This Pond Stinks!

Reflections on AFO Lagoons that Offend Us

Ponds That Stink

- What we mean by, “stink”
- Why it stinks
- Avoiding the stink
- Getting rid of the stink
- What “stink” has to do with anything else

Defining “Stink”

- Concentration
- Intensity
- Offensiveness
- Hedonic tone
- Duration
- Frequency

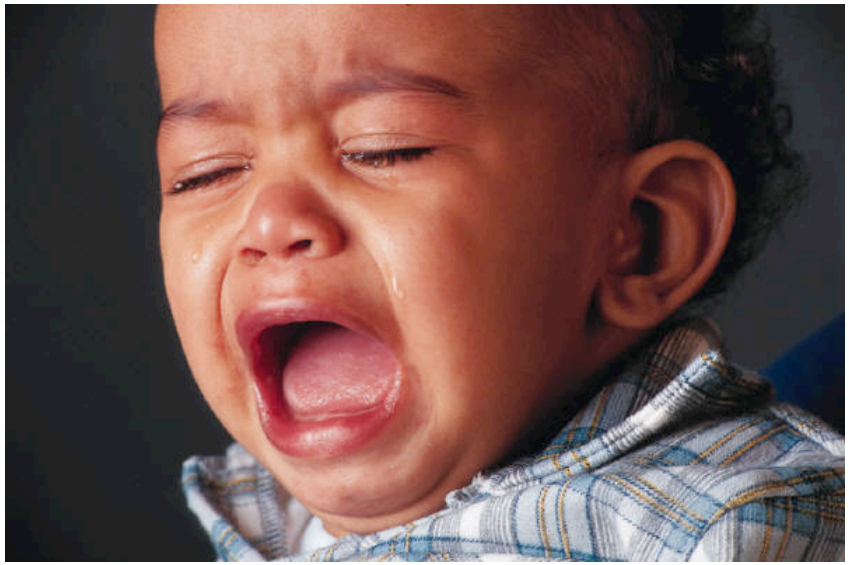
Concentration

- How “loud” is the odor?
- How much do I have to dilute the odor before I can’t tell whether it’s there or not?
- We use human panelists to do this
- We need dilution machines, too

Intensity

- Comparison to a series of synthetic odors of varying intensity
- Usually a pure odorant in aqueous solution
  - *n*-butanol
  - Other
- Intensity score (0 to n) varies with aqueous concentration

Offensiveness

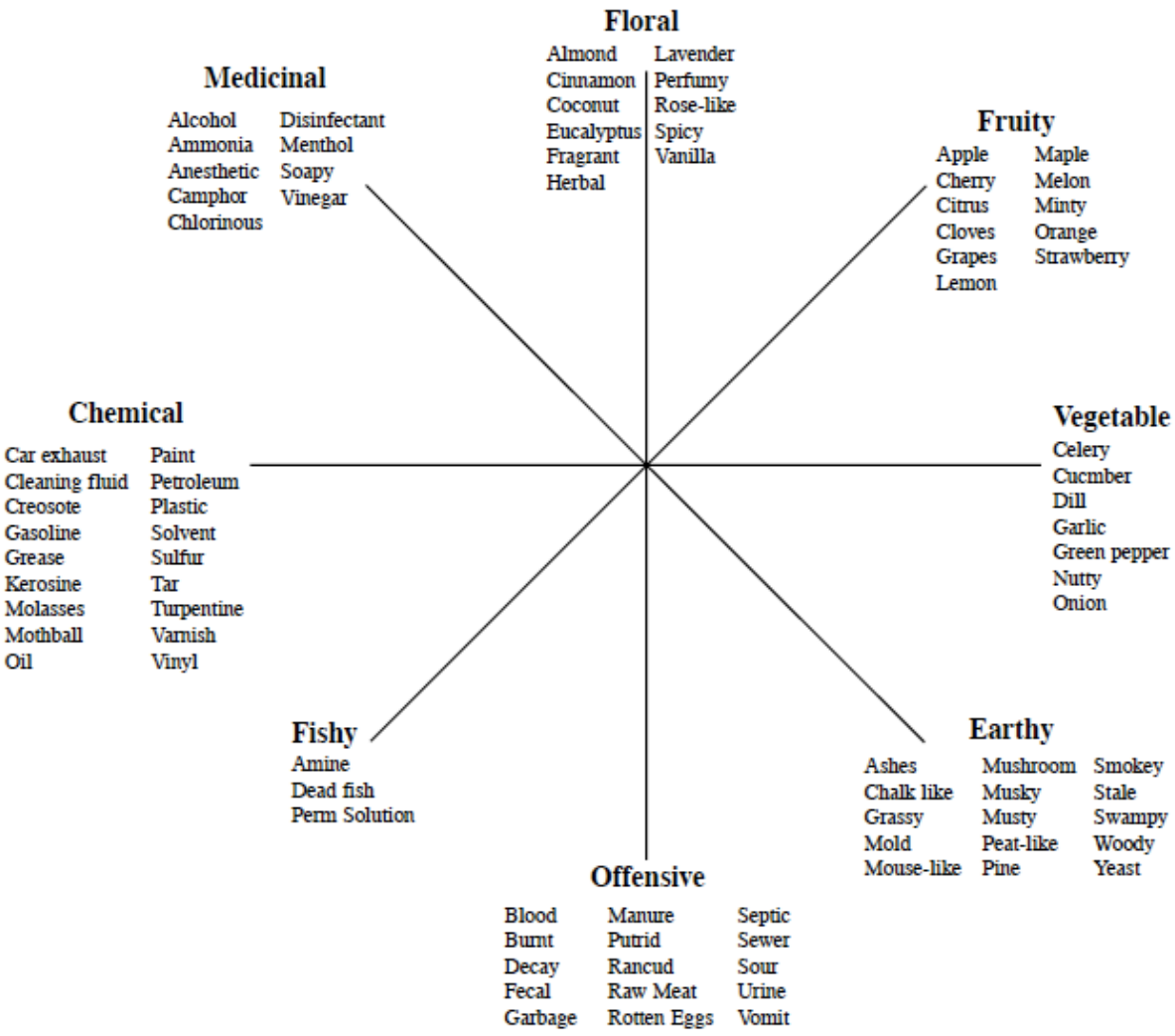


- Arbitrary scale (-n to n)
  - -5 “I’m about to puke”
  - 0
- Unique to each person

Hedonic Tone

- What does it smell like?
  - Earthy
  - Medicinal
  - Offensive
  - Fruity (e. g.,
    - Citrusy
    - Lemony…)
  - Floral
- “Skanky” is not a recognized hedonic tone

Figure 4: Odor Descriptors Wheel



Duration and Frequency

- How often does it occur, and how long does it last?
- Usually, not long enough to verify it in response to a complaint
- For lagoon odor, duration depends on source dimension, wind variations, and distance to the receptor

Why "Treatment Ponds" Stink

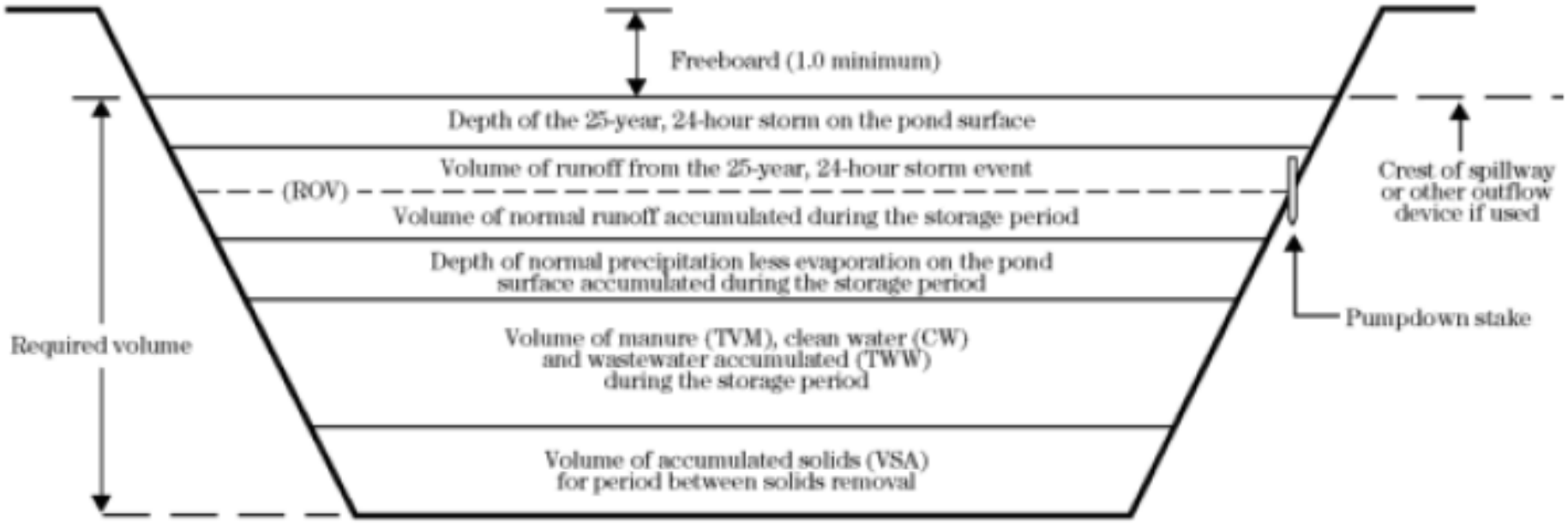
- *Complete* anaerobic digestion is at least a two-stage process:
  1. Acetogens (acid formers) convert OC to intermediate products, including organic acids
  2. Methanogens (methane formers) convert intermediate products into CO_2, CH_4, etc.
- Incomplete anaerobic digestion interrupts the process after stage 1
- Result: accumulation of organic acids and associated VOCs, many of which are odorous

It Really Is That Simple

- Methanogen ecology is delicate, but acetogen ecology is relatively more robust
- Foul odors are an inescapable result of lagoon "indigestion" and accumulation of OVOCs
- Avoid lagoon indigestion, and the problem is solved:
  - Design
  - Start-Up
  - Management
  - Remediation, if necessary

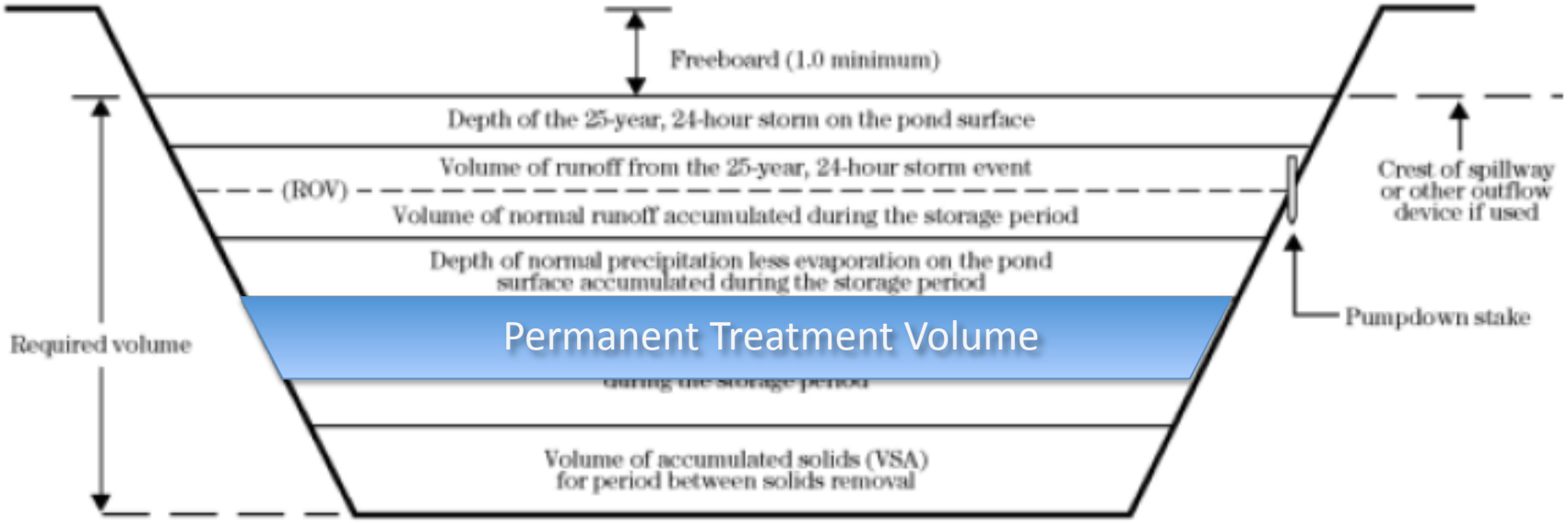
Holding Pond Design

Figure 1 Cross section of waste storage pond with watershed.



LAGOON Design

Figure 1 Cross section of waste storage pond with watershed.



Design: Volatile Solids Loading Rate

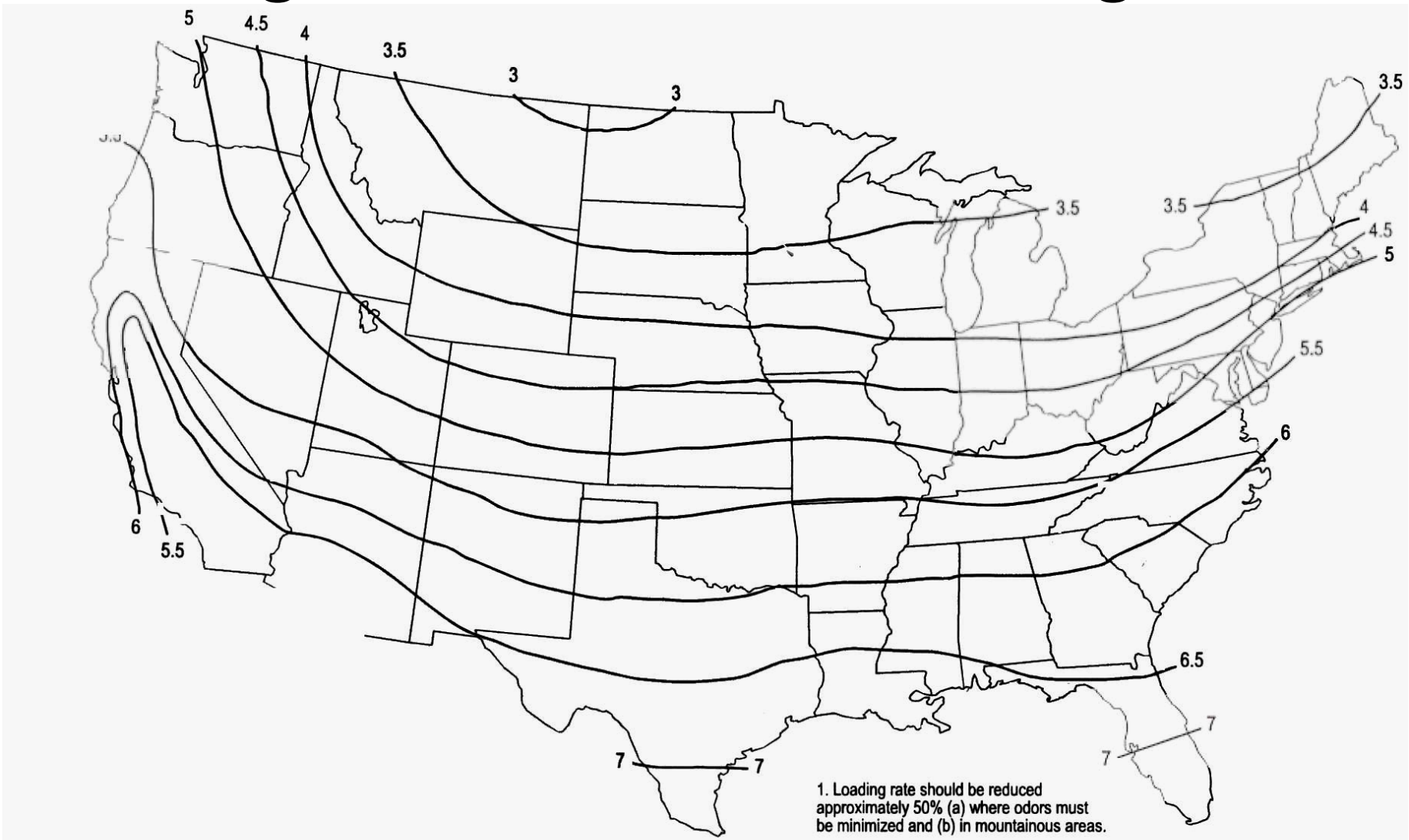


Figure 21-5. Anaerobic lagoon loading rate, lb VS/1,000 ft³/day.

Start-Up

- Start in spring or early summer
- Begin with fresh water to ½ of permanent treatment volume (rainfall, runoff, or direct)
- Add manure
- May take up to a year to begin functioning optimally
- Remediation: Empty and start over

Operation and Management

- Track nutrient, COD, pH, and salt concentrations via periodic sampling
  - EC<8 mmho/cm is OK
  - pH>6.5 is OK
  - Color should be reddish purple during warm season
  - Visible sludge “sandbar” is a no-no

Remove Sludge When Necessary

Courtesy Jones et al. (2006)

Maintain Effluent Levels Properly

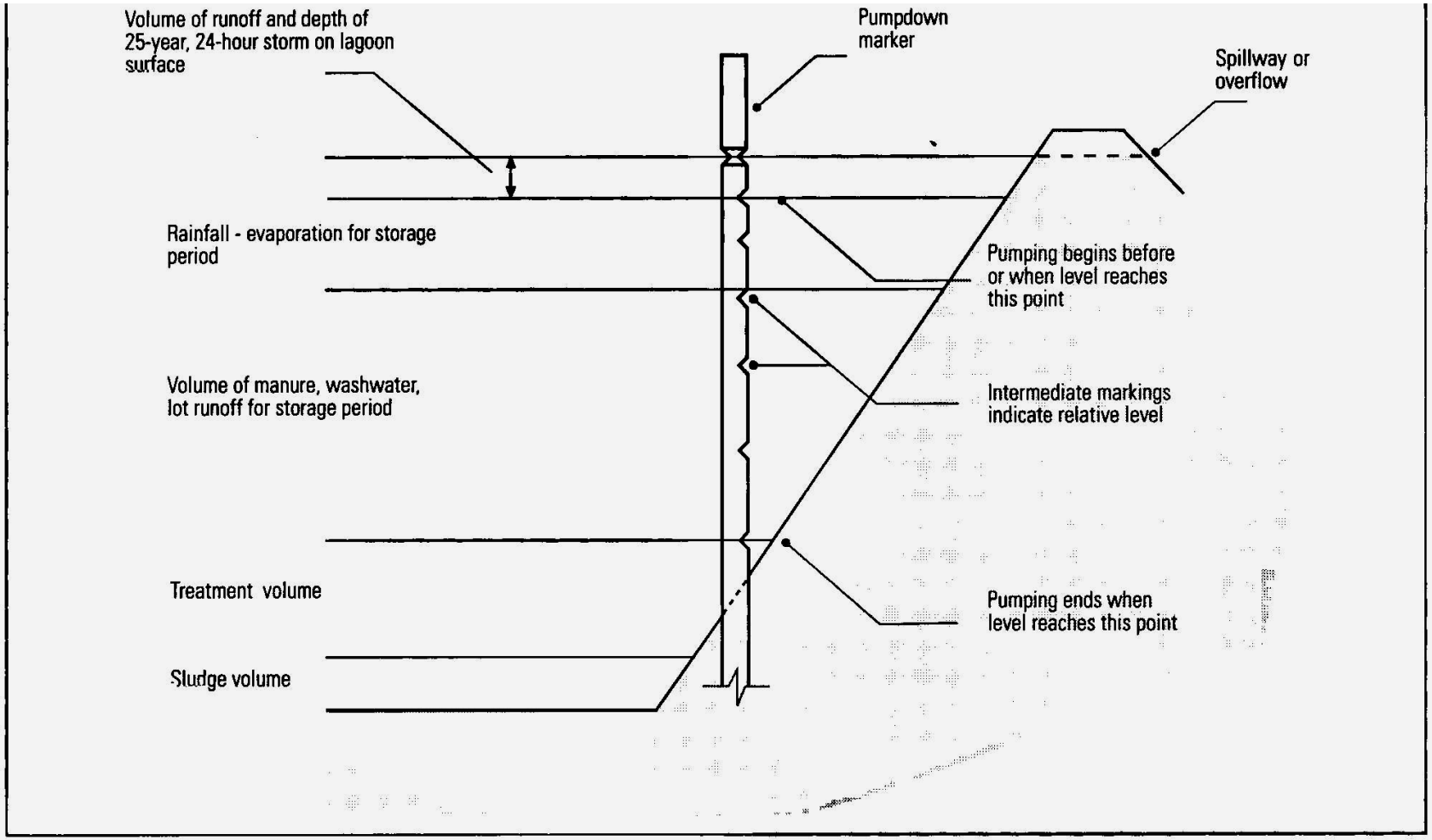
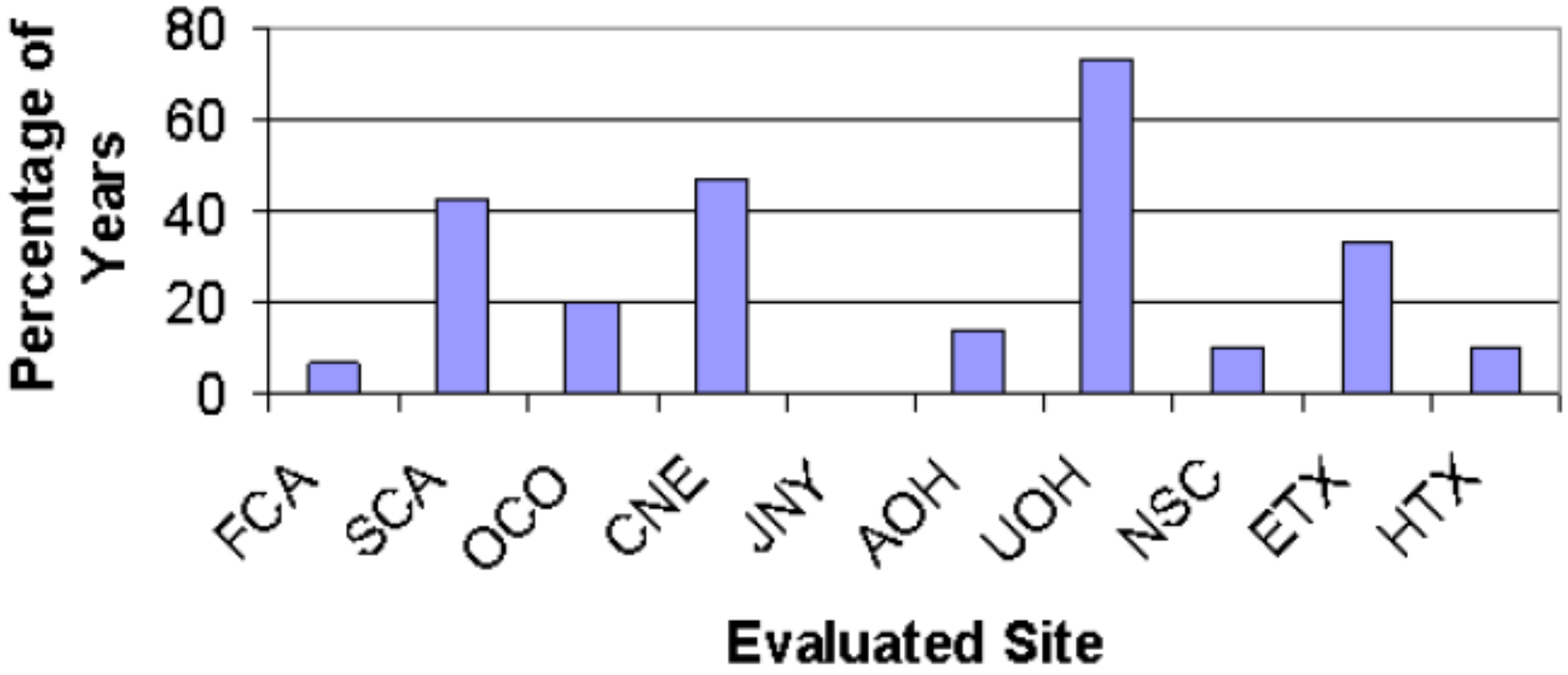


Figure 21-7a. Schematic of a pumpdown marker in lagoon.

Figure 2 Frequency of pumping during critical storage period to maintain storm volume - AWM Design



Courtesy Moffitt et al. (2003)

What If It Goes Sour?

Remedial Strategies and Tactics

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Effect of Intervention on Odor from a Two-Stage Dairy Lagoon System in Idaho

Table 5. A comparison of "as-measured" VOC emission rates ($\mu g\ m^{-2}\ min^{-1}$) for the storage and treatment lagoons among 2004, 2005, and 2006.[a]

	Storage Lagoon			Treatment Lagoon		
Compound	2004	2005	2006	2004	2005	2006
Acetic acid	1.59	0.45	0.97	2.04	1.5	1.31
Propionic acid	0.55	0.19	0.35	0.48	0.31	0.26
Isobutyric acid	0.31	0.1	0.16	0.22	0.16	0.2
Butyric acid	4.17	2.87	4.92	7.13	3.3	1.88
Isovaleric acid	0.05	0.03	0.03	0.11	0.05	0.04
Valeric acid	0.52	0.03	0.54	1.23	0.67	0.5
Hexanoic acid	0.76	0.47	0.61	1.8	0.77	1.38
Phenol	87.09	2.5	2.84	154.98	10.49	6.97
P-cresol	51.62	22.33	3.06	116.84	19.32	10.79
4-ethylphenol	3.83	1.56	0.38	7.75	1.55	2.02
Indole	4.67	0.73	0.41	9.41	2.62	0.89
Skatole	2.07	0.37	0.6	27.45	2.33	1.42
Sum ($\mu g\ m^{-2}\ min^{-1}$)	157.21	31.62	14.88	329.45	43.07	0.0[b]

[a] Emission rates were measured in the laboratory using a small wind tunnel with a wind velocity of 1.3 m/min.

[b] Field emissions were effectively zero because the treatment lagoon was covered in 2006. (Emissions from wastewater measured in the laboratory were 27.7 $\mu g\ m^{-2}\ min^{-1}$).

Courtesy D. Parker (2008)

Parker's Intervention, 2004-2006

- Covering the storage lagoon was not practical
- Reduce VS loading rate by 50%
  - Vacuum removal of manure from flush lanes prior to flushing; reduce flushing frequency
  - Maintain settling basins more aggressively
  - Separators put into continuous operation
- Increase aeration capacity 3x in storage lagoon (from 7.3 to 22.0 hp/ac)
- Reduce sludge accumulation rate by eliminating sand bedding

Q&A