

Why is the Cedar River Stage at Waterloo vs. Cedar Falls so Different?

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Introduction

Sometimes the terms “river stage” and “water depth” are used interchangeably. These two terms do not mean the same thing however. Water depth refers to how deep the water is at a given location, whereas river stage may not. River stage is measured relative to a reference elevation called the “zero datum.” The zero datum is set at a known elevation above sea level. Elevations above the zero datum elevation level are positive and elevations below it level are negative. An elevation at—or equal to—the zero datum elevation is zero. The reported river stage is a measure of how far the surface of the river is above or below the zero datum elevation. If the surface of the river is above the zero datum elevation then the reported river stage will be a positive number. If the surface of the river is below the zero datum elevation then the reported river stage will be a negative number. If the surface of the river is at the zero datum elevation then the reported river stage will be zero.

Why Use the Zero Datum Method?

The zero datum method is used because doing so yields a reported river stage figure which is easier to conceptualize and use. If the zero datum method was not used then the reported river stage figures would be much larger—they would be relative to sea level.

In addition, the zero datum is typically set at an elevation such that the reported river stage would not be negative or zero. Such elevations may cause confusion. Typically, the zero datum elevation is set at least slightly below the river bed. Over time, however, scour may push the river bed elevation to below the zero datum elevation. Then, if the reported river stage is low enough then a negative or zero river stage may become possible. Ideally, the zero datum elevation would be set far enough below the river bed to prevent these problems.

Since the zero datum elevation is normally set to an elevation below the river bed, the reported river stage in most cases does not indicate the river depth. But even if it did, consider this. Since the elevation of the river bed changes with location even over short distances such as a couple feet, the depth of river changes just as much because it depends on the river bed elevation. Thus, river depth cannot be described by a single number. River depth can vary greatly from locations

near the river banks to locations in the middle of the river. And the depth at locations in the middle of the river can vary as well. Thus, river depth is a variable number which is not easily described by a single value.

Example—Cedar River Stage at Waterloo vs. Cedar Falls

Let's consider an example to help illustrate the above information. Suppose that the reported river stage on the Cedar River at Waterloo, Iowa is 6.4 feet. Does it mean that the river is 6.4 feet deep? Not necessarily. Instead, it means that the surface of the water is 6.4 feet above the zero datum for that river gage. If the zero datum method was not used then the river stage would be reported as 830.5 feet above mean sea level (MSL). This number is considerably larger than 6.4 feet and thus may be hard to conceptualize and use. Instead of reporting the river stage as 830.5 feet MSL, the zero datum elevation for the Cedar River at Waterloo is set at 824.1 feet MSL. Then the reported river stage would be $830.5 \text{ feet MSL} - 824.1 \text{ feet} = 6.4 \text{ feet}$ above the zero datum elevation, which is the figure that you would normally see.

In contrast, for the Cedar River at Cedar Falls, the zero datum elevation is 763.0 feet MSL which is much lower than the zero datum elevation downstream at Waterloo. In fact, it is 61.1 feet lower. This difference in the zero datum elevations accounts for the large difference in stage values between the Cedar River at Waterloo and Cedar Falls. Since the zero datum elevation for the Cedar River at Cedar Falls is set so much lower than the zero datum elevation for the Cedar River at Waterloo, the difference between the zero datum elevation and the water surface elevation at Cedar Falls is much greater than it would be at Waterloo. Thus the reported stage at Cedar Falls is much higher than the reported stage at Waterloo. In fact, if the water surface elevation at Cedar Falls was the same as the water surface elevation at Waterloo (i.e., 830.5 feet), then the reported river stage at Cedar Falls would be $830.5 \text{ feet} - 763.0 \text{ feet} = 67.5 \text{ feet}$.

Remember that the reported river stage is actually the difference between the elevation of the river surface and the zero datum. Thus, if the elevation of the zero datum is really low then the reported river stage will be really high.

How was the Zero Datum Chosen for the Cedar River at Cedar Falls?

Considering all of the above information and example, one may be left wondering how the zero datum for the Cedar River at Cedar Falls was chosen to be 763.0 feet MSL. After all, the zero datum at Cedar Falls results in the reported river stage there to be much higher than many upstream and downstream river gages.

Before explaining how the zero datum was chosen for the Cedar Falls river gage, it should be noted that the National Weather Service typically does not choose the zero datum elevations at any river gage. Instead, the zero datum is typically chosen to meet the needs of the agencies, organizations, etc., which are helping to support the gage.

According to Randy Lorenzen (the City Engineer for the City of Cedar Falls), today's zero datum of 763.0 feet MSL at the Cedar Falls river gage was the result of decisions that were made before the gage was installed in 2000. Today's zero datum for the Cedar Falls river gage is set relative to a reference location on the front steps of the old Cedar Falls City Hall. (The Cedar Falls Historical Society states that the old City Hall was built in the 1890s one block from Main Street. It served as the primary location for city activities until 1967.) The flood stage of 88.0 feet at the Cedar Falls river gage translates to an elevation that was 12 feet below the reference location on the front steps of the old City Hall. Before the river gage was installed, all of the river level records for Cedar River at Cedar Falls were kept locally and were relative to the reference location at the old City Hall. When the river gage was installed, the zero datum was not changed because many of the Cedar Falls citizens and businesses were used to the already established levels. There was concern that changing the zero datum may result in confusion especially among the local citizens and businesses during flood events.

For More Information

For more information contact the National Weather Service in Des Moines, Iowa at w-dmx.webmaster@noaa.gov or at 515-270-2614.

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