IRRIGATION DESIGN THAT HELPS TO MEET SUSTAINABILITY

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Establishing the Water Reqirement

MAWA = (ETo) (0.62) [(0.7 x LA) + (0.3 x SLA)]
MAWA = Maximum Applied Water Allowance (gallons per year)
ETo = Reference Evapotranspiration (inches per year)
0.62 = Conversion Factor (to gallons)
0.7 = ET Adjustment Factor (ETAF)
LA = Landscape Area including SLA (square feet)
0.3 = Additional Water Allowance for SLA
SLA = Special Landscape Area (square feet)
MAWA = (51.1 inches) (0.62) [(0.7 x 50,000 square feet) + (0.3 x 0)]
= 1,108,870 gallons per year
To convert from gallons per year to hundred-cubic-feet per year:
= 1,108,870/748 = 1,482 hundred-cubic-feet per year (100 cubic feet = 748 gallons)

COMPLYING WITH LOCAL ORDINANCES

ETWU = (ETo x 0.62) x [((PF x HA)/IE) +SLA]

Where:
ETWU = Estimated Total Water Use per year (gallons)
ETo = Reference Evapotranspiration (inches per year)
PF = Plant Factor from WUCOLS (see Section 491)
HA = Hydrozone Area [high, medium, and low water use areas] (square feet)
SLA = Special Landscape Area (square feet)
0.62 = Conversion Factor
IE = Irrigation Efficiency (minimum 0.71)

1,090,740 = (51.6*0.62)*((0.65*50000)+0)

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WHAT TOOLS ARE AVAILABLE FOR WATER CONSERVATION?

WHERE DOES WATER CONSERVATION BEGIN?

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Know Your Customer's Knowledge Level

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What Are The Goals Of Irrigation Design?

- ✓ Provide adequate soil moisture content in the plants root zone, as a supplement to rainfall.
- ✓ Protect the landscape investment.
- ✓ Minimize financial risk of a costly under or over designed system.
- ✓ Minimize the amount of water the system will need to use.
- ✓ Minimize the amount of labor required to efficiently operate the system.
- ✓ Provide a system that will last for years with as little maintenance as possible.

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CALCULATING REQUIRED SYSTEM GPM

GPM = (0.0104 x ETo x Area x Kc) / (DU x Hrs. Available)

<u>Variable Value Ranges:</u>

GPM = gallons per minute required

ETo = peak daily evapotranspiration for the worst case scenario in inches

Area = area to be irrigated in square feet

Kc = Crop Coefficient – use 1.0 if actual crop coefficient is not known

DU = distribution uniformity or irrigation efficiency

Hrs. Available = hours available for irrigation each day in the worst case

0.0104 = constant for conversion of area, flow and inches per day, etc. into common units

(0.0104 x 0.36 x 50,000 x 0.7) / (0.71 x 8) =
23.07 GPM

Pipe Sizing

Schedule 40 IPS PVC Plastic Pipe

(1120, 1220) C=150

PRESSURE LOSS PER 100 FEET OF PIPE (PSI) SIZES ½" THROUGH 3"

Nominal Size Pipe ID Pipe OD Wall Thick	½" 0.622 0.840 0.109		¾" 0.824 1.050 0.113		1" 1.049 1.315 0.133		1¼" 1.380 1.660 0.140		1½" 1.610 1.900 0.145		2" 2.067 2.375 0.154		2½" 2.469 2.875 0.203		3" 3.068 3.500 0.216		Nominal Size Pipe ID Pipe OD Wall Thick
Flow GPM	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Flow GPM
1	1.05	**0.43**	0.60	**0.11**	0.37	**0.03**	0.21	**0.01**	0.16	**0.00**							1
2	2.11	**1.55**	1.20	**0.39**	0.74	**0.12**	0.43	**0.03**	0.31	**0.02**	0.19	**0.00**					2
3	3.16	**3.28**	1.80	**0.84**	1.11	**0.26**	0.64	**0.07**	0.47	**0.03**	0.29	**0.01**	0.20	**0.00**			3
4	4.22	**5.59**	2.40	**1.42**	1.48	**0.44**	0.86	**0.12**	0.63	**0.05**	0.38	**0.02**	0.27	**0.01**			4
5	5.27	**8.45**	3.00	**2.15**	1.85	**0.66**	1.07	**0.17**	0.79	**0.08**	0.48	**0.02**	0.33	**0.01**	0.22	**0.00**	5
6	6.33	**11.85**	3.61	**3.02**	2.22	**0.93**	1.29	**0.25**	0.94	**0.12**	0.57	**0.03**	0.40	**0.01**	0.26	**0.01**	6
7	7.38	**15.76**	4.21	**4.01**	2.60	**1.24**	1.50	**0.33**	1.10	**0.15**	0.67	**0.05**	0.47	**0.02**	0.30	**0.01**	7
8	8.44	**20.18**	4.81	**5.14**	2.97	**1.59**	1.71	**0.42**	1.26	**0.20**	0.76	**0.06**	0.54	**0.02**	0.35	**0.01**	8
9	9.49	**25.10**	5.41	**6.39**	3.34	**1.97**	1.93	**0.52**	1.42	**0.25**	0.86	**0.07**	0.60	**0.03**	0.39	**0.01**	9
10	10.55	**30.51**	6.01	**7.77**	3.71	**2.40**	2.14	**0.63**	1.57	**0.30**	0.95	**0.09**	0.67	**0.04**	0.43	**0.01**	10
11	11.60	**36.40**	6.61	**9.26**	4.08	**2.86**	2.36	**0.75**	1.73	**0.36**	1.05	**0.11**	0.74	**0.04**	0.48	**0.02**	11
12	12.65	**42.77**	7.21	**10.88**	4.45	**3.36**	2.57	**0.89**	1.89	**0.42**	1.15	**0.12**	0.80	**0.05**	0.52	**0.02**	12
13	13.71	**49.60**	7.81	**12.62**	4.82	**3.90**	2.79	**1.03**	2.05	**0.48**	1.24	**0.14**	0.87	**0.06**	0.56	**0.02**	13
14	14.76	**56.90**	8.41	**14.48**	5.19	**4.47**	3.00	**1.18**	2.20	**0.56**	1.34	**0.16**	0.94	**0.07**	0.61	**0.02**	14
15	15.82	**64.65**	9.01	**16.45**	5.56	**5.08**	3.21	**1.34**	2.36	**0.63**	1.43	**0.19**	1.00	**0.08**	0.65	**0.03**	15
16	16.87	**72.86**	9.61	**18.54**	5.93	**5.73**	3.43	**1.51**	2.52	**0.71**	1.53	**0.21**	1.07	**0.09**	0.69	**0.03**	16
17	17.93	**81.52**	10.22	**20.75**	6.30	**6.41**	3.64	**1.69**	2.68	**0.80**	1.62	**0.24**	1.14	**0.10**	0.74	**0.03**	17
18	18.98	**90.62**	10.82	**23.06**	6.67	**7.12**	3.86	**1.88**	2.83	**0.89**	1.72	**0.26**	1.20	**0.11**	0.78	**0.04**	18
19			11.42	**25.49**	7.04	**7.87**	4.07	**2.07**	2.99	**0.98**	1.81	**0.29**	1.27	**0.12**	0.82	**0.04**	19
20			12.02	**28.03**	7.42	**8.66**	4.28	**2.28**	3.15	**1.08**	1.91	**0.32**	1.34	**0.13**	0.87	**0.05**	20
22			13.22	**33.44**	8.16	**10.33**	4.71	**2.72**	3.46	**1.28**	2.10	**0.38**	1.47	**0.16**	0.95	**0.06**	22
24			14.42	**39.29**	8.90	**12.14**	5.14	**3.20**	3.78	**1.51**	2.29	**0.45**	1.61	**0.19**	1.04	**0.07**	24
25			15.02	**42.38**	9.27	**13.09**	5.36	**3.45**	3.94	**1.63**	2.39	**0.48**	1.67	**0.20**	1.08	**0.07**	25
26			15.62	**45.57**	9.64	**14.08**	5.57	**3.71**	4.09	**1.75**	2.48	**0.52**	1.74	**0.22**	1.13	**0.08**	26
28			16.83	**52.27**	10.38	**16.15**	6.00	**4.25**	4.41	**2.01**	2.67	**0.60**	1.87	**0.25**	1.21	**0.09**	28
30			18.03	**59.40**	11.12	**18.35**	6.43	**4.83**	4.72	**2.28**	2.86	**0.68**	2.01	**0.28**	1.30	**0.10**	30
32			19.23	**66.94**	11.86	**20.68**	6.86	**5.44**	5.04	**2.57**	3.06	**0.76**	2.14	**0.32**	1.39	**0.11**	32
34					12.61	**23.13**	7.28	**6.09**	5.35	**2.88**	3.25	**0.85**	2.28	**0.36**	1.47	**0.12**	34
[illegible]					12.98	**24.41**	7.50	**6.43**	5.51	**3.04**	3.34	**0.90**	2.34	**0.3[illegible]**	[illegible]	[illegible]	[illegible]
[illegible]					13.35	**25.72**	7.71	**6.77**	5.67	**3.20**	3.44	**0.95**	2.41	**0.4[illegible]**	[illegible]	[illegible]	[illegible]

Static PSI Measurement

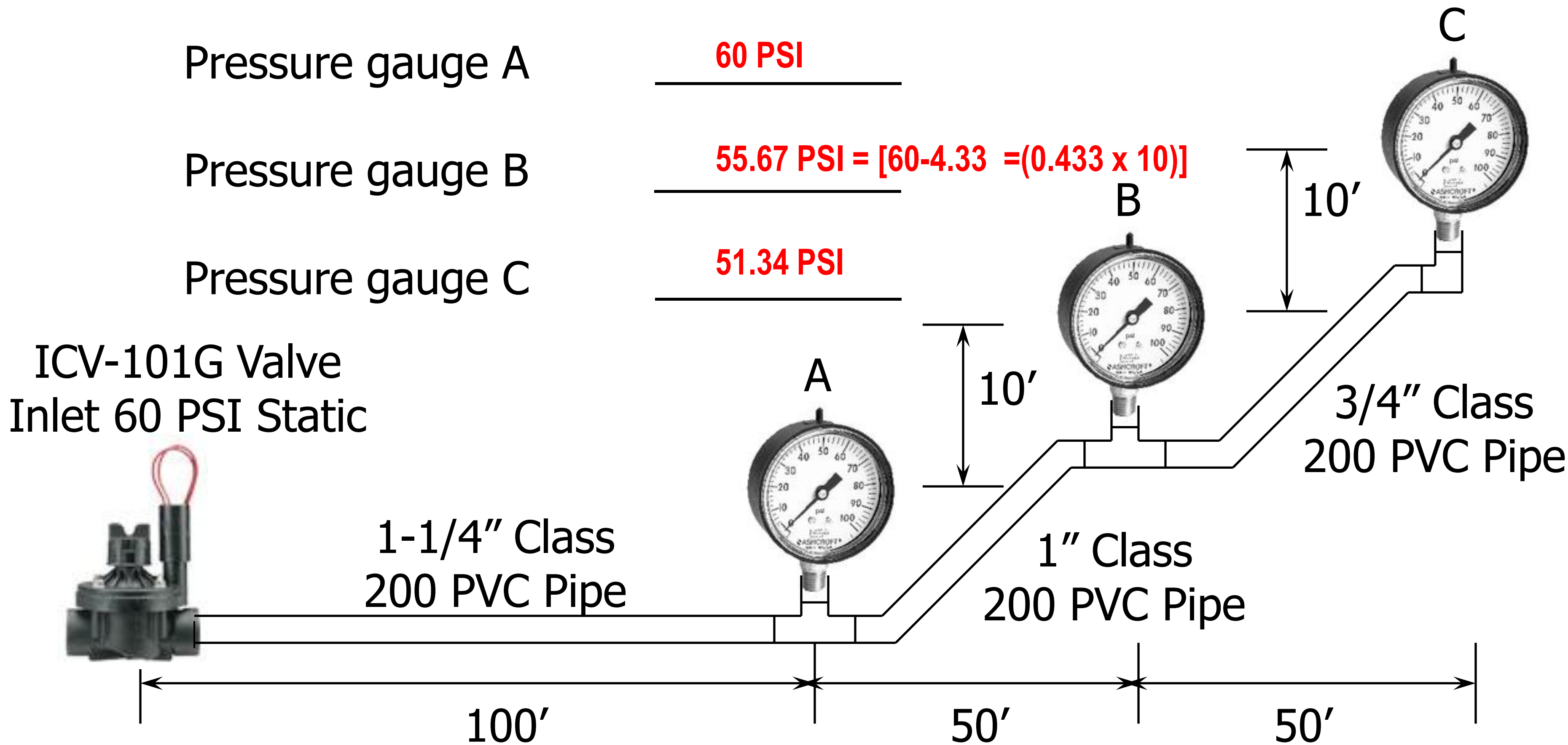
Calculate the static pressure at the following points:

Outlet of control valve ___60 PSI___

Pressure gauge A ___60 PSI___

Pressure gauge B ___55.67 PSI = [60-4.33 =(0.433 x 10)]___

Pressure gauge C ___51.34 PSI___



Dynamic PSI Measurement

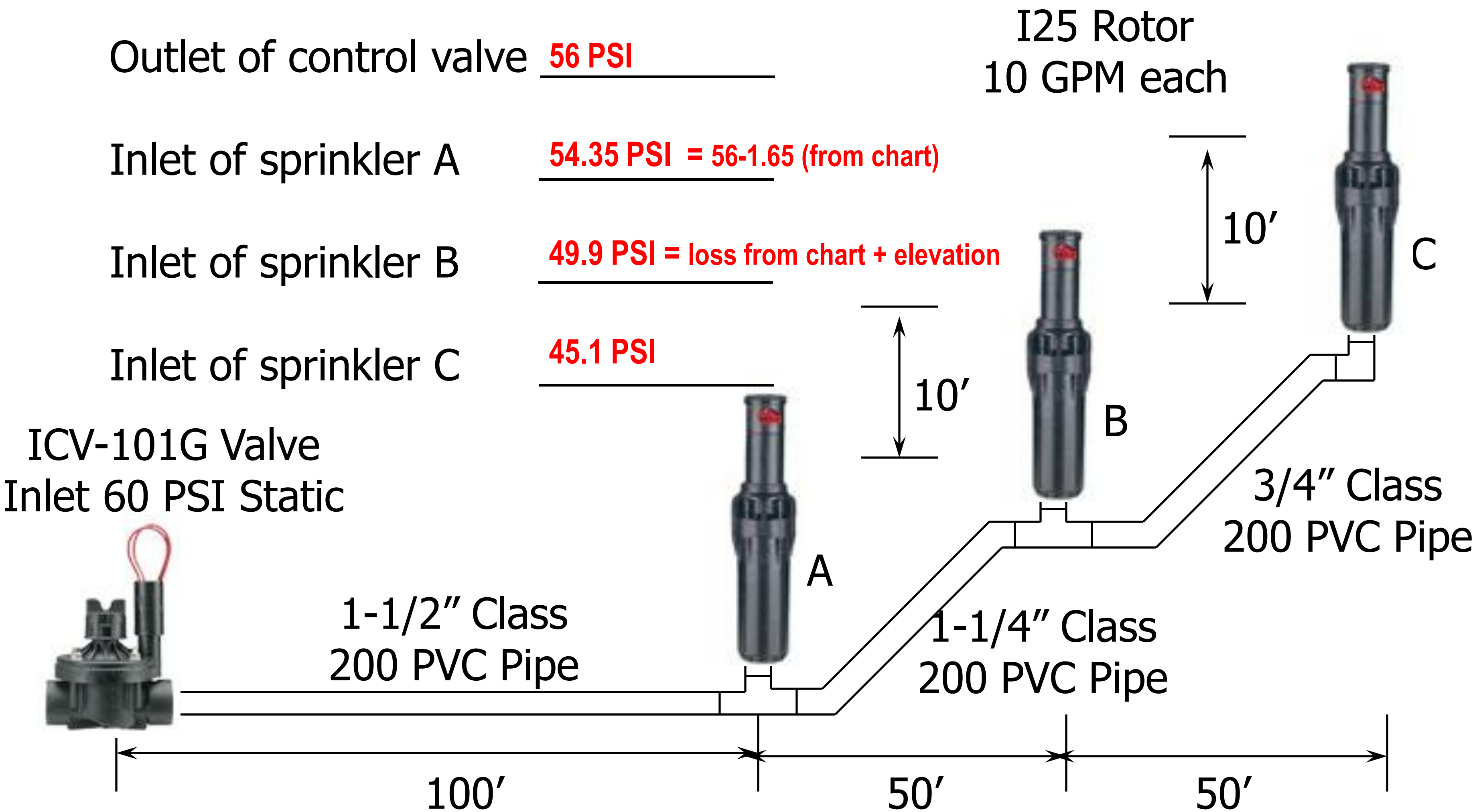
Calculate the dynamic pressure at the following points:

Outlet of control valve **56 PSI**

Inlet of sprinkler A **54.35 PSI = 56-1.65 (from chart)**

Inlet of sprinkler B **49.9 PSI = loss from chart + elevation**

Inlet of sprinkler C **45.1 PSI**



Pipe Sizing

Class 200 IPS U.S. PVC Plastic Pipe

(1120, 1220) C=150 SDR 21

PRESSURE LOSS PER 100 FEET OF PIPE (PSI) SIZES ¾" THROUGH 4"

Nominal Size Pipe ID Pipe OD Wall Thick	¾" 0.930 1.050 0.060		1" 1.189 1.315 0.063		1¼" 1.502 1.660 0.079		1½" 1.720 1.900 0.090		2" 2.149 2.375 0.113		2½" 2.601 2.875 0.137		3" 3.166 3.500 0.167		4" 4.072 4.500 0.214		Nominal Size Pipe ID Pipe OD Wall Thick
Flow GPM	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss	Flow GPM
1	0.47	**0.06**	0.29	**0.02**	0.18	**0.01**	0.14	**0.00**									1
2	0.94	**0.22**	0.58	**0.07**	0.36	**0.02**	0.28	**0.01**	0.18	**0.00**							2
3	1.42	**0.46**	0.87	**0.14**	0.54	**0.04**	0.41	**0.02**	0.27	**0.01**	0.18	**0.00**					3
4	1.89	**0.79**	1.15	**0.24**	0.72	**0.08**	0.55	**0.04**	0.35	**0.01**	0.24	**0.01**					4
5	2.36	**1.19**	1.44	**0.36**	0.90	**0.12**	0.69	**0.06**	0.44	**0.02**	0.30	**0.01**					5
6	2.83	**1.67**	1.73	**0.51**	1.09	**0.16**	0.83	**0.08**	0.53	**0.03**	0.36	**0.01**	0.24	**0.00**			6
7	3.30	**2.23**	2.02	**0.67**	1.27	**0.22**	0.97	**0.11**	0.62	**0.04**	0.42	**0.01**	0.28	**0.01**			7
8	3.77	**2.85**	2.31	**0.86**	1.45	**0.28**	1.10	**0.14**	0.71	**0.05**	0.48	**0.02**	0.33	**0.01**			8
9	4.25	**3.55**	2.60	**1.07**	1.63	**0.34**	1.24	**0.18**	0.80	**0.06**	0.54	**0.02**	0.37	**0.01**			9
10	4.72	**4.31**	2.89	**1.30**	1.81	**0.42**	1.38	**0.22**	0.88	**0.07**	0.60	**0.03**	0.41	**0.01**			10
12	5.66	**6.04**	3.46	**1.83**	2.17	**0.59**	1.65	**0.30**	1.06	**0.10**	0.72	**0.04**	0.49	**0.02**	0.30	**0.00**	12
14	6.60	**8.04**	4.04	**2.43**	2.53	**0.78**	1.93	**0.40**	1.24	**0.14**	0.84	**0.05**	0.57	**0.02**	0.34	**0.01**	14
15	7.08	**9.13**	4.33	**2.76**	2.71	**0.89**	2.07	**0.46**	1.33	**0.16**	0.90	**0.06**	0.61	**0.02**	0.37	**0.01**	15
16	7.55	**10.29**	4.62	**3.11**	2.89	**1.00**	2.21	**0.52**	1.41	**0.17**	0.96	**0.07**	0.65	**0.03**	0.39	**0.01**	16
18	8.49	**12.80**	5.19	**3.87**	3.26	**1.24**	2.48	**0.64**	1.59	**0.22**	1.09	**0.09**	0.73	**0.03**	0.44	**0.01**	18
20	9.43	**15.56**	5.77	**4.71**	3.62	**1.51**	2.76	**0.78**	1.77	**0.26**	1.21	**0.10**	0.81	**0.04**	0.49	**0.01**	20
22	10.38	**18.56**	6.35	**5.62**	3.98	**1.80**	3.03	**0.93**	1.94	**0.32**	1.33	**0.12**	0.90	**0.05**	0.54	**0.01**	22
24	11.32	**21.81**	6.93	**6.60**	4.34	**2.12**	3.31	**1.09**	2.12	**0.37**	1.45	**0.15**	0.98	**0.06**	0.59	**0.02**	24
25	11.79	**23.52**	7.22	**7.12**	4.52	**2.28**	3.45	**1.18**	2.21	**0.40**	1.51	**0.16**	1.02	**0.06**	0.62	**0.02**	25
26	12.27	**25.29**	7.50	**7.65**	4.70	**2.45**	3.59	**1.27**	2.30	**0.43**	1.57	**0.17**	1.06	**0.07**	0.64	**0.02**	26
28	13.21	**29.01**	8.08	**8.78**	5.06	**2.82**	3.86	**1.46**	2.47	**0.49**	1.69	**0.19**	1.14	**0.07**	0.69	**0.02**	28
30	14.15	**32.96**	8.66	**9.97**	5.43	**3.20**	4.14	**1.65**	2.65	**0.56**	1.81	**0.22**	1.22	**0.08**	0.74	**0.02**	30
32	15.10	**37.15**	9.24	**11.24**	5.79	**3.61**	4.41	**1.86**	2.83	**0.63**	1.93	**0.25**	1.30	**0.10**	0.79	**0.03**	32
34	16.04	**41.56**	9.81	**12.58**	6.15	**4.03**	4.69	**2.09**	3.00	**0.71**	2.05	**0.28**	1.38	**0.11**	0.84	**0.03**	34
35	16.51	**43.86**	10.10	**13.27**	6.33	**4.26**	4.83	**2.20**	3.09	**0.74**	2.11	**0.29**	1.42	**0.11**	0.86	**0.03**	35

Question - Why Do We Use Different Pipe Sizes In An Irrigation System?

DESIGNING TO MANUFACTURER'S SPECIFICATION

When Does It Pay To Install A Booster Pump

DESIGN TO MANUFACTURER'S SPECIFICATION

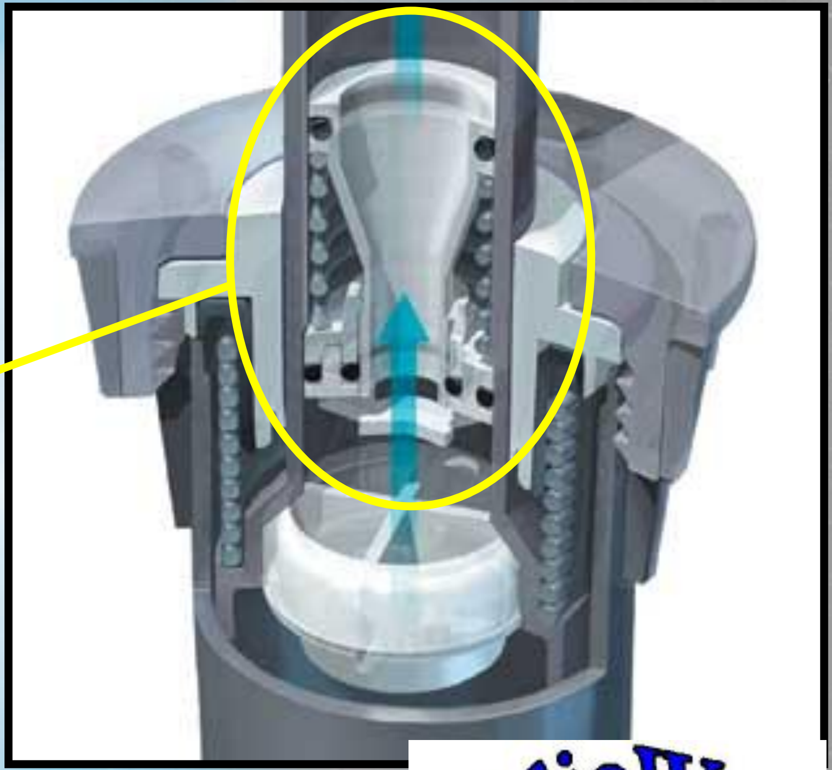
(C) The irrigation system shall be designed to ensure that the dynamic pressure at each emission device is within the manufacturer's recommended pressure range for optimal performance.

Passive Conservation Devices

(C) The irrigation system shall be designed to ensure that the <u>dynamic pressure</u> at each emission device is within the <u>manufacturer's recommended pressure range</u> for optimal performance.

<u>Pressure Regulation At The Head</u>

Standard in-stem pressure regulator eliminates misting and fogging – regulates nozzle output to a true 30 PSI optimum



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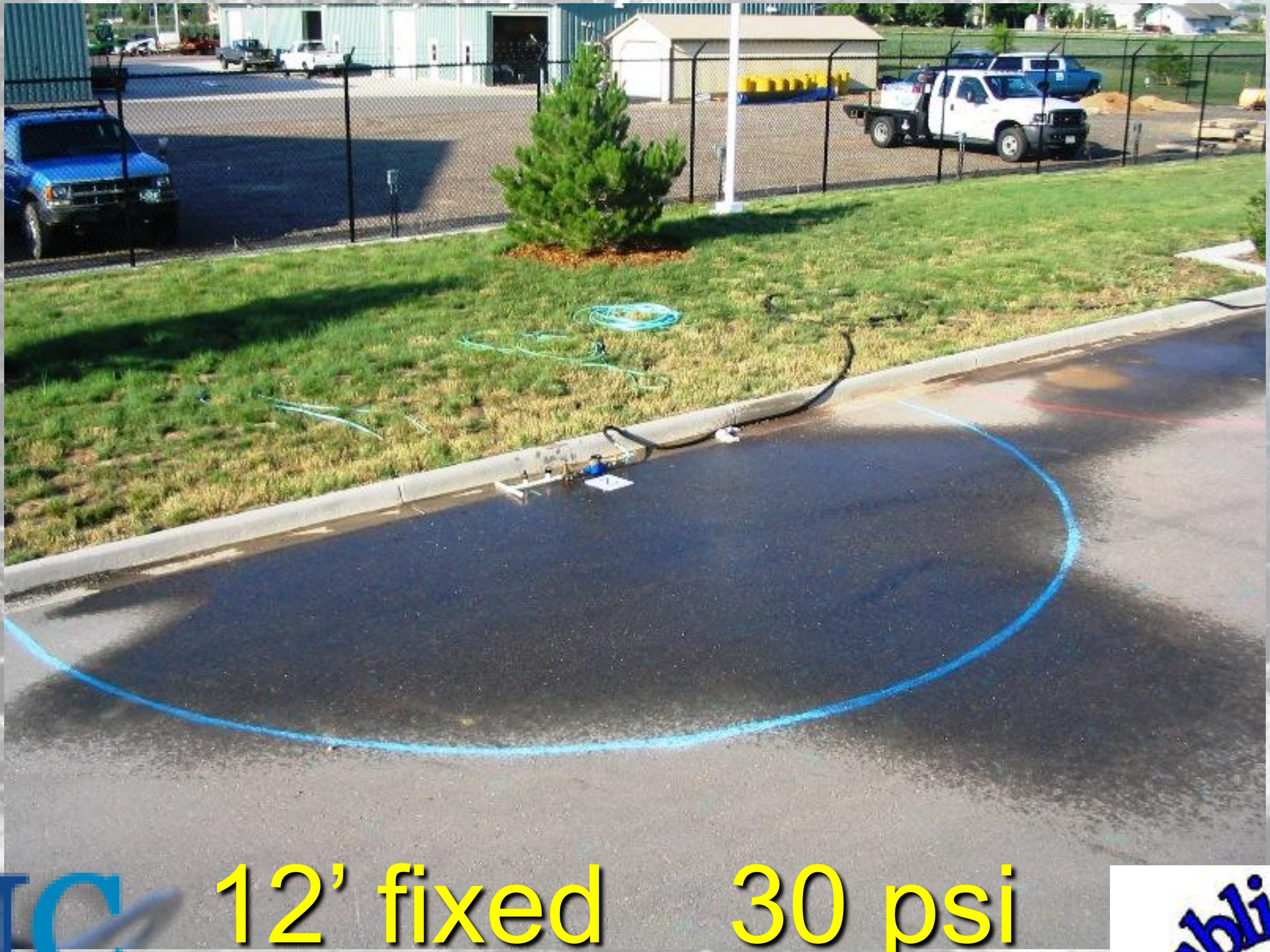
Correct Operating Pressure



12’ fixed 30 psi

Incorrect Operating Pressure

§ 492.7

(1-Q) Check valves or anti-drain valves are required for all irrigation systems.

Check Valve Eliminates Low Head Drainage

Check valve installed to control low head drainage.

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Gallons per 100 feet

1”	4.08
1 1/2”	9.17
2”	16.31
2 1/2”	25.49
3”	36.71
4”	65.26

Typical Residence

- 500’ of 1” pipe
- 4.08 gallons per 100’
- 20.4 gallons drains per irrigation cycle
- 180 irrigation days per year

3,672 gallons per year wasted

Climate Based
or
Soil Moisture Based?

SWAT Tested?

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IRRIGATION ASSOCIATION

6540 Arlington Boulevard
Falls Church, VA 22042

Tel: 703-536-7080
www.irrigation.org

Smart Water Application Technologies (SWAT) Performance Report

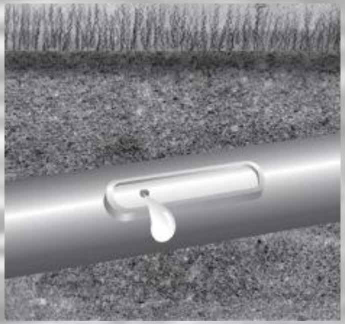
Testing Agency: Center for Irrigation Technology	**www.californiawater.org**
Testing Date: February-March 2007	**Weather Station: CIMIS 80 Fresno State, Fresno**
Product Type: Climatologically Based Controller	**Reference #:**
Product: Hunter ET System with Pro-C 300 Controller [Serial # 3K06]	
Product Description: ET System is an on site ET sensor suite with outdoor interface ET model for direct connection to Hunter SmartPort-enabled controllers.	

SWAT Protocol*: Turf and Landscape Equipment Climatologically Based Controllers 7th Draft Testing Protocol (Nov. 2006)
The concept of climatologically controlling irrigation systems has an extensive history of scientific study and documentation. The objective of this protocol is to evaluate how well current commercial technology has integrated the scientific data into a practical system that meets the agronomic needs of turf and landscape plants. The evaluation is accomplished by creating a virtual landscape subjected to a representative climate to evaluate the ability of individual controllers to adequately and efficiently irrigate that landscape. After initial programming and calibration the controller is expected to perform without further intervention during the test period. Performance results indicate to what degree the controller maintained root zone moistures within an acceptable range. If moisture levels are maintained without deficit, it can be assumed the crop growth and quality will be adequate. If moisture levels are maintained without excess it can be assumed that scheduling is efficient.

*All SWAT protocol may be viewed at www.irrigation.org.

Surplus (inches): Water applied in excess of root zone working storage	0.01	0.00	0.00	0.00	0.00	0.04
***Irrigation Adequacy,%:** Reflects how well irrigation met the consumptive use of vegetation. $Irrigation\ Adequacy(\%)=\left(\frac{ETc,in-Deficit,in}{ETc,in}\right)100$	100%	100%	100%	100%	100%	100%
Schedule Efficiency,%: Reflects how well irrigation cycles avoided direct, soak runoff and exceeding the root zone working storage capacity. Scheduling Losses (in.) = Direct Runoff (in.) + Soak Runoff (in.) +Surplus (in.) $Sch.eff\ (\%)=\left(\frac{Irr.(Net,in)-Sch.losses\,(in.)}{Irr.(Net,in)}\right)100$	99.2%	100%	100%	100%	100%	97.7%

What Head Should I Use?



From Predicting and Estimating Landscape Water Use (2001)
Sprinklers

Table 5-3: Estimated Sprinkler DU

	Excellent	Very Good	Good	Fair	Poor
Fixed Spray	0.75	0.65	0.55	0.50	0.40
Rotor	0.80	0.70	0.65	0.60	0.50
Stream Rotor	0.85	0.80	0.75	0.65	0.55
Impact	0.80	0.70	0.65	0.60	0.50

	Excellent	Very Good	Good	Fair	Poor
Micro Spray	0.80	0.70	0.60	0.50	0.40
Drip Standard	0.80	0.70	0.65	0.55	0.50
Drip – Pressure Compensating	0.95	0.90	0.85	0.80	0.70

Drip Systems

Table 5-4: Estimated Drip/Micro EU

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High Distribution Uniformity

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Impact Rotor Head

High Distribution Uniformity


Impact Rotor
High Distribution Uniformity
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Spray or Mist Head

Typically Poor Distribution Uniformity

Uniformity Improvements 51 Audits

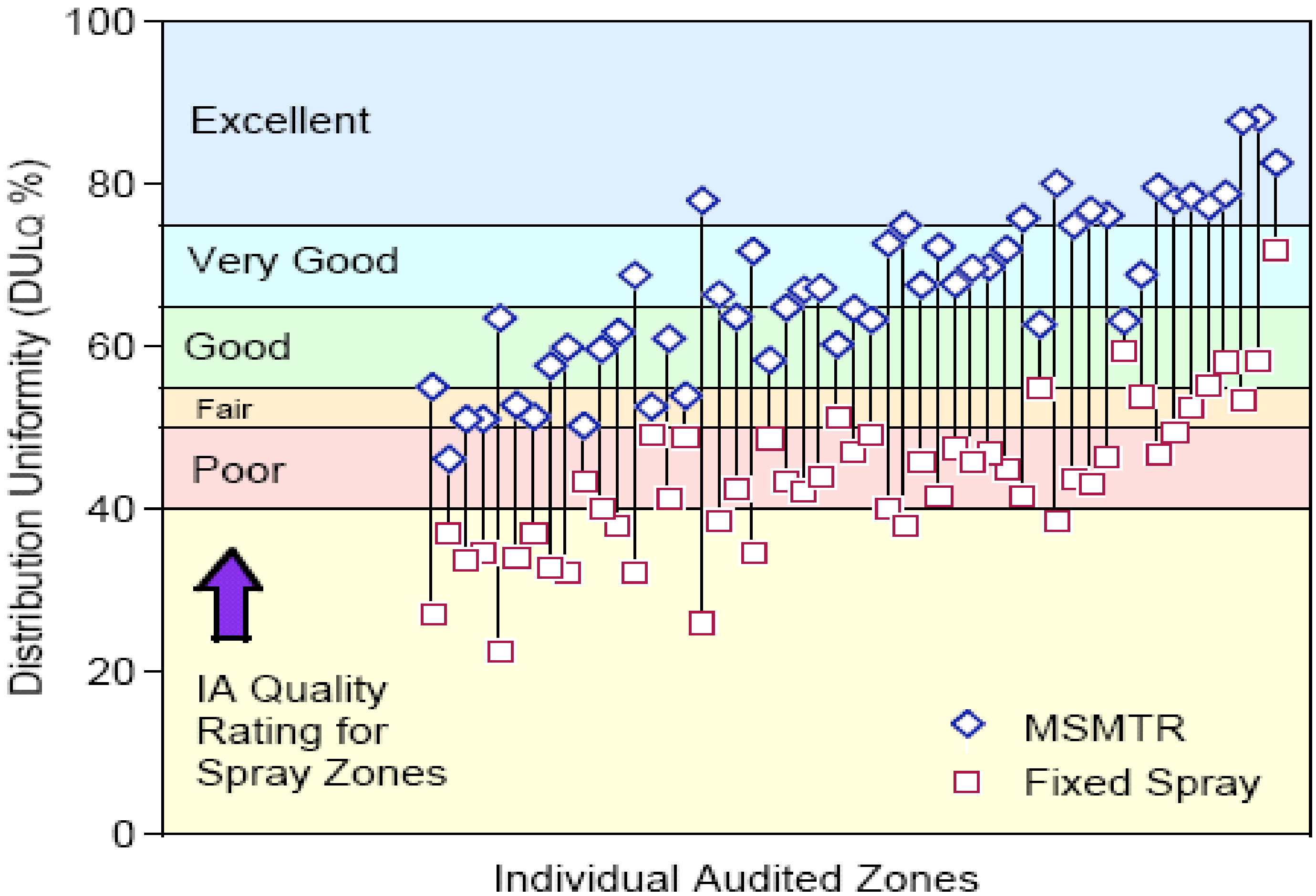
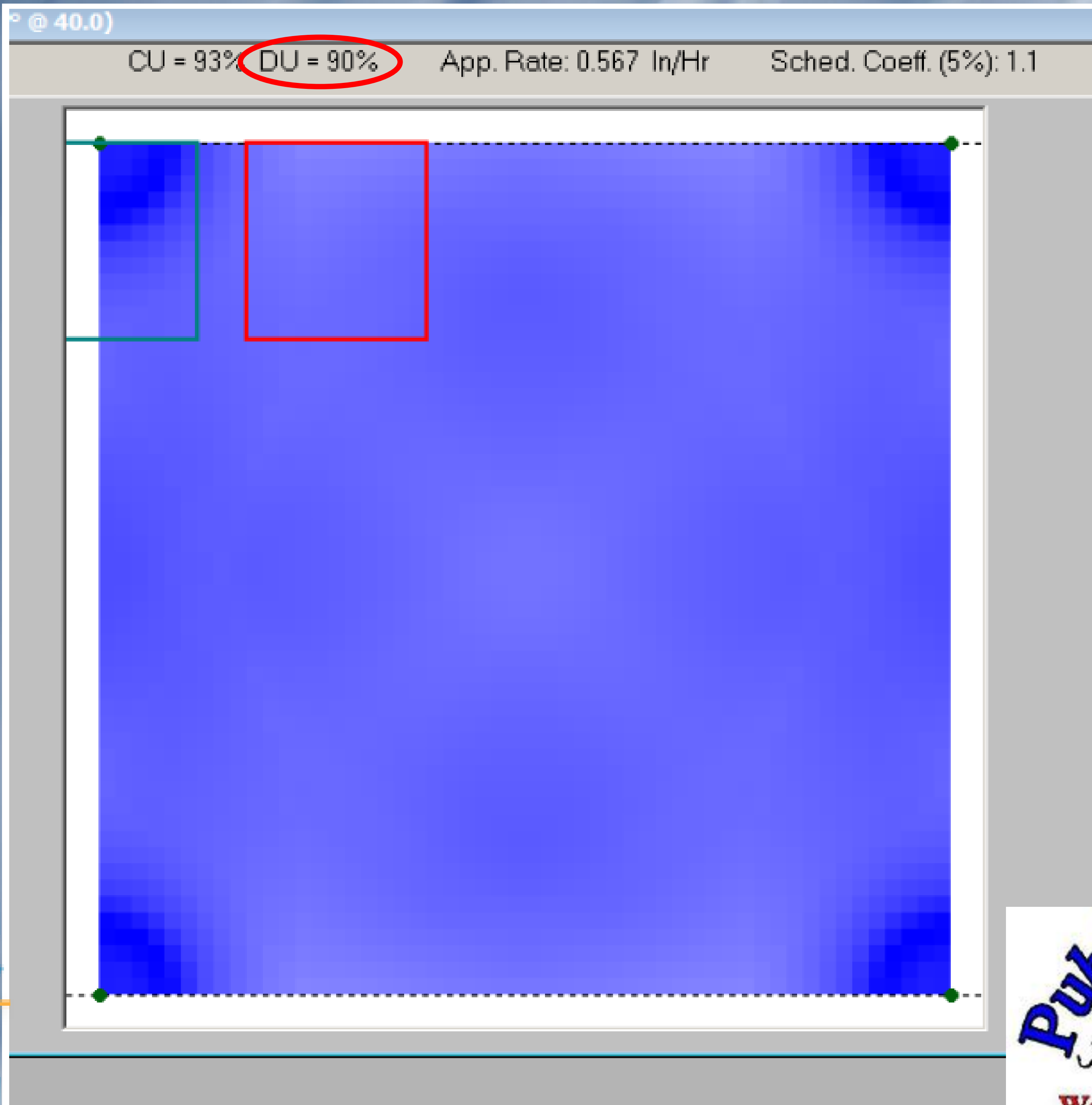


Figure 4. On average, DULQ improved by 23 points after conversion to MSMTR sprinklers.



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High Distribution Uniformity


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Working for YOU

Point Source Emitter

High Distribution Uniformity

In-Line Emitter

High Distribution Uniformity

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Line Source Emitters

High Distribution Uniformity

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Recent installs

Eco-Mat Installation Water Test

3 Min after startup

24 Min after startup

Eco-Mat Installation

Selecting Sprinklers & Spacing Ranges

- Sprinkler performance charts contain the following:

SRS AND PS SPRAYS

	PSI	Radius in Feet	GPM
10-FOOT SPRAY			
	25	10	0.39
	30	11	0.49
	35	11	0.51
	25	10	0.78
	30	11	0.97
	35	11	1.02
	25	10	1.56
	30	11	1.95
	35	11	2.04
12-FOOT SPRAY			
	25	12	0.56
	30	13	0.71
	35	14	0.76
	25	12	1.12
	30	13	1.42
	35	14	1.52
	25	12	2.24
	30	13	2.85
	35	14	3.05
15-FOOT SPRAY			
	25	15	0.88
	30	16	0.93
	35	16	1.03
	25	15	1.75
	30	16	1.86
	35	16	2.06
	25	15	3.50
	30	16	3.71
	35	16	4.12

- **PSI:**
  - sprinkler operating pressure.
- **Radius:**
  - distance from the sprinkler to the edge of throw (in feet).
- **GPM:**
  - flow rate of the sprinkler with different size nozzle orifices.
- **Precipitation Rate:**
  - delivery rate based on nozzle, arc and spacing.

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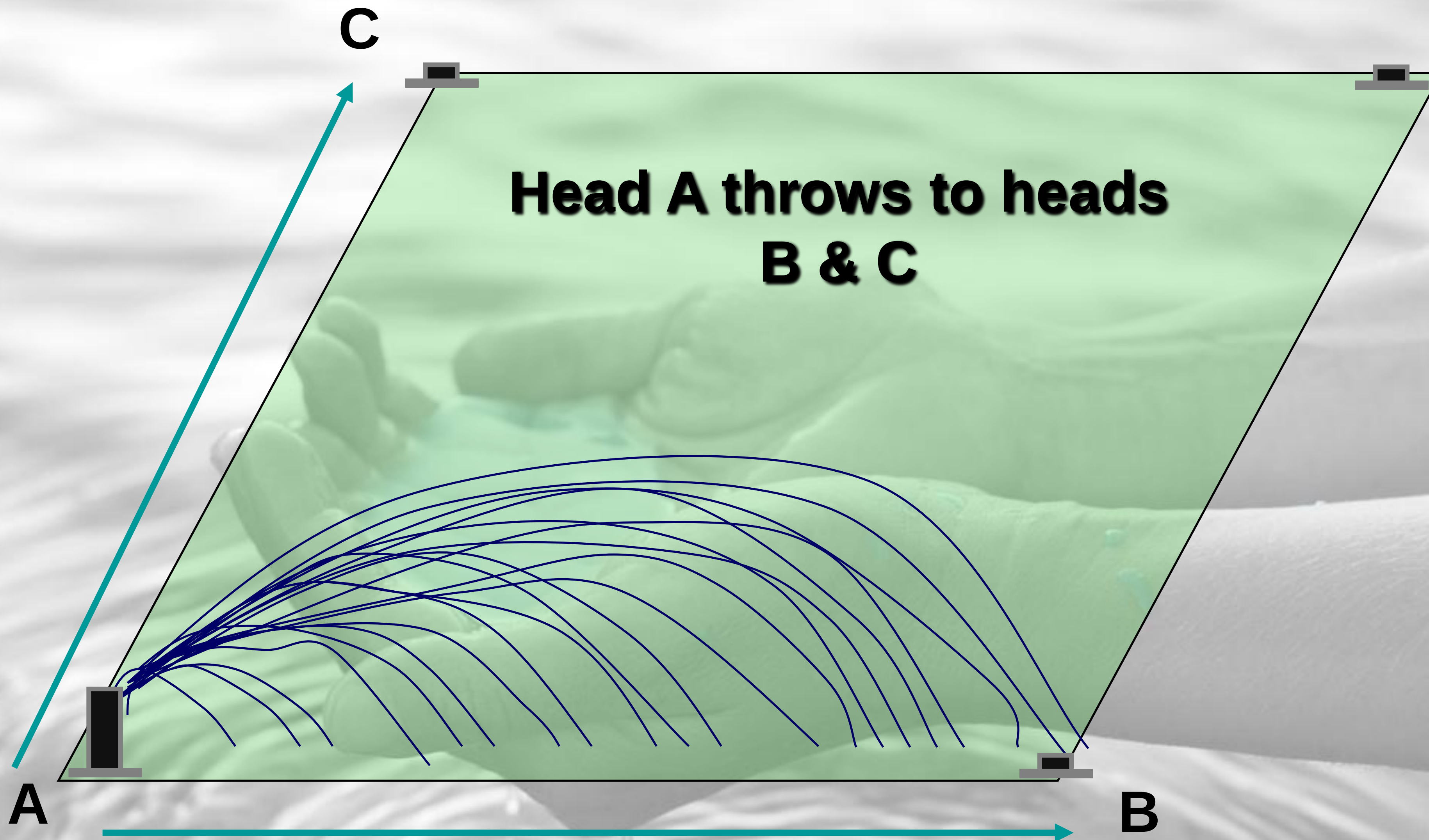

Head to Head Spacing

Selecting Sprinklers & Spacing Ranges

Head Spacing & Layout Impacts on Uniformity

- **"Coverage" does not always mean good uniformity**
- **Triangle Patterns are not always better than Square Patterns**

I-25 *Ultra* Nozzle Performance Data

Nozzle	Pressure PSI	Radius ft.	Flow GPM	Precip in/hr ■	Precip in/hr ▲
10 Lt. Green*	50	51'	10.1	0.75	0.86
	60	52'	11.1	0.79	0.91
	70	53'	12.1	0.83	0.96
	80	54'	12.9	0.85	0.98

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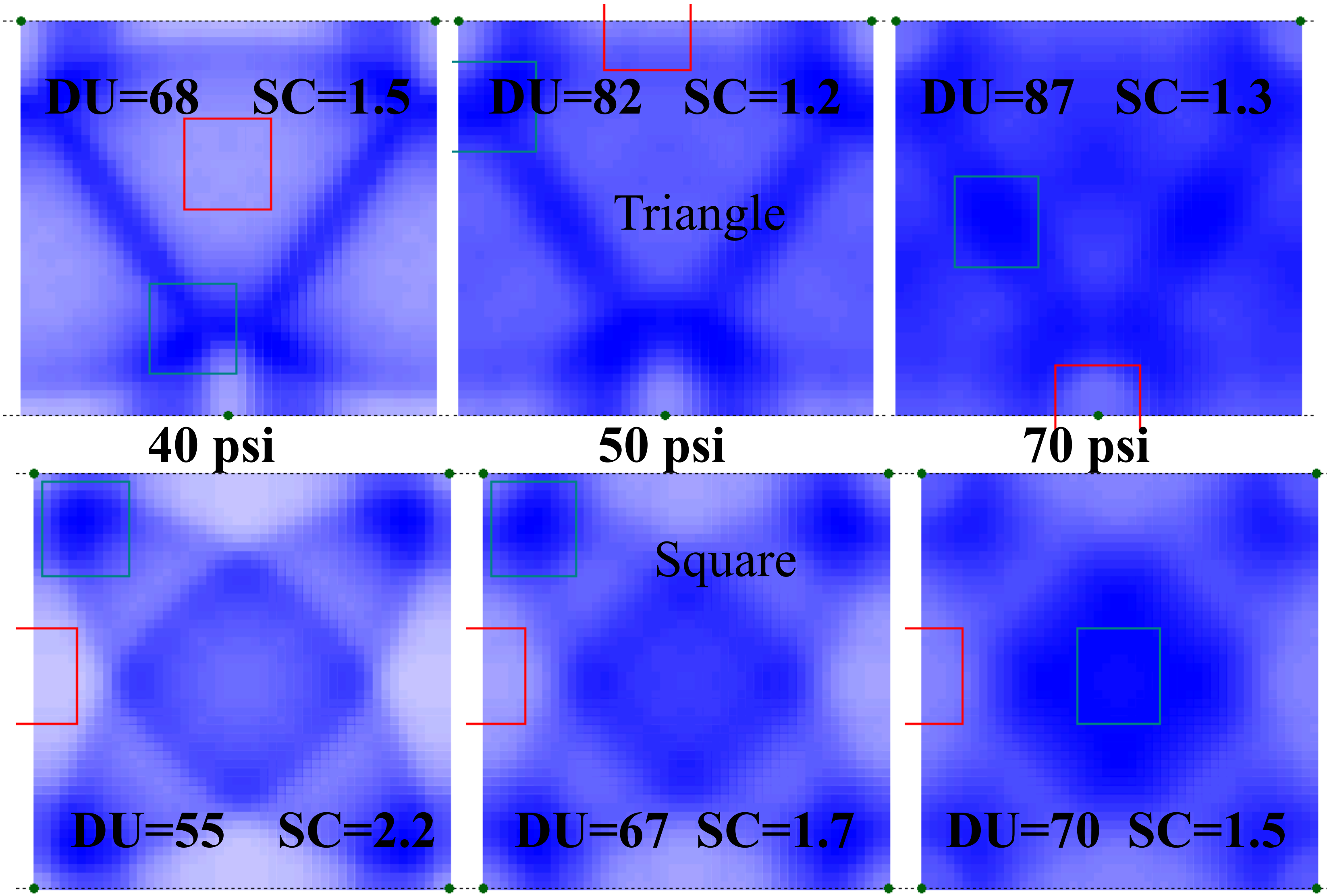
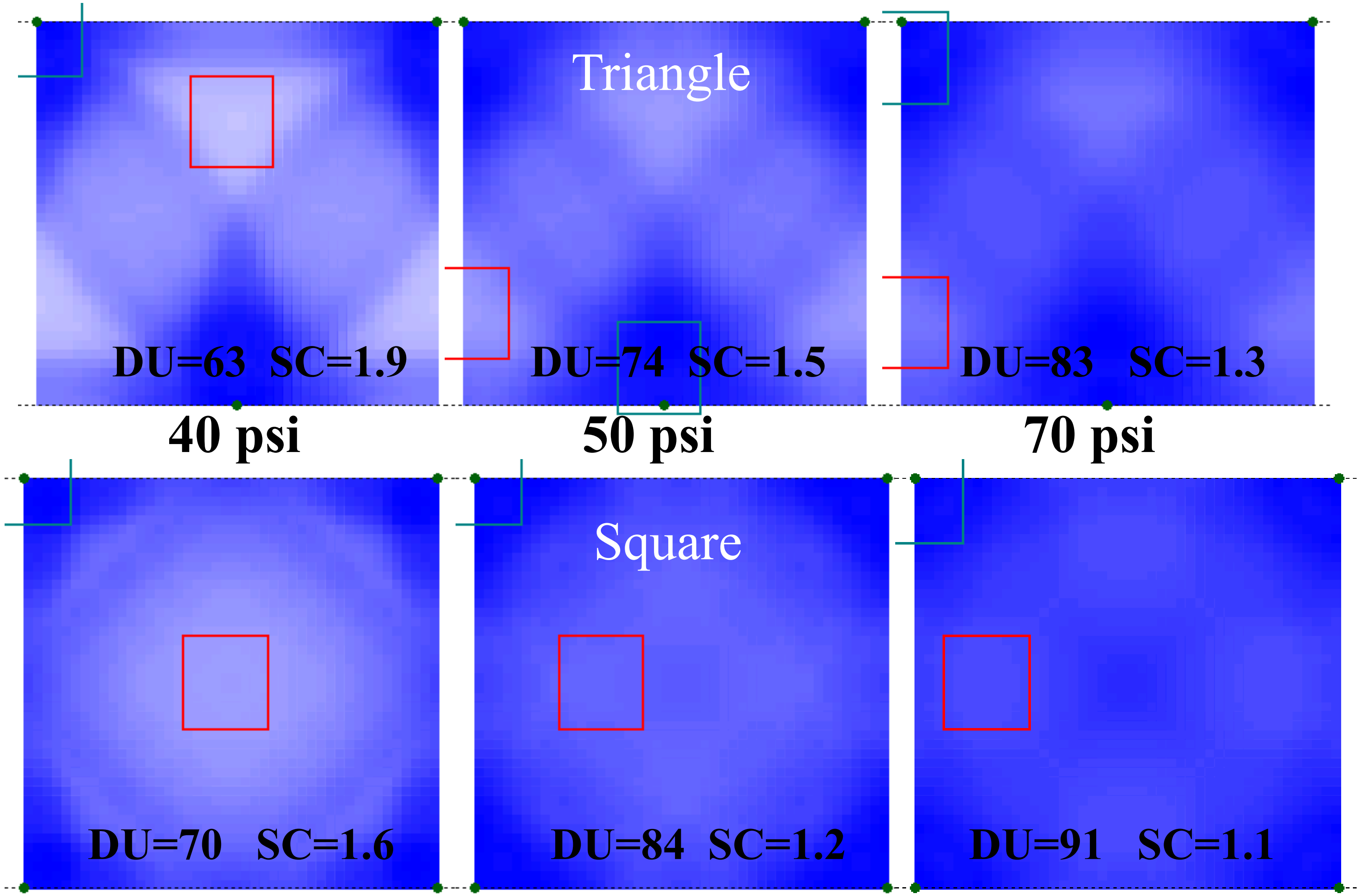
Selecting Sprinklers & Spacing Ranges



#10 47' O.C. Head Spacing

Selecting Sprinklers & Spacing Ranges



#10 Nozzle 40’ o.c. spacing

RESULTS OF HEAD TO HEAD COVERAGE

AVOIDING RUN OFF

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TYING IT ALL TOGETHER

- Landscape Design
- Determine The Water Requirement
- Is There Sufficient Pressure?
- Select The Proper Equipment (Controls, Heads, Sensors)
- Proper Hydro Zoning
- Head Placement
- Pipe Sizing
- Educate The End User

THANK YOU

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