



## Applied Water Use Efficiency

Working Metric Version 1.0 | Adopted July 31, 2013

Water is already in short supply in parts of the world and will become increasingly scarce as populations increase and climate change continues to alter weather patterns. It is also increasing in cost in many places. Therefore, efficient irrigation is a critical component of sustainable crop production.

The **Applied Water Use Efficiency** metric measures the total amount of applied water used to produce the crop. A second metric, **Simple Irrigation Efficiency**, which measures the amount of water applied to the crop relative to the crop's water need resulting from transpiration and soil evaporation (ETc), is in development, but has not yet been finalized.

### Metric:

Applied Water Use Efficiency	$\frac{\text{Acre-inches applied water}}{\text{Tons of product harvested}}$
<p><i>Notes:</i></p> <ul style="list-style-type: none"> <li>- <i>Applied water: Total ground and surface water applied.</i></li> <li>- <i>The same land area (an acre, a field of known size) should be used to quantify both acre-inches applied and tons of product harvested.</i></li> <li>- <i>Includes all irrigation events from the end of the previous harvest to the current harvest.</i></li> <li>- <i>For educational purposes, metric can also be presented on a per acre basis as:</i>  <b>Acre-inches applied water/acre planted</b> </li> </ul>	

### **Recommended Issues to Consider in Future:**

Through working group discussions, technical review, and Metric Technical Advisory Committee discussions, the following items have been identified as issues to consider in future iterations of this metric:

- Finalizing Simple Irrigation Efficiency metric
- Distinguishing between water use in arid versus moist regions
- Salinity (added to recommended issues for the soil working group as there is no working group for water quality)

### **Technical Notes:**

In order to maintain sufficient accuracy and precision, growers may select from one of the following water conveyance methods, based on irrigation conveyance type, that have been pre-approved for calculating applied water. Determination of “applied water” must be measured at the field (SISC Management Area) level. Method 4 provides a way to estimate field-level usage if actual measurement has not been performed.

Approved methods for measuring applied water are listed here, with detail on each provided below.

1. Irrigation District Reporting (with approved measurement devices)
2. Closed Conduit Measuring Devices (aka pressurized pipe)
3. Standard Open Channel Measuring Devices for Surface Irrigation
4. Alternative to Direct Measurement: Using Power Records
5. Alternative to Direct Measurement: Estimating for Subsurface Drip Irrigation Systems

*Note: The standard for precision is +/- 6%.<sup>1</sup>*

### **Irrigation District Reporting**

If water is delivered by an irrigation district, district measurements may be used if each of the following conditions applies:

- Water is measured directly by an approved measurement device (see below).
- Water is measured at the field/block level.
- The field being measured is the same as where the crop is grown.

---

<sup>1</sup> The standard is based on the 1998 California Department of Water Resources guidelines. However, new water measurement regulations that took effect in California July, 2012 require +/- 12% accuracy for existing systems and +/- 10% field accuracy for new systems. (California CCR Title 23, Div. 2, Ch. 5.1, sec. 597.3) SISC still supports a +/-6% accuracy goal.

### **Closed Conduit Measuring Devices (aka Pressurized Pipe)**

If water is delivered through pressurized pipe, whether groundwater or surface water, to irrigation devices such as drip or center-pivot irrigation, then the following technologies are acceptable. Note that the pipeline must be flowing full to work properly and the water user must demonstrate a reliable method of recording total flows with a display unit.

- Mechanical in-line propeller meter
- Insertion type electromagnetic meter
- Full profile magnetic type flow meters, such as acoustic transit-time or Doppler flow meter.

### **Standard Open Channel Measuring Devices for Surface Irrigation**

If water is delivered via gravity-fed surface irrigation, such as flood or furrow irrigation, then the following methods are acceptable:

- Flow gates or control structures with an accurate rating curve and level sensors in an adjacent stilling well. Approved devices include:
  - Sharp-crested weir
  - Undershot or Waterman gate (with up- and downstream water levels)
  - Parshall flume
  - Trapezoidal flume
  - Ramped broad-crested weir (or ramped flume)
- Acoustic Doppler Flow Meter (ADFM)
- A propeller meter for systems using gated pipe. An acoustic sensor or a pressure transducer can be used for measuring the head on the meter.

### **Alternative to Direct Measurement: Using Power Records<sup>2</sup>**

If none of the direct measurement methods is appropriate, then a grower may use extrapolation from power records to estimate the annual diversion from a pump as an alternative measurement method. The following conditions apply in order to qualify to use this method.

Derivation of the Power Consumption Coefficient (PCC) is required, which is the ratio of the number of kilowatt-hours needed to pump an acre-foot of water. This number is unique to each well or pumping plant due to physical aspects of the system and can be applied to the year-end power records to determine the total acre-feet pumped.

To determine the rate of flow, a portable measuring device, such as a non-invasive ultrasonic flow meter can be used. Simultaneous with the flow measurement, power is measured using the utility's kilowatt-hour meter. A qualified individual with the necessary equipment will be required to perform these measurements. Because systems wear and water levels change, the flow-to-power ratio may change over time. Therefore, the power consumption coefficient must be re-calibrated at least once every three years.

---

<sup>2</sup> Excerpted from Idaho Department of Water Resources, "Minimum Acceptable Standards for Open Channel and Closed Conduit Measuring Devices." October 2009

### **Alternative to Direct Measurement: Using Power Records (continued)**

Pumps must be single speed, not variable rate or variable frequency.

**CONSTRAINTS:** If any of the following are true, a different method must be utilized as then power records are unlikely to yield acceptable results:

- If the well flows (artesian) so that water can be diverted when the pump is off.
- The electrical meter also records power used by other devices not integral to the irrigation system.
- The electrical meter records power used by more than one pump.
- Variable frequency drives operate the pump, resulting in variable flow rates.
- The energy supplied to the pump cannot be accurately and reliably measured. For example, most diesel and propane driven pumps do not have provisions to measure the fuel used by the engine.
- The flow rate from the pump varies significantly due to changes in demand or operation. For example, pumps that discharge into a pressurized system sometimes and then open discharge at other times, or pumps that supply multiple pivots and/or other discharge points, would likely have flow rates that change considerably. These changes generally alter the flow to power ratio, causing inaccurate estimates of diversions.

### **Alternative to Direct Measurement: Estimating for Subsurface Drip Irrigation Systems**

Growers using subsurface drip irrigation systems may estimate applied water inputs based on pressure, emitter size and spacing, and length of drip line. The University of Arizona Cooperative Extension provides instruction and simple calculator for this estimation approach at <http://ag.arizona.edu/crops/irrigation/azsched/drip.html>.