Efficiency in Wastewater Treatment

The fate of fecal coliform

National Onsite Wastewater Recycling Association

Mega Conference
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Presented by: Jake Lowe

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The opinions and information presented here is that of the author(s) and not of NOWRA

Background

Suspended Growth:

- In solution

Attached Growth:

- Synthetic media
- Fabric
- Natural aggregate or sand

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Background

Attached Growth

Background

- Physical
- Biological
- Chemical

Background

Three most important factors for treatment:

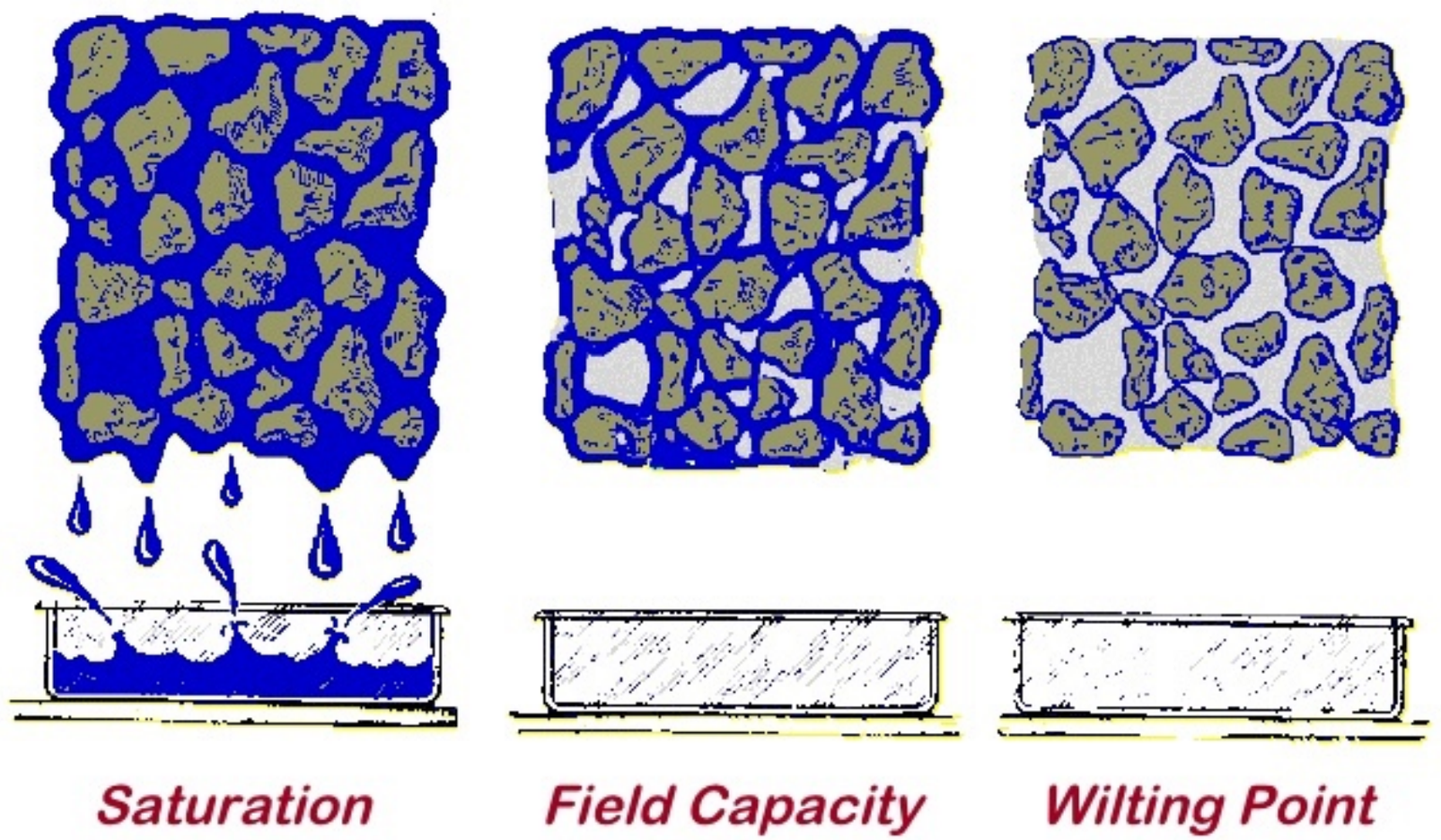
Retention time

Retention time

RETENTION TIME

Maximize Retention Time

Water holding capacity

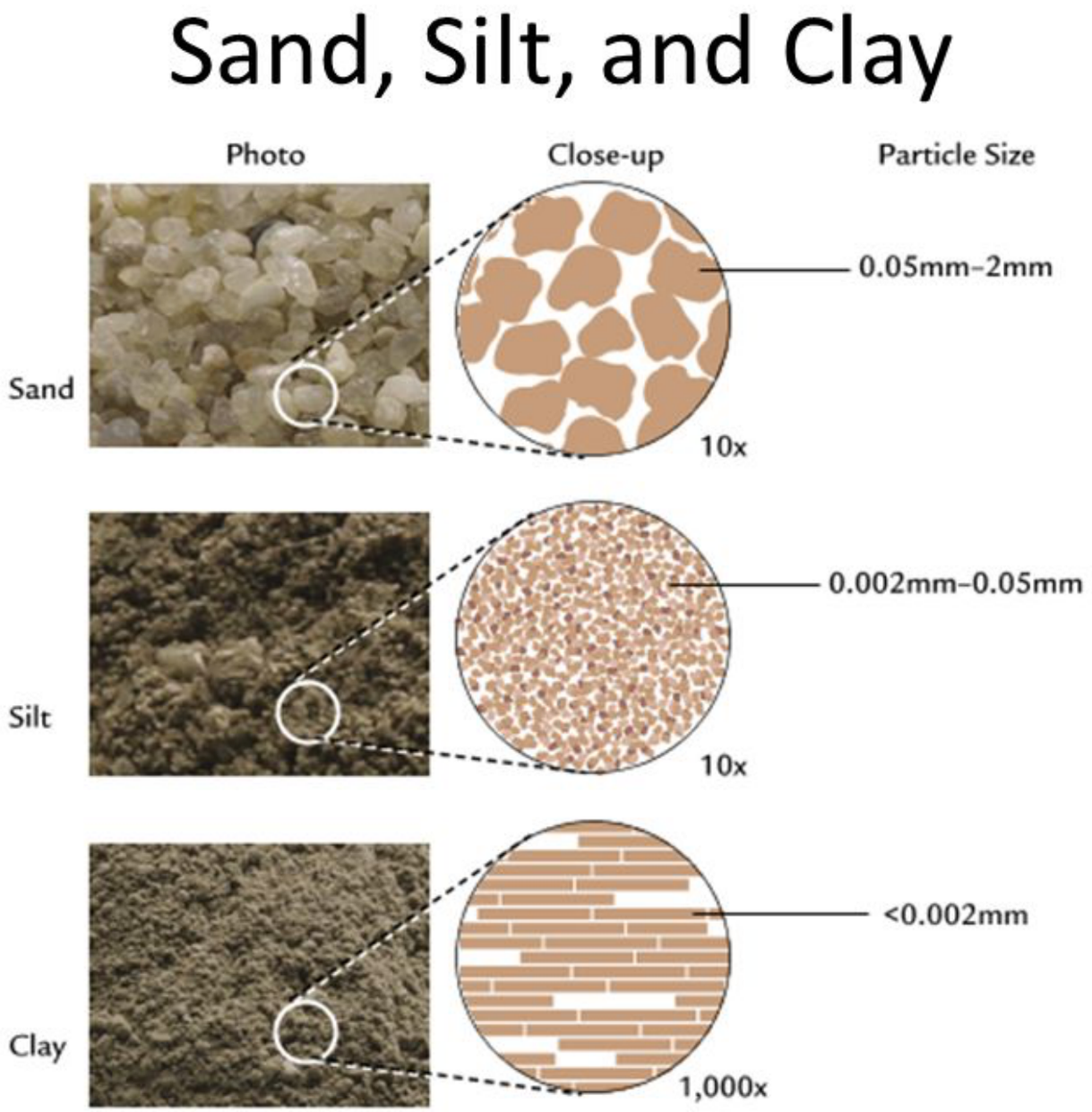


Background

Factors that effect retention time:

1. **Particle size**
2. **Media depth**
3. **Loading rate**
4. **Dose volume**
5. **Dose frequency**
6. **Distribution pattern**

Particle Size

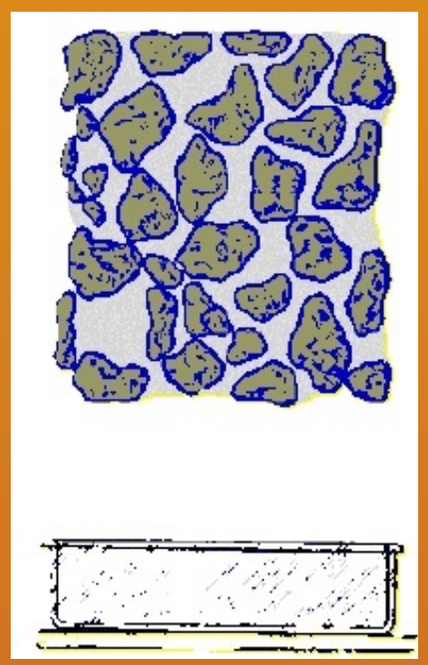


Media Depth

Increased media depth = increased retention time

Loading Rate

Increasing loading rate = reducing retention time



Dose Volume

Single vs. Multiple doses

Lawrence, MA Testing Station, 1890 to 1910

Dose Frequency

Demand dosing vs. Timed dosing

Multiple evenly spread out doses

University of Florida, Gainesville, 1940s & 50s

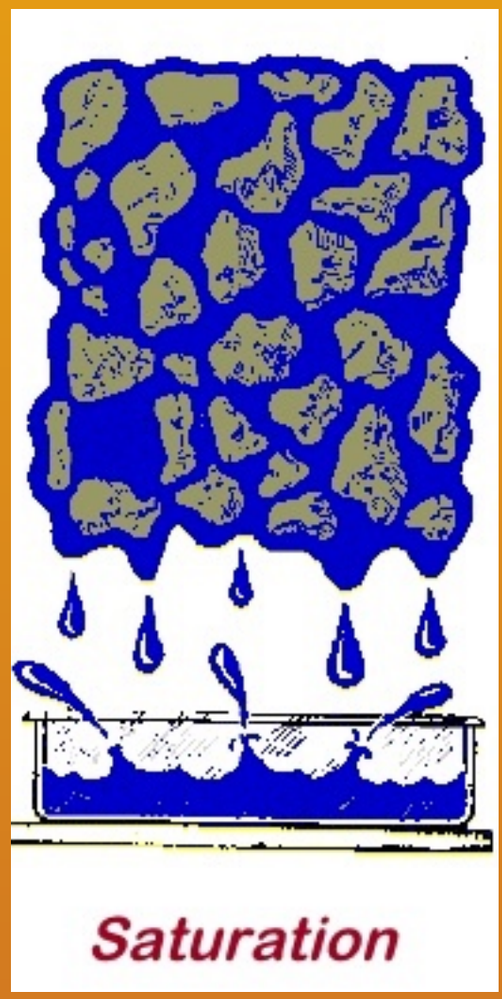
Distribution Pattern

Fewer vs. many distribution points

Dose volume vs. *distribution point volume*

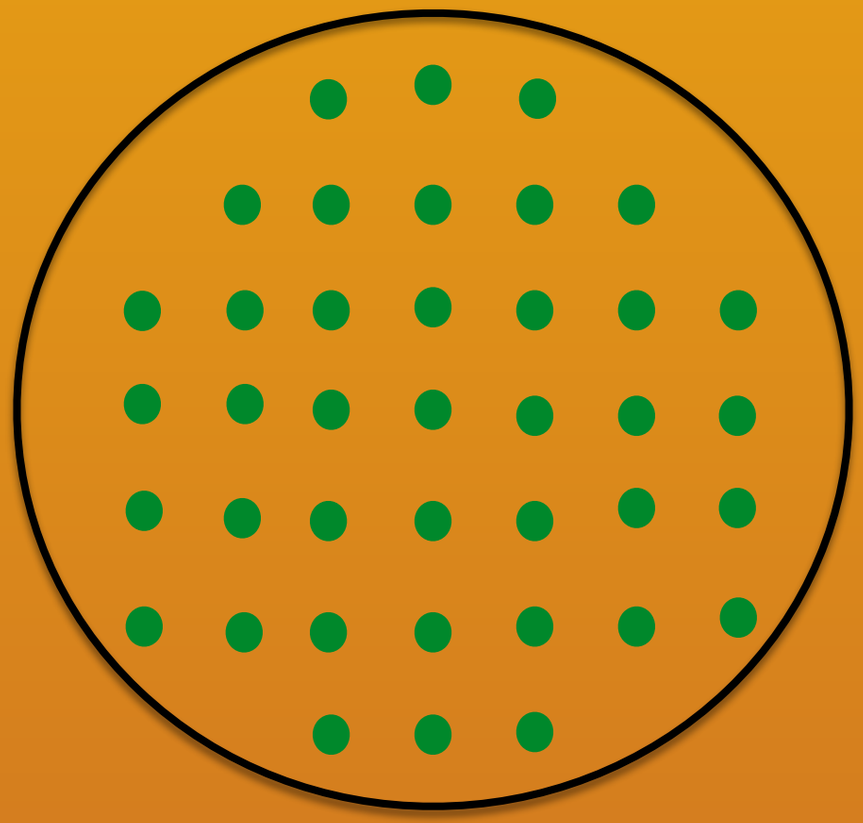
Distribution Pattern

1 gal/dose

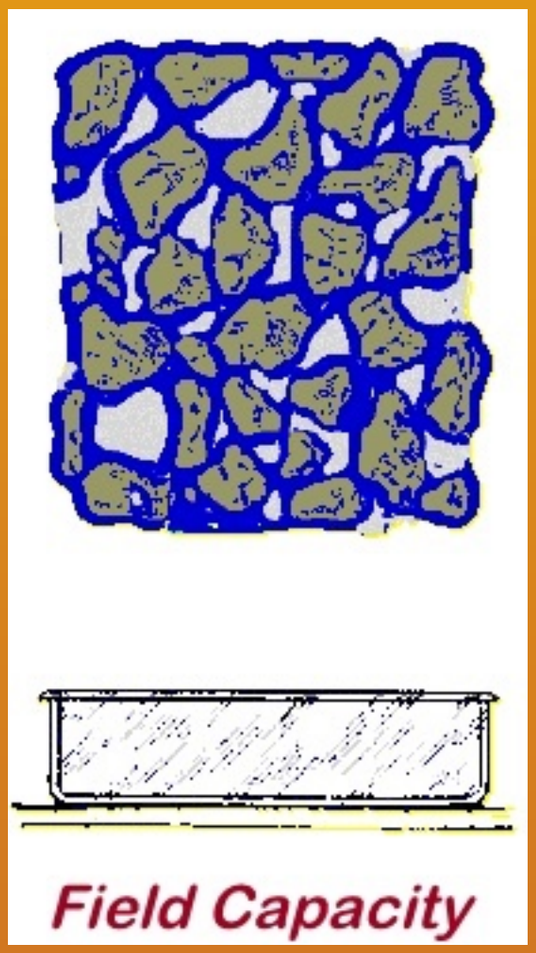


Distribution Pattern

1 gal/dose



3 oz./dose/point



Field Capacity

Distribution Pattern

In the 1940s and 50s no controls or piping materials to accomplish timed dosing.

In the 70s and 80s many States adopted sand based systems: ISF or mounds.

Distribution Pattern

1980 and subsequent USEPA onsite design manual outlined LPD systems for reduction in vertical separation requirements.

In the 1990s, WA State adopted the 3 foot vertical separation rule:

- **36 inches for gravity**
- **24 inches for LPD**

Distribution Pattern
&
Dose Frequency

Pressure Distribution Systems - Recommended Standards and Guidance
Effective Date: July 1, 2012

Soil Type 1 and 2	4 times per day
Soil Type 3	4 times per day
Soil Types 4-6	1 to 2 times per day

Maximize Retention Time

1. Small particle size
2. Increased media depth
3. Reduce loading rate
4. Small dose volumes
5. Frequent/time dosed
6. Maximize distribution pattern

Practicality

- Limits on space
- Limits on materials
- Limits on money

Test for Efficiency

- What aspects of treatment are the most important?
- Which aspects have diminishing returns?

Maximize Efficiency

- Small sand size
- Small dose volumes
- Frequent/time dosed
- Maximize distribution pattern
- Decrease media depth
- Increase loading rate

Point of Reference

Washington Sand Filter:

- **24” sand**
- **1 g/ft/d**
- **1 orifice/6 ft**
- **18 dose**
- **42 oz. / dose volume/ dist. point**
- **<1,000 fc/100 ml**

Experiment Test

- **Assumptions:**
  - **ASTM C-33 sand**
  - **6” & 12” media depths**
  - **2 & 1 gal. / ft. sq./ day**
  - **Distribution pattern = 2 emitters/ ft. sq.**
  - **360 doses per day: 1 dose every 4 minutes**

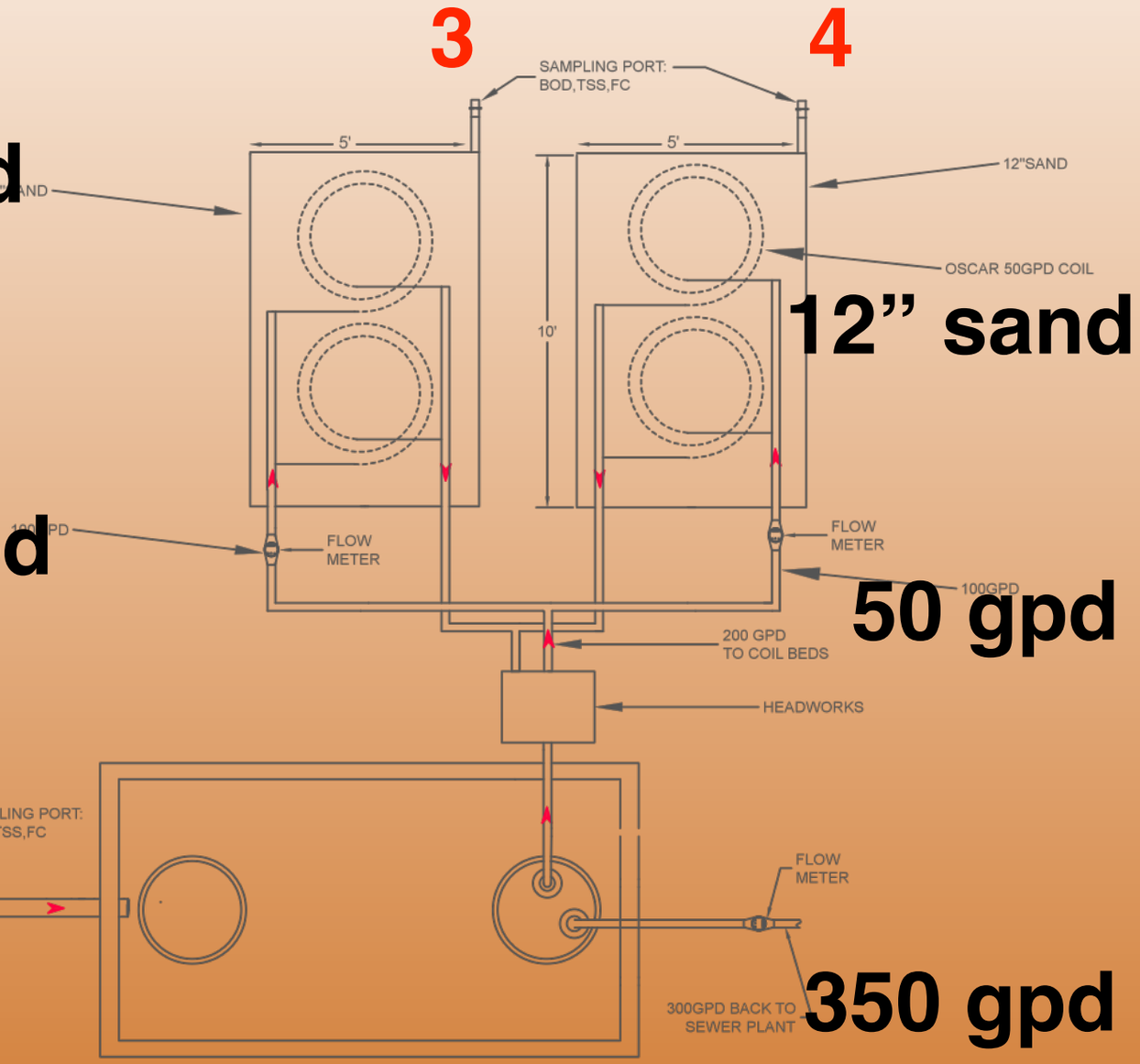
Testing Parameters

- **NSF Standard 40**
- **Washington State Fecal Coliform reduction protocol**
  - **Three grab samples per week**

Test System

500 gpd

6” sand



100 gpd

12” sand

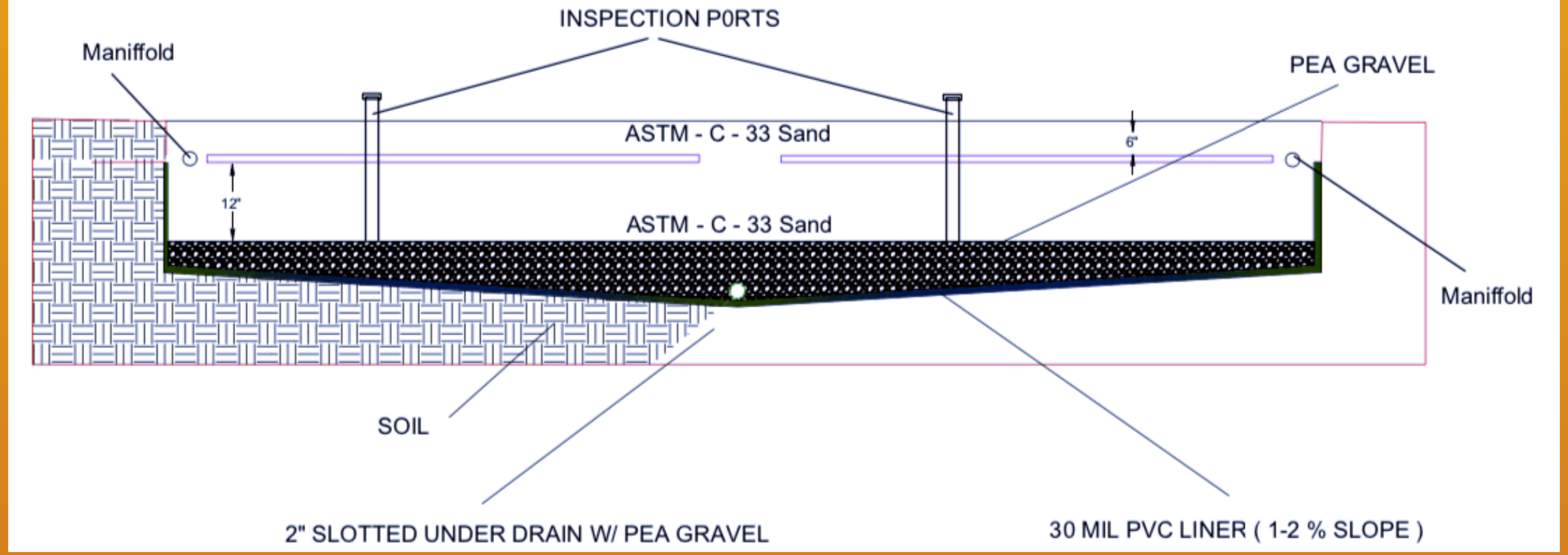
50 gpd

350 gpd

Septic

Pump Tank

Test System Cross Section



Six Months Averages

Septic Tank Influent

	Pre-septic
BOD	240 mg/l
TSS	190 mg/l
Fecal coli.	50,000,000

Six Months Averages

Septic Tank Effluent

	Pre-septic	Post-septic
BOD	240 mg/l	100 mg/l
TSS	190 mg/l	85 mg/l
Fecal coli.	50,000,000	10,000,000

Six Months Averages

Six Inch Unit Effluent

	Pre-septic	Post-septic	Post 6” OS
BOD	240 mg/l	100 mg/l	2 mg/l
TSS	190 mg/l	85 mg/l	3 mg/l
Fecal coli.	50,000,000	10,000,000	<1,000

Six Months Averages

Twelve Inch Effluent

	Pre-septic	Post-septic	Post 6” OS	Post 12” OS
BOD	240 mg/l	100 mg/l	2 mg/l	2 mg/l
TSS	190 mg/l	85 mg/l	3 mg/l	2 mg/l
Fecal coli.	50,000,000	10,000,000	<1,000	<200

Comparison

Washington Sand filter vs. Test unit

WA sand filter:

- 24” sand,
- 1 g/ft/d,
- 1 orifice/6 ft
- 18 dose
- 42 oz. / dose volume
- <1,000 fc/100 ml

Test unit:

- 6” sand,
- 2 g/ft/d,
- 2 emitter/ 1 ft
- 360 doses
- 0.35 oz. / dose volume
- Test ave.: 755 fc/100ml

Conclusions

- **Factors that have the *<u>least</u>* effects on treatment level:**
  - **Loading rate**
  - **Media depth**

Conclusions

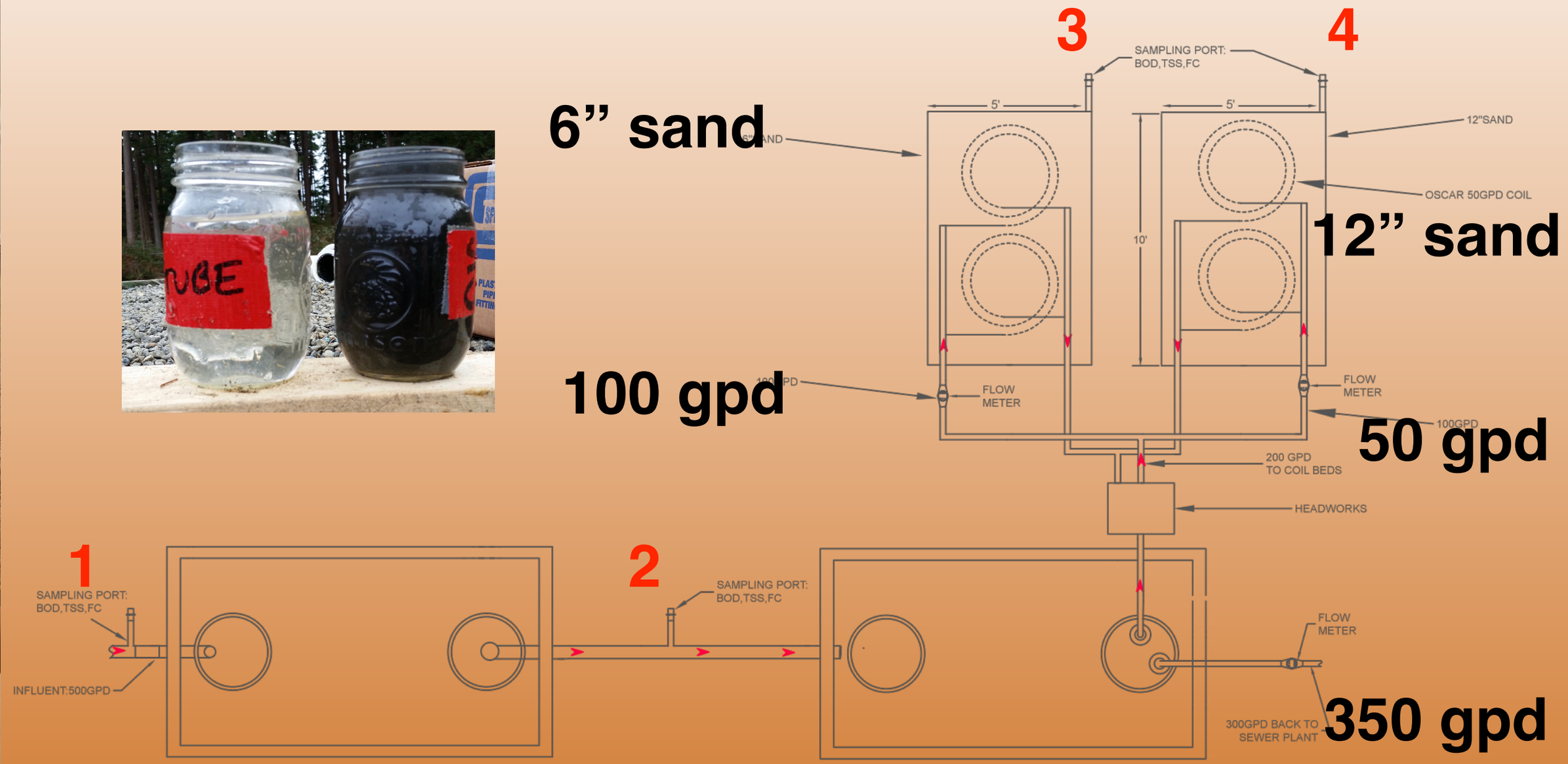
- **Factors that have the *<u>most</u>* effects on treatment level are:**
  - **Dose frequency**
  - **Distribution pattern**

Additional Modifications That Effect Fecal Coliform

Change the Waste Characteristics

6” sand

100 gpd



12” sand

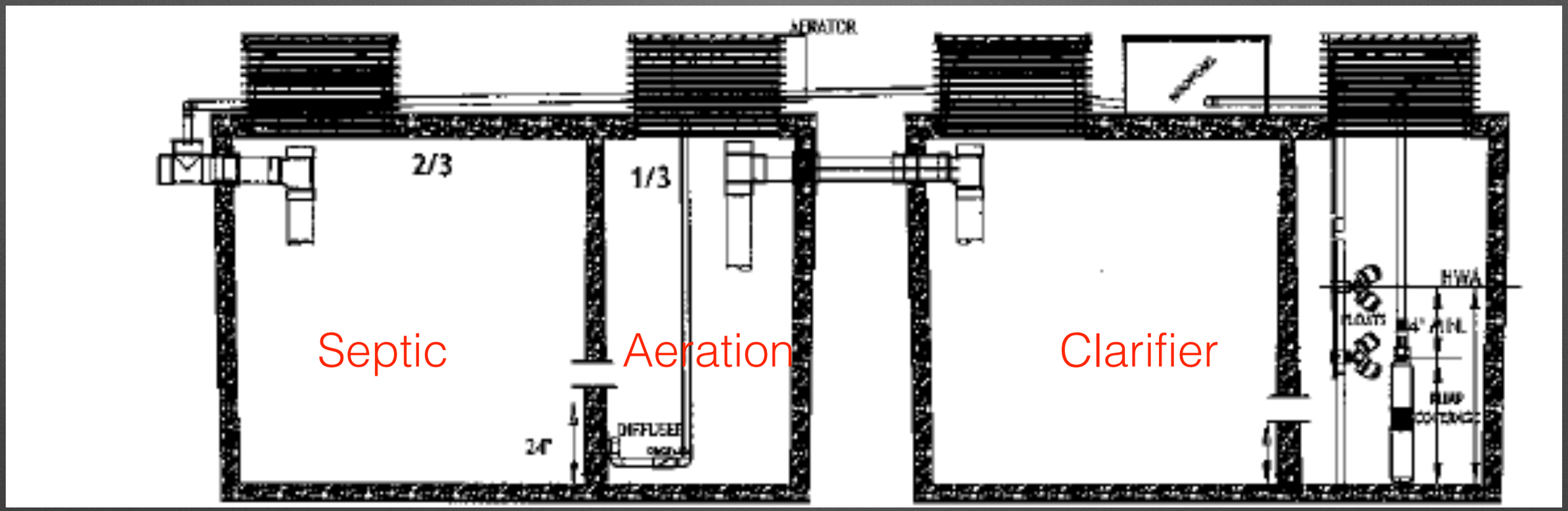
50 gpd

350 gpd

Septic

Pump Tank

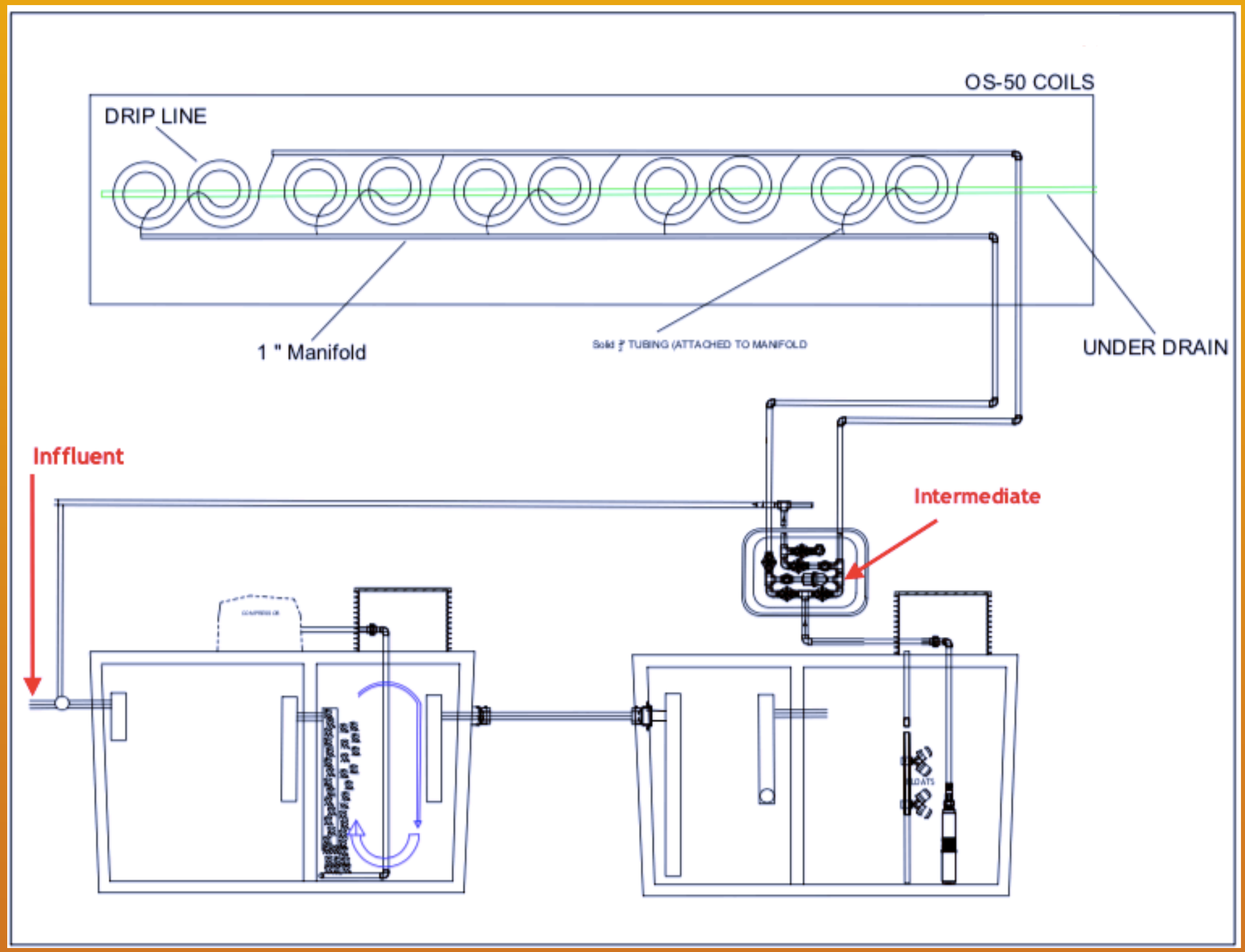
Change the Waste Characteristics



1,000 gallon

1,000 gallon

Change the Waste Characteristics

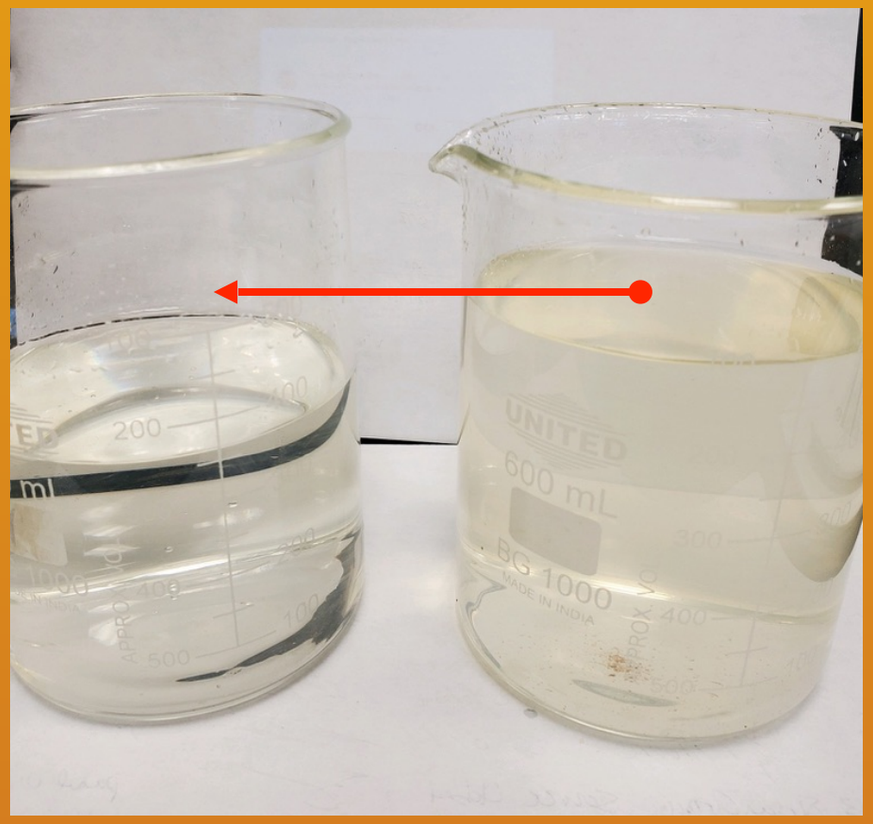


Testing Parameters

- NSF Standard 40 (BOD/TSS)
- NSF Standard 350 (Water Reuse)
- Washington State Fecal Coliform reduction protocol
  - Three grab samples per week

Septic Tank Effluent

Aerated Effluent



Prior to Sand Media Treatment

	Influent	Pre Unit
BOD	205	30
TSS	160	6
Fecal Coliform	3,000,000	30,000

Post Sand Media Treatment

	Influent	Pre Unit	Post Unit
BOD	205	30	3
TSS	160	6	2
Fecal Coliform	3,000,000	30,000	2

Post Sand Media Treatment

E. Coli.

	Influent	Post Unit
E. Coli	3,500,000	2

Class A Reclaimed: 10/10 BOD/TSS, 2.2 E. Coli

Summary

Evidence Suggests:

- Small, frequent doses, many distribution points surpasses sand depth and loading rate.
- Lowering concentration furthers reductions
- Water reuse can be achieved without disinfection.

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