DIVISION 6
FUNCTIONAL STANDARDS FOR HEADGATES AND MEASURING DEVICES

Division of Water Resources
Department of Natural Resources

Version 2.0
August 2024

COLORADO
Division of Water Resources
Department of Natural Resources

Revision Log

Version No.	Date Effective	Version Description
1.0	August 15, 2019	These standards were developed by the staff of Division 6 of the Division of Water Resources to better define what is acceptable to the Division and to provide some suggestions when installing structures and devices deemed necessary for the proper administration of water within the Division pursuant to C.R.S. 37-84-112.
2.0	August 2024	Version 2.0 is an update to Version 1.0, incorporating aspects and requirements of the Division 6 Measurement Rules.

I. PURPOSE

These standards have been updated to be consistent with the Rules Governing the Measurement of Surface Water and Groundwater Diversions and Storage, Release, and Delivery of Water Located in Water Division 6 ("Measurement Rules" or "Rules") that became effective on January 16, 2024. The purpose of this document is to provide Water Users in Division 6 a standard for Measuring Devices and Headgates to be in compliance with the Measurement Rules. Alternative Measurement Methods are not covered in this document. Capitalized terms used in this document take the meanings assigned to them in the Measurement Rules.

II. DEFINITIONS

Headgate - Means a structure sufficient to control the rate of Diversion of water at all ordinary stages, as more fully described in section 37-84-112(1), C.R.S.

Measuring Device - Means a Measurement Method that is a permanently installed device, such as a flume, weir, staff gage associated with a stage-storage curve, or totalizing flow meter, including a totalizing flow meter that may be removed in the winter when the structure is not in use, used to directly determine the Flow Rate, Total Volume, or volume of water diverted, stored in a Reservoir, released from a Reservoir, or delivered for any purpose within the standards of accuracy identified in the Rules.

Recording Devices - Means any device acceptable to the Water Commissioner or Division Engineer that is capable of recording the flow data or water level for a Diversion Structure or Other Structure.

III. REQUIREMENTS

Headgates

Must allow the Water Commissioner or Owner at the direction of the Water Commissioner, to accurately adjust the Diversion of water with reasonable effort and within a reasonable amount of time and to secure the Diversion Structure at the adjusted condition so as to prevent any unauthorized Diversion or adjustment.

Measuring Devices

For Flow Rates greater than 1.0 cfs, the Measuring Device shall be designed to accurately measure flows within plus or minus five percent (5%) of anticipated flows.

For Flow Rates greater than 0.25 cfs and less than or equal to 1.0 cfs, the Measuring Device shall be designed to accurately measure flows within plus or minus 0.05 cfs of anticipated flows.

For Flow Rates less than 0.25 cfs, the Measuring Device shall be designed to meet the accuracy standard approved by the Division Engineer.

All Measuring Devices must be located within reasonable proximity of the Diversion Structure to enable the Water Commissioner to observe the effect of any Headgate adjustments within a reasonable amount of time.

All Measuring Devices must be properly installed and maintained and have a standard rating table, accepted custom rating table, or stage-storage table, as applicable.

For Reservoirs, a stage-capacity table must be developed from a topographic survey that ascertains contour lines at no greater than one foot intervals. Stage-capacity tables must be accompanied by a staff gage that is installed on a stable or reinforced surface that is resistant to warping or sagging and weathering. In cases where a staff gage is believed to be impractical, the Water User must get approval of an Alternative Measurement Method that will be used for determining the water surface level in relation to a known point that correlates to the stage-storage table.

Recording Devices

Must be capable of recording continuous flow rates at no greater than 15-minute intervals with a resolution of 0.01 feet and have a means to verify on-site that the recording device is properly calibrated. If the Water Commissioner does not already have access to the software necessary to download and process recorded data, the Water User must provide the proper software in order for the Water Commissioner to do so.

IV. SUGGESTED DEVICES

Headgate - Slide gate or turn wheel style gate installed in a concrete headwall (or other stable non-leaking frame structure) which has sufficient freeboard to prevent overtopping into the ditch. In many instances these devices will need to be modified to ensure that the Water

Commissioner can secure the Diversion Structure at the adjusted condition so as to prevent any unauthorized Diversion or adjustment of the Headgate.

Measuring Device – The standard Measuring Devices for ditches within Division 6 are Parshall Flumes, sharp crested weirs, and totalizing flow meters (TFM), though ramp flumes are also sometimes used. In a ditch where submergence is a common issue, it is advised to avoid the use of weirs due to the need for greater head loss for the device to function properly. Because the most commonly used Measuring Devices in Water Division 6 are Parshall flumes, weirs and TFMs, these standards only cover these devices.

Totalizing Flow Meters – A TFM must be designed and manufactured for the purpose of measuring the flow of water, have a totalizing feature, and meet the minimum requirements listed in Section III above in order to be considered an acceptable TFM.

Recording Devices - Preferred sensors and data collectors:

- Sutron Model SDR-0001-1 Data Logging Shaft Encoder or equivalent that has been properly installed in a stilling well with lockable protective shelter.
- VEGAPuls C21 or C23 Radar with Sutron XLink100 data collector

V. RECOMMENDED CONDITIONS

A. PARSHALL FLUMES (see illustration below):

1. The ditch channel immediately upstream of the flume should be straight and free of obstructions to flow (debris, vegetation overgrowth, etc.) for a distance of at least 10 times the regular channel width or throat width of the flume.

2. All flumes should be placed at a **minimum of four inches** higher than the normal ditch bottom elevation. Flumes can be placed higher in the ditch if submergence is an issue as long as water upstream of the flume does not overtop the ditch or back up to the headgate and impede the flow of water through it.

3. The ditch channel upstream of the flume should be both wider and deeper than the ditch cross section at the flume entrance to create a stilling pool.

4. The **stilling pool should be 6” to 18” deeper** than the transitional area up to the flume floor at its entrance so that water flow is tranquil (smooth surface) and slow (2.0 - 5.0 feet per second).

5. The upstream stilling pool area should be kept free of debris, vegetation growth, and sediment deposition should be routinely removed.

6. The transitional area from the wider ditch section upstream to the entrance of the

7. flume, either with or without wing walls, should be smooth and **no shallower than a 1:4 slope**.

8. Wing walls (preferably curved) should be installed from the channel section to the entrance of the flume to ensure accurate staff gage readings. Forty-five degree wing walls are acceptable as long as accurate staff gage readings can be made.

9. Flumes should be installed far enough downstream from the Headgate to ensure that there is room for the stilling pool section to slow water down and no further than necessary as to prevent the Water Commissioner from observing effects of Headgate changes within a reasonable amount of time. However, there may be instances when the best location for proper installation of a flume is not within close proximity of the Headgate. In such instances, the Water User should consult with the Water Commissioner or Division Engineer to obtain approval of the proposed location of the flume.

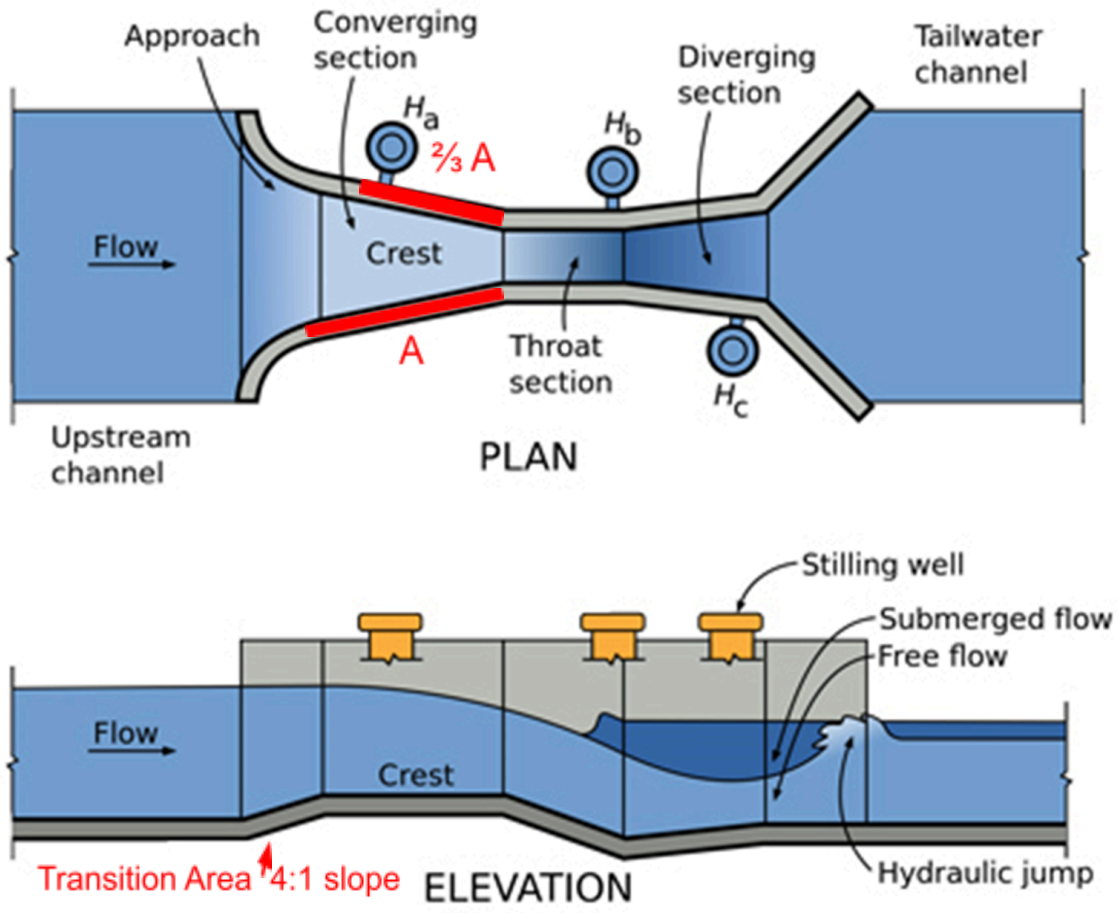
10. The ditch channel downstream of the flume should be routinely maintained and kept free of debris and vegetation overgrowth so that water does not back up into the flume throat causing submerged flow.

11. The flume floor must be **level from side-to-side** and **front-to-back** and maintained as such.

12. A staff gage reading in hundredths of feet should be set at H_a or **two thirds** of the length of the converging section of the flume (see illustration below).

13. Routine maintenance is the most important component in keeping a flume in good working condition. Debris, sediment and vegetation overgrowth should be removed upstream and downstream of the flume on a seasonal basis to keep water from running too fast, causing water to back up into the flume making it submerged, or causing inaccurate staff gage readings.

Note: Submerged flow in a flume causes a higher reading on the staff gage, which will indicate a falsely high discharge reading, meaning the Water User may not be receiving the full water right they are entitled to.



B. SHARP-CRESTED RECTANGULAR AND V-NOTCH WEIRS (see illustration below):

Weirs are not the most suitable method of measurement for wide ditches, high flow Diversions or flat ditches; however, for narrow ditches and smaller Diversions, weirs can be the simplest and most economical way of measuring open channel flows. Two of the most commonly used weirs include sharp-crested rectangular weirs and 90-degree or v-notch weirs.

1. The rectangular weir must be constructed with a defined crest width **(half or whole foot width such as 1.0 feet or 1.5 feet)**.

2. Weirs should be installed: (1) far enough downstream from the Headgate to ensure that there is room for the **stilling pool section (10 to 15 times max H)** to slow water down (less than 0.5 feet per second) by the time it reaches the weir, while also not

backing water up to the Headgate; and (2) no further than necessary as to prevent the Water Commissioner from observing effects of Headgate changes within a reasonable amount of time.

3. The upstream bottom and sides of the rectangular opening should be faced with a **thin metal strip** to give the necessary sharp edge.

4. The centerline of the weir must be parallel to the direction of water flow.

5. The weir crest must be **level** so water passing over it will be the same depth across the width of the opening. **No deviation is acceptable.**

6. The weir crest must also be level so as to not lean forwards or backwards and be perpendicular to the direction of flow.

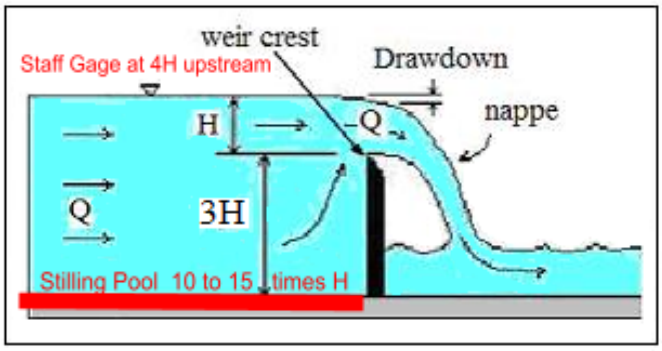
7. The weir crest must be high enough above the ditch bottom so the water will fall freely below the weir leaving an **air space (nappe) on the downstream edge**.

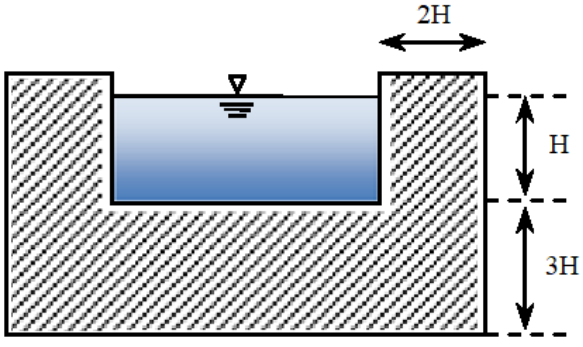
8. The depth from the bottom of the ditch to the crest should be approximately **three times** the expected maximum depth of the water flowing over the crest of the weir (H) to allow the water to freely fall and to avoid submergence.

9. The sides of the rectangular weir opening should be **two times** the maximum expected depth of the water flowing over the crest of the weir (H).

10. **A staff gage measured in hundredths of feet should be firmly placed along the ditch bank upstream of the weir a distance of four times the maximum expected depth of water over the crest (H). The zero point of the staff gage must be set at the same elevation as the crest of the weir.**

Note: (a) Installation of a v-notch weir is the same as that for a rectangular weir including the requirement that the crest be sharp and the staff gage installed far enough upstream of the weir to not be affected by the drawdown of water over the weir. (b) Weirs can become submerged easily and require much more head loss than flumes. (c) Weirs are sensitive to debris/sediment build up in the stilling pool upstream and require frequent routine maintenance.





C. METERS:

Totalizing flow meters are commonly used with pumps. For very small pumps (less than 15 gallons per minute), a TFM that only records the Total Volume of water diverted must be approved by the Division Engineer; however for larger Diversions, the TFM must provide both the instantaneous reading of the Diversion and Total Volume of water diverted. The State Engineer may adopt written standards and specifications for the installation, calibration, testing, repair, and maintenance of TFMs.

1. The TFM must have nonvolatile memory
2. The TFM must have a totalizing function
3. The TFM must be sealed from the factory and be tamper resistant
4. The TFM must not have a reset button
5. The totalizing measurement readout must be in acre-feet or gallons
6. The TFM must be maintained at all times such that it provides a continuous, accurate, and readable record of Diversions of water.
7. The TFM must installed in a straight level section of pipe to allow for full pipe flow in order for the meter to register flow correctly.
8. TFMs are to be installed in accordance with manufacturer's specifications and recommendations.

It is suggested that a screen box be used to protect the meter and pump. Depending on the amount of debris in the river, the screens may need to be checked and cleaned daily. A screen should not be placed directly on the end of the intake as it can plug easily, impede flow and potentially destroy the pump.

9. The TFM should be removed before freezing weather.
10. The TFM impeller should be inspected for damage yearly because even a small nick in one blade will alter the operation of the meter and affect its accuracy.
11. Pictures of TFM installation and impeller conditions may be requested by the Division Engineer at any time to ensure accurate operating conditions are met.

The Division Engineer has the authority to order any Measuring Device to be reset, cleaned, recalibrated or replaced under C.R.S. 37-92-502(5)(a) if evidence suggests it is no longer operating properly.