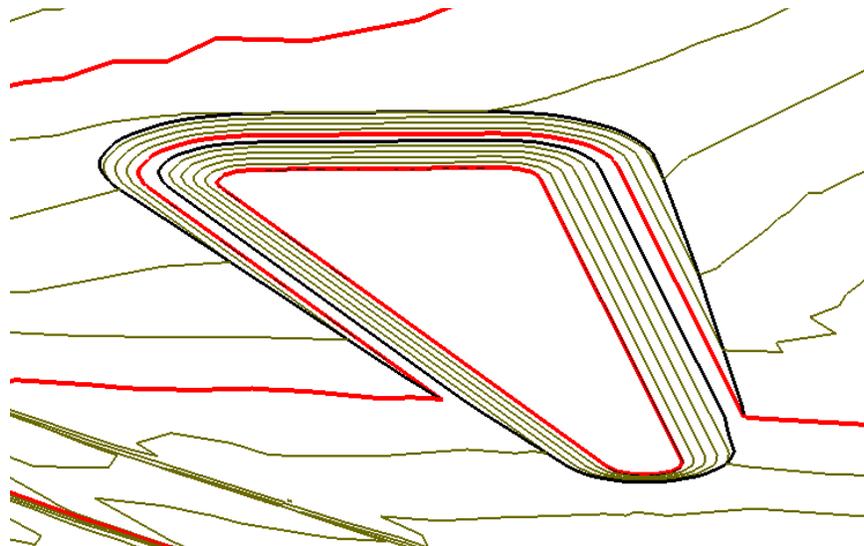


Chapter 16 - Surface Editing Tools

It is not unusual for a project to require more detail than a surface generated by Roadway Designer can provide. Nor is it unusual to need a surface that cannot be easily created using templates. A few of the many examples that may require an additional level of detail include:

- Intersections
- Interchanges
- Divided highways
- Bridge abutments
- Borrow pits
- Pedestrian refuges
- Ponds
- Parking areas

Rather than try to build a final surface by using typical sections alone, then merging or running many corridors at once to build a parking lot, for example, you can build breakline features for your surface using multiple methods. With this approach, you can use a variety of tools to contribute to the model. Instead of trying to force one workflow (e.g. Typical Sections and Modeling) to create everything, use individual commands designed specifically to create or modify features, combining their resulting breaklines for your overall model.



Section Objectives:

- To learn techniques for refining a design DTM, such as a composite model made up of more than one design surface.
- To accomplish project-specific design scenarios by manipulating individual features.
- To learn how to manipulate features for grading in areas that don't lend themselves to the Roadway Modeling process, such as slopes around bridges, borrow pits or ponds.
- To learn where the Surface Creation and Editing tools fit into the overall CDOT Design process and how they can be used to your advantage.

Locks



Before working with features, there are lock settings that should be understood: **Feature Filter**, **Feature Highlight**, **Pen/Pencil**, **Delete Ink**, **Locate Features / Locate Graphics** and **Point Snap/Element Snap/No Snap**. Suggestions on when to use each are listed below. For additional details on the locks, see the **InRoads Online Help**.

Feature Filter



Feature filters can be created to segregate the features listed in InRoads dialog boxes. For example, you can create a filter based on any number of criteria, such as whether or not a feature is triangulated. When you toggle on the lock, only features that meet the active filter criteria are shown in dialogs, and therefore available for editing. This can be handy, for example, when you are working with a surface containing hundreds or thousands of features, but you only want to see/edit edges of oil. Set up a filter to look for only features with 'oil' in the name, then toggle the lock on.

Filters are stored in your XIN file and standard filters already exist for your use.

Feature Highlight



When the **Feature Highlight** lock is toggled on, any command that includes a feature list field will highlight the feature in plan view when it is selected in the list, whether it is displayed or not. This is a good check to visually verify the feature you want to display and / or edit.

Important! Turning on the **Feature Highlight** lock slows the opening of dialog boxes that include feature lists.

Pen / Pencil



When the features you are editing are displayed with **Pen/Pencil** set to **Pencil**, the modified features are kept 'up-to-date' in the graphics file. If set to **Pen**, original graphics are left in place and modified features are added, resulting in multiple graphical copies of features, although the DTM only contains the most recent update.

Delete Ink



When **Delete Ink** is toggled on, the **Pen** setting acts very much like **Pencil**, as all previous versions (Pencil or Pen) of a feature are deleted when the feature is modified.

Locate Graphics / Locate Features



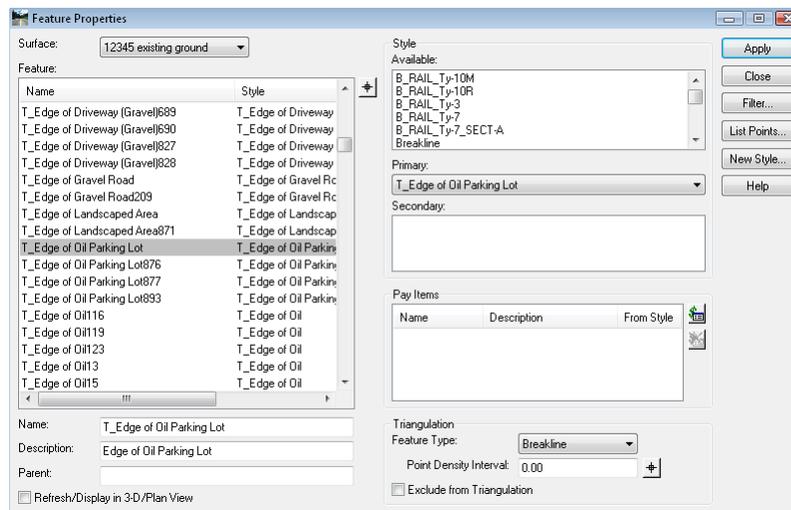
Several of the commands described in this chapter are dual purpose. They can create features or they can create graphics. Likewise, they can use graphics or features as input. On most commands, you will note this difference when you Apply the command and it prompts for either features or elements, based on this lock's setting. For others, the current **Locate** mode is shown at the top of the dialog box, some also have a **Generate Graphics Only** toggle.

Point Snap



When using **Partial Delete** or **Break Feature**, the **Point Snap** limits the selected points to existing points on the feature. In other words, no new points are added at the beginning and end of the break. **Element Snap** has no effect on surface editing tools. For information on how the snaps affect geometry, see the **InRoads Online Help**.

Feature Properties



The **Feature Properties** command (**Surface > Feature > Feature Properties**) provides a list of all of the features contained in the surface and the style assigned to each feature. Use this dialog box for a variety of functions including:

- Changing feature properties like **Name**, **Description**, **Point Type**, **Point Density Interval**, etc.
- Making a non-triangulating feature part of the triangulated network, or vice-versa.
- Assigning the feature a parent name or secondary style for filtering purposes.

In addition, you can select **List Points** to generate a report on basic feature information along with the feature's length and coordinate information for each vertex on the feature. This is helpful when checking a feature's elevation.

Note: If the feature's **Style** doesn't exist in the current XIN, it will display red in the list.

Creating Features

There are many options within InRoads that assist in CDOT's design process besides typical sections and roadway modeling. Using these tools, you can build surfaces from scratch or add to previously created surfaces (design or existing).

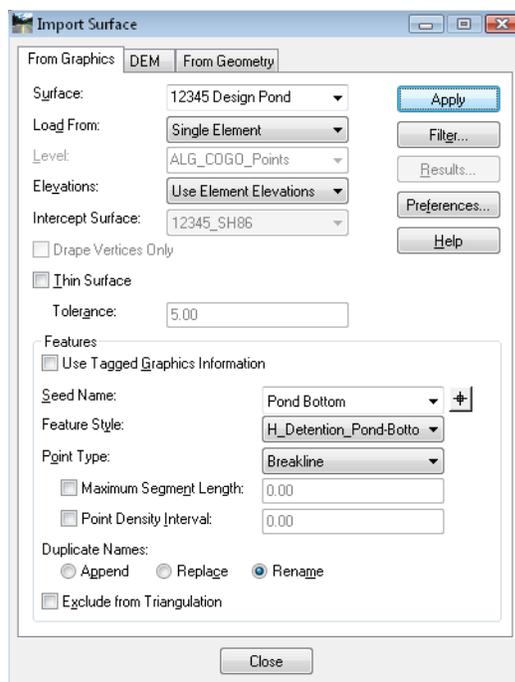
Section Objectives:

- To be able to create new features from scratch.
- To develop an understanding of when each of the feature creation commands should be used.
- To learn techniques that will help refine existing surface models by adding features.

Import Surface from Graphics

MicroStation graphics can be imported into a surface to form features. If you are comfortable drawing with MicroStation, you might find it useful to first draw what you want in the design file, then import the graphics as features as opposed to creating the features from scratch. This is especially useful in situations where the graphics are relatively simple, or when you want the new feature to take on the elevations of a known surface so you do not have to worry about setting the z-coordinate manually. You can also use this command to create a “flat” feature, then use **Generate Longitudinal Feature (GLF)** to add elevations. See the **Generate Longitudinal Feature** section in this chapter for details.

1. Draw the graphics with MicroStation.
2. Select **File > Import > Surface > From Graphics**.



3. Specify the **Surface** where the feature is being imported.

Note: If the surface has not been created, you may type the name in and it will be created when you Apply.

4. Specify the **Load From** option.

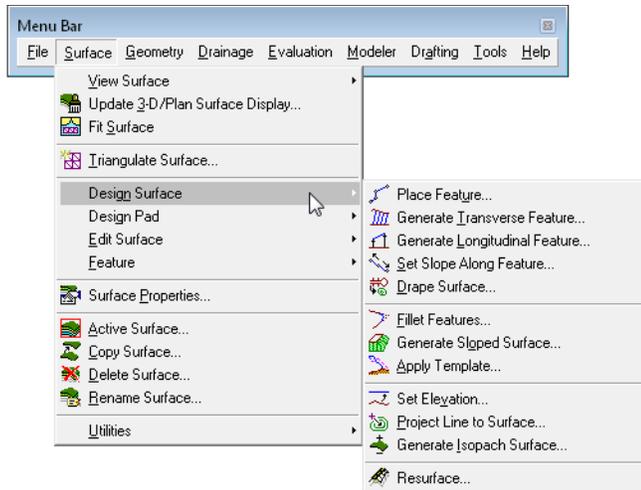
Note: To use a selection set, choose the **Single** option. When you Apply, you'll be asked if you want to use the active selection set.

See the **InRoads Online Help** for information on the other options in this dialog.

5. **<D> Apply** and follow the prompts to load your feature(s) into the surface.

Accessing Design Surface commands

While there are many commands in InRoads that create features, several of them are grouped under **Design Surface**. You can access them from the **Surface > Design Surface** pull-down menu, or from the **Design Surface** toolbar. Most are described in the following section.

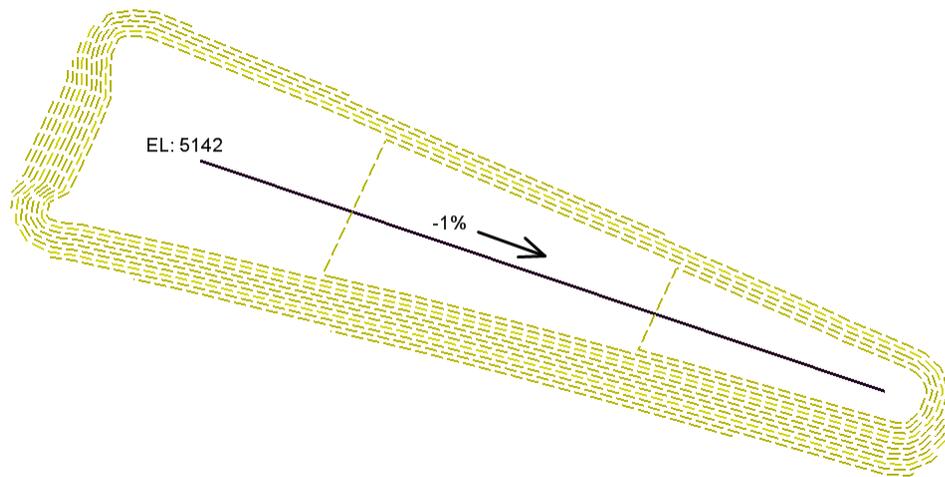


Generate Longitudinal Feature

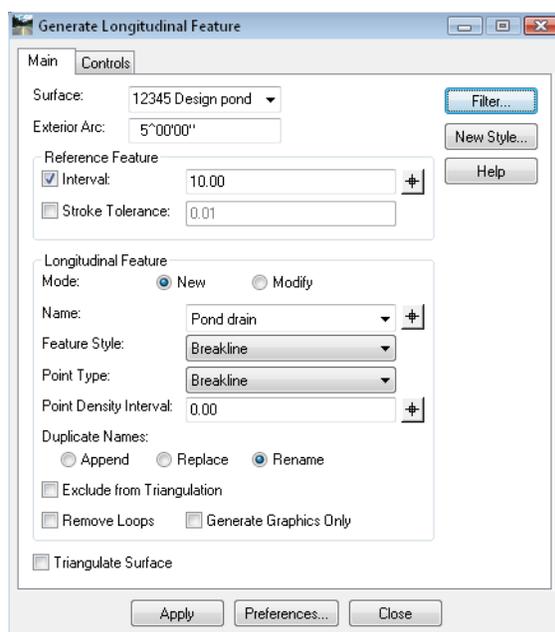
Generate Longitudinal Feature (GLF) is used to create and/or modify 3D MicroStation elements or features in a DTM. It is an extremely powerful tool that allows much easier manipulation in 3D than MicroStation alone.

When using this command to create a new feature, one of the easiest methods is to draw the feature in plan view with MicroStation without regard to the elevation, then use **GLF** to copy the element, creating a feature while adding elevations at the same time.

In this example, a drain line is added to the bottom of a pond. The design calls for the drain to start at a fixed elevation and proceed at a longitudinal grade along the prescribed route.



1. Use MicroStation to draw the drain line in the plan view.
2. Select **Surface > Generate Longitudinal Feature**.



The Main tab

1. Specify the *Surface* where a feature is being added or modified.

Note: The *Exterior Arc* is used when the new feature is horizontally offset from the original. In this case, it is set to 5^\wedge . When the copy is offset to the outside of a corner, the resulting feature will fan out from the corner in 5^\wedge increments, giving the effect of a fillet. The smaller the setting, the smoother the fillet.

Reference Feature

This category is for specifying how many vertices will be created in the resulting feature. Either *Interval*, *Stroke Tolerance* or both must be toggled on.

Interval is a master-unit setting that determines how often along the reference feature or element a new vertex is created.

1. In this case, the *Interval* is toggled on and set to **10**. In general, this setting should reflect a similar interval to the surrounding features. Here, the pond bottom has a similar interval.
2. Toggle on *Stroke Tolerance*. This option has two functions:
 - First, if the reference element contains a curve or arc, this setting is used to stroke the curve or arc into a series of vertices. See the *InRoads Online Help* for more information.
 - Second, it ensures the creation of a vertex at each occurrence of a vertex in the reference.

Longitudinal Feature

1. Set the *Mode* to *New*.

Longitudinal Feature options are available or not depending upon two things:

- If *Generate Graphics Only* is toggled on or off – if on, several of the feature settings do not apply, since only graphics result from the command. In this case, it is toggled off.
 - If the *Mode* is *New* or *Modify* – if *Modify*, several of the feature settings do not apply, as they are already established for the feature or element being modified.
2. Key in a *Name* for the new feature.
 3. Assign the new feature a *Feature Style*.

Hint: If there is already a feature using the desired style, save time by selecting it as the *Name* to populate the *Feature Style* field, then type over the name with your new one.
 4. Select a *Point Type* from the drop-down.
 5. For *Point Density* key in **0**.

Note: *Point Density* is a densification factor applied to the feature when it is triangulated. Fixed vertices are not added to the feature using this option – but triangulation vertices are. This setting can be added or changed after the fact in **Feature Properties**.

Note: The **Duplicate Names** area is only applicable if you have chosen a name that already exists in the surface. The options are:

- **Append:** The feature added is appended to the end of the named feature. As points are added, there is rubberbanding in the graphics file to show which end of the feature is being appended. If it is not the desired end, use **Surface > Edit Surface > Reverse Feature Direction** to first change the orientation of the original feature
- **Replace:** The old feature is removed and the new one added in its place
- **Rename:** A numeric suffix is added onto the name and used for the new feature

6. Toggle off **Exclude from Triangulation**.

Note: Toggle this option on if the feature is a utility, right-of-way, or some other breakline that you want to show on profiles and cross sections but do not want to affect the triangulation.

7. Toggle off **Remove Loops**.

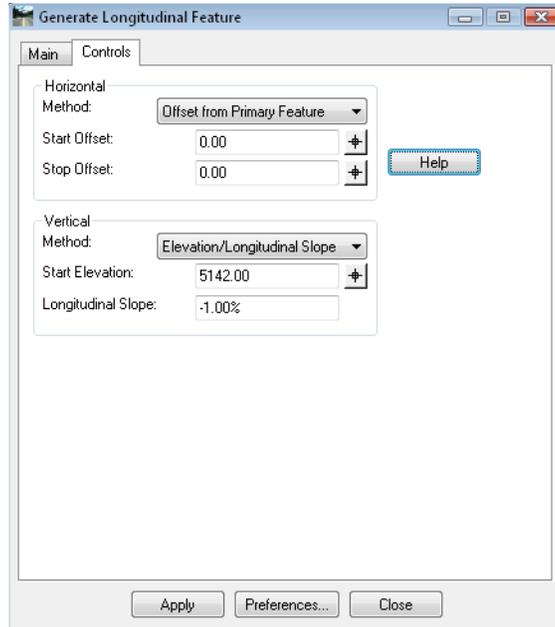
Note: If **Remove Loops** is on, this option will remove the loops when you are copying a feature or element with horizontal offsets that would result in loops in interior corners.

8. Toggle off **Triangulate Surface**.

Note: Toggle on **Triangulate Surface** if it's desired to see results of re-triangulation after each feature is added or modified.

The Controls Tab

On this tab, the horizontal and vertical location of the new or modified feature is set. For details on each of the options, see the *InRoads Online Help*.



1. For the *Horizontal Start* and *Stop Offsets* key in **O**, since the drain line has been drawn in the correct horizontal location.
2. Set the *Vertical Method* to *Elevation/Longitudinal Slope*. Here, the beginning of the drain line starts at 5142 and will slope at -1%.
3. <D> **Apply**.

Note: You are prompted to identify *Primary* and *Reference* elements or features based on the *Locate Graphics / Locate Features* lock settings. This lock may be toggled in the middle of the command, so you can identify a *Primary Feature*, then toggle to *Locate Graphics* and identify a *Reference Element*.

Remember, the *Primary* element or feature is what you are copying or modifying and the *Reference* is for:

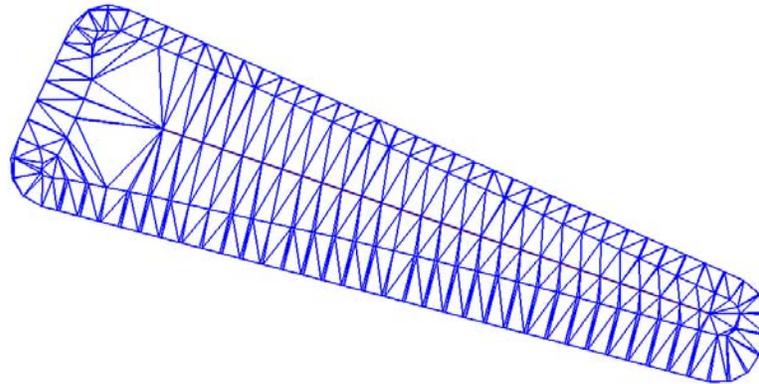
- ◆ Applying the interval
- ◆ Specifying what the result is perpendicular to, and
- ◆ Stroking

For a situation such as the drain line created here, the original element is both the *Primary* and *Reference*.

4. <D> on the drain line for the *Primary* element and <D> to accept.
5. <D> on the drain line for the *Reference* element and <D> to accept.

Note: Once the **Primary** and **Reference** are identified and accepted, the **Identify Location** prompt is shown. When the copy or modification is horizontally offset, it is necessary to <D> on the side of the desired result. When it's not horizontally offset, you can accept anywhere.

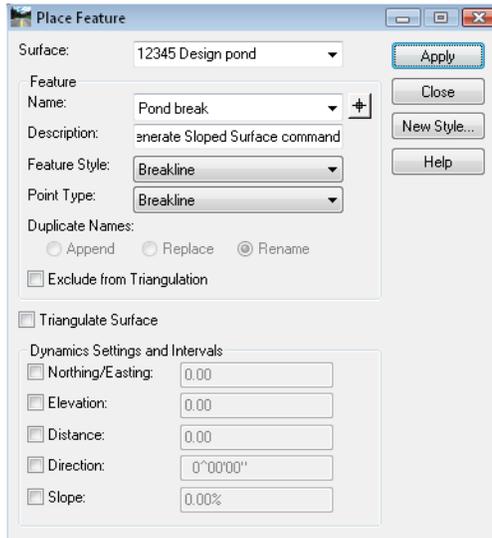
6. Since there is no horizontal in this case, <D> anywhere in the view to finalize the result.
7. View the triangles (**Surface > View Surface > Triangles**) and contours (**Surface > View Surface > Contours**) to see the results.



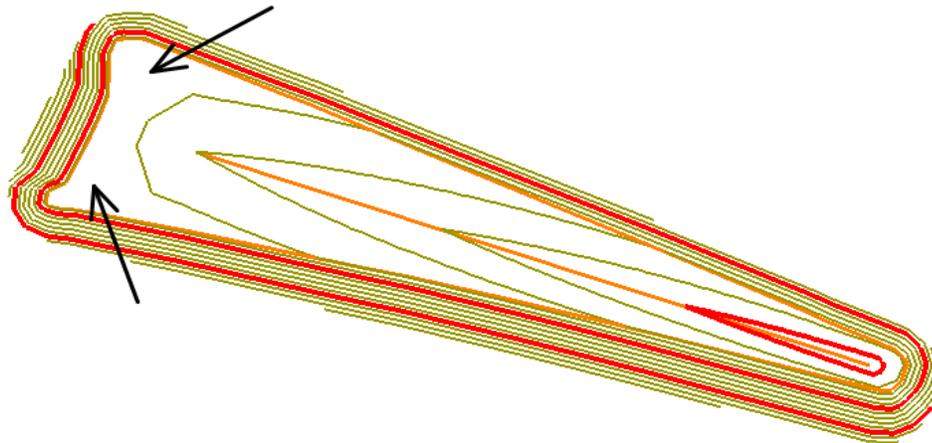
Here, you'll notice that there are triangles cutting across the corners, causing some erroneous contours. See the process for **Place Features** in this chapter for a suggestion on how to combat this situation and further enhance the surface.

Place Feature

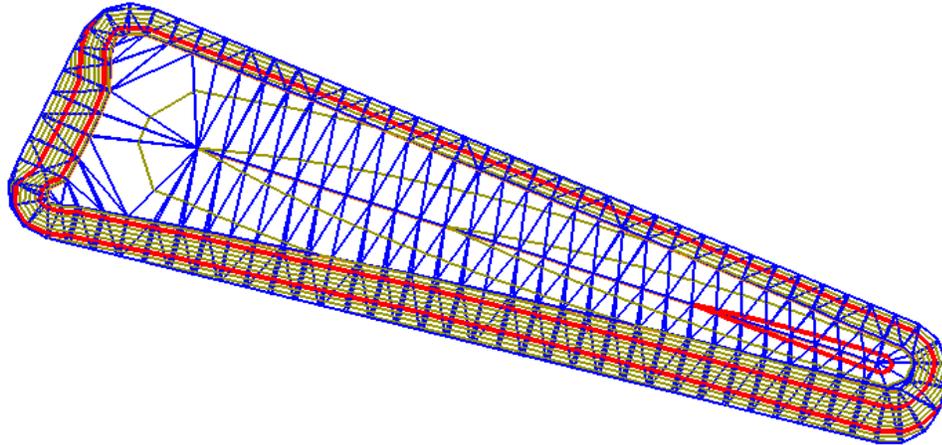
The **Place Feature** command is used to create individual 3D features in a DTM. This is useful in various situations, such as adding a utility to a DTM, controlling triangulation in a specific area, or just adding a breakline for a portion of the design.



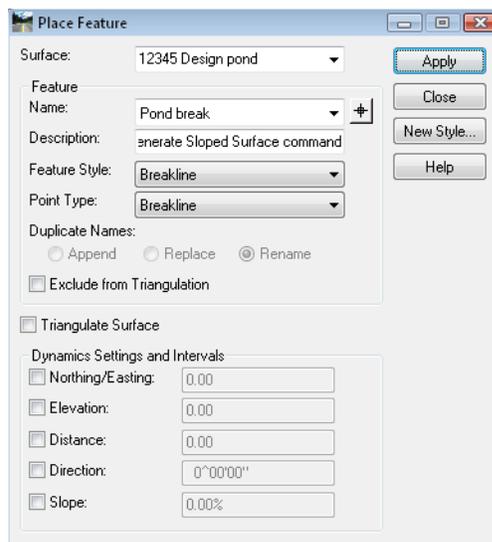
In this example, a breakline is added to enhance the triangulation of a sloped bottom pond. Notice how the contours do not follow the shape of the pond bottom in the corners.



Displaying the triangles shows why; in the corners the triangles have all three points touching the edge of the pond bottom, with nothing projecting to the drain line in the middle of the pond. Breaklines can help resolve this issue, resulting in a better surface model.



1. Select **Surface > Design Surface > Place Feature**.



2. Specify the **Surface** to add the feature to in the drop-down list.

Note: If it is a brand new surface, the name can be typed in here and the surface is created when the command is applied.

Note: The **Feature** area of the dialog is automatically populated with information from the first feature in the active surface. This is the area where the new feature information is entered.

3. Either key in a **Name** or choose one from the drop-down.

Note: See the **Duplicate Name** information below regarding what happens if an existing feature name is chosen.

4. Enter a **Description** (optional).
5. Choose a **Feature Style** from the drop-down list that matches the feature being created. These styles are stored in CDOT's XIN file.

Hint: If there is already a feature using the desired style, save time by selecting it as the **Name** to populate the **Feature Style** field, then type over the name with your new one.
6. Set the **Point Type** to **Breakline**.
 - ◆ In general, this command is used to create breakline features, although you can also create **Random**, **Contour**, **Interior** or **Exterior** features.
 - ◆ Random features do not show up on cross sections or profiles.

Note: The **Duplicate Names** area is only applicable if you have chosen a name that already exists in the surface.

 - **Append:** The feature added is appended to the end of the named feature. As points are added, there is rubberbanding in the graphics file to show which end of the feature is being appended. If it is not the desired end, use **Surface > Edit Surface > Reverse Feature Direction** to first change the orientation of the original feature.
 - **Replace:** The old feature is removed and the new one added in its place.
 - **Rename:** A numeric suffix is added onto the name and used for the new feature.
7. Toggle off **Exclude from Triangulation**.

Note: Toggle this option on if the feature is a utility, right-of-way, or some other breakline that you want to show on profiles and cross sections but do not want to affect the triangulation.
8. Toggle off **Triangulate Surface**.

Note: Toggle this option on if it's desired to see results of re-triangulation after each feature is added.
9. Toggle off all options under **Dynamic Settings and Intervals**.

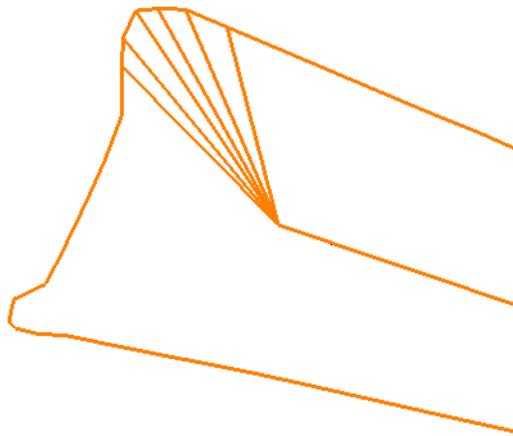
Note: These options are intervals, not actual values. For example, if you set the **Distance** interval to **100**, the vertices of the feature being placed are locked into multiples of 100 master units apart. This is useful if the breakline represents pipe that must be placed in fixed lengths, for example.
10. <D> **Apply** to open the **Set Elevation** dialog box and begin the process of entering the feature.

The Set Elevation Box

A second dialog appears when the command is applied. This dialog allows the elevation of the cursor to be overridden for each vertex.

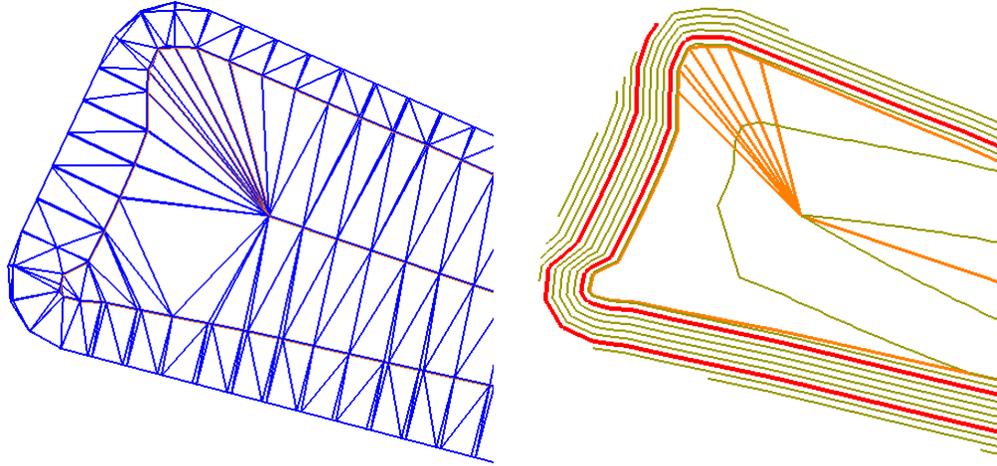


1. Toggle off both *Specify Elevation* and *Elevation from Surface*.
 - ◆ If you toggle on *Specify Elevation* the elevation of each vertex can be entered.
 - ◆ If you toggle on *Elevation from Surface* each vertex pulls its elevation from the listed surface. This surface does not have to be the same as the to which the feature is being added. An *Elevation Adjustment* is also allowed for adding the feature a specified distance above or below the listed surface. This is useful for specifying coverage for a utility.
 - ◆ If you leave both toggles off the elevations are taken from the cursor location (element's elevation if you snap to something or active depth if you do not).
2. Snap to the drain line end, then the pond bottom, to pick up the elevations and place the feature.



Note: Additional features can be added as necessary.

3. Triangulate the surface (*Surface > Triangulate Surface*) when done, and view the contours to see any improvement.



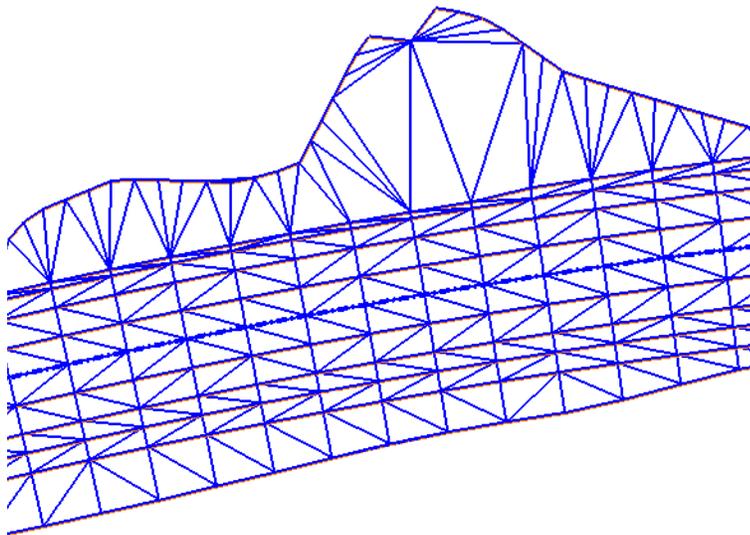
This process is iterative and a choice must be made as to the value of continual refinement to the DTM, the goal being not to pass the point of diminishing returns.

Generate Transverse Feature

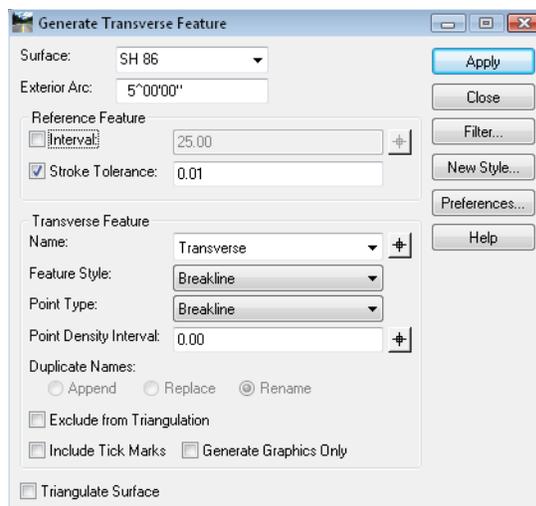
The **Generate Transverse Feature** command creates a new feature that consists of lines at a specified interval connecting two known features. The lines are perpendicular to, and the interval is specified along, a reference feature. You can also work in **Graphics Only** mode and identify MicroStation elements as either of the known or the reference lines.

Transverse features are useful when triangulation is not forming the slopes between the two known features as you need. For example, if one feature has less points than the other, there may be large, irregular triangles formed, or if one or both of the known features have concave areas where triangles are cutting across and touching only one of the features.

In the diagram below, notice the sideslopes in the fill area are created with triangles that are not perpendicular to the centerline. This could happen in cases where you create the sideslope after the backbone model is formed or when you're using **Surface Edit** tools to create a new model.



1. Choose **Surface > Design Surface > Generate Transverse Feature**.



2. Specify the *Surface* to add the feature to in the drop-down list.

Note: If it is a brand new surface, the name can be typed in here and the surface is created when the command is applied.

3. For *Exterior Arc*, key in 5^\wedge .

Note: The *Exterior Arc* is used when the reference feature has exterior corners between the two known features. In this case, it is set to 5^\wedge . When the transverse feature is created to the outside of a corner, the resulting feature lines will fan out from the corner in 5^\wedge increments, giving the effect of a fillet. The smaller the setting, the smoother the fillet.

Reference Feature

This category is for specifying at how many locations that transverse lines will be created in the resulting feature. Either *Interval*, *Stroke Tolerance* or both must be toggled on.

4. Set the interval to 25. In general, this setting should reflect a similar interval to the surrounding features.

Note: Interval is a master-unit setting that determines how often along the reference feature or element a new transverse line is created.

5. Toggle on *Stroke Tolerance* and set to **0.01**.

Note: Stroke Tolerance has two functions:

- ◆ First, if the reference element is a curve or arc, this setting is used to stroke the curve or arc into a series of vertices. See the *InRoads Online Help* for more information.
- ◆ Second, it ensures the creation of a vertex at each occurrence of a vertex in the reference feature or element.

6. Toggle *Generate Graphics Only* off. If on, several of the feature settings do not apply since only graphics result from the command.

7. Key in a new *Name* for the transverse feature you're creating.

8. Choose a *Feature Style* that matches the feature being created. These styles are stored in CDOT's XIN file.

Hint: If there is already a feature using the desired style, select it as the *Name* to populate the *Feature Style* field, and then type over the name with your new name.

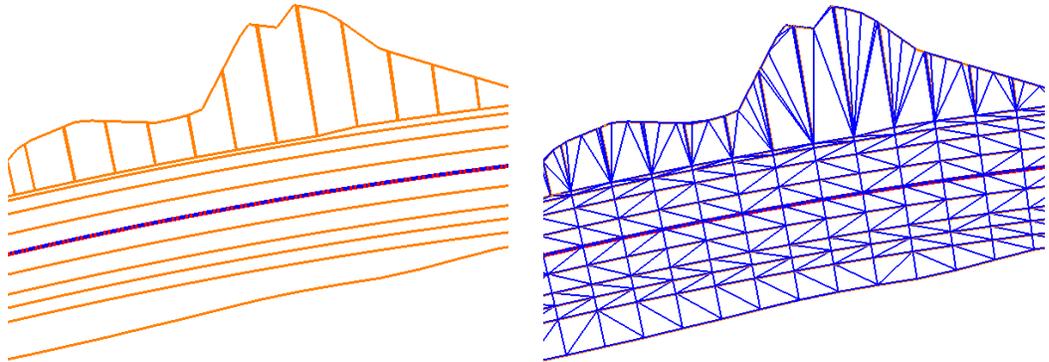
9. Set the *Point Type* to *Breakline*.

- ◆ In general, this command is used to create breakline features, although you can also create *Random*, *Contour*, *Interior* or *Exterior* features.
- ◆ Random feature do not show up on cross sections or profiles. Use breaklines for that purpose, even though they do not have to be triangulated.

For details on other options, see the *InRoads Online Help*.

10. <D> **Apply** and follow the prompts and <D> to identify the **Primary**, **Secondary** and **Reference** lines.

Note: These can be either graphics or features as specified by the **Locate Graphics / Locate Features** lock. Here, the POSS is the **Primary** Feature (where the transverse lines are coming from), the Fill slope is the **Secondary** Feature (where the transverse lines are going) and the POSS is the **Reference** (what the transverse lines are perpendicular to, and where the interval is measured).



Notice in this case, you may need to add additional features to “catch” each of the vertices in the new toe of slope.

Fillet Features

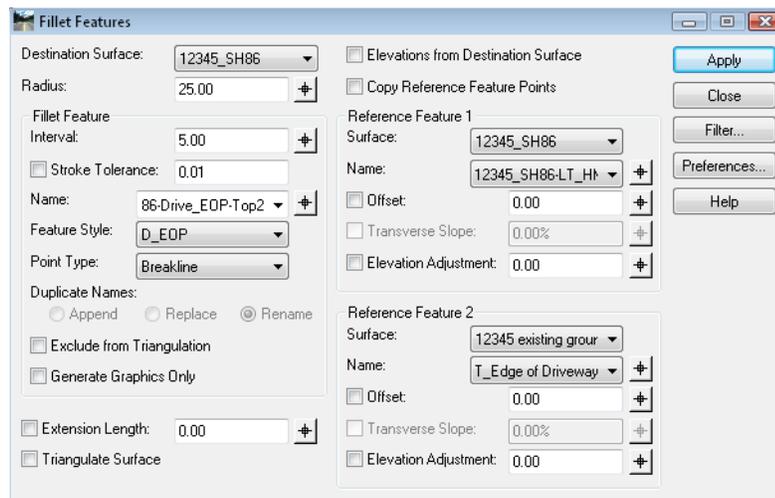
The **Fillet Features** command is used to create a 3D fillet between two existing elements or features. The result can be either a new feature or a graphic element, depending upon the **Generate Graphics Only** toggle. While it can be used anytime a fillet is needed, one of the most common uses is to create a return for a driveway. Intersection returns are typically handled with templates. See the **Roadway Modeling** chapter for additional details.

Note: This command produces a 3D linestring or feature, not a true arc.

Note: The **Multi-Center Curve** command can also be used in this situation, creating a horizontal and vertical alignment for the 3D return, followed by running a template for the return.

To create a driveway fillet:

1. Select **Surface > Design Surface > Fillet Features**.



2. Select the **Destination Surface** where you want the fillet placed. In this case, it's the proposed model.
3. Set the **Radius** desired for the fillet.
4. For **Interval** key in **5**.
5. Toggle off **Stroke Tolerance**.

Note: The **Interval** and **Stroke Tolerance** determine the density of the vertices in the resulting feature.

6. Specify the **Name** of the feature.

Hint: If you choose a name that exists already, it will populate the **Feature Style** and the **Point Type** so you don't have to. You can then type over the existing name with a new one.

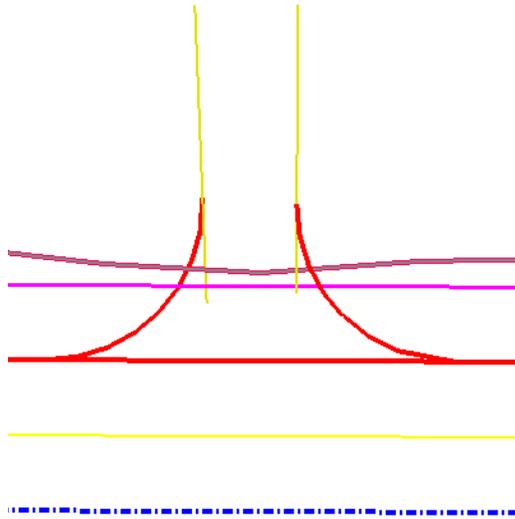
7. Select **Reference Features 1** from the drop-down list or use the target locator button to graphically select the feature.

- Repeat for **Reference Feature 2**.

Note: **Reference Feature 1** and **2** are the features from which you are creating the fillet. The order in which you select the features determines the direction of the resulting fillet feature (direction is from 1 to 2).

For details on the other options, see the **InRoads Online Help**.

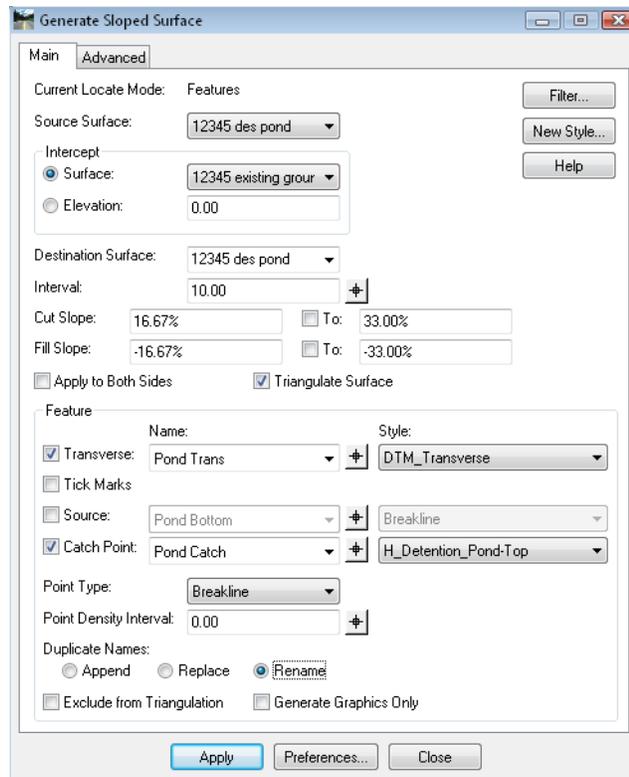
- <D> **Apply** and when prompted, identify the quadrant where you want the fillet.
- Accept with a <D>.



Generate Sloped Surface

The **Generate Sloped Surface (GSS)** command can be used anywhere you need to generate a slope extending from a known feature or graphic element to a surface. In this case, it is used to create a sideslope for a pond.

1. Select **Surface > Design Surface > Generate Sloped Surface**.



Note: The *Current Locate Mode* is determined by the *Locate Features / Locate Graphics* lock.

2. Set the *Source Surface* to the surface where the origin of the slope is located.
3. Set the *Intercept Surface* to the surface that you are intercepting with the slope.

Note: You can also tie into an elevation, such as when you want to bench the slope at an elevation.

4. Set the *Destination Surface* to the surface where the slopes are placed. The surface can exist already, or you can type in the name of a new one and it is created when you Apply.
5. Key in the values for the *Cut* and *Fill* Slopes.

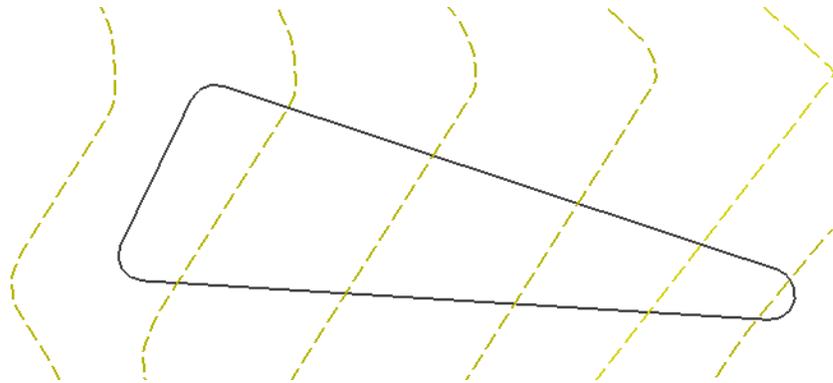
Note: For the *Cut* and *Fill* Slopes, there is a percentage and a *To:* option. Use this when you want to transition between two sideslopes.

- Toggle off *Apply to Both Sides*.

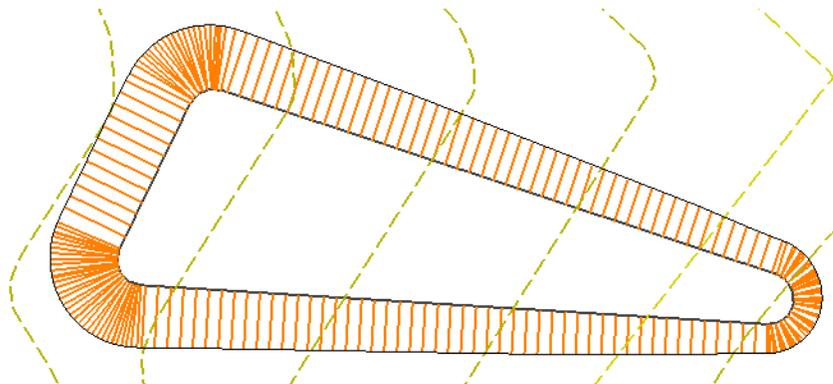
Note: Use *Apply to Both Sides* when you want slopes extending from both sides of the feature or element, such as when you are creating a ditch.

For details on the other options, see the *InRoads Online Help*.

- <D> **Apply** and when prompted, identify the feature you're sloping from.



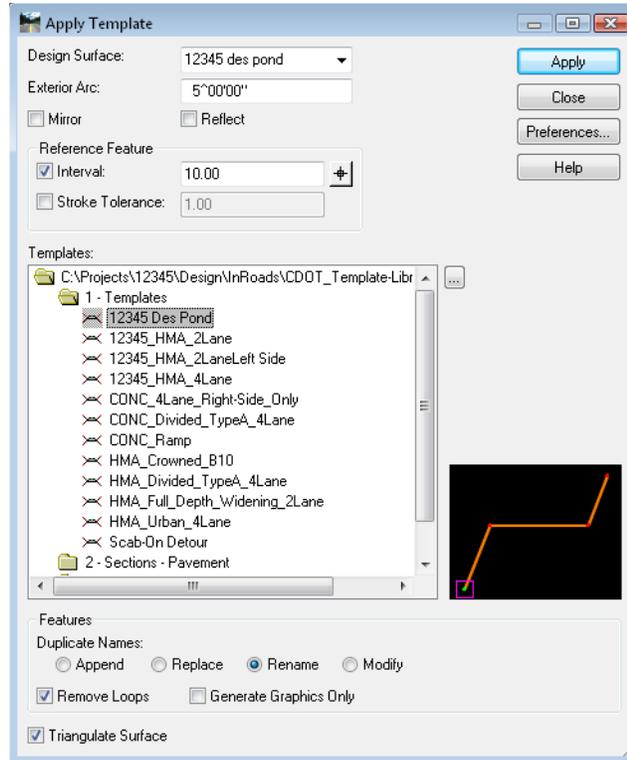
- When prompted, <D> to identify the beginning point of the sideslope, then <D> again for the ending point. Optionally, you <R> to use the entire feature, as shown here.
- <D> to accept the sideslope on the side of the original feature where you want the sideslopes to be formed.



Apply Template

Apply Template basically allows you to use any MicroStation element or InRoads feature as the horizontal and vertical control for creating a DTM from a template, without having to set up a corridor using Roadway Designer. This is very useful, for example, when creating:

- Sideslopes from a pond or pit that are more complex than **Generate Sloped Surface** is capable of producing
- Walls created without Designer, such as the terraced walls under an interchange bridge



While the same templates can be used for Roadway Designer's **Template Drops** and the **Apply Template** command, keep in mind that **Apply Template** cannot transition between different templates or use any of the other advanced modeling options available in Designer such as **Point Controls** and **Parametric Constraints**.

In this example, a pond is being modeled from a known bottom (created previously with **Generate Longitudinal Feature**). The sideslope of the pond is set to slope up to a certain elevation, berm and then proceed in cut until interception with the existing ground.

Note: Most CDOT end condition templates are created with the **Target** listed as **Active Surface**. If this is the case for the template being used with **Apply Template**, be certain the correct surface is active before Applying.

1. Select **Surface > Design Surface > Apply Template**.
2. Toggle off **Generate Graphics Only**, or the command will not create features.
3. Specify the **Design Surface**.

Note: The *Design Surface* is where the resulting features are placed, not the target surface for the template.

4. Toggle off *Mirror* and *Reflect*.

Note: The direction of the graphic or feature determines the direction the template is run. If necessary, you can reverse the direction (for a graphic, use **Change Element Direction**; for a feature, use **Reverse Feature Direction**) or you can *Reflect* the template. If you want to run the template down both sides of the graphic or feature, select *Mirror*.

5. Select your template from the library and set the other options as shown.

For details on the other options, see the *InRoads Online Help*.

6. <D> **Apply** and identify the graphic or feature the slopes are coming from (in this case, the pond bottom).

Note: You are prompted based on your *Locate Graphics / Locate Features* toggle for either a *Primary Element* or a *Primary Feature*.

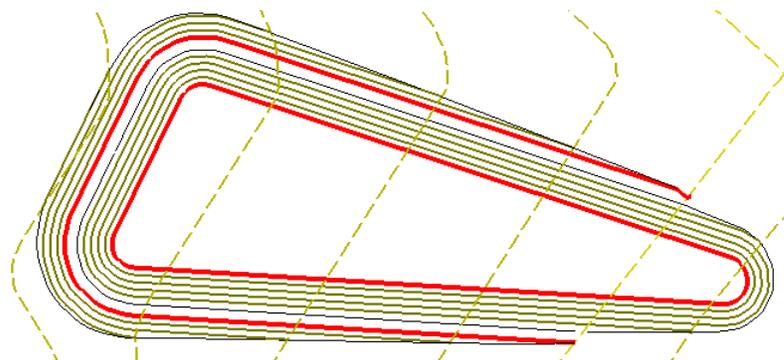
7. <D> on the bottom of the pond to identify it as the *Primary*.
8. Next, you are prompted for the *Reference*. <D> on the bottom of the pond as the reference.

Note: The template is applied perpendicular to the Reference, and the interval is applied to the Reference. In this case, the bottom of the pond is both the Primary and the Reference. An example of when they might not be the same is when you are applying the template to an edge of pavement, but you want the results perpendicular to the centerline alignment.

9. You are then prompted to identify the beginning (and subsequently the end) of the pond bottom or if you Reset <R>, the entire feature is used. In this case, <R> to identify the entire pond bottom. Notice also there is tracking so you can see the direction of the feature.
10. <D> to accept the solution and the sideslopes are created.

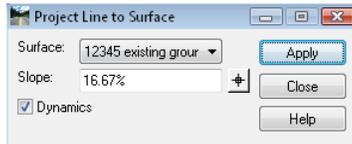
Note: When the *Triangulate Surface* option is toggled on, the features created by **Apply Template** are incorporated into the triangulated DTM.

11. View the triangles or contours to see the results.



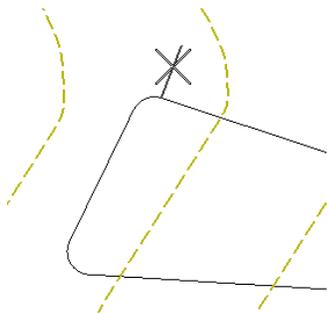
Project Line to Surface

The **Project Line to Surface** command is useful when you need to know where a certain slope intercepts a surface before creating a sideslope. It can also be used for line-of-site studies. The input for the command is a MicroStation graphic to start from and the result of this command is a MicroStation line; no features are used or created.

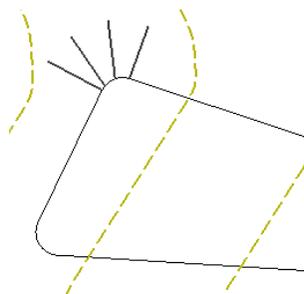


1. Select **Surface > Design Surface > Project Line to Surface**.
2. Set the **Surface** to the one you want to intercept.
3. Key in a **Slope** of the resulting line.
4. Toggle on **Dynamics**.
5. **<D> Apply**.
6. When prompted, snap to the element you're sloping from.

Note: In the direction defined by the location of the cursor, a line extends until it intercepts the given surface. A **<D>** creates the line as an element. If you want to come from the same point in a different direction, you can continue to move your cursor and **<D>** wherever necessary.

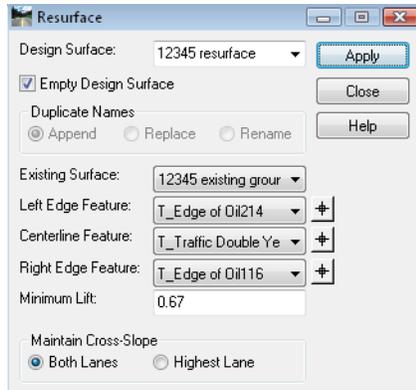


In this case, multiple points are checked along the element to see where the slope intercepts. The endpoints of these lines could be joined with a linestring and loaded as a feature for the toe of slope, or you can now use **Generate Sloped Surface** to create the features after identifying the desired slope with the **Project Line to Surface** command.



Resurface

The **Resurface** command is useful when you need to define features for a resurfacing project that ‘clear’ the existing surface plus a minimum lift. Using the **Maintain Cross Slope – Both Lanes** toggle, the features are created so that when the existing cross slope on each side of the roadway is maintained, the new features form a surface that is the lift-height above the closest orthogonal point to the new surface. In order to use this command, you must have features for the existing centerline and pavement edges.



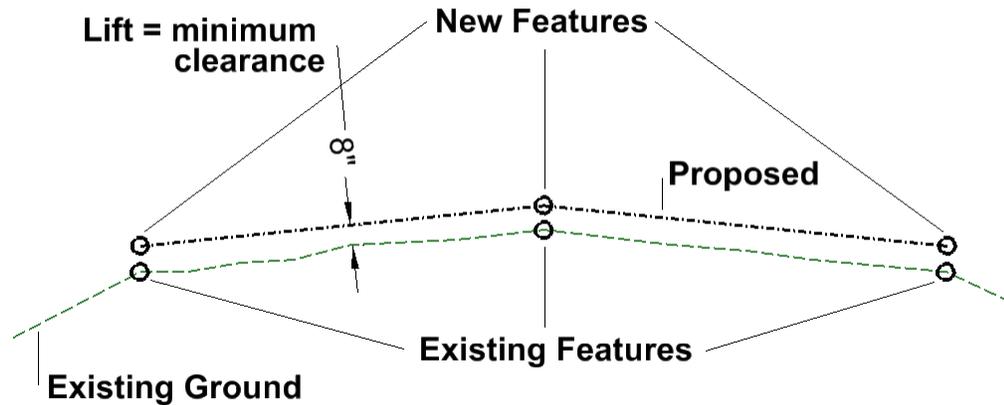
Resurface is an **Application Add-In** that must be toggle on prior to use. Select **Tools > Application Add-Ins** and toggle **Resurface** on if you don't initially see it on your menu.

1. Select **Surface > Design Surface > Resurface**.
2. Set the **Design Surface** to the surface where you want the new features to be created.
3. Set the **Existing Surface** to the surface where the current features for the Centerline, Left and Right Edge features are located.
4. Key in the minimum lift.

For details on the other options, see the **InRoads Online Help**.

5. <D> **Apply** to create the new features.

At each vertex along the centerline feature, the current cross slope is measured, the highest orthogonal distance from that cross slope is determined, and new features are added so that the same cross slope can be maintained along with a minimum clearance between the existing surface and new cross slope equal to the lift value.



Since there are no components added to the proposed surface using this command, the real value comes from using these new features as controls when creating a model using Templates and Roadway Designer. See the *Typical Sections* and *Roadway Modeling* chapters in this guide for additional information.

Section Summary:

- Design surfaces do not have to be created from Roadway Designer alone.
- Commands that create features allow you to enhance a surface created with other tools or create a new surface from scratch.
- Templates can be used with surface manipulation commands without using Roadway Designer or setting up corridors.
- Features resulting from these commands can be used in combination with Roadway Designer, such as for **Point Controls** or horizontal and verticals control for a corridor.

Modifying Features

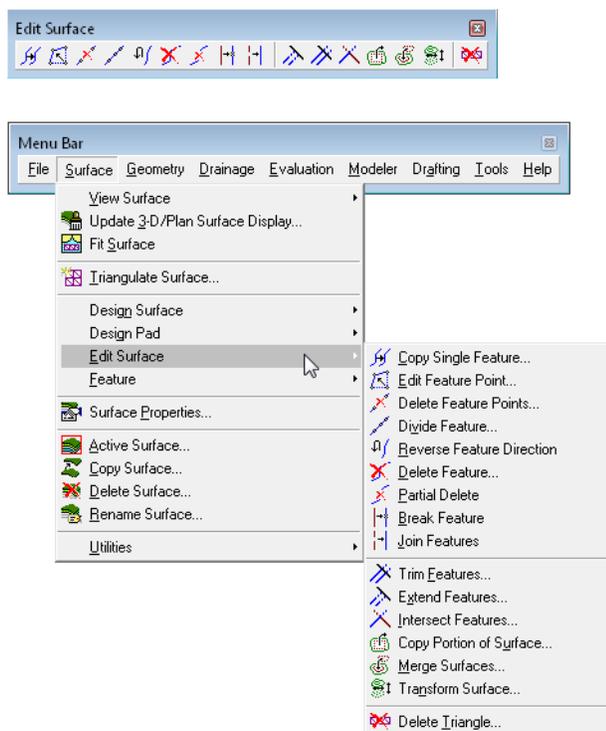
There are many options within InRoads that assist in manipulating design models by changing current features. These tools are used when creating surfaces from scratch, such as ponds or parking lots, or when modifying previously created models such as roadways developed with Roadway Designer.

Section Objectives:

- To be able to modify horizontal and vertical locations of existing features.
- To develop an understanding of when each of the feature editing commands should be used.
- To learn techniques that refine existing surface models by modifying features.

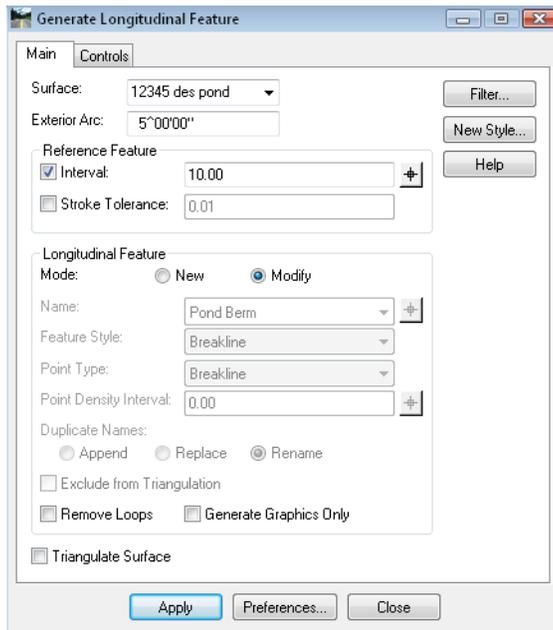
Accessing Edit Surface Commands

While there are many commands in InRoads that modify features, several of them are grouped under **Edit Surface**. You can access them from the **Surface > Edit Surface** pull-down menu, or from the **Edit Surface** toolbar. Most are described in the following section.



Generate Longitudinal Feature

Generate Longitudinal Feature (GLF) is used to create and/or modify 3D MicroStation elements or features in a DTM. It is an extremely powerful tool that allows much easier manipulation in 3D than MicroStation alone.

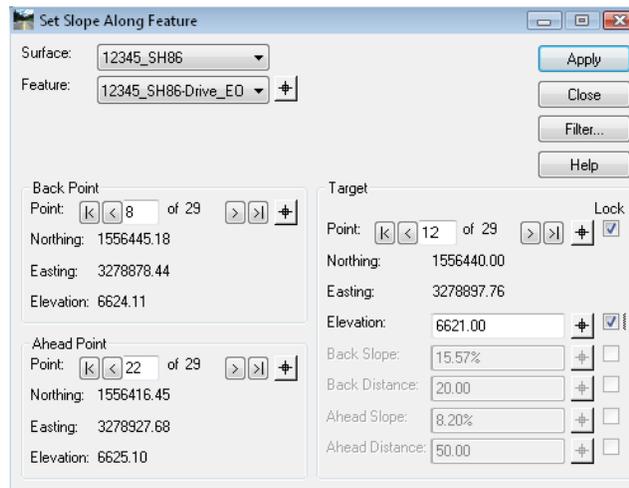


When using this command to modify existing features, several of the options are not available, as they are already set for the feature (such as *Name*, *Style*, etc).

For information on using **GLF**, see the **Generate Longitudinal Feature** topic in the **Creating Features** section of this chapter.

Set Slope Along Feature

The **Set Slope Along Feature** command is used when you need to modify elevations of points in a feature by defining a slope along the feature, but you do not want to modify the XY location of any of the points. For example, use this command when you need to ensure a drain line slopes to a low point on the feature.

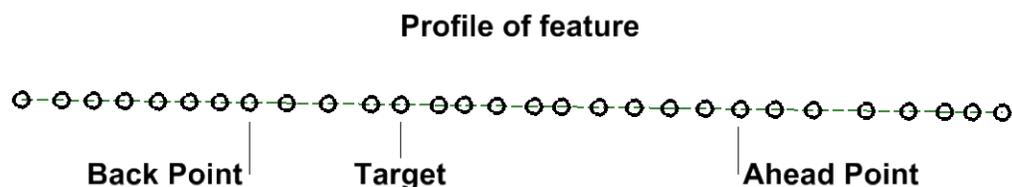


In this example, a low point is needed in the middle of a return.

1. Select **Surface > Set Slope Along Feature**.
2. Set the **Surface** to the surface containing the feature you are changing.
3. Select the **Feature** from the drop-down list, or use the **Locate** button to select the feature graphically.

For this example:

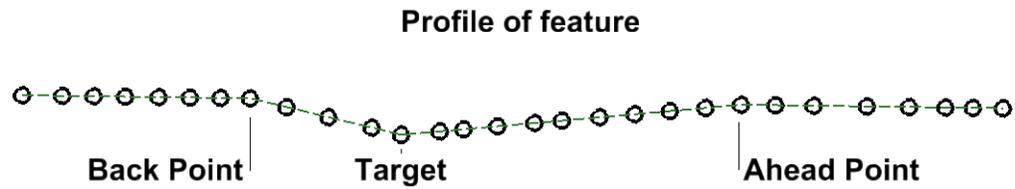
4. Set the **Back** and **Ahead Points** to the points you want to hold constant.
5. Set the **Target** to the point you want to assign a new elevation.



6. In the Target section, toggle on **Lock** for the **Point** and **Elevation** and key in the elevation.

Note: When setting the target, you have the option of locking two of several inputs to create the desired results. In this case, we want the Target **Point** locked (so a new point is not created), and we want the **Elevation** locked for that point. All points between the **Back** and **Ahead** are adjusted in elevation to accommodate the modified point.

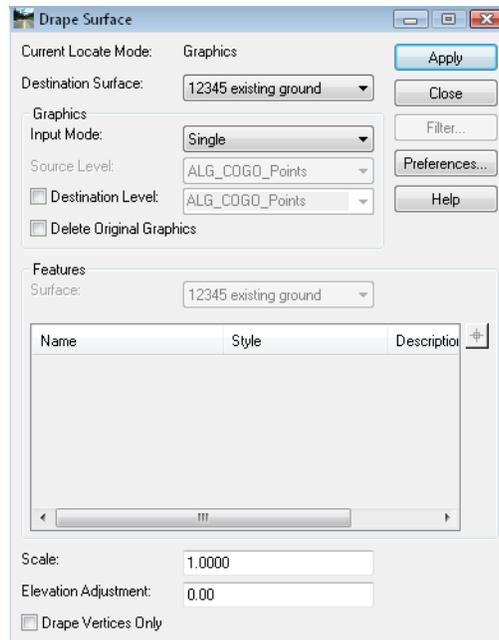
7. <D> **Apply** to modify the feature.



For details on using the other *Target* options, see the *InRoads Online Help*.

Drape Surface

Drape Surface is used when you want to force a graphic element or a feature (based on the *Locate Graphic / Locate Feature* toggle) to take on the elevations of an existing DTM. This command increases the number of vertices, since not only are the original vertices assigned the elevations of the surface, but a vertex is added everywhere a triangle is crossed. The exception is when *Drape Vertices Only* is on, in which case only the original vertices are assigned new elevations.



The *Destination Surface* determines the elevations and is where the new feature is created if the *Destination* and *Features Surfaces* are not the same. (If they are the same, the feature is modified.)

In the following example, the outer perimeter of a pond is known, so to begin modeling the pond, this perimeter must first be draped onto the existing surface. If the perimeter was draped as a feature, it would then reside in the existing surface model. Since the pond is modeled in a separate surface, it is draped as a graphic, then imported.

1. Set the *Locate Graphics / Locate Features* toggle to *Locate Graphics*.
2. Draw the perimeter of the pond with MicroStation if it doesn't already exist.
3. Select **Surface > Design Surface > Drape Surface**.
4. Set the *Input Mode* to *Single*.

Note: You can use a Level or Fence from the drop-down. You can also use a MicroStation selection set by having it active first, then choosing *Single*.

5. Toggle off **Destination Level** and **Delete Original Graphic**.

Note: If **Destination Level** is toggled on, the new draped graphic is created on that level. If not, it is created on the level of the original graphic, which may or may not be deleted based on the **Delete Original Graphics** toggle.

6. For **Scale** key in **1**.

Note: The **Scale** is used to exaggerate the display of the results. It does not affect the actual elevations if creating a feature.

7. For **Elevation Adjustment** key in **0**.

Note: **Elevation Adjustment** is used when you want to add or subtract a set amount from the elevation of each vertex. For example, you can use this to drape an underground utility to 6' below the existing ground.

8. <D> **Apply** and <D> on the graphic to drape.

9. <D> to accept the results and the new graphic is created.

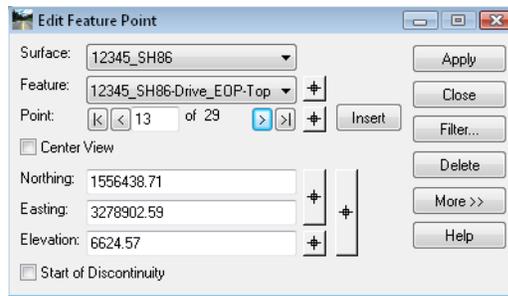
Important! If you want to drape a feature onto one surface but have it placed in another, you can use the **Drape Vertical** option in **Generate Longitudinal Feature** or **Import Surface from Graphics** with the **Drape** option.

The draped graphic may now be imported or used with either **Generate Sloped Surface** or **Apply Template**.

Edit Feature Point

Edit Feature Point is useful when you need to edit or delete one vertex of a feature at a time. For example, if you have a spike in a surface caused by a zero-elevation point that was accidentally included in a breakline, use this command to delete it.

1. Select **Surface > Edit Surface > Edit Feature Point**.



2. Set the **Surface** to the surface that contains the feature you want to edit
3. Select the **Feature** that you want to edit.
4. Select the feature **Point** that you want to edit.

Note: You can step through the points, or you can use the **Locate** button to choose the point graphically. When the point is active, there is a target symbol identifying it in the MicroStation view. If the **Center View** option is toggled on, MicroStation will center the current view on the selected point.

5. Change the **Northing**, **Easting** and/or the **Elevation** by keying in new values or by using the appropriate **Locate** button and setting the values graphically.
6. Select the **More >>** button to access additional options for setting the location of the active point. These options are similar to those found on the **Set Slope Along Feature** command.

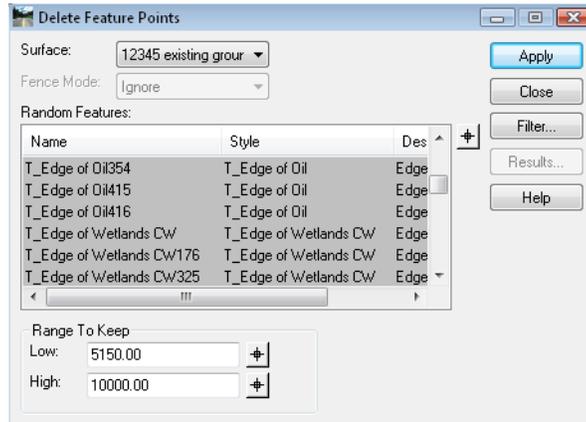
Note: You can edit more than one point in a feature before you choose Apply, but changes are not made in the surface or reflected graphically until you do.

7. <D> **Apply** to edit the point(s).

For details on the other options, see the **InRoads Online Help**.

Delete Feature Point

The **Delete Feature Point** is useful when you want to delete Random points in a DTM that are outside of an elevation range. For example, if you have several points with a zero elevation, you can use this command to get rid of them all at once without having to find and delete them individually.



Note: The features containing the points that are out of the **Range to Keep** specified must be highlighted before choosing Apply. Only Random point features are shown in the dialog, and you can use **Feature Filters** to further limit the features shown.

Reverse Feature Direction

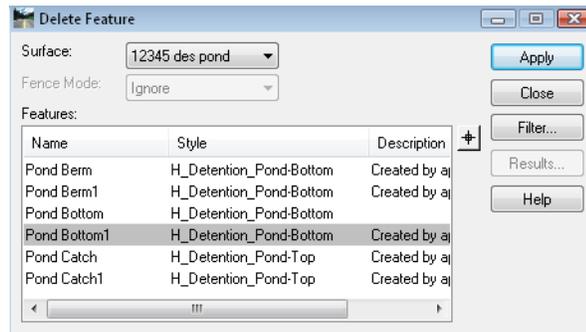
The **Reverse Feature Direction** command is very much like the **Change Element Direction** command in MicroStation. It is useful when you have a feature running in one direction and you would like it to run in the other. For example, if you are using the feature for the horizontal and vertical control in a corridor (in place of a horizontal and vertical alignment) and the feature was built in the opposite direction you want your model created.

1. Select **Surface > Edit Surface > Reverse Feature Direction**.
2. When prompted, <D> to identify the feature.
3. Once highlighted, the name of the feature is shown in the message field and you can **Accept <D>** or **Reject <R>** the feature. Reject it and the next closest feature is highlighted for you to Accept or Reject.

Note: There is no dialog box for this command, so be sure to read the prompts.

Delete Feature

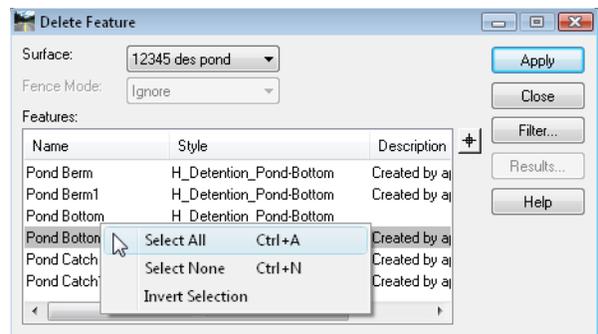
The **Delete Feature** command allows you to remove one or more features from a surface. In the dialog box, the list of features is controlled by the **Feature Filter** lock, so you can segregate out just the features you want to see, if necessary.



1. Choose **Surface > Edit Surface > Delete Feature**.

Note: If there is a fence active, you can choose from **Ignore**, **Inside** or **Outside** options. These modes act like the **Clip** option in MicroStation. If a feature extends out both sides of the fence, using the **Inside** option results in a feature with a gap.

2. In the feature list, **<D>** to highlight the feature or features you want to delete. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert Selection**.



Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

3. **<D> Apply** and the feature or features selected are deleted from the surface.
4. Select **Results** to see how many feature points were removed with the action. (**Results** will only show points deleted from Random, Breakline and Interior Features, even though other types may be deleted.)

Note: If you want to delete all the features in a surface, **<R>** on the surface in the Explorer portion of the InRoads menu and select **Empty**.

Partial Delete

The **Partial Delete** command works much like the MicroStation **Partial Delete**, except it works with features. The MicroStation display of the feature is also updated if it was originally displayed in *Pencil* Mode.

1. Select **Surface > Edit Surface > Partial Delete**.
2. When prompted, <D> on the feature to identify it.
3. <D> to *Accept* the feature or <R> to *Reject* the feature when it highlights and its name appears in the prompt field.
4. <D> on a *Starting* point for the delete.
5. <D> on an *Ending* point for the delete.

The results are one feature with a gap where you partially deleted it. To make two features out of the gapped feature, see the following **Break Feature** command.

Note: There is no dialog box for this command, so be sure to read the prompts.

Important! When you **Partial Delete** a feature, a point is added at each end of the delete. If you want to only retain original points in the feature, turn the *Snap* lock to *Point Snap* and the starting and ending points of the deletion are forced to fall on existing vertices.

Break Feature

Break Feature quite simply make two features out of one. The second feature has the same name as the first with a counter appended on the end. This command does not leave a gap, but rather leaves the two features with a common point where they meet. If the feature already has a gap, you can break the feature at either end of the gap to get two features.

1. Select **Surface > Edit Surface > Break Feature**.
2. <D> the feature you want to break.
3. *Accept* <D> if the correct feature name is shown, *Reject* <R> if not.
4. Once the feature is accepted, a tracking line is displayed from the feature to your cursor. Locate the point where you want to break the feature and <D>.

Note: There is no dialog box for this command, so be sure to read the prompts.

Important! When you break a feature, a point may be added to each feature at the break point. If you want to only retain original points in the feature, turn the *Snap* lock to *Point Snap* and the break point is forced to fall on an existing vertex.

Join Features

The **Join Features** command is very similar to the MicroStation **Create Complex Chain** command. It allows you to select two or more features to combine into one. Where it differs from the MicroStation command is in how the features are accepted. In MicroStation, you can select that next line with the accept of the current one. In joining features, you must select and accept each feature before moving on to the next one.

Use the **Join Feature** command when you want to combine more than one feature to use as the basis of a Roadway Designer **Corridor**, the **Apply Template** command, or as a target for an end condition, for example.

1. Select **Surface > Edit Surface > Join Features**.
2. <D> on the first feature, and <D> again to accept if it is the one that highlights and whose name is listed in the prompt field.

Note: The first feature selected determines the name of the resulting combined feature.

3. <D> on the second feature and <D> again to accept.

The second feature is deleted as it becomes part of the original feature.

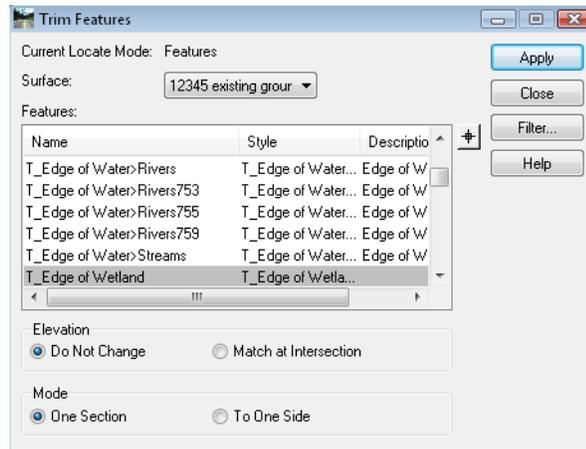
4. Continue to identify features and accept them until you have all the features you want combined.

Important! When the features do not touch, they are joined with a straight line closure. If the features overlap, they will still overlap after combining (i.e. they are not trimmed automatically). Since overlaps may cause DTM tolerance problems when triangulating, you can **Trim** or **Partial Delete** the features prior to joining. For more information about these commands, see their sections in this chapter.

Trim Features

The **Trim Features** command is similar to the **Trim** command in MicroStation. It allows you to trim a single feature or groups of features based on a cutting feature or cutting element. You can use **Trim Features** after combining features from different models where there is overlap, for example.

1. Select **Surface > Edit Surface > Trim Features**.



Note: Notice the current **Locate Mode**, which is controlled by the **Locate Graphics / Locate Features** lock. This determines whether you can identify a graphic element or a feature as the cutting element.

2. Select the **Surface** where the features reside.

Note: If you are clipping with a feature, it must reside in the same surface. If it does not, you can display it graphically, then use the **Locate Graphics** toggle.

3. In the feature list, highlight one or more features using the **<Shift>** or **<Ctrl>** keys when necessary. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert** the current selection. (You can use **Feature Filters** to narrow the list of features.)

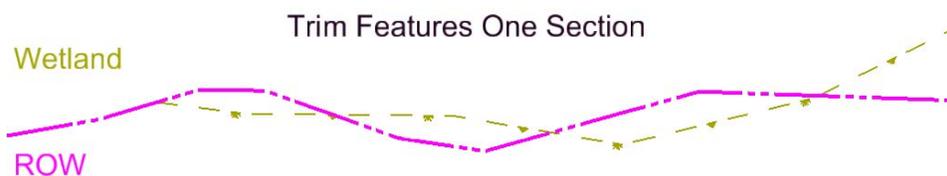
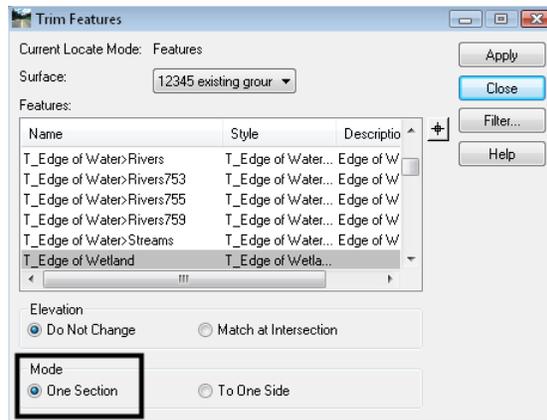
Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

4. In the **Elevation** section:

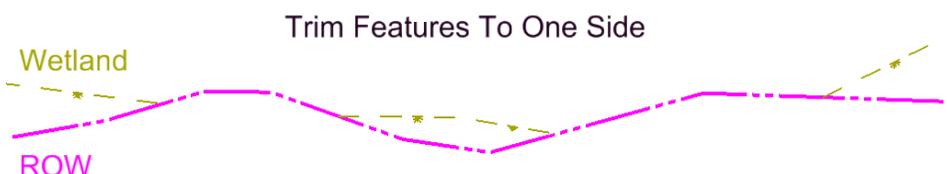
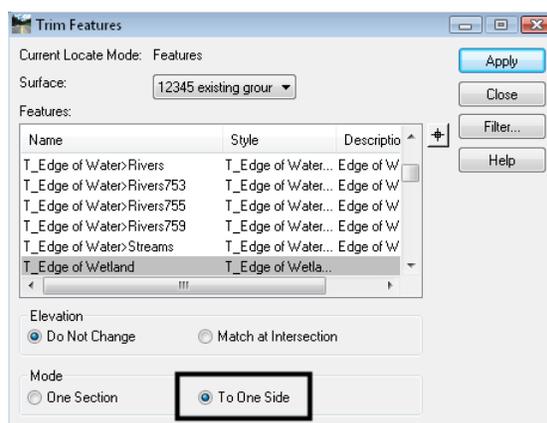
- ◆ Select **Do Not Change** when you want all features to retain their original elevations.
- ◆ Select **Match at Intersection** when you want the feature being clipped to adjust their elevations at the clip point to match that of the clipping feature or element.

- Select one of the **Mode** options. The **Mode** refers to how many trims you want to make on each feature.

◆ **One Section** is typical, when you want to trim the end of a feature back to another.



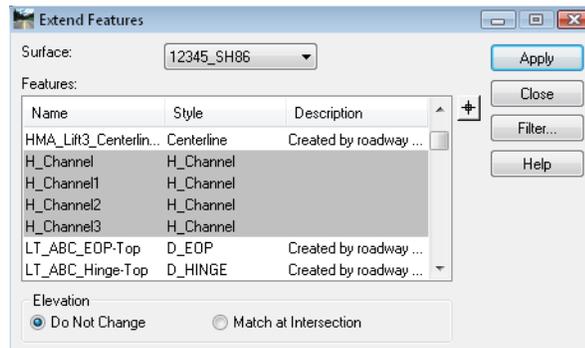
- Use **To One Side** when you want to only keep the portion of a feature that is on one side of another. For example, if you have a wetland feature and a ROW feature that overlap back and forth, and you're only concerned with the wetland if it's inside of your ROW. Highlight the wetland feature in your feature list, then identify the ROW as the clipping feature. With the mode set to **To One Side**, you'll be able to keep all parts of the wetland that are on one side of the ROW.



6. <D> **Apply** and select the clipping graphic or feature.
7. <D> to *Accept* the clipping graphic or feature.
8. <D> on the side you want to delete.

Extend Features

The **Extend Features** command is similar to the **Extend Line** command in MicroStation. It allows you to extend a single feature or groups of features until interception with another feature or graphic element.



1. Select **Surface > Edit Surface > Extend Features**.
2. Select the **Surface** where the feature(s) you are extending reside. If you are extending to a feature, it must reside in the same surface. If it does not, you can display it graphically, then use the **Locate Graphics** toggle.
3. In the feature list, highlight one or more features using the **<Shift>** or **<Ctrl>** keys when necessary. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert** the current selection. (You can use **Feature Filters** to narrow the list of features.)

Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

4. In the **Elevation** Section
 - ◆ Select **Do Not Change** when you want the features to extend at the same slope as the last segment of the feature.
 - ◆ Select **Match at Intersection** when you want the feature being extended to match the elevation of the feature or element to which it's being extended.
5. **<D> Apply** and select the graphic or feature to which you're extending.

Note: The **Locate Graphics / Locate Features** lock determines whether you can identify a graphic or a feature.

6. <D> to **Accept** the graphic or feature.

Features Before Extension

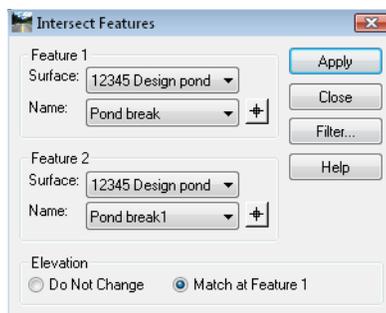


Features After Extension



Intersect Features

The **Intersect Features** command is similar to the **Extend Elements to Intersection** command in MicroStation. It allows you to extend two features until they intercept, and optionally change the elevation of the second to match that of the first at the intersection point.



1. Select **Surface > Edit Surface > Intersect Features**.
2. Select the **Surfaces** and **Features** you are intersecting. If you are not matching elevations, the order does not matter.
3. <D> **Apply**.
4. You are prompted to accept the intersection to keep. If there is more than one intersection, you can move your cursor to see additional intersections and <D> to keep the one you want.

Delete Triangle

The **Delete Triangle** command allows you to delete one or more triangles from a surface. It is useful when the triangulation routine creates triangles that you do not wish to keep. Sometimes, this is most obvious when creating contours which are derived from the triangles.



1. Select **Surface > Edit Surface > Delete Triangle**.



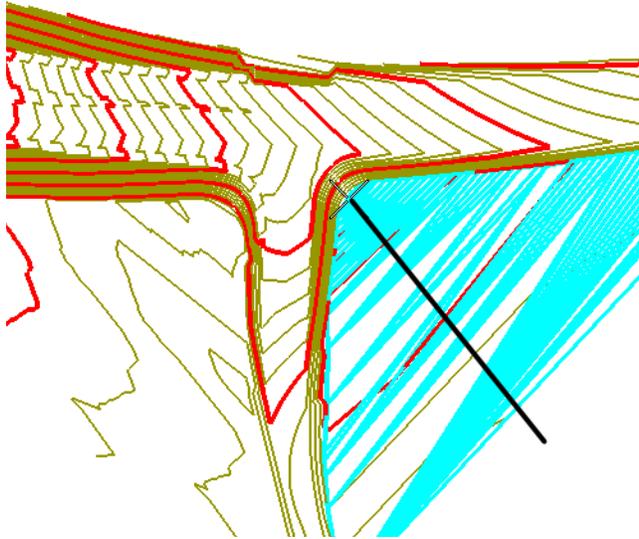
2. Select the *Surface* where the triangles exist.
3. <D> **Apply**.

If you are deleting one triangle:

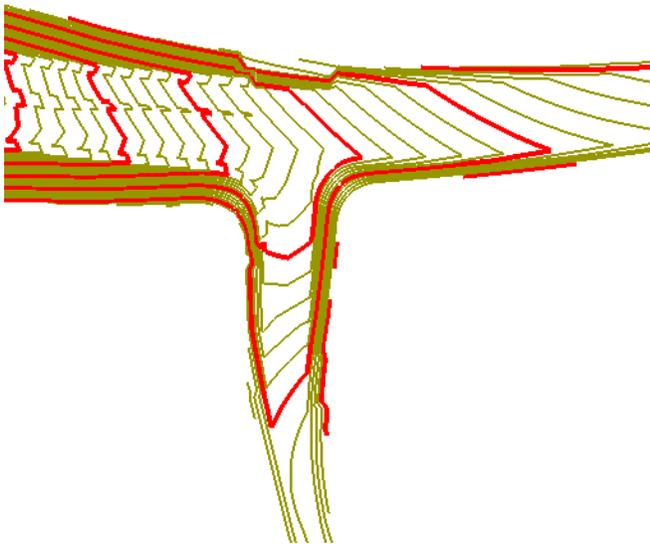
4. <D> on the same triangle twice, and <D> to **Accept**.

If you are deleting a series of adjacent triangles:

5. <D> on a starting point and move the cursor, drawing a line across the triangles you want to delete.



6. <D> to end the selection.
7. <D> again to accept the highlighted triangles as the ones to delete.

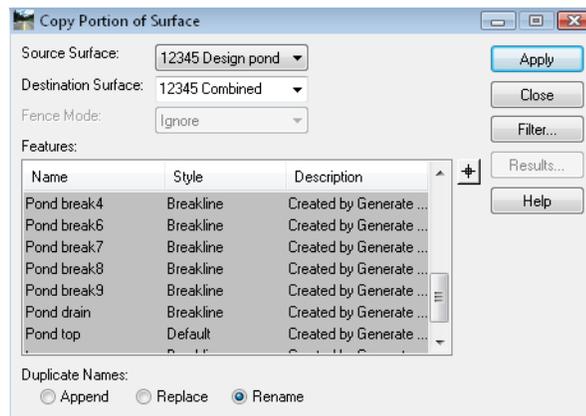


Note: The triangles do not have to be displayed. When you select them, they highlight. If you drag the cursor across a series of triangles, they are temporarily displayed; only the highlighted ones when you accept are actually deleted.

Important! If you delete triangles and the surface is re-triangulated, the triangles are re-created. To make certain the deletions are permanent, you can either add an exterior if the triangles are on the edge of the model as shown in this example, or add an interior if they are on the inside.

Copy Portion of Surface

The **Copy Portion of Surface** command is for copying features from one surface into another. You can combine two surfaces by copying all features, or you can selectively choose features to copy.



When copying an exterior from one surface to another, keep in mind there can only be one exterior in a surface and the last exterior added will be the exterior used in the surface.

1. Select **Surface > Edit Surface > Copy Portion of Surface**.
2. Specify the *Source Surface* where the feature currently resides.
3. Specify the *Destination Surface* where the features are going. If the surface does not exist, you can key in the name and it will be created when the command is applied.
4. In the feature list, highlight one or more features to copy using the **<Shift>** or **<Ctrl>** keys when necessary. **<R>** on the list for a menu that allows you to **Select All**, **Select None** or **Invert** the current selection. (You can use **Feature Filters** to narrow the list of features.)

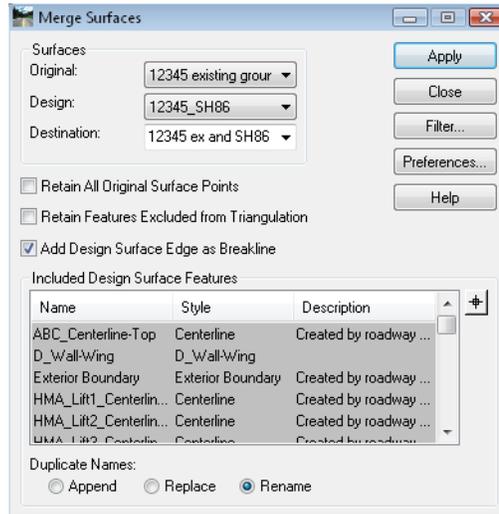
Note: **Select All** can be accessed with **<CTRL> A** and **Select None** with **<CTRL> N** without right-clicking.

5. **<D> Apply** to copy the features.

For details on other options, see the *InRoads Online Help*.

Merge Surfaces

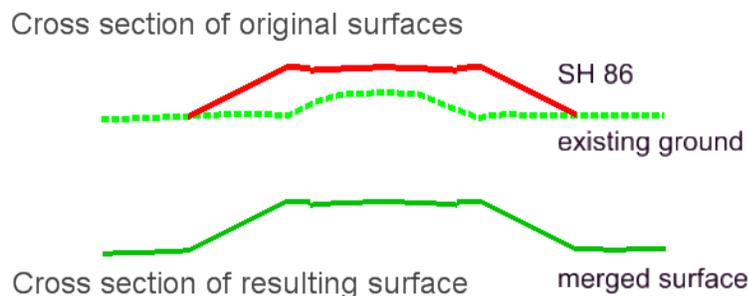
The **Merge Surfaces** command combines two surfaces. It is most useful for creating an ‘as-designed’ model, since it removes the portion of an **Original** surface that overlaps a **Design** surface. After using this command, you can create contours for the combined model showing what the surface should look like after the design is built.



1. Select **Surface > Edit Surface > Merge Surfaces**.
2. Specify the **Original** and **Design** surfaces.
3. Specify the **Destination Surface** where the combined model is created.

Note: If the surface does not exist, you can key in the name and it will be created when the command is applied. While you can replace the existing surface with the combined, it is not recommended.

4. **<D> Apply** and the surfaces are combined and the resulting merged surface is triangulated as shown in these before and after cross sections.

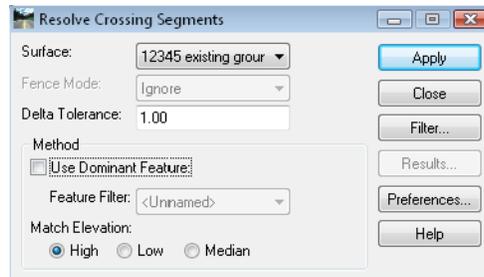


For details on other options, see the **InRoads Online Help**.

Note: Multiple merges typically begin to bog down the surface. This is not a good option for combining several surfaces, such as for the different models that may be created in designing an interchange. Use either **Copy Portion of Surface** or run multiple corridors at once with Roadway Designer.

Resolve Crossing Segments

The **Resolve Crossing Segments** command assists in correcting crossing linear features in a surface. When two linear features cross at the same elevation, a point is assumed at the crossing and the surface triangulates as normal. When the features cross but at different elevations, the software cannot triangulate the area since triangles cannot cross linear features. This command resolves those situations.



1. Select **Surface > Utilities > Resolve Crossing Segments**.
2. Key in the **Delta Tolerance**. This is the maximum difference in elevation you allow this command to correct. Anything larger and the crossing will be reported as unresolved.
3. If you have several crossings and there is a dominant feature or features, you can create a **Feature Filter**, toggle on **Use Dominant Feature** and select it from the list.

For example, if you have several drives that cross edges of pavement, you can set up a filter to filter everything but the edge of pavement features. In that case, anywhere there is a crossing within the specified vertical tolerance, the crossing is resolved by adding a point at the elevation of the edge of pavement.

4. Select one of the **Match Elevation** options.

Note: If the crossing does not involve an edge of pavement, or if it involves two edges of pavement, the **Match Elevation** toggle controls, forcing the new point to take on the elevation of the **High** feature, **Low** feature, or the **Median** elevation between.

5. <D> **Apply** and the crossing segments that meet the **Delta Tolerance** criteria are resolved.
6. Select **Results** to see a report of which feature crossings were resolved and which were left unresolved.

For details on other options, see the **InRoads Online Help**.

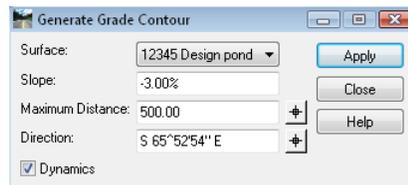
Note: If the crossing features are in an existing ground surface, you should report the problem to the Survey group for correction.

Generate Grade Contour

The **Generate Grade Contour** command is a great tool for finding a path down a sideslope that meets a certain longitudinal grade. For example, if you need to create a haul road into a pit or an access road down a sideslope and you are required to meet a certain longitudinal grade, this command helps designate the path.

Here, it is used to traverse the sideslope of a pond, helping define the path of an access road.

1. **Generate Grade Contour** is an **Application Add-in**, so toggle it on before starting.
2. Select **Surface > Utilities > Generate Grade Contour**.

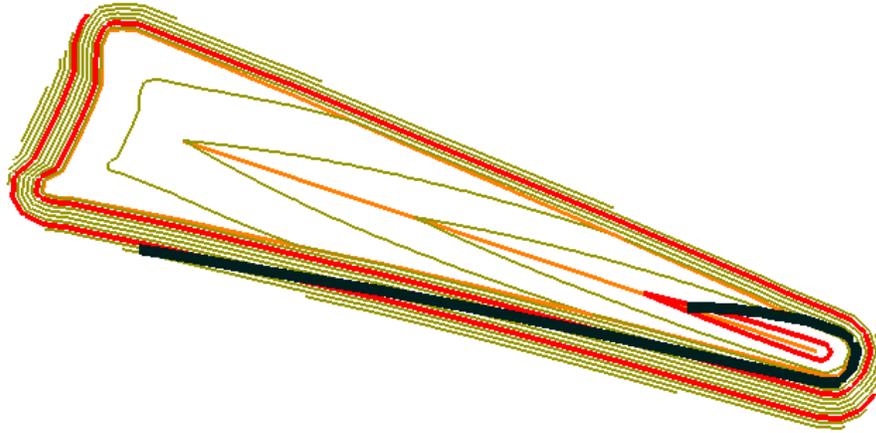


3. Select the **Surface** from the drop-down.
4. Key in the longitudinal **Slope** desired.
5. Key in the **Maximum Distance** for the path created.
6. Key in (or use the **Locate** button to define) the starting **Direction**.

Note: The direction does not actually define a fixed direction for the resulting path. It just lets the command know the general direction you want the path to take (i.e. to the right or left around the pond in this example).

7. Toggle on **Dynamics** to see the path before accepting it.
8. **<D> Apply**.
9. Move your cursor along the slope and a path dynamically follows.

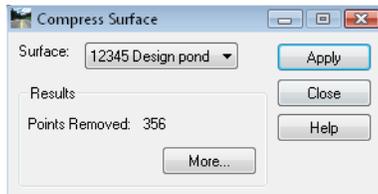
10. <D> where you want the path to start.



The result is a 3D MicroStation linestring that follows the defined longitudinal slope, traversing the surface selected. Vertices are created for the linestring at each crossing of a triangle. You can now import the graphic as a horizontal and vertical alignment using **File > Import > Geometry from Graphics**, refine the alignments as necessary, and use them in Roadway Designer to create the access road.

Compress Surface

When working with features in a surface, you are often deleting portions of features or deleting points in features. These points are marked for deletion in the surface and are no longer triangulated, but are not actually removed from the surface. Since they cannot be recovered, they are taking up space and memory unnecessarily and should be periodically removed from the surface using **Compress Surface**. This command not only removes points that have been deleted with surface editing commands, but also removes any duplicate Random points, or Random points that are duplicates of other type points.



1. Select **Surface > Utilities > Compress Surface**.
2. Select the *Surface* you want to compress from the drop-down menu.
3. <D> **Apply** and the points are removed.

Section Summary:

- Features can be manipulated within a surface using tools similar to MicroStation editing tools.
- Point elevations, slopes of features and location of features or individual points can all be modified.
- There are tools available for modifying features one at a time, and also for modifying groups of features.

Chapter Summary:

- Create and Edit feature tools allow you to design surfaces that do not fit the mold of a typical section following a horizontal and vertical alignment.
- Using these tools with surfaces created by Roadway Designer allow you to refine and enhance your designs that *do* fall into the category of templates following a horizontal and vertical alignment.
- Using each InRoads Surface Creation or Surface Editing tool for what it does best allows you to be more efficient in your design process.
- The Surface Creation and Editing tools can be an integral part of the CDOT design process when used to their full potential.