Condensate Collection in Arizona?

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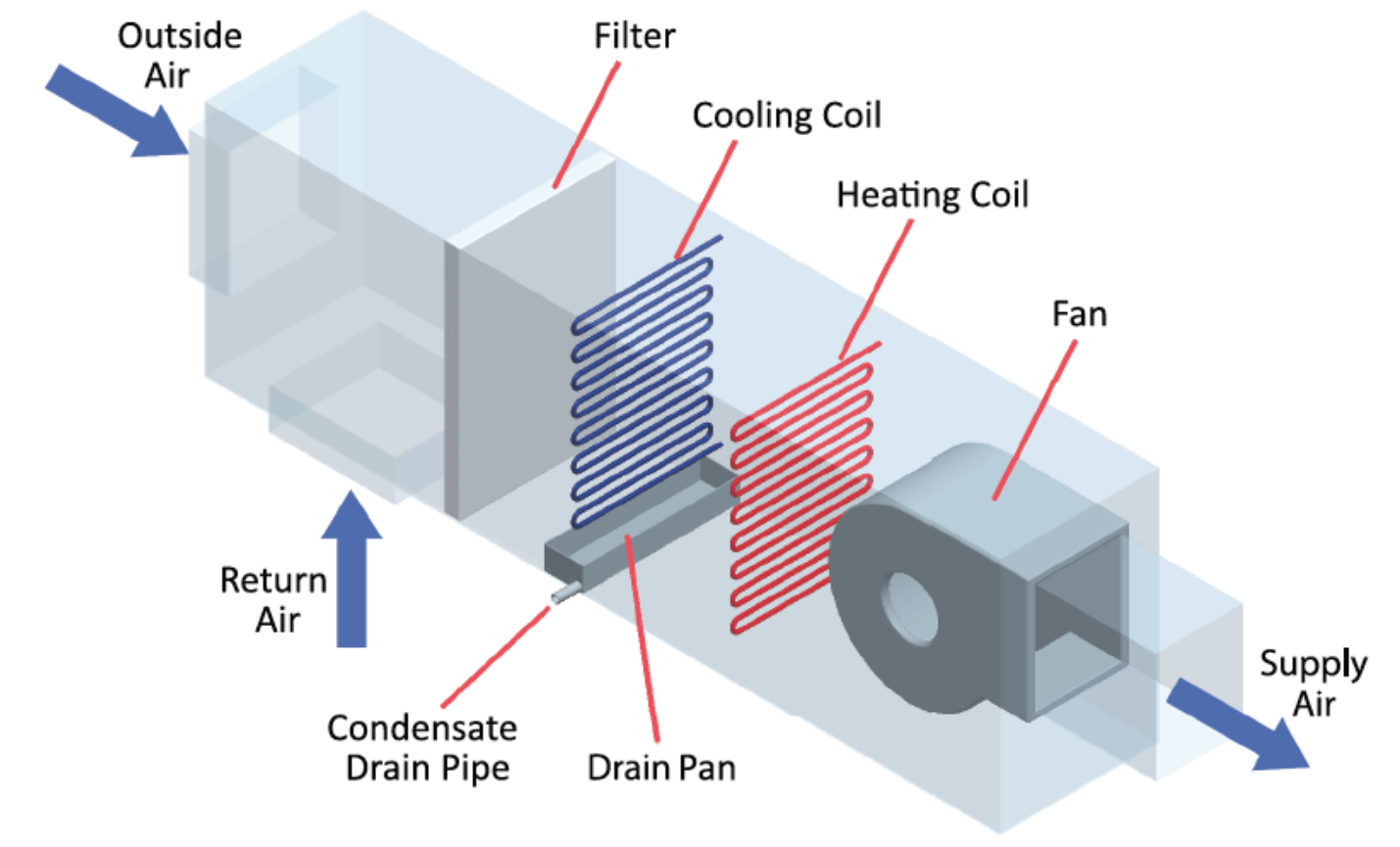
Condensate

Water that collects on a cool surface because the temperature of the surface is below the point at which moisture in the air forms liquid droplets (i.e. dew point)

Air Handling Unit (AHU)



(Source: *San Antonio Condensate Collection and Use Manual for Commercial Buildings 2013*)

Water Quality

Table 8-1. Water Quality Considerations for Onsite Alternative Water Sources*

Possible Sources	Level of Water Quality Concern					
	Sediment	Total Dissolved Solids (TDS)	Hardness	Organic Biological Oxygen Demand (BOD)	Pathogens (A)	Other Considerations
Rainwater	Low/ Medium	Low	Low	Low	Low	None
Stormwater	High	Depends	Low	Medium	Medium	Pesticides and fertilizers
Air Handling Condensate	Low	Low	Low	Low	Medium	May contain copper when coil cleaned
Cooling Tower Blowdown	Medium	High	High	Medium	Medium	Cooling tower treatment chemicals
Reverse Osmosis and Nanofiltration Reject Water	Low	High	High	Low	Low	High salt content
Gray Water	High	Medium	Medium	High	High	Detergents and bleach
Foundation Drain Water	Low	Depends	Depends	Medium	Medium	Similar to stormwater

Note: The use of single-pass cooling water is also a possible source of clean onsite water, but facility managers should first consider eliminating single-pass cooling because of its major water-wasting potential. For that reason, it is not included in the list.

*Key:
Low: Low level of concern
Medium: Medium level of concern; may need additional treatment depending on end use
High: High concentrations possible and additional treatment likely
Depends: Dependent upon local conditions
(A): Disinfection for pathogens is recommended for all water used indoors for toilet flushing or other uses

(Source: *EPA WaterSense at Work. EPA 832-F-12-034*)

Quality Research: Water Sampling Kit

Bottles Used in Collection

Metals & Minerals

Test for Elements With Spectrometry

Microbes

Aeromonas

Enterococcus

E. Coli
Total Coliforms

Amoebas

Legionella

EC, TDS, pH

Test for pH and Total Dissolved Solids (TDS)

Reasons to Collect Condensate

- Economic benefit for building owner
- Bypass drought restrictions (in some jurisdictions)
- Reduce burden on central water utility systems
- Water savings, energy savings, CO_2 savings

Is it worth collecting in Arizona?

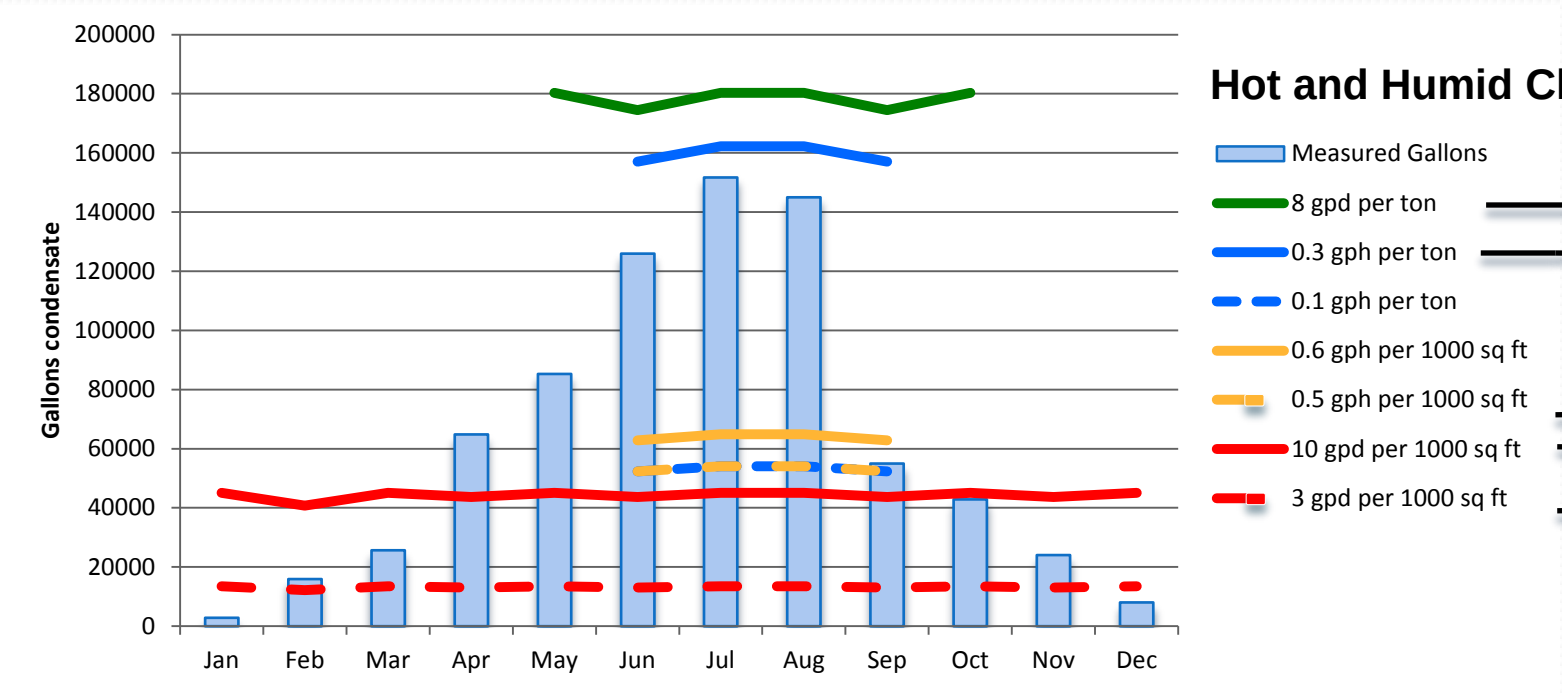
- Condensate quality is good
- Quantity depends on climate and facility
- Cost depends on application and facility
- Economic payback depends on projected water prices
- Other benefits may be considered in decision

Let’s go through the steps of making a decision

Key Factor is How Much Condensate?

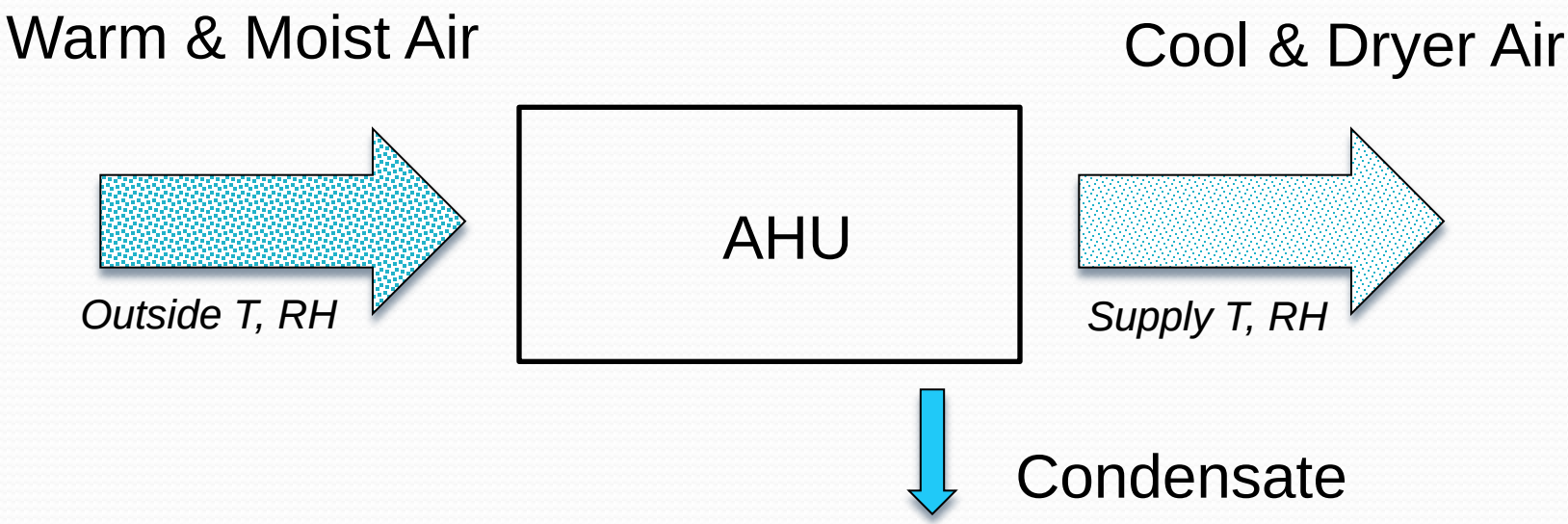
How Much Condensate? (Rule of Thumb)

San Antonio Example: 154,440 sq ft (727 ton) applied engineering and technology building measured condensate (747,290 gallons/yr) with predictions



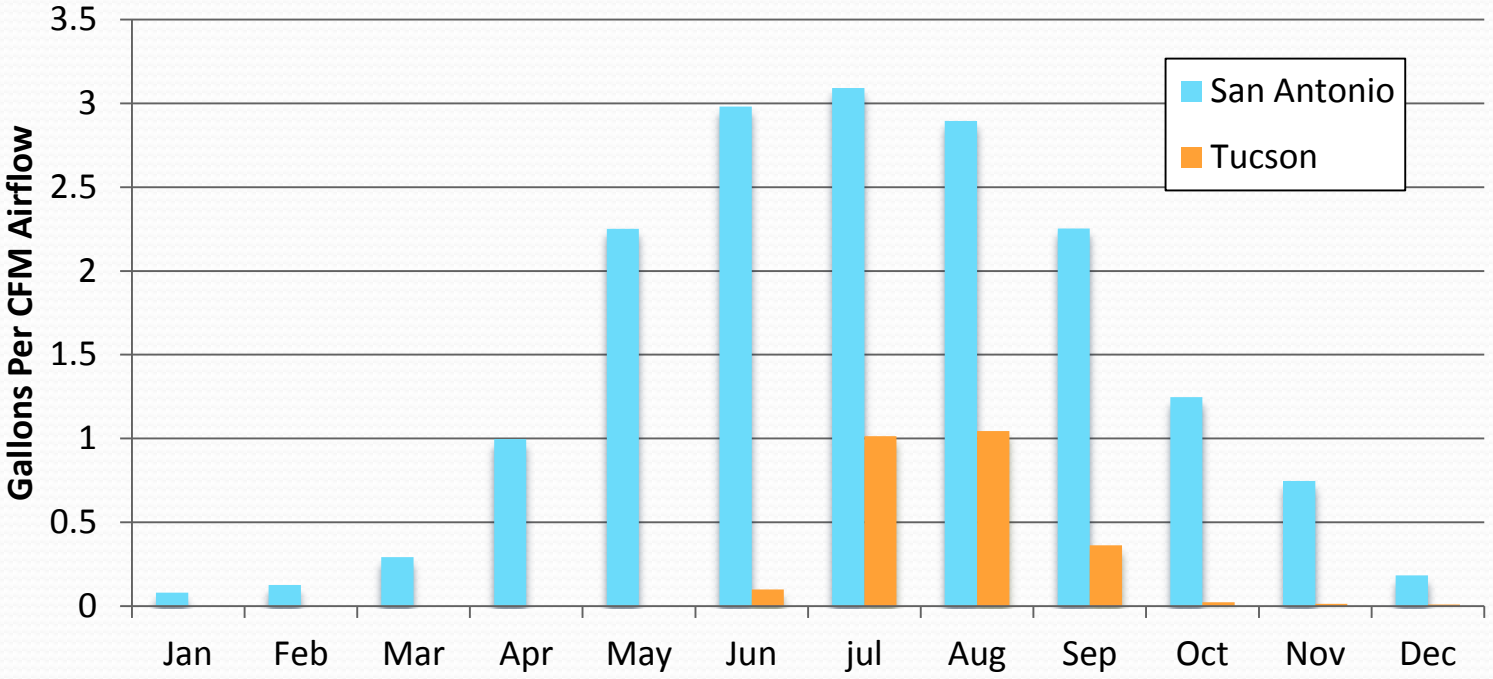
(Source: *San Antonio Condensate Collection and Use Manual for Commercial Buildings. 2013*)

Thermodynamic Model



- Thermodynamic equations of state
- Conservation of mass for both water and air
- Calculate condensate gallons per cubic foot of air passing through AHU per minute (g/cfm)

San Antonio vs. Tucson Potential



- San Antonio condensate potential 7 times more than Tucson for 100% outside air

(Data Source for Calculations: *DOE/NREL Typical Meteorological Year (TMY3) database)*

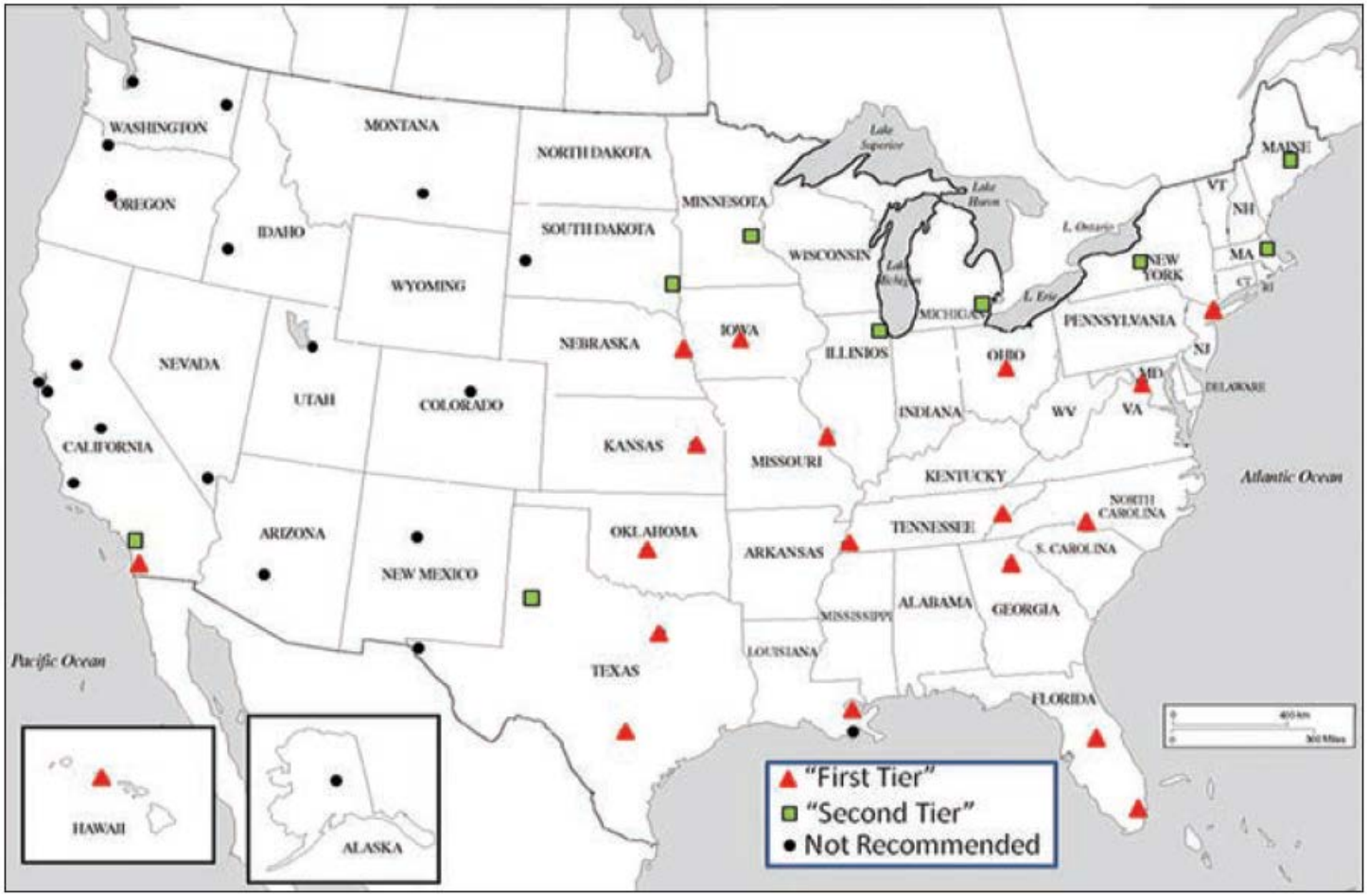
Condensate Potential Across the USA

Location	Weather Data Predicted gal/cfm OA	Regression Equation Predicted gal/cfm OA	Cost of Water ($/1,000 gal)	Simple Payback Period (Years)
Albuquerque, NM	0.7	*	$6.51	70
Athens, GA	13.3	13.9	$7.57	3.3
Bangor, ME	3.3	3.3	$9.36	10.8
Billings, MT	0.2	*	$4.05	355
Boston, MA	0.06	5.1	$3.85	4.5
Burbank, CA	5.1	4.6	$14.21	5.0
Charlotte, NC	4.7	12.4	$13.86	3.4
Chicago, IL	11.4	6.1	$8.49	14.2
Columbus, OH	6.2	5.5	$3.73	6.8
Dallas, TX	6.5	16.5	$7.43	4.0
Denver, CO	16.0	*	$5.24	139
Des Moines, IA	0.6	6.5	$4.26	5.7
Detroit, MI	5.7	4.9	$6.41	9.0
El Paso, TX	2.7	1.9	$6.25	19.7
Fairbanks, AK	0.2	*	$14.71	98
Fresno, CA	1.7	4.6	$3.31	60
Honolulu, HI	25.7	20.2	$6.01	2.1
Knoxville, TN	10.9	11.2	$5.71	5.3
Las Vegas, NV	0.6	*	$3.31	182
Lubbock, TX	5.0	5.9	$6.34	10.5
Memphis, TN	13.3	15.1	$2.66	9.3
Miami, FL	31.4	31.9	$10.75	1.0
Minneapolis, MN	4.6	2.4	$8.00	8.9

Location	Weather Data Predicted gal/cfm OA	Regression Equation Predicted gal/cfm OA	Cost of Water ($/1,000 gal)	Simple Payback Period (Years)
New Orleans	24.0	24.0	$7.35	1.9
New York, NY	8.4	9.0	$9.04	4.4
Oklahoma City, OK	10.3	12.2	$5.50	5.8
Omaha, NE	9.5	7.9	$2.27	15.4
Orlando, FL	26.4	26.2	$4.82	2.6
Phoenix, AZ	2.7	7.3	$6.77	18.0
Portland, OR	1.8	4.1	$5.05	35.9
Rapid City, SD	1.6	*	$7.01	30.4
Redmond, OR	0.7	*	$6.37	72.0
Sacramento, CA	1.8	3.4	$11.47	16.0
Salt Lake City	0.2	*	$6.21	333
San Antonio	19.0	17.1	$3.63	4.8
San Diego, CA	7.3	4.9	$10.23	4.4
San Francisco	1.2	1.7	$12.10	22.2
San Jose, CA	1.8	2.5	$10.84	16.8
San Luis Obispo, CA	1.3	1.6	$17.49	14.5
Seattle, WA	0.8	*	$17.35	25.4
Sioux Falls, SD	4.8	2.4	$8.11	8.5
Spokane, WA	0.04	*	$7.42	1113
St Louis, MO	8.0	9.5	$4.68	8.8
Syracuse, NY	6.5	6.4	$5.15	9.9
Topeka , KS	11.2	10.9	$6.27	4.7
Washington, DC	9.8	10.0	$9.21	3.7

(Source: Lawrence, Thomas, Jason Perry, and Tyler Alsen. "AHU Condensate Collection Economics." ASHRAE Journal, May 2012)

Simple Economic Analysis



(Source: Lawrence, Thomas, Jason Perry, and Tyler Alsen. "AHU Condensate Collection Economics." ASHRAE Journal, May 2012)

Estimating System Cost

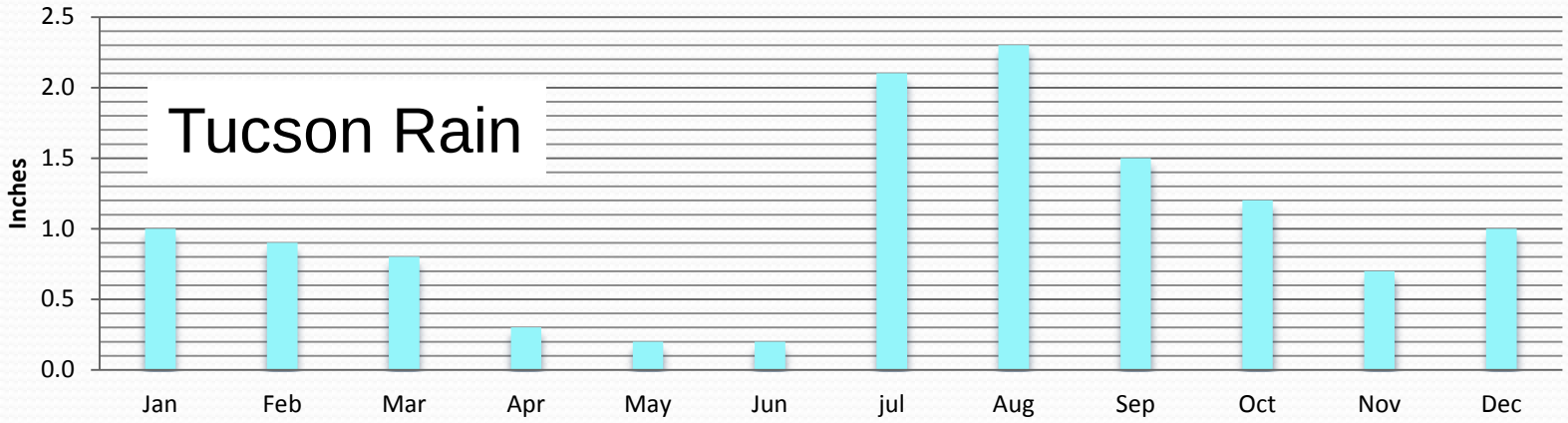
- Expect only inexpensive systems to be viable in Tucson
  - Cooling tower make-up water
  - Adding to existing (rain) water storage tank
- Condensate only produced Jun-Sep in Tucson
  - Condensate as supplemental water makes most sense

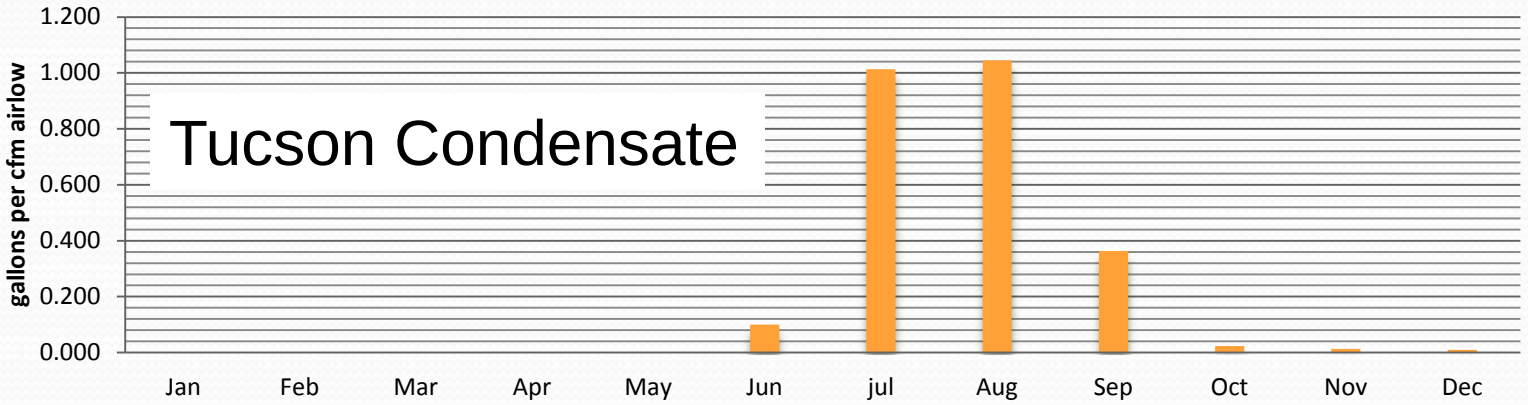
Best Application of Condensate

- Cooling tower make-up water is BEST application
  - Low initial cost
  - Easy implementation
  - Cool and pure water a plus
  - Low maintenance

San Antonio Example: Building producing 224,511 gallons per year. Cost to install retrofit system for cooling tower makeup water was $2,272 materials (pipes and pumps) plus $750 labor. SAWS rebate 50%. Incremental investment $1,511. Payback period 16 months. No water treatment beyond that already existing for cooling tower water. No overflow and no storage requirements. Maintain air seal and pump (if applicable). (**Arizona longer payback period ~ 5 yrs)**

Or Add to Other Alternative Water





(Data Source for Calculations: *DOE/NREL Typical Meteorological Year (TMY3) database)*

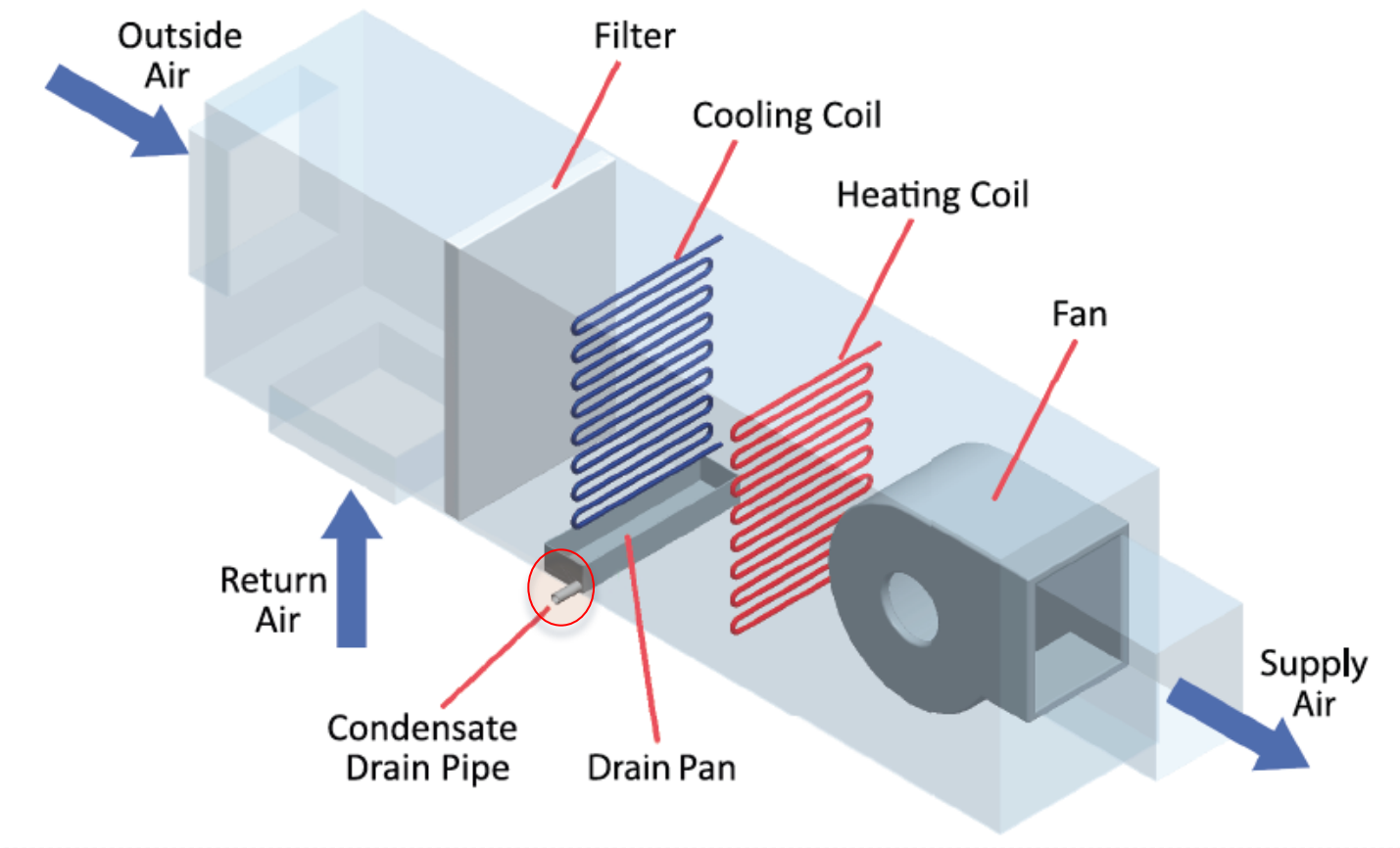
Reasonable Applications Elsewhere

- Cooling tower
- Irrigation
- Fountains, water features (bypass drought restrictions)
- Car washing (low TDS)
- Toilet flushing
- Process water
- Others

Condensate Success

- [x] Initial investment/payback period
- [ ] Achieve an effective design and installation
- [ ] Operate and maintain

Effective Design – Drain Line Air Seal



(Source: *San Antonio Condensate Collection and Use Manual for Commercial Buildings. Pending publication*)

Air Seals : Standard P-trap

- Isolates air handling unit
- Minimizes pipe wet time
- Maintenance access point
- Dry trap is most likely cause of failure in dry climates

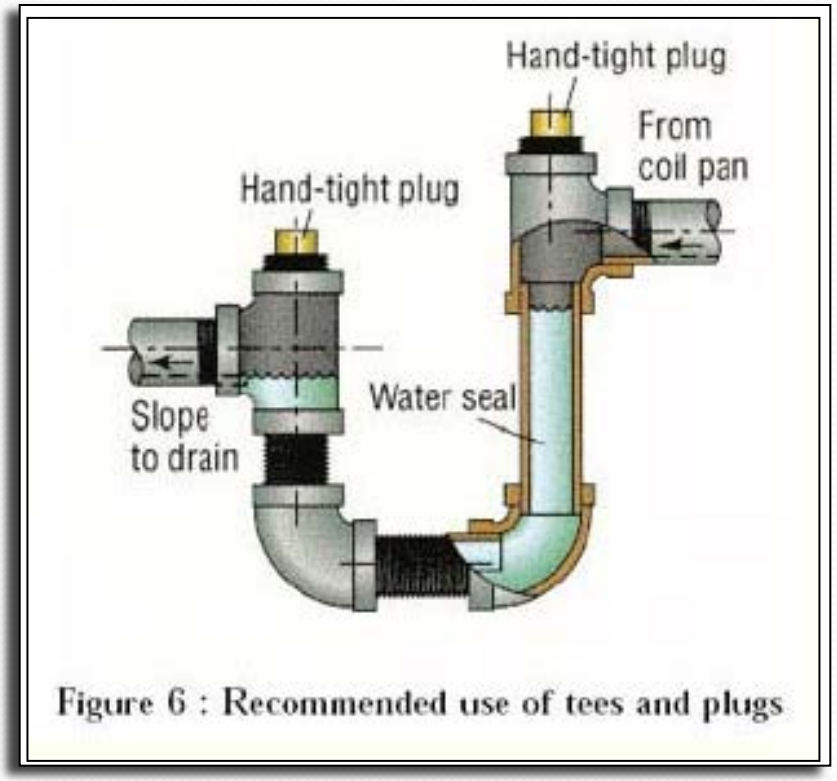


Figure 6 : Recommended use of tees and plugs

(Source: Brusha, Ronald F. “Condensate Traps for Cooling Coils.” HPAC Engineering, Oct 2001)

Effective Design – Drain Line Air Seal

- Functioning air seal supports proper condensate drainage
- Consequence of improper condensate drainage
  - Overflow of drain pan
  - Overspray into fan and ductwork
  - Ingestion of toxic fumes through drain line (draw through)
  - Energy loss with exit of conditioned air through drain line (blow through)
  - Stagnant water in drain pan
- Air Quality Connection
  - Legionella bacterium
  - Sick building syndrome

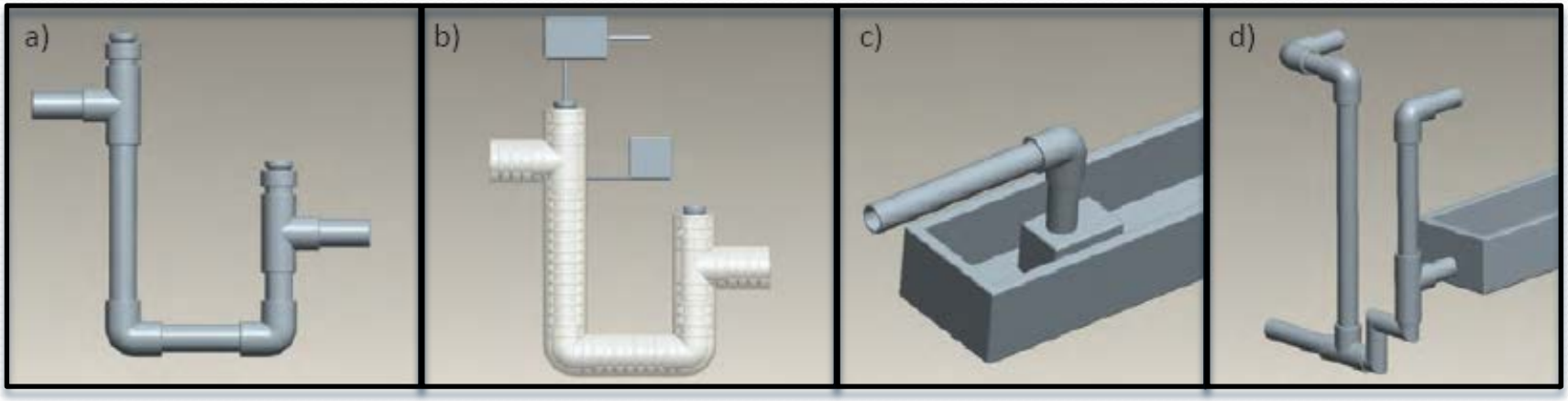
Alternatives to Standard P-trap

P-trap

P-trap with additions

Condensate pump in drain pan

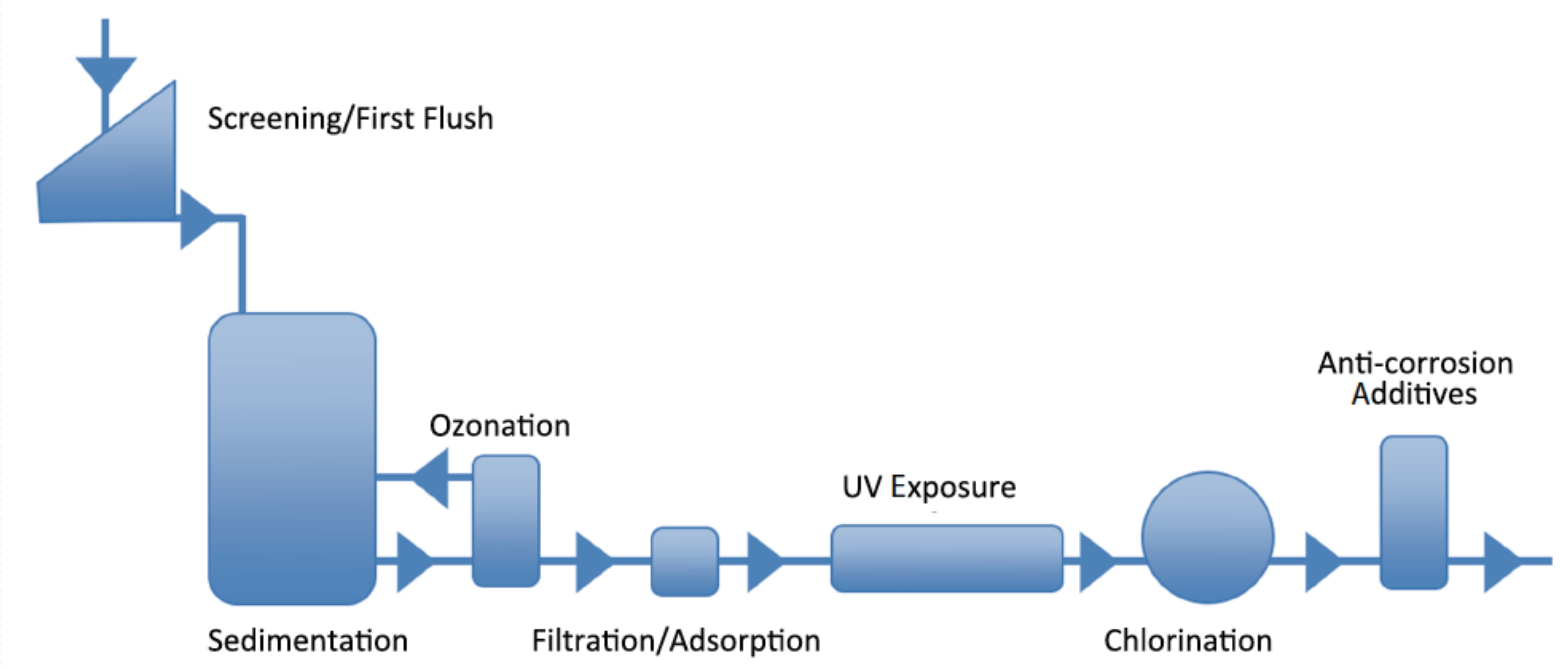
Pneumatic air seal



(Source: *San Antonio Condensate Collection and Use Manual for Commercial Buildings. 2013*)

Effective Design – Treatment Train

- Depends on reclaimed water source(s)
- Depends on application : “fit for purpose”

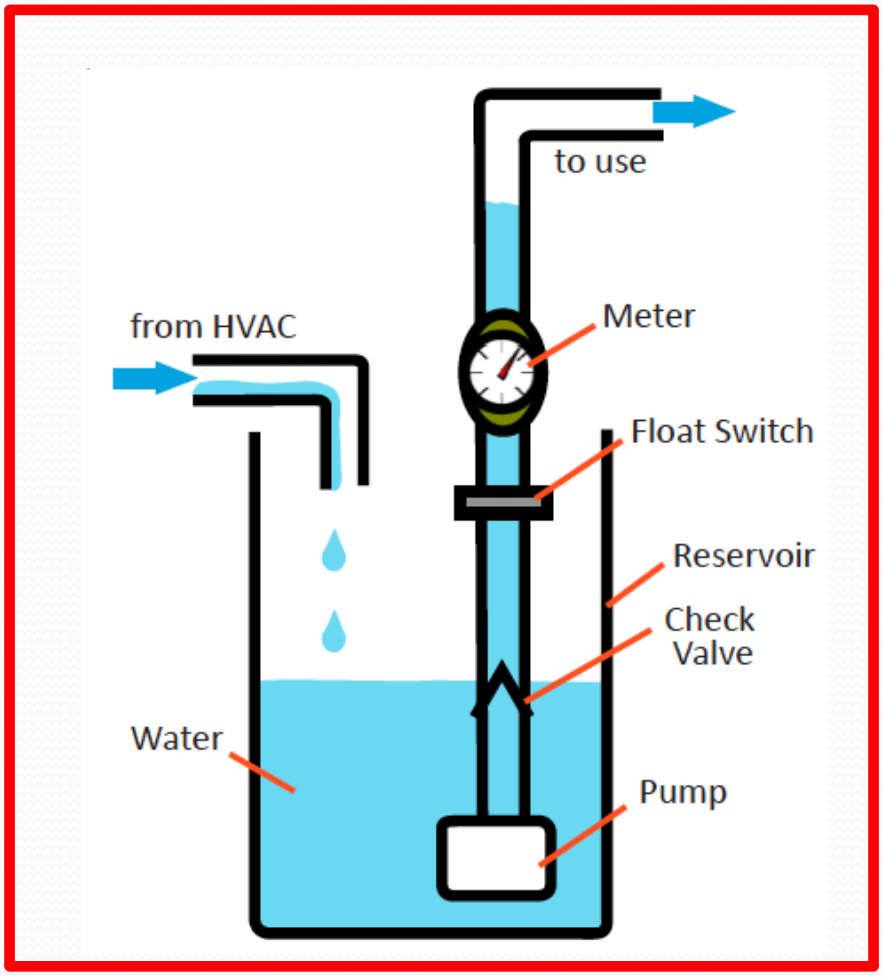


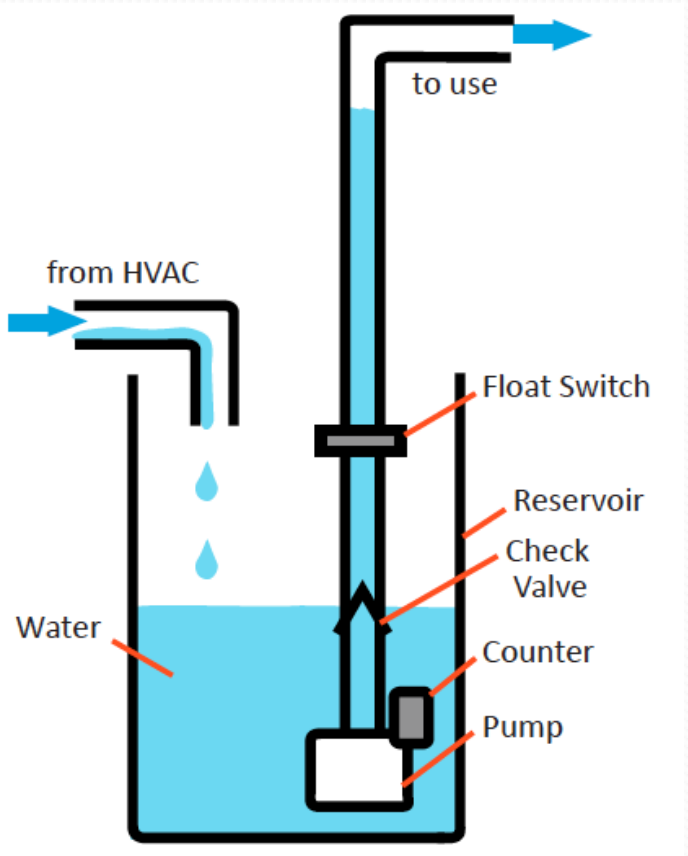
(Source: Adapted from Mechell et. al, *Rainwater Harvesting: System Planning.* 2010)

Effective Design – Automated Monitoring

- Drip pan overflow alarm
- Condensate meter data collection
- Water quality sensors in treatment train
- Make it difficult for system failures to go unnoticed

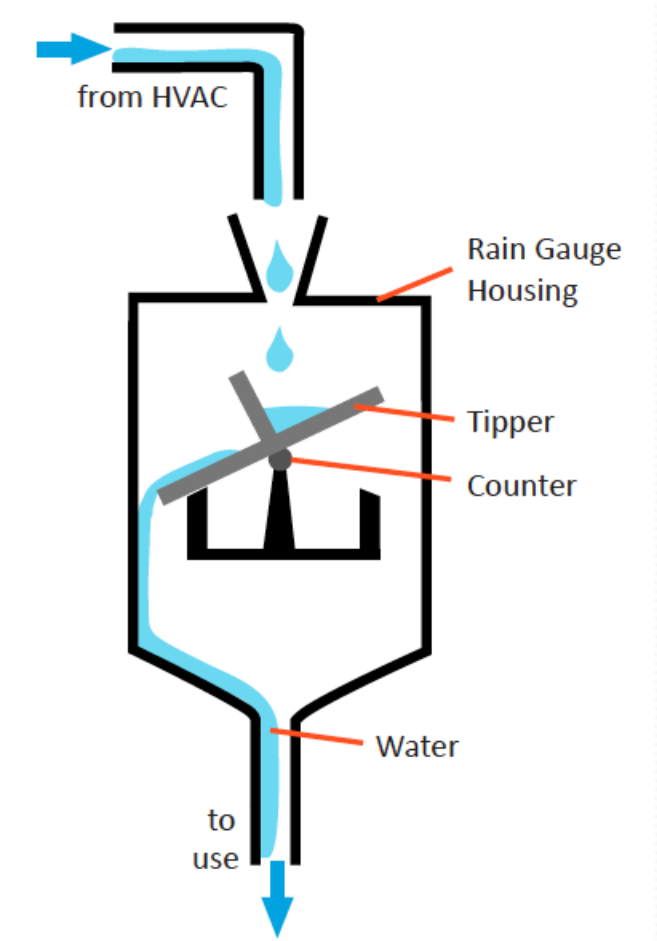
Meter Configuration: Pump-Driven Flow

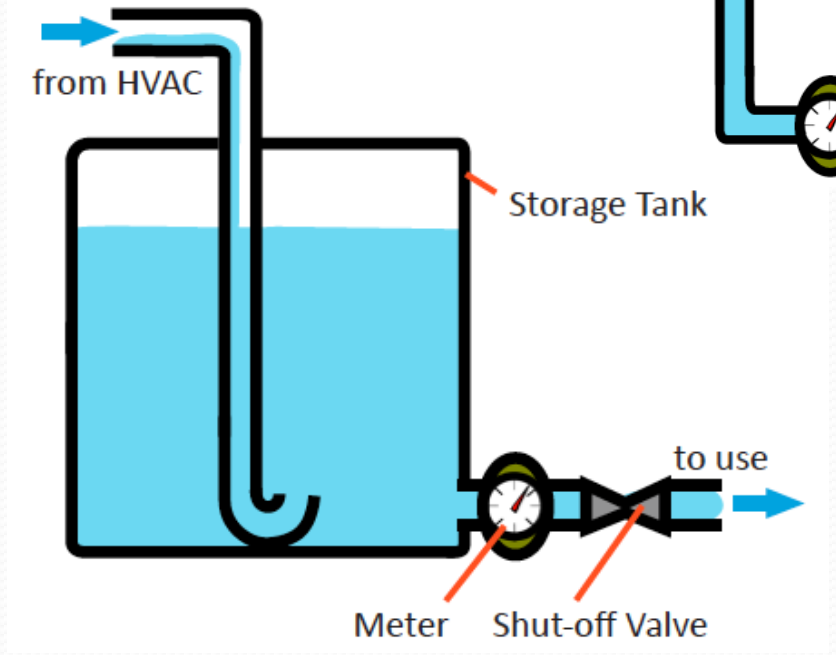


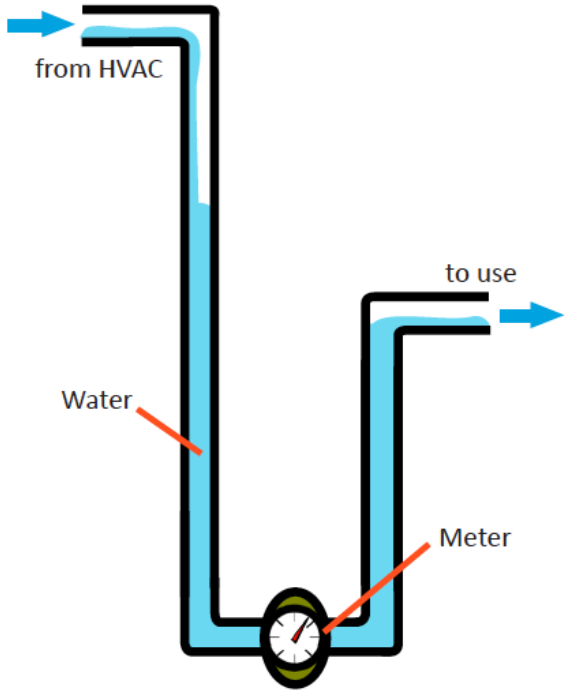


(Source: *San Antonio Condensate Collection and Use Manual for Commercial Buildings 2013*)

Meter Configurations: Gravity-Driven Flow







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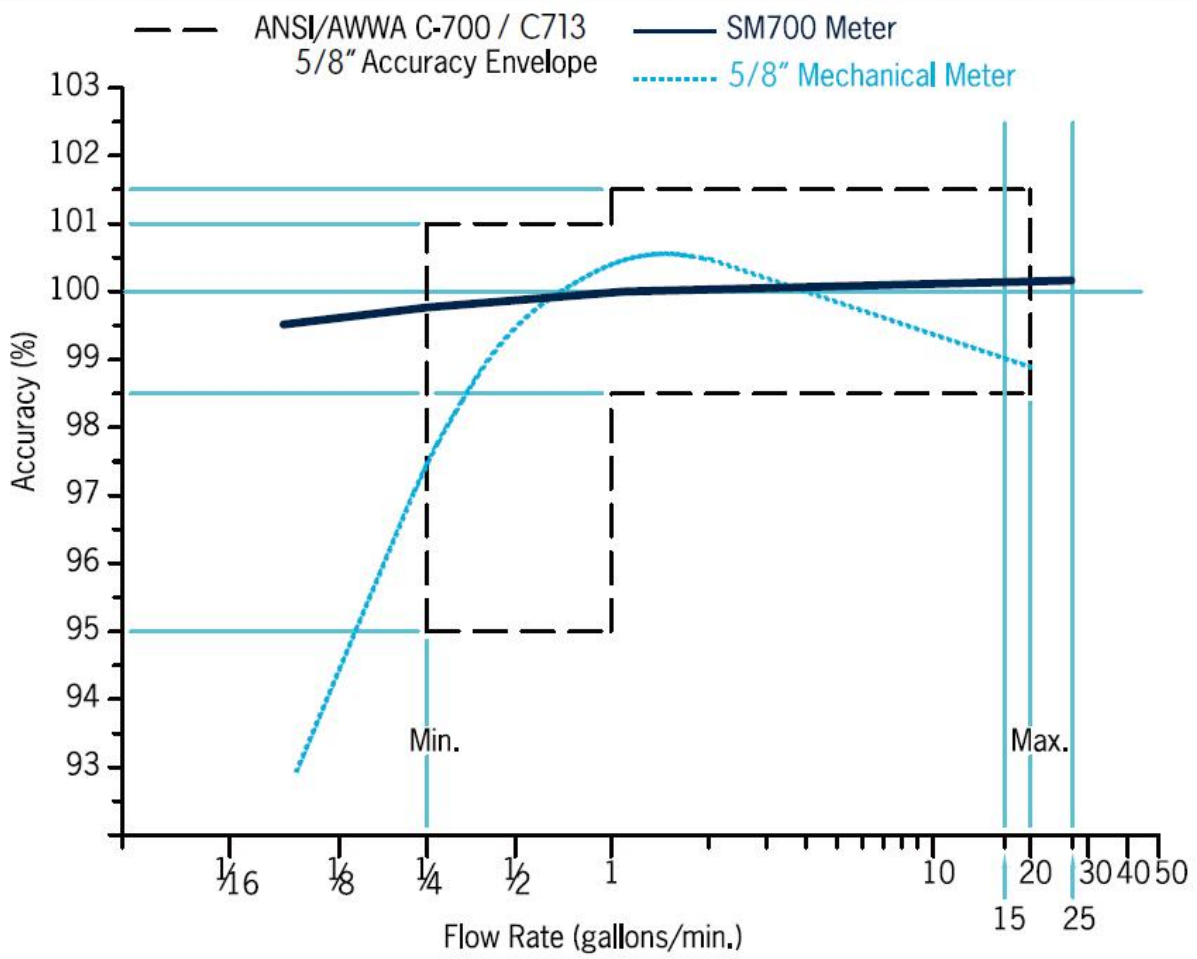
Positive Displacement Meter



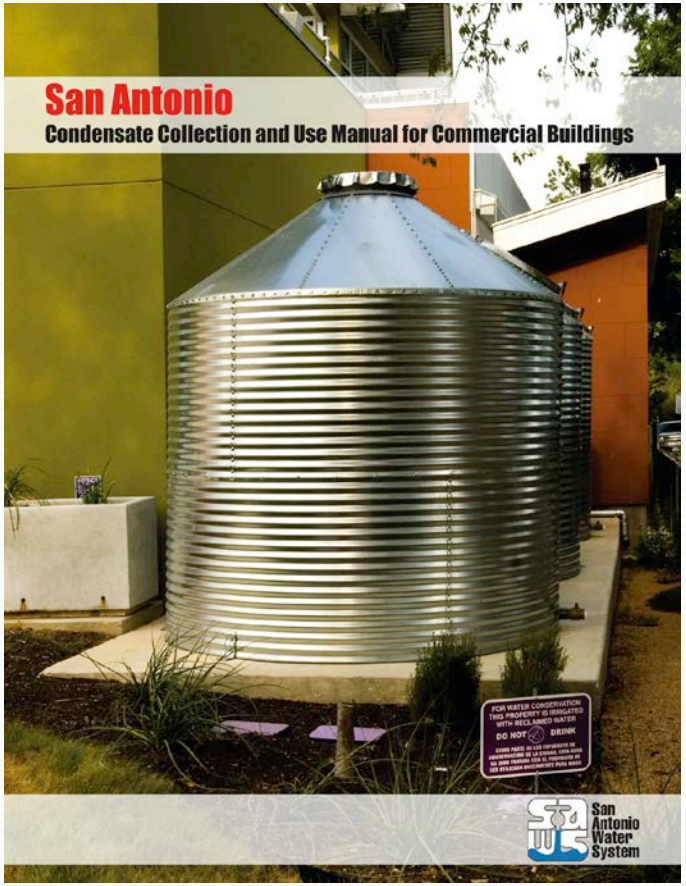
(Source: www.elstermetering.com)

Operation and Maintenance -Scheduled Maintenance Program

- Start with commissioning during installation!
- AHU: air filter, cooling coils, drain pan
- Drain seal
- Piping, pumps, and valves
- Storage Tank: overflow and makeup water control
- Backflow valve inspection
- Water treatment filters, lamps, etc.
- Water quality tests

San Antonio Condensate User Manual

- In collaboration with San Antonio Water System (SAWS)
- Design through maintenance
- Public access on SAWS website www.SAWS.org
- Resources in appendices
- 110 pages



Codes and Standards

- Condensate is governed by local jurisdictions, not Federal
- Code and Standards Resources/References
  - International Green Construction Code
  - Green Plumbing and Mechanical Code Supplement
  - NSF/ANSI Standards 350 & 350.1
  - ASHRAE 189.1

Questions

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