MINISTRY OF TRANSPORTATION

InRoads Typical Example 2:

Reconstruction of a Rural Undivided Highway

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1.0 Overview

This typical example illustrates the process for using InRoads in the design of reconstruction and widening a rural undivided highway with granular lift and resurfacing. The project presented in this example is for demonstration only. The example doesn't reflect the whole range of InRoads capabilities and there are different ways for doing things in InRoads. The work flow may need to be modified from project to project to reflect different conditions and requirements.

For easy identification, the directory, folder and file names are in *italics* in this document.

Project Type

Reconstruction and widening of a rural, two lane, undivided highway with granular lift/asphalt padding and resurfacing.

Prerequisites

AutoCAD:

- Basic View Control & Editing Command
- MTO AutoCAD Standards (IESCAD 2009)

InRoads:

User should be familiar with InRoads:

- Working Environment
- Tools
- Surfaces
- Features
- Geometry
- Template
- Roadway Designer
- Reports

It is also recommended that the user be familiar with the following:

- MTO InRoads Project Template
- MTO Customization Documentation
- MTO InRoads Standards and Preferences Manual

Highway Design:

- Design principles
- MTO Design Manuals, Guidelines, and Policies

Software Version

- AutoCAD 2009
- InRoads V8i (SELECTseries 1)

Design Data and InRoads Files

The design data used in this example project is for demonstration only. Actual projects may vary.

The length of this example project is 500m.

Proposed Design

Design Speed	100 km/h
Horizontal Curve	R = 500m
Spiral Parameter	A = 220
Spiral Length	Ls = 96.8m
Vertical Curve K Value	45 Sag 70 Crest
Pavement Width	10+500 to 10+620: 2x3.50m to 4x3.50m
	10+620 to 11+000: 4x3.50m
Shoulder Width	2.50m
Partially Paved Shoulder	0.5m
Shoulder Rounding	0.5m
Cross-fall	2% (Pavement), 6%(Shoulder)
Superelevation	5.7% (Max 6%)
Pavement	Roadway:

New Construction:

40mm Asphalt Top Course
50mm Asphalt Base Course
150mm Granular A
300mm Granular B

Widening (Grade Raise/Resurfacing):

40mm Asphalt Top Course
50mm Asphalt Base Course
150mm Granular A
Excavation depth 600mm

Partially Paved Shoulder:

50mm Asphalt Surface Course

Assumptions

Existing Pavement Depth	90mm Asphalt
Full Depth Pavement Removal	90mm
Partial Depth Pavement Removal	50mm (Maximum)
Excavation depth	600mm

The files listed and described below are provided in the **Example 2** data set *Data2.zip*:

Existing Ground Surface (.dtm)
……*Data2\Surfaces\Ex2_OG.dtm*

Geometry File (.alg)
……\ *Data2\Geometry\Ex2.alg*

AutoCAD Drawings (.dwg)
……\ *Data2\Drawings\Ex2.dwg*
……*Data2\Standards\MTO_InRoads_Template.dwg*

Inroads Template Library (.itl)
……*Data2\Standards\MTO_STD_Templates.itl*

MTO Preference File (.xin)
……\ *Data2\Standards\ MTO_civil.xin*

The following files will be created for the project design:

Projects (.rwk)

Roadway Design (.ird)

Design Surfaces (.dtm)

Reports (XML Data, .xml)

Design Drawings (Plan, Profile, Cross Section, .dwg)

Topics Covered:

- Setting up InRoads Project
- Viewing Surface
- Designing Horizontal Alignment (Horizontal Element Design)
- Creating Existing Ground Profile
- Designing Vertical Alignment
- Defining Typical Section
- Modeling Roadway
- Applying Superelevation
- Creating Design Cross Sections and Surfaces
- Performing Quantity Computations
- Generating Design Drawings
- Producing InRoads Reports

2.0 InRoads Project Setup

Note: All InRoads data files shall be as per the **MTO InRoads Project** directory structure posted on the MTO web site: http://www.xfer.mto.gov.on.ca/PTASapps/index.htm

This directory structure is mandatory for all in-house and service provider design work done with InRoads.

This section describes how to set-up the InRoads project directory and file structure.

2.1 Project Directory Set-up

Getting started

1. For this example, on your C drive create a project folder named *InRoads Projects* and then a folder named *Example2*.

   The folder path should now be: C*:\InRoads Projects\Example2*.

   Note: For all InRoads design work, put in the project *GWP/WP* folder a subfolder called *InRoads* or something similar. This is where the InRoads highway design files should be kept.

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2. Go to the web site:

   http://www.xfer.mto.gov.on.ca/PTASapps/index.htm

   then, scroll down to find a list of InRoads files. Click on the file *InRoads Project Template.exe* and save it to the folder called *InRoads Projects* that you created in step 1. Click **Close**.
3. Install the required directory structure by going to the folder *InRoads Projects* and double clicking on the file *InRoads Project Template.exe* to run the file. Click **Install**. Directories will be automatically set-up in the *InRoads Projects* folder in a new folder called *InRoads Project Template*
4. From the *InRoads Project Template* folder copy the following directories to the *Example2* folder:
   - Corridors
   - Design Notes
   - Documentation
   - Drawings
   - Geometry
   - Reports
   - Standards
   - Surfaces

5. The folder *Example2* will now look like this:

6. Copy Example 2 data set *Data2.zip* to the folder *Example2*. Right click on the compressed file Data2.zip and select **Extract All** from the pop-up menu.

7. Follow the Extraction Wizard. When the target directory appears on the dialog, make sure the path is pointed to the folder *Example2*.

8. When finish, go through each folder to verify that files are installed properly as described under sample data set section in Section 1.
9. Start InRoads V8i (SELECTseries 1) with AutoCAD 2009.

10. Load MTO_InRoads_Template.dwg from the folder ...*Example2\Standards* into AutoCAD.
11. Click AutoCAD's **File > Save As** command to save a working drawing under …*Example2\Drawings*.

Note: MTO_InRoads_Template.dwg file contains proper layers and blocks to be used with MTO InRoads preference file as described in MTO InRoads Preference and Standards Manual.

2.2 Project Defaults

By setting up the project defaults, the user can set the default directory locations for opening/saving files for project design. The InRoads **Project Defaults** command is used to set up default directories for all file types that can be accessed through the File/Open and File/Save As dialog boxes. These include Project (.rwk), Surface (.dtm), Geometry (.alg), Template Library (.itl), and Roadway Design (.ird). All other files, which are opened or saved throughout the program, use the Project Default Directory setting. The project default file directories are stored in the computer's registry.

1. Click to **File > Project Defaults** on the InRoads Main Menu.
2. Click on the **New** button and the New Configuration dialog box will appear.
3. Type in ***Example2*** in the *Name* field, click **OK** to save and close the dialog box.

4. Click in the *Preferences (*.xin)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2\Standards* folder.
5. Select *MTO_civil.xin*, and click **Open**,
6. Click in the *Project Default Directory* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2*, and Click **Open**.
7. Click in the *Report Directory* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2\Reports*, and Click **Open**.

8. Click in the *Projects (*.rwk)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2*, and Click **Open**.
9. Click in the *Surfaces (*.dtm)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2\Surfaces*, and Click **Open**.
10. Click in the *Geometry Projects (*.alg)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2\Geometry*, and Click **Open**.
11. Click in the *Template Libraries (*.itl)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2\Standards*, and Click **Open**.
12. Click in the *Roadway Design (*.ird)* field and click the **Browse** button. The Open dialog will appear. Browse to …*Example2\Corridors*, and Click **Open**.
13. Click the **Apply** button to save the configuration, and then click the **Close** button.

2.3 Project Files

InRoads allows users to create a project file for each project. With project file, the user can quickly load all files needed for a particular project. A project file is composed of a list of files with path names. To create a project file for example 2:

1. Click to **File > Open** on the InRoads Main Menu.
2. Change the *Files of type* to Surfaces (*.dtm) and select *Ex2_OG.dtm.* Click **Open**.

Note: After selecting the file type, the path will change to the folder as defined in the Project Defaults.

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3. Change the *Files of type* to Geometry Projects (*.alg) and select *Ex2.alg*. Click **Open**.
4. Change the *Files of type* to Template Libraries (*.itl) and select *MTO_STD_Templates*. Click **Open** and then **Cancel**.
5. Create Project file (.rwk). Click to **File > Save > Project** on the InRoads Main Menu.
6. On the lower right corner of the Save As dialog box, click the **Options (…)** button. The Project Options dialog box will appear.

7. For Surfaces tab, check **Add** for the Existing surface ***Ex2_OG*** that was loaded in step 2.

Note: Proposed surfaces will be created in the design process. These files will be checked with both **Add** and **Update** options.

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8. For the Geometry Project, XIN Preferences, and Template Library tabs, check **Add** and **Update** on each file listed under the **File Name**.
9. Click **OK** button to close the Project Options dialog box.
10. In the Save As dialog box click in the *File name* field and type in ***Example2***. Click the **Save** to complete creating the project file. Click **Cancel** to close the dialog.

Note: Project files must be maintained and updated through the project design process. After running Roadway Designer and creating proposed surfaces, the surfaces (.dtm) and Roadway Design (.ird) will be added to the .rwk.

3.0 Viewing Existing Conditions

3.1 Original Ground (OG) Surface

Viewing OG surface

InRoads provides users several viewing tools to display the surface data including the perimeter, triangles, contours and features.

1. Turn off the *Style* lock and select *Pencil* mode on the *Locks* toolbar.

Note: If the *Style* lock is on, the dialog box will not appear when you choose one of the View Surface commands.

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2. Select **Surface > View Surface > Perimeter**.

3. Click on the **Preferences** button. Make sure the preference **MTO** is selected. Close the Preference dialog.
4. Select the *Surface* ***Ex2_OG*** from the drop-down list.
5. Click on the **Apply** button and the perimeter is drawn in AutoCAD. Go to AutoCAD and zoom to the result.

6. Click **Close**.
7. Select **Surface > View Surface > Triangles.**

8. Click on the **Preferences** button. Make sure the preference **MTO** is selected. Close the Preference dialog.
9. Select the *Surface* ***Ex2_OG*** from the drop-down list.
10. Click on the **Apply** button and the triangles are drawn in AutoCAD.

11. Click **Close**.
12. Delete the perimeter and triangles with AutoCAD delete command.
13. Select **Surface > View Surface > Contours.**

14. Click on the **Preferences** button. Select and load the preference **MTO_SP.** Close the Preference dialog.
15. Select the *Surface* ***Ex2_OG*** from the drop-down list.
16. Click on the **Apply** button and the contours are drawn in AutoCAD.

17. Click **Close**.
18. Delete the contours with AutoCAD delete command.
19. Select **Surface > View Surface > Features.**

20. Select the *Surface* from the drop-down list.
21. Select ***EP/ES*** feature from the *Features* list.
22. Click **Apply** then **Close**.
23. Selected EP/ES features are drawn with given styles in AutoCAD.

3.2 View OG Surface in Cross Sections

The original ground surface can be viewed in cross sections along the given alignment (*Ex2.alg*).

1. Make sure the geometry project *Ex2.alg* is loaded and is the active geometry project.
2. Select **Evaluation > Cross Section > Cross Sections**.
3. Click **Preferences** button.

4. If the *Active Preference* is not **MTO**, load it. Click **Close**.
5. Select *General* leaf. Set interval to ***20*** and check surface *Ex2_OG* in the Surfaces list.
6. Select *Source* leaf. Make sure alignment *Ex2* is selected.
7. Click **Apply** and select an insert point in AutoCAD.

3.3 Generate Cross Section Reports

After generate the cross section set, the Cross Section Report command can be used to create station, offset, and elevation report.

1. Select **Evaluation > Cross Section > Cross Section Report**.
2. On the Cross Section Report dialog, select *Cross Section Set* ***EX2***.
3. Select ***Ex2_OG*** from the *Include Surfaces* list.

4. Click on **Apply**.
5. In InRoads Report Browser, select ***CrossSectionGradbookWide.xsl*** under Evaluation. The surface is reported in Station, Elevation, and Offset format.

Note: For multiple surfaces, you can report each surface separately or select all the surfaces and report them in one single report.

4.0 Horizontal Alignment (Element Method)

4.1 Creating Horizontal Alignment

A geometry project Ex2.alg is provided with the sample data set. In this example, element method is used to create horizontal alignment. To active horizontal element commands, select **Tools > Applications Add-ins**. Toggle on ***Horizontal and Vertical Elements Add-in*** from the *Available* list.

A drawing *Ex2.dwg* provided with the sample data set contains 4 points. Point P2-1 and P2-2 are on the incoming tangent. Point P2-3 and P2-4 are on the outgoing tangent.

Shown above is *Ex2.dwg*. The closed polygon represents OG boundary. P2-1 defines the point of beginning (POB) on the alignment and line P2-1, P2-2 is part of the incoming tangent. P2-4 is the point of ending (POE) on the alignment and line P2-3, P2-4 is part of the out going tangent. The *Ex2.dwg* file can be found at …*Example1\Drawings\Ex2.dwg*

The process described below will create a horizontal alignment with the same parameters as alignment *Ex2* provided in the geometry project *Ex2.alg*.

1. From AutoCAD, open *Ex2.dwg*.
2. Make sure the geometry project *Ex2.alg* is loaded and it is the active geometry project.
3. Create a new horizontal alignment under geometry project *Ex2* with name ***Example2,*** style ***PD-N-ALI-CL,*** and a description.

4. Select **Geometry > Horizontal Element > Add Fixed Line**.
5. For *Mode*, select ***By Two Points***.
6. Toggle on both *Point 1* and *Point 2*.
7. Use the data point button next to the input field to get *Northing* and *Easting* from the drawing. Identify point *P2-1* as the first point (beginning of the element), and point *P2-2* as the second point.

8. Click **Apply.** A red linear element is shown in AutoCAD. Follow the prompts in AutoCAD Command Line window to accept the solution.

9. Repeat steps from 4 to 8 to place the outgoing linear element. Identify the point *P2-4* as the ending point of the element.

10. Click Close to dismiss the dialog.

Note: The order of the points is important. It defines the direction of the incoming/outgoing tangent of the element.

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11. Select **Geometry > Horizontal Element > Add Free Curve.**
12. On Add Free Horizontal Curve dialog, type in ***96.8*** for both *Leading* and *Trailing* transitions. Type in ***500*** for *Radius*.

13. Click **Apply**.
14. Follow the prompt, identify the element by place a data point adjacent to the first linear element (P2-1, P2-2).
15. Follow the prompt, identify the second linear element (P2-3, P2-4).
16. The curve set is shown in the AutoCAD. Follow the prompt, right click to accept the solution.

Note: If the radius or spiral is not suitable, or elements selected in a different order, InRoads may have different or no solution.

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17. Follow the prompt right click once. When the Add Free Horizontal Curve dialog shows up again, click **Close** button to close the dialog.
18. Save the geometry project.

4.2 Viewing the Active Horizontal Alignment

1. Delete the graphics with AutoCAD *ERASE* command.

2. Select **Geometry > View Geometry > Active Horizontal.**

4.3 Setting the Starting Station

1. Select **Geometry > Horizontal Curve Set > Stationing**.
2. In the Stationing dialog enter ***10+500*** in the *Starting Station* field. By default, the starting point is the first PI (POB) placed in the geometry. The *Vertical and Superelevation Alignments* options should be set to ***Maintain Station Difference***.

3. Click **Apply** then **Close**.
4. Click **File > Save > Geometry Project**.

4.4 Reviewing Horizontal Alignments

The Review Horizontal Alignment command is used to review a selected geometry in detail.

1. Select **Geometry > Review Horizontal**.
2. In the *Mode* section, select ***Element***.
3. Click **Next** button to move along the alignment

Note: As you move along the alignment, the element is highlighted in AutoCAD.

4. In the *Mode* section, select ***Alignment***. The Review Horizontal Alignment dialog displays information on all the elements in the alignment.

Shown below is the Review Horizontal Alignment dialog with the *Alignment* mode selected. The starting station (POB) is 10+500.000 as set in previous session. The review information can be displayed in AutoCAD using the Display button or saved as an ASCII file using the Save As button, and be used to recreate the horizontal alignment.

4.5 Displaying Stationing

The View Stationing command is used to place station annotation text along the active horizontal alignment at a specified interval.

1. Select **Geometry > View Geometry > Stationing**.
2. Click on the **Preferences** button. Select and load the named preference **MTO_Alignment_P&D.** Close the Preference dialog.
3. Click **Apply** and then **Close**.
4. Stationing will be generated on the Planning and Design layer as defined in MTO AutoCAD Standards Guide.

4.6 Annotating Horizontal Alignments

Horizontal Annotation command is used to display and annotate horizontal alignments, points, and elements.

1. Select **Geometry > View Geometry > Horizontal Annotation**
2. Click **Preferences** button.
3. On Preferences dialog, select ***MTO_Alignment_P&D***, click **Load > Close**.
4. Click in the *Horizontal Alignments Include* field.
5. Click **Filter** button.
6. On the Geometry Selection Filter dialog, select alignment ***Example2*** from the *Available* side.
7. Click **Add** button to put the alignment on the *Selected* side.
8. Click **OK** return to the View Horizontal Annotation dialog.
9. Click **Apply**. The selected alignment is displayed with element data.

10. Click **Close**.
11. Select **Geometry > View Geometry > Curve Set Annotation**.

12. Click **Preferences** and load named preference ***MTO_Alignment_P&D***.
13. Click **Close** return to Curve Set Annotation dialog.
14. Select ***Example2*** in the *Horizontal Alignment* field for annotation.
15. Click **Apply** to display annotation.

4.7 Generating Horizontal Alignment Report

The Review Horizontal command can be used to report detailed information about the elements in selected horizontal alignment. The information can be displayed in AutoCAD or saved to an ASCII file.

Select different *Mode* to report different parts of the alignment.

1. Select **Geometry > Review Horizontal.**
2. Select ***Ex2*** for *Geometry Project* and ***Example2*** for *Horizontal Alignment*.
3. Select *Mode* to review and report information in different format.

Horizontal Alignment Report also can be generated by InRoads XML Reports command and used with a large number of style sheets.

1. Select **Tools >XML Reports >Geometry**.
2. On the Geometry Report dialog, type ***Example2*** in the *Horizontal Alignments Include* field.
3. Press **Tab** on the keyboard. The alignment *Example2* is listed on the *Selected* list.

Note: *Filter* or select button also can be used to select alignments. Use * will select all the alignments in the geometry project.

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4. Click **Apply** to create the report. Bentley Civil Report Browser is displayed.
5. Select ***HorizontalAlignmentReview*** style sheet.

6. Select **Tools > Format Options** in the Bentley Civil Report Browser.
7. Make the desired changes to the format of the generated report.
8. Select **File > Save As** in the Bentley Civil Report Browser to save the data into file with selected file type.

5.0 Profile and Vertical Alignment

5.1 Extracting OG Profile

1. Select **Evaluation > Profile > Create Profile** and the Create Profile dialog will appear.
2. Click on **Preferences** button. Select and load named preference **MTO**.
3. Close the Preference dialog.
4. Click on the *Source* leaf. The *Create* field should be *Window and Data*.
5. Check and make sure the *Alignment* is ***Example2***.

6. Click on *General* leaf. By default, the *Set Name* is set to the active horizontal alignment *Example2*.
7. Make sure surface *Ex2_OG* is checked in the *Surfaces* list.

8. Click on *Controls* leaf. Make sure the *Elevation* range and *Station* range are not used.
9. Click **Apply** and select an insertion point in AutoCAD.

5.2 Creating Vertical Alignment

After extracting OG profile along the horizontal alignment, the vertical alignment can be defined. The following PI input will be used:

Station	Elevation
10+500	*298.420*
10+650	*295.720*
10+867	*299.843*
11+000	*297.920*

1. Check and make sure the horizontal alignment *Example2* is the active alignment.
2. Select **File > New**.
3. On the New dialog, select *Geometry* tab.
4. Set the dialog as following:
   - Type: ***Vertical Alignment***
   - Name: ***Example2***
   - Description: ***Centerline Finished Grade***
   - Style: ***PD-N-ALI-CL***
   - Curve: ***Parabolic***

5. Click **Apply** and **Close**.
6. Check InRoads Explorer, make sure vertical alignment *Example2* is created under horizontal alignment Example2 and is active.
7. Select **Geometry > Vertical Element > Add Fixed Line**.
8. On Add Fixed Vertical Line dialog, select ***By Two Points*** from the *Mode* list field.
9. Toggle on both *Station* input fields and define the first linear vertical element:

10. Click **Apply**. The first linear element is shown in the profile window.

11. Follow the prompt in AutoCAD Command Line to accept the element.
12. Remain the Add Fixed Vertical Line dialog active and define the second and the third linear elements with station and elevation.

13. Follow the prompt in AutoCAD Command Line to accept the element. See below.

14. Close the Add Fixed Vertical Line dialog.
15. Select **Geometry > Vertical Curve Set > Define Curve**.
16. When Define Vertical Curve Set dialog appears, the first PI point at 10+650 is displayed. In the *Vertical Curve* section, select ***K = l/(g2-g1)*** from the *Calculated By* field.
17. Type in ***45*** in the *K Value* input field.

18. Click **Apply**. The defined vertical curve is displayed and highlighted at the first PI point in the profile window.

19. On the Define Vertical Curve Set dialog, click **Next** button to move to the next PI point at 10+867.
20. Select ***K = l/(g2 - g1)*** from the *Calculated By* field and type in ***70*** in the *K Value* input field.

21. Click **Apply**. The second curve is added to the vertical alignment.

22. Click **Close** to dismiss the dialog box.
23. Save the geometry project.

5.3 Reviewing Vertical Alignment

After creating the vertical alignment, the Review Vertical Alignment command can be used to display information about the geometry of the active vertical alignment. The vertical alignment review information can be displayed in AutoCAD drawing file or saved as an ASCII file.

1. Select **Geometry > Review Vertical**.

2. In the *Mode* section, select ***Element***.
3. Click **Next** button to move along the alignment.

Note: As you move along the alignment, the element is highlighted in the profile window.

5.4 Viewing Vertical Alignment

The Active Vertical command is use to display the active vertical alignment without annotation. The geometry style associated with the alignment when they are created will be used for displaying.

Select **Geometry > View Geometry > Active Vertical**.

5.5 Annotating Vertical Alignment

Use the Vertical Annotation command for more detailed annotation and display. Predefined preference is used to display the alignment points, tangent lines and vertical curves, and annotate the geometry.

1. Select **Geometry > View Geometry > Vertical Annotation**.
2. Make sure both the Horizontal Alignment and Vertical Alignment are *Example2*.
3. Click **Preferences**.
4. Select named preference ***MTO_Proposed*** and **Load** it.
5. Close Preferences dialog
6. Click **Apply**.

7. Use AutoCAD command to zoom in and view annotation.
8. Close the View Vertical Annotation dialog box.

5.6 Generating Vertical Alignment Report

The Review Vertical command can be used to report detailed information about the geometry of the active vertical alignment. The information can be displayed in AutoCAD or saved to an ASCII file. Select different *Mode* to review alignment or element information.

1. Select **Geometry > Review Vertical**.
2. Select ***Ex2*** for *Geometry Project*, ***Example2*** for *Horizontal Alignment* and ***Example2*** for *Vertical Alignment*.
3. Select *Mode* to review and report information in different format.

Vertical Alignment Report also can be generated by InRoads XML Reports command and used with a large number of style sheets.

1. Select **Tools >XML Reports >Geometry**.
2. On the Geometry Report dialog, type ***Example2*** in the *Horizontal Alignments Include* field.
3. Press **Tab** on the keyboard. The alignment *Example2* is listed on the *Selected* list.
4. Check the *Include Vertical Alignments* section.
5. Toggle on the *Active* option.

6. Click **Apply**. Bentley Civil Report Browser is displayed.
7. Select ***VerticalAlignmentReview*** style sheet.

8. Select **Tools > Format Options** in the Bentley Civil Report Browser.
9. Make the desired changes to the format of the generated report.
10. Select **File > Save As** in the Bentley Civil Report Browser to save the data into file with selected file type.

6.0 Typical Sections

6.1 Setting Up Project Template Library

MTO standard template library contains predefined typical sections, components, and a point name list that point names are associated with MTO standard styles. This template library can be used as a start point to create project specific template library.

1. Select **File > Save As**.
2. On the Save As dialog, Change the *Save as type* to Template Libraries (*.itl).
3. In the *File name* field, type in ***Example2***.
4. Click **Save**. A new template library *Example2* is saved to the proper project folder as defined in project default.

5. On the Save As dialog, Change the *Save as type* to Projects (*.rwk).
6. Select *Example2.rwk* from the file list. *Example2.rwk* will appear in the *File name* field.

7. Click **Options** then select *Template Library* tab.
8. On Project Options dialog, check both **Add** and **Update** options.

9. Click OK to close the Project Options dialog.
10. Click **Save** then **Yes** to confirm replace the existing project file.
11. Click **Cancel** to close the Save As dialog.
12. Select **Modeler > Create Template**. The Create Template dialog will appear.
13. Select **File > New > Folder**.
14. Type in ***Example2*** for the name of the new folder in the Template Library window.

15. Double click on **MTO Library > Complete Templates > Inner & Outer Lane**.
16. Select template **Type 3**.

17. Select **Edit > Copy**.
18. Select folder *Example2*.
19. Select **Edit > Paste**.
20. Double click folder *Example2*. The standard template is copied to folder *Example2*.

21. Click **File > Save**.

Note: Project specific templates should be created/copied and modified in the project specific folder.

6.2 Creating Example 2 Templates

In previous section, a template is selected from MTO Library folder and copied to the project template folder. This template is going to be modified to use in this example for new construction, reconstruction and

pavement widening with granular lift and resurfacing. We will start with creating a New Construction template.

New Construction Template

1. Select the new copied template *Type 3* in the *Example2* folder.
2. Select **Edit > Rename**.

3. Type in a new name: ***Example2 NewConstruction***.
4. Provide additional information in the *Description* field in the Current Template section.

5. Click **File > Save**.

Note: During the process of customize the project template, save the template library when the modification is worth saving.
Refer to Proposed Design in section 1 for parameters to be used in the project template.

---

6. To keep the template simple, delete all rock related components since no rock is present in this project. In the template display window, find and right click on component **L-Rock Shatter**, select **Delete Component** from the pop-up menu.

7. Find and delete component **L-Rock Cut, L-Rock Cut1, R-Rock Shatter, R-Rock Cut,** and **R-Rock Cut1.**
8. Right click on left side brown fill component, select **Delete Component** from the pop-up menu.

9. Select **L-Rock Fill** component from the pop-up Component Selection list.

10. Right click on right side brown fill component, select **Delete Component** from the pop-up menu then select **R-Rock Fill** component from the pop-up Component Selection list.

11. Click **File > Save**.
12. In the template display window, find and double click on the point **L-TP-ES**. On the Point Properties dialog, go to *Constraints* section. Type ***-2.50*** in the *Value* field for the *Horizontal* constraint.

13. Click **Apply** Then **Close**.
14. Find and double click on the point R-TP-ES in the template display window. On the Point Properties dialog, type ***2.50*** in the *Value* field for the *Horizontal* constraint.

15. Click **Apply** then **Close**.
16. Similarly, for partially paved shoulder, set *Horizontal* constraint value to ***-0.5*** for point L-TP-EPS, and ***0.5*** for R-TP-EPS.
17. For asphalt top course depth, set *Vertical* constraint value to ***-0.04*** for point L-AB1-EP, L-AB1-EP1, AB1-CL, R-AB1-EP1, and R-AB1-EP.
18. For asphalt base course depth, set *Vertical* constraint value to ***-0.05*** for point L-TA-EP, L-TA-IP1, TA-CL, R-TA-IP1, and R-TA-EP.
19. Modify the shoulder on the left side. Zoom in and right click on L-AB1-EP. Select **Delete Point** from the pop-up menu.

20. From the Delete Point dialog, select ***L-Asphalt Shoulder Top Course*** from the *Select Shape(s) to Delete Point From* list.

21. Click **OK.** The point L-AB1-EP is deleted from the partially paved shoulder component.

22. Right click on the line between points L-PPS1-EPS and L-TP-EP. From the pop-up menu select **Insert Point**.

23. Move the active point curser on to the line between points L-TP-EP and L-AB1-EP, then click. A new point is added to the shoulder surface course component.

24. Right click on the point and select **Finish** from the pop-up menu.

25. Double click on the newly created point. The Point Properties dialog will appear. On the Point Properties dialog, select ***EP*** from the *Name* drop-down list.

26. The *Name* field is populated with the selected name *EP* and the *Surface Feature Style* is changed to the style associated with the point name EP.

27. Rename the point name to ***L-PPS1-EP***. Click **Apply**. Set the point constraints as following.

28. Click **Apply** then **Close**.

29. Set *Vertical* constraint value to ***-0.05*** for point L-PPS1-EPS.
30. Right click between the shoulder top course and base course components. Select **Delete Component** from the pop-up menu.

31. From Component Selection dialog, move the curser to select ***L-Asphalt Shoulder Base Course*** from the list. The component is highlighted in the template display window.

32. Click on the selected component to delete it.

33. Right click on point L-AB1-EP and select **Delete Point**. When Delete Point dialog appears, select ***L-Granular Shoulder*** from the list then click **OK**.

34. Right click on point L-TA-EP and select **Delete Point**. On Delete Point dialog, select ***L-Granular Shoulder*** from the list then click **OK**.

35. Right click on point L-PPS2-EPS and select **Delete Point**.

36. Right click on point L-TP-EP and select **Delete Point**. On Delete Point dialog, select ***L-Granular Shoulder*** from the list then click **OK**

37. Right click on the line between points L-PPS1-EPS and L-TA-EP. From the pop-up menu select **Insert Point**. Move the active point curser on to the point L-PPS1-EP then click. A new point is added to *L-Granular Shoulder* component at L-PPS1-EP.

38. Right click on the point and select **Finish** from the pop-up menu. A green cross is shown on the point L-PPS1-EP.

39. Right click on the point L-PPS1-EP and select **Merge Points** from the pop-up menu.

40. Select point ***L-*** From the Delete Point dialog.

41. Click on the selected point to delete it.

42. Repeat steps from 19 to 41 to modify the shoulder on the right side.

43. Change the *Vertical* constraint value to -0.09 for both points L-TA-AUX and R-TA-AUX.
44. Right click on point L-TA-ER and select **Edit Point**. Set the point constraints as follow:

45. Select point R-TA-ER and set the point constraints as follow:

Note: When modify an existing templates, some point constrains may get lost because of deleting other points. Make sure proper constraints are maintained.

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46. Verify that the *Vertical* constraint value is 0.15 for points L-TB-AUX, L-TB-EP, L-TB-IP1, TB-CL, R-TB-IP1, R-TB-EP, and R-TB-AUX.
47. Verify that the *Vector-Offset* constraints for L-SG-GR and R-SG-GR are set as follow:

48. Find and double click on the point L-TP-EP in the template display window. Type ***2.0%*** in the *Value* field for the *Slope* constraint.

49. Click **Apply** then **Close**.
50. Find and double click on the point R-TP-EP in the template display window. Type ***2.0%*** in the *Value* field for the *Slope* constraint.

51. Click **Apply** then **Close**.
52. Verify that the *Slope* constraint value is 2.0% for points L-TP-EP1 and R-TP-EP1.
53. Select **File > Save** to save changes made to the template.
54. **Close** the Create Template dialog.

Before creating the widening template, a preliminary corridor is to be created using the New Construction template with superelevation applied, and then be reviewed for roadway widening.

7.0 Roadway Modeling

7.1 Roadway Designer Overview

InRoads Road Designer is a highly interactive command that allows user to perform a majority of the road design within the command itself. The main dialog has 3 views in standard mode and 4 views in superelevation or overlay mode. User will see the design results simultaneously in plan, profile, and the cross section at the current station. This command is also used to create new design surfaces that represent a new roadway or other type of surface.

Before running Roadway Designer, you must have:

- A horizontal and vertical alignment or a surface feature that defines the location of the roadway.
- One or more existing surfaces.
- One or more templates to define the proposed typical section(s).

7.2 Creating Corridor

1. Select **Modeler > Roadway Designer**. The Roadway Designer dialog appears with three view windows.
2. Select **Corridor > Corridor Management**.
3. On the Manage Corridors dialog, type ***Example2*** in the *Name* field.
4. Set the *Surface Symbology* to ***DTM_Proposed***.
5. Set the *Type* to ***Alignment***.
6. Select ***Example2*** for the *Horizontal Alignment*.
7. Select ***Example2*** for the *Vertical Alignment*.
8. Set *PI Rounding Tangent* to ***0.000***
9. Toggle off the station *Limits* for applying to the entire alignment.
10. Click **Add** to create the corridor.

11. Click **Close** to dismiss Manage Corridors dialog. If the *Active Surface* is not *Ex2_OG*, make sure it is loaded and select it from the drop-down list.

12. Click **File > Save As**. The Save Roadway Design As dialog will appear. The location will be …*Example2**Corridors* as defined in the project default.
13. For *Save as type*, select ***Roadway Design (*.ird)***.
14. For *File name*, type ***Example2***.
15. Click **Save** and close the Save As dialog.

16. Go to InRoads main menu, select **File > Save As** to update the project file with newly created Roadway Design file.

7.3 Inserting Template Drops

With an active corridor in place, the template drops can be added to the roadway design.

1. On the Roadway Designer dialog, select **Corridor > Template Drops**. The Template Drops dialog will appear.
2. In the *Library Templates* list window, select ***Example2 > Example2 NewConstruction***.
3. Change the *Interval* to 25 and the *Station* should be ***10+500.000***.
4. Click **Add**. The selected template is added to the *Current Template Drops* list.

5. Close the Template Drops dialog.

6. Add pavement width transition. Select **Tools > Parametric Constrains...**
7. The Parametric Constraints dialog will appear. On the dialog, set the values in the input fields as following:

Click **Add** button on the right side to add a new entry for left side pavement width transition.

8. Set the values in the input fields as following:

Click **Add** button on the right side to add a new entry for right side pavement width transition then click **Close** to return to roadway designer.

9. Click **File > Save** to save the roadway design file with template drops and Parametric Constrains inputs.
10. Close Roadway Designer.

7.4 Applying Superelevation

Superelevation is used to control the cross-fall of roadways in areas of horizontal curves. InRoads provides tools to create, display, and report Superelevation in the roadway design process.

1. Select **Tools** from InRoads main menu. If *Variable Manger* command is already listed under Tools, skip step 1.

Select **Tools > Application Add-Ins**. From the *Available* list on Application Add-Ins dialog, find and toggle on the ***Variable Manger Add-In***.

2. Select **Tools > Variable Manager**. From the Variable Manager dialog, find the option ***Modeler – 1% Superelevation Points***. Verify and make sure it is toggled on.

3. Select **Modeler > Roadway Designer**.
4. Click on the **Process All** button and set the *Display Mode* in the lower right corner to ***Superelevation***.

5. Select **Superelevation > Create Superelevation Wizard > Table**. The Table Wizard dialog will appear.
6. Click the browse button icon ... to the right of the *Table* input field. The Open Superelevation Table dialog box will appear.
7. Navigate to …*Example2**Standards* folder. Select the superelevation table ***MTO_06_100k.sup***.

8. Click **Open**.
9. Calculate the tangent runout and enter in the *Specify Runout* input field. Tangent Runout L = 400 * 0.02 * 7.0 = 56m.

Note: 400 is the transition rate to be used for MTO standards; 0.02 is the difference between normal crown and 0% slope; 7.0m is the width of cross section to be superelevated.

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10. Click on **Load Values From Table** button. The maximum *Superelevation Rates* are read from the ASCII file specified in the *Table* field.

11. Click **Next**. On the Superelevation Section Definitions dialog, click **Add** button
12. On the Add Superelevation Section dialog, accept the default *Name* to be ***Section1***. Make the following selections:
    - Crown Point: ***TP-CL***
    - Left Range Point: ***L-TP-EP***
    - Right Range Point: ***R-TP-EP***

13. Click **OK** button to accept the inputs and return to Superelevation Section Definitions dialog.
14. Highlight the superelevation section created in previous operations from the *Superelevation for Selected Section* list.

15. Click **Edit** button at the bottom of the *Superelevation for Selected Section* list. Superelevation Curve Information dialog appears. Toggle on the ***Use Spiral Length*** option for both *Start Curve Transition* and *Stop Curve Station* sections. This will override the calculated runoff length with the defined Spiral Length.

Note: By default, this option is automatically checked on when the spiral length is greater than the calculated superelevation transition length.

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16. Click **Apply** then **Close**.
17. Click **Next** button then click on the **Finish** button on the Superelevation Controls dialog. Four superelevation control lines are created for points L-TP-EP, L-TP-EP1, R-TP-EP1, and R-TP-EP.

18. Set the *Display Mode* in the lower right corner to ***Normal*** to view the complete template and all layers. Review sections in both tangent and curves. All layers under pavement except for the subgrade are superelevated appropriately. The subgrade, partially paved shoulder, granular shoulder and granular A layer under shoulder will be treated separately.

Subgrade Superelevation

1. Select **Corridor > Template Drops**. Select ***Example2 NewConstruction*** under the *Current Template Drops* list and then click on the **Delete** button.
2. From the *Library Templates* list window, Select ***MTO Library > Complete Templates > Inner & Outer Lane > Type 1,2,2A,3 SG Sub for Supers***. Then click **Add**.

3. Close the Template Drops dialog and return to Roadway Designer dialog. The subgrade layer is added to the current model.

4. **Superelevation > Create Superelevation Wizard > Table**. Follow the wizard define a new section of superelevation for subgrade template with the same inputs as used for the complete template. Set the points as shown below. Then click **OK**.

5. Highlight the superelevation section just created from the *Superelevation for Selected Section* list.

6. Click **Edit** button at the bottom of the *Superelevation for Selected Section* list. Superelevation Curve Information dialog appears. Toggle on the ***Use Spiral Length*** option for both *Start Curve Transition* and *Stop Curve Station* sections.
7. Click **Apply** then **Close** the Superelevation Curve Information dialog.
8. Click **Next** button on the Superelevation Section Definitions dialog then click **Finish** button on the Superelevation Controls dialog. The subgrade layer is now superelevated. The subgrade layer must be edited to follow MTO standards.

9. Switch to *Superelevation* mode. Select the superelevation diagram view. Locate the point at 0%. Right click on it. From the pop-up menu, select **Delete Point**. Then select the **Section2** line.

10. Right click on the 1% point and then select **Move Point** from the pop-up menu. Select the **Section2** line. The Dynamics Setting dialog will appear. Set the *Step* to ***1%*** and make sure both *Snap To* options ***Cardinal Points*** and ***Superelevation Points*** are selected. Move the cursor until the cursor hits the constant -3% value to be maintained at the 1% point from the *Section1* line (Section2 line stays -3% until the Section1 line reaches 1%).

11. Right click on the *Section2* line between the -3% point and 3% point. Select **Insert Point** from the pop-up menu then select the **Section2** line. Move the cursor to the 2% point from the *Section1* line.

12. Repeat the same steps for the outgoing superelevation behaviour.

13. Select **Superelevation > Apply Shoulder Rollover Lock**. On the Apply Shoulder Rollover Lock dialog, select *Shoulder Point* ***L-SG-AUX***. Set the slope *Difference* to ***4%*** and *Maximum Slope* to ***-3%*** on the *High Side*. Set the slope *Difference* to ***0%*** on the *Low Side*. Click on **Apply**.

14. Apply the same settings to R-SG-AUX then close the dialog.
15. Set the *Display Mode* in the lower right corner to ***Normal***. Select **Corridor > Template Drops** and delete the current template drop from the list.

16. Select the ***Example2 NewConstruction*** template from the Example2 directory and then click on **Add**. Now the subgrade layer is superelevated appropriately.

17. Select **File > Save** to save changes made to the corridor.

Shoulder Superelevation

1. The partially paved shoulder, granular shoulder and granular A layer under shoulder on the high side of the superelevation must be properly superelevated to follow MTO standards. Select ***Superelevation*** Mode and then select **Superelevation > Create Single Control Line**.
2. On the Create Superelevation Control dialog, type ***L-Partially Paved Shoulder*** in the *Name* field. Select ***Section1*** as *Parent Section* (or leave blank). Select ***Section1 L-TP-EP1-L-TP-EP*** from the *Copy From* drop-down list. Set *Normal Crown* to ***-6%*** and *Maximum Cross* to ***5.7%,*** and then click **OK**.

3. Select **Superelevation > Create Single Control Line**. On the Create Superelevation Control dialog, type ***L- Granular Shoulder*** in the *Name* field. Select ***Section1*** as *Parent Section* (or leave blank). Select ***Section1 L-TP-EP1-L-TP-EP*** from the *Copy From* drop-down list. Check the ***Copy Values from Original*** option, and then click **OK**.

4. Right click on the superelevation diagram. Select **Superelevation Display List** from the pop-up menu.

5. On the Superelevation Display List dialog, select ***L-Granular Shoulder*** from the *Available Superelevations* list. Click **Apply** and **Close**.

6. In the superelevation diagram view, only the selected control line *L-Granular Shoulder* is displayed. The -2%, 0%, 1%, 2% and 5.7% point are copied from the L-TP-EP control line.

7. Right click on the line between 2% and the 5.7% point. Select **Insert Point** from the pop-up menu. On Dynamics Settings dialog, set *Step* to **1.00%.** Insert a point at **4.00%** *Cross Slope*.

8. Right click on the newly created 4% point, and then select **Edit Point**. On the Superelevation Point Properties dialog, set *Conctraint1* to ***Vector-Offset*** and select the 2% and 5.7% points as *Parent 1* and *Parent 2*. The *Value* should be ***0***. Click on **Apply**.

9. Repeat the same steps to add 4% point for outgoing superelevation control and set the ***Vetor-Offset*** constraint with 2% and 5.7% points as the *Parent 1* and *Parent 2*.

10. Delete the two 5.7% points from the control line.

11. Right click on the first point and select **Edit Point**. The Superelevation Point Properties dialog appears. Use the **<Previous** and **Next>** button navigate through entire control line and change the *Cross Slope* value as list below:

Existing Cross Slope	New Cross Slope
-2%	-6%
0%	-4%
1%	-3%
2%	-3%
4%	-2%

12. Select **Superelevation > Create Single Control Line.** On the Create Superelevation Control dialog, type ***L-Shoulder Top A*** in the *Name* field. Select ***Section1*** as *Parent Section* (or leave blank). Select ***Section1 L-TP-EP1-L-TP-EP*** from the *Copy From* drop-down list. Set *Normal Crown* to ***-6%*** and *Maximum Cross* to -3***%,*** and then click **OK.**

13. Right click on the superelevation diagram. Select **Superelevation Display List** from the pop-up menu. Select **All** and click **Apply** to display all the superelevation control lines within the current mode.

14. Switch back to *Normal* mode. All the shoulder superelevation control lines are created now. Next, proper point controls have to be set up before these controls can take effect.
15. Select **File > Save** to save changes made to the Roadway Designer file.

7.5 Point Controls

Point controls are used to modify the behavior of points in a template. Depending on the *Mode* selected, different control types can be applied to a point. Superelevation control lines are used as vertical point controls.

1. Select **Corridor > Point Controls**. The Point Controls dialog appears. The superelevation control lines created with the superelevation wizard in previous section are automatically added to point control list as vertical controls. See below.

2. The superelevation control lines created with Create Single Control Line command can be used for point control through the Point Controls dialog. On the Point Controls dialog, select ***L-TP-EPS*** from the *Point* drop-down list (or use the locate button). Set the *Mode* to ***Vertical***. Then select ***Superelevation*** for *Control Type*, ***L-Partially Paved Shoulder*** for *Superelevation*, and ***L-TP-EP*** for *Reference Point*. Click **Add**.

3. Select ***L-TP-ES*** from the *Point* drop-down list. Set the *Mode* to ***Vertical***. Then select ***Superelevation*** for *Control Type*, ***L-Granular Shoulder*** for *Superelevation*, and ***L-TP-EPS*** for *Reference Point*. Click **Add**.

4. Select ***L-TA-AUX*** from the *Point* drop-down list. Set the *Mode* to ***Vertical***. Then select ***Superelevation*** for *Control Type*, ***L-Shoulder Top A*** for *Superelevation*, and ***L-TA-EP*** for *Reference Point*. Click **Add**.

5. Three vertical controls for shoulder superelevation are added to the point control list.

E...	P...	Name	Start Station	Stop Station	Mode	Type	Control
X	1	L-TP-EP	10+500.000	11+000.000	Vertical	Superelevation	Section1 L-TP-EP1-L-TP-EP:L-TP-EP1
X	1	L-TP-EP1	10+500.000	11+000.000	Vertical	Superelevation	Section1 TP-CL-L-TP-EP1:TP-CL
X	1	R-TP-EP1	10+500.000	11+000.000	Vertical	Superelevation	Section1 TP-CL-R-TP-EP1:TP-CL
X	1	R-TP-EP	10+500.000	11+000.000	Vertical	Superelevation	Section1 R-TP-EP1-R-TP-EP:R-TP-EP1
X	1	L-SG-EP	10+500.000	11+000.000	Vertical	Superelevation	Section2 SG-CL-L-SG-EP:SG-CL
X	1	R-SG-EP	10+500.000	11+000.000	Vertical	Superelevation	Section2 SG-CL-R-SG-EP:SG-CL
X	1	L-SG-AUX	10+500.000	11+000.000	Vertical	Superelevation	Section2 L-SG-AUX:L-SG-EP
X	1	R-SG-AUX	10+500.000	11+000.000	Vertical	Superelevation	Section2 R-SG-AUX:R-SG-EP
X	1	L-TP-EPS	10+500.000	11+000.000	Vertical	Superelevation	L-Partially Paved Shoulder:L-TP-EP
X	1	L-TP-ES	10+500.000	11+000.000	Vertical	Superelevation	L- Granular Shoulder :L-TP-EPS
X	1	L-TA-AUX	10+500.000	11+000.000	Vertical	Superelevation	L-Shoulder Top A:L-TA-EP

Note: Additional point controls can be added for project design requirements.

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6. Close the Point Controls dialog. Select **File > Save** to save the changes.
7. View the complete template and all layers in *Normal* Display Mode. Review sections in both tangent and curves. All layers are superelevated appropriately.

7.6 Roadway widening

The pavement widening in this example involves both granular grade raise and resurfacing. See below section ② and ③.

Reviewing Preliminary Corridor

1. In Roadway Designer, select **Corridor > Display References**.
2. On the Display References dialog, select *Feature* option and set the dialog as shown below:

3. Click **Add**.
4. Select ***REP*** from the *Feature* drop-down list and click **Add**.
5. Close the dialog. View cross sections in Roadway Designer. The EP lines of existing roadway are shown in the cross-section view from station 10+720 to the end.
6. With the reference of the edge of pavement, we can easily see how existing pavement merged to the new roadway from left side.

   a) Started from left side of the corridor:

   When right EP of existing pavement is located on the left side of left EP of new pavement, the new construction will apply.

   b) Merging, partially under the new pavement:

When the left EP of existing pavement is located on the left side of left EP of new pavement, apply shoulder widening on the left side, and pavement and shoulder widening on the right side.

c) Fully under the new pavement:

When the left EP of existing pavement is located on the right side of left EP of new pavement, apply pavement and shoulder widening on both sides.

Widening Template

The following OPSD 209.010 Rural Pavement Widening is used for creating Widening template.

The assumptions made below are for this example only. For individual projects, refer to project Geotechnical Report or the Regional Geotechnical Section's recommendation.

A) Granular Grade Raise Widening Template

For pavement widening with grade raise, following assumptions are used:

a) Existing pavement asphalt to be fully removed (90mm).

b) New pavement asphalt to be 40mm top course and 50mm base course

c) Granular A depth to be 150mm under widening.

d) Maximum depth of granular A lift to be 150mm, remainder will be granular B

e) Excavation depth to be 600mm from existing pavement.

1. Select **Modeler > Create Template** to open the Create Template dialog.
2. Select the template ***Example2 NewConstruction*** from the *Template Library* on the left side of the dialog. Right click on the template then click **Copy** on the pop-up menu.

3. Right click on the folder *Example2* then click **Paste** on the pop-up menu.

4. Right click on the newly copied template and click **Rename** on the pop-up menu.

5. Type in a new name ***Example2 Widening-GranularGradeRaise.***

6. Provide additional information in the *Description* filed for template *Example2 Widening-GranularGradeRaise*.

7. Click **File > Save**.
8. There are two granular A lift components to be created for this example: one for existing pavement partially under the new pavement and one for existing pavement fully under the new pavement.

   a) Component **GranularA_Lift** (for fully overlap)

      1) Create two Null points ***L-EX-EP*** and ***R-EX-EP*** one on each side of the new roadway center line. Create a Null point ***EX-CL*** between points *L-EX-EP* and *R-EX-EP.* These points are to be used to locate center line and the edge of pavement of existing roadway. Put the points above the top of the new pavement. The point locations will be controlled in Roadway designer.

2) Create three Null points ***L-OG-EP, OG-CL*** and ***R-OG-EP.*** Put the points within the granular A layer of the new pavement. The point locations are temporary and will be projected to the OG surface at center line and edge of pavement of existing roadway.

Set point constrains as:

L-OG-EP

OG-CL

R-OG-EP

3) Create a Null point ***TA-EX-CL*** between points L-TA-EP and TA-CL. Set point constrains as:

TA-EX-CL

4) Create a new *Overlay/Stripping* component ***GranularA_Lift*** with information input as shown below:

Component depth 0.15 is the maximum depth of granular A lift. Surface depth 0.09 is the pavement removal depth.

The component is to be placed on the top of granular A layer and will go through point *TA-CL*.

5) Rename the left point to ***L-TA-EX*** and set point constrains as:

6) Rename the right point to ***R-TA-EX*** and set point constrains as:

b) Component **GranularA_Lift_P** (for partially overlap)

1) Create a new *Overlay/Stripping* component ***GranularA_Lift_P*** with information input as shown below:

The component is to be placed on the top of granular A layer. It will start from left of point *L-TA-EP*, go through point *L-TA-EP* and end to the right of point *L-TA-EP*.

2) Rename the left point to ***L-TA-EX1*** and *Use Feature Name Override* ***L-TA-EX***. Set point constrains as:

3) Rename the right point to ***R-TA-EX1*** and *Use Feature Name Override* ***R-TA-EX***. Set point constrains as:

9. Create three granular A widening components: two on the left side, one for existing pavement fully under the new pavement and one for existing pavement partially under the new pavement; one on the right side for both scenarios since the partially overlap section is within the superelevation range with reverse crown.

   a) Component ***L-GranularA*** (left side for fully overlap)

      1) Create a new *Constrained* component ***L-GranularA***. Start from point *L-TA-EX*, go through points *L-TA-EP, L-TA-AUX, L-TA-ER, L-TB-GS, L-TB-AUX, L-TB-EP*, and put the final point ***L-TB-EX*** under point *L-TA-EX* on the top of granular B layer.

      2) Set point constrains for **L-TB-EX**:

3) Set component properties as:

b) Component ***L-GranularA_P*** (left side for partially overlap)

1) Create a new *Constrained* component ***L-GranularA_P***. Start from point *L-TA-EX1*, go through points *L-TA-AUX, L-TA-ER, L-TB-GS, L-TB-AUX*, and put the final point ***L-TB-EX1*** under point *L-TA-EX1* on the top of granular B layer.

2) Set point properties for **L-TB-EX1**:

3) Set component properties as:

c) Component ***R-GranularA*** (right side)

1) Create a new *Constrained* component ***R-GranularA***. Start from point *R-TA-EX*, go through points *R-TA-EP, R-TA-AUX, R-TA-ER, R-TB-GS, R-TB-AUX, R-TB-EP,* and put the final point ***R-TB-EX*** under point *R-TA-EX* on the top of granular B layer.

2) Set point constrains for **L-TB-EX**:

3) Set component properties as:

10. Create two granular B lift components: one for existing pavement partially under the new pavement and one for existing pavement fully under the new pavement.

a) Component **GranularB_Lift** (for fully overlap)

Create a new *Overlay/Stripping* component ***GranularB_Lift*** with information input as shown below:

The component is to be placed on the top of granular B layer and will go through points *L-TB-EX, TB-CL*, and *R-TB-EX*.

b) Component **GranularB_Lift_P** (for partially overlap)

1) Create a new *Overlay/Stripping* component ***GranularB_Lift_P*** with information input as shown below:

The component is to be placed on the top of granular B layer. Start from the left side of point *L-TB-EP*, go through point *L-TB-EP*, then end to the right side of point *L-TB-EP*.

2) Move left point to *L-TB-EX1* and merge with point *L-TB-EX1*.
3) Rename the right point to ***R-TB-EX1*** and *Use Feature Name Override* ***R-TB-EX***. Set point constrains as:

11. Create three granular B widening components similar as step 9: two on the left side and one on the right side.

a) Component ***L-GranularB*** (left side for fully overlap)

1) Create a new *Constrained* component ***L-GranularB***. Start from point *L-TB-EX*, go through points *L-TB-EP, L-TB-AUX, L-TB-GS, L-SG-GR,* and put the final point ***L-SG-EX*** under point *L-TB-EX*.

2) Set *Surface Feature Style* to ***PD-N-MSC-EX***.
3) Set point constrains for **L-SG-EX:**

4) Set component properties as:

b) Component ***L-GranularB_P*** (left side for partially overlap)

1) Create a new *Constrained* component ***L-GranularB_P***. Start from point *L-TB-EX1*, go through points *L-TB-AUX, L-TB-GS, L-SG-GR*, and the point *L-SG-EX*.

2) Set component properties as:

c) Component ***R-GranularB*** (right side)

1) Create a new *Constrained* component ***R-GranularB***. Start from point *R-TB-EX*, go through points *R-TB-EP, R-TB-AUX, R-TB-GS, R-SG-GR,* and put the final point ***R-SG-EX*** under point *R-TB-EX*.

2) Set *Surface Feature Style* to ***PD-N-MSC-EX***.
3) Set point constrains for **R-SG-EX:**

4) Set component properties as:

12. Set point constrains for ***L-SG-GR*** as:

Set the *Slope* constraint (*Constraint 2*) as:

13. Set point constrains for **R-SG-GR** as:

Set the *Slope* constraint (*Constraint 2*) as:

14. Both L-SG-GR and R-SG-SG are referenced to the subgrade excavation points now. Next, remove the Granular B components but remain all the points.

Right click on point ***SG-CL***, select ***Delete From Components (Make Null)*** from the pop-up menu.

Repeat the above process to make points ***L-SG-AUX, L-SG-EP, R-SG-EP***, and ***R-SG-AUX*** to Null points.

15. Right click on point ***L-SG-GR***, select ***Delete Point*** from the pop-up menu. When Delete Point dialog appears, select **Granular B** from the *Select Shape(s) to Delete Point From* list.

Click **OK** button to confirm the selection.

16. Repeat the above process to delete component *Granular B* from points ***L-TB-GS, L-TB-EP, L-TB-IP1, TB-CL, R-TB-IP1, R-TB-EP, R-TB-GS,*** and ***R-SG-GR***.

17. Set display rules for granular A components. For granular A layer, if the lift is more than 150mm from left EP to EP, the full granular A layer will be applied. The maximum lift will be 60mm from the existing pavement with assumption of 90mm full pavement removal. Double click on the *GranularA_Lift* component, and then click the **Edit** button to the right of *Display Rules* field. The Component Display Conditional Express dialog appears. Click **Add** button to add following display rules.

Template Display Rules

Name	Type	Expression	Test	Value	Result
GranA_LiftTest_EX-CL	Vertical	TA-EX-CL - OG-CL	<	0.060	False
GranA_LiftTest_EX-L	Vertical	L-TA-EX - L-OG-EP	<	0.060	False
GranA_LiftTest_EX-R	Vertical	R-TA-EX - R-OG-EP	<	0.060	False
GranularA_Lift_Display	Component is Displayed	GranularA_Lift			True
GranularA_Lift_P_Display	Component is Displayed	GranularA_Lift_P			True
Left_EP	Horizontal	L-EX-EP - L-TP-EP	>=	0.000	True

Select rules from the *Template Display Rules* list to construct the conditional expression for component ***GranularA_Lift*** as shown below:

Conditional Expression for GranularA_Lift Component

Left_EP AND (GranA_LiftTest_EX-L OR GranA_LiftTest_EX-CL OR GranA_LiftTest_EX-R)

AND | OR | NOT | (|) | Selected Rule

Select rules from the *Template Display Rules* list to construct the conditional expression for component ***GranularA_Lift_P*** as shown below:

Select rules from the *Template Display Rules* list to construct the conditional expression for component ***GranularA*** as shown below:

Select rules from the *Template Display Rules* list to construct the conditional expression for component ***R_GranularA*** as shown below:

18. Set display rules for granular B components.

    Select rules from the *Template Display Rules* list to construct the conditional expression for component ***GranularB_Lift*** as shown below:

Select rules from the *Template Display Rules* list to construct the conditional expression for component ***GranularB_Lift_P*** as shown below:

B) Resurfacing and Granular Widening Template

For pavement widening with resurfacing, following assumptions are used:

a) Existing pavement asphalt to be partially removed up to 50mm.
b) New pavement asphalt to be 40mm top course and 50mm base course.
c) Granular A depth under widening to be 150mm.
d) Excavation depth to be 600mm from existing pavement.

1. Select **Modeler > Create Template** to open the Create Template dialog.
2. Select the template ***Example2 Widening-GranularGradeRaise*** from the *Template Library* on the left side of the dialog. Right click on the template then click **Copy** on the pop-up menu.
3. Right click on the folder *Example2* then click **Paste** on the pop-up menu.
4. Right click on the newly copied template and click **Rename** on the pop-up menu.
5. Type in a new name ***Example2 Widening-Resurfacing.***

6. Provide additional information in the *Description* filed for template Example2 Widening-Resurfacing.

7. Click **File > Save.**
8. First, remove all the display rules from the template. Double click on the *GranularA_Lift* component, and then click the **Edit** button to the right of *Display Rules* field. The Component Display Conditional Express dialog appears. Highlight all the rules from the *Template Display Rules* list, then click **Delete** button to remove all the rules.

Clean up the expression of the component.

9. Double click on the *GranularA* component and clean up the *Display Rules* expression of the component.
10. Delete ***GranularA_Lift_P*** component from the template. The ***L_GranularA_P*** component will be deleted at the same time as a child component of *GranularA_Lift_P*.
11. Delete ***GranularB_Lift_P*** component from the template. The ***L_GranularB_P*** component will be deleted at the same time as a child component of *GranularB_Lift_P*.
12. Double click on the *L-GranularB* component and remove the *Parent Component* ***L-GranularA***.

13. Delete ***GranularB_Lift*** component from the template.
14. Rename the *GranularA_Lift* component to ***Asphalt Padding*** and set the Component Properties as shown below:

15. Add a display rule to component GranularA so we can hide the component but keep all the points. Double click on the *GranularA* component, and then click the **Edit** button to the right of *Display Rules* field. The Component Display Conditional Express dialog appears. Click **Add** button to add following display rules:

Select rules from the *Template Display Rules* list to construct the conditional expression for component ***GranularA*** as shown below:

16. Move points *L-EX-EP, EX-Cl*, and *R-EX-EP* slightly to the right so EX-CL is close to the center line.

17. Create a new *Overlay/Stripping* component ***Milling*** for existing pavement partial removal with information input as shown below:

The component is to be placed on the top of granular A layer. Start from point *L-TA-EX*, go through point *TA-CL*, and end to point *L-TB-EP*.

18. Save the template and close the Create Template dialog.

Updating Corridor

1. Open Roadway Designer. Select **Corridor > Template Drops**. The Template Drops dialog appears.
   a) On the dialog, verify that the current *Corridor* is ***Example2***.
   b) Type ***10+775*** in the *Station* field and ***25*** in the *Interval* field.
   c) In the *Library Templates* list window, double click on the active template library ***Example2.itl***, and then double click on the folder ***Example2***.
   d) When the folder expanded, select template ***Example2 Widening-GranularGradeRaise*** from the library tree.
   e) Click **Add** button on the right side to add the selected template to the *Current Template Drops* list.
   f) Type ***10+875*** in the *Station* field and ***25*** in the *Interval* field
   g) Select template ***Example2 Widening-Resurfacing*** from the library tree *Example2*.
   h) Click **Add** button on the right side to add the selected template to the *Current Template Drops* list.

2. Disable template transition by clicking on the **X** in the *Enable Transition column* in the *Current Template Drops* list.

The column will show blank after the transitions have been removed between the templates.

3. Click **Close** button to dismiss the dialog and return to Roadway Designer. Select **File > Save** to save the corridor file with new template drops.
4. Select **Corridor > Point Controls**. The Point Controls dialog appears:
   a) On the dialog, select ***L-EX-EP*** from the *Point* drop-down list. Set the *Mode* to ***Horizontal***. Then select ***Feature*** for *Control Type*, ***Ex2_OG*** for *Surface*, and ***LEP*** for *Feature*. Click **Add**.

b) Select ***EX-CL*** from the *Point* drop-down list. Set the *Mode* to ***Horizontal***. Then select ***Feature*** for *Control Type*, ***Ex2_OG*** for *Surface*, and ***CR*** for *Feature*. Click **Add**.

c) Select ***R-EX-EP*** from the *Point* drop-down list. Set the *Mode* to ***Horizontal***. Then select ***Feature*** for *Control Type*, ***Ex2_OG*** for *Surface*, and ***REP*** for *Feature*. Click **Add**.

d) Click **Close** button to dismiss the dialog and return to Roadway Designer. Select **File > Save** to save the corridor file with new point controls.

5. Go through the cross sections. Within the corridor, there are different cross sections:
   a) New construction

b) Widening with full granular A and granular B lift

c) Widening with granular A lift up to 150mm then granular B lift

d) Widening with padding and resurfacing, exist pavement partially removed up to 50mm

6. At the end of the corridor, in the pavement transition from resurfacing to existing, the milling of existing pavement is to be up to the bottom of new pavement asphalt.

7. Select **Tools > Parametric Constraints.** On the Parametric Constraints dialog, add following entry:

8. Click on **Close** to dismiss the dialog. In Roadway Designer, check the cross sections. The pavement removal is now ended at the bottom of new pavement asphalt for pavement transition.

9. Save the Roadway Designer file.

7.7 Creating Finished Surface

1. On the Roadway Designer dialog, click **Process All** button under the cross-section view.
2. Select **Corridor > Create Surface**.
3. On the Create Surface dialog, verify that only corridor ***Example2*** (if you have more than one corridors) is selected and all the options selected as shown below:

4. Click **Apply**. InRoads will process all the cross section in the selected corridor. A message window pops up to show the progress.

5. When the process finish, click **Close** to dismiss the Create Surface dialog.
6. Close Roadway Design. Save the changes when see following message.

7. Go to InRoads Explorer. In the left pane, check the *Surfaces* folder. Surface *Example2* is listed under *Surfaces*.

7.8 Creating Alternate Surfaces

To create TA, TB and SG surfaces, specify the alternate surface name in the point properties and then check the Alternate Surface option when use Create Surface command.

1. Select **Modeler > Create Template**.
2. On the Create Template dialog, select template ***Example2 NewConstruction*** from Template Library.
3. Double click on point ***L-TA-ER*** and type ***TA*** in the *Alternate Surface* field. Click **Apply** button.

4. Repeat above process for all the other points on top of A surface.

5. Set *Alternate Surface* name to ***TB*** for all points on top of B surface.
6. Set *Alternate Surface* name to ***SG*** for all points on subgrade surface.
7. Save template library.
8. Select template ***Example2 Widening-GranularGradeRaise*** from Template Library.
9. Set *Alternate Surface* name to ***TA*** for all points on top of A surface.
10. Set *Alternate Surface* name to ***TB*** for all points on top of B surface.
11. Set *Alternate Surface* name to ***SG*** for all points on subgrade surface.
12. Save template library.
13. Select template ***Example2 Widening-Resurfacing*** from Template Library.
14. Set *Alternate Surface* name to ***TA*** for all points on top of A surface.
15. Set *Alternate Surface* name to ***TB*** for all points on top of B surface.
16. Set *Alternate Surface* name to ***SG*** for all points on subgrade surface.
17. Save template library and close the Create Template dialog.
18. Select **Modeler > Roadway Designer.**
19. Select **Corridor > Templates Drops**.
20. Select all the template drops in red and click on the **Synchronize with Library** button. Close the dialog.
21. Select **Corridor > Create Surface.**
22. Select corridor ***Example2***.
23. Check the *Create Alternate Surfaces* option on the Create Surface dialog.

24. Click **Apply**. Save Roadway Designer and close the dialog.
25. Go to InRoads Explorer. In the left pane, check the *Surfaces* folder. Alternate surfaces are created under *Surfaces.*

26. Right click on surface ***Example2-SG*** and select ***Properties*** from the pop-up menu.
27. Click on the **Advanced** tab on the Surface Properties dialog. Select ***DTM_SG*** from the *Symbology* drop-down list for both *Cross Sections* and *Profiles*.

28. Click **Apply > Close**.
29. Repeat the process to set symbology ***DTM_TA*** for surface ***Example2-TA***.

30. Set symbology ***DTM_TB*** for surface ***Example2-TB***.

31. Save surfaces Example2, Example2-TA, Example2-TB, and Example2-SG.

7.9 Updating Project File

1. Go to InRoads main menu, select **File > Save As**.
2. On the Save As dialog, verify the *Save as type* is Projects (*.rwk) and select *Example2.rwk.*
3. Click the **Options (…)** button on the lower right corner of the Save As dialog box. The Project Options dialog box will appear.
4. Click *Surfaces* tab, check **Add** for Example2, Example2-SG, Example2-TA, and Example2-TB surfaces.

5. Click **OK** button to close the Project Options dialog box.
6. Click the **Save** button and confirm to replace existing project file.

8.0 Cross Sections

8.1 Creating Cross Sections

1. Load *MTO_InRoads_Template.dwg* from project folder...*Example2\Standards.*
2. Click AutoCAD's **File > Save As** command to save the drawing to project folder …*Example2\Drawings* with name ***CrossSections***.
3. Set the **Global Scale Factors** to 0.1.
4. Select **Evaluation > Cross Section > Cross Sections**.
5. Click **Preferences** and load named preference **MTO_Sheet(1:100).** On the dialog of *General* leaf, select surface ***Ex2_OG*** and ***Example2*** from the *Surfaces* list.

6. Click **Source** and verify that alignment *Example2* is show in the *Alignment* field.

7. Click **Controls > Limits**. Verify the Station range.

8. Click **Critical Sections** under *Controls*. Select options.

9. Click **Apply** and follow the prompt at AutoCAD command line to provide an insert point in the drawing.
10. View the cross sections that have been created.

Whole Sheet:

New Construction:

Widening with Granular Lift:

Widening with Resurfacing:

8.2 Updating Cross Sections

1. Select **Evaluation > Cross Section > Cross Sections**.
2. Click on the **Update Cross Section** folder on the left pane of Cross Sections dialog.
3. Click on *Crossing Features* leaf. Toggle on the **Display On** option.
4. Select surface ***Example2*** from the *Surface* list.
5. Turn on the *Feature Filter Lock* and select filter ***TP Surface Features***, and then select all the features in the *Feature* list.

6. Click **Apply**. Top surface features are displayed in the cross sections (shown as points).
7. Select surface ***Example2-SG*** from the Surface list.
8. Turn off the *Feature Filter Lock*, and then select all the features in the *Feature* list (feature *Exterior Boundary* is greyed out and will not be selected).

9. Click **Apply**. All the subgrade surface features are displayed in the cross sections (shown as points).
10. Close the dialog and save the drawing.

8.3 Annotating Cross Sections

Surface or surface crossing features (if loaded) can be annotated in cross sections. Verify that the **Global Scale Factors** is set to 0.1.

OG surface

1. Select **Evaluation > Cross Section > Cross Sections**.
2. Click on the **Annotate Cross Section** folder on the left pane of Cross Sections dialog.
3. Click on **Preferences** and load named preference ***MTO_OG (1:100).***
4. Click on *General* leaf and select ***Ex2_OG*** surface.
5. Click on *Points* leaf and check **Include Points** option.

6. Click **Apply**. The OG surface is annotated in cross sections.

TP Surface.

1. With the Cross Sections dialog open, click on **Preferences** and load named preference ***MTO_TP (1:100)***.
2. Click on *General* leaf unselect surface ***Ex2_OG*** and select surface ***Example2***.
3. Click on *Features* leaf then click on *Annotate*. Select all the features from the *Feature* list.

4. Click **Apply**. The top surface is annotated in cross sections.

SG Surface.

1. With the Cross Sections dialog open, click on **Preferences** and load named preference ***MTO_SG (1:100).***
2. Click on *General* leaf and unselect surface ***Example2*** and select surface ***Eexample2_SG***.
3. Click on *Features* leaf then click on *Annotate*. Select all the features from the *Feature* list.

4. Click **Apply**. The subgrade surface is annotated in cross sections.

5. Close the Cross Sections dialog and save the AutoCAD drawing.

9.0 Volumes

After creating cross section set, the End-Area Volumes can be used to perform the traditional end-area volume calculation to compute cut, fill, and net volumes. To compute the quantities of components, the components must be displayed in the cross section.

InRoads calculates the exact end areas at each stations. The neat volumes area calculated between stations using the average end area method. The computed volumes can be adjusted for shrinkage or expansion.

9.1 Defining stripping area

This example includes both new construction and widening. For new construction, assume stripping will be across the entire cross section. For widening, since the section is short and fill is low in general, assume stripping will be from existing edge of shoulder to proposed widening daylight line. In order to use the *Unsuitable Materials By Feature* in the *End-Area Volumes* calculation, area features (closed shapes) must be created in plan that represent areas to be stripped.

1. Load *MTO_InRoads_Template.dwg* from project folder...*Example2**Standards*.
2. Select **Surface> View Surface> Options**. Turn on the *Planarize* option on the Surface Options dialog. Set the *Elevation* to ***0.000***.

3. Click **Apply** then **Close**.
4. **Select Surface> View Surface> Perimeter**; Select ***Exampl2*** from the *Surface* drop-down list on the View Perimeter dialog.

5. Click **Apply** then **Close**. The exterior boundary of design surface is displayed.

6. Select **Surface> View Surface> Features**. On the View Features dialog, select ***Ex2_OG*** from the *Surface* drop-down list then select ***LES*** and ***RE***S from the Features list.

7. Click **Apply** then **Close**. The existing edge of shoulder features are displayed.

8. Use AutoCAD to create the desired closed shapes between the existing shoulder line and the daylight lines.

9. Select **File> Import> Surface**. On the Import Surface dialog, select the *From Graphics* tab. Set the dialog as shown below:

10. Click **Apply** and then select the left side stripping boundary.
11. Click **Apply** and then select the right side stripping boundary.
12. Close the dialog and save the updated surface.
13. Save the drawing with the stripping shapes for future use.

9.2 Calculating End-Area Volumes

Note: The Compaction/Expansion factor and stripping depths used in this example are for demonstration only. For individual projects, refer to Geotechnical Report or the Regional Geotechnical Section's recommendation.

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1. Verify that the cross section drawing created in previous section is the active drawing.
2. Verify that the **Global Scale Factors** is set to 0.1.
3. Select **Evaluation > Cross Section > Cross Sections**.

4. Click on the **End-Area Volumes** folder on the left pane of Cross Sections dialog.
5. Click on **Preferences** and load the named preference **MTO.**
6. Click on **Annotation**. Check the default settings of the named Preference **MTO**. Change the options as you need.

7. Click **General**. In the Surface list, make sure the existing surface ***Ex2_OG*** and the design surface ***Example2*** are checked. With the preference *MTO*, the volume will be calculated for whole cross section set and the *Create XML Report* option is toggled on.

8. Click **Unsuitable Materials by Feature.** Use this option for the widening section with the closed shapes created in previous section. With this option, the cut stripping and fill stripping will be calculated with the same depth. Assume the stripping depth is 0.15m.
9. Select ***Example2*** from the *Surface* drop-down list. Type ***0.15*** in the *Depth* field. From the *Available Closed Features* list select feature ***Stripping***. Click **Add** button.
10. Select feature ***Stripping1*** then click **Add**. Both features are listed under *Unsuitable Materials* with the specified depth.

11. Click **Unsuitable Materials by Station.** For new construction, assume stripping will be across the entire cross section. Also assume the stripping depths are 0.15m in cuts and 0.30 in fills.
12. Add the stripping section (10+500 to 10+725) to the list with the *Style* set to ***Stripping***, *Cut Depth* ***0.15m*** and *Fill Depth* ***0.30m***.

13. Click **Classification**. Use *Cut/Fill Factor* to account for any swell or shrinkage that may occur when remove/place material. Assume 15% increase for the computed earth fill quantity to compensate handing and compaction lose. Edit the Cut/Fill factors in the Materials List table.

14. Click **Apply** to calculate the volumes. InRoads will annotate the cross section set based on the selections on the *Annotation* leaf.

15. With *Create XML Report* option toggled on, Bentley Civil Report Browser displayed. Select **EndAreaVolume** style sheet from the *Evaluation* folder in the left pane of the dialog to view the results.

16. Select **Volumes** style sheet and go to the end of the report. A summary table of total volumes of each material is generated by InRoads. There are 4 columns in the table. From left to right they are Material (component) Name, Volume, Adjusted Volume, and if the material is included in the Mass Ordinate.

17. Based on the template and the input during quantity calculation, the quantity of:

    a. Excavation = Normal Cut
    = 5047.28 m^3

    b. Milling is the volume of the partial depth pavement removal (up to 50mm) calculated with the component *Milling*.

    Note: Refer to Widening Template in Section 7.6 for details.

    Milling =19.46 m^3

    c. To calculate the materials available for fill, the volume of pavement removed is to be subtracted from the excavated volume.

    The full depth pavement removal (90mm) deduction area is the existing pavement within the grading limit as shown below.

Full depth pavement removal area = 1882.95 m^2

Available Materials for Fill:

= Normal Cut (excavation) – Pavement Removal

= 5047.28 – (1882.95 x 0.09 + 19.46)

= 4858.35

d. Asphalt Base Course 2 is the volume of asphalt padding.

Note: Refer to Widening Template in Section 7.6 for details.

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18. Save the drawing with a different name (Cross section with end-area quantities).

10.0 Reports

10.1 End-Area Volume Report

The End-Area Volume Report is generated with End-Area Volumes command. Refer to Section 9.2 for details about end-area volume calculation and report generation. Once the report is generated by InRoads and the Bentley Civil Report Browser is displayed, a few style sheets from the Evaluation folder can be used to view End-Area Volume.

10.2 Cross Section Reports

Cross Section Report command is used to create station, offset, and elevation report for a specified cross section set. All surfaces, features, and components that you want in the report must be displayed in the cross section set.

10.2.1 Top of Pavement (TP) Report

The InRoads generated design surface can be used for Top of Pavement report.

1. Open the saved cross section drawing (or you can generate a new set).
2. Select **Evaluation > Cross Section > Cross Section Report**.
3. On the Cross Section Report dialog, verify the *Cross Section Set* is ***Example2***.
4. Select surface ***Example2*** (design surface) from the *Include Surfaces* list.

5. Click **Apply**.
6. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionStakingTable.xsl**.

7. Save the report then close the Bentley Civil Report Browser.

10.2.2 TA and TB Reports

1. Select **Evaluation > Cross Section > Cross Sections**.

2. Click on the **Update Cross Section** folder on the left pane of Cross Sections dialog.
3. Click on *Surfaces*. Toggle on the **Display On** option.
4. Select surface ***Example2-TA*** from the *Surface* list. Click **Apply**.
5. Select surface ***Example2-TB*** from the *Surface* list. Click **Apply**.
6. Toggle on the **Display Off** option to make sure TA and TB surfaces have been added to the cross section set.

7. Close Cross Sections dialog.
8. Select **Evaluation > Cross Section > Cross Section Report**.
9. On the Cross Section Report dialog, verify the *Cross Section Set* is ***Example2***.
10. Select surface ***Example2-TA*** from the *Include Surfaces* list.

11. Click **Apply**.
12. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionGradeBookWide.xsl**.

13. Save the report then close the Bentley Civil Report Browser.
14. On the Cross Section Report dialog, select surface ***Example2-TB*** from the *Include Surfaces* list.
15. Click **Apply**.
16. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionGradeBookWide.xsl**.

17. Save the report then close the Bentley Civil Report Browser.
18. Close the Cross Section Report dialog.

10.2.3 Subgrade Report

1. Repeat steps 1 to 7 in section 10.2.2 to add surface ***Example2-SG*** to the cross section set.
2. Select **Evaluation > Cross Section > Cross Section Report**.
3. On the Cross Section Report dialog, verify the *Cross Section Set* is ***Example2***.
4. Select surface ***Example2-SG*** from the *Include Surfaces* list.
5. Click **Apply**.
6. In the Bentley Civil Report Browser, select **Evaluation > CrossSectionGradeBookWide.xsl**.

7. Save the report then close the Bentley Civil Report Browser.
8. Close the Cross Section Report dialog.