This presentation premiered at WaterSmart Innovations

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INNOVATIONS

Technology Working Group

Testing Protocols for Water Efficient Irrigation Technology

October 4, 2017
WaterSmart Innovations

FLOW SENSORS

Brent Mecham
CID, CLWM, CAIS, CIC, CLIA

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- Testing the flow sensor component only.
- Not testing controllers and how they manage the inputs from the flow sensor

- **4.1 Flow meter**
  - A flow meter includes a sensing device for flow and can translate a signal into a readout to indicate either a flow rate or volume of water or both.
- **4.2 Flow sensor**
  - The instrument or device that detects the flow of water and transmits a signal to an indicating device that can store and display the volume or flow rate of the passing water.
    - 4.2.1 **Impeller-style flow sensor** utilizes a paddle-wheel impeller that is inserted into the piping system to detect or measure flow. The flow sensor produces an output signal of electrical frequency or pulses proportional to flow.


Data Industrial for RAIN BIRD
CAUTION


CAUTION

Flow sensors

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Sizing

- Accommodate the range of flows they will measure, rather than match the size of the mainline pipe.
- Generally best practice is pipe velocity below 5 ft./s for the plastic piping.
- However, higher velocity in the sensor piping can increase accuracy.
- i.e. 3" mainline pipe but 2" flow sensor

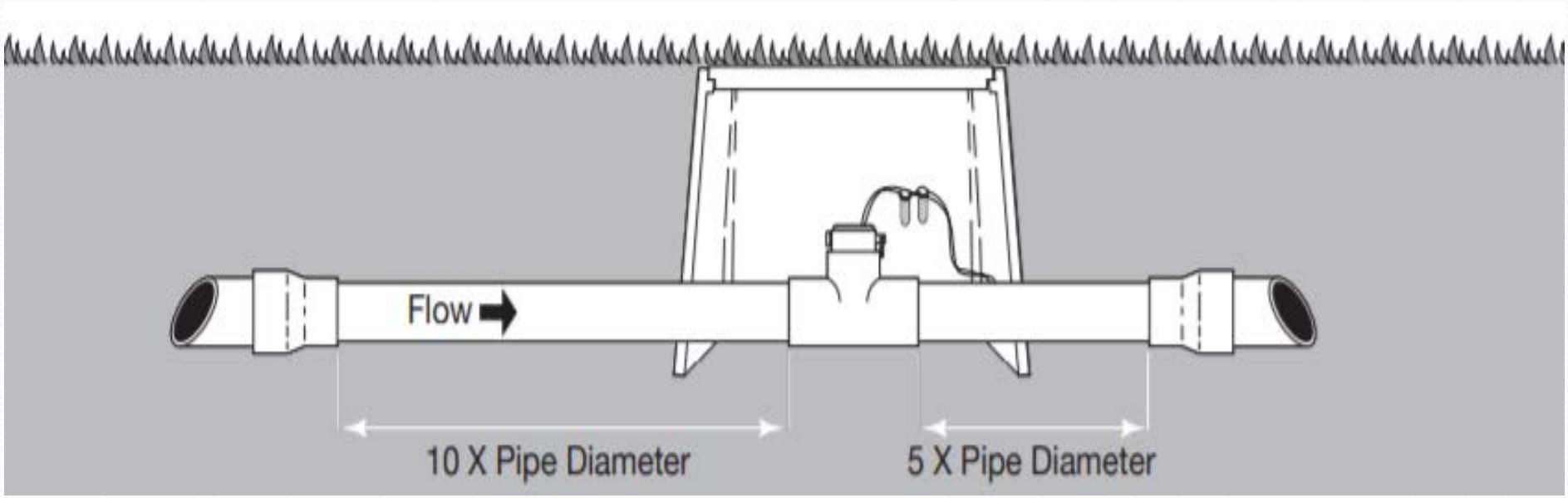
Sizing

FLOW SENSOR MODEL		FSI-T10-001	FSI-T15-001	FSI-T20-001
NOMINAL SIZE		1 "	1 1/2"	2"
	Feet per Sec	GPM	GPM	GPM
Minimum Flow	0.25	0.86	1.8	2.8
	1	3.5	7.24	11.3
	2	7	14.5	23
	3	10.4	22	34
	5	17	36	57
	7	24	51	79
	10	35	72	113
	12	42	87	136
Maximum Flow	15	52	108	170

Flow Sensors Installation

- To increase accuracy
  - Straight section of smooth, clean pipe
  - Avoid nearby fittings & components that cause turbulence
  - Flow sensor oriented at 12 noon—not tilted

Minimum requirements



Flow Sensor Comparison

	Accuracy full scale	Low flow	High flow	Upstream straight pipe diameters	Down-stream straight pipe diameters	K value	Offset
A	±3%	5	50	>10	>5	0.26112	1.2
B	±3%	5.4	54	>10	>5	0.26112	1.2
C		0.86	52	>10	>5	0.322	0.20
D		2	17	>10	>5	0.44	0.39
V	±2%	0.5	25	>10	>5	direct	read

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Cost comparison?

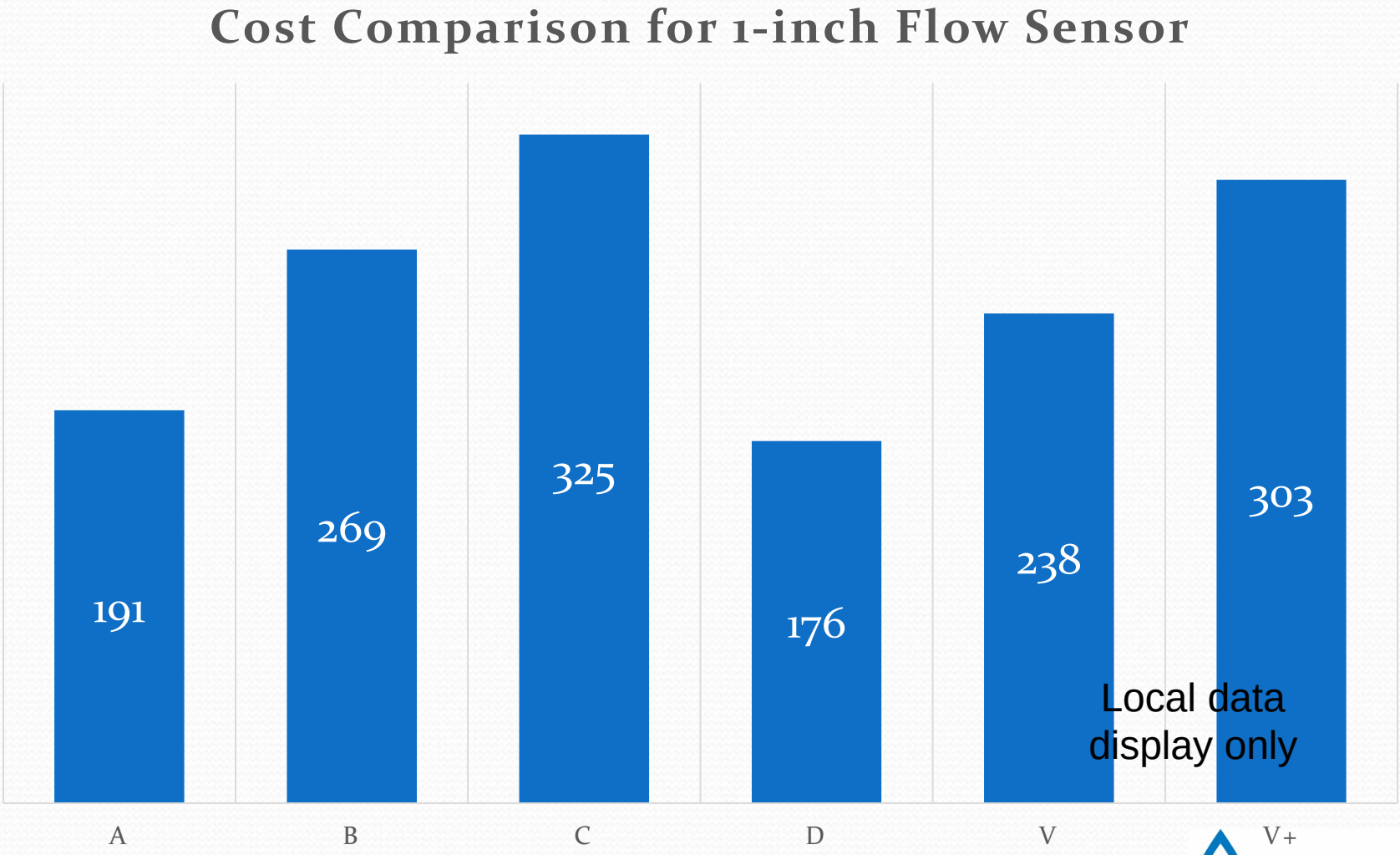

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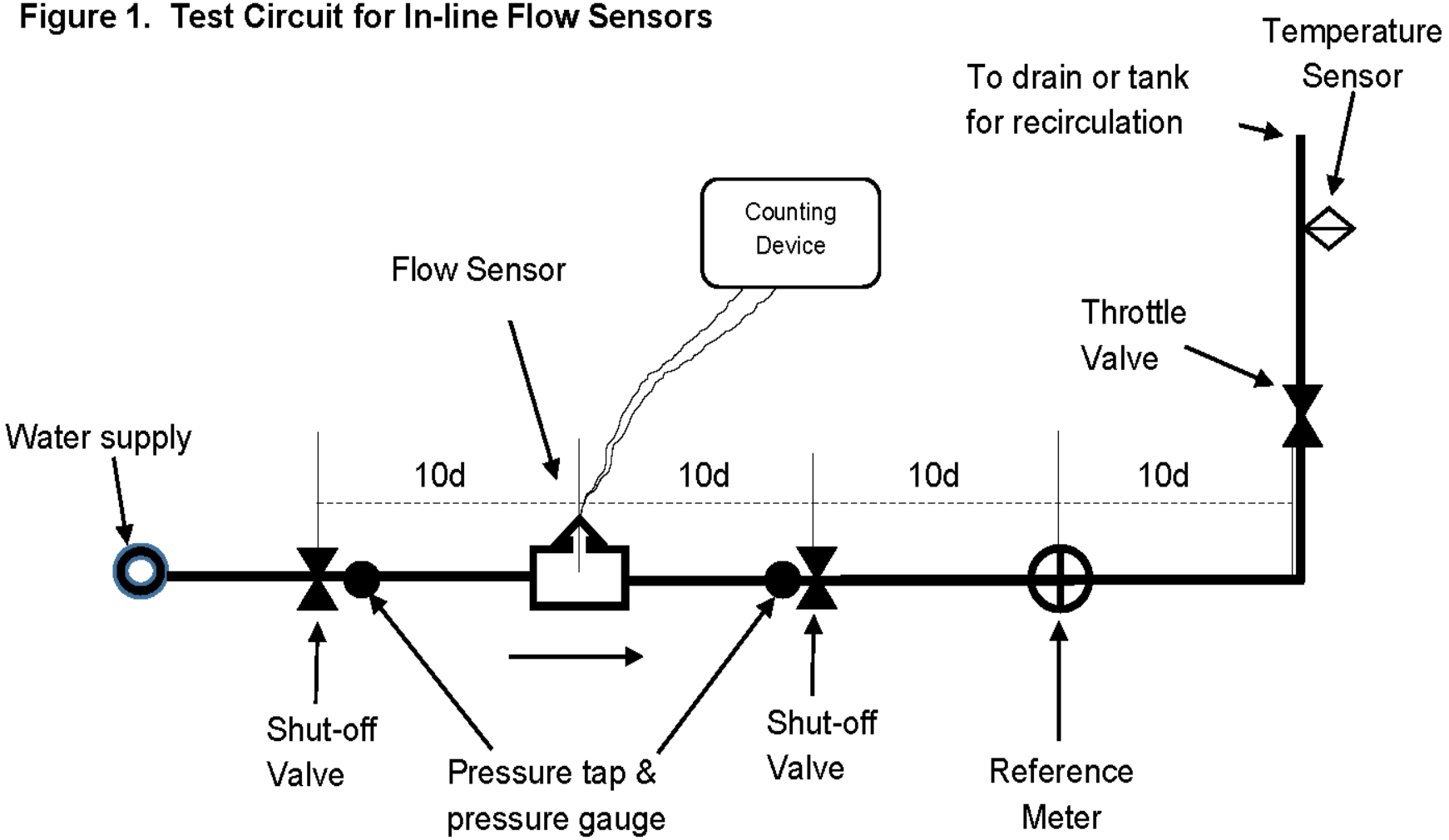
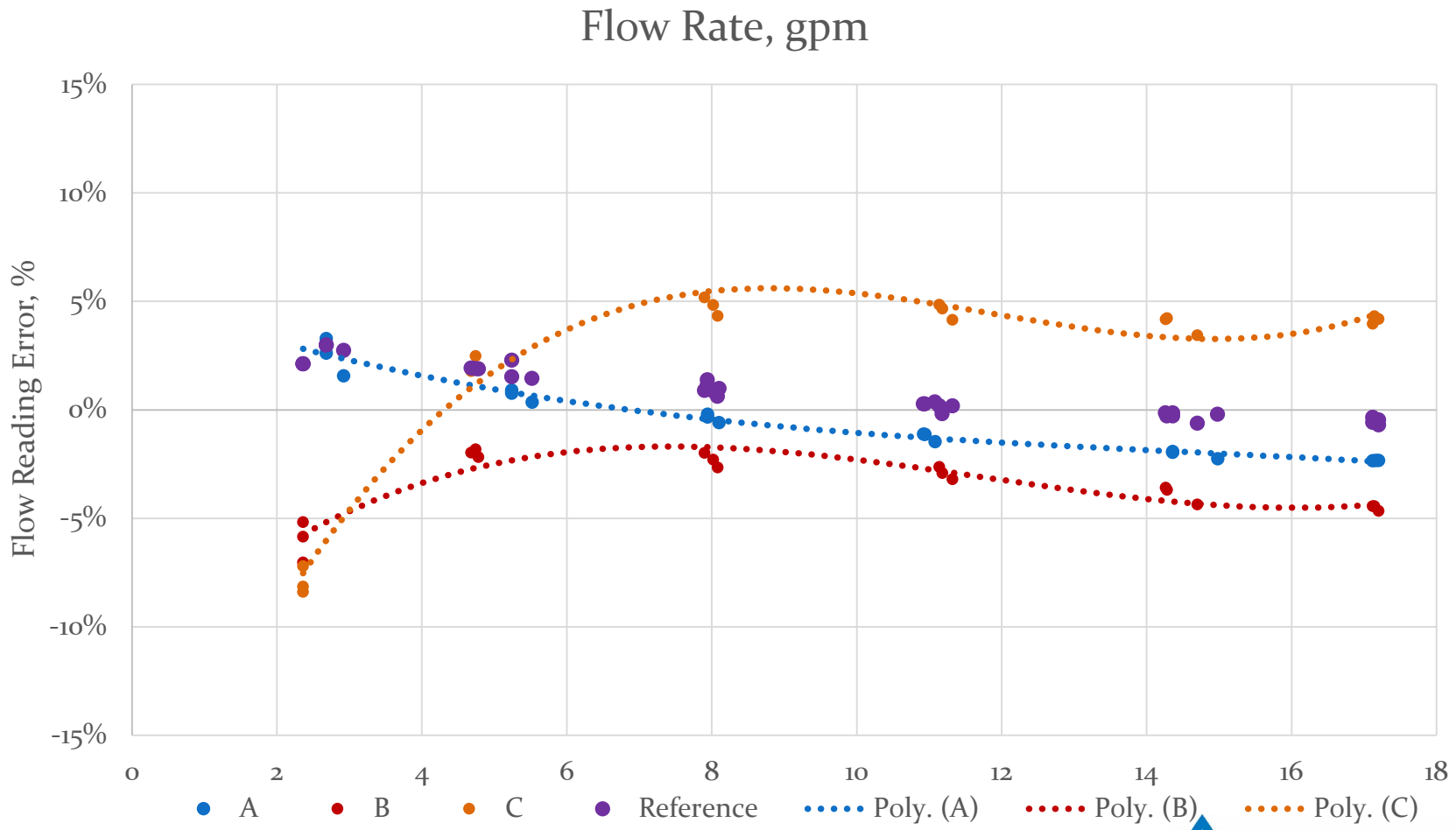
Figure 1. Test Circuit for In-line Flow Sensors



Uniform Flow Upstream of 10D



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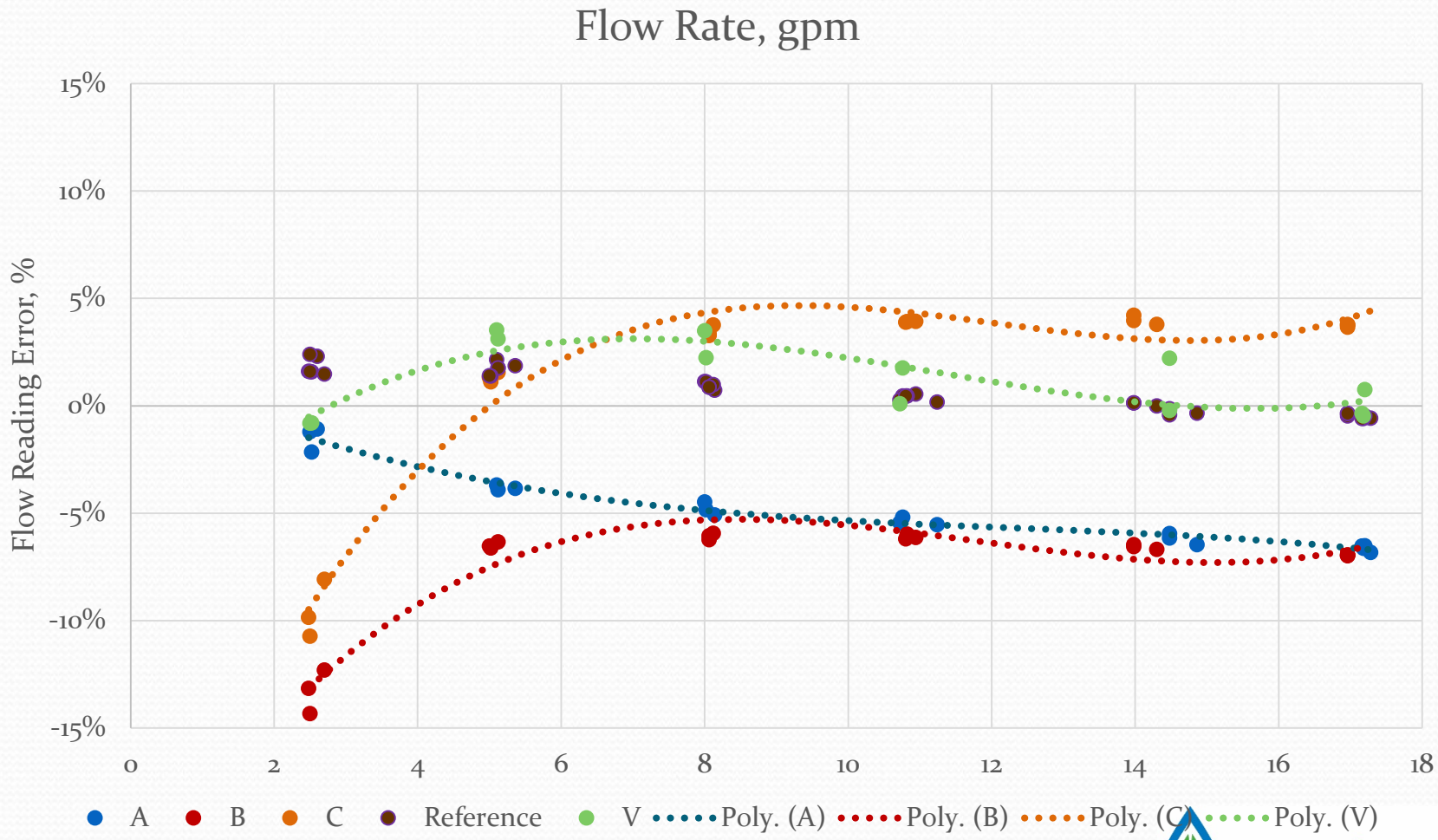
Non-Uniform Flow Upstream of 10D



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Tilting the Flow Meter with Non-uniform Flow Conditions at 17.7 gpm

	Metron-Farnier 7040791	Metron-Farnier 7040792
Tilted 5 deg right	2.29 %	1.64 %
Tilted 5 deg left	1.73 %	0.33 %
Difference	**0.56 %**	**1.30 %**

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Winterizing Flow Sensors

- Before freezing temperatures and/or blowing out sprinkler piping:
  - Remove sensor and safely store
  - Install plug in place of sensor

- Plastic bearing surfaces may melt from the excessive velocities of compressed air during winterization w/o water to cool/lubricate

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Test flow rate accuracy

Sensor SN_____		**Sensor size**_____		
Test flow rate	Reference Meter Flow Rate gpm	Sensor Flow Rate gpm	Inlet Pressure psi	Outlet Pressure psi
Minimum flow rate				
20% of maximum				
40% of maximum				
60% of maximum				
80% of maximum				
Maximum flow rate				

Durability tests

	PRESSURE *psi*	WATER TEMP °*F*	FLOW RATE *unit per minute*	OPERATING PERIOD
Continuous test	70	72	Q (80% of maximum)	10 hours
Cyclic test	70	72	Q (80% of maximum)	2,500 cycles

Environmental Test

- Flow sensor submerged for 30 days and tested for performance
- Simulate field conditions often encountered

THANK YOU

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swatirrigation.org

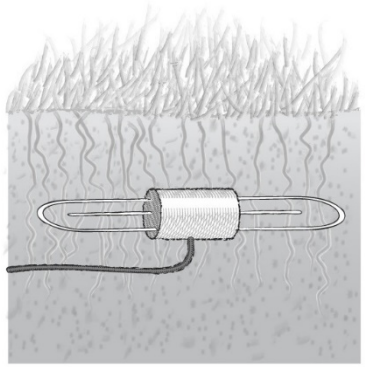
SWAT UPDATE

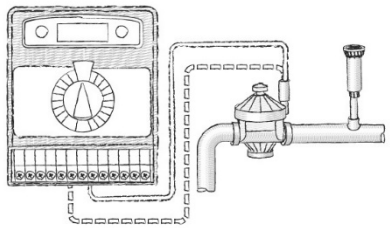
Promoting Smart Technologies and Efficient Irrigation Systems

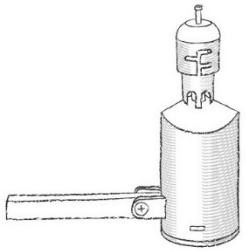
Brian E. Vinchesi, Chair
October 4, 2017
Irrigation Show

SWAT's Story

- Started in 2002, SWAT is a partnership initiative of water purveyors and irrigation industry representatives to promote landscape water-use efficiency through technology.
  - Promote irrigation products that improve water use efficiency—Promotions Working Group.
  - Write testing protocols to validate product performance—Technology Working Group.







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SWAT Activities

Protocols

Testing Reports

Marketing Resources

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Protocol Development

- In place
  - Weather-based irrigation controllers
  - Soil moisture sensors
  - Rain sensors
  - Pressure regulating spray sprinklers
  - Check valves
  - Sprinkler nozzle performance characteristics
- SWAT protocols try to align with EPA WaterSense criteria, but not always

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Sprinkler Application Efficiency

- SWAT still exploring a new way to measure sprinkler application (operational) efficiency
  - considers uniformity and off-target application
- Part of sprinkler nozzle efficiency protocol
  - Atmospheric losses
  - Jet interference
  - Overspray
  - Percolation losses
  - Coverage
- More testing with other then 15 foot spray nozzles need to be performed

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Updating Testing Protocol/Reports

- ASABE standard X627
  - Weather-based Landscape Irrigation Control Systems
  - Based on SWAT protocol and considers EPA WaterSense labeling requirements
  - Proposed draft of standard is complete.
  - Beta testing being done to validate the test procedure before public comment period by CIT and Northern Colorado Water Conservancy District.
  - Funds needed to continue and expand Beta testing.

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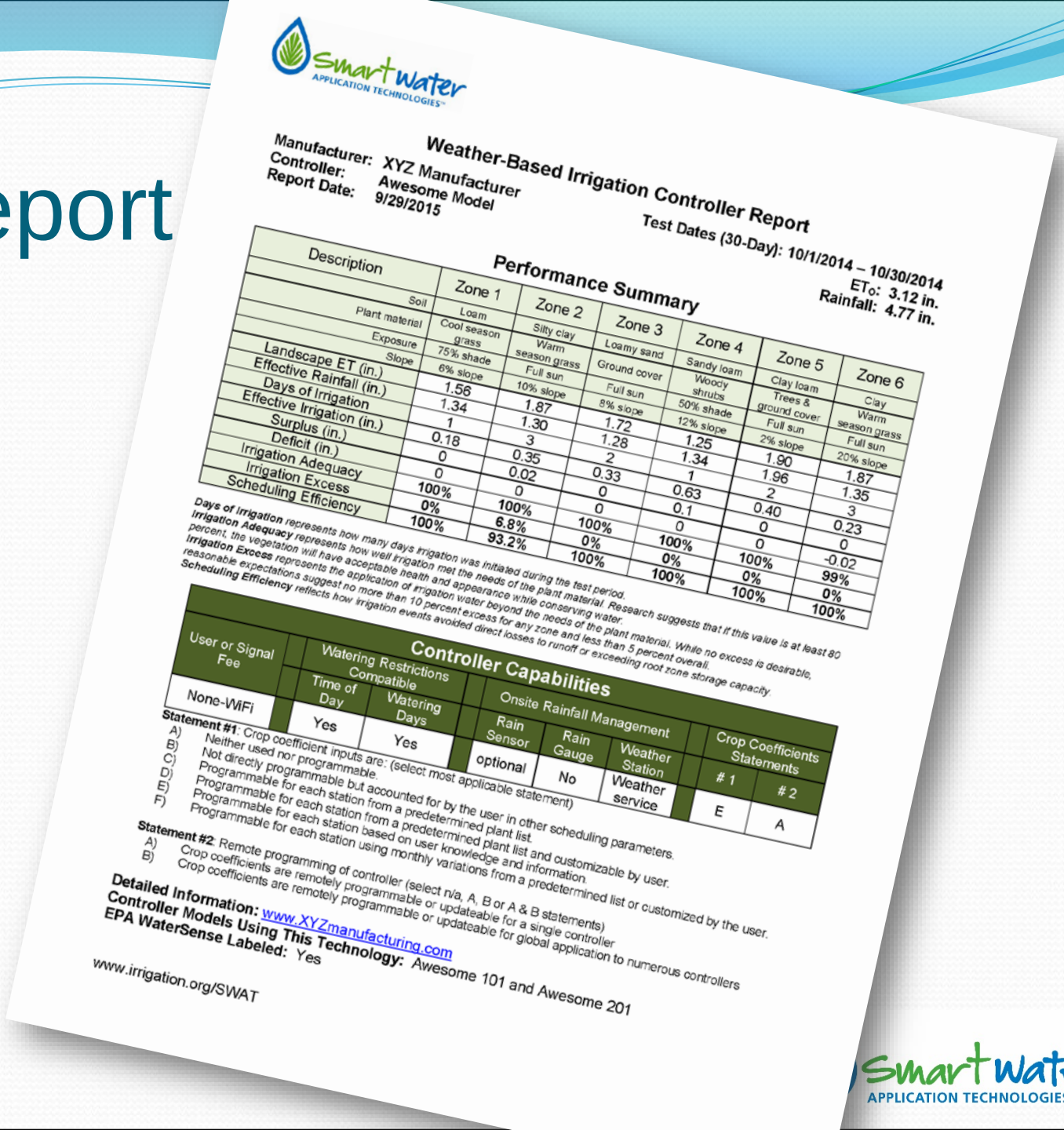
Test Report



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Weather-Based Irrigation Controller Report

Manufacturer: XYZ Manufacturer
Controller: Awesome Model
Report Date: 9/29/2015

Test Dates (30-Day): 10/1/2014 – 10/30/2014
ETo: 3.12 in.
Rainfall: 4.77 in.

Performance Summary

Description	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Soil	Loam	Silty clay	Loamy sand	Sandy loam	Clay loam	Clay
Plant material	Cool season grass	Warm season grass	Ground cover	Woody shrubs	Trees & ground cover	Warm season grass
Exposure	75% shade	Full sun	Full sun	50% shade	Full sun	Full sun
Slope	6% slope	10% slope	8% slope	12% slope	2% slope	20% slope
Landscape ET (in.)	1.56	1.87	1.72	1.25	1.90	1.87
Effective Rainfall (in.)	1.34	1.30	1.28	1.34	1.96	1.35
Days of Irrigation	1	3	2	1	2	3
Effective Irrigation (in.)	0.18	0.35	0.33	0.63	0.40	0.23
Surplus (in.)	0	0.02	0	0.1	0	0
Deficit (in.)	0	0	0	0	0	-0.02
Irrigation Adequacy	100%	100%	100%	100%	100%	99%
Irrigation Excess	0%	6.8%	0%	0%	0%	0%
Scheduling Efficiency	100%	93.2%	100%	100%	100%	100%

Days of Irrigation represents how many days irrigation was initiated during the test period.
Irrigation Adequacy represents how well irrigation met the needs of the plant material. Research suggests that if this value is at least 80 percent, the vegetation will have acceptable health and appearance while conserving water.
Irrigation Excess represents the application of irrigation water beyond the needs of the plant material. While no excess is desirable, reasonable expectations suggest no more than 10 percent excess for any zone and less than 5 percent overall.
Scheduling Efficiency reflects how irrigation events avoided direct losses to runoff or exceeding root zone storage capacity.

Controller Capabilities

User or Signal Fee	Watering Restrictions Compatible		Onsite Rainfall Management			Crop Coefficients Statements	
	Time of Day	Watering Days	Rain Sensor	Rain Gauge	Weather Station	# 1	# 2
None-WiFi	Yes	Yes	optional	No	Weather service	E	A

Statement #1: Crop coefficient inputs are: (select most applicable statement)
A) Neither used nor programmable.
B) Not directly programmable but accounted for by the user in other scheduling parameters.
C) Programmable for each station from a predetermined plant list.
D) Programmable for each station from a predetermined plant list and customizable by user.
E) Programmable for each station based on user knowledge and information.
F) Programmable for each station using monthly variations from a predetermined list or customized by the user.

Statement #2: Remote programming of controller (select n/a, A, B or A & B statements)
A) Crop coefficients are remotely programmable or updateable for a single controller
B) Crop coefficients are remotely programmable or updateable for global application to numerous controllers

Detailed Information: www.XYZmanufacturing.com
Controller Models Using This Technology: Awesome 101 and Awesome 201
EPA WaterSense Labeled: Yes

www.irrigation.org/SWAT

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Surplus (in.)	0	0.02	0	0.1	0	0
Deficit (in.)	0	0	0	0	0	-0.02
Irrigation Adequacy	**100%**	**100%**	**100%**	**100%**	**100%**	**99%**
Irrigation Excess	**0%**	**6.8%**	**0%**	**0%**	**0%**	**0%**
Scheduling Efficiency	**100%**	**93.2%**	**100%**	**100%**	**100%**	**100%**

Days of Irrigation *represents how many days irrigation was initiated during the test period.*
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Scheduling Efficiency *reflects how irrigation events avoided direct losses to runoff or exceeding root zone storage capacity.*

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Controller Capabilities

Controller Capabilities									
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Controller Models Using This Technology: Awesome 101 and Awesome 201
EPA WaterSense Labeled: Yes

www.irrigation.org/SWAT

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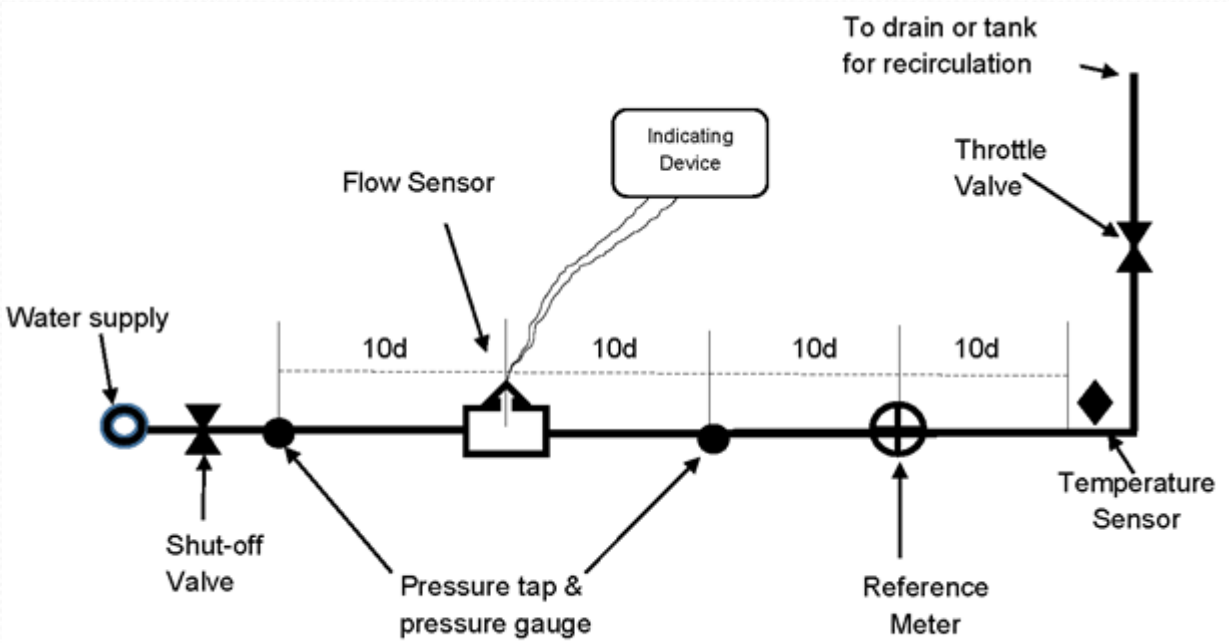
Flow Sensor Protocol

- Version 3.0 – April 2017
- Responding to comments received
- 30 Day review period of Version 3.1 expected out for public comment in October
- Brent to discuss

Test Circuit for In-line Flow Sensors



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Soil Moisture Sensors

- High priority
- Multiple rounds of Beta testing
- Beta testing is from a grant and administered by EBMUD—funds are depleted, but testing is not.
- EPA to elaborate as soon as I am done

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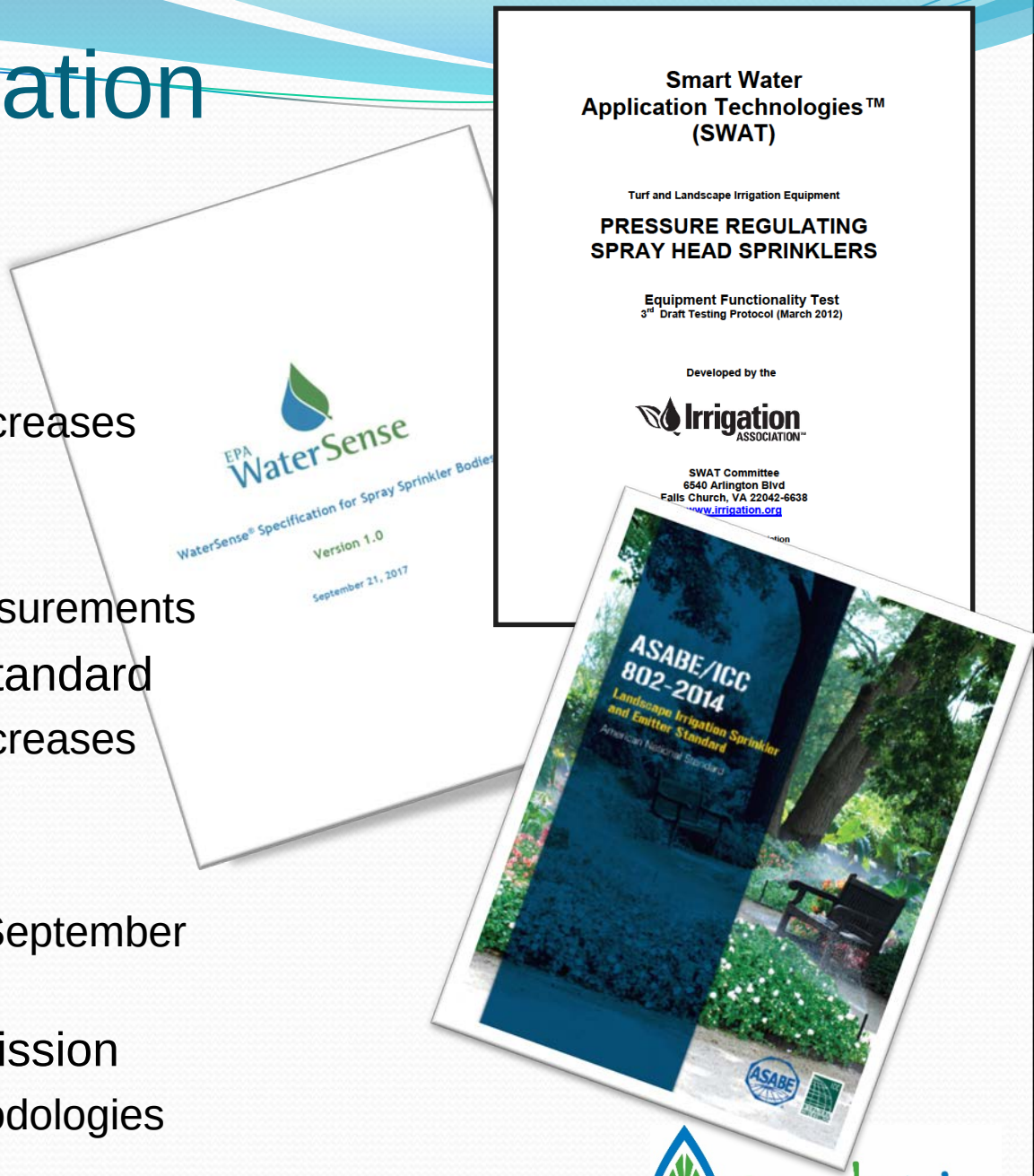
Pressure Regulation Testing

- SWAT 2012
  - Continuous pressure increases
  - Step-test
  - Missing nozzle test
  - Focus on pressure measurements
- ASABE/ICC 802-2104 Standard
  - Continuous pressure increases
  - Missing nozzle test
- EPA WaterSense
  - Specification released September 21, 2017
- California Energy Commission
  - Exploring various methodologies



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Example from Catalog

Pressure psi	Nozzle Flow gpm	△ Pressure	△ Flow
20	2.85	-33.3%	-20.8%
30	**3.60**	**0%**	**0%**
40	4.20	33.3%	+16.7%
50	4.58	66.6%	+27.2%
60	5.09	200%	+41.4%
70	5.50	233%	+52.8%

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Issues

- ASABE/ICC 802-2014 standard now referenced in codes.
  - Pressure regulating sprinklers are mandatory.
- EPA did some evaluations.
  - The continuous test not a good test.
  - Step test is a better evaluation.
- SWAT is developing a revised test protocol.
- California Energy Commission is interested in the energy use as well as the water use.
- Market demand is increasing.

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SWAT Protocol Changes

- Focus on step test procedure
- Measurements
  - At pressure
  - At increasing pressure steps 40, 50, 60, 75, maximum psi
- Measure flow based on incoming pressures or measure outlet pressures
- Test pop up sprays and rotors
- Added missing nozzle test
- With and without check valves

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Water Savings Calculations Low-flow Nozzle

Pressure psi	Non PR gpm	PR-CV-F gpm	Δ Flow
25	1.13	1.08	4.6%
30	**1.23**	**1.15**	**7.0%**
40	1.41	1.21	16.5%
50	1.54	1.22	26.2%
60	1.69	1.26	34.1%
70	1.84	1.30	41.5%

Pressure-regulated sprinklers compared to non-pressure regulated sprinkler, but using same nozzles.

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Water Savings Calculations High-flow Nozzle

Pressure psi	Non PR gpm	PR-CV-F gpm	△ Flow
25	3.271	3.050	7.2%
30	**3.578**	**3.325**	**7.6%**
40	4.113	3.497	17.6%
50	4.663	3.641	28.1%
60	5.058	3.695	36.9%
70	5.389	3.771	42.9%

Pressure-regulated sprinklers compared to non-pressure regulated sprinkler, but using same nozzles.

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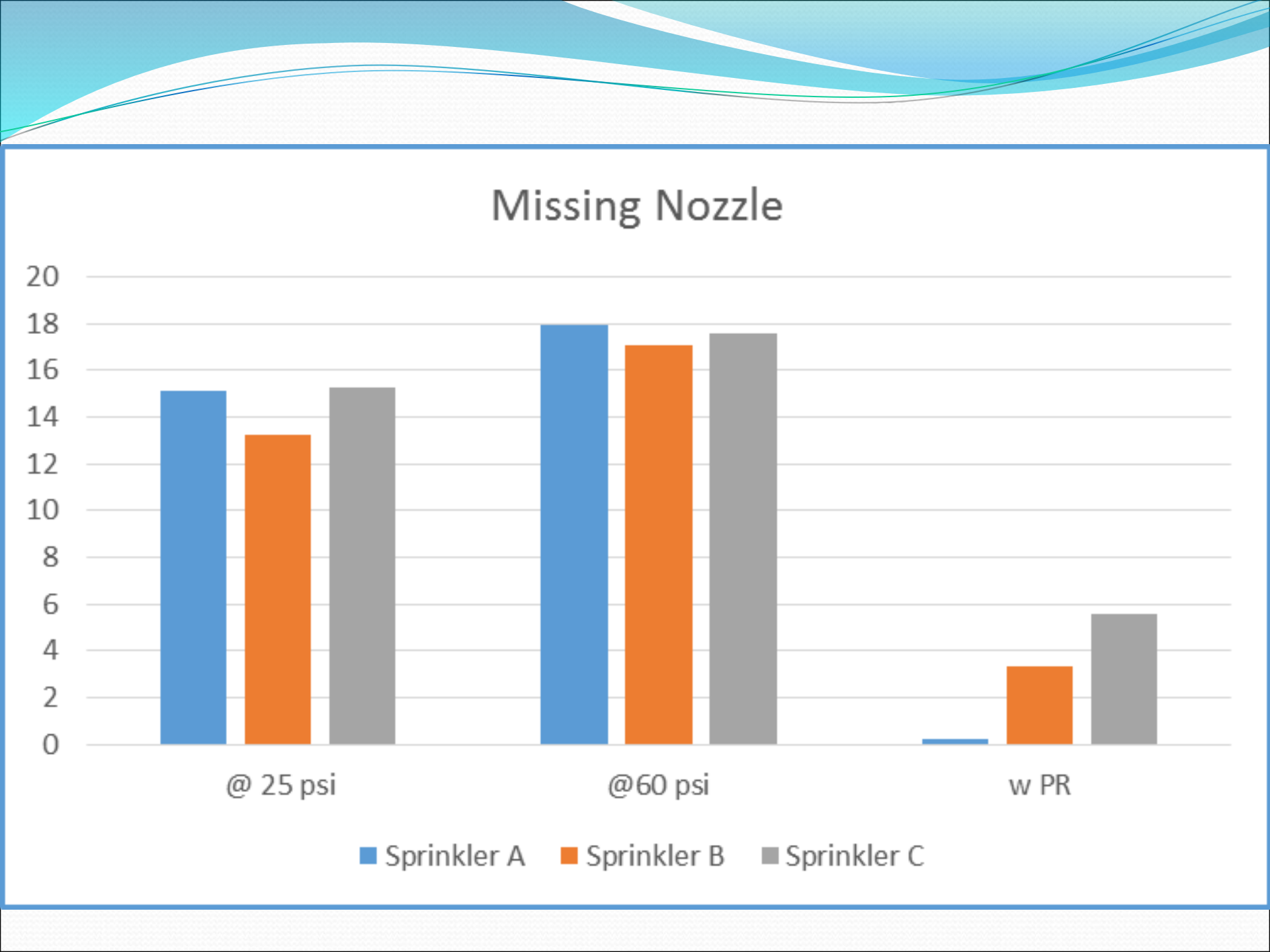
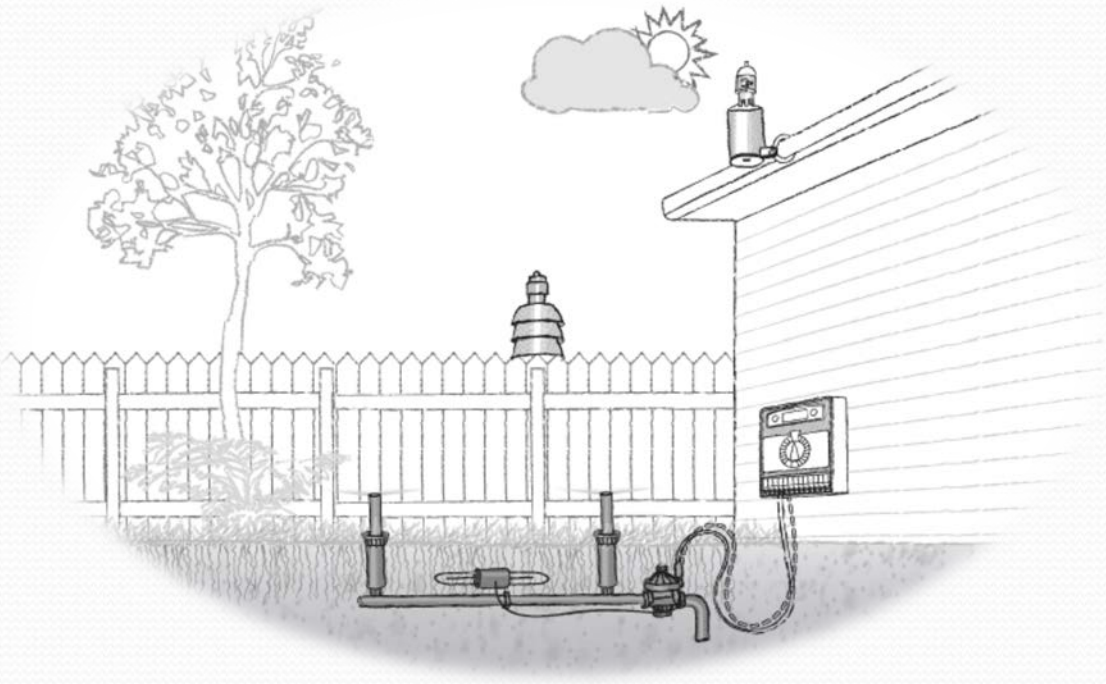

Missing Nozzle
20
18
16
14
12
10
8
6
4
2
0
@ 25 psi
@60 psi
w PR
Sprinkler A
Sprinkler B
Sprinkler C

SWAT TWG—Going Forward



- Pressure regulating valves
- Scheduling programs/apps

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www.irrigation.org/SWAT

Weather-based Controllers

Weather-based controllers

Soil Moisture-based Controllers

Using a probe buried in the soil

Rain Sensors

Changing weather can quickly affect irrigation needs and lead to wasted irrigation. SWAT

Marketing Tools

SWAT provides numerous tools and resources to help water providers promote water-use

Literature

- Because Consumers /End-users are large audience water purveyors need a place to refer customers PWG developed the “Home Owner’s Guide to Landscape Irrigation”
- Discusses:
  - Planting
  - Proper design and Installation
  - Proper Maintenance

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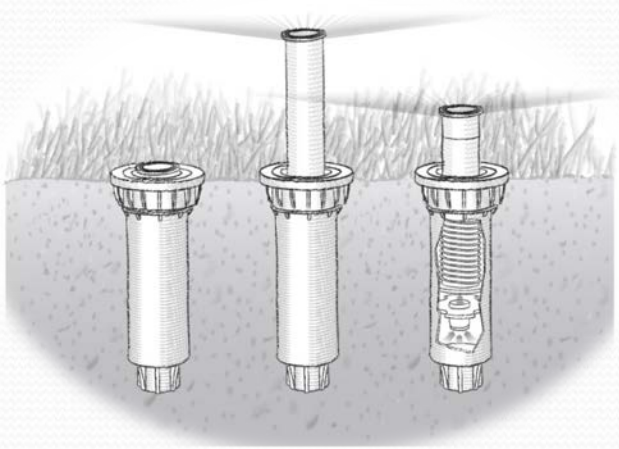
Volunteers

Representatives from water providers and the irrigation industry donate time and expertise to identify and implement strategic priorities.



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THANK YOU

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