Engaging Irrigation Design for Long Term Ownership

IRVINE COMPANY
Since 1864

Newport Center (Corporate HQ)

Who We Are

- 153 year old privately held company

Who We Are

- 153 year old privately held company
- One of the largest diversified real estate investment and development enterprises in the United States

Who We Are

- 153 year old privately held company
- One of the largest diversified real estate investment and development enterprises in the United States
- Over 4,200 employees

Who We Are

- 153 year old privately held company
- One of the largest diversified real estate investment and development enterprises in the United States
- Over 4,200 employees
- Offices in Newport Beach, Irvine, San Diego, Los Angeles and Silicon Valley

Three Operating Groups

- Irvine Company Community Development

Three Operating Groups

- Irvine Company Community Development
- Irvine Pacific

Three Operating Groups

- Irvine Company Community Development
- Irvine Pacific
- Investment Properties Group
  - ICOP-Office Properties
  - ICRP-Retail Properties
  - ICAC-Apartment Communities
  - ICRP-Resort Properties

What We Do

- Plan and develop “best of class”:
  - Residential villages
  - Business districts
  - Apartment communities
  - Regional, community and neighborhood retail centers
  - Resort properties including hotels, golf courses and marinas

What We Do

- Lease and manage high-quality, income-producing properties
- Retain ownership of real estate investment assets for long-term appreciation


The Old
Spanish and Mexican
RANCHOS OF
ORANGE COUNTY
CALIFORNIA
RANCHO LA HABRA
LA HABRA
RANCHO SANTA GERTRUDES
RANCHO LA PUENTE
BREA
RANCHO RINCON DE LA BREA
SAN BERNARDINO COUNTY
RANCHO SAN JUAN CAJON DE SANTA ANA
YORBA LINDA
RANCHO CAÑON DE SANTA ANA
LOS ANGELES COUNTY
BUENA PARK
FULLERTON
PLACENTIA
Yorba Reservoir
RANCHO LOS COYOTES
CYPRESS
ANAHEIM
OLIVE
STANTON
LOS ALAMITOS
RANCHO LOS ALAMITOS
ORANGE
IRVINE PARK
EL MODENO
Peters Canyon Reservoir
Santiago Reservoir Irvine Lake
GARDEN GROVE
WESTMINISTER
MIDWAY CITY
SANTA ANA
TUSTIN
RANCHO LOMAS DE SANTIAGO
SEAL BEACH
RANCHO LA BOLSA CHICA
SUNSET BEACH
WINTERSBURG
TALBERT
RANCHO SANTIAGO DE SANTA ANA
RIVERSIDE CO
Santiago Peak El. 5680'
RANCHO LAS BOLSAS
HUNTINGTON BEACH
IRVINE
U.S. MARINE CORPS AIR STATION
RANCHO CAÑADA DE LOS ALISOS
RANCHO POTRERO LOS PINOS
COSTA MESA
RANCHO SAN JOAQUIN
EL TORO
RANCHO TRABUCO
NEWPORT BEACH
BALBOA
CORONA DEL MAR
RIVERSIDE
PACIFIC OCEAN
RANCHO NIGUEL
LAGUNA BEACH
Mission San Juan Capistrano
SOUTH LAGUNA
RANCHO MISSION VIEJA
SAN JUAN CAPISTRANO
THREE ARCHES
RIOS
RANCHO BOCA DE LA PLAYA
DANA POINT
SERRA
DOHENY PARK
CAPISTRANO BEACH
SAN CLEMENTE
SAN DIEGO COUNTY
TI
PREPARED AND ISSUED BY
Title Insurance and Trust Company


IRVINE RANCH—1910
BLACKSMITH SHOP
ACROSS FROM RANCH HOUSE


orangecountyhistory.org


Orange County Archives
IRVINE
BEAN & GRAIN GROWERS
ASSOCIATION


CINEMAS

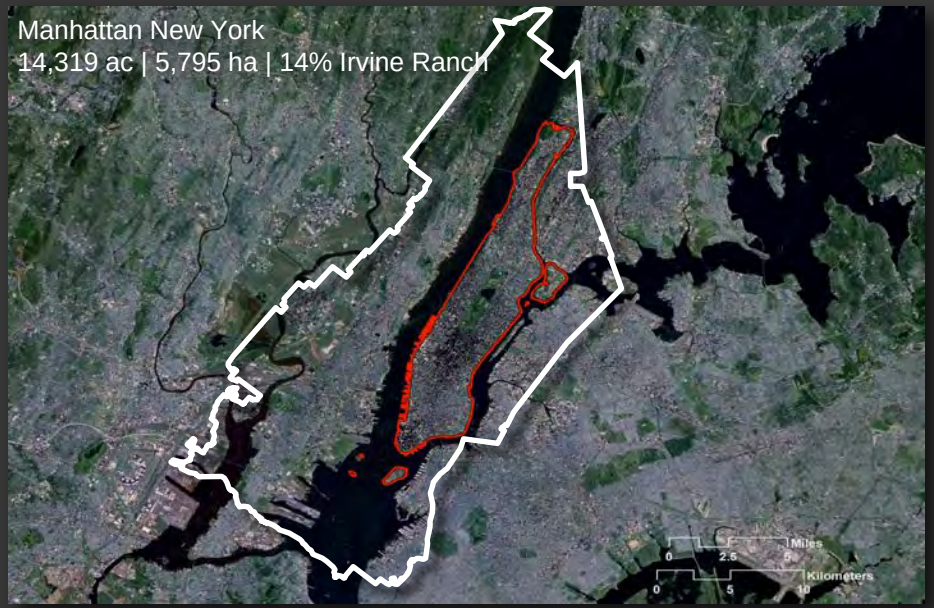

MARINES

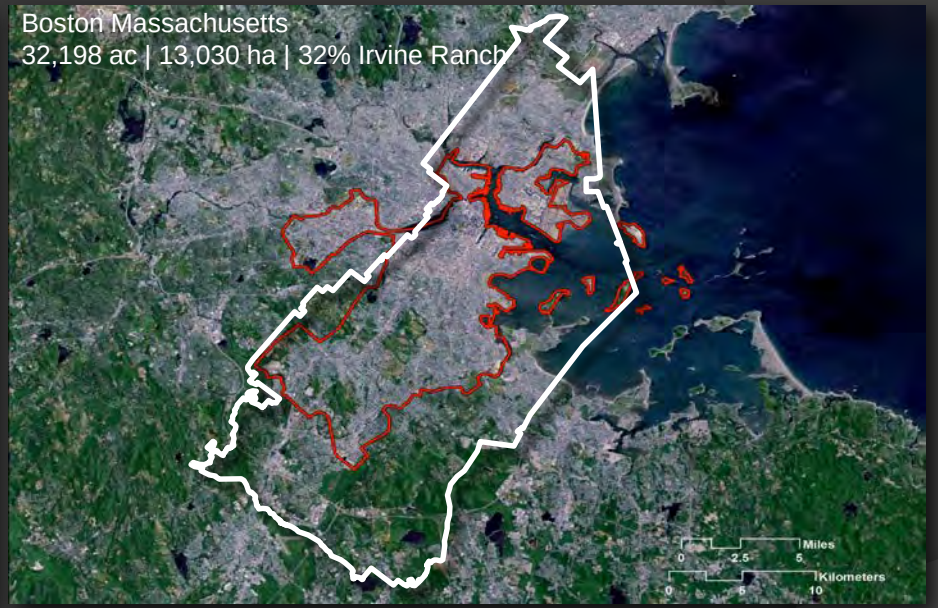

U.S.NAVY

THE IRVINE COMPANY HEADQUARTERS
(Photograph by Jim England Photography, Los Angeles)


22 M/35Km long and 9 M/15Km wide
90,000 Ac/31,422Ha
187 Sq M/484 Sq Km
Los Angeles
Long Beach
Santa Ana
San Diego
The Irvine Ranch
Orange County


Rancho Santiago De Santa Ana
Rancho La Bolsa
Rancho Lomas De Santiago
Rancho Semiahuaquin


Manhattan New York
14,319 ac | 5,795 ha | 14% Irvine Ranch
Miles
0 2.5 5
Kilometers
0 5 10


Boston Massachusetts
32,198 ac | 13,030 ha | 32% Irvine Ranch
Miles
0 2.5 5
Kilometers
0 5 10

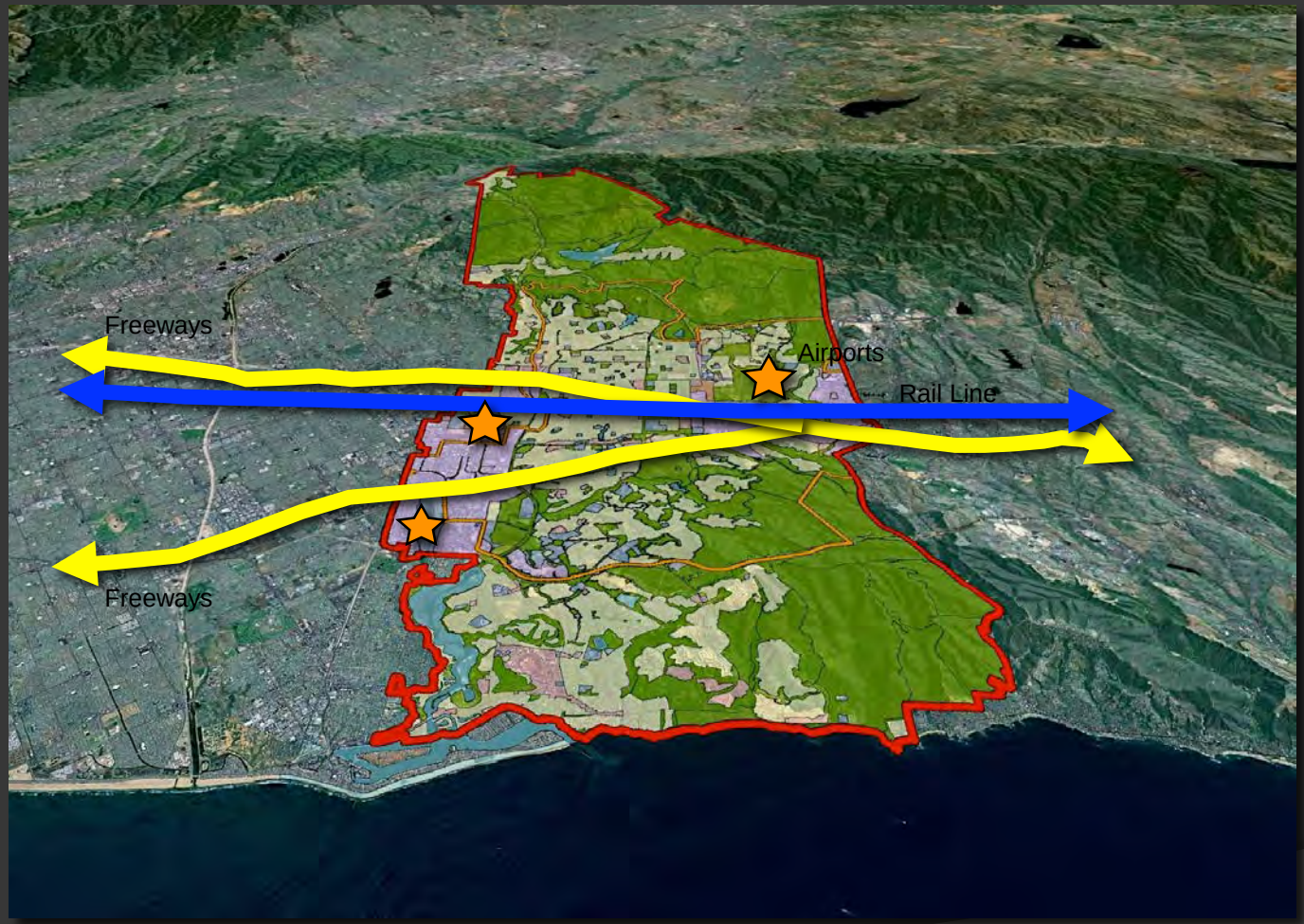
1947-1959 • Orange County population increased from 200,000 to 700,000, creating pressure for residential and industrial development.

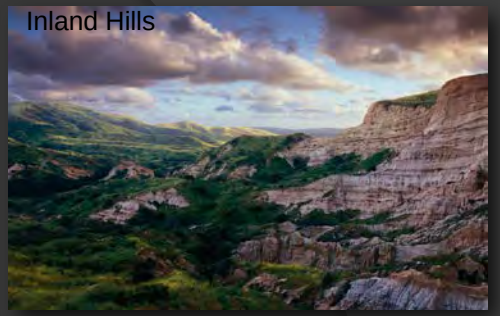

Ridge Lines
Ranch Boundary
Airports
Rail Line
Freeways
Freeways


Inland Hills


Valley


Coastal Hills


Freeways
Airports
Rail Line
Freeways


Inland Hills


Valley


Coastal Hills

What is Master Planning?

- Its function is to guide development, to set standards and to enlarge rather than inhibit the potential…
- A basic land use plan has been drawn, fully cognizant of what exists at present, what is being planned in surrounding areas and what is likely to evolve in the foreseeable future.”
  -William Pereira

Ranch Master Plan Objectives:

- Orderly transition from agriculture to urbanized land uses
- Retain the unique character of the place
- Plan for infrastructure to support build-out of ranch
- Establish boundaries for the City of Irvine, incorporated in 1971, 47,500 Acres
- Establish University of California, Irvine on 1,500 Acres
- Preserve 50,000 Acres of parks and open space
- Flexible enough to allow for social or economic change

Ranch Master Plan Objectives:

- Orderly transition from agriculture to urbanized land uses
- Retain the unique character of the place
- Plan for infrastructure to support build-out of ranch
- Establish boundaries for the City of Irvine, incorporated in 1971, 47,500 Acres
- Establish University of California, Irvine on 1,500 Acres
- Preserve 50,000 Acres of parks and open space
- Flexible enough to allow for social or economic change

Guiding Principles

- Maintain the land under a single owner.
- Establish a Master Plan for all 93,000 acres to guide land use and infrastructure decisions, ensuring that the whole would be greater than the sum of its parts.
- Create an internal planning group to guide the evolution and implementation of the Master Plan.

Guiding Principles

- Establish three major planning sectors on The Ranch to help break the master-planning work into manageable areas: Coastal Sector, Valley Sector and Mountain Sector.
- Continually reinvest in the land.

Guiding Principles

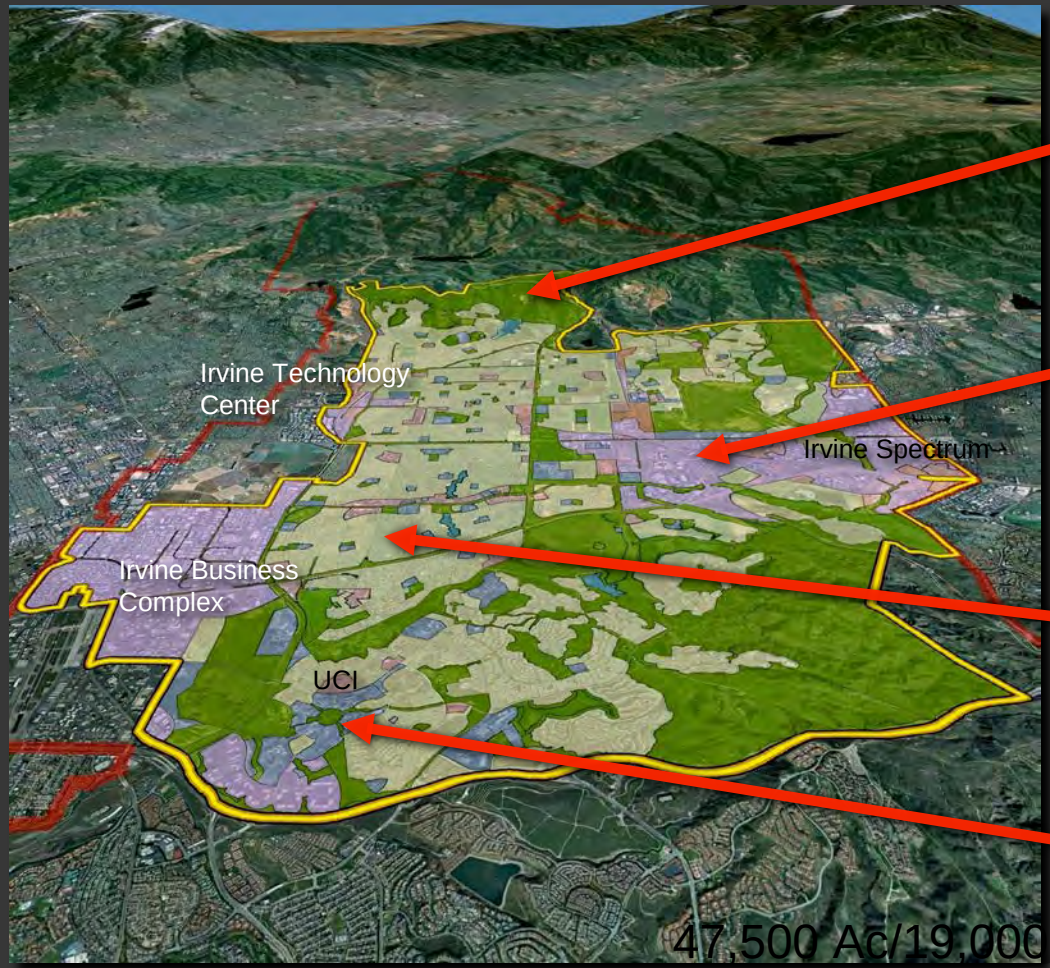
- Ensure that the three planning sectors adhere to topography and jurisdiction constraints.
- Continue the tradition of land stewardship, with an eye on the long-term view.
- Contribute to the quality of the cities on The Irvine Ranch.
- Make sound, realistic economic and political decisions.

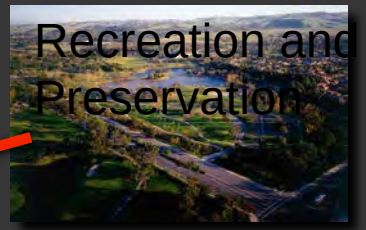
Three fundamental principles are followed in designing all residential, office, retail and resort structures on The Irvine Ranch

- Design integrity: Assuring that the design of the architecture has integrity, that the structures are pleasing as well as appropriate to the area in which they exist and that they always communicate a sense of place.

- Timeless architecture: Applying the principles of classical architecture to create a sense of timelessness and ensure that communities on The Irvine Ranch will age gracefully.

- Four-sided architecture: Using the same material on all four sides of a structure so that, no matter what vantage point it is viewed from, the design is never interrupted and all the parts are perceived as part of a unified whole.





City of Irvine Planning Objectives:

- Alternative to sprawl
- Balance development and open space
- Full range of land uses
- Economically self-sufficient
- Residential areas organized in villages
- Provide work, shopping, learning, and recreational opportunities near housing
- Infrastructure to support ultimate build-out
- Planned for an ultimate population of 214,000 residents

A Complete Range of Land Uses

The City of Irvine

- Consistently ranked as one of the safest cities of its size in the U.S.
- World renowned educational institutions – University of California, Irvine and Irvine Unified School District
- 66 square miles of well maintained neighborhoods, world class dining, shopping, recreation and cutting edge workplaces


NORDSTROM


Clean Energy
MacArthur Court
NEWPORT BEACH

What We Manage

- Square feet of Landscape – 84,000,000
- Square feet of Turf – 20,000,000
- Number of trees – 144,000
- Number of Irrigation controllers – 1,550
- Number of Maintenance contractors – 31
- Number of Tree pruning contractors – 14
- Total number IC landscape maintenance employees - 17

Landscape Awards

- McCarthy Center CLCA First Place Large Commercial Maintenance 2009 Gachina The Plaza at La Jolla CLCA Landscape Beautification Judges Award 2011 Brickman 20/40 Pacifica PLANET Grand Award 2011 ValleyCrest 8001 Irvine Center Drive CLCA Landscape Beautification - Outstanding Achievement 2011 Vandergeest Jamboree Center CLCA Landscape Beautification - Winner 2012 Vandergeest The Plaza at La Jolla PLANET Merit Award 2012 Brickman Discovery Business Center CLCA Landscape Beautification - Winner 2012 Bemus McCarthy Center PLANET Distinction Award 2012 Gachina Westwood Gateway CLCA statewide Achievement Award 2012 ValleyCrest McCarthy Center CLCA statewide First Place Large Commercial Maintenance 2012 Gachina The Plaza at La Jolla CLCA First Place Judges Award 2013 Brickman Pacific Arts Plaza CLCA large commercial landscape renovation 2013 Mission The Plaza at La Jolla CLCA statewide John Redmond Memorial Award for Best entry from all maintenance categories in California 2013 Brickman Jamboree Center CLCA Landscape Beautification - Winner 2014 Vandergeest 8001 Irvine Center Drive CLCA Achievement Award 2014 Vandergeest 8105 Irvine Center Drive CLCA First Place Large Commercial Maintenance 2014 Vandergeest MacArthur Court PLANET Grand Award 2014 CEI Market Place Center CLCA Landscape Beautification - Winner 2015 Bemus Newport Center - Block 500 CLCA 1st place Beautification Award 2015 Vandergeest Jamboree Center CLCA 2nd place - Outstanding Achievement Award 2015 Vandergeest 100 Spectrum Center Drive CLCA 1st place Beautification Award 2015 Vandergeest 300 Spectrum Center Drive CLCA 2nd place - Outstanding Achievement Award 2015 Vandergeest Jamboree Center CLCA statewide 1st place - Unlimited Commercial Maintenance Award 2015 Vandergeest Newport Center - Block 500 CLCA statewide John Redmond Memorial Award for Best entry from all maintenance categories in California 2015 Vandergeest McCarthy Center CLCA Achievement Award for Commercial Installation 2016 Gachina Block 500 at Newport Center CLCA 1st Place Award "Retail/Office/Industrial" 2016 Vandergeest 100 Spectrum Center Drive CLCA 1st Place Award "Landscape Maintenance Project Over 30yrs Old & Over $3k/month" 2016 Vandergeest Discovery Business Center CLCA Landscape Beautification - Winner 2016 Bemus

Landscaping is the Slowest of the Performing Arts

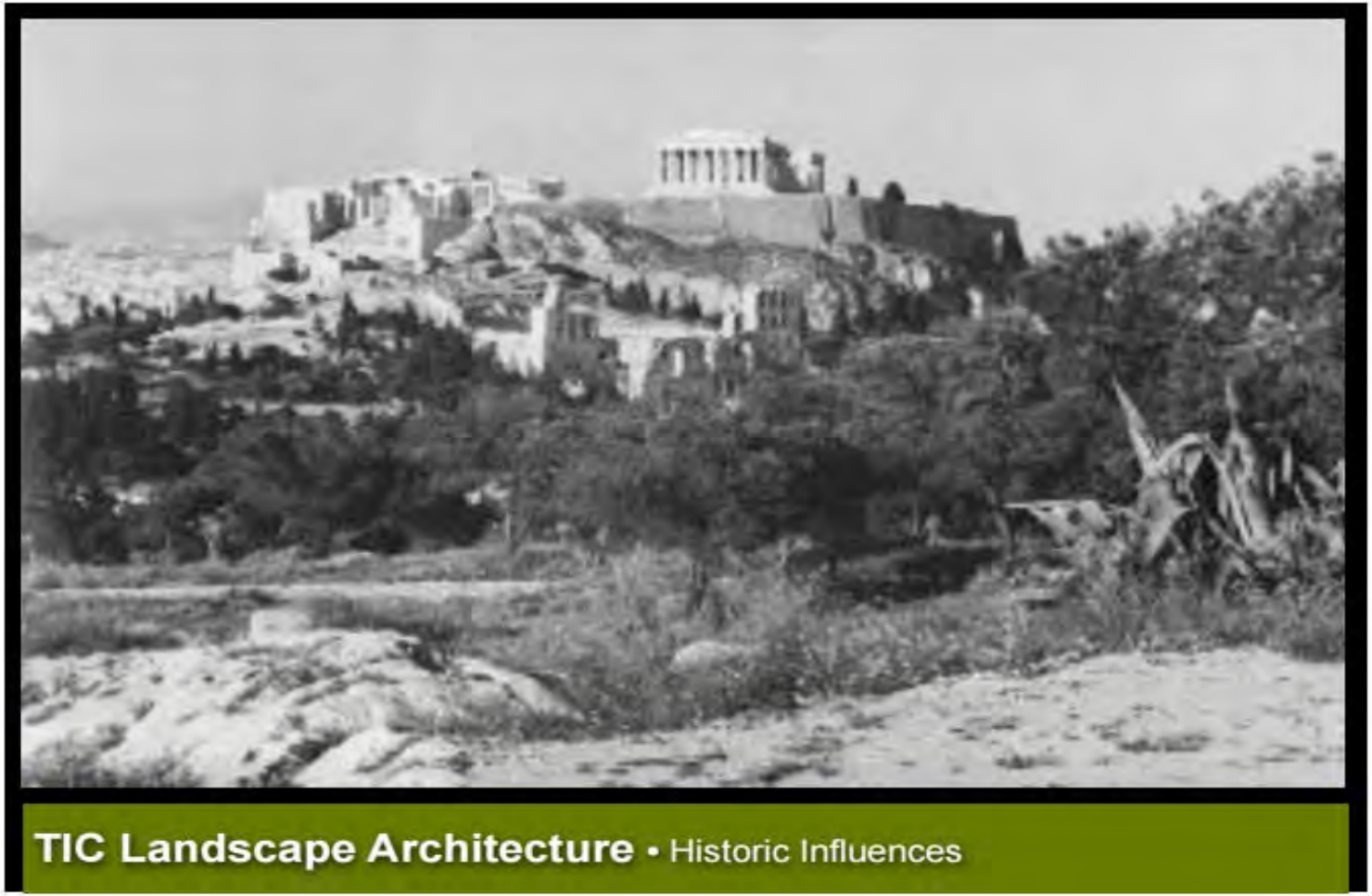

Uncle Sam says -
GARDEN
To Cut Food Costs
CITY
FARM
U.S. Department of Agriculture Washington, D.C.


MORGAN DREXEN

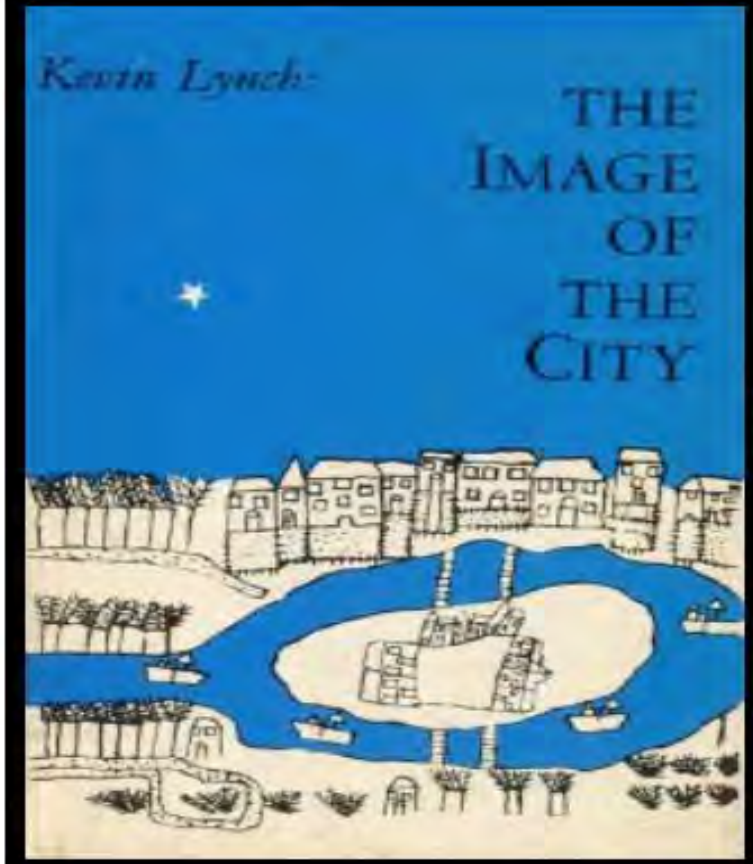
TIC Landscape Architecture • Why doesn't ours look like this?

TIC Landscape Architecture • Why doesn't ours look like this?

TIC Landscape Architecture • Ranch Landscape



TIC Landscape Architecture • Historic Influences



"Place legibility" is a term used to describe the ease with which people can understand the layout of a place. Lynch identified a network of five key elements:

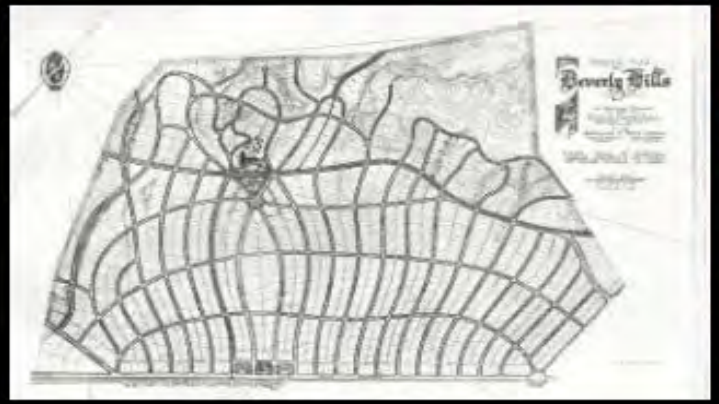
- paths
- edges
- districts
- nodes
- landmarks

1. HISTORIC PRECEDENT
   - Influences
2. RANCH CONTEXT
   - Geography
   - Topography
3. MEDITERRANEAN CLIMATE
4. SITE PLANNING and LANDSCAPE DESIGN
   - The City of Irvine

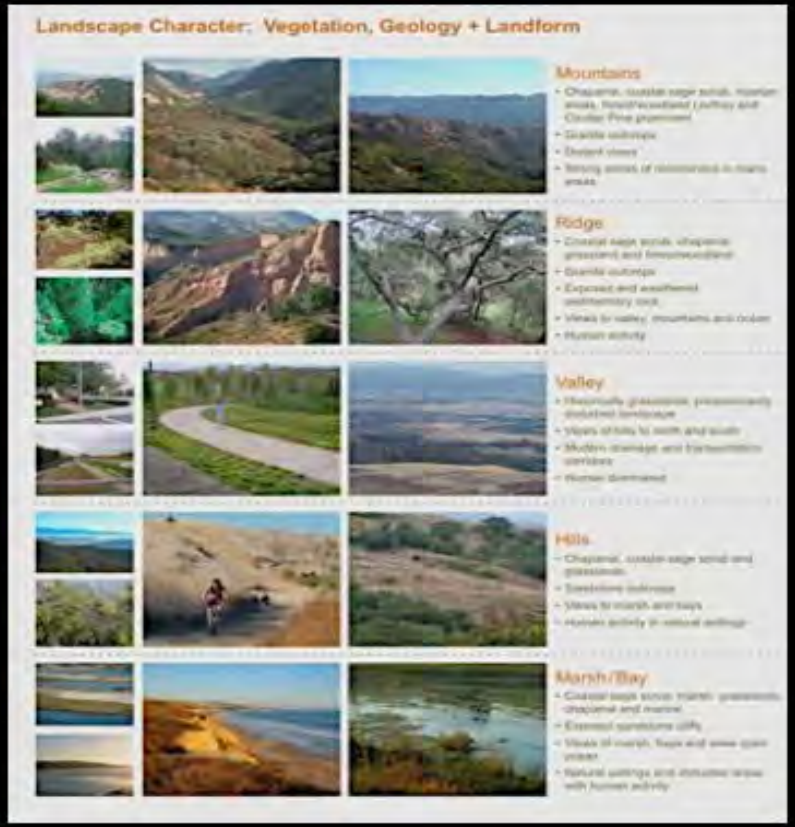
- Architecture
- **Landscape Architecture and Site Planning**
- Interior Design

Planning and Design Influences

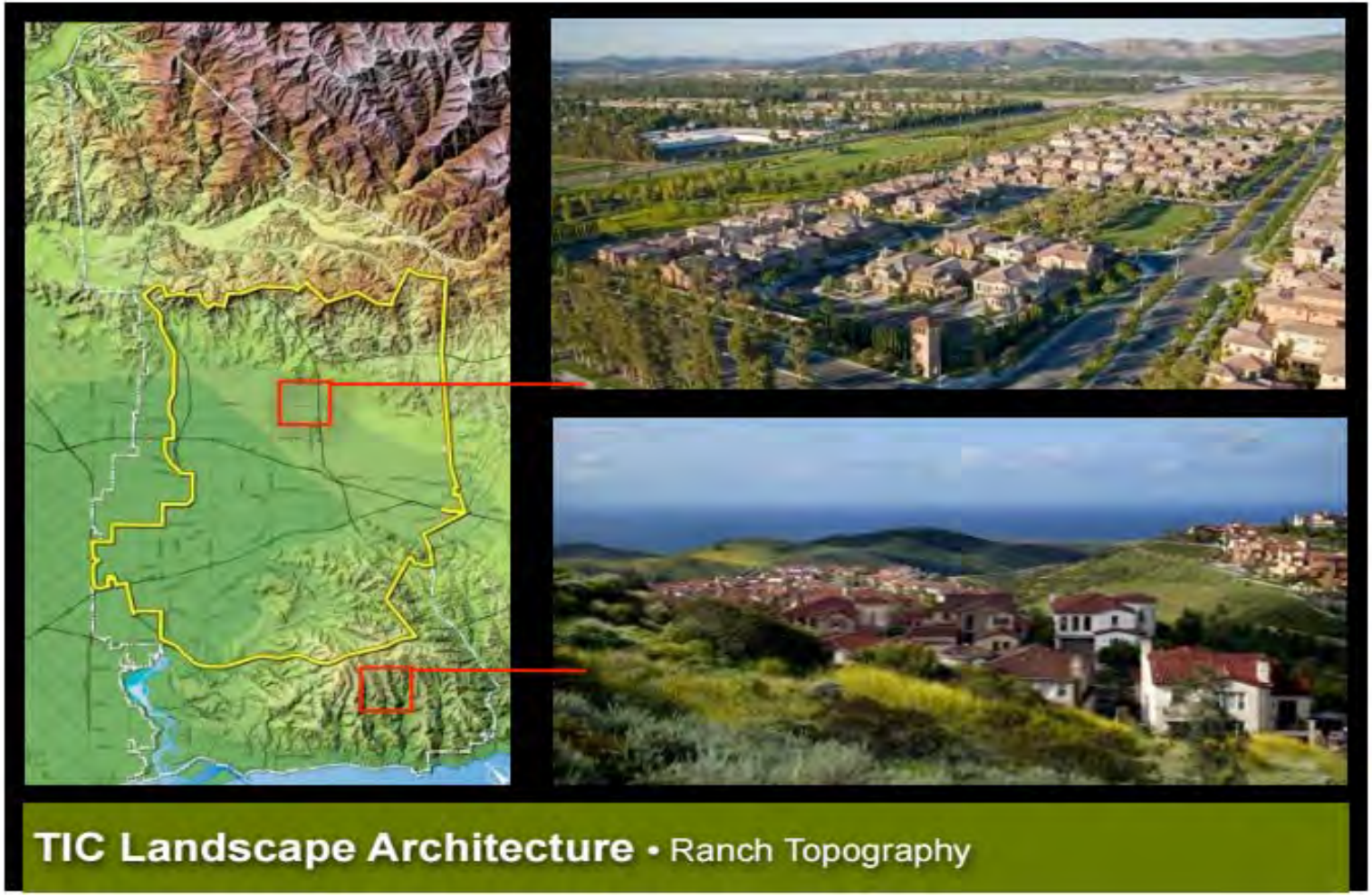
It Takes a Village....

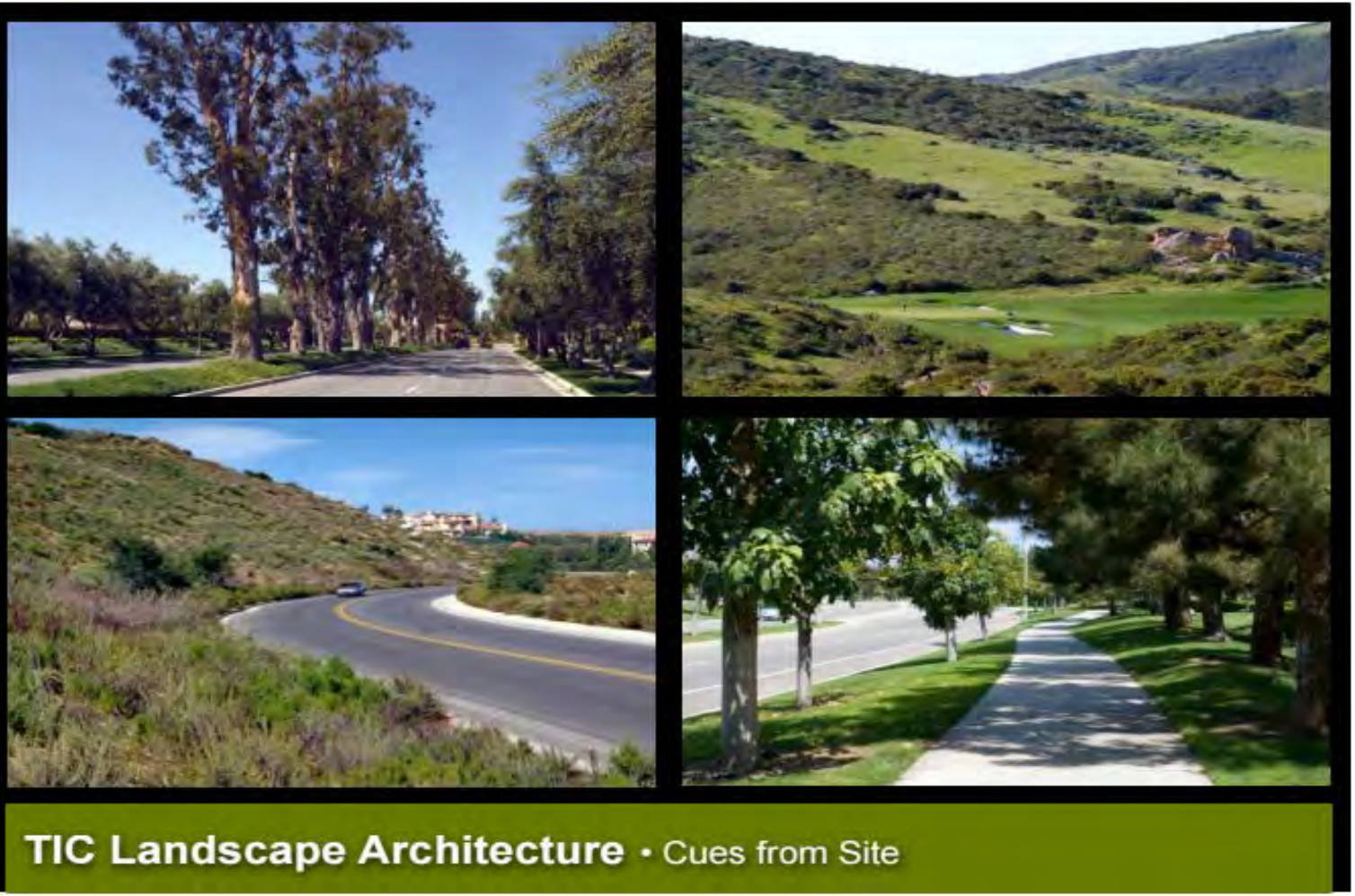


TIC Landscape Architecture • Historic Influences



TIC Landscape Architecture • Ranch Geography


TIC Landscape Architecture • Ranch Topography


TIC Landscape Architecture • Cues from Site

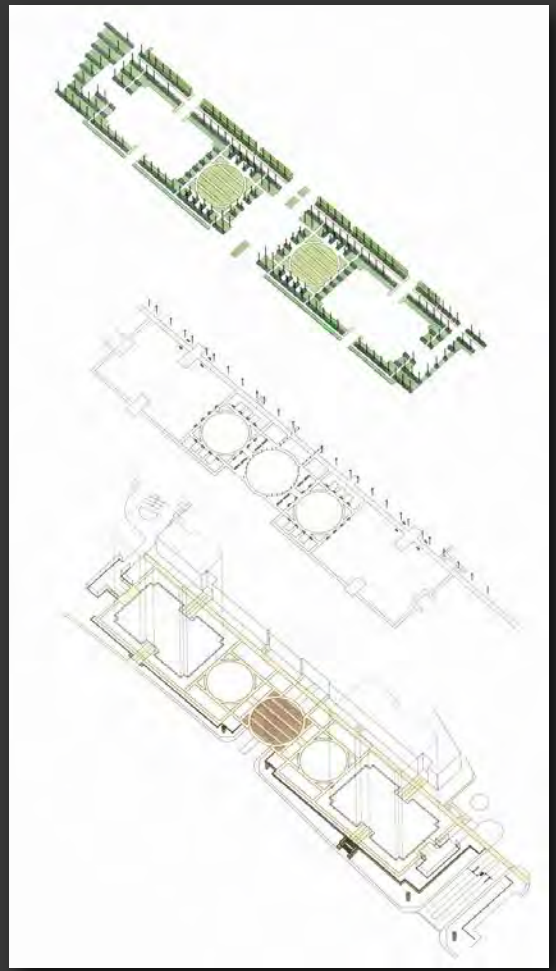

CRMLS

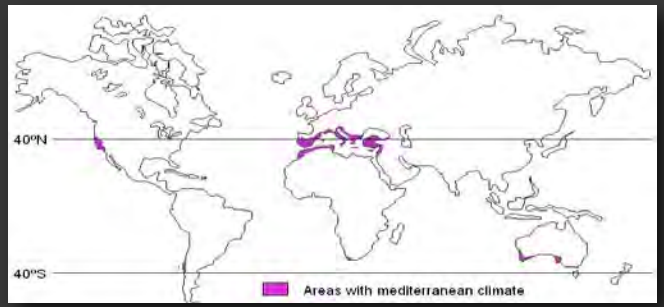
Landscape Architecture has two distinct disciplines
site planning and **landscape design**

TIC Landscape Architecture • Site Planning and Landscape Design

Site Planning - the art of organizing program elements on a site such as structures, driveways, parking lots, landscaping and utilities. Considerations include:

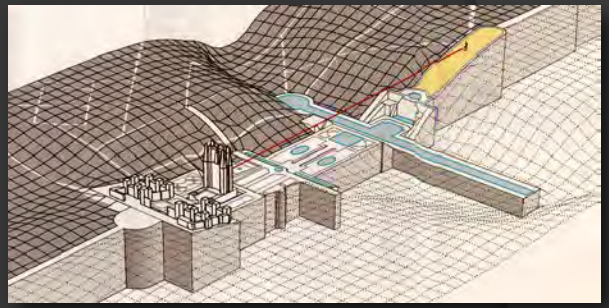
- Respond to context
- Positive arrival experience
- Clear auto and pedestrian circulation system
- Buildings create desirable exterior spaces
- Care in grading the site
- Minimize visual impact of site utilities
- Space for landscape





Landscape Architecture

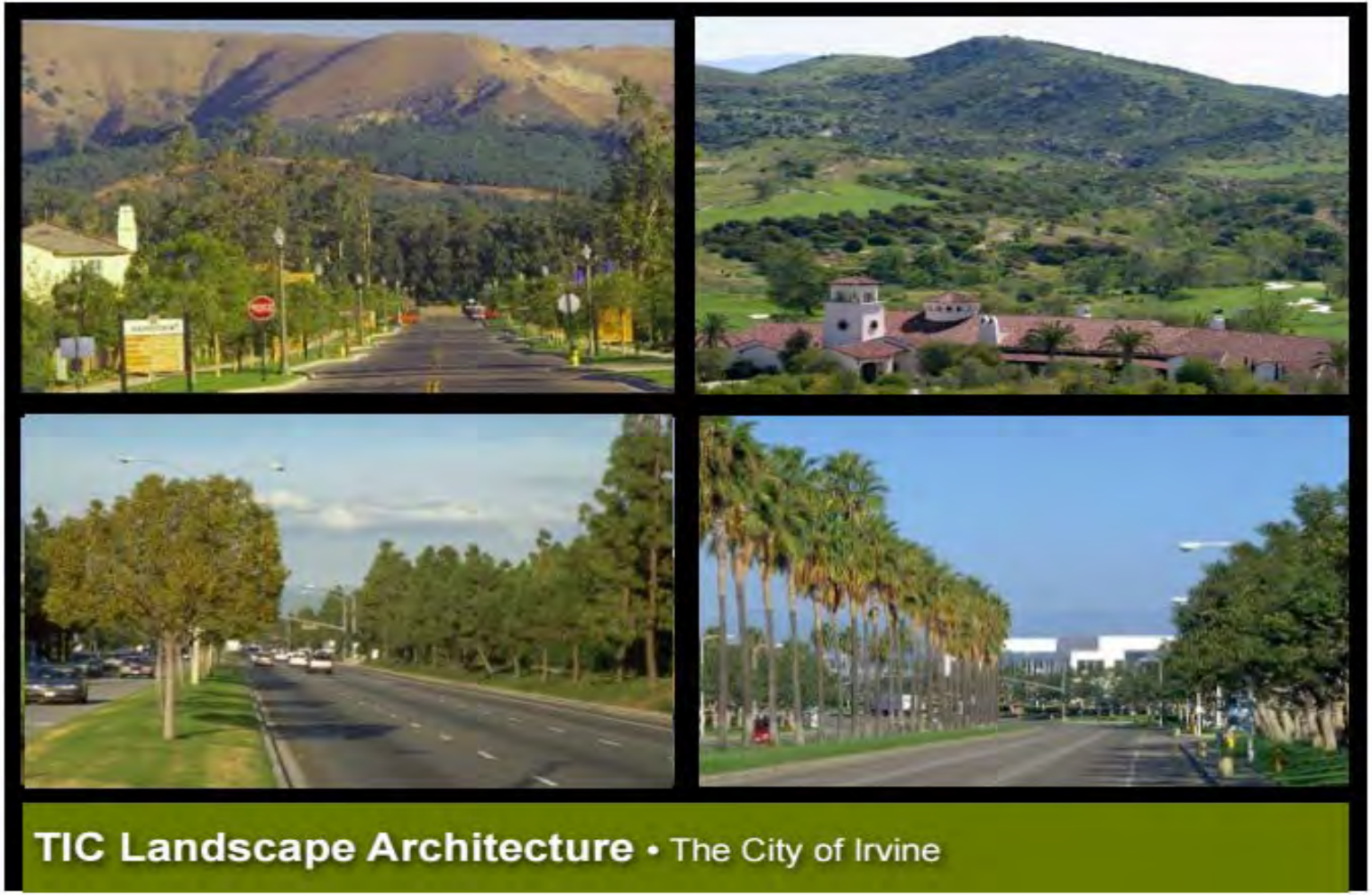
- Reinforces site plan
- Creates space
- System of trees, shrubs, ground cover, paving and site furniture
- Establishes character
- Regionally influenced
- Classically inspired
- Small plant palette
- Evergreen

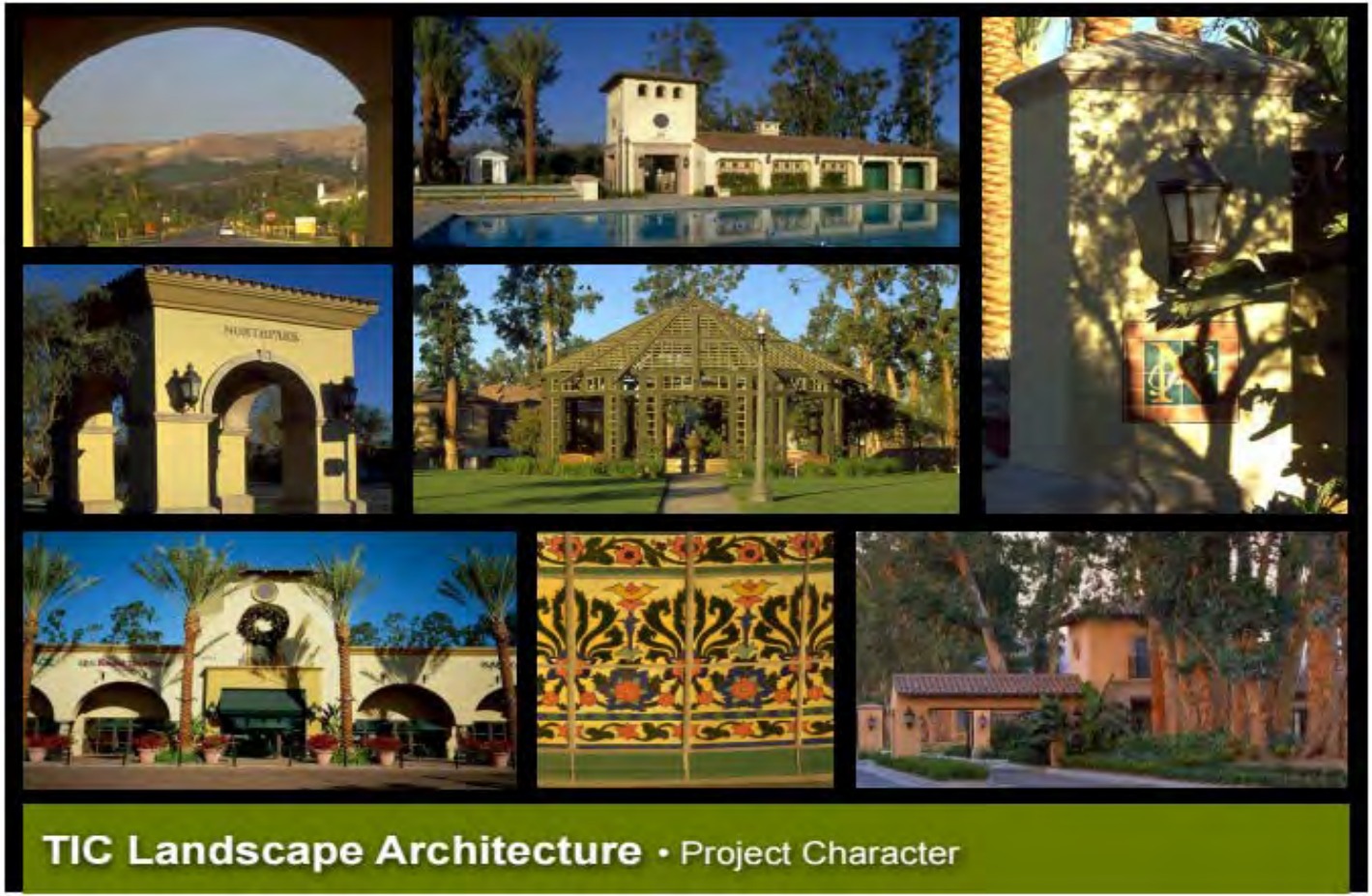



TIC Landscape Architecture • Planting Design Discipline

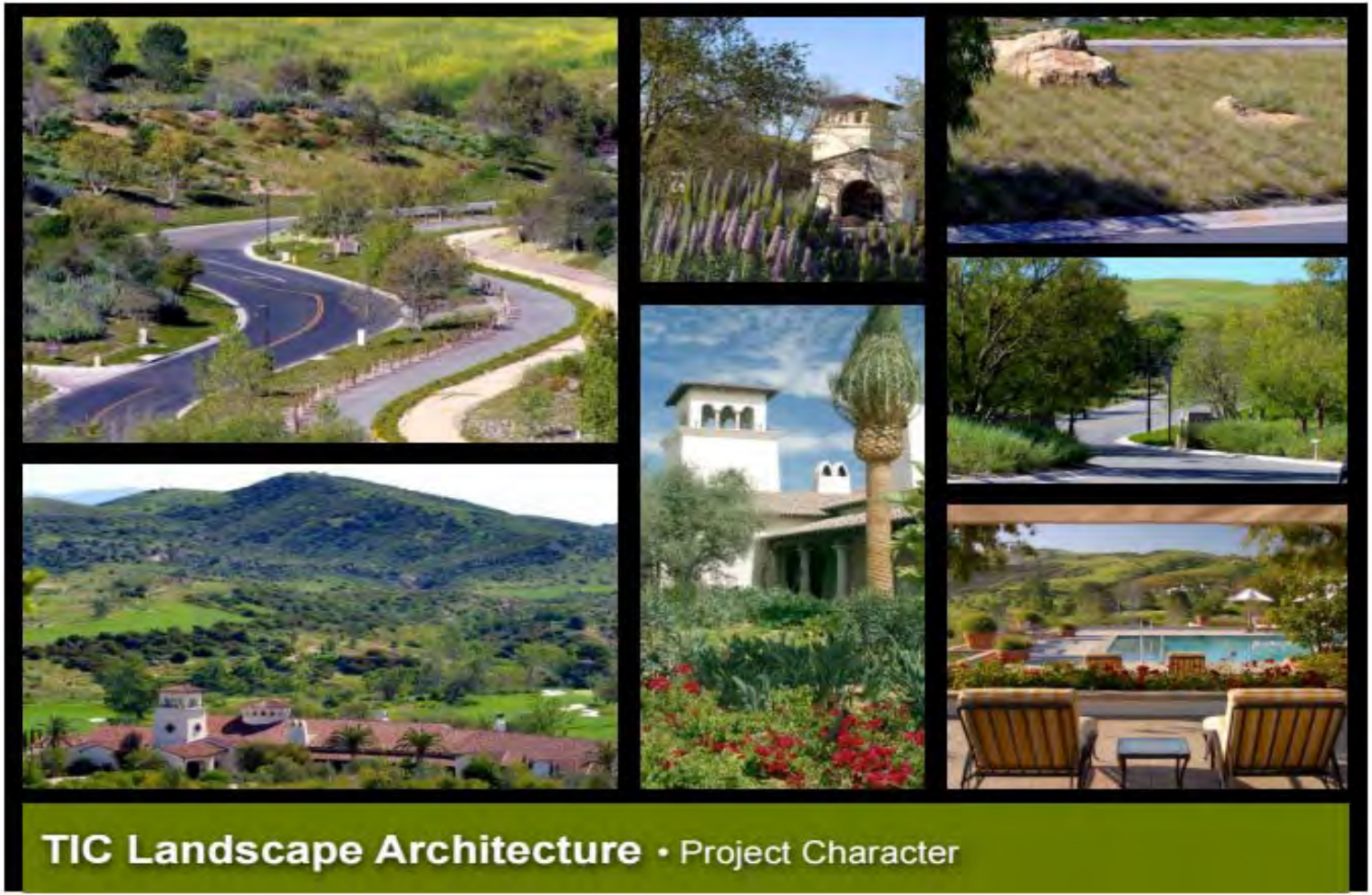

TIC Landscape Architecture • Visual Site Plan Cues


TIC Landscape Architecture • More than plants


TIC Landscape Architecture • The City of Irvine



TIC Landscape Architecture • Project Character



TIC Landscape Architecture • Project Character


M AGRIPPA L F COS TERTIVM FECIT


NEWPORT COAST


number


HOT TOPIC
© 2011, R.A. Hansen

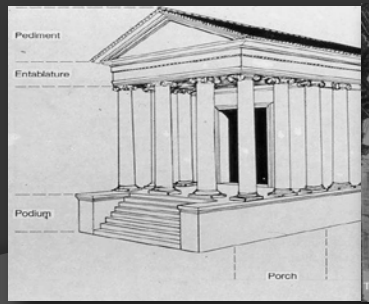

Sur

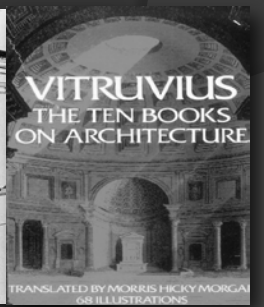
TIC Architecture

- **Regionally inspired**
- **Traditional forms**

Classical Architecture

- **Derived from ancient Greek and Roman buildings**
- **Symmetrical, axial, ordered and hierarchical relationships in plan and elevation**
- **Scale and proportion based on mathematic formulas and scale of human body**
- **Create architectural “orders”, a repetitive system for organizing architectural elements including columns, capitals, entablature, architrave, frieze and cornice**
- **Stone and masonry construction**





IRVINE SPECTRUM

BUILDER DESIGN GUIDELINES

FEBRUARY 27, 2017


1-3 BANTING


ORANGETREE
The Capital Group Companies
Oak Creek Community Park
EAST IRVINE
Irvine RV Storage
Costco Wholesale
IRVINE TECHNOLOGY CENTER
Alton Marketplace
Walmart
Courtyard by Marriott Irvine Spectrum
Blizzard Entertainment
IRVINE SPECTRUM CENTER
Quail Ridge Apartments
Target
Google

GIS rev: 10/13/2016

IRRIGATION DESIGN GUIDELINES
FOR
IRVINE COMPANY OFFICE PROPERTIES

PREPARED FOR:

IRVINE COMPANY
OFFICE PROPERTIES
550 NEWPORT CENTER DRIVE
NEWPORT BEACH, CALIFORNIA

UPDATED April 15, 2015

PREPARED BY:

d.d. PAGANO, INC.
IRRIGATION CONSULTANTS
4705 EAST CHAPMAN AVENUE
ORANGE, CA 92869
(714) 771-9200

IRRIGATION DESIGN GUIDELINES
FOR
IRVINE COMPANY OFFICE PROPERTIES

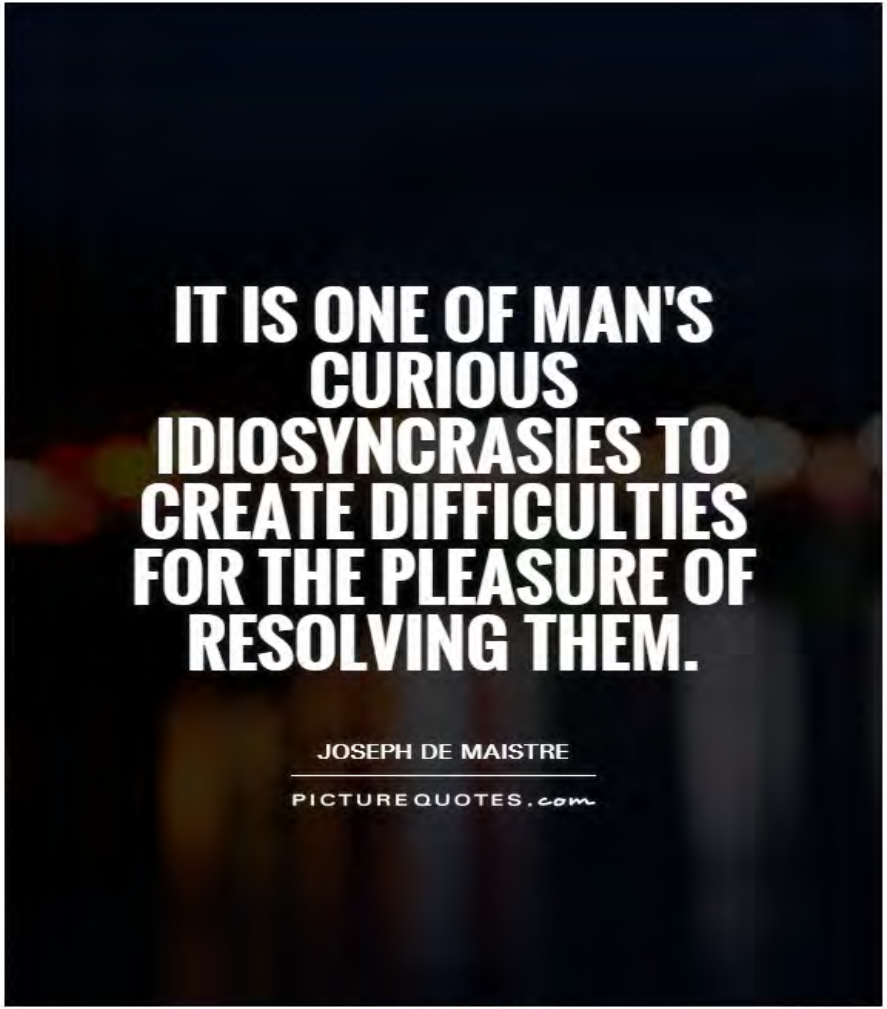
PREPARED FOR:

IRVINE COMPANY
OFFICE PROPERTIES
550 NEWPORT CENTER DRIVE
NEWPORT BEACH, CALIFORNIA

UPDATED April 15, 2015

PREPARED BY:

d.d. PAGANO, INC.
IRRIGATION CONSULTANTS
4705 EAST CHAPMAN AVENUE
ORANGE, CA 92869
(714) 771-9200



PICTUREQUOTES


FASHION
ISLAND
ISLAND HOTEL


NEWPORT
CENTER
ISLAND HOTEL


NEWPORT
CENTER
ISLAND HOTEL
NO
PARKING
ANY TIME


Lake Oroville on July 20, 2011


Lake Oroville on July 20, 2015

What Do We Want?

What Do We Want?

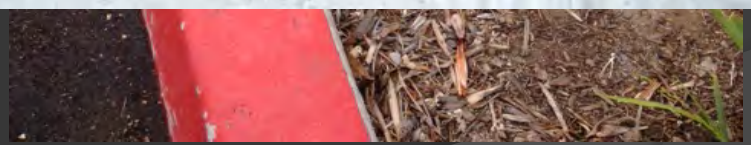
- To be able to apply the precise amount of water needed by each landscape zone with perfect coverage and zero runoff or overspray

What Do We Want?

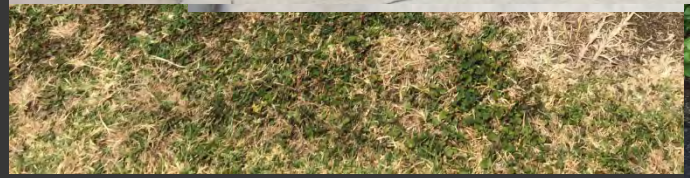
- To be able to apply the precise amount of water needed by each landscape zone with perfect coverage and zero runoff or overspray
- For our maintenance vendors to be able to maintain the system to work as well as it did on day one

What We Don’t Want

Don’t Want




NO
STOPPING
ANY
TIME



Challenges

- Irrigation design and maintenance are one of the most crucial components of a landscape

Challenges

- Irrigation design and maintenance are one of the most crucial components of a landscape
- Typically new irrigation systems start deteriorating the day after installation

Challenges

- Irrigation design and maintenance are one of the most crucial components of a landscape
- Typically new irrigation systems start deteriorating the day after installation
- There is a serious shortage of knowledgeable, experienced irrigation managers in landscape maintenance

IC Water Management Best Practices

IC Water Management Best Practices

- **Require written proof of monthly irrigation inspections**

IC Water Management Best Practices

- **Require written proof of monthly irrigation inspections**
- **Partner with your vendor and share water bills and allocations. Hold them financially accountable for water penalties due to overwatering**

IC Water Management Best Practices

- **Require written proof of monthly irrigation inspections**
- **Partner with your vendor and share water bills and allocations. Hold them financially accountable for water penalties due to overwatering**
- **Upgrade irrigation systems with smart controllers, low flow sprinklers, drip irrigation and master valves with flow sensors where appropriate**

IC Water Management Best Practices

- **Require written proof of monthly irrigation inspections**
- **Partner with your vendor and share water bills and allocations. Hold them financially accountable for water penalties due to overwatering**
- **Upgrade irrigation systems with smart controllers, low flow sprinklers, drip irrigation and master valves with flow sensors where appropriate**
- **Convert to reclaimed water**

IC Water Management Best Practices

- **Require written proof of monthly irrigation inspections**
- **Partner with your vendor and share water bills and allocations. Hold them financially accountable for water penalties due to overwatering**
- **Upgrade irrigation systems with smart controllers, low flow sprinklers, drip irrigation and master valves with flow sensors where appropriate**
- **Convert to reclaimed water**
- **Re-landscape with low water use plants**

IC Water Management Best Practices

- **Require written proof of monthly irrigation inspections**
- **Partner with your vendor and share water bills and allocations. Hold them financially accountable for water penalties due to overwatering**
- **Upgrade irrigation systems with smart controllers, low flow sprinklers, drip irrigation and master valves with flow sensors where appropriate**
- **Convert to reclaimed water**
- **Re-landscape with low water use plants**
- **Reduce your turf footprint**

Irvine Company Water Savings

- **We have converted 603 irrigation controllers to “smart controllers” (Savings of approximately 100,800 gallons annually per 24 station controller)**

Irvine Company Water Savings

- **We have converted 603 irrigation controllers to “smart controllers”**
  (Savings of approximately 100,800 gallons annually per 24 station controller)

- **We have converted 1,300 valves to drip irrigation**
  (water savings approximately 25,700 gallons annually per valve)

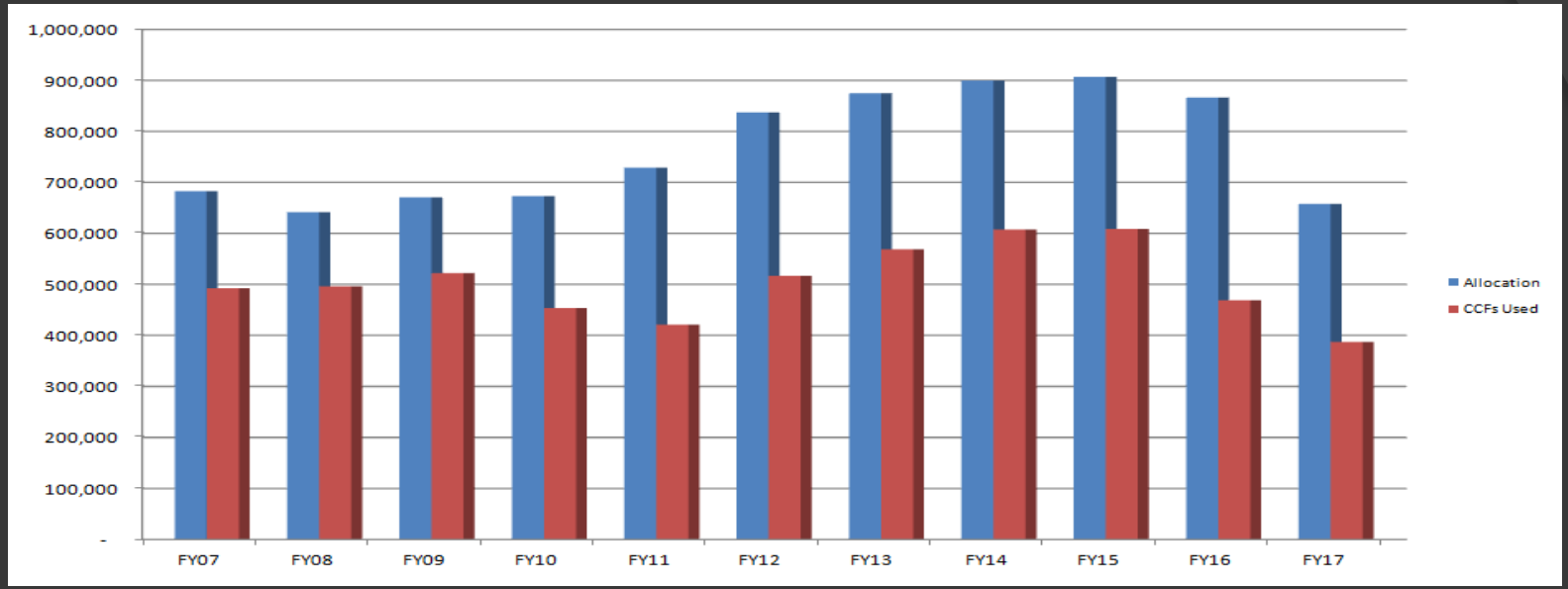
Irvine Company Water Savings

- **We have converted 474 irrigation controllers to “smart controllers”**
  (Savings of approximately 100,800 gallons annually per 24 station controller)

- **We have converted 1,400 valves to drip irrigation**
  (water savings approximately 25,700 gallons annually per valve)

- **We have converted about 70,000 sprinklers to low flow, high efficiency nozzles**
  (water savings approximately 1,303 gallons annually)

How Have These Investments Changed Actual Water Use?

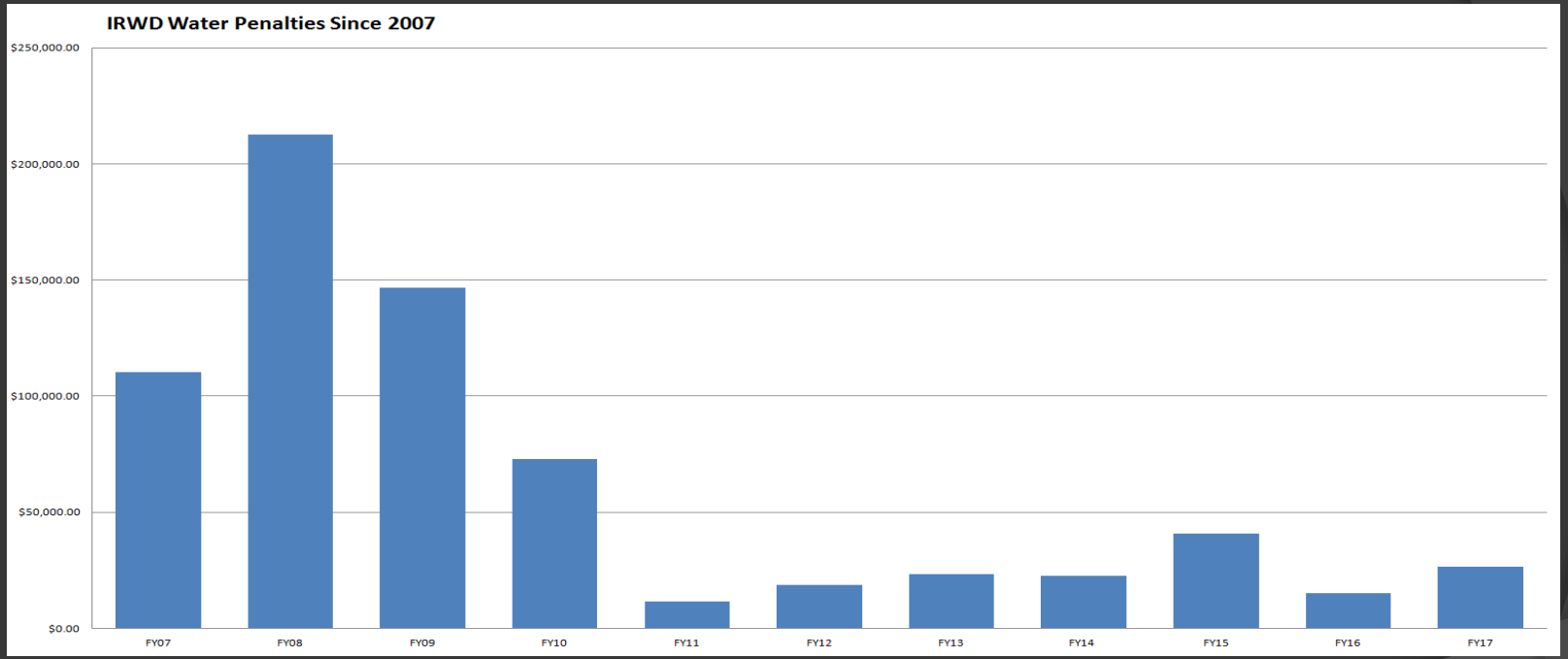


Allocations have steadily increased, but actual usage has either declined or stayed flat, resulting in more water saved annually and less water penalties over time. **Average percentage used is 70% of allocation.**

Estimated Annual Office Portfolio Savings- **$112,000**

82,000,000 Gallons

IRWD Water Penalties Since 2008



- 900% Savings vs. 2008 water penalties

Irrigation Principles

- Design for ownership
  - Equipment standardization
  - Effective after landscape matures and evolves
  - Allow for expansion
  - Durability
  - Precise application and hydrozoning

Irrigation Principles

- Facilitate maintenance
  - Simplify repairs
  - Fertigation
  - POC assemblies

Irrigation Principles

- Integration of irrigation with our amenities
  - Hardscape
  - Signage
  - Windows
  - Trees
  - Lighting

Irrigation Principles

- Drip Irrigation highly utilized
  - Shrub and ground cover areas
  - Small turf areas
  - Turf areas around signage
  - Areas where water staining can occur

Irrigation Principles

Irrigation Principles

Irrigation Principles

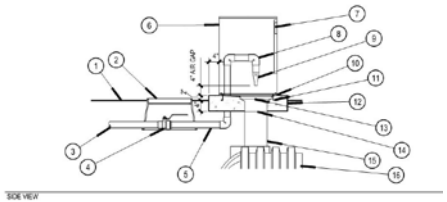
Irrigation Principles

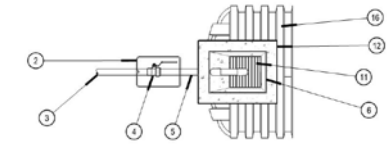
- Weather based centralized irrigation control
- Flow monitoring and management

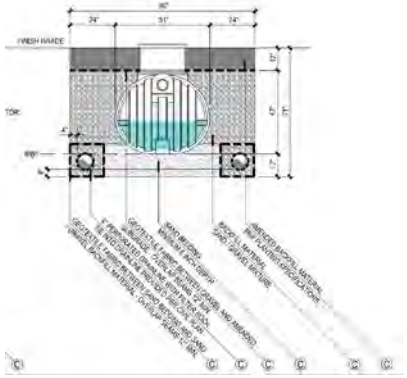
Santa Clara Square

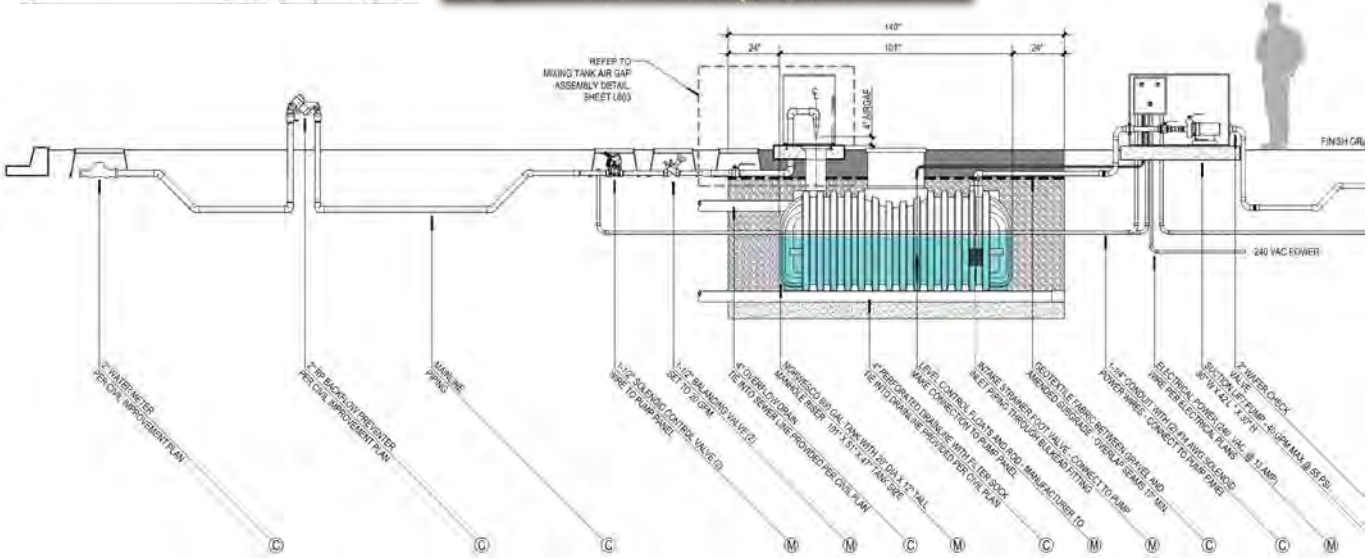
Santa Clara Square

	Redwood Limits	Recycled Source	Potable Source	50% Blend
pH		7.38	7.74	7.56
Salinity	3	1.00	0.66	0.83
Sodium	70	117	30	73
Adjusted SAR	3	5.1	1.6	3.7
Chloride	150	180	16	113
Bicarbonate	100	99	233	166
Boron	0.70	0.29	0.09	0.19









Santa Clara Square

Selecting a Contractor

Selecting a Contractor

- The work speaks for itself

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
- Reputation

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
- Reputation
- Size

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
- Reputation
- Size
- Communication

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
- Reputation
- Size
- Communication
- Location

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
- Reputation
- Size
- Communication
- Location
- Appearance of employees and trucks

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
- Reputation
- Size
- Communication
- Location
- Appearance of employees and trucks
- Willingness to innovate

Selecting a Contractor

- The work speaks for itself
- Length of time in the industry
- Reputation
- Size
- Communication
- Location
- Appearance of employees and trucks
- Willingness to innovate
- Proactive

Irvine Company Best Practices – Landscape Maintenance

Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers

Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
- Walk every square inch of every property every month

Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
- Walk every square inch of every property every month
- Create comprehensive punch list with completion dates

Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
- Walk every square inch of every property every month
- Create comprehensive punch list with completion dates
- Score the quality of the landscape maintenance with a judging sheet each month

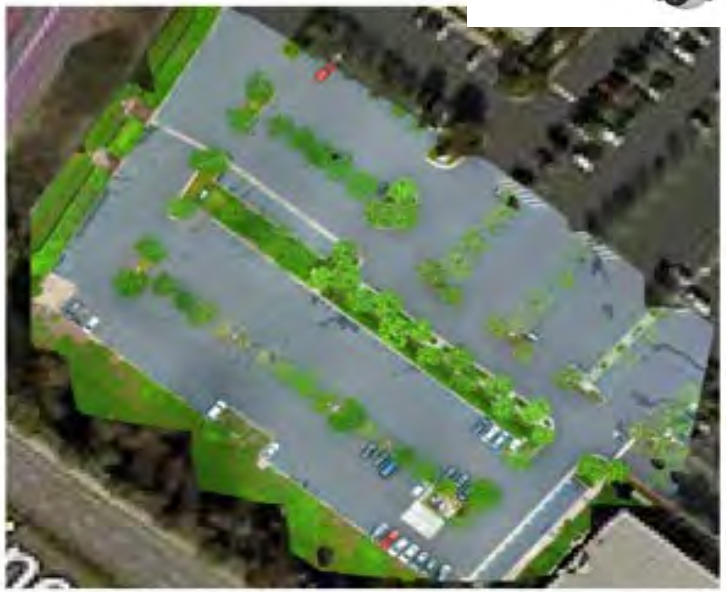
Irvine Company Best Practices – Landscape Maintenance

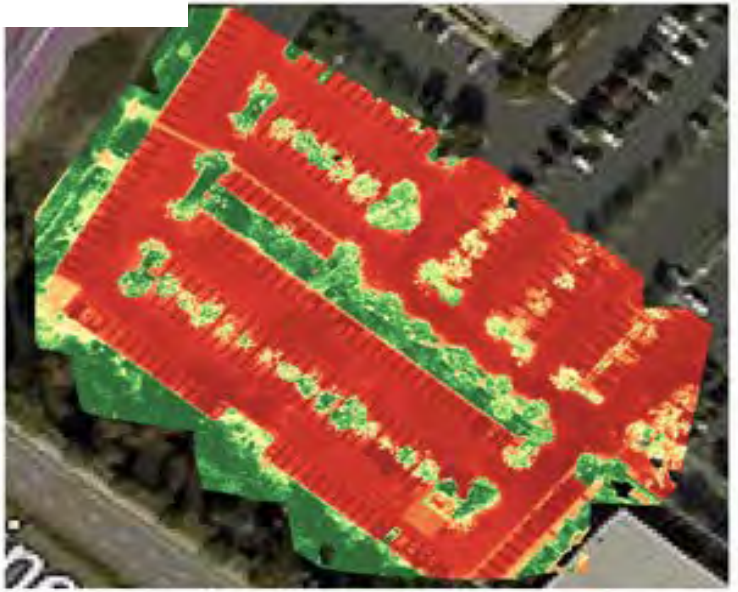
- Planning and Design team – Gatekeepers
- Walk every square inch of every property every month
- Create comprehensive punch list with completion dates
- Score the quality of the landscape maintenance with a judging sheet each month
- Drive-by two weeks after walkthrough

Irvine Company Best Practices – Landscape Maintenance

- Planning and Design team – Gatekeepers
- Walk every square inch of every property every month
- Create comprehensive punch list with completion dates
- Score the quality of the landscape maintenance with a judging sheet each month
- Drive-by two weeks after walkthrough
- Partnering with our vendors


WHAT
WE LOVE





Value	Indication
<0	Unsuitable / dead material, e.g. roads, buildings, soil or dead plants
0 – <0.33	Unhealthy plant material
0.33 – <0.66	Healthy plant material
≥ 0.66	Very healthy plant material


ANY
QUESTIONS
?

On a "Lighter" Note: UV Disinfection 101

Dan Shaver
Strategic Account Manager, Aquionics Inc.

Aquionics Background

HALMA

Process Safety	Infrastructure Safety	Medical	Environmental & Analysis
• Castell Safety • Crowcon • Elfab • Fortress Interlocks • Kirk Key • Netherlocks • Oseco • Cosasco • SERV Trayvou • Smith Flow Control	• Advanced Electronics • Apollo Group • Avire • BEA Group • FFE • Firetrace • Texecom	• Accudynamics • Accutome • Bio-Chem Fluidics • Cen Trak • Diba • Keeler • Longer Precision Pump • Medical • MicroSurgical Technology • Riester • SunTech Medical • Visionmetrics • Volk Optical	• Alicat Scientific • Avo Photonics • Fiberguide • HWM-Water • Hydreka • Labsphere • Ocean Optics • Palintest • Perma Pure • Sensorex • Hanovia • Berson • Aquionics

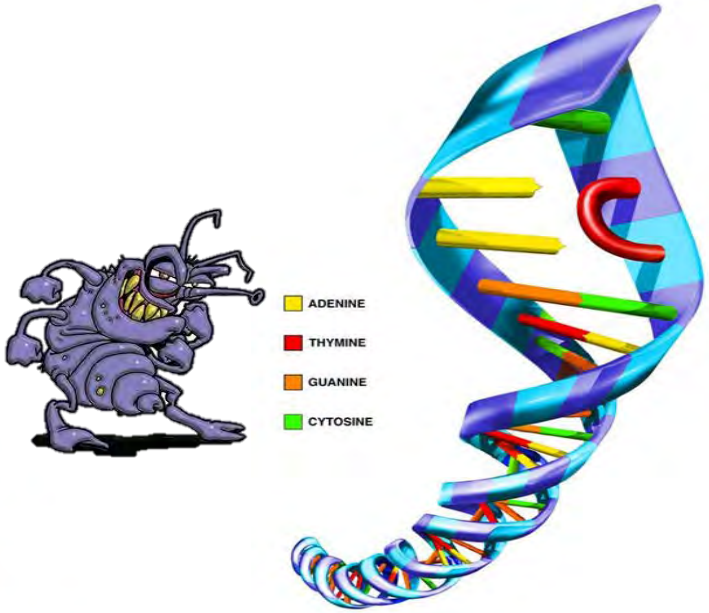
Aquionics Background

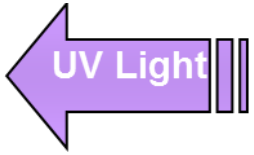
AQUIONICS UV Delivered	Est. 1983 Charlotte, NC	AMERICAS Municipal & Industrial Applications
Hanovia the power in UV technology	Est. 1924 Slough, UK	EMEA & ASIA Industrial Applications
berson Masters in UV	Est. 1972 Eindhoven, Holland	EMEA & ASIA Municipal Applications

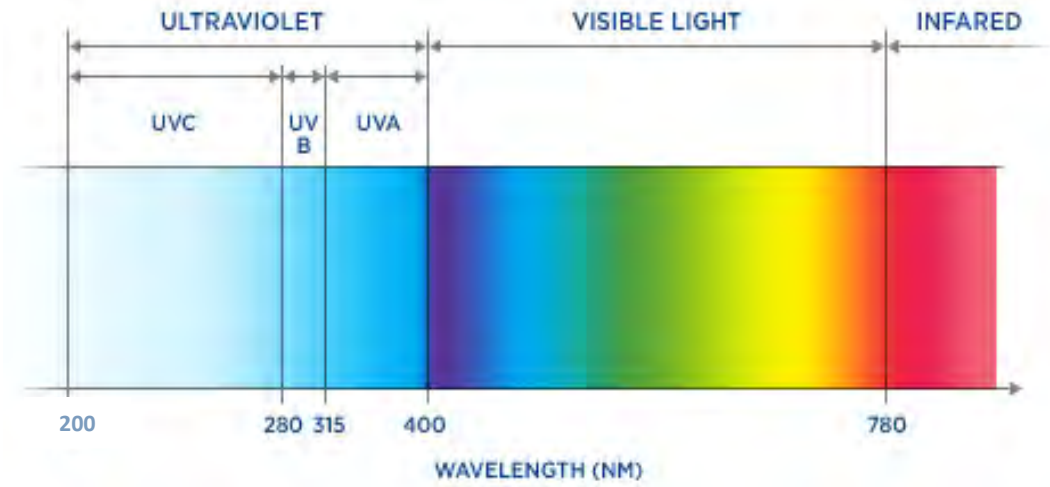
#1 - What is UV Disinfection and why do I need it?

What is UV disinfection?

- Mercury vapor lamps produce UV-C light at a wavelength of 253.7nm
- DNA of many common bacteria & virus have a peak absorption around 260-265nm
- Exposure to UV-C destructs part of the DNA, preventing reproduction
- UV-C is the only effective treatment for many chlorine resistant organisms such as cryptosporidium and giardia

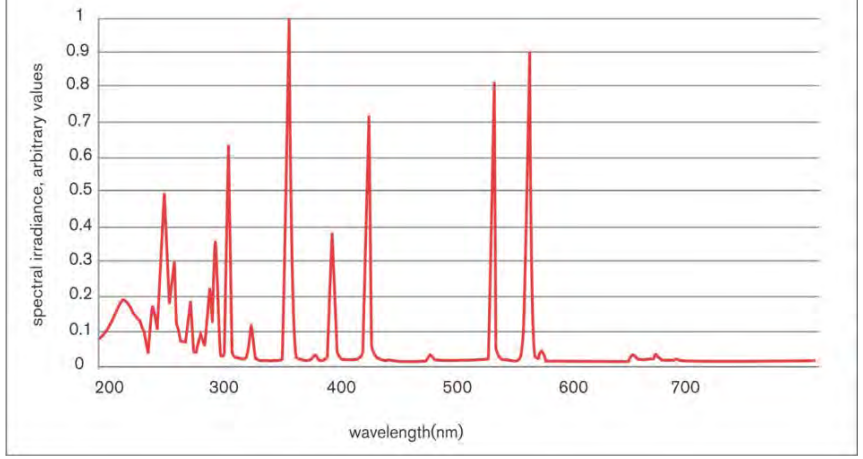




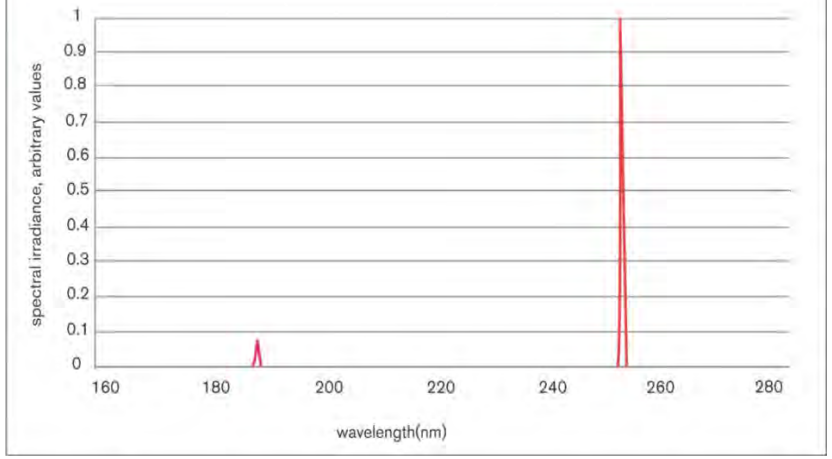


UV Lamp Technology Comparison

Medium Pressure (MP) UV Lamp Output



Medium Pressure (MP) lamps are also called polychromatic lamps, as they emit multiple wavelengths. MP lamps provide a higher output, but for usually a shorter amount of time, allowing for a smaller footprint and less lamps.



Low Pressure (LP) or Low Pressure Amalgam (LPHO) lamps are called monochromatic, as they emit only one wavelength. LP lamps are usually longer, and more are required to treat the same amount of flow as a MP lamp, however they consume less energy and typically last longer.

LP vs. MP Applications

There is not one place where one technology is used over another, as each have their positive and negative attributes.

Low Pressure (LP)

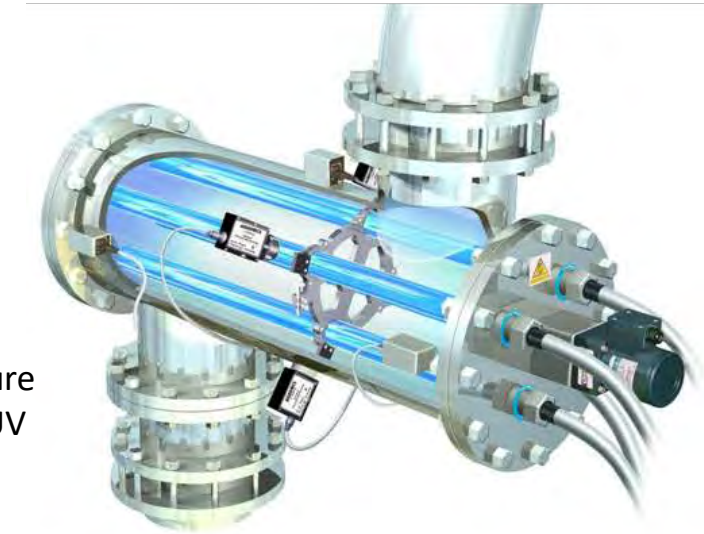
- Where space is not limited.
- Typically in lower flow situations.
- Where power costs are high.
- In batch processing.

Medium Pressure (MP)

- Limited space.
- When a high DOSE/level of disinfection is required.
- With continuous flows.
- Low maintenance requirement due to low number of lamps.

UV System Examples

- Full range of low-pressure and medium pressure UV systems
- Inline, U-shape and S-shape design (medium pressure)
- Single lamp horizontal or vertical installation (low pressure)



Maintenance Expectations

UV Lamps

- Works best with no more than 4 on/off cycles in 24 hours of operation
- MP Lamps – 8,000 hours of run time
- LP Lamps – 12,000 – 16,000 hours of run time

Quartz Sleeve

- Solarizes over time
- Replace every 2 years

Intensity Sensor

- Ages/drifts over time
- Calibration check against NIST standard every 12 months
- In-field sensor verification monthly a good practice

Auto-Wiper

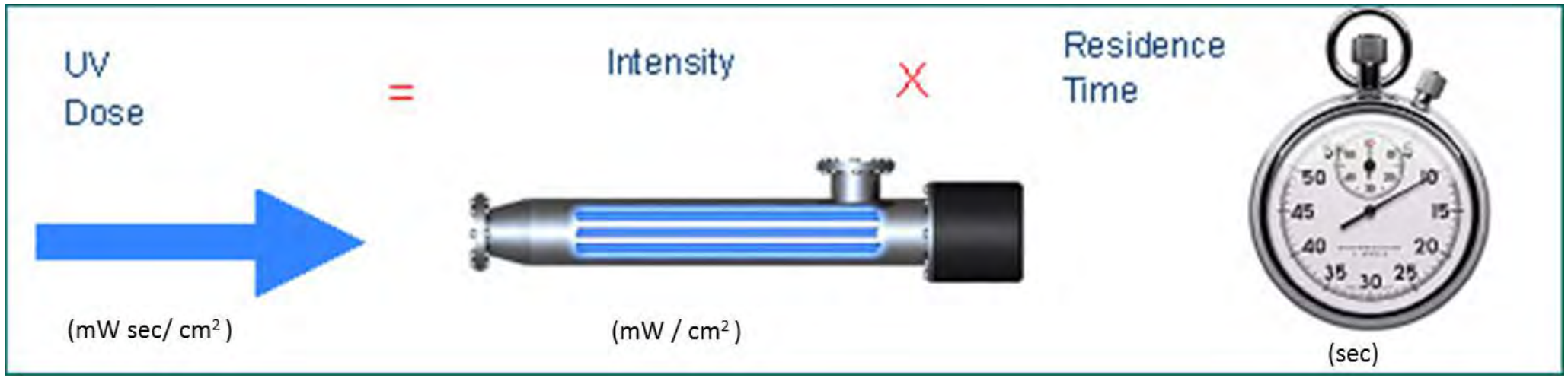
- Keeps sleeve surface clean and reduces the effects of fouling
- Replace wiper rings every 12 months

#2 - What is UV Dose and how much do I really need?

Understanding UV Dose

- UV Fluence or commonly referred to as **Dose**, is the energy required to inactivate a microorganism and is measured in mW sec/cm^2 or mJ/cm^2.

- It is important to understand that actual equations used by UV systems are more complex than this and vary from UV system to UV system to account for UV reactor design differences.



Understanding UV Dose

AQUIONICS UV Delivered

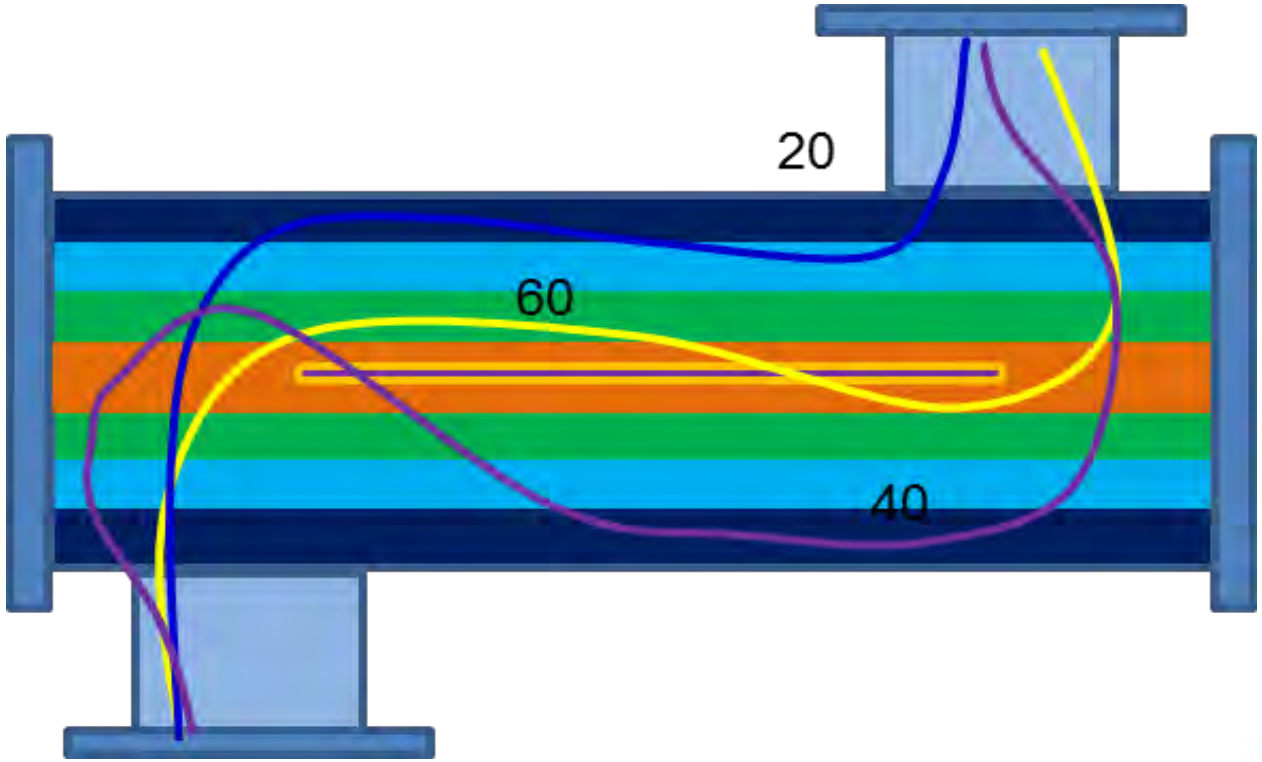
- While there is some regulation that drives the level of DOSE required, many facilities look to UV manufacturers to make recommendations.

- Studies have been conducted to prove the DOSE require for most common bacteria, protozoa, molds & spores and virus.

Organism	UV DOSE (mJ/cm2) for a given Log Reduction							Reference
	1	2	3	4	5	6	7	
Legionella pneumophila (ATCC 43660)	3.1	5	6.9	9.4				Wilson et al. 1992
Salmonella spp.	<2	2	3.5	7	15	29		Yaun et al. 2003
Streptococcus faecalis)ATCC29212)	6.6	8.8	9.9	11.2				Chang et al. 1985
Cryptosporidium hominis	3	5.8						Johnson et al. 2005
Giardia lamblia	<2	<2	<4					Mofidi et al. 2002
Adenovirus (type 15)	40	80	122	165	210			Thompson et al. 2005
Bacillus subtilis (ATCC6633)	36	48.6	61	78				Chang et al. 1985

Theoretical Dose Calculation (Average)

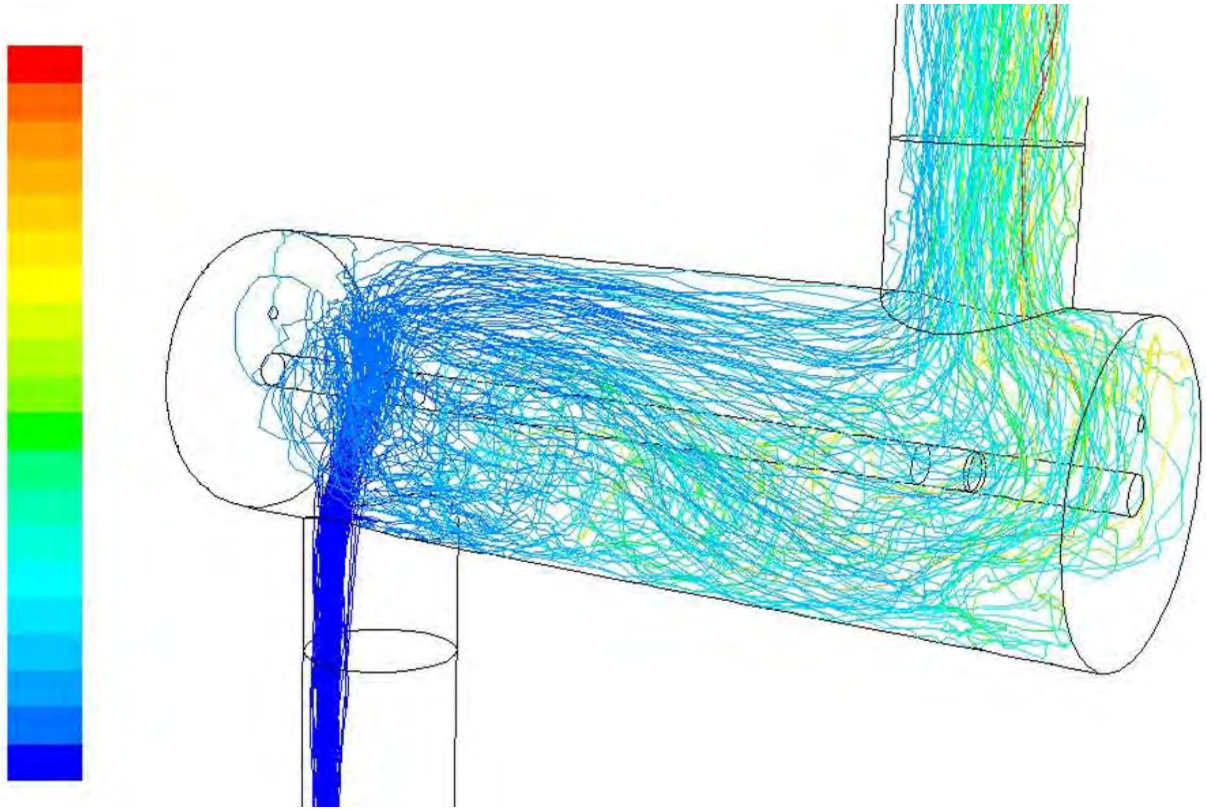
Particle (microbe) flow pattern	Dose (mJ/cm^2)	Microbe Status
Track 1 Dark Blue	20	Still Activate
Track 2 Purple	40	Inactivated
Track 3 Yellow	60	Inactivated



Theoretical Dose Calculation (CFD model)

CFD (Computational Fluid Dynamics) can be used to predict:

- Path of an organism through the system
- Path of flow through the system
- The RED (reduction equivalent dose) DOSE delivered by the system

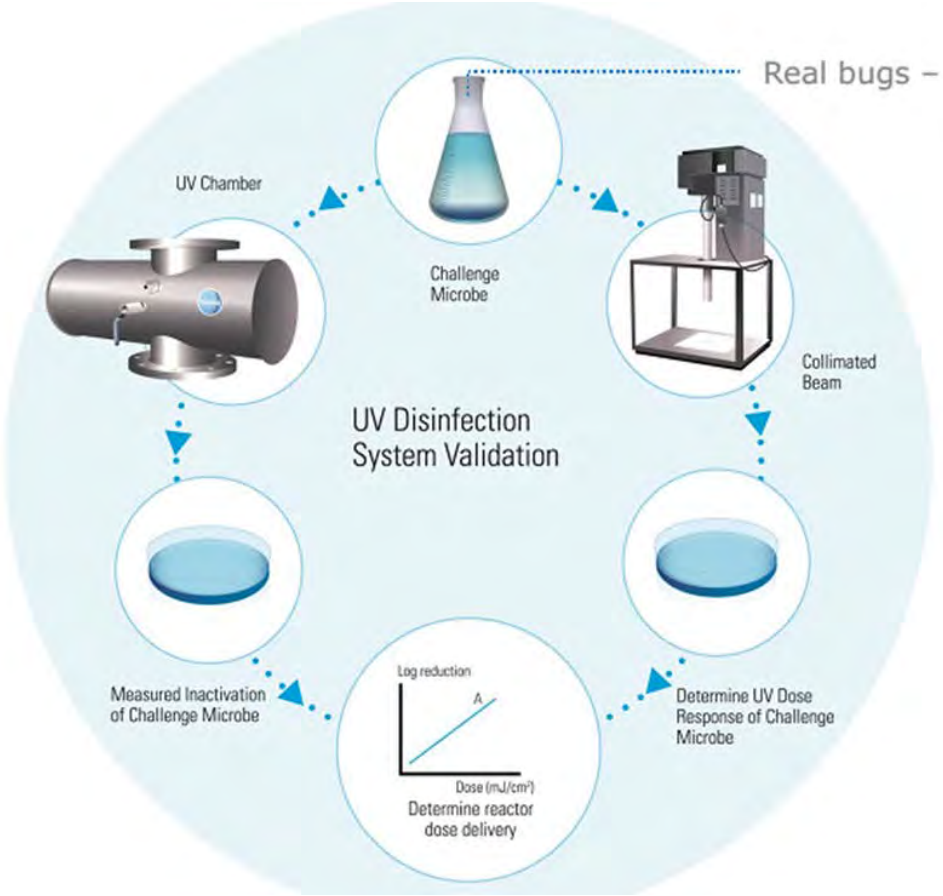


Medium level of biosecurity, good for primary disinfection as part of multi-barrier treatment approach.

Validated Dose – 3rd Party Bio Assay

- Introducing a test microorganism into a UV reactor and taking sample counts before and after the reactor.
- Proves the system will disinfect the target organism at a certain UV Dose under a certain set of operating conditions (flow rate, UVT, UV intensity)
- Provides a fully calibrated UV dose
- Validated equipment is often referred to as **3rd party validated**

Maximum level of biosecurity, guaranteed disinfection for critical applications.



Lab testing

What Level of Security is Required?

Increased Biosecurity

Biosecurity Level	Product Design	Comments
Minimum	Average Dose – simple numerical calculation.	Theoretical model. Supplementary disinfection
Medium	CFD calculated Reduction Equivalent Dose (RED)	Theoretical model. Primary disinfection as part of multi-barrier treatment.
Maximum	Bio-Assay based RED according to UVDGM	Calibrated model. Guaranteed disinfection for critical processes

Industry Development

Validation Protocols & Regulation

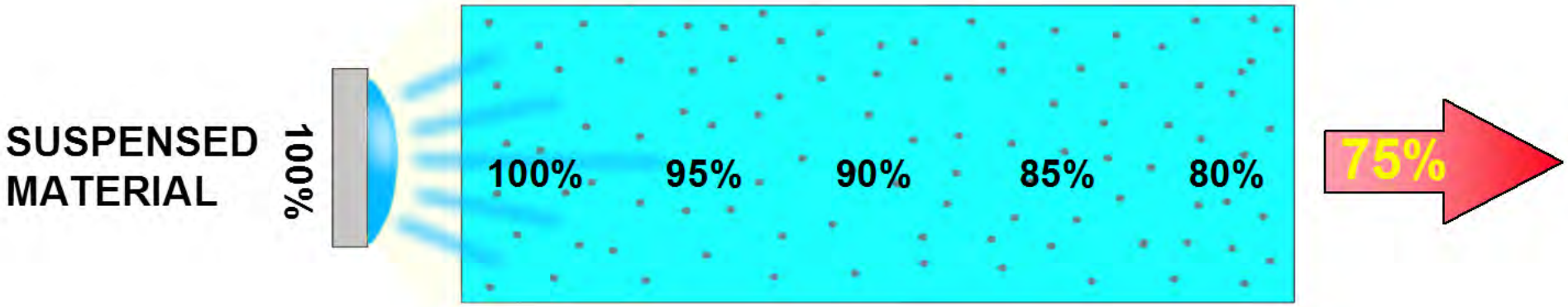
- **US EPA Drinking Water (UVDGM) – Municipal Drinking Water Applications:**
  - 2006 guideline written for standardization on UV disinfection, specifically for chlorine resistant organisms such as Cryptosporidium and Giardia
- **FDA Pasteurized Milk Ordinance (PMO) – Dairy Applications:**
  - 2009 regulation follows US EPA UVDGM, but uses 120 mJ/cm2 Validated UV Dose for 4-log reduction of Adenovirus.
  - Includes instrumentation, controls, monitoring and reporting software requirements
- **National Water Research Institute (NWRI) – Reuse Applications:**
  - Minimum UV Dose 80 mJ/cm2 RED MS2
  - N+1 System Redundancy

#3 - What can affect UV Dose?

Turbidity (NTU)

Measurement of UV light which scatters due to suspended materials, color and other matter found in the liquid which is to be treated by the UV system.

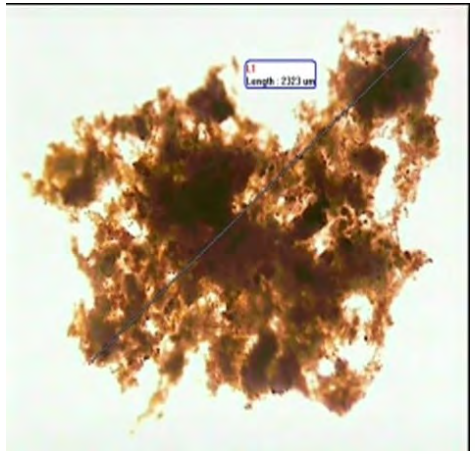
Parameter	Influence / Effect	Typical Range
Turbidity	Measure of light scattering Effects disinfection performance	< 5 NTU recommended



Suspended Solids (TSS)

More commonly found in wastewater, solids block the UV-C, reducing disinfection. Particles can “shadow” bacteria, keeping them from being deactivated.

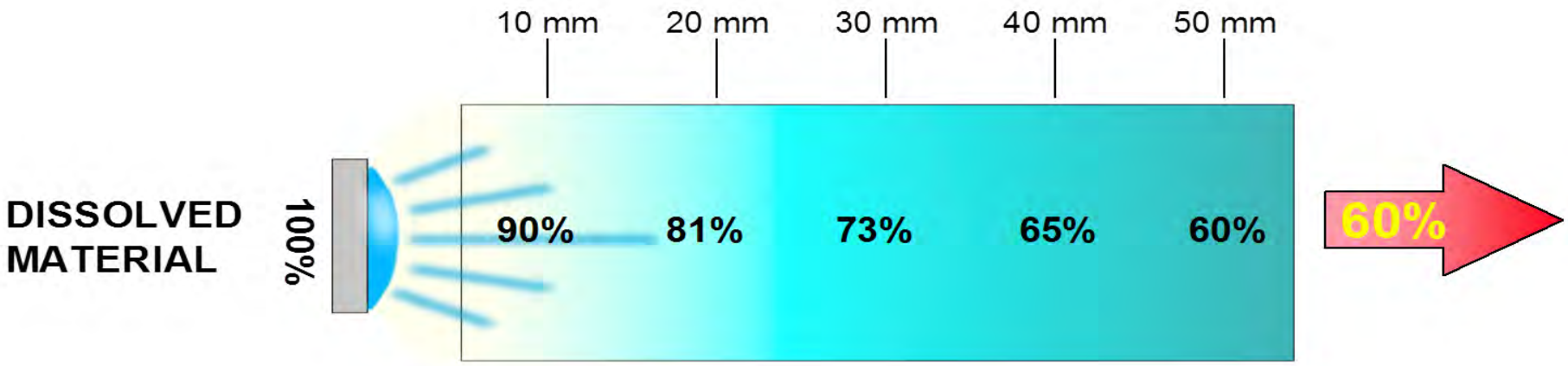
Parameter	Influence / Effect	Typical Range
Suspended Solids	Absorbs UV light & shields bacteria Effects disinfection performance	< 30mg/l recommended



UV Transmittance (UVT)

- Measurement of UV light which passes through one (1) cm of the liquid to be treated. One of the most important factors that affect UV system sizing and performance.
- Different than Turbidity (NTU) or Suspended Solids (TSS) as UVT also takes into consideration dissolved organic matter.

Parameter	Influence / Effect	Typical Range
UV Transmittance (UV-T)	Measure of UV absorption Effects system sizing requirements	50 – 70 %



UV Transmittance (UVT)

100% UVT 70% UVT 40% UVT 20% UVT 5% UVT

Minerals & Coagulants

More commonly found in wastewater/reuse, minerals can have an effect on a UV systems performance. Minerals such as iron or manganese will adhere to the quartz sleeve, and causing fouling and poor system performance.

Parameter	Influence / Effect	Typical Range
Minerals (Coagulants)	Can cause scaling on quartz sleeves Effects UV transmission	Fe <0.1 mg/l Mn <0.1 mg/l

Iron & Manganese Fouling

If you can visibly see any fouling, it is major fouling in the eyes of the UV system!

This is why is a wiper is recommended for lower UVT applications!

Iron & Manganese Fouling

If you can visibly see any fouling, it is major fouling in the eyes of the UV system!

This is why is a wiper is recommended for lower UVT applications!

#4 - Where would I use a UV Disinfection System?

Food & Beverage Application Summary

AQUIONICS UV Delivered

Application	Description & Value
Source Protection, UV as a Firewall	Source water protection, FSMA compliance, quality assurance, brand safeguarding
Pre-treatment, Filtration Stage	Disinfection after GAC or UF/NF, protects process from potential contamination from bacteria in filtration effluent
Dechlorination/Disinfection, RO Stage	Disinfection and Dechlorination (replace GAC or SMBS), reduced maintenance & CIP, added protection ahead of RO
Pasteurized Equivalent Water	Meets FDA PMO requirements for creating pasteurized equivalent water, substantial energy savings for dairies
Sugar Syrup Disinfection	Inline disinfection of liquid sucrose, alternative to heat pasteurization, target heat resistant molds (HRMs)
Brine Disinfection	Disinfection of meat brines by recirculation, extends brine life and reduces disposal frequency

Other Industrial Applications

AQUIONICS UV Delivered

Aquaculture

Chemical-free treatment prevents spread of disease in fish farming facilities especially during early rearing.

Deozonation

Removal of ozone from process water after storage tanks to prevent it from entering final product.

Cooling Tower

Disinfect make-up water or cooling tower loop. Reduce dependence on chemical biocide and eliminate risk of Legionella.

Pharmaceutical Water

Enhanced hygienic system design for disinfection of pre-treatment or high-purity pharmaceutical water loop.

Irrigation Reuse

Disinfection of harvested rainwater or other source water for irrigation supply and wastewater reuse applications.

Industrial Wastewater

Control final effluent quality, reduce risk of exceeding bacteria limits and incurring municipal fines.

New Inquiries – What Do I Need to Know?

"I have an application…..what information do you need?"

Application/Process –

- General overview of the process flow and proposed location
- What is happening upstream of the UV System?

Flow Rate –

- Minimum/maximum flow rates
- Intermittent flow, batch process

Water Quality –

- UVT (transmittance) – take a sample or make conservative assumptions based on pre-treatment
- Other elements that could affect performance (TSS, Fe, Mn, etc.)

Other Considerations:

- Validation requirements, regulatory issues, corporate water quality specifications
- QA/QC performance goals (log reduction, etc.)
- Installation requirements (connections, materials, NEMA ratings, temperature, etc.)

AQUIONICS
UV Delivered

#5 - Wow this presentation was the most amazing thing I've ever sat through, how do I contact Dan?

Dan Shaver

Strategic Account Manager

Aquionics, Inc.

dan.shaver@aquionics.com

613-929-8499