4.1.2 VOLUMETRIC MEASUREMENT OF IRRIGATION WATER USE

A. Applicability

This BMP is applicable to agricultural irrigation systems and agricultural producers that irrigate. The requirements and applicability of volumetric measurement of irrigation water use varies between specific geographic regions and political subdivisions in the State.

B. Description

The volumetric measurement of irrigation water use provides the water user with information needed to assess the performance of an irrigation system and better manage an irrigated crop. There are numerous types of volumetric measurement systems or methods that can be used to either directly measure the amount of irrigation water used or to estimate the amount of water from secondary information such as energy use, irrigation system design, or mechanical components of the irrigation system.

1) Direct Measurement Methods

Direct measurement methods usually require either the installation of a flow meter or the periodic manual measurements of flow. Several common direct measurement systems for closed conduits (pipelines) are:

- Propeller meters
- Orifice, venturi or differential pressure meters
- Magnetic flux meters (both insertion and flange mount)
- Ultrasonic (travel time method)

Several common methods for direct measurement of flow in open channels are:

- Various Types of Weirs and Flumes
- Stage Discharge Rating Tables
- Area/Point Velocity Measurements
- Ultrasonic (Doppler and travel time methods)

2) Indirect Measurement Methods

Indirect measurement methods estimate the volume of water used for irrigation from the amount of energy used, irrigation equipment operating or design information, irrigation water pressure, or other information. Indirect measurements require the correlation of energy use, water pressure, system design specifications, or other parameters to the amount of water used during the irrigation or to the flow rate of the irrigation system when irrigation is occurring.

Several common indirect measurements for irrigation systems are:

- Measurement of energy used by a pump supplying water to an irrigation system
- Measurement of end-pressure in a sprinkler irrigation system
- Change in the elevation of water stored in an irrigation water supply reservoir
- Measurement of time of irrigation and size of irrigation delivery system

Estimating irrigation water use from an indirect method can be as accurate as a direct measurement. For example, to estimate the volume of water pumped by a new electric powered irrigation pump based on kilowatt-hours of energy used during the billing period of the electric service provider, the following equation can be used:

$$\text{Acre-Feet per Billing Period} = \frac{\text{(Kilowatt Hours/Billing Period) x Pumping Plant Efficiency (\%)}}{\text{236.6 x Pump Pressure (psig)}}$$

Where the pump pressure is the total dynamic head (ft) of the pump converted to pressure, and Pumping Plant Efficiency (typically 55 percent to 75 percent) equals the pump efficiency (usually obtained from the pump manufacturers pump curves, typically 60 percent to 80 percent) multiplied by the motor efficiency (typically 90 percent-95 percent for 3 phase motors greater than 20 horsepower). The total dynamic head for a turbine pump installed in a water well includes the head required to lift the water from the well and head lost to friction.

C. Implementation

When implementing this BMP it is important to be aware that the installation of a flow meter or indirect measurement varies significantly with each site, type of measurement being made, desired accuracy of the measurement, and the volume or flow rate of the water being measured. Each type of direct measurement flow meter should be installed according to the recommendations of the manufacturer of the meter. Indirect measurement methods require the water user to determine the correlation between the indirect measurement (kilowatt hours, gallons, or ccf of fuel) and the volume of water used. Typically, the indirect measurement is correlated to the amount of water used by an engineer or technician using a portable flow meter or information from the irrigation system design. Both direct and indirect measurement methods should be periodically evaluated for the accuracy of volume or flow rate of the water being measured.

D. Schedule

For direct measurement systems, the time required to install a flow meter can vary from an hour or two for a saddle mount or insertion meter to several days for the construction of a metering vault and fabrication of associated piping or the construction of a weir, flume, or open channel metering station. For indirect measurement, once the indirect measurement (such as energy usage) is correlated to the volume of water used, no additional installation or construction is required. However, the indirect measurement correlation may need to be repeated periodically to verify pumping capabilities due to normal wear on irrigation equipment.

E. Scope

The methods for volumetric measurement of irrigation water and the associated scope vary from site to site, and each site and method may have unique limitations or requirements. The scope for volumetric measurement ranges from very simple (recording the amount of energy used per month from an energy bill), to complex (installation and management of a large open channel flow measurement station). Furthermore, metering requirements vary by geographic region and by political subdivision (River Authorities, Irrigation Districts, Water Improvement Districts, Groundwater Conservation District, etc.).

F. Documentation

The water user should record the total quantity of water used per site, field, or system on a periodic basis as determined by the water user to be necessary for implementing other BMP practices. At a minimum, recording of the volume of irrigation water used should be done every year. Indirect measurements, such as energy use, are often documented by a monthly bill or statement from the supplier of the energy (i.e. the electric service provider), which becomes the record of the amount of water used during such billing period.

G. Determination of Water Savings

This BMP is used in coordination with other BMPs and in itself does not directly conserve any water. However, the information gained helps better inform the user of costs associated with water use and will assist the user in implementing voluntary conservation measures.

H. Cost-Effectiveness Considerations

Cost for volumetric measurement of irrigation water use varies greatly from application to application. Typical impeller meter installations for irrigation pipelines with diameters between 4 inch and 15 inch cost between $600 and $1,000 per meter. Cost for installation of a large open channel flow meter (flume, weir, or metering station) can be in the tens of thousands of dollars. Cost for indirect measurements, such as energy use, depends on the amount of time required to correlate the indirect measurement to the amount of water used and the time required to compile and record such information. The cost and the benefits of statewide implementation of this BMP are significant. The TWDB's 2001 *Survey of Irrigation in Texas* reported that there were approximately 6.4 million acres of land irrigated in 2000 in Texas and 115,857 irrigation wells.

Most of these wells do not have flow meters, and the exact number of unmetered irrigation wells is unknown.

I. References for Additional Information

1) *Water Measurement Manual,* U.S. Bureau of Reclamation, 1997, U.S. Government Printing Office, Washington, D.C. 318 p.
2) *Techniques of Water Resource Investigation Reports, Book 3 Application of Hydraulics*, U.S. Geological Survey.
3) *Energy Use for Pumping*, Center for Irrigation Technology, California State University at Fresno. http://www.wateright.org/site2/advisories/energy.asp
4) *Buying an Energy-Efficient Motor*, Office of Industrial Technologies, U.S. Dept. of Energy, Best Practices. http://www.oit.doe.gov/bestpractices/motors/factsheets/mc-0382.pdf
5) *Survey of Irrigation in Texas*, Report 347, 102 p., Texas Water Development Board, August 2001.