# Implementing Sustainable Design

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs."

NACWA
2010 Summer Conference
and Annual Meeting
San Francisco, CA
July 22, 2010

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**Insist on the right of humanity and nature to co-exist** in a healthy, supportive, diverse, and sustainable condition.

**Recognize Interdependence.** The elements of human design interact with and depend on the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.

**Respect relationships between spirit and matter.** Consider all aspects of human settlement including community, dwelling, industry, and trade in terms of existing and evolving connections between spiritual and material consciousness.

**Accept responsibility for the consequences of design decisions** upon human well-being, the viability of natural systems, and their right to co-exist.

**Create safe objects of long-term value.** Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creations of products, processes, or standards.

**Eliminate the concept of waste.** Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems in which there is no waste.

**Rely on natural energy flows.** Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.

**Understand the limitations of design.** No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled.

**Seek constant improvement by the sharing of knowledge.** Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.

# BILL OF RIGHTS FOR THE PLANET*

**Hannover Expo 2000 - William McDonough Architects*

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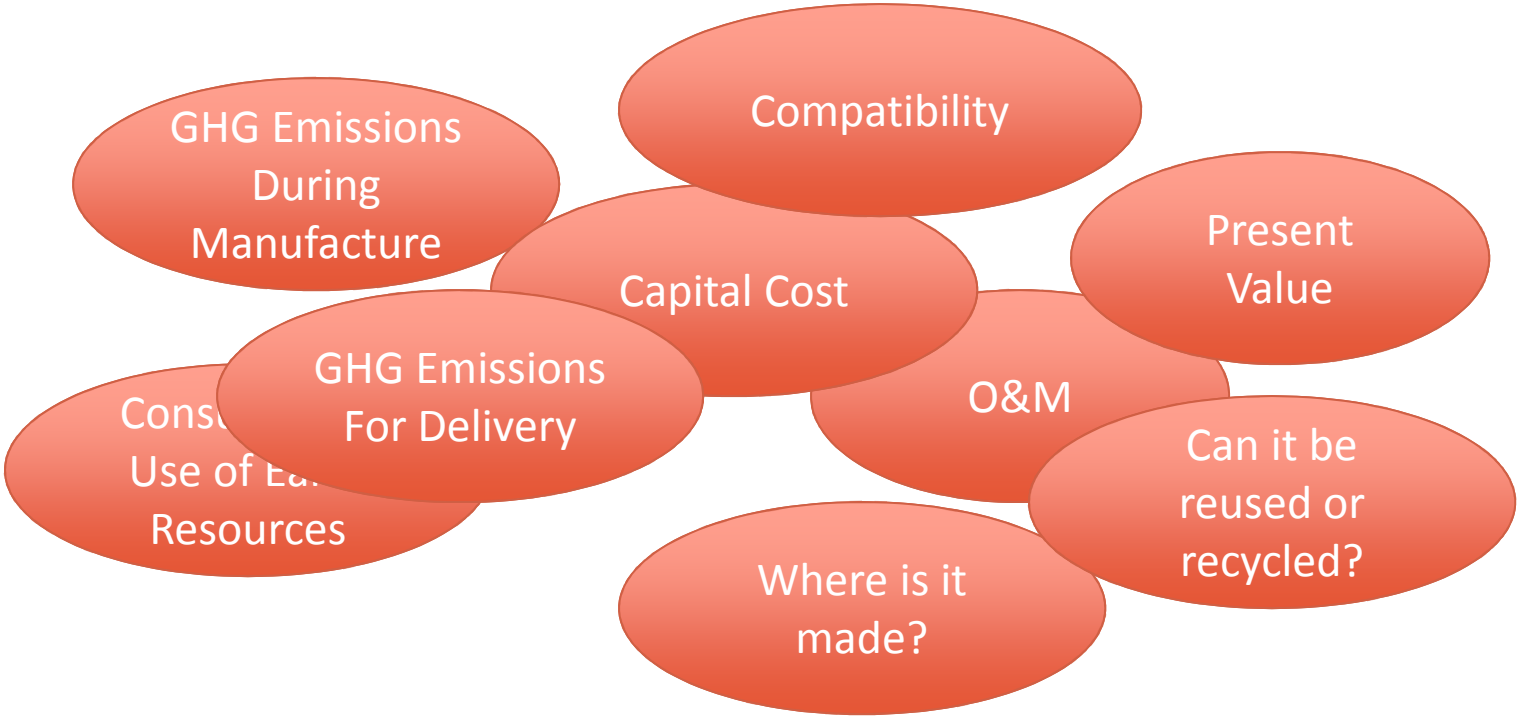
# Good Engineering is Key to Sustainability

- Engineers are great problem solvers
- But, we need to make sure that we are solving the right problem
- One of our challenges of sustainable design is that it redefines the definition of "good engineering"
- Tomorrow's problems will be increasingly complex
- Tools and training are needed to foster sustainable design

# Take a simple problem…

- What type of pipe should I use for my new sewer?



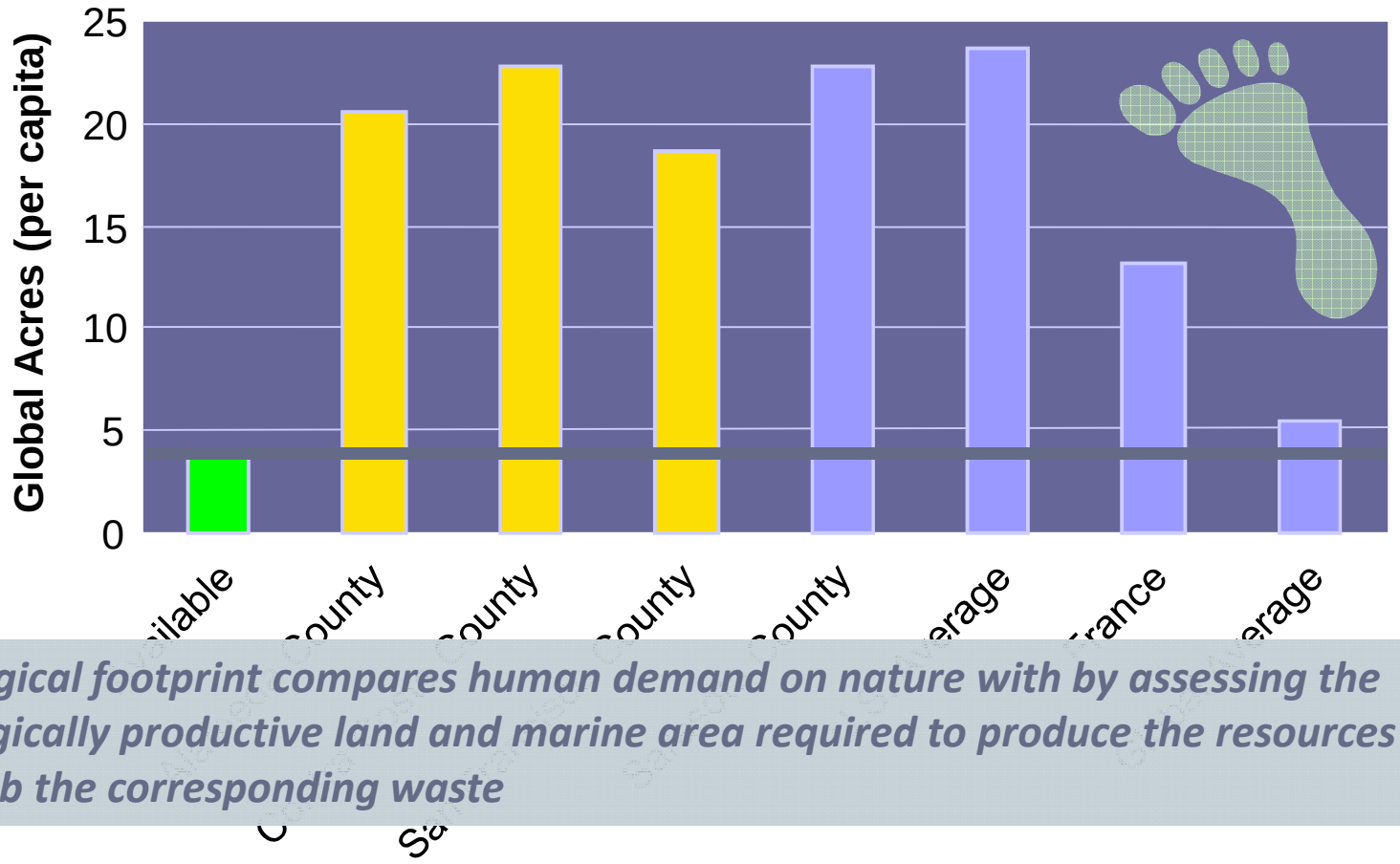
# But maybe the real problem is…

Do I need a new sewer?

- Develop tools for evaluating decisions and objectives
- Triple Bottom Line – People, Planet, Profit

# ACCEPT RESPONSIBILITY FOR THE CONSEQUENCES OF DECISIONS ON THE PLANET AND OUR FUTURE

# Ecological Footprint to Help with Evaluating Sustainability




*Ecological footprint compares human demand on nature with by assessing the biologically productive land and marine area required to produce the resources and absorb the corresponding waste*

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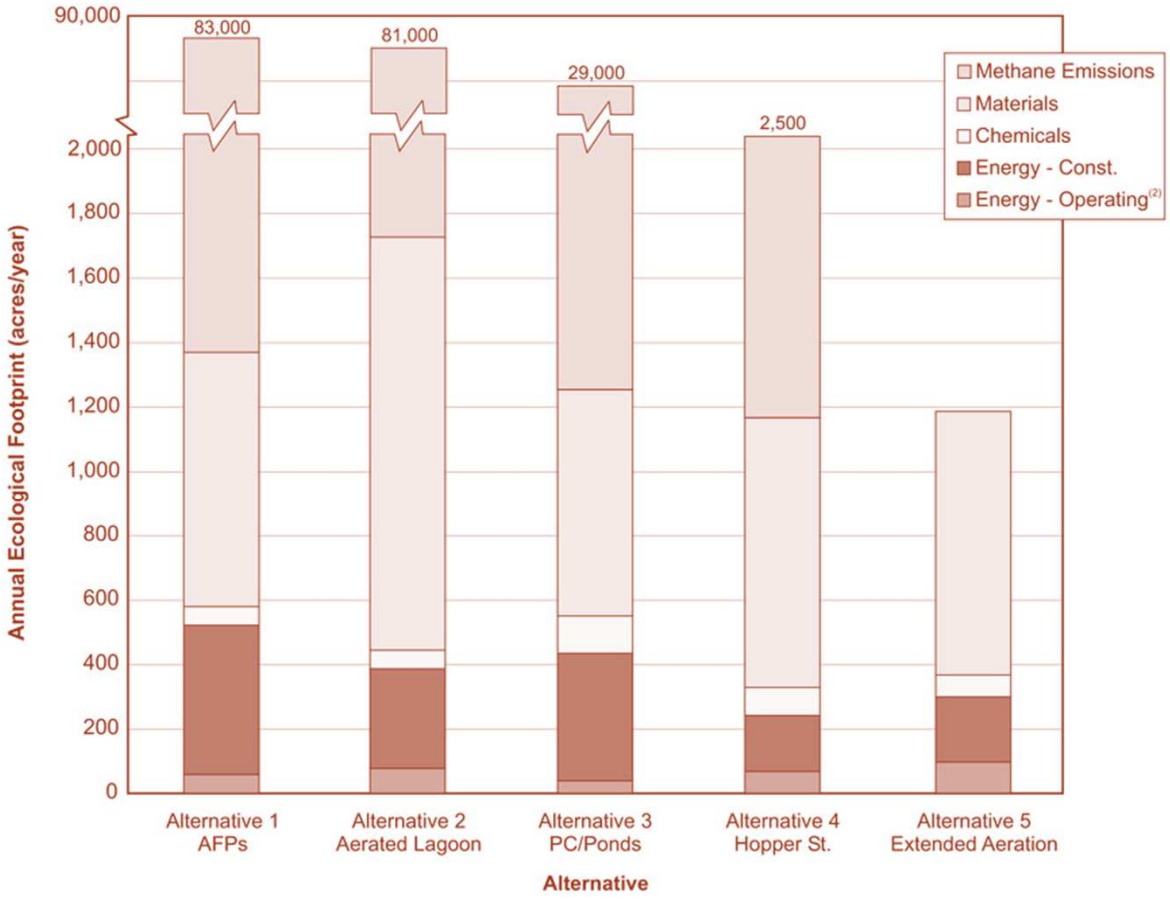
# In Petaluma, Process Evaluation Considered the Ecological Footprint




(1) Assuming UV Disinfection
(2) Assuming continued use of Calpine power (green power source)

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# The Resulting Project Merges Technology with Nature

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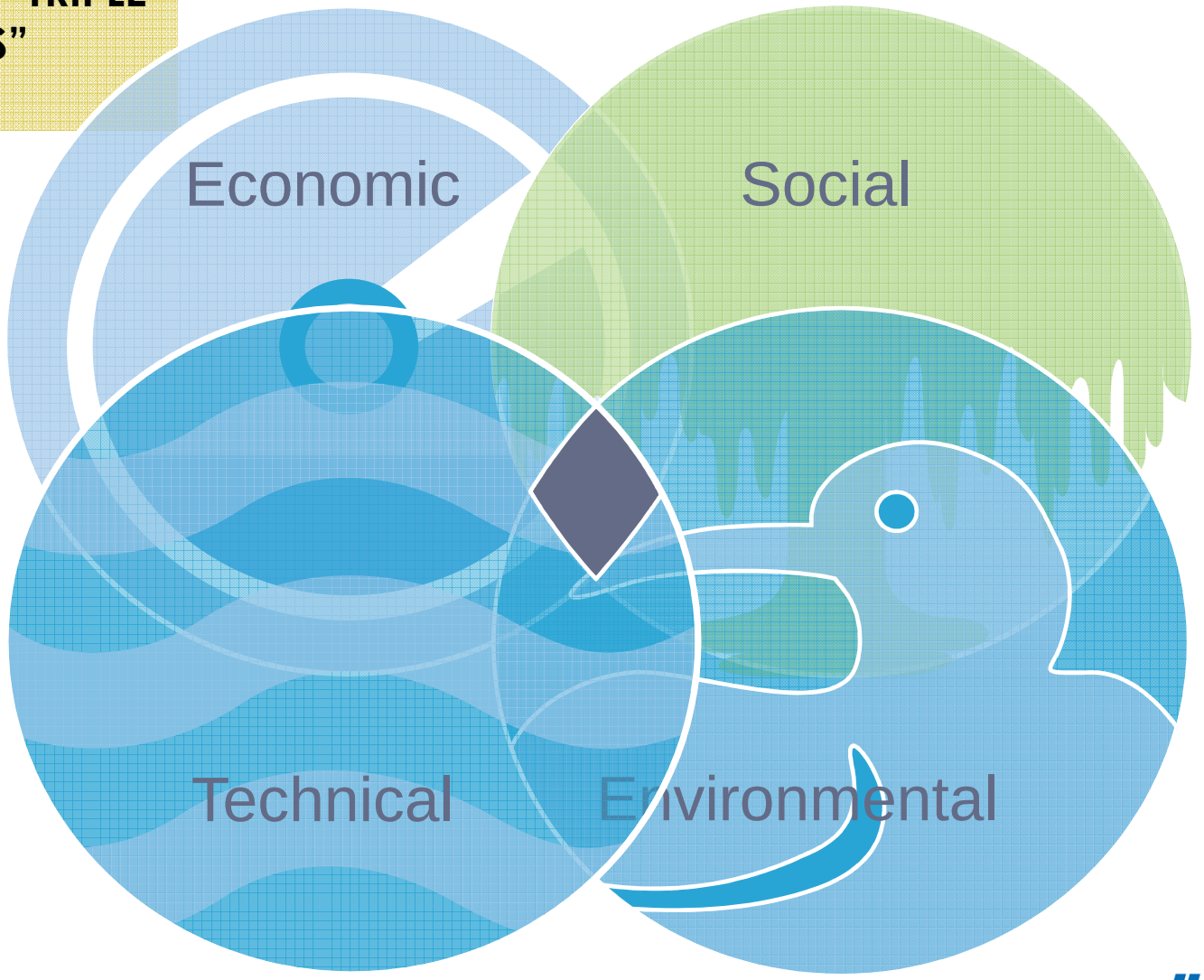
**SFPUC Sewer System Master Plan Evaluated Alternatives using "TRIPLE BOTTOM LINE-PLUS"**

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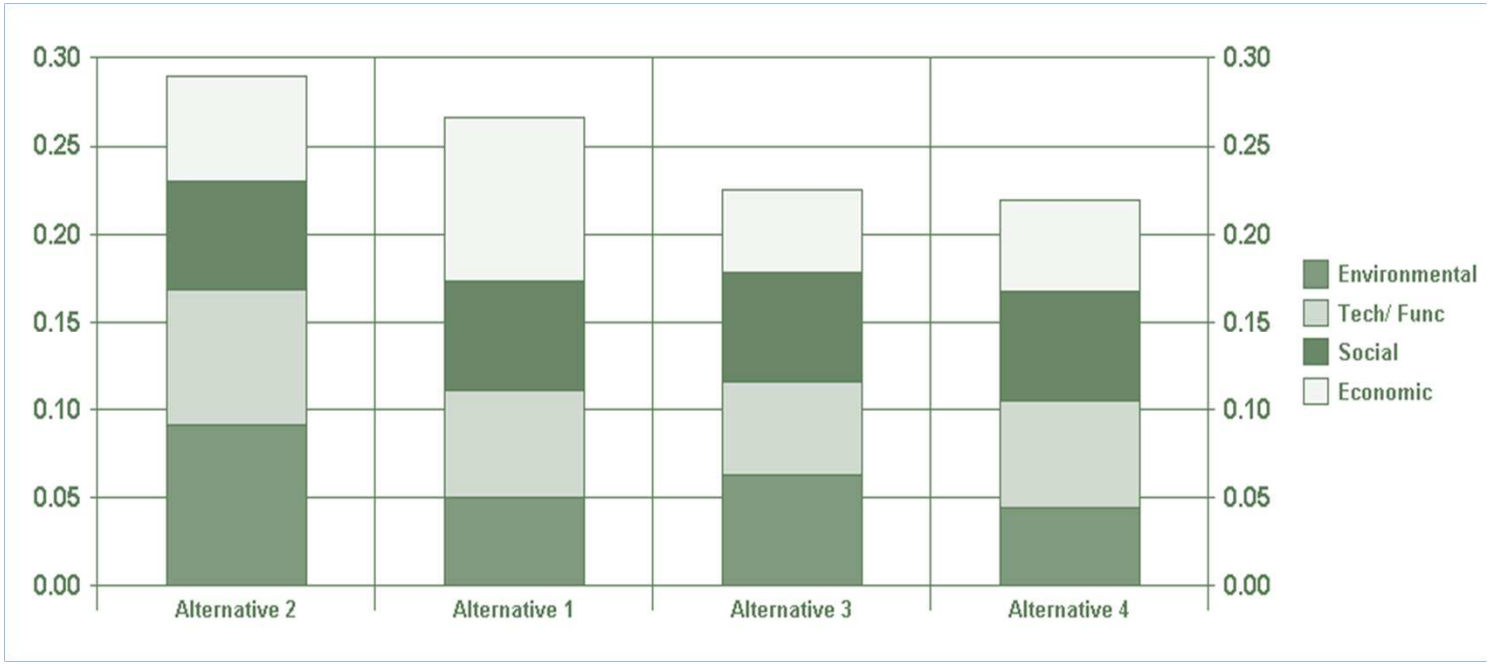
# SFPUC Sewer System Master Plan

- Sustainability in goals & evaluation criteria
- Climate change considered
- LID to reduce storm water flows

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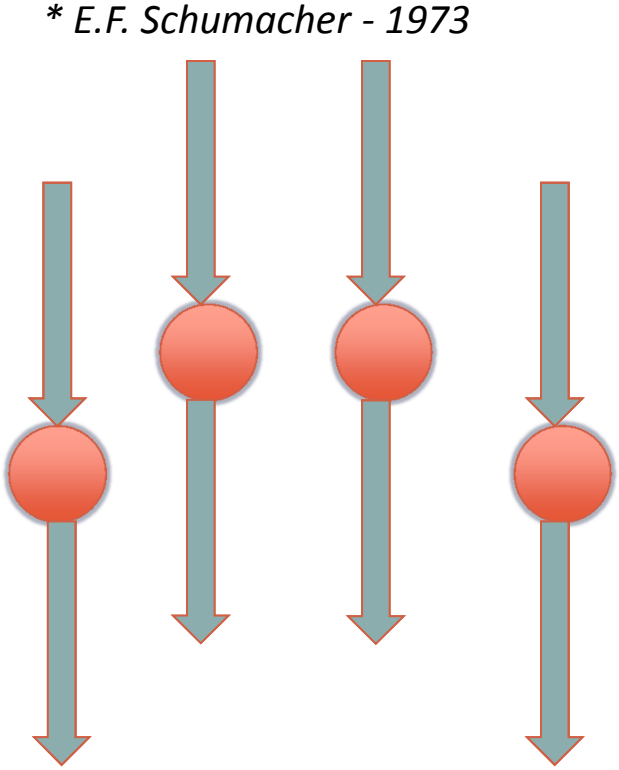
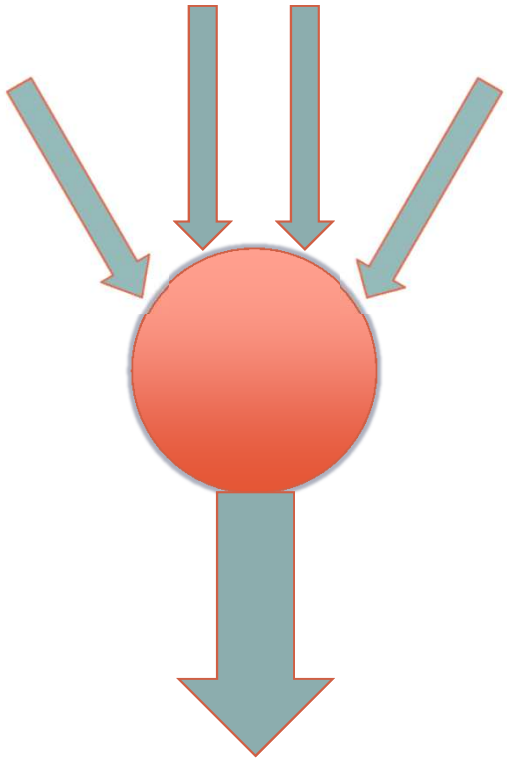
- "Small is Beautiful"
- Natural design is elegant design – mimic nature
- Honor natural cycles
- Nature is diverse and adaptable

**TREAT NATURE AS A MENTOR, NOT AN INCONVENIENCE TO BE CONTROLLED**

# "Small is Beautiful*" vs. "Bigger is Better"

** E.F. Schumacher - 1973*





*Economies of scale often favor a single, larger solution to a problem*

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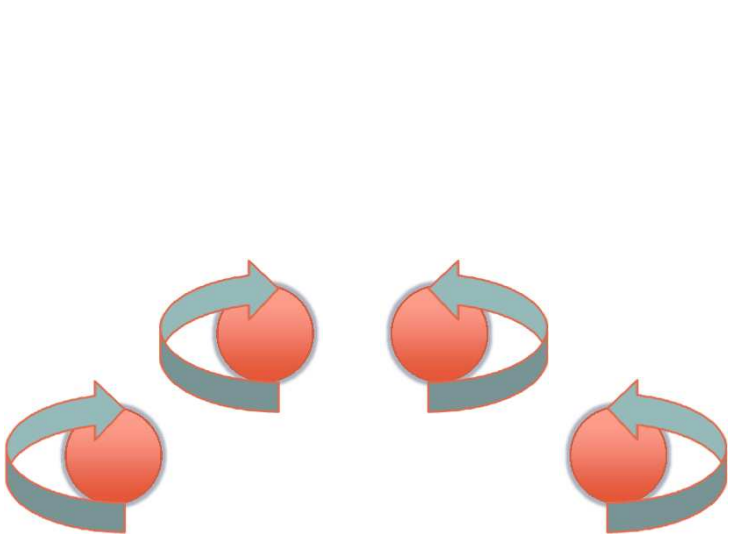
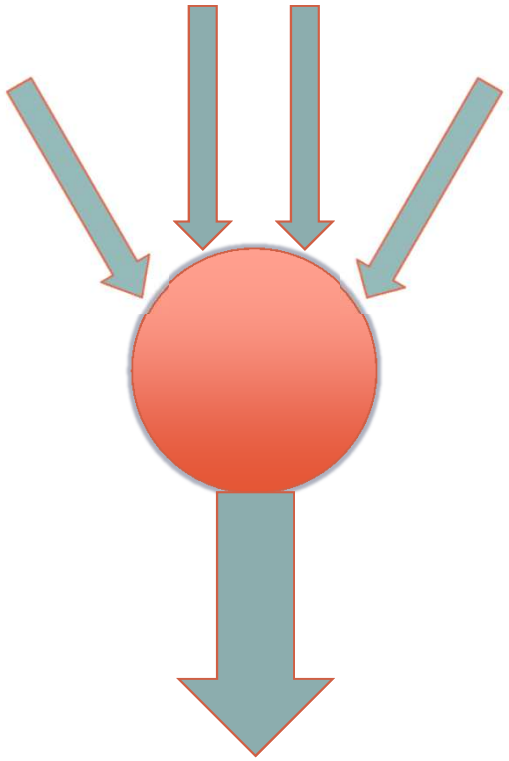
# "Small is Beautiful" vs. "Bigger is Better"





*Thinking smaller and more locally can often redefine the problem*

# Restore Natural Hydrologic Function in Urbanized Areas with Low Impact Development



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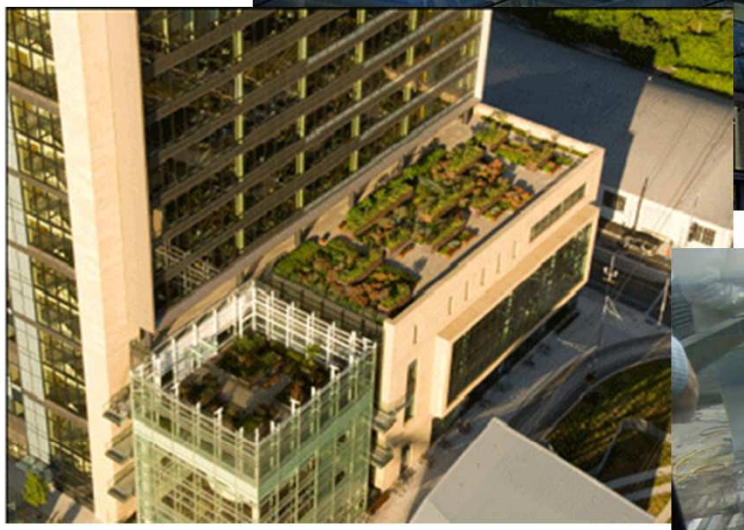
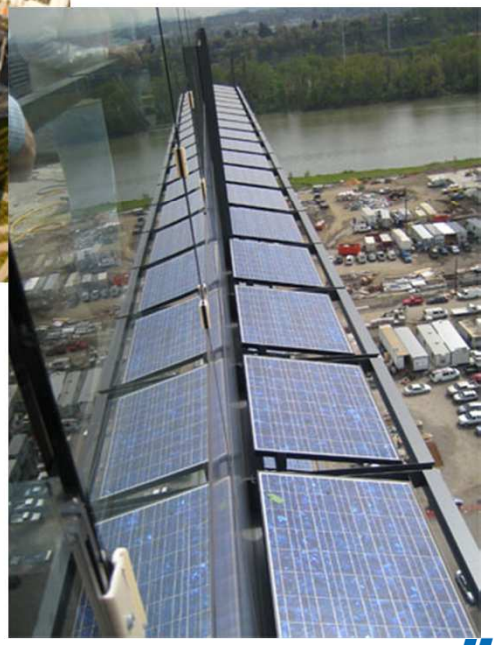
# Oregon Health Sciences University Portland, Oregon

- Platinum LEED Building
- 412,000 SF
- Enviroquip MBR treatment plant in basement - 35,000 gpd capacity
- 60 % of water recycled for flushing and irrigation
- EcoRoof on several roof levels of building
- NPDES permit for discharge of unrecycled water
- Solar and on-site microturbine for electricity generation meets 30 percent of needs
- Waste solids sent to sewer



***Potable water used for life-sustaining functions, rainwater used as a resource, impermeable ground cover minimized***

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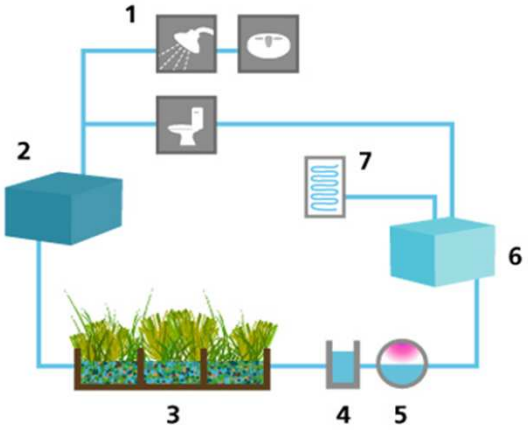
# New Port of Portland Headquarters recycles water for toilet flushing and cooling


**THE LIVING MACHINE SYSTEM**

1. Office building: toilet, sink & shower
2. Primary & equalization tanks
3. Tidal flow wetland
4. Polishing vertical flow wetland
5. UV sterilization disinfection
6. Clean effluent tank
7. HVAC office cooling tower




**WATER EFFICIENCY**

- **A.** 8th floor landscape deck with adaptive plants and micromist irrigation
- **B.** Low-flow fixtures
- **C.** Eco-roof with adaptive plants and micromist irrigation
- **D.** Living Machine System

**ENERGY EFFICIENCY**

- **E.** Reflective membrane roof
- **F.** High performance glazing
- **G.** Radiant heating & cooling ceiling
- **H.** 200 wells provide ground source heating & cooling with auxiliary cooling tower for peak periods (augmented by the Living Machine)

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# Learning From Other Industries

***Big "Lumpy" Investments Aren't Adaptable to an Uncertain Future***

- 10,000 large power plants in America with low thermal efficiency of 33%
- No heat recovery because not near industries that can use heat
- Big lumpy projects - slow turnover and archaic technology

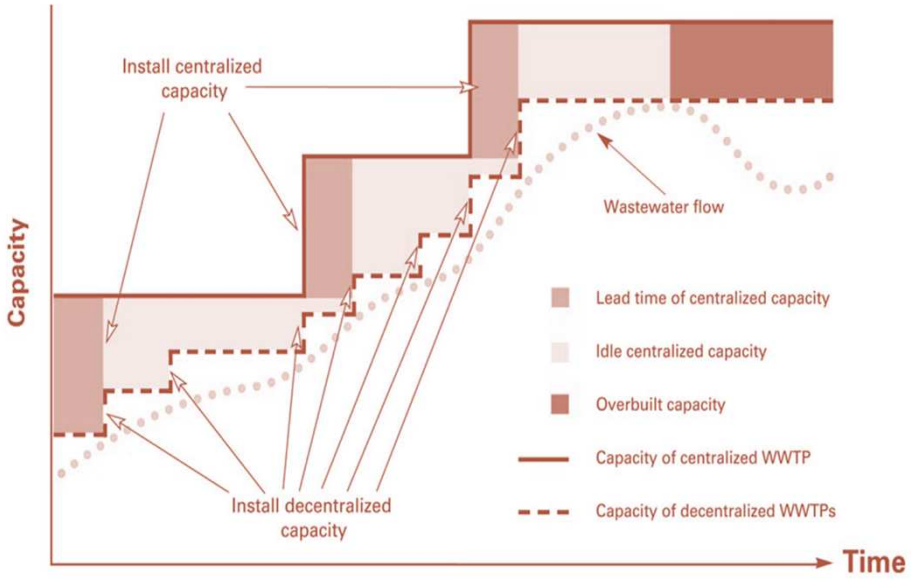
# Fundamentally, Half a Dam is No Dam at All

- A large project must be completed to give service, and if something changes half way through, there is little hope of adapting the project to the new circumstances.
- The entire risk is assumed at the start of the project, based on long term projections
- 500 distributed power generation projects may supply half the power of a dam, but more adaptable, easier to implement, less risk

*Teton Dam – June 1976*

# Agility Created by Smaller, Distributed Projects, has Real Value

- Shortening lead time and avoiding investments in idle capacity has value
- The small unit size of decentralized systems allows closer matching of growing demand for wastewater capacity
- In cases when future demand fails to meet expectations, additional scheduled increments of decentralized capacity can be foregone
- Plan can minimize regret, because capacity can be added or foregone to match actual demand

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- We manage resources, not waste
- U.S municipal POTWs manage a water resource of over 34 billion gallons per day
- We manage over 12 million pounds of extractable nutrients each day

# ELIMINATE THE CONCEPT OF WASTE

# Let's Quit Talking About "Wastewater"

- Limit potable water consumption to life sustaining needs
- Use natural water and recycled water for broad range of non-potable uses within the natural hydrologic cycle
- Mine nutrients from "resource" water
- Generate green energy from our wastes

*This water has 100% post-consumer, recycled content*

# The Cost of Transporting Water Limits Affordable Water Recycling

- 70-85 percent of the value of your utility assets are in your collection system
- 80-90 percent of water utility assets are in the distribution system
- Treatment asset costs are only 5-10 percent of what is needed to recycle water at centralized facilities
- Satellite treatment facilities have higher per unit treatment costs but ideally, reduce conveyance and distribution costs

# Satellite Treatment Facilities Can Lower the Cost of Moving Water and Help Restore Natural Hydrologic Cycles

**Low-Cost Treatment Technologies for Small-Scale Water Reclamation Plants**

*Final Project Report*


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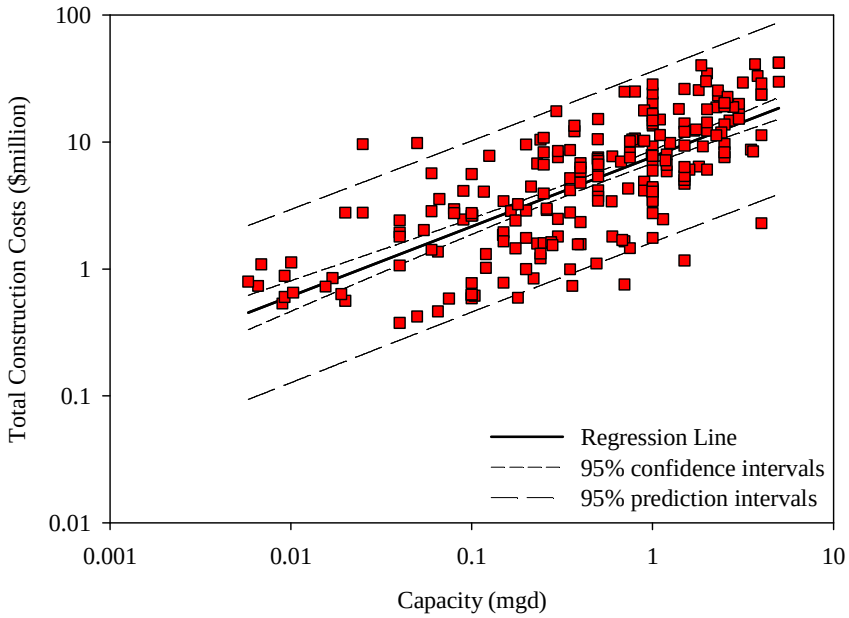


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# Phosphorus Removal Coupled with Fertilizer Production at Clean Water Services, OR

- U.S. first full-scale installation
- On-line May 2009
- Durham AWWTP must meet 0.1 mg/l TP on seasonal basis
- Eliminates struvite accumulation in plant
- Reduces phosphorus recycle and retreatment
- Lowers green house gas emissions
- expected to produce 500 tons of premium, slow-release fertilizer – Crystal Green® per year


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- 3-4% of the nation's electricity is spent on water treatment and transport
- 25 billion kW-hrs/year are consumed in U.S. for wastewater treatment
- Potential exists to turn POTWs into net energy producers

# RELY ON NATURAL ENERGY FLOWS

# Electricity – a currency in short supply

- U.S. EIA says 280 gigawatts of new generating capacity will by needed by 2025
- 40% of U.S. energy is used to generate electricity
- Municipalities can become a significant component of a more agile, distributed, power generation system

# Moving From Energy Consumption to Net Energy Generation

- Water conservation and flow reduction
  - 80% of energy is spent moving water
  - More concentrated waste streams are more amenable to lower energy treatment
- Treatment innovation and efficiency improvements
- Methane gas production and cogeneration
  - Sludge stabilization
  - Separate high strength waste streams – satellite anaerobic
  - Liquid stream treatment

# Gain the Benefits of Cogeneration (CHP)

- Produces power at a cost below retail electricity
- Displaces purchased fuels for thermal needs
- Qualifies as a renewable fuel for green power programs.
- Enhances power reliability for the plant.
- Offers an opportunity to reduce greenhouse gas and other air emissions

# Simple Step - Utilize Built Capacity

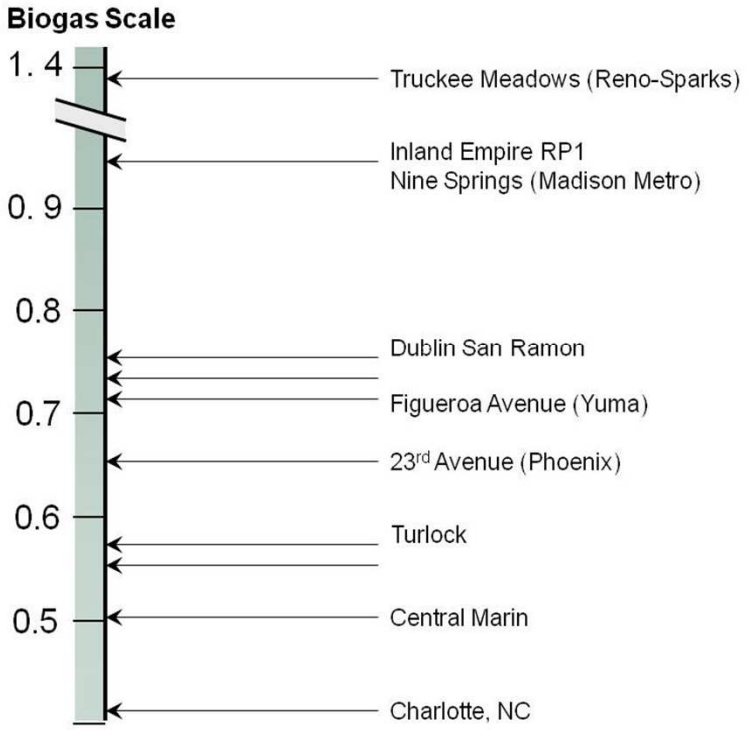
- 544 POTWs (>5 mgd) have anaerobic digesters
- 106 actually utilize gas – remainder flare
- If all 544 were to install CHP, approximately 340 MW of clean electricity could be generated, offsetting 2.3 million metric tons of carbon dioxide emissions annually. **These reductions are equivalent to planting approximately 640,000 acres of forest, or offsetting the emissions of approximately 430,000 cars.**

*U.S. Environmental Protection Agency Combined Heat and Power Partnership - 2007*

# Create an Energy Generation Campus at Your POTW

- Gas generation potential of sludge stabilization is limited
- Feeding digesters with FOG and imported high strength waste increase green power generation 1.5 - 2x


$\frac{Ft^3 \text{ biogas/day}}{Ft^3 \text{ of tankage}}$



# Fuel cells can generate electricity from digester gas without GHG emissions

## Operating Installations

Santa Barbara, CA
LA County San. District, CA
City of Tulare, CA *
DSRSD, CA
City of Riverside, CA
EMWD, CA (Moreno Valley) *
TID/City of Turlock, CA *
City of Rialto, CA

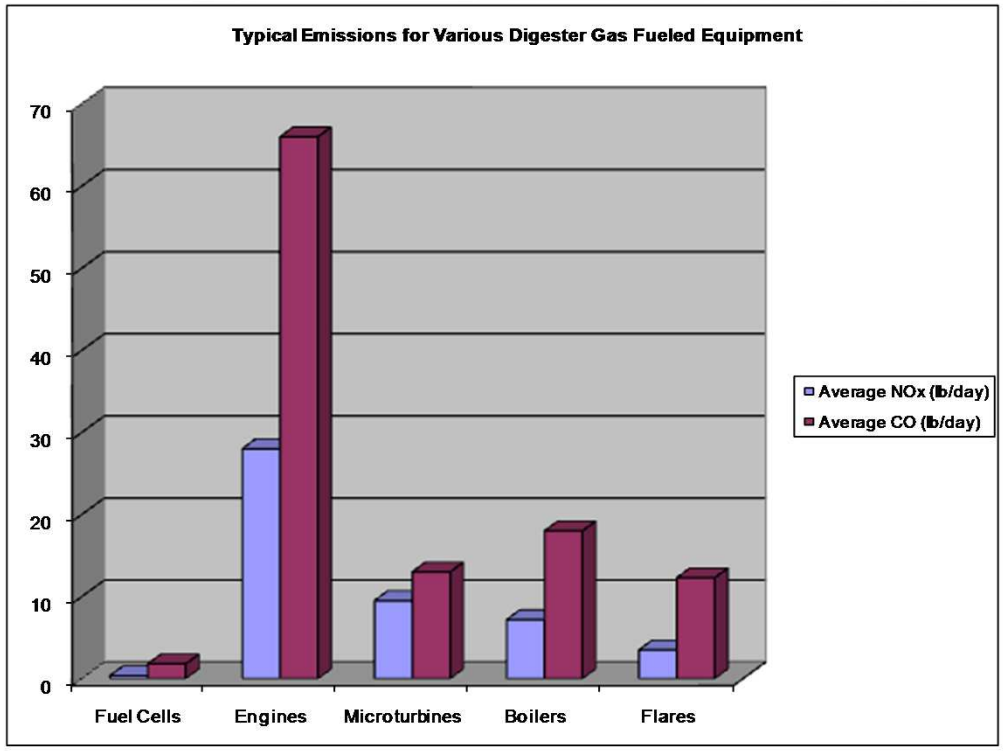
## Under Construction

EMWD, CA (Perris Valley) *
City of Tulare, CA *

## Projects Under Consideration

City of South San Francisco, CA *
Union Sanitation District, CA *
Palm Springs, CA *
MRWPCA, CA *
City of Visalia, CA *
City of Livermore, CA *
City of Redlands, CA *
Las Virgenes Municipal Water District, CA
EMWD, CA (Temecula) *
City of Yuma, AZ *
City of Salem, OR *
Delta Diablo Sanitation District, CA *
City of Fayetteville, NC *
City of San Jose, CA *
City of Fresno, CA *
OCSD
Inland Empire Utilities
MID/City of Modesto, CA *
City of Davis, CA *

* *Carollo involvement*

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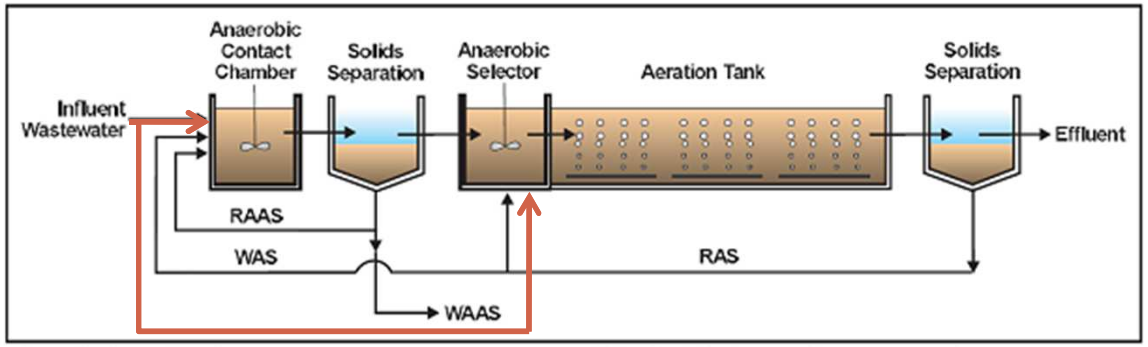
# Treatment Innovation Holds Promise for Reducing Energy Consumption

- Membrane concentration followed by anaerobic treatment of concentrate - IMANS ™
- WASAC ™
- High-rate liquid stream anaerobic treatment
- New blower technologies and aeration control strategies
- Natural treatment systems

# WASAC™

## Waste Activated Sludge Anaerobic Contactor

- Removes up to 60 percent of the incoming BOD without aeration, dramatically reducing operating power costs for aeration.
- Waste biomass from WASAC™ treatment contains more recoverable energy than aerobic waste activated sludge, - resulting in a 30 to 40 percent increase in recoverable energy.
- Results in purchased energy savings of up to 90 percent as compared to a conventional plant.




*Carollo has developed a new treatment process (WASAC) that reduces dependence on outside energy sources.*

- Result - treatment facility that is nearly energy independent
- Full-scale testing is ongoing at Chico, CA

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# Ozone May Reduce Fouling in Water Reuse Membrane Systems

- *WRF 08-08 – Pilot Scale Oxidative Technologies For Reducing Fouling Potential in Water Reuse Membrane Systems*
- Ozone ahead of RO may improve RO Flux by 50% - dramatically reducing energy usage


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## New Blower System Design Can Reduce Aeration Costs by 10-15 Percent

- 50% or more of treatment plant electrical usage is for aeration blowers
- New high-speed blower technology is more efficient
- Smaller footprint allows for more capacity in same footprint, reducing new building construction
- Many existing systems have large blowers and poor turndown capabilities
- Additional efficiencies can be achieved by better $O_2$ control strategies

*New 7,000 scfm high speed turbo blower reduced power consumption 12-15% at Rock Creek*

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- Practice humility in the face of nature
- Design does not solve all problems
- Problems change – good solutions for yesterday's problems may not be good solutions for today and tomorrow

# UNDERSTAND THE LIMITATIONS OF DESIGN

- As consulting engineers and municipal leaders, we can drive sustainable design
- We can leverage the industry to move towards reducing our footprint on the planet
- As an industry, we need to develop standard tools and metrics to evaluate sustainable design – beyond LEED

# SEEK CONSTANT IMPROVEMENT BY THE SHARING OF KNOWLEDGE

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# Smaller Scale, Distributed Projects, Help Manage Risks

- **Unit Size** - Modular instead of "lumpy" investments may allow deferral of big expenditures
- **Unit Lead Time** - big projects are complicated to implement and have long lead time – impacting NPV
- **Unit flexibility** – the future is not deterministic but unfolds in unpredictable ways. Less risk if incremental, small steps are taken