

Shoreland Bluff Profile Tool & Instructions

Overview

The [Shoreland Bluff Profile Tool](#) is an Excel spreadsheet that uses elevation data downloaded from MnTOPO to graphically depict a slope profile, including the toe and top of bluff. The tool may be helpful for planning and zoning staff to communicate with property owners where bluffs exist including the locations of bluff impact zones and bluff setbacks for structure placement.

The tool uses procedures and formulas that approximate the location of the toe of bluff, slope, and top of bluff and is thus best suited for guiding general site planning and design. A field survey is recommended to identify a bluff and the top of bluff locations for locating structure setbacks.

The bluff profile tool requires some effort and time commitment to use and is best used after the possible presence of a bluff is verified using the basic features in [MnTOPO](#). MnTOPO is a DNR web application for viewing LiDAR-derived elevation data. See the [Quick Guide to Analyzing Slope Features with MnTOPO](#).

The bluff profile tool contains two pairs of tabs. One pair is labeled “sample” and is used to illustrate the explanations below. The other pair is for entering and manipulating user data downloaded from MnTOPO. This tool assumes an understanding of how to identify bluffs as explained in the [Identifying Bluffs in Shoreland](#) guidance document as well as a basic working knowledge of Excel. Please review the two sample tabs to understand how the tool works before downloading data. In these instructions, all action steps are identified in **bold** text. All other text provides further explanations.

Determine the Ordinary High-Water Level Elevation (OHWL)

Find the OHWL elevation of the water body nearest the slope of interest before downloading MnTOPO data and using the bluff profile tool.

The OHWL elevation is used in the shoreland bluff definition to determine if a bluff exists. If you don’t know the OHWL elevation, contact your [DNR Area Hydrologist](#). Ask them to verify that the OHWL elevation is using the NAVD88 vertical datum or to convert it for you if it is not. LiDAR uses the NAVD88 vertical datum and it’s important that both the OHWL elevation and LiDAR elevation data are using the same vertical datum.

Instructions for using MnTOPO

Those unfamiliar with MnTOPO should review the [MnTOPO Help](#) document first.

1. **Open [MnTOPO](#) and zoom to the slope feature you are interested in and turn on the imagery layer (one of the base map options).**
2. **Use the “line” elevation tool to draw a line segment bisecting the steepest part of the slope feature.**



Draw the line segment at a 90-degree angle to the contour lines, as much as possible.

Start your line at the bottom of the slope. This will result in the data points and profile being displayed in the bluff profile tool from low to high and from left to right, the viewing format comfortable for most people. Draw the line segment, starting just beyond the bottom of the slope and ending it just beyond the top of the slope. If the slope rises from or near the water, include the OHWL elevation in the line segment.

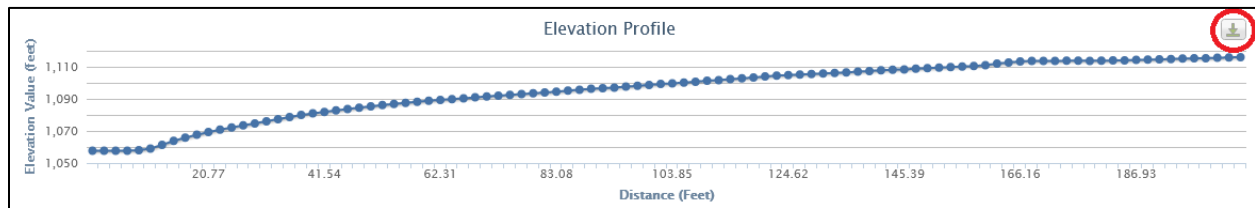
In some situations where the slope rises from or near the water, it won't be possible to include the OHWL elevation within the line segment. This is because LiDAR was collected when water levels were higher than the OHWL elevation and LiDAR doesn't penetrate water and thus cannot collect elevation data below water. In these situations, start the line segment on the contour line closest to the water (this line may or may not overlap the water).

Keep the line segment as short as possible while still capturing the full extent of the slope feature. MnTOPO captures 100 points of data for every line segment, regardless of length. Thus, with shorter segments, there will be less data interpolation and greater precision in the data points.

3. **Take a screen grab of the line segment you just created. You may need to reference the line you're evaluating later.**



4. **Export the data using the download button in the upper right corner of the elevation profile generated in MnTOPO.** This will be CSV data in an Excel spreadsheet.



Instructions for using the Bluff Profile Tool

1. **Open the CSV data file you just downloaded from MnTOPO.**

It will contain three columns of data which represents three-dimensional space. The X and Y coordinates locate a point on the ground and the Z coordinate is the elevation of that point. This data is in meters. The bluff profile tool will convert this data into two-dimensional data represented in feet.

2. **Copy the three columns of CSV data and paste them into the first three columns of the “MnTOPO Data” tab of the bluff profile tool.**

There will be 100 rows of data. The tool converts the X and Y coordinates into distance in Column D using the Pythagorean Theorem and into cumulative distance in Column E. All data in the MnTOPO Data tab are in meters.

3. **Open the “Slope Profile” tab of the tool.**

You will see cumulative distance in Column A and elevation data in Column B, both displayed in feet. Columns C, D, and E contain percentages, respectively, for toe of bluff, slope, and top of bluff determinations. Column F shows the “bluff extent” and is used for creating the line graph of the bluff profile. This column duplicates the elevation data from Column B. Note that the bluff profile uses a different distance scale for the X and Y axis and thus the profile looks different than the profile displayed in MNTPOPO.

YOU MUST MANUALLY ADJUST THE EXCEL FORMULAS FOR THE TOE OF BLUFF, SLOPE, AND TOP OF BLUFF DETERMINATION COLUMNS (COLUMNS C, D AND E) as follows:

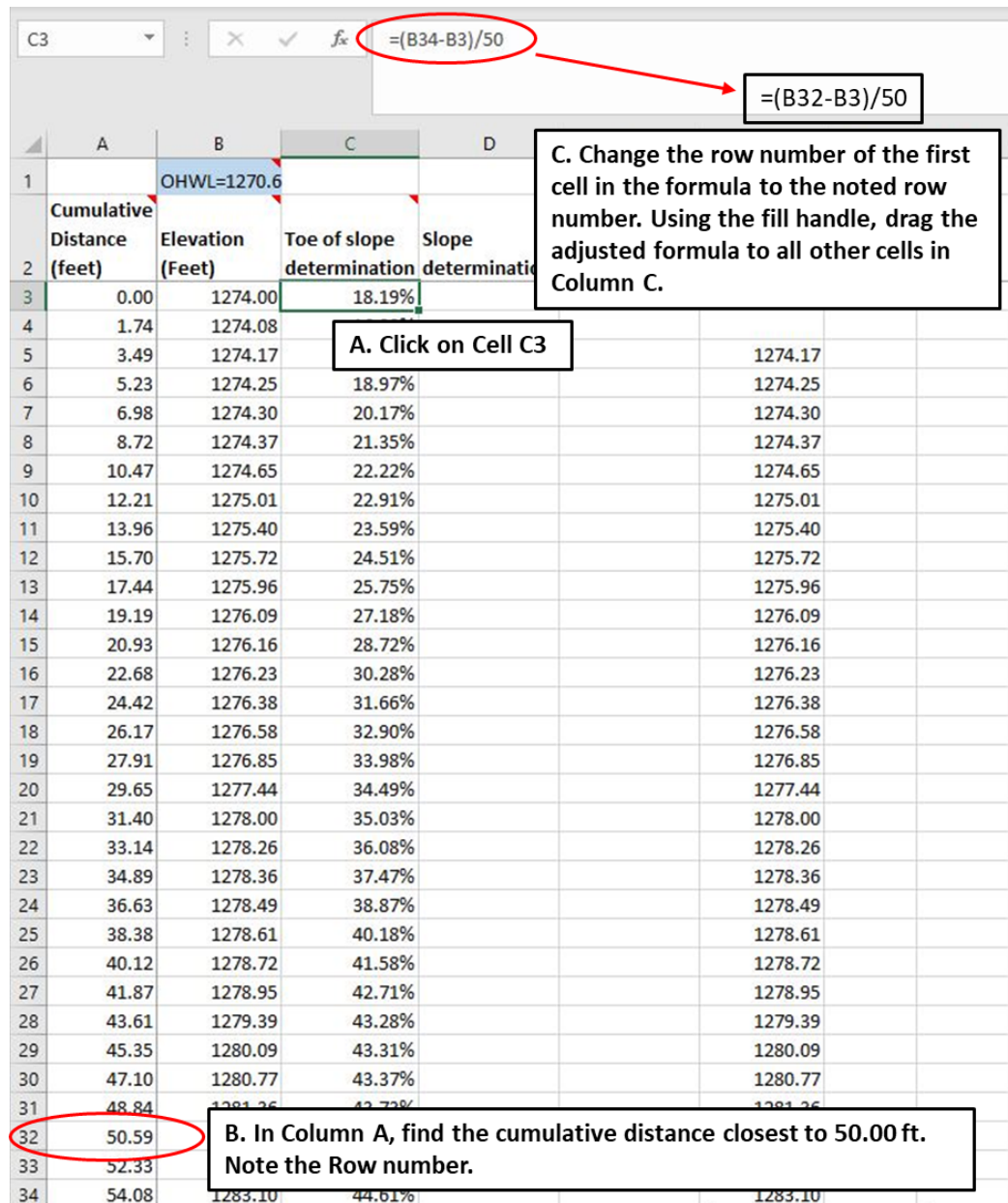
4. Identify the OHWL Elevation
 - A. **Enter the OHWL elevation in cell B1 (blue highlighting).** This is a label cell only and not used in any formulas.
 - B. If the OHWL elevation is included within the range of elevation data downloaded, **identify the elevation in Column B that is closest to the OHWL elevation with blue highlighting and label it “OHWL” in column G.**

5. Find the toe of bluff

Next, we need to adjust the formula in Column C to find the “toe of the bluff” which is the lowest point of a 50-foot segment that is greater than 18% (See Figure 1).

- Click on cell C3, the first cell in Column C. This is the cell where we will adjust the formula.
- In Column A, find the cell with the cumulative distance closest to 50.00 feet. Note the row number of this cell.
- Change the row number of the first cell in the formula to the noted row number. Do not change any other part of this formula. Using the fill handle, drag the adjusted formula to all other cells in Column C.

Figure 1



- D. Find the elevation of the first cell in Column C that is “closest” to 18.00%. This is the toe of the bluff. In the same row, identify the elevation in Column B with green highlighting and label it “Toe of Bluff” in Column G.**

While the bluff definition states that the toe of the bluff is the lowest point of a 50-foot segment that is greater than 18%, in practicality, we are looking for the point where the slope of a 50-foot segment changes from less than 18% to greater than 18%. Because the profile tool is limited by the downloaded data, the percentage in Column C that is closest to 18% is the best approximation of this point.

If all cells in Column C have slopes substantially greater than 18%, then the toe the bluff elevation is the same as the OWHL elevation. **In this case, change the highlighted color of the cell in Column B from blue (used to identify the OWHL elevation) to green to indicate it is the toe of the bluff and label it “Toe of Bluff” in Column G.** If a slope rises rapidly within 50 feet of the water, the toe elevation and the OWHL elevation are usually the same.

6. Identify the elevation that is 25 feet above the OWHL elevation.

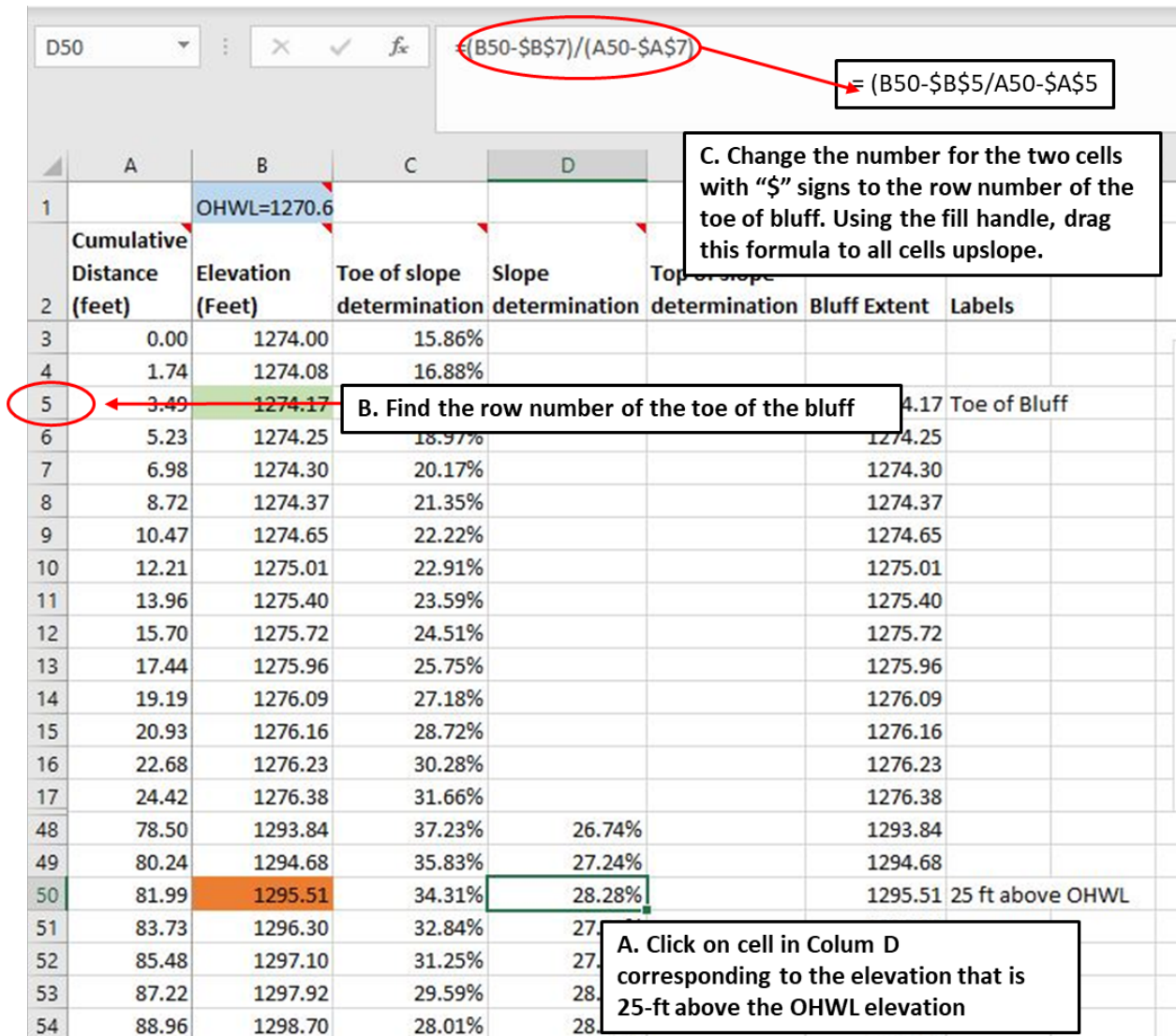
- A. In Column B, identify the cell with an elevation that is closest to 25 feet above the OWHL elevation with orange highlighting and label it “25 ft. above OWHL” in Column G.**

7. Determine the slope of the bluff

Next, we need to adjust the formula in Column D to calculate the slope percentage between the toe of the bluff elevation (highlighted in green) and the point 25 feet or more above the OWHL elevation (highlighted in orange) (See figure 2).

- A. In Column D, click on the cell in the row corresponding with the elevation that is 25 feet above the OWHL elevation (the orange highlighted cell).**
B. Find the row number of the toe of the bluff (the green highlighted cell). Note this number.
C. Change the number for the two cells with “\$” signs to the row number of the toe of bluff (green highlighted cell). Do not change any other part of this formula. Using the fill handle, drag the adjusted formula to all other cells upslope in Column D (the cells in rows below the one we just edited).

Figure 2



- D. If the slope in Column D in the row corresponding to the row number of the orange cell, or in any row upslope of the orange cell, is 30% or more, then the slope feature is a bluff.

Highlight all cells in Column D greater than 30% with light grey highlighting. Highlight the last of these cells with dark grey highlighting. If no cells in column D exceed 30%, then the selected cross section does not represent a bluff. However, consider evaluating other adjacent cross sections to thoroughly evaluate the entire slope feature of interest.

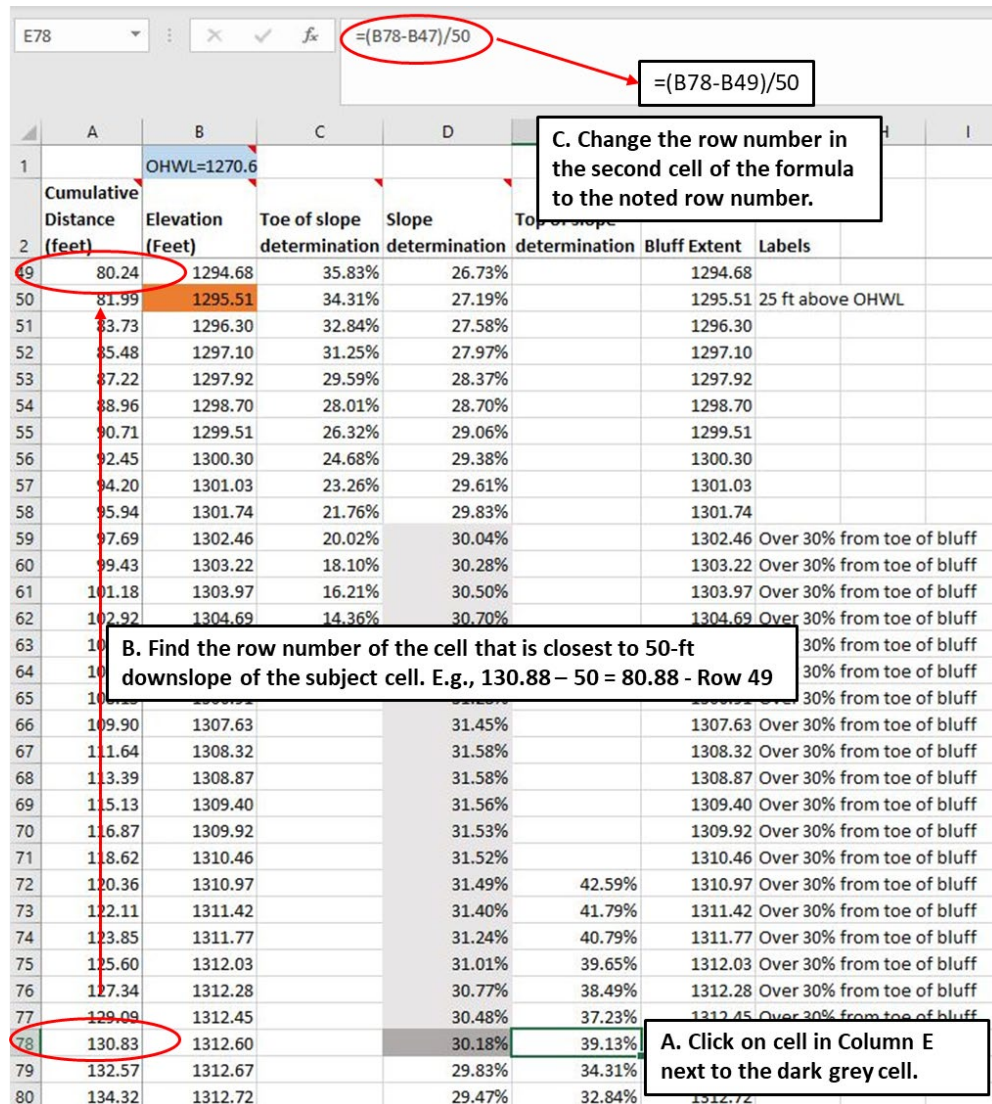
8. Find the Top of Bluff

Next, we need to adjust the formula in Column E to find the top of the bluff, which is the highest point of a 50-foot segment that is greater than 18%. (See Figure 3):

- Click on the cell in Column E next to the dark grey highlighted cell.** This is the cell where we will adjust the formula.
- Find the row number of the cell that is closest to 50-feet downslope from the subject cell.** Note this row number.

- C. Change the row number in the second cell of the formula to the noted row number. Do not change any other part of this formula.

Figure 3



- D. Using the fill handle, drag this adjusted formula to all cells in Column E upslope and downslope from the subject cell until you find the first cell in Column E that is closest to 18%. This point is the top of bluff. In Column B, identify the corresponding cell and highlight that cell in yellow and label it "Top of Bluff" in Column G.
9. Graphically identify the bluff extent on the line chart.
- A. Column F automatically copies elevation data from Column B. In Column F, only keep data between, and including, the toe of bluff (identified in green in Column C) and the top of bluff (identified by yellow in column E) - delete all other rows of data. This will turn all data

points on the line chart orange that correspond with the bluff extent. The first data point at the bottom of the bluff extent is the toe of the bluff and the last data point at the top of the bluff extent is the top of bluff. All other parts of the slope profile that are not part of the bluff extent will be blue.

10. Enhance the line chart and spreadsheet with graphics as desired. See examples in the “sample slope profile” tab.
 - A. **Insert graphics and notes in the line chart to communicate as needed.**
 - B. **Insert the screen grab from MnTOPO in the Bluff Profile tool spreadsheet.**