Poudre Runs Through It River Flow Gages Project

From Idea to Installation

The Idea

The idea for our Poudre River bridge-mounted gages emerged from brainstorming from the Poudre Runs Through It Work Group. Our intent was to help the interested public learn what a "cubic foot per second" really means because it is so important in dealing with flowing water in the west. Though it is easy to look up river flow at discrete points on the internet, there is no better opportunity for education as when you are in or near the river itself and curiosity strikes.

Creating a Stage-Discharge Relationship for a River Location

The foundation for the stream gages we installed is what is called a rating curve that relates the water level (or stage) at a single location to the amount of flow (discharge) in the river. Though often laborious to create for a wide range of flows, having such a stage-discharge relationship enables an individual, or an electronic gage, to simply measure the water level in order to estimate the flow at that location. The value of flow estimated from stage depends on the shape of the stream channel, the slope of the river, and whether any obstructions are present.

Much has been written about the technical aspects of creating such a stage-discharge relationship, or rating curve. The U.S. Geological Survey, who is responsible for most stream gages in the United States, provides their guidelines for developing a rating curve at http://water.usgs.gov/edu/streamflow3.html. The USGS is interested in high accuracy at all flow levels and they regularly recalibrate their gages, especially if there is a reason to believe that the stage-discharge relationship may have changed.

Developing an accurate rating curve is typically labor intensive. Hydrologists usually wade the river multiple times at different flow levels and measure the water's velocity and depth at frequent intervals across the river as well as the height of the water's surface as measured from a fixed benchmark elevation. They integrate the velocity and depth measurements to determine the river's flow at that time. See http://water.usgs.gov/edu/streamflow2.html for more about how this works. These measurements can be relatively easy at low flow but dangerous at high flow, so often other techniques must be used, such as boating, measuring from a cable or bridge, or even using new radar-like technology. Measuring both low flows and high flows are important because they tend to occur less often, but can be of great importance when they do happen.

Figure 1. Flywater's Matt Shupe and Parker Scherman surveying stream channel characteristics at the McMurry site.

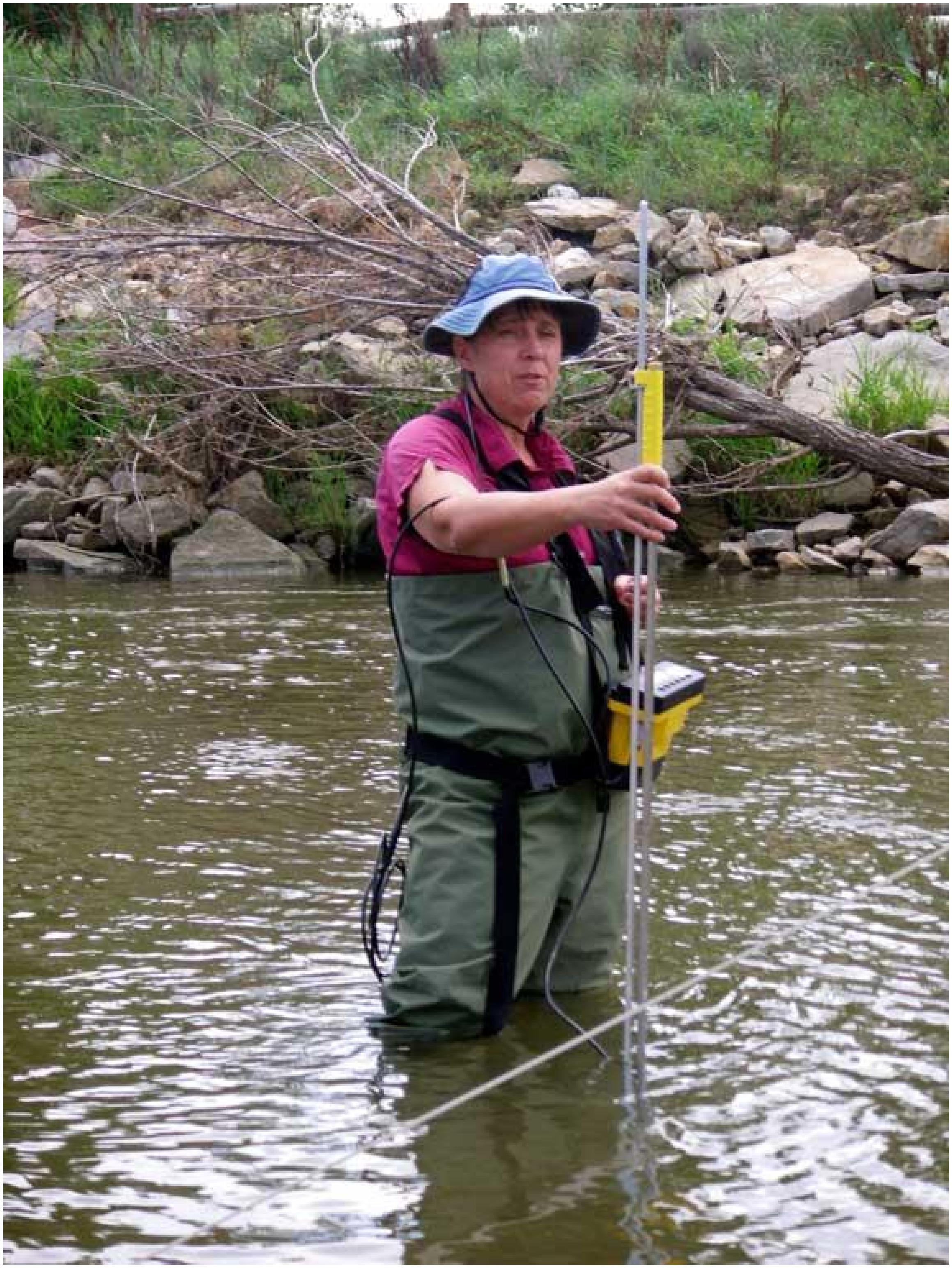


Figure 2. Water and Earth Technologies' Kate Malers measuring water velocity and depth across the channel at the County Road 13 site. Below the water's surface is a device that measures the velocity and marks on the rod measure depth.

It is also possible to develop a stage-discharge relationship with less field data collection. Well-respected and thoroughly validated computer models can compute the relationship given enough data about the shape of the channel, the slopes of the river's bed and the water's surface, and knowledge of how much friction may affect the water's velocity. In general, the more actual field measurements that are fed into such a model, the more trustworthy the model becomes, especially its ability to predict the stage-discharge relationship outside the range of measured flows. The HEC-RAS software was used for this project.

If one is fortunate enough to have an accurate river gage nearby, it is possible to develop a stage-discharge relationship in yet a different way. One can repeatedly visit the site at a variety of flows and measure the water surface elevation from a fixed benchmark, say on a bridge. Then, the height of the water at that location can be correlated with the known flow measured at the nearby gage. This could be called empirical modeling, as distinct from computer modeling, but it takes numerous measurements to capture the full range of flows.

To develop our river gages on the bridge abutments, we combined elements from all of the above methods, taking some detailed velocity and channel shape measurements, applying a numerical hydraulic model, and integrating the empirical data. Each data set and technique, along with professional judgment, contributed to our final results, as shown in the figure below.

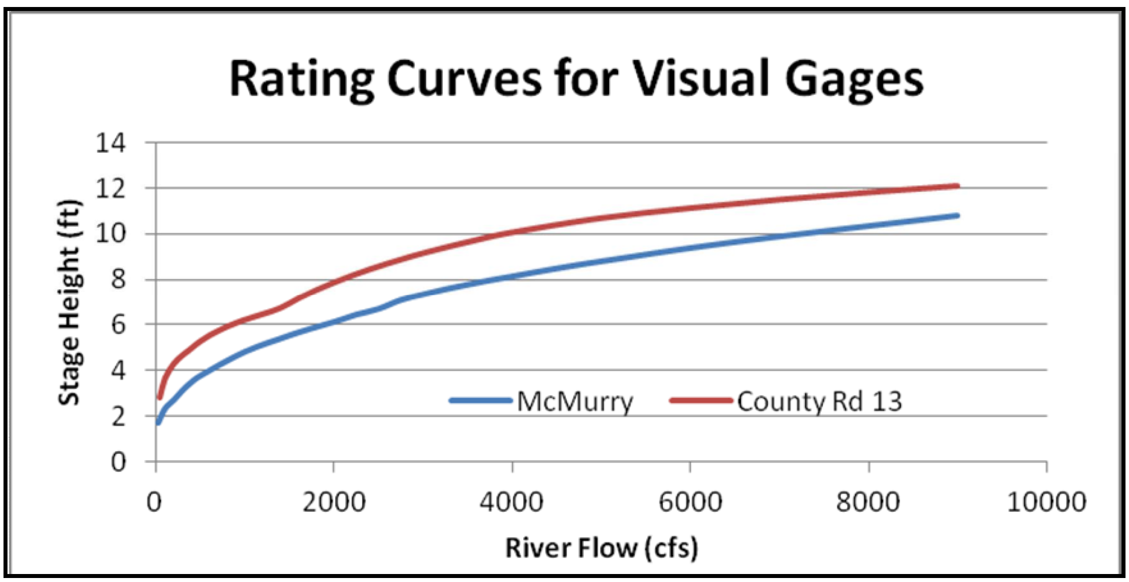


Figure 3. Approximate relation between river stage and flow for the two installed gages.

Limitations

Each of the methods we employed had some uncertainty associated with it. Without being exhaustive, we can point out some of the major uncertainties we dealt with. Due to resource limitations, were only able to collect a limited set of field velocity measurements. Though one of the sites (McMurry) was fairly straightforward in terms of measuring the channel shape, the other (County Road 13 Bridge) was much trickier, including a bridge abutment and sizable gravel bar, among other challenges. And though the empirical data were collected at a variety of flow levels, there were issues in relating those data to nearby gages because the McMurry site has an intervening irrigation diversion between it and its closest gage at Lincoln Avenue, and the County Road 13 site was quite a distance away from its closest gage below the New Cache diversion, has unmeasured surface and groundwater additions to the river below it, and may be somewhat less accurate than many other gages. Even the U.S. Geological Survey cautions that their stream gages have a 5-10% uncertainty factor.

Disclaimer

From the above discussion, it should be apparent that our visual stream gages should not be viewed as accurate in any legal sense. Though we have done our best to represent the stage-discharge relationship faithfully, their real purpose is for education. Also, depending on future river flows, the channel may change at each gage location, potentially reducing the fidelity of our current rating curves.

Acknowledgements

Many people contributed their time, expertise, and equipment freely to this project and for that we are extremely grateful. Several people from Flywater Consulting helped survey the channel, including Corey Engen, Matt Shupe, and Parker Scherman. Kate Malers from Water and Earth Technologies supplemented those channel measurements and did the complex hydraulic modeling. John Bartholow collected the empirical data, with help from Mark Simpson, our Poudre River Commissioner. Robert Milhous provided quality control and added guidance across all the measurement techniques. Jeffrey Boring, Anastasia Patterson, James Johnson, and John Bartholow braved the water to install the gages. Wade Willis dug deep holes for the sign.

Jeffrey Boring led the charge, including coordinating with the sign makers. Several representatives from the Poudre Runs Through It workgroup (Steve Malers, Brad Modesitt, Dale Trowbridge, Wade Willis, and Brad Wind) and other interested people (Sue Kenny from the City of Fort Collins) helped develop the interpretive sign narrative and this web page.

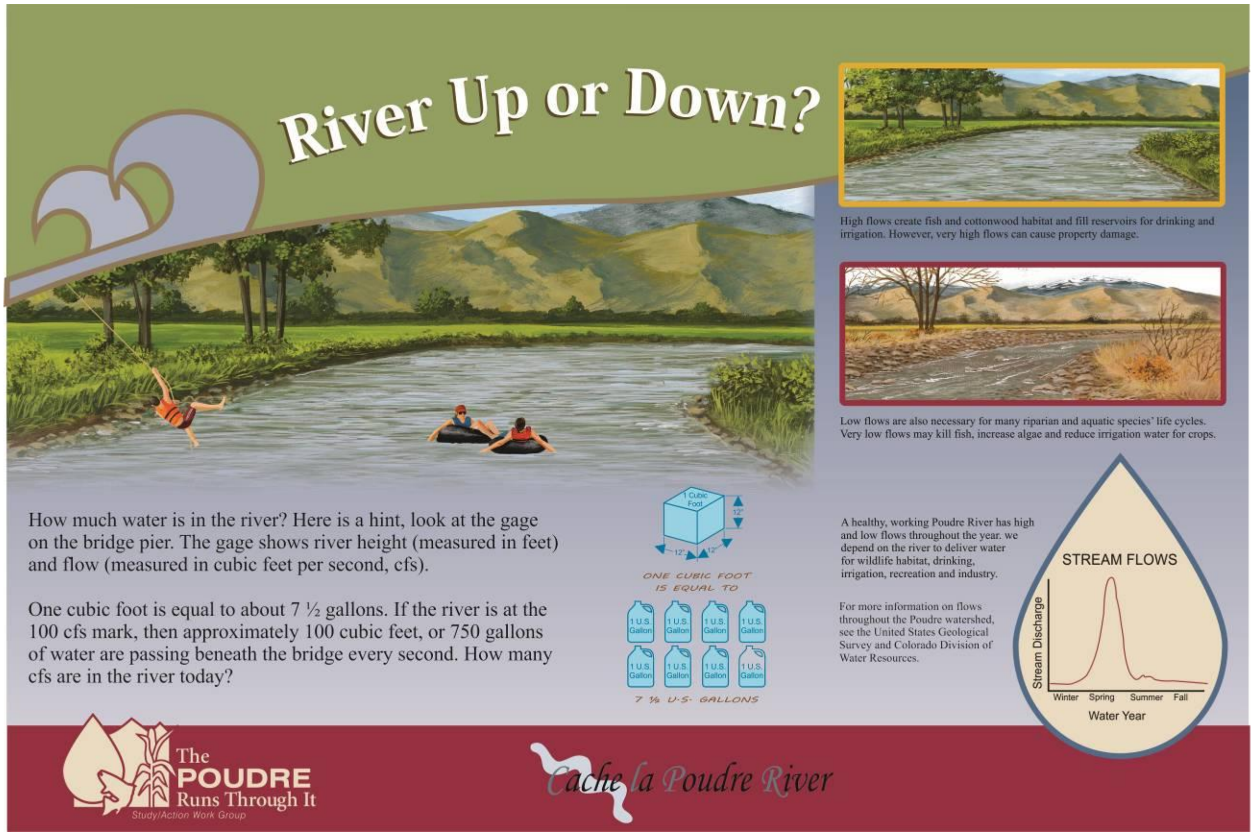
Finally, we would also like to thank the Poudre Heritage Alliance and the Bohemian Foundation's Pharos Fund who helped fund this effort.

Figure 4. The happy crew at County Road 13.

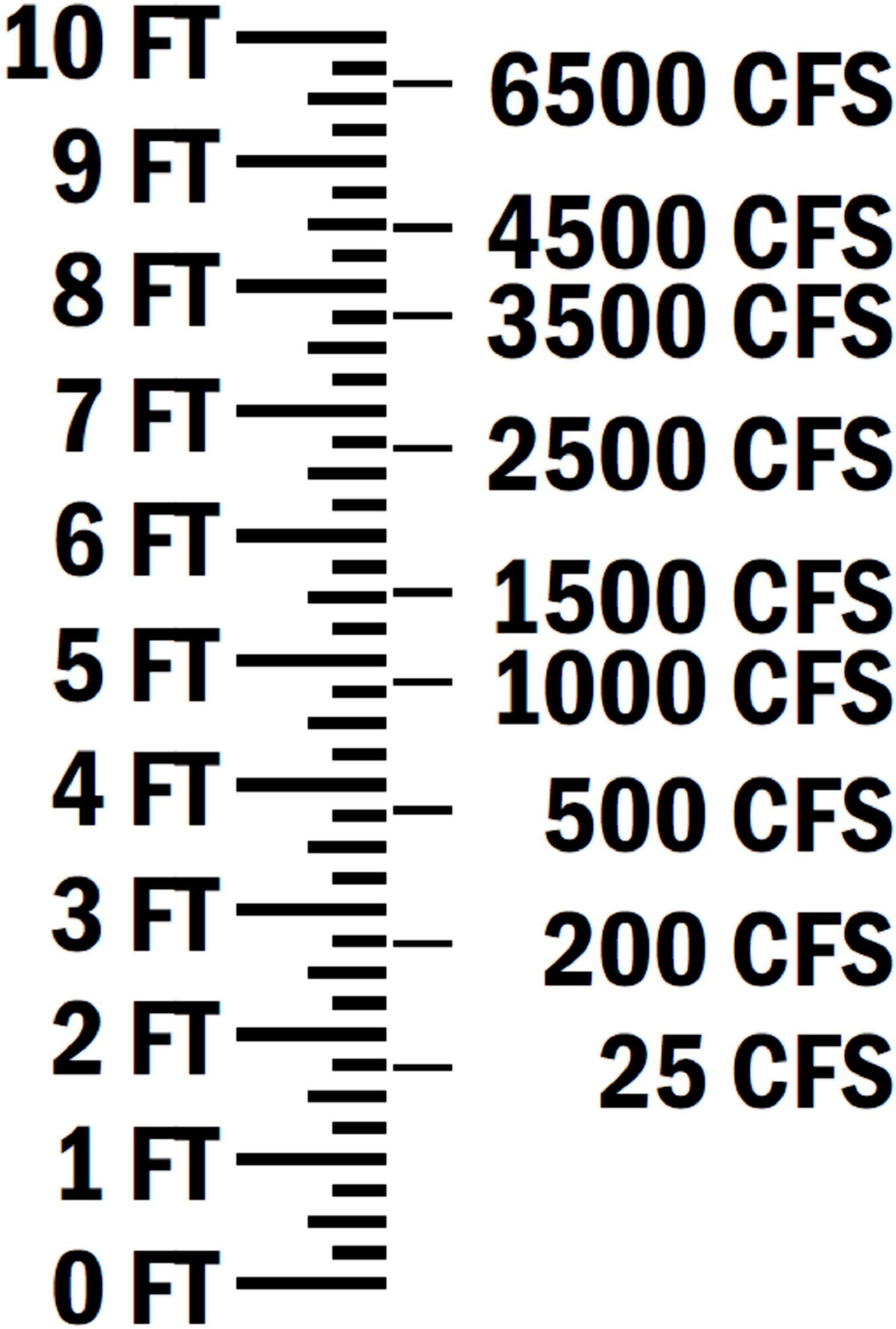
Feedback

We hope to expand our gages to more locations along the Poudre River in the future, so if you have any suggestions to improve this web page, or our stream gages, please contact us.

Attachments



Interpretive signage accompanying the gages.



McMurry Bridge gage.