



MEASURING FLOW IN AN IRRIGATION DITCH

Because you can't control what you don't measure

Caleb Carter

Increased demand for limited water amounts is making a contentious topic even more so in Wyoming and across the West. Using water more efficiently is more important than ever.

Most irrigation water in Wyoming is delivered through canals and ditches. Knowing how much water is flowing in a ditch can help determine if there is enough water and when to turn it off.

Measuring flow

Rate of flow in an irrigation ditch is measured in cubic feet per second (cfs), corresponding to a cubic foot volume of water (1-foot wide, 1-foot high, and 1-foot long) passing a given

point every second. This is equivalent to approximately:

- 450 gallons per minute (gpm).
- 1 acre-inch per hour (1 inch of water covering 1 acre).
- 2 acre-feet per day (24 hours) (2 feet of water covering 1 acre).

Open ditch flows are typically measured using a weir, flume, or a submerged orifice installed in a channel. Water flows over a notch (weir), through a channel (flume), or through a submerged hole (submerged orifice) of predetermined size, and a depth reading is taken. Flows are determined using a table or graph. Each has advantages and disadvantages and specific conditions in which it will operate correctly. Cost, ease of measurement, and maintenance are other

considerations for determining which type is best.

Some general guidelines to obtain accurate results include:

- The ditch or canal must have a shallow grade with a relatively straight segment upstream and uniform cross-section with little turbulence.
- Weirs require more slope than flumes or submerged orifices.
- The location must not cause excessive sediment loading, debris buildup, or flooding of surrounding areas.

Weirs

Weirs are simplest to install and use. They can provide very accurate flow measurements when properly

designed, installed, and maintained. There are square, trapezoidal, and v-notch weirs, with the v-notch being especially good at handling a wide range of flows.

Flow is measured using a staff gauge (see lower left), placed in the channel far enough above the structure so it is unaffected by the curve of the water over the weir. The depth of the water is measured where the water surface touches the gauge.

Weirs do have limitations. They require enough ditch slope so water can flow freely over the structure to the downstream water surface, and a pool, or stilling area, above to slow water velocity. Both can be an issue with silt-laden water or in an earthen ditch, as the pool may silt up and the drop may cause excessive erosion below the weir.

Flumes

Parshall flumes (below right) are the most common type of structure used and can provide very accurate flow measurements. They have a channel of predetermined shape and



size. Flumes can provide accurate measurement with less drop needed between the upstream and downstream water surface than weirs.

Other advantages include:

- Can carry sand/silt through the flume (so less opportunity for build-up) with no effect on accuracy.
- Requires about one-fourth the loss of head (see description below*) compared to a weir, meaning the water won't be slowed as much.
- Can obtain accurate measurements with varying water velocity or flow rates. Wide range of

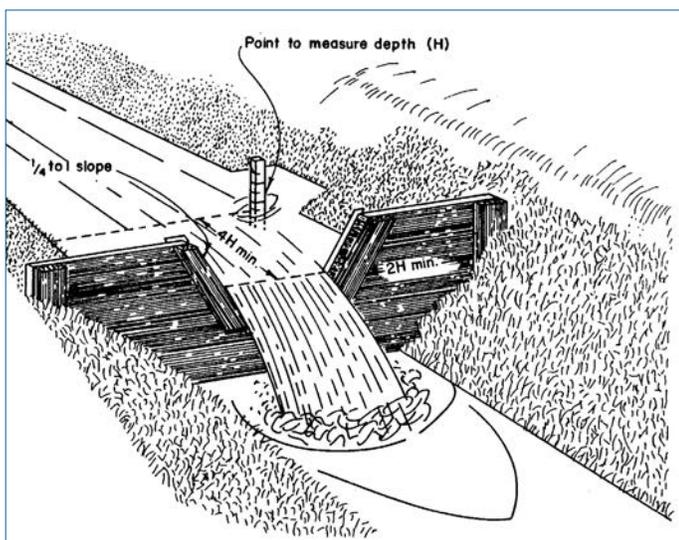
capacity: a flume with a 1-foot throat will measure from 1/3 cfs to 10 cfs.

- Can be made from wood, metal, or concrete, but they must be fabricated to precise dimensions and properly installed to measure irrigation water accurately.

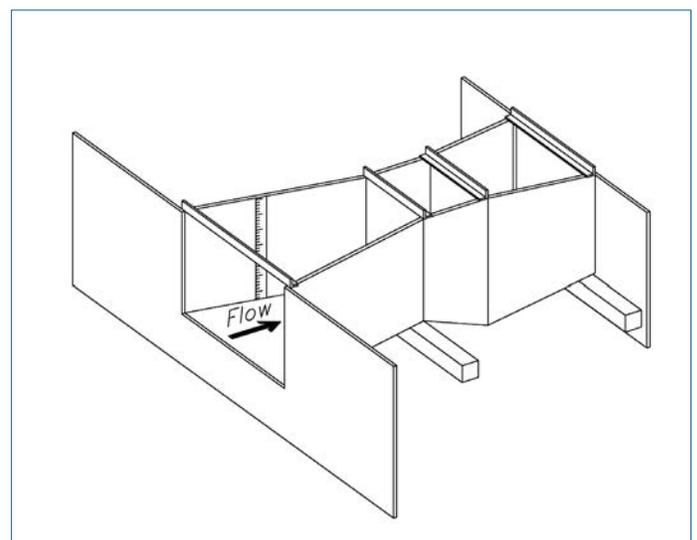
The trapezoidal flume is another style. This structure can be easy to install, as its shape conforms well to the shape of the ditch. Other advantages include:

- Water is not slowed as much, which results in very little back-water and less scouring of the earthen ditch around the structure.
- Does not clog easily.
- Flume will operate under greater submergence (when the downstream water level is high enough to inhibit free flow through the channel) without having to make necessary corrections to determine actual discharge.

A disadvantage is a small change in head (*difference in elevation



Cipolletti weir



Parshall flume

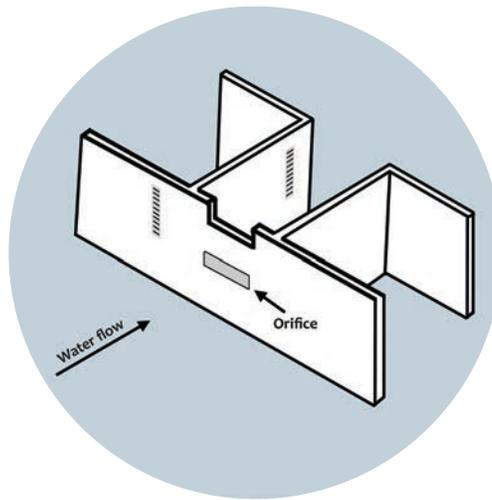
between the water above the orifice and the water below the orifice), or reading on the measuring gauge, can cause drastic changes to flow measurements. Accurate depth readings are critical to obtain accurate flow measurements.

A flume should be in a straight section of the ditch where flow is unimpeded in its approach to the structure. Flow should be smooth with no turbulence. The measuring device is mounted to the side of the flume, at the top and bottom of the structure.

Submerged orifice

A submerged orifice measures water flowing through an opening of predetermined size. The opening must be fully submerged to be an accurate measure of water flow in the ditch. This works well with very little change in head, or in flat ditches. The essential components of a submerged orifice include:

- A smooth, vertical face of sufficient size.



Submerged orifice

- An orifice with smooth, sharp edges and of accurate dimensions.
- A provision for measuring the head.

To measure head, two stakes are set, with the tops at the same elevation – one above the orifice, one below. Measurements are made from the top of each stake to the water surface. Stakes should be placed where the water is calm. The head, in feet, is then compared to an appropriate chart for that orifice to determine flow.

Submerged orifices typically cost less than weirs and can fit into smaller spaces. A meter gate, a type of submerged orifice, can be used to let water from a main ditch into a field, as the gate can be opened/closed or partially opened to set a specific flow. A disadvantage of the submerged orifice is the potential for clogging if water is carrying lots of silt or debris.

Most irrigation systems work most efficiently when run at correct capacity. Accurately measuring water flowing to the field can assure maximum efficiency and help determine how long to run an irrigation set, if you are meeting crop water needs, or if there is a leak or other issue.

Ensure all structures are installed and maintained properly, including cleaning out any debris buildup each spring. Take time to learn accurate management and measurement techniques for any structures in use. This will help you to make the best use of one of Wyoming's most valuable resources.

Installation, measurement information

Proper installation and measurement using structures described here is beyond the scope of this article. Please refer to the University of Wyoming Extension publication *Irrigation Water Measurement: Irrigation Ditches and Pipelines, Bulletin 538R* that can be purchased online for \$7.50 at <http://bit.ly/watermeasure> or check with your local extension office.



Parshall flume in action

There is no device yet (that we know of) that measures the flow of information from someone but if there were, Caleb Carter would move the needle high. A University of Wyoming Extension educator, he is based in Goshen County and serves southeast Wyoming. He can be reached at (307) 532-2436 or ccarte13@uwyo.edu.