DEPARTMENT OF NATURAL RESOURCES

Identifying Bluffs in Shoreland

Purpose

The purpose of this technical guidance is to help local government staff and property owners determine if a bluff exists on a property and how to find the toe and top of bluff, as defined by the statewide shoreland rules. Identifying bluffs and tops of bluffs is important for applying bluff setback, land alteration, and vegetation management standards in shoreland zoning districts. Always check with the local zoning authority to verify local requirements.

Bluff and Top of Bluff Determination Process

This part explains the three-step process for: 1) determining if a bluff exists, 2) locating the top of bluff, and 3) determining if the bluff exemption provision applies. MnTOPO is a useful website for obtaining data to help determine if a bluff is likely to exist and for identifying the general locations for the top and toe of a bluff. MnTOPO shows LiDAR-derived two-foot contour lines overlaid on a map and contains tools for selecting and measuring slopes. Onsite measurements are still needed to conclusively determine whether a bluff exists and for accurately locating the top and toe of a bluff. This guidance assumes use of MnTOPO data, a site survey, or other mapped representation of slope data. The process described in this document can be used to identify the boundaries of bluffs by using it on different parts of the slope feature.

Step 1 – Determining if a Bluff Exists

Bluffs are determined using an evaluation process based on four criteria in the bluff definition in the shoreland rules (see part 6120.2500, subp. 1b). These criteria build on each other. Each criterion <u>must be met</u> before moving on to the next one. If one criterion is not satisfied, then the evaluation process stops - there is no bluff. Locating the top of bluff is not needed to determine if a bluff exists. The top of bluff is only located after it is determined that a bluff exists. Following is an explanation of each criterion in the four-part evaluation process:

Criterion 1: Part or all of the feature is located in the shoreland district.

Determine if any part of the slope feature is located within the shoreland district (Figure 1). Local zoning maps may help in making this determination. If it is, this criterion is met.

Though only part of the slope feature needs to be in the shoreland district, the entire feature (those areas that may be outside of the district) is included in determining whether the feature is a bluff using this four-part criteria. If the feature is determined to be a bluff, then only that part of the bluff that is within the shoreland district is subject to shoreland standards. For example:

Figure 1. The Shoreland District includes land within 1,000 feet of the ordinary high water level (OHWL) of a lake or 300 feet of a river or the extent of a mapped floodplain, whichever is greater.
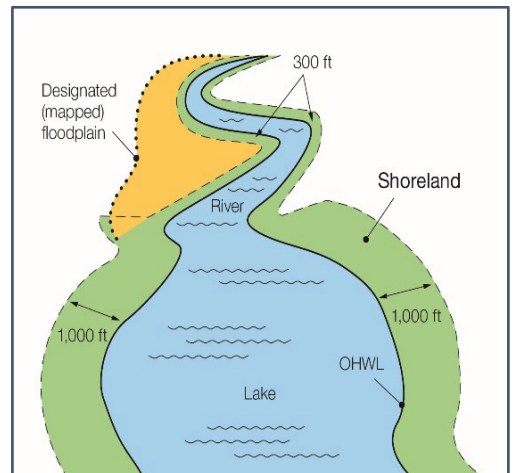
- If the top of the bluff is outside of the district, the shoreland requirement to place structures 30 feet from the top of bluff does not apply.
- Vegetation cutting and land alteration standards applicable in the bluff impact zone only apply to the part of the bluff within the district.

Criterion 2: The slope drains toward the waterbody.

If it is not readily apparent that the slope drains toward the waterbody, evaluate the contour lines of the slope feature to determine if the general direction of runoff is toward the water body. The slope does not need to face or drain <u>directly</u> toward the water body to meet this criterion. The slope features shown in Figure 2 do not all directly face the waterbody but runoff from them drains toward the waterbody, as illustrated by the blue arrows, and meet this criterion.

Figure 2. Slope must drain toward the waterbody. Blue lines below indicate water flow based on contours. (Source: MnTOPO)

Criterion 3: The slope rises at least 25 feet above the ordinary high water level (OHWL) of the waterbody.

This is an evaluation of the change in elevation, or vertical height, of the slope feature measured from the OHWL. To measure, add 25 feet to the elevation of the OHWL. If the slope feature rises to this elevation, or higher, this criterion is met.

The OHWL (an elevation in feet) for many lakes can be found through DNR's Lakefinder webpage. To find the OHWL for rivers or lakes with no OHWL data on Lakefinder, please contact the DNR Area Hydrologist for your area.

Criterion 4: The grade of the slope from the toe to a point 25 feet or more above the OHWL averages 30% or greater.

This step requires locating **two points** along a line:
   1) **the toe of the slope,** and
   2) **a point 25 feet or more above the OHWL**.

In situations where the slope feature rises quickly from the OHWL, the toe of the slope is the same as the OHWL. For other situations, see Figure 4 to determine the location of the toe.

Once the toe is located, draw a line from the toe of the slope to a point 25 feet in elevation or more above the OHWL. If you are measuring on a topographic map, this line will need to be as perpendicular to the contour lines as possible. (Figure 3).

Figure 3. Steepest part of slope is where contour lines are closest.

The grade or percent of a slope is calculated by **dividing the vertical change** between the two points **by the horizontal change** between the two points multiplied by 100. This is often expressed as "rise over run." In mathematical terms:

$$\textit{Slope Grade (\%)} = \frac{\textbf{Y2 - Y1} \textit{ (rise or vertical change between two points)}}{\textbf{X2 - X1} \textit{ (run or horizontal change between two points)}} \times 100$$

If the grade of the slope from the toe to a point 25 feet or more above the OHWL is 30% or greater, then this criterion is met.

If all four criteria are met, a bluff exists.

Step 2 - Locating the Top of Bluff

Once a bluff is verified, the next step is to locate the top of bluff. The top of bluff is used to measure building setbacks and to delineate the bluff impact zone - where land alteration and vegetation removal activities are limited. The bluff impact zone is the area between the toe of the bluff AND 20 feet from the top of the bluff. The method for locating the top of bluff is described in Figure 4.

Figure 4: Directions for locating the top and toe of a bluff.

Locating the Top and Toe of Bluff

The definitions for the "top of bluff" and "toe of bluff" are structured the same. The only difference is that the "top" definition is used to find the highest point of a 50-foot segment and the "toe" definition is used to find the lowest point of a 50-foot segment. Conceptually, the method to find the top and toe is the same.

Top of Bluff

The shoreland rules define the top of bluff as "the **highest point** of a 50-foot segment with an **average slope exceeding 18 percent**." (See part 6120.2500, subp. 18c)

For finding the top of bluff, imagine moving a 50-foot string segment up the face of the bluff. The top of bluff is the location of the uphill end of the string when the slope, over the 50-foot segment, is marginally greater than 18%, or for practical purposes, 18%. This is the point where the slope rises 9 feet over the 50-foot distance. Following is a graphic for finding the top of bluff.

Graphic
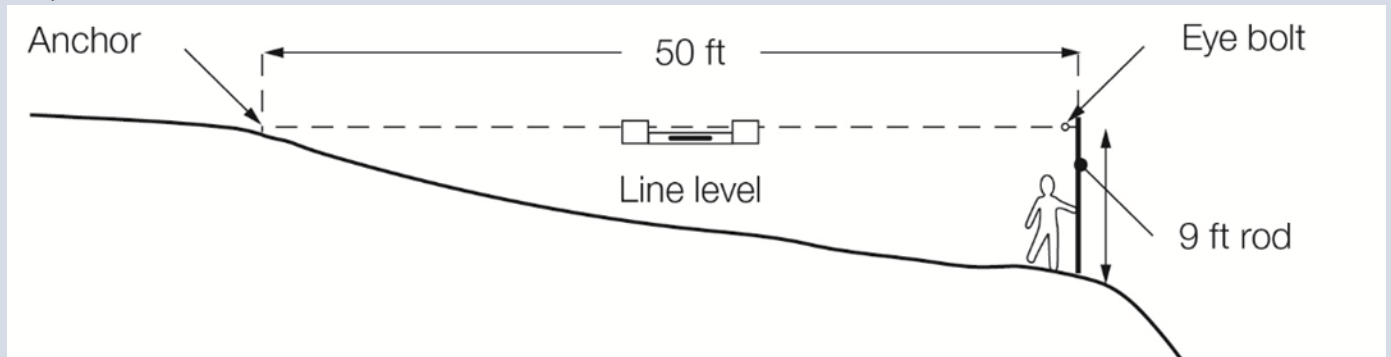
Toe of Bluff

The shoreland rules define the toe of a bluff as "the **lower point** of a 50-foot segment with an **average slope exceeding 18 percent**." (See part 6120.2500, subp. 18b)

For finding the toe of bluff, imagine moving a 50-foot string segment down the face of the bluff. The toe of bluff is the location of the downhill end of the string when the slope, over the 50-foot segment, is marginally greater than 18%, or for practical purposes, 18%. This is the point where the slope rises 9 feet over the 50-foot distance.

Step 3 – Does the Exemption Apply?

In rare situations, bluff features contain relatively large flat areas or terraces. In these cases, after the top of bluff is located, you may want to see if the flat area can be "exempted" from the bluff feature and used as a buildable area. The bluff definition in rule states:

"An area with an average slope of less than 18% over a distance of 50 feet or more shall not be considered part of the bluff." See Figure 5.

The Shoreland Rules statement of need and reasonableness document or SONAR explains that the purpose of this exemption is to provide areas for building sites, as long as bluff setbacks can be met. Bluff setback standards for structures were designed to minimize risks for soil erosion and slope failure as well as reduce structure visibility from public waters.

Figure5: Areas with an average slope less than 18% over a 50-foot distance are not part of the bluff.
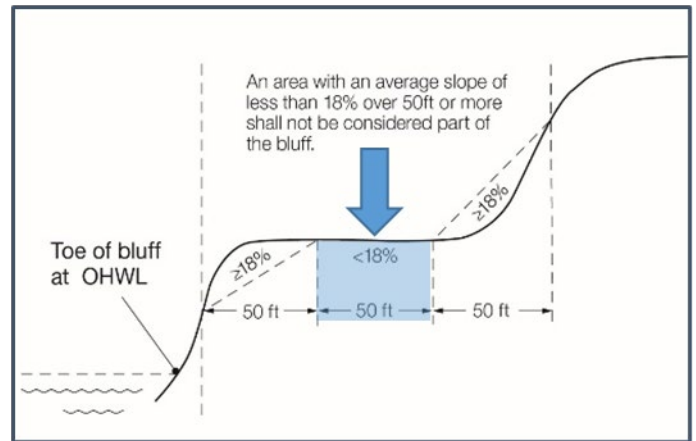
This exemption cannot be applied to the "toe of bluff" or "top of bluff," which refer to the lower and higher points, respectively, of a 50-foot segment with an average slope exceeding 18%. These areas are physically and visually part of a bluff feature. Exempting the toe and top of bluff would undermine the purpose of the bluff setback standards as well as standards prohibiting vegetation removal and land alteration in the bluff impact zone by allowing development within a bluff, an area at high risk to erosion and failure.

This bluff exemption provision should only be applied to slopes less than 18% over 50 feet **THAT ARE NOT** part of the toe or top of slope dimensional measurement.

Bluff Examples

In this next part, we will apply the above described process to two examples. In both cases, **we assume that the feature is located within the shoreland district and that the slope drains toward the waterbody (thus Criteria 1 and 2 are met).**

## Example A: The slope feature rises quickly from the OHWL (toe of the slope and the OWHL are the same).

Step 1 - Determining if a Bluff Exists

Criterion 1: Is part or all of the feature located within a shoreland district? → Yes (assumed).

Criterion 2: Does the slope drain toward the waterbody? → Yes (assumed).

Criterion 3: Does the slope rise at least 25 feet above the OHWL?

Figure 6 shows the cross section of a slope feature with distance shown on the x-axis and elevation shown on the y-axis. For this example, the toe (or OHWL in this case) is at an elevation of 1,194 feet, and 25 feet above this point is an elevation of 1,219 feet. In this example, the slope actually rises 28 feet above the OWHL to an elevation of 1,222 feet (see blue arrowed line), at which point it visually begins to taper off (or get less steep). → Yes, the slope rises at least 25 feet above the OHWL.
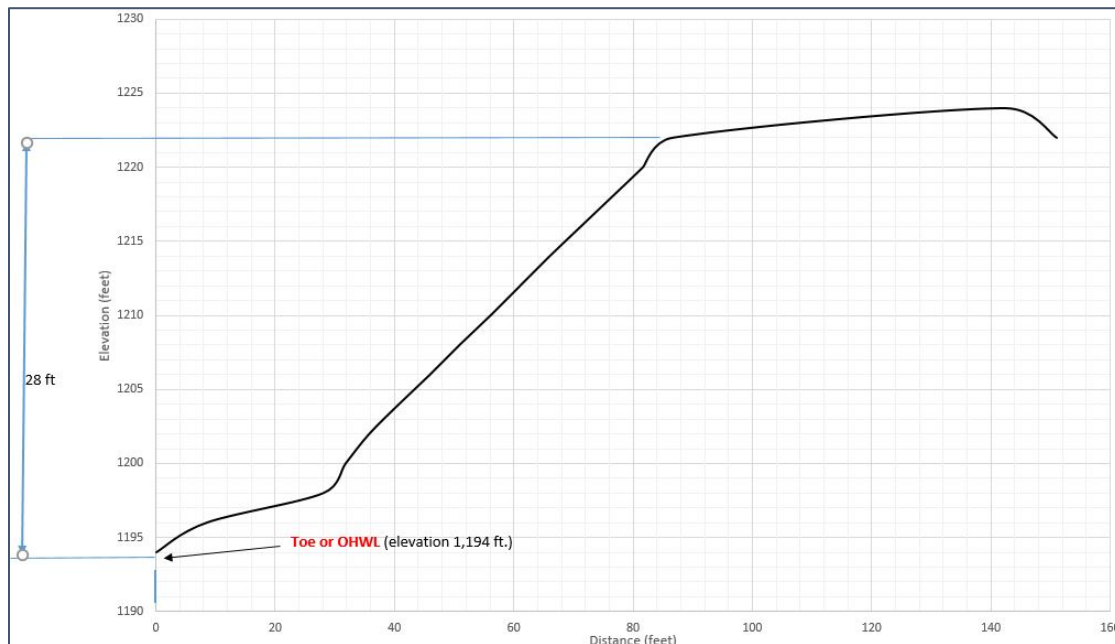
Criterion 4: Does the grade of the slope from the toe of the slope (the OHWL in this case) to a point 25 feet or more above the OHWL average 30% or greater?

To determine a slope percent, we need to know the horizontal distance of the slope's rise from the toe to a point 25 feet or more above the toe. Figure 7 shows that the horizontal distance between the toe of the slope (noted as 0 feet on the horizontal distance axis, or "x-axis") and the point 25 feet or more above the OHWL is 86.5 feet (see solid red arrow line).

In this example, the slope rises 28 feet over a distance of 86.5 feet for a slope of 32.4%:

(28 feet/86.5 feet) X 100 = 32.4%, or

(1,222 – 1,194)/(86.5 – 0) X 100 = 32.4%

→ Yes, the slope averages greater than 30%.

Since the average slope is greater than 30% and all previous criteria have been met, this slope feature **is a bluff**. Furthermore, there are no areas (within the red dashed line) with an average slope of less than 18% over a distance of 50 feet that are considered not part of the bluff.

Figure 7. Average grade of slope exceeds 30% for example where the toe of the slope feature and the OWHL are the same.
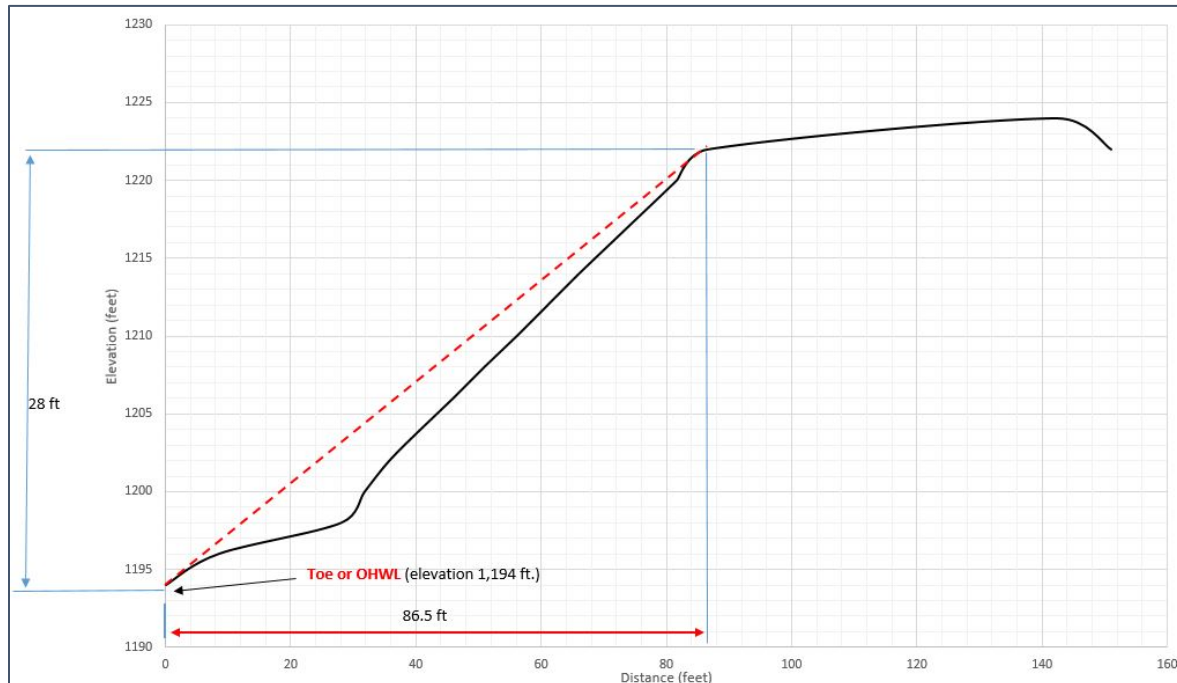
Step 2 - Locating the Top of Bluff

Now that a bluff has been verified, the next step is locating the top of bluff, or the higher point of a 50-foot segment with an average slope exceeding 18 percent. To do this, move a 50-foot horizontal segment up the slope and calculate the percent slope (rise over run) as the segment is moved. Stop when the percent slope for the segment is just marginally over 18%; the elevation at the higher point of that 50-foot segment is the top of bluff.

In this example, the orange dashed line in Figure 8 shows where the percent slope of this 50-foot segment is just marginally over 18%. The elevation of the slope at the higher point of the 50-foot segment is 1223.05 feet and the elevation at the lower point is 1214.00 feet. The percent slope was calculated as follows:

1223.05 feet – 1214.00 feet = 9.05 feet (this is the rise)

(9.05 feet (rise)/50 feet (run)) X 100 = 18.1%

If the 50-foot segment were moved much further uphill, the slope would become 18% or less. Therefore, **the elevation for the top of bluff is 1,223.05 feet**.

This elevation determines where the 30-foot structure setback begins (indicated with a green arrow line). Note that the bluff impact zone (not shown) extends 20-feet beyond the top of bluff elevation.

Figure 8. Top of Bluff Location.
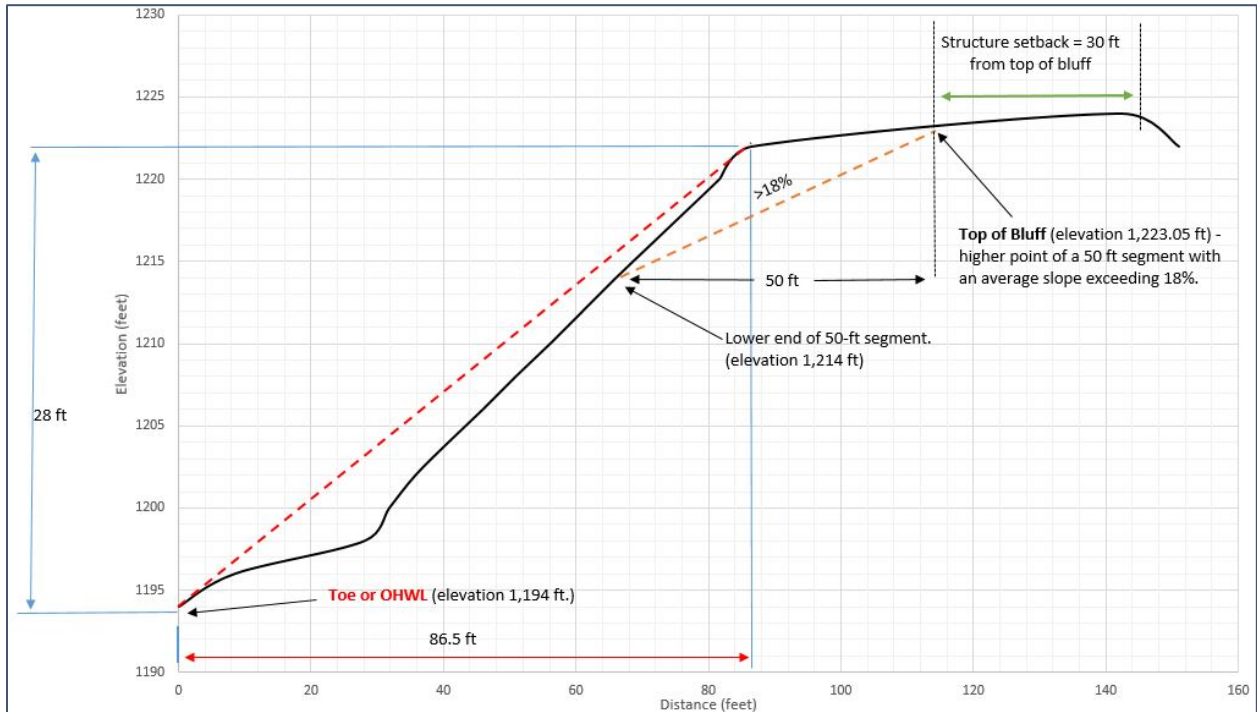
Example B: The slope feature rises at some distance from the OHWL (toe of the slope and the OHWL are different).

### Step 1 - Determining if a Bluff Exists
Criterion 1: Is part or all of the feature located within a shoreland district? → Yes (assumed).

Criterion 2: Does the slope drain toward the waterbody? → Yes (assumed).

Criterion 3: Does the slope rise at least 25 feet above the OHWL?

Figure 9 shows the OHWL at an elevation of 1,050 feet. Twenty-five feet above this point is an elevation of 1,075 feet (see blue arrowed line). In this example the slope rises slightly higher than this. → Yes, the slope rises at least 25 feet above the OHWL.

Figure 9. Slope rising at least 25 feet above the OHWL.
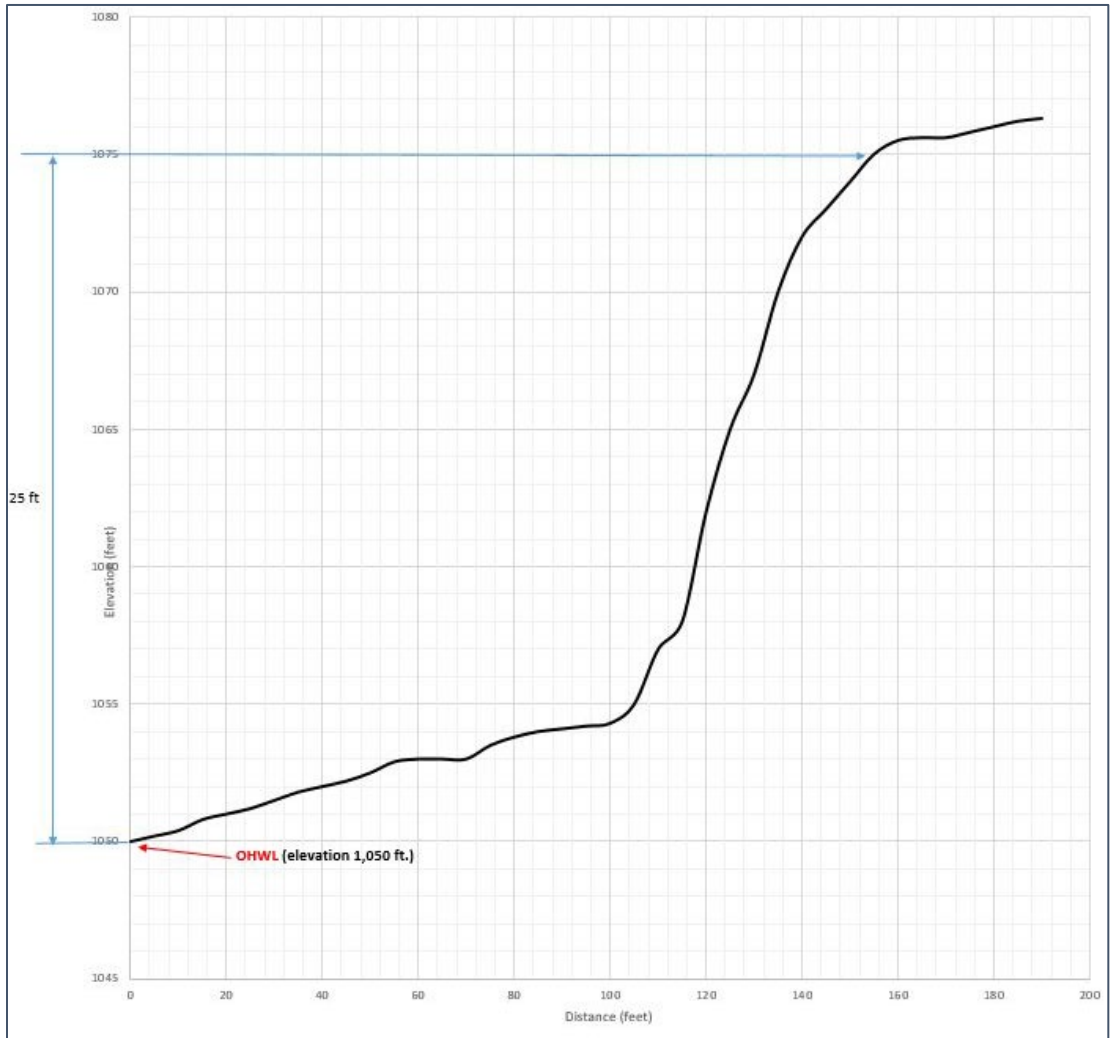
Criterion 4: Does the grade of the slope from the toe of the slope to a point 25 feet or more above the OHWL average 30% or greater?

To determine the grade of a slope located away from the OHWL, we first need to determine the toe of the slope, the lower point of a 50-foot segment with an average slope exceeding 18%. In this example, the orange dashed line in Figure 10 shows where the slope of this 50-foot segment is marginally more than 18%. The elevation of the slope at the lower point of the 50-foot segment is 1,053 feet and the elevation at the higher point is 1,062.05 feet. The percent slope was calculated as follows:

1,062.05 feet – 1,053.00 feet = 9.05 feet (this is the rise)

(9.05 feet (rise)/50 feet (run)) X 100 = 18.1%

If the 50-foot segment were moved much further downhill, the slope would become 18% or less. In this example, the toe is located at an elevation of 1,053 feet, 70 feet from the OWHL.

Once we know the location of the toe, we need to know the horizontal distance of the slope's rise. Figure 10 shows that the horizontal distance between the toe of the slope (starting at 70 feet on the horizontal distance axis, or "x-axis") and the point 25 feet above the OHWL (ending at 140 feet on the x-axis) is 70 feet (see solid red arrowed line). In this case, the slope rises 22 feet over a distance of 70 feet for a slope of 31.4%:

(22 feet/70 feet) X 100 = 31.4%, or

(1,075 feet – 1,053 feet/140 feet – 70 feet) X 100 = 31.4%.

→ Yes, the slope averages greater than 30%.

Since the average slope is greater than 30% and all previous criteria have been met, **this slope feature is a bluff**. Furthermore, there are no areas (within the red dashed line) with an average slope of less than 18% over a distance of 50 feet that would be considered not part of the bluff.

Figure 10. Average grade of slope exceeds 30% for example where the toe of the slope feature is more than 50 feet from the OWHL.
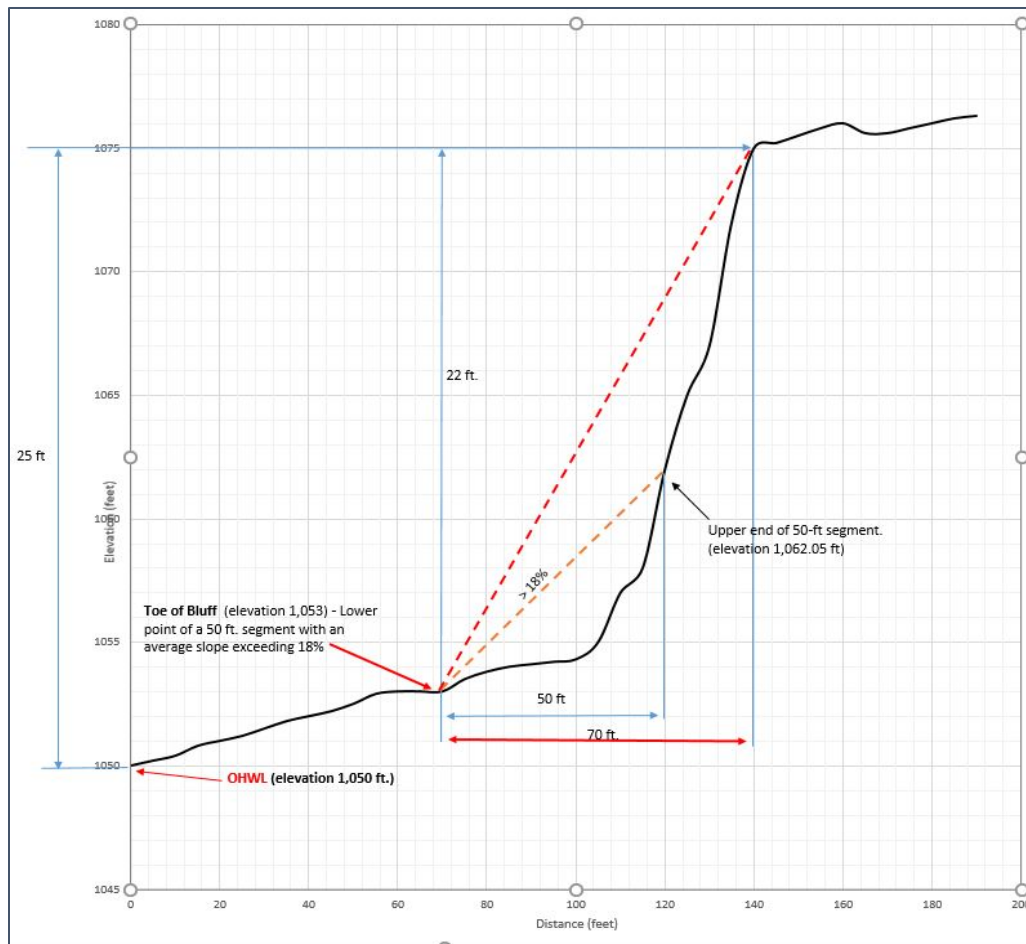
Step 2 - Locating the Top of Bluff

Now that a bluff has been verified, the next step is locating the top of bluff, or the higher point of a 50-foot segment with an average slope exceeding 18 percent. The upper orange dashed line in Figure 11

shows where the percent slope of this uppermost 50-foot segment is marginally more than 18%. The elevation of the slope at the higher point of the 50-foot segment is 1,076 feet and the elevation at the lower point is 1,066.95 feet. The percent slope was calculated as follows:

1,076.00 feet – 1,066.95 feet = 9.05 feet (this is the rise)

(9.05 feet (rise)/50 feet (run)) X 100 = 18.1%

If the 50-foot segment were moved much further uphill, the slope would become 18% or less. Therefore, **the elevation for the top of bluff is 1,076 feet.**

This elevation determines where the 30-foot structure setback begins (indicated with a green arrow line). Note that the bluff impact zone (not shown) extends 20-feet beyond this top of bluff elevation.

Figure 11. Top of Bluff Location
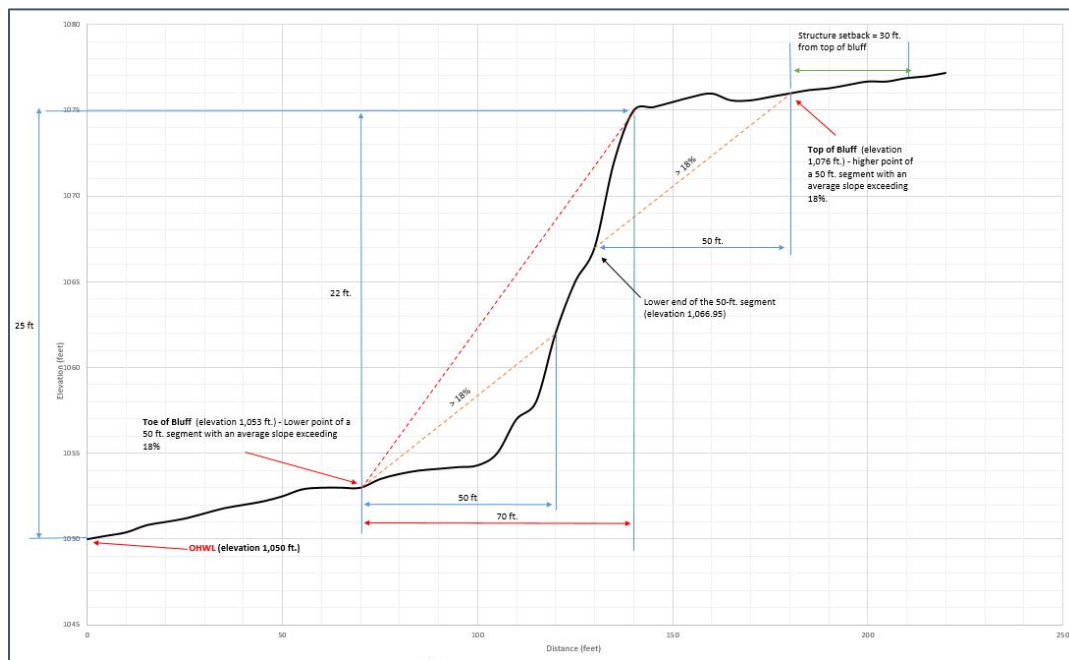
Sources

MNDNR Lakefinder webpage – OHWL information is available for many individual lakes. For lakes not listed here and for rivers, please contact your DNR Area Hydrologist or your local government for OWHL information.
MnTOPO – is a website containing elevation data and is useful for estimating whether a bluff may exist on a property. Properties can be located by address.
MnTOPO Guidance Document – a DNR publication explaining how to use MnTOPO tools and data to evaluate slopes – useful for local government staff and DIY property owners.

The statements in this document do not have the force and effect of law. This document is informational only and should not be interpreted as creating new criteria or requirements beyond what is already established in the relevant statutes and rules. Whether a local shoreland ordinance complies with the relevant statutes and rules will be determined on a case-by-case basis. Nothing in this document should be considered legal advice. Local governments should consult their attorney for specific advice in adopting, amending, and administering ordinances.