Smart Management for Small Water Systems

Technologies to Save Energy, Resources and Time in Water System Operations

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EFCN environmental finance center network

NADO National Association of Development Organizations

GFOA Government Finance Officers Association

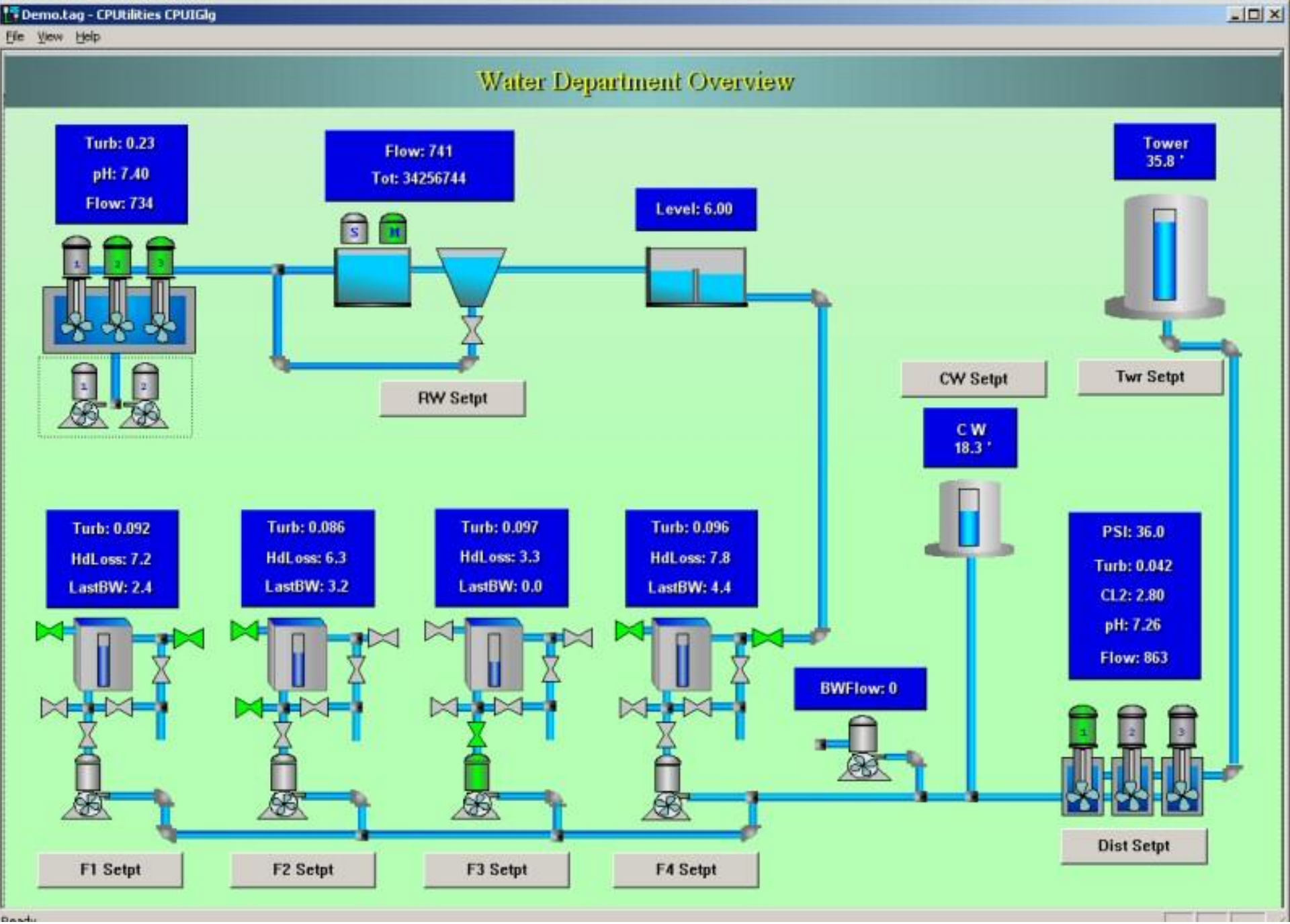
This program is made possible under a cooperative agreement with the U.S. EPA.

Webinar Overview

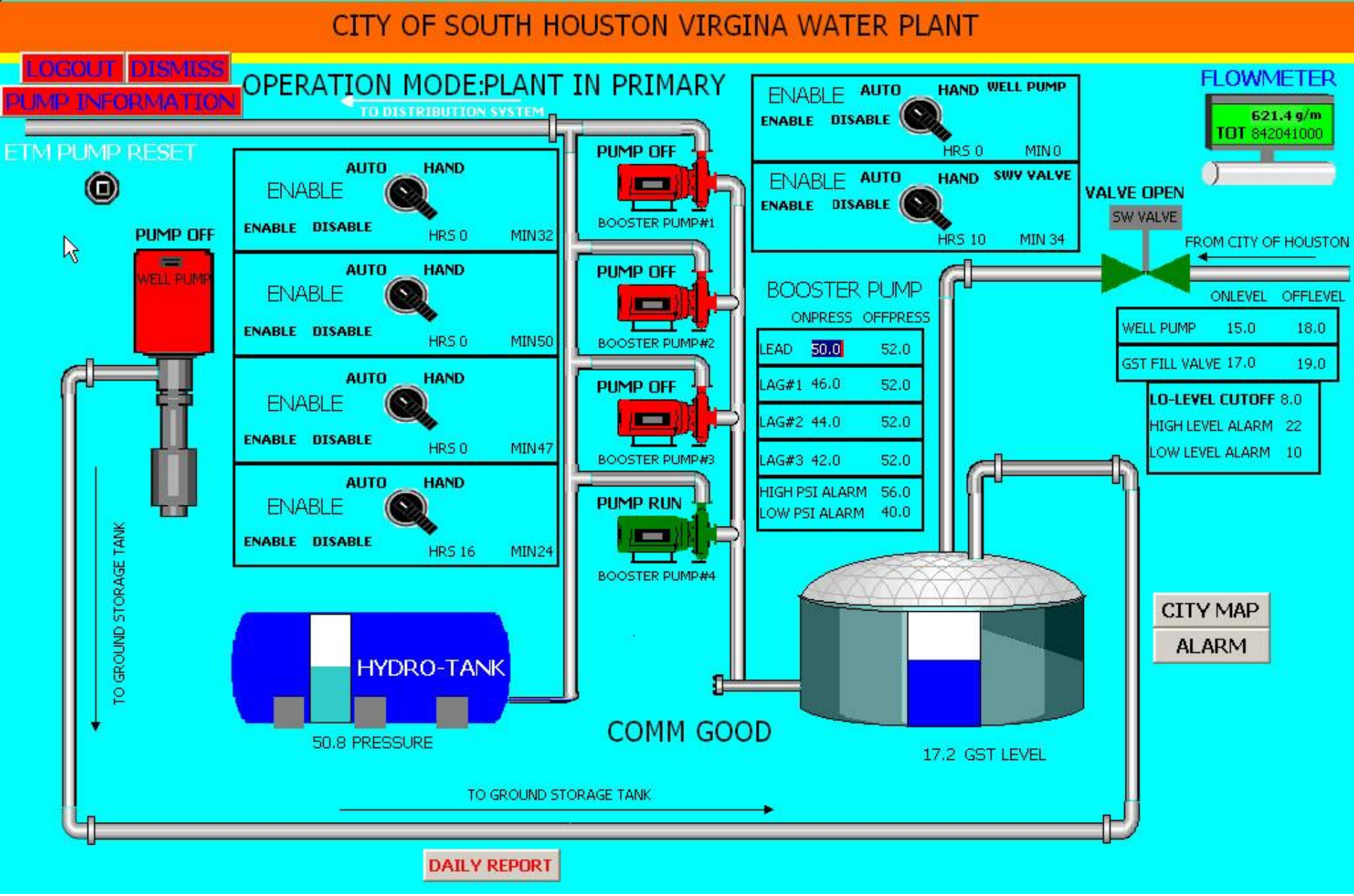
- SCADA – Supervisory Control & Data Acquisition
- Variable Frequency Drives
- Remote Monitoring
- Niche & Emerging Technologies

SCADA Overview

- Supervisory Control & Data Acquisition
- Largely for process controls
  - Graphical user interface
- Can be local plant, remote or both
- Widely used in water & wastewater utilities



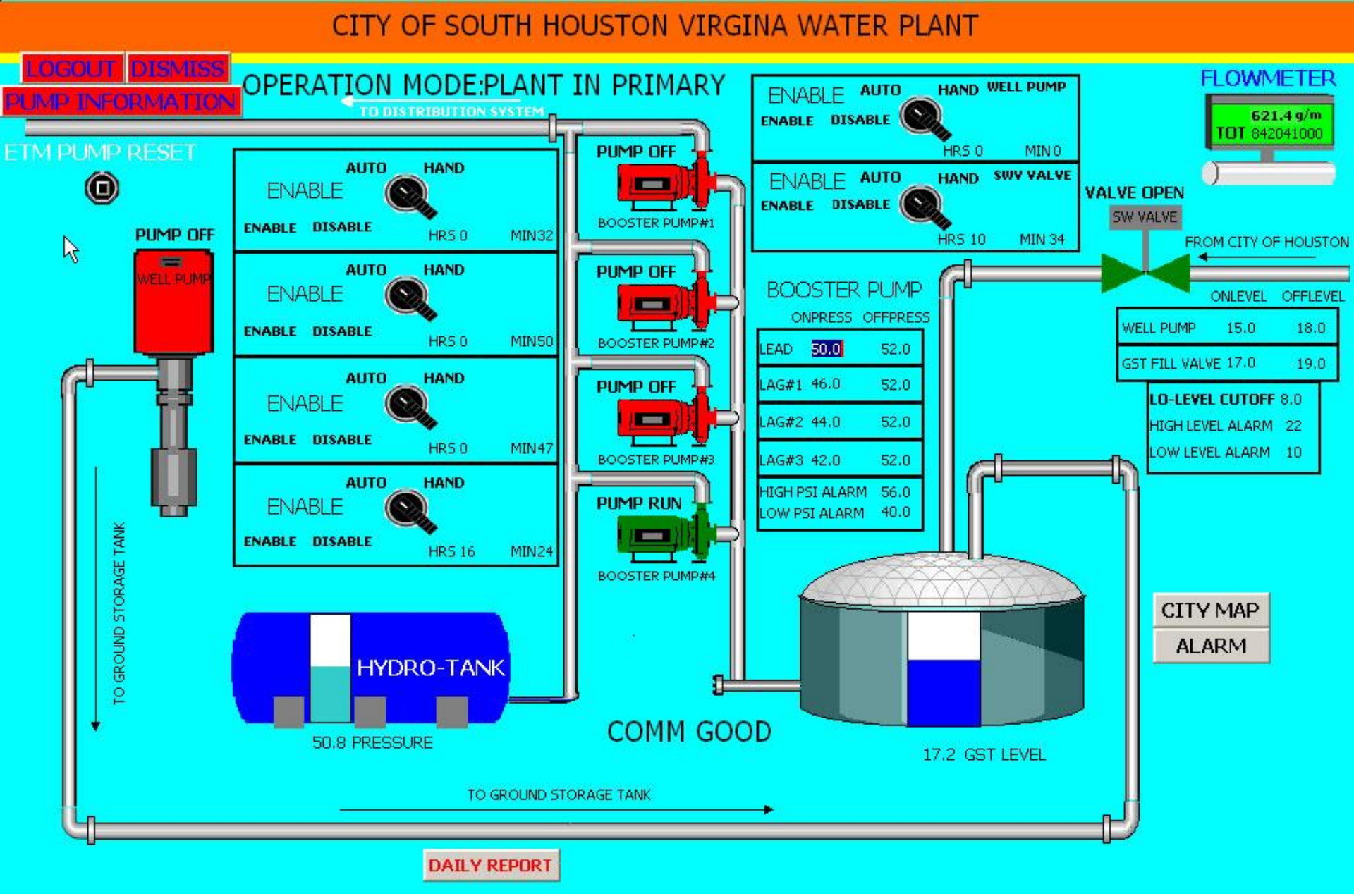
From Generic Logic



From Tofino Security

SCADA Equipment

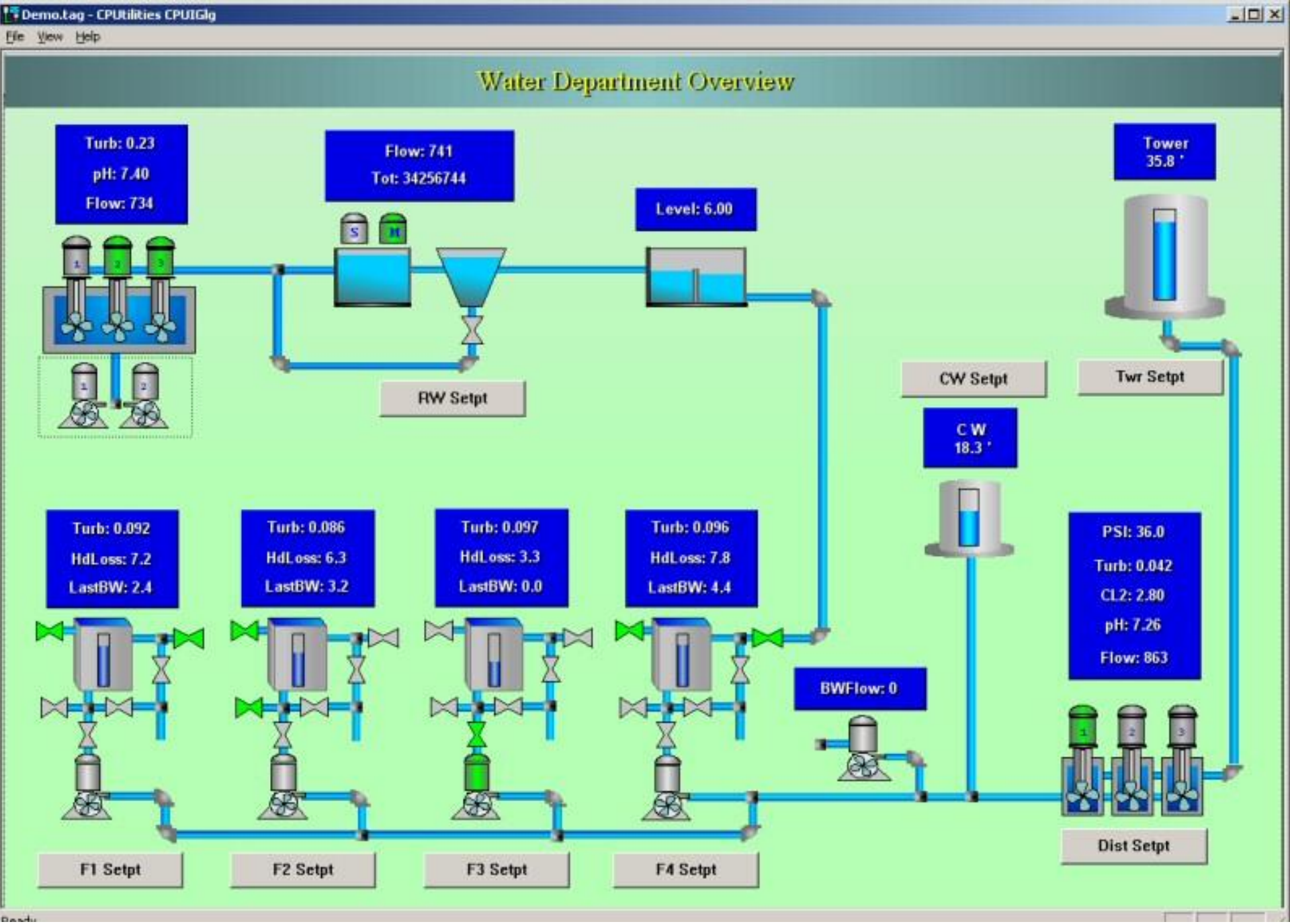
- Electronic Sensors
- Programmable Logic Controls
- Computers, software, custom programming
- Communications



From Tofino Security

SCADA for Optimization

- Electrical Savings
  - Equipment power status
  - Monitor Usage/Hours/Amps
  - Control variable speed pumps
- Labor savings
  - Remote turn on/off
  - Automatic logging of data
  - Alarms/dialers
- Water Conservation
  - Real-time flow
  - Real-time pressure
- Chemical Savings
  - Allows monitoring/pacing
- Reliability & Safety
  - Trend monitoring
  - Instant responses
  - Faster diagnostics
  - Alarms
  - Confined spaces



From Generic Logic

Variable Frequency Drives

Learn how they work & where they are appropriate

What is a VFD?

- Adjusts frequency of input electricity to vary motor speed.
- Very high power savings if the speed of the motor can be dropped without sacrificing performance.
- Requires inverter rated motors

VFD Math – Pumps/Affinity Law

Flow is proportional to speed

$$\frac{Q_1}{Q_2} = \left(\frac{N_1}{N_2}\right)$$

Pressure proportional to square of shaft speed

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$$

Power proportional to cube of shaft speed

$$\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$$

Equations from Wikipedia.

VFD Energy Savings

- Power Input

$$HP \approx rpm^3$$

Example: speed reduction to 50%

$$HP_{0.5} = HP_1 \times (0.5)^3$$
$$= HP_1 \times 0.126$$

*VT/VH = Variable Torque/Variable Horsepower

VT/VH Power vs Speed	
Speed	Power
100%	100%
90%	73%
80%	51%
70%	34%
60%	22%
50%	13%
40%	6%
30%	3%
20%	1%
10%	0.1%

What kind of energy savings?

- VFD manufacturer reps can calculate based upon specific loads and operating conditions.
- 10% to 30% is not uncommon
- Biggest savings are where there's a lot of waste
  - i.e. throttling valves

What a VFD can do.

- Soft start, soft stop
  - Prevent pressure spikes
  - Lower machinery stress
  - Lower main breaks
- Match supply/demand almost perfectly
  - Keep reservoirs full
  - Allow to run during tower outage
- Ability to have feedback loops for controls
  - Tower Elevation
  - System Pressure
- Most have motor protections similar to soft starts

Cautions against VFDs

- VFDs can be programmed to match demand almost instantaneously.
  - What does this do to water storage and age?
  - Make sure to swing tower elevation in programming.
- VFDs can take pumps away from their most efficient set point.

More VFD Considerations

- VFDs cost money to install & maintain
  - Don’t forget sensors for feedback loops/automatic controls
- VFDs take up space
  - Smaller than the past
- VFDs require proper ventilation

VFD Summary

- VFDs can save a lot of energy in the right application

- VFDs only work when:
  - Proper sensors are in place
  - Proper programming has been completed
  - Systems are maintained

- VFDs are sometimes utilized as a band-aid
  - Ensure equipment is right before VFD install

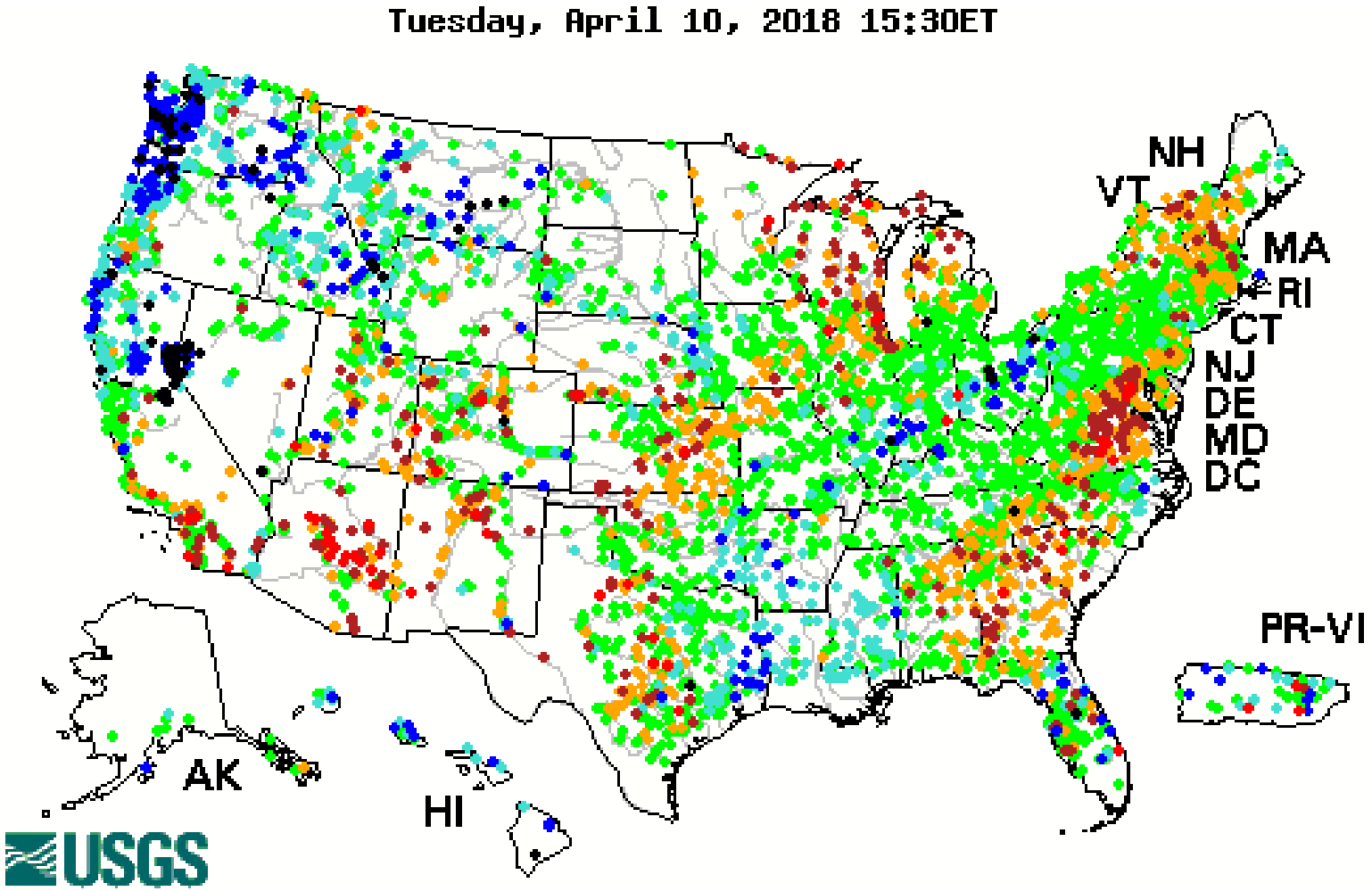
Remote Monitoring

What exists and how it can benefit your utility.

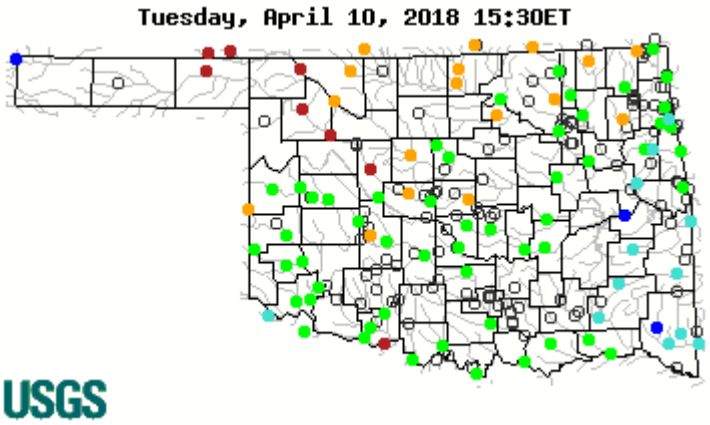
Existing Remote Monitors

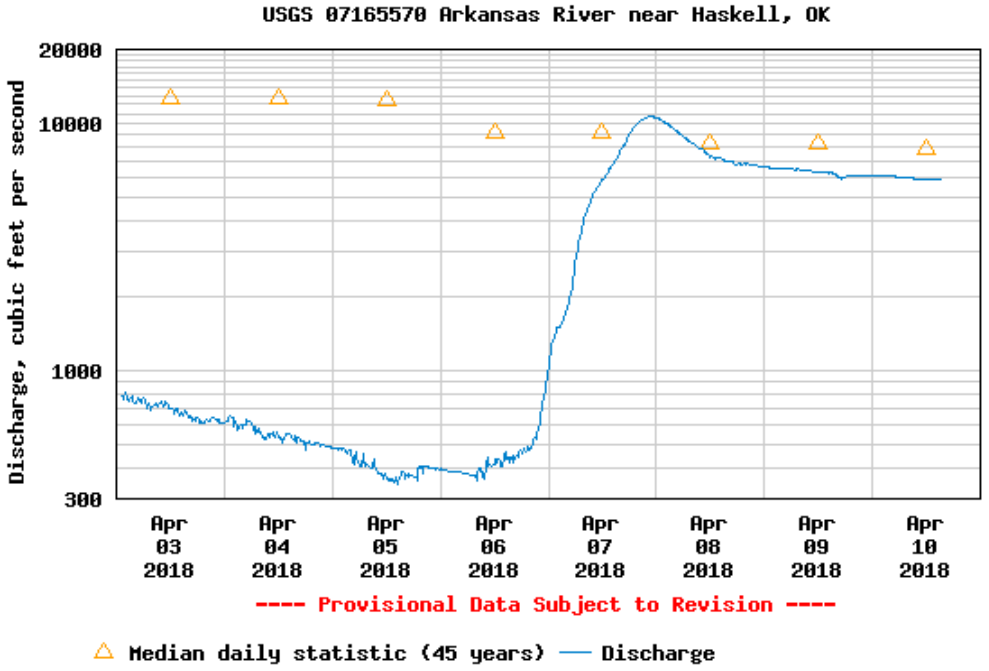
- Numerous in-place remote monitors may be beneficial to your utility
  - Surface Water
  - Groundwater Levels
  - Weather
  - Evapotranspiration

USGS Real Time Streamflows



USGS State Level Views





Available Parameters	Available Period
☐ All 3 Available Parameters for this site	
☑ 00045 Precipitation	2017-12-11 2018-04-02
☑ 00060 Discharge	1987-10-07 2018-04-10
☑ 00065 Gage height	2007-10-01 2018-04-10

Output format
- ◉ Graph
- ○ Graph w/ stats
- ○ Graph w/o stats
- ○ Graph w/ (up to 3) parms
- ○ Table
- ○ Tab-separated

Days (7)

-- or --

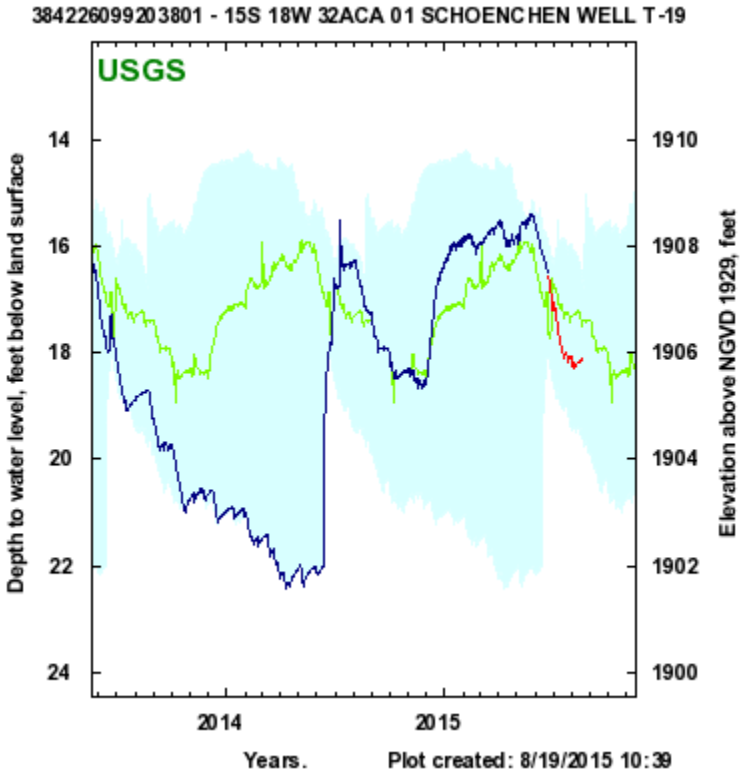
Begin date 2018-04-03

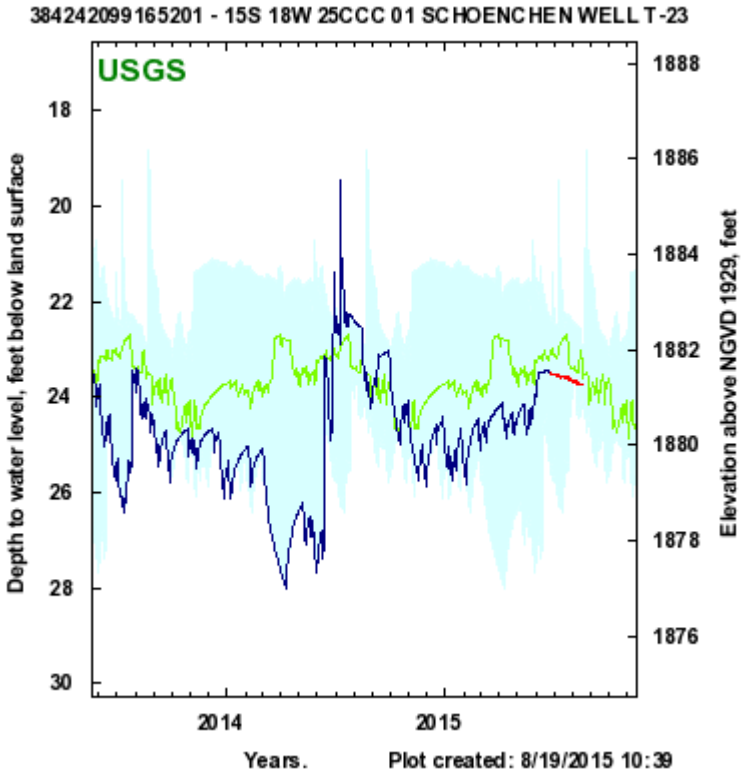
End date 2018-04-10

GO

[Summary of all available data for this site]
[Instantaneous-data availability statement]

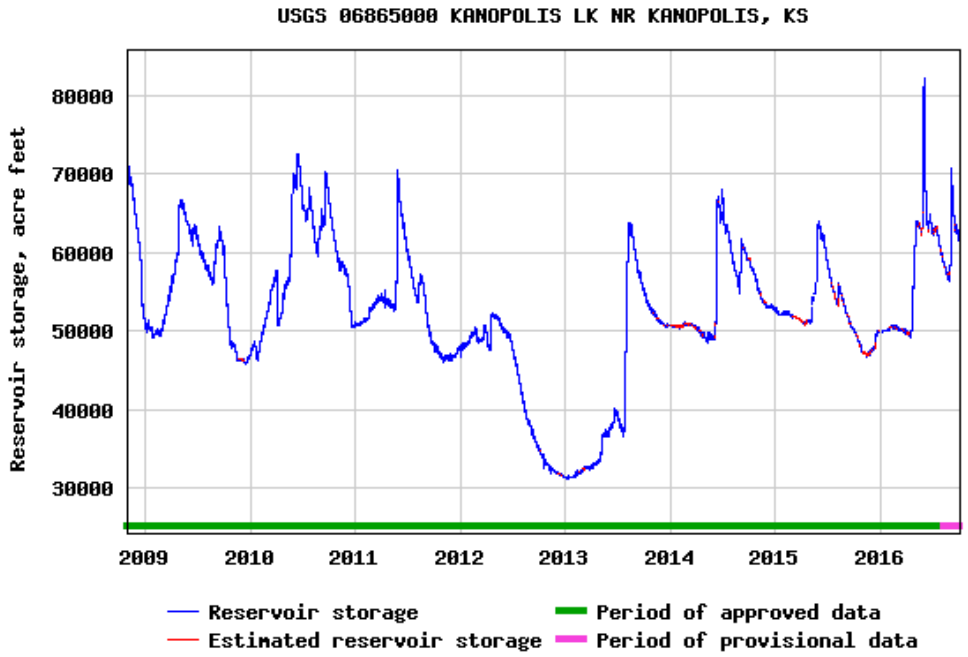
USGS Groundwater Levels





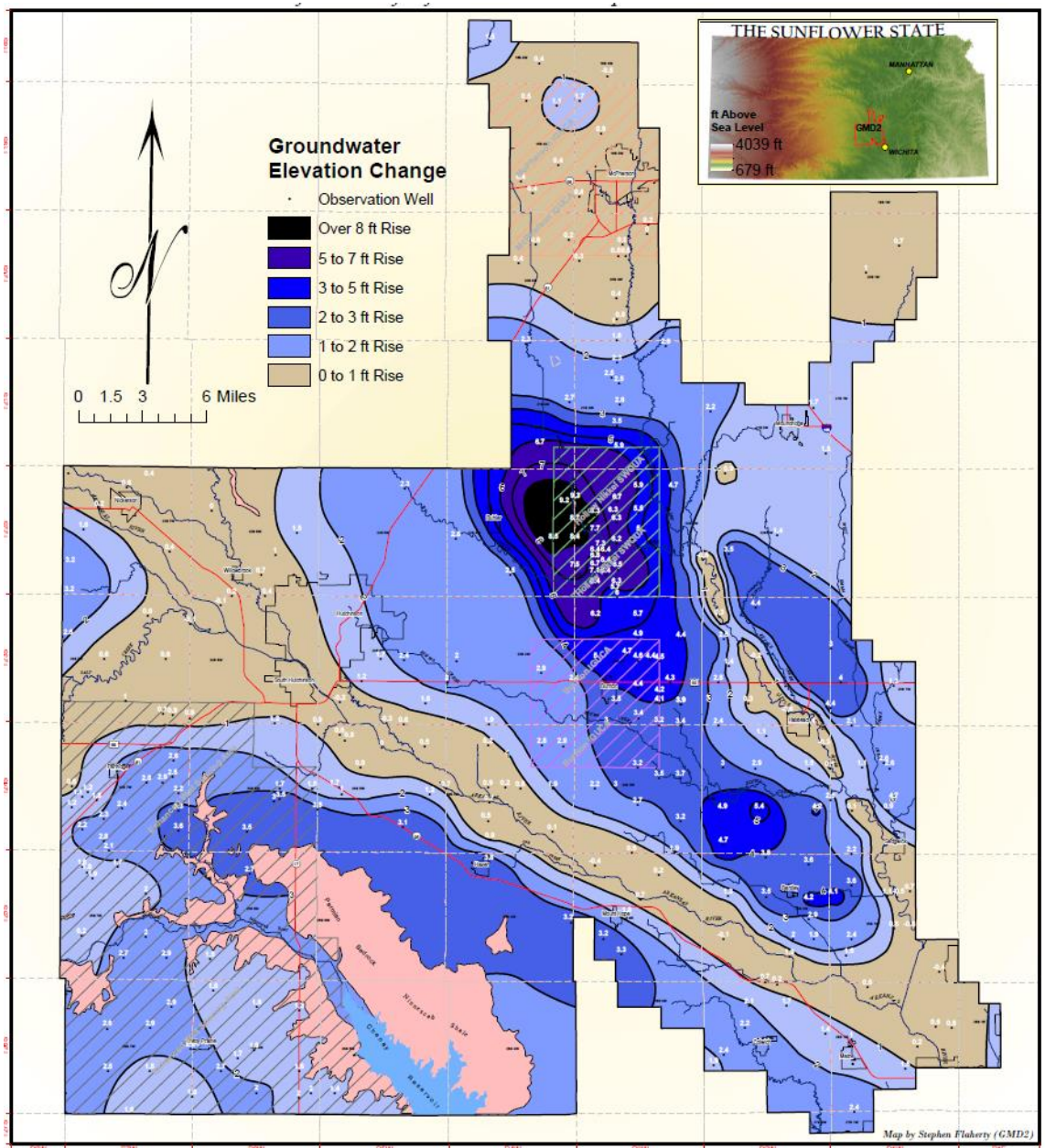
Reservoir Levels

- Data may be hosted on various federal sites
  - i.e. Bureau of Land Management, Army Corps of Engineers, USGS, etc.
- Data may be on state-level or project-level sites
  - i.e., state park, water office, irrigation district, etc.



Local Groundwater Monitoring

- Local & State Districts may monitor groundwater volumes & quality
- Can this be a proxy for your utility?
- Source, Kansas GMD2



Utility Specific Monitoring

- Generally will use SCADA to implement
- Monitors may/may not feed into control system

SCADA Monitoring Capacities

- Electrical
  - Voltage
  - Amperage
- Water flow rates/volumes
- Pressure
- Tank elevations
- Valves on/off

Water Level Monitoring

- Elevated Tanks
- Underground Tanks
- Supply Reservoirs
- Wells
- Treatment Processes
- Local Streams

Water Quality Monitoring

Supplies

- Turbidity
- Temperature
- pH
- Conductivity

Treatment/distribution

- Turbidity
- Chlorine
- pH
- Temperature
- Pressure (proxy for biological contamination)

Security

- New internet connected cameras/sensors greatly expand ability of utilities to remotely monitor security of remote facilities

- Requires:
  - Power supply
  - Internet connection
  - Monitors for employees

Niche & Emerging Technologies

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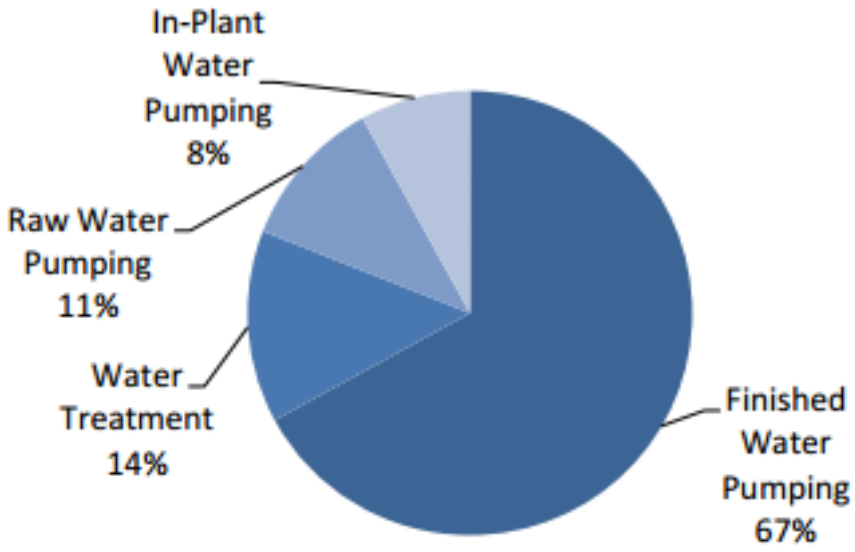
Storage Tanks as Batteries

How often do your pumps turn on?

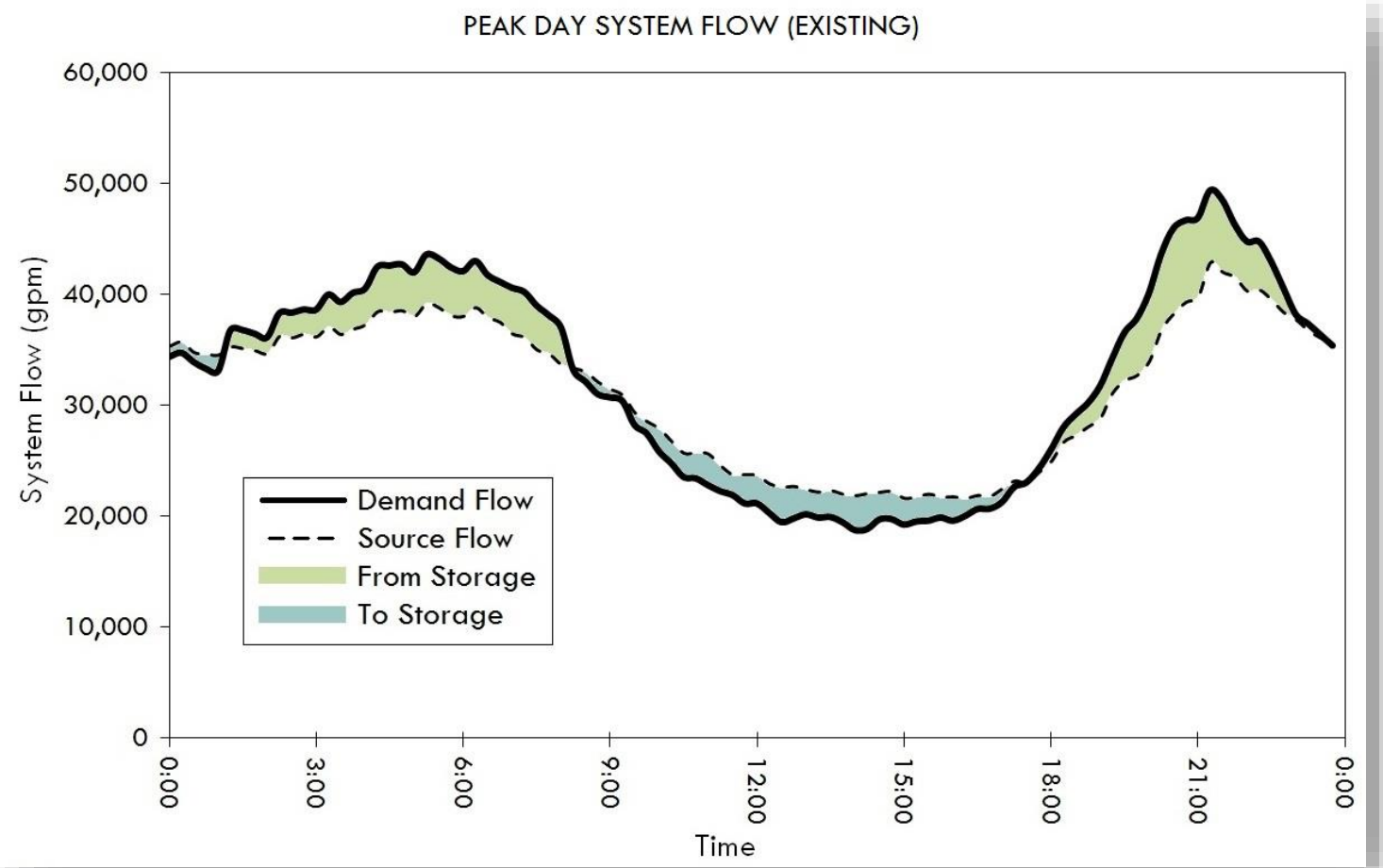
- Pumping uses a lot of energy
- Energy costs are typically a significant part of a utility's budget
- Frequent start/stop adds wear and tear to the pump – and pipes
- How do you meet peak demand?

Typical Energy End-Uses in Public Surface Water Systems

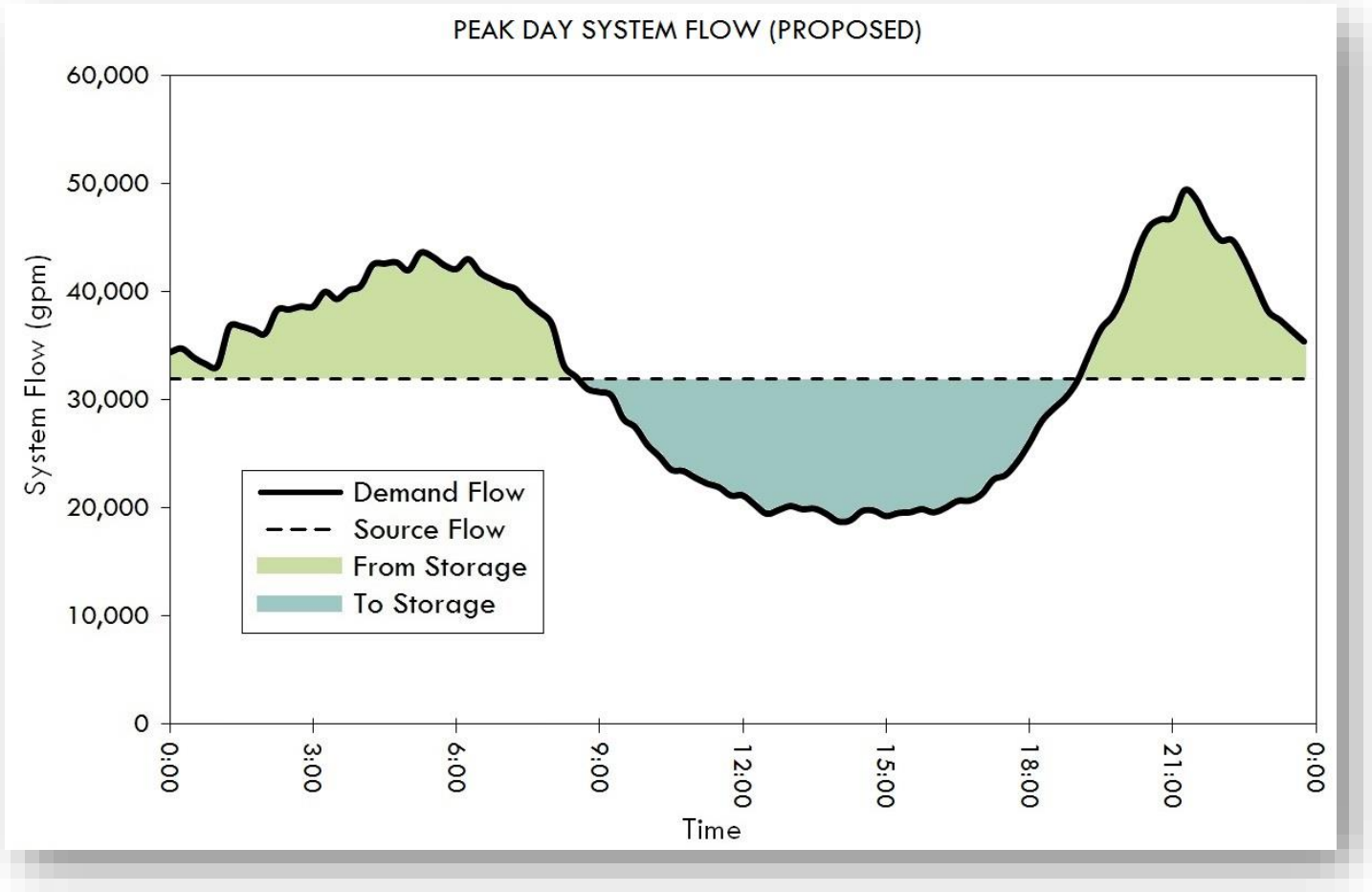


Source: Keith Carns, EPRI Solutions, "Bringing Energy Efficiency to the Water & Wastewater Industry: How Do We Get There?," presented at *WEFTEC 2005*, Washington DC, November 2, 2005.

Loading Problem

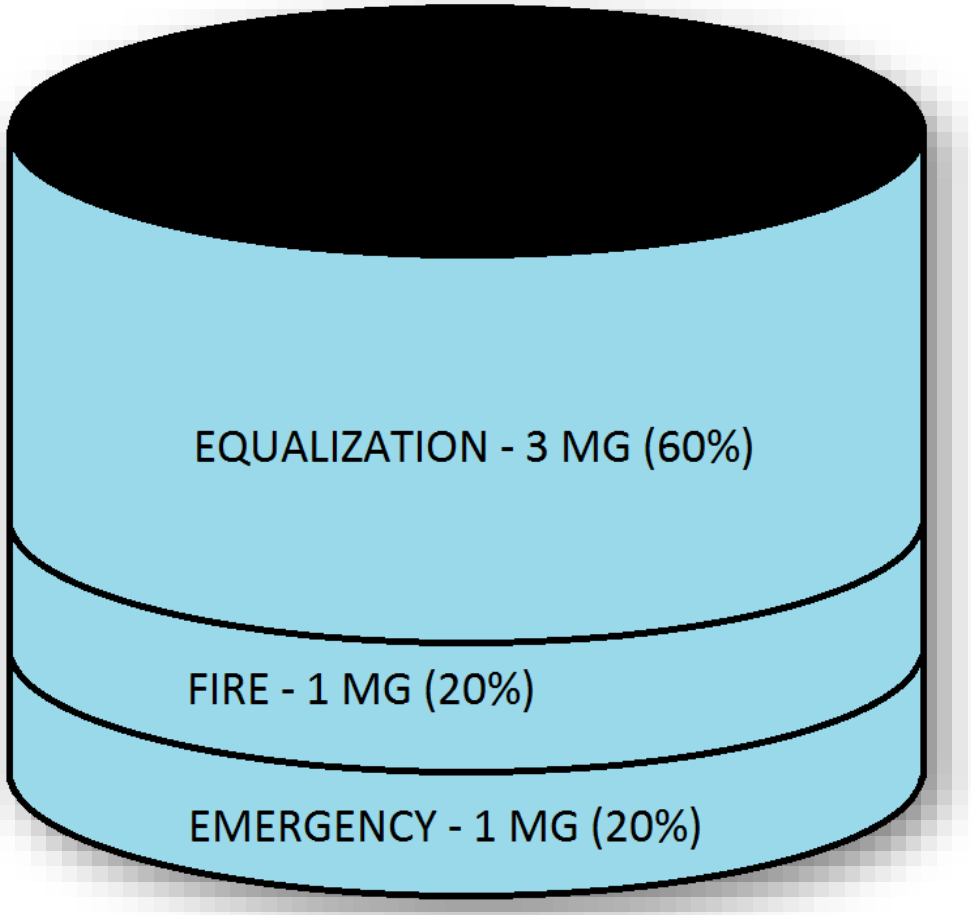


Loading Solution

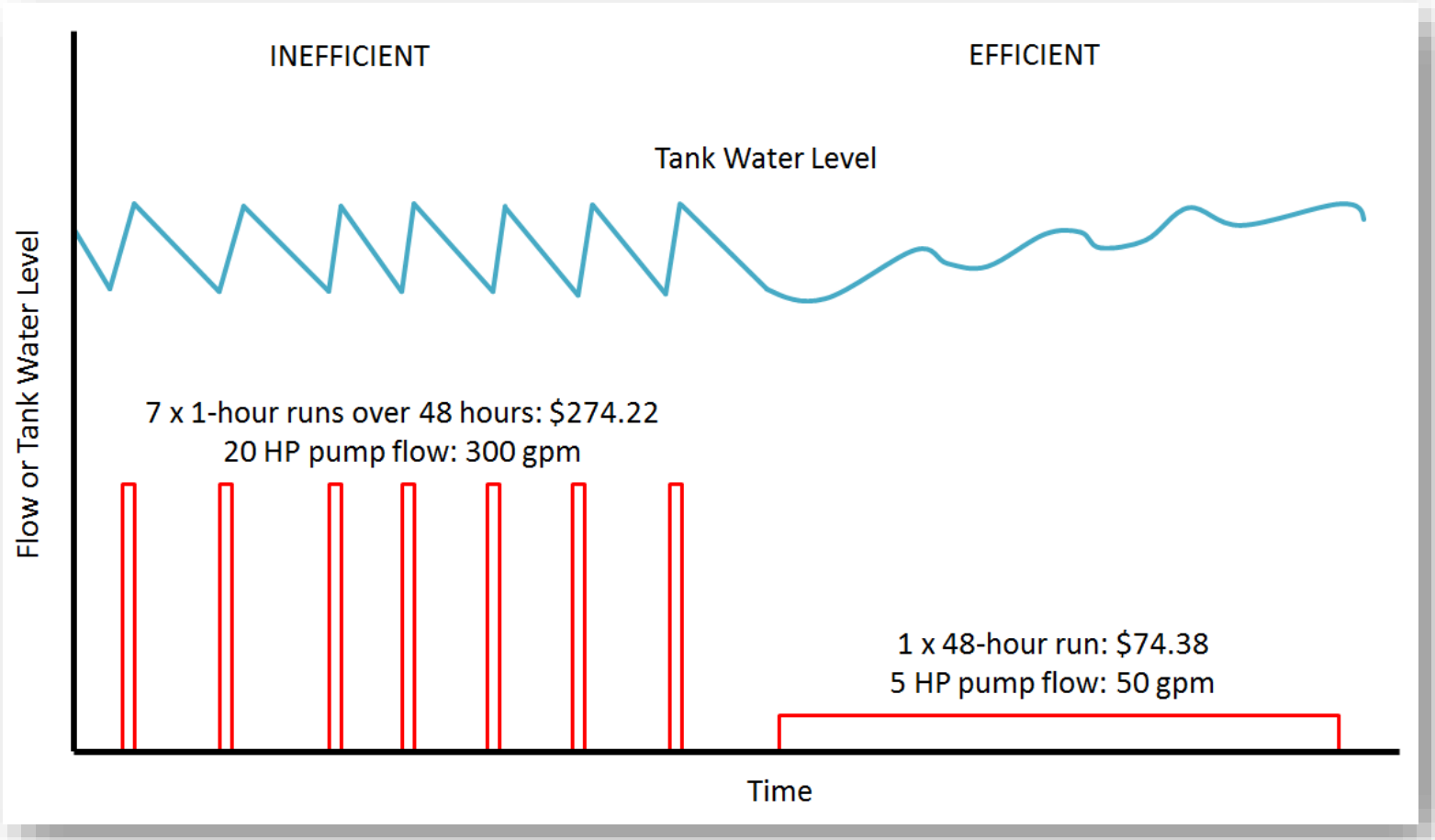


U.S. DEPARTMENT OF ENERGY

Loading Solution



Loading Example



Loading Diagnosis

How to detect:

- Intermittent pump operation
- Oversized facilities
- Little storage fluctuation
- Hydraulic modeling

How to resolve:

- Use storage
- Keep source and pump flow as constant as possible
- Modify pump station

Niche & Emerging Technologies

Leaks and Leak Detection Technologies

Lost Water = Lost $ | How much are you losing?

- Water Produced – Water Sold = THIS IS NOT CORRECT
- Water Produced – Water Sold = Non-Revenue Water
- Non Revenue Water Includes anything we don't sell
  - Water we give away
  - Theft
  - Errors (meters and/or data)
  - Real Losses
- Real Water Loss = Leaking Water (mains, service lines and tanks)

Determine the causes of Non-Revenue Water First

- AWWA's Water Audit Software
  - Industry Standard (M36)
  - Free
  - Excel based
  - http://awwa.org/waterlosscontrol

American Water Works Association

If Real Losses (Leaks) are a problem

Issue you are addressing	Tools to use	Cost Range
Real Losses	Collecting & Analyzing Break Data	Low
Real Losses	Improve speed/quality of repairs	Low
Real Losses	Locate & eliminate pressure transients (surges, water hammer)	Low-Mid
Real Losses	Night Flow Analysis	Mid
Real Losses	Reduce peak and overall pressure	Mid-High
Real Losses: Leakage on Mains	Main Replacement	High
Real Losses: Leakage on Services	Service Replacement	Mid - High
Real Losses: Unreported Leaks	Acoustic leak survey	Mid
Real Losses: Overflows and Leakage on Storage Tanks	Tank Management, Data Collection, & Inspection	Low

Leak Detection Technologies

- Active Listening
  - Sonic ground listening devices
  - Correlators
  - Probes
  - Walking main lines and listening at valves
- Passive Listening
  - Permanent and semi-permanent listening devices
  - Transmits data to central location
  - Analyzes night flows
- Other detection technologies
  - Tracer Gas Leak Detection
  - Sahara, Smartball, internal devices

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Drone Use

Drone Use

- Wide range of possibilities: inspection, maintenance, testing
- Same locations and angles every visit for fair before and after comparisons
- Safer and faster than in-person
- More frequent visual inspection can be completed for less money
- Can be equipped with sensors (ultrasound, thermal imaging)
- Eliminates concerns of getting to remote areas in times of snow or wet weather

Source: ReliabilityWeb.com

Niche & Emerging Technologies

Energy Based Condition Monitoring

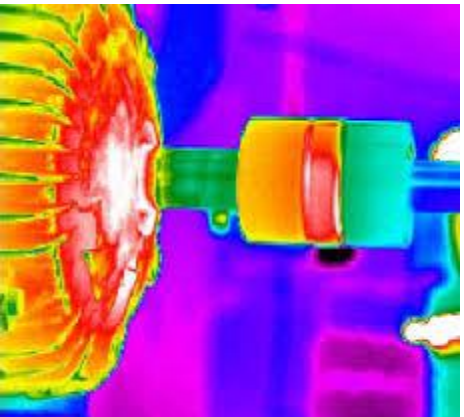
Condition Monitoring

- Condition monitoring can decrease your motor operations and maintenance (O&M) expenses by up to 25 percent
- The use of energy monitoring is increasing
- Energy based condition monitoring
  - affordable method for providing continuous, remote monitoring
  - can detect motor damaging electrical stressors, so you have a chance to intervene and correct the issue before it harms your asset.

Source: ReliabilityWeb.com

Condition Monitoring

- Thermography
  - Thermal cameras produce thermal (heat) pictures of equipment which can indicate if the equipment may soon fail
  - For preventive maintenance, thermal images taken over time are compared and changes can indicate problems to investigate before they cause failure.
  - Technology is becoming more affordable – cell phone cameras are available

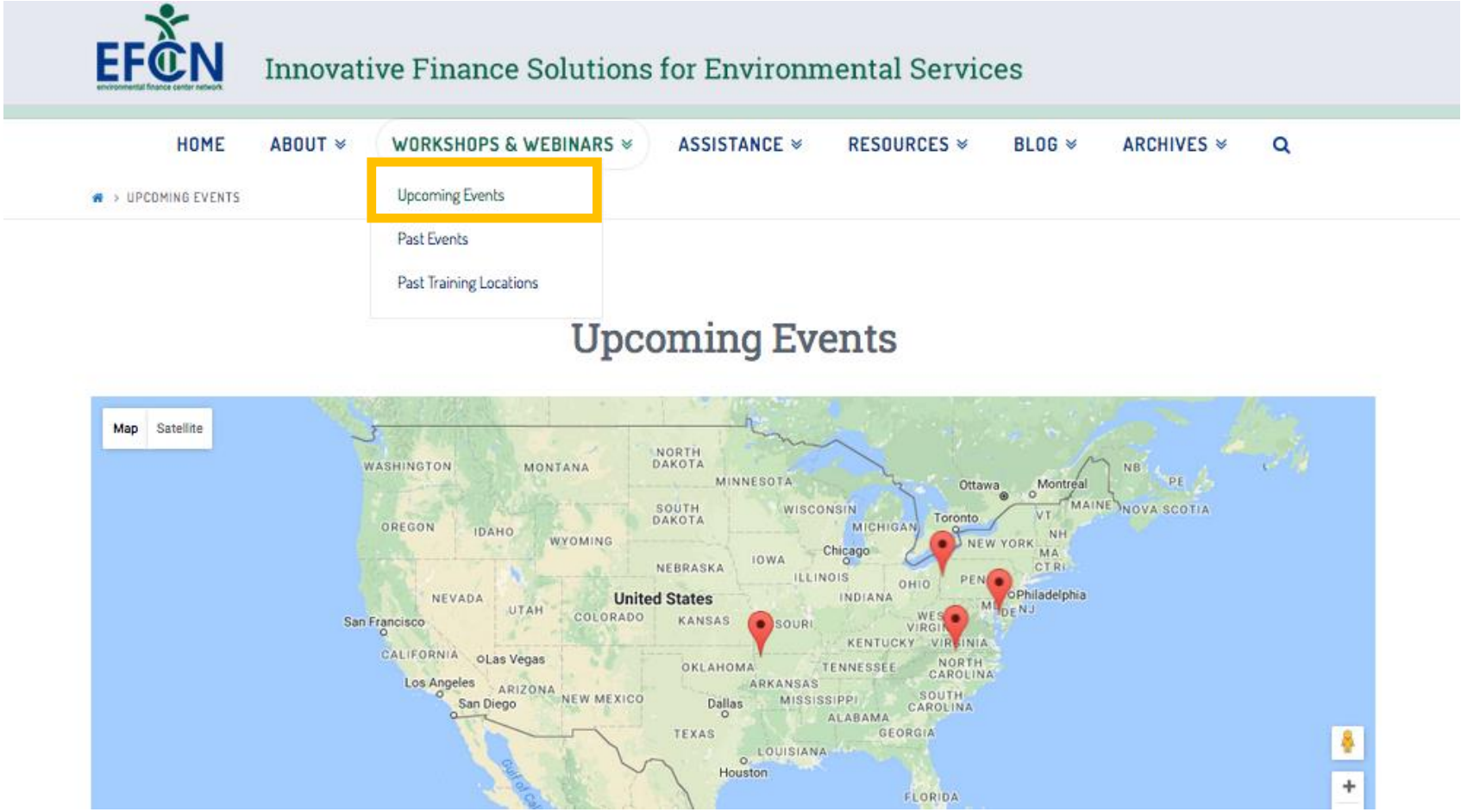


Visit the EFCN Website – *www.efcnetwork.org*

for more information on upcoming events, funding, and resources.

Upcoming Events Calendar

Select “Upcoming Events” under the Workshops & Webinars Tab.

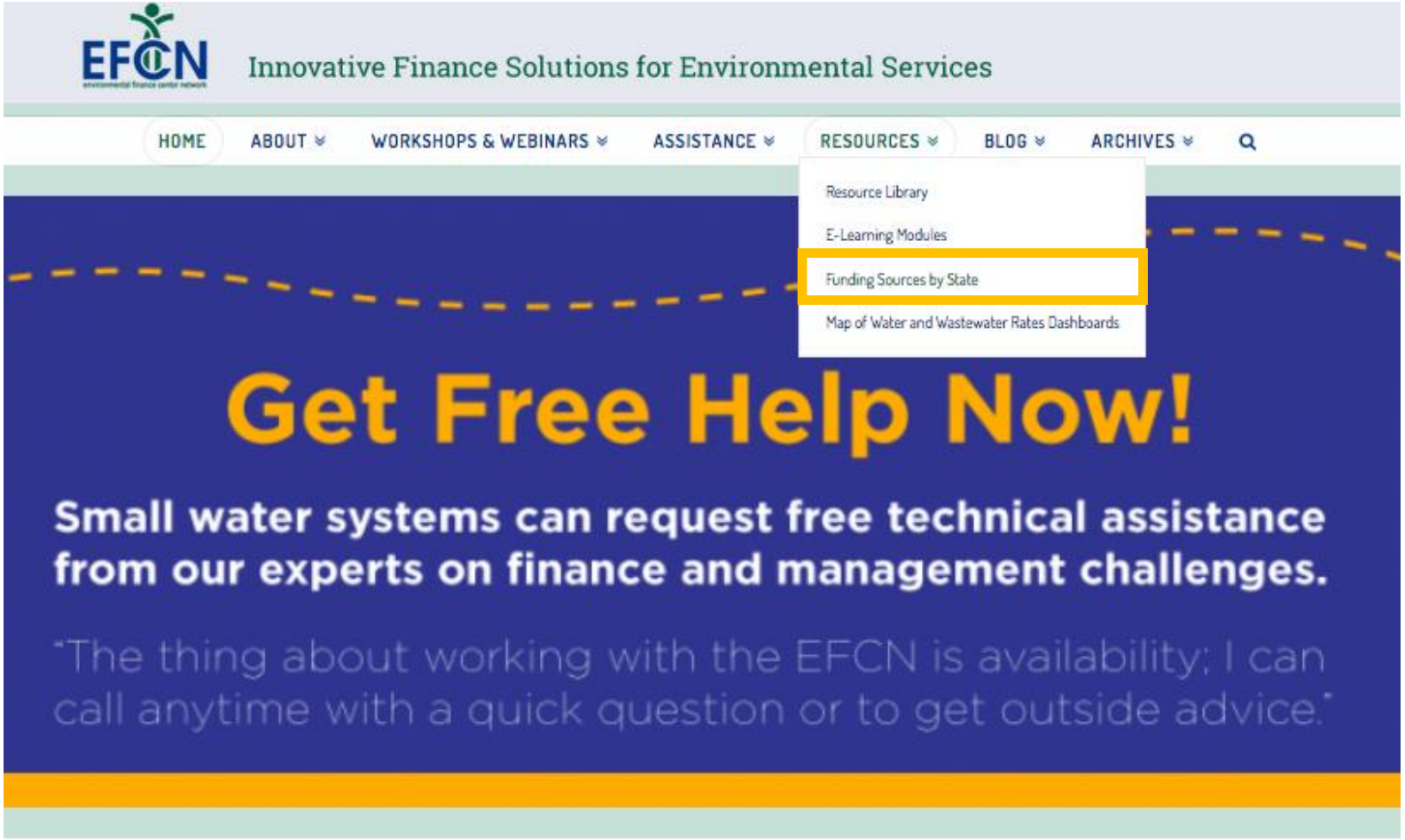


= In Person Event = Webinar

Type	Date/Time	Event
	03/09/2017 2:00 pm - 3:00 pm	WEBINAR I Preparing Winning Financing Applications for Water Infrastructure Projects
	03/22/2017 2:00 pm - 3:00 pm	WEBINAR I Water Audits and Water Loss Control: Entering Your Data into the Spreadsheet
	03/30/2017 9:00 am - 4:30 pm	Maryland I Rates and Finance Workshop for Small Water Systems *Easton Utilities, Easton MD*
	04/04/2017 1:00 pm - 2:00 pm	WEBINAR: Workforce Development: An Overview of Key Components
	05/11/2017 9:00 am - 4:30 pm	Virginia I Rates and Finance Workshop for Small Systems *The Institute for Advanced Learning and Research, Danville Virginia*
	05/25/2017 9:00 am - 4:30 pm	Arkansas I Rates and Finance Workshop for Small Water Systems *Beaver Water District, Lowell AR*
	09/13/2017 9:00 am - 4:30 pm	Pennsylvania I Rates and Finance Workshop for Small Water Systems *Pennsylvania American Water Co, New Castle PA*

Funding Tables By State

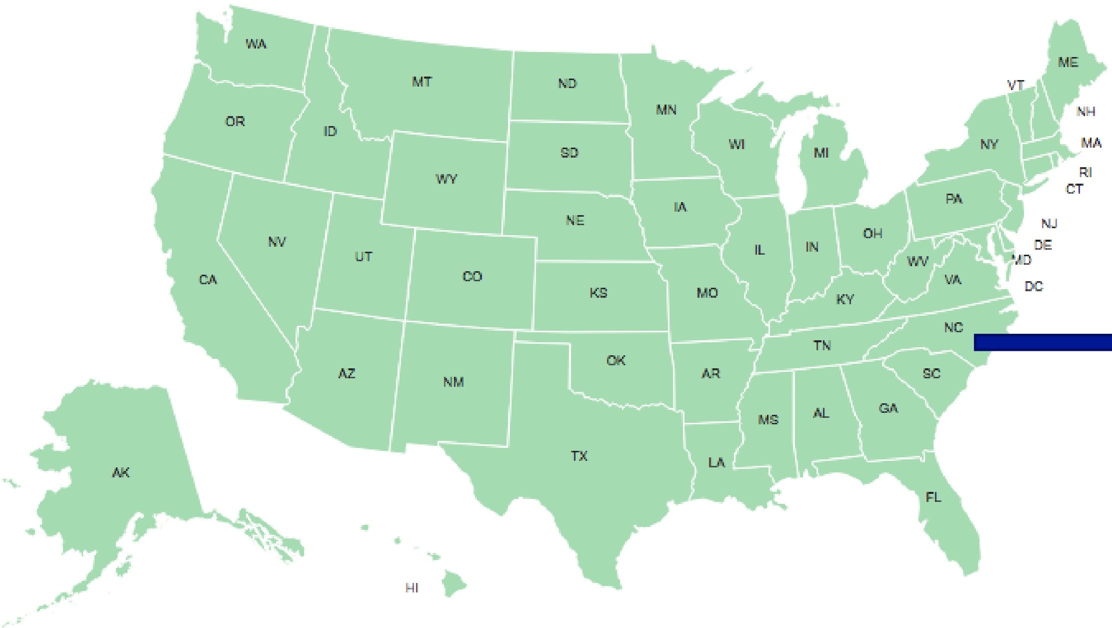
Select “Funding Sources by State” under the Resources Tab.



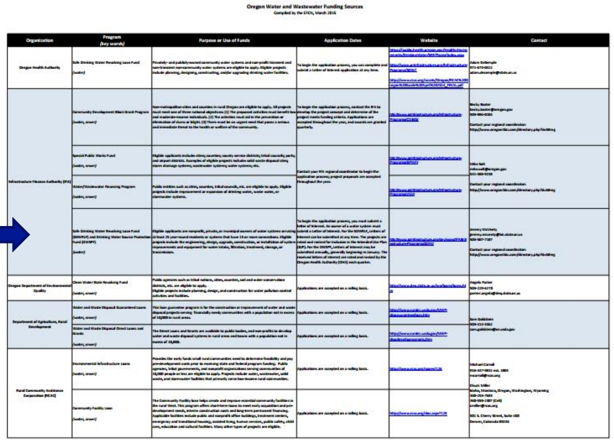
Funding Sources by State

Note: Some states may have additional resources listed below the map.

Click on the map below to view funding sources for each state:



Click on an individual state to view funding table.

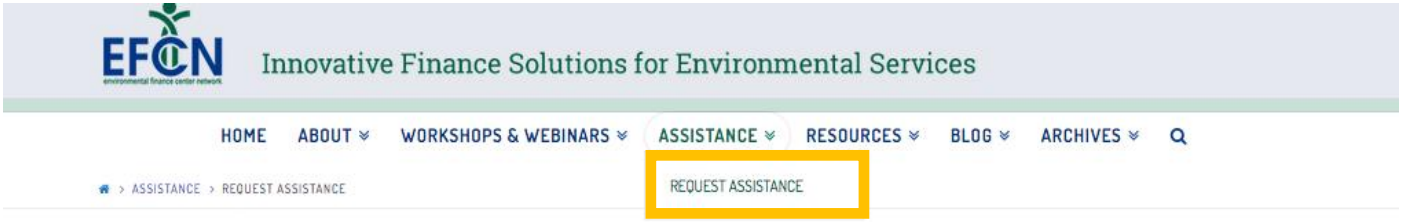


Oregon Water and Wastewater Funding Sources
Compiled by the EFCN, March 2015

Organization	Program (key words)	Purpose or Use of Funds	Application Dates	Website	Contact

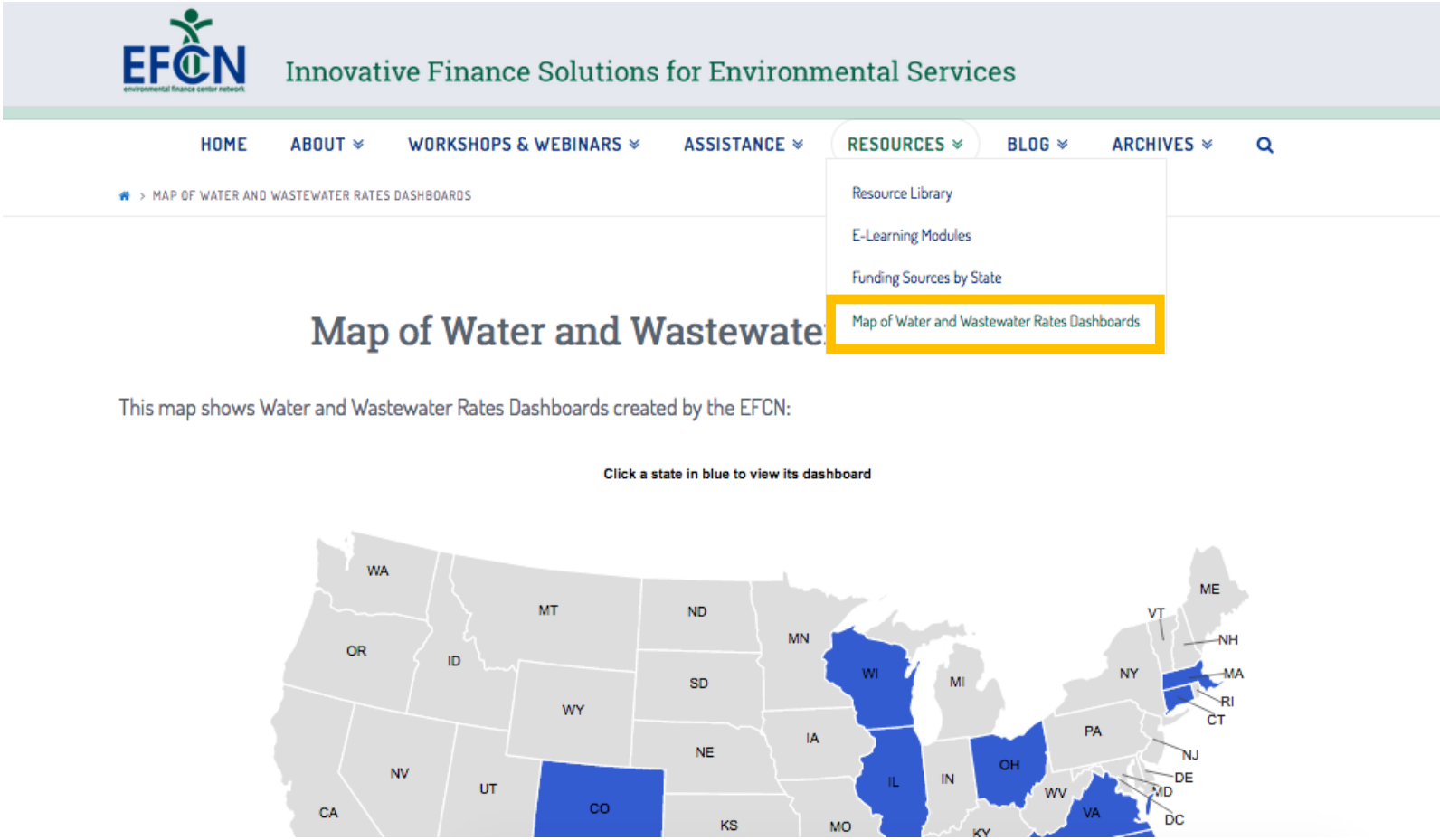
Request Technical Assistance

Select “Request Assistance” under the Assistance Tab off the EFCN homepage to access and submit the TA request form electronically.



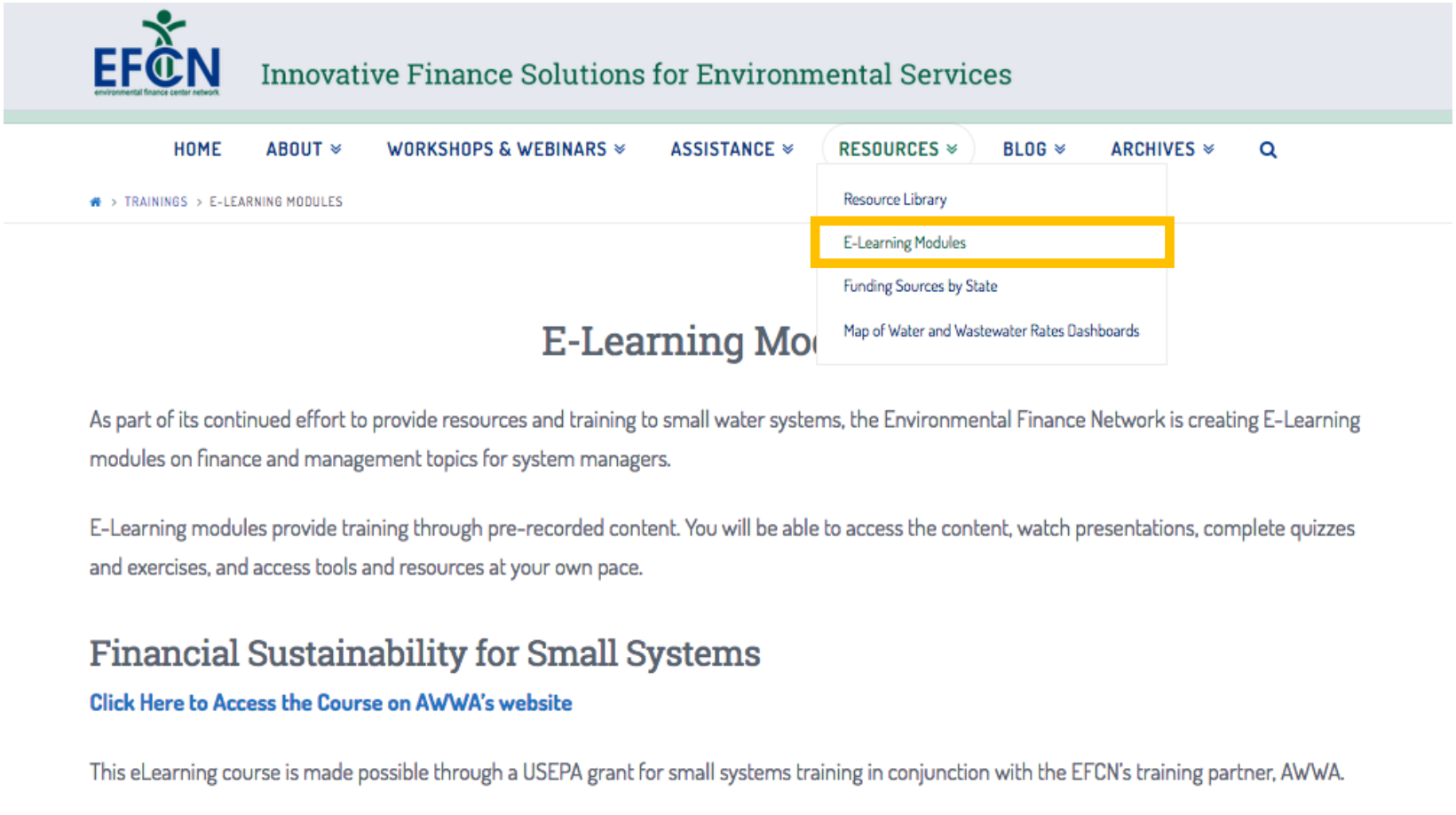
Rates Dashboards

Select “Map of Water and Wastewater Rates Dashboards” under the Resources Tab, and click on any state in blue to view its dashboard.



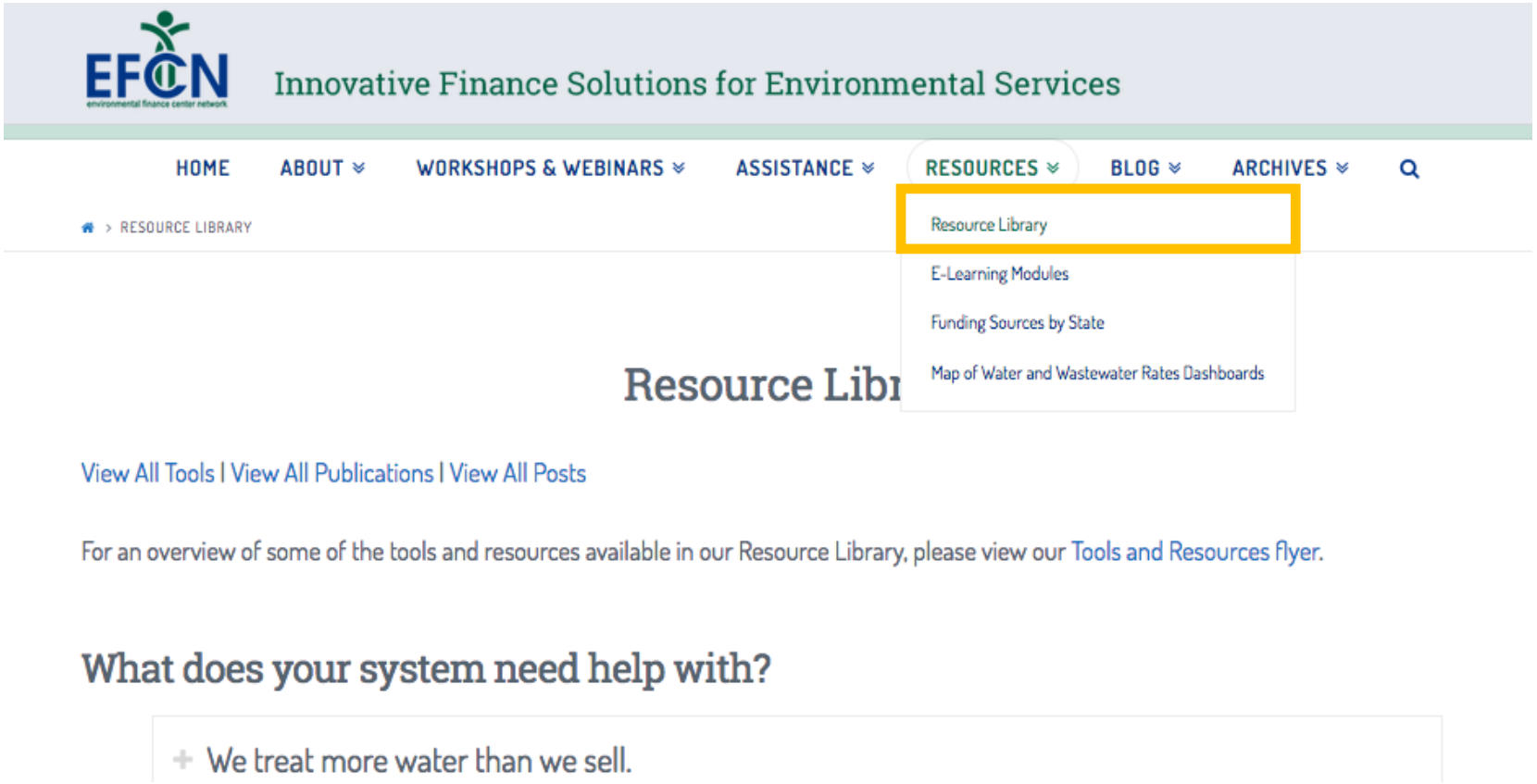
E-Learning Modules

Select “E-Learning Modules” under the Resources Tab off the EFCN homepage.



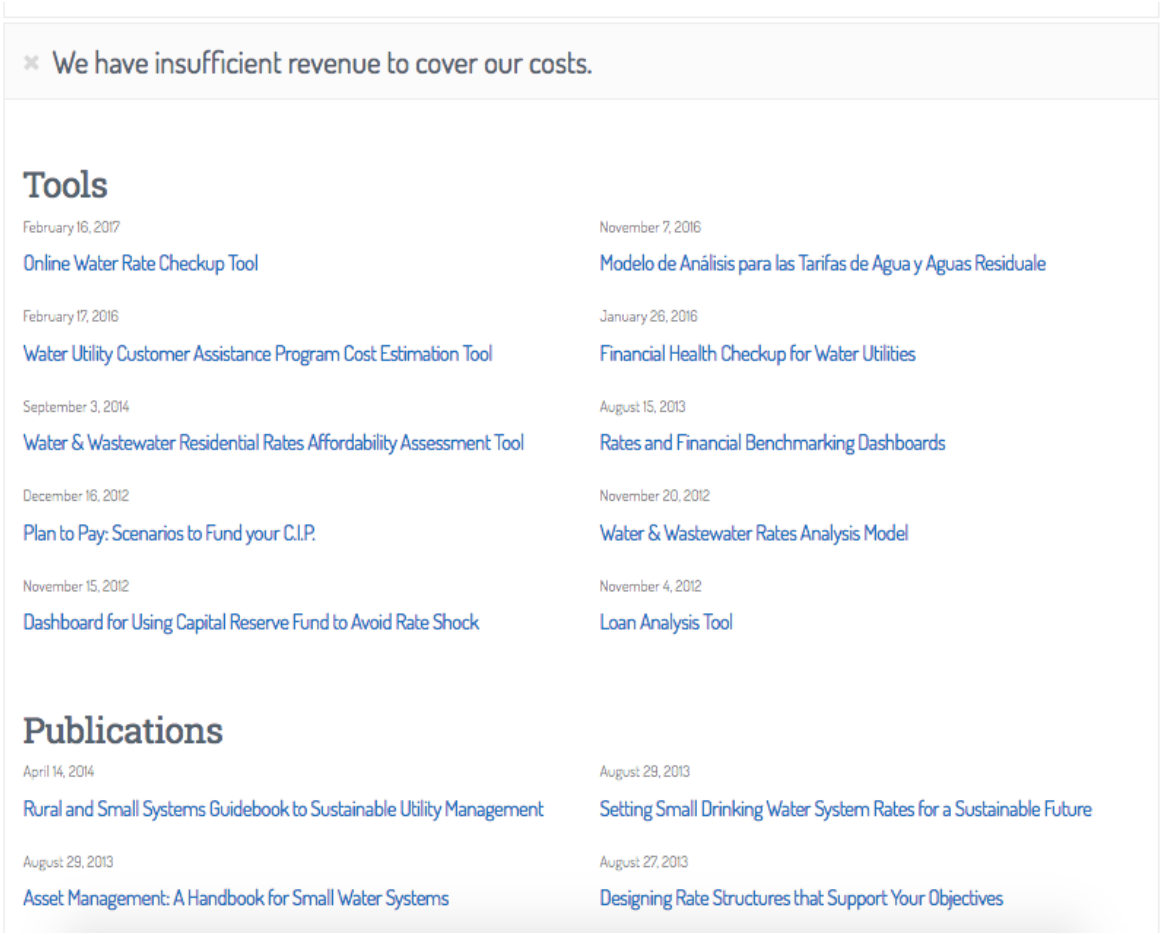
Resource Library

Select “Resource Library” under the Resources Tab off the EFCN homepage.



Resource Library Continued…

Click on a what your system needs help with to reveal tools and publications related to that topic.



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Smart Management for Small Water Systems

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Thank you for participating today.
We hope to see you at a future workshop!

www.efcnetwork.org

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