

TROUBLESHOOTING AN OWTS USING PUMP OPERATIONAL DATA

PRESENTED BY

BRUCE LESIKAR, PH.D., P.E.

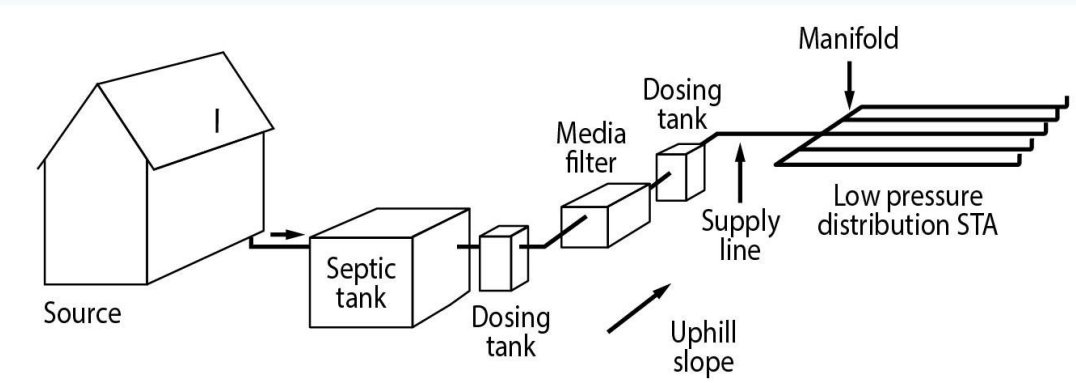
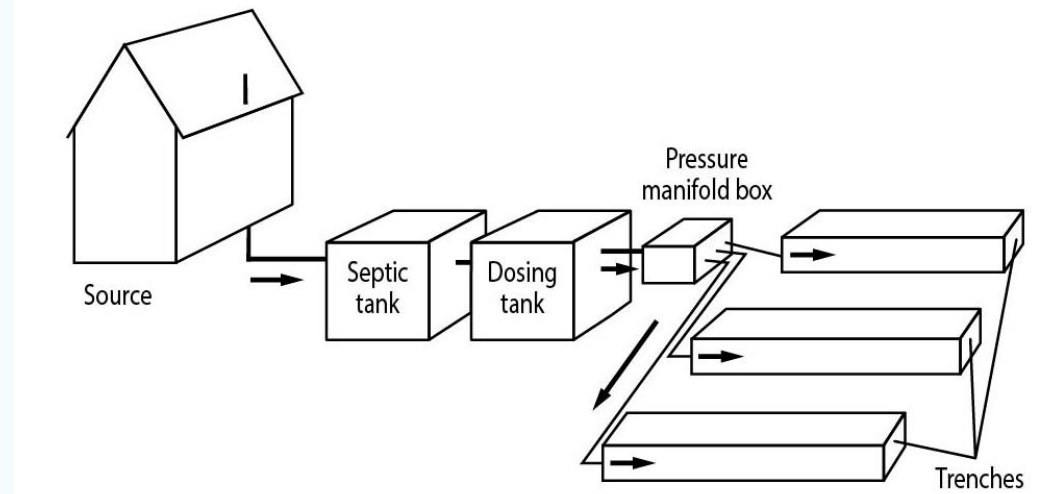
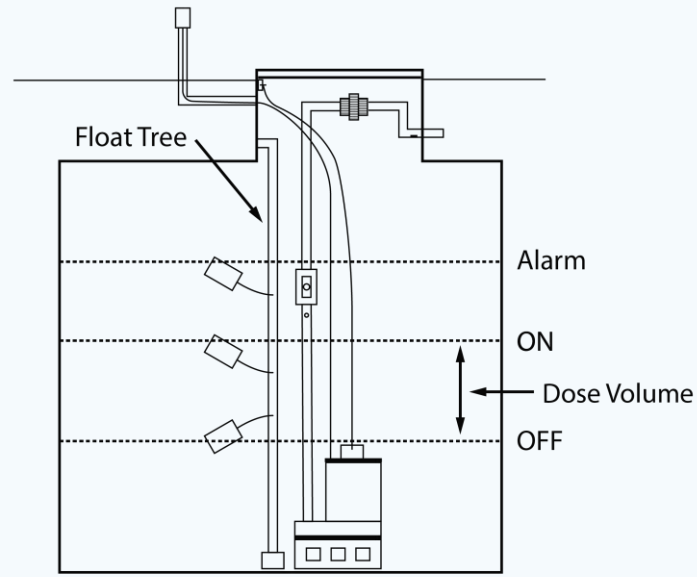
**THE MATERIALS PRESENTED ARE THE OPINIONS OF
THE AUTHOR AND NOT AN OFFICIAL
REPRESENTATION OF NOWRA OR RCAP**

Overview

- Causes for changes in pump run time per cycle in a demand dosing system.
- Causes for changes in the number of pump cycles per day in a time dosing system
- Maintenance activities to correct changes in pump operation
- Reactive vs. proactive maintenance

Typical dosing system

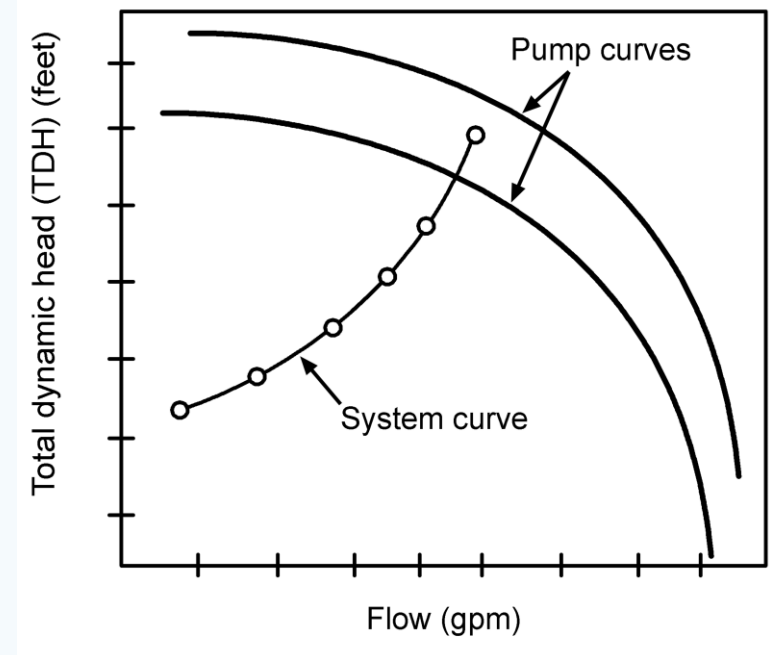
- Dosing tank
- Pump
- Discharge assembly
- Controls
- Wiring



Performance and system curves

Pumps operate on a *pump performance curve*

- Relationship between flow (gpm) and total dynamic head (TDH in feet)
- Impeller design defines the relationship
- Pressure increases result in flow decrease



Performance and system curves

Systems operate on a ***system curve*** that reflects:

- Static head: elevation plus operating pressure
- Dynamic head: friction loss through piping at various flow rates
- Total head: Static head plus dynamic head

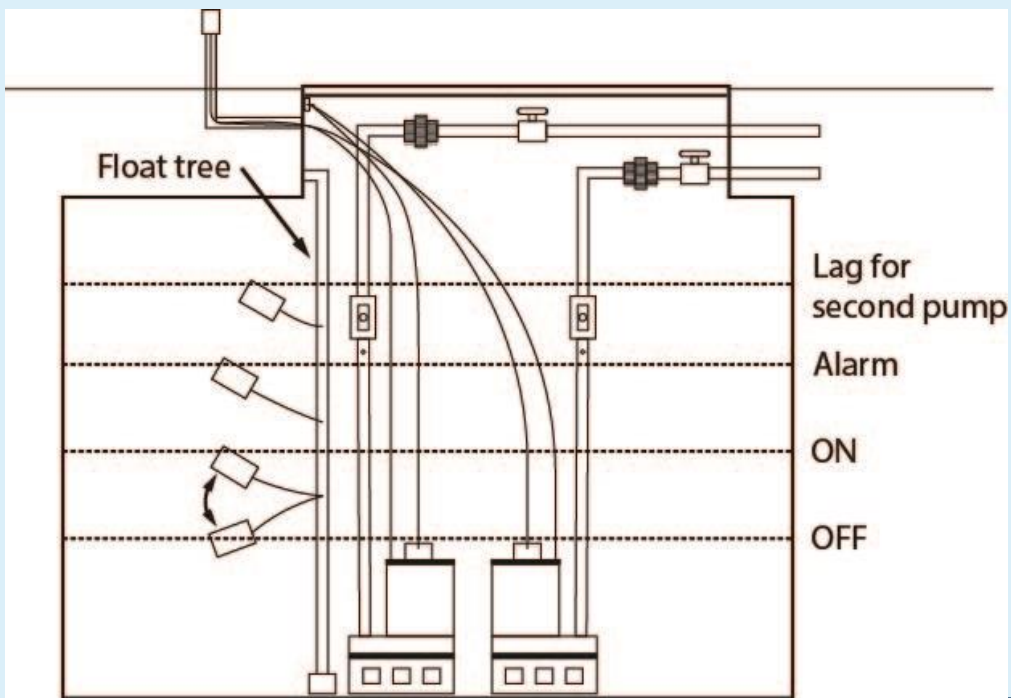
Troubleshooting using operational data

- Operational assumptions
 - Demand systems – Average daily flow less than 70% of design
- Potential causes for changing values
 - Source, pump and/or system
- What is the typical reason for changing values – need for MAINTENANCE

- Controlled by usage at source
- Dosing occurs when usage occurs
- Dose volume remains relatively constant
- No limitations on dosing events or pump run time
- Flow restrictions = longer pump run time

What is demand dosing?



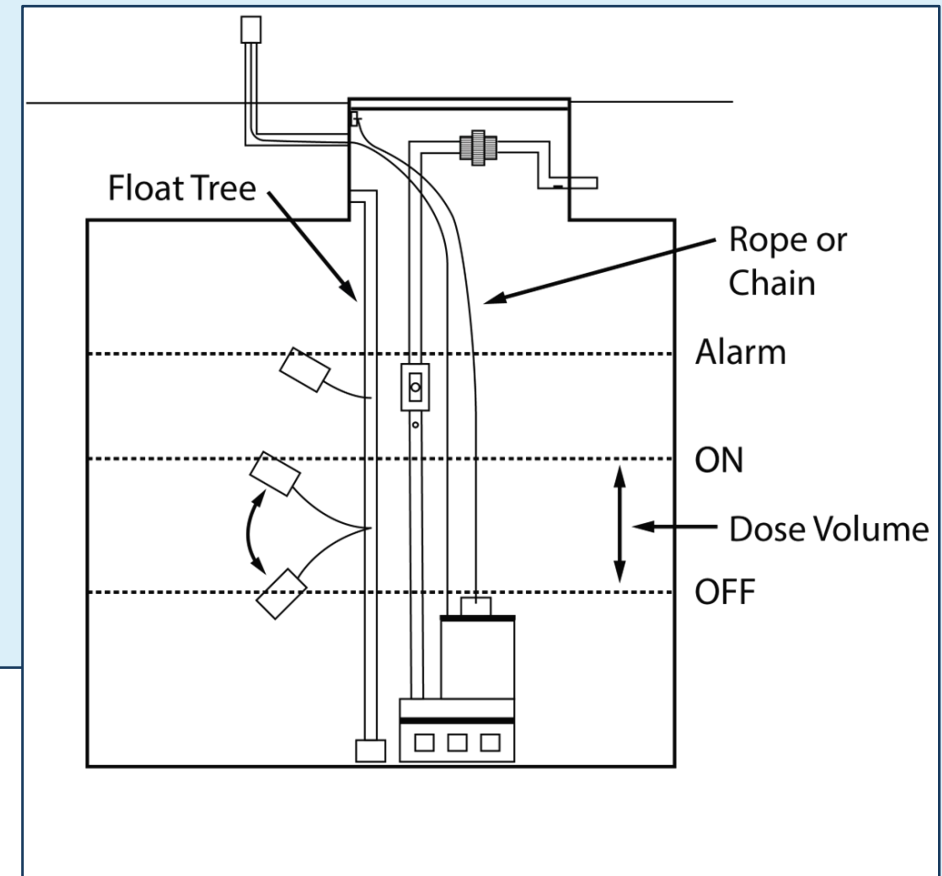
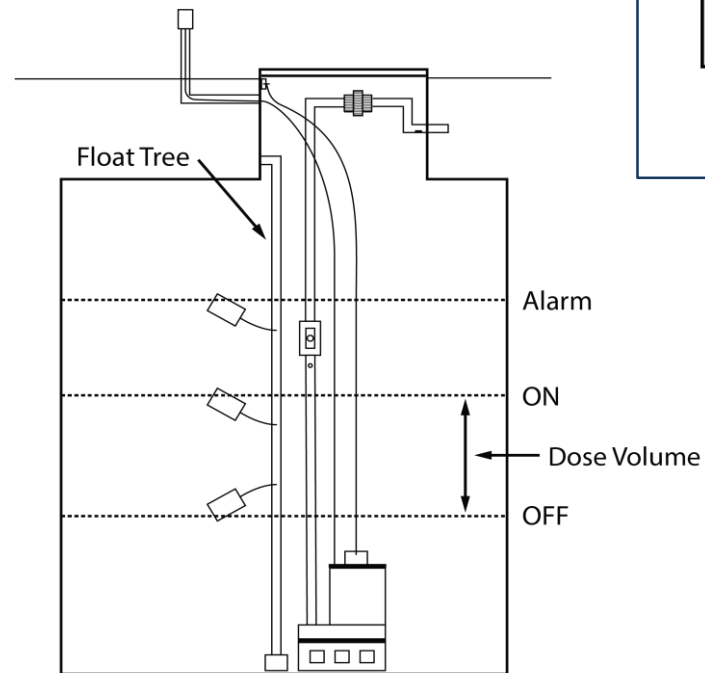


Duplex pumps

- Alternating pump operation
- Lag pump above alarm
- Alarm latches and remains activated until silenced

Simplex pump – three float system

- Pump 'on' float
- Pump 'off' float
- Shorter tether lengths, potential for greater dose volume
- Alarm float switch



Simplex pump-two float system

- Differential float switch
- Dose volume controlled by tether length
- Alarm float switch

Demand dosing: Check performance (relative to design values)

Using Cycle Counter (CC) data

- Number of days between readings (while in operation)
- Design daily dose frequency
- Elapsed number of cycles (Total number of cycles [NC])

$$\text{Days} \times \text{Dose frequency} = \text{Max cycles}$$

- Compare max cycles to actual NC

Demand dosing: Check performance (relative to design values , cont.)

- Cycle Counter reading:

Current visit: 45,289 cycles

Last visit: 44,891 cycles

$45,289 \text{ cycles} - 44,891 \text{ cycles} = 398 \text{ cycles}$

Total times the system turned on/off since last visit.

Demand dosing: Check performance (relative to design values , cont.)

Number of cycles (NC) ÷ Days = Cycles per day (CPD)

$$398 \text{ cycles} \div 365 \text{ days} \approx 1 \text{ CPD}$$

If only 100 days between readings:

$$398 \div 100 = 4 \text{ CPD}$$

At another site:

$$3,905 \text{ cycles} \div 365 \text{ days} = 10.6 \text{ CPD}$$

What if the design value was 4-5 cycles per day?

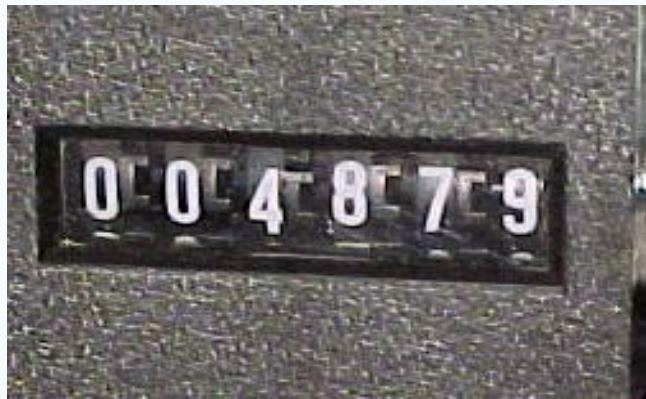
Demand dosing: Check performance (relative to operational values)

Cycles per day:

Number of cycles / elapsed days = cycles/day

Run time per cycle:

Elapsed time (min) / #of cycles = runtime (min) /cycle



Demand dosing: Check performance (relative to operational values, cont.)

- What does the runtime per cycle represent?
 - How long the pump must run to distribute the dose volume.
- Why is this value important?
 - Increasing value indicates maintenance needed –
 - Clogged distribution system
 - “Oil light is flashing on the dashboard.”

Demand dosing: Increasing number of cycles per day

- Excessive water usage by source
- Leaking fixtures & open faucets in facility
- Drain back from a flooded soil treatment area (STA)
- Ground or surface water infiltration to tanks
- Broken risers, piping, tanks, leaking seams
- Decreased tether length of pump float switch

Demand dosing: Decreasing number of cycles per day

- Decreased water usage by source
- Dry time of year – less infiltration
- Maintenance performed to repair leaking risers, piping or tank
- Increased tether length of float switch
- Root intrusion into treatment tanks removing water from system.

Demand dosing: Decreasing number of cycles per day, cont.

- System - potential causes
 - Exfiltration – lower volume to be pumped so fewer cycles
 - Decreased recirculation flow to dosing tank
 - Float switch malfunction in 'on' position – continuous pump operation

Demand dosing: Increasing run time per cycle

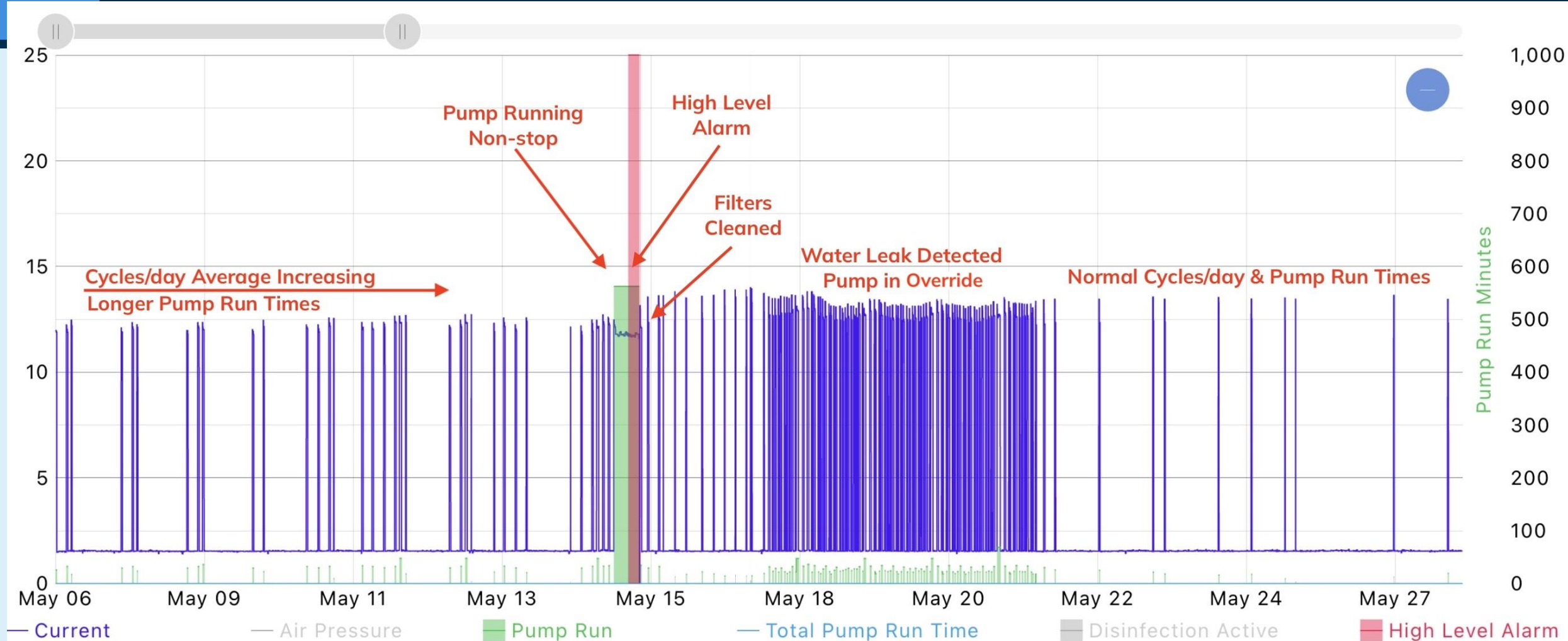
- Potential cause: System issues
 - Plugging orifices/emitters
 - Plugged filtration – screen or disk
 - Plugged component, internal screen (meter)
 - Increased friction loss in the piping



Demand dosing: Increasing run time per cycle, cont.

- Potential cause: System issues (cont.)
 - Crushed piping
 - Inline valve: changed position to more closed
 - Increased recirculation flow to dosing tank
 - Float malfunction float - fail in 'on' mode, continuous power

Plugged filtration & water leak - example



Demand dosing: Decreasing run time per cycle

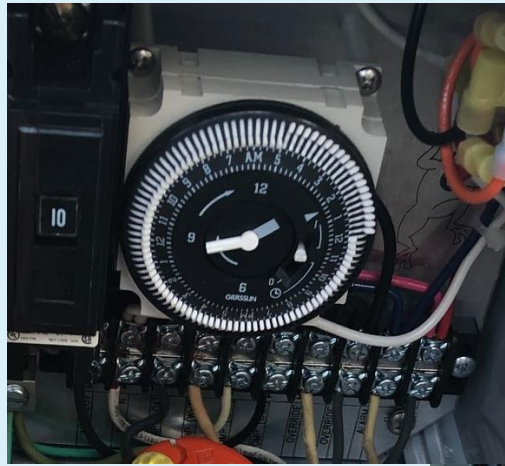
- Potential cause: System issues
 - Broken piping
 - Opened inline valves
 - Closed recirculation valves
 - System maintenance performed

Demand dosing: Decreasing run time per cycle, cont.

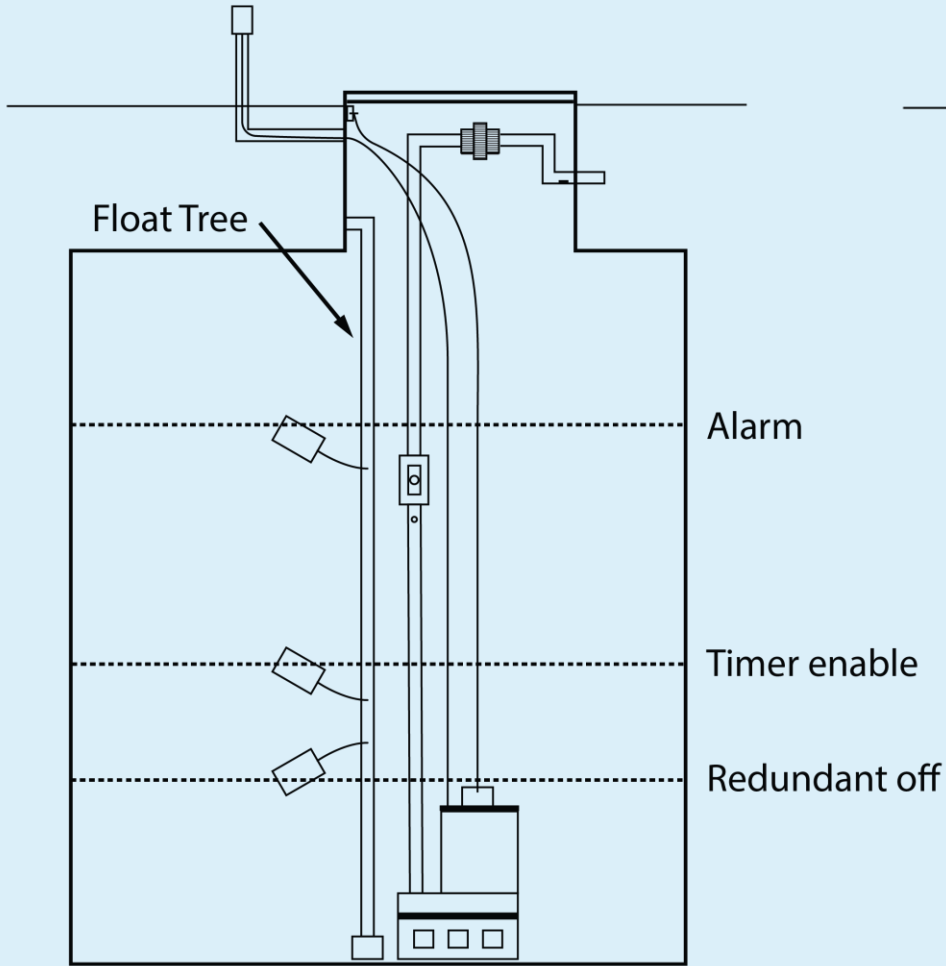
- Potential cause: Pump issues
 - New pump
 - Higher pump delivery rate
 - Pump maintenance performed to remove debris restricting flow

What is time dosing?

- Flow controlled by a timer
- Uses 24 hours of day, timer starts in "OFF" mode
- Pump run time limited by "ON" setting
- Pump dosing events limited by "OFF" setting
- Flow restrictions = more cycles

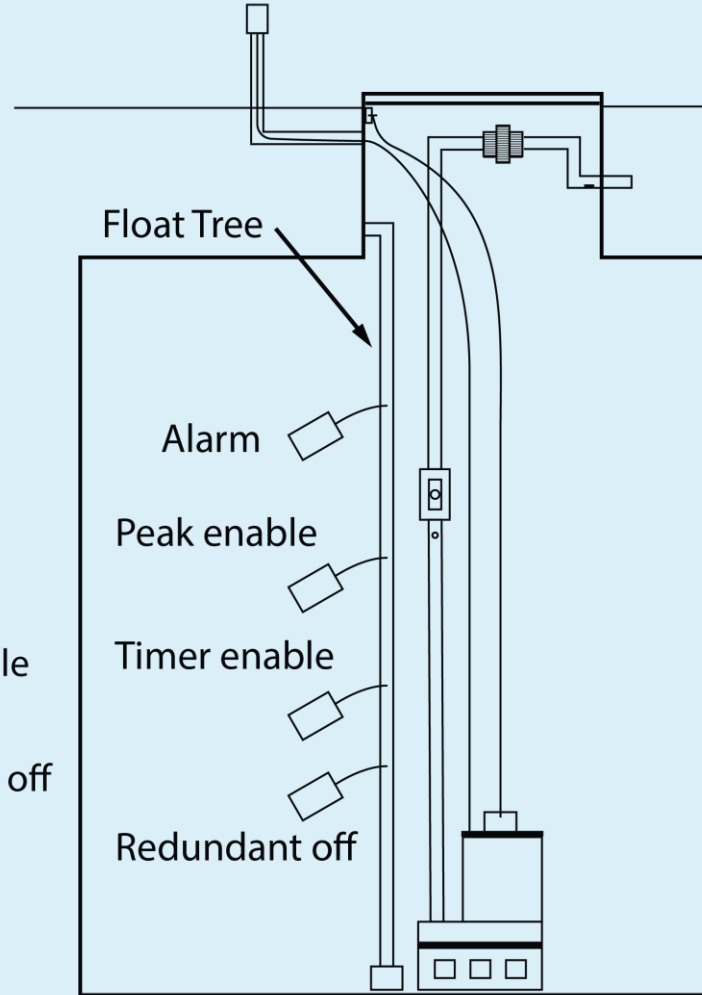


Examples of time dosing float configurations



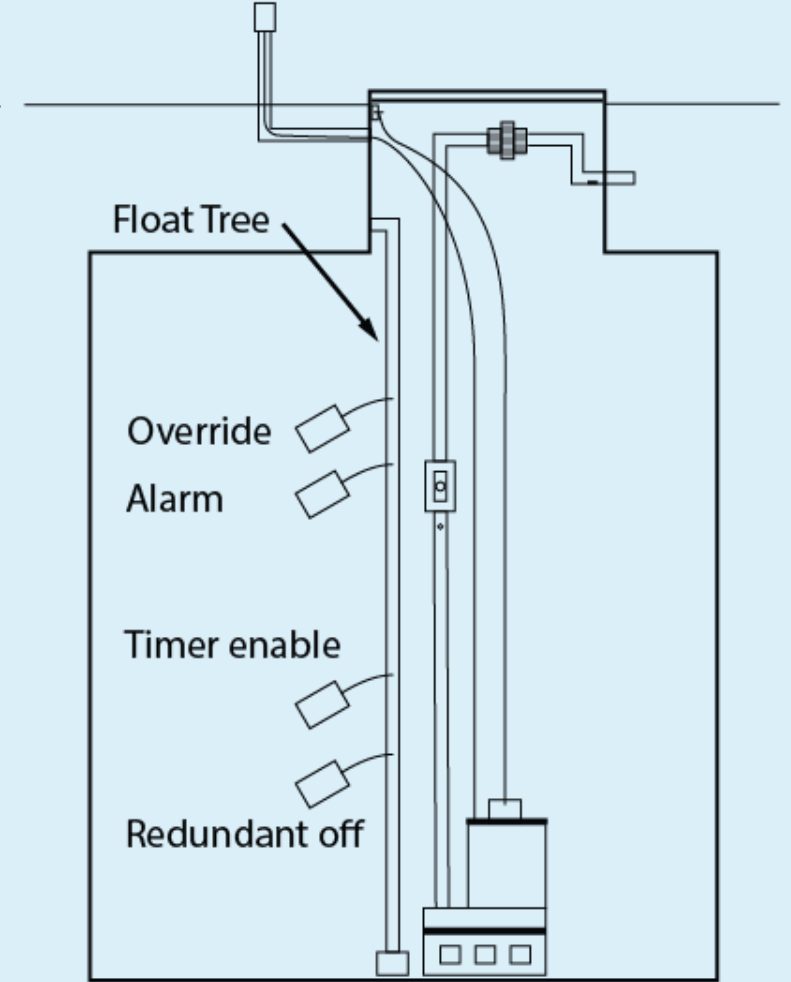
Timer enable

- OFF cycle first
- Activates pump for specified period
- Redundant off protects pump



Peak enable

- AKA "Override timer"
- Engages a secondary timer with a shorter OFF setting
- Deactivates the primary timer



Override:

- AKA "Timer override"
- Converts time dosing to demand dosing;
- Primary timer remains engaged

Time dosing: Check performance (relative to design values)

- Using Cycle Counters (CC)
 - What do I need to have?
 - *Number of days between readings (only when in operation)*
 - *Design daily dose frequency*
 - *Elapsed number of cycles = Total number of cycles (NC)*

Days x Dose frequency = Max cycles

- Compare max cycles to actual number of cycles NC

Time dosing: Calculate number of doses (cycles) per day

Design value:

Days x Dose frequency = Total doses

365 days x 4 doses/day = 1460 doses

Actual cycles in one year:

[17,990 - 16,540] = 1450 doses (cycles)

Excessive usage!!!!

Time dosing: Check performance (relative to operational values)

- Cycles per day

$$\# \text{ of cycles} / \text{elapsed days} = \text{cycles/day}$$

- Run time per cycle

$$\text{Elapsed time} / \# \text{ of cycles} = \text{run time /cycle}$$

Time dosing: Increasing number of cycles per day

- Potential cause: Increased water
 - Source excess usage
 - Leaking fixtures & open faucets
 - Drain back from field
 - Ground and surface water infiltration



Time dosing: Increasing number of cycles per day, cont.

- Potential cause: Pump issues
 - Impeller wear – low flow volume
 - Plugged intake screen
 - Debris in impeller
 - New pump – wrong duty point

Time dosing: Increasing number of cycles per day, cont.

- Potential cause: System issues
 - Plugging orifices/emitters
 - Plugged filtration – screen or disk
 - Plugged component, internal screen (meter)
 - Changed timer settings – decrease “on” time



Time dosing: Increasing number of cycles per day, cont.

- Potential cause: System issues
 - Increased friction loss in the piping
 - Crushed piping
 - Inline valve change position to less open
 - Increased recirculation flow to dosing tank

Time dosing: Decreasing number of cycles per day

- Potential cause: Decreased water
 - Source: less water
 - Dry time of year
 - Maintenance sealed infiltration points in system

Time dosing: Decreasing number of cycles per day, cont.

- Potential cause: Pump issues
 - New pump
 - Greater pump delivery rate
 - Pump maintenance to remove flow restrictions

Time dosing: Decreasing number of cycles per day, cont.

- Potential cause: System issues
 - System maintenance performed
 - Changed timer to increase “ON” time
 - Broken piping
 - Broken filtration



Time dosing: Decreasing number of cycles per day, cont.

- Potential cause: System issues (cont.)
 - Inline valve position changed - increasing downstream flow
 - Decreased recirculation flow to dosing tank



Time dosing: Short cycling

- Runtime per cycle: $\text{total time} / \text{Number of cycles}$
- Compare value to timer "ON" setting (Min. /cycle)
- If runtime per cycle is less than the "ON" setting, pump is short cycling

Time dosing: Short cycling (cont.)

- Low flow system
- Timer enable switch will stop operation
- Not dosing over full 24-hour period
- Increase “OFF” time to fully utilize the dosing timeframe

Time dosing: high water alarm condition

- Why do you have a high-water alarm?
 - Pump run time limited to “ON” setting
 - Pump cannot run for extended time to remove water from the pump tank (no timer override)
 - Increased water usage by source
 - Water infiltration to tanks
 - Decreased pumping system flow rate
 - Sensor and/or control system malfunctions

Time dosing: high water alarm condition communicates system status

- Control panel malfunction
- Timer settings
- Float settings – tether length
- Float malfunction
- Power off for a period of time
- Excess water usage
- Pump malfunction
- System water tightness issue
- Maintenance needed
 - Plugging of orifices
 - Plugging of emitters
 - Plugging of filter
 - Debris on pump intake
 - Replace controls/sensors

Time dosing: managing tank liquid level

- Timer override
 - Converts time dosing to demand dosing
 - Downstream components operate outside of normal hydraulic and organic loading rates
 - Override event recorded with cycle counter
- Override timer
 - Activates a secondary timer – changes the “OFF” setting
 - Downstream components operate within design loading rates

Reactive vs Proactive Maintenance

- Reactive maintenance service visits
 - Fix malfunctioning components
 - Replace broken pumps, compressors, or plumbing backup in house
- Proactive maintenance service visits
 - Preventative maintenance: performing routine maintenance
 - Condition-based maintenance: process monitoring
 - Risk-based maintenance: real-time process monitoring and evaluation
 - Performing routine maintenance on components extends component life
 - Repair or replace mechanical components before catastrophic malfunction
 - Replace components before degradation of effluent quality

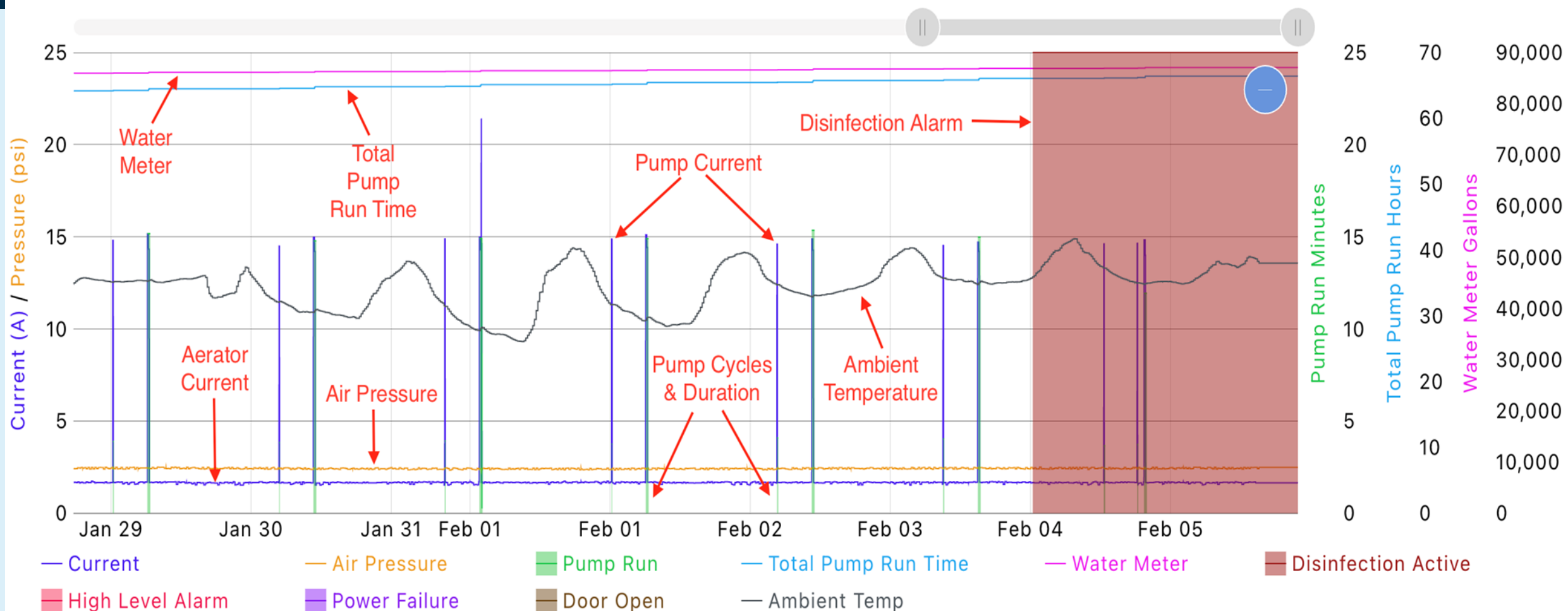
Proactive maintenance - condition-based maintenance

- Process monitoring to determine component operational status and maintenance actions
- Analyze component operation data to predict future component malfunction
- Compare current operational values to previous values
- Identify data trends indicating the need for maintenance
- Identify operating parameters outside of normal ranges
- Identify data anomalies indicating deviations from normal operation
- Parameter examples: water volume, air pressure, pump run times, dosing events, electrical usage, alarm conditions

Telematics

- Combine telecommunication with recorded system data
- Data stored by receiving entity associated with control system
- Track system component operating parameters
 - Pressure, electrical, run time, dose frequency, etc.
- Record component operational data
- Alarm conditions are communicated to specified individuals: owner, service provider, RME, or regulatory community

Telematics - Example



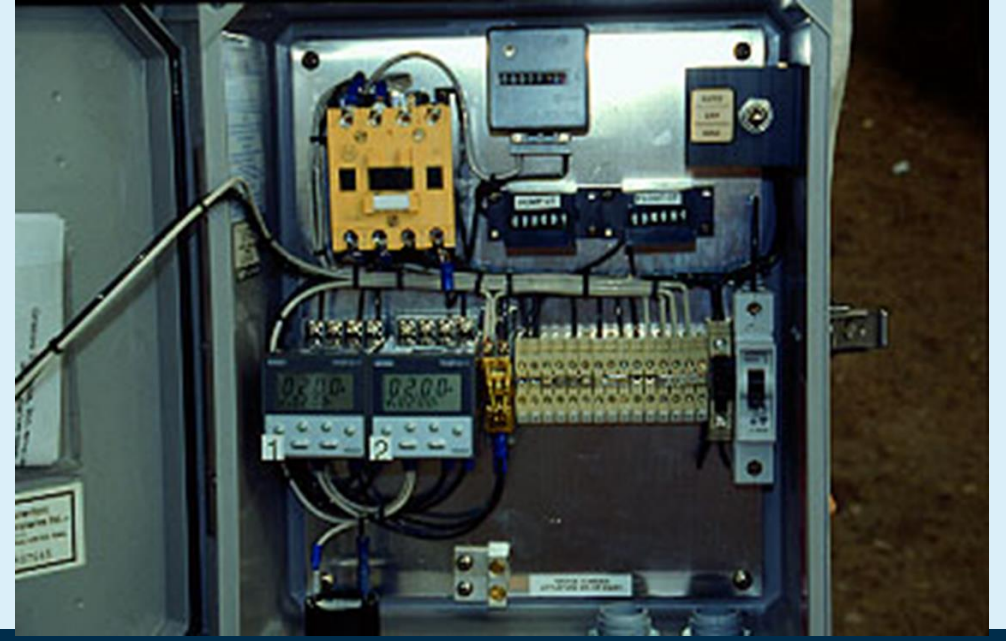
Proactive maintenance – condition-based

- Real time remote process monitoring
- Access and continuously analyze process component operational data
- Notify owner of deviations from normal operating conditions
- Functions as an OWTS App
- Provides an early warning system regarding system malfunction
- Can reduce risk of public health issues when implementing water reuse systems (Risk based maintenance)
- Notifications to owner, service provider, RME, or regulatory community

Summary

- Causes for changes in pump run time per cycle in a demand dosing system.
- Causes for changes in the number of pump cycles per day in a time dosing system
- Maintenance activities to correct changes in pump operation
- Reactive vs. proactive maintenance

QUESTIONS?



*Instructor's Contact information
here*