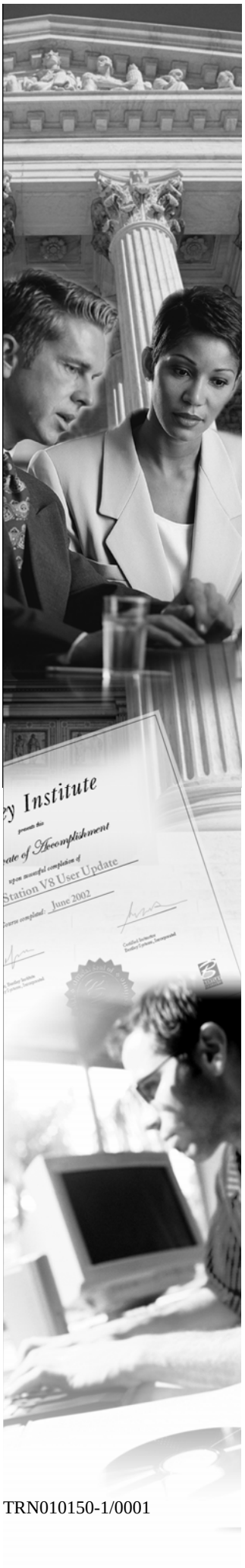

W15

Earthwork Volume Computations

XM Edition

Bentley Institute

TRN010150-1/0001

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WORKSHOP OBJECTIVES

This workshop focuses on getting results from the End-Area Volumes command found in the InRoads Group of products. You will cover a number of different topics from other commands while you build up the project data in preparation for using the End-Area Volumes command. In addition, you will be working with multiple subsurfaces and unsuitable materials as well as volume reporting. In this workshop, you will:

- Modify a template to include an undercut component
- Run Roadway Designer using the modified template
- Use the boundary of the design surface to create stripping features
- Display cross sections of your design
- Set up parameters for the End-Area Volumes command and run the command
- View volume reports and save the XML data
- Create a mass-haul diagram from the XML data

Note	This workshop covers intermediate topics using Bentley InRoads XM Edition V8.9 running on MicroStation XM Edition. It is assumed that you have a basic familiarity with InRoads commands from V8.7 or higher.

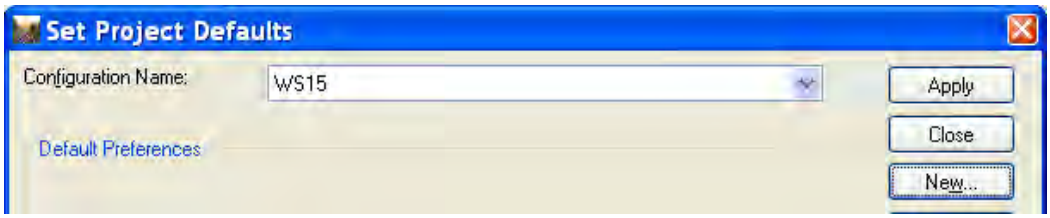
BEFORE YOU BEGIN

Before beginning the exercises outlined in this workshop, you need to start InRoads and load the workshop files. To do so, follow these steps:

1. From the *Start* > *Programs* > *Bentley* > *InRoads Group XM* menu, select *InRoads*.

2. Navigate to the workshop directory and select the *volumes.dgn* file from the *MicroStation Manager*. This design file has a reference file attached showing some of the existing topological features which are stored in the DTM. You may turn off the display of the reference file at any time, if you wish, by selecting *File* > *Reference* from the MicroStation menu and toggling off the checkmark in the *Display* column. We only use this data for visual reference during the workshop.

3. From the *InRoads Explorer*, select *File* > *Project Defaults* and set the *Configuration Name* to **WS 15**. Close the *Project Defaults* dialog.



Set Project Defaults

Hint	If WS 15 does not show up in your list, select the *Import* button from the *Project Defaults* dialog, navigate to the workshop directory, and open *WS15.reg*.

4. Select *File* > *Open* and load the workshop files by selecting the project file named *volumes.rwk*. This project file contains a geometry project, three surfaces, a template library and a roadway design file for use in the remainder of this workshop.

5. Select *Tools* > *Locks* > *Toolbar* to turn on the *Locks* toolbar, if it is not already on.

You are now ready to begin the exercises in this workshop. If, for any reason, you must exit the software before the end of the workshop, simply repeat the steps in this section.

If you are unable to complete an exercise as you proceed through this workshop, the completed files for that lesson are stored in subdirectories labeled with the exercise number. For example, if you cannot complete Exercise 3, you can copy the completed files from the *\Exercise 3* subdirectory to your working directory before beginning Exercise 4.

LESSON 1: ANALYZING YOUR DESIGN DATA

LESSON OBJECTIVE:

In this lesson, you will become more familiar with the project data you will be using during this workshop. You will display your geometry and some surface data as well as create a profile along the centerline.

EXERCISE 1: DISPLAYING YOUR DESIGN DATA

In this exercise, you will display some of the data making up your design project.

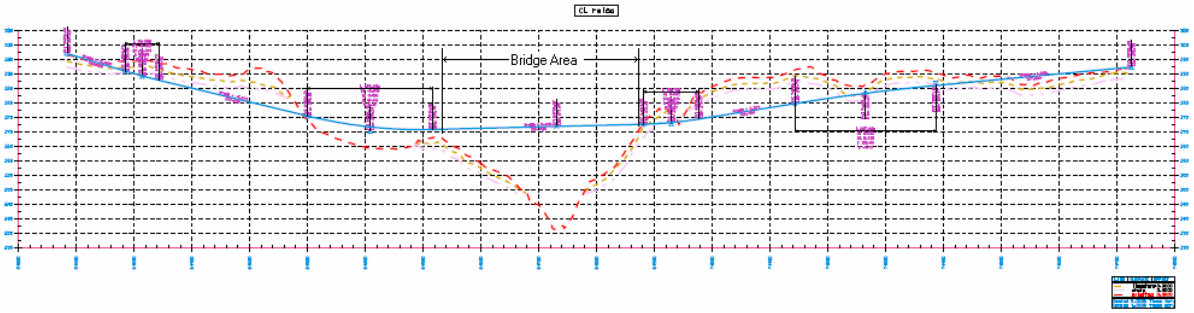
1. You will notice a number of topological features displayed in the attached reference file. This project involves the resurfacing and relocation of a rural two lane road and a new creek crossing. The resurfacing portion has already been completed and the design surfaces have been merged into the existing ground surface. You will be completing the relocation during this workshop.

2. Select *Geometry* > *View Geometry* > *Horizontal Annotation* from the *InRoads Explorer* menu. Keyin **CL reloc** in the *Horizontal Alignments Include* field and select *Apply*. You should see a mint green line representing the centerline of the relocated portion of your design.

3. Select *Geometry* > *View Geometry* > *Stationing* and select *Apply*. Window in to the beginning of your alignment and note that it begins at Station 5+884. Pan along the alignment, if you wish. Fit your view.

4. Select *Evaluation* > *Profile* > *Create Profile* and verify that all three surfaces – **limestone**, **shale** and **existing** – are selected. Select *Apply* and place the profile below your plan graphics. You will notice that your **existing** surface is represented by a red line, the **limestone** subsurface by a gold line and the **shale** subsurface by a light pink line. The **limestone** and **shale** surfaces are not continuous along the length of your profile.

5. Select *Geometry* > *View Geometry* > *Vertical Annotation* and select *Apply*. As you can see, this project includes a bridge from Station 6+538 to Station 6+866.



Vertical Alignment

6. Select *Surface* > *View Surface* > *Perimeter* and *Surface* > *View Surface* > *Contours* to display your **existing** surface.

LESSON 2: ADDING AN UNDERCUT COMPONENT TO THE TEMPLATE

LESSON OBJECTIVE:

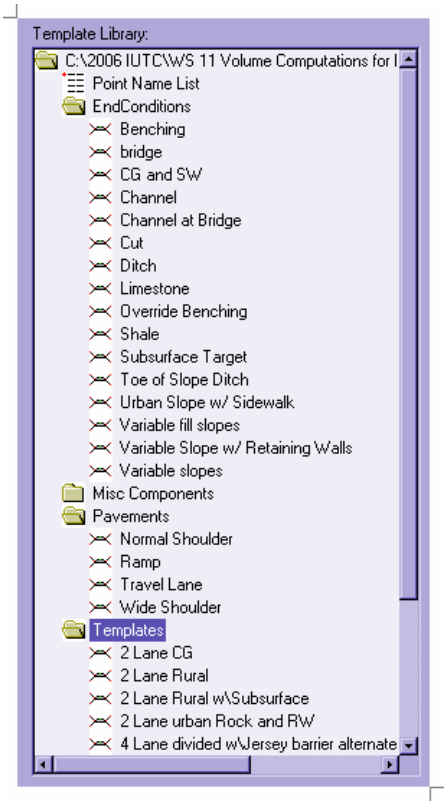
A frequent requirement for rock excavation is to cut away additional rock material beneath the road surface and to fill this area back in with normal fill which can be compacted. This is typically referred to as "undercut."

This lesson will guide you through the steps required to add an **undercut** component to your template which will only be activated when the bottom of the **aggregate base** component falls below the **shale** surface. The new component will be controlled by null points and display rules.

EXERCISE 2: TEMPLATE OVERVIEW

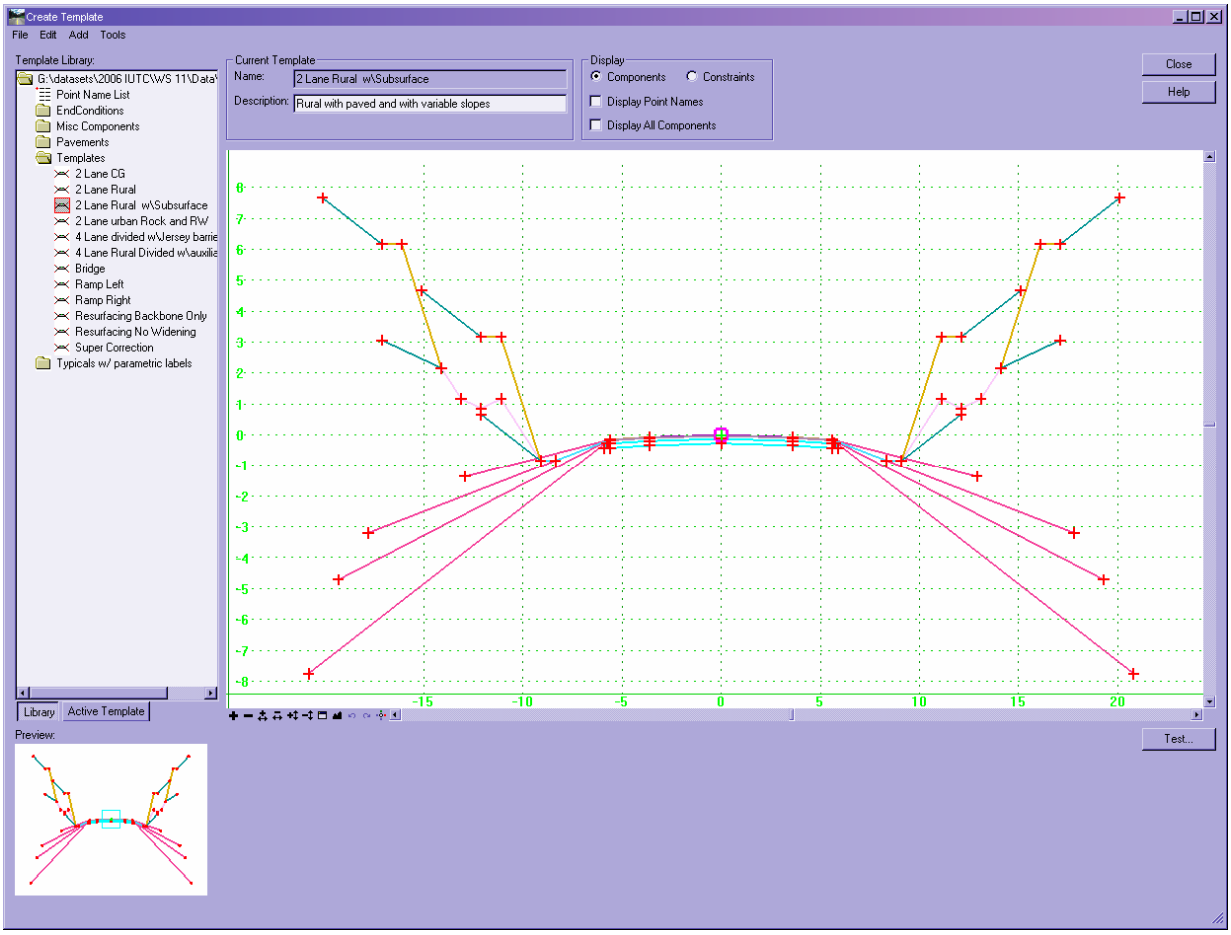
In this exercise, you will analyze an existing template contained in your template library.

1. Select *Modeler* > *Create Template* from the *InRoads Explorer* menu and expand the root folder. You will notice that your library already contains a number of end conditions, pavements, templates, etc.



Template Library Contents

2. The template you are going to use in this workshop is located in the *Templates* folder and is called **2 Lane Rural w\Subsurface**. Make it the active template by double-clicking it in the treeview on the left side of the dialog. Turn off the *Display Point Names* option, if you wish.



2 Lane Rural w\Subsurface

3. Spend a few moments getting familiar with this template. You will notice that in addition to the usual pavement and base components, it contains a number of slope options for fill situations (the bright pink lines) and several options for cut situations. In addition to a flat bottom ditch, the cut options also include teal lines which target the active surface, gold lines which target limestone and light pink lines which target shale.

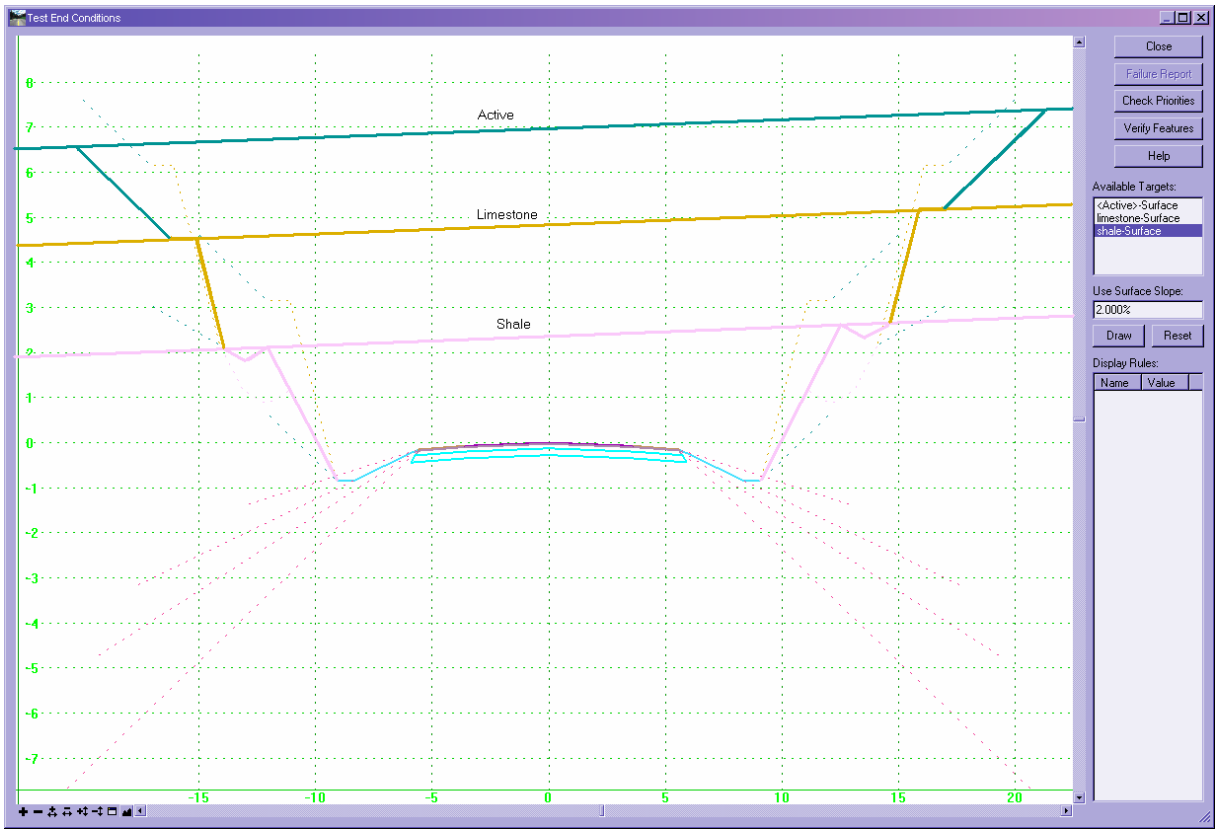
4. Select the *Test* button at the bottom of the template display window.

5. Keyin a slope of **2%** in the *Use Surface Slope* field and select **<Active>-Surface** in the *Available Targets* list. Then select the *Draw* button.

6. Move the surface line up and down in the display window to see the effect of depth on the fill slopes and how the template behaves in a cut situation. Place the line near the top of the display window.

7. Now select **limestone-Surface** in the *Available Targets* list and *Draw* it. See the effect on the template as you move it up and down. Place the **limestone** surface line below the active surface line. Notice that the **limestone** components contain a segment that follows the top of the **limestone** surface for 1 meter before testing for the next target.

8. Next, select **shale-Surface** in the *Available Targets* list and *Draw* it. Note the changes in the sideslopes. The **shale** components contain a v-bottom ditch at the top of the **shale** surface before testing for the next target.



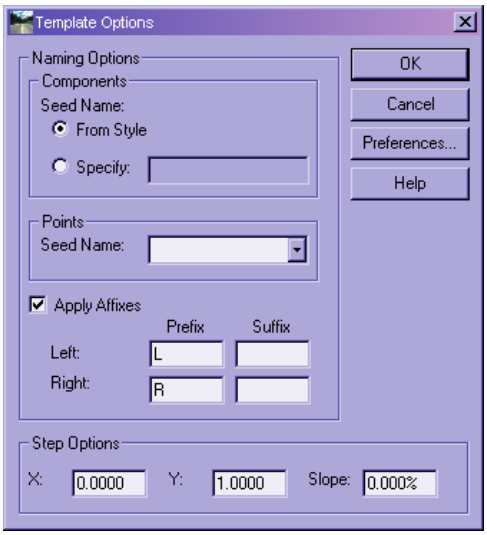
Testing the 2 Lane Rural w\Subsurface Template

9. If you like, *Reset* the display and test the template with just the active surface and the **shale** surface to verify that these conditions are accounted for. *Close* the *Test* dialog.

EXERCISE 3: CREATING NULL POINTS FOR CONTROL OF THE UNDERCUT COMPONENT

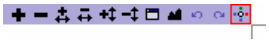
A null point is a template point that is purposely not related to any particular component. It is most often used as a reference for controlling other points. In this exercise, you will create null points for control of the **undercut** component.

1. Select *Tools* > *Options* from the *Create Template* menu and turn on the *Apply Affixes* option. Key in **L** for the *Left Prefix* and **R** for the *Right Prefix*.



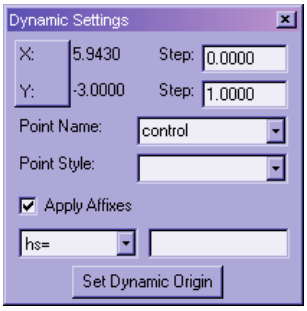
Setting Affixes

2. Display the *Dynamic Settings* dialog by clicking the *Toggle Dynamic Settings Dialog* button at the bottom right of the template display window.



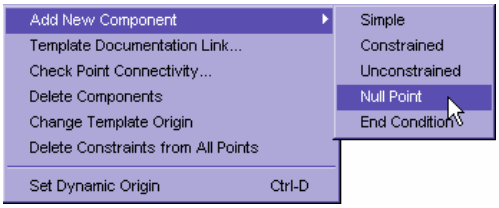
Template Window Toolbar

3. Set the *Y Step* to **1.0000** and key in **control** in the *Point Name* field. Make sure *Apply Affixes* is toggled on.



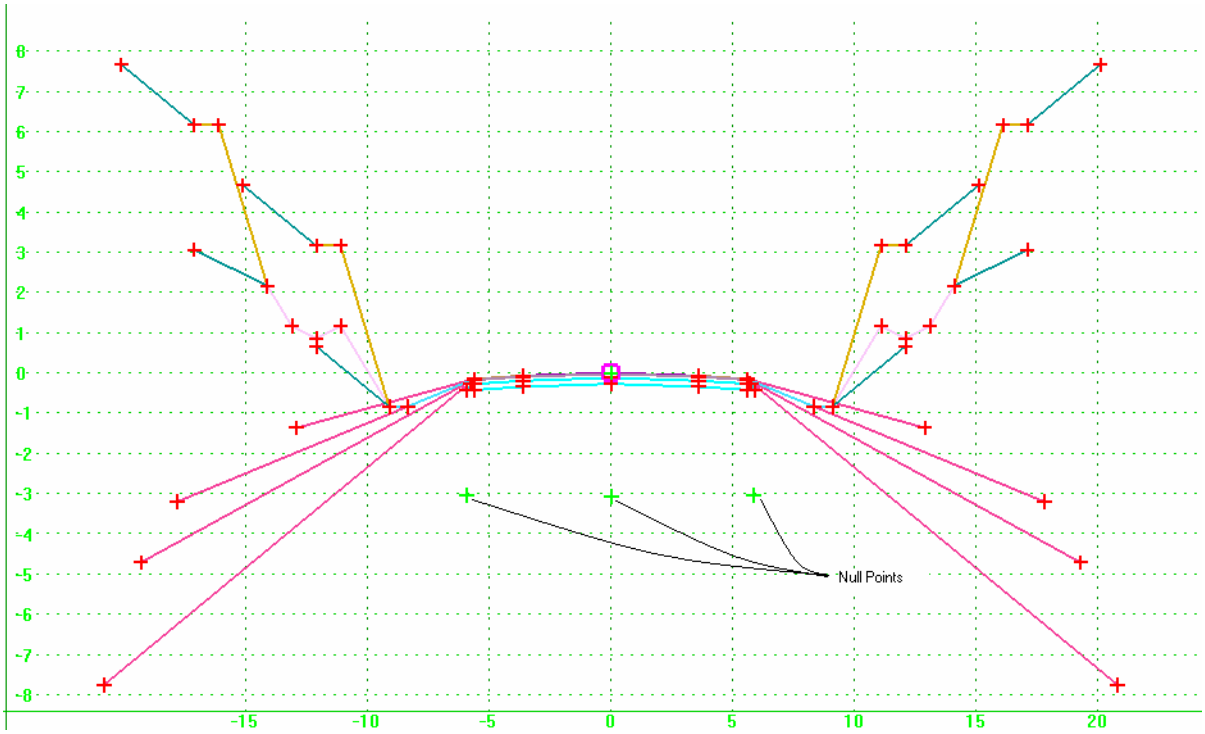
Dynamic Settings for the Null Points

4. Right-click the display area of the *Create Template* dialog and select *Add New Component* > *Null Point*.



Adding a Null Point

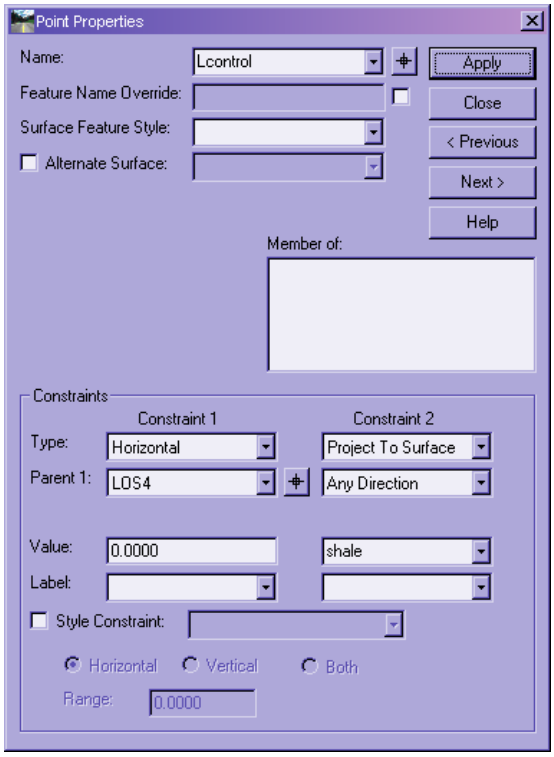
5. Place three null points at an elevation of approximately **-3**, two below the shoulder points and one below the center. The exact location isn't important because you will use constraints to precisely locate the null points.



Three Null Points

6. Window in so that you can see the three null points and the driving surface points in your display window. Right-click the left null point and select *Edit Point*.

7. Verify that the name of the point is **Lcontrol** and set the *Type* for *Constraint 1* to **Horizontal** and its *Parent 1* to **LOS4**, either by selecting it from the dropdown list or by using the *Locate* button. Set the *Type* for *Constraint 2* to **Project to Surface** and its *Parent 1* to **Any Direction**. Keyin a *Value* of **0.0000** for *Constraint 1* and select **shale** for *Constraint 2*. Select *Apply* to save your changes.



Edit Point Properties for Lcontrol

8. Follow a similar workflow for the right control point (**Rcontrol**) and use **ROS4** as *Parent 1*, **0.0000** as the first *Value* and **shale** as the second *Value*. For the center control point, rename it **CLcontrol** and use **CL** as *Parent 1*, **0.0000** as the first *Value* and **shale** as the second *Value*.

9. *Save* your template library.

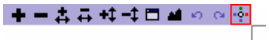
EXERCISE 4: CREATING AN UNDERCUT COMPONENT

In this exercise, you will create an **undercut** component below your **aggregate base** (cyan colored) component.

Note Window in so that you can see the right side of the **Pavement**, **base** and **aggregate base** components. If your point names are not displayed, toggle their display on by selecting the *Display Point Names* option.

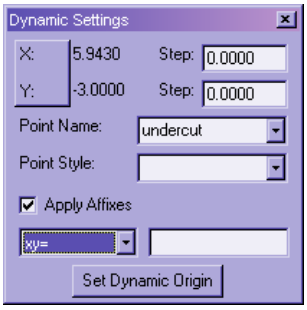
Hint	You may want to maximize your *Create Template* dialog because you will be snapping to multiple existing points in the next steps.

10. If the *Dynamic Settings* dialog is not already displayed, display it by clicking the *Toggle Dynamic Settings Dialog* button at the bottom right of the template display window.



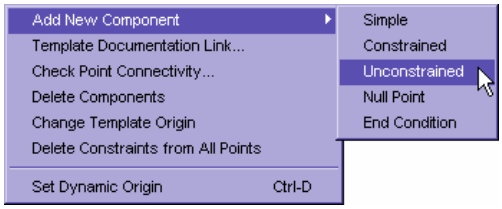
Template Window Toolbar

11. Key in **0.0000** in the *Y Step* field, and **undercut** in the *Point Name* field. Set the key-in type to **xy=** on the *Dynamic Settings* dialog.



Dynamic Settings for the undercut Component

12. Right-click the template display window and select *Add New Component* > *Unconstrained*.



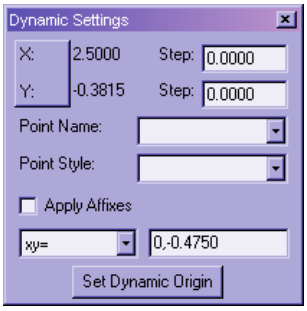
Adding an Unconstrained Component

13. In the *Current Component* area of the *Create Template* dialog, key in **undercut** in the *Name* field and choose **undercut** in the *Style* list.

14. Before placing the first point, right-click in the template display window again and turn on the *Mirror* toggle, if it is not already on.

Mirror On

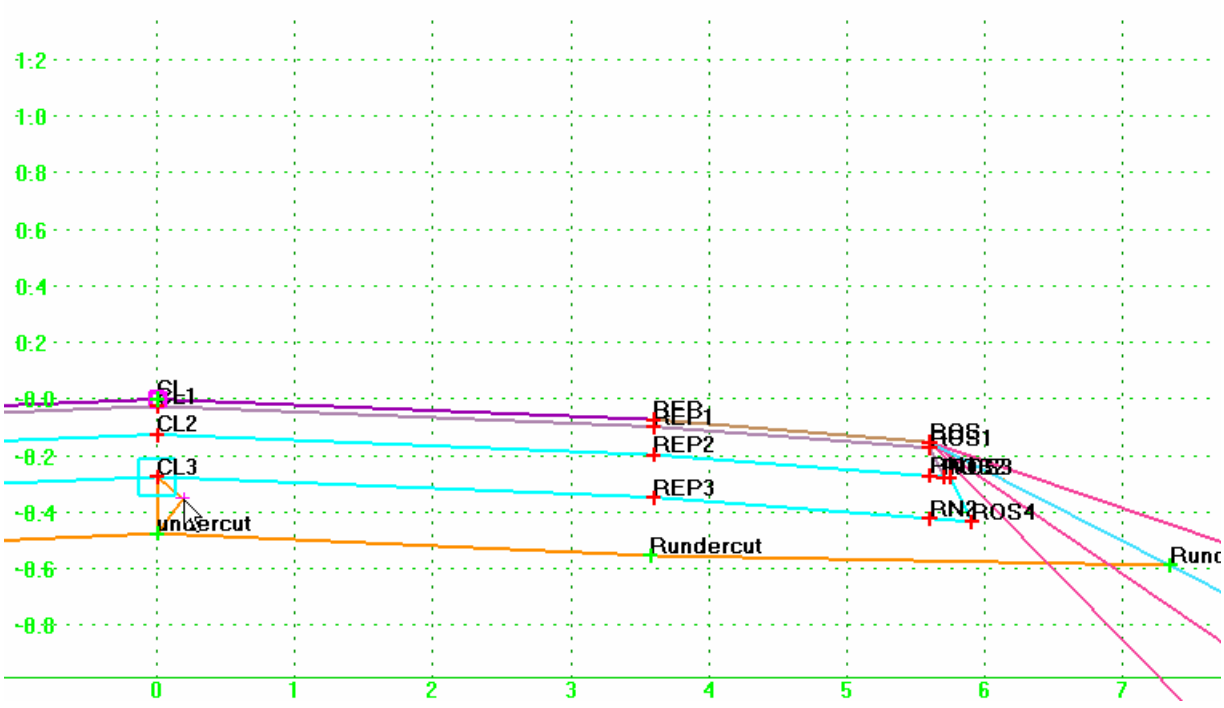
15. On the *Dynamic Settings* dialog, keyin **0,-0.4750** in the value field and select the ENTER key. Your first point will display in the template display window below point **CL3**.



Precision Keyin

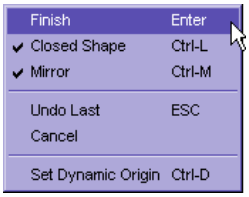
16. Place the next point below **REP3** and then a point at approximately the same slope intersecting with the blue ditch foreslope line. Again, the exact location will be controlled by constraints. Now snap to the other points making up the edge of the shoulder and aggregate layers in the following order: **ROS**, **ROS1**, **ROS2**, **ROS3**, **ROS4**, **REP3** and **CL3**.

Note	Do not snap to the null points named RN1 and RN2. If you did snap to the null points, simply select the *Undo* button from the template window toolbar and begin this exercise again.



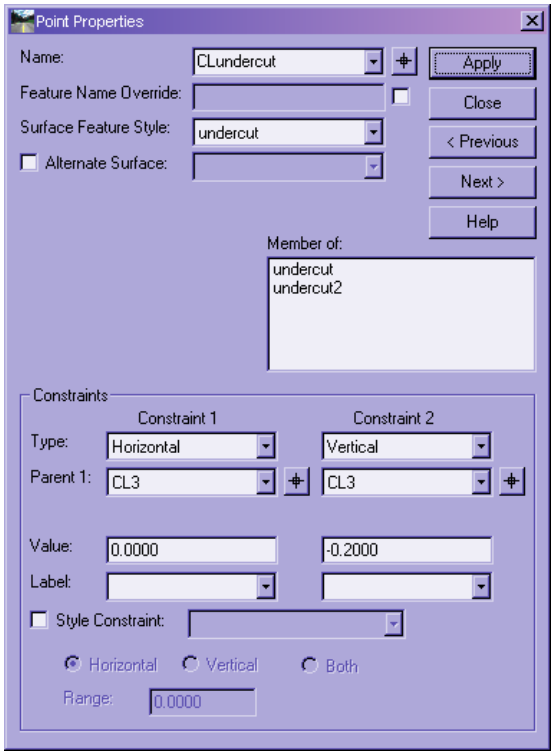
Placing the Undercut Component

17. Now right-click in the display window and select *Finish*.



Finished

18. Right-click and edit the first point you placed as part of the **undercut** component just below **CL3**. Change its *Name* to **CLundercut** and set up the remainder of its properties as shown in the following figure:



Editing CLundercut

Hint	Don't forget to select *Apply* after setting each point's properties.

19. Set the properties for the other four points along the bottom of the **undercut** component as follows, beginning at the far left:

Name:	**Lundercut1**
Constraint 1 Type:	**Vector-Offset**
Parent 1:	**LEP3**
Parent 2:	**LOS4**
Value:	**-0.2000**
Constraint 2 Type:	**Vector-Offset**
Parent 1:	**LOS**
Parent 2:	**Lditch foreslope**
Value:	**0.0000**

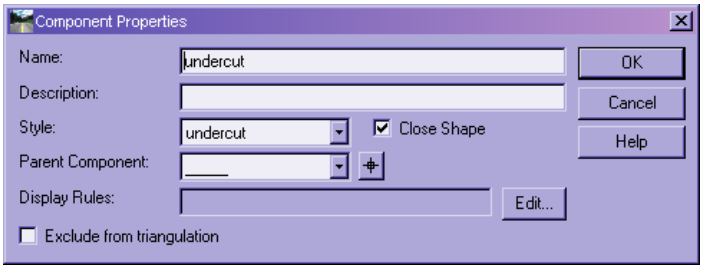
Name:	**Lundercut**
Constraint 1 Type:	**Horizontal**
Parent 1:	**LEP3**
Value:	**0.0000**
Constraint 2 Type:	**Vertical**
Parent 1:	**LEP3**
Value:	**-0.2000**

Name:	**Rundercut**
Constraint 1 Type:	**Horizontal**
Parent 1:	**REP3**
Value:	**0.0000**
Constraint 2 Type:	**Vertical**
Parent 1:	**REP3**
Value:	**-0.2000**

Name:	**Rundercut1**
Constraint 1 Type:	**Vector-Offset**
Parent 1:	**REP3**
Parent 2:	**ROS4**
Value:	**0.2000**
Constraint 2 Type:	**Vector-Offset**
Parent 1:	**ROS**
Parent 2:	**Rditch foreslope**
Value:	**0.0000**

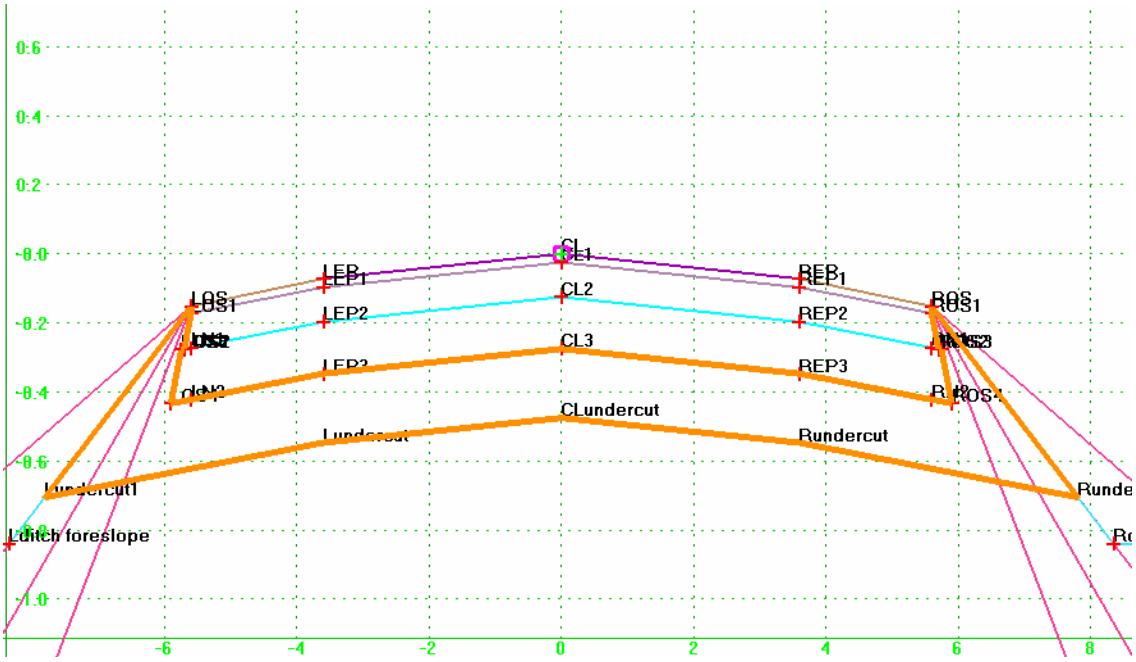
20. When you have finished modifying the points, right-click the orange line between **CL3** and **CLundercut** and select *Merge Components*.

21. Double-click the orange component and change its *Name* back to **undercut**.



Edit Component Properties for undercut

22. Select the *Active Template* tab at the bottom of the treeview. Expand the *Components* folder and select the **undercut** component. Your finished component should look like the figure below. *Save* your template library.



Finished Undercut Component

EXERCISE 5: ADDING DISPLAY RULES

Adding a display rule to one or more components in a template allows you to apply one template that changes based on what is occurring at a particular station. It frees you from knowing where a change in conditions might require a different template and allows the rules within a template to make the modifications for you. In this exercise, you will create display rules that will prevent the **undercut** component from displaying except when any two points along the bottom of the **aggregate base** component are below the **shale** surface.

1. First, *Test* the template to see how it behaves before you apply any display rules. As currently defined, the **undercut** component is displayed no matter how high or deep the driving surface.

2. Double-click the **undercut** component and select *Edit* beside the *Display Rules* field. Select *Add* below the *Template Display Rules* list.

3. Create three rules with the following parameters:

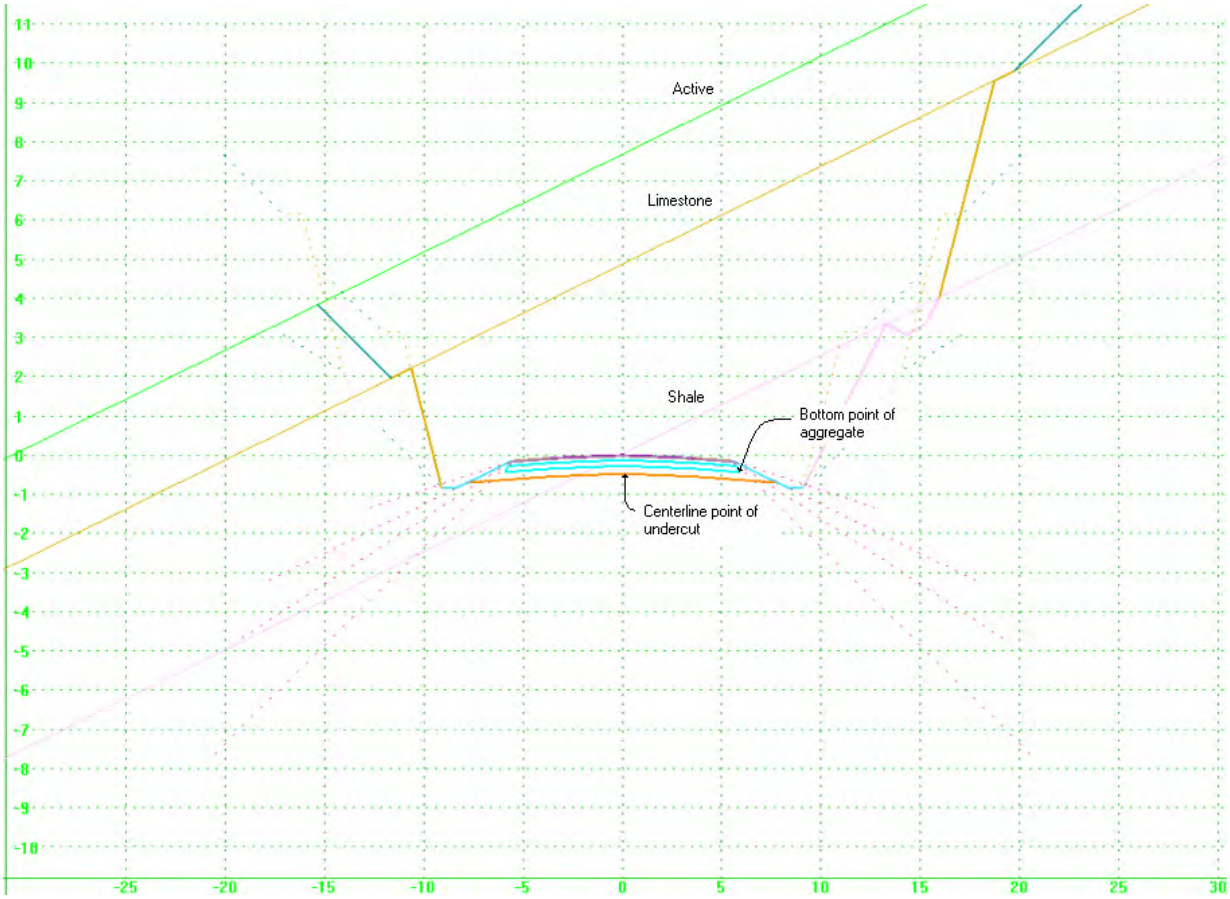
Name:	**Rule1**	**Rule2**	**Rule3**
Type:	**Vertical**	**Vertical**	**Vertical**
Between:	**LOS4**	**ROS4**	**CLundercut**
And:	**Lcontrol**	**Rcontrol**	**CLcontrol**
Condition:	**> 0.0000**	**> 0.0000**	**> 0.0000**

4. In the *Conditional Expression* field type in or use the buttons to add the following expression:

   (NOT Rule1 OR NOT Rule2) AND NOT Rule3

   Since the control points have been constrained to follow the **shale** surface, the conditions you have just created have the effect of limiting the display of the **undercut** component unless the centerline point of the bottom of the **undercut** plus either of the two bottom-most points of the **aggregate base** component is below the **shale** surface. This prevents undercut conditions unless at least half of the roadway is affected.

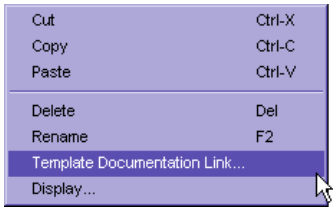
5. Select *OK* on both dialogs and *Test* your template. Enter a value of **25%** in the *Use Surface Slope* field. *Draw* the **active** surface, then the **limestone** surface, then the **shale** surface. Slide the **shale** surface up and down. Notice that the **undercut** component does not appear until display rules created above are satisfied.



Testing the Display Rules

6. Close the *Test* dialog and save your template library.

7. On the *Create Template* dialog, make sure your active tab at the bottom of the treeview is set to *Library*, right-click the **2 Lane Rural w\Subsurface** template in the treeview and select *Template Documentation Link*.



Template Documentation Link

8. On the *Template Documentation Link* dialog, select the *Browse* button beside the *File Name* field. Navigate to the workshop directory and select the file named *2LaneRuralWSubsurface.chm*.

Adding a Documentation Link

9. Select the *Open Link* button and view the documentation created for this template.

Note	This file was created by modifying the HTML output from the style sheet named *TemplateComponentDetails.xsl* in the *\XML Data\TemplateLibrary* directory.

10. *Save* your template library again. This link is now saved with your library and will be available to anyone using the library.

LESSON 3: RUNNING ROADWAY DESIGNER

LESSON OBJECTIVE:

This lesson will guide you through the steps required to use your modified template in the *Roadway Designer*.

EXERCISE 6: SYNCHRONIZING THE TEMPLATE DROPS

In this lesson, you will synchronize your roadway design file with your template library.

1. From the *InRoads Explorer*, select *Modeler* > *Roadway Designer*. Spend a minute getting familiar with your design. Select the first button on the toolbar – *Manage Corridors*. You will notice that your *Corridor* named **CL-278** has already been created. Close the *Manage Corridors* dialog.

Manage Corridors Button

2. Select the second button on the toolbar – *Template Drops*. Notice that template drops have also already been specified but several of them are red. This is because they no longer match what is stored in the template library due to the changes you made in the last lesson.

Template Drops Button

3. Highlight each of the red entries in the *Current Template Drops* list and select *Synchronize with Library*. Close the *Template Drops* dialog.

Hint	You can change multiple entries at once by using the CTRL key to select multiple entries in the list.

4. On the *Roadway Designer* dialog, select *Process All*. Take a few minutes to navigate through the various stations and review your design.

   At Station 5+930, the template first dips below **limestone**, and you can see the result of the **limestone** end condition. At Station 5+970, the template first dips below **shale**, and you can see the result of the **shale** end condition. Notice, however, that neither the right bottom **aggregate base** point nor the center **undercut** point is below the **shale**, so the **undercut** component is not displayed. At station 5+980, the right bottom **aggregate base** point is below the **shale**, but the center **undercut** point still is not. By the time you reach 5+990, though, both the right **aggregate base** point and the center **undercut** point have fallen below the **shale** surface, so you now see your **undercut** component.

5. *Save* your Roadway Design file.

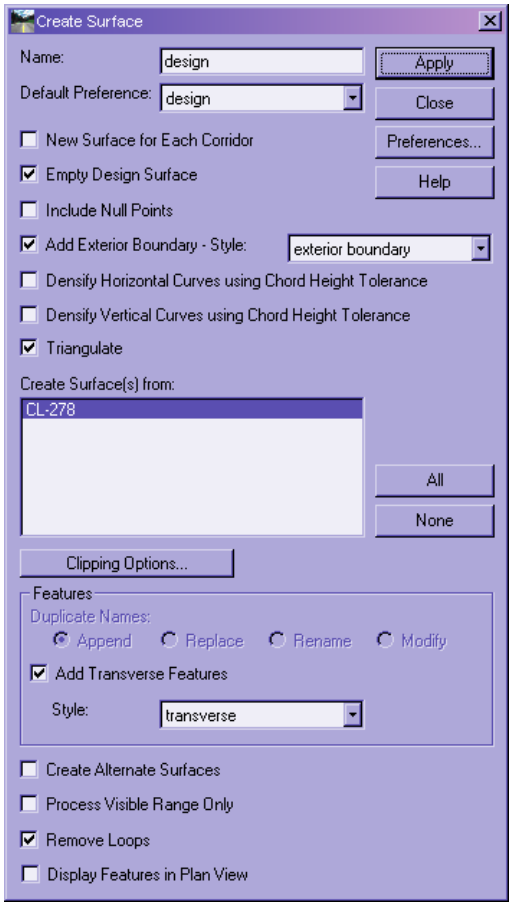
EXERCISE 7: CREATING THE DESIGN SURFACE

In this lesson, you will create the **design** surface and modify its properties before saving it.

1. On the *Roadway Designer* dialog, select the second to last button on the toolbar – *Create Surfaces*.

Create Surfaces Button

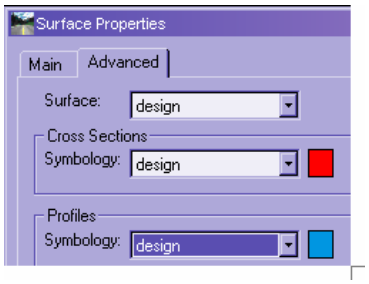
2. Setup the surface parameters to match the following figure and select *Apply*.



Create Surface Dialog

3. Close the *Create Surface* dialog and the *Roadway Designer* dialog. Be sure to save your roadway design, if prompted.

4. From the *InRoads Explorer* menu, select *Surface* > *Surface Properties*. In the *Surface* field, select **design**. On the *Advanced* tab, set the *Symbology* fields for both *Cross Sections* and *Profiles* to **design**. Select *Apply* to save the changes and *Close* the dialog.



Design Surface Properties

5. Select *File* > *Save* > *Surface* and save the surface as **design.dtm**.

LESSON 4: EVALUATING THE DESIGN

LESSON OBJECTIVE:

One of the methods an engineer typically uses to evaluate the success of his design is to produce and review cross sections along the alignment. In addition, he calculates the volumes of earthwork involved. This lesson will guide you through this process using InRoads commands.

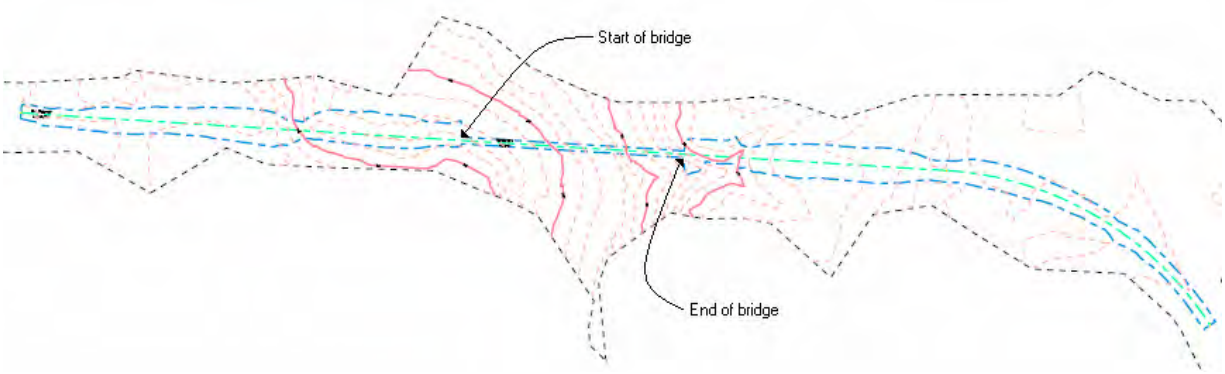
EXERCISE 8: CREATING TOPSOIL STRIPPING FEATURES

In this exercise you will create features to represent the areas to be stripped of topsoil for your project.

1. If **design** is not your active surface, make it active by selecting *Surface* > *Active Surface*.

2. Select *Surface* > *Feature* > *Feature Selection Filter* and set the *Filter Name* to **exterior only**. Select the *OK* button.

3. Select *Surface* > *View Surface* > *Features* and select *Apply*. The **exterior boundary** from the **design** surface is displayed in yellow in your design file (but displayed in blue in the image below for visibility).

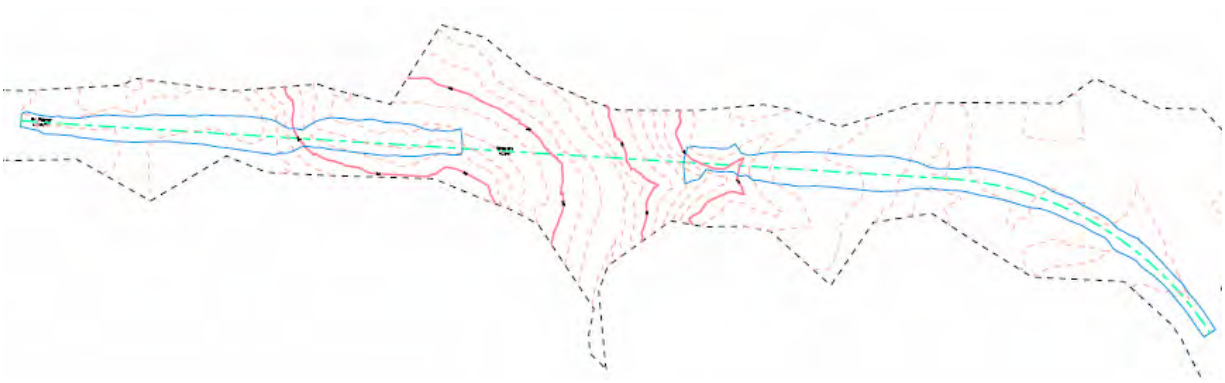


Exterior Boundary from Design Surface

4. Window in to the area near the beginning of the bridge.

Hint	If you haven't already turned off the display of the reference file, you may wish to do so now. You may also wish to temporarily turn off the display of the stationing level.

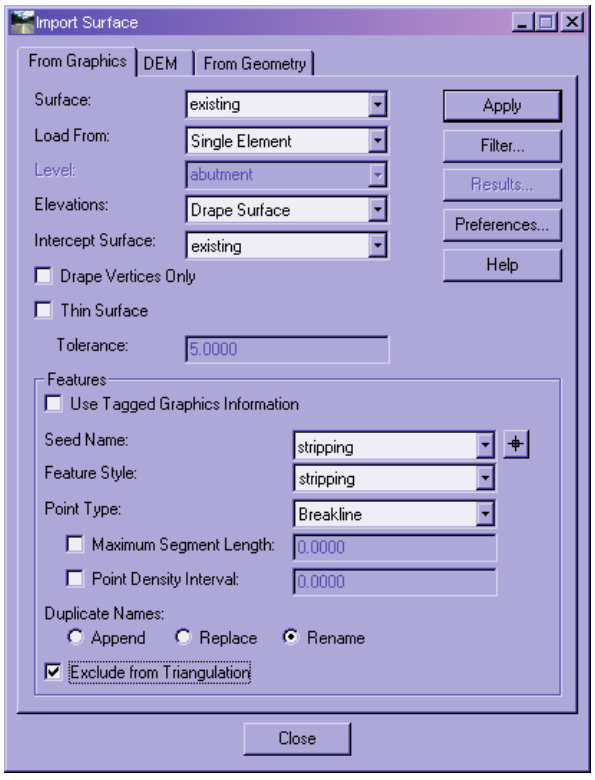
5. Use MicroStation commands to delete the narrow bridge portions near the center of the boundary, place lines across the openings of the two shapes and create closed shapes from them like the following figure.



Closed Shapes Representing Stripping Areas

Hint	The MicroStation commands most likely to be useful here are: *Partial Delete* from the *Tools* > *Main* > *Modify* toolbox, *Place Line* from the *Tools* > *Main* > *Linear Elements* toolbox and *Create Complex Shape Automatic* from the *Tools* > *Main* > *Groups* toolbox. Be sure to click to accept the closed shape. The shape should change to the active color and linestyle if it is closed. Also, be sure to turn off *Graphic Group* lock when deleting the unneeded portion of the exterior boundary.

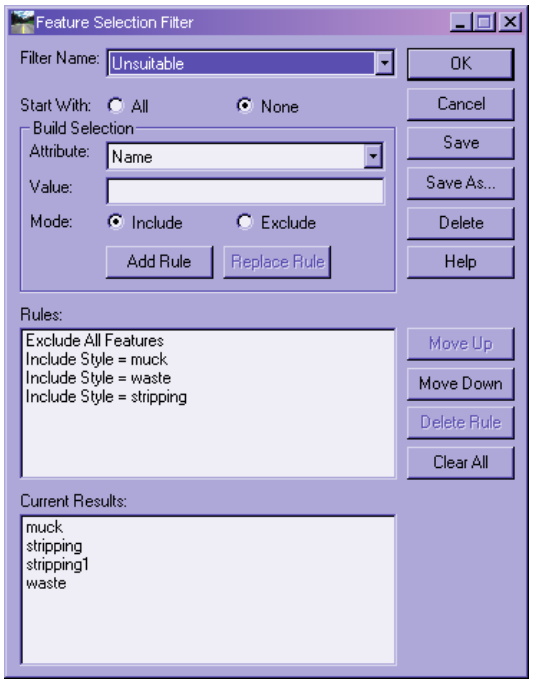
6. Select *File* > *Import Surface* > *From Graphics* and setup the parameters according to the following figure:



Import Surface from Graphics

7. Select *Apply* and select the first shape, then repeat for the second shape. Delete the two shapes from graphics and restore the display of the **stationing** level, if it is off. Also, turn the *Graphic Group* lock back on.

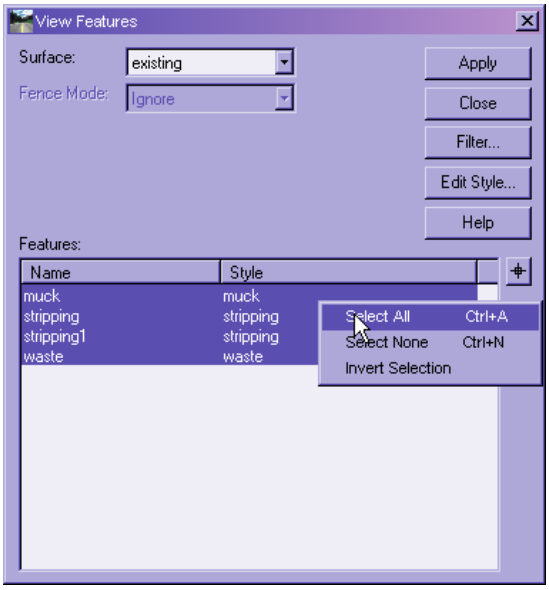
8. Select *Surface* > *Feature* > *Feature Selection Filter* and set the *Filter Name* to **Unsuitable**.



Feature Selection Filter for Unsuitable

Notice that this filter includes only features whose *Styles* are **muck**, **waste** or **stripping**.

9. Select *Surface* > *View Surface* > *Features*. Right-click in the list, choose *Select All* and then select *Apply*. There are four features that meet the unsuitable criteria – the two dark green **stripping** features you just created, a brown **muck** feature near the final curve and a purple **waste** feature representing asphalt to be removed near the start of the relocation.



10. Select *File* > *Save* > *Surface* and save the **existing** surface.

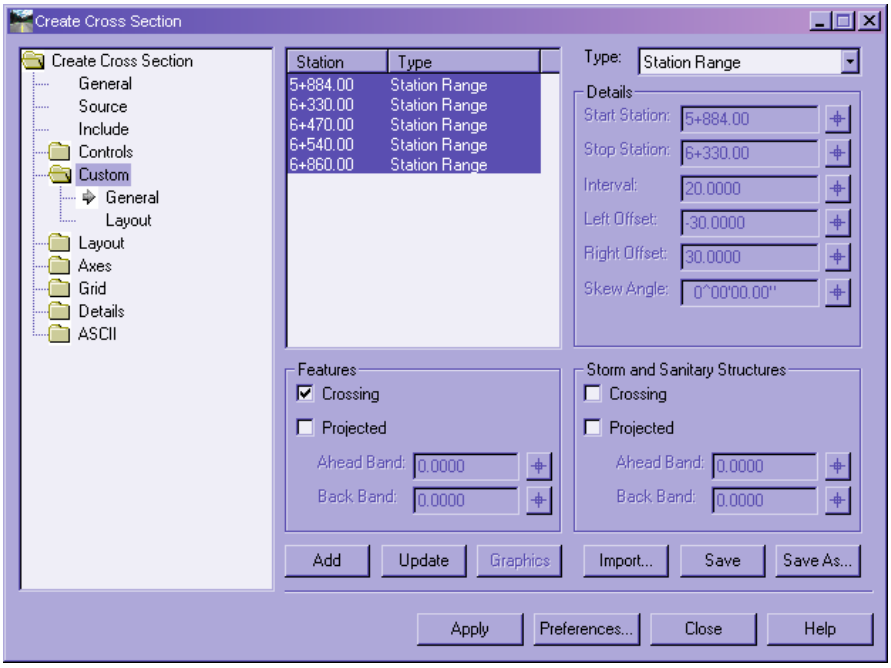
EXERCISE 9: CREATING CROSS SECTIONS

In this exercise, you will create cross sections along your proposed realignment.

1. Select *Evaluation* > *Cross Section* > *Create Cross Section*. Verify that all four surfaces are selected on the *General* leaf.

2. On the *Controls* > *Critical Sections* leaf, verify that the *Horizontal Event Points* option is selected.

3. On the *Custom* leaf, select the *Import* button and open the *volumes.xsc* file. Highlight all five entries in the *Station* list and toggle the *Crossing* option on in the *Features* group. Select the *Update* button and then the *Save* button to save your changes.



Custom Cross Sections

4. Select *Apply* and place the cross sections above your plan graphics. *Close* the dialog.

5. Select *Evaluation* > *Cross Section* > *Cross Section Viewer* to view some of the cross sections.

   On Stations 5+884 through 5+960, you will see purple diamonds representing the edges of the **waste** asphalt to be removed. You will also see green Xs representing the edges of the **stripping** feature you created on all stations. On Stations 7+240 and 7+260, you will see a brown symbol representing the edge of **muck** to be removed.

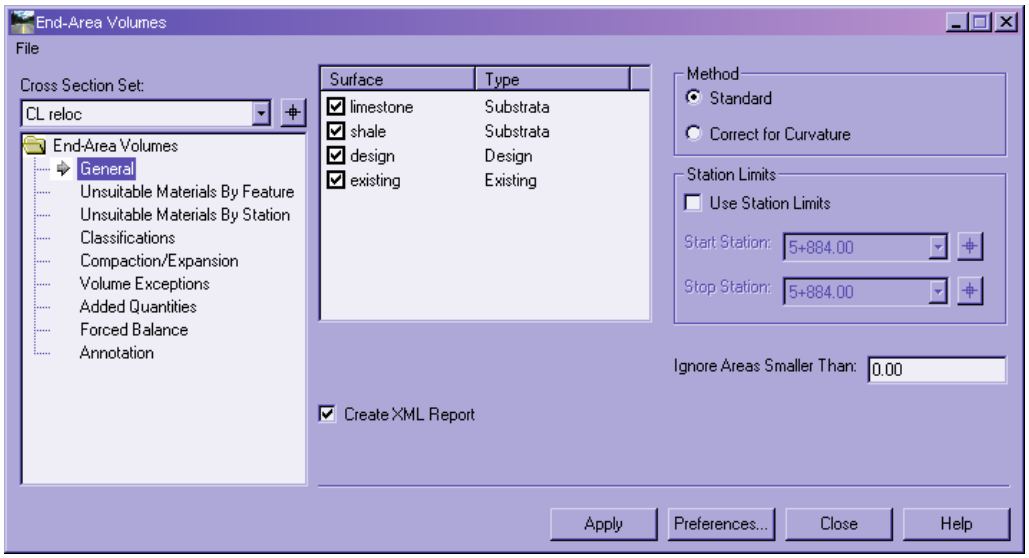
Hint	If you do not see feature points for the stripping, waste and muck features, make sure your *Feature Selection Filter* is still set to Unsuitable and select *Evaluation* > *Cross Section* > *Update Cross Section*. Set the *Mode* to *Display On*, and on the *Crossing Features* leaf, highlight the *Surface* existing and any features in the *Feature* list. Select *Apply*. You may also need to set the *Mode* to *Refresh*, highlight the *Surface* existing and any features in the *Feature* list, and select *Apply* once more.

EXERCISE 10: END-AREA VOLUMES SETUP

The End-Area Volumes command has been redesigned beginning with V8.7, but all the options with which you are familiar can still be found, along with some new ones.

In this exercise, you will begin to setup some of the parameters for end-area volumes.

1. From the *InRoads Explorer*, select the *Evaluation* > *Volumes* > *End-Area Volumes* command.



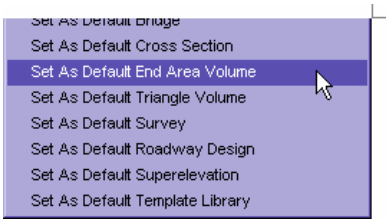
End-Area Volumes – General Leaf

The default behavior is to include in the volume computations all the surfaces displayed on the cross section set, which are listed in the surfaces list, but you can exclude them from computations at this time, if you wish. You can also limit the volume computations by *Station Limits*. The *Method* and the *Ignore Areas Smaller Than* options are the same as in versions prior to V8.7.

For this workshop, we want to include all four surfaces, so make sure they are all selected. Also make sure the *Create XML Report* option is selected.

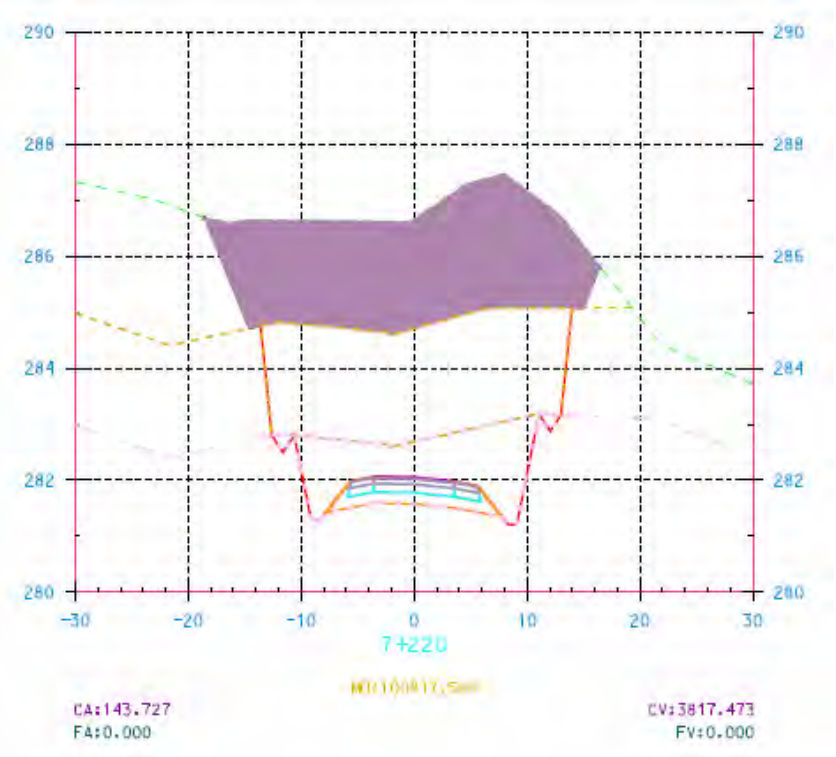
2. Select *Apply* to see what your volumes are before any refinements are made. Page down to the bottom of the report and you should see a net volume of about 129,000 m^3.

Hint	If you receive a warning from the *Report Browser* about setting a Style Sheet Default, select Yes on the warning box. Once the *Report Browser* is displayed, navigate to the *Evaluation* folder, right-click *MultipleMaterialVolumes.xsl* and select *Set As Default End Area Volume*.



Setting a Default Style Sheet

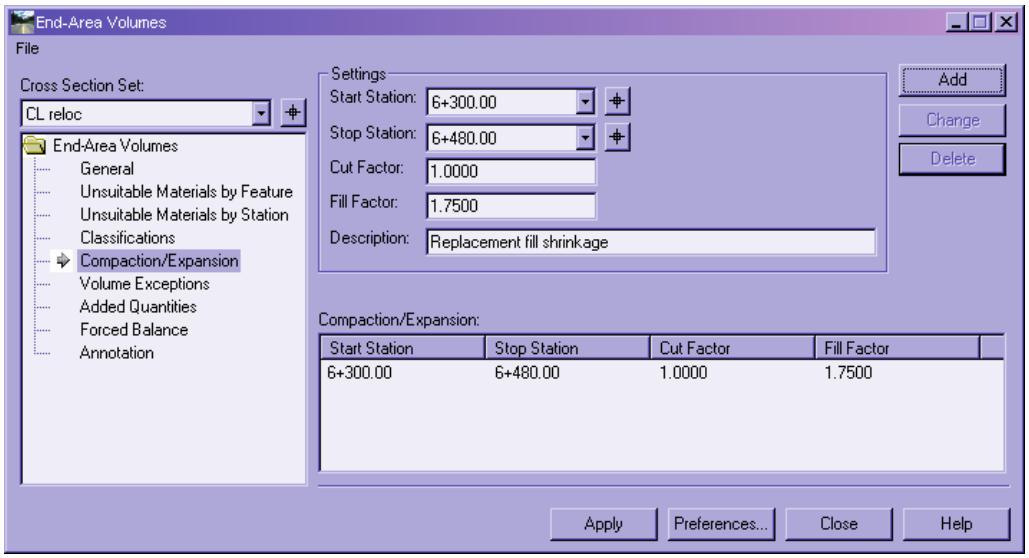
3. Use the *Cross Section Viewer* to review the volume annotation displayed on your cross sections.



Volume Annotation on Cross Section

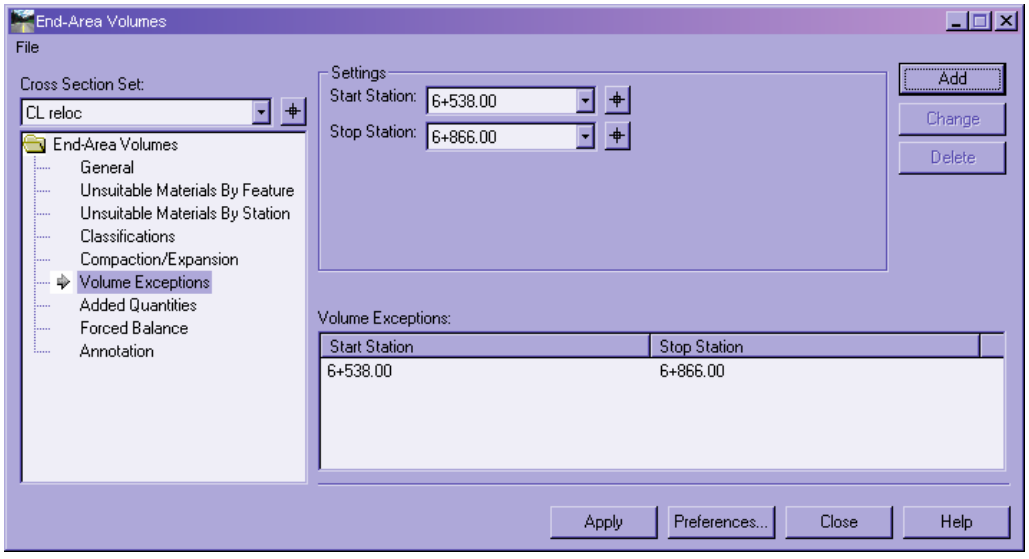
The cyan-colored areas are "normal fill" and the mauve-colored areas are "normal cut." Everything else is a specific volume. For example, areas below the limestone and shale surfaces are calculated as discreet volumes of limestone and shale, respectively, as are the components making up the template.

4. Return to the *End-Area Volumes* dialog and skip down to the *Compaction/Expansion* leaf. The options on this leaf are very similar to those in previous versions. Add a special compaction/expansion factor for the station range between a *Start Station* of **6+300** and a *Stop Station* of **6+480** to account for shrinkage of the replacement fill in the depression. Set the *Fill Factor* to **1.7500**. Select the *Add* button.



Compaction/Expansion Factors by Station Range

5. Select the *Volume Exceptions* leaf. Again, this leaf is very similar to previous versions. Since you have a bridge crossing a creek in your design, you will create a volume exception across that station range. This means that no volumes at all will be calculated across the specified range. Set the *Start Station* to **6+538** and the *Stop Station* to **6+866** and select the *Add* button.

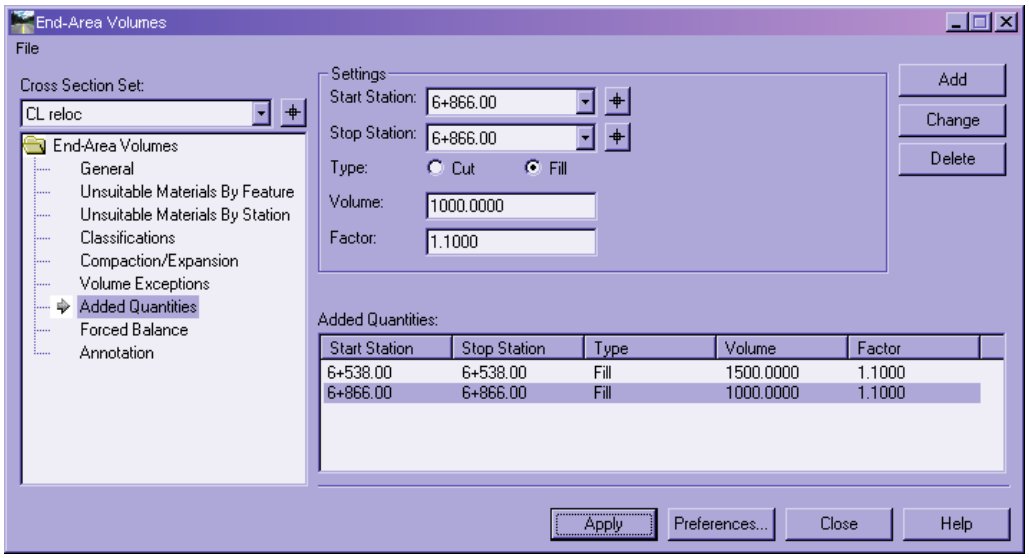


Volume Exceptions

Note	The only stations that will display in the station lists are those at the same locations where you created a cross section. This means you must create a cross section

wherever you expect to calculate special volumes. You can see a number of ways this can be accomplished on the *Evaluation* > *Cross Section* > *Create Cross Section* > *Controls* > *Critical Sections* leaf, such as creating cross sections at cardinal points, event points, key stations from *Roadway Designer*, etc. In this case, your design includes *Event Points* at the beginning and end of the bridge.

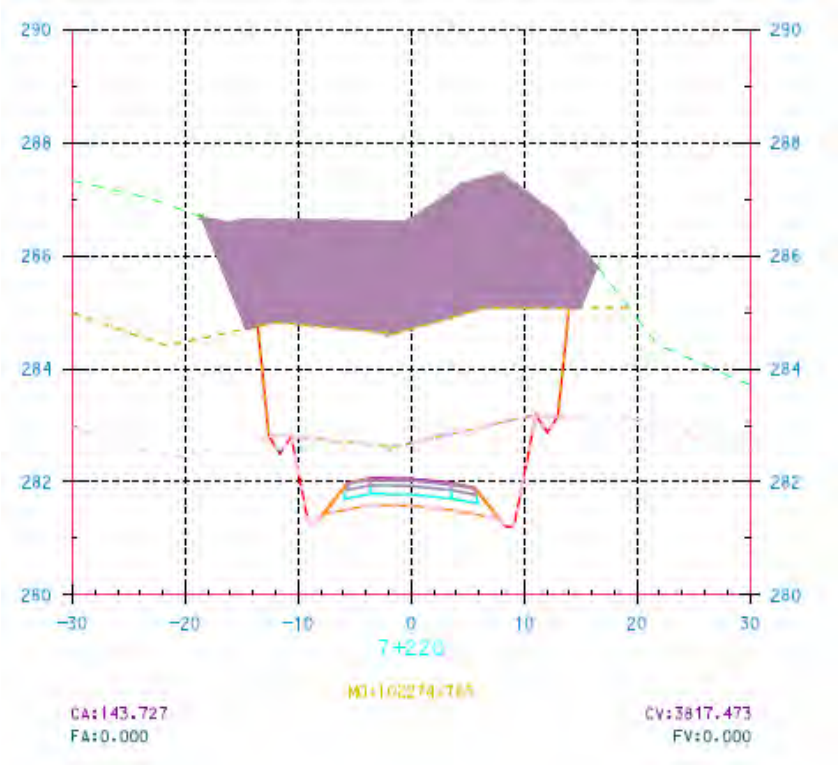
6. On the *Added Quantities* leaf, add *Fill* quantities of **1500.0000** at the bridge abutment *Start Station* **6+538** and **1000.0000** and the bridge abutment *Stop Station* **6+866**, both with *Factors* of **1.1000**. Select the *Add* button after each entry.



Added Quantities

Hint	If you make a mistake, you can highlight the incorrect entry in the *Added Quantities* list, change the values, and then select the *Change* button.

7. Select *Apply* again and view the results of your modifications. Note the adjusted fill beginning at Station 6+300. Page down and notice that no volumes at all are calculated between Stations 6+538 and 6+866, except for the two added quantities you included. You should now see a net volume of about 130,000 m^3, an increase of about 1000 m^3, mostly due to excluding the fill through the bridge.



Volume Annotation after Modifications

8. Because generating end-area volumes generally involves project-specific parameters, you store the data in an EAV file rather than in the XIN file. On the *End-Area Volumes* dialog, select *File* > *Save* and save your end-area volumes parameters as *volumes.eav*.

9. Use the *Cross Section Viewer* to view the cross sections and volumes at some of the locations where you have modified the end-area volume parameters.

EXERCISE 11: UNSUITABLE MATERIALS AND CLASSIFICATIONS

InRoads now offers two ways to specify unsuitable materials – by *Feature* and by *Station* range. The important concept to remember with both is that the volumes resulting from these methods are simple volumes calculated by dropping vertically down a specified depth below the existing surface across the width of the feature or between catch points for the *Station* method.

For the *Station* method, you can also specify a *Fill Depth*, in which case, a vertical height is calculated. You can specify a different *Cut Depth* and *Fill Depth* for each station range you create.

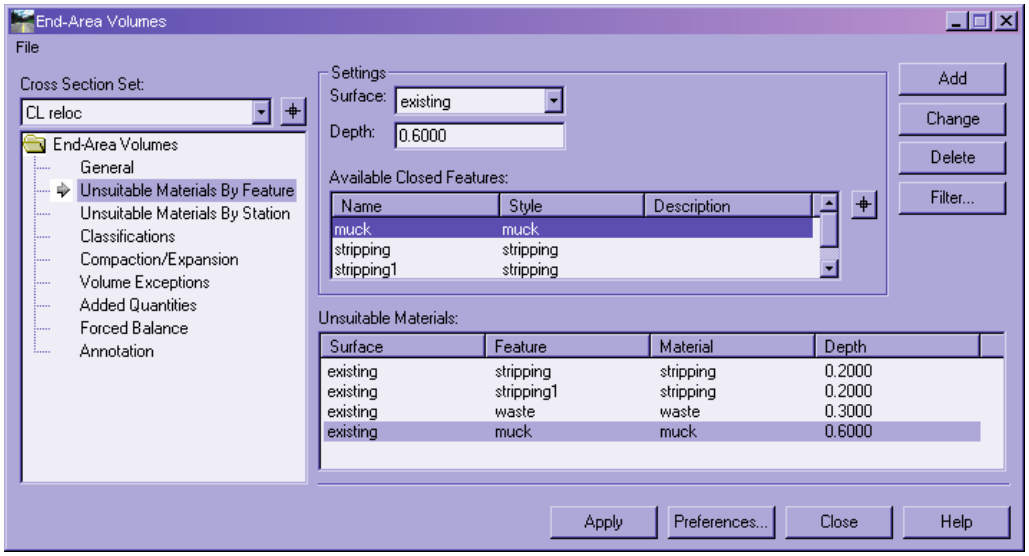
For both methods, the style of the selected features will be reported as a *material*.

In this lesson, you will learn how to specify unsuitable materials using the *Feature* method and you will learn about the various classifications used by InRoads.

1. Select the *Unsuitable Materials by Feature* leaf. The first thing you will notice is that the feature list is labeled *Available Closed Features*. This means that any feature you intend to use as an unsuitable feature must be closed.

Hint	If your *Feature Selection Filter* is still set to Unsuitable, you will see only four features. If your filter is not currently on, you may want to set it to Unsuitable again to limit the features displayed.

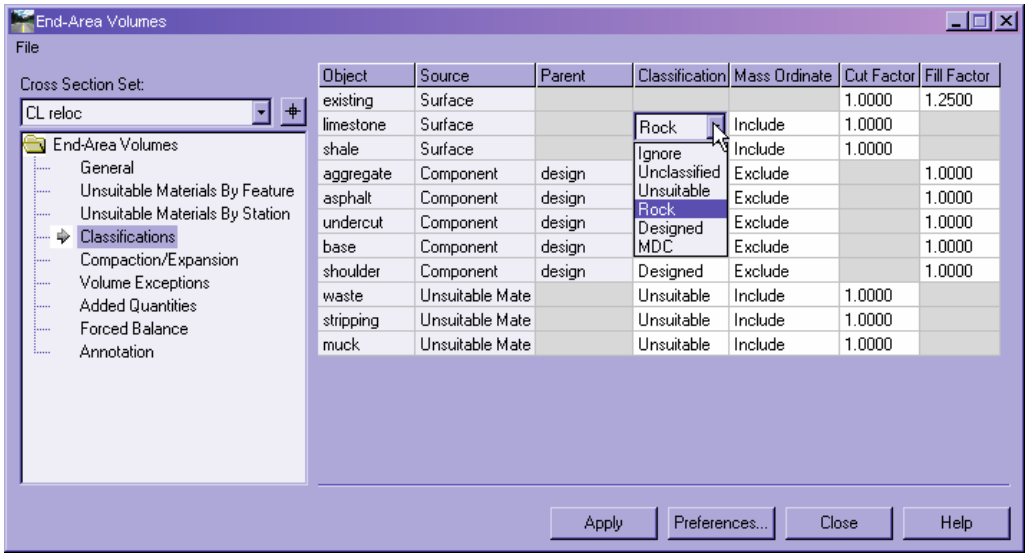
2. Set the *Surface* field to the surface containing the unsuitable materials. In your case, the features are in the **existing** surface, but they could be in a different surface or even in several surfaces. However, the depth will always be calculated to whichever surface whose *Surface > Surface Properties > Type* is designated as *Existing*. Set the depths for your unsuitable materials as follows:



Adding Unsuitable Materials

Hint	If the two stripping features are not listed, it probably means they were not completely closed when you created them. To quickly fix this, select *Surface > Feature > Feature Properties* and highlight the two stripping features. Change the *Feature Type* to Interior and select *Apply*. Then change the *Feature Type* back to Breakline and select *Apply* again.

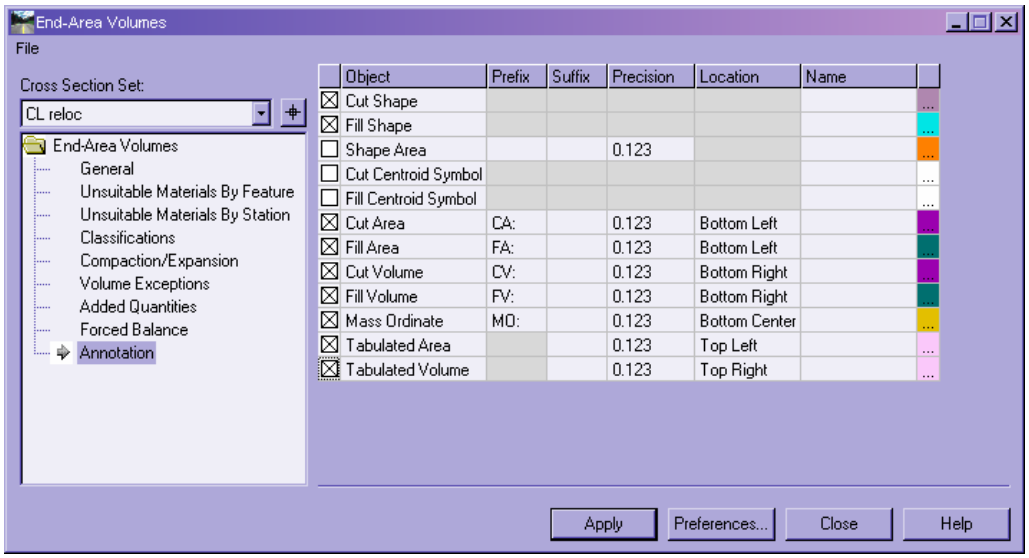
3. Select the *Classifications* leaf and review the parameters that have automatically been created for what you have done so far. Note the choices available to you under the *Classification* heading. *Ignore* means the surface, material or component will not be calculated at all. *Unclassified* is for normal cut and fill, and *Unsuitable* is automatically set for any material specified by the two *Unsuitable Materials* methods. Surfaces whose *Type* is set to *Substratum* are automatically designated as *Rock*, but you could change it here, if you wish. Components contained in a surface whose *Type* is set to *Design* are automatically designated as *Designed* here. The last option, *MDC*, is a very specialized calculation and will not be covered in this workshop.



Classifications

4. Notice also that all objects, except the surface designated as *Existing*, can be *Included* or *Excluded* from the *Mass Ordinate*. This gives you even more flexibility in how your volumes are calculated and reported. Set the *Mass Ordinate* option to **Include** for the **undercut** component and set the *Fill Factor* for the **existing** surface to **1.2500**.

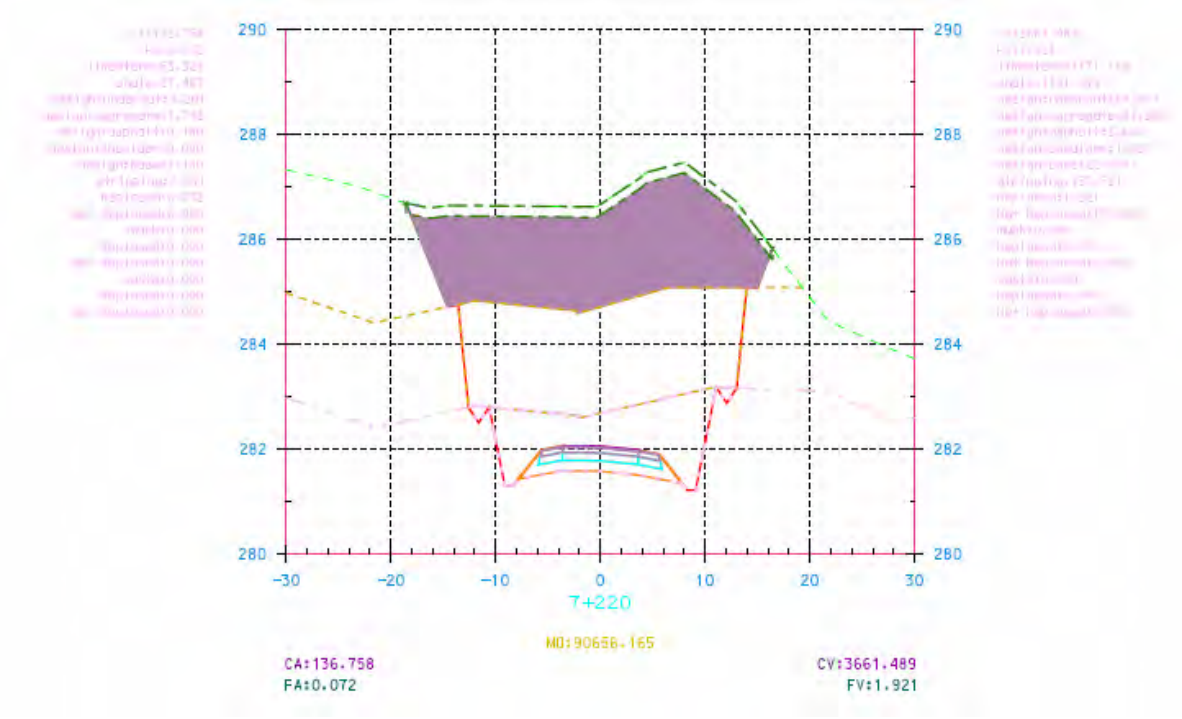
5. Select the *Annotation* leaf and toggle on the *Tabulated Area* and *Tabulated Volume* options.



Including Tabulated Area and Volume Annotation

6. *Save* your EAV file and select *Apply* once again to see the final volumes for your design. You will notice that your report now contains several additional columns of data for the additional materials you have specified. Your final net volume should be about 112,000 m^3.

7. Use the *Cross Section Viewer* to view some of your cross sections. Notice the new areas for the **stripping**, **muck** and **waste** unsuitable features. These areas are now no longer part of "normal cut" and "normal fill," but are calculated and reported as discreet areas and volumes. You can also the *Tabulated Area* and *Tabulated Volume* displayed at each cross section for each object in your end-area volumes set.



Final Volume Annotation

EXERCISE 12: MORE REPORTS AND MASS-HAUL DIAGRAM

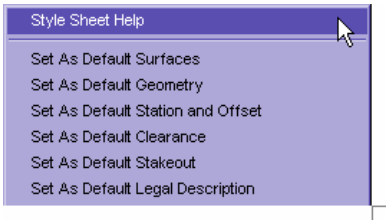
In this lesson, you will view more of the volume reports delivered with the software. You will also save your data to an XML file from which you will produce a mass-haul diagram.

1. In the *Report Browser*, select *MultipleMaterialVolumes.xsl*, if it is not already selected. Select *File > Save As* and save the file as *MultipleMaterials.htm*. You can double-click the file to open it in your web browser, if you like.

2. Up until now, you have focused on the **Multiple Material Volumes** report. This report lists normal and adjusted cut and fill, plus adjusted added volumes and adjusted values for other objects. However, if you want to see every volume contained in your dataset and how it has been applied to the mass ordinate, a good report to use is the one called *Volumes.xsl*.

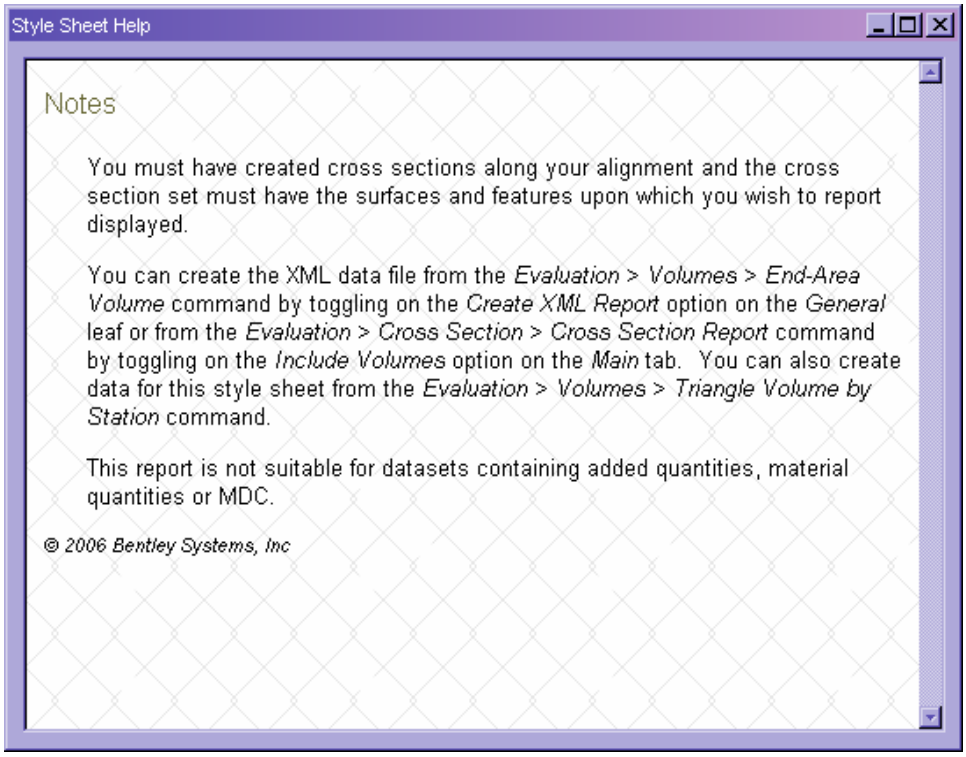
3. Next, select *VolumesToCSV.xsl*. This style sheet outputs the XML data to a CSV file suitable for importing into a database or spreadsheet program such as Microsoft® Office Excel. Select *File > Save As* and save the file as *VolumeCSV.txt*. Notice how the *Report Browser* automatically knows when to save the report as an HTML file and when to save it as plain text.

4. A number of reports are not suitable for complex datasets containing added quantities or multiple materials. If you are not seeing the numbers you expect to see, try right-clicking the style sheet and select *Style Sheet Help*. This small Help file will give you information specific to the style sheet you are using at the moment.



Style Sheet Help

5. Right-click *BasicVolume.xsl* and select *Style Sheet Help*. The following window will display:



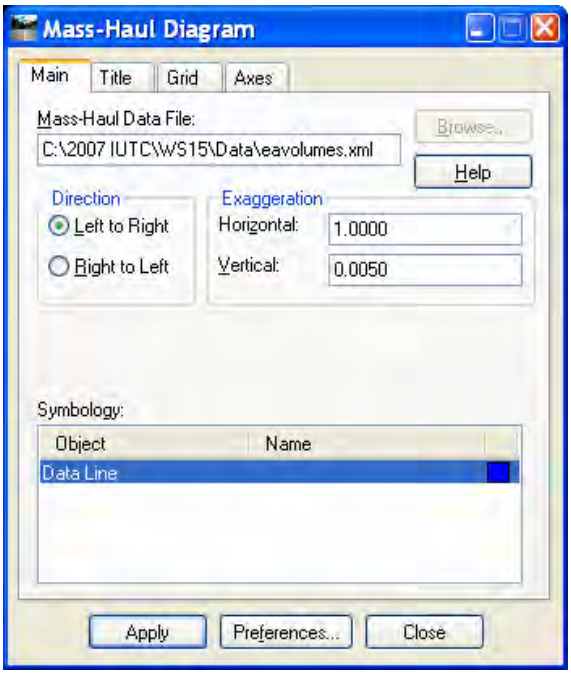
Style Sheet Help for BasicVolume.xsl

6. Many of the cross section reports found in the *Evaluation* folder can also be viewed because the cross section XML data file and the end-area volumes XML data file use the exact same schema, or storage structure.

7. Spend a few minutes viewing various reports in the *Evaluation* folder.

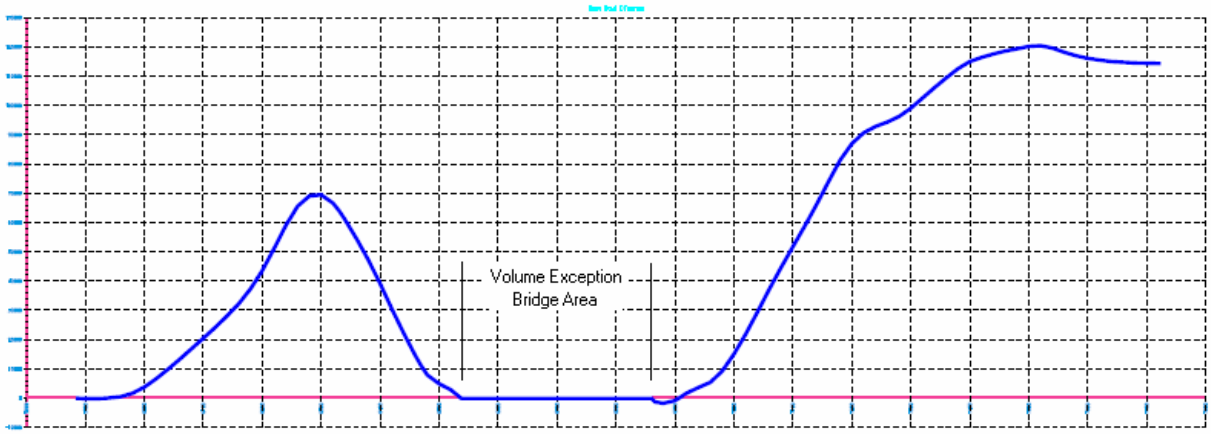
8. Scroll to the bottom of the style sheet treeview and select *raw-xml.xsl*. This style sheet always displays the actual XML data produced by the InRoads software. Select *File > Save As* and save the file as *EAVolumes.xml*. Once again, the *Report Browser* knows to save the report as an XML file because of the style sheet you are using to display the data.

9. Return to InRoads and select *Evaluation* > *Volumes* > *Mass-Haul Diagram*. Place your cursor in the *Mass-Haul Data File* field and select the *Browse* button to open *EAVolumes.xml*.



Mass-Haul Diagram Dialog

10. Select *Apply* and place the mass-haul diagram in your design file.



Mass-Haul Diagram

As you can see, this project has a surplus of material along most of its length. You can also clearly see the station range where you applied your volume exception for the bridge.

SUMMARY

This workshop covered a number of intermediate concepts relating to the End-Area Volumes command in the InRoads Group of products. The following commands and concepts were covered:

- Working with multiple subsurface layers in profile view and in the template library
- Creating an undercut component on a template
  - Creating null points for control of the undercut component
  - Creating display rules
- Adding a documentation link to a template
- Running Roadway Designer
  - Synchronizing template drops
  - Creating the design surface
- Evaluating the design
  - Creating topsoil stripping features
  - Creating cross sections
  - Running the End-Area Volumes command
    - Adding Compaction/Expansion factors by station range
    - Adding a Volume Exception and Added Quantities by station range
    - Specifying Unsuitable Materials by feature
    - Reviewing Classifications
  - Reviewing and saving volume reports
  - Creating a mass-haul diagram