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SECTION 1 - VAOT InRoads FUNDAMENTALS MANUAL

1. INTRODUCTION

The primary functions of the VAOT InRoads Fundamentals Manual are to:

- 1. Provide requirements and guidance on Bentley InRoads applications methods and standards used by VAOT when using the InRoads applications.
- 2. Assure uniformity of practice for projects designed by or for the Agency.

This manual does not eliminate the need for other references or training. Instructions from CADD support, books, publications and other related material may need to be referred to for further details, or clarification. Portions of the material in this manual may be specifically superseded by subsequent Official Issuances of the Agency (e.g., Engineering Instructions).

Variations from this manual will be necessary for special or unusual conditions, or between the issuances of new or revised source documents and any corresponding updates of the VAOT InRoads Fundamentals Manual (reference). Consequently, instructions in this document are not intended to preclude the exercise of individual initiative and judgment in reaction to project specific conditions or application of current state of the art practices. Rather, such initiative and judgment is encouraged when it is appropriate and there is a rational basis for deviation. However, it is equally important that there be consistency in the application of this manual. The objective is uniformity of process and presentation.

1.1. DISTRIBUTION

This manual, in its entirety, may be freely copied and distributed for the purpose of providing a consistent guide to InRoads Design requirements of the Vermont Agency of Transportation. This manual, Standard CADD files and other support files can be downloaded from the VAOT CADD website at the following address.

http://www.aot.state.vt.us/caddhelp

1.2. REVISIONS AND UPDATES

The office of VAOT CADD support IT section, with input from the VAOT CADD Technical Committee, CADD users and the consultant and construction community, will develop and maintain standards and configuration files for the Agency's Computer Aided Design related activities.

If you have comments or suggestions please email: <u>AOTCaddMaster@state.vt.us</u>

The Vermont Agency of Transportation strives to stay current with state of the art trends in AEC technical advancements. Impacts on project delivery schedules and the resources necessary to provide future support for new features must be considered prior to any change. Updating this manual is intended to be an ongoing process. Revisions will be issued periodically and posted at the CADD website address shown in <u>Section 1.1</u> Distribution.

Revisions to this manual will be documented in Appendix Z - Amendments.

1.3. TRADEMARKS

"MicroStation" and "InRoads", are registered trademarks of Bentley Systems, Incorporated. Other trade names computer protocols, and file formats mentioned in this manual are the trademarks of their respective owners. In no event will the appearance of any graphic, description of a graphic, picture, screen display, or any other method of conveying meaning, be considered to impair the rights of the respective owners.

2. INTRODUCTION

InRoads includes the features your road and site design work requires. It offers advanced DTM capability, associative alignments with spirals, user-defined template typical sections -- including superelevation and independent slope and ditch control. Plans, profiles, cross sections, contour mapping and design data reports can be extracted from a design model.

MicroStation is the platform application for which InRoads runs in combination with. MicroStation is used to view, display and present InRoads design data with a variety of options.

2.1. STARTING THE APPLICATION

There are several methods for starting InRoads. The official method for starting InRoads is to use the Windows Start menu > All Programs > Bentley > InRoads Group XM > InRoads. This will start MicroStation and load InRoads. InRoads executable files can be copied to your desk top as shortcut icons with a < right click > drag to your desk top > release > select copy here. Other methods for starting InRoads use the MDL application startups. For InRoads 8.9 the MDL startup is in the "bin" folder as shown below.

"C:\Program Files\Bentley\InRoads Group V8.9\bin\CivUstXM.ma"

You can use the MDL application browse option or the MicroStation key-in option by keying in the path shown above including the quotes. There are also startup menu options under the MicroStation VAOT menu that will start InRoads.

InRoads, records your application preferences in the windows registry. All customization of tools and preferences are stored in your personal windows profile. Other users of your computer will not have the same settings; if you change computers your InRoads customizations will not follow you. If you get a new service pack for InRoads your settings should remain intact, if you get a new release your settings may not remain.

2.2. InRoads INTERFACE AND EXPLORER WINDOWS

When you load InRoads you will get the InRoads Explorer which contains a main menu bar and two windows for viewing and manipulating active data files and their contents. All InRoads command can be located from the main menu bar. Tool bars can be activated for quick access to the different commands and dialogs. Right click on the gray space to the right of the InRoads main menu help, you will get a shortcut to the LOCKS tool bar (you will need to activate this tool by clicking on locks) and to the Customize dialog where all tool bars are listed. The lock tools are shown below, with a description. In **bold** are common setting, on or off etc.



Bentley InRoads Suite 200	4 Edition	
<u>File</u> Surface Geometry Bridge	Drainage Survey Evaluatio	n <u>M</u> odeler Dr <u>a</u> fting <u>I</u> ools <u>H</u> elp
	Name	Description
日 品 Geometry Projects	∫ BR28channel	Bridge 28 Channel Line
🗉 崖 Default	Cogo Buffer	
	∫ TH20existing	Existing Alignment T.H. 20
E 5e055 28	✓ TH22existing	Existing Alignment T.H. 22
	/VT14detour_1	VT14 Bridge 28 Temporary Detour
	/VT14existing	Existing Alignment VT 14
	VT14propDN_1	VT14 Downstream Alignment 1
🔠 Geometry 🖄 Prefere 4	< ■	2
		1

2.2.1. Explore Window Functions

The left window (Workspace Bar) contains a listing of active data; in the image above the window is displaying Geometry Project Data. The red square near the + symbol indicates the active Geometry Project. A < right click > on geometry listed in the Geometry window will active a shortcut dialog with options to Save, Copy, set Active etc. Tabs at the bottom of the window allow you to toggle to the different data files types loaded i.e. Surface Data, Template Library File etc.

```
🛢 Surfaces 🖁 Geometry 📓 Preferences 🗔 Drainage 🚨 Survey 🚧 Templates 👫 Corridors
```

The right window is displaying information about data contained in the geometry project, In this case we have 6 horizontal alignments listed and the Cogo Buffer. Again the red square indicates the active horizontal alignment. The importance of active data will become more apparent as we move through this manual. Each Horizontal Alignment has a Name and Description; the description will be very useful as the project grows. <u>All Horizontal Alignments should have GOOD descriptions</u>.

2.3. ONLINE APPLICATION HELP

This manual is not intended to be a sole source of information to the InRoads user. InRoads, has extensive online help available through the main menu Help. Additionally when you are using the different InRoads dialog boxes, each box has a Help button. These buttons link you directly to information specific to the work being preformed. It is generally expected that new or even seasoned InRoads users will need to reference the online help regularly. There is vast number of tools available and most have many options. The best solution to a problem usually requires testing and multiple options. Practice and experience using InRoads is the key to being proficient at using InRoads.

VAOT CADD support has setup InRoads preferences and standardized VAOT InRoads practices in an effort make using InRoads as productive as possible.

InRoads Help Contents contains a media library with video presentations and example of standard workflows.

2.4. THE T: DRIVE & ITS STRUCTURE

An overview of the T: Drive and an explanation of what this network drive is used for can be found in the VAOT CADD Standards and Procedure Manual. In an effort to reduce duplication

of effort this document will concentrate on the portions of the T: Drive that pertains directly to InRoads. VAOT standardized InRoads files are located in the path structure show below. An explanation and details on the use to these files will follow through this manual. See Resource File Location Table 2a.

Table: 2a

T:\CADD\Workspace\Projects\English\InRoads (OR) T:\CADD\Workspace\Projects\Metric\InRoads

Folder Name	Content Description
Prefs	Preference Files .xin (replaces the .ini)
SnSdata	Storm Water Data Files .idf .dat
super	Super Elevation Tables - AASHTO 2001 & AASHTO 2004)
template	Typical Section Template Library Files .itl (replaces the .tml)
XMLreports	VAOT Customized XML Report Style Sheets

* The T: dirve or \\AOTCADD\CADDSTD share is the VAOT in-house storage location for resource files. For off network configurations the locations are similar, substitute the T:\CADD\Workspace with C:\Program Files\Bentley\Workspace. All VAOT CADD standards resource files can be downloaded at the <u>VAOT CADD Help</u> web sit.

2.5. BASIC InRoads FILE TYPES DEFINED

The files listed and described below are the basic files that all InRoads user will need to be very familiar with. Every VAOT project designed using InRoads will use the file listed below. Learning what each of these files is used for and what data is contained in them will greatly increase your odds of being a successful InRoads user.

2.5.1. Surface File = (.dtm):

<u>Digital Terrain Models</u>: Existing ground and design terrain surface models are stored in these files. A DTM is composed of point data, triangulation of point data, and a perimeter. Point data can be stored in several features types, Random, Breakline, Contour, Interior Boundary, Exterior Boundary, and Inferred. Point data is not required to be part of the triangulation, some points are tagged Do Not Triangulate.

2.5.2. Geometry File = (.alg):

This file consists of all the horizontal and vertical design data for the project. Roadway horizontal geometry consists mainly of Tangent Lines and PI points, Curve definitions, Stationing, and Events. Roadway vertical geometry consists mainly of linear elements defining grade; parabolic curves defining sag and crest vertical curves.

2.5.3. InRoads Template Library = (.itl):

This file is the collection of templates (or typical sections) used to define the proposed roadway. Templates define the cross section construction of the roadway transverse to the roadway horizontal geometry.

2.5.4. InRoads Roadway Designer = (.ird):

This file contains information defining what templates are used at specified stations, and additional parameters, including super elevation controls to model a corridor. The combination of cross section templates, Horizontal and Vertical geometry are combined go generate a 3 dimensional Digital Terrain Models with points defined by the template drops as they follow the geometry. Super elevation control lines are saved in this file.

2.5.5. General Preference File = (.xin):

This file contains all general parameters for InRoads including the alignment and geometry point parameters. This is the main source of standardization where all InRoads design and graphical output are configured to meet VAOT standards.

2.5.6. Inroads Project File = (.rwk):

This file contains directory and file information for loading and saving InRoads data files. Opening a project file opens all files specified (listed) in the Project File.

2.6. OTHER InRoads FILE TYPES DEFINED

2.6.1. Survey Data = (fwd):

InRoads Survey Fieldbook data file. This file is created by importing survey data from a field data collector. InRoads, converts and combines survey data and saves all edits to the survey data in the Fieldbook data file.

2.6.2. Storm Drainage Database = (sdb):

InRoads Storm & Sanitary database file where project storm water design information is stored. This includes type and locations of Drainage Inlets, Pipes, Culverts and the defined drainage areas.

2.6.3. Drainage Structures = (dat):

This file contains VAOT-defined materials, roughness coefficients, sizes and thicknesses for pipes, culverts, channels, manholes, and inlets.

2.6.4. Interactive Coordinate Geometry Subsystem = (ICS):

This file format is used to import coordinate geometry data into the InRoads. Information for this file format is provided in the Cogo Classic Commands.

2.6.5. ASCII file format = (txt):

InRoads both imports and exports a variety of ASCII text file formats. This includes coma separated CSV files; pipe delineated files tab delineated and much more. Text import and export is customizable to the needs.

SECTION 3 – SETTING UP & LOADING DATA

3. INTRODUCTION

Setting up an organized working environment and having standardized file management greatly increases productivity and reduces probability for errors. Having the correct files loaded is essential to a proper design. InRoads users must master file management for all InRoads design and data files. InRoads provides methods for working with the correct preferences and data files via setting up project defaults and creating a project file for each project.

Setting up the project defaults and creating a project file helps you quickly load all files needed to get the job done. Additionally, the project file helps coworkers load and analyze current design data. Keeping the project file current is an important part of project file management.

3.1. CREATE PROJECT WORKING DESIGN FILE (dgn)

The InRoads user needs to have a MicroStation Design file (dgn) to work on InRoads design data. This is known as the InRoads work (**wrk**) file where all InRoads work is performed. Create this file by either saving the PROJ#sv.dgn as **PROJ#wrk.dgn** then deleting all unwanted graphics or creating a new DGN from seed. The **PROJ#sv.dgn** is referenced into this file so existing topographical information can be obtained as needed. (i.e. survey points, location of breaklines, etc.)

When a suitable alignment has been attained, a profile and cross sections are generated. The alignment information is copied into **PROJ#nu1.dgn** and the profile and cross sections are generated into **PROJ#xs.dgn** where the finishing touches are added for the submittals being prepared. The **wrk** file serves as a blank CAD drawing available to view geometry and surface information without the clutter of other active elements in the file. Working in a blank drawing, allows for all levels **ON**, avoiding looking for certain data i.e. features, geometry, or stationing etc., not finding the data, then realizing that the level was turned off. In many projects it is necessary for each designer working on the project to have their own **wrk** file adding their initials as a suffix to the file name. Remember graphics in the any **wrk** file are never considered part of the project; this file is a blank slate for working InRoads Design.

The **wrk** drawing file should never be submitted with new or proposed graphical data as part of the design. While the **wrk** file is often referenced by the nu1 it should never be the source of the design data. No **wrk** file graphical data will be considered acceptable by VAOT, if it is part of the design it needs to be in the proper file i.e. nu1, xs1 etc. We will not use or accept any data in the **wrk** file received from Consultants. All **wrk** file graphical data is considered deficient or oddments; no exceptions.

3.2. SETUP PROJECT DEFAULTS

The Project Defaults command, located under File on the InRoads pull down menu, specifies which preferences files to open on InRoads startup, and can save multiple configurations i.e. Design Preferences vs. Survey Preferences and project specific with the logical paths to a specified or sets of specified directories for different data file types.

T:\CADD\Workspace\Projects**English**\InRoads\Prefs\VTcivil_1.xin

T:\CADD\Workspace\Projects**English**\InRoads\Prefs\VTcivil_sv.xin

T:\CADD\Workspace\Projects**Metric**\InRoads\Prefs\ (not available)

Roads Fundamentals Manual-		
🖬 Set Project Defaults		
Configuration Name:	English	Apply
Default Preferences		Close
		Ne <u>w</u>
Preferences (*.xin):	rkspace\Projects\English\InRoads\Prefs\VTcivil_1.xin	<u>C</u> opy
Turn <u>o</u> uts (*.txt):		Rena <u>m</u> e
Drainage Structures (*.dat):	\Projects\English\InRoads\SnSdata\VT_structures.dat	Delete
Rainfall Data (*.idf):	pace\Projects\English\InRoads\SnSdata\VTIDF_22.idf	<u>B</u> rowse
Bridge Sections (*.txt):		Import
Drafting Notes (*.dft):		Export
Pay Items (*.mdb):		Help

Click the new button, name the new configuration English, then click in the Preferences window then click < browse > locate the English VTcivil_1.xin file (as shown above) > Click Apply. This is the typical preference file used on proposed projects designed in Imperial (English) units of measure. As shown above other preference files such as the Rainfall Data (*.idf) files can be loaded from the project defaults dialog.

In Addition to setting up an English Preference project default you can save a configuration specific to your project that will setup default directory paths related to the project you are working on. On the bottom portion of the "Set Project Defaults" dialog box there are default directory paths which can be specified.

If the project is English select an English configuration then click the copy button, next rename your copy of the configuration to the project name. Customize the configuration by selecting the window field to the right of the Project Default Directory, then click the browse button and select the project specific folder you wish to be directed to when opening up or saving InRoads files. Setting the "Project Default Directory" and "Projects (*.rwk) option will in most cases be enough unless you store DTM, ALG, TML etc. in data specific folders.

Each time you open InRoads your last used Project Defaults will activate, *verify* you are loading the proper files for your project. If you need to switch Project Defaults open the dialog click on the configuration name (in the pull down) appropriate to your project. When you close (not X) the dialog the new defaults will be loaded.

- Default Directory Paths	
Projectivise Directory:	
Project Default Directory:	M:\Projects\86e055
Report Directory:	
Projects (*.rwk):	M:\Projects\86e055

We continue to use the project *.rwk file to load alignments (.alg), surfaces (.dtm), Template Library (.itl) and Roadway Designer (.ird). This is to insure that co-workers will have the ability to load all current design data when and if they need work on or use project data. Project Defaults do not load data files, only preference files. Data must be loaded by browsing to the files or using the project (.rwk) file.

3.3. LOADING ORIGINAL GROUND DATA (dtm)

Most Project Development projects have an original ground survey collected in the scoping

VAO

stages of the project design cycle. This survey data is imported into InRoads Survey and a resulting survey drawing file is created showing topographical features of the project area. This same survey data is used to create a Digital Terrain Model of the project area and any structures that may exist relating to the project. This DTM will be the basics for design of the proposed surface and roadway geometry.

3.3.1. Opening a DTM file

- a) Select File > Open.
- b) Set Files of type to Surfaces (*.dtm).
- c) Browse to the Survey original ground surface model. For most projects the survey og DTM will be located in the Projects\PPMS#\Survey\ folder. The proper name for a projects original ground DTM file is xPPMS#sv.dtm. For more on proper file naming see the VAOT CSPM, file naming convention.
- d) Once the surface is loaded you can go to the surface tab of the InRoads workspace bar and select surface. Information relative to the surface is displayed in the data window to the right.

<u>File Surface Geometry B</u>	ridge	Drainage Survey Ev	valuation <u>M</u> odeler	Dr <u>a</u> fting <u>T</u> ools	<u>H</u> elp	
<unnamed></unnamed>	- 1	🣚 🚳 🔪 🎽 🖷 🚽				
		Data Type	Active	Features	Deleted	Tota
🗉 🚚 Surfaces		The Breakline Features	5440	514	765	6205
😐 🤜 Default		Scontour Features	0	0	0	C
🕀 🌌 x86e055og		Exterior Features	0	0	0	C
		₩ Inferred Breaklines	0	0	0	C
		Interior Features	0	0	0	C
		* Random Features	828	28	2	830
		Range Points	4	542	0	4
		Triangles	10741	0	341	11082
🛢 Surfaces 🔚 Geometr 4		2				

e) The original ground DTM is loaded and will be in read only status (unless you are a member of VAOT survey section). This does not stop you from viewing or editing the original ground but you cannot save the changes.

3.4. CREATE GEOMETRY PROJECT FILE (alg)

- a) Select File > New.
- b) Select the geometry tab on the top of the dialog.
- c) Set the Type: to geometry project.
- d) Type in the geometry project name > example: **z85e088prop.**
- e) Give the geometry project a Description > example: **ROYALTON BRS 0147(13).**
- f) Close the New dialog and go to the geometry tab on the workspace bar; < right click > on the geometry project you created, then click save.
- g) Browse to the project folder where you will save the geometry file, name the file, and click the save button. The internal geometry project name **z86e088prop** is also the proper file naming convention for proposed geometry files with the added (.alg).

3.4.1. Create Horizontal & Vertical Geometry

Horizontal geometries are children of the geometry project. One geometry project can contain many defined horizontal geometries. Vertical geometries are children of the horizontal geometry and grand children of the geometry project. Horizontal geometry can contain many defined vertical geometries. We will create two horizontal geometries one that is intended to match the existing roadway centerline, the other will define a new proposed alignment. Each of these horizontals will contain at least one defined vertical alignment.

- a) Select File > New.
- b) Select the geometry tab.
- c) For the Type select horizontal geometry in the pull down window.
- Type in a proper name and description. It is common practice to begin the name of the horizontal geometry with the proper route name such as VT100, I89 or US2 etc. Examples shown:

CHANNEL LINE	mlongstreet	6/28/2006 1:58:54 PM
Drive @ 384+50 lt.	mlongstreet	6/28/2006 1:58:54 PM
Drive @ 392+31.49 LT	mlongstreet	6/28/2006 1:58:54 PM
Match Existing Alignment	mlongstreet	6/28/2006 1:58:54 PM
On Alignment Option	mlongstreet	6/28/2006 1:58:54 PM
Upstream Alternative	mlongstreet	6/28/2006 1:58:54 PM
Mainline Avoid Cutting Right Bank	mlongstreet	6/28/2006 1:58:54 PM
Most Upstream Alignment	mlongstreet	6/28/2006 1:58:54 PM
Upstream Alternate 4	mlongstreet	6/28/2006 1:58:54 PM
Extended Approach	mlongstreet	6/28/2006 1:58:54 PM
Same as 4a excepts ends @ 399+50	mlongstreet	6/28/2006 1:58:54 PM
	CHANNEL LINE Drive @ 384+50 lt. Drive @ 392+31.49 LT Match Existing Alignment On Alignment Option Upstream Alternative Mainline Avoid Cutting Right Bank Most Upstream Alignment Upstream Alternate 4 Extended Approach Same as 4a excepts ends @ 399+50	CHANNEL LINEmlongstreetDrive @ 384+50 lt.mlongstreetDrive @ 392+31.49 LTmlongstreetMatch Existing AlignmentmlongstreetOn Alignment OptionmlongstreetUpstream AlternativemlongstreetMainline Avoid Cutting Right BankmlongstreetMost Upstream AlignmentmlongstreetUpstream Alternate 4mlongstreetExtended ApproachmlongstreetSame as 4a excepts ends @ 399+50mlongstreet

- e) Under the Description field is the Style: field select one of the predefined alignment styles. Alignment styles control the drawing display and level assignments for the geometry element, points and geometry annotations.
- f) Click the Apply button then change the Type: to vertical alignment.
- g) Name the vertical alignment > v1 and enter a good description for this vertical Definition. Verticals are children of the horizontal, the name of the horizontal will help define the vertical. Vertical alignments are typically named v1, v2, v3. It is also good practice to always have v1 the accepted vertical alignment. This is to aid future users in knowing what vertical should be use. Vertical alignments also have Style assignments the default or align1 is normally used for v1.
- h) Repeat this process for each horizontal definition needed in your project. Remember one horizontal can have multiple verticals. When creating verticals they are added to the active horizontal.

3.4.2. Active Geometry

When viewing geometry in the workspace bar you can < right click > and select Set Active to make a geometry the active geometry; the red outline indicates active status. You can have only one geometry project, horizontal alignment, and vertical alignment active at any time. The child parent structure effects active geometry i.e. if you choose to make a vertical alignment active, its parent horizontal will also become active; likewise its geometry project will become active if it resides in a separate geometry project.

3.5. CREATE TEMPLATE LIBRARY FILE (itl)

At this point in the process we will create a project specific template library file. Then save the file to the proper project folder. We will not open the template library or create templates at this time. Creating templates will be covered in a later section of this manual.

- a) From the workspace bar select the Template tab.
- b) Right Click on the Template Library entry in the workspace bar window.
- c) Select the New... option.
- d) A save as dialog appears. Browse to your project location and save the file with the proper name. In this example the proper name should be z85e055.itl. No file description segment of the name is required since a project should only have one current template library file.

3.6. CREATE ROADWAY DESIGNER FILE (ird)

At this point in the process we will create a project specific roadway designer file. Then save the file to the proper project folder. We will not open the roadway designer or define any corridors at this time. Defining roadway corridors will be covered in a later section of this manual.

- a) From the workspace bar select the Corridors tab.
- b) Right Click on the Roadway Designer entry in the workspace bar window.



🗉 📴 Template Library

🕂 Templates 📲 Corrid 🖣 🕨

New...

Open...

- c) Select the New... option.
- d) A save as dialog appears browse to your project location and save the file with the proper name. In this example the proper name should be z85e055.ird. No file description segment of the name is required since a project should only have one current Roadway Designer file.

3.7. PROJECT FILE

The project file contains directory and file information for loading and saving InRoads data files. Opening a project file opens all files specified (listed) in the Project File. The save project file command saves all of the files specified (listed) to their respective file locations based on the information set in the Project Options dialog. This file is an ASCII file that can be edited directly using an ASCII editor such as note pad.

RWK

- DTM M:\Projects\86e055\Survey\x86e055og.dtm,N
- ALG M:\Projects\86e055\Consultants\InRoads\z86e055_27.alg
- ALG M:\Projects\86e055\Consultants\InRoads\z86e055_28.alg
- ITL M:\Projects\86e055\Consultants\InRoads\z86e055.itl
- IRD M:\Projects\86e055\Consultants\InRoads\z86e055.ird

Shown here is the content of a project **rwk** file. It is basically a list indicating where files are located and the name of the file. Note the (,N) after the og.dtm is an option indicating the file is opened as read only and will not be saved when the save project command is used.

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3.7.1. Create the rwk file.

- a) Make sure all the files needed in the project file are currently loaded into the InRoads session. If you created something new but did not save the file to a specified location and give it a file name it will not be included in the project file.
- b) Select File > Save As
- c) In the save as dialog set the Save as type: to "Projects (*.rwk)
- d) Browse to the location where you will save this project file.
- e) Name the project file example z86e055.rwk No file description segment of the name is required if a project should only have one current project file. Some projects may have multiple project files but all projects should have at one that loads all current data.
- f) Click the Options... button on the bottom right corner of the save as dialog.
 - The Options dialog contains tabs for each of the file types that can be listed in the **rwk** file. Each tab will list the currently loaded file with a toggle box indicating if the file should be tagged as Add and/or Update. Add indicates that the file can be loaded using the **rwk** file; Update indicates that the file can be saved using the save project command.
- g) On Surface Tab toggle (on | Add) & (off | update) for og surface. It may already be set by default
- h) On Geometry Project Tab (on | Add) & (on | update) for your project geometry file.
- i) On the XIN Preferences Tab (off | Add) & (off | update) for the VAOT standard preference file. We use the project defaults to load all preferences not the **rwk** file.
- j) On the Template Library Tab (on | Add) & (on | update) for your project template file.
- k) On the Roadway Design Tab (on | Add) & (on | update) for your project roadway file.
- I) Click OK > Save > Cancel.

As you add or create more data files such as proposed surface models you must update the project file by repeating the process above. The options will remain as you initially set them but you will need to overwrite the old project file with the updated file.

SECTION 4 – DIGITAL TERRAIN MODELS

4. INTRODUCTION

In the previous section you loaded an original ground DTM. This section will discuss tools used to display and view as well as the structure of the Digital Terrain Model. Throughout most of this section a DTM created from survey data is used, however these tools are applicable to any DTM loaded into InRoads.

A DTM contains a series of defined triangles formed by surface points using a triangulation algorithm. This algorithm, based on Delaunay's criteria, creates triangular planes that define the terrain surface. Since the x,y,z coordinates of each triangle's vertices are known, the elevation of any point on the resulting triangular plane can be computed through interpolation given its x,y coordinates.

This ability to interpolate elevations of any point allows for a virtual surface that can be displayed and viewed in numerous ways to suit needs during the design process. This section will discuss common methods for viewing surface data including:

- The Perimeter
- Triangles (Wire frame and Rendered)
- Contours and Contour Elevations
- Surface Elevations
- Feature Properties

4.1. SURFACE > VIEW SURFACE TOOLS

Open the surface you are planning to view, if not already open. For information on opening surfaces see <u>Section 3</u> of this manual. You should be in a working design file as defined in <u>Section 3</u> of this manual with all levels ON. The InRoads main menu contains a Surface menu; this is where the View Surface > tools are located. There are however, other tools that use surface data including Evaluation and Modeler commands.

4.1.1. The Perimeter

- a) Select Surface > View Surface > Perimeter.
- b) Set the appropriate surface active in this example x86e055og is the surface that will have its perimeter generated.
- c) Select Preference Tab. To load a named preference, double click on the name of the preference. The **old_ground** preference is standard for the original ground DTMs. Named

<u>dinace</u> . [x86	ie055og 💌	Apply
		Close
		Preferences
		Help
Symbology:		

preferences (Perimeter Surf-1 through Perimeter Surf-5) are used to achieve levels separation of perimeter graphics. Select and load the **old_ground** preference. > Close the Preference dialog.

d) Click the Apply button. An outline of the triangulated model will be displayed in the active DGN view. Close the View Perimeter dialog.

By definition the perimeter is a graphical display of the outside or exterior edge of the current

triangles as they reside in the model. This graphical display does not control the triangles it only identifies the perimeter of the current triangles. This is not the same an exterior boundary feature, even though they often appear in the same spatial location.

4.2. DTM TRIANGULATION

Triangles are a very good way to dynamically view the 3D surface. Viewing the triangles lets you see elevation breaks, river channels and much more. Rendering the triangles gets you an even greater visualization of existing surface model conditions. This method of viewing the surface is excellent for analyzing and checking the existing surface or proposed surfaces for errors or problem areas.



Shown here is an example surface triangulation display. Each triangle vertices has a known x,y,z coordinate. The triangulated model is the basis for surface display and surface computations made by InRoads. Surface reporting, quantity information, and evaluation data is only as good as the triangulated models they are referencing.

4.2.1. View Triangles

- a) Select Surface > View Surface > Triangles.
- b) Set the appropriate surface active in this example x86e055og is the surface that will be represented by the triangles.
- c) Select Preference Tab. To load a named preference, double click on the name of the preference. The **old_ground** preference is standard for the original ground DTMs. Named

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Fence <u>M</u> ode:	Inside	~	Close
Colored <u>M</u> od	el		Preferences
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preferences (Surf-1 through Surf-5) are used to achieve levels separation of triangle graphics. Select and load the **old_ground** preference > Close the Preference dialog.

d) Click the apply button. Triangles that represent the surface model will be displayed in the active DGN view. Close the View Triangles dialog.

4.3. CONTOUR DISPLAY

- a) Select Surface > View Surface > Contours.
- b) Set the appropriate surface active in this example **x86e055og** is the surface that will be

- c) The Interval: sets the contour interval. This number represents the vertical change in elevation that will be represented by a contour line. In this case 2 will generate a contour line at every 2 foot change in elevation.
- d) Minors per Majors: sets the number of minor contours that will be displayed between the major contours. The settings shown here will generate a contour line ever 2 ft with 4 minors per major resulting in a major contour every 10 ft.
- e) Select Preference Tab. To load a named preference, double click on the name of the preference. The **old_ground** preference is standard for the original ground DTMs. Named preferences (Cont Surf-1 through Cont Surf-5) are used to achieve levels separation of contour graphics. Select and load the **old_ground** preference > Close the Preference dialog.
- f) In the symbology section of the dialog notice that Major, Minor, and Major Labels are "X" to indicate they are ON and will be displayed when applied. Click the Apply button > Close the View Contours dialog.



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- g) Shown here is an example of contours drawn at 2 ft intervals with majors at 10 ft interval and labels on the major contours. This is the default contour spacing, other contour intervals may be required on very flat or very steep areas.
- h) To change the contour interval to a 1 ft interval with labeled majors at 10 ft.
 - 1) Change the Interval: number to **1** for one foot > Click the TAB key.
 - 2) Change the Minors per Major: to **9** > Click the TAB key.
 - 3) Click the Apply button or (Enter key) > Close the Dialog

Note: Typically for InRoads the **ENTER** key is equivalent to the **Apply button** on a dialog. Use the **TAB** key to enter or accept input entries in dialog fields. If you click the ENTER key the command will initiate. This is particularly important on the more complex dialogs with lots of options where initiating the command prior to completing input may cause undesirable changes to your data.

4.4. SURFACE POINT ELEVATIONS

As stated earlier the triangulated model allows for the elevation of any point on the resulting triangular plane to be computed through interpolation given its x,y coordinates. The surface elevation tools will label the elevation of any given coordinate over a surface model. There are several options or methods used for labeling elevations. The simplest is to label all points on a given surface model.

- a) Select Surface > View Surface > Surface Elevations.
- b) Set the appropriate surface active in this example **x86e055og** is the surface that will be represented by point elevations.
- c) By default All Points is the active mode and should be fine for small surface models.
 - For large surface models place a MicroStation fence around the area elevations are to be labels.
 - 2) When you have a MicroStation fence active the Fence Mode option activates with inside mode as the default preference. This indicates that only points inside the fence will be labeled.



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- d) Click the Apply Button > Click the Close Button.
- e) **Single point elevation** can be labeled at any point specified by a data point on the screen. Select Surface > View Surface > Single Point > Surface Elevation.
- f) Click Apply > Hold the MicroStation cursor over and data point or snap to the point and a single point elevation will be labeled.

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4.5. FEATURE PROPERTIES

To this point we have referred to surface models as points connected by a series of triangle legs that form a virtual surface model that can be utilized for multiple purposes. There is more to the DTM then points. Point data can be tagged as specific point types and connected to other points of the same type forming a feature. For example, a series of points can be connected to form a crown of the road feature. This type of point data is called a breakline. A breakline is unique in that no triangle legs are allowed to cross a breakline. This adds control to the triangulation by specifying that certain linear features have different feature types. Breaklines are the most common feature type in civil site work. Features and points can also be tagged as do not triangulate, they will be saved in the DTM but will be ignored for the triangulation.

Breaklines provide enhanced accuracy to the surface models defining edges, corners, ridges, exterior and interior boundaries etc. Breakline triangle legs are formed prior to non breakline triangle legs, resulting in each linear breakline point connection forming a leg of the resultant triangulated model. The triangulation process alone will connect each point to the nearest point in the x,y plane, allowing no one triangle leg to cross another. Breaklines override the triangulation process of finding the nearest point in the x,y plane.

Breakline features formm the VAOT survey topographical drawing. Graphical elements shown in each projects survey file are representations of breaklines collected by a field survey. To view or edit surface model (DTM) feature properties:

- a) In your MicroStation View turn on all level. Turn off all reference files.
- b) Select Surface > View Surface > Feature > Feature Properties.
- c) In the Feature: list scroll down to a feature named CR*. CR is the VAOT survey alpha code for Crown of the Road. Select one of the CR* features. Note the Triangulation Feature type is Breakline.
- d) Select all the features with the CR* name. Notice the features are highlighted in the active DGN view.

Viewing and editing feature properties will be much more valuable on proposed surface models. In order to create accurate complete proposed surface models you will need a comprehensive understanding of features and their properties. More information is available from InRoads help and should be explored.

5. INTRODUCTION

The basis for laying out a roadway is the horizontal control geometry. This consists mainly of defining the straight and curved sections in the roadway design. Roadway design is tied to horizontal control geometry. Often the horizontal geometry is the center or crown of the road. Horizontal geometry affects the speed and safety of a roadway design. Proper engineering design of roadways is important and should follow state and federal guidelines. The Vermont Agency of Transportation relies on several sources for Engineering Design References.

- VAOT Road Design Manual
- VAOT Structures Manual
- AASHTO Roadside Design Guide
- VAOT Standards Drawings

These are some of the basic reference materials but there are many more engineering reference materials used during the design process. <u>Section 5</u> will focus on the basic InRoads tools used to layout horizontal control geometry not on engineering design practices.

5.1. LAYOUT CURVE SET TANGENTS

The PI method for layout of horizontal geometry seems to work for most standard VAOT roadway layouts. This method involves defining horizontal tangent line <u>P</u>oints of <u>I</u>ntersection. For most projects we start by defining a horizontal geometry that matches the existing roadway design. The original ground survey drawing is used as a reference for locating existing geometry tangents and the PI's.



Shown here in Figure 5.1a is an example of 4 tangent lines defined by 5 PI's. PI - 1 defines the POB or point of beginning on this alignment while PI -2 is a true point of intersection. These five points were defined using the insert PI command.

In <u>Section 3.4</u> the process for creating a Geometry Project and naming a Horizontal Geometry was explained. The next section will walk through the process for defining the elements that make-up horizontal geometry.

5.1.1. Add PI - Define Point of Intersection (PI)

- a) Set the appropriate horizontal geometry active. For this example set **VT14prop_1** as the active horizontal alignment.
- b) Turn ON all DGN file levels. Turn ON the survey original ground reference.
- c) Select Geometry > Horizontal Curve Set > Add PI
- d) For PI-1 data point on the center of the existing roadway at the beginning of the project then data point to accept the point. **NOTE:** always read and follow the MicroStation prompts at the bottom left corner of the application.
- e) After accepting PI-1 you will automatically be asked to select the next point. A dynamic display of the geometry tangent should follow the curser to the next point. Following the existing topographical drawing, data point and accept the location of PI-2 (See Figure 5.1a). PI-2 is not on the roadway center line it is where the first tangent will intersect the second tangent. It is not critical that PI's be placed exactly in the proper position on the first attempt. PI's can be moved to best fit a design.
- f) Work your way along the project data pointing and accepting PI locations similar to what is shown in Figure 5.1a.
- g) It is a good practice to delete the graphics generated after creating geometry, and then redisplay the alignment elements. This will ensure that the saved alignment is the same as what is shown on the screen. <u>Do not assume graphical elements shown on the</u> <u>screen are the same as what is in memory. When uncertain re-display the alignment</u> <u>elements</u>.
 - To re-display geometry Select > Geometry > View Geometry > Active Horizontal.

Geometry can be reviewed in detail using the Review Horizontal Alignment command. This data can be saved in a text file or printed for review and project records.

- a) Set the active horizontal geometry appropriately. For this example set **VT14prop_1** as the active horizontal alignment.
- b) Select Geometry > Review Horizontal.

Shown below is the content of a Review Horizontal Alignment command. This is a review of the geometry placed and shown in Figure 5.1a. Note that PI-1 is represented as the POB. The first element spans from POB (1) to PI (2) then the second element spans from PI (2) to PI(3) and so on. The Stationing, Northing and Easting of each point is listed. The direction of each element and its length are also reported. Notice there are different modes available for reviewing the geometry. As the geometry is extended and curves are defined these review modes will become very useful. This review information can be used to re-create the exact geometry (if required) using MicroStation precision key-in commands to place each PI.

VAOT InRoad	s Fundamentals Manual			200)7
Hori zonta	Project Name: z86e Description: P al Alignment Name: V Description: V Style: a	e055prop roposed Geometry T14prop_1 T14 On Alignment Op Lign1	ti on		
	Styre. u	STATION	NORTHI NG	EASTI NG	
Element:	Linear POB (1) PI (2) Tangent Direction: Tangent Length:	0+00.00 1+39.36 S 74^47'08.57" W 139.36	491864. 1400 491827. 5670	1617790. 0592 1617655. 5806	
Element:	Li near Pl (2) Pl (3) Tangent Di recti on: Tangent Length:	1+39.36 8+41.68 S 84^26'08.60" W 702.32	491827.5670 491759.4683	1617655. 5806 1616956. 5692	
Element:	Linear PI (3) PI (4) Tangent Direction: Tangent Length:	8+41.68 16+37.44 S 30^35'56.23" E 795.76	491759. 4683 491074. 5200	1616956. 5692 1617361. 6296	
Element:	Linear PI (4) POE (5) Tangent Direction: Tangent Length:	16+37.44 20+28.97 S 13^52'51.28" E 391.53	491074. 5200 490694. 4224	1617361. 6296 1617455. 5598	

Note: The process for creating the horizontal geometry can be iterative. In some cases the POB of the alignment then the POE (Point of Ending) are placed before any other PI points. The sequence for placing points does not matter. Place points where they seem reasonable, then insert and move points to get the desired alignment.

5.1.2. Insert PI

Use this command to insert a PI between two existing PI locations.

- Select Geometry > Horizontal Curve Set > Insert PI (Read and Follow the MicroStation Command Line readout)
- Redisplay geometry Select > Geometry > View Geometry > Active Horizontal.

5.1.3. Move PI

Use this command to move a PI that existing in the active alignment.

- Select Geometry > Horizontal Curve Set > Move PI
- Redisplay geometry Select > Geometry > View Geometry > Active Horizontal.

5.1.4. Delete PI

Use this command to delete a PI that existing in the active alignment.

- Select Geometry > Horizontal Curve Set > Delete PI
- Redisplay geometry Select > Geometry > View Geometry > Active Horizontal.

5.2. DEFINE CURVES

Defining a curve between tangent lines is an important part of the horizontal alignment. We will use the define curve command and review several of the options that can be used to set and refine the proper curve radius. There are other tools available to generate horizontal alignments and curve sets. The other geometry tools available are more advanced and can be very useful for more complex geometry such as compound curves.

5.2.1. Radius

To use the Define curve by radius command you must have tangent elements defined in your active horizontal alignment.

- a) Select Geometry > Horizontal Curve Set > Define Curve.
- b) On the Define Horizontal Curve Set dialog are several options. At the bottom notice the next > Last and Select curve navigation buttons. If you click the Next > button you walk down your alignment PI points. If you watch your MicroStation view each PI tangent set will highlight as they become the active curve.
- c) Above the curve navigation buttons it the Define By: Toggle on the Radius option.
- d) Above the Define By: section is the Horizontal Curve section here you will enter in curve information.
- e) Go to the First curve set in the horizontal alignment. Notice the curve radius is set to 0.00 if you have not changed it. Enter in a reasonable curve radius for your project. Click the TAB key to enter the data > Click the Apply button.

Horizontal PI				Apply
Define By: Known PI	l Coordinate	s	•	
Direction Bac <u>k</u> :	S 74	47'08.57" W	+	Close
Length <u>B</u> ack:	139.30	6	-+-	Undo
Point Na <u>m</u> e:				Rate Calc
Northing:	49182	27.5670		Design Calc.
E <u>a</u> sting:	16176	55.5806		Curve Calc
Direction Ahead:	S 84^	26'08.60" W	- + -	Report
Length Ahead:	702.32	2	+	Hole
Horizontal Curve Curve Set Type: Define Transitions By: Leading Transition: Radius <u>1</u> :	 ● S<u>C</u>S ● Length Clothoid 	C SCSCS C Constant	t 0.00 835.00	
Horizontal Curve Curve Set Type: Define Transitions By: Leading Transition: Radius <u>1</u> : Compound Transition:	S <u>C</u> S Length Clothoid	← <u>S</u> CSCS ← C <u>o</u> nstant	0.00 835.00	
Horizontal Curve Curve Set Type: Define Transitions By: Leading Transition: Radius <u>1</u> : Compound Transition: Radius <u>2</u> :	(SCS (Length Clothoid	C SCSCS C Constant	t 0.00 835.00 0.00	
Horizontal Curve Curve Set Type: Define Transitions By: Leading Transition: Radius <u>1</u> : Compound Transition: Radius <u>2</u> : Trailing Transition:	© S <u>C</u> S © Length Clothoid Clothoid	C SCSCS C Constant ✓	e 0.00 835.00 0.00 0.00	e
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Horizontal Curve Curve Set Type: Define Transitions By: Leading Transition: Radius <u>1</u> : Compound Transition: Radius <u>2</u> : Trailing Transition: Define By: • Radius C Tangent t	S <u>C</u> S Eength Clothoid Clothoid Clothoid Clothoid clothoid	C SCSCS C Constant C Point Name	t 0.00 835.00 0.00 0.00 0.00	
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Horizontal Curve Curve Set Type: Define Transitions By: Leading Transition: Radius <u>1</u> : Compound Transition: Radius <u>2</u> : Trailing Transition: Define By: • Radius • Tangentt • Spiral to T • Point on C	S <u>C</u> S Length Clothoid Clothoid Clothoid Clothoid Clothoid Clothoid Correl Curve	C SCSCS	0.00 835.00 0.00 0.00 0.00 491846.00 1617723.6	• • • • • • • • • • • • • • • • • •
Horizontal Curve Curve Set Type: Define Transitions By: Leading Transition: Radius <u>1</u> : Compound Transition: Radius <u>2</u> : Trailing Transition: Define By:	S <u>C</u> S Eength Clothoid Clothoid Clothoid Clothoid Clothoid Clothoid Clothoid to Spiral Tangent Curve to PCC (PC)	Constant Con	e 0.00 835.00 0.00 0.00 0.00 491846.00 1617723.6 0^0000.0	

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f) The curve should dynamically display the curve radius on the screen. If your radius is too large the software will not accept it and notify you of a solution overlap.

5.2.2. Point on Curve

Often for matching into existing project curves the quickest way to find a radius is to identify a point through witch you need the curve to pass through. This can be done using the Point on Curve method.

- g) Select Geometry > Horizontal Curve Set > Define Curve.
- h) Navigate to the curve using the <Previous, Next> or Select buttons on the bottom of the dialog.
- i) Toggle on the Define By: Point on Curve option.

 j) Use the target button to the right of the coordinate display to select a location the curve will pass through.

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Tangent to Spiral	Point Na <u>m</u> e:		
Spiral to Tangent	Northing:	491846.0640	+
Point on Curve	E <u>a</u> sting:	1617723.5941	

- k) Click the Apply button.
- I) Toggle the Define By: option back to Radius. You can now edit the radius to refine the curve definition.

Note: If you attempt to define a radius that is too large the software will not find a solution. Adjust your parameters and try again. You can move PI locations after curves have been defined.

5.2.3. Curve Calculator

The curve calculator computes parameters of a curve based on two known parameters. This is used primarily in association with other commands to compute the length and radius of circles or spirals when given known parameters.

To calculate the DOC of a curve for a given radius lock the radius value in the calculator and lock in one of the other parameters i.e. Length:, Angle:, Chord:, etc. an click the Compute button.

To calculate a Radius for a given DOC Lock in the desired DOC and one of the other parameters (make sure the Radius is unlocked) click the Compute button.

When you have computed the results click the OK button. Computed values will be entered into the Define Curve Set dialog. Click the Apply button to apply the defined parameters to the curve.

Description	Parameter	SIMPLE CURVE	DOC	Radius (FT)
Radius (R)	Radius		1	5,729.6
Degree of	DOC	PI VSA	2	2,864.8
Curve			3	1,909.9
Arc (A-B)	Length	T E T	4	1,432.4
Angle (Δ)	Angle	c ·	5	1,145.9
Chord (A-B)	Chord		10	573.0
Tangent (T)	Tangent	A	15	382.0
Distance (E)	External	PC D PT	20	286.5
Distance (M)	Ordinate		25	229.2
			30	191.0
			40	143.2
		× ×	50	114.6
		\bigvee_{0}	60	95.5
			90	63.7

5.3. ALIGNMENT STATIONING

Stationing is linear horizontal measurement along the horizontal alignment, where a defined linear length value is assigned to a point on the geometry. All points along the geometry are measured relative to the assigned stationing value. This forms a relative method of reference for all transactions related to the geometry.

General Stationing Rules:

- No Roadway horizontal alignment should start with a 0+00 Stationing value.
- Roadways should have significantly distinct stationing values e.g. 500+00 vs. 600+00.
- Existing Stationing should be matched when possible.

5.3.1. Define Stationing

When ready to define the stationing for alignments, set the horizontal alignment active. By default the first PI placed in the geometry will have station 0+00. PI's added to the first PI placed will have negative station values; stations added after or inserted between the POB and POE will have positive values. We can define the stationing value at any single point in the geometry. Generally it is sufficient to define the stationing for the POB.

- a) Select > Geometry > Horizontal Curve Set > Stationing.
- b) In the Stationing dialog you can select the Horizontal Alignment e.g. set to VT14prop_1.
- c) In the Starting Station field enter the stationing value for your alignment e.g. 500+00. It is not required to type the (+).
- d) By default you are defining the stationing for the POB if you need to select an alternate point or location you can do so with the target button to the right of the point name field.
- e) Vertical and Superelevation Alignments options should be set to **Maintain Station Difference** unless you are specifically attempting to shift alignment stationing.
- f) Click Apply
- g) Review the Horizontal Alignment, in the Review Dialog note that the POB now has a station value of 500+00.

Hori zonta	Project Name: Description: al Alignment Name: Description: Style:	z86e055 Propose VT14pro VT14 On align1	prop d Geometry p_1 Alignment Op	ti on	
	Styre.	arrynn	STATI ON	NORTHI NG	EASTI NG
Element:	Linear POB (2 PC (2 Tangent Direction Tangent Length) 2) 1: S 74	500+00.00 500+68.88 ^47'08.57"W 68.88	491864. 1400 491846. 0640	1617790. 0592 1617723. 5941

- h) Select > Geometry > View Geometry > Stationing.
- i) Select the appropriate Horizontal Alignment e.g. set to VT14prop_1. The limits toggle off will station the entire alignment.
- j) The default preference will generate stationing graphics for general use, in the preference option there are several predefined preferences aling1-5 for general

alignment stationing and the Title stationing for title sheet specific stationing. Load the aling1 preference > Close

k) Click the apply button. Stationing will be generated in a standard VAOT format.



There are many options for stationing found on the View Stationing dialog. These options can change what is getting station labels such as Major or Minor Stations. You can rotate the direction of the station labels under the regular station labels tab. This is sometimes needed depending on the rotation of your project layout. The image above shows typical stationing.

5.3.2. Tracking Tools

The Tracking Tools track along the active Horizontal and Vertical geometry dynamically and/or graphically displaying information relative to the geometry.

- I) Select > Tools > Tracking > Horizontal Alignment.
- m) Move your cursor or snap to a location on the screen. The information display at the bottom of the InRoads Explorer will dynamically display Station, Offset and Elevation of the active horizontal alignment. The elevation portion will show the elevation of the Active vertical alignment. If you have no vertical the Elevation should display as Zero.
- n) Select > Tools > Tracking > Tracking > Activate.
- o) This will dynamically display tracking information in the Tracking dialog and if you select a location on the screen the information will be written to the screen in MicroStation Graphics. Note the elevation shown with this tool is the elevation of the Active surface.

5.3.3. Station Equations

Station equations denote a change in stationing along an alignment due to a change in length of the alignment. A change in length can occur for example when a revision to a project flattens a curve, straightens a section of roadway, or in some other way alters the road so that it is longer or shorter than its original length. Instead of re-stationing the entire roadway, a station equation is created so that as little of the road as possible requires re-stationing. For more information on Station Equation setup refer to the InRoads help.

5.4. DEFINE EVENT POINTS

There are a number of reasons to add event points to the horizontal alignment. Events are basically points of interest i.e begin project location, end project location, roadway intersections, driveway intersections, begin bridge, end bridge etc. Event points can be defined by Station and Offset values, Northing and Easting values or Cogo Points. Events are reported in the geometry reports and can be annotated graphically along with other geometry point annotations.

- a) Set active horizontal geometry e.g. VT14prop_1
- b) Select > Geometry > Horizontal Curve Set > Events.
- c) Define By: > Single Station
- d) Add As > Station and Offset.
- e) Locate By: you can use the target to select a location or enter the proper station and offset. In this example I will enter the station as 502+00 with an offset of 0.00 this event will help define the begin project.

This event is tied to the stationing if the stationing is changed this point will follow and remain at station 502+00. If you define events using the "Add As" **Station and Offset (S+O)** method then change the stationing of the geometry such that the event points are outside the range of the horizontal geometry the events are deleted.

Defining a point by Northing and Easting will store the point using its coordinate value. If the stationing on the alignment changes it does not change the event point coordinate values.

Note: Horizontal geometry should extend beyond the construction limits, i.e. where the project will start and stop. Vertical alignments are not required to extend beyond but should include the start and stop points.

5.5. HORIZONTAL ANNOTATION

The Horizontal Annotation tool provides an expanded ability to display and annotate. These tools provide the ability to display multiple horizontals at the same time as well as display all the different point and element types. Preferences have been setup GP_ALIGN-1 through GP_ALING-5 these preferences basically are the same settings but the display is generated on the appropriate alignment control levels i.e. AC1_P through AC5_P.

- a) Select > Geometry > View Geometry > Horizontal Annotation
- b) Select > Preference button > Load the GP_ALIGN-1 preference > Close.
- c) Select in the Horizontal Alignment Include field.
- d) Select the Filter Button (Top Right near Help).
- e) In the Geometry Selection Filter to the left are all available horizontal geometries. To the Right are the selected geometries. Using the Add, Remove, Swap, None and All buttons put the geometry you are annotating on the selected side of the dialog. Click OK.
- f) Click the Apply button on the View Horizontal Annotation Dialog. The selected geometry is displayed with additional data including the Subtangents. This is a standard VAOT horizontal annotation on the new and proposed design plans.

	_
	1
Filter	

Horizontal Alignments

Include:

Fi <u>l</u> ter	
Help	1

5.6. REVIEW AND REPORT HORIZONTAL GEOMETRY

The review horizontal geometry dialog displays detailed information about the elements in the selected horizontal alignment.

- a) Select Geometry > Review Horizontal
- b) Geometry Project Field is used to specify the geometry project that contains the Horizontal alignment you want to review.
- c) Horizontal Alignment field is used to specify the Horizontal alignment you want to review. The target button can be used to tag the horizontal alignment elements on the screen.
- d) Mode: area will filter what parts of the alignment you are reviewing.

<u>G</u> eometry Project:	z86e055prop	•	Mode		
Hori <u>z</u> ontal Alignment	VT14prop_1	+	C Curve Sets	 Alignment 	⊖ <u>E</u> lement

- o Curve Sets option will display information based on curve sets.
- o Alignment will display all elements in the specified Alignment.
- Element option will display one element in the alignment at a time. The Select, First, Previous, Next and Last buttons can be used to view each element in the alignment. The element currently being reviewed is highlighted in the current view.

<u>S</u> elect
<u>F</u> irst
< Previ <u>o</u> us
<u>N</u> ext >
<u>L</u> ast

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The save as command will save the current review contents to an ASCII file. It is good practice to save the Alignment review to file in the project folder and print it out for the project file.

5.6.1. Report Horizontal Geometry

XML Reports offer a long list of report capabilities. Using XML reports we can choose from standard delivered InRoads Style sheets and if so inclined you can create your own XML style sheets.

- a) Select Tools > XML Reports > Geometry.
- b) Select the Include field > Filter > Use the Add, Remove, Swap, None and All buttons to get the geometry you are reporting on in the **Selected** window. Click OK
- c) Alternatively if you know the name of the alignment you could type it into the Include field, or use the target to graphically select the alignment.
- d) Click the Apply Button.
- e) The Report browser will start. On the left side you will see a list of available reports in the geometry folder. HorizontalAlingmentReview.xsl sheet will give a report very similar to the standard review horizontal command but with format options.
- f) In the report browser select Tools > Format Options > Here you can adjust the Angular mode, Precision and change the format. These changes are instantly shown in the report browser.
- g) Under the Report Browse File menu there are options for Printing or saving the report.

6. INTRODUCTION

Roadway horizontal geometry will require vertical control. The vertical geometry will define the grade of the roadway and the vertical curves. Using a profile generated along a defined horizontal geometry we can layout and design the vertical geometry. Vertical geometry is the defined vertical data at or relative to the horizontal control geometry. Proper engineering design of roadway vertical control is important and should follow state and federal guidelines. The same engineering practices explained in Section 5 apply to this section. Section 6 will focus on the basic InRoads tools used to layout vertical control geometry not on engineering design practices.

6.1. CREATE A PROFILE ALONG HORIZONTAL GEOMETRY

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Vertical geometry requires an existing horizontal geometry to be defined and set active. Generating a profile along the horizontal geometry is also required before you can begin to define the vertical geometry. This profile will be considered a working profile and should be generated in your working DGN file as defined in Section 3 of this manual. Once the vertical geometry is designed and finalized a PROFILE is generated and annotated in your profile DGN for engineering plan set use. For this section we will use the profile only as a means to define the vertical geometry when finished the profile can be deleted.

6.1.1. Evaluation Profile Create Profile

- a) Load all data files; you will need the existing ground DTM file and the Geometry Project file as a minimum to generate this profile.
- b) Select Evaluation > Profile > Create Profile
- c) On the General Leaf Toggle ON the og surface
- d) The Exaggeration value by default is set at a value of 2 in this working example it was changed

Create Profile General Source Include Network Offsets Controls Controls	Set Name: VT Direction C Left to Right C Right to Left Surfaces:	14prop_1	Exaggera Vertical: Horizonta	tion 10.0000 I: 1.0000
- 🛅 Grid	Object	Name		
ASCII	Default x86e055og	Default default	BYI BYI	

to 10 because of the relative flatness of the project. Set your vertical exaggeration accordingly.

e) On the Source Leaf the Alignment option should be toggled on and the horizontal alignment that the profile will follow should be set active e.g. VT14prop 1.

Create Profile	Create:	Window and Data	-
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- There are many other options available to set in the create profile dialog. Preferences f) have been setup for the VAOT standard profile generations including the default preference. Click the Apply Button.
- g) Data point on the screen the point where you want the bottom left corner of the profile to

be drawn. (horizontal & vertical axis always align with the drawing X,Y axis)

6.2. CREATE VERTICAL GEOMETRY

<u>Section 3.4.1</u> of this manual explains the process for creating and naming a Vertical Geometry. At this point you should have an empty vertical geometry created and named as a child of the Horizontal geometry that was used to create the profile.

- If you do not have a vertical geometry created and named refer back to <u>Section 3.4.1</u> or follow the steps shown below.
- If you have a vertical geometry but it is not empty create another vertical geometry or empty the one you have. You can review the vertical geometry using the Geometry > Review Vertical Geometry command (It should be empty at this point).
 - To create Vertical geometry use the File > New > Geometry Tab
 > Type: set to Vertical Geometry > Name the Vertical Geometry and set the Style > Click Apply.
- New... Set Active Copy... Delete Empty View Edit... Review... Check Integrity...

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 To Empty a Vertical geometry use the InRoads explorer Geometry Tab > Select the vertical geometry and RIGHT CLICK; you will get a short cut menu with several useful tools including the Empty command.

6.3. DEFINE VERTICAL CURVES

To begin defining the vertical curve we must realize that the vertical alignment must match into existing ground at begin and end of project. For this reason we will start the vertical geometry by defining the begin and end points to match existing grade.

6.3.1. Annotate Existing Ground elevations

- Select Evaluation > Profile > Annotate Profile > Preference Button > Load the <u>existing</u> preference > Close.
- In the annotate profile dialog Surface should be set to Existing Ground and the active profile set should be set and outlined on the screen if not use the target to select and activate it. Click Apply

6.3.2. Add Vertical PI

- a) Select > Geometry > Vertical Curve Set > Add PI
- b) In the Add Vertical PI dialog toggle off the Dynamic rounding toggles, Click Apply, use the MicroStation key-in window and key-in SE= Station and Elevation of the beginning point of the vertical alignment e.g.
 SE=50025,530.6. This can be read from the profiles horizontal axis. Click the Enter Key.
- c) Read and follow the MicroStation command prompt to accept (data point) the PI location.



- d) Repeat the MicroStation Key-in with the Ending station and elevation of the vertical alignment e.g. SE=51675,526.6 [enter].
- e) Above is one method for entering in VPI locations you could use the Add Vertical PI
Dynamics or select locations within the profile.

6.3.3. Insert Vertical PI

To this point we have a Vertical alignment with a constant grade from the begin project to the end project. In a workflow similar to inserting or adding PI location in a horizontal alignment we will add or insert VPI locations to the vertical alignment.

- a) Select > Geometry > Vertical Curve Set > Insert PI
- b) In the Insert Vertical PI dialog you can set Dynamics for rounding the Stations, Elevations etc. then click the Apply button.
- c) Select on the screen the geometry element you are inserting the PI in and you will get a rubber banding display of the grade lines. Data point and accept the location of the new PI. Repeat this process for all PIs in the vertical alignment. PI locations can be move and adjusted as needed to achieve the proper design.

6.3.4. Move Vertical PI

Use this command to identify and move VPI station and elevations using similar tools to what was used in creating the VPIs

6.3.5. Delete Vertical PI

Use this command to identify and delete VPI one at a time in the vertical alignment.

6.3.6. Define Vertical Curve

- a) Select > Geometry > Vertical Curve Set > Define Curve
- b) This dialog is similar in function to the Define Horizontal Curve. But Vertical curve parameters are parabolic.
- c) The Station and Elevation of a VPI can be edited from this dialog.
- d) Vertical Curve can be calculated using several methods including by Length of the curve, Rate of change, Middle Ordinate, Pass-through point, K value, Unsymmetrical Length.
- e) The active curve set will highlight in the profile to help identify the curve you are working on.

Vertical PI			Apply
Define PVI <u>B</u> y:	Station and Elevation	•	0
S <u>t</u> ation:	505+00.00		Close
Ele <u>v</u> ation:	523.50	₩	Undo
Entrance <u>G</u> rade:	-1.49%	+	Design <u>C</u> alc
E <u>x</u> it Grade:	1.46%	ф	Report
			<u>H</u> elp
vertical Curve — Calculate B <u>y</u> :	Length of Curve		
L <u>e</u> ngth:	150.00	+	
Adjacent Curves – Update By: 「 <u>D</u> istance:	Length of Curve	+	

- f) Defining and refining a vertical geometry can be iterative. It is important to note that one horizontal alignment can have several alternate vertical alignments defined.
- g) Save your geometry project whenever you get definitions that you would like to keep. All software has the potential of crashing especially when you have large data sets.

6.4. DEFINE VERTICAL EVENT POINTS

Vertical Event points basically serve the same purpose as horizontal events; they define events that are specific to the vertical geometry. Now that we have both a Horizontal and Vertical

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alignment defined it is possible to add events as both horizontal and vertical events at the same time using the toggles located in each of the Define Events dialogs. Vertical Events can be annotated in the profile.

6.5. VERTICAL GEOMETRY ANNOTATION

Vertical Geometry Annotation is the annotation of vertical elements in profile. During the design process this annotation is one method for reviewing the geometry. This is the standard method for showing vertical geometry in construction plan sets. Profile sets are generated for every section of roadway in the project. Generally each plan sheet has a matching profile sheet e.g. if a plan layout sheet is showing a section of road from STA 502+00 to STA 508+00 then a profile sheet should be setup to display vertical geometry from STA 502+00 to STA 508+00. In some situations such as VAOT bridge projects plan and profile are shown on the same sheet.

Shown here is a short example of a profile with the vertical geometry displayed and annotated. As shown it is standard to label the Length (L) of the curve, K value, stopping Sight Distance (SSD), stations and elevation of the PVC, PVI and PVT, as well as the entrance and exit grades. The profile is annotated with the elevation of the existing ground and the proposed vertical alignment at 25 foot station marks on the bottom horizontal axis.



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6.5.1. Vertical Annotation

- a) Select Geometry > View Geometry > Vertical Annotation
- b) In this dialog you will set the proper horizontal alignment that contains the vertical you are planning to annotate e.g. VT14prop 1.

View Vertical Annotation				
Main Points Curves	Tangents Affixes			
Horizontal Alignment: VT14prop_1				
Vertical Alignment:	v1	•		
Profile Set	VT14prop_1	•		

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- c) Set the Vertical Alignment to the one you are planning to annotate e.g. v1.
- d) Set the Profile set to the proper profile in your drawing. This option is used if there is more than one profile drawn. Select the profile set you are using to display vertical annotation, a box should display around the profile set you are working on.
- e) Click the Apply button. Vertical annotations may need to be moved around and cleaned up, some curve data and other annotations may conflict with each other, this is normal.

6.6. **PROFILE ANNOTATIONS**

In a previous section we utilized the profile annotation tools to label the elevation of the existing ground. Now we will use some of the other Profile annotation tools.

- a) Select Evaluation > Profile > Annotate Profile.
- b) Click the Preference button > Load the Existing/Proposed named preference.
- c) Close the Preferences dialog.
- d) Set the Profile set to the proper profile in your drawing. This option is used if there is more than one profile drawn. Select the profile set you are annotating, a box should display around the profile set you are working on.
- e) Set the Vertical Alignment: appropriately e.g. v1. This is where the proposed elevation data will be calculated from.
- f) Set the Surface: to the original ground DTM e.g. x86e055og. This is where the existing elevation data will be calculated from. Any surface loaded in this field will get displayed as the existing elevation.
- g) Click the Apply button, elevations are shown on level XANNOT_P_T, existing is shown with line weight 0 with an accuracy shown to the 1/10 place; proposed is shown with line weight 1 with an accuracy to the 1/100 place.

6.7. REVIEWING AND REPORTING VERTICAL GEOMETRY

The review and reporting capability for the vertical geometry is basically the same process as the horizontal geometry. When creating XML reports the vertical geometry report is available separate from the horizontal or in the same report.

6.8. Review Vertical

- a) Select Geometry > Review Vertical
- b) The review report dialog appears, it can be use in the Alignment mode or an Element by element mode. Shown below is the Alignment mode review for the section of the vertical alignment shown previously in <u>Section 6.5</u>. Note, the Vertical POB and the Horizontal POB are not at the same station; the horizontal POB was set to be STA 500+00. This is normal the vertical alignments cannot extend outside the extent of the horizontal and usually starts some distance inside, near the begin project location.

Project Name: Description: Horizontal Alignment Name: Description: Style: Vertical Alignment Name: Description: Style:	z86e055p Proposed VT14prop VT14 On al i gn1 v1 VT14 On al i gn1	rop Geometry 1 Alignment Op Alignment Op STATION	otion otion ELEVATIO	DN
Element: Linear				
P	OB	500+25.00	530.6	50
r Tangent Grade	vC :	-1.49	324.0)2
Tangent Length	:	400.00		
Element: Parabola				
P	VC	504+25.00	524.6	52
P	VT	505+00.00	523.5	50 59
VL	OW	505+00.92	524.0)5
Lengtn Headlight Sight Distance		350.34		
Entrance Grade	:	-1.49		
Exit Grade r = (q2 - q1) / l		1.46 1.97		
$K = I / (g^2 - g^1)$	•	50.79		
Middle Ordinate	:	0.55		
Element: Linear				
P	VI VC	505+75.00 507+35.00	524.5 526 0	59 23
Tangent Grade	:	1.46	520.	, 0
Tangent Length	:	160.00		

SECTION 7 – CONSTRUCTING ROADWAY TEMPLATES

7. INTRODUCTION

Templates are used to define the transverse geometry of the Roadway or corridor. Transverse geometry of the roadway is basically the slope and distance perpendicular to the horizontal and vertical geometry to each transition point in the cross section. We define these template parameters in the Template Library and the data is stored in the *.itl file. We have created a VAOT Template Library where standardized templates are stored and can be used as needed for project specific templates in a project Template Library. Creating templates is one of the major changes implemented in InRoads 8.7 and later. The process for creating templates has changed dramatically; it is now much more graphical and all inclusive. Template components and end condition components replace previous forms of modeling transverse geometry.

InRoads help documentation contains in-depth explanations describing Template Point and Template Components. Basically components are a series of points that are connected. Each point in the component defines a transition or potential transition in the Template. Points (formally know as Transition Control points) are used to define longitudinal breakline features in a surface model (DTM). There are many ways to control points in a Template; we will go over the common point constraints i.e. horizontal, vertical and slope there are several others covered in the InRoads help documentation.

End condition components are components that ultimately seek a target. Often the target is original ground or the active surface but there are several other target types available. Multiple End conditions components can be attached to a point and defined to seek for different parameters such as slope, once a target is found the end conditions for that point are resolved. End condition priorities are assigned to control the order of end condition target analysis. If the first end condition fails, the second will seek if it fails, the third will seek and so on.

7.1. THE VAOT STANDARD TEMPLATE LIBRARY

A VAOT standard template library has been created. This library contains predefined components and component assemblies that are saved as templates in the library. Standard Templates can be copied to your projects template library. These templates can then be edited or used to assemble your design cross sectional template. The standard template library also contains a predefined point name list where point names are assigned style symbology.

7.1.1. Starting a Project Template Library

<u>Section 3</u> of this manual covered the creation of a new blank template library and saving the library file to the project folder as well as adding it to the project file. This section will cover the process for migrating standard templates into the project library file.

- a) Select Modeler > Create Template. The create template dialog opens up. Your project specific template library file should be displayed in the top left corner. If you double click on it only a point list template will display.
- b) From the create template dialog Select Tools > Template Library organizer > Two windows display in the organizer dialog the left is your library to the right is the source library. Click the [...] button to select the VAOT standard template library.
 - a. T:\CADD\Workspace\Projects\English\InRoads\template\VT_TempLib.itI

 d) Using the right mouse button click and drag Point Name List from the right side to the left side drop it on the left side Point Name list. This will copy all point names from the standard library to the project library.

vailable In:	Available In:
N:\Projects\86e055\Consultants\XYZE '≣ Point Name List	T:\CADD\Workspace\Projects\Englist

- e) Using the right mouse button click and drop the **Components** folder, then **End Conditions** folder to the left side (Drop it on the file name).
- f) Click the OK button and Yes to save the project template library to file.

Available In:
M:\Projects\86e055\Consultants\XYZEN
Components
🔁 End Conditions
Point Name List

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g) You now have the basic building block to create a project specific template.

The Standard Template Library contains several folders with per assembled templates but they will require edits to fit your project. For this lesson we will create a template from new components and predefined simple components. In order to effectively use the predefined templates you should understand components from the ground up. The predefined templates can vary in complexity; changing one parameter will/can affect other points in the template.

7.2. CREATE COMPONENT TEMPLATES

Good Template management is essential to setting up a well defined project design. The template library we have up to this point contains two folders one for Components and one for End Conditions. We will be defining templates to be used on VT Route 14 just as with the geometry we will name our templates according to there route and a description of that they do as well as put them all in a folder name VT Route 14.

7.2.1. Creating New Template and Template Folders

Open the Create Template dialog. Open the project template library file (if not already open).



- a) Right click over the file name select the new option then Select the folder option. Name the folder accordingly e.g. VT Route 14.
- b) Right click over the folder previously create i.e. VT Route 14 select new > Template. Name the template accordingly e.g. VT14mainline.

You now have a project roadway specify folder and one template designated as the mainline template for your project roadway design. As the design grows you will likely have several templates for each roadway. Each different template will be designed to create typical cross section conditions in your design i.e. templates with sidewalk without sidewalk, with guardrail without guardrail, bridge templates etc.

7.2.2. Adding a Simple Component

Although there are template components available in the template library you should know how to create and edit components. In order to fully understand components we will create some basic components and edit the points.

From the Create Template Library dialog double click on the new empty template. This will display the template editor window with a grid. The active temple is shown with a RED outline in the template library list window.

80					
	Add New Component	Simple			
20 · · · ·	Set Dynamic Origin Ctrl-D	Constrained	: :		
.10		Null Point			
		End Condition			
0 · · · ·					
. 10 · · ·					
- 20 · · ·					
-30					
-40 ····					
	-100	-50	0 5	0 10	00 150

- a) Select Tools > Options set the Point Seed Name to PAVE_1
- b) Toggle ON the Apply Affixes option. > set the step values to 1.00 (this is like a grid lock)
- c) Right Click in the template editor window > Click Add New Component > Simple.
- d) At the bottom of the Create Template dialog the Current Component options will display.
 - **Name** of the component > Pavement.
 - Style > Select SURFACE_TYPE 3
 - **Slope** > -2.00%
 - Thickness set to > 0.5 feet
 - Width set to > 11 feet
- e) You should now see a Pavement component attached to your cursor when you navigate around the editor window. Right Click in the window > in the short cut menu select or toggle ON the mirror option.
- f) You now have a left and right side Pavement component attached to your cursor.
- g) Zoom in to the center of the editor window using the mouse wheel or the navigation tools in the bottom left corner of the editor window. Place you cursor at the 0,0 origin (Magenta Square) and click to place the components
- h) Use the Fit tool at the bottom left corner of the editor window.
- i) The two components can be **merged** to be one component. Right Click over the line separating the two components i.e. the line between point PAVE_1 and PAVE_11. Select the Merge Components command.
- j) Repeat the steps above with the following changes.
 - Point Seed Name set to SHOULDER_1
 - Slope > -6.00%
 - Width set to 3 feet

k) Merge the new components with the pavement component so we have one pavement component. Notice that **points** merge automatically in this situation.

7.2.3. Editing Component Points

We now have a component shape that defines a standard (2) lane roadway with 11'-0" wide traveled way lanes @ -2% banking and 3'-0" shoulders @ -6% banking. We still must edit the point names and symbology so that things display and work properly. The point names were all created automatically from the point seed but we will edit them. Also the symbology was all set the same so we will change each point's symbology. Double clicking on a point initiates the Point Properties dialog.

- a) Double Click on the 0,0 point (PAVE_1) this is the point that will follow the horizontal and vertical alignment in the corridor definition. Change the name of this point to ORGIN. The pull down will list all point in the Point Name List. Points selected from the point list have pre set styles assigned. You will need to type in the L_ and R_ prefixes as shown in the image below for this example exercise. Names can be typed in but Styles must be selected from the pull down list.
- b) Rename all points and assign Styles to the points as shown below. Point Names and Styles are set in the Point Properties dialog box, Click the **Apply** button after editing each point.



The Point Properties dialog can also be used to change the dimensions of the component. The constraints section of this dialog is where points are assigned location relative to other points or specified values. The InRoads help covers in-depth the constraint types. The Simple component we create uses Horizontal, Vertical and Slope constraints.

Example: the Point **R_LANE** has both a Slope constraint and a Horizontal constraint.

Constraint 1 sets the point at -2.00% slope from the point ORGIN. **Constraint 2** sets the point 11 feet right of the point ORGIN. (- values are left; + values are to the right).

Constraints	3	
	Constraint 1	Constraint 2
Type:	Slope 💌	Horizontal
Parent 1:	ORIGIN 💌 🕈	ORIGIN 💌 🕈
Parent 2:	Rollover Values	
Value:	-2.00%	11.00

Point **R_SSF:** Constraint 1 sets this point at 0.5 feet below point R_LANE while Constraint 2 sets the point horizontally 0.0 feet from point R_LANE.

If you move point R_LANE to have a horizontal constraint of 12 feet to the right of the point

-Constraints	Constraint 1		Constraint?	
Туре:	Vertical	•	Horizontal	•
Parent 1:	R_LANE		R_LANE	<u> </u>
	,		,	
Value:	-0.50		0.00	

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ORGIN, point R_SSF will also move retaining its horizontal constraint that says it must be 0.0 feet from the R_LANE. Give this a try change the constraints on points to see what affect it has on other points.

<u>II NOTE</u>: The Template editor has UNDO (edit undo or Ctrl +z) capabilities.

7.2.4. Define Alternate Surface

The main function of a Template inevitably is to be added to a corridor definition and used to create DTM surface models. All points in the top level of components are automatically used in creating the primary surface model. Often we need to have surface models created from subsurface features. Alternate layers are defined using the Point Properties Dialog.

- a) Double click on a point that will be included in the subsurface or alternate surface. In our example template SSF points will be defined as the bottom of pavement DTM.
- b) Under Surface Feature Style toggle on the Alternate Surface option > Type in the name of the alternate surface e.g. PAVEBOTTOM.
- c) For each of the points in our template that represent the bottom of pavement, toggle on the alternate surface option and set the name to PAVEBOTTOM.
- d) We are unrestricted in the number of alternate surfaces we can use however a single point can only be assigned to one alternate surface. Alternate surface feature points cannot break the standard triangulation rules i.e. no vertical surfaces.

7.2.5. Constrained Components

Constrained Components consist of points that are all constrained to the previous point placed. Each point is placed to form the component shape. This component type is useful for constructing curbs, sidewalks, etc. after creating these components the constraints can be edited to any available constraint combination.

- a) Create a new Template. This can be done with a right click on a template folder select new template.
- b) Name this new template "Curb" you should get a new blank template with a magenta square at the 0,0 point. This is where the curb template will attach to a pavement shoulder point.
- c) In the Create Template dialog select Tools > Dynamic Settings > set the dynamic settings as shown.
 - a. Steps @ 0.1 ft this is a snap like grid in the template editor window.
 - b. Point Name to CURB_1
 - c. Point Style to ROAD_CURB_CONCRETE
 - d. Apply Affixes OFF and do not close this dialog, but move it to the side of your



Dynamic	Settings		×	
X:	0.00	Step:	0.10	
Y:	0.00	Step:	0.10	
Point Na	ime:	CURB_1	•	
Point Style: ROAD_CURB_TOI				
Apply Affixes				
vs= Key-in-Field}				
Set Dynamic Origin				

screen we will be entering numbers in the key-in field to the bottom right.

- d) Right Click in the template editor window select Add New Component > Constrained.
- e) Place a point at 0,0 in the template editor window (xy=0,0). The point is displayed and you are ready to place the next point.
- f) Set the Key-in Type to vs= for Vertical Slope this means you enter in a value for the vertical and a value for the slope. Perform the following Key-in operations to draw the curb component. The enter button will place the point at the specified Key-in locations.

Key-in Type	Key-in
vs= {vertical slope}	7",6/1
hs= {horizontal slope}	6",0
dl= {delta from last point}	0,-18"
dl= {delta from last point}	-9",0

- g) There are other key-in types; InRoads help covers these and much more on using the dynamic dialog box.
- h) All the points were placed using the point seed name set in the dynamic dialog box as well as the point style. Rename the points as shown below.
- i) While in the point properties dialog view and verify that the constraints are set as you

expected. All points should be located horizontally and vertically to the previous point; all tied back to the first point placed in this case the CURB_CONC point.

j) To test that all points are tied back to the CURB_CONC point, Right Click over it and choose move, as you can see all points move with this point. Right Click to cancel the move command.



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7.2.6. End Condition Components

End Condition Components are linear components that target a surface, or some other specified parameter such as an alignment. End conditions replace Decision tables from previous versions of InRoads software. Using the template creation dialog we can use the test option to graphically analyze end condition results for the various parameters.

End conditions can be used to generate cut and/or fill slopes off the backbone components. We will create 6 different end condition components 3 for a fill situation and 3 for a cut situation. These end condition components will then be inserted into our VT14mainline template.

- a) Right Click on the template folder you are working in and create a new template named Cut/Fill set this template active and create the end conditions as directed below.
- b) Tune on the dynamic settings dialog > set the point name to ORIGIN > set the point style to ROAD_CUT



- d) Below the editor window; Name this component CUT 25 > Style to ROAD_CUT
- e) Set the Target Type to Surface > set the surface to be <Active>
- f) Click on the 0,0 point in the editor window to place the ORIGIN point, OR key-in xy=0,0
- g) In the dynamic setting dialog. Set point name to DITCH > Style to ROAD_DITCH; note if you select the point name from the list the style is set automatically
- h) Key-in hs=8,-0.25 [enter] (8 ft to the right @ -25% slope)
- i) Set point name to CUT_25
- j) Key-in hs=20,0.25 [enter] (20 ft to the right @ 25% slope)
- k) Right Click > Finish
- Using the edit point properties dialog box, toggle the Check for Interception option OFF for the point DITCH. This is to insure that in this cut situation the DITCH point will be placed because the end condition will not seed the surface between the point ORIGIN and the point DITCH.



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- m) Using the edit point properties dialog box, toggle ON the Feature Name Override option for the point CUT_25 and set the name to ROAD_CUT. All the cut end conditions should have the same feature name i.e. ROAD_CUT as apposed to the actual point name of CUT_25.
- N) Use the Test button at the bottom right of the editor window to test this CUT end condition, notice that when the surface crosses the first segment it does not terminate the component, this is where the Check for intercept toggle effected the segment.

The above process is a method for creating a standard 1:4 cut with ditch end condition. This method can be repeated to create a 1:3 cut with ditch end condition and a 1:2 cut with ditch end condition or any slope required by the design. It is a standard practice to create all these cut

end conditions in the same template as well as the fill end conditions.

Create the above mentioned cut with ditch end conditions then create the fill end conditions. Fill end conditions will start at the point ORIGIN then have one segment that ends with the points FILL_25, FILL_33, FILL_50 as shown. Remember to set the component names and styles accordingly.

<u>Tip:</u> If you Right Click over a point when selecting new end condition the end condition will automatically attach to this point as the start location. If you when click directly on a point it will automatically merge the points. You should not have points on top of points this will cause tolerance issues.



Once the cut and fill end conditions are created set the feature name override for all the cut end points to ROAD_CUT (as explained above) and set all the fill end point to have an override of ROAD_FILL. With all these end conditions defined we then assign priority levels to each one.

Generally the 1:4 cut and fill are more preferred than the steeper slopes. For this reason we will set the priority accordingly where the 1:4 fill is tested first, the 1:4 cut second, the 1:3 fill third, the 1;3 cut forth and so on. Priority settings are shown in component properties dialog; this can be access by double clicking on a component. Priority can be set when placing the components; by editing component properties or they can be set when using the [Test...] option.

7.2.7. Test End Conditions

The test option button is located to the bottom right of the template editor window. This option brings up its own Test End Condition dialog where you have several testing options. To test our Cut/Fill end conditions we will use the *<Active>-Surface* option in the Available Targets window. In the Use Surface Slope window we can set a slope to the targets surface. Clicking the draw button allows you to dynamically move the surface elevation line with your cursor and view the end condition for each situation. When attempting to test the template you may get a message alerting *end condition priority conflicts* > click OK we will Check Priorities and edit them in the testing dialog.

- a) Enter the TEST dialog by clicking the [Test...] button on the Create Template dialog
- b) OK > through the conflicts warning if you get it. If not we can still edit the Priorities settings in the testing dialog.
- c) Click the Priorities button, if you have more then one point with end conditions you can choose the point you would like to check end conditions for. In the Cut/Fill template all end conditions are attached to the point ORIGIN.
- d) The fix priority dialog allows you to enter priority values 1 or the lowest number being the highest priority or best solution. End condition components will highlight in the test window as you place your cursors in the priority window fields.

Priority	End Condition Component
1	CUT 25
2	FILL_25
3	CUT 33
4	FILL_33
5	CUT 50
6	FILL_50

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e) After priorities are set, click OK and close. Now use the Test > Draw button to view the end conditions interactively.

Note: Each design may require different End Condition priorities. This example sets the 1:4 cut with ditch end condition as the first priority, in some cases the 1:4 fill may be the most desirable solution therefore it would get the first priority setting.

7.2.8. Infinite End Conditions

When creating end conditions the constraints on the CUT and FILL points were set by default according to their placement. In the workflow above we used key-in commands to precisely place points resulting in constraints that reflect position. End condition points are by default place with horizontal and slope constraints regardless of how you placed the point. Placing the point in the proper position initially will set the constraints properly without edits.

After testing the end conditions it is apparent if the surface extends beyond a horizontal constraint the end condition fails and moves on to the next according to priority settings. The intent is, if a 1:4 slope cannot connect with the target surface (og) within the horizontal constraint distance, move on to an alternate slope. This process works until we get to the last end condition in the set. In our set, when a 1:2 slope does not connect with the target, there are no more options, resulting in no end condition solution.

In most end condition component sets we define points having an infinite horizontal reach. This is done as a last attempt to intercept with the target surface regardless of its distance. Generally the last priority CUT and FILL end conditions will be set to "End Condition is Infinite". In our example Cut/Fill end condition set the CUT_50 and FILL_50 are the last priority and should be set to "End Condition is Infinite".

End Condition Properties Check for Interception Place Point at Interception End Condition is Infinite Do Not Construct

End condition points can be edited by double clicking on the point to get the point properties dialog box. Make sure to click the **apply button** after making any changes to points in the point properties dialog.

When testing the end condition now, you will see if you move you target surface line to the top of the window the CUT_50 end condition will always intercept. Likewise if you move the target surface to the bottom of the window the FILL_50 end condition will always intercept.

7.3. ASSEMBLE TEMPLATE FROM COMPONENTS

In the previous section we created components that can be combined to create a complete design cross section template. We created the pavement component, created a curb component, and end condition components. The components created can be used and edited as needed and can be used in combination with other components in the template library. The VAOT standard template library contains several other predefined components. In this section we will combine components to create a typical design cross section template. As we will see after constructing a template from components it may be necessary to edit individual components to fit the design.

- a) Open the Template Library: Modeler > Create Template...
- b) Double click the template library in the left window listing to expand the library folders
- c) Double click on the folder where you have the template and double click (to set active) the template you are going to edit e.g VT14mainline. The active template is the one displayed in the editor window, the red outline on the template bullet icon indicates the active template in the list window.



- d) This template contains a pavement backbone component that was created in a previous section of this manual. We will be adding to this template
- e) Turn on the Dynamic settings dialog and toggle on the Apply Affixes option. This will prefix new components with the L_ or R_ depending on the location
- f) Click once on the curb template notice that the curb is displayed in the preview window, with a cyan marker indicating the insertion point, this point can be move by clicking on points in the preview window. In this case the insertion point as shown here is correct. Click and drag the curb to the template editor window
- g) When your cursor is over the editor window you will see the curb component. Right click to activate the context sensitive short cut menu > toggle ON the mirror option. Now you should see two curb components that dynamically mirror each other.
- Place the cursor over the point R_SHOULDER when it highlights *white* indicating a snap to the point > click to place the curb component.



- Click once on the EdgeBuffer template located in the components folder that was copied from the VAOT Template library in a previous section of this manual > drag this template to the point R_CURB_BAK
- j) Click once on the Cut/Fill template > drag this template to the point R_EDGE_BUF that was part of the EdgeBuffer template.
- k) This template is almost complete; you can use the test option to test the end conditions. You can use the check priorities button in the test dialog to change the priorities if required.

7.3.1. Vector-Offset Constraint

This template now represents a design typical section template. If you zoom in on a curb section where the curb meets the pavement you will see where the pavement overlaps the curb. We should edit the pavement component points to match the face of the curb. This can be done using a vector-Offset constraint. To setup a Vector-Offset we will identify two

points in the template then enter a value for the offset. In this case the two points will be points that form the face of curb. We want the pavement to follow the face of curb so the offset in this instance will be 0.00 feet.

- a) Edit the properties of the point R_SSF_1 (double click on a point to activate the edit properties dialog)
- b) The constraints are set to one horizontal and one vertical > set the Horizontal constraint to Vector-Offset > Set Parent 1: to R_CURB_TOP and Parent 2: to R_CURB_SSF, and the Value to 0.00. You can use the target buttons to select parent points.
- c) Click The Apply button. > Close
- d) Repeat this process for the left side point L_SSF_1 that overlaps with the concrete curb component.

The pavement component point R_SSF_1 now is positioned at a 0.00 FT offset from the vector formed by the points R_CURB_TOP and R_CURB_SSF. This slope on the pavement edge could have been done using other constraint types i.e. horizontal, vertical or slope. In this case it seems appropriate to set the pavement edge using the curb face.





Value:

0.00

7.4. EDIT AND REVIEW TEMPLATE

At this stage of the process we have a usable typical section template. There are several other methods that deserve mentioning that can be used to edit and review template points and components. In the Create Template dialog we have several display options. In the Template Library window to the right of the create template dialog we have the Library tab and the Active Template tab. There is also a process for placing a template in the active design file with dimensions and slopes annotated.

7.4.1. Display Options

At the top of the Create Template Dialog the Display Options can be very useful. The first and most common, is Components. This is the mode we have been using up to this point.

The Constraints option graphically shows symbology that indicates how each point is constrained. A blue arrow pointing to CURB_TOP from CURB_CONC indicates that CURB_TOP is constrained to CURB_CONC. In this case the + symbology on the blue arrow indicates the constraint is both horizontal and vertical. Check out the other points and familiarize yourself with the symbology used to display constraints.

		тор	 JRB_BAK
		NC	
			
CURB	SSF		 JRB_SSF_1

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7.4.2. Active Template Tab

To the side of the Create Template dialog at the bottom of Template Library window the Active Template TAB allows you to view point and component information in the active template. In this window you will find folders for template points, components and Display Rules. When you select the points in the point folder the point highlights in the editor window and properties are listed in the window. Double clicking on points in this window will also activate the point properties dialog where edits can be made.

7.4.3. Graphical Display Options

In the Create Template Library dialog you have the ability to generate a graphical display that can be place and use in your design file.

- a) From the Create Template Library dialog, Template Library window > Right click on the template you are generating graphics for e.g. VT14mainline.
- b) Select at the bottom of the short cut menu the Display option. This will activate the Display Template dialog.
- c) Notice the end condition components are dotted. Using your mouse cursor click ON all the end condition components that you require in your display. When you select them they will turn to solid lines.
- d) Click the Apply button and data point in your design file to indicate the location for the Template Display.



The display of VT14mainline above is the result of the Template Display command. Minor edits were made to clean up the extra dimensions and slopes associated with the CONCRETE CURB components. Note: shoulder slopes when curbing is used will often do not change from the traveled way slopes, maintaining a constant slope on narrow shoulders is common. In this example the shoulder brakes to a 6% transverse slope but could easily be changed to 2% if and when applicable.

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SECTION 8 – ROADWAY DESIGNER

8. INTRODUCTION

The roadway designer is an interactive command/process that combines horizontal and vertical geometry with transverse geometry defined in the templates. The process involves defining corridors with the required geometry i.e. horizontal, vertical and transverse, then uses a variety of controls, exceptions, references, transitions, modified templates and super elevation definitions, to create 3 Dimensional models of the roadway design. The roadway designer is intended to minimize the amount of edits made directly to the DTM.

InRoads Help, provides in-depth explanations on every aspect of the Roadway Designer. This section of the manual is intended to provide a standard work flow as a template for using the Roadway Designer command and its processes. We will create a proposed surface model using basic tools available in the modeler. The modeler has many advanced capabilities for controlling surface models; see InRoads Help documentation for more information on these capabilities.

Section 3 of this manual covers creating, saving and loading Roadway designer .ird files.

DEFINE A ROADWAY CORRIDOR 8.1.

Each new roadway or other type of surface involves naming and creating a corridor based on an alignment or feature. One roadway designer file or .ird can contain many corridor definitions. Typically we will use the corridors to define roadways but they can define channels or ditches or any other surface that is based on a linear control.

- a) From the InRoads main menu select > Modeler > Roadway Designer, at this point you should see the Roadway Designer dialog with 3 empty view windows. This dialog and all the windows are resizable using you mouse cursor.
- b) Select > Corridor > Corridor Manager command \rightarrow or the **||** button
- c) In the Manage Corridor dialog type the name of the corridor e.g. **RT14prop**. Note: the corridor name will also be the name of the DTM created by this corridor.
- d) Set the Type: to Alignment
- e) Select your design Horizontal Alignment e.g. VT14prop_1
- f) Select your Vertical Alignment e.g. v1

g) PI Rounding for

Set the Type: to						
Alignment	Name: RT14prop			Limits		Add
	Туре:	Alignment	•	Station		Close
Select your design	Horizontal Alignment	VT14prop_1	+	500+25.00	+	Change
e a VT14prop 1	Vertical Alignment:	v1	•	Stop:		Сору
	PI Rounding Tangent	0.00		516+75.00		Copy From
Select your Vertical Alignment e.g. v1	Co <u>r</u> ridors:					Help
0 0	Name	Туре	Source Name	Start Station	Stop S	Station
PI Rounding for	RT14prop	Alignment	VT14prop_1	500+25.00	516+75	5.00
roadways will typically be 0.00						

- h) Station range can be toggled off to allow the corridor to apply to the entire alignment from POB to POE of the vertical geometry.
- i) Use the ADD button to add or create this corridor; Click > Close.

We now have a new corridor defined in the roadway modeler. Notice the other button on the right hand side of the corridor manager we can select and change corridor parameters. The *copy* or *copy from* command can copy a corridor in the current modeler or from an .ird file in another project.

8.1.1. Roadway Designer Options

Located on the Roadway Designer main menu > Tools > Options

This dialog offers many useful options including **Critical Sections** (set ON by default) to use during the design and Display Options. Over the next few sections we will be setting up some of the Display types that can be toggled **ON** or **OFF**. We will be working with **Reference Graphics** once we set them up we can toggle them display on or off as desired the same is true for the **Transition Graphics** markers, there can be many transition markers if they get in the way toggle them off when you do not need them.

8.2. ADD TEMPLATE DROPS TO CORRIDOR

Template drops are where the templates from the template library are applied to the horizontal and vertical geometry assigned to the corridor. Templates are **copied** not referenced from the template library to the roadway modeler and assigned to station ranges. It is possible to drop different templates at defined station ranges to achieve changes in the roadway design. As an example one section of roadway may be a two lane typical that transitions into a bridge then back to a two lane typical.

Using point controls and parametric labels one template can be setup to change depending on parameters defined in the roadway modeler. This method can reduce the number of different templates used. In this design we will use the template we created in the previous section as well as one directly from the VAOT standard library. We will then apply simple point controls and define parametric labels to change the transverse geometry of the roadway design.

- a) From the Roadway Designer Select > Corridor > Template Drops
- b) From the Template Drops dialog select the corridor e.g. RT14prop
- c) The station is the first station that this template will be applied e.g. STA 500+25.00 is the beginning of the vertical alignment. The target button to the right of this field will allow you to graphically select template drop locations on the screen. Hold down the [Ctrl] when selecting the target to get to the active MicroStation design view.
- d) Interval: is the spacing that templates will be dropped, set this at a value appropriate for your project e.g. if you plan on displaying



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cross sections at 25 foot intervals your Interval value should be evenly divisible into 25' this will make your cross sections more accurate. In this case we will use a **5 Foot** Interval.

e) In the Library Templates window expand the library folders and select your design template e.g. **VT14mainline**.

- f) Click the **Add** button
- g) Click on the [...] button to the right of the Library Template window. We will browse directly to the VAOT standard template library to select the next template. Browse to VT_TempLib.itl and OPEN. (location shown previously)
- h) Double click on the library to expand and navigate down to the DesignTYPICAL folder and select VT_Bridge/TYP
- In this case the bridge begins at station 506+35.00 and will be dropped at the 5' interval

Corridor:	RT14prop	•]	Add
Station:	506+35.00		+	Close
Interval:	5.00		+	Change
Library Temp	plates:			onango
🔄 Desig	INTYPICAL	.S 🔼		Сору
	rbConc/Dr SVTroute/2 SVTroute/F	ain P-4Lane/SW, FullSand		Help
	SVTroute/1			
	_Bridge/T _linterstate	yp e/Sand		
<				
Current Temp	plate Drop:	S:		
Station	Interva	al Template		
		NATE A COLOR		
500+25.00	5.00	V I 14mainline		

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- j) Click the Add button to add to the list of template drops
- Next select by clicking the first template drop in the list in this case that is STA 500+25.00 VT14mainline.
- I) Change the Station value from 500+25.00 to 507+40.00 then use the **Copy** Button to add this as a new template drop in the list of drops.
- m) Click on the Close button > Use the Roadway Designer File > Save command to save your roadway designer file to disk.

In this example we now have 3 template drops defined. The blue template name is simply indicating that the template does not exist in the current template library. We could, and most often will, have all the templates we need in our project template library but this illustrate some of the additional functionality of the template drop dialog.

Note: When templates are selected and used in the roadway designer they are copied to the roadway designer .ird file. These templates are not automatically synchronized with the library they originated from. However if you load the library that the template originated from they can be synchronize using the synchronize button on the bottom of the template drop dialog. If a template drop is red this is an indication that they are out of sync with the template library. It is not necessary to have synchronized templates, but it is a good practice to keep the template library up-to-date and keep all template drops synchronized when possible.

8.2.1. Roadway Designer Main Dialog

- Menu Items located at the top left corner of the dialog.
- **Buttons** located directly below the menu items can be used as a shortcut to access menu items.
- **Plan View Window:** Upper right corner used to display and locate horizontal alignment and plan information while using the modeler.
- **Profile View Window:** Lower right corner used to display vertical alignment and profile information while using the modeler.
- **Cross Section View Window:** Right side of the modeler, used to show template component and end conditions along the corridor. The Active surface is shown as well as all other targets associated with your templates and referenced by the modeler.

8.2.2. Template Transitions

When templates that contain points that do not match up i.e. templates contain additional points or points of a different name, a transition must be defined. Notice in the example from the last section that 2 yellow highlights were displayed in the plan view of the Roadway Designer Dialog. These indicate that a transition condition exists.

Right click over the yellow high light and select the edit command. This will initiate the edit transition dialog. This dialog shows a window with an outline of the two templates that are transitioning. In the example the VT14mainline has points that do not connect e.g. the two shoulder points and the crown points do not match.

You can right click over points in this dialog to move the view angle. This may be required to see all the points that do not match up. The bolded (+) indicates orphaned points.



- a) Use your mouse to drawn lines that connect the VT14mainline ORGIN point to the Bridge CRWN point (shown here as Dark-Blue). Simply click on the ORGIN point then click on the CRWN point.
- b) Connect the Left shoulder line from VT14mainline to the bridge template (shown here White).
- c) Connect the Right shoulder line from VT14mainline to the bridge template (shown here Magenta).
- d) In this example the bold red points of the subsurface in the VT14mainline template would not want to be connected to the bottom of the bridge deck so we can leave them orphaned as required.
- e) Next click the OK button you will get the Edit Transition Midpoint dialog. For more details using this dialog refer to the InRoads Help. In this example edits to this portion of the transition is not required. Select the OK button
- f) The yellow highlight should turn cyan indicating that edits have been made. Right click over the cyan highlight and toggle off

the check mark by enable. This will stop the transition from happening over the entire length of the template drops but will transition from the last interval template drop.

g) Repeat this process for all transitions.

<u>Note:</u> The process of editing transitions may need to be redone if you change or synchronize templates involved in the transition. You should hold off transition edits until your templates are finished or you may need to redo them. <u>In this example we do not intend to transition</u> <u>VTmainline into a Bridge</u>. To turn off a transition, right click on the transition area and un-check the Enable option. The template transition options would be more applicable for a 2 lane to 4 lane transitions or sidewalk to no sidewalk etc.

TEMPLATE POINT CONTROLS 8.3.

There are several different ways to control template component points. One very powerful method is point controls. This is where we select a point that exist in the current roadway corridor and define instructions for what that point should do over certain station ranges. This could involve horizontal, vertical or both types of controls. We will use these types of controls when we define the superelevation.

One simplified method of using point controls is to use Parametric Labels for controlling points. This is a predefined set of labeled point constraints that allows for point constraint modifications over defined station ranges. This method can control several points of a different name as long as the share the same parametric label in the template.

In the example we have been using VT14prop, we used the VT14mainline template and a Bridge template from the VAOT standard template library. The VT14mainline template does not contain parametric labeled constraints but the **Bridge** template we used contains several. We will use these labeled constraints to parametrically alter lane and shoulder widths of the bridge template to match our design. Most of the templates and components in the VAOT Standard Template Library have labeled constraints.

8.3.1. Define Parametric Labels

- a) Select from the roadway modeler > Tools > Parametric Constraints
- b) Select Constraint Label: L LANE WIDTH from the pull down list.

Corridor:	RT14prop		Station Limits		Add
Constraint Label:	L_LANE_WIDTH	•	Start. 506+35.00		Close
Start Value:	11.00		Stop: 507+40.00	+	
otart value.	-11.00		,		Change
Stop Value:	-11.00				
Override Values:	1				Help
Name	Start Value	Stop Value	Start Station	Stop S	tation
L_LANE_WIDTH	-11.00	-11.00	506+35.00	507+40.	00
R_LANE_WIDTH	11.00	11.00	506+35.00	507+40.	00
L_SHLD_WIDTH	-3.00	-3.00	506+35.00	507+40.	00
R SHID WIDTH	3.00	3.00	506+35.00	507+40	00

c) Change the L_LANE_WIDTH Start Value to -11.00 ft.

- d) Change the Station Limits to the stationing where we are intending to alter the lane width in this example Start STA = 506+35; Stop STA = 507+40.
- e) Proceed with changing both lane width values to 11'-0" and the shoulder (SHLD_WIDTH) values to be 3'-0". Values to the left of the of the center line are (-) negative.

Note: This exercise in parametric labels was only used as an example. In reality you should copy the bridge template to your project and make edits to the template to match your design criteria. Parametric labels can be used for adding turning lanes or widening the shoulders where the design requires. These labels can also be used to change vertical, slope or any other constraint value that is assigned a parametric label in the templates.

8.3.2. Define Point Controls

Point Controls are used to horizontally and vertically control template points. These controls override all other forms of control applied by point constraints. There are several control types available in the Point Controls dialog. For more information on point controls see InRoads Help.

In this example we will transition the right side lane after the bridge exit from one lane to two lanes accounting for traffic entering from the side roads. The two lanes will merge back to one lane after the horizontal curve ends.

a) From the Roadway Designer > Select Corridor > Point Controls

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- b) Point = R_LANE
- c) Mode = Horizontal
- d) Control Type = Alignment with the Horizontal Alignment set to VT14prop_1
- e) The lane widening will begin at STA 507+60 and end at STA 511+00
- f) The two lanes will be a total of 22.00 feet wide to the right of the horizontal alignment VT?

Corridor: RT14prop							Add
Point	R_LANE	•	+	-Statior Start:	507+60.00	+	Close
Mode Horizontal (Vertical	C Both		Stop:	511+00.00	+	Change
Control Typo:	Lau .		1	- Horizo	ntal Offecte		Help
Control Type.	Alignment	•		Start	22.00	•	
Horizontal Alignment:	VT14prop_	1 💌	<u>+</u>	Chan	22.00	<u> </u>	
				Stop:	22.00	<u>+</u>	
Use as Secondary	Alignment			Madia	0.0		
				Start	lo oo		
				-	0.00	Ψ.	
					0.00	+	
Priority:	1						
Horizontal and Vertical	Controls:						
Enabled Priority	Name	Start Station	Stop	Station	Mode	Туре	Control
X 1	R_LANE	507+60.00	511+0	00.0	Horizontal	Alignment	VT14prop_1
X 1	R_LANE	511+00.00	512+0	0.00	Horizontal	Alignment	VT14prop_1

horizontal alignment VT14prop_1 from Start to Stop.

- g) The two lanes will merge back to one starting at STA 511+00 and stopping at STA 512+00.
- h) The start of the merge is the full 22.00 feet wide the stop point of the merge is set back to the 11.00 feet to the right of the horizontal alignment.

This lane widening involves an intersection with two side roads. The features generated by the modeler at the intersection will be edited or clipped out when the intersection is completed using feature edits or more advanced corridor definitions with surface clipping options. For now we will ignore the back bone features that cross into the intersection area.

8.4. DEFINE END CONDITION EXCEPTION

The backbone components of a template can be considered components that are not End Condition Components. End condition components are defined and created in the template to seek a target in our example the target is existing ground. It is often the case where we need to control or override the end conditions seek function solution. This is done using End Condition Exception Tools.

Note: To this point we have not discussed superelevation. **Superelevation banking** if required on your project should be done prior to overriding and transitioning end conditions. This is because superelevation will affect the starting elevation of your end conditions therefore it will affect the intercept location. In this example we explore end condition modifications assuming there is no superelevation in this design. We will then in the next example define superelevation. If you have superelevation in your design most of your end condition modifications should be done after not before using the superelevation wizard and defining rollover locks.

8.4.1. Backbone Only

The simplest of Exceptions is to eliminate the end condition entirely for a given side and station range. This is done using the Override option with the Backbone only toggle on. For this example we will apply the backbone only option to the area of our design where side roads meet our proposed roadway corridor.

- a) From the Roadway Designer Select > Corridor > End Condition Exceptions
- b) The station range will be from 507+55 to 508+52

- c) Apply To: Right Override
- d) Toggle ON Backbone Only
- e) Click the Apply button

8.4.2. Overrides

Within the End Condition Exception dialog the Left Override and Right Override serves as a

		2007			
Corridor: RT14propNOendCover		Add			
Station Range	Apply To	Close			
Start: 507+55.00 +	C Left Override	Chenco			
Stop: 508+52.00	Right Override				
Rackhana Only	C Left Transition	Help			
J• Dackbone Only	Right Transition				
End Condition Exceptions:					
Start Station Stop Stat	ion Type				
507+55.00 508+52.00	Right Ove	rride			

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method for overriding current end condition solutions. This involves locating sections of the corridor where the end condition solutions do not meet the design requirements. There are a variety of reasons why end conditions may need to have overrides defined. As an example one reason to use the override is when a stretch of roadway/corridor is in a fill situation but a mound or lump in the existing ground causes a small section to switch into a cut situation resulting in a ditch. In this instance we can go to the station just prior to the ditch starting and use an End Condition Exception Override to force the fill end condition through. This process involves defining the start and end station then editing a template override to solve as desired through the defined range.

Example: Cross Sections: STA 504+10 - STA 504+60



- a) Use the end conditions example shown at STA 504+10 "FILL" to override the resultant ditch through STA 504+60.
- b) Set your active template drop view to STA 504+10. This can be done using the < > arrow buttons below the cross section view window or by typing in the station value and clicking the TAB key. The yellow line shown on the plan and elevation views indicate the active template drop view location.
- c) Select Corridor > End Condition Exceptions
- d) The dialog should show the active template drop as the start station, if not set Station Range Start value to STA 504+10 for this example.
- e) Set the Stop Station Range value to STA 504+60
- f) The Apply To option will be set to "Left Override" in this example as shown in the cross section set above.
- g) Click the Add button > Then the Edit Button
- A template editor window appears. From this dialog notice only the left side end condition is shown solid indicating edits can only be made to this component or you could construct or insert new end conditions



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- i) Double click on the L\_FILL\_25 point to edit the point properties
- j) Set the End Condition is Infinite toggle ON
- k) Set the Horizontal and Vertical Constraints to the design criteria, in this example the Horizontal is set to -5' from the L\_EDGE\_BUF point. The slope is set to 1:4 from the edge buffer point.

| -Constraints |              |   |                 |
|--------------|--------------|---|-----------------|
|              | Constraint 1 |   | Constraint 2    |
| Type:        | Horizontal   | - | Slope 💌         |
| Parent 1:    | L_EDGE_BUF   | + | L_EDGE_BUF      |
|              |              |   | Rollover Values |
| Value:       | -5.00        |   | 25.00%          |

Click the Apply > Close > OK; this end condition exception is now completed. As you
define exceptions they will be listed in the End Condition Exceptions dialog. Close the
End Condition Exceptions dialog.

This is a new concept as far as editing the end conditions or side slopes in your design. Prior to InRoads 8.7 these type edits were made directly to the surface model features. The edit features in cross section command was removed and functionality such as this tool replace it.

#### 8.4.3. Transitions

When end condition solutions change, such as from a 1:4 fill to a 1:2 fill, a smooth transition over a defined station range may be required. This transition will be a linear slope change over a defined station range.

Slope Transition Example: Cross Sections: STA 513+95 - STA 516+65



- f) Using your mouse cursor click on the GREEN + symbols to connect them. The line you created represents the slope transition portion of the L\_FILL point.
- g) Click the OK, this dialog lets you view the transition, notice by moving the slider button you can view the slope component changing from a 1:4 to a 1:2 this is a symbolic representation.
- h) Click OK and Close, now in the plan view you will see a dark blue marker representing a defined transition range.



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Shown above is the cross section set from STA 513+95 - STA 516+65 the same range as prior to the transition override but now the slopes transition linear from 1:4 to 1:2. The precision value for slopes has been bumped to 1/10,000 to help show the transition.

**NOTE:** We have discussed procedures for modifying end conditions. Later on we will go over a procedure for defining superelevation for the roadway. Superelevation banking will effect the elevation of the shoulders as well as the starting point for end conditions. Do not get overly ambitious with end condition modifications until backbone point elevations are well defined.

# 8.5. DISPLAY REFERENCE IN DESIGNER

This tool provides a method for viewing alignment and or feature data in the modeler plan and cross section view windows. In the example we have been using we will display several features from the original ground DTM.

### 8.5.1. Display References by Feature

- a) From the Roadway Designer Select > Corridor > Display References
- b) Toggle ON the Features option > Select the proper surface for your feature for this example the surface is x86e055og the survey original ground DTM.

| Corridor: RT14propNOendCover |           |     |  |  |  |  |
|------------------------------|-----------|-----|--|--|--|--|
| C Alignment VT14prop_1 +     |           |     |  |  |  |  |
| Surface:                     | x86e055og | •   |  |  |  |  |
| Feature:                     | P365      | • + |  |  |  |  |
| O Filter:                    | x_DRIVES  | ~   |  |  |  |  |
| Display as Right of Way      |           |     |  |  |  |  |

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- c) In the feature list pull down select the feature you are displaying as a reference. If you do not know the feature name use the target button to select the feature on the screen. In this example we need to display a drainage pipe crossing the road. The name of the feature is P365. The alpha code P is used by the survey section to pick up drainage pipe inverts the numbering (365) is due to incremental name changes.
- d) Click the Add button. The bottom of the dialog list all current display references

#### 8.5.2. Display References by Filter

- a) From the Roadway Designer Select > Corridor > Display References
- b) Toggle ON the Filter option > Select a filter from the list of filters, for this example we will use the x\_ROAD filter. This filter will display existing roadway features picked up by the survey.
- c) Click the Add button
- d) Select the X\_DRIVES filter and click the Add button. This filter will display all existing drives picked up by the survey.

#### 8.5.3. Display Reference Graphics Options

Once you define Display references they appear as pink lines in the modeler plan view and point markers in the cross section view. To turn off the reference graphic or hide them you can use the Tool > Options dialog > Toggle OFF or ON the Reference Graphics.

| Corridor: RT14propNOendCover   |                |  |  |  |  |
|--------------------------------|----------------|--|--|--|--|
| Display Reference              |                |  |  |  |  |
| <ul> <li>Alignment:</li> </ul> | VT14prop_1 💌 🕈 |  |  |  |  |
| Surface:                       | x86e055og 💌    |  |  |  |  |
| Feature:                       | •              |  |  |  |  |
| Filter:                        | x_DRIVES -     |  |  |  |  |
| Display as Right of Way        |                |  |  |  |  |

## 8.6. DEFINE SUPER ELEVATION

Super elevation is stored in the InRoads Roadway Designer IRD file. The process for setting up super elevation is done using the Roadway Designer, super elevation wizard. The wizard has several methods normally VAOT uses the table method then selects one of the corresponding AASHTO tables. For legacy projects there is an import super elevation command that will translate super elevation geometry to corridor superelevation control lines.

#### 8.6.1. Range Point Name Check

Super elevation is stored in the roadway designer as point controls of the type superelevation. For this reason point names in templates that are used as superelevation control points should be named constantly. The example corridor we have defined point names that do not remain consistent.

In super elevation we will use the Center Line of the road for the Crown Point, the left and right lane will be the left and right Range points. Additionally the left and right shoulder points will be used for the rollover locks. We will check and edit these points to have consistent names.



The image above shows point names used for the **VT\_Bridge** template. The image below shows the point names used for the **VTmainline** template. If we use the bridge template as the standard since it came directly from the VAOT Template Library notice the center line of the road should be named CRWN and the left and right shoulder should be L\_SHLD and R\_SHLD. The left and right lane point names are OK.



#### 8.6.2. Edit and Synchronize Templates

- a) From the InRoads main menu select Modeler > Create Templates
- b) Select in the template library the template we are going to edit e.g. VT14mainline
- c) Double click on the ORGIN point and rename by selecting CRWN from the point name pull down list.
- d) Double Click on the L\_SHOULDER point and replace SHOULDER with SHLD you will need to key the new name in. >> Repeated for the R\_SHOULDER point.
- e) Save the template library: File > Save > then Close
- f) Open the Roadway designer > Select the Template Drop command. Notice that VT14mainline is displayed in red. This means it is out of sync with the template library.
- g) Select the Red Template drops with your pointer > Click the Synchronize with Library button.

| Current Template Drops:  |          |               |  |  |  |
|--------------------------|----------|---------------|--|--|--|
| Station                  | Interval | Template      |  |  |  |
| 500+25.00                |          | VT14mainline  |  |  |  |
| 506+35.00                | 5.00     | VT_Bridge/Typ |  |  |  |
| 507+40.00                | 5.00     | VT14mainline  |  |  |  |
|                          |          |               |  |  |  |
| ]                        |          |               |  |  |  |
| Synchronize with Library |          |               |  |  |  |
|                          |          |               |  |  |  |

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h) These templates in the Roadway Modeler now match your project template library.

**Note:** Back in <u>Section 8.2.2 Template Transitions</u> it was mentioned that when the "Synchronized with Library" command is used the template transitions may reset. In this example this tool was used and the transitions must be redone, refer back to <u>Section 8.2.2</u>. If the templates were edited directly in the Roadway Designer the transitions will not completely reset but you will still need to edit and reconnect the points, in this example it seems reasonable to keep the library up-to-date and use the synchronize tool.

#### 8.6.3. Use Superelevation Wizard

Once you have template drops defined it is possible to define superelevation. Superelevation will use horizontal control lines to control range points and rollover points. Changes to your design such as template point names or geometry stationing will alter superelevation. Any such changes to the design will require reworking or redefining superelevation.

- a) From the roadway modeler Select > Superelevation > Table...
- b) The default table loaded here is the (e<sub>max</sub>=8%\_V<sub>d</sub> =70mph) table or 08\_70.sup file > Click the [...] browse button and select the appropriate table for your curve.

| General Superelevation Data                                                |                                     |                               |                                     |                      |  |  |
|----------------------------------------------------------------------------|-------------------------------------|-------------------------------|-------------------------------------|----------------------|--|--|
| Table: CADD\Workspace\Projects\English\InRoads\super\AASHTO 2004\08_70.sup |                                     |                               |                                     |                      |  |  |
| % Runoff on Tangent 60% Interpolate Table Values                           |                                     |                               |                                     |                      |  |  |
| Specify Runout. Transition Lengths Are:                                    |                                     |                               |                                     |                      |  |  |
| Non-Linear Curve Length: 0.00  Runoff C Total Transition                   |                                     |                               |                                     |                      |  |  |
| Horizontal Curve Sets                                                      | :                                   |                               |                                     |                      |  |  |
| ID Start Station                                                           | Stop Station                        | Superelevation                | Table                               | Design Speed         |  |  |
| 1 500+68.88<br>2 503+43.31<br>3 511+25.46                                  | 502+09.51<br>509+52.05<br>514+63.93 | 8.00%<br>8.00% 8.00%<br>8.00% | 08_70.sup<br>08_70.sup<br>08_70.sup | 0.00<br>0.00<br>0.00 |  |  |
| Selected Curves:                                                           | Load Values From                    | m Table 📃 🔲 L                 | Jpdate Geometry fr                  | om Table             |  |  |

Super Tables are located in the

Workspace\Project\English\InRoads\super\ {folder}. There are several versions currently the VAOT standard uses AASHTO 2001 but the AASHTO 2004 is very close in value, and widely considered an improved method.

For this design example **curve 1** and **curve 3** will be designed for (55mph with  $e_{max}=8\%$ ) while **curve 2** will be designed for (35mph with  $e_{max}=6\%$ ).

- c) Under *General Superelevation Data* in the *Table Wizard* change the loaded table to the 08\_55.sup file using the [...] browse button to the right of the Table field. Select and open the appropriate file. This example will use the **AASHTO 2004 08\_55.sup** file
- d) Use the mouse cursor with the Ctrl key depressed to select both curve 1 and 3 from the curve set list.
- e) Click > Load Values From Table button, this will update the curve set list to show the table being used is the 08\_55.sup
- f) Browse to and select the AASHTO 2004 06\_35.sup file
- g) Use the mouse cursor to select curve 2 from the curve set list
- h) Click the > Load Values From Table button
- The Curve Set list should indicate that the correct super tables are being used for each curve as the design requires.

| Horiz | zontal Curve Sets: |              |                |           | _         |
|-------|--------------------|--------------|----------------|-----------|-----------|
| ID    | Start Station      | Stop Station | Superelevation | Table     | Design Sp |
| 1     | 500+68.88          | 502+09.51    | 8.00%          | 08_55.sup | 0.00      |
| 2     | 503+43.31          | 509+52.05    | 6.00% 6.00%    | 06_35.sup | 0.00      |
| 3     | 511+25.46          | 514+63.93    | 7.80%          | 08_55.sup | 0.00      |

j) Click the Next> button on the bottom of the *Table Wizard*, this will bring you to the *Superelevation Section Definitions* dialog.

- k) Use the Add... button to start your section definition
- I) The section name by default will be **Section 1**
- m) For the Crown Point select > CRWN point. This can be done using the pull down list or by using the target button to select the point on the screen from the modeler cross section view window.
- n) Set the Left Range Point to L\_LANE

| Name:              | Section1         |   |
|--------------------|------------------|---|
| Crown Point        | CRWN             | • |
| eft Range Point:   | L_LANE           | • |
| Right Range Point: | R_LANE           | • |
| Pivot Direction:   | From Crown Point | • |
| Number of lanes:   | 2 C 4            |   |

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- Set the Right Range Point to R\_LANE, the pivot direction is OK at From Crown Point and this is a 2 lane design. Click OK
- p) From the *Superelevation Section Definitions* dialog review the definitions setting. The start stop stations are indicated as well as the runoff lengths and more.
- q) Click the Next> button, the Superelevation Controls dialog allows you to review the vertical control line data, what they will be named and what point and slopes are involved. The Station rounding has been set at 1 foot by default but can be changed if required.
- r) Click the **Finish** button; if you have **Overlaps** you will get the Fix Overlap dialog for more information on this dialog refer to InRoads Help. Our overlap edits will be corrected later in the dynamic super display window (**Close this dialog**)

The main super control is now defined; to view the superelevation click on *Display Superelevation* button on the bottom right corner of the roadway designer dialog. The *Process All* button will make the display of super in this window display completely.



From the display superelevation option of the roadway modeler we can view different aspects of the super elevation. Each window has a purpose. The yellow line indicator in each window shows your current cross section template drop location.

| <u>Super Display View</u> | Description and usage of view windows                                                                                                                                                    |  |  |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| TOP LEFT                  | Plan view with color coded banking Blue = 8%, Orange = 6%, White = 0% and a gradient range in-between these colors                                                                       |  |  |
| BOTTOM LEFT               | Cross Section view of corridor backbone with color that match the plan view                                                                                                              |  |  |
| TOP RIGHT                 | Color coded Profile view of the corridor                                                                                                                                                 |  |  |
| BOTTOM RIGHT              | Banking Diagram Control line view; from this view edits to the banking can be made. Edits are done using a variety of tools we will use several of these in modifying the example design |  |  |

In the example design we have Runoff overlaps in the superelevation control lines for all 3 curves. This is typical and we can easily edit the overlaps from the Banking Diagram Control line view. Additionally we have overlapping full super start and stop stations for curve 1. We will edit and correct all these errors while graphically viewing the changes in the roadway designer *Display Superelevation* mode.

# 8.6.4.1. Display List

In some cases the control line view may have many different control lines. A Right Click over an empty blank space in the control line view will get you a short-cut menu with the Superelevation Display List dialog. From this dialog all the control lines are listed in the example design we have two. By selecting and deselecting the superelevation in the list then clicking the apply button we can turn off the display in super control line window view. This will become very useful when you get into more

| Available Superelevations: | Apply |  |  |
|----------------------------|-------|--|--|
| Section1 CRWN-R_LANE       | Close |  |  |
|                            | Help  |  |  |
|                            | All   |  |  |
|                            | None  |  |  |
| Delete                     | li.   |  |  |

advanced super definitions including rollover locks. Note that from this dialog we can delete the superelevation control lines simply select one and click the Delete button.

# 8.6.4.2. Control Curve Set Station Edit

The same short-cut menu that had the Display List command has an *Edit Curve Set Stations* command. This will bring up a dialog that will list controls for the superelevation. From this dialog we will edit *Curve Set 1* Full Super start and stop stations.

| Section Name: | Section1 |             |         |          |                    | • |
|---------------|----------|-------------|---------|----------|--------------------|---|
| Curve Set:    | < <      | 1 >         | >       | Show Cur | ve Set Information |   |
| Туре          |          | Constrained | Station |          | Cross Slope        | + |
| Reverse Crown |          | $\boxtimes$ | 499+9   | 7.00     | 2.00%              |   |
| Full Super    |          |             | 501+5   | 0.00     | 8.00%              | _ |
| Full Super    |          | $\boxtimes$ | 501+2   | 8.00     | 8.00%              |   |
| Reverse Crown |          |             | 502+8   | 1.00     | 2.00%              |   |

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- a) In the Superelevation Control Curve Set Station Edit dialog make curve set 1 active, this is indicated by the number shown directly below the Section Name.
- b) Change the Station value for the first Full Super in the list from STA 501+50 to STA 501+39 > Click the Apply button. Notice the control line display immediately reflects the update.

We changed the first one in the list because it controls the super rate value. The second Full Super in the list is simply constrained vertically to the first. Now that this is defined in a tolerable location we can delete the additional full super points for this curve. In this curve design we will always be in transition, first runoff entering then runoff exiting the curve. We theoretically only have Full Super at one location i.e. STA 501+39.

- c) Close the Superelevation Control Curve Set Station Edit dialog.
- d) If you need to know a points name you can hover over the point and the data will display.
- e) Right Click over the L\_LANE Full Super Point at STA 501+28 > Click the Delete point command
- Right Click over the R\_LANE Full Super Point at STA 501+28 > Click the Delete point command

The **Red** control line is the Left side superelevation control. The **Yellow** control line is the Right side superelevation control.

Once these points are deleted use the Edit Curve Set Stationing short-cut command to review this curves banking data.

Notice now there is only one Full Super defined for curve 1. This can also be observed directly from the banking diagram.





| Туре          | Constrained | Station   | Cross Slope |
|---------------|-------------|-----------|-------------|
| Reverse Crown | $\boxtimes$ | 499+92.60 | 2.00%       |
| Full Super    |             | 501+39.00 | 8.00%       |
| Reverse Crown |             | 502+81.00 | 2.00%       |

**Note:** An alternative and perhaps more acceptable solution would be to alter the Full Super section station values to eliminate the cross over then reduce the Cross slope value. Each design will require judgments, often to find the best solution you will need to test and evaluate multiple situations.

# 8.6.4.3. Full Super to Full Super Planar Transition

There is an option to create full super to full super planar transitions in the *Fix Superelevation Overlap* dialog it would have worked perfectly in this example. However we can directly edit the superelevation control points to create this transition. Overlapping curve transitions is common. The process for creating Full Super to Full Super is quite simple. If curves have extreme

overlaps the *Fix Superelevation Overlap* dialog will not delete points that extend into full super sections.

The image shown here represents super control lines that overlap. The left lane or red line returns to normal crown well into the entrance transition of reverse curves 1 & 2. This same overlap condition is present between curves 2 & 3. We will delete all control points that reside between the last full super of



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curve 1 and the first full super of curve 2. Then repeat the process between curves 2 & 3.

- a) From the Display Superelevation mode of the Roadway Designer dialog zoom into the overlap area as shown in the image above
- b) Holding your mouse cursor over a blank or black area in this view > Right Click > Select Delete Points
- c) <u>To Delete Multiple Points</u> > use your mouse cursor > Click and Hold down > drag your mouse creating a fence around all points in the transition overlap area. When you **RELEASE** the mouse button points inside the window will be deleted.

<u>Note:</u> There is an Undo available [Ctrl + z] or use the undo button on the bottom of the super control line view window.

d) Zoom into the transition overlap area between curves 2 & 3





The resulting banking diagram at this point is shown here. At the POB of this design we are basically in a reverse/normal crown situation that transitions to full super (e=8%) at STA 501+39; then reverse curve transition from full super to full super (e=6%) at STA 503+90: then remain full super to STA 509+06; then reverse curve transition from full super to full super (e=8%) STA 512+05; then remain full super to STA 513+84; then transition runoff to normal crown at STA 516+34 to POE.

File > Save your Roadway designer file.

# 8.6.5. Apply Shoulder Rollover Lock

To this point we have altered the transverse slope of the roadway from the center point (CRWN) of the road to the Left and Right Lane points using super elevation controls. Shoulder transverse slopes have remained at slopes as defined in the template. This may result in a sharp change in slope, especially where a full super of +8% changes to a shoulder with a transverse slope of -6% resulting in an algebraic difference of 14%.

Shoulder Rollover Locks are used to limit the algebraic difference that can occur between transverse slopes. As a rule VAOT limits the rollover algebraic difference to 7% on the high side of a curve and 0% on the low side of a curve. In our example project we will define rollover locks to be applied to pavement sections between the L\_LANE – L\_SHLD and the R\_LANE – R\_SHLD points.

- a) From the roadway modeler menu > Superelevation > Apply Shoulder Rollover Locks...
- b) From the Apply Shoulder Rollover Lock dialog> Set Shoulder Point: = L\_SHLD
- c) The Control Line Name: = L\_SHLD
- d) High Side Difference = **7.00%**
- e) Low Side Difference = 0.00%
- f) Both Maximums are OFF and Station Limits OFF
- g) Click > Apply
- h) Set Shoulder Point: = R\_SHLD
- i) The Control line Name: = R\_SHLD
- j) High Side Difference = 7.00%
- k) Low Side Difference = 0.00%
- I) Maximums are OFF and Station Limits OFF
- m) Click > Apply > Close

Using the Superelevation Display mode of the Roadway Modeler we can view cross sections along the corridor to verify the transverse slope is working according to our intended design. The image right shows super at a rate of -7.80% for the traveled way lanes. The right shoulder has a slope of -7.80% resulting in a 0.00% algebraic difference as we intended. The Left shoulder has a slope of -0.80% the



resulting algebraic difference here is 7.00% as intended.

<u>Note:</u> In this example we still have curbing everywhere. Curbing will not run the entire length of this design when completed. Curbing on this project can be removed where needed when parametric constraints and display rules are defined.

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#### 8.6.5.1. Modify Rollover Locks

Rollover Lock super control lines can be modified when required. Bridges often have a 0.00% break from lane to shoulder. In this example we will modify the rollover lock to be 0.00% on the high and low sides for the bridge and its approaches. The approaches start and end 30 feet before and after the bridge in this example. We will modify the rollover locks to transition from the standard 7% high 0% low break over 20 feet to the required 0% high and low.

From the template drops defined in the example project the bridge starts at STA 506+35 and ends at STA 507+40. This means the transition starts at STA 505+85 then reaches the 0% rollover lock at STA 506+15 holds this to STA 507+70 then transitions back to the standard at STA 507+90.

- a) From the Superelevation Display mode of the Roadway Modeler zoom in on curve 2 in the control line window
- b) The yellow line represents the R\_LANE super control; the cyan line represents the R\_SHLD control line. When you hover over lines data pop-ups indicate the control line name.
- 504+00 506+00 508+00  $510 \pm 0$
- c) Right Click over the cyan line > Select Insert Point
- d) In the Dynamic Settings dialog we will type in the station and slope value we are setting for the rollover lock. This is not the algebraic difference but rather the actual slope the shoulders will be set at. Type the following list in the x+xx,x = field as shown here: [tab] means click the tab key on your keyboard.
  - o 50585,-0.01 [tab]
  - o 50615,0.06 [tab]
  - 50770,0.06 [tab] 0
  - 50790,-0.01 [tab] 0



e) Right Click in the Super Display window and select *Finish*. File > Save > the Roadway Modeler File.

The result will be four points added to the R SHLD control line that will create the transition as defined for this example. The image right shows the control line with the four points added. The cross sections should also be viewed to insure that the transitions are working as designed.

At this point in the design process you should



We have shown in this example project how to generate a roadway corridor and covered the basic tools involved. The next step in the process is to generate proposed surface models that can be used for creating plan set cross sections, proposed contours, quantity information and much more.

# 8.7. CREATE PROPOSED SURFACE

The Roadway Modeler final output is in the form of surface digital terrain model. The combination of Horizontal Geometry, Vertical Geometry, Transverse Geometry, and roadway modeler tools create the Surface from defined corridors. If you have several corridors in your modeler they can be combined to create one surface or a new surface for each corridor. For the purpose of this manual we will always create a new surface for each corridor.

When using the Create Surface tools we will select the appropriate corridor from a list if need we can toggle on the Create Alternate Surfaces option. There are many advanced tools available when creating surfaces we will concentrate on fundamental tools.

Creating a surface from the Roadway Modeler in past versions of InRoads was an iterative process. In the latest versions of InRoads the surface should be relatively complete before you need to create a surface. The DTM created, if the modeler is used to its potential, will require much less direct edits than in previous InRoads versions. That being said most all the standard feature edit and design surface tools available previously continue to be available.

#### 8.7.1. Create Surface

In the exercise we will create a proposed surface model. The name of the surface model will by default be the same as the name of the corridor. We will also utilize the alternate surface option to create a model for the bottom of pavement. Finally we will modify the properties of the surfaces created and save them to file as well as add them to the project rwk file.

- a) In the Modeler set the Active Surface accordingly, in this example we will set the active surface to the original ground i.e. x86e055og
- b) From the Roadway Modeler Select > Corridor > Create Surface
- c) From the Create Surface dialog select the one corridor you are creating surfaces for from the Create Surface(s) from: window. For this example we will select the RT14prop corridor. If you have several corridors defined they will all be selected automatically. This dialog will run all corridors if you let it! Select only the corridor you require.
- d) The default options are shown here.
- e) Toggle **ON** the *Add Transverse Features* option. This option will make your surface model more accurate and help control the triangles at template drops.
- f) Toggle **ON** the *Create Alternate Surface* Options at the bottom of the dialog.
- g) Click the Apply button.... Wait....
- h) Close the dialog when the process is completed. Close Roadway Modeler

| N                                                                                                                                                              |             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Name:                                                                                                                                                          | Apply       |
| Default Preference:                                                                                                                                            | Close       |
| ✓ New Surface for Each Corridor                                                                                                                                | Preferences |
| Empty Design Surface                                                                                                                                           | Help        |
| ☐ Include Null Points                                                                                                                                          |             |
| Add Exterior Boundary - Style: Exterior Bou                                                                                                                    | ndary 💌     |
| Densify Horizontal Curves using Chord Height Toler                                                                                                             | ance        |
| Densify Vertical Curves using Chord Height Toleran                                                                                                             | ce          |
| ▼ Triangulate                                                                                                                                                  |             |
| Create Surface(s) from:                                                                                                                                        |             |
| FlatTest                                                                                                                                                       |             |
| RowTest                                                                                                                                                        |             |
| RT14prop                                                                                                                                                       |             |
| TKT14plop_1                                                                                                                                                    |             |
|                                                                                                                                                                | All         |
|                                                                                                                                                                | All None    |
| Clipping Options                                                                                                                                               | All None    |
| Clipping Options                                                                                                                                               | None        |
| Clipping Options Features Duplicate Names:                                                                                                                     | None        |
| Clipping Options Features Duplicate Names: C Append C Replace C Rename                                                                                         | All None    |
| Clipping Options Features Duplicate Names: C Append C Replace C Rename Add Transverse Features                                                                 | All None    |
| Clipping Options Features Duplicate Names: Add Transverse Features Style: TDANSVEDCE CEATURE =                                                                 | All None    |
| Clipping Options<br>Features<br>Duplicate Names:<br>Append C Replace C Rename<br>Add Transverse Features<br>Style: TRANSVERSE_FEATURE                          | All None    |
| Clipping Options  Features Duplicate Names:  Add Transverse Features  Style:  TRANSVERSE_FEATURE  Create Alternate Surfaces                                    | All<br>None |
| Clipping Options Features Duplicate Names: Add Transverse Features Style: TRANSVERSE_FEATURE Create Alternate Surfaces Process Visible Range Only              | C Modify    |
| Clipping Options Features Duplicate Names: Add Transverse Features Style: TRANSVERSE_FEATURE Create Alternate Surfaces Process Visible Range Only Remove Loops | All<br>None |
| Clipping Options<br>Features Duplicate Names:                                                                                                                  | C Modify    |

#### 8.7.1.1. Surface Properties

The surfaces created from the modeler have default properties and should be modified to display correctly in plan and cross section. The alternate surface should also be triangulated with minor modifications to reduce extraneous triangles.

- a) From the InRoads explore workspace bar window select the surface Tab
- Right Click over the proposed surface e.g. RT14prop > Select > Properties
- c) On the Main Tab change the Preference field from Default to **Surf1**. This will control the level that triangles will display on in plan view.
- d) On the Advanced Tab change Cross Section > Symbology to SURFACE\_PROPOSED
- e) On the Advanced Tab change Profiles > Symbology to SURFACE\_PROPOSED
- f) Click the Apply Button
- g) Right Click and Edit the Properties of the alternate surface e.g. RT14prop-PAVEBOTTOM
- h) From the Main Tab change the Name: to RT14subbase and the Description to Stone Subbase Surface.
- Name:
   RT14subbase

   Description:
   Stone Subbase Surface

   Maximum Length:
   50.00

   Preference:
   surf5

   Type:
   Ignore

🗄 🥌 Default

🗄 🤜 x86e055og

E 🛃 RT14prop-PAVEBOTTOM

🛚 Surfaces 🔠 Geometry 🖌 🕨

🗄 🤜 RT14prop

- i) Change the Preference to surf5
- j) Change the Maximum Length to 50.00; this will limit triangle legs from being more than 50 feet in length when the surface is triangulated. *In InRoads 8.9 alternate surfaces do get and exterior boundary if add exterior boundary is toggled on when creating surfaces.*
- k) On the Advanced Tab set Cross Section and Profile symbology to SURFACE\_STONE the bottom of pavement is also the top of the subbase compacted stone layer. These setting control the color and level that the surface graphics will be displayed on in their respective uses.
- I) Click the Apply Button

#### 8.7.1.2. Triangulate Proposed Surface

The alternate surface in this example must be triangulated. This is the process of applying the triangulation algorithm explained in earlier sections of this manual. When ever changes are made to a surface such as features are added or deleted or in our example the maximum length is change the surface must be triangulated to include the changes.

- a) From the InRoads main menu Select > Surface > Triangulate Surface
- b) Set the surface to be triangulated active in this dialog e.g. RT14subbase
- c) The Maximum Length can be change in this dialog but in our example it should be already set to 50.00 if not set it.
- d) Click the Apply button > Close

| t | to |  |  |
|---|----|--|--|
#### 8.7.1.3. Save Proposed Surfaces

The two surfaces we created are currently saved in virtual memory only. These files do not exist on any physical memory to this point. We will save out proposed surfaces to physical memory then add these surfaces to our project rwk file. Project rwk file usage was explained in <u>Section 3.7</u>.

- a) From the InRoads explore workspace bar window select the surface Tab
- b) Right Click over the proposed surface e.g. RT14prop > Select > Save As, The surface you are saving will be shown as Active: at the bottom of the Save As dialog. If you use the pull down you can select any of the loaded files to save at this point. Use the pull down and select the RT14prop surface. Notice that the File name: is automatically filled in as RT14prop.dtm. When saving this file to disk it should be saved using the VAOT standard file naming convention e.g. z86e055prop.dtm or z86e055vt14prop.dtm to be more descriptive.
- c) Change the file name to follow the standard (z86e055vt14prop.dtm) > Click Save.
- d) From the Active Pull down select the VT14subbase surface
- e) Change the file name to follow the standard e.g. z86e055vt14subb.dtm > Click Save.
- f) Cancel the Save As dialog.

#### 8.7.1.4. Project File Update

We now have two more files to add to our project file. It is important to keep the project file upto-date. This file, not only saves you time when loading the project it allows others in the design team to load the files included in the Design. A large portion of good InRoads design practices is associated with file management. As we have see there are lots of different types of files associated with the InRoads design, the project file will help track design data.

- a) From the InRoads main menu Select > File > Save AS
- b) From the Save As dialog set the save as type to Project (\*.rwk)
- c) Browse to your current project file and select it.
- d) At the bottom of the Save As dialog Select > Options button
- e) From the Project Options dialog select the Surfaces Tab
- f) Toggle on the Update and Add option for the new surfaces e.g. VT14prop and VT14subbase, as shown here.
- g) Click > OK > Save > Yes you do want to replace your existing project file with this new and revised one. > Cancel the Save As dialog when done.



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# **SECTION 9** – CROSS SECTION EVALUATION

# 9. INTRODUCTION

Cross Sections are used to display and annotate surfaces and features in a vertical plane. Normal Cross Sections are cut at a specified interval perpendicular to the mainline geometry. Custom Cross Sections can be defined at any skew angle where needed. Cross Sections are an integral part of design plans. When InRoads is used to its potential, many of the tedious processes involved in drawing Cross Sections can be automated.

Typically VAOT generates cross sections at 25 or 50 foot intervals, depending on the project. VAOT standard cross section sets are drawn with a vertical exaggeration factor of one. The amount of annotation that is shown on each cross section can vary depending on the type of project. In this Section of the manual we will generate a standard set of cross sections along the example project mainline horizontal alignment i.e. RT14prop. These cross sections will show the existing ground surface model as well as the proposed surface model. We will generate the typical annotations that all VAOT cross sections include, and some that are used to aid in the design process.





# 9.1. CREATE CROSS SECTION SET

Before creating cross section you should load/open all the data files. For this example we need the geometry project loaded. We are using the horizontal alignment VT14prop as the source for creating the cross sections. Also load/open the surface models that will be shown in the cross sections for this example load the original ground surface and the proposed surface model. The proposed surface model we are using is the one created from the Modeler > Roadway Designer >in Section 8.7.1 Create Surface.

Note: Cross Sections that are used as part of the design plan set must but drawn and annotated

in the proper drawing file e.g. z86e055xs1.dgn. The "xs1.dgn" file is the VAOT standard file name that indicates cross section data content.

#### 9.1.1. Steps to Create Cross Section

- a) Set the active horizontal alignment to the one you are creating cross sections for e.g. VT14prop.
- b) From the InRoads main menu Select > Evaluation > Cross Section > Create Cross Section...
- c) Select <u>Create Cross</u> <u>Section - General Leaf</u> (Double click on items in the left window to expand and activate dialog leafs)
- d) <u>Set Name:</u> by default will be the same as your active alignment
- e) <u>Create:</u> *Window and Data* is the standard setting.

| Create Cross Section<br>General<br>Source<br>Include<br>Controls<br>Layout<br>Axes<br>Grid<br>Details<br>ASCII | <u>S</u> et Name:<br>Crea <u>t</u> e: |                                                 | VT14prop        |                                                     |                          |
|----------------------------------------------------------------------------------------------------------------|---------------------------------------|-------------------------------------------------|-----------------|-----------------------------------------------------|--------------------------|
|                                                                                                                |                                       |                                                 | Window and Data |                                                     |                          |
|                                                                                                                | Inter <u>v</u> al:                    |                                                 | 25.00           | )                                                   | - <del>†</del> -         |
|                                                                                                                | Left Offset:                          |                                                 | -70.00          |                                                     | +                        |
|                                                                                                                | <u>R</u> ight Offset                  |                                                 | 70.00           |                                                     | +                        |
|                                                                                                                | Vertical Exaggeration:                |                                                 | 1.0000          |                                                     |                          |
|                                                                                                                | Show Data Outside Elevation Range     |                                                 |                 |                                                     |                          |
|                                                                                                                | Surfaces:                             |                                                 |                 |                                                     |                          |
|                                                                                                                |                                       | Object                                          |                 | Name                                                |                          |
|                                                                                                                |                                       | Default<br>x86e055og<br>RT14prop<br>RT14subbase |                 | Default<br>default<br>SURFACE_PROP<br>SURFACE_STONE | BYI<br>BYI<br>BYI<br>BYI |
|                                                                                                                |                                       |                                                 |                 |                                                     |                          |

- f) Interval: The default setting is 50, in our example we will change this to a 25 foot interval.
- g) <u>Left/Right Offset:</u> 70' left and 70' right will work in this example, each project may require adjustments to this offset depending on the width of the design.
- h) As noted earlier the typical vertical exaggeration for VAOT cross sections is 1.
- i) Toggle on by clicking to X the Surfaces in the surface list window e.g. x86e055og and RT14prop are ON and will be drawn in the cross section set.

<u>Note:</u> When creating cross sections the main goal is to setup the cross sections with proper intervals and left/right offsets as well as all other layout and spacing settings. Once the cross section set is generated these type settings cannot be changed; if this requires change the entire set must be **regenerated**. Surface data including features and components as well as the surface lines can be updated or added into cross section sets after the set is created.

 j) Click on the Source leaf and make sure that Alignment is the selected source and that



the proper horizontal alignment is shown as active in this dialog.

- k) Click on the Include leaf and toggle on the Surface > Components option to include surface components in the cross section set.
- I) Click back to the General leaf
- m) At the bottom of the dialog select the **Preferences** button. There are 2



named preferences "10\_Scale" and "Final x-sec", the preference "Default" is exactly the same as the "10\_Scale". The "Final x-sec" has a cross grid and additional window clearance of 10 feet above and below the surfaces models displayed in the cross section window. If you choose to use the preferences they should be loaded before making modifications such as interval of 25' on the General Leaf because they will be reset

when you load a named preference. Use the Close button to close the dialog without loading a preference.

- n) Click the Apply button > you are now prompted by MicroStation to identify a location in your drawing window. Data point to select the bottom left corner of your cross section set location. Cross Sections and Profiles are always placed straight in the X,Y plane of the drawing, never rotated.
- o) !!Now <u>**REPEAT</u>** steps (a) through (n) after loading the named preference "Final x-sec" as explained in steps (m).</u>

**Note:** use Evaluation > Cross Section > Cross Section Viewer dialog to quickly and efficiently browse through large cross section sets one cross section at a time.

# 9.2. UPDATE CROSS SECTION SET

The Update Cross Section dialog is used not only to update surfaces within a cross section but to add, remove, or refresh surfaces, Components, Crossing features, Projected Features, and Storm and Sanitary Structures. This function only works on Cross Section Sets that retain their cross section set association. To use the update cross section set commands the geometry used to create the cross sections (not a copy of the geometry) and the data to be updated must be loaded into the InRoads session. There are internals ID's on geometry data, InRoads copies of geometry are not considered to be same data i.e. they receive new ID's. Files outside of InRoads can be copied and ID's will remain intact i.e. file save as or copy past to create a copy of the file. This being said, care must be taken to keep the original geometry that was used to create the cross section set (if you need to retain association).

Note: Moving or copying cross sections around in a drawing, or from one drawing to another is not recommended. This can cause them to drop association. For this reason we carefully organize and label all cross sections and profiles in the proper cross section design file where only cross section/profile tasks are done.

# 9.2.1. Update Surfaces

Window in on the cross sections to be updated

a) Select > Evaluation > Cross Sections > Update Cross Section > Select the Surface leaf



- b) Use the target button to the right of the cross section set window to select the set to be updated. A MicroStation highlight box will appear around the active set
- c) To Refresh the surface RT14prop toggle the Refresh mode ON and select the surface in the surface name listing, multiple surfaces can be selected and refreshed > Click the Apply button
- d) To Display Off both surfaces Toggle on the Display Off mode > Select both x86e055og & RT14prop surfaces and > Click the Apply button
- e) Display ON, is the same procedure but Toggle on the Display On mode

# 9.2.2. Components Display Off/On

The proposed surface in this example contains components. Notice when the Surface > Display Off mode is applied to RT14prop the components remained visible only the triangulated

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#### surface line disappeared

The process for updating surface Components is much the same as updating surfaces. Toggle on the mode i.e. Refresh | ON | OFF, the select the surface. A list of components that are in the selected surface will be listed in the components name window. Right Click > Select All > or pick and choose only the components that require an update.

#### 9.2.3. Crossing Features On

This is an important update function to get familiar with. Crossing Features must be displayed in cross section to be annotated or used in segment slope annotations.

Window in on the cross sections to be updated

- a) Select > Evaluation > Cross Section > Update Cross Section > Select the Crossing Features; leaf
- b) Toggle the Display On mode > Select the proposed surface e.g. RT14prop
- c) Select all the Features in the Feature Name list window > Right Click > Select All
- d) Click > Apply, features points will display in the cross section set > Close



Shown here is an image of proposed surface components with crossing feature points displayed in cross section. Points must be shown in cross sections for feature and segment annotations to use them. Notice all points are shown some as Dots others as + some (not shown here) points display as triangles and some will display as detailed cells.

#### 9.3. ANNOTATE CROSS SECTION SET

This tool offers the ability to annotate surfaces within a cross section set. Surface annotations typically include transverse slopes (Slope), Finish Grade Elevations (<u>F.G. Elevation</u>), Point Offset & elevation (*Offset/Elevation*), and feature names (*Feature w/Leader*) or (*Feature (Pipes)*). On this dialog there are preferences for each of these typical annotations preference name are shown in parenthesis. The (*Default*) preference is the same as the (*F.G. Elevation*).

<u>Note:</u> When annotating cross section toggle the pencil lock to pen lock, this will allow multiple annotations without erasing the previous annotation.

#### 9.3.1. Annotate Cross Sections (Finish Grade)

- a) Make sure all appropriate levels are on in the design file
- b) On the Lock Tool bar change the Pencil lock to Pen lock.
- c) Select > Evaluation > Cross Section > Annotate Cross Section...
- d) One design file can contain several cross sections sets. At the top of the Annotate

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Cross Section dialog is a pull down list of sets in the design file that are able to be annotated. Use the target button to tag the cross section set on the screen or select if from the list. When the cross section set is active a MicroStation box should highlight around the set.

- e) Select the named Preference *F.G. Elevation* > Load > Close (from the preference button at the bottom of the dialog)
- f) On the Annotate Cross Section General leaf toggle on the proposed surface that is considered Finish Grade. The Click Apply.



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- g) Annotate Cross Sections (Slopes)
- h) Select the named Preference *Slope* > Load > Close
- i) In the General leaf toggle on the proposed surface e.g. RT14prop
- j) In the Segments Leaf > Annotate > Select all the Crossing Features that require slope annotation between them. This will vary from design to design. For this example we will annotate the roadway traveled way slopes. Use the CTRL key to select the required features.
  - j) In the Segments Leaf > Annotate > Select all the Crossing Features that require slope annotation between them. This will vary from design to design. For this example we will annotate the roadway traveled way slopes. Use the CTRL key to select the required features.

|        | CRWN |        |
|--------|------|--------|
| L_LANE |      | R_LAN  |
| L_SHLD |      | R_SHLD |

k) With Pen Lock ON > Click the Apply button, now segment slopes between these features have been annotated. (Right Click > Select None to clear the selection)

<u>Note:</u> We do not annotate slope for curb or curb buffers because this value is set by the typical section details and should not vary along the roadway design.

 We will now annotate the slope for end conditions. This process is done in two steps Left side then the Right side because we are annotating all slopes between selected features and we do not want a slope annotated between L\_EDGE\_BUF and R\_EDGE\_BUF. Use the CTRL key to select the required features

| 1 <sup>st</sup> Selection set |  |
|-------------------------------|--|
| L_EDGE_BUF                    |  |
| L_ROAD_CUT                    |  |
| L_ROAD_FILL                   |  |
| L_DITCH                       |  |
|                               |  |

2<sup>nd</sup> Selection set R\_EDGE\_BUF R\_ROAD\_CUT R\_ROAD\_FILL R DITCH

With Pen Lock ON > Click the Apply button after each selection set; now end conditions are annotated. Notice slopes greater then 10% are annotated via a slope ratio (Rise:Run). (Right Click > Select None)

#### 9.3.2. Annotate Cross Sections (Offset/Elevation)

- a) Select the named Preference Offset/Elevation > Load > Close
- b) On the General leaf toggle on the proposed surface e.g. RT14prop
- c) On the Features > Annotate leaf select the features to annotate the offset and elevation for. Use the CTRL key to select the required features

| L_ROAD_CUT  | R_ROAD_CUT  |
|-------------|-------------|
| L_ROAD_FILL | R_ROAD_FILL |
| L_DITCH     | R_DITCH     |

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- d) With Pen Lock ON > Click the Apply button, now cross sections with cut/fill intercepts will get elevation and offset labels on the intercepts. Cross sections with a Ditch will also be labels; this will work for any crossing feature that is displayed in the cross section set. (Right Click> Select None)
- e) **!!!** Toggle the write lock back to <u>Pencil</u> (Standard Setting should be Pencil)

<u>Note:</u> Any annotation or point displays can be made larger or smaller using the global scale factor add-in or the Tools > Options > Factors Tab, and entering in the desired scale factor.

This concludes <u>SECTION 9 – CROSS SECTION EVALUATION</u>. The work flow in this section provides a cross section set on the example project with cross sections at the specified 25 foot interval. The annotations in the example set should be as shown on the STA 506+00 cross section, at the beginning of this Section. Cross sections are a fundamental part of the design plan set. Cross section surface data and annotations are only as good as the surface models used to generate them. Previous versions of InRoads contained Edit Feature in Cross Section tools these tools are no longer available. Edits to the surface should ideally be made in the Roadway Designer then regenerate the surface, but there are many tools other than the Roadway Designer to edit and design surfaces.

From InRoads Cross Section Sets there are tools available for generating reports such as feature offset and slope staking reports or average end area volumes reports/annotations. While cross sections provide practical means for construction staking and quantity takeoffs the actual surface models (DTM) when well formed and accurately generated can also provide construction staking and quantities directly and more accurately. The use of DTM or other file formats that can be generated from DTM's is actively being sought after by the construction industry to use for construction layout and staking.