

REAL-TIME STREAM FLOW GAGES IN MONTANA

Montana is home to over 264 real-time stream gages located throughout the state. These gages and their networks assist in delivering water data to scientists and the public. While Montana's demand for water continues to grow, water availability varies from year-to-year and can change dramatically in any given year. Managing supply and demand challenges is an ongoing feature of life.

Accurate, near real-time, publicly accessible information on stream flows assists both day to day decision making and long-term planning, as well as emergency planning and notification. This information is generated in Montana by multiple networks of real-time stream gages operated by the U.S. Geological Survey (USGS), the Department of Natural Resources and Conservation (DNRC), and some tribes. Within each network, the operation and maintenance of gages are financially supported by different sources including federal, state, tribal, local, and private funds. Some of the gages are funded by multiple agencies and organizations.

The recorded data are essential to make informed water management decisions across the state. Real-time gages are used by organizations to assist with local water source planning, distribute water for water rights administration, manage fisheries, operate reservoirs, manage stream flows for fishing and boating, and predict flooding.

In addition, the 2015 State Water Plan recommended that Montana be better prepared to manage water in real-time to adjust to seasonal changes in supply and demand as well as prepare for long-term changes. The stream gages provide this data, and more gages are necessary to continue to understand and manage water.

Many of the stream gages have data records that are at least 50 years long, and Montana has a few with 100-year records. A long historical record is valuable to understand the highs and

lows and improve water management practices. It can drive the understanding for other sciences and helps inform citizens on how we can prepare for changes in our water supply. It is imperative to maintain as many gages as possible to preserve these historical records for current and future generations.

REAL-TIME GAGES

A real-time stream gage is used to report stream flow (discharge) in cubic feet per second. These gages measure the stage (height) of the river in feet, and water temperature along with other environmental data.



The measurements happen automatically about every 15 minutes, and that data is sent out once an hour to a satellite that transmits it to the network's hub computers. Most real-time stream gages in Montana, use a pressure sensing device to determine the river stage. The benefit of these systems is that they are highly accurate and maintain consistent records with low maintenance.

The DNRC has been a cost-share partner with USGS on stream gages for over 38 years. In the last decade, overall costs have increased, and federal and state budgets have stayed the same or decreased. As funding becomes unstable or is cut, real-time gages have been at risk of shutting down,



or have been turned off. The USGS network identifies gages that are at risk of being shutoff and ones that have been rescued. These changes are usually due to funding shortfalls. Many of these gages are operated with funds from multiple organizations. If there is a shortfall in one organization for a gage, other organizations need to increase their cost share. If the costs can't be met these gages go dark. The DNRC network has also had financial challenges.

Why is it gage and not 'gauge'?

This can be confusing for people and sometimes it is harder to find information about stream gaging if the search contains the more used spelling "gauge."

When water measurement methods were first developed by the USGS in the late-1800's, the Chief Hydrologist, Frederick H. Newell adopted that spelling that was also being used in the Standard Dictionary of the time. (1)

Costs

The initial installation of a real-time gage is about \$15,000 which includes the equipment costs, and any needed permitting. Personnel time for installation is an additional cost. The design and development of stream gage equipment is a niche industry. It is designed, patented and sold by private companies. The equipment takes multiple water measurements in extremes of hot and cold weather, is waterproof, and sends the data hourly via a satellite to hub computers for processing and verification before being sent to websites that broadcast the data to users. In addition, the stream gage stores the sent data as a back-up to minimize the potential for any lost data.

Although some electronic devices are getting less expensive, the equipment costs for the gages will most likely remain stable for the near future. Montana uses the national infrastructure including satellites and computer systems to transmit the data from each gage to the internet.

All stream gage data needs to be calibrated and checked regularly. Personnel who travel to and check the gages are skilled practitioners with significant higher education and work training.

Ongoing operation and maintenance for a gage is about \$16,500 a year with much of that being computer networks, data processing, personnel, and travel costs.

How and why data is checked on the ground

Rivers are dynamic and always changing, often in ways that the casual observer can't see. In particular, the riverbed can change dramatically after high or low water, scour events, or because of erosion (Figure 2). Real-time gages are checked about every six weeks when they are operating. Hydrologists and technicians travel to each site to verify gage height, download the backup data and take stream measurements, this is often called "ground-truthing." DNRC follows the USGS guidelines, which is the gold standard for water surveying in the world.

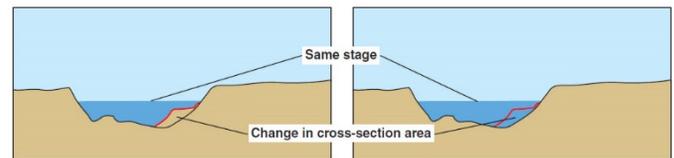


Figure 2 (2)

There is a three-prong watch hydrologists manage while making final decisions on the days to visit: the current weather, including recent weather events; unexpected variations of data that is being sent by the gage; and an understanding of how each stream responds to natural events. For instance, mountain streams are driven mostly by snowmelt, however, streams that are more valley-based can be a little "flashier" and rise or fall quickly after storm events.



In addition, inflow from valley streams, wetlands and meadows that act as natural storage, and irrigation diversions may all impact the readings.

While at the gage, personnel use a flow meter as they cross the channel to take current water measurements, taking at least 20 measurements on each site. That data is then calibrated at an office using mathematical equations to determine if the river has undergone major changes that would impact the formulas currently used to determine streamflow for that area.

The more years hydrologists and technicians spend monitoring the gage, the more institutional memory is built that assists in developing the most accurate information.

Where you find the data

The data collected by gages in Montana can be found in multiple locations. Most streamflow data links can be found in links at: <http://dnrc.mt.gov/divisions/water/management/raining-education/water-commissioner-information/streamflow-data> .

Sources:

- (1) https://www.usgs.gov/faqs/why-does-usgs-use-spelling-gage-instead-gauge?qt-news_science_products=0#qt-news_science_products
- (2) U.S. Geological Survey Streamgaging, Fact Sheet 2005-3131, March 2007.

ADDITIONAL STREAM GAGE INFORMATION

USGS Documents about Gages

- How Does a U.S. Geological Survey Streamgage Work?
<https://pubs.usgs.gov/fs/2011/3001/pdf/fs2011-3001.pdf>
- From the River to You: USGS Real-Time Streamflow Information:
<https://pubs.usgs.gov/fs/2007/3043/FS2007-3043.pdf>
- U.S. Geological Survey Streamgaging:
<https://pubs.usgs.gov/fs/2005/3131/FS2005-3131.pdf>
- USGS How Streamflow is Measured:
<https://water.usgs.gov/edu/measureflow.html>
- USGS Montana Current Water Conditions:
<https://www.usgs.gov/centers/water-dashboard/surface?state=mt>

More information about stream gages can be found at:

- <http://prairiepopulist.org/stream-gages/>
- <https://www.newsdeeply.com/water/articles/2017/06/21/funding-woes-for-stream-gages-put-crucial-water-data-at-risk>
- https://en.wikipedia.org/wiki/Stream_gauge

