GEOPAK OpenRoads Technology for Civil Design

For GEOPAK V8i (SELECTseries 4) or PowerGEOPAK V8i (SELECTseries 4)

Prepared on behalf of
The Ohio Department of Transportation,
Office of CADD and Mapping Services by

Eric Thomas

Eric Thomas Consulting LLC

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This training guide was prepared with the following software versions:

Bentley PowerGEOPAK V8i (SELECTseries 4) 08.11.09.845
Windows 7 Enterprise, Service Pack 1

Prepared for the Ohio Department of Transportation, Office of CADD and Mapping Services by
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TABLE OF CONTENTS

1 Introduction 1

1.1 Course Prerequisites 1

1.2 Course Outline 1

1.3 Course Schedule 2

1.4 CPD Credit 2

1.5 ODOT CADD Standards and Support 2

1.6 ODOTcadd Standards 3

1.7 Companion Training Guides 3

Project Management with the ODOTcadd Standards 3

ODOT GEOPAK Road 1 and Road 2 Training Guides 4

1.8 Bentley Online Training Resources 4

2 OpenRoads Overview 5

2.1 What is OpenRoads? 5

2.2 How does OpenRoads differ from GEOPAK Road/Survey? 5

2.3 3D Modeling vs Plan Production 7

2.4 OpenRoads Online Help 9

2.5 The ODOT Workspace 10

Exercise 1 - Training File Installation 12

2.6 Task Navigation 17

2.7 Project Explorer 18

2.8 MicroStation Design File Settings 19

2.9 MicroStation User Preferences 20

2.10 Project Explorer > Civil Standards 21

Civil Standards > Feature Definitions 22

3 Using OpenRoads Survey Data 25

3.1 OpenRoads Survey Data format 25

3.2 Data Integrity 26

3.3 Survey Basemaps 26

Point Features 26

Linear Features 27

Field Attributes 28

3.4 MicroStation Levels for Survey Data 29

3.5 Geographic Coordinate Systems 31
ODOT Seed Files and Geographic Coordinate Systems 31
Project Specific Seed Files 32
Reviewing/Selecting the GCS Definition 32
Longitude and Latitude Coordinates 34
3.6 Referencing Design Files with a GCS Defined 36
3.7 Working with OpenRoads Terrain Models 37
Terrain Model Feature Definitions 40
Terrain Model Features and Contour Display 43
3.8 Importing GEOPAK TIN files for OpenRoads Use 47

4 Working with 3D Files 49

4.1 The Design Cube 49
4.2 Active Depth 50
4.3 Viewing a 3D Model 51
Display Styles 51
Rotating Views in 3D 53
Clip Volumes 53

5 Horizontal Geometry 57

5.1 Basemap Design File Requirements 57
The Geometry Basemap 57
Using Multiple “Federated” Basemaps 58
Exercise 5A – Geometry Basemaps 61
5.2 Civil Formatting 65
5.3 Design Standards 66
5.4 Civil Geometry Manipulation and Modification 67
Element Manipulators 68
Design Intent 69
5.5 OpenRoads Geometry Commands 71
General Geometry 71
Horizontal Geometry 74
5.6 Civil AccuDraw 79
5.7 OpenRoads Feature Definitions 84
5.8 Working with GPK Files 87
Exercise 5B –GPK Files 88
5.9 Exporting OpenRoads Geometry to the GPK 91

Export to Native 91
Exporting via the Feature Definition 91
Using Feature Definitions to Draw OpenRoads Geometry 92
Using the "Scratch Alignment" Feature Definition 93
5.10 Stations and Station Equations 96
Start Station 96
Add Station Equation 97
5.11 Design Standards 98
To Apply a Design Standard 100
To Review a Design Standard Violation 101
Exercise 5C – Proposed State Route 185 102
Exercise 5D – St. Peter Road Improvements 112
5.12 Importing OpenRoads Geometry from a GEOPAK GPK file 114
Exercise 5E – Proposed Jameson Road 116

6 Vertical Geometry 119

6.1 Profile Settings 119
6.2 Existing Ground Profiles 120
6.3 Profile Feature Definitions 123
6.4 Exporting Existing Profiles to the GPK File 123
Exercise 6A –Existing Profiles 124
6.5 Proposed Vertical Alignments 127
Using CivilAccudraw in Profile Mode 128
Exporting Proposed Profiles to the GPK File 130
Exercise 6B – St. Peter Road Proposed Profile 131
Exercise 6C – S.R. 185 Proposed Profile 133

7 Corridor Modeling 137

7.1 Corridor Modeling Commands 137
7.2 Corridor Modeling Design Files 137
Exercise 7A – Corridor Design Files 139
7.3 Templates 140
ODOT Template Library 141
The Create Template Dialog 142
7.4 Template Points 148
7.5 Template Components 148

7.6 Creating Template Components 150
7.7 Point Names and Affixes 152
7.8 Reviewing and Editing Point and Component Names 153
Exercise 7B – Basic Template Creation 155
7.9 Drag and Drop Component Operations 159
7.10 Component Editing 160
7.11 Mouse Wheel Functions While Creating Templates 160
7.12 The ODOT template Library 161
7.13 Basic Template Creation Workflow 162
Exercise 7C – Create Templates from Components 163
7.14 Corridor Modeling Basics 165
Exercise 7D – St. Peter Road Corridor 171
7.15 Advanced Template Design 175
Point Constraints 175
The Point Properties Dialog 177
Point Constraint Types 179
Constraint Labels 183
Editing Points with the Right-Click Menu 184
Adding Components to the Template 185
Creating Simple Components 186
Creating Constrained and Unconstrained Components 187
Null Points 188
Testing Point Controls 189
ODOT Standard Point and Component Names and Features 190
7.16 End Conditions 193
End Condition Point Properties 195
End Condition Priority 196
Testing End Conditions 198
7.17 Component Properties 200
Exercise 7E - Creating and Testing End Conditions 202
7.18 Corridor Editing Tools 205
Corridor Properties 206
Corridor Views 206
Reports 207
Corridor References 207
Process Corridor 208

Lock – Deactivate Rule 208
Delete 208
Corridor Creation Tools 208
Corridor Objects 209
Create Template Drop 209
Create Transition 209
Create Secondary Alignment 209
Define Target Aliasing 209
Create Parametric Constraint 210
Create End Condition Exception 210
Create Point Control 211
Create Curve Widening 211
Key Station 212
Assign Superelevation to Corridor 212
Processing Order for Point Overrides 212
Exercise 7F – Point Controls: Horizontal 213
Part 1: Creating the S.R. 185 Template 213
Part 2: Create the S.R. 185 Corridor Model 215
Part 3: Adjusting the Lane Width to meet Existing Pavement 216
Part 4: Adjusting the Pavement Slope to meet Existing Pavement 220
Exercise 7G – Ditch Profiles 224
Part 1: Redefining a Ditch Profile with an Elevation and Grade Point Control 224
Part 2: Defining a Special Ditch Profile 227

8 Superelevation 233

8.1 Superelevation Design Files 234
8.2 Applying Superelevation to a Corridor 234
Create Superelevation Sections 235
Assign Superelevation to Corridor 241
8.3 Templates for Superelevated Sections 243
Defining the Shoulder Rollover for the Low Side of Superelevation 243
Defining the High Side of Superelevation 246
Using ODOT's Backbones 248
Exercise 8A – Defining the Superelevation for the SR 185 Corridor 249
Exercise 8B – Defining Superelevation Templates 253
Exercise 8C: Curve Widening 261

9 Intersection Modeling 263

Process Overview 263
Exercise 9A – Modeling an Intersection 264
Part 1: Corridor Design Files 264
Part 2: St. Peter Road Intersection and Pavement Surface Terrain Model 266
Part 3: St. Peter Road Intersection Templates 276
Part 4: Adjusting the S.R. 185 Corridor in the Intersection 280

10 Civil Cells 283

10.1 ODOTcadd_CivilCells.dgnlib 283
10.2 Civil Cells Toolset 283
10.3 Placing Civil Cells 284
10.4 Modifying Civil Cells after Placement 288
Editing the Pavement Surface Template 289
Editing the Shoulder Template 289
Making Graphical Edits 290
Adding End Condition to Civil Cell components 292
Exercise 10 – Jameson Road Intersection 294

11 Cross Sections 302

11.1 Open Cross Section View 303
Edit Station 304
Place Temporary Dimension Line, Remove All Temporary Dimensions 305
Locate Station via Datapoint 305
11.2 Create Cross Sections 306
Cross Section Graphics 306
Creating Cross Sections in Sheet Format 307
Creating Cross Sections in GEOPAK Format 311
11.3 Annotate Cross Sections 315
PGL Station/Elevation Labeling 316
Slope Labels 318
Labeling Ditch Elevations 320
11.4 Cross Section Viewer 322
11.5 Displaying Right-Of-Way Labels on Cross Sections 323
11.6 End Area Volumes 325
11.7 Setting up cross section sheets for printing 329
Exercise 11 - Cross Sections 330

12 Subsurface Utilities 334

12.1 Subsurface Utility Tools 334

12.2 Utility Design Files 336

12.3 Extract Graphics 337

Using Filters to Extract 3D Catch Basins, Manholes, and Inlets 338

Modifying Storm Sewer Nodes 339

Extracting 3D Storm Sewer Lines 340

Modifying 3D Storm Sewer Links 343

Extracting Utilities by Depth of Cover 344

12.4 Underground Utilities and Cross Sections 347

12.5 Proposed Utilities 348

Proposed Utility Design Files 349

Placing Proposed Storm Sewer Nodes 351

Placing Proposed Storm Sewer Links 353

Proposed Box Culverts 355

1 Introduction

1.1 Course Prerequisites

This training course is intended for ODOT personnel directly involved in the production of roadway construction plans. The course serves as an overview of the OpenRoads tools for Corridor Modeling available in GEOPAK/PowerGEOPAK V8i (SELECTseries 4) tools and should not be considered a comprehensive reference guide. For additional information regarding specific software functions not covered in this manual, please refer to Bentley's online help information.

It is required that students meet the following prerequisites:

- Familiarity with ODOT's design policies, procedures, and CADD Standards
- Plan preparation experience
- A working knowledge of Windows 7
- A working knowledge of MicroStation V8i
- A working knowledge of GEOPAK Road

This course builds upon the concepts and processes detailed in the following ODOT training guides:

- **GEOPAK V8i SELECTseries 1, Road 1**
- **GEOPAK V8i SELECTseries 1, Road 2**
- **Project Management with the ODOTcadd Standards**

It is assumed that class participants have completed these courses.

1.2 Course Outline

The following topics are covered in the class:

- ODOT Project Configuration Standards
- ODOT CADD Standards for Survey and Design
- Using OpenRoads Survey Data
- Annotation Scale
- Working with 3D MicroStation Files
- Geographic Coordinate Systems
- Civil AccuDraw
- Horizontal Geometry
- Vertical Geometry
- Plan Graphics
- Templates
- Corridor Modeling
- Superelevation
- 3D Geometry
- Intersection Design
- Civil Cells
- Cross Section Sheets
- Cross Section Annotation
- Component Quantities

1.3 Course Schedule

	Start Time: 8:30 AM **End Time**: 3:00 PM
	Breaks: 15 Minutes per half day
	Lunch: 30 Minutes
	Web Browsing: Please limit web browsing to break times and lunch.
	Email: Please limit email usage to break times and lunch.
	Cell Phones: Please set cell phones to vibrate and take calls only at break times and lunch unless absolutely necessary. Please refrain from texting during the class

1.4 CPD Credit

Participants in the class are eligible for CPD credit*. A certificate for CPD credit is available upon request from the instructor at the completion of this course.

*Please note that final determination on what qualifies for CPD credit ultimately lies between the license holder and the State Board for Professional Engineers and Surveyors.

1.5 ODOT CADD Standards and Support

ODOT CADD Standards for MicroStation, GEOPAK, and OpenRoads are maintained and distributed by the ODOT Office of CADD and Mapping Services.

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Pages/default.aspx

The **ODOT CADD Engineering Standards Manual** is available in Adobe Acrobat PDF format on the ODOT Website:

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Standards/Pages/Manuals.aspx

ODOT's Design Resource Reference Center is a centralized online reference center to help locate online or printed material. Additionally, several mailing lists are available to keep you informed about updates to ODOT standards. Visit the Design Resource Reference Center at the following URL:

http://www.dot.state.oh.us/drrc/Pages/default.aspx

Support for Bentley Software is the responsibility of the Office of CADD and Mapping Services. Support questions can be sent to the CADD Support staff using the following form:

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Support/Pages/ServiceRequest.aspx

1.6 ODOTcadd Standards

The ODOTcadd Standards for MicroStation V8i (SELECTseries 3) and GEOPAK V8i (SELECTseries 4) are located in the following folder:

I:\ODOTcadd\Standards

For users external to ODOT, these CADD Standards can be downloaded from the ODOT website:

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Standards/Pages/Files.aspx

The standards are maintained and distributed by the CADD Services group within the Office of CADD and Mapping services. Requests for enhancements and questions about these standards should be directed to the CADD Services group using the following form:

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Support/Pages/ServiceRequest.aspx

The ODOT CADD Standards for MicroStation V8i (SELECTseries 3) and GEOPAK V8i (SELECTseries 4) are not intended to be used with older versions of MicroStation and GEOPAK software.

1.7 Companion Training Guides

This training guide is specific to the GEOPAK and OpenRoads tools used for Corridor Modeling. Topics related to project configuration and plan production using the legacy GEOPAK Road commands are not covered in this training guide. ODOT provides two other training guides, listed below, that are complimentary to this training guide.

It is assumed that the student is familiar with the content each of these training guides.

Project Management with the ODOTcadd Standards

ODOT provides a separate training guide for the ODOTcadd Standards that covers several project management tasks, including the following topics:

- Standard Directory Structure
- Standard Design File Names
- New Project Creation
- File Creation
- Design Files, Models, and Annotation Scale
- Sheet Cells and Tags
- Sheet Management and Cross References
- PDF Printing

Many of these topics are relevant to this course, however we will not cover these topics in this training guide. See the **Project Management with the ODOTcadd Standards** training guide, located in the ODOTcadd folder, for more information on these topics:

I:\ODOTcadd\Stadards\ODOT\Traning\Guides\ODOT_ODOTcaddTrainingGuide.pdf

ODOT GEOPAK Road 1 and Road 2 Training Guides

The OpenRoads tools included with GEOPAK v8i (SELECTseries) 4 are primarily aimed at creating a 3D model of the project. Plan production tasks are still accomplished using the legacy GEOPAK Road tools. The ODOT GEOPAK Road 1 and Road 2 training guides are still relevant for plan production processes.

Any references to a project folder structure and file names detailed in the Road 1 and Road 2 training guides are superseded by the ODOTcadd Standards as detailed in the **CADD Engineering Standards for ODOTcadd** manual and the **Project Management with the ODOTcadd Standards** training guide.

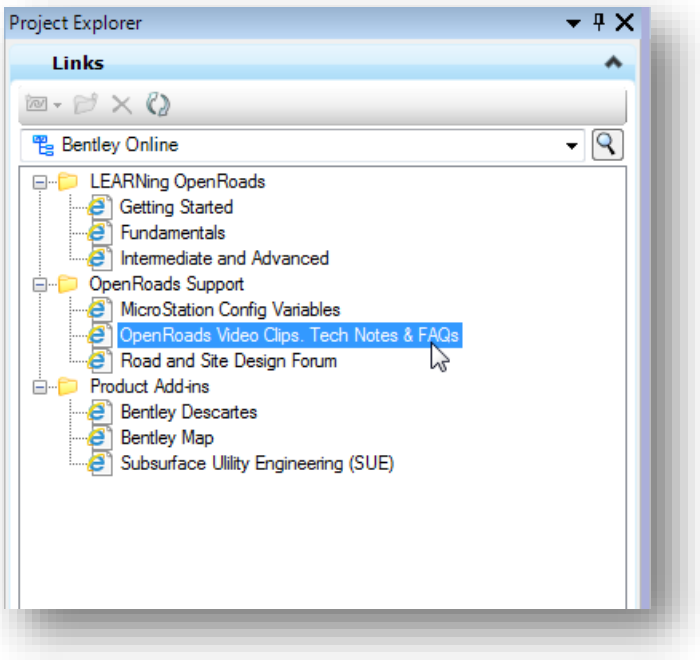
ODOT's GEOAPK Road 1 and Road 2 training guides can be found in the following location:

I:\ODOTcadd\Stadards\ODOT\Traning\Guides\ODOT_GEOPAK_V8i_Road1.pdf
I:\ODOTcadd\Stadards\ODOT\Traning\Guides\ODOT_GEOPAK_V8i_Road2.pdf

1.8 Bentley Online Training Resources

The ODOTcadd configuration contains links to Bentley Online training resources.

In the MicroStation *Project Explorer* dialog, select the **Links** group. From the drop-down list, choose **Bentley Online**.



Of particular note is the **OpenRoads Video Clips. Tech Notes & FAQs** link. Be sure to take a look at the information available at this link by double-clicking the item in the *Project Explorer* dialog.

2 OpenRoads Overview

2.1 What is OpenRoads?

You may have heard of Bentley's "OpenRoads" technology and the SELECTSeries 4 release of MicroStation and Bentley Civil products. But exactly what is OpenRoads?

OpenRoads is not a software product that can be purchased and installed separately. OpenRoads is a technology that is included with the installation of Bentley's InRoads, GEOPAK, and MXROAD software.

OpenRoads is described as follows on the Bentley Website:

> *"OpenRoads technology represents the continued evolution of merging functionality for Bentley's road design, drainage analysis and design, data input and reduction, and bridge modeling products. This shared technology is embedded in InRoads, GEOPAK, MXROAD, and PowerCivil. It expands these products to include information-rich 3D modeling integrated with CAD, mapping, GIS, and business tools like PDFs, i-models, and hypermodels."*
>
> *"OpenRoads technology provides the common workflow, data structure, and modeling tools that civil engineering organizations need to meet today's information modeling and accelerated project delivery requirements."*

But what does this mean for ODOT's GEOPAK Road and GEOPAK Survey users? It means that a new generation of Bentley Civil tolls is upon us that will eventually supersede Bentley's current civil products InRoads, GEOPAK and MXROAD.

2.2 How does OpenRoads differ from GEOPAK Road/Survey?

There are several key differences between the OpenRoads technology and GEOPAK Road/Survey. Some of the major differences are summarized below.

- Unlike GEOPAK, *all* OpenRoads data is stored directly in MicroStation
  - The GPK file is no longer necessary to store survey points, survey chains, or geometric alignments and profiles; however, a GPK file is still necessary for some plan production processes.
  - All ground survey data processed using OpenRoads Technology is stored in a 3D MicroStation design file.
  - GEOPAK TIN models are no longer used. Terrain models are stored directly in MicroStation in the same design file as the survey information.

- 3D MicroStation Design Models are used for OpenRoads survey processing
  - The design files you receive from ODOT's Surveyors will be 3D files.

- All graphics generated using OpenRoads technology tools use MicroStation's Annotation Scale functionality
    - Note: With the current implementation of the software, some of the graphics will still be annotated using the GEOPAK Design and Computation Manager. As with previous releases of GEOPAK, these graphics do not honor the Annotation Scale setting.

- The ODOT implementation of OpenRoads uses a new MicroStation User Configuration file (ODOTcadd) and project specific Project Configuration Files (PCF).
    - Users must use the MicroStation Manager dialog to open design files in order to select the correct UCF and PCF files before opening the design file.
    - It is no longer acceptable to open MicroStation files by double-clicking on the file name in Windows Explorer.

- All ODOT projects will use the ODOT standard directory structure and file naming convention. See the **ODOT CADD Engineering Standards Manual (ODOTcadd)** for details.

- Default project settings for OpenRoads are stored in DGN Libraries that are included in the ODOT workspace configuration.

- Geographic Coordinate Systems (GCS) will be used to establish the coordinate system for the project data. This allows easy translation between grid and ground coordinates and other Geo-referenced systems such as Google Earth, Bing Maps, Aerial Mapping, and GIS systems.

- The user interface has changed. OpenRoads tools are built into the MicroStation **Task Navigation** menu and the **Tools** pull-down menu. OpenRoads tools are not accessed through the **Applications > GEOPAK** pull-down menu

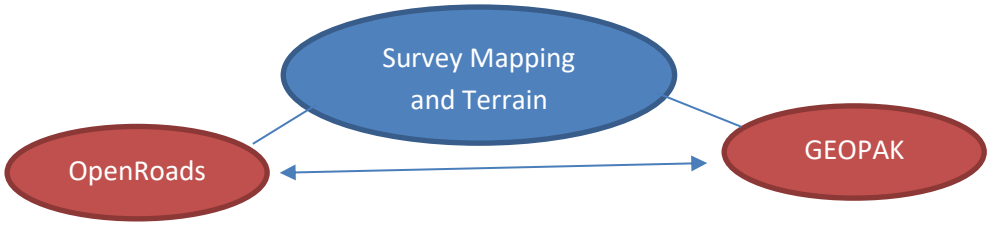
- Feature definitions are defined in MicroStation DGN Libraries. The GEOPAK D&C Manager database (.ddb) is no longer used for most OpenRoads functions; however it is still used for stationing alignments.

- OpenRoads tools fully support MicroStation's Undo functionality.

2.3 3D Modeling vs Plan Production

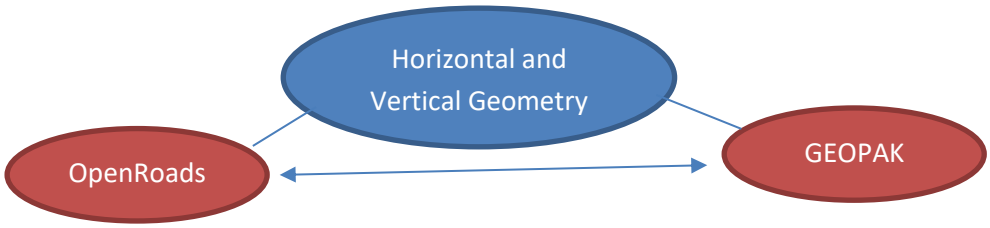
The OpenRoads technology is designed specifically to help users produce a 3D model of the proposed design. To date, the available OpenRoads technology tools have been developed primarily for this purpose. Plan production tools, such as labeling, plan and profile sheet clipping, etc… are not currently supported using OpenRoads specific tools. For most plan production functions, the legacy GEOPAK tools are still used. This guide will focus specifically on the use of the OpenRoads technology to generate a 3D model. The legacy plan production tools are not covered by this manual. See the **ODOT GEOPAK Road 1** and **ODOT GEOPAK Road 2** training guides for information on the legacy GEOPAK software functions.

Many design functions can be completed with ether the legacy GEOPAK tools, or the OpenRoads Technology tools. Import and export functions within the OpenRoads toolset allow users to move to/from the use of the OpenRoads Technology and the legacy GEOPAK tools. The table below summarizes a few of the major work processes and the relationship between the legacy GEOPAK tools and the Open Roads technology.



Survey mapping from GEOPAK Survey can be used with OpenRoads. The TIN file from GEOPAK Survey must be imported to an OpenRoads Terrain Model.

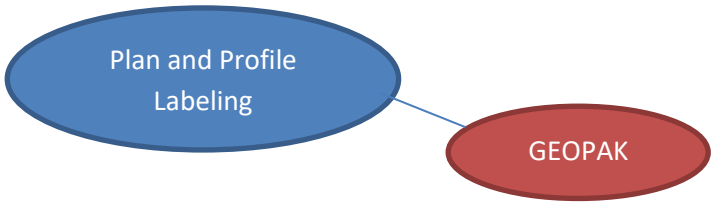
Survey mapping generated using the OpenRoads Technology can be used by the legacy GEOPAK Tools, however the OpenRoads Terrain Model must be exported as a GEOPAK TIN. OpenRoads Survey points and linear features are contained in the DGN file and are not stored in a GEOPAK GPK file; however, survey points and linear features can be selectively exported to a GPK file as needed.



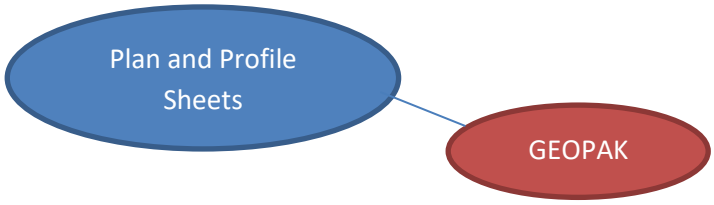
OpenRoads alignments are stored in a DGN file. The geometric data can be exported to a GEOPAK GPK file as necessary.

GEOPAK Alignments and profiles stored in the GPK file can be imported as OpenRoads geometry.

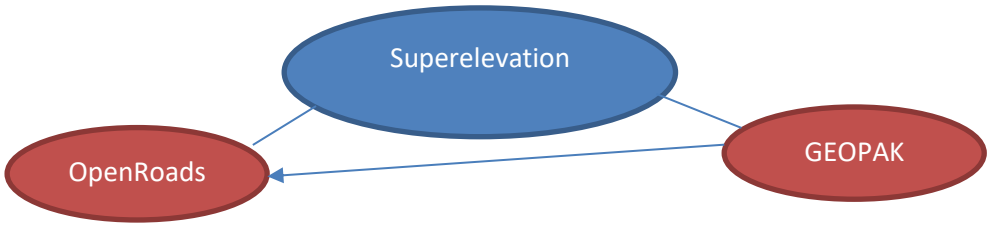
Many legacy coordinate geometry functions are not supported directly by OpenRoads tools. OpenRoads geometry is typically exported to the GPK file as a part of the workflow process.



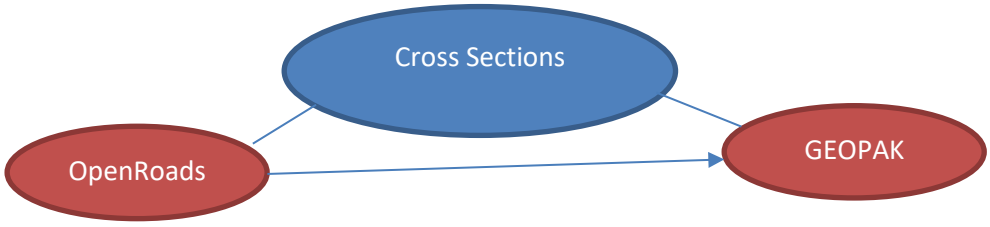
All plan view labeling is done using the legacy GEOPAK tools, including centerline stationing. The Stationing can be automated, however it is still a function of the GEOPAK Design and Computation Manager.



OpenRoads vertical geometry is stored with the horizontal alignment in the DGN file, but the vertical geometry is not drawn in the design file in the traditional manner. For plan and profile sheet generation, both the horizontal and vertical geometry must be exported to a GPK file and plotted using the GEOPAK Design and Computation Manager.



Superelevation definitions for OpenRoads are computed using the legacy GEOPAK SEP file and are stored in the DGN file using control lines for each lane of pavement. A GEOPAK Shape Input File can be read into OpenRoads; however, OpenRoads superelevation definitions cannot be exported for use with the legacy GEOPAK tools.

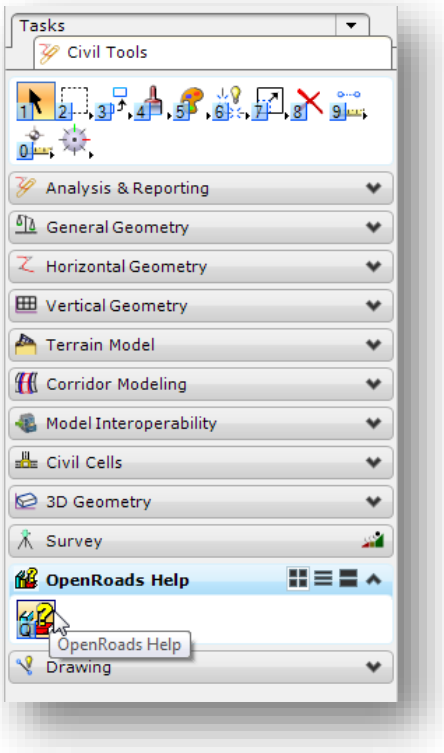


OpenRoads cross sections are a byproduct of the 3D model. All OpenRoads commands are utilized with the intent to generate the 3D model. Cross sections generated by OpenRoads can be placed with a GEOPAK Control Cell for use with legacy GEOPAK Cross Section functions.

Cross section sheets can be generated using OpenRoads tools, or the legacy GEOPAK cross section sheet tool. For ODOT purposes, the legacy tools provide better options.

2.4 OpenRoads Online Help

To access the OpenRoads help information, select **Civil Tools > OpenRoads Help > OpenRoads Help** from the MicroStation **Tasks** menu as shown below.

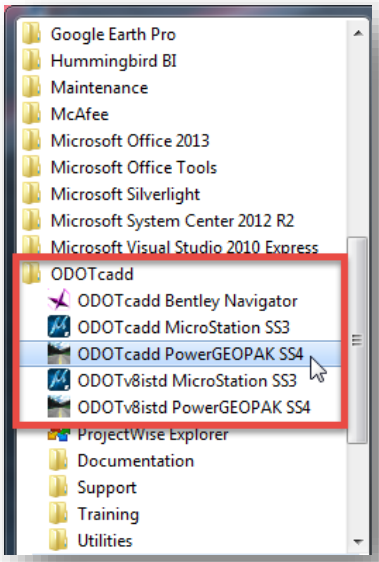


The *Civil Tools V8i SELECTseries 4* dialog shown below is opened.

2.5 The ODOT Workspace

A Workspace is a custom MicroStation environment or configuration. By selecting a workspace, you are customizing MicroStation and the Civil products for a specific discipline, project, or task. The workspace contains pointers to the CADD standards, DGN libraries, cell libraries, seed files, symbology resources, etc. necessary for the project.

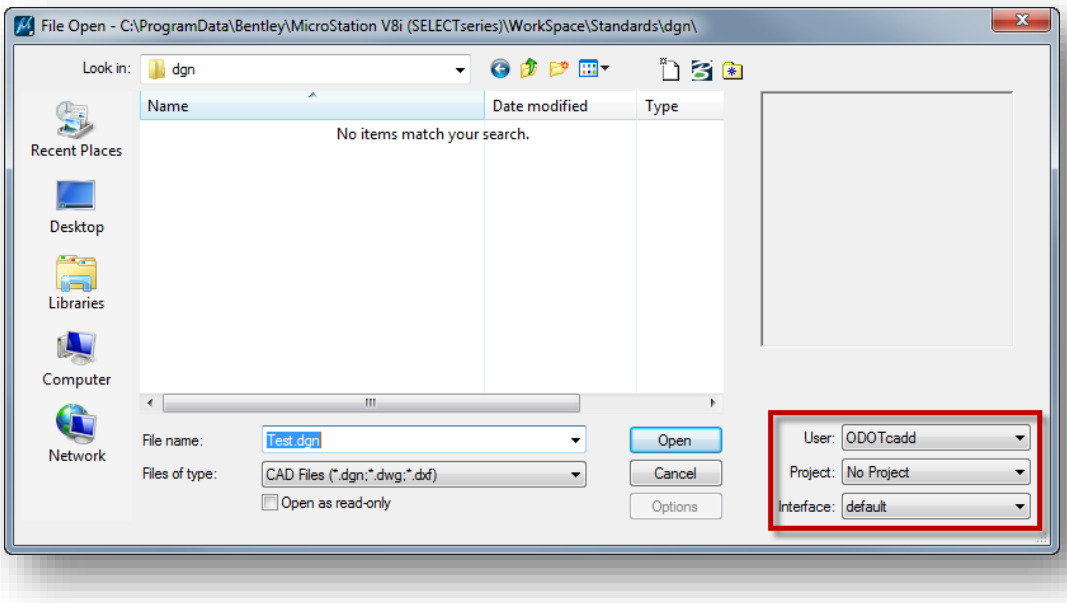
ODOT's Standard configuration provides two workspaces for MicroStation and GEOPAK projects. These workspaces are selected by choosing the appropriate item from the Windows Start Menu as shown below.



The workspaces are configured to access MicroStation/PowerGEOPAK with either the legacy V8istd CADD Standards or the new ODOTcadd Standards.

Care must be taken to select the appropriate item for the project that you intend to open to ensure that the correct CADD standards are accessed.

When the **ODOTcadd PowerGEOPAK SS4** item is selected, the MicroStation *File Open* dialog shown below is opened.



User Configuration
The **User** option is used to select the MicroStation user configuration file (.ucf). When MicroStation is opened the **User** option will default to **ODOTcadd** as shown above.

Project Configuration
With MicroStation and PowerGEOPAK V8i (SELECTseries 4), ODOT will transition to using a MicroStation project configuration (.pcf) file for each project that has been assigned a PID number. The PCF file is used to define project specific MicroStation variables. The **Project** menu will contain a list of the available projects. When a project is selected from the list, the *File Open* dialog will default to the root folder that has been defined for the project.

Important!
Many users are in the habit of opening MicroStation files by double-clicking the file name in Windows Explorer. When a MicroStation file is opened in this fashion, the **User** and **Project** configuration files that were active the last time MicroStation was opened will be used. In order to ensure that the correct configuration files are selected for OpenRoads projects, users should get in the habit of opening MicroStation from the program shortcut in order to select the appropriate **User** and **Project** configuration files before prior to opening MicroStation design files.

Exercise 1 - Training File Installation

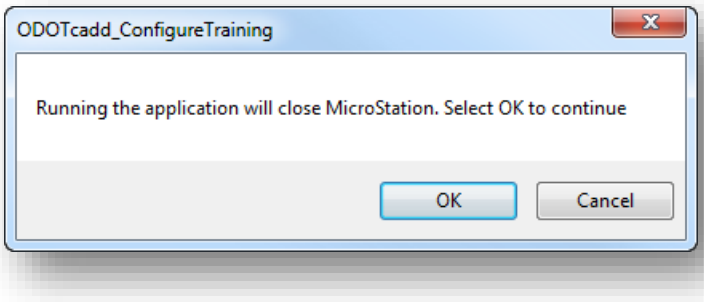
The training files for this class can be installed from the ODOT CADD Standards folder by use of a custom application.

- ✓ From the Windows Start Menu, select **All Programs > ODOTcadd > Utilities > ODOTcadd_ConfigureTraining** to install the training files.

  You can also run the program from the following location:

  I:\ODOTcadd\Standards\ODOT\Training\ODOTcadd_ConfigureTraining.exe

  The application will prompt you to close MicroStation if it is running. Select **OK** to proceed.

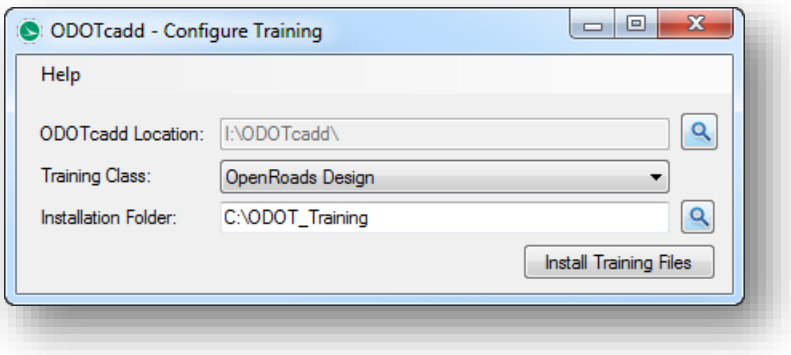


  The program must access the ODOTcadd Standards in order to install the training files. The program will search for the ODOTcadd folder in the following location:

  I:\ODOTcadd

- ✓ If the program cannot find the ODOTcadd folder in the location specified above, the *Browse for Folder* dialog is opened and you must choose the ODOTcadd folder.

  After the ODOTcadd folder has been successfully identified, the dialog shown below is opened.



- ✓ Choose the **OpenRoads Design** option.

- ✓ Specify the **Installation Folder** for the training data installation. Use the default location for the training file installation.

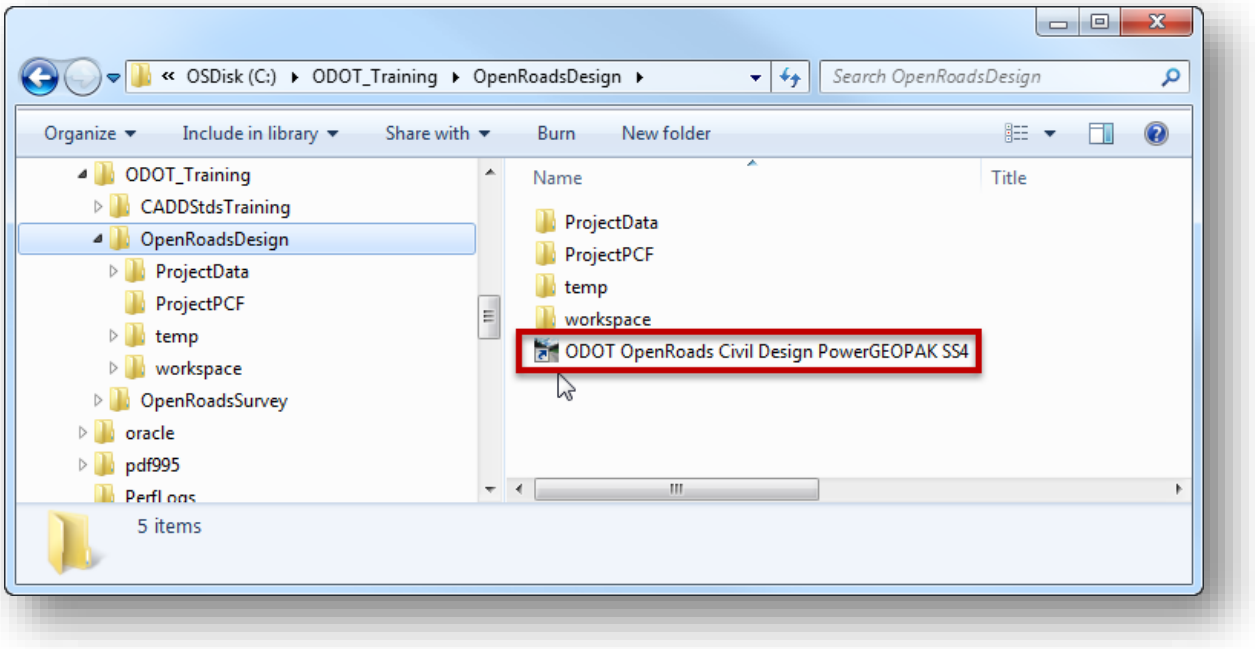
If you elect to change the installation folder, the selected folder will automatically be appended with the "\ODOT_Training" folder name. For example, selecting the path ***W:\myFiles*** will result in an installation folder of ***W:\myFiles\ODOT_Training***.

✓ Select the **Install Training Files** button to begin the installation process.

If a previous installation of the training files exists on the computer, you will be prompted to remove the old files.

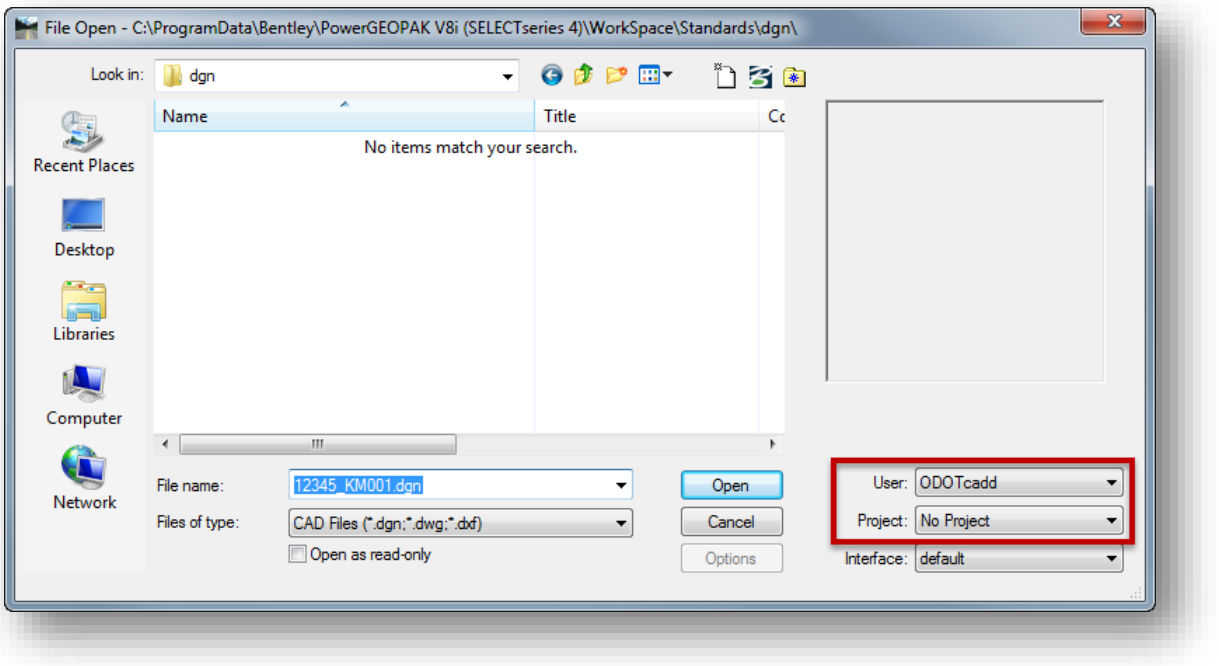
In addition to copying the necessary training files for the selected class from the CADD Standards to the selected folder, the program will create a shortcut that must be used to launch MicroStation with the proper workspace configuration for the training material.

If the training files are installed to the default location, ***C:\ODOT_Training***, the shortcut shown below is located in the following folder: ***C:\ODOT_Training\OpenRoadsDesign***



Important!
This shortcut should be used for training only. When working on ODOT projects, be sure to open MicroStation from the Windows Start Menu to access the normal ODOT working environment.

Double-click the training shortcut to launch MicroStation for the training environment. The *File Open* dialog is opened as shown below.



User Configuration

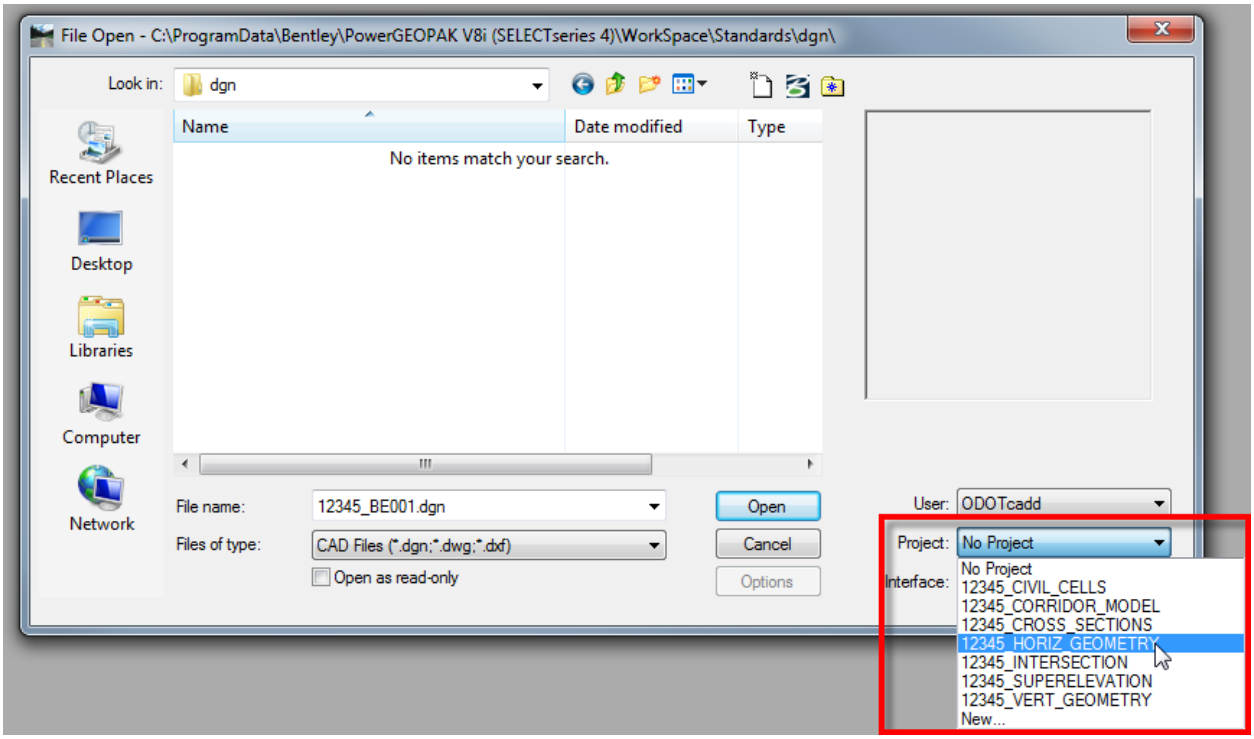
The **User** option is used to select the MicroStation user configuration file (.ucf). When MicroStation is opened using the training shortcut, the **User** option will default to **ODOTcadd** as shown above.

Project Configuration

The training data for this class uses MicroStation project configuration files (.pcf) to open the dataset for various exercises. These PCF files are located in the following folder for the training class:

C:\ODOT_Training\OpenRoadsDesign\ProjectPCF

The PCF files define project specific MicroStation configuration variables. The dataset for the training has several PCF files that are selected from the *File Open* dialog before accessing the project data, as shown on the following page.



When a **Project** is selected from the list, the *File Open* dialog will automatically change to the parent folder for the selected project.

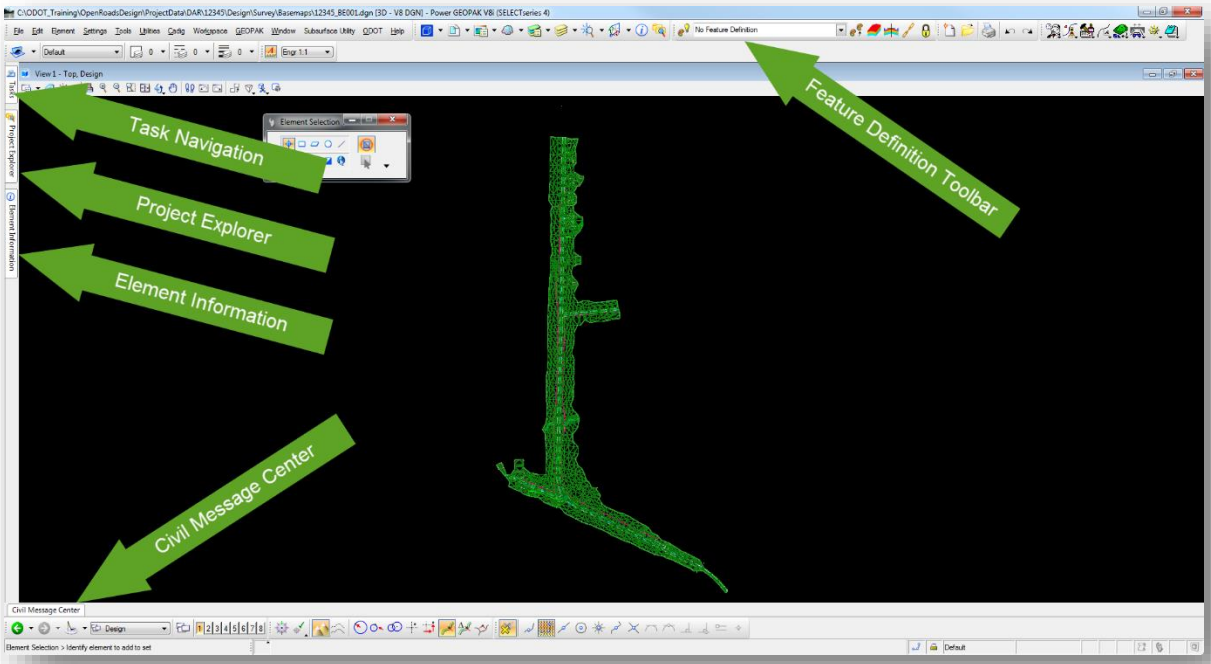
Take the following steps to open the dataset for our sample project:

- ✓ Select the **Project** configuration file **12345-HORIZ_GEOMETRY** as shown above. The *File Open* dialog will automatically change to the **Design** folder for the project.

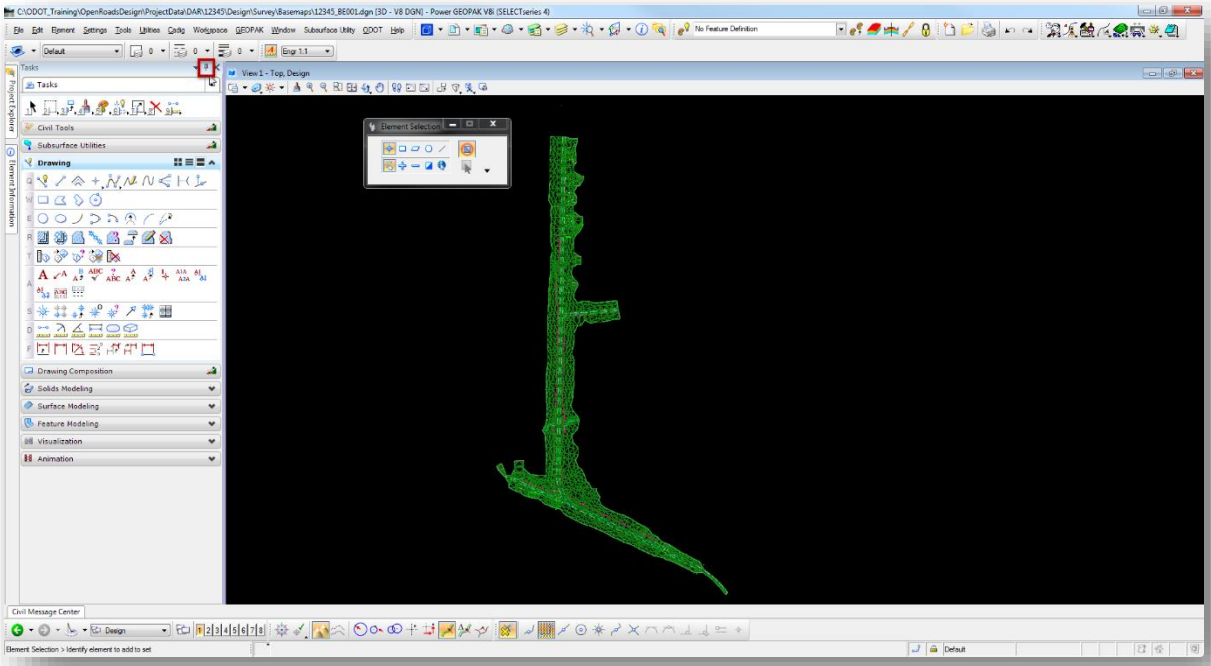
- ✓ Open the following design file:

\Survey\Basemaps\12345_BE001.dgn

When a file is opened, the interface should appear similar to the example shown on the following page.



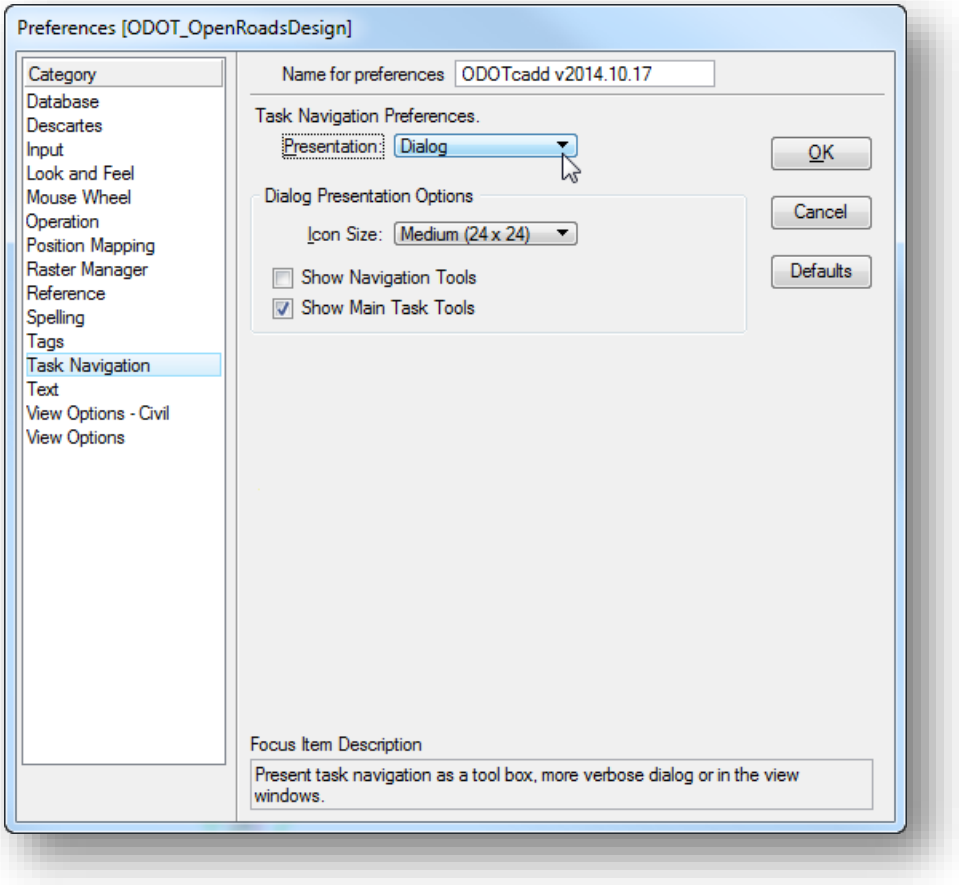
The *Task Navigation, Project Explorer*, and *Element Information* dialogs are docked and "unpinned" at the left of the screen. Floating the cursor over each of these tabs will expand the dialogs for use. The dialogs can be "pinned" in place using the push-pin icon at the upper right corner of each dialog. In the example below, the *Task Navigation* menu is pinned in place.



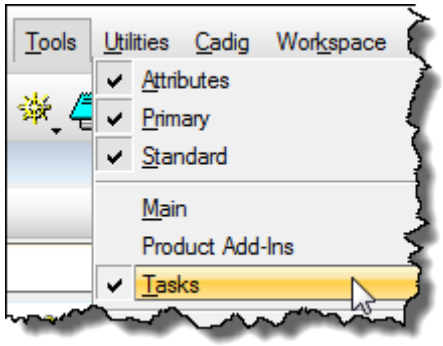
2.6 Task Navigation

By default, the *Task Navigation* menu is docked to the left of the screen as shown in the example on the previous page. This menu is used to select OpenRoads by selecting **Civil Tools** from the *Tasks* menu.

- If the *Task Navigation* menu is not shown, it can be configured by selecting **Workspace > Preferences** to access the *Preferences* dialog shown below. Set the **Task Navigation > Presentation** option to **Dialog**.



- The *Task Navigation* menu can be opened by selecting **Tools > Tasks.**



2.7 Project Explorer

The *Project Explorer* dialog is used extensively with OpenRoads. By default this dialog is docked on the left side of the screen as shown previously.

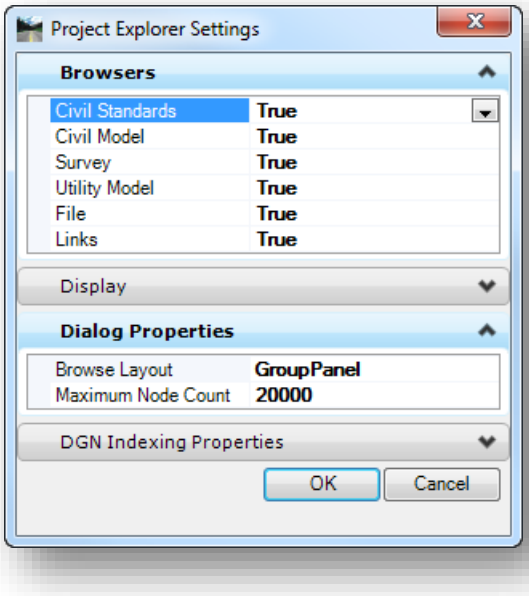
- If the *Project Explorer* dialog is not shown, the dialog can be opened by selecting **File > Project Explorer** from the MicroStation pull-down menu.

The *Project Explorer* dialog contains several tabs which can be toggled on or off in the project explorer settings. To review the settings, select **Settings > Project Explorer** from the MicroStation pull-down menu to open *the Project Explorer Settings* dialog shown below to the right.

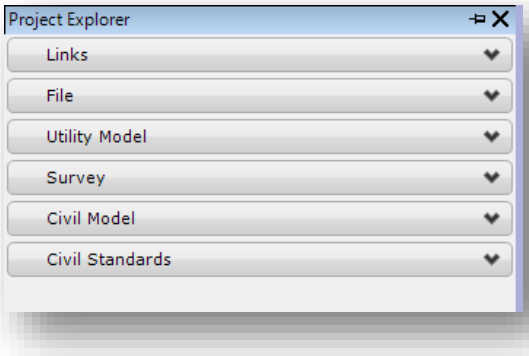
Recommended settings:

Browsers
Set all of the available options to **True**.

Dialog Properties
Set the **Browse Layout** option to **Group Panel** .

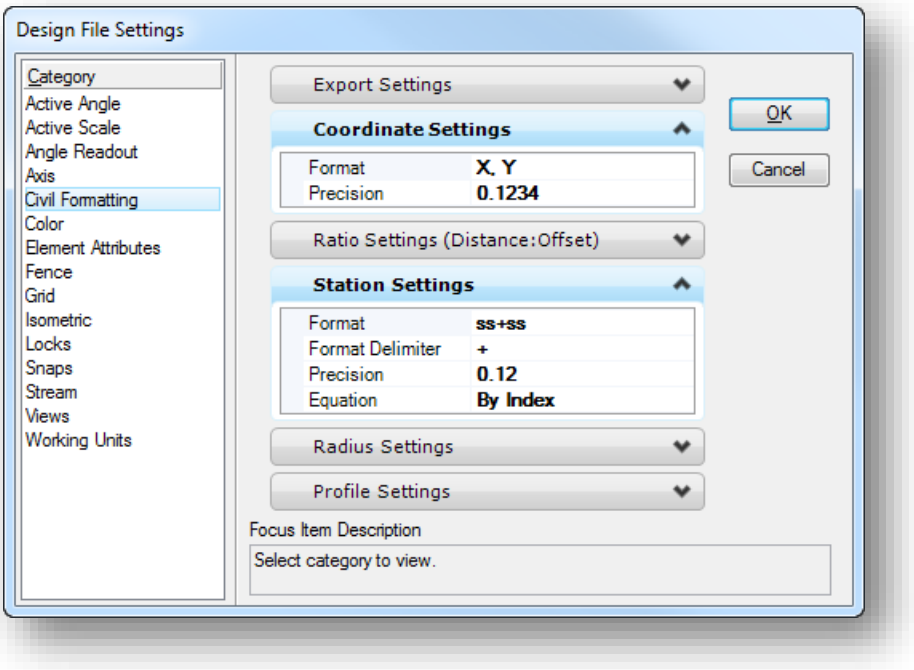


Once configured, the *Project Explorer* dialog should contain all the the **Group Panels** shown in the example shown at right.



2.8 MicroStation Design File Settings

The design file itself also has several settings used by the OpenRoads software. To access these settings select **Settings > Design File** and then click the **Civil Formatting** item from the list on the left of the dialog.



These settings are initially defined in the ODOT Seed files and have been configured appropriately for ODOT projects. However, you may wish to change the following settings on a file-by-file basis.

Coordinate Settings

- The **Format** can be set to **X, Y** or **N, E** as desired.
- The **Precision** setting is used to control the display and precision of coordinates within the various civil and survey dialogs.

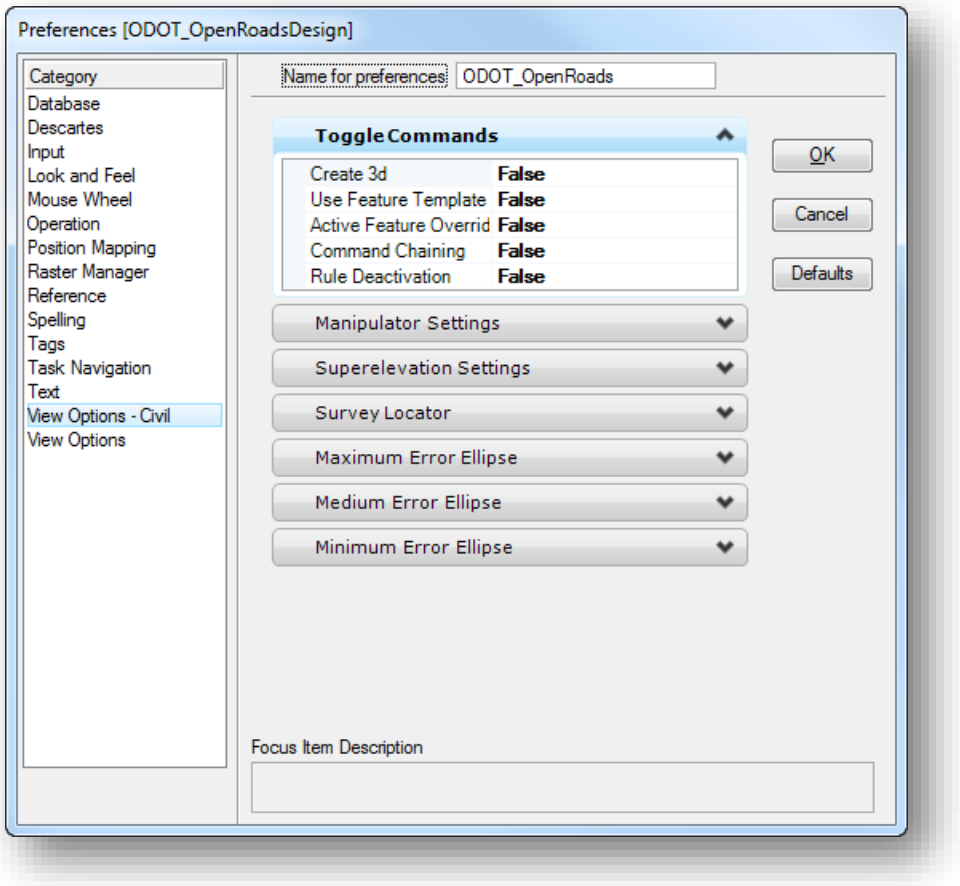
Station Settings

Controls the format, delimiter and precision of the station values to be used and displayed in the various civil dialogs. In addition, there are two options to control how equations are represented within the station values.

- **By Name** - This is the standard InRoads presentation (A100+00, B105+00, etc.)
- **By Index** - This is the standard GEOPAK presentation (100+00 R 1, 105+00 R 2, etc.)

2.9 MicroStation User Preferences

The MicroStation User Preferences includes several options for OpenRoads. These parameters are accessed by selecting the **View Options – Civil** item on the *Preferences* dialog as shown below.



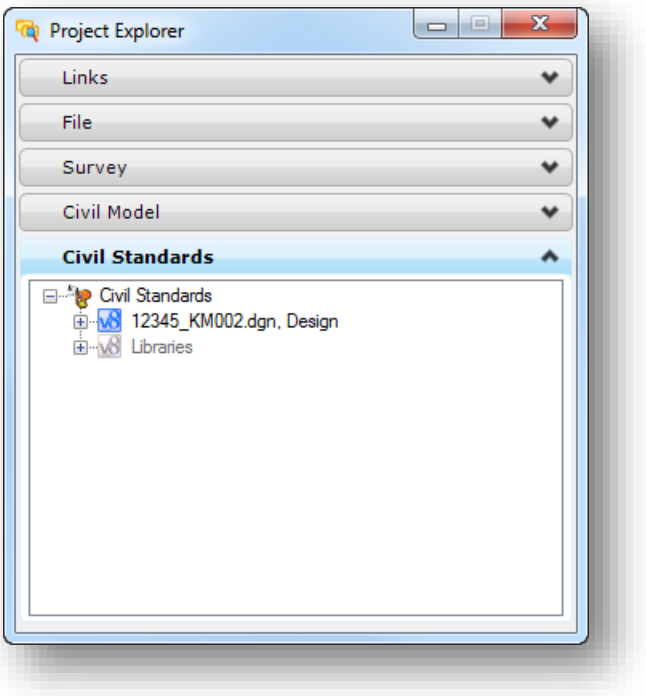
Most of these settings are related to OpenRoads Survey and are not documented here.

The **Toggle Commands** group is used to set the default on/off settings for the OpenRoads **Feature Definition Toggle Bar**.

2.10 Project Explorer > Civil Standards

The OpenRoads technology uses MicroStation DGN Libraries extensively to define various standards used by both OpenRoads Civil and Survey tools. These DGN libraries are defined by the ODOT workspace.

When a new MicroStation design file is created, these standards are referenced by the configuration and can be reviewed from the **Civil Standards** tab of the *Project Explorer* dialog.



The **Civil Standards** tree contains two main branches; one for the active design file, and one for **Libraries**, as shown above.

When a new file is created, the standards are initially defined only in the **Libraries** branch. These are the default standards that are defined for ODOT projects.

As a particular standard is accessed, the standard is copied to the active file where they can be reviewed and modified if necessary. This is done so that the design file can be easily shared with other users independent of the configuration.

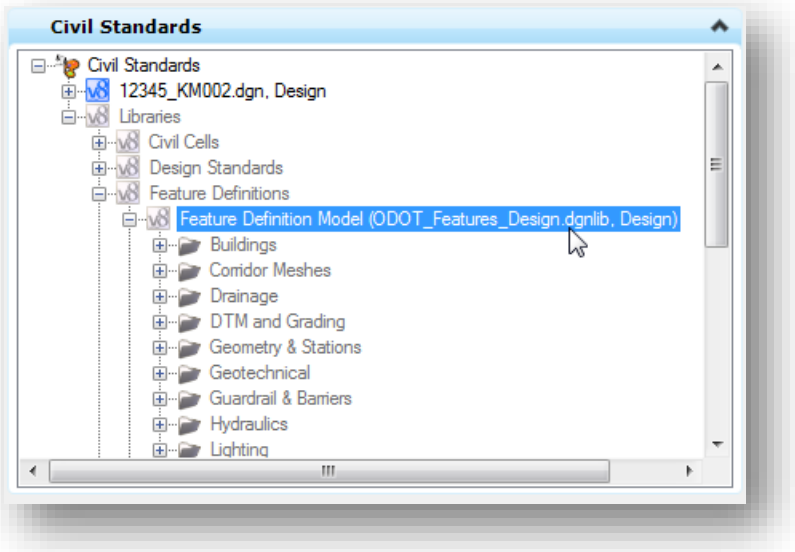
Civil Standards > Feature Definitions

Feature definitions are used to control symbology, annotation, and various other properties that are applied to geometric elements and terrain models.

The feature definitions are used by the software for the following:

- Define what the geometric information actually represents such as curb, centerline, edge of pavement, a mailbox, etc.
- 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, etc.) for each surveyed point or linear feature.
- Define the display characteristics of terrain models.

Feature definitions are defined in MicroStation DGN Libraries (.dgnlib). Several DGN libraries are configured according to ODOT CADD Standards for use with Bentley's OpenRoads Technology as shown in the *Project Explorer* dialog below.



The **Feature Definitions** branch of the **Civil Standards** tab lists the feature libraries that have been configured for the ODOT workspace. Three types of features can be defined:

- Linear
- Point
- Surface

Linear and **Point** feature definitions are used to define a wide variety of parameters for each specific feature. A specific feature can be configured to read settings from a GEOPAK DDB file, a GEOPAK SMD file, or a MicroStation Element template. In each case, the following settings are defined for each feature:

- Symbology settings for various contexts (plan, profile, cross section, 3D)
- Whether a specific feature is defined for Survey use
- Whether a specific feature is configured to automatically process a 3D model

Surface features are used to define terrain model display parameters for the terrain model itself as well as any profiles that are extracted from the terrain model.

The use of features will be discussed in greater detail throughout this training guide.

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3 Using OpenRoads Survey Data

3.1 OpenRoads Survey Data format

Survey mapping processed with the OpenRoads Survey tools are written to a MicroStation design file similar to data that has been processed using the legacy GEOPAK Survey tools. However, there are several key differences:

- Survey data is processed in MicroStation using a Survey "Field Book" design file
  - The field book design file is contained in the project's \Design\Survey\RawData folder
  - This file is named with a "FB" file type code; example: 12345_FB001.dgn
  - The field book design file is normally accessed by only the surveyors
  - When the survey processing is complete, the data is exported to a Survey basemap in the project's \Design\Survey\Basemaps folder. This file is named with the "BE" two character file type code. The BE file is normally used by design personnel
  - Survey processing "rules" are stripped from the survey basemap BE design file when the data is exported to the BE file. The BE file contains simple MicroStation graphics and the terrain model
  - If additional survey information is needed, the new information will be processed in the field book FB design file. A new survey basemap BE file will be generated for the survey mapping and terrain. Previous edits to the survey basemap BE design file will be lost

- Survey Data is typically mapped to a 3D Model
  - Designers will typically work in 2D models
  - MicroStation allows 3D models to be referenced to 2D models, and vice-versa

- The Survey points and linear features are stored directly in the Survey field book design file
  - Survey information is not written to a separate GEOPAK COGO Database (.gpk file)
  - Selected data can be exported to a GPK if needed

- The Terrain Model is contained in the DGN file
  - Survey points and linear features in the FB design file are dynamically linked to the terrain model. Changes to the survey points and linear features are immediately reflected in the terrain model
  - The terrain model is included in the survey basemap BE design file when the survey data is exported from the field book design file
  - The terrain model contained in the basemap BE file is not dynamically linked to the survey points and linear features
  - The terrain model can also be exported to a GEOPAK TIN file if needed
  - Terrain display is handled using OpenRoads **Feature Definitions** and MicroStation **Element Templates**

- A MicroStation **Geographic Coordinate System** (GCS) may be applied to the data if desired.
  - The GCS is used to identify the location of the data on the Earth's surface
  - The use of GCS is optional at this time

3.2 Data Integrity

Protecting the integrity of the survey information has always been a concern for ODOT's Survey personnel. The accuracy of the Survey information is the responsibility of the surveyor and therefore the original survey information should not be edited by design personnel. ***Under no circumstances should design personnel edit the survey data contained in the Survey field book FB design file.*** If changes need to be made to the survey files, these changes should be coordinated with the originator of the survey data.

3.3 Survey Basemaps

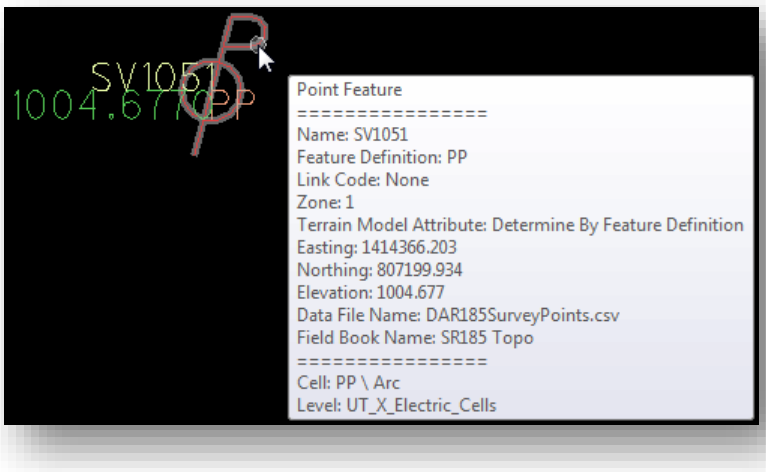
The Survey basemap is stored in the ***\Design\survey\basemaps*** folder within the project directory structure. The survey information for the training datasets is located in the following design file:

.. \Design\survey\basemaps\12345_BE01.dgn

To gain access to the survey mapping and the terrain model, designers should use MicroStation References to attach the survey basemap. No graphics are to be drawn in the survey basemap by design personnel.

Point Features

When survey data is processed, each field shot is stored as a **Point Feature** in a **Field Book** within the survey field book FB design file. For example, the field code "PP" is used to designate a power pole. When the survey data is processed, the power pole code is plotted in MicroStation using an ODOT standard cell element as shown below:



Notice that text elements for the point name (SV1051), elevation (1004.6770), and field code name (PP) are plotted along with the power pole symbol. Each of these text elements are placed on their own level and can be toggled on/off as desired.

Each survey point must have a unique point name. Point names are assigned in the field by the surveyor as the data is collected.

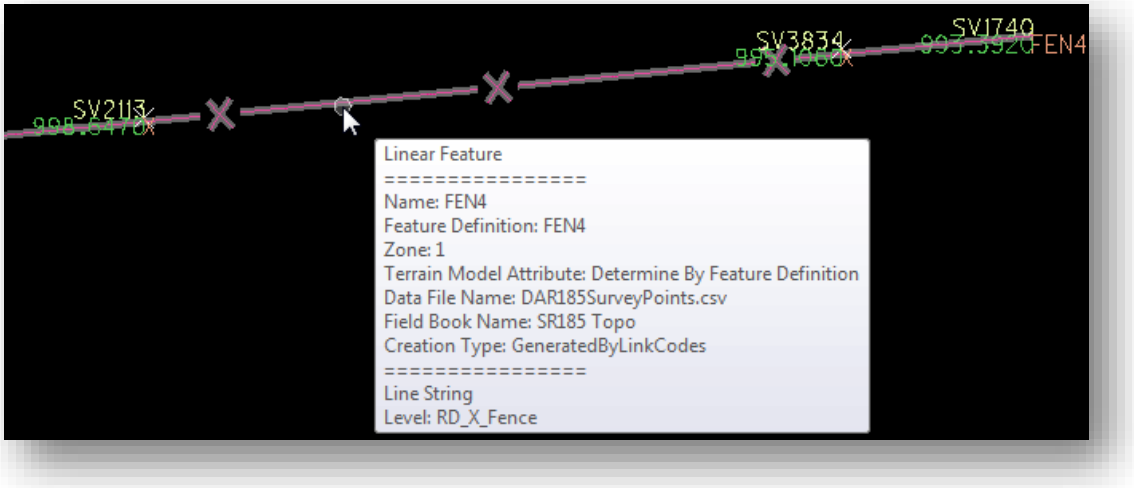
Floating your cursor over the point symbol or the text associated with a point in the Field Book design file will open a pop-up menu with information about the point as shown in the example above.

When the survey information is exported to the survey basemap BE design file, all of the survey processing rules are removed from the survey points and linear features. Floating the cursor over a survey point will display only the information for a simple MicroStation graphic as shown in the example below.

The point name is included in the design file export, as shown above, however the survey points are not included in a GEOPAK GPK file.

Linear Features

A series of points representing curvilinear features can be connected together as a **Linear Feature** as shown in the example below.



Floating your cursor over the linear feature in the field book FB design file will open a pop-up menu with information about the feature line as shown in the example above.

Similar to point features, the survey attributes for linear features are removed from the design file when the survey data is exported from the survey field book FB design file to the survey basemap BE design file.

Field Attributes

Many of the ODOT field codes allow for the use of attributes to store additional information with a specific survey shot. For example, the feature code “PP”, used to specify a Power Pole, has the following attributes:

Material
Owner
Pole#

The attributes are plotted in the file similar to the example shown below.

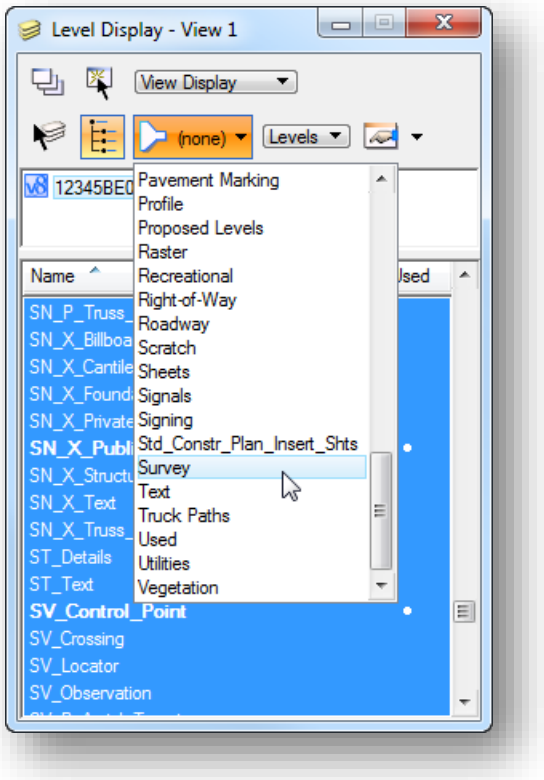
See the ODOT Code list for a summary of feature codes and the associated attributes.

3.4 MicroStation Levels for Survey Data

ODOT's CADD Standards include several levels specific to survey information. These levels are grouped in the level library using the prefix "SV".

The levels can be turned on/off using the MicroStation *Level Display* dialog. The *Level Display* dialog can be opened by selecting **Settings > Levels > Display** from the MicroStation pull-down menu, or from the **Level Display** icon in the *Primary Tools*.

The *Level Display* dialog includes the ability to filter the dialog to only show specific levels. By selecting the **Survey** filter, the dialog will show only the survey levels.

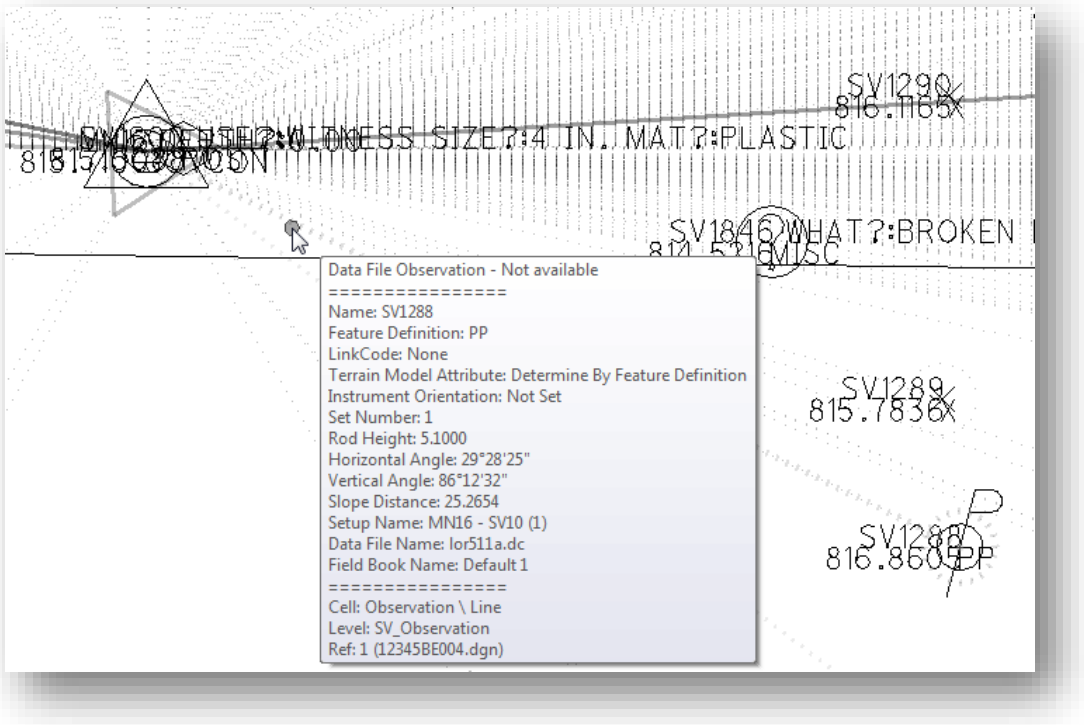


The survey levels include several levels specific to survey data that has been mapped using OpenRoads Survey. Each survey point displays text on the following levels:

- SV_X_Text_Comment
- SV_X_Text_Description
- SV_X_Text_Elevation
- SV_X_Text_Name

These levels can be toggled on or off as desired using the *Level Display* dialog.

If the survey information was generated using raw observation data, the software also draws **Observation Lines** and **Setup Lines**. An example of the observation lines is shown below.



- Observation Lines are drawn on the level **SV_Observation**
- Setup Lines are drawn on the level **SV_Setup**

These lines can be turned on/off using the MicroStation *Level Display* dialog. Depending on how the data was processed or exported from the field book FB design file to the survey basemap BE design file, these lines may not be present in the survey basemap BE design file.

3.5 Geographic Coordinate Systems

A MicroStation **Geographic Coordinate System** (GCS) is used to define the position of the survey and design information on the Earth's surface. Once that position is established, the design can be easily coordinated with other data for which the geographic location is known such as Google Earth, Bing Maps, Geo-Referenced Imagery, or GIS systems.

Whether the survey data originates from ground survey or aerial mapping, the data is typically mapped on the appropriate State Plane Zone in the design file.

A library of predefined **GCS** is available in MicroStation. Optionally, a custom GCS can be defined to reposition the data using ground coordinates, if required.

The process to create a custom GCS for Grid-to-Ground conversions is the responsibility of ODOT's Survey personnel and is not covered in this manual. This manual will cover the basics to review the GCS and create new design files using the same GCS that has been defied by the Survey personnel.

ODOT Seed Files and Geographic Coordinate Systems

A seed file is an empty MicroStation design file that has been configured specifically to meet a particular need. When new design files are created, the seed file specified by the user is copied and renamed to create the new file. ODOT provides several seed files for use with OpenRoads. The seed files are located in the following folder:

I:\ODOTcadd\Standards\seed

Seed files are provided without a GCS definition as well as seed files with the Ohio North and South Zone coordinate systems defined, as shown below.

ODOTSeed2d.dgn	No Geographic Coordinate System Defined
ODOTSeed2d_OH83-2011-NF.dgn	OH83/2011-NF NAD83/2011 Ohio State Planes, North Zone, US Survey Feet
ODOTSeed2d_OH83-2011-SF.dgn	OH83/2011-SF NAD83/2011 Ohio State Planes, South Zone, US Survey Feet
ODOTSeed2d_OH83-NF.dgn	OH83-NF Ohio State Planes, North Zone, US Survey Feet
ODOTSeed2d_OH83-SF.dgn	OH83-SF Ohio State Planes, South Zone, US Survey Feet
ODOTSeed3d.dgn	No Geographic Coordinate System defined
ODOTSeed3d_OH83-2011-NF.dgn	OH83/2011-NF NAD83/2011 Ohio State Planes, North Zone, US Survey Foot
ODOTSeed3d_OH83-2011-SF.dgn	OH83/2011-SF NAD83/2011 Ohio State Planes, South Zone, US Survey Foot
ODOTSeed3d_OH83-NF.dgn	OH83-NF NAD83 Ohio State Planes, North Zone, US Survey Foot
ODOTSeed3d_OH83-SF.dgn	OH83-SF NAD83 Ohio State Planes, South Zone, US Survey Foot

When a new project is created using the **ODOT_CreateNewProject.exe** application, 2D and 3D seed files are copied from the ***I:\ODOTcadd\Standards\Seed*** folder to the project's ***\Design\standards\seed*** folder for the project. The seed files copied into the project folder can then be modified by the Survey Personnel to define a custom GCS definition that is used to facilitate Grid-to-Ground projection.

The GCS tools available in **Bentley Map** allow ODOT's Survey personnel to define a custom GCS definition that can be used to facilitate Grid-to-Ground conversion of the project data. This allows users to work in ground coordinates and distances while maintaining the ability to seamlessly integrate the

project data with other Geo-referenced systems such as Google Earth, Bing Maps, Aerial mapping and imagery, and GIS systems.

Project Specific Seed Files

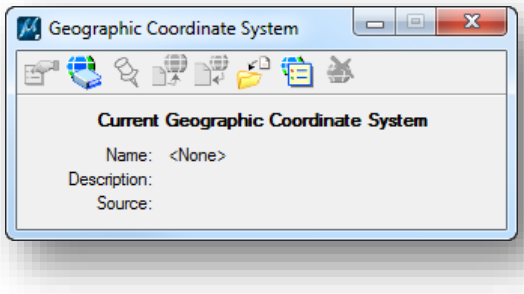
When the survey data for the project is initially processed, it is the responsibility of the Surveyor to define the appropriate GCS for the project data. As the designer for the project, it is your responsibility to ensure that all new design files created for the project use the same GCS as defined by the Surveyor.

ODOT's Surveyors have been asked to define the GCS in project specific seed files. When creating new design files for a project, the designer should always use the seed files that are contained in the projects ***\Design\standards\seed*** folder.

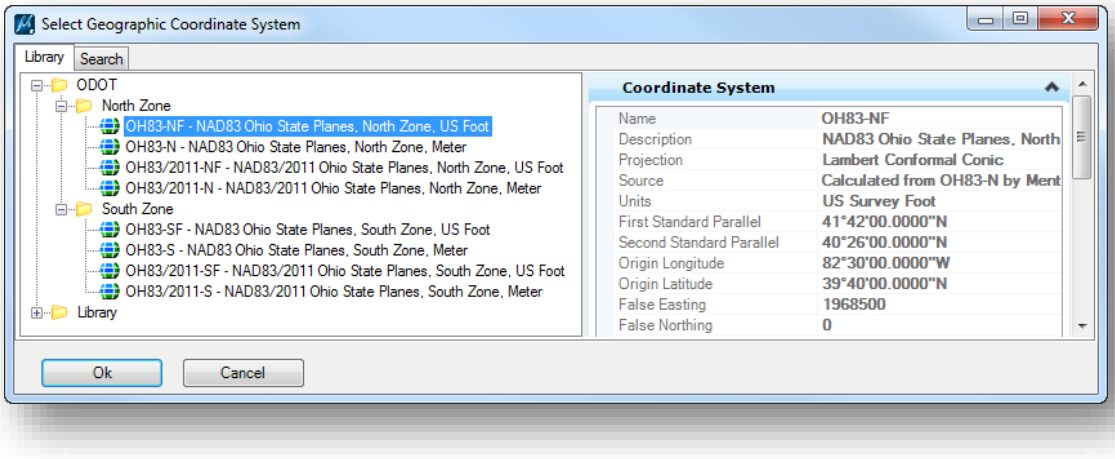
If the project mapping comes from Aerial mapping, the designer must review the Aerial Mapping design file's GCS to ensure that new files are created using the appropriate GCS.

Reviewing/Selecting the GCS Definition

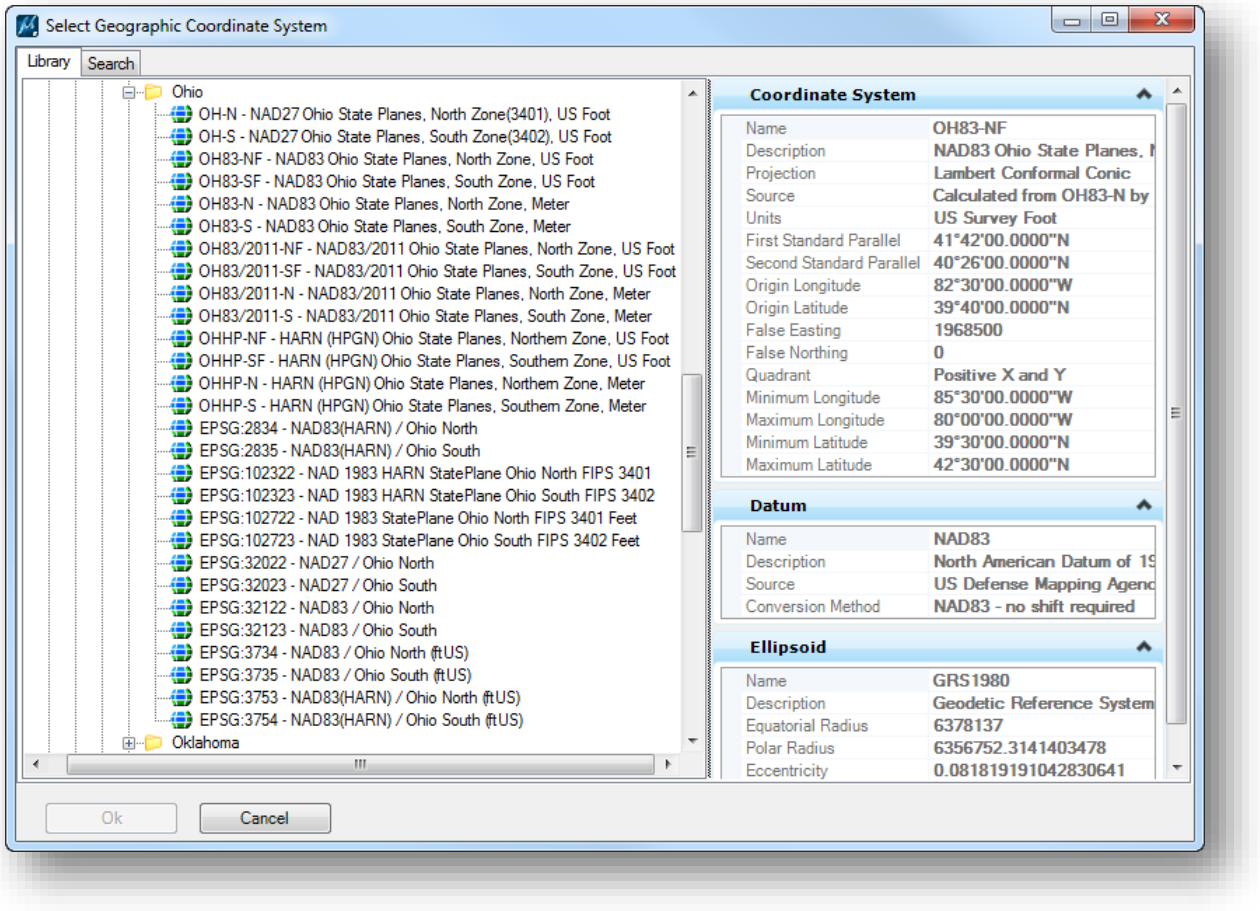
The GCS can be reviewed or selected by choosing **Tools > Geographic > Select Geographic Coordinate System** from the MicroStation pull-down menu. The *Geographic Coordinate System* dialog shown below is opened.



To choose a GCS from the library, select the second icon, **From Library**. The *Select Geographic Coordinate System* dialog shown below is opened.



The ODOT workspace defines the State Plane coordinate systems typically used on ODOT projects in the **ODOT** folder as shown above. Choose the appropriate GCS from the list. A different GCS can be selected by browsing the **Library** folder. The GCS definitions for Ohio shown below are available by selecting **Library > Projected (northing, easting) > North America > United States of America > Ohio**.

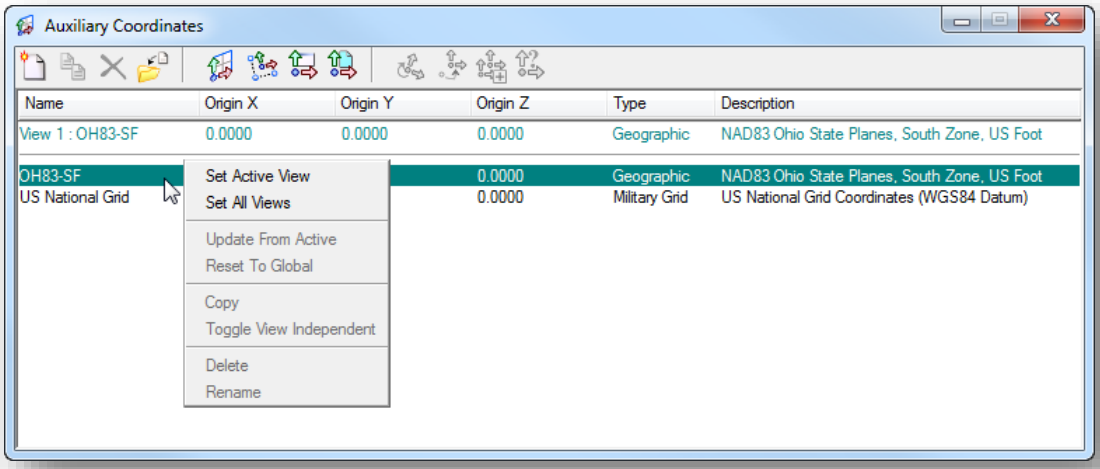


When a GCS is initially selected, you are simply telling MicroStation where the data resides. It is important to note that choosing a GCS when one has not been previously defined does not re-project existing data in the design file to the selected GCS. The data is only re-projected when changing from one GCS to another.

Longitude and Latitude Coordinates

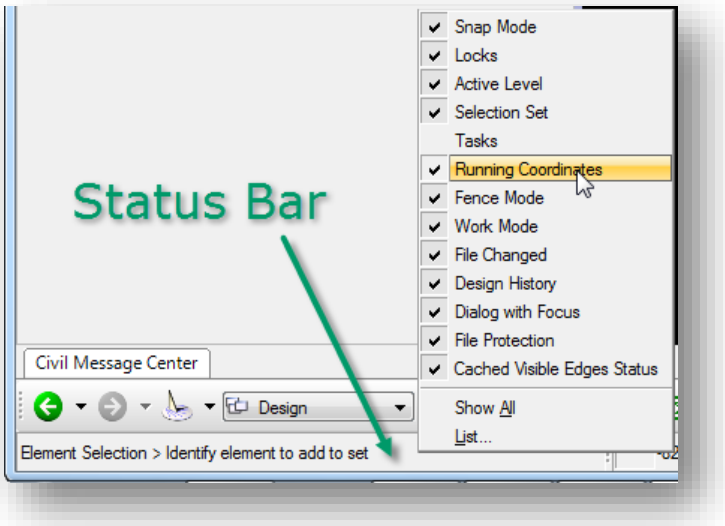
When a geographic coordinate system is assigned to a model, it appears in the *Auxiliary Coordinates* dialog (**Tools > Coordinate Systems > ACS > Auxiliary Coordinates**). When it is made the active auxiliary coordinate system, data can be entered in longitude, latitude format, and coordinate readout can be set to show longitude and latitude.

- Select **Tools > Coordinate Systems > ACS > Auxiliary Coordinates** to open the *Auxiliary Coordinates* dialog shown below.

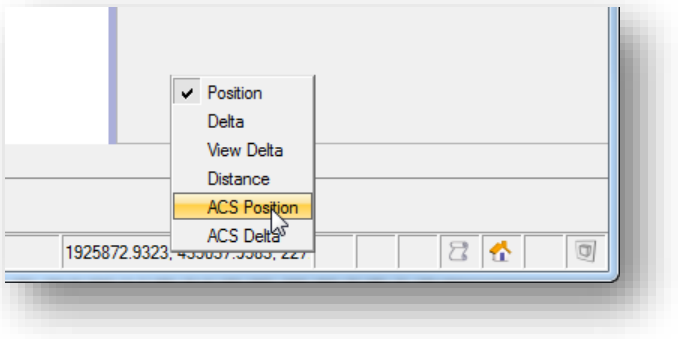


- Right-click on the coordinate system in the list and choose either the **Set Active View** or **Set all Views** option.

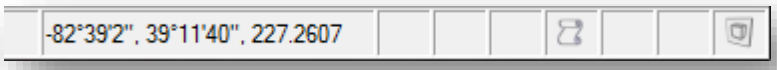
- To get a longitude, latitude coordinate readout, turn on **Running Coordinates** by right-clicking the status bar (located to the lower left of the MicroStation window as shown below).



- Next, click on the coordinates (located at the bottom of the MicroStation window, towards the right side) and select **ACS Position**.



As the cursor is moved in the MicroStation window, the running coordinates will display in longitude and latitude format as shown in the example below:

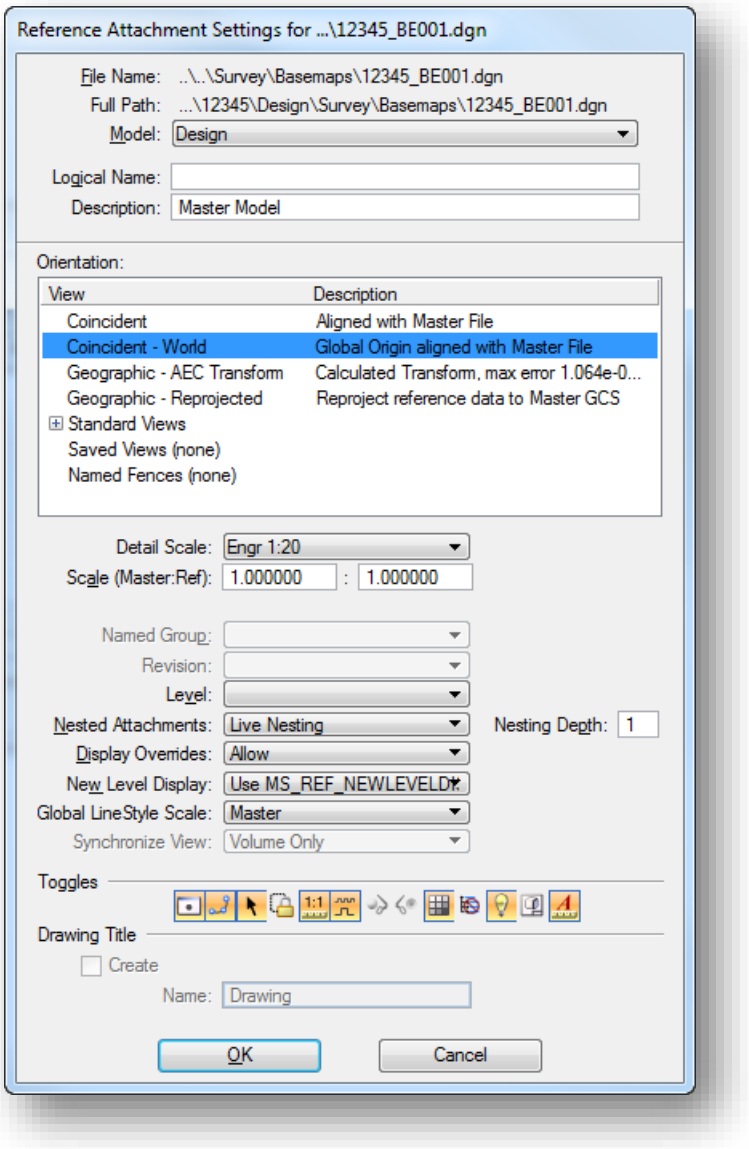


The mode, precision, and format of the longitude and latitude values are controlled in the *Design File Setting* dialog under **Angle Readout** and **Working Units**.

Click on the coordinates display and select **Position** to change the readout back to X, Y, Z coordinates.

3.6 Referencing Design Files with a GCS Defined

When attaching the survey design file, if the active model and the reference model have the same GCS defined, choose the **Coincident - World** option to align the referenced the active model as shown below.



If the referenced model has a different coordinate system than the active model, choose the **Geographic – Reprojected** option to reproject the referenced model to the coordinate system that is defined in the active model.

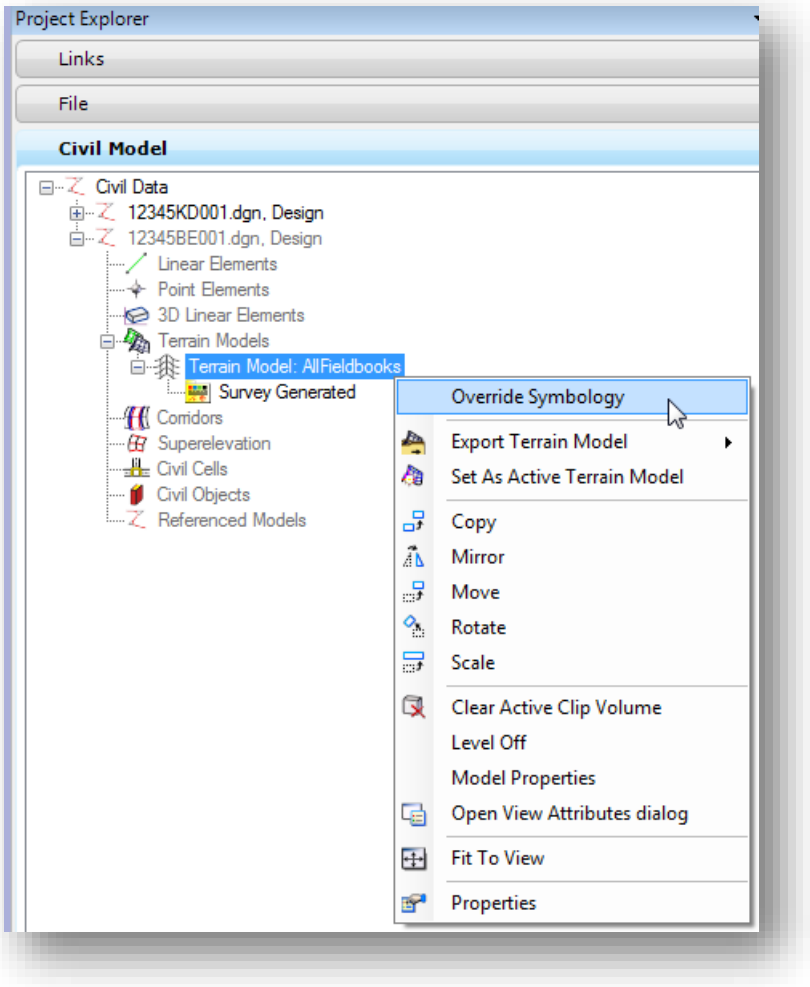
3.7 Working with OpenRoads Terrain Models

Terrain models generated by OpenRoads Survey are stored in the same MicroStation design file that contains the survey data as a Terrain Model element type.

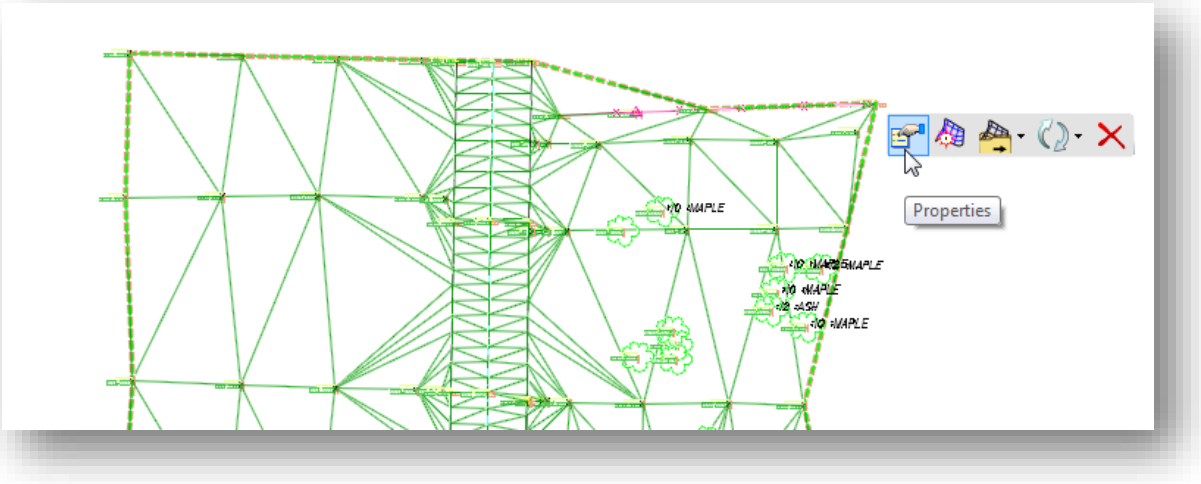
The terrain model can be accessed by design personnel by attaching the survey basemap BE design file as a reference to the active model.

In the example below, the active file is **12345_KD001.dgn**. The terrain model is contained in the file **12345_BE001.dgn** which has been attached as a reference file.

The terrain model is part of the **Civil Model** and can be reviewed from the *Project Explorer* dialog under the **Civil Model** tab by expanding the **Terrain Model** item as shown below.

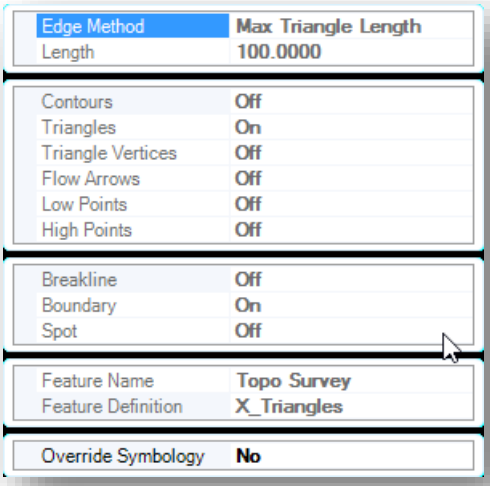


Right-clicking on the name of the terrain model will reveal the menu of commands shown above. The most commonly used commands are available by selecting the terrain model boundary as shown on the following page.



Properties

When the **Properties** icon is selected, the menu shown below is opened.



Since the design file containing the terrain model has been attached as a reference, the following parameters cannot be changed:

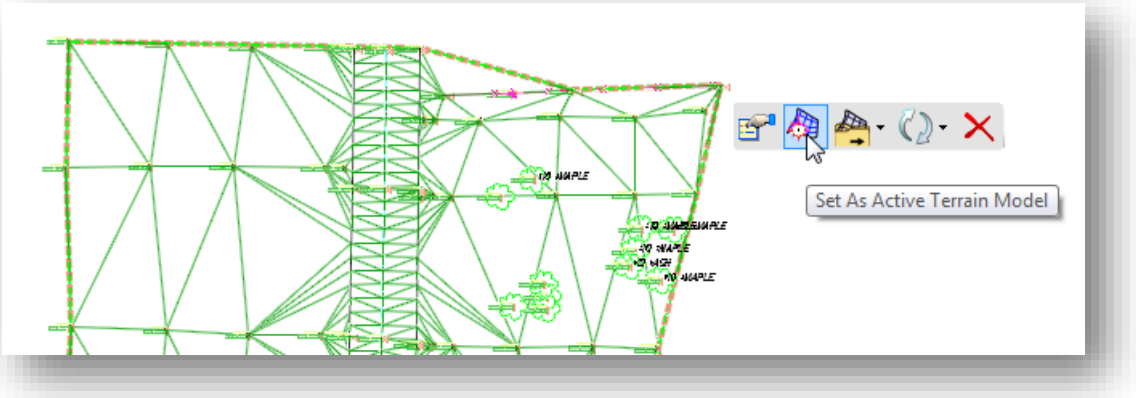
Edge Method
Length
Feature Name
Feature Definition

Changing the **Override Symbology** value to **Yes** will to allow changing the on/off display status for the remaining parameters.

Typically, it is a better option to use the MicroStation *Level Display* dialog to turn on/off terrain features rather than using the **Override Symbology** option shown above.

Set as Active Terrain Model

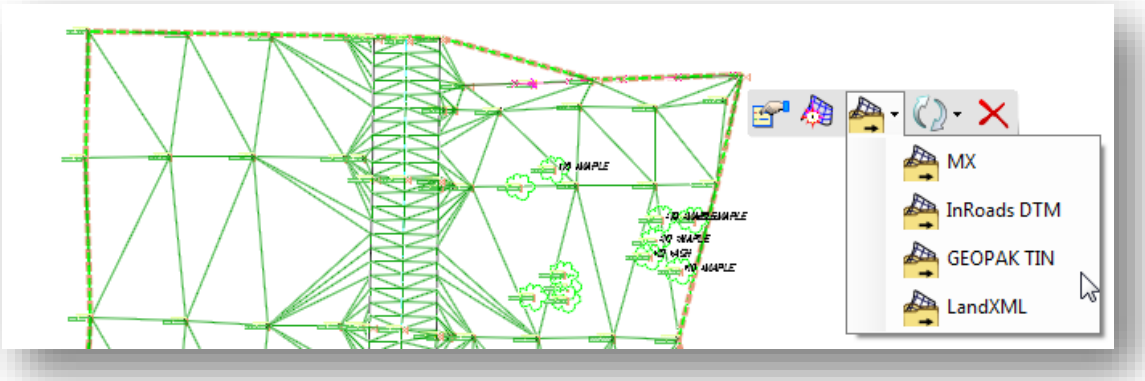
Choose the **Set As Active Terrain Model** icon to set the terrain model as the active terrain model. When profiles are extracted for an OpenRoads alignment, the active terrain model is used to extract the existing ground profile. The active terrain model is also used to define the existing ground in corridor modeling.



Export

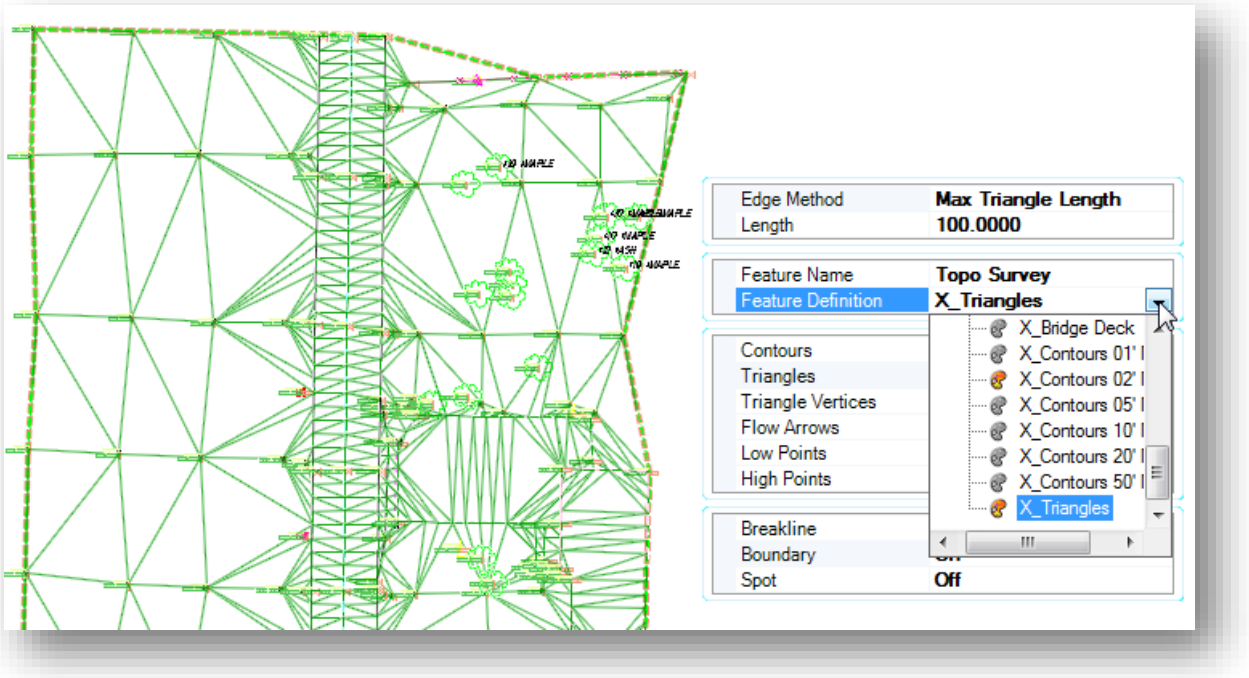
Terrain models can be exported to the following formats:

MX
InRoads DTM
GEOPAK TIN
Land XML



Terrain Model Feature Definitions

Terrain model display is controlled by the use of a **Feature Definition**. The feature definition can be selected by choosing the terrain model and opening the **Properties** dialog as shown below.

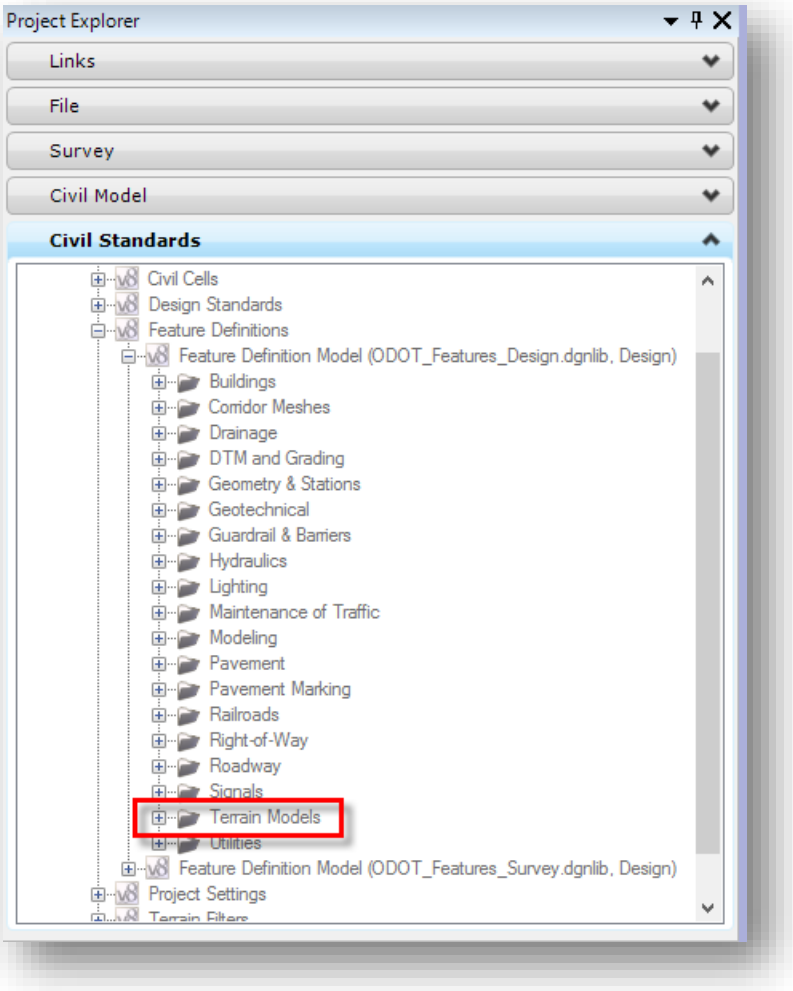


Note: The feature is assigned to the terrain model in the basemap survey BE design file and cannot be changed when the terrain model is attached as a reference. To change the terrain model **Feature Definition**, first open the survey basemap BE design file.

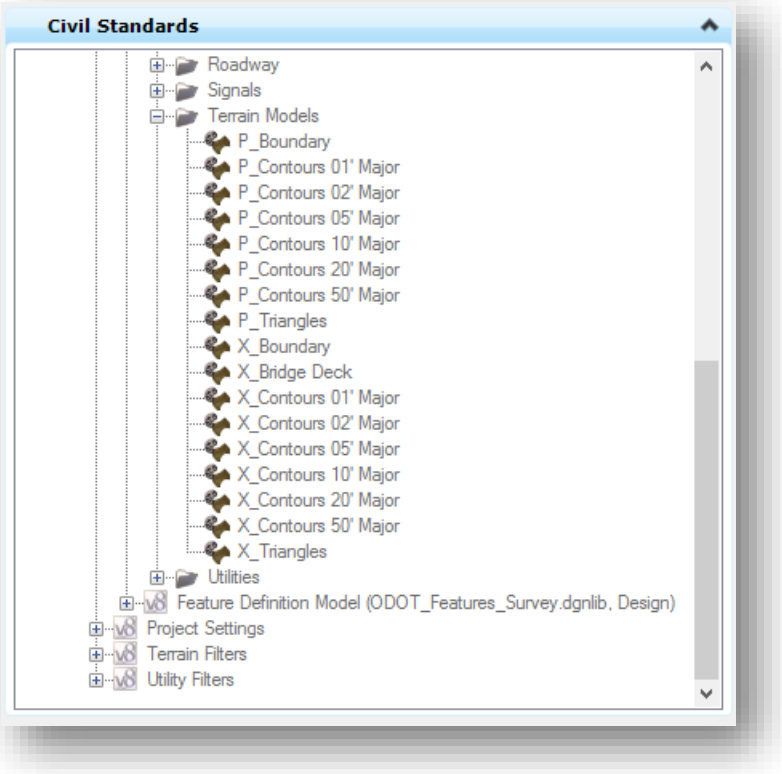
A library of feature definitions are available in the ODOTcadd Standards. The features for Terrain Model display are contained in the following MicroStation DGN library:

\ODOTcadd\Standards\dgnlib\ODOT_Features_Design.dgnlib

The available terrain features can be reviewed in the MicroStation *Project Explorer* dialog by selecting the **Civil Standards** tab and expanding the **Libraries** item as shown below.



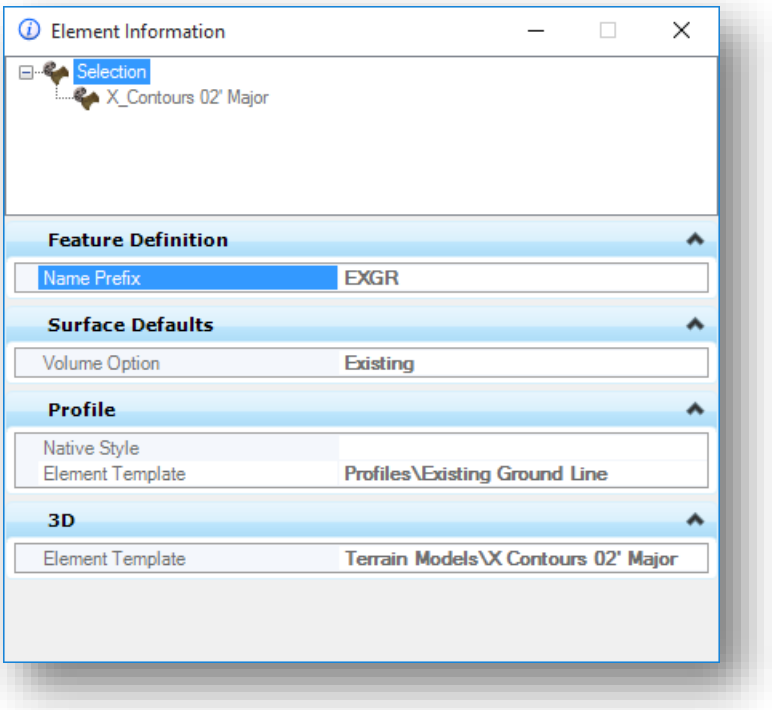
Expanding the **Terrain Models** category will reveal several surface features that have been configured for your use as shown on the following page.



Feature definitions are available for both existing and proposed terrain models. Each feature definition uses a MicroStation Element Template to define the display parameters for the terrain model.

The terrain model feature definition also controls how existing ground profiles and cross sections are displayed, again, by the use of MicroStation Element Templates.

Right-click on a terrain feature definition and select **Properties** to review information about the selected feature definition. The properties for the X_Contours 02’ Major feature definition is shown on the following page.



The **Name Prefix** is used as the prefix for the name of exported terrain models.

The **Surface Defaults** option defines how the terrain model is included in earthworks quantity computations.

The **Profile** option is used to define how profiles extracted from the terrain model are displayed. This can be defined by a **Native Style**, which refers to a GEOPAK Design and Computation Manager item, or by an **Element Template**.

The **3D** item defines the element template that is used for the terrain model display (triangles, contours, spots, break lines, void areas, etc) as well as the symbology for existing ground cross sections extracted from the terrain model.

Note: The boundary of the terrain model is displayed using the same setting that is used to display cross sections extracted from the terrain model. This is normal.

Terrain Model Features and Contour Display

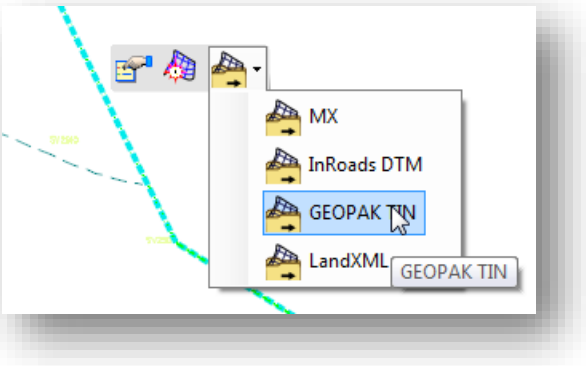
Several features definitions in the ODOTcadd Standards have been configured to display major and minor contour lines at various intervals. The Feature Definition can be changed in the survey basemap BE design file.

Elevation labels that are displayed using an OpenRoads feature definition are dynamically displayed based on the active model's Annotation scale setting and the zoom extents. Therefore, the location of the elevation labels will shift when the MicroStation Zoom controls are used to adjust the view display. This will yield unpredictable results on printed plan sheets with the contours displayed.

For plan drawings where contours are displayed, it may be better to export the OpenRoads Terrain Model to a GEOPAK TIN file, and then use the TIN file to display static graphics using the legacy GEOPAK DTM Tools to load the contours.

To export a GEOPAK TIN from the OpenRoads Terrain Model:

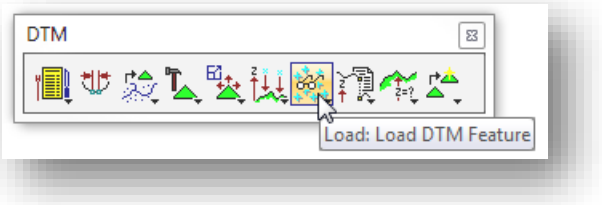
- Select the Terrain Model boundary and choose the **Export GEOPAK TIN** option from the pop-up menu as shown below.



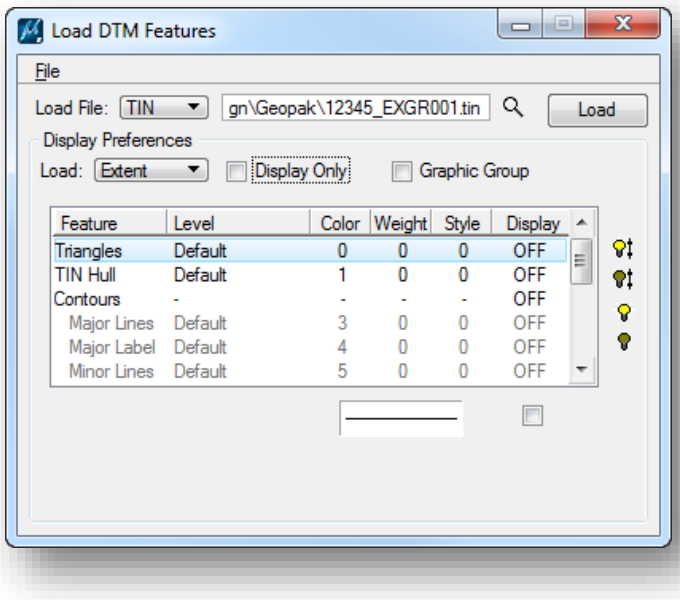
- Save the GEOPAK TIN file in the \Design\Geopak\ folder. Be sure to name the TIN file appropriately according to the ODOT CADD Standards.

  Note: The exported TIN file is not associated with the OpenRoads terrain model contained in the MicroStation design file. A new GEOPAK TIN model must be exported if changes are made to the OpenRoads terrain model.

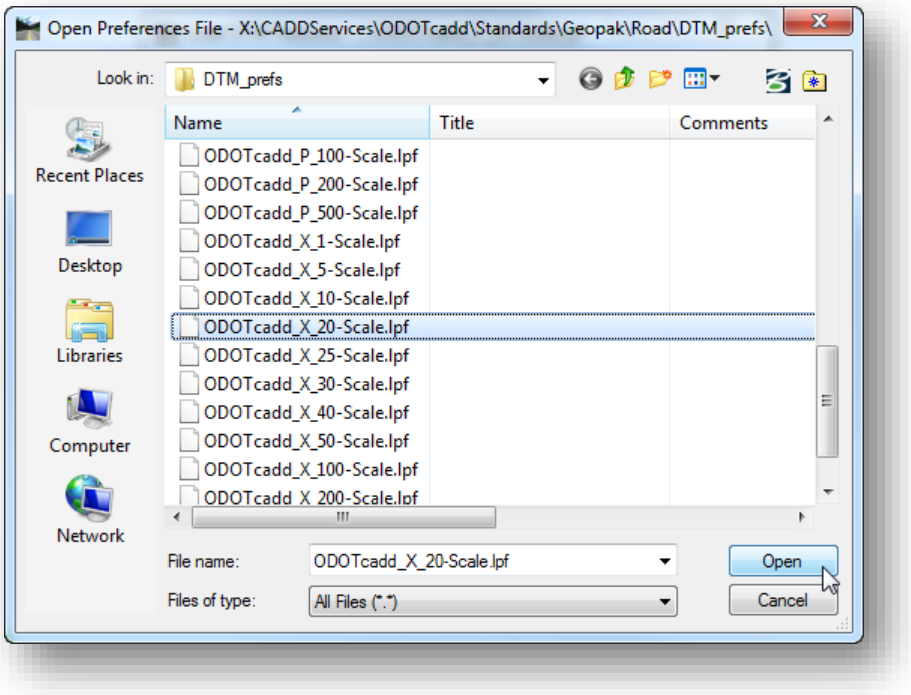
- Select **Applications > GEOPAK > Road > DTM Tools** to access the tool palette shown below.



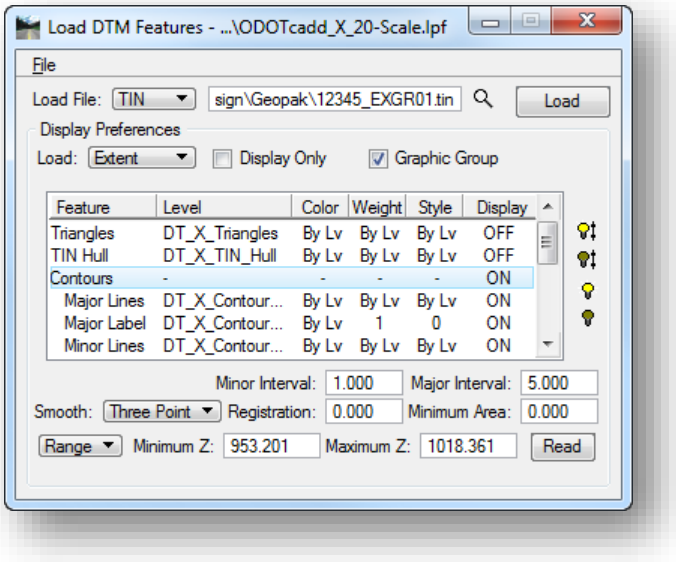
- Choose the **Load DTM Features** icon as shown above. The *Load DTM Features* dialog is opened as shown below.



- The *Load DTM Features* dialog is used to load various digital terrain model features, such as the triangles, boundary (TIN Hull), contour lines, etc… **Preference Files** are used to set the symbology for these features. To choose a preference file, select **File > Open** from the *Load DTM Features* dialog. Several preference files have been configured for your use in the ODOT CADD Standards as shown below. Choose the appropriate preference file, existing or proposed, for the intended plotting scale. **Note:** The text placed for the contour line labels using the *Load DTM Features* dialog is a static text size and does not respond to Annotation Scale changes.



- Turn on the contour feature by double-clicking the word **Contours**. The dialog should appear similar to the example shown below.



There are several parameters in the *Load DTM Features* dialog. See the GEOPAK online help for complete details.

Choose the **Load Extent** option to load contours for the entire DTM file.

When the **Display Only** option is toggled on, the contours are displayed on-screen but are not written to the file. Toggle this option off to write the contours to the file.

Toggle on the **Graphic Group** option to place the contour lines and labels in a MicroStation graphic group.

The **Minor** and **Major Intervals** are used to set the increment values for the contour lines. Major and Minor contours have different symbology settings as defined by the preference file.

Contours can be placed for a **Range** of elevations, defined by the **Minimum Z** and **Maximum Z** parameters. Choose the **Read** option to set the minimum and maximum values by reading the vertical extents of the TIN file.

The symbology for the **Major Lines**, **Major Label**, **Minor Lines**, and **Minor Label** can be set by clicking on each item. These values have been set according to ODOT standards when choosing one of the ODOT preference files as detailed in the preceding page.

Choose the **Load** option to write the contours to the active model.

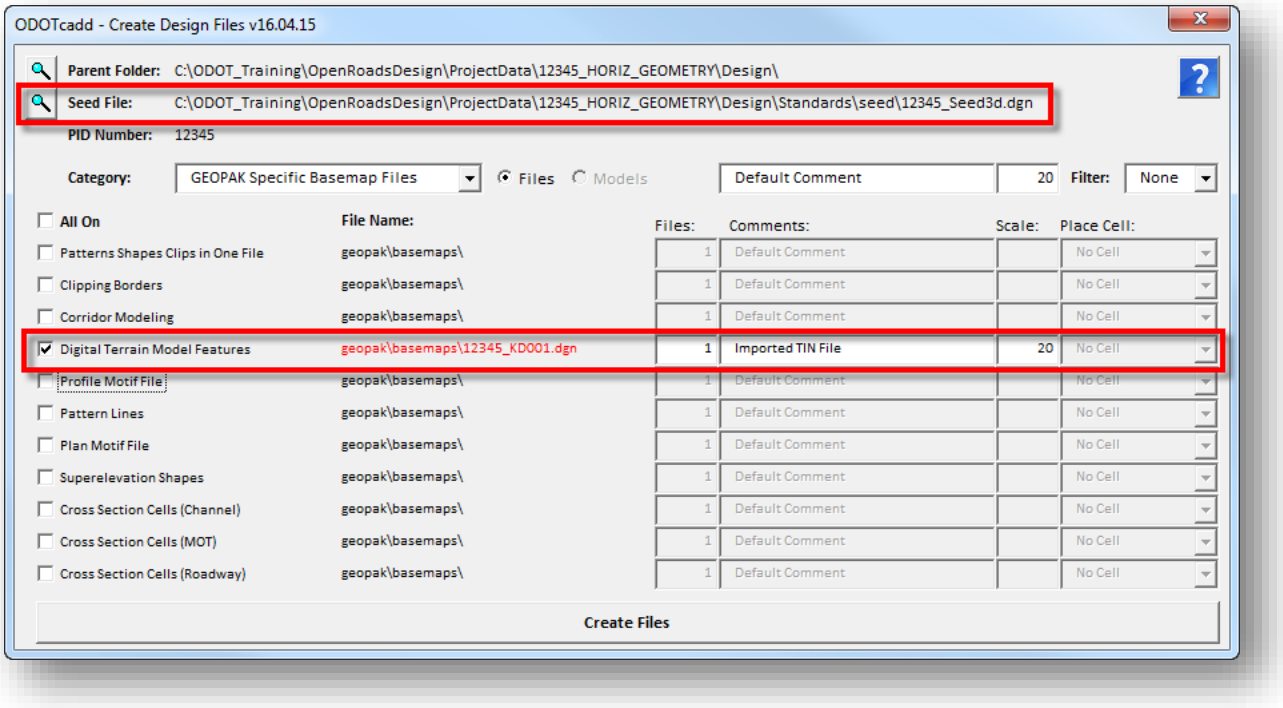
3.8 Importing GEOPAK TIN files for OpenRoads Use

The data for projects that have been mapped using the legacy GEOPAK Survey tools will normally include a GEOPAK Triangle Model in the GEOPAK TIN format. This file can be imported as an OpenRoads Terrain Model for use with the OpenRoads technology.

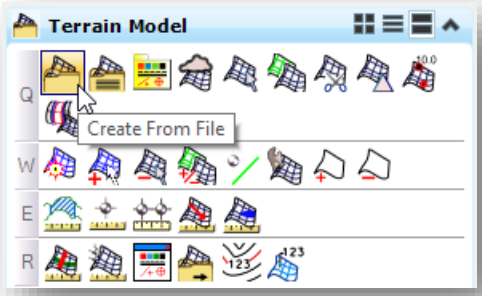
We do not recommend importing legacy GEOPAK TIN models into the Survey Basemap. TIN files should be imported into the Digital Terrain Model Features basemap type. This file has a "KD" two character file type code and can be created using the **ODOT_Files.mvba** application as shown below.

The **ODOT_Files.mvba** application is used to create new design files. The program, shown below, is accessed by selecting **ODOT > File Management > Create Design Files** from the MicroStation pull-down menu.

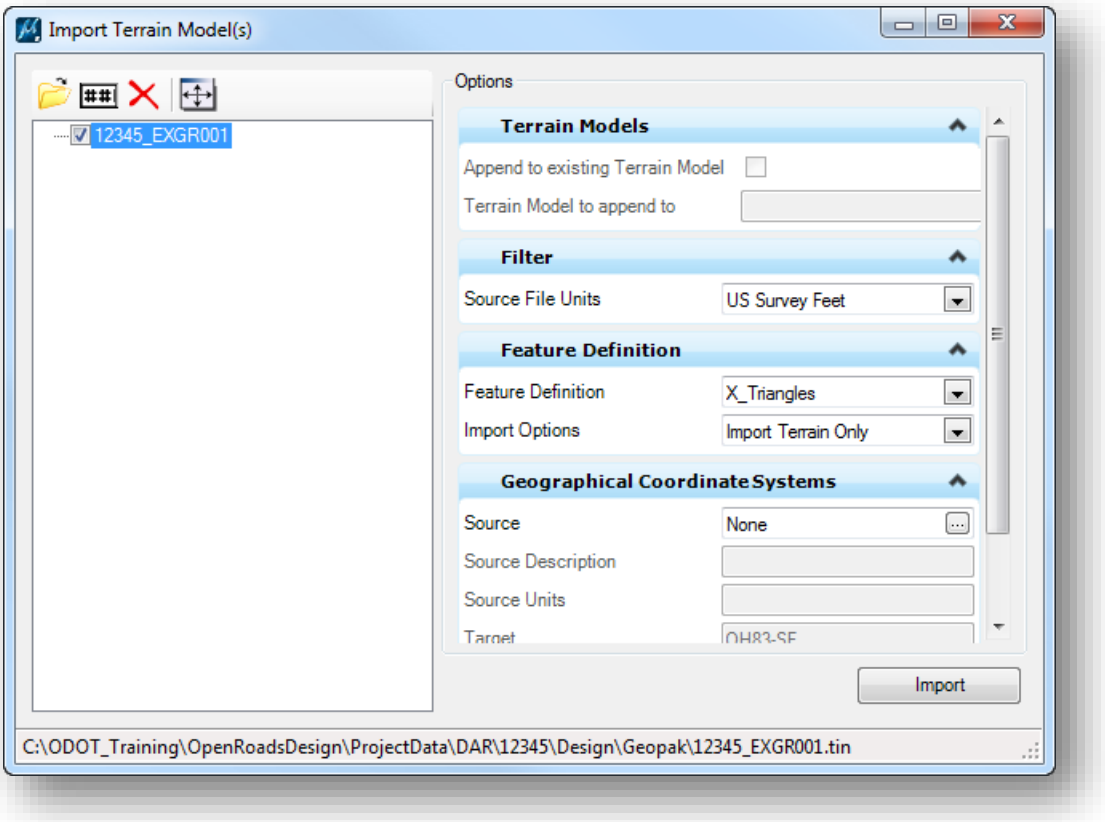
Note: Be sure to use the 3D Seed file when creating the KD file.



To import the TIN file, from the *Task* list choose **Civil Tools > Terrain Model > Create From File**.



Change the **Files of Type** option to **GEOAPK TIN (*.tin)**. Browse for the TIN file that you wish to import. The *Import Terrain Models(s)* dialog is opened.



Review the available parameters using the OpenRoads Help. Choose **Import** to initiate the process.

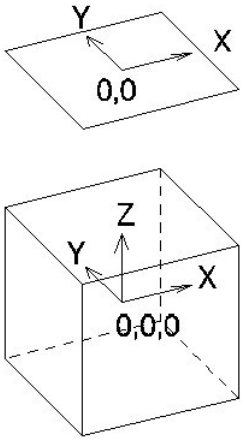
4 Working with 3D Files

In addition to using a 3D MicroStation model for the Survey information, OpenRoads also uses 3D models for the 3D Corridor Model that is generated for your design. Many ODOT CADD users have never worked in 3D before. This intent of this chapter is to cover some introductory basics of working with 3D files and not to provide a comprehensive guide. Further information can be found in the MicroStation online help documentation. Additionally, ODOT employees have access to the Bentley Learn server and can sign up for online MicroStation 3D training. See your CADD Manager for more information about Bentley Learn.

4.1 The Design Cube

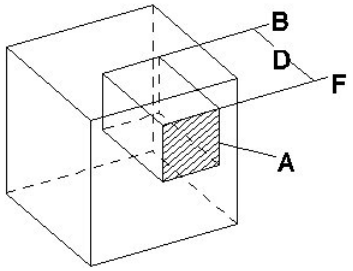
3D DGN files consist of a design cube in which you work. The design cube represents a 3D DGN file's total volume, in which points are defined with x-, y-, and z-values, or coordinates. Points can be placed anywhere within the design cube, and are not restricted to a single plane as is the case when you work in a 2D DGN file.

Design cube coordinates are expressed in the form (x, y, z). The global origin in the 3D seed files provided with MicroStation is located at the exact center of the design cube and assigned the coordinates (0, 0, 0). Any point above the global origin has a positive z-value and any point below it has a negative z-value.



The 2D design plane (top) and 3D design cube (bottom)

The view volume (sometimes called the display volume) is the volume of the design cube that is displayed in a 3D view. In most cases, only a part of the design cube is displayed in a view.

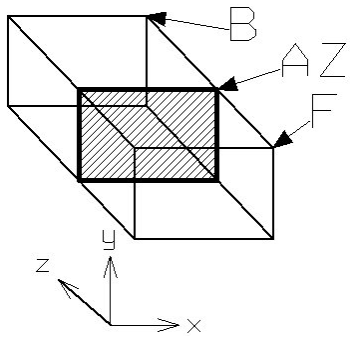


"A" denotes the window area (hatched).
"D" denotes the Display Depth, bounded by the front "F" and back "B" clipping planes.
The large cube shows the design cube, part of which is displayed in each view.

Any elements or parts of elements, not contained in the view volume are not displayed in the view. Unless a clip volume has been applied to a view, the view volume is bounded by the window area, and its display depth.

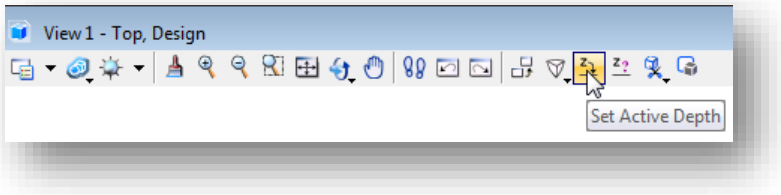
4.2 Active Depth

The **Active Depth** in a view defines the position of a plane, parallel to the screen, on which data points are placed.



The active depth is denoted by "AZ."
"x," "y," and "z" denote the View axes.
"F" and "B" denote the front and back clipping planes, respectively.

You set the active depth graphically with the **Set Active Depth** view control.

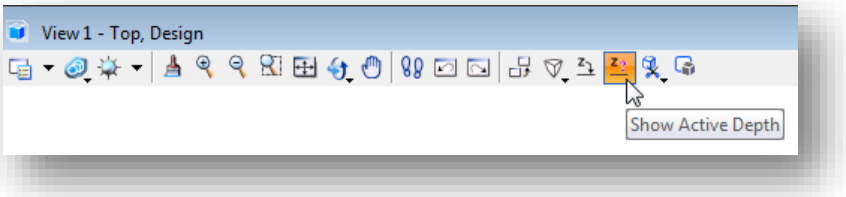


1. Select the **Set Active Depth** view control.
2. Select the view in which you want to set the active depth.
3. Enter a data point at the desired location.

You can also set the active depth for a specific view window using a key-in command.

1. Key in **ACTIVE ZDEPTH ABSOLUTE** <depth>.
   or Key in **AZ=** <depth>.
2. Select the view(s).

You can also query a view window for the current active depth value with the **Show Active Depth** command.



1. Select the **Show Active Depth** view control.
2. Select the view. The view's active depth setting is shown in the status bar.

4.3 Viewing a 3D Model

A 3D view can display part of the design cube from any point, looking in any direction.

- As in 2D, elements to the left, right, above, or below, can be excluded from a view by zooming in or windowing so that the elements are outside the view's area.

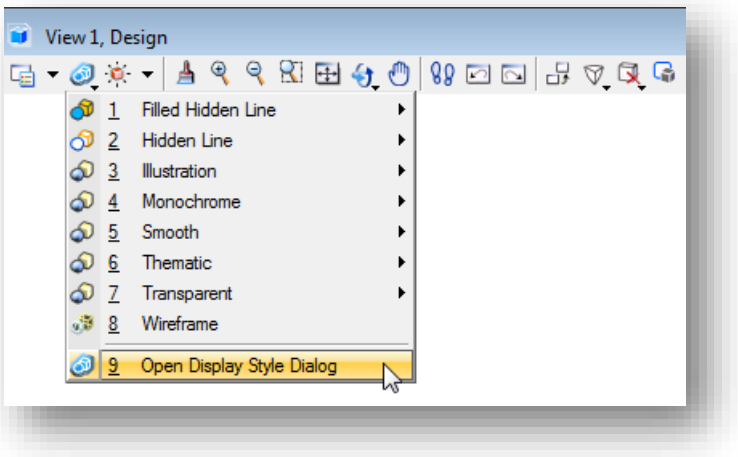
- 3D views also have depth. You can exclude the display of elements located in front of, or behind, a required object by changing the view's display depth, or by applying a clip volume. See the MicroStation online help for information on changing the display depth or applying a clip volume.

  Note: In the ODOT seed files for OpenRoads, the view attribute for the **Clip Volume** has been turned off for all views.

Display Styles

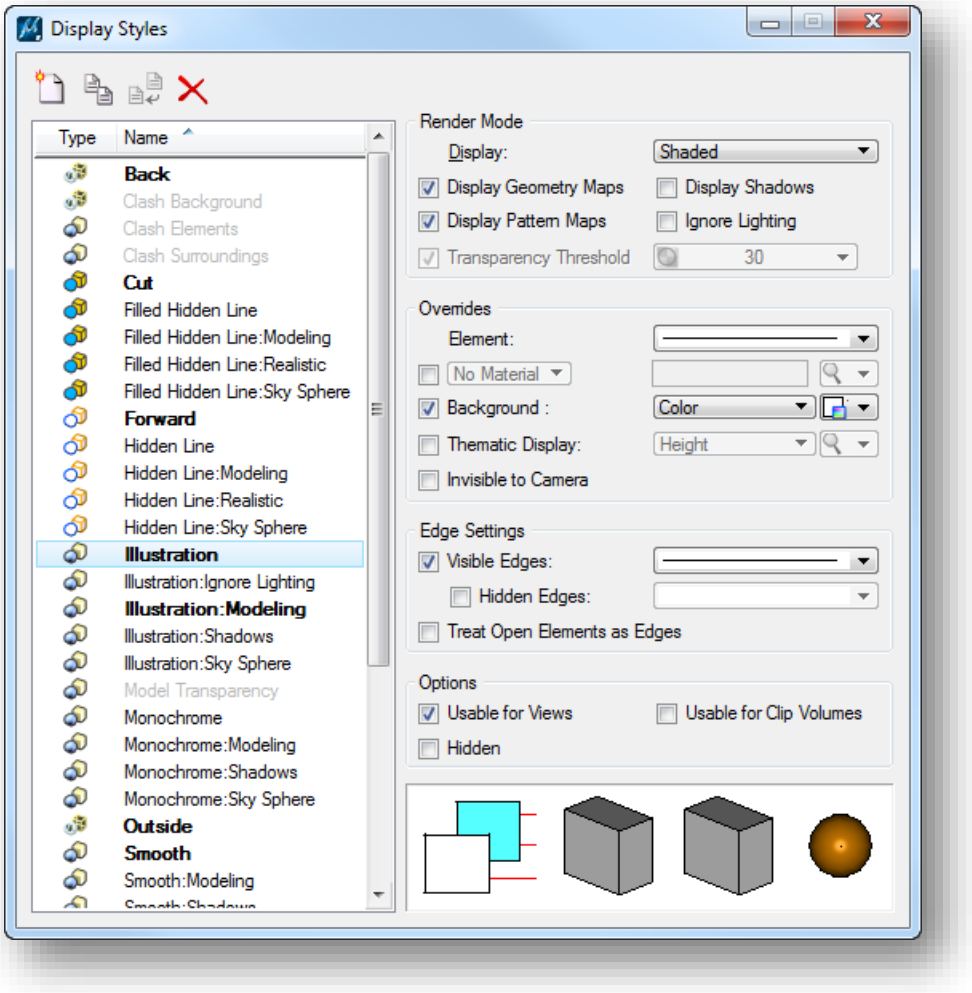
The *Display Styles* dialog is used to select from a list of predefined render overrides that can be assigned to a view.

In the view control bar, select the **Choose View Display Style** icon. A list of available styles is presented as well as the option to **Open Display Style Dialog**.



By default, the display style is set to **Wireframe** when using the ODOT seed files.

Select the **Open Display Style Dialog** option to access the *Display Styles* dialog shown on the following page.

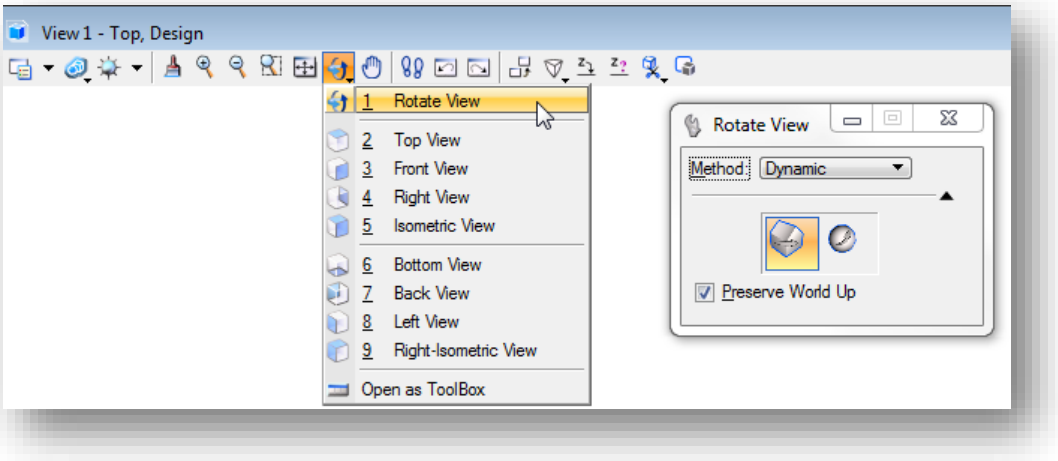


The predefined list of display styles can be selected and edited using this dialog. When a style is selected the preview pane, located at the bottom right of the dialog, shows an example of how the display will appear using the selected style. In the example above, the **Illustration** style is selected.

See the MicroStation online help for more information about editing and defining display styles.

Rotating Views in 3D

The **Rotate View** control is used in 3D files to rotate a view to a custom orientation or one of the standard views (**Top**, **Front**, **Right**, etc.) as shown below.



When rotating views in 3D, an important point to consider is the axis about which you want the view to rotate. By default, the pivot point is the center of the view, at the active depth. If the active depth is far behind the elements in the view, then you can quickly rotate the geometry out of sight. You can, however, move the pivot point to another location prior to rotating the view as follows:

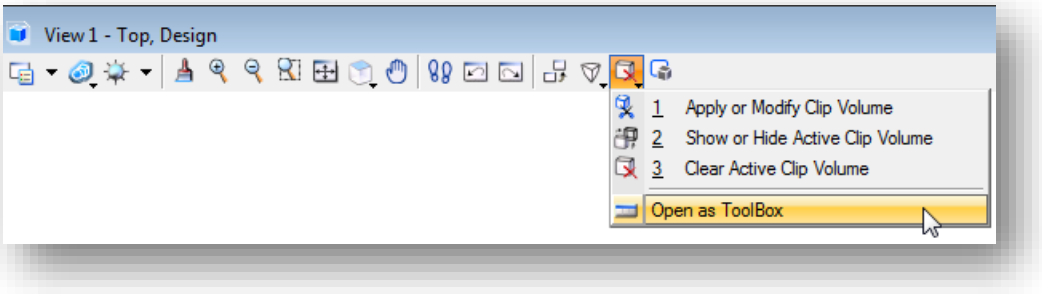
1. Select the **Rotate View** view control.
2. Set **Method** to **Dynamic**. A plus sign (+) appears at the center of the view.
3. Click on the plus sign at the center of the view.
4. Enter a data point to reposition the pivot point.

Clip Volumes

Clip Volumes can be used to limit the display of the survey data to a specific portion of the model without being hindered by elements outside the area of interest. When a clip volume is applied to a view, only elements located within the clip volume are displayed, or can be snapped to, in that view. Each view may have a different clip volume displayed.

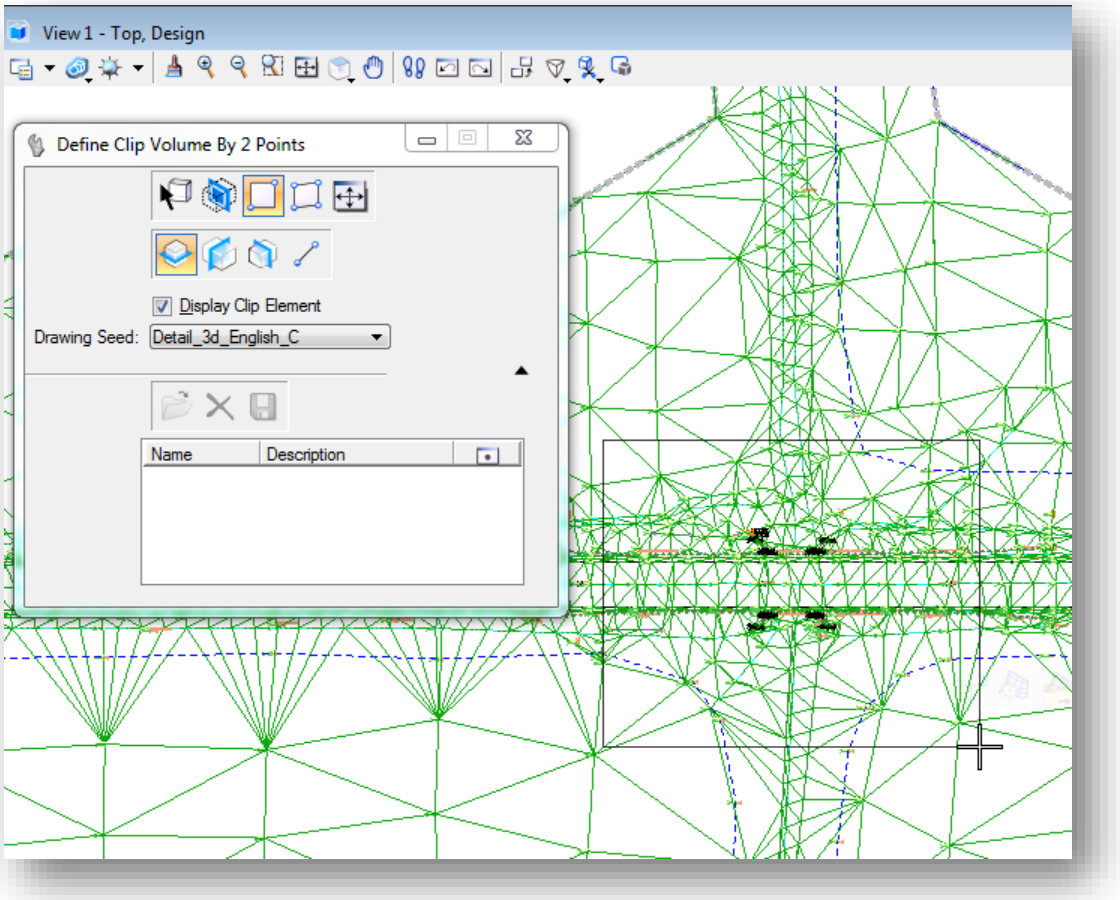
Once a clip volume has been defined, operations such as view rotation, fence processing, and rendering honor the clip volumes. Elements that are not displayed within the defined volume are ignored.

The Clip Volume tools can be accessed from the View window as shown on the following page.

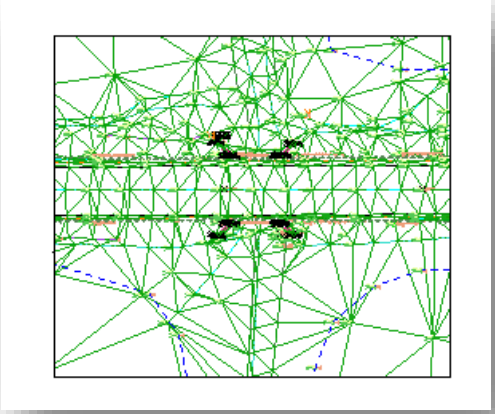


See the Bentley Online Help for complete documentation of these commands. An example using the **Apply Clip Volume by Two Points** command is documented below.

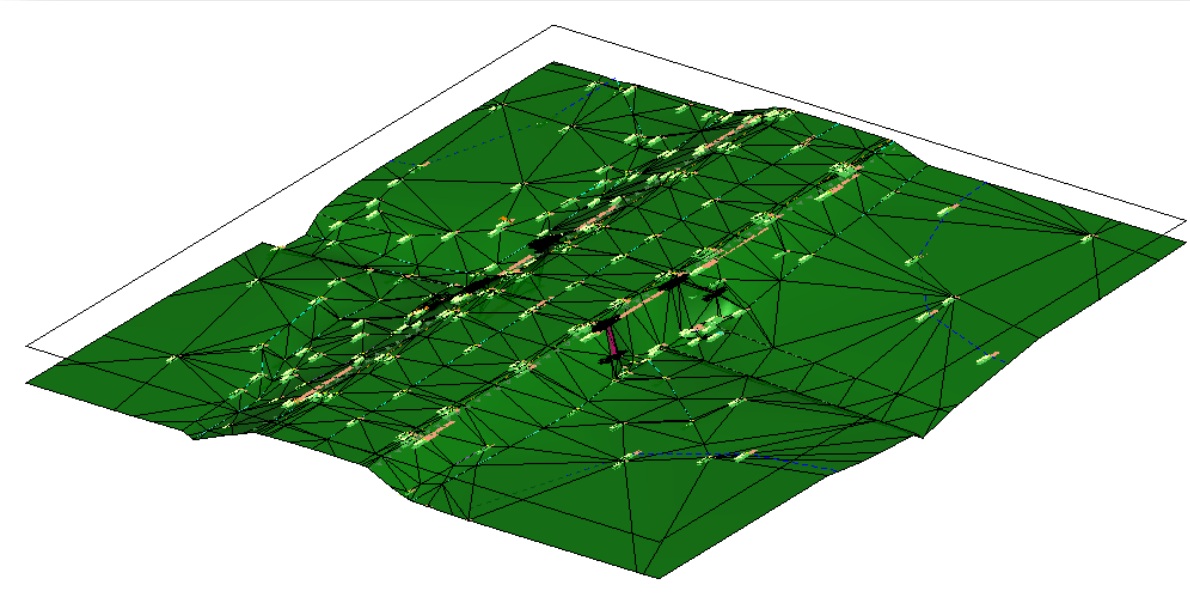
In the example below, the **Apply or Modify Clip Volume** command has been selected. The **Clip By 2 Points** command is used to define a rectangular region in the top view to be used to define the clip volume.



Once the rectangular region has been defined, the display of the graphics is clipped as shown below.



If desired, the clipped area can be rotated and rendered as shown below.



The display of the rectangle representing the clipping limits can be toggled on or off using **the Show or Hide Active Clip Volume** command.

The **Clear Active Clip Volume** command is used to remove the clipping mask from the selected view.

Clipping elements can be manipulated/modified with the standard MicroStation tools.

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5 Horizontal Geometry

5.1 Basemap Design File Requirements

ODOT's CADD Standards detail the use of basemap design files to draw plan, profile, and cross section information for your project in real world dimensions. These drawings are then referenced into sheet design files to produce the plan sheets for the project.

Several basemap files may be used depending on the project complexity. The ODOT CADD Standards allow for multiple basemap design files for each unique discipline (drainage, lighting, mot, roadway, signals, etc…). For smaller projects, it is permissible to combine the design information into fewer basemap files; however it is not desirable to place all the information in one design file. As a minimum, the following basemap design files are required:

- Existing Ground Survey
- Geometry
- Proposed Design
- Right-of-Way
- 3D Modeling

The use of additional discipline specific basemaps for larger projects is optional. See the **ODOT CADD Engineering Standards Manual (ODOTcadd)**, **Section 300 File Management** for more details.

The Geometry Basemap

OpenRoads Horizontal alignments are stored directly in a MicroStation design file. A GEOPAK GPK file is not required when using the OpenRoads geometry tools; however, the GPK file is still required for many of the legacy GEOPAK functions that are used for plan production.

ODOT's CADD Standards designate a specific basemap design file for storing OpenRoads geometry. It is not permissible to store the OpenRoads geometry information in the same design file as the plan view graphics or the survey basemap. Geometry basemaps are located in the ***\Design\Geopak\Basemaps*** folder for the project.

The file is named as follows:

nnnnnn_BK###.dgn

where:
nnnnnn = the 5 or 6 digit PID number for the project
= a three digit number for the file (001. 002, 003, etc…)

Example:
12345_BK001.dgn

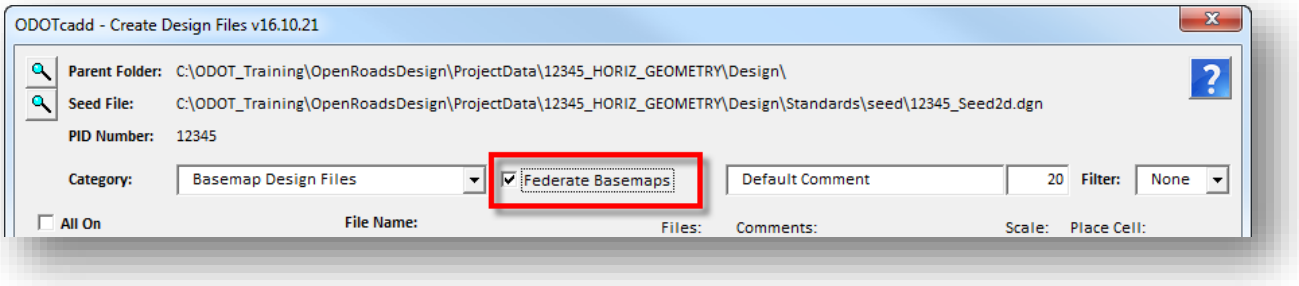
Using Multiple "Federated" Basemaps

Multiple horizontal alignments may be stored in one geometry basemap design file, however on projects with more than one alignment it is recommended to store each alignment in a separate design file. This "federated" approach will allow multiple designers to work on different alignments simultaneously.

It is up to the individual designer/design team to make a decision on whether to use one or more geometry basemaps depending on the magnitude of the individual project.

If multiple geometry basemaps are used, the "000" geometry basemap file, nnnnnn_BK00.dgn, is used as the federated basemap "collector" design file. This file is an empty design file with a reference attachment for each geometry basemap. This allows users of the project to easily access all of the geometry for the project by attaching the 000 file as a reference with a nest depth value of 1.

The October, 2016 update to the ODOTcadd Standards included a change to the ***ODOT_Files.mvba*** application to facilitate creating the "000" files when new design files are created. A **Federate Basemaps** option has been added as shown below:



When the **Federated Basemap** option is used, the ***ODOT_Files.mvba*** application will create the "000" file for a given file type, if it does not already exist. As each new design file is created, the file is automatically add a reference attachment to the "000" file for that file type.

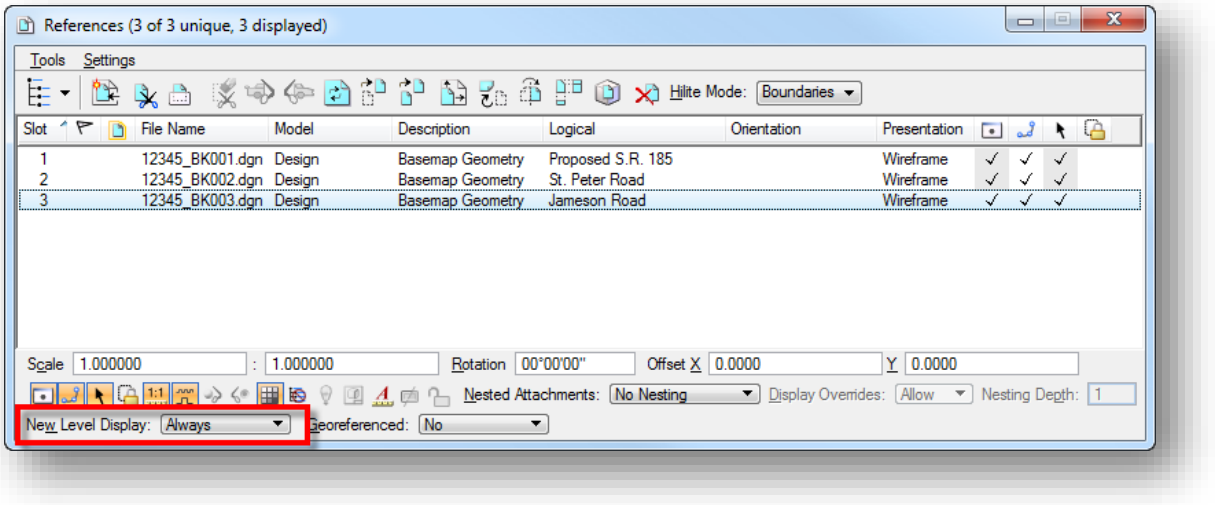
As graphic elements are drawn in each basemap design file, these graphics are displayed in the "000" file, or any other file that references the basemap, according to the setting of the configuration variable **MS_REF_NEWLEVELDISPLAY**. This variable is defined as follows in **ODOT_Site.cfg**:

MS_REF_NEWLEVELDISPLAY = 0

As new elements are drawn in the various federated basemaps, the graphics are not dynamically displayed in the "000" file (or in any other file that may reference these graphics) with the variable defined as shown above. Users must open the MiroStation *Level Display* dialog to turn on/off levels for each reference attachment, as desired.

In some cases, this behavior is desirable as it prevents new and potentially unwanted information from being automatically displayed on any plan sheets that reference one or more of the federated basemaps. Other users may find this behavior frustrating as new graphics must be manually turned on for each reference attachment.

The default variable definition can be overwritten when a reference file is attached by setting the **New Level Display** parameter to a value of **Always**. When files are created using the ***ODOT_Files.mvba*** application, the references are attached to the "000" collector file with the **New Level Display** option set to **Always** as shown below.

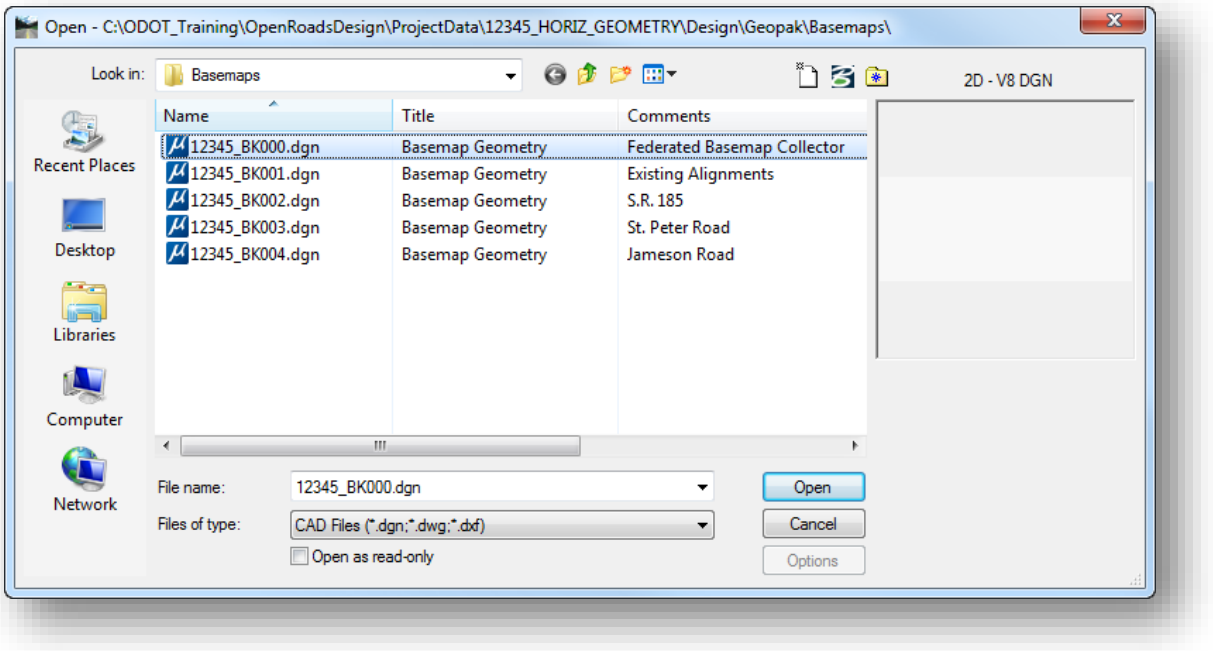


Some users may prefer a dynamic display of the graphics for all reference attachments in all design files as the project is developed. The configuration variable can be defined on a per-project basis in the project's PCF file. Set the variable as follows in the PCF File for the project:

MS_REF_NEWLEVELDISPLAY = 1

The variable could also be redefined in **ODOT_Site.cfg**, keeping in mind that it will default back to the value defined by ODOT if an update to the site configuration file is issued with the ODOTcadd Standards quarterly update.

When a federated workflow is used with multiple geometry basemaps, the MicroStation **Comments** property can be used to identify the name of the alignment contained within the geometry basemap file. The **Title** and **Comments** properties can be displayed in Windows Explorer, as well as the MicroStation *File Open* dialog as shown in the example below.



See the **Project Management with the ODOTcadd Standards** guide for more information on the use of the **Title** and **Comments** properties.

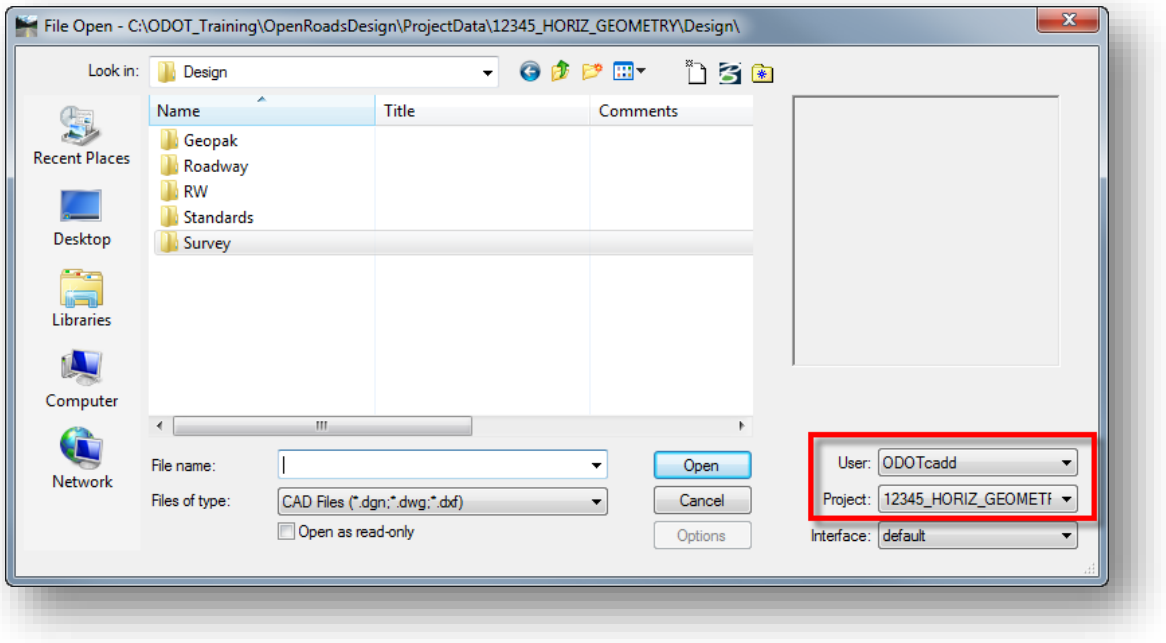
Exercise 5A – Geometry Basemaps

In this exercise we will create multiple design files to house our geometry for the project.

✓ To get started, open MicroStation using the shortcut that has been specifically configured for the training course located in the following folder:

C:\ODOT_Training\OpenRoadsDesign

The MicroStation *File Open* dialog is displayed.



✓ The **User** should default to **ODOTcadd** as shown above

✓ Select the **12345_HORIZ_GEOMETRY** project.

The sample project already includes a geometry basemap, *12345_BK001.dgn*, containing the existing centerline information.

✓ Open the following design file from the project's folder:

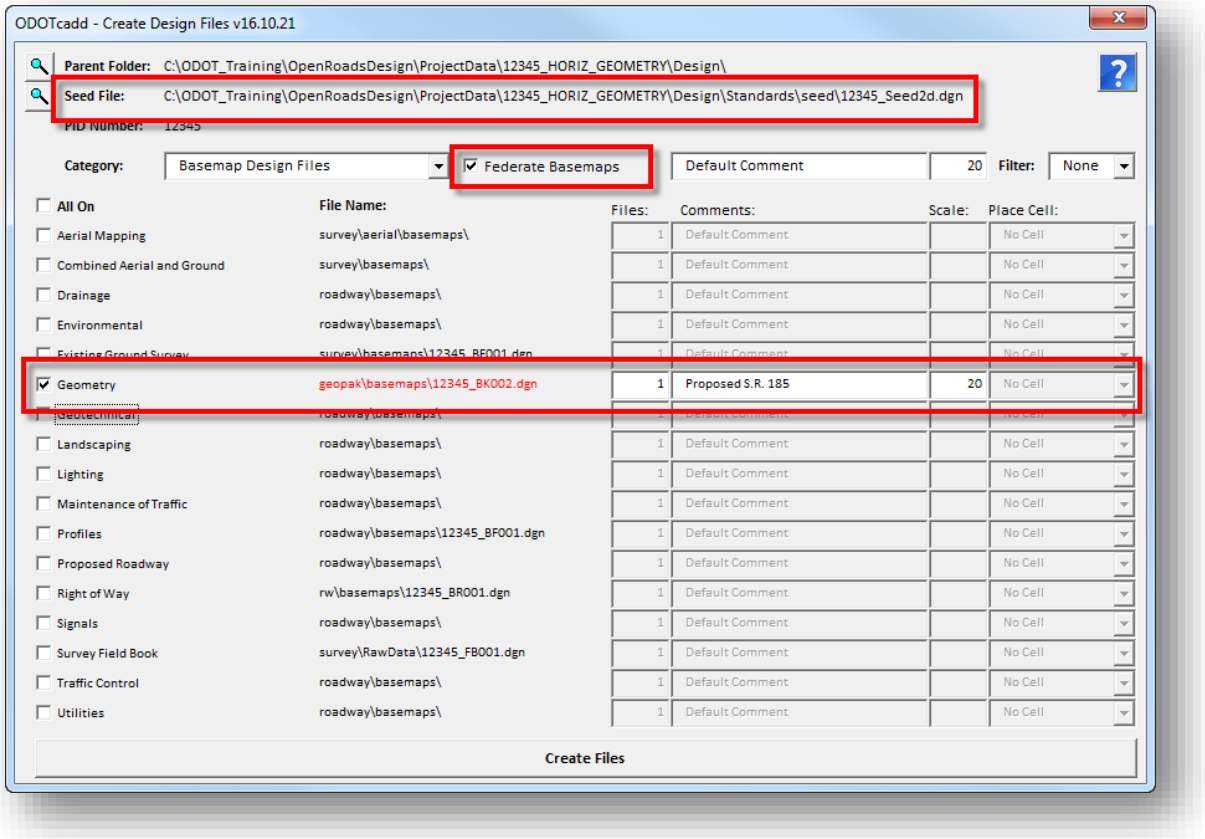
..\Design\Geopak\Basemaps\12345_BK001.dgn

Depending on the project and the District office, you may or may not receive a basemap with the existing centerline information. For this example, all of the existing alignments are stored in this file.

The existing alignments have been visualized with an OpenRoads Feature Definition for an existing centerline and are not considered plan production graphics.

The ODOT_Files.mvba application is used to create new design files for the project. Take the following steps to create three new geometry basemaps for the project:

- ✓ From the MicroStation pull-down menu, select **ODOT > File Management > Create Design Files** to open the **ODOT_Files.mvba** Visual Basic Application shown below.



- ✓ Verify that the correct **Seed File** for the project is selected. 2D files are used for most OpenRoads design files

- ✓ Toggle the **Federate Basemaps** option on. This will create a "000" file for each basemap type created. In the example above, the file 12345_BK000.dgn will be created.

- ✓ Toggle on the **Geometry** basemap option to create the file 12345_BK002.dgn. This file will be used to store the proposed centerline of State Route 185.

- ✓ Set the **Comments** for the first file as "**S.R. 185**".

- ✓ Set the **Scale** value to **20**. This is used to set the **Annotation Scale** setting in the newly created design file

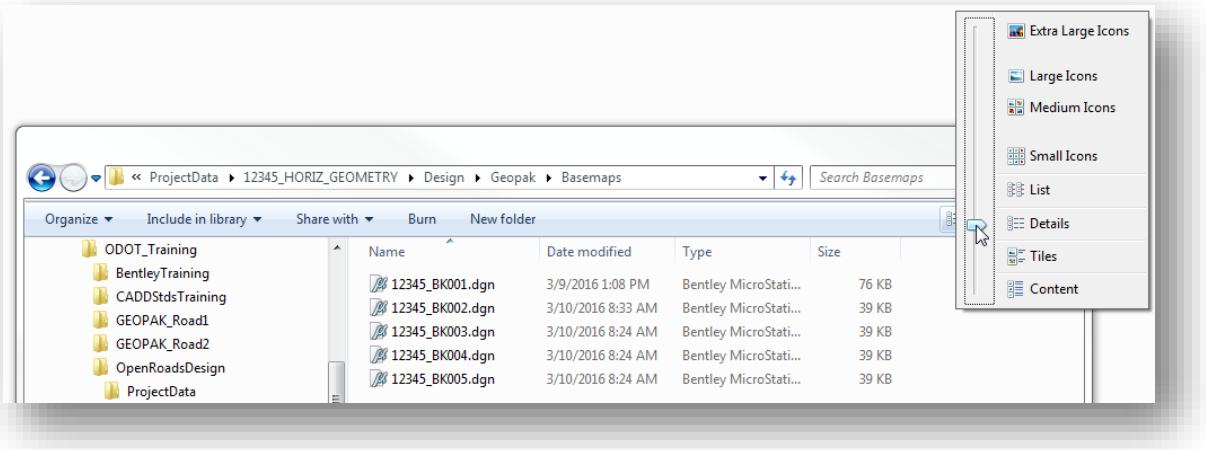
- ✓ Choose the **Create Files** option. The first geometry basemap, named **12345_BK002.dgn** is created in the ***\Design\geopak\basemaps*** folder.

- ✓ Create two more geometry basemaps by assigning the **Comments** for each file as follows:

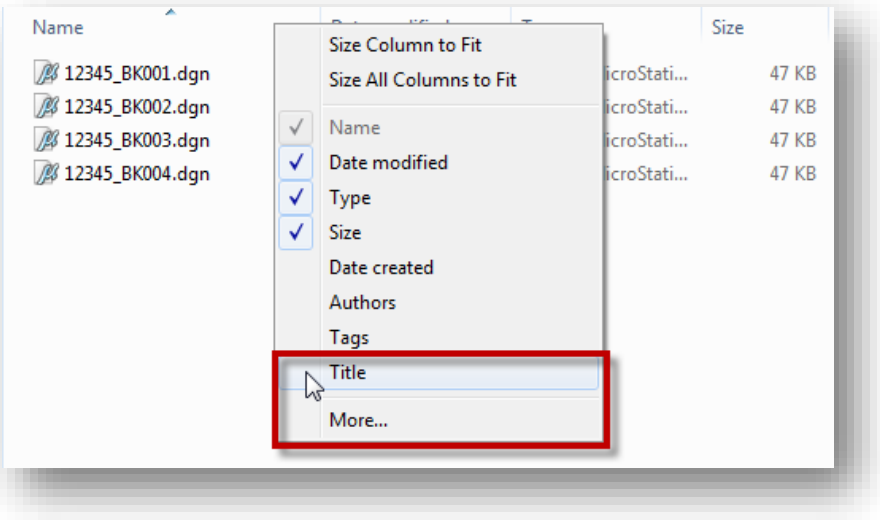
File Name	Comments
12345_BK003.dgn	Proposed St. Peter Road
12345_BK004.dgn	Proposed Jameson Road

The **Title** and **Comments** fields can be displayed in the *Windows Explorer* and in the MicroStation *File Open* dialogs. Take the following steps to enable the display of these fields:

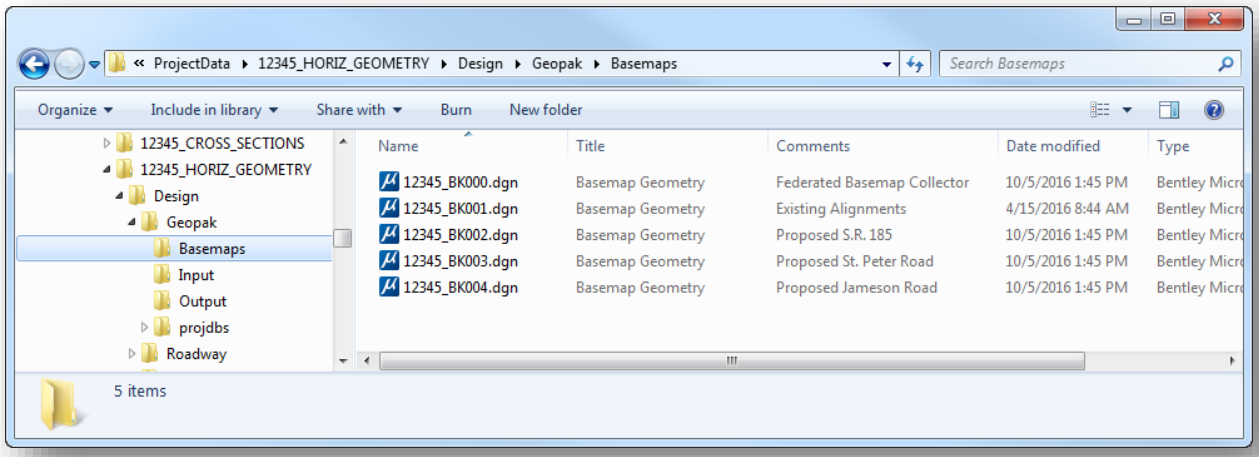
- ✓ Exit MicroStation
- ✓ Open Windows Explorer and set the **View Option** to **Details** as shown below.



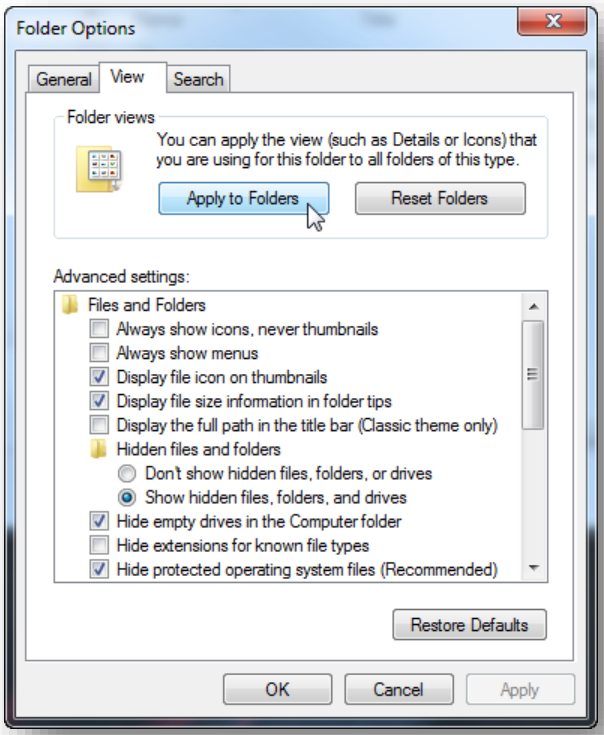
- ✓ Right-click on the **Name** column header and turn on the **Title** field



- ✓ Choose the **More…** option and toggle on the **Comments** field
- ✓ After toggling on the fields, you can arrange the fields in the order that you wish be dragging the column header to the desired location. Move the **Title** and **Comments** fields to the right of the **Name** field. The Windows Explorer dialog should appear similar to the example below.



✓ Next we'll apply these changes to all folders on the computer. From the *Windows Explorer* dialog, select **Organize > Folder and Search Options** to open the *Folder Options* dialog shown below.

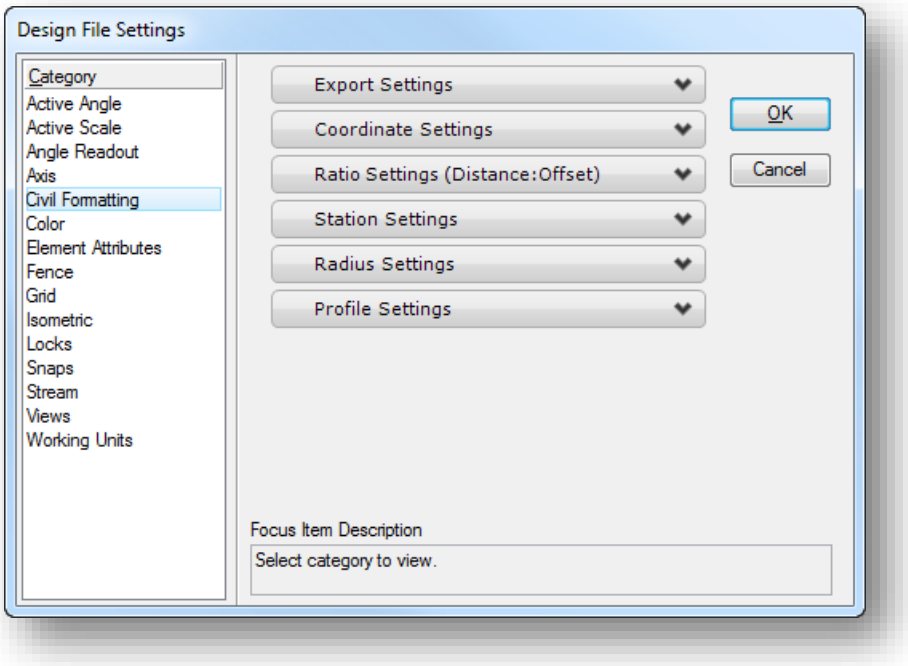


✓ From the **View** tab, choose the **Apply to Folders** option. Confirm the change when prompted

✓ Choose **OK** to close the dialog.

5.2 Civil Formatting

Before getting started with the OpenRoads Geometry tools, it is a good idea to review the design file settings to ensure they are set correctly for ODOT projects. From the MicroStation pull-down menu, select **Settings > Design File** to access the *Design File Settings* dialog shown below.



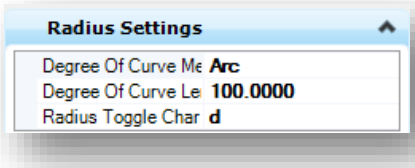
Choose the **Civil Formatting** option to review the current settings. Settings specific to ODOT are detailed below. These setting are set in the ODOT seed files. See the online help for additional information.

Station Settings

Make sure the **Equation** option is set to **By Index** for compatibility with the GEOPAK GPK file.

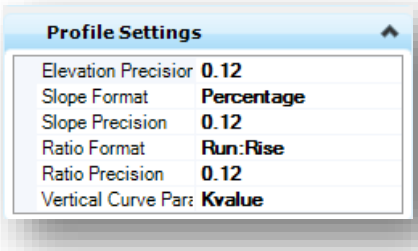
Radius Settings

The **Radius Settings** should be set as shown at right



Profile Settings

The **Profile Settings** should be set as shown at right



5.3 Design Standards

A **Design Standard** can be assigned to a geometric alignment to preform alignment checks and set required degrees of curvature when laying out your geometric alignments. Design Standards work at two levels:

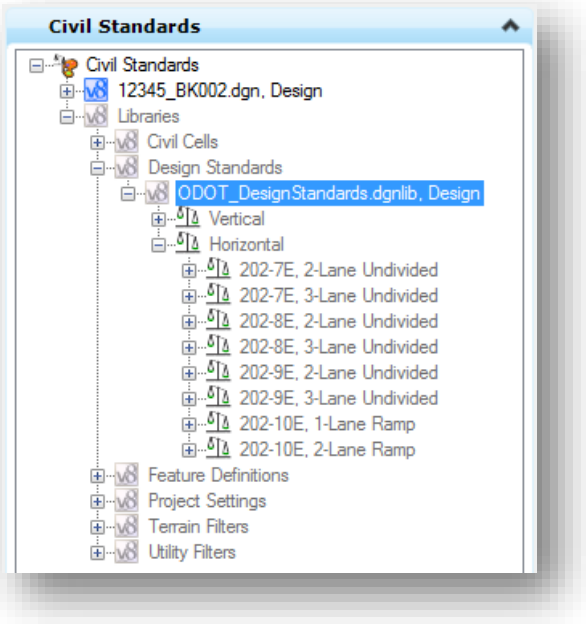
- Provide values for the element creation tools (for example: radius values and transition lengths)
- Check the design of complex elements (for example: check for kinks in an alignment)

When a design standards is violated, feedback is provided in two ways:

- An icon is displayed on the graphics of the element that has the problem
- The Civil Message Center reports details on the error

The use of design standards is optional.

Design Standards are defined in a MicroStation DGN Library and can be reviewed by the **Project Explorer** dialog as shown at right.



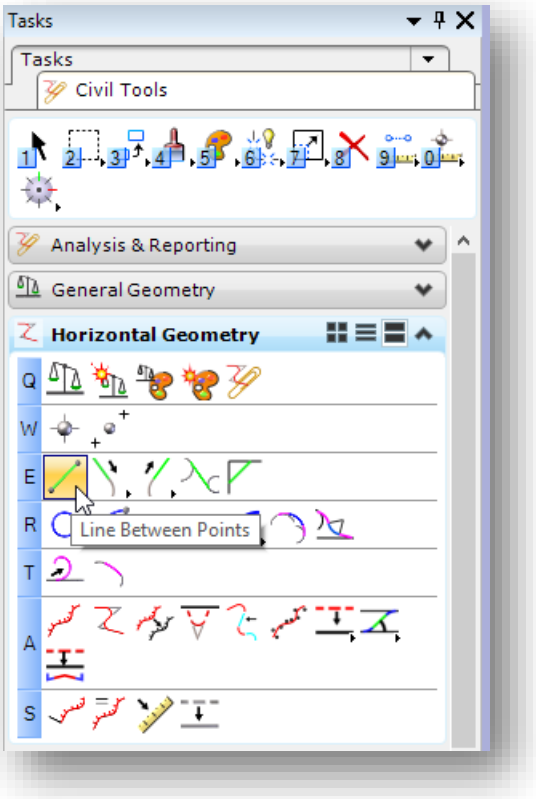
The **Civil Standards** group can be used to review the Design Standards that have been configured in the ODOTcadd workspace. The **Horizontal** group contains the design standards for various ODOT design standards as shown at right.

The application of Design Standards is covered later in this chapter.

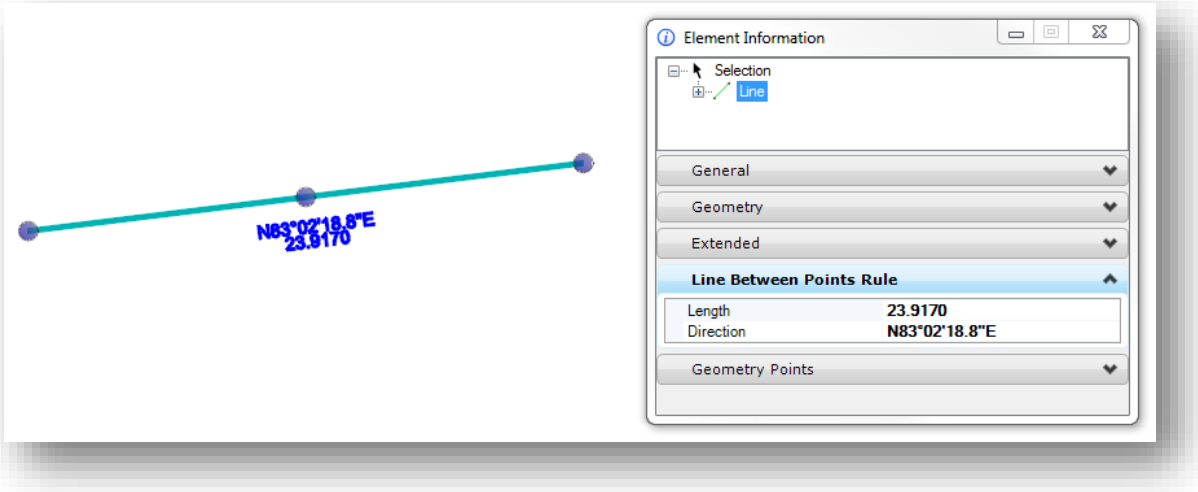
5.4 Civil Geometry Manipulation and Modification

Civil Geometry elements drawn using the OpenRoads tools are “ruled” graphics that behave according to the geometric rules that define how the element was placed.

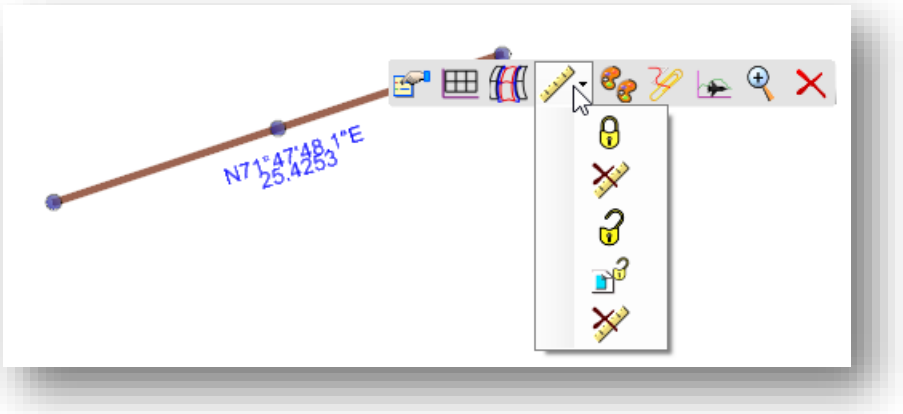
For example, a simple line drawn using the **Line Between Points** command has two rules: Length and Direction.



The rules can be reviewed in the *Element Information* dialog. An example for a line element is shown below.



MicroStation's **Manipulate** commands (Copy, Move, Scale, Rotate, etc.) cannot be used on ruled geometry. The rule must be removed in order to use these commands. To remove a rule, select the line and choose the Rules menu as shown below.



The following options are provided:

Lock – Deactivate Rule
Remove Rule
Unlock – Activate Referencing Rues
Lock – Deactivate Referencing Rues
Remove Rule

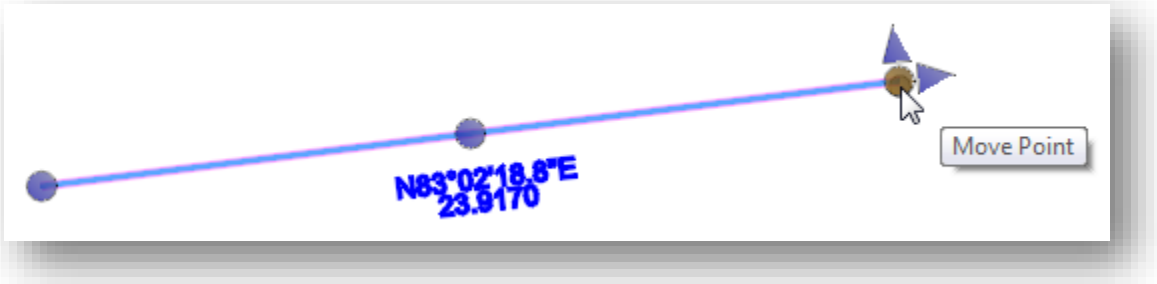
Element Manipulators

OpenRoads Geometry elements have **Manipulators** that are displayed in MicroStation when an element is selected. These manipulators can be used to edit the selected element graphically or by entering a value.

For example, a simple two-point line has several manipulators as shown below.

Clicking on the direction or the length manipulator will open an editor to change the display as shown below.

Clicking on one of the keypoint manipulators will display direction arrows to edit the line, as shown on the example below.

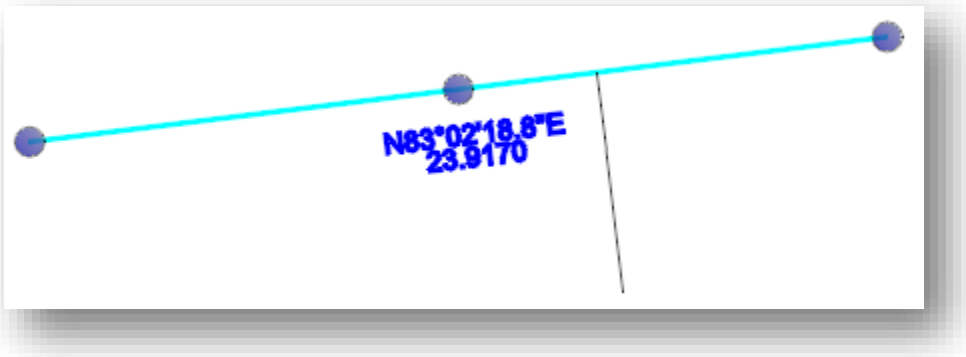


Tip: The size and color of the Manipulator Text can be adjusted in the **User Preferences**. From the MicroStation menu, select **Workspace > Preferences** and then choose the **View-Options - Civil** item on the left side of the dialog. The **Manipulator Size** or the **Manipulator Font Scale** parameters can be used to adjust the text size.

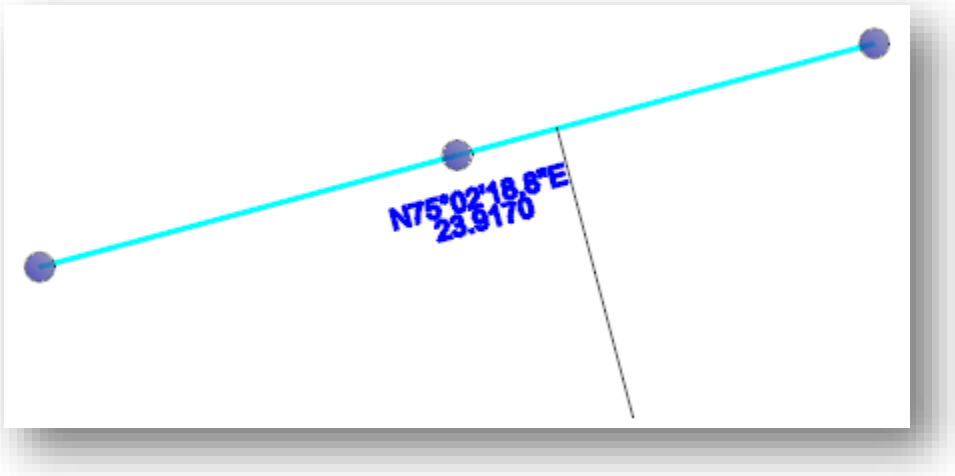
Design Intent

As geometric elements are drawn in MicroStation using the OpenRoads Horizontal Geometry tools, the software retains information about not only ***what*** element was drawn, but ***how*** it was drawn. This is referred to as the **Design Intent**.

In the example below, the horizontal line was drawn first. The second line was drawn using the MicroStation Perpendicular snap to draw the line at a perpendicular form the horizontal line to a specific ending point.



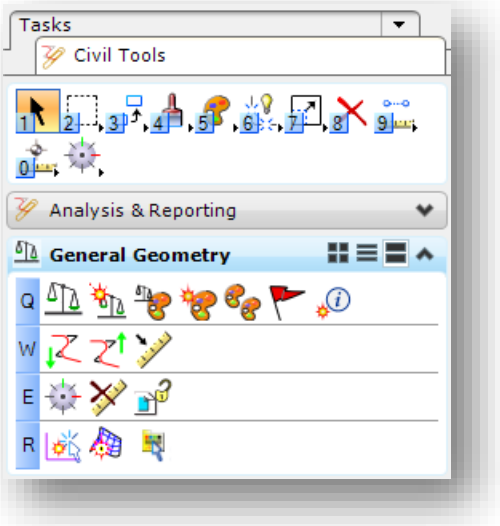
If the horizontal line is modified by changing the direction of the line, the design intent for the perpendicular line is preserved. The Perpendicular rule, and the ending location are preserved. The result is shown below.



5.5 OpenRoads Geometry Commands

OpenRoads Geometry commands are contained in two task lists as summarized below.

General Geometry



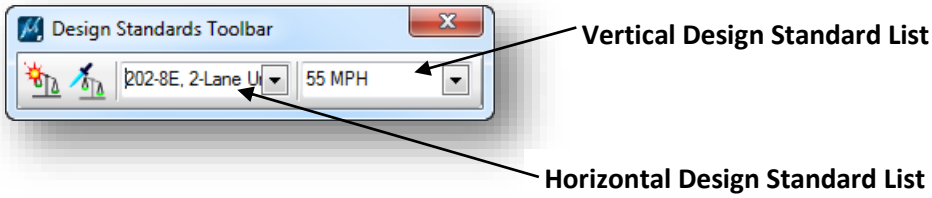
The **General Geometry** commands are accessed from the *Task Navigation* dialog by selecting **Civil Tools > General Geometry**.

This toolset is split into four separate groups as summarized below.

See the online help for more information.

Geometry Toggles

Design Standards Toolbar
Opens the *Design Standards Toolbar*, shown below, which allows selecting the active design standard as well as setting the design standard for a specific element.



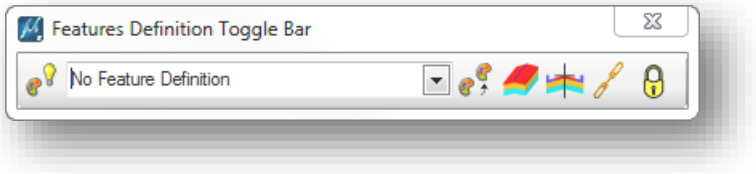
Set Design Standard
Used to assign a design standard to an element that previously had none. The active design standard is assigned to the selected element(s).

Toggle Active Design Standard
When toggled on and placing a "civil" element, that element is assigned with the active design standard when drawn to the model. When toggled on certain tool parameters will be set automatically to meet the active design standard.

Set Design Standard

This tool is also found in the **Design Standards Toolbar**, See description above.

Features Definition Toggle Bar
Opens the *Features Definition Toggle Bar* shown below.



Use Active Feature Definition
Forces the active OpenRoads tool to use the feature definition defined here.

Feature Definition List
Drop-down list to choose the active feature definition

Match Feature Definition
Will set the **Feature Definition List** to the feature definition that is assigned to the selected element.

Create 3D Automatically
Click the **Create 3D Automatically** icon to generate 3D model elements for the created elements. The 3D element is computed by best fit of the default terrain model. But, if the element being created is adjacent to other geometry elements which have a defined design profile, then a quick profile transition is computed to define the 3D element.

Use Feature Definition Template
Click the **Use Feature Definition Template** icon apply a roadway template to the created element automatically. The feature definition must have a template assigned in its properties.

Chain Commands
If the 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 for base elements to construct its fillet.

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

Set Feature Definition
Used to assign a feature definition to a civil geometry element, or change the feature definition on an element.

Match Feature Definition

This tool is also found in the **Features Definition Toggle Bar**, See description above.

Civil Message Center
Opens the *Civil Message Center* dialog which is used to review errors in the design standards that have been placed in the file.

Set Element Information
This command can be used to add a note to an element that is displayed in the Element Information dialog.

Geometry Import/Export

Import Geometry
Import geometry elements that are stored in the COGO databases

Export to Native
Used to export selected civil geometry elements into one of the following COGO databases: MX FIL files, InRoads ALG files, or GEOPAK GPK files.

Create Civil Rule Feature
Assign Civil Geometry rules to elements created by tools other than civil geometry commands.

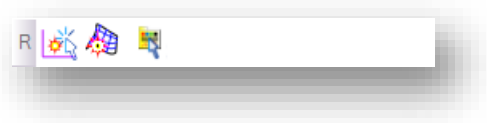
Geometry Civil Toggles

Activate Civil AccuDraw Toolbar
Activates or deactivates Civil AccuDraw.

Remove Rules
Removes rules on selected elements.

Deactivate Reference Rules
Deactivates reference rules on selected elements. Reference rules are elements upon which the chosen element is dependent. For example, a curve between elements depends on the two other elements that define it. This command allows deactivating the rules for those other elements.

Geometry Design Elements



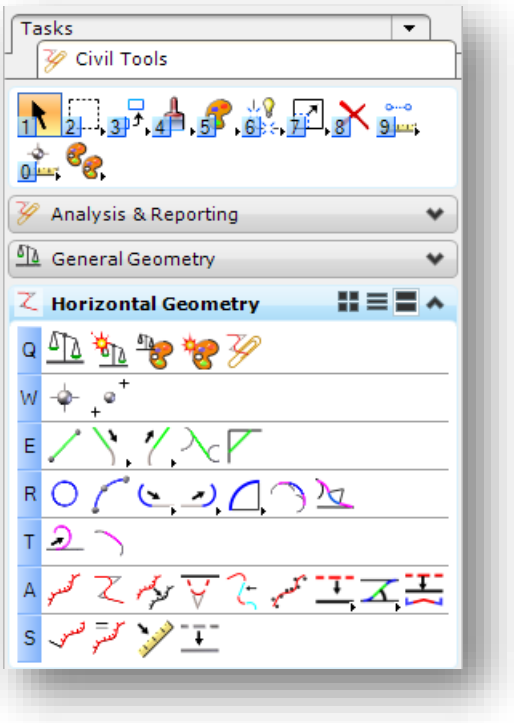
Set Active Profile
Used to define which profile element is used to define the 3D model for a corridor

Set Active Terrain Model
Used to designate the active terrain model. The active terrain model is used when a profile is generated and also used as the default target for corridor modeling.

Select by Graphical Filter
Places all elements matching the Graphical Filter into a MicroStation selection set.

Horizontal Geometry

The **Horizontal Geometry** commands are accessed from the *Task Navigation* dialog by selecting **Civil Tools > Horizontal Geometry**.



This toolset is split into several separate groups as summarized below.

See the online help for more information.

Horizontal Geometry Point

Point
Constructs a civil point element.

Equal Spaced Points
Inserts a specified number of points, points at a defined interval, or a combination of both into the View.

Horizontal Geometry Line

Line Between Points
Creates a line between two user defined points.

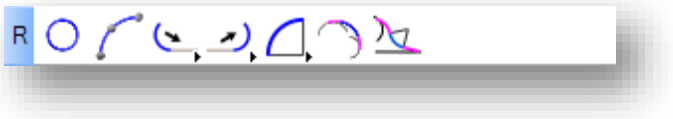
Simple Line to Element
Constructs a line at a skew to a reference element. Note other line to element tools can be accessed via this button with a long left click.

Simple Line from Element
Constructs a line at a skew from a base element. Note other line from element tools can be accessed via this button with a long left click.

Line Between Arcs
Constructs a line between two previously placed arcs.

Chamfer Between Elements
Planes a corner, example, it alters an existing intersection by inserting a line between the elements.

Horizontal Geometry Arc



Circle
Draws a circle.

Arc Between Points
Creates an arc between points.

Simple Arc to Element
Constructs an arc based on a selected base element which controls tangency at one end. Note other Arc to Element tools can be accessed via this button with a long left click.

Simple Arc From Element
Constructs an arc based on a selected base element that controls tangency at one end. The construct may also include an optional spiral transition or arc transition (2 center curve). Note other Arc from Element tools can be accessed via this button with a long left click.

Simple Arc Between Elements
Constructs 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. Note other Arc Between Element tools can be accessed via this button with a long left click.

Arc Between Arcs
Constructs an arc between two previously placed arcs. This tool has the ability to optionally apply both a back and/or forward transition between the base arcs and the constructed arc.

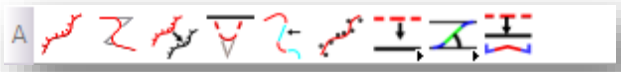
Complex Transition Between Any Element and Arc
Constructs an arc between two previously placed elements. This tool has the ability to optionally apply a Back Spiral and/or Ahead Transition between the elements and the constructed arc.

Horizontal Geometry Spiral

Spiral From Element
Constructs a spiral from a previously placed element, using this base element to determine tangency at one end.

Spiral Between Elements
Constructs a spiral (or spirals) between two base elements that determine tangency.

Horizontal Geometry Complex



Complex By elements
Constructs a complex element of previously placed elements by joining them in sequence.

Complex by PI
Creates a linear element with curves based on user input of PI (point of intersection) locations. The curves can include transitions or set the radius to zero for no curves at the PI.

Complex Redefine
Replicates an element at a specified distance from the original.

Insert Horizontal Fillet
Inserts a curve into a previously created element.

Append Element
Constructs a complex element by appending additional elements in a previously established complex element.

Define Horizontal By Best Fit
Constructs an element that best fits a course defined by a selected linear object.

Simple Offset Entire Element
Constructs linear elements based on various methods of offsets from a base element. The base element may be a line, arc, spiral, or complex. Note other offset tools can be accessed via this button with a long left click.

Reverse Curve by Angle
Constructs reverse curves between previously drawn elements. Note other Reverse Curve tools can be accessed via this button with a long left click.

Create Geometry by Template
Used to access the Pick Template dialog then insert the chosen template into the drawing relative to a reference element. Any point in the template, whose feature definition is set to create geometry, will produce offset element constructions at the template defined offset.

Horizontal Geometry Modify

Start Station
Assigns stationing to an element.

Add Station Equation
Defines a station equation at a designated location on an element.

Create Civil Rule Feature
Assigns Civil Geometry rules to elements created by tools other than civil geometry commands.

Copy Element
The Copy Element tool creates a new instance of visible geometry only.

5.6 Civil AccuDraw

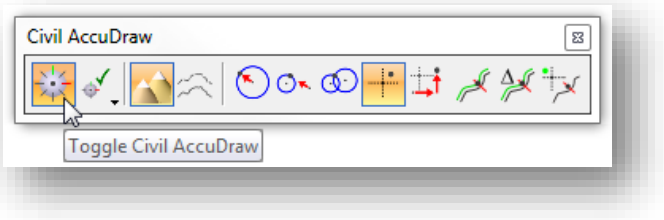
Placing elements in a 2D model is like manual drafting — all elements appear on the same plane, the sheet of paper.

In 3D, you place elements in space — horizontally (for example, a floor), vertically (for example, a wall), or at any other angle or direction (for example, a sloping roof).

By default, data points in a 3D model are placed at the view's Active Depth. Where you snap a tentative point or place a data point in a blank part of a view, it will be located at the active depth. You can, however, snap a tentative point to an existing element at any depth in a view. When you accept such tentative points, the data point is placed at the level of the snap point.

Civil AccuDraw and its drawing plane let you place elements away from the active depth. Often this improves productivity, since you need not constantly change the active depth.

Select **Tools > Civil AccuDraw > Activate Toolbar** from the MicroStation pull-down menu to open the *Civil AccuDraw* dialog shown below. The first icon is used to turn Civil AccuDraw on or off.

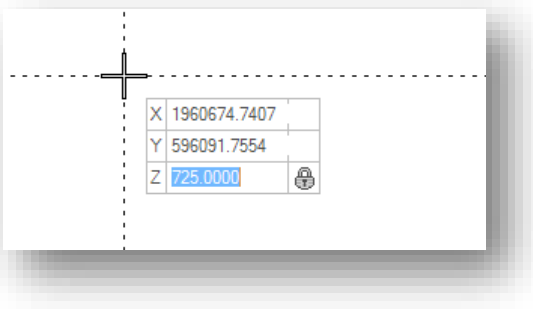


Civil AccuDraw performs many of the same functions as MicroStation AccuDraw but has greatly expanded capabilities for the civil designer.

> **Note:** Simultaneous use of Civil AccuDraw and MicroStation AccuDraw will cause errors. Close MicroStation AccuDraw when using Civil AccuDraw.

This guide will cover only a few of functions available when using Civil AccuDraw. For more information, see the GEOPAK online help by selecting **Applications > GEOPAK > Road > Help**. From the *Civil Help* dialog, select **Civil Tools > Civil AccuDraw**.

The coordinates of the current cursor position are displayed by default in a floating dialog as shown below. You can switch between the floating or fixed dialogs using the up and down arrow keys. The contents of the dialog will depend upon the current ordinate system selected.



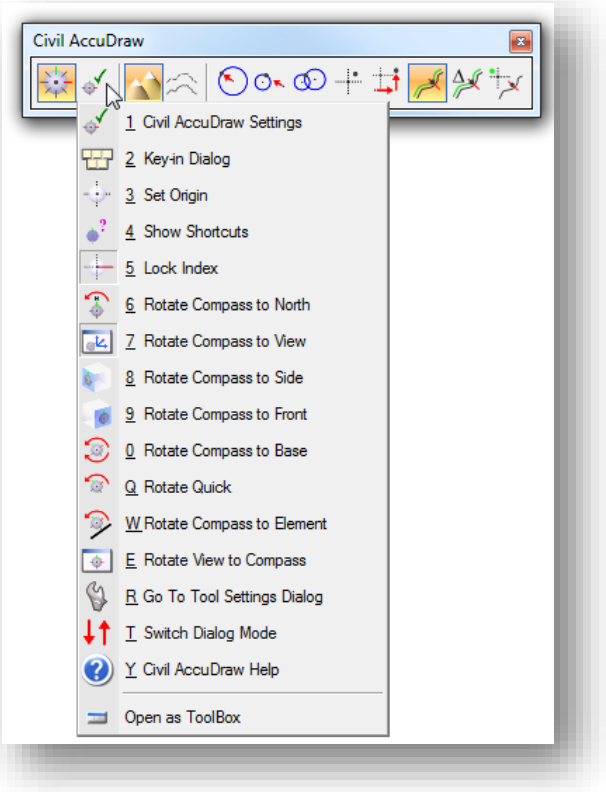
The **Tab** key is used to move through the key-in fields in the dialog.

Values entered in the floating dialog are locked when the **Enter** key is pushed.

To unlock a value, tab to the field and push the **End** key.

Shortcuts: Civil Accudraw Settings

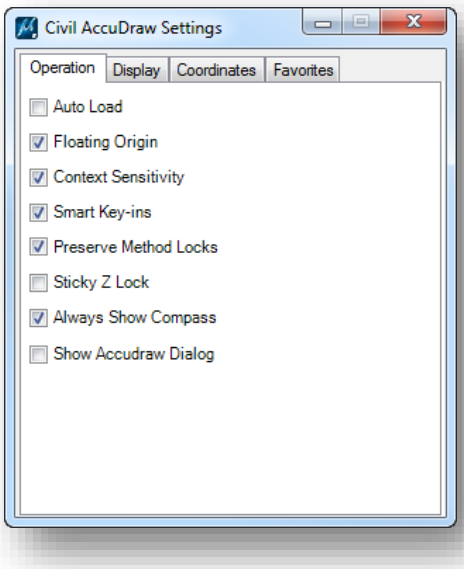
Civil AccuDraw shortcuts and settings are accessed by selecting and holding down the left mouse button on the second icon as shown below.



These shortcuts are described in the online help by selecting **Applications > GEOPAK > Road > Help**.

From the *Civil Help* dialog, select **Civil Tools > Civil AccuDraw > Civil AccuDraw > AccuDraw Tool Access > Shortcuts.**

A single-click on the second icon will open the *Civil AccuDraw Settings* dialog shown below.

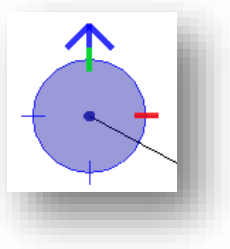


These settings are described in the online help by selecting **Applications > GEOPAK > Road > Help**.

From the *Civil Help* dialog, select **Civil Tools > Civil AccuDraw > Civil AccuDraw > Settings.**

Civil AccuDraw Compass

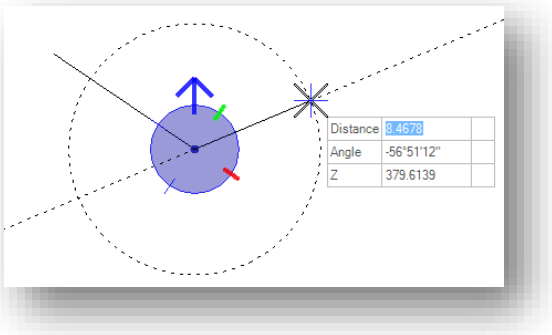
When the **Always Show Compass** setting is toggled on, a compass is displayed at AccuDraw's origin point when Civil AccuDraw is active.



The compass is always circular and is marked by a number of tics. The default is 4 compass points which can be changed in the settings.

The north arrow on the compass will always point to north as defined in **Settings > Design File > Angle Readout**.

If the *Civil AccuDraw Settings* dialog (shown on the previous page) has the **Context Sensitive** option turned on (default), then the compass auto-rotates in a similar fashion to MicroStation AccuDraw:

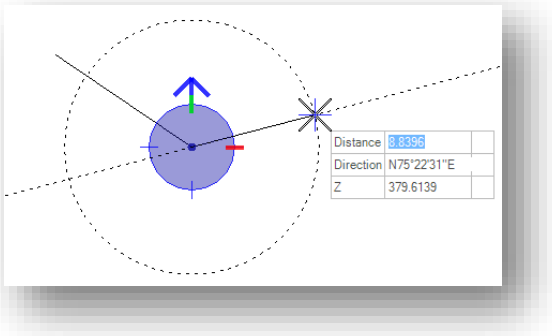


Note that rather than direction being shown, the label and value are now an **Angle**. This is because the context is based on the direction of the preceding line segment rather than an absolute direction.

The compass can be rotated with the **V**, **B**, **T**, **RQ**, **RE** shortcuts.

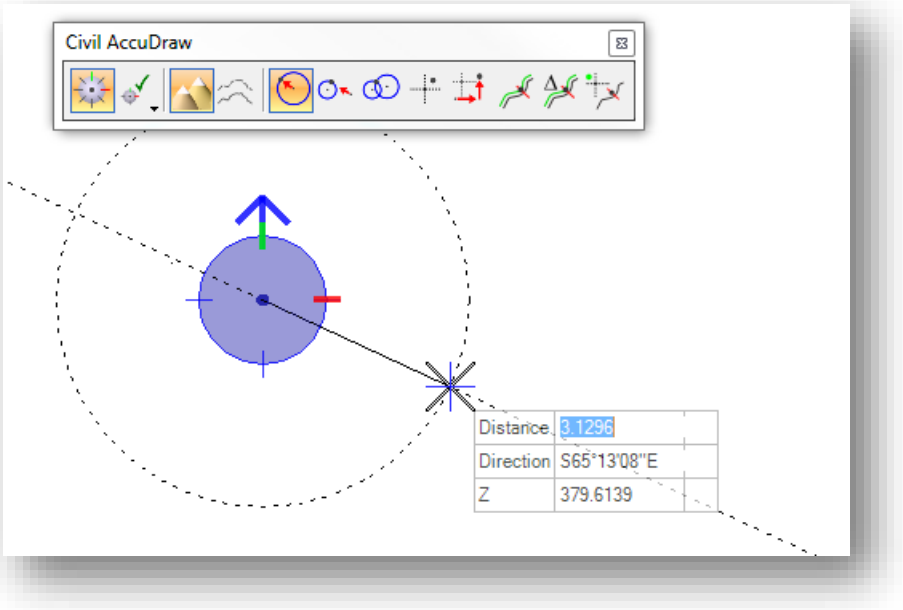
V rotates the drawing plane to align with the view axes.
T rotates the drawing plane to align with the axes in a standard Top view.
RQ is used to quickly and temporarily rotate the drawing plane.
RE rotates the drawing plane to match the orientation of a selected element.

Use the **T** (Top) shortcut or the corresponding drop-down to return to a pure direction.



Distance-Direction

The **Distance-Direction** ordinate is used to enter points in polar coordinates as shown below.



Angle Syntax
The input for angle and direction fields follows the MicroStation **Settings > Angle Readout** settings.

Valid forms for the various settings are as follows:

DD.DDDD, Radians or Grads - Use the customary decimal input.

DD MM SS or DD MM - The following delimiters are supported between degrees, minutes and seconds:

Colon - For example DD:MM:SS

^ (caret) to designate degrees, minute (') and second (") - For example DD^MM'SS"

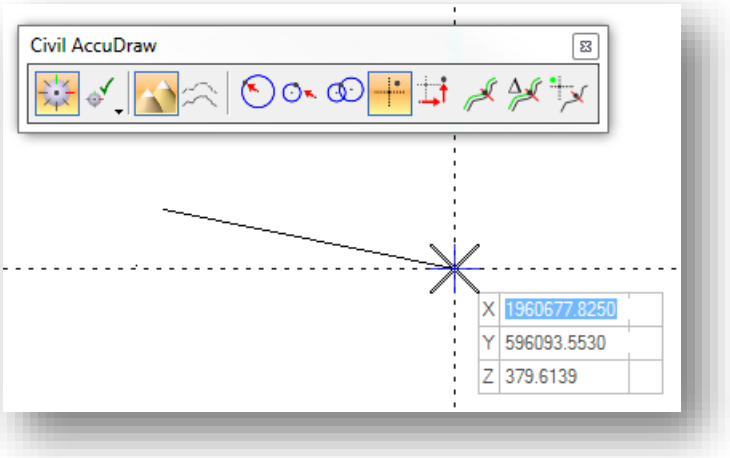
The following are not supported in the current version:

A space between degrees, minutes and seconds because space launches the Civil AccuDraw popup menu

Use of d, m and s to designate degrees, minutes and seconds.

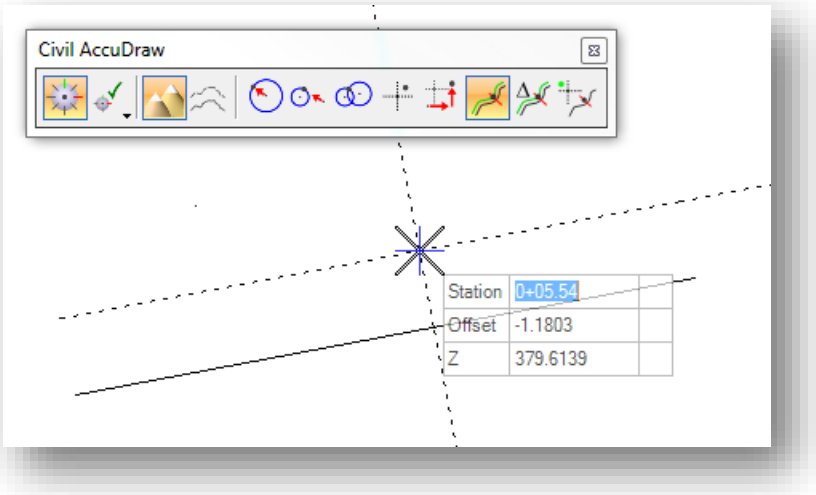
XY

Rectangular coordinates can be entered by use of the **XY** ordinate as shown below.



Station-Offset

The **Station-Offset** ordinate is used with a reference element to enter information as a station and offset relative to a selected element.



The reference element can be a MicroStation element or a Civil Geometry element. If a MicroStation element is selected, the beginning of the element is assumed to be station 0+00. If a civil element is selected with stationing defined, the station value of the selected element is used.

To select the reference element, with the **Station-Offset** ordinate active use the **O** shortcut to select the reference element. Once selected, data can be entered using station and offset values relative to the reference element as shown in the example above.

5.7 OpenRoads Feature Definitions

As you draw information using the OpenRoads horizontal geometry tools, the plan view representation of the item is drawn using the active MicroStation settings. OpenRoads **Features** are used to define not only the plan view representation of an object, but also how the object will appear in other contexts such as the profile, cross sections, and 3D.

What is a Feature?

Simply stated, a feature is anything in your design that represents a real-world object such as:

- Curb and Gutter
- Pavement
- Catch basins, Manholes, Inlets
- Walls
- Ditches
- Cut and Fill Slopes
- Etc.

Feature Definitions are normally created in advance for your use in order to standardize the design. Three types of Feature Definitions are supported by the software:

Point Features

- Control Points
- Catch Basins
- R/W Marker
- Etc.

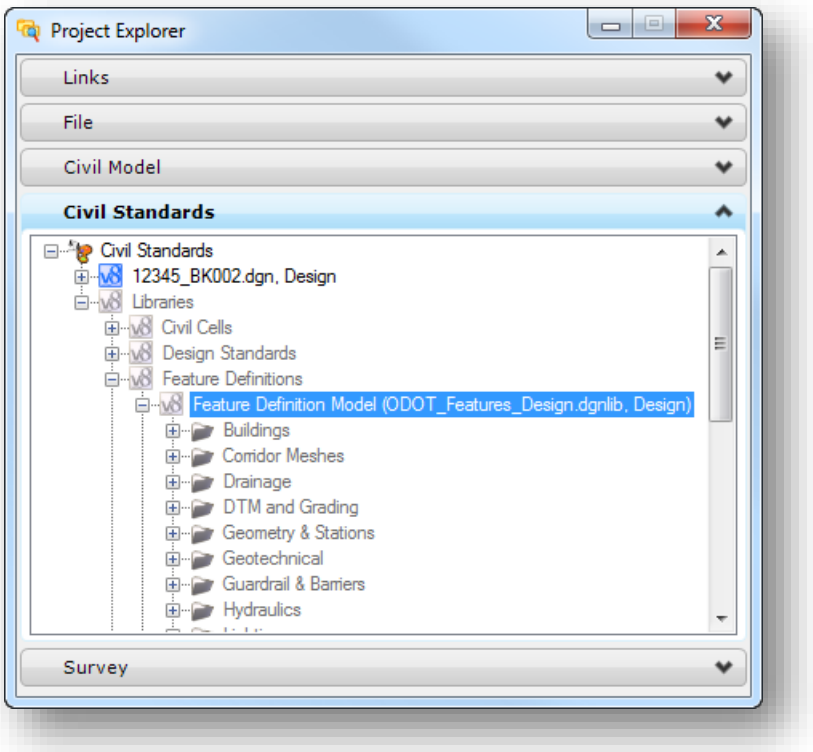
Linear Features

- Curb and Gutter
- Walls
- Ditches
- Etc.

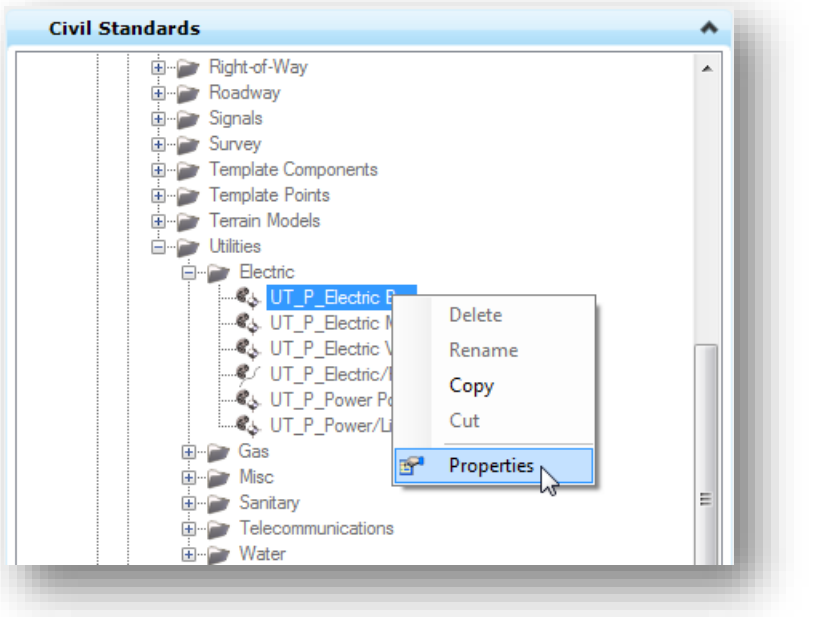
Surface Features

- Existing Ground
- Aggregate Base
- Asphalt Pavement
- Etc.

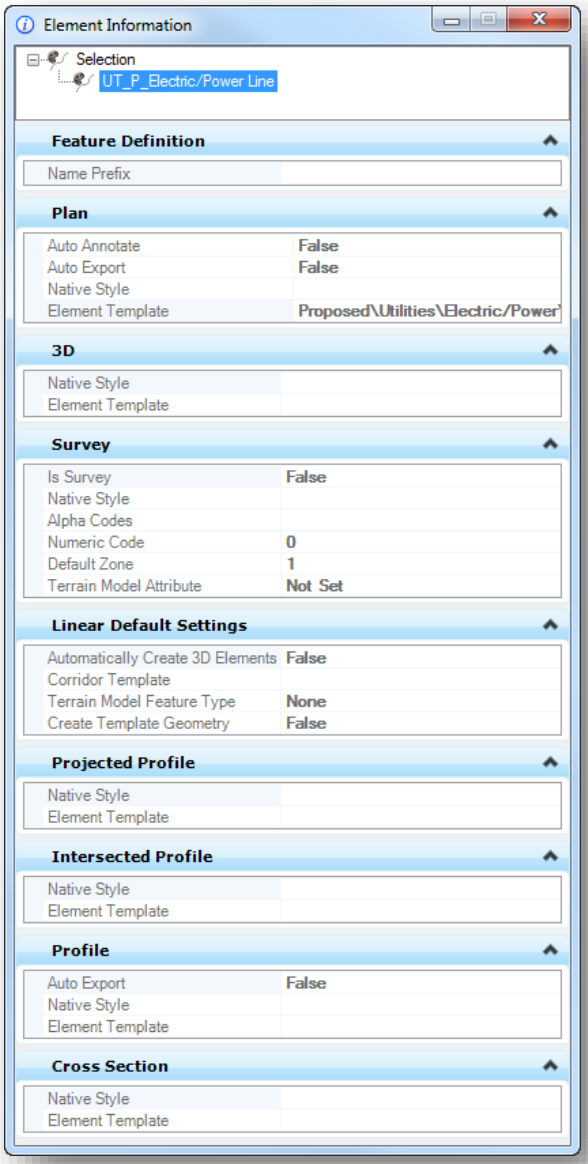
Features are defined in MicroStation DGN Libraries. The ODOTcadd Configuration defines which feature libraries are available for ODOT use. The libraries can be reviewed using the in the **Civil Standards** tab of the *Project Explorer* dialog as shown below.

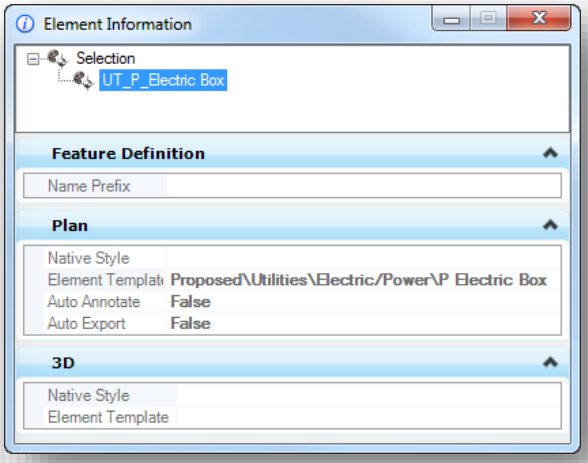


The Features are organized by categories. Expanding a category will reveal the features available in the category. Right-click on a Featre to review the properties as shown below.



Depending on the type of feature definition, there are various properties defined for the item. Some examples are shown below.





5.8 Working with GPK Files

Legacy GEOPAK Road commands use the GEOPAK Coordinate Geometry (COGO) Database to store all of the geometric alignment information (both Horizontal and Vertical) for the project. The COGO database has a .gpk file extension.

Horizontal and vertical alignment information generated using the OpenRoads Geometry tools is stored directly in the active MicroStation model. The GPK file is not required for OpenRoads commands; however OpenRoads horizontal and vertical alignment information must be exported to the GPK file for use with the legacy GEOPAK commands.

There are two ways to export OpenRoads geometry to the GEOPAK GPK file:

- Manually export selected OpenRoads geometry alignments using the **Export to Native** command.
- Automatically export OpenRoads geometry as the alignments are created by use of specific feature definitions that have been configured to auto-export the alignment.

In either case, the GPK file must be created before exporting the geometric information. The export process does not create a GPK file.

Exercise 5B –GPK Files

OpenRoads alignment information is stored in MicroStation design files, however, it is still necessary to create a GEOPAK Coordinate Geometry Database that will also contain the horizontal and vertical alignments.

The location of the GEOPAK COGO database is defined by the **Working Directory** parameter in the GEOPAK *User Preferences* dialog. Creating a GPK file is as simple as defining the **Working Directory**, and entering a **Job Number** for the GPK file when the COGO command is accessed.

Note: For most projects it is desirable to create a GEOAK Project and use the GEOPAK Project Manager to facilitate the plan production process. The procedure to create a GEOPAK Project is detailed in ODOT's GEOPAK Road 1 Training Guide.

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Standards/Documents/Startmenu/GEOPAK_V8i_Road1.pdf

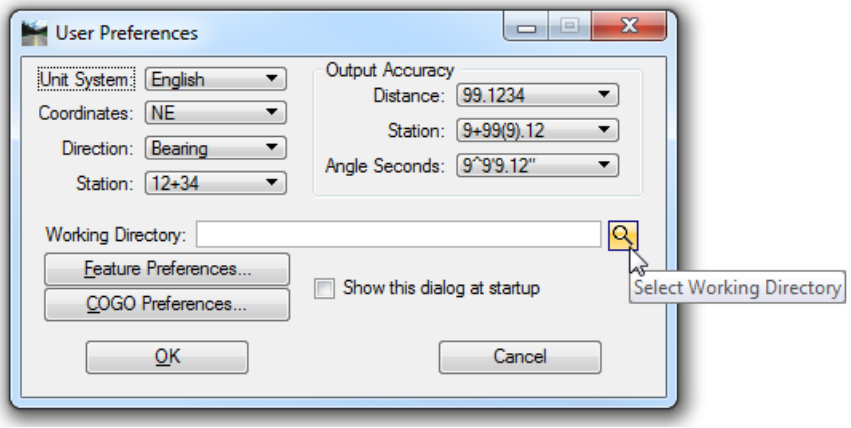
The training data already contains a GPK file that was created by the Survey personnel. This file contains the existing alignment information. For the purpose of OpenRoads training, we will define the **Working Directory** and review the process to create a GPK file for cases where one has not been provided by the Survey personnel.

- ✓ Open MicroStation using the shortcut provided for the training class.
  C:\ODOT_Training\OpenRoadsDesign

- ✓ In the MicroStation *File Open* dialog, set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_HORIZ_GEOMETRY

- ✓ Open the following design file for the training project:
  \Design\Geopak\Basemaps\12345_BK002.dgn

- ✓ Set the GEOPAK **Working Directory** by selecting **Applications > GEOPAK > Road > User Preferences**. Define the **Working Directory** as the ***\Design\Geopak*** folder for the project.

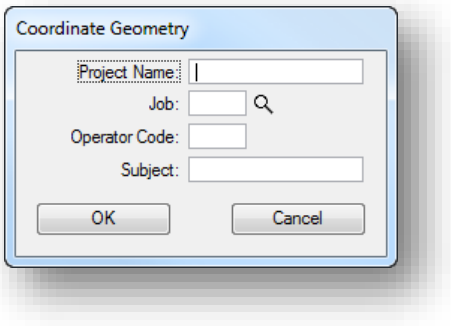


- ✓ Check the **Show this dialog at startup** option to automatically open the *User Preferences* dialog every time GEOPAK is activated. This is useful to verify that GEOPAK is pointed to the correct folder location for the project that you are currently working on.

- ✓ Select **OK** to confirm the dialog settings.

After configuring the *User Preferences*, we can now open the *GEOPAK Coordinate Geometry* dialog to gain access to the GEOPAK GPK file.

- ✓ From the MicroStation pull-down menu, select Appl**ications > GEOPAK > Road > Geometry > Coordinate Geometry** to access the dialog shown below.



The dialog has the following options:

Project Name
This optional field is used to set a description that is displayed at the top of any COGO input and output files.

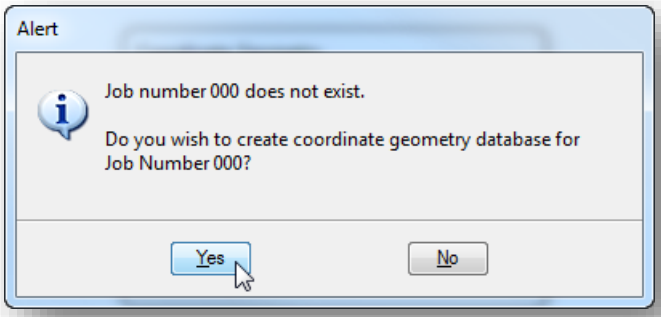
Job
This is used to designate the GPK file name. The **Job Number** entered here can be alphanumeric, three characters maximum, with no spaces or special characters. The resulting GPK file is named as follows: Job###.gpk

To the right if the **Job** field is a selection button that can be used to browse the current **Working Directory** to select any previously created GPK files.

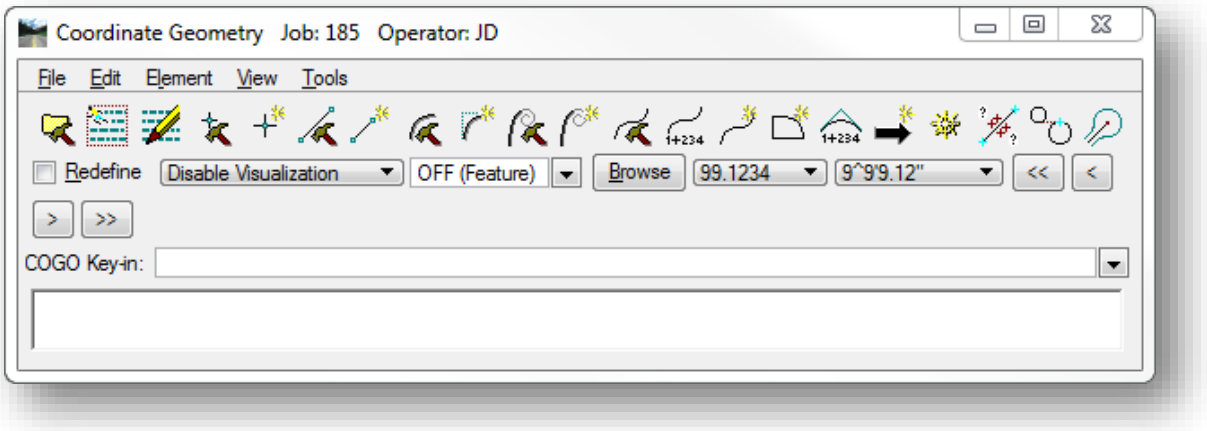
Operator Code
The **Operator Code** is used to identify each individual user of the COGO database by their initials. The field has a maximum of two alphanumeric characters. COGO input and output files are stored using the Operator Code as part of the resulting file name.

Subject
This optional field is used to enter a description.

- ✓ Enter **000** for the **Job Number**
- ✓ Enter your initials for the **Operator Code**.
- ✓ Select the **OK** button. You are prompted to create the GPK file as shown below.



- ✓ Select **Yes** to create the GPK file. The *Coordinate Geometry* dialog shown below is opened.



The file is created in the folder specified by the GEOPAK **Working Directory** parameter and is named as follows: ***job000.gpk***

NOTE!
We will not use this GPK file for the training class. This file was created simply to illustrate the GPK file creation process without creating a GEOPAK Project. As stated previously, users will normally create a GEOPAK Project as detailed in ODOT's GEOPAK Road 1 training guide.

Tip:
ODOT recommends setting the visualization mode to **Disable Visualization** when working with the OpenRoads tools.

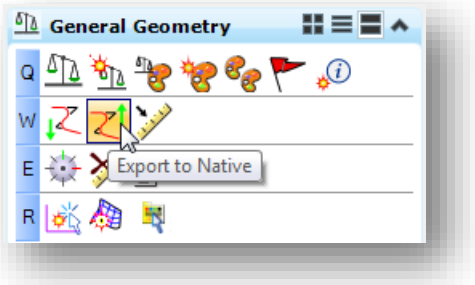
- ✓ Close the COGO dialog. It is not necessary to keep the COGO dialog open when exporting OpenRoads geometry to the GEOPAK GPK file. All that is necessary is the **Working Directory** is defined with the path to the folder where the GPK file is located, and the GPK file has been previously created.

5.9 Exporting OpenRoads Geometry to the GPK

OpenRoads geometry can be manually exported using the **Export to Native** command, or automatically exported by using a Feature Definition that has been configured with the **Auto Export** and **Auto Annotation** options toggled on. Each option is discussed below.

Export to Native

The **Export to Native** command is located in the **General Geometry** task group as shown below.

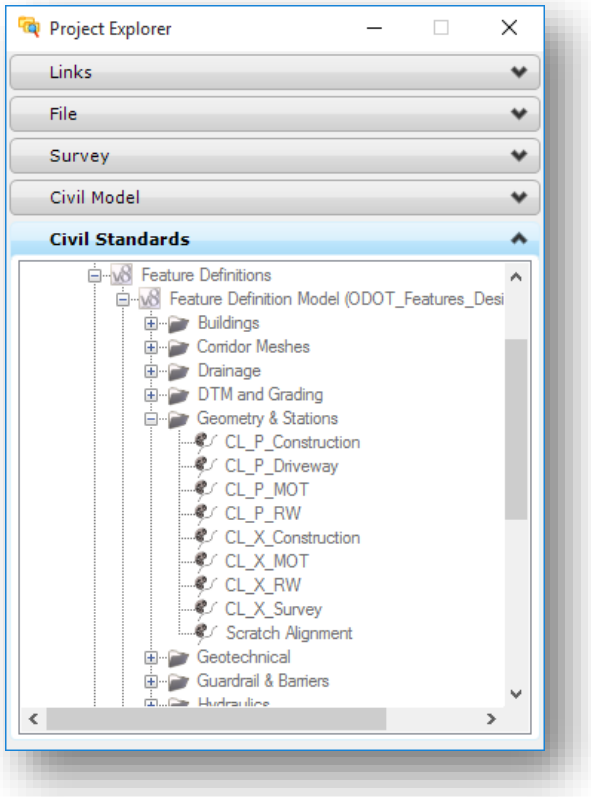


When the command is selected, you are prompted to select the OpenRoads geometry elements that you would like to export. After selecting the element(s), right-click (reset click) to complete the process.

Exporting via the Feature Definition

The ODOTcadd configuration contains several feature definitions that are used for geometric alignments. These features are defined in the DGN Library **ODOT_Features_Design.dgnlib**.

The features can be reviewed in the *Project Explorer* dialog in the **Civil Standards** group as shown at right. Unique features are defined for various types of geometric data as shown at right.



These features, contained in the **Geometry & Stations** category, define two key parameters that are used for storing the geometric data in the GPK file and also for annotating the geometry: **Auto Export**, and **Auto Annotate**.

Auto Export

The **Auto Export** parameter is enabled for every feature in the **Geometry & Stations** category except the **Scratch Alignment** feature.

With this parameter enabled, OpenRoads graphics drawn using one of these feature definitions will be automatically exported to the GPK file when the element is initially drawn or subsequently edited.

Auto Export will update the GPK definition for the alignment for every action that is done to the alignment graphics, including deleting the graphics.

Auto Annotate
The legacy GEOPAK Design and Computation Manager Database is used to annotate stations and curve data along your OpenRoads geometric alignments.

Each Feature Definition in the **Geometry & Stations** category has been defined to correspond to a companion item in ODOT's legacy GEOPAK Design and Computation Manager Database, ODOT.ddb.

When the geometry is exported to the GPK, the **Auto Annotate** parameter will trigger the station annotation function using the corresponding item in ODOT.ddb.

These feature definitions have been specifically configured for working with OpenRoads alignments in the Geometry basemap BK design file. These features annotate only the station and keypoint information and are not intended to be used for plan production purposes in the roadway basemap BP design file. Curve data is not annotated when using these features.

The current annotation scale value is used to determine the text size for the annotation. The following annotation scale values are supported:

Engr: 1:10
Engr: 1:20
Engr: 1:50
Engr: 1:100
Engr: 1:200
Engr: 1:500

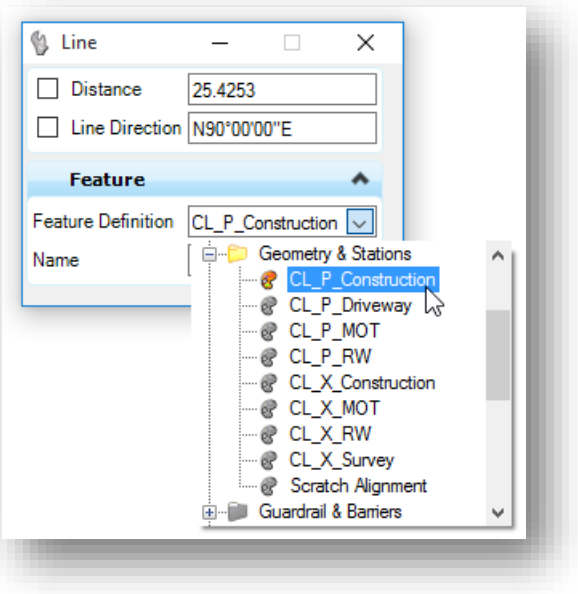
The **Auto Annotate** parameter is enabled for every feature in the **Geometry & Stations** category except the **Scratch Alignment** and **CL_P_Driveway** features.

Using Feature Definitions to Draw OpenRoads Geometry

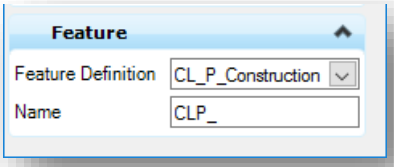
As we have discovered, Feature Definitions control the appearance of our OpenRoads alignments in various contexts (plan, profile, 3D, cross sections).

Feature Definitions can be applied as the graphics are drawn, or defined later. For example, the Horizontal Geometry command, **Line Between Points** can be defined with the parameters shown at right. One of these parementers is the **Feature Definition**, which is selected from the drop down list.

The **Use Active Feature Definition** option can be used if you have previously defined a feature as the active feature by use of the *Features Definition Toggle Bar* (see page 70).



After a feature has been selected, the **Name** field will be populated with a prefix to use for naming the geometric alignment. The prefix is defined in the selected feature. For example, choosing the feature definition **CL_P_Construction** will default to a **Name** value of CLP_ as shown at right.



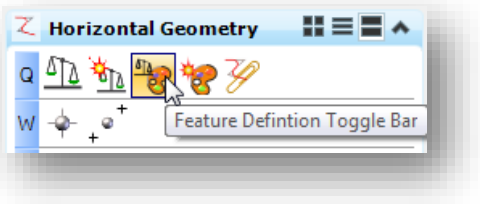
See the **ODOT CADD Engineering Standards Manual (ODOTcadd)**, Section 300, for more information on naming standards for geometric alignments.

Using the "Scratch Alignment" Feature Definition

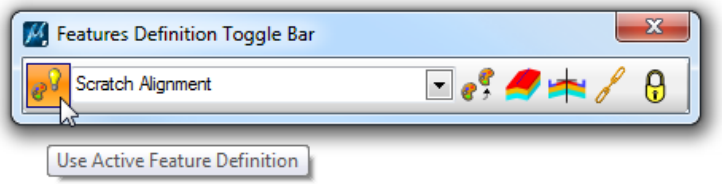
We recommend designing your alignments with a temporary feature assigned so the individual components of the geometric alignment (lines, arcs, spirals) are not automatically exported to the GPK file until you have completed the design of your alignment.

You can choose the Feature Definition as each element is placed, as shown on the previous page, or you can set the Active Feature as detailed below:

- ✓ Open the **Feature Definition Toggle Bar** from the **Horizontal Geometry** task group as shown below.



- ✓ Choose the feature definition **Geometry & Stations > Scratch Alignment** to use while working on alignments. This will draw the geometry on the level SC_Scratch1 and will not automatically export the individual elements (lines, arcs, spirals) to the GPK as they are drawn.

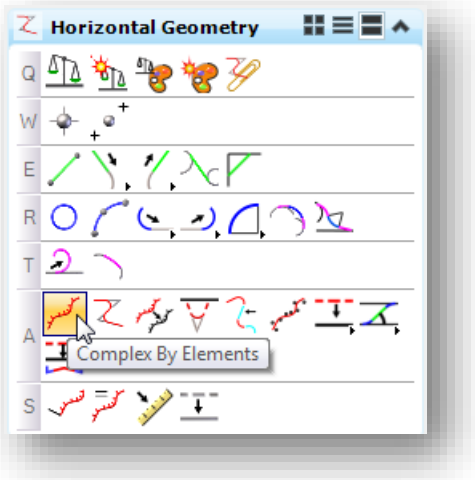


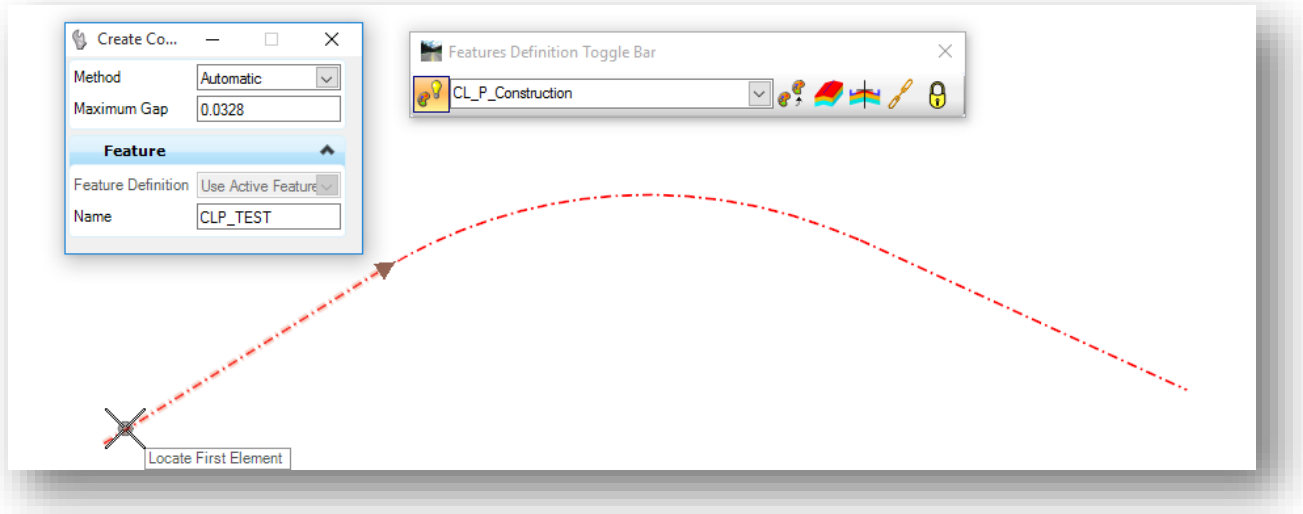
- ✓ Toggle on the **Use Active Feature Definition** option as shown above. This will automatically assign the selected feature as the active feature as you use various OpenRoads Geometry commands.

- ✓ Once the alignment has been completely defined, assign the appropriate feature to export and annotation the alignment when you store the graphics as a complex alignment. See the example on the following page.

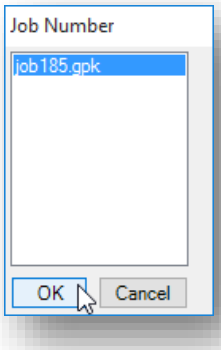
In the example below, two lines were drawn using the **Line Between Points** command. The central curve was created using the **Simple Arc** command.

The **Complex By Elements** command is used to create the alignment that will be exported to the GPK file and annotated.

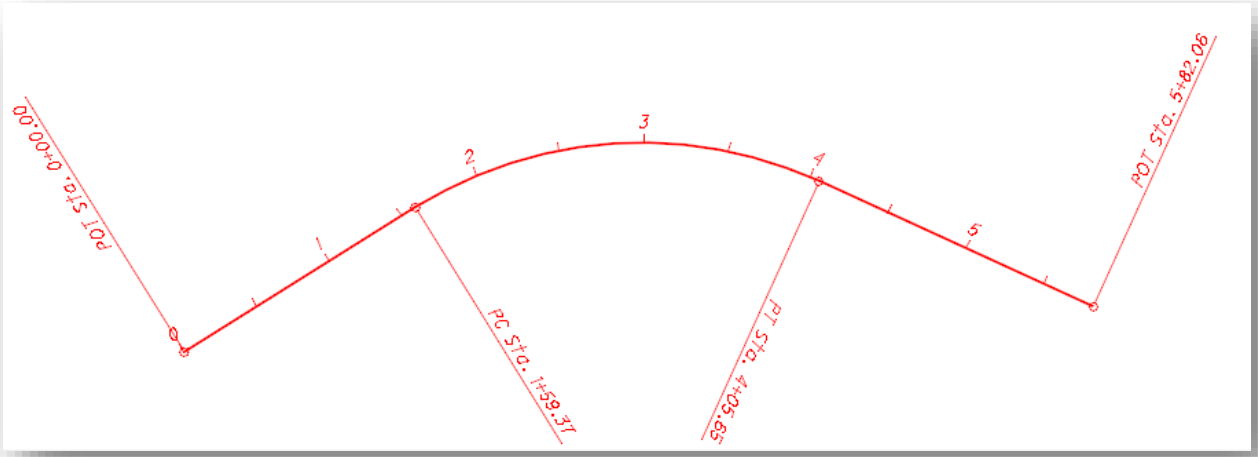




After the complex element has been created, the Auto Export function that has been defined for the Feature Definition will now automatically store the alignment in the GPK. You are prompted to select the GPK file to store the alignment as shown at right.



The graphics are updated using the **Active Feature** as shown on the following page.



In this example, the MicroStation Annotation Scale was set to **Engr 1:20** and the feature **Geometry & Stations > CL_P_Construction** was used. The graphics are placed on the level shown below for each feature definition.

Feature Name	MicroStation Level
CL_P_Construction	CL_P_Construction
CL_P_Driveway	GE_P_Driveway_CL
CL_P_MOT	CL_P_MOT
CL_P_RW	CL_P_RW
CL_X_Construction	CL_X_Construction
CL_X_MOT	CL_X_MOT
CL_X_RW	CL_X_RW
CL_X_Survey	CL_X_Survey
Scratch Alignment	SC_Scratch1

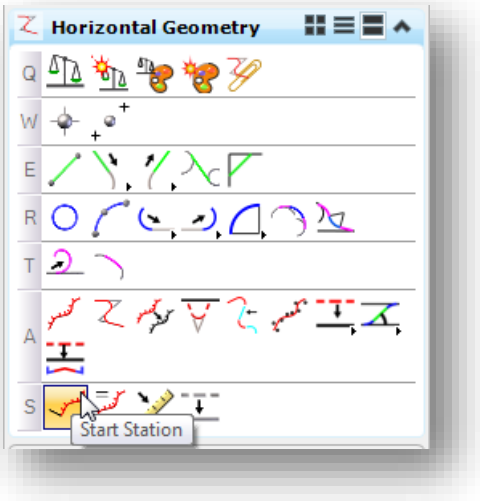
Notes:

- Use the **Scratch Alignment** feature when you are working on an alignment. Don't assign one of the other features until you create the complex element.
- The driveway Feature Definition does not place any stationing in the design file.
- These items should be thought of as equivalent to COGO Visualization graphics when using the legacy GEOPAK COO tools. The graphics and stations drawn when using these feature definitions are not intended for plan production.
- For plan production purposes, use the GEOPAK D&C Manager to plot the centerline and station information in the appropriate basemap design file.

5.10 Stations and Station Equations

Start Station

When OpenRoads alignments are stored, the software assumes a beginning station value of 0+00. This station can be redefined by use of the **Start Station** command.



The command has two parameters:

Start Distance
The distance along the alignment to assign the **Start Station**. The beginning station is computed based on the **Start Distance** and the **Start Station** value.

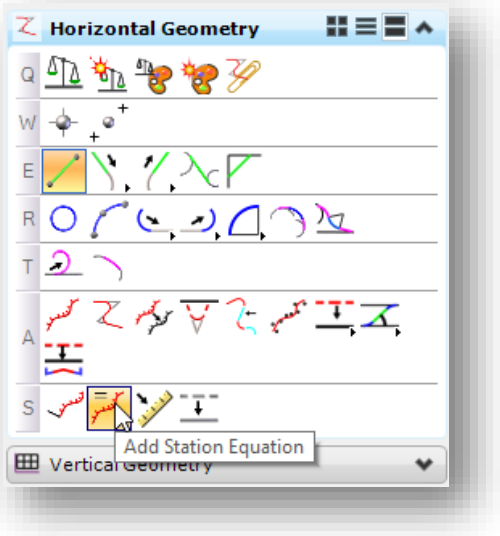
Start Station
The station value to be assigned at the **Start Distance** location.

When you assign the **Start Station** value to the alignment, if the feature definition that is assigned to the selected element has been defined with **Auto Export** and **Auto Annotate** set to **True**, the alignment is automatically updated in the GPK file and the graphics are updated to reflect the new station value.

Tip: Make sure MicroStation's current **Annotation Scale** setting is set to one of the supported, as defined on page 89, in order for the **Auto Annotate** function to properly update the graphics and display the alignment stationing.

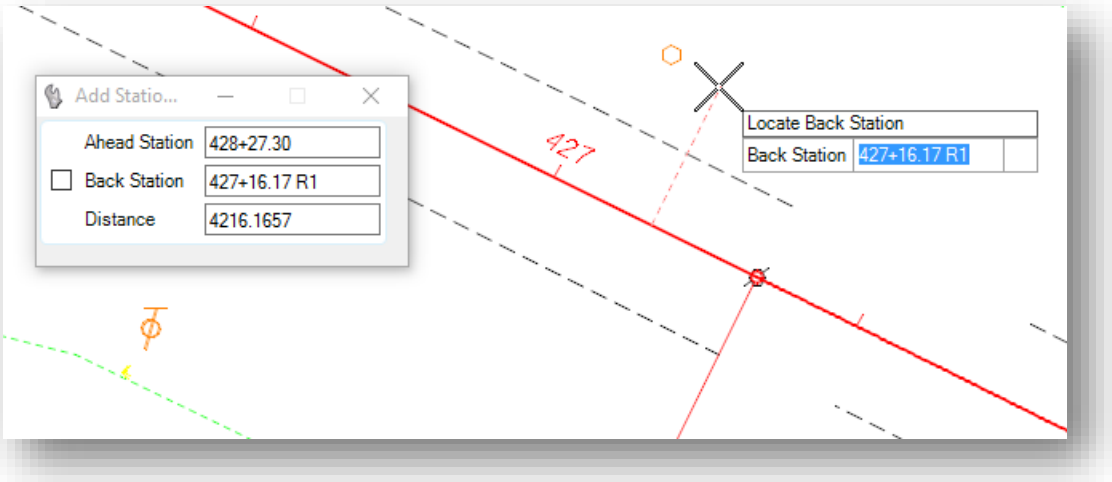
Add Station Equation

The **Add Station Equation** command, located to the right of the **Start Station** command adds parameters for the **Ahead Station** and **Back Station**.



When the command is selected, the user is prompted to select the alignment to assign the station equation.

After the alignment has been selected, the location of the equation can be identified graphically, or by keying in the **Back Station** value as shown below.



When the equation is applied, if the feature definition that is assigned to the selected element has been defined with **Auto Export** and **Auto Annotate** set to **True**, the alignment is automatically updated in the GPK file and the graphics are updated to reflect the new station equation.

Station equations are defined using the "Region" concept in the same manner as GEOPAK COGO chains. See ODOT's **GEOPAK Road 1 Training Guide** for more information on station equations.

5.11 Design Standards

Design Standards are used to monitor various alignment parameters on OpenRoads geometry elements. The standards are stored in the DGN Library ODOT_DesignStandards.dgnlib.

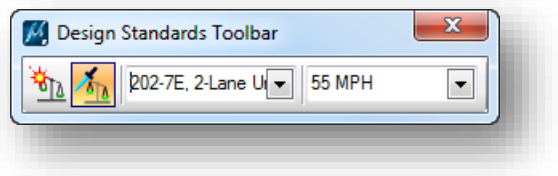
The design standards can be used for two purposes:

- Provide default values for element creation tools such as radius of a curve for a selected ODOT standard
- Check and report on the compliance of a geometric element with the design standard that has been assigned to the element

When a design standard is violated, the user is notified in two ways:

- An icon is displayed on the graphics to indicate that there is a problem
- The Civil Message Center reports any errors

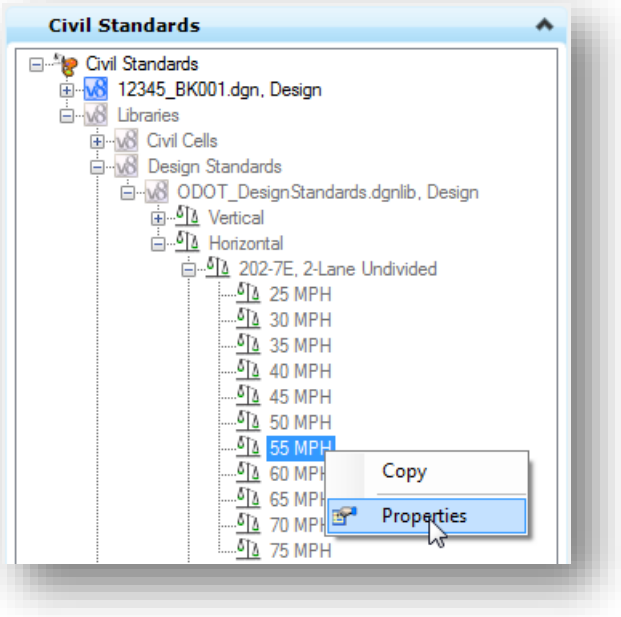
The **Design Standards Toolbar** allows you to select and apply a design standard. On the *Task* menu, select **Tasks > Civil Tools > General Geometry > Design Standards Toolbar**.



The toolbar contains a drop-down list to select the design standards and the design speed. The Vertical design standard is automatically set when the Horizontal design standards is selected.

There are two icons located to the left of the drop-down menus. The first, **Set Design Standard**, is used to apply the current design standard to selected geometric elements. The second, **Toggle Active Design Standard**, is used to set the selected design standards active for relevant commands.

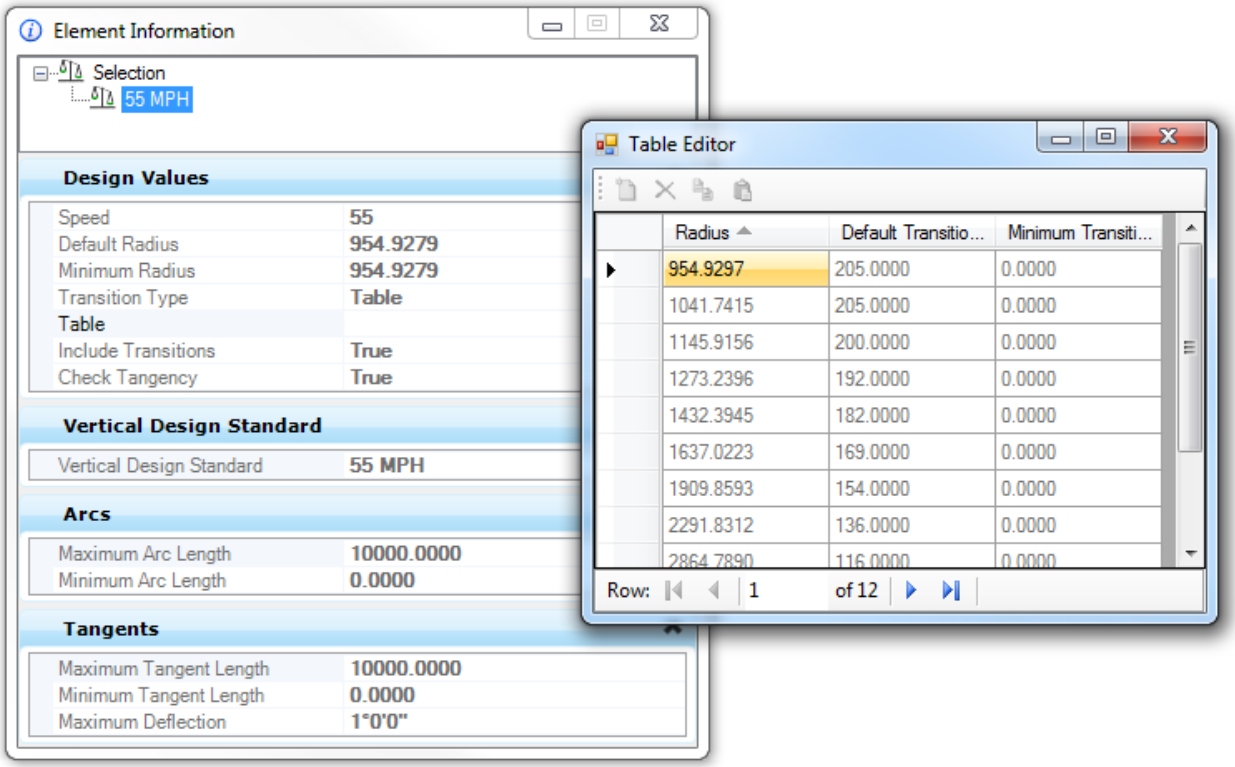
The values defined for a design standard can be reviewed in the *Project Explorer* dialog by right-clicking on the Design Standard and choosing the **Properties** option.



The properties for the selected design standard are shown below.

Transition lengths for acceptable radius values are defined in a table. Selecting the Table option in the properties list will allow you to review the values that have been defined for a specific design standard.

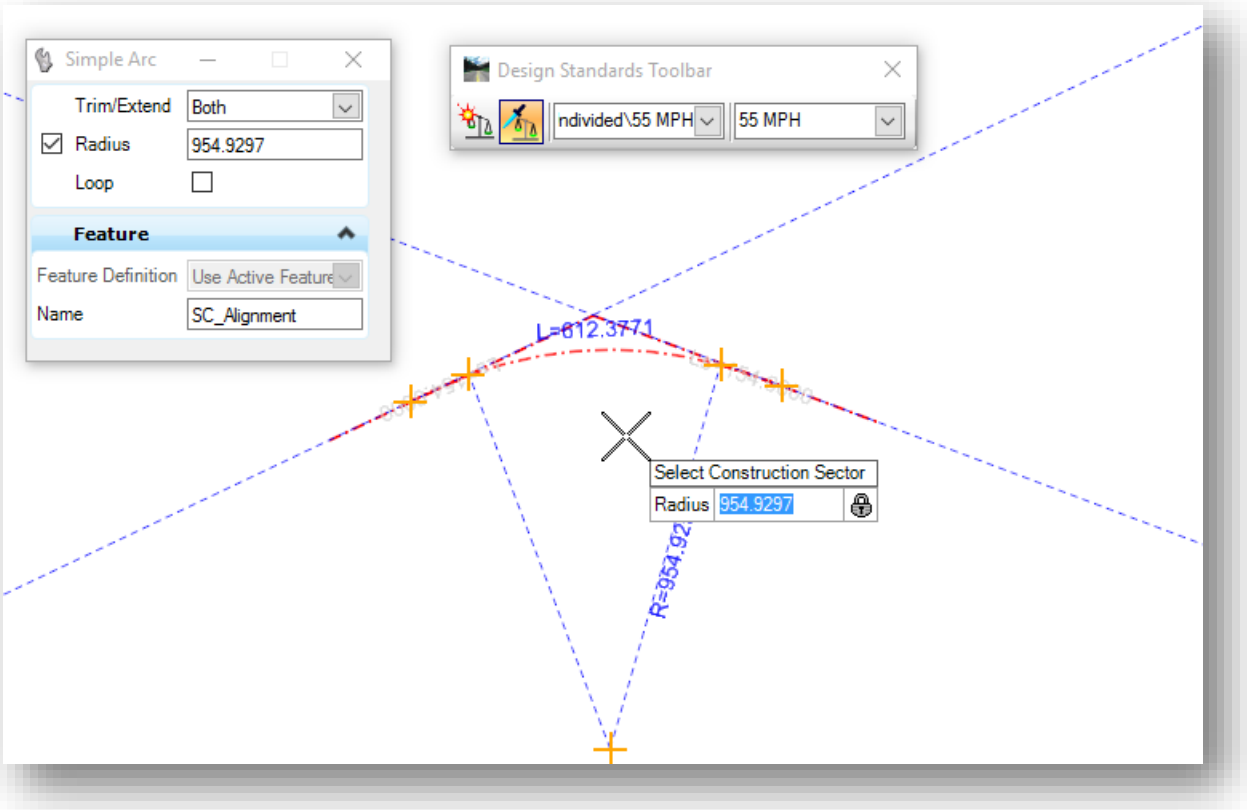
For each radius entry, the appropriate transition (spiral) length is shown.



To Apply a Design Standard

Let's take a look at an example applying a design standard when using the Simple Arc command to place a curve between two tangent lines.

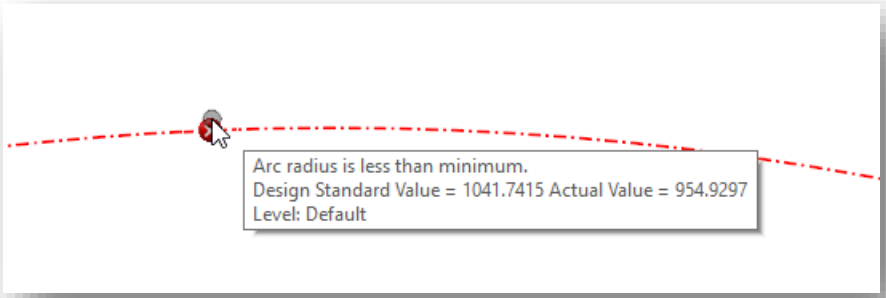
- The *Design Standards Toolbar* is set to the ODOT standard **202-8E, 2-Lane Undivided** with a design speed of **55 MPH**
- The **Toggle Active Design Standard** icon is checked on
- Using the **Simple Arc** command, the **Radius** value defaults to the value defined in the selected design standard, **954.9279**
- The design standard defines a minimum transition length of 205 for the default radius. Spirals will be placed even though the **Simple Arc** command was initially selected.



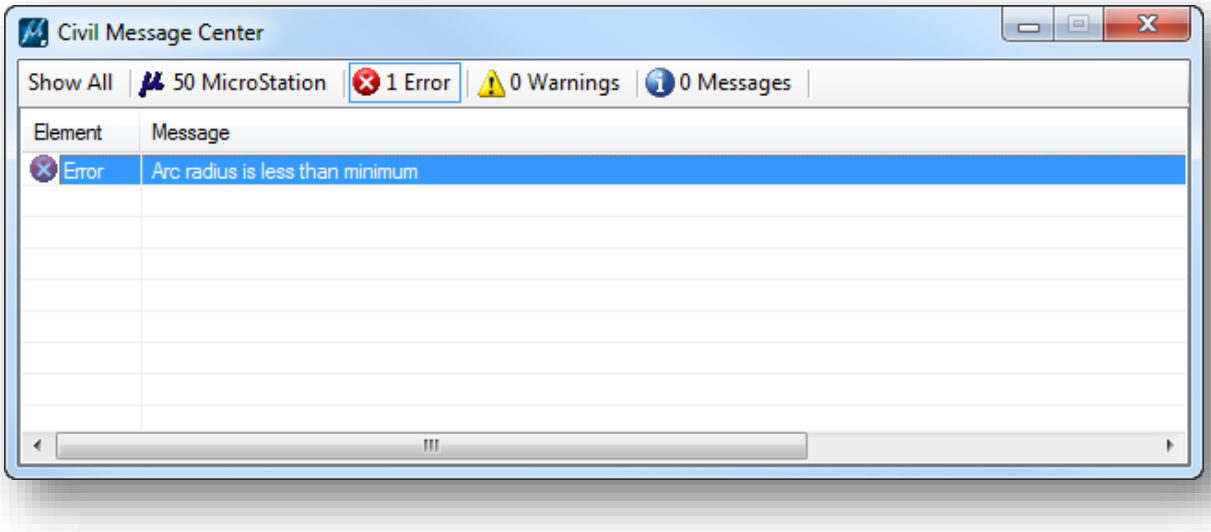
Design Standards can also be applied to an element after it has been created by using the **Set Design Standard** icon on the *Design Standards Toolbar*.

To Review a Design Standard Violation

In the event that a design standard is violated, the software will display an icon on the element with the violation similar to the example below. Floating the cursor over the icon will display the error message.



Errors can also be reviewed in the Civil Message Center by selecting Ta**sks > Civil Tools > General Geometry > Civil Message Center**. Toggle on the **Error** option to view any errors.



You can zoom to the error by right-clicking on the error and choosing the **Zoom To** option.

Exercise 5C – Proposed State Route 185

State Route 185 is the main alignment for our project. In this exercise we'll lay out a new proposed alignment for State Route 185.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ In the MicroStation *File Open* dialog, set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_HORIZ_GEOMETRY

- ✓ Open the geometry basemap for State Route 185:

  ..\Design\Geopak\Basemaps\12345_BK002.dgn

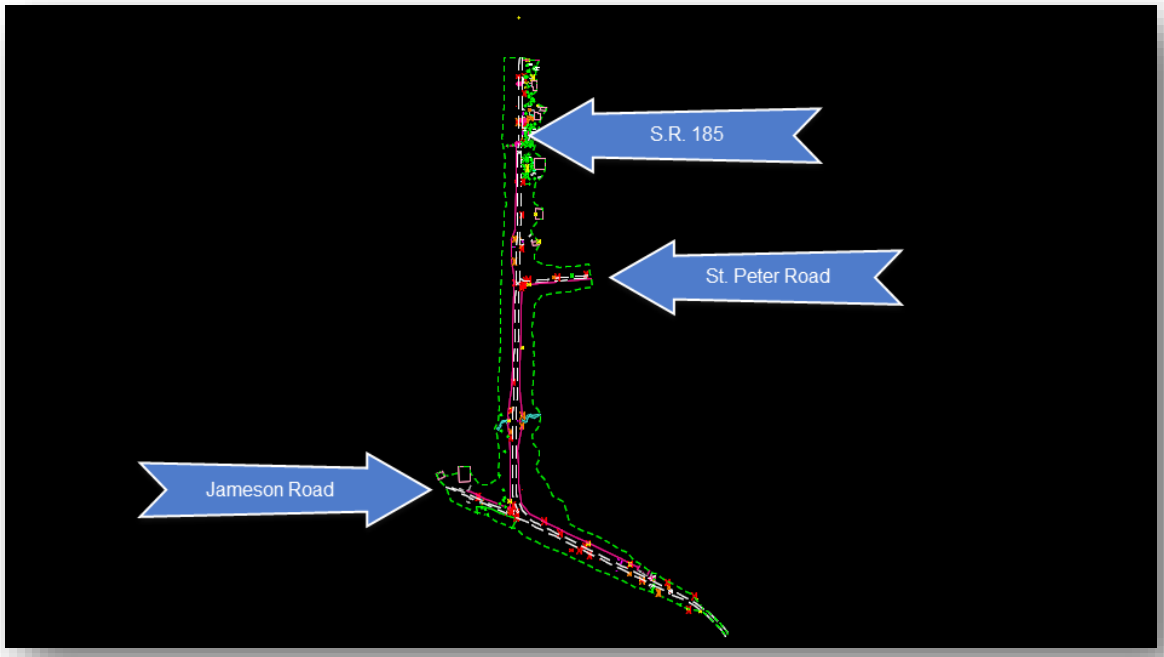
- ✓ Attach the survey information as a reference file. The survey information is located in the following design file:

  ..\Design\Survey\Basemaps\12345_BE001.dgn

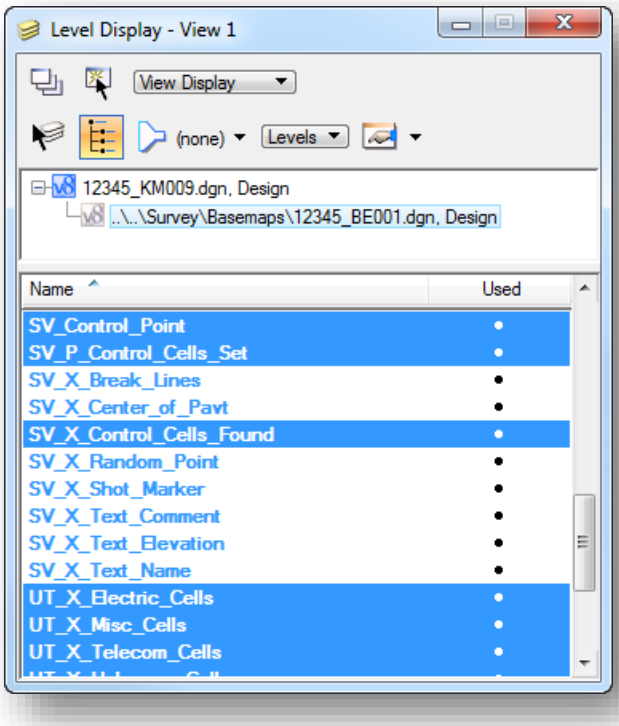
  When attaching the reference file, which **Orientation** option should be used? **Coincident – World**, or **Geographic – Reprojected**?

  Should **Live Nesting** be used?

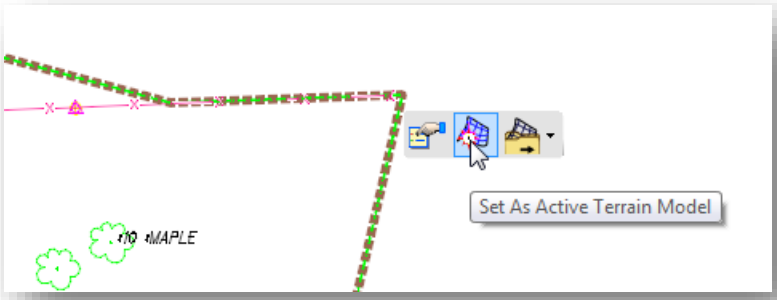
The sample project contains three roads as shown below.



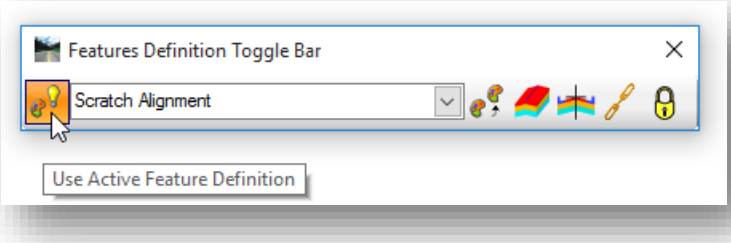
✓ Turn on/off levels for the survey information as necessary. Start by turning off the levels shown below, and any other levels that you may not want to see while working on the geometry for the project.



✓ Select the terrain model graphics from the reference attachment and set it as the Active Terrain (select the terrain boundary and then hover the mouse over the boundary to get the pop-up toolbar seen below, a long right click on the boundary will bring up a context menu where the Set of Active Terrain Model button can be found as well).

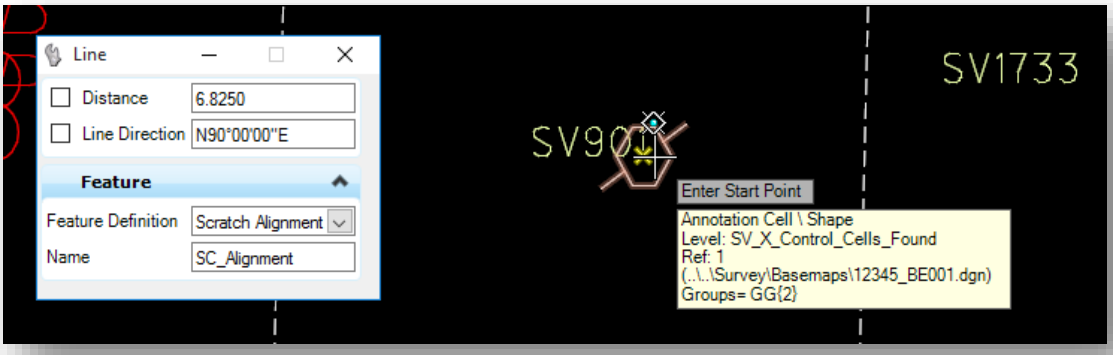


✓ From the **Civil Tools > General Geometry** task list, choose the **Features Definition Toggle Bar** icon. Set the active feature to **Geometry and Stations > Scratch Alignment**. Toggle on the **Use Active Feature Definition** icon.



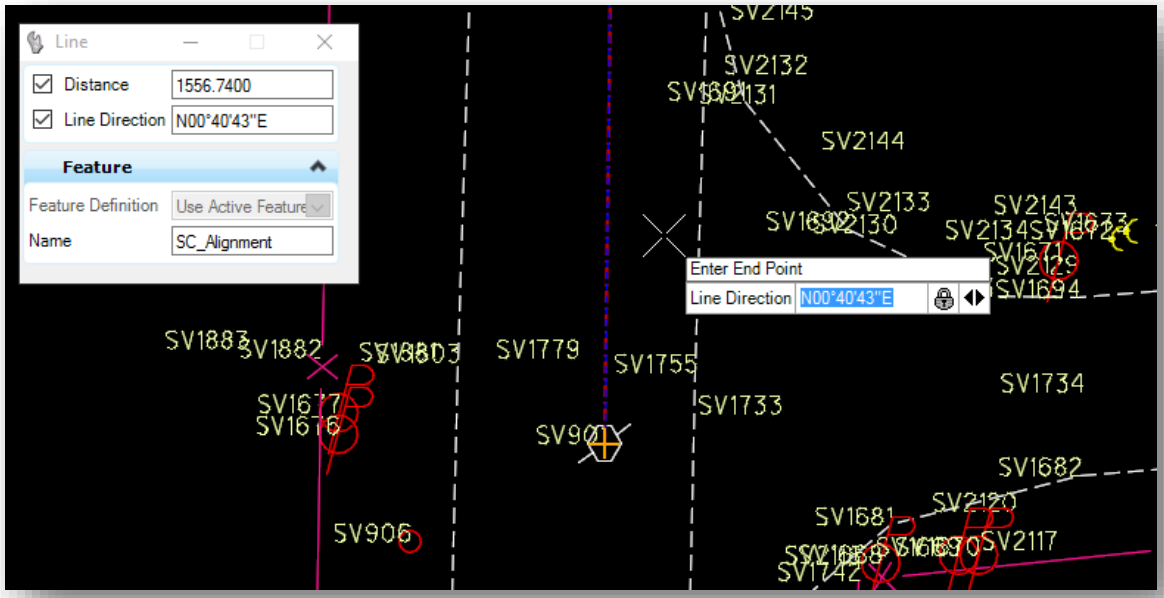
✓ From the *Task* list, choose the **Civil Tools > Horizontal Geometry > Line Between Points** command.

Start by placing a line from the RSPK feature located at the intersection of St. Peter Road and S.R. 185. This is point SV901 in the Survey file. Use the MicroStation Origin Snap to ensure you are starting the first point of the line by snapping to the center of the RRSKP cell.



✓ Define the second point of the line with a **Distance** of **1556.74** and a **Line Direction** of **N00^40’43”E** as shown below.

Tip: Degrees, minutes, and seconds are entered using the colon character as a separator. Example: n00:40:43e



✓ Use the **Line Between Points** command to store the following lines.

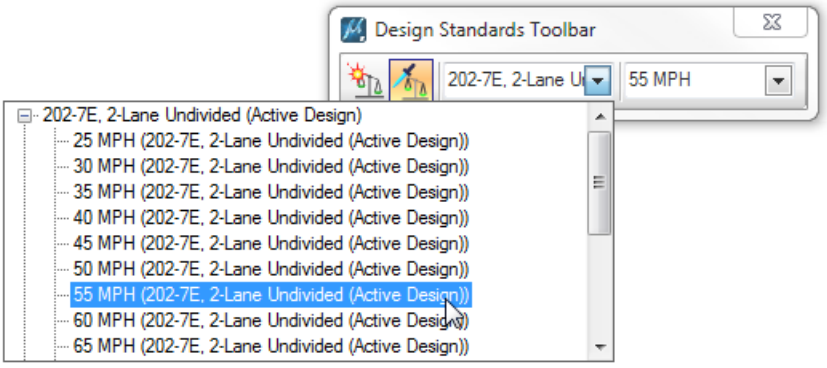
Starting from the RRSPK feature, SV901.
Distance: 1595.31
Line Direction: s01:13:48"w

Starting from the end of the previous line.
Distance: 1838.00
Direction: s63:50:18e

Starting from the end of the previous line.
Distance: 650.00
Direction: s03:35:00w

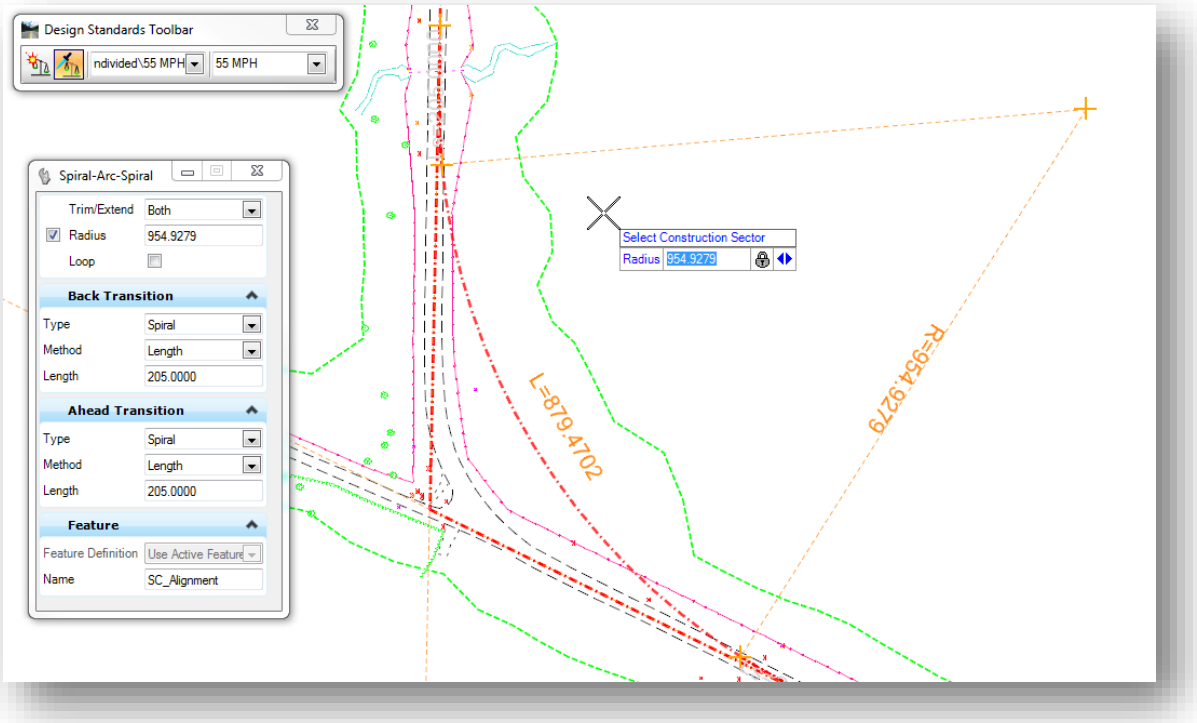
✓ Next we'll use the *Design Standards Toolbar* to place a spiral-curve-spiral set. From the MicroStation *Task* list, choose the **Civil Tools > General Geometry > Design Standards Toolbar** icon.

✓ Toggle on the second icon, **Toggle Active Design Standard**, and select the item shown below.

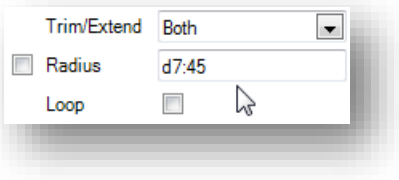


✓ From the *Task* list, choose the **Civil Tools > Horizontal Geometry > Spiral-Arc-Spiral** command (this is a sub-command of the **Simple Arc** command and is accessed by holding down a data-point on the **Simple Arc** command).

When using a **Design Standard**, the software will set the length of the spirals and the degree of curvature is set to the default values defined by the selected design standard.



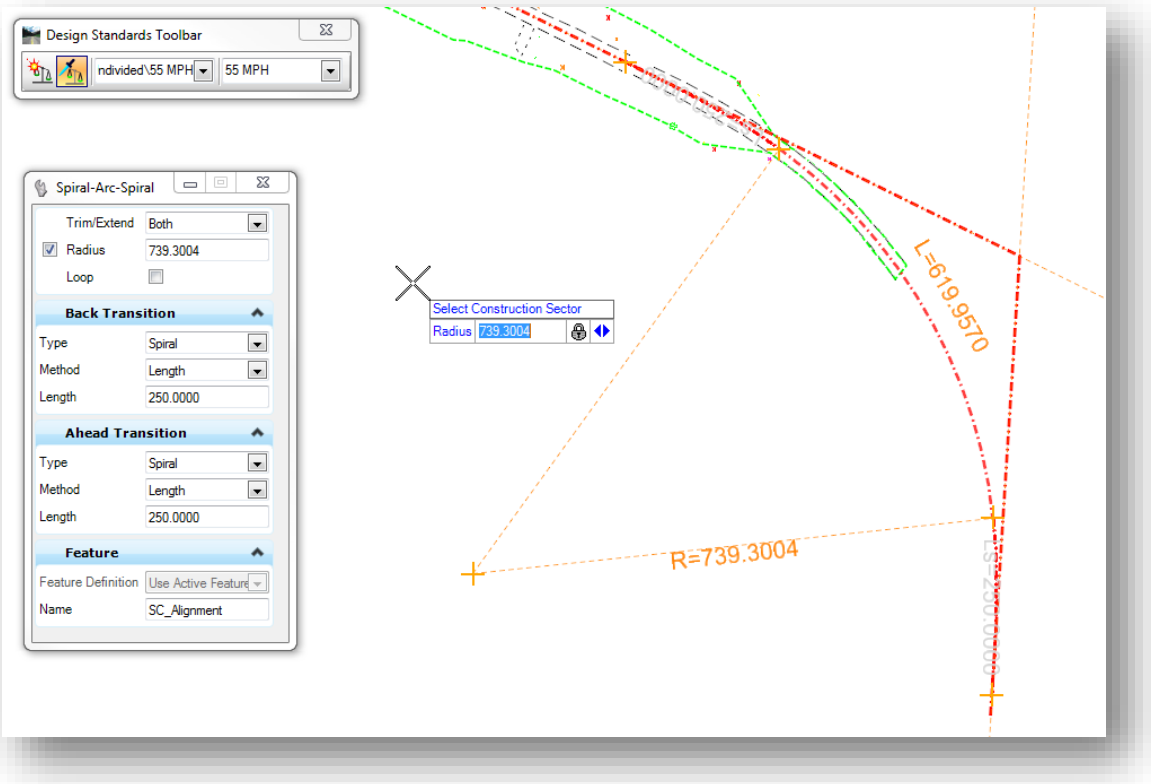
✓ Use the **Trim/Extend Both** option to complete the process



✓ Place the second spiral-curve-spiral using the following values:

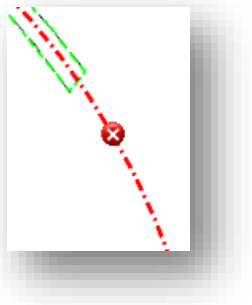
Radius: d7:45
Back Transition Length: 250
Ahead Transition Length: 250

Tip: The degree of curve can be set by keying in the degree value in the **Radius** field prefixed with a lower case "d". Degrees, minutes, and seconds are separated by the colon character.



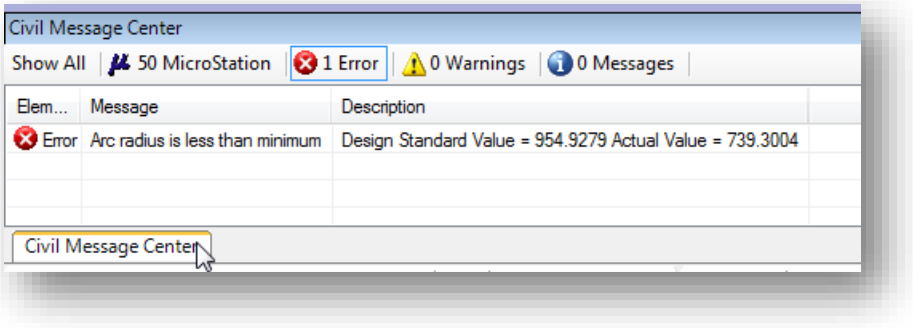
✓ Use the **Trim/Extend Both** option to complete the process

The second spiral-curve-spiral combination does not meet the currently selected 55 MPH Design Standard. A red X is displayed on the curve as shown at right. Design errors can be reviewed in the *Civil Message Center* dialog.



In the default ODOT configuration, the *Civil Message Center* is docked and unpinned below the MicroStation view window.

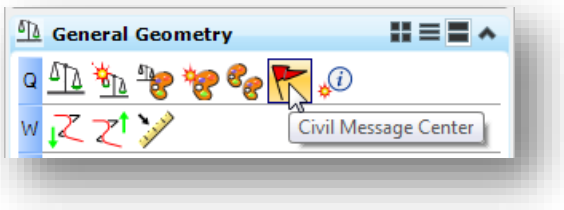
Floating your cursor over the tab will open the dialog as shown below.



Information about the error is displayed similar to the example above.

No action is required to remedy the error in order to continue designing the corridor model. This is strictly informational and can be ignored if the data is correct.

If the *Civil Message Center* dialog has been closed, it can be opened from the **General Geometry** task group as shown below.



Next we will create a complex chain from the individual elements that have been placed for the proposed centerline of S.R. 185.

We will assign a feature definition for the complex element that will automatically export the centerline element to the active GEOPAK Coordinate Geometry Database (GPK file). Before creating the complex chain, make sure the GEOPAK **Working Directory** is defined to specify the location of the GPK file and that the GPK file exists.

- ✓ Open the GEOPAK *User Preferences* dialog by selecting **GEOPAK > Road > User Preferences**
- ✓ Verify that the **Working Directory** is set appropriately for the active project. For this training class, the **Working directory** should be set as follows:

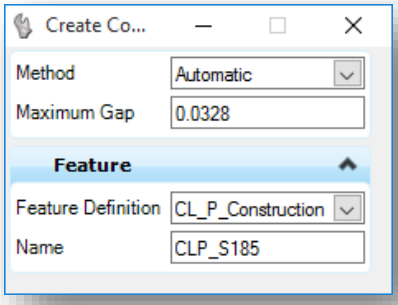
  C:\ODOT_Training\OpenRoadsDesign\ProjectData\12345_HORIZ_GEOMETRY\Design\Geopak

- ✓ Close the *User Preferences* dialog when complete

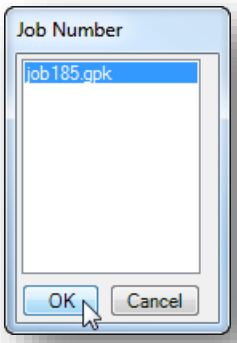
After verifying the **Working Directory** is set correctly for the project, take the following steps to create the complex element:

- ✓ Set the MicroStation **Annotation Scale** value to **Engr 1:20** (from the MicroStation pull-down menu select **Settings > Drawing Scale**). Remember that the various centerline feature definitions are configured to support only specific annotation scale values as previously described.

- ✓ From the *Task* list, choose the **Civil Tools > Horizontal Geometry > Complex By Elements** icon
- ✓ Set the **Feature Definition** to the **Geometry and Stations > CL_P_Construction** as shown at right.
- ✓ Key in the **Name** for the centerline element. Remember that a chain element will be stored in the GPK file; therefore the name must follow GEOPAK COGO element name restrictions. See the **ODOT CADD Engineering Standards Manual (ODOTcadd) Section 300** for more information on naming COGO elements.



- ✓ Using the **Automatic Method**, choose the first element to define the complex element. Note that the direction of the element is significant. When you move the cursor over the first element, an arrow is displayed indicating the direction the complex element will be defined.



- ✓ Select and accept the first element. The entire complex chain is highlighted. The *Job Number* dialog is opened displaying a list of all the GPK files found in the current GEOPAK **Working Directory**. Choose the **job185.gpk** file to store the complex element in the GPK.

- ✓ The complex element is created and stored in the GPK using the **Name** you have specified. If a chain exists in the GPK with the same name, it is overwritten. The COGO **Redefine** option is ignored.

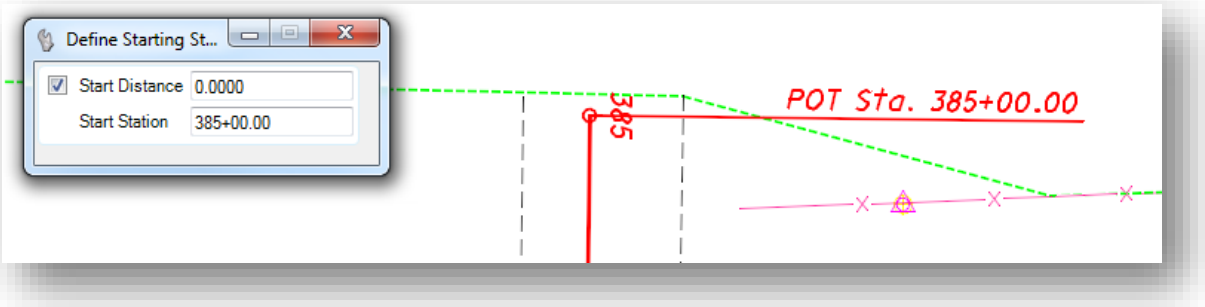
- ✓ The **Auto Annotate** function defined by the feature definition will ensure that the stationing is displayed in the design file. If the stationing is not displayed, either the chain was not successfully stored in the GPK file, or the current MicroStation **Annotation Scale** setting does not match one of the scales that the **Feature Definition** that was configured for.

The chain is stored with a default beginning station value of 0+00. Use the **Start Station** tool to define the beginning station for the newly created alignment as detailed below.

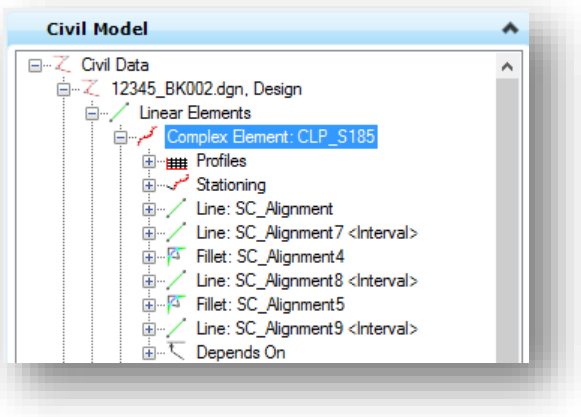
- ✓ From the *Task* list, choose **Civil Tools > Horizontal Geometry > Start Station**.

  The **Start Distance** parameter defines the location along the selected alignment where the **Start Station** value is applied. The **Start Distance** should be 0 and the **Start Station** is 385+00.00

  When the **Start Station** value is assigned, the stationing is automatically updated in the design file, as well as in the GPK file. This automatic update to the COGO Chain in the GPK file only happens if the Feature Definition of the selected alignment has the Auto Export parameter set to a value of **True**.

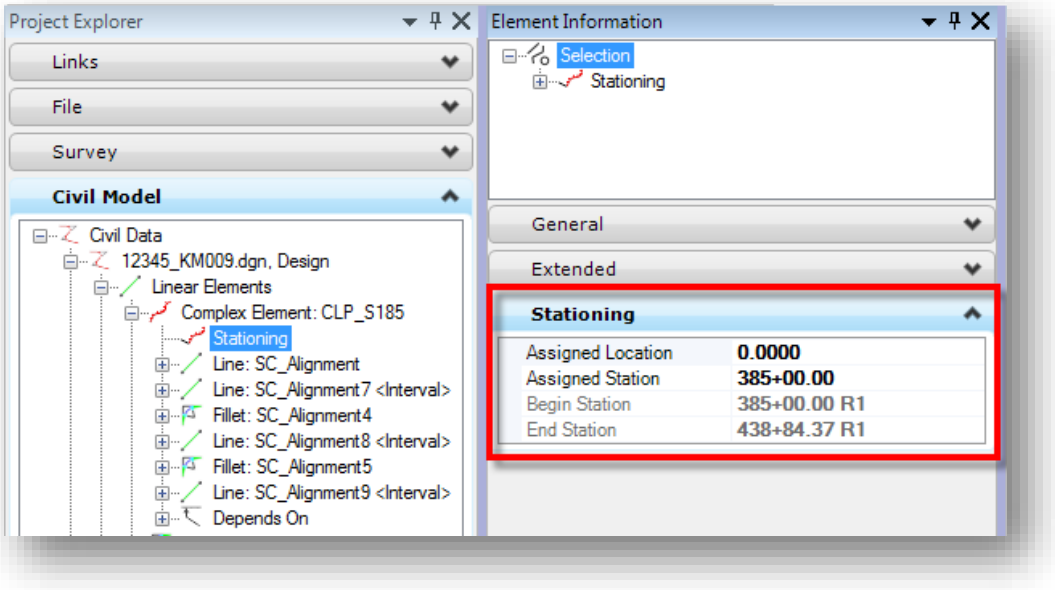


The parameters for each alignment can be reviewed using the *Project Explorer* dialog's **Civil Model** group.



Various parameters can be reviewed and/or edited in *Project Explorer* by right-clicking on an item and selecting **Properties**.

For example, the **Assigned Station** value can be reviewed and edited in the *Element Information* dialog as shown below.



When a federated approach is used to create separate design files for each alignment, the graphics may not automatically display in the "000" basemap (see **Using Multiple "Federated" Basemaps**).

- ✓ Open the file 12345_BK000.dgn
- ✓ Verify that the file containing the S.R. 185 centerline, 12345_BK002.dgn, is attached as a reference
- ✓ If the graphics for the S.R. 185 centerline are not displayed, use MicroStation's ***Level Display*** dialog to turn on/off the desired levels for each reference attachment
- ✓ Save settings and close the 000 file when complete

Exercise 5D – St. Peter Road Improvements

St. Peter Road is located roughly in the center of the project. This is a simple centerline consisting of only one tangent line. Take the following steps to define the centerline for St. Peter Road:

- ✓ Open MicroStation using the shortcut provided for the training class.

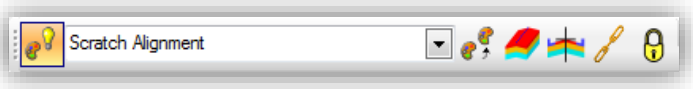
- ✓ Set the MicroStation **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_HORIZ_GEOMETRY

- ✓ Open the design file that will be used for the St. Peter Road alignment:
  ..\Design\Geopak\Basemaps\12345_BK003.dgn

- ✓ Attach the alignment information for CLP_S185 as a reference file. Use a **Nest Depth** of **1**.
  ..\Design\Geopak\Basemaps\12345_BK000.dgn

- ✓ Attach the survey information as a reference file.
  ..\Design\Survey\Basemaps\12345_BE001.dgn

- ✓ In the *Features Definition Toggle Bar*, set the **Active Feature** to **Geometry and Stations > Scratch Alignment** and toggle on the **Use Active Feature** option



- ✓ Use the **Line Between Points** command to store a line with the following parameters:

  Start Point:
  Snap to the center of the RSPK feature at Station 400+56.74 on CLP_S185

  End point:
  Distance: 500’
  Bearing: N84^09’20”E

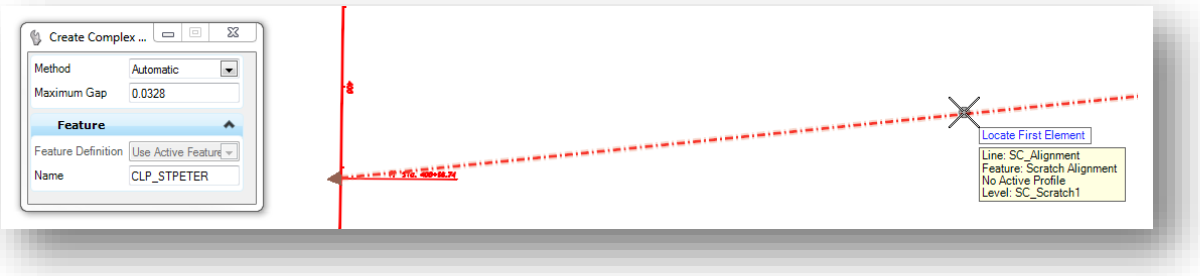
Even though this centerline consists of a single element, we still have to make it a complex element to store it as a chain in the GPK file.

- ✓ Use the **Complex By Elements** command to define a chain named **CLP_STPETER**.

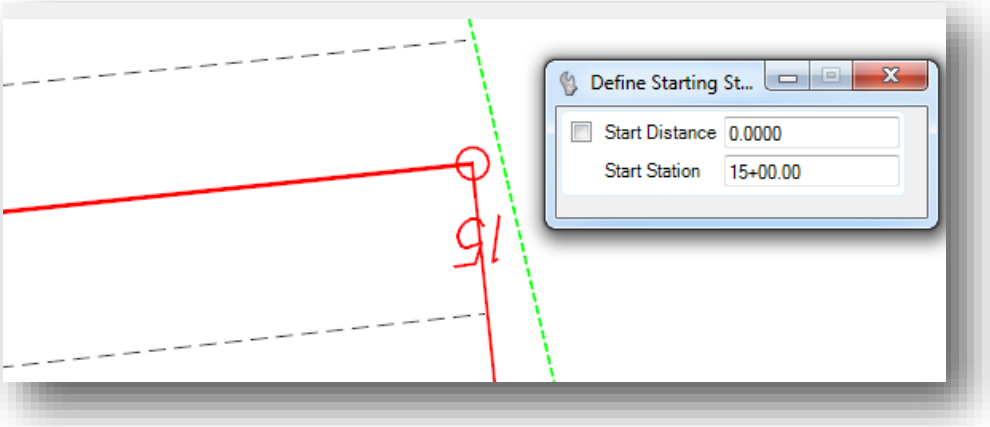
- ✓ Set the model **Annotation Scale** value to **1:20**

- ✓ In the *Features Definition Toggle Bar*, set the **Active Feature** to **Geometry and Stations > CL_P_Construction** and toggle on the **Use Active Feature** option

- ✓ Be sure to define the complex element for the centerline of St. Peter Road with the direction going towards the centerline of S.R. 185 as shown below.



- ✓ When prompted, store the alignment in job185.gpk
- ✓ Use the **Start Station** command to redefine the Start Station as 15+00 with a Start Distance of 0.



- ✓ From the MicroStation menu, choose **File > Save Settings** when complete

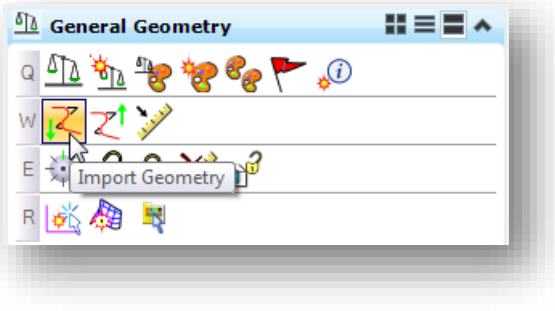
When a federated approach is used to create separate design files for each alignment, the graphics may not automatically display in the "000" basemap (see **Using Multiple "Federated" Basemaps**).

- ✓ Open the file 12345_BK000.dgn
- ✓ Verify that the file containing the St. Peter Road centerline, 12345_BK003.dgn ,is attached as a reference
- ✓ If the graphics for the St. Peter Road centerline are not displayed, use MicroStation's ***Level Display*** dialog to turn on/off the desired levels for each reference attachment
- ✓ Save settings and close the 000 file when complete

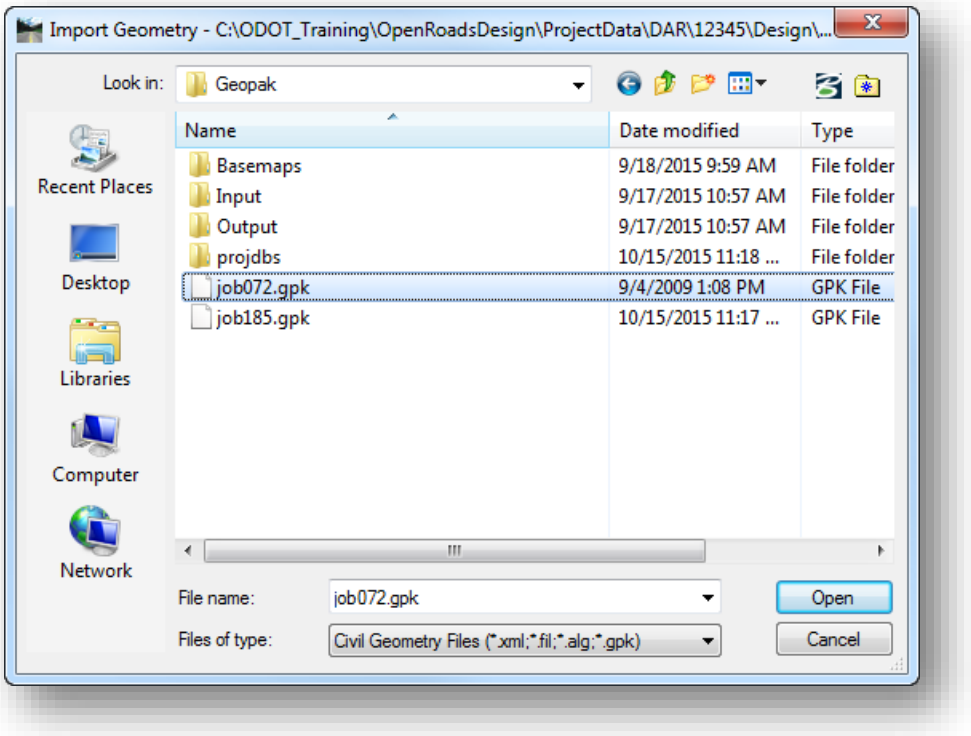
5.12 Importing OpenRoads Geometry from a GEOPAK GPK file

Geometry that has been previously defined in a GEOPAK Coordinate Geometry database can be easily imported from the GPK file into the design file as an OpenRoads Civil Geometry element. This includes both horizontal and vertical geometry; however, vertical geometry cannot be imported without a corresponding horizontal alignment.

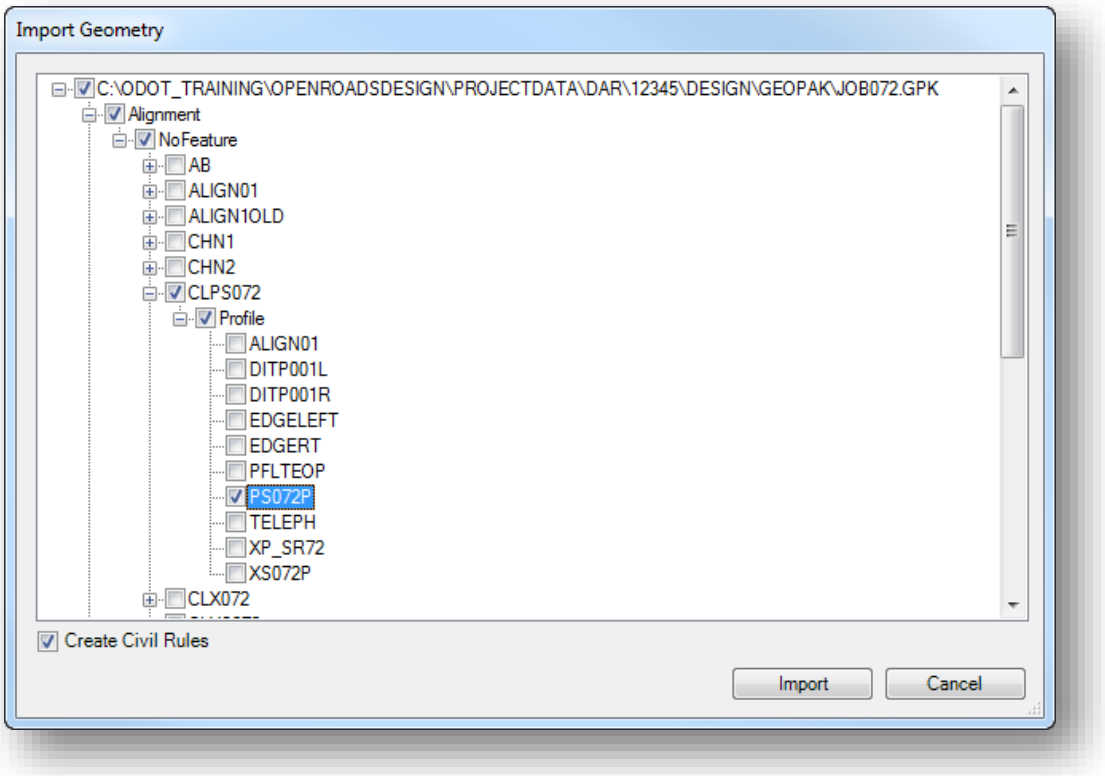
To import geometry from a GPK file, choose the **Import Geometry** command from the *Tasks* menu's **General Geometry** group as shown below.



The *Import Geometry* dialog is opened as shown below. Select the GPK file that you wish to use to import the geometry.



After selecting the GPK file, another Import Geometry dialog is opened as shown on the following page. This dialog allows users to specifically choose which alignments and profiles to import as civil geometry alignments.



When importing profiles, be sure to choose only the proposed profile. There is no need to import existing profiles as the OpenRoads software will automatically create an existing profile from the active terrain model.

Toggle on the **Create Civil Rules** option to create ruled geometry.

Choose **Import** to initiate the process.

The geometry is imported using the feature definition defined in the GPK file. If no feature definition is defined, the resulting geometry in the dgn file will not have a feature definition assigned.

Note: The feature definition can be changed to an ODOT definition after the geometry has been imported. Remember that choosing a feature definition with the **Auto Export** option set to a value of **True** will export the geometry to a GPK file.

Exercise 5E – Proposed Jameson Road

The alignment and profile for Jameson Road has been previously stored in a GPK file. In this example, we will import the alignment and profile for Jameson Road from the GPK file.

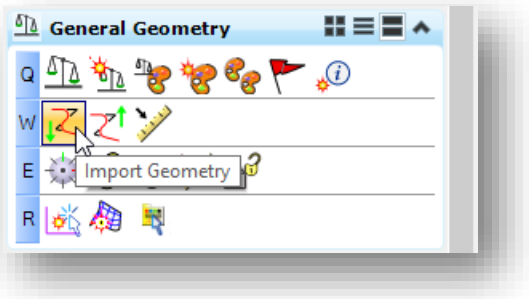
- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the User and Project as follows:
  User: ODOTcadd
  Project: 12345_HORIZ_GEOMETRY

- ✓ Open the design file that will be used for the Jameson Road alignment:
  ..\Design\Geopak\Basemaps\12345_BK004.dgn

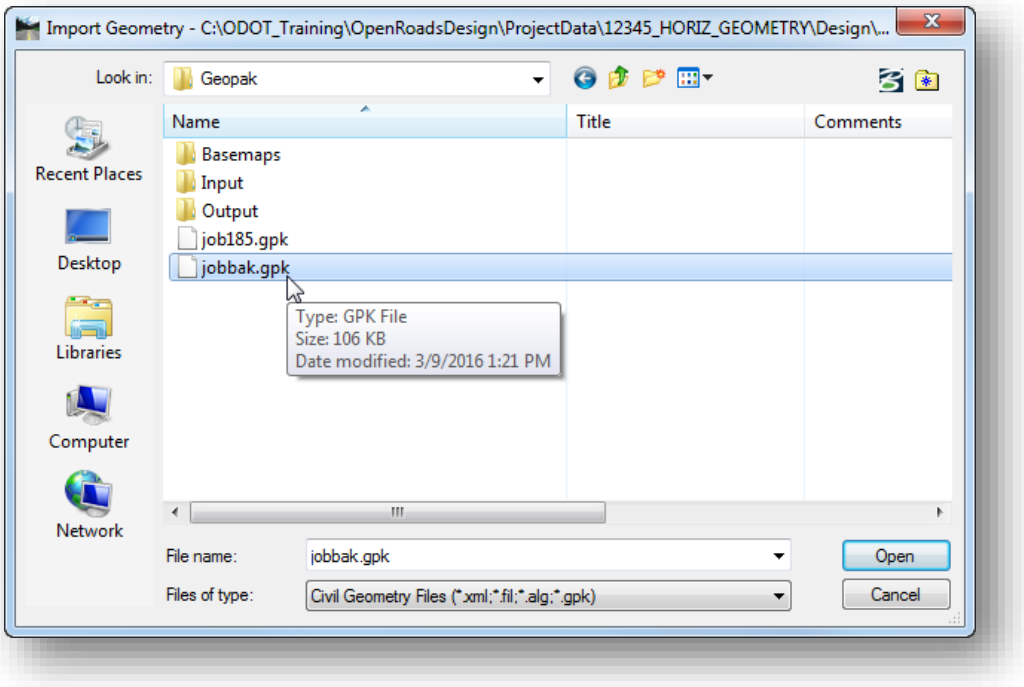
- ✓ Attach the survey information as a reference file.
  ..\Design\Survey\Basemaps\12345_BE001.dgn

- ✓ Select the **Import Geometry** command from the **General Geometry** task group as shown below.

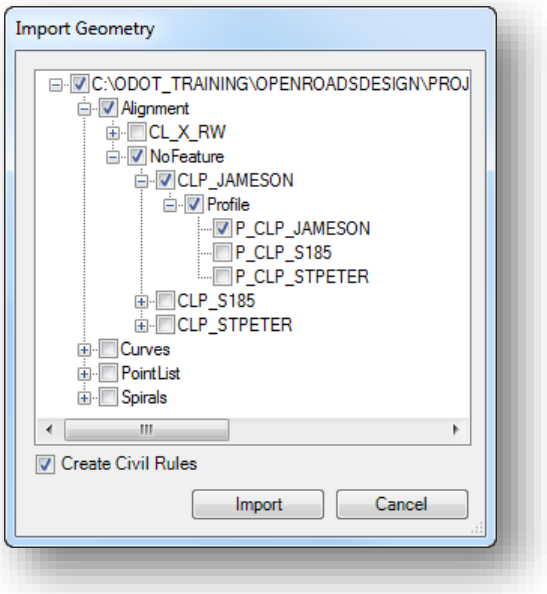


- ✓ You are prompted to select the GPK file containing the data that you wish to import. Select the file ***jobbak.gpk***.

  The *Import Geometry* dialog is opened as shown on the following page.

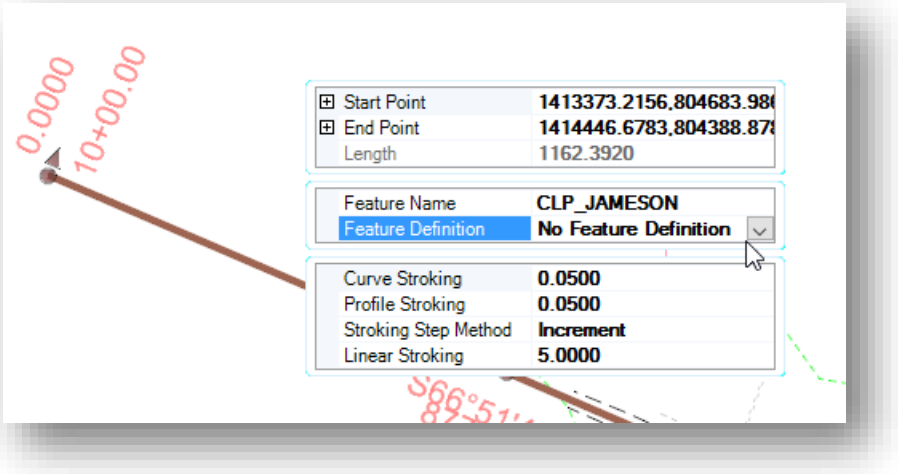


✓ Select the **Alignment** and associated **Profile** as shown below. Check on the **Create Civil Rules** option. Choose the **Import** command to initiate the process.



The alignment and profile are imported into the active design file using the feature definition that is assigned in the GPK file. In the example above, **No Feature** was defined for the alignment. The data is imported without an assigned feature definition.

- ✓ Select the alignment and choose the *Properties* icon to review the **Feature Name** and **Feature Definition** as shown below.



The alignment can be given a **Feature Definition** by choosing one of the **Geometry and Stationing** features from the list. Remember, when one of the **Geometry and Stationing** feature definitions is assigned the **Auto Export** and **Auto Annotate** functions will write the chain and profile to the selected GPK file and annotate the stations for the alignment. Be sure to choose the job185 GPK file to write the data back to the correct gpk file for the project.

- ✓ Set the **Feature Definition** to **Geometry & Stations > CL_P_Construction** for the Jameson Road Alignment

- ✓ When prompted to store the alignment in a GPK file, choose **job185.gpk**

  The alignment and stationing is redrawn using the selected feature definition

- ✓ From the MicroStation menu, choose **File > Save Settings** when complete

When a federated approach is used to create separate design files for each alignment, the graphics may not automatically display in the "000" basemap (see **Using Multiple "Federated" Basemaps**).

- ✓ Open the file 12345_BK000.dgn
- ✓ Verify that the file containing the Jameson Road centerline, 12345_BK003.dgn ,is attached as a reference
- ✓ If the graphics for the Jameson Road centerline are not displayed, use MicroStation's ***Level Display*** dialog to turn on/off the desired levels for each reference attachment
- ✓ Save settings and close the 000 file when complete

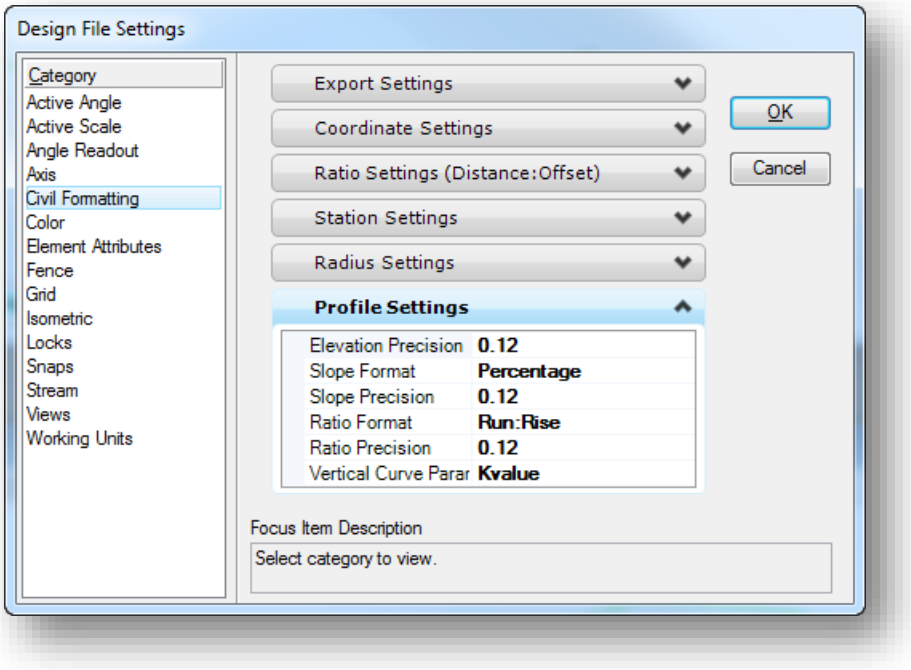
6 Vertical Geometry

The OpenRoads technology stores vertical alignments as a component of the horizontal alignment in the same design file as the horizontal geometry. This is true for both existing vertical alignments, which are extracted from an OpenRoads Terrain Model, and proposed vertical alignments.

Although the vertical geometry is stored in the design file, the graphical display of the vertical alignment information is not plotted in the design file. Vertical alignments are displayed in a profile window for review and editing. To plot the vertical alignment information in a design file that can be used for plan and profile sheet clipping, the vertical alignments must be exported to a GPK file and drawn into MicroStation using the legacy GEOPAK Design and Computation Manager tool.

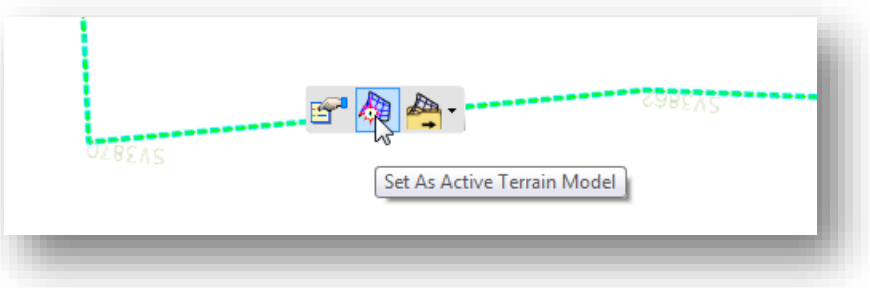
6.1 Profile Settings

The Design File settings contain parameters for formats as you work with vertical alignments. Select **Settings > Design File** and then click the **Civil Formatting** item from the list on the left of the dialog. The **Profile Settings** are set to the values shown below in the ODOT seed files.

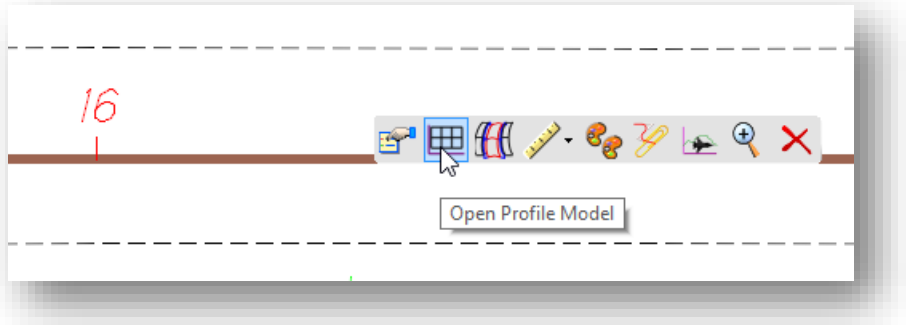


6.2 Existing Ground Profiles

Existing ground profiles are extracted along the selected element from the active terrain model. The active terrain model is set by selecting the terrain element and choosing the **Set As Active Terrain Model** icon as shown below.

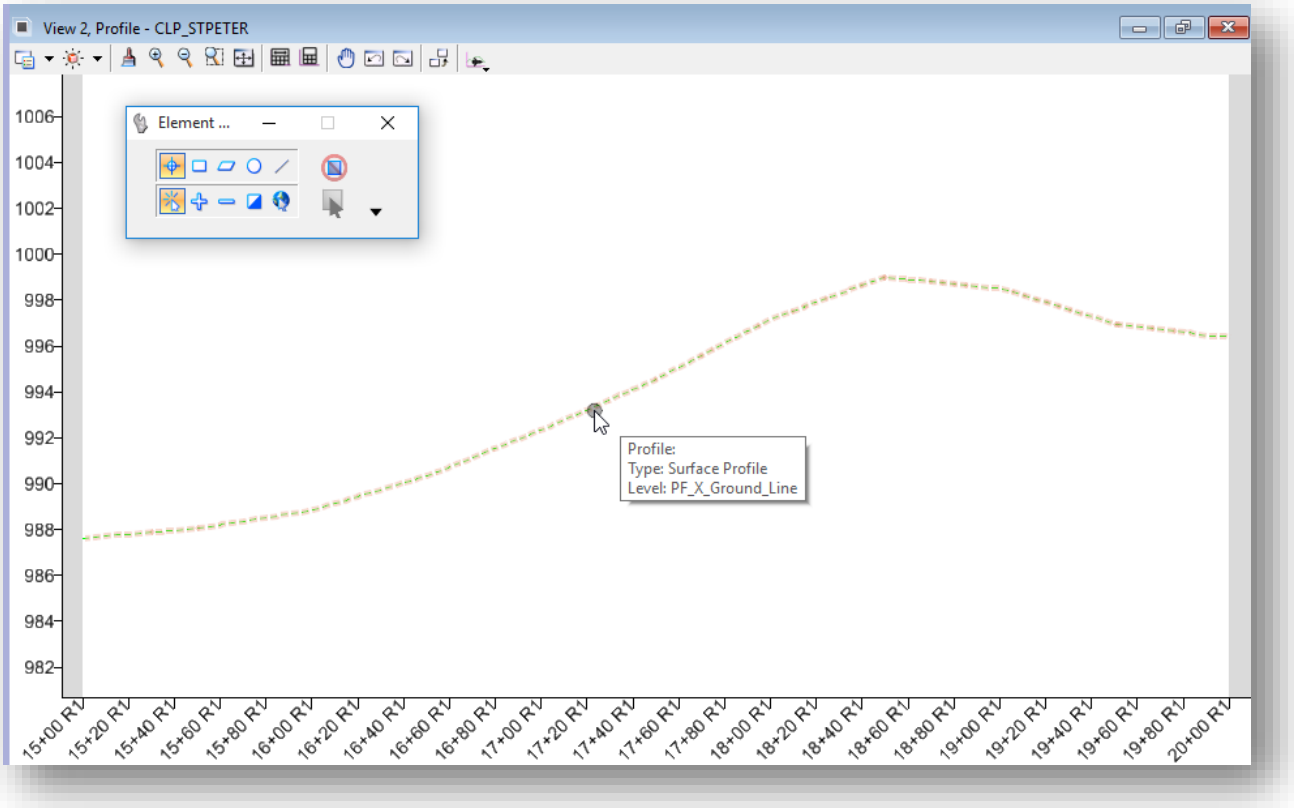


To extract the existing profile, select the alignment graphics and choose the **Open Profile Model** icon as shown below.

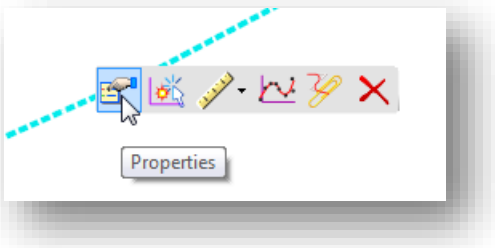


You are prompted to select or open a view window to use for the profile display. Open a new view window and then left-click in the view window to display the profile. An example is shown on the following page.

Note: The profile is displayed in the profile view for review and editing; however, the profile is not written to the design file. The selected view window is used as a temporary display of all the profiles associated with the selected alignment. The selected view window is not specifically associated with a particular alignment/profile and can be used to display the profiles from a different geometric alignment as needed.



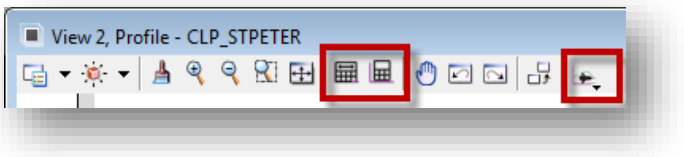
Selecting a profile graphic reveals a pop-up menu with commonly used commands as shown below.



The following commands are available. See the online help for more information

- Properties
- Set as Active profile
- Rules
- Create Best Fit Profile
- Profile Report
- Delete

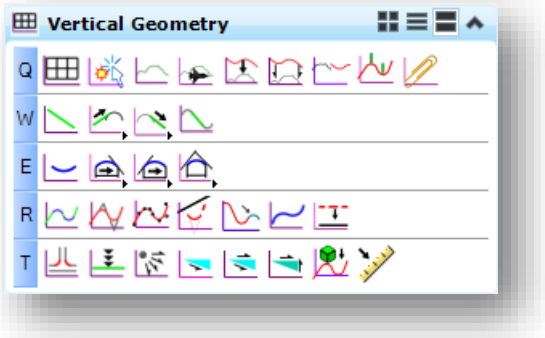
The **Profile** view window contains command icons specific to profiles as shown below.

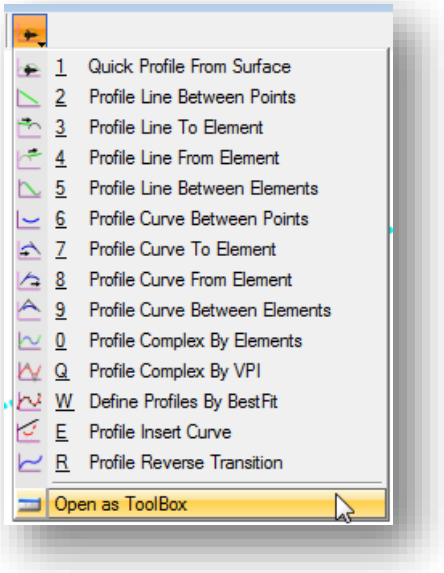


The following commands are available. See the online help for more information.

- Fit Plan Extents
- Fit Profile Elements
- Vertical Geometry Tools

The **Vertical Geometry Tools** can be selected from the last icon, as shown at right, or selected from the *Task* list by selecting **Tasks > Civil Tools > Vertical Geometry**, as shown below.





See the online help for information on the individual **Vertical Geometry** commands.

6.3 Profile Feature Definitions

The symbology of vertical geometry is defined by Feature Definitions; however, the feature definition for profiles is not assigned by the user. Feature definitions for vertical alignments are defied as follows:

- Existing vertical alignments inherit their display parameters from the feature definition that has been assigned to the terrain model that was used to extract the profile.
- Proposed vertical alignments inherit their display parameters from the feature definition that has been assigned to the horizontal geometry that the vertical geometry is associated with.

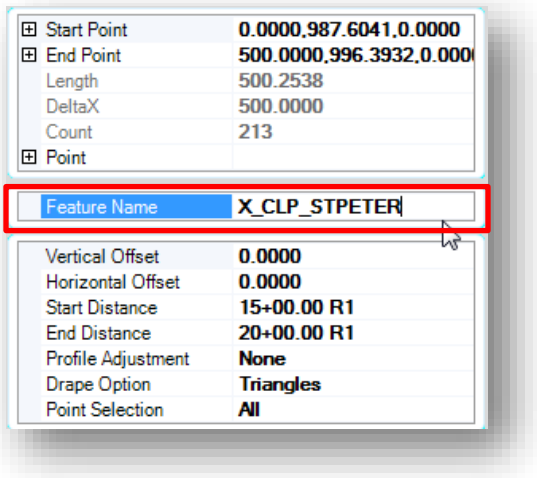
6.4 Exporting Existing Profiles to the GPK File

Both existing and proposed profiles can be exported to the GEOPAK Coordinate Geometry database (GPK) as needed.

Existing profiles must be exported manually using the **General Geometry** task group's **Export to Native** command. Before exporting, it is necessary to define the **Feature Name** for the profile.

Select the profile element and choose the **Properties** item from the pop-up menu.

The **Properties** item can be used to review an edit various parameters for the selected profile as shown at right.



The **Feature Name** item is used when the profile is exported to the GPK file and should be set according to the naming conventions defined in the **ODOT CADD Engineering Standards Manual (ODOTcadd) Section 300**.

After defining the **Feature Name**, use the **Export To Native** command to export the profile elements to the selected GPK file.

Exercise 6A –Existing Profiles

For the purpose of plan sheet production using the legacy GEOPAK Plan and Profile Sheets commands, it is necessary to store both the existing and proposed alignments in the GEOPAK GPK file for the project. The profiles can then be plotted in the appropriate basemap design files by use of the GEOPAK Design and Computation Manager. See ODOT's GEOPAK Road 1 training guide for more information.

Using the ODOT Feature Definitions, the feature definition that is assigned to the horizontal geometry controls whether the proposed profile is automatically exported to the GPK file as described earlier in this chapter. Existing ground profiles are not automatically exported to the GPK file and must be manually exported.

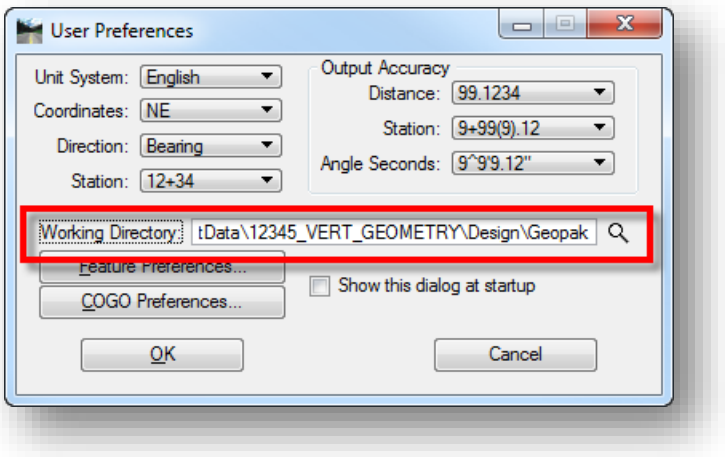
Exiting ground profiles are automatically generated from the Active Terrain when a profile window is opened for a particular horizontal alignment. In this exercise we will export the existing profiles for St Peter Road, SR 185, and Jameson Road to the GEOPAK GPK file for the project.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the User and Project as follows:
  User: ODOTcadd
  Project: 12345_VERT_GEOMETRY

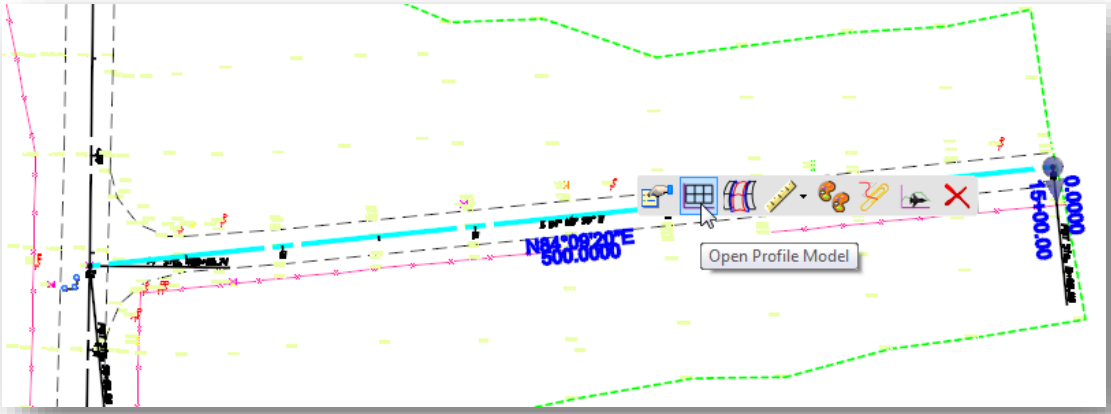
- ✓ Open the design file containing the St. Peter Road horizontal alignment:
  \Design\Geopak\Basemaps\12345_BK003.dgn

- ✓ Verify that the GEOPAK **Working Directory** is set correctly. Select **GEOPAK > Road > User Preferences** to access the User Preference dialog. Set the **Working directory** to the ***…\12345_VERT_GEOMETRY\Design\GEOPAK*** folder for the exercises in this chapter



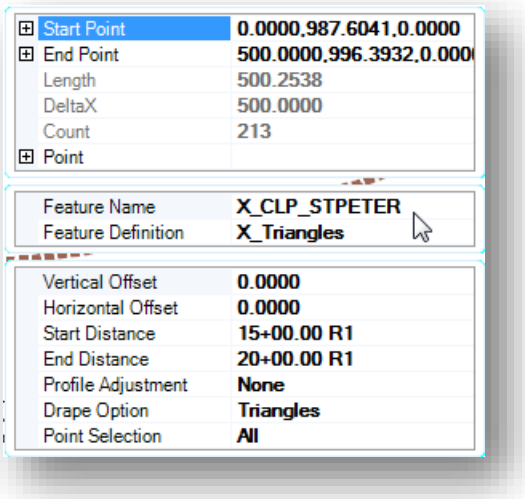
✓ The survey information was attached as a reference in a previous exercise. Select the referenced terrain model and ensure that it is set as the **Active Terrain** from the pop-up menu.

✓ Use the **Element Selection** tool to select the centerline alignment for St. Peter Road. From the OpenRoads pop-up menu, select the **Open Profile Model** command.



✓ Open view window 2 and issue a data point (left mouse click) to select the view. The existing profile for St. Peter Road is displayed in the view.

✓ Next we'll assign a name to the profile. Use the **Element Selection** tool to select the existing ground profile. From the OpenRoads pop-up menu, select the **Properties** option. Assign the **Feature Name** as **X_CLP_STPETER**.



✓ Lastly, we'll export the profile to the GEOPAK GPK file. Before exporting the profile, make sure the GEOPAK **Working Directory** is defined for the project to the folder containing the GPK file.

✓ To export the profile, choose the **Tasks > Civil Tools > General Geometry > Export to Native** command.

- ✓ Select the existing ground profile line. Right-Click to end the selection process
- ✓ The *Job Number* dialog is opened. Select the **job185.gpk** file and choose the **OK** button. The selected profile is exported to the GPK file.

Export the existing ground profile for S.R. 185

- ✓ Open the following design file containing the S.R. 185 horizontal Alignment:
  ..\Design\Geopak\Basemaps\12345_BK002.dgn

- ✓ Set the referenced survey terrain model as the active terrain.

- ✓ Open a profile view for the S.R. 185 vertical alignment.
- ✓ Select the existing ground line. Choose the **Properties** option from the pop-up menu.
- ✓ Assign the existing ground profile the **Feature Name X_CLP_S185**

- ✓ From the *Tasks* menu, select the **Tasks > Civil Tools > General Geometry > Export to Native** command
- ✓ Select the existing ground profile line. Right-Click to end the selection process
- ✓ The *Job Number* dialog is opened. Select the **job185.gpk** file and choose the **OK** button. The selected profile is exported to the GPK file.

Export the existing ground profile for Jameson Road

- ✓ Open the following design file containing the S.R. 185 horizontal Alignment:
  ..\Design\Geopak\Basemaps\12345_BK004.dgn

- ✓ Set the referenced survey terrain model as the active terrain

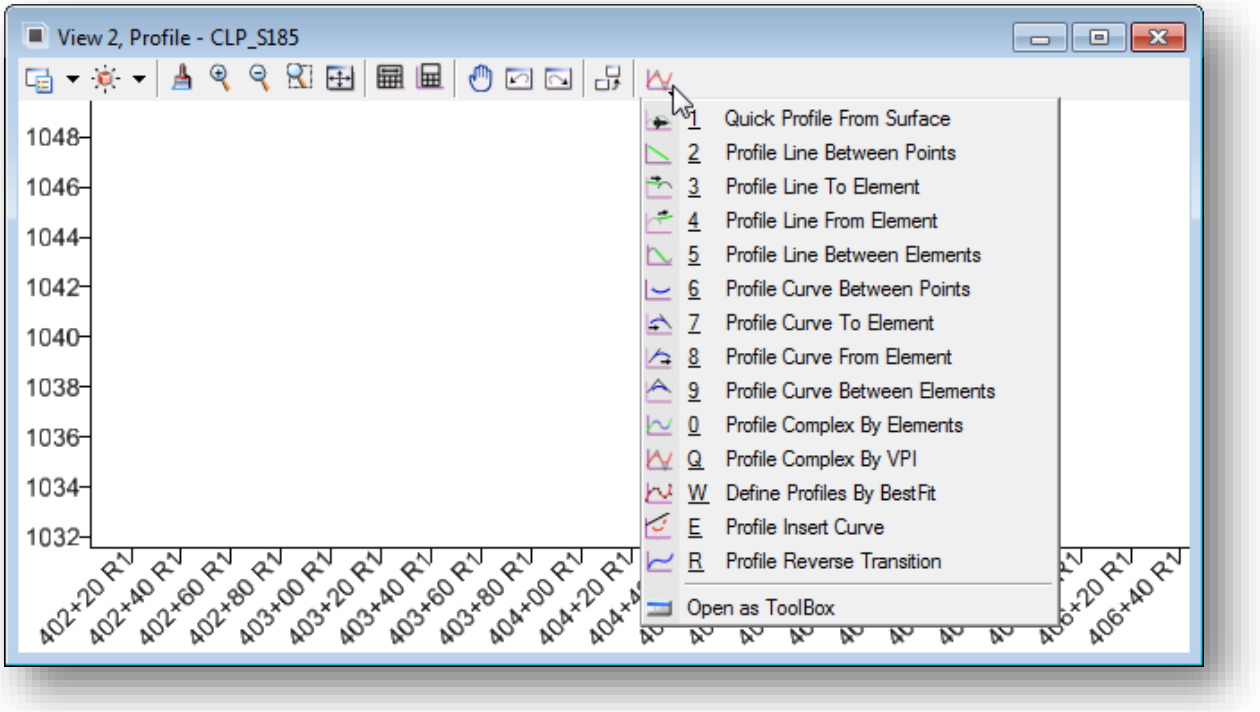
- ✓ Open a profile view for the Jameson Road vertical alignment.
- ✓ Select the existing ground line. Choose the **Properties** option from the pop-up menu.
- ✓ Assign the existing ground profile the **Feature Name X_CLP_JAMESON**

- ✓ From the *Tasks* menu, select the **Tasks > Civil Tools > General Geometry > Export to Native** command
- ✓ Select the existing ground profile line. Right-Click to end the selection process
- ✓ The *Job Number* dialog is opened. Select the **job185.gpk** file and choose the **OK** button. The selected profile is exported to the GPK file.

6.5 Proposed Vertical Alignments

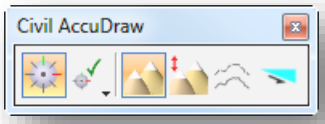
Proposed vertical alignments can be defined by placing disjointed line and curve elements, which are later joined as a complex element, or by use of the **Profile Complex by VPI** command. A **Best Fit Profile** command is also available.

Profile creation commands are available directly in the profile view window, as shown below, or from the task list by selecting **Tasks > Civil Tools > Vertical Geometry**.



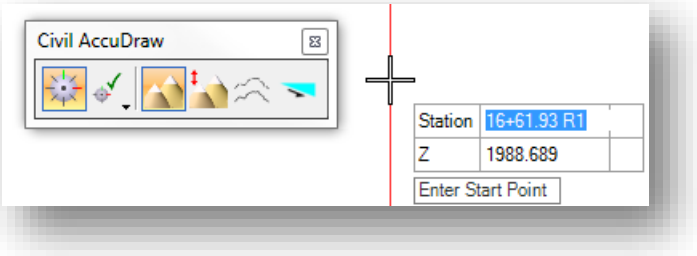
Using CivilAccudraw in Profile Mode

Civil Accudraw can be used to facilitate the profile creation process. When a profile window is active, the *Civil Accudraw* menu appears similar to the example below:



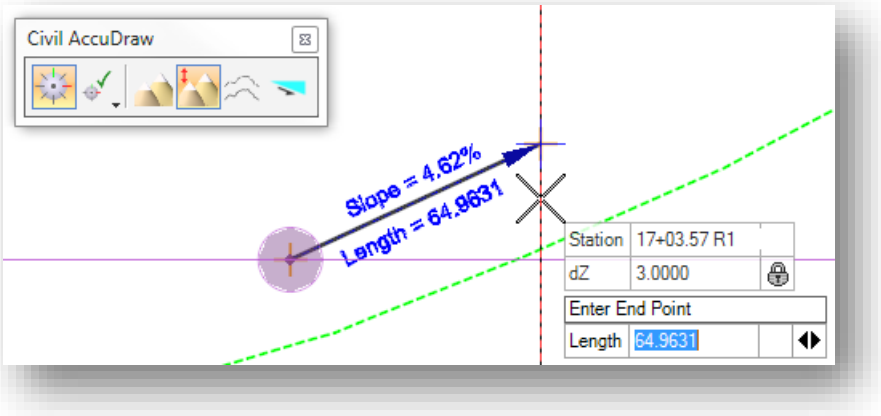
Z

This ordinate is used to issue a **Station** and **Elevation** to the active Vertical Geometry command.



dZ

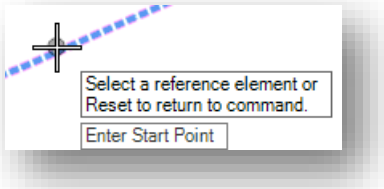
This ordinate is used to issue a delta Z value from a reference point.



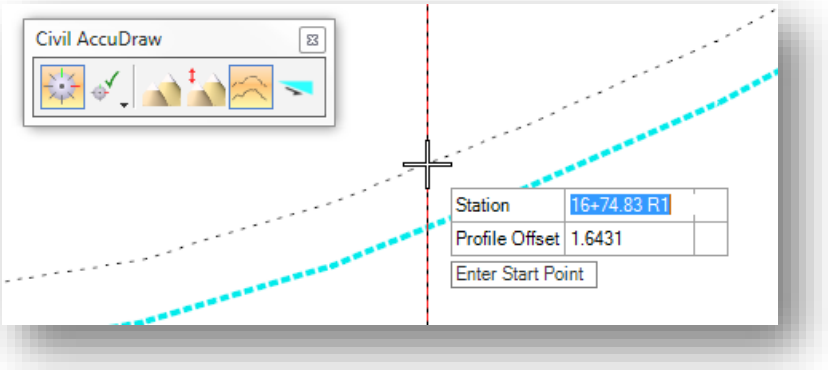
ProfileOffset

This ordinate is used to issue profile points at a defined station and offset. The station is defined by the horizontal alignment. The offset is defined from the selected profile. Note, that the reference profile that is used for the offset value must be selected using the Civil Accudraw shortcut “o”.

To select the reference profile, with Civil Accudraw active use the **Tab** key to shift focus to the **Profile Offset** field. Enter the “o” shortcut to define the reference profile. Select the profile when prompted as shown at right.



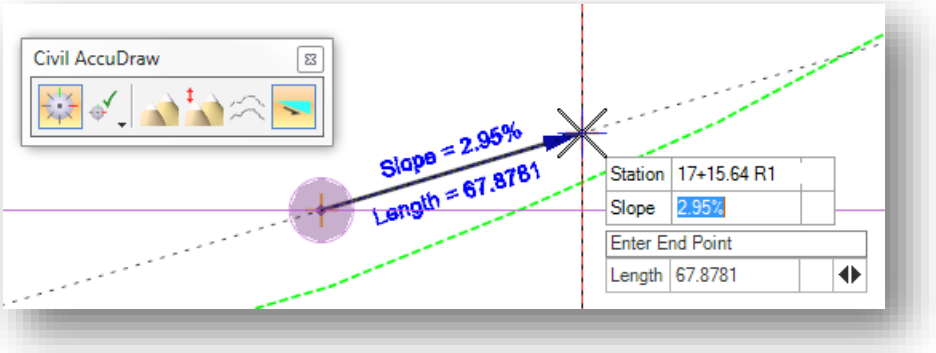
Once the profile has been defined, the station and offset can be entered when working with the vertical geometry commands. The example below shows placing a profile line using the vertical geometry command **Profile Line Between Points**.



Slope

The slope ordinate is used to enter a station and slope value.

In the example below, a starting point has been issued for the **Profile Line Between Points** command. The endpoint of the line can be defined at a specific station and slope from the start point using the **Slope** ordinate.

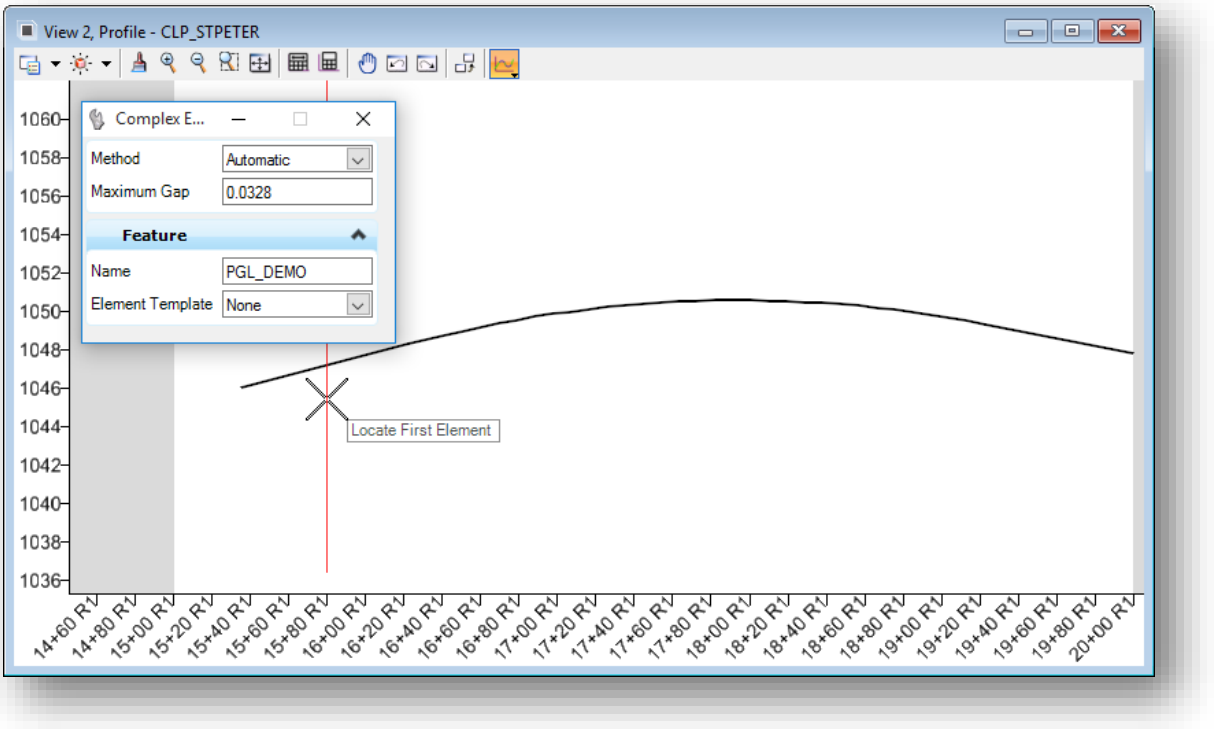


Exporting Proposed Profiles to the GPK File

Similar to proposed alignments, proposed profiles are exported to the GPK file using the value of the **Auto Export** function, which is defined by the feature definition assigned to the parent horizontal alignment.

When graphics are drawn for a proposed vertical alignment, these graphics inherit the feature definition that has been defined for the associated horizontal alignment. With the ODOTcadd Standards, the **Auto Export** value is set to **True** for vertical alignments. However, the vertical alignment is not exported to the GPK file until it is completed and has been assigned a **Feature Name**.

In the example below, two profile lines were drawn using the **Profile Line Between Points** command. A vertical curve was added using the **Profile Curve Between Elements** command. The **Profile Complex by Elements** command is used to join the elements together as a single profile. When this command is processed a **Feature Name** is assigned to the profile and the profile is stored in the GPK file containing the parent horizontal alignment.



Note:
If the proposed profile is edited or deleted these changes are automatically exported to the GPK file.

Exercise 6B – St. Peter Road Proposed Profile

In this exercise, we'll define the proposed profile for St. Peter Road using individual profile elements that will be chained together to define the vertical geometry.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_VERT_GEOMETRY

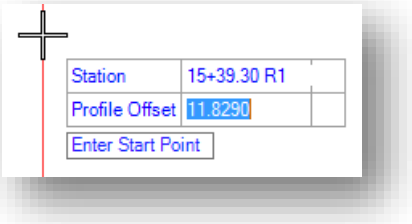
- ✓ Open the following design file containing the St Peter Road alignmet:
  ..\Design\Geopak\Basemaps\12345_BK003.dgn

- ✓ Open a profile view for the St. Peter Road vertical alignment

- ✓ Use the **Profile Line Between Points** command with **Civil Accudraw** to enter the tangent lines for the profile using the values in the table below.

Station	Elevation	Civil Accudraw Ordinate
17+00	Meet Existing	ProfileOffset
18+25	997.8800	Z
19+70	995.6026	Z
20+00	996.0826	Z

Tips:
To use the **Civil Accudraw Profile Offset** ordinate, use the tab key to shift keyboard focus to the **Offset** field as shown below.

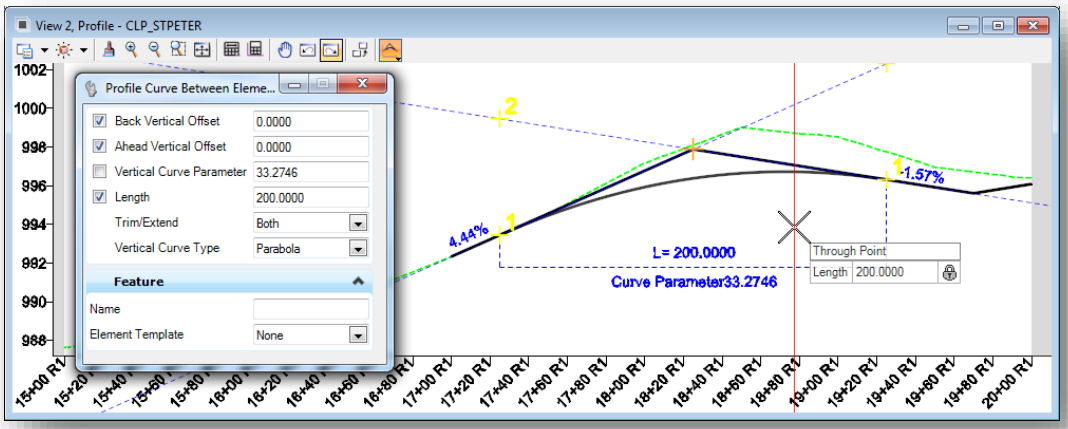


With focus in the **Offset** field, key in the "o" shortcut to select the profile element that will be used as the origin for the **Station** and **Profile Offset** values. You are prompted to **Select a reference element**. Select the exiting ground line for St. Peter Road.

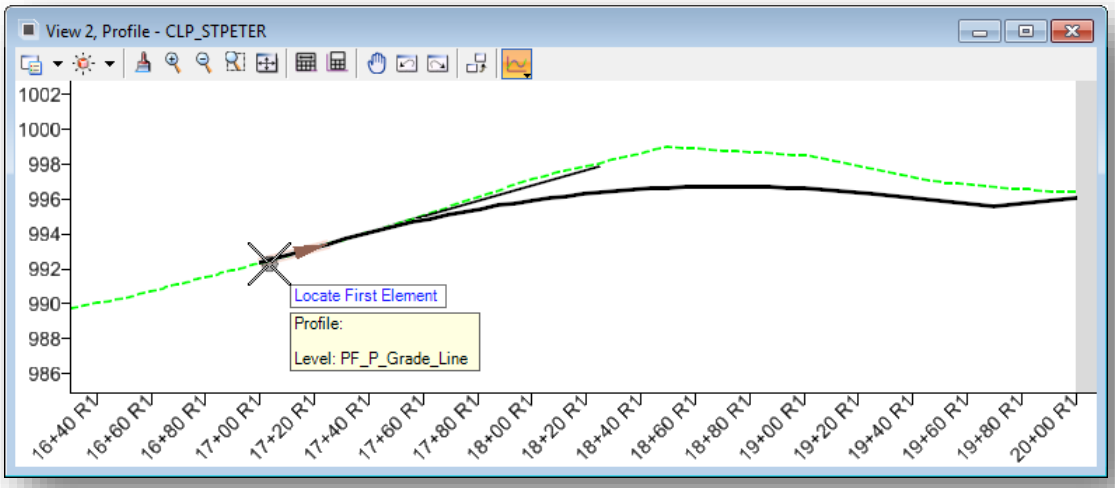
- ✓ After the vertical tangent lines have been defined, use the **Profile Curve Between Elements** command to place vertical curves with the following values:

Station	Curve Length
18+25	200'
19+70	10'

Use the **Trim/Extent Both** option when defining the curves as shown on the following page.



✓ Create a complex element from the profile components using the **Profile Complex By Elements** command. Define the **Feature Name** for the profile as **P_CLP_STPETER.** Be sure to start the profile by selecting the first tangent line as shown below.



The profile is automatically exported to the GPK.

✓ Set the proposed profile as the active profile by selecting the profile and choosing the **Set Active Profile** icon from the pop-up menu.

✓ Both the existing and proposed profiles should be available in the GPK file. Open the GEOPAK *Coordinate Geometry* dialog and use the COGO Navigator to verify that both profiles for St. Peter Road are included in the GPK file.

Exercise 6C – S.R. 185 Proposed Profile

In this exercise, we'll define the proposed profile for State Route 185. The proposed profile will be defined using the **Profile Complex By VPI** command.

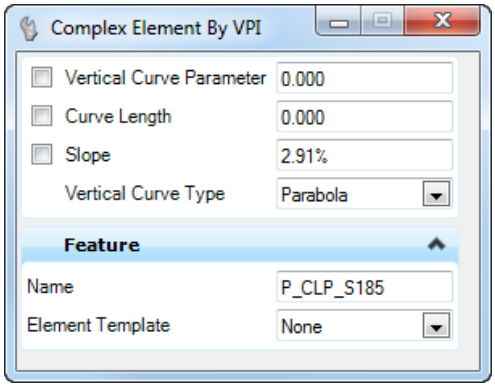
- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_VERT_GEOMETRY

- ✓ Open the following design file containing the S.R. 185 horizontal alignment:
  ..\Design\Geopak\Basemaps\12345_BK002.dgn

- ✓ To enter the first VPI, select the **Profile Complex by VPI** command

- ✓ In the *Tool Settings* dialog, key in the **Feature Name P_CLP_S185** as shown at right.



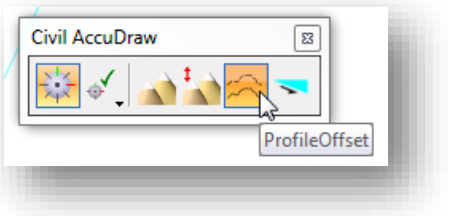
Store the proposed profile for S.R. 185 using the values shown in the table below.

Note: The **Curve Length** values shown in the table above are used to define the curve at the VPI previous to the VPI point being entered. For example, the 700' vertical curve is applied to the VPI at station 392+00 as the VPI at station 398+00 is being defined.

VPI	Station	Civil Accudraw Ordinate	Offset/Elevation	Curve Length
1	386+25	ProfileOffset	Offset = 0	0
2	387+00	ProfileOffset	Offset = 0.25	0
3	392+00	Z	Elevation = 1014.07	0
4	398+00	Z	Elevation = 998.65	700
5	403+00	Z	Elevation = 993.65	300
6	410+00	Z	Elevation = 982.17	300
7	422+50	Z	Elevation = 966.61	300
8	426+00	Z	Elevation = 964.45	400
9	428+27.30	ProfileOffset	Offset = 0	150

Use Civil Accudraw with the appropriate ordinate to facilitate entering the profile points.

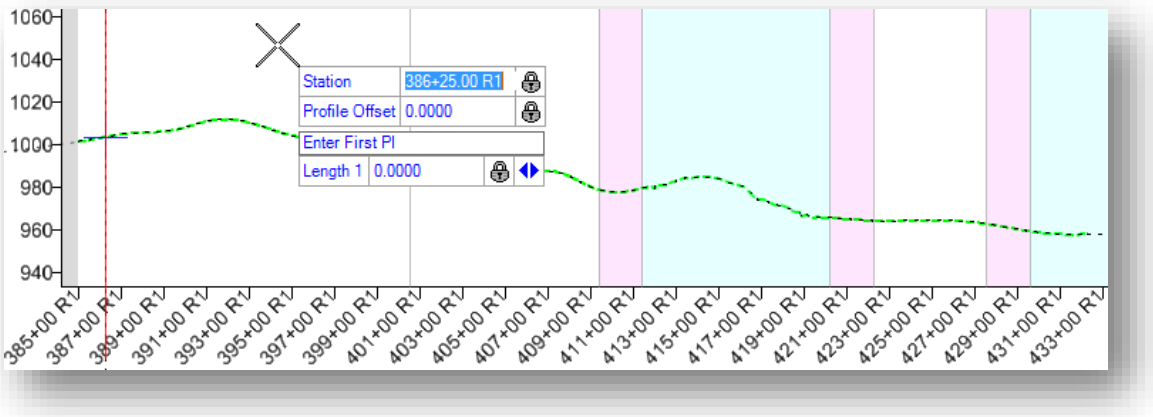
- ✓ Activate Civil Accudraw and choose the **ProfileOffset** ordinate



- ✓ The Civil Accudraw **Station** and **Profile Offset** fields are now floating on the cursor. Use the **Tab** key to set the keyboard focus to the **Profile Offset** field. Key-in an "o". The "o" shortcut is used to define the origin element for Civil Accudraw.

- ✓ When prompted to **Select a reference element or Reset to return to command**, select the existing ground line. The existing ground line is now the reference element for entering the first station and offset value.

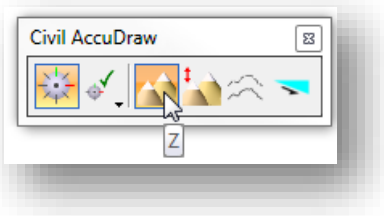
- ✓ Enter the first station and offset values from the table on the previous page, as shown below



- ✓ When entered, the values are locked in the dialog. Enter a data point (left mouse click) to accept the values. The first VPI has been defined.

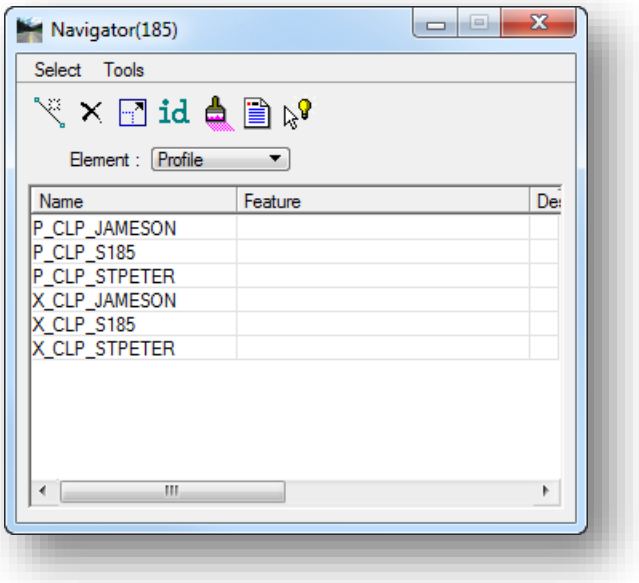
- ✓ Define the second VPI by entering the station and offset values shown in the table

- ✓ Change the Civil Accudraw ordinate to **Z** (elevation) to enter the station, elevation, and curve length values for VPIs 3-8



- ✓ Change the Civil Accudraw ordinate to ProfileOffset to define the last VPI and vertical curve.

- ✓ Issue a Reset (right-mouse click) when you have completed the profile definition.
- ✓ The profile is automatically exported to the GPK file based on the feature definition that has been assigned to the horizontal alignment.
- ✓ Open the GEOPAK GPK file to verify all of the profiles are contained in the GPK as shown below.



- ✓ Set the proposed profile as the active profile by selecting the profile and choosing the **Set Active Profile** icon from the pop-up menu.
- ✓ Save settings and exit MicroStation when complete.

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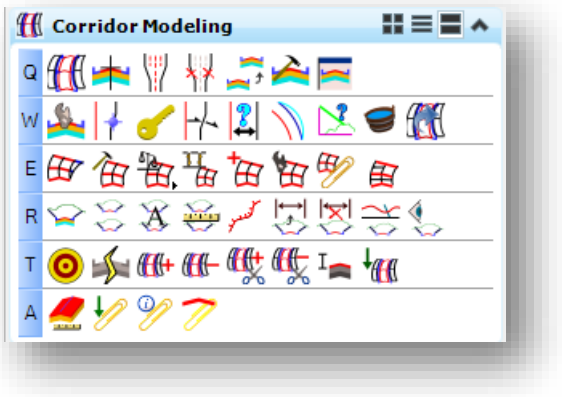
7 Corridor Modeling

The OpenRoads technology provides several corridor modeling and site design tools to facilitate generating the 3D model. Designers work primarily in 2D files to define the planametrics for the project. The OpenRoads technology tools automatically generate the 3D model.

7.1 Corridor Modeling Commands

The corridor modeling commands can be accessed from the MicroStation task list by selecting **Tasks > Civil Tools > Corridor Modeling**.

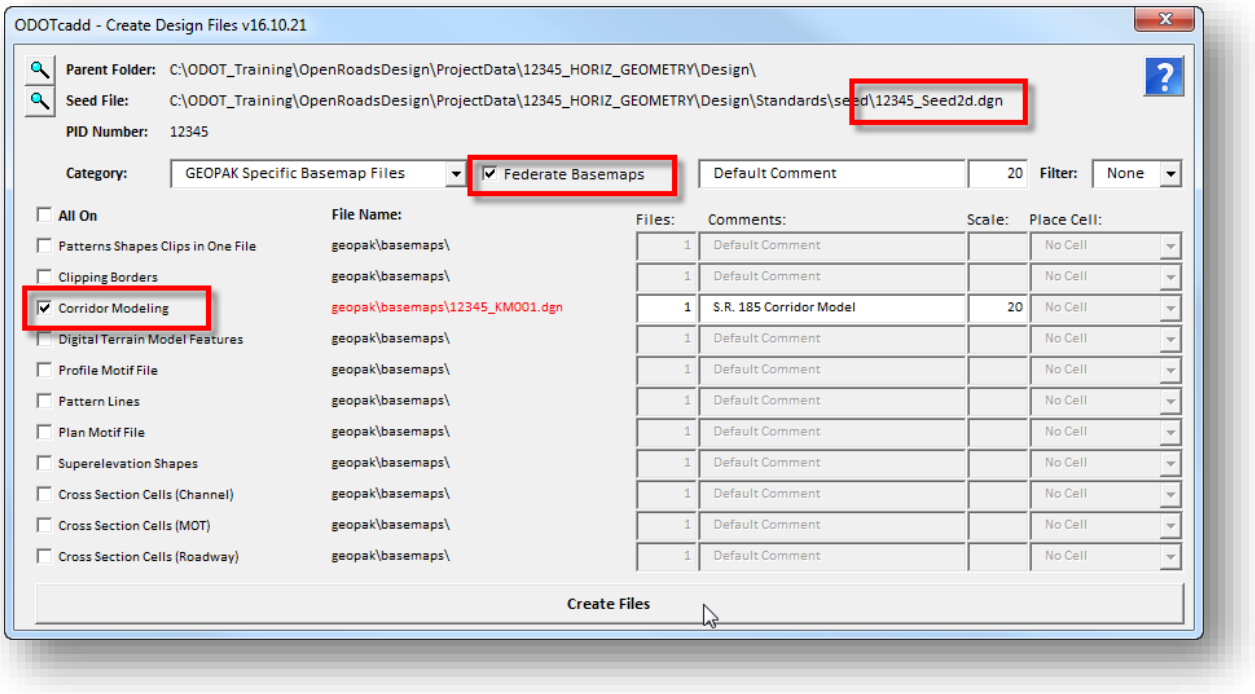


The most commonly used commands are detailed in this training guide. See the online help for additional information.

7.2 Corridor Modeling Design Files

The 3D model is generated in a “KM” basemap design file. For smaller projects with only one alignment, it is acceptable to generate the entire model in one KM design file. For projects with more than one alignment, it is recommended that users take a federated approach to store each corridor model in its own KM design file.

The **ODOT_Files.mvba** application is used to create design files for the project as shown in the example on the following page.



The **Comments** field is used to define the alignment name that is used for each corridor model design file.

For projects with multiple corridor files, choose the **Federate Basemaps** option. With this option selected, the program will create a file named "#####_KM000.dgn" if one has not been previously created (see **Using Multiple "Federated" Basemaps**).

Note: The 2D seed file is used for corridor model design files.

Exercise 7A – Corridor Design Files

In this exercise we will create separate design files for the 3D model of each alignment in the project.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL

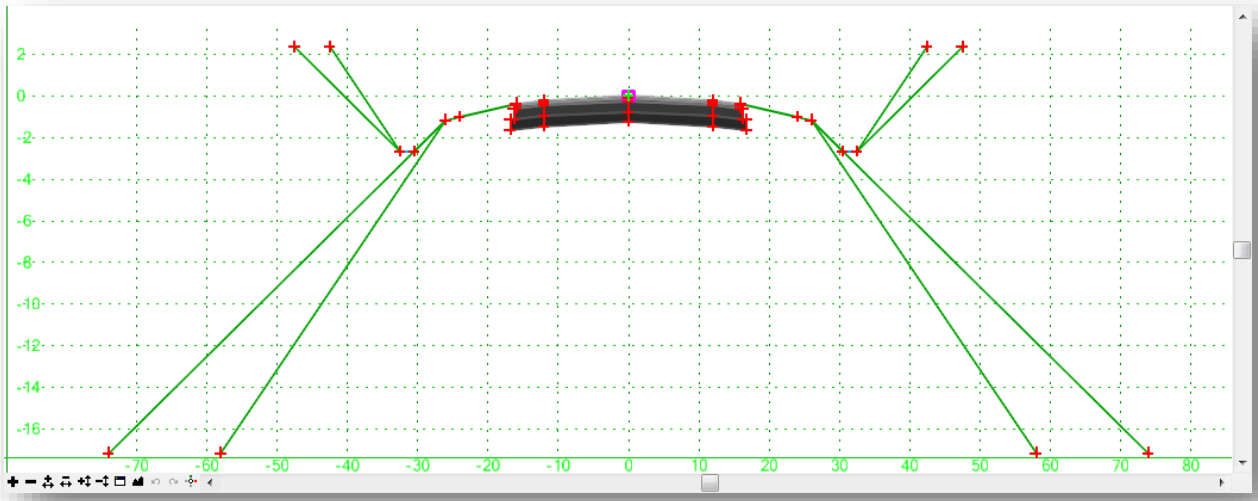
- ✓ Open the following design file for the training project:
  ..\Design\Geopak\Basemaps\12345_BK002.dgn

- ✓ Use the ODOT_Files.mvba application by selecting **ODOT > File Management> Create Design Files** to create the following design files for the corridor modeling process. Be sure to toggle on the **Federate Basemaps** option.

File Name	Comments
12345_KM001.dgn	S.R. 185 Corridor Model
12345_KM002.dgn	St. Peter Road Corridor Model
12345_KM003.dgn	Jameson Road Corridor Model

7.3 Templates

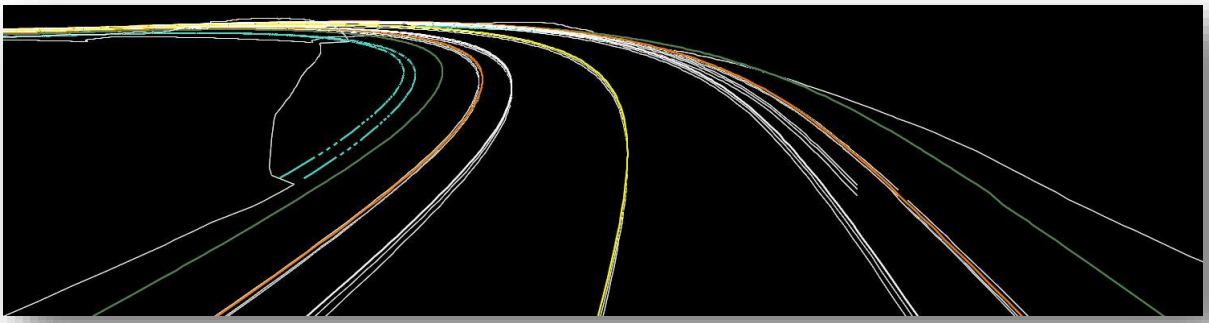
In simple terms, the template is a “smart” typical section that you “push” along an alignment in order to create the proposed 3D model. An example of a template for a 2-Lane undivided highway, with cut and fill slope options, is shown below.



Templates are stored in a template library (*.itl).

Templates are defined by inserting **Points**, **Components**, and **End Conditions**. A component is a set of points that define an open or closed shape. There is no limit to the number of points or components in a template.

When the template is processed, the template points are connected between template “drop” locations to form the longitudinal break lines that are used to create the proposed surface. An example of the longitudinal break lines plotted from a 3-dimensional design surface is shown below.



Only the top template points are used to create the proposed surface mesh. Points below the surface are excluded from the proposed design surface.

The sub-surfaces can be included in the proposed cross sections as “components” or alternate surfaces. These components can be used for volume calculations.

ODOT Template Library

ODOT provides a sample template library in the following folder:

..\ODOTcadd\Standards\Geopak\Road\templates\ODOTcadd_Templates.itl

The templates contained in the ODOT library can be used as a starting point to define templates for specific projects. Many of the templates represent individual components that can be combined to generate the full template for a specific typical section design. For example, a template representing a lane of pavement can be combined with another template representing curb and gutter.

The templates for each project are stored in their own project specific template library. When a new project is created using the **ODOTcadd_CreateNewProject.exe** application, the ODOT template library is copied into the **\Design\Geopak** folder for the project and renamed as follows:

######_Templates.itl
Where ###### = the 5 or 6 digit PID number for the project.

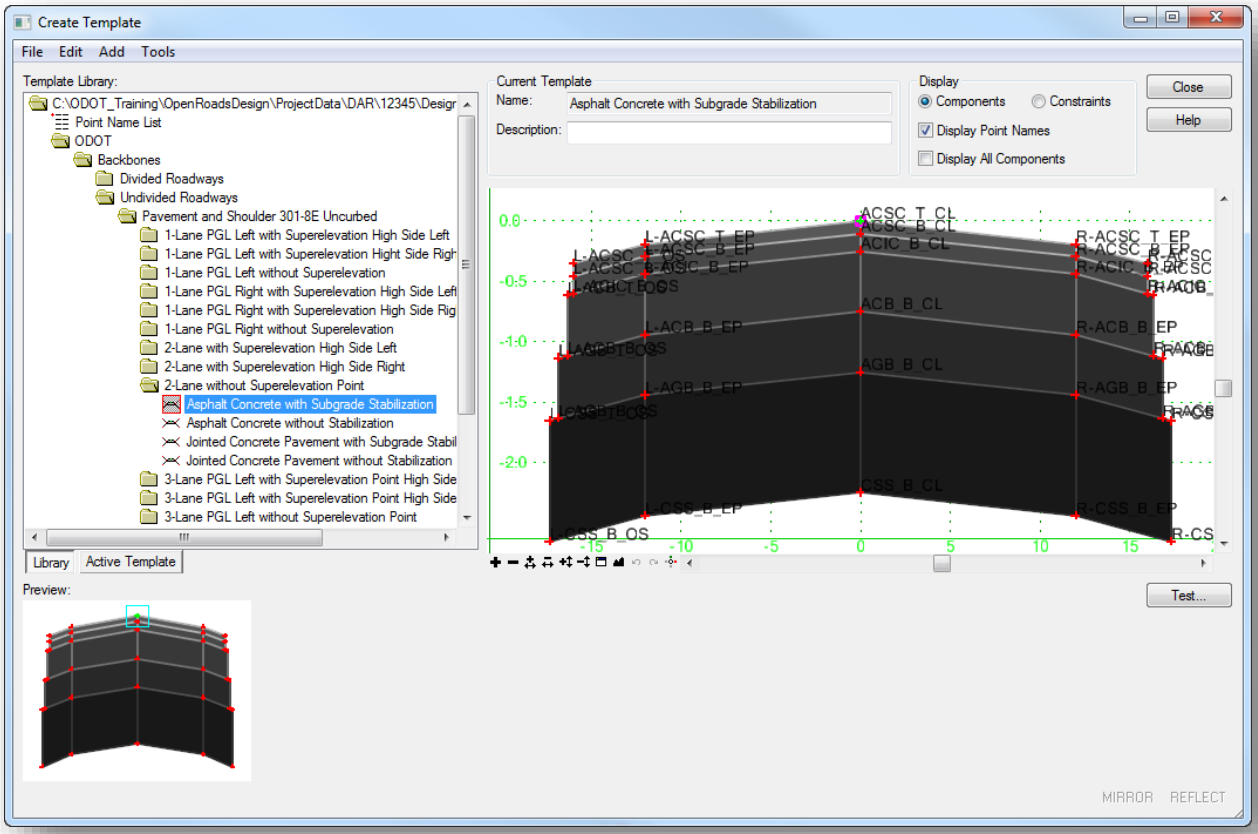
The template library can be specified by a MicroStation configuration variable in the PCF file for the project. When a new project is created using the **ODOT_CreateNewProject.exe** application, the variable is defined in the PCF file similar to the example below:

CIVIL_ROADWAY_TEMPLATE_LIBRARY = $(_USTN_PROJECTDATA)Geopak/12345_Templates.itl

Template creation is a key component to the Corridor Modeling process. The designer must have a thorough understanding of how to create and modify template components in order to make necessary design-specific modifications.

The Create Template Dialog

To open a template library, select the **Tasks> Civil Tools > Corridor Modeling > Create Template** icon. The *Create Template* dialog is opened.



The dialog is split into several areas. Each area is briefly described on the following pages. See the online help for information not presented here.

Menu Commands

The **File** menu contains familiar commands for creating new Templates and new folders within the template library, as well as commands to save and open template libraries,

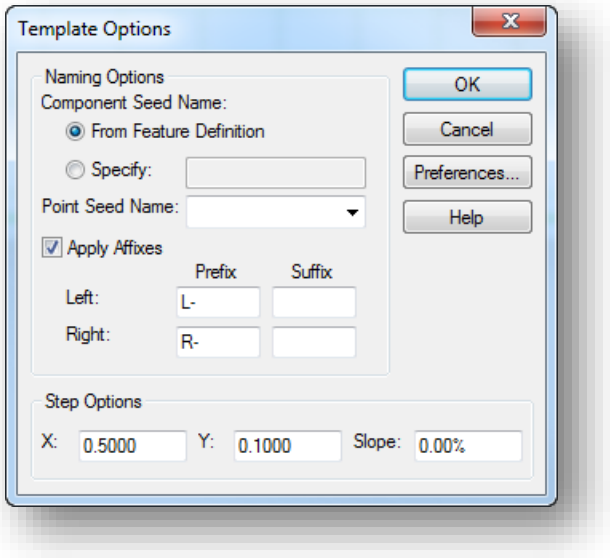
The **Edit** menu contains commands used when editing templates such as **Undo**, **Redo**, **Cut**, **Copy**, **Paste**, etc…

The **Add** menu contains commands to add points and components to the active template.

The **Tools** menu contains various tools for template creation. The Options and Dynamic Settings menu items are described on the following page.

Options

Selecting **Tools > Options…** displays the *Template Options* dialog which allows you to specify naming and step options for the current template. Use the **Dynamic Settings** dialog, detailed on the following page, to toggle these settings on/off as you design the template.



Naming Options

Component Seed Name

From Feature Definition indicates, when selected, the component name is derived from the style specified when the component is created.

Specify indicates, when selected, the component name is specified in the field.

Point Seed Name allows you to specify the seed name for point in the current template. Since point names must be unique, the seed name is appended with a different number each time a point is created.

Apply Affixes

Indicates, when on, that affixes are applied.

Left Prefix/Suffix specifies which prefix/suffix should be added to a point or component when the value is on the left of 0.0 (absolute).

Right Prefix/Suffix specifies which prefix/suffix should be added to a point or component when the value is on the right of 0.0 (absolute).

Step Options

These options are used to specify precision step input for components and points. These values can also be accessed from the *Dynamic Settings* dialog.

X Step specifies the step increment for the X distance from the dynamic origin. If this value is non-zero, then the cursor moves to the horizontal increments of the specified value as measured from the dynamic origin.

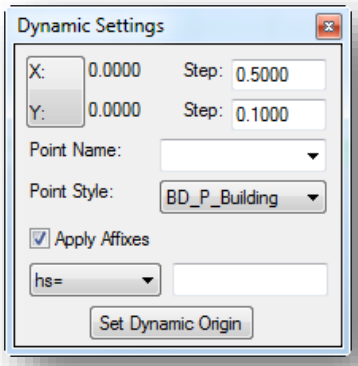
Y Step specifies the step increment for the Y distance from the dynamic origin. If this value is non-zero, then the cursor moves in vertical increments of the specified value as measured from the dynamic origin.

Slope specifies the step increment for slope from the dynamic origin. If this value is not 0, then the cursor moves in slope increments of the dynamic origin. Slope is applicable only when the dynamic settings are in horizontal/slope mode.

Dynamic Settings

Select **Tools > Dynamic Settings** to display the *Dynamic Settings* dialog, which is used for precision input of template components and to assign point names and styles when defining components. The dialog can also be accessed by selecting the icon located at the bottom of the **Current Template** window as shown below.

The *Dynamic Settings* dialog, shown below, is opened.



X:Y/X:Slope toggles between X,Y step lock and X/Slope step lock.

X Value displays the current X distance from the dynamic origin.

X Step specifies the step increment. If this value is non-zero, then the cursor moves in horizontal increments of the specified value as measured from the dynamic origin.

Y value displays the current Y distance from the dynamic origin.

Y Step specifies the step increment. If this value is non-zero, then the cursor moves in vertical increments of the specified value as measured from the dynamic origin.

Point Name specifies the name of the point to be placed.

Point Style allows you to set the style of the point. The style is used to draw feature lines in the plan view. For ODOT projects, the style **CM_P_Feature_Line** should be used as the default style for most template points unless you want to assign a specific style that can be plotted in the display view 3D model.

Apply Affixes specifies, when selected, that point name affixes (prefix or suffix) are to be applied to the point name when placing points. The **Affixes** are defined on the *Template Options* dialog.

The **Key-in** pull down is used to specify the type of key in to be performed.

- XY= key in absolute coordinates
- DL= key in delta coordinates from last point placed (defaults to the dynamic origin if it is the first point of a component.
- HS= key in horizontal delta distance and slope from last point placed.
- VS= key in vertical delta distance and slope from last point placed.
- OL= key in delta coordinates from dynamic origin.
- OS= key in horizontal delta distance and slope from dynamic origin.

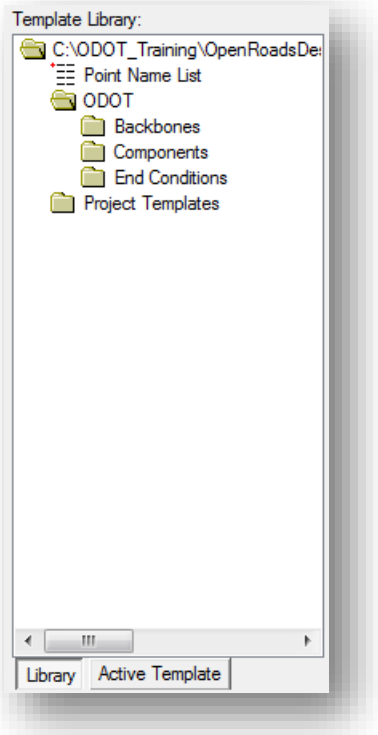
Set Dynamic Origin sets the location of the dynamic origin

Template Library

On the left side of the *Create Template* dialog is the **Template Library** area which contains a Windows-like folder structure. This area is used to manage the content of the current template library. Two tabs are supported for the **Template Library** area as described below.

Library

When the **Library** tab is selected, the **Template Library** displays the contents of the current template library in a familiar Windows folder structure as shown at right. The **Template Library** area also supports common Windows functions like drag, drop, cut, paste, etc.



If you double-click a template name, it becomes the active template.

When a template is selected from the list, the **Preview** window is used to display a preview of the template.

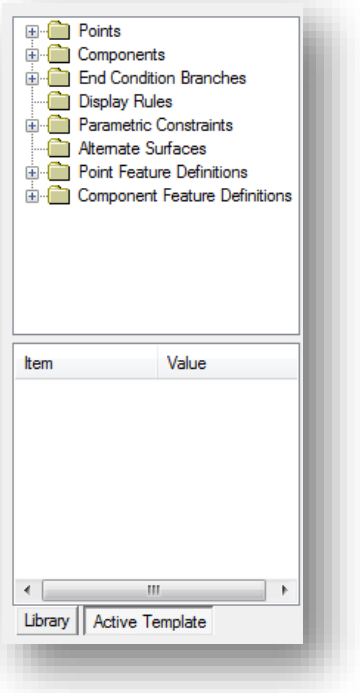
Double-click the template name to set it as the active template.

The **ODOT** category contains various components and end conditions that can be used to build templates for your project.

The **Project Templates** category is used to create new templates for the active project.

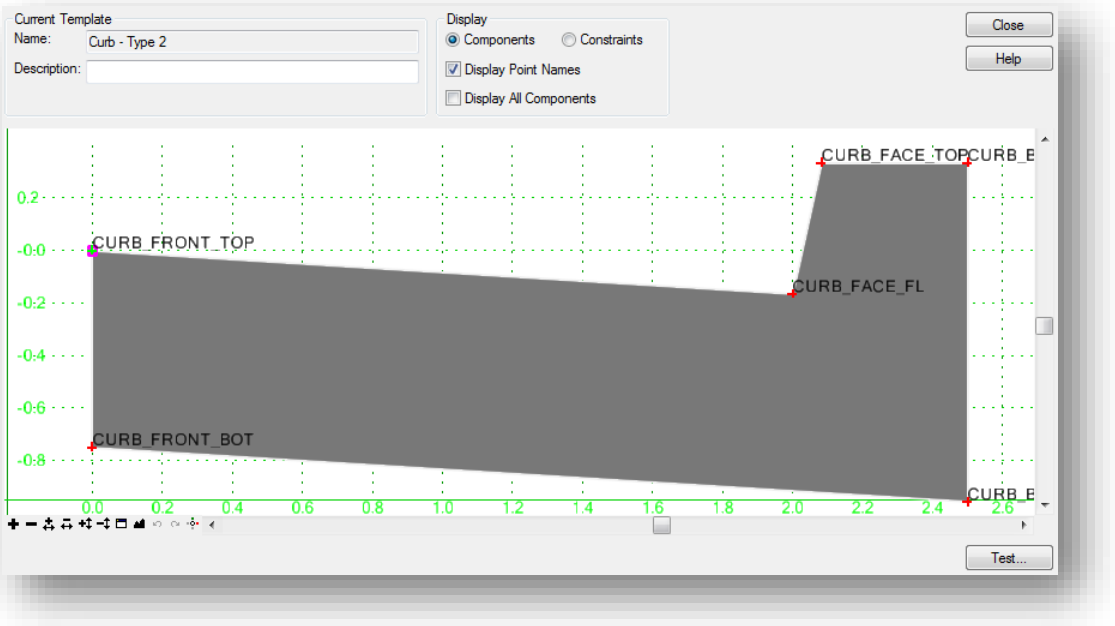
Active Template

When this tab is selected, the **Template Library** area displays the contents of the active template as shown at right.



Current Template

The right side of the **Create Template** dialog is used to display and edit the current template.



Name
Shows the name of the current template

Description
Allows you to review/edit the current template description

Display

Components/Constraints
This option is used to set the display mode of the template. If **Components** is selected, then the template components are displayed. If **Constraints** is selected, then the point constraints for the template are displayed. Template points are always displayed.

Display Point Names
Toggle this option on to display the template point names.

Display All Components
When this option is checked on, any components that are “hidden” are displayed with dashed lines.

Current Template Window
The Current Template Window is used to display and edit the current template. The window uses its own graphics engine and is not a MicroStation view.

A magenta colored box is used to designate the origin of the template.

At the bottom of the **Current Template** Window are view commands similar to the MicroStation view commands.

The two buttons that look like MicroStation View Previous and View Next commands are actually undo and redo commands used on template operations. The CTRL-Z keyboard shortcut can also be used to undo the last template operation.

Within the **Current Template Window** you can right-click to access commonly used template functions. You can also double click template components for editing purposes.

7.4 Template Points

When the template is processed using the corridor modeling command, the points of a template are connected to form *breakline* features. Each point will be connected longitudinally to the next template drop location to form 3-D longitudinal breakline surface features. The breaklines are drawn using the symbology defined with the **Feature Definition** that is assigned to each point.

Since the template points are connected to generate the completed surface, establishing a standard name for template features that are used on each template is very important to the quality of the proposed design surface. For example, if a pavement point is named ACSC_T_CL on the first template, and it is named PAVT_SURFACE on the next, the software will not automatically connect these points to generate the breakline feature. ***Following a point naming convention is important in order to obtain the best results with Corridor Modeling.***

It is equally important to ensure that the feature definition assigned to points is consistent from template to template.

Each template point name must be unique to the template. The software automatically appends a number to the point name if the same name is used during template creation.

There is no limit to the number of points in a template.

The ODOT template library uses standards point names and feature definitions that are documented in the following Microsoft Excel spreadsheet:

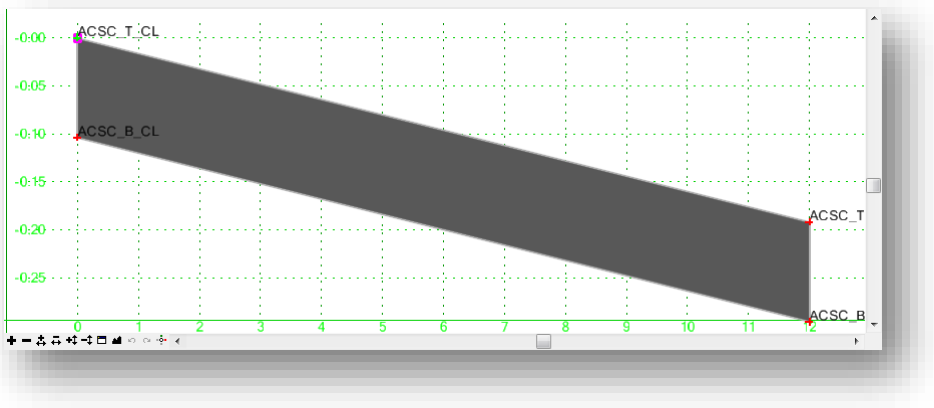
\ODOTcadd\Standards\Geopak\Road\templates\ODOTcadd_RoadwayTemplateDefinitions.xlxs

7.5 Template Components

A component is a set of points that define an open or closed shape. Each component, whether open or closed, can represent a different material or area of interest. Components are named and have an assigned feature style. There are 6 types of components as described below:

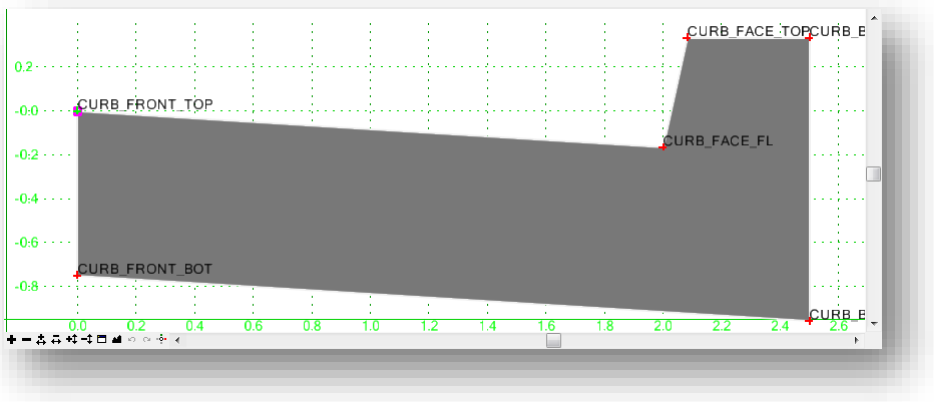
Simple

A simple component typically represents a section of pavement. It's a closed parallelogram (4 constrained points) that is defined by the slope and thickness.



Constrained

A constrained component consists of points that are all restricted to the movement of the first point. A constrained point is typically used to manage the behavior of other points in the template. When a point (parent) is moved, any constrained point (child) also moves. This restriction only affects the offset and elevation (x,y) of the restrained point and the relationship is unidirectional (movement of child point does not move the parent point). Fully constrained points are displayed with a red + symbol.



Unconstrained

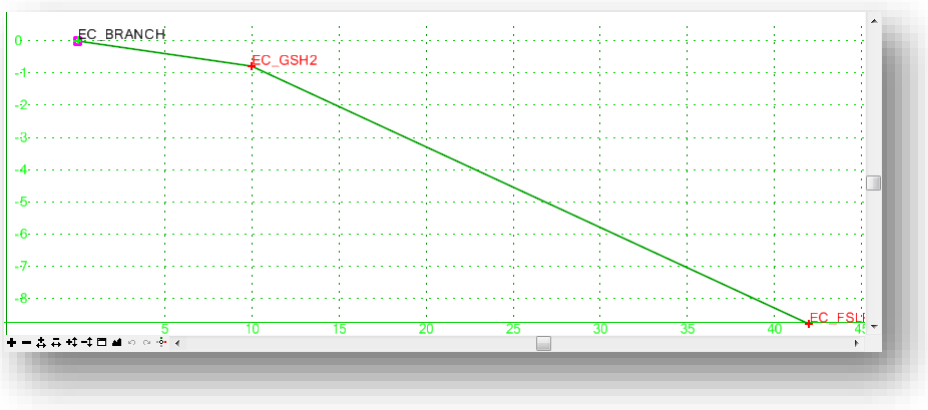
An unconstrained component is open or closed-shaped with no movement restrictions. Moving one point has no impact on the other points that make up the component.

Null Point

A null point is a template point that is purposely not related to any particular component. It's most often used as a reference for controlling other points.

End Condition

An end condition is a special open-shaped component that targets a surface, an elevation, or an alignment. End conditions are typically used to define cut and fill slope solutions.

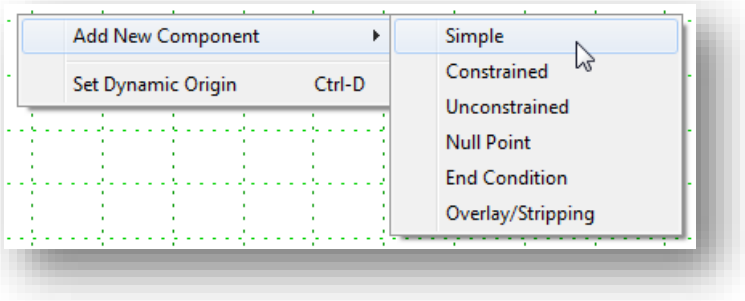


Overlay/Stripping
A specialized component type that is used for defining pavement planning and overlay materials.

7.6 Creating Template Components

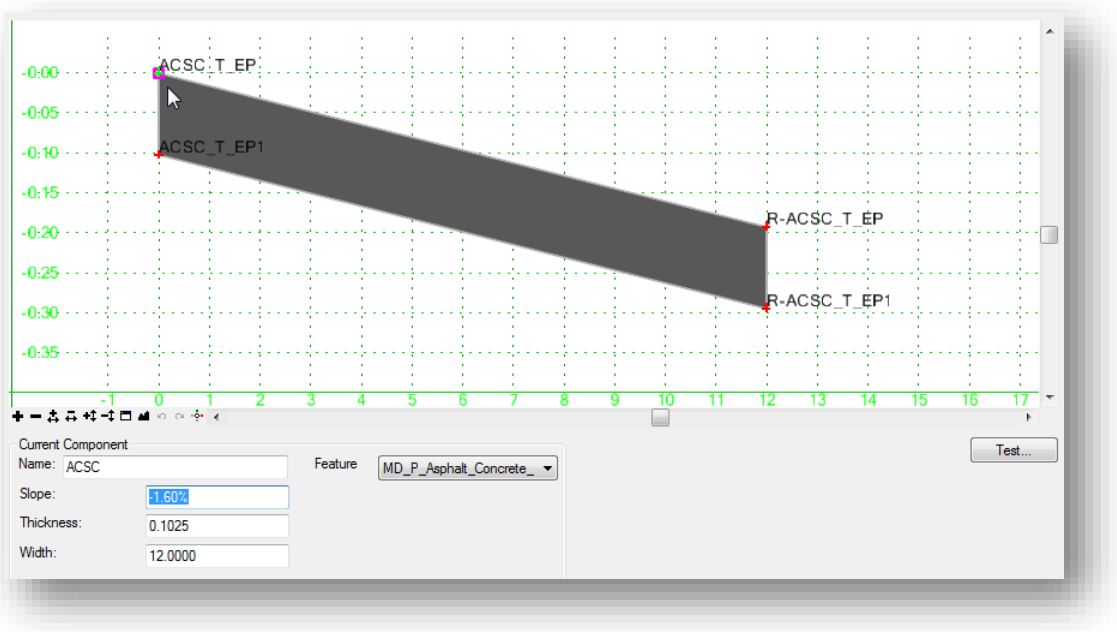
ODOT provides an example template library that contains several commonly used components. These components can be used to build templates. It may also be necessary to make specialized components to meet specific project requirements.

Components are added to the current template by selecting the component that you wish to add from the **Add** pull-down menu, or by right-clicking in the **Current Template** window to access the **Add New Component** menu shown at right.

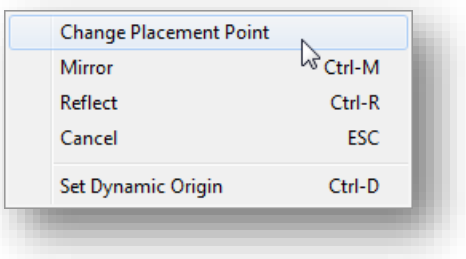


As new components are created, the **Current Component** portion of the *Create Templates* dialog is used to define the **Name**, **Style**, and any other relevant parameters for the component type being created.

In the example below, a simple component is created representing a single lane of pavement.



Before placing the component in the template, various options are available to control how the template is placed by right-clicking in the template window to reveal the menu shown below.



Change placement Point can be used to change which component point is used as the point placed at the point you specify. Each time this command is selected, the placement point will move in a clockwise direction to the next point in the component.

Mirror will create the original component as well as a mirrored component reflected horizontally about the template origin.

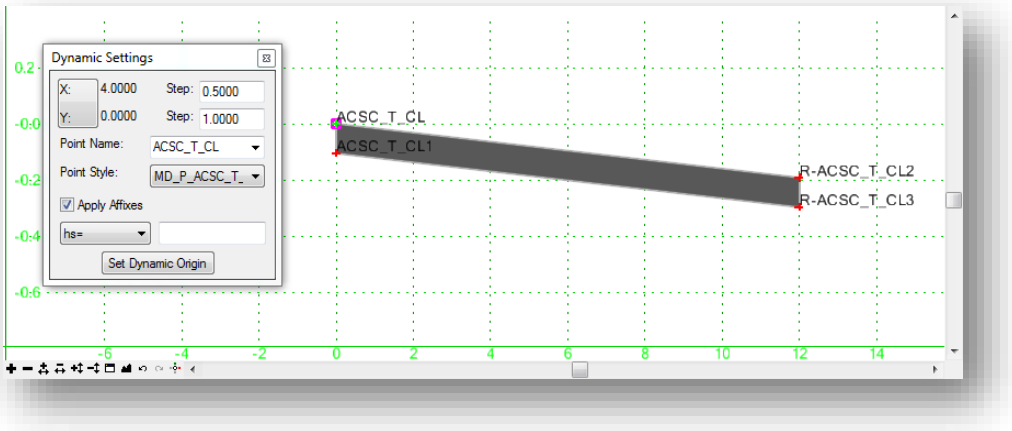
Reflect will create a single component reflected about the template origin.

The **Mirror** and **Reflect** options are toggles that are turned on or off and remain active. The on/off status of the **Mirror** and **Reflect** options is displayed at the bottom right corner of the *Create Templates* dialog.

Select **Set Dynamic Origin** to set the location of the dynamic origin. The dynamic origin is indicated by the purple box in the template display window.

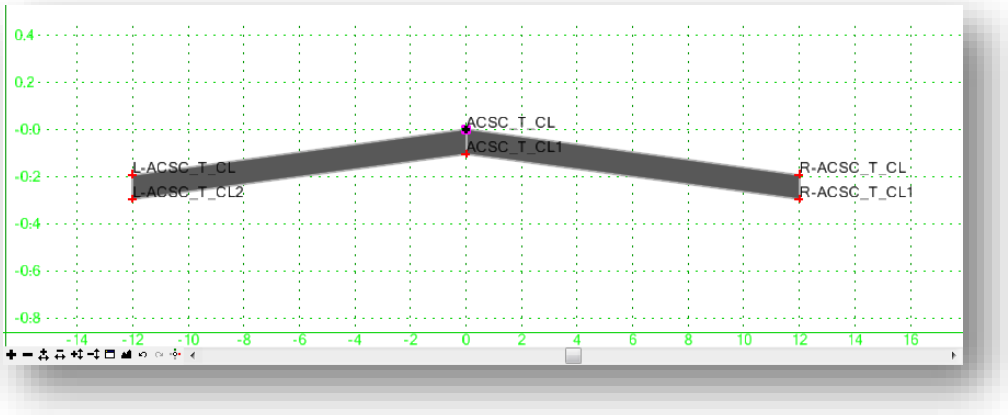
7.7 Point Names and Affixes

When components are added to a template, the points that make up the component are named according to the **Point Name** and the **Pont Style** defined in the *Dynamic Settings* dialog (**Tools > Dynamic Settings**). The **Point Name** is automatically appended with the number 1, and the appended number is automatically incremented for each point in the component as shown in the example below.



The **Point Name** can be keyed in or selected from the drop-down menu. When selected from the menu, the **Point Style** is automatically assigned for the point according to ODOT standards.

The **Apply Affixes** option is used to add a user defined prefix or suffix to the point name. In the example below a simple component was added with the **Mirror** option toggled on. The prefix of "L-" is applied to the points on the left side of the template. The prefix of "R-" is applied to the points on the right side of the template.

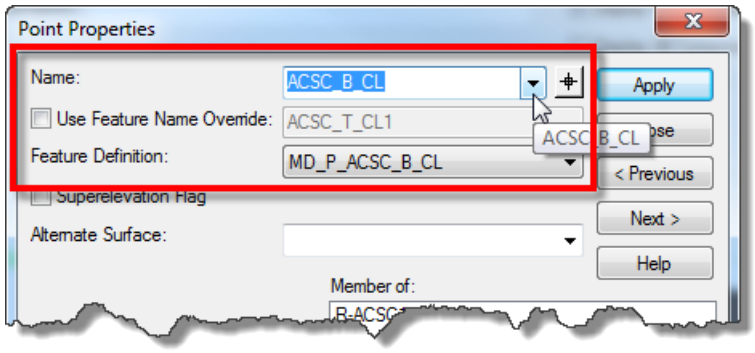


The affixes are defined in the *Template Options* dialog.

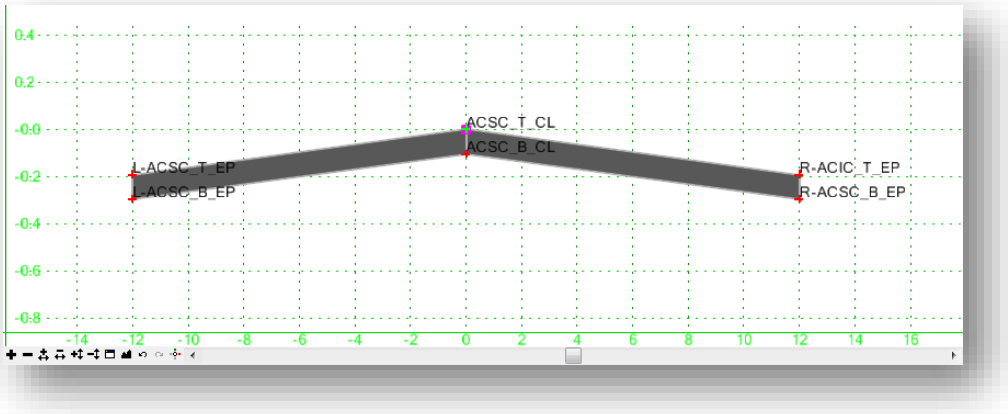
Tip: As a general rule, affixes should not be applied to templates that contain individual components that will be used as "building blocks" for complete roadway templates. This is because the component may be used on either the left or right side of the template. Affixes should always be applied when creating completed templates for use with Roadway Designer.

Note that all the points of the component are named using the currently defined **Point Name**. In the example on the previous page, the points were placed using the **ACSC_T_CL** (**A**sphalt **C**oncrete **S**urface **C**ourse **T**op **C**enter **L**ine) point name. After the component is placed, it is necessary to rename the points and assigned feature definitions to ensure that the points and 3D line strings are drawn using the appropriate standards. This can be done by double-clicking on each point to access the *Point Properties* dialog shown on the following page.

The **Name** can be typed in, or selected from the drop-down list. If the **Name** is selected from the list, the associated **Feature Definition** is automatically defined. The *Point Properties* dialog is covered later in this document.

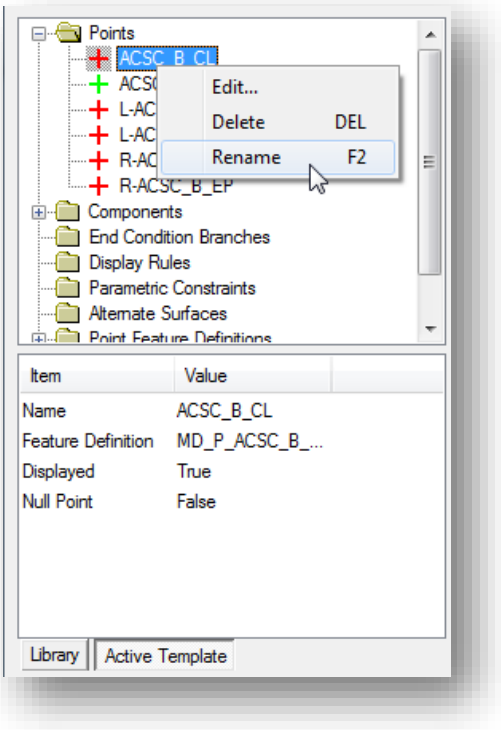


The points have been renamed appropriately in the example shown below.



7.8 Reviewing and Editing Point and Component Names

Point and component names can easily be reviewed and edited using the **Active Template** tab as shown below.



Right-click on a point or component name to reveal the menu shown at left. Choose **Rename** to rename the selected element.

The **Item** and **Value** list, shown below the elements, is used to review various parameters but cannot be used for editing.

Choose the **Edit** option for more editing operations.

Points and **components** can also be edited by double-clicking on a point or component in the template window. The *Point Properties* and *Component Properties* dialogs are covered later in this document.

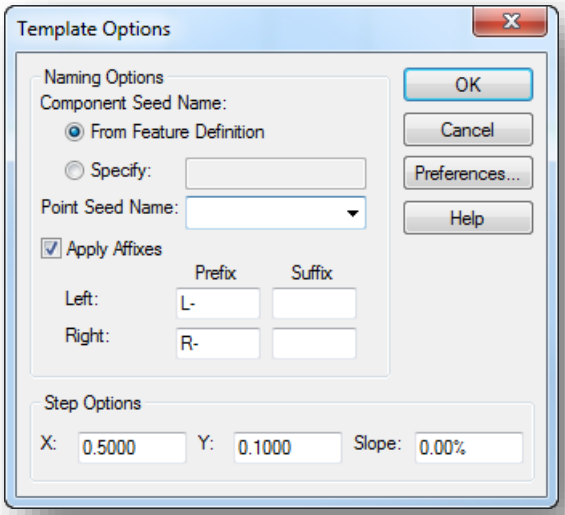
Note: The **Feature Definition** cannot be edited using the **Active Template** editing options.

Exercise 7B – Basic Template Creation

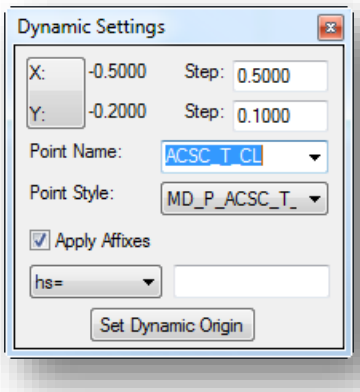
In this exercise we will create a simple template consisting of only the pavement and shoulders.

- ✓ Open MicroStation using the shortcut provided for the training class.
- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL
- ✓ Open the following design file for the training project:
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

- ✓ Select **Tasks > Civil Tools > Corridor Modeling > Create Template** to open the *Create Templates* dialog.
- ✓ In the **Template Library** list, right-click on the **Project Templates** folder and choose the **New > Template** option. Name the new template **Exercise7B**.
- ✓ Select **Tools > Options** to open the *Template Options* dialog. Set the parameters for the dialog as shown at right.



- ✓ Select **Tools > Dynamic Settings** to open the *Dynamic Settings* dialog. Set the parameters as shown at right.



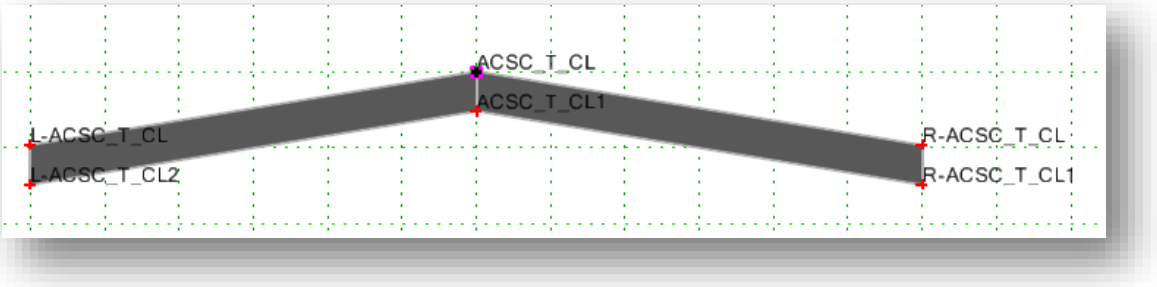
- ✓ Right-Click in the template window and choose **Add New Component > Simple**. A simple component is floating on the cursor using the default settings for the **Slope**, **Thickness**, and **Width**.

- ✓ Set the parameters for the new component that will be created as follows:

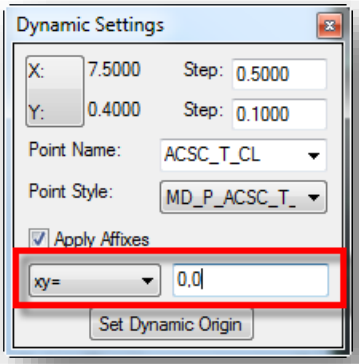
  Name: ACSC
  Feature: MD_P_Asphalt_Concrete_Surface_Course
  Slope: -1.60%
  Thickness: 1.25”
  Width: 12

- ✓ Right-Click in the template window and choose the **Mirror** option (**Ctrl-M**). The simple component is now mirrored and appears on both the left and right sides. The component is mirrored about the **Dynamic Origin** location.

- ✓ Identify the template origin by issuing a data point at the (0,0) coordinate location in the template window. The component constrained to the nearest point in the grid by the **Step** values defined in the *Dynamic Settings* dialog. The mirrored components are shown below.



Tip: You can use the **XY=** option in the *Dynamic Settings* dialog to enter the (0,0) coordinate.

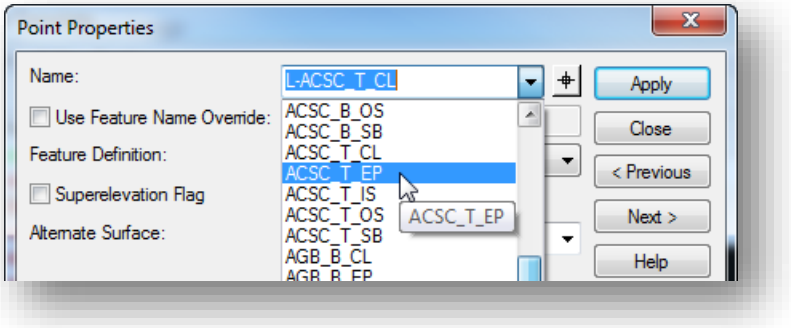


Take note of the point names for the components. Each point is named according to the **Point Name** parameter in the *Dynamic Settings* dialog. Points to the left and right of the origin are prefixed according to the affixes defined in the *Template Options* dialog shown on the previous page. The **Point Style** (feature definition) is the same for each point. It is necessary to review and edit the points to assign the appropriate point name and style.

The *Point Properties* dialog (documented in section 7.15 of this training guide) is used to edit points.

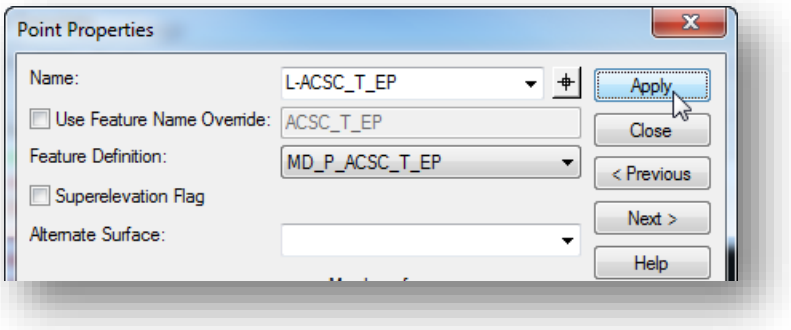
✓ Double-click on point **L-ACSC_T_CL** to review and edit the properties of the point. Take the following steps in the **Point Properties** dialog:

- Change the point name to **ACSC_T_EP** by selecting the name from the list.



- When the point name is selected from the list, the corresponding **Feature Definition** is automatically assigned for the point. Verify that the **Feature Definition** is now set to **MD_P_ACSC_T_EP**

- The point name still needs to have a prefix assigned. Add the prefix **L-** to the point name. The point name and feature definition should be set as shown below.



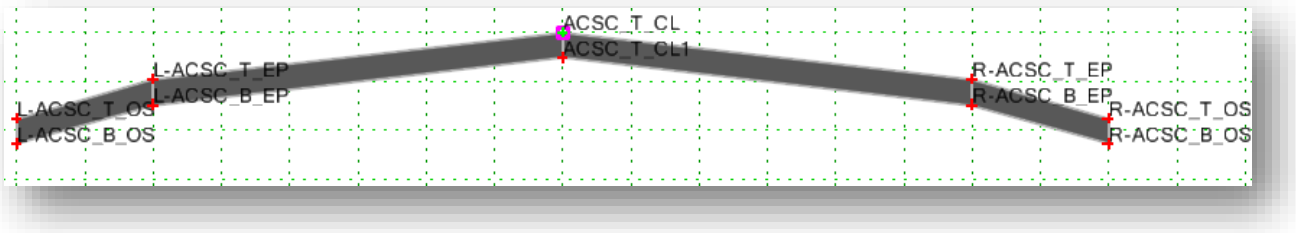
- Select the **Apply** button to save the changes.

✓ Review the remaining points to set the appropriate point **Name** and **Feature Definition** for the top and bottom of the pavement layer. Remember, the feature definition that is assigned to each point will control the level symbology for the 3D line strings that are drawn in the corridor model.

- ✓ Add a simple component for the shoulder surface to the template using the **Mirror** option with the following settings:

  Name: ACSC-OS
  Feature: MD_P_Asphalt_Concrete_Surface_Course
  Slope: -4.00%
  Thickness: 1.25”
  Width: 4

- ✓ Edit the point names for the shoulders by double-clicking on each point to open the *Point Properties* dialog. Be sure the pick the point names from the drop-down menu list so that the corresponding feature definitions are assigned. When completed, the points should be named as shown below.



- ✓ When complete, save your template by choosing **File > Save** from the *Crete Template* dialog pull-down menu.

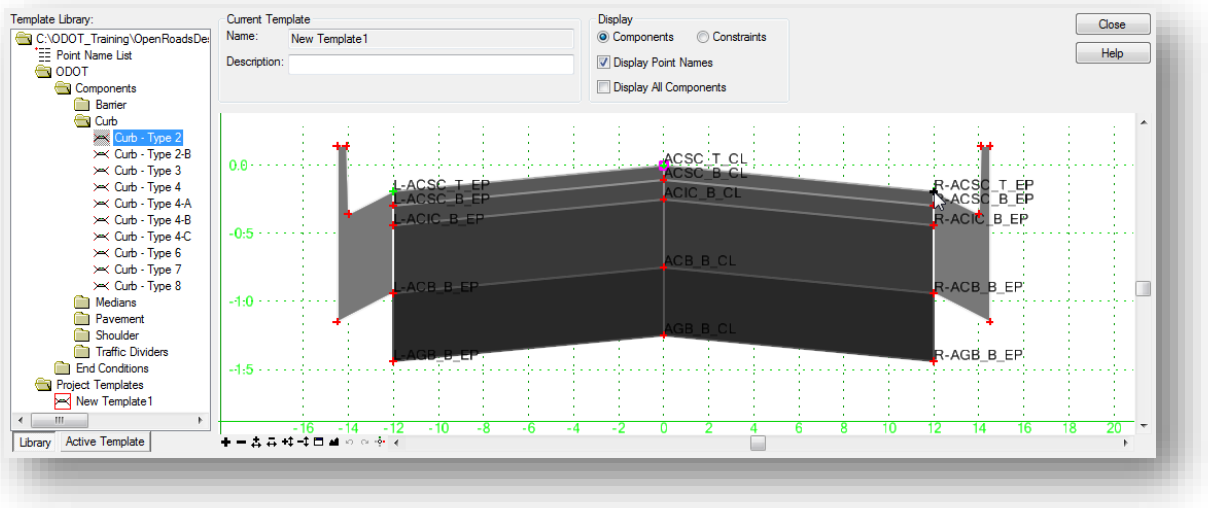
7.9 Drag and Drop Component Operations

A previously created template component can be included in the active template by use of drag and drop operations. Select a previously drawn component from the active template library and drag the component into the **Current Template** window. The component dynamically floats on the cursor. Release the mouse button to drop the component at the desired location.

While dragging the component in the **Current Template** window, right-click anywhere in the **Current Template** window to access the placement options discussed previously (**Mirror**, **Reflect**, etc…)

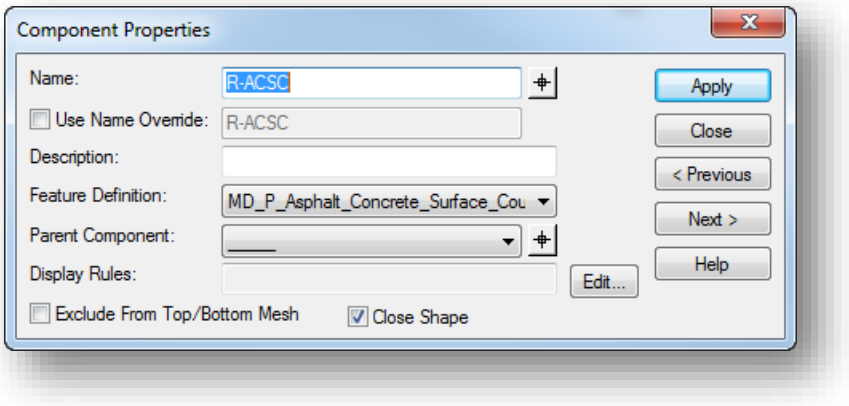
When connecting two components by dragging a component into the active template, the connecting point will change to a white colored plus sign prior to placing the component to indicate that the points are coincident. The point name from the previously placed component will be retained. Point names can be edited at any time during the template creation process.

In the example below, a previously defined curb and gutter component is placed at the edge of pavement in the active template (**New Template1**) by dragging the **Curb – Type 2** component and dropping it on the right edge of pavement point. The **Mirror** option is turned on, with **Apply Affixes** also toggled on, to place the curb and gutter on both sides of the pavement.

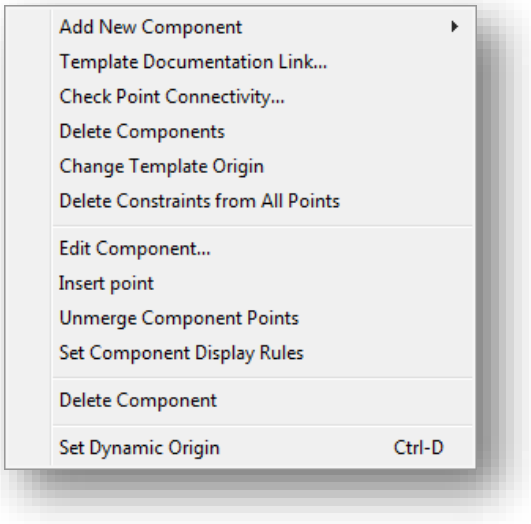


7.10 Component Editing

Components are edited by double-clicking on a component to open the *Component Properties* dialog shown below, or by issuing a right mouse click on a previously drawn component.



The right-click menu shown below is shown below.



See the online help for details on each of these functions.

7.11 Mouse Wheel Functions While Creating Templates

The mouse wheel has the following functions when creating templates:

- Scroll the wheel to zoom in or out in the template window.
- Hold down the **Shift** key while scrolling the mouse wheel to zoom in or out in the vertical direction only.
- Hold down the **Ctrl** key while scrolling the mouse wheel to zoom in or out in the horizontal direction only.

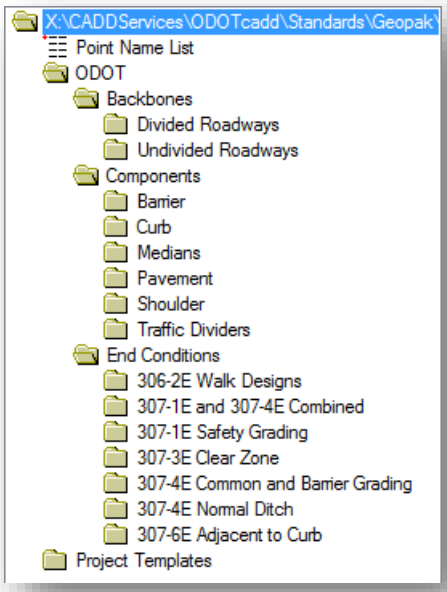
7.12 The ODOT template Library

ODOT provides a template library with many template components defined that can be used as the starting point for creating and editing templates for your project. The template library is available in the following folder:

\ODOTcadd\Standards\GEOPAK\Road\Templates\ODOTcadd_Templates.itl

This template library is copied to the project when the **ODOTcadd_CreateNewProjects.exe** application is used to create the project folder structure.

ODOTcadd_Templates.itl has two main folders containing the template and components as show below.



Each folder is summarized below:

ODOT

This folder contains various **Components** and **End Conditions** that can be used to create completed templates.

Backbones

The “backbone” is defined as the pavement and shoulder portion of the template. The **Backbones** folder contains several common pavement and shoulder configurations for divided and undivided roadways. A variety of configurations are available for superelevated and non-superelevated roadways.

Components

The **Components** folder contains individual design components that can be used as the “building blocks” for a complete template. A Type 2 Curb and Gutter is an example of a component.

End Conditions
Several end conditions are defined for cut and fill conditions according to ODOT design standards.

Project Templates
This is an empty folder to be used by the designer to create templates for the project.

7.13 Basic Template Creation Workflow

While the process to create templates will have many variables, the basic procedure to create templates is summarized below:

- Open the template library
- Create a new template or copy a template. Templates can be copied from one library to another by selecting **Tools > Template Library Organizer** from the *Create Templates* dialog.
- Drag and drop template backbones or individual components into the active template
- Create/edit the components as necessary
- Merge components as desired
- Review the point names and point name overrides
- Review the component names and component name overrides
- Test the template behavior
- Save the template library

Exercise 7C – Create Templates from Components

In this exercise we will assemble the template for St. Peter Road by dragging and dropping components from the ODOT template library.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL

- ✓ Open the following design file for the St. Peter Road corridor model:
  ..\Design\Geopak\Basemaps\12345_KM002.dgn

- ✓ Attach the Survey base map with a **Nest Depth** value of 0.
  ..\Design\Survey\Basemaps\12345_BE001.dgn

- ✓ Select the terrain model boundary and choose the **Set As Active Terrain Model** option

- ✓ Attach the All Geometry base map with a **Nest Depth** value of 1.
  ..\Design\Geopak\Basemaps\12345_BK000.dgn

Next we will create a folder in the template library to contain the St. Peter Road templates.

- ✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Templates** to open the *Create Template* dialog.

- ✓ Create a folder named **St. Peter Road** to store all the templates for St. Peter Road. Right-click on the **Project Templates** folder and choose the **New > Folder** option.

Take the following steps to create the template for St. Peter Road:

- ✓ Right-click on the St. Peter Road folder and choose **New > Template** to create the first template for St. Peter Road. Name the template “St. Peter Road”.

- ✓ Open the *Dynamic Settings* dialog (**Tools > Dynamic Settings**) to define the **Step** increment values as 0.5 and 0.1. This is helpful to ensure that the initial pavement placement is constrained on the “grid”
- ✓ In the *Dynamic Settings* dialog, turn off the **Affixes** option. We will drag in a pavement backbone that already has the left and right sides defined.

- ✓ Drag the following pavement Backbone into the template at the 0,0 origin:

  ODOT > Backbones > Undivided Roadways > Pavement and Shoulder 301-8E Uncurbed > 2-Lane without Superelevation Point > Asphalt Concrete without Stabilization

St. Peter Road will use a pavement width of 10'. Take the following steps to define the pavement width:

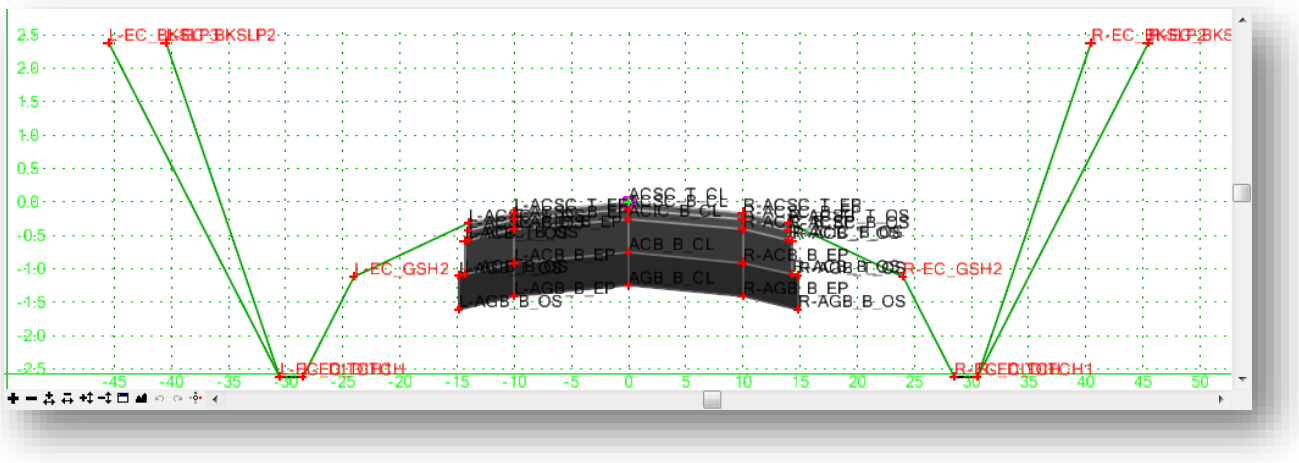
- ✓ Edit point **L-ACSC_T_EP** to define the **Horizontal** constraint with a value of **-10**
- ✓ Edit point **R-ACSC_T_EP** to define the **Horizontal** constraint with a value of **10**

Next we will add the end conditions to the template.

- ✓ In the *Dynamic Settings* dialog, turn on the **Affixes** option
- ✓ Drag the following component onto the edge of shoulder point. Right-click and use the Mirror option to place it on both sides simultaneously.

  ODOT > End Conditions > 307-4E Common and Barrier Grading > 307-4E Cut 3:1

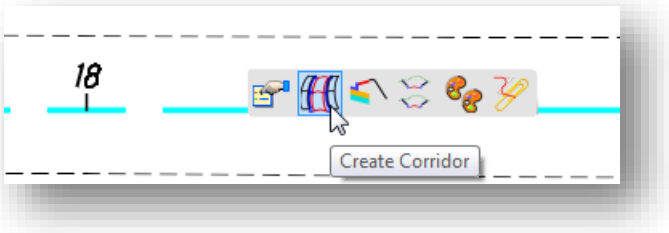
The completed template should appear as shown below.



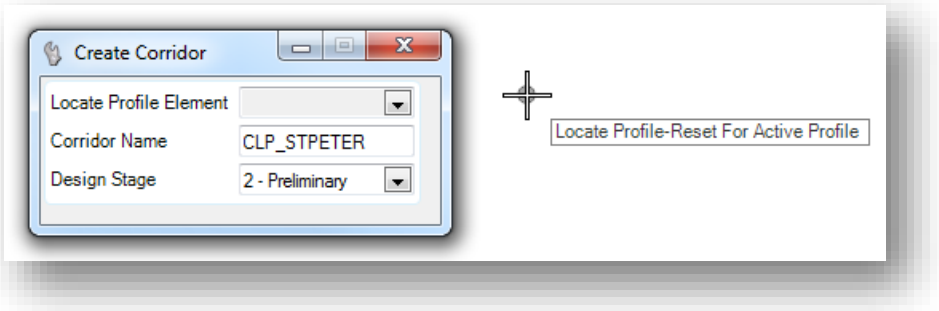
- ✓ When complete, save your template by choosing **File > Save** from the *Crete Template* dialog pull-down menu.

7.14 Corridor Modeling Basics

A corridor model is created by applying a template to selected horizontal and vertical geometry. The **Create Corridor** tool can be selected from the task list, **Tasks > Civil Tools > Corridor Modeling > Create Corridor**, or by the pop-up menu when a horizontal alignment is selected.



When the command is selected, the software will step you through a series of prompts. These prompts appear on the cursor and can also be defined using the **Tool Settings** dialog.



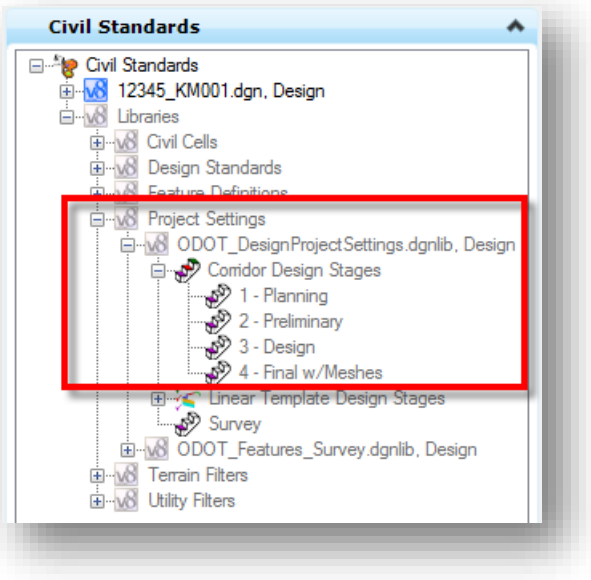
You are prompted to define the following parameters:

Locate Profile – Reset For Active Profile
Select the profile name from the drop down list, or issue a reset button to accept the Active Profile that is defined for the Horizontal Alignment. ODOT recommends using the Active Profile option rather than specifically choosing a profile name.

Corridor Name
Define the name for the corridor. It is recommended that you use same name as the horizontal alignment.

Design Stage
Design stages are used to define a variety of parameters to control the template drop interval as well as which elements are drawn in the 3D model (3D line strings, 3D components, surface meshes, etc). The design stages are defined in **ODOT_DesignProjectsettings.dgnlib** which is attached by a configuration variable.

The design stages can be reviewed in the **Civil Standards** tab of the *Project Explorer* dialog as shown on the following page.



The design stage can be changed at any time throughout the corridor modeling process.

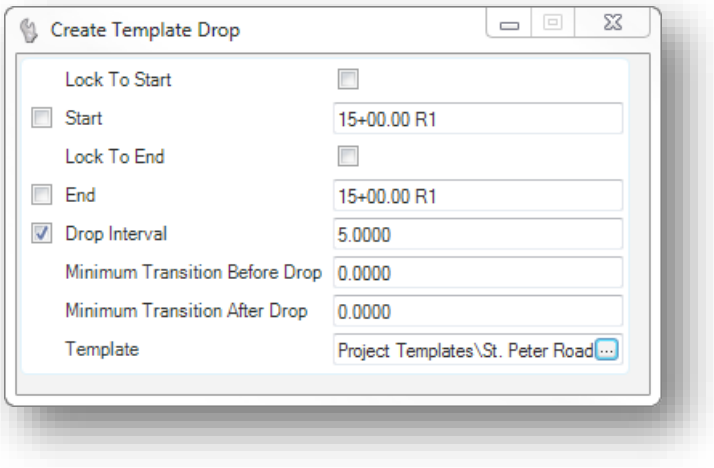
Each design stage is defined to provide more detailed information as you work from conceptual design for the final design. The settings for each design stage are defined in the ODOT standards and vary for each design stage as shown below:

Template Drop Interval Multiplier
When templates are applied to the horizontal and vertical geometry, the user is prompted to enter a template drop interval. ODOT recommends an interval of 5. The **Template Drop Interval Multiplier** parameter is used to specify a multiplier, which is applied to the initial template drop interval, to determine the actual interval of each template drop location according to the selected design stage. This is useful to speed up processing for early design stages where less detailed information is required. The ODOT design stages have been defined with the multiplier values shown in the table below.

Output Settings
The **Output Settings** contain on/off toggles for the graphics that are drawn in the 3D model. Less information is drawn in the 3D model for the early design stages. The table below details the graphics drawn for each design stage.

Design Stage	Template Drop Interval Multiplier	Create Top Mesh	Create Bottom Mesh	Create Linear Features	Create Component Meshes	Include Null Point Linear Features
Planning	10	False	False	True	True	False
Preliminary	5	False	False	True	True	False
Design	1	False	False	True	True	False
Final w/Meshes	1	True	True	True	True	False

After defining the **Profile**, **Corridor Name**, and **Design Stage**, you are prompted to define the **Template Drop** information as shown below.



The parameters can be defined in the *Crete Template Drop* window, as shown at left, or by dialogs floating on the cursor that will step you through the parameters.

Each parameter is defined below:

Lock to Start
Toggle this option on to lock the start of the corridor to the start of the horizontal alignment.

Start
Define the **Start** station for the Corridor.

Lock to End
Toggle this option on to lock the end of the corridor to the end of the horizontal alignment.

End
Define the **end** station for the Corridor.

Drop Interval
This parameter is used to define the interval that the template will be applied to the corridor. We recommend a **Drop Interval** of **5** for ODOT projects.

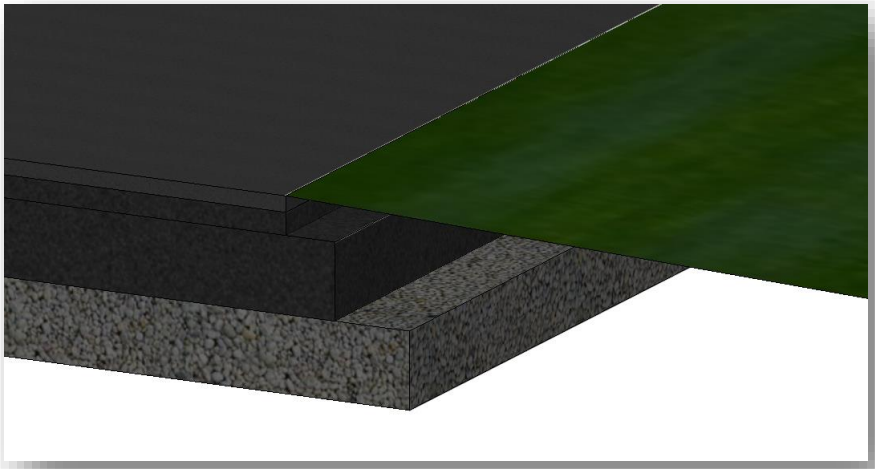
The selected **Corridor Design Stage** includes a parameter, **Template Drop Interval Multiplier**, which impacts the **Drop Interval** that is applied to create the corridor. For example, the **Preliminary Corridor Design Stage** has a **Template Drop Interval Multiplier** value of **5**. When the **Preliminary Corridor Design Stage** is used, the **Drop Interval** is multiplied by 5 which results in a template drop ever 25'.

Minimum Transition Before Drop / Minimum Transition After Drop
If they are non-zero, then a transition drop is created at the beginning/end of the template drop with a length greater than or equal to the value entered. The actual length is determined by how far it is between the new drop and the drop before/after the new drop. If there isn't enough space to meet the minimum, then the previous/next drop is shortened to accommodate the transition. If there is no previous/next drop, then no transition drop is created.

After defining the *Create Template Drop* parameters, the template is applied to the selected horizontal and vertical alignments to create the corridor.

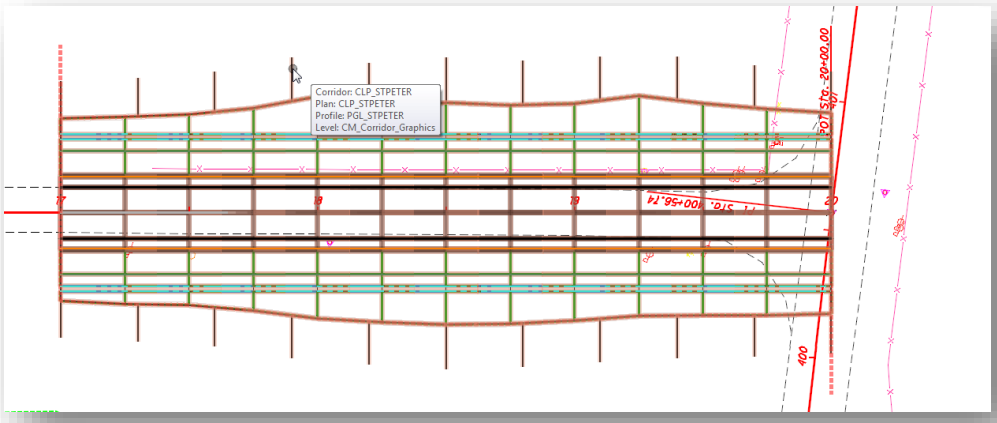
- A 3-Dimensional model named **Design-3D** is automatically created in the active design file and referenced to the active model. The referenced graphics are not always desirable and can be turned off using the MicroStation Reference Attachment tools.

  The 3D model can be opened and viewed as necessary. 3D Mesh elements are created for each component in the template. An example of the components for the shoulder and graded shoulder is shown below.

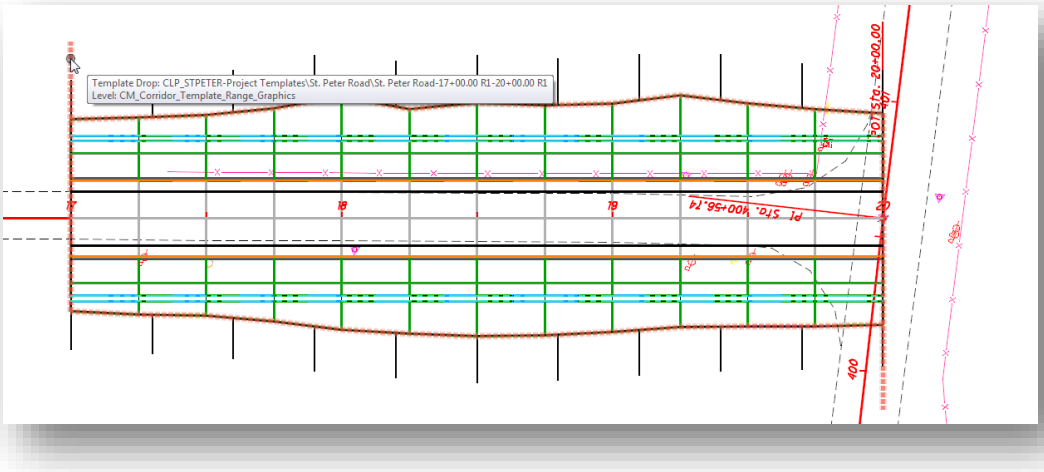


- 2-Dimensional graphics are drawn in the active model as defined by the features assigned to the individual points in the template. The ODOT feature definitions that are assigned to points on the Surface of the template are the only template features that draw these 2D plan graphics.

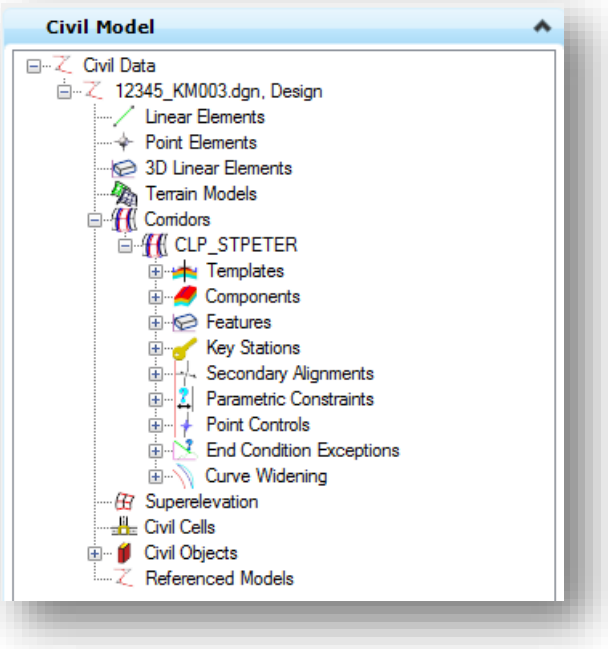
- Graphics representing the length of the corridor model are created in the active model. This graphics is placed on the level **CM_Corridor_Graphics** and include several “handles” that can be easily selected to identify the Corridor Model as shown below.



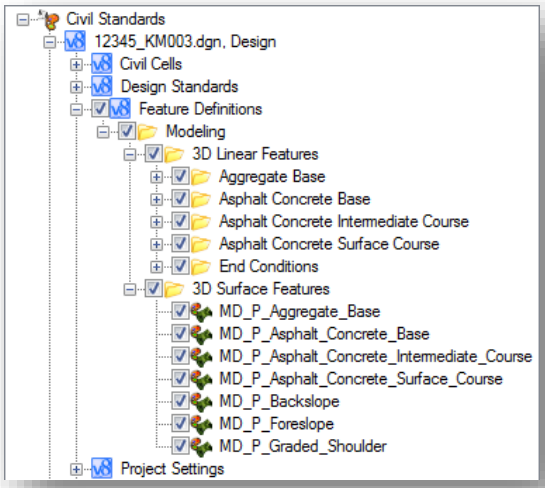
- Graphics representing the template drop range are drawn on the level **CM_Template_Range_Graphics** as shown below. This graphic can be selected to edit or modify the template drop parameters.



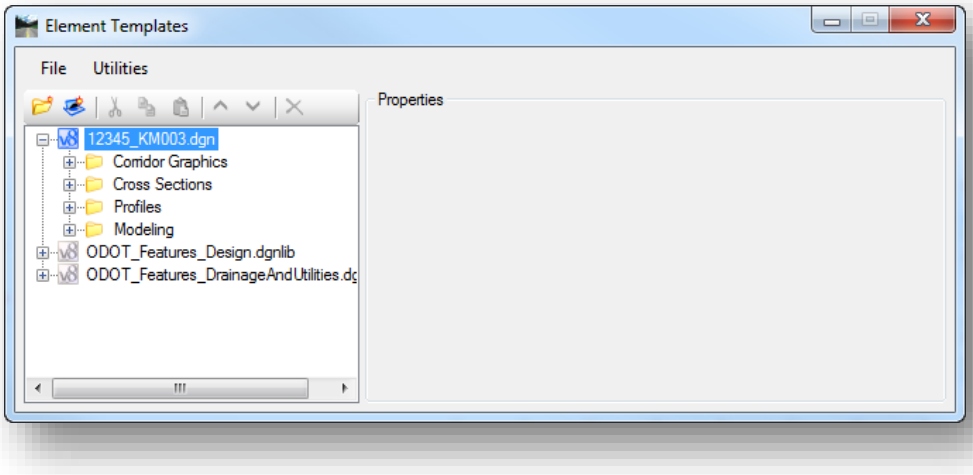
- The corridor is added to the **Civil Model**, which can be reviewed by selecting the **Civil Model** tab in the *Project Explorer* dialog.



- The **Feature Definitions** are copied from the DGN Library to the active file. The feature definitions can be reviewed and modified in the **Civil Standards** tab on the *Project Explorer* dialog.



- Element Templates, which are assigned to the various feature definitions, are also copied from the DGN Library to the active design file. The Element Templates can be reviewed by selecting **Element > Element Templates** from the MicroStation pull-down menu.



The **Feature Definitions** and **Element Templates** are copied to the file to facilitate sending the file to other users who may not have the ODOT workspace configured. All of the information will still display with the correct symbology since the Features, Levels, Element Templates, Line Styles, etc… are all imbedded in the file.

If a **Feature Definition** or **Element Template** definition is changed in the standards, it is necessary to delete any **Feature Definitions** and **Element Template** definitions that have been copied to the design file in order for the file to read the updated standards.

Exercise 7D – St. Peter Road Corridor

In this exercise we will apply a template to define a corridor for St. Peter Road. We will model the intersection for St. Peter Road and S.R. 185 in a later exercise.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the User and Project as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL

- ✓ Open the following design file for the St. Peter Road corridor:
  \Design\Geopak\Basemaps\12345_KM002.dgn

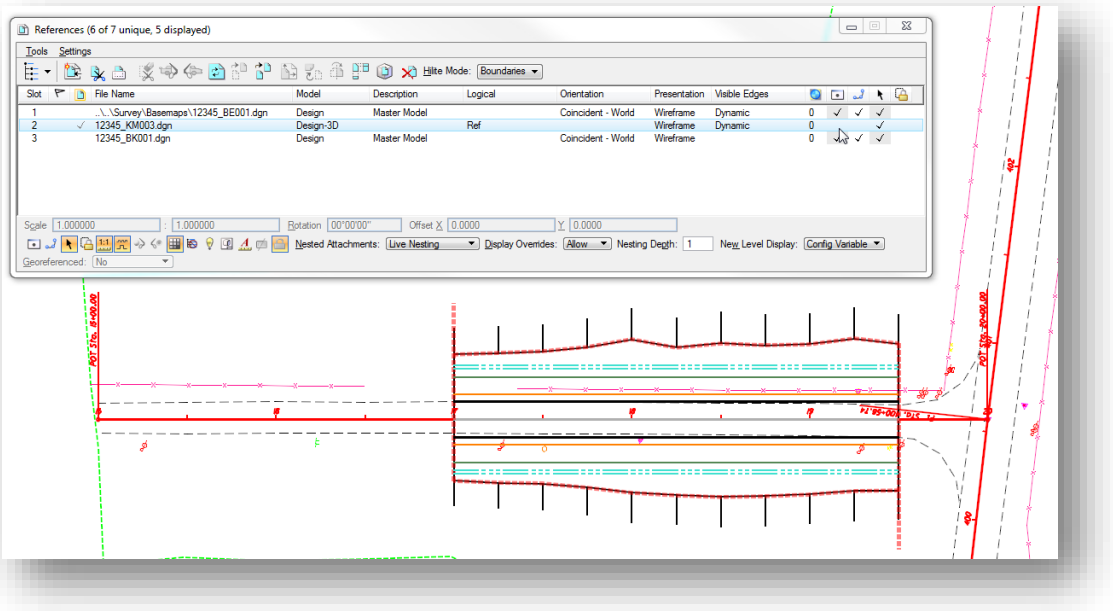
- ✓ Select the horizontal alignment for St. Peter Road and choose the **Create Corridor** command from the pop-up menu. Define the corridor with the following settings:

  Profile: P_CLP_STPETER
  Corridor Name: CLP_STPETER
  Design Stage: 2 - Preliminary

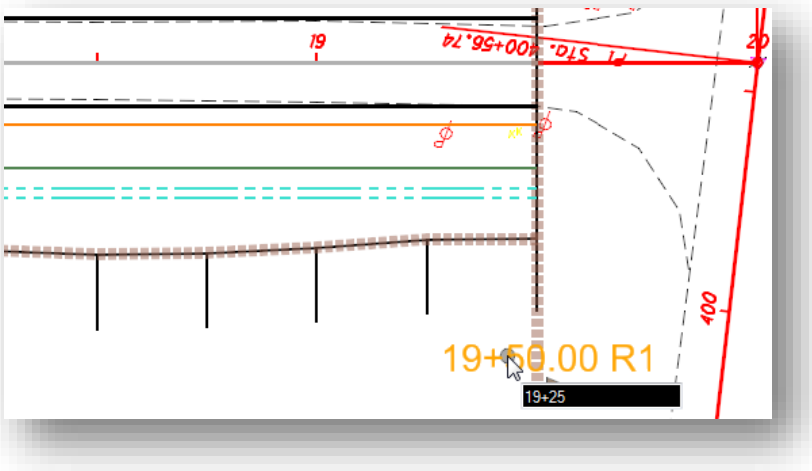
- ✓ Use the following settings on the *Create Template Drop* dialog:
  Start: 17+00
  End: 19+50
  Drop Interval: 5
  Minimum Transition Before Drop: 0
  Minimum Transition After Drop: 0
  Template: Project Templates\St. Peter Road

  The corridor is created as well as the 3D-Model for the corridor graphics.

- ✓ Use the *References* dialog to turn off the display of the 3D model. This is optional, but is usually helpful to make it easier while working with the corridor model for subsequent operations.

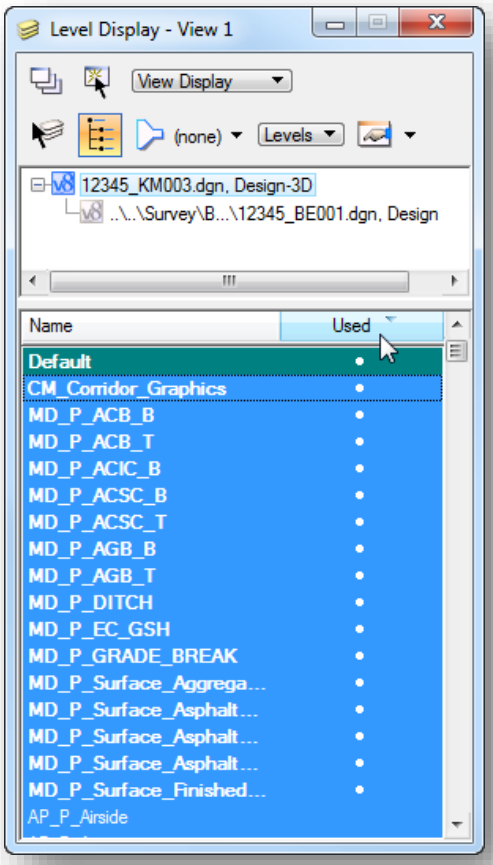


✓ Change the ending station of the corridor to 19+25. This is easily accomplished by selecting the Template Drop graphic as shown below. The template drop **Start** and **End** locations can be edited by selecting the **Manipulator Text** and keying in a new value, or by dragging the manipulator arrow. The corridor is automatically updated when the new value is entered.

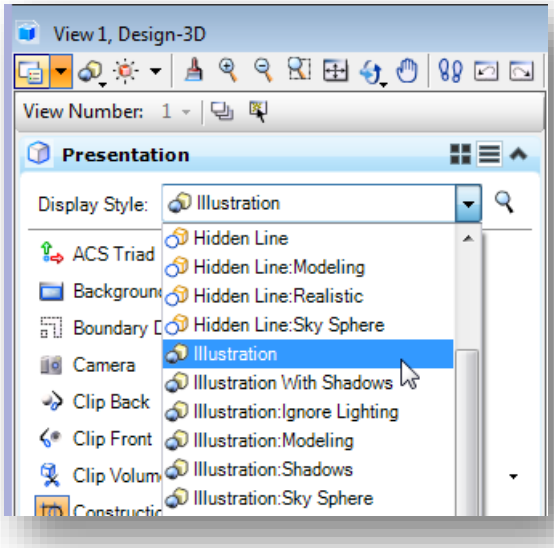


✓ Use the MicroStation *Models* dialog to open the **Design-3D** Model. Set the view rotation to the **Isometric** view.

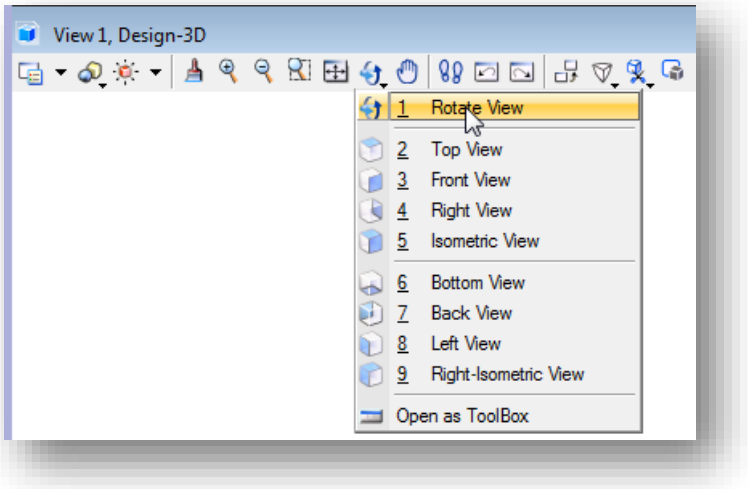
✓ In the 3D model, open the **Level Display** dialog. Sort the levels using the **Used** column to review the levels that are used to place the corridor graphics. Toggle off all the levels and then turn them back on one at a time to see which graphics are drawn on each level.



✓ Change the view display mode to **Illustration** to view the rendered graphics for the corridor.



✓ Use the **Rotate View** command to rotate the view to review the 3D graphics.



✓ Using the *Models* dialog, open the **Design** model.

✓ **Save Settings** before exiting the design file.

7.15 Advanced Template Design

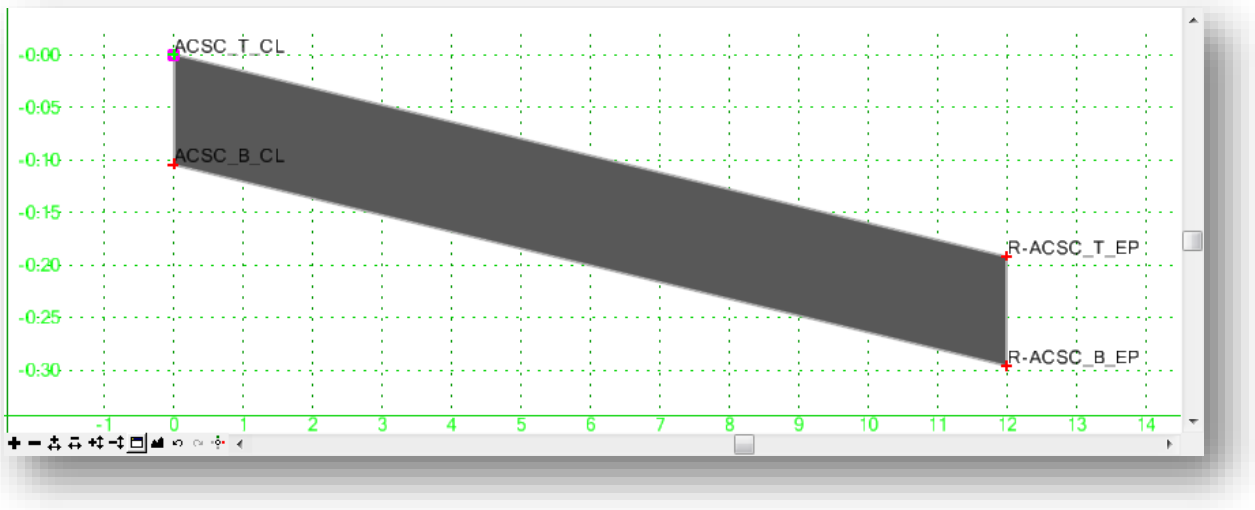
The corridor modeling tools provide a lot of options that can be used to create very complex templates that handle a variety of design scenarios. However, care should be taken not to create overly complex "Franken-Templates" that can be hard to edit and even harder to diagnose when things don't work as expected. It's better to define a few simpler templates for specific station ranges than it is to define one overly complex template.

In this section, we will take a deeper look at the available template parameters.

Point Constraints

Point constraints are used to manage the behavior of points in a template. They are used so that if a point is moved in a template, either by the user editing the template or by the application of a horizontal or vertical control during design processing, all the points related to the point being moved behave in a rational and predictable manner.

For example, when a **Simple** component is inserted into the active template, it is comprised of four points which are connected together to define the component as shown in the example below.



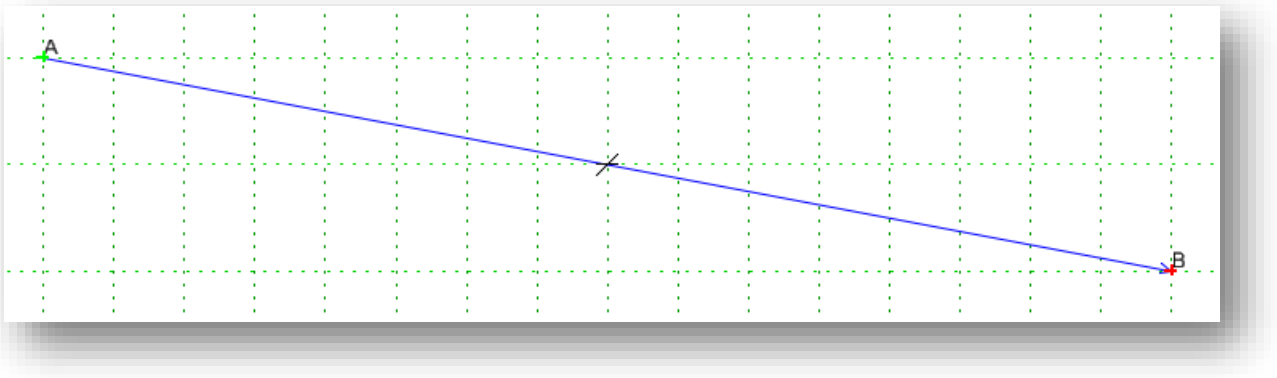
Three of the four points are constrained with relation to the insertion point. If the original insertion point is moved, the other three points move in relation to the first point.

A point can have, at most, 2 constraints on it. If two constraints are defined, the point is said to be "fully constrained". A point that is fully constrained is represented by a red plus sign. In the example above, points **R-ACSC_T_EP**, **R-ACSC_B_EP**, and **ACSC_B_CL** are fully constrained.

A point that is partially constrained, meaning that it has only one constraint on it, is shown as a yellow plus sign.

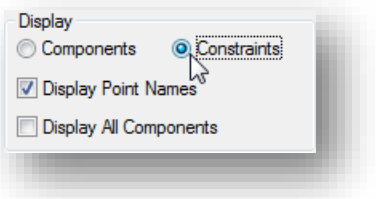
An unconstrained point is shown as a green plus sign. In the example above, point **ACSC_T_CL** is unconstrained.

Point constraints are two-dimensional and one-way. Two-dimensional means that the constraints can only affect the points offset and elevation (x and y coordinates in the cross section view). One-way means there is a child-parent relationship between points. In other words, if point B is constrained by point A, point A is said to be the parent of point B and moving point A will affect point B, but you cannot move point B to affect point A. The example below shows a sample of this where the blue arrow indicates a parent/child relationship from point A to point B:



Constraints can also be labeled so that during processing, the value(s) of labeled constraint(s) may be changed. For example, the template may have a constraint label called **ACSC Thickness** that controls the thickness of the first pavement layer. This value can then be changed over one or more station ranges during the corridor modeling process.

The constraints for all the points in a template can be displayed by choosing the **Display Constraints** option on the *Create Template* dialog.



Constraints are displayed as blue lines between the parent and the child point. At the midpoint of the constraint line, there is a short white line designating the constraint type as follows:

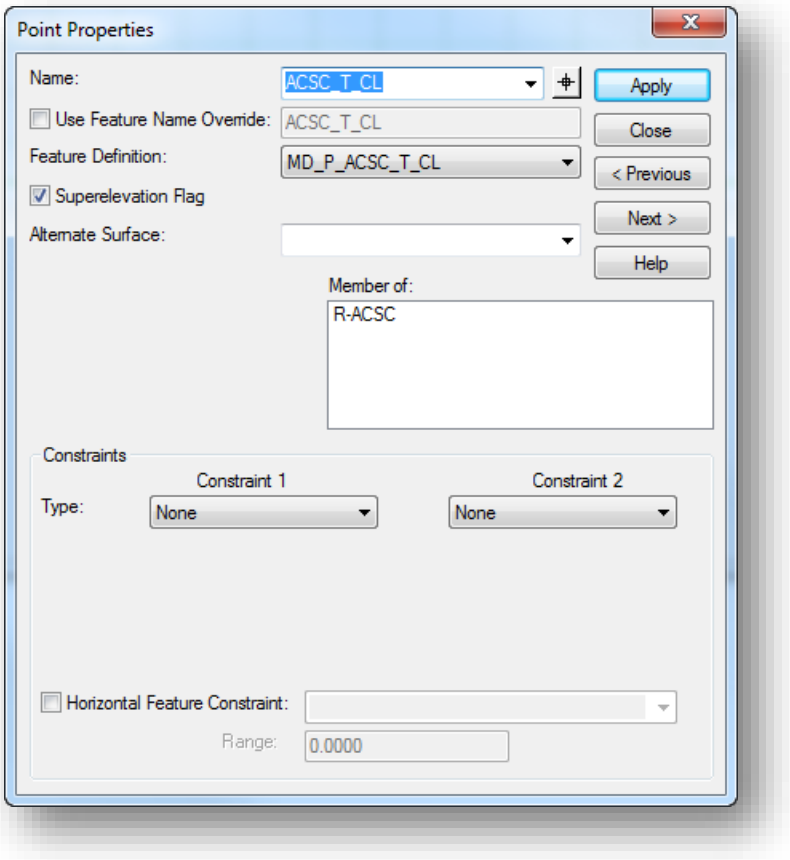
- Horizontal line = Horizontal Constraint
- Vertical line = Vertical Constraint
- Sloped line = Slope Constraint

Multiple lines will be shown for points with two constraints.

Floating the cursor over a point will temporarily display an arrow designating the direction of the constraint (the arrow points to the child point) and a pop-up menu displaying information about the point.

The Point Properties Dialog

The *Point Properties* dialog is used to review and edit various properties associated with the template points, including the definition of the point constraints. To access the *Point Properties* dialog, in the *Create Template* dialog double-click on the point in the **Current Template** window. The *Point Properties* dialog, shown below, is opened.



The dialog contains the following options:

Name displays the point name. The point name can be keyed-in or selected from the drop-down list. If the point name is selected from the list, the corresponding **Feature Definition** is automatically assigned. Point names must be unique to the template.

Use Feature Name Override displays the name of the feature that will be created in the surface to correspond to the point. This field is optional. If it is blank, then the point name will be used as the feature name.

- The option is intended primarily for end condition components to create connectivity from one station to the next when the template end conditions change. For example, if you want all surface tie-in points to belong to one feature, then set the feature name of all the ending end condition points on each side of the template to the same name (i.e. all Cut and Fill end points on the right would be given the feature name R-Tie and all the ones on the left would be given the feature name L-Tie).

- If the point has a **Feature Name Override** defined, the point name is displayed in red in the Template window.

The **Superelevation Flag** is used to identify the point as a candidate to be used for assigning superelevation control lines. This option should only be toggled on for pavement points on the surface of the pavement.

Feature Definition is used to define the feature definition of the point. If no style is specified, then it comes from the first component of which the point is a member.

Alternate Surface allows you to specify the name of an alternate surface for a point. You may choose multiple alternate surface names. Select from the list of available surfaces in the active template.

Member Of indicates in which components the point is included.

Constraints

The **Constraints** portion of the *Point Properties* dialog allows you to review/edit the constraints on a point.

Type specifies the constraint type: **None**, **Horizontal**, **Vertical**, **Slope**, **Vector-Offset**, **Project to Surface**, **Project to Design**, **Horizontal Maximum**, **Horizontal Minimum**, **Vertical Maximum**, **Vertical Minimum**, **Angle Distance**. The constraints are described in more detail on the following page.

Setting up the appropriate constraint types is critical to achieve the desired results when pavement layers, superelevation, and transitioning are introduced to the design.

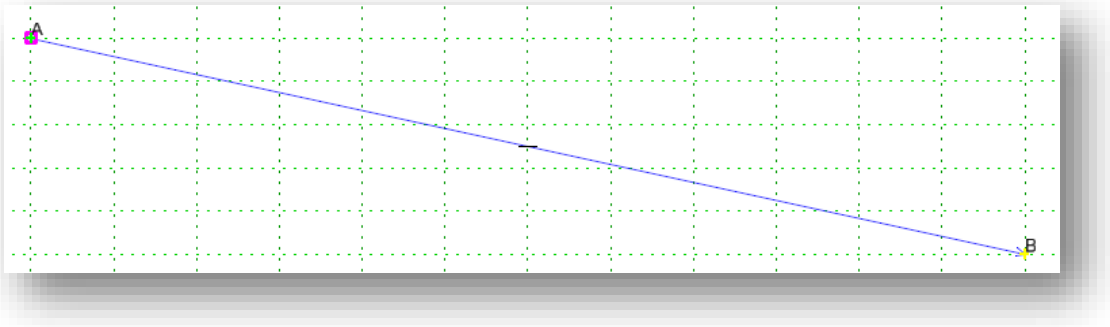
Label displays the optional label for the constraint. Constraints that are labeled can have their value changed during design processing. The same label name can be assigned to more than one constraint and more than one point. See Section 10.4 for details.

Horizontal Feature Constraint is used to allow a point to target elements in the design file that are defined with the specified **Feature Definition** within a specific **Range**. Use of this option is not recommended.

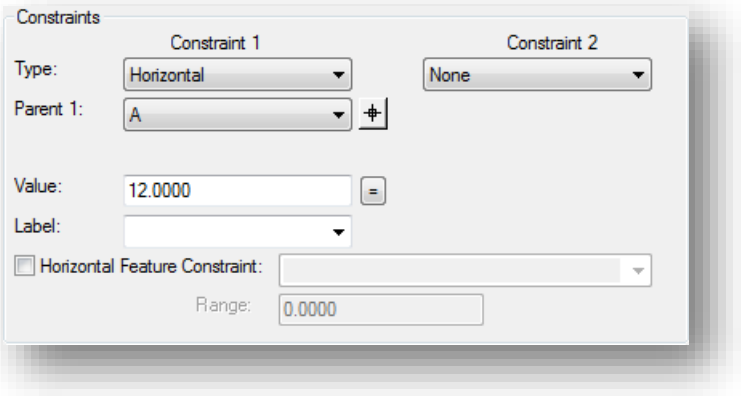
Point Constraint Types

Horizontal

The child point remains at the given horizontal distance from the parent point.



In the example above, point **B** has been constrained to point **A** with one constraint as shown below.

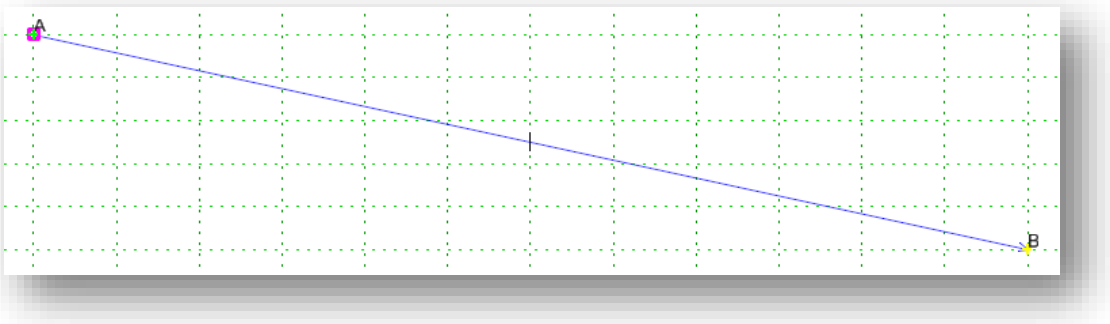


If point **A** is moved horizontally, point **B** will maintain its relative distance from point **A**.

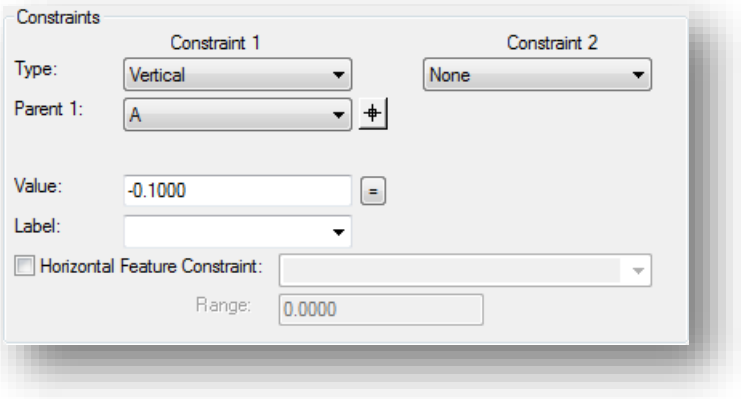
If point **A** is moved vertically, point **B** is unaffected.

Vertical

The child point remains at the given vertical distance from the parent point.



In the example above, point **B** has been constrained to point **A** with one constraint as shown below.

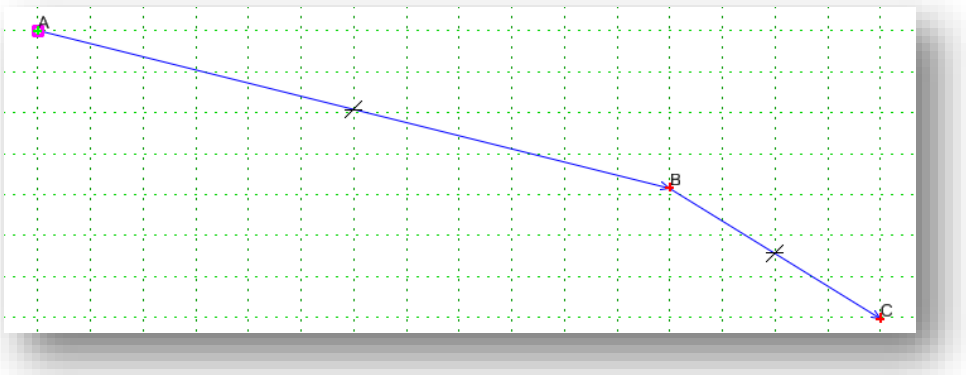


If point **A** is moved horizontally, point **B** is unaffected.

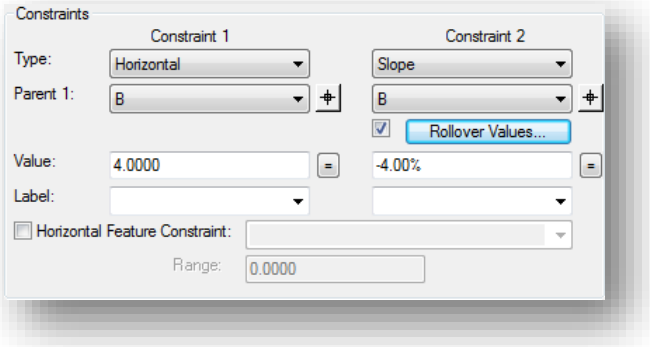
If point **A** is moved vertically, point **B** will maintain its vertical relationship to point **A**.

Slope

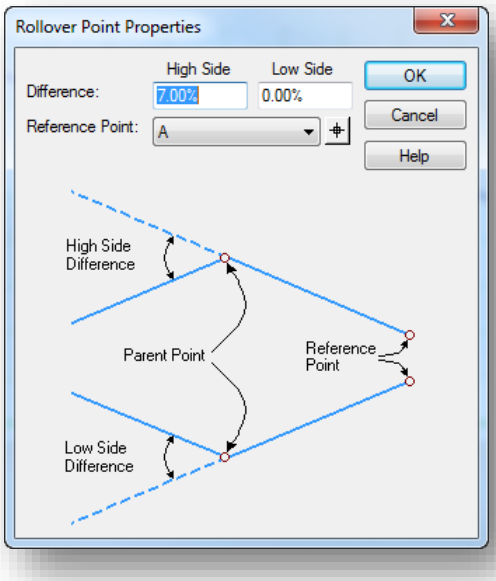
The child point will maintain the given slope from the parent point.



In the example above, point **C** has been defined with a **Horizontal** and a **Slope** constraint as shown below:



Slope constraints are absolute. Slopes going from lower-left to upper-right are positive regardless of whether the child point is to the left or right of the parent.



Slope constraints can also have **Rollover Values** assigned to them. Rollover values are used to set the slope constraint based on a **High Side** slope difference and a **Low Side** slope difference. A **Reference Point** is specified which defines the controlling slope to the parent point.

Note that the **Rollover Values** can be used for ODOT projects only in cases where a shoulder break is not required for the high side of superelevation.

Horizontal Maximum
The child point has two parent points and remains at the given horizontal distance from the parent point that is farthest to the right (has the maximum horizontal or X value).

Horizontal Minimum
The child point has two parent points and remains at the given horizontal distance from the parent point that is farthest to the left (has the minimum horizontal or X value).

Vertical Maximum
The child point has two parent points and remains at the given vertical distance from the parent point that is highest (has the maximum vertical or Y value).

Vertical Minimum
The child point has two parent points and remains at the given vertical distance from the parent point that is lowest (has the minimum vertical or Y value).

Vector Offset
The child point has two parent points and will be projected onto the vector defined by the two parents. If the offset is not zero, then the child point will maintain a perpendicular offset from the parent vector at the specified offset value. Negative values indicate an offset to the left of the vector defined by the parent points. Positive values indicate an offset to the right.

Project to Surface
This constraint must be used in conjunction with one of the previously define constraints. The other constraint will define the projection direction. The child point will then be projected to the surface with the name or parametric label given when the design is processed. If the surface does not exist, or no solution is found, then the point will remain where it is placed in the template.

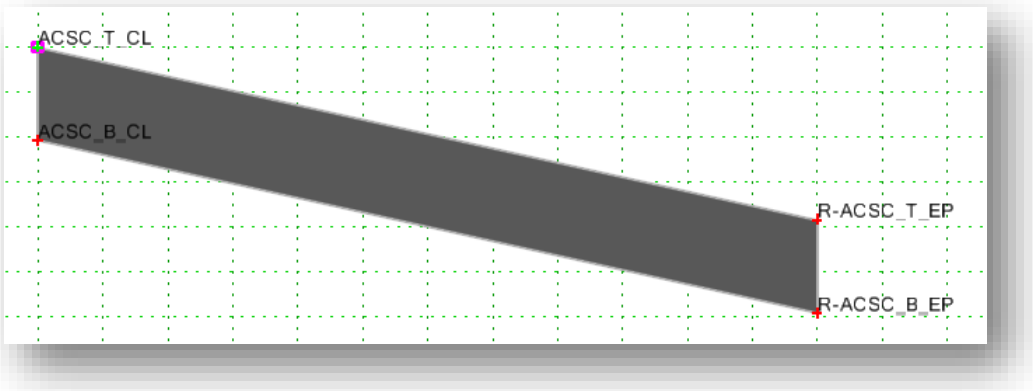
Project to Design
This constraint is similar to the Project to Surface, except that the point is projected to the design surface of the template. A projection value is given to indicate whether the projection is to be to the left or to the right. The point must also be constrained by one of the previous constraints, excluding the Project to Surface, so that a direction for the projection may be determined. A negative value limits the projection to the left of 0; a positive value limits the projection to the right. A value of 0 will seek to the left and to the right of 0 to project the point. If no solution is found, then the point will remain where it is placed in the template.

Angle Distance
This constraint takes two parent points, a distance, and an angle. The selected point is then fully constrained to the location defined by the first parent, and the angle from the first parent relative to the vector defined by the two parent points. This constraint creates a rigid-body rotation. When selected, no other constraints types are available.

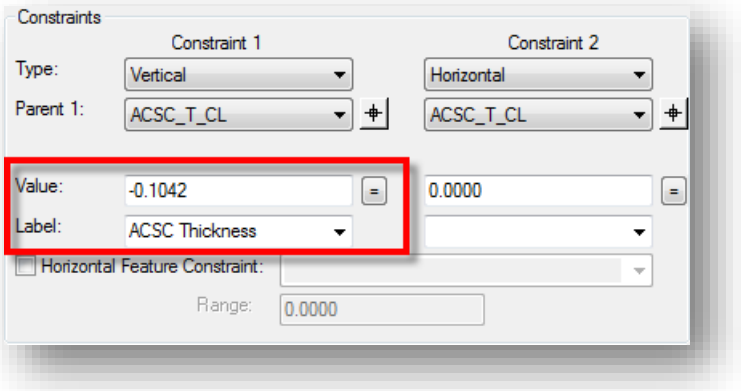
Constraint Labels

Constraint **Labels** can be assigned for points in your template that may have a variable value in your design, or a different value from one project to another. The value for the **Label** can be modified in the corridor modeling process. Assigning labels will allow your templates to be more flexible and therefore make them useful for more than one project.

In the example below, a simple component has been created representing the Asphalt Concrete Surface Course for one lane of pavement.



The depth of the pavement at points **ACSC_B_CL** and **R-ACSC_B_EP** has been defined as -0.1042' as shown below.

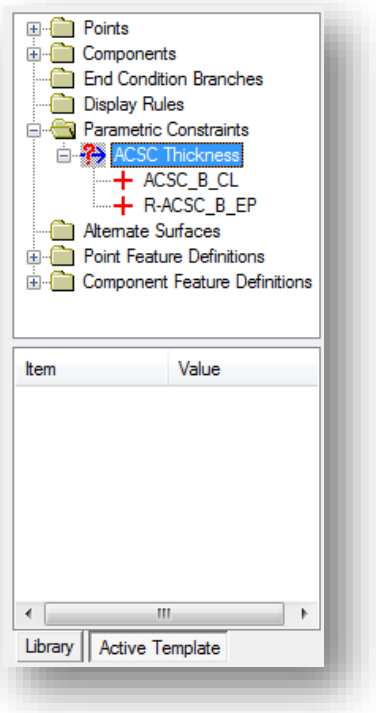


The thickness of the pavement can be changed by editing the template points, or by adding a **Label**. In the example above, the **Label** "ACSC Thickness" has been assigned for point **ACSC_B_CL** and also for point **R-ACSC_B_EP**.

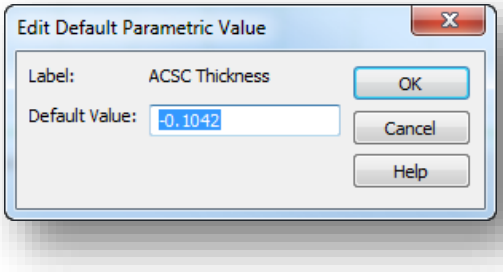
The **Label** name is user definable. The same label name is used for each point in the template that will use the value of the label. Once a label name has been assigned, it is available to be selected from the drop down label list as other points are defined.

The value of the label can be changed in the **Create Template** dialog, or during the corridor modeling process.

To change the value in the **Create Template** dialog, select **Parametric Constraints** in the **Active Template** option. The points that have been assigned the label are listed as shown at right.



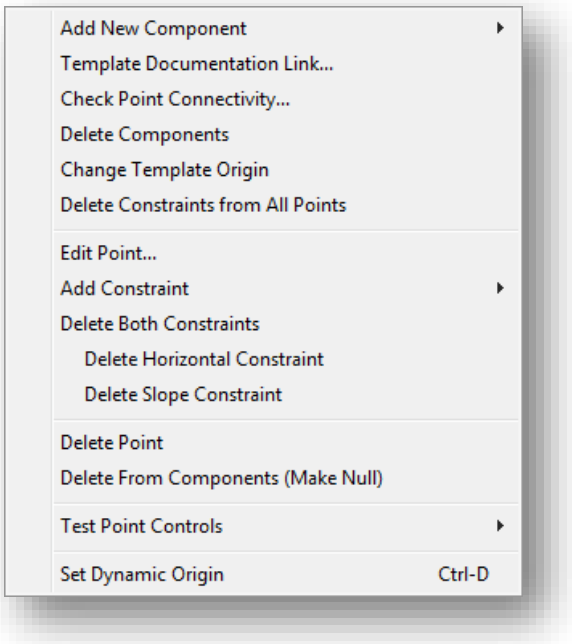
Double-click the name of the **Parametric Constraint** that you wish to edit. The *Edit Default Parametric Value* dialog show below is opened which allows you to edit the value.



The template graphics are automatically update to reflect the new value.

Editing Points with the Right-Click Menu

In addition to the *Point Properties* dialog, points can be edited from a pop-up menu that is accessed by right-clicking on a point in the **Active Template** window. The menu is shown below.



Some of these commands are covered later in this training guide. See the online help for documentation of commands not covered in this document.

Adding Components to the Template

A component is a set of points that define an open or closed shape.

When defining new components using precision input, the sign of the distance is dependent on the parent-child relationship of the points. The parent is always the first point placed when creating template components. The following rules apply:

- A child placed to the right of the Parent point is at a positive distance
- A child placed to the left of the Parent point is at a negative distance
- A child placed above the Parent point is at a positive distance
- A child placed below the Parent point is at a negative distance
- The Slope is the algebraic slope

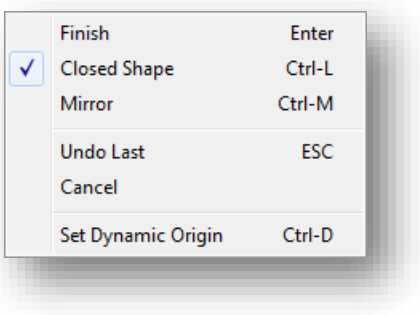
There are six types of components:

- Simple
- Constrained
- Unconstrained
- Null Point
- End Condition
- Overlay/Stripping

Each component type is described in further detail on the following pages.

As you add components to your template, the area under the active template window is used to display various parameters for the component. This is called the **Current Component** area.

Right-click in the current template window at any time during the component creation process to access the menu shown below:



Select **Finish** when you have completed creation of the component.

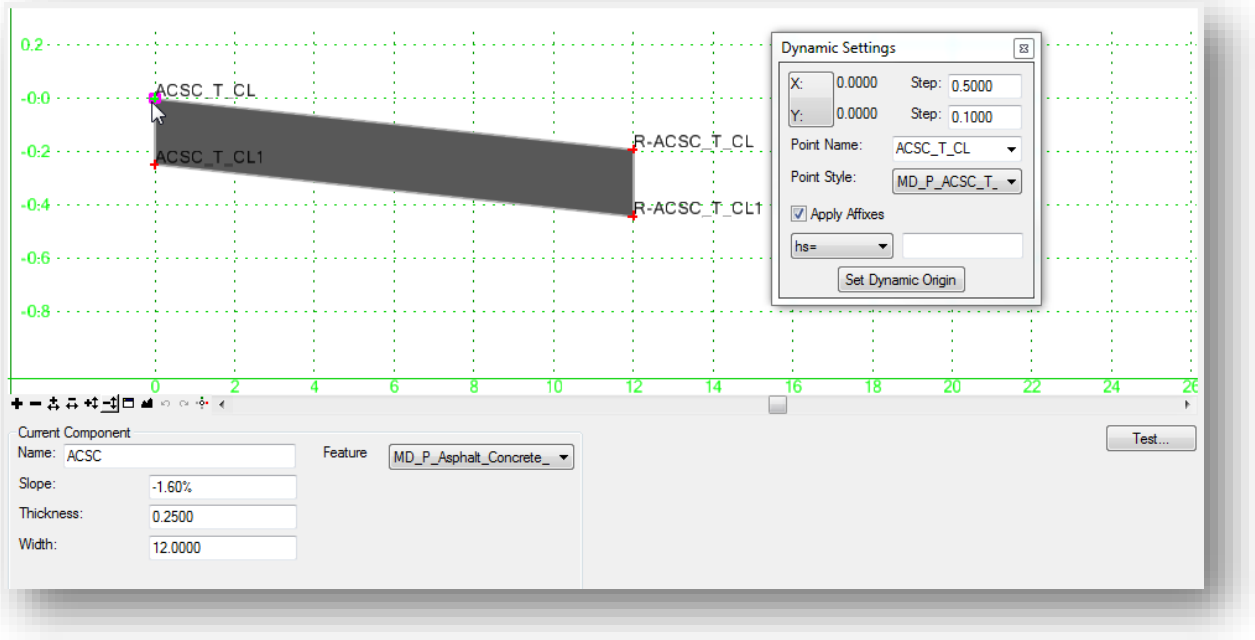
Creating Simple Components

A simple component consists of four points defined by **Slope**, **Thickness**, and **Width**. The top points are constrained by **Horizontal** and **Slope** constraints. The lower points are constrained to the points directly above them by a **Horizontal** and **Vertical** constraint.

To create a simple component, right-click in the active template window and select **Add New Component > Simple**, or select **Add > Simple** from the pull down menu of the *Create Template* dialog to initiate the command.

Define the **Name**, **Slope**, **Thickness**, **Width**, and **Feature** of the component before placing the component in the template.

The **Feature** is used to set the symbology for the graphics drawn to represent the component in the 3D model.



The *Dynamic Settings* dialog is used to facilitate component placement. The point names are derived from the **Point Name** selected in the *Dynamic Settings* dialog. Each point is appended with a number that is incremented. The points are assigned the **Point Style** feature that is active in the *Dynamic Settings* dialog.

Point names and the feature that is assigned to each point should be reviewed and edited after the component is placed.

Creating Constrained and Unconstrained Components

Constrained or **Unconstrained** components can be used to create any open or closed shapes in the template such as curb and gutter, median barriers, retaining walls, or complex pavement situations such as the shoulder break on the high side of superelevation.

Constrained Components

To create a constrained component, right-click in the current template window and select **Add New Component > Constrained**, or select **Add > Constrained** from the pull down menu of the *Create Template* dialog to initiate the command.

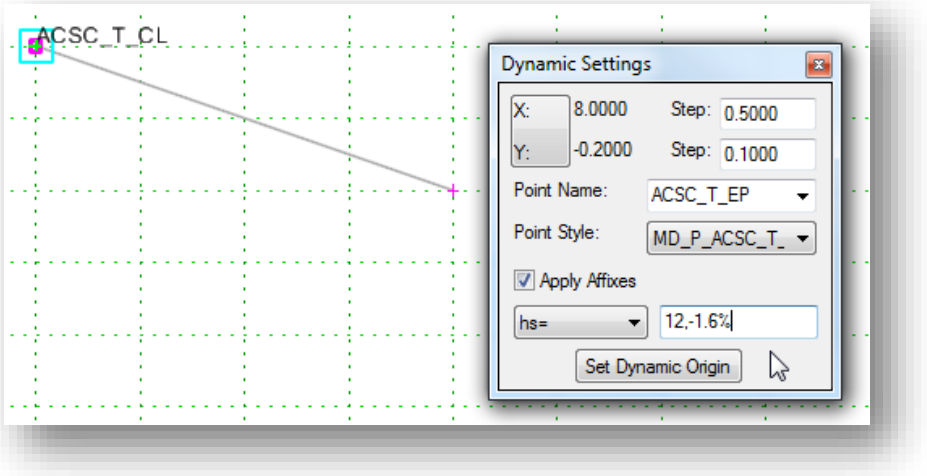
When constrained components are created, both horizontal and vertical constraints are applied to each point.

Unconstrained Components

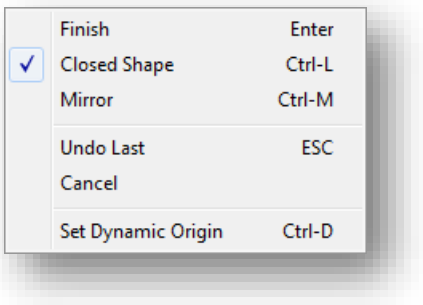
To create an unconstrained component, right-click in the current template window and select **Add New Component > Unconstrained**, or select **Add > Unconstrained** from the pull down menu of the *Create Template* dialog to initiate the command.

When unconstrained components are created, no constraints are applied. This option is useful when you wish to define constraints other than Horizontal and Vertical constraints.

The *Dynamic Settings* dialog can be for precision input when creating the component. In the example below, point **ACSC_T_EP** will be created at a defined horizontal distance and slope from point **ACSC_T_CL** using a horizontal distance of 12 and a slope of -1.6% by using the **hs=12** option with a value of **12,-1.6%**. Use the **Enter** key to execute the command.



Right-click in the current template window at any time during the component creation process to access the menu shown below:



- Select **Finish** when you have completed creation of the component.
- Components can be created as open or closed shapes. To toggle on/off the option to placed closed shapes, select **Closed Shape**.
- Select **Mirror** to create two components at the same time. The second component is a mirror image of the one you are defining. The component is mirrored about a vertical line passing through the **Dynamic Origin** location.
- Select **Undo Last** to undo the last point that was added to the component.
- Select **Cancel** to terminate the component creation process.
- Select **Set Dynamic Origin** to specify the location of the dynamic origin.

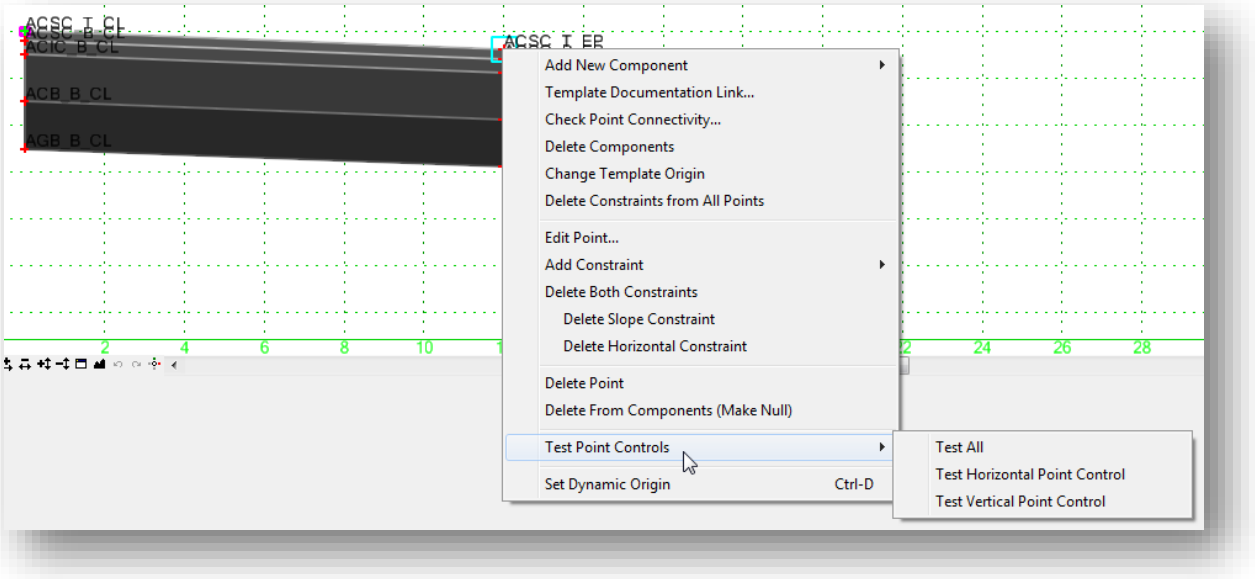
Null Points

A null point is a template point that is purposely not related to any particular component. It's most often used as a reference for controlling other points.

To create a null point, right-click in the current template window and select **Add New Component > Null Point**, or select **Add > Null Point** from the pull down menu of the *Create Template* dialog to initiate the command.

Testing Point Controls

The behavior of fully constrained points can be tested by right-clicking on the point and selecting **Test Point Controls** as shown below.

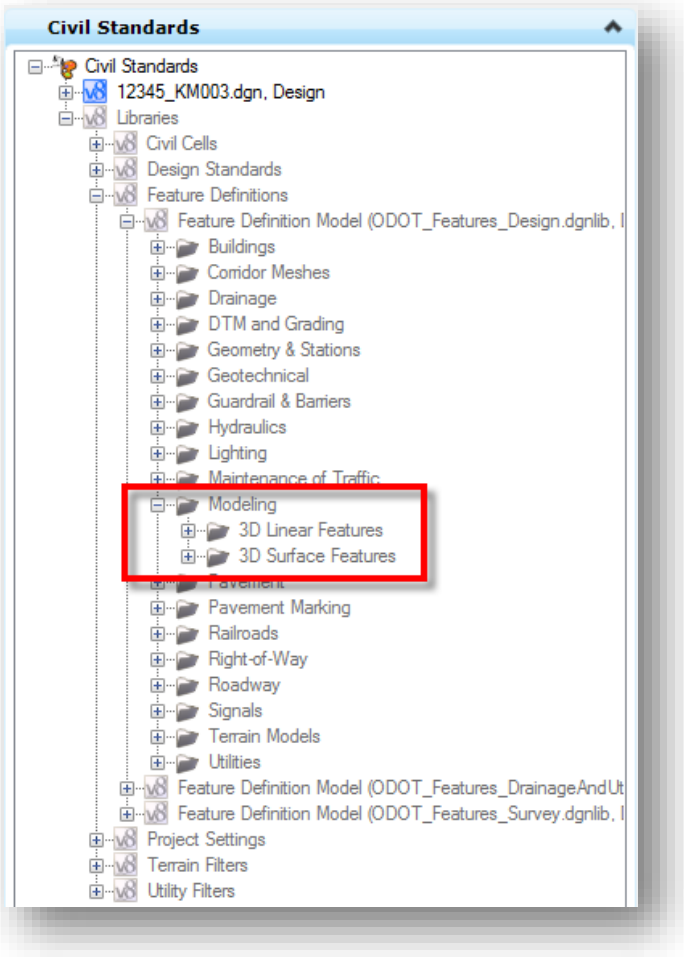


Select the desired option to test the behavior of a template as the point is moved either horizontally, vertically, or both at the same time.

ODOT Standard Point and Component Names and Features

As you create templates, each point and component in the template is assigned a **Name** and a **Feature Definition**. It is important to ensure that the points and components are named and assigned features consistently in each template.

Feature definitions for template points and components are defined in **ODOT_Features_Design.dgnlib**, which is attached by a configuration variable. These features can be reviewed in the *Project Explorer* dialog by selecting the **Civil Standards** tab as shown below.



Template points are used to create 3D linear features in the corridor model. The **3D Linear Features** category contains the feature definitions that are applied to template points.

Template components are used to create 3D surfaces in the corridor model. The **3D Surface Features** category contains the feature definitions that are applied to template components.

The features are also detailed in an Excel Document in the ODOTcadd Standards. See the following document:

\ODOTcadd\Standards\Geopak\Road\templates\ODOTcadd_RoadwayTemplateDefinitions.xlsx

Point Names and Features

As the template is applied to the corridor, 3D line strings are drawn in the design file by connecting the points from template drop to template drop by their **Name**. The symbology of these line strings is controlled by the **Point Style** (aka **Feature Definition**) that is assigned to each point.

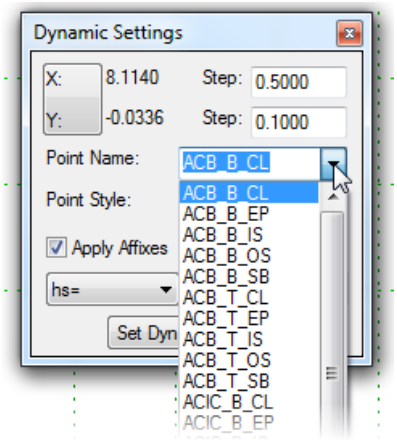
The ODOT workspace for OpenRoads includes several **Feature Definitions** that can be used for template points.

Features can be reviewed and assigned in a variety of ways.

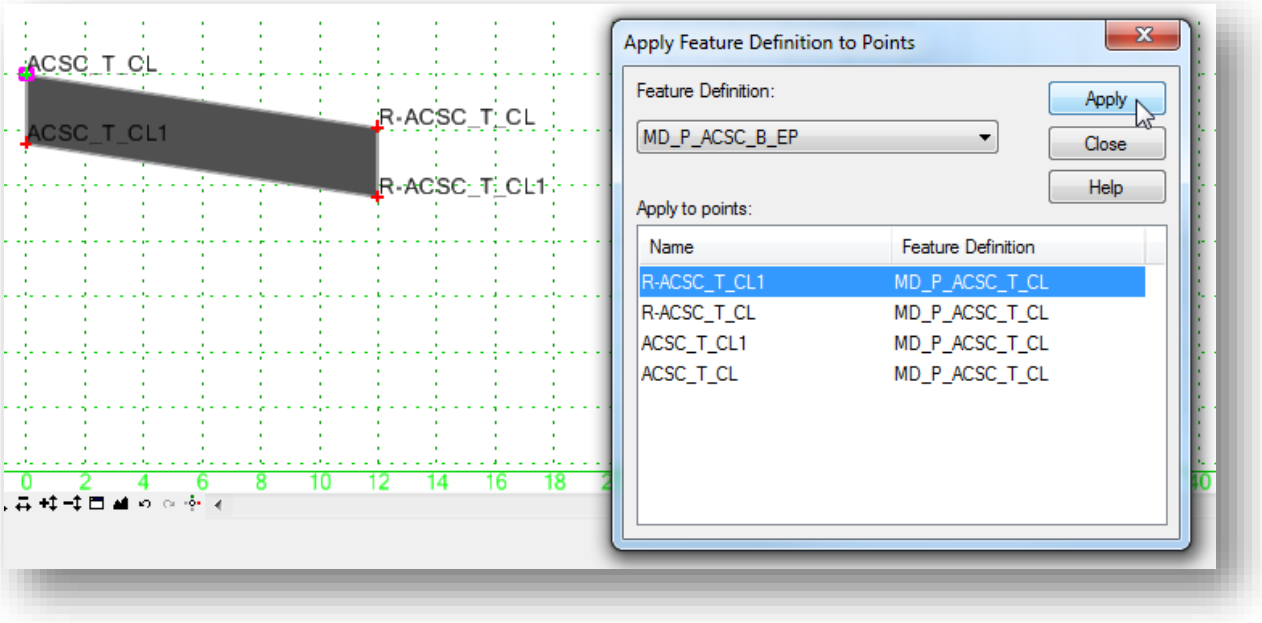
- We have already discussed the *Point Properties* dialog which is accessed by double-clicking the point in the **Current Template** window. The **Name** and **Feature Definition** can easily be edited using this dialog.

- The *Dynamic Settings* dialog can be used to define the **Point Name** that will be assigned to points as they are created. The **Point Name** field can be used to key-in a name for the point or to select a name from a predefined list as shown at right. It is recommended that you use the point names from this list when designing your templates.

  When a point name is selected from the list, the **Point Style**, which is the **Feature Definition**, is automatically set to the appropriate value. The **Point Style** list contains a list of all the **Feature Definitions** available in the ODOTcadd workspace.



- Features can also be assigned to one or more points by selecting **Tools > Apply Feature Definition to Points** from the *Create Template* dialog as shown below.

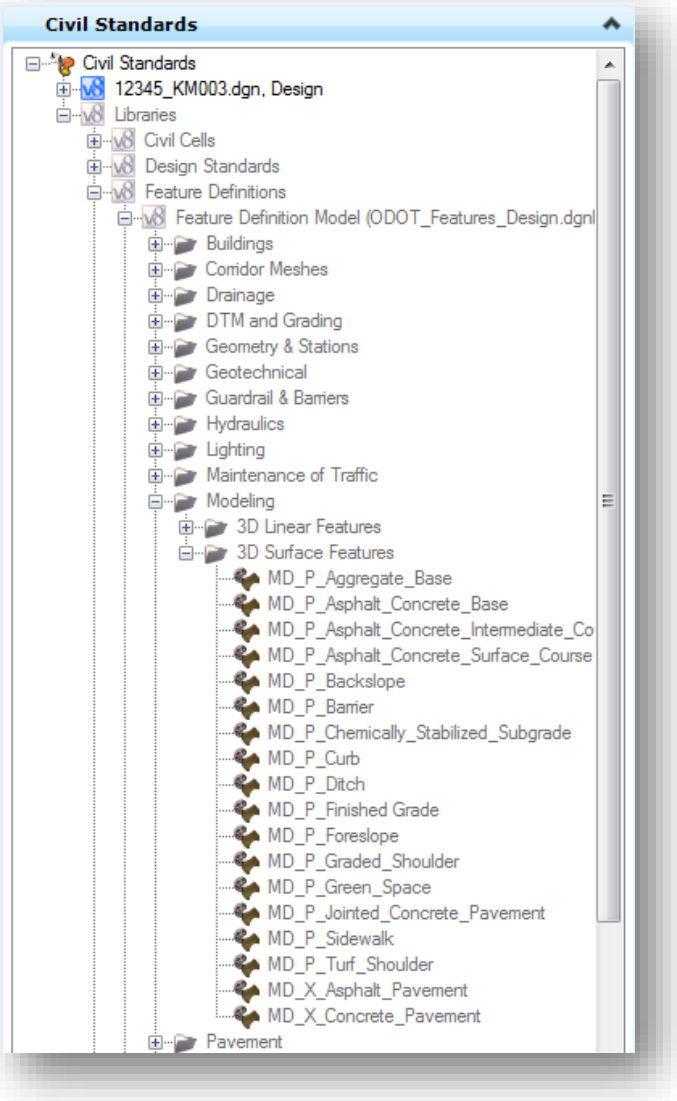


Component Names and Features

Component Names and **Features** are defined as each component is created. The available features within the ODOTcadd workspace can be reviewed in the **Civil Standards** tab of the *Project Explorer* dialog as shown at right.

Component Names and Features can be reviewed and edited in a variety of ways:

- Double-click on a component to open *the Component Properties* dialog.
- Select **Tools > Apply Feature Definition to Components…** to apply a selected **Feature Definition** to one of more components in the template.

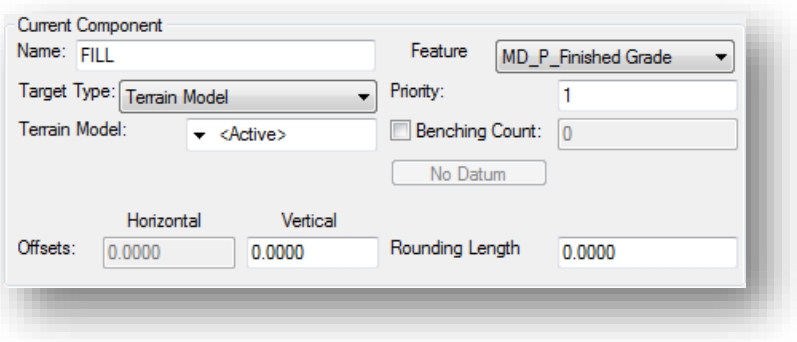


7.16 End Conditions

An end condition is a special open-shaped component that targets a surface, a feature of a surface, an elevation, or an alignment. End Conditions are commonly used for cut and fill definitions. End Conditions are added to the end of simple, constrained, or unconstrained components.

To create an end condition, right-click in the template window and select **Add New Component > End Condition**, or select **Add > End Condition** from the *Create Template* dialog's pull down menu.

When adding an end condition to the current template, the **Current Component** portion of the *Create Template* dialog displays the following options:



The **Name** field is used to specify the user defined name for the component.

The **Feature** is used to set the feature definition for the component.

Target Type specifies the type of target the End Condition is seeking. Targets include:

- **Terrain Model** – Seeks an OpenRoads Terrain Model
- **Elevation** – Seeks a particular elevation
- **Linear Horizontal/Vertical/Both** – Seeks the intersection with a particular linear element selected from a list.
- **Feature Definition Horizontal/Vertical/Both** – Seeks the intersection with a particular feature type.

Horizontal Offset specifies a horizontal offset from the target. This option only applies if the target is a horizontal target, or has a horizontal aspect.

Vertical Offset specifies a vertical offset from the target. Applies only if the target is a vertical target or has a vertical aspect. For an elevation target, specify the elevation here.

Priority specifies the order in which end conditions are attempted in seeking a solution. Where more than one End Condition starts at the same point, this value determines the order in which End Conditions are attempted to find a solution. Lower numbers, which have a higher priority, are attempted first.

Benching Checkbox indicates, when on, the set of segments of the End Condition are repeated until a solution is found.

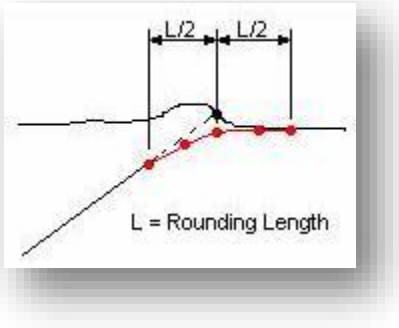
Benching Count indicates the maximum number of times that benching should occur. If this value is 0, then the repeat count is unlimited, and the benching End Condition must find its target for it to be valid. If any other number is entered, then if the benching is repeated for the specified count and if the target is not reached, the benching End Condition will still be considered successful if an End Condition attached to the end of the benching End Condition is successful.

From Datum indicates, when on, the benching will use a datum elevation and step elevation to set the benching rather than using the End Condition segments as they are defined.

Datum Elevation specifies the elevation that represents the basis for the step elevation. Datum + Current bench elevation = n * Step Elevation.

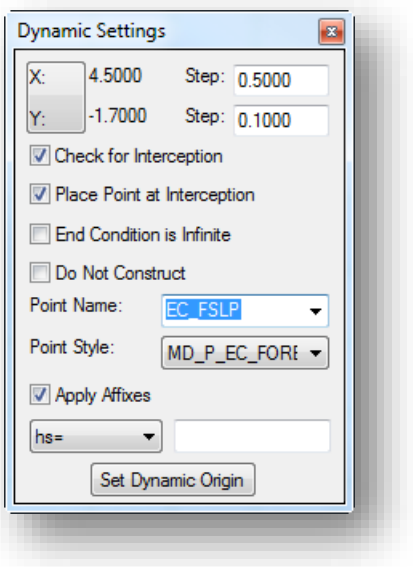
Step Elevation specifies the increment for benching when a datum is being used. Each bench elevation is always located at the end of the first segment (or the second point) of the benching End Condition.

Rounding Length specifies the length used to round the end condition. When this value is something other than 0.0, 4 additional points are added to the end of the end condition using a parabolic formula to smooth out the transition of the intersection of the end condition with the surface. This rounding effect is only applied when the target is a terrain model or an elevation. Any other end conditions attached to the end of this one is attached to the end of the rounded section.



End Condition Point Properties

As you are defining points for an end condition, the *Dynamic Settings* dialog includes additional options for the point definition as shown below.



Check for Interception specifies the preceding segment will be checked for interception of the target when the end-conditions are solved. If it is turned off, then the segment will be ignored when checking for interceptions.

Place Point at Interception specifies that when an interception is found along the preceding line segment, the line segment will be drawn to the interception. Otherwise, if the interception is found, the line segment will be drawn to its maximum width.

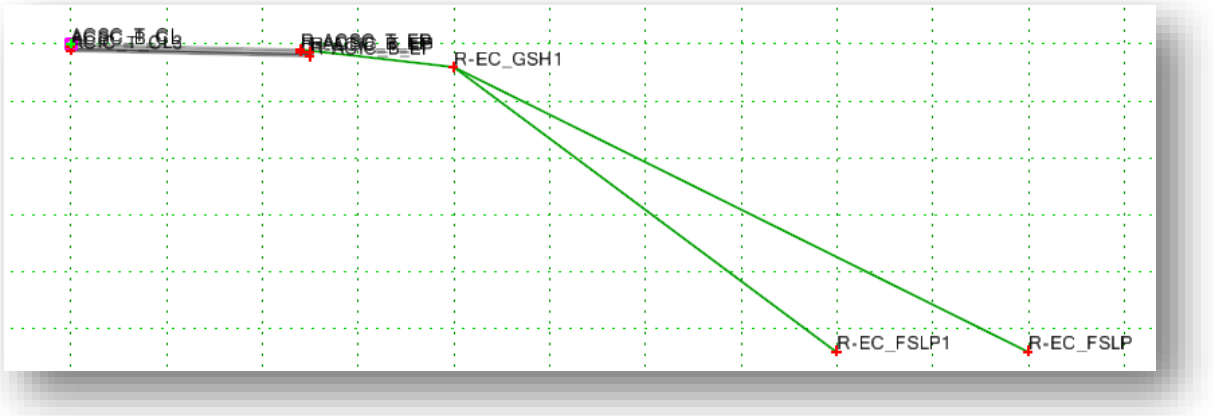
End Condition is Infinite specifies the last segment will be considered to be of infinite length when attempting to intercept the target. This option is applicable only to the last point on the end condition.

Do Not Construct specifies the point will be solved like all other points in the end-condition, but the point will be skipped when drawing the component segments.

These end condition point properties can be edited in the *Point Properties* dialog. Double click on an end condition point to review or edit the properties.

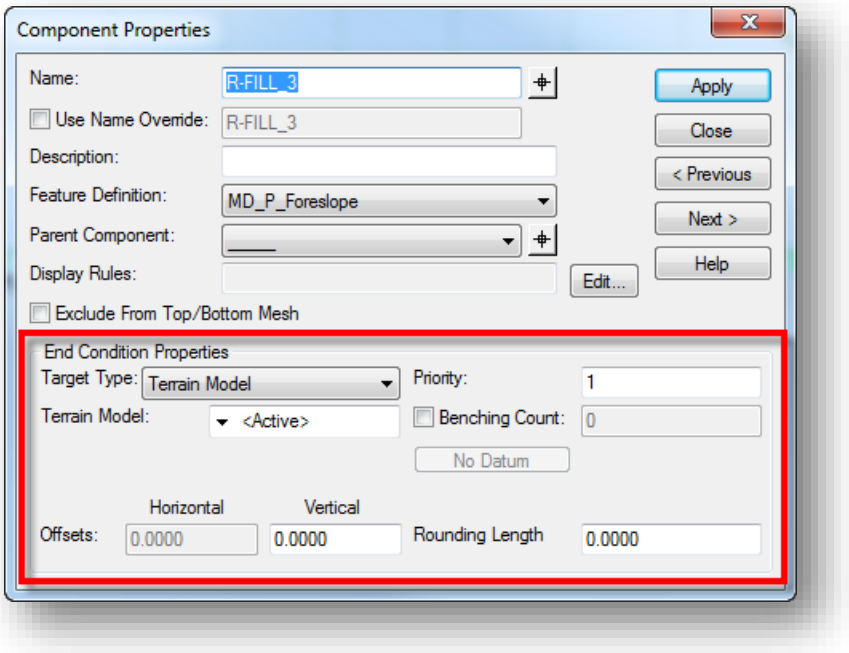
End Condition Priority

The end condition priority value is used when more than one end condition is defined starting at the same point. A simple end condition consisting of two fill lines is shown in the example below.

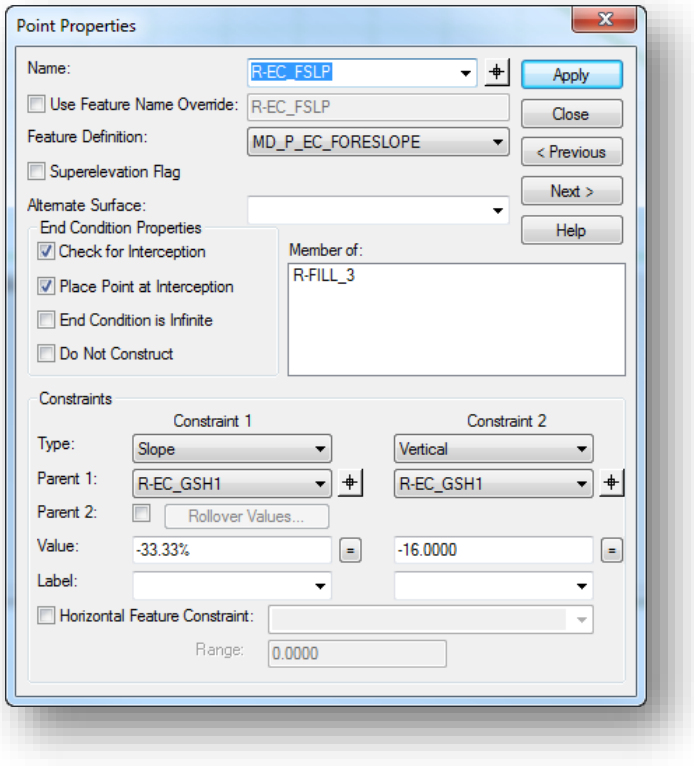


When the end condition is processed in corridor modeling, each end condition will be tested in the order specified by the user. The order is determined by the **Priority** value entered by the user during the end condition creation. The most desirable solution, and the first condition to be tested, is given a priority value of 1.

Double-clicking on a component will open the *Component Properties* dialog shown below. If the component is an end condition, the **End Condition Properties** are displayed. The **Priority** is set as shown below.



The properties for point R-EC_FSLP were defined as shown at right. **Check for Interception** is toggled on and **End Condition is Infinite** is toggled off. The point is defined with a -33.33% Slope for a vertical distance of 16.0' from the graded shoulder point R-EC_GSH1.



The properties for the point R-EC_FSLP1 were defined to specify a 2:1 slope with the **End Condition is Infinite** option toggled on. The priority for the end condition component R-FILL_2 is set to a value of 2.

With these settings, the end condition R-FILL_3 will be tested first (Priority=1) for an interception with the surface within the vertical distance of 16.0'. If an interception is found within the vertical distance, the end condition is used for the cross section and a point will be placed at the interception.

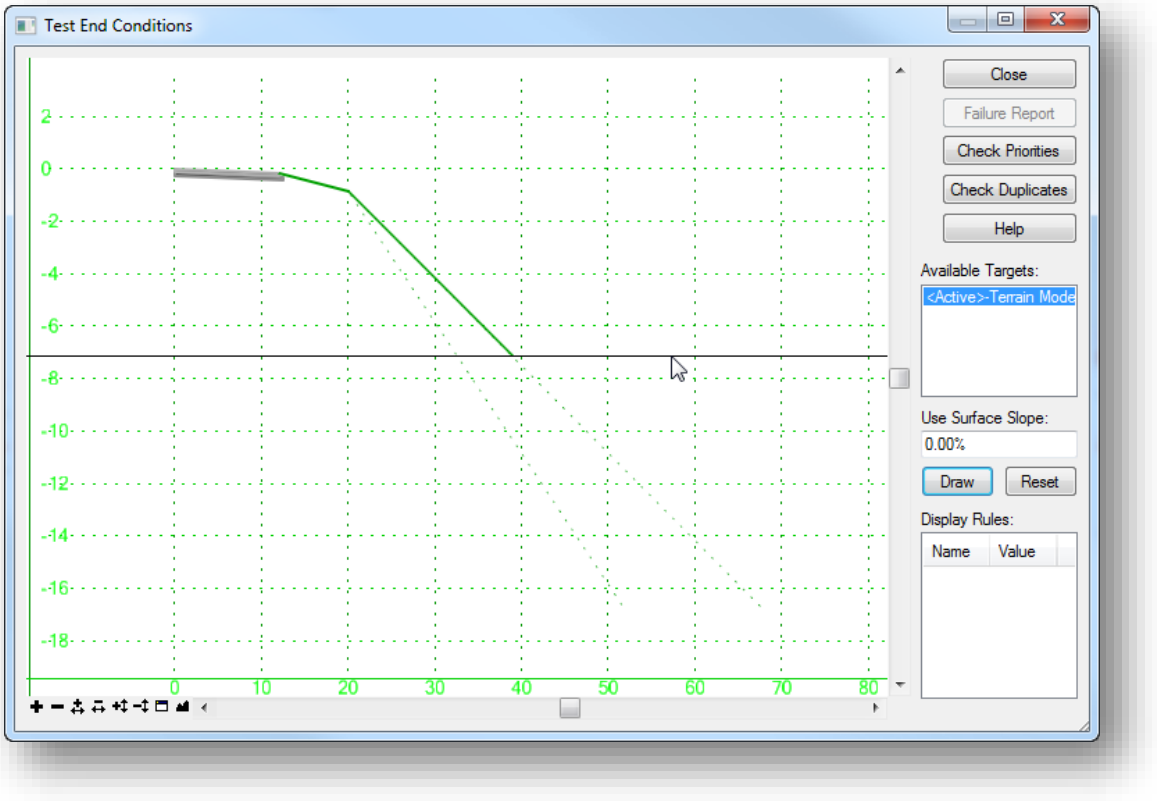
If no interception is found within 16.0' vertically from point R-EC_GSH1, the condition fails and the software will test the next end condition, R-FILL_2, which has a Priority value of 2.

Since **End Condition is Infinite** is toggled on for point R-EC_FSLP1, the solution will solve for an interception with the surface regardless of the vertical constraint definition.

Testing End Conditions

End conditions can be tested in the *Create Template* dialog before processing the template with corridor modeling. Testing simulates how the end condition will behave when the corridor is processed.

This is extremely useful for complex end condition definitions with multiple solutions. To test the end condition, select the **Test** command, located below the **Current Template** window. The *Test End Conditions* dialog is opened.



The software will check for conflicts in the priorities defined in the template before opening the *Test End Condition* dialog. If conflicts exist, a warning is issued.

The dialog displays the current template. Non-solved end conditions, and their child components, are displayed in dashed lines. Normal components and solved end conditions are displayed as solid lines.

To test the end condition, select one of the available targets and then select the **Draw** button. Move your cursor over to the testing window. The end conditions will change from a dotted line to a solid line indicating the solution for the target interception.

Failure Report activates the *Results* dialog. When you fail to get a solution on one or both sides, the results show which components failed and which end condition start points were not solved.

Check Priorities tests the template for priority conflicts. When conflicts exist, a message is displayed indicating there are end conditions that start from the same point and have the same priorities. The *End Condition Priority Conflicts* dialog is displayed. If no conflicts exist, a message box indicating no conflicts is displayed.

Available Targets lists all of the targets applicable to the current template. You can select the desired target and draw it in the display.

Use Surface Slope specifies the slope of the surface that is being placed. This is useful in certain instances where an end condition intersects a surface more than once, such as a ditch profile.

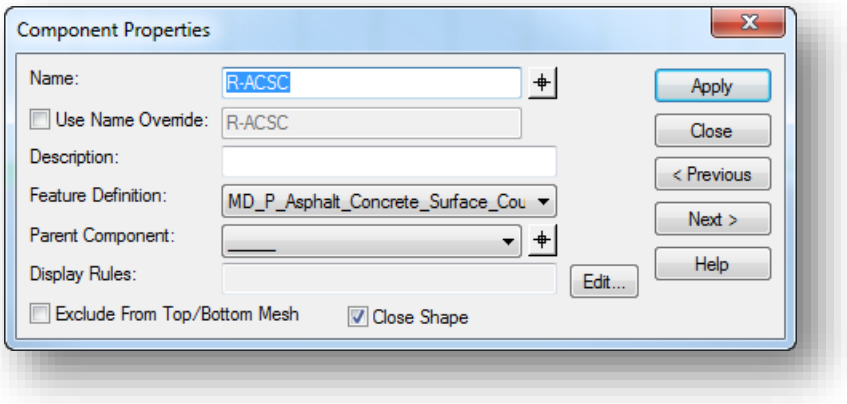
Draw draws the selected target. Surfaces and elevations are drawn as horizontal lines. Features and alignments are drawn as a "+" mark. As you draw a target, the display dynamically updates to show the solution(s).

Reset clears all the drawn targets.

Display Rules list the display rules for the current template. Left-click the **Value** to toggle between **True** and **False**. Press the **Reset** button to restore the original **Display Rules** values.

7.17 Component Properties

The properties of the component can be edited by double-clicking on the component. The *Component Properties* dialog is opened.



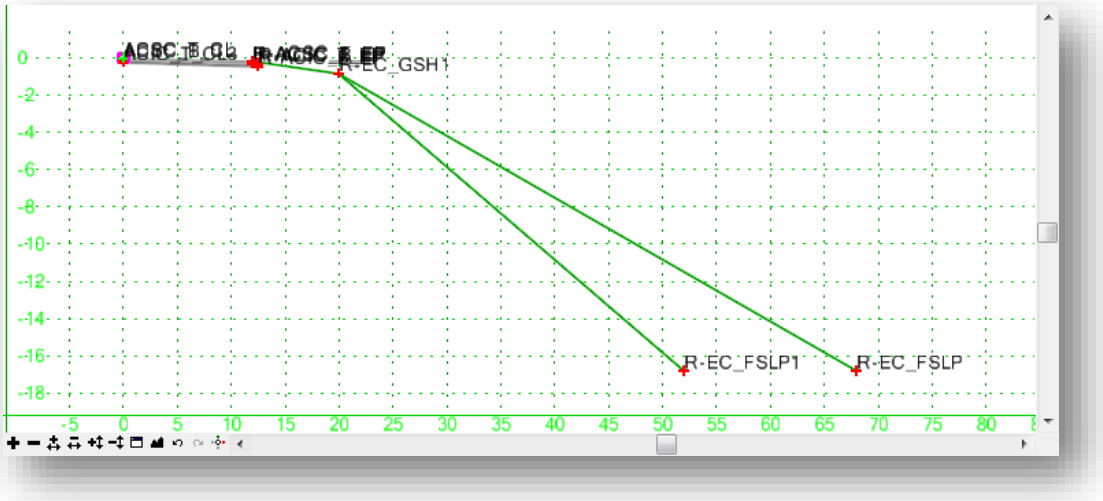
Name

Specifies the name of the current component. Select a different component using the locate button.

Use Name Override

The name override is used to specify the name used by the software to connect components from one template drop location to the next.

The option is intended to create connectivity from one station to the next when the template components change. For example, a template may contain more than one solution for a fill condition as shown below.



Two end conditions are defined for the fill slopes named R-FILL2 and R-FILL3. When the templates are processed, the software will evaluate each template drop location to determine whether the R-FILL2 or the R-FILL3 component is used. 3D Mesh elements are created by connect all the components by the name of the component. All of the components named R-FILL2 will be connected to create 3D Mesh element, and all of the components named R-FILL3

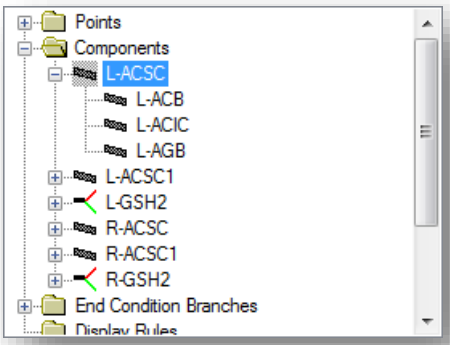
will be connected to create another mesh element. This leaves a gap in components at the locations where the fill slope transitions from 3:1 to 2:1 since the components named R-FILL3 will not be connected to the components named R-FILL2. The solution is to assign the same **Override Name** for each component.

Description
Specifies an optional description of the component.

Feature Definition
Specifies the feature style of the component. This option is used for display and also to define the component's material. ODOT has defined a specific group of styles to be used for components prefixed with the word "Component". When the components are plotted in MicroStation, either as a 3D model, or as cross sections, the symbology defined by the selected Style is used. Care should be taken to select the appropriate style for each template component.

Parent Component
Specifies the parent component. If a component has a parent component, then it is only displayed if the parent component is displayed. The parent component can be either a non-end condition component, or an end condition component. Specify the component or identify it using the locate button.

The **Active Template** listing can also be used to display and edit the parent child relationship between points and components. In the example at right, the **Components** category is open to show the parent/child relationship between the components in the tree. Drag and drop operations can be used to move one component under another.



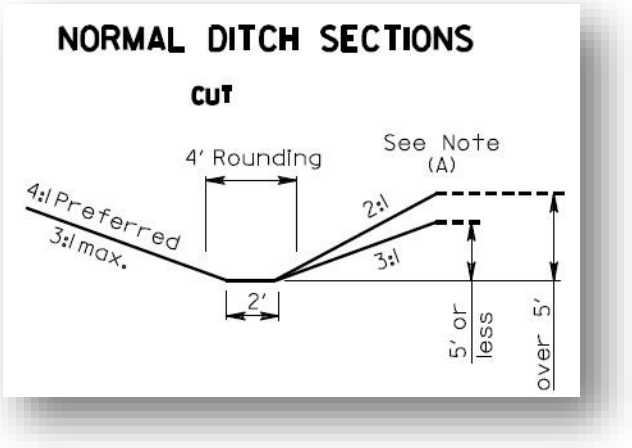
Note: The component names are listed alphabetically, not from top to bottom as drawn in the template.

Exclude from Top/Bottom Mesh
Specifies that the component will be excluded from the top and bottom mesh elements that are created in the corridor modeling process.

Close Shape
This option is only available for non-End Condition components. Only closed shapes can be used to compute component quantities.

Exercise 7E - Creating and Testing End Conditions

In this exercise, you will create a simple cut end condition with a 3:1 foreslope and a 2' ditch. The backslope will contain two end conditions, a 3:1 slope and a 2:1 slope as shown below.



- ✓ Open MicroStation using the shortcut provided for the training class.
- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL
- ✓ Open the following design file for the training project:
  ..\Design\Roadway\Basemaps\12345_KM002.dgn
- ✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Templates**
- ✓ Create a new template named **Normal Ditch** in the **Project Templates** folder.
- ✓ Open the *Dynamic Settings* dialog and select the **Point Name** to "EC_HINGE" from the list. The **Point Style** is automatically set. Set the **Step** values as desired. Uncheck **Apply Affixes**.
- ✓ Add an End Condition for the graded shoulder
  - Right-click in the template window and choose **Add New Component > End Condition**.
  - Start the End Condition at coordinate 0, 0 (xy=0, 0).
  - Name the component "GSH1"
  - Use the Feature "MD_P_Graded_Shoulder" for the component
  - Be sure to check off **Check for Interception** in the *Dynamic Settings* dialog after placing the first point.
  - Change the Point Name in the *Dynamic Settings* dialog to "EC_GSH1" After placing the first point but before placing the second point. By choosing the name from the list, the **Feature Definition** is automatically assigned.
  - Place the second point 6' horizontally from the first point at a slope of -8% (hs=6, -8%)
  - Right click and select Finish.

- ✓ Add an End Condition for the ditch foreslope.
  - In the *Dynamic Settings* dialog, select the **Point Name** EC_FSLP.
  - Right-click in the template window and choose **Add New Component > End Condition**.
  - Name the component "3:1 Foreslope"
  - Use the **Feature** "MD_P_Foreslope" for the component
  - Create the component with a vertical constraint of -1.5 at a 3:1 slope (vs=-1.5,-1:3) from the point EC_GSH1. Be sure to check off **Check for Interception** in the *Dynamic Settings* dialog after placing the first point.
  - Right click and select Finish.
  - Double click on the 3:1 Foreslope End Condition and set the Parent component to GSH1. Hit **Apply**.

- ✓ Add an End Condition for the 2' ditch bottom.
  - In the *Dynamic Settings* dialog, select the **Point Name** EC_DITCH.
  - Right-click in the template window and choose **Add New Component > End Condition**.
  - Name the component "DITCH"
  - Use the **Feature** "MD_P_Ditch" for the component
  - Create the component with a horizontal constraint of 2.0 and a vertical constraint of 0 (dl=2,0) from the point EC_FSLP. Be sure to check off **Check for Interception** in the *Dynamic Settings* dialog after placing the first point.
  - Right click and select Finish.
  - Double click on the DITCH End Condition and set the Parent component to 3:1 Foreslope. Hit **Apply**.

Next we'll define two end conditions for the backslope.

- ✓ In the *Dynamic Settings* dialog, select the **Point Name** EC_BKSLP
- ✓ Right-click in the template window and choose the **Add New Component > End Condition** option.
- ✓ Name the end condition "3:1 Backslope"
- ✓ Set the Feature for the end condition to "MD_P_Backslope"
- ✓ Create the component with a vertical constraint of 5' at a 3:1 slope (vs=5,1:3) from the point EC_DITCH. Be sure to check on **Check for Interception** in the *Dynamic Settings* dialog after placing the first point.
- ✓ Right click and select Finish.
- ✓ Double click on the 3:1 Backslope End Condition and set the Parent component to DITCH. Hit **Apply**.

Add a second End Condition for the 2:1 backslope using the settings detailed below.

- ✓ In the *Dynamic Settings* dialog, select the **Point Name** EC_BKSLP
- ✓ Right-click in the template window and choose **Add New Component > End Condition**.
- ✓ Name the end condition "2:1 Backslope"
- ✓ Set the Feature for the end condition to "MD_P_Backslope"
- ✓ Set the component **Priority** to **2**
- ✓ In the *Dynamic Settings* dialog, toggle on the **Check for Interception** and **End Condition is Infinite** options (options not available until the first point of the end condition is placed).
- ✓ Create the component with a vertical constraint of 5' at a 2:1 slope (vs=5,1:2) from the point EC_DITCH

- ✓ Right click and select Finish.
- ✓ Double click on the 2:1 Backslope End Condition and set the Parent component to DITCH. Hit **Apply**.

Next we'll review the point names and feature styles, as well as the Override names for the points and components.

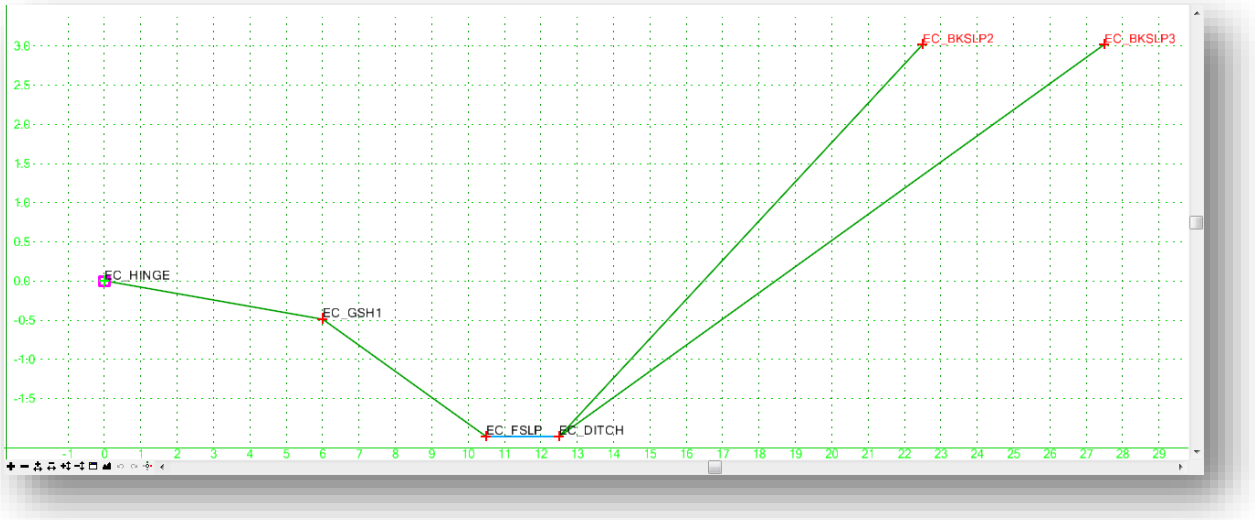
- ✓ Double-Click on the point **EC_BKSLP** to make the following change:
  - ✓ Toggle on the **Use Feature Name Override** option and enter an override name of "**BKSLP**" and change the name to "**EC_BKSLP3**" then hit **Apply**.
- ✓ Double-Click on the point **EC_BKSLP1** to make the following changes:
  - ✓ Toggle on the **Use Feature Name Override** option and enter an override name of "**BKSLP**" and change the name to "**EC_BKSLP2**" then hit **Apply**.

Review the component properties for the backslope components to set the override name.

- ✓ Double-click the **2:1 Backslope** component. Toggle on the **Use Name Override** option and set the override name to "**Backslope**"

- ✓ Double-click the **3:1 Backslope** component. Toggle on the **Use Name Override** option and set the override name to "**Backslope**"

The completed template should appear as shown below.

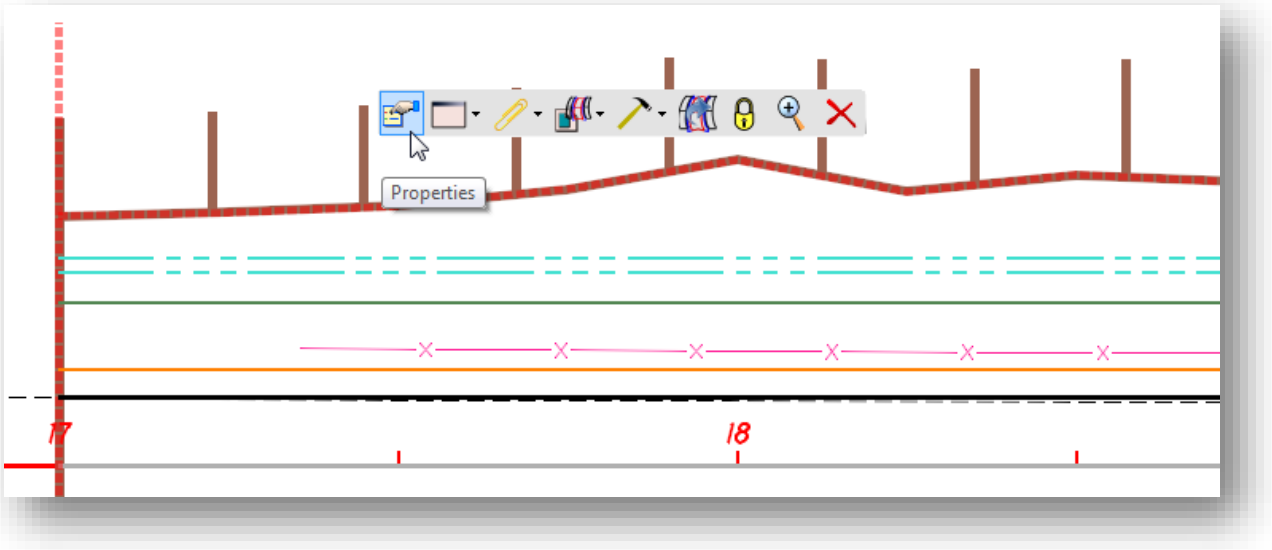


- ✓ Use the **Test** option to ensure that the backslope components behave as intended. The 3:1 backslope should solve first for backfills up to 5' high. The 2:1 solution should solve for backslopes greater than 5'.

- ✓ When complete, choose **File > Save** from the *Create Template* dialog to save the changes to the template library.

7.18 Corridor Editing Tools

Select one of the corridor handles, as shown below, to access a menu of common corridor commands.



The commands in the menu are grouped as follows:

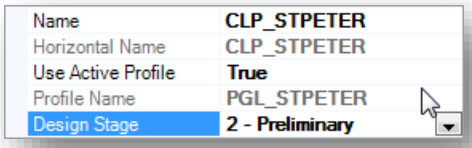
- Properties
- Corridor Views
- Reports
- Corridor References
- Corridor Creation Tools
- Lock – Deactivate Rule
- Delete

These commands are also available in the MicroStation task list by selecting **Tasks > Civil Tools > Corridor Modeling**.

Commonly used commands are detained in this training guide. For additional information, see the online help.

Corridor Properties

Select **Properties** from the corridor pop-up menu to access the dialog shown below.

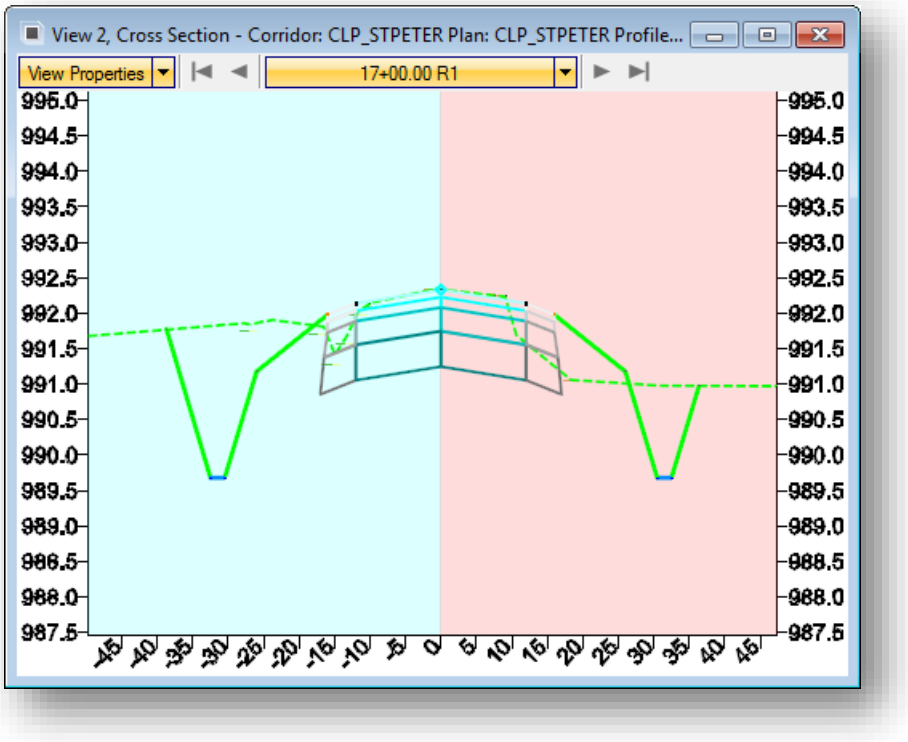


With the exception of the **Horizontal Name**, the corridor parameters shown above can be edited in the properties dialog. This dialog is most commonly accessed to change the profile used for the corridor or the **Design Stage**.

Corridor Views

The **Corridor Views** icon has one command, **Open Cross Section Model**. This command is used to create a dynamic cross section view to review the model by scrolling through cross sections.

When selected, you are prompted to **Open or Select View** for the cross section display. In the example below, View 2 was selected to display the dynamic cross sections.



This dynamic view is a temporary display of the cross sections. The sections are not written to the design file using this command.

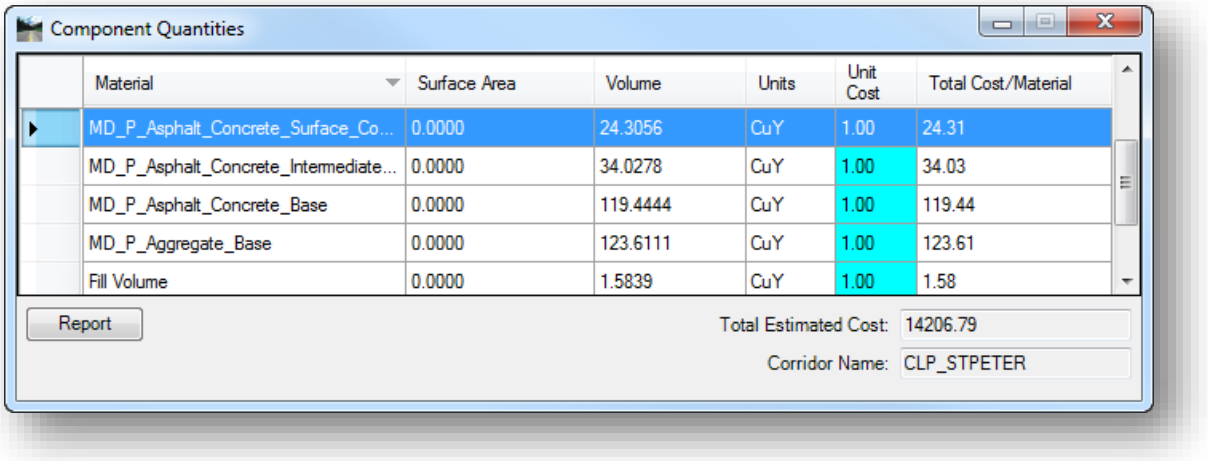
Reports

The **Reports** icon provides access to the following four reports:

- Corridor Component Quantities
- Design Input Report
- Results Report
- Milling Report

These reports are detailed in the online help.

The **Corridor Component Quantities** report is used to generate a quick cost estimate for the selected corridor by assigning a Unit Cost for each component in the corridor templates.



Corridor References

The following four **Corridor References** commands are available:

Add Corridor Reference
This tool is used to add graphical elements to the corridor processing. This must be done when a **Feature** is targeted in the template definition. This enables the software to process only the identified elements which speeds up processing. For example, if the template targets a right-of-way line, the right-of-way lines must be included as a Corridor Reference in order for the template to find the lines.

Remove Corridor Reference
This tool is used to remove graphical elements from the corridor processing.

Add Clipping Reference
This command is used to remove areas of overlap when working with multiple corridors. For example, in a corridor intersected by a crossing roadway, clipping is used to remove overlapping features within the intersection.

Remove Clipping Reference
This tool is used to remove any clipping references defied for a corridor.

Process Corridor

Select this icon to reprocess the corridor.

Lock – Deactivate Rule

This command can be used to temporarily deactivate processing rules on the corridor. This is useful when making edits so that the corridor does not automatically update as the edits are made. Once the edits have been completed, the rules can be turned back on and the corridor reprocessed.

Delete

Select this command to delete the corridor.

Corridor Creation Tools

The **Corridor Creation Tools** menu contains commonly used corridor commands. The tools are listed below. These tools are detailed on the following pages.

Corridor Objects

Create Template Drop

Create Transition

Create Secondary Alignment

Define Target Aliasing

Create Parametric Constraint

Create End Condition Exception

Create Point Control

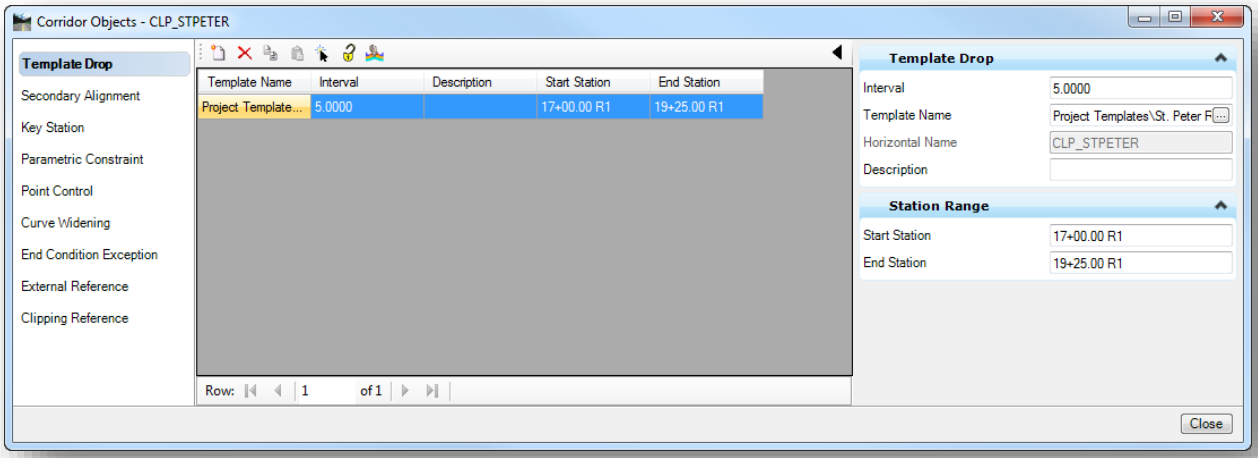
Create Curve Widening

Key Station

Assign Superelevation to Corridor

Corridor Objects

This option is a one-stop shop to view, create, and edit corridor objects. Most of the options contained in the **Corridor Creation Tools** can be accessed from this dialog as shown below.



Create Template Drop

This tool is used to create a new te mplate drop location on the corridor.

Create Transition

A transition is created between templates of different names, as templates generally don't instantaneously change from one template to another. This tool creates the transition by selecting the two templates drops which are adjacent to it. Once the transition location is created, it is up the user to define how the transition is applied.

See the online help for more information.

Create Secondary Alignment

Secondary alignments are used to modify the direction of cross section processing. By default, at any given station, the cross section is created orthogonal to the main alignment. If a secondary alignment exists, then that portion of the cross section which lies outside the secondary alignment will be orthogonal to the secondary alignment instead of the main alignment.

See the online help for more information.

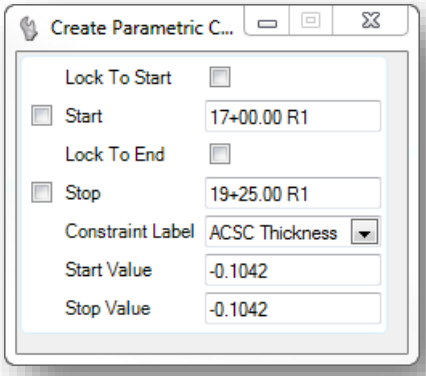
Define Target Aliasing

Target aliasing allows you to target other corridor surfaces or features or to set up a prioritized target list for end condition solutions on surfaces, features and alignments.

See the online help for more information.

Create Parametric Constraint

Parametric constraints can be used to change one or more labeled constraint values of a template while the template is being processed in the corridor modeler.



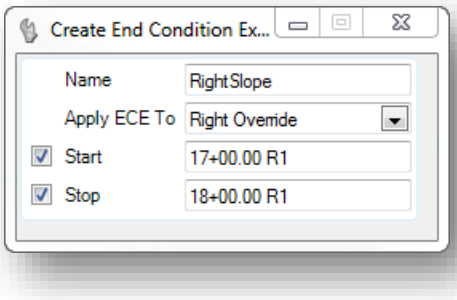
In the example at left, the **Constraint Label** "ACSC Thickness" is assigned in the template for the **Vertical** constraint of the Asphalt Concrete Surface Course point. The **Parametric Constraint** can be used to define a new value for a specified station range.

Create End Condition Exception

End Condition Exceptions are used to modify the behavior of an end condition solution without requiring the use of additional template drops. When an end condition exception is added, it must be edited to change its behavior. End condition exceptions come in two classes:

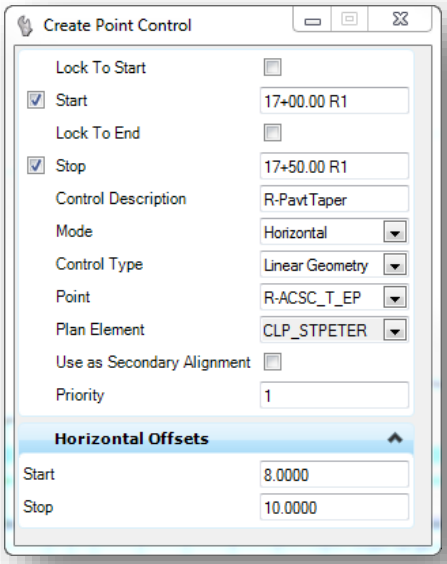
- **Overrides** allow you to replace or override the template drop end conditions on the left or right of the backbone. When you choose this option, you must edit the override to set up the new end condition. When the override exception is edited, the *Create Template* dialog is displayed allowing you to edit the end-condition.

- End condition **Transitions** are used where the end condition may change suddenly due to changes in the existing surface or other reasons, and you want the transition to be smooth over a specified station range rather than a sudden change over a short length.



Create Point Control

Point controls are used to override the normal locations of one or more points and or components in a cross section. Examples of this include lane widening, staying within the right-of-way, or maintaining a particular slope for a ditch.



Create Curve Widening

Curve widening is used to automatically create and apply horizontal controls to widen lane and/or edge of pavement lines around curves, moving them further away from the centerline at each curve of the controlling alignment. The tool is used in conjunction with an ASCII file (*.wid) which contains parameters to define the widening.

Curve widening is defined in the **Location and Design Manual, Volume 1 Roadway Design**, **Section 301.1.3 Travelled Way Widening on Highway Curves**.

ODOT does not provide curve widening tables at this time. Use Point Controls to manually assign the station ranges and offsets for curve widening.

Key Station

This command is used to add stations that are not coincident to the template interval to the corridor processing. For example, a key station can be added at a drive or culvert location to ensure the template is processed at that station.

Assign Superelevation to Corridor

Superelevation is covered in the next chapter.

Processing Order for Point Overrides

As you can see, there are several ways in the corridor processing to override the template definition for various constraints using Parametric Constraints, Point Controls, and Horizontal Feature Constraints.

This is generally the order in which OpenRoads solves the location of points and components at each template drop:

1. Template is dropped, and points are placed according to the point constraints stored in the template.
2. Parametric constraints are applied as defined in the template, and in the corridor.
3. Horizontal Feature constraints are applied to move points if the feature is found in the specified range.
4. Point controls are applied to the assigned points, overriding the corresponding constraint, and all points that are constrained back to the point controlled point will be recalculated.
5. Component display rules are solved based on the current position of all points.
6. End conditions are solved by extending designated segments along the specified slope to seek their targets.

Exercise 7F – Point Controls: Horizontal

In this exercise we will create a template and corridor for State Route 185. We will use Point Controls to taper the lane width at the beginning of the project and to define curve widening for the spiral-curve-spiral in S.R. 185.

Part 1: Creating the S.R. 185 Template

In this exercise we will create the template for S.R. 185

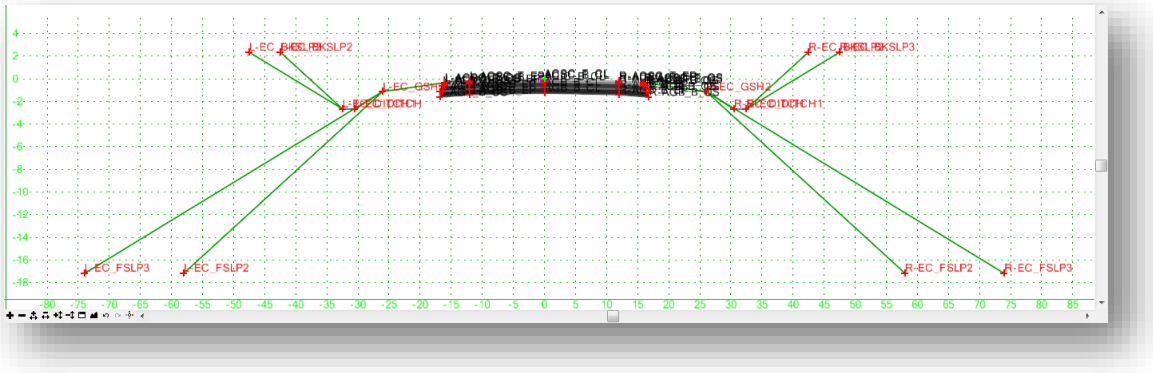
- ✓ Open MicroStation using the shortcut provided for the training class.
- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL
- ✓ Open the design file for the S.R. 185 Corridor Model:
  ..\Design\Geopak\Basemaps\12345_KM001.dgn
- ✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Template**
- ✓ In the **Project Templates** folder, create a new folder named "**S.R. 185**" to house the State Route 185 templates
- ✓ In the S.R. 185 folder, create a new template named "**S.R. 185**"
- ✓ Open the *Dynamic Settings* dialog to ensure the **Step** values are defined as desired.
- ✓ Create the S.R. 185 template by dragging in the components listed below. Be sure to pay attention to the **Apply Affixes** setting and turn it on when dragging in the end conditions.

  ODOT > Backbones > Undivided Roadways > Pavement and Shoulder 301-8E Uncurbed > 2-Lane without Superelevation Pont > Asphalt Concrete without Stabilization

  ODOT > End Conditions > 307-4E Common and Barrier Grading > 307-4E 3:1 Cut, Fill Table
- ✓ After dragging in the end conditions, we will remove some of the options. For this project, we only want to use fill slopes of 3:1 or 2:1. Remove the following components:

  There are two different Graded Shoulder components in the end condition on each side of the template. The components R-GSH1 and L-GSH1 are used when the 6:1 slope is used. Remove these two components by right-clicking on the component and choosing the **Delete Component** option. Since these two graded shoulder solutions overlap, you are prompted to select the component you wish to delete as shown on the following page. Remove the R-GSH1 and L-GSH1 components. The 6:1 slope component is also removed since it has been defined as a "child" component of the graded shoulder 1 component.

✓ Delete the 4:1 fill slope component on each side of the template. The completed template should appear as shown below.



✓ From the *Create Template* dialog, choose **File > Save**. Close the *Create Template* dialog.

Part 2: Create the S.R. 185 Corridor Model

In this exercise we will create the corridor for State Route 185

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL

- ✓ Open the design file for the S.R. 185 Corridor Model:
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

- ✓ Attach the following design files as references:

  Geometry Basemap
  ..\Design\Geopak\Basemaps\12345_BK000.dgn

  Be sure to set the **Nest Depth** parameter to a value of **1** when attaching the geometry basemap.

  Survey Basemap
  ..\Design\Survey\Basemaps\12345_BE001.dgn

  Set the **Nest Depth** parameter to **No Nesting** when attaching the survey basemap.

- ✓ Select the terrain model boundary and choose the **Set As Active Terrain Model** option

- ✓ Select the State Route 185 alignment and choose the **Create Corridor** command from the pop-up menu. Create a corridor named CLP_S185 using the **Active Profile**, and the **Preliminary Design Stage**. Use the parameters below and the S.R. 185 template created in the previous exercise.

  Start Station: 386+25
  End Station: 428+27.30
  Template Drop Interval: 5

When a federated approach is used to create separate design files for each corridor model (see Using Multiple "Federated" Basemaps) users should add the corridor design file as a reference to the "KM_000" design file.

- ✓ Open the file 12345_KM000.dgn
- ✓ Verify that the corridor design file is pre-attached and displayed. If the file is not attached, manually attach the KM001 design file containing the State Route 185 corridor
- ✓ Save settings and close the 000 file when complete

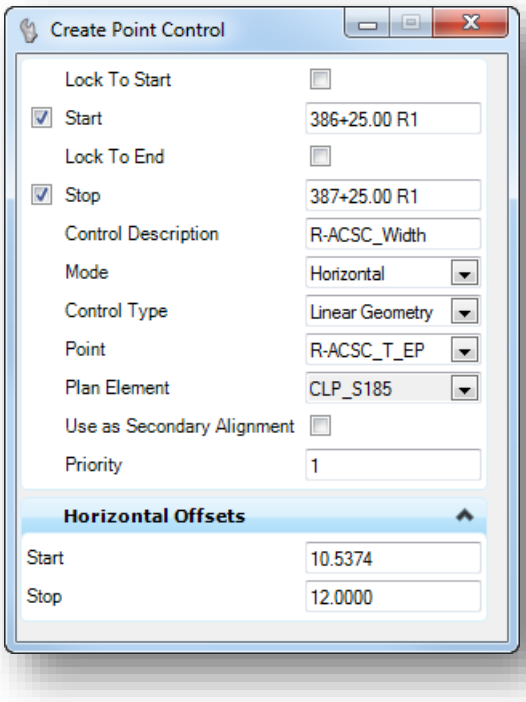
Part 3: Adjusting the Lane Width to meet Existing Pavement

In this exercise we will use **Point Controls** to taper the lane widths at the beginning of the project to tie in to the existing pavement.

- ✓ Open MicroStation using the shortcut provided for the training class.
- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL
- ✓ Open the design file for the S.R. 185 Corridor Model:
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

- ✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Point Control**
- ✓ When prompted, select the corridor for S.R. 185

We will define the taper for the point R-ACSC_T_EP using the settings shown below.



- The **Control Description** is a user definable name for the point control definition.
- The **Mode** for this example is **Horizontal** as we are only adjusting the right lane's horizontal offset and not the vertical offset.
- The **Control Type** is used to define what will be used as the basis for the point control horizontal offsets. Select **Linear Geometry** to use an OpenRoads horizontal alignment as the basis for the lane width offsets.

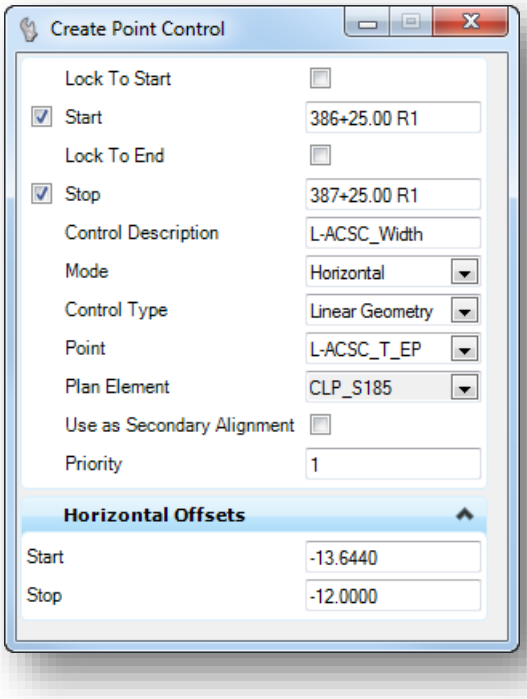
- The **Point** parameter is used to define the point name in the template that the point control is assigned to.

After identifying the Point, the software will prompt to select the Plan or Profile Element that will be used as the Linear Geometry in order to define the point control Horizontal Offsets.

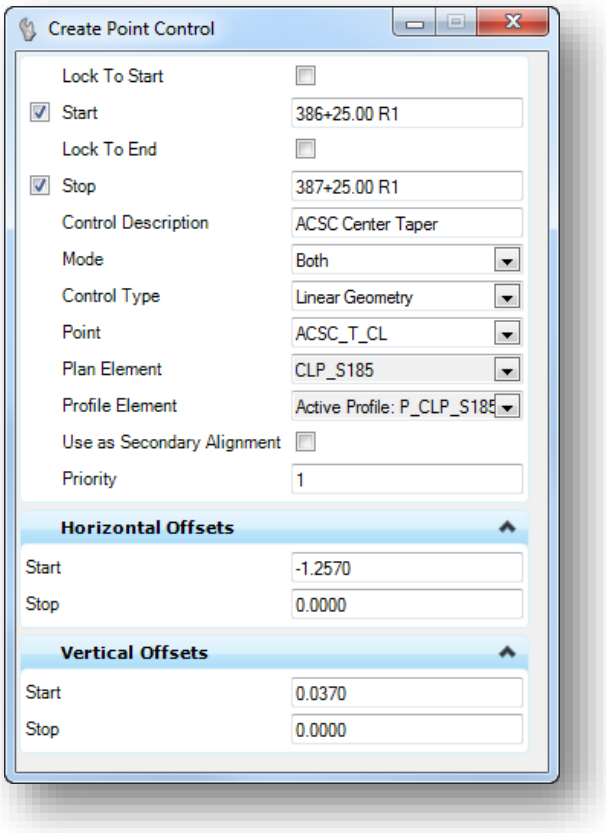
✓ Select the Horizontal Geometry for S.R. 185

✓ Step through the remaining prompts using the values shown on the previous page

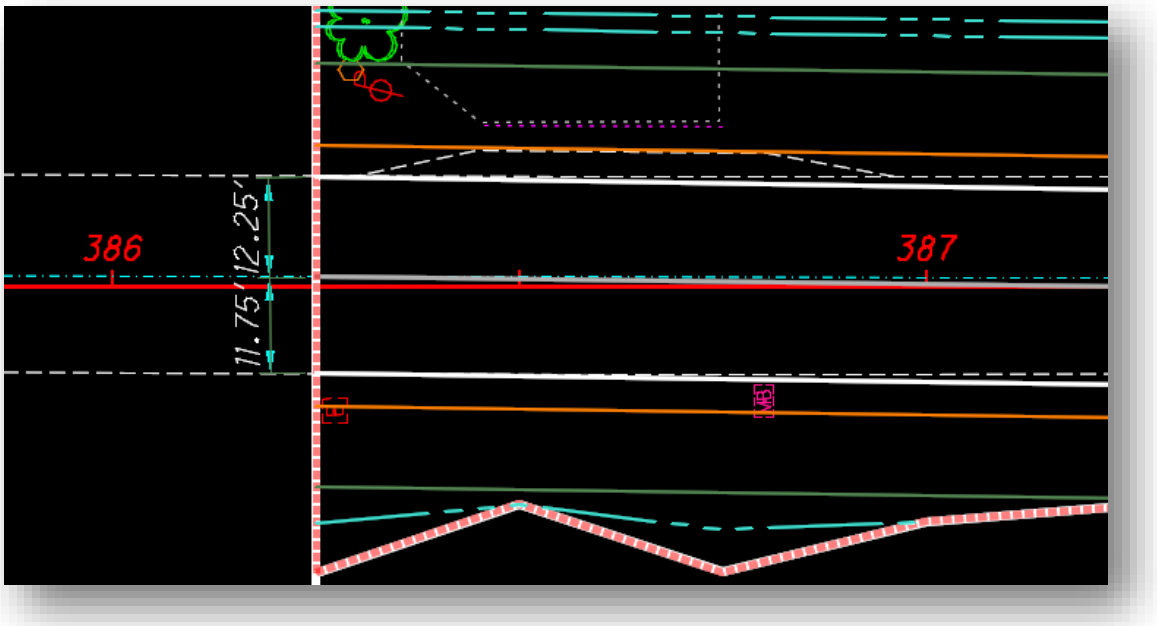
Define the taper for the point L-ACSC_T_EP using the settings shown below.



The proposed centerline of S.R. 185 does not meet the crown of the existing pavement. Next we'll define a point control for point ACSC_T_CL to force the crown of the template to meet the crown of exiting pavement. The dialog settings to create the point control are shown on the following page.



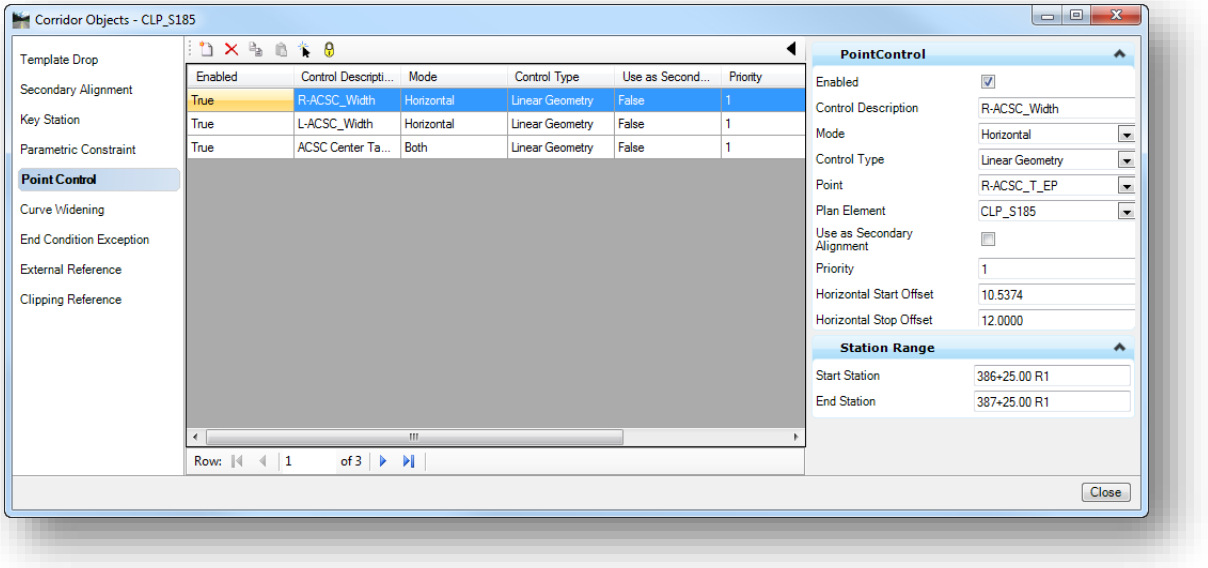
When complete, the edge of pavement and ACSC_T_CL lines are tapered to meet the existing conditions as shown below.



After a point control has been defined, it can be reviewed and edited using the **Corridor Objects** command.

✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Corridor Objects**

✓ When prompted, select the S.R. 185 corridor. The *Corridor Objects* dialog is opened as shown below



Select the **Point Control** item from the list on the left of the dialog. The parameters of the selected corridor can be reviewed and edited using this dialog.

Tip: As edits are made, the corridor is automatically updated since it is locked to the rules defined in this dialog. If you have to make multiple changes, you will have to wait for the corridor to update before making the next change. You can temporarily unlock the rules using the lock icon at the top of the dialog. After making the changes, turn the lock back on. The corridor is not automatically updated when the lock is turned on. Select the corridor and choose the **Process Corridor** command to update the corridor.

Part 4: Adjusting the Pavement Slope to meet Existing Pavement

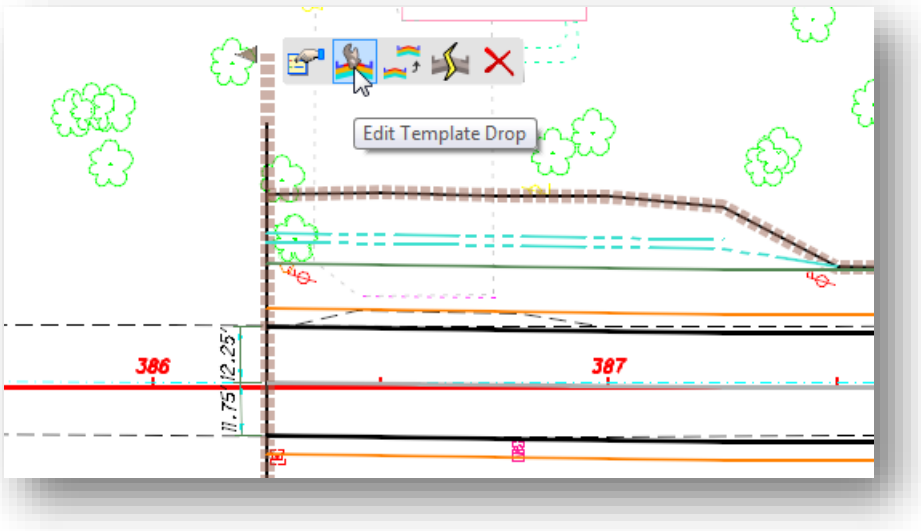
In this exercise we will use a **Parametric Constraint** to override the pavement slope defined in the template to tie into the existing pavement slope at the beginning of the project

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL

- ✓ Open the design file for the S.R. 185 Corridor Model:
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

To override the pavement slope using a **Parametric Constraint**, it is first necessary to define a **Label** for the point constraint that we wish to manipulate in the template definition. The label can be defined in the corridor by selecting the corridor graphic and choosing the **Edit Template Drop** command as shown below.

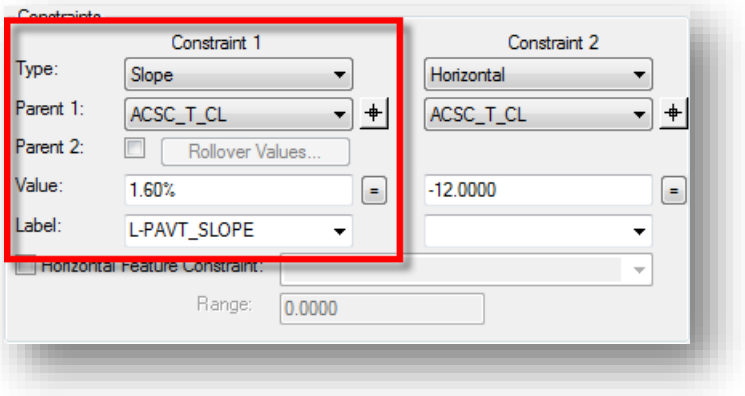


Using this command edits the template definition as applied to the corridor, not the template as defined in the library. When the command is selected, the *Editing Roadway Designer Template Drop* dialog is opened. **Note:** Synchronizing the template with the library will override and changes that may have been made to the corridor's template definition.

Take the following steps to assign a Label to the points L-ACSC_T_EP and R-ACSC_T_EP:

- ✓ Double-click on point L-ACSC_T_EP to open the *Point Properties* dialog.

- ✓ Key in the name "L-PAVT_SLOPE" in the **Label** field for the **Slope** constraint as shown on the following page.



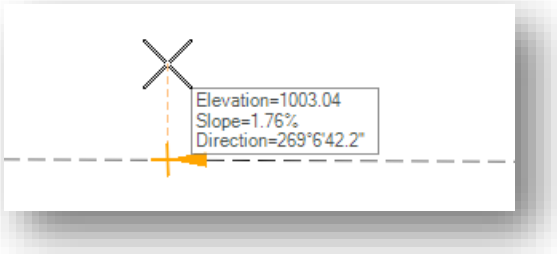
✓ Select the **Apply** button to accept the change.

✓ Edit the point properties for the point R-ACSC_T_EP to assign the Label name "R-PAVT_SLOPE" to the Slope constraint. Select the **Apply** button to accept the change.

We will use these two labels to override the pavement slope at the beginning of the project to meet the existing pavement slope.

The next step is to analyze the existing pavement to get the elevations and lane widths in order to compute the existing pavement cross slopes at station 326+25. To do this, we will use the **Analyze Point** command.

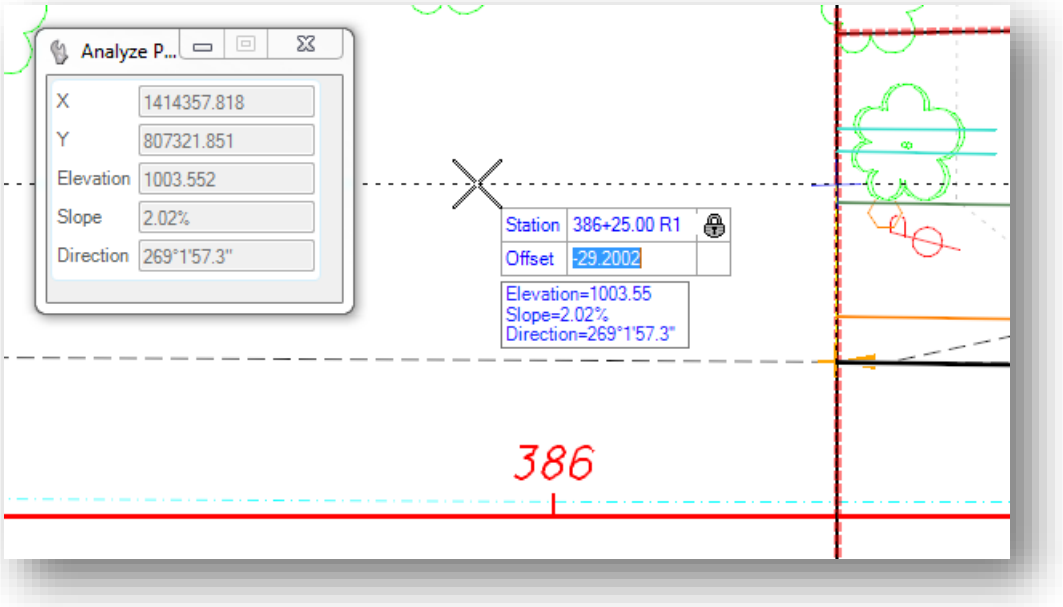
✓ From the *Tasks* menu, select **Tasks > Civil Tools > Terrain Model > Analyze Point**. This command can be used to analyze the terrain model as well as 3D linear features. When prompted to **Select Element to Analyze Point**, choose the existing edge of pavement line on the east (left) side of the alignment. As you drag the cursor along the selected element, the **Elevation**, **Slope**, and **Direction** are reported as shown below.



Civil Accudraw can be used to key in the station on the proposed centerline that you wish to analyze the selected feature.

- With Civil Accudraw toggled on select the **Station-Offset** ordinate.
- In the Civil Accudraw settings, use the Tab key to highlight the **Offset** field.
- With focus set to the **Offset** field, key in the letter "o" to define the element that you wish to use for the station and offset ordinate.

- Once defined, you can now key in a **Station** value to get the elevation on the selected linear feature at the station location. The results are shown on below.



Note: The **Offset** value is irrelevant as the command will project a perpendicular from the alignment to the selected linear feature in order to report the elevation on the linear feature.

Using the **Analyze Point** command, get the elevations for the left and right edge of pavement and the center of the existing pavement at station 386+25. Note, the surveyed line for the center of pavement is on the level SV_X_Center_of_Pavement. Enter the elevation values in the table below.

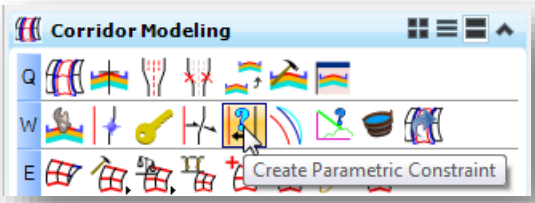
Selected Linear Feature	Elevation
Left Edge of Pavement	
Center of Pavement	
Right Edge of Pavement	

Compute the existing pavement cross slope and enter the value in the table below.

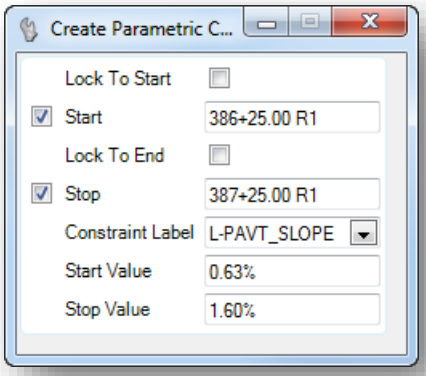
Side	Width	Cross Slope %
Left	12.3870’	
Right	11.7944’	

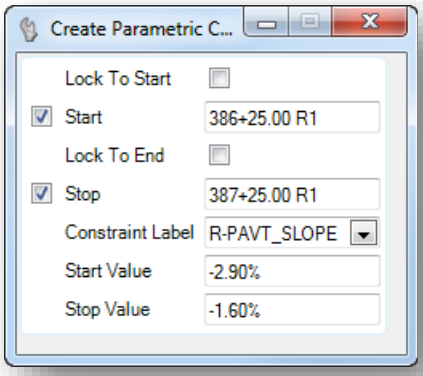
Now we are ready to define the **Parametric Constraints** to override the pavement slope at the beginning of the project.

✓ From the *Tasks* menu, select Ta**sks > Civil Tools > Corridor Modeling > Create Parametric Constraint**.

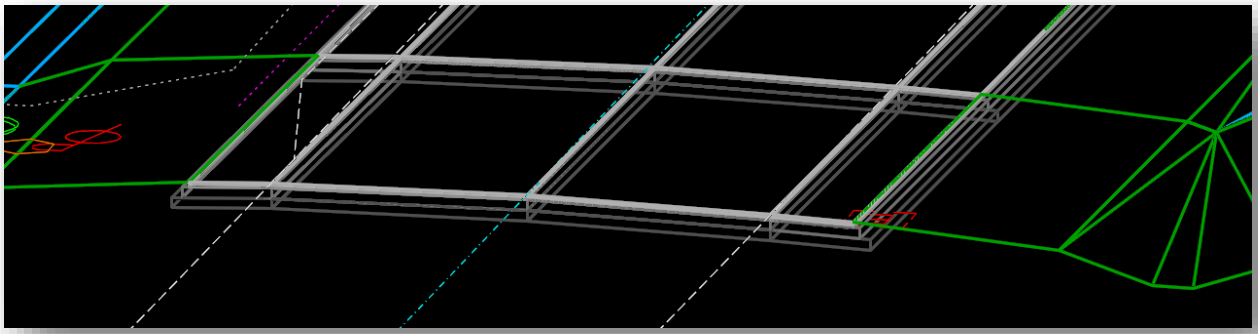


✓ Create parametric constraints for the L-PAVT_SLOPE and R-PAVT_SLOPE labels from station 386+25 using the slopes computed above, to end at 1.60% at station 387+00.





After the labels have been defined, the proposed pavement should meet the existing pavement in the 3D model, within an acceptable tolerance, similar to the example shown below.



Whether it is necessary to adjust the model to this level of detail is debatable as the construction contractor will ensure that the proposed pavement ties in to the existing pavement. However, this exercise illustrates the power of point controls and parametric constraints to override the initial template definition.

Exercise 7G – Ditch Profiles

The template definition for S.R. 185 contained end conditions for both cut and fill conditions. When the template is applied, the priority of each end condition is used to determine the order in which the end conditions are processed. As each option is evaluated, the first option that is successful will be used for the template drop location.

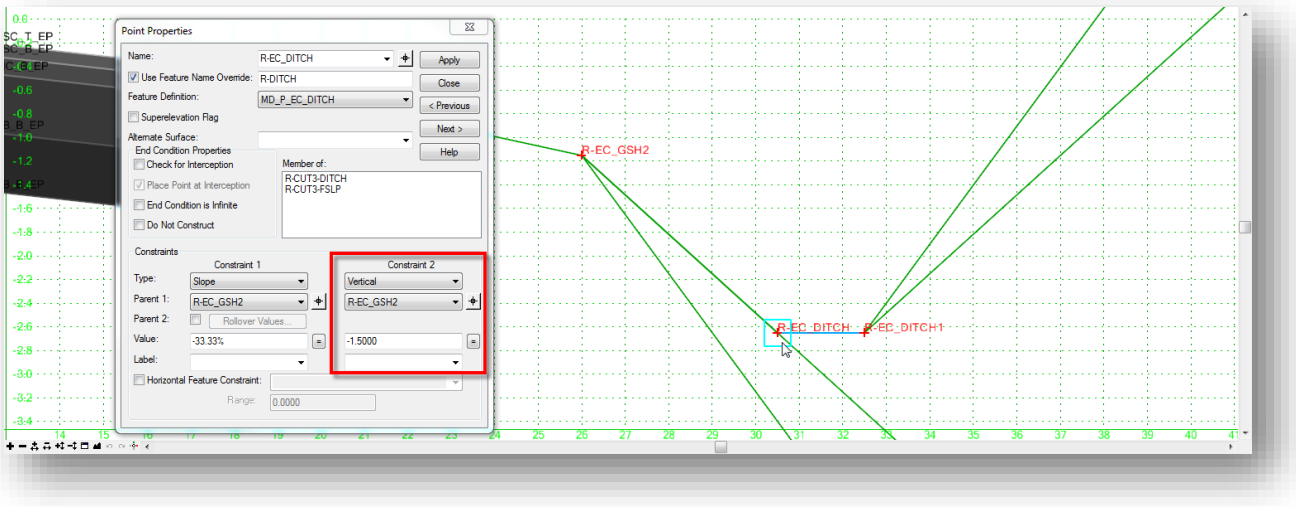
In many cases, it will be necessary to define a new profile for a ditch, or even override the template solution in order to force a ditch in areas where the solution that was used for a range of template drop locations did not include a ditch. This exercise will look at a few different ditch modification scenarios.

The length of the example project contains too many ditches for us to define them all in this training course. We will take a look at a few specific areas in order to introduce you to the available tools to define ditch profiles.

Part 1: Redefining a Ditch Profile with an Elevation and Grade Point Control

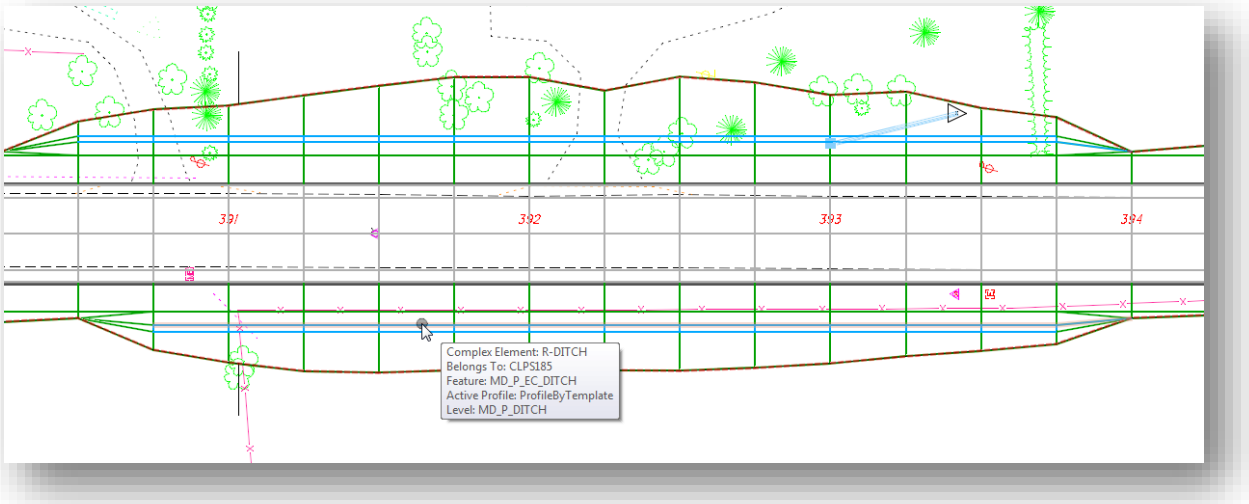
Point controls can be used to defile a ditch profile by a starting elevation and a grade for a range of stations.

The template used for S.R. 185 will draw a ditch in cut conditions. This ditch point **R-EC_DITCH** is set with a **Vertical** constraint value of -1.5’ from point **R-EC_GSH2** as shown below.



Point **R-EC_Ditch1** is constrained 2’ horizontally and 0’ vertically from point **R-EC_Ditch**. Defining a point control for point **R-EC_Ditch** will also adjust the elevation for point **R-EC_Ditch1** since it is constrained vertically to point **R-EC_Ditch**.

In this example we will define a new profile for the ditch on the right side of the corridor from stations 390+75 to 394+00.



✓ Open MicroStation using the shortcut provided for the training class.

✓ Set the **User** and **Project** as follows:

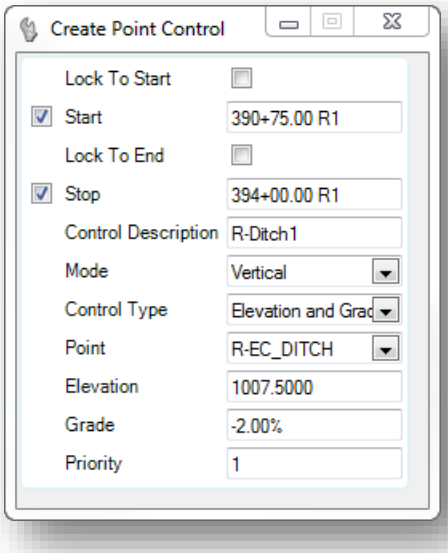
User: ODOTcadd
Project: 12345_CORRIDOR_MODEL

✓ Open the design file for the S.R. 185 Corridor Model:

..\Design\Geopak\Basemaps\12345_KM001.dgn

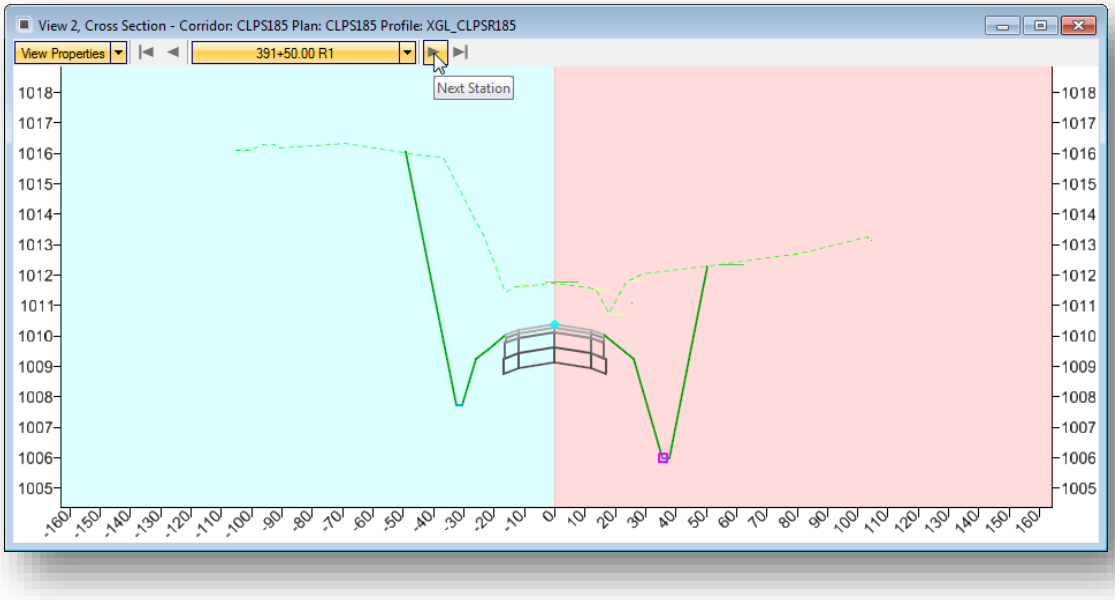
✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Point Control**. When prompted to **Locate Corridor**, select the S.R. 185 corridor model.

✓ Create the vertical point control using the settings shown below.



When the point control is applied, the 3:1 slope from the graded shoulder to the ditch elevation is maintained. The ditch line moves out appropriately.

✓ The results can be reviewed by opening a cross section view. From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Open Cross Section View**. When prompted, select the S.R. 185 corridor and then data point inside view 2. The cross section for Station 391+50 is shown below. The point control is indicated by the purple box drawn around point R-EC_Ditch.



✓ Review the 3D model to inspect the changes. Obviously this is not a legitimate design solution as the ditch does not have an outlet, but the example illustrates one way to manipulate a ditch profile.

Part 2: Defining a Special Ditch Profile

When a corridor model is created, some of the Feature Definitions that have been assigned to the points in the template are configured to draw 2D plan view graphics into the corridor design file. These plan view graphics have a profile defined that can be reviewed in a profile window.

The **Feature Definition** MD_P_EC_DITCH is configured to draw 2D plan graphics in the corridor design file. The ditch profiles can be displayed relative to the centerline stationing in the profile window. All profiles must be defined in the same design file that contains the centerline geometry, the geometry basemap "BK" design file.

- ✓ Open MicroStation using the shortcut provided for the training class.

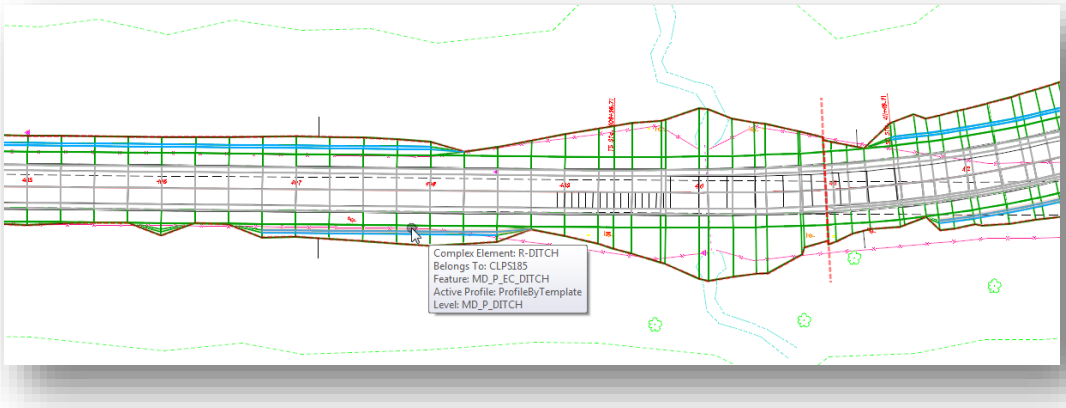
- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_CORRIDOR_MODEL

- ✓ Open the design file for the S.R. 185 geometry:
  ..\Design\Geopak\Basemaps\12345_BK002.dgn

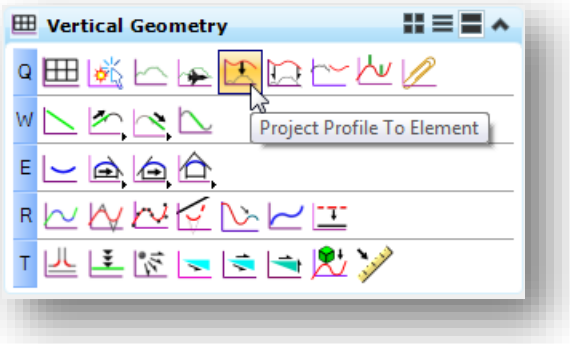
- ✓ Attach the Design model for the S.R. 185 corridor design file with a **Nest Depth** value of **0**.
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

  It is not necessary to attach the corridor model to design a new ditch profile. This is only necessary if you wish to display the ditch profile that was generated by the corridor model onto the S.R. 185 profile.

  We will define a new ditch profile for the right side of the corridor from stations 405+00 to 412+00. Notice that the template did not place a ditch for the full station range.



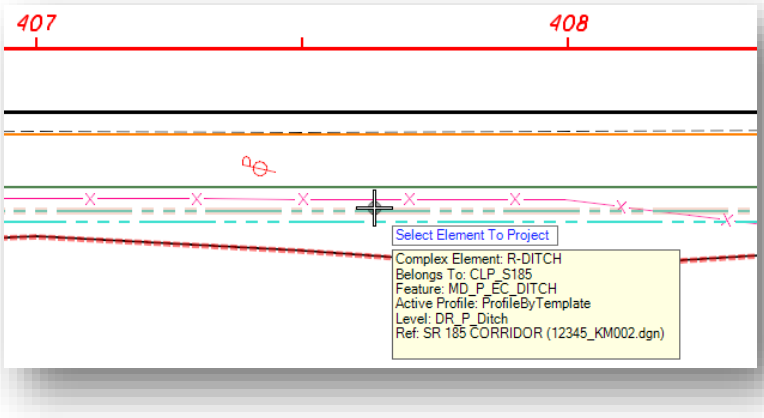
The profile of the ditch line as defined by the initial corridor model processing can be projected to the S.R. 185 profile by use of the **Project Profile to Element** command, or the **Project Profile Range to Element** command, contained in the **Tasks > Civil Tools > Vertical Geometry** group.



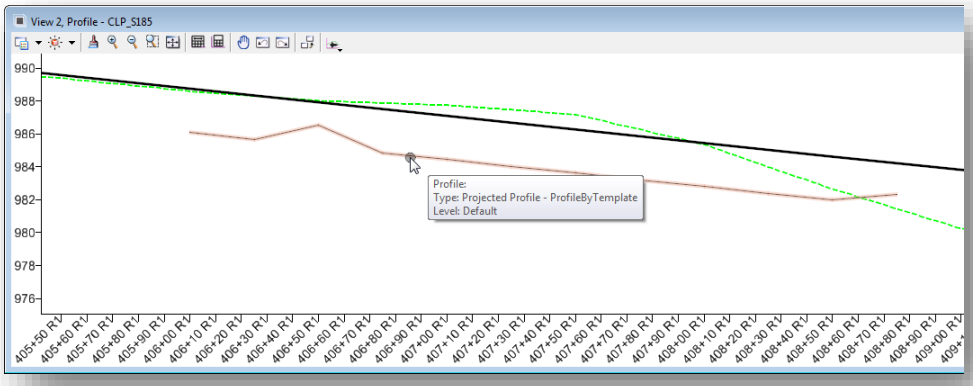
✓ To define the new ditch profile, select the centerline of S.R. 185 and choose the **Open Profile Model** command from the pop-up menu. Open view 2 to display the profile.

✓ To display the current ditch profile as defined in the corridor model, select the **Project Profile to Element** command.

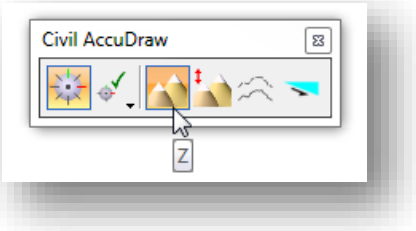
- When prompted to **Select Element to Project**, choose the inside ditch line on the right side of the corridor



- When prompted to **Select Element to Project Onto**, choose the horizontal alignment for SR 185. The ditch profile is displayed in the profile view as shown below.



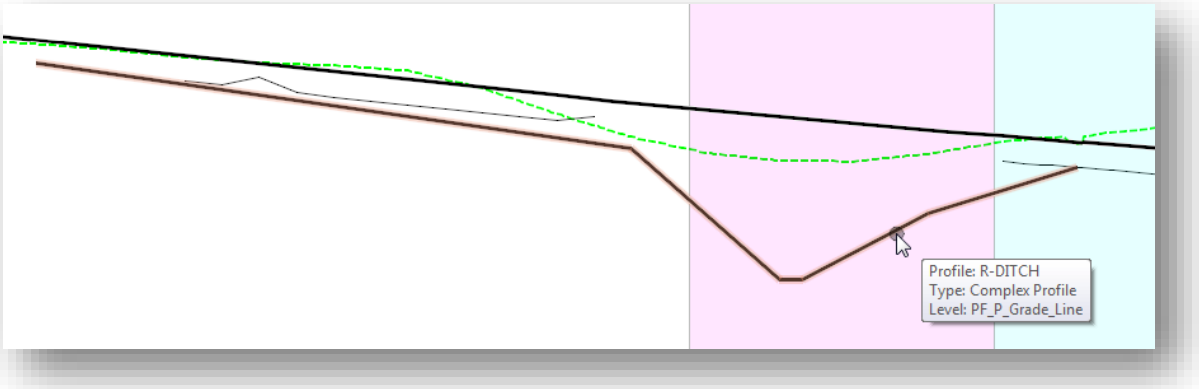
- ✓ In the *Profile* view window, choose the **Profile Complex by VPI** command.
- ✓ Toggle on *Civil Accudraw* and select the **Z** ordinate option.



- ✓ Place a profile without any vertical curves (**Curve Length** = 0) using the following station and elevation values.

405+00	987.94
409+00	979.00
410+00	965.25
410+15	965.25
411+00	972.25
412+00	977.00

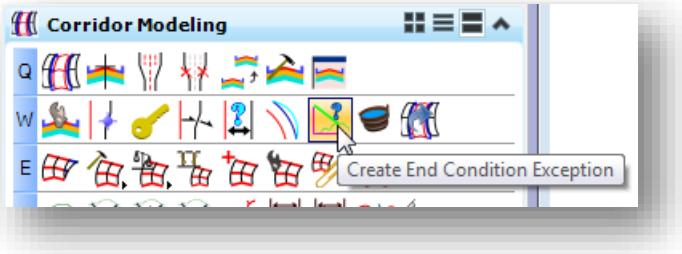
- ✓ After placing the profile, select the profile and choose the **Properties** icon from the pop-up menu. Define the **Feature Name** of the profile as **R-Ditch**. The ditch profile should appear similar to the example below.



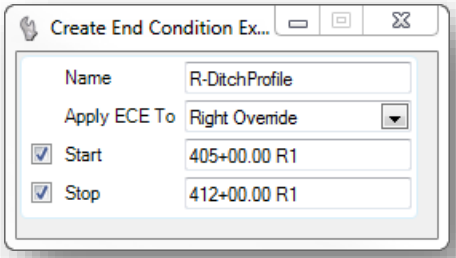
✓ Open the design file for the S.R. 185 corridor model:
..\Design\Geopak\Basemaps\12345_KM001.dgn

First we will define an **End Condition Override** to define a ditch for the full station range from 405+00 to 412+00.

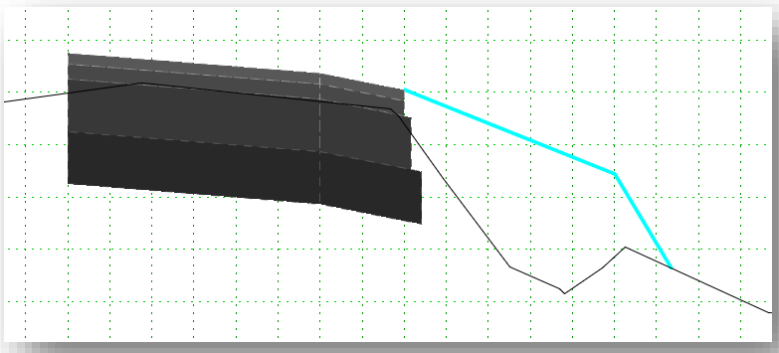
✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create End Condition Exception**. When promoted, select the S.R. 185 corridor.



✓ Define the end condition exception with the values shown below.



✓ The *Right Override* dialog is opened to display the right side template drop at station 405+00. Right-click in the template window and choose the **Delete Components** option to delete the graded shoulder and side slope lines. The deleted lines are still displayed as shown below.

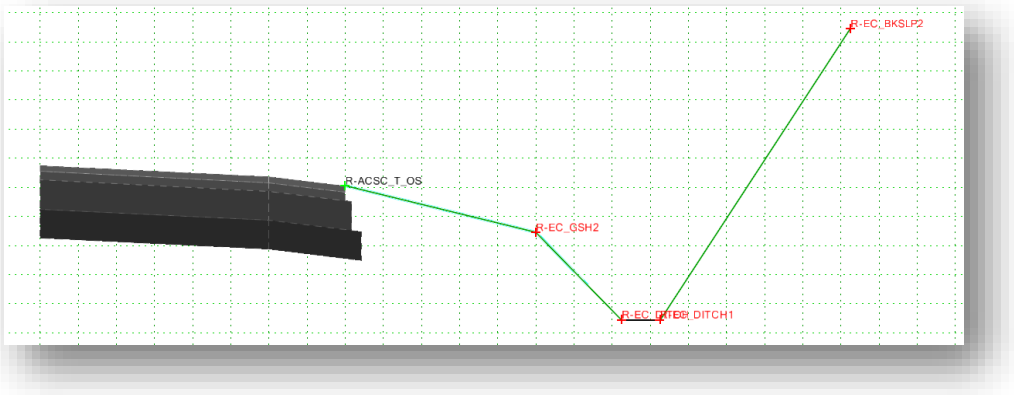


✓ Open the *Dynamic Settings* dialog (**Tools > Dynamic Settings**) and toggle on the **Apply Affixes** option

✓ Select the following end condition and drag it onto the edge of shoulder point:

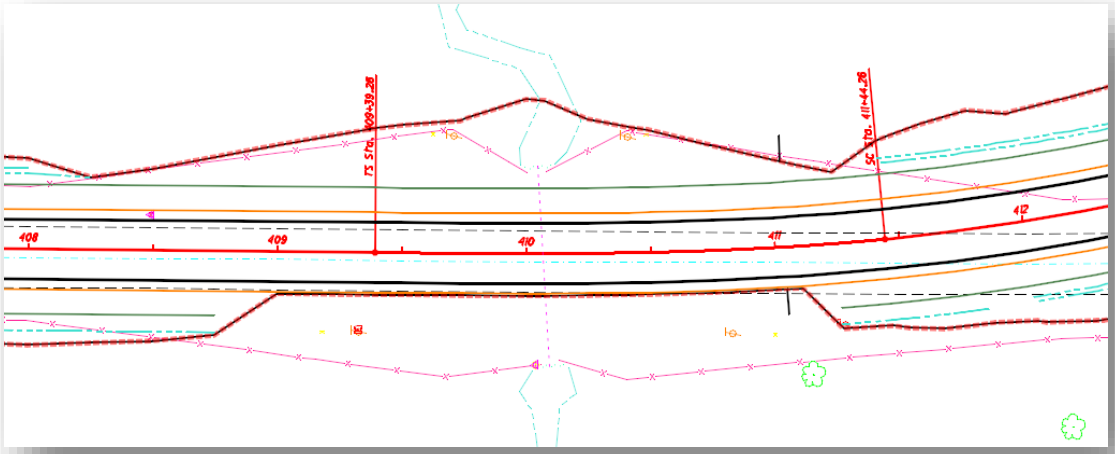
ODOT > End Conditions > 307-4E Common and Barrier Grading > 307-4E Cut 3:1

✓ Delete the 3:1 backslope component. The end condition override should appear as shown below.



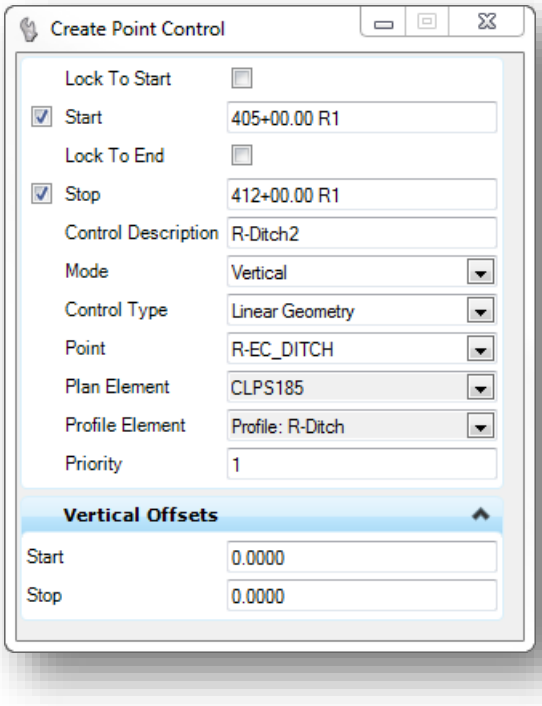
When the dialog is closed, the corridor is reprocessed and the ditch is drawn for template drop locations where the template conditions are met.

For this example, there will be stations where the end condition does not solve as shown below. We will remedy this by assigning the new ditch profile to the corridor.

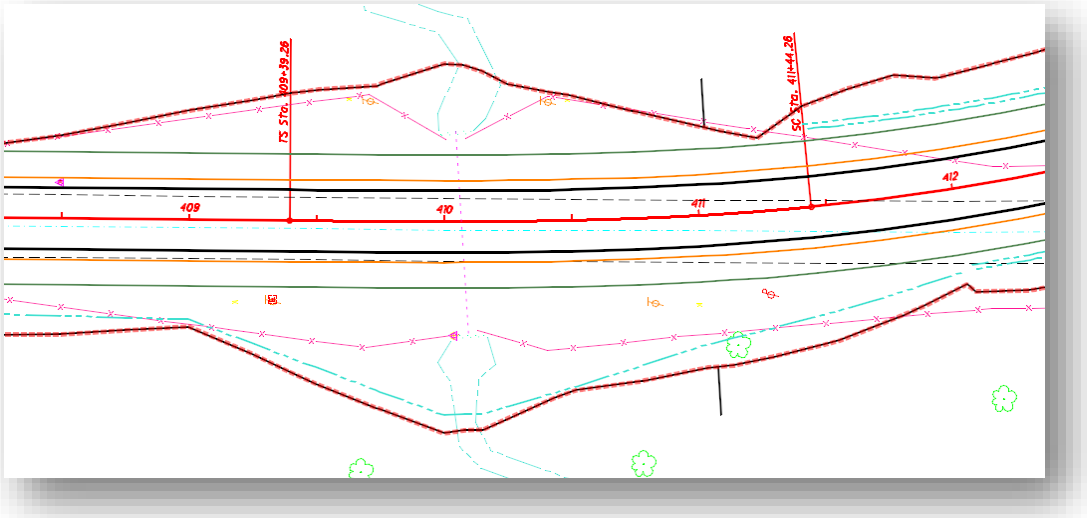


✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Point Control**. Select the S.R. 185 corridor when prompted.

✓ Create the point control using the settings shown below.



When the ditch profile is applied, some of the template drops will display the new ditch line as shown in the example below



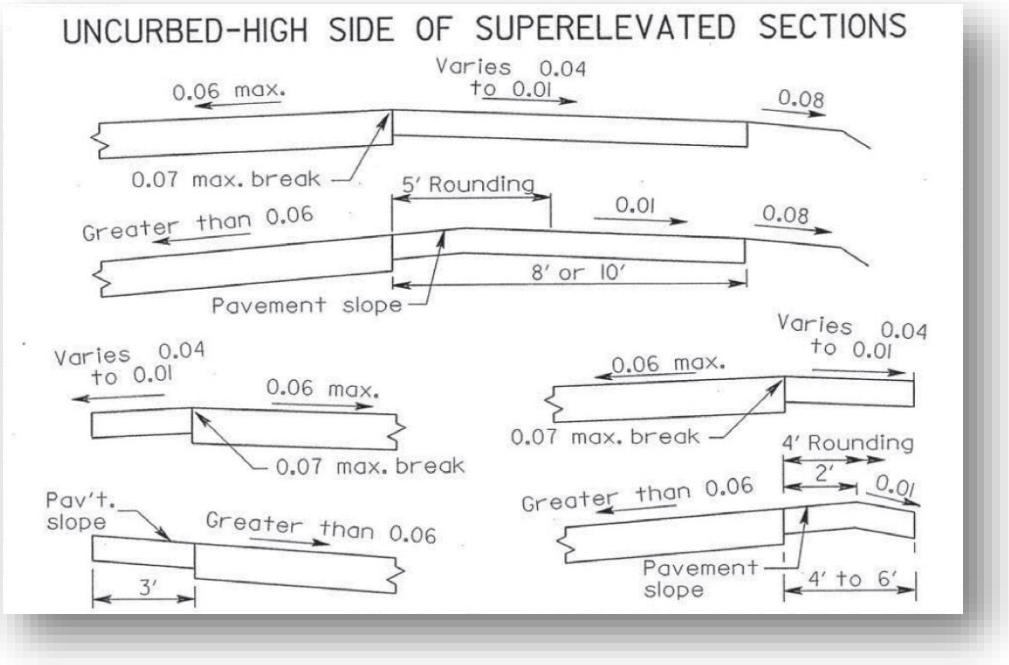
Normally a culvert would be designed for this location. Culvert design and grading around the culvert are beyond the scope of this training course. The purpose of this exercise is to illustrate the process to define and apply a special ditch profile in the corridor model.

8 Superelevation

The Superelevation commands calculate how much banking to apply to curves in the horizontal alignment to help offset centrifugal force. These commands also compute how the road will make the transition from normal crown to a fully banked curve and back again.

Pavement slopes are initially defined in the template. Superelevation is created and applied after the corridor is defined and the template drops have been assigned. This chapter will detail how superelevation is computed with OpenRoads as well as how to accurately model the shoulder break for the high side of Superelevation as defined in the **Location and Design Manual, Volume 1, Roadway Design, Figures 301-8E, 301-9E, and 301-10E** using the Table Wizard with ODOT's ASCII Superelevation Tables.

For this example, we will reference the shoulder break for uncurbed roadways defined in **Figure 301-8E** shown below.

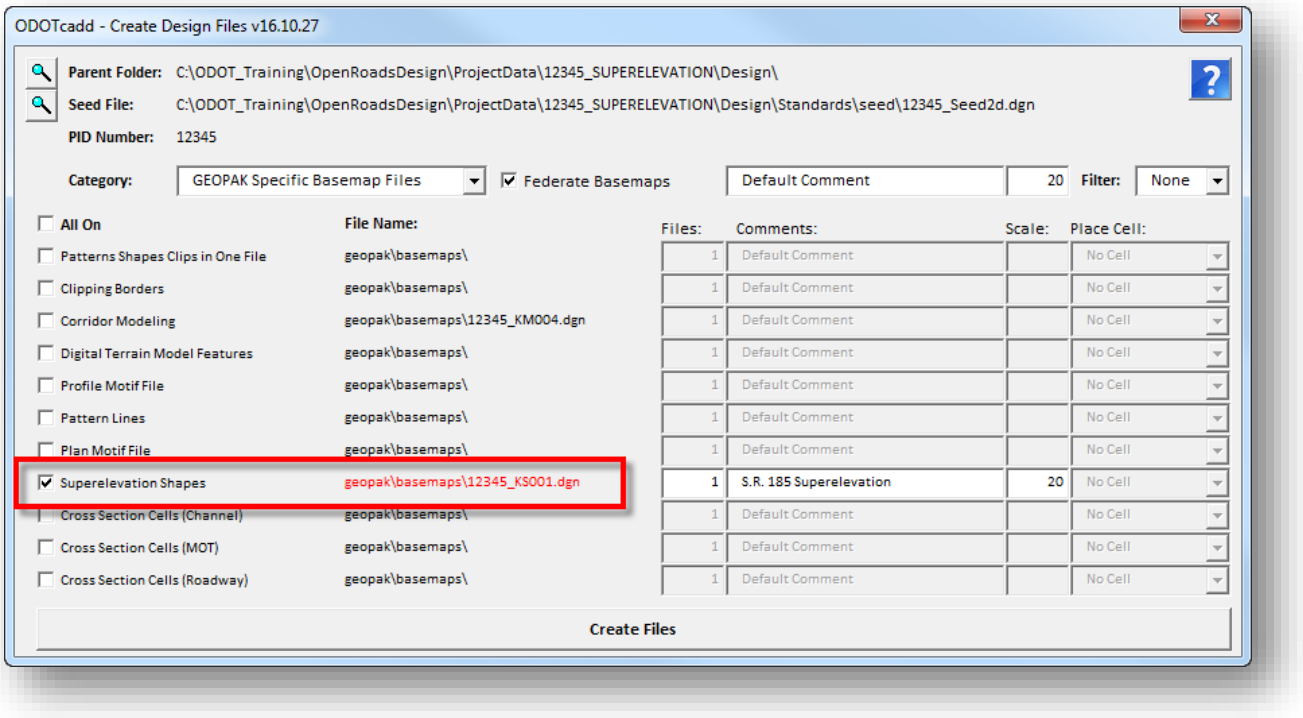


The behavior for the low side of superelevation is easily facilitated by applying a **Rollover Lock** to the shoulder point in the template definition.

The high side of superelevation presents some challenges. For pavement slopes greater than 3%, the shoulder slope maintains a 7% maximum break. This can also be facilitated with the **Rollover Lock** parameter in the template point properties. If the pavement slope exceeds 6%, a 2' break is introduced. Modeling this behavior cannot be modeled using the rollover lock. This chapter will document the procedure to model the superelevation using the ODOT template library.

8.1 Superelevation Design Files

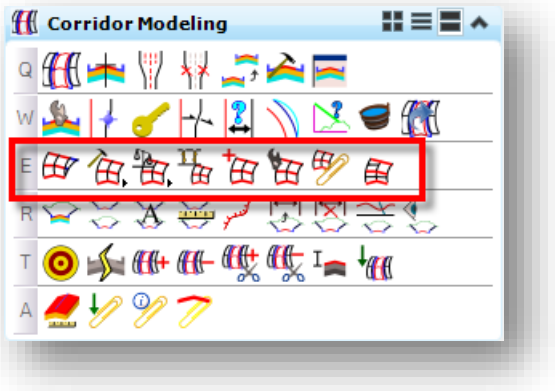
Superelevation graphics for each alignment are normally be placed in a separate design files. The **ODOT_Files.mvba** application is used to create superelevation design files for the project as shown below.



Notice that the file is created in the \geopak\basemaps folder for the project.

8.2 Applying Superelevation to a Corridor

The Superelevation tools are located in the **Tasks > Civil tools > Corridor Modeling** group as shown below.



From left to right, the following tools are available:

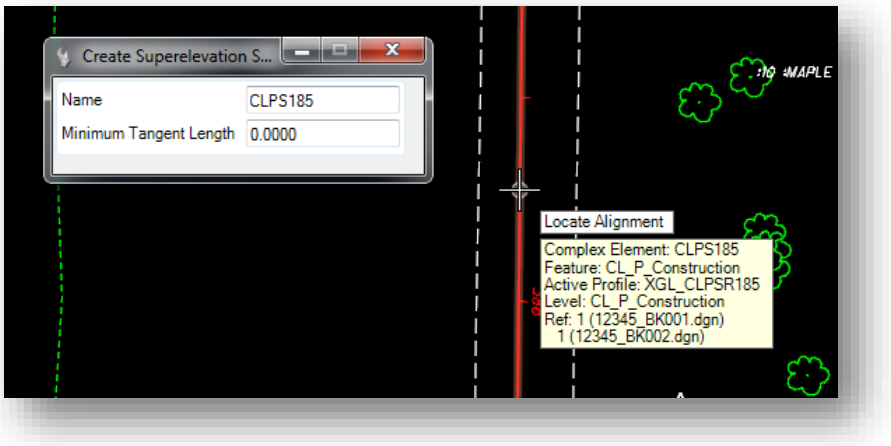
- Create Superelevation Sections
- Create Superelevation Lanes
- Calculate Superelevation/Import Superelevation
- Assign Superelevation to Corridor
- Insert Superelevation/Cross-Slope
- Superelevation Editor
- Superelevation Report
- Display Superelevation in Plan

See the online help for tools not covered in this training guide.

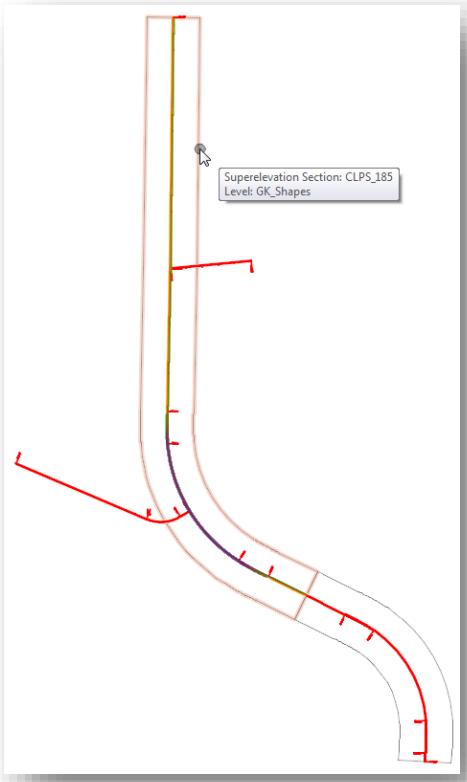
Create Superelevation Sections

Superelevation graphics are drawn on the active MicroStation level. Activate the **GK_Shapes** level before processing the superelevation commands.

When the **Create Superelevation Section** tool is accessed, you are prompted to enter a **Name** for the superelevation section and to select the alignment as shown below.



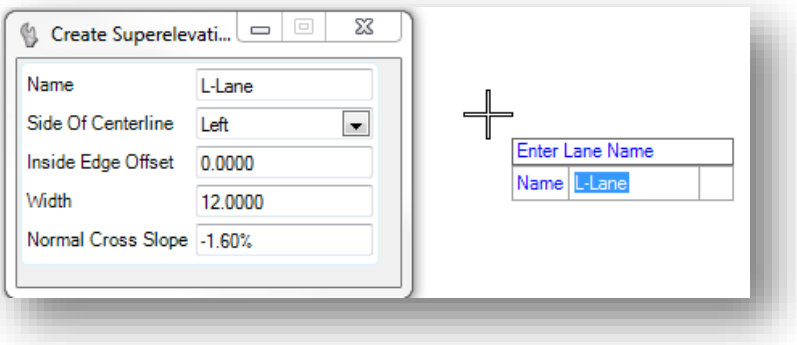
After the alignment is selected, you are prompted to enter the **Start** and **End Stations** for the superelevation definition. In the example below, the entire length of the chain was used to define the start and end locations. Two superelevation sections were created, one for each curve set.



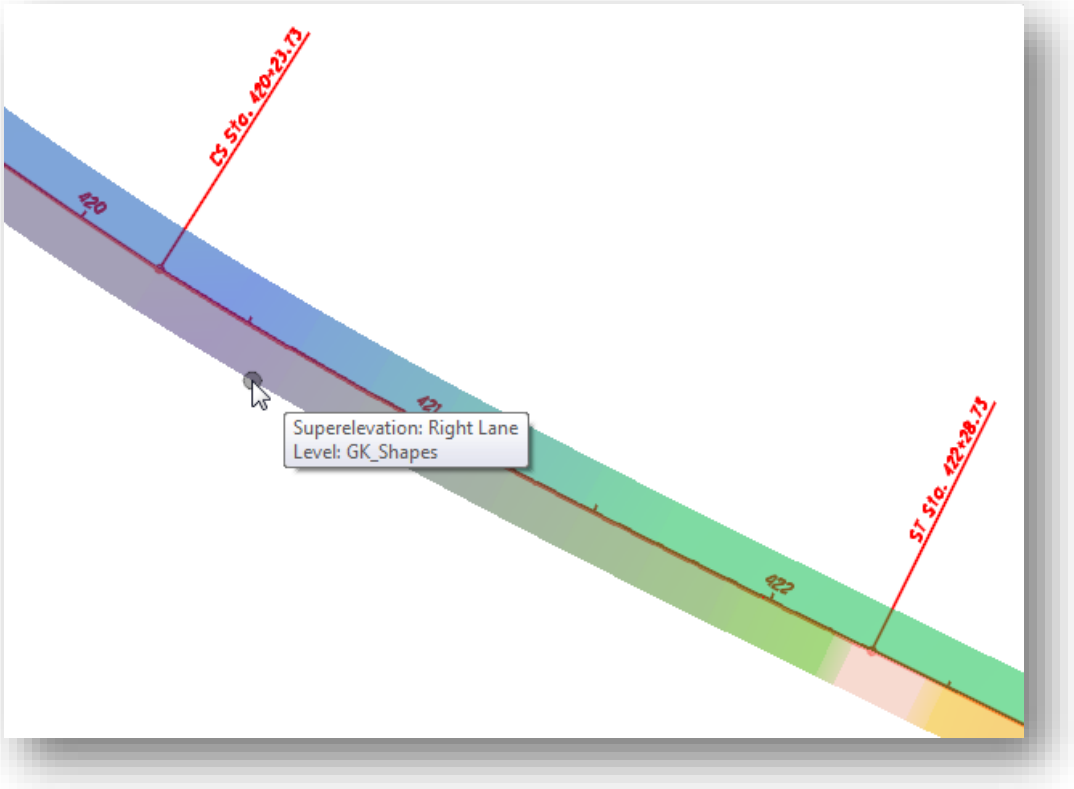
In the example at left, there are two separate shapes defining the superelevation “sections”. Each curve set of the horizontal alignment is the basis of a superelevation section.

The superelevation definition is drawn on the active level.

Next you are prompted to define the pavement lanes as shown below. Issue a **Data** button (left-click) to accept each value as you are prompted by the software.

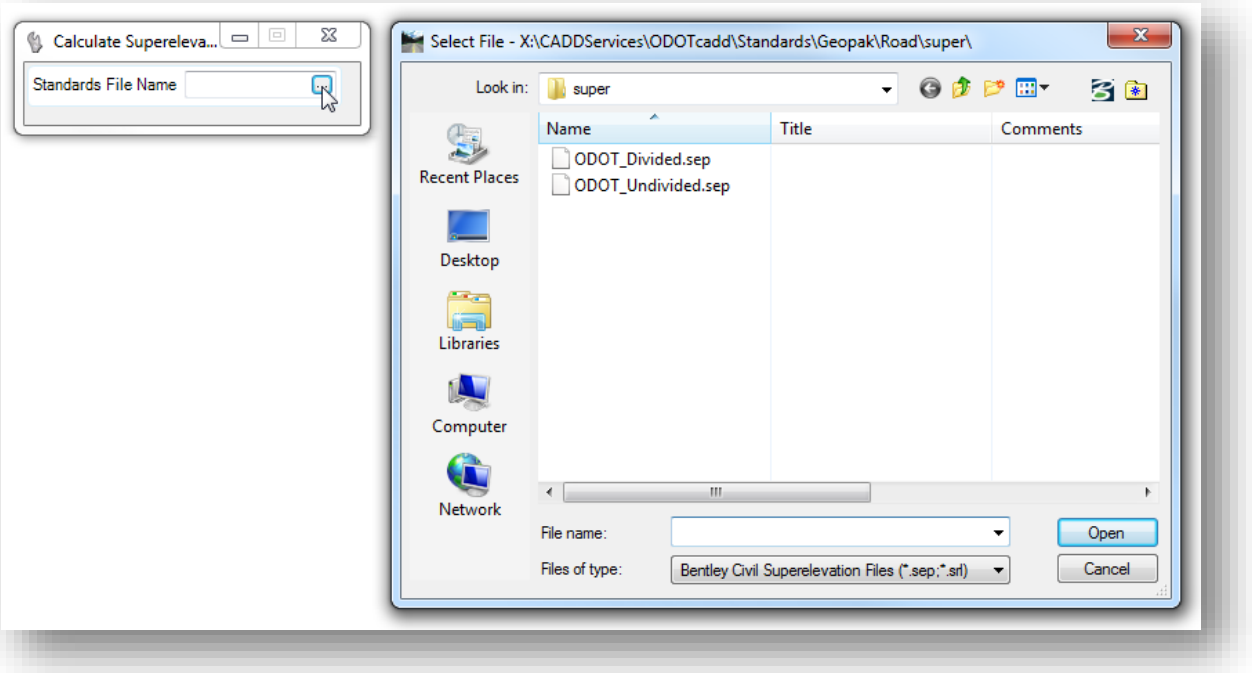


As each lane is defined, a shaded shape is displayed on the active level, for the lane.



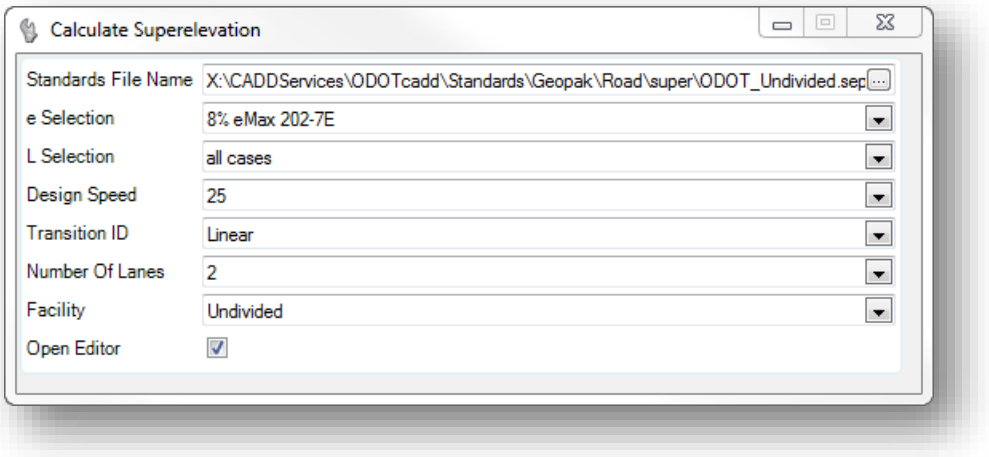
Note: Fill display is turned off in the default ODOT workspace. To turn it on, select the **View Attributes** command and toggle on the **Fill** option.

After defining the lanes, issue a **Reset** button (right-click) to move to the next step; selecting the standards file, as shown below.

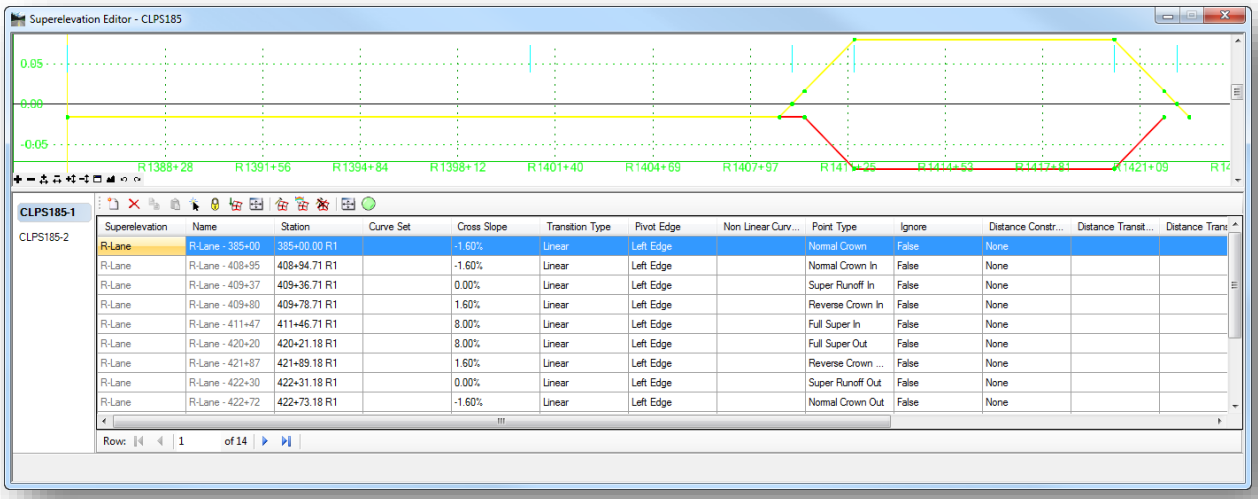


Two superelevation preference files are provided in the ODOTcadd standards as shown above. These are the same preference files used with the GEOPAK Road tools.

After the preference file is selected, the dialog shown below is opened to allow selecting the appropriate parameters for the project.

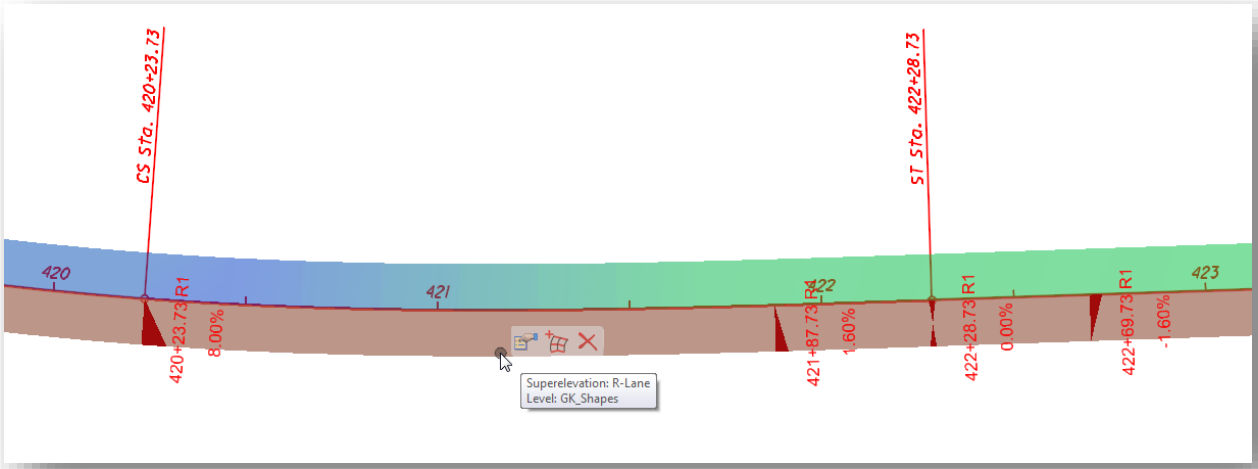


Toggle the **Open Editor** option **on** to access the dialog shown on the following page.

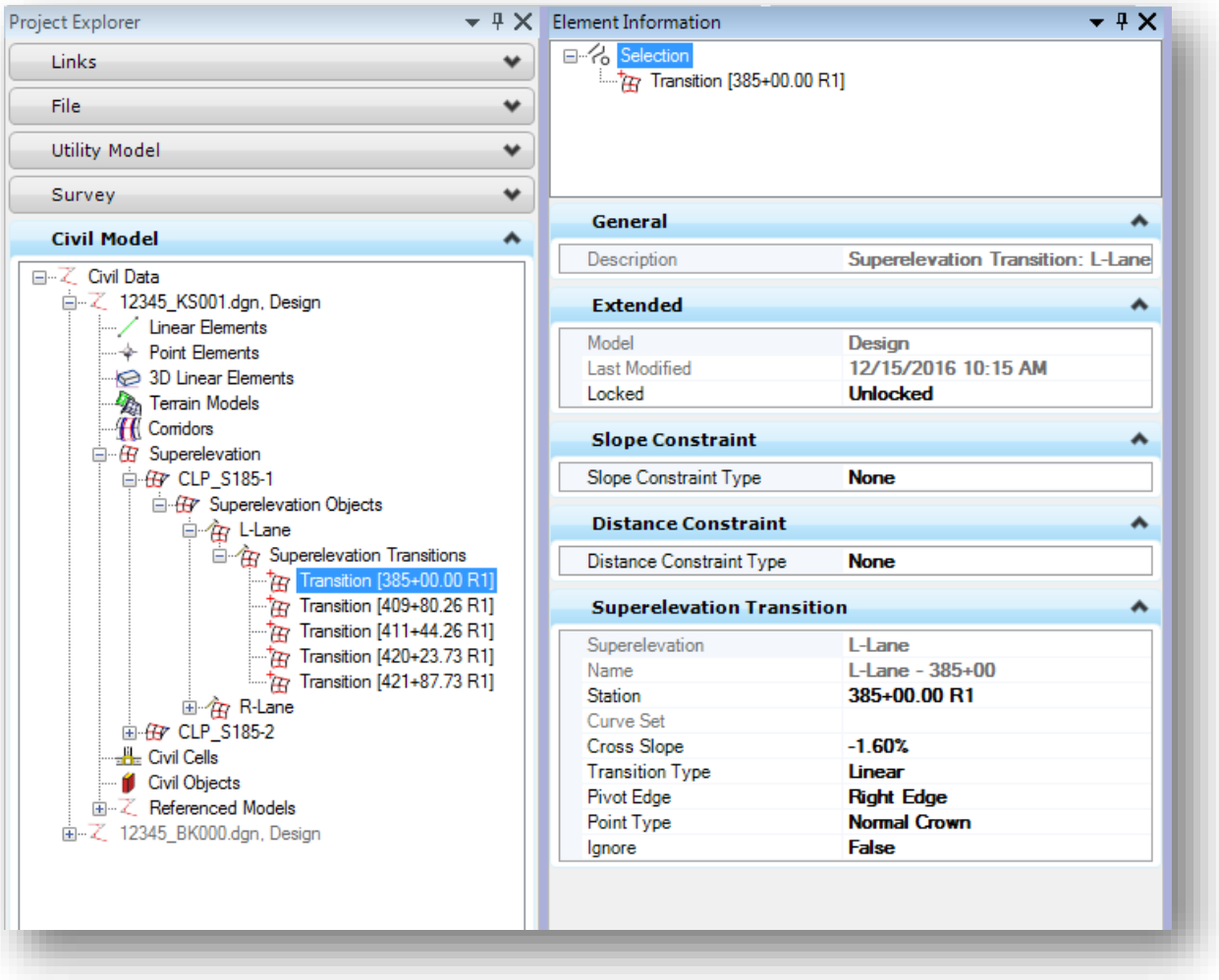


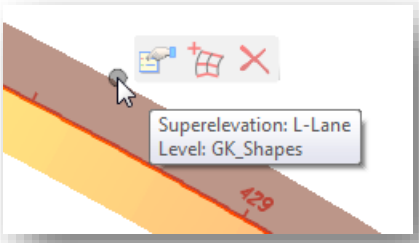
This dialog is used to review and edit the superelevation parameters.

The superelevation values can also be reviewed and edited by selecting one of the pavement lanes as shown below. Each of the text items designating the station and cross slope can be edited by selecting the text.



Superelevation values can also be reviewed and edited in the Project Explorer's Civil Model group as shown on the following page.



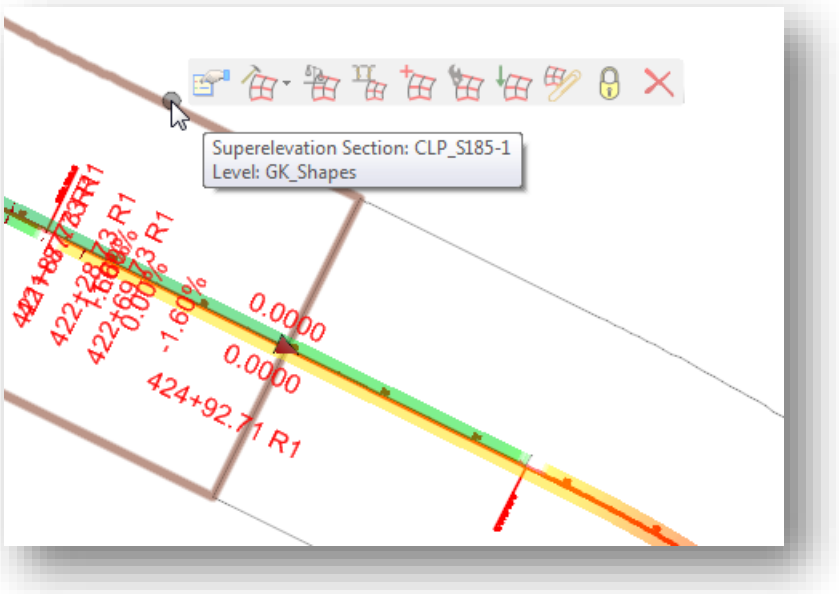


Selecting a superelevation shape, as shown at left, allows you to access a menu with the following three commands:

- Properties
- Insert Superelevation Station/Cross Slope
- Delete

See the online help for more information on these commands.

Selecting the superelevation section graphic, as shown below, provides access to a pop-up menu containing the superelevation commands listed below.



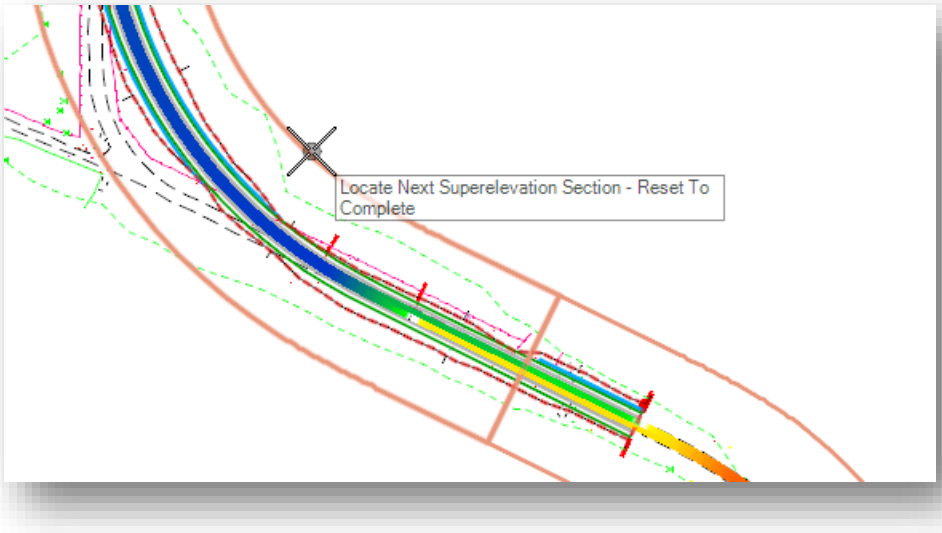
- Properties
- Create Superelevation Lanes
- Calculate Superelevation
- Assign Superelevation to Corridor
- Insert Superelevation Station/Cross Slope
- Superelevation Editor Tools
- Import Superelevation
- Superelevation Report
- Lock/Deactivate Rule
- Delete

See the online help for more information on these commands.

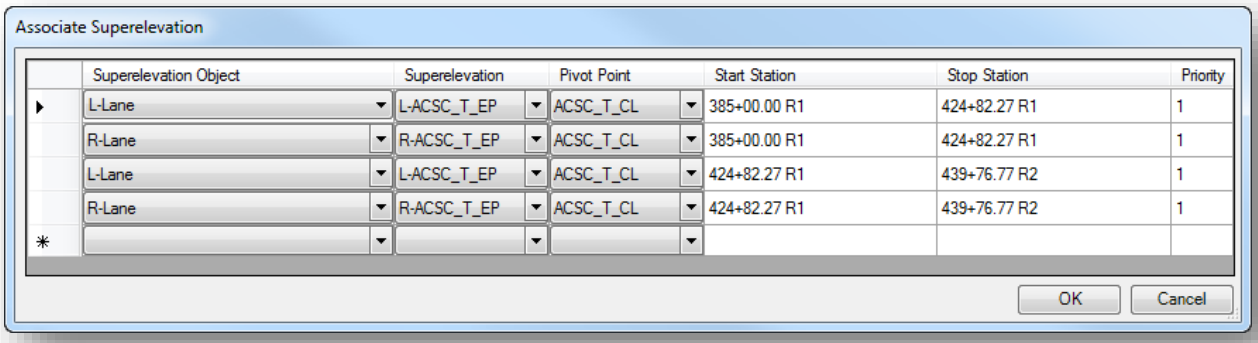
Assign Superelevation to Corridor

After the superelevation values have been computed, the next step in the process it to assign the superelevation sections to a corridor. Before assigning the superelevation to the corridor, it is necessary to attach the reference file containing the superelevation definition. If a Federated basemap collector design file is used for the superelevation, the "KS000" design file is attached with a **Nest Depth** value of **1**.

After the reference file containing the superelevation definition has been attached, it can now be assigned to the corridor. Choose the **Assign Superelevation to Corridor** command. Select each superelevation section that you wish to apply to the corridor similar to the example below.



After the sections and the corridor have been identified, the *Associate Superelevation* dialog similar to the one shown below is opened. This dialog is used to associate specific points in the template to the superelevation lanes.

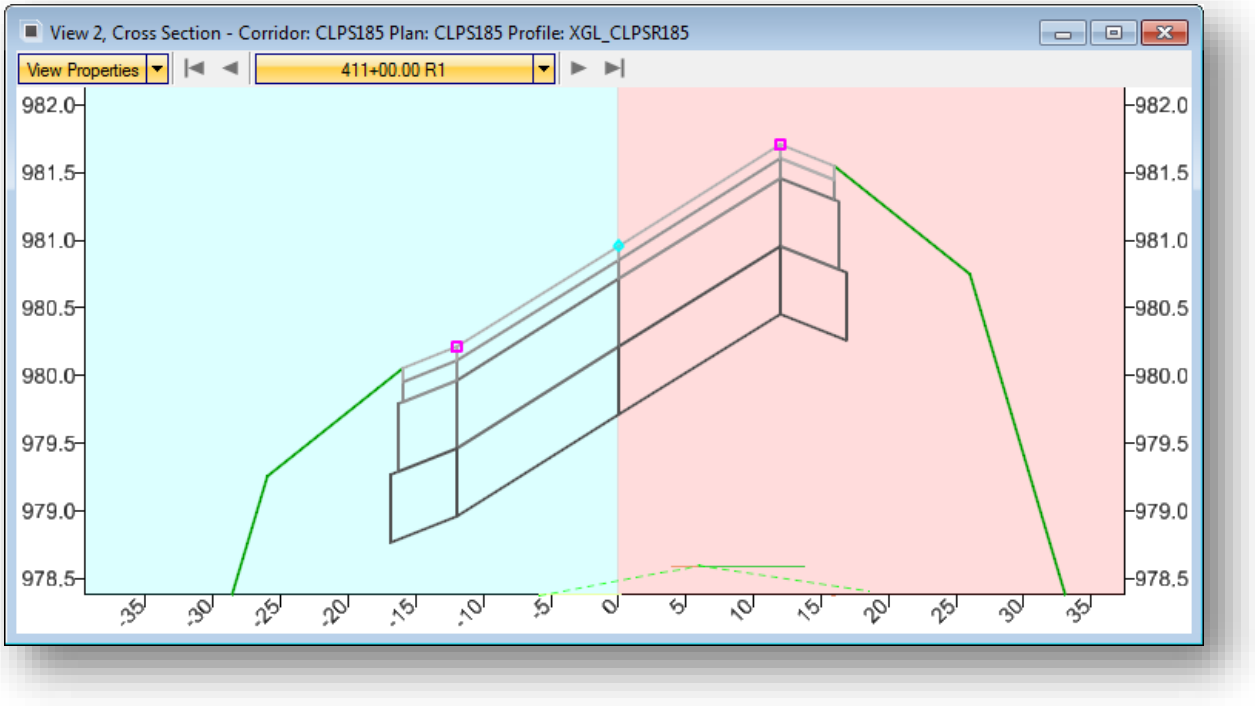


In the example above, the **Superelevation Objects L-Lane** and **R-Lane** are shown for each of the two superelevation sections. The objects default to the points that have been identified with the **Superelevation Flag** toggled on in the template definition.

After reviewing and making any corrections to the assigned points for each lane, select **OK** to apply the superelevation to the corridor.

The model is automatically updated with the superelevation values which override the cross slopes initially defined in the templates.

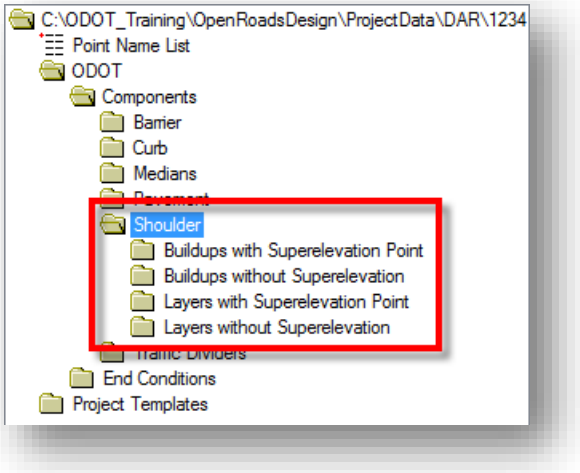
Superelevation is applied to the pavement lanes, but not the shoulders. The **Rollover Lock**, described in the following pages, is used to define the behavior for the shoulders. Using ODOT's design standards, this will facilitate superelevated roadways where no shoulder break is required on the high side of superelevation. We will review the **Rollover Lock** settings and discuss the procedure to insert templates for the superelevation and correct the shoulder slopes in the next section.



8.3 Templates for Superelevated Sections

ODOT's template library contains shoulder templates for superelevated sections. These templates are intended as the starting point for defining the superelevation and will require some modification to accurately reflect the superelevated roadway.

The ODOT template library includes shoulder buildups for superelevation as shown below.



The shoulders defined in the **Buildups without Superelevation** folder are used for normal crown roadways without superelevation and for superelevated roadways where the pavement slope is less than the value specified for a shoulder break condition. Shoulders greater than 6% include the shoulder break point in this example using **Figure 301-8E**.

Shoulders defined in the **Buildups with Superelevation Point** folder are used for roadways with a shoulder break introduced.

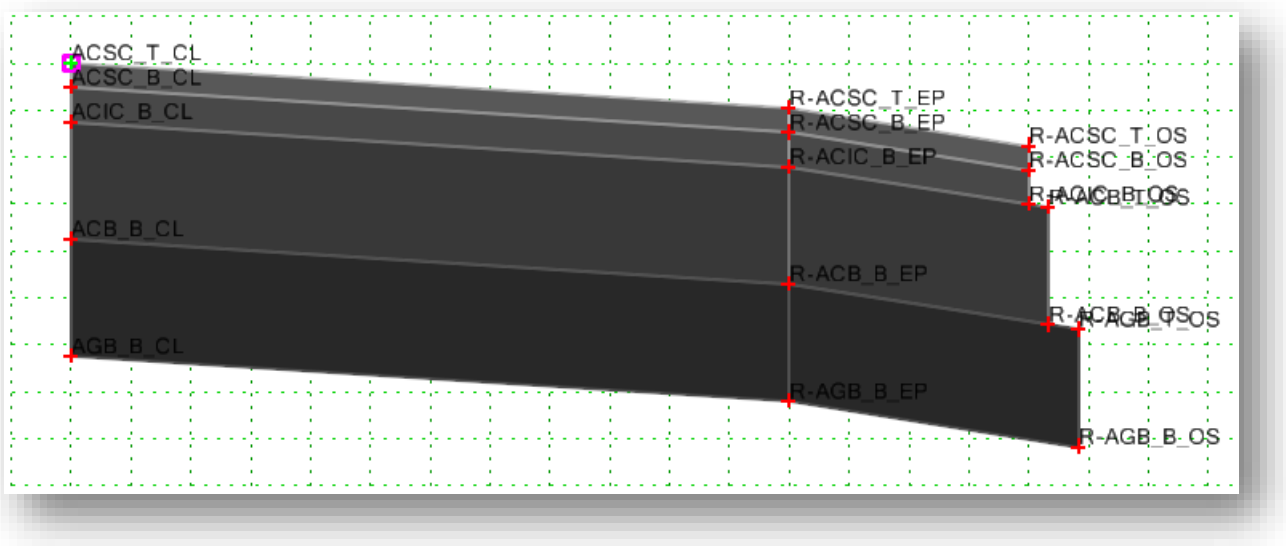
In either case, the user will have to make some modifications to the shoulder components when the template is created. Each case is explained below.

Defining the Shoulder Rollover for the Low Side of Superelevation

According to figure 301-8E, the shoulder slope will match the pavement slope for superelevated sections when the pavement slope is greater than 4%. This behavior can be modified using the **Rollover Lock**. The rollover lock cannot be defined in the shoulder templates since it requires a **Reference Point** (the inside edge of the adjoining pavement lane) and the **Parent Pont** (the edge of pavement point). After the pavement and shoulder have been defined in a template, the rollover lock can be applied.

In the example shown on the following page, the template was constructed by dragging in the following two templates from the ODOT library:

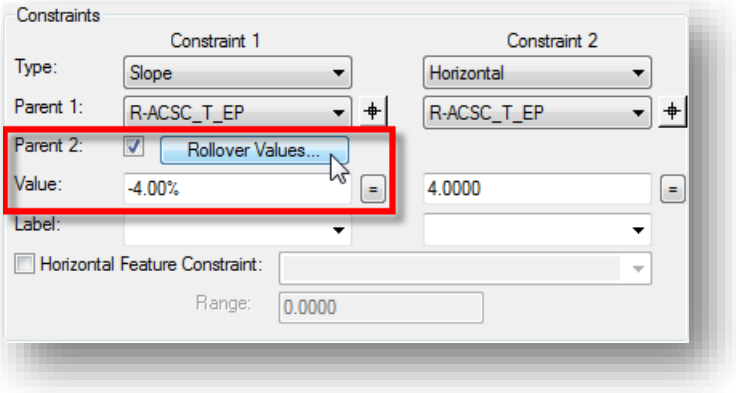
ODOT > Components > Pavement > Buildups > Asphalt Concrete without Stabilization
ODOT > Components > Shoulder > Buildups without Superelevation > Asphalt Concrete without Stabilization



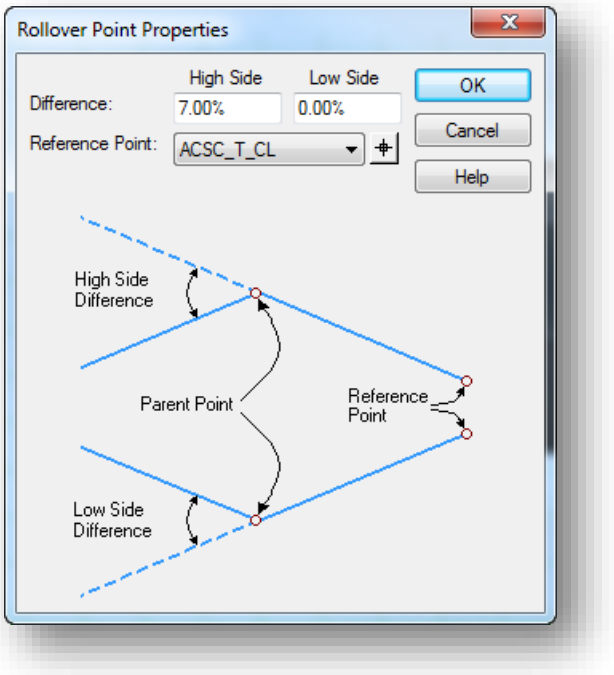
The shoulder rollover for the low side of superelevation is defined as follows:

- Double-Click the outside edge of shoulder point **R-ACSC_T_OS** to open the *Point Properties* dialog

- Toggle on the **Rollover Values…** option



- Select **Rollover Values…** to define the rollover parameters shown on the following page



- The **High Side Difference** parameter is set to 7% to define the maximum slope break for the high side of superelevation

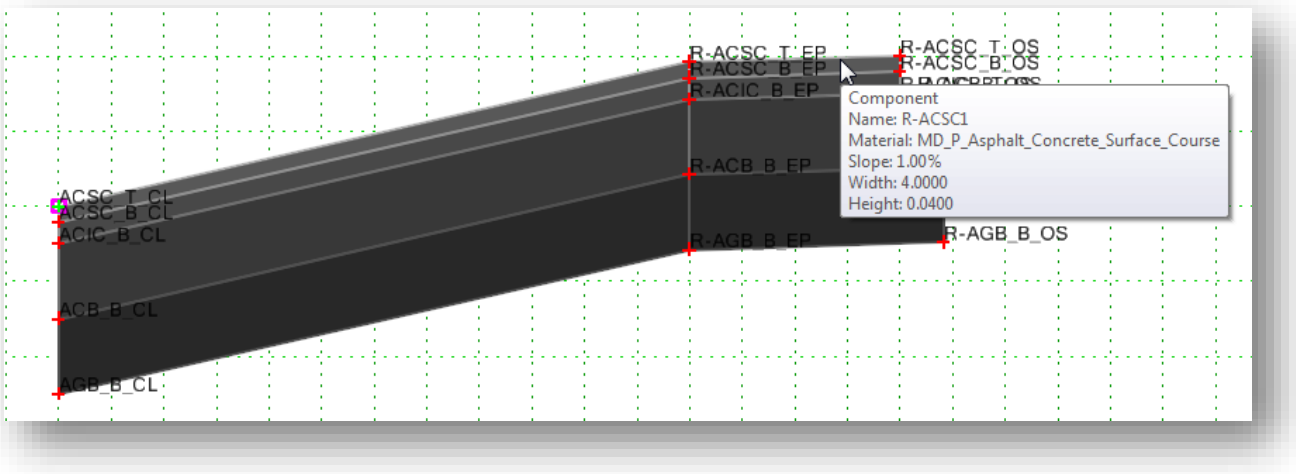
- The **Low Side Difference** parameter is set to 0% to constrain the shoulder slope on the low side of superelevation to match the pavement slope

- The **Reference Point** is set to the point on the inside edge of pavement adjacent to the shoulder

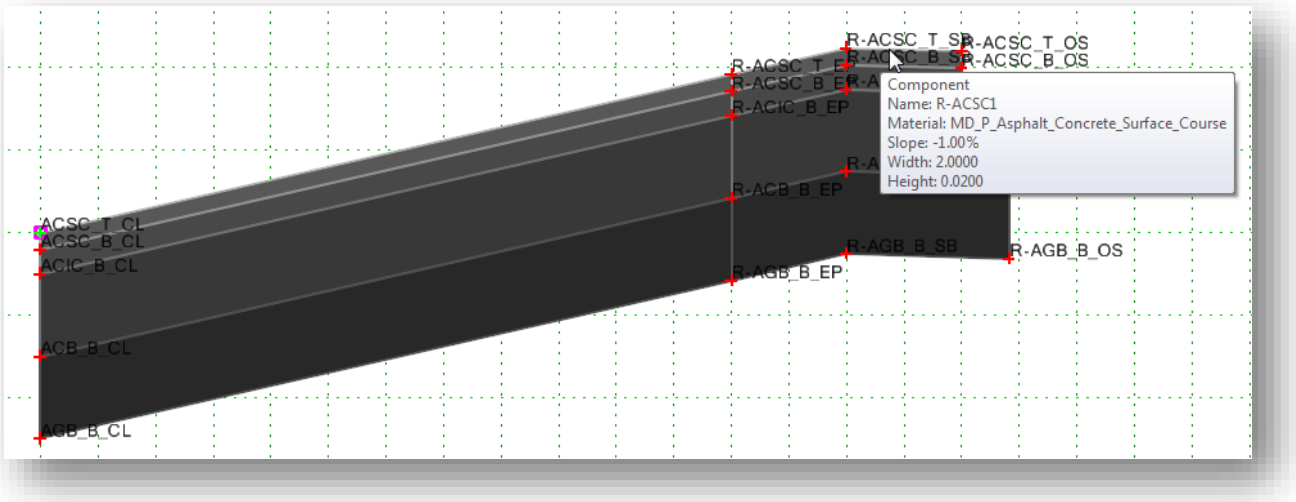
After defining the rollover lock, you can test the behavior of the shoulder by editing the edge of pavement point to set various pavement slopes and examine the results. You can also test the behavior without editing the slope constraint value by right-clicking on the edge of pavement point and choosing **Test Point controls > Test Vertical Point Control**.

Defining the High Side of Superelevation

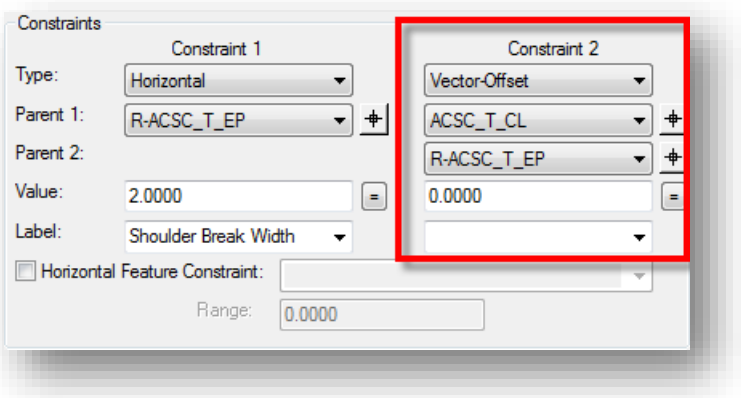
The rollover lock defines the behavior for the high side of superelevation with the **High Side Difference** parameter which we have set to 7% in this example. Figure 301-8E dictates that a shoulder break is introduced when the pavement slope exceeds 6%. In the example below, the **Slope** constraint for point R-ACSC_T_EP has been set to 8% with the **High Side Difference** parameter of 7% applied. Note the shoulder slope.



To correct this, we will insert the shoulder buildup template as shown below.

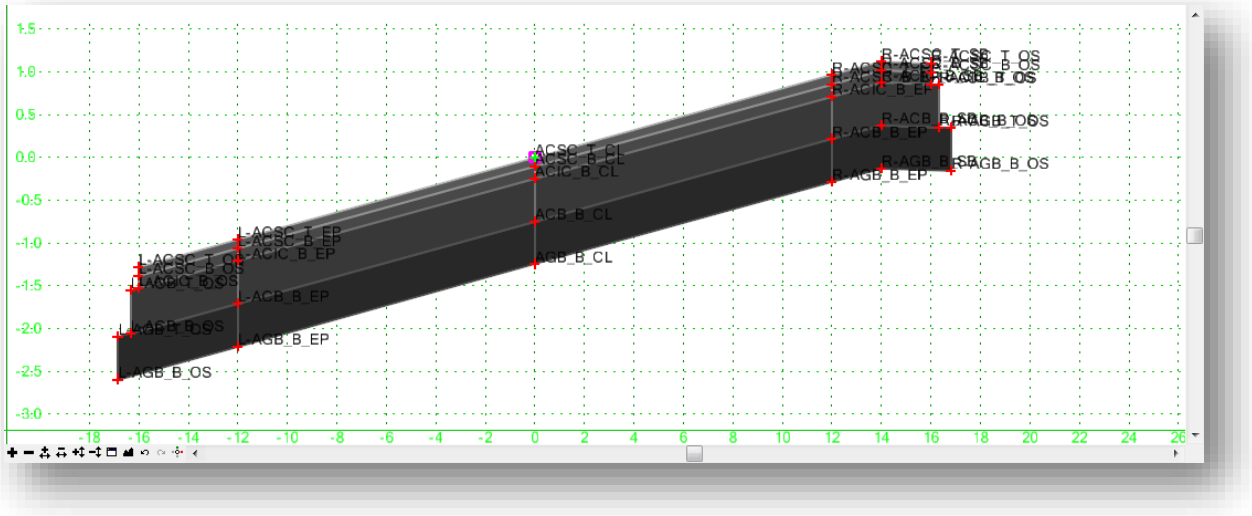


With this template inserted, we can see that the slope for the inside portion of the shoulder matches the pavement slope, and the slope for the outside portion of the shoulder is defined as -1%. This template is correct for a superelevation rate of 6% but the **Slope** constraint for point **R-ACSC_T_SB** must be edited in order to accommodate other pavement slopes greater than 6%. The *Point Properties* dialog for point **R-ACSC_T_SB** is shown on the following page.



The default template is defined with a **Slope** constraint of 6% for the shoulder break point. In order to ensure that the slope for the shoulder break matches the pavement slope, use the **Vector-Offset** constraint instead of the **Slope** constraint. Define the vector using the points from the adjacent pavement lane with an offset value of 0 as shown in the example above.

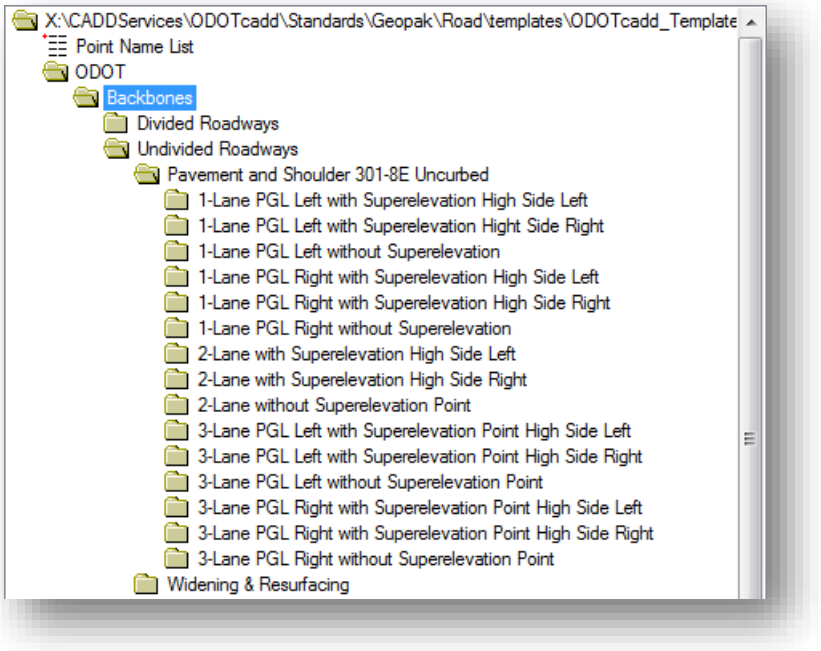
An example of a template defined for a superelevated section is shown below.



Note that templates must be defined uniquely for horizontal curves with the high side on the left or the right.

Using ODOT's Backbones

Templates can also be constructed using one of the predefined pavement and shoulder configurations in the Backbones category of ODOTcadd_Templates.itl.



The pavement and shoulder components defined in the **Backbones** category already have the proper constraints and **Rollover Lock** assigned for superelevated roadways.

Backbones defined with and without a superelevation point in the shoulder are provided. Backbones defined without a superelevation point can be used for normal crown and superelevated sections up to the maximum pavement slope where no shoulder break is required on the high side of superelevation.

Backbones with a superelevation break point in the shoulder are proved for cases where the high side of superelevation is on either the left or right side of the roadway.

Exercise 8A – Defining the Superelevation for the SR 185 Corridor

In this exercise we will define the superelevation sections for the State Route 185 Corridor.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_SUPERELEVATION

- ✓ Open the design file containing the S.R. 185 Corridor Model:
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

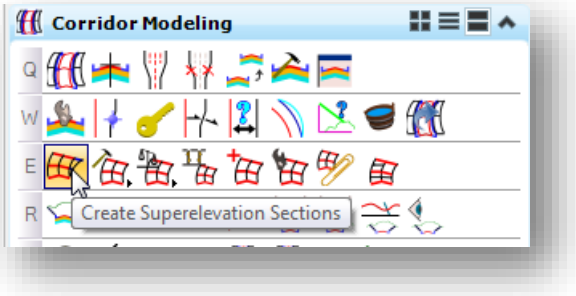
- ✓ Use the **ODOT_Files.mvba** application to create a design file for the S.R. 185 superelevation definition. Be sure to check on the **Federate Basemaps** option.

  With the **Federate Basemaps** option toggled on, two files are created: **12345_KS000.dgn** and **12345_KS001.dgn**.

- ✓ Open the **12345_KS001.dgn** file to define the superelevation for proposed S.R. 185.

- ✓ Set the active MicroStation level to **GK_Shapes**.

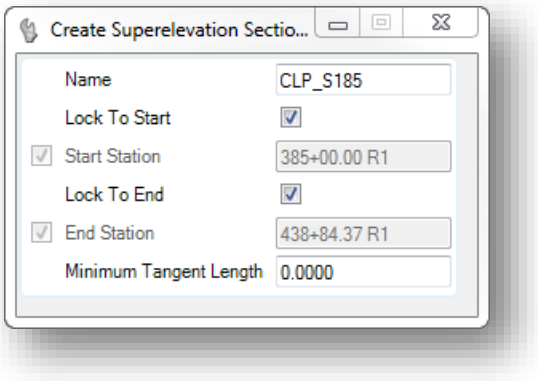
- ✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Superelevation Sections**



- ✓ You are prompted to define the **Name** for the superelevation section. Use the same name as the horizontal alignment, CLP_S185.

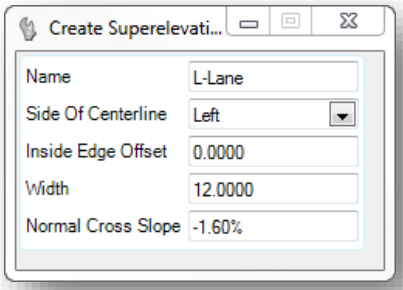
- ✓ Next you are prompted to select the alignment. Select the CLP_S185 alignment

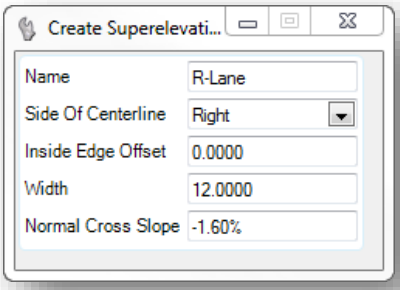
- ✓ Use the entire length of the chain for the start and ending stations by toggling on the **Lock to Start** and **Lock to End** options



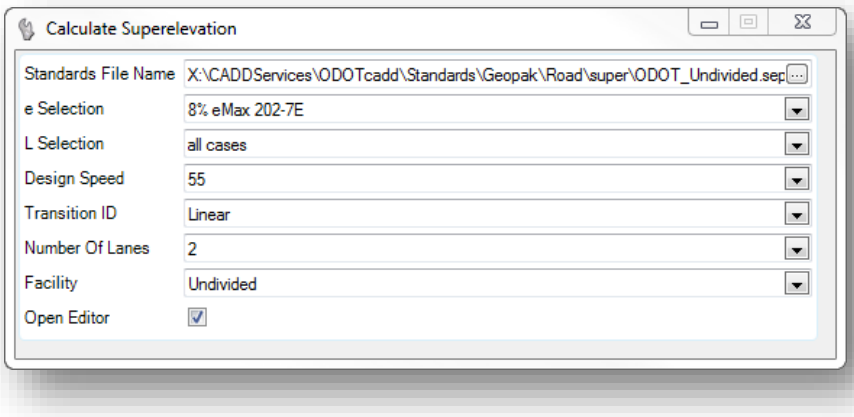
Next, the software will step you through the process to define the pavement lanes.

✓ Define two lanes for the superelevation as shown below

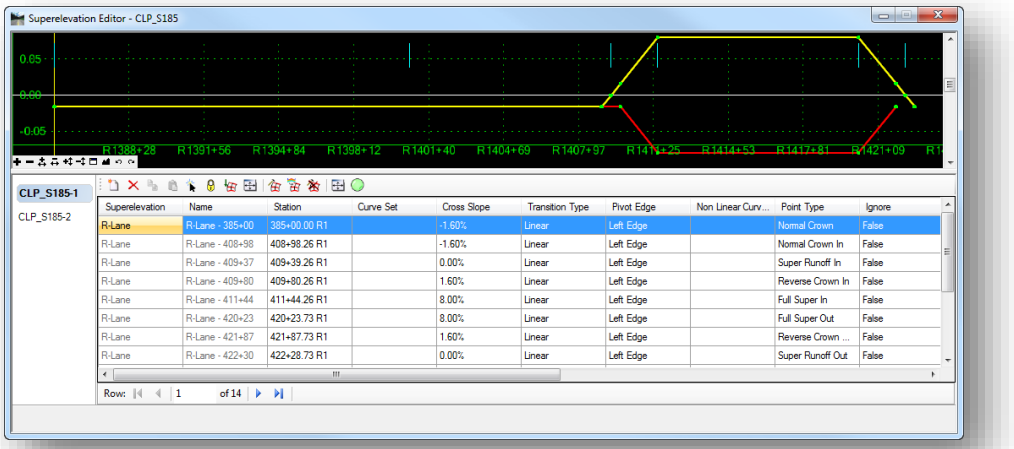




✓ After defining both lanes, right click to terminate the lane creation process. The *Calculate Superelevation* dialog is opened. Choose the **ODOT_Undivided.sep** file by navigating to the following ODOTcadd standards location, …\ODOTcadd\Standards\Geopak\Road\super. The file browser will default the user to this directory via configuration variable. Use the settings shown below.



✓ After accepting the dialog settings, the *Superelevation Editor* dialog is opened.

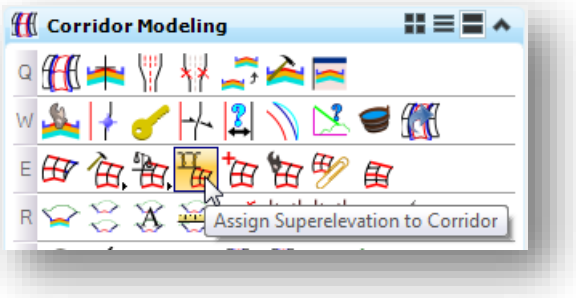


Review the superelevation parameters and close the dialog when completed. The maximum superelevation rate should be 8.0% for this alignment.

The **Assign Superelevation to Corridor** command is used to associate the superelevation settings with the corridor model and the template points. This assignment is made in the corridor design file.

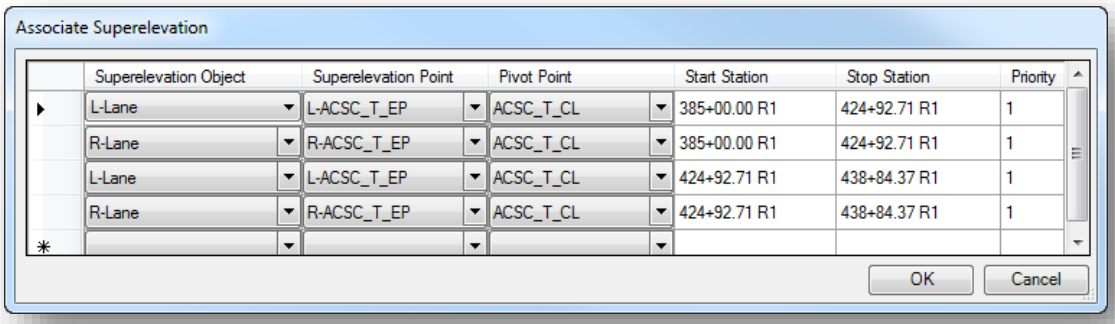
- ✓ Open the **12345_KM002.dgn** file containing the corridor for S.R. 185
- ✓ Attach the superelevation definition design file, **12345_KS000.dgn**, to the corridor design file, **12345_KM002.dgn**, with a **Nest Depth** value of **1**.

- ✓ Select the **Assign Superelevation to Corridor** command to associate the superelevation settings with the corridor model and the template points

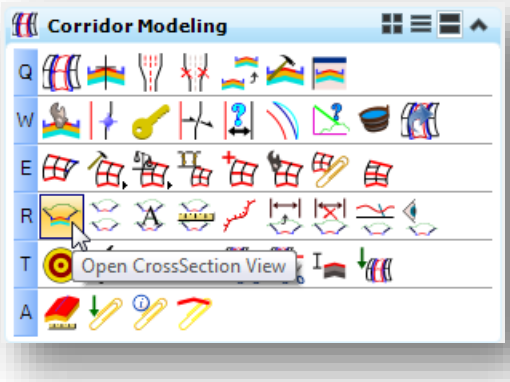


Choose the graphics that were drawn for the boundary of both superelevation sections, and then right-click (reset) to accept the sections

- ✓ When prompted to **Locate Corridor**, select the white corridor graphic for the S.R. 185 corridor boundary.
- ✓ The *Associate Superelevation* dialog is opened. The dialog should default to the correct settings but it is good practice to review the settings before accepting them.



✓ After associating the superelevation sections with the corridor, use the **Open Cross Section View** command to review the corridor.



When prompted, sect the corridor and select a new view window to display the corridor.

After reviewing the corridor cross sections, close the cross section view window.

Exercise 8B – Defining Superelevation Templates

In this exercise we will define and insert a new template for the station range where the superelevation is greater than 6%

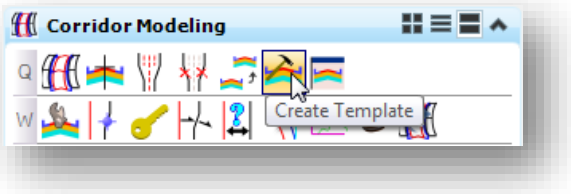
The normal crown template that has already been configured for State Route 185 has a **Rollover Lock** defined for the shoulders. Start by reviewing the template for S.R. 185 to verify the rollover values.

- ✓ Open MicroStation using the shortcut provided for the training class.

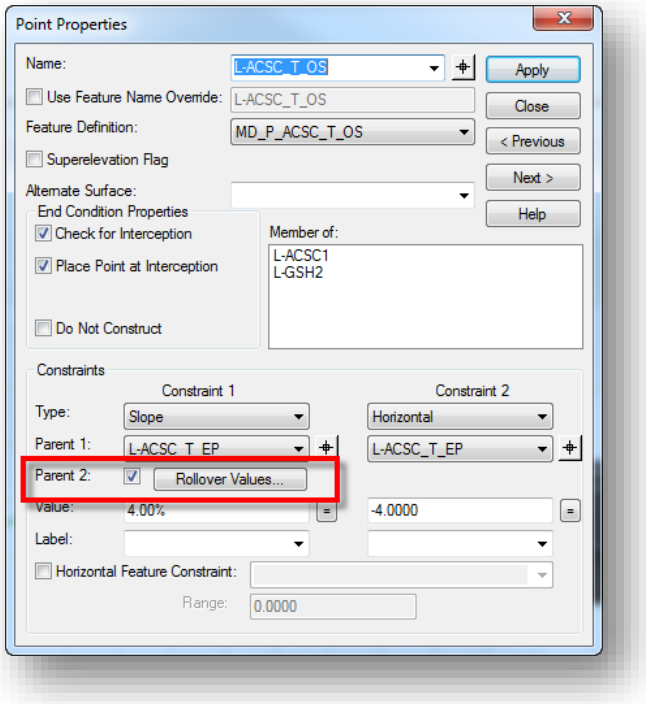
- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_SUPERELEVATION

- ✓ Open the design file containing the S.R. 185 Corridor Model:
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

- ✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Template**



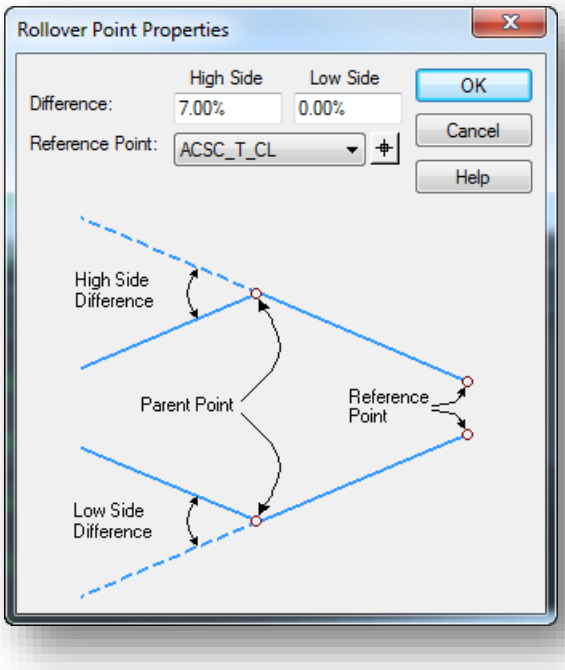
- ✓ Open the previously created template for SR 185 in the **Project Templates > SR 185** folder.



Double-click the left edge of shoulder point **L-ACSC_T_OS** to review the properties.

Select the **Rollover Values** button to access the dialog shown on the following page.

For ODOT projects using Figure 301-8E, the values show below should be entered.

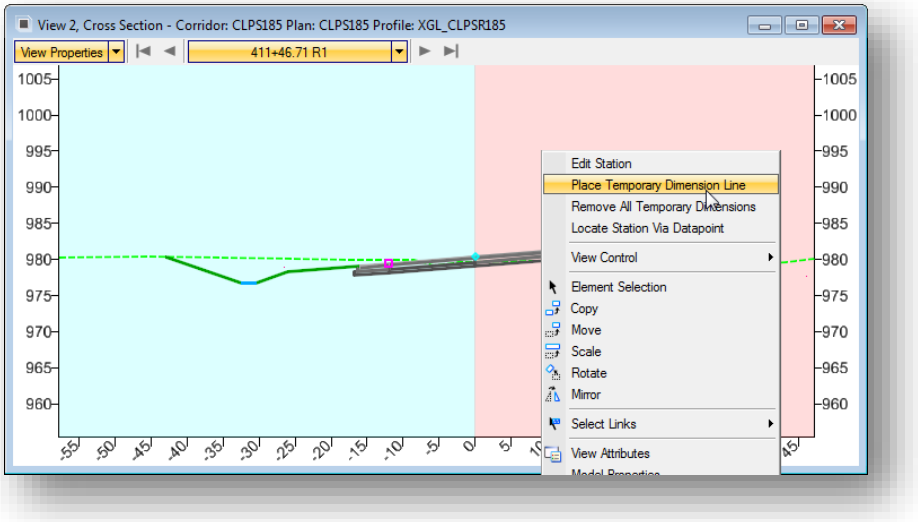


These values should also be entered for point **R-ACSC_T_OS**.

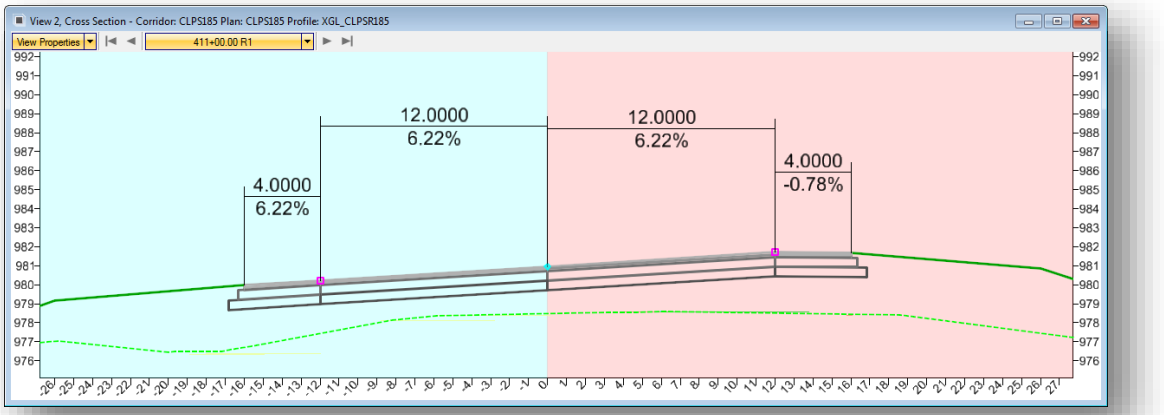
Using these values, the rollover lock will ensure that the shoulder slopes are correctly transitioned for superelevation rates < 6.0%. This can be reviewed and verified in the Cross Section View.

Close the Create Templates dialog after completing the review of the Rollover Lock values.

- ✓ Use the **Open Cross Section View** command to review the corridor.
- ✓ A temporary dimension line can be displayed in the cross section view window to review the width and slope between two selected template points. Hold down the right mouse button until the pop-up menu appears as shown below. Select the **Place Temporary Dimension Line** command.



✓ Define the **Start Point**, **End Point**, and **Dimension Height** for the temporary dimension line. Define dimension lines for the shoulder and pavement lanes as shown below.



The cross section for station 411+00 reveals that the shoulder definition on the low side of superelevation is correctly following the pavement slope, but we need to define the shoulder break on the high side of superelevation since the pavement slope for the road exceeds 6.0%.

For projects using Figure 308-1E where the pavement slope is <= to 6.0%, this template with the rollover lock defined is sufficient. However for projects where the pavement slope exceeds 6.0% a new template will need to be inserted to model the shoulder break on the high side of superelevation.

The next step is to create a new template for station range where the superelevation is greater than 6.0%. This can be accomplished by creating a new template in the template library, and then inserting a new template drop in the corridor.

✓ Choose the **Create Template** command to open the template library for the project

✓ The new template for the superelevation can be created from scratch or by copying the normal crown template for S.R. 185 and replacing the pavement and shoulders with new components. For this example, copy the S.R. 185 template and rename the copy as “S.R. 185 Superelevation”

✓ Double-click the SR 185 Superelevation template to make it the active template. Make the following edits:

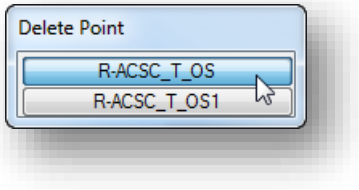
- Delete the pavement and shoulder components for the entire template
- Open the *Dynamic Settings* dialog and toggle off the **Apply Affixes** option
- Drag the following pavement backbone into the template at the 0,0 location

  ODOT > Backbones > Undivided Roadways > Pavement and Shoulder 301-8E Uncurbed > 2-Lane with Superelevation High Side Right > Asphalt Concrete without Stabilization

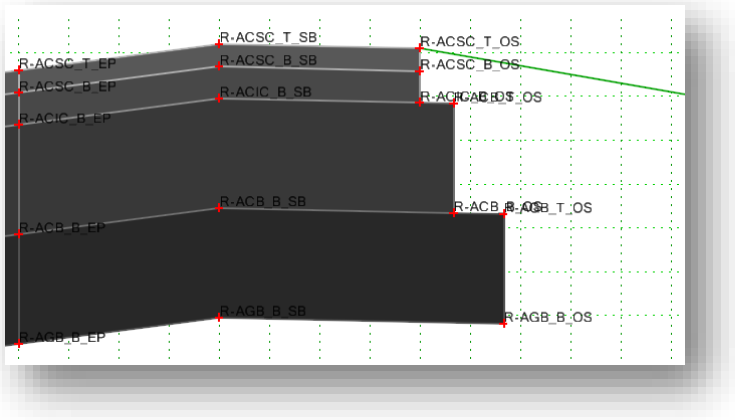
The previously defined points **R-ACSC_T_OS** and **L-ACSC_T_OS** are still in the template since those are the points where the end conditions connect. The point for the new shoulder points are named **R-ACSC_T_OS1** and **L-ACSC_T_OS**.

- Right-click on point **R-ACSC_T_OS** and select the **Move Point** command. Move point **R-ACSC_T_OS** to place it on top of point **R-ACSC_T_OS1**

- Right-click on the moved point and choose the **Merge Points** command. Delete the old point **R-ACSC_T_OS**. We want to keep the new point since it already has the correct constraints assigned for the superelevation break.

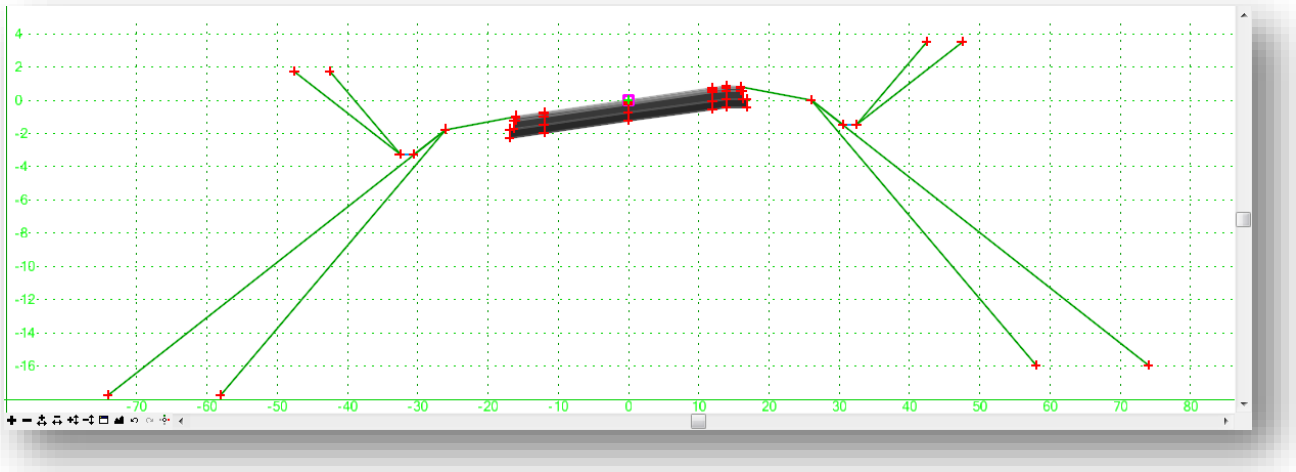


- Double-click point **R-ACSC_T_OS1** and rename it to **R-ACSC_T_OS**. The right side of the shoulder should appear as shown below.



- Repeat the steps above to move the left end condition to the left shoulder point, merge the points, and rename the point.

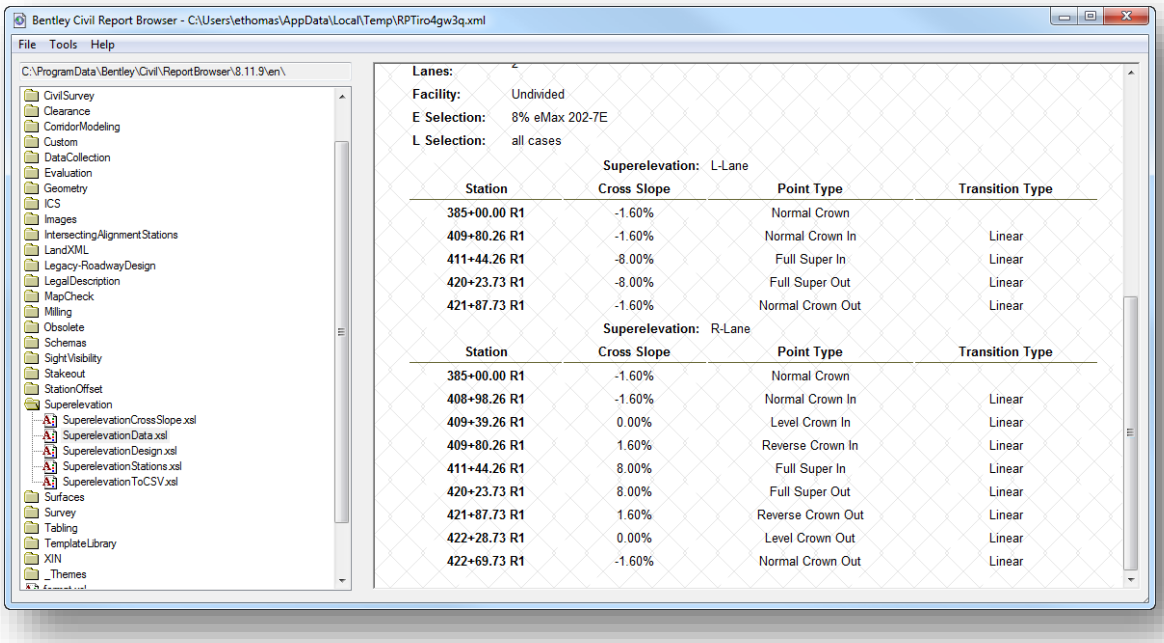
The completed template should appear similar to the example shown on the following page.



Now that we have a new template defined with a shoulder break point for the right (high) side of superelevation, the next step is to compute the station ranges that we will use to apply the template. After the new template drop is defined, we'll compute and apply values for the labels.

First we need to compute the stations on the entrance and exit spirals where the pavement reaches the 6.0% cross slope.

The superelevation report is a good place to get started by reviewing the key points for the superelevation transition. From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Superelevation Report**. After identifying the superelevation section, a report similar to the example below is opened.

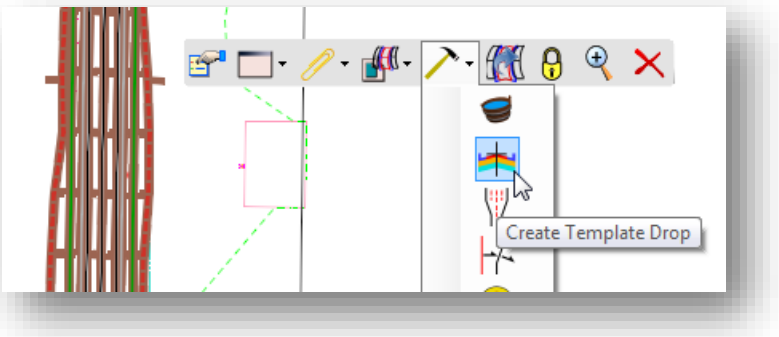


The transition values for the superelevation are shown above. Using the stations and cross slopes, compute the station where the pavement will equal 6.0% for the entrance and exit spiral:

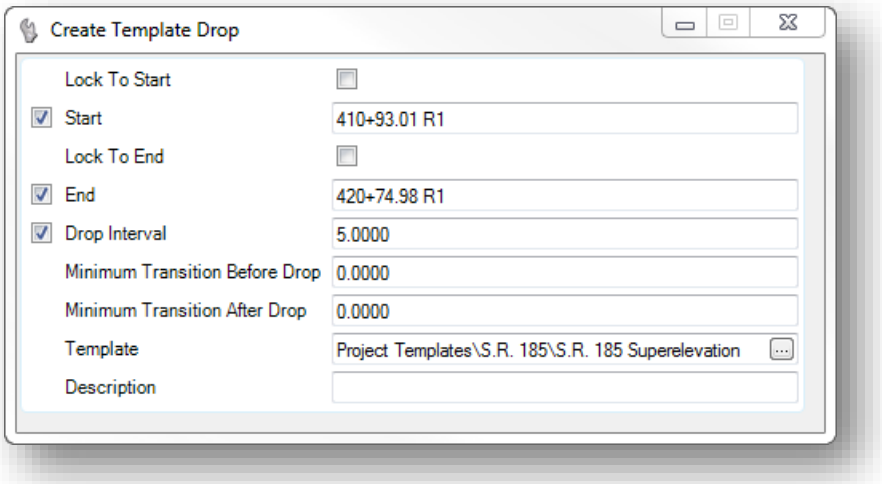
Location	Cross Slope	Station
Entrance Spiral	6.0%	
Exit Spiral	6.0%	

Next we will insert a new template drop using the **SR 185 Superelevation** template with the stations computed above.

✓ Choose the **Create Template Drop** option by selecting the corridor as shown below. The command can also be selected from the *Tasks* menu by selecting **Tasks > Civil Tools > Corridor Modeling > Create Template Drop**.

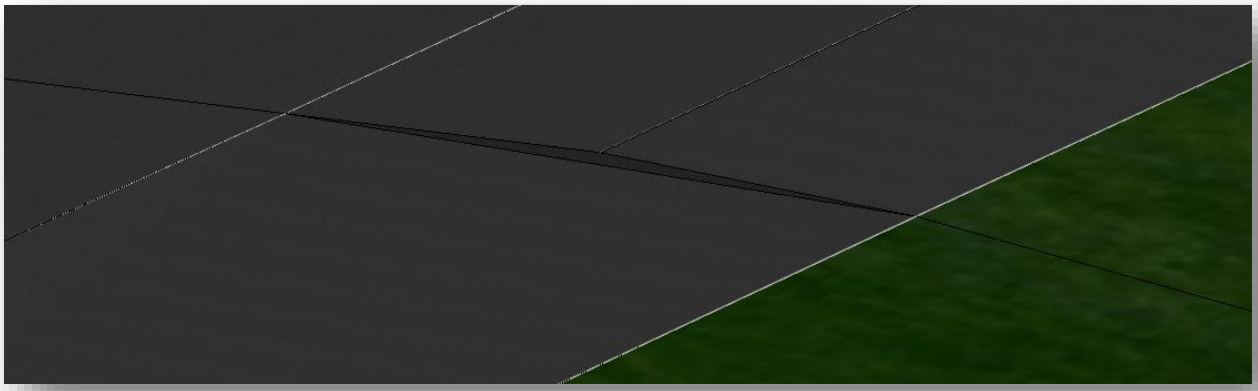


✓ Use the values shown below to create the template drop



The template drop is inserted into the corridor. You can review the model with the **Open Cross Section View** command to verify the results.

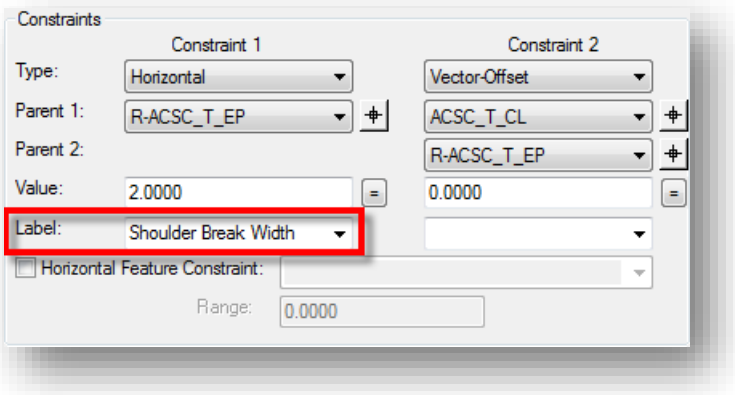
You can also review the 3D model to examine the results. The shoulder break for the entrance spiral is shown below.



As we can see, the model produces an abrupt transition from one template drop to the next. We will use a **Parametric Constraint** to apply a transition for the shoulder break width on both the entrance and exit spirals.

The length of the shoulder break transition is not defined in the **Location and Design Manual**. For the purpose of generating the model, you can choose to ignore this area, or define a short transition length.

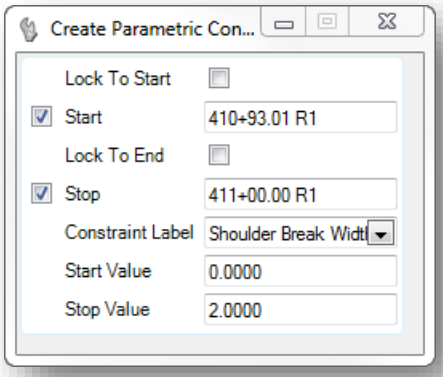
In the template definition, the point **R-ACSC_T_SB** has a **Label** defined that can be used to control the width of the shoulder break as shown below.



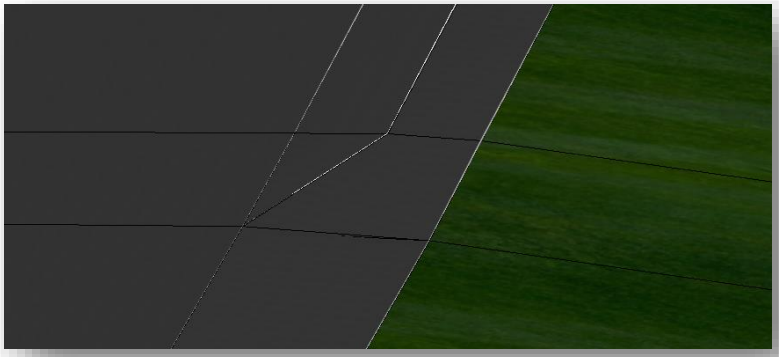
Take the following steps to define values and station ranges for the parametric constraint.

- ✓ Select **Tasks > Civil Tools > Corridor Modeling > Create Parametric Constraint**
- ✓ When prompted, choose the corridor to add the parametric constraint

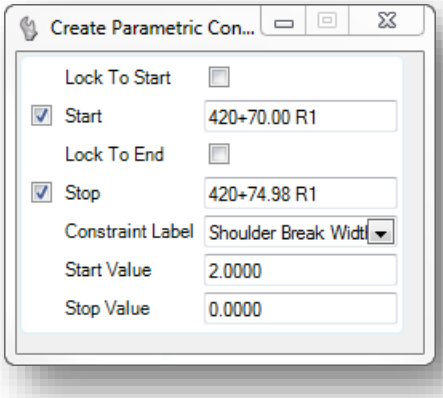
✓ Create the parametric constraint for the entrance spiral using the values shown below



After the parametric constraint is created, the 3D model now includes a short transition for the shoulder break as shown below.



✓ Create a second parametric constraint for the exit spiral using the values shown below.

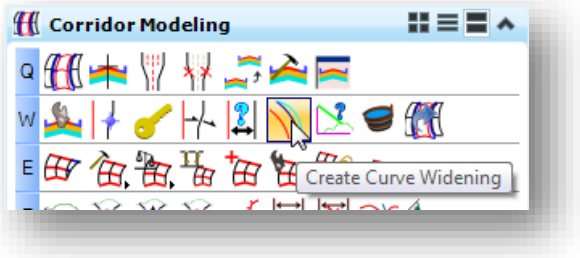


After defining the parametric constraint values, the definition of the superelevation transition for the shoulder on both the low and high sides of superelevation is complete. Review the results by examining the 3D model and by use of the **Open Cross Section View** command.

Exercise 8C: Curve Widening

Curve widening is defined in the **Location and Design Manual, Volume 1 Roadway Design**, **Section 301.1.3 Travelled Way Widening on Highway Curves**.

The OpenRoads tools include a command to compute and apply curve widening as shown below. The curve widening values are read from a table in order to create point controls that are applied to the edge of pavement points in order to accommodate the lane widening.



ODOT does not provide curve widening tables at this time. We will use **Point Controls** to manually assign the station ranges and offsets for curve widening.

For a 55 MPH design with a 6 degree curve, **Figure 301-5cE** defines a curve widening value of 3.0'. The widening is applied to the edge of pavement in the inside of the curve, point L-ACSC_T_EP in this example. The widening is applied through the length of the horizontal curve. Point controls for the lane width transition from 12' to 15' will occur over the length of the entrance and exit spirals.

To define the widening, three point controls must be defined for both transitions and for the curve.

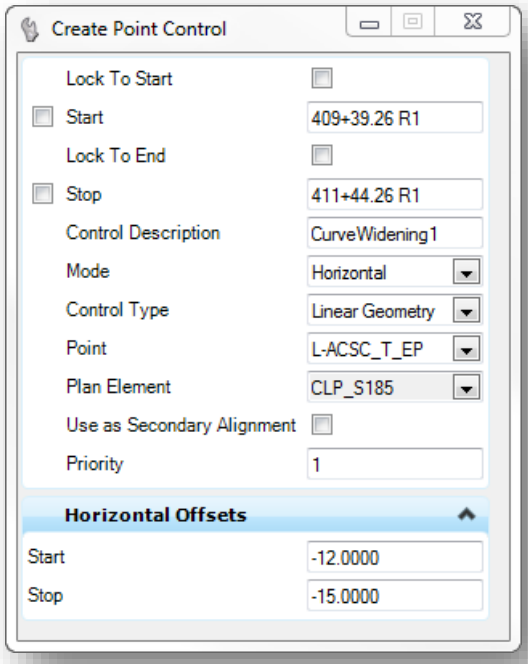
- ✓ From the *Tasks* menu, select **Tasks > Civil Tools > Corridor Modeling > Create Point Control**

- ✓ When prompted, select the corridor for S.R. 185

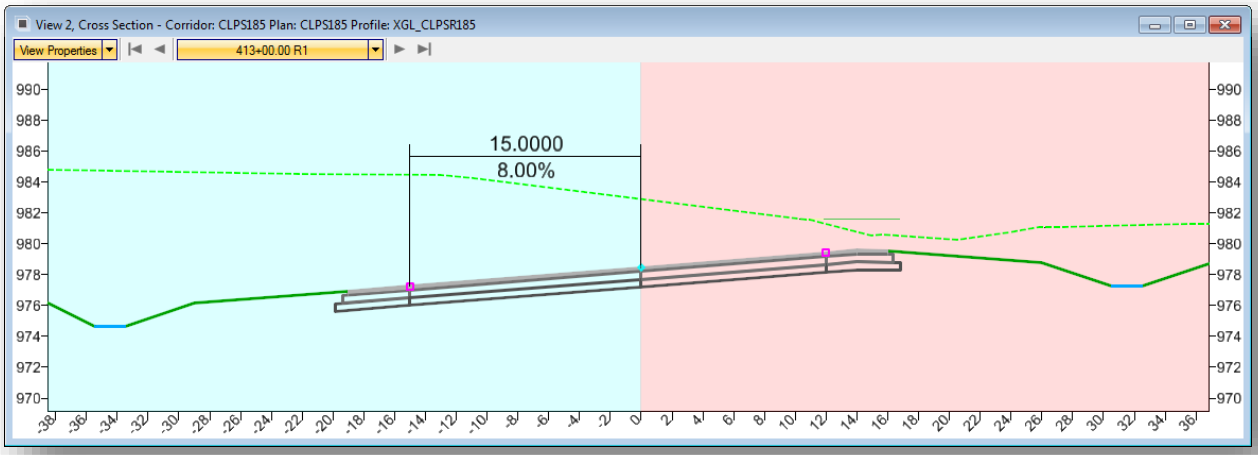
  Create the first point control for the entrance widening taper using the values shown at right.

- ✓ Create the second point control for the length of the curve. Name the point control **CurveWidening2**. Use a **Start** and **Stop Offset** value of -15.

- ✓ Create the third point control for the length of the exit spiral. Name the point control **CurveWidening3**. Use a **Start** value of -15 and a **Stop** value of -12

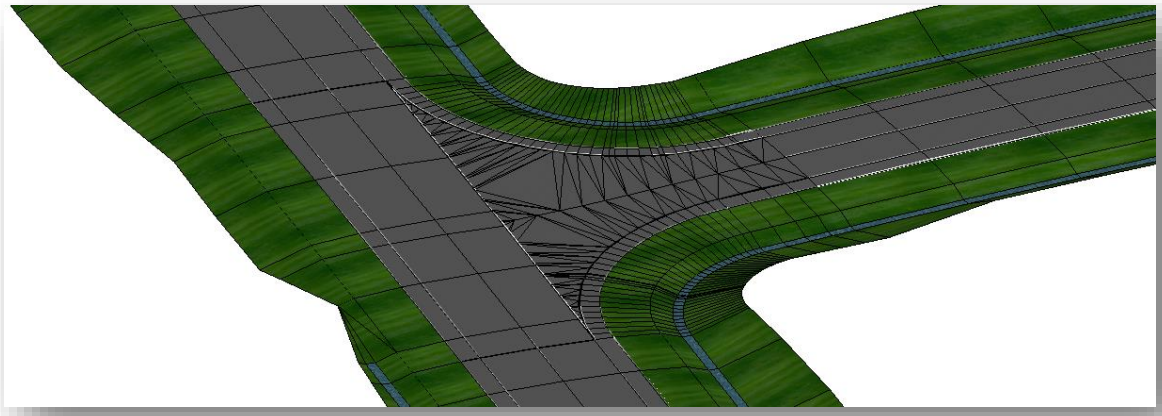


When complete, the **Open Cross Section View** command can be used to review the cross sections. The **Place Temporary Dimension Line** command is used in review the left lane width the example below.



9 Intersection Modeling

In this chapter we will step through the process to model the intersection of S.R. 185 and St. Peter Road using the OpenRoads tools. The completed intersection will appear similar to the example shown below.



Depending on the scope of the project, it may be desirable to place each corridor in a separate design file. For very small projects with a single designer, it is acceptable to put all of the corridors in one design file. For larger projects, it is recommended that you place each corroder in a separate design file and use reference attachments to pull the data together. In this example, each corridor is stored in a separate design file.

Process Overview

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

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

Exercise 9A – Modeling an Intersection

Part 1: Corridor Design Files

The St. Peter Road corridor model will be created in its own design file. The design files for the corridor models were created in Exercise 7B. Take the following steps to prepare the 12345_KM003.dgn file for the corridor modeling process.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_INTERSECTION

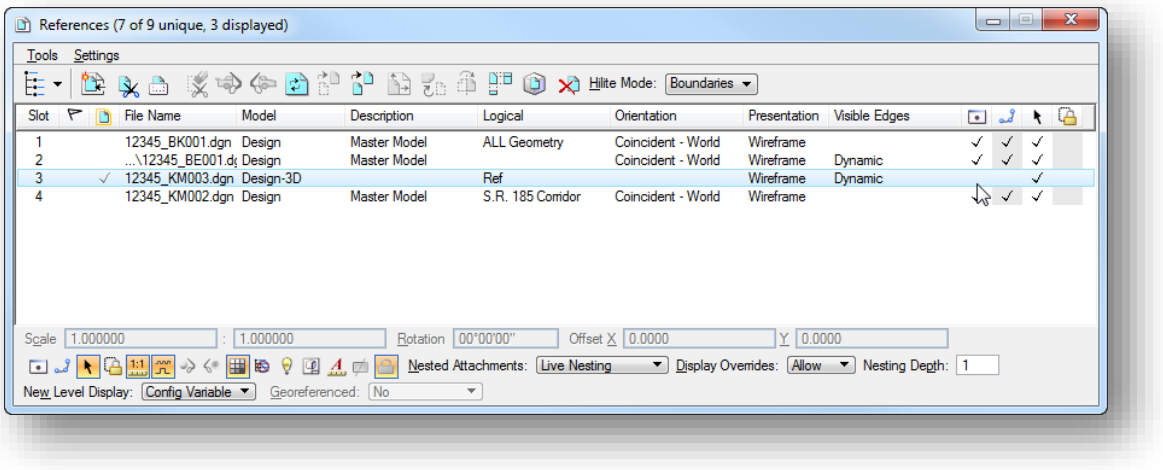
- ✓ Open the following design file for the St. Peter Road corridor model:
  ..\Design\Geometry\Basemaps\12345_KM002.dgn

  The alignment, profile, and corridor for St. Peter Road as well as S.R. 185 were competed in previous exercises. In order to model the intersection, we'll need to attach the S.R. 185 corridor.

- ✓ Attach the corridor model for S.R. 185 with a **Live Nesting** value of 0
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

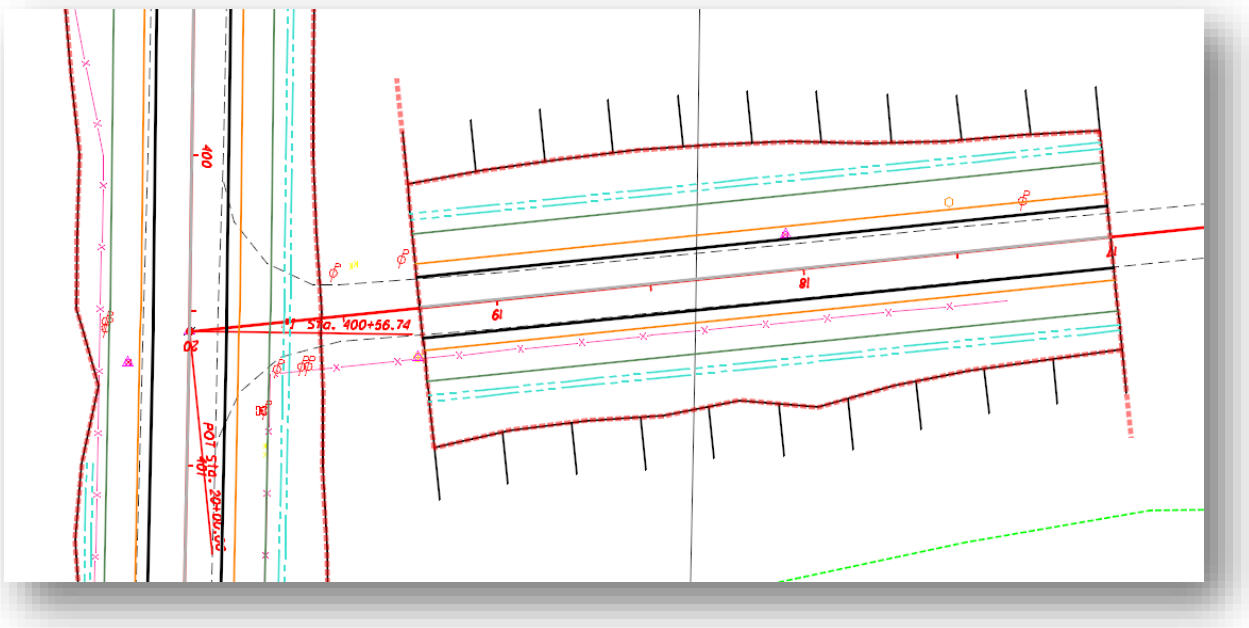
- ✓ Zoom in on the intersection of S.R. 185 and St. Peter Road. Turn off any unnecessary levels in the survey basemap.

- ✓ Open the *References* dialog and turn off the display of the 3D model for St. Peter Road.



- ✓ Choose **File > Save Settings** from the MicroStation menu.

We are now ready to begin the modeling process for the St. Peter Road intersection. The corridors should appear similar to the example shown on the following page.



When a federated approach is used to create separate design files for each corridor model (see Using Multiple “Federated” Basemaps) users should add the corridor design file as a reference to the “KM_000” design file.

- ✓ Open the file 12345_KM000.dgn
- ✓ Attach the design file containing the St. Peter Road corridor as a reference to the 000 file
- ✓ Save settings and close the 000 file when complete

Part 2: St. Peter Road Intersection and Pavement Surface Terrain Model

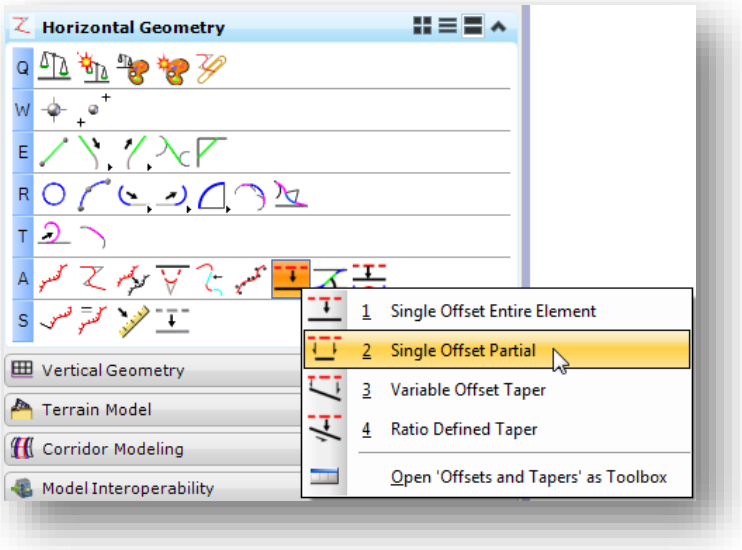
The corridor for St. Peter Road ends at station 19+25. To define a terrain model representing the pavement surface for the intersection, we will need to start by placing the edge of pavement lines and radius returns for the intersection.

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

✓ In the *Features Definition Toggle Bar*, set the active feature definition to **Pavement > PV_P_Edge_of_Pavement**

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

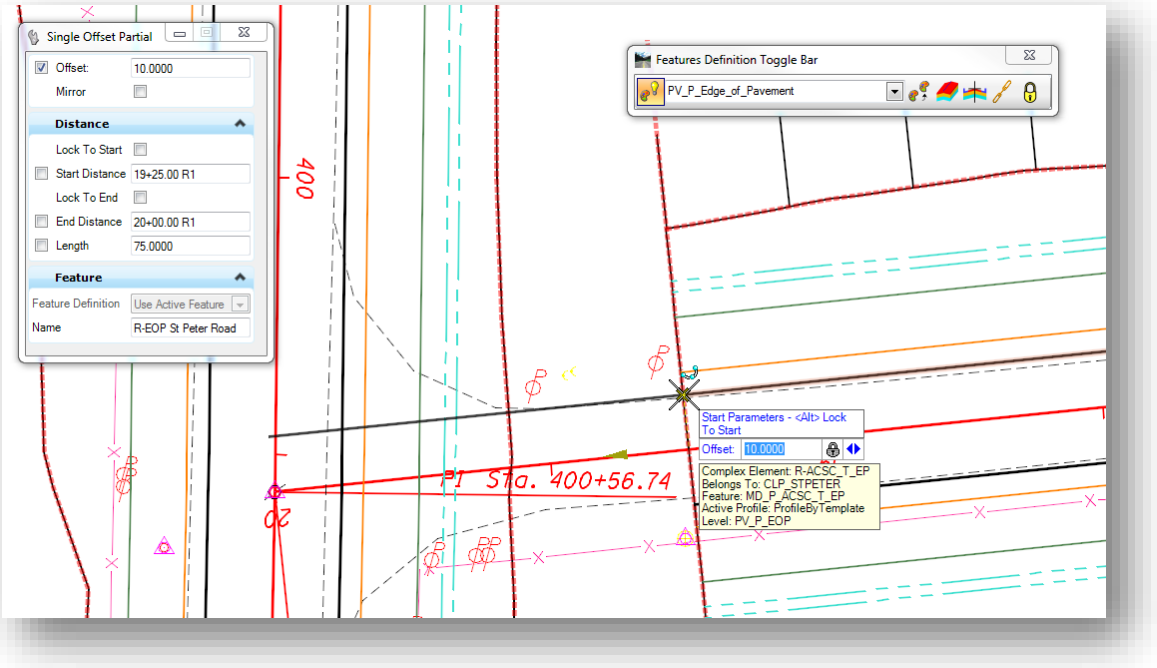
✓ From the *Tasks* menu, choose the **Single Offset Partial** command as shown below.



This command is used to place a civil geometry element at an offset from the selected alignment. When prompted to **Locate Element**, choose the St. Peter Road alignment.

- ✓ Enter a **Name** for the element a shown below, **R-EOP St Peter Road**.

- ✓ Using an **Offset** of 10', define the starting point of the offset element by snapping to the edge of pavement line at the end of the corridor as shown below.



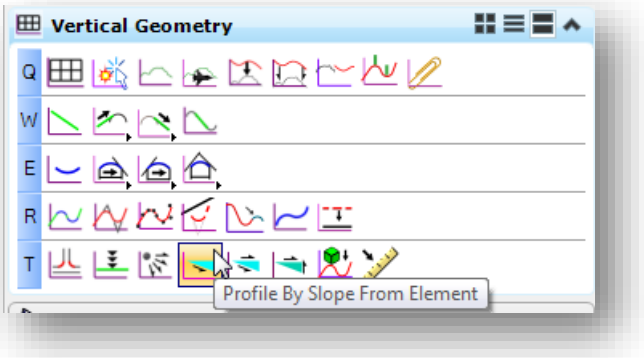
- ✓ Enter the **End Distance** by issuing a data point at the end of the corridor.

- ✓ When prompted to **Mirror** the solution, choose **Yes**.

- ✓ The mirrored line is named R-EOP St Peter Road1. Change the name to **L-EOP St Peter Road** by selecting the line element and choosing the **Properties** command from the pop-up menu.

Next, assign a profile to the newly created edge of pavement elements.

✓ From the *Tasks* menu, choose the **Profile By Slope From Element** command as shown below.



✓ When prompted to **Locate First Element to Profile**, choose one of the new edge of pavement elements. Continue by choosing the other element when prompted to **Locate Next Element to Profile**. After choosing both elements, right click (reset) to end the selection process.

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

✓ Enter a **Slope** value of -1.6%

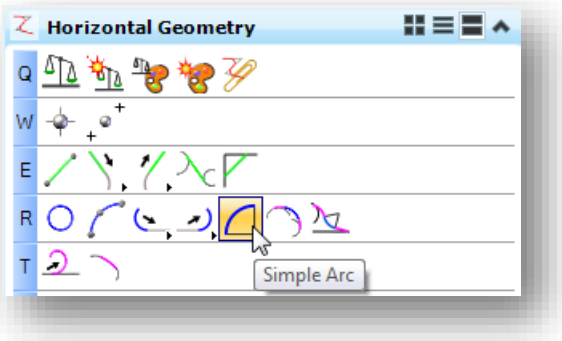
✓ Choose the **Point Selection** mode **All**

✓ Use a **Profile Adjustment** of **None**

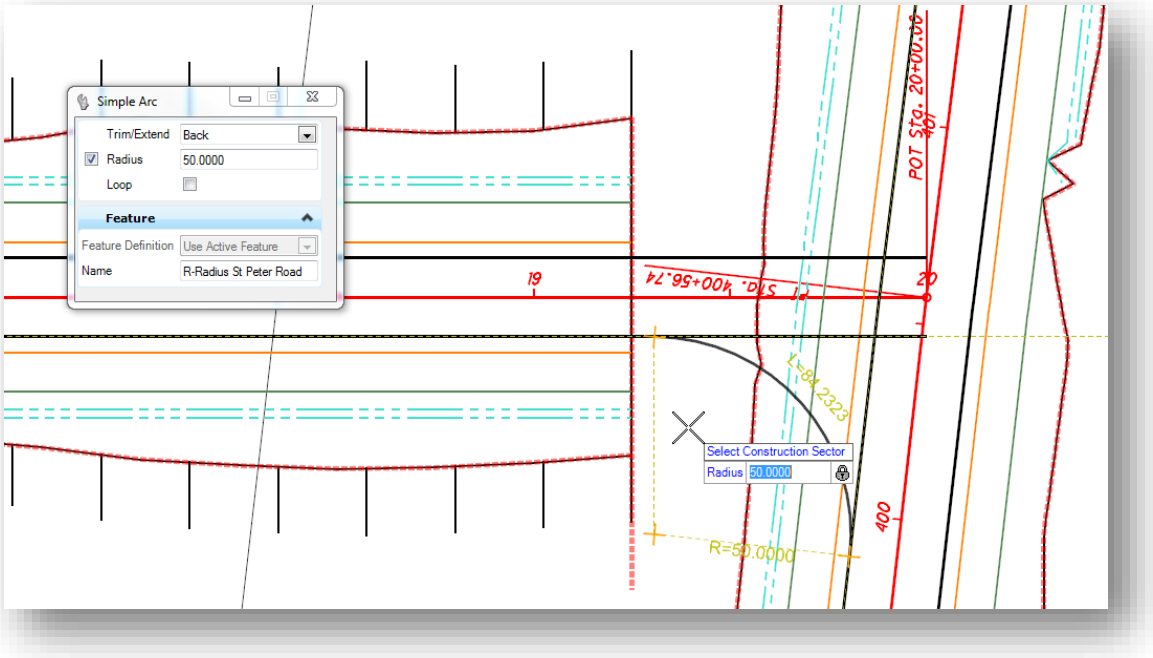
✓ Enter a **Vertical Offset** of **0**

Next, create the radius returns for the intersection.

✓ From the *Tasks* menu, select the **Tasks > Civil Tools > Horizontal Geometry > Simple Arc** command.

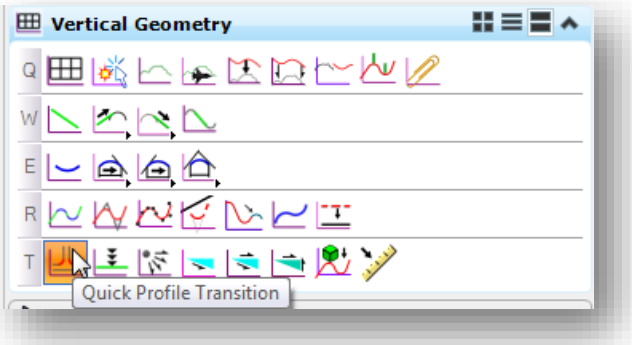


✓ Create the first arc on the right side of St. Peter Road using a 50’ radius. Be sure to enter a **Name** of **R-Radius St Peter Road** for the radius return element. Choose the **R-EOP St Peter Road** line as the first element. When prompted to **Trim/Extend**, choose the **Back** option.



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

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

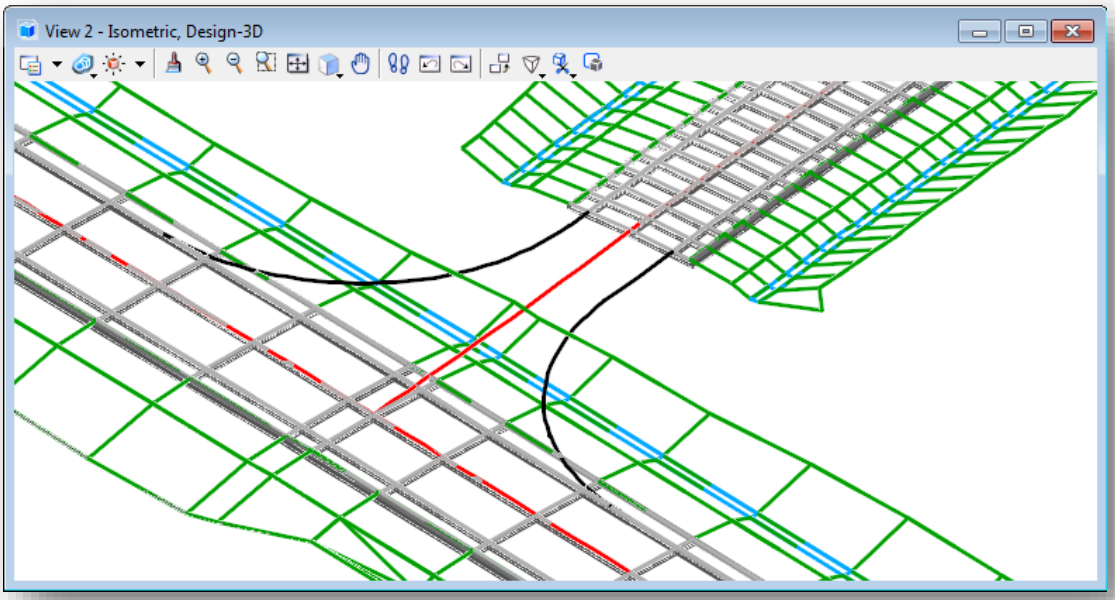


✓ After selecting the command, you are prompted to choose the **Quick Transition Method**. Select the **Parabolic** option.

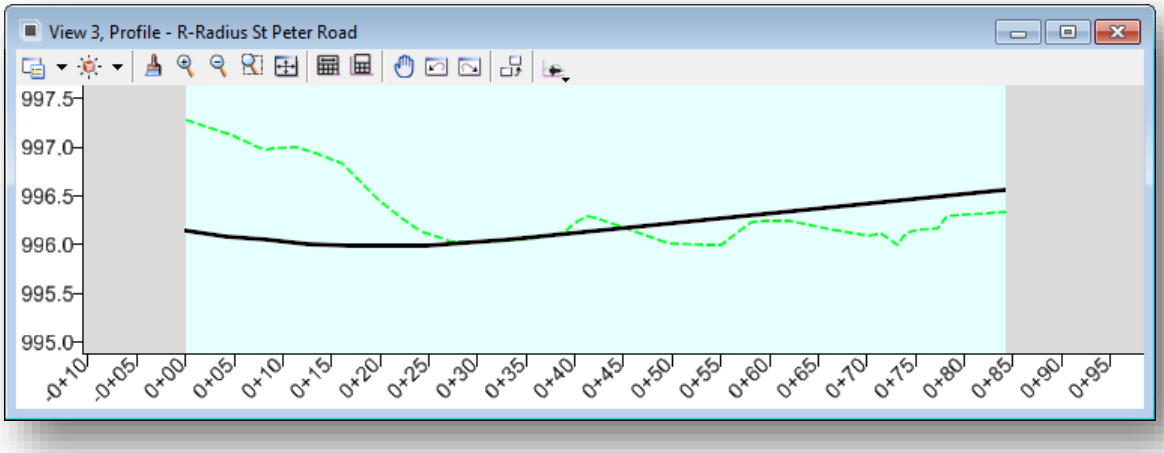
✓ When prompted to **Locate What to Define**, select one of the radius return elements. A quick profile is created for the element.

✓ Repeat the procedure for the second radius return

After the profiles are assigned, the edge of pavement and radius return lines should appear in the 3D model similar to the example shown below.



The profile for each radius return can be reviewed and edited by selecting one of the radius returns and selecting the **Open Profile Model** command. The profile for **R-Radius St Peter Road** is shown below.

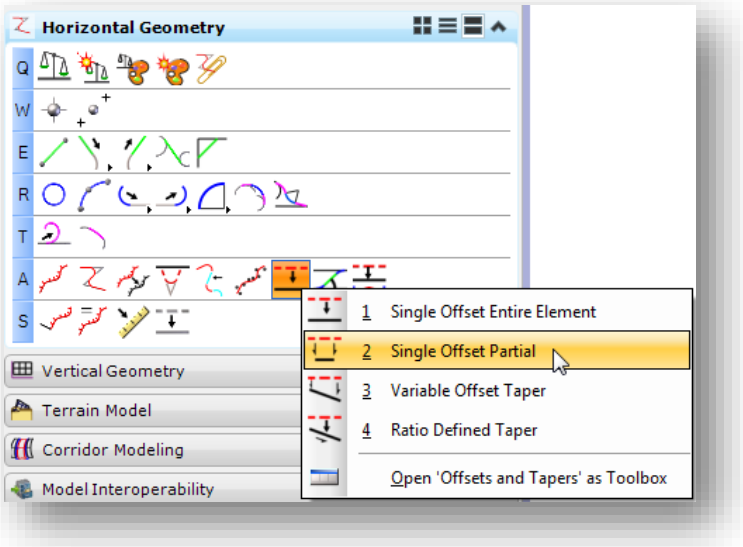


In addition to the two radius returns, we will need a line that follows the edge of pavement for S.R. 185 that extends from the ends of the radius returns. This is necessary to define the boundary of the intersection area that will be used to make the surface terrain model. We cannot use the edge of pavement line from the CLP_S185 corridor model as the line must be constrained to the limits of the radius returns.

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

✓ In the *Features Definition Toggle Bar*, set the active feature definition to **Modeling > 3D Linear Features > Misc > MD_P_DNC**. The initials "DNC" stand for Do Not Construct. This feature definition can be used for linear elements used in the modeling process whose graphics will not be used for part of the plan production process. Graphics drawn with this feature are placed as construction elements on the level MD_P_DNC.

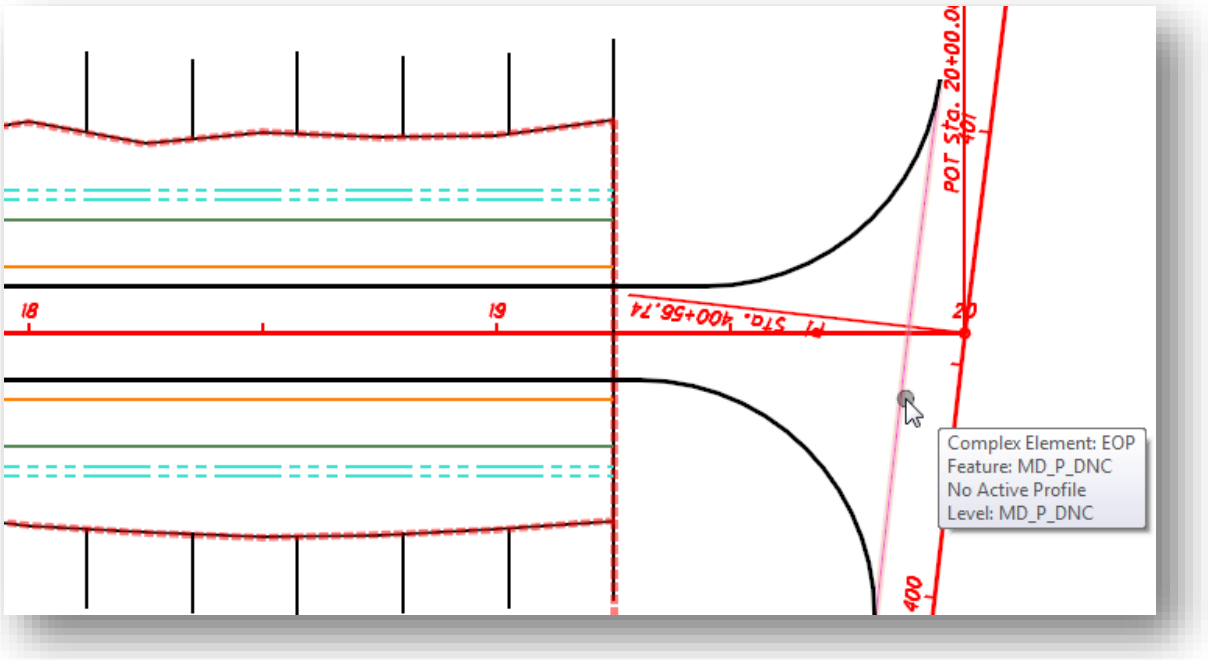
✓ From the *Tasks* menu, choose the **Tasks > Civil Tools > Horizontal Geometry > Single Offset Partial** command.



✓ Create an offset line 12' to the left of the CLP_S185 alignment from the ends of the radius returns.

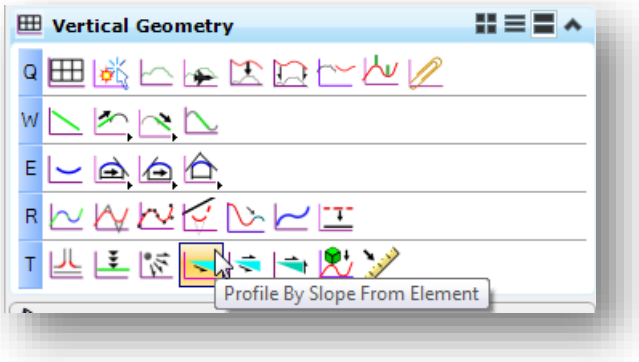
✓ Because this new line is drawn on top of the edge of pavement line for S.R. 185, it is easier to temporarily turn off the reference file display of the S.R. 185 corridor model to ensure the line was drawn correctly. Open the *References* dialog and turn off the display of the 12345_KM002.dgn file.

✓ The completed graphic should appear similar to the example on the following page.



Next, assign a profile to this new edge of pavement line.

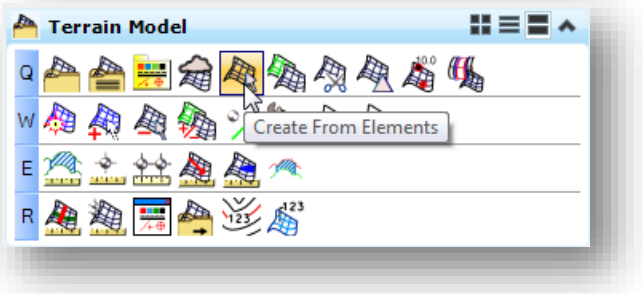
✓ From the *Tasks* menu, choose the **Civil Tools > Vertical Geometry > Profile By Slope From Element** command.



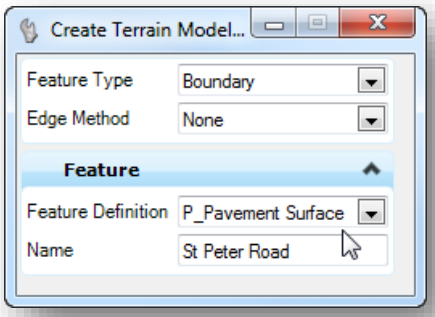
✓ Define the profile with a -1.6% slope from the centerline of S.R. 185

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

✓ From the *Tasks* menu, choose the **Create From Elements** command as shown below.



✓ Set the **Feature Definition** to **P_Pavement Surface** in the *Create Terrain Model From Elements* dialog as shown at right. **Note:** Since this is a terrain feature it cannot be selected from the *Feature Definition* tool bar.



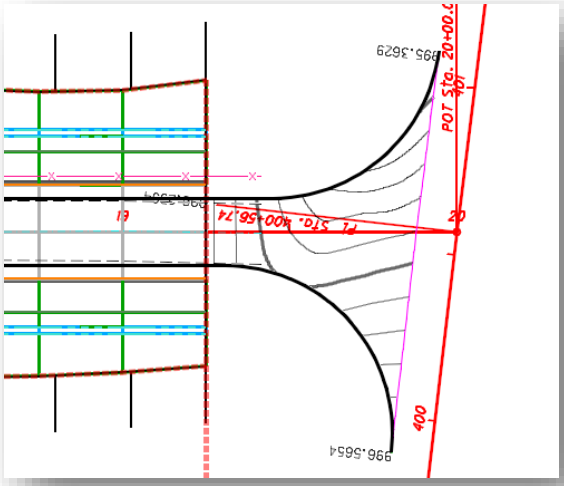
✓ Set the feature **Name** to **St Peter Road**

✓ Choose the two edge of pavement and radius returns for St. Peter Road as well as the partial offset line for S.R. 185. Reset when the elements are selected.

✓ Set the **Feature Type** to **Boundary**

✓ Set the **Edge Method** to **None**

The surface is created and contour lines are drawn as shown at right.



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

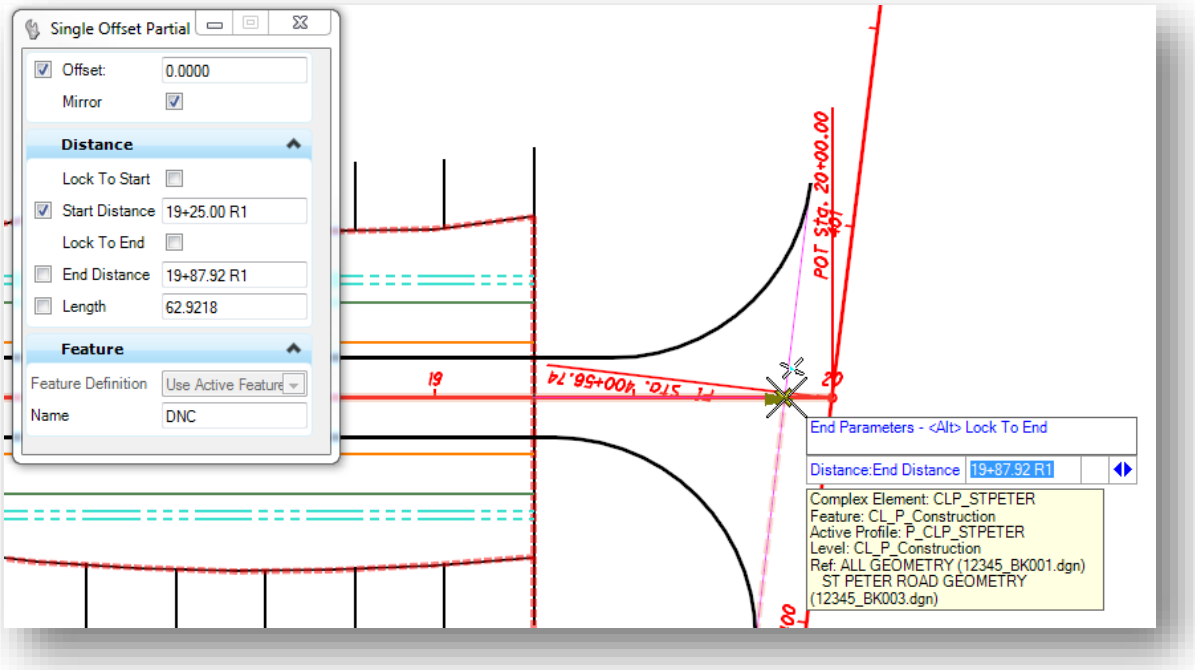
✓ In the *Features Definition Toggle Bar*, set the active feature definition to **Modeling > 3D Linear Features > Misc > MD_P_DNC**.

✓ From the *Tasks* menu, choose the **Tasks > Civil Tools > Horizontal Geometry > Single Offset Partial** command.

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

✓ Start the line at the end of the St. Peter Road corridor, **Station** 19+25 with an **Offset** value of 0.

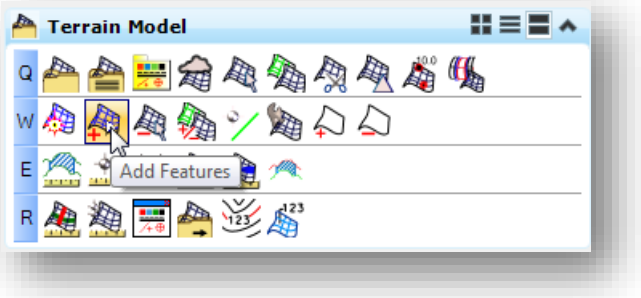
✓ Use the MicroStation **Intersection Snap** to end the line at the intersection of St. Peter Road with the S.R. 185 Edge of Pavement.



✓ After placing the line, we will assign a profile to the line using the **Profile By Slope From Element** command. The **Reference Element** is the centerline of St. Peter Road. Since the new element overlaps the centerline of St. Peter Road, use a **Slope** value of **0.0%.**

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

✓ From the *Tasks* menu, select the **Terrain Model Add Features** command as shown below.

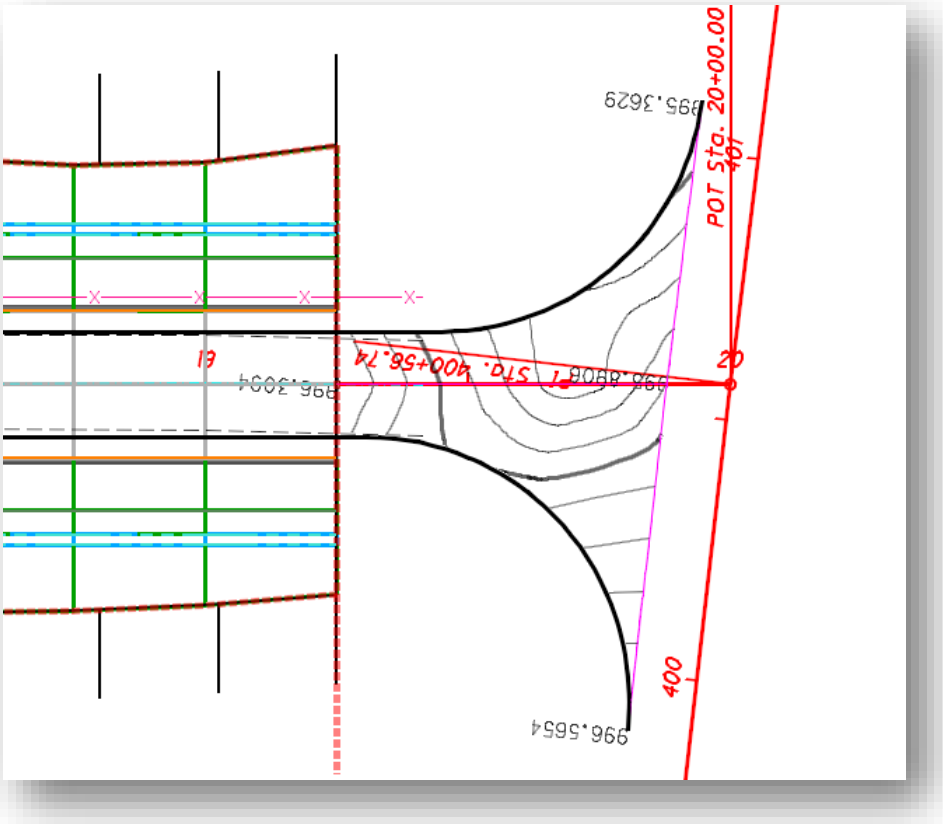


✓ Set the **Feature Type** to **Break Line**

✓ Select the **St Peter Road** terrain model when prompted to **Locate Terrain Model to Add Elements**

✓ Select the partial offset of the centerline of St Peter Road when prompted to **Locate Element to Add**.

After the break line element is added, the St Peter Road terrain model should appear similar to the example below.



Part 3: St. Peter Road Intersection Templates

Two templates are necessary in order to define the pavement, shoulders, and side slopes for the St. Peter Road intersection area.

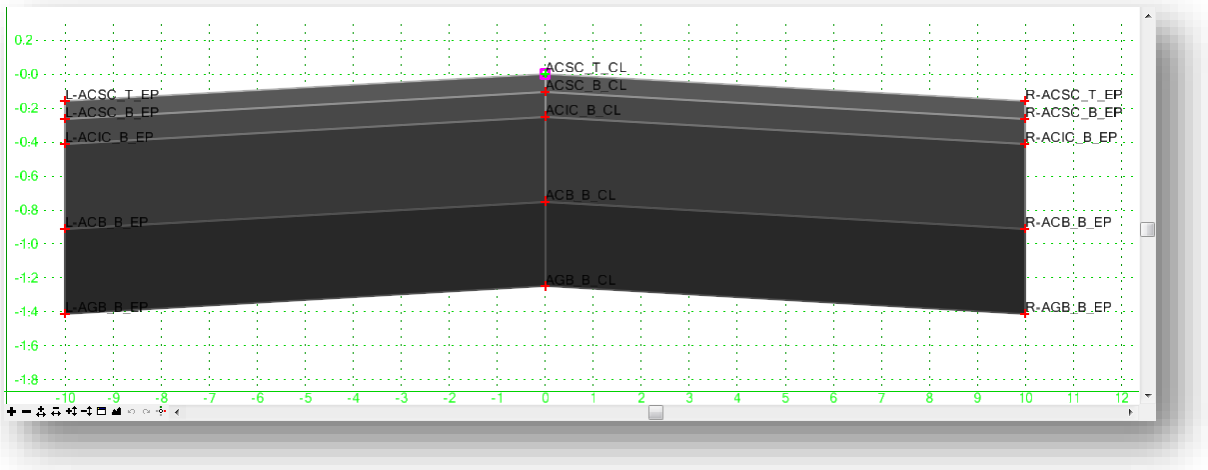
- One template will be used to define the pavement buildup without the shoulder or end condition components. This template will be applied to a surface terrain model to define the intersection pavement surface and pavement buildup.

- A second template will be used to define the shoulder and side slopes. This template will be applied to the radius return and edge of pavement graphics for St. Peter Road.

Take the following steps to create the pavement template:

- ✓ Open the Template library by choosing the **Create Template** command.
- ✓ Copy the **St. Peter Road** Template.
- ✓ Rename the copied template to **St. Peter Road Pavement**
- ✓ Double-click the **St. Peter Road Pavement** template to make it active
- ✓ Right-click in the **Current Template** window and choose the **Delete Component** command. Delete the shoulders and the side slopes on both sides of the template.

The completed St. Peter Road Pavement template contains only the pavement as shown below.

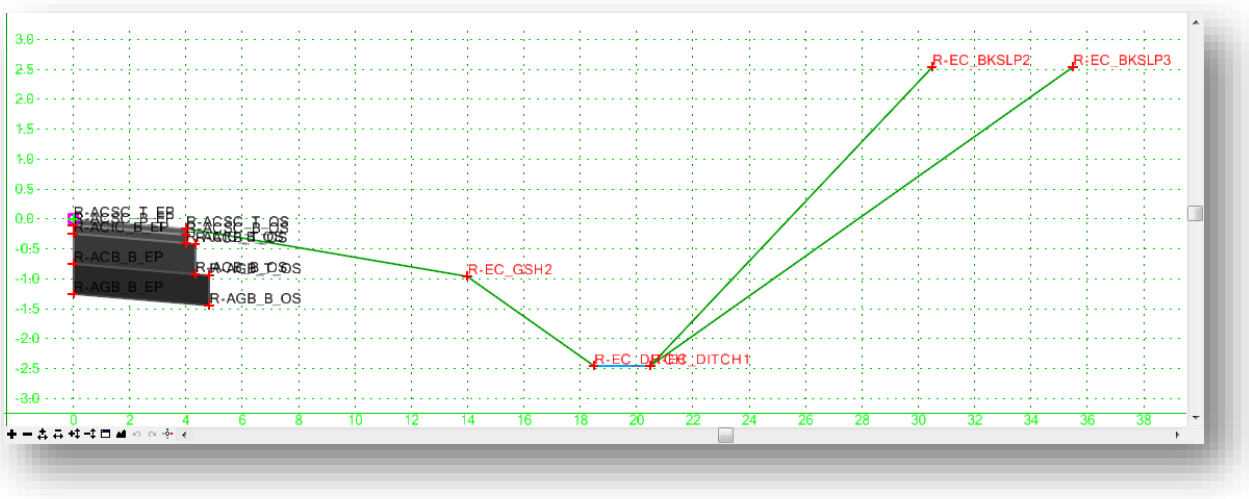


Note: The actual slopes of the components as defined in the template is irrelevant. The template will be applied to the slope of the surface terrain.

Take the following steps to create the radius return template:

- ✓ Copy the **St. Peter Road** Template
- ✓ Rename the copied template to **St. Peter Road Shoulder**
- ✓ Double-click the **St. Peter Road Shoulder** template to make it active
- ✓ Right-click in the **Current Template** window and choose the **Delete Component** command. Delete the Pavement, the left shoulder, and end conditions on the left side. Leave the right shoulder and the right end conditions in place.
- ✓ Open the *Dynamic Settings* dialog to ensure the **Step** values are defined.
- ✓ Right-click on point **R-ACSC_T_EP** and choose the **Move Point** command. Move the point to the (0,0) position.
- ✓ Double-click point **R-ACSC_T_OS** to access the *Point Properties* dialog. Add a **Slope** constraint to the point with a -4.00% slope from point **R-ACSC_T_EP**.

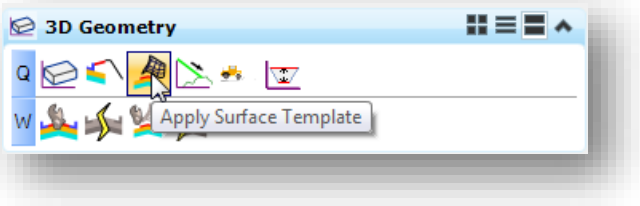
The completed template for the radius returns should appear as shown below



- ✓ Save and close the Template library.

Next we will assign the pavement template to the **St Peter Road** terrain model.

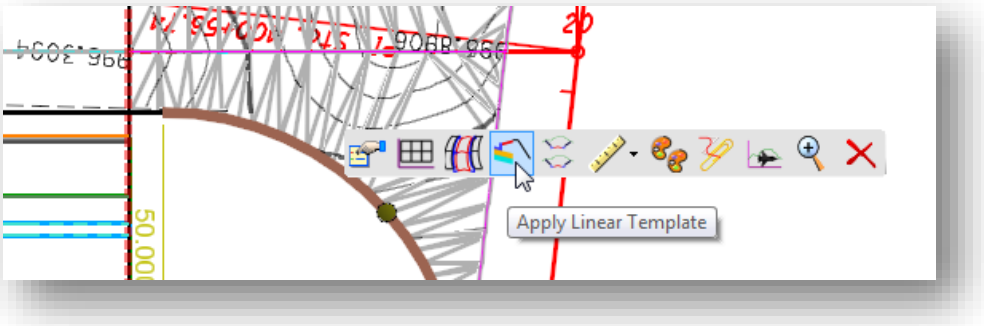
- ✓ From the *Tasks* menu, select the **Tasks > Civil Tools > 3D Geometry > Apply Surface Template** command as show below



- ✓ When prompted, select the **St Peter Road** terrain model
- ✓ Select **No** for the **Apply Clipping Boundary** option
- ✓ Choose the **St. Peter Road Pavement** template.
- ✓ Data point to accept the selection. The template is applied to the terrain model.

Take the following steps to apply the St. Peter Road Shoulder template to the edge of pavement tangent lines and the radius return elements:

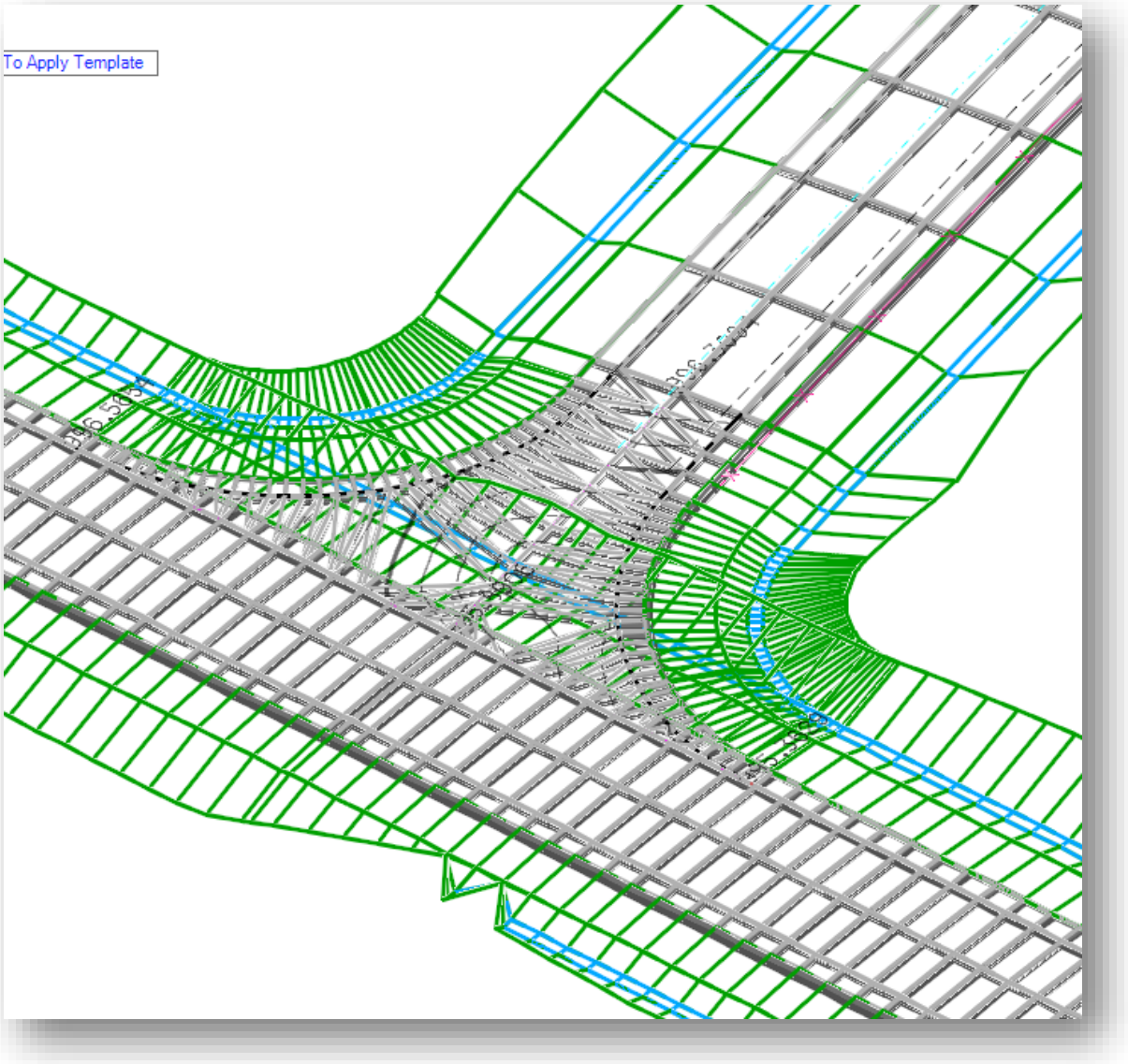
- ✓ Select the right radius return graphic and choose the **Apply Linear Template** command from the pop-up menu



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

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

When complete, the intersection should appear similar to the example below.



The next step is to remove the left shoulder and the end conditions for S.R. 185 through the intersection area.

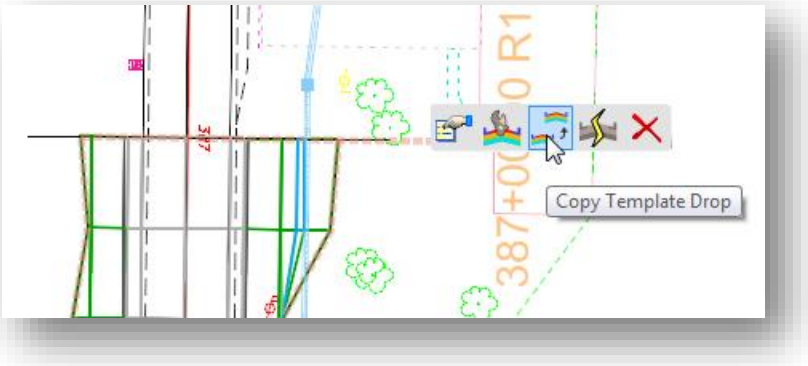
Part 4: Adjusting the S.R. 185 Corridor in the Intersection

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

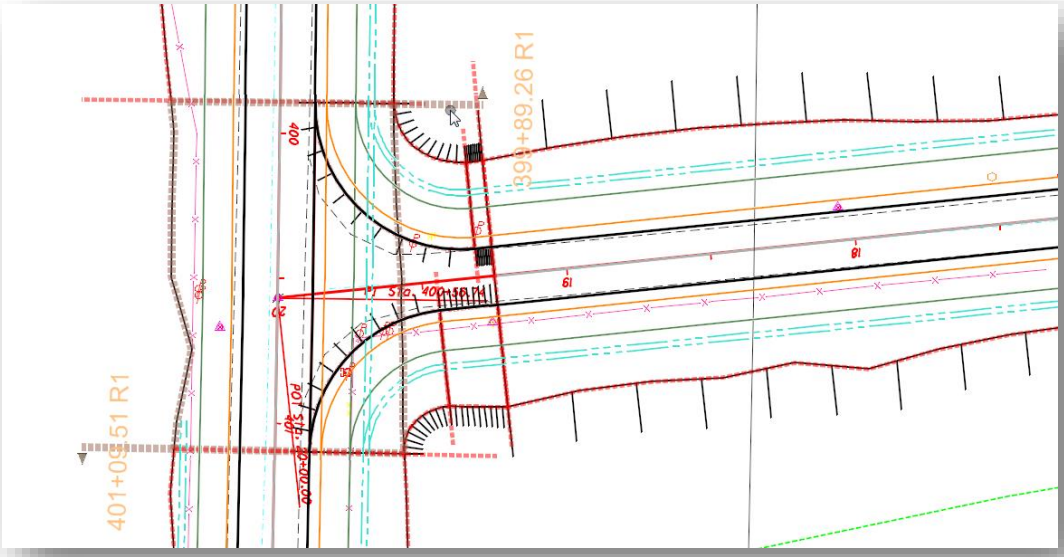
- ✓ Open the design file containing the corridor model for S.R. 185
  ..\Design\Geopak\Basemaps\12345_KM001.dgn

- ✓ Attach the St. Peter Road corridor with a **Live Nesting** value of **0**
  ..\Design\Geopak\Basemaps\12345_KM002.dgn

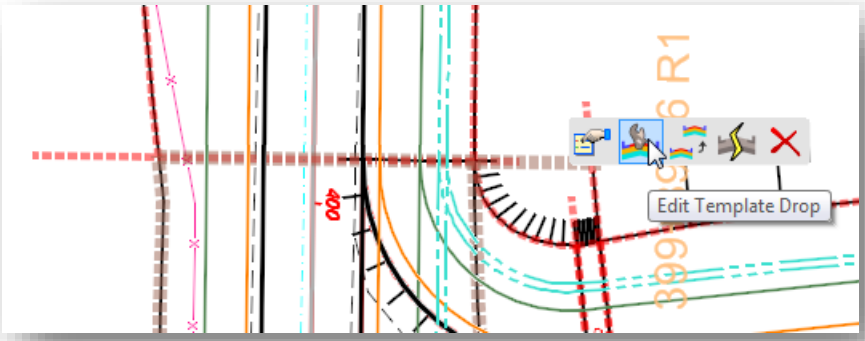
- ✓ Copy the template drop for the S.R. 185 Corridor by selecting the Template Range Graphics and choosing the **Copy Template Drop** option



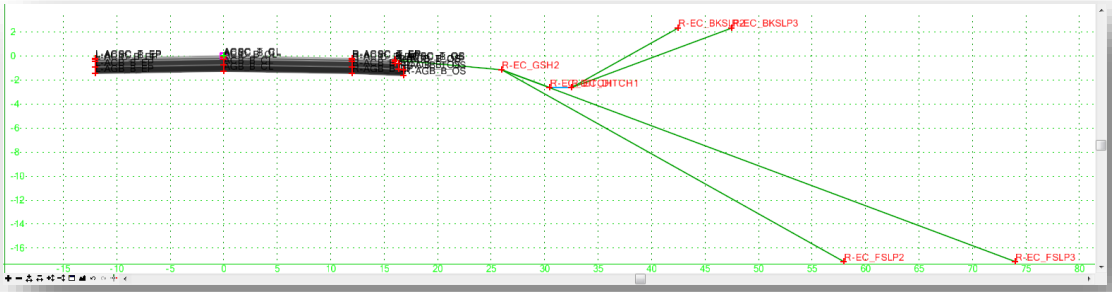
- ✓ Define the **Start** and **End** station of the new template drop by snapping to the radius return graphics. The new template drop is created as shown below.



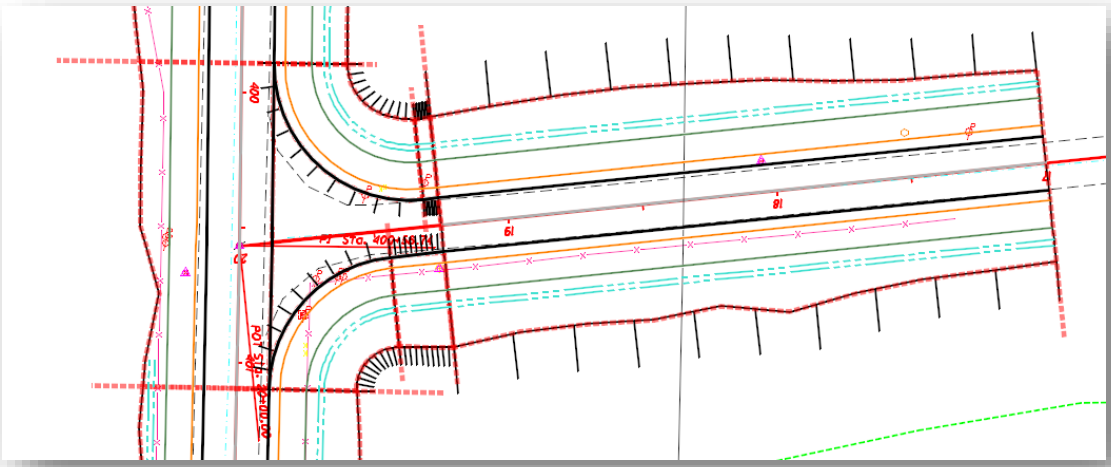
✓ Select the new template drop and choose the **Edit Template Drop** command.



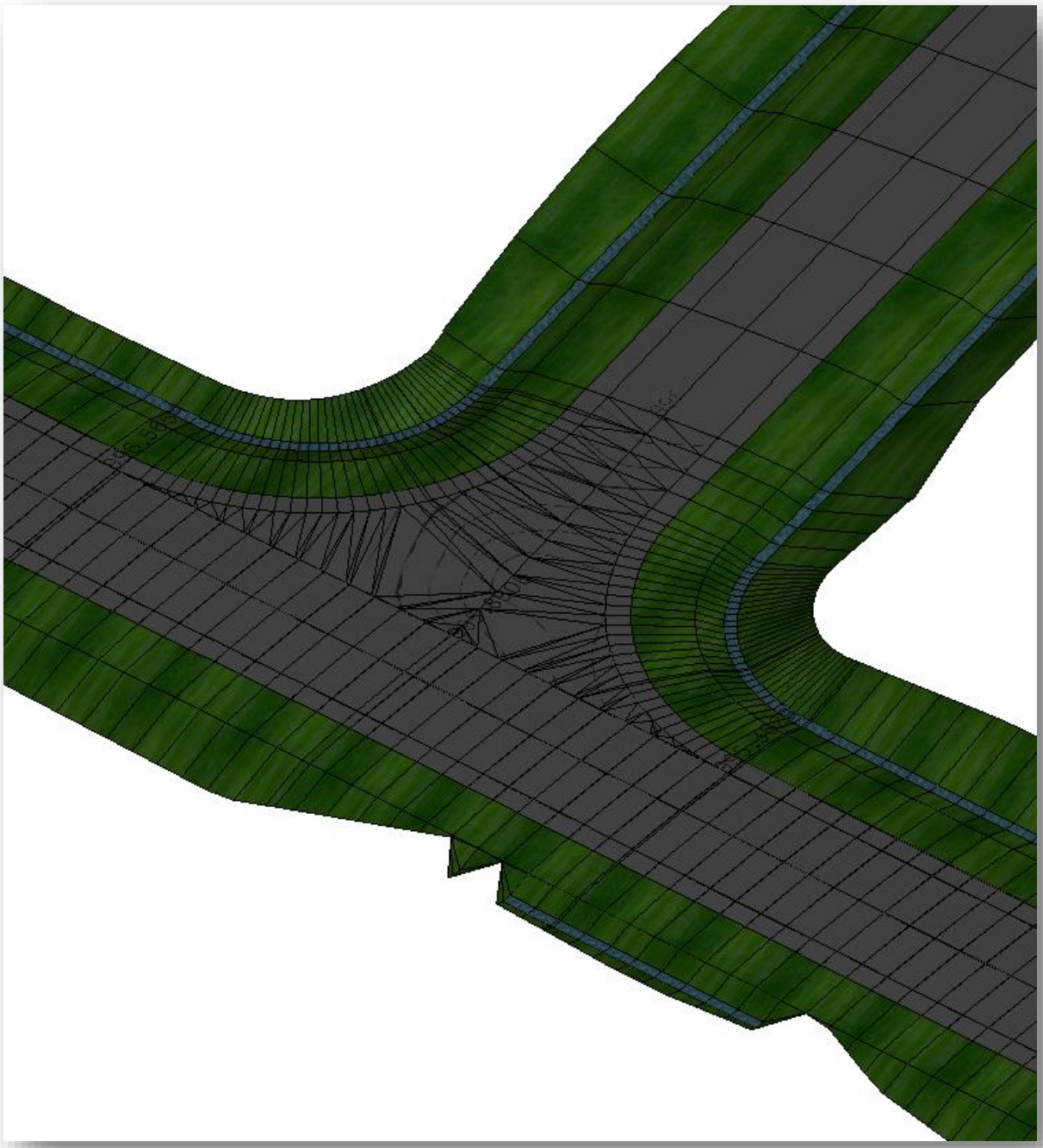
✓ Edit the template drop to remove the end conditions and the shoulder on the left side of the template.



After the template drop has been edited, the corridor for S.R. 185 appears as shown below.



The 3D view of the modeled intersection should appear similar to the example shown on the following page.



10 Civil Cells

Civil cells can be created to define typical design components that can be repeatedly placed in the design. Civil cells can contain horizontal and vertical geometry, terrains, linear templates, area templates, and simple corridors. Think of a civil cell as a collection of civil elements that can be placed relative to the geometry in your specific design.

When a civil cell is created, all of the rules associated with the various civil elements are retained. When a civil cell is placed in the design, the elements that make up the civil cell retain their original ruled relationships which are applied to the selected geometry in the design.

10.1 ODOTcadd_CivilCells.dgnlib

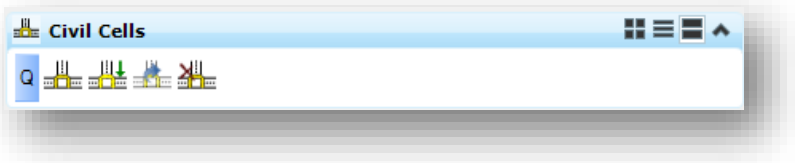
Civil cells are stored in a MicroStation DGN Library. ODOT provides an example civil cell library that contains a few civil cells for basic T-Intersections and residential driveways. Additional civil cells will be added in the future.

The configuration variable CIVIL_CIVILCELLDINLIBLIST is used to define the dgnlib file(s) that contain the civil cells. The variable has been defined as follows in ODOT_Site.cfg:

CIVIL_CIVILCELLDGNLIBLIST = $(ODOT_STD)Geopak/Road/civil_cells/*.dgnlib

10.2 Civil Cells Toolset

Four tools are provided in the *Task* menu for placing civil cells as shown below.



Create Civil Cell
This command steps you through a series of prompts to create a civil cell. Creating civil cells is not covered in this document. See the OpenRoads help for more information.

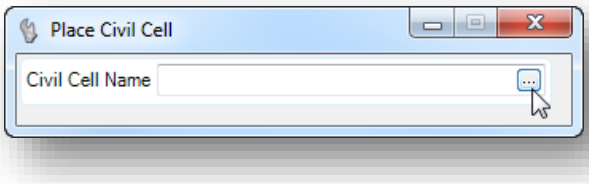
Place Civil Cell
Civil cells can be selected from configured libraries or from civil cells placed in the active file.

Process Civil Cell
Reprocesses all linear templates and templates for the selected civil cell.

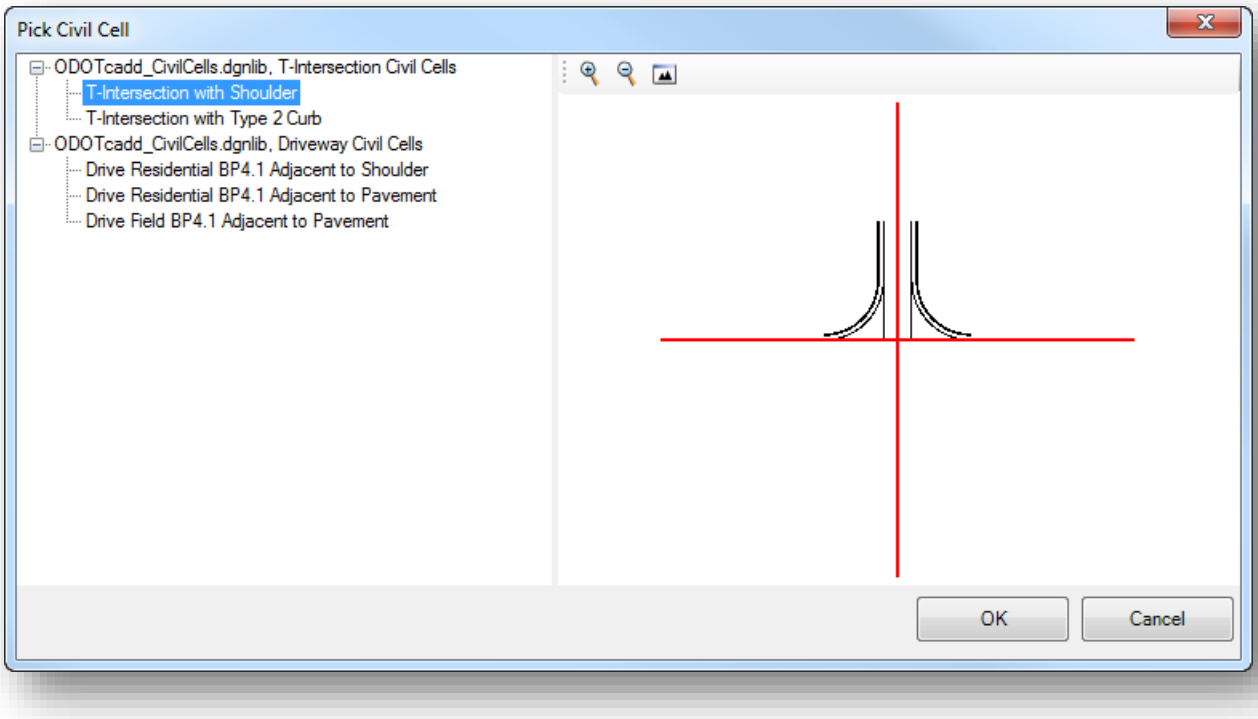
Drop Civil Cell
Used to drop the civil cell into separate civil elements.

10.3 Placing Civil Cells

The command to place a civil cell is activated from the *Task* menu by **selecting Tasks > Civil Tools > Civil Cells > Place Civil Cell**.

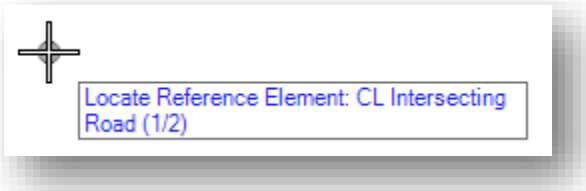


Click the browse button to open the *Pick Civil Cell* dialog shown below.



Selecting one of the Civil Cells in the library will display the civil cell on the right side of the dialog as shown in the example above.

Depending on how the civil cell is constructed, each civil cell will have different required **Reference Elements** that the user must identify as the civil cell is placed in the design. The placement process will prompt the user to select the required civil elements. Prompts are displayed floating on the cursor similar to the example below.

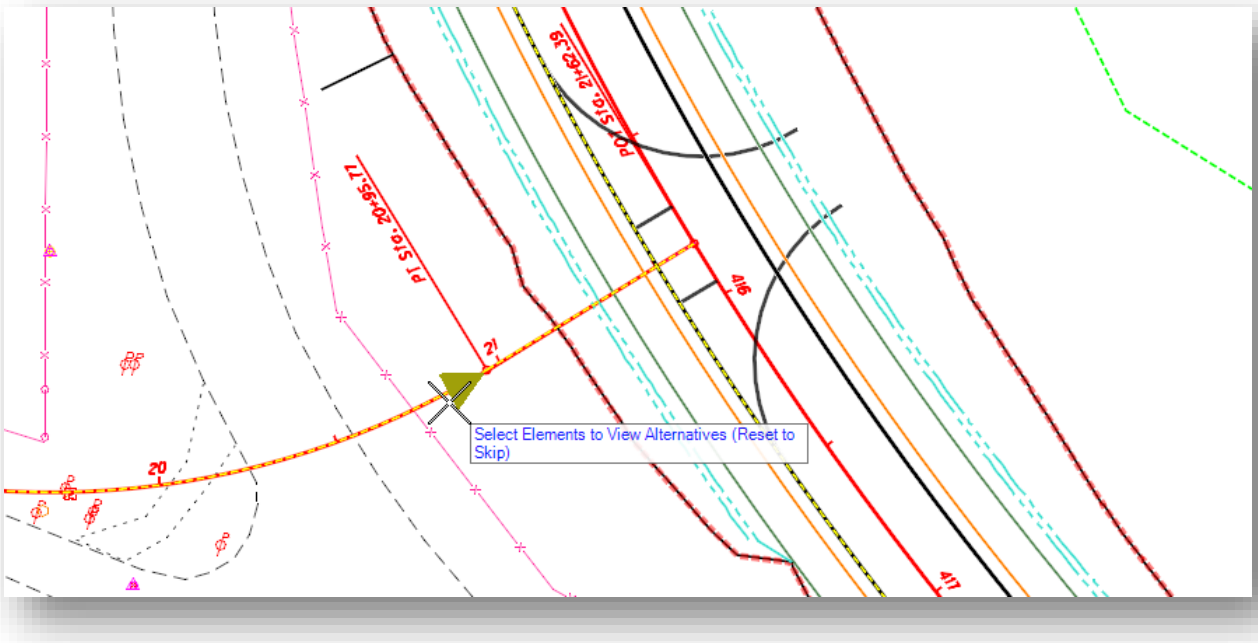


The **T-Intersection with Shoulder** civil cell requires that you select two horizontal alignments as part of the placement process. Each of the selected alignments must have a vertical profile defined. The following two civil elements are required:

- CL Intersecting Road
- Through EOP

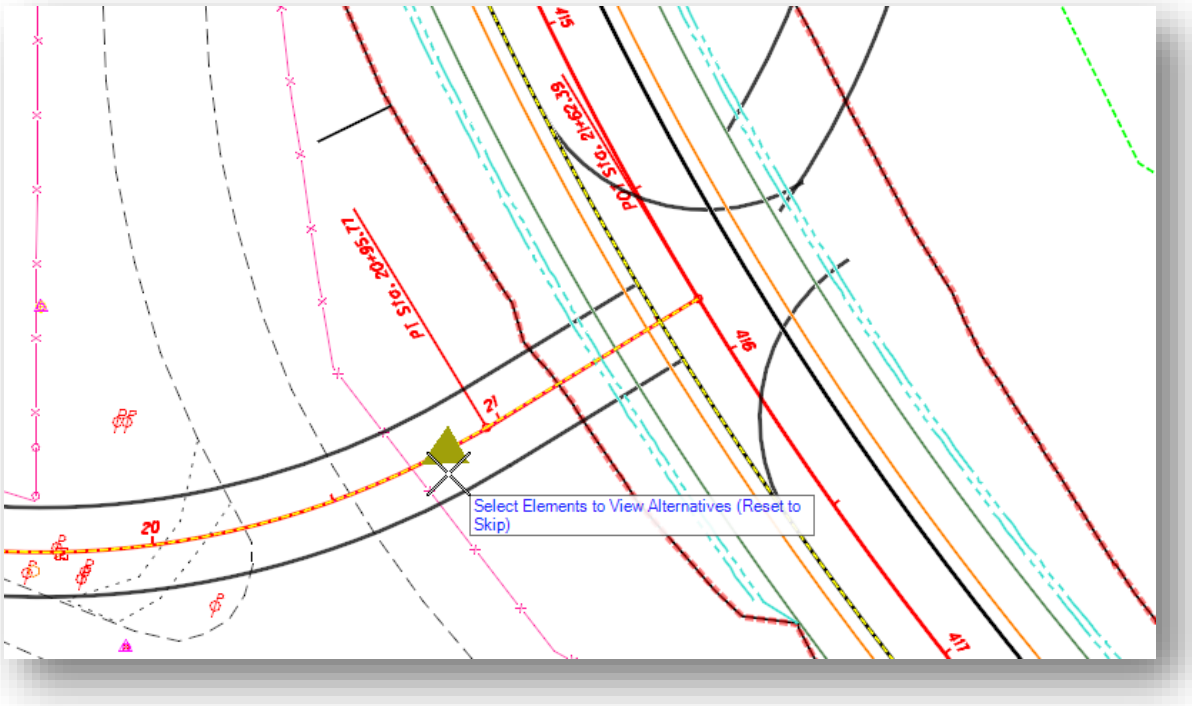
Note: Corridor graphics drawn in the 2D model such as edge of pavement and shoulder lines can be selected as reference elements for Civil Cell placements since these corridor graphics have a profile defined.

After the reference elements are selected, the civil cell is displayed in the design, but has not been placed in the file at this point. The direction of the selected elements may not match the direction of the reference elements that were used when the civil cell was originally created. In the example below, the civil cell is drawn on the wrong side of the intersection.

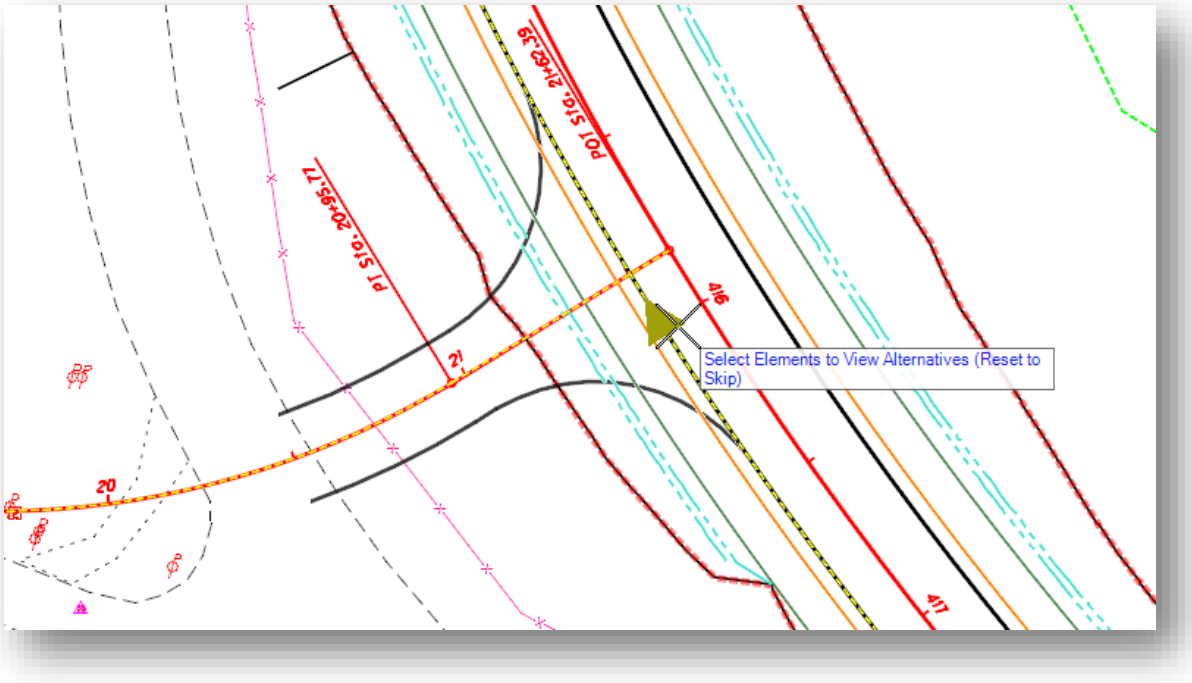


You are prompted to **Select Elements to View Alternatives (Reset to Skip)** as shown above. As the cursor is floated over each element, the direction of the element is displayed with an arrow as shown above. Issue a data point to reverse the direction of the civil cell placement.

When a data point is entered to reverse the direction of a reference element, the civil cell graphics are updated to show the current orientation of the civil cell. The example shown at the top of the following page shows the results after the direction of the **CL Intersecting Road** reference is reversed.



Issuing a data point over the reference element that was selected for the **Through EOP** reference results in the solution shown below.



When the solution appears as desired, issue a **Reset** button to continue to the next step.

After issuing the reset, you are prompted to accept the civil cell placement as shown below.

The civil cell is placed in the design file similar to the example shown below. Note: The reference file attachment for the 3D model is turned on in this example.

Both 2D and 3D graphics are generated for the civil cell. The geometry, vertical profiles, and templates applied to the elements that make up the civil cell can all be edited as shown in the following sections.

The civil cell can be edited using a variety of methods as described on the following pages.

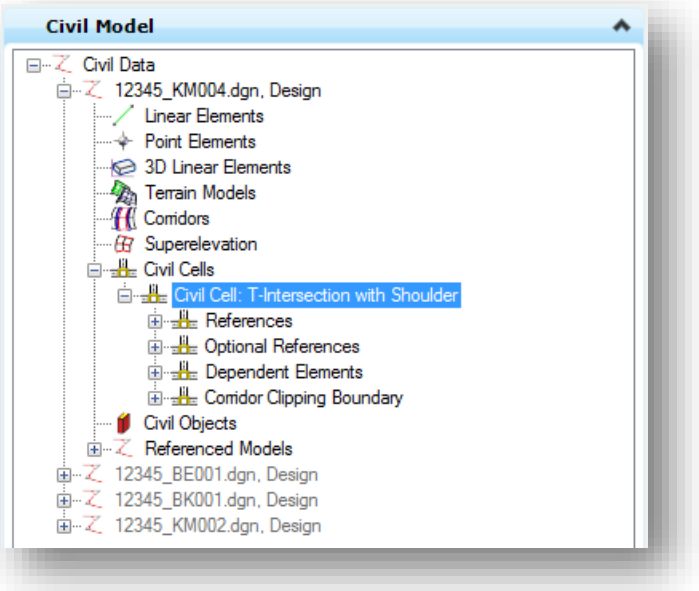
Note that the ODOT civil cells have not been configured to automatically clip the corridor of the intersecting alignment.

Also note that the ODOT civil cells do not currently include any side slopes. These can be added as detailed in the next section.

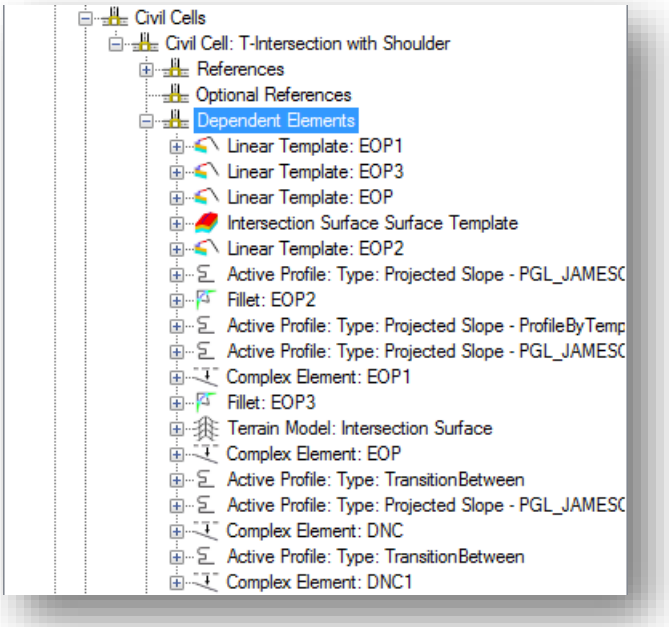
10.4 Modifying Civil Cells after Placement

Civil cells can be dropped using the **Drop Civil Cell** command from the *Tasks* menu, or by the MicroStation **Drop Cell** command. However, many edits to the civil cells can be performed without dropping the civil cell.

After a civil cell is placed, it can be reviewed from the *Project Explorer* dialog in the **Civil Model** group as shown in the example below.



Expanding the **Dependent Elements** item will reveal a list of dependent elements similar to the example shown below.



Choosing one of the **Dependent Elements** from the list will highlight the element in the design file.

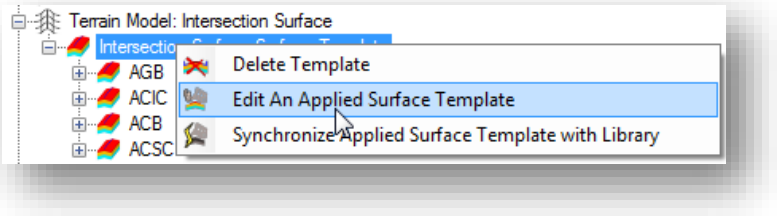
Right-clicking on an item will reveal a menu of applicable commands.

Various editing options are described on the following pages.

Editing the Pavement Surface Template

The main pavement area for the ODOT T-Intersection and Driveway civil cells are defined as a Surface Template using the Asphalt Concrete without Subgrade Stabilization template. The assigned template can be edited as follows:

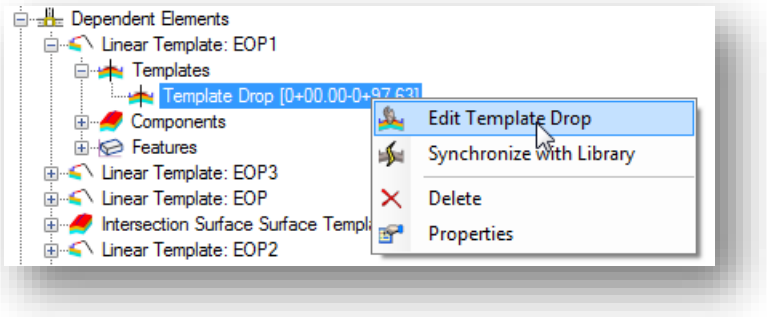
- Right-Click on the surface terrain in the list of **Dependent Elements** for the civil cell



- Select the **Edit Applied Surface Template** option
- The *Editing Roadway Designer Template Drop* dialog is opened to allow changes to the applied template
- After making the necessary changes, save and close the *Editing Roadway Designer Template Drop* dialog. Note, changes made are not stored in the template library for the project. These changes are saved for the template definition that is stored with the civil cell.
- The changes are automatically applied to the civil cell and the 3D model.

Editing the Shoulder Template

Linear Templates are used to define the shoulders in the ODOT civil cells. Expanding the **Linear Template** item reveals the items shown in the example below. Right-click the **Template Drop** and choose the **Edit Template Drop** item to make changes to the template that has been applied for the selected item.



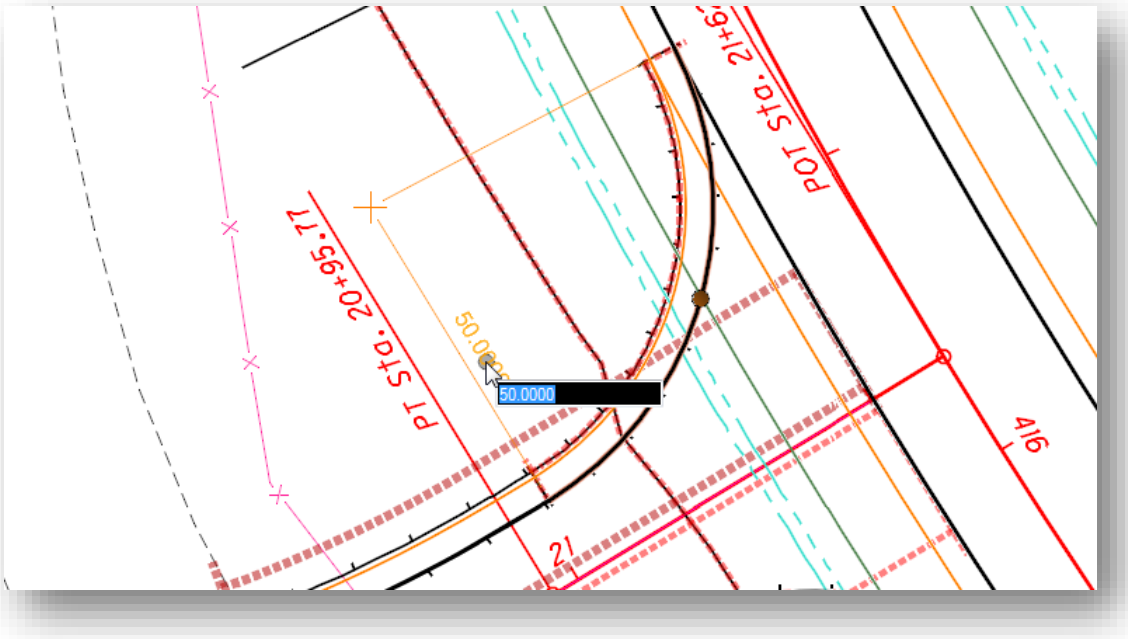
Changes are automatically applied to the Civil Cell and the 3D model.

Each **Linear Template** item for pavement edge lines and the radius returns must be edited uniquely.

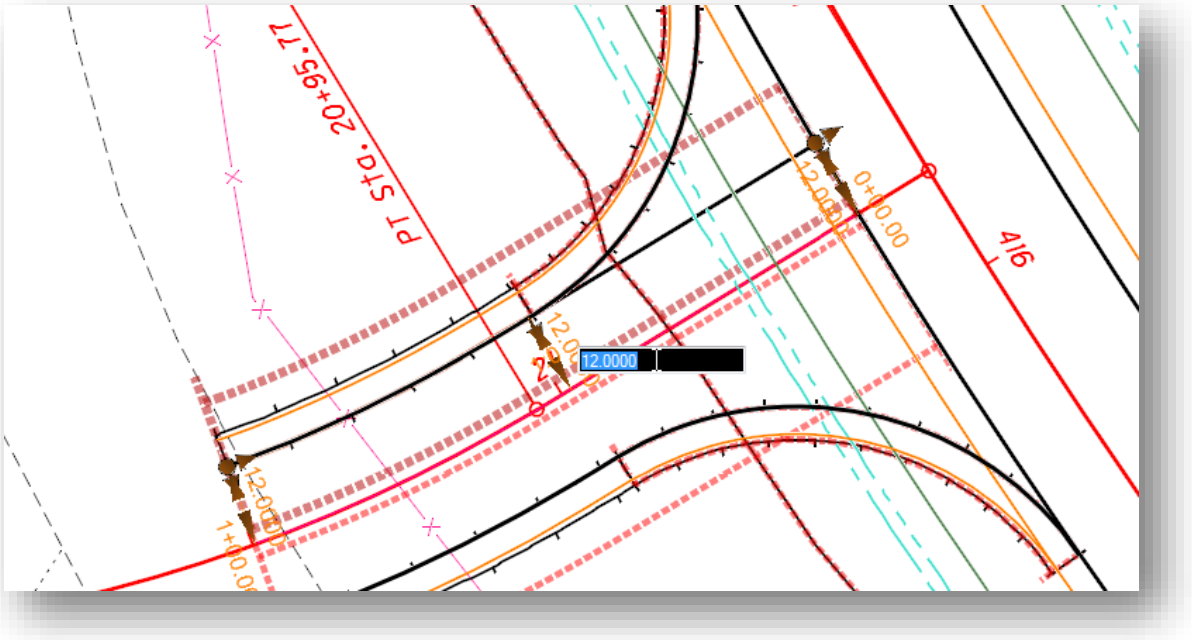
Making Graphical Edits

Civil cells are placed with the same ruled geometry that was used in the initial civil cell definition.

In the example below, the radius return is selected. The radius can be edited using the element manipulators as shown below.



The width of a pavement lane can be edited similar to the example below.

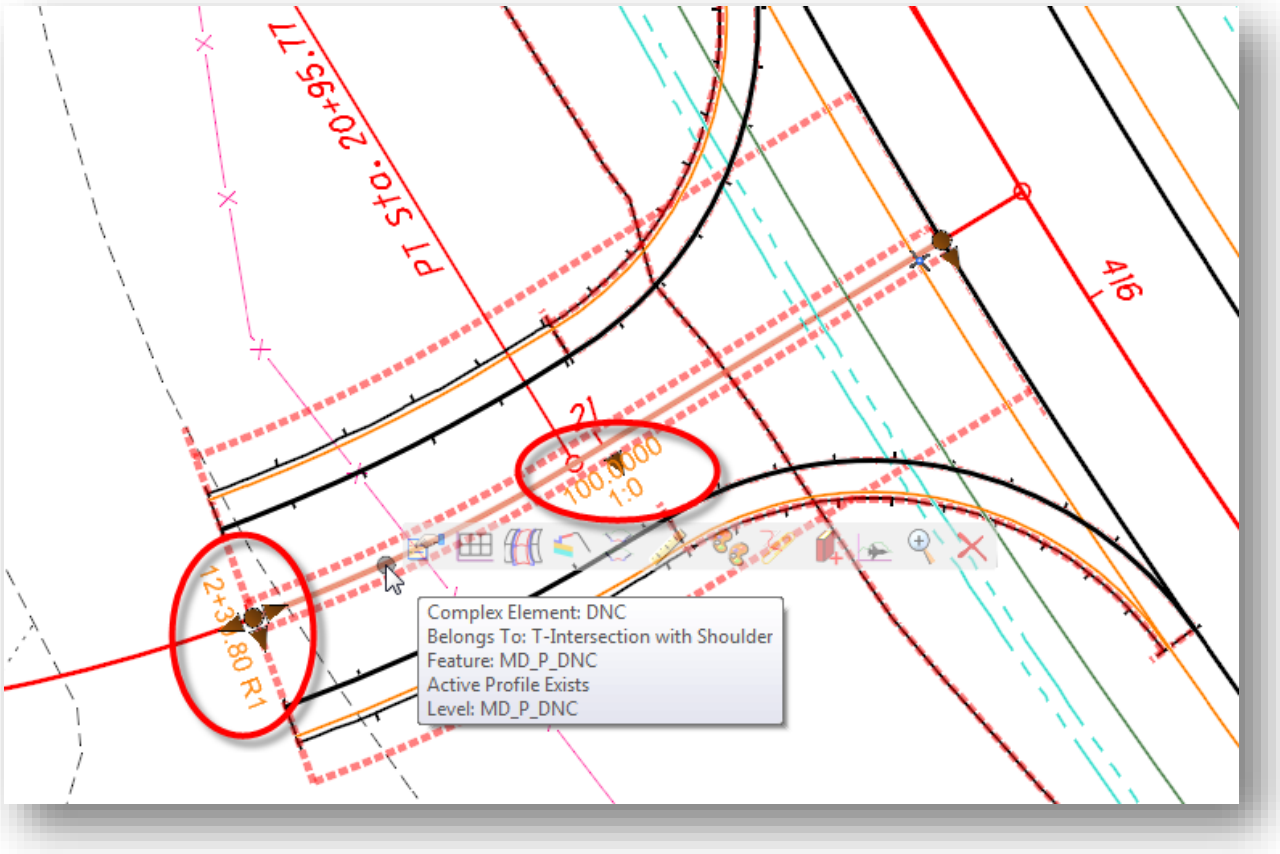


These edits are dynamically reflected in the civil cell graphics and the 3D model.

Civil cells are placed in the design file independent of the stationing assigned to the selected reference Element. The civil cell does not inherit the stationing of the selected alignment.

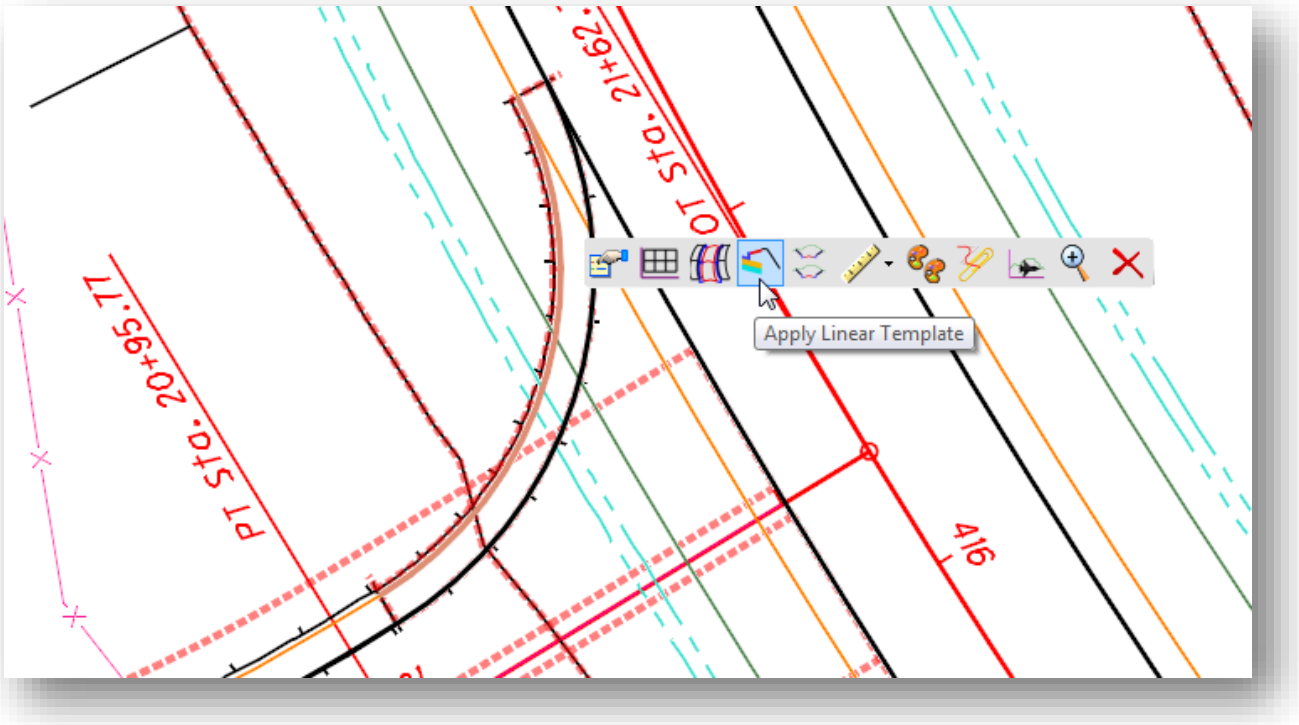
When the civil cell is placed, the length of the civil cell defaults to the length that it was created. The length can be changed by editing the “DNC” (Do Not Construct) element that is placed along the centerline of the civil cell.

In the example below, the element placed on the level MD_P_DNC is selected. This element is placed as part of the civil cell along the centerline of the selected reference element. When the element is selected, the manipulators for the end and the length can be edited.

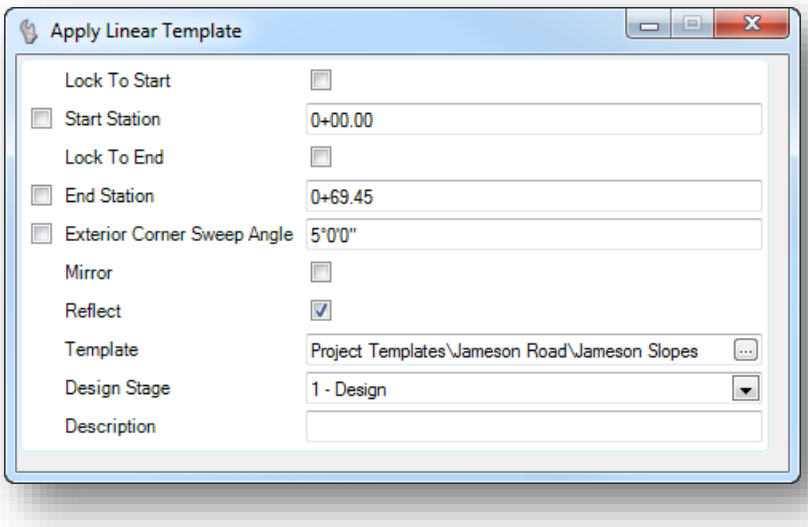


Adding End Condition to Civil Cell components

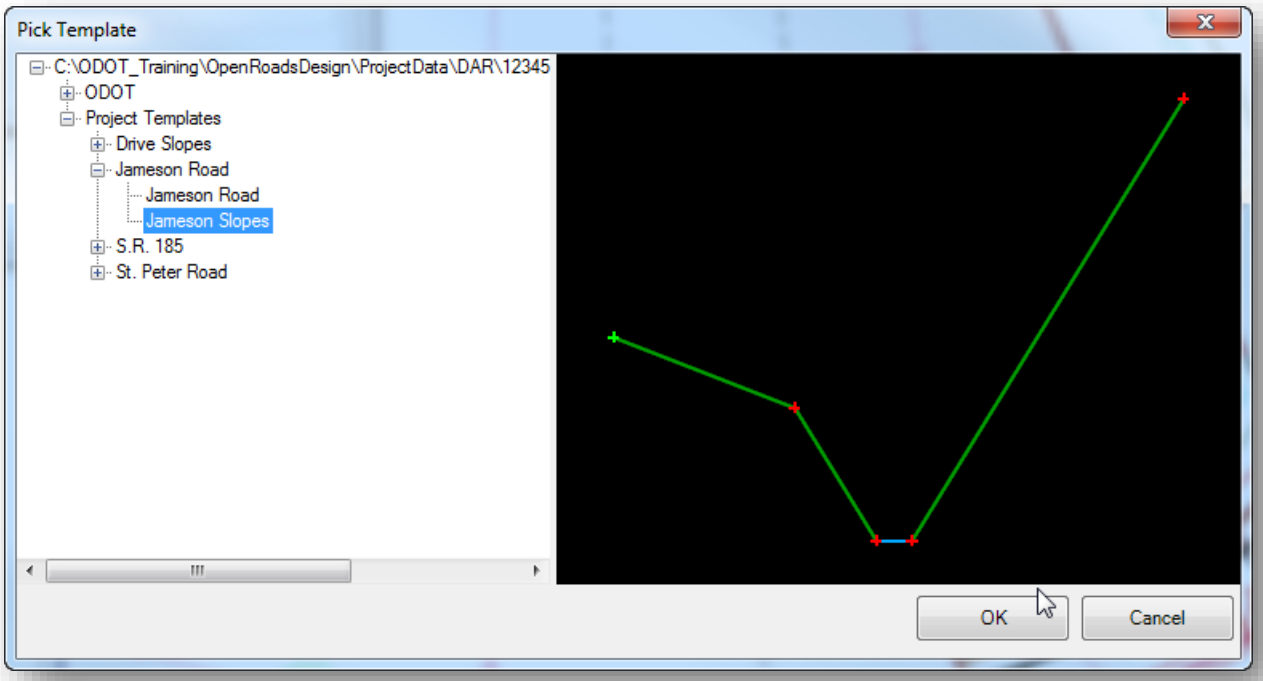
Individual elements in the civil cell can be used to apply a linear template. In the example below, the edge of shoulder graphic is selected to reveal the pop-up menu for the element. The **Apply Linear Template** option is used to add an end condition to the element.



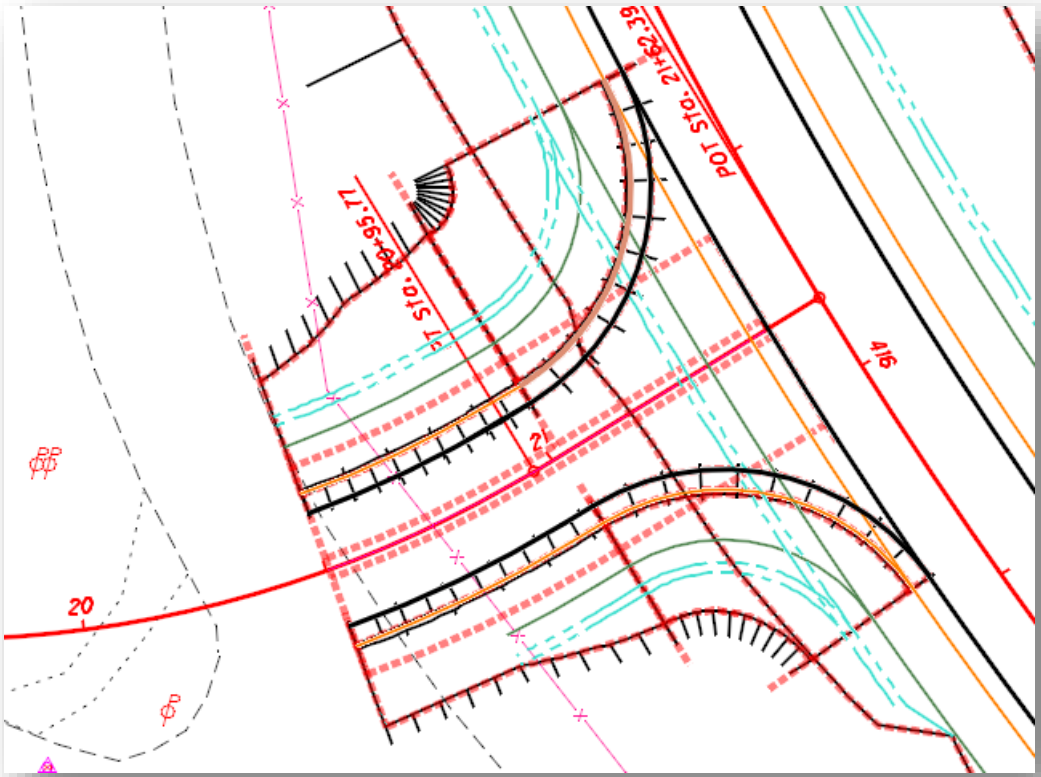
When the command is selected, the *Apply Linear Template* dialog is opened. This dialog is discussed in the Intersection Modeling chapter of this training guide.



For this example, the applied template will contain the graded shoulder and side slope elements as shown on the following page.



In the example below, the end condition has been applied to the edge of pavement and radius return elements for the civil cell.



Exercise 10 – Jameson Road Intersection

In this exercise we will model the intersection for Jameson Road using a Civil Cell.

- ✓ Open MicroStation using the shortcut provided for the training class.

- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345_INTERSECTION

- ✓ Open the following design file for the Jameson Road corridor model:
  ..\Design\Geometry\Basemaps\12345_KM003.dgn

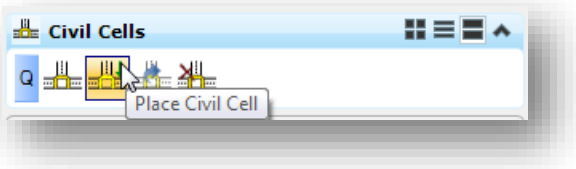
- ✓ Attach the geometry basemap with a **Nest Depth** value of **1**:
  ..\Design\Geometry\Basemaps\12345_BK000.dgn

- ✓ Attach the S.R. 185 corridor model with a **Nest Depth** value of **0**:
  ..\Design\Geometry\Basemaps\12345_KM001.dgn

- ✓ Attach the survey information with a **Nest Depth** value of **0**:
  ..\Design\Survey\Basemaps\12345_BE001.dgn

- ✓ Select the terrain model and make it the active terrain by selecting **Set As Active Terrain Model** rom the pop-up menu.

- ✓ Select the **Place Civil Cell** command to place the civil cell **T-Intersection with Shoulders** on the centerline of Jameson Road.

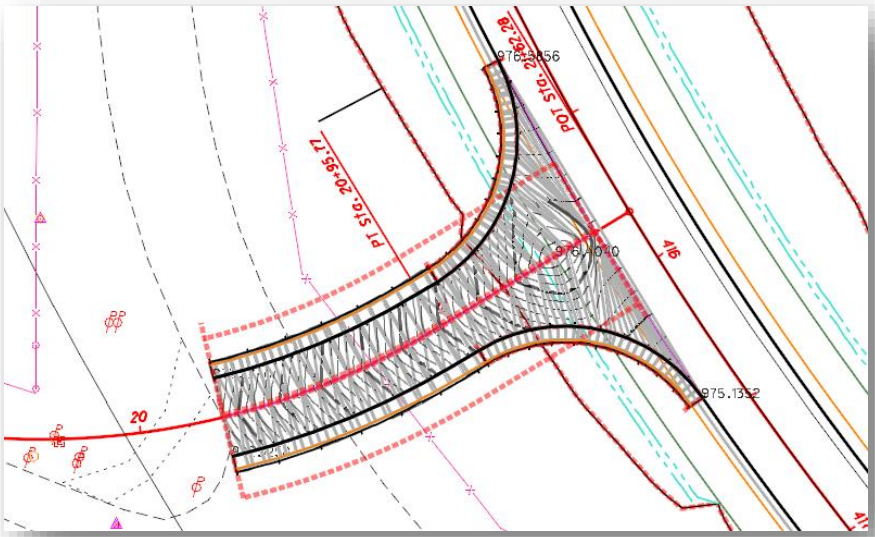


- When prompted to **Locate Reference Element: CL Intersecting Road**, choose the centerline of Jameson Road

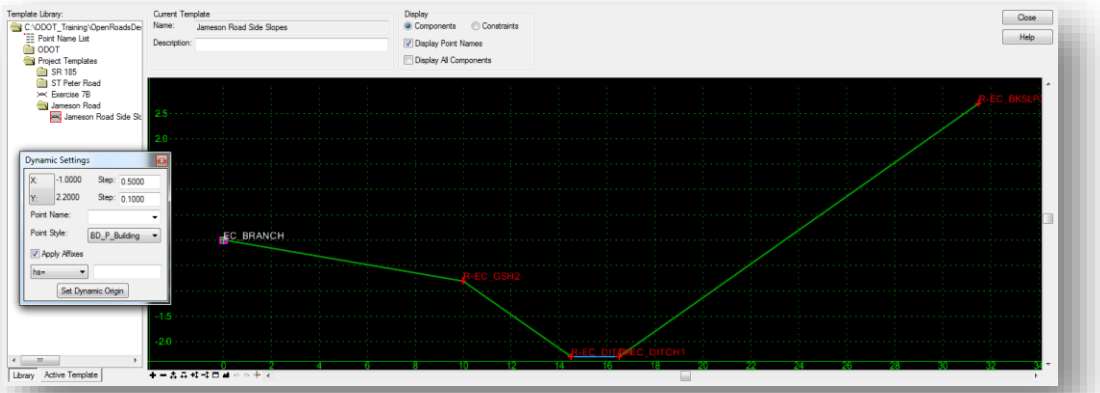
- When prompted to **Locate Reference Element: Through EOP**, choose the edge of pavement for S.R. 185

- The Civil Cell may not orient properly. If it does not, when prompted to **Select Elements to View Alternatives**, issue a data point on the centerline and another on the edge of pavement elements to view the alternatives. When the cell is oriented properly, issue a reset to move to the next step.

- Issue a data point to accept the civil cell placement. The cell is placed and should in the file and should appear similar to the example below.



✓ The civil cell does not include any end conditions for the side slopes. Create a new template named **Jameson Road Side Slopes** for the side slopes of Jameson Road as shown below.

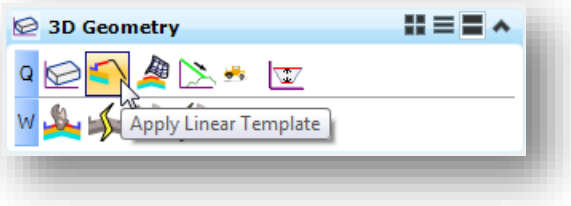


Take a look at the templates contained in the **ODOT > End Conditions > 307-4E Common and Barrier Grading** folder in the template library. The **307-4E Cut 3:1** template may be just what you are looking for.

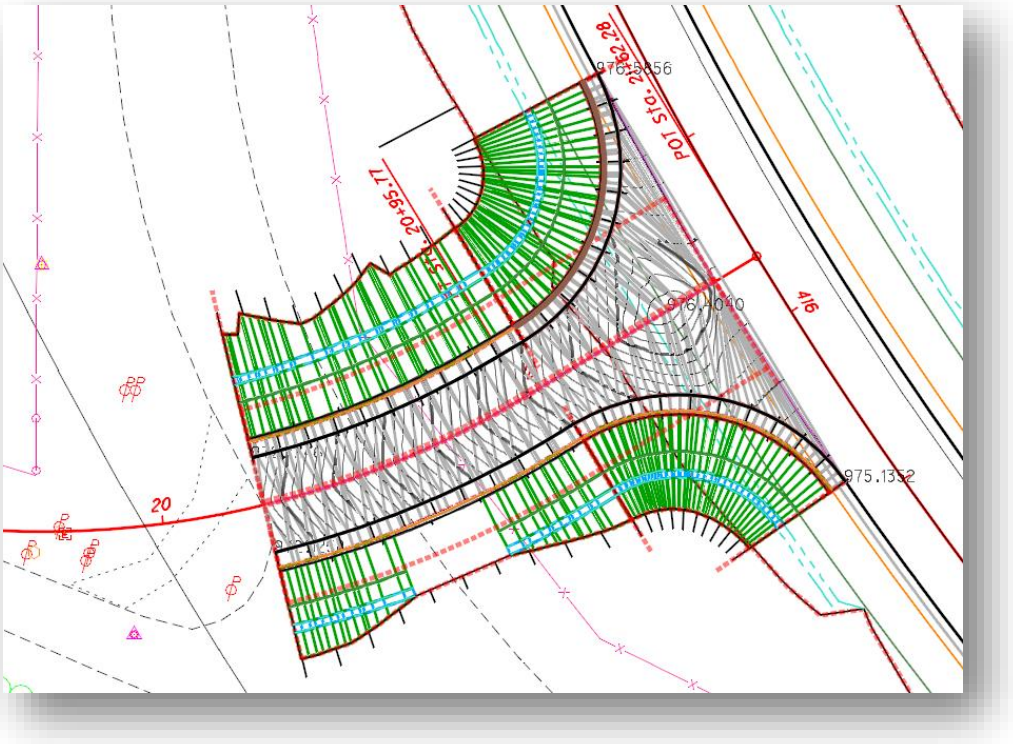
Drag this template into the new template that you created for the project. Be sure to open the *Dynamic Settings* dialog and turn on the affixes before dragging in the end condition.

✓ Delete the 2:1 Backslope.
✓ Double Click on the point "*R-EC_BKSLP3*" and check on **End Condition is Infinite**.
✓ Save and close the Template Library.

✓ Use the **Apply Linear Templates** command to assign the Jameson Road side slope template to the edge of shoulder graphics in the civil cell. The command can also be selected from the pop-up menu when one of the Jameson road edge of shoulder elements is selected.



The side slopes for Jameson Road should appear similar to the example below.



The proposed work for Jameson Road starts at station 17+00. The remainder of Jameson Road can be modeled by creating a new template and corridor.

Take the following steps to create a template for Jameson Road:

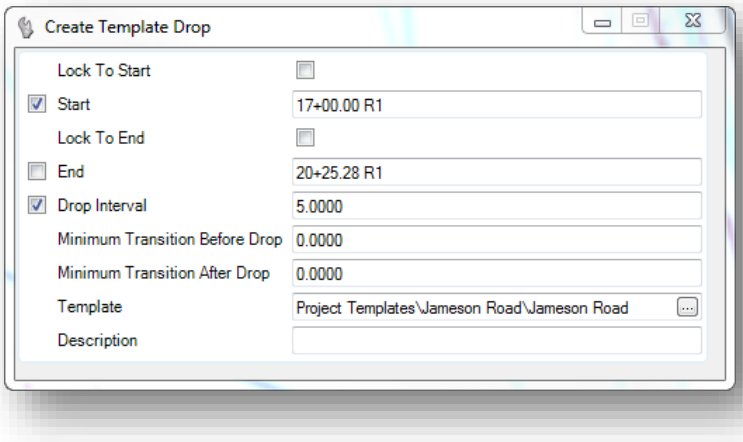
- ✓ Select the **Create Templates** command and create a new template in the **Project Templates > Jameson Road** folder named Jameson Road.
- ✓ Open the *Dynamic Settings* dialog and turn off the **Apply Affixes** option.
- ✓ Drag the following ODOT Backbone into the Jameson Road template at the 0,0 coordinate:

  ODOT > Backbones > Undivided Roadways > Pavement and Shoulder 301-8E Uncurbed > 2-Lane without Superelevation Point > Asphalt Concrete without Stabilization
- ✓ In the *Dynamic Settings* dialog, turn on the **Apply Affixes** option
- ✓ Drag the following end condition onto the left and right sides of the template:

  ODOT > End Conditions > 307-4E Common and Barrier Grading > 307-4E 3:1 Cut, Fill Table
- ✓ Remove the **R-GSH1** and **L-GSH1** components from the template
- ✓ Save the and close the template library

Take the following steps to create the corridor for Jameson Road:

- ✓ Select the Jameson Road alignment and choose the **Create Corridor** command from the pop-up menu
- ✓ When prompted to **Locate Profile-Reset For Active Profile**, issue a left-click (reset) to use the active profile
- ✓ Name the Corridor **CLP_JAMESON**
- ✓ Use the settings below to create the template drop for Jameson Road. Note, the end station shown here corresponds to the start of the civil cell.



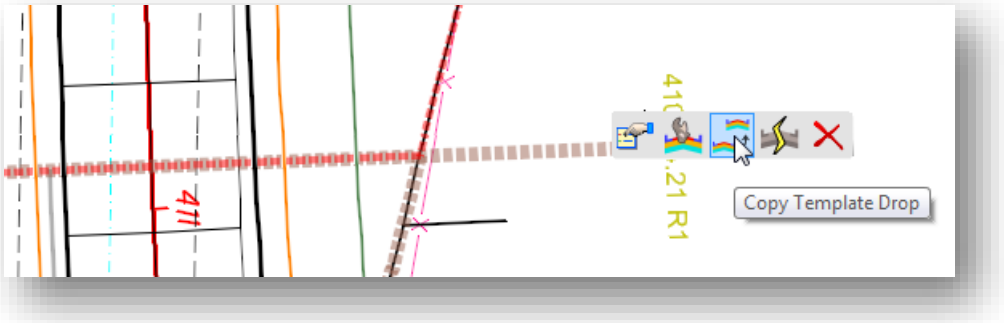
The ditch on the right side is incomplete and can be designed by defining a ditch profile and using a point control to assign the ditch profile to the corridor, similar to the procedure used in Exercise 7G. We will not specifically address the ditch profile in this exercise.

The corridor for State Route 185 extends through the intersection. Take the following steps to edit the S.R. 185 corridor:

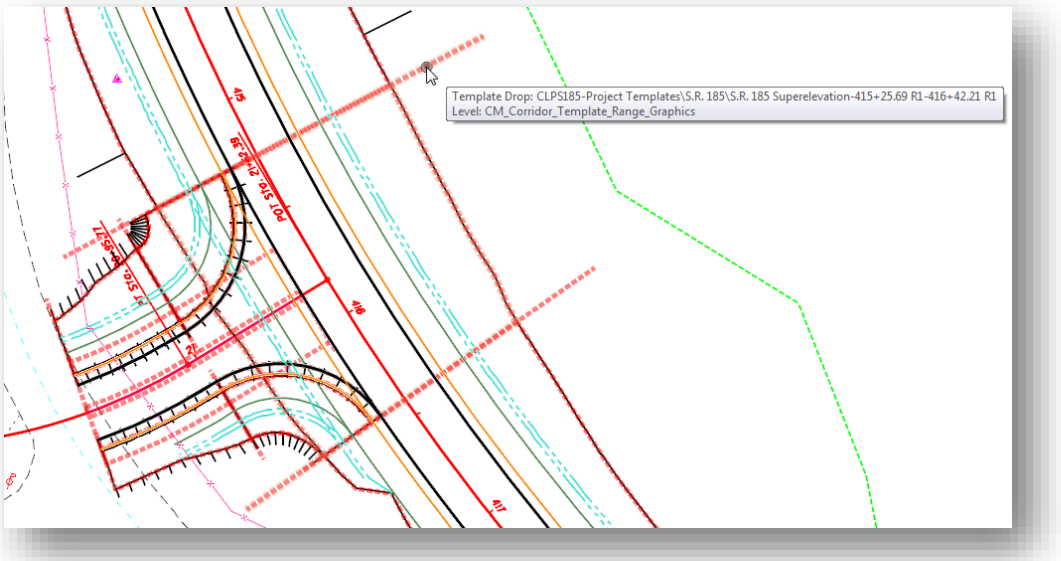
- ✓ Open the following design file for the S.R. 185 corridor model:
  ..\Design\Geometry\Basemaps\12345_KM001.dgn

- ✓ Attach the Jameson Road corridor as a reference with a Nest Depth value of 0
  ..\Design\Geometry\Basemaps\12345_KM003.dgn

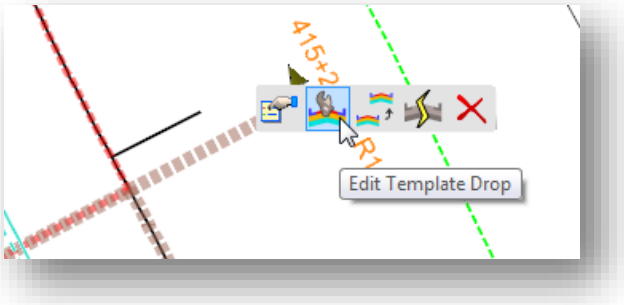
- ✓ Use the **Copy Template Drop** command to add a new template drop on the State Route 185 Corridor at the end of the radius returns for Jameson Road. The command is accessed by selecting the template range graphics, and then choosing **Copy Template Drop** from the pop-up menu. Be sure to choose the template drop graphics for the superelevated template drop.



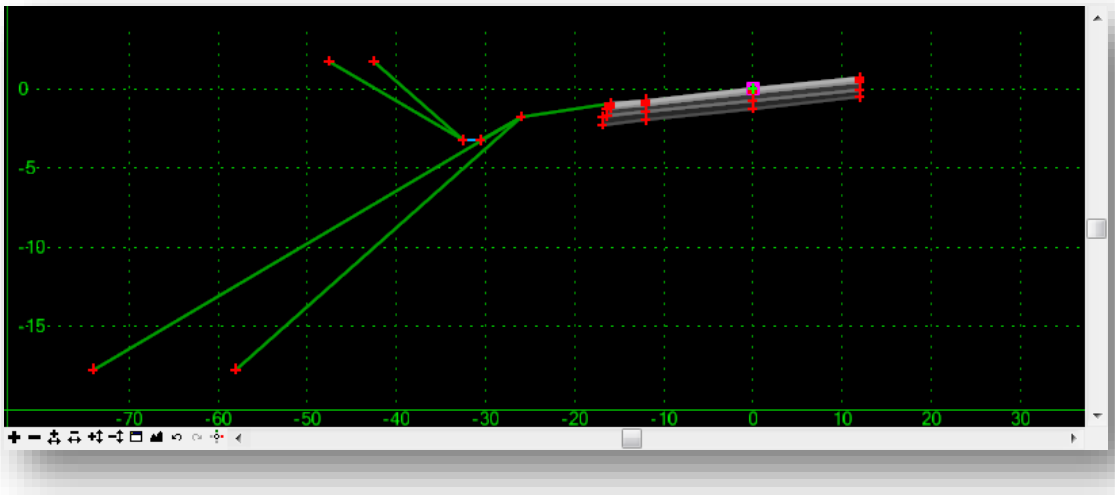
The new template drop should be inserted at the beginning and end of the radius returns as shown below.



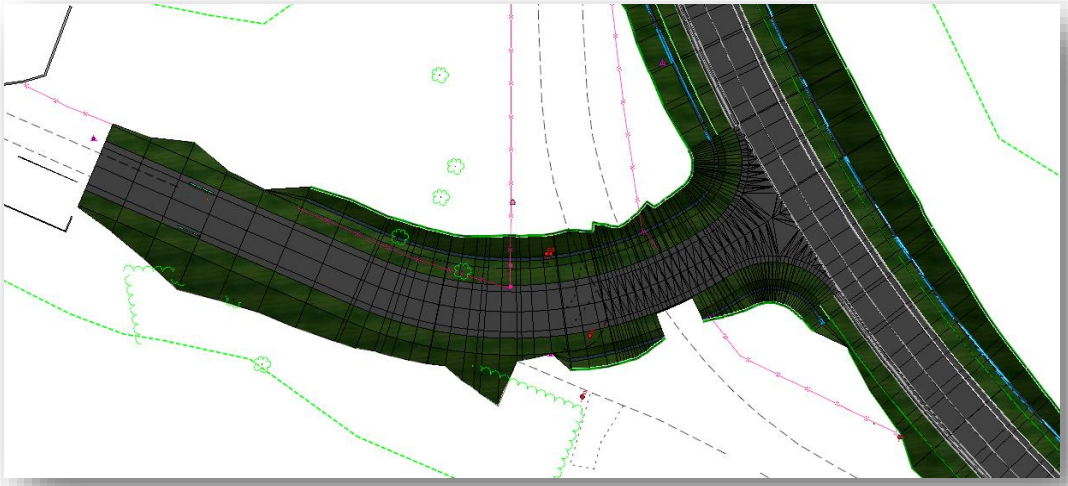
✓ Choose the template range graphics for the new template drop and select the **Edit Template Drop** command from the pop-up menu.



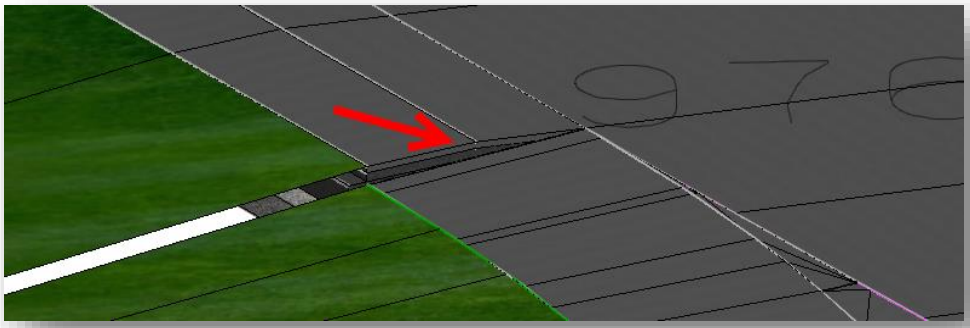
✓ Remove the shoulders and the end conditions from the right side of the template as shown below.



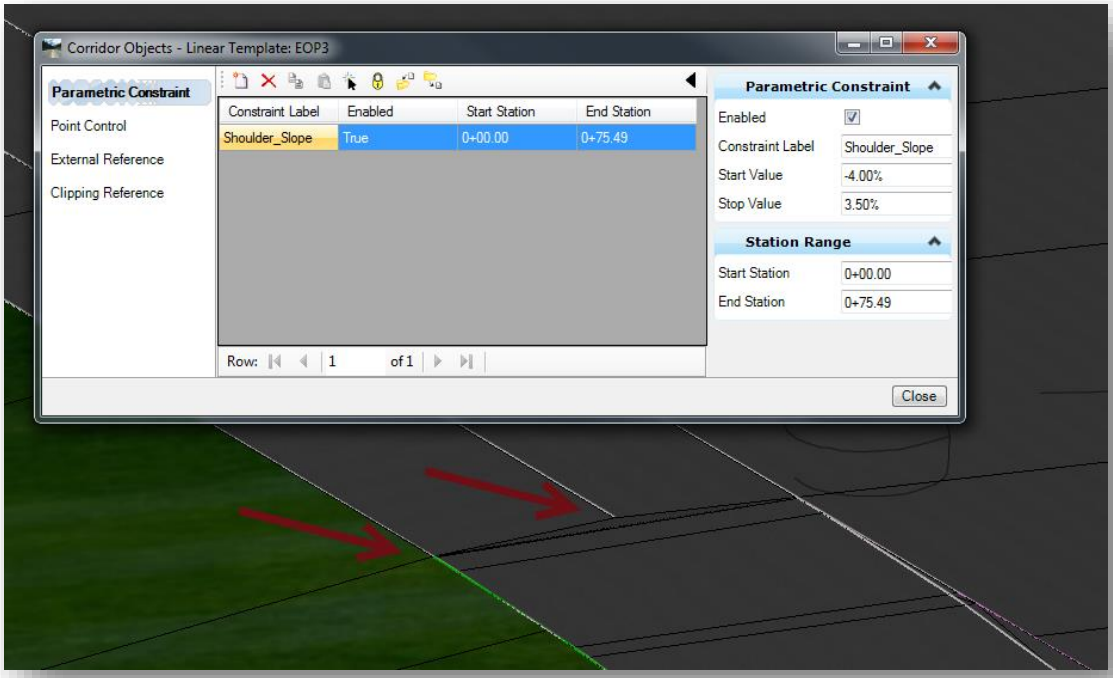
After the edit is applied, the 3D model for the intersection of S.R. 185 and Jameson Road should appear similar to the example below.



✓ The State Route 185 corridor is in full superelevation with a shoulder break on the high side of the superelevation. The shoulders in the civil cell used for Jameson Road are defined with a slope of -4.0%. How would you fix this problem?



In the example below, the **Parametric Constraint** named **Shoulder_Slope** is assigned to point **ACSC_T_OS** in the linear template for the radius return. The value for the constraint was edited as shown below:



This solution does not include a corresponding break in the shoulder for the radius return.

This example also applies the transition from the 3.5% slope to the -4.0% slope across the entire length of the radius return. Ultimately it will be up to the construction personnel to determine how this break will be constructed as the **Location and Design Manual** does not provide any guidance for the shoulder break entrance and exit transition lengths.

When a federated approach is used to create separate design files for each corridor model (see Using Multiple “Federated” Basemaps) users should add the corridor design file as a reference to the “KM_000” design file.

- ✓ Open the file 12345_KM000.dgn
- ✓ Attach the design file containing the Jameson Road corridor as a reference to the 000 file
- ✓ Save settings and close the 000 file when complete

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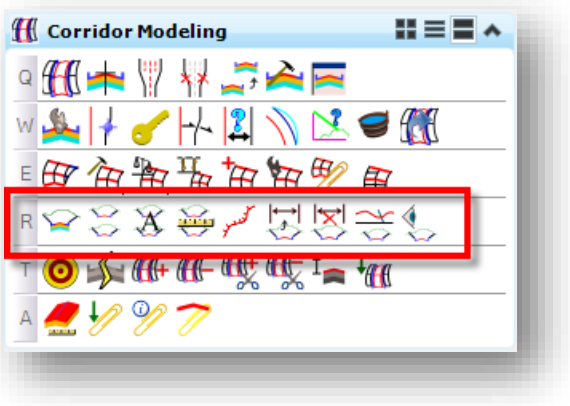
11 Cross Sections

OpenRoads tools provide options to cut cross sections directly into a cross section sheet, or as stand-alone sections with a GEOPAK cross section control cell. Each option is covered in this training guide.

The cross section commands are located in the **Tasks > Civil Tools > Corridor Modeling** menu as shown below.



From left to right, the following commands are provided:

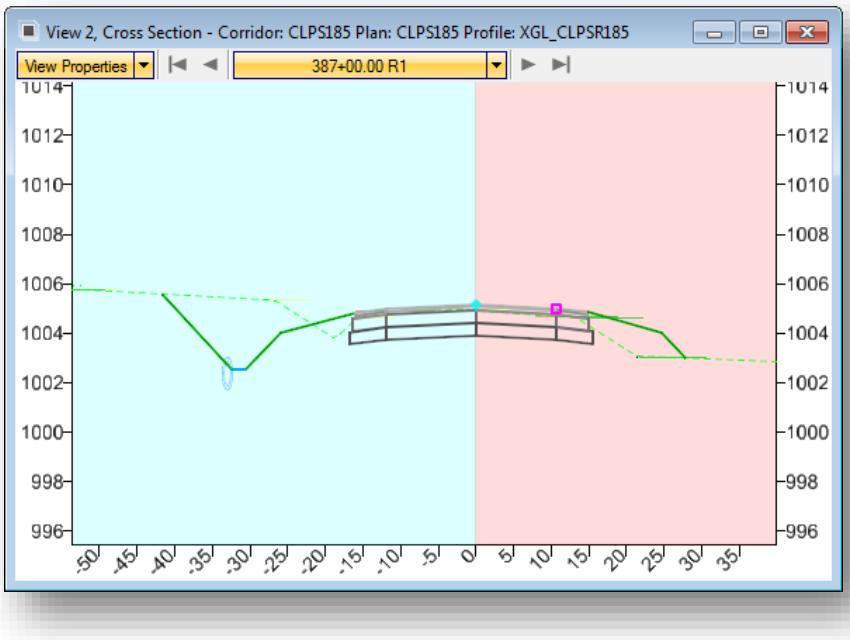
- Open Cross Section View
- Create Cross Sections
- Annotate Cross Sections
- End Area Volumes
- Edit Station
- Show Place Dimension
- Remove Temporary Dimensions
- Locate Station via Datapoint
- Cross Section Viewer

11.1 Open Cross Section View

The **Open Cross Section** view command is used to generate a temporary cross section view window to review the selected corridor in a cross section format.

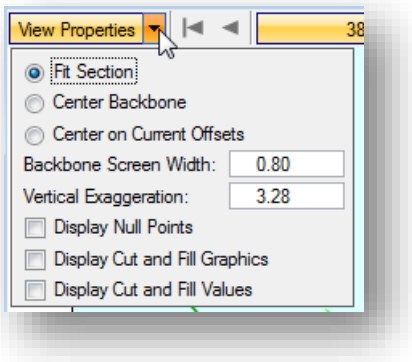
When the command is selected, you are prompted to **Locate Corridor or Alignment**. If you select an alignment, you are prompted to identify the **Left** and **Right Offsets** as well as the **Station** and **Interval** for the cross sections.

After selecting the corridor or alignment, you are prompted to **Select or Open View**. Open a new view window and issue a data point within the newly opened view to display the cross sections. An example is shown below.



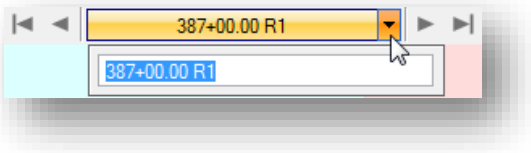
The cross sections are not written to the file.

The **View Properties** item provides the following options:



These options are more or less self-explanatory. See the online help for details.

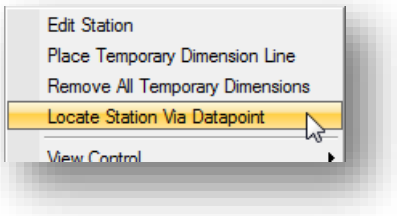
You can scroll through the stations or enter a specific station using the options shown below.



The following commands in the cross section group are used with the temporary cross section view:

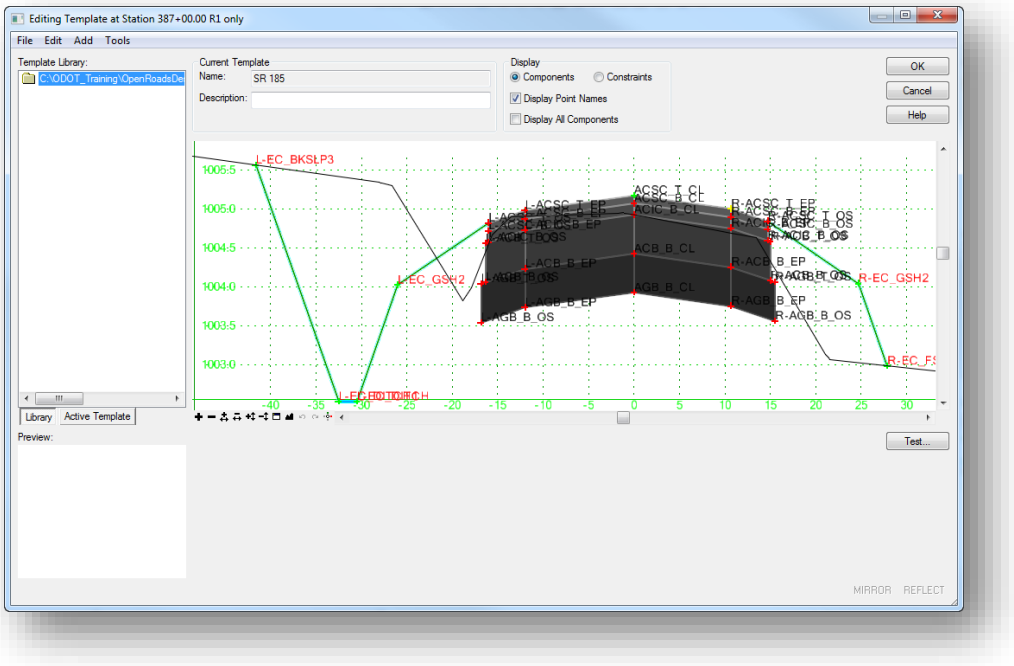
- Edit Station
- Show Place Dimension
- Remove Temporary Dimensions
- Locate Station via Datapoint

These commands can also be selected from a pop-up menu by holding down the right-mouse button in the temporary cross section view as shown below.



Edit Station

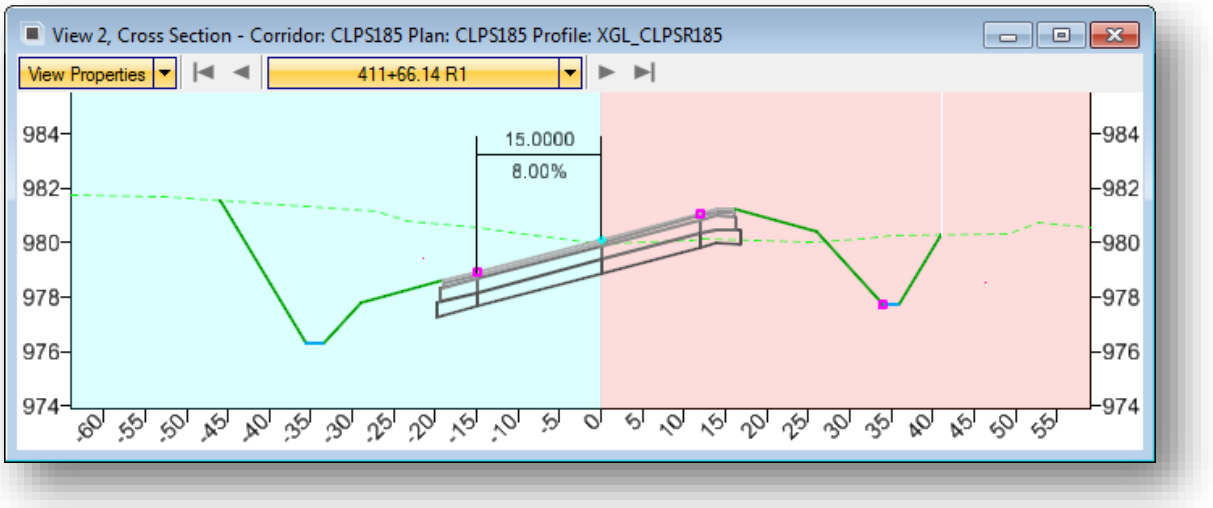
The **Edit Station** command allows you to edit the current station. When the command is selected, the *Edit Template at Station* dialog is opened as shown below. This dialog is used to make any necessary edits to the selected template drop location and is not applied to any other stations.



Place Temporary Dimension Line, Remove All Temporary Dimensions

The **Place Temporary Dimension Line** command is used to review the length and slope of selected components in the cross section view window.

When the command is selected, you are prompted to enter the **Start Point**, **End Point**, and **Dimension Height**. The temporary dimension line for one of the pavement lanes is shown below. As you scroll through the cross sections, the dimension line is updated for each cross section.



The **Remove All Temporary Dimensions** command is used to remove the display of the dimension lines.

Locate Station via Datapoint

This command is used to display a temporary cross section at the station location identified by issuing a data point in the plan view.

11.2 Create Cross Sections

The **Create Cross Sections** command is used to create a new Drawing model within the active design file containing the cross sections. It can also be launched by selecting an alignment and clicking the **Create Cross Sections** button from the pop-up menu.

Cross sections can be created is a sheet format or in a free-floating format with a GEOPAK cross section cell. The choice whether to cut the cross sections directly a cross section sheet, or as stand-alone cross sections with a GEOPAK cell depends on the intended use of the cross section information.

- If you intend to use any legacy GEOPAK cross section commands, such as seeding quantities or processing criteria, use the GEOPAK format option.

- If you do not intend to use any legacy GEOPAK functions and all you need are simple cut and fill quantities, use the Sheet format option.

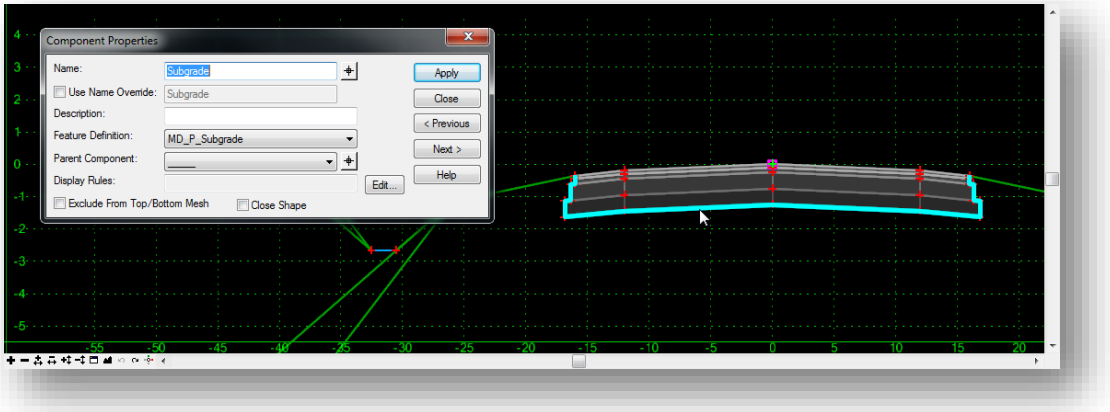
Each option is discussed on the following pages.

Cross Section Graphics

Cross sections are cut directly from the 3D model. Whatever is drawn/displayed in the 3D model will be drawn on the cross sections.

The components included in the template are drawn on the cross sections. Each pavement layer component will be displayed in the cross section model. Traditionally, ODOT has not displayed the individual pavement layers on the cross sections. The subgrade line, drawn at the bottom of the pavement layers, is typically displayed on the final cross sections. The subgrade line must be included as a separate component in the template if you wish to display the subgrade line in the cross sections.

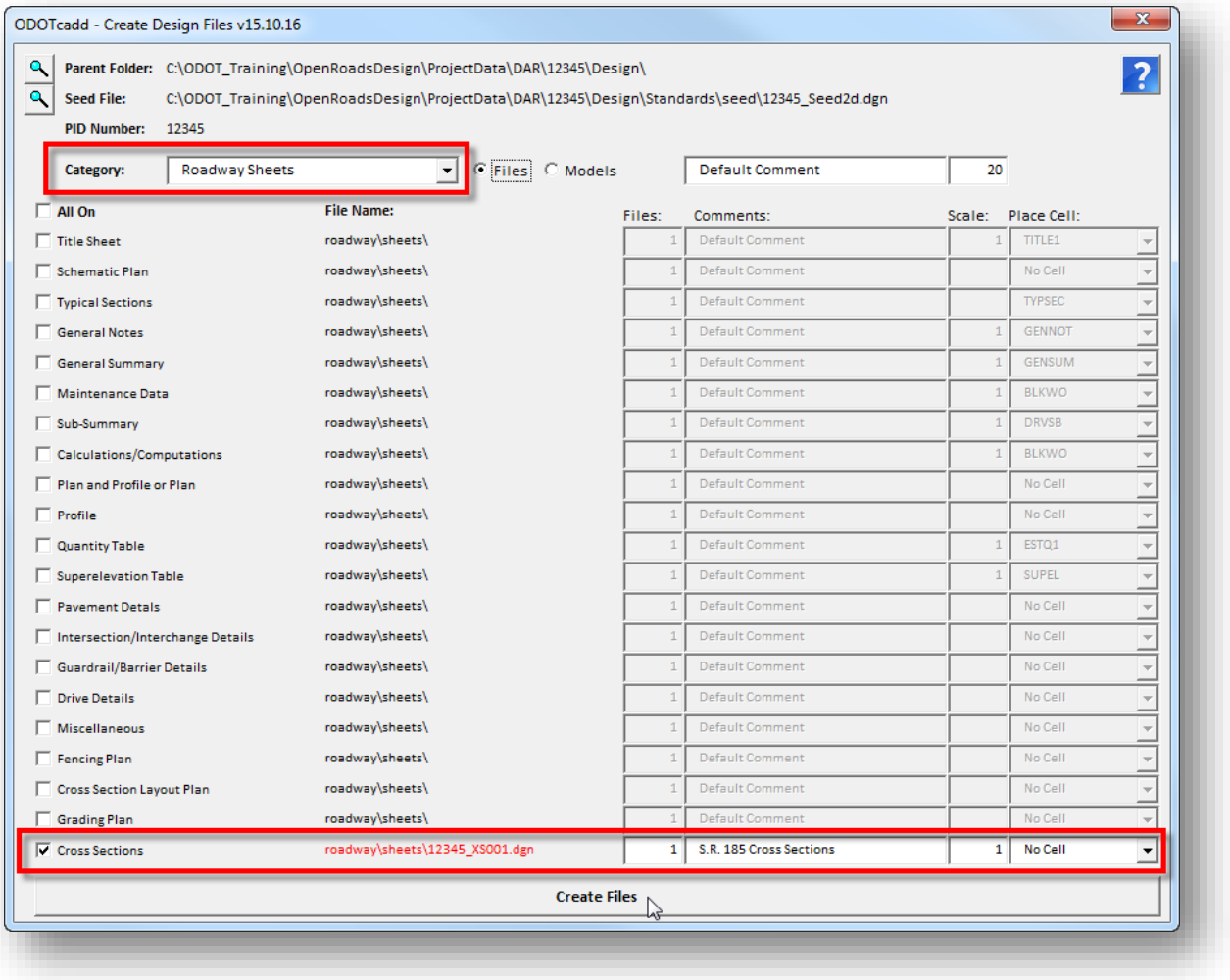
To add a subgrade component to a template, in the *Create Template* dialog, right-click in the **Current Template** window and choose **Add New Component > Unconstrained** from the pop-up menu. Name the component **Subgrade** and use the **MD_T_Subgrade** feature. Trace the pavement layers to define the subgrade component. Be sure that this element is not placed as a closed component. An example of the component is shown below.



Creating Cross Sections in Sheet Format

Cross Section design files are created using the ODOT_Files.mvba Application. To launch this application from the MicroStation pull-down menu, select **ODOT > File Management > Create Design Files**.

Select the **Roadway Sheets** category to create a cross section sheet design file.



The "XS" file type is used for cross section sheets. This file is stored in the ***\Roadway\Sheets*** folder for the project.

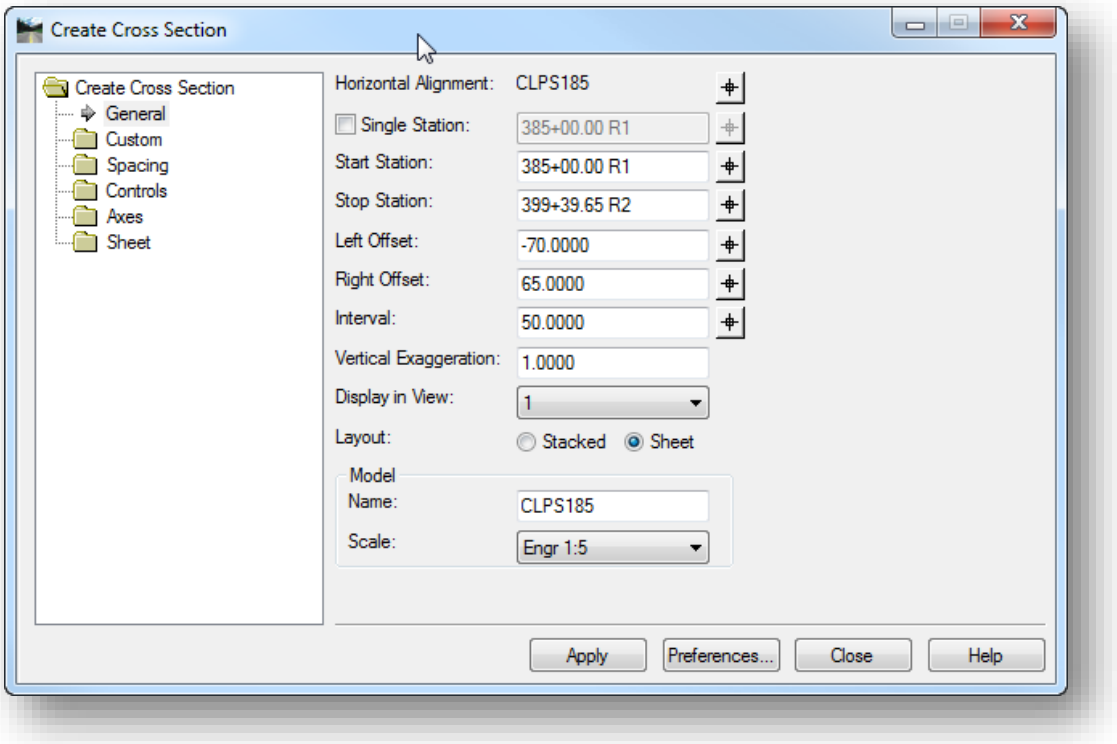
Tips:

- When the Cross Section design file is created, use a **Scale** value of **1**
- The OpenRoads tools will be used to create the cross section sheets and set the annotation scale for the cross section sheet model.

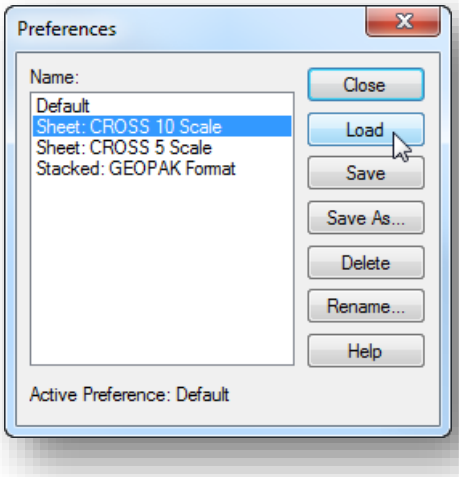
Cross sections are extracted from referenced corridor models, 3D graphics, and terrain models. Before extracting the cross sections, attach the necessary references and turn on/off the desired graphics.

- In the Cross Section design file, be sure to set the **Design** model as the active model before attaching references

When the **Create Cross Sections** command is selected, you are prompted to **Locate Alignment**. After selecting the desired alignment, the *Create Cross Sections* dialog is opened.



The dialog defaults to a 5-Scale sheet option. To change the format, select **Preferences** button. The ODOTcadd workspace included three options as shown below.



Sheet: CROSS 10 Scale
This preference will cut cross sections and place them on the ODOT sheet cell CROSS at a scale of 10.

Sheet: CROSS 5 Scale
This preference will cut cross sections and place them on the ODOT sheet cell CROSS at a scale of 5.

Stacked: GEOPAK Format
This preference will cut cross sections and place them with GEOPAK cells. This preference will allow the user to use the legacy GEOPAK tools.

There are several options in the *Create Cross Section* dialog.

- The **General** tab is where most of the user edits will be made. The other tabs in this dialog have been set up by the loaded preference. The **General** tab is where the user can set the **Start Station**, **Stop Station**, **Left** and **Right Offset** and the **Interval** to cut cross sections.

- Unlike with GEOPAK tools, pattern lines are not used to set locations to cut cross sections. If the GEOPAK format preference is loaded, then when the cross sections are generated pattern lines will be drawn.

- Another option the user will set is the **Display in View** option. After the cross sections are cut they will be displayed in the selected view.

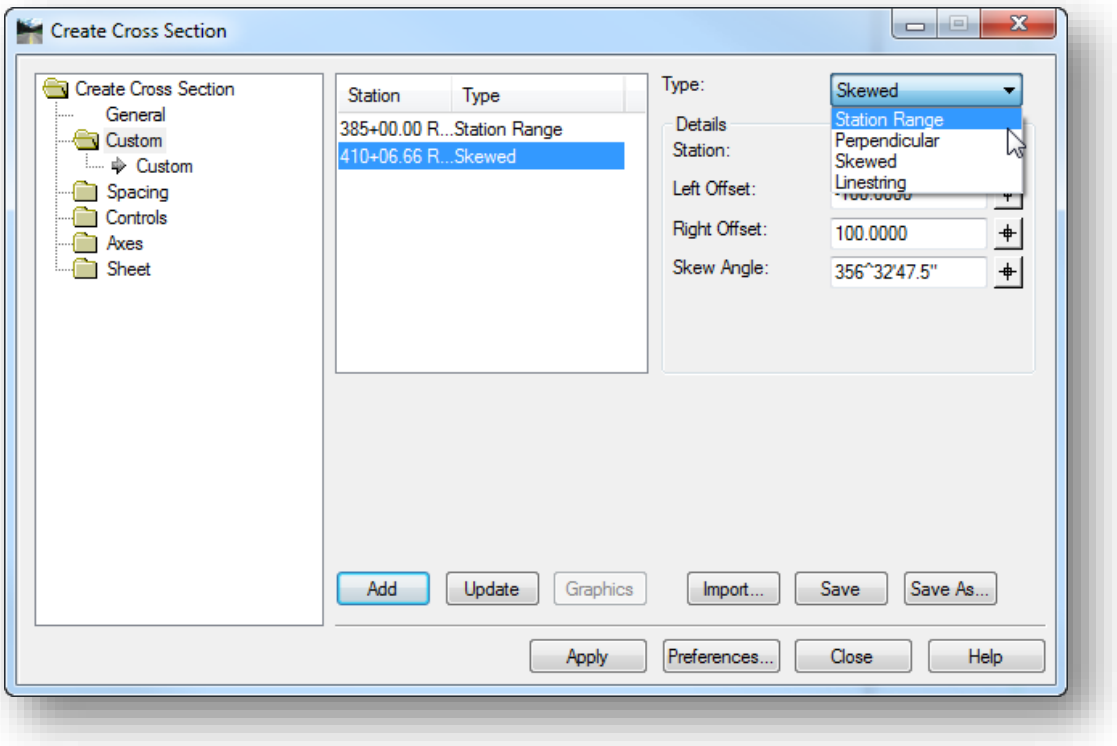
- When cross sections are cut, a new drawing model is created. The **Model Name** can be specified in the **General** tab.

To cut cross sections select the **Apply** button in the *Create Cross Section* dialog.

With this release of the software, the cross sections generated using this tool are static and do not dynamically update as changes are made to the corridor model.

Cross sections are extracted at the specified **Interval** on the **General** tab.

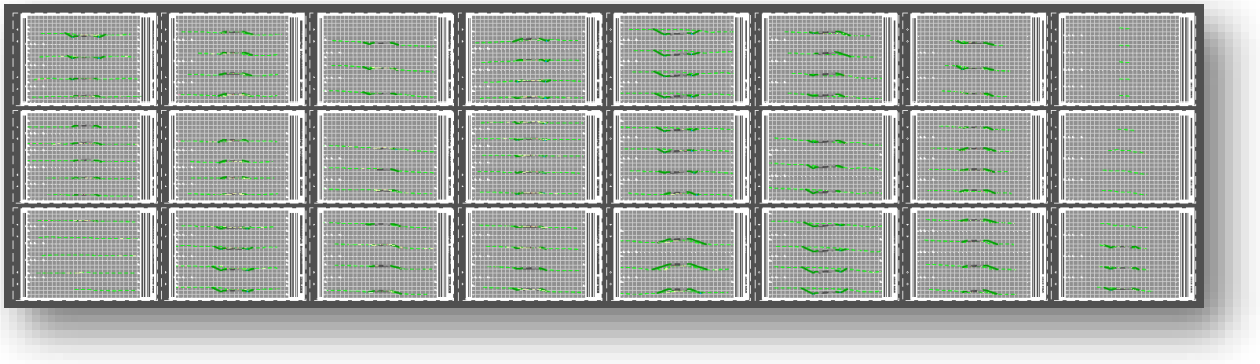
If cross sections are required at specific locations not covered by the **Interval**, the **Custom** tab is used to define the cross section locations.



If any custom cross sections are defined in the list view on the **Custom** tab, the settings for interval and offsets on the **General** tab are ignored. However, the toggles for critical sections (**Controls > Critical Stations**) are honored.

- **Station Range** allows you to extract multiple cross sections spanning a range of stations.
- **Perpendicular** allows you to extract a single cross section that is perpendicular to the alignment or graphics.
- **Skewed** allows you to extract a cross section that is skewed to the alignment or graphics.
- **Linestring** allows you to extract a cross section that is along the path of a linestring.

The cross section sheets are written to a Drawing Model. By default, the Drawing model has a gray background. Since the ODOT pavement components are drawn with gray scale values, it may be desirable to change the background color for the Drawing Model in your User Preferences (**Workspace > Preferences > View Options**).



The cross sections are placed in column format as shown above. The sheets can be split into separate models, or separate files, using the ODOT Split Sheet Cells application which is detailed later in this chapter.

Creating Cross Sections in GEOPAK Format

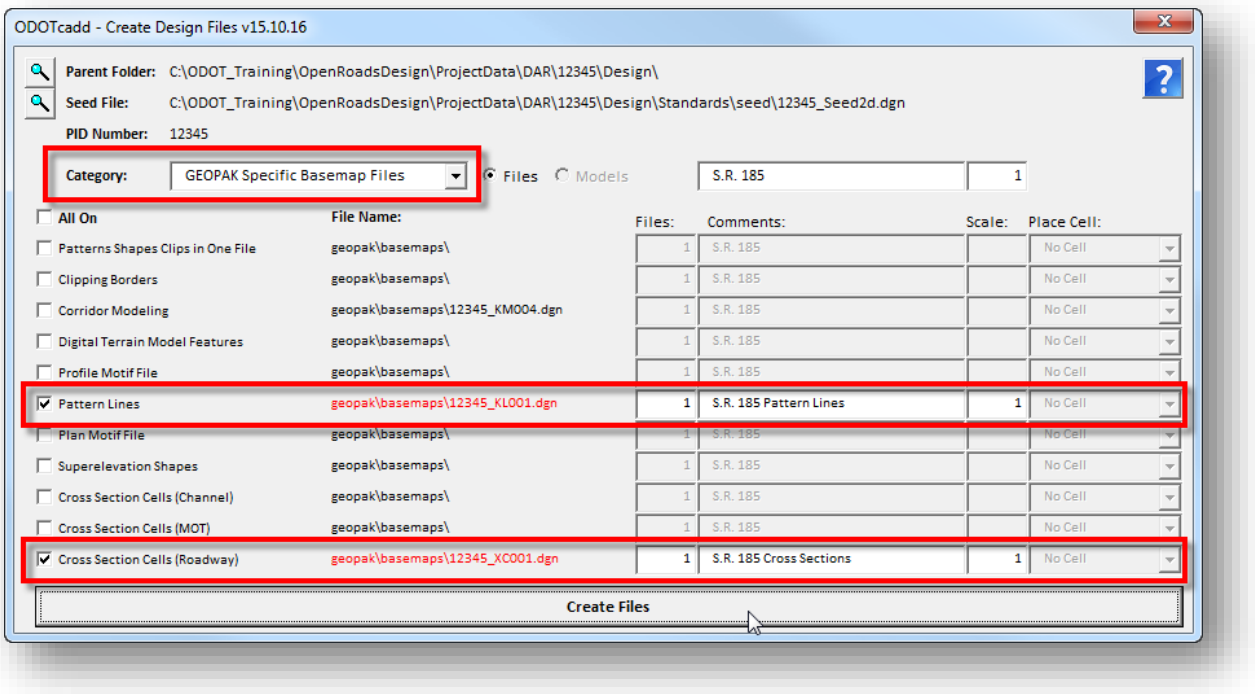
If you intend to use any legacy GEOPAK functions, it is necessary to process the cross sections into a format that is compatible with the legacy tools. The legacy tools, such as Earthworks Quantities, Seeding Quantities, or criteria processing, require the following information for processing:

- Horizontal alignments stored as chains in the GPK
- Vertical alignments stored as chains in the GPK
- GEOPAK Pattern Lines
- Cross Sections with GEOPAK Cells

GEOPAK functions will not allow both the pattern lines and the cross sections to reside in the same design file. When the cross sections are extracted from the 3D model, the pattern lines are draw in the Design Model and the cross sections are placed in a Drawing model within the active design file. The pattern lines and the cross sections must be split into separate design files in order for GEOPAK to recognize these graphics when processing the legacy tools.

According to ODOT CADD Standards, pattern lines are drawn in the "KL" dgn file. The cross sections and GEOPAK cells are drawn in the "XC" dgn file. The **ODOT_Files.mvba** application is used to create the files.

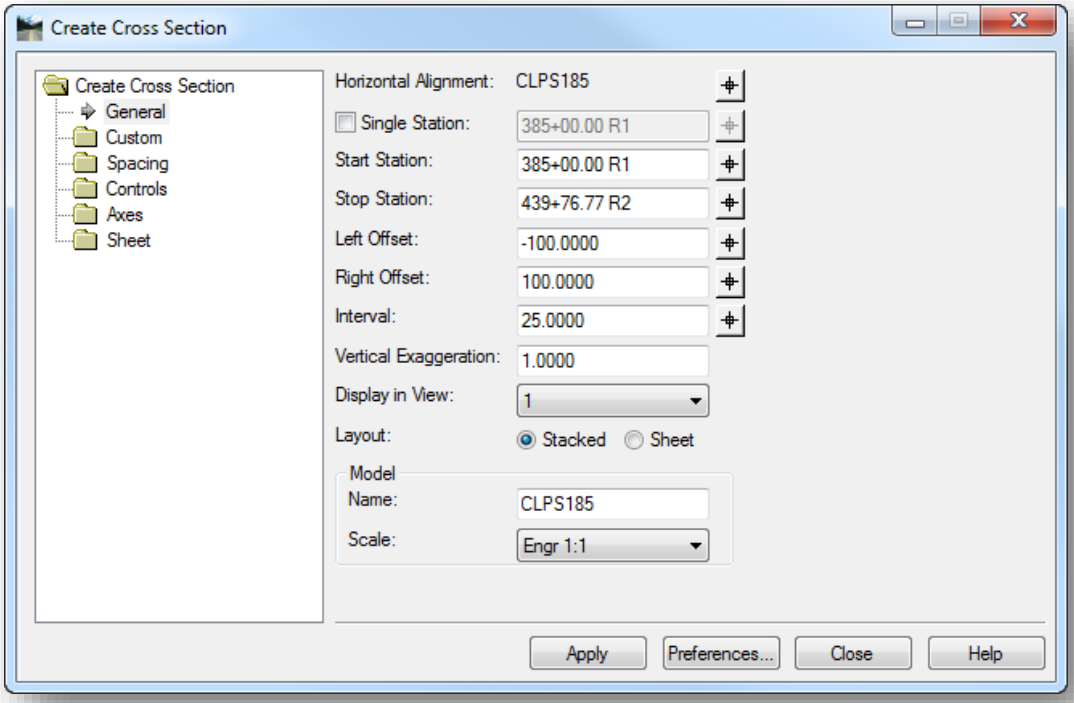
From the MicroStation menu, select **ODOT > File Management > Create Design Files** to open the dialog shown below. Toggle the **Category** option to **GEOPAK Specific Basemap Files** to create the **KL** file and the **XC** file for the pattern lines and cross sections.



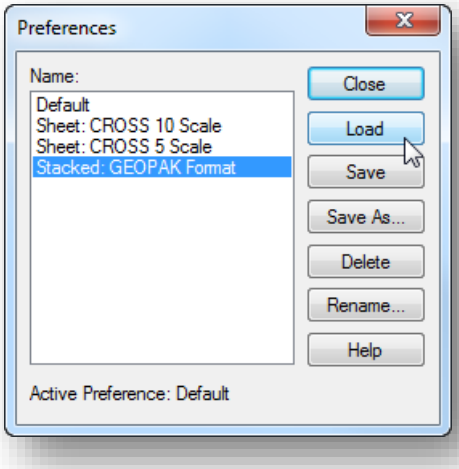
Take the following steps to extract the cross sections in GEOPAK format:

- ✓ Open the **XC** file and attach all of the 3D corridor design files, survey, and any other 3D information that you wish to use to extract the cross sections. Remember, cross sections ae a byproduct of the 3D model. Anything that you wish to show up on the cross sections must be drawn in the model.

- ✓ Select the **Create Cross Sections** command and then choose the desired alignment as prompted.

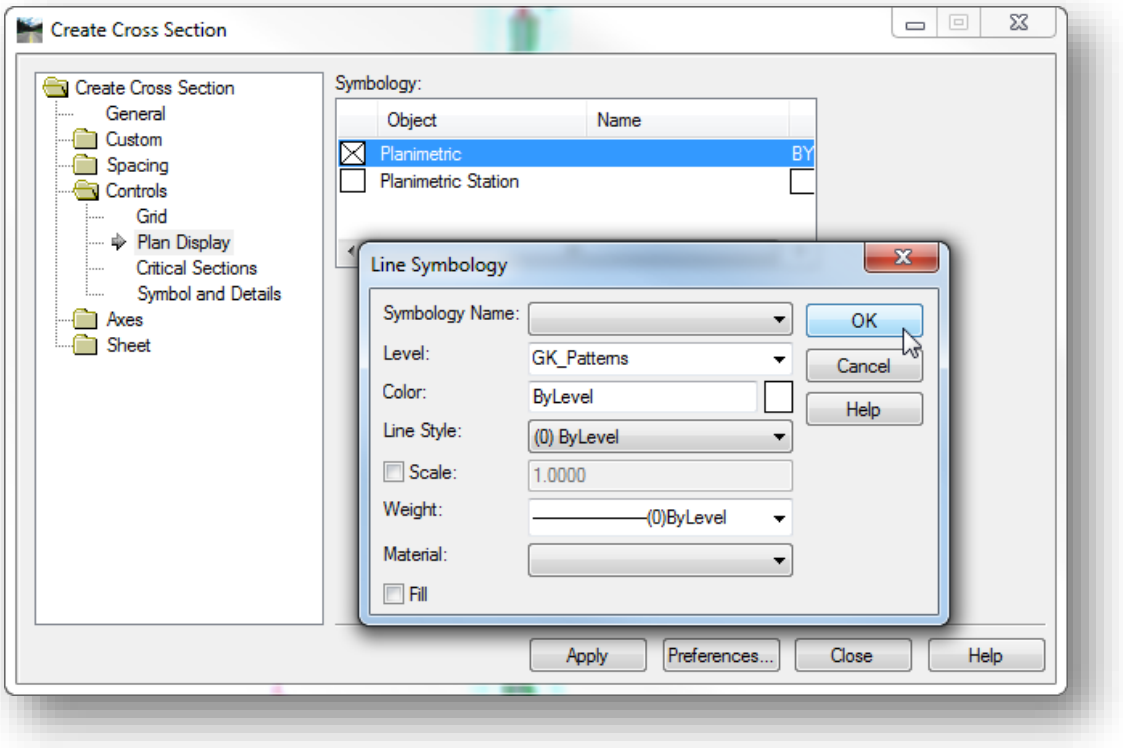


- ✓ From the *Create Cross Sections* dialog, choose the **Preferences** button. Select the **Stacked: GEOPAK Format** option and choose the **Load** button as shown below.



- ✓ From the *Create Cross Sections* dialog, set the **Start Station**, **Stop Station**, **Left Offset**, **Right Offset**, and Interval settings as desired. The **Custom** item can be used to set a custom station range as well as specifying additional stations for cross section locations as detailed previously in this document.

- ✓ The Pattern Line symbology is defined by the **Controls > Plan Display > Planimetric** item. Double-click on the item to edit the settings as shown below.



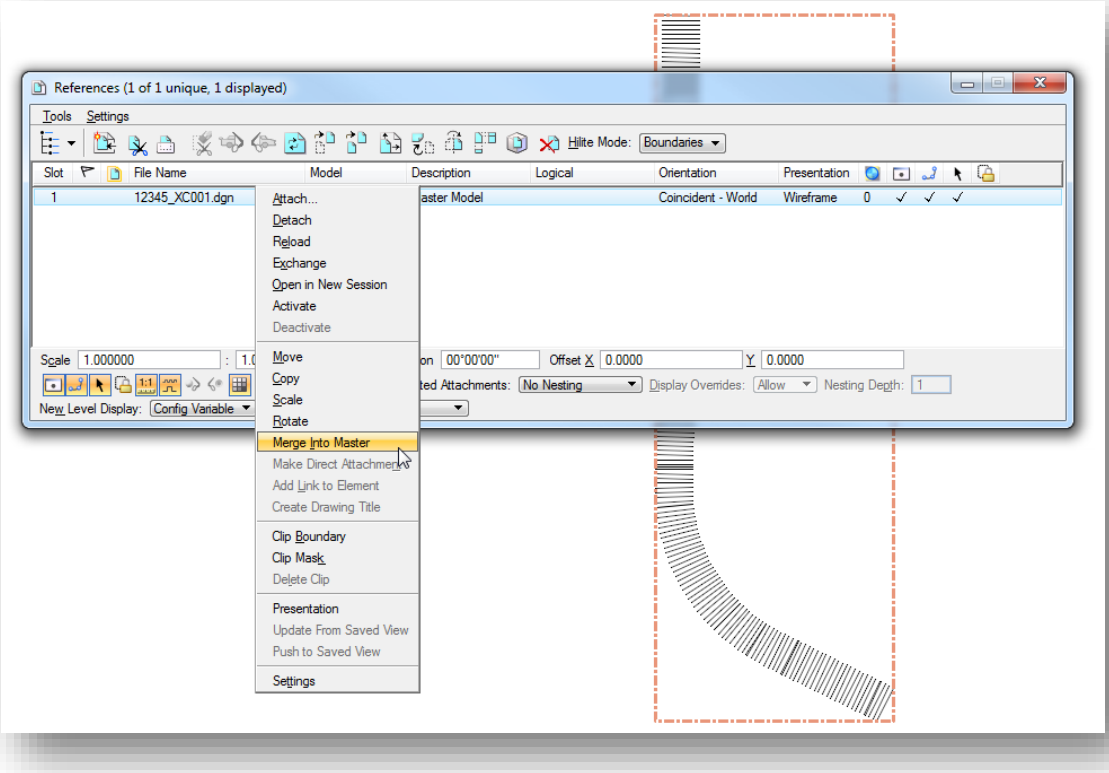
- ✓ Select the **Apply** button to initiate the process. The cross sections are written to a new Drawing Model within the active **XC** dgn file. The new drawing model is named according to the **Model Name** specified in the **General** settings of the *Create Cross Sections* dialog.

- ✓ From the MicroStation pull-down menu, select **File > Save Settings** to save the cross section model as the active model.

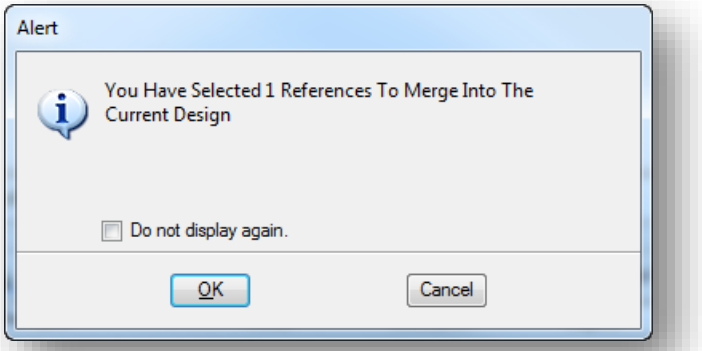
The pattern lines must be contained in their own design file is order for the legacy GEOPAK commands to locate the pattern lines. The easiest way to put the pattern lines in the KL design file is through the use of references. Take the following steps to copy the pattern lines to the KP design file:

- ✓ Open the KL file and attach the design model from the XC design file as a reference attachment. Turn off **Live Nesting** when making the attachment.

- ✓ Once attachment is made, you can merge the referenced elements into the active file. Right-Click on the XC reference attachment and choose the **Merge Into Master** command as shown on the next page.



✓ When the command is issued, you are prompted to select the view to merge the reference. Select the active view. Select **OK** from the *Alert* dialog when it appears.



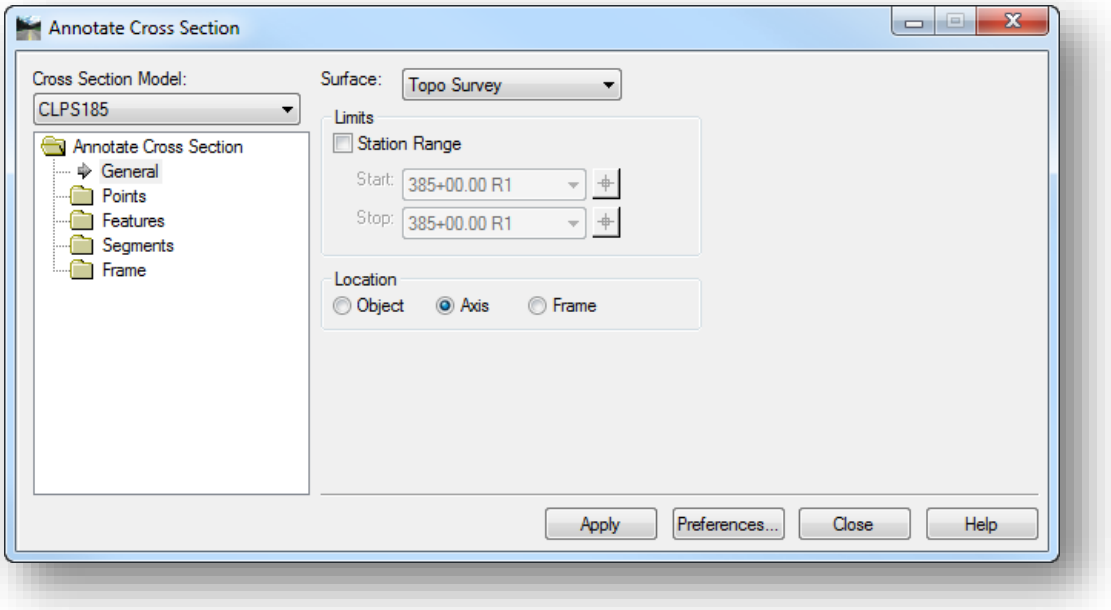
✓ The reference content is merged into the active file. The reference attachment is automatically removed. From the MicroStation pull-down menu, select **File > Save Settings** to save the design file settings.

Remember:
The cross sections contained in the XC file are not dynamically linked to the model. Changes to the model will necessitate manually recreating the cross sections and pattern lines.

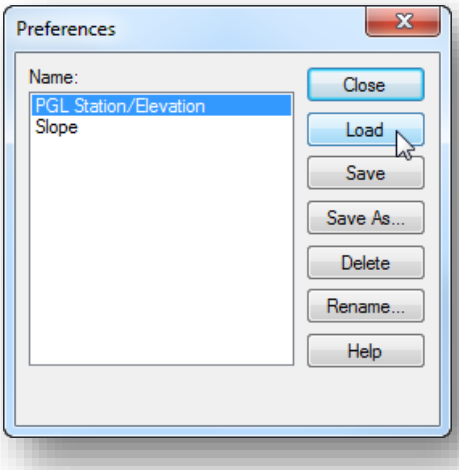
11.3 Annotate Cross Sections

Cross sections extracted from the model are not annotated. This is true whether the cross sections are extracted into sheets or in GEOPAK format. The **Annotate Cross Section** tool is used to annotate cross section elevations and slopes.

The tool can be found in the **Civil Tools** task in the **Corridor Modeling** group. The *Annotate Cross Section* dialog in shown below.



ODOT has two preferences configured to help annotate cross sections. To load a preference, select the **Preferences…** button. In the *Preferences* dialog shown below select the desired preference and select load.



PGL Station/Elevation:
This preference will set up the *Annotate Cross Section* dialog with the correct settings for placing the proposed grade line station and elevation.

Slope:
This preference will set up the *Annotate Cross Section* dialog with the correct settings for placing slope values above a given line.

There is currently a limitation in using this tool to place the Existing elevation.

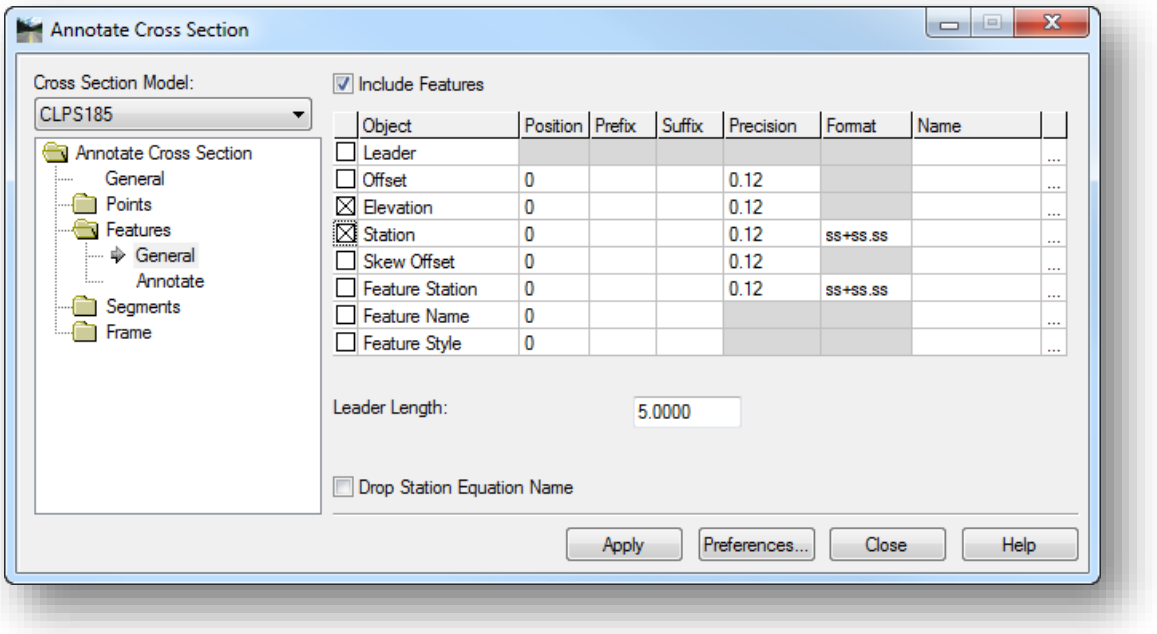
The *Annotate Cross Section Dialog* has several sections. First the user should select the **Cross Section Model** to annotate. Then the user should select the **Surface** to annotate.

When using either of the two ODOT preferences the user to should select the corridor as the surface. In the **General** tab there is also an option to set a station range to apply the annotation to.

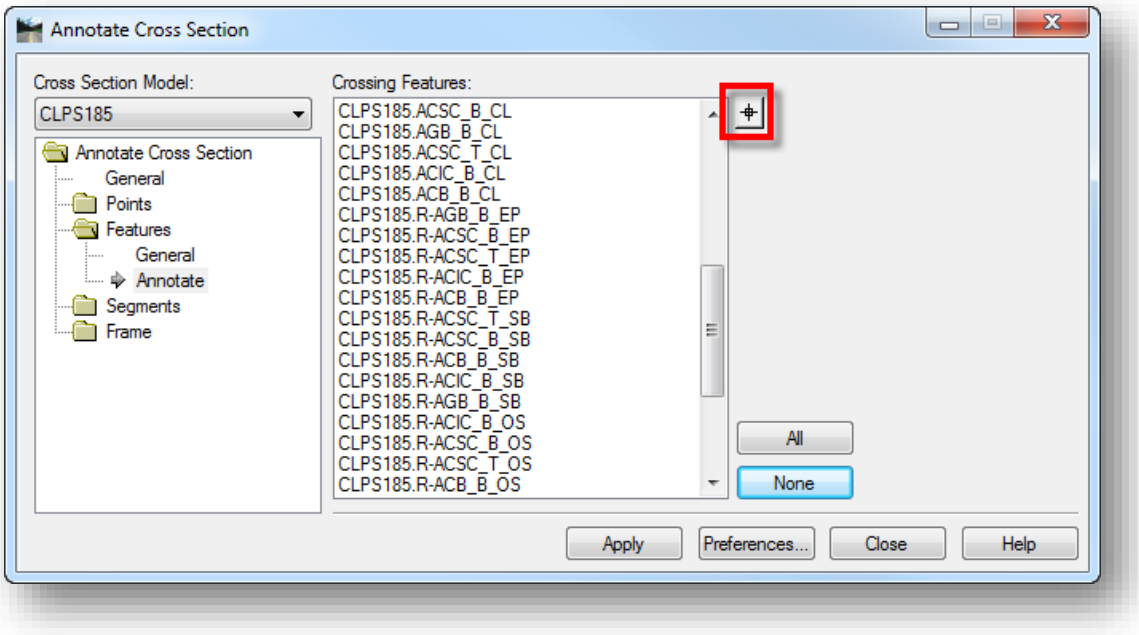
There are four folders shown in the dialog, **Points**, **Features**, **Segments**, and **Frame**. The user only needs to edit the **Features** and **Segments** Folder.

PGL Station/Elevation Labeling

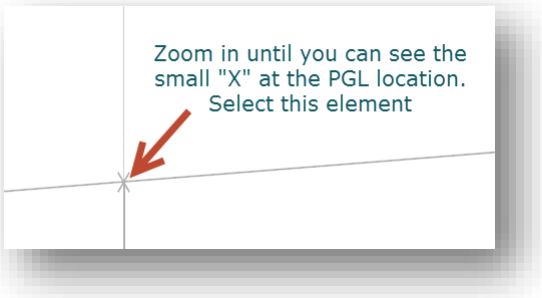
To place station and proposed grade line elevations the user needs to first load the **PGL Station/Elevation** preference as described above. When this preference is loaded the **Features > General** folder will appear as shown below.



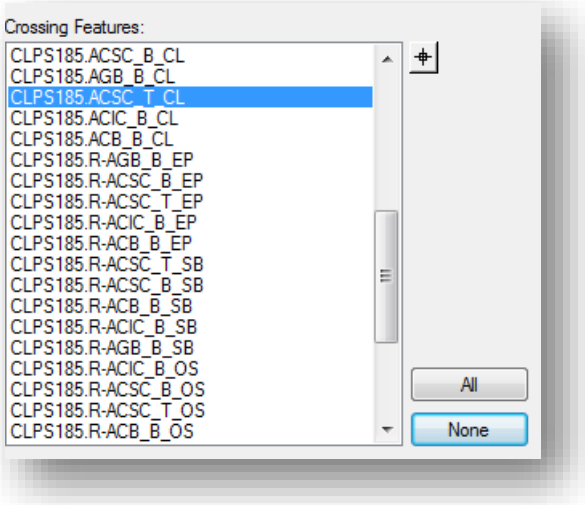
The Image shows the **Include Features** checkbox is checked and that **Elevation** and **Station** are check on in the list. In order to place the station and elevation data on the cross sections the user needs to select the **Crossing Feature** name from the list of points that are defined in the cross sections. To do this the user should click in the **Annotate** tab in the **Features** folder and click the locate element button as shown below.



When that button is selected the dialog will temporally disappear and in MicroStation the cursor will be a selection cursor to identify an element. The user should navigate to any cross section in the desired cross section model and zoom in on the part of the cross section where the proposed center of pavement is. When the template was made for the corridor there were features assigned to certain locations, the features are set to display an X on the cross sections. The X's are placed at an extremely small scale and are construction levels and therefor will not be plotted. See the section on templates for more information. The image below shows a zoomed in view of the center line feature at the proposed center line location in a cross section.

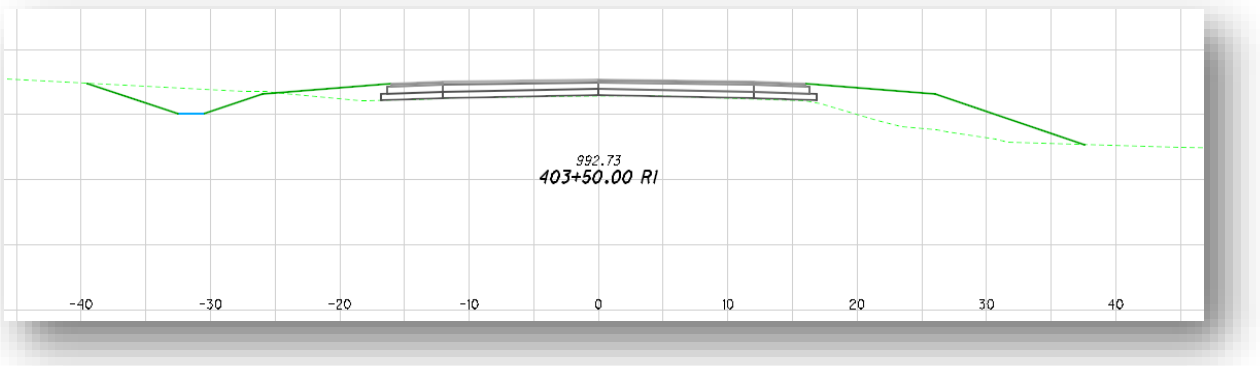


The *Annotate Cross Section* dialog will reappear after a selection is made and the selected feature will be highlighted in the **Crossing Features** list as shown below.



Note: The points that are selected in the **Crossing Features** list will be annotated using the current settings of the *Annotate Cross Sections* dialog. Use the **All** button to select all the points. Use the **None** button to clear the selected points.

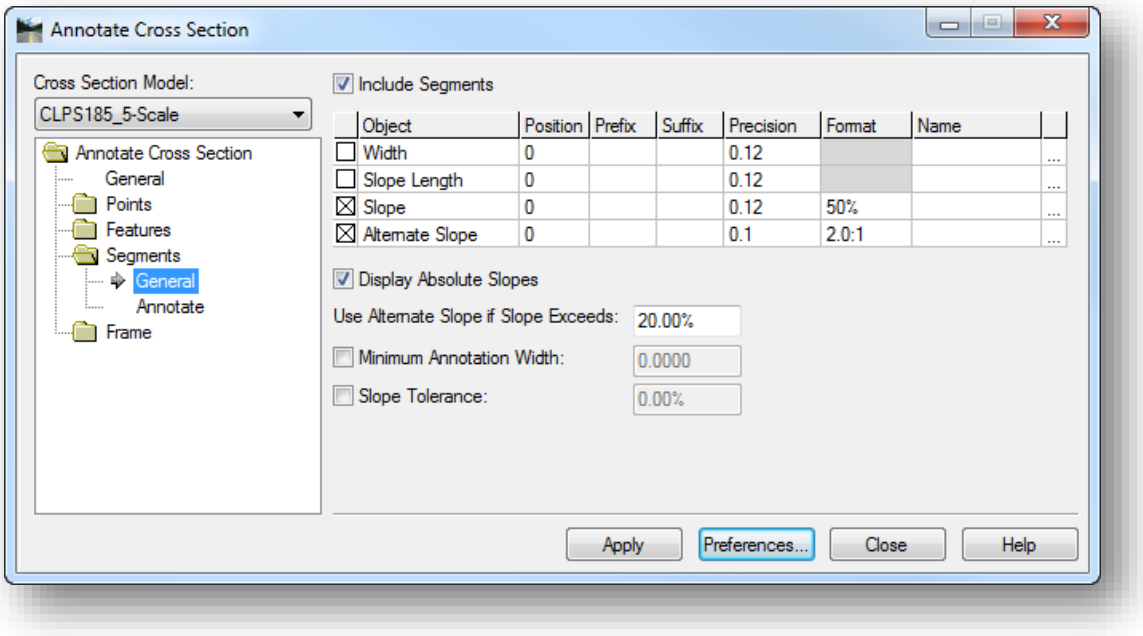
When the **Apply** button is selected, all the cross sections in the selected cross section model and within the specified station range if set are annotated with the respective station and PGL elevation as shown in the example below.



Note: The vertical location of the text is determined by an offset value in the preference settings. The offset is measured relative to the selected point, not relative to the cross section grid. The location of the station and elevation text will not be centered vertically within the cross section grid lines as seen in the example above.

Slope Labels

A similar process can be used to annotate slopes. To do this the user should first load the **Slopes** preference in the *Annotate Cross Section* dialog described above. Now navigate to the **Segments** folders. The dialog should look as imaged below.



Notice the **Include Segments** checkbox is check on as well as **Slope** and **Alternate Slope** are checked in the list.

The loaded preference has set default values to annotate slopes, these settings can be edited as desired from the list by selecting the ... button in the last column of the list.

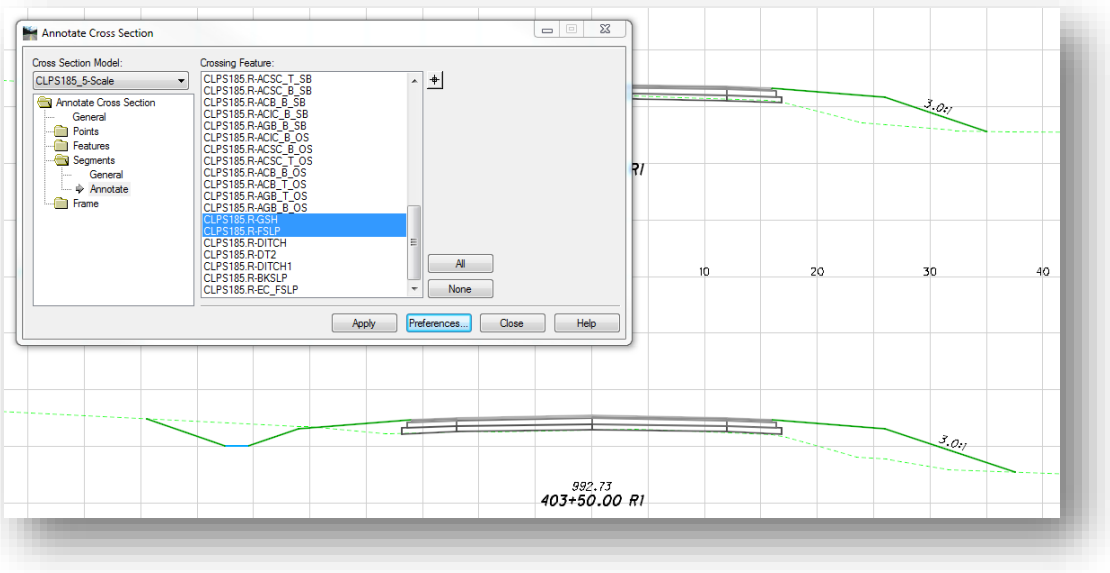
The **Alternate Slope** annotation settings are used if the slope exceeds 20% as defined by the **Use Alternate Slope if Slope Exceeds** parameter.

Note that the number of decimal places is user definable by changing the **Precision** parameter.

Again the user needs to select the features to annotate. To do this the user should select the **Annotate** tab in the **Segments** folder and click the locate element button to select the points that will be used to annotate a slope. When that button is selected the dialog will temporally disappear and in MicroStation the cursor will be a selection cursor to identify an element. The user should navigate to any cross section in the desired cross section model and zoom in on the part of the cross section where the desired slope starts and issue a data point (left click).

When the template was made for the corridor there were features assigned to certain locations, the features are set to display an X on the cross sections. The X's are placed at an extremely small scale and are construction levels and therefor will not be plotted. These features were placed in the template at the start and end locations of the slopes in the end conditions.

After the user clicks on the desired feature for the start of a slope the *Annotate Cross Section* dialog will appear again with the selected feature highlighted in the list. The user should repeat this process to select the feature at the end of the slope. The *Annotate Cross Section* dialog should look similar to what's shown below. There should be two features selected representing the beginning and end of a given slope. Now the user should select the **Apply** button. This will go through all the cross sections in the selected cross section model and within the specified station range if set and annotate the respective slope, an example is shown below.

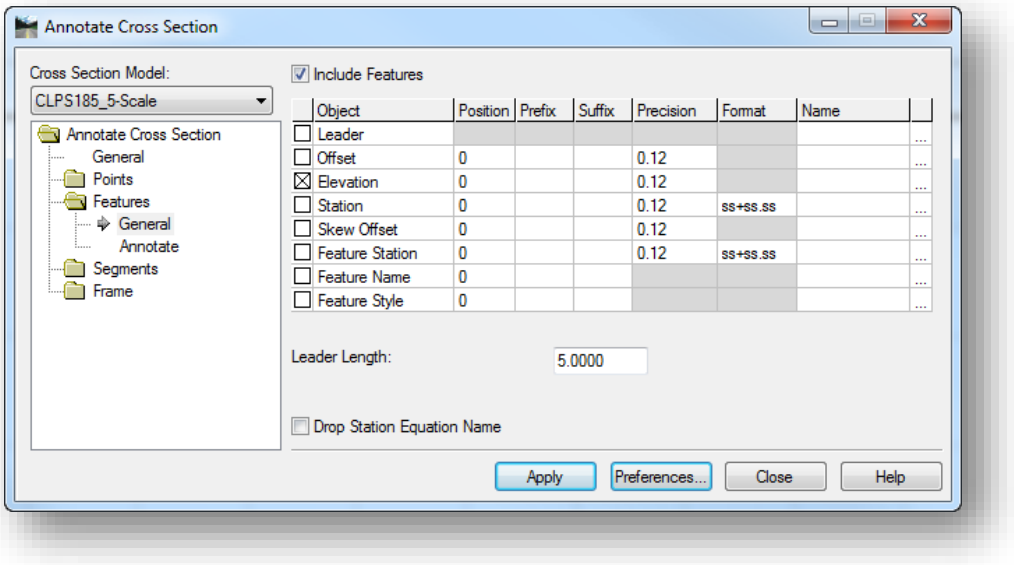


Tip: The software will annotate the slope between all the selected points. Selecting more than two points will lead to unwanted annotations. Annotate each segment by selecting one pair of points at a time.

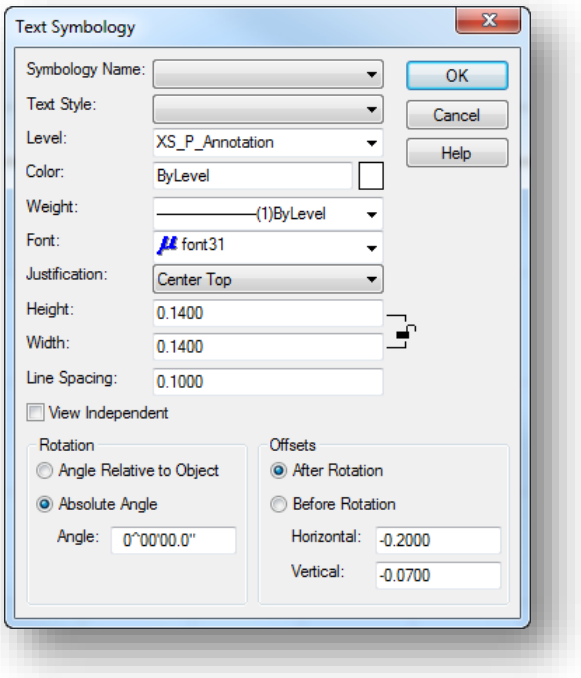
Labeling Ditch Elevations

Although an ODOT preference has not been configured specifically to annotate ditch elevations, annotation for ditch elevations can be easily labeled using the *Annotate Cross Sections* dialog.

Select the **Features** tab and check on the **Include Features** item. Toggle on the **Elevation** item as shown below.



The format for the text is set by choosing the ... button at the end of the item list. Set the **Text Symbology** parameters as shown below to label ditch elevations.

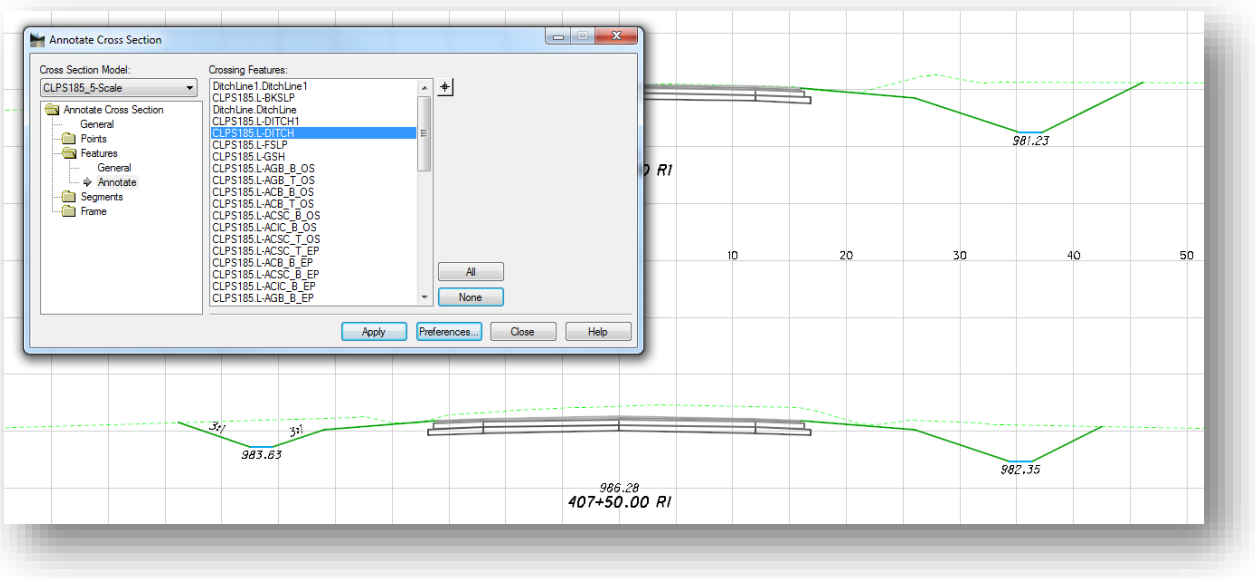


The **Horizontal** offset is used to offset the text horizontally from the point that is selected for annotation. We will select the inside ditch point for ditches on the left side of the cross section, and the outside ditch point for ditches on the right side of the cross section.

The **Horizontal** offset value is multiplied by the annotation scale to determine the text location. In this example the value of -0.2 will be multiplied by the annotation scale value of 5 for an offset of -1.0 from the selected point.

The **Features > Annotate** tab is used to select the points to be annotated. Select the point names from the **Crossing Features** list, or use the **Locate** button to graphically select the small "X" that is placed on the cross section points.

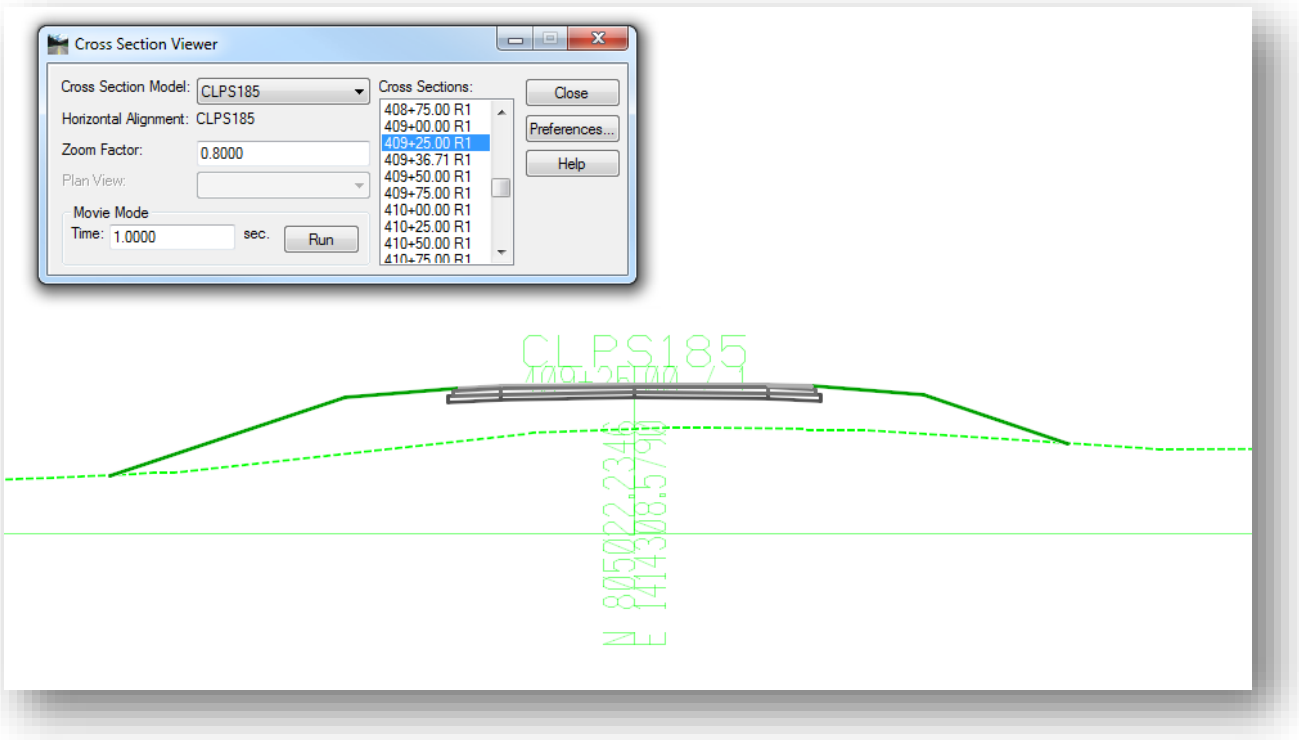
An example of the annotated ditch elevations is shown below.



11.4 Cross Section Viewer

This tool can be found in the **Civil Tools** task in the **Corridor Modeling** group. The *Cross Section Viewer* dialog is shown below.

Using this dialog, the user can navigate to the desired cross section within the selected **Cross Section Model**.



The dialog will list all the stations where a cross section was cut. The user can click on a desired station and the cross section at that station will be centered in the view. The user can use the arrow keys to move to the next cross section. A **Zoom Factor** can also be set as well as a movie mode can be run where the view will move through the cross sections at a specified time interval.

11.5 Displaying Right-Of-Way Labels on Cross Sections

Right-of-Way labels can be displayed on the cross sections with the OpenRoads tools as shown in the example below.

In order to display the Right-of-Way on the cross sections, the right of way lines must be defined as 3D elements and referenced to the 3D model. The recommended procedure to generate 3D right-of-way lines is to reference the survey model into the right-of-way design file and activate the terrain as the active profile for each right-of-way line.

According to the ODOT CADD Standards, right-of-way lines are normally drawn in a separate right-of-way basemap, using the "BR" file code, in the following location:

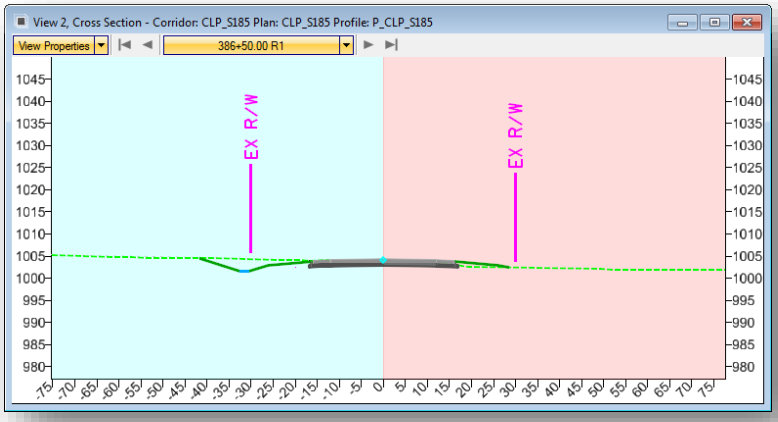
\Design\rw\basemaps\nnnnnn_BR###.dgn

Right-of-way lines drawn in 2D in the Design model can be used to generate the 3D right-of-way lines by taking the following steps:

- ✓ Attach the Survey basemap with the existing ground terrain as reference attachment
- ✓ Set the Survey terrain as the active terrain model
- ✓ Open a Profile View for the right-of-way lines, one at a time
- ✓ Set the existing ground line as the active profile to the selected right-of-way line
- ✓ When the profile is assigned, a 3D line string is generated in the 3D model for the right-of-way lines.

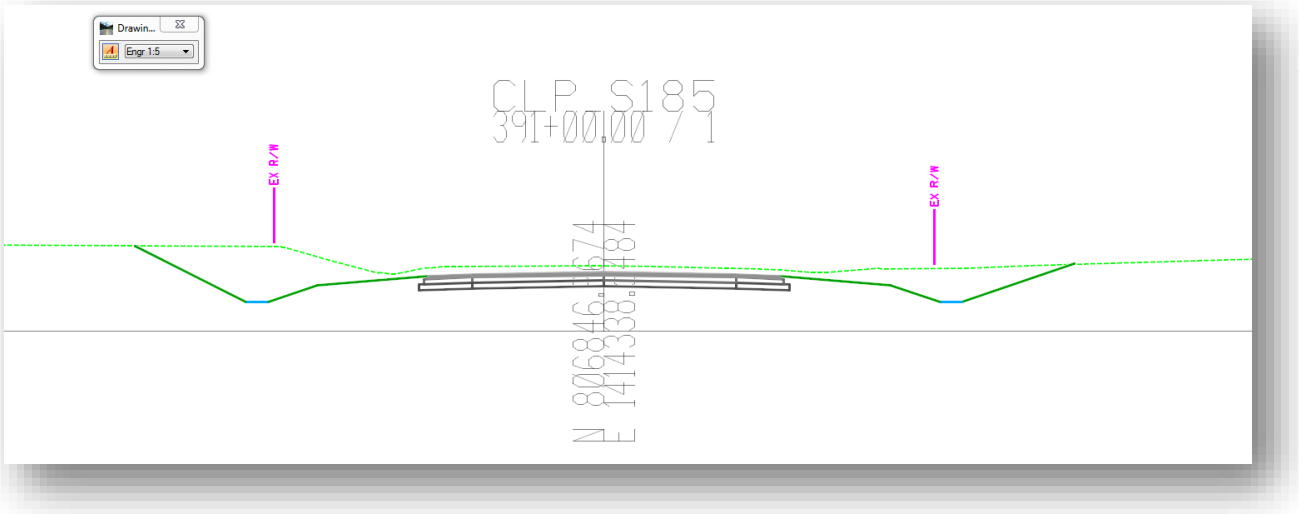
To display the right-of-way lines on the cross sections, reference the BR file with a **Nest Depth** value of **1** to the cross section design file.

The example below shows how the labels appear when using the **Open Cross Section View** command. The size of the label in the dynamic cross section view is not user controllable.



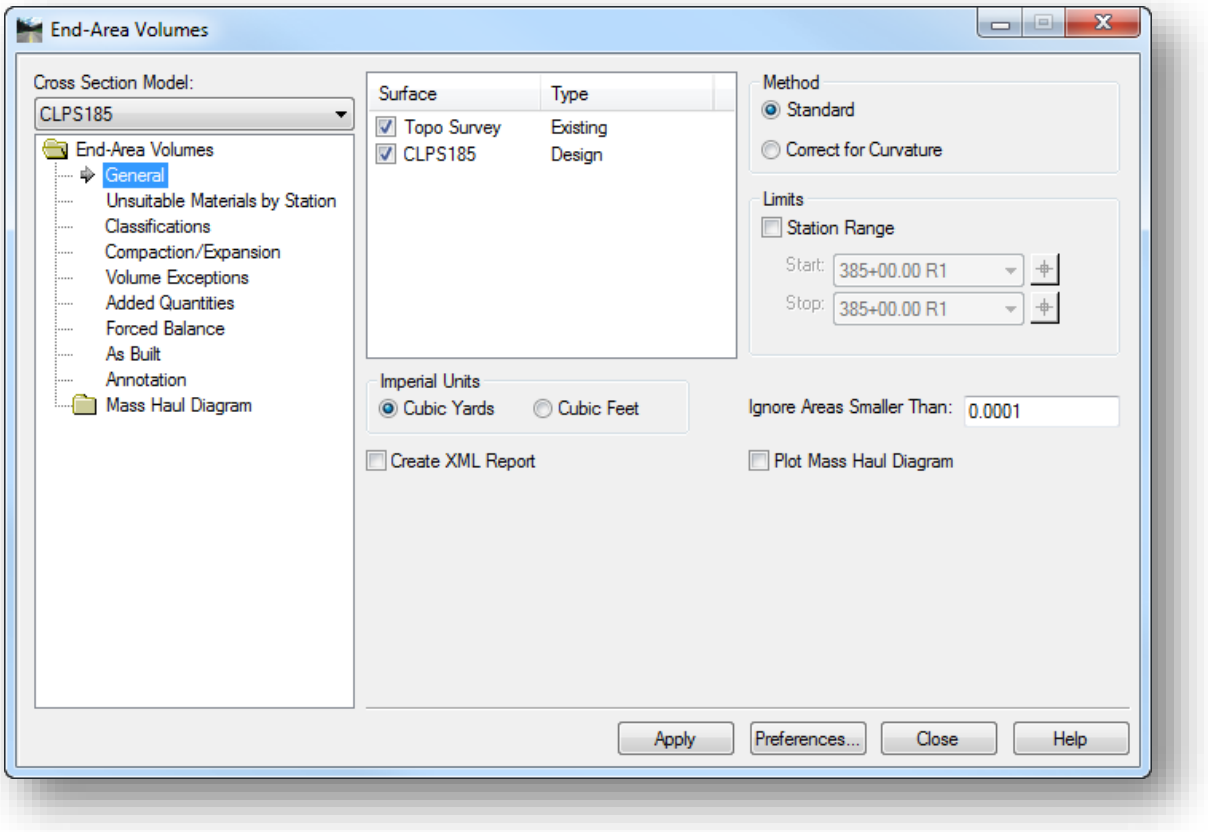
When the cross sections are processed using the **Create Cross Sections** command, the size of the right-of-way label is controlled by the model **Annotation Scale** setting.

The example below shows a cross section that was processed with the **Create Cross Sections** command. The **Stacked: GEOPAK Format** preference was used for this example.



11.6 End Area Volumes

The **End-Area Volumes** dialog can be found in the **Civil Tools** tasks, in the **Corridor Modeling** group. When launched a dialog will appear as the image below shows



This tool currently has some limitations. ODOT pays for concrete removal as a separate pay item. Asphalt pavement is sometimes removed with excavation, but may be a separate removal item depending on the project. This tools is used for simple cut and fill quantities and cannot be used for more complex situations with separate concrete removal areas.

If your project requires more than simple cut and fill quantities, you must cut cross sections using the GEOPAK format with cross section control cells and then use the legacy GEOPAK tools to generate the cross section quantities. See ODOT's **GEOPAK Road 2** training guide for information on the legacy GEOPAK earthwork quantity tools.

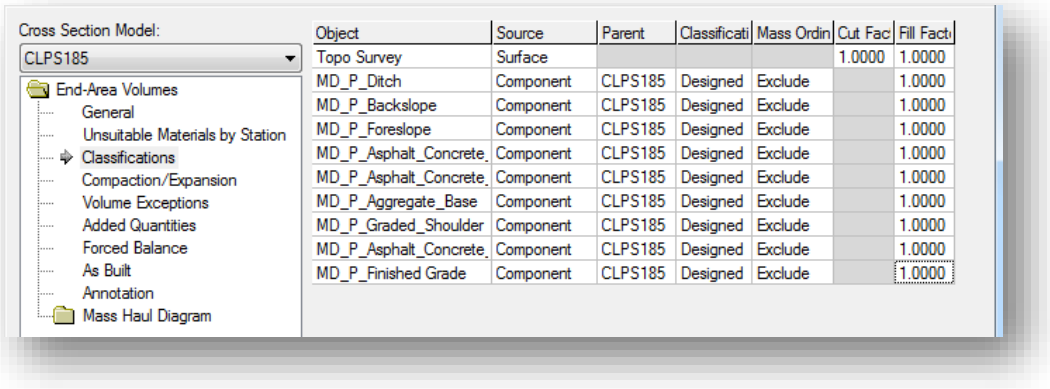
ODOT has a preference that can be loaded for this dialog. This preference can be loaded by selecting the **Preferences…** button. Then selecting **ODOT Basic Cut Fill** preference and hit load.

The *End-Area Volumes* dialog has several options. The **General** tab imaged above will list the surfaces found for the selected alignment. This will typically be existing survey and a proposed corridor. Each surface has a type. The type is set by the feature definition. There are 4 types of surface, **Existing**, **Design**, **Substrata**, and **Subgrade**. Existing survey surface will be set to existing and a corridor should be set to a design type.

The **General** tab has options for calculation method, station range limits, area size to ignore, units, and reports. The **Create XML Report** checkbox is useful to review and see quantities. ODOT recommends checking this checkbox on. XML reports are described below.

The **Unsuitable Materials by Station** tab can be used for top soil striping, ODOT does not currently do top soil striping.

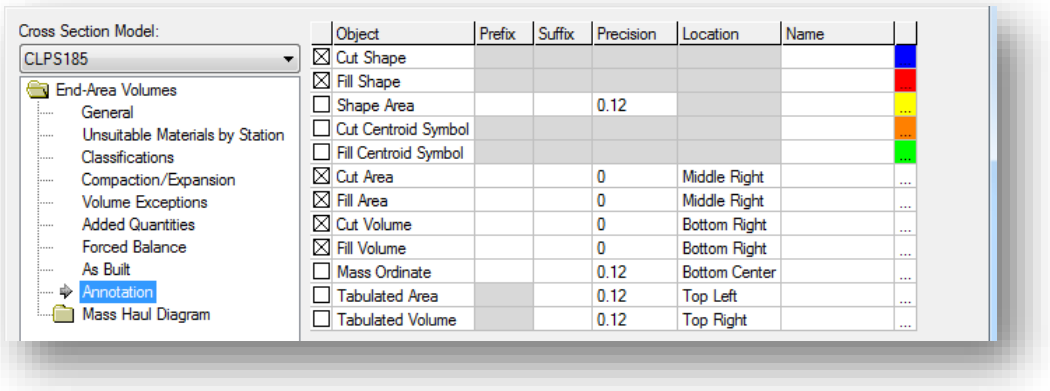
The **Classifications** tab will list the surface and components of the corridor. The image below shows an example of what the classifications tab looks like. The calculations will produce volumes for these components. **Fill Factors** can be set for a given component.



The **Compaction/Expansion** tab can be used to set cut and fill factors for given station ranges.

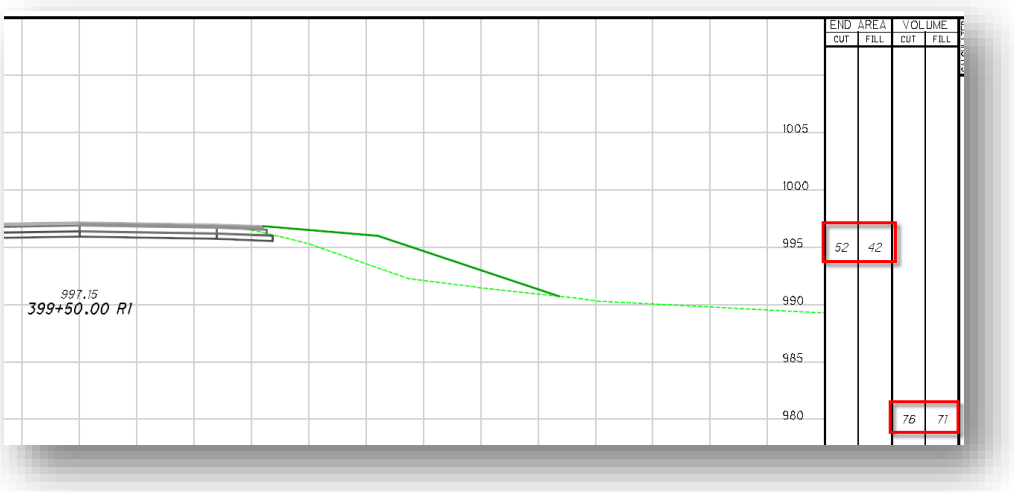
The **Volume Exceptions** tab can be used to set station ranges to be excluded from volume calculations. This would typically be used to exclude bridge locations.

The **Annotation Tab** sets what will be drawn on the cross sections for end-area calculations. When **ODOT Basic Cut Fill Preference** is loaded this tab will look as shown below.

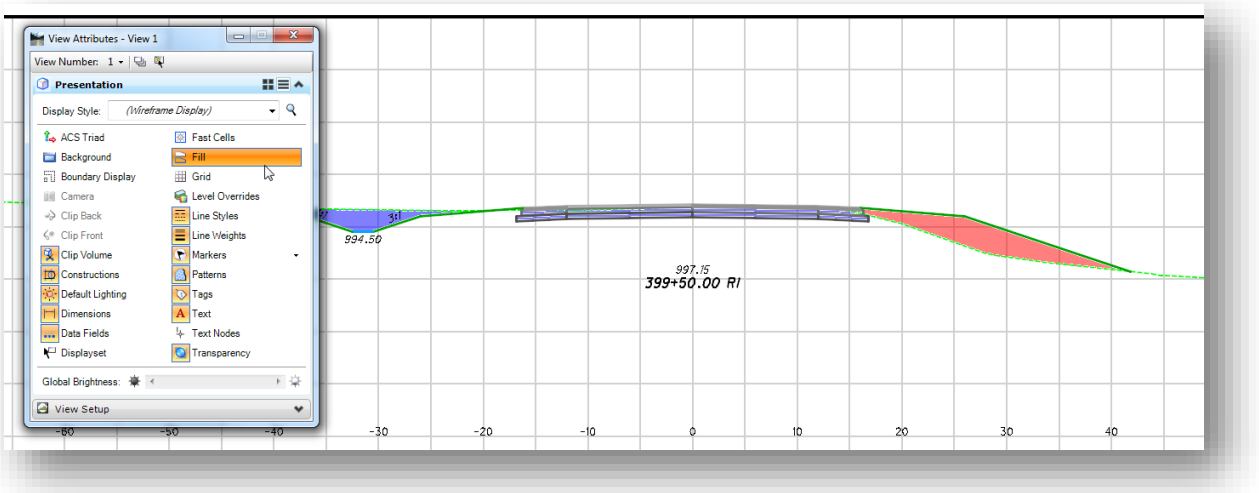


A **Cut Shape** and **Fill Shape** will be plotted on the cross sections as well as the **Cut Area**, **Fill Area**, **Cut Volume**, and **Fill Volume** text will be placed in the appropriate column on the ODOT sheet cell.

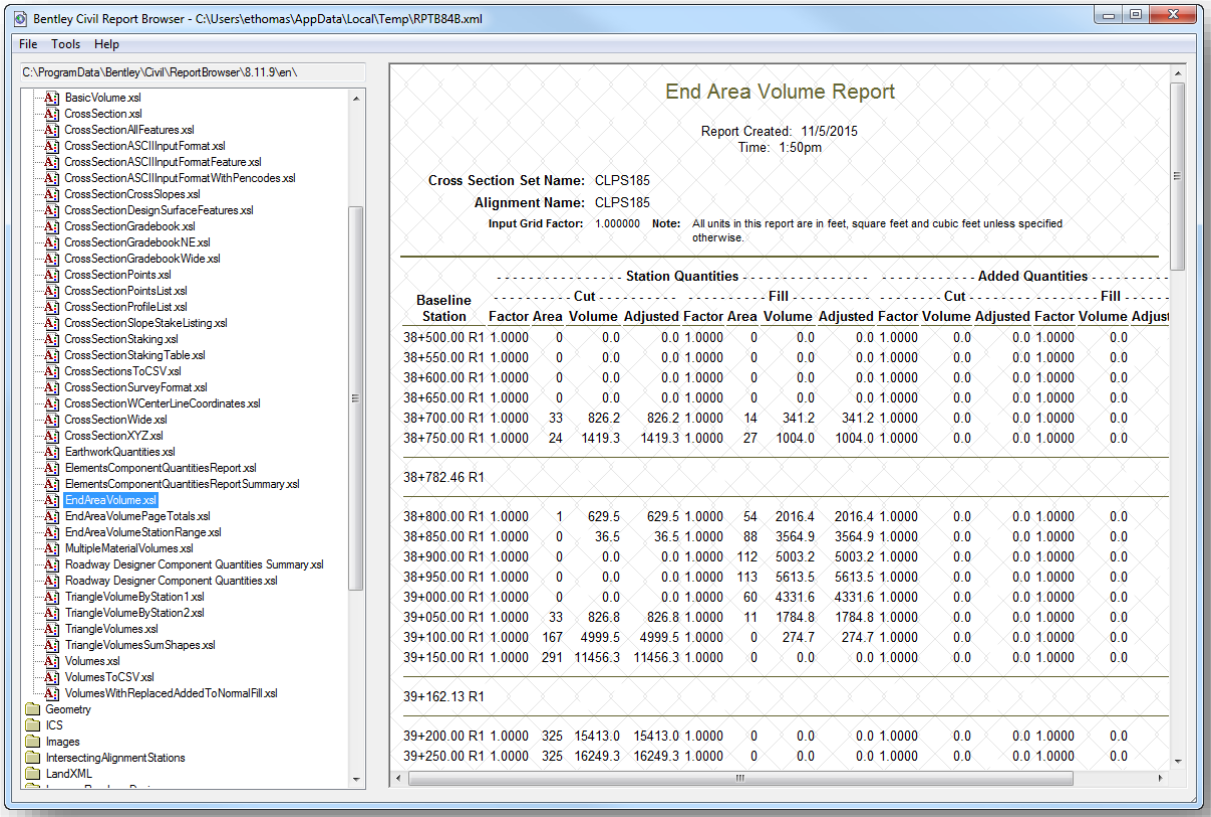
When the **Apply** button is selected the annotation will be plotted to the cross sections, the image below shows an example for where the cut and fill areas and volumes are placed in the model.



In order to view the cut and fill shapes the **Fill** view attribute must be toggled on, as pictured below. The shapes are placed on the level **XS_P_Earthwork_Shapes**.



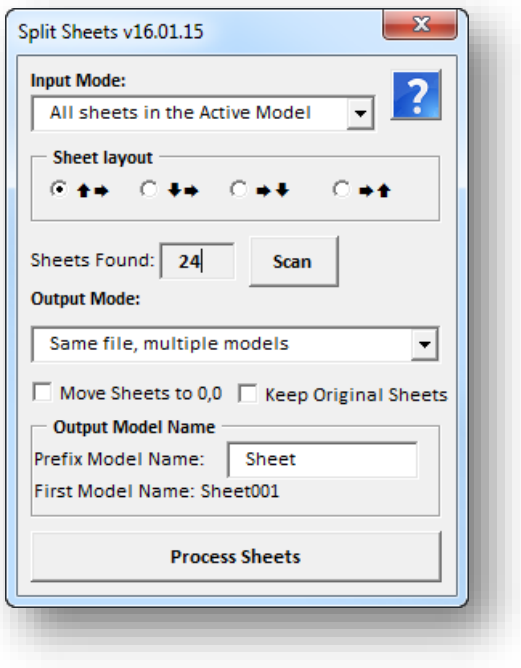
If **Create XML Report** checkbox was checked a report viewer will appear as imaged below. There are many reports to choose from. The user can double click on different reports, the **Volumes.xsl** report is a good report for viewing the calculations. The report will list each station a cross section was drawn at and give quantities for cut and fill areas as well as volumns for the components. The bottom of the report will list totals. The report can be printed to a pdf to be saved. Select **File > Print** in the report veiwer to print the report to PDF.



11.7 Setting up cross section sheets for printing

When cross sections are cut from the OpenRoads tools they are placed in a drawing model. ODOT has not previously made use of the drawing model. In order for the cross sections sheets to work with other applications and print organizer and to comply with ODOT standards the sheets need to be separated to one sheet per model for that file or separate the sheets to one sheet per file.

ODOT has written an application to assist in this process. The application can be launched from the MicroStation menu by selecting **ODOT > Sheet Management > Split Sheet Cells**. This will open the dialog imaged below.



Select the desired settings and select **Process Sheets** to initiate the process.

For more information click the Help icon to open up PDF documentation for the application.

Exercise 11 - Cross Sections

Use this chapter as a guide to extract cross sections for S.R. 185 in cross section sheet format.

Before creating the new design file for the cross sections, take the following steps to create 3D Right-of-Way lines:

- ✓ Open MicroStation using the shortcut provided for the training class.

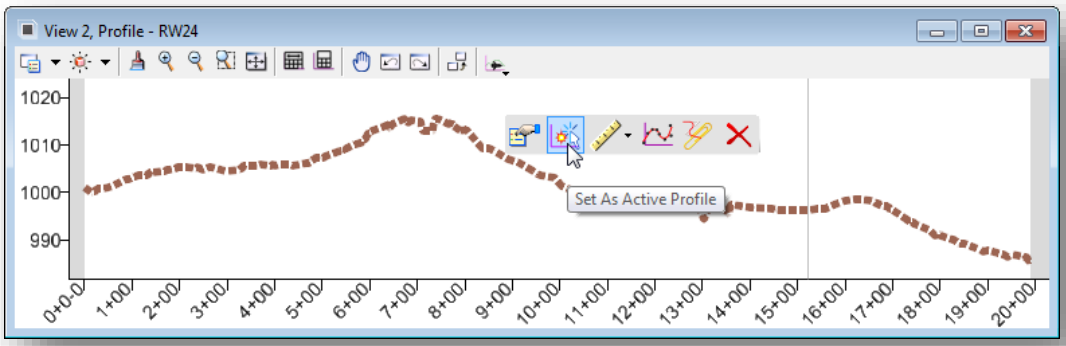
- ✓ Set the **User** and **Project** as follows:
  User: ODOTcadd
  Project: 12345-CROSS_SECTIONS

- ✓ Open the Right-of-Way basemap design file:
  ..\Design\RW\Basemaps\12345_BR001.dgn

- ✓ The existing right-of-way lines are already drawn in the file. The survey basemap has been attached as a reference. Select the terrain model and choose the **Set As Active Terrain** icon from the pop-up menu.

- ✓ Each right-of-way line must have a profile defined in order to create a 3D line sting for the right-of-way lines. The elevation of the profile will be used when the right-of-way markers are placed on the cross sections. Select each right-of-way line and choose the **Open Profile Window** command and follow the prompts to display the existing ground profile in a new window.

- ✓ Set the existing ground profile as the active profile for each right-of-way line.



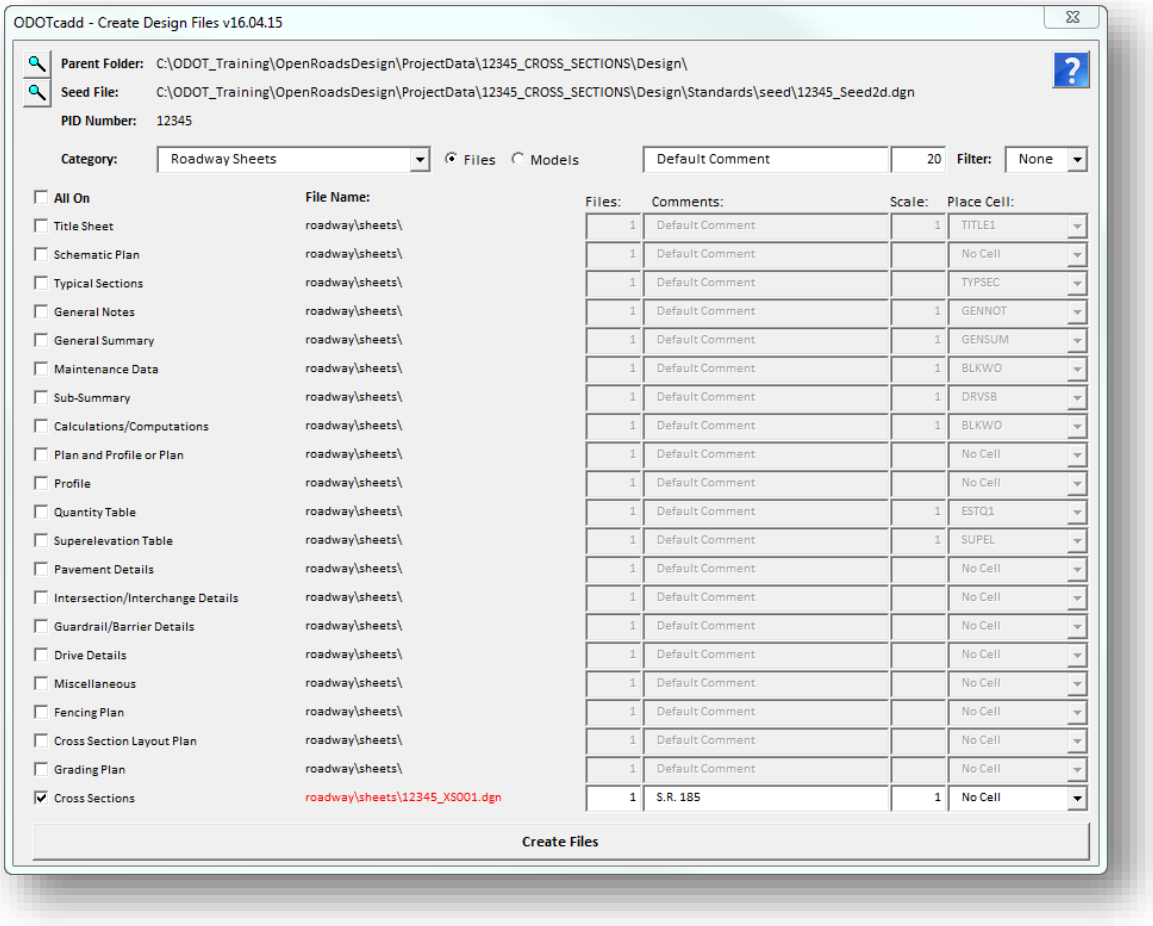
- ✓ Open the 3D model in the right-of-way file to verify that the 3D line strings have been created for each right-of-way line.

- ✓ After verifying the 3D line strings have been created, return to the Design Model and save settings.

  This procedure is not limited to existing right-of-way lines. Proposed right-of-way lines can also be displayed on the cross sections is a similar manner.

Take the following steps to create a design file for the S.R. 185 Cross Sections:

- ✓ Use the **ODOT_Files.mvba** application (**ODOT > File Management > Create Design Files**) to create the new design file for the cross section sheets as shown below. Make sure the scale is set to 1.



- ✓ Note the location of the new sheet file. Open the new file after it has been created.

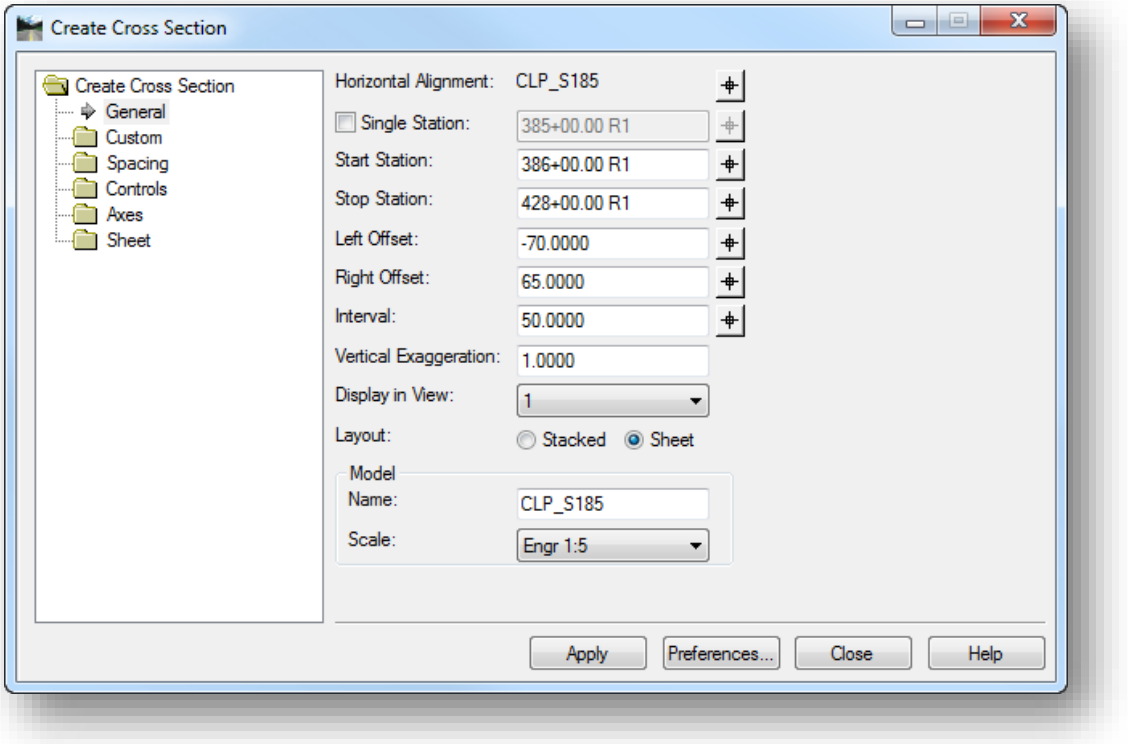
- ✓ The Sheet model is the active model. Open the Design model.

- ✓ Attach the Design model from the following references with the next depth value shown below:

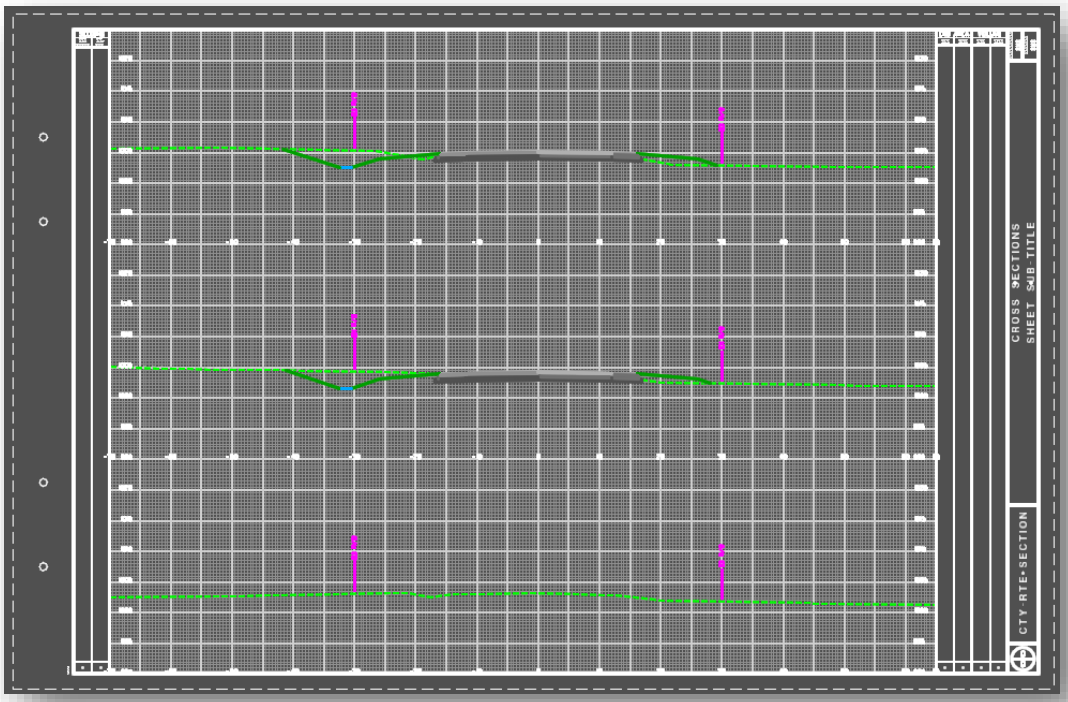
	File Name	Nest Depth
All Geometry	*..\Design\Geopak\Basemaps\12345_BK000.dgn*	1
S.R. 185 Corridor	*..\Design\Geopak\Basemaps\12345_KM001.dgn*	0
St. Peter Road Corridor	*..\Design\Geopak\Basemaps\12345_KM002.dgn*	0
Jameson Road Corridor	*..\Design\Geopak\Basemaps\12345_KM003.dgn*	0
Existing Right-Of-Way	*..\Design\RW\Basemaps\12345_BR001.dgn*	0
Existing Ground Survey	*..\Design\Survey\Basemaps\12345_BE001.dgn*	0

- ✓ Set the terrain model active by selecting the terrain boundary and choosing the **Set As Active Terrain Model** command from the pop-up menu
- ✓ Use the **Create Cross Sections** tool to extract the cross sections for S.R. 185.

  - Select the **Preferences** button. Use the **Sheet: CROSS 5 Scale** preference to extract the cross sections.
  - Set the **Start Station** value to 386+00
  - Set the **End Station** value to 428+00
  - Set the **Scale** to **Engr: 1:5**



The cross sections are extracted to a Drawing Model in the active design file. The first sheet is shown on the following page.



✓ Use the **Annotate Cross Sections** command to annotate the PGL Station and Elevation, the side slopes, and the ditch elevations. See section 11.3 of this chapter.

✓ Use the **End Area Volumes** command to extract cut and fill quantities from the cross sections. See section 11.6.

✓ Run the **ODOT Spit Sheets** application to spit the cross section sheets into separate models. See section 11.7.

12 Subsurface Utilities

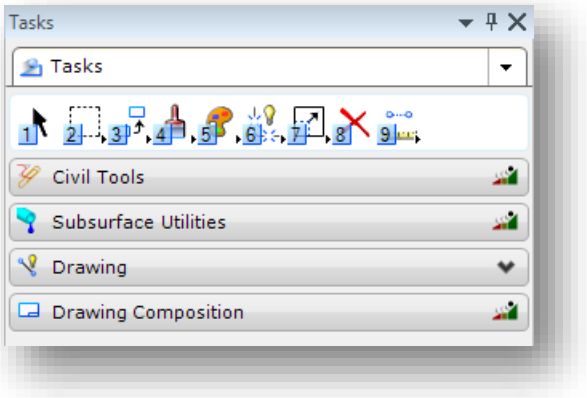
Plan view graphics representing various underground utilities can be extracted to create 3-dimensional objects using the **Subsurface Utilities** commands. This section will discuss the process to generate 3D graphics for underground utilities using the **Extract Graphics** command. This section is not intended cover the Bentley subsurface utilities commands in detail.

Additional information on existing utilities is presented in the ODOT_OpenRoadsSurvey training guide.

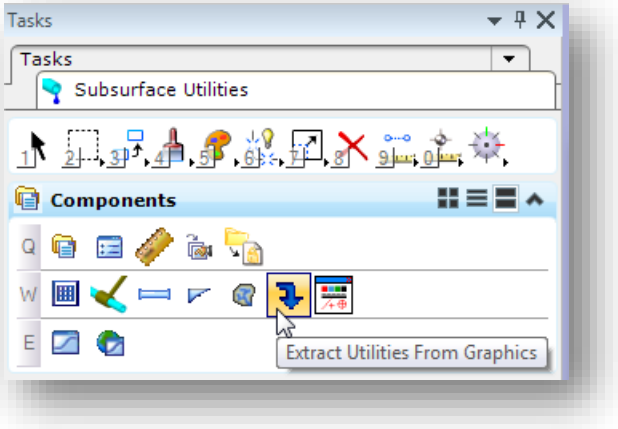
12.1 Subsurface Utility Tools

GEOPAK V8i (SELECTseries 3) and subsequent releases include Bentley's new **Subsurface Utilities** tools. These tools are included and installed as part of PowerGEOPAK and the GEOPAK Suite.

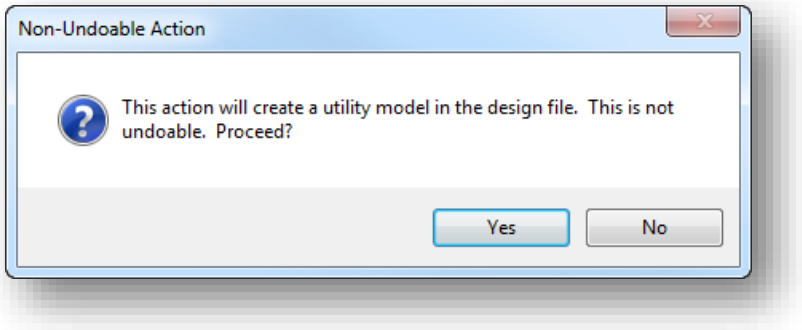
These tools are used to extract 2D or 3D utility graphics to generate a 3-dimensional representation of the utilities. The **Subsurface Utilities** commands are located in the MicroStation Tasks menu as shown below.



The **Extract Graphics** command, shown below, is used to generate 3D models for the subsurface utility information.

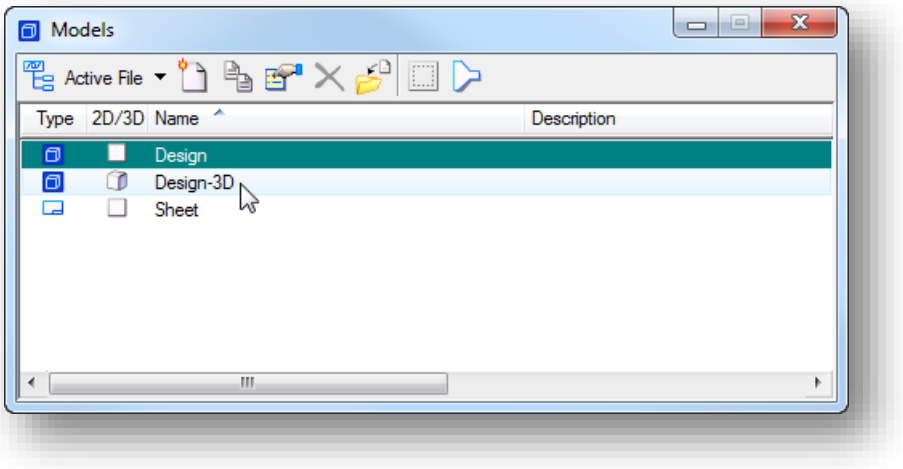


The first time the command is selected, the software prompts the user as shown below. Select **Yes** to create the utility model.



When the utility model is created, the software takes the following action:

- ✓ If the current MicroStation model is a 2D model, the software will automatically create a new 3D model named **Design-3D**. This is the typical workflow for ODOT projects.



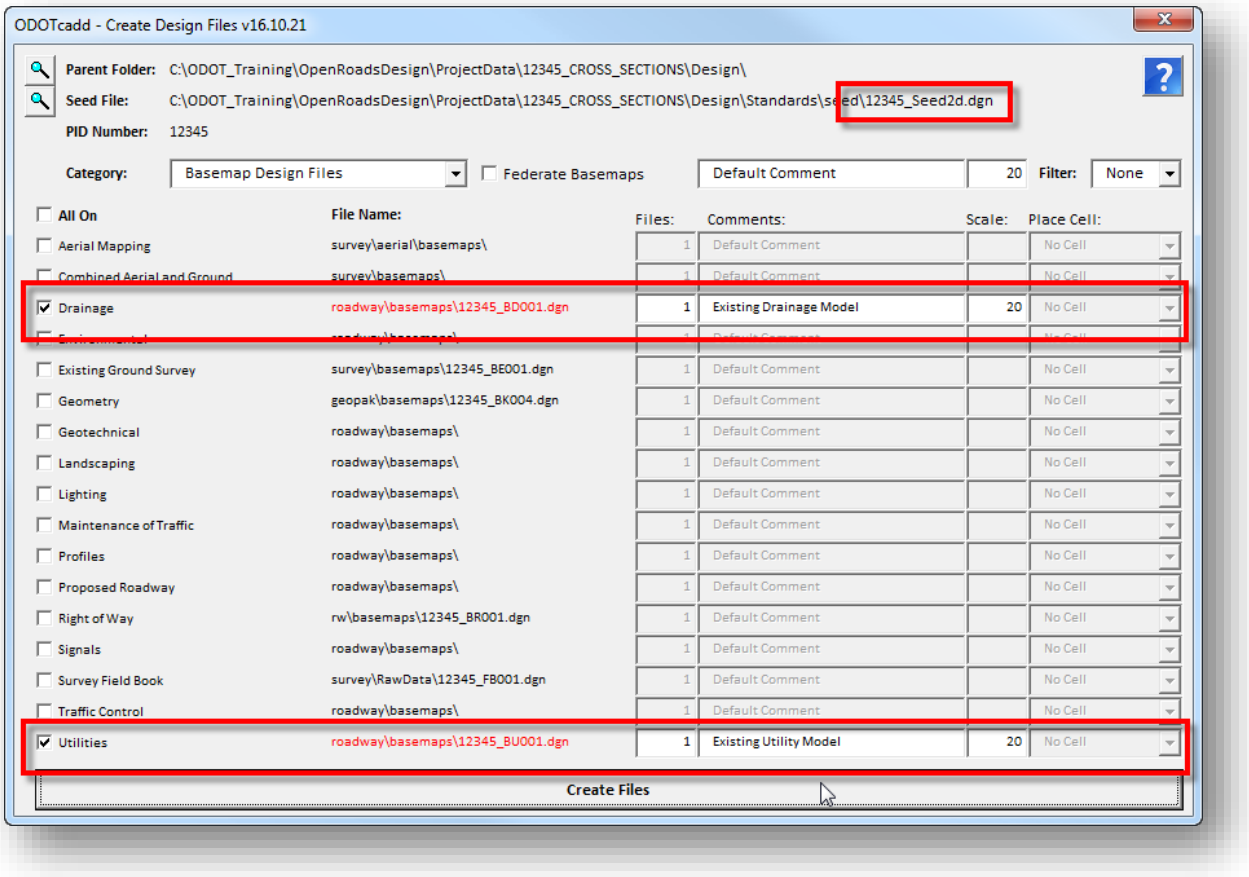
- ✓ If a current MicroStation model is a 3D model, the utility graphics will be extracted in the current 3D model. This is not the typical workflow for ODOT projects.

12.2 Utility Design Files

Three dimensional graphics for the subsurface utilities are normally extracted in a separate utility basemap. Do not use the survey basemap, “BE” file, for extracting subsurface utility information. It is recommended that all 3D utility information is extracted to the following files:

- The 3D model for storm sewer information is extracted in the “BD” drainage basemap
- The 3D model for all other underground utilities is extracted in the “BU” utility basemap

The **ODOT_Files.mvba** application is used to crate these design files as shown below. The application is accessed by selecting **ODOT > File Management > Create Design Files** from the MicroStation pull-down menu.



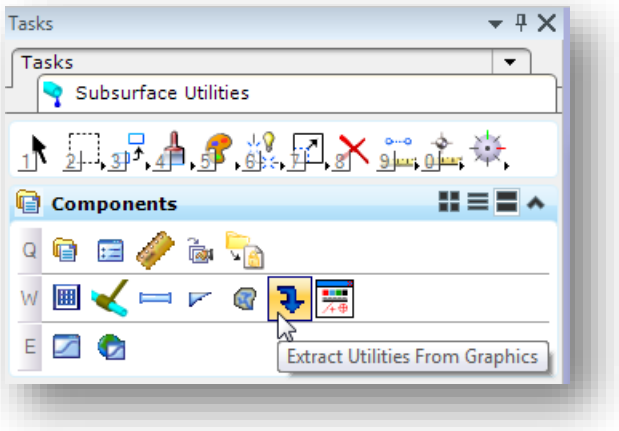
Be sure to select the 2D seed file for the new design files as shown above. The typical workflow for ODOT projects is to allow the **Extract Graphics** process to create a separate 3D model for the 3-dimensional graphics.

Check on the **Federate Basemaps** option to create a “000” file if you will have more than one basemap design file for each file type.

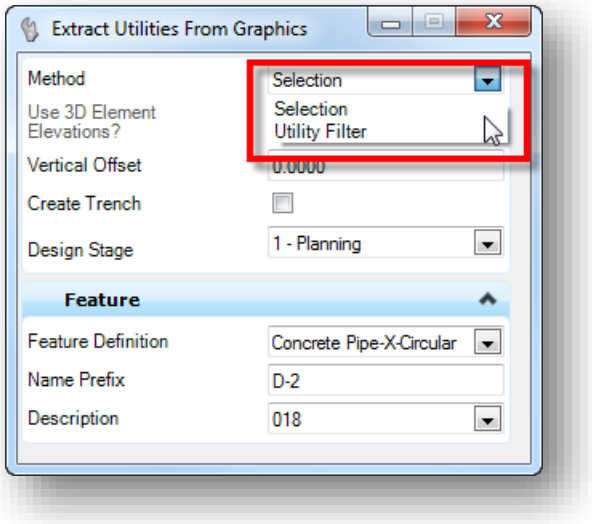
After these files are created, the normal workflow is to attach the survey basemap as a reference to the 2D design model.

12.3 Extract Graphics

The **Extract Graphics** command, shown below, is used to generate 3D models for the subsurface utility information.



The command provides two methods to extract utility information: **Selection**, or **Utility Filter**, as shown below.



- The **Utility Filter** option is used to scan the current file and attached references for plan view cells representing catch basins, inlets, and manholes.

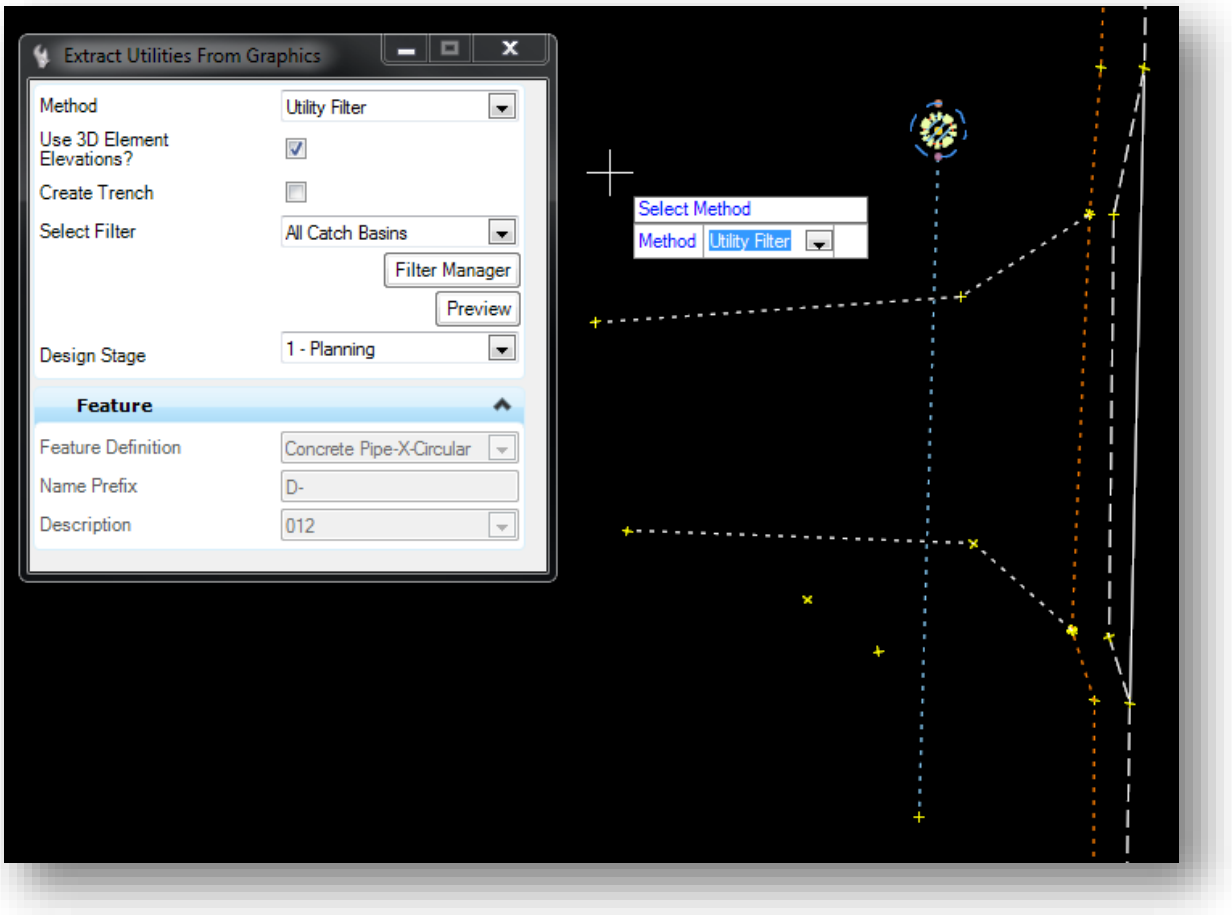
- The **Selection** option is used to manually select individual utility lines, or storm sewer pipes, in order to generate 3D graphics for these items.

In either case, the elevation for the elements can be defined by the original graphics (if these graphics have been drawn in a 3D model at their actual elevation) or relative to the active terrain by specifying a **Vertical Offset** value.

Using Filters to Extract 3D Catch Basins, Manholes, and Inlets

ODOT provides several **Utility Filters** to extract the various catch basin, inlet, and manhole types.

In the example below, the **Select Filter** option is set to use the **All Catch Basins** filter.



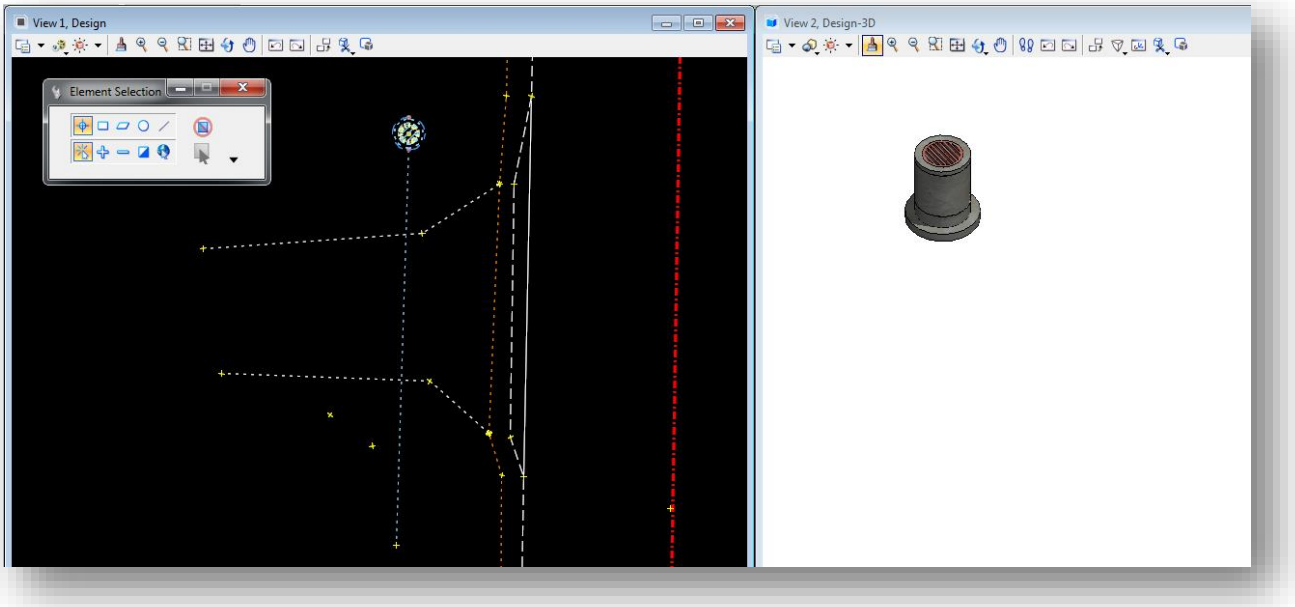
After selecting the **Method** and **Filter**, be sure to toggle on the **Use 3D Element Elevations** option if the original survey data is drawn at the correct elevations in a 3D model (this is the normal process for ODOT survey processing).

The software will step the user through the filter extraction process by prompts on the cursor.

Left-click to accept the following options to extract 3D utility information:

- ✓ **Method: Utility Filter**
- ✓ **Select Filter**

The software scans the active file and any attached references to find ODOT cells matching the selected utility filter parameters. As each item is processed, 3D graphics for each object are drawn in the Design-3D model as shown on the following page.

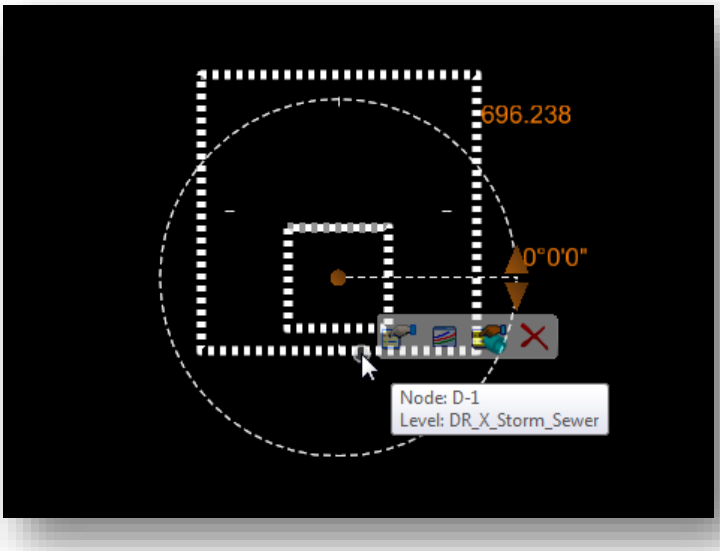


In the example above, View 1 displays the 2D Design model with the survey information attached as a reference. View 2 displays the Design-3D model for the CB-7 catch basin that was extracted using the All Catch Basins utility filter.

Note: With the ODOT configuration, select **Alt-F2** to open view 2 to display the Design 3D model.

Modifying Storm Sewer Nodes

Individual catch basins, inlets, and manholes are referred to as a "**Node**" in the subsurface utility software. As each storm sewer catch basin, inlet, and manhole is processed, the software places a plan view graphic for each node in active model. This graphic can be used to manipulate the 3D graphic for the node. An example of the node graphic placed for a CB-2-5 is shown below.

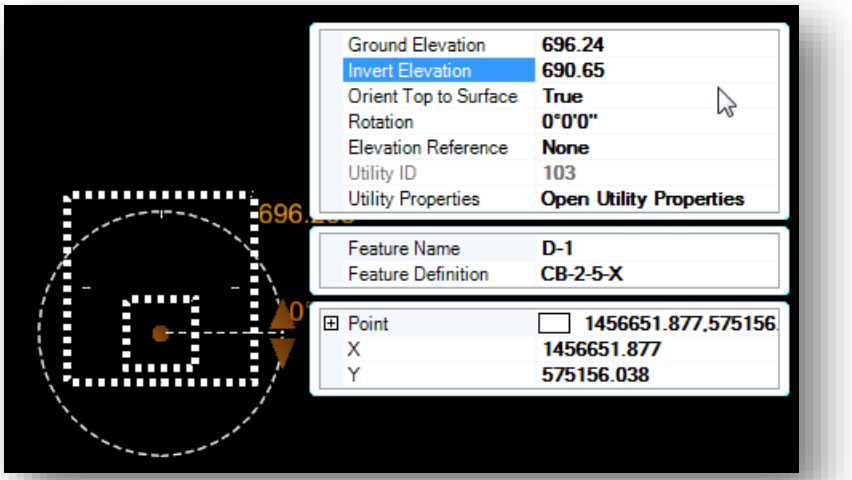


When the node is selected, a pop-up menu appears with the following commands:

- Properties
- Graph
- Utility Properties
- Delete

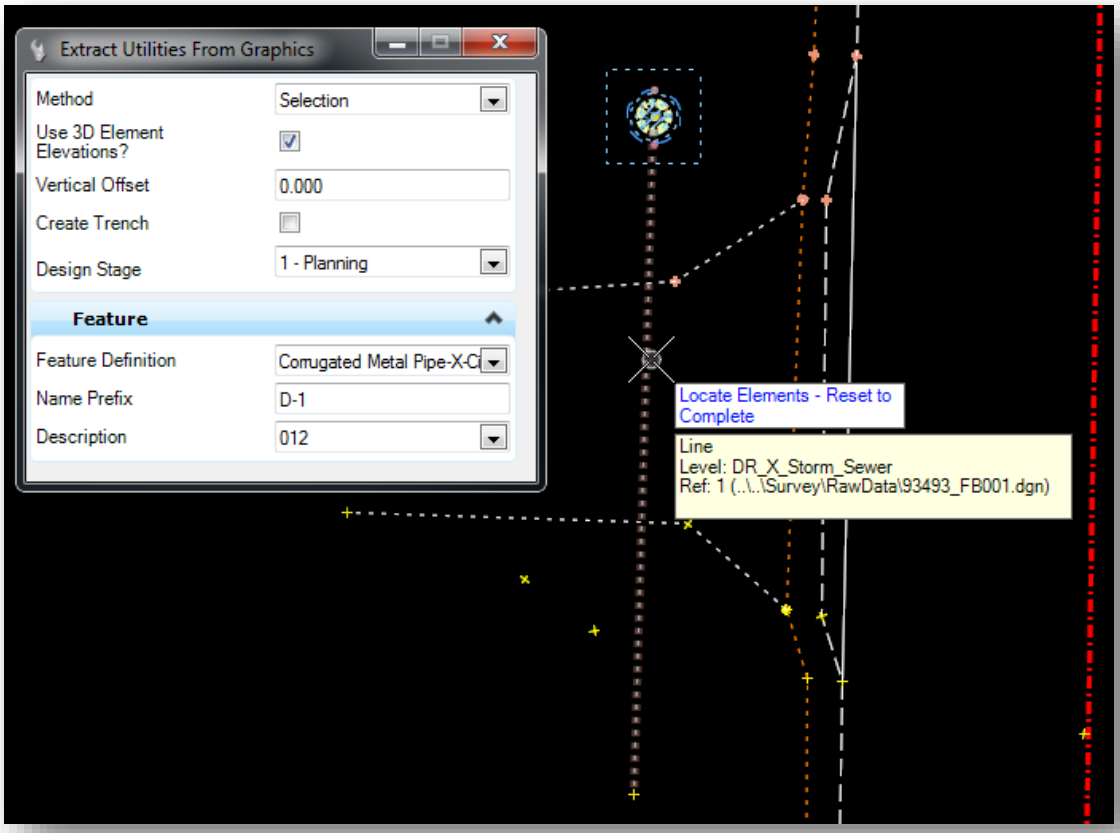
Additionally, two fields appear for the **Node Top Elevation** and **Node Rotation**. Left-click one of these text fields to edit the value. Changes are automatically applied to the 3D model.

When the **Properties** item is selected from the pop-up menu, the options below are available. Changes to the properties of a node are automatically applied to the 3D model.



Extracting 3D Storm Sewer Lines

3D storm sewer lines are extracted using the **Selection** method as shown below.



In the example above, the survey information is referenced from a 3D survey basemap. The lines representing storm sewer conduit are drawn as a 3D line between the survey points. These lines are drawn at the proper elevation defined by the endpoints, however, these are flat lines, not 3D pipes.

When the command is selected, the application will prompt the user to select the elements to extract as shown above. One or more graphics can be selected for extraction, however; it is important to note that the selected items are all extracted using the current parameters. Be sure to select only elements of the same **Feature Type** and size for extraction.

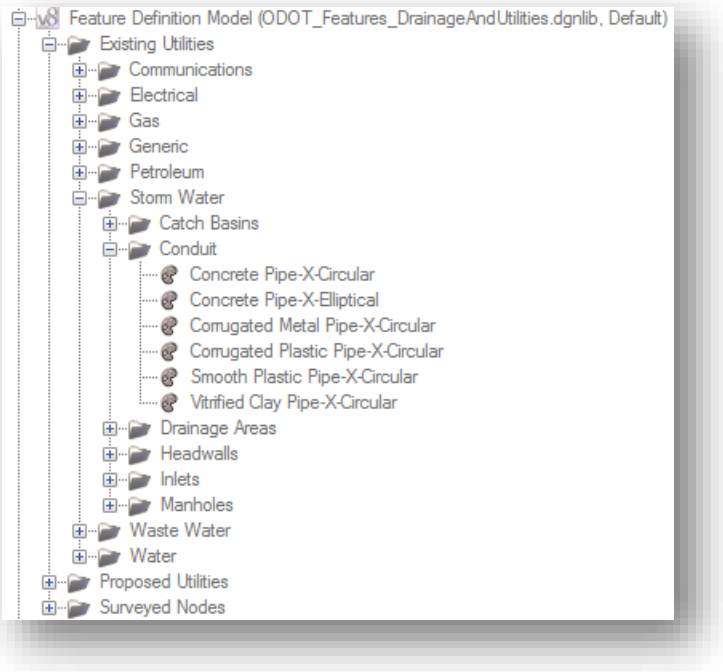
As the selected storm sewer line(s) is extracted, the following parameters are defined:

Use 3D Elevations?
Toggle this option on to use the elevation of the selected elements. Note, this option cannot be selected until after at least one graphic element has been selected

Vertical Offset
Storm sewer pipes are normally drawn at their invert elevation in the ODOT workflow. A **Vertical Offset** value of **0** is typically used for ODOT projects.

Create Trench
The **Create Trench** option is used to apply a linear template to the selected utility line. This template is defined by the selected Feature Definition. The ODOT Feature Definitions for storm sewer lines do not have a template defined.

Feature Definition
Various feature definitions are defined for storm sewer conduit as shown below.

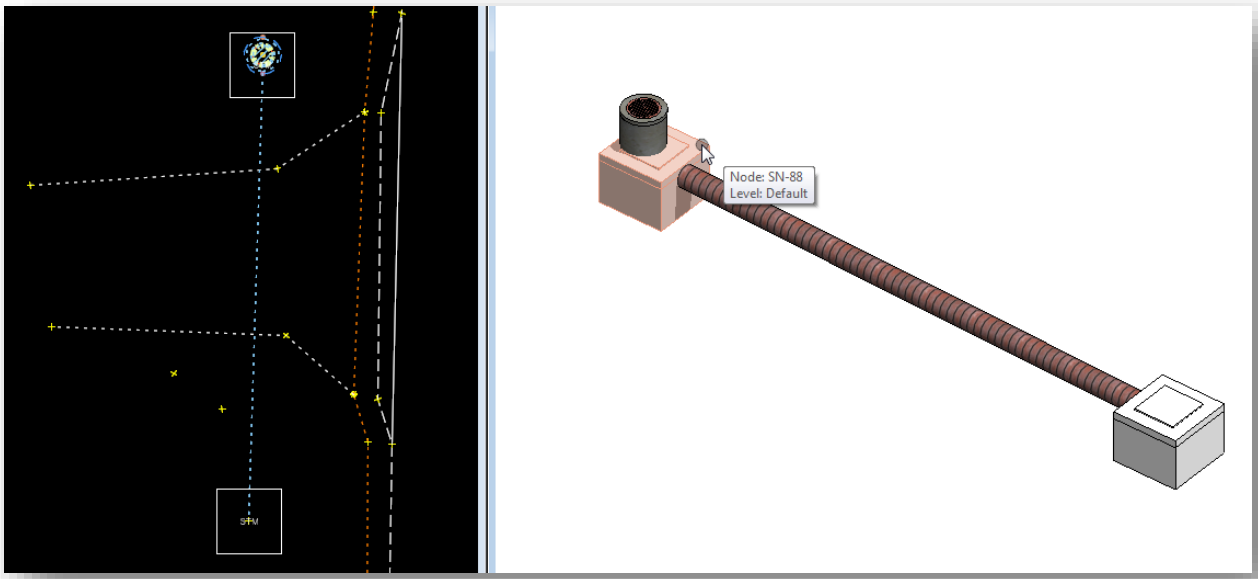


Name Prefix
As each storm sewer conduit line is extracted, a unique name is given to each element created. When extracting a single element, the name can be manually assigned as shown in the example above. If multiple elements are selected, the **Name Prefix** value is incremented for each element.

Description
The **Description** item is used to define the size of the conduit.

The software prompts the users for information before extracting the selected element(s). Left-click to accept each option as prompted.

An example of an extracted storm sewer conduit is shown below.

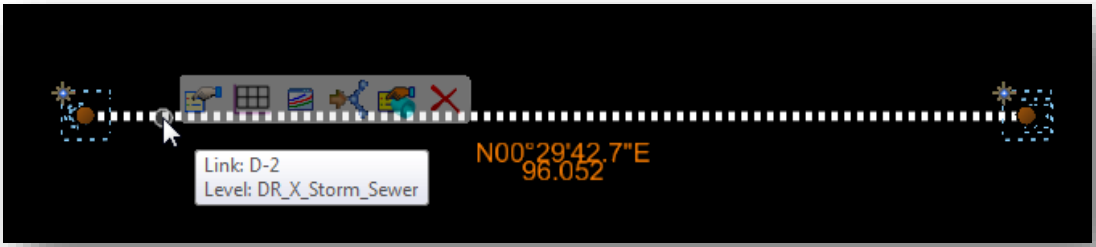


Each individual storm sewer line is referred to as a "**Link**" by the subsurface utility software. A link must have a node at each end. When the Extract Graphics command is used to generate a link, the software automatically places a node at each end of the link, even if a node already exists in the file. The node is placed on the active level in the 2D model, but on level Default in the 3D model. It is recommended to set the active level to Default in the 2D model before processing so that these elements are on the same level on both models. The Default level should be turned off in the 3D model, as shown on the following page.

The 3D model of the storm sewer information can be generated by the surveyor, or the designer. Responsibility to generate a 3D model for the storm sewer information will vary from District to District.

Modifying 3D Storm Sewer Links

In addition to the 3D graphics, a line is drawn in the active 2D model for the extracted link as shown below.



Selecting the link reveals a pop-up menu of commands, as well as two editable fields designating the direction and length of the length. The following commands are available from the pop-up menu:

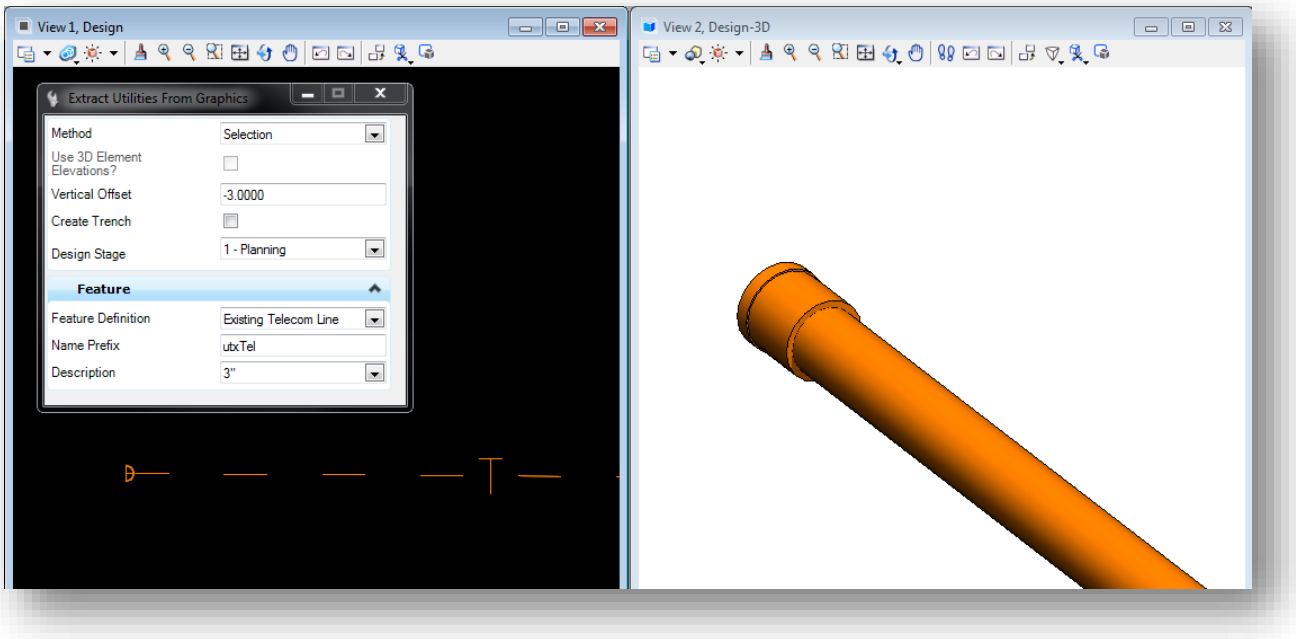
- Properties
- Profile
- Graph
- Split Link
- Utility Properties
- Delete

The **Properties** dialog is used to review and edit the properties of the selected link. See the online documentation for information on the other commands.

Extracting Utilities by Depth of Cover

The **Extract Graphics** command is also used to extract underground utility lines defined by a depth below the active terrain surface.

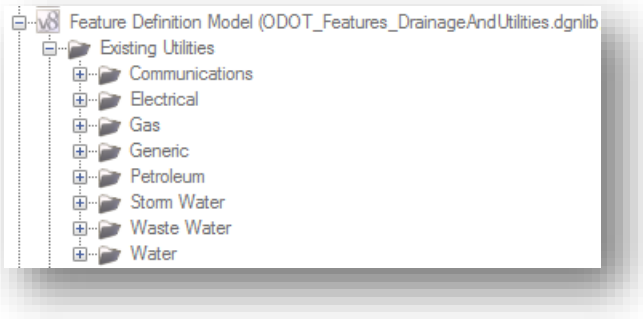
The example below shows the settings to extract an existing telecommunications line at a depth of 3' below the terrain model surface, using the **Selection Method**.



The **Vertical Offset** parameter is used to define the depth below the surface for the utility extraction.

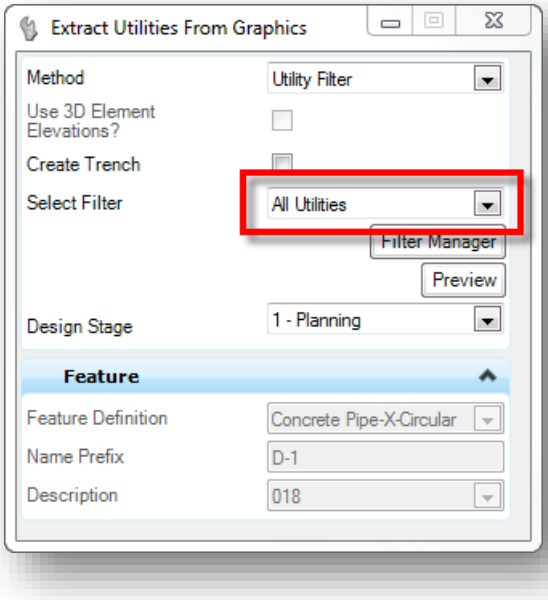
The software automatically places a node at the end of the utility line. The default nodes are defined by the software and in some cases may not be entirely appropriate for ODOT purposes. Unfortunately the default nodes cannot be deleted. In the example above, an end cap node is placed at the beginning and end of the telecommunications line.

The ODOTcadd Standards provide feature definitions for various underground utilities as shown below.



The **Selection** method is used to manually select individual elements representing a specific utility line. This method is advantageous as it allows the user to set the **Vertical Offset** and **Description** (size) parameters uniquely for each utility as it is extracted.

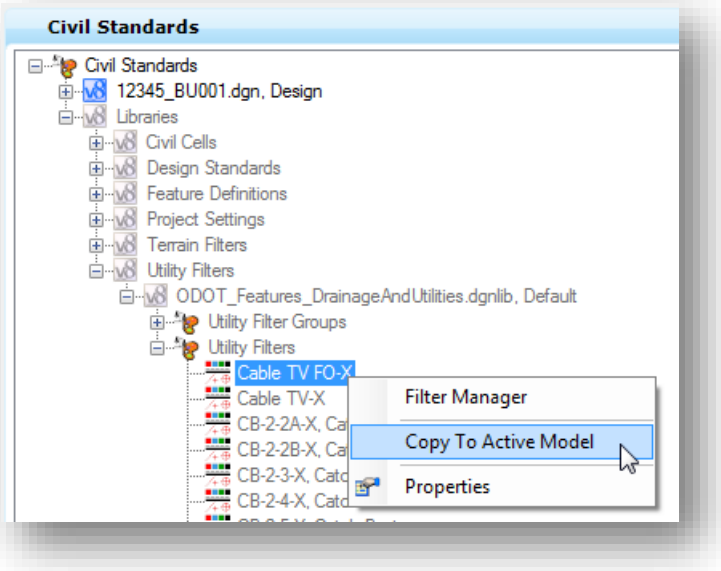
The **Utility Filter** option is advantageous to extract multiple utilities simultaneously. Filters are available in the ODOTcadd Standards to extract **All Utilities**, or utilities of a specific type.



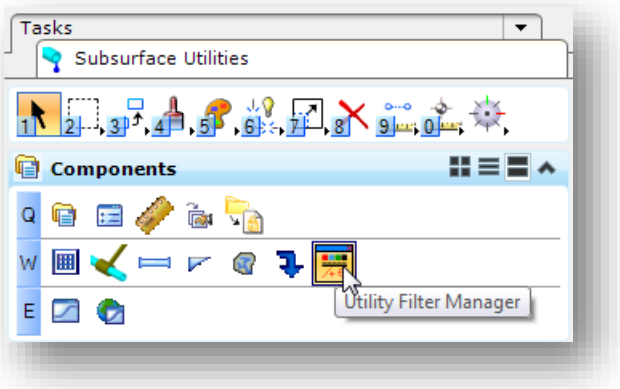
The disadvantage when using the **Utility Filter** method is that all of the utilities will be extracted using default values for the depth and size. The table below list the default values for the ODOT filters.

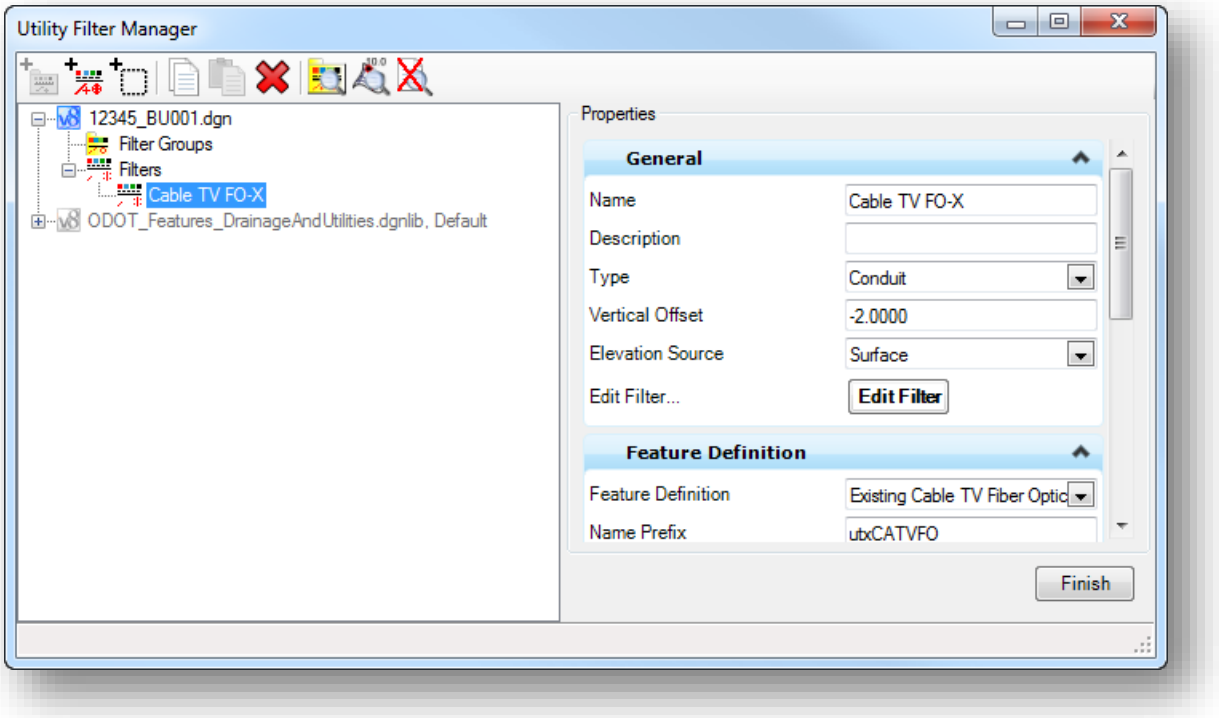
Utility Type	Default Depth	Default Size
Communications	-2’	2”
Electrical	-2.5’	2”
Gas	-3’	6”
Water	-3.5’	6”
Petroleum	-5’	6”
Waste Water	-8’	6”

Individual filters can be copied from the Drainage and Utilities dgn library to the active file to edit the default values on a per-dgn file basis, as shown at right.

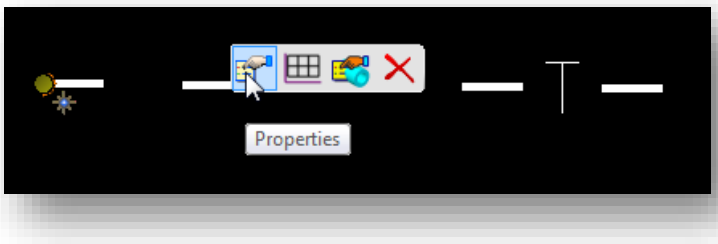


Copied Filters are edited using the **Utility Filter Manager** command, shown below. For additional details, see the OpenRoads online help.



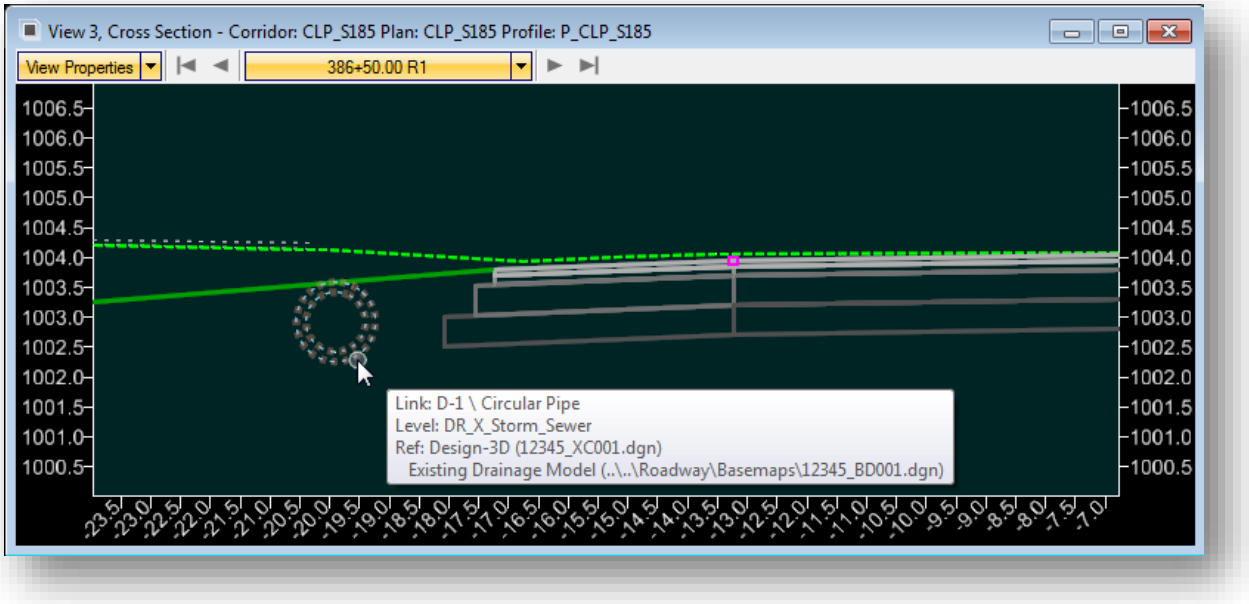


Regardless of the extraction method used, the **Properties** command can be used to review and edit an individual utility line as shown below. Note that the utility depth cannot be edited in the properties; the depth is set at the time the utility is extracted.



12.4 Underground Utilities and Cross Sections

In order for the underground utilities to display on the cross sections, the Design-3D model for the drainage and utility basemap design files must be attached as a reference to the Design-3D model in the cross section design file. Once attached, the utilities will be displayed on the cross sections similar to the example below.



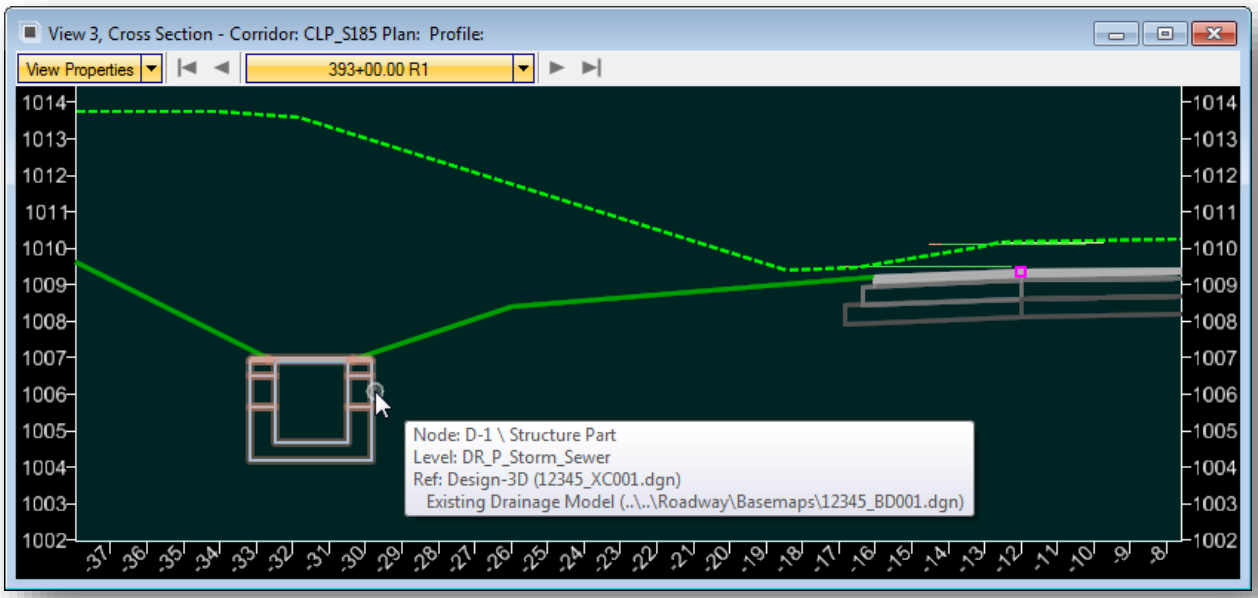
Notes:

- The Feature Definitions for the various utility conduit items include both the internal diameter and the wall thickness values. The outside diameter is necessary for clash detection reports (clash detection is available when using a full Subsurface Utility license, not from a GEOPAK or PowerGEOPAK license). As a result, both the internal and external diameter will be displayed on the cross sections as shown in the example above.

- The utilities are not labeled in the cross sections and must be labeled manually on the cross section sheets.

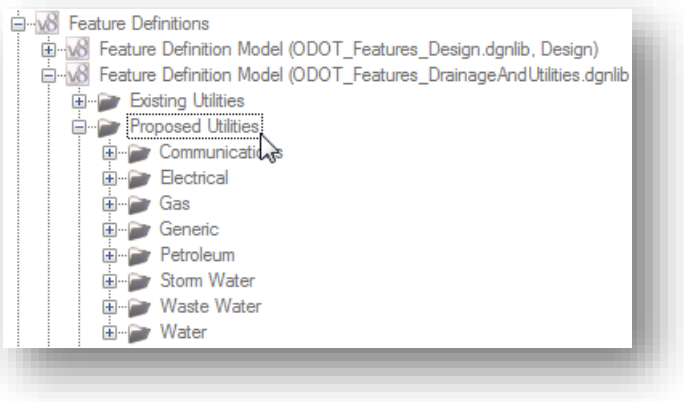
- Storm Sewer structures (catch basins, inlets, and manholes), that fall between cross sections cannot be projected to the nearest cross section. In order to show a particular storm sewer node, you must extract a cross section at the specific station that will intersect each node. The graphics representing a specific node are based on the graphics drawn in the Design-3D model.

  Also note that nodes displayed in the cross section are not labeled by the software. An example is shown below.



12.5 Proposed Utilities

The ODOT feature definition libraries provide various features for proposed underground utilities as shown below.



Similar to existing utilities, proposed utilities, including storm sewers, are placed using the **Subsurface Utilities** tools.

As of this release of the ODOTcadd Standards, the subsurface utility tools have not been configured for design and analysis of the storm sewer network.

This section of the training guide will document the process to place storm sewer nodes and links.

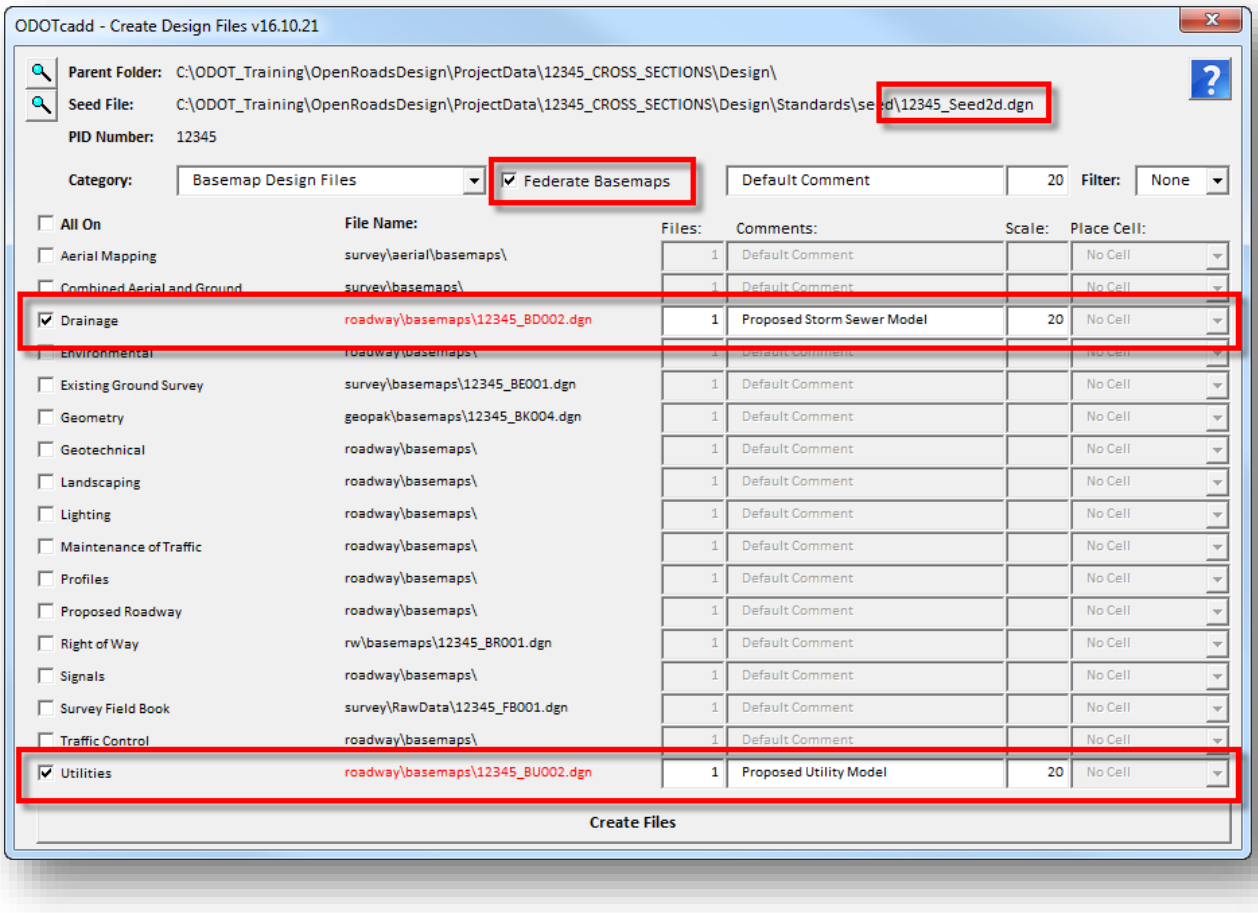
Proposed Utility Design Files

Proposed utilities are typically be placed in their own design files and not in the same file with the existing utility and storm sewer information.

For smaller projects, it is permissible to place the existing and proposed utilities and storm sewer information in the same design file. It is up to the project designer to use their judgement as to whether this information is best placed in the same or multiple files.

Proposed utilities are normally placed in a 2D design model. The Subsurface Utility software creates the 3D model as the 2D nodes and links are defined.

The **ODOT_Files.mvba** application is used to create these design files as shown below. The application is accessed by selecting **ODOT > File Management > Create Design Files** from the MicroStation pull-down menu.



Be sure to use the 2D seed file when creating the Drainage and Utility basemap file types.

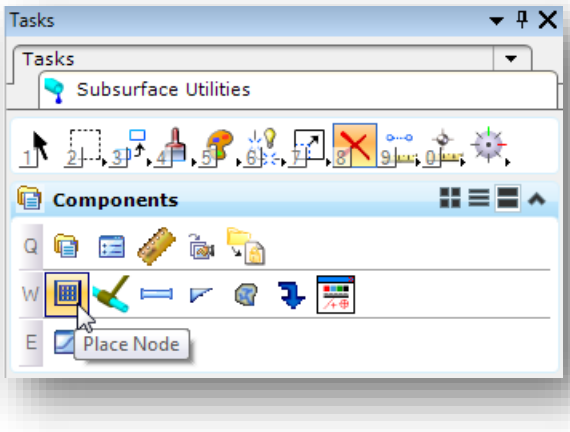
Toggle on the **Federate Basemaps** option to create a “000” file if you will have more than one basemap design file for each file type.

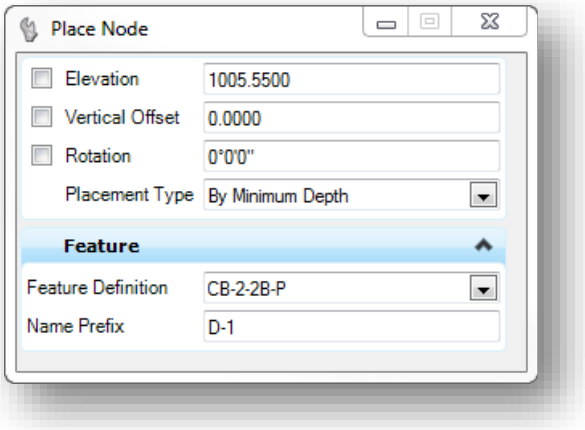
The survey, geometry, corridor, and existing utilities may be attached as references, as needed.

Placing Proposed Storm Sewer Nodes

Proposed storm water utilities are normally placed in a 2D model in the drainage (BD) basemap design file. The **Subsurface Utility** software will generate the 3D model for the proposed utility.

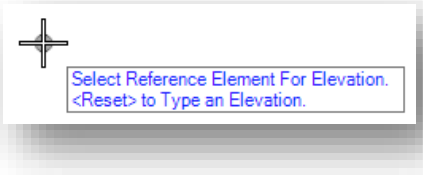
Catch basins, inlets, manholes, and headwalls are placed as a **Node** using the **Place Node** tool shown below.





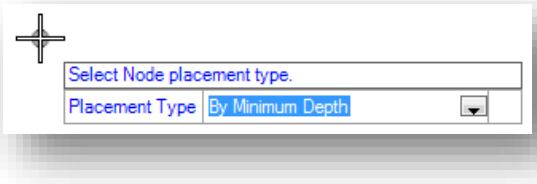
When the command is selected, the dialog shown at right, above, is displayed.

The user is prompted to select a reference element for the node elevation as shown below.



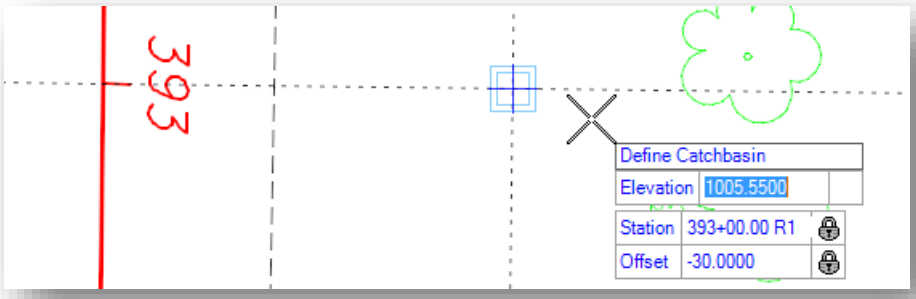
Nodes can be placed at a specific elevation, or relative to the selected surface or a corridor model. Select the surface or issue a **Reset** to type an elevation.

After the elevation reference is selected, the user is prompted to set the **Placement Type**.



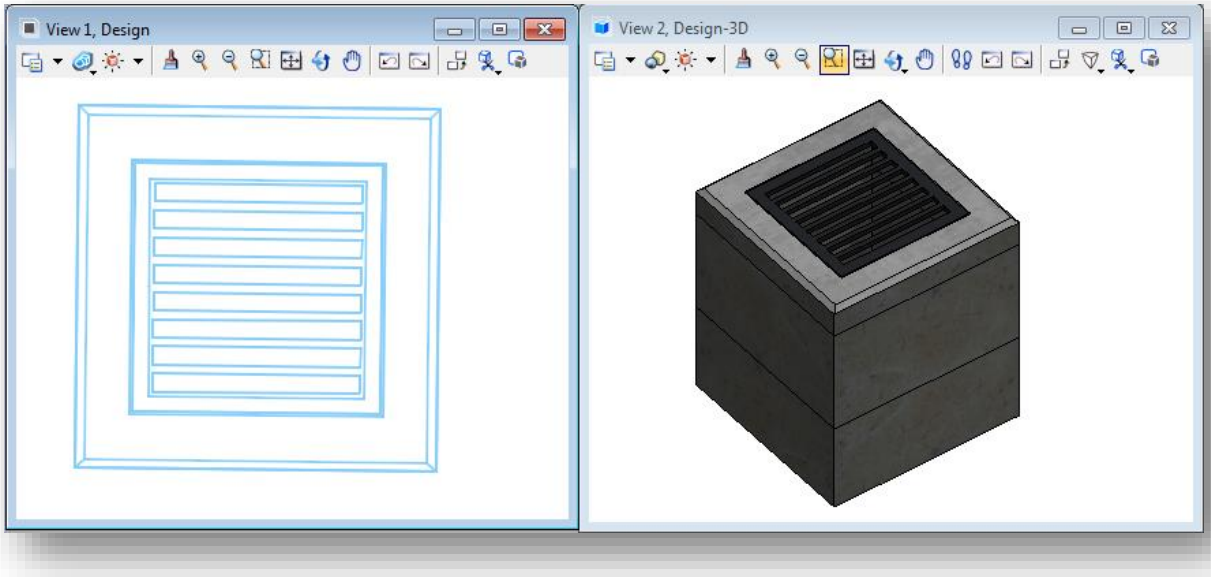
The **By Minimum Depth** option is used to set the initial depth using a default value. The invert elevation can be edited after placement if necessary.

Next the user is prompted to set the location of the node. Civil Accudraw can be used to set the location of the node by a station and offset value relative to a specific alignment as shown in the example below.



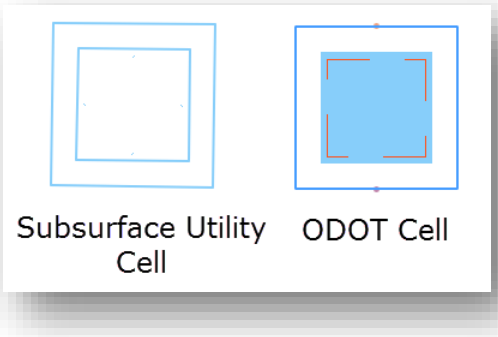
Finally, the user is prompted to enter the rotation for the node. The rotation angle can be keyed in, or specified by a data point.

The node is drawn in the 2D model, and the 3D model as shown below.



The 3D model is automatically referenced to the 2D model, as shown at left, above. Turning off the reference display of the 3D model reveals the 2D graphic as shown below.

This graphic differs from the plan view cells that have been traditionally used for ODOT plans. The Subsurface Utility software forces all of the sub-elements of the cell to the same symbology and does not allow for filled elements.



Placing Proposed Storm Sewer Links

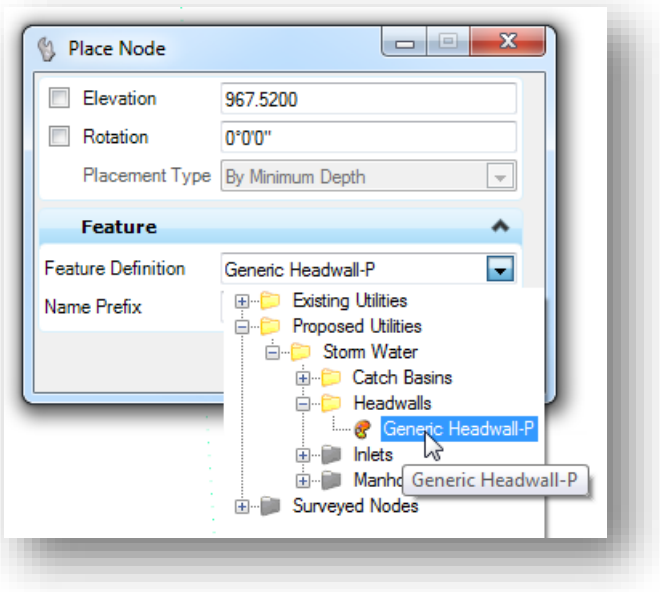
Proposed storm water utilities are normally placed in a 2D model in the drainage (BD) basemap design file. The Subsurface Utility software will generate the 3D model for the proposed utility.

Storm sewer conduit is placed as a "**Link**" by the Subsurface Utility software. Links are placed between nodes and require a node at each end, even for culverts and outlet pipes.

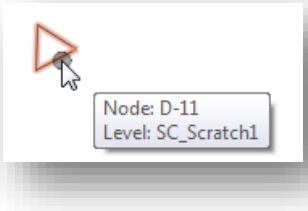
The ODOTcadd Standards provide a generic node that is used for each end of a culvert, or at an outlet location. This generic symbol is defined as a headwall in the ODOTcadd Standards but it does not draw a headwall shape. A simple triangle is drawn at the headwall node location.

Headwalls will not be added to the ODOTcadd Standards for the SELECTseries versions of GEOPAK and PowerGEOPAK. ODOT plans to add headwalls to the ODOTcadd Standrds after new functionality is introduced with the forthcoming release of OpenRoads Designer Connect Edition in 2017.

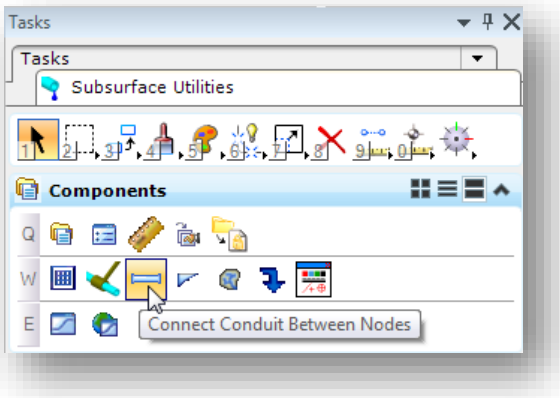
The example below shows the location of the headwall feature definition in the ODOTcadd Standards.



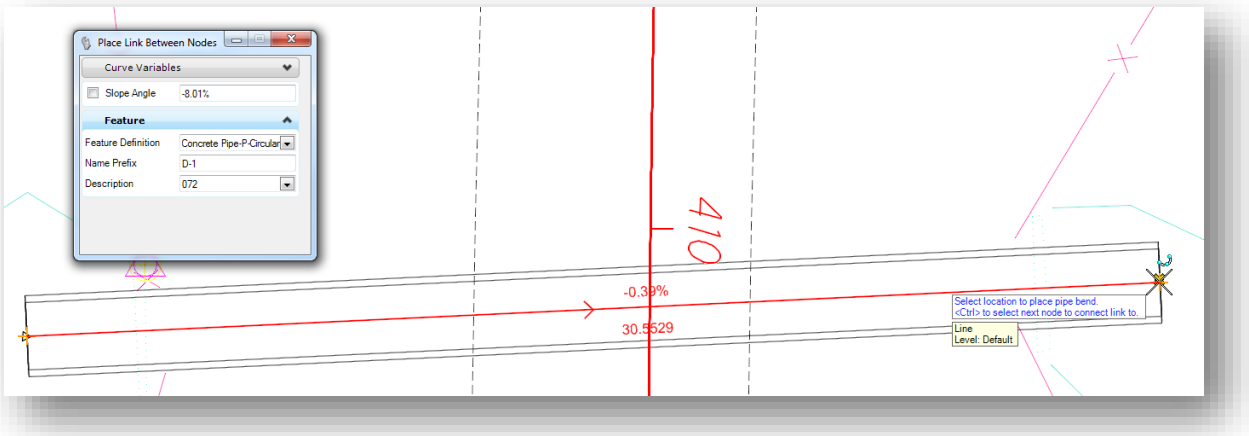
The generic headwall node is placed using a triangle symbol on the level SC_Scratch1 as shown below. The direction of the triangle is irrelevant to the flow direction of any links connected to the node.



To place a link, select the **Connect Conduit Between Nodes** command as shown at right.

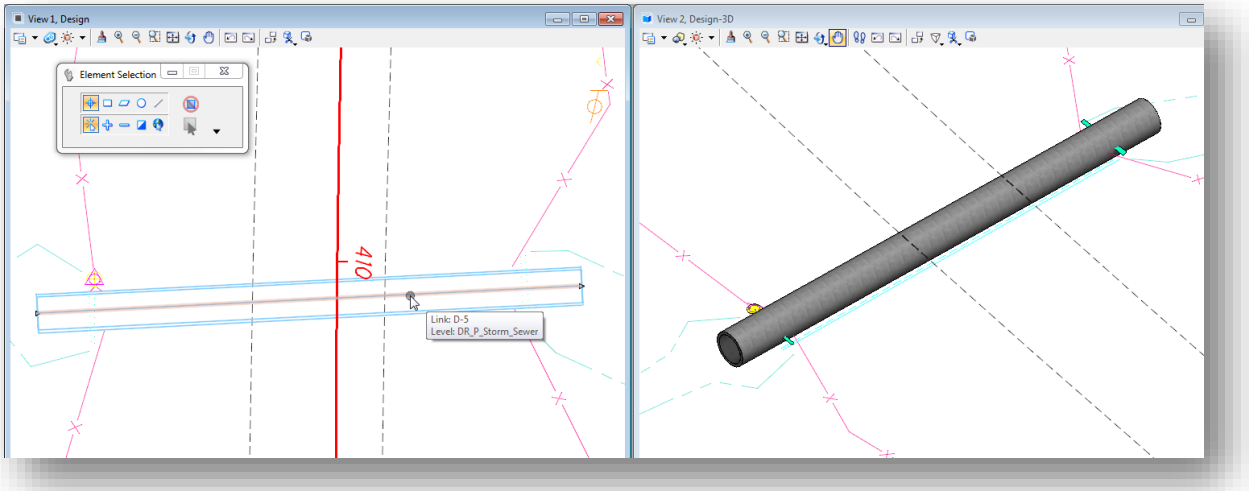


Select each node to place the conduit, similar to the example below.



Notes:

- A single line is drawn in the 2D plan view regardless of the pipe size.
- The pipe is drawn as a 3D element in the Design-3D model as shown below
- The Design-3D model is referenced to the 2D model, as shown at left below. The inner and outer dimensions of the conduit are displayed as shown below.

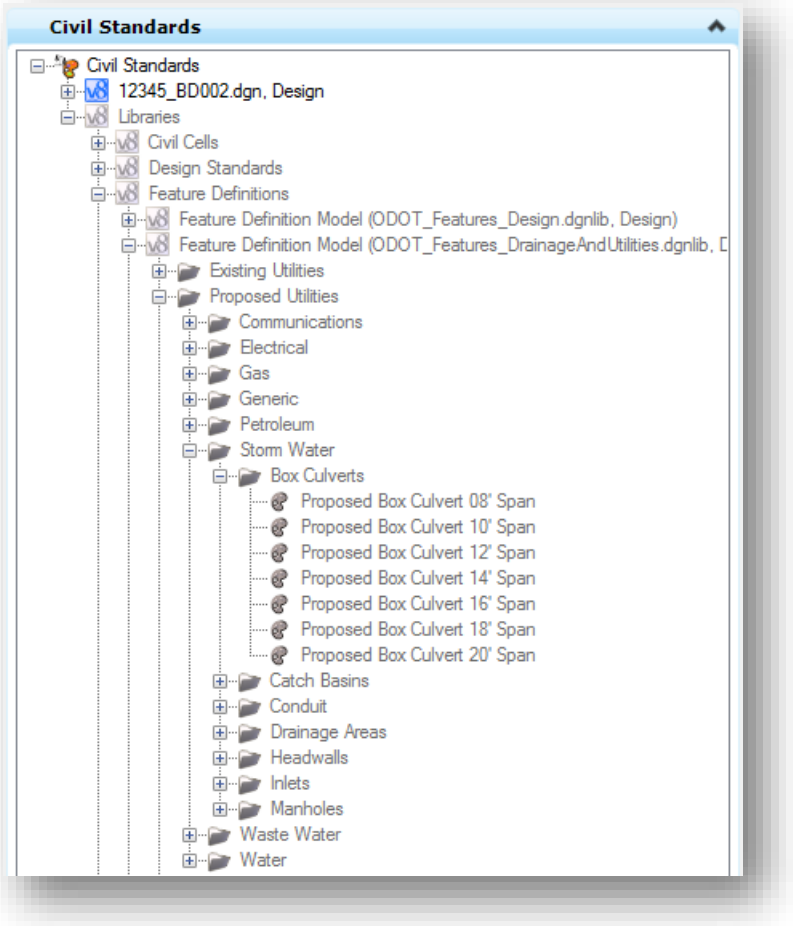


- Nodes for drainage structures have specific connection areas. When connecting a link to a node, be sure to zoom in to ensure that you are connecting the link the for correct side of the desired node.

Proposed Box Culverts

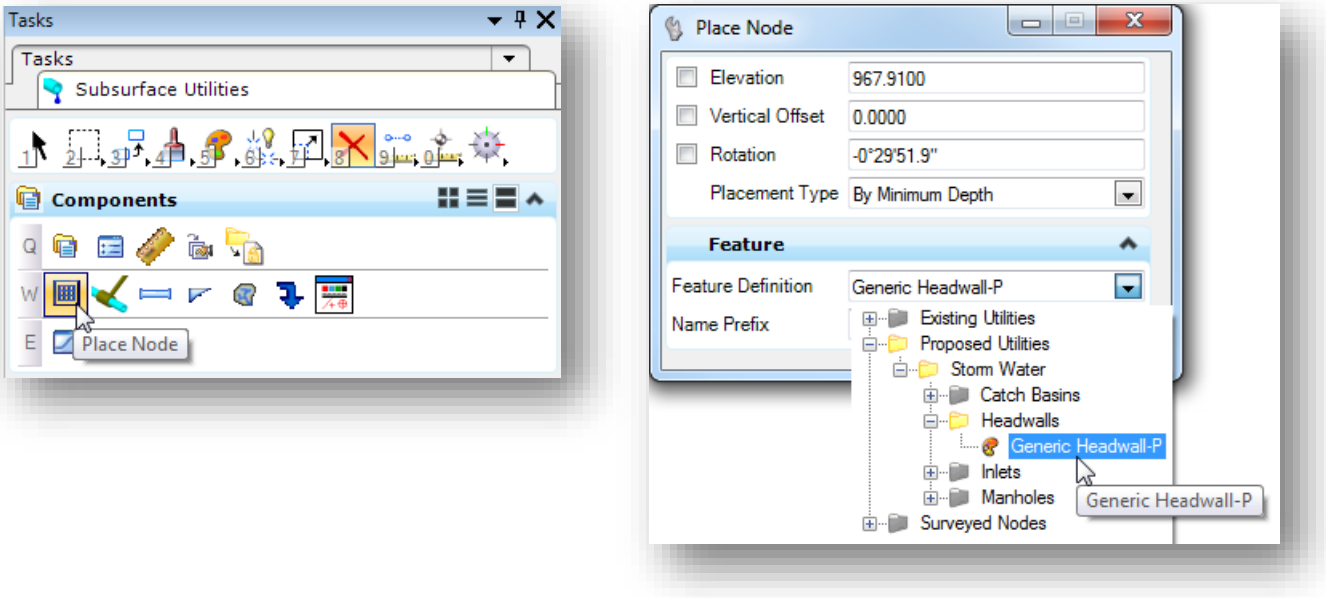
Proposed storm water utilities are normally placed in a 2D model in the drainage (BD) basemap design file. The Subsurface Utility software will generate the 3D model for the proposed utility.

Feature definitions for existing and proposed box culverts are provided in the ODOT standards. The available features for proposed box culverts are shown below. Available culvert sizes are based on the **Figure 1008-14** of the **ODOT Location and Design Manual – Volume 2, Drainage Design**.



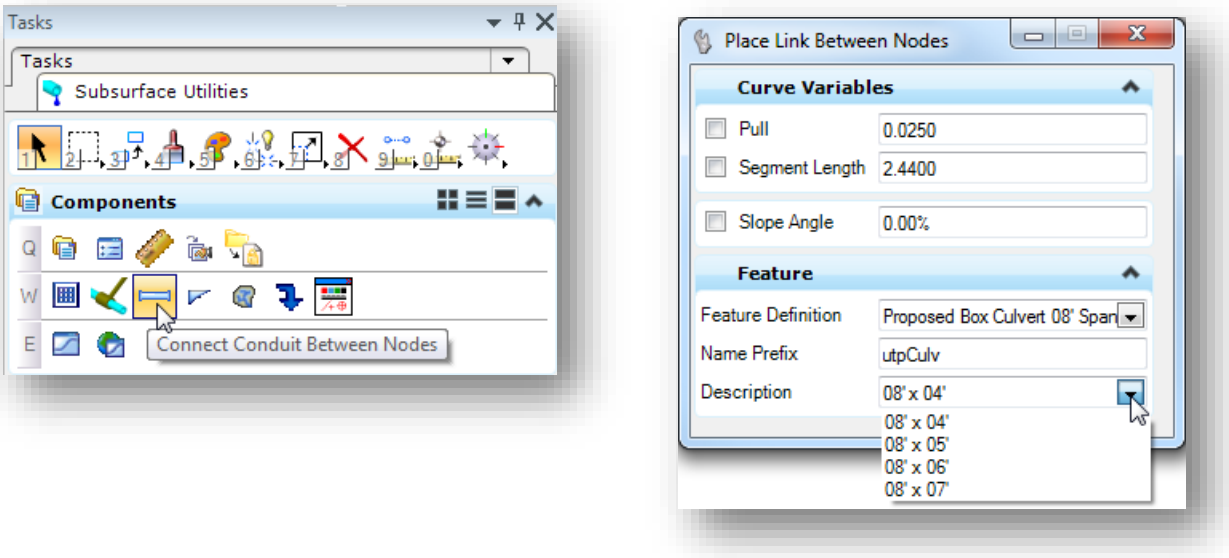
Box culverts are placed as a link by the **Subsurface Utility** software by use of the **Connect Conduit Between Nodes** command. A node must first be placed at each end of the proposed box culvert in the design file by use of the **Place Node** command. The generic headwall feature definition is used to define the location of each end of the box culvert.

Select the **Place Node** command from the task list as shown below.



Place a node at each end of the proposed box culvert using the **Generic Headwall-P** feature definition as shown above. The **Place Node** command has been previously document in this chapter.

The **Connect Conduit Between Nodes** is used to place the proposed box culvert.

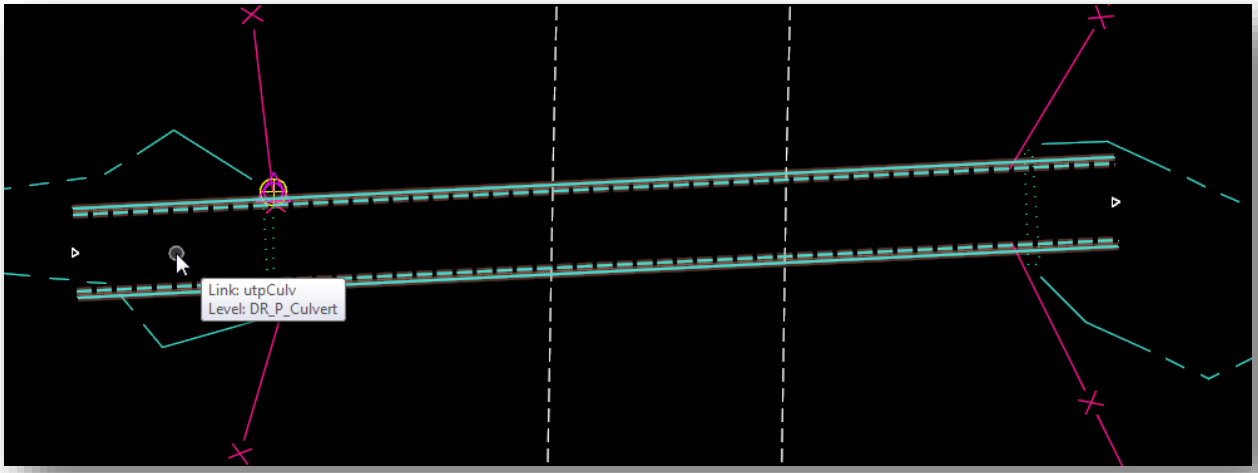
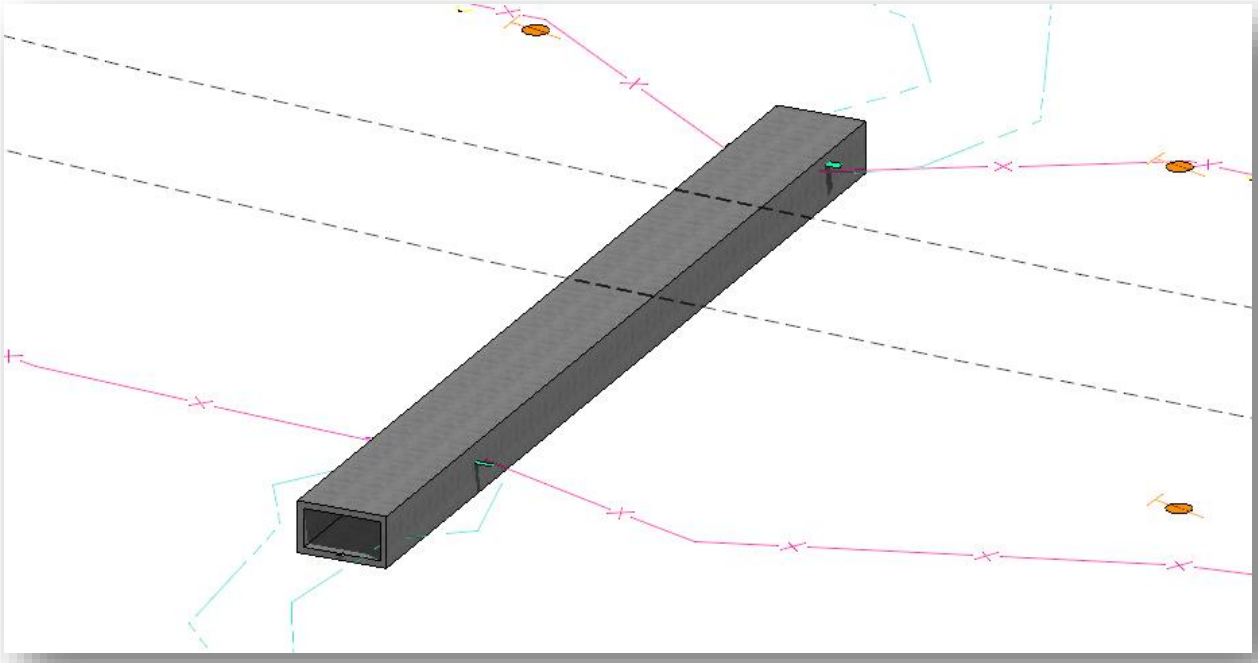


Each box culvert feature definition contains a drop-down list of available sizes as defined in **Figure 1008-14** of the **ODOT Location and Design Manual – Volume 2, Drainage Design**.

The **Connect Conduit Between Nodes** command has been documented previously in this chapter.

When the box culvert is placed, two sets of graphics are drawn for the proposed box culvert as shown below:

The appropriate custom line style is used to draw the box culvert in the 2D model on the level DR_P_Culvert as shown below. By default, the software automatically references the 3D model to the 2D model. The display of the referenced 3D model has been turned off in the example below.



The box culvert is drawn in the Design-3D model on the level DR_P_Culvert, similar to the example shown below.