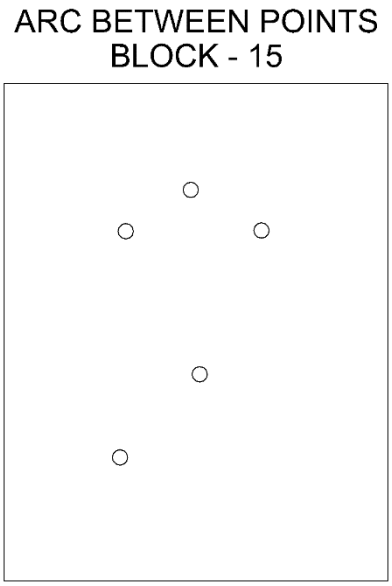


Arc Between Points

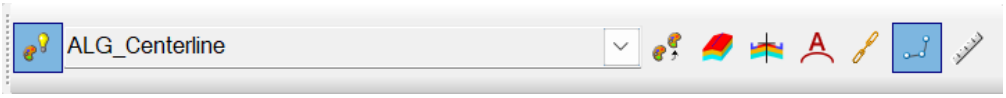
This tool uses various methods to create a simple Arc. This tool is very similar to the place arc tool used in Microstation V8i

1. Arc Between Points

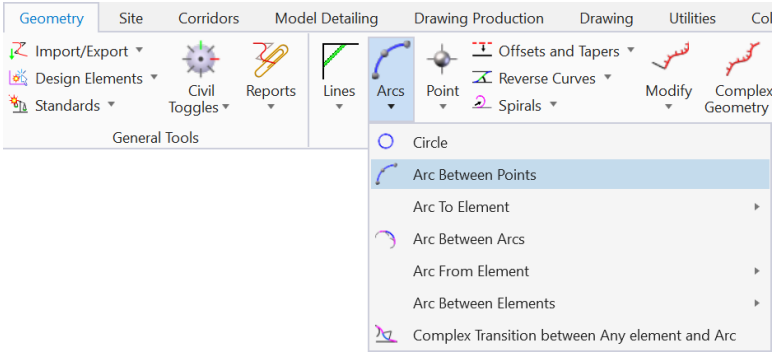
A. Locate the Arc Between Points exercise location in Block – 15.



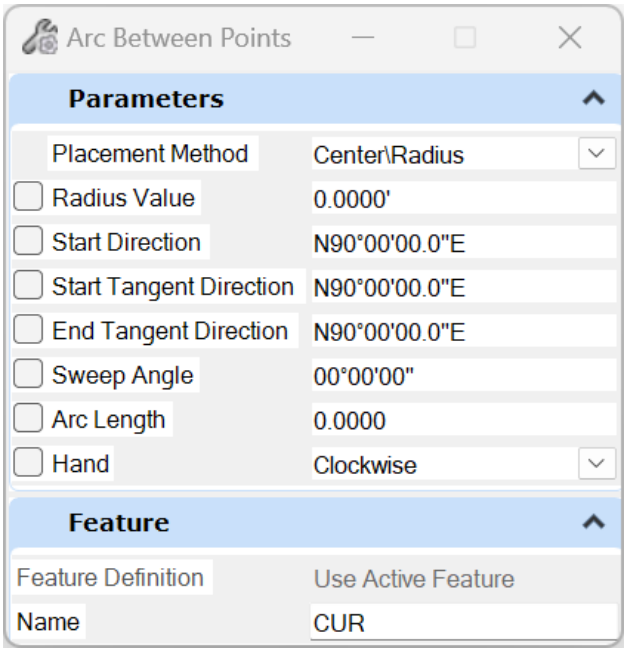
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



C. Select the **Arc Between Points** tool from the *Horizontal* section of the *Geometry* Ribbon.



D. The dialog box and the heads up prompt will appear. Like other tools any known information can be entered into the dialog box and locked. In general placing a curve is easier to do dynamically using various snaps. Leave all boxes unchecked.

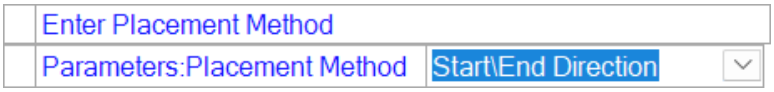


E. The available placement methods are

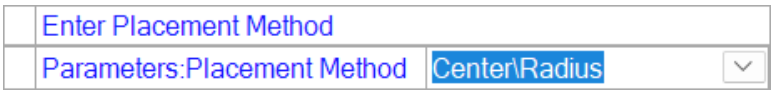
- Start\Radius
  1. Select a (1) Start Point and (2) Define a radius by data entry or graphically
- Center\Radius
  1. Select a (1) Center Point and (2) Define a radius by data entry or graphically
- Start\End\Pass-through
  1. Select a (1) Start Point (2) End Point (3) A point on the Arc
- Start\Pass-through\End
  1. Select a (1) Start Point (2) A Point on the Arc (3) End Point
- Start Direction\End
  1. Select a (1) Start Point and Tangent Direction and an (2) End Point
- Start\End Direction
  1. Select a (1) Start Point and an (2) End Point and End Direction

The two most common methods for a roadway designer would typically be Center/Radius and Start\Pass-through\End.

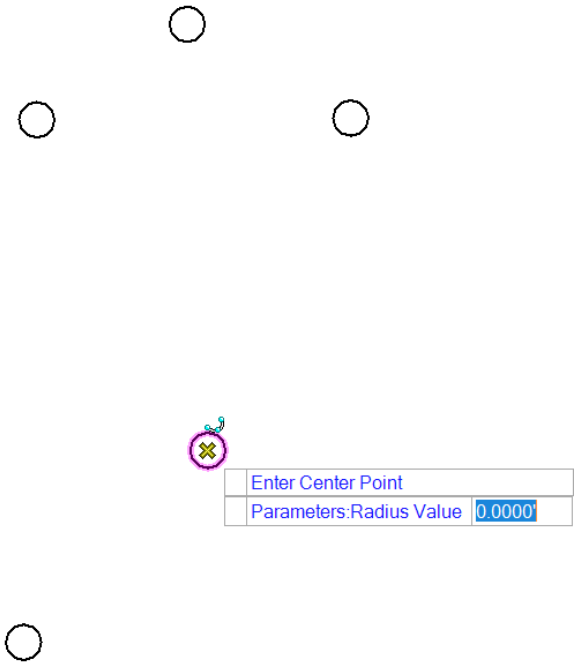
F. The method used to place the last curve will show up as the current selection in the heads up prompt. With the focus in the heads up prompt us the <DOWN> or <UP> arrow to change the Parameters Placement Method to Center\Radius



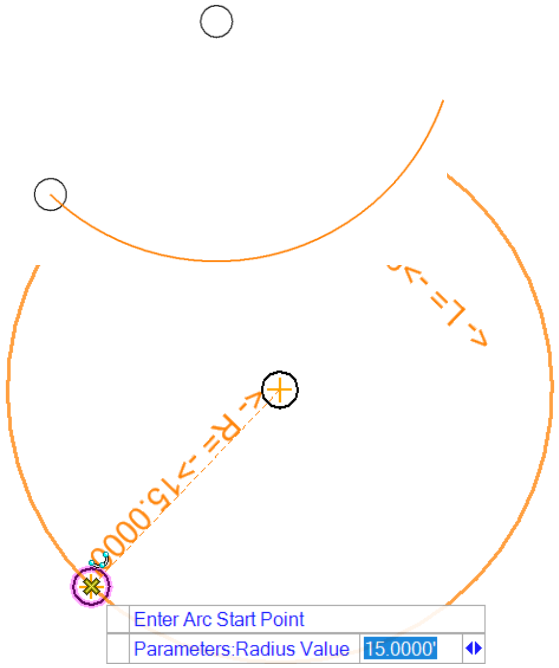
G. Left click to accept Center\Radius as the placement method. This will not set the Start Point, this only confirms the selected method



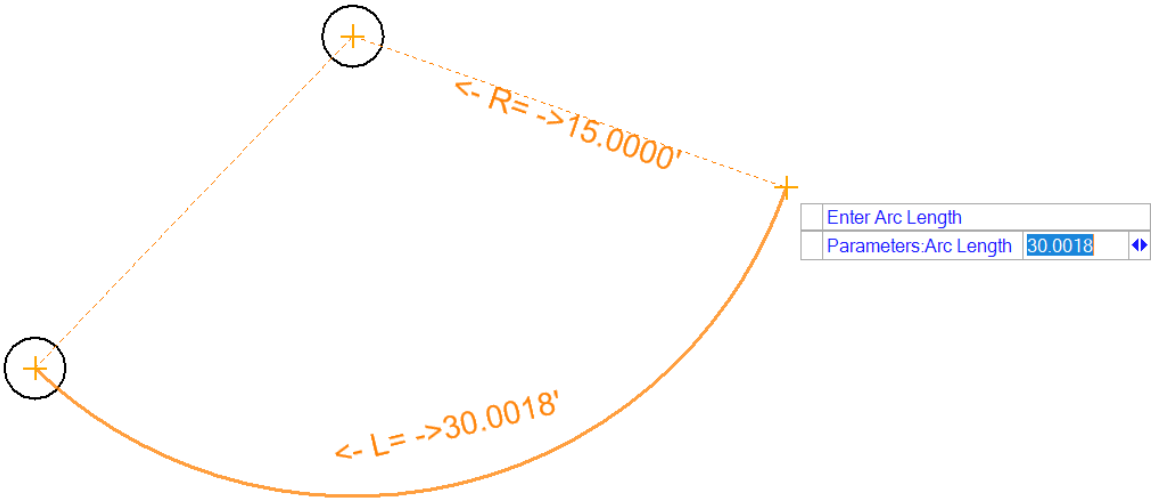
H. Sanp to the center of the circle near the middle of the box and left click to accept as the center point of the arc.



I. Snap to the center of the circle in the lower left corner of the box to set the radius.



Left click to accept the radius value and to set the start point. The radius should display 15.00’. The arc will be shown as a circle initially until the Start Point is

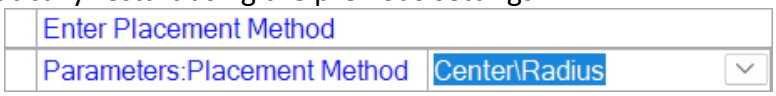


confirmed.

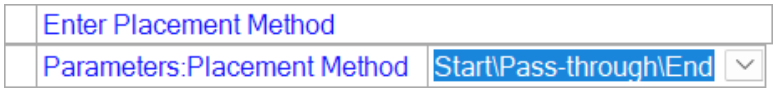
J. Move the cursor to dynamically change the arc length.

K. Left click to set the end point and complete the arc placement.

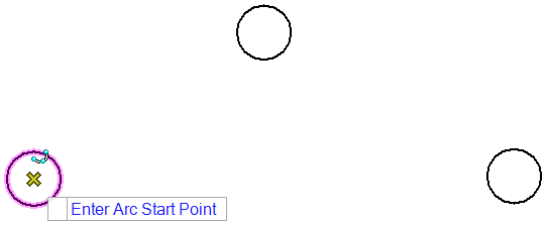
L. At this point the tool will restart the placement process and the Center\Radius Placement Method will be displayed in the heads up prompt. This is a common functionality of the ORD tools, once the tool has been completed it will automatically restart using the previous settings.



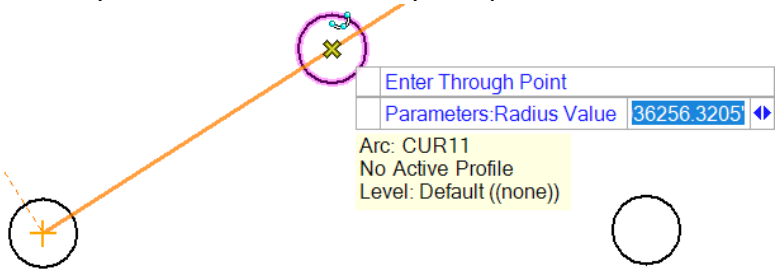
M. With the focus in the heads up prompt us the <DOWN> or <UP> arrow to change the Parameters Placement Method to Start\Pass-through\End. Left click to accept the placement method, this will not set the start point. This only accepts the placement method.



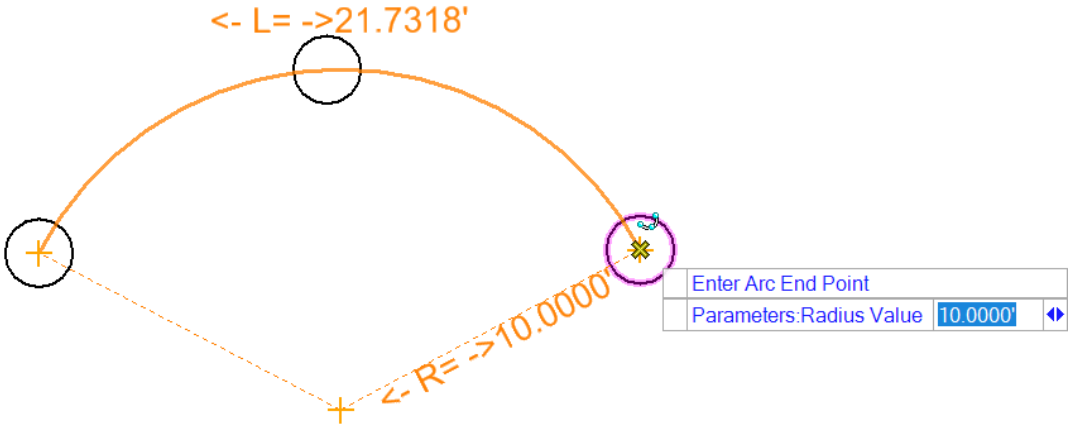
N. Snap to the center of the circle in the upper left corner and left click to accept the Start Point.



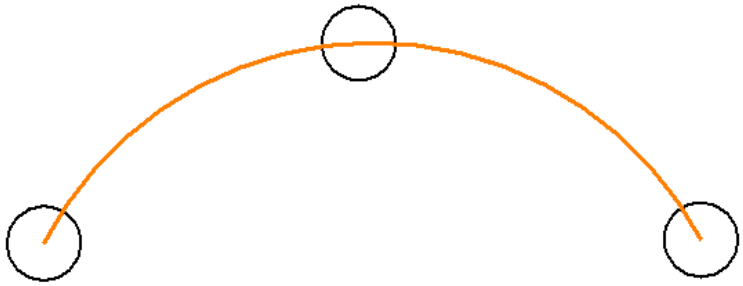
O. Snap to the circle in the middle to select and accept the Pass-through point. Note that the arc will appear to be a line, this is because it is currently only based on two points and only a line can be defined by two points.



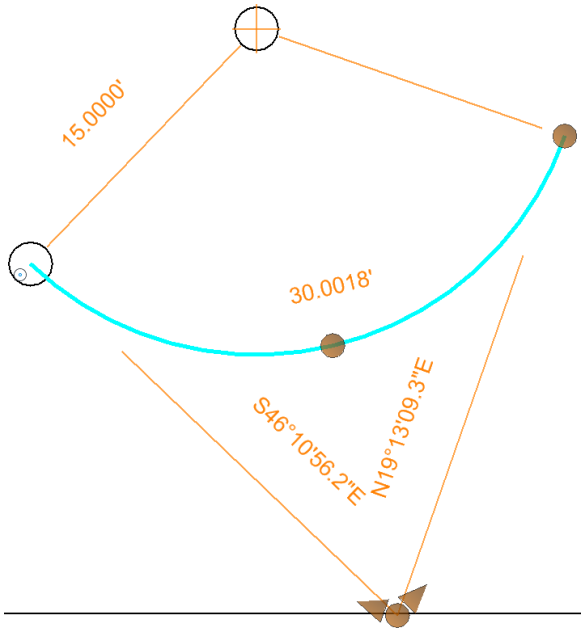
P. Snap to the center of the circle on the right and left click to select and accept the end point. The dynamic display should indicate the radius is 10.00’



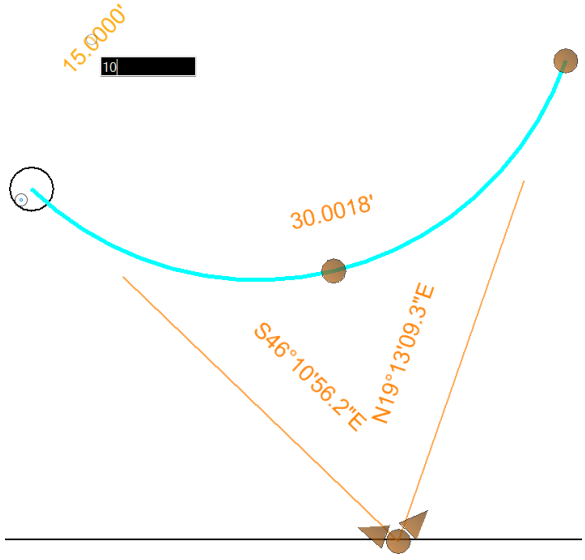
Q. This will place the arc and end the tool.



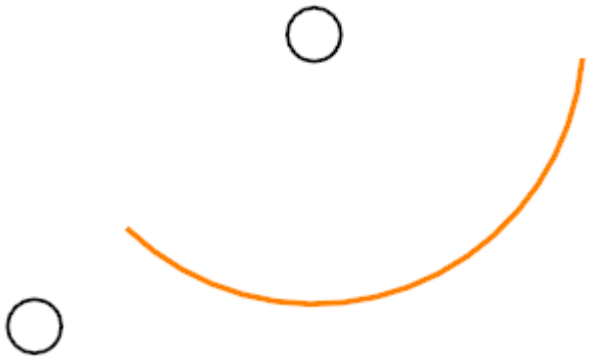
R. Use the Element Selection tool to highlight the bottom arc.



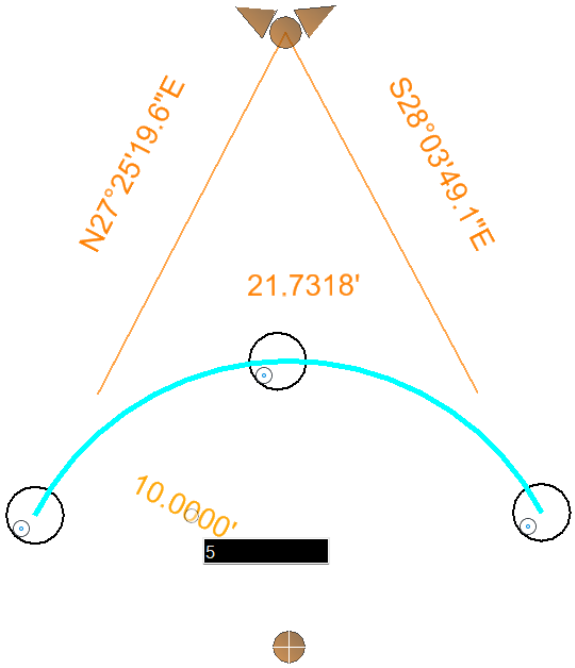
S. Select the 15.00’ text manipulator and change the value to 10.00’



T. Note that the start and point maintained the same position relative to the center point and it is just the radius of the circle that changed. This arc was placed with the Center\Radius method, so the center point was maintained and the radius was changed with the text manipulator.



U. Now highlight the top arc and change the radius to 5.00’

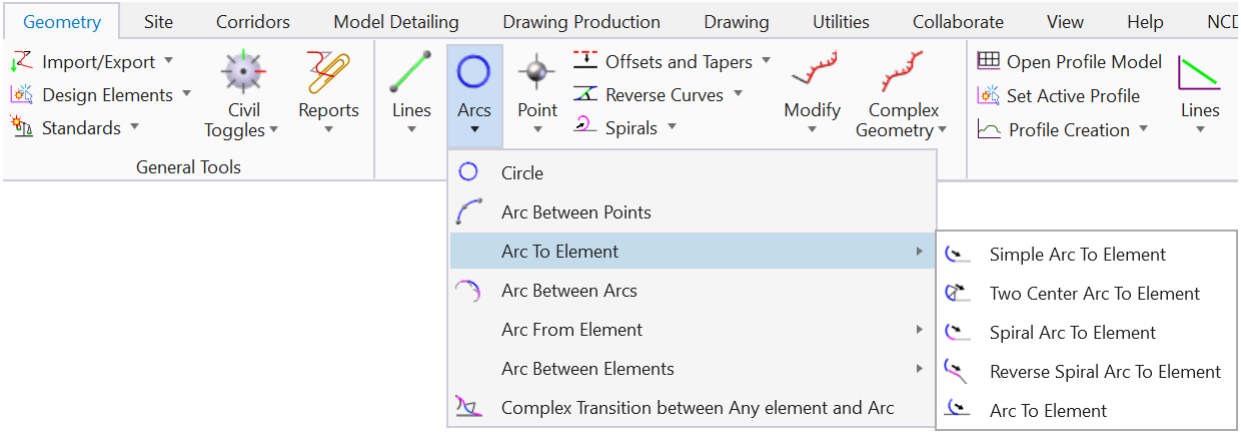


V. Note that the arc turns into a red dashed line with a red ‘X’. This is because there is not a possible solution for an arc with a radius of 5.00’ to pass through the three points. Because each of the smaller circles was snapped to when placing the arc they are all persisted snap locations and they will not be broken by the change to the radius. If the arc had been placed without using a snap the radius could be modified.

I WAS UNABLE TO GET THE RADIUS TO CHANGE TO 5, IT DIDN’T GIVE ME A RED DASHED LINE

Arc To Element Tool Group

Arc To Element Tools are under the **Arcs** tool group of the *Horizontal* section of the *Geometry* Ribbon<



This group contains tools that will allow the user to draw an arc that will be based on another element. This group of tools will function on the same concepts outlined in the Line To Element tool group, the user will specify a point in space where the Arc will begin and then the program will draw that arc To the specified element.

This group contains 5 tools

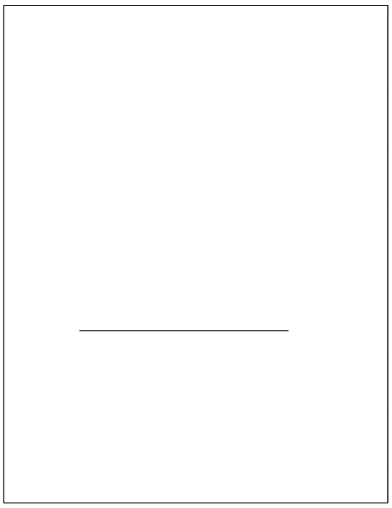
- **Simple Arc to Element**
  - Creates a simple radius arc without any transition to another element.
- **Two Center Arc To Element**
  - Creates an arc with an arc transition to another element
- **Spiral Arc To Element**
  - Creates and arc with a spiral transition to another element
- **Reverse Spiral Arc To Element**
  - Creates an arc with a reverse spiral transition to another element, applicable only when the To Element is a curve of the opposite direction.
- **Arc To Element**
  - Constructs an arc based on a selected base element which controls tangency at one end.

1. Simple Arc To Element

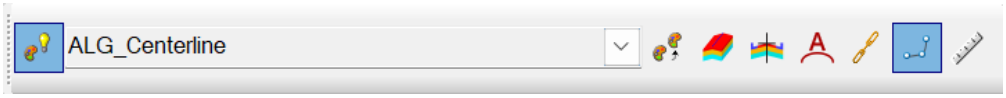
A. The Simple Arc to Element tool is a basic tool that will draw an arc with a specified radius tangent to another element. This tool will work if the To Element is a line or an Arc.

B. Locate the Simple Arc to Element exercise location in Block -16.

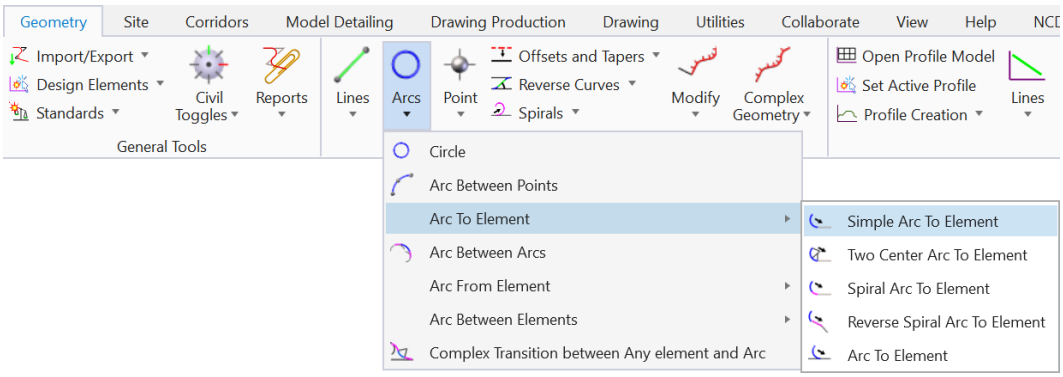
SIMPLE ARC TO ELEMENT
BLOCK - 16



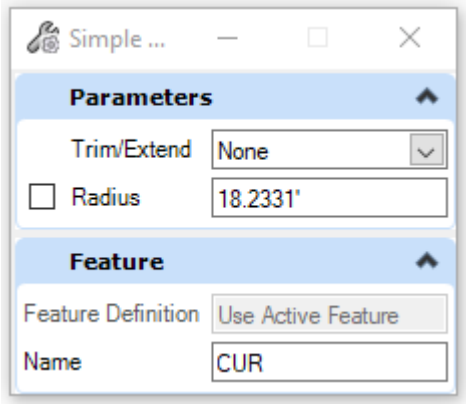
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



D. Select the **Simple Arc to Element** tool from the *Horizontal* section of the *Geometry* Ribbon.

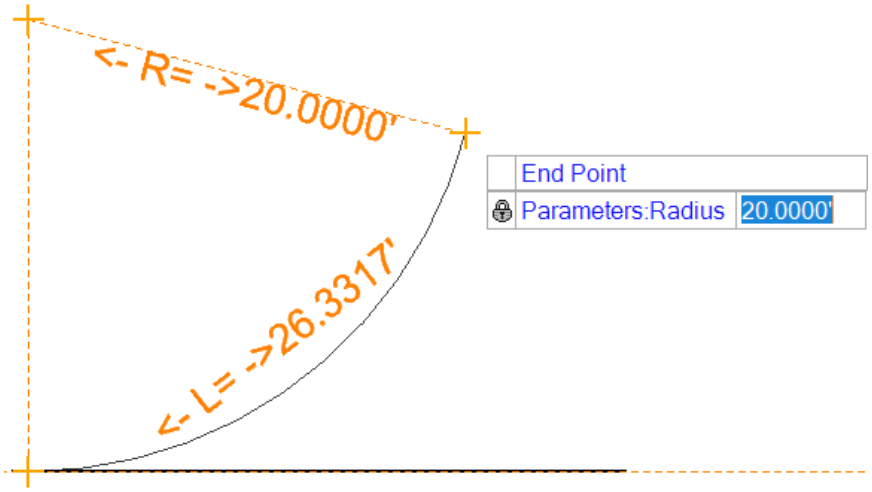


E. The dialog box will display
   - Set Trim/Extend = *None*
     1. The other option is Back and these function the same as they do with Line tools
   - Leave the radius unchecked
   - Name = *CUR*
     1. This is not important as long as it is not the name of the alignment

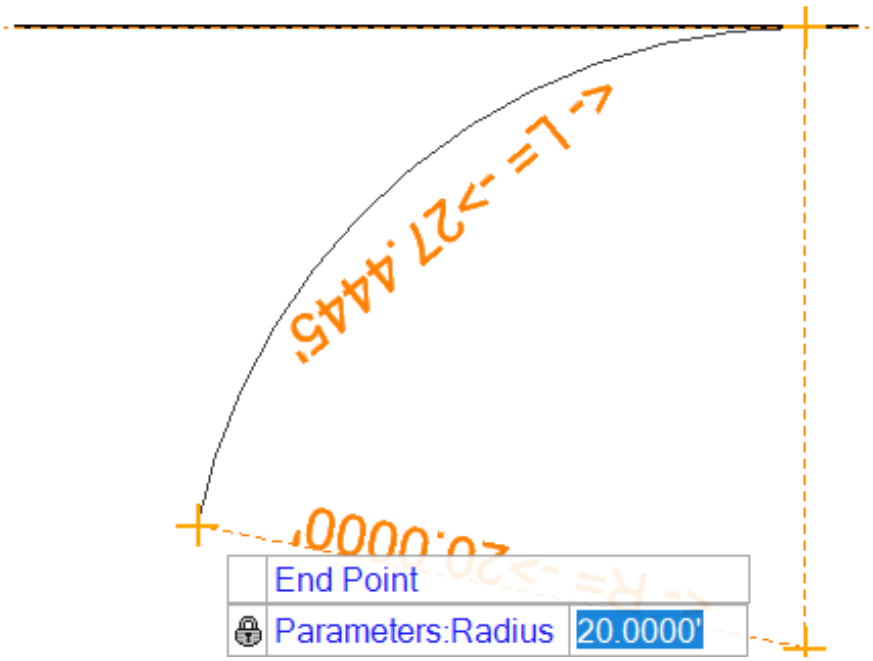


F. At the heads up display left click to locate the To Element

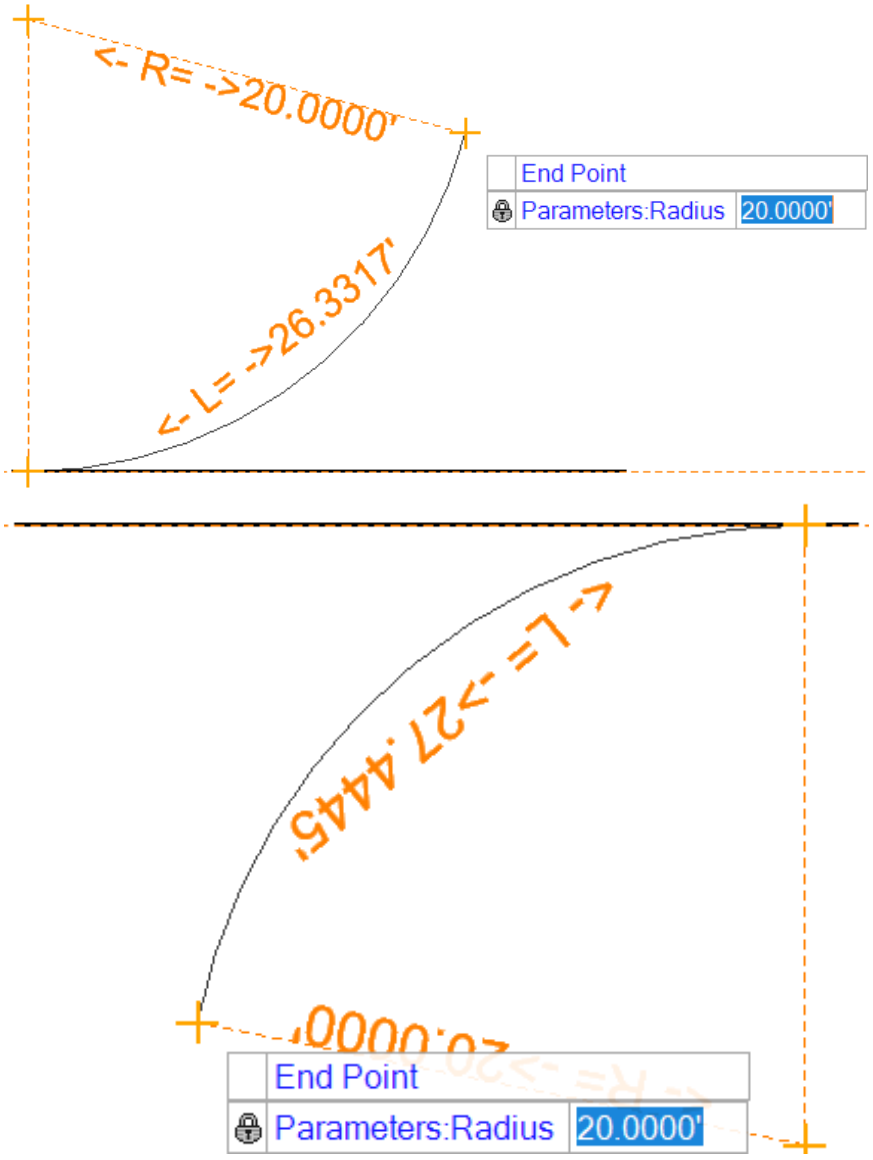
G. Enter 20.00’ for the radius and press the <ENTER> key to lock the value.



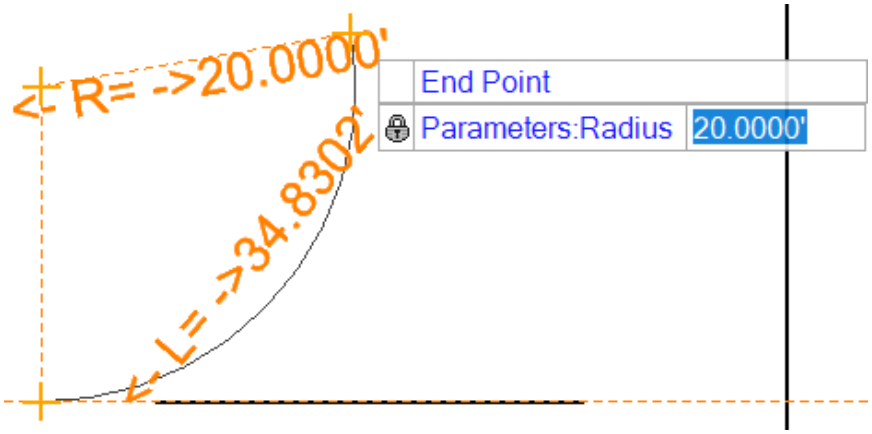
H. To move the curve to the opposite of the line, from the Top to the Bottom just move the cursor from the top of the line to the bottom of the line.



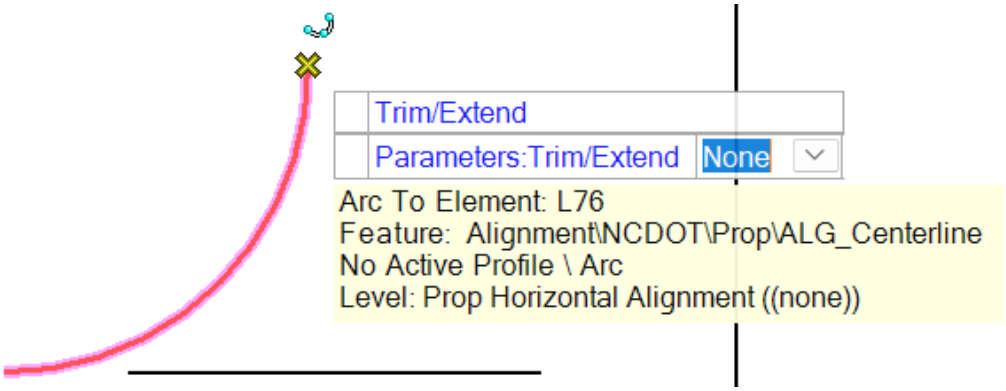
I. To change the curve from a clockwise to a counter-clockwise solution use the <SHIFT> key. Using the <SHIFT>Key to alternate between solutions will be common for the Arc tools.



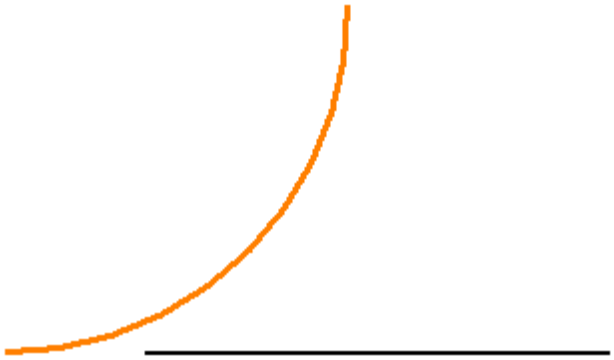
J. Note the extension of the To Element is shown as a possible solution. Also by moving the cursor the location of the tangent point shifts. This is the key difference between the To Element tool groups and the From Element tool groups. With the To Element tools the point in space is selected first. With the From Element tools the point on the reference element is selected first.



K. Left click to accept the radius value of 20.00’ and to set the start point. Click in a location that moves the tangent point off the To Element to the left.



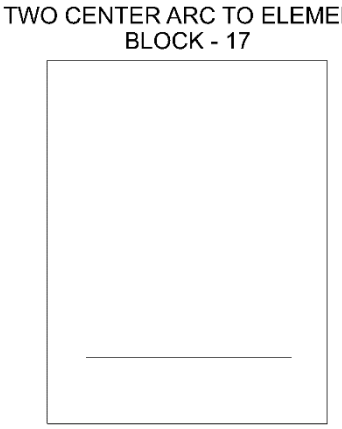
L. The Trim/Extend option will display none because that was the selection made in the dialog box. Left Click to accept the solution and complete the tool.



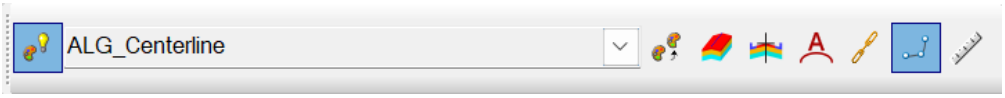
M. Note that the solution was made for a curve that ties off the To Element.

2. Two Center Arc to Element

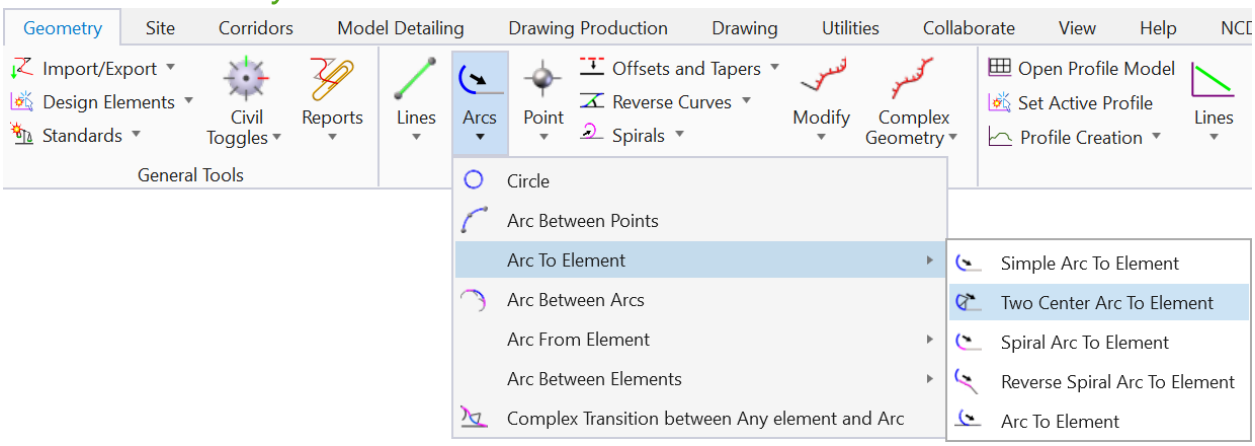
A. Locate the Two Center Arc to Element exercise location in Block – 17. This tool can be used when the To Element is a line or an arc.



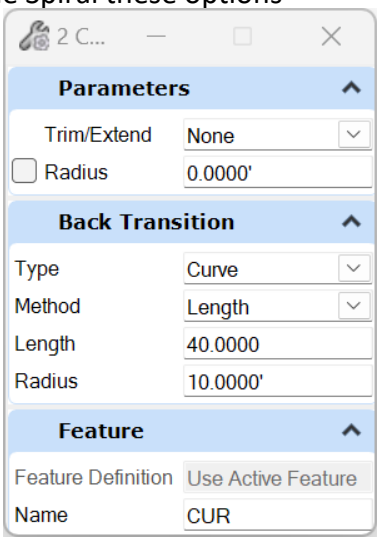
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



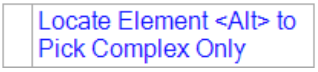
C. Select the **Two Center Arc to Element** tool from the *Horizontal* Section of the *Geometry* Ribbon.



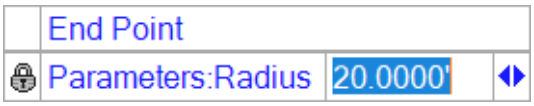
D. The Dialog box will appear with multiple options for the design parameters
   - Set the Trim/Extend = None
     1. Back is also an option
   - Leave the radius unchecked
     1. This radius is the radius of the curve that does not intersect the To element
   - Type = Curve
     1. None eliminates the transition, using the option will give the same result as the **Simple Arc to Element** tool.
     2. Spiral creates a spiral transition from the curve to the To Element. This will create the same solution as the **Spiral Arc to Element** tool.
     3. Double Spiral creates a reversing spiral transition, this option can only be used when the To element is a curve and will give the same solution as the **Reverse Spiral Arc to Element** tool.
     4. The transition element to the To Element will be a curve, this option creates a true Two Centered Curve solution
     5. Arc Ratio creates a transition of a specified radius and a second curve with a radius that is a ratio of the transition curve.
   - Method = Length
     1. Length will set the transition curve to a specified length.
     2. Deflection will set the transition curve based on a specified deflection angle
     3. Offset will set the end of the transition curve at a specified distance from a tangent line starting at the beginning of the transition curve.
     4. Note that when the type is set to Spiral or Double Spiral these options change to spiral related parameters
   - Radius = 40.00’
     1. This is the radius of the transition curve
   - Length = 10.00’
     1. This is the length of the transition curve
   - Name = CUR



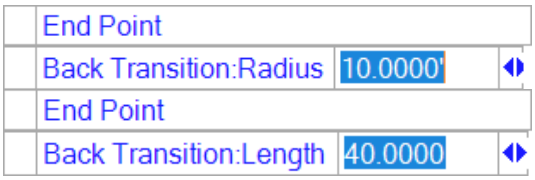
E. At the heads up prompt left click to locate the To Element.



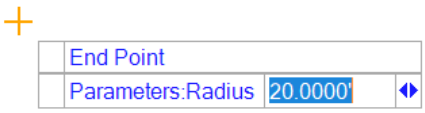
F. The next prompt will ask for a Radius and an End point for the curve that does not tie to the To Element.



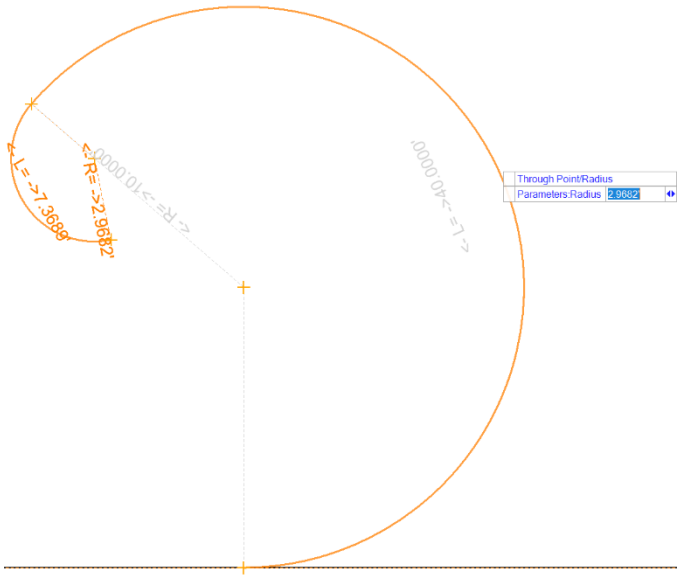
G. Note the blue arrows, Left and Right, on the right side of the dialog box. This indicates that additional settings can be accessed at the heads up prompt by using the <LEFT> and <RIGHT> arrow keys. This will be the same parameters entered into the dialog but will give the user the chance to make changes before placing the Two Centered Curve.



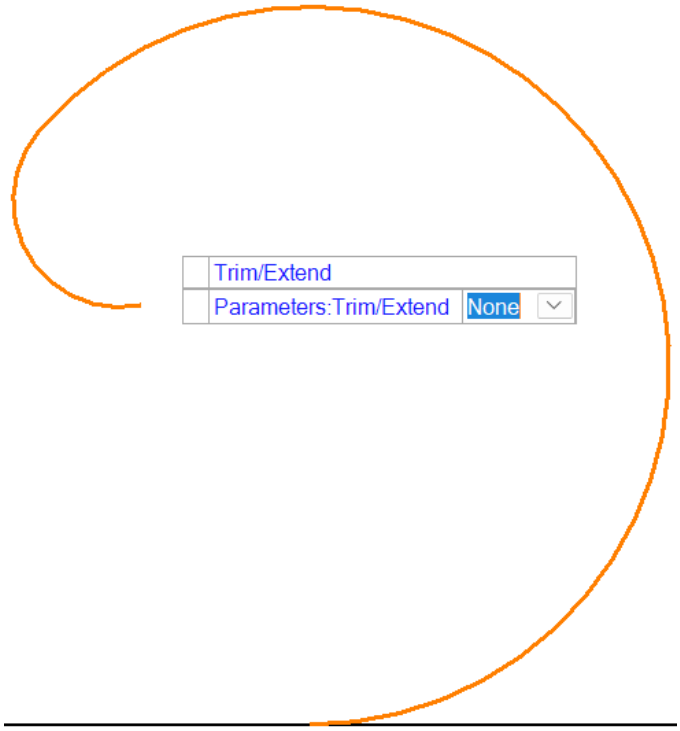
H. Left click to accept the end point



I. Left click to accept a through point on the curve. This will set the radius of the second curve and solve for the transition curve

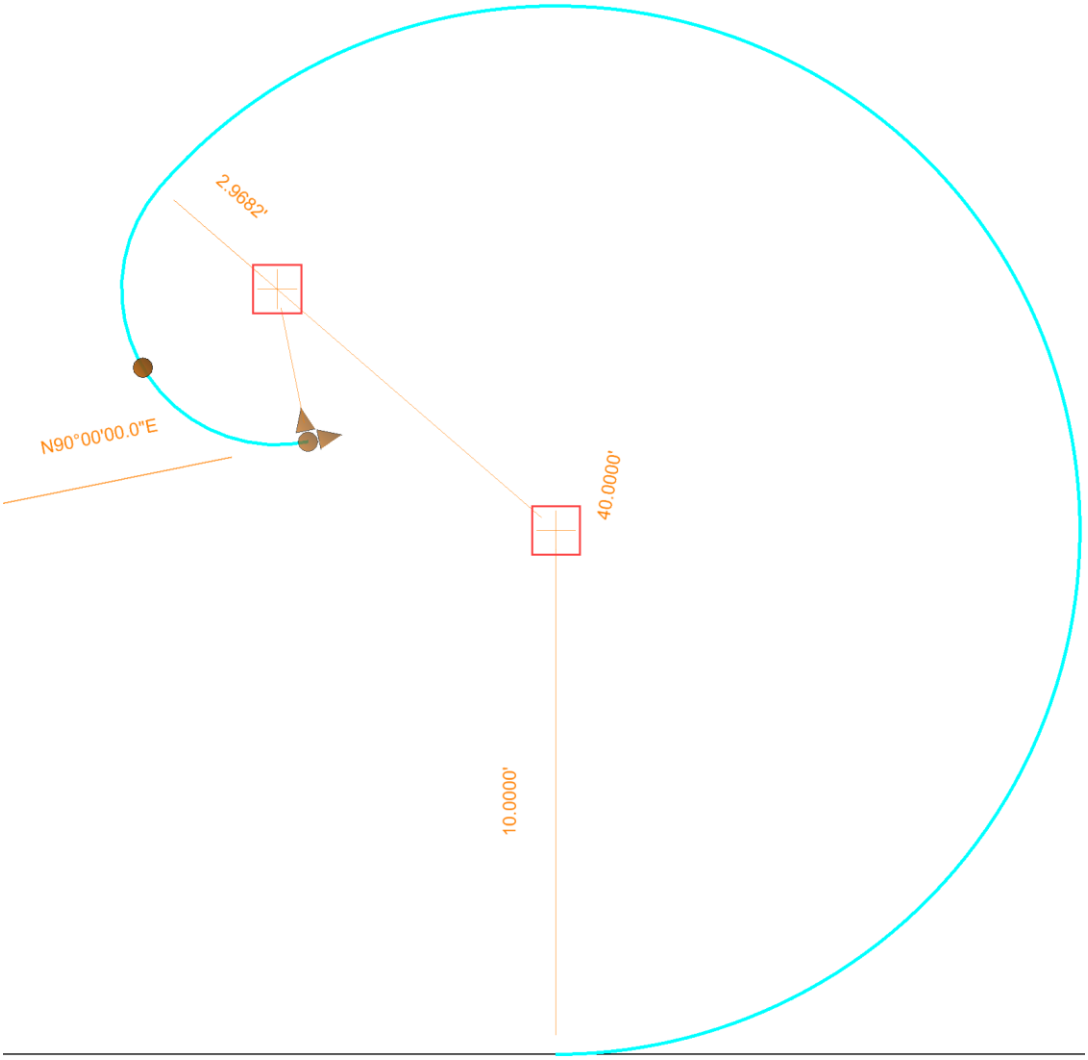


J. The radius of the second curve will be dynamically updated. As indicated in the heads up display and the black text manipulators. The red parameters for the transition curve, Radius = 10.00’ and Length = 40.00’ are shown and red and were set when the initial end point was selected. Note that in the dialog box there is no checkbox next to these parameters.

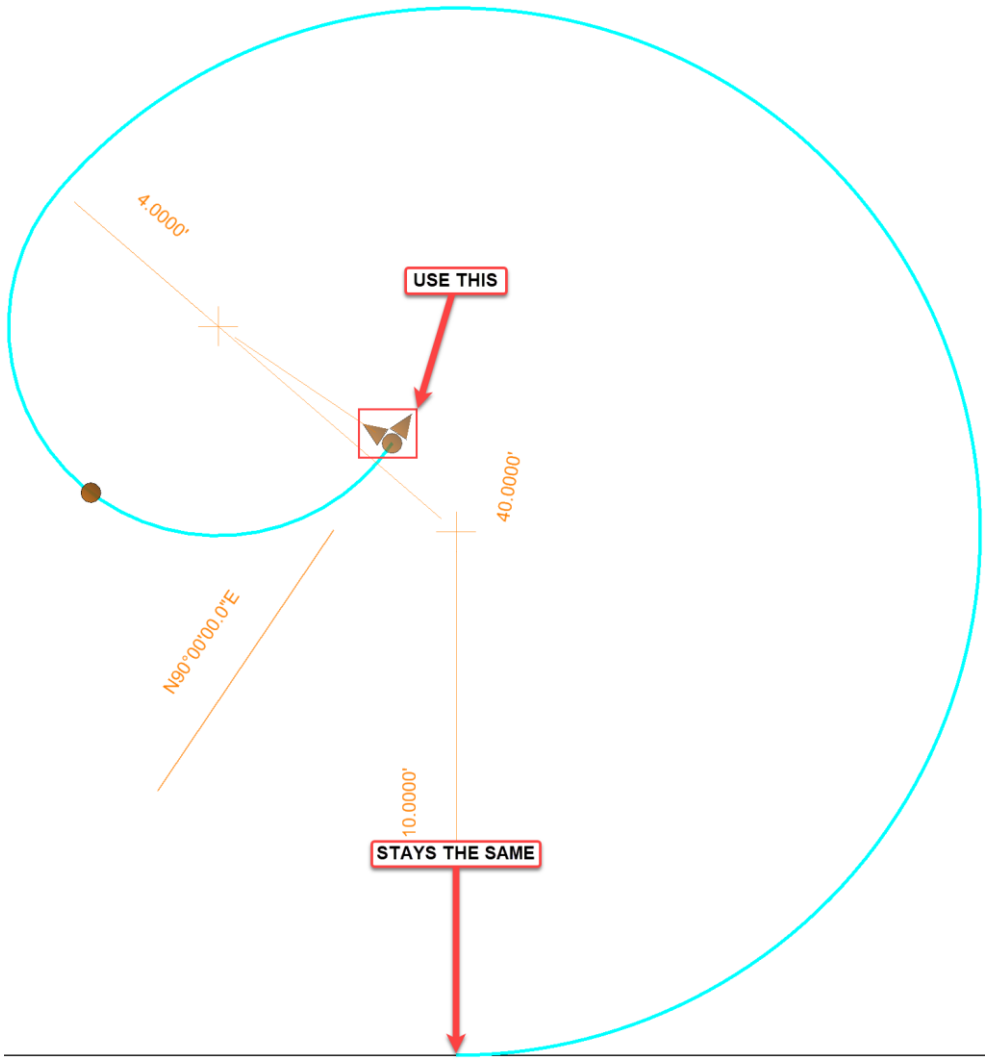


K. Left click to accept the trim option None.

L. This completes the tool and places the element. Use the Element Selection tool to select the placed element. The text manipulators and drag handles will appear and indicate that this is a two centered curve.

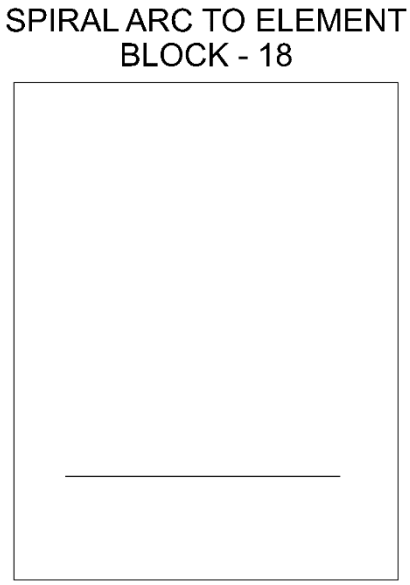


M. Also note that with this tool that by using the text manipulators to change the radius of the second curve from 2.9682’ to4.00 the transition curve moves and the start point remains in the same place. That is because this is a To Element tool and the initial end point is what is used to construct the element.

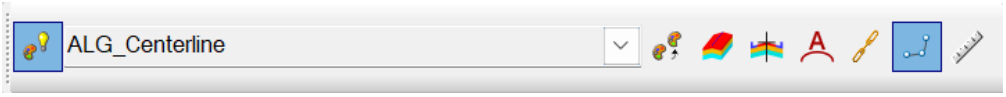


2. Spiral Arc to Element

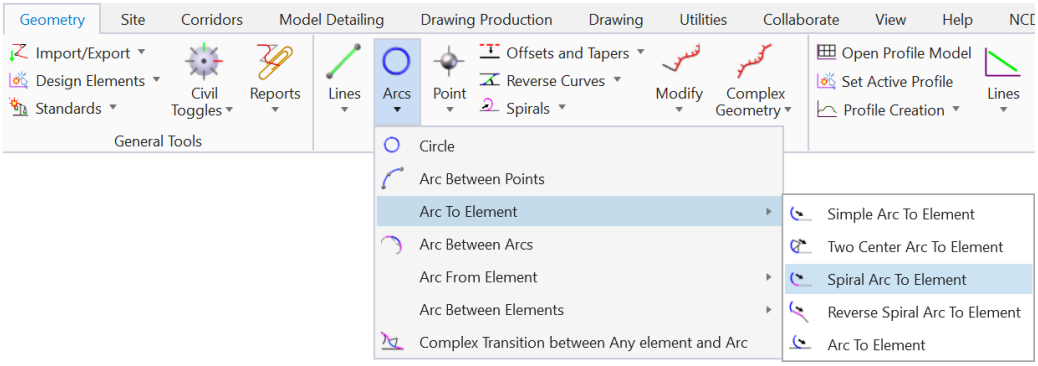
A. The **Spiral Arc to Element** tool works like the **Two Center Arc to Element** tool, the only difference is that the transition is a spiral and not an arc. This tool will work with a line or an arc as the To Element. Locate the Spiral Arc to Element exercise location in Block – 18.



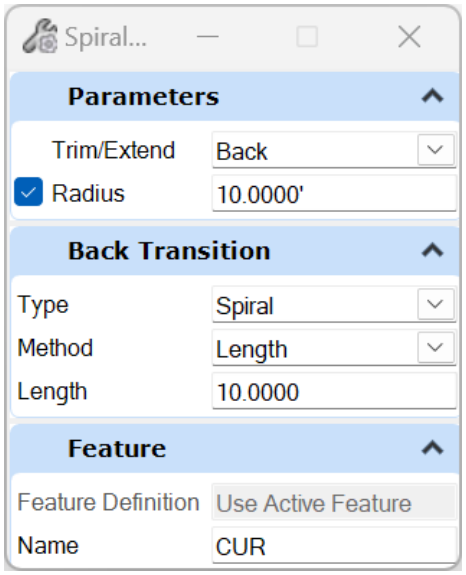
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



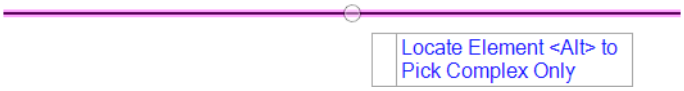
C. Select the **Spiral Arc to Element** tool from the *Horizontal* Section of the Geometry *Ribbon*.



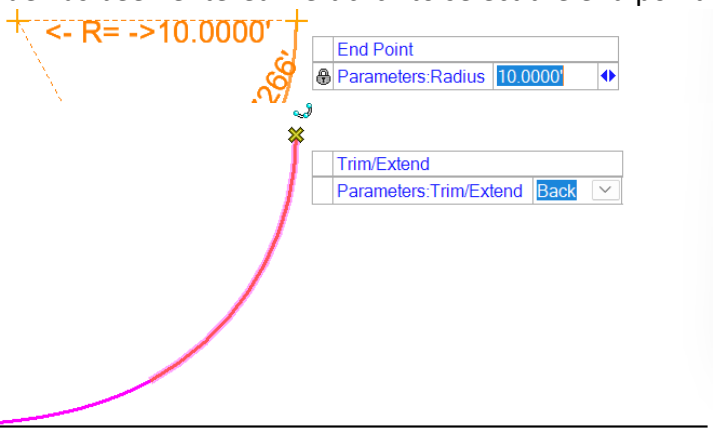
D. This is the same dialog as the Two Center Arc to Element dialog. Some options will be different with the method set to Spiral.
   - Trim/Extend = Back
   - Radius = 10.00’ check the box next to Radius
   - Type = Spiral
   - Method = Length
     1. A-Value
     2. Deflection
     3. Offset
     4. R-Value
     5. None of these other methods are common for NCDOT Roadway Designers
   - Length = 10.00’
     1. This defines the length of the Spiral Transisiton
   - Name = CUR



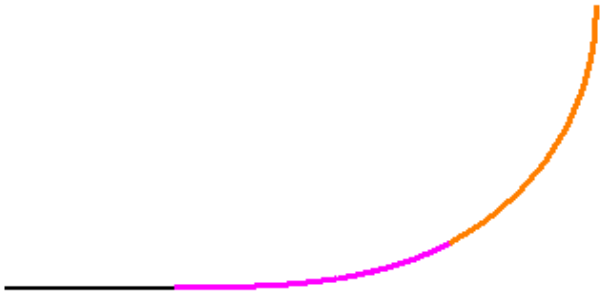
E. At the heads up prompt left click to select the To Element



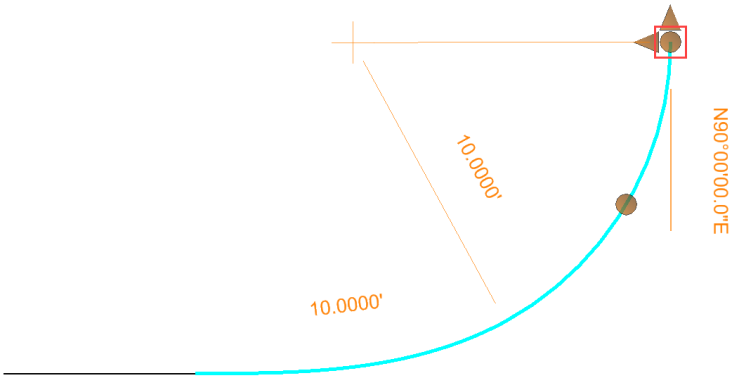
F. Because the radius was selected at the dialog box the heads up prompt will show a lock indicating the value has been entered. Left click to select the end point.



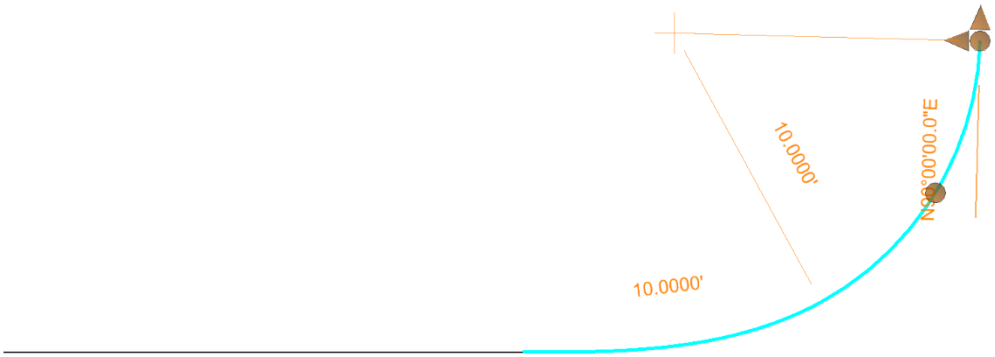
G. Left click to accept the Trim/Extend option of Back.
H. This will complete the tool and place the element.



I. Use the Element Selection tool to highlight the element. Grab the circular drag handle at the top of the curve.



J. Pull the curve to left, note that the spiral will move and the To Element, the line segment, will update to maintain the Back Trim.

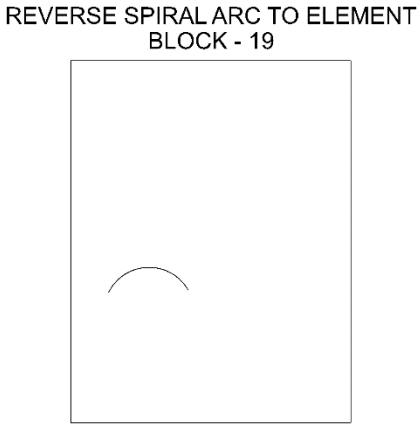


3. Reverse Spiral Arc to Element

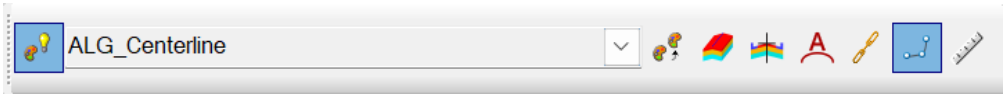
This tool *does* work correctly.

In a previous version of ORD this tool was broken and functioned incorrectly. As such, there was no exercise designed for this tool, and frankly, I doubt very many of you are still reading to this point anyway (Shoutouts to the real ones though, lord knows I spent enough time on these modules). The tool itself is fairly self-explanatory. I encourage you to mess around with the tool and see how it works, and I have attached some images of the tool. Knowledge is power!

A. Locate the Reverse Spiral Arc to Element exercise location in Block – 19. This tool will only work when the To Element is a curve in the opposite direction. This tool will draw a spiral transisiton from the To Element that curves in the same direction then a reversing spiral that curves in the reverse direction then an arc that curves in same reversing direction. This tool could be used to start a ramp that ties to a curve on the mainline alignment.

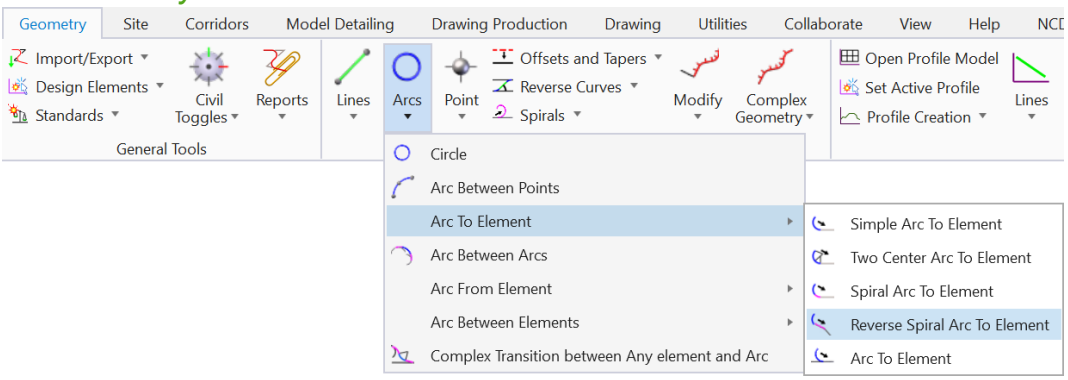


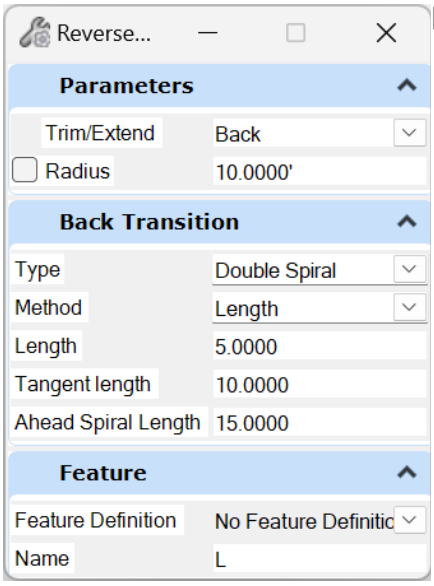
B. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on

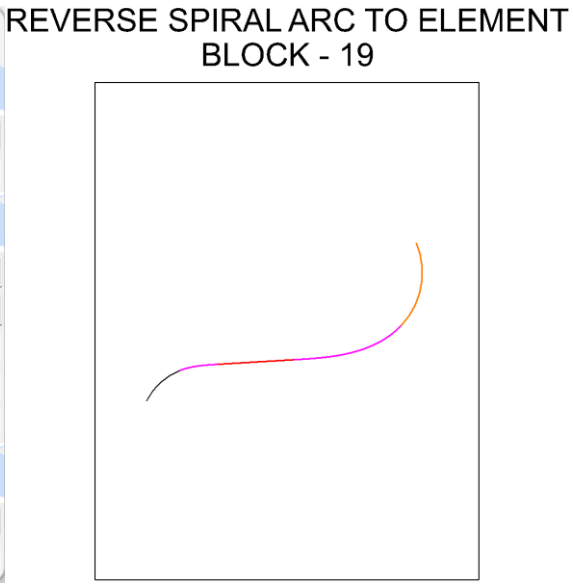


the use Active Feature Definition Icon.

C. Select the **Reverse Spiral Arc to Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



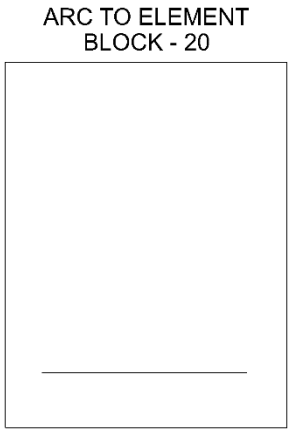




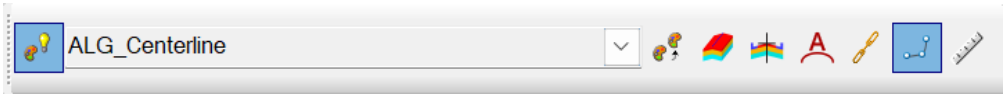
4. Arc to Element

A. The **Arc to Element** tool can be used to design a solution similar to all the other To Element tools with the addition of a user specified offset from the To Element.

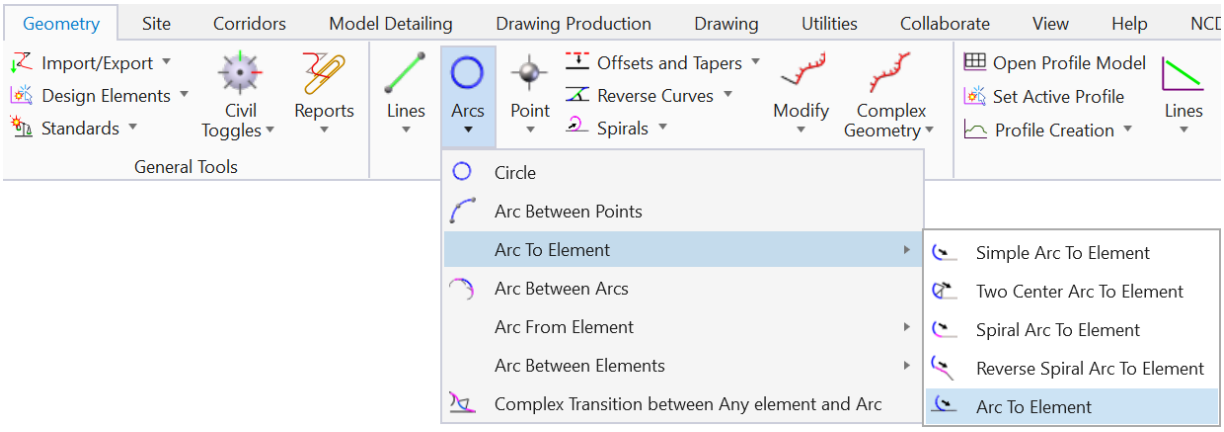
B. Locate the Arc to Element exercise location in Block -20.



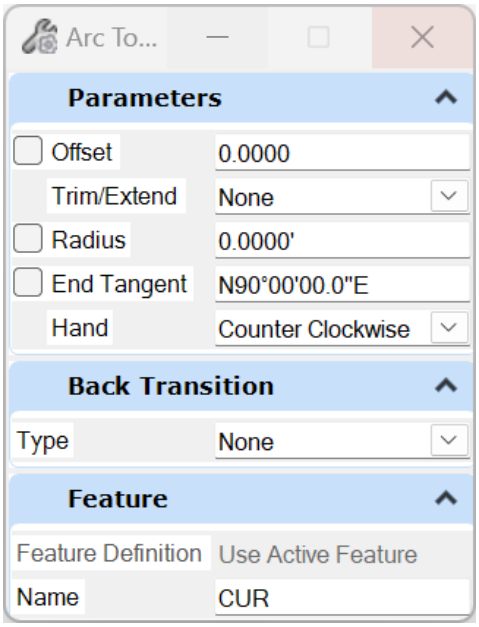
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



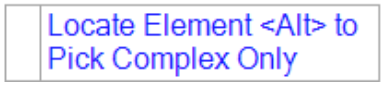
D. Select the **Arc to Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



E. The dialog box will display
- Leave the offset box unchecked. This can be selected at the heads up prompt.
- Leave the radius box unchecked. This can be selected at the heads up prompt.
- Leave the End Tangent box unchecked. This can be determined dynamically during placement of the curve
- Set the Hand to *Counter Clockwise*. This is the direction of the solution, this setting can be changed to Clockwise during placement by using the <SHIFT> key.
- For the Back Transition set the Type = None
  1. The other available options will all apply transitions that match the other To Element Arc tools.
     a. Spiral
     b. Double Spiral
     c. Curve
     d. Arc Ratio
- Set Name = CUR
  1. This is not important as long as it is not the alignment name.

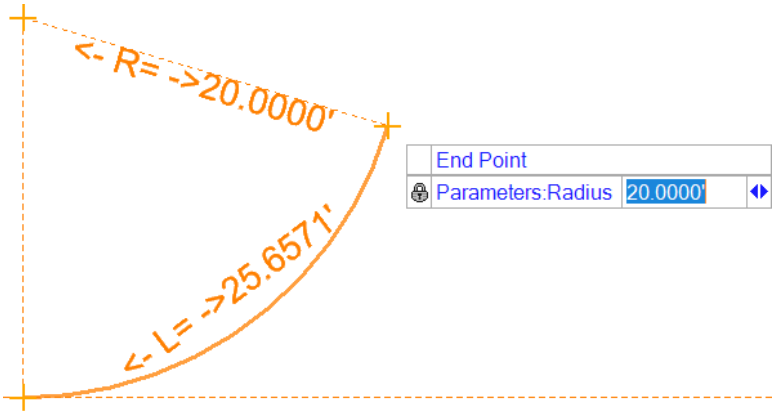


F. At the heads up prompt left click to select the To Element.



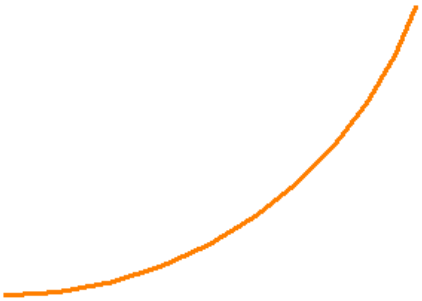
G. At the prompt for the Offset Parameter type in -5.00’ and <EBTER> to lock the distance. Left click to accept the offset distance. The dashed line represents the 5.0’ offset.

H. At the heads up prompt type in 20.00’ for the radius. Press <ENTER> to lock the value. A dynamic solution for the arc will appear.

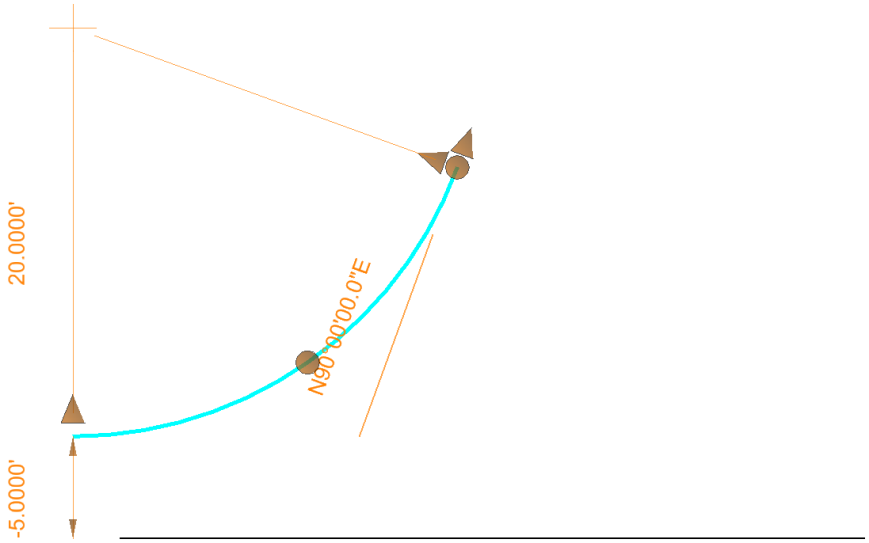


I. Note the blue arrows to the right of the radius value. These indicate that more parameters are available for precision input. By using the left and right arrow keys the user can toggle between different input. For this tool the input is the End Tangent Direction. No input is needed this will be solved for graphically.

J. Left click to accept the arc and place the element.



By using the Element Selection tool and selecting the arc all the text manipulators and drag handles are available showing all the editable information.

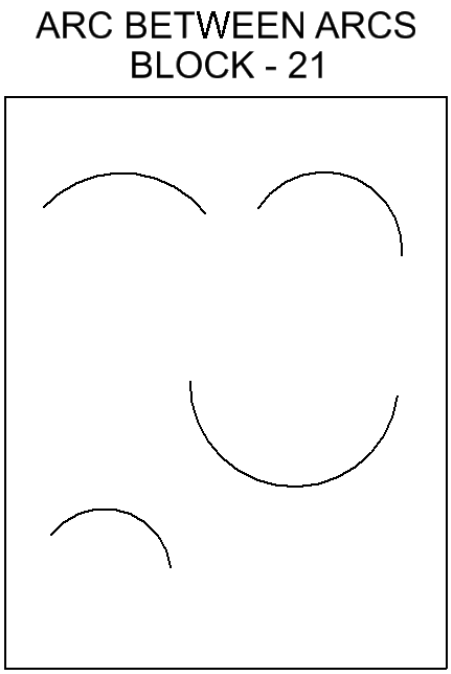


Arc Between Arcs

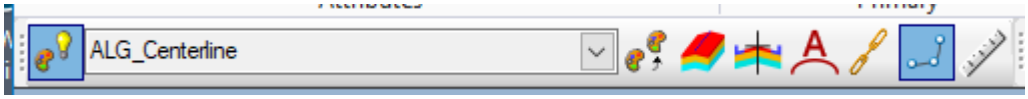
1. Arc Between Arcs

A. The Arc Between Arcs tool can be used to draw a complex transition between two existing Arcs. The tool can be used to draw a single arc, or an arc with a spiral transition on one end or both ends, or an arc with reversing spiral transitions on one end or both ends, or any combination of the available transitions. This is the type of tool that would be useful for complex interchange design where multiple curved alignments were being connected. Because ORD maintains design intent and when using the text manipulators, the user can easily edit the design parameters this is the type of tool where the user could start with a simple solution and then using the editing tools refine the design through multiple steps to reach a more desired solution.

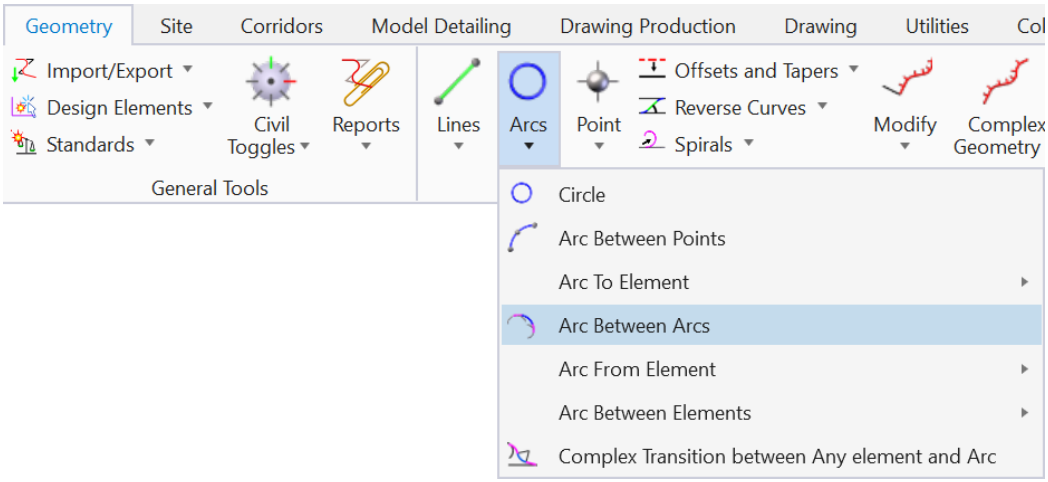
B. Locate the Arc Between Arcs exercise location in Block -21.



C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

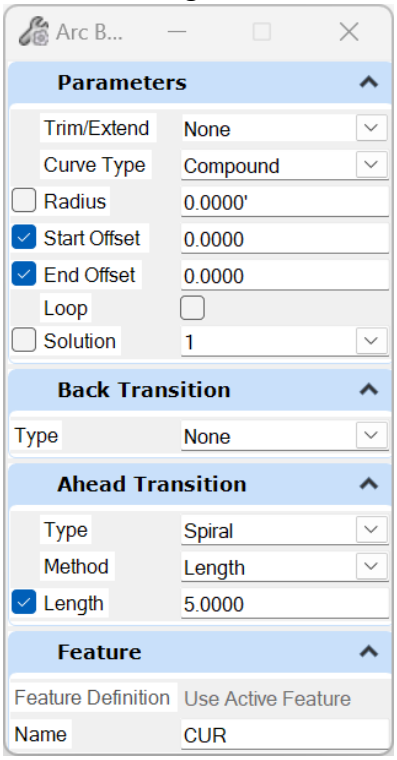


D. Select the **Arc Between Arcs** tool from the *Horizontal* section of the *Geometry* Ribbon.

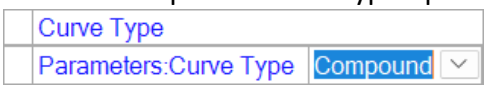


E. The dialog box will display. For large dialogs with multiple options the user may find it easier to input the design parameters into the dialog and then only left click to accept the values and select the To Elements.
   - Trim/Extend = None
     1. Back will trim or extend the first To Element Selected
     2. Ahead will trim or extend the second To Element Selected
     3. Both will trim or extend bot To Elements
   - Curve Type = Compound
     1. Compound will construct an arc that curves in the same direction as the To Elements
     2. Reverse will construct an Arc that curves in the opposite direction of the To Elements.
     3. Because ORD can create a solution for the extension of the To Elements it is helpful to think of the To Elements as complete circles and not arcs. There will always be a Compound and Reverse solution regardless of the orientation of the To Elements.
   - Radius = 50.00’
     1. This is the radius of the primary arc. Depending on the type of transition selected there may be additional arcs or spiral constructed. If the radius is not large enough there may not be a solution available. A red ‘X’ will display to indicate this problem.

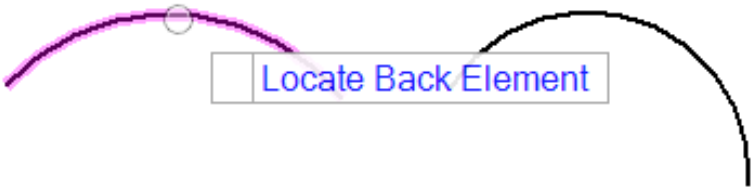
- Start Offset = 0.00’
- End Offset = 0.00’
  1. These offsets are the distance offset from the To Element where the new arc or transition elements will tie tangentially.
- Loop = leave this unchecked
  1. If this box is checked the longer length of circular arc will be used for the solution – the loop part
- Solution = 1
  1. There will always be four solutions for this tool. These solutions can be selected during placement using the <ALT> key, similar to previous tools
- Back Transition = None
  1. The arc will tie directly to the To Element
- Ahead transition = Spiral
  1. This will place a spiral transition between the Arc and the To Element
  2. The double spiral option will place a reversing spiral combination between the Arc and the To element. Note that for the double spiral option the curve solution will always be reversing because the double spiral is a reversing combination of spirals.
- Method = Length
  1. This defines the spiral by length which is the most common practice for NCDOT Roadway Designers.
- Length = 5.00’
  1. This is the spiral length, this option will change depending on the method selected
- Name = CUR
  1. This is not important as long as it is not the name of the alignment.



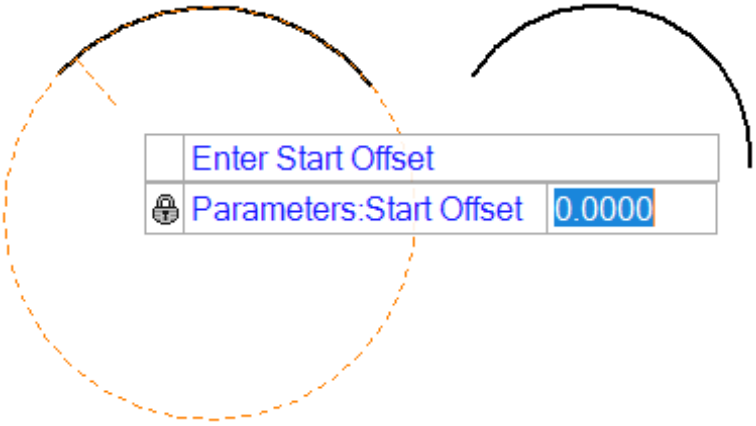
F. At the prompt Left Click to accept the Curve Type option of Compound



G. Left click to select the back element. Choose the arc in the upper left corner.

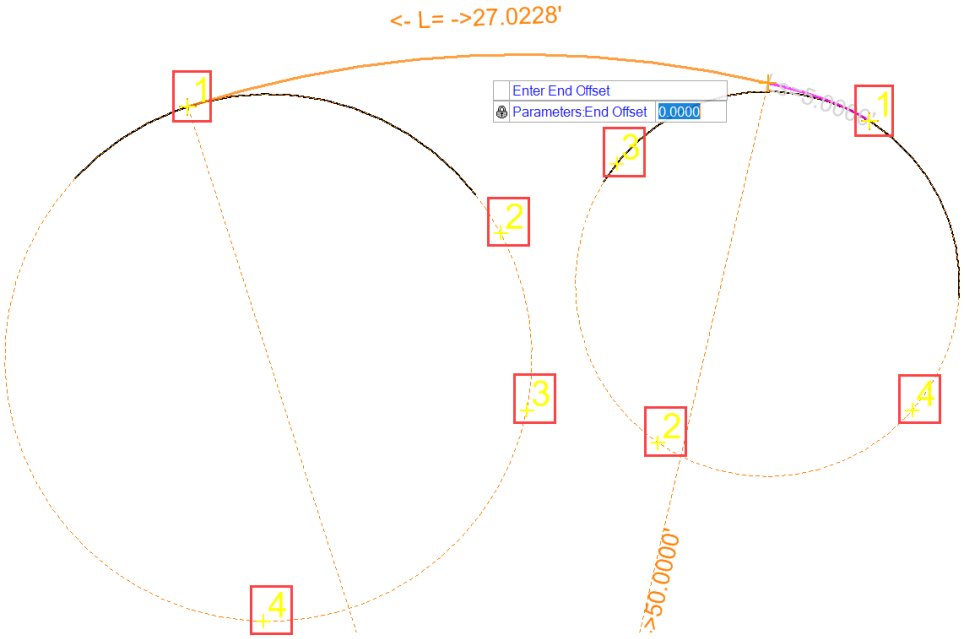


H. Left click to accept the Start Offset = 0.00'. Note that the entire circle is shown as a dashed element because the solution can be placed anywhere on the extension of the original arc, not just the portion of the arc in the dgn file.

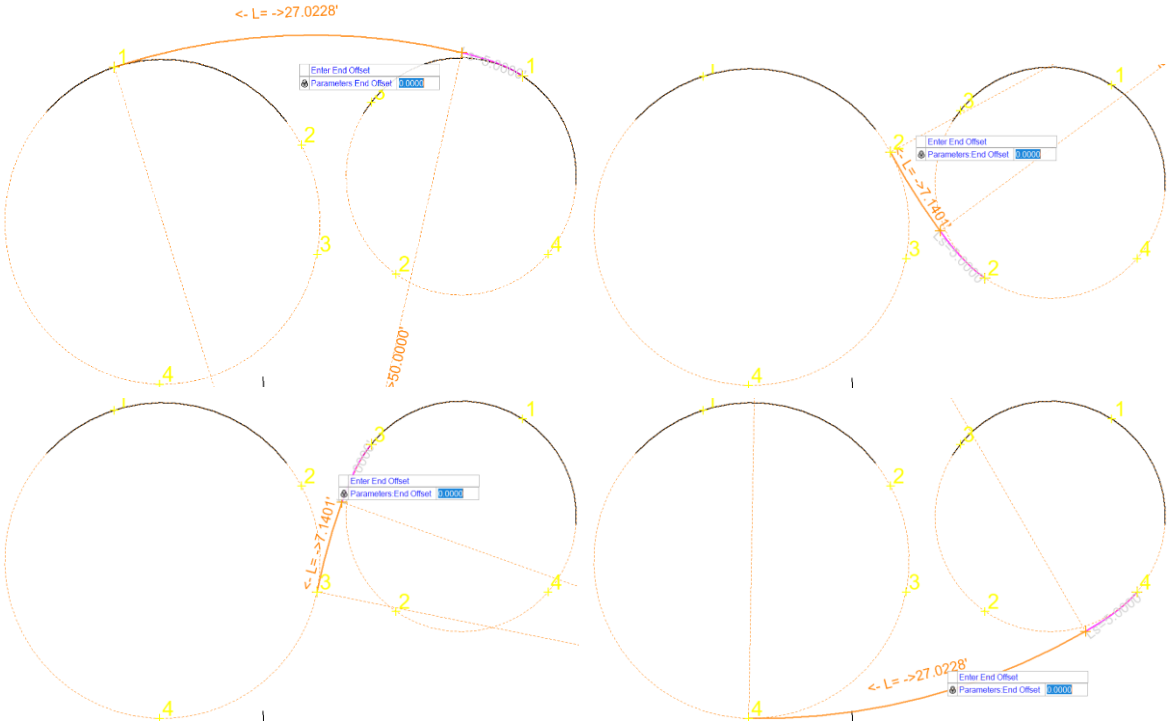


I. Left click to select the ahead element. Choose the arc in the upper right corner.

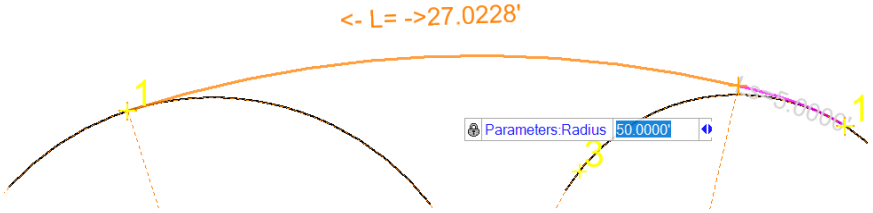
J. At this point the dynamic solution will appear, note the yellow number pair indicating the four possible solutions. The user can switch between solutions by pressing the <ALT> key.



K. There will always be four solutions for this tool.



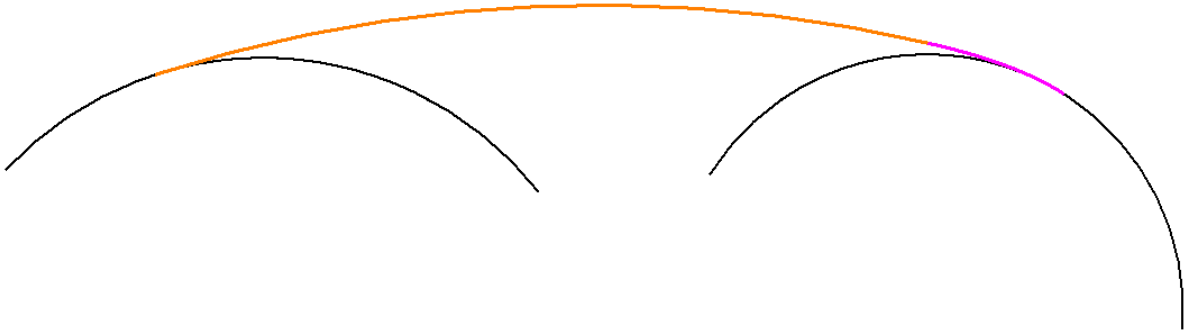
L. Left Click to accept the offset = 0.00’



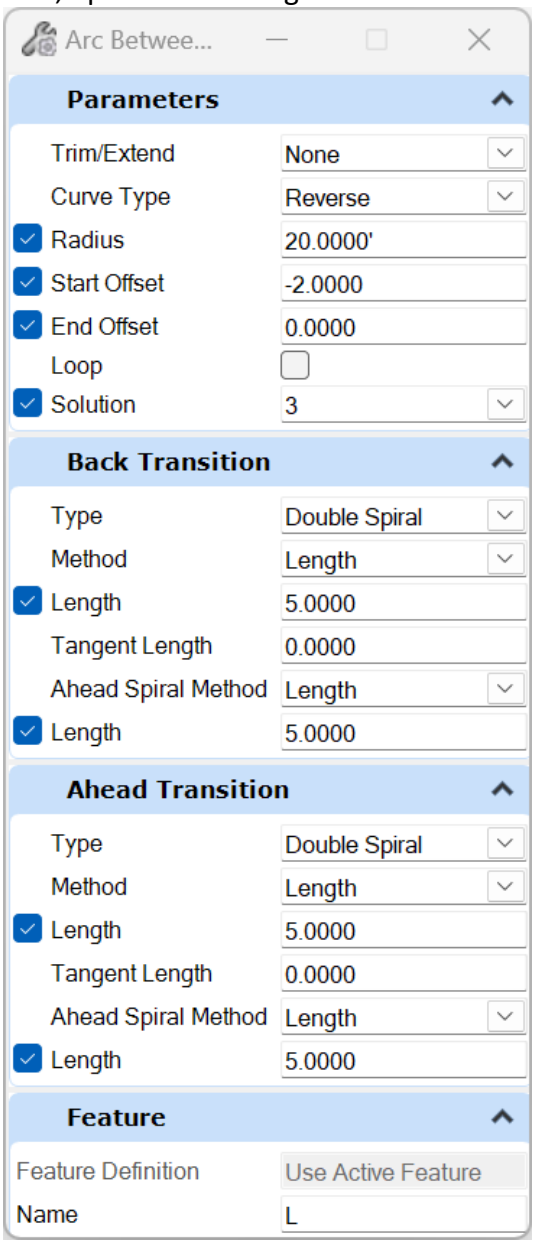
M. Left click to accept the arc radius = 50.00’

N. Left click to accept the Trim/Extend setting = None

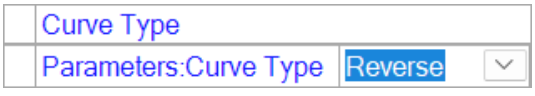
O. This will complete the tool and place the element, an Arc with a 50’ radius that is tangent to the back To Element and includes a spiral transition that is tangent to the ahead To Element.



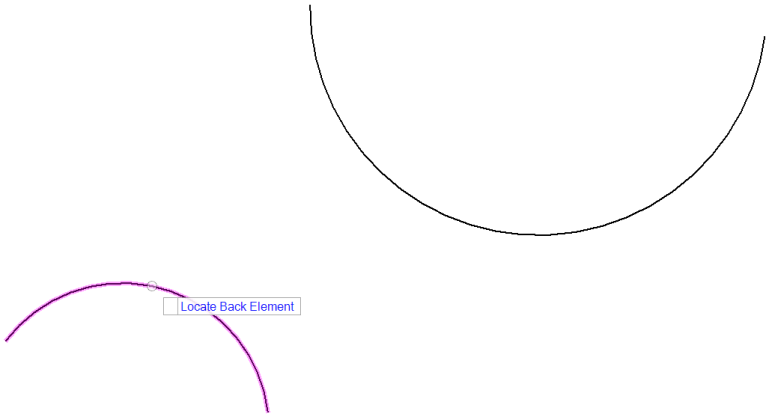
P. The tool will restart, update the dialog to match the setting below.



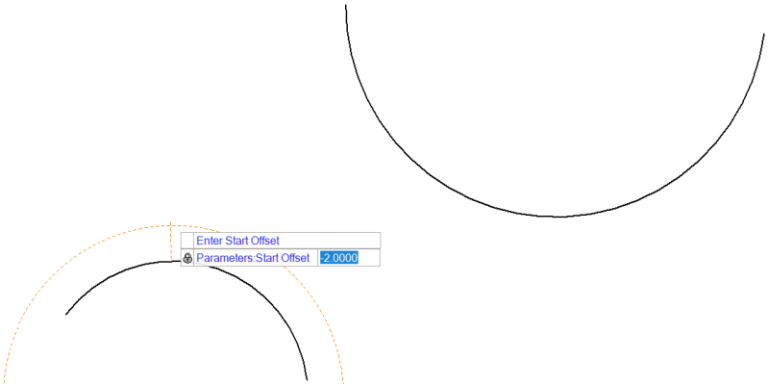
Q. Left click to accept curve type as Reverse.



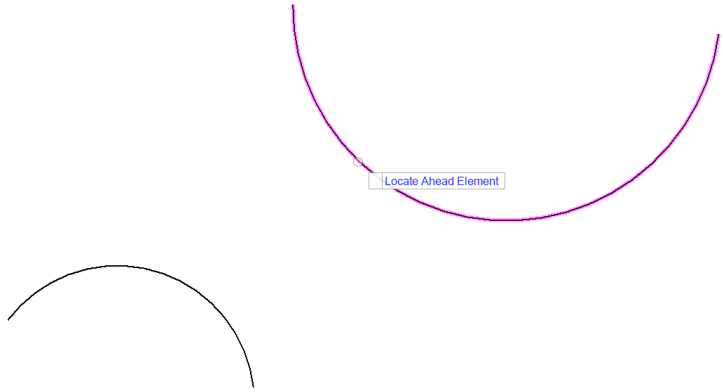
R. Left click to select the Back Element. Choose the arc in the lower right corner.



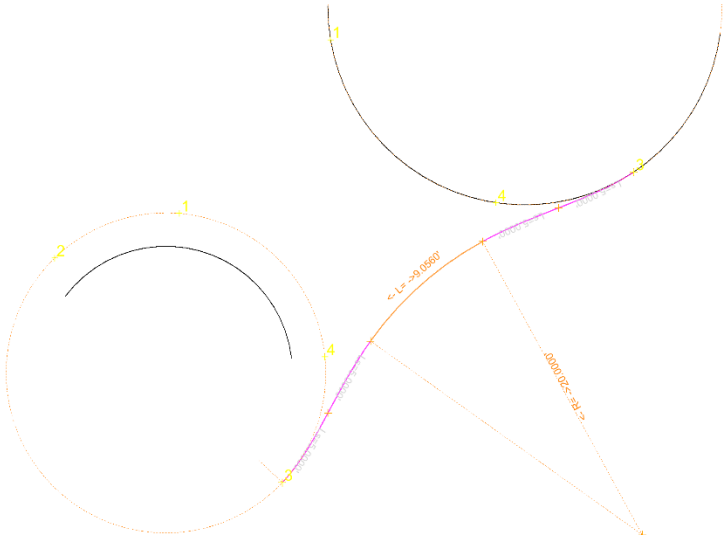
S. Left click to set the offset distance to -2.00, this will put the offset to the outside of the arc.



T. Left click to locate the ahead element.

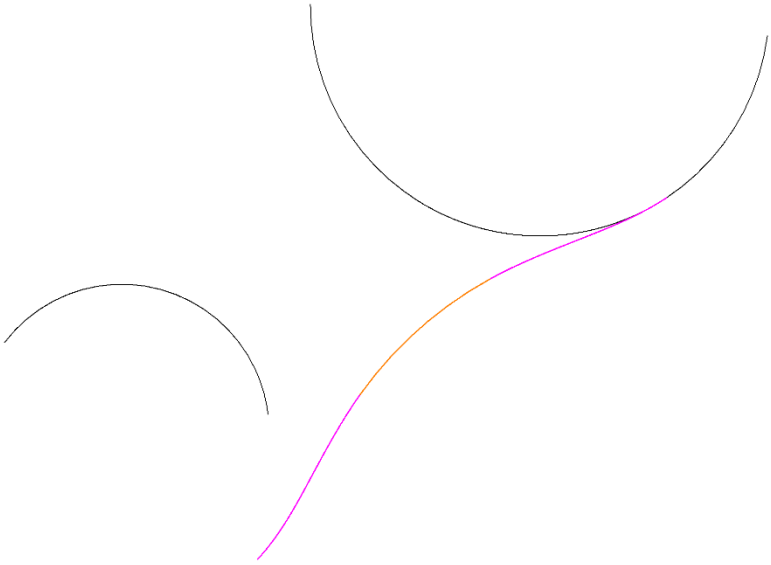


U. Use the <ALT> key to select solution #3.

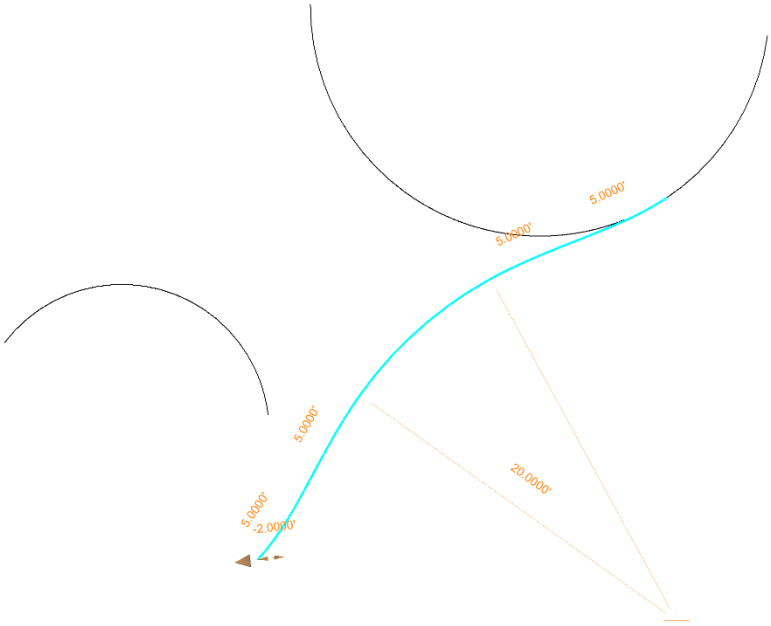


V. Left click to accept the end offset = 0.00’
W. Left click to accept the arc radius = 20.00’
X. Left click to accept trim parameters = None.

Y. That completes the tool and places the elements.

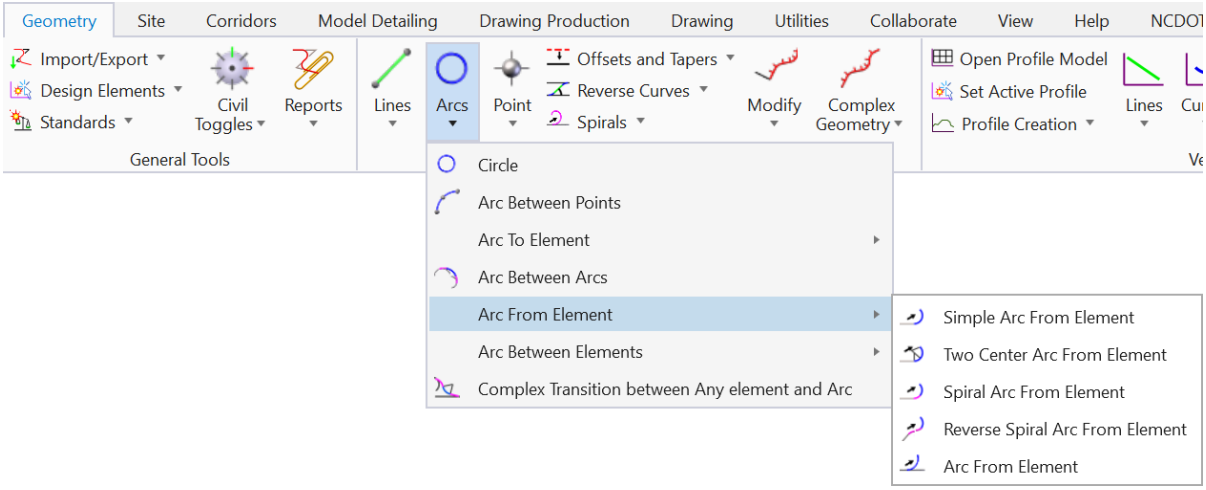


Z. Use the Element Selection tool to highlight the element and note that the spiral ties 2.00’ offset from the project of the Back Arc. There are reversing spiral transistions at each end and an arc with a radius of 20.00’ in the middle.



Arc From Element Tool Group

Arc From Element Tools are under the **Arcs** tool group of the *Horizontal* section of the *Geometry* Ribbon<



This group contains tools that will allow the user to draw an arc that will be based on another element. This group of tools will function on the same concepts outlined in the Line From Element tool group.

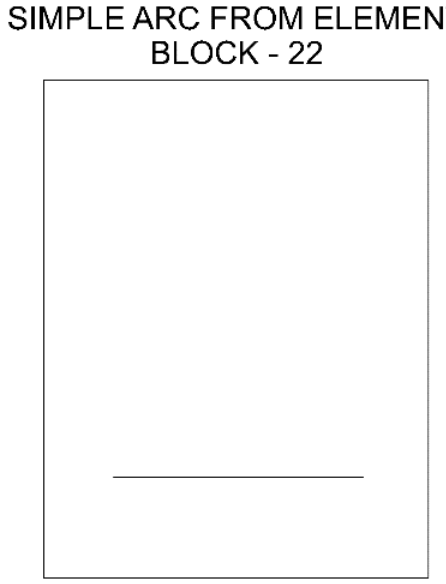
This group contains 5 tools

- **Simple Arc From Element**
  - Creates a simple radius arc without any transition from another element.
- **Two Center Arc From Element**
  - Creates an arc with an arc transition from another element
- **Spiral Arc From Element**
  - Creates and arc with a spiral transition from another element
- **Reverse Spiral Arc From Element**
  - Creates an arc with a reverse spiral transition from another element, applicable only when the To Element is a curve of the opposite direction.
- **Arc From Element**
  - Constructs an arc based on a selected base element which controls tangency at one end.

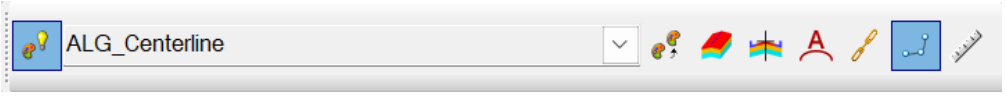
1. Simple Arc From Element

A. The **Simple Arc From Element** tool draws an Arc with a defined radius and length at a user defined start point tangent to a From Element.

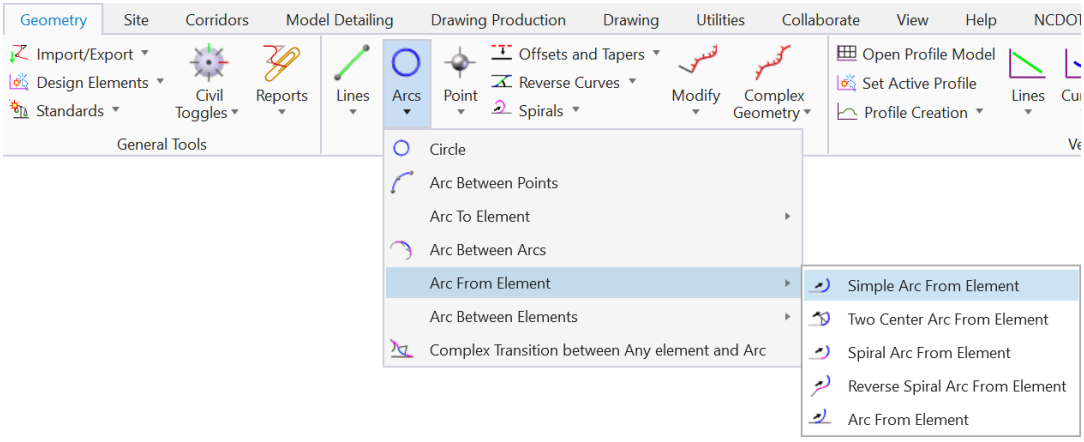
B. Locate the Simple Arc From Element exercise location in Block – 22.



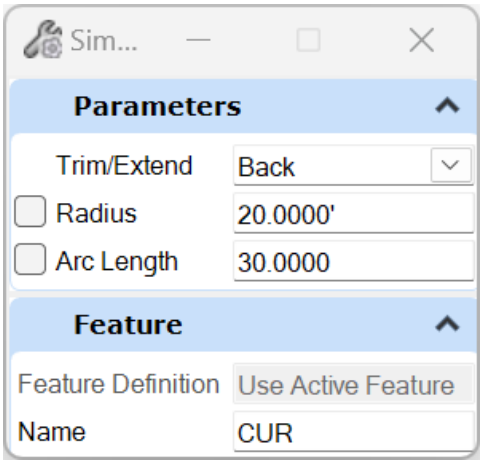
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



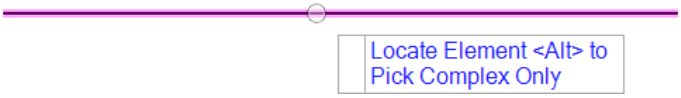
D. Select the **Simple Arc From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



E. The dialog will appear
   - Set Trim/Extend to Back
     1. The other option is None
   - Leave Radius Unchecked
   - Leave Arc Lnegth Unchecked
   - Set Name to CUR

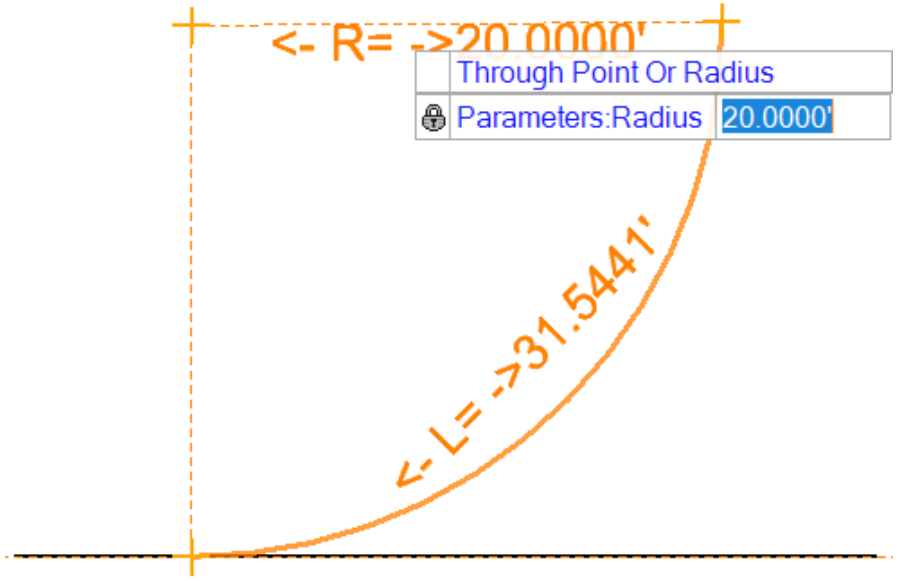


F. Left click to locate the From Element

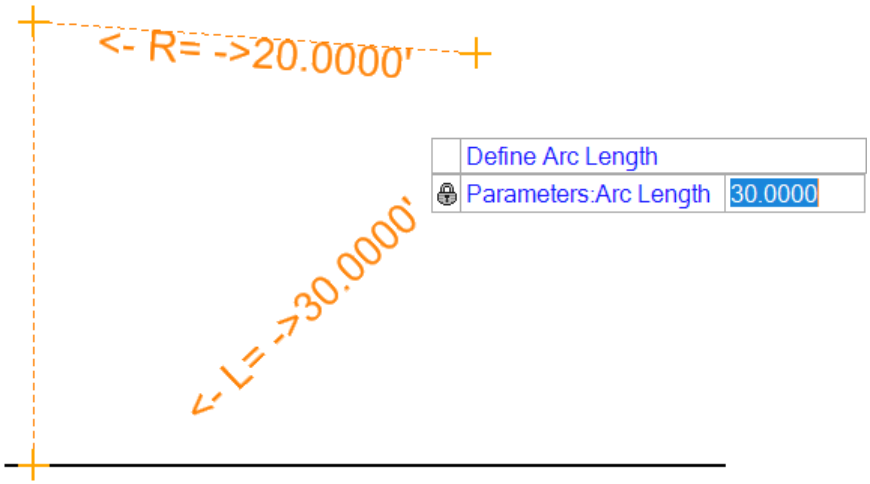


G. Left click to select the start point. This is the point where the arc will tie tangentially to the From Element. The offset is locked at 0.00’ for this tool. Ther vertical dashed line indicates the projection back to the From Element and the horizontal dashed line represents the extension of the From Element. The start point can be located anywhere along the projection.

H. In the heads up display type in 20.00’ for the radius and press <ENTER> to lock the value. Left click to accept the value.



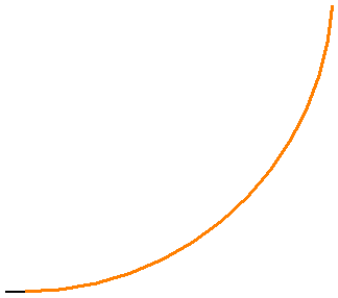
I. At the heads up prompt enter 30.00’ for the length and press <ENTER> to lock the value. Left Click to accept the length>



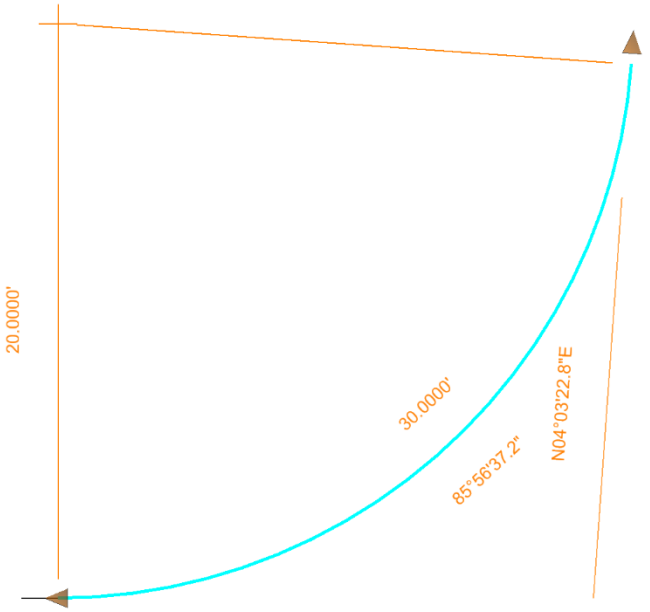
Yeah I don’t know what happened to the arc either. It’s fine though.

J. Left click to accept the Trim option as Back. If the Trim option displayed is None use the Down Arrow key to change the selection to back, then left click to accept.

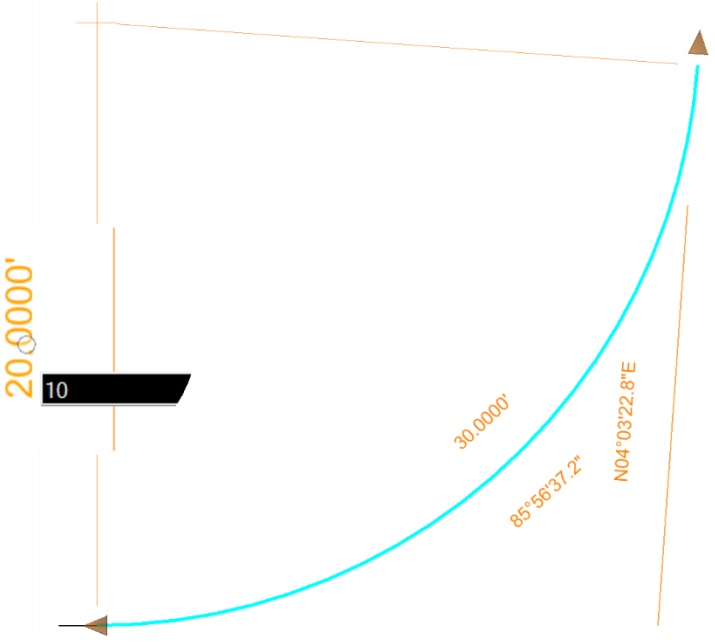
K. This will complete the tool, place the arc and trim the From Element.



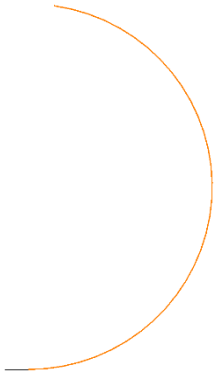
L. Use the Element Selection tool to pick the curve and display the text manipulators and drag handles.



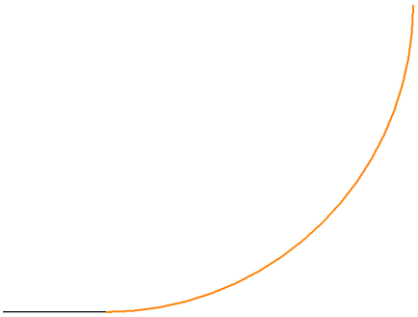
M. Change the radius to 10.00’



N. Note that the point on the From Element remained the same and the end point changed based on the new radius. That is one of the Main differences between the From Element Tools and the To Element Tools.



O. There is a similar curve placement with the To Element tool and a radius of 20.00’

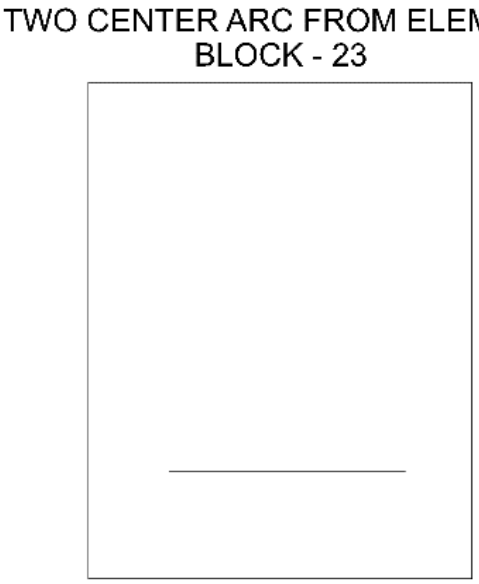


P. When the radius is edited to 10.00’ the point on the To Element moves to match the new radius. This is the opposite of the From Element tools.

5. Two Center Arc From Element

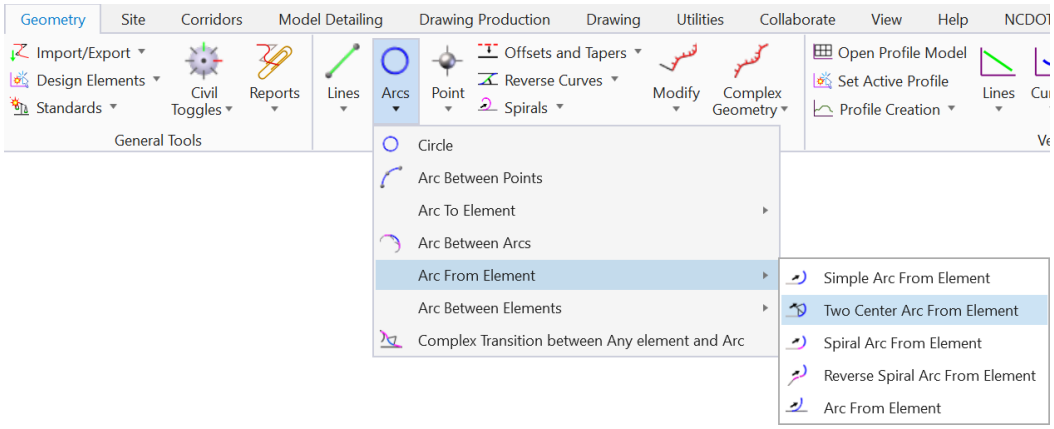
A. The **Two Center Arc From Element** tool draws an Arc with a defined radius and length, and a transition curve at a user defined start point tangent to a From Element.

B. Locate the Two Center Arc From Element exercise location in Block – 23.

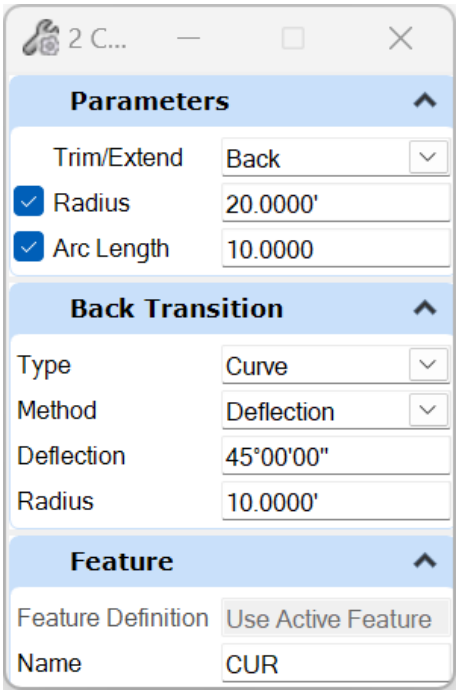


C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

D. Select the **Two Center Arc From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.

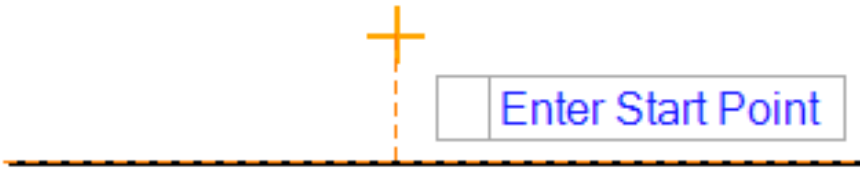


E. The dialog will appear
- Set Trim/Extend to Back
  1. The other option is None
- Set Radius to 20.00’
  1. This is radius of the primary curve, this can also be established graphically
- Set the Arc Length to 10.00’
  1. This can also be established graphically
- Set the Back Transition Type to Curve
  1. The Curve option will result in a two center curve being constructed
  2. The None option will result in an Arc with no transition to the From Element and will match the **Simple Arc From Element** tool
  3. The Spiral Option will result in an Arc with a Spiral transition to the From Element and will match the **Spiral Arc From Element** tool.
  4. The Double Spiral option will result in a reversing spiral transisiton to the From Element. This setting can only be used when the From Element is an Arc turning the opposite direction. This will match the **Reverse Spiral Arc From Element** tool.
  5. The Arc Ratio option will construct a two centered curve where the radius of the transition curve will be a ratio of the radius of the primary curve.
- Set Method to Deflection
  1. The deflection option will set the curve length based on the deflection angle.
  2. The length option will set the transisiton curve based on the length of the curve
  3. The offset option will set the length of the transition curve based on the offset from the tangent.
- Set the radius to 10.00’
  1. This is the radius of the transisiton curve
- Set the Deflection to 45°00’00”
  1. This is the deflection of the transition curve
- Set the Feature Name to CUR



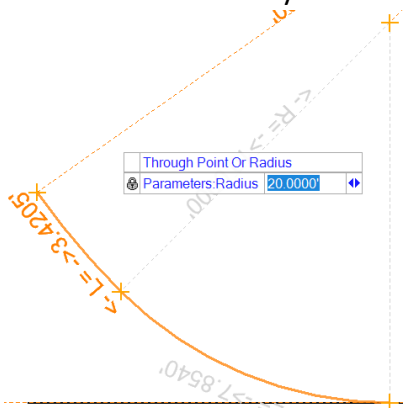
F. Left click to locate the From Element

G. Left click to set the start point. This is the point on the From Element where the transition curve will tie tangentially. This can be done by snapping to a point on the From Element or by snapping in space. The dashed black line shows the project to the From Element.

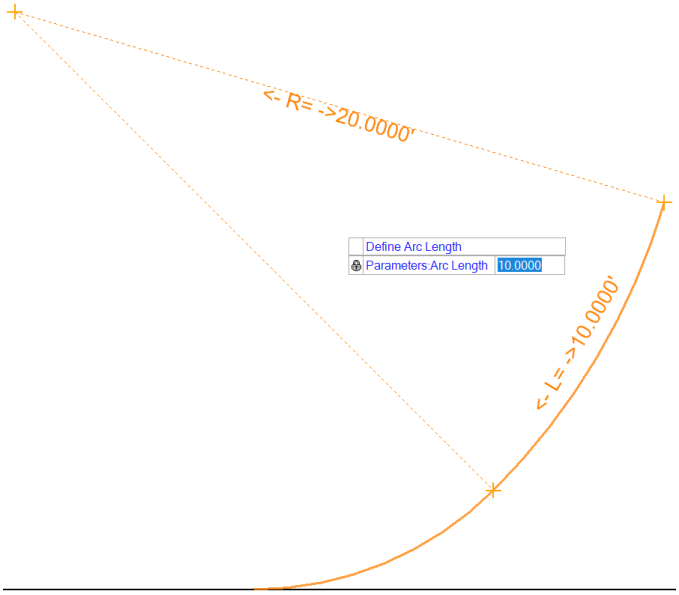


H. By moving the cursor to different sides of the Start Point or the From Element different solutions will be displayed.

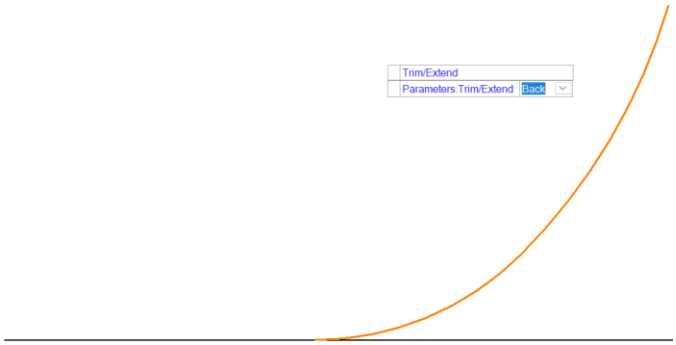
I. Left click to accept the radius of the Primary curve as 20.00'.



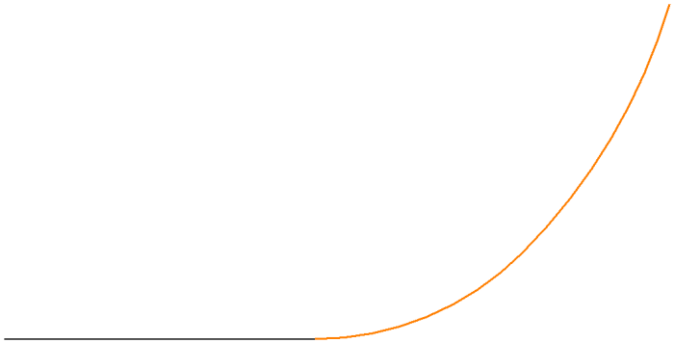
Left click to accept the primary curve length of 10.00’



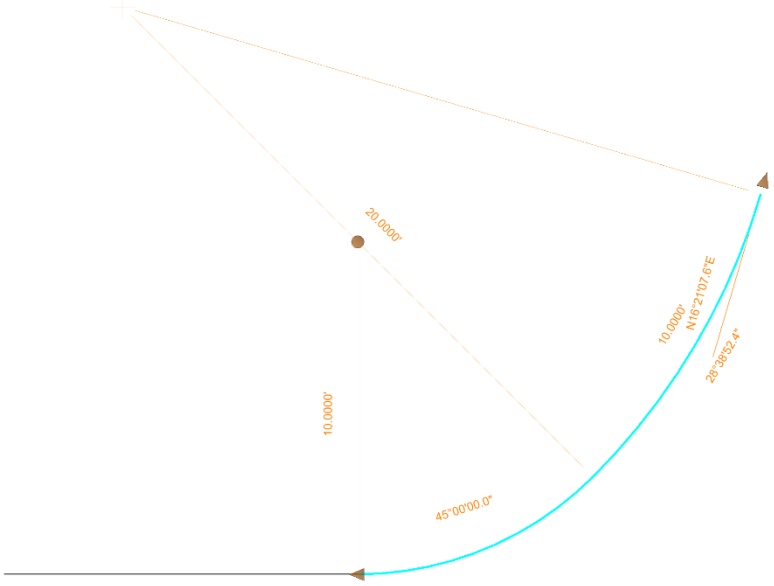
J. Left click to accept the Trim/Extend option of Back.



K. This will finish the tool, place the element and trim the From Element to match the transition curve.



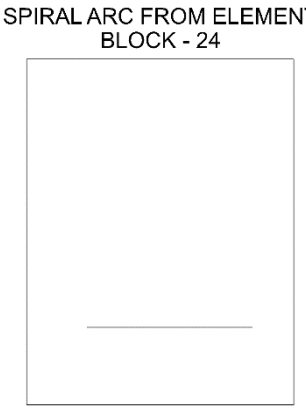
L. Use the Element Selection tool to highlight the curve and display the two center curve geometry.



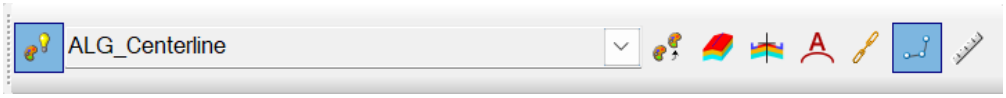
3. Spiral Arc From Element

A. The **Spiral Arc From Element** tool draws an Arc with a defined radius and length, and a transition spiral at a user defined start point tangent to a From Element.

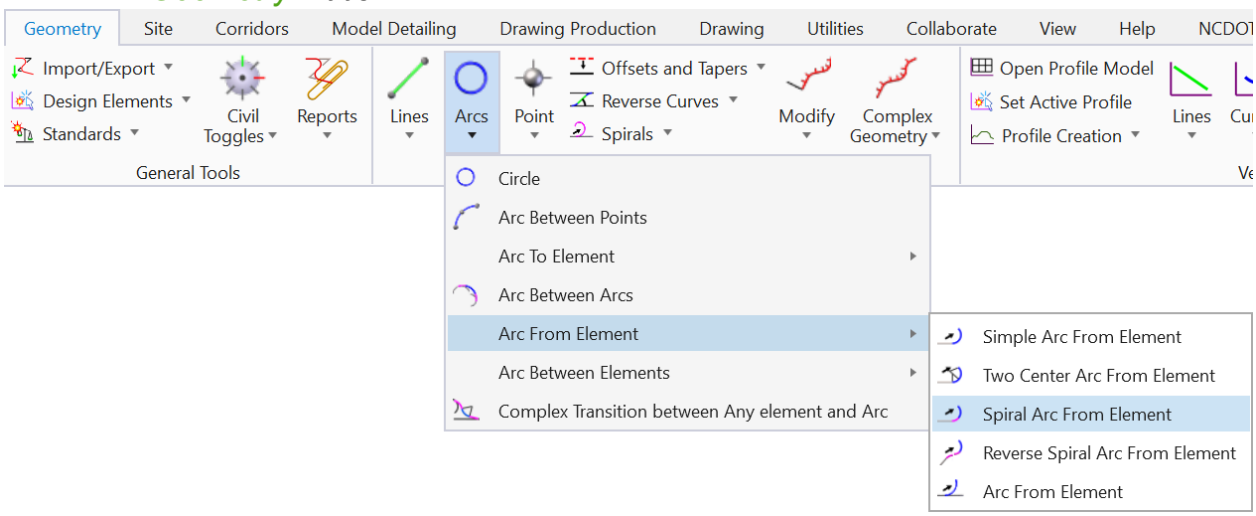
B. Locate the Spiral Arc From Element exercise location in Block – 24



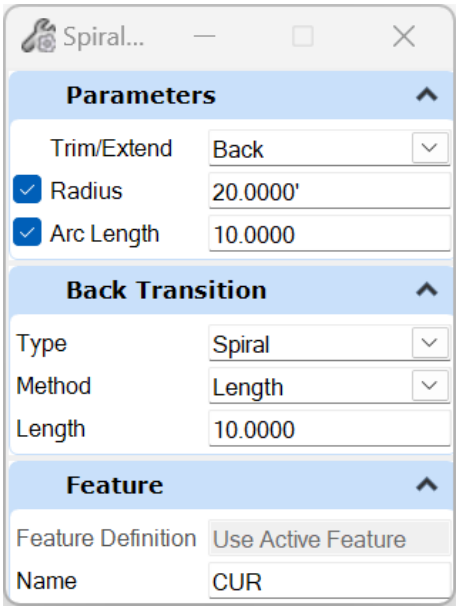
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



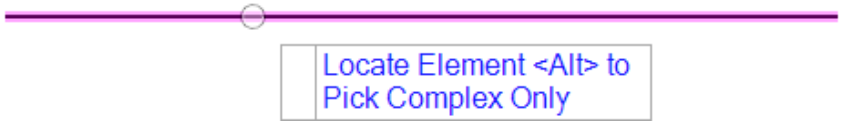
D. Select the **Spiral Arc From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



E. The dialog will appear, this dialog is the same as the **Two Center Arc From Element** tool dialog box, the difference will be selecting the transition type to be a Spiral.
   - Set Trim/Extend to Back
   - Set Radius to 20.00’
   - Set the Arc Length to 10.00’
   - Set the Back Transition Type to Spiral
   - Set Method to Length
     1. There are other options to define a spiral but length is the only option used by NCDOT roadway designers
   - Set the length to 10.00’
     1. This is the radius of the transisiton curve
   - Set the Feature Name to CUR

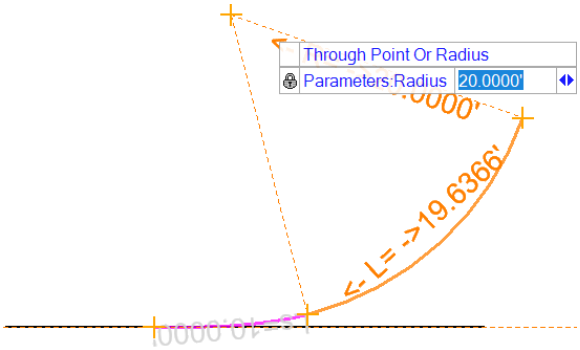


F. Left click to locate the From Element

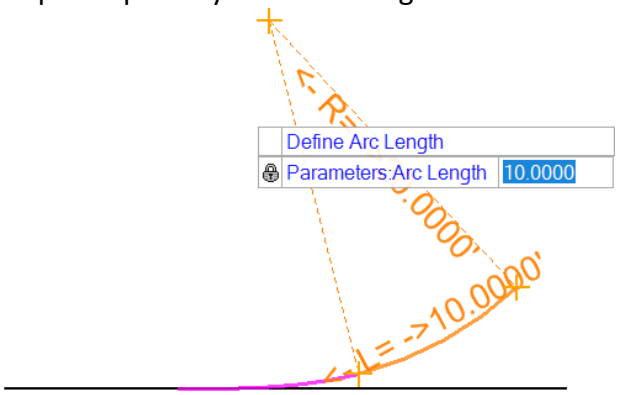


G. Left click to set the start point. This is the point on the From Element where the transition curve will tie tangentially. This can be done by snapping to a point on the From Element or by snapping in space. The dashed black line shows the project to the From Element.

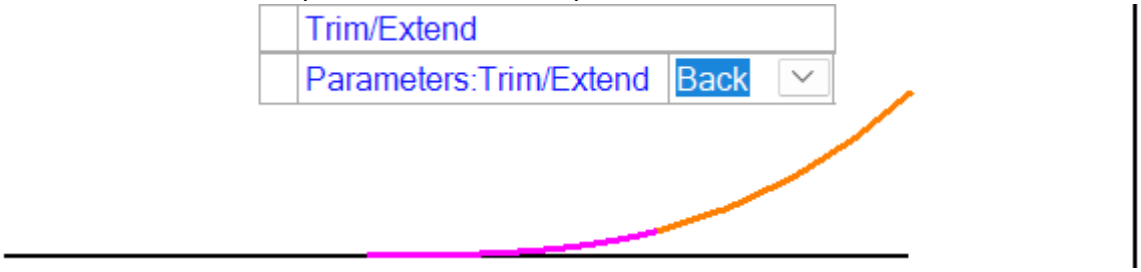
H. Left click to accept the primary curve radius of 20.00’ and to set the location of the solution.



I. Left click to accept the primary curve arc length of 10.00’



J. Left click to accept the Trim/Extend option of Back

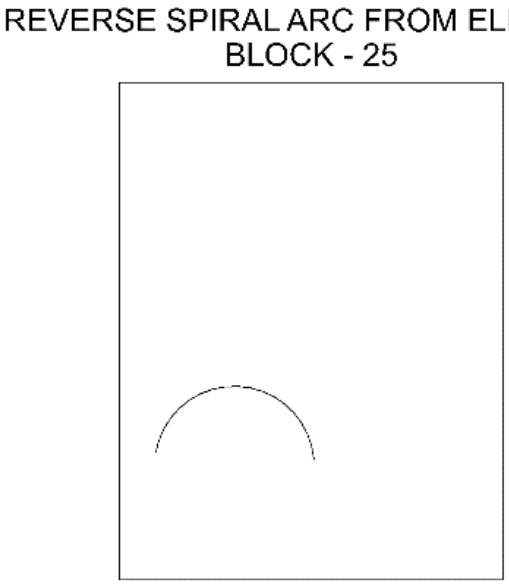


K. This will complete the tool, place the element and trim the From Element to match the transition spiral.

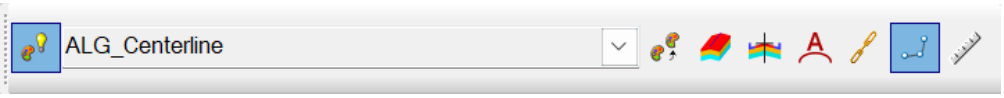
4. Reverse Spiral Arc From Element

A. The **Reverse Spiral Arc From Element** tool draws an Arc with a defined radius and length, and a transition reversing spiral at a user defined start point tangent to a From Element. This tool can only be used when the From Element is an Arc.

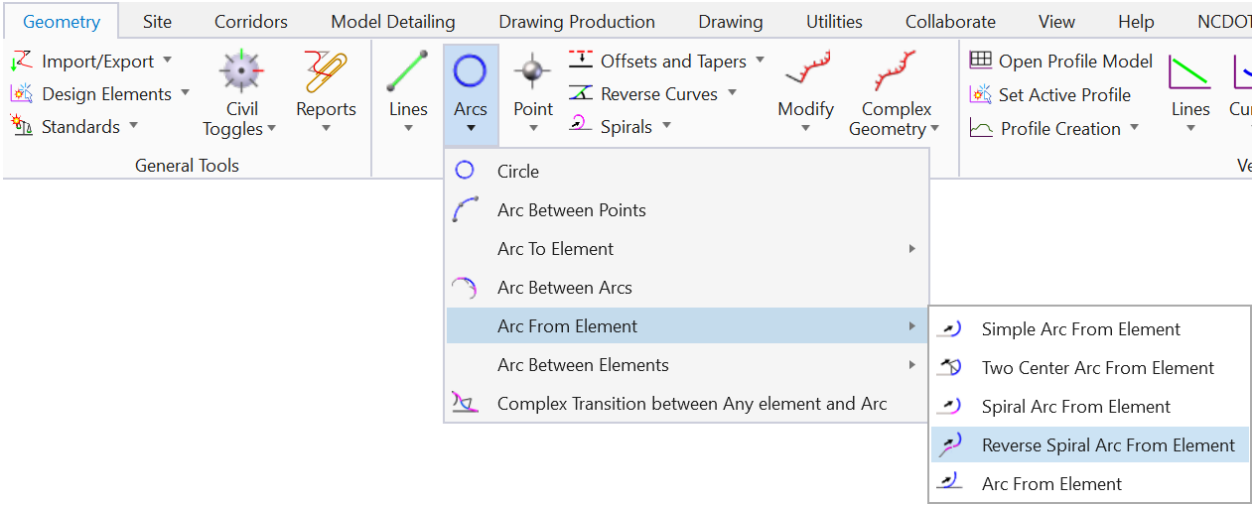
B. Locate the Reverse Spiral Arc From Element exercise location in Block – 25



C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

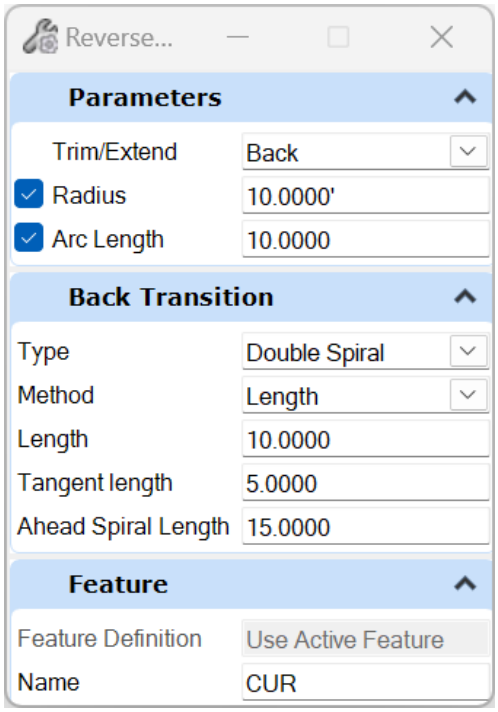


D. Select the **Spiral Arc From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.

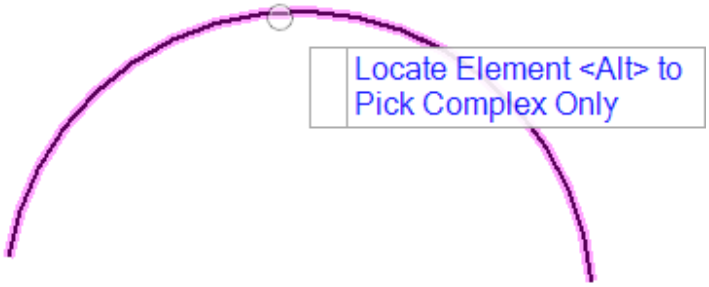


E. The dialog will appear, this dialog is the same as the **Two Center Arc From Element** tool dialog box, the difference will be selecting the transition type to be a Double Spiral.
   - Set Trim/Extend to None
   - Set Radius to 10.00’
   - Set the Arc Length to 10.00’
   - Set the Back Transition Type to Double Spiral
   - Set Method to Length
   - Set the length to 10.00’
     1. This is the length of the first spiral that will be tangent to and turning the same direction as the From Element
   - Set the Tangent Length to 10.00’
     1. This is the tangent length between the spirals
   - Set the Ahead Spiral Length to 15.00’
     1. This is the length of the reversing spiral that will transition to and be curved in the same direction as the primary curve

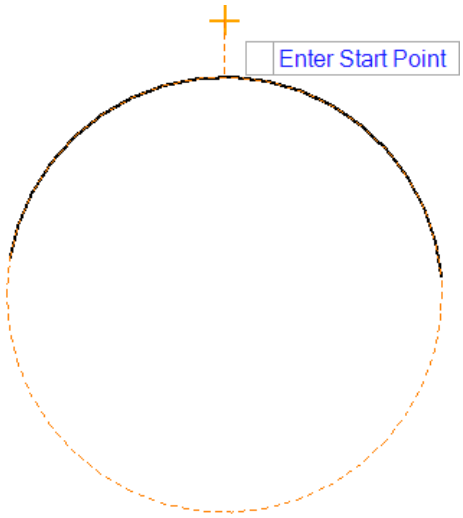
F. Set the Feature Name to CUR



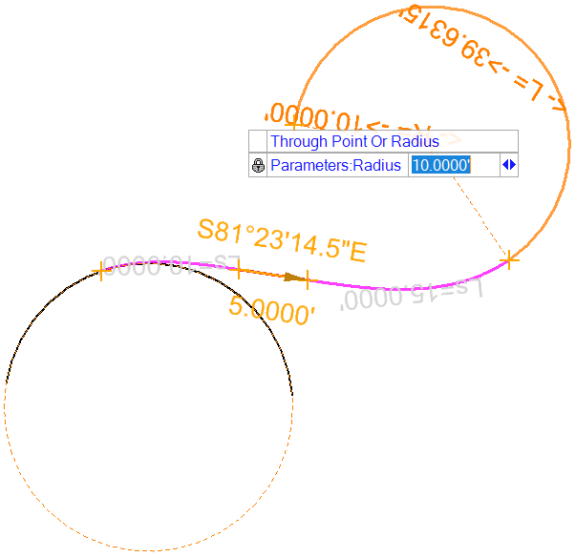
G. Left click to locate the From Element



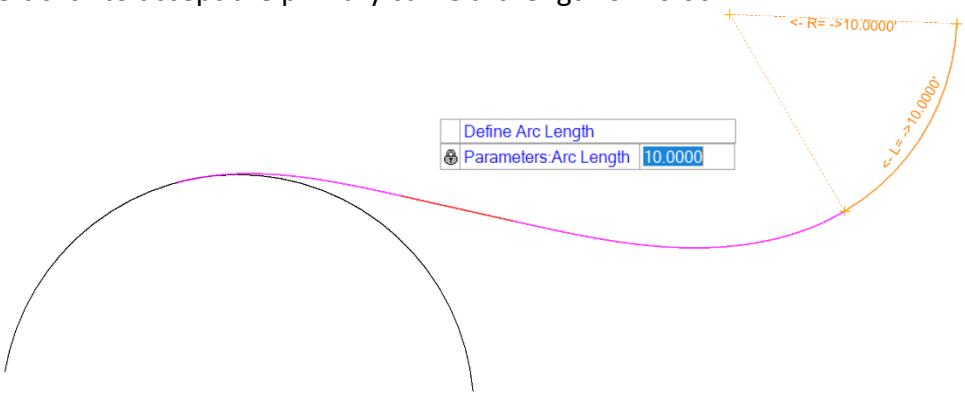
H. Left click to set the start point. This is the point on the From Element where the transition curve will tie tangentially. This can be done by snapping to a point on the From Element or by snapping in space. The dashed black line shows the project to the From Element. Note that the start point can be selected anywhere on the projection of the From Element.



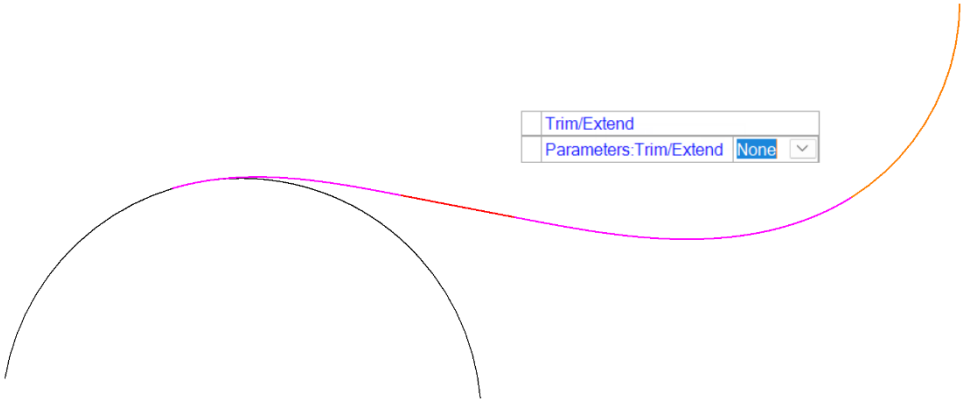
I. Left click to accept the primary curve radius of 10.00’ and to set the location of the solution.



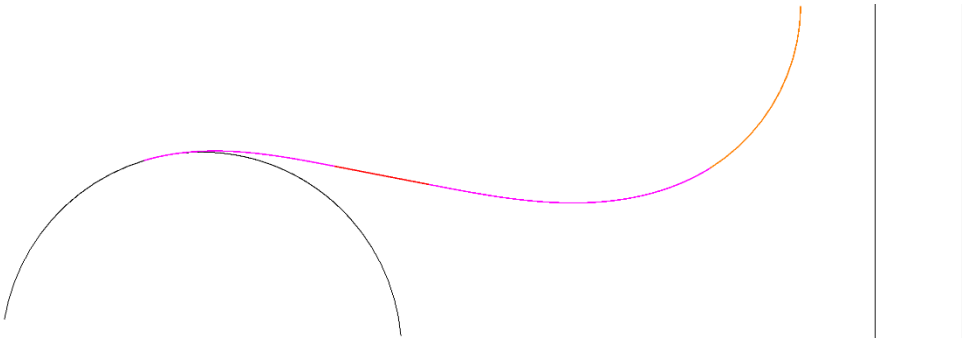
J. Left click to accept the primary curve arc length of 10.00’



K. Left click to accept the Trim/Extend option of Back



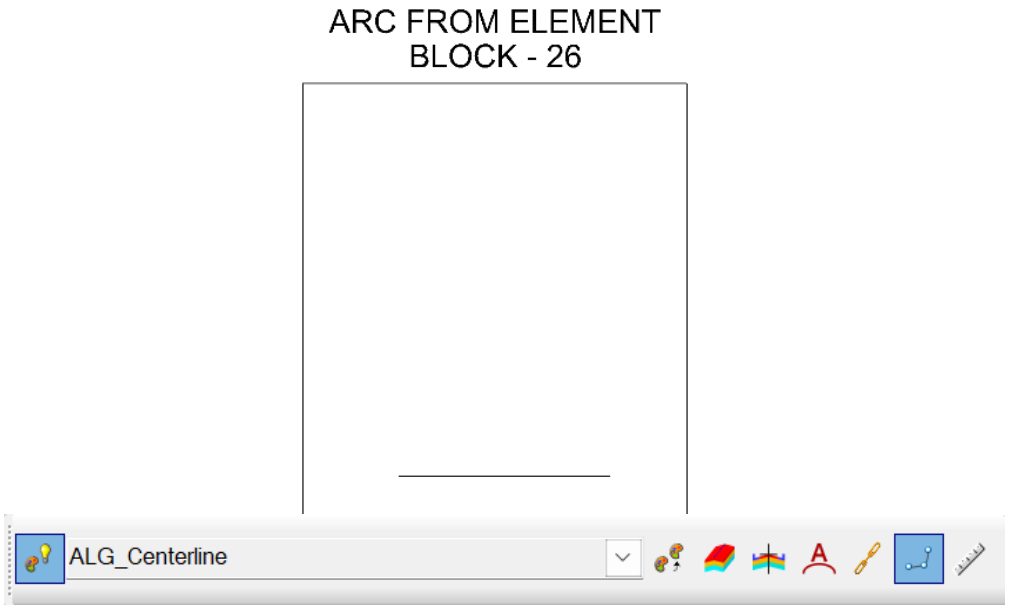
L. This will complete the tool, place the element and trim the From Element to match the transition spiral.



5. Arc From Element

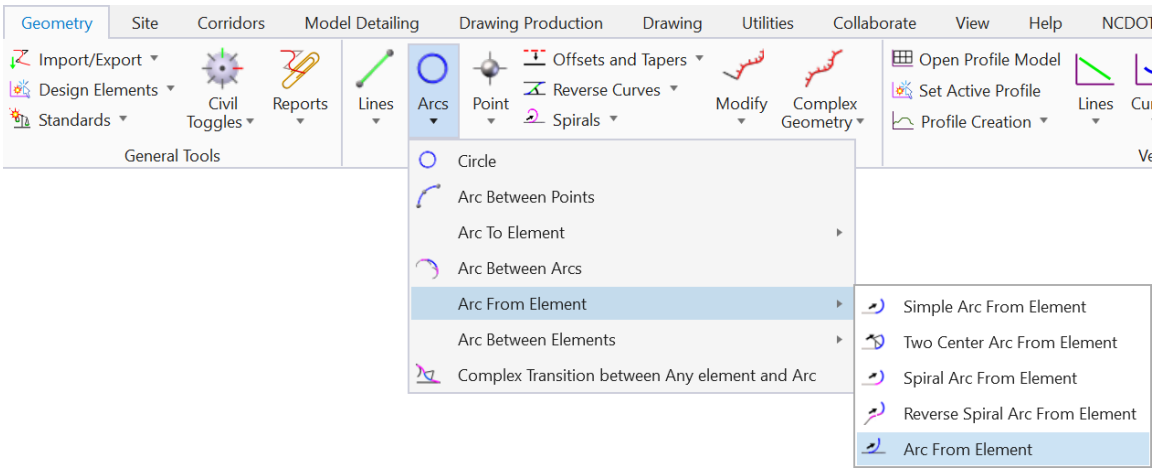
A. The **Arc From Element** tool will allow the user to construct an Arc Element at a specified offset to the From Element. This tool also allows the user to select any of the transition curves to match any of the other tool in the Arcs From Element tool group.

B. Locate the Arc From Element exercise location in Block - 26

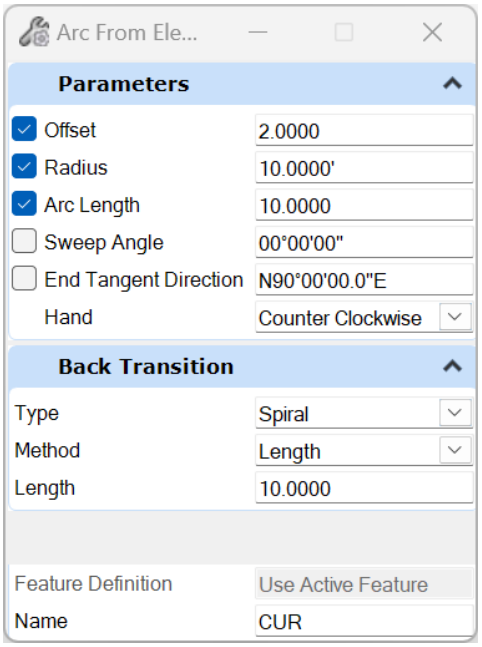


C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

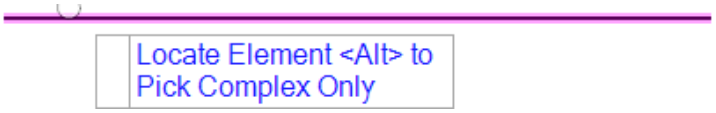
D. Select the **Arc From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



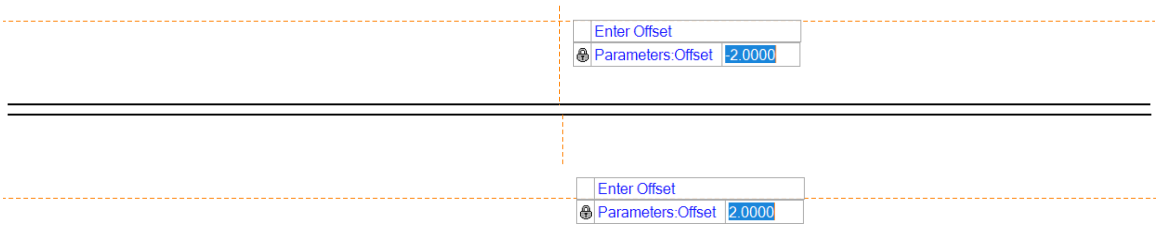
E. The dialog will appear, this dialog will be different than the dialog for the previous tools but will be based on the same concepts and options.
   - Set the offset to 2.00’
     1. This is the offset to the From Element where the Curve or Transition curve will start tangentially. The sign is not important, it only control which side of the From Element the new Arc be constructed and can easily be selected graphically.
   - Set the Radius = 10.00’
   - Set the Length = 10.00’
   - Leave Sweep Angel Unchecked, this will be solved graphically
   - Leave End Tangent Direction Unchecked, this will be solved graphically
   - Set Hand to Counter Clockwise, this setting is also easily changed graphically during placement of the Arc.
   - Set Back Transition Type to Spiral
     1. All the transition types in the Arc From Element tool group are available
   - Set Method to Length
   - Set Length to 10.00’
   - Set Feature Definition Name to CUR



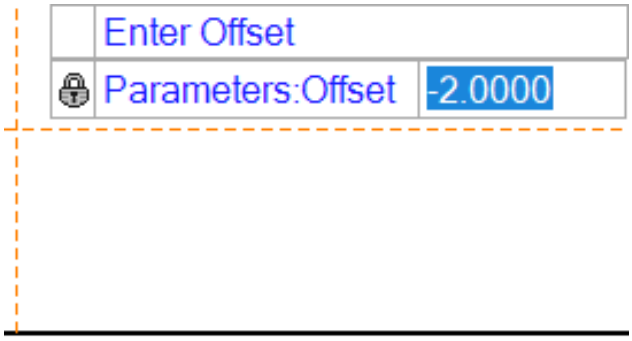
F. Left click to locate the From Element.



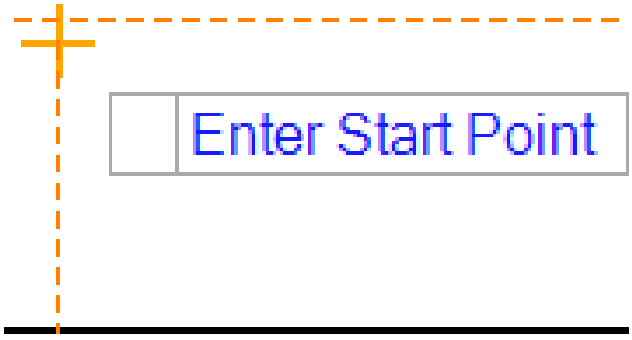
G. Left click to select the offset. Based on the position of the cursor this will be to the Left (-) or Right (+) of the From Element.



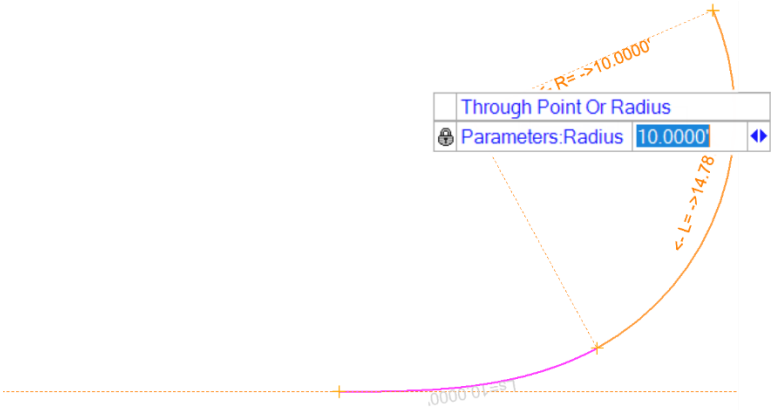
H. Left click to select the Left (-) side of the From Element.



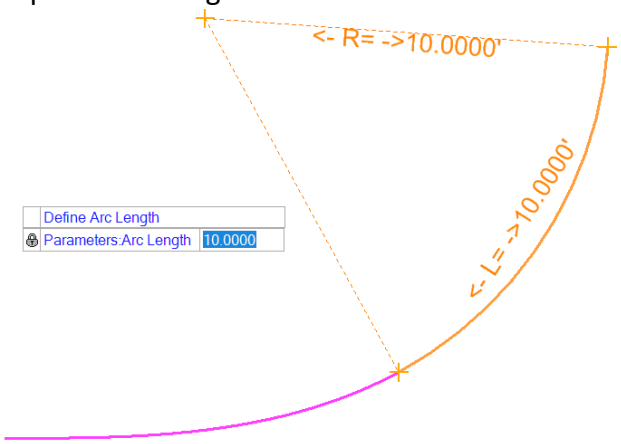
I. Left click to accept the start point.



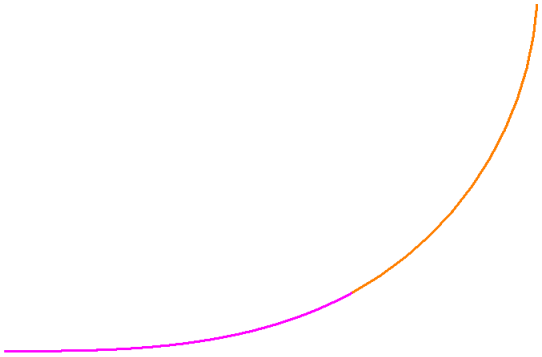
J. Left click to accept the Arc radius of 10.00’



K. Left click to accept the Arc length of 10.00’

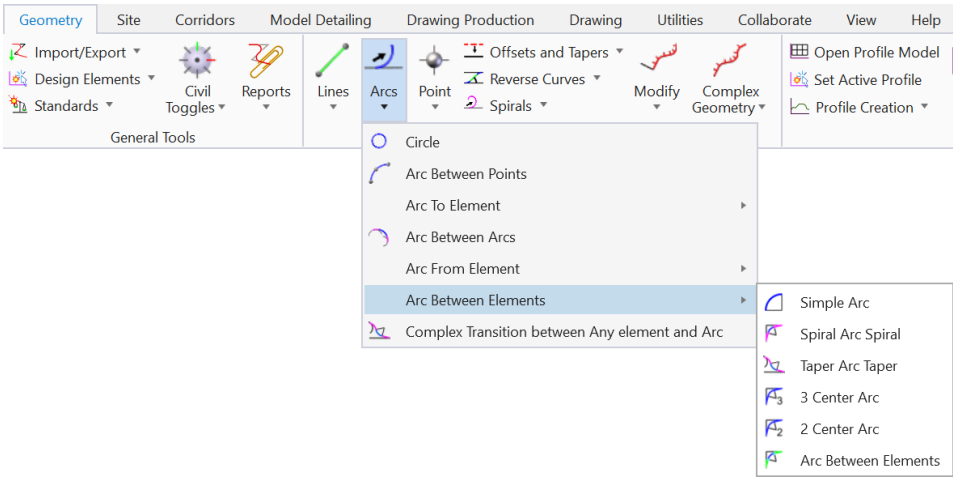


L. For the selected transition type of Spiral this will finish the tool and place the element.



Arc Between Elements Tool Group

Arc Between Element Tools are under the **Arcs** tool group of the *Horizontal* section of the *Geometry* Ribbon<



This group contains tools that will allow the user to construct an arc between two previously placed elements. This tool has the ability to optionally apply a back and/or forward transition and/or taper between the elements and the constructed arc. This tool group will be commonly used by the roadway designer.

These tools function in a very similar manner to the previous tools, the main difference being that instead of a single element as the To or From reference element this tool involves two elements. For detailed explanations of the available options and the way in which the options affect the solution refer to the previous sections on the To Element and From Element tools.

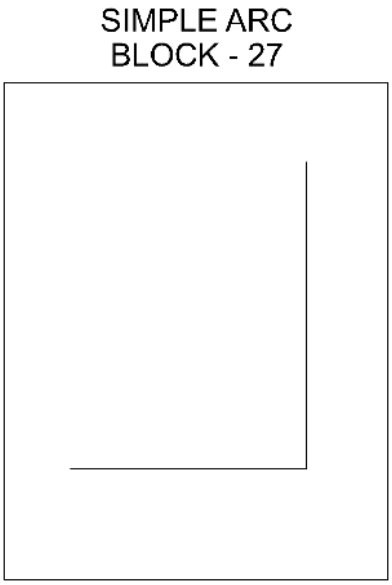
This group contains 6 tools

- **Simple Arc**
  - Creates a simple arc without spirals or tapers at both ends.
- **Spiral Arc Spiral**
  - Creates an arc with spiral transitions but no tapers at both ends.
- **Taper Arc Taper**
  - Creates an arc with tapers but no transitions at both ends
- **3 Center Arc**
  - Creates an arc with radius transitions at both ends, a three centered curve.
- **2 Center Arc**
  - Creates an arc with radius transitions at one end, a two centered curve
- **Arc Between Elements**
  - Creates an arc between two previously placed elements

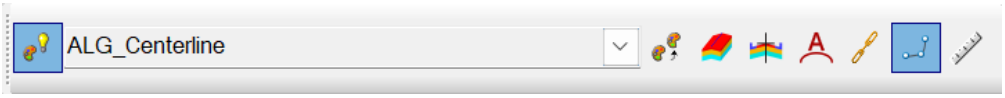
1. Simple Arc

A. The **Simple Arc** tool draws an Arc with no transitions between two previously placed elements. For these exercises the previous elements will be lines but they could be arcs or any combination of elements.

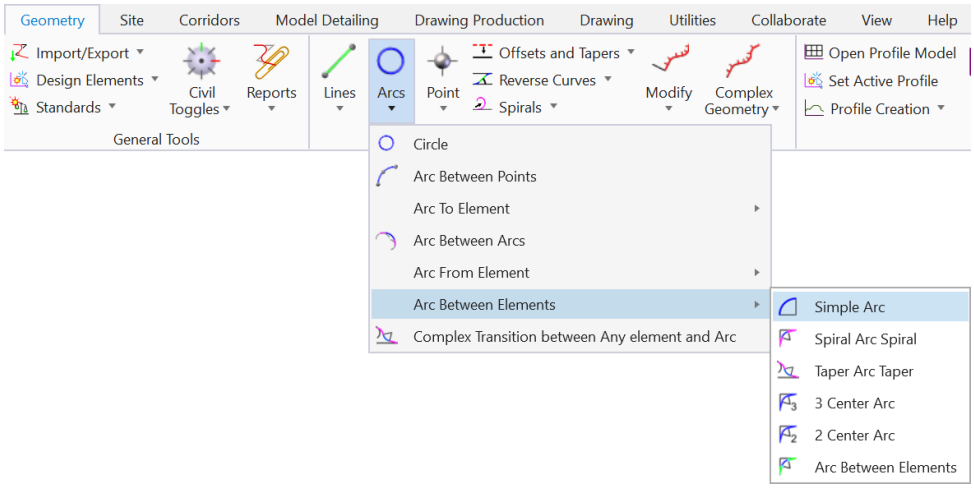
B. Locate the Simple Arc exercise location in Block 27



C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

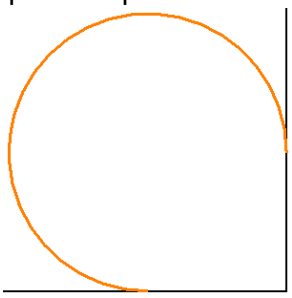


D. Select the **Simple Arc** tool from the *Horizontal* section of the *Geometry* Ribbon.

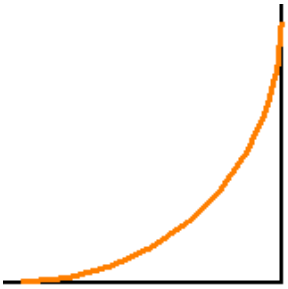


E. The dialog will appear

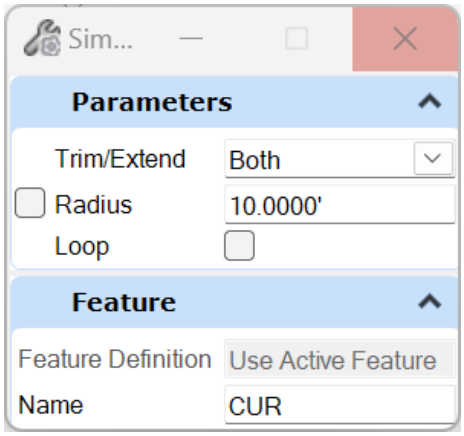
- Set Trim/Extend Option to Both
- Leave the Radius unchecked
- Leave Loop Unchecked
  1. Loop is a special option for this group of tools, if loop is checked the solution will be the longest possible path



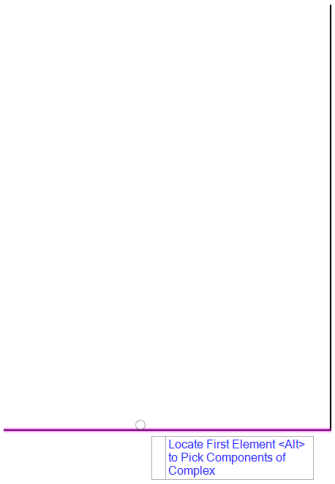
If loop is unchecked the solution will be the shortest possible path.



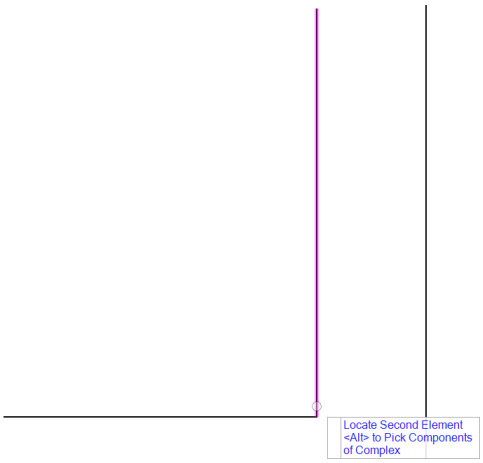
- Set Feature Definition Name to CUR



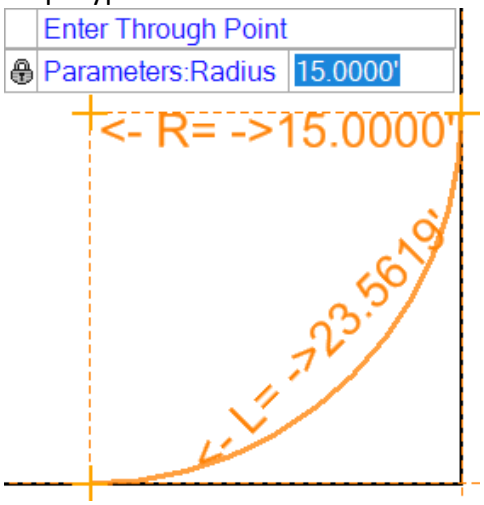
F. Left click to locate the first element



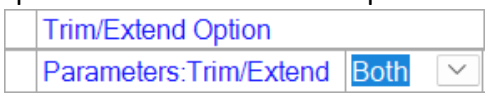
G. Left click to locate the second element



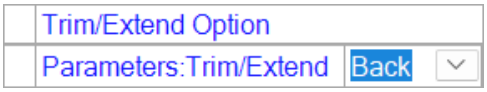
H. At the heads up prompt type in 15.00’ for the radius and left click to accept.



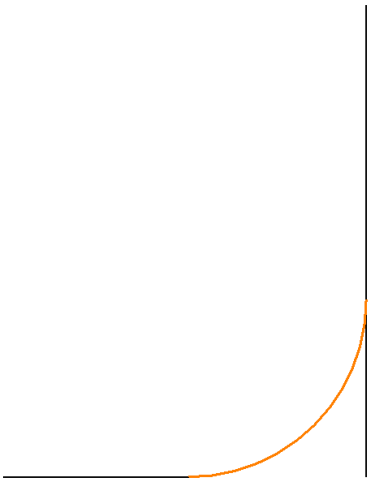
I. The heads up prompt will switch to the Trim Option



J. Use the <DOWN> Arrow key to switch to the Back option and left click to accept.



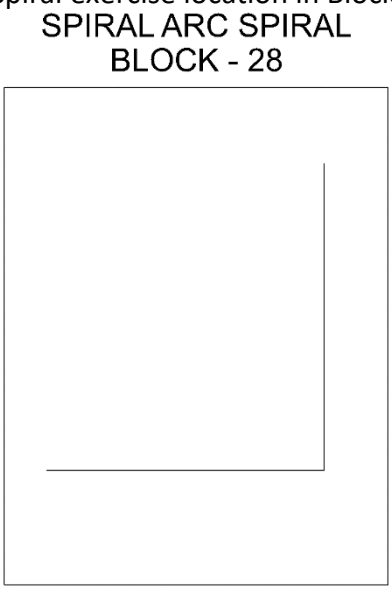
K. This will complete the tool and place the curve. This also trims the back element to match the curve, this was the first element selected as a reference.



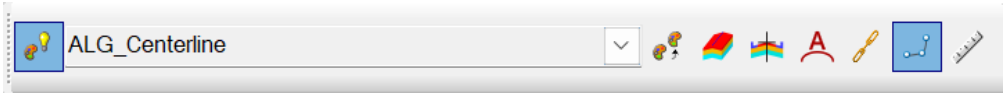
6. Spiral Arc Spiral

A. The **Spiral Arc Spiral** tool draws an Arc between two previously placed elements. Similar to the other Arc tools there are options for the transitions to be Spirals to match the tool or to be curves or a combination of both.

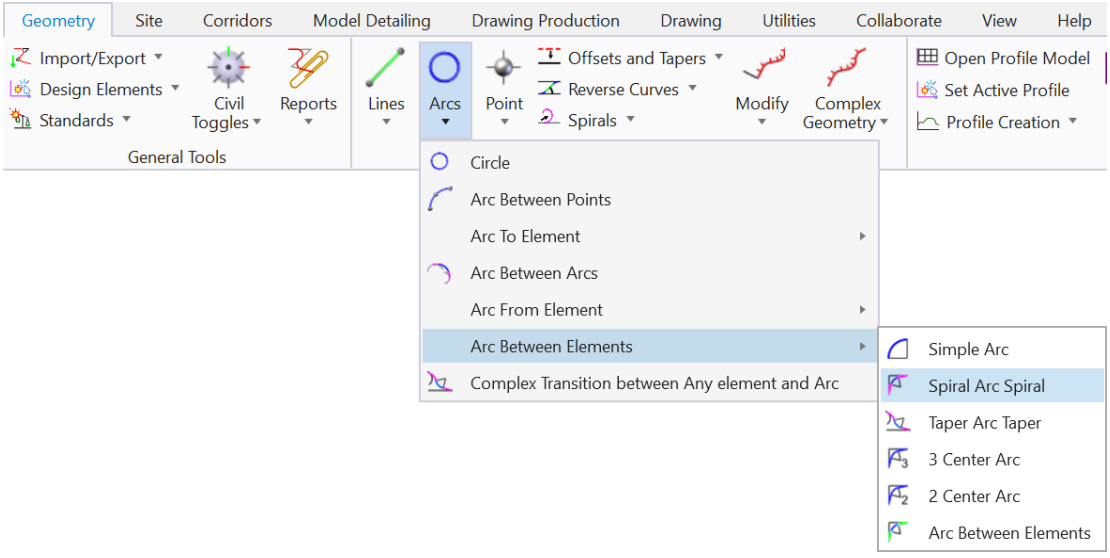
B. Locate the Spiral Arc Spiral exercise location in Block – 28.



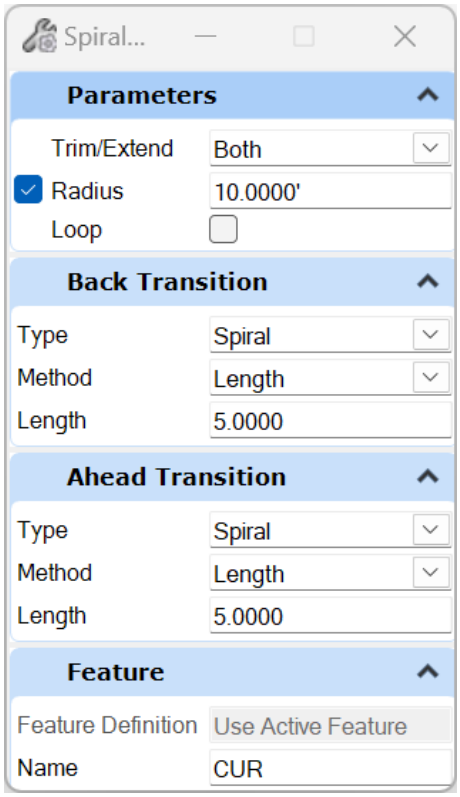
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



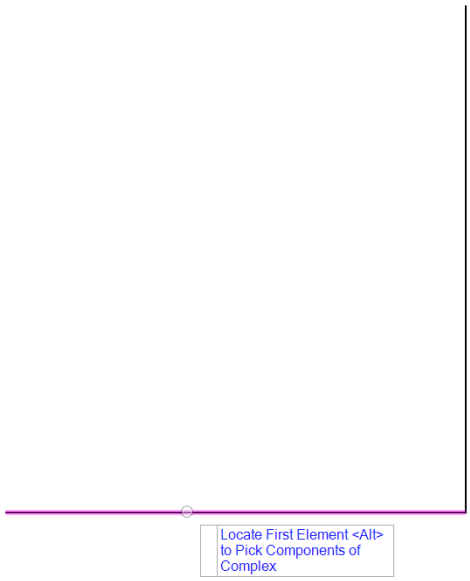
D. Select the **Spiral Arc Spiral** tool from the *Horizontal* section of the *Geometry* Ribbon.



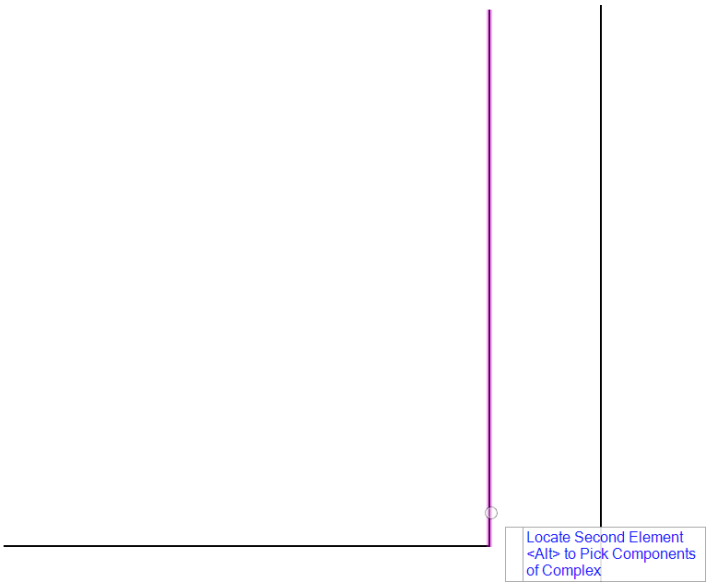
E. The dialog will appear
- Set Trim/Extend to Both
- Set Radius to 10.00’
  1. This is the radius for the central Arc
- Leave Loop Unchecked
- Set Back Transition to Spiral
  1. There are options for None, Curve and Arc Ratio that are the same as the options in the To and From tools.
- Set Method to Length
- Set Length to 5.00’
- Set the same options for the Ahead Transition
- Set the Feature Definition Name to CUR



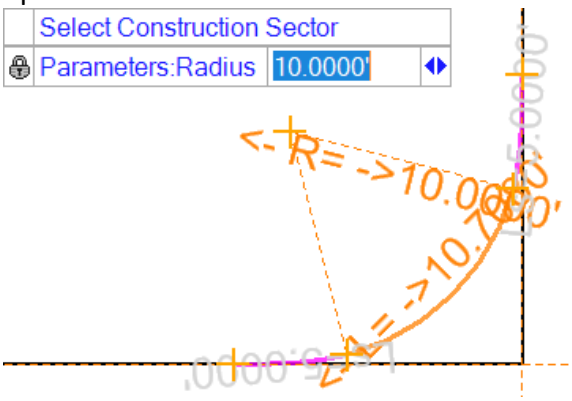
F. Left click to locate the first element



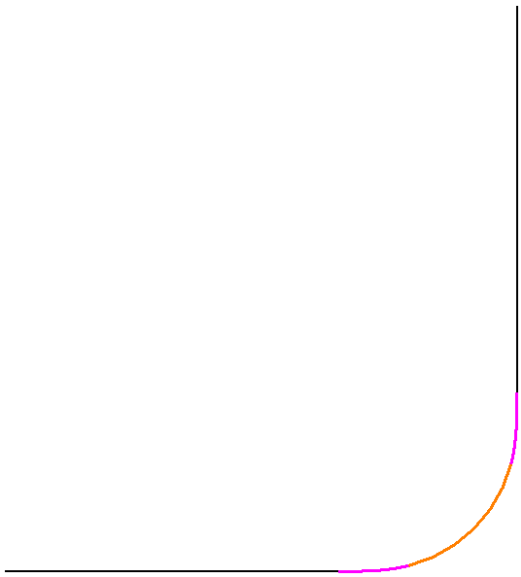
- Left click to locate the second element



G. Left click to accept the Central Arc radius of 10.00’



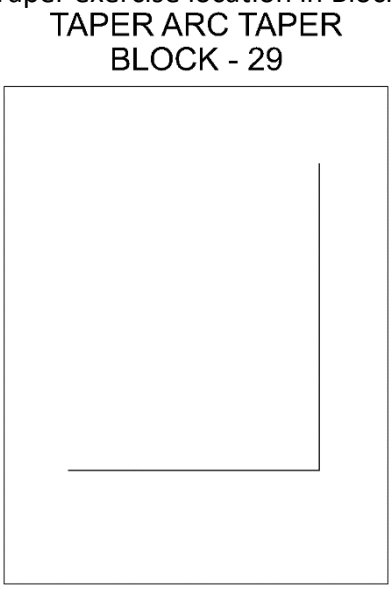
H. Left click to accept the Trim option of Both. This will complete the tool and place th Spiral Curve Spiral combination. This also trims the reference elements to the spiral transitions.



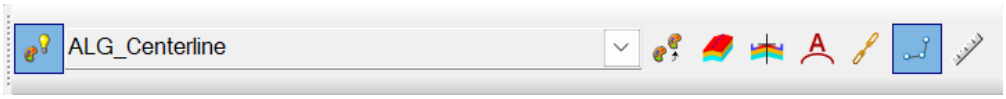
3. Taper Arc Taper

A. The **Taper Arc Taper** tool will construct a central Arc with a linear taper on one or both ends.

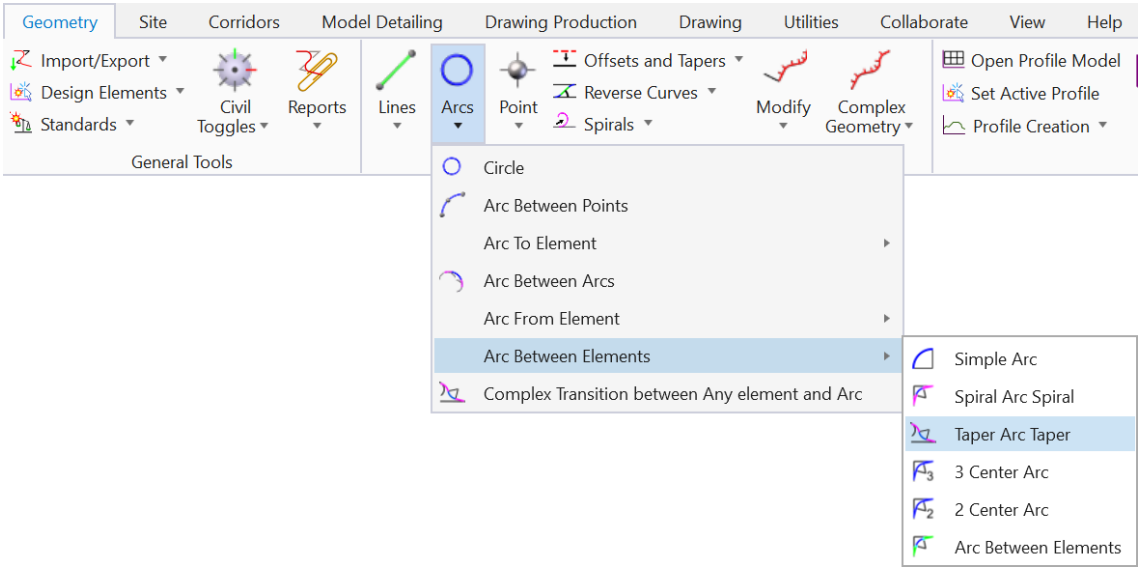
B. Locate the Taper Arc Taper exercise location in Block – 29



C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

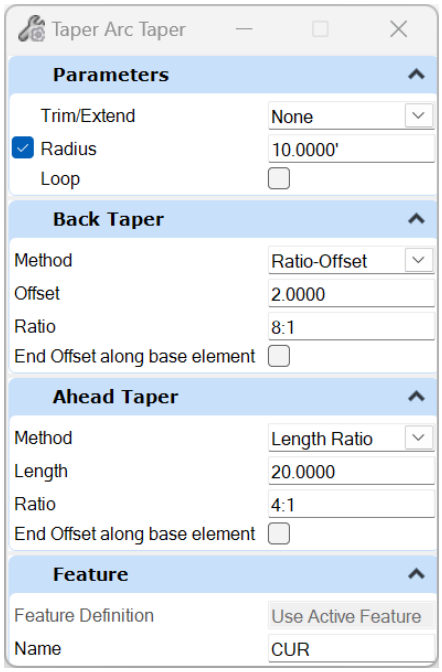


D. Select the **Taper Arc Taper** tool from the *Horizontal* section of the *Geometry* Ribbon.

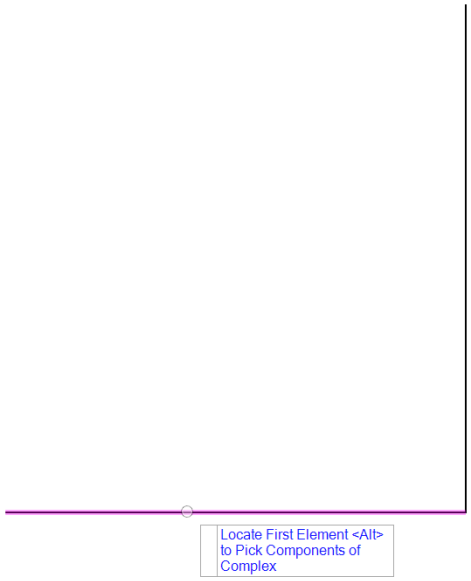


E. The dialog will appear

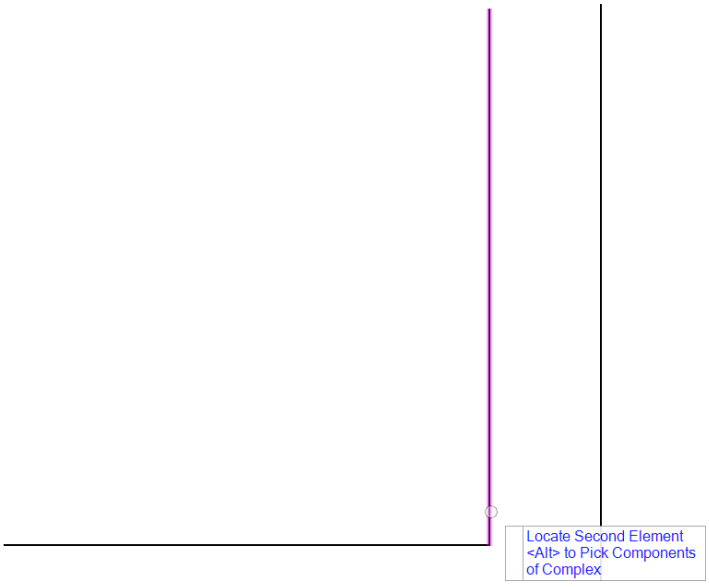
- Set Trim/Extend option to None
- Set the radius to 10.00’
- Leave Loop Unchecked
- Set Back Taper Method to Ratio Offset
    1. Ratio Offset will determine the length of the taper based on the specified taper ratio, corresponding to length along the reference element per 1.00 offset from the reference element.
    2. Length Ratio will determine the offset by using a specified length at a specified ratio
    3. Length Offset will determine the ratio based on the specified length and offset.
- Set Offset to 2.00’
    1. This is the offset from the first element to the start point of the central arc
- Set End Offset along base element checked off.
    1. The option will only make a difference when one of the base elements is an Arc.
    2. If check on the offset will be measured based on the position of the end point of the taper in relation to the Arc.
    3. If checked off the offset will be measured based on the position of the end point of the taper in relation to a line that is tangent to the Arc at the point where the taper starts.
- Set Ratio to 8:1
    1. This is the ratio, longitudinal to perpendicular, of the taper
- Set Ahead Taper Method to Length Ratio
- Set Length to 20.00’. This is the total length of the taper
- Leave End Offset along base element unchecked
- Set Ratio to 4:1
- Set Feature Definition name to CUR



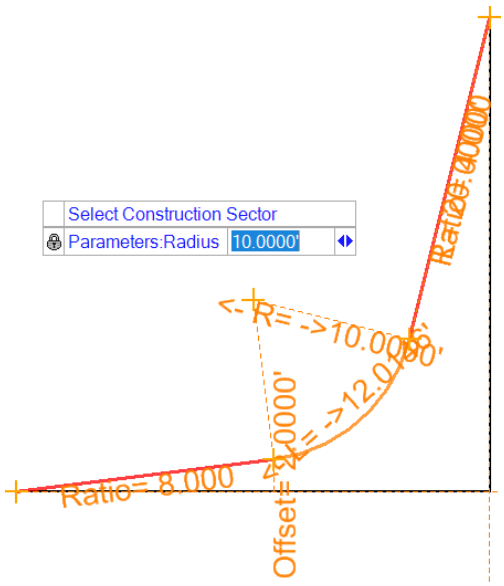
F. Left click to locate the first element, this is the Back element



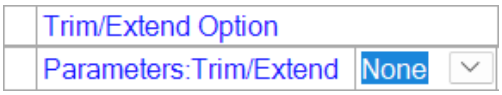
G. Left click to locate the second element, this is the Ahead element



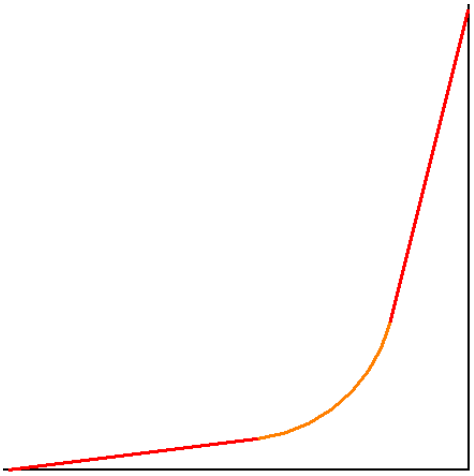
H. Left click to accept the central Arc radius of 10.00’ and to set the location of the solution.



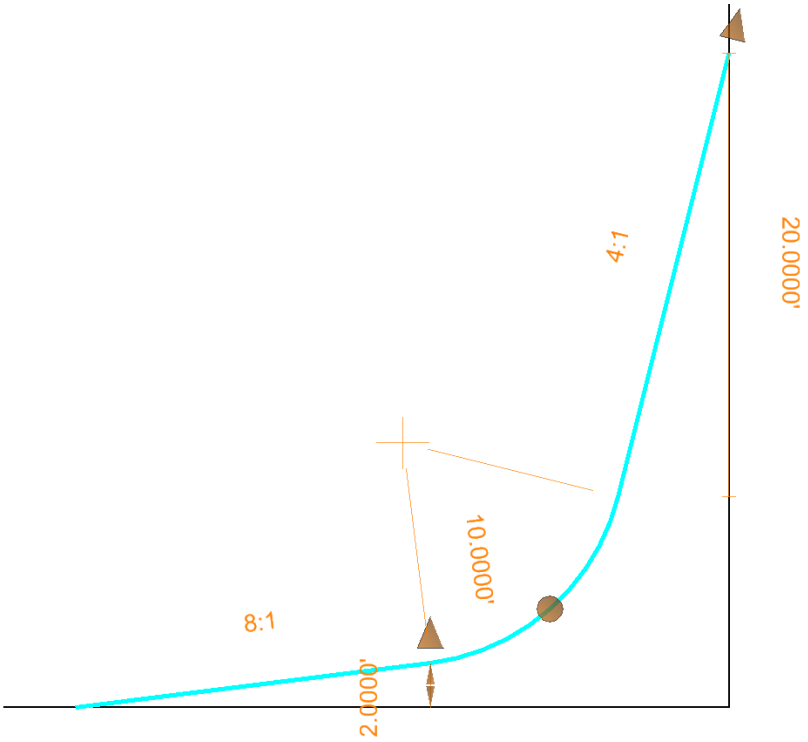
I. Left click to accept the Trim Parameters of None



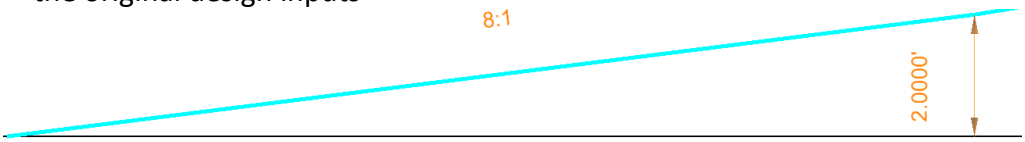
J. That Completes the tool and places the Taper Arc Taper combination.



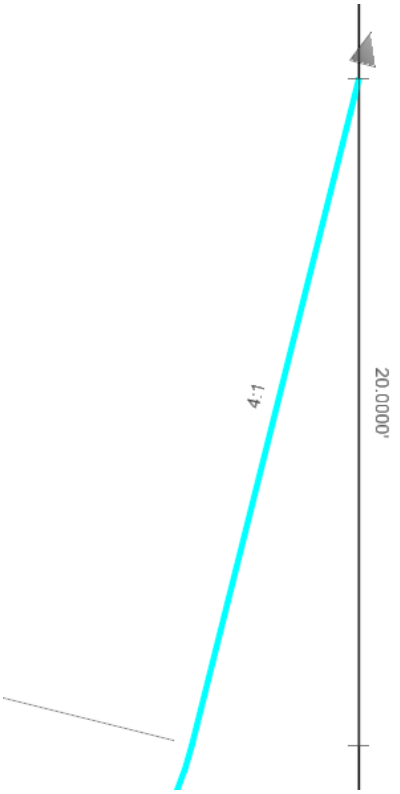
K. Use the Element Selection tool to highlight the element and display the drag handles and text manipulators.



L. Note that the manipulators displayed match the original design parameters. For the Back Taper the manipulators display an 8:1 Taper and a 2.00’ Offset. This matches the original design inputs



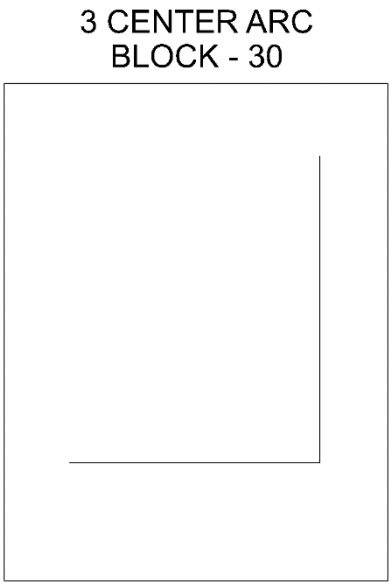
M. For the Ahead Taper the manipulators display a 4:1 Taper and a total taper length of 20.00’



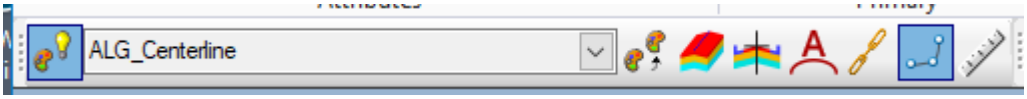
4.3 Center Arc

A. The **3 Center Arc** tool draws a 3 Centered Curve between two previously placed elements. This function of this tool is like the **Spiral Arc Spiral** tool but instead of spiral transitions the user specifies arc transitions.

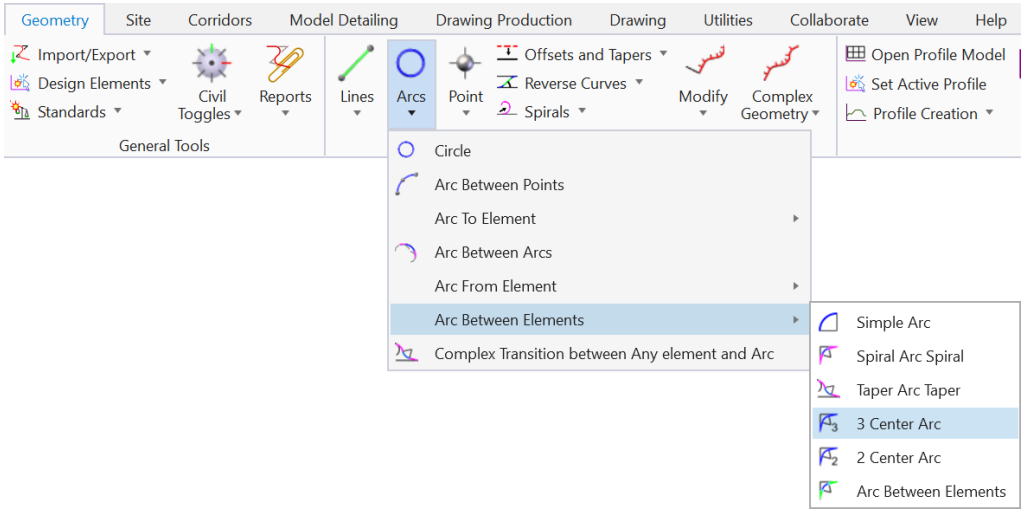
B. Locate the 3 Center Arc exercise location in Block – 30



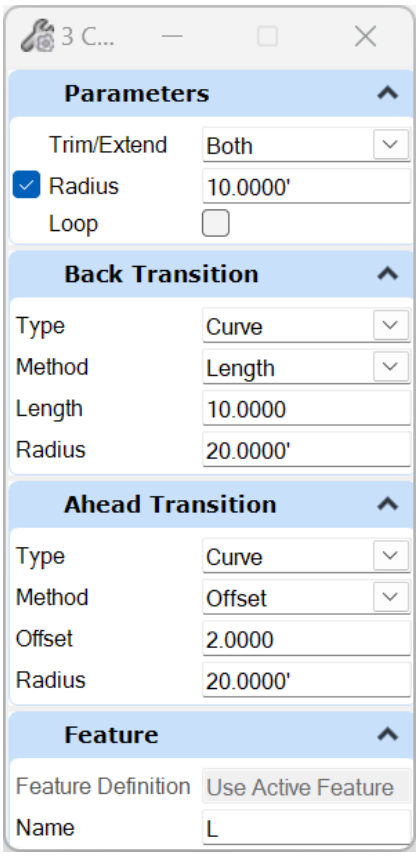
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



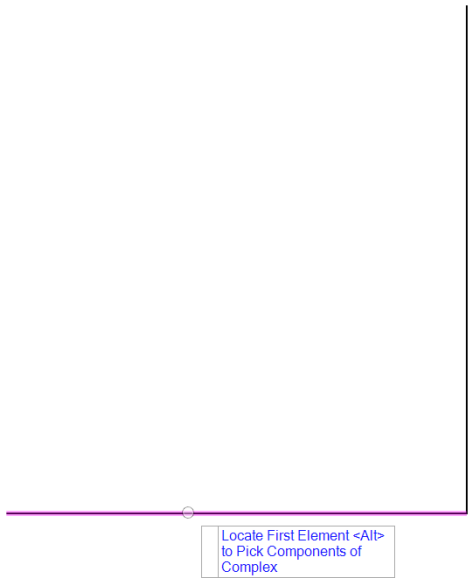
D. Select the **Spiral Arc Spiral** tool from the *Horizontal* section of the *Geometry* Ribbon.



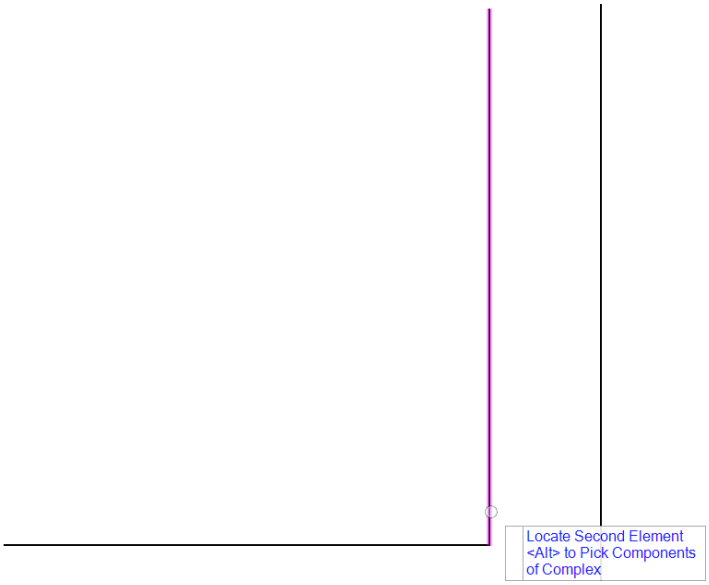
E. The dialog will appear, this matches the dialog used for the **3 Center Arc** tool.
- Set the Trim/Extend option to Both
- Set the Radius to 10.00’
- Leave the Loop box Unchecked
- For Back Transition set the Type to Curve
- Set the Method to Length
- Set the Radius to 20.00’
- Set the Length to 10.00’
- For Ahead Transition set the Type to Curve
- Set the Method to Offset
- Set the Radius to 20.00’
- Set the Offset to 2.00
  1. This is the offset from the Ahead element to the point where the central arc ends and the ahead transition begins
- Set the Feature Definition name to CUR



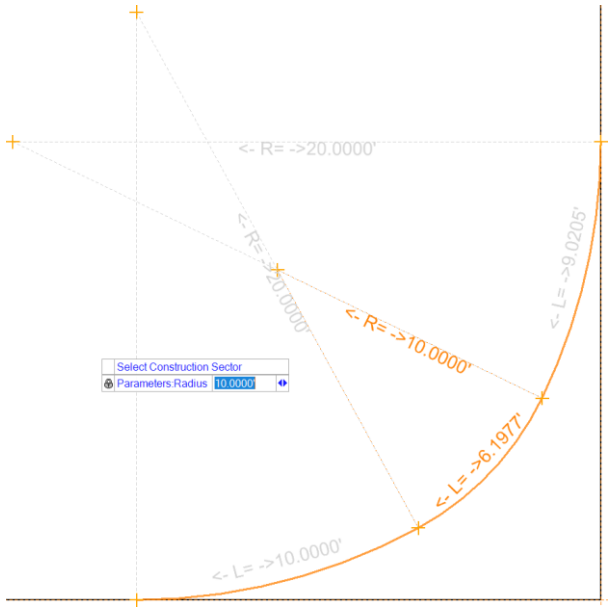
F. Left click to locate the first element.



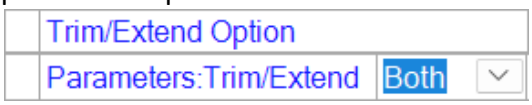
G. Left click to locate the second element.



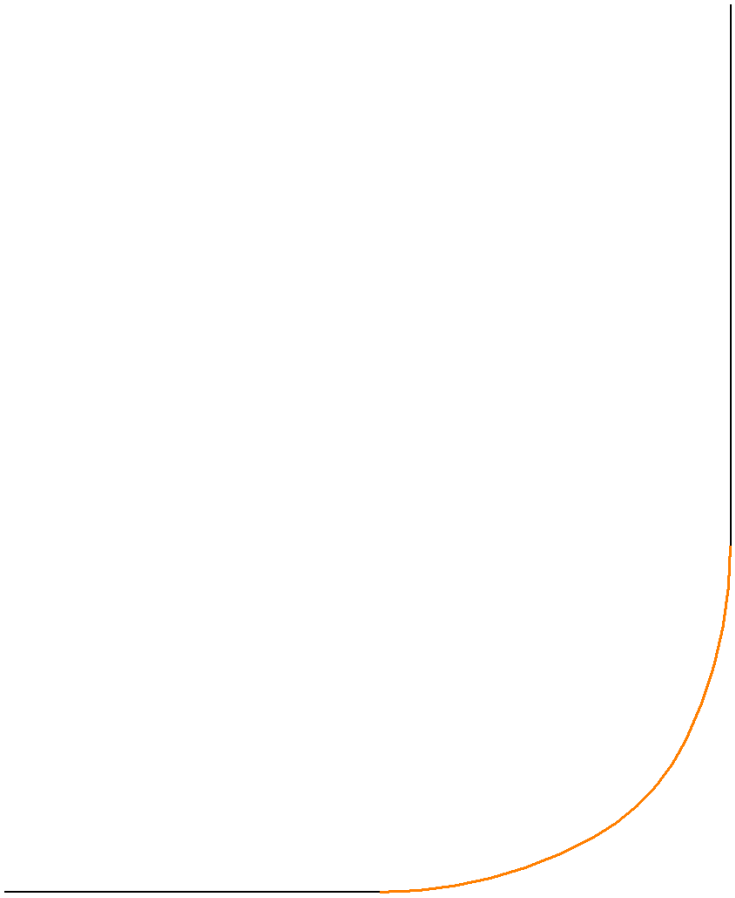
H. Left click to accept the central arc radius of 10.00’ and to set the location of the solution.



I. Left click to accept the trim option of Both.



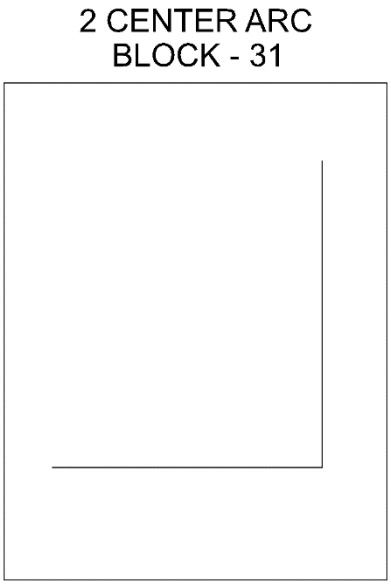
J. This will complete the tool and place the element. This will also trim both base elements to match the curve transitions.



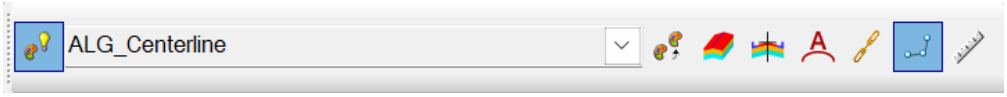
5.2 Center Arc

A. The **2 Center Arc** tool draws a 2 Centered Curve between two previously placed elements. This function of this tool is like the **3 Center Arc** tool but there is no option for an ahead transition. The **3 Center Arc** tool could be used to produce the same result by setting the ahead transition to None.

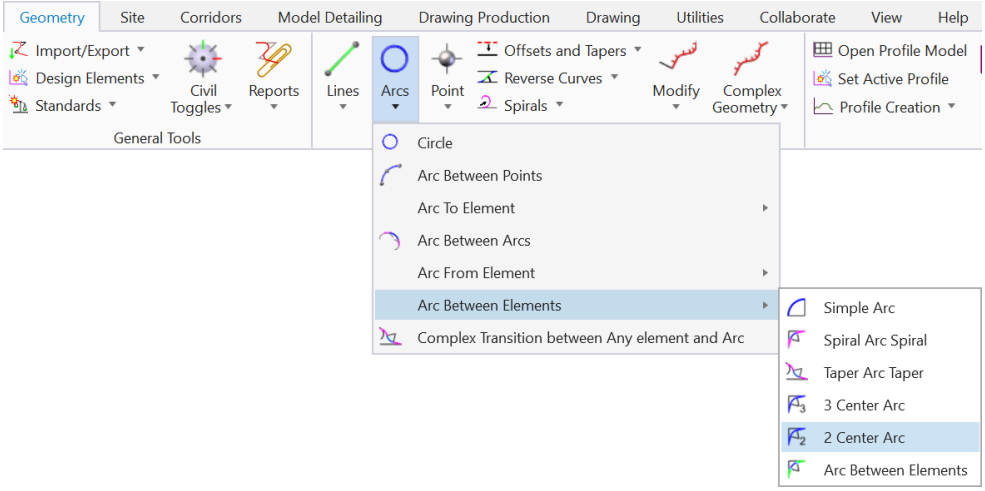
B. Locate the 2 Center Arc exercise location in Block – 30



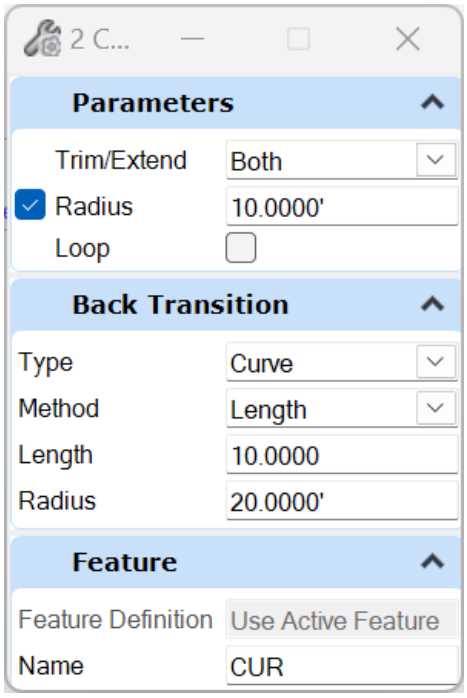
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



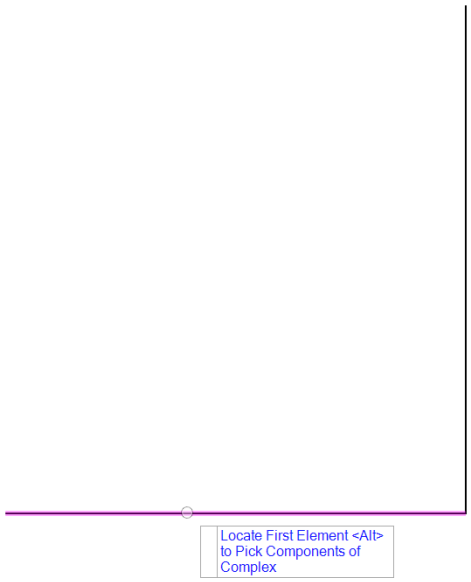
D. Select the **2 Center Arc** tool from the *Horizontal* section of the *Geometry* Ribbon.



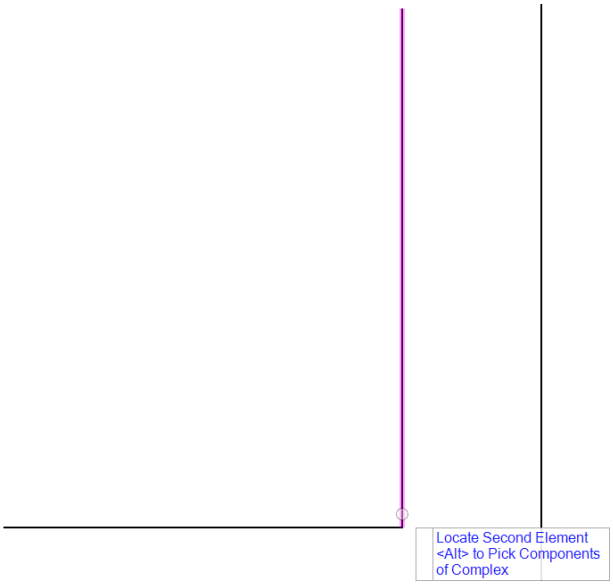
E. The dialog will appear, this will be like the 3 Center Arc dialog but will not have a section for the ahead transition.
   - Set the Trim/Extend option to Both
   - Set the Radius to 10.00’
   - Leave the Loop box Unchecked
   - For Back Transition set the Type to Curve
   - Set the Method to Length
   - Set the Radius to 20.00’
   - Set the Length to 10.00’
   - Set the Feature Definition name to CUR



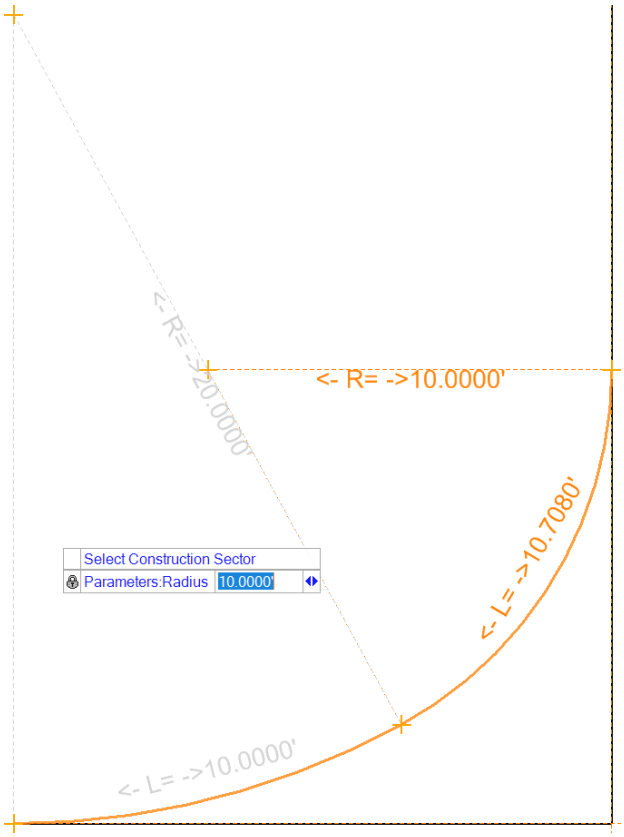
F. Left click to locate the first element.



G. Left click to locate the second element.

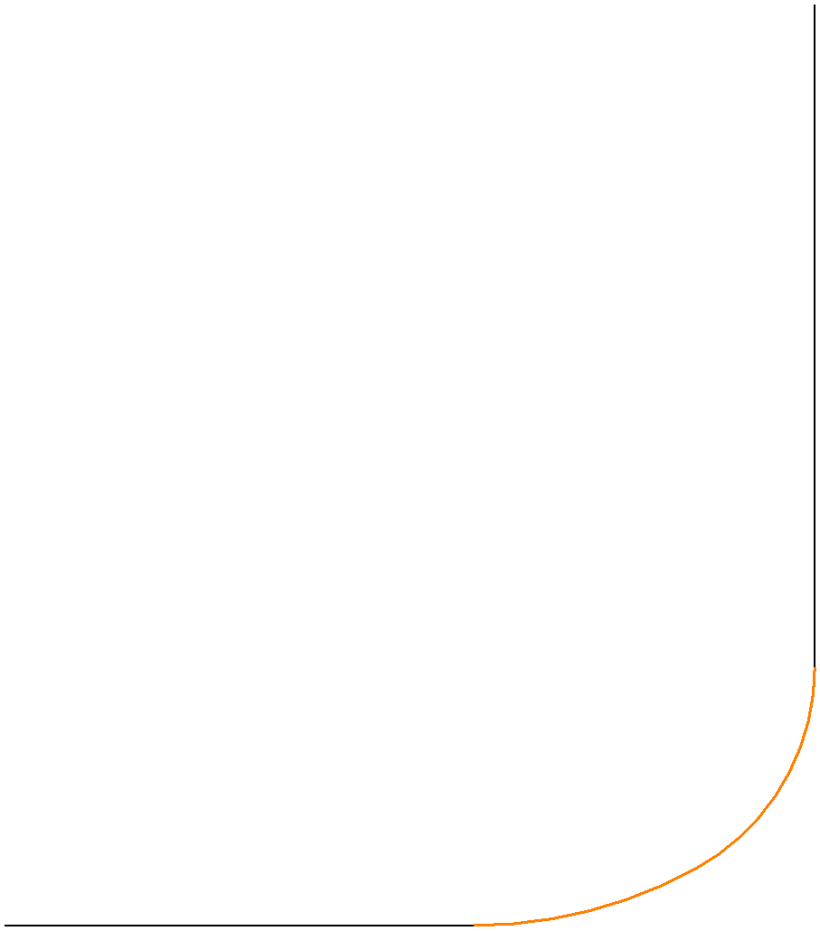


H. Left click to accept the central arc radius of 10.00’ and to set the location of the solution.



I. Left click to accept the trim option of Both.

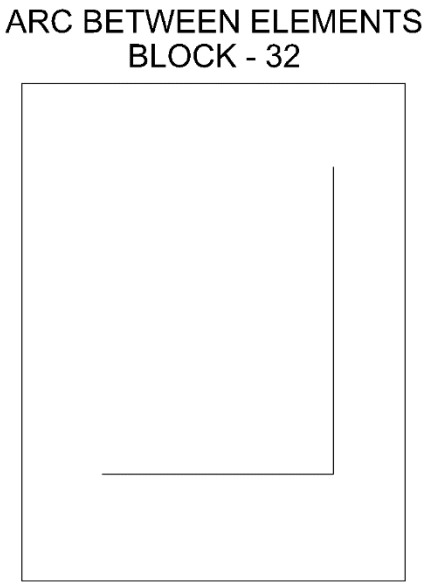
J. This will complete the tool and place the element. This will also trim both base elements to match the curve transitions.



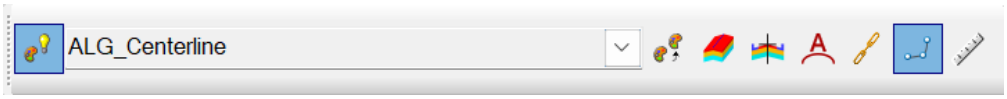
6. Arc Between Elements

A. The **Arc Between Elements** tool is the most powerful tool in this group. It combines all of the available options to use tapers and offsets and includes the option to offset the entire element group from the base elements.

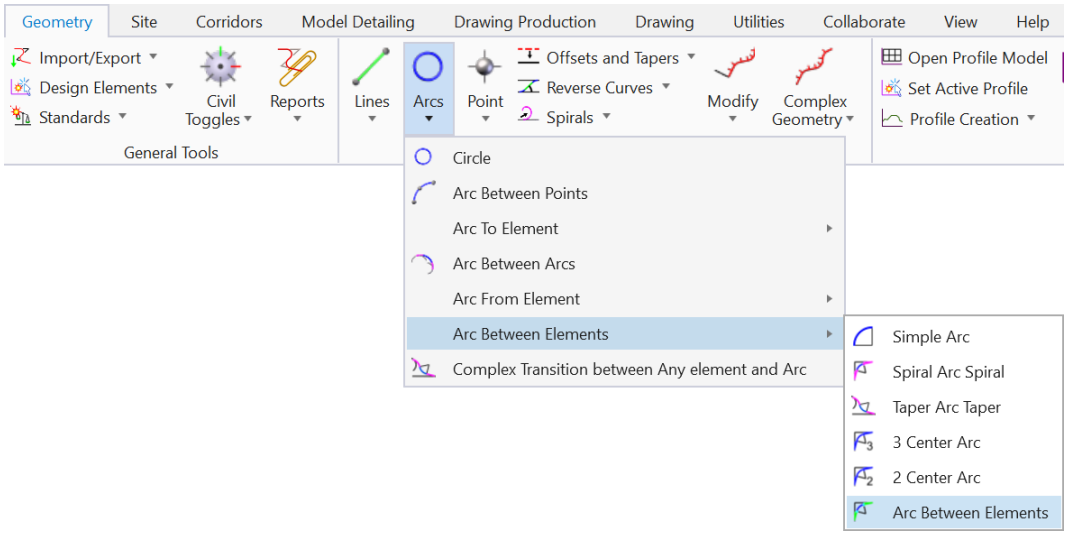
B. Locate the Arc Between elements exercise location in Block -32



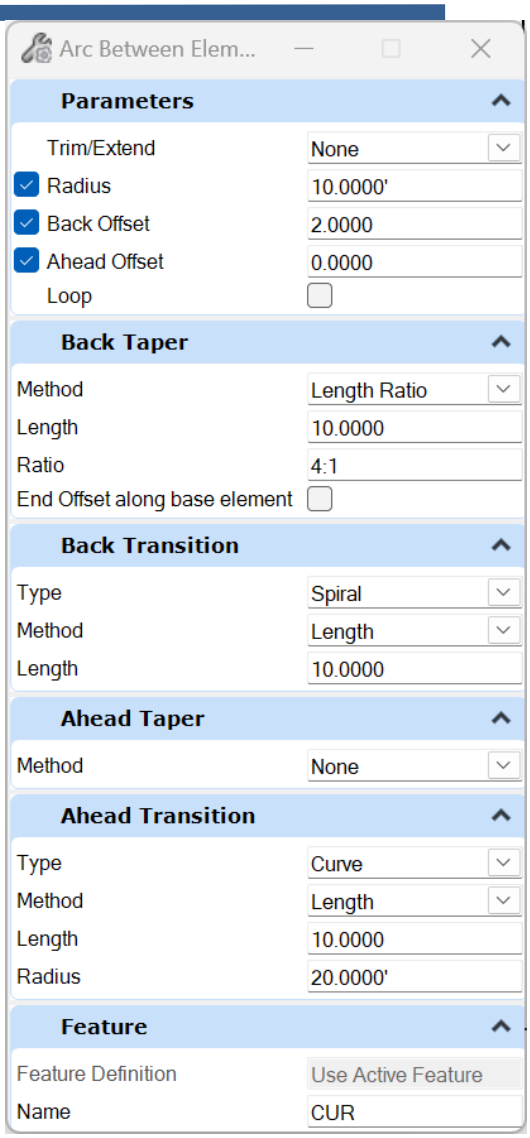
C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



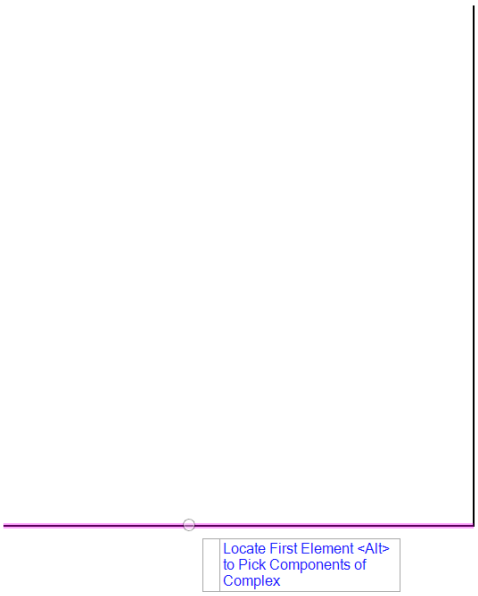
D. Select the **Arc Between Elements** tool from the *Horizontal* section of the *Geometry* Ribbon.



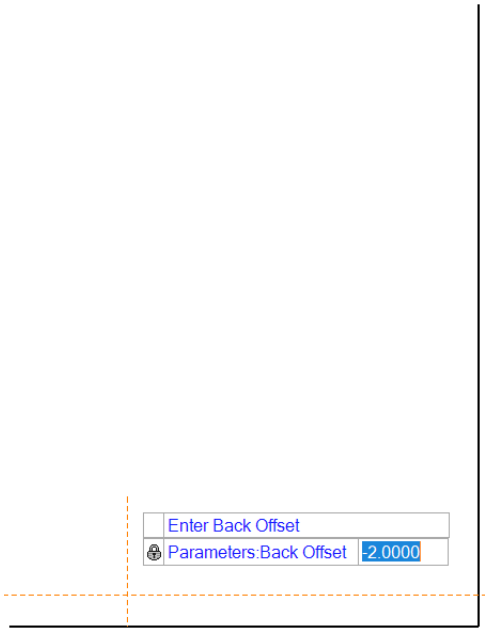
E. The dialog will appear, this will be the largest dialog box in the tool group with the most options but all of the options have been used in previous tools.
   - Set the Trim/Extend option to None
   - Set the Radius to 10.00’
   - Set the Back Offset to 2.00’
     1. This is the offset of the transition or taper, if there is one, to the base element
   - Set the Ahead Offset to 0.00’
   - Set the Back Taper Method to Length Ratio
   - Set the Length to 10.00’
   - Leave the End Offset Along base element box unchecked
   - Set the Ratio to 4:1
   - Set the Back Transition to Spiral
   - Set the Method to Length
   - Set the Length to 10.00’
   - Set the Ahead Taper to None
   - Set the Ahead Transition Type to Curve
   - Set the Method to Length
   - Set the Radius to 20.00’
   - Set the Length to 10.00’
   - Set the Feature Definition name to CUR



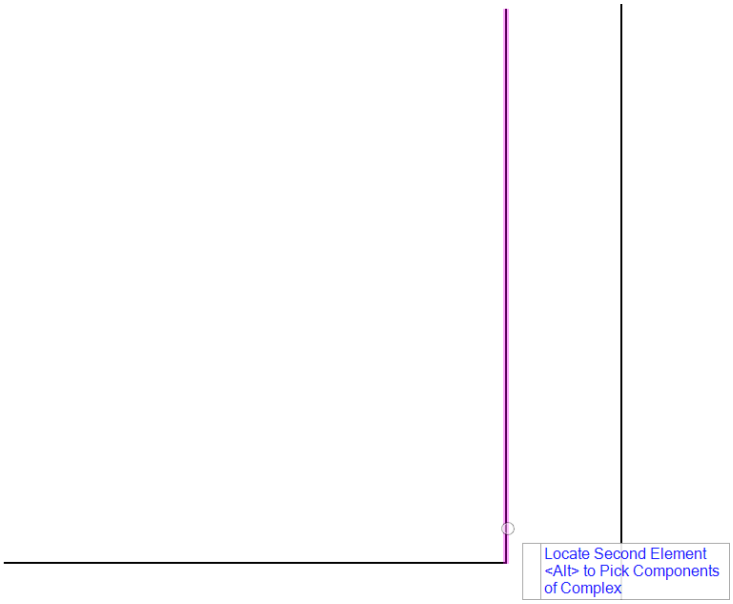
F. Left click to locate the first element.



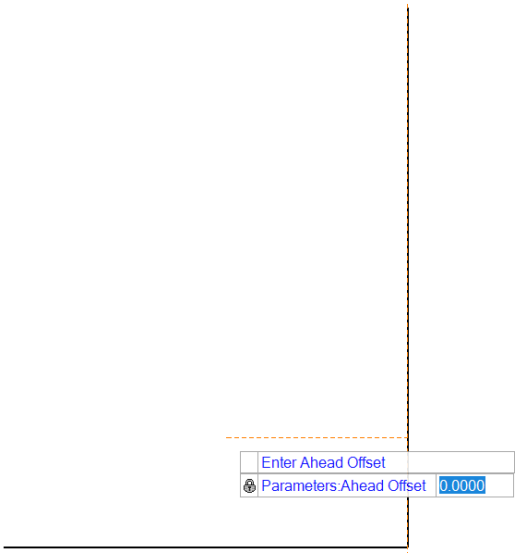
G. Left Click to accept the Back offset of 2.00’ and to set the side of the offset.



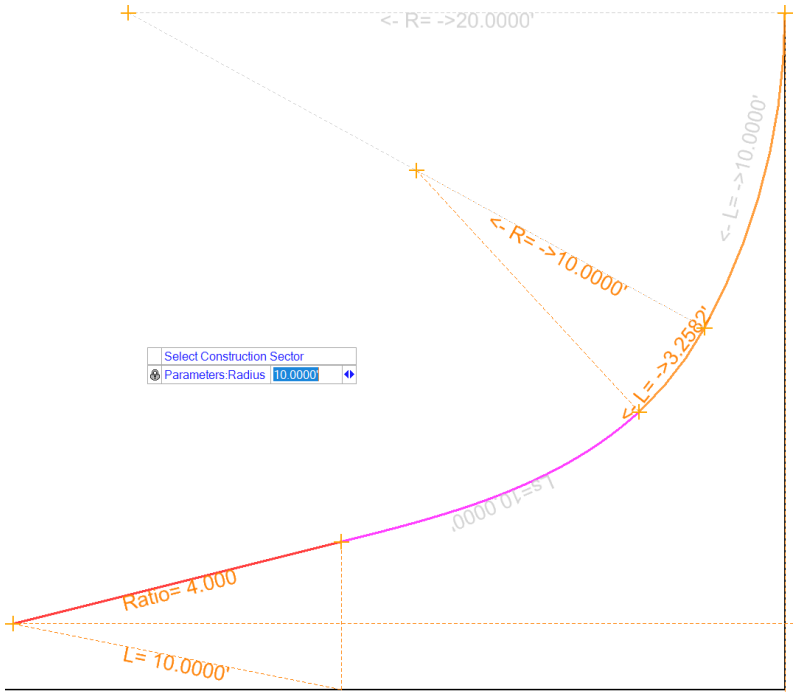
H. Left click to locate the second element.



I. Left click to accept the Ahead Offset = 0.00’

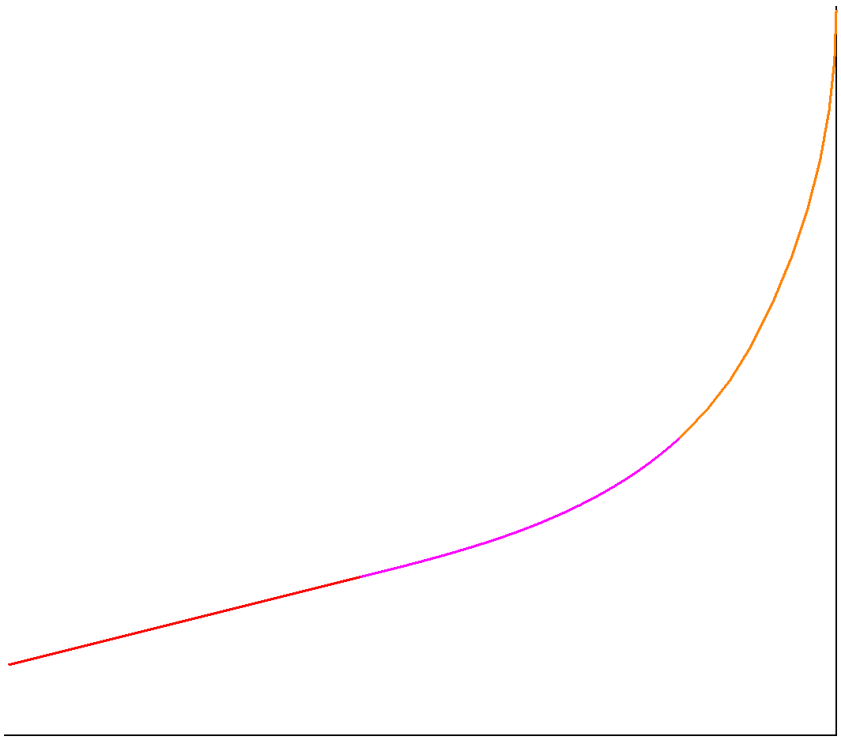


J. Left click to accept the central arc radius of 10.00’ and to set the location of the solution.

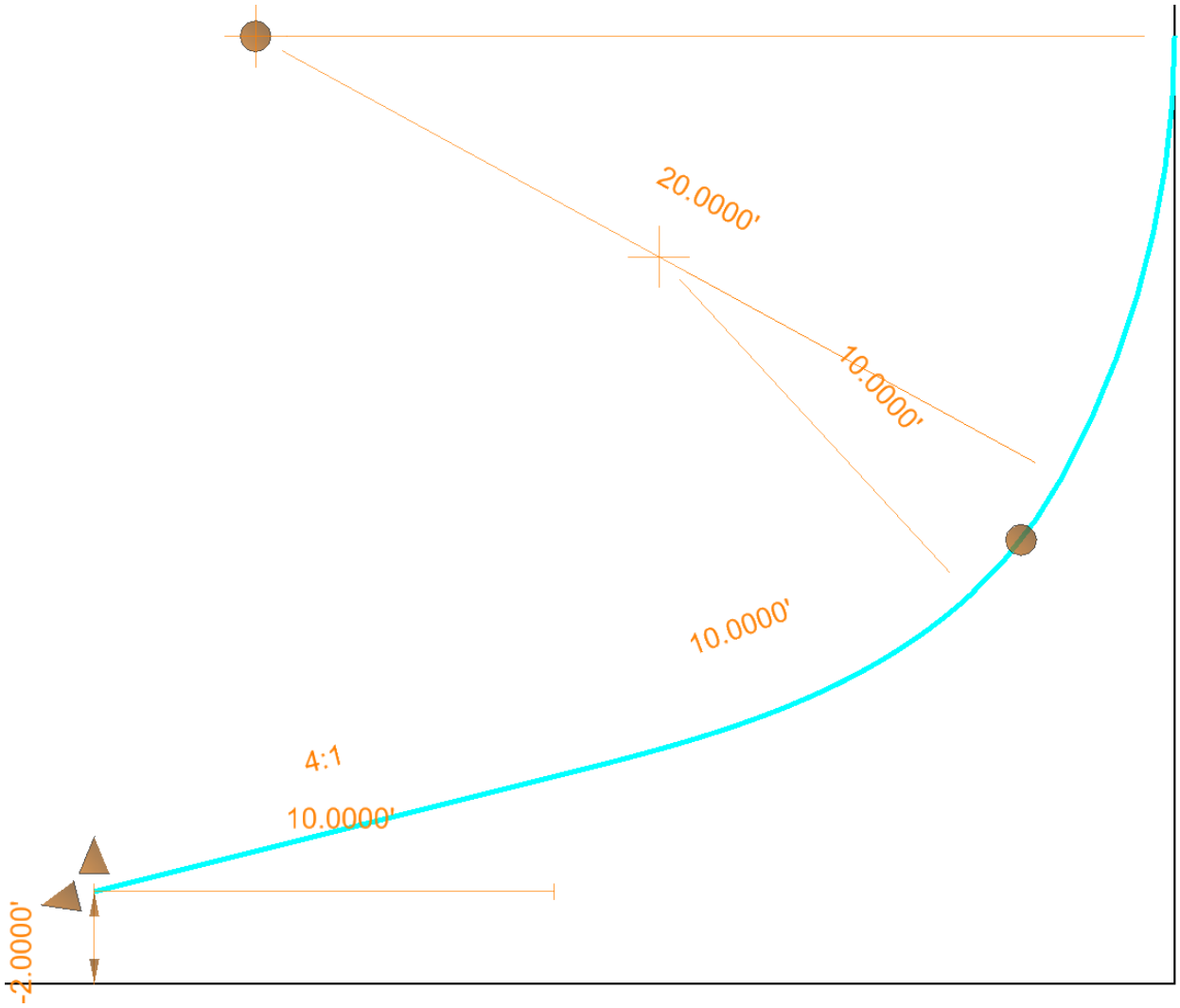


K. Left click to accept the Trim option of None.

L. This will complete the tool and place the element. The is a linear taper offset from the base element by 2.00'. There is a Spiral-Arc-Arc combination that is tangent to the second base element. This is unlikely to be a situation that would be encountered during roadway design but it is meant to illustrate the flexibility of the **Arc Between Elements** tool.

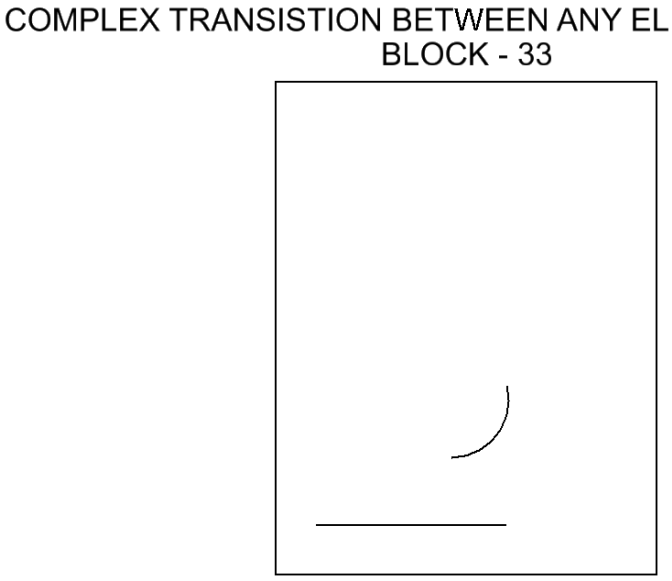


M. Use the **Element Selection** tool to highlight the element and display all the geometric rules.

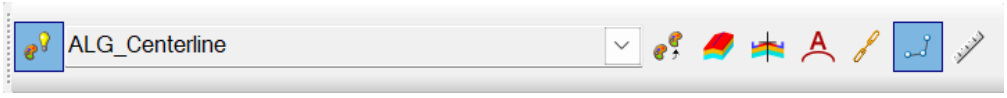


Complex Transition Between Any Element and Arc

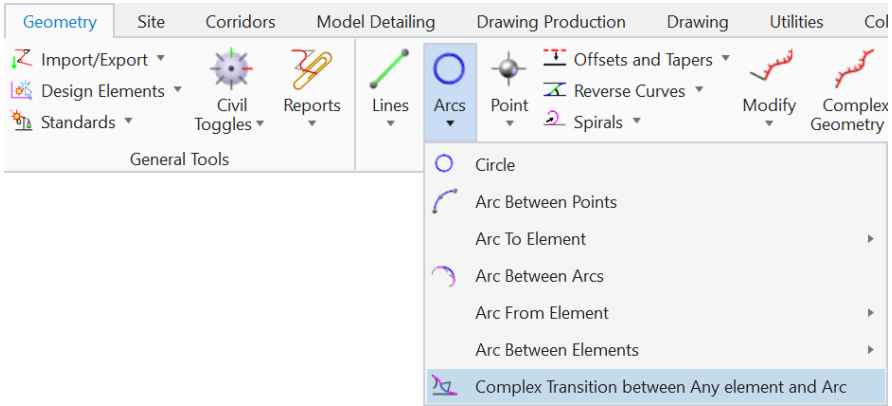
1. **Complex Transition Between Any Element and Arc**
   A. The **Complex Transisiton Between Any Element** tool draws an Arc that transitions between a reference element and another Arc.
   B. Locate the **Complex Transition Between Any Element and Arc** exercise located in Block – 33



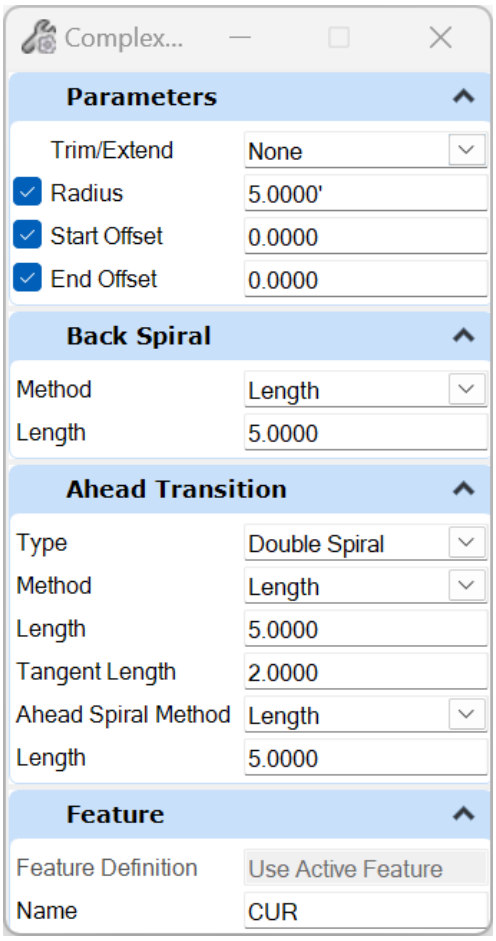
   C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.



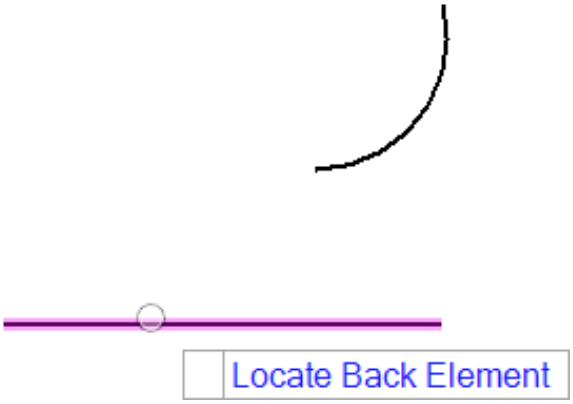
   D. Select the **Complex Transistion Between Any element and Arc** tool from the *Horizontal* section of the *Geometry* Ribbon.



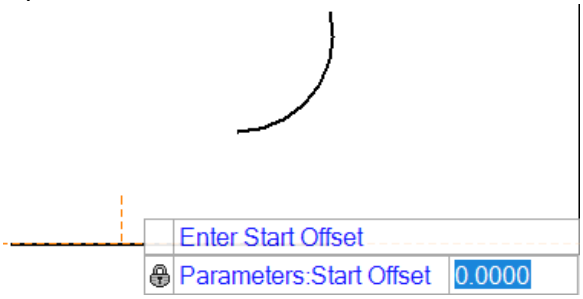
E. The dialog will appear and display options that should be familiar from the other Arc tools.
   - Set Trim/Extend to None
   - Set the Radius to 5.00’
   - Set the Start Offset to 0.00’
   - Set the End Offset to 0.00’
   - Set the Back Spiral Method to Length
   - Set the Length to 5.00’
     1. The tool will always use a spiral as the back transition
   - Set the Ahead Transition to Double Spiral
     1. The other options are None or Spiral
   - Set the Method to Length
   - Set the Length to 5.00’
   - Set the Tangent Length to 2.00’
     1. This is the tangent length between the reversing spirals
   - Set the Ahead Spiral Method to Length
   - Set the Ahead Spiral Length to 5.00’
   - Set the Feature Definition name to CUR



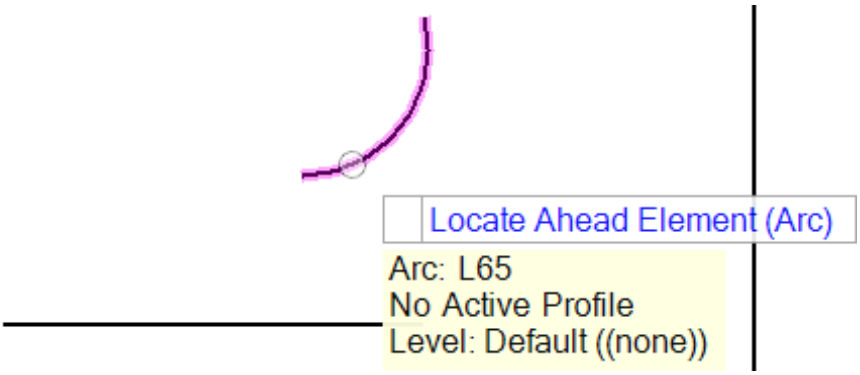
F. Left click to Locate the Back Element



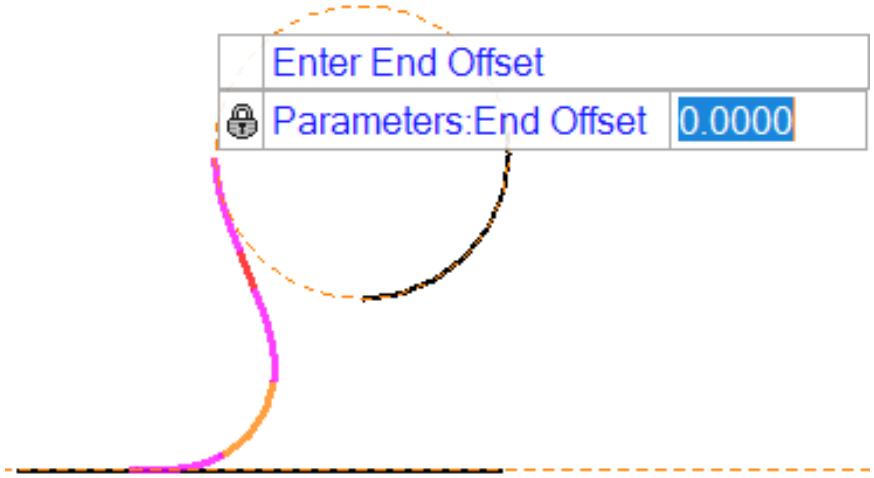
G. Left click to accept the Start Offset of 0.00’



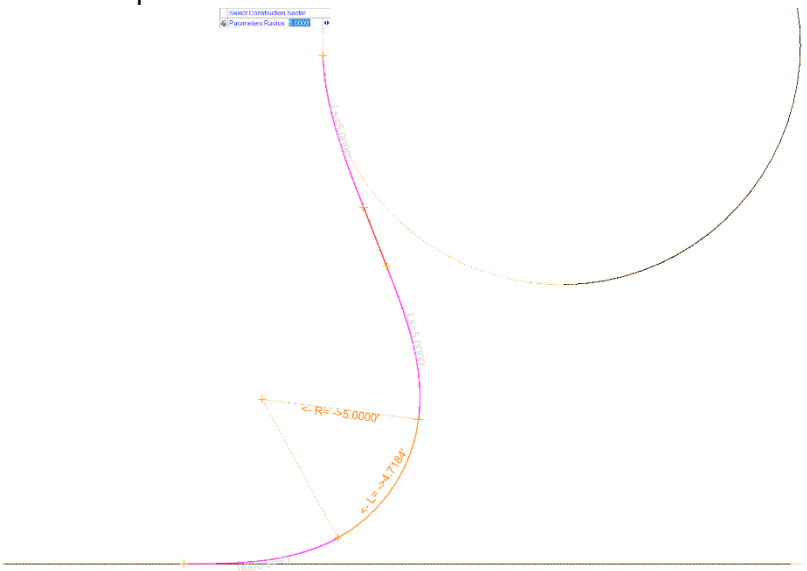
H. Left Click to Locate the Ahead Element. This must be an Arc.



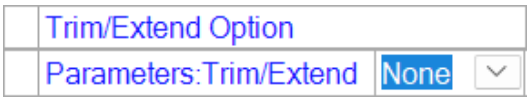
I. Left click to accept the End Offset of 0.00’ at this point a dynamic solution will also appear.



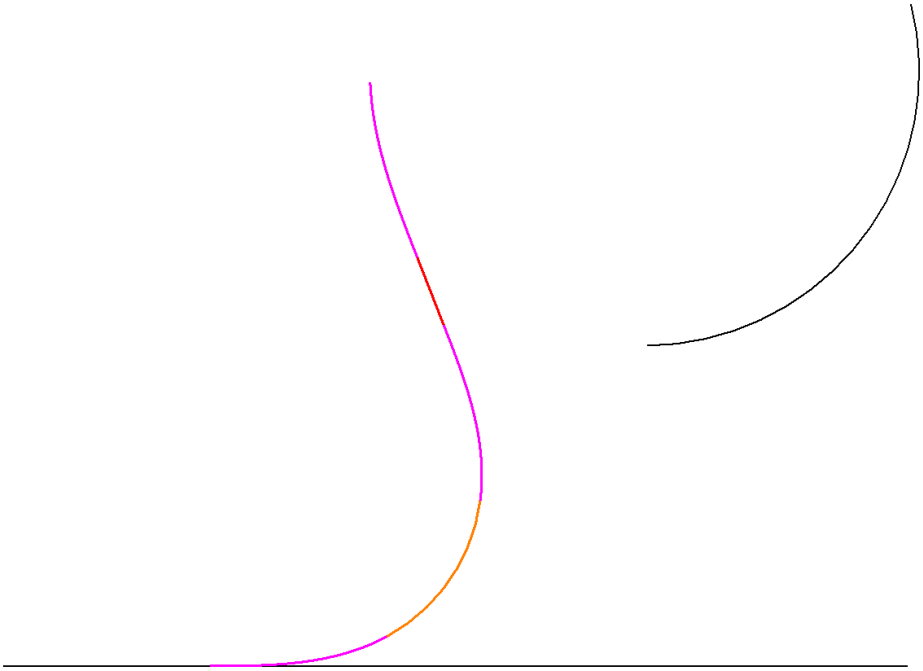
J. Left click to accept the Arc radius of 5.00’ and to set the location of the solution.



K. Left click to accept the Trim Option of None.



L. This will complete the tool and place the element. Note that because a Trim option of None was used that the reference Arc was not extended to meet the proposed transition. The proposed transition ties to the projection of the reference arc.

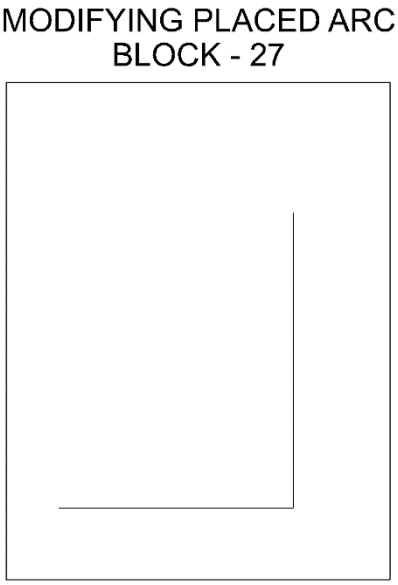


Edit Arcs

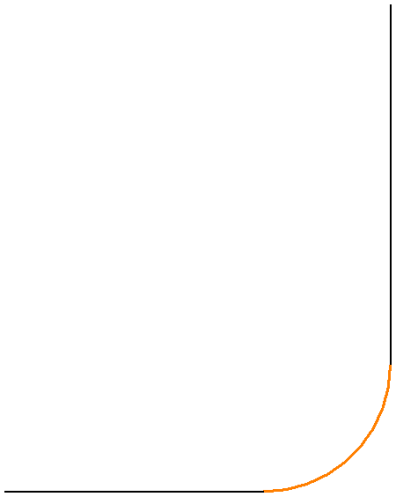
In this exercise, you will learn how to edit a simple Arc that has already been placed. You will see how to add tapers or transitions and revise the radius using the Properties dialog. This is part of the enhancements in ORD that will allow the user to revise placed geometry quickly and easily. Along with design intent and a properly constructed design file a change to the properties of a single curve could be carried through to the stationing, horizontal plan elements, profiles models and cross sections automatically.

The ability to place a simple Arc and then edit the tapers, transitions and radius after is so simple and powerful that many designers may use this method to place almost all the Arcs throughout a project instead of relying on the various Arcs tools to incorporate detailed geometric design.

1. **Modifying a Previously Placed Arc**
   A. Locate the Modifying Placed Arc exercise location in Block – 27

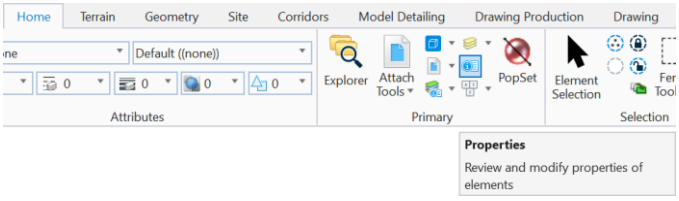


   B. Set the Feature Definition to ALG_Centerline and using the **Arc Between Elements** tool construct a simple Arc with a radius of 10.00’ between the two elements and trim both.

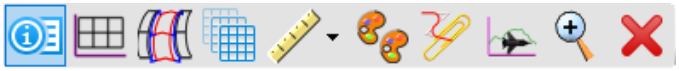


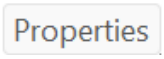
C. Use the **Element Selection** tool to select the Arc. Locate the Properties Dialog box and scroll to the bottom.

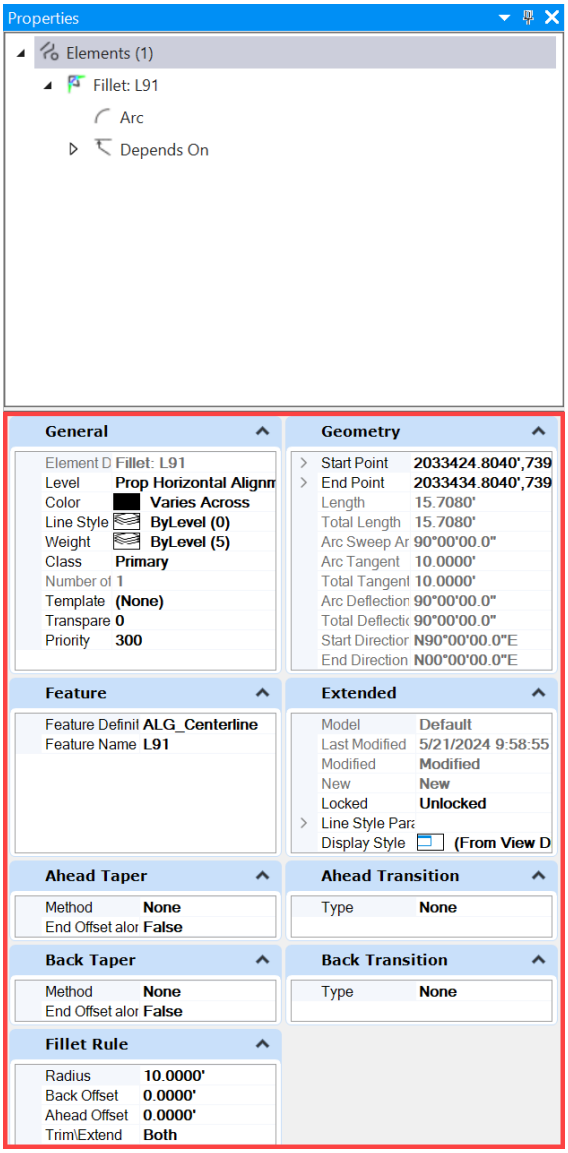
If the properties Dialog Box is not visible select it from the *Primary* Section of the *Home* Ribbon.



Or from the Pop Up Context Menu.







D. At the bottom of the properties dialog there are sections for
   - Back Transition
   - Ahead Transition
   - Ahead Taper
   - Fillet Rule
   - Back Taper

Ahead Taper	
Method	None
End Offset along base eler	False

Ahead Transition	
Type	None

Back Taper	
Method	None
End Offset along base eler	False

Back Transition	
Type	None

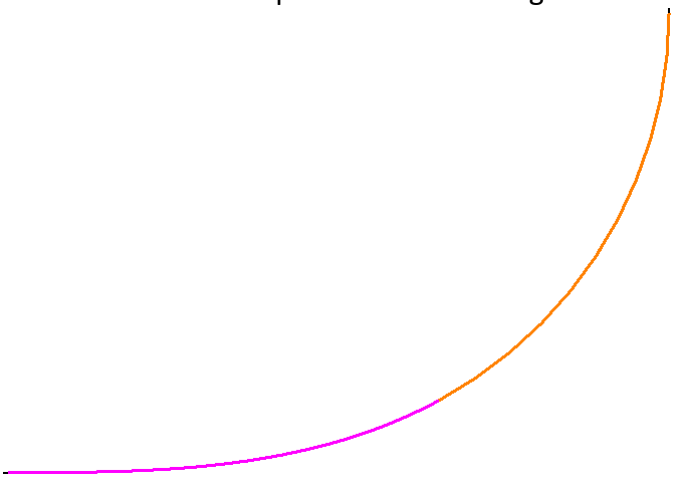
Fillet Rule	
Radius	10.0000'
Back Offset	0.0000'
Ahead Offset	0.0000'
Trim\Extend	Both

E. These sections can be used to modify the geometry of the simple Arc

F. Change the Back Transition to Spiral and set the Length to 10.00’

Back Transition	
Type	Spiral
Method	Length
Length	10.0000'

G. A spiral will be added to the simple curve with a length of 10.00’

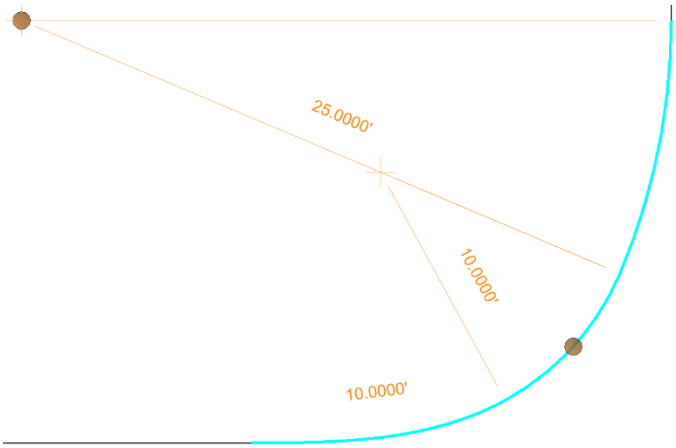


H. Set the Ahead Transition to a Curve with a Length of 10.00’ and a radius of 25.00’

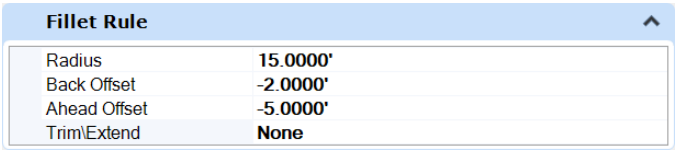
Ahead Transition	
Type	Curve
Method	Length
Radius	25.0000'
Length	10.0000'

I. This will add a Curve transition to the Spiral Arc combination.

J. Set the back transition and ahead transition back to None. In the Fillet Rule section change the radius to 15.00’. Set the Back Offset to (-)2.00’ and the Ahead Offset to (-)5.00’. Note that the Trim/Extend option may automatically update to None

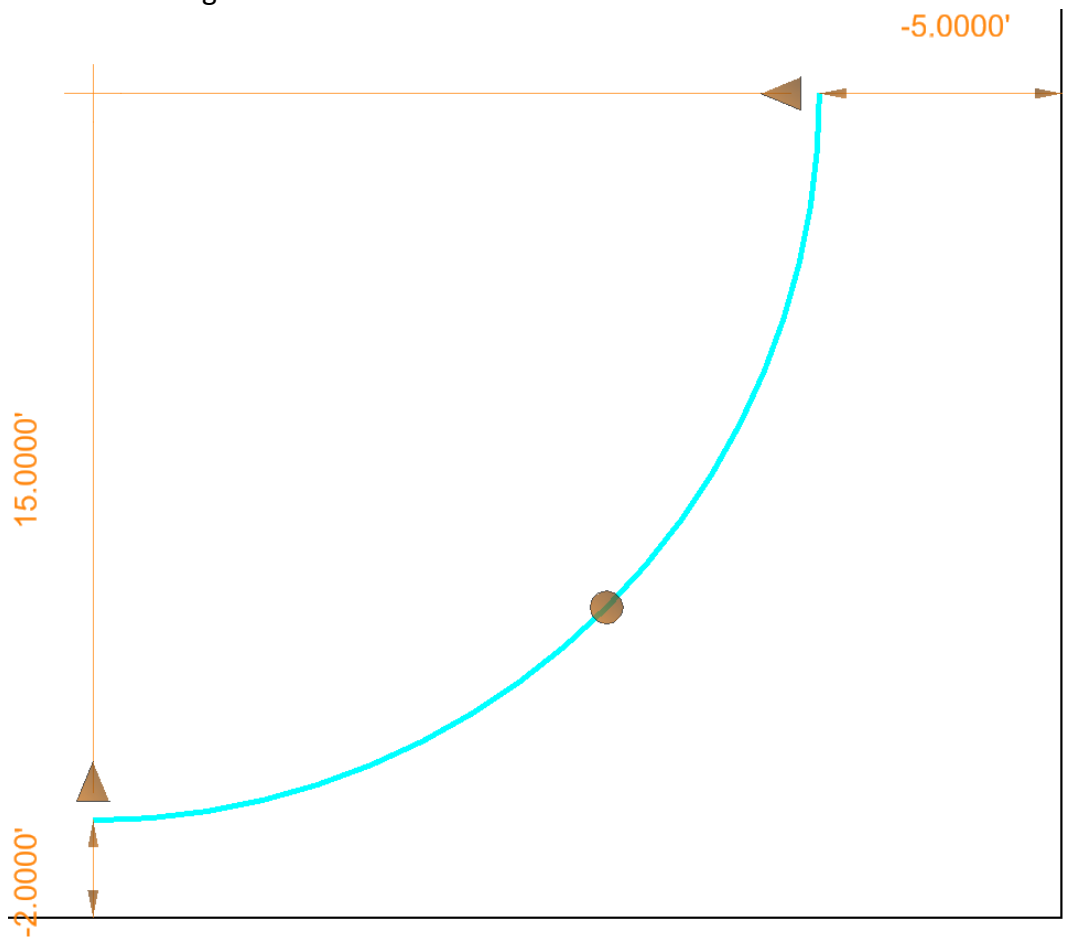


because the curve does not intersect either base element after the offsets are added. If you cannot change one of the offsets, try setting the Trim\Extend to None

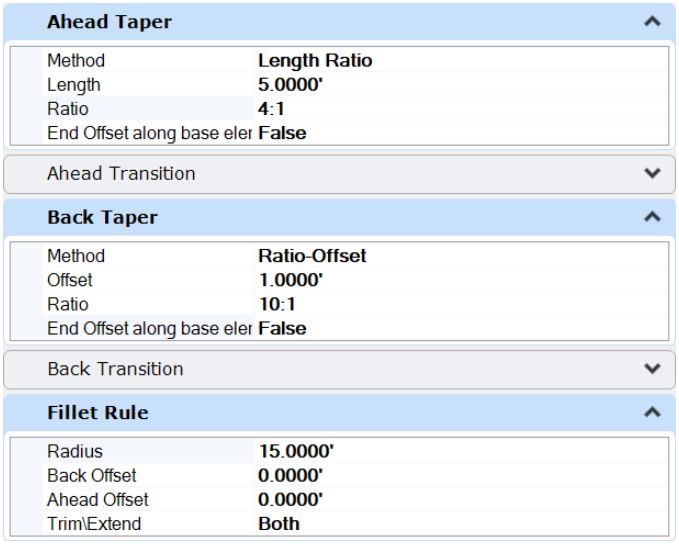


first.

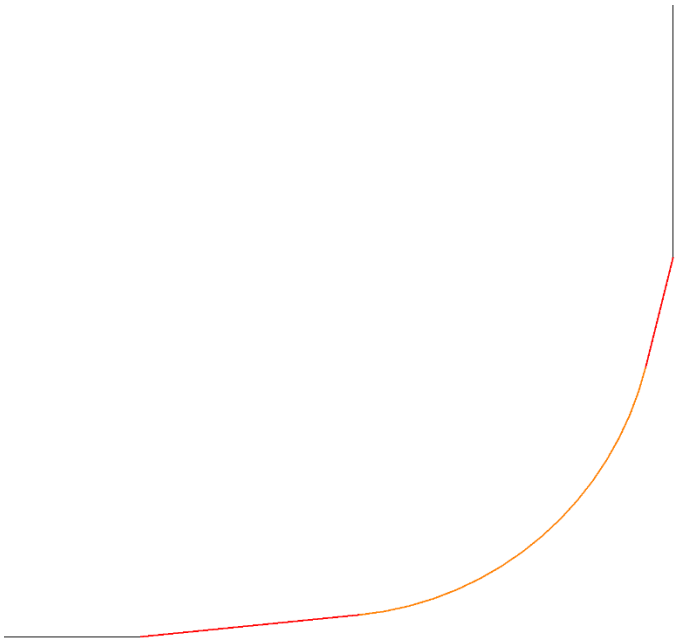
K. This will change the radius to 15.00’ and offset the curve from the base elements



L. Set the Fillet rule to 15.00’ Radius and 0.00’ Back and Ahead Offset and Trim to Both. Set the Ahead Taper to Length-Ratio with a Length of 5.00’ and a ratio of 4:1. Set the Back Taper to Ratio-Offset with an Offset of 1.00’ and a ratio of 10:1.



M. This will produce an Arc with two linear tapers and will reestablish the trim of the two base elements to match the tapers.



N. The properties dialog box will allow the user to modify an existing arc or arc combination in almost any way.

Horizontal Geometry – Point Tools

The point tools allow the user to set individual points or draw points equally spaced along another element. These points can have a user specified elevation or a pull an elevation from a Terrain Model.

Based on the new ORD workflow utilizing dynamic graphically design for alignments and not using input files like Geopak the use of setting points for the purpose of horizontal alignments and geometry is longer a necessity.

The main reason to set points and possibly the only reason for many roadway projects will be to locate RW and Permanent Easement Markers. The RW and Easement lines can be placed using the Horizontal Geometry tools but the individual Markers will be placed using the Point tools.

Information on how to set these points using these tools will be covered in the Plan Geometry training module.

Horizontal Geometry –Offsets and Tapers

The tools located within the Offsets and Tapers group will generally be used to establish roadway design features like bay tapers and turn lanes, concrete islands, etc. All the items that are based on another alignment.

These tools will be covered in the Plan Geometry training module.

Horizontal Geometry –Reverse Curves

The tools located within the Reverse Curves group will generally be used to establish roadway design features like EOT shifts, median crossover travel paths, etc. They are used to design reversing curves between, in most cases, to parallel elements

These tools will be covered in the Plan Geometry training module.

Horizontal Geometry Exercise–Spirals

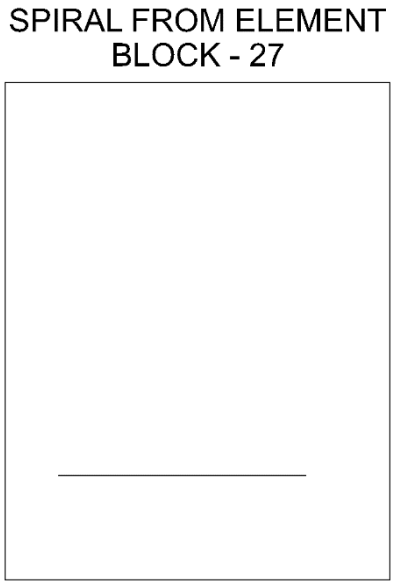
In this exercise, you will learn how to place individual spiral elements. In almost all cases a NCDOT roadway designer will place a spiral element that is connected to an Arc using one of the Horizontal Geometry Arc Tools. Placing a spiral as an individual element will not be a common practice.

Spiral From Element

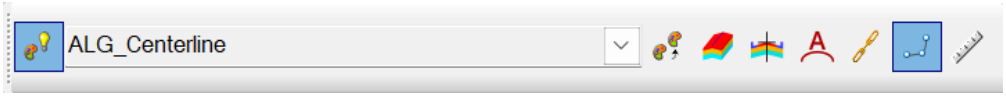
1. Spiral From Element

A. The **Spiral From Element** will place a spiral element based on a From Element and a user defined Length and End Radius.

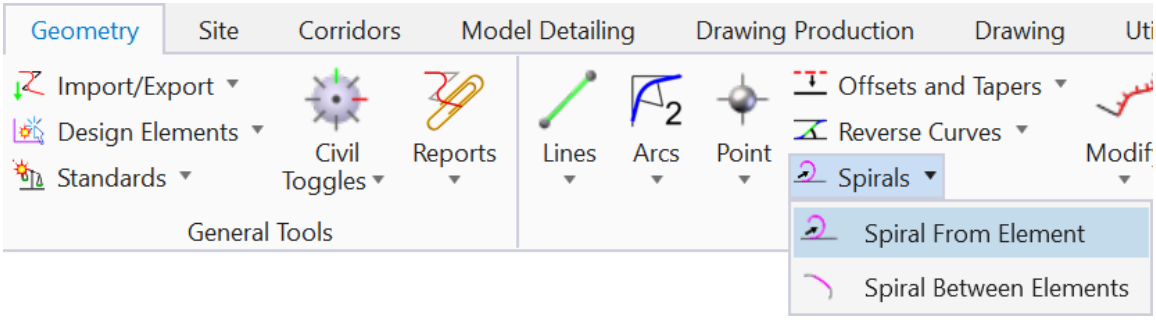
B. Locate the Spiral From Element exercise location in Block – 27



C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

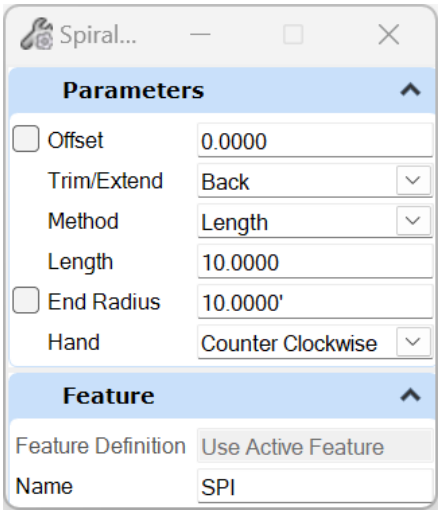


D. Select the **Spiral From Element** tool from the *Horizontal* section of the *Geometry* Ribbon.



E. The dialog box will appear.

- Leave all boxes unchecked, design data will be entered at the heads up prompt
- Set the Trim/Extend Option to Back
- Set the Method to Length
- Set the Hand to Counter Clockwise
- Set the Feature Definition name to SPI

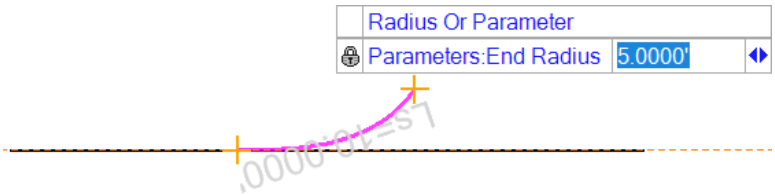


F. Left click to locate the From Element

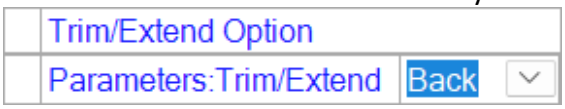
G. At the heads up prompt enter 0.00’ and press <ENTER> to lock. Left click to accept the value.

H. Left click to select a start point.

I. -At the heads up prompt enter 5.00’ for the End Radius and press <ENTER> to lock. Left click to accept the value. This will also set the location of the solution.



J. Left click to accept Back as the trim option. If the heads up prompt displays None as the Trim option use the <UP> or <DOWN> arrow key to change the selection.



K. This will complete the tool, place the spiral and trim the From Element.

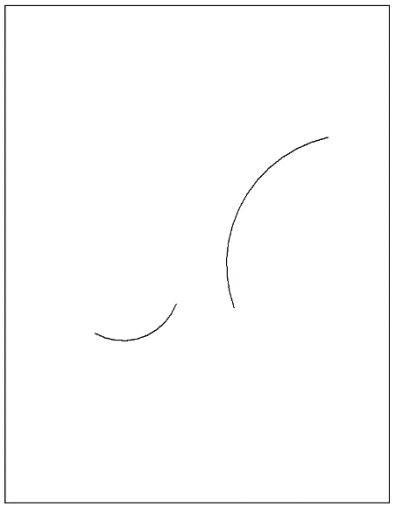
Spiral Between Elements

1. Spiral Between Elements

A. The **Spiral Between Elements** tool is capable of producing complex transitions from one element to another, particularly from one curve to another where the solution will be a compound spiral or a reversing spiral.

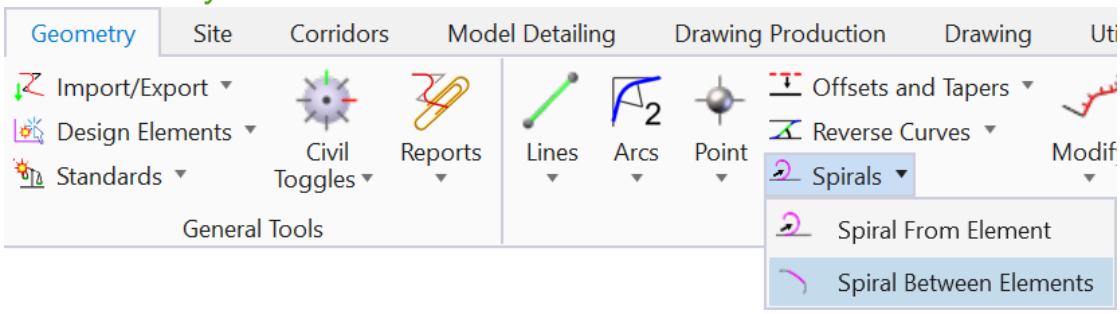
B. Locate the Spiral Between Elements exercise location in Block – 28.

SPIRAL BETWEEN ELEMENTS
BLOCK - 28

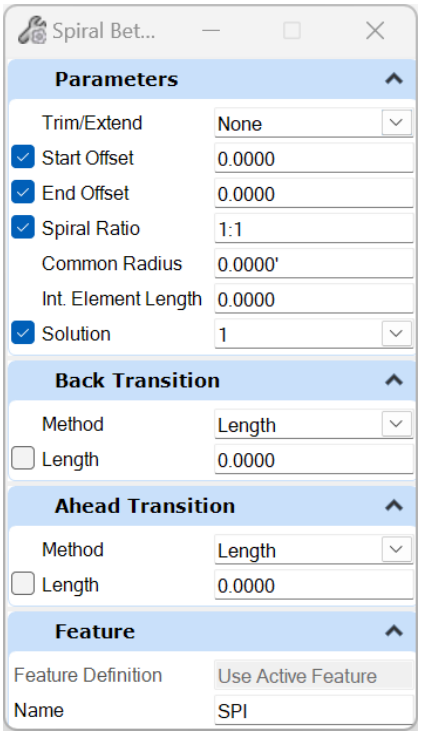


C. Set the Feature Definition to Alignment/NCDOT/Prop/ALG_Centerline and toggle on the use Active Feature Definition Icon.

D. Select the **Spiral Between Elements** tool from the *Horizontal* section of the *Geometry* Ribbon.

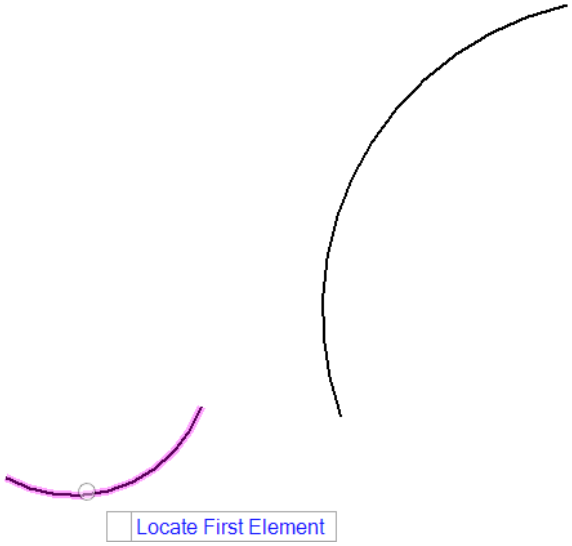


E. The dialog will appear

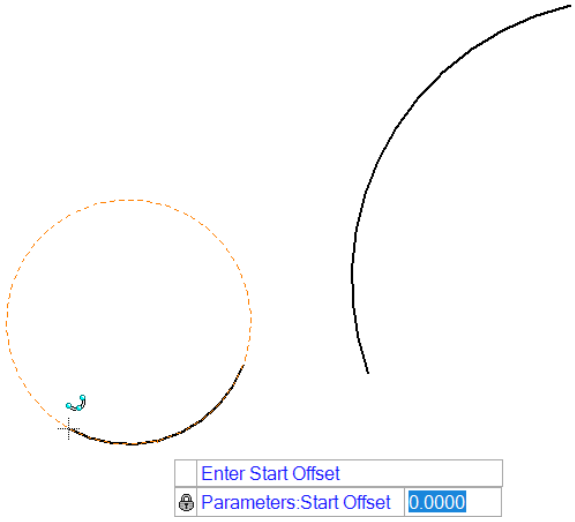


- Set Trim/Extend to None
- Set the Start Offset to 0.00’
- Set the End offset to 0.00’
- Set Spiral Ratio to 1:1
  1. When solving for compound or reversing spiral ratios the spiral ratio will affect the lengths of the spiral by making one spiral a ratio of the other. A spiral ratio of 1:1 will produce equal length spirals.
- Set Common Radius to 0.00’
  1. When solving for compound or reversing spirals the common radius is the radius at the end of each spiral where the two spirals meet.
- Set Solution to 1
  1. The can be chosen during placement by using the <ALT> key.
- Set Back and Ahead transition Method to Length and Leave both Boxes unchecked
  1. You may lock one of the spiral lengths, but not both. When one spiral is locked, then the length of the second will adjust to produce the compound or reverse spiral. If both spirals are locked, then the effect is same as if both were unlocked. That is, the two spirals are made of equal length to fit the solution.

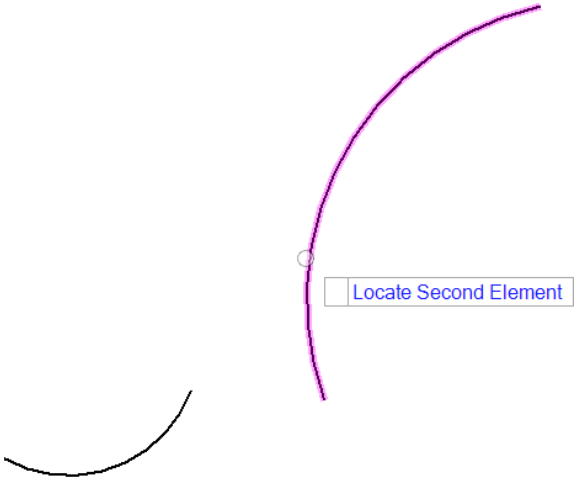
F. Left Click to locate the first element



G. Left click to accept a start offset of 0.00’

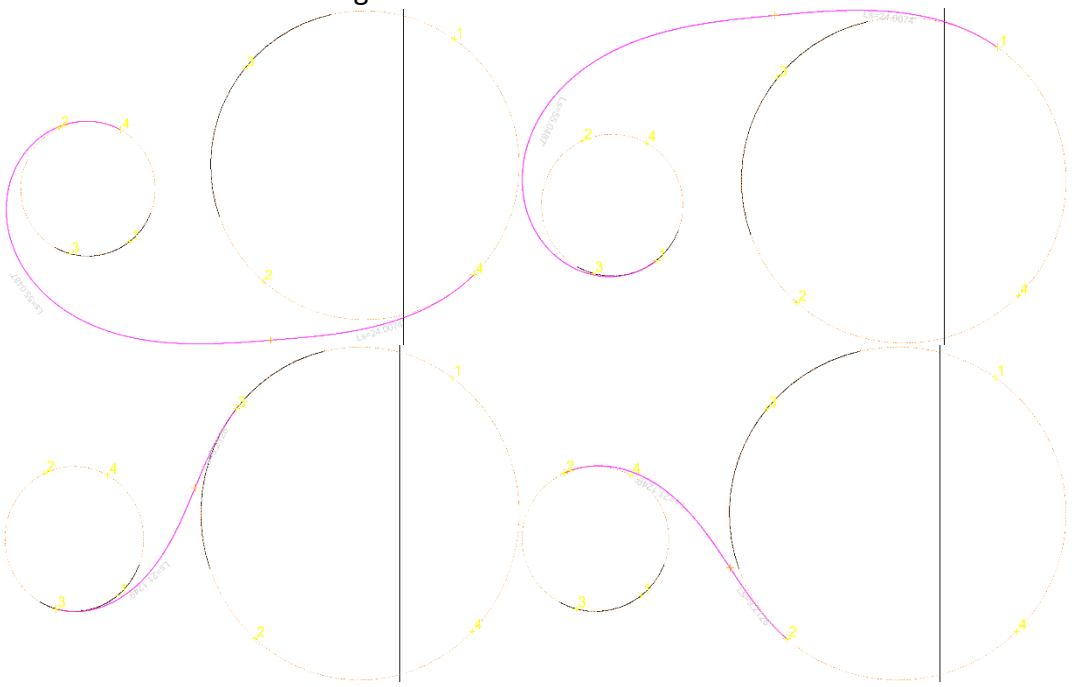


H. Left click to select the second element.

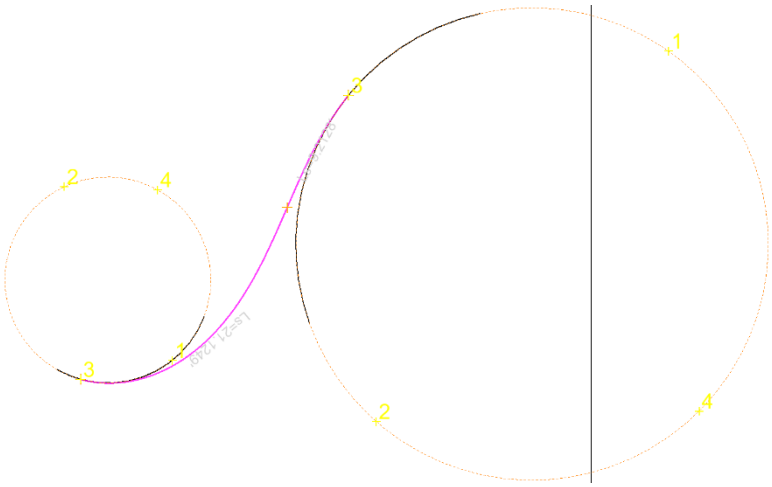


I. Left click to accept the end offset of 0.00’

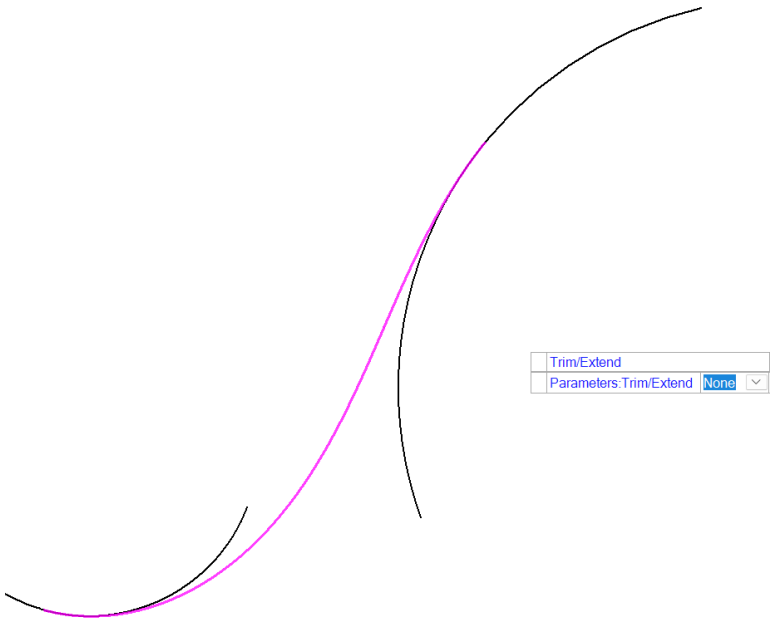
J. For the two arc that are the From Elements there are four solutions for the spiral combination, two compound spiral solutions and two reversing spiral soltuions. Move the cursor to change between the four solutions.



K. Move the cursor to select solution 3, a reverse spiral option. Left click to select the solution for the spiral combination



L. Left click to accept the Trim option of None. This will complete the tool and place the spiral combination.



Horizontal Geometry Exercise – Complex By PI

In this exercise, you will learn how to create a complex centerline alignment when the PIs are known. This type of alignment is very quick and easy to complete. The user only needs to identify the PI locations and provide the design parameters for the Horizontal curves.

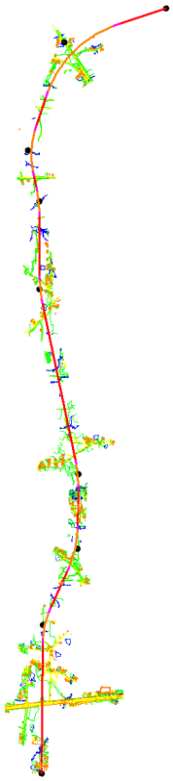
WHEN I OPENED THE FILE THERE WAS ALREADY AN ALIGNMENT PRESENT. NOT SURE IF INTENDED OR NOT. IF INTENDED, IT WAS DISTRACTING AND CONFUSING TO PLACE ANOTHER ONE DOWN. RECOMMEND IT DELETED FROM MASTER FILES IF UNNECESSARY.

This is the process that could be used for an L line alignment, especially for larger new location facilities. In this case the user may want to have long tangent sections, it also may be the case that the L line alignment is being provided through the planning process and the user only needs to enter known alignment data into ORD.

This would also be a good process to use during the planning process if no survey was available and the user was using an Aerial Image to establish a centerline.

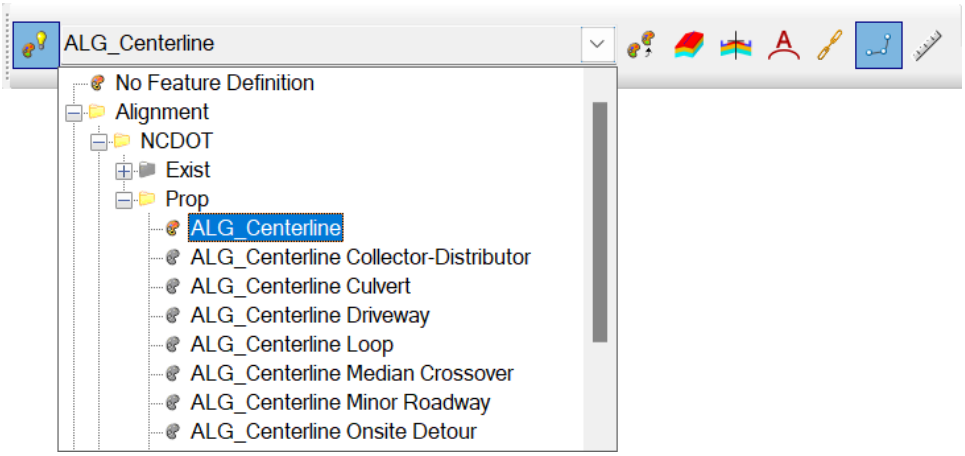
1. **Complex By PI – L Alignment**
   A. A. Create a new design file using the 2D seed file, and name the file: ***R-2635C_RDY_ALG_L.dgn***
      - This file should be created in the Alignments folder of the training directory *…\Module 3 Horizontal Alignment\R-2635C\Roadway\Alignment*

   B. Attach the Final Survey file ***R-2635C-NCDOT_FS.dgn*** and the Existing Terrain Model ***R-2635C_NCDOT_FS.dgn*** from the FinalSurvey Folder.
   C:\NCDOT Training\Roadway\Training-RD_R-2635C\Module 3 - Horizontal Alignment\Final Survey



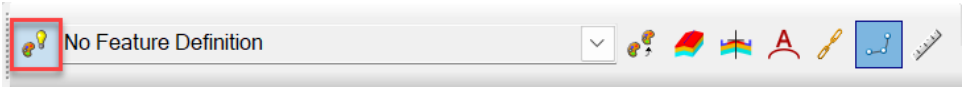
C. Attach ***R-2635C_RDY_ALG_HA-PI-L.dgn*** file from the *Roadway\Alignments\Training Files* folder. This file contains circles at all the PI locations. By turning off the Survey and the Terrain Model the user should see 9 circles.

D. Find the Feature Definition Tool bar and set the Feature Definition to *Alignment\NCDOT\Prop|ALG_Centerline*

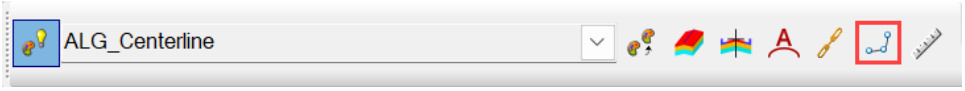


It is important to select the Feature Definition that corresponds to the type of roadway centerline being designed. The featured definition will control the display properties of the centerline annotation and each type of alignment has different standards.

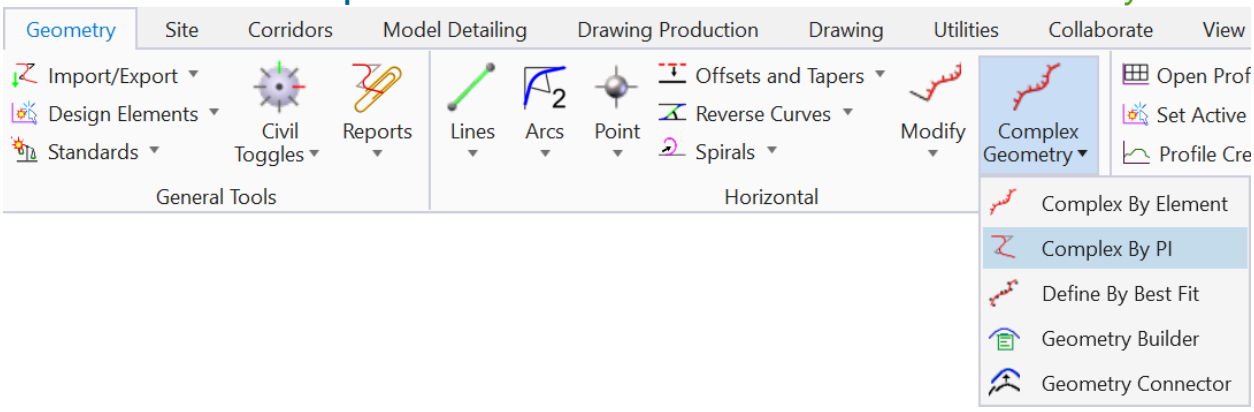
E. Set Use Active Feature Definition to ON, this will apply the ALG_Centerline Feature Definition to the proposed alignment.



F. Set the Persist Snaps and Rule to OFF. In this instance we do not want to rule the L line geometry to the PI location we only want to use the PI locations to establish the L Line alignment. The user will have to make decisions about how and when to rule one alignment to another element. Because the L Line is the basis for all other alignments ruling the alignment to existing features, other than possibly the existing alignment at the beginning and the end, may not be warranted. Because Ramps and Loops are based on the L and Y line alignment ruling the ramps and loops to the L and Y line should be considered. This would ensure any revisiosn to the L or Y were also applied to the ramps.

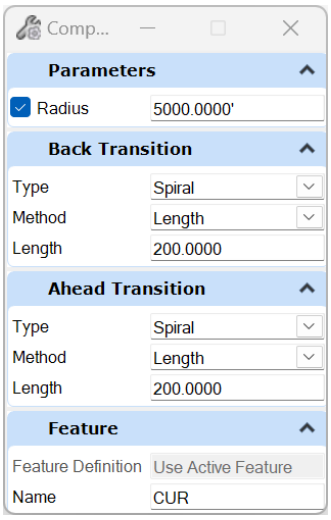


G. Select the **Complex BY PI** tool from the *Horizontal* Section of the *Geometry* Ribbon.



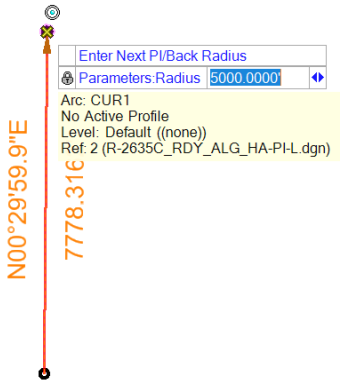
H. The dialog will appear.

- Set the Radius to 5000.00
  1. This is the radius for the curve that will be placed at Each PI. The user can locate each PI and use the same curve radius at each and then go back and edit the radius for each curve. Or change the curve radius at each PI as they are being placed.
  2. Set Back Transition Type to Spiral
     a. This will be the default transition type used during the placement of the alignment. Like the curve radius this can be used throughout the alignment and easily modified after placement, or this can be changed at each PI during placement.
  3. Set Method to Length
  4. Set Length to 200.00’
  5. Set Ahead Transition Type to Spiral
  6. Set Method to Length
  7. Set Length to 200.00’
  8. Set Feature Name to L
     a. For Centerline Alignments it is important to set the Feature Definition name to the name of the alignment. This is one of the design procedures where the naming is important.

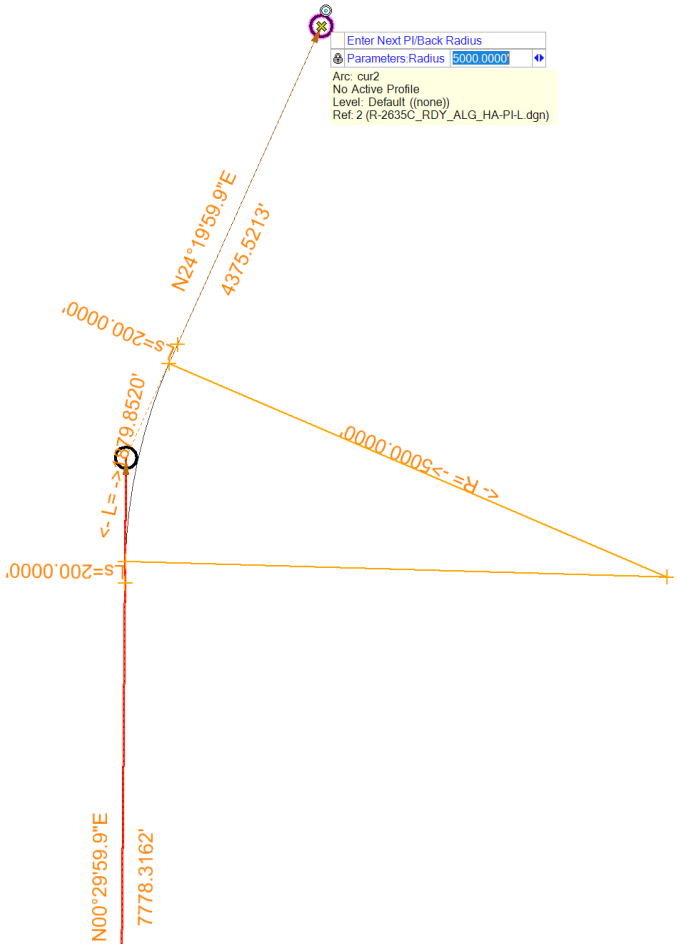


I. Snap to the center of the Circle at the bottom of the dgn design and left click to accept and to start the alignment, this will set the first PI.

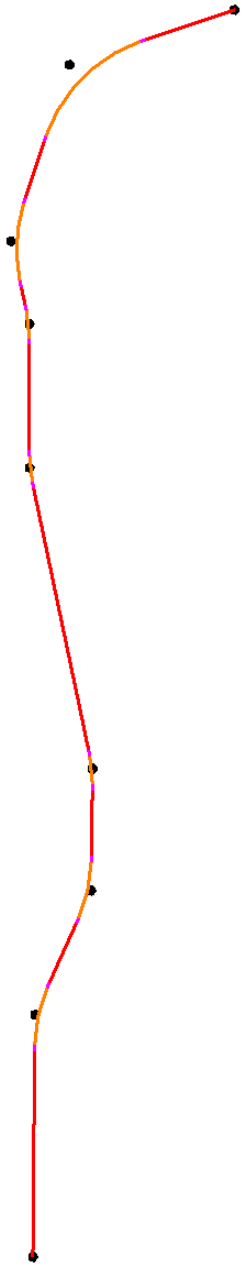
J. Snap to the center of the next circle and left click to accept. This will establish the first tangent and set the first PI that will contain a curve. Note that the heads up prompt displays a radius of 5000.00’ and shows the lock symbol. This is based on the dialog settings. A curve with a radius of 5000.00’ with a beginning and ending spiral of 200.00’ will be constructed at this PI. This is the point in the design where the user could modify the radius in the heads up prompt or in the dialog and place a curve with different parameters. The bearing and length of the proposed tangent will also be dynamically displayed.



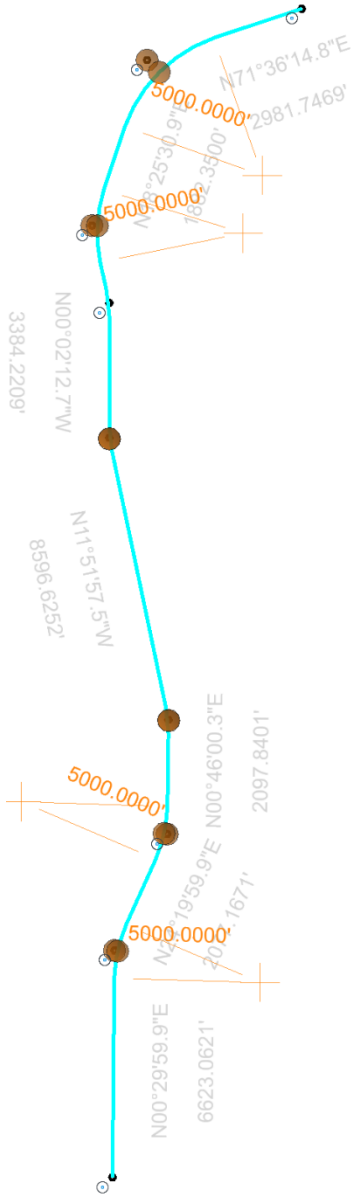
K. Snap to the center of the third circle and left click to accept the next tangent. The curve components will be displayed at this point.



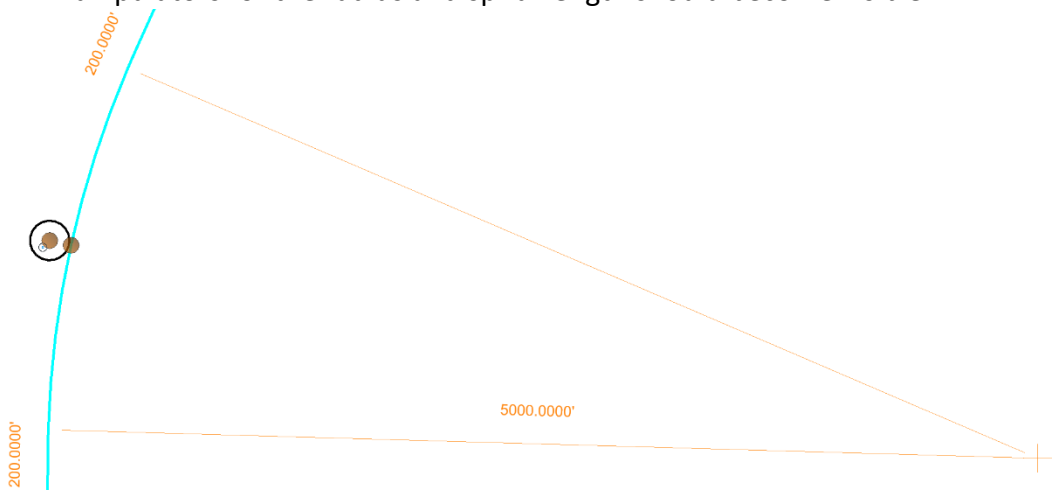
L. Snap and Left click at each remaining PI location in order. This will place the tangents and a curve with a 5000.00’ radius and a 200.00’ spiral at each end at each PI location. After left clicking to accept the final PI location, right click to reset and end the tool. The proposed centerline alignment will now be complete.



M. At this point all the curves have a radius of 5000.00’ and have a begin and end spiral transition 300.00’ in length. These curves and spiral need to be revised to reflect the intended final design.
N. Use the element Selection tool to highlight the L alignment. Note that to make the design attributes legible some of the data is not displayed if the entire alignment is fit in the design plane.



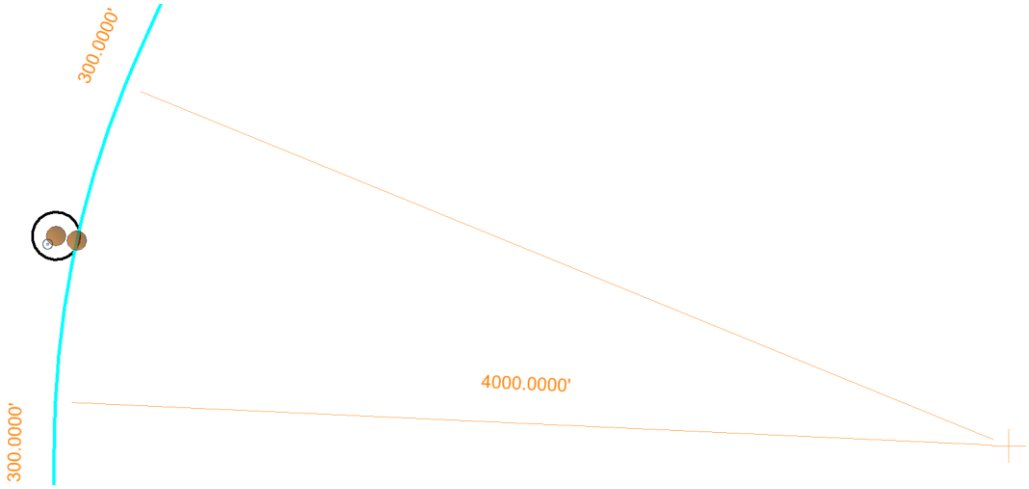
O. Zoom in close to the first curve, leaving the alignment selected. The text manipulators for the radius and spiral length should become visible.



P. Edit the Curve Radius to be 4000.00', press <ENTER> to accept the change.

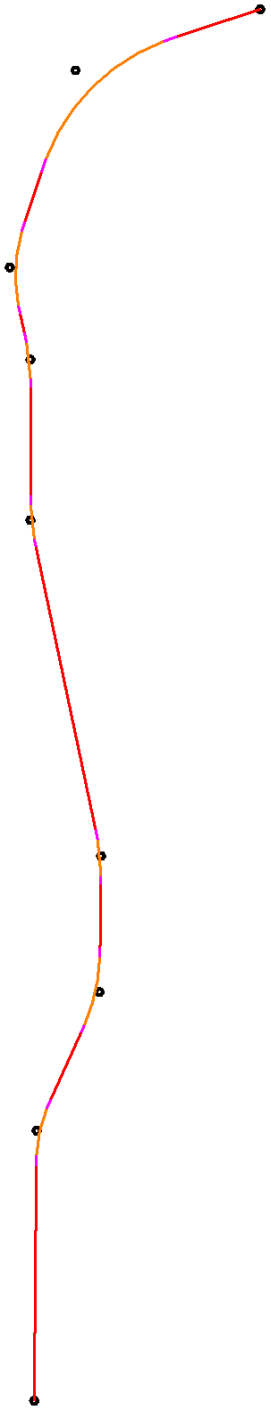
Q. Edit each spiral length to be 300.00', press <ENTER> to accept the change

R. The first curve should now have a radius of 4000.00' with a begin and end spiral transition with a length of 300.00'



S. This process needs to be completed for the remaining 6 curves
   - Curve 2 = Spiral 250.00', Radius 5500.00', Spiral 300.00'
   - Curve 3 = Spiral 250.00', Radius 6000.00', Spiral 300.00'
   - Curve 4 = Spiral 250.00', Radius 6000.00', Spiral 300.00'
   - Curve 5 = Spiral 250.00', Radius 6000.00', Spiral 300.00'
   - Curve 6 = Spiral 250.00', Radius 4500.00', Spiral 300.00'
   - Curve 7 = Spiral 410.10', Radius 5741.46', Spiral 410.10'

T. This will end the placement L Alignment, see the next section for Stationing..



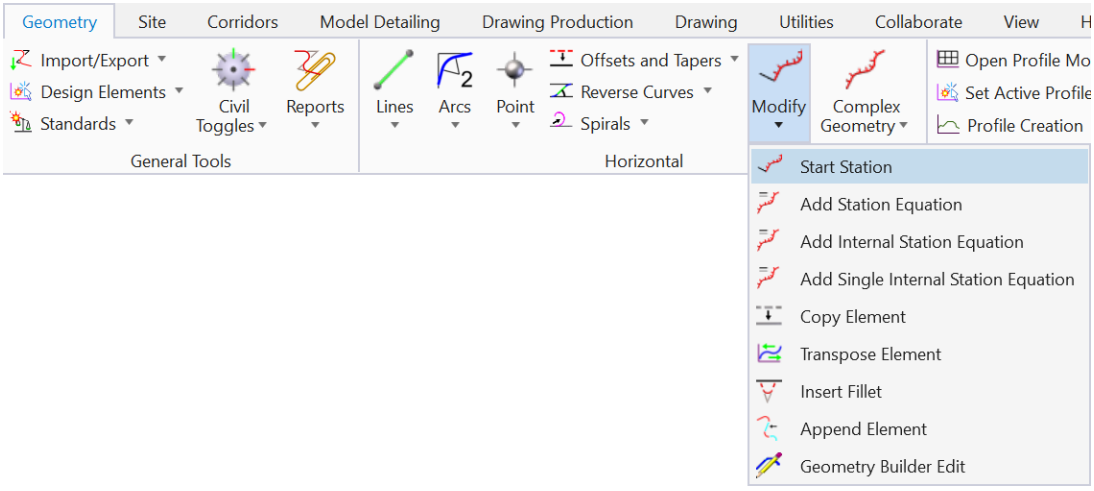
Horizontal Geometry Exercise – Stationing

In this exercise, you will learn how to station a complex centerline alignment. By default, for newly created alignments the stationing begins at 0+00.00. The user will need to apply new stationing to complete the alignment

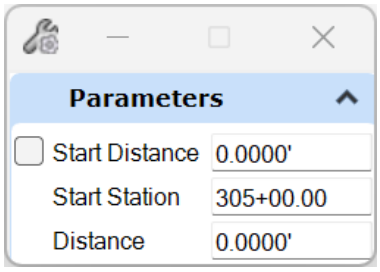
1. Changing the Start Station

A. The last task to complete the alignment definition is to add the stationing. For this project the stationing should begin at Station 305+00.00.

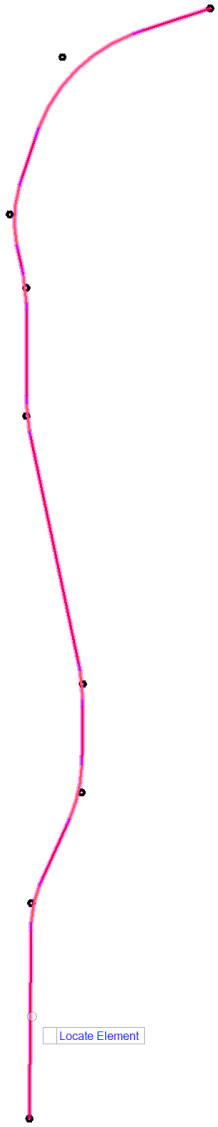
B. Select the Start Station tool from the Horizontal Section of the Geometry Ribbon.



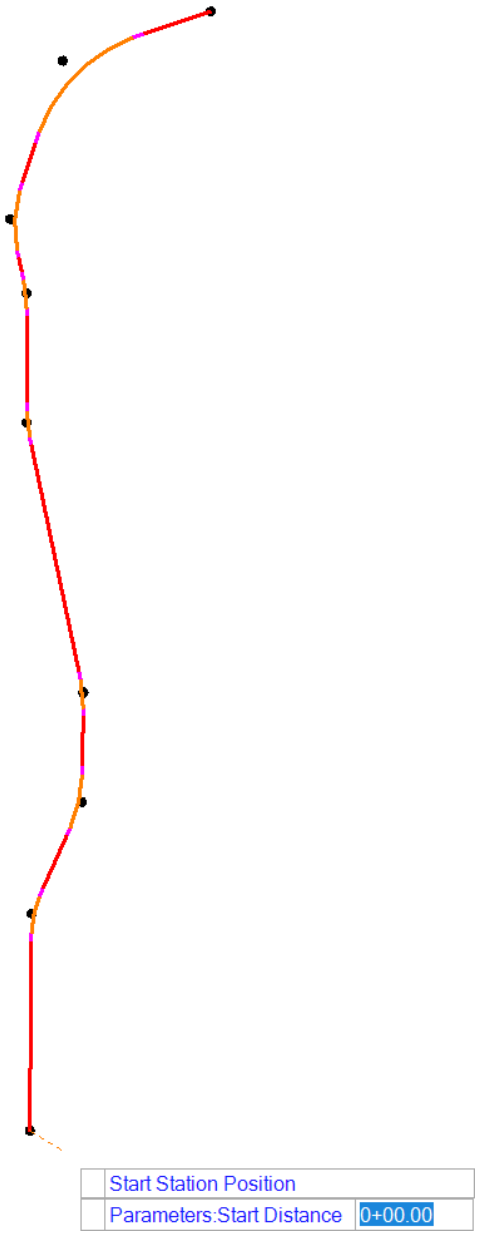
C. The dialog will display
- Leave the start distance box unchecked
  1. This is the distance along the alignment from the beginning point where the new station will be applied. If the user wanted to set station 11+00.00 at a point that was 200.00’ from the start of the alignment the program would use that point to set a starting station of 9+00.00. This will be useful if the alignment is extended back at some point during the project and the user does not want any ahead station to change. In most cases we will set the start station at 10+00.00 at the beginning of the alignment.
- Set the start station value at 305+00.00
- The distance box is not a user defined number The distance value will default to show 0.00’, If a Start Distance is selected that is not 0.00’ and not at the beginning of the element when the start station command is started this value will change to a station value and the distance box will show the distance from the beginning of the alignment. This is useful if a Start Distance other than 0.00’ is determined graphically.



D. Left click on the Alignment at the prompt to locate the element to add stationing.



E. Left click to accept the start distance. This is the distance from the beginning where station 305+00.00 will be applied. The program will then apply station line ahead and line back from that point. In this case 305+00.00 should be located at the beginning of the alignment. By positioning the cursor before the beginning of the alignment the heads up prompt will display 0+00.00 indicating the new station 305+00.00 will be applied at the beginning of the alignment.



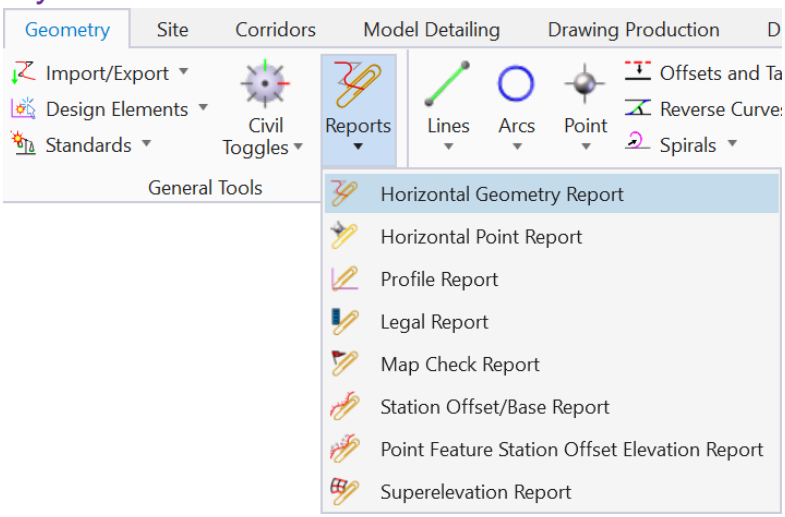
F. Left click to accept a start station value of 305+00.00.

G. That will end the tool and apply the new stationing to the Alignment. To review the stationing the user has a couple of options. There is a report function that will produce a report on the geometry similar to the output reports from geopak or the user can review the alignment in a simpler format in the Table Editor.

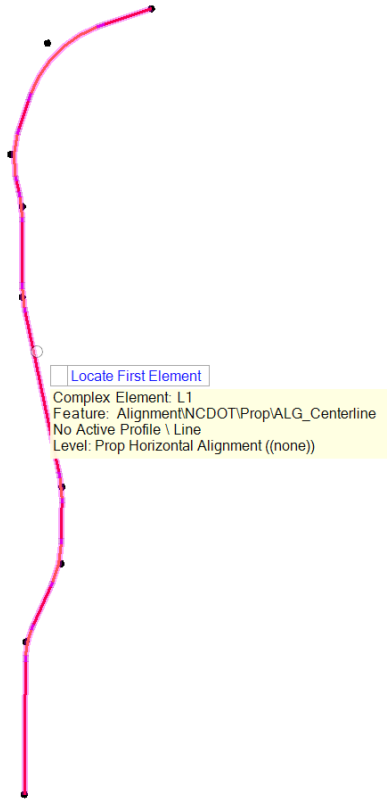
Horizontal Geometry Reports

1. Horizontal Geometry Report

A. Select the **Horizontal Geometry Report** tool from the *General* Tools section of the *Geometry* Ribbon.

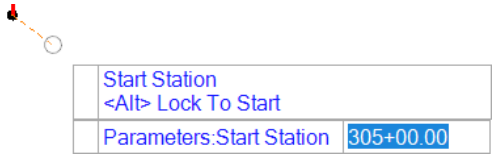


B. Left click to locate the alignment, multiple alignments can be added to a single report.

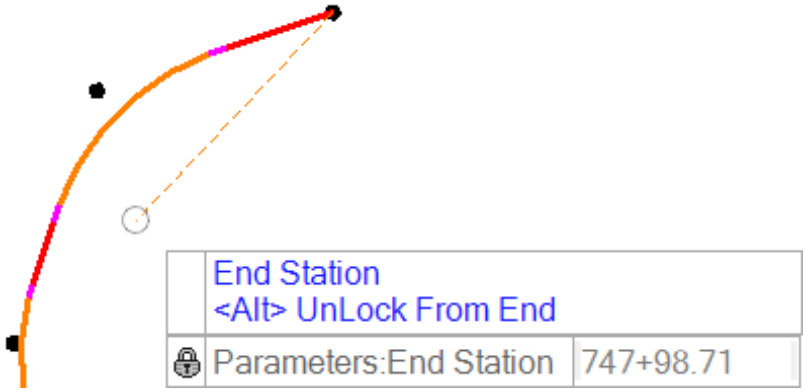


C. Right click to end the selection process

D. Left click to set the start station, generally this will be the beginning of the alignment but it is possible to report on sections of the alignment and not the entire length. Additionally the <ALT> key can be used to lock the beginning station



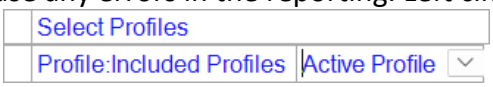
E. Press the <ALT> key to lock the end station to the end of the alignment. This will include the entire alignment in the geometry report. Left click to accept.



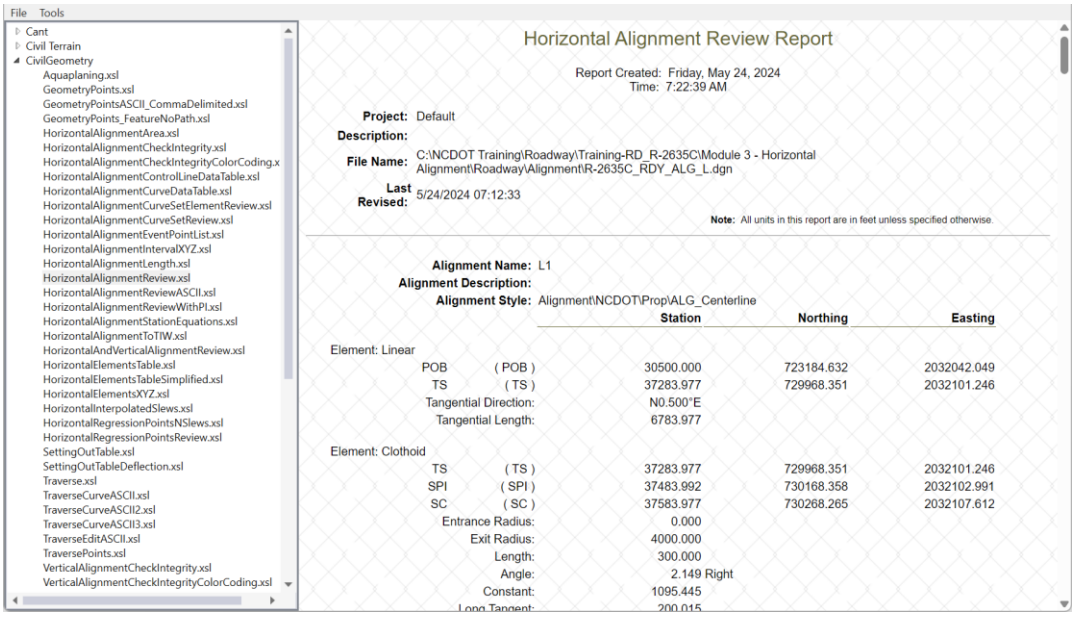
F. Set the interval to 0.00. For a number larger than 0.00', additional points, computed event points, will be added to the report. These reports will be spaced along the alignment at the specified interval and can be used to display information like stations, coordinates or elevations. Left click to accept.

G. Set the include event points as None. These points would report like the interval points but instead of being at a specific interval they would be individual points located by the user at specific locations. Left click to accept.

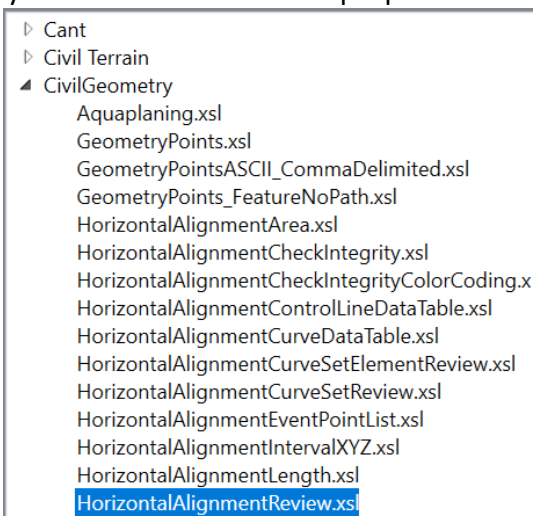
H. Use the <DOWN> arrow to set the include profile option to Active Profile. This should be the general setting when running a report. For this alignment there is no profile yet so the report will not return any information, but setting the to Active Profile will not cause any errors in the reporting. Left click to accept.



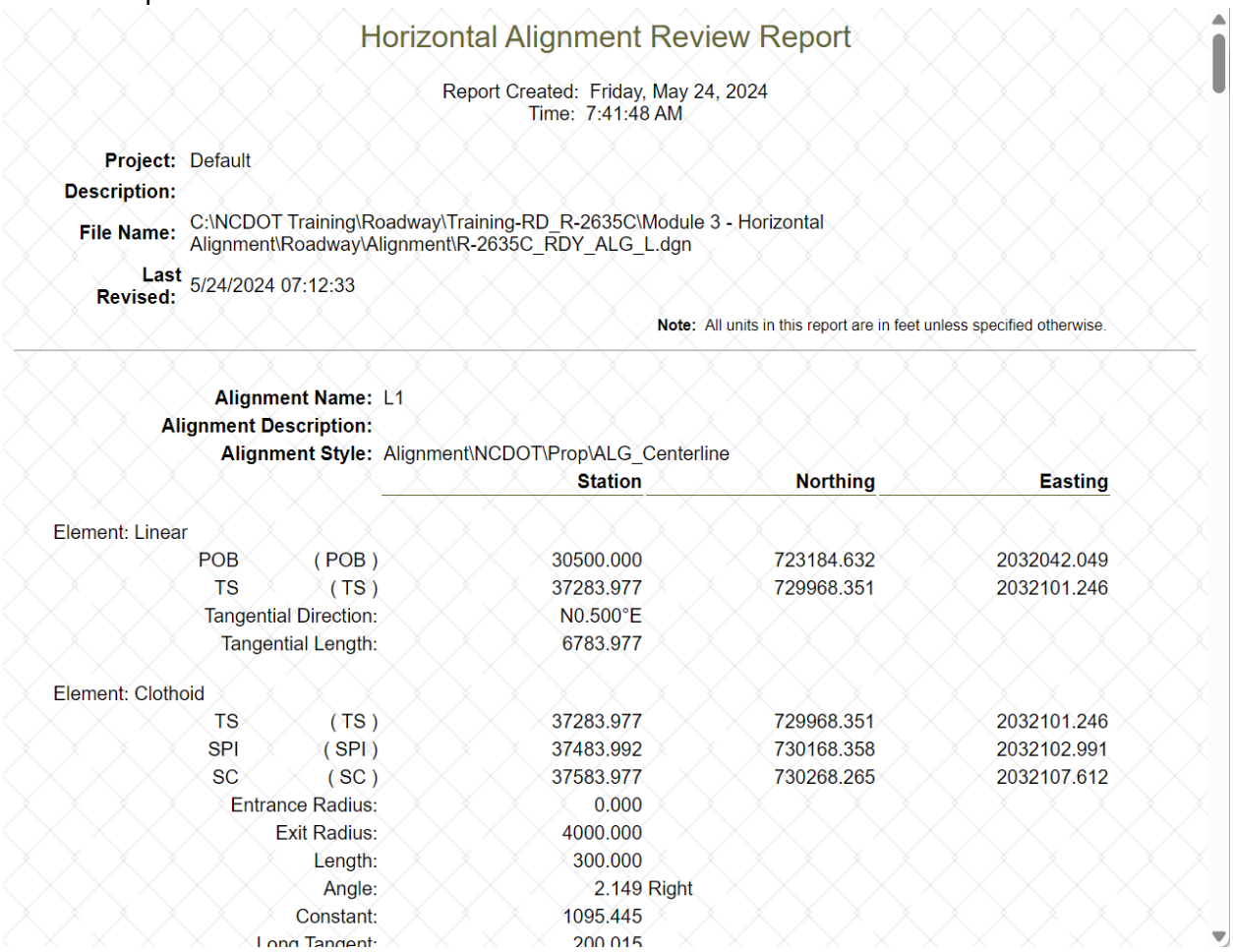
I. That will complete the selection process and bring up the reporting window. The window will list various available style sheets that will produce geometry reports in different formats and on different geometric data.



J. In the CivilGeometry section the HorizontalAlignmentReview.xsl will probably be the most common style sheet used for review purposes.



K. This will display an XML report that details all the geometric properties of the alignment, and details about when the report was run and the file that was used to produce it.



Horizontal Alignment Review Report

Report Created: Friday, May 24, 2024
Time: 7:41:48 AM

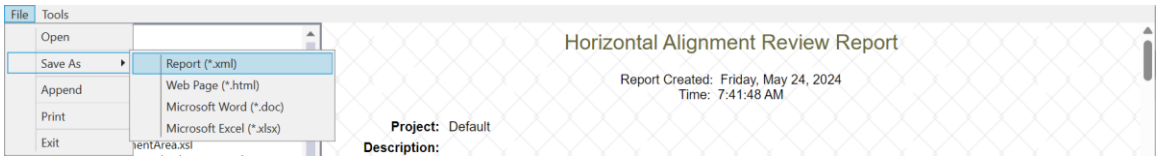
Project: Default
Description:
File Name: C:\NCDOT Training\Roadway\Training-RD_R-2635C\Module 3 - Horizontal Alignment\Roadway\Alignment\R-2635C_RDY_ALG_L.dgn
Last Revised: 5/24/2024 07:12:33

Note: All units in this report are in feet unless specified otherwise.

Alignment Name: L1
Alignment Description:
Alignment Style: Alignment\NCDOT\Prop\ALG_Centerline

		Station	Northing	Easting
Element: Linear				
POB	(POB)	30500.000	723184.632	2032042.049
TS	(TS)	37283.977	729968.351	2032101.246
Tangential Direction:		N0.500°E		
Tangential Length:		6783.977		
Element: Clothoid				
TS	(TS)	37283.977	729968.351	2032101.246
SPI	(SPI)	37483.992	730168.358	2032102.991
SC	(SC)	37583.977	730268.265	2032107.612
Entrance Radius:		0.000		
Exit Radius:		4000.000		
Length:		300.000		
Angle:		2.149 Right		
Constant:		1095.445		
Long Tangent:		200.015		

L. This file can be saved in various formats.



M. For this alignment you can now see the start station is 305+00.00

Element: Linear

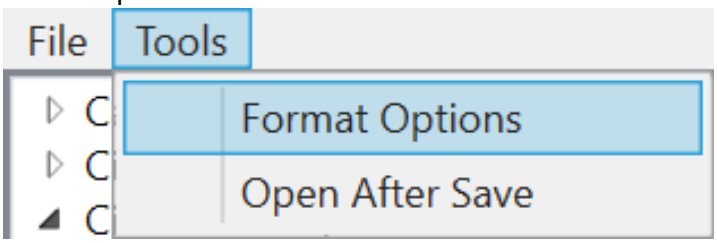
POB	(POB)	30500.000	723184.632	2032042.049
TS	(TS)	37283.977	729968.351	2032101.246
Tangential Direction:		N0.500°E		
Tangential Length:		6783.977		

N. And the end station is 748+04.46

Element: Linear

ST	(ST)	72293.576	762452.852	2036147.517
POE	(POE)	74798.712	763243.425	2038524.637
Tangential Direction:		N71.604°E		
Tangential Length:		2505.136		

O. The format of all the reports can be controlled by the dialog accessed under Tools → Format Options



P. This allows for control over Mode, Precision and Formats

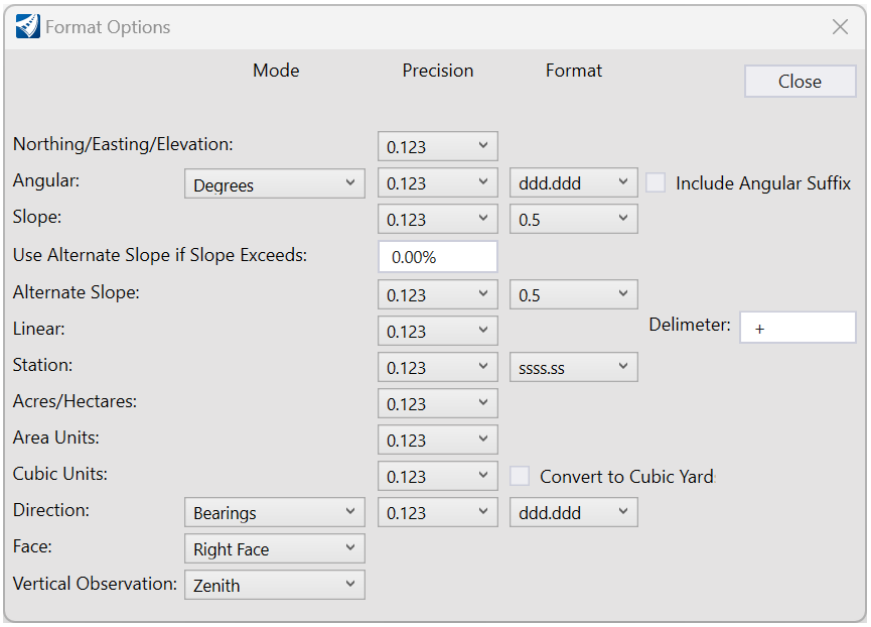
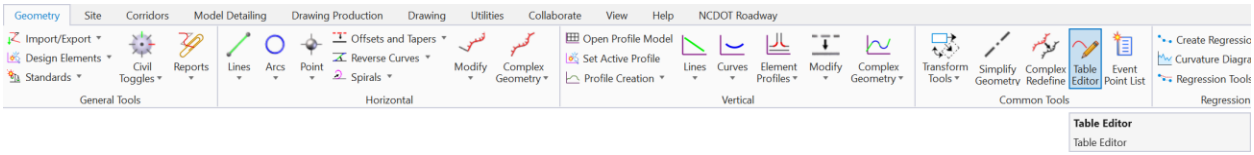


Table Editor

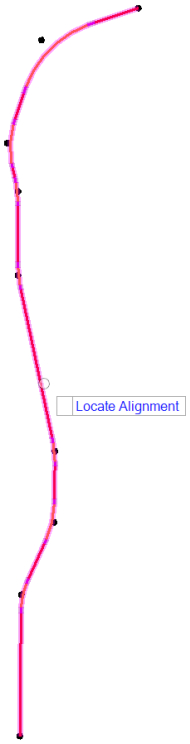
1. Using the Table Editor to Review Geometry

A. The primary function of the Table Editor is to make edits to the geometric properties of the alignment. Properties like Radius, Bearing, Length etc. The table editor can be used for a quick review of the alignment as well. This will not provide as much detail as the Geometry Reports but it will give the user an overview of the most important geometric parameters.

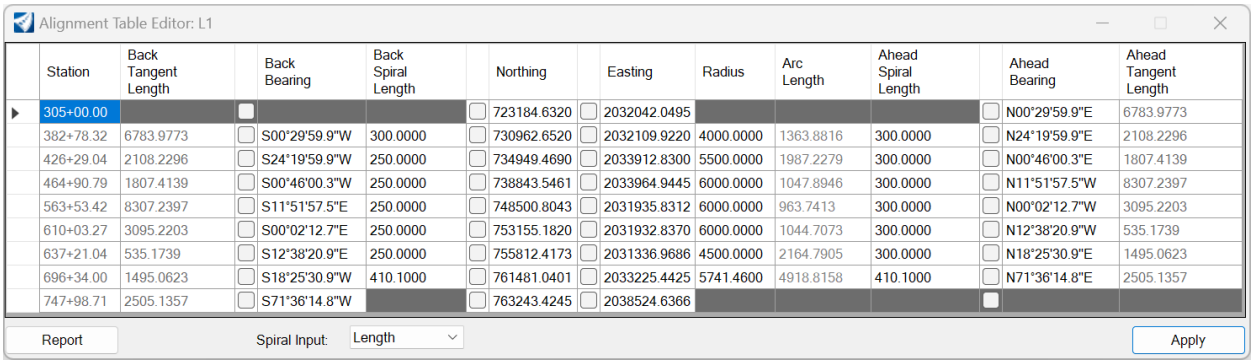
B. Select the **Table Editor** tool from the *Common Tools* section of the *Geometry* ribbon.



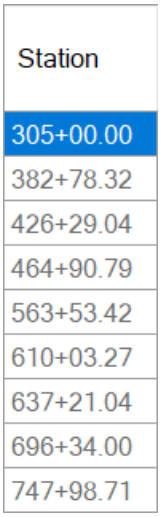
C. Left click on the alignment to select.



D. This will bring up the table editor dialog. This dialog can be used to change any of the design parameters shown but it can also be used for review. It shows the Begin/End Stations and the Stations of the PIs as well as Spiral Lengths and the Radius of each Curve.



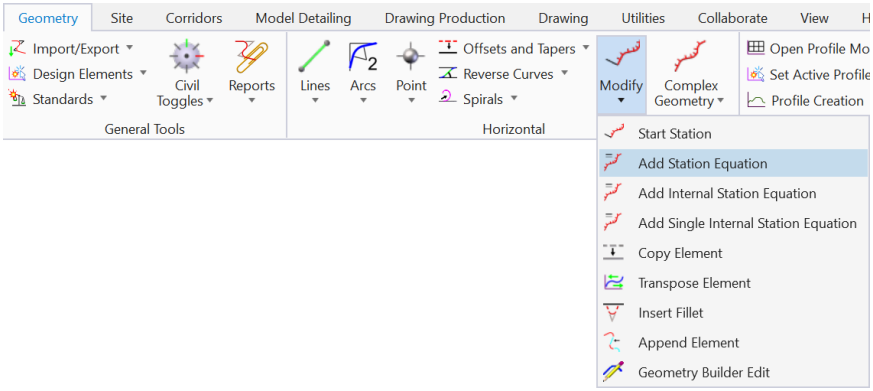
E. This dialo also shows that the start station is now 305+00.00 and the end station is 748+04.46



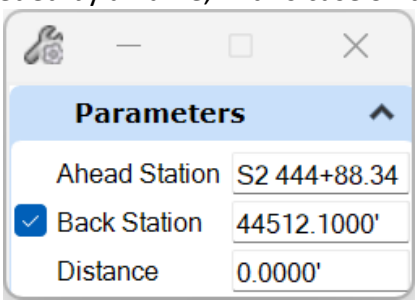
2. Adding a Station Equation

A. For this project the L alignment also contains a Station Equation.
Sta 445+12.10 BK = Sta 444+99.34 AH

B. To add the station equation select the Add Station Equation tool from the Horizontal section of the Geometry Ribbon.



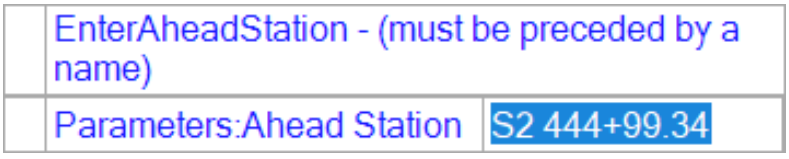
C. At the dialog prompt enter 444+99.34 for the Ahead Station and 445+12.10 for the Back Station. Check the box for back station to lock the value. Note that the ahead station must be preceded by a name, in this case S2 to represent Section 2



D. Left click to locate the Alignment

E. Left click to accept the back station value.

F. Left click to accept the Ahead Station Value



G. This will complete the tool

H. Rerun the Horizontal Geometry Report and scroll to the area where the stationing is in the range of the equation. The Back and Ahead stations will be displayed and the ahead geometry will have the prefix S2 added based on the name supplied during the station equation process

Chord Direction:		N1.288°E		
Radial Direction:		S89.233°E		
Tangent Direction:		N0.767°E		
Element: Linear				
ST	(ST)	43893.316	736246.306	2033930.186
	EQNBK	44512.100	736865.034	2033938.466
	EQNAHD	S2 44499.340	736865.034	2033938.466
TS	(TS)	S2 45687.970	738053.558	2033954.372
Tangential Direction:		N0.767°E		
Tangential Length:		1807.414		
Element: Clothoid				
TS	(TS)	S2 45687.970	738053.558	2033954.372
SPI	(SPI)	S2 45854.641	738220.213	2033956.602
SC	(SC)	S2 45937.970	738303.548	2033955.982
Entrance Radius:		0.000		
Exit Radius:		6000.000		
Length:		250.000		

Horizontal Geometry Exercise – Complex By Element

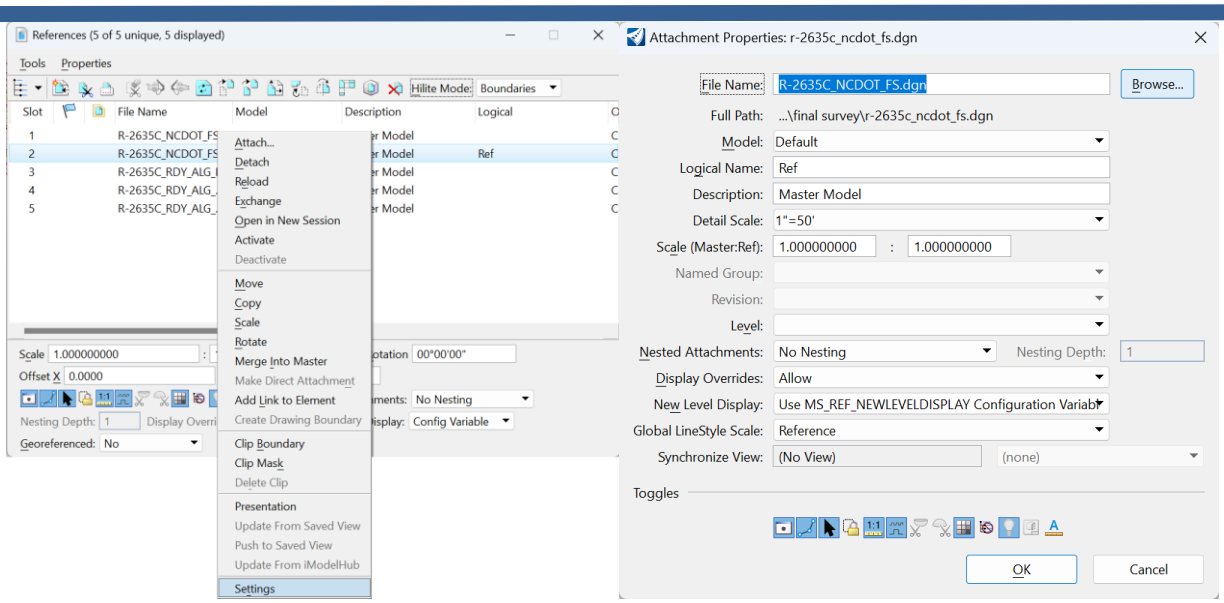
In this exercise, you will learn how to create an alignment from elements. We will place individual elements based on established alignments. Join those elements together into a single alignment and add stationing.

This exercise will create a Collector-Distributor alignment parallel to the L line. The tools and processes shown in this exercise are not the only way to create this type of alignment. There may be other tools and concepts that are easier and more efficient. The purpose of this exercise is to show how to use the individual tool covered in the beginning of this section to develop an alignment.

The lengths, radii, and spiral elements are based on the original R-2635C plans. This exercise is not meant to show how to determine those parameters only how to build elements based on those known paramerters.

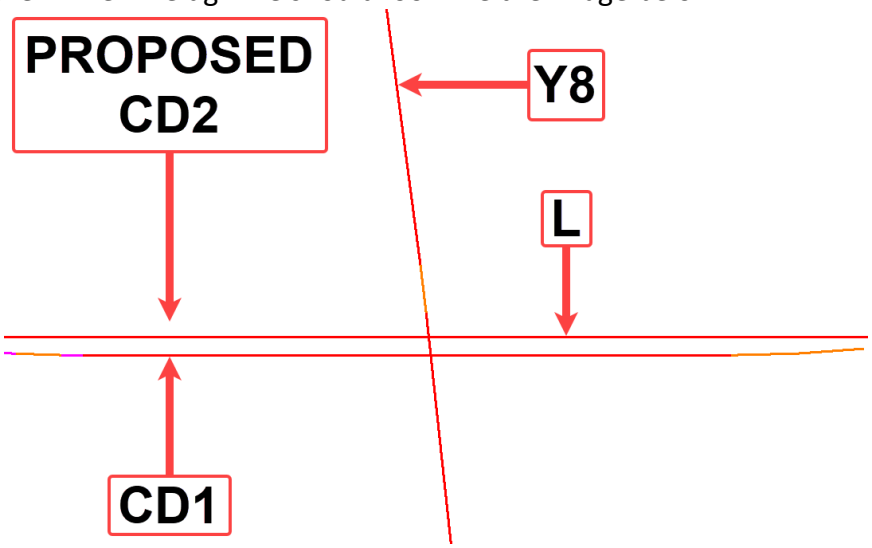
1. **Complex By Element – CD2 Alignment**
   A. A. Create a new design file using the 2D seed file, and name the file: ***R-2635C_RDY_ALG_CD2-SB.dgn***
      - This file should be created in the Alignments folder of the training directory *…\Module 3 Horizontal Alignment\R-2635C\Roadway\Alignment*
        R-2635C_NCDOT_FS

   B. Attach the Final Survey file ***R-2635C_NCDOT_FS.dgn***
      and the Existing Terrain Model ***R-2635C_NCDOT_FS.dgn*** from the FinalSurvey Folder.
      C:\NCDOT Training\Roadway\Module 3 Horizontal Alignment\R-2635C\FinalSurvey
   C. Attach the following ALG files from the Alignment Directory
      - R-2635C_RDY_ALG_L.dgn
      - R-2635C_RDY_ALG_Y8.dgn
      - R-2635C_RDY_ALG_CD1.dgn



D. If the attachments are already loaded, but red, then right click, and click on settings at the bottom of the menu. Then, navigate to the browse button on the settings pop-up, and select the correct files from the file path given in step B. You got this! If you're still reading this!

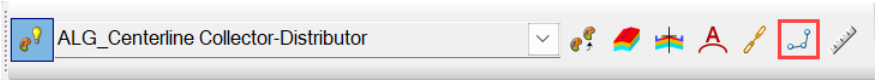
E. Turn off the Existing Terrain model and the Final Survey and Rotate the view parallel to the L Line. The dgn file should look like the image below.



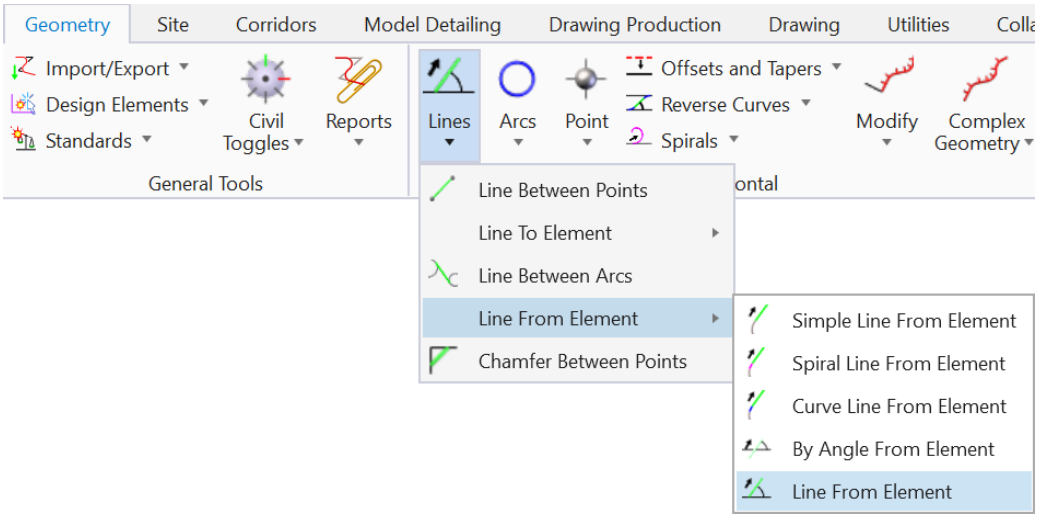
F. The proposed CD2 alignment will be created on the opposite side of L from the CD1 alignment and will be a mirror image of CD1.
   - The alignment will be stationed from Right to Left on the image Shown
   - The central tangent is parallel to the L alignment and 107’ to the Left.
   - The alignment begins as an angular exit with a deflection of 3°34’46.5”
   - There is a Spiral Curve Spiral Combination with the Spiral Length = 125’ and the Curve Radius = 6320.40’
   - There is a reversing curve combination with match curve radius = 8000.00’

G. Draw a line parallel to the L alignment 107’ to the left and 2100’ on each side of the intersection with Y8. There are several ways to accomplish this, and later training modules may introduce other tools that could also work for this scenario use the **Line From Element** tool.

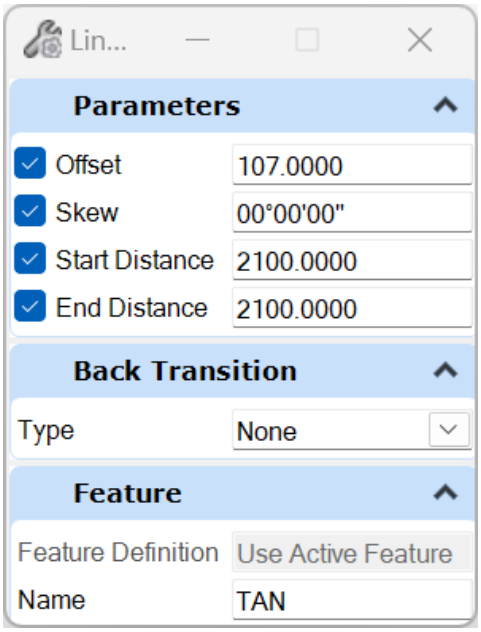
H. Set the Feature Definition to ALG Centerline Collector Distributor and turn Persist Snaps to Off.



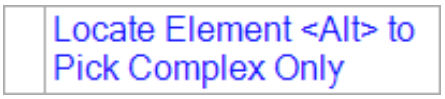
I. Start the **Line From Element** tool.



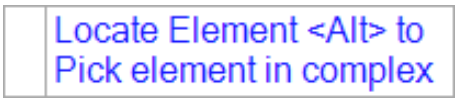
J. Set the dialog to
- Offset = -107.00 – The Offset to L
- Skew = 0°0’0” – This will set the Line Parallel to L
- Start and End Distance 2100.00’ – This will set the length f the line to either side of the start point. These distances will be adjusted after the other elements are placed.
- No Transition
- Name = TAN



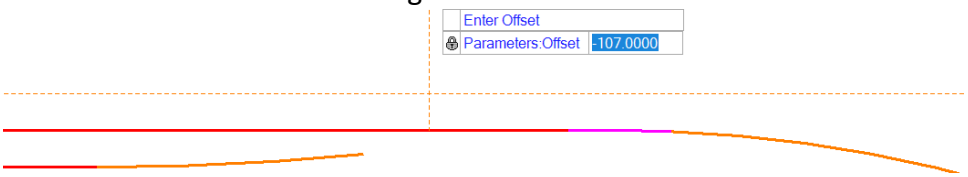
K. The heads up prompt indicates to pick the From Element.
- Note that the prompt indicate <ALT> to Pick Complex Only. This indicates that the current setting will pick an element within the Complex. By pressing the <ALT> key this setting would change to Pick Complex Only. The heads up prompt indicates the available setting change not the current setting.



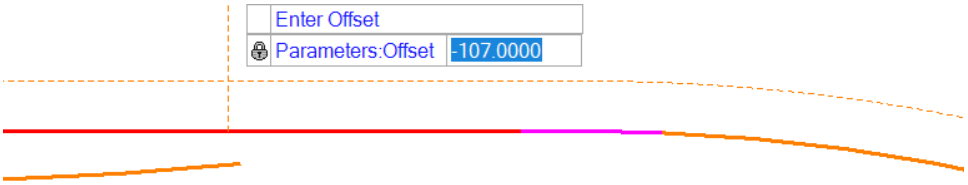
- Pressing the <ALT> key changes to setting to Pick Complex Only and shows that the available setting to change to is to Pick element in complex.



- A Complex element in ORD is analogous to a Chain in Geopak
- In this example the L line is the From Reference Element and the L alignment is a complex element.
- By using the *Pick an element in complex* setting when the To or From element is selected only the element that was actually clicked on will be selected and the tool will use the extension of that single element for any offset or tie calculations. As indicated by the horizontal dashed black line that appears at a 107.00’ offset when the red tangent section of L is selected as the From element.

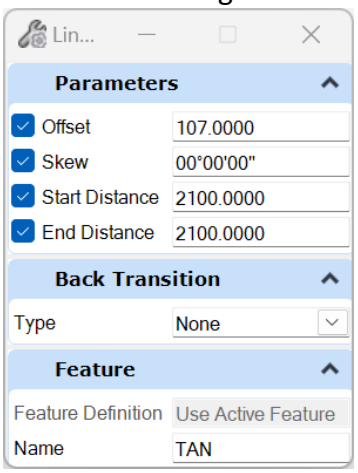


- By using the *Pick Complex Only* setting when the To or From element is selected the entire complex will be selected and the tool will use the entire element including all the tangents, curves and spirals for any offset or tie calculations based on the point along the Complex where the tie occurs. As indicated by the dashed black line that appears parallel to L at a 107.00’ offset when the red tangent section of L is selected as the From element

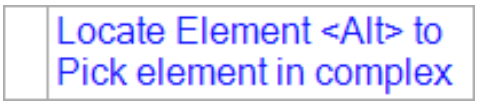


- Each setting has advantages and disadvantages depending on the constraints and the desired outcome.

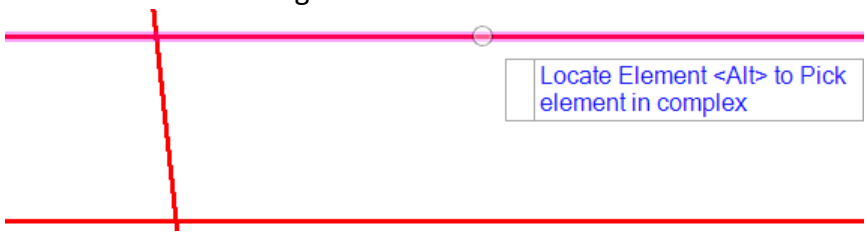
L. The dialog setting should match the image below.



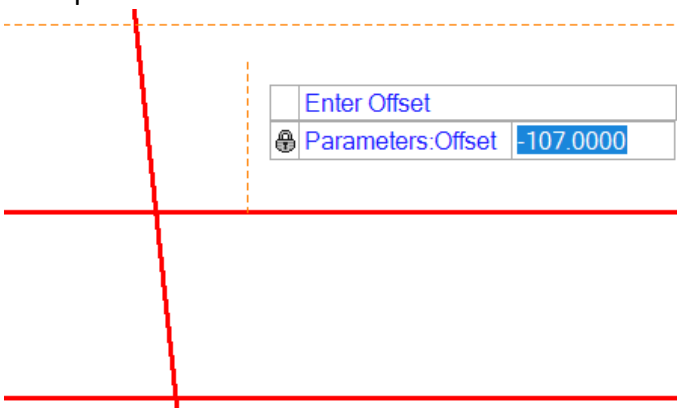
M. Use the <ALT> key to change the selection to Pick Complex Only which means that the prompt will indicate Pick element in complex, the alternate setting.



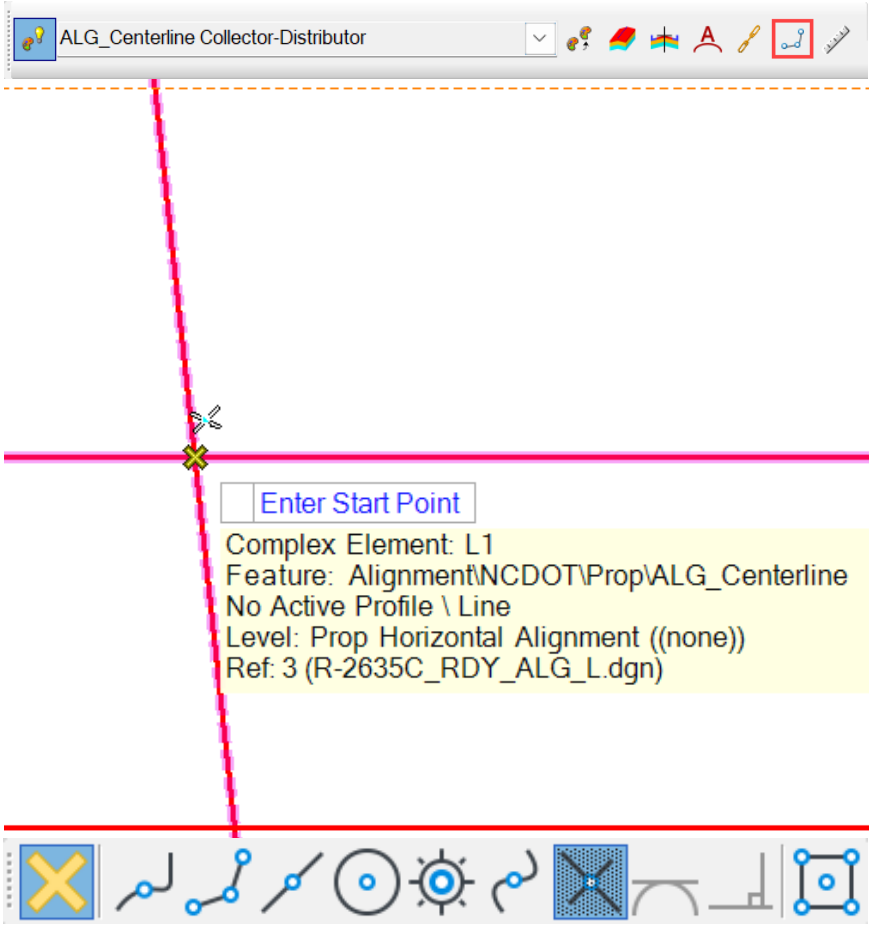
N. Left click to select the L alignment



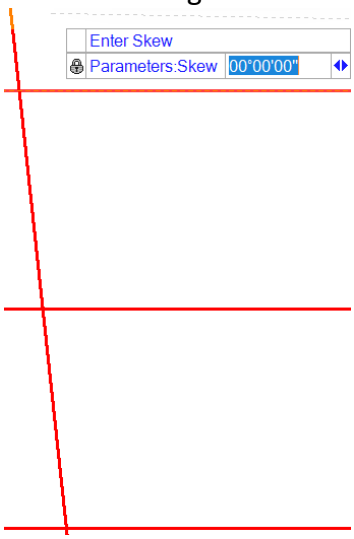
O. Left click to accept the offset of -107.00’



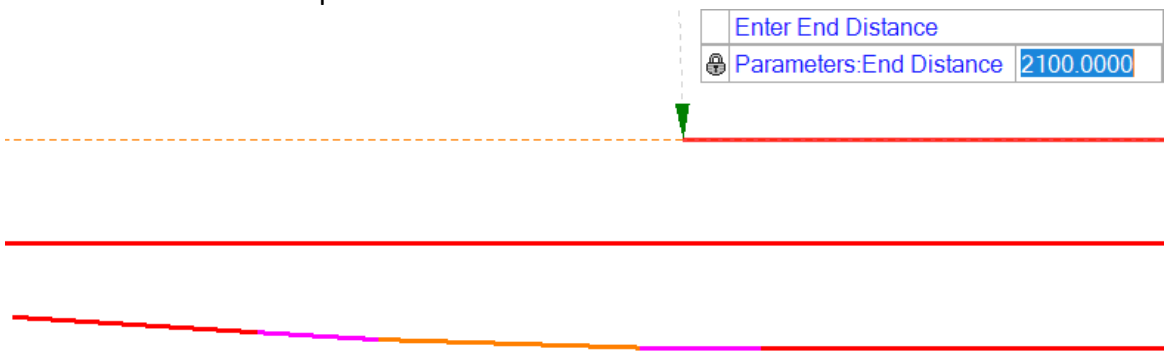
P. Snap to the intersection of L and Y8. The Persist Snap is set to OFF so this will not create a snap rule.



Q. Left Click to Accept the Skew of 0°0’0”, that will create the line parallel to the L Alignment. This will also accept the Start Distance of 2100.00’ because that distance was entered and locked into the dialog.

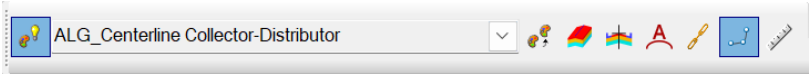


R. Left click to accept the end distance of 2100.00’

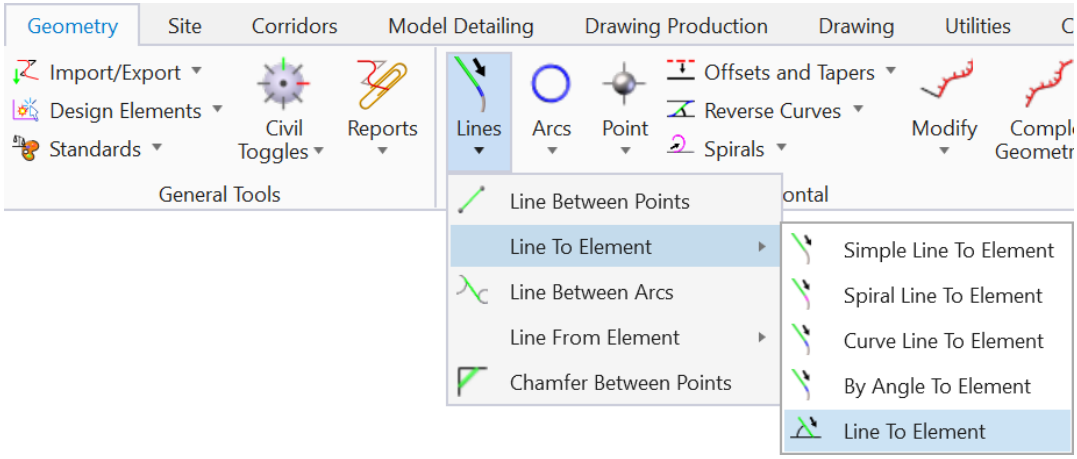


S. That will place the central tangent of the Collector Distributor alignment.

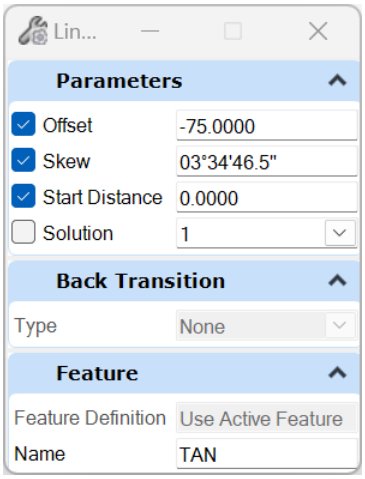
T. Set the Persist Snap to ON. This element should have a geometric snap rule tied to the end point of the central tangent. If done this way when the length of the central tangent changes the intersection point and the initial tangent will move. This point will be the PI of the Spiral-Curve-Spiral combination, so the entire curve combination will move. This is the design intent of the element placement.



U. The next step is to construct the initial tangent (going from Left to Right) at an offset of 75.00’ and a skew of 3°34’46.5” to the L alignment. Start the **Line To Element** tool. Select this tool because it will allow for the end point of the initial tangent to be set at a skew to the L line to To Element, and have the intersection tied to the central tangent placed in the last set. By doing it this way, when the length of the central tangent is modified the entire curve set and initial tangent will also be modified. This tool ties the element to the first element while allowing a reference to the second element.

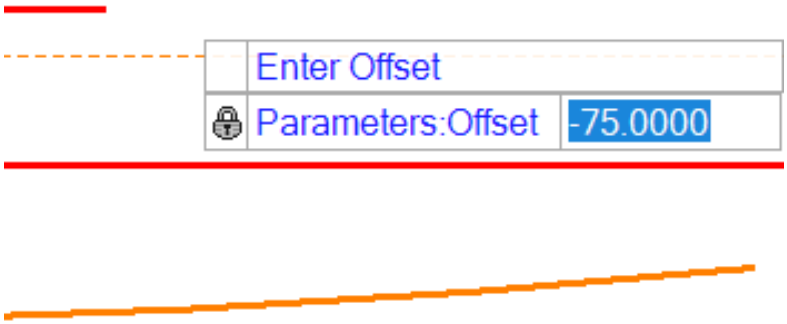


V. Set the Dialog to
   - Offset 75.00’ – This is the offset from the L line to the beginning of the initial tangent
   - Skew 3°34’46.5” – This is the skew to the L Line
   - Start Distance 0.00 – This is the distance from the initial point to the start of the tangent, along the skew.
   - Feature Definition name to TAN

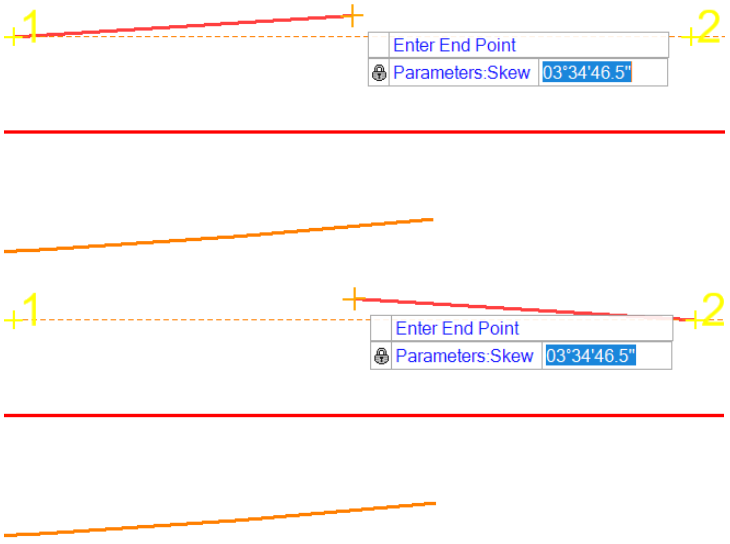


W. Left click to select the L line as the To Element. Use the Pick Complex Element Option because the tie point of the Collector Distributor is not yet known. Note the heads up prompt displays the unselected option.

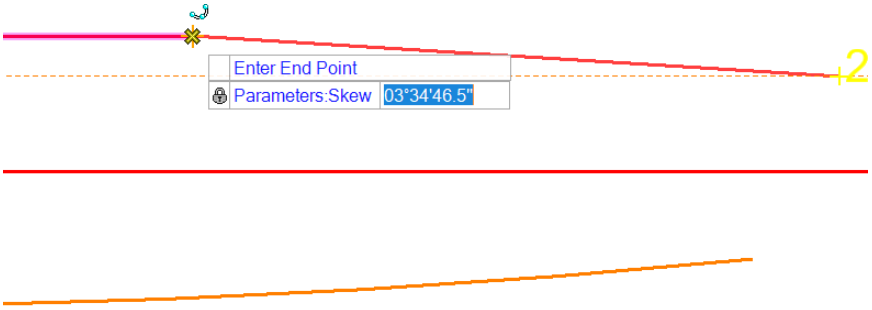
X. Left click to accept the offset of 75.00’



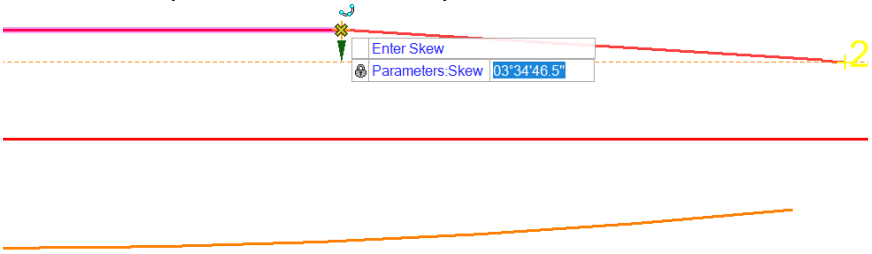
Y. Press the <ALT> key to select option 2 and change the direction of the initial tangent.



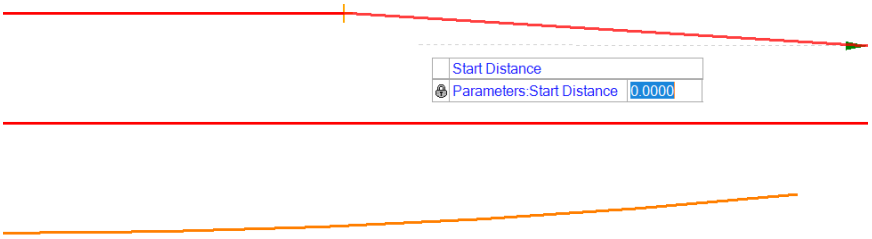
Z. Sanp to the end of the central tangent to create a geometric rule. This will carry through any changes to the central element and shift the PI as the length of the central tangent is modified.



AA. Left click to accept the skew and end point

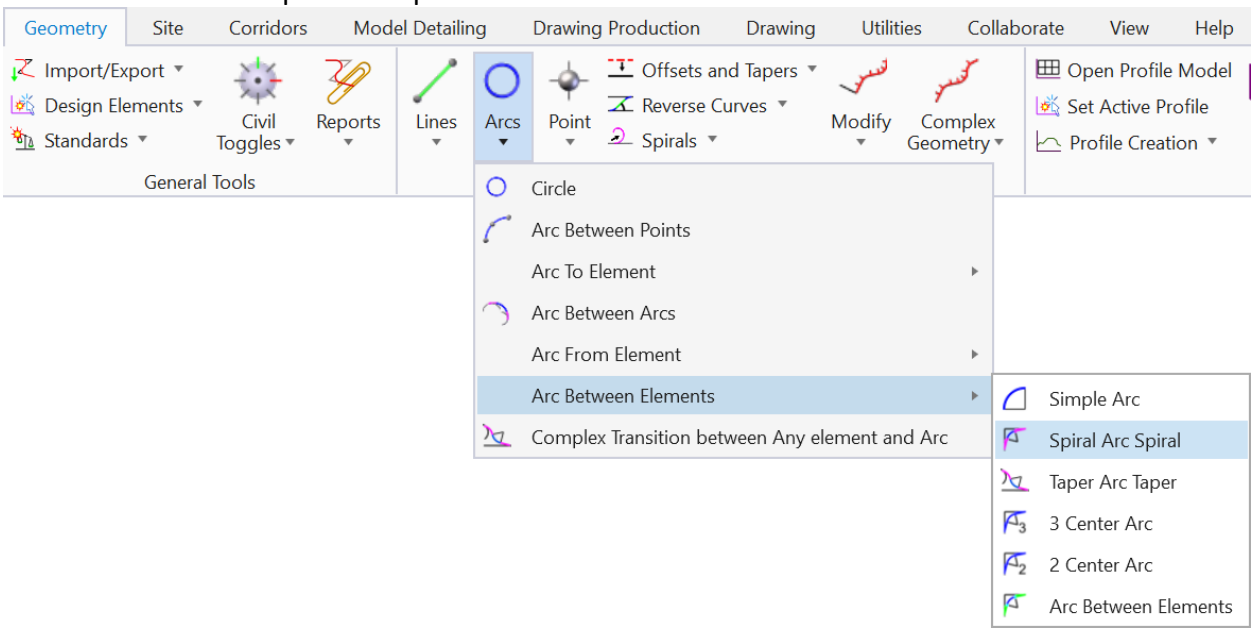


BB. Left click to accept the start distance of 0.00’. This places the start of the line exactly on the 75.00’ offset from the L line entered in the dialog.



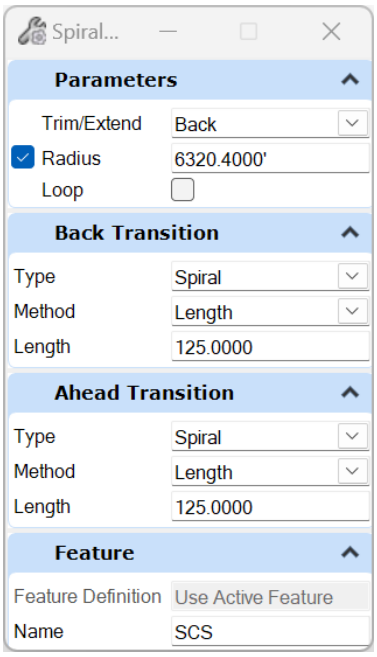
CC. The next step is to construct the Spiral-Curve-Spiral combination between the two tangents.

DD. Start the Spiral Arc Spiral tool in the Arc Between Elements Section.



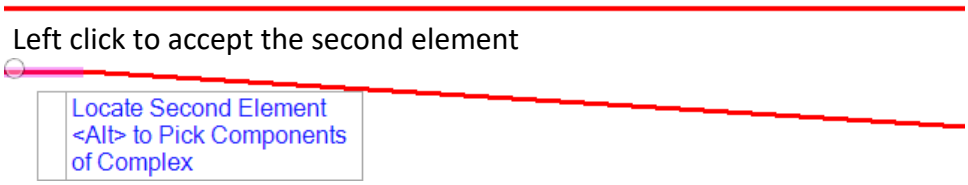
EE. In the dialog set

- Radius to 6320.40’
- Back Transition to Spiral of 125.00’
- Ahead Transition to Spiral of 125.00’
- Feature Definition Name to SCS

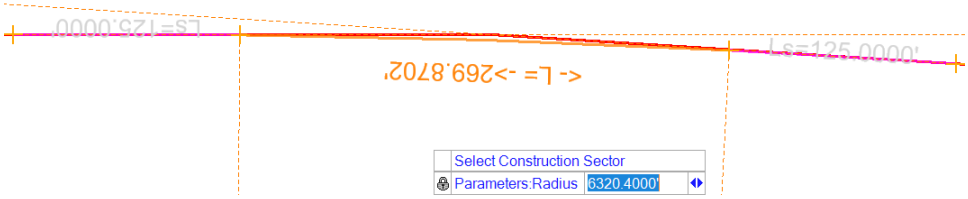


FF. Left click to locate the First Element

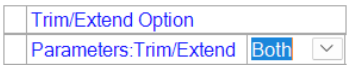
Left click to accept the second element



GG. Left click to accept radius of 6320.40’



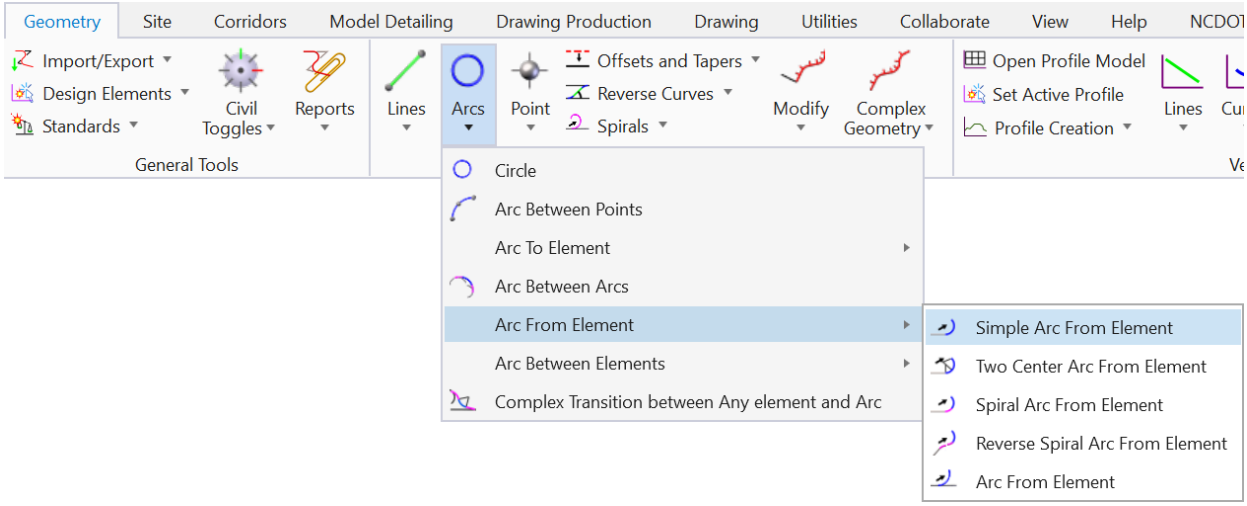
HH. Use the down arrows to change the Trim/Extend options to both and left click to accept.



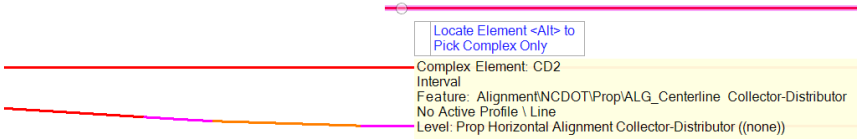
II. This will complete the placement of the SCS combination.

JJ. At the other end of the Collector Distributor there will be reversing curves with matching radius of 8000.00'. To construct these arcs use the **Simple Arc From Element** tool to construct an initial arc from the central tangent and then the **Arc Between Elements** tool to construct an arc to tie to a 75.00' offset from the L line.

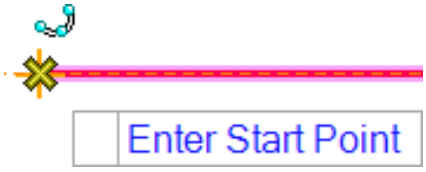
KK. Start the Simple Arc From Element tool



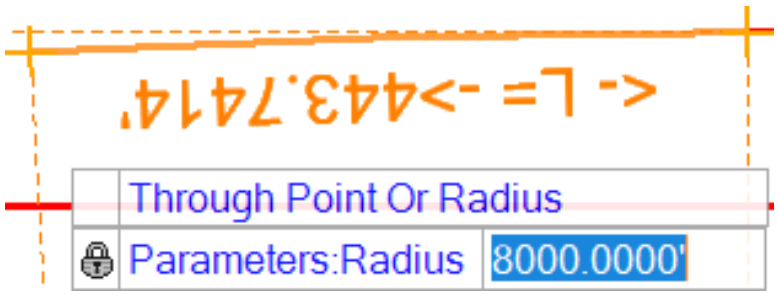
LL. Left click to locate the central tangent of the Collector Distributor alignment



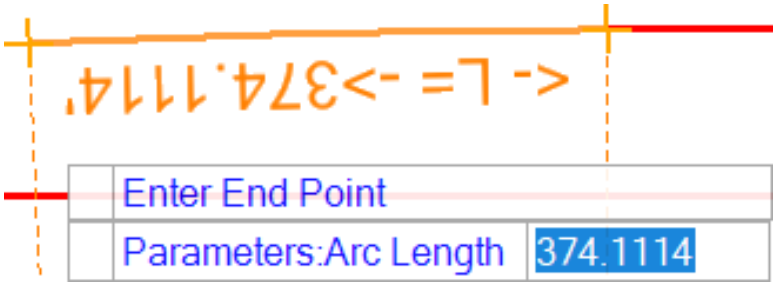
MM. Snap to the end point of the central tangent to locate the start point and to create a snap constrain to the central tangent. This will act much like the snap constraint at the beginning PI and will transfer revisions to the tangent length to the reversing curves.



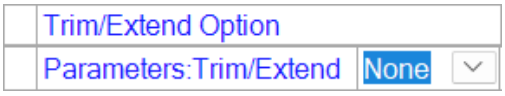
NN. At the prompt type in 8000.00’ for the radius and <ENTER> to lock. Left click to accept.



OO. Left click to dynamically accept am Arc Length. This length can be any value. During the placement of the reversing curve the trim option can be set to back and the curves will adjust to tie at the tangent point.

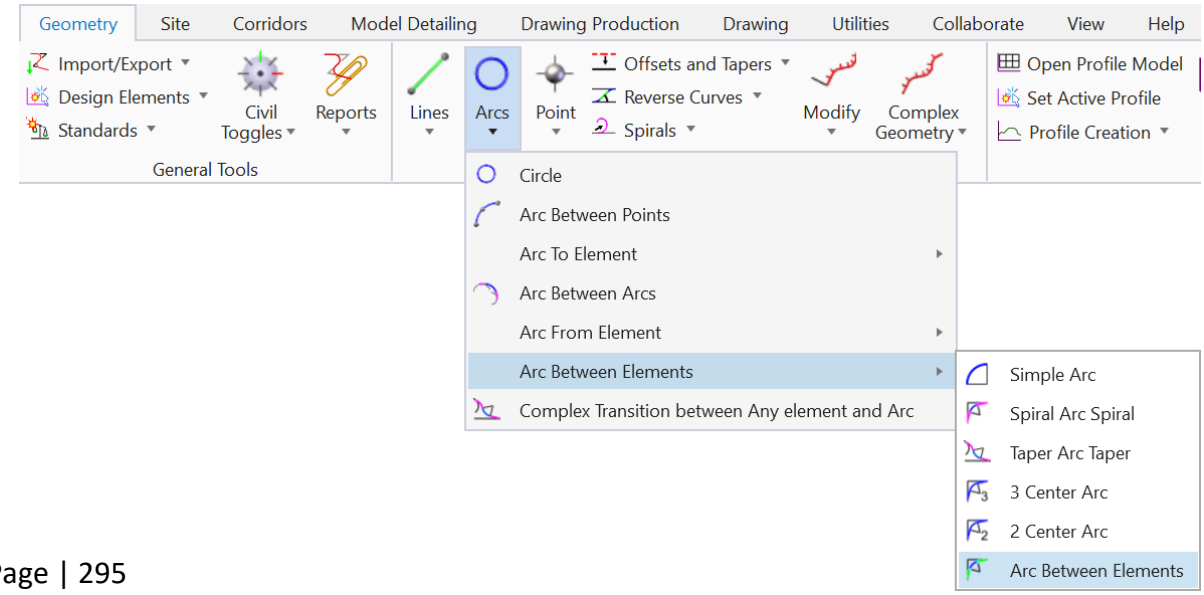


PP. Left click to accept the trim option as None. Because the curve start point was set at the end of the tangent the Trim/Extend option needs to be set to None. If this was set to back when the length of the central tangent was modified the Trim/Extend option would automatically trim or extend it to meet the curve and the curve position would not adjust.

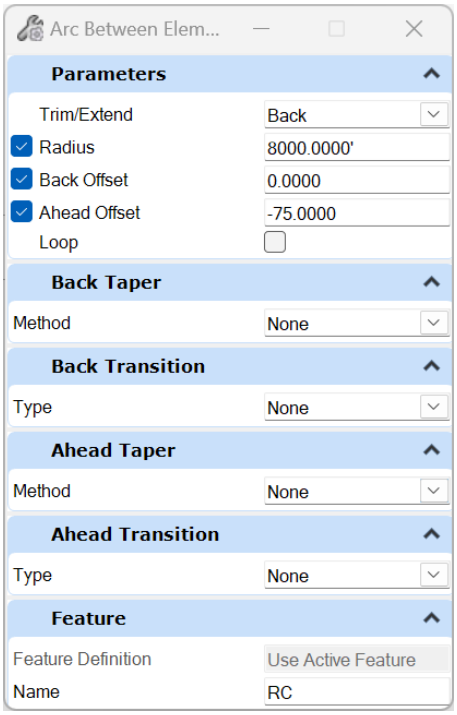


QQ. This will complete the placement of the first curve.

RR. Start the **Arc Between Elements** tool.

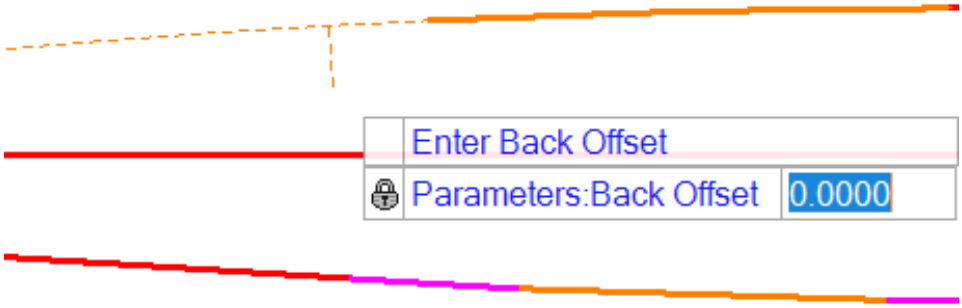


SS. Set the dialog to
- Radius – 8000.00’
- Back Offset to 0.00’
- Ahead Offset to -75.00’
- Name to RC



TT. Left click to locate the first element, this is the first curve in the reversing curve combination based on the way the Back and Ahead offset were set.

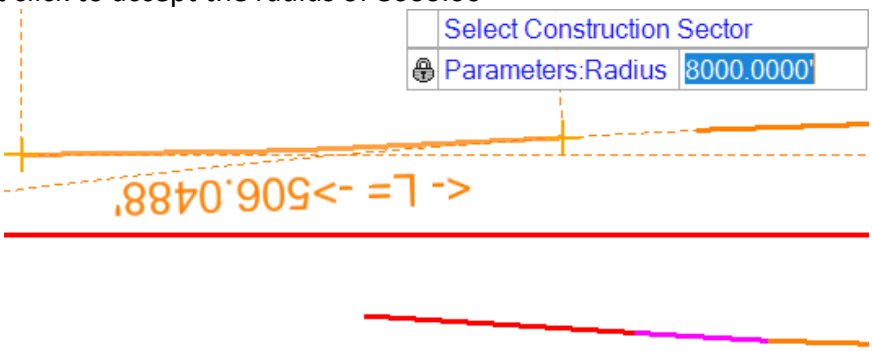
UU. Left click to accept back offset of 0.00'



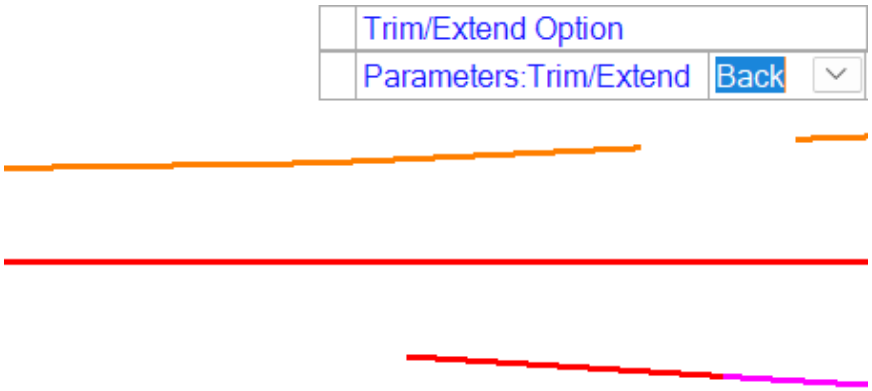
VV. Left click to locate the second element, this is the L Line.

WW. Left click to accept the offse of -75.00’

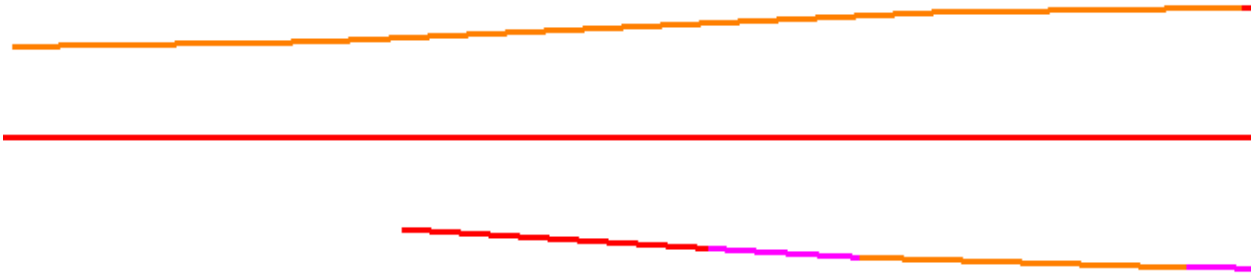
XX. Left click to accept the radius of 8000.00’



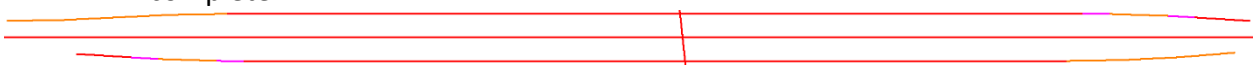
YY. Use the <DOWN> arrow key to change the Trim/Extend option to back and left click to accept.



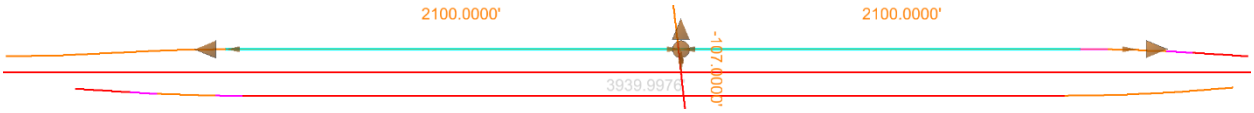
ZZ. This will complete the tool and place the reversing curve.



AAA. All of the elements required to create Collector Distributor alignment are now complete.



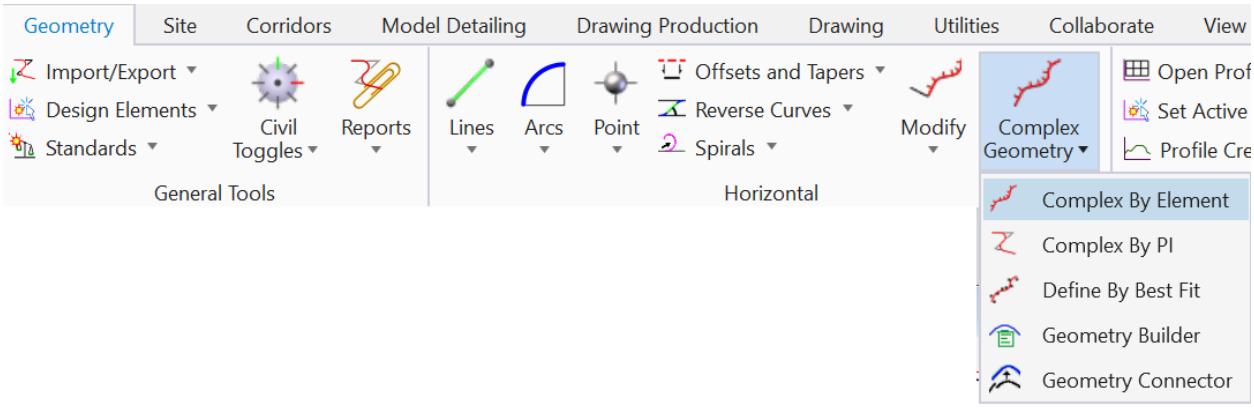
BBB. The last step is to set the tangent lengths required. This would normally be done in conjunction with the ramp and loop designs. For this design we know that the tangent length to the Left of Y8 Should be 1791.14’ and to the right should be 2235.16. Use the element selection tool to highlight the central tangent and active the text manipulators.



CCC. Change the manipulator on the left from 2100.00 to 1791.14

DDD. Change the right side to 2235.16

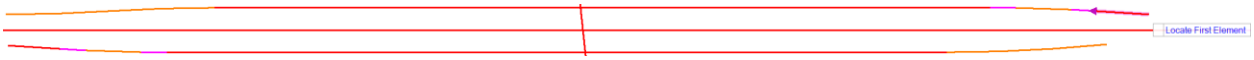
EEE. The elements are now completed. The next step is to create Complex Geometry. Select the Complex By Element tool.



FFF. This dialog is very similar to the create complex chain dialog form microstation. There is a manual and an automatic option with a maximum gap.

- Set the Method to Automatic
- Set the Maximum Gap to 0.0001
- Set the Name to CD
    1. **This is the name of Alignment, this is important to set to the name of the Alignment**

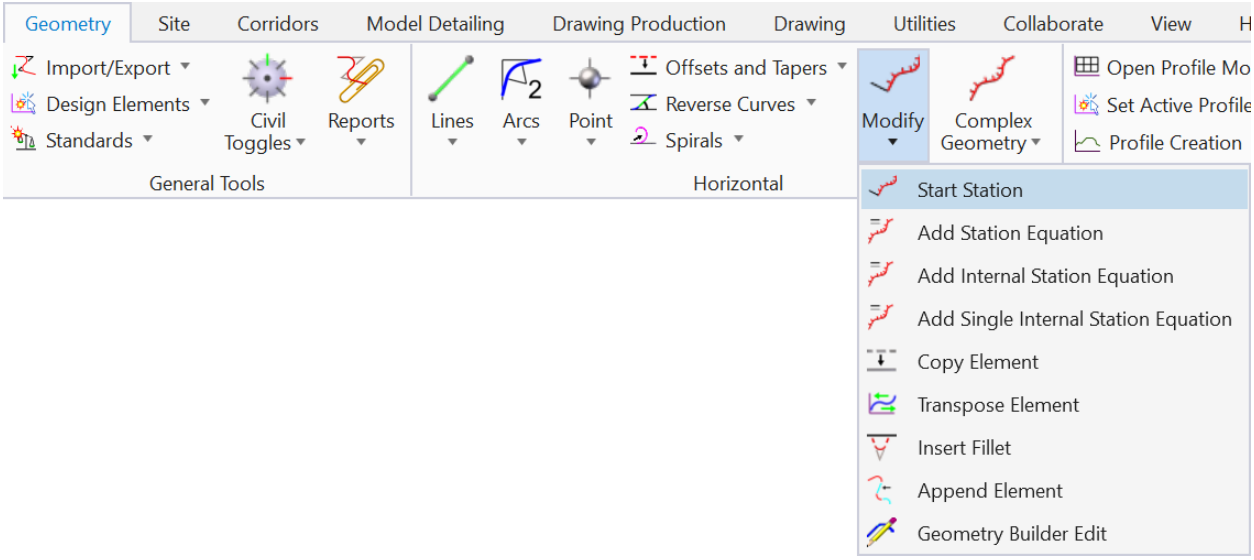
GGG. Left click to locate the first element. This is the tangent of the left side of the proposed alignment. Note that an arrow will display the direction of the Complex Element. This will match the direction of the stationing. In order for the arrow to point in the correct direction the user should select the left side of the first element in this design.



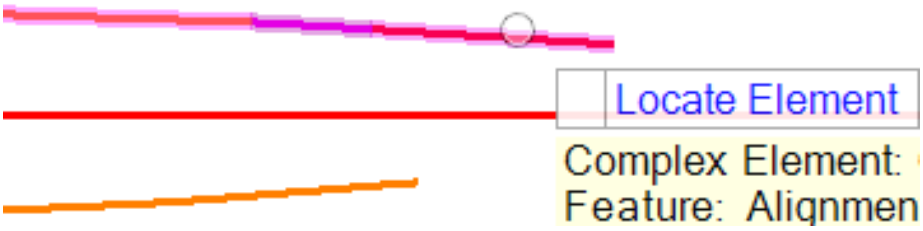
HHH. All the connecting elements will highlight. Left click to accept the complex element. This will create the Complex Element (Geopak Alignment) and complete the tool

III. The final step is to apply stationing. The CD2 Station begins at 5+00.00

JJJ. Select the Start Station tool.



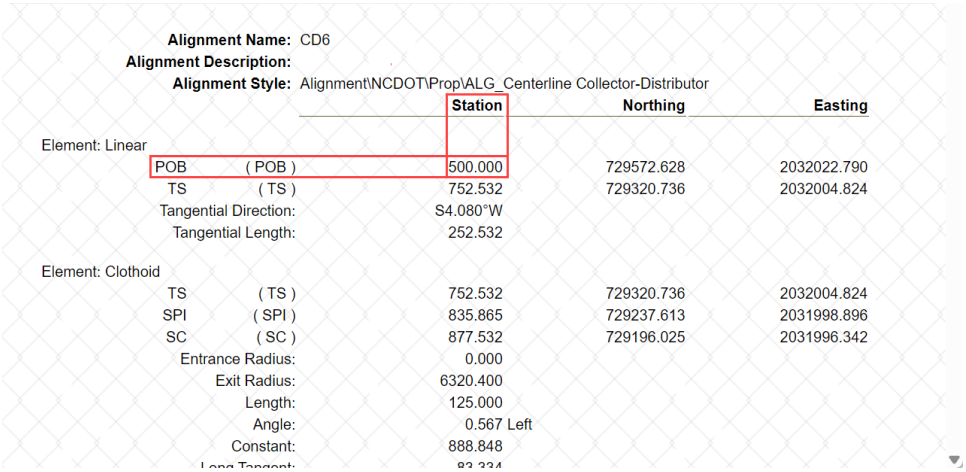
KKK. Left click to accept the CD2 Complex Element



LLL. Left click to set the start distance at 0.00

MMM. Left click to accept the start station as 5+00.00

NNN. That comeplets the Collector Distributor alignment. The Horizontal Geometry Report tool can be used to verify the geometry and the stationing.



Alignment Name: CD6
Alignment Description:
Alignment Style: Alignment\NCDOT\Prop\ALG_Centerline Collector-Distributor

		Station	Northing	Easting
Element: Linear				
POB	(POB)	500.000	729572.628	2032022.790
TS	(TS)	752.532	729320.736	2032004.824
Tangential Direction:		S4.080°W		
Tangential Length:		252.532		
Element: Clothoid				
TS	(TS)	752.532	729320.736	2032004.824
SPI	(SPI)	835.865	729237.613	2031998.896
SC	(SC)	877.532	729196.025	2031996.342
Entrance Radius:		0.000		
Exit Radius:		6320.400		
Length:		125.000		
Angle:		0.567 Left		
Constant:		888.848		
Long Tangent:		83.334		

Horizontal Geometry Exercise – Complex By Element

In this exercise, you will learn how to create an alignment for a Loop. Using Geopak Loop alignments could be complicated. Using ORD a Loop alignment is very simple and can be completed in only a few steps. This process is still using the Complex by Element procedure but instead of joining multiple elements together the Loop will be created as a single complex element.

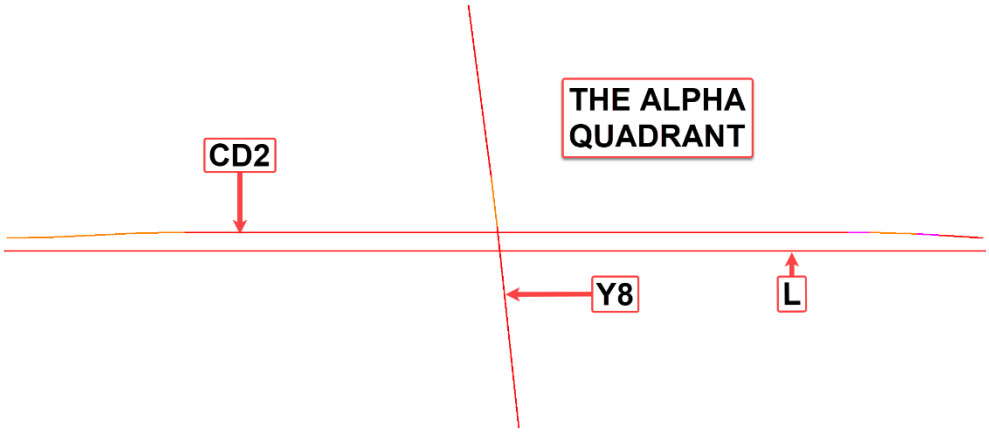
1. Complex By Element – LP1A Alignment

A. Create a new design file using the 2D seed file, and name the file:
R-2635C_RDY_ALG_LP1A.dgn
- This file should be created in the Alignments folder of the training directory
…\Module 3 Horizontal Alignment\R-2635C\Roadway\Alignment

B. Attach the Final Survey file ***R-2635C_NCDOT_FS.dgn***
and the
Existing Terrain Model ***R-2635C_NCDOT_FS.dgn***
from the FinalSurvey Folder.
C:\NCDOT Training\Roadway\Module 3 Horizontal Alignment\R-2635C\FinalSurvey

C. Attach the following ALG files from the Alignment Directory
- R-2635C_RDY_ALG_L.dgn
- R-2635C_RDY_ALG_Y8.dgn
- R-2635C_RDY_ALG_CD2.dgn
  1. This is the dgn file created in the previous exercise

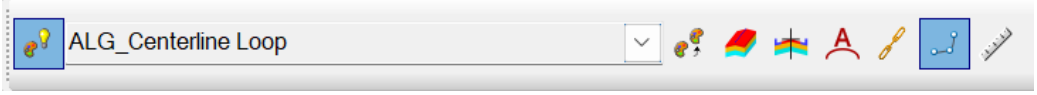
D. Turn off the Existing Terrain model and the Final Survey and Rotate the view parallel to the L Line. The dgn file should look like the image below.



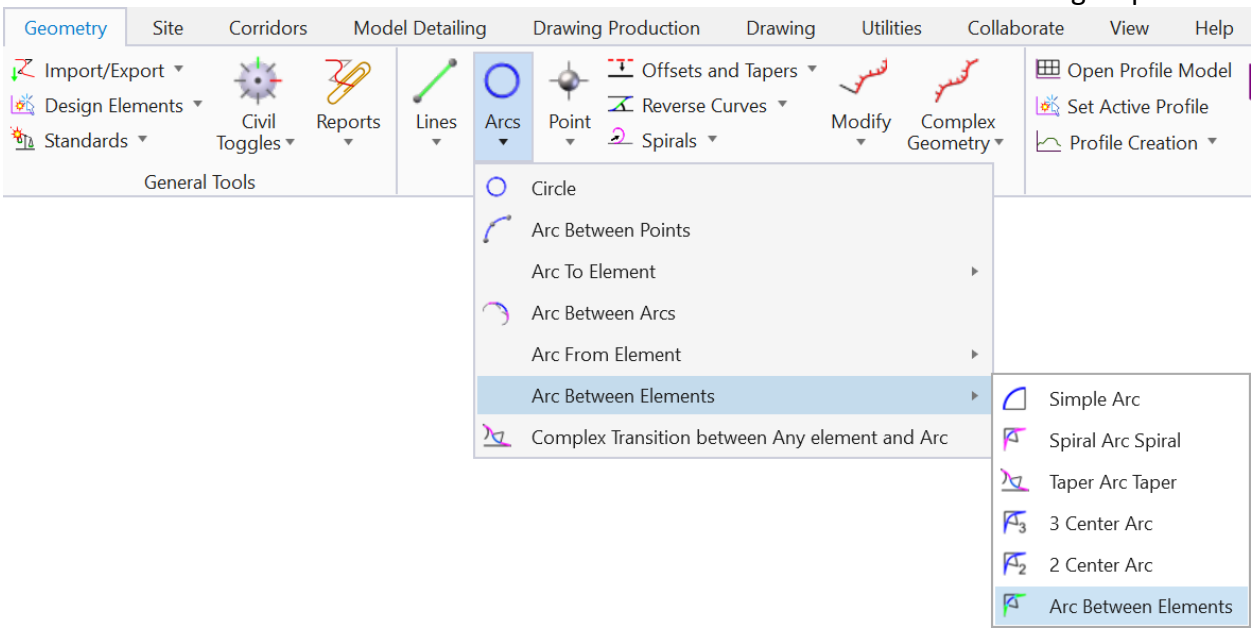
E. The Loop will be created in The Alpha Quadrant based on the following properties.
   - The centerline will be a Spiral-Curve-Spiral Combination with the Spiral Lengths = 200’ and the curve radius = 250’
   - The offset from Y8 is 47.50’
   - The offset from CD2 is 12.00’

thank goodness it wasn’t the delta quadrant.

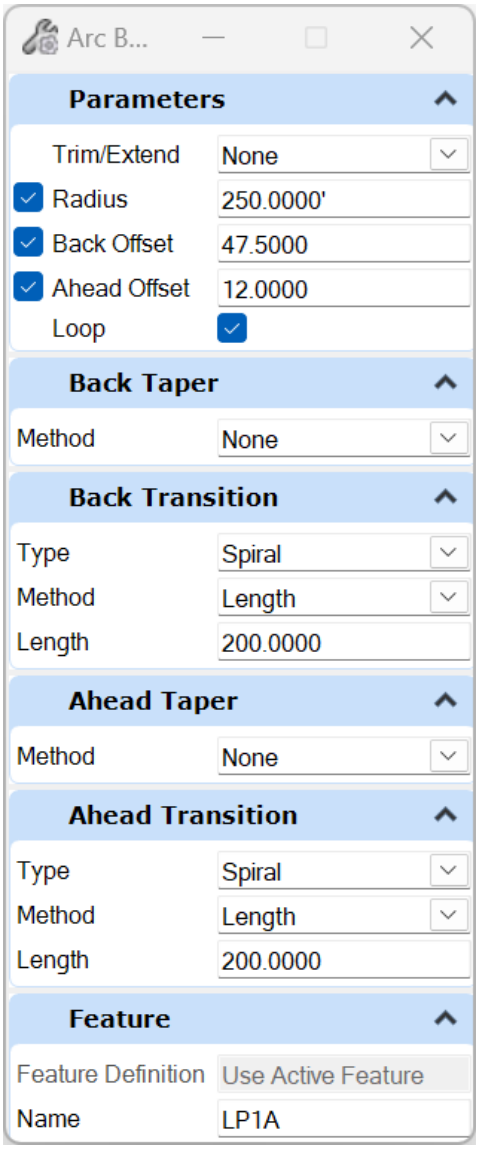
F. Set the Feature Definition to ALG Centerline Loop



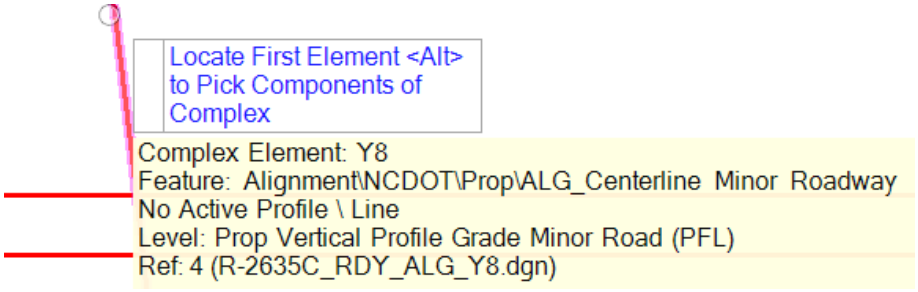
G. Select the **Arc Between Elements** tool from the Arc Between Elements group.



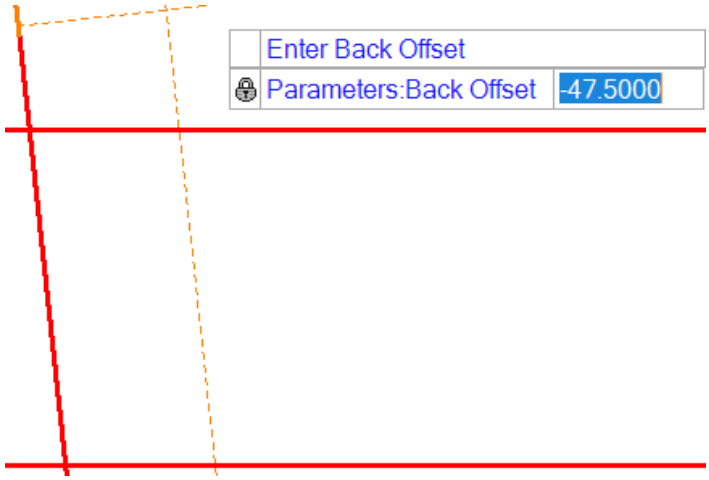
H. Set the dialog box to
- Trim/Extend = None
  1. The loop ties to an offset of the reference alignments so there will not be a trim mode
- Radius = 250.00’
- Back Offset = 47.50’
  1. This requires making Y8 the first element selected
- Ahead Offset 12.00
  1. This requires making CD2 the second element selected
- Loop: checked
- Back and Ahead Transition = Spiral
- Spiral Lengths = 200.00’
- Feature Name = LP1A



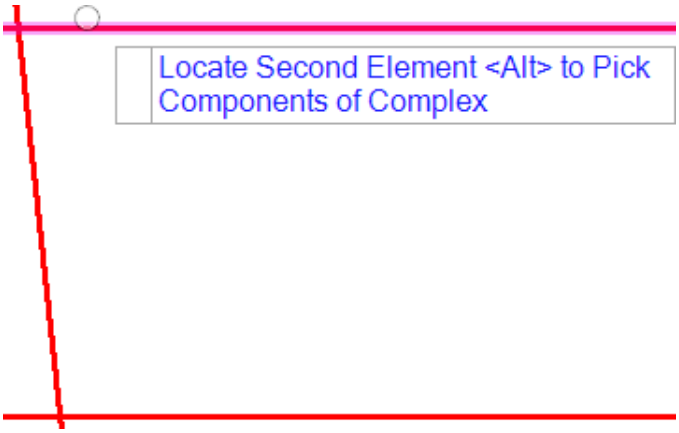
I. Left click to select Y8. The selection method should be set to Pick Complex Only because the loop could tie to the tangent on Y8 or the curve on Y8. Since the tie point is unknown and the offset needs to be 47.50’ from the alignment not an element in the alignment the method should be Pick Complex only. Use the <ALT> key to change between Pick Complex Only and Pick Components of Complex. The active setting is not the setting displayed.



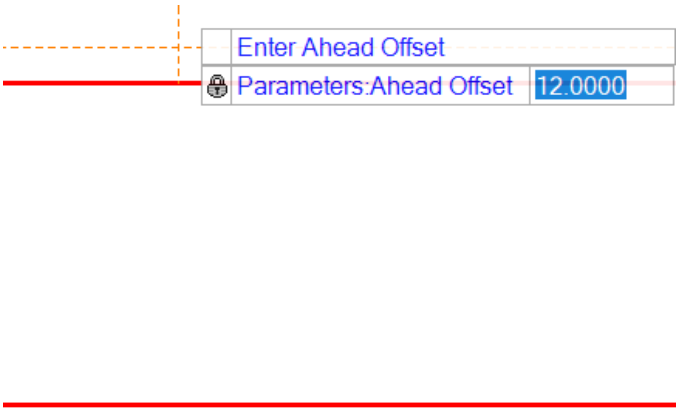
J. Left click to accept the offset of 47.50’. Note that the dashed line representing the offset follows the Y8 alignment not the extension of the tangent on Y8.



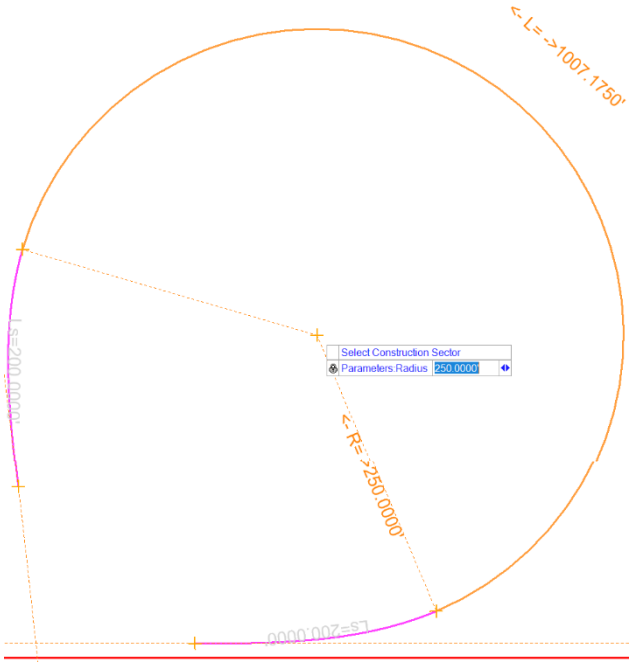
K. Left click to select CD2 as the second element.



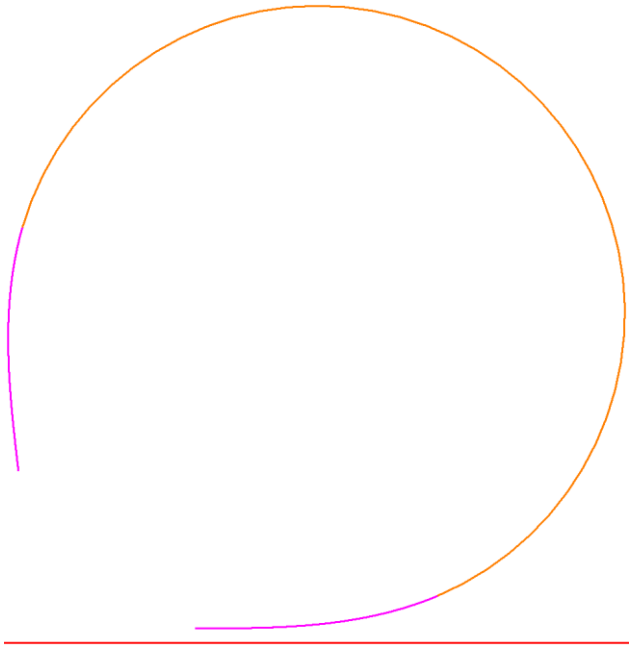
L. Left click to accept the offset = 12.00’



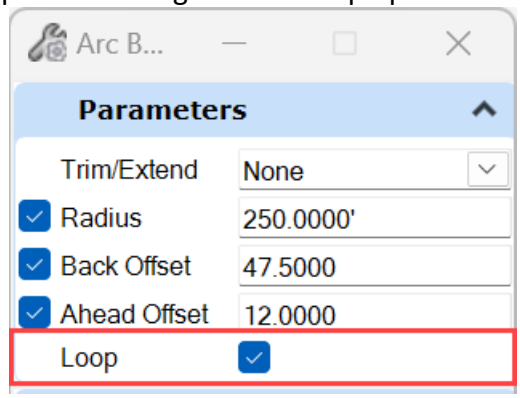
M. The Loop alignment will now dynamically display. Left click to accept the radius of 250.00’.



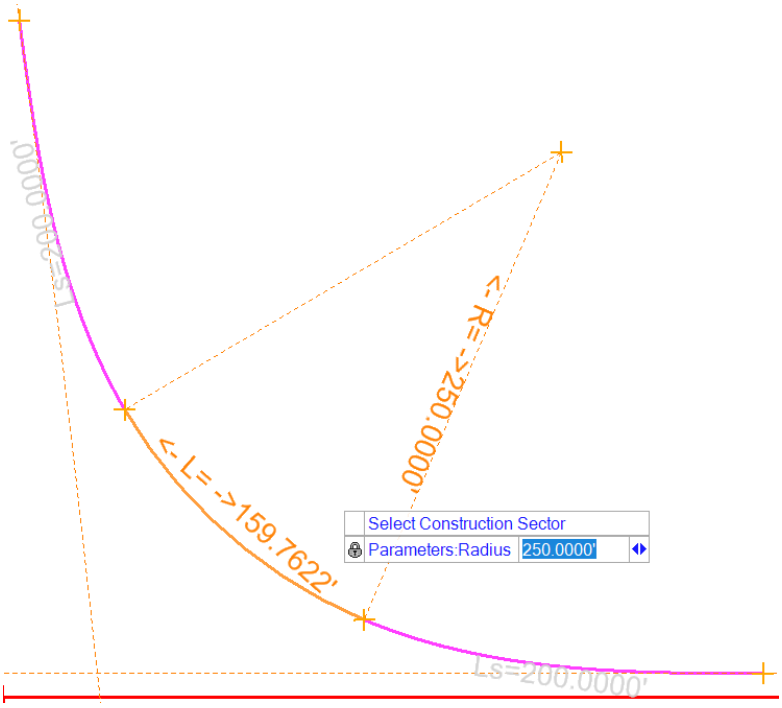
N. No trim option will appear because the loop ties to offsets of the reference element. This completes the placement of the loop centerline.



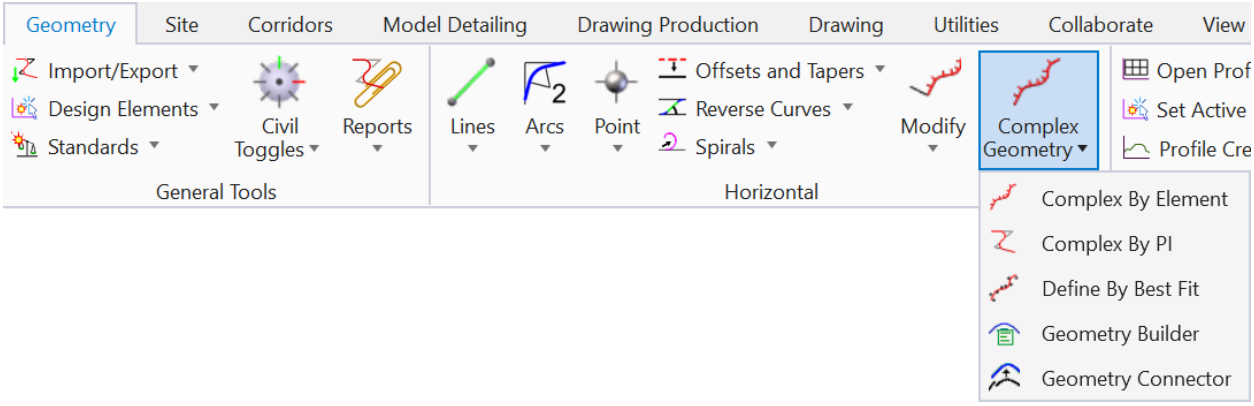
O. In the initial setup of the dialog box the Loop option was checked ON.



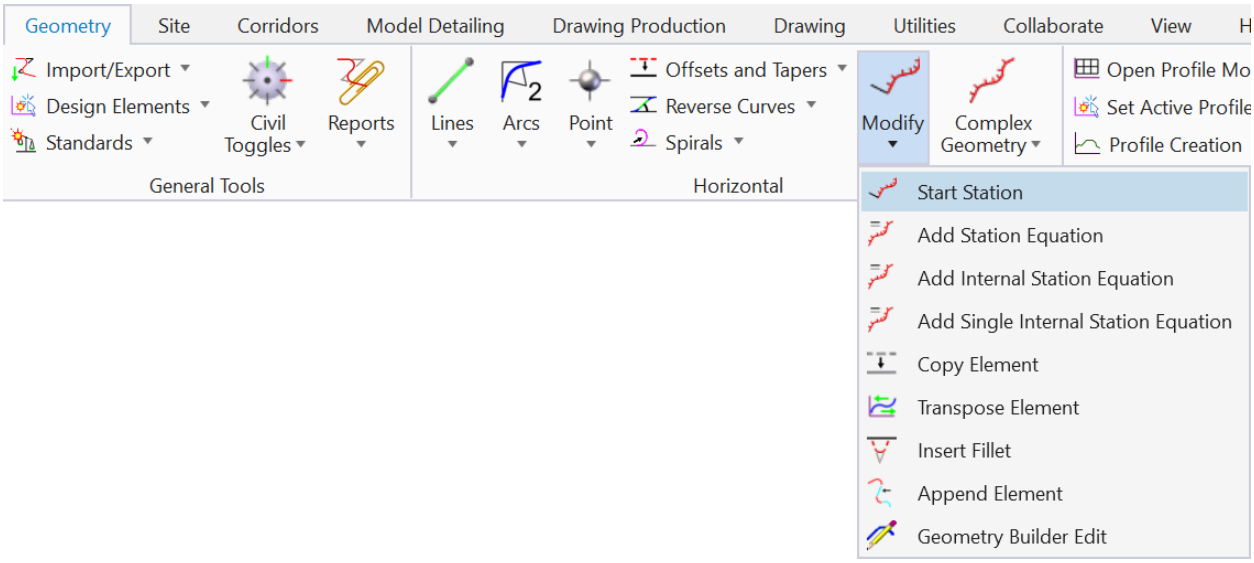
P. This is what the solution would look like without the Loop option checked on in the dialog.



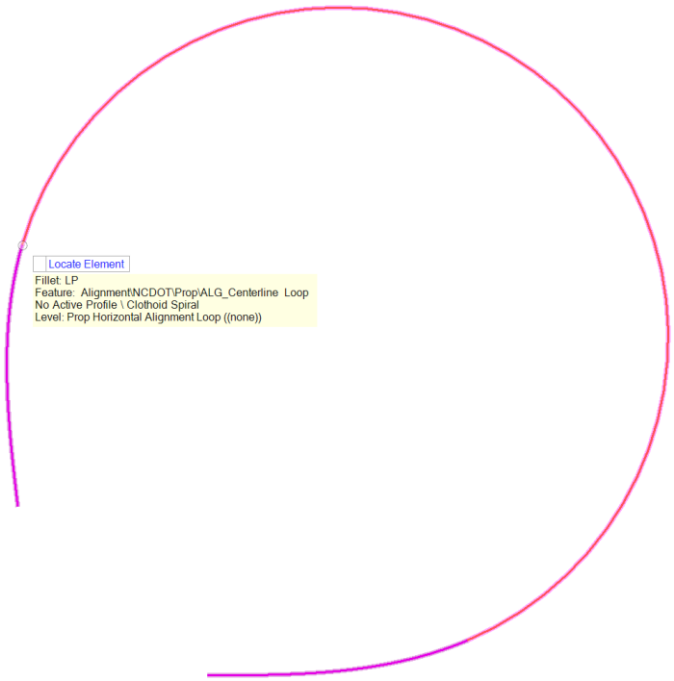
Q. Since the Loop is already a complex element there is no need to use any tools under the complex geometry tool group.



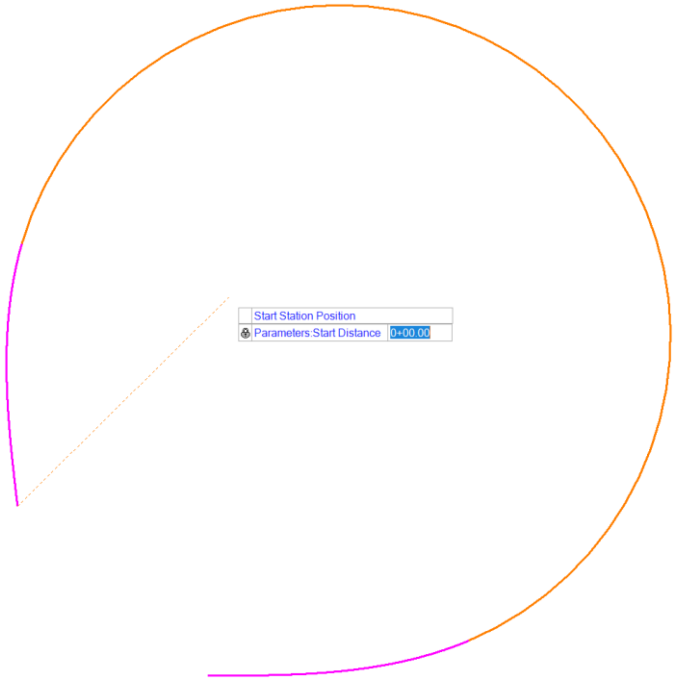
R. The only task left to accomplish is to Station the Complex Element. The Loop Alignment starts at Station 5+00.00 at Y8. Select the **Start Station** tool.



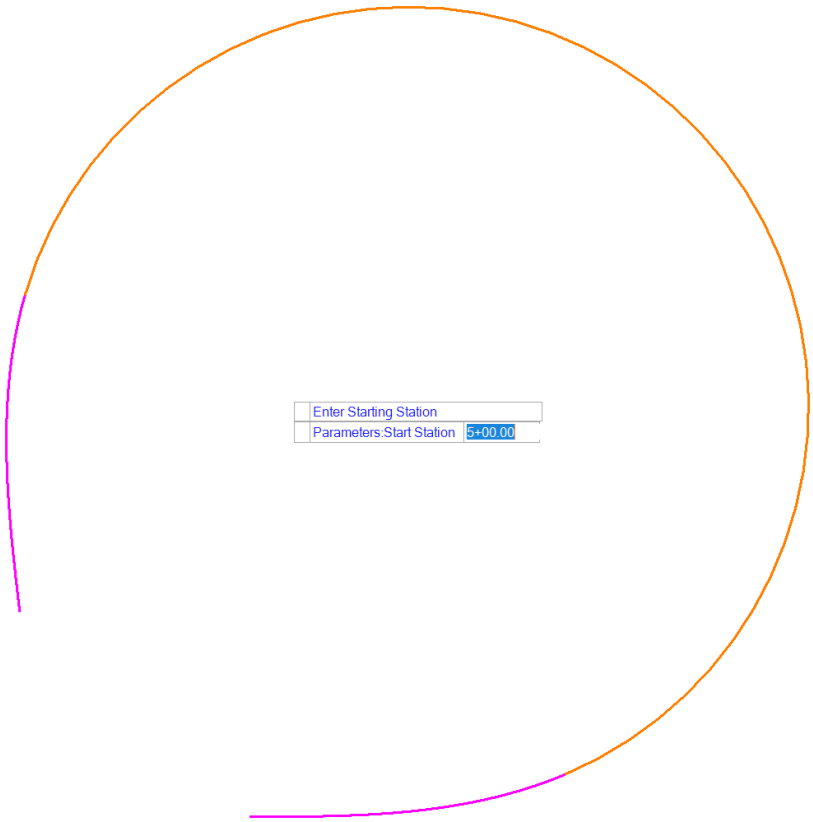
S. Left click to select the Loop.



T. Left click to set the start distance at 0+00



U. Left click to set the start station at 5+00



V. Use the Horizontal Geometry Report to Review the Alignment.

Horizontal Geometry Exercise – Complex By Element

In this exercise, you will learn how to create an alignment for a Loop. Using Geopak Loop alignments could be complicated. Using ORD a Loop alignment is very simple and can be completed in only a few steps. This process is still using the Complex by Element procedure but instead of joining multiple elements together the Loop will be created as a single complex element.

1. Complex By Element – RP1B Alignment

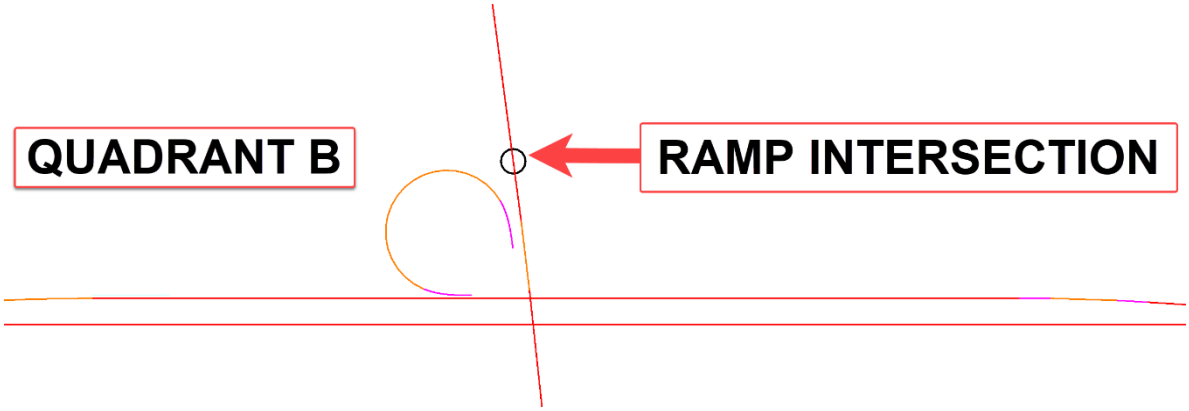
A. Create a new design file using the 2D seed file, and name the file:
R-2635C_RDY_ALG_RP1B.dgn
- This file should be created in the Alignments folder of the training directory
…\Module 3 Horizontal Alignment\R-2635C\Roadway\Alignment

B. Attach the Final Survey file ***R-2635C_NCDOT_FS.dgn***
and the
Existing Terrain Model ***R-2635C_NCDOT_FS.dgn***
from the FinalSurvey Folder.
C:\NCDOT Training\Roadway\Module 3 Horizontal Alignment\R-2635C\FinalSurvey

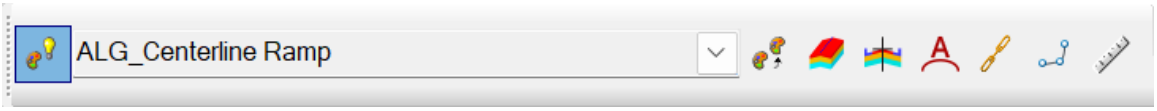
C. Attach the following ALG files from the Alignment Directory
- R-2635C_RDY_ALG_L.dgn
- R-2635C_RDY_ALG_Y8.dgn
- R-2635C_RDY_ALG_CD2.dgn
- R-2635C_RDY_ALG_LP1B.dgn
    1. The CD2 and LP1B files were created in the previous exercises

D. Attach ***MODULE-3-Ramp-Terminals.dgn*** from the Training Files sub directory in the Alignments directory.
…\Module 3 Horizontal Alignment\R-2635C\Roadway\Alignment\Training Files
This file is provided to mark the ramp intersection with Y8, normally this location would be determined based on other design constraints.

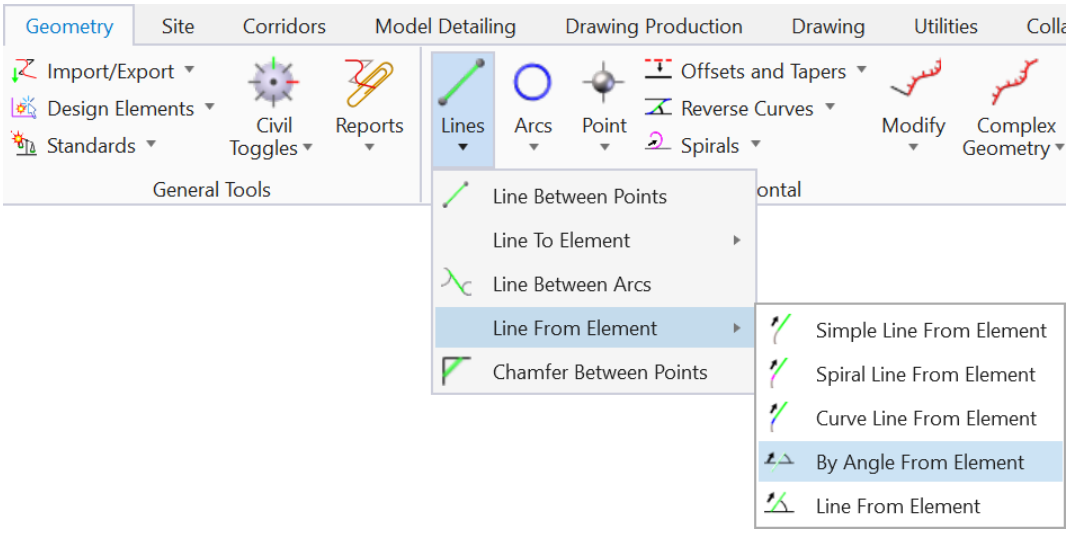
E. The design file should look like this, and the ramp alignment will be created in Quadrant B



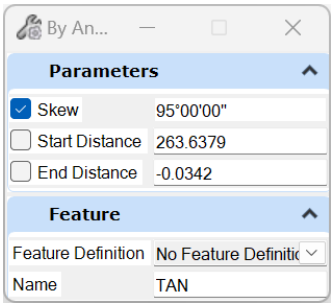
F. Set the Feature Definition to ALG Centerline Ramp and ***Turn off the Persist Snap option.***



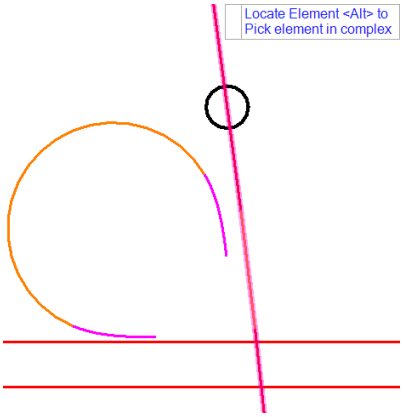
G. This will be a parallel ramp entrance. The ramp intersection skew is 95°0'0". Start by drawing the Tangent that intersects Y8. Use the Line By Angle From Element tool.



H. Set the dialog to
- Skew = 95°00’00”
- Name = TAN

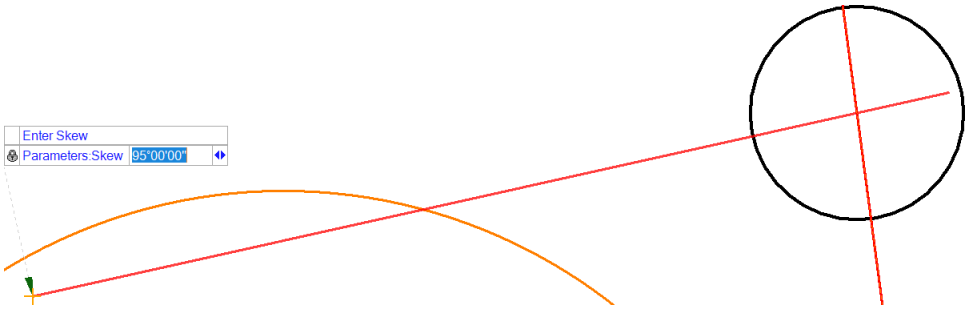


I. Left click to select Y8

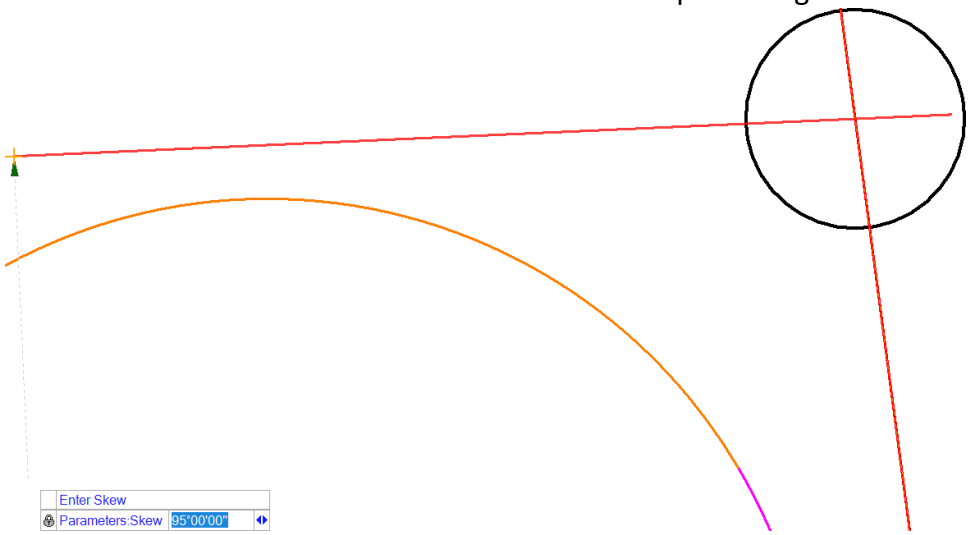


J. Snap to the center of the black circle and left click to accept the Start Point.

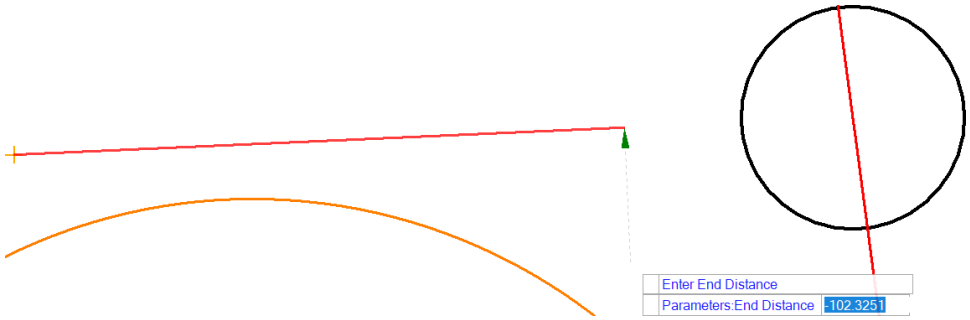
K. Left click to accept the skew. Note that the position of the cursor determines the quadrant where the 95° skew angle is located. By placing the cursor above the line the skew angle is located above the line.
By placing the cursor below the line the skew angle is located below the line.



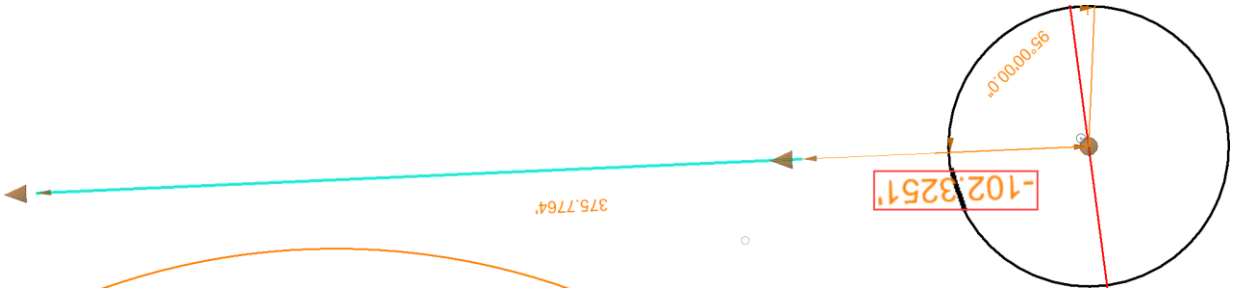
Place the cursor below the line and left click to accept the angle.



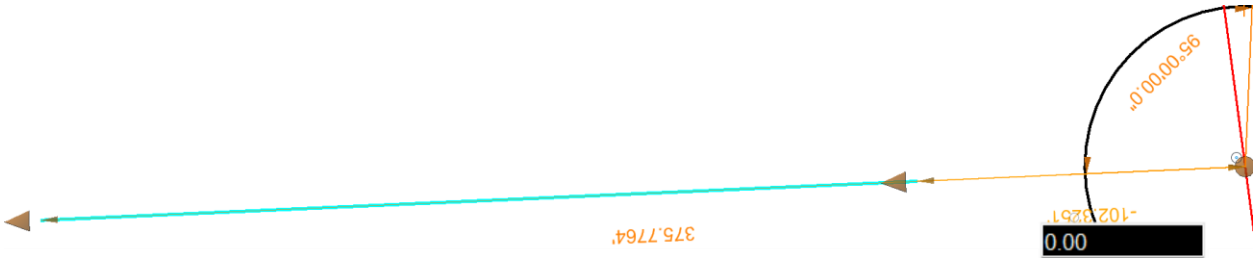
L. Left click anywhere to accept an end distance. This distance is not important because we will use the trim option to determine the end point when placing the curve.



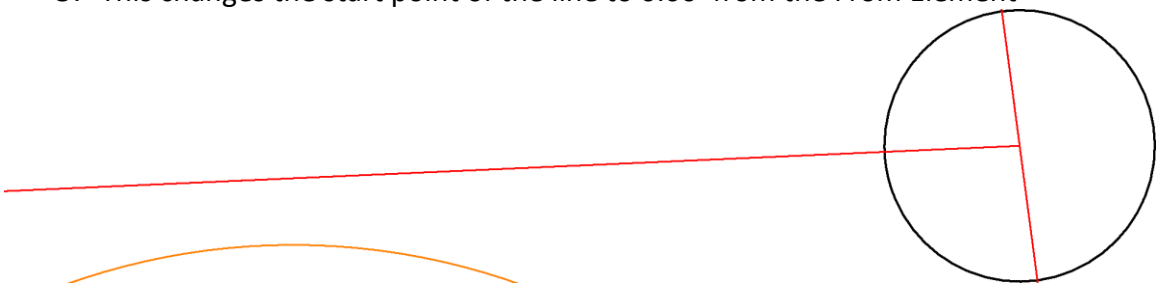
M. Using this method the line does not intersect Y8 because the start distance was not set correctly to 0.00’ This is easy to fix. Use the Element selection tool to highlight the tangent and display the text manipulators. Locate the distance shown between Y8 and the end point of the tangent.



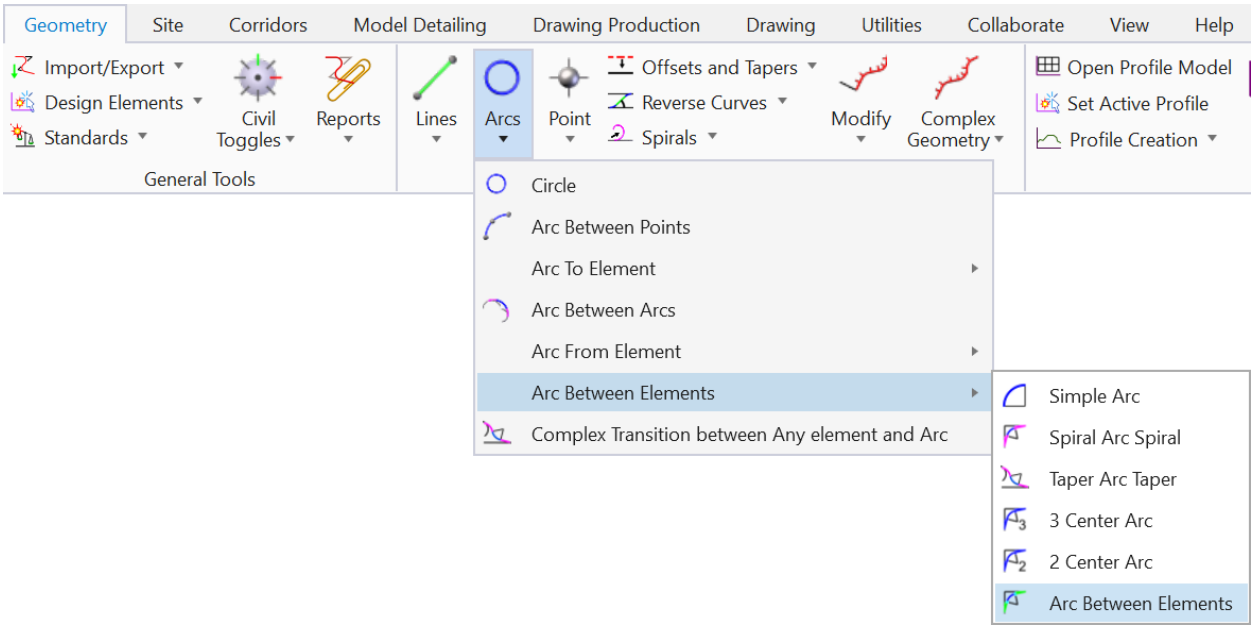
N. Change this distance to 0.00’



O. This changes the start point of the line to 0.00’ from the From Element

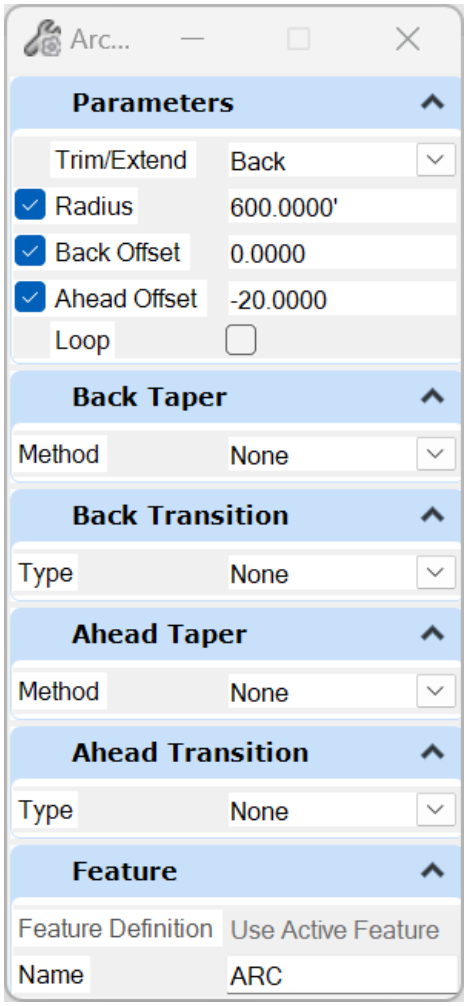


P. The next step is to construct a curve with a radius of 600.00’ that is 20.00’ offset from the Loop centerline. Start the **Arc Between Elements** tool.

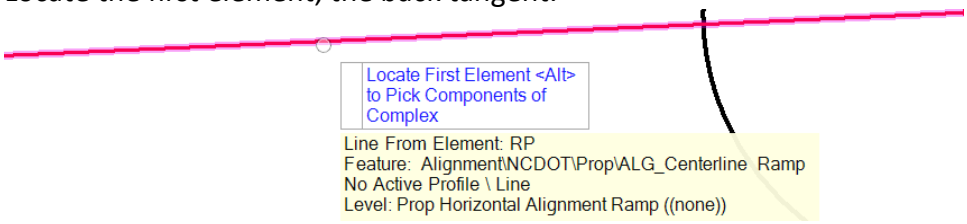


Q. Set the dialog for

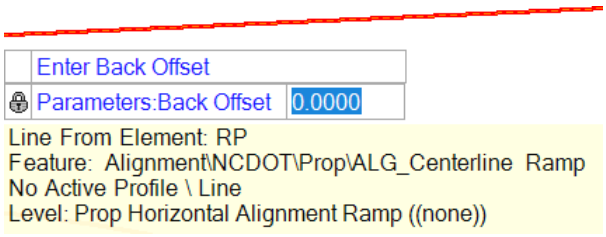
- Radius = 600’
- Back Offset = 0.00’
  1. This is the offset from the tangent line
- Ahead offset = 20.00’
  1. This is the offset from the Loop Alignment.
- Set all Tapers and Transitions to None.
- Set name to ARC



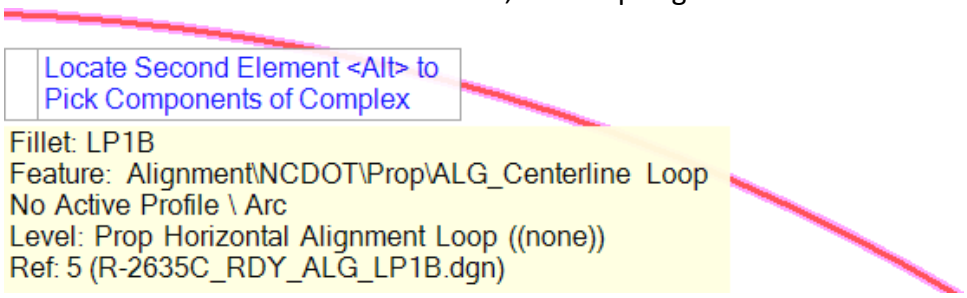
R. Locate the first element, the back tangent.



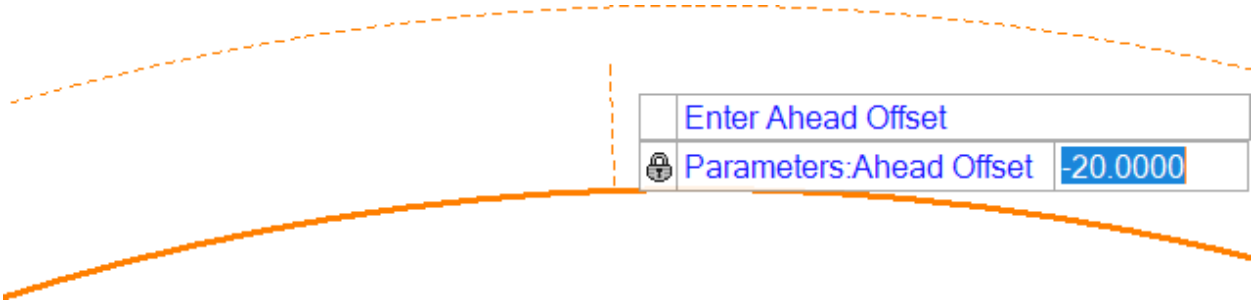
S. Left click to accept the offset of 0.00'



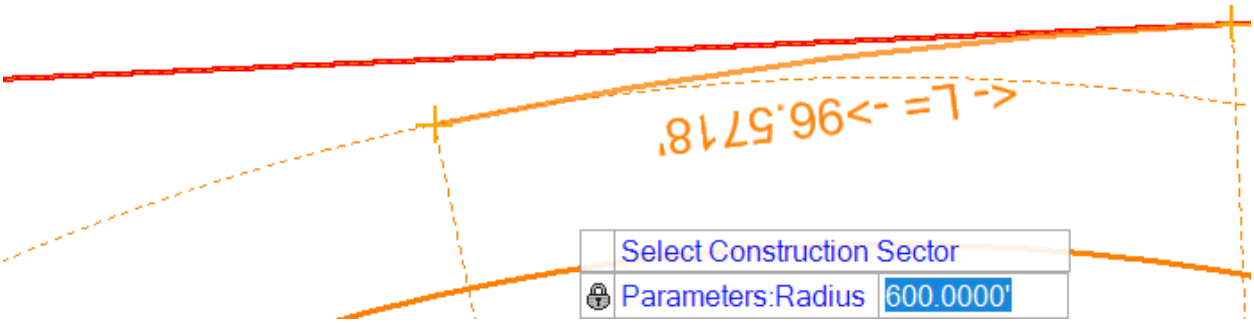
T. Left click to locate the second element, the Loop alignment.



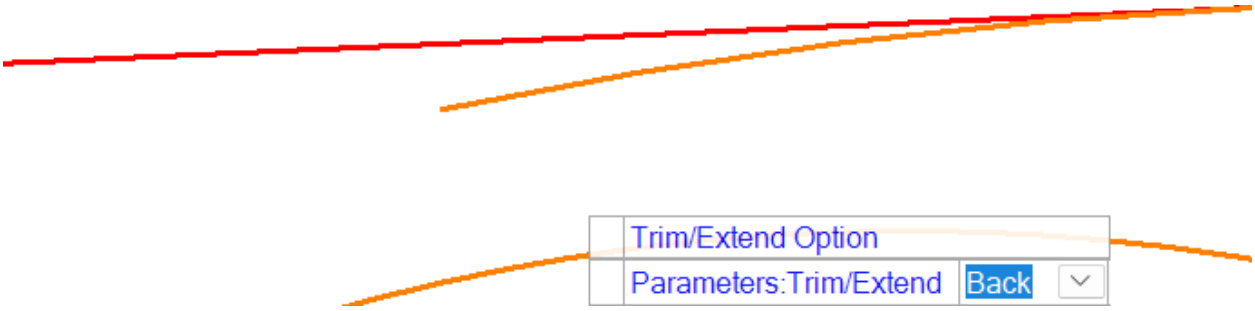
U. Left click to accept the offset of 20.00', make sure the cursor is on the outside of the Loop alignment.



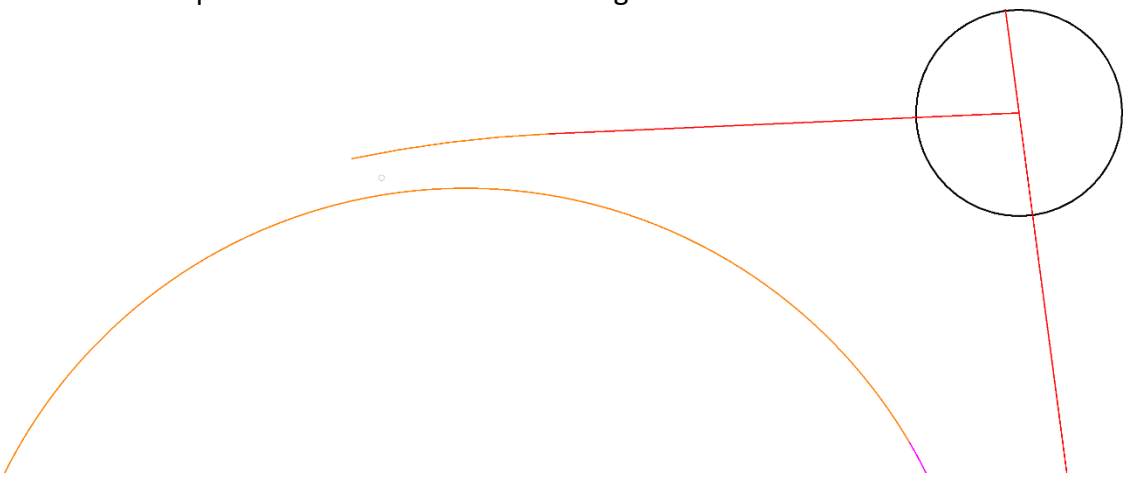
V. Position the cursor in a location that shows the desired solution and left click to accept the radius of 600.00'



W. Left click to accept the Trim option of Back.



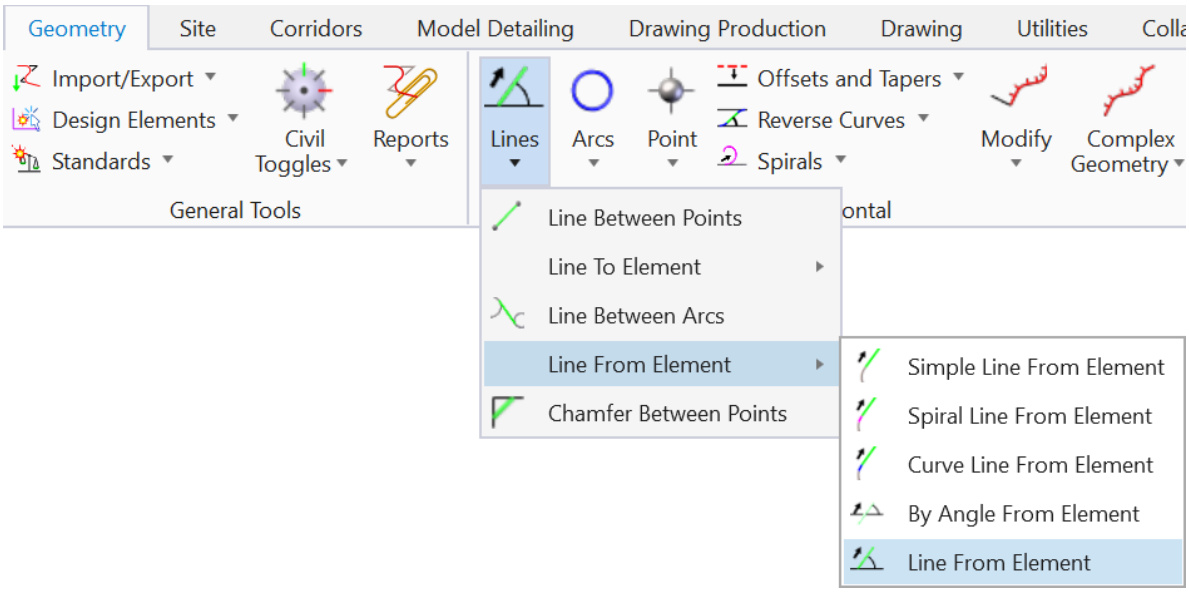
X. This will place the curve and trim the tangent.



Y. Note that this step is not normally required. At the time of this training the Offset functionality of the **Complex Transition Between Any Element and Arc** tool is not working properly. This requires the user to draw a construction line to use as a reference element for the tool. When the tool is corrected an offset could be specified and this line would not be needed.

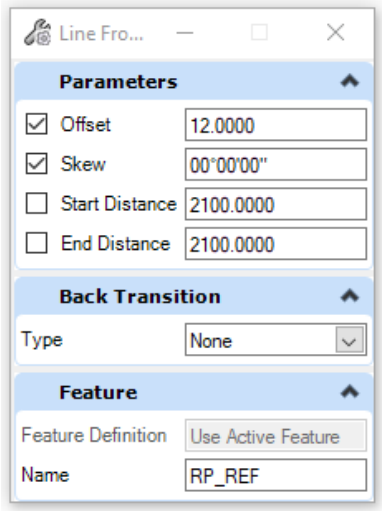
Z. Set the feature definition to ALG_Centerline Temporary, this will place the reference line on a level that can be turned off. Because we will be using this line to generate geometric rules we do want to keep it in the dgn file.

AA. Use the **Line From Element** tool to draw a line 12.00’ offset from CD2 at a 0°0’0” skew.



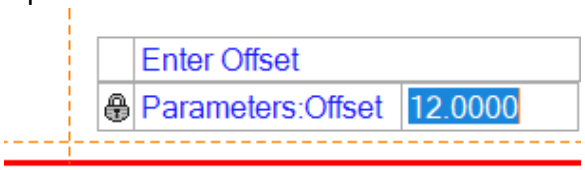
BB. Set the dialog for

- Offset = 12.00’
- Skew = 0°0’0”
- Leave Start and End distance unchecked
- Back transition is None
- Name is RP_REF

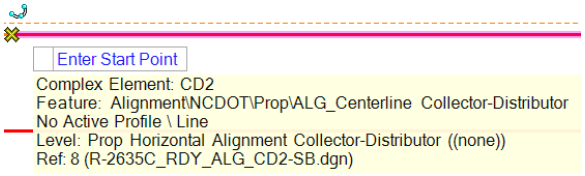


CC. Left click to locate the CD2 alignment.

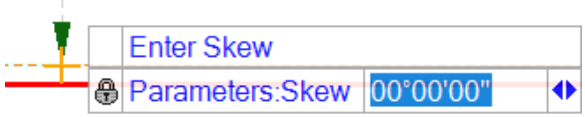
DD.Left click to accept offset of 12.00’.



EE. Snap to the end of the tangent to set the start point and left click to accept.

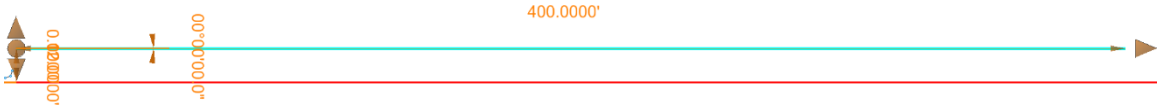


FF. Left click to accept the skew of 0°0’0” and to set the end point, the exact location of the end point is not critical.



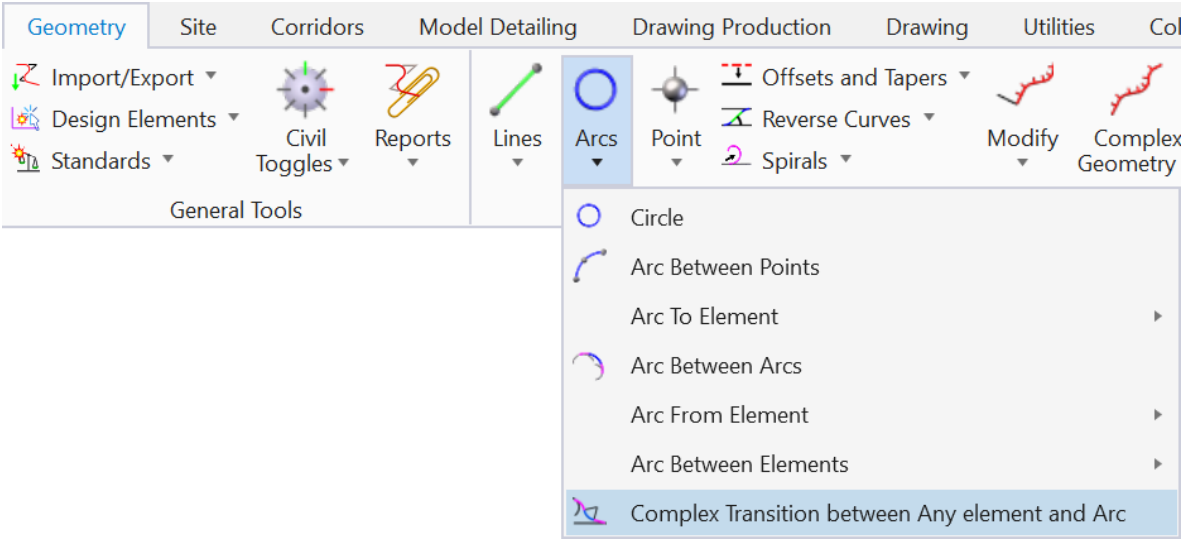
GG. Type in 0.00’ for the end distance and left click to accept and place the reference line.

HH.This will place a light blue line at 12.00’ off the CD that can be used as a reference.



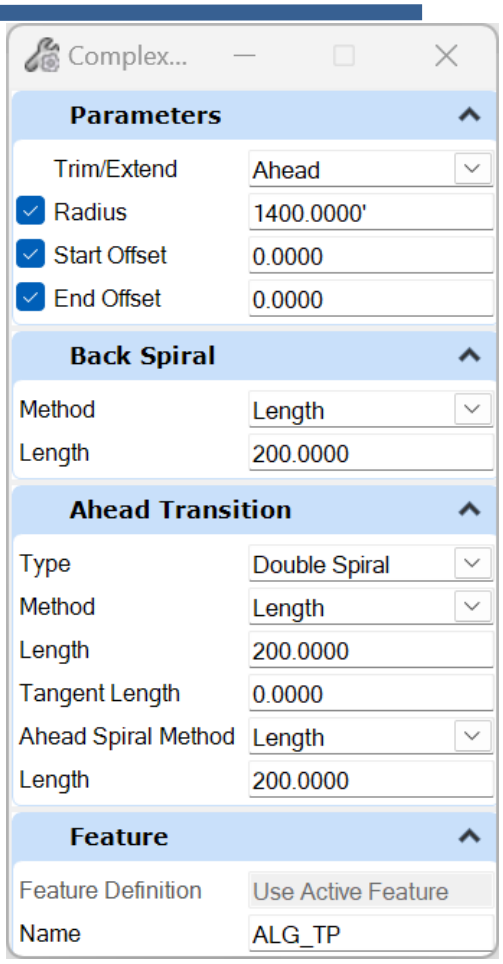
II. Reset the Feature Definition to ALG_Centerline Ramp

JJ. Select the **Complex Transition between Any element and Arc** tool. This is the tool that will be useful for any alignment that includes reversing spirals between two arcs.

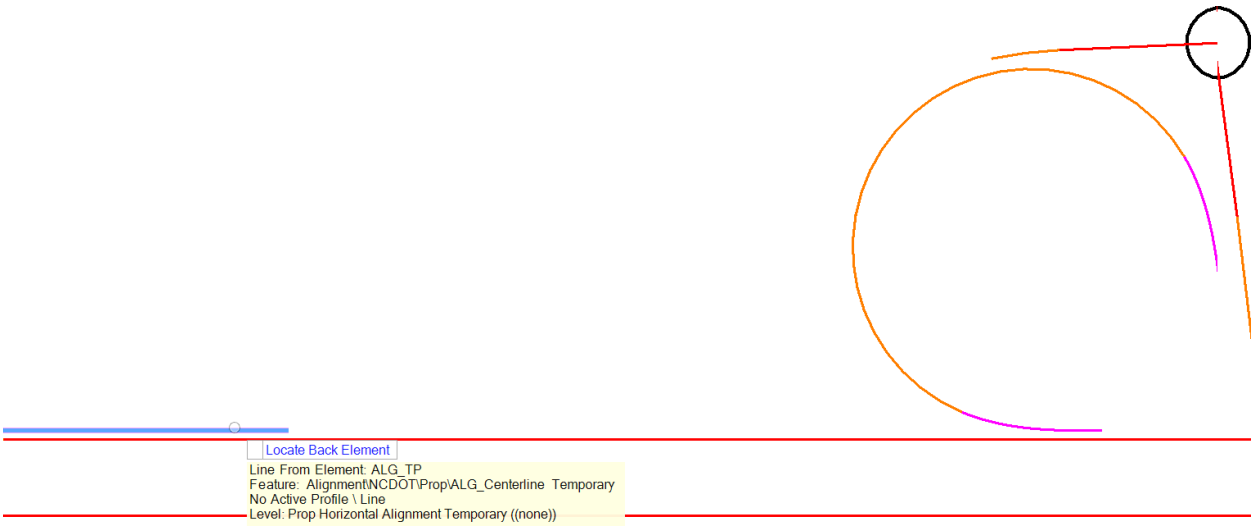


KK. Set the dialog to

- Trim/Extend = Ahead
  1. This will trim the curve placed on the tangent at Y8
- Start Offset = 0.00’
  1. This is the option in the tool that currently does not work, all offsets will be 0.00’. This is why the reference line is needed.
- End Offset = 0.00’
  1. 1. This is the option in the tool that currently does not work, all offsets will be 0.00’.
- Back Spiral Method to Length
  1. This is the spiral that transition to the CD2 alignment at 12’ offset
- Back Spiral Length to 200.00’
- Ahead Transisiton Type to Double Spiral
  1. This will produce two reversing spirals
- Method to Length
- Length to 200.00’
- Tangent Length to 0.00’
  1. This is the tangent length between the two spirals
- Ahead Spiral Method to Length
- Length to 200.00’
- Name to SCS

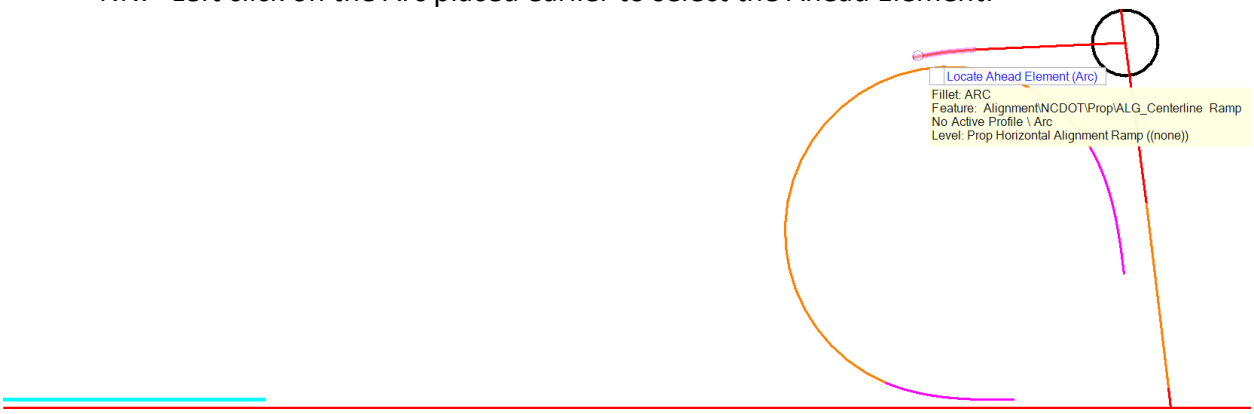


LL. Left click to select the Back Element, this is the faint blue reference line. If the tool is working correctly the back element can be the CD2 Alignment with the Back offset set to 12.00’

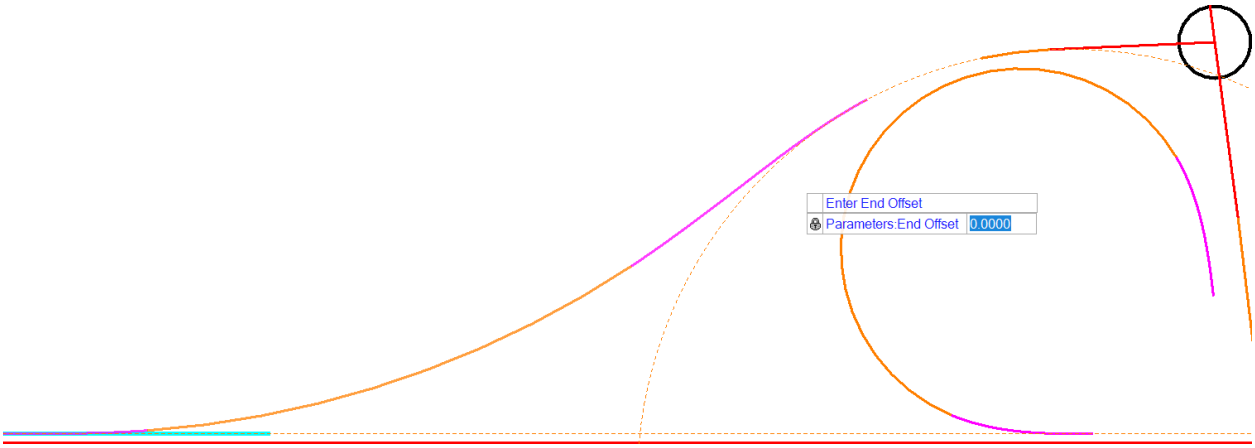


MM. Left click to accept the offset of 0.00’

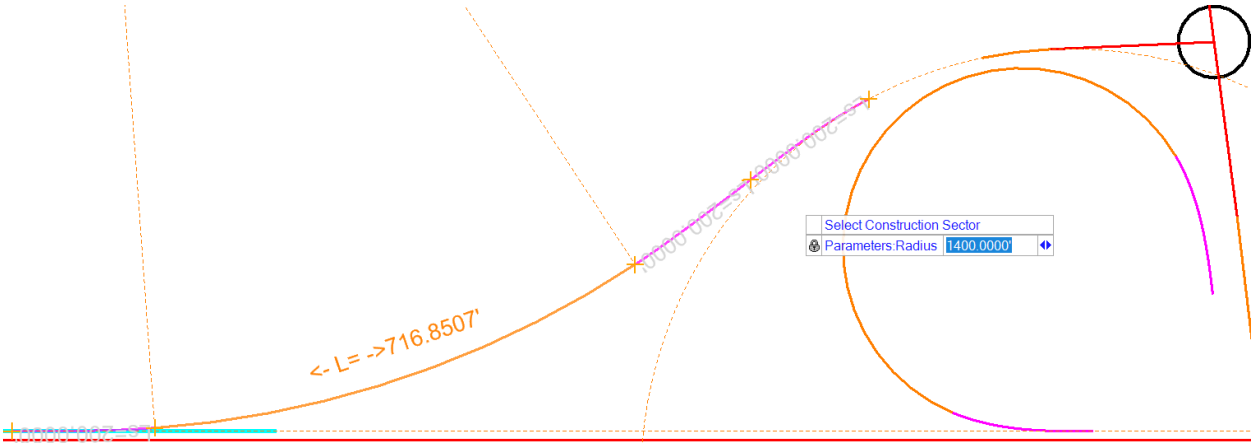
NN. Left click on the Arc placed earlier to select the Ahead Element.



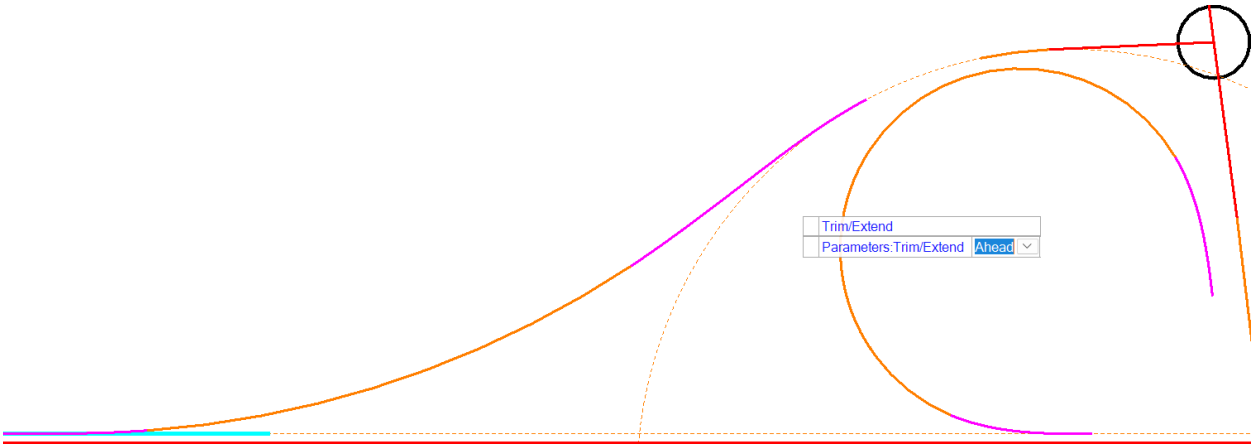
The dynamic solution will display. Left click to accept the offset of 0.00'.



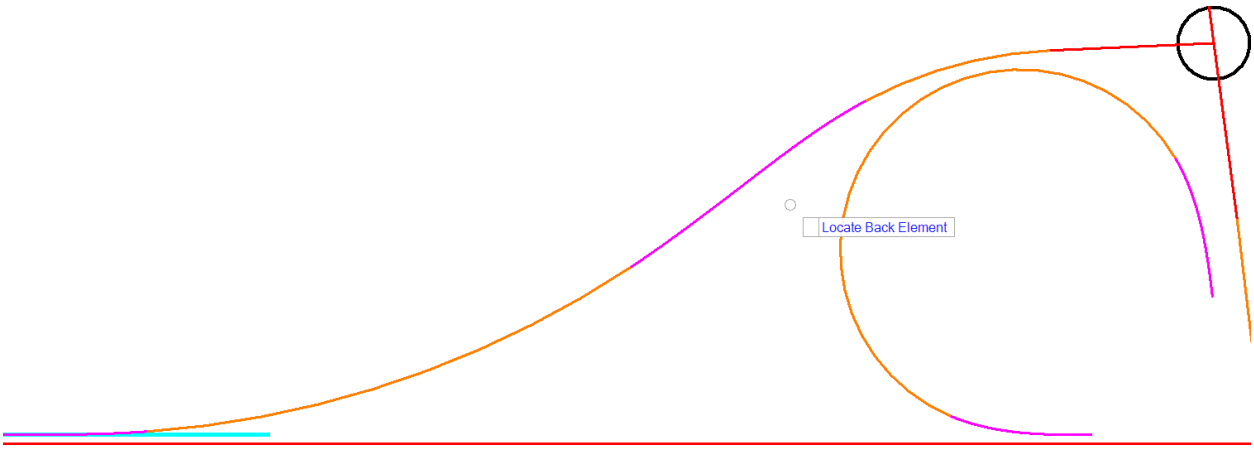
OO. Left click to accept the radius of 1400.00'. Place the cursor in a location that displays the desired solution, this step will also set the solution.



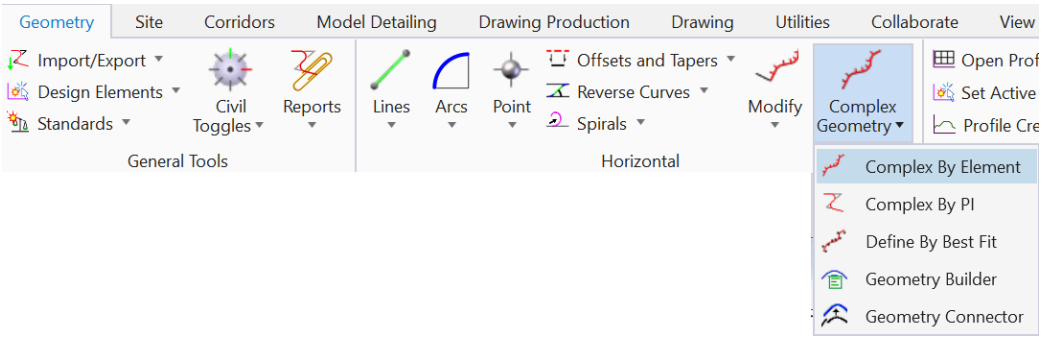
PP. Left click to accept the Trim/Extend option of Ahead.



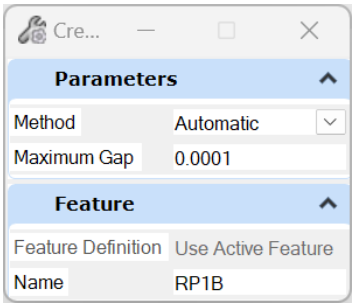
QQ. This will finish the tool and place the Spiral-Curve-Spiral-Reverse Spiral combination and extend the Ahead Arc to match.



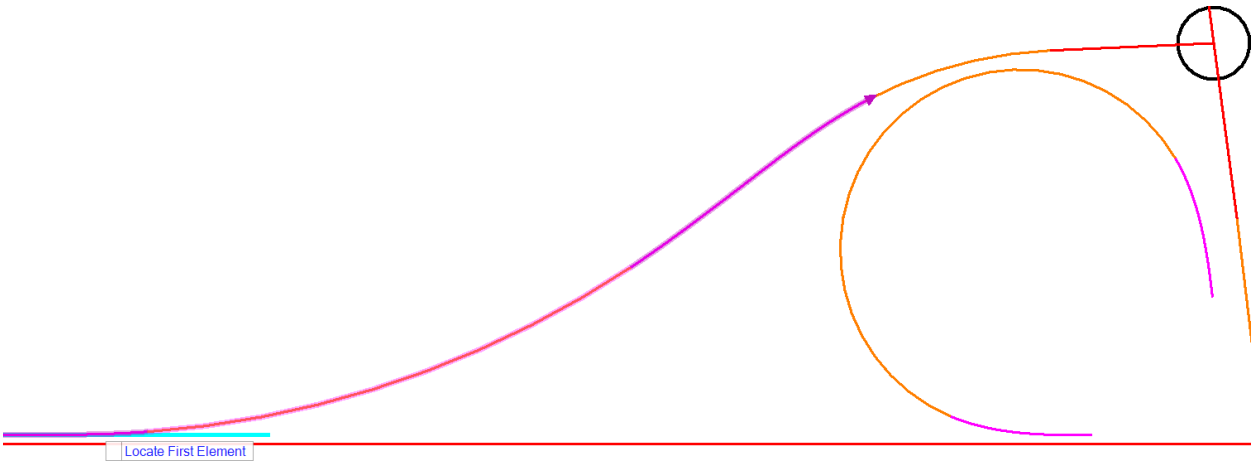
RR. Create a complex element with the Complex By Element tool.



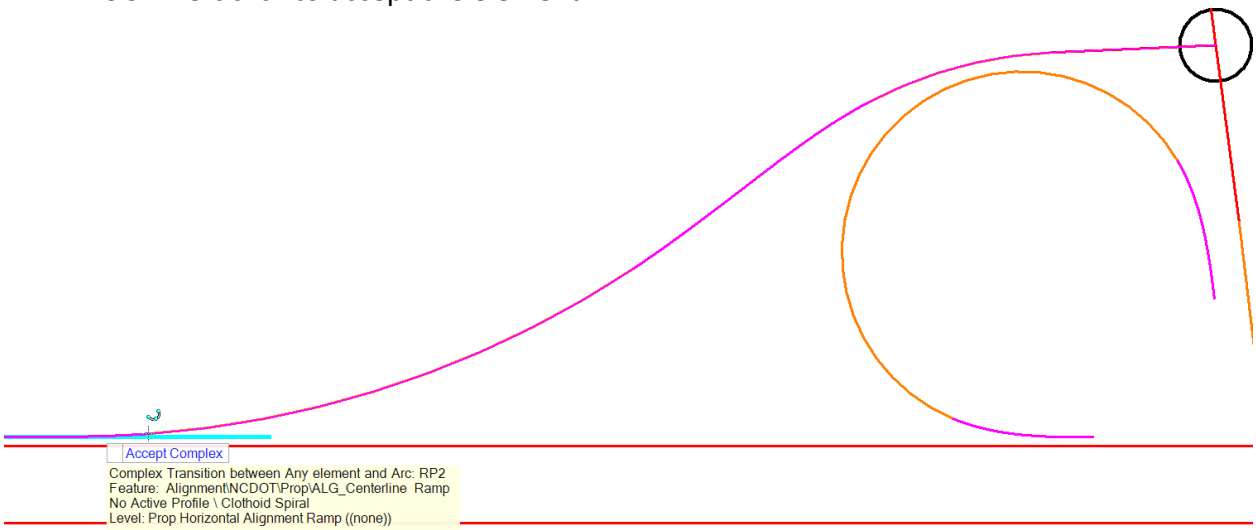
SS. Set the Method to Automatic and the Name to RP1B.



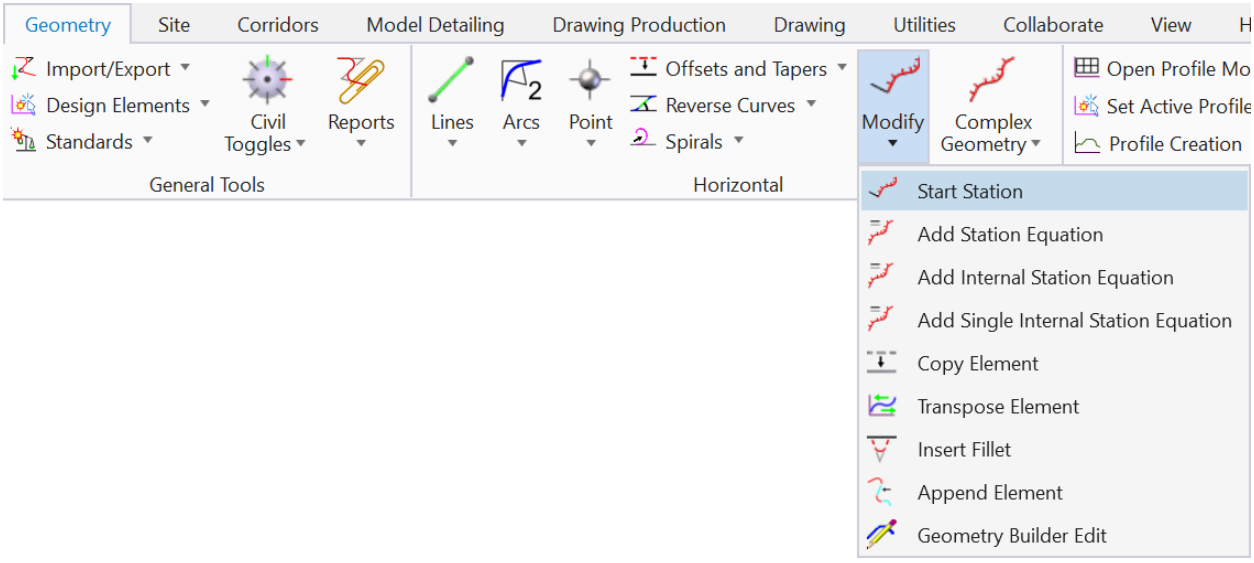
TT. Left click on the left side of the spiral curve combination to locate the first elment. The arrow will indicate the direction of the Complex Element. Make sure to select the spiral curve combination and not the temporary element.



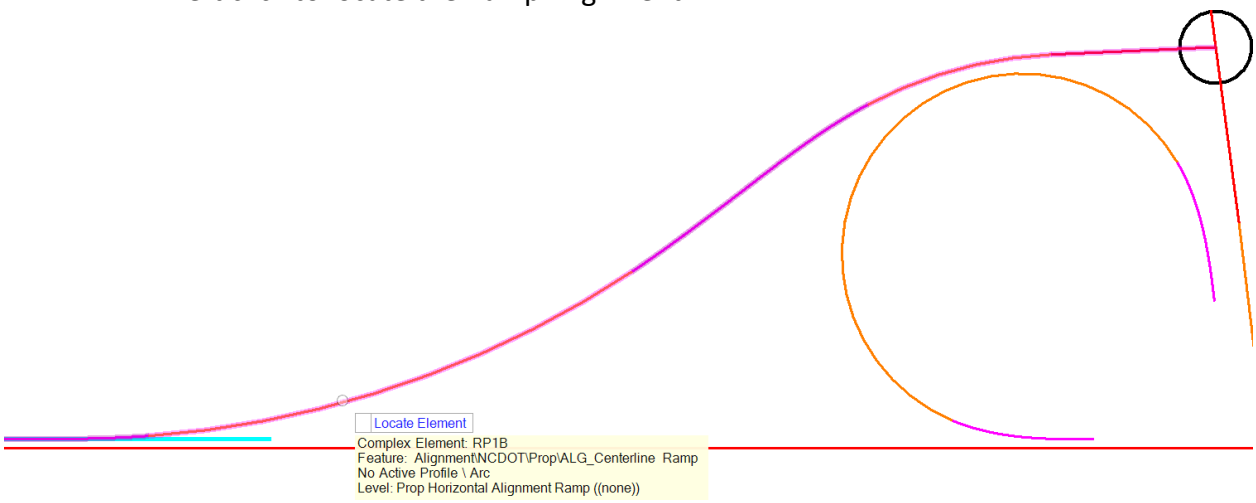
UU. Left click to accept the element.



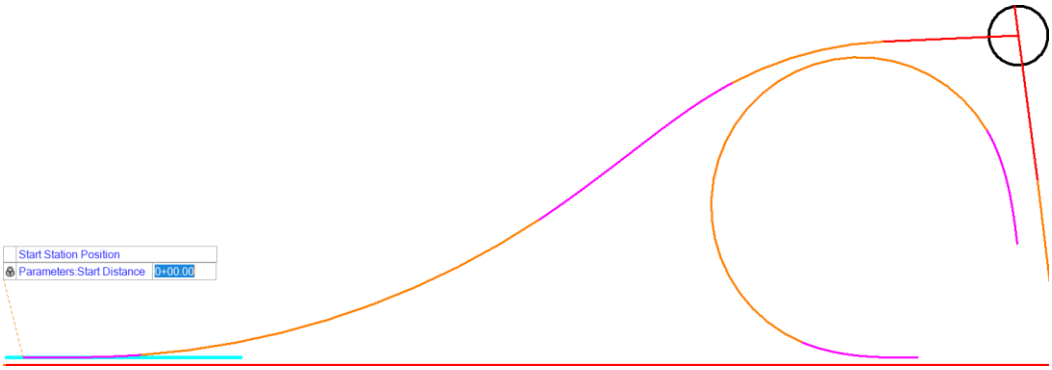
VV. Use the Start Station tool to set the Ramp Alignment Stationing to begin at 5+00.00



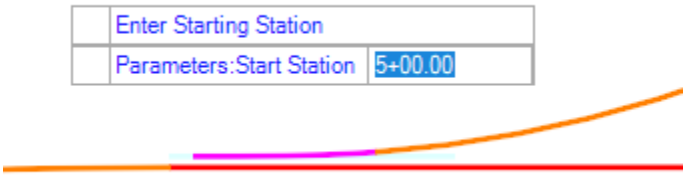
WW. Left click to locate the Ramp Alignment



XX. Left click to set start distance to 0+00.00



YY. Type 5+00.00 into the dialog and left click to accept the new start station.



ZZ. Use the Horizontal Geometry Report to Review the Ramp Alignment.

Horizontal Alignment Review Report

Report Created: Friday, June 28, 2024
Time: 10:11:21 AM

Project: Default
Description:
File Name: C:\NCDOT Training\Roadway\Training-RD_R-2635C\Module 3 - Horizontal Alignment\Roadway\Alignment\R-2635C_RDY_ALG_RP1B_USER.dgn
Last Revised: 6/28/2024 10:11:06

Note: All units in this report are in feet unless specified otherwise.

Alignment Name: RP1B
Alignment Description:
Alignment Style: Alignment\NCDOT\Prop\ALG_Centerline Ramp

		Station	Northing	Easting
Element: Clothoid				
TS	(TS)	500.000	725065.233	2031939.455
SPI	(SPI)	633.369	725198.597	2031940.619
SC	(SC)	700.000	725265.165	2031936.440
Entrance Radius:		0.000		
Exit Radius:		1400.000		
Length:		200.000		
Angle:		4.093 Left		
Constant:		529.150		
Long Tangent:		133.369		
Short Tangent:		66.699		
Long Chord:		199.955		
Xs:		199.898		
Ys:		4.760		
P:		1.190		

Horizontal Geometry Exercise – Define By Best Fit

In this exercise, you will learn how to create a best fit centerline alignment based on existing survey data. This will not be a common procedure for a NCDOT roadway designer but it may be useful for smaller roads that did not have an existing centerline developed by L&S or for use during the planning stage when only shell mapping is available with the existing pavement shown and there is no centerline.

1. Complex By Element – LP1A Alignment

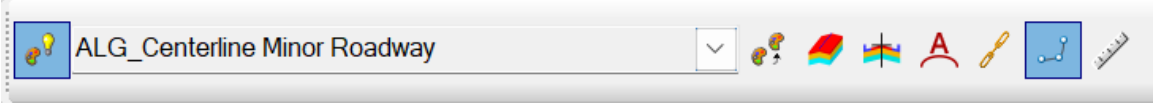
A. Create a new design file using the 2D seed file, and name the file:
R-2635C_RDY_ALG_Y16.dgn
- This file should be created in the Alignments folder of the training directory
…\Module 3 Horizontal Alignment\R-2635C\Roadway\Alignment

B. Attach the Final Survey file ***R-2635C_NCDOT_FS.dgn***
and the
Existing Terrain Model from the same file: ***R-2635C_NCDOT_FS.dgn***
from the Final Survey Folder.
C:\NCDOT Training\Roadway\Module 3 Horizontal Alignment\R-2635C\FinalSurvey

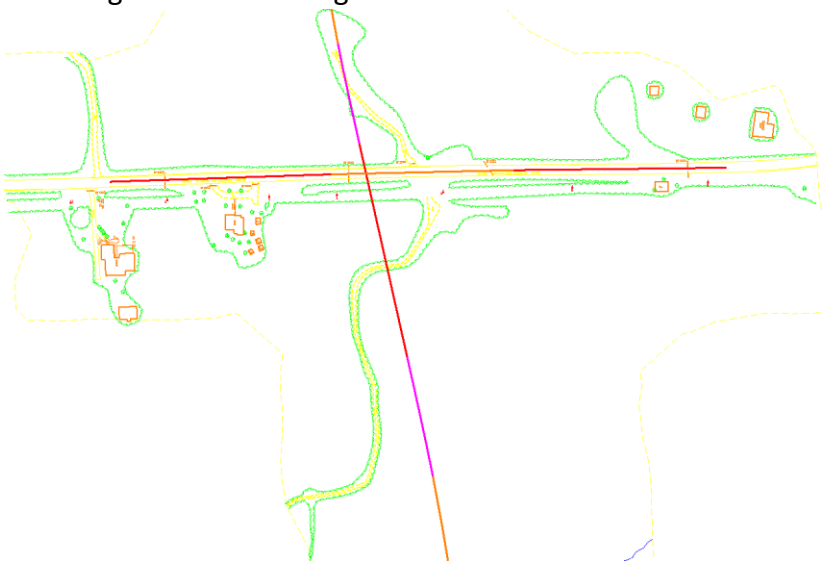
C. Attach the following ALG files from the Alignment Directory
- R-2635C_RDY_ALG_L.dgn
  1. This is the dgn file created in the previous exercise

D. Attach ***MODULE-3-Best Fit Y16.dgn*** from the Training Files sub directory in the Alignments directory.
…\Module 3 Horizontal Alignment\R-2635C\Roadway\Alignment\Training Files
This file is provided to mark the location of the Y16 alignment and make it easier to find in the dgn file.

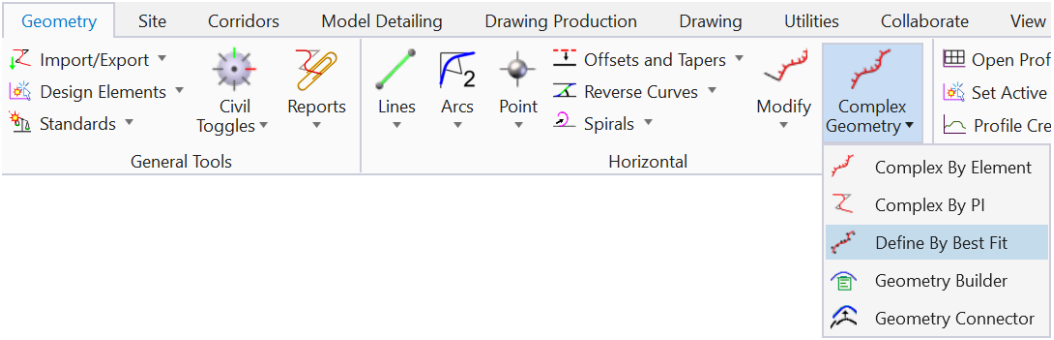
E. In this exercise we will first define the Best Fit Alignment and then use the editing tools to revise the alignment to a design alignment. Set the Feature Definition to ALG_Centerline Minor Roadway.



F. Note that for this exercise the FS file was updated to allow for better use of the Best Fit tool. The Edge of Pavement lines were joined together into a line string matching the limits on the alignment. The dgn file should look like the picture below, the Y16 alignment will go from Left to Right on the screen.

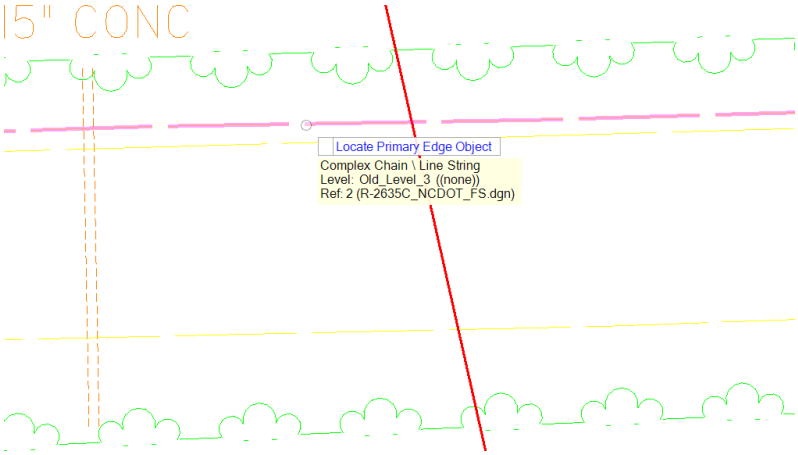


G. Start the Define By Best Fit tool.

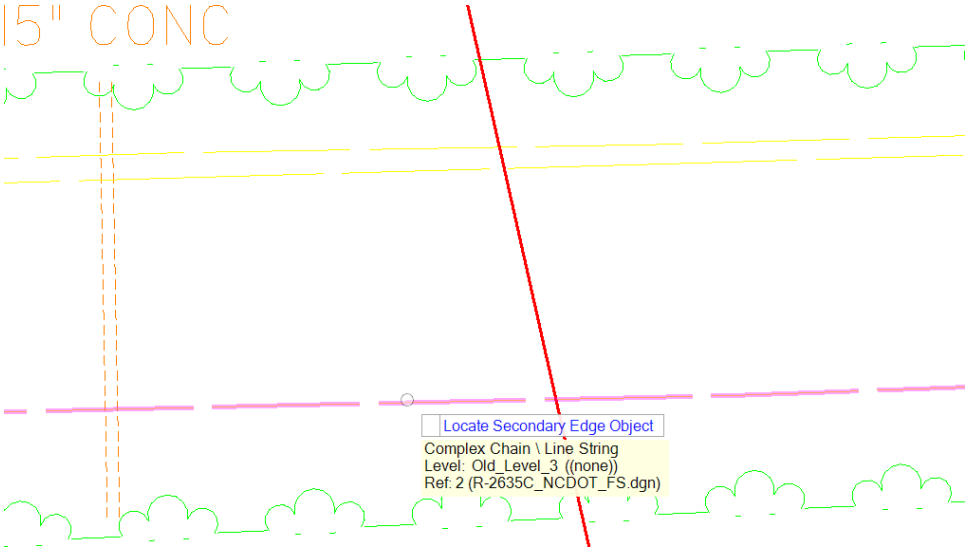


H. yyLeft click to accept the Complex By Edges option, use the <DOWN> arrow key to change to this option if necessary.

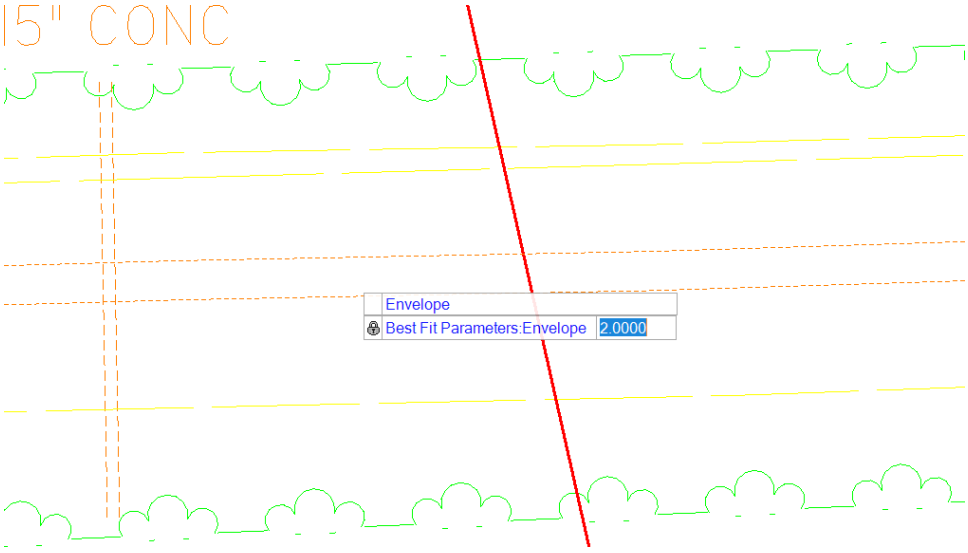
I. Left click on the EOP line to Locate the Primary Edge Object. This has no impact on the direction of the alignment or the stationing and can be either side. For this example, select the left EOP.



J. Left click on the right EOP to locate the Secondary Edge Object



K. At the prompt enter 2.00’ for the Best Fit Parameters Envelope and left click to accept. The proposed Best Fit alignment must fit within this width, it is the width out from the center based on the two Edge Objects and is represented by the black Dashed Lines. A higher number will produce more tangent sections and less curves and a lower number will produce more curves and less tangent sections.



L. At the prompt Enter 100’ and left click to accept the rounding radius, this rounding number will be used for all the proposed curves.

	Radius Rounding	
	Best Fit Parameters:Radius Rounding	100

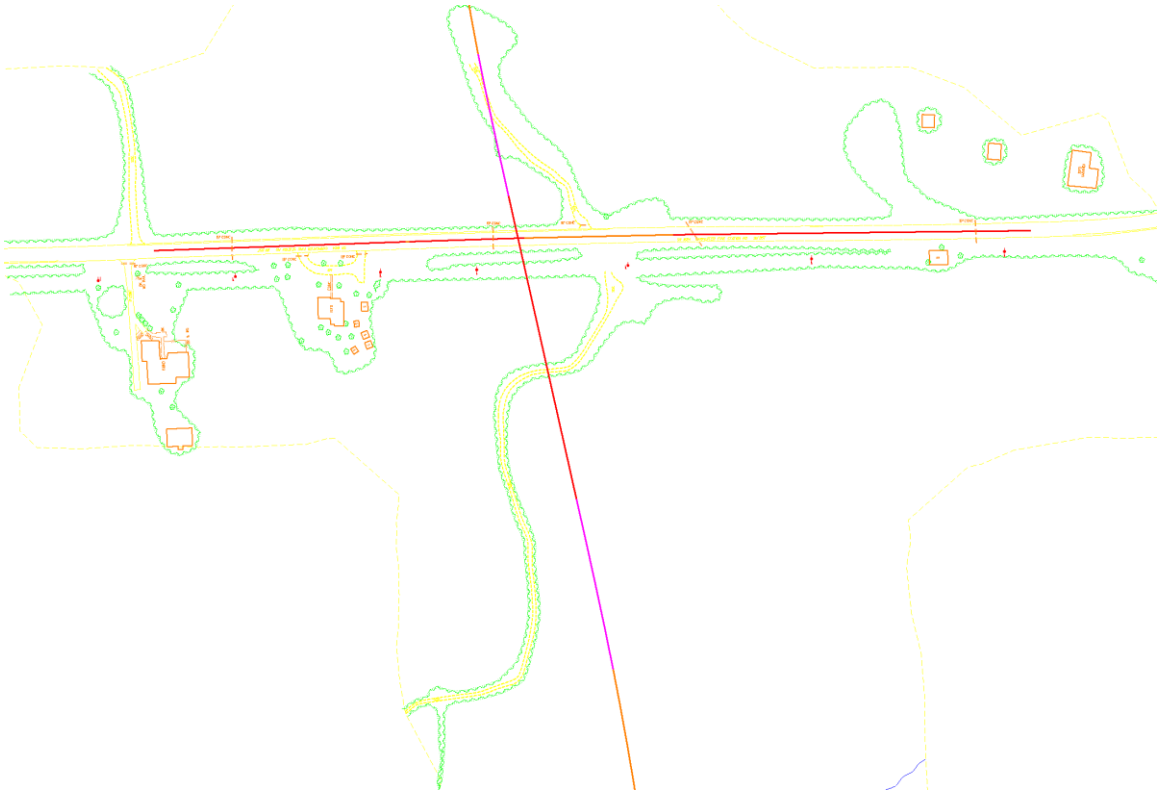
M. At the prompt Left click to accept No for include spirals, this alignment does not have spirals.

	Include Spirals	
	Best Fit Parameters:Include Spirals	No

N. Enter 2000.00’ for the best fit default radius. This will force the program to use larger radii which are more appropriate for the alignment, this will be determined on an individual basis.

	Default Radius	
	Best Fit Parameters:Default Radius	2000.0000'

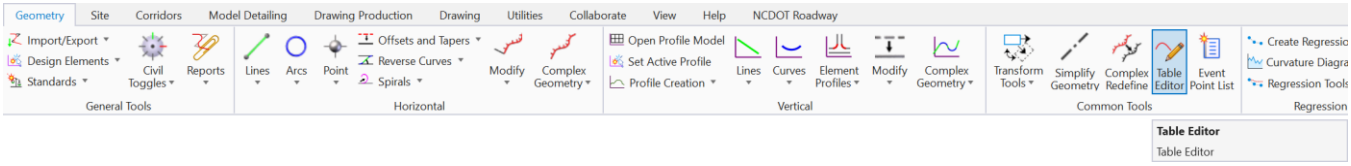
O. This will finish the tool and add the alignment.



P. By turning off the reference files you can see that this alignment consists of a Tangent, a very Short Curve, a Tangent, a Curve, and a final Tangent.

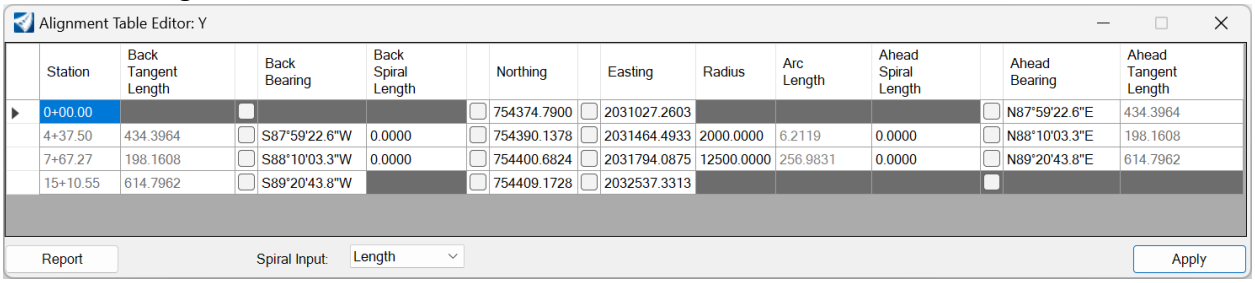
Q. For roadway design purposes we want to remove the short curve from the alignment.

R. One way to do this is with the table editor. Select the **Table Editor** tool from the *Common Tools* section of the *Geometry* ribbon.



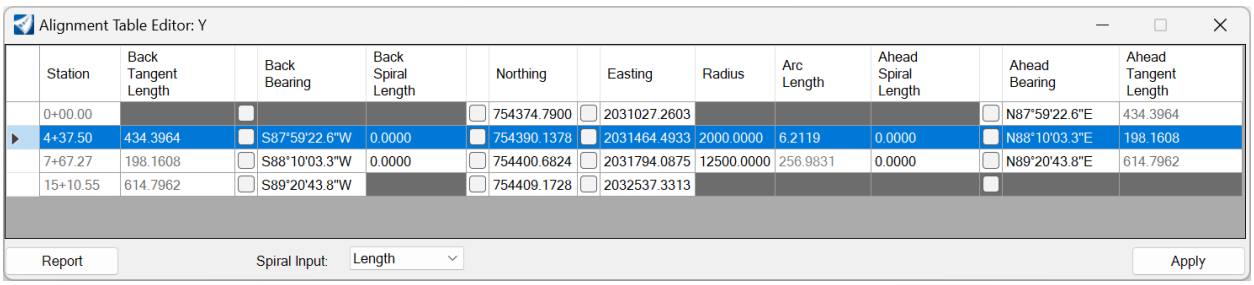
S. There is no dialog initially, left click to locate the alignment.

T. The table editor will display, with all the relevant geometric properties of the alignment shown.

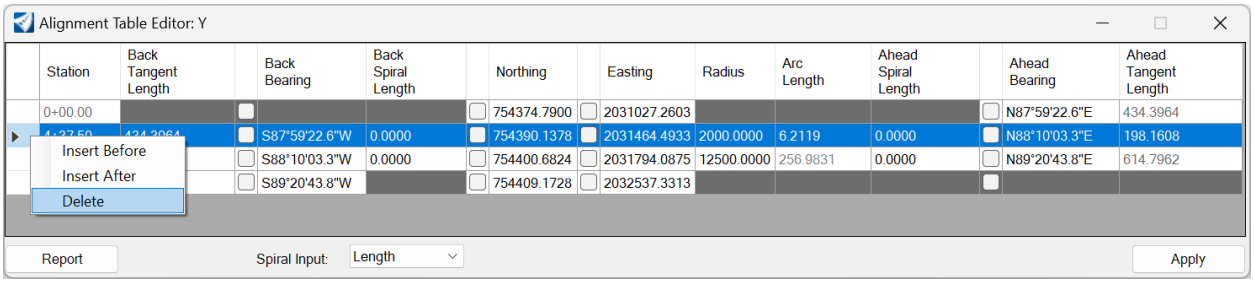


U. The table editor works like an Incomplete Alignment toolbox. All the fields with checkboxes next to them are editable. By checking the box next to a field that value is locked. By leaving a box unchecked the value can be changed to anything else. Similar to Incomplete Alignments it is possible to fix too many values and input new data that does not allow for a solution. When using the Table Editor, it is preferrable to make changes to a single element at a time instead of trying to manipulate multiple elements simultaneously.

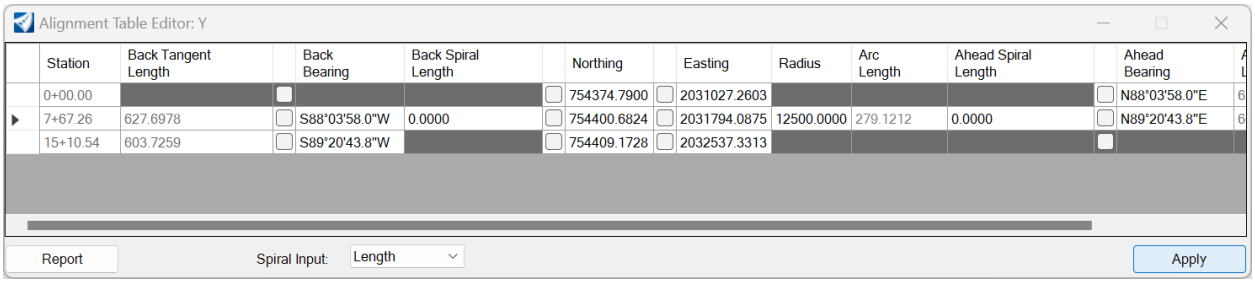
V. The first thing to do is to eliminate the small curve near the beginning of the alignment. To do this highlight the row that contains the curve.



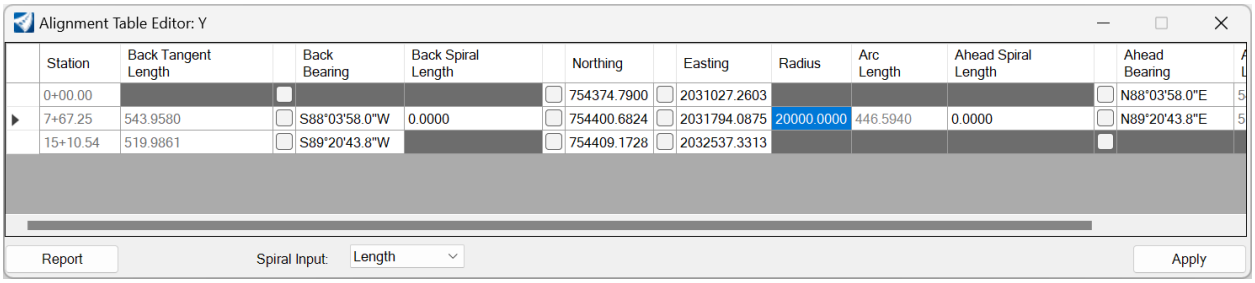
W. Right click to bring up the pop-up menu and left click to select delete.



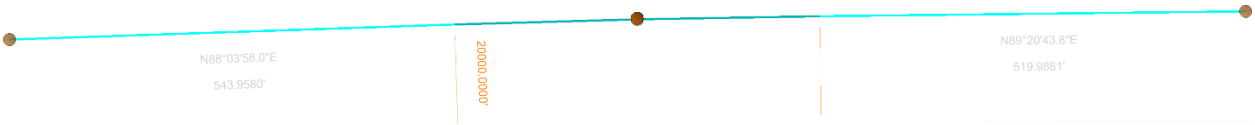
X. The curve will be deleted and select Apply to accept the change.



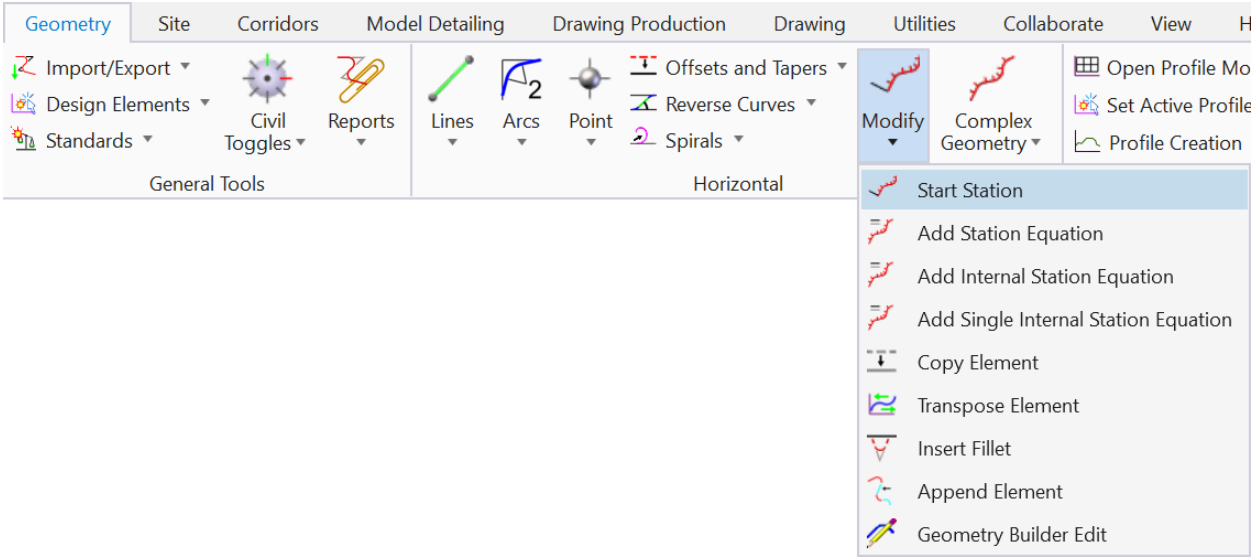
Y. The next thing we want to revise is the curve radius, as a roadway designer we want to use 20,000.00’ for the radius. Left click in the radius box and change the value to 20,000.00’



Z. Press <ENTER> and select Apply to accept the change. This will complete the tool and finish the adjustments to the Alignment. Note that there is only one central curve at this point.



AA. The last step is to apply stationing starting at 10+00.00. Select the Start Station tool under Modify.



BB. Follow the prompts to adjust the start station and use the horizontal geometry report to review the alignment.

Horizontal Geometry – Geometry Builder

The **Geometry Builder** Tool defines geometry for ROW and Parcel definition. This tool will not be common used by the roadway designer. For more information about this tool and how and when to use it, the user should find more specialized training.

Horizontal Geometry – Geometry Connector

The **Geometry Connector** Tool is a manual, table-based platform that can be used to develop centerline geometry. The tool works be selecting a beginning and ending element and providing design parameters for all the elements the user needs to connect the beginning and ending element. Some parameters will be fixed (set) and some parameters will be Free (Unknowns). The program will then create a solution based on the Begin and End elements and the specified design parameters.

This process is very similar to the development of an Incomplete Alignment Input file in Geopak.

The user should learn to use the individual geometry tools, they will be more efficient and productive when compared to the **Geometry Connector**. The individual tool will provide instant graphical feedback of the solutions and more dynamic options and flexibility.

For more information about this tool and how and when to use it the user should find more specialized training.