Saving Water in Labs: How to Do It and Why You Should Care

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Dan Doyle
Chairman, Grumman/Butkus Associates
CFO, International Institute for Sustainable Laboratories

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Learning objectives

At the end of this session, participants will be able to:

1. Understand why water efficiency should be a priority
2. Understand how water and energy resources are inextricably linked
3. Describe some of the basic equipment and systems that consume water in laboratory facilities
4. Identify ways to reduce water usage of process equipment and cooling systems
5. Identify a potential alternative source of water for non-potable uses

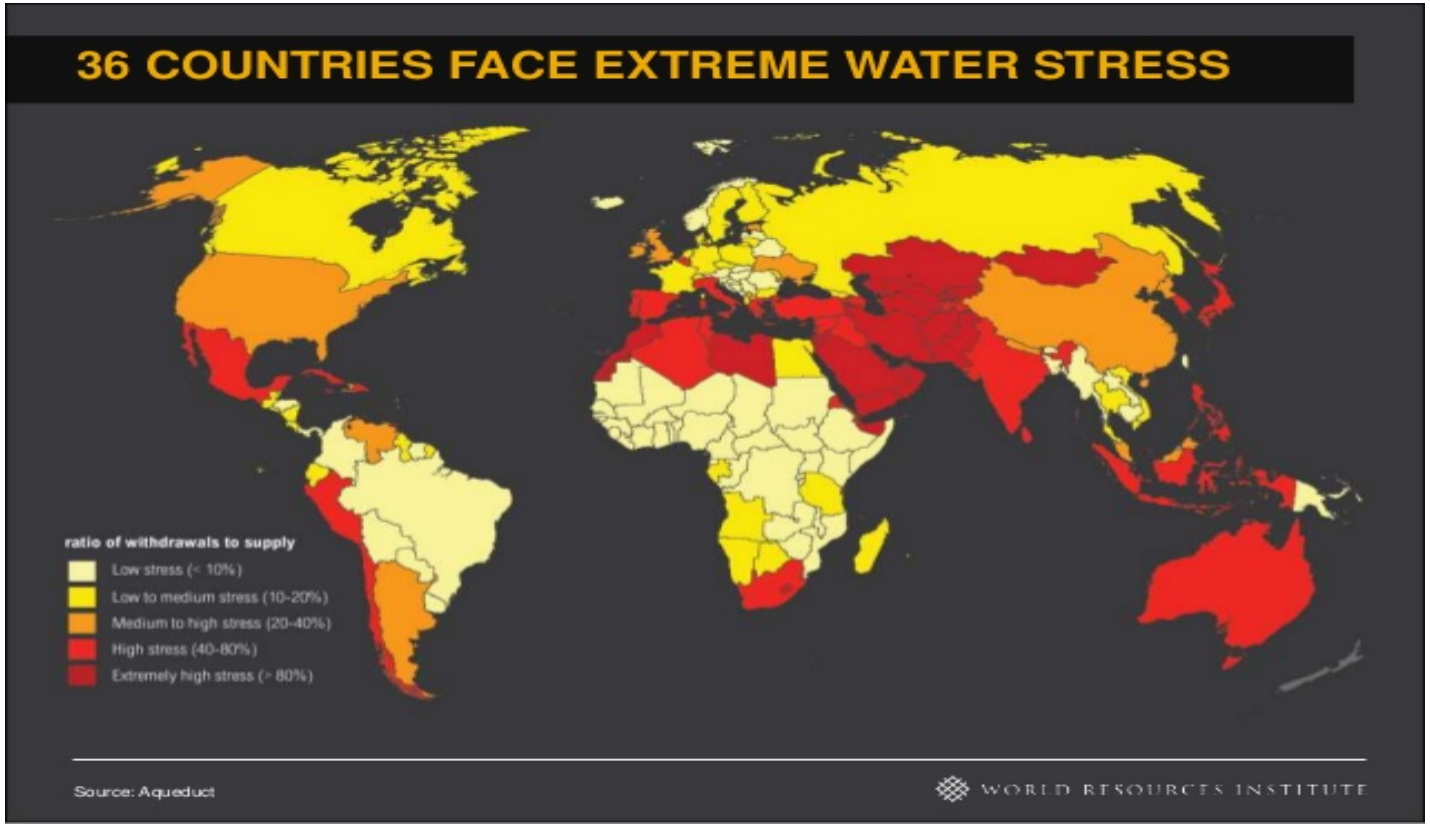
Issues affecting water resources

Photo © charity: water
www.charitywater.org

- Chemical and biological contamination of water sources
- Increases in population
  - ✓Population **increases** have been greatest in many areas with the most water scarcity
- Aquifers are being depleted with no effective recharge
- Climate changes are causing many dry, arid climates to become even drier, exacerbating water shortages

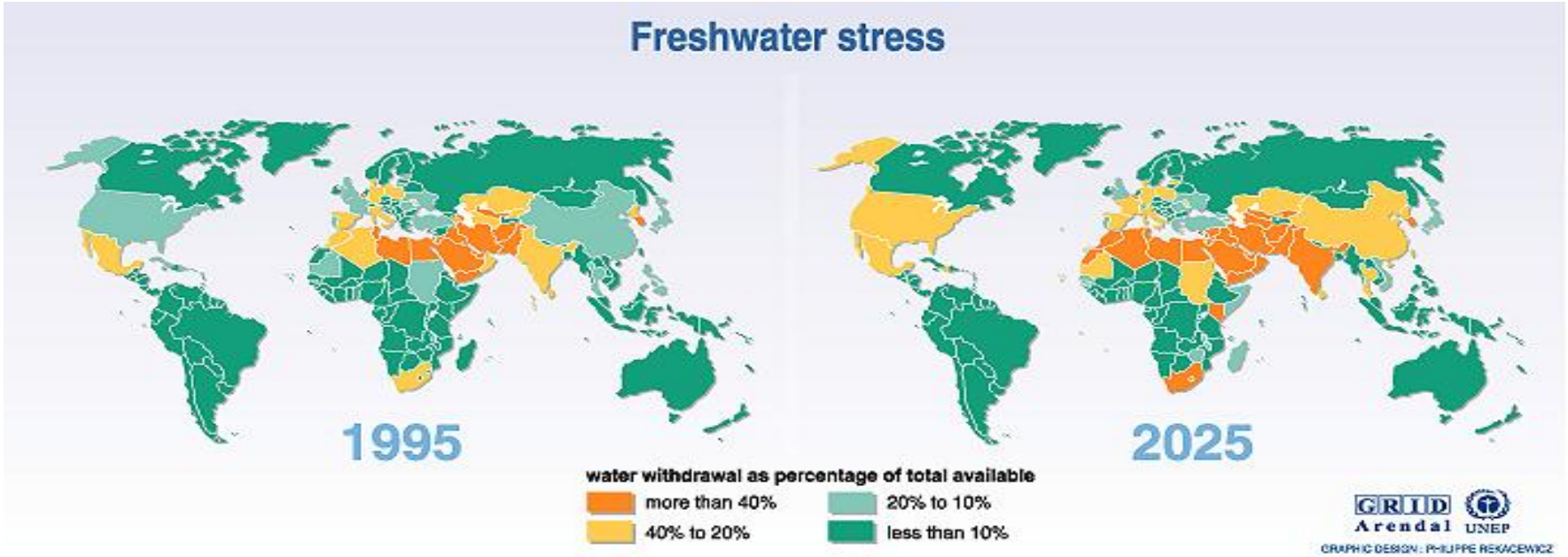
Water scarcity

- Supplies may vary by region and by year, but abundance is never assured (2015 data)



Water scarcity

- As population patterns shift, water withdrawal as a percentage of the total available is rising in many areas. In general, population is growing in areas that are already stressed.



Source: Global environment outlook 2000 (GEO), UNEP, Earthscan, London, 1999.

A drought of conservation

- Water conservation is often ignored or given a low priority in labs
  - ✓Targets and strategies for energy reduction are better understood and offer greater ROI
  - ✓Water costs are rising, but are still "small potatoes" compared with costs for energy

Why water conservation should be a priority

- Wide range of water-using equipment in laboratories
- Relatively easy to improve efficiency
- Excellent savings potential

Conserving water also conserves energy

Reducing water consumption reduces energy use:

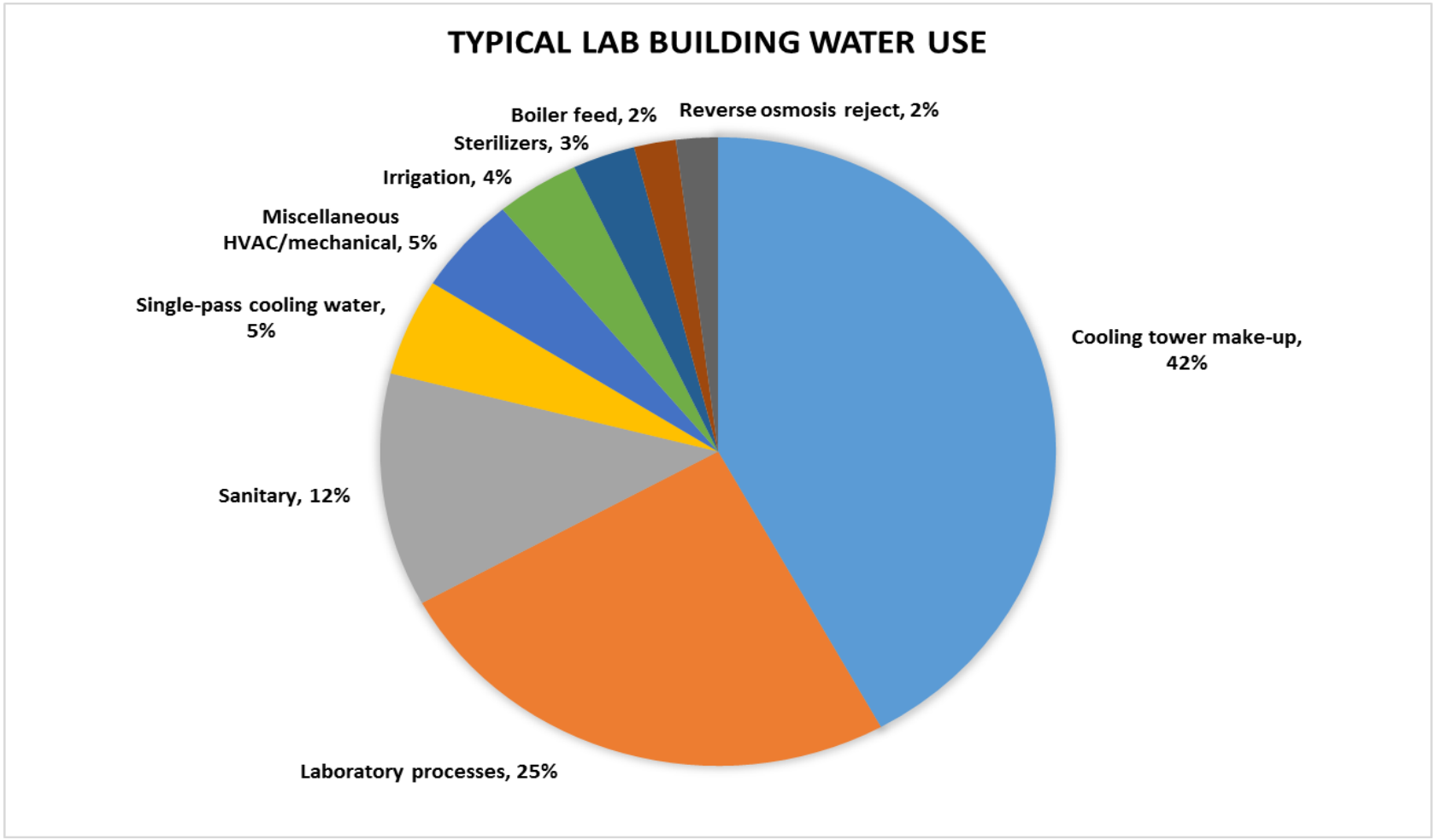
- The extraction, treatment, and delivery of water accounts for as much as 15% of energy consumption in some parts of the country
- Energy constitutes 80% of a typical water bill

Reducing electricity and gas consumption saves water usage:

- Power plants use a lot of fresh water (45% of nationwide total), and nearly half of that evaporates (per latest U.S. Geological Survey water use report, 2010)
- The production of natural gas by hydraulic fracturing uses large quantities of water

By increasing efficiency through water conservation and recycling practices, lab facilities can further cut energy consumption and thus carbon footprint

Lab buildings use lots of water



Source: U.S. Environmental Protection Agency, 2015 (reflects performance at EPA facilities)

Water efficiency opportunities

- The high water consumption in research facilities provides more opportunities to make cost-effective improvements in water efficiency, especially with respect to the amount of water they use in:
  - ✓ Taps, toilets, urinals
  - ✓ Water stills and RO / DI systems
  - ✓ Sterilizing systems
  - ✓ Icemakers
  - ✓ Vacuum aspirators
  - ✓ Western blots
  - ✓ Single-pass cooling equipment
  - ✓ Cooling towers
  - ✓ Humidification systems
  - ✓ Irrigation
- Alternative sources of water can often be effectively integrated into a laboratory facility's operations
- Irrigated areas are often sources of large water consumption and are prime targets for efficiency measures

Taps, toilets, and urinals

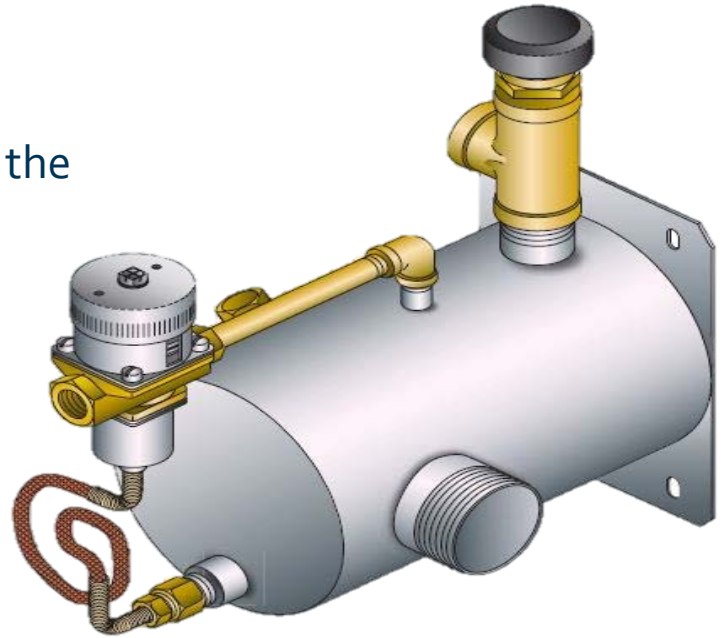
- Use low-flow fixtures
  - ✓Low-flow aerators (less than 2.0 gpm) on lavatories, lab faucets
  - ✓Low-flow dual-flush toilets
  - ✓Low-flow urinals (or waterless type)
- Use electronic faucets
  - ✓Turn-off automatically when not required
- Water timers
  - ✓When filling a jug or rinsing glassware, it can be easy to forget to turn off the water
  - ✓Installing a timer will help avoid needless water use

Lab infrastructure and equipment

- Water purification systems (RO / DI)
  - ✓Choose high recovery rate
  - ✓Reuse reject water
  - ✓Use the appropriate quality water for each task

Lab infrastructure and equipment

- Disinfection/sterilization systems
  - ✓Run at full capacity
  - ✓Auto shutdown (must include a standby mode)
  - ✓Efficiency retrofit kit (a Water-Mizer device, which eliminates the "tempering" water consumption during the non-sterilizing portion of a sterilizer cycle, can save 40 to 50 gallons of water per hour)
  - ✓Newer models are available that use less water (and energy)



Lab infrastructure and equipment

- Icemakers
  - ✓A typical icemaker uses two to three times as much water as is actually needed to make the ice you use
  - ✓Use air-cooled instead of water-cooled (open loop) icemakers, or tie into a year-round process cooling loop if one is available
  - ✓Specify ENERGY STAR icemakers that use an average of 15% less energy and 10% less water

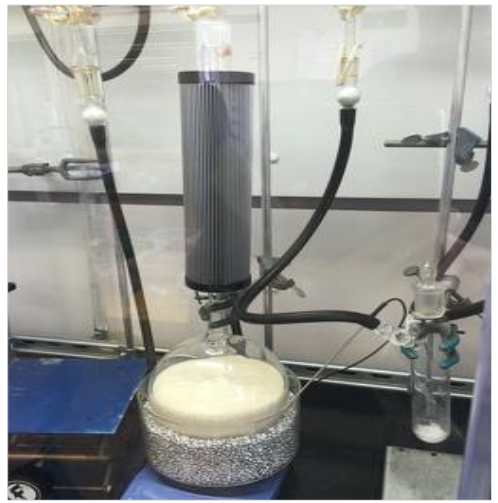
- Vacuum aspirators
  - ✓Vacuum aspirators consume nearly 15 liters per minute
  - ✓An oil-free vacuum pump is often available for the same task, and can save 900 liters per hour

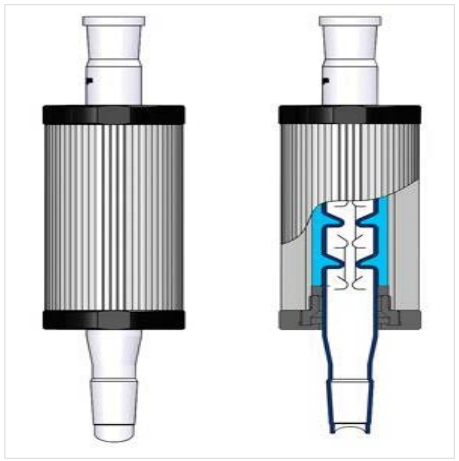
Additional lab process opportunities for water savings

Photo © Getinge

- Cage and bottle washers in animal facilities
- Gas laser cooling – often these lasers can be replaced by solid-state lasers
- Glass pipette washing – some procedures have people running water for 24 hours or more
- Turn down water pressure to laboratories

Single-pass cooling





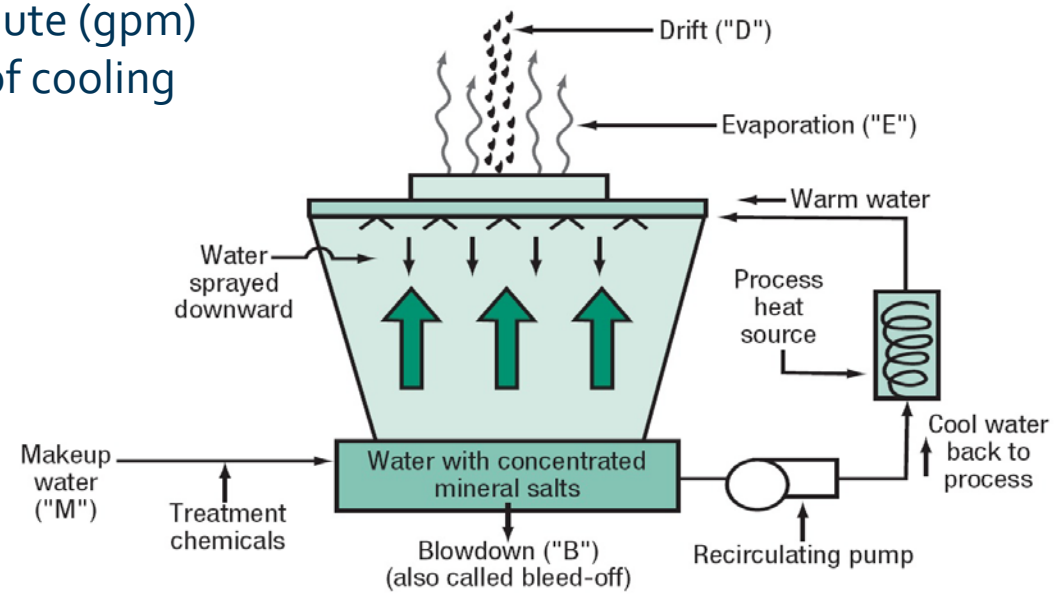
- Often used in chemistry departments (cooling down reactions)
- There are viable alternatives, including recirculating water baths and apparatus called Findenser
  - ✓Replaces water-cooled condensers in more than 95% of common chemistry applications
- Common equipment to watch for:
  - ✓Condensers
  - ✓Air compressors
  - ✓Vacuum pumps
  - ✓Icemakers
  - ✓Specialty lab equipment

Single-pass cooling

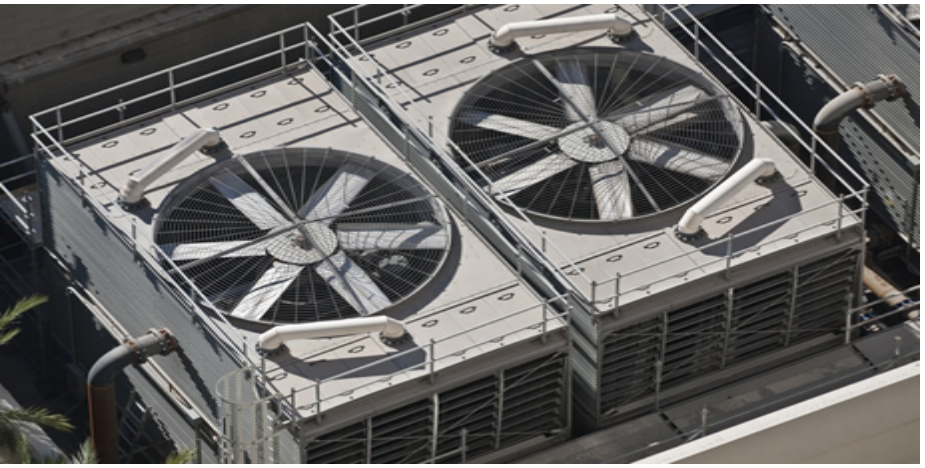
- The best solution: Use a process cooling system (closed loop)
  - ✓ Will increase on-site energy use
- This loop provides water at a preset temperature to meet process needs
- A small packaged chiller or central plant cooling towers can reject the heat from these systems (usually must run year-round)
- Other efficiency options include:
  - ✓ Reuse single-pass discharge water for irrigation or initial rinses
  - ✓ Recover the heat from one process for use in another

Cooling towers

- Cooling towers use water in three ways:
  - ✓**Evaporation** (E) – is fixed and controlled by thermodynamics; about 2.4 gallons per minute (gpm) of cooling water is used for every 100 tons of cooling
  - ✓**Drift** (D) – losses are typically a function of tower design
  - ✓**Blowdown** (B) – contains the concentrated, dissolved solids and other material left behind from evaporation



Cooling towers



- The primary methods for conserving water use in cooling towers are operational
  - ✓Increasing concentration ratio (CR) reduces blowdown
- Increasing the CR from 2 to 5 yields almost 85% of savings obtained by increasing CR from 2 to 10
- Increasing CR above 6 does not significantly reduce make-up water use
- It does increase likelihood that deposits will form and cause fouling of the system

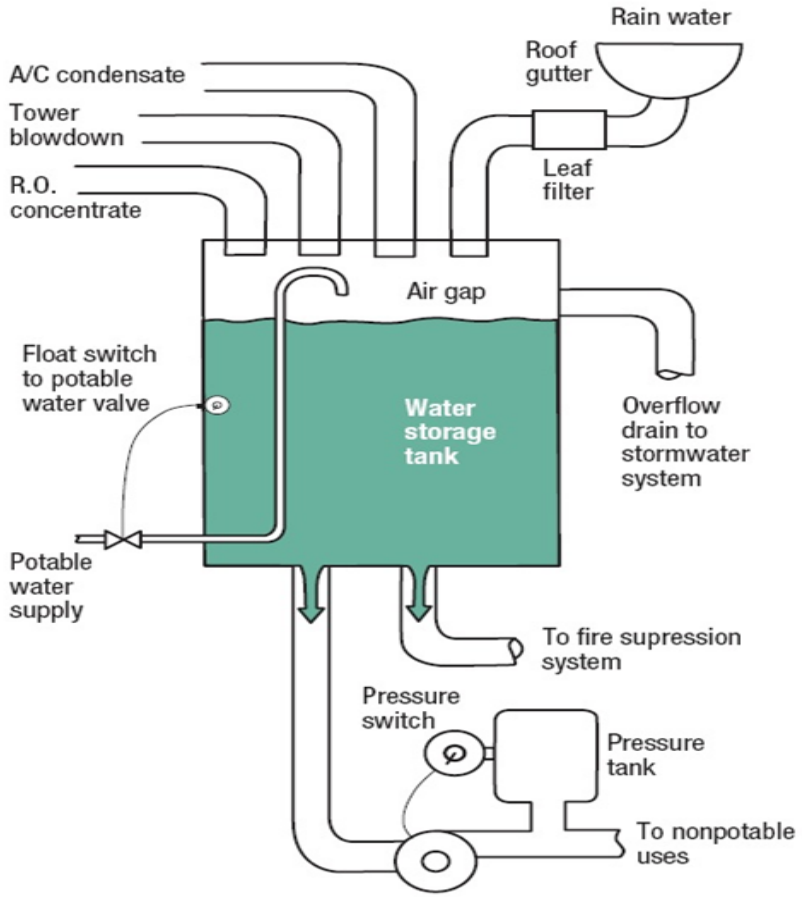
Non-chemical water treatment devices (NCDs) for cooling towers

- Have seen increased use as a "green" alternative
  - ✓LEED point
- Recent ASHRAE research paper 1361-RP* evaluated five NCDs for efficacy in reducing microbial populations in pilot-scale cooling systems
  - ✓None demonstrated significant biological control under test conditions

**1361-RP, "Biological Control In Cooling Towers Using Non-Chemical Water Treatment Devices", by Jane Macher, University of Pittsburgh, sponsored by ASHRAE Technical Committee TC 3.6, Water Treatment*

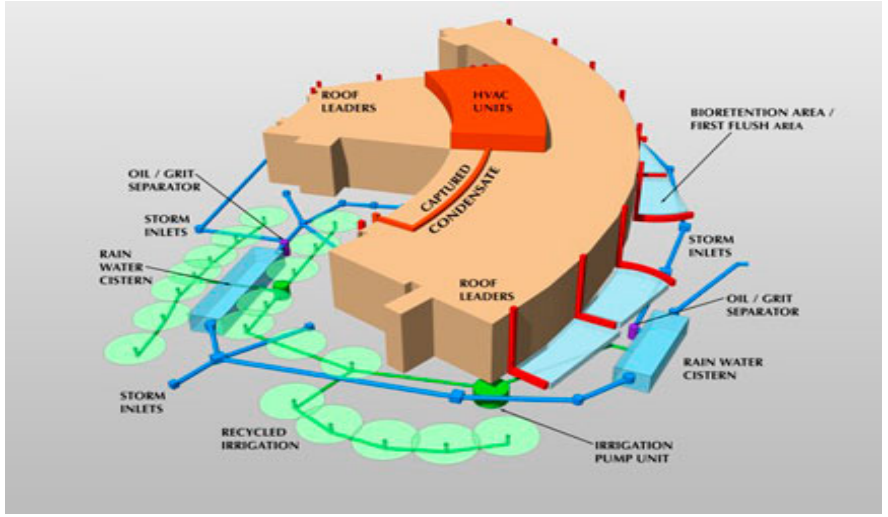
Alternative water sources

- Large laboratory buildings are good candidates for alternative, or unconventional, water sources because they usually use a large amount of non-potable water
- These facilities can greatly increase their total water supply without adding capacity from the public system or well



Alternative water sources

- The two most useful water sources for laboratory buildings are air-conditioning condensate recovery and rainwater harvesting*
- Both can provide fairly steady sources of relatively pure water; they are limited primarily by the cost of capturing the water
- GOAL: Minimize the use of potable water for process applications



Condensate recovery and rainwater harvesting at Georgia Tech's Klaus Advanced Computing Building, by Perkins+Will

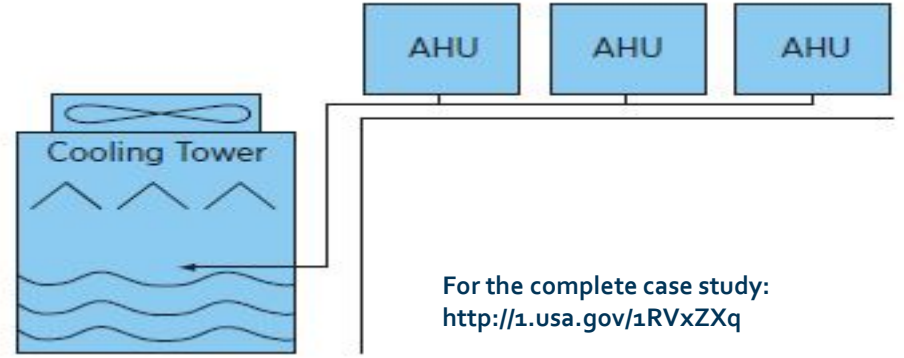
*Both are less viable in drier climates

For more information: http://b.gatech.edu/1RVArgF

Cooling coil condensate recovery

- Another strong case for this strategy is the EPA's Science and Ecosystem Support Division, a 66,000-square-foot lab facility built in 1996 in Athens, GA
- The system routes condensate from three air handling units to the facility's cooling tower, reducing potable water usage and improving cooling tower water chemistry
- Total cost: $24,500
- From May through December 2008, the project saved 540,000 gallons of water, resulting in a 16% reduction in overall water use at the site
- The water savings at the time of initial analysis was valued at $3,500 (at $6.52 per thousand gallons)
- Simple payback: <6 years

The collection manifold from each of the three units as the condensate is collected together. Image: EPA



For the complete case study: http://1.usa.gov/1RVxZXq

There are hidden opportunities for water savings in labs.

Some are hidden in plain sight.

Others require conversations with scientists.

Together, we can significantly improve water conservation.

Questions ?

Dan Doyle, Grumman/Butkus Associates
ddoyle@grummmanbutkus.com