

Velocity (v)

Velocity is the average speed at which water moves in the direction of flow. The unit of velocity commonly used is feet per second. To aid in understanding the size of this unit, it is compared with a more familiar unit:

$$1 \text{ foot per second (ft/sec or fps)} = 0.68 \text{ miles per hour}$$

Cross-sectional Area (a)

The cross-sectional area is the size of the surface that is perpendicular to the direction of flow. For example, in a pipe flowing full this is the area of a circle with a radius equal to the inside diameter of the pipe.

The cross-sectional area is normally given in square feet (ft²) or square inches (in²) where

$$1 \text{ square foot (ft}^2\text{)} = 144 \text{ square inches (in}^2\text{)}.$$

Flow Rate (Q)

Flow rate is the volume of water flowing through a given cross-sectional area per unit time. As indicated in equation (1), flow rate is the multiple of velocity and cross-sectional area. Thus, a small-diameter pipe may have the same flow rate as a larger-diameter pipe, if the velocity in the smaller pipe is greater than that in the larger pipe.

The units of flow rate commonly used for agricultural applications are gallons per minute, cubic feet per second, and acre-inches per hour. The relationships between these units are as follows:

$$1 \text{ gallon per minute} = 0.00223 \text{ cubic ft per second} \\ (\text{gal/min or gpm}) \quad (\text{ft}^3/\text{sec or cfs})$$

$$1 \text{ gallon per minute} = 0.00221 \text{ acre-inches per hour} \\ (\text{gal/min or gpm}) \quad (\text{ac-in/hr})$$

$$1 \text{ cfs} = 449 \text{ gpm} = 0.992 \text{ ac-in/hr}$$

$$1 \text{ ac-in/hr} = 453 \text{ gpm} = 1.01 \text{ cfs}$$

Also, water management districts sometimes use units of millions of gallons per day in issuing permits.

$$1 \text{ million gal/day (mgd)} = 1.55 \text{ cfs} = 1.53 \text{ ac-in/hr}$$

Volumetric Flow-Rate Measurements

Volumetric flow-rate measurements are made by collecting a volume of water for some interval of time. A graduated container or container of known size can be used with a stopwatch for these measurements. The