DESIGN ASPECTS OF TIME DOSING AND FLOW EQUALIZATION

Kevin Sherman, PE, PhD, D,WRE
SeptiTech, Inc. Lewiston, ME

SeptiTech®
a subsidiary of Bio-Microbics, Inc.

Disclaimer

The materials presented here should not be construed as the opinions of the

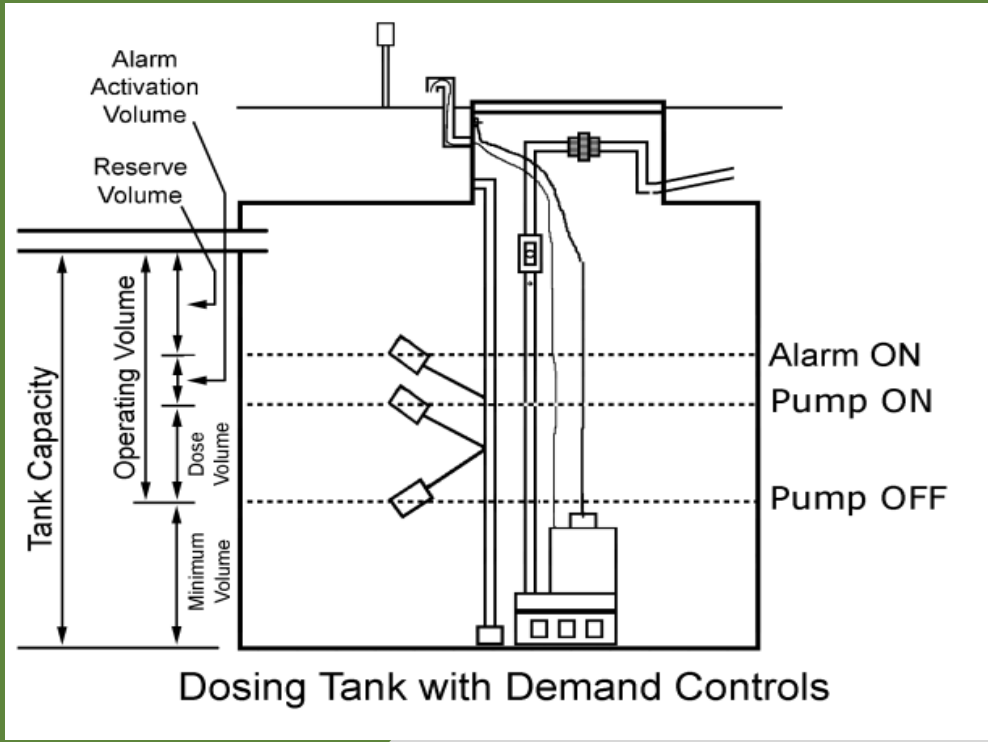
National Onsite Wastewater Recycling Association

Types of Pump Dosing

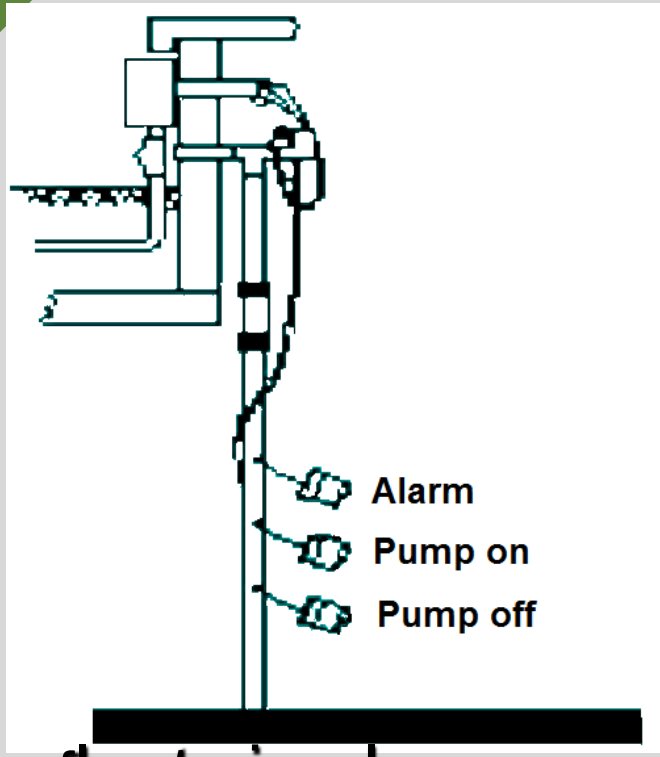
- **Demand dose**
  - Dose delivered based on effluent level in pump tank
  - Operates in response to wastewater generation
  - Controls consist of liquid level sensors set to dose predetermined effluent elevations

- **Time dose**
  - Timer provides set dose volume multiple times/day
  - Controls consist of liquid level sensors and timer
  - Requires surge capacity pump tank
    -- does not directly respond to demand

Demand Dose float configuration



Dosing Tank with Demand Controls



Two float simplex

One wide-angle differential float

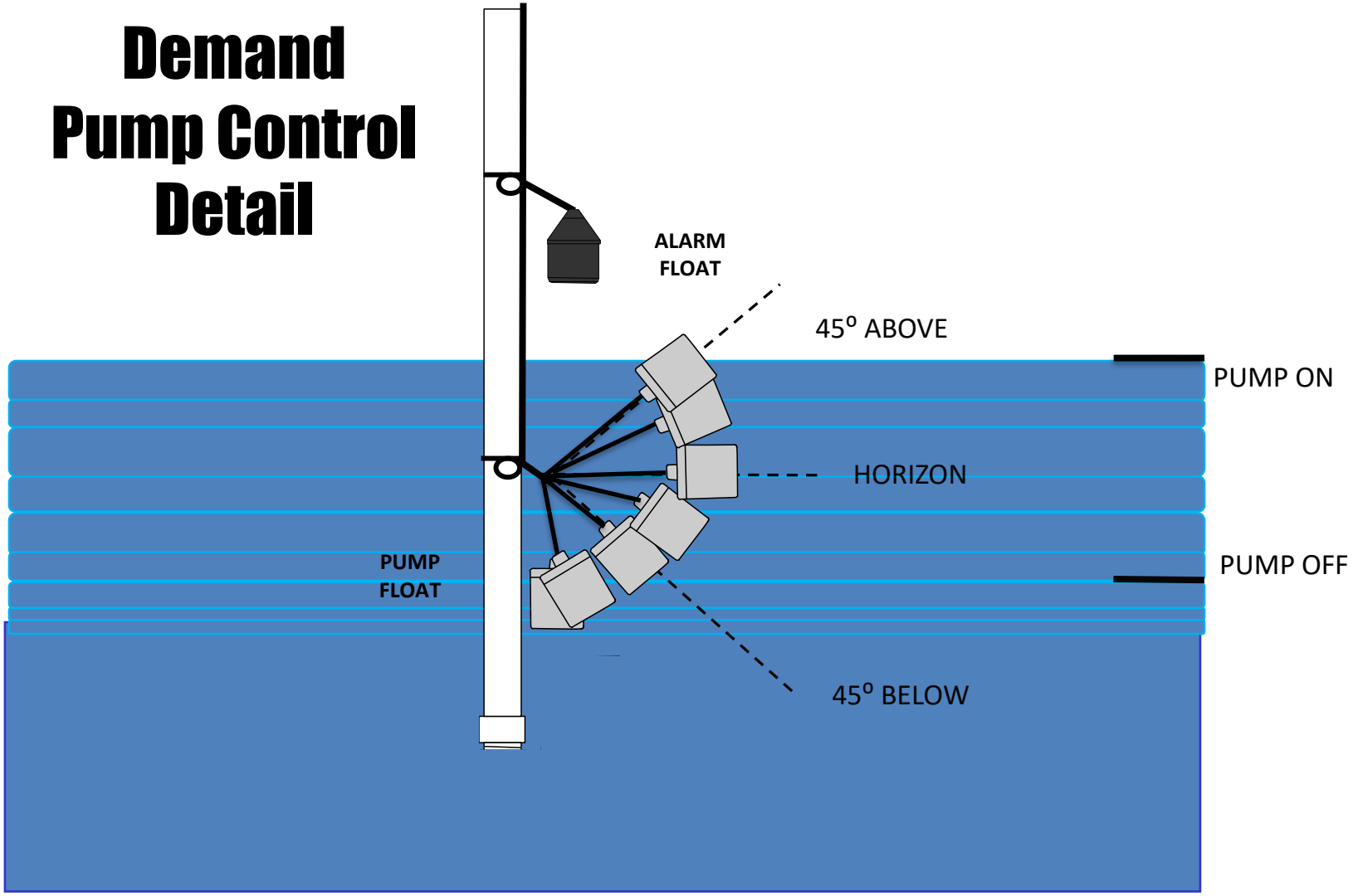
One Alarm float

Three float simplex

One float for OFF One float for ON

One Alarm Float

Demand Pump Control Detail

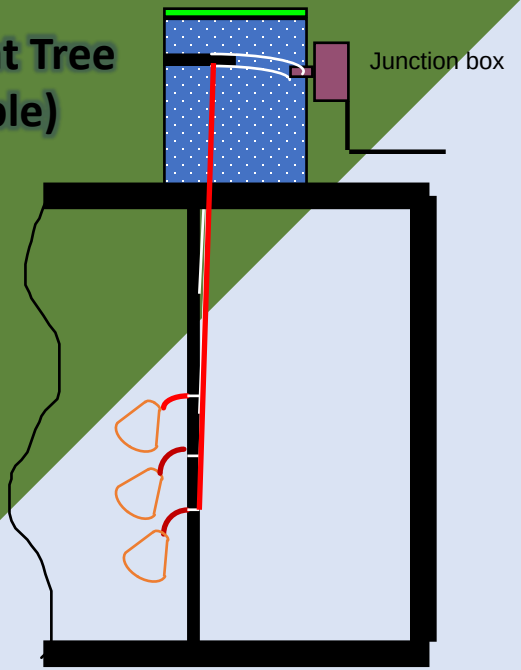


Float Types

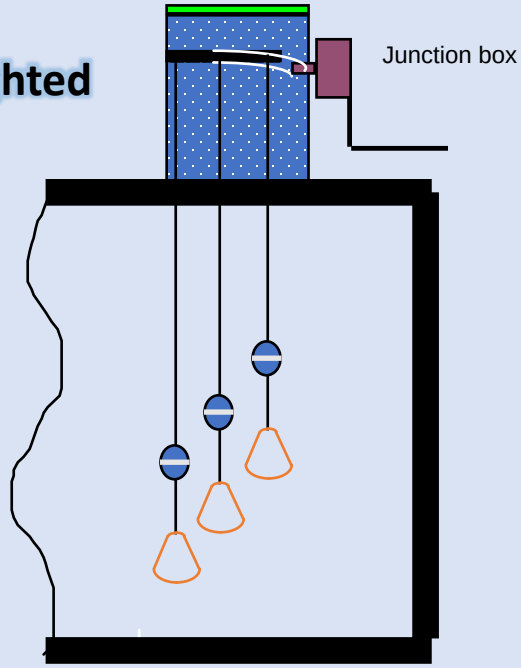
- **Mechanical or Mercury**
  - Used to detect liquid levels in pump tank and turn pump on and off
- **Attached to a separate float tree (left) or on weighted hanger (right)**

Connecting float options

Vertical Float Tree
(removable)



Weighted



Demand dosed settings: Single wide angle

- **Effective range tether length about 3” to 7”**
- **Drawdown about 4” to 10”**

ON / OFF separation

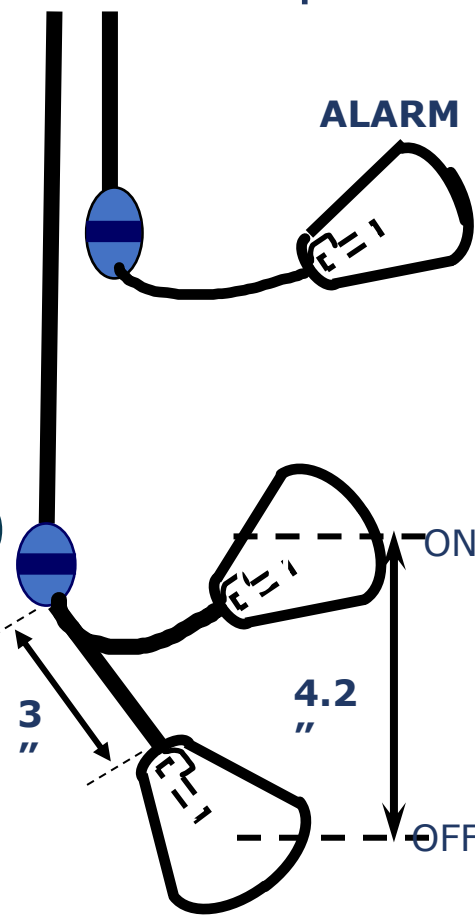
X (times)

Gallons per inch (gpi)

= (equals) dose volume (dv)

4.2 in. x 20 gpi = 84 gal dv

For example:



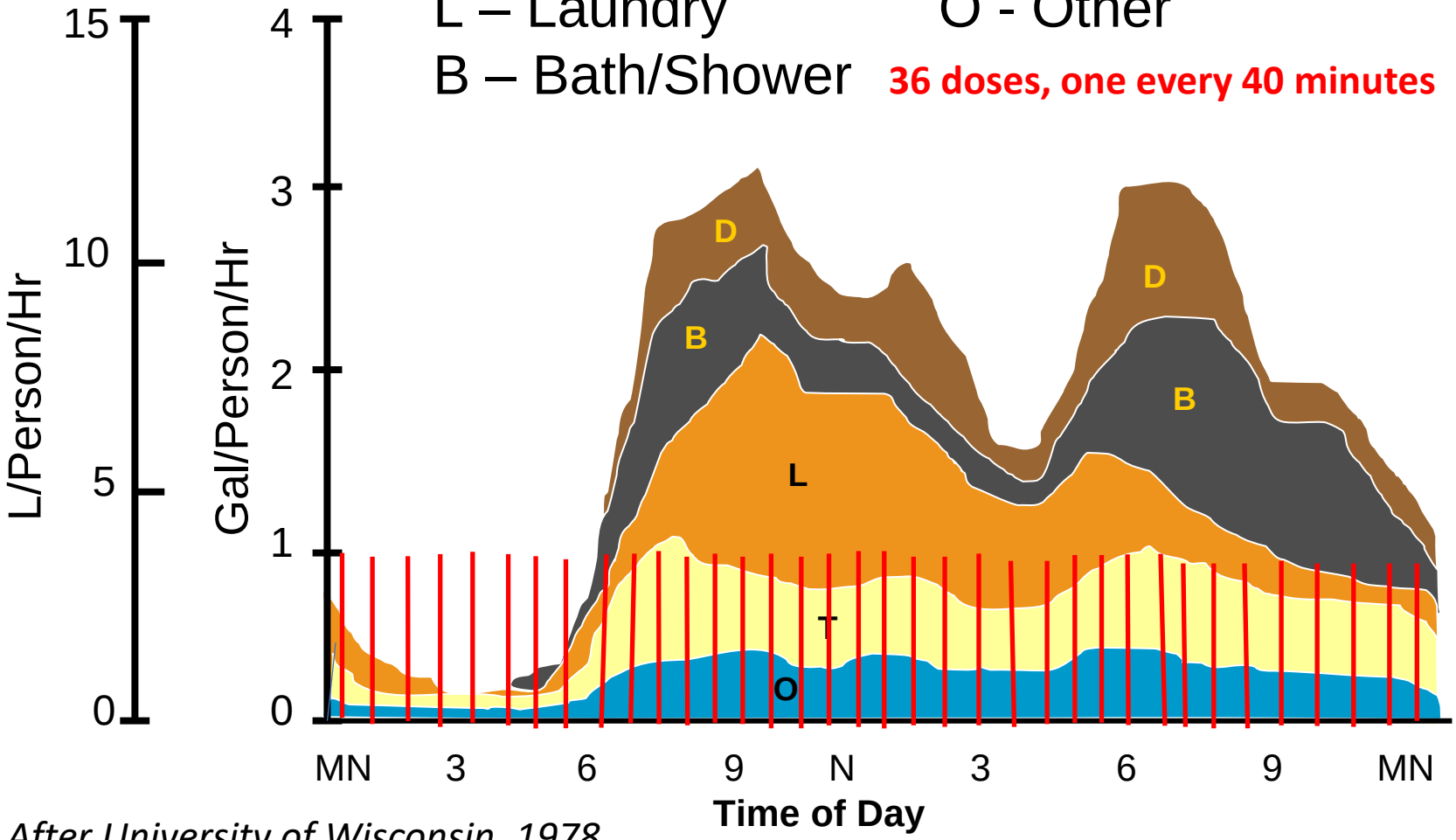
Advantages / Limitations of Demand Dosing

- A: Simple and less expensive
- L: Provides no control on total amount or when effluent is dosed to soil treatment area
- L: Provides limited information on usage
- L: Delivers variable effluent volumes depending on unrecognized events
- L: Difficult to deliver very small (10's of gallons) or very large (200+ gallons) doses
- O: Some call this delivery method 'social dosing'

Time dosing over 24 hours

T – Toilet
L – Laundry
B – Bath/Shower
D – Dishwasher
O - Other

36 doses, one every 40 minutes

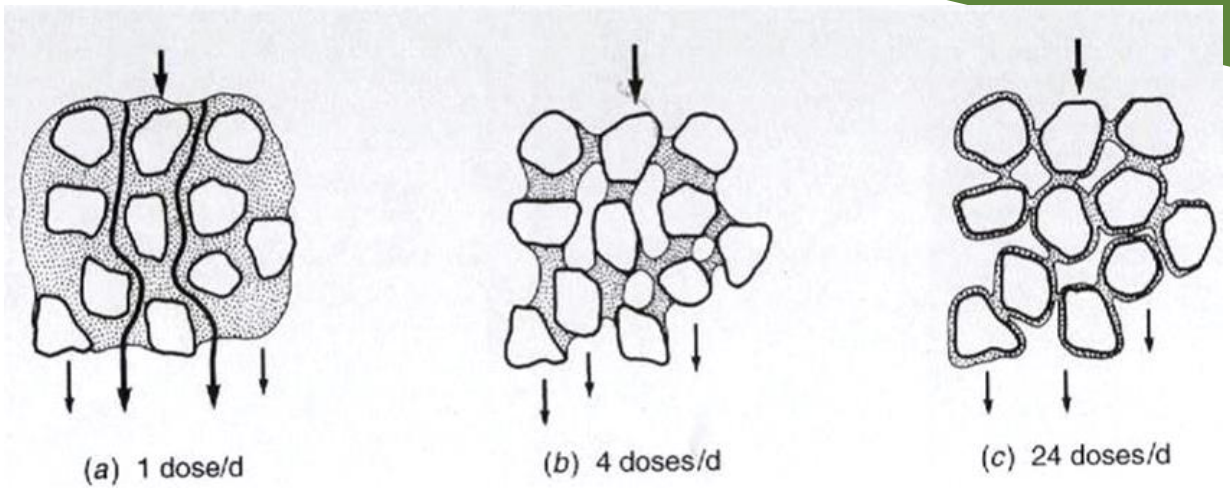


After University of Wisconsin, 1978

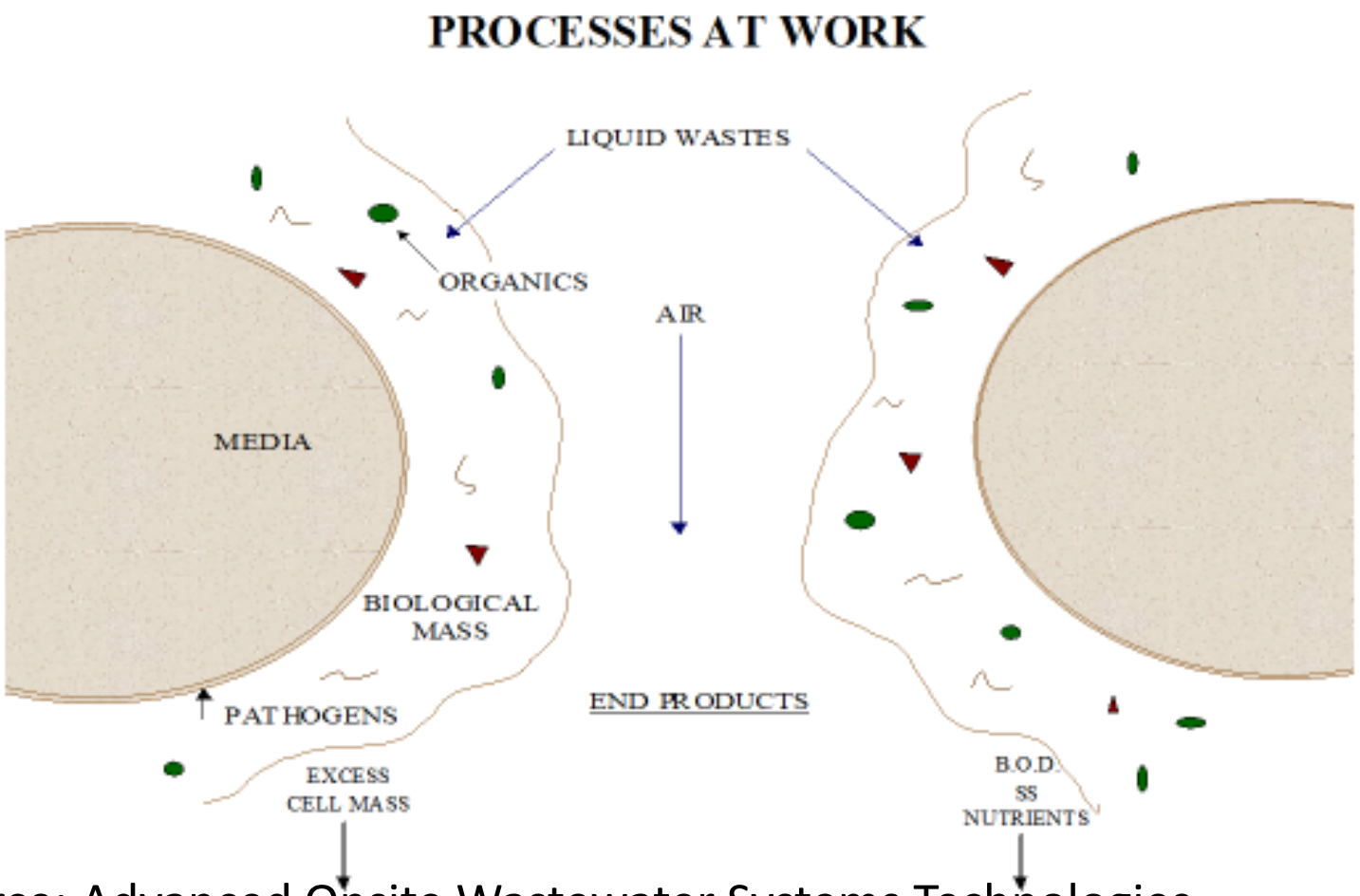
Time dosing addresses the limitations of demand dosing

- Allows pre-determined volume to be delivered over discrete time periods
- Pump operates for a pre-programmed length of time and rests for a pre-programmed length of time, typically over 24 hours
- Protects downstream components from overloads
- Uses a control panel with adjustable on-off timer
- Control panel should also include an event counter and elapsed time meter to aid in O&M activities. Read and record data every service visit and compare to previous readings

Benefits of Micro-dosing film flow = better treatment



Source: Small and Decentralized Wastewater Management Systems, Crites & Tchobanoglous, 1998



Source: Advanced Onsite Wastewater Systems Technologies
Jantrania & Gross, 2006

Time Dosing as a management tool

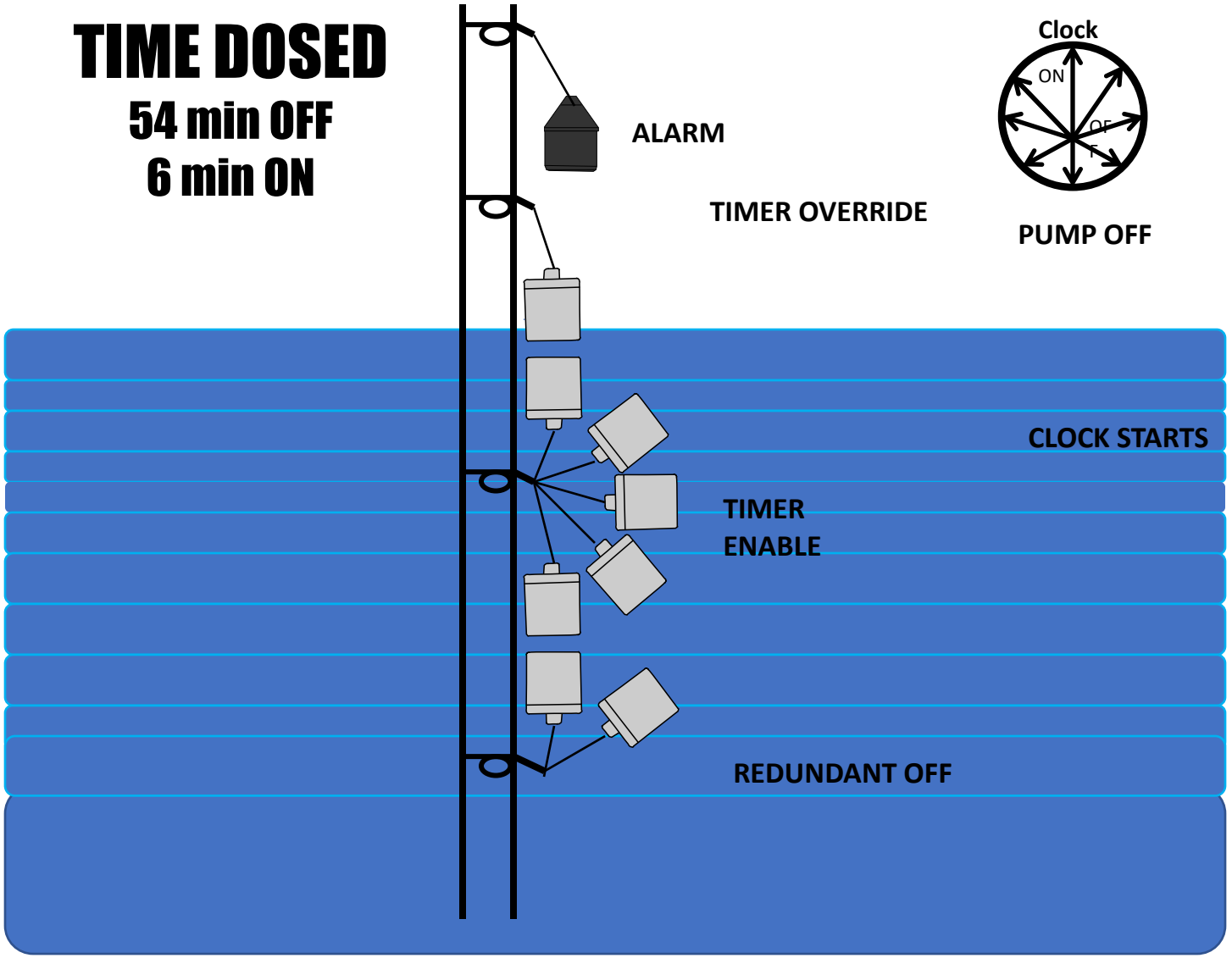
- Set timer to limit flow rate to design flow to STA
- Alarm will warn of excess flow (i.e. overuse, stuck toilet valve, leaking tank riser, etc.)
- Prompts action before allowing damage to soil treatment area

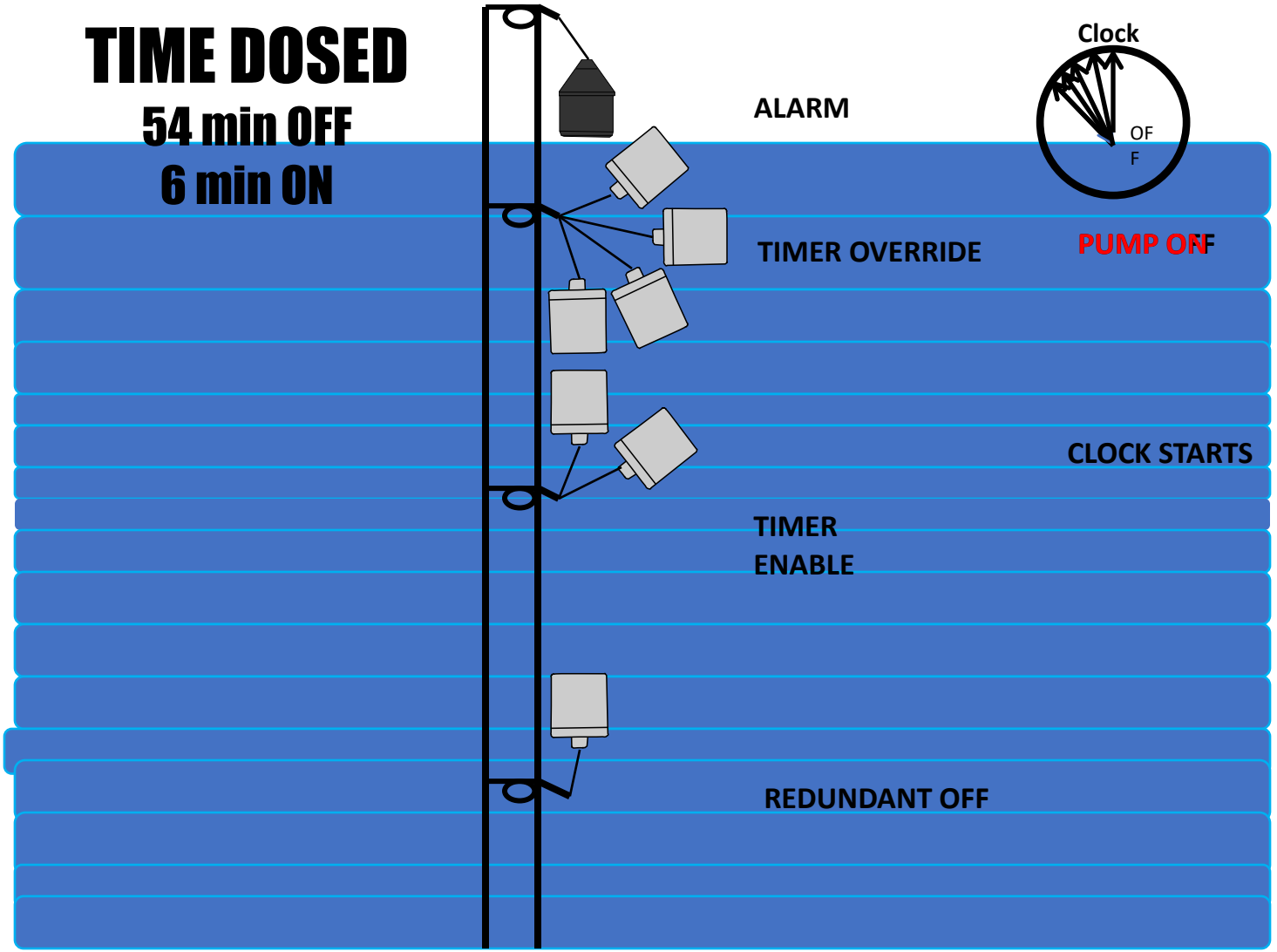
Location, name, purpose of Floats (from bottom up)

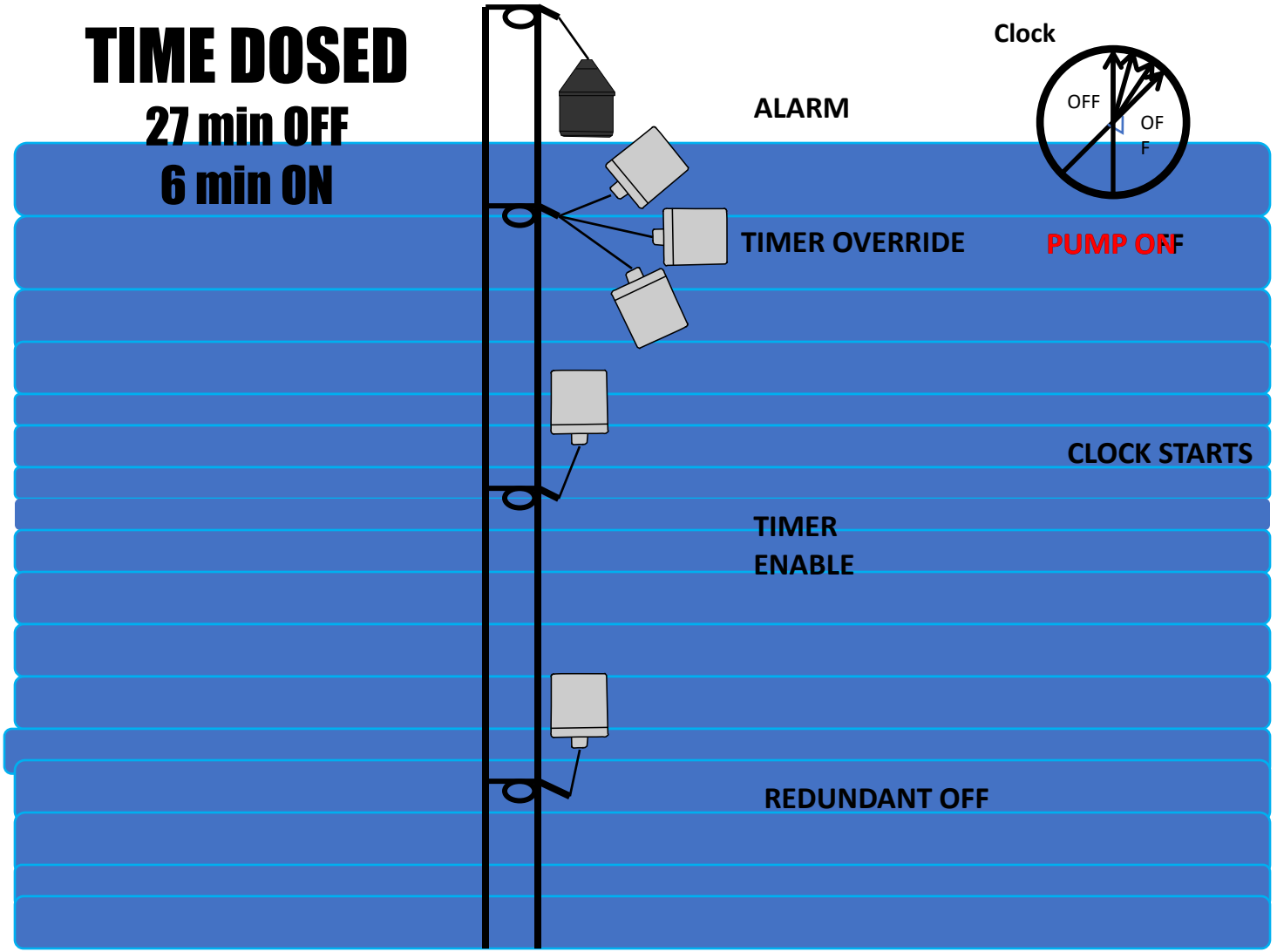
- Redundant off –Closest to Tank Bottom
  - stops the pump from running the tank dry
  - keeps pump submerged
  - should be combined with a low-water alarm
- Timer enable - just above Redundant off
  - start / stop the timer
  - assure minimum dose volume exists above Redundant off
- Timer override– Between Timer enable and Alarm
  - when activated, halves selected “off-time” to catch pump up
- Alarm—Top float (can also be at or below Timer override)
  - warn of malfunction or excessive water use

TIME DOSED

54 min OFF
6 min ON




TIME DOSED
54 min OFF
6 min ON
ALARM
Clock
OF
F
TIMER OVERRIDE
PUMP ON
CLOCK STARTS
TIMER
ENABLE
REDUNDANT OFF


TIME DOSED
27 min OFF
6 min ON
ALARM
Clock
OFF
OF
F
TIMER OVERRIDE
PUMP ON
CLOCK STARTS
TIMER
ENABLE
REDUNDANT OFF

How low should the lowest float be?

- Pump intake should be installed a few inches (~4”) above bottom to avoid sucking in collected solids in tank
- Liquid surrounding pump cools it
- By placing 100% of the pump casing under liquid 100% of the time, you will double the effective pump life – Chuck Schwabe – Liberty Pumps
- After servicing the pump tank return water to at least the top of the pump casing - why?

Important aspects of control panels

- H(and), O(ff), A(uto) switch – must be in A(uto) when leave site
- Gas tight seals in conduit pipe to control panel and in tank (belt and suspenders)
- Use multi-meter to check amp draw and voltage – looking for changes over time
- Reading elapsed time meter, event counter (#alarms, electrical failures, timer overrides)

Cycle Counter and Elapsed Time Meter

Example #1 using data from control panel

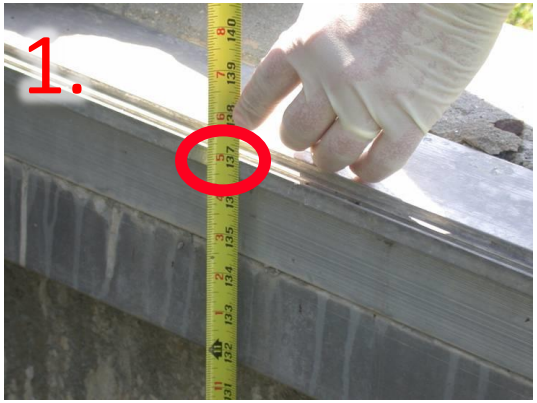
	Date	Cycle Counter	Elapsed Time
Observation 1	2/20/2021	8,788	14,409 minutes
Observation 2	7/1/2021	9,428	15,710 minutes
Difference	138 days	640 doses	1,301 minutes

- If pump delivers 30 gpm, total flow estimated at 30 g/min x 1,301 min = 39,030 gal
- Average number of doses per day = 640 doses / 138 days = 4.6 doses per day
- Average gallons used per day = 39,030 gal / 138 days = 283 gallons per day

In-field pump delivery rate measurement

- Over time pump's efficiency may decrease
- Pipe network may build up internal coatings
- Designer set pump gpm may no longer be accurate
- Must check/confirm discharge rate in field
  - At system start-up to confirm timer settings are correct
  - Periodically, to re-confirm, adjust settings as needed

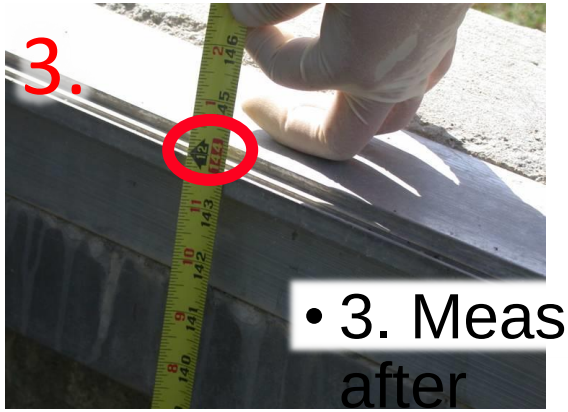
How To Measure Pump Delivery Rate



1. Measure & record effluent level before
137”

2. Run pump for 3 to 5 min.

144”-137” =
7” drawdown



- 3. Measure & record effluent level after
144”

Example #2

- Information as in previous slide
- Additional information – Run time 4.5 minutes
- Tank is rectangular 6’ long 5’ wide

- What is pump delivery rate?

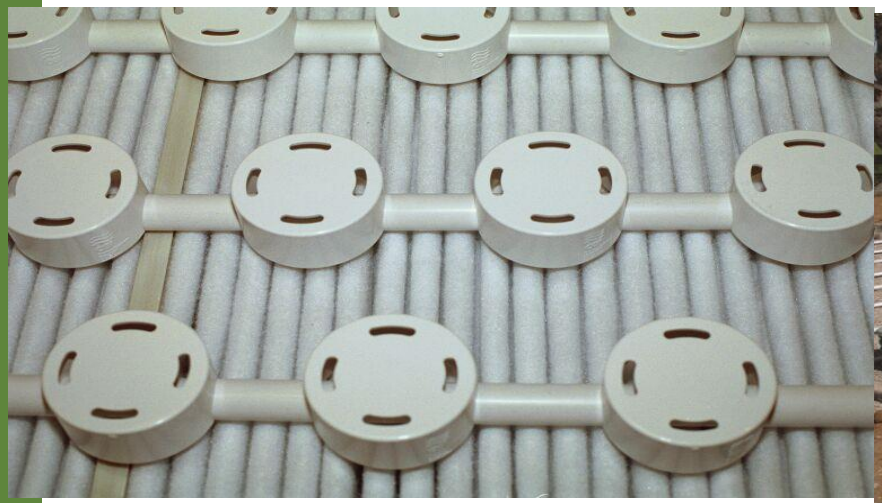
Solution: Example #2

- Volume of water pumped
  5’ x 6’ x 0.58’ (drawdown) = 17.5 ft^3
- 17.5 ft^3 x 7.48 gal / ft^3 = 130.9 gallons
- 130.9 gallons / 4.5 minutes = 29.1 gpm

Time dosing advanced pretreatment systems

Example #3: Recirculating Media Filter

- Q=1200 gpd.
- Recirc Ratio = 3:1
- Dose Filter 48 times/day: 1200x4 = 4800/48 = 100 g/dose
- Based on 25 gpm: Set timer at 4-min on; 26-min off



Example #4 - Incorporating time dosing in drip dispersal

- Q=360 GPD (3-bedroom)
- Drip Field pump-rate: 3 gpm
- “Normal” Flow settings to deliver 60% = 0.6 x 360 = 216 gallons/day
- for 12 doses/day: 216/12 =18 gals/dose
- “On-time”=18/3 =6m; “Off-time”=114m
- (1440 minutes/day/12 = 120 m/cycle)
- “Override” Settings: “Off-Time” = 66m
- [1440/(66+6) = 20 doses x 18 = 360 gals]

Recording information gathered during a service visit

- Forms ensure you are looking at parts of the system in a logical sequence – not jumping around
- Forms ensure you write the information down
- Ask you to rate components as acceptable (operable) or unacceptable (substandard or damaged)
- May need to repair, maintain, upgrade, or investigate further

Form 6-3 Operational Checklist: Pump: time-dosed system (PTD)

Service provided on: Date:_____ Time:_____ Reference #:_____
Service provided by: Company: _____ Employee:_____
Date of last service: _____ By: ☐ You ☐ Other:_____
Date of last inspection: _____

1. Controls Timer manufacturer:_____
   a. Is enclosure watertight. Yes____No_____
   b. Alarm test switch working properly. Yes____No_____
   c. At time of inspection, timer was set at: "On"____ Mode setting____
      "Off"____ Mode setting____
   d. At time of inspection, control switch (HAND-OFF-AUTO) was set at:
      "Hand/Manual"_____
      "Off" _____
      "Auto" _____
   e. If timer was changed from above, new setting is: "On"____ Mode setting____
      "Off"____ Mode setting____
   f. Electrical meter readings:

		Reading (this)	Reading (last)	Difference	N.A.
i)	ETM			min	
ii)	Cycles/events			Events (NC)	

Calculate cycles/day: _____ [NC] / [Days] = _____ [CPD]

   g. Telemetry operational. N.A._____Yes ____ No _____
      Type: _____

NOTES

1. ☐ Acceptable
   ☐ Unacceptable

2. Pump
   a. Pump operating properly. Yes_____No_____
   b. Type of pump: ☐ Multi-stage ☐ Single-stage
   c. Amps measured: _____amps
   d. Voltage measured: _____volts
   e. Pump turns on/turns off. Yes _____No_____

3. Water level sensors
   a. Type of water level sensor: ☐ Floats ☐ Pressure transducers ☐ Ultrasonic ☐ Other:_____
   b. Pump sensors functioning properly. Yes_____No_____
   c. Alarm sensor operating audible and visible alarms. Yes_____No_____

2. ☐ Acceptable
   ☐ Unacceptable

3. ☐ Acceptable
   ☐ Unacceptable

4. Sensor settings:

Sensor Number*	Function	Operational	Set At:		Secured
			Inches**	Datum	
1		Yes___ No___			Yes___ No___
2		Yes___ No___			Yes___ No___
3		Yes___ No___			Yes___ No___
4		Yes___ No___			Yes___ No___
5		Yes___ No___			Yes___ No___

**(Designate starting from bottom of tank)*

*** Measurements are taken from a fixed point ("Datum") near the surface or bottom of float tree in inches)*

5. Pump delivery rate (PDR) (measured)
   a. Pump Off_____ – Pump On _____ = _____in
   b. GPI: _____ (*From* Form 6.1 – Item 3 e)
   c. Verified pump run time: _____min

(_____In x _____GPI) ÷ Pump run time (min) =_____(GPM)

6. Dose volume (DV) (from timer setting)
   a. Pump delivery rate: _____ GPM (from Item 5)
   b. Verified pump run time: _____min

   _____ GPM x _____ min/cycle =_____(DV[Gal/ cycle])
7. Total gallons (from elapsed time meter)
   a. [_____(PTR) - _____(LTR)] x _____(GPM) = _____Total Gal

   OR Total gallons (from event/cycle counter)

   [_____(PCR) - ____ (LCR)] x _____(DV) =_____Total Gal
8. Gallons per day (GPD)

   _____Total gal ÷ _____No of days = _____Gal./Day (GPD)

CPD: cycles per day
DV: dose volume
ETM: elapsed time meter
GPD: gallons per day
GPI: gallons per inch
GPM: gallons per minute
HAND-OFF-AUTO: Hand-Off-Auto Switch
LCR: last cycle reading
LTR: last time reading
PCR: present cycle reading
PDR: pump delivery rate
PTR: present time reading

Source: Residential Onsite Wastewater Treatment Systems: An Operation and Maintenance Service Provider Program CIDWT, 2008

FLOW EQUALIZATION

Time dosing is essential to flow equalization

Flow Equalization

Flow Equalization Systems utilize Time Dosing to distribute wastewater to an advanced pretreatment system (over 24 hours) or effluent to a soil treatment area uniformly over an extended time period (more than 24 hours)

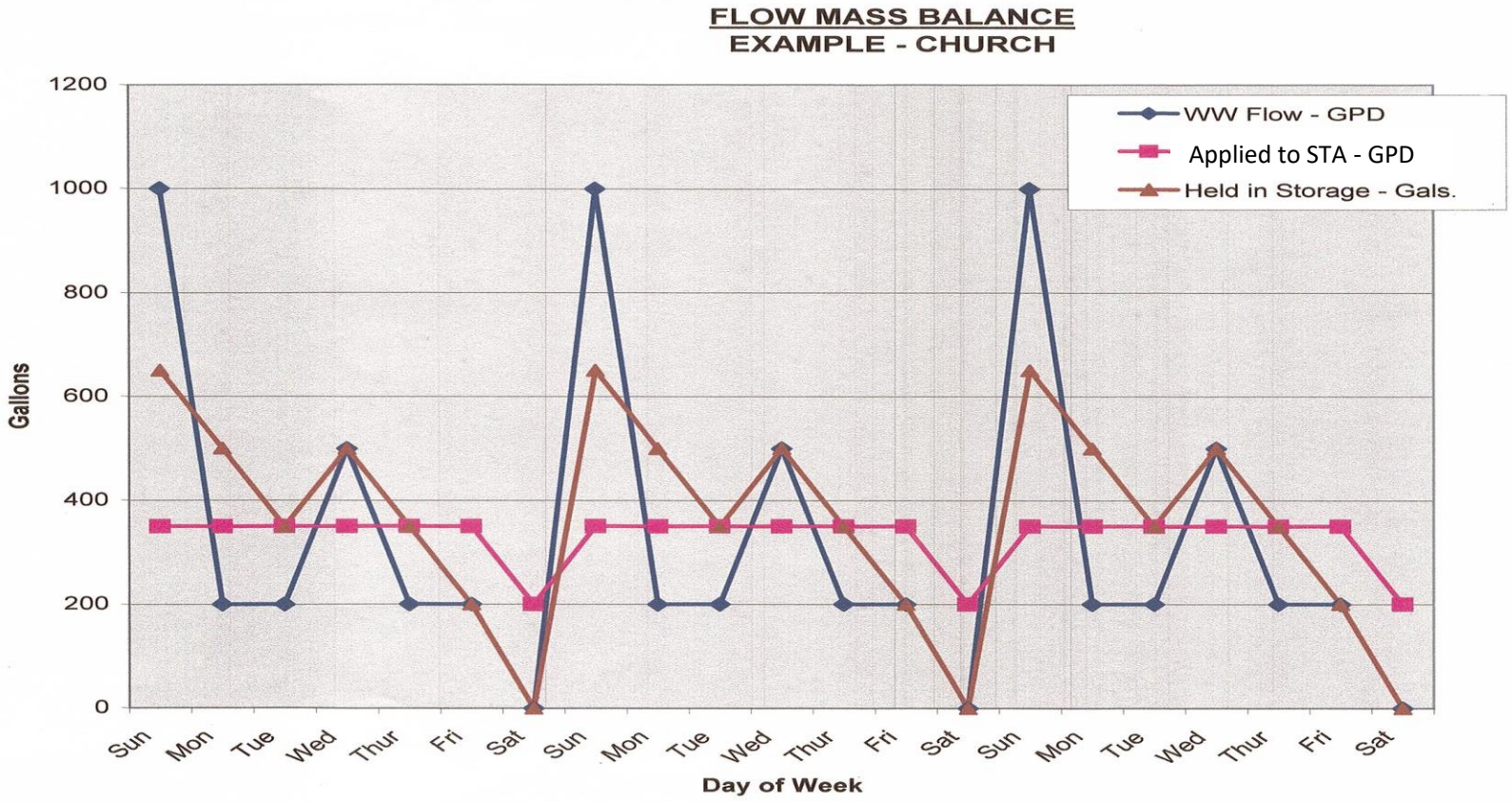
- Used as means for reducing soil treatment area for select facilities
- Facilities must have daily use pattern well established, and not subject to change.
- Equalized Flow Time period typically multiple days (≤ one week)

Objectives of Flow Equalization tank(s)

- Provide a controlled flow rate to downstream operations and processes
- Use equalization tank to:
  -dampen variation in flow rate
  -reduce required size of downstream
- components
  -e.g., allow treatment and/or dispersal to be designed on average flows, not peak (up to 50% cost savings)

Which facilities can benefit from flow equalization?

- Commercial facilities with substantial daily flow variations
- Facilities with days where flow is very low and very high
- Facilities that use advanced treatment
- Examples: Schools, offices (5 days of flow per week)
- Houses of worship (1-3 days of flow per week)
- Festivals, Flea Markets (2-3 days of flow per week)
- Banquet / rental halls (occasional use)
- Stadiums, Arenas, performance centers (occasional use)


FLOW MASS BALANCE
EXAMPLE - CHURCH
1200
1000
800
600
400
200
0
Gallons
WW Flow - GPD
Applied to STA - GPD
Held in Storage - Gals.
Sun
Mon
Tue
Wed
Thur
Fri
Sat
Day of Week

Calculating the storage needed

Example #3: 200 Seat Church

Flow Mass Balance			
Day	WW Flow – GPD	Applied to STA – GPD	Held In Storage – Gals.
Sun	1000	350	650
Mon	200	350	500
Tue	200	350	350
Wed	500	350	500
Thur	200	350	350
Fri	200	350	200
Sat	0	200	0
	Average: 329 GPD		

Sizing parts of the system

- Size components upstream of flow equalization on estimated peak flows
- Size components downstream of flow equalization tanks are sized on average flow
- In example #4, we can size the soil treatment area on 350 gpd average flow

Design considerations for flow equalization tank(s)

- One large tank or multiple tanks with hydraulic connection at and below tank liquid level (watertight connections)
- Blended wastewater released to next step in treatment
- Time dosing of stored contents is essential
- Pump “on-time” based on measured drawdown
- Buoyancy counter-measures are also essential
- In addition to Equalization Volume also provide Emergency Storage Capacity volume

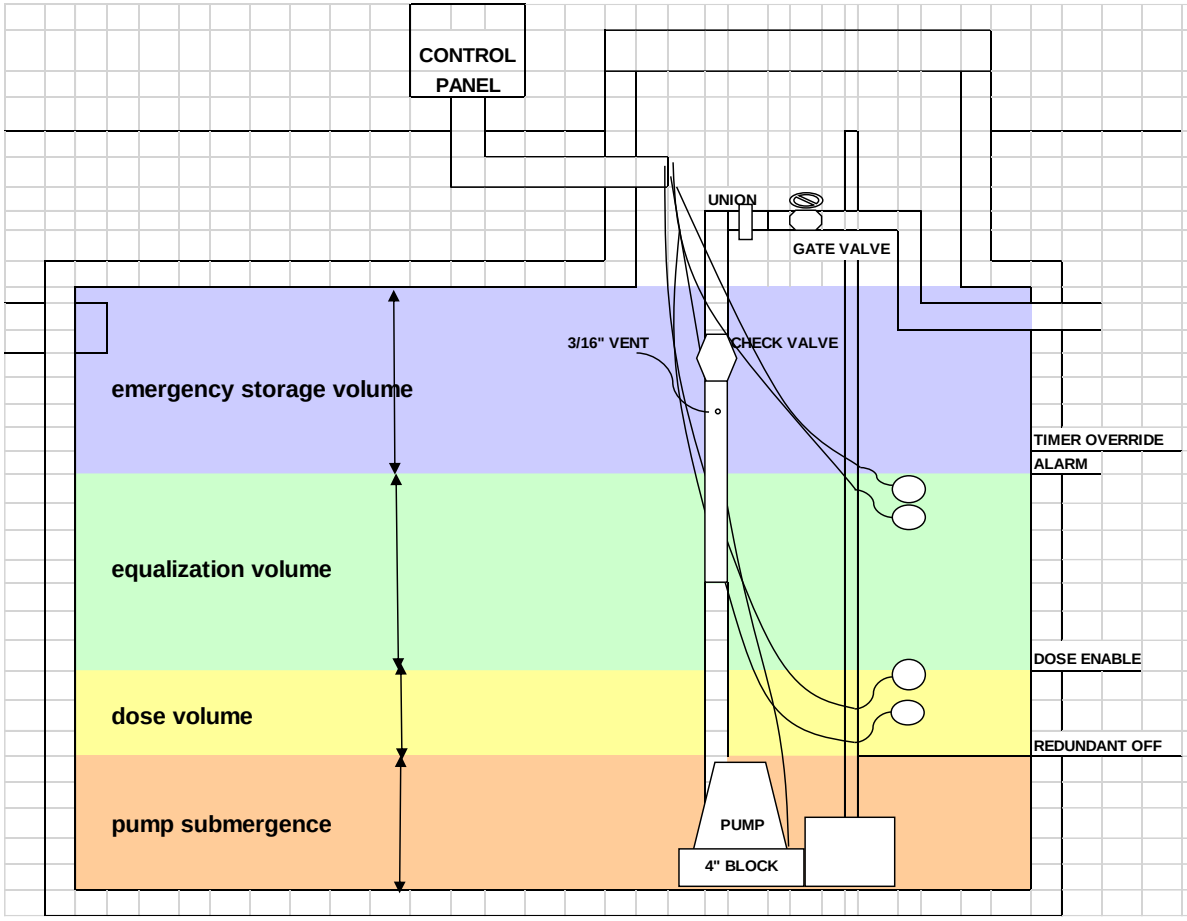
Example #4

- 200 seat church with daily flows as shown on previous slides
- If a single flow equalization tank is desired what is an acceptable tank volume?

Choosing an adequate tank volume

- Want to capture/contain peak flow every time
- Include safety factor (e.g., 25%) to capture any exceptional flow
- Review data collection
- Choose an average flow that fits existing data
- Run a spreadsheet simulation of tank volumes over time
- Iterative process

Pump (Equalization) Tank Volume



EXAMPLE:

200-Seat Church

Peak Daily Flow: 1000 GPD

Equalized Daily Flow: 350 GPD

Septic Tank Volume: (Based on Peak Daily: e.g., 1800 gallons)

Pump (Equalization) Tank Volume:

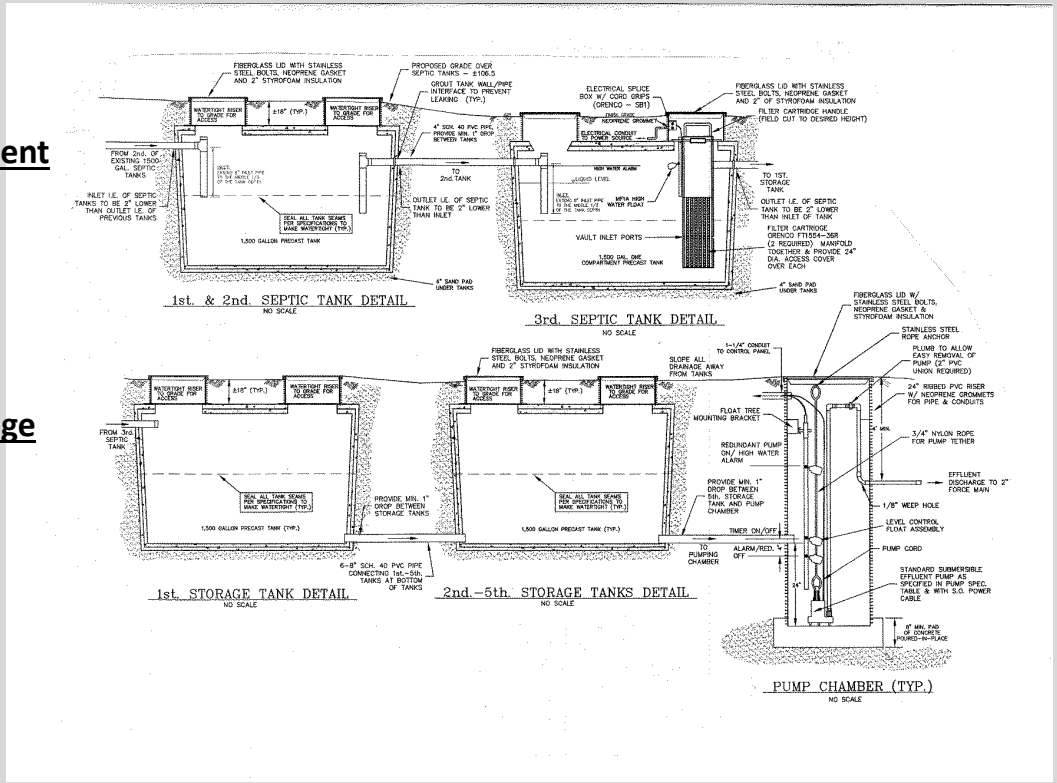
(assume Tank 5-ft x 10-ft = 31 gallons/inch)

Pump Submergence: (4" + 19"): 23 x 31	=	713	gallons
Dose Volume (twice/day): (350 x .5)	=	175	gallons
Equalization Volume (650 x 1.25)	=	813	gallons
Emergency Storage Volume (1/2 Peak)	=	500	gallons
Total		**2201**	**gallons**

Multi-Tank storage option for flow equalization tanks

First Treatment

Then Storage



QUESTIONS?

Kevin Sherman's email, ksherman@septitech.com

SeptiTech®
a subsidiary of Bio-Microbics, Inc.