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2019 NATIONAL CONFERENCE
SANTA FE, NEW MEXICO

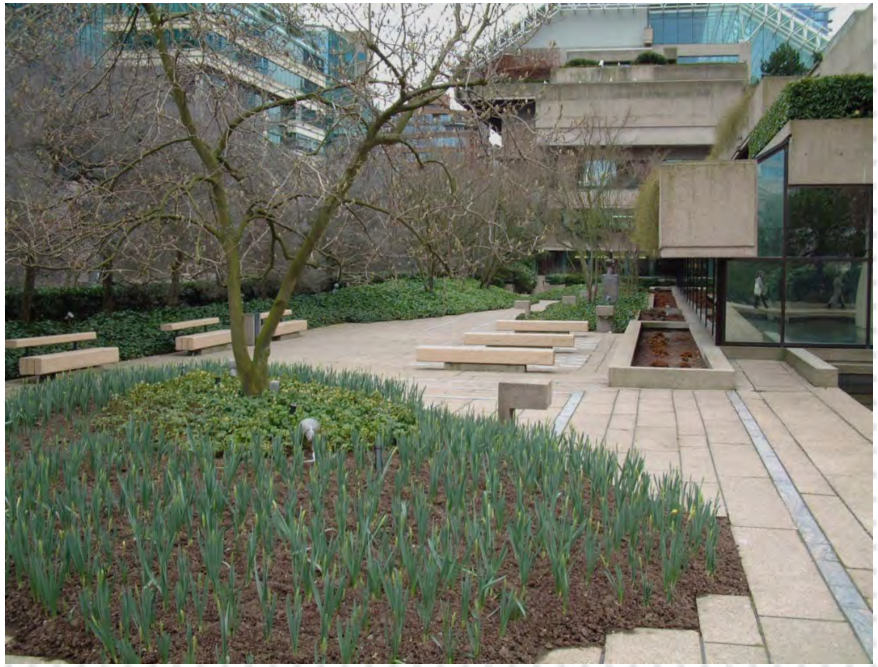
Irrigation for Green Roofs

Brad Rowe

Michigan State University

Design Intent

Intensive greening



Extensive greening

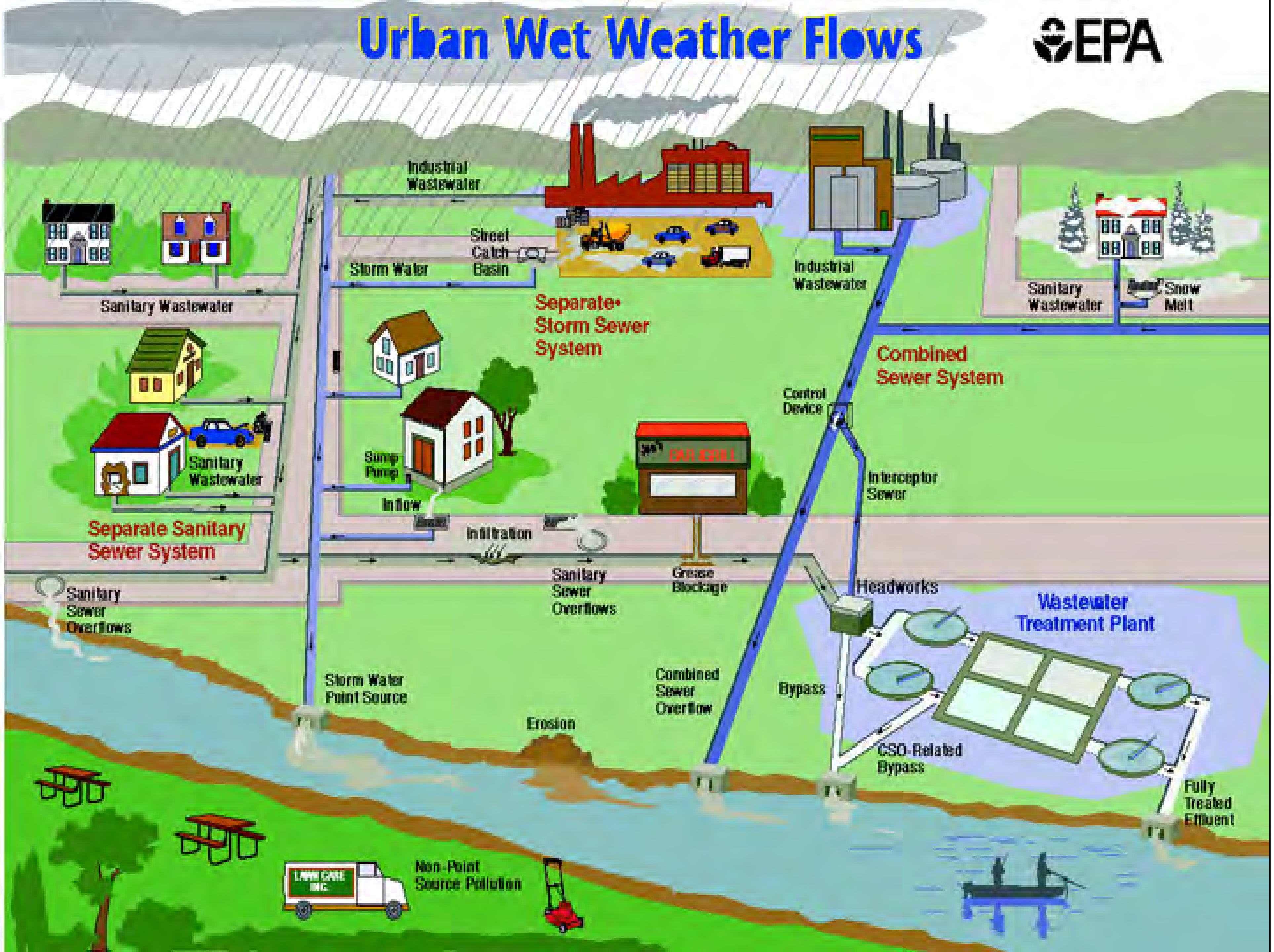

Delta

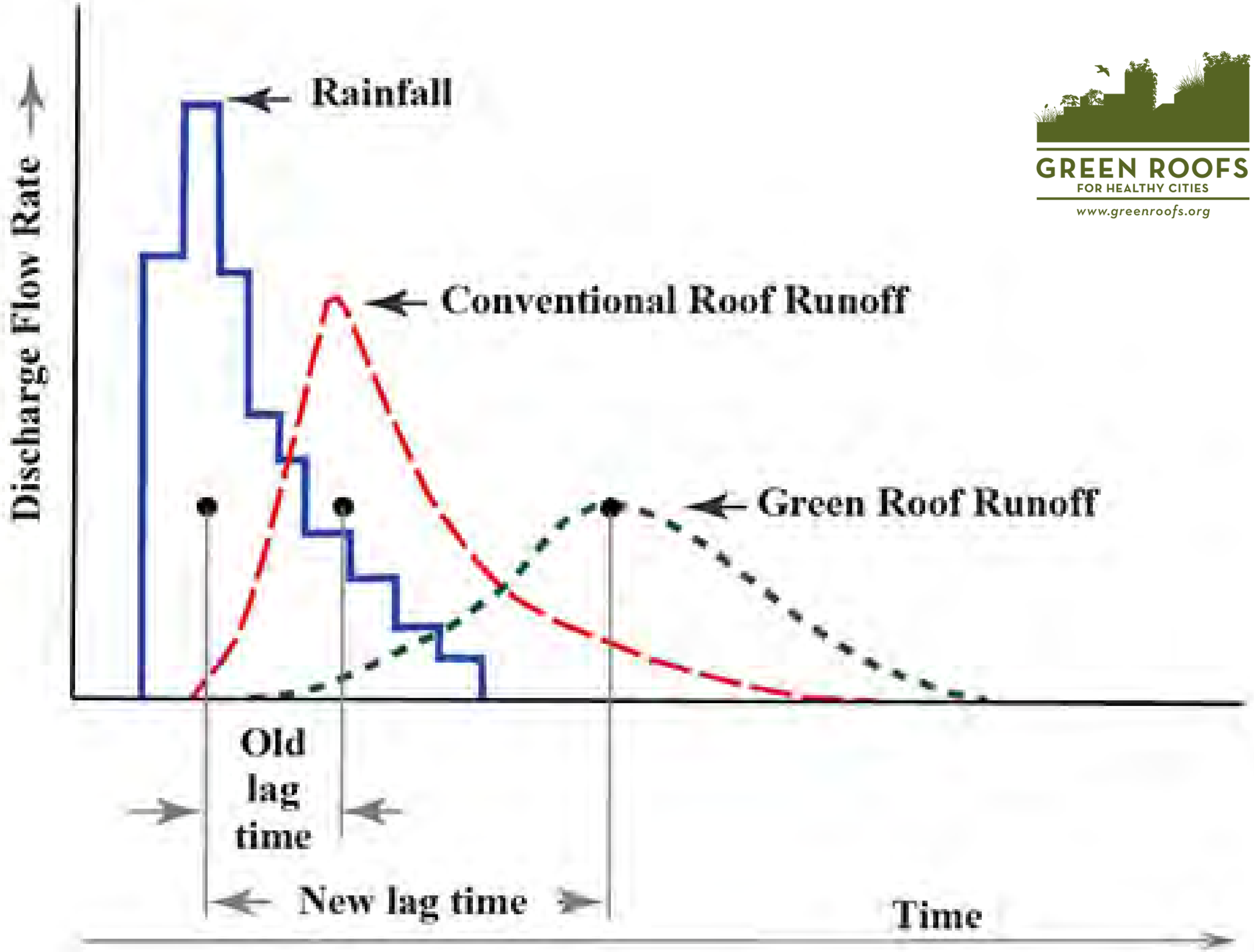

Ford


Photo © Walbridge Aldinger


August 2018

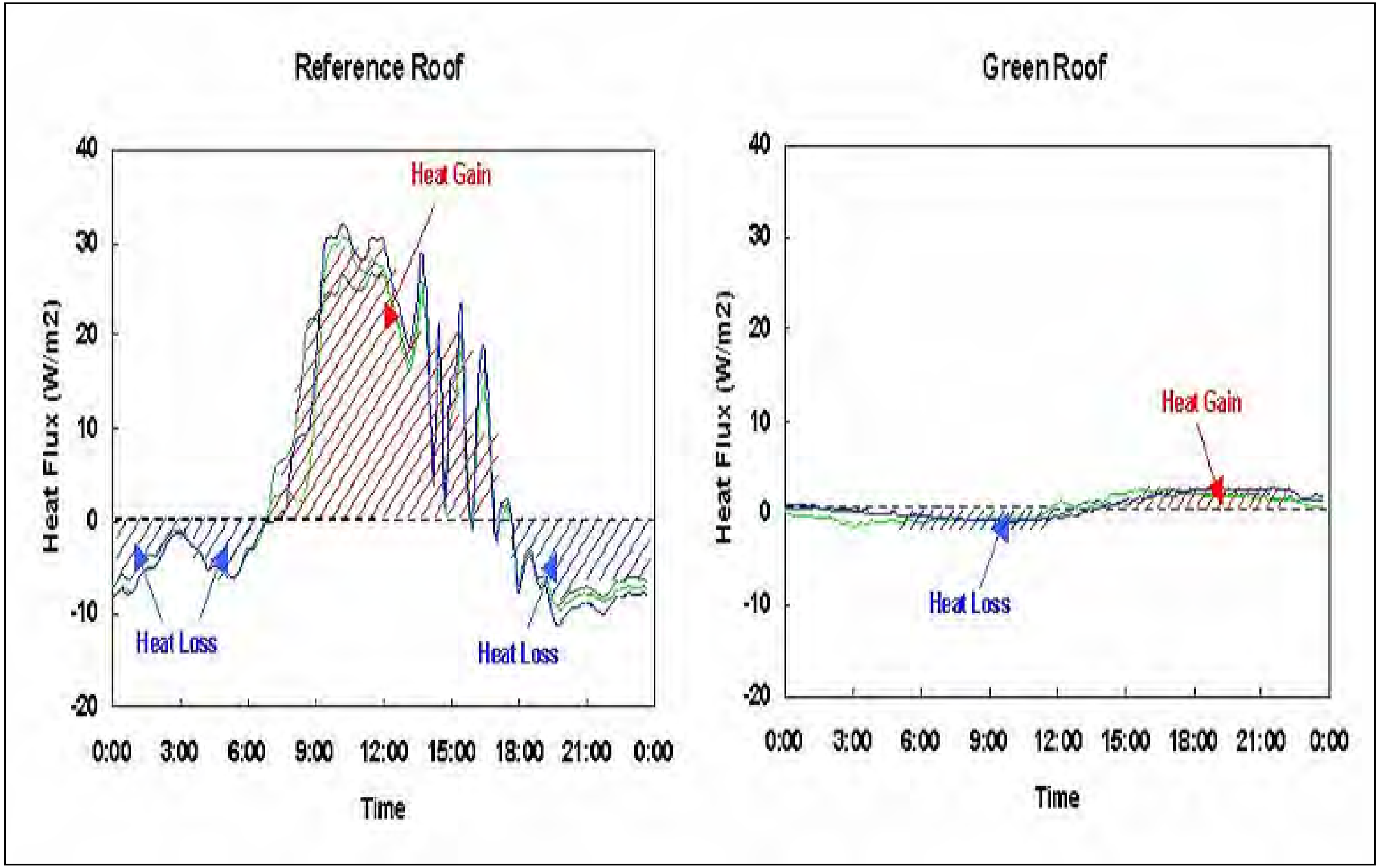
Why Green Roofs?


Urban Wet Weather Flows
EPA
Industrial Wastewater
Street Catch Basin
Storm Water
Sanitary Wastewater
Separate Storm Sewer System
Industrial Wastewater
Sanitary Wastewater
Snow Melt
Combined Sewer System
Control Device
Interceptor Sewer
Sanitary Wastewater
Sump Pump
Inflow
Infiltration
Separate Sanitary Sewer System
Sanitary Sewer Overflows
Grease Blockage
Headworks
Wastewater Treatment Plant
Sanitary Sewer Overflows
Storm Water Point Source
Combined Sewer Overflow
Bypass
Erosion
CSO-Related Bypass
Fully Treated Effluent
LAWN CARE INC.
Non-Point Source Pollution



GREEN ROOFS
FOR HEALTHY CITIES
www.greenroofs.org

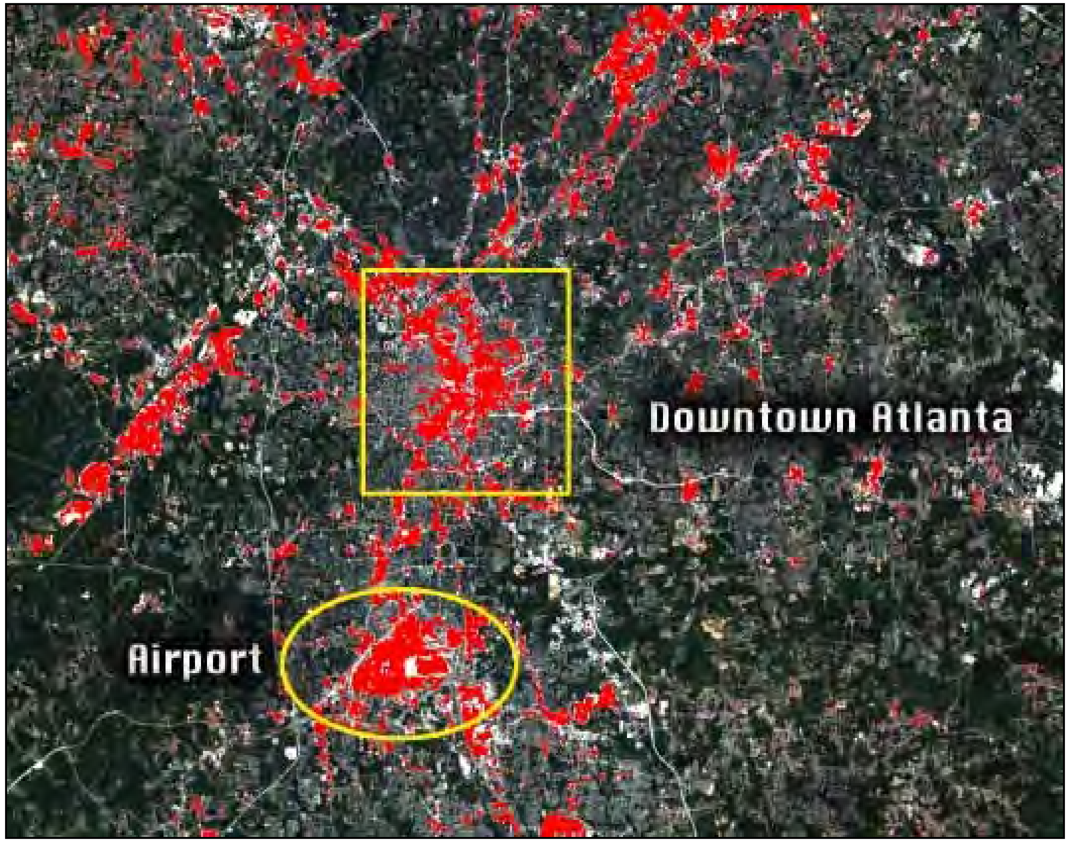
Energy Efficiency



Source: National Research Council , Institute for Research in Construction

Urban Heat Island Effect

Source: Environment Canada



Source: Remote Sensing Advanced Technology

Cantonel University Hospital, Basel


Uncommon Ground Restaurant, Chicago


Brooklyn Grange Navy Yard Farm


CARRABBA'S
ITALIAN GRILL
RESERVED PARKING
RESERVED PARKING
RESERVED PARKING

Benefits

- Stormwater management – Quantity and Quality
- Building insulation / Moderation of urban heat island
- Longevity of roof membrane
- Water and air purification, Noise reduction
- Carbon sequestration
- Aesthetics
- Recovery of green space / Human health
- Biodiversity
- Urban food production

Should green roofs be irrigated?

Irrigated roofs

- Efforts to ban or limit irrigation
  - Portland Bureau of Environmental Services adopted laws limiting irrigation on roofs receiving benefits from the city (Schroll et al., 2011)
- Source
  - Potable
  - Collect runoff
  - Grey water

Irrigated roofs - Yes

- Plant establishment/health/survival
- Drought
- Erosion – Wind/Water
- Aesthetics
- Intensive/Extensive (species dependent)
- Rooftop agriculture
- ET – Energy conservation
- Carbon sequestration

Irrigated roofs - No

- Cost
- Maintenance of system
- Water availability
- Wasting water
- Reduces stormwater retention
- Nutrient leaching/pollution
- Plant dependence
- Fewer weeds


Should green roofs be irrigated?
And if so, then how?

Objectives

- Determine irrigation efficiency of overhead, drip, and sub-irrigation for coarse green roof substrates

  - Water retention and distribution
  - Plant growth and health

Rowe, D.B., M.R. Kolp, S.E. Greer, and K.L. Getter. 2014. Comparison of irrigation efficiency and plant health of overhead, drip, and sub-irrigation for extensive green roofs. Ecological Engineering 64:306-313. (http://dx.doi.org/10.1016/j.ecoleng.2013.12.052)

Green roof substrates

- Shallow depths
  - Must have adequate pore space to allow for drainage
- Coarse
  - Less water holding capacity
  - Little capillary movement
  - Vertical and lateral
- Increase depth
  - Weight limitations

Materials and Methods - Phase I

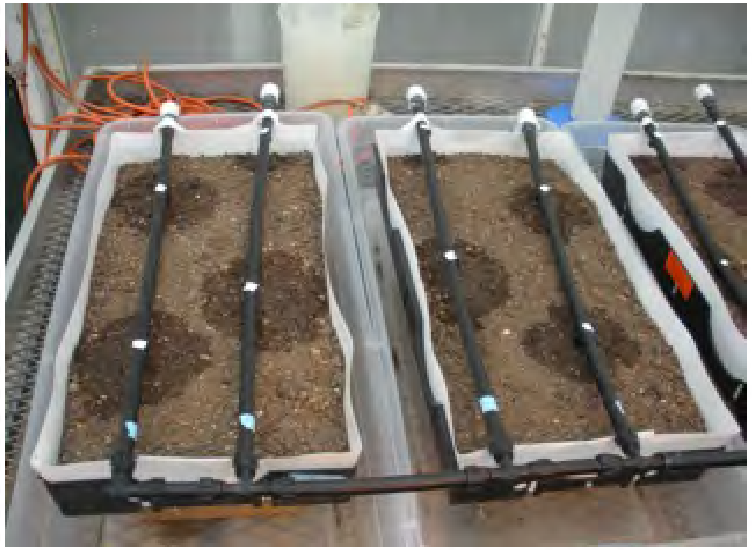
- MSU Plant Sciences Greenhouses
- LiveRoof modules
  - (30.5 cm x 61 cm x 10 cm)
- Treatments
  - 3 irrigation methods
  - 5 substrates/systems
  - 8 replications

Irrigation methods

- Overhead
  - Fixed spray heads 5 ft matched precipitation rate nozzles

Irrigation methods

- Drip
  - Pressure compensating 3.78 liters/hr (1 gal/hr) emitters
  - 4 emitters per module (spaced 30 cm on 2 lines)



Irrigation methods

- Sub
  - Pressure compensating 3.78 liters/hr (1 gal/hr) emitters on dripper line
  - 4 emitters per module (spaced 30 cm on 2 lines)

Substrates

- LiveRoof
- LiveRoof with 100% vegetation
- Renewed Earth (MSU)
- Renewed Earth (MSU) with Moisture Retention Fabric (MRF)
- Fafard
  - Fafard 3B Professional Formula Potting Mix

- Depth = 10 cm

Substrate physical properties

Property	Renewed Earth (MSU)	LiveRoof	Fafard
OM by LOI @ 360 ºC (%)	1.2	4.9	54.1
Bulk density (g/cm^3)	1.20	1.04	0.22
Capillary pore space (%)	18.97	19.93	43.45
Non-capillary pore space (%)	21.33	27.70	28.93
Infiltration rate (cm/hr)	34.01	90.60	28.60
Water holding capacity @ 0.1 bar	15.86	19.17	196.35

A&L Laboratories, Fort Wayne, IN

Substrates

- Moisture retention fabric
  - 0.75 cm thick
  - Capable of holding 5.7 kg/m^2 of water

Vegetated modules

Sedum acre ‘Aureum’

S. album ‘Coral Carpet’

S. floriferum ‘Weihenstephaner Gold’

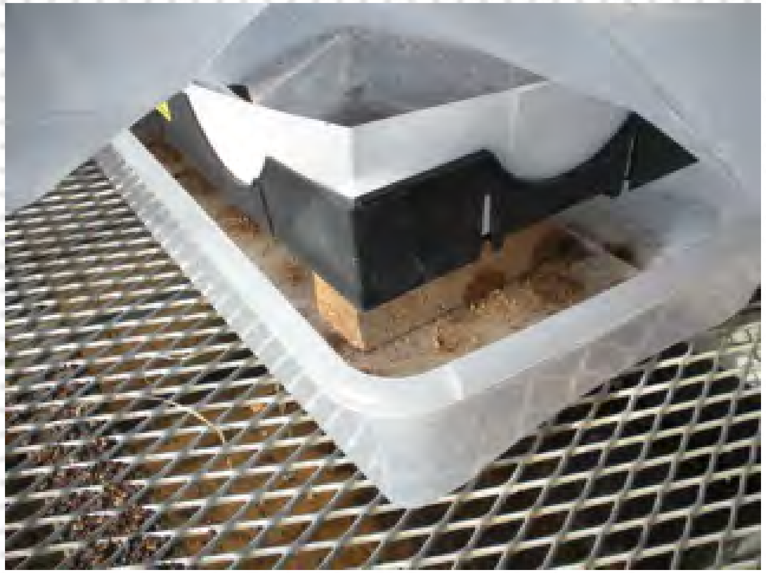
S. rupestre ‘Angelina’

S. spurium ‘Fuldaglut’

S. takesimense ‘Gold Carpet’

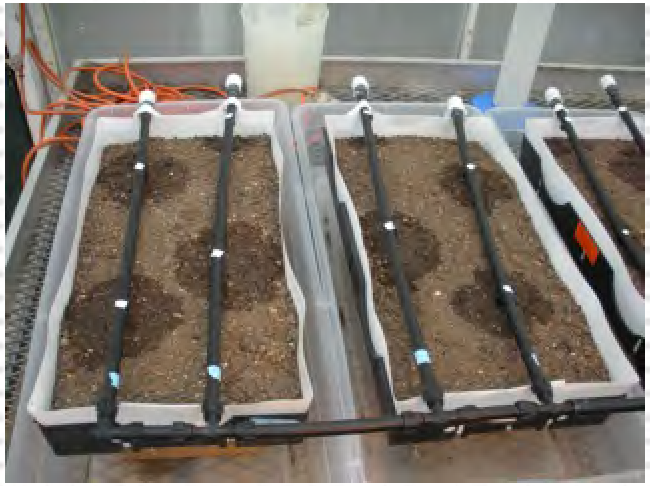
Data collection

- Water applied
  - 30 minutes
  - Modules dried to VMC = 0 before next application
- Volume of runoff (Wasted water)
  - Collected in tubs
- Water retention
  - Weight of module
    - Initial
    - Final at 40 minutes (Container capacity)

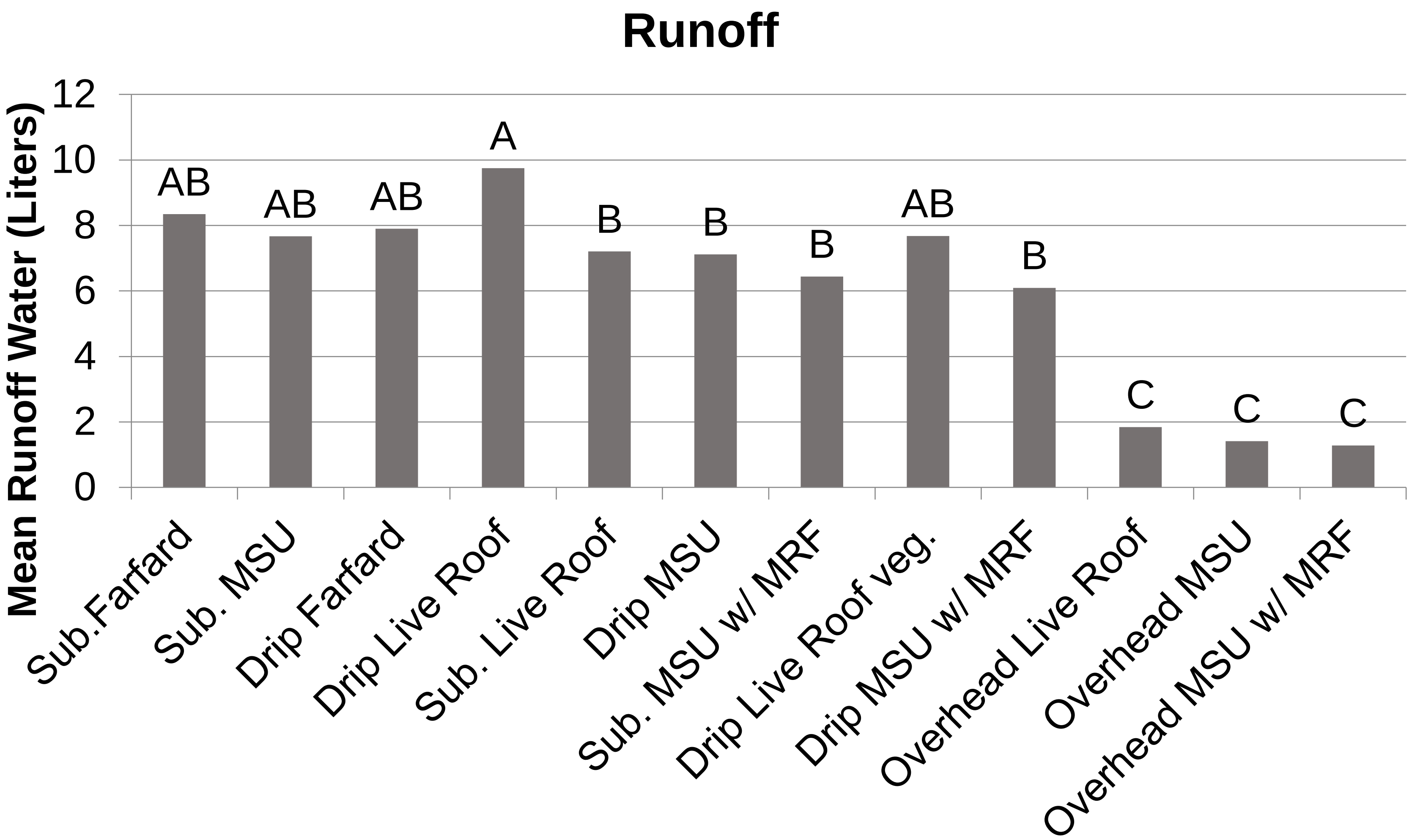


Data collection

- Water dispersal
  - Distance surface water front moved horizontally from emitter at 10, 20, and 30 min
- Volumetric moisture content (Theta probe ML2x, Delta-T Devices, Ltd., Cambridge, U.K.)



Results – Phase I



Letters represent mean separation by Tukey's honestly significant difference (P<=0.05)

Wastewater runoff and water retention 10 minutes after termination of irrigation treatment (n = 8).

Irrigation method	Substrate	Retention (L)	Runoff (%)
OH	Live Roof	2.5 DEF	34.7 F
OH	Renewed Earth (MSU)	2.7 EF	21.8 F
OH	Fafard	1.2 B	58.9 DE
OH	Renewed Earth (MSU) MRF	3.0 F	18.6 F
Drip	Live Roof	1.9 CDE	83.1 BC
Drip	Renewed Earth (MSU)	1.4 BC	82.6 BC
Drip	Fafard	1.3 BC	85.6 B
Drip	Renewed Earth (MSU) MRF	2.9 F	67.3 E
Drip	Veg Live Roof	2.3 DEF	77.3 CD
Sub	Live Roof	1.7 BCD	80.8 BC
Sub	Renewed Earth (MSU)	0.6 A	92.3 A
Sub	Fafard	0.4 A	95.9 A
Sub	Renewed Earth (MSU) MRF	1.8 BCDE	78.3 C

Means separation with Tukey's adjustment. Upper case letters denote differences in columns.

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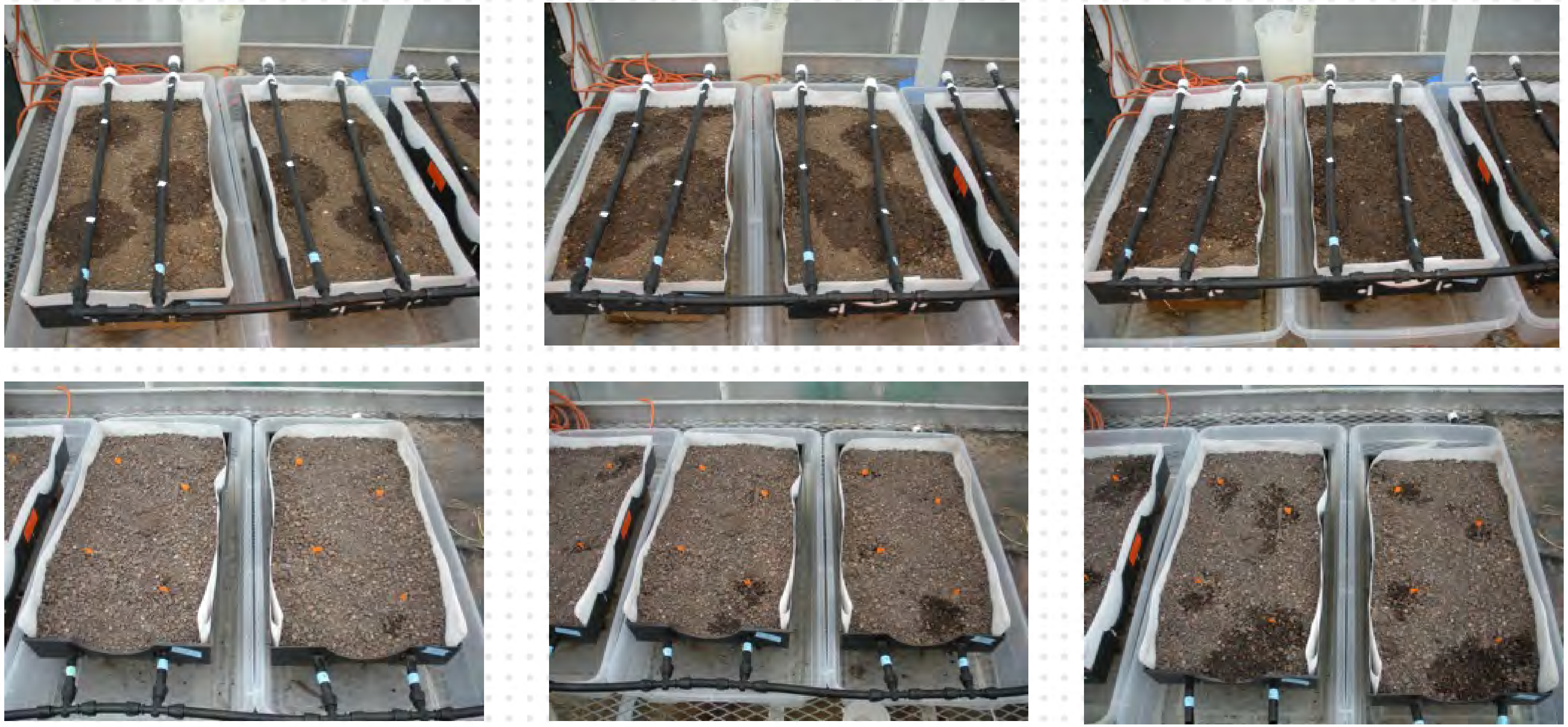
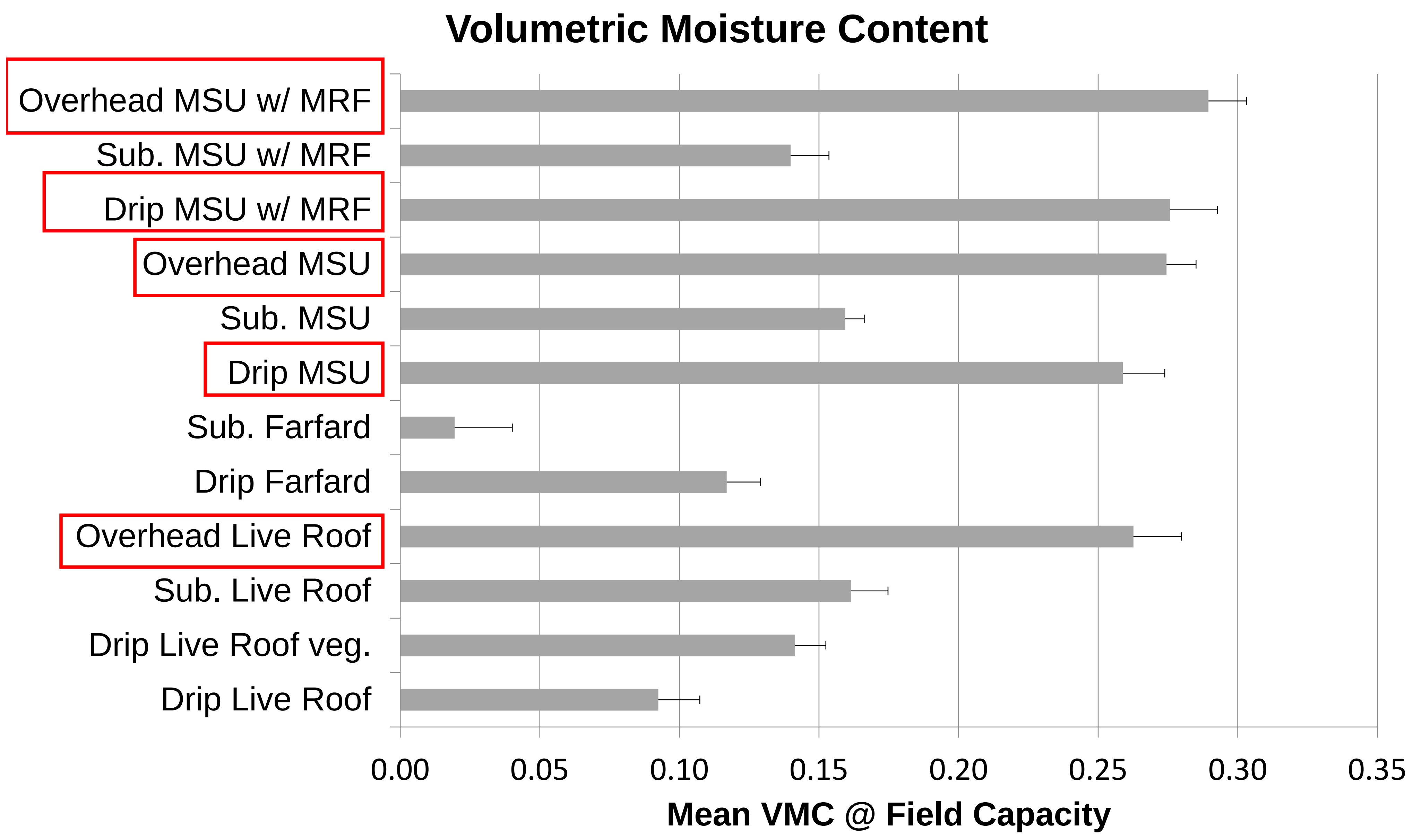
Water front movement

Drip

Sub



10 min 20 min 30 min


Volumetric Moisture Content
Overhead MSU w/ MRF
Sub. MSU w/ MRF
Drip MSU w/ MRF
Overhead MSU
Sub. MSU
Drip MSU
Sub. Farfard
Drip Farfard
Overhead Live Roof
Sub. Live Roof
Drip Live Roof veg.
Drip Live Roof
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Mean VMC @ Field Capacity

Materials and Methods - Phase II

- Substrate (10 cm)
  - Renewed Earth with and w/o MRF
- Irrigation
  - OH, drip, sub, and no irrigation
- Plants
  - *Sedum album*
  - *Sedum floriferum* (*S. kamtschaticum* var. *floriferum*)
  - 8 plugs of each species per module
- 4 replications per treatment

Data collection

- Survival
- Growth
- Plant stress (Chlorophyll fluorescence)
- Substrate volumetric moisture content
- Harvested dry weights (day 84)




Influence of irrigation method on plant growth and health

Irrigation method	Plant Dry Wt	Root:Shoot Ratio	Chlorophyll Fluor (day 63)
Sedum album			
OH MRF	1.05 A	0.11 AB	0.792 A
OH No MRF	0.99 A	0.08 ABC	0.795 A
Sub MRF	0.94 A	0.05 CD	0.811 A
Drip No MRF	0.77 AB	0.06 BCD	0.817 A
Drip MRF	0.59 AB	0.03 D	0.821 A
Sub No MRF	0.40 B	0.05 CD	0.728 B
No Irrigation	0.09 C	0.13 A	0.449 C
Sedum floriferum			
OH No MRF	1.64 A	0.14 B	0.834 A
OH MRF	1.45 AB	0.19 B	0.836 A
Drip MRF	0.99 BC	0.18 B	0.826 AB
Sub MRF	0.89 C	0.21 B	0.801 BC
Drip No MRF	0.83 C	0.14 B	0.834 A
Sub No MRF	0.66 C	0.38 A	0.730 C
No Irrigation	0	0	0.026 D

Means separation with Tukey’s adjustment (n=16). Upper case letters denote differences in columns.

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Overhead


Drip


Sub


No irrigation

Conclusions

- Overhead was most efficient.
- Perceived water conservation with drip or sub-irrigation may be shortsighted and result in wasting water.
- Moisture retention fabric improved performance of drip and sub-irrigation.
- Must choose most cost effective and environmentally friendly method based on climate, design intent, plant selection, and substrate depth and composition.

Other considerations

- Results for these substrates and conditions
- Substrate composition (capillary action) and depth
- Irrigation scheduling
- Emitter flow rates
- Increase number of emitters
- Recirculate runoff
- Wind
- Evaporation
- Plant establishment vs. Growth
- Crop grown

ASIC

2019 NATIONAL CONFERENCE
SANTA FE, NEW MEXICO

Options and Trends for Remote Monitoring and Control of Pumping Systems

Richard Embry

General Manager

ProPump & Controls, Inc.

Today's Speaker has been working with irrigation, pumps, and controls for over 44 years.

Which may have been too long.

Background Information

ProPump & Controls is an independent contractor specializing in sales, installation, and service of pumps, pump stations, pump controls, and SCADA systems.

We work in several different markets: Turf and Agricultural irrigation, Muncipal Water and Waste Water, and Industrial.

Background Information

In 2004, operating then as Flowtronex Field Service, our personnel in what is now ProPump & Controls began immersing ourselves in technology in everyday use in SCADA applications, in a big step beyond the pump station monitoring systems of the time.

Today's pump station monitoring systems have advanced considerably since 2004, with the utilization of ethernet capable PLC's and data storage in the Cloud.

So What is SCADA?

Supervisory Control And Data Acquisition.

(With emphasis on DATA Acquisition)

SCADA combines automation controls and data acquistion with telemetry.

Four Components of a SCADA System

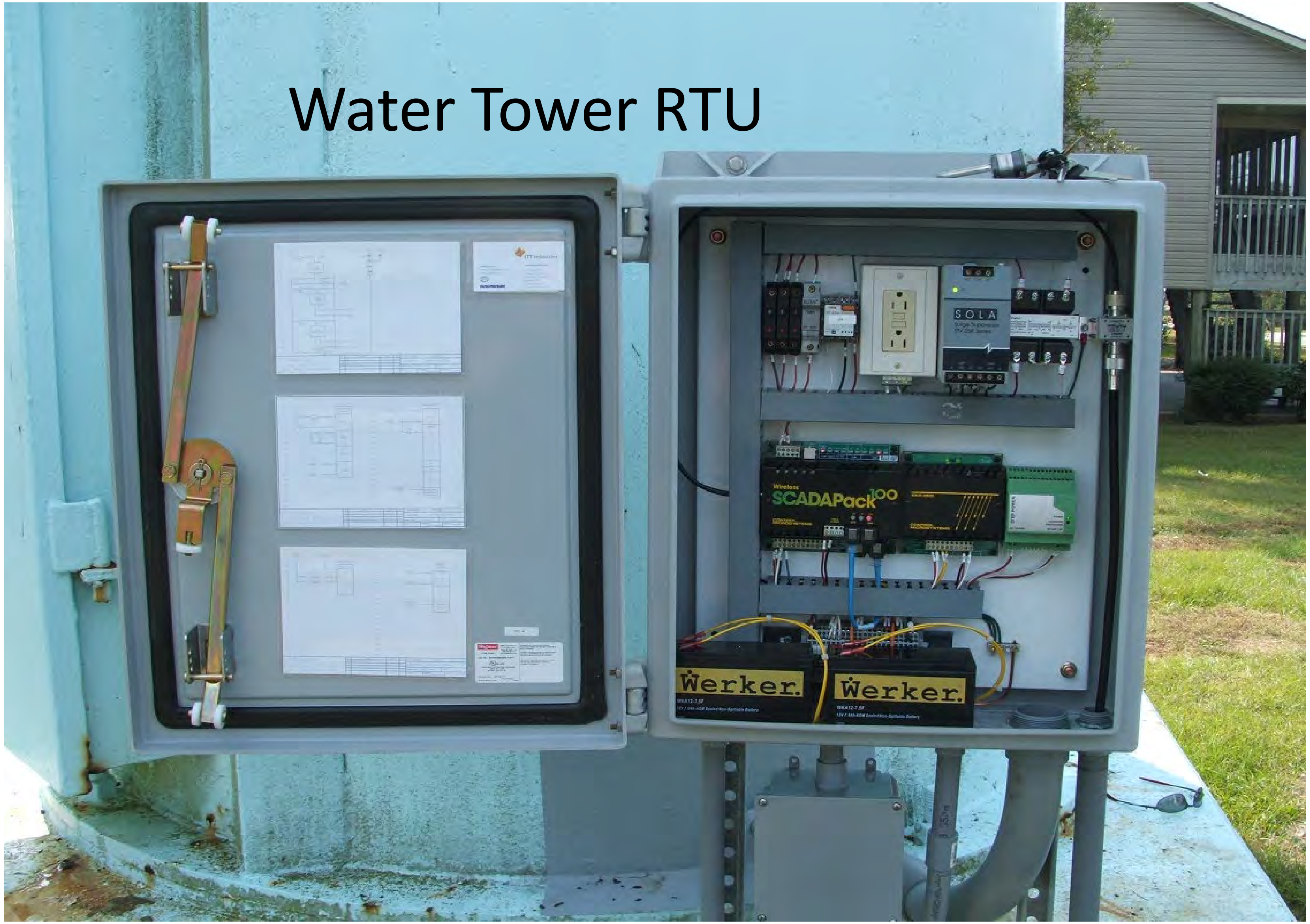
Field Hardware

Communications or Telemetry

Central Station (PC or Master Controller)

Integration: HMI software Package

Water Tower RTU



Telemetry Means

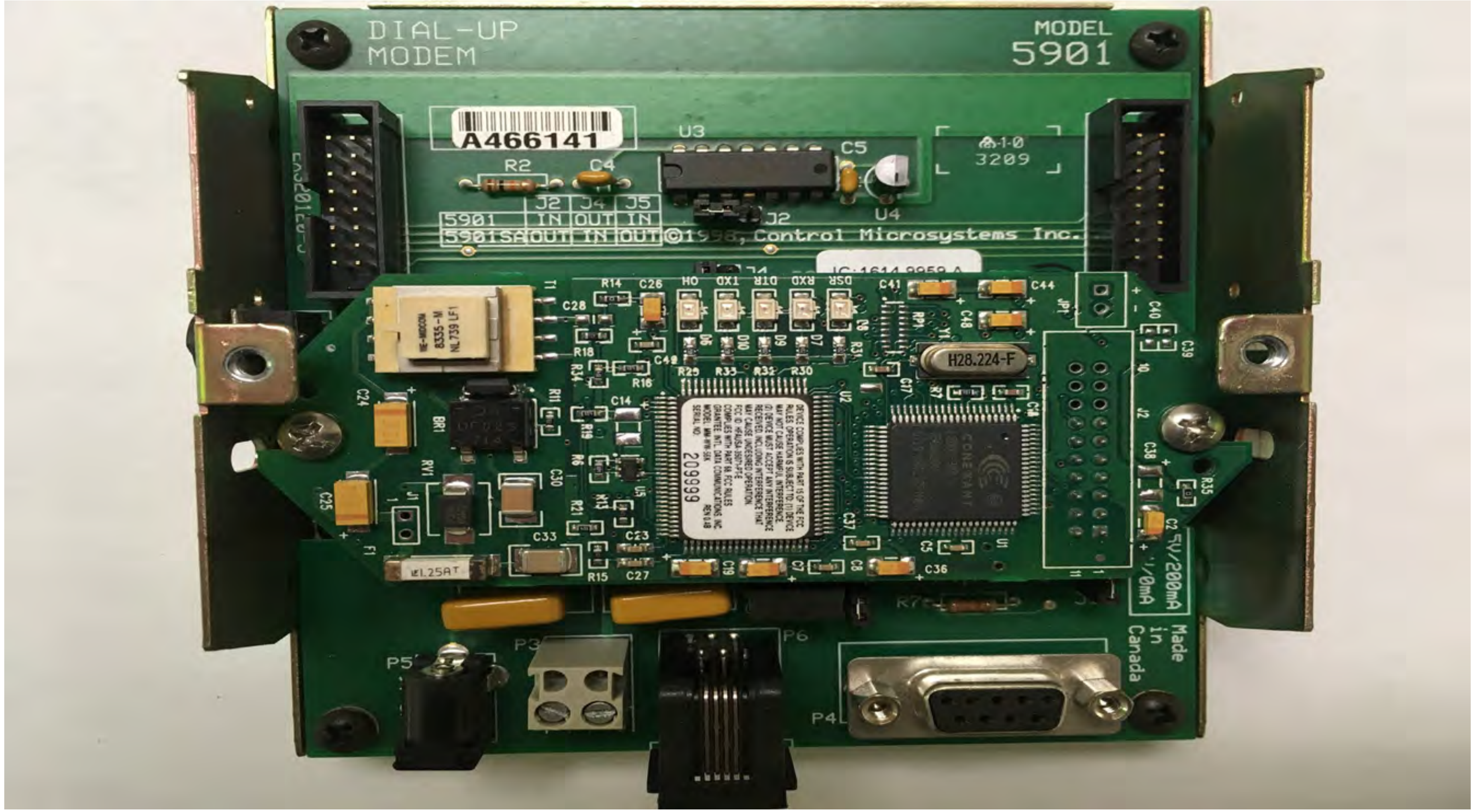
Hardwire—common for equipment within close proximity

Telephone Modems - Dedicated (Leased) Line, Dial Up—early technology, 1200 bps

Fiber Optic—fast and impervious to noise, lightning and electrical surges

Hard-Wired Systems

1200 Baud Bell Modem for Dial-up Connections



Telemetry Means

- Radio—Licensed (UHF/VHF) and Unlicensed Spread Spectrum (900 Mhz/2.4 GHz)
- Cellular—including carrier frequencies
- Internet—DSL, LAN networks
- Satellite--Commonly used where DSL and Cellular communications are not available.

VHF-UHF 5 watt Licensed Radios

UHF and VHF Narrow-Band Licensed Radios

- Require FCC licenses and fees
- Frequency “refarming” has made licenses easier to obtain.
- Use with PLC’s for store and forward capability.

UHF and VHF Narrow-Band Licensed Radios

- Robust, with longer range better penetration of vegetation than higher frequency radios.
- Line of sight may not be required.
- Not enough throughput for many modern requirements.

Spread Spectrum Radios—900 MHz & 2.4 GHZ

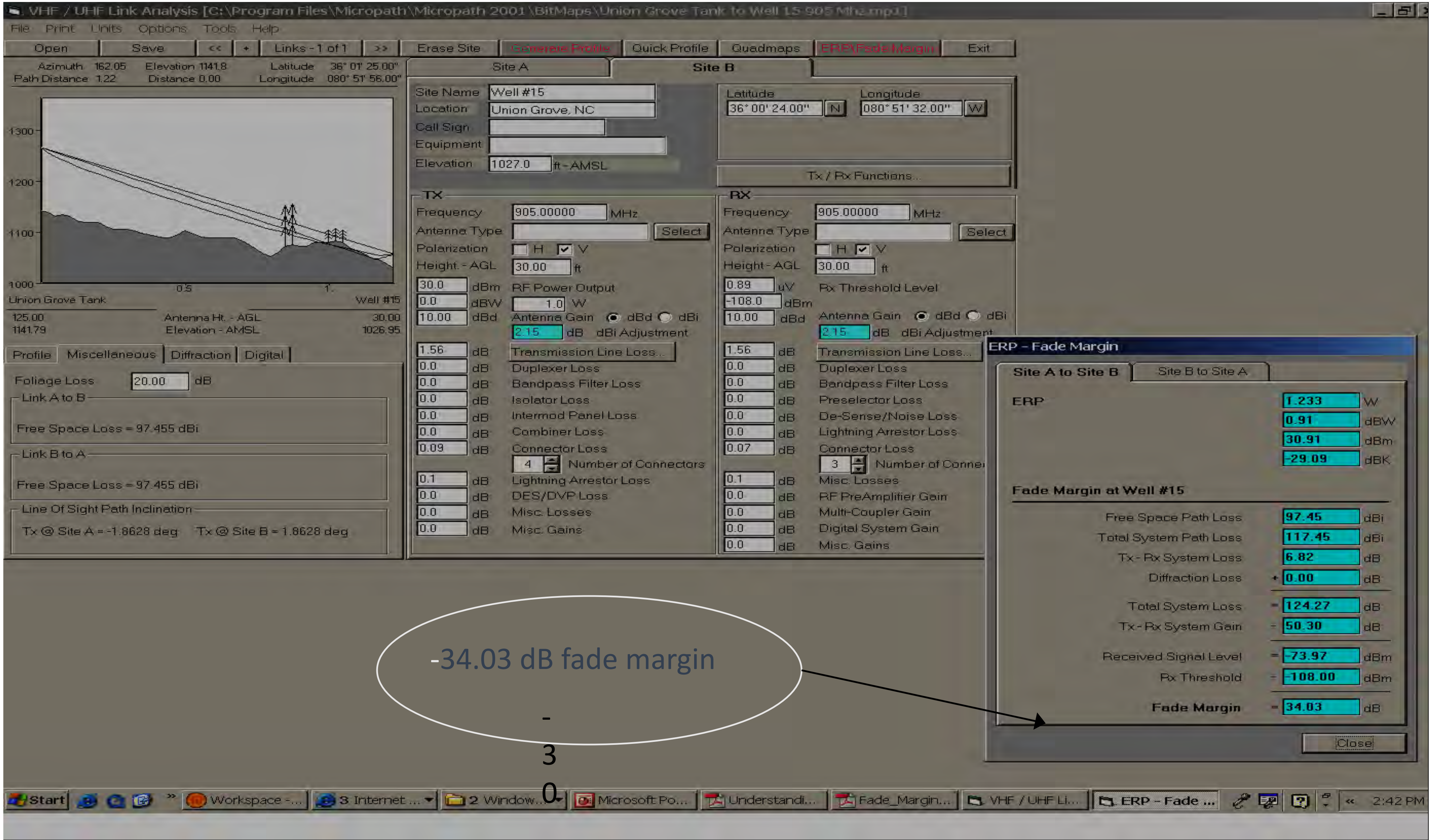
Unlicensed Spread Spectrum Radios

- Serial and ethernet models available.
- Each radio has repeater capability.
- Frequencies ranging from 900 MHz to 2.4 GHz for “long range” radios.
- Baud rates up to 80 kpbs to 4Mbps (Freewave)

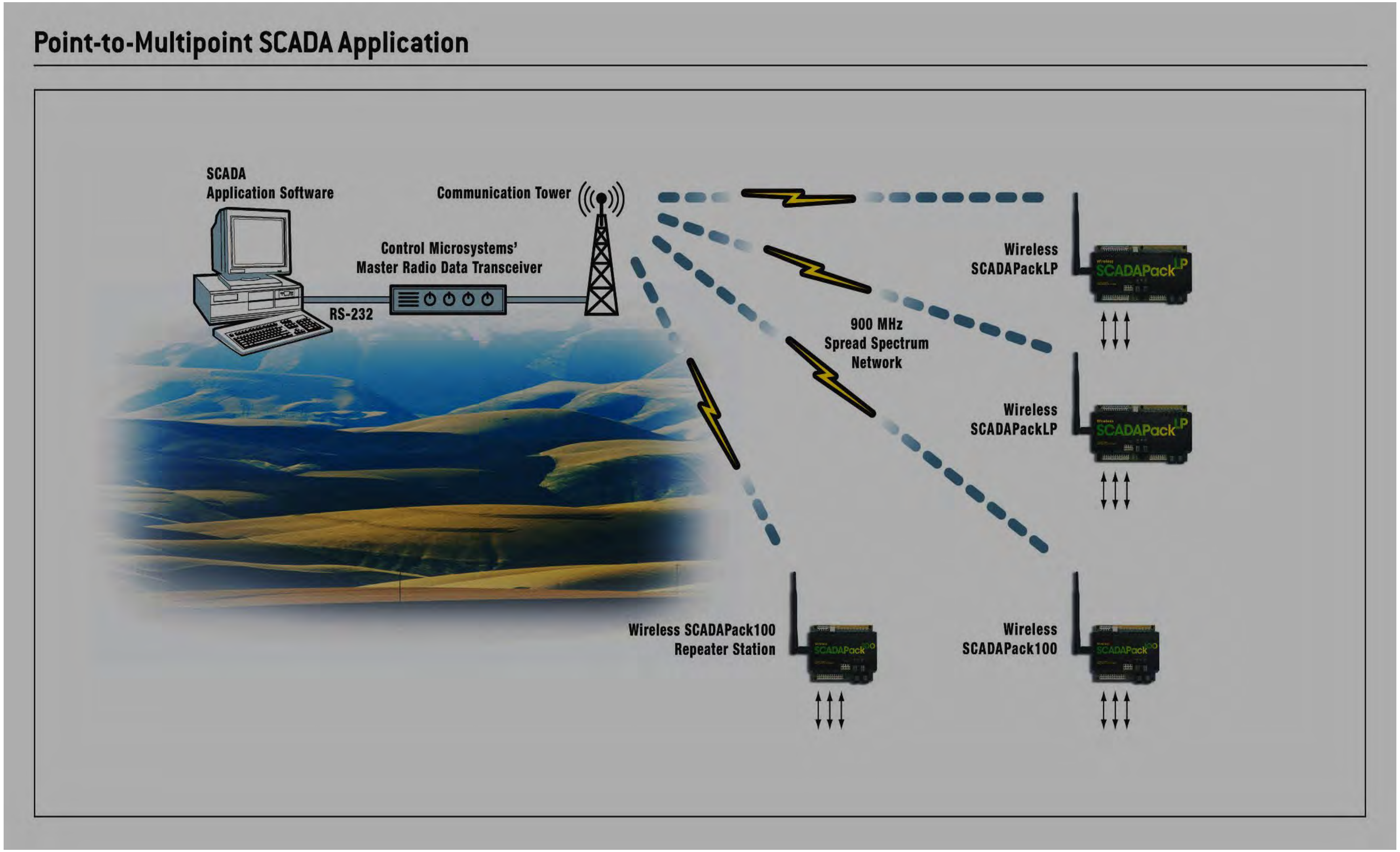
Unlicensed Spread Spectrum Radios

- Programmable for frequency and power output.
- Limited by FCC to 3.4 watts ERP.
- Line of sight recommended.
- Penetration through vegetation, especially pine trees, is poor

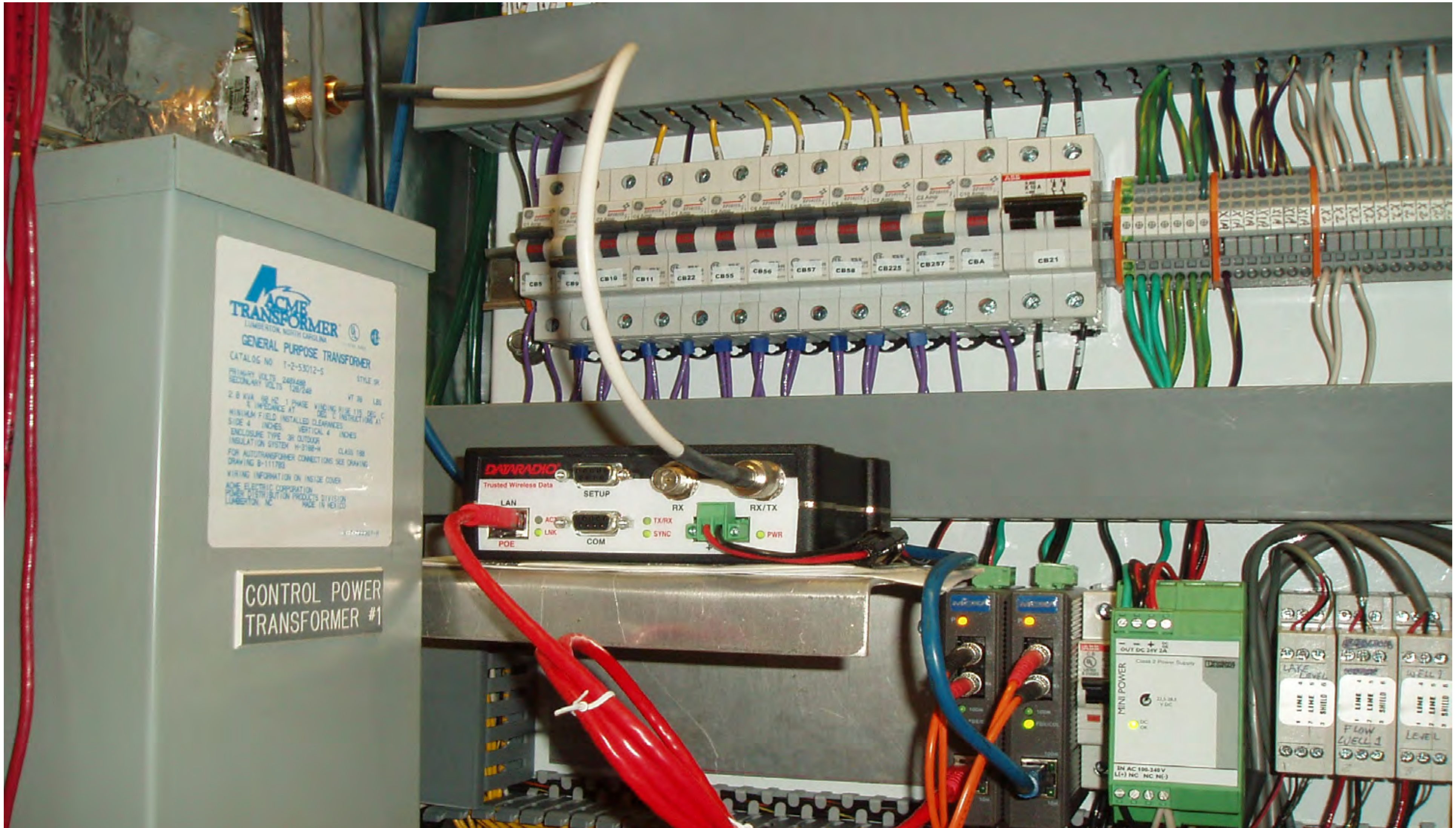
Radio Path Analysis Software



High Infrastructure Costs with Radio Based Systems



Useful tip: In lightning prone areas, use a Fiber Optic Cable Interface to Isolate PLC from Lightning Stike on Radio Antenna



Cell Modem


AirLink® LS300
Network
Signal
Activity
Power
Reset
POWERED BY ALEOS™

Cell Modems

- Cell phone systems minimize expenditure for site surveys & antenna systems for a private radio system.
- 2nd and 3rd Generation Cell networks are being phased out by ATT and Verizon in favor of 4G LTE networks.
- Older cell modems subject to attacks by hackers to use them in bot networks or gain access to control panels. New versions are more secure.
- Early drawback of high charges for data by the carriers has been greatly reduced with the development of protocols allowing “Report by Exception” for data transfer.

Cell Modems

- 4G LTE networks allow realistic download speeds of 5-12 Mbps and upload speeds of 2-5 Mbps.
- These speeds allow use with protocols which permit “Report by Exception” messaging to greatly reduce user costs for data.
- Cell phone modems are rapidly becoming the preferred communication link in the turf irrigation industry.

Protocols

A protocol is simply a set of rules which govern the formatting, control procedures, and relative timing between devices in a control system.

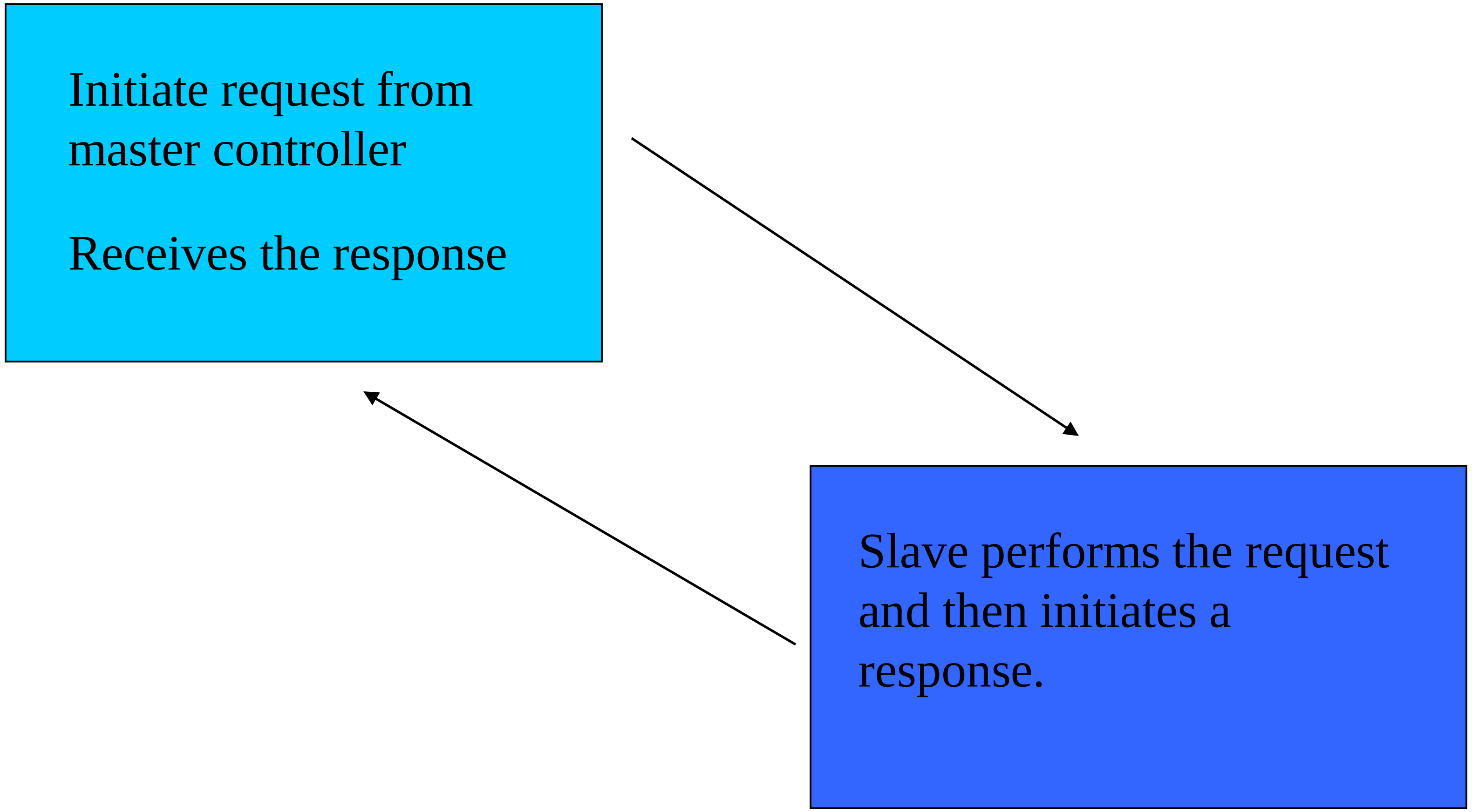
Modbus

- Modbus is an open, serial communications Master – Slave protocol widely used for years in conventional SCADA systems.

- With Modbus the master controller has full control of communication, whereas a slave will only respond when polled by the master. Modbus is simple to implement and good for small control applications where a small amount of data needs to be transferred from Point A to Point B.

- Modbus TCP/IP was added later as a means of encapsulating a modbus data packet within a TCP/IP packet. It is fast enough for many monitoring actions, but slow compared to modern ethernet protocols.

Modbus is a request/reply protocol.
There are different variations of Modbus



Report by Exception

- Newer communication protocols (DNP3 and IEC870) introduced "Report by Exception" and "Polled Report by Exception".
- In Report by Exception, the RTU stores a list of points which are to be treated as RBE and sends data to the Master controller only when one of these points change by a deadband amount (analog value) or state (digital value).
- Not reporting all values in every poll (Polled Report by Exception) reduces bandwidth requirement.
- Unsolicited Report by Exception requires a fast network like Ethernet which can handle data collisions without slowing the system down or losing data.

The Cloud

- Pumping system manufacturers along with thousands of other businesses have begun using the cloud for data transmission and storage.
- The Cloud offers high speeds, scalability of storage space, and data security by major players specializing in advanced technology, reducing cost compared to hosting private servers.
- Cloud utilization and computing permits linking of an unlimited number of devices, ideal for generating reports. Watertronics and Caltran have collaborated on a system of 350 landscape irrigation stations linked together through the cloud with customized water use reporting on a daily basis. The system also incorporates Toro Sentinel controllers using the cell modems in adjacent pump stations.

Here is something to get (sort of) excited about…

Cellular Networks and the Cloud

Report-by-Exception technology, pooled minutes from Cellular carriers, and secure global access and data storage in the Cloud, enable vendors and end users to employ highly capable SCADA systems without expensive infrastructure and in-house resources.

Universal, low cost SCADA systems available from dozens of vendors

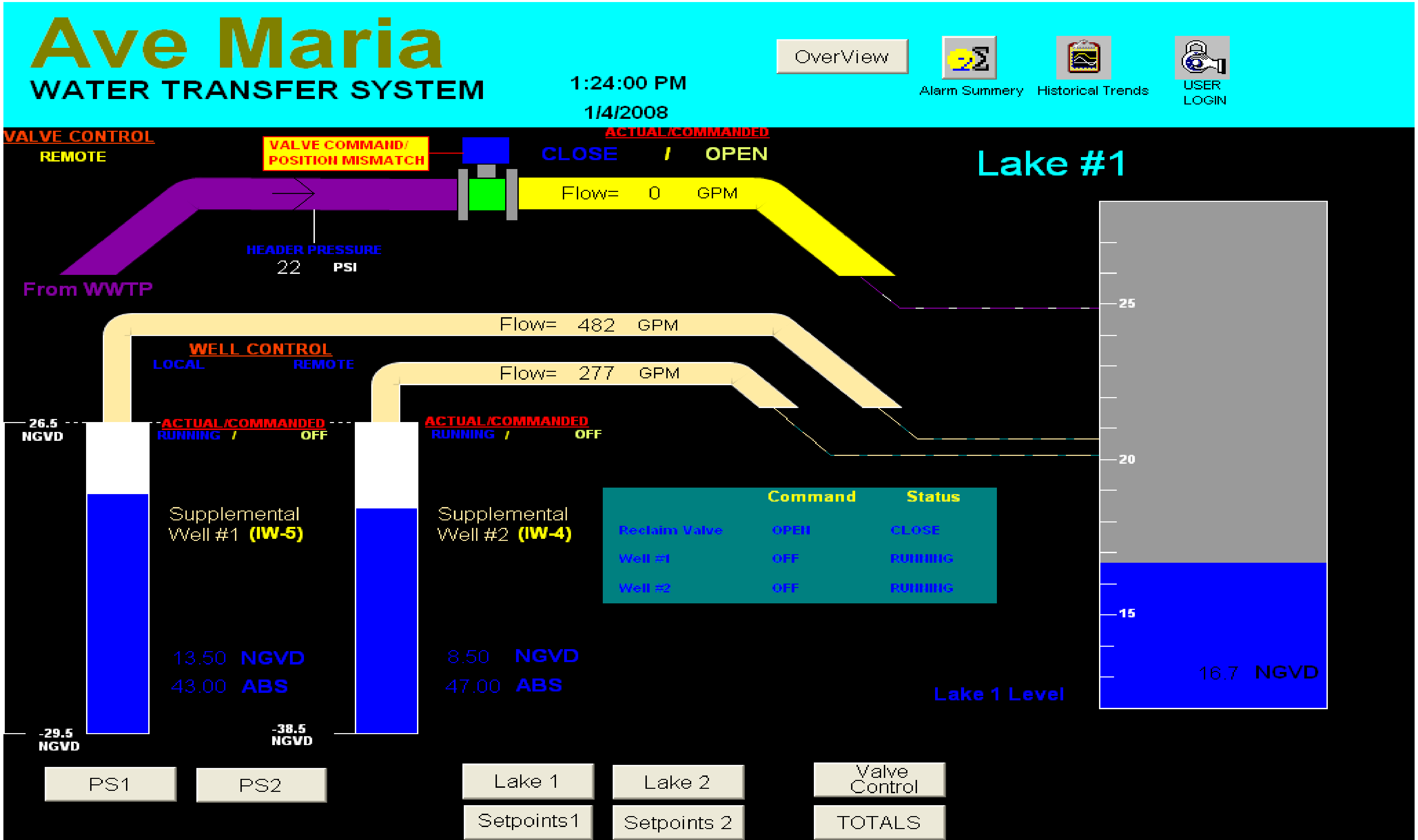
VS350 SCADA Server

Human Machine Interface

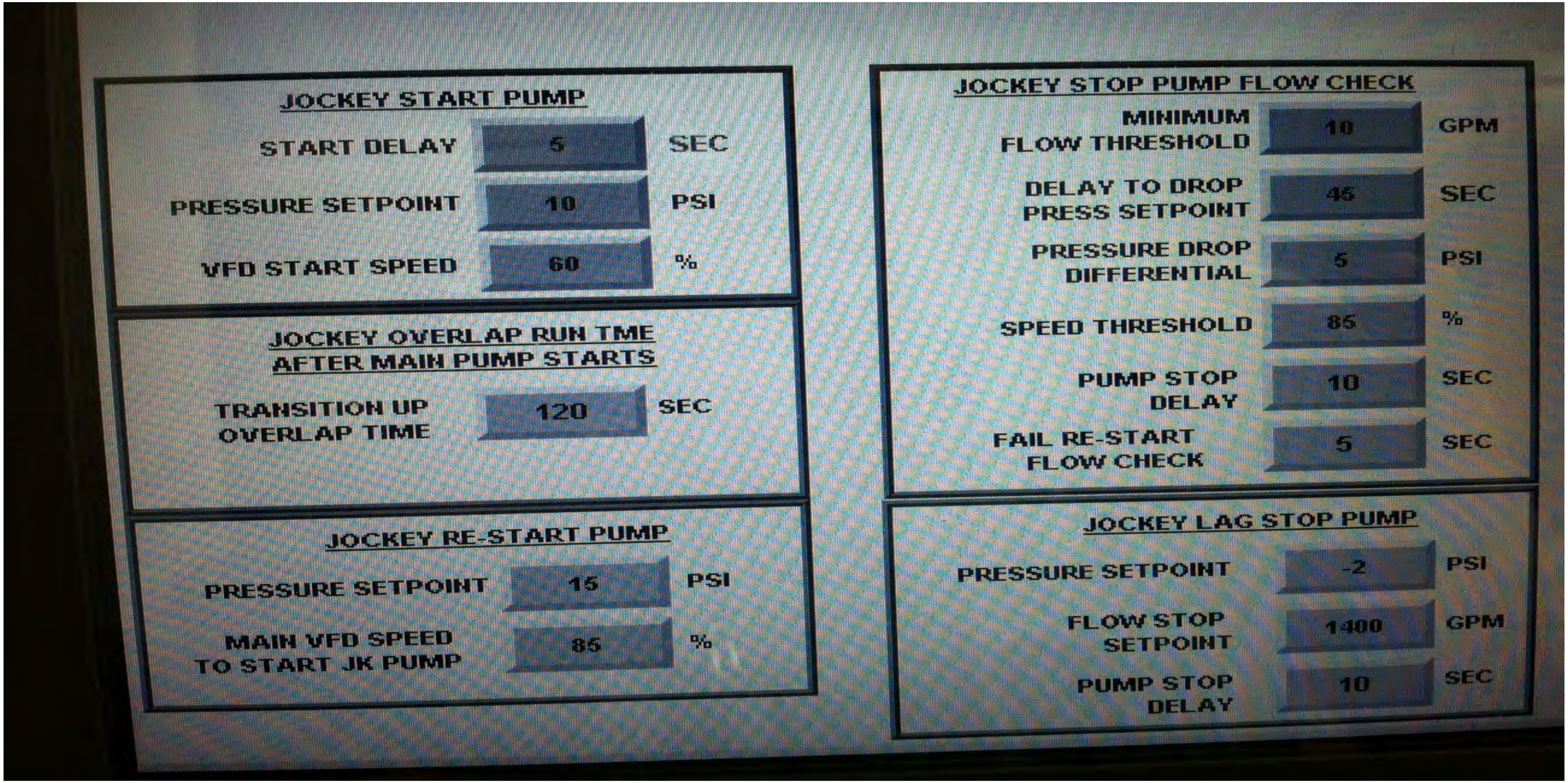
"HMI" or Human Machine Interface, is a software application which presents information to an operator or user about the state of a process, and allows the user to make changes to the machinery or process.

Information is typically displayed in a graphic format, or GUI.

GE Intellution HMI Screen for Well Control



Settings Page on MCI Panel HMI @ Dry Creek WWTP



Interfacing Pumping Stations to Irrigation Control Systems

Pump station controller typically sends data to the irrigation controller—Pump availability, and capacity, real time flow & pressure, alarm status.

Depending on the capabilities of the irrigation controller software, the irrigation controller may:

- Initiate a pump start up and flush filters in preparation for an irrigation program start.

Interfacing Pumping Stations to Irrigation Control Systems

- Irrigation Central selects sprinklers to approximately match calculated flow to real time flow. Reduces water window and operates station at maximum efficiency.
- Compares pump station real time flow to irrigation system calculated flow and take action if discrepancy exceeds predetermined threshold.
- Reduces irrigation flows if a pump faults at pump station. (Rainbird recalculates and reduces demand on the fly. Toro system may pause irrigation, recalculate, and restart under reduced flow.

Interfacing Pumping Stations to Irrigation Control Systems

- Comparison of real time flow versus irrigation system calculated flow is probably the most valuable feature of either system in that a pipe leak may be detected and result in system shut-down.

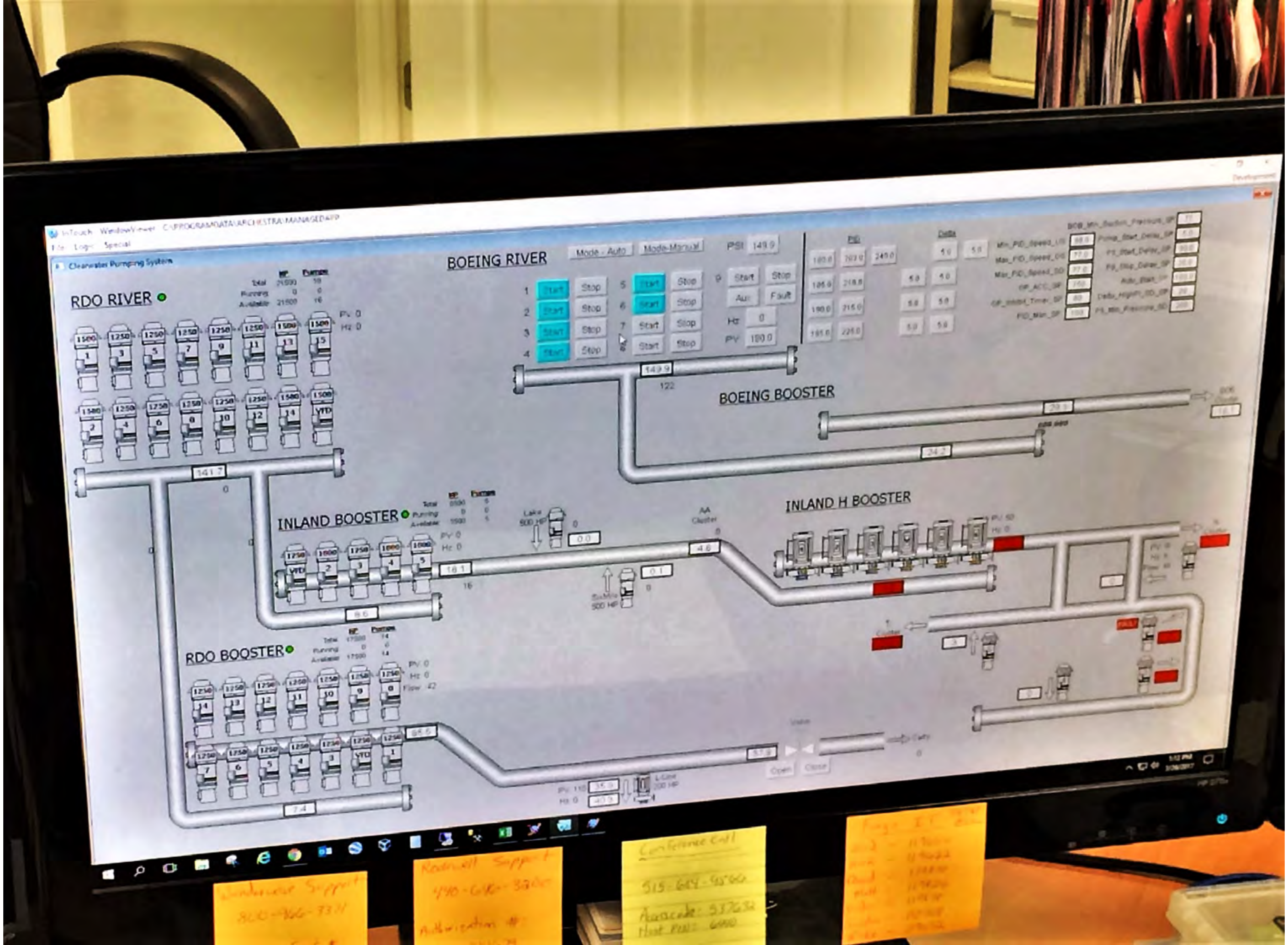
- It is a challenge to maintain irrigation databases as accurately as possible, otherwise flow management attempts may not be as efficient as hoped.

Pump Efficiency Calculation

Knowing motor current, discharge pressure, and rate of flow, for an individual pump, we can use a SCADA system to calculate efficiency and compare the relative efficiency of different well pumps.

Case study: 3 Mile Canyon Farm in Boardman Oregon

3 Mile Canyon Farm-Boardman, Ore 330+ Center Pivots



Clearwater Pumping System
RDO RIVER
BOEING RIVER
BOEING BOOSTER
INLAND BOOSTER
INLAND H BOOSTER
RDO BOOSTER
Mode - Auto
Mode-Manual
PSI

3 Mile Canyon Farm-Boardman, Ore.
RDO Booster System—14 Pumps—21,000 HP/150,000 GPM

Sequencing Pumps based on power efficiency at Three Mile Canyon Farm

Project to design a PLC algorithm to sequence pumps based on their relative efficiency, i.e. pumps will start in order of highest to lowest efficiency.

PLC is an Allen Bradley Controllogix with high speed scan rate and 5GHz radio system. Pumps are being fitted with individual flowmeters. All pumps have current transducers. System will routinely perform autoscans to track efficiency. Scans will be run only in an efficient operating range.

Sequencing Pumps based on power efficiency at Three Mile Canyon Farm

For pumping water at individual pump stations at 3MCF:

Relative Pump efficiency =

$$\frac{\text{Flow X (Discharge PSI) X 2.31}}{\text{3960 X ((4160*Amps*PF*1.73)/746)}}$$

ProPump & Controls Systems Integrator Mike Nealy at the RDO booster station

Motivating a programmer to stay on task for 10 hours a day takes sugar and coffee!

Sensors Commonly Used in Other Industries

- Vibration
- Bearing and Winding Temperatures
- pH
- TDS/Salinity
- Turbidity
- Chlorine Residual
- Current
- Voltage
- With a communications interface card, any viewable parameter in a VFD can be transmitted to a Central Computer via SCADA

Hach SC200 Controller

Commonly used in municipal water and wastewater plants to monitor pH, Temperature, Chlorine Residual, TDS, Turbidity, Dissolved Oxygen, etc.

Seeing some use in irrigation systems to monitoring pH and TDS .

Useful in blending applications to mitigate excess salinity.

Real Time SCADA Demonstrations

- Optima kV biogas system
- Amelia Island Golf Course Water System

Other Thoughts on Pump Station Control—Dedicated VFD's

- Dedicated VFD's are gaining in popularity in Irrigation markets.
- Dedicated VFD's are smoother in transitions.
- Dedicated VFD's operating in load sharing mode keep larger pumps from operating on the far left side of the pump curve, which is detrimental to pump life.
- Dedicated VFD's are simple to troubleshoot.
- Stations with multiple pumps with dedicated VFD's are common in municipal and industrial applications.

Small Muncipal Booster Station with Multiple Drives

Water Booster Station with Dedicated VFD's—Turks & Caicos Water Co.

Other Thoughts on Pump Station Control—Jockey Pumps

- Jockey pumps with dedicated VFD's are making a comeback.
- A jockey pump approximately 50% of the size of the main pump is more efficient than operating a larger main pump at low flows and will prolong the life of the main pumps.
- With the jockey pump on a VFD, a PM pump can be eliminated on a new irrigation system which is relatively tight.
- In a system with a single shared VFD for the main pumps, the jockey pump can be restarted between 1st and 2nd main pumps to keep the main pump using the drive from operating at a flow on the left hand side of the curve.

Horizontal Station with 1-30 HP Pump & 2-60 HP Pumps

THE END

GO HAVE SOME FUN!

Thanks for Your Time!

Richard Embry

General Manager

ProPump & Controls, Inc.

Office: 704-528-0677

Cell Phone: 704-658-8083

rembry@propumpservice.com

ASIC

2019 NATIONAL CONFERENCE
SANTA FE, NEW MEXICO

Guess what? You have been standardized.

Brent Mecham CID, CLWM, CIC, CLIA, CAIS

Irrigation Association

Small victory

- Successfully renamed Chapter 14 of the ICC International Plumbing Code from Subsurface Landscape Irrigation to Subsurface Graywater Soil Absorption System.
- All references to subsurface landscape irrigation within the chapter were modified.
- Also was successful with a similar change in the International Residential Code.

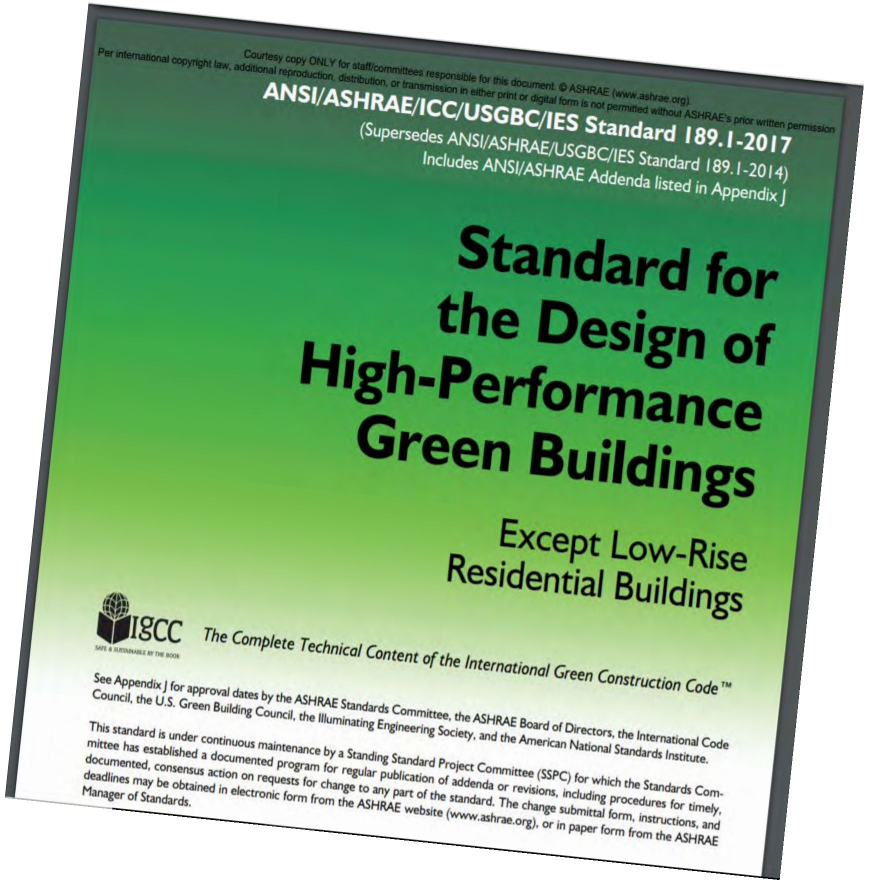
- Next step is with IAPMO UPC

Provisions in ASHRAE 189.1:

- 33% of improved landscape area can use potable water
- If using on-site alternate water sources = 100% of site can be irrigated
- 40% of improved landscape area any type of plant
- 60% of site = native, adapted or rainfall-ETc compatible plants
  - potable or reclaimed for establishment, no permanent irrigation system
  - only reclaimed for establishment within 200 feet of site
- Conflicting sections on use of reclaimed water

ASHRAE 189.1

- Proposed some changes:
  - Golf courses to be exempt from this standard
  - Remove requirement to use off-site reclaimed water for temporary irrigation
  - A few items to be considered above code and can be selected as optional requirements.



- Challenges
  - Reclaimed water is too good for irrigation—put it back into the ground
  - Vegetated roofs and walls only irrigated with onsite harvested water

IAPMO WE-Stand

- Attempt to add in landscape requirements
  - Only 40% of the landscape can have overhead irrigation with potable water
  - Drip irrigation exempt

- Water efficiency is about landscape plant selection—

Water use efficiency

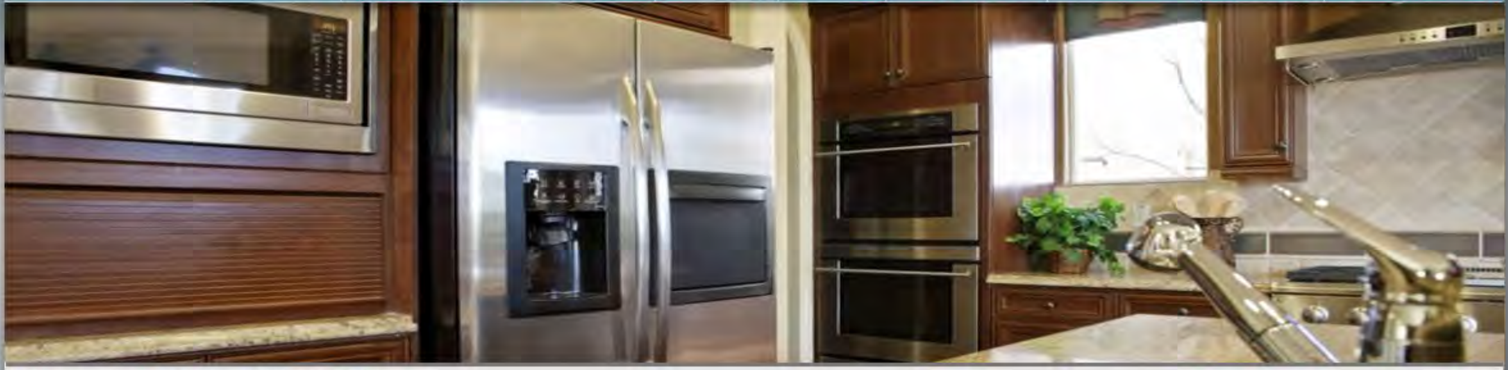
- Landscape transformation
- Sustainable landscapes
- Local-friendly landscapes
- It is about choosing plants with lower water demand—usually a reduction in ornamental turfgrass
- Position: we are experts at delivering water to plants, but not experts in plant selection.
- Potable water for irrigation needs to be eliminated.

California Energy Commission

- Title 20 Regulations that mandate only pressure regulating spray sprinklers to be sold after October 1, 2020.
- Public comment period: April 26 – June 10, 2019
- Public hearing on June 18, 2019 in Sacramento
- Use EPA WaterSense testing specification
- Table X requires reporting performance. No compliance, no selling.

CA.GOV

CALIFORNIA ENERGY COMMISSION



Spray Sprinkler Bodies

Docket # 19-AAER-01

The California Energy Commission proposes amendments to the Title 20 Appliance Efficiency Regulations that would result in new mandatory water efficiency standards for spray sprinkler bodies. There are currently no water efficiency standards for spray sprinkler bodies.

For questions about this proceeding, contact:

Sean Steffensen
California Energy Commission
Appliances Office

Proceeding Documents

- Display Documents for this Proceeding (19-AAER-01)
- Submit e-Comment
- Submit e-Filing

Calendar

May 01, 2019
Webinar: Upcoming Portable Electric Spas Standards and Test Procedure

ASABE/ICC 802 Landscape Sprinkler & Emitter Standard

- Revisions
  - Testing for pressure regulating sprinklers—to be the same as EPA WaterSense
  - Check valve test to be more detailed.
  - Changes to definitions to harmonize with California proposed regulations
    - To minimize loopholes

Rainwater Harvesting Standards

- Differentiation between rainwater and stormwater
- ASPE-ARCSA-IAPMO
  - Standard 63 Rainwater Harvesting Standard
  - Standard 78 Stormwater Harvesting Standard
- ICC-CSA 805 Rainwater Harvesting Systems Standard
- Disinfection UV or Chemical
  - Water temperature above 77 degrees has a 0.5mg/L chlorine residual

Rating Systems

- RESNET HERS H2O
- Water Efficiency Rating System – WERS
  - Based on a program started by Santa Fe Builders
  - Lower score more water efficient
- NGBS WRI in appendix
- EPA WaterSense program looking to adopt them as a compliance path for labeling new homes.
- Complicated math
- Mysterious "black box" approach.
- Less lawn, lower gpm zones = lower score.

Rating Systems

- Geared toward residential
- Compare expected or potential water use to a “reference home”
- Considers both indoor and outdoor water use
- Home builders can use the score to differentiate their product
- Irrigation design/build contractor impacted

WERS **NGBS-WRI** **$\mathbf{HERS_{H2O}}$**

Water Efficiency Rating Score

- Developed by Green Builder Coalition
- 3rd party verification tool.
- Predict water use for new or existing properties.
- Flexible—builder can decide where & how to conserve water.
- Goal to reduce the use of potable water.
- Incentives to use on-site water sources
  - Graywater
  - Rain water harvesting

WERS

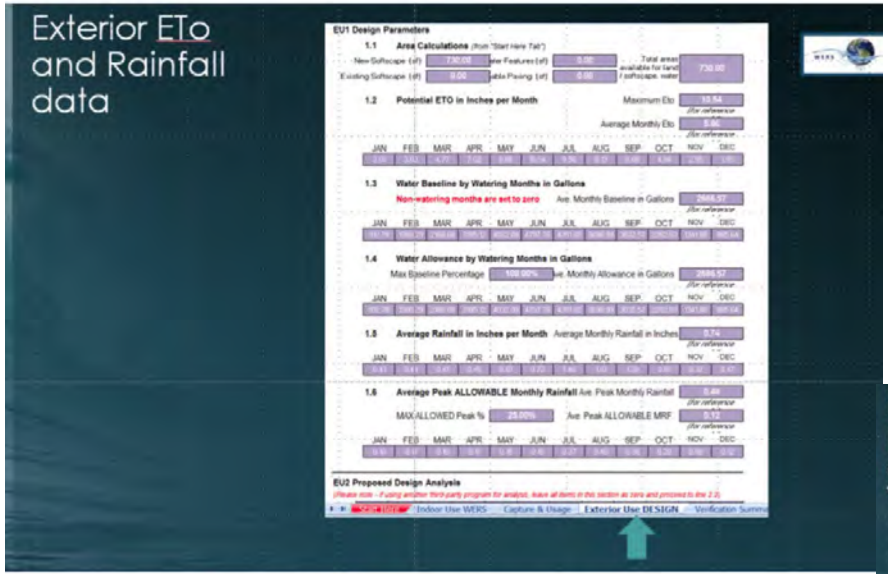
Outdoor methodology of WERS

- Step 1 – Create an outdoor water budget (based on EPA WaterSense, but modified)
- Step 2 – Determine the outdoor water demand projection via subtractive method

  (Lot – Impervious Surfaces – Undisturbed Areas – Encroachments)

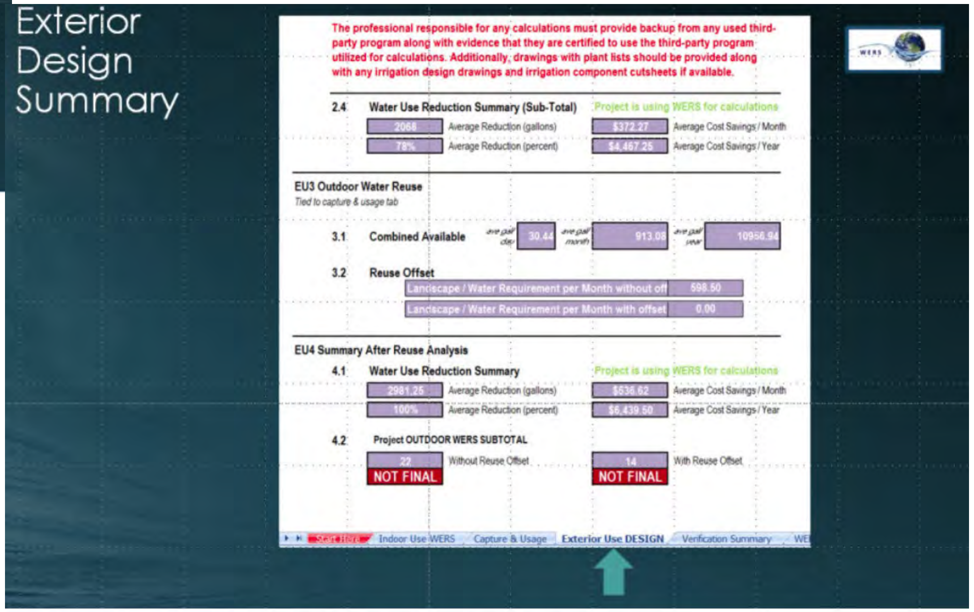
- Step 3 – Offset outdoor water demand with reuse techniques (if applicable)

WERS



Exterior Use WERS: Gathers information regarding outdoor water use
Image 7 / 10

Uses a traditional water budget approach based on monthly ETo and Rainfall

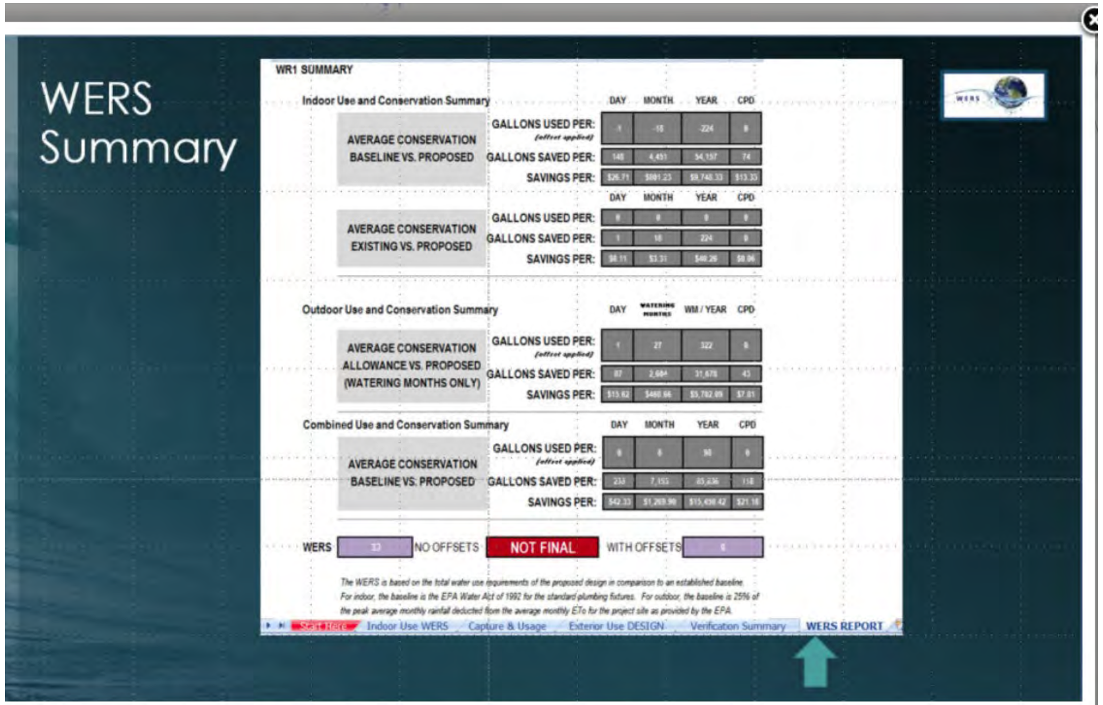


Exterior Use WERS: Summary with WERS sub-total
Image 9 / 10

Reducing Potable Outdoor Water Use

- Plant selection
- Use of technology—smart controllers, sensors etc.
- Use nonpotable water—gray water, rain water harvesting, etc.

- Compared rated home to a baseline. The lower the score the better.



WERS Report indicating complete indoor & outdoor WERS, with or without offsets
Image 10 / 10

WERS Compliance Options

EU2 Preliminary / Assessment Design Analysis

(Please note - if using another third-party program for analysis, skip section 2.1 and leave questions as No and values as zero)

2.1 OPTION ONE: Landscape / Water Requirement Using WERS

Use of the following pull-downs affects the "Average Peak ALLOWABLE Rainfall" percentage.

N Rain Sensor present? (10%)

Y Smart Controller present? (10%)

(EPA label must be on the controller)

5 *Select the number of lines needed and complete the table below with the information that best describes the outdoor water use.*

Line	Area Name or Notes *(optional)*	Irrigated or Non-Irrigated Soft-scape Area (sf)	Plant / Feature Type & Water Requirement	K_L	Irrigation Type	IE	LWR_H (G/M) *average only - for watering months*
1	Apple tree	200.00	Trees - Medium	0.5	Drip-Standard	0.7	544.41
2	Vegetable Garden	200.00	Food Gardens	0.7	Drip/Micro	0.8	706.76
3	Sagebrush	1000.00	Groundcover - Low	0.2	No Irrigation	0.7	747.26
4		0.00	<select item type>	0	<select irrigation>	0	0.00
5		0.00	<select item type>	0	<select irrigation>	0	0.00
Total Area		1400.00	Landscape / Water Requirement for Site (G/M)				1998.43

2.2 OPTION TWO: Landscape / Water Requirement Via Third-Party Program

OUTDOOR WATER USE CALCULATION PROGRAM

Are non-WERS calculations being done for this home? Yes

2.3 NON-PERMANENT IRRIGATION AFFIRMATION

Use this section only if there is landscaping but no irrigation for the project.

Xeriscaping? No Percent of softscape?

I CERTIFY AS THE DESIGN PROFESSIONAL OF RECORD THAT THE LANDSCAPE AS DESIGNED SHOULD NOT REQUIRE WATER BEYOND THAT WHICH IS NEEDED FOR INITIAL ESTABLISHMENT OF PLANTINGS.

SIGNED:____________________________ DATE: __________

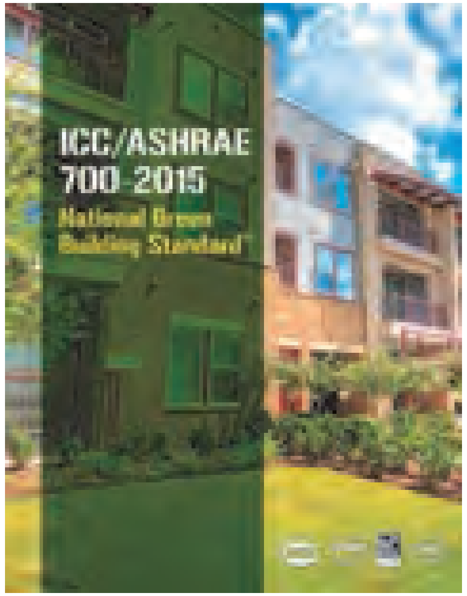
The professional responsible for any calculations must provide backup from any used third-party program along with evidence that they are certified to use the third-party program utilized for calculations. Additionally, drawings with plant lists should be provided along with any irrigation design drawings and irrigation component cutsheets if available.

Water Efficiency Rating Score (WERS)®

- Applicability
  - New or Existing Properties
  - Single Family or Multifamily
  - Design or Audit Tool
- Outputs
  - Score: 0-100 (lower is better)
  - Projected usage in gallons: Daily, monthly and yearly
  - Projected water costs: Daily, monthly and yearly
- Adopted/Implemented
  - State of New Mexico: Tax credit since Jan. 1, 2017
  - City of Santa Fe: Single-family code since March 2017
  - City of Santa Barbara, CA: Multifamily code since Sept. 2018
  - Built Green Canada: Pilots in 2019; implement in 2020
- Future
  - 3 green building programs incorporating into water efficiency chapter
  - WaterSense for Homes 2.0: Under consideration for dual certification

National Green Building Standard

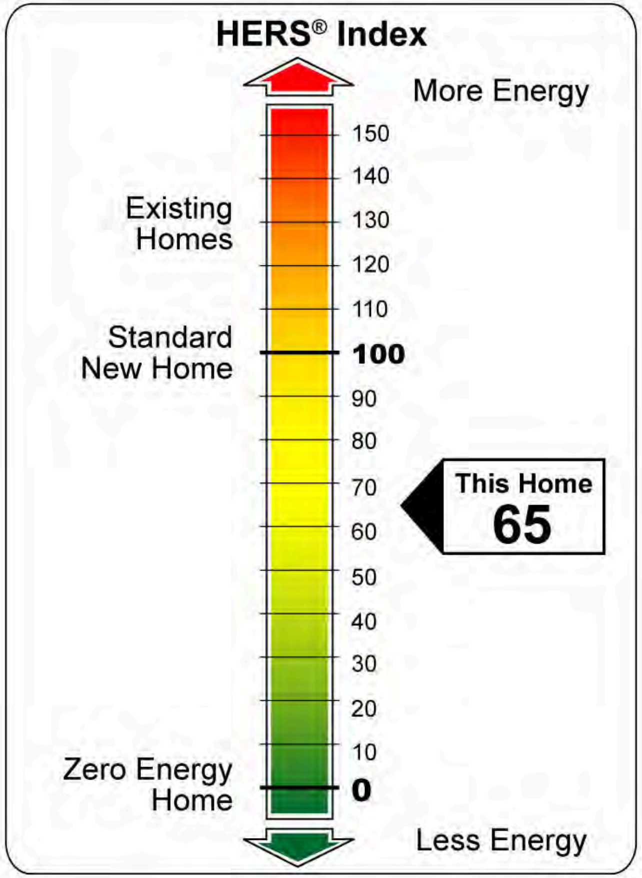
- Points-based system
- Points for doing irrigation efficiently
- Points for not doing irrigation
- Points for not using potable water
- Alternate method is WRI Water Rating Index (Appendix F)
- Based on WERS



Bronze, Silver, Gold, Emerald
More points is better

HERS$_{H2O}$

- Development by Residential Energy Services Network (RESNET)
  - Home Energy Rating Systems—estimate the amount of energy a home uses based on types of equipment that are installed.
  - HERS H2O doing the same for water usage—Water Efficiency Rating Index
    - Indoor and Outdoor
  - Currently developing an ANSI standard



HERS Reference Home

- Attributes of a standard home built about 2006
- Outdoor water use based on data from REUWS 2
- Complicated equations create the modeling worksheet

Reference home outdoor water use:

- Rated home has Net ET <12 inches/year or has automatic irrigation system

$$\left[\frac{\exp(A)}{1+\exp(A)}\right]\times 1.18086\times(2.0341\times netET^{0.7154}\times Ref\_Irr\_Area^{0.6227}+0.5756\times ind\_Pool\times netET)$$

- Rated home has NetET >12 inches/year AND does not have automatic irrigation

$$\left[\left[\frac{\exp B}{1+\exp B}\right]\times 1.22257\times\left[1.4233+0.6311\times netET+0.9376\times Ref\_Irr\_Area\right]\right]+ref\_Pool$$

Where:

- Exp(A)= exponent of [1.4416 + 0.5069 * (IrrArea/1,000)]
- Exp(B)= exponent of [0.6911 + 0.00301 * netET * (IrrArea/1,000)]
- Ref_Irr_Area= The size of the irrigated area in the reference home, calculated in accordance with section 4.4.1
- Rat_Irr_Area= The size of the irrigated area in the rated home
- netET= The annual historic sum of mean reference evapotranspiration minus the mean precipitation for all months that evapotranspiration exceeds precipitation

Irrigated Area

- Lot size of Rated Home <7,000 s.f. the Reference Home shall be calculated as:
- *Ref_Irr_Area=* $\text{Lot\_Area} \times (0.002479 \times \text{Lot\_Area}^{0.6157})$

- Lot size of Rated Home >7,000 s. f., the Reference Home shall be calculated as:
- *Ref_Irr_Area=* Lot_Area x 0.577

Rated home outdoor water use

- Rated home has automatic irrigation system

$$\left[\frac{\exp(A)}{1+\exp(A)}\right]\times 1.18086\times(2.0341\times netET^{0.7154}\times \mathrm{R}at\_Irr\_Area^{0.6227}+0.5756\times ind\_Pool\times netET)$$

- Rated home does not have automatic irrigation

$$\left[\left[\frac{\exp B}{1+\exp B}\right]\times 1.22257\times[1.4233+0.6311\times netET+0.9376\times \mathrm{R}at\_Irr\_Area]\right]+Pool\_use$$

Where:

- Exp(A)= exponent of [1.4416 + 0.5069 * (Rat_Irr_Area/1,000)]
- Exp(B)= exponent of [0.6911 + 0.00301 * netET * (Rat_Irr_Area/1,000)]
- Rat_Irr_Area= The size of the landscape that might receive supplemental water in the rated home
- netET= The annual historic sum of mean reference evapotranspiration minus the mean precipitation for all months that evapotranspiration exceeds precipitation
- ind_Pool= Indicator representing the presence or absence of a swimming pool
- Pool_use= equation 1 (using ind_Pool = 1) – equation 1 (using ind_Pool = 0)

Example Water Use Calculations

User input fields are yellow

Location (pull down)	Denver, CO
Distribution system	std
HW pipe Insulation	none
Shower (gpm)	2.5
Kitch Faucet (gpm)	2.2
Lav Faucet efficiency	std
Std sys pipe length	89
Recirc sys loop length	159
Recirc sys branch length	10
Recirc pumpWatts	50
DW heat recovery?	no
Lot Area (ft2)	8,500
Landscaped Area (ft2)	5,000
% Outdoor H2O =	*40%*
Ref Irr_Area =	*4,905*
Tot_Ref Irr_ratio =	*57.7%*
Net_Lscape_ratio =	*68.5%*
Lot size (acres) =	0.195
Ref std sys pipe length =	*89.3*
Ref recirc sys loop length =	*158.6*

Water Use	Cold Wtr	Hot Wtr	Total Wtr
Shower_gpd	7.2	16.9	24.1
KitchF_gpd	4.2	9.9	14.2
LavF_gpd	1.9	4.5	6.4
Waste_gpd	4.7	11.0	15.7
CW_gpd	20.6	3.9	24.5
DW_gpd		4.3	4.3
Toilets_gpd	21.9		21.9
Soft_gpd	0.0		0.0
Other_gpd	15.7	2.1	17.8
EP_gpd	0.0	0.0	0.0
Indoor_gpd	76.2	52.6	128.9
Outdoor_gpd	86.7	0.0	86.7
Total_gpd	162.9	52.6	215.5
Ref_In =	76.2	52.6	128.9
Ref_Out =	86.2	0.0	86.2
Ref_Tot =	162.5	52.6	215.1
Save_Tot =	-0.5	0.0	-0.5
H2O_in =	100	100	100
H2O_Out =	101	100	101
H2O_Tot =	100	100	100
$HERS_{H2O}$ =	100	SaveH2O*=	-167

* Gallons per year

Home characteristics:	
CFA	2400
Nbr	3
Nfl	2
Bsmt	0
Appliances:	
Dishwasher	std
Clothes washer	std
WF	9.5
Toilets:	
gpf	1.6
Water Softener:	
Softener	no
gal/removed	5.0 gallons/1,000 grains removed
Outdoors:	
Inground Pool?	no
Automatic Irrigation?	no
Smart controller?	no
Use RICI?	no
Zone flow rates	27.0 Sum of irrigation zone flow rates
Prof Audit?	yes
Static Pressure	75

Drain Water Heat Recovery:	
Showers connected	all
Equal flow?	yes
CSA 55.1 $DWHR_{eff}$	54.0%
Tmains =	*58.0*
WHinTadj =	*0.00*
WHinT =	*58.0*

Indoor_gpd	76.2	52.6	128.9
Outdoor_gpd	86.7	0.0	86.7
Total_gpd	162.9	52.6	215.5
Ref_In =	76.2	52.6	128.9
Ref_Out =	86.2	0.0	86.2
Ref_Tot =	162.5	52.6	215.1
Save_Tot =	-0.5	0.0	-0.5
H2O_in =	100	100	100
H2O_Out =	101	100	101
H2O_Tot =	100	100	100
$HERS_{H2O}$ =	100	SaveH2O*=	-167

Water Softener:	
Softener	no
gal/removed	5.0
Outdoors:	
Inground Pool?	no
Automatic Irrigation?	no
Smart controller	no
Use RIC?	no
Zone flow rates	27.0
Prof Audit?	no
Static Pressure	75

Indoor_gpd	76.2	52.6	128.9	**Water Softener:**	
Outdoor_gpd	256.0	0.0	256.0	Softener	no
Total_gpd	332.3	52.6	384.9	gal/removed	5.0
Ref_In =	76.2	52.6	128.9	**Outdoors:**	
Ref_Out =	252.8	0.0	252.8	Inground Pool?	no
Ref_Tot =	329.0	52.6	381.6	Automatic Irrigation?	yes
Save_Tot =	-3.3	0.0	-3.3	Smart controller?	no
H2O_in =	100	100	100	Use RICI?	no
H2O_Out =	101	100	101	Zone flow rates	27.0
H2O_Tot =	101	100	101	Prof Audit?	no
$HERS_{H2O}$ =	101	SaveH2O*=	-1,200	Static Pressure	75

Indoor_gpd	76.2	52.6	128.9
Outdoor_gpd	217.6	0.0	217.6
Total_gpd	293.9	52.6	346.5
Ref_In =	76.2	52.6	128.9
Ref_Out =	252.8	0.0	252.8
Ref_Tot =	329.0	52.6	381.6
Save_Tot =	35.1	0.0	35.1
H2O_in =	100	100	100
H2O_Out =	86	100	86
H2O_Tot =	89	100	91
$HERS_{H2O}$ =	91	SaveH2O*=	12,819

Water Softener:	
Softener	no
gal/removed	5.0
Outdoors:	
Inground Pool?	no
Automatic Irrigation?	yes
Smart controller?	yes
Use RICI?	no
Zone flow rates	27.0
Prof Audit?	no
Static Pressure	75

Indoor_gpd	76.2	52.6	128.9
Outdoor_gpd	206.8	0.0	206.8
Total_gpd	283.0	52.6	335.6
Ref_In =	76.2	52.6	128.9
Ref_Out =	252.8	0.0	252.8
Ref_Tot =	329.0	52.6	381.6
Save_Tot =	46.0	0.0	46.0
H2O_in =	100	100	100
H2O_Out =	82	100	82
H2O_Tot =	86	100	88
$HERS_{H2O}$ =	88	SaveH2O*=	16,791

Water Softener:

Softener	no
gal/removed	5.0

Outdoors:

Inground Pool?	no
Automatic Irrigation?	yes
Smart controller?	yes
Use RICI?	no
Zone flow rates	27.0
Prof Audit?	yes
Static Pressure	75

DW heat recovery?	**no**
Lot Area (ft2)	**8,500**
Landscaped Area (ft2)	**5,000**

% Outdoor H2O = *62%*

Ref Irr_Area =	*4,905*
Tot_Ref Irr_ratio =	*57.7%*
Net_Lscape_ratio =	*68.5%*
Lot size (acres) =	0.195

Indoor_gpd	**76.2**	**52.6**	**128.9**
Outdoor_gpd	**206.8**	**0.0**	**206.8**
Total_gpd	**283.0**	**52.6**	**335.6**
Ref_In =	**76.2**	**52.6**	**128.9**
Ref_Out =	**252.8**	**0.0**	**252.8**
Ref_Tot =	**329.0**	**52.6**	**381.6**
Save_Tot =	**46.0**	**0.0**	**46.0**
H2O_in =	**100**	**100**	**100**
H2O_Out =	**82**	**100**	**82**
H2O_Tot =	**86**	**100**	**88**
$HERS_{H2O}$ =	**88**	**SaveH2O*=**	**16,791**

Water Softener:

Softener	**no**
gal/removed	**5.0**

Outdoors:

Inground Pool?	**no**
Automatic Irrigation?	**yes**
Smart controller?	**yes**
Use RICI?	**no**
Zone flow rates	**27.0**
Prof Audit?	**yes**
Static Pressure	**75**

Voluntary Programs

CHPS COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS

LEED LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

Florida Water

GREEN BUILDING INITIATIVE™ GREEN GLOBES

THE Sustainable SITES Initiative®

Voluntary Programs

- Prerequisites or requirements (prescriptive)
- Options to earn credits or points (performance)
- Levels of accomplishment

- **Green**
- **Greener**
- **Greenest**
- **Greenisimo**

Summary:

- Market trends toward sustainability affect the irrigation industry.
- Trends in landscapes is to use native/native-type plants—no irrigation.
- Reducing potable water use in the landscape.
- Standards, codes & ordinances are being adopted.
- Volunteer programs for commercial landscapes
  - Prerequisites and credits or points
- Rating systems for residential properties
  - Third-party verification
  - EPA WaterSense proposing to use rating systems for new homes
- Opportunity to understand and help clients who embrace sustainability.