Brent Mecham

How to Efficiently Manage Irrigation Using BMPs

OUR STAMP ON THE FUTURE

Through Technology, Best Practices and Awareness

Brent Mecham, CID, CLWM, CAIS, CIC, CLIA

Irrigation Association

Collaboration between ASIC & IA

BMP & Practice Guidelines

- **Design**
- **Installation**
- **Management**

Appendices

- Inspection & Commissioning
- Water Budgeting
- Scheduling


IRRIGATION ASSOCIATION & AMERICAN SOCIETY OF IRRIGATION CONSULTANTS

Landscape Irrigation Best Management Practices

May 2014

Prepared by the Irrigation Association and American Society of Irrigation Consultants

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Irrigation ASSOCIATION

ASIC

The Irrigation Association and the American Society of Irrigation Consultants have developed the *Landscape Irrigation Best Management Practices* for landscape and irrigation professionals and policy makers who must preserve and extend the water supply while protecting water quality. The BMPs will aid key stakeholders (policy makers, water purveyors, designers, installation and maintenance contractors, and consumers) to develop and implement appropriate codes and standards for effective water stewardship in the landscape.

www.irrigation.org/landscapebmps

http://asic.org/our-solutions/best-management-practices/

OUR STAMP ON THE FUTURE
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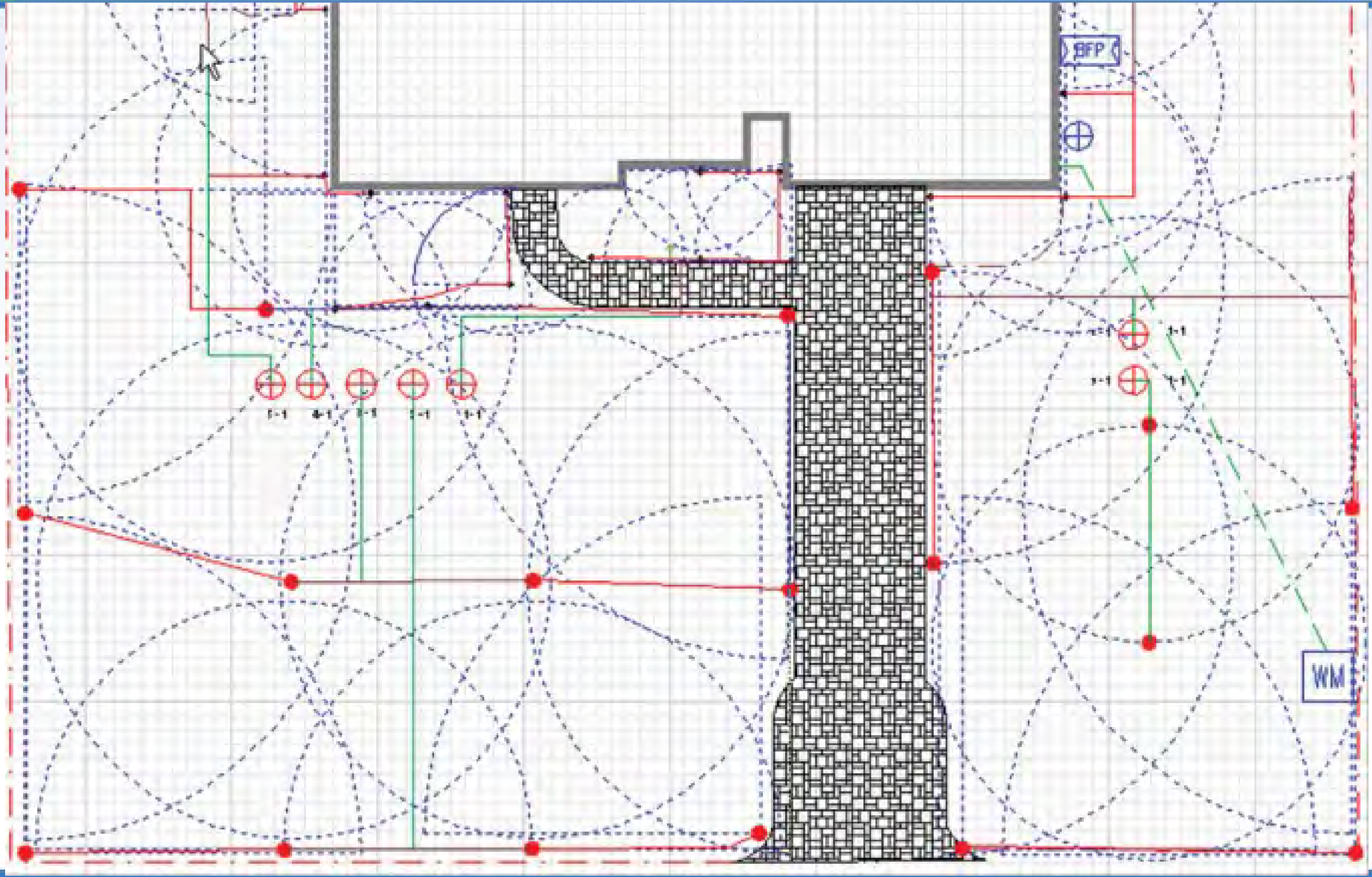


Basis of Design [BOD]

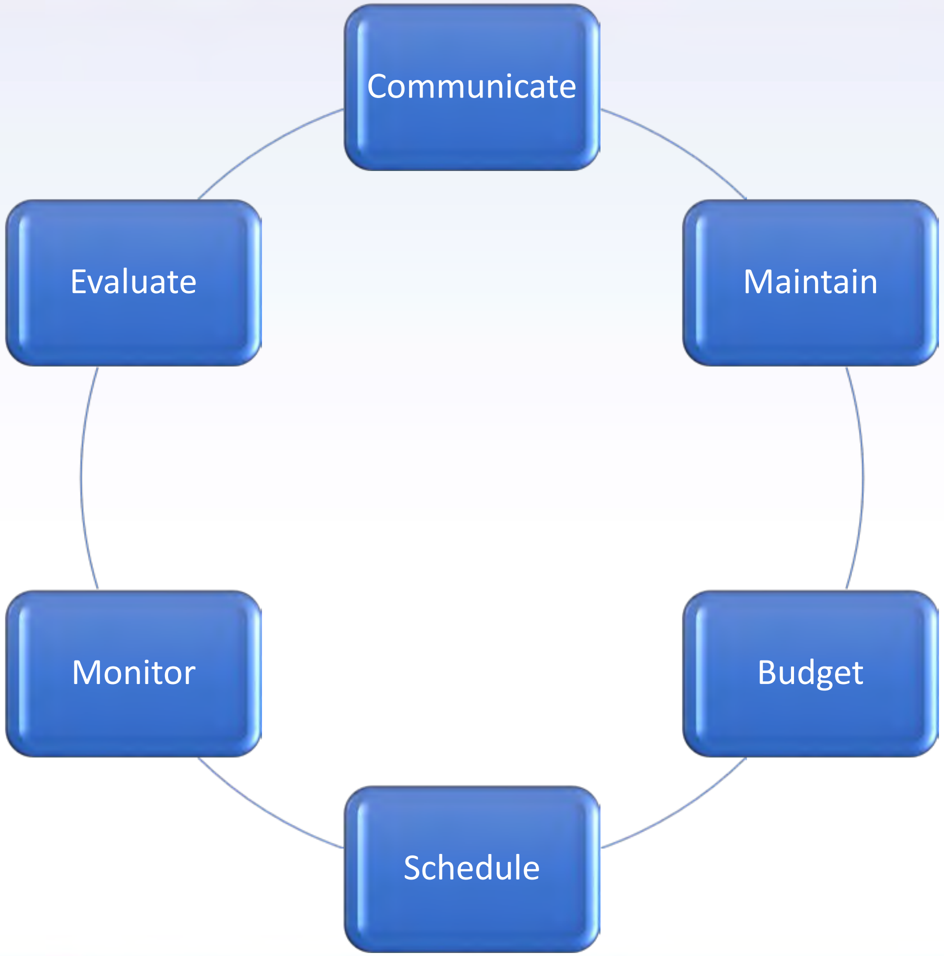
Written narrative describing how the irrigation system will meet the functional purposes of the project owner.

How does the irrigation system contribute to water use efficiency and sustainability.

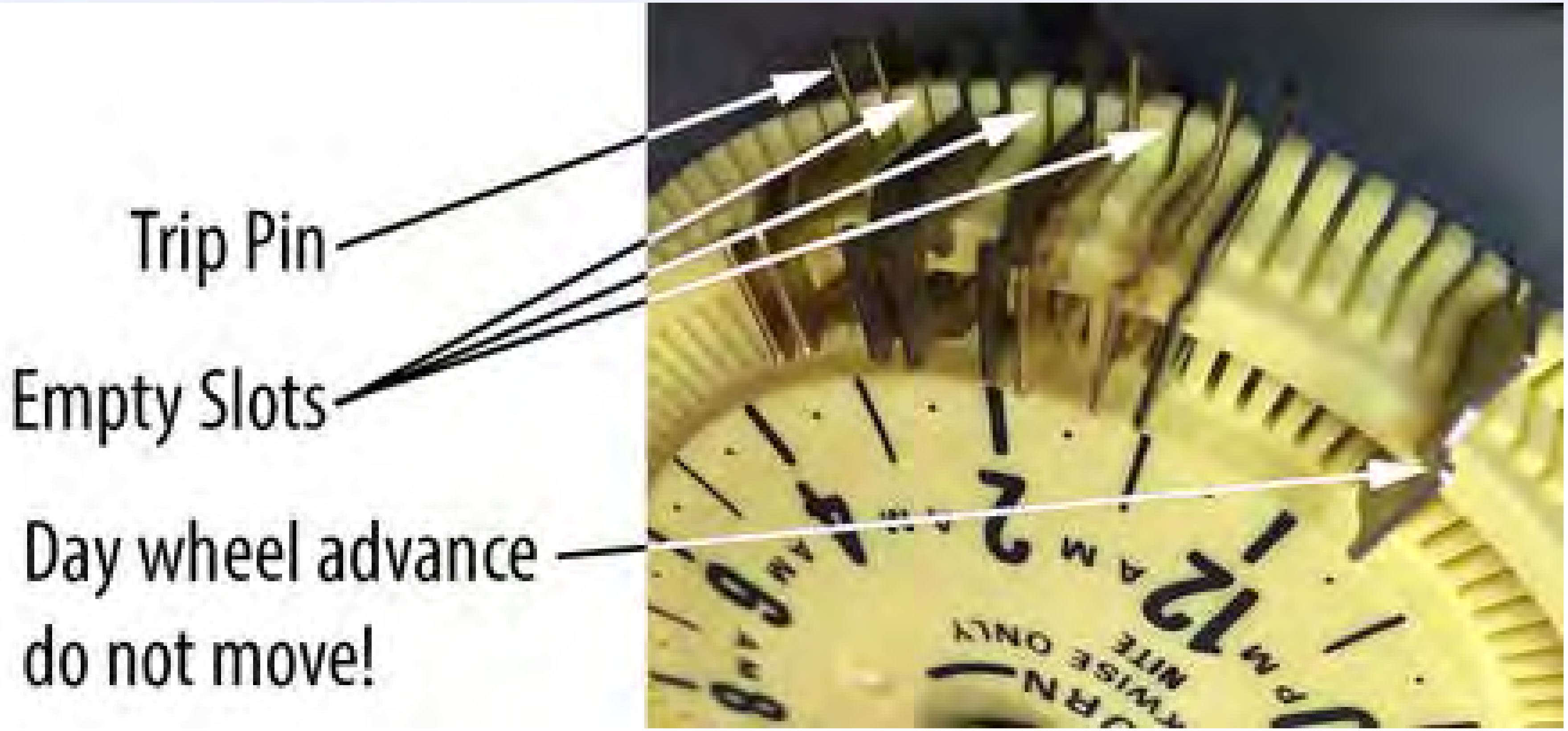
Installation

- Qualified contractors
  - Who are they?
  - How do the prove they are qualified
  - What is the right price?
- WIIFM
  - Inspections
  - Functional performance testing
  - Commissioning

Management



$$WR_H = \frac{((ET_O \times PF) - R_e) \times LA \times 0.623}{IE}$$


Trip Pin
Empty Slots
Day wheel advance
do not move!

measure

to manage

- Inspections
- Functional performance testing
- Commissioning [Cx]

Technology

Distribution

Energy

Discussion or Questions?

Dr. Bernd Lienauer

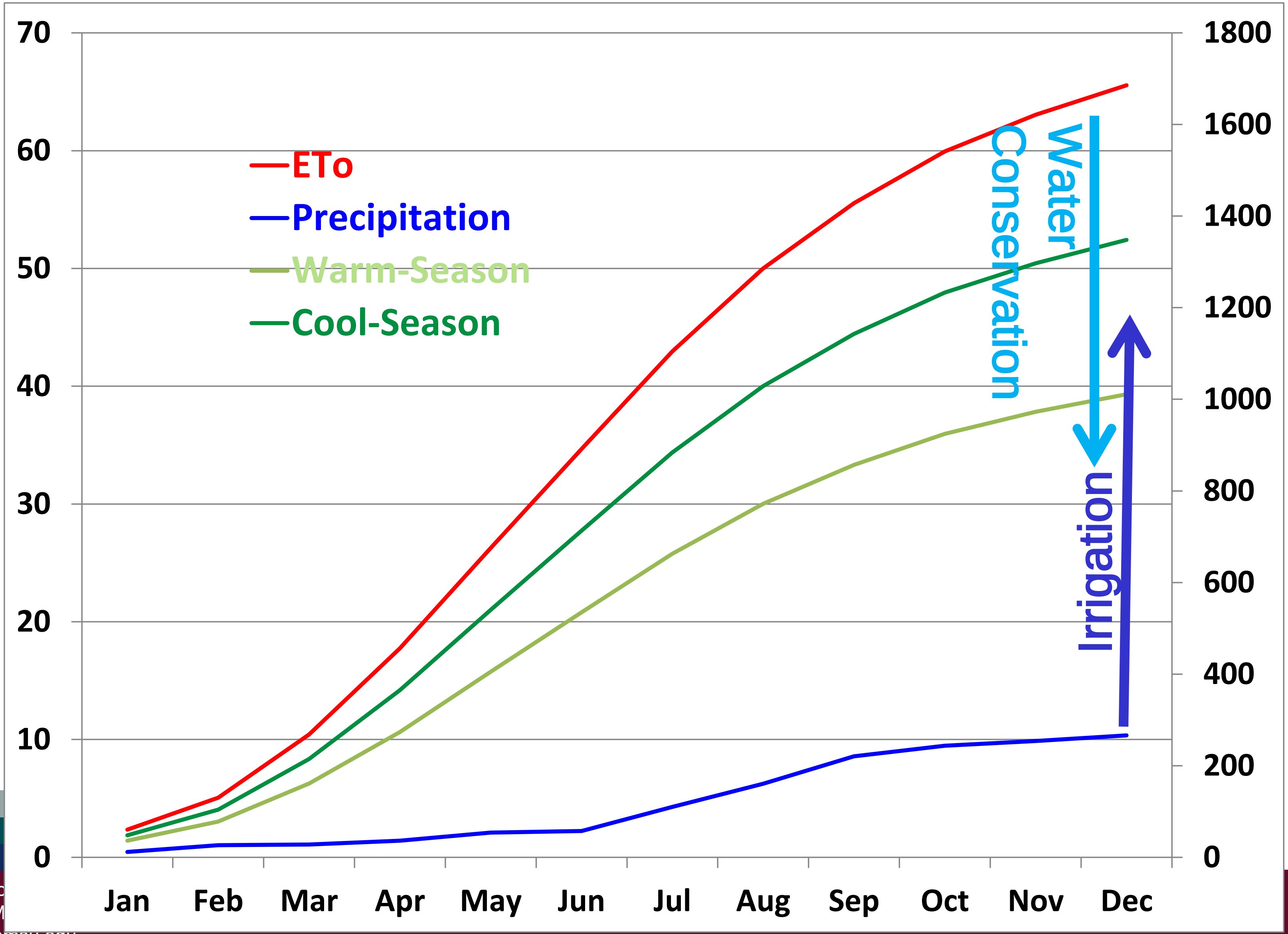
Turfgrass Water Conservation and Irrigation Efficiency

Bernd Leinauer

Professor & Extension Turfgrass Specialist

New Mexico State University

Turfgrass Irrigation Requirement
Las Cruces, NM (2005 – 2009)



NM STATE

All Abo…
New M…
aces.nmsu.edu

Turfgrass Irrigation

Las Cruces

Cool-season 50”

Warm-season 38”

GCSAA Survey
(Gelernter et al., 2015)

46.4”

Grass Type	1500 ft^2	700 ft^2
WS	35,500 gal	16,560 gal
CS	46,700 gal	21,790 gal

Ecosystem Services: Mitigation of Heat Islands

- Trees and vegetation lower surface and air temperatures
- Shaded surfaces may be 11–25°C (20–45°F) cooler than the peak temperatures of unshaded materials
- Evapotranspiration, alone or in combination with shading reduces peak summer temperatures by 1–5°C (2–9°F)

Strategies for Irrigation Water Conservation

1. Artificial Turf
2. **Reduce area under irrigation**
3. Irrigation with recycled/impaired water
4. Use of low water use turfgrass species
5. Accept quality reduction
6. Increase irrigation efficiency
   I. Scheduling
      a) Climate data
      b) Soil water status
   II. Improve Water Distribution

Turf removal

- $3.75/ft^2
- Install a new landscape:
  - ➢no live turf or turf looking plants
  - ➢includes plants (no turf)
- synthetic turf may be eligible

http://socalwatersmart.com

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Irrigation with Recycled/Alternative Water

Water Quality Comparisons

	Ground Water				Recycled Water		Sea Water	CBM Water (47 Wells)	potable
	El Paso		Las Cruces	Carls-bad, NM	CA	Las Cruces			
pH	7.8	6.4	7.3	7.7	7.0	7.5		7.6	7.5
EC	2.6	1.1	4.0	6.4	2.0	2.3	50	3.0	0.6
TDS	1,644	710	2,560	3,925	1,266	1,500	34,500	2,010	390
SAR	11.5	5.2	10.5	6.4	4.8	7.6	39.8	29	1.4

Data from Assadian, 2006; Asano et al., 1985; Duncan et al., 2009, and Rice et al., 2000

Salinity Tolerance

Shoot saline ion exclusion central to salinity tolerance

- Salt sensitive plants:
  accumulate saline ions to toxic levels
- Salt tolerant plants:
  excrete excess saline ions from shoots

Correcting salinity problems

Remediate sodic vs. saline soils

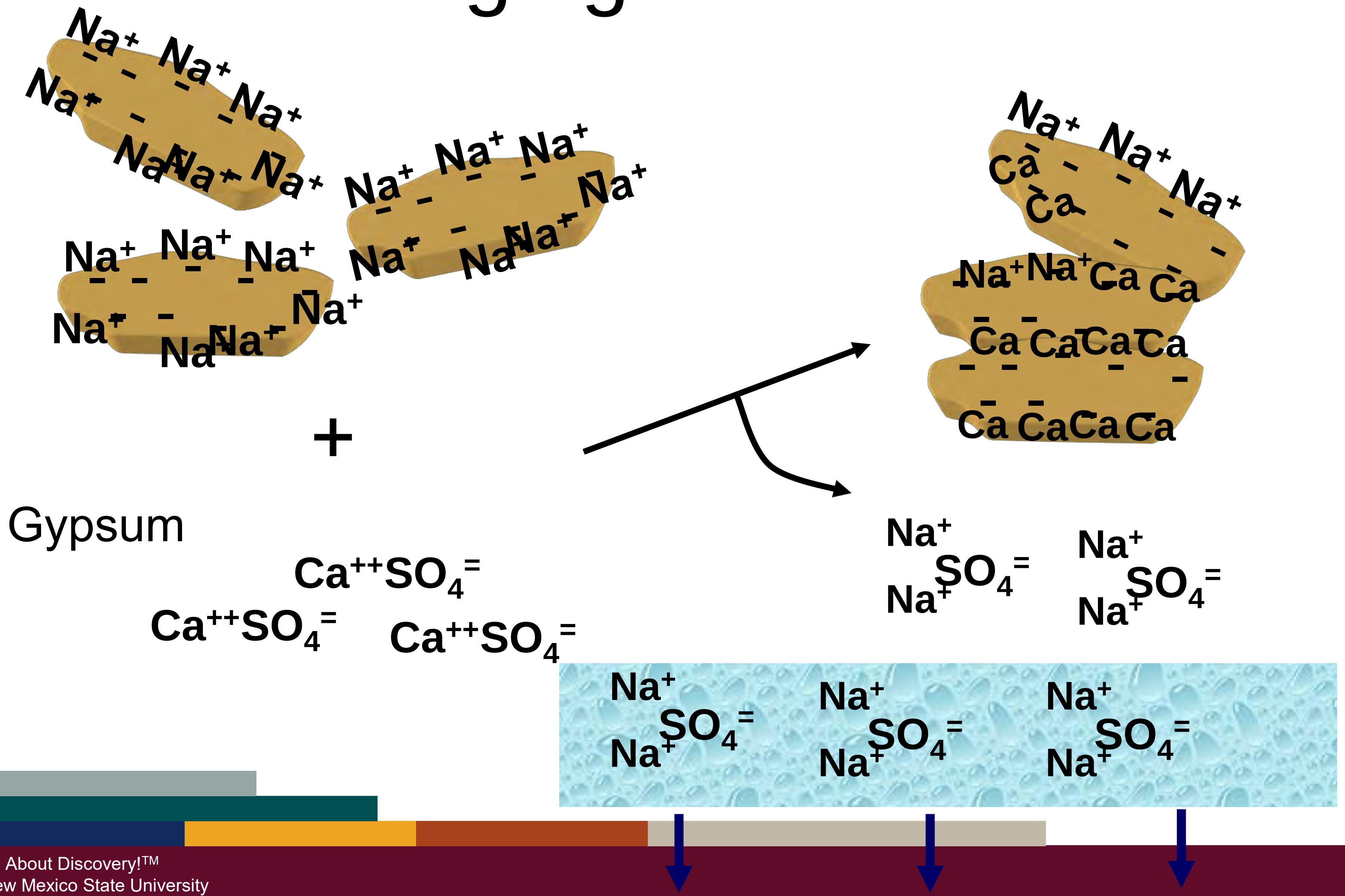
1) Sodic soils

- Basic (pH > 7)
  - Stabilize structure through Gypsum ($CaSO_4$)
  - Acidify irrigation water
    (e.g. synthetic acid, sulfuric acid)
- Acid (pH < 7)
  - Adding lime ($CaCO_3$ / $MgCO_3$)

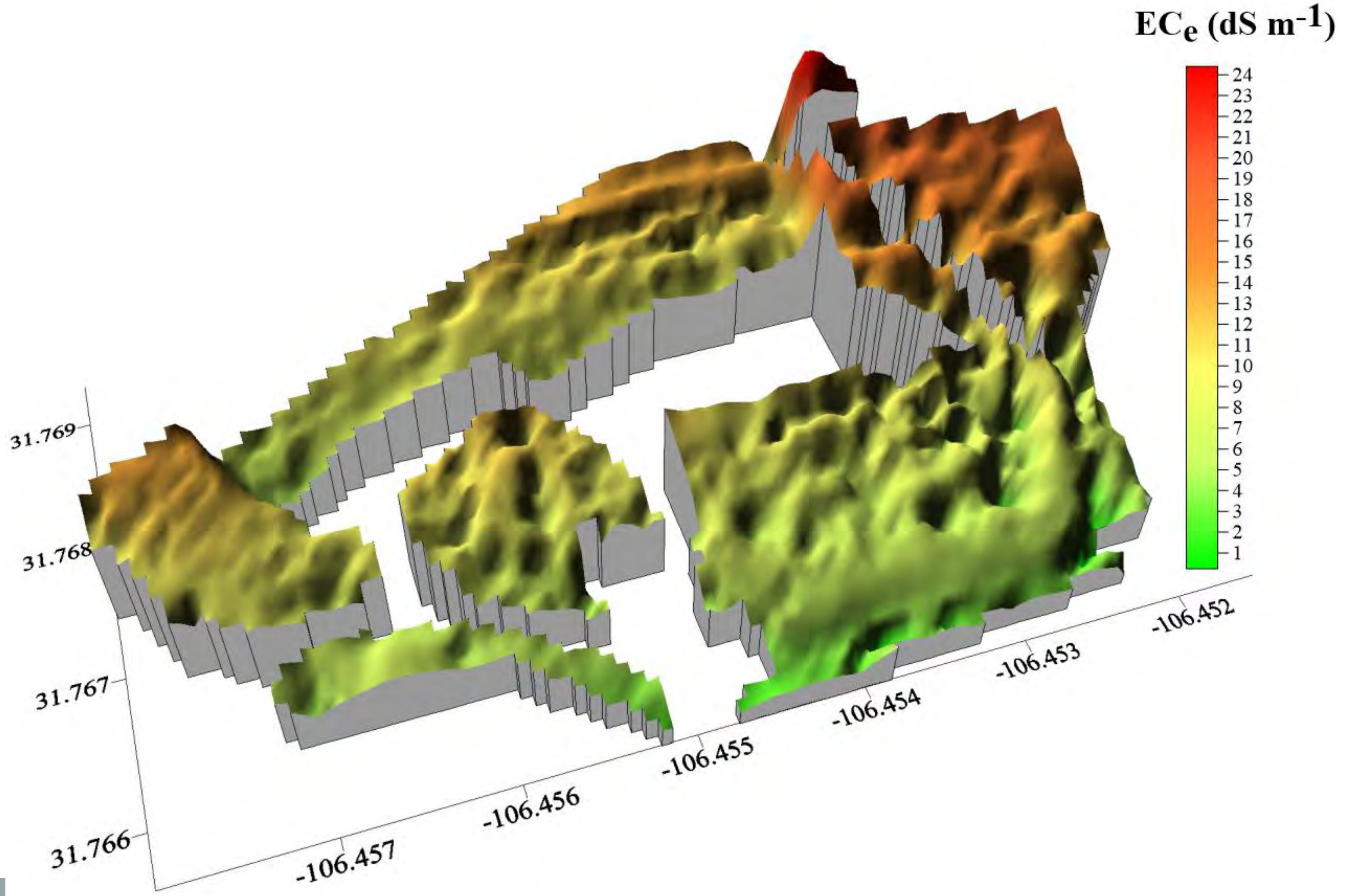
2) Saline soils

1) Leaching
2) Improve Drainage
   (Surfactant)

Managing Sodic Soils

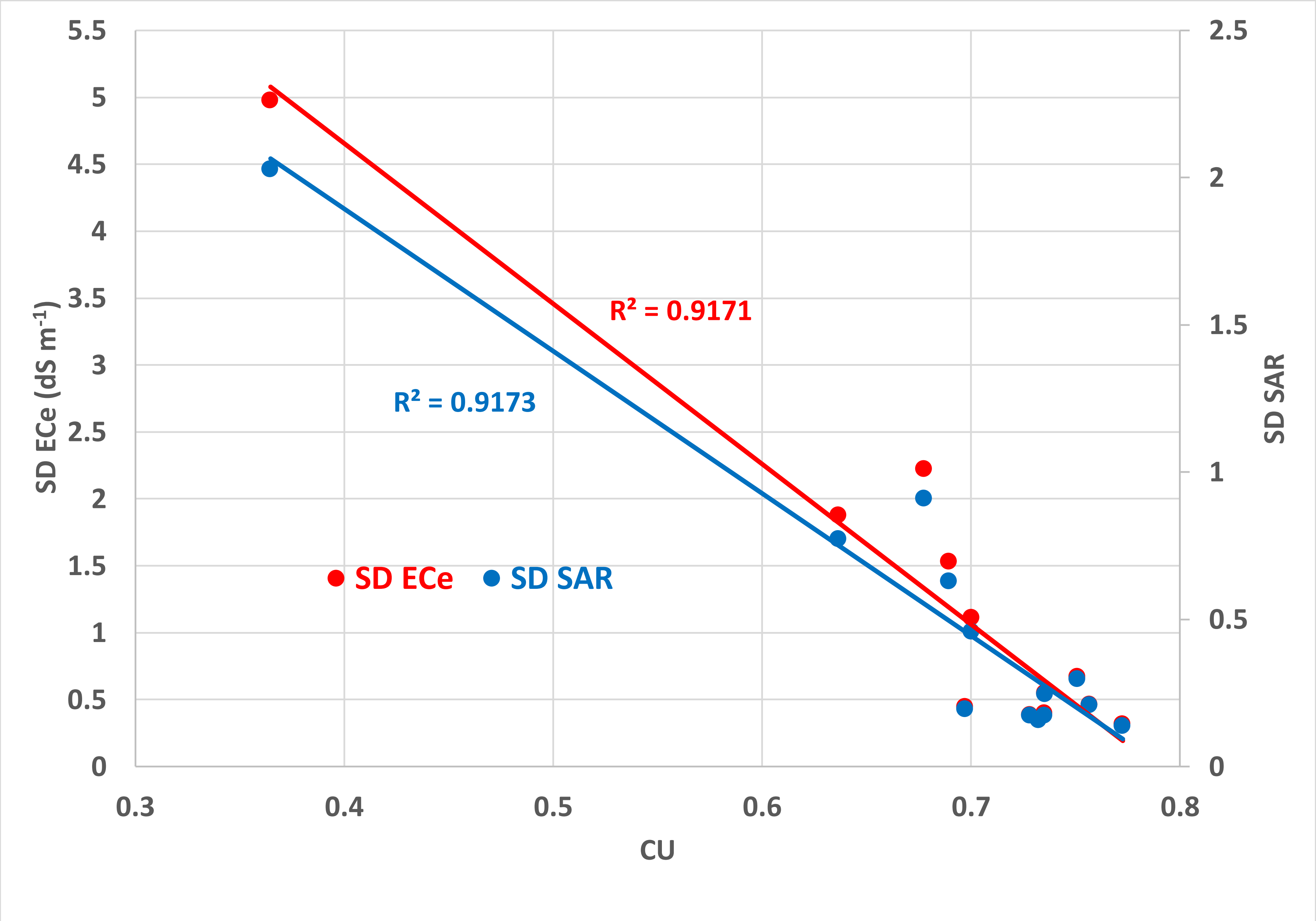


- Chamizal National Memorial
- 140 ha irrigated turf area, El Paso, TX
- 46 years irrigated with saline groundwater
- EC = 1.1 dS m^{-1}; SAR = 5.2



ECe (dS m-1)
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
31.769
31.768
31.767
31.766
-106.457
-106.456
-106.455
-106.454
-106.453
-106.452

Relationship between irrigation system uniformity and soil salinity



Alternate Water Sources and How They Impact the Landscape

In an arid or semi-arid environment, alternate water sources generally have a higher salinity and sodicity than traditional sources:

1. Select salt tolerant plants
2. Correct salinity problems
   a) Reduce salt inputs
   b) Remediate saline/sodic soils:
      Control calcium and sodium to avoid structural problems
   c) Avoid soil amendments that increase moisture retention
3. High irrigation system uniformity

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Turfgrass Irrigation Requirement

$$IR = \sum (A, ETo, ISe, Wq, Kc) \quad f_{(Kc)} \ Sp, TQ, GDD, PAW, Mi$$

A: Area under irrigation

ETo: reference Evapotranspiration

ISe: Irrigation System Efficiency

Wq: Water Quality

Kc: Crop coefficient

SP: Species

TQ: Turf quality

GDD: Growing Degree Days

PAW: Plant available water

Mi: Management Intensity

Irrigation Water Use > Irrigation Water Requirement

Mean Summer Evapotranspiration Rates of Different Turf Species

ET rate in/wk	ET rate mm/day	Cool season	Warm season
2.0 – 3.5	7.2 – 12.6	Tall Fescue	
1.8 – 3.1	6.6 – 11.2	Perennial ryegrass	
1.7 – 2.2	6.2 – 8.1		Seashore paspalum
1.6	5.7		Blue grama
1.5 – 2.0	5.3 – 7.3		Buffalograss
1.0 – 2.2	4.0 – 8.7		Bermudagrass
1.3 – 2.1	4.8 – 7.6		Zoysiagrass
1.1 – 1.8	4.1 – 6.6	Kentucky bluegrass	

Gaussoin, 2003

Buffalograss - Water Use

(Stewart et al., 2004)

- No difference in water extraction between buffalograss and Kentucky bluegrass for well watered conditions

<u>Incipient water stress:</u>

- Kentucky bluegrass depleted 50% of soil water to 30 cm depth (6 days)
- Buffalograss depleted 60% of soil water to 90 cm depth (20 days)

Irrigation Water Requirement (1)

- Historically, ET rates determined under non-limiting moisture conditions
- A wide range of ET (within and between species) indicates that water use is affected by many factors, e.g. soil moisture availability and quality expectations
- Consequently, in the context of water conservation, the question is not how much water do turfgrasses use, but what is the minimum amount of water they require to survive and meet desired quality expectations
- Deficit irrigation → Kc

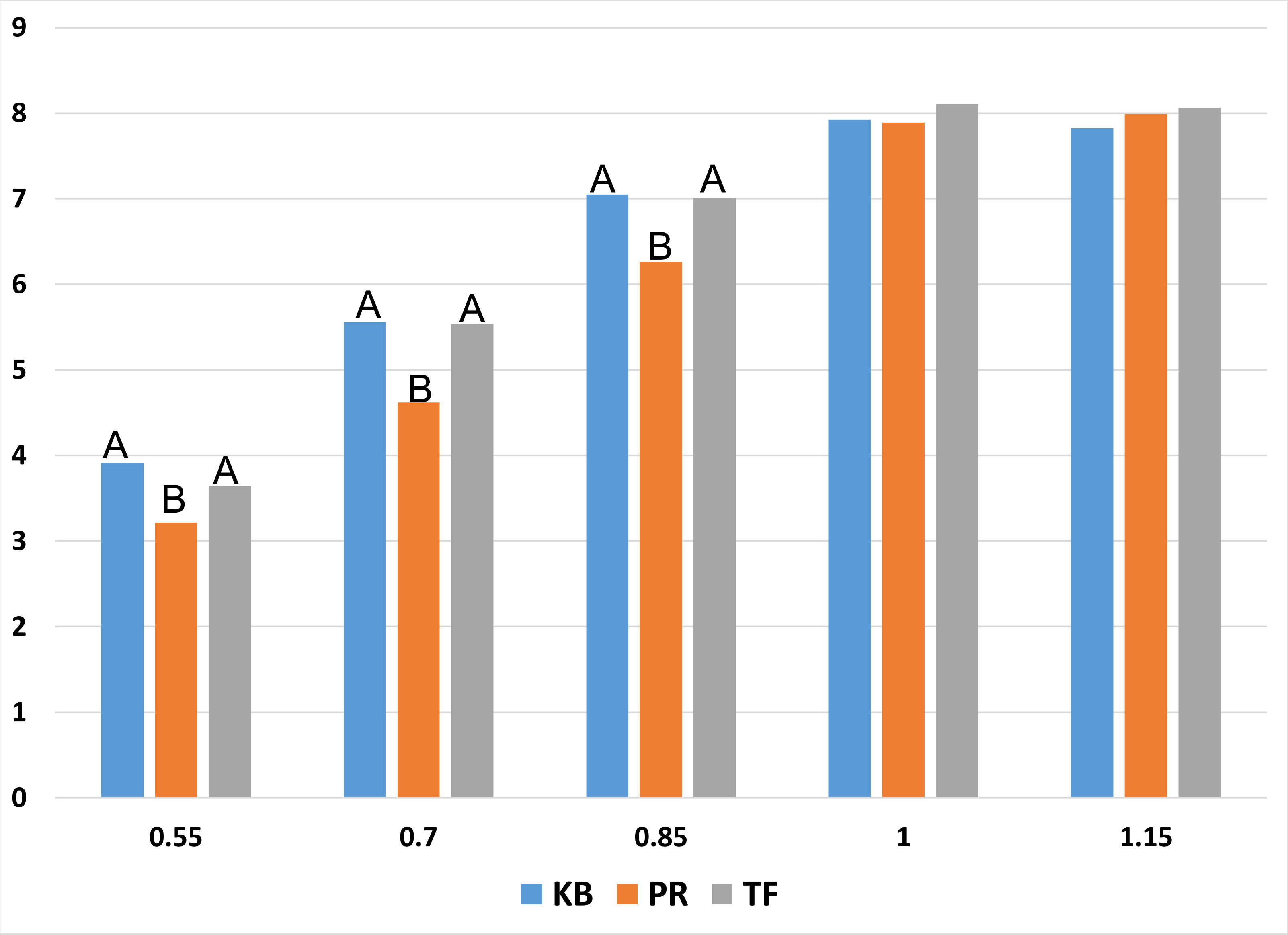
Irrigation Water Requirement (2)

- Deficit irrigation is only effective if turf areas receive sufficient rainfall to occasionally recharge the soil profile (Shearman 2008).
- When occasional natural precipitation is insufficient, drought periods need to be followed by periodic increased irrigation amounts for grasses to recover (Baird, et al., 2009; Devitt and Morris, 2008).
- The main drought resistance mechanism from a lack of sufficient irrigation may be dormancy which results in a loss in color and cover.

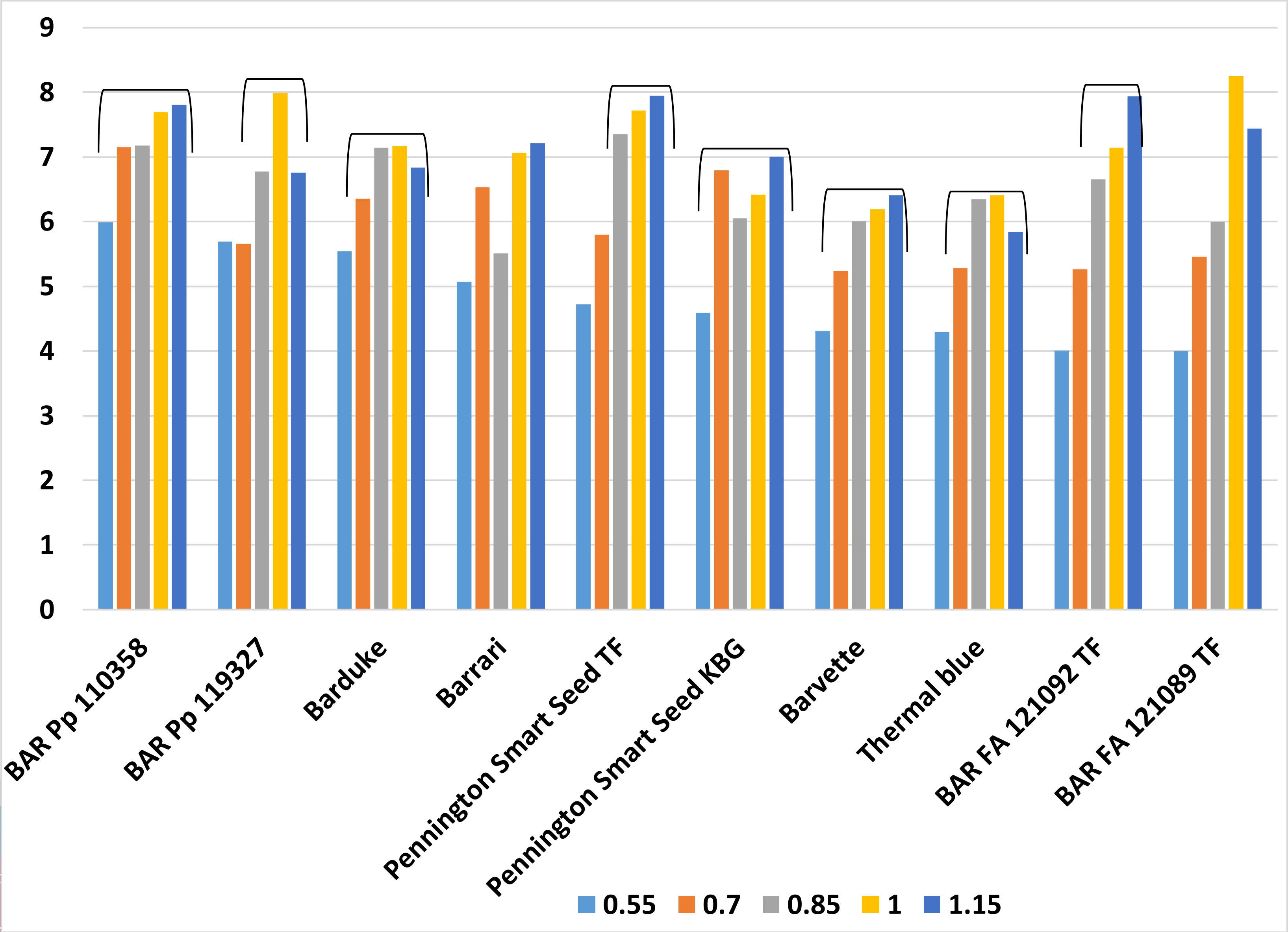
Study

- 5 Species:
  Bermudagrass (3), Buffalograss (2), Kentucky bluegrass (8), Perennial ryegrass (7), Tall fescue (10)
- 5 ETos levels:
  1.15, 1.0, 0.85, 0.7, 0.55
- 3 Years:
  2013 – 2015
- Data:
  Visual quality, Green Cover, NDVI

CS Turfgrass Quality Summer 2014



CS Turfgrass Quality Summer 2015



Conclusion

1) Traditional cool season grasses may perform adequately even with less water than historically been thought
2) “high water use grasses” may perform equally acceptable than “low water use grasses” even at the same reduced amount of irrigation
3) In order to make useful recommendations, regional testing under water limiting conditions is necessary
4) Consider additional stresses, e.g. salinity, traffic

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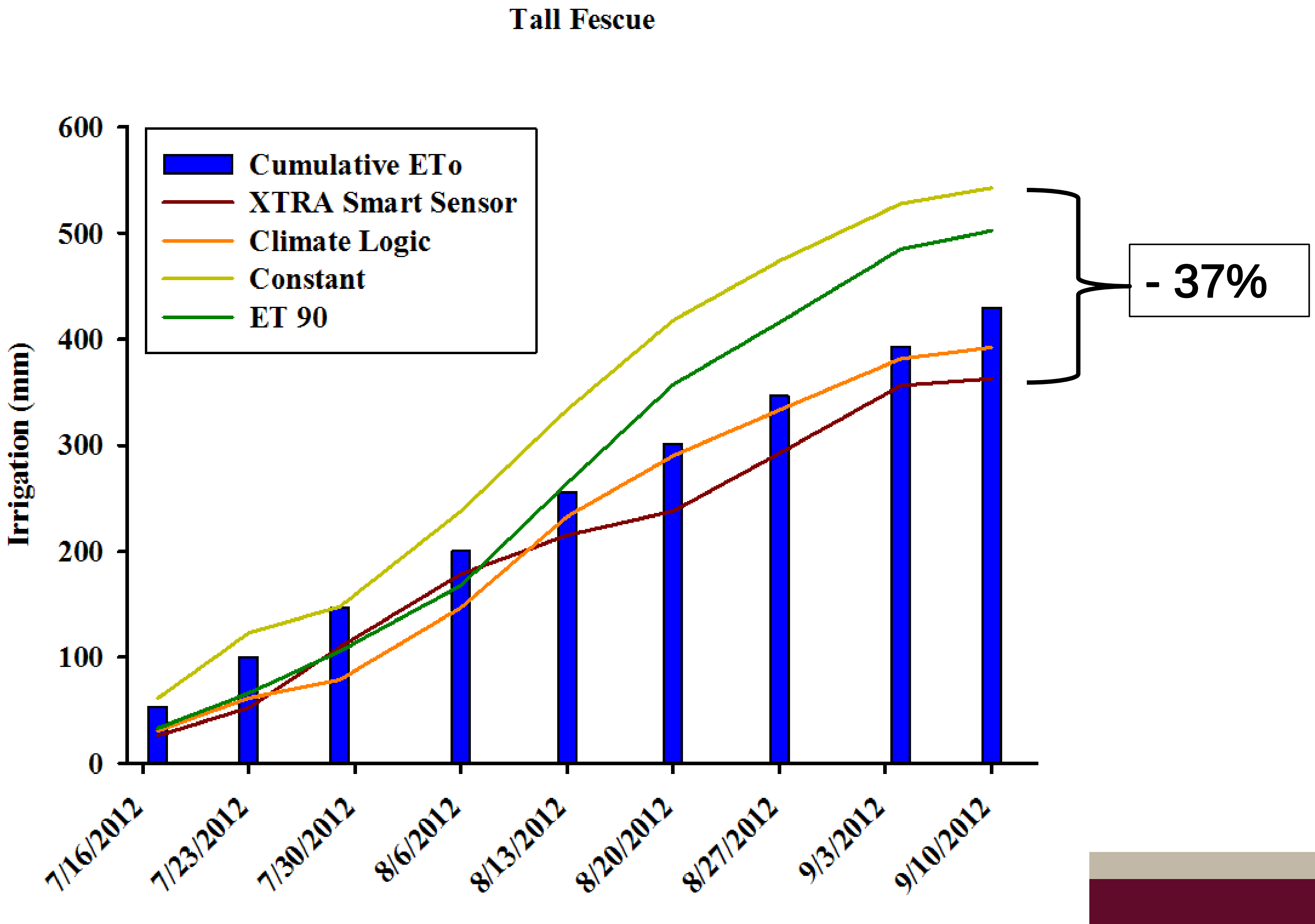
Results


Tall Fescue
Cumulative ETo
XTRA Smart Sensor
Climate Logic
Constant
ET 90
Irrigation (mm)
0
100
200
300
400
500
600
7/16/2012
7/23/2012
7/30/2012
8/6/2012
8/13/2012
8/20/2012
8/27/2012
9/3/2012
9/10/2012
- 37%

Strategies for Irrigation Water Conservation

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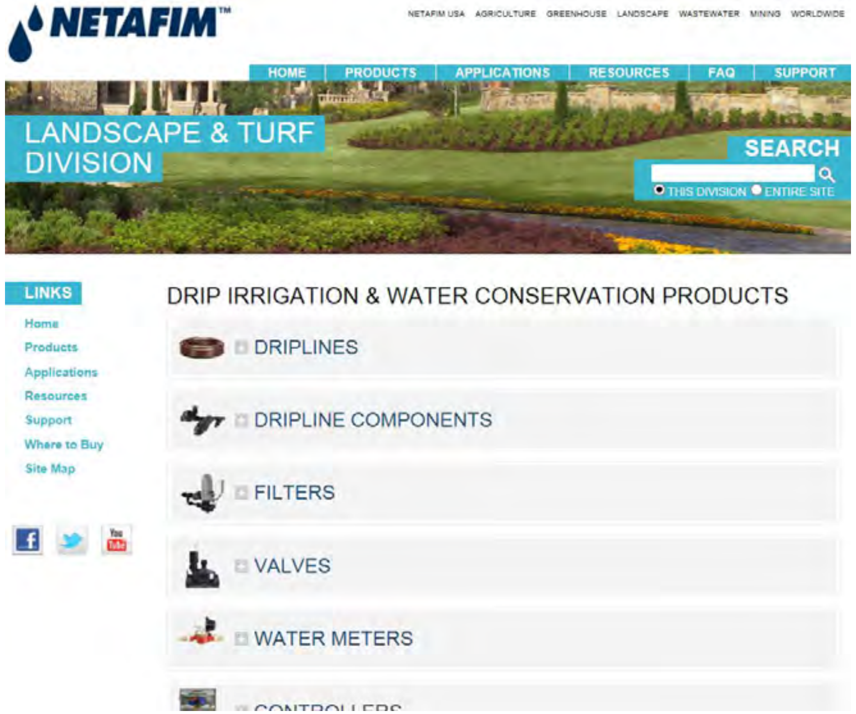
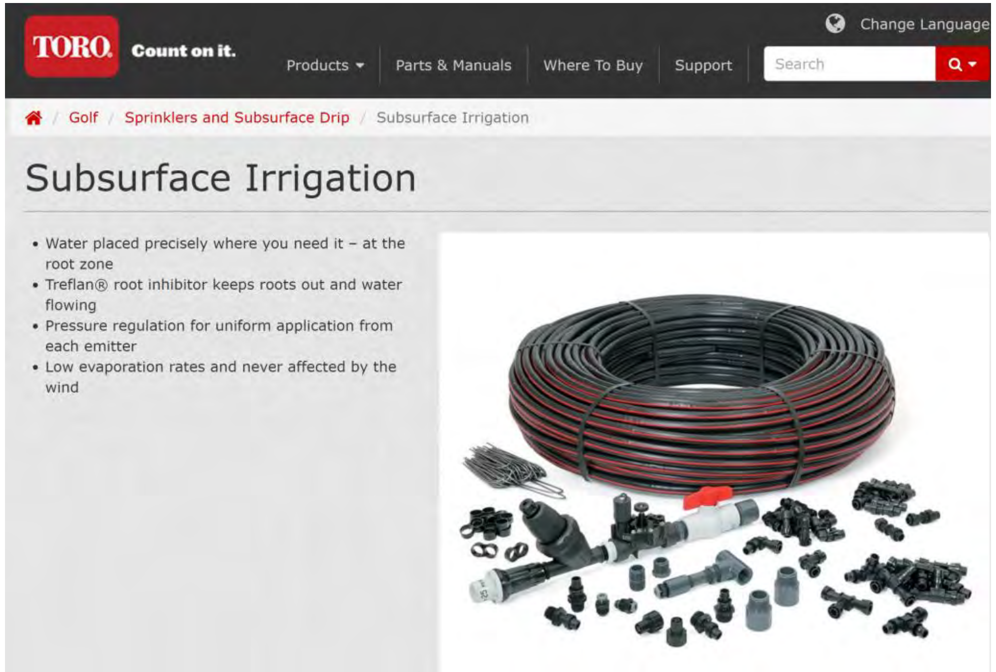
Irrigation Efficiency

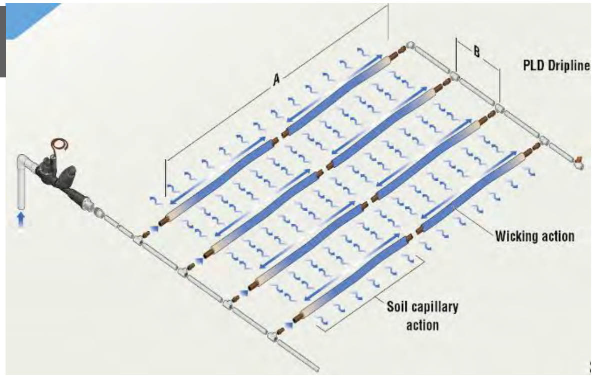
- Mecham (2004): Summary of uniformity data from over 6800 irrigation audits (Utah, Nevada, Colorado, Arizona, Texas, Oregon, and Florida)
- Average DU of 0.5

The amount of irrigation water doubles compared to what "the grass plant needs" to maintain an adequate quality level

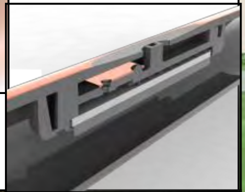




PLD-ESD



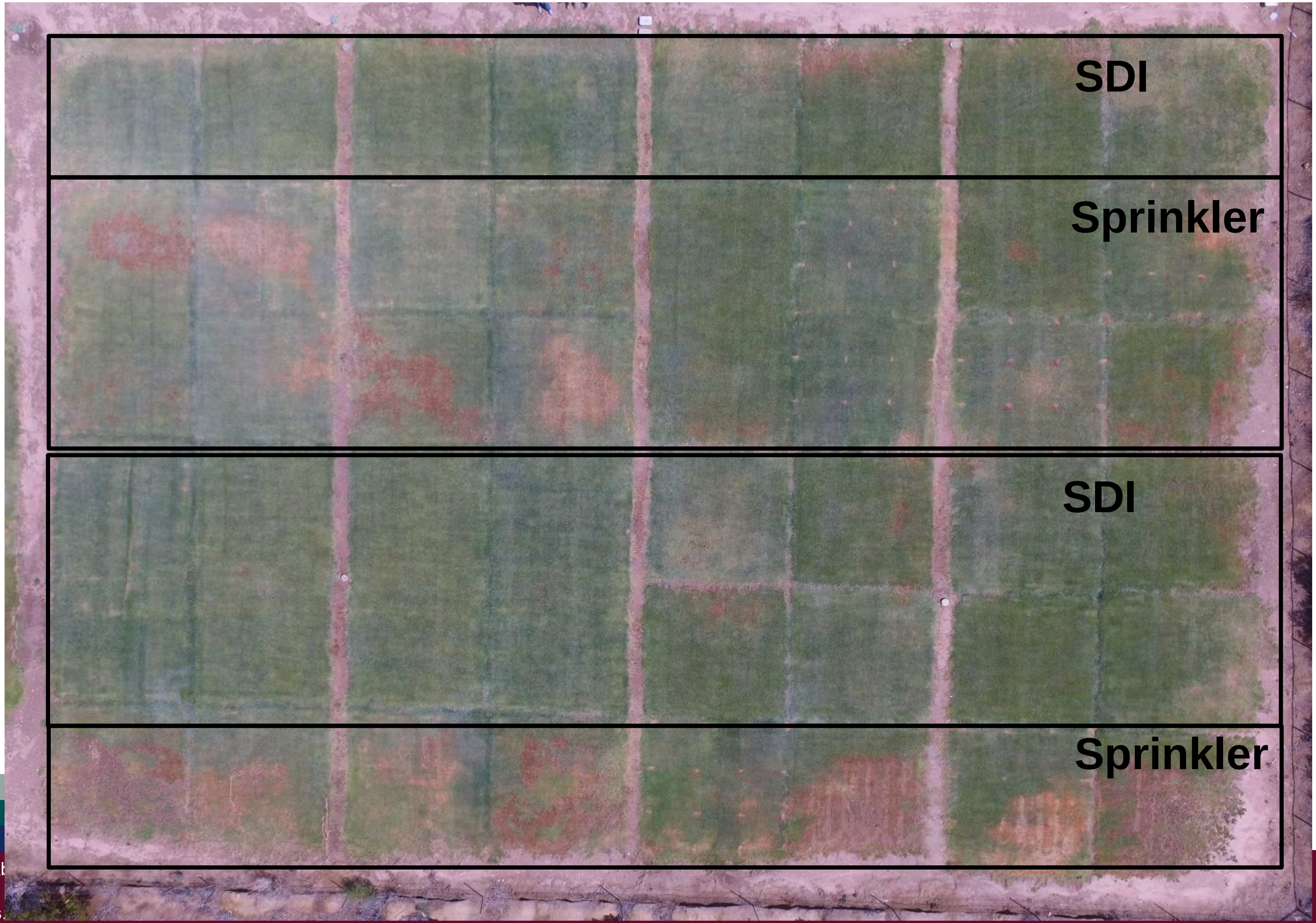
XFS Subsurface Dripline



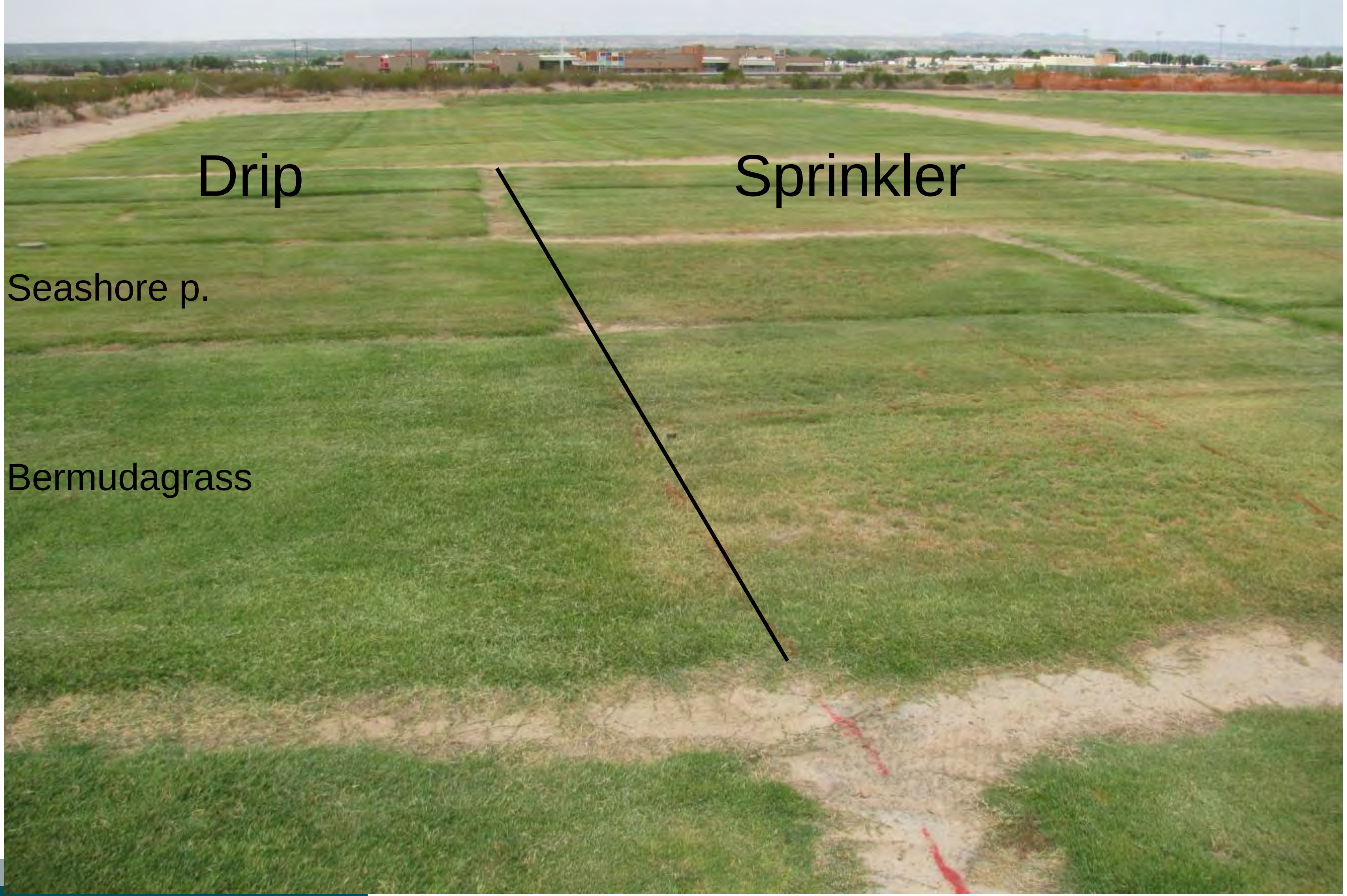

Conclusions

1) Subsurface drip irrigation can be used to irrigate turf efficiently
2) also in combination with saline water
3) is a viable alternative to traditional sprinkler systems if installed, monitored, and maintained properly
4) More education and public outreach needed to promote technology

Irrigation effect on brown patch (Rhizoctonia sp.) occurrence



3 years of potable irrigation @ 50% ET_o



August 2012

Las Campanas, NM

Problem:

Las Campanas

Course	Tee	Product	Area (ft^2)	Spacing	Emitter (gal/hour)	Emitter #	Delivery/hour (gal)	Delivery/hour (in)
Sunrise	5	Toro	746	9	0.5	995	1990	0.80
Sunrise	11	Rainbird	314	12	0.42	314	748	0.67
Sunrise	13	Toro	236	12	0.5	236	472	0.8
Sunrise	14	Rainbird	324	12	0.42	324	771	0.67
Sunrise	14	Control	503	DU=0.79				0.98
Sunset	6	Rainbird	760	9	0.42	1013	2412	0.67
Sunset	15	Control	590	DU=0.68				1.51
Sunset	18	Toro	375	12	0.5	375	750	0.8

References (1)

- Schiavon, M., B. Leinauer, M. Serena, B. Maier, and R. Sallenave. 2014. Plant Growth Regulator and Soil Surfactants' Effects on Saline and Deficit Irrigated Warm-season Grasses: I. Turf Quality, Color Retention, and Soil Moisture Distribution. **Crop Science** doi: 10.2135/cropsci2013.10.0707
- Schiavon, M., B. Leinauer, M. Serena, B. Maier, and R. Sallenave. 2014. Plant Growth Regulator and Soil Surfactants' Effects on Saline and Deficit Irrigated Warm-season Grasses: II. Pigment Content and Superoxide Dismutase Activity. **Crop Science**. doi: 10.2135/cropsci2013.10.0708
- Ganjegunte, G., B. Leinauer, M. Schiavon, and M. Serena. 2013. Using Electro-Magnetic Induction to Determine Soil Salinity and Sodicity in Turf Root Zones. **Agronomy Journal** 105:836–844.
- Sevostianova, E., B. Leinauer, R. Sallenave, D. Karcher, and B. Maier. 2011. Soil Salinity and Quality of Sprinkler and Drip Irrigated Warm-Season Turfgrasses. **Agronomy Journal** 103:1773-1784.
- Sevostianova, E., B. Leinauer, R. Sallenave, D. Karcher, and B. Maier. 2011. Soil Salinity and Quality of Sprinkler and Drip Irrigated Cool-Season Turfgrasses. **Agronomy Journal** 103:1503-1513
- Schiavon, M., B. Leinauer, E. Sevostianova, M. Serena, and B. Maier. 2011. Warm-season turfgrass quality, spring green-up, and fall color retention under drip irrigation. Online. **Applied Turfgrass Science** doi:10.1094/ATS-2011-0422-01-RS.

References (2)

- Serena, M., B. Leinauer, M. Schiavon, B. Maier, and R. Sallenave. 2014. Establishment and Rooting Response of Bermudagrass Propagated with Saline Water and Subsurface Irrigation. Crop Science 54: 827-836.
- Schiavon, M., B. Leinauer, M. Serena, R. Sallenave, and B. Maier. 2013. Establishing tall fescue and Kentucky bluegrass using subsurface irrigation and saline water. Agronomy Journal 105:183-190.
- Schiavon, M., B. Leinauer, M. Serena, R. Sallenave, and B. Maier. 2012. Bermudagrass and Seashore Paspalum Establishment from Seed Using Differing Irrigation Methods and Water Qualities. Agronomy Journal 104:706-714.
- Schiavon, M., M. Serena, R. Sallenave, B. Leinauer, and J. Baird. IN PRESS. Seeding date and irrigation system effects on establishment of warm-season turfgrasses. Agronomy Journal.
- Sevostianova, E. and B. Leinauer. 2014. Subsurface-Applied Tailored Water: Combining Nutrient Benefits with Efficient Turfgrass Irrigation. Crop Science 54:1926-1938. doi:10.2135/cropsci2014.01.0014

Acknowledgements

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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Water Efficiency

vs

Energy Efficiency

What's the Nexus?

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Water Efficiency vs Energy Efficiency
What's the Nexus?

SPONSOR

- Hong Kong Based, Global reach
- Not-for-Profit
- Integrated Community Development
- Environmental clean-up
- Waste water treatment
- Energy efficiency

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for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

PROGRAM

- About the Presenter – career experiences
- WE vs EE – what's the nexus" ?
- Applying energy efficiency in irrigation

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Energy Efficiency
for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

• About the Presenter

- Mixed farm GULNARE, South Australia
- 1948 - 1958
- 2km creek for playground
- Did farm "apprenticeship"

- Innovation permeated farm life
- Made own toys etc
- Pedal car = prime mover
- Challenged status quo throughout life

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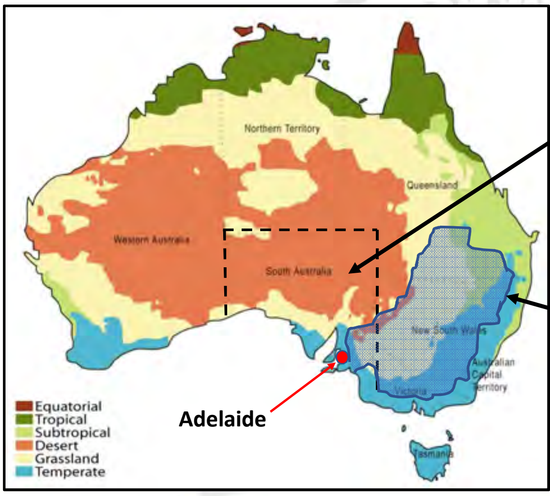
Water Efficiency vs Energy Efficiency
What's the Nexus?



South Australia

Driest State
of the
Driest Continent
in the World

Murray/Darling
catchment

2/3 size of Mississippi/Missouri

South Australia

- 95% area < 10" rainfall
- River Murray lifeline
- 1.5 x area of Texas

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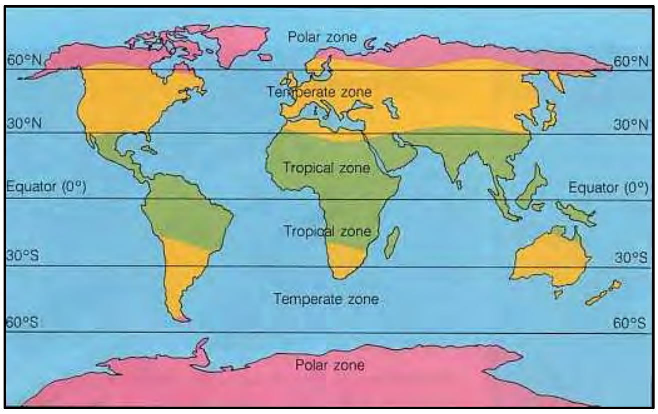
Water Efficiency vs Energy Efficiency
What's the Nexus?



Note that USA almost all above 30th Lat Nth.
Australia almost all above 30th Lat Sth.
Therefore, Aust much drier climate.

6

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Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

PUMP TESTING with SA Water for 20 years.

- Adelaide, 1.2 million
- Dry year, 90% water pumped from River Murray
- 1000' lift, 3 or 4 stages
- 4 major pipeline systems
- Approx 130,000 kW (175,000 HP)
- $millions/annum pumping costs
- > 1000 pump tests over 20 yrs

Murray Bridge – Onkaparinga Pipeline and No 3 PS
3 x 5,600 kW pumps (7,500 HP each)

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Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

PIPELINE FRICTION TESTING with SA Water for 20 years

- From largest (1.8m) to smallest (80mm) pipeline, (Hazen & Williams "C" Values)
- Determine maintenance policy
- Pumping economics

Mannum – Adelaide Pipeline No 3 PS (1955)
3 x 1,600 kW pumps (2,500 HP each)

Murray Bridge – Onkaparinga Pipeline and No 3 PS (1973)
3 x 5,600 kW pumps (7,500 HP each)

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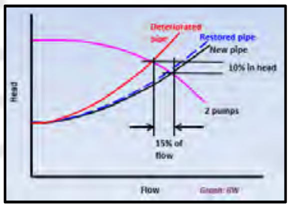
Water Efficiency vs Energy Efficiency
What's the Nexus?

Pump Design and Build Hydrotech (Aust) 6 yrs

- 100 pumping systems
- Turf, Horticulture, Ag, Golf
- Design, Build, Commission
- Engineered Product

Defining moment



"There's a wheel barrow in my Pipeline"

- 10 km of 450NB PVC
- Pumps reduced output
- Pipeline friction test, 2000
- Willunga Basin Water Co

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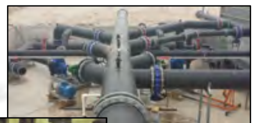
Water Efficiency vs Energy Efficiency
What's the Nexus?

Pump Design 3 yrs HydroPlan (Aust)

- Pumping systems
- Pipeline systems, Dams
- Irrigation systems (drip)

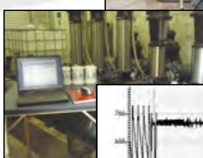
Tallemenco Pty Ltd 2003 to present

- Designed P.S. up to 1,000 l/s
- Bore draw-downs
- Field Evaluations – Irrigation (CIAL Certified)



System Evaluations

- Pumping systems
- Pipeline systems
- Irrigation systems
- Pumping Energy Efficiency audits



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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Tallemenco Pty Ltd 2003 to present, (13 yrs)

Pumping System Evaluations

- Pumping Energy Efficiency audits, identified > **$500,000 annual elect savings**
- More energy efficiency losses in pipes (hydraulics) than in pumps
- Case Study: Pumping energy efficiency audit, Windsor NSW turf farm (for DPI NSW 2014)
  - Efficient Lateral Move
  - 90% losses in pipes
  - 10% losses in pump

Defining moment

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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

How many "MPG" does your pump system do?

$$/yr* = 3.15 x feet head x c/kWh x Mg/yr
motor η x pump η x drive η

Elevation
Filter head loss
Main line head loss
Laterals head loss
Layflat hose head loss
Emitter head loss
Residual head

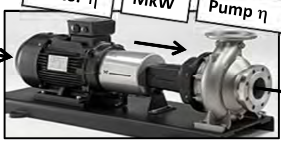
Pump less water
a) scheduling
b) Soil moisture monitoring

Motor efficiency fixed

Pump efficiency
- Worn
- off-BEP

Tariff – choice of
- peak
- Off-peak
- Week-end

Motor η
MkW
Pump η
EkW



WkW

*Refer www.talle.biz/data.html

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TALLEMENCO
Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Water Efficiency V's **Energy Efficiency**

a) Water Requirement
b) Irrigation scheduling
c) Distribution Uniformity
d) Crop water use efficiency

a) Head pumped
b) Pump effy
c) Motor effy
d) Tariff (c/kWh, $/Litre diesel)
e) ML pumped

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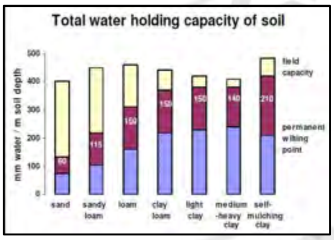
TALLEMENCO Energy Efficiency for Irrigation

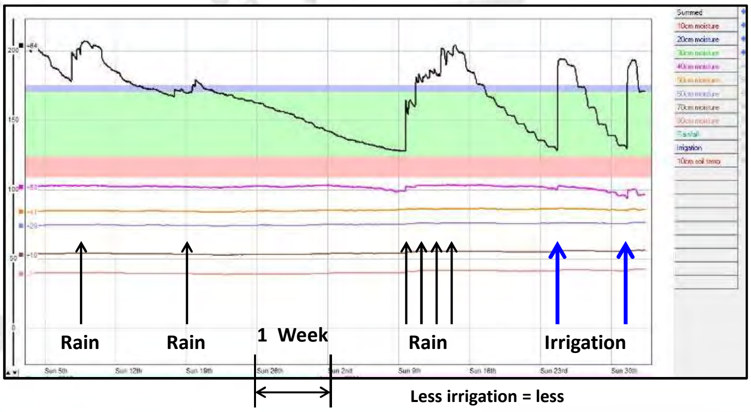
Water Efficiency vs Energy Efficiency
What's the Nexus?

Water Required vs Pumped Volume

Soil Moisture Monitoring



Eg, Capacitance Probe



Less irrigation = less pumping costs.

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Water Efficiency vs Energy Efficiency

What's the Nexus?

Irrigation Scheduling vs Pumped Head

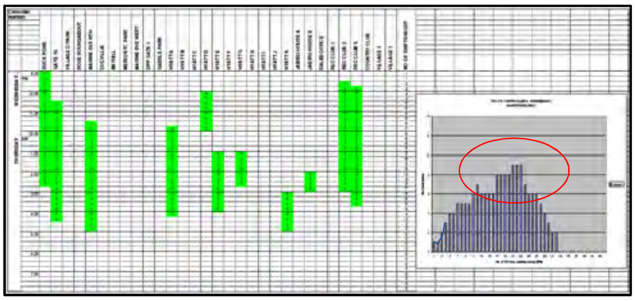
Sanctuary Cove Resort,
Gold Coast, QLD. 2010

Manual scheduling 1

70 acres landscaping site, 31 stand alone controllers

Pump system failing on low pressure

Concentration of scheduling resulted in high peak flow rates, high head losses in pipes



Charts: R Welke

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Water Efficiency vs Energy Efficiency

What's the Nexus?

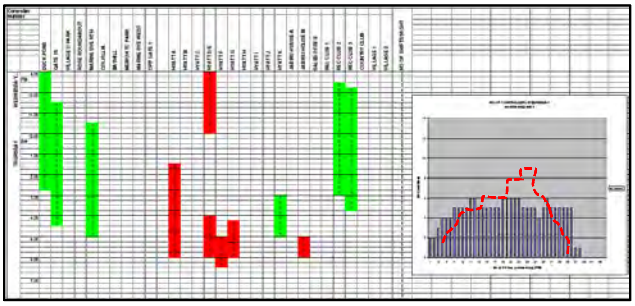
Irrigation Scheduling vs Pumped Head

Manual Scheduling 2

28Ha landscaping site, 31 remote controllers

Rescheduling optimised pump duty required

Rescheduling reduced peak flow by 35%, resulting in less friction losses.



Charts: R Welke

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Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Water Efficiency V's **Energy Efficiency**

Water Efficiency:

a) Water Requirement
b) Irrigation scheduling
c) Distribution Uniformity
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Energy Efficiency:

a) Head pumped
b) Pump effy
c) Motor effy
d) Tariff (c/kWh, $/Litre diesel)
e) ML pumped

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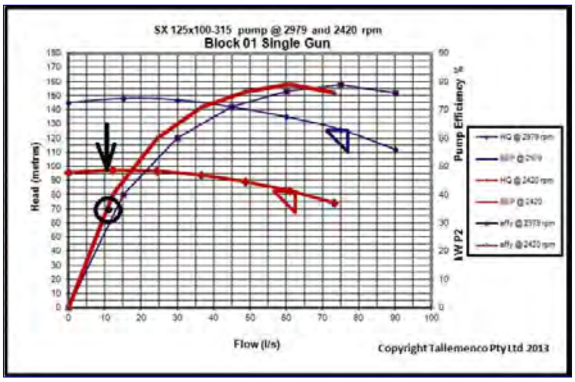
Water Efficiency vs Energy Efficiency
What's the Nexus?

Irrigation Scheduling vs Pump Effy/motor effy

Irrigating cabbages
Lindenow, VIC.
Mitchell River

57kW (75hp) diesel
125x100-315
2950rpm pump



Can affect energy efficiency if irrigation flows are reduced or increased.

$300/ML ($370/ac.ft)

Charts: R Welke

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TALLEMENCO Energy Efficiency for Irrigation

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What's the Nexus?

Water Efficiency V's **Energy Efficiency**

Water Efficiency	Energy Efficiency
a) Water Requirement	a) Head pumped
b) Irrigation scheduling	b) Pump effy
c) Distribution Uniformity	c) Motor effy
d) Crop water use efficiency	d) Tariff (c/kWh, $/Litre diesel)
	e) ML pumped

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Water Efficiency vs Energy Efficiency
What's the Nexus?

Irrigation Scheduling vs Pumped Volume

- ❑ Clay soil
- ❑ 6 water melon plants
- ❑ 8" x 8" soil (paver removed)
- ❑ Pulse irrigation (Hunter X-Core)
- ❑ 1 x Shrubbler
- ❑ Pulse application
- ❑ 1 minute x 4 times/day
- ❑ 0.7 litre per application
- ❑ 360 litres (95 US gall) total
- ❑ 9 melons
- ❑ 86kg (190 lb) crop

Irrigation Scheduling – pulse irrigation

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TALLEMENCO Energy Efficiency for Irrigation

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What's the Nexus?

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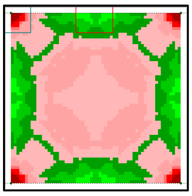
Water Efficiency vs Energy Efficiency
What's the Nexus?

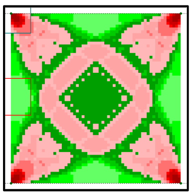
Distribution Uniformity vs Pumped Head

Scheduling Co-efficient

- If CU/DU down
- SC up (Scheduling Coefficient)
- Eg, DU falls from 84% to 73%
- SC rises from 1.3 to 1.6
- That's 23% more water required



Example:
Toro 640 @ 450 kPa
DU = 84%
SC = 1.3



Example:
Toro 640 @ 350 kPa
DU = 73%
SC = 1.6

Image: Space Pro by Hunter

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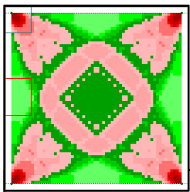
Water Efficiency vs Energy Efficiency

What's the Nexus?

Distribution Uniformity vs Pumped Head



Example:

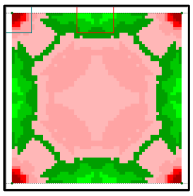
Toro 640
@ 350 kPa

DU = 73%
SC = 1.6

Restoring Pipeline efficiency – known as Pigging or Swabbing

(removing the wheel barrows)

Pigging 6" PVC, Penrith NSW



SC Restored

Toro 640 @ 450 kPa

DU = 84%

SC = 1.3

Image: Space Pro by Hunter

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Water Efficiency vs Energy Efficiency

What's the Nexus?

Pipeline friction

Combine "Hazen & Williams" and "Darcy Weisbach Friction factor" Graph of "Pipe Wall Roughness" to "C" value

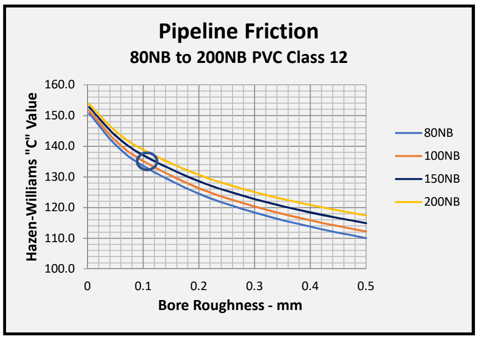
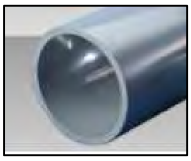


Chart: R Welke

Reduction of 10% pipe efficiency (C=135) due to only 0.1mm (4 thou) of pipe wall roughness.

This level of roughness cannot be seen with naked eye.

New pipe



Used pipe

Photos: R Welke

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Water Efficiency vs Energy Efficiency

What's the Nexus?

Distribution Uniformity vs Pumped Head

Irrigation Trust, SA
2 x 270hp pumps
675 acres vines, almonds, citrus

River Murray, Mannum SA

- ❑ Founded 1968
- ❑ 15", 12", 10", 8" Asbestos Cement pipes
- ❑ Audited 2015
- ❑ H&W C Value new = 140, now = 80 to 110
- ❑ Bryozoa - aquatic invertebrate animals (20 thou long)
- ❑ Overheads at end of farm < ½ irrigation radius
- ❑ DU's 10 to 20%
- ❑ PIR reduced 40% to achieve required distribution efficiency

Long term solution: Replace pipes

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Water Efficiency vs Energy Efficiency

What's the Nexus?

Distribution Uniformity vs Pumped Head

Pump Corrosion **(Pump efficiency and H-Q loss)**

Materials Evaluation

Blue Lake PS, Mt Gambier, SA. 1971

Austenitic Cast Iron casings (Ni Resist)

- ➢ **Resistance to sea water corrosion**
- ➢ used on ships propellers
- ➢ **Ni 20.0, Cr 2.5, C 3.0, Si 2.0, Mn 1.0 typ.**

- ❑ Tested after 1 year for efficiency
- ❑ Down 10%
- ❑ Casings badly corroded
- ❑ Materials specific to water quality

Blue Lake PS
Mt Gambier, SA.
Primary Lift Pumps

Photo: ABC.net.au

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Water Efficiency vs Energy Efficiency

What's the Nexus?

Distribution Uniformity vs Pumped Head

Impeller Coatings Evaluation

Mannum Adelaide No. 1
Pumping Station. 1975

Cast Iron casings, Bronze impellers
- pump tested, efficiency recorded
- impeller coated - DULUX gloss enamel
- pump retested – 4% efficiency gain
- pump tested 1 yr, lost η% and paint

Conclusions
- smooth coating > increased η%
- conventional coatings not satisfactory
- search for hi-tech coatings
- adopted "Belzona", 25% metallic content

Mannum - Adelaide No.1 PS

Photo: R Welke 1973

Water Efficiency vs Energy Efficiency

What's the Nexus?

Distribution Uniformity vs Pumped Head

Impeller Coatings (pump corrosion)

Eg, Irrigation and Water Supply Pumps, Riverland Region, SA, 1980's

Eliminate Blulon (asbestos) gland packing
- move to mechanical seals
- rotating elements balanced
- pump casings coated (Belzona)
- impellers coated (Belzona – 25% metal)

Pumps tested less regularly
- Sustained efficiency
- High reliability

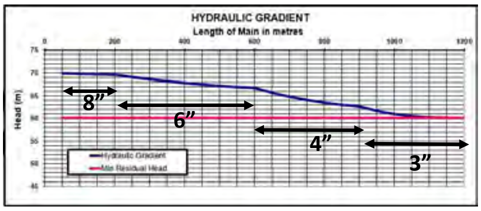
Neil Harvey painting a rebalanced pump impeller with an epoxy coating.

Photo: R Welke

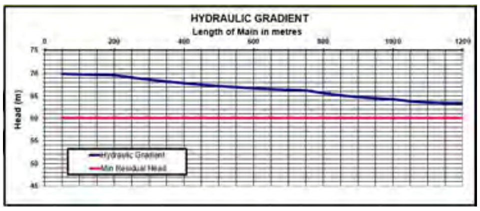
Water Efficiency vs Energy Efficiency

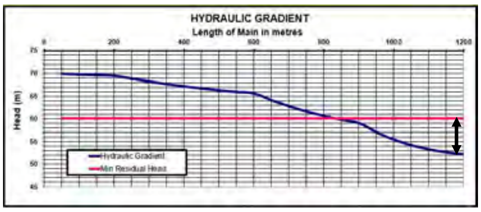
What's the Nexus?

Distribution Uniformity vs Pumped Head



As designed
25 l/s flow
10m head loss





Modified
- Add 3 l/s end of pipe
- 8m extra head loss

Optimized pipe system
- Extend 6" by 150m
- Shortened 4" by 50m
- Shortened 3" by 100m
- Gained 3.4m
- Saved $13,400 / 15 yrs

TALLEMENCO
Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency

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Water Efficiency vs Energy Efficiency

What's the Nexus?

Distribution Uniformity vs Tariff

River Murray, Mannum SA

Irrigation Trust, SA
2 x 270hp pumps
675 acres vines, almonds, citrus

- H&W C Value new = 140, now = 80 to 110
- Overheads at end of farm < ½ irrigation radius
- DU's 10 to 20%
- PIR reduced 40% to achieve required distribution uniformity
- Overflow irrigation into higher day time tariff

1. Energy Charges		
Peak	43063.50 kWh	8.4598 c/kWh
Off Peak	54288.50 kWh	5.2035 c/kWh

TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency

What's the Nexus?

Water Efficiency V's Energy Efficiency

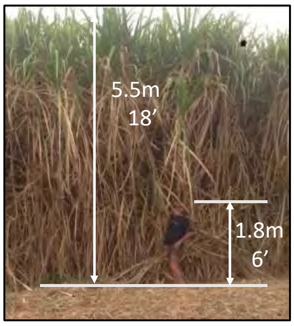
Water Efficiency	Energy Efficiency
a) Water Requirement	a) Head pumped
b) Irrigation scheduling	b) Pump effy
c) Distribution Uniformity	c) Motor effy
	d) Tariff (c/kWh, $/Litre diesel)
d) Crop water use efficiency →	e) ML pumped

Water Efficiency vs Energy Efficiency

What's the Nexus?

Crop Yield vs Pumped Volume (+ Scheduling + Tariff)

Example: Sugar cane crop, Nth QLD



Example per Jim Phillips, ASIC's newest Aussie member – ph +61 435 187 486

BEFORE

- PIR 11mm/day
- CP/LM or Gig Gun (SC 1.2/1.6)
- 11 ML/Ha (8.9 ac.ft)
- Evenly across crop life
- 95 t/Ha (38t/ac) ave
- $2600/Ha ($1040/ac) ave

AFTER

- PIR 14mm/day
- Sub Surface Drip (+30% CAPEX, -30% pumping head, -30% SC)
- 7 ML/Ha (5.7 ac.ft)
- (50% less kWh pumping)
- Growth based irrigation (flowering/fruiting)
- 137 t/Ha (55t/ac) ave, 238t/Ha max
- $4500/Ha ($1800/ac) ave

ML x 0.81 = ac.ft

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TALLEMENCO
Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency

What's the Nexus?

Water Efficiency V's Energy Efficiency

Water Efficiency	Energy Efficiency
a) Water Requirement	a) Head pumped
b) Irrigation scheduling	b) Pump effy
c) Distribution Uniformity	c) Motor effy
d) Crop water use efficiency	d) Tariff (c/kWh, $/Litre diesel)
	e) ML pumped

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Water Efficiency vs Energy Efficiency

What's the Nexus?

Crop Yield vs Tariff

Example: Sugar cane crop, Nth QLD

Irrigation during day time "crop water uptake" = higher tariff costs

ML x 0.81 = ac.ft

Example per Jim Phillips, ASIC's newest Aussie member – ph +61 435 187 486

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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency

What's the Nexus?

Water Efficiency V's Energy Efficiency

Summary

a) Water Requirement
b) Irrigation scheduling
c) Distribution Uniformity
d) Crop water use efficiency

a) Head pumped
b) Pump effy
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e) ML pumped

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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Water Efficiency V's Energy Efficiency

- ❑ How to assess poor energy efficiency?
- ❑ How to design best practice energy efficiency irrigation systems
- ❑ Get more "MPG" from your pumping system!

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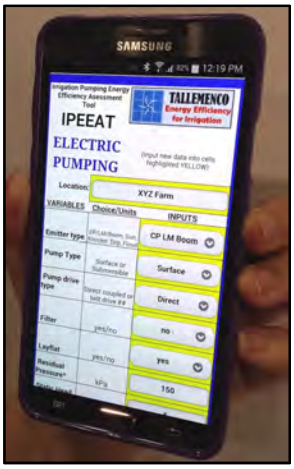
TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

IPEEAT
Irrigation Pumping Energy Efficiency Assessment Tool

An APP based program to:

- assess the energy efficiency of an irrigation pumping system (electric)
- compare it to a similar irrigation system designed to best practice
- determine the commercial viability of pursuing further energy auditing
- Suitable for rising mains up to 1km (1,000 yds) long
- Available on Google Play Store



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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

IPEEAT: Irrigation Pumping Energy Efficiency Assessment Tool

Divides Irrigation into 8 distinct hydraulic models:

- CP/LM, Boom,
- Gun
- Knocker, Rotor,
- Drip, spray
- Flood
- Pipe & Riser
- Transfer
- Marine

Suited for rising main up to 1000 yards long

IPEEAT assesses overall pumping energy efficiency considering both pumping efficiency and hydraulic efficiency by comparing existing on farm performance with a similar type irrigation system built to best practice design in its class

Irrigation Pumping Energy Efficiency Assessment Tool

IPEEAT© Rev 03

ELECTRIC PUMPING

TALLEMENCO Energy Efficiency for Irrigation

Overwrite raw data into cells highlighted YELLOW. Click CALCULATE.

Location:	Greener Lawn, Windsor, NSW	
VARIABLES	Choice/Units	INPUTS
Emitter category	CP/LM/Boom, Gun, Knocker/Rotor, Drip/Spray, Flood, Transfer, Pipe & Riser, Marine	CP LM Boom
Motor Type	Surface or Submersible	Surface
If surface motor	Direct coupled or belt drive ##	Belt
If subby/turbine pump	Is riser pipe >20m? ###	no
Filter type	Filter, Hydrocyclone, None *	none
Layflat	yes/no	yes
Residual Pressure*	kPa	150
Static Head **	metres elevation	6
Water pumped****	ML/yr	140
kWh consumed***	kWh/yr	57,107
Electricity cost	$$/yr	13,705
Electricity tariff	cents/kWh (derived)	24.0
RESULTS (in green cells)		Calculate
Actual Pumping Cost	$$/ML	97.9
Achievable Pumping Cost	$$/ML	42.7
Achievable Electricity Cost	$$/yr	$5,982
Potential Electricity Savings ^	$$/yr	$7,723
Potential Electricity Savings ^	%	56%
NPV (whole years only-15 max) # ^	10	$79,676

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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

IPEEATproLP: Irrigation Pumping Energy Efficiency Assessment Tool Professional (Long Pipe)

Considers:

- Pumping system
- Pipeline system (any length)
- Does not include emitters

IPEEATpro assesses pipeline energy efficiency by comparing existing on farm pipeline performance with a similar type pipeline system built to best practice design in its class over 25yr life cycle.

Under development

Release late 2017

23	RESULTS (in green cells)		Calculate
24	COSTS	System	
25	Actual Pumping Cost	$$/ML	173.7
26	Potential Pumping Cost	$$/ML	85.1
27	Potential Electricity Cost	$$/yr	$121,280
28	SAVINGS achievable	Pumps	Hydraulics
29	System Efficiencies	33.2%	102.1%
30	Electricity Savings $$/yr	$126,243	$0
31	Combined potential electricity savings	$126,243	
32	Potential Electricity Savings %	51%	0%
33	Scheme Life (yrs only, 15 max)	10	
34	Nett Present Value	$1,302,445	$0
35	EMISSIONS	SA	
36	kg CO^2 - e/kWh	0.56	
37		Pumps	Hydraulics
38	Carbon Emissions Savings/yr, tonne	388.22	0.00
3.5	Copyright TALLEMENCO PTY LTD 2017 www.talle.biz rob@talle.biz ph 0414 492 256		

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TALLEMENCO
Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Irrigation System Design approach - typical

Irrigation design

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Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Irrigation System Design approach - typical

Irrigation design

Pumping/pipeline design – all too often

Irrigation control
Life Cycle Costs
Pump cost
NPSH
Energy cost
Corrosion
Pump control
Pipeline friction
PS design
Specification

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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Irrigation System Design approach - Tallemenco

Irrigation design

Pumping/pipeline design

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TALLEMENCO Energy Efficiency for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

TALLEMENCO – Online Training

"Advanced Pumping & Hydraulics"

(Teaches how to apply pumping energy efficiency principles to existing irrigation systems)

6 sessions of 2 hrs per session over 6 weeks
Next course commences May 30th 2017
Cost $650 AUD

"Advanced Pumping System Design"

(Teaches how to design pumping energy efficiency principles into new irrigation systems)

6 sessions of 2 hrs per session over 6 weeks
Next course commences May 30th 2017
Cost $650 AUD

Both courses endorsed by Irrigation Australia Limited (IAL) for Professional Development – 2 PD points each

Courses run through River Murray Training, Berri South Australia. Ph Barb on +61 417 824 442.

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TALLEMENCO
Energy Efficiency
for Irrigation

Water Efficiency vs Energy Efficiency
What's the Nexus?

Water Efficiency V's Energy Efficiency

Proudly presented
by

Rob Welke, Tallemenco

Thank you

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