Table of Contents

Typography ......................................................................................................................... 2
System Requirements ........................................................................................................... 2
Important Licensing Information .......................................................................................... 2
Simple Surfaces ..................................................................................................................... 4
  Overview ........................................................................................................................... 4
  Creating a Surface ............................................................................................................. 5
  Editing Surface Settings .................................................................................................... 6
  Recomputing a Surface ...................................................................................................... 7
  Editing Topo Points .......................................................................................................... 8
  Smoothing Contours ......................................................................................................... 9
  Drawing the TIN ............................................................................................................... 10
  Creating a Transect .......................................................................................................... 11
  Computing Volumes ........................................................................................................ 13
  Slope Analysis .................................................................................................................. 14
  Creating a Surface from Selected Points .......................................................................... 15
Advanced Surfaces ............................................................................................................... 16
  Overview ........................................................................................................................... 16
  Creating a Surface from a Traverse .................................................................................. 17
  Editing a Surface Border ................................................................................................. 19
  Surface Border Summary ................................................................................................. 21
  Editing Breaklines ........................................................................................................... 21
  Surface Exclusions ........................................................................................................... 24
  Restricting Elevations ...................................................................................................... 25

Typography
We will be using the following typography to distinguish items in the text:

[Enter] Brackets indicate keys on the keyboard.

*bold* Bold is used to highlight words for more emphasis.

Lot 2 Numbers or text that you enter.

System Requirements
This version of TPC Desktop requires Windows 10 / 8.1 / 8 and Internet Explorer Version 6.0 or later. We recommend you have 2 GB of RAM (32-bit OS) 4 GB RAM (64-bit OS) and 60 MB of free hard disk space in which to install the program. An internet connection is required for program validation.

Important Licensing Information
Our License Agreement allows you to use TPC on only one computer at a time unless you
purchase additional licenses. We do offer one courtesy installation for an additional home or field computer, *but not for a second user* and assuming that the two programs are not being used at the same time. To request a courtesy license contact Traverse PC.
This chapter demonstrates:

- Creating a surface
- Editing surface settings
- Recomputing a surface
- Editing topo points
- Smoothing contours
- Drawing the TIN
- Creating a transect
- Computing volumes
- Slope analysis
- Creating a surface from selected points

Overview

Surfaces and Volumes are available in the Premium and Professional Editions of TPC. Transects and Slope Analysis are available only in the Professional Edition.

🔗 To learn more about surfaces (contours)
1. Choose Help | Search For Help On… and left-click the Contents tab.
2. Scroll down and select Surfaces (Contours / TIN / DTM).

➢ Getting Started
1. From the Tasks Manager choose Sample Surveys.
2. Double-click the LEARN CONTOURS.TRV file.
3. Choose File | Save Survey As then enter the name Contours and choose Save.
4. If prompted to replace the existing file, choose Yes.

➢ Three Types of Contours:

- All the topo points in a border.
- All the topo points in a traverse.
- Selected topo points within a border.
Creating a Surface

In this lesson, we will start with a simple stockpile survey with two traverses. The **Existing Boundary** traverse defines the boundary of the stockpile, while the **Topo 3/11/02** traverse contains the shots taken on the stockpile. We have already designated the Topo points (you'll learn how to do this a little later).

1. From the desktop menu choose **Manage | Surfaces** to open the Surfaces manager.
2. Double-click any blank line in the Surfaces manager to display the Surface Settings dialog.
3. Enter **3” Stockpile** for the **Name**.
4. Expand the **Border Traverse** list and choose the **Existing Boundary** traverse.
5. Now choose **Apply**. TPC will compute and draw the surface.

Congratulations – you just created a surface!
Simple Surfaces

**Editing Surface Settings**

You can change the way TPC draws contours by editing the contour settings. You’ll find options for major and minor contours, labels, smoothing and more.

► **Using Major and Minor Settings**

1. Left-Click the Contours tab.
2. Turn on the Label option in both the Major and Minor boxes and choose Apply.

Surfaces have separate settings for the major and minor contour lines and labels, making the contours easier to read. You can edit their colors, line type, line widths and fonts.

3. To close this dialog and return to the drawing, choose OK.

► **Accessing Surface Settings**

You can access the Surface Settings dialog any time using one of these methods

1. Double-click the surface in the Surfaces manager.
2. Double-click any surface object (contour, breakline, etc.) in a drawing.
3. Right-click any surface object (contour, breakline, etc.) in a drawing and choose Surface Settings.
Recomputing a Surface

For small surfaces of a few hundred points, speed is not really an issue. For large surfaces with thousands of points, speed can become critical because of the dynamic nature of the Drawing View.

Surfaces are unique in that as you edit the topo points, breaklines and border used by the surface, you want the surface to re-compute and redraw itself so you can see the changes. However, once the surface has been edited, it becomes relatively static, so you don't want your computer to take the time to recompute the surface each time you regenerate the drawing.

TPC accommodates this through **Manual** and **Automatic** re-computing of surfaces.

➤ **Recomputing a Surface Automatically**

1. Before you begin editing the topo points, border points or breaklines, open the Surface Settings dialog and left-click the Advanced tab.
2. Turn off the Manual Recompute option and choose OK.

As you edit the surface or if you regenerate the drawing, the surface will recompute itself automatically.

➤ **Recomputing a Surface Manually**

1. Once you have the contour the way you want it, open the Surface Settings, Advanced tab and turn Manual Recompute on.
2. You can still recompute the surface at any time by right-clicking any surface line or label and choosing Surface Tools | Recompute. Opening and closing the Surface Settings dialog also recomputes the surface.

➤ **Embedded Labels**

When they are turned on, contour labels are embedded in the contour lines. Embedding cannot currently be turned off. Contour labels always face uphill (as is the standard on USGS topo maps).

➤ **Smoothing Contour Lines**

A smoothed contour takes longer to compute since extra points need to be computed for the smoothing. Once computed however, a smoothed contour takes only slightly longer to draw than an unsmoothed contour. As a rule, turn smoothing off while you are editing the surface, then turn it back on when you are finished. Smoothing can also make it more difficult to identify the cause of problems with the surface.
Editing Topo Points

TPC will only calculate surfaces based on points that have been designated as topo points. You can designate topo points a number of different ways. Once the surface is drawn, you can even turn off the topo designation for individual points to fix blunders in your surface.

Designating Topo Points

1. Choose Help | Content.
2. Left-click the Contents tab, scroll down to the Surfaces chapter, double-click it, double-click Editing Surfaces and double-click Editing Topo Points.

You'll find tools for defining topo points by points in the Points Manager and by traverses in the Traverses Manager. These are the fastest ways to tell TPC which points are available to the contour objects. These are also the methods you will normally use to tell TPC that points are, or are not, topo points. In this task however, you'll select topo points right from Drawing View.

3. When you are finished, close the Editing Topo Points help topic window.

Delineating Topo Points in the Drawing View

1. In the Drawing View choose View | Delineate | Topo Points. TPC highlights the topo points with a colored highlight.

Editing Topo Points in Drawing View

1. Turn off Manual Recompute (previous lesson) so you can see the surface changes as you edit the points.
2. Right-click the T3 point symbol or label and choose Topo Off. You will immediately see the effects of the change. You may want to zoom in to select point T3 or keep an eye on the status bar to make sure you are on point T3.

3. Now right-click the T3 point symbol or label and choose Topo On.
4. Try some of the other topo points.

Notice that border points are not delineated like the topo points. That's because border points are edited differently than the topo points.
**Smoothing Contours**

1. Double-click any surface line or label to display the Surface Settings dialog and Left-click the **Contours** tab.

2. In the **Contour Smoothing** section, left-click **Curve Fit**. Double check to make sure your **Tension** value is 1.0.

3. Choose **OK**.

TPC redraws the contours using the same Curve Fitting routine it uses to smooth any polyline. This routine guarantees that the contours pass through the interpolated elevation points on each triangle edge. These are the same elevations that all the contour computations like volumes and transects are based on, so you can rest assured that these smoothed contours are doing a good job of accurately representing the contour surface.

►**Adjusting the Tension**

The **Tension** factor determines the extent to which TPC smooths the contours. A tension value of 1.0 guarantees that no contour lines will overlap. It says in essence, “I will let the position of each contour line vary by up to 1 minor contour interval.” A tension value of 0.0 does no smoothing.

Typical tension values are 0.5 to 2.0.

►**Max Angle**

The **Max Angle** lets you specify an angle above which no smoothing is applied. This allows TPC to skip over very flat angles along the contour line where smoothing would have little if any impact on the shape of the contour.
Simple Surfaces

**Drawing the TIN**

TPC generates its contours from a TIN (Triangulated Irregular Network). It creates triangles that model the surface by connecting all the border and topo points then interpolating the elevations along the edges of each triangle.

1. Double-click any surface line or label to display the Surface Settings dialog.
2. Left-click the Contours tab and turn off the Major and Minor Contours Draw options so that the surface does not draw any contour lines or labels.
3. Left-click the TIN tab and turn on the TIN, Draw option.
4. Choose Apply.

Now you can see what the TIN looks like. This will prove to be a useful tool as you work with some of your own contours.

5. Choose Cancel to return to the drawing without retaining the changes you just made. TPC redraws the surface with the original contours.
Creating a Transect

- Note: Transects are available only in the Professional Edition of TPC.

A transect is a profile of the intersections created by the transect object (a line or traverse) and a surface’s triangles (TIN). When you create a transect, you add the computed intersections to a new or existing traverse. Once the traverse is added to the survey, it can be viewed as a profile or printed out in a report.

1. From the Drawing View, choose Draw | Line and draw a line across the contour like the one shown here from A to A (make sure you are not in Paper Space mode – refer to the Drawing Learning Guide for more information).

2. Right-click any surface line or label and choose Surface Tools | Create a Transect (profile).

3. Following the command prompt in the status bar, position the cursor over the line you just drew and left-click it to display the Transect dialog.

4. Enter Transect A-A for the Name.

5. Select Alignment for the Format and Alignments for the Settings.


7. Choose Append.

TPC creates the Transect A-A traverse and opens its View.
Simple Surfaces

► Drawing the Transect

1. In the Traverse View for Transect A-A, choose Tools | Draw This Traverse Only. This creates a temporary drawing for just this traverse.
   TPC displays the traverse in Drawing View in Plan mode.

2. To switch to Profile mode choose View | Profile Mode in the Drawing View.
   ► Note: Profiles are only available in the Professional Edition.

You can insert a grid with 1FT vertical spacing and 10FT horizontal spacing into the drawing to show the transect better.

Your transect may look something like this.

3. Close the Transect A-A traverse by clicking the X in its upper right corner.

4. If TPC tells you that you have edited a temporary drawing and asks if you want to save it, choose No.
Computing Volumes

1. Double-click any surface line or label to display the Surface Settings dialog then left-click the Volume tab.

2. Left-click the Compute button to compute the volumes using the current To Border option.

TPC computes and displays the Volume information.

The surface’s volume is computed by comparing its surface with another surface. The other surface can be the border of the contour, an arbitrary elevation or another surface.

When computing volumes, TPC keeps track of cuts and fills separately. Cut volumes are always displayed as positive while fill volumes are always displayed as negative. Cut and fill areas are planimetric (2-D) as opposed to slope (3-D).

☞ You’ll find lots of help on computing volumes in the on-line help. Just look up Surfaces to get started.

▶ Reporting Volumes

1. To add the volume information to the Report View, just choose Summary.
**Slope Analysis**

Let’s take a quick look at TPC’s slope analysis. Like volumes.

►Note: This feature is available only in the Professional edition.

1. Left-click the **Slope** tab.
2. Turn on the two **Drawing Options** and set the colors and percentages as shown here.
3. Choose **Compute** to compute the slope.
4. Choose **Apply** to update the drawing.

You can select **Summary** to add this information to the current Report View.

TPC shades the slope ranges in the current drawing and adds the slope information to the legend.

This is a very simple example of slope analysis but it serves to show how easily you can compute slopes for any surface.
Creating a Surface from Selected Points

You can select a group of topo points in Drawing View and create a surface for just those points. When you do, TPC creates a traverse to hold the selected points and designates this traverse as the source traverse for the surface. TPC then generates a convex border traverse for the surface and creates the surface.

1. Untag the 3” Stockpile surface in the Surfaces Manager.
2. Untag the Existing Boundary traverse in the Traverses Manager.
3. Delete the drawn line in the drawing.
4. In the Drawing View, choose Edit | Select objects. Press the W key for Window then left-click two diagonal points to draw a window and then right-click to end the selection tool.
5. Right-click any of the selected points and choose Topo On.
6. Right-click any of the selected points and choose Surface Tools | Create Surface from Selected Points. TPC displays the Surface Settings dialog.
7. In the Surface tab, enter Stock Pile #1 for the Name. Since the selected points do not already have a name, TPC uses the surface name you enter here to name the source traverse it creates to hold the selected points.
8. Choose OK.
This chapter demonstrates:

- Creating a surface from a traverse
- Editing a surface border
- Surface border summary
- Editing breaklines
- Restricting elevations

Overview

Now that you understand basic contouring in TPC, we will move on to a more complex project to examine some of the situations you will come across in your own work.

Premium and Professional Editions

Contours and Volumes are available in the Premium and Professional Editions of TPC. Transects and Slope Analysis are available only in the Professional Edition.

To learn more about contours

1. Choose Help | Search For Help On... and left-click the Contents tab.
2. Scroll down to Surfaces (Contours / TIN / DTM) and double-click it.
3. Double-click Surfaces to expand the chapter and then double-click Inserting Surfaces.

Getting Started

We will use another actual project we did here at Traverse PC.

1. From the Tasks Manager choose Sample Surveys.
2. Double-click the LEARN ADVANCED CONTOURS.TRV file.
3. Choose File | Save Survey As then enter the name Advanced Contours and choose Save. If prompted to replace the existing file, choose Yes.
4. Activate the Drawing View by left-clicking it or by choosing Window | Drawing View.
Creating a Surface from a Traverse

In TPC, you create surfaces from traverses to compare two surfaces, like phases of an excavation project. You can topo the project as many times as you want, just create a separate traverse for each topo (i.e. Topo – 3/11/03, Topo – 3/18/03, etc.). Now you can create a separate surface for each phase, showing the progress of the project. The trick is creating surfaces from traverses.

►Designating Topo Points in a Traverse
1. In the Drawing View choose View | Delineate | Topo Points. You will not see any change, indicating that none of the points shown are flagged as Topo points.
2. Go to the Traverses Manager, right-click the TOPO POINTS traverse and choose Modify (all traverse points) | Topo On (include in surfaces). TPC turns on the Topo status for each survey point referenced by this traverse. Because Delineate Topo Points is turned on in the Drawing View, all of the points are now highlighted in yellow.

►Note: If you create a surface from a traverse that does not contain any topo points, TPC automatically makes each point in the traverse a topo point. This is handy when bringing in data from a data collector.

►Creating a Surface from this Traverse
1. Return to the Drawing View, right-click any point and choose Surface Tools | Create Surface from Traverse.
2. TPC displays the Surface Settings dialog showing Topo Points in Traverse as the Source and listing the TOPO POINTS traverse.
3. Choose OK.
4. Choose View | Delineate | Topo Points to turn the topo highlights off.
Evaluating the Surface

It is obvious that being familiar with the property being modeled will help you see where your surface needs work. Even if you aren’t familiar with the property, it is usually possible to spot problems with the surface border. There are two obvious problem areas in the current surface border, even if you aren’t familiar with the property.

1. It is obvious that there aren’t any topo points along the line between point 100 at the northernmost point and point 107 near the northeast end. It looks like our border should run from 100 – 101 – 102 – 104 – 105 – 106 – 107.

2. The contour lines make some very jagged turns and once again, it looks like there aren’t any topo points out near the border.
Advanced Surfaces

Editing a Surface Border

A surface border is just a traverse that further defines the extents of the surface. When you insert a surface, you can specify any border traverse you want or let TPC generate a convex border that you can then edit as needed. Here are some rules about borders.

- The border defines the limits of the surface. Only the topo points that lie within the border of a surface are used to create the surface.
- The border affects the shape of the surface.
- All points in the surface’s border are used as part of the surface. (This means that you can’t just arbitrarily choose zero elevation points for the surface border or your surface will drop to zero elevation at the border.)

Creating a Surface Border

1. In Drawing View, double-click any contour line to access the Surface Settings dialog.
2. Under Border Traverse click New Border.
   
   TPC assigns the name Border – TOPO POINTS to the new border traverse.

3. Choose Plat Check Lots as the Settings, turn on Share current drawing and Set Tag and choose Append. This provides a contrasting red border line and point labels

4. Choose OK.
   Traverse PC has “snapped a rubber band” around all the topo points to create a border traverse.

5. In the Traverses Manager, drag and drop the Border – TOPO POINTS traverse above the TOPO POINTS traverse.

6. In the Drawing View, choose View | Regenerate.
   This lets the border traverse draw all of the border points in red so they stand out.
Advanced Surfaces

► Editing the Border
Because the border is a traverse, you can edit it, easily adding or removing points as needed to better define the border.

1. In the Drawing View, right-click any contour line and choose Surface Tools | Edit Border.
2. Left-click the point label for point 101.
TPC adds point 101 to the border traverse and draws it in red. Hint, before you left-click a point label, look at the status bar - it will display the point label you are positioned over.
3. Repeat this step for the following points: 102, 104, 105, 106 and 232
At this point, it is becoming difficult to pick out the points along the south and west sides of the property to add them to the border traverse so we need to make some changes.
4. Right-click on the drawing to end the Edit Border tool.
5. Double-click any contour line to display the Surface Settings dialog.
6. On the Contours tab, turn off the option to Draw the Minor Contours.
7. On the Advanced tab, make sure Manual Recompute is not turned on.
8. Choose OK.
Now the minor contours won't be in our way and the contours will update immediately as we edit the border. You can zoom in and out as needed to complete the border.
► Hint: Turning off Zoom Points in the Zoom portion of the View menu of the Drawing View can make it easier to identify the point labels as you zoom in on an area.
9. Right-click any contour and choose Surface Tools | Edit Border.
10. Left-click the point labels for the following points: 165, 166, 170, 172, 217, 218, 219, 220, 221 and 222
11. Right-click anywhere in the Drawing View to end the Edit Border tool.
12. Double-click any contour line to access the Surface Settings dialog.
13. Turn on the Draw option for the Minor Contours on the Contours tab and choose OK.
Surface Border Summary

As we have seen, TPC can create a border automatically for your surface by “snapping a rubber band” around the topo points in the surface. You then have to manually edit the border traverse to fit the area that you need contours in. The introduction of a border traverse further defines which points are to be included in the contour and modifies the triangles and edges that are produced as part of the TIN. It also prevents contours from running outside the area you want them in.

You can also create your border traverse completely on your own by creating a closed loop traverse around the area you need. (But having TPC create the basic traverse for you automatically makes it less work to achieve the end result you need.) If you create a border traverse independently of the surface, you will need to tell TPC that you want to use it for your surface. To do so, go to the Surface Settings dialog box, expand the list of Border Traverses and select the traverse you created. Choose OK and TPC redraws the surface using your border traverse.

Turn the minor contours back on in the Surface Settings dialog Contours tab.

The contours look much better at 1 and 2 since we created the border traverse. This is how we use borders to improve the way TPC models the actual surface.
**Editing Breaklines**

Breaklines allow a surface to model grade breaks like ‘top of slope’ and ‘toe of slope’ with a minimal number of points. You can accomplish the same final surface shape without breaklines, but it requires taking numerous points along each breakline. It takes a little practice to gain experience collecting and using breaklines, but the investment is well worth it.

1. In the Traverses Manager, untag the **Border – TOPO POINTS** traverse to remove it from the drawing.
2. Double-click any surface line or label to display the **Surface Settings** dialog.
3. Left-click the **Contours** tab and turn off the **Major** and **Minor, Draw** toggles.
4. Left-click the **TIN** tab, turn on the **TIN and Breaklines, Draw** toggles and choose **OK**.
5. Turn off Zoom Points and use the Zoom Window tool to zoom in on the north end of the property around point **100**.
6. Right-click any TIN line and choose **Surface Tools | Edit Breaklines**.
7. Choose **Yes** if TPC asks if you want the surface to recompute as you edit.
8. Left-click point **110** (south of **100**) and then left-click point **111** (south of **111**). TPC inserts the breakline between **110** and **111** and regenerates the TIN. Notice how the triangles changed.

9. Right-click to end the Edit Breaklines command.
10. Now double-click any TIN line to display the **Surface Settings** dialog.
11. Left-click the **Contours** tab and turn on the **Major and Minor, Draw** toggles.
12. Left-click the **TIN** tab and turn off the **TIN and Breaklines, Draw** toggles then choose **OK**. TPC redraws the contour with the effects of the breakline included.

▶ Hint: To delete a breakline, use the Edit Breaklines tool and left-click the breakline you wish to delete. Right-click anywhere in the drawing to end the tool.
Breaklines are Associated with Survey Points

Breaklines are always associated with Survey Points. If the survey point referenced by a breakline changes, the breakline changes with it. Breaklines do not store the end point coordinates of the breakline, they store the survey points that are referenced.

Getting Breaklines from Existing Traverses

You can import breaklines from a traverse or manually add and remove them from the surface as we did a moment ago. Our field crew did a good job and used Point Codes to identify the breaklines. The Sort Points Into Traverses By Code tool in the Point Codes Manager created our breakline traverses for us. Let’s put the field crew’s hard work to good use now by importing those breakline traverses into the surface.

1. Double-click any contour line to display the Surface Settings dialog then left-click the Breaklines tab.
2. In the Traverses Manager, select the traverses shown here.
3. In the Breaklines tab, choose Get from the Traverse Options.
4. Choose OK when TPC tells you it Imported 31 Breaklines.
5. Repeat steps 2 and 3 as many times as you need to import additional breaklines from other traverses.

TPC searches the selected traverses for control point sequences that define new breaklines and imports them into the surface.

6. Choose OK to close the Surface Settings dialog and redraw the surface with these breaklines included.

TPC recomputes the surface using the breaklines that were imported. You can now see the driveway as well as the access road. The retaining walls are also doing their jobs.
Advanced Surfaces

**Surface Exclusions**

You can easily exclude contours from level areas, like the covered trailer area in this drawing.

You exclude either 1) individual TIN triangles or 2) traverses that define the exclusion.

1. In the Traverses Manager, tag the **TRAILER COVER** traverse and zoom in around it. Notice how the contour runs through it.
2. Right-click any of the contours in the drawing and choose **Surface Tools, Exclusions, Get exclusions from existing traverse**.
3. Following the prompt in the status bar, left click any line or label of the TRAILER COVER traverse.
4. TPC ends the command and redraws the surface, excluding any contours from the TRAILER COVER area.

▶ **Turning Exclusions On/Off**

Once you have created exclusions, you can tell TPC to apply them to the surface or not.

1) Double-click any of the contours in the drawing to open the Surface Settings dialog.
2) Left click the **Exclusions** tab.
3) Turn [ ] **Apply Exclusions in Surface** off to remove them and turn it back on to include them.

You can add as many exclusions as needed to a surface.
Restricting Elevations

TPC reports the vertical extents of a surface to you and lets you restrict the elevations of the surface if you need to.

1. Double-click any contour line to bring up the Surface Settings dialog box.
2. Click on the Surface tab.

The Information area of the Surfaces tab provides a lot of good information about your surface including any errors TPC sees. You can create a report of this information by choosing Summary.

3. To restrict elevations, turn on the Restrict Elevations option and specify the Minimum and Maximum inclusive elevations allowed.

In the example shown here, we’ve restricted the surface to those topo points with elevations between 30’ and 120’ inclusive.

The Information area and the Summary in the Report View report that 13 points were rejected because they were outside the elevation range.

In addition, we have Unresolved border edges and Unresolved edges because restricting the elevations after creating the border and importing the breaklines has caused some conflicts. These issues would need to be resolved if this were an actual project.