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# **Designing for BOD When Using NSF Standard 40 Listed Units**

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**First you must understand the  
test !**

# Test Overview

- Unit size test 400-1500 gpd typically 500 gpd
- Length of test 6 months
- Dosing Frequency

6am-9am	35% of rated flow	(175g)
11am-2pm	25% of rated flow	(125g)
5pm-8pm	40% of rated flow	(200g)
	Total	(500g)

- Flow is delivered in ten gallon doses, but no rate defined.

- Test includes stress loading simulations four conditions.
  1. Wash day stress
  2. Working parent stress
  3. Power/equipment failure stress
  4. Vacation stress
- Test Report will provide Average influent BOD<sub>5</sub> and effluent CBOD average , as well as average flow.
- Test report identifies if unit is equipped with primary treatment.

# What is learned from a test and understanding the test?

- The Maximum Hydraulic Daily Flow the unit is rated for, as well as instantaneous peak flows ( $\approx 5$  gallons in 16 seconds or 18.75 gpm) and 100% of flow in 14 hours as well as 40% of flow in 3 hours. These are hydraulic peak flows to consider when designing.
- The report also typically list the **MAXIMUM** daily organic loading, the unit is rated for. Normally it is 1.25 lbs BOD<sub>5</sub> for a 500 gpd unit or 3.75 lbs BOD<sub>5</sub> for 1500 gpd unit.
- This is developed using the maximum (not actual) theoretical BOD<sub>5</sub> loading during a Standard 40 Test.

$$\frac{1500}{1,000,000} \times 300 \text{ mg/L} \times 8.34 = 3.75$$

Test influent range is 100 mg/L to 300 mg/L

# What is learned from a test and understanding the test? (cont.)

- A design using the maximum organic load without a safety factor is likely to not perform properly!
- Here is an example of how to design for BOD<sub>5</sub> using the three methods I routinely see.
- Method 1- most common Method 2 -common Method 3 -correct.
- Assume we are designing for an RV Park with 40 RV's. This park allows up to two persons per RV, and only new RV's are allowed.
- Hydraulic flow 40 gpd with water saving fixtures from Table III Chapter 285.

$$40 \times 40 \text{ gpd} = 1600 \text{ gpd}$$

# Method 1

Method 1 : Designer specifies two 800 gpd units and if you are lucky, two 1000 gpd units.

The system includes a 500 gallon septic tank then a Tee fitting to split the flow to the two treatment units .

# Method 2

- Designer understands RV parks have higher strength wastewater and was told the County will not approve anything less than 600mg/l BOD strength.

Designer calculates BOD Strength.

$$\frac{1600}{1,000,000} \times 600 \text{ mg/l} \times 8.34 = 8 \text{ lbs}$$

Designer reads Manufacturer's 1500 gpd unit and it says it's rated at 3.75 lbs BOD a day.

Designer specifies two 1500 gpd units , assuming the septic tank will reduce the incoming BOD by 30% so the two units will be fine .

# Method 2 continued

- The designer lays out the system as follows, knowing flow equalization is important as well as duplex pumps on commercial systems :
  - 800 gallon septic tank
  - 2000 gallon flow equalization tank with a duplex pump set up, one pump going to one aerobic unit, one going to the other.
  - Two 1500 gpd aerobic units.

# Method 3

- Designer assumes the same average daily flow but understands the common definition of average “ average , mean , medium, normally means something that represents a **middle point**”.
- Designing on the average means designing to fail 50% of the time.
- To ensure this is considered designer assumes 150% of average flow or 2400 gpd.
- Designer knows that County minimum BOD for RV parks is 600 mg/l BOD , but also that 900 mg/l is more realistic.
- Designer chooses to use 900mg/l but adds a safety factor by using 150% in flow as noted above.

# Method 3 continued

- Designer wants adequate pretreatment so specifies approximately the design flow capacity plus a commercial effluent filter or three 500 gallon tanks for 1500 gallons treatment capacity , this way ensuring a small vacuum truck can pump the tanks dry and taking no credit for BOD reduction in pretreatment.
- Designer wants adequate flow equalization tanks so a volume of 3000 gallons is used, The designer includes a duplex pump set up pumping to surge flow splitter tank .
- Designer calculates BOD as  $2400/1000000 \times 900 \times 8.34$  or 18 lbs

# Method 3 continued

- Designer sees aerobic unit brochure that says the ACME 1500 gpd unit is rated at 3.75 lbs per day, and owner insists on using that brand. Designer assumes 70% of rated capacity as that's maximum ( not average ). ACME tells owner designers should use the 3.75 number. Designer is unsure so requests a copy of the test report. Test report shows that average BOD during test was 201 mg/l and CBOD barely passed the test. So Designer calculates tested BOD instead of Maximum.  $1500/100000 \times 201 \times 8.34 = 2.51$  lbs BOD . Designer elects to use 2.5 lbs reduction per 1500gpd ACME unit.

# Method 3

- Designer takes 18 lbs BOD divided by 2.5 lbs per ACME unit equals 7.2 units. ( that's 10,800 gpd in rated capacity so eight 1500 gpd units or eleven 1000 gpd units ) Designer chose the 8 units.
- System has the following :
  - Three 500 gallon septic tanks in series with last one having a commercial effluent filter as the outlet. ( 1500 gpd total capacity
  - Two 1500 gallon flow equalization tanks connected at the bottom\..

# Method 3 continued

- In the flow equalization tank battery there is a duplex pump set up discharging to the surge tank . The designer calculates the flow using a pump curve and surge tank capacity ensuring that equal doses occur 24 times a day and equal flow goes to all units .
- The surge tank discharges equally to all 8 of the ACME 1500gpd units.

# Comparing Methods

- Method 1 : 500 septic tank , Tee flow splitter and two 1000gpd units.
- Method 2 : 800 septic tank 2000 gallon flow equalization duplex pump each pump discharging to one 1500 gpd unit.
- Method 3 : Three 500 septic tanks last one with an effluent filter , 3000 gpd flow equalization , duplex pump discharging to an 8 outlet surge tank , 8 1500 gpd units.
- Cross Check BOD loading per person.

$$40 \text{ RV's} \times 2 \text{ persons per} \times 0.175 \text{ BOD/person} = 14 \text{ lbs}$$

- The assumption used to be 0.175 lbs per person, however with the increased use of garage disposals ( including in park model RV's,)some jurisdictions use 0.20 lbs per person resulting in 16 lbs .

# Compring Methods continued

- Method 1 true capacity  $1000/1000000 \times 201 \times 8.34 = 1.67$  per unit or 3.35 lbs so 4 times undersized
- Method 2 true capacity  $1500/1000000 \times 201 \times 8.34 = 2.51$  per unit or 5 lbs so about 3 times undersized.
- Method 3 true capacity  $1500/1000000 \times 201 \times 8.34 = 2.51$  per unit or 20 lbs system is properly sized .

# Test Data Chart

		AVG	Std Dev	Min	Max	Med	1 Quart	2 Quart	3 Quart	4 Quart	Data Points
Dosed Volume (Gals)		468	118	0	500	500	500	500	500	500	182
Dissolved Oxygen, mg/L	Aeration chamber	2.90	0.53	1.79	4.82	2.92	2.53	2.92	3.21	4.82	116
	Effluent	2.10	0.66	1.03	5.56	2.08	1.62	2.08	2.58	5.56	116
Ambient Temperature, °C	Influent	14.8	9.0	4.0	26.4	20.7	4.0	20.7	22.5	26.4	131
	Aeration chamber	19.4	3.3	13.7	27.1	19.8	16.2	19.8	21.8	27.1	116
	Effluent	13.6	8.9	4.0	26.8	17.5	4.0	17.5	21.8	26.8	116
pH	Influent	7.43	0.17	6.67	7.95	7.43	7.36	7.43	7.51	7.95	131
	Aeration chamber	7.21	0.15	6.76	7.72	7.21	7.12	7.21	7.30	7.72	116
	Effluent	7.22	0.16	6.93	7.64	7.21	7.09	7.21	7.32	7.64	116
BOD, mg/L	Influent	200	36	130	330	200	180	200	220	330	132
CBOD, mg/L	Effluent	9	4	3	23	9	7	9	11	23	116
Total Suspended Solids, mg/L	Influent	180	56	71	490	180	140	180	210	490	132
	Aeration chamber	1,900	1,800	12	8,900	1,500	590	1,500	2,700	8,900	116
	Effluent	9	5	2	24	8	6	8	11	24	116
Volatile Suspended Solids, mg/L	Influent	37	31	0	140	24	12	24	58	140	134
	Aeration chamber	710	670	5	3,400	510	220	510	980	3,400	116
	Effluent	4	4	0	20	3	2	3	6	20	116
Settleable Solids (mL/L)	Aeration chamber	150	110	9	460	130	72	130	230	460	116

Table 1 Summary of Analytical Data

# From the Standard 40 Report

- Average Daily Flow 468 gpd
- Average BOD 200 mg/L
- Average BOD Load during test

$$\frac{468}{1,000,000} \times 200 \text{ mg/L} \times 8.34 = 0.78 \text{ lbs}$$

This is for a 500 gpd unit.

- Max BOD loading calculated.

$$\frac{500}{1,000,000} \times 300 \times 8.34 = 1.25 \text{ often reported}$$

Up-sized units are proportional

- 1500 gpd unit is 3 times a 500 gpd
- So, if this 500 gpd treats 0.78 lbs a day - a 1500 gpd would treat  $3 \times 0.78 = 2.34$  lbs.
- This method requires access to the test report.

# General Thoughts

In general its safe to assume BOD treatment capacity is 70% of maximum capacity.

A unit that has 200 BOD influent and 5 CBOD effluent is better than a unit with 205 BOD influent and 25 CBOD effluent.

Pretreatment tanks with effluent filters are your friend , flushable wipes aren't.

# OSSF Texas Trivia

- When spray irrigation was first approved for use by the Texas department of Health what was the reasoning?
- A .Nothing was working along the Gulf Coast due to tight clay soils and high groundwater and high rainfall amounts.
- B. The Texas Board of Engineers insisted.
- C To help with the water shortage occurring in the state.

# Answer

- C To help with the water shortage occurring in the state.
- Note regulators were asking due to nothing working along the Gulf Coast due to tight clay soils and high groundwater and high rainfall amounts.

# OSSF Texas Trivia continued

- .Where was the first residential aerobic spray system installed in Texas ?
- A .Brazoria County 1983 at the home of a City of Houston Health Official who want a system that worked in tight clay with high ground water.
- B Travis County where a LCRA official wanted to prove it worked.
- C Harris County at a Cemetery along I 45.

# Answer

- A is correct
- .Brazoria County 1983 at the home of a City of Houston Health Official who want a system that worked in tight clay with high ground water.
- B Applies to first LCRA Spray system
- Travis County where a LCRA official wanted to prove it worked.
- C Is first spray system in Harris County
- Harris County at a Cemetery along I 45.



**Questions or  
Comments?**

# NSF 245 Nitrogen Reduction

- Why worry about Nitrogen ?

# Why worry about Nitrogen ?

- **Water Pollution**
- **Heath Concerns**

# Water Pollution

Excess nitrogen can harm water bodies in many ,including :

**Eutrophication:** When nitrogen causes algae to grow too much , it can clog water intakes, use up oxygen, and block light to deeper waters. This can lead to unsightly algae scum on the surface , fish kills , and even “kill” a lake by depriving it of oxygen.

**Neurotoxins :** Some algae species,like red tide algae and blue-green algae, can release neurotoxins that are dangerous to fish.These toxins can accumulate in filter feeding shellfish ,which can then poison people or other wildlife that eat them.

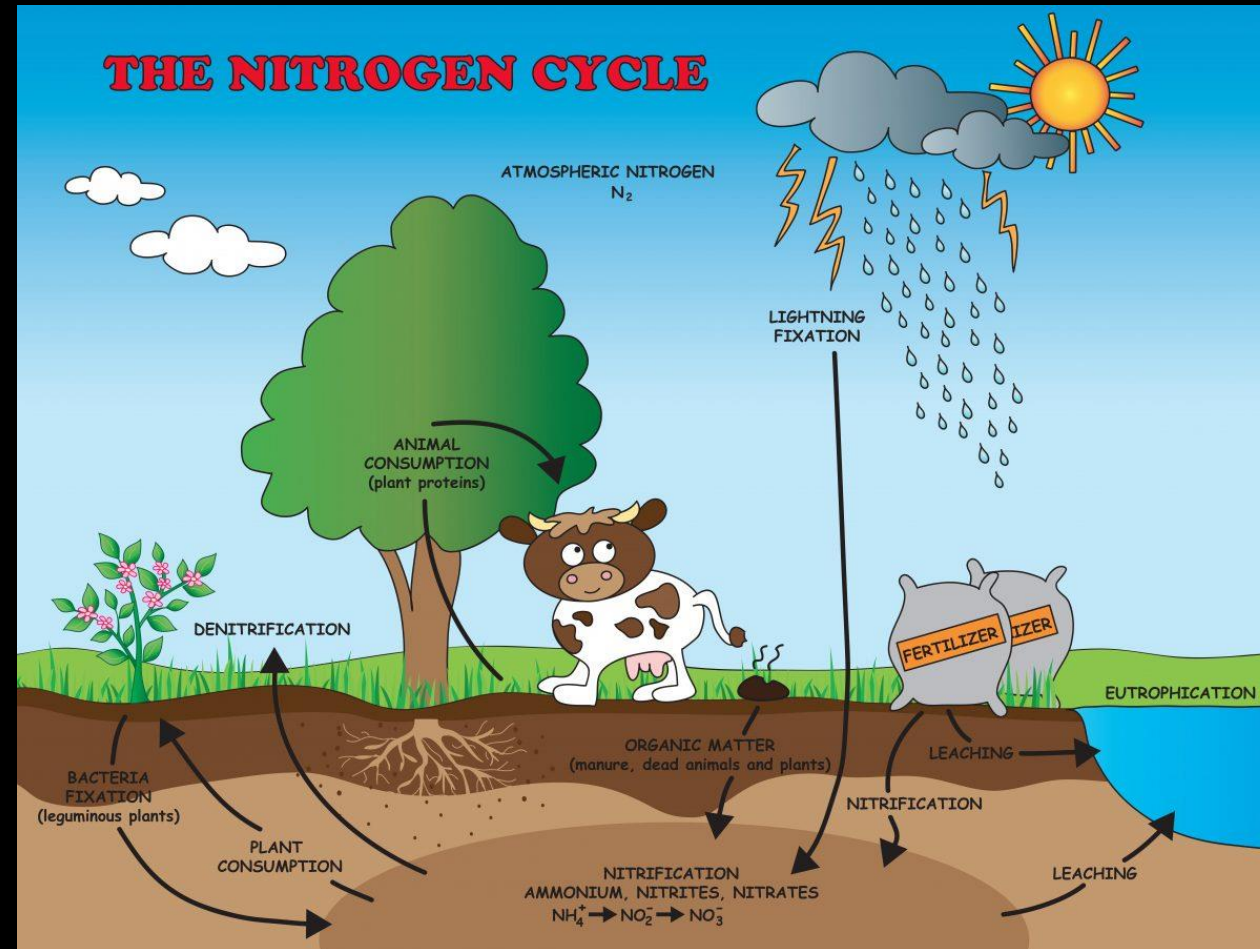
# Health Concerns

- Drinking water with high levels of nitrate can have negative health effects on people of all ages, including:
  - In Babies
    - Nitrate can cause blue baby syndrome, which is a condition that affects how the blood carries oxygen.
    - This can lead to weakness, fatigue, dizziness, and an increased heart rate. Infants with blueish skin should be taken to a healthcare provider immediately.
    - To reduce the risk of illness, you can boil and cool all bore water used for formula to room temperature on the day you use it.

# Health Concerns continued

- In Pregnant Women
- Nitrate can increase the risk of neural tube defects, which are birth defects that affect how the brain and spinal cord form. These defects can occur early in pregnancy, often before a woman knows she is pregnant. Some studies have also found an increased risk of miscarriage. If nitrate levels are high, pregnant women or women who may become pregnant should avoid drinking water with levels above 10 mg/L and using it to prepare food that requires a lot of water.
- In Adults
- Nitrate may increase the risk of thyroid disease, colon cancer, and other health effects, such as increased heart rate, nausea, headaches, and abdominal cramps. However, there is not yet scientific consensus on whether nitrate is associated with an increased risk of cancer.
-

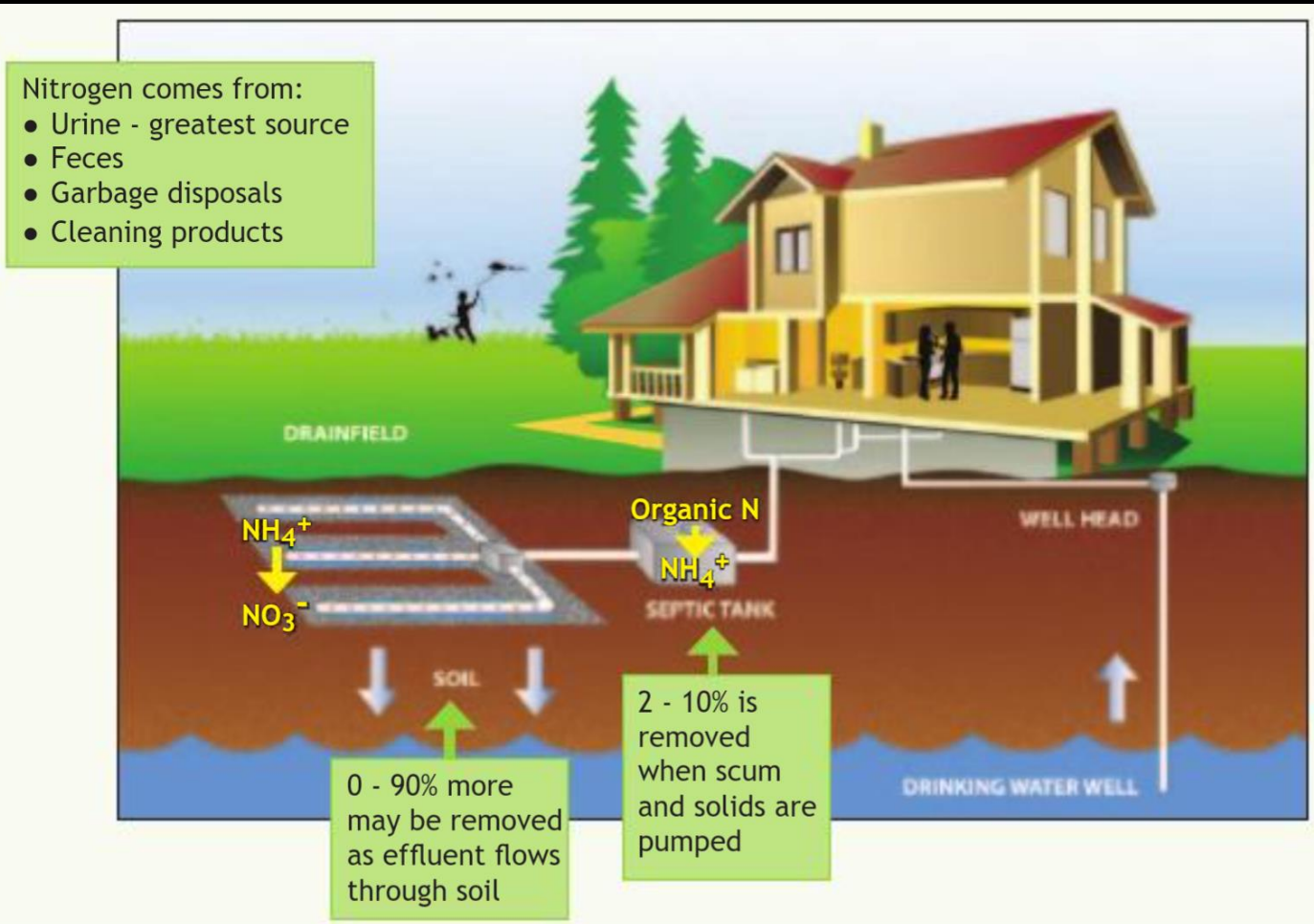
# How is Nitrogen Reduced ?



# The Nitrogen Cycle in Wastewater

- First Nitrify Effluent by introducing Oxygen ( Injecting Air , Flowing through Unsaturated Soil, etc. ).
- Next Denitrify by causing Effluent to be in an Anoxic Condition ( depleted of dissolved oxygen )
- Once in this condition the Nitrogen releases to the environment in a Gas Form

# Septic Tanks don't !



# Just like Standard 40 but .....

- During the design loading periods, flow proportioned 24-hour composite influent and effluent samples are collected three times per week. The influent samples are analyzed for five-day biochemical oxygen demand (BOD5), total suspended solids (TSS), alkalinity, **total Kjeldahl nitrogen (TKN), and ammonia-N**. The effluent samples are analyzed for carbonaceous five-day biochemical oxygen demand (CBOD5), TSS, alkalinity, **TKN, ammonia-N, nitrite-N and nitrate-N concentrations**. Onsite determinations of the influent and effluent pH, temperature and dissolved oxygen are made five days per week using grab samples.

# Just like Standard 40 continued

- Stress testing is designed to evaluate how the plant performs under non-ideal conditions, including varied hydraulic loadings and electrical or system failure. The test sequence includes (1) Wash Day stress, (2) Working Parent stress, (3) Power/Equipment Failure stress, and (4) Vacation stress.
- During the stress test sequences, 24-hour composite samples are collected twice during each stress recovery period (the week following completion of each of the stress simulations described). The analyses and onsite determinations completed on the samples are the same as described for the design load testing. Each stress is followed by seven consecutive days of dosing at design rated capacity before beginning the next stress test. Sample collection is initiated twenty-four hours after completion of Wash Day, Working Parent and Vacation stresses, and beginning 48 hours after completion of the Power/Equipment Failure stress.

# **In order for the system to successfully pass the Standard 245 evaluation:**

- (1) CBOD5: The average of all effluent samples shall not exceed 25 mg/L. ( like Standard 40 )
- (2) TSS: The average of all effluent samples shall not exceed 30 mg/L. ( like Standard 40 )
- (3) Total nitrogen: The average total nitrogen concentration of all effluent samples shall be less than 50% of the average total nitrogen concentration of all influent samples.
- (4) pH: Individual effluent values shall remain between 6.0 and 9.0 SU.

# Is 50 % enough ?

- Florida has areas requiring 65% and 80%.
- How much reduction you need depends on whats going on in the environment.
- Small lots and sandy soils make nitrogen travel off the property.
- A Study conducted by Texas Tech University found the the current Texas Spray Irrigation rates could cause overloading of nitrogen in arid regions of the state.

# There is no requirement now ,or is there?

- G. All on-site sewage facilities installed along the main body of Lake Houston east of I-45, (the main body being where 100' or more exist between parallel banks at normal pool elevation shall have the following additional standards.
  - 1) All systems installed within one thousand feet (1000') of the main body of Lake Houston shall have secondary treated effluent.
  - 2) All systems, installed within one thousand feet (1000') of the main body of Lake Houston shall incorporate nutrient reduction Best Management Practices (BMP's) in the treatment or disposal systems.

# Where they should be specified

- Areas close to waterbodies used for drinking water or recreation.
- When setbacks to wells or water bodies are reduced.
- In arid regions where irrigation rate is low.
- In sandy soils where effluent migration is a concern.

**Questions or Comments?**

# OSSF Texas Trivia

- . How was the loading rate for spray irrigation systems established?
- A Texas A & M Agricultural Department established the rates for the Texas Department of Health.
- B. A scientific study was performed to establish the rate.
- C A daily pan evaporation rate chart was taken from an agricultural document. The theory is you don't depend on the soil at all.

# Answer

- C A daily pan evaporation rate chart was taken from an agricultural document. The theory is you don't depend on the soil at all.

# OSSF Texas Trivia continued

- . Why doesn't Texas have comprehensive flush rates for aerobic drip irrigation systems like some states ?
- A TOWA fought against them.
- B. Aerobic onsite drip irrigation was developed in Texas , there is no science that establishes flush rate requirements, and those who developed the technology would not be persuaded by outside influences caused by failures in septic drip.
- C The Texas Department of Health determined they were not necessary.

# Answer

- B. Aerobic onsite drip irrigation was developed in Texas , there is no science that establishes flush rate requirements, and those who developed the technology would not be persuaded by outside influences caused by failures in septic drip.
- Flush rates are often specified at the scour rate for municipal sewer pipes that engineers learned in college and not based on scientific studies.

# NSF 350

- NSF/ANSI 350 - 2022 Onsite Residential and Commercial Water Reuse Treatment Systems .
- Note Commercial is included in the standard as well as Graywater.
- Systems may include:
  - – greywater treatment systems having a rated treatment capacity up to 5,678 LPD (1,500 GPD): this applies to onsite residential and commercial treatment systems that treat greywater, those that treat laundry water from residential laundry facilities, and those that treat bathing water.
  - – residential wastewater treatment systems having a rated treatment capacity up to 5,678 LPD (1,500 GPD): this applies to onsite residential treatment systems that treat combined wastewater generated by the occupants of residence(s).
  - – commercial treatment systems: this applies to onsite commercial treatment systems that treat combined commercial facility wastewater and commercial facility laundry water of any capacity, and those treatment systems that treat greywater from commercial facilities with capacities exceeding 5,678 LPD (1,500 GPD). These systems shall be performance tested and evaluated at the location of the reuse system installation, using the wastewater generated onsite from the facility serving the treatment system. See Section 8.3 for performance testing and evaluation. The key elements of a field evaluation of a commercial onsite treatment system are described in Annex A.

# Purpose

- The purpose of this standard is to establish minimum material, design, and construction, and performance requirements for onsite residential and commercial water reuse treatment systems. This standard also specifies the minimum literature that manufacturers shall supply to authorized representatives and owners as well as the minimum service-related obligations that a manufacturer shall extend to owners.

# How is Commercial Different

- Commercial treatment systems. This applies to onsite commercial treatment systems that treat one or more of the following:
  - — all wastewater from a commercial facility of any capacity;
  - — laundry wastewater from a commercial facility of any capacity; or — greywater from commercial facilities with capacities exceeding 5,678 LPD (1,500 GPD).
- These systems shall be performance **tested and evaluated at the location of the reuse system installation, using the wastewater generated onsite from the facility serving the treatment system.**

# How is Commercial Different continued

- Commercial systems are tested at the location where the wastewater is generated not at a third party ANSI accredited testing facility.
- These systems shall be performance tested and evaluated at the location of the reuse system installation, using the wastewater generated onsite from the facility serving the treatment system. The key elements of a field evaluation of a commercial treatment system are described in an Annex .

# Standard's Comparison

- Standard 40 – reduces effluent to Secondary Standards ( 30-d average of CBOD > 25 mg/L),
  - ( 30-d average of TSS > 30 mg/L)
- Standard 245- reduces effluent to Secondary Standards ( same as above)
  - - reduces nitrogen by over 50%
- Standard 350- Test averages must be:
  - CBOD 10mg/l or less
  - TSS 10mg/l or less
  - E coli to 14 MPN/100ml or less
  - Turbidity to 5 NTU or less average
  - Nitrogen 50% reduction or more
  - **Note** Graywater standards are different, as well commercial systems

# Whats the Standard for ?

- Management methods and end uses appropriate for the treated effluent discharged from onsite residential and commercial treatment systems meeting Class R (single-family residential) or Class C (multi-family and commercial facilities) requirements of this standard include indoor restricted urban water use, such as toilet and urinal flushing, and outdoor unrestricted urban water use, such as surface irrigation. Effluent quality criteria consistent with these uses are described in Section 8.6, Criteria. This standard is intended to address public health and environmental issues. Actual performance for any site or system may vary, depending on variations in raw water supply (such as alkalinity and hardness), wastewater constituents,

# But we already spray with Standard 40 units ?

- In Texas that is true but in many States ,they only allow Standard 40 units in lieu of septic tanks or to reduce drainfield sizing in soils where biomat is the limiting factor ( New England for example).
- Texas continues to surprise Health Officials throughout the Country that we allow spray of Standard 40 effluent.
- Without more rigorous maintenance oversight Texas is one upset legislator away from ending spray irrigation or any required maintenance depending on what happens.

# When a NSF 350 unit should be specified

- Areas close to waterbodies used for drinking water or recreation.
- When setbacks to wells or water bodies are reduced.
- In arid regions where irrigation rate is low.
- In sandy soils where effluent migration is a concern.
- Reduced setbacks to waterbodies including wells and perched groundwater.
- Public contact is more likely.

# OSSF Texas Trivia

- Why did Texas adopt ASTM Standards for concrete septic tanks and not an equivalent standard for Fiberglass and poly tanks?
- A The Texas Department of Health had a membership in ASTM.
- B Texas Tech did a study and determined it was needed.
- C The quality of concrete tanks was so bad , that success was getting one in the hole without falling apart.

# Answer

- C The quality of concrete tanks was so bad, that success was getting one in the hole without falling apart.

# OSSF Texas Trivia continued

- What are minimum lot sizes based on and how do they compare to other states and how were they decided on?
- A One acre for lots with a well , half acre for lots with public water. Maine is 20,000 sf for any lot. Washington has no minimum its setback driven. Sizes were established based on Hill County Regulators wishing to control development density.
- B A A One acre for lots with a well , half acre for lots with public water. Texas has the largest lot requirements in the US and they were developed by the scientists at Texas A& M
- C A One acre for lots with a well , half acre for lots with public water. Texas has average requires as they follow EPA's 1980 best practices manual.
- Note question isn't considering drip legislation and lot size effecting two counties.

# Answer

- A One acre for lots with a well , half acre for lots with public water. Maine is 20,000 sf for any lot. Washington has no minimum its setback driven. Sizes established based on Hill County Regulators wishes to control development density.
- Since individuals writing the rules where in Austin they were very sensitive to the political wishes of the surrounding County's.



**Questions or  
Comments?**