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INNOVATIONS

The California Water Smart Irrigation Controller Project

Results and Perspective on a Large Field Study of an Important Emerging Technology

Project Funding Provided by California Department of Water Resources

Project Team

Researchers

Peter Mayer, P.E. William DeOreo, P.E. and Matt Hayden– Aquacraft, Inc.
Erin Caldwell – National Research Center

Utility Partners Presenting Today

Alice Webb-Cole – MWD & 26 S. Cal Providers
Jon Bauer – EBMUD
Bob Eagle – Contra Costa Water District
Kevin Galvin – SCWWD

Evaluation Project Management

Marsha Prillwitz & Chris Brown – CUWCC

What are Smart Controllers?

Smart irrigation controllers – aka "weather-based irrigation controllers" utilize prevailing weather conditions, current and historic evapotranspiration, soil moisture levels, and other relevant factors to adapt water applications to meet the estimated needs of plants.

Smart Water Application Technology (SWAT) definition

"Smart controllers estimate or measure depletion of available plant moisture to operate an irrigation system that replenishes water as needed while minimizing excess. A properly programmed smart controller makes irrigation adjustments throughout the season with minimal human intervention."

Two Fundamental Control Technologies

- On-Site Sensor based control
  - uses real-time measurements of one or more locally measured factors to adjust irrigation timing. The factors typically considered include: temperature, rainfall, humidity, solar radiation, and soil moisture.
- Broadcast Signal based control
  - receives a regular signal of prevailing weather conditions via radio, telephone, cable, cellular, web, or pager technology.

Smart Controller Grant Information

GRANT INFORMATION	MWD – S. California	EBMUD – N. California
Grant amount	$1,778,700	$1,660,725
Cost share amount	$1,072,933	$441,957
Smart controller installation goal[1]	5,514 controllers	2,605 controllers
Estimated 10-year potential water savings over useful lifetime of device[2]	27,500 AF	30,477 AF

[1] The installation goal is a maximum ("up to") target number to be achieved.
[2] Estimated savings were included in the original grant proposal and reflect various individual agency assumptions and rough estimates based on the types of controllers to be installed and the water demand in each area. Actual savings are anticipated to differ substantially.

Aquacraft selected to conduct impact evaluation.

Alice Webb-Cole
MWD

Southern California State Grant

- February 2004 – April 2007
- $1.8 million awarded
- Original estimate of 5,514 controllers
  - Residential 4,961
  - Commercial 553
- Direct installation and self installation
  - Direct 1,600
  - Self 3,914

Initial Approach:
Feb 2004 – May 2005

- Allocated grant among 22 member agencies
- Worked with agencies to develop implementation plans
- Issued RFI to compile list of available devices

Initial Approach:
Feb 2004 – May 2005

- Very Little Success
- Challenges for homeowners
  - Didn't know:
    - What a smart controller was
    - What it did
    - Where to purchase
  - High cost compared to standard controller

Rethinking the Approach: **May 2005 – Nov 2005**

- Workshop with agencies to identify issues
  - Consumer awareness
  - Availability of product
  - Cost for customer
- Internal brainstorming on program implementation
- Survey of 500 homeowners on awareness

Rethinking the Approach: **May 2005 – Nov 2005**

- Developed concept of free distributions
  - Modeled after ULFT distributions
- Sought landscape industry partners
- Issued RFP to purchase small quantity of controllers
- Developed forms and promotional materials

First Free Exchange Event
Nov 2005

- Partnerships
  - LADWP
  - Armstrong's Garden Center
- Provided programming training
- Exchanged 120 smart controllers

First Free Exchange Event

Nov 2005 - Marketing

First Free Exchange Event

Nov 2005 – Old Controllers

Free Exchange Events
Nov 2005 – Nov 2007

- Methods tested
  - Walk-up
  - Drive-through
  - California-Friendly Landscape Training
  - Community College
  - Internet sign-up

Rebate Programs
Jul 2005 – Dec 2006

- Residential rebates
  - Six agencies
  - 195 rebates
- Commercial rebates
  - Seven agencies
  - 400 rebates

Direct Installation Programs
Jul 2005 – Feb 2007

- Residential direct-installations
  - Six agencies
  - 910 controllers
- Commercial direct-installations
  - Nine agencies
  - 654 controllers

Southern California Results

	Original Estimates	Actual Results
Residential self-install	3,520	2,665
Residential direct-install	1,441	910
Commercial self-install	394	400
Commercial direct-install	159	654
Totals	5,514	4,629

Southern California Results

- February 2004 – October 2008
- Completed 4,629 controllers
  - Residential 3,575
  - Commercial 1,054
- Direct installation and self installation
  - Direct 1,564
  - Self 3,065

Implementation Methods

- Commercial
  - Direct-installation 60%
  - Rebate or voucher 40%
- Residential
  - Free distributions 70%
  - Direct-installation 25%
  - Rebate or voucher 5%

Results – Public Awareness

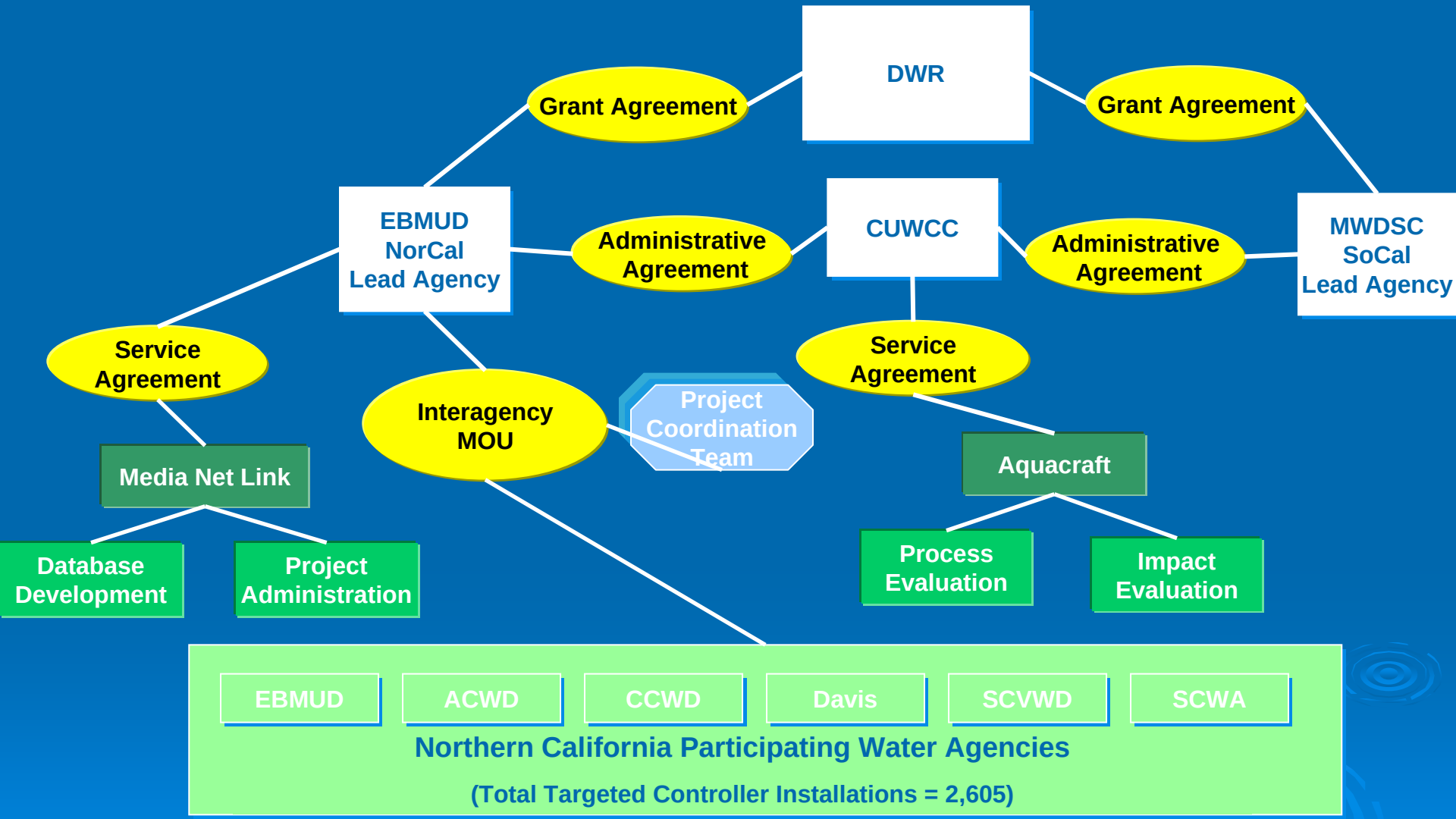
- Increased awareness
  - 15% in 2005
  - 38% in 2007

Jon Bauer
EBMUD

Water Smart Irrigation Controller Program

Northern California Program Results and Perspectives

Northern California Weather-Based Irrigation Controller Program



Elements Common to Northern California Programs

- Targeted at higher water users
- All are variations on a rebate incentive
- Strong educational or follow up component

Northern California WSIC Installations by Agency

	1 to 12 Stations		13 to 24 Stations		25 Stations and up		Number Controllers Installed	Number Controllers Allocated
	Direct Install	Self Install	Direct Install	Self Install	Direct Install	Self Install		
EBMUD		442		297		63	**802**	1305
Alameda	6	47	20	37	1	3	**114**	124
Contra Costa		56		60		25	**141**	149
Santa Clara	66	12	40	200	3	137	**458**	657
Sonoma	88	40	19	26	4	21	**198**	291
Total	**160**	**597**	**79**	**620**	**8**	**249**	**1713**	**2605**

WaterSmart
Irrigation Controller Program

Initial EBMUD WSIC Program

- Targets both high-use residential and commercial customers
- Retrofit only (not new construction)
- We chose a voucher as the financial incentive
- Marketed directly to customers (direct mail) and key influencers (landscape professionals, distributors, manufacturers)

Initial EBMUD WSIC Program

- Pays up to 50% of controller cost
- Maximum voucher amounts based on irrigation use (Summer – Winter use for mixed meters)

Irrigation Use (gpd)	Max Voucher Amount
750 to 2,999	$300
3,000 to 5,999	$600
6,000 and above	$1,200

Initial EBMUD WSIC Program

- Effective marketing materials developed in cooperation with the Irrigation Association Smart Water Application Technology (SWAT) Initiative

Initial EBMUD WSIC Program

- 4% response from three direct mailings to 23,000 customers using more than 750 gpd of irrigation
- Issued ~1200 vouchers
- Only 20% of vouchers issued were redeemed for controllers

Initial EBMUD WSIC Program

- Voucher Program proved complicated and costly to administer for water agency, customer, and distributor.
- Vouchers didn't provide strong incentive for contractors.
- Confusion over value of voucher
  - $300, $600, $1,200 maximum amounts
  - Value only 50% up to maximum
  - One reason we think some customers didn't redeem voucher (along with a complex pre-application process)

Revised EBMUD WSIC Program

- Beginning January 1, 2008 the program was revised and simplified.
- The biggest revision was that the financial incentive was changed from a voucher to a rebate.
- Also, the application process was simplified to remove the pre-application.
- Customers can not get rebate until they have an inspection.

Revised EBMUD WSIC Program

- New consolidated brochure
- Article in Customer Pipeline (bill insert)
- Point of Purchase displays
- Improved web page
- Ads in print media

Revised EBMUD WSIC Program

- Based on the account's average IRRIGATION water use over the past three years.

Irrigation Use (gpd)	Rebate Amount
250 to 749	$100
750 to 2,999	$250
3,000 to 5,999	$350
6,000 and above	$500

Note: Special Rules apply when replacing 2+ controllers.

EBMUD WSIC Overall Goals and Activity

Sector	1 to 12	13 to 24	= or > 25	Installations Complete
Residential	175	149	10	334
Commercial	267	148	53	468
Total	**442**	**297**	**63**	**802**

What seems to work . . .

- When we communicate meaningful benefits that are understood by the customer using effective marketing materials
- Add in a financial rebate incentive
- And follow up to verify the controller is installed and programmed properly . . .

For program information contact
EBMUD Project Managers:

Jon Bauer: jbauer@ebmud.com

or

Scott Sommerfeld: sommerf@ebmud.com

Bob Eagle
CCWD

CCWD's 'Smart' Programs

- 'Smart Sprinkler Timer Rebate
  - Single Family Residential
    - Rebate is $25 per active station
    - Targeted high users by summer to winter difference
- 'Smart Irrigation Controller Rebate
  - CII/Multi-family Customers
    - Rebate is $40 per active station
    - Targeted high users via Water Budget program

Program Process

- ‘Smart Sprinkler Timer
  - Pre-inspection
    - Residential Survey Program
  - Post-inspection
    - Survey System
    - Program Timer
- ‘Smart Irrigation Controller
  - Pre-inspection
    - Verify Landscape/Irrigation Quality
  - Post-Inspection
    - Verify Installation
    - Offer CCWD’s Scheduling Services

Program Adjustments

- Single Family Residential
  - Changed Informational Material in Response to Customer Feedback
- CII/Mult-family Customers
  - Revised Some Requirements in Response to Landscaper Feedback

What seems to work…

- Seminars
  - Benefits of Smart Timers
  - Manufacturers' Display Tables
- Scheduling Based on Results of Thorough System Evaluation
- Promoting Needs of Customer

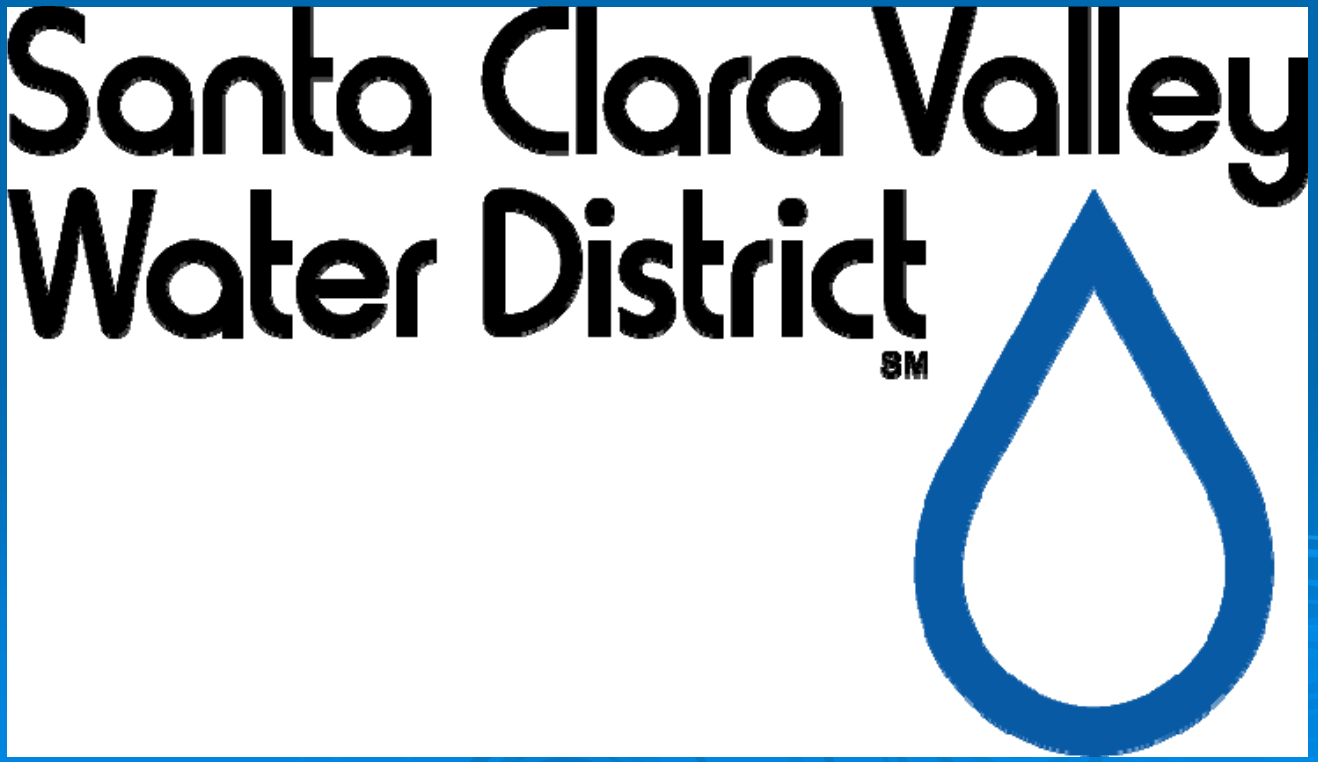
Recommendations…

- Target High Users
- Materials That Provide Solutions to Customers' Concerns
- Train Installers to Properly Schedule Units
- Promote Importance of Effective Water Management

For program information contact
CCWD Program Manager:

Bob Eagle beagle@ccwater.com

Kevin Galvin
SCVWD



SCVWD's WSIC Installation Program

- WSIC Installation Program Design
  - Single Family and CII Program
    - Pre-Installation survey required for each participant
    - Two controller types: Signal Based and Non-Signal Based
    - 50% participant co-payment for controller cost
    - Direct Installation or Self Installation options
- WSIC Installation Program Marketing
  - Utilize residential and CII survey program data to mail to "pre-qualified" sites
  - Direct mail sent to retailer's list of top water users

WSIC Installation Program Requirements

- Minimum irrigated landscape size
  - Resi: 1,600 sq ft
  - CII: 1 acre
- Minimum number of active stations
  - Resi: 6 stations
  - CII: 18 stations
- Functioning Irrigation System
  - Determined by pre-installation survey
- Co-Payment
  - Resi: $50-$100 per controller
  - CII: $200-$275 per controller

WSIC Installation Program Process

- Pre-Installation Survey
  - Verify site meets program criteria
  - Inventory of landscape by station
- Direct Installation
  - Installation of new WSIC
  - Programming of WSIC, verify that stations are working properly
- Self-Install WSIC Workshop
  - Review survey forms
  - Program controller / Explain installation instructions

SCVWD's WSIC Rebate Program

- WSIC Rebate Program Design
  - CII Program
  - Pre-Installation survey required for each participant
  - Minimum criteria to qualify
  - Qualifying controllers must have published SWAT testing results
  - Rebates ranging from $300 to $1,100 per controller

SCVWD's WSIC Rebate Program

- WSIC Rebate Program Perceived Benefits
  - Meeting Demand
  - Program Flexibility
  - Adaptability for New Technology
  - Marketing
  - Manageability
  - Minimize Liability Perceptions

What seems to work…

- Checking irrigation system efficiency
- Working with landscape contractors and property management companies
- Cross promotion of WSIC rebate program with rebates for other irrigation hardware upgrades

For program information contact
SCVWD Program Manager:

Kevin Galvin kgalvin@valleywater.org

Peter Mayer, P.E.

Aquacraft inc
WATER ENGINEERING & MANAGEMENT

Program Evaluation Project

- Process Evaluation
- Impact Evaluation
- Customer Survey
- Agency Survey
- Water Savings Analysis
- Benefit-Cost Analysis

Preliminary results presented today.

Customer Satisfaction Survey

- Mail survey sent to all participants in both Northern and Southern California
- 3,455 surveys mailed out
- 1,351 usable surveys returned
- 39% response rate

Overall Satisfaction

Overall, how satisfied are you with the performance of the smart controller(s)?	Percent	Number
very satisfied	45.9%	N=612
somewhat satisfied	33.4%	N=445
somewhat dissatisfied	9.5%	N=127
very dissatisfied	8.5%	N=113
don't know	2.8%	N=37
Total	100.0%	N=1334

Type of Property

Is the property where the smart controller was installed a . . .	Percent	Number
single-family private residence	95.6%	N=1222
multi-family housing complex	1.6%	N=20
park, playground or median	1.3%	N=17
commercial, industrial or institutional property	1.5%	N=19
Total	100.0%	N=1278

Perceived Benefits

Which, if any, of the following do you perceive as a benefit of having a smart controller?	Percent	Number
Saves time and effort	52.7%	N=661
Makes programming the settings easier	33.5%	N=420
Saves money	49.0%	N=614
Water-efficient	80.7%	N=1012
Cost-efficient	37.4%	N=469
Improves the health of the landscape	34.9%	N=438
Other	7.1%	N=89
Total*	100.0%	N=1254

**Actual totals will equal more than 100% as respondents could give more than one answer*

Is Programming Correct?

How confident are you that the irrigation schedule set for your smart controller is correct?	Percent	Number
very confident	39.2%	N=447
somewhat confident	40.0%	N=456
not very confident	16.1%	N=183
don't know	4.7%	N=53
Total	100.0%	N=1139

Impact Analysis – Water Use

- At least 1 full year of pre-installation water consumption
- At least 1 full year of post-installation water consumption
- Weather data for concurrent period – CIMIS and NCDC - >70 different weather stations
- Site specific area

Weather-Corrected Water Use

- Site Application Ratio (SAR)= Actual application / Theoretical application requirement
- SAR Calculated for Pre- and Post- year for each site
- Δ SAR = Post-SAR – Pre-SAR
- Δ SAR/ Pre-SAR = weather corrected % change in usage

Site Application Ratio (SAR)

SAR = Actual application (in.) / Theoretical application requirement (80% of Net ET) (in.)

SAR is a measurement of how much water was actually applied to the site, compared with what “should” have been applied based on climate data.

SAR “corrects” for differences in climate and in landscape size and allows for a reasonable measurement of weather-adjusted water savings and comparison between sites.

Analysis Sample Size

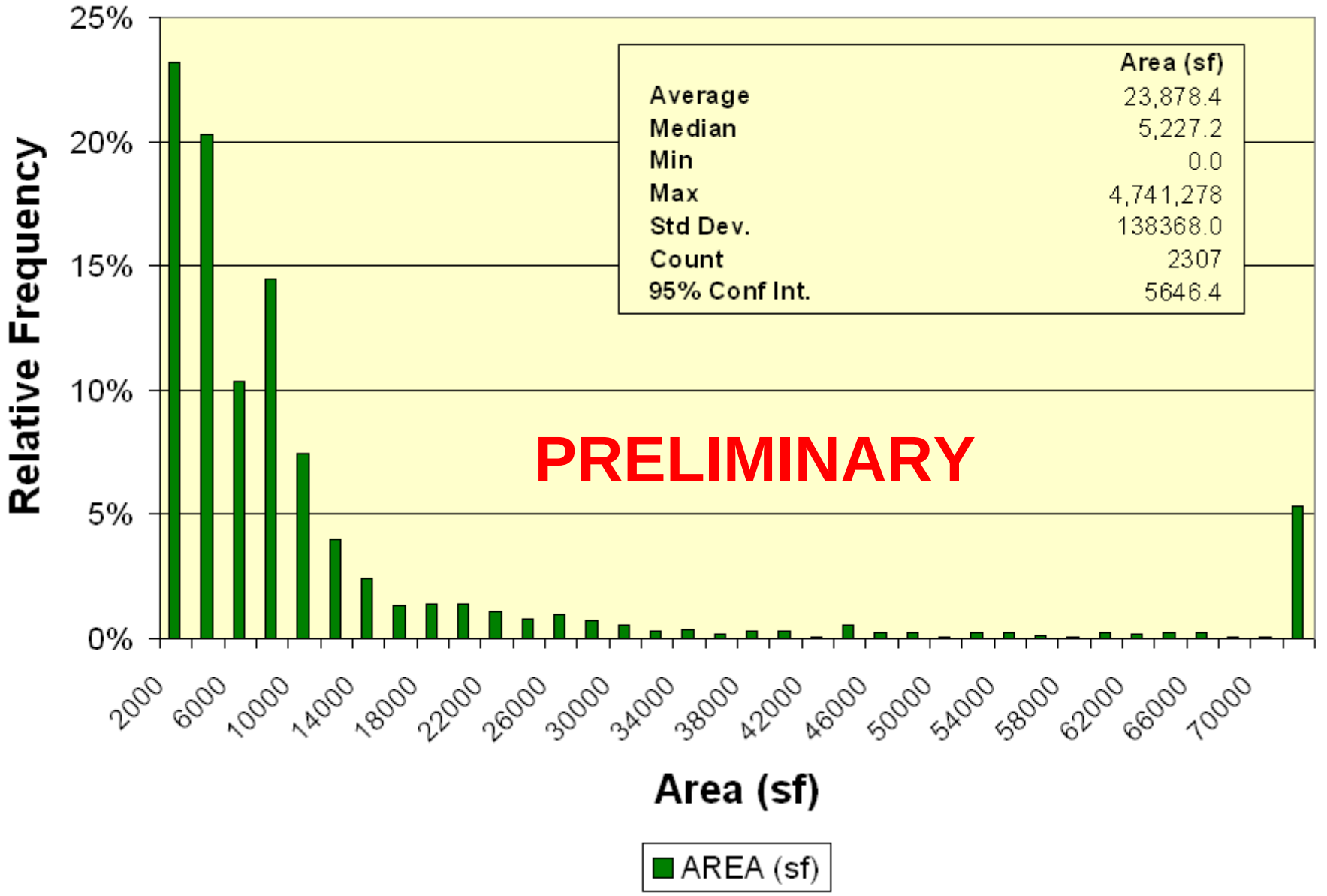
2,332 Sites (with minimum data requirements)

3,008 Smart Controllers installed on 2,332 sites

2,122 Sites (with necessary data for pre- post-analytic comparisons)

- 1,738 sites in S. California
- 384 sites in N. California

Landscape Area at Smart Controller Sites



Climate Conditions Pre- and Post-Installation

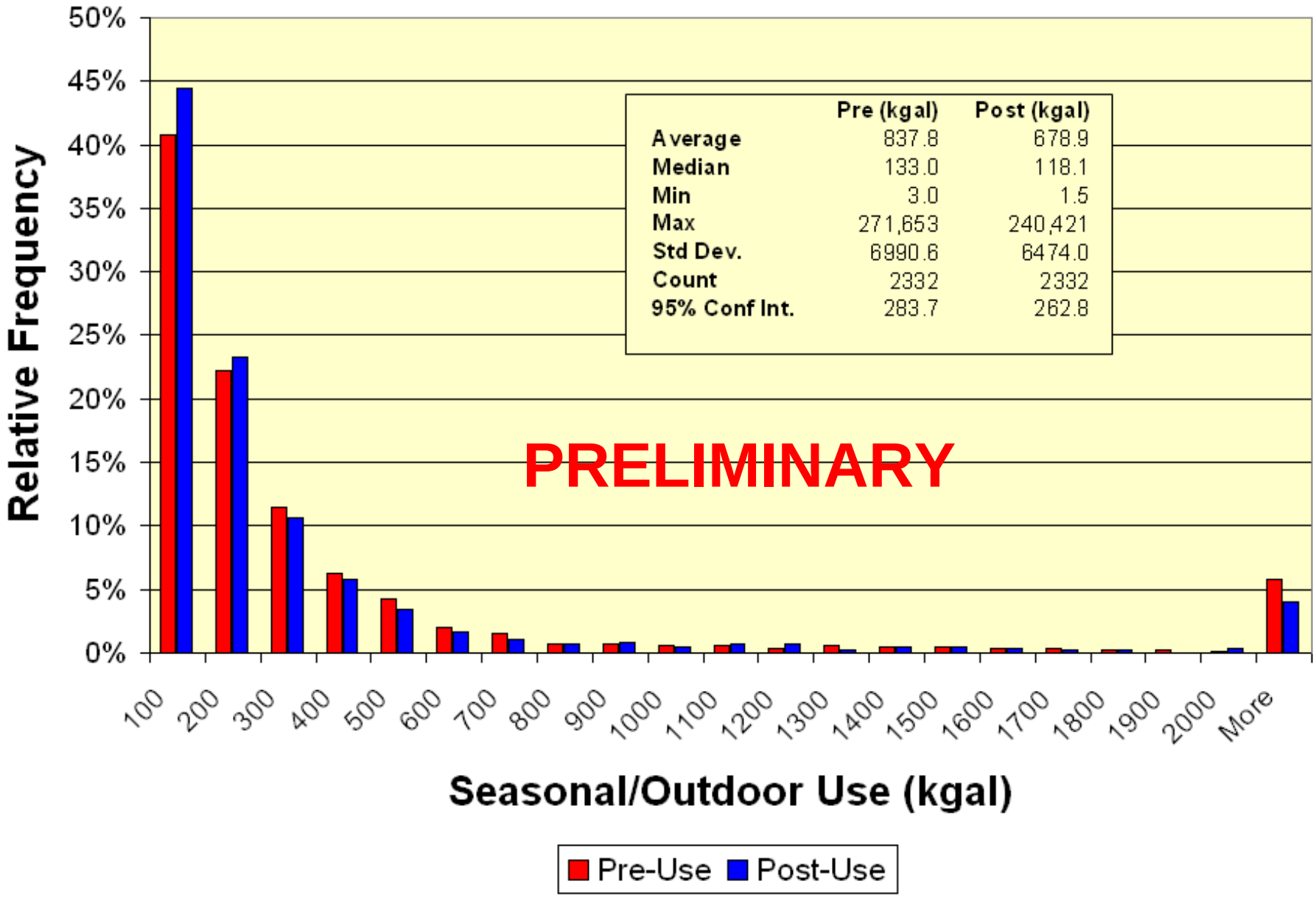
	Pre-ETo (inches)	**Post-ETo** (inches)	**Pre-Net ET** (inches)	**Post-Net ET** (inches)
Total	47.7	50.6	37.2	42.0
S. Cal	48.1	51.6	39.5	44.5
N. Cal	46.0	45.9	26.1	29.5

Averaged over **all** CIMIS and NCDC stations used for the study.

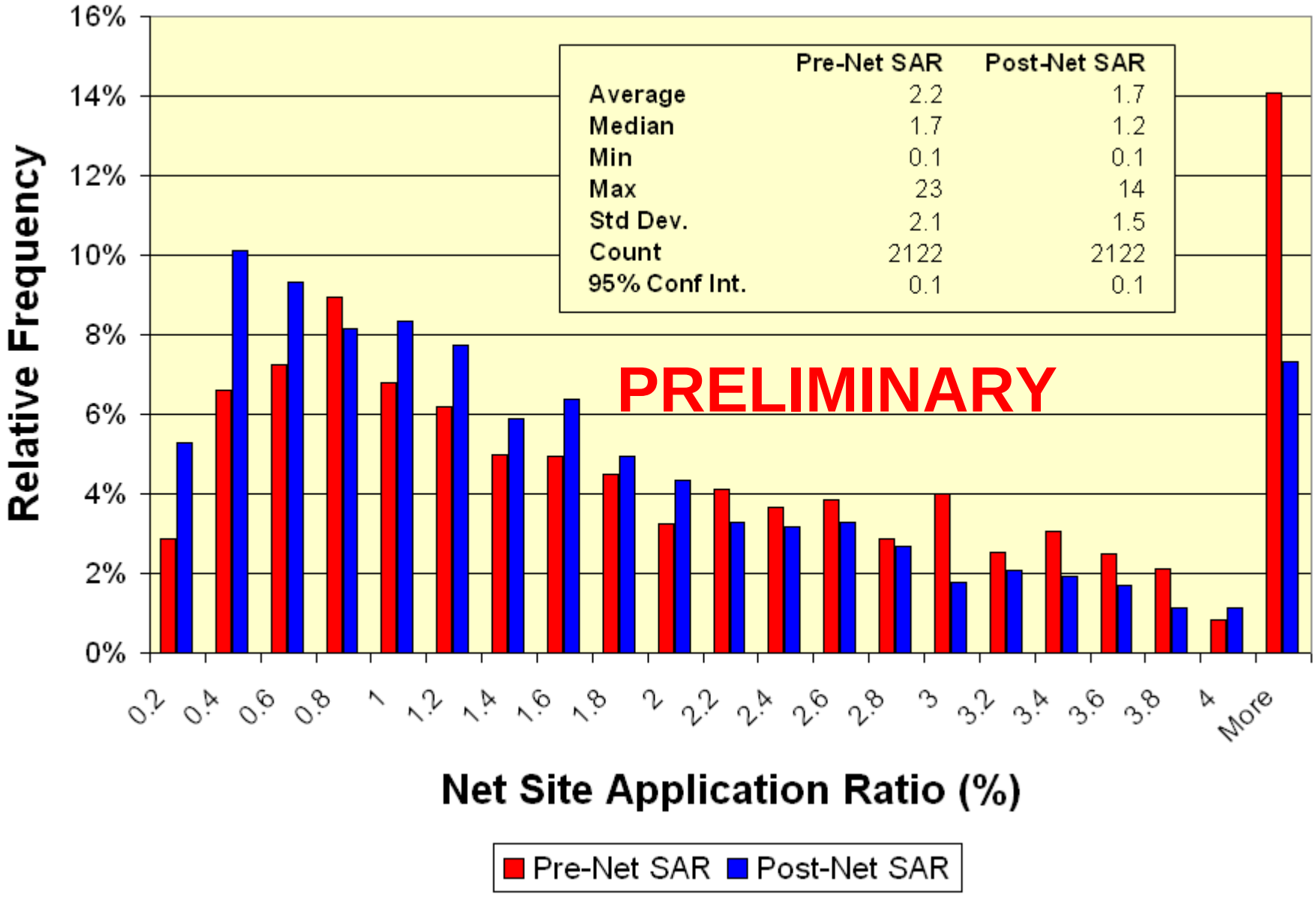
Generally it was slightly hotter and drier in the post-installation year.

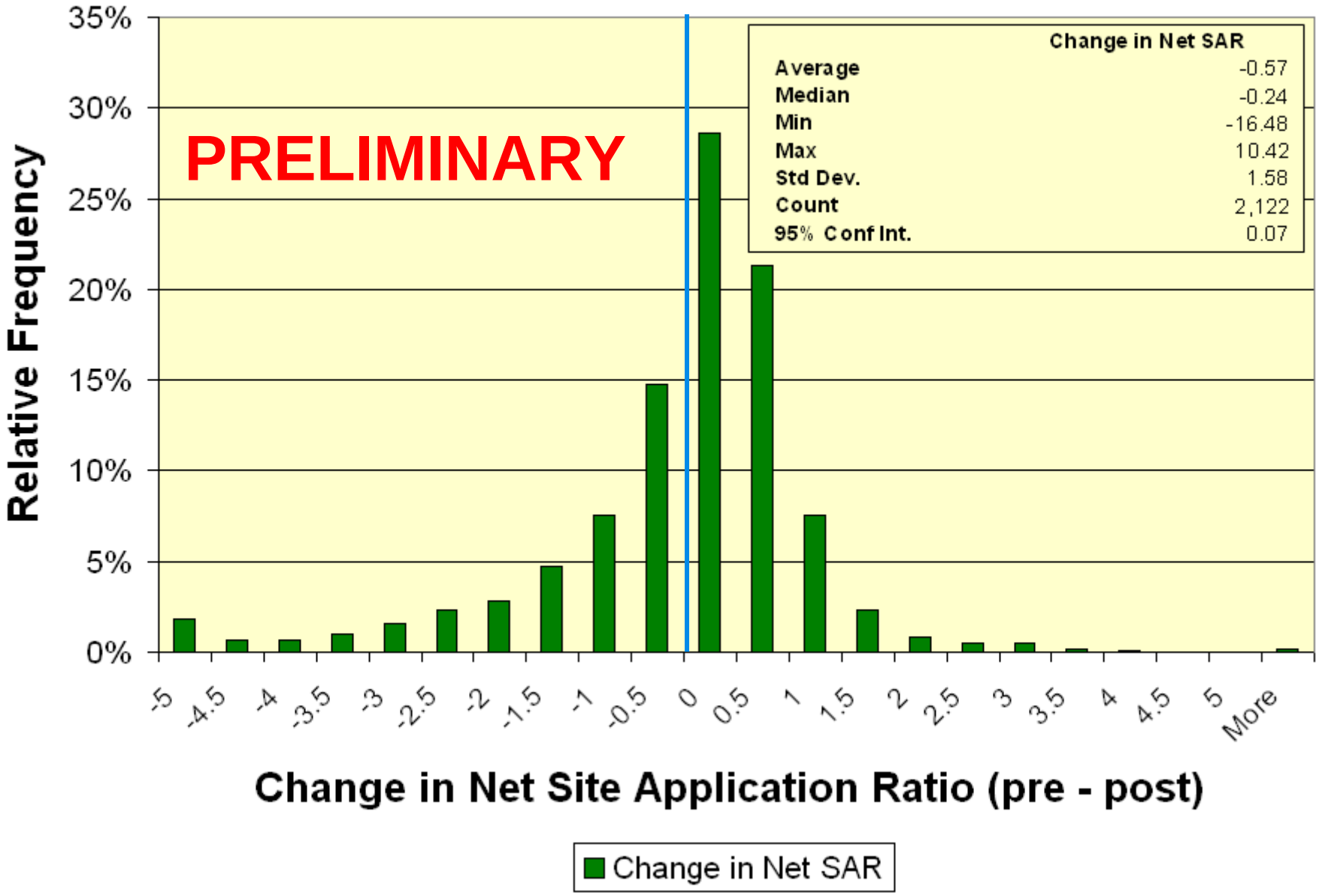
PRELIMINARY

Pre- and Post- Seasonal Water Use



Pre- and Post- Net Site Application Ratio




PRELIMINARY
Change in Net SAR
Average -0.57
Median -0.24
Min -16.48
Max 10.42
Std Dev. 1.58
Count 2,122
95% Conf Int. 0.07
Relative Frequency
35%
30%
25%
20%
15%
10%
5%
0%
-5
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
More
Change in Net Site Application Ratio (pre - post)
Change in Net SAR

Increases and Decreases In Usage After Smart Controller

	N. Cal	S. Cal	Total
Decrease in SAR	85.4%	56.3%	61.6%
No Change in SAR (95% bounds)	1.8%	10.2%	8.7%
Increase in SAR	12.8%	33.5%	29.7%
Total	100%	100%	100%

PRELIMINARY

% Change – All Sites

	N (sample size)	Range of 95% Conf. Interval
All Sites	2,122	-23.5% - -27.4%

PRELIMINARY

Corrected for changes in ET and Precipitation

% Change – S. Cal Sites

	N (sample size)	Range of 95% Conf. Interval
All Sites	2,122	-23.5% - -27.4%
S. Cal Sites	1,738	-15.4% - - 17.0%

PRELIMINARY

% Change – N. Cal Sites

	N (sample size)	Range of 95% Conf. Interval
All Sites	2,122	-23.5% - -27.4%
S. Cal Sites	1,738	-15.4% - - 17.0%
N. Cal Sites	384	-21.5% - -68.8%

PRELIMINARY

Determining Factors that Influence Water Use Change

- Analysis of variance (ANOVA) tests performed to determine statistically significant variables for explaining water use.
- Factors with p-values of less than 0.05 (95% confidence level) were considered statistically significant.
- Only factors shown to be significant were selected for multiple-linear regression models.

Factors that Influence Savings
at 0.05 Significance

- **Pre-Installation Watering Patterns** – i.e. what % of ET was applied to begin with
- Region (S. Cal or N. Cal) – programmatic differences
- Installation method – self installed* or professionally installed
- Climate zone – Coastal, Inland, or Foothill
- Make and model of smart controller (sometimes significant)

PRELIMINARY

***Self installed means the customer was responsible for the installation, but could have had someone else do it.**

Factors that did **Not** Influence Savings
at 0.05 Significance

- Type of site – residential vs. non-residential

PRELIMINARY

Researchers are still investigating sensor vs. signal based controllers to determine if this is a significant factor in water savings.

Modeling Results

- Δ SAR used as the *dependent* variable for multiple-regression modeling
- Independent variables examined:
  - Pre-SAR (did this site over irrigate to begin with)
  - Region (S. Cal vs. N. Cal)
  - Climate zone (Coastal, Inland, Foothill)
  - Controller make and model (anonymous)
  - Installation method (self vs. professional)

PRELIMINARY

Modeling Results Cont.

R	R Squared	Adjusted R Squared	Std. Error of the Estimate	Degrees of Freedom	F	P-value
0.731	0.535	0.531	1.0863	2110	141.5	0.000

Predictors: (Constant), Pre-SAR, N.Cal (compared to S.Cal), Professional install (compared to self), Inland and foothill climate zone (compared to coastal), controller make and model (compared to N1)

Dependent Variable: Δ SAR

PRELIMINARY

B (Beta) Coefficients

The B coefficient present the magnitude of the effect of the different independent variables in the model. **PRELIMINARY**

In this case, B represents the magnitude in % SAR change.

PRELIMINARY

Modeling B Coefficients

Variable	B	Std. Error	t	Sig.
(Constant)	0.859	0.069	12.45	0.000
Region N Cal	-0.194	0.097	-2.002	0.045
Install - Pro	0.198	0.094	2.102	0.036
Inland – Clim. Zone	-0.248	0.067	-3.734	0.000
Foothill–Clim. Zone	-0.019	0.098	-0.003	0.846
Controller A1	-0.098	0.075	-0.022	0.193
Controller B1	-0.264	0.117	-2.262	0.024
Controller B3	0.066	0.138	0.477	0.633
Controller C1 – K1	.....	.....	.....	.....

Preliminary Conclusions

- Smart controllers reduce water use – particularly at sites that have historically over-irrigated.
- Weather adjusted change in usage was measured to be -25.5% across all 2,122 sites.
- Self installed controllers reduced water use more compared with professionally installed controllers.

PRELIMINARY

Preliminary Conclusions 2

- Climate zone (Coastal, Inland, Foothill) influenced changes in usage. Additional analysis is required.
- Most controllers appear capable of reducing demand.
- Specific controller technology is less important than pre-installation irrigation habits.

PRELIMINARY

Preliminary Conclusions 3

- Smart control technology appears to have tremendous potential for managing outdoor urban water demands.
- Results presented here are PRELIMINARY and are subject to change as additional work is done.
- Project final report will be available in the first quarter of 2009.

PRELIMINARY

Final Report Available in 2009

- Final presentation available at www.aquacraft.com
- Project report available in early 2009
- Agencies will monitor performance of WBICs for another 5 years.

Aquacraft inc
WATER ENGINEERING & MANAGEMENT

mayer@aquacraft.com