

## **“ET” Controllers; “Weather-Based” Controllers; “Smart” Controllers: What Do You Need to Know to Achieve Long-term Water Use Efficiency?**

The urgency for public agencies to move head-long into landscape water conservation grows. As of December 2003, 70% of the West was still experiencing drought (*US Drought Monitor*) and newspaper headlines (*LA Times, Monday December 22, front page*) described that water shortages are having a huge impact on our economy, our life-style and our environment. While low flow plumbing programs have returned significant water conservation results, more is needed. The next water conservation target is the landscape. Experts describe that to be efficient, urban landscapes need **(1)** upgraded irrigation systems, **(2)** changes in plant materials and to **(3)** use new controller technologies to achieve necessary reductions in water demand. How much can be saved? Doug Bennett of the Southern Nevada Water Authority sees 50% landscape water savings as possible. Irvine Ranch Water District has reduced commercial landscape water use by 58% since 1991. It is clear that landscape water efficiency is the target and that public agencies, homeowners, property managers, the building industry and the landscape industry all must achieve.

That target has prompted new approaches and new technologies to be developed by the private sector irrigation industry to address landscape water use. None has received more attention, and offers more promise, than what is referred to as **“ET”** controllers, sometimes grouped together as **“Weather-Based”** controllers and with high hopes called **“Smart”** controllers. What is ET? What is a “Smart” controller? Where does the weather information come from and, more importantly, how is it used to make sure landscapes receive the right amount of water in a way that benefits agencies and the end users?

This paper will describe what you get with these new controller technologies. Not in terms of technical features, which are available from controller manufacturers, but in more basic terms in order to better understand how various technologies work and what might the impacts be on landscapes, water efficiency and end users.

First, this paper will quickly address basic information related to the concept of ET and plant water need as background for making controller technology comparisons. Then the known controller technologies will be grouped into 4 distinct categories: **(1)** Real Time ET (no geographic barriers), **(2)** Real Time ET (single fixed sources), **(3)** Historical ET and **(4)** Single-Sensor gauge controllers. Then the following questions will be asked related to the technology categories:

- How is weather used in the controllers?
- How do controllers “get” irrigation schedules?
- What is the water savings “confidence level” and long-term savings potential?
- What is the ability of the controllers to handle landscape extremes (ex. high water use plants and low water use plants)?
- Is there service charges associated with the technologies (and the pros and cons of such fees)?
- Is customer service required and who will provide the service?

### **What is ET?**

Evapotranspiration is the combined process of water loss by evaporation and water transfer to the air through plant tissues (Calif. Dept. of Water Resources; [www.cimis.water.ca.gov](http://www.cimis.water.ca.gov)). Reference Evapotranspiration (ETo) is the term used to describe the evapotranspiration rate measured from a known source, such as turf grass. ET and ETo are expressed in inches (of water). You will see ET and ETo described in daily, weekly, monthly and annual inches. ET and ETo is a highly researched, landscape and agriculture specific weather data.

ETo is measured by weather stations. Those stations have specific sensors that read and record net solar radiation, wind/speed, air temperature, vapor pressure and precipitation. Weather station sensors are maintained on a consistent basis to insure accurate data is captured. These weather factors are in constant flux. Weather data alone does not automatically provide “ETo”. Sophisticated mathematical equations are used to take the various weather elements to calculate what we call ET or ETo. The most commonly accepted and used formula is called the Penman Montith equation. This is the formula used by the United Nations Federation of Agricultural Organizations and by most universities. The CIMIS station network uses a modified Penman Montith equation. ET is used as the basis for state water law (AB 325) and public agency water use guidelines (BMP #5).The data collected by an ET weather station may look like the following:

#### U.C. Riverside - Los Angeles Basin - Station 44

Date	CIMIS ETo (in)	Precip (in)	Sol Rad (Ly/day)	Avg Vap (mBars)	Max Air Temp (° F)	Min Air Temp (° F)	Avg Air Temp (° F)	Max Rel Hum (%)	Min Rel Hum (%)	Avg Rel Hum (%)	Dew Pt (°F)	Avg wSpd (MPH)	Wnd Run (miles)	Avg Soil Temp (° F)
12/17/2003	0.13	0.00	250	2.3	69.7	42.8	57.4	24	9	14	9.4	5.6	135.3	48.9
12/18/2003	0.12	0.00	245	2.7	77.9	46.7	62.3	24	9	14	12.6	4.0	95.7	50.1
12/19/2003	0.08	0.00	207	3.8	76.9	45.6	56.8	38	10	24	20.4	2.9	69.0	51.0
12/20/2003	0.04	0.00	92	6.4	63.9	46.5	55.0	75	25	43	33.0	2.5	59.5	51.1
12/21/2003	0.05	0.00	217	10.4	63.2	46.1	53.6	88	54	74	45.5	2.1	51.2	53.3
12/22/2003	0.08 R	0.00	205	6.5	70.2	40.3	56.2	88	23	42	33.7	3.1	73.9	52.4
12/23/2003	0.02	0.04	64	7.7	60.6	44.6	51.7	88	32	59	37.6	2.1	49.7	52.0
Total/Avg	0.52	0.04	183	5.7	68.9	44.7	56.1	61	23	39	27.5	3.2	76.3	51.3

#### What to Look for with ETo Data:

- ETo changes dramatically day to day and within a week. See the ETo column where the daily ETo changes from .13 inches on 12/17 to .08 on 12/19. This is a 39% change in plant water need in 2 days. By weeks end the ETo is 85% less.

- Weather station data can be faulty. See the ETo column for 12/23 (0.08 R). The “R” indicates poor or incomplete data collected for that day. Corrections may be accounted for by weather providers at a later date.
- The interplay of weather factors is what changes the ETo and plant water needs. Notice the ETo on 2/18 and 12/19. ETo takes a 33% drop in one day. The solar radiation measurement is close to the same both days. The temperature is very close to the same both days. But humidity (amount of moisture in the air) went up 42% and wind speed dropped 27%. This sudden change of 2 weather factors that help make up ETo created a 33% drop in the amount of water plants need, or the daily ETo.
- Individual weather station ETo data can change dramatically in a single day and up to 200% in a single week, depending upon the interaction of solar radiation, wind, humidity and temperature. For examples around California:

Station #44 (Riverside) – In 2003 a range of 225% above historical daily ET to 92% below historical daily ET. Only 28 days (7.6%) of 2003 matched the historical daily average ET. (317%)

Station #101 (Piru/Ventura) – In 2003 a range of 244% above historical daily ET to 100% below historical daily ET. On 15 days (4.1%) matched historical daily average ET. (344%)

Station #149 (Oakland) – In 2003 a range of 167% above historical daily ET to 100% below historical daily ET. (267%)

Station #83 (Santa Rosa) – In 2003 a range of 250% above historical daily ET to 100% below historical daily ET. (350%)

Station #6 (Davis) – In 2003 a range of 400% above historical daily ET to 100% below historical daily ET. (500%)

Station #153 (Escondido) – In 2003 a range of 188% above historical daily ET to 92% below historical daily ET. (280%)

Station #133 (Glendale) – In 2003 a range of 171% above historical daily ET to 100% below historical daily ET. (271%)

- Plants respond to real time ET to maintain an optimum physiological balance

### **ET Weather Stations:**

Requiring a specific set of elements and a sophisticated mathematical equation to generate accurate ETo, it is necessary to have credible weather station data on which to base local plant water needs. In California, the Department of Water Resources manages and maintains the CIMIS ET station network ([www.cimis.water.ca.gov](http://www.cimis.water.ca.gov)). The DWR is actively seeking more sites that would be appropriate for CIMIS station placement and upgrading existing weather station sites. In Colorado, go to [www.ncwcd.org](http://www.ncwcd.org). Some other states have smaller versions of ET networks.

Weather station sensors require consistent maintenance to provide accurate ETo data. The California Dept. of Water Resources provides maintenance services to water agencies to maintain CIMIS weather stations in good operating condition. Even with consistent maintenance, ET weather stations record missed data, poor data or sensors go down for various reasons. Relying on a single source of ET can pose a risk for technologies without an alternate ET back-up.

### Do You Need a Weather Station?

A new service, called “*ET Everywhere*” combines existing ET weather stations, NOAA weather stations, CIMIS, MesoNet, and other state and local weather data sources (over 12,000 nation wide) and university developed climatological and topographic modeling, called MM5 used by the FAA and US Military), to create virtual ET (ETo) for any location in the U.S. and Canada. The level of accuracy has been tested to be within .01 inches (of existing ET stations) over 95% of the country. The coverage of the “virtual local ET” (ETo) is every 1 square kilometer (.6 of a mile), or a medium sized neighborhood. The ability to have access to daily, local ET (ETo) by neighborhood or microclimate removes the barrier of not having a local weather station, in order to take advantage of smart, real time ET controllers. This service is available in California with controllers produced by Toro, Motorola, HydroPoint and other future licensees (for more information go to [www.hydropoint.com](http://www.hydropoint.com)).

Access to ET data **does not** insure that efficient landscape watering will happen.

### How Is ET Used to Determine Specific Plant Water Needs?

ETo is the measurement of evapotranspiration of water in ever-changing weather for cool season turf grass. Cool season turf, (Fescue, Kentucky Blue, Rye) is called the “reference plant”. ET weather stations sit in an area of cool season grass to measure the evapotranspiration rate (ETo). Generally, cool season turf is ranked at the high end of plant water need. Cool season grass is known as the “reference” crop for ET, measured as 1.0 or 100%. ***(Having ET data alone does not insure accurate irrigation scheduling and efficient water application. See below.)***

All other plants need **as much or less** water than turf. How much water do other plants need?

### Crop Coefficients (Kc) Establish Plant Water Needs:

A crop coefficient, or Kc, is the relative amount of water a plant needs in relation to reference ETo. Studies by universities and Extension agents suggest ranges of water need for many plants. In California this research data is called **WUCOLS** (Water Use Classification of Landscape Species). Crop coefficient is available from the Center for Irrigation Technology ([www.waterright.com](http://www.waterright.com)). In Colorado, recent Kc research has been completed on 58 common plant species. Landscape professionals often collaborate with university researchers to document relative water needs of plants used in the landscape. An example of typical plant water needs, expressed as a Kc percentage of 100%, is listed below:

Cool Season Grass - .80 Kc  
Common Trees - .65-.75 Kc

Annuals - .50 - .80 Kc  
Rose - .50 – 6.5 Kc

Common Shrubs - .40 - .60 Kc  
Warm Season Grass - .50 - .60 Kc

Ca. Natives - .0 - .30 Kc  
Orn. Grasses - .35 - .50

Utilizing Kc values in combination with ET will reduce water applications, save water and produce healthier plants if an efficient irrigation schedule is developed.

### **What is Needed to Set an Efficient Irrigation Schedule? (Reference: Center for Irrigation Technology; Cal Poly Pomona; Irrigation Association)**

1. The daily ET data for the local microclimate (ET<sub>o</sub>)
2. The type of plants being irrigated (K<sub>c</sub>)
3. The soil type (infiltration rate of water into the soil in inches per hour)
4. The depth of the plant roots (inches)
5. The maximum allowable soil moisture depletion (typically set at a 50% depletion rate)
6. The slope of the area being irrigated (necessary to calculate the potential for runoff, or the number of cycles to be used to maximize water use efficiency)
7. The sun or shade level of the area being irrigated
8. The precipitation rate of the irrigation system
9. The uniformity of the irrigation system

### **“Expectations” Related to New ET, Weather-based and/or Smart Controllers:**

1. **“Water will be saved...”**
2. **“Set it and forget it” is the perception**
3. **“Anything that goes wrong in the landscape (stuck valves, turf hot spots, etc.) is caused by the new controller...”**

### **Reality of New Controller Technology:**

- Leaks, stuck valves, water runoff, turf hot spots, dead plants, high water bills, under watering, etc. that currently happen in landscapes can and will continue to happen. Landscape management will continue to be an important part of efficient water management.
- Irrigation systems may not be efficient (not uniform in coverage, miss-matched heads, valves irrigating both high and low water use plants, or valves irrigating in sun and shade, etc.) will reduce the effectiveness of new controller technology
- Irrigation system leaks, pools and even interior water use inefficiencies will limit good measurement of new controller technology, especially in tests and studies
- Irrigation leaks and system malfunctions will happen regardless of the type of irrigation controller used
- Setting a controller and forgetting it is highly unlikely given the dynamics of irrigation systems, landscapes and people
- Without controller protections or consistent updates, controllers can be easily “changed”, reducing the water efficiency potential

**And most importantly...**

- You will only save water **IF** the site wasted water before installing an ET, Weather-based or Smart Controller
  - There is no guarantee of how much any product will save (only the amount of wasted water can be saved)
  - Water savings will vary between new controller products (because they use different methods and have different abilities). Do not assume the same savings levels between products, across homes and commercial landscapes.

**Using a “Water Budget” to Target, Evaluate and Monitor Landscapes for Water Use Efficiency**

Marketing campaigns for new controller technologies will describe \_\_\_% or \_\_\_\$ savings if you use the particular controller. While studies may average water savings into easy numbers, the reality is that the only water that can be saved is the water that is being wasted. What is water waste? Any water used above the amount needed for healthy plant maintenance and growth. How is the “right amount” of water determined? Use the information described above to determine a site **water budget**.

**Water budgets will be important to:**

1. Target prospective sites for (successful) ET controller and landscape conservation programs
2. Measure actual water savings of ET controller and landscape conservation programs
3. Report program impacts for current grants, future grants and conservation program justification

The formula for determining a site water budget is:

**(ET) (Kc) (Landscape Area) = Site Water Budget**

**Riverside Water Budget Example:**

ET = Actual local weather (ETo).....(55 inches)  
Kc = Plant water need factor.....(.80 Kc for turf)  
Area = Irrigated area (sf or acres).....(1 acre)

(55) (.80) (1) = A water budget of 44 inches of irrigation for 1 acre of turf, or 1,597 ccf for the year

Actual site use = 1,996 ccf

\*Water savings potential = 1,996 – 1,597 = 399 ccf’s/yr. (25%)

To determine a water budget for turf in your area, insert the annual ETo inches and calculate...  
 To determine a water budget for other plants in your area, insert the annual ET0 and Kc and calculate...  
 To determine a water budget for different plants, different areas and different sized sites, insert the proper numbers...

Before assuming that an **ET**, **Weather-based** or **Smart** controller will save water, take the following steps.

**(Step 1)** Determine a site water budget.

**(Step 2)** Compare the site water budget to actual site water use.

**(Step 3)** Subtract the site water budget amount from the actual use. The difference is the amount of **potential water** that can be saved. New irrigation controller technologies will only save water if the site history shows over-water use.

**Do not expect**, or give customers, study participants and agency officials, the expectation that they will **automatically save water** if they install this new technology. Know the answer to whether a site can save water by using a water budget calculation for every site.

### **Saving Water in a Landscape:**

Three areas offer opportunities to save water in landscapes.

1. **Irrigation system efficiency:** This means the irrigation system can deliver water uniformly across the landscape area, without leaks, over-spray, misting, separate valves for plants and micro-climates and stuck valves. Irrigation system efficiency is measured in percentage of 100%. California uses an average irrigation efficiency of 62.5% in state ordinances. Irrigation systems range in efficiency from 40% - 80% (as much as 95% for drip irrigation systems). Note: If an irrigation system is 50% efficient, it means twice as much water (in terms of ET) needs to be applied for the landscape. **Poor irrigation system efficiency wastes landscape water.**
2. **Appropriate plant materials:** This means that high water use plants are used only where they are needed and that low water use plants make up a significant portion of the landscape. Changing plant materials **increases the potential** to save water on the site. Changing plant materials **does not guarantee** that water will be saved. How much water could be saved? Compare Kc levels of the existing plants to the replacement plants. The difference is the percentage of water that could be saved.

**(Using a complete “Smart Controller” solution can mean that the right amount of water will be applied to the landscape, and that water will be saved if the site was previously over-watered).**

3. **Smart Controllers:** A truly “smart controller” would utilize what science shows works, has been tested and proven by university experts and landscape professionals. This would include:
- a. **Utilize real time ET** (recognized Penman Montieth formula)
  - b. **Access localized ET** (produce accurate ET for micro climates in any location in the country)
  - c. **Utilize plant crop coefficients (Kc) to help calculate schedules**
  - d. **Utilize site specific characteristics** (soil type, slope, sun, shade, root depth of the plants and irrigation system precipitation) **to help calculate schedules**
  - e. **Use the concept of soil moisture depletion to calculate watering schedules** (typically 50% soil moisture depletion)
  - f. **Have flexibility to create schedules appropriate for high water use plants and low water use and/or native plants** (i.e. intervals of days, weeks, or months, between irrigation time)
  - g. **Ability to change irrigation times, days and cycles automatically as weather changes** (w/out human actions)

### What is a “Smart” Controller?

Based on the current state of wasteful landscape water use, urban runoff and water pollution, continuing drought, water limits and increasing population growth, there is a significant need for “smart” irrigation control. What makes a controller truly “smart”? In practice, a smart controller would be able to set and change efficient irrigation schedules for the specific site variables as the actual weather changes w/out human input.

### What Makes a Controller a Water Efficiency “Failure”?

### What Makes a Controller an “Average” Efficiency Tool?

- User schedule input (users determine the irrigation schedule set into the controller)
- User must change the schedule as weather changes
- No recognition of plant type (Kc)
- No ability to use real time ETo
- Limited cycles (to control for runoff)
- 7 day watering cycle (controller must water at least once during a 7-day period)
- High irrigation “default” mode (activated with power surges or dead batteries)
- No ability to upgrade, check or change controller inputs automatically

- Initial user schedule input
- Pre-set schedule changes (based on average ET)
- No ability to recognize site characteristics (soil type, Kc, root depth, precipitation rates, slope, sun, shade)
- Limited run cycles (to control runoff)
- Use of a single weather data source
- Use of a single weather element (temperature, solar radiation) to adjust irrigation schedules
- Use of average ET values

### **What Makes a Controller a “Smart” Water Efficiency Tool?**

- Access to real time local ET data
- Recognition of site specific conditions (soil type, Kc, root depth, precip. rates, slope, sun, shade)
- Automatic, scientific scheduling method w/out user input
- Ability to update controller settings & data automatically
- Ability to protect the controller from improper user changes

### **Conclusion:**

A truly “smart” controller has the ability to take site specific conditions, determine the most efficient irrigation schedule possible to maximize plant health and appearance, without water runoff, and perform those functions continuously as weather changes without human interaction. The access to accurate, local ETo is essential and completes the potential to save the most water while maintaining a high quality landscape.

**Note:** If a site is found to be a water waster with a water budget evaluation, controllers that deliver part of the listed requirements can still save some level of water.

### **Water Savings Confidence Level:**

Current controller products can not be expected to apply water efficiently. They require people to calculate and set efficient irrigation schedules. To keep up with weather changes, people must repeat the action of inputting the correct scheduling information over and over again. Most current controller products are also limited in their ability to perform “advanced” scheduling operations, such as 30 day schedules, provide more than a few cycles, or irrigate for precise minutes and seconds. All of today’s controllers contain a “high water use” default schedule that significantly over-waters when batteries wear out or there are power outages or power surges. Based on field experiences, completed and partial public agency studies, the following “water savings confidence level” is provided for program planning and education:

## Water Savings Confidence Level:

- **Current controller products: Low confidence level**– Why? Water use histories show that current controllers do not save landscape water. AWWA residential end use studies across the country show that homes with automatic irrigation controllers use 47% more water than homes without automatic controllers. Denver Water data shows that single family homes with automatic controllers use 50% more water than landscapes really need. Current controllers are only as efficient as the people that operate them are knowledgeable and persistent. The Jordan Valley Water Conservancy District shows similar over use in landscapes. Xeriscapes in Arizona studies were found to often be over-watered. **(no water efficiency)**
- **Single Sensor controller products: Medium confidence level**– Single sensors that monitor one element of what makes up ET are subject to a variety of risks and problems. First, one sensor can not keep up with the multiple weather elements that effect plants. Second, the single sensor may not be placed in the proper location to monitor the element accurately. For example, if the sensor is a solar gauge, a tree growing to cause shade, or seasonal sun patterns will greatly affect the sensor data. Neither temperature nor solar sensors can measure wind that can quickly dry and stress plants. Single sensor controller products are also described as “stand-alone” models. This means that people still need to input an initial irrigation schedule and take other actions to modify controller functions. Finally, sensors need maintenance. Without a consistent sensor maintenance program, weather data used by the controller may not be accurate. The result will be over or under watering and/or loss of efficiency over time in the landscape. **(0-50% of the potential site water savings)**
- **Historical (average) weather products: Medium confidence level**– As shown with CIMIS weather station data for 2003, weather varies significantly from the average or historical ET. Products that uses historical ET to change schedules on a set average curve is going to over-water or under-water, depending upon the actual ET. These products also are marketed as stand-alone products, requiring people to insert an initial, maximum high summer schedule and make any adjustments as is deemed appropriate by the site owner/manager. This type of product can save water on sites that show water waste. However, they will not maximize water savings using the average approach. For example, in Denver where homes with controllers use 50% more water than landscapes really need, an “average” ET controller approach would likely save approximately 20% of site water. This would leave as much as 30% of the wasted water still to be saved. **(overwatering-50% of the potential site water savings)**
- **Single-source, Real time ET controller products: Medium to medium high confidence level**– Real time ET is the most credible data available to help determine proper water amounts for landscapes. However the weakness with this general product category is the lack of ET data to draw from. First, the single source of ET (from an existing weather station) means that data may be interrupted (dropped or unavailable from the station location). Second, the single ET data source may be far removed from the actual landscape site(s) using the

controller products. The specific site micro-climate may have much different weather and weather changes than the location of an ET weather station. These products are limited for accuracy to the same general microclimates of the existing ET weather stations. Another limitation is how irrigation schedules are initially set and then, how are they changed as weather changes. To date, there are no completed 3<sup>rd</sup> party studies available to test the reliability, credibility and operation of this group of controller products. **(10%-75% of the potential site water savings)**

- **Real time ET, ET Everywhere and Scientific Auto-Scheduler: High confidence level** – Based on an independent, 3<sup>rd</sup> party statistical study, a controller product with these characteristics saved 85% of the potential water to be saved ([www.irwd.com](http://www.irwd.com)). It is believed that indoor water waste also existed in the test homes (but was not the focus of the study) that would help to explain the 15% of potential unrealized savings. In a 2<sup>nd</sup> study with the same product, water savings increased by 9 percent per home and other benefits were measured in this study, including the ability to reduce water runoff. With approximately 75% of the test area landscapes (home and commercial) irrigated by way of a real time controller with a scientific auto-scheduler, 95% of the water runoff was eliminated from the test acreage. Therefore, a high confidence level (up to 95%) of water savings can be anticipated when a complete “smart” controller solution is applied to home and commercial landscapes. **(85%-95% of the potential site water savings)**

**Notes:**

1. Public agency staffs should consult completed and ongoing studies by public agencies to verify savings potential of various controller products.
2. Some products may cross the artificial boundaries described with the four-group categories (single sensor, historical, single source real time ET, real time ET/ET Everywhere/Auto Scheduler). Agencies and contractors should verify the methods used by various manufacturers.
3. Soil moisture sensors are not included in this review. That technology has been available for over 25 years. It is commonly used in agricultural settings. The technology requires multiple site placements (such as multiple root zone depths, multiple valves or plant groupings), maintenance. It is difficult to retrofit into existing landscapes, can be damaged during landscape maintenance or renovation and has relatively short product life cycles. However, *soil moisture sensors can also save some level of wasted water.*

**Controller Group Comparisons:**

<b><u>Group 1:</u></b>	<b><u>Group 2:</u></b>	<b><u>Group 3:</u></b>	<b><u>Group 4:</u></b>
Real Time ET	Single Source ET	Historical ET	Single Sensor
ET EveryWhere	Managed Schedule	Pre-set Changes	Proprietary Changes
Auto Scheduler/Service Fee	Service Fee	No Service Fee	No Service Fee

**What is Weather Data Source?**

Real time, daily ET. Delivered at local neighborhood level(.06 sq mile)source (ET weather station). Accurate to .01 inches for 95% of US. Proven, validated data.	Real time, single existing source (ET weather station). Non-validated (for missing or subject data).	Average or historical ET. May use proprietary curves. Variance from real time ET is high (-100% to +250% daily based on example stations).	Single sensor attempts to track ET. No validation of data. Not ETo.
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**How is Weather Data Used by the Controller?**

Daily ET updates internal auto-scheduler to adjust run times, # of cycles and # of days to irrigate for each valve.	ET updates proprietary scheduling methods. Controller is turned on/off based on data.	Pre-set schedule changes occur based on average weather or proprietary curve.	Sensor transmits signals for controller to react to in a proprietary fashion.
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**How Does the Controller Create an Irrigation Schedule?**

Using IA & CIT protocols, calculates efficient schedule for site-specific conditions (soil, sun, shade, precipitation rate, plant Kc, slope, root depth and system uniformity) for each valve. Run time, cycles and days can adjust.	Various proprietary methods. Users may set initial schedules. On/off method may be used.	Users set initial schedule. Irrigation changes at a set time based on historical weather (no precise local data).	User sets initial schedule. Proprietary schedule changes.
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<b>Group 1:</b> Real Time ET ET EveryWhere Auto Scheduler/Service Fee	<b>Group 2:</b> Single Source ET Managed Schedule Service Fee	<b>Group 3:</b> Historical ET Pre-set Changes No Service Fee	<b>Group 4:</b> Single Sensor Proprietary Changes No Service Fee
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**What is the Controllers Ability to Handle Various Landscape Situations** (turf to native plants, slopes, soil types, various irrigation, etc.)

Proven on all plant types with	May have abilities to manage	Limited ability to manage	Limited ability to manage
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improved appearance. Comes with ability to set schedules for natives with long non-water intervals. Sets schedules based on soil type, plant Kc, slope, precipitation rates of site sprinklers for every valve as set by IA, CIT.

across broad range of conditions. Proprietary management techniques varies with products. Can not localize ET which may affect plants.

across a broad range of landscapes. Limited by ability of the technology and the source of setting schedules. Can not account for above/below average ET changes which may affect plants

across a broad range of landscapes. Unknown, proprietary scheduling methods. Can not account for certain weather variables such as wind that may affect plants.

**Installation Requirements:**

Conventional attachment to valves. Requires outside protective case. Customer service walks installer through signal activation (5 minutes)

Conventional attachment to valves. Needs customer service for signaling service. Requires outside protective case. User must access Internet to schedule, or service will manage schedules.

Conventional attachment to valves. User must input schedules. Requires outside protective case.

Conventional attachment to valves. User must input schedule. Requires outside protective case.

**Customer Service Prospectus:**

Core business concept to assist customers with low water bills and high plant quality to insure future sign-ups for daily ET data. Fee

Core business concept to see customers have low water bills and high plant quality. Different methods and costs of services. No indication

No customer service built into business model.

No customer service built into business model.

**Group 1:**  
Real Time ET  
ET EveryWhere  
Auto Scheduler/Service Fee

**Group 2:**  
Single Source ET  
Managed Schedule  
Service Fee

**Group 3:**  
Historical ET  
Pre-set Changes  
No Service Fee

**Group 4:**  
Single Sensor  
Proprietary Changes  
No Service Fee

will not rise. Consistent customer contacts to monitor satisfaction.

of fee stability.

**Broadcasting / Services Pros, Cons and Opportunities:**

**Pros:** Verification of site data & installation. Long-term efficiency reliability. Control over inaccurate controller changes. Accurate ET on a local, daily basis. Used to update new data, new software and new services. Useful for drought and peaking management.  
**Cons:** New business model from current controllers

**Pros:** Verification of site data & installation. Consistent ET updates. Useful for drought mgt.  
**Cons:** Limited to single source of ET for large areas. New business model compared to current controllers.

**Pros:** No service costs  
**Cons:** No real time ET. No customer service abilities. No ability to check and verify long-term efficiency. Schedules can be altered w/out agency knowledge

**Pros:** No service costs.  
**Cons:** No real time ET. No customer service abilities. No ability to check and verify long-term efficiency. Schedules can be altered w/out agency knowledge.

**Longevity /Long-Term Savings Prospects:**

Multiple, large company partners with licensing interests Attractive business model for partners. Highly studied and proven ability to save water. Accurate data, customer service focus and protections of controller settings allow for high

Single company manufacturers. Good short-term savings potential. Proprietary managed systems (on websites) provide less long-term savings confidence. No proven studies.

Single company manufacturers. Savings may decrease over time due to set, “average” data and inability to measure important weather variables. No proven studies.

Single company manufacturers. Savings may decrease over time due to single weather source. No proven studies.

**Group 1:**  
 Real Time ET  
 ET EveryWhere  
 Auto Scheduler/Service Fee

**Group 2:**  
 Single Source ET  
 Managed Schedule  
 Service Fee

**Group 3:**  
 Historical ET  
 Pre-set Changes  
 No Service Fee

**Group 4:**  
 Single Sensor  
 Proprietary Changes  
 No Service Fee

**Longevity /Long-Term Savings Prospects: continued...**

confidence level for long-term

savings. Proven multiple benefits (saved water, runoff reduction, plant quality).

**Note:** This comparison chart will be updated with future public agency tests, reports, etc. CIT (Fresno St.) will provide criteria for new controller technologies and will test products for “certification” by public agencies.

#### **How Example Products Fit into the Group Classifications:**

AquaConserve: **Group 3, 4** ET Water Systems: **Group 2**  
Irrisoft: **Group 2** (w/ user schedule or existing controller parameters)  
Micromet: **Group 2** Motorola (WeatherTRAK enabled): **Group 1**  
Rainmaster Eagle: **Group 2** (w/ user schedule)  
Toro (WeatherTRAK enabled): **Group 1**  
Water2Save: **Group 2** WeatherMatic: **Group 4**  
WeatherSet: **Group 4** WeatherTRAK: **Group 1**

*Tom Ash authored this white paper draft for CALFED, reviewed by Ca. Dept of Water Resources, for the education of public agencies seeking to reduce water demand in urban landscapes. Tom initiated the first studies on ET/Weather-based and/or “Smart” controllers in 1998. The landmark studies have helped create a new market for efficient irrigation products, and prompted public agencies to offer rebates for “smart” controllers. Without precise irrigation, the landscape and the building industry face limited water supplies and more regulation, including restrictions on building and planting. As one grower said after seeing the results of public agency tests, “this technology will save the landscape industry...”*  
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