NOWRA

To strengthen and promote the decentralized wastewater industry.

Subsurface Drip for Decentralized Wastewater Dispersal

Soil / Siting Assessment

Best Practices Workshop

NOWRA

To strengthen and promote the decentralized wastewater industry.

Presented By:

Tom Ashton

R.E.H.S, L.P.S.S., M.A.O.S.E

American Manufacturing Co., Inc.

Presentation Overview

Characteristics / Overview of the Soil Receiving Environment

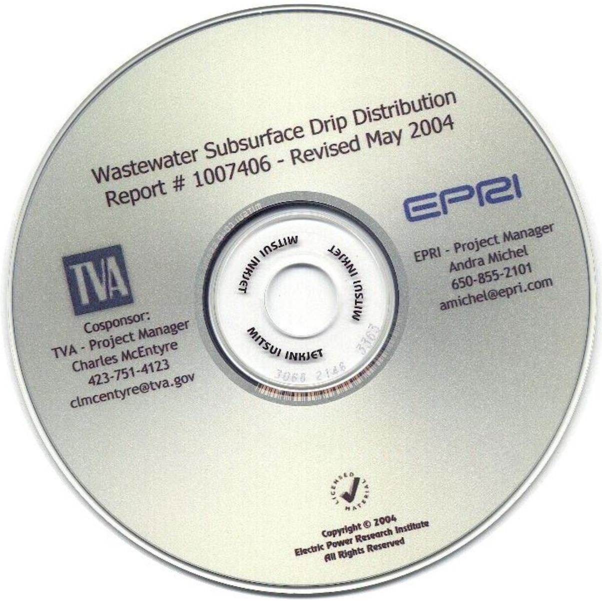
Loading Rates and Sizing Methodologies: Critical Elements

In-Situ Drip Dispersal

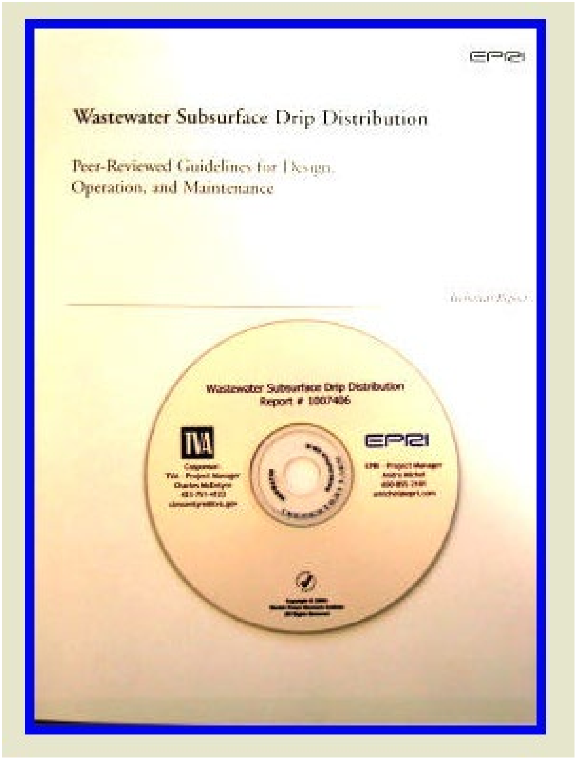
The Soil Treatment Unit

Wastewater Subsurface Drip Distribution: Peer Reviewed Guidelines for Design, Operation, and Maintenance

EPRI, Palo Alto, CA and Tennessee Valley Authority, Chattanooga, TN: 2004.
Author and Principal Investigator, J. Watson P.E.



TENNESSEE VALLEY AUTHORITY



On-Site Wastewater Treatment Systems Manual

EPA/625/R-00/008 Washington, D.C.: 2002)

EPA United States Environmental Protection Agency

<u>Chapter 4</u> Treatment Processes and Systems

<u>Chapter 5</u> Treatment System Selection

Table 5.1 <u>Types of Mass Loadings</u>

Table 5-1. Types of mass loadings to subsurface wastewater infiltration systems.

Mass loading type	Units	Typical loading rates
Hydraulic		
• Daily	Volume per day per unit area of boundary surface	<u>Septic tank effluent</u>: 0.15–1.0 gpd/ft^2 (0.6–4.0 cm/d) <u>Secondary effluent</u>: 0.15–> 2.0 gpd/ft^2 (0.6–>8.0 cm/d)
• Instantaneous	Volume per dose per unit area of boundary surface	1/24–1/8 of the average daily wastewater volume
• Contour (Linear)	Volume per day per unit length of boundary surface contour (which can be a critical design parameter in areas with high water tables)	Depends on soil K_{sat}^{a}, maximum allowable thickness of saturated zone, and slope of the boundary surface (see section 5.3)
Constituent		
• Organic	Mass of BOD per day per unit area of boundary surface	0.2–5.0 lb BOD/1000 ft^2 (1.0–29.4 kg BOD/1000 m^2)
• Other pollutants	Mass of specific wastewater pollutant of concern per unit area of boundary surface (e.g., number of fecal coliforms, mass of nitrate nitrogen, etc.)	Variable with the constituent, its fate and transport, and the considered risk it imposes

****Hydraulic Loading Rates*

****Constituent Loading Rates*

Organic

Compliance (Microbial / N / P etc.)

****Boundary Design*

The Consortium of Institutes for Decentralized Wastewater Treatment

Decentralized Wastewater Glossary

Decentralized Wastewater Glossary

Compiled by

The Consortium of Institutes for Decentralized Wastewater Treatment

National Onsite Wastewater Recycling Association

National Onsite Wastewater Recycling Association

Recommended Guidance for the Design of Wastewater Drip Dispersal Systems

This document is an engineering standard developed by the Technical Practices Committee of NOWRA, accepted by the Board of NOWRA (2006).

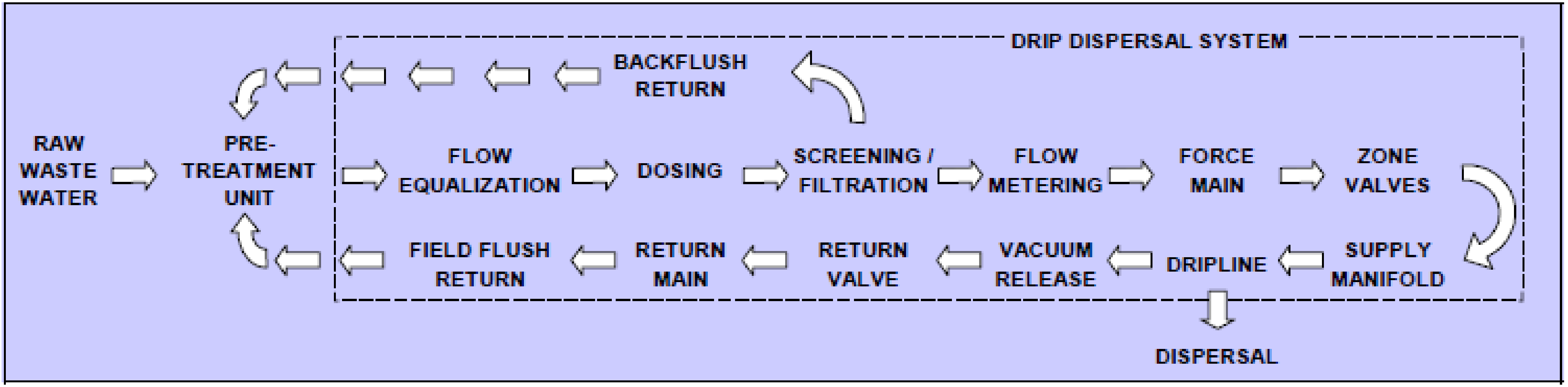


Figure 1: Drip Dispersal System Component Train

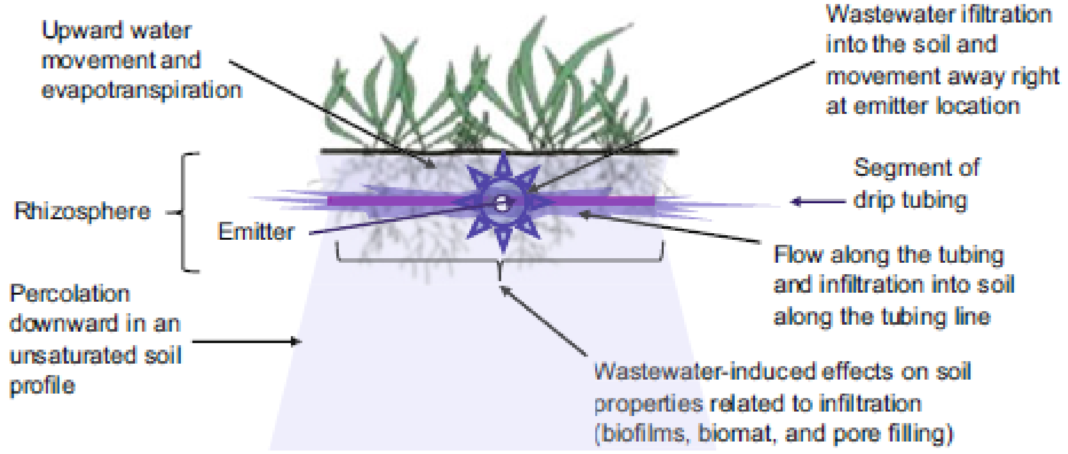
Robert Siegrist
2017

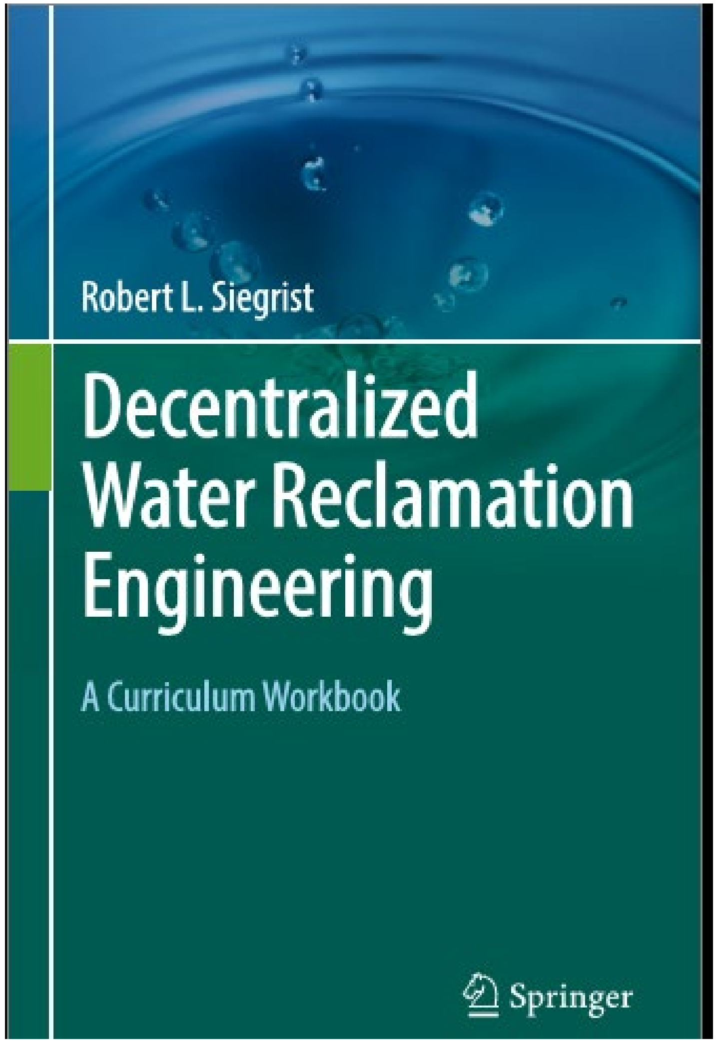
Chapter 11

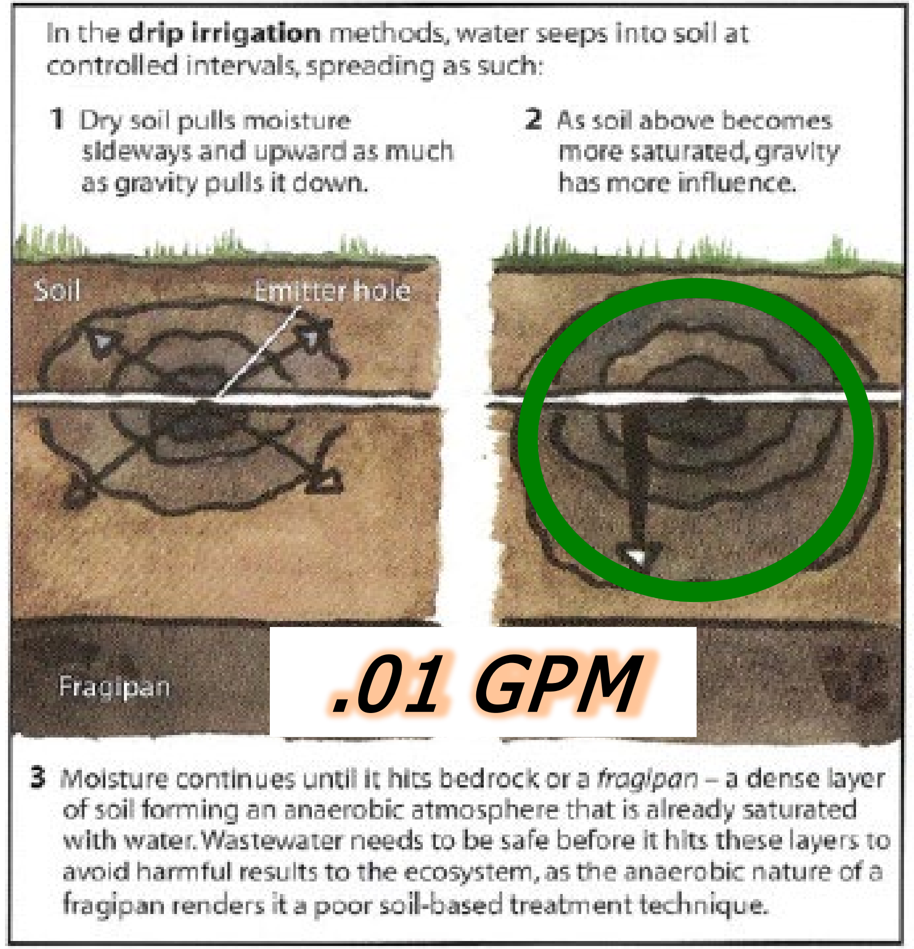
Treatment Using Subsurface Infiltration

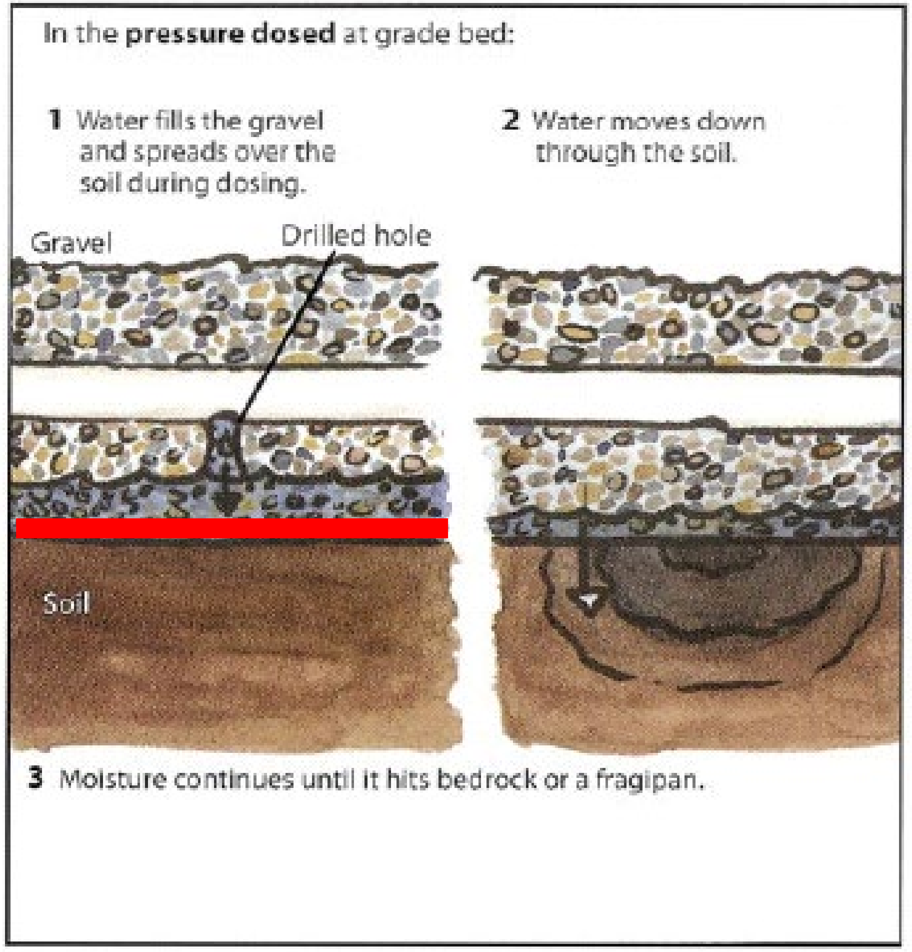
Chapter 12

Treatment Landscape Drip Dispersal









DRIP PLACES EFFLUENT *INTO* THE NATURAL SOIL SYSTEM

Graphic from "L.D. Hepner ***Alternative On-Lot Technology Research / Soil Based Treatment Systems*** (Del-VAL Phase 2)"

NOT ONTO A CONSTRUCTECTED INTERFACE

Drip *in situ* vs. LPD *interface*

SINGLE FAMILY HOME application

Drip Dispersal is often the only option /solution on Marginal Sites:

Shallow to Rock / Restriction

Shallow to Wetness

Slow Permeability Material

Shallow Placement

Reduction in Footprint (?)

Commonwealth of Virginia
State Board of Health

Sewage Handling and Disposal Regulations

12 VAC – 5-610

"Treatment works" means any device or system used in the storage, treatment, disposal or reclamation of sewage or combinations of sewage and industrial wastes, including but not limited to pumping, power and other equipment and appurtenances, septic tanks and any works, including *land*, that are or will be
(i) an integral part of the treatment process or
(ii) used for ultimate disposal of residues or effluent resulting from such treatment.

§§ 32.1-12 and 32.1-164 of the Code of Virginia.

The Soil Treatment Unit (STU)

- -The **SITE / SOIL characteristics** **determine what type of** *Treatment and Dispersal system is required.*
- **- The STU is the Primary Point of system compliance, with a system design that provides that effluent will not surface, or pollute surface and groundwater resources.**
- **- The STU is always site specific including specification of site delineation, loading rate(s), depths to seasonal / apparent wetness, and the characteristics of Permeability Limiting Features.**
- - *DRIP DISPERSAL SYSTEMS ARE TYPICALLY SPECIFIED ON THE MOST SENSITIVE & RESTRICTIVE CONDITIONS*

DRAINAGE CLASSES (old approach)

USDA–SCS SOIL DRAINAGE CLASSES

DRAINAGE CLASS	GENERAL DESCRIPTION
Excessively drained	Mottling deeper than 40 inches, very rapid permeability (sands)
Somewhat excessively drained	Mottling deeper than 40 inches, rapid permeability (loamy sands)
Well drained ★	Mottling deeper than 40 inches
Moderately well drained ★	Gray mottles (≤2 chroma) between 20 to 40 inches
Somewhat poorly drained ★	Gray mottles (≤2 chroma) between 10 to 20 inches
Poorly drained	Gray colors (≤2 chroma) and/or red mottles within upper 10 inches with predominantly gray matrix (>60%) below 10 inches
Very poorly drained	Very dark or black surface with gray subsoils

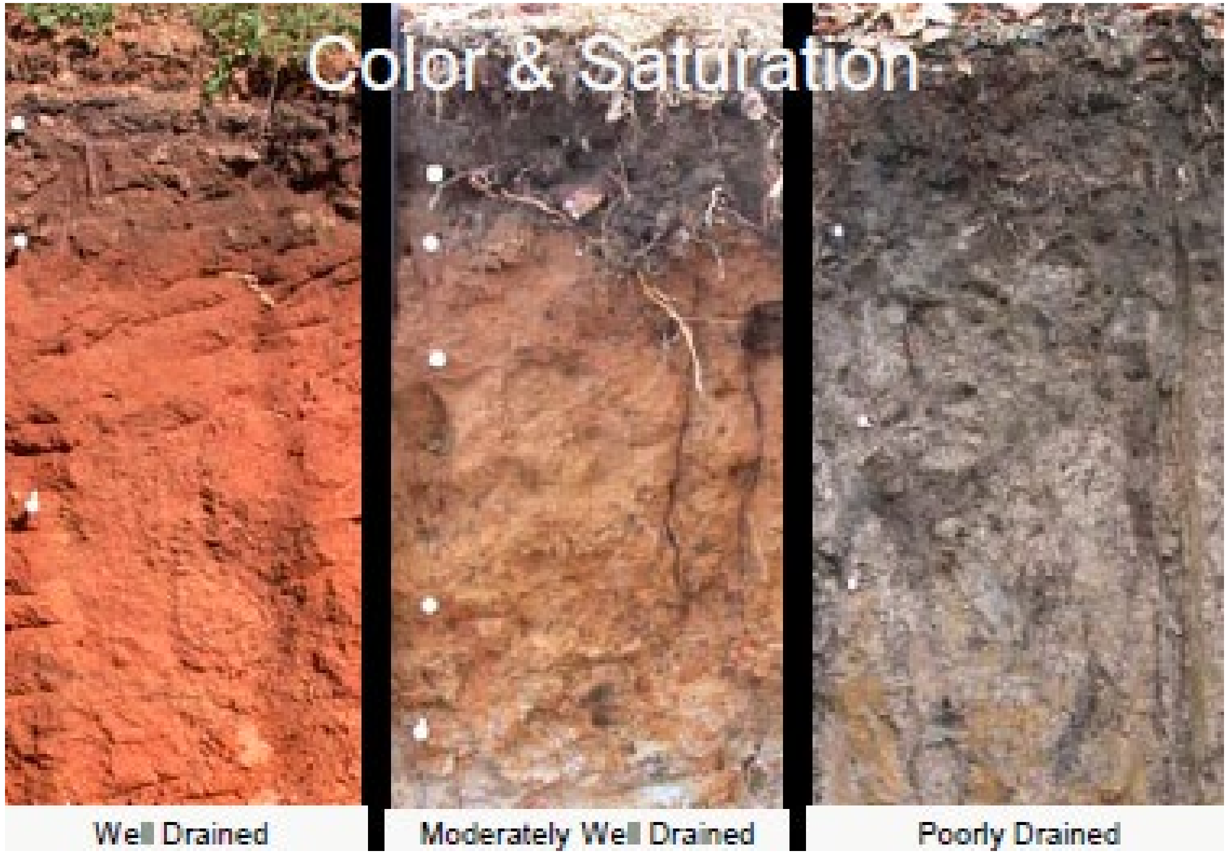
SOURCE: USDA–SCS Maryland State Office (1990).

Depth to "Chroma 2 Mottles"

10" to 20" to 40"

DRAINAGE CLASSES (Current approach)

Moderately well drained. Water is removed from the soil somewhat slowly during some periods of the year. **Internal free water occurrence commonly is moderately deep and transitory through permanent. The soils are wet for only a short time within the rooting depth** during the growing season, but long enough that most mesophytic crops are affected. They commonly have a ***moderately low* or *lower saturated hydraulic conductivity* in a layer within the upper 1 m, periodically receive high rainfall, or both.**



DRAINAGE CLASSES (Current approach)

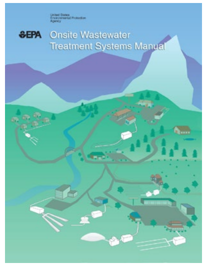
Somewhat poorly drained. Water is removed slowly so that the soil is wet at a shallow depth for *significant periods during the growing season*. The occurrence of internal free water commonly is shallow to *moderately deep* and *transitory to permanent*. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: *low or very low saturated hydraulic conductivity, a high water table*, additional water from seepage, or nearly continuous rainfall.

"Imperfectly Drained"

DESIGN BOUNDARIES AND BOUNDARY LOADINGS

Wastewater System design must focus on identifying the critical design boundaries between System components, **System /Soil interfaces**, and other places where design conditions abruptly change (*Variable Flow*).

System failure occurs at design boundaries because they are sensitive to hydraulic and mass pollutant loadings.



In a soil based system, determining critical design boundaries is the primary objective of the soil / site evaluation.

Design boundaries may be defined by the rule. Soil infiltrative surfaces, hydraulically restrictive horizons, or zones of saturation are often *critical design boundaries*.

More than one design boundary can be expected in every system, but ***not all of the identified boundaries will control design.***

EPA United States Environmental Protection Agency

Design Boundaries

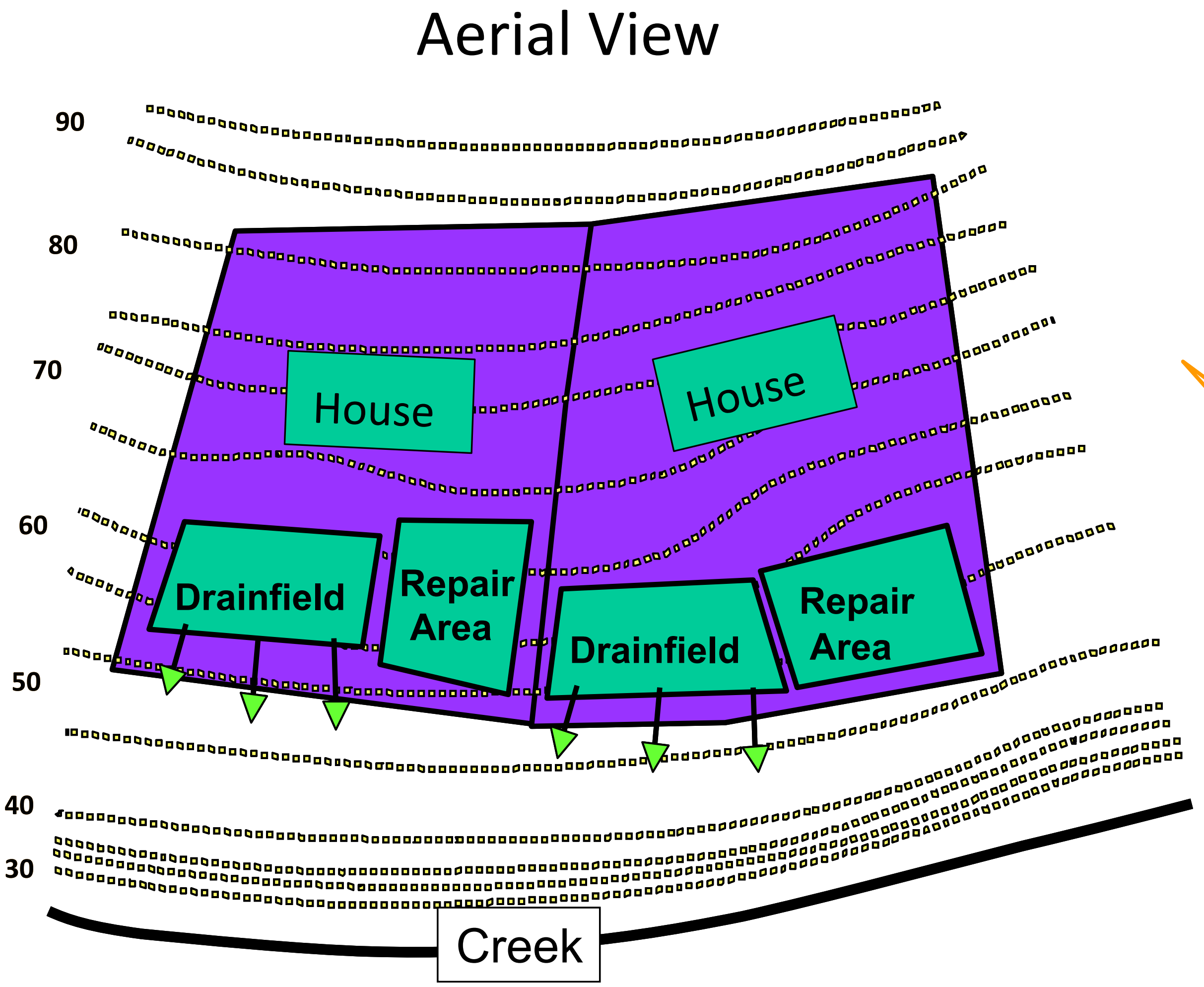
(1) INFILTRATVE SURFACE **Waste Water applied must readily leave trench**

(2) VADOSE ZONE **Water must move vertically through least permeable soil layer**

(3) PERMEABILITY LIMITING **FEATURES (PLF) Water reaching a impermeable / slowly permeable layer or Ground water must "leak" and / or move laterally away**

(4) **RECEIVING ENVIRONMENT / Compliance Boundary is the point where renovated effluent is discharged to the ground or surface water system.**

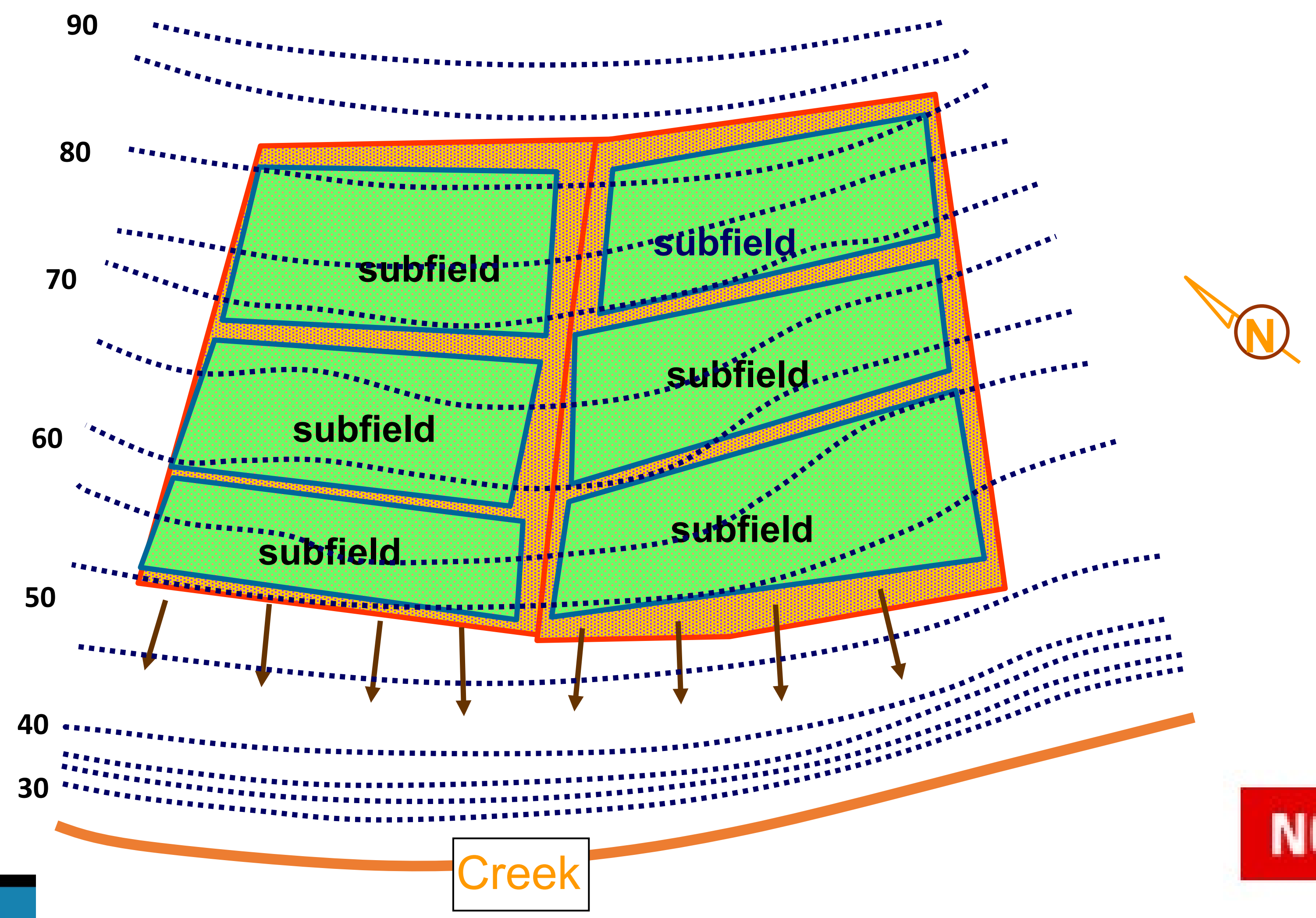
HYDROLOGY OF INDIVIDUAL SEPTIC SYSTEMS



Two one acre lots, 1000 GPD

HYDROLOGY OF A LARGE SEPTIC SYSTEM

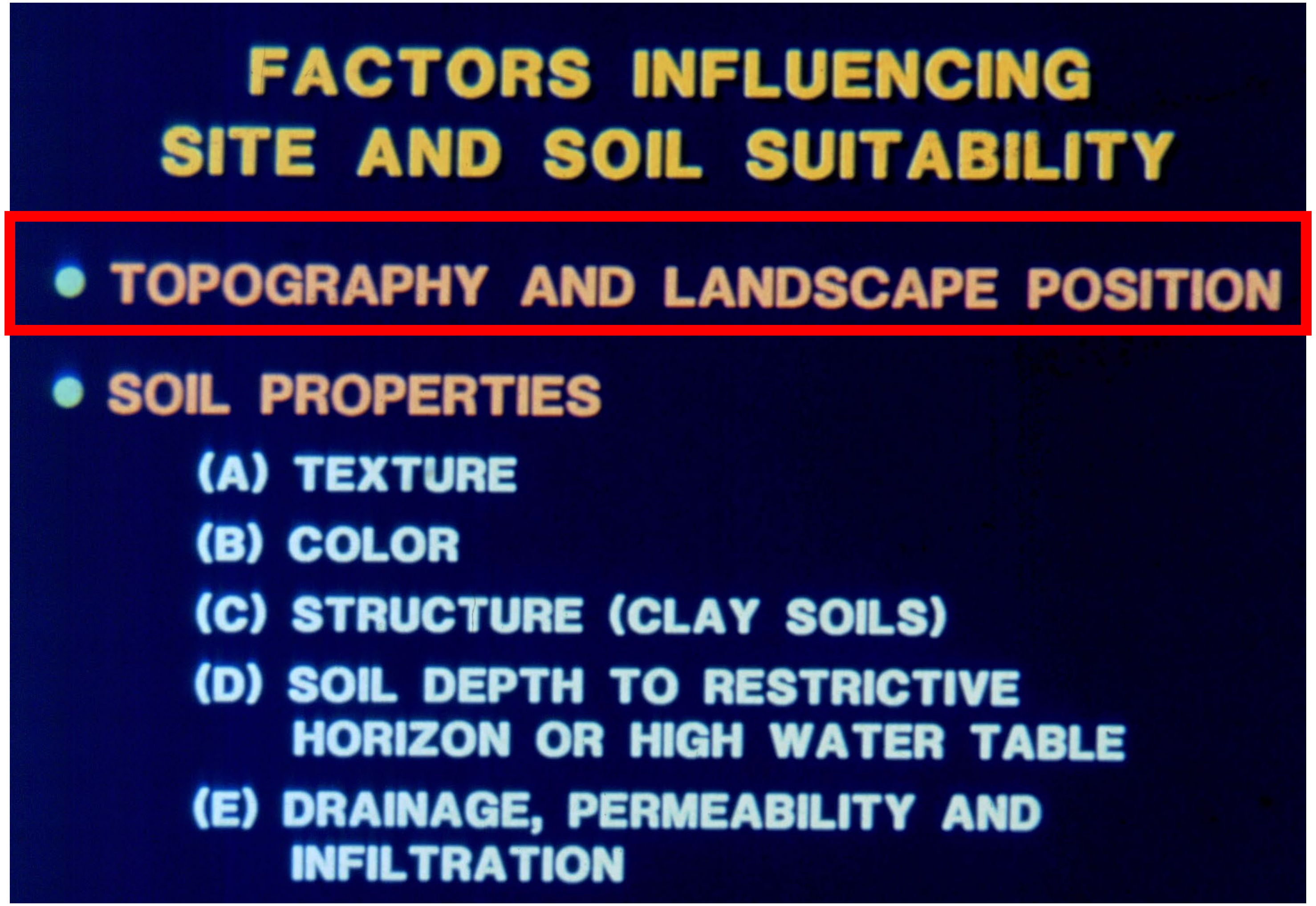
2 acres, 0.2 gal/(ft^2 d) = 114 inches per year 8700 GPD



NC STATE

It is all about the Landscape

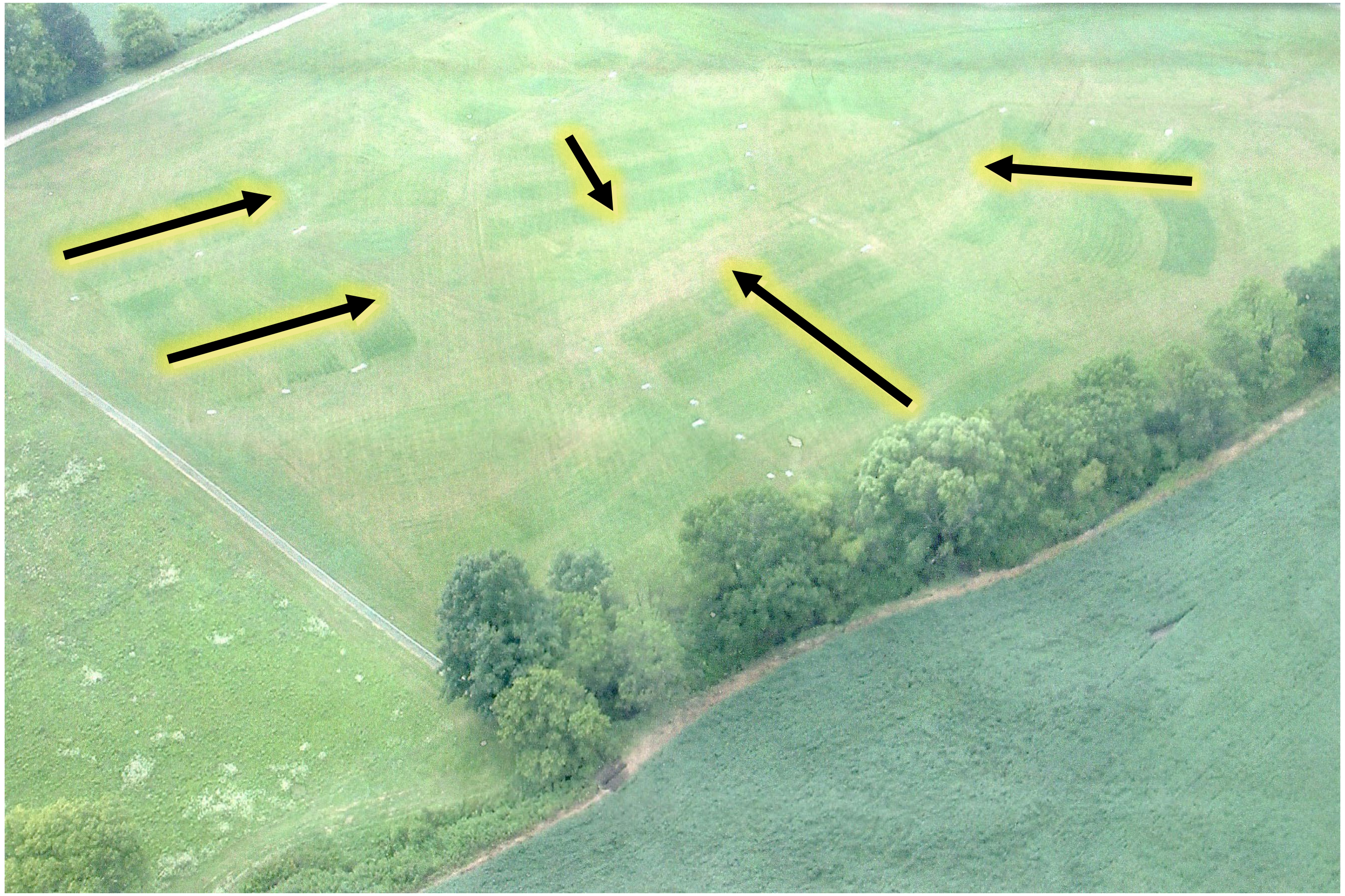
Site SPECIFIC and REGIONAL



Site Delineation

Large Flow System

TOTAL Area required may need to be increased by a factor of 1.2 to 2x + to account for unsuitable / complex topography, separation between zones, conveyance piping, access, etc.



Loading rate, hydraulic:

quantity of water applied to a given treatment component, usually expressed as <u>volume per unit of infiltrative surface area per unit time</u>, e.g., gallons per day per square foot (gpd/ ft^2).

TYPICALLY THE ONLY PRESCRIPTIVE STANDARD

Decentralized Wastewater Glossary

Compiled by

The Consortium of Institutes for Decentralized Wastewater Treatment

Effluent Quality?

Peak Daily Design Flow?

Average Flow?

<u>INFILTRATIVE SURFACE</u>

TEXTURE is general guide

TABLE 7-2

RECOMMENDED RATES OF WASTEWATER APPLICATION FOR TRENCH AND BED BOTTOM AREAS (4)(11)(12)[a]

Soil Texture	Percolation Rate min/in.	Application Rate[b] gpd/ft^2
Gravel, coarse sand	<1	Not suitable[c]
Coarse to medium sand	1 - 5	1.2
Fine sand, loamy sand	6 - 15	0.8
Sandy loam, loam	16 - 30	0.6
Loam, porous silt loam	31 - 60	0.45
Silty clay loam, clay loam[d]	61 - 120	0.2[e]

Trench Bottom Loading Rates / EPA 1980 “Perc” MPI

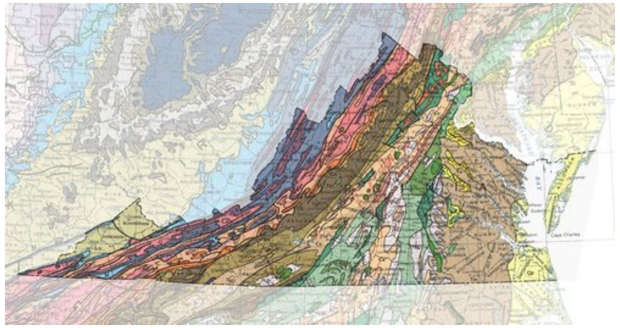
610 SH&DR STE Trench Bottom Loading Rates

Increased LOADING RATES for Dispersal

Commonwealth of Virginia
State Board of Health

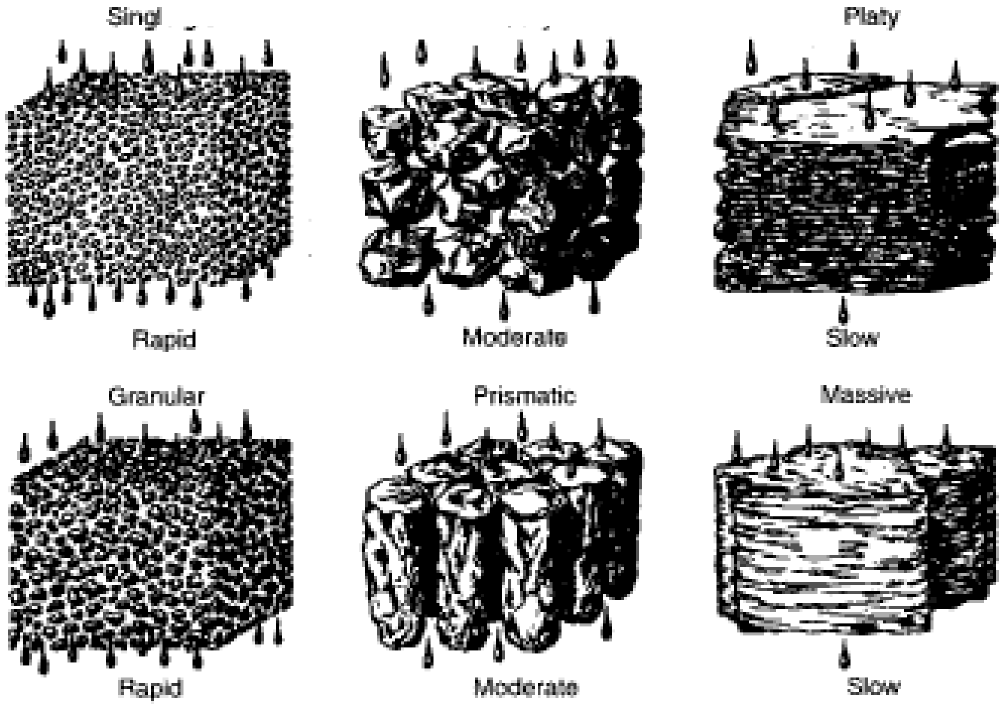
SOIL TEXTURE GROUP	TEXTURE SOIL MORPHOLOGY	TRENCH BOTOM LOADING RATE Gal. / Ft^2 / Day		MINUTES Per INCH
		STE / (Gravity)	STE / (LPD)	
I SANDS	Sand (Sd) Loamy Sand (LSd)	.91 - 76	.91 - .76	<15
IIA COARSE LOAMS	Sandy Loam (SdL) Structureless	.68- .63	.68 - .63	20 - 25
IIB	Sandy Loam (SdL) Loam (L) Sandy Clay Loam (SdCL)	.57 - .44	.61 - .54	30 – 45
IIIA FINE LOAMS	Silt Loam (SiL) Sandy Clay Loam (SdCL)	.4 - .28	.52 - .42	50 – 70
IIIB	Clay Loam (CL) Silty Clay Loam	.25 - .19	.4 - .35	75 – 90
IV CLAYS	Sandy Clay (SdC) Silty Clay (SiC) Clay (C)	.17 - .11	.35 - .22	90 – 120

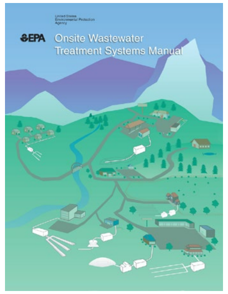
Sewage Handling and Disposal Regulations



EPA 2002

United States Environmental Protection Agency





Soil Characteristics			Infiltration Loading Rate, gal/da/ft²	
Texture	Structure Shape	Structure Grade	>30 mg/L	<30 mg/L
COS, S, LCOS, LS	--	0SG	0.8	1.6
FS, VFS, LFS, LVFS	--	0SG	0.4	1.0
CSL, SL	--	0M	0.2	0.6
	PL	1	0.2	0.5
		2, 3	0.0	0.0
	PR/BK /GR	1	0.4	0.7
		2,3	0.6	1.0
FSL, VFSL	--	0M	0.2	0.5
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.2	0.6
		2,3	0.4	0.8
L	--	0M	0.2	0.5
	PL	1,2, 3	0.0	0.0
	PR/BK /GR	1	0.4	0.6
		2, 3	0.6	0.8
SIL	--	0M	0.0	0.2
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.4	0.6
		2,3	0.6	0.8
SCL,CL SICL	--	0M	0.0	0.0
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.2	0.3
		2,3	0.4	0.6
SC, C, SIC	--	0M	0.0	0.0
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.0	0.0
		2,3	0.2	0.3
A	B	C	D	E

INCREASE In LOADING RATE

for ** Strong Structure

**** Pretreatment**

From . 4 - .6 gal/ft^2/day

Decentralized Wastewater Glossary

Compiled by

The Consortium of Institutes for Decentralized Wastewater Treatment

CIDWT
Consortium of Institutes for Decentralized Wastewater Treatment

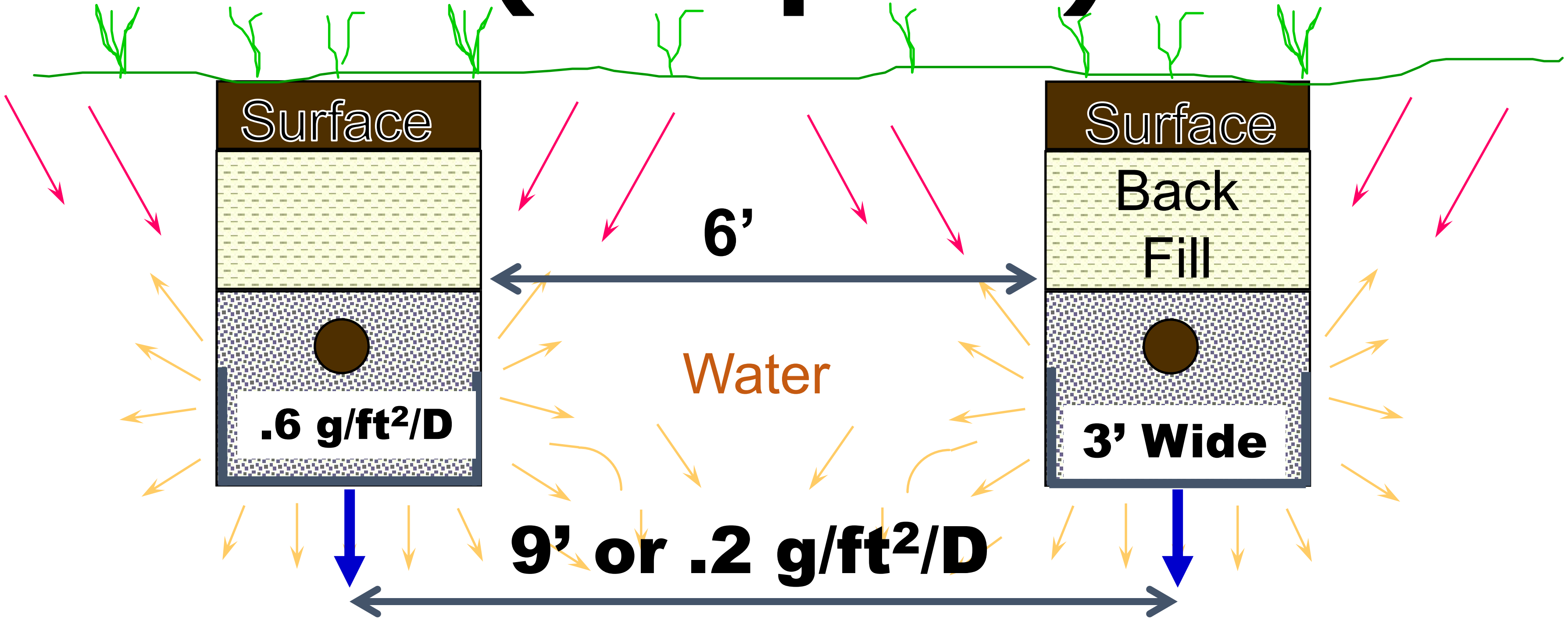
CIDWT
Consortium of Institutes for Decentralized Wastewater Treatment

Loading rate, areal: quantity of effluent applied to the footprint of the soil treatment area (or the absorption area of an above-grade soil treatment area) expressed as volume per area per unit time, e.g., gallons per day per square foot (gpd/sq. ft.).

Area or "Footprint" Loading Rate

AREA ft^2 / 2 = Minimum Tubing Length

AREA LOADING RATES Trench Spacing (footprint)



Assume 3′ trench, with 9′ center

Trenches installed on centers 3X width

EPA United States Environmental Protection Agency

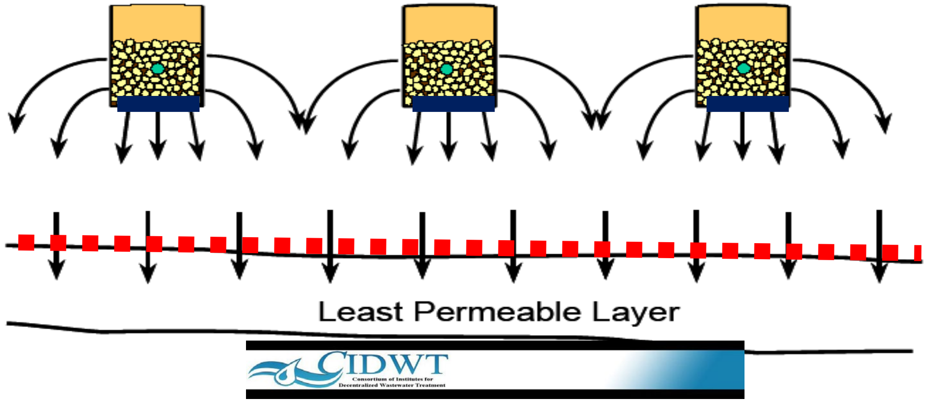
Soil Characteristics			Infiltration Loading Rate gal/day/ft²	
	Structure		>30 mg/l	<30 mg/l
Texture	Shape	Grade	BOD	BOD
COS, S, LCOS, LS	--	0SG	0.8	1.6
FS, VFS, LFS, LVFS	--	0SG	0.4	1.0
CLS, SL	--	0M	0.2	0.6
	PL	1	0.2	0.5
		2,3	0.0	0.0
	PR/BK /GR	1	0.4	0.7
		2,3	0.6	1.0
FSL, VFSL	--	0M	0.2	0.5
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.2	0.6
		2,3	0.4	0.8
L	--	0M	0.2	0.5
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.4	0.6
		2,3	0.6	0.8
SIL	--	0M	0.0	0.2
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.4	0.6
		2,3	0.6	0.8
SCL, CL, SICL	--	0M	0.0	0.0
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.2	0.3
		2,3	0.4	0.6
SC, C, SIC	--	0M	0.0	0.0
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.0	0.0
		2,3	0.2	0.3

K-1

.6

Infiltrative "Trench Bottom" Loading Rates

The "MODEL"



K-2

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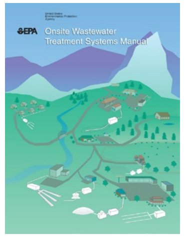
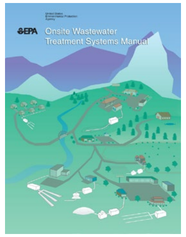
Area "Footprint" Loading Rates

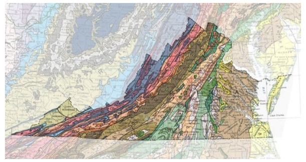
Trench Bottom / 3

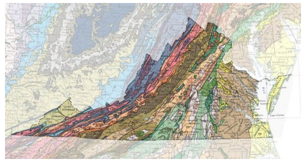




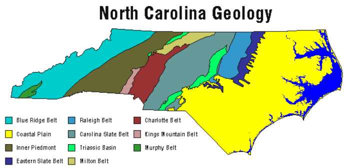
Soil Characteristics			AREA Loading Rate gal/day/ft²	
	Structure		>30 mg/l	<30 mg/l
Texture	Shape	Grade	BOD	BOD
COS, S, LCOS, LS	--	0SG	0.26	.53
FS, VFS, LFS, LVFS	--	0SG	0.13	.33
CLS, SL	--	0M	.06	0.2
	PL	1	.06	.16
		2,3	0.0	0.0
	PR/BK /GR	1	.13	0.23
		2,3	.2	.33
FSL, VFSL	--	0M	.06	.16
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	.06	.2
		2,3	.13	.36
L	--	0M	.06	.166
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	[illegible]	.2
		2,3	.2	.26
SIL	--	0M	0.0	0.2
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	.13	.2
		2,3	.2	.26
SCL, CL, SICL	--	0M	0.0	0.0
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	.06	.1
		2,3	.13	.2
SC, C, SIC	--	0M	0.0	0.0
	PL	1,2,3	0.0	0.0
	PR/BK /GR	1	0.0	0.0
		2,3	.06	0.1

613 AOSS REGS Pressure Trench Bottom Loading Rates

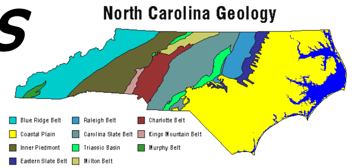




SOIL TEXTURE GROUP	TEXTURE SOIL MORPHOLOGY	TRENCH BOTOM LOADING RATE Gal. / Ft^2 / Day STE / (LPD)	 TL - 2 NSF 40	 TL – 3 10 / 10		MINUTES Per INCH
I SANDS	Sand (Sd) Loamy Sand (LSd)	.91 - .76	1.8 – 1.53	3.0 - 2.33	3x	<15
IIA COARSE LOAMS	Sandy Loam (SdL) Structureless	.68 - .63	1.4- 1.3	2.00–1.75		20 - 25
IIB	Sandy Loam (SdL) Loam (L) Sandy Clay Loam (SdCL)	.61 - .54	1.2 – .9	1.5 – 1.13		30 – 45
IIIA FINE LOAMS	Silt Loam (SiL) Sandy Clay Loam (SdCL)	.52 - .42	.8 - .62	1.0 – .78	2x	50 – 70
IIIB	Clay Loam (CL) Silty Clay Loam	.4 - .35	.58 - .44	.72 - .56	+/-	75 – 90
IV CLAYS	Sandy Clay (SdC) Silty Clay (SiC) Clay (C)	.35 - .22	.4 - .25	.5 - .32		90 – 120



ANAEROBIC EFFLUENT Areal Loading Rates



Soil Group	LTAR (area basis) (gpd/ft^2)	**Mid- Point**
I.	0.6-0.4	**.5**
II.	0.4-0.3	**.35**
III.	0.3-0.15	**.22**
IV.	0.15-0.05	**.1**

SOIL GROUPS BY TEXTURE

Broad ranges due to structure / consistence

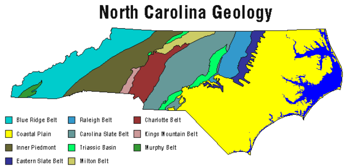
Loading Rates assigned by evaluator

(A) SOIL GROUP I - SANDY TEXTURE SOILS. The sandy group includes the sand and loamy sand soil textural classes and shall be considered SUITABLE with respect to texture.

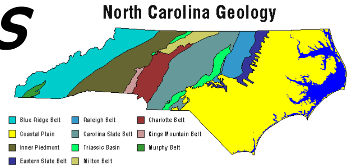
(B) SOIL GROUP II - COARSE LOAMY TEXTURE SOILS. The coarse loamy group includes sandy loam and loam soil textural classes and shall be considered SUITABLE with respect to texture.

(C) SOIL GROUP III - FINE LOAMY TEXTURE SOILS. The fine loamy group includes silt, silt loam, sandy clay loam, clay loam, and silty clay loam textural classes and shall be considered PROVISIONALLY SUITABLE with respect to texture.

(D) SOIL GROUP IV - CLAYEY TEXTURE SOILS. The clayey group includes sandy clay, silty clay, and clay textural classes and shall be considered PROVISIONALLY SUITABLE with respect to texture.



PRETREATED EFFLUENT Areal Loading rates



DRIP

AREA

LOADING

RATES

NORTH CAROLINA DEPARTMENT
OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL HEALTH
ON-SITE WATER PROTECTION SECTION

INNOVATIVE WASTEWATER
SYSTEM APPROVAL

INNOVATIVE WASTEWATER SYSTEM NO: IWWS-93-1-R6B

FOR: American Perc-Rite® Subsurface Drip System, Aerobic

Soil Group		LTAR (area basis) (gpd/ft^2)		
		NSF-40	TS-I	TS-II
Sd	I.	1.0-0.6	1.2-0.8	1.5-0.8
L	II.	0.6-0.4	0.8-0.5	0.8-0.6
CL	III.	0.4-0.15	0.6-0.2	0.6-0.2
C	IV.	0.15-0.05	0.2-0.05	0.2-0.05

Mid- Point

TS-2

1.15

.7

.4

.12

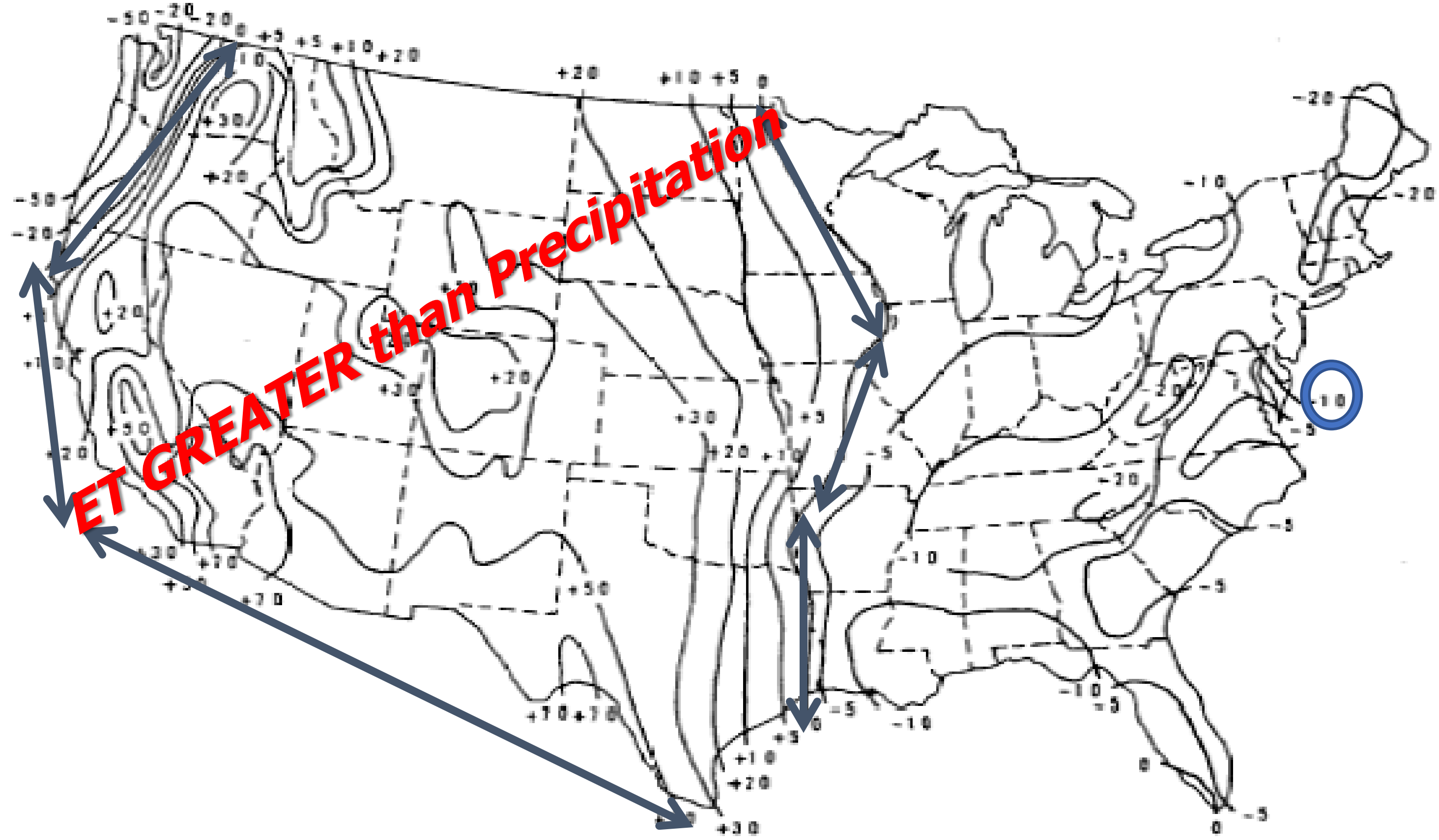
Special Site Evaluation / Hydraulic Assessment required when:

- **Loading rate is greater than midpoint of the range of GROUP I – III Soils**
- **GROUP IV Soils proximity**
- **When require by Administrative Authority / >1500 GPD**

FIGURE 3-1

POTENTIAL EVAPORATION VERSUS MEAN ANNUAL PRECIPITATION (4)

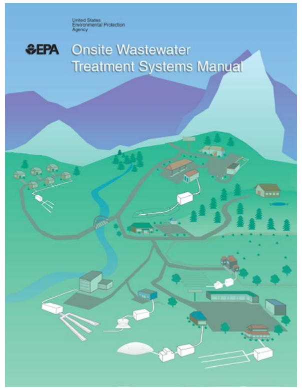
(inches)



\+ Potential Evapotranspiration more than mean annual precipitation

\+ 10″ Precip
per Year
DULLES

"PET" positive in many regions



AREAL Inches per Week

	Footprint DRIP gal./ft2/day	Inches Per Week	
Trench .51 gal/ft²/day	0.170	1.909	> 99” per Year
	0.148	1.662	
	0.125	1.404	
Trench .3 gal/ft²/day	0.100	1.123	> 58” per Year
	0.075	0.842	

WATER BALANCE

Decentralized Wastewater Glossary

Compiled by

The Consortium of Institutes for Decentralized Wastewater Treatment

Loading rate, linear:

quantity of effluent applied along the length of a lateral, trench or bed, typically expressed as volume per unit length per unit time (e.g. gallons per foot per day).

Volume (GALLONS) per UNIT Length of trench, bed, tubing etc.

EXAMPLE

450 GPD

100' Trench Length on Contour

50' Header Ditch

.09 Gal / Ft² / Day "AREAL"

* 6 lines, 100' long, 3' wide, 9' CENTERS = 1800 FT² HYDRAULIC

450 GPD / 600' trench = **.75** gallon per linear foot

* 9 lines, 100' long, 2' wide, 6' CENTERS = 1800 FT² HYDRAULIC

450 GPD / 900' trench = **.5** gallon per linear foot

* DRIP 24 lines, 2' centers

450 GPD / 2400' tubing = **.19** gallon per linear foot

Low Linear Loading Values = Greater Soil Contact

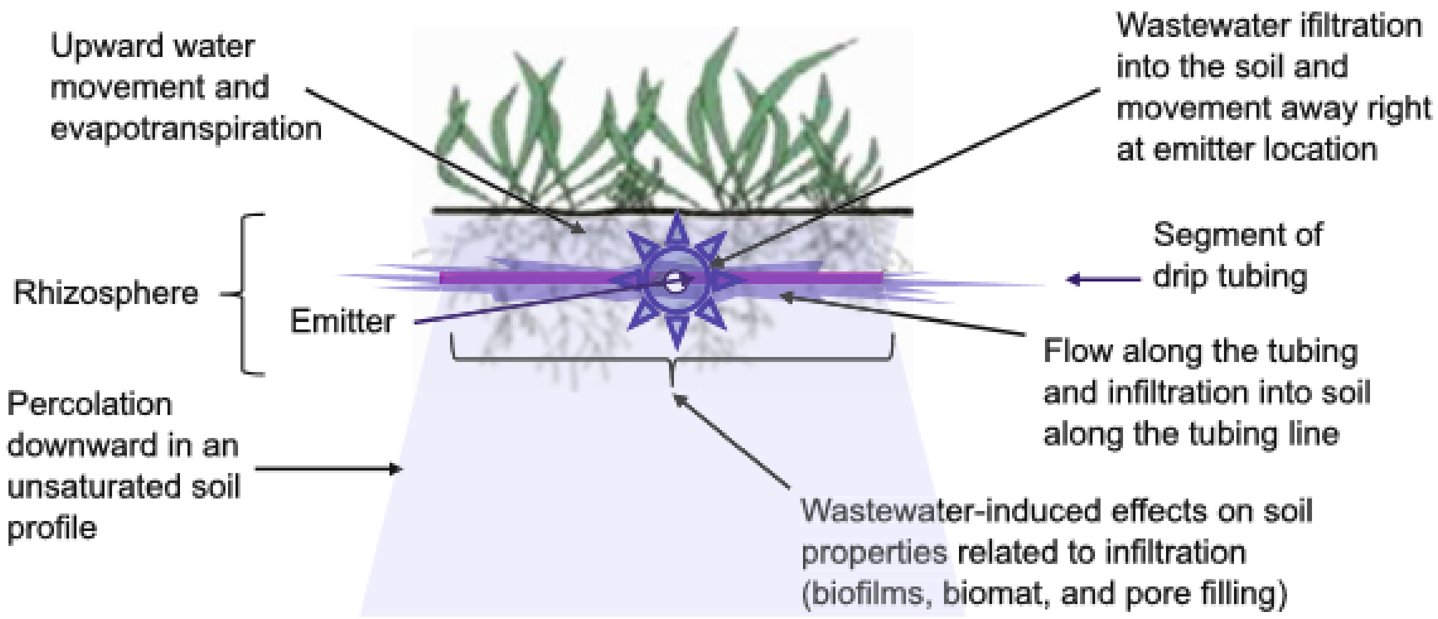
Encourage conditions of unsaturated flow / enhanced treatment

CALCULATIONS *Drip Dispersal*

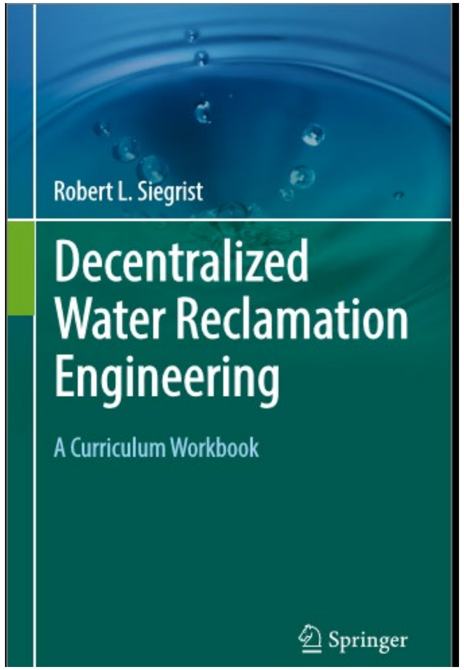
- 25,000 GPD ÷ .15 Gal./Ft.^{2}/D Areal = 166,667 Ft^2 area required
  3.83 acres 1.68 in. / Week
- 166,667 Ft^2 area required ÷ 2′ spacing = <u>83,333 linear feet of tubing required</u>
- .15 Gal./Ft.^{2}/D x 2′ spacing = .3 Gal./Lin. Ft./Day
- 25,000 GPD ÷ .3 Gal./Lin. Ft. Tubing /Day = <u>83,333 linear feet of tubing required</u>

Based on indicated Zone Size in linear feet of Tubing, delineate into Landscape

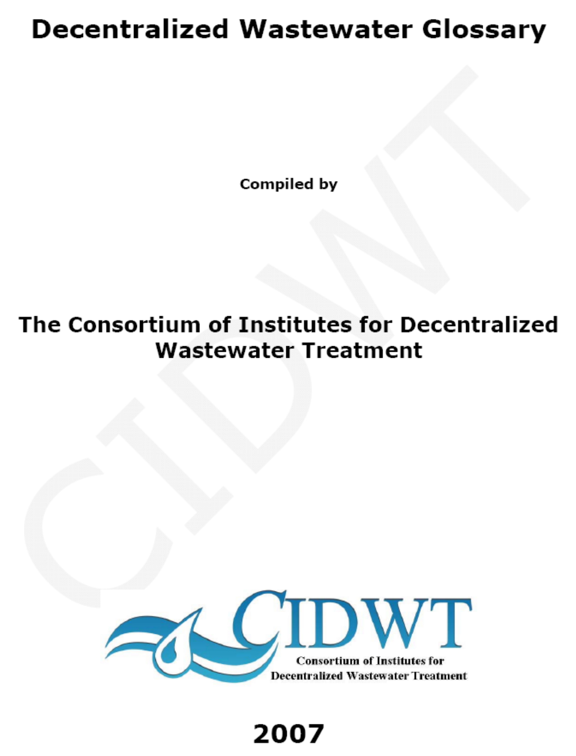
Fig. 12.4 Illustration of the rhizosphere and water movement is a segment of drip tubing



"(*Note*: the boundaries on water movement shown are sharp and linear but in reality they are irregular and less distinct.)"



Siegrist *2017*


Decentralized Wastewater Glossary

Compiled by

The Consortium of Institutes for Decentralized Wastewater Treatment

2007

Loading rate, instantaneous:

quantity of effluent discharged to a unit area of the infiltrative surface during a dosing event expressed as volume per unit time, e.g., gallons per minute per square foot (gpm/ft^2).

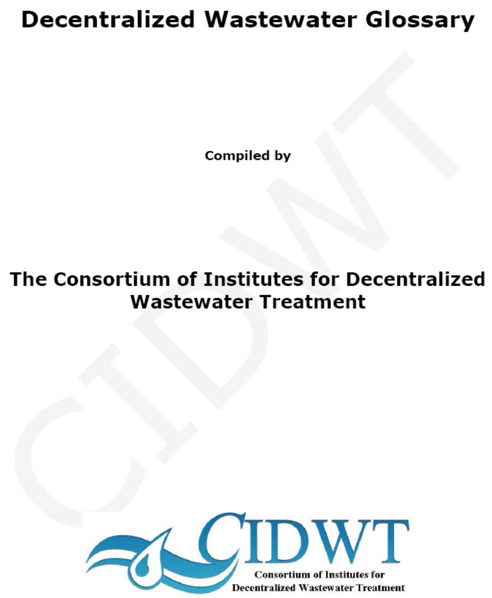
How effluent is applied to the soil

DOSING REGIME (Dose Volume / Frequency)

.01 GMP x 10 minutes = .1 gal per dose (12.8 oz)

CIDWT Consortium of Institutes for Decentralized Wastewater Treatment — CIDWT Glossary 2007

__Flow Equalization__: **system configuration that includes sufficient effluent storage capacity to allow for uniform flow to a subsequent component despite variable flow from the source; (CITWT GLOSSARY)**


Decentralized Wastewater Glossary

Compiled by

The Consortium of Institutes for Decentralized Wastewater Treatment

CIDWT Consortium of Institutes for Decentralized Wastewater Treatment

__KEYWORDS__

Variable Source (in) Flow

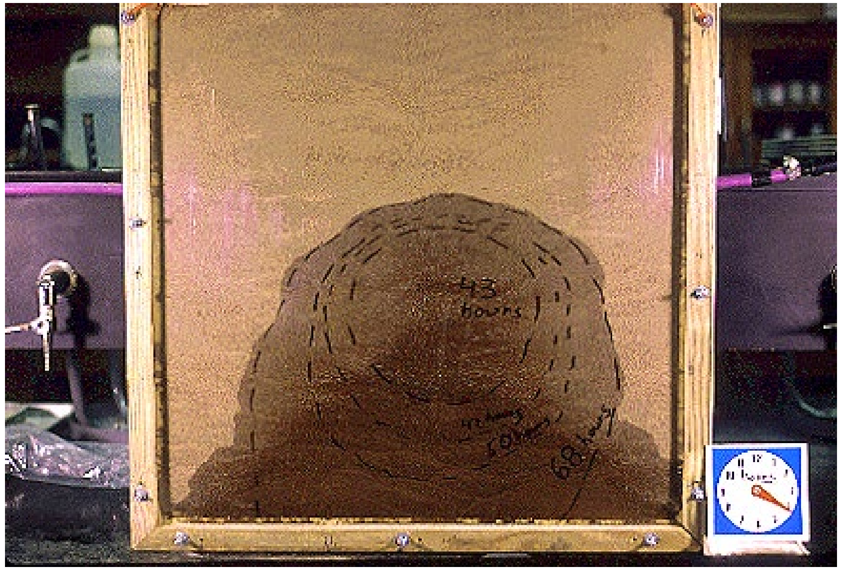
Sufficient Effluent Storage

Uniform (out) Flow to a subsequent, downstream Component

__Dosing, timed :__ **configuration in which a specific volume of effluent is delivered to a component based upon a prescribed interval, regardless of facility water use; (CITWT GLOSSARY)**

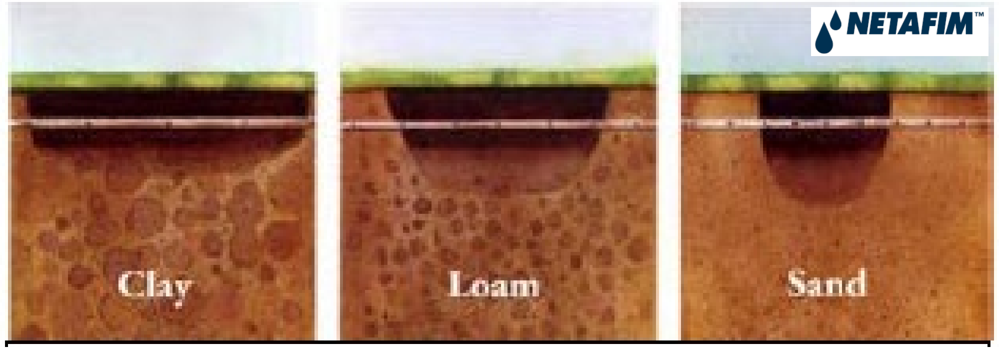
Water Movement Through Soil

- Wet to dry
- From large pores to small pores
  - – Capillary Action
- Water moves radially until saturated
- At saturation gravity moves water down



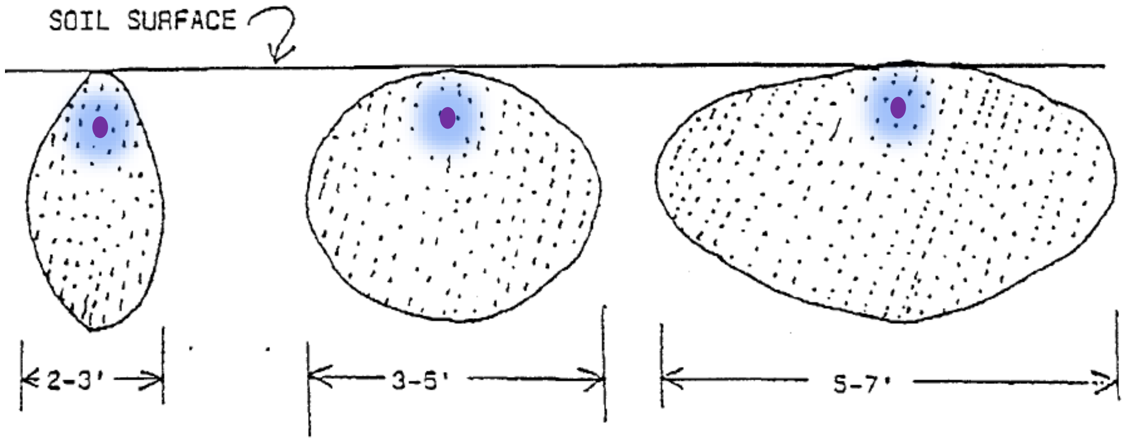
Design of Drip Disposal Systems For Wastewater Treatment and Disposal

D.J. Osborn, J.R. Harmen
SSSNC (1993)

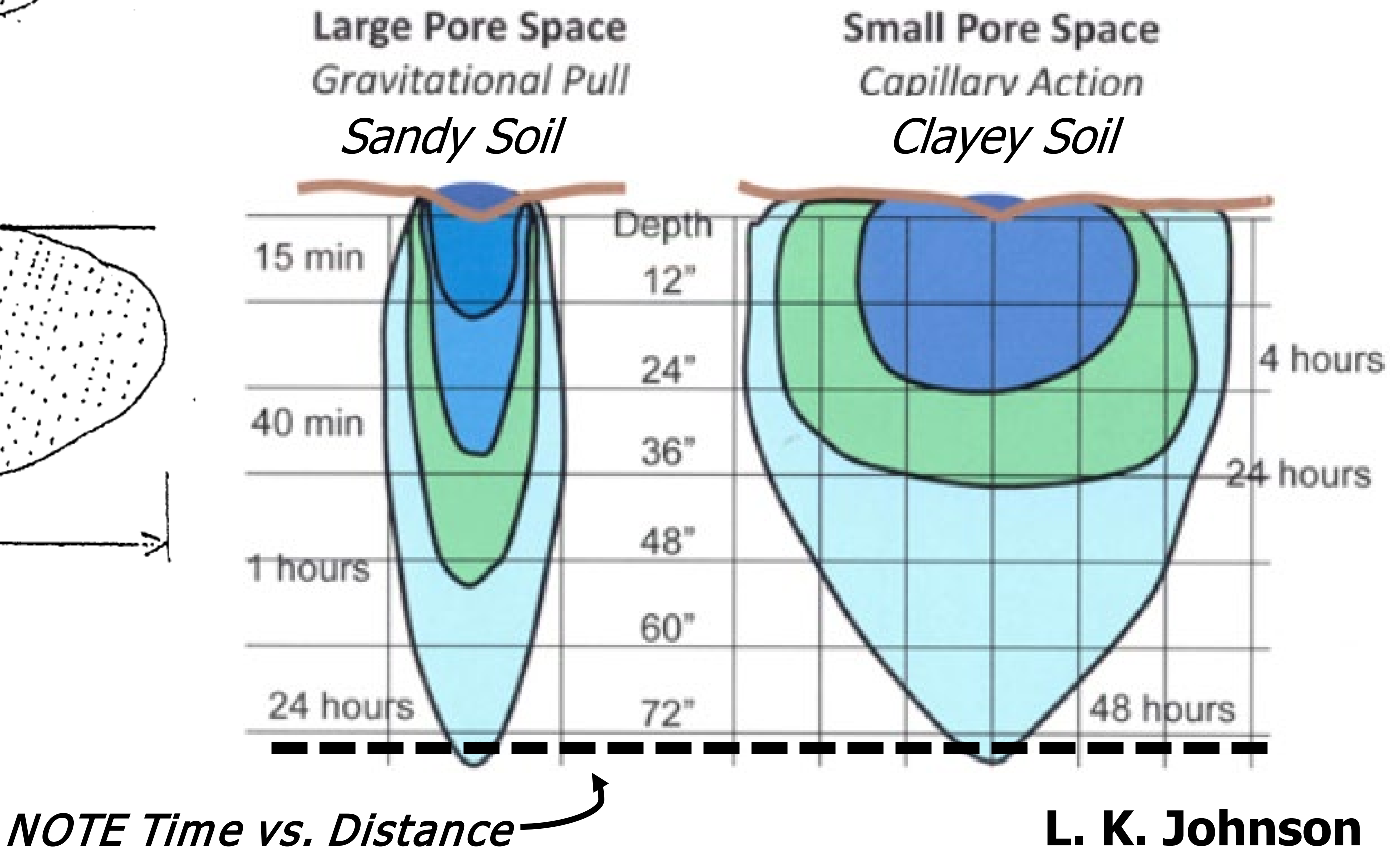


PLAN View

END View



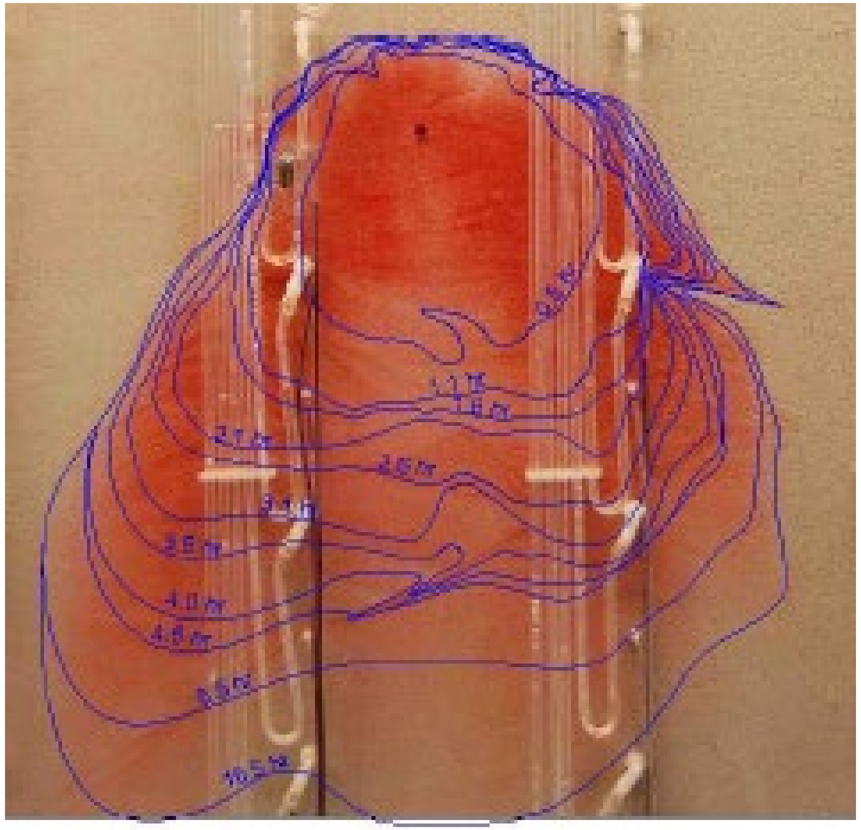
Affect of Texture
On
Dispersal

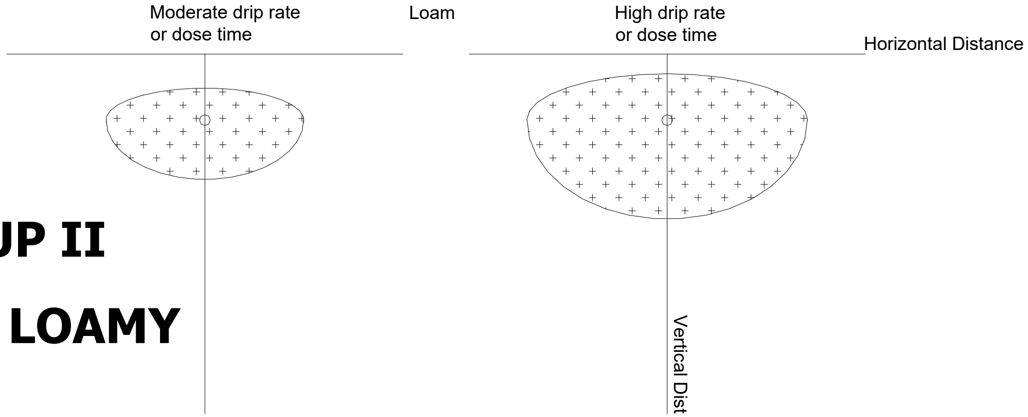


L. K. Johnson

GROUP I

L. K. Johnson

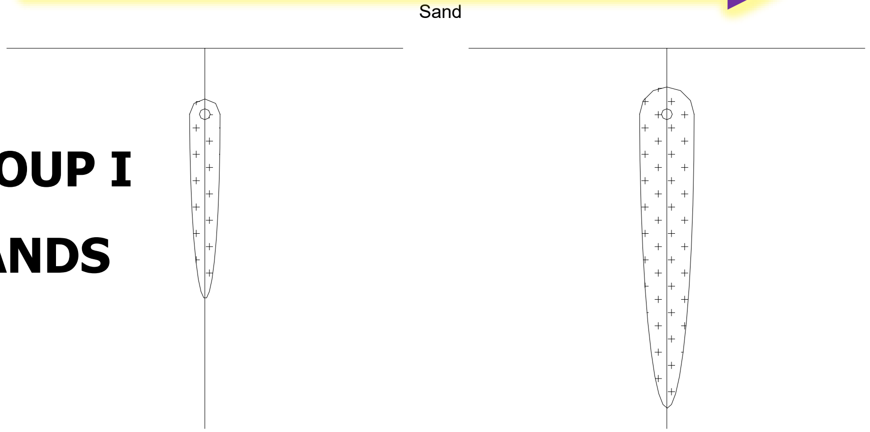




GROUP II

COARSE LOAMY

DOSE VOLUME INCREASE



GROUP I

SANDS

TENNESSEE VALLEY AUTHORITY

Soil Texture/ Porosity / Structure dictate <u>INSTANTANEOUS</u> Dose

Larger Networks may require larger dose volumes for equal distribution

Restrictive sites require smaller instantaneous doses

POROSITY

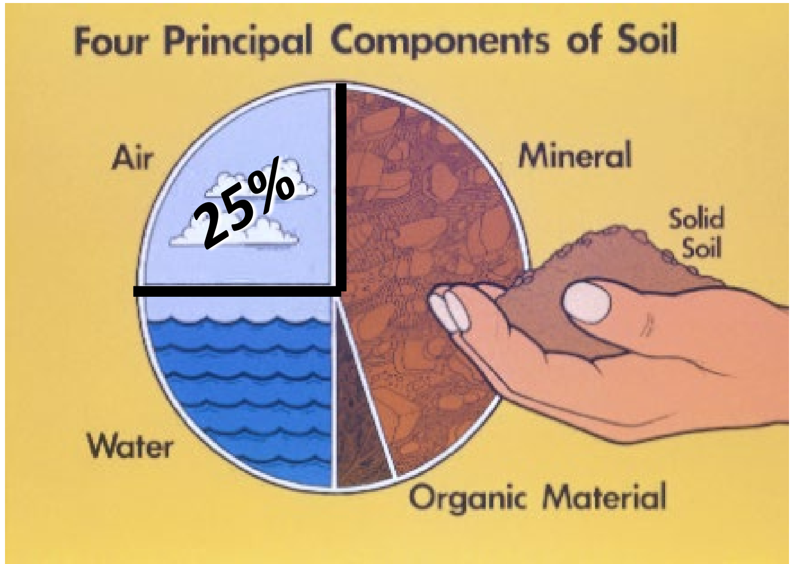
- *__Porosity__* **refers to that portion of the soil that is not occupied by solid material (mineral or organic). Porosity is a function of texture of the soil and structure of the soil.**

Soil as a Three-Phase System

Solid (particles)

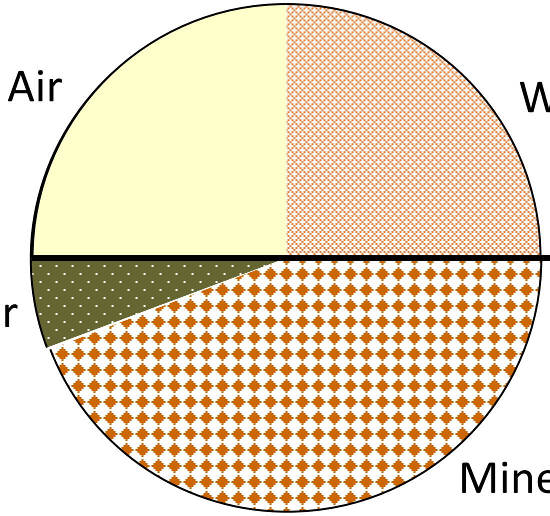
Liquid (water)

Gas (air)



- *__Porosity__* **has a direct influence on aeration, infiltration of water, and movement of water through the soil profile.**

- **Soil pores represent 50% of the volume, can be air filled (macro & micro pores) or water filled (micro pores).** ***Saturated flow occurs through macropores, and*** **unsaturated flow occurs through micropores.**



PORE SPACE **50%**
(1/2 BIG ½ SMALL)
SOLID **50%**

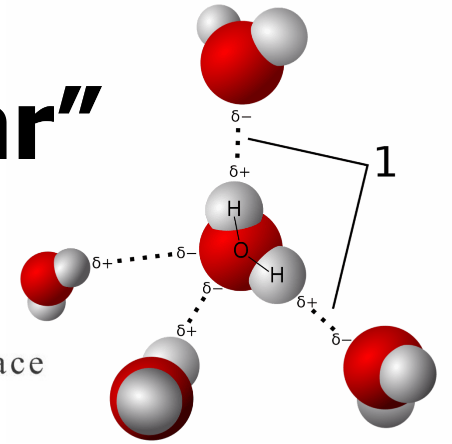
Sand vs Clay

Sand
- Large pores
- Water moves fast
- Low surface area
- Less treatment capacity

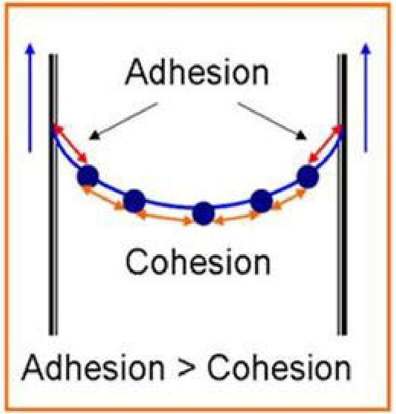
Clay
- Small pores
- Water moves slow
- High surface area
- More treatment capacity

Onsite systems need to balance water movement with wastewater treatment

Water is “DiPolar”

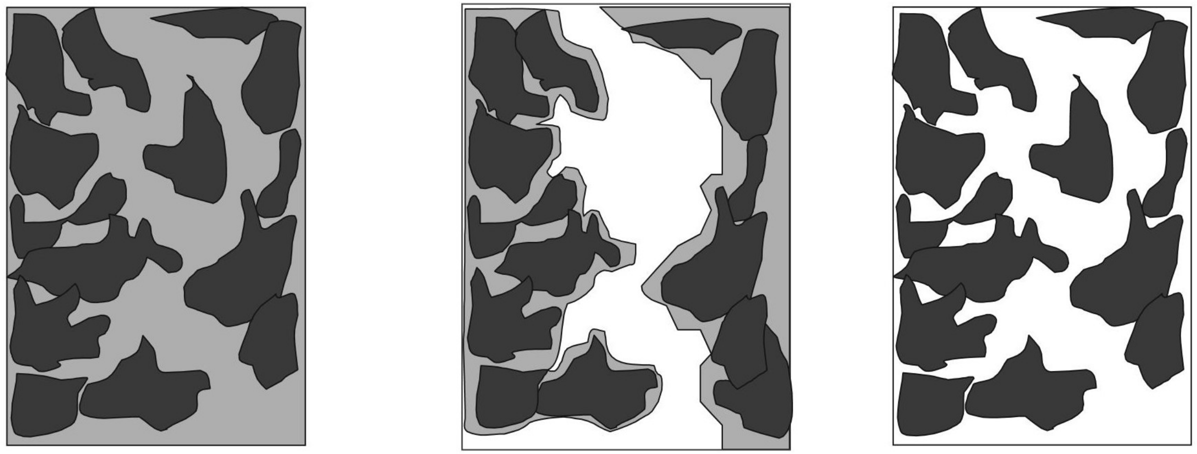


Soil particles
Water filled pore space
Air filled pore space



ADHESION **Forces of attraction between unlike molecules, e.g., water and solid.**

COHESION **Forces of attraction between like molecules, e.g., water and water.**



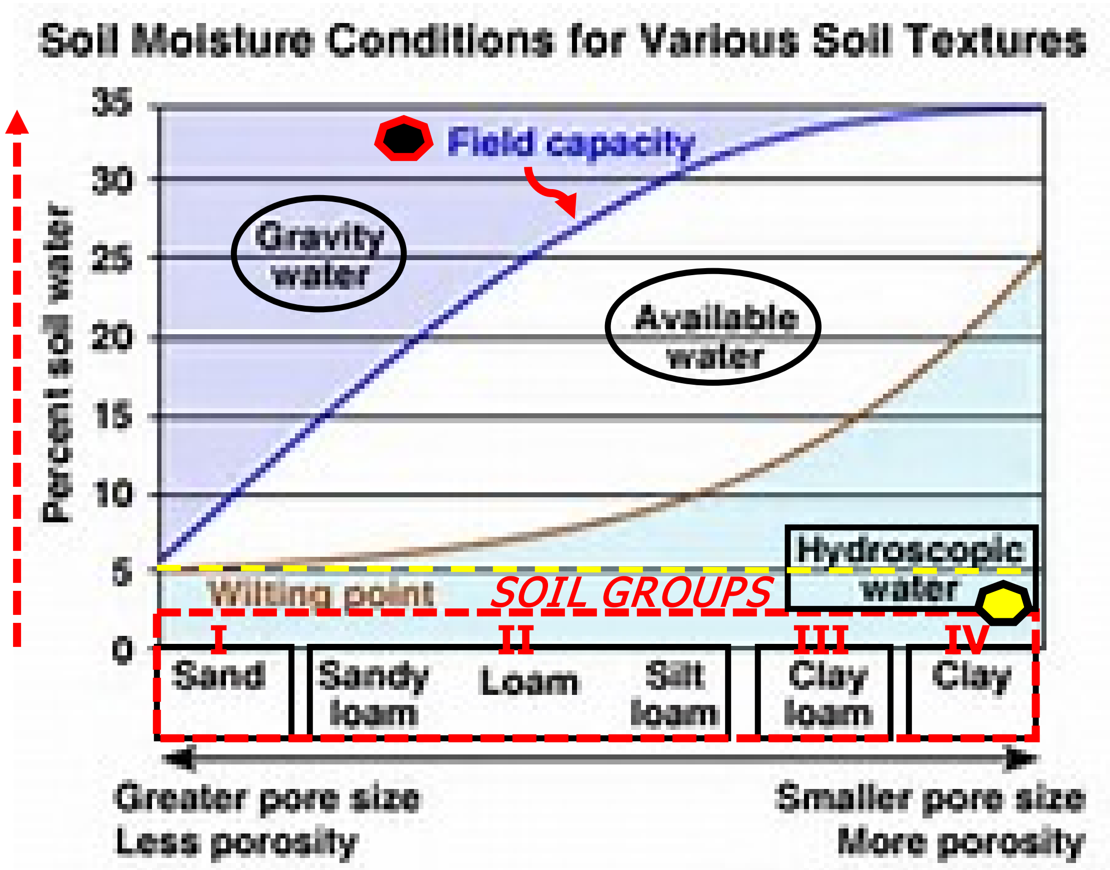
Saturation Macro Pores GRAVITY	Micro Pores Filled Macro Pores Open “*FILM*” Flow	DRY

WATER RETENTION **A property of soil that results from the attraction of the soil matrix for water.**

A MODEL FOR SOIL OXYGEN DELIVERY TO WASTEWATER INFILTRATION SURFACES J. Erickson, E. J. Tyler
9TH International Symposium on Individual and Small Community Sewage Systems. ASAE

STATUS OF SOIL WATER vs. TEXTURE

Field Capacity The content of water, on a mass or volume basis, remaining in a soil 2 or 3 days after having been wetted with water and after free drainage is negligible.



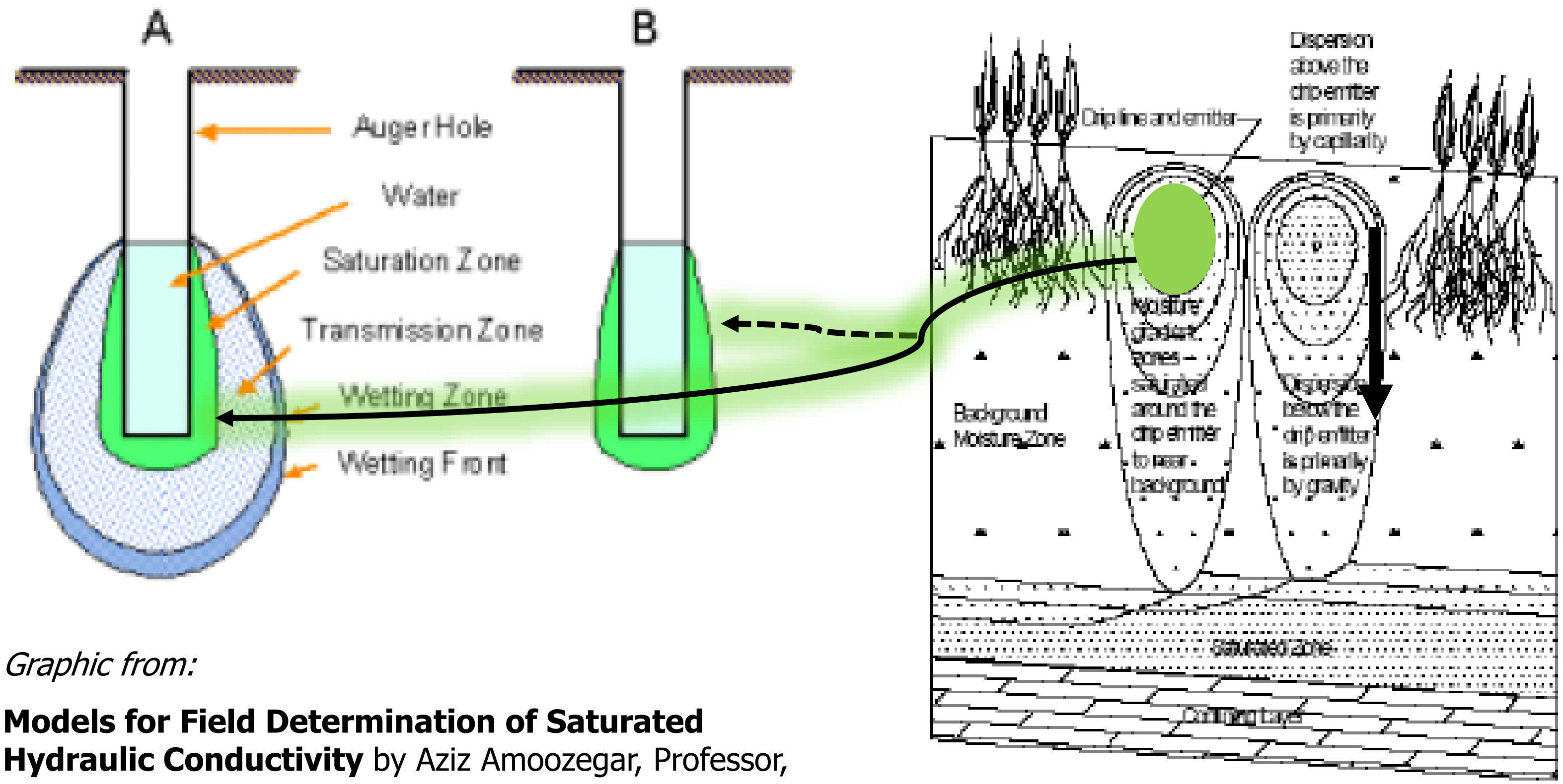
Available Water (capacity) The amount of water released between in situ field capacity and the permanent wilting point. It is not the portion of water that can be absorbed by plant roots, which is plant specific.

Gravitational Water Water that moves into, through, or out of the soil under the influence of gravity.

SANDIER *drains* more water
CLAYIER *holds* more water

Narrow Borehole / Hydraulic Assessment

Infiltration **Steady - State**



K-1 Infiltration Zone

K-2 Boundary

Graphic from:

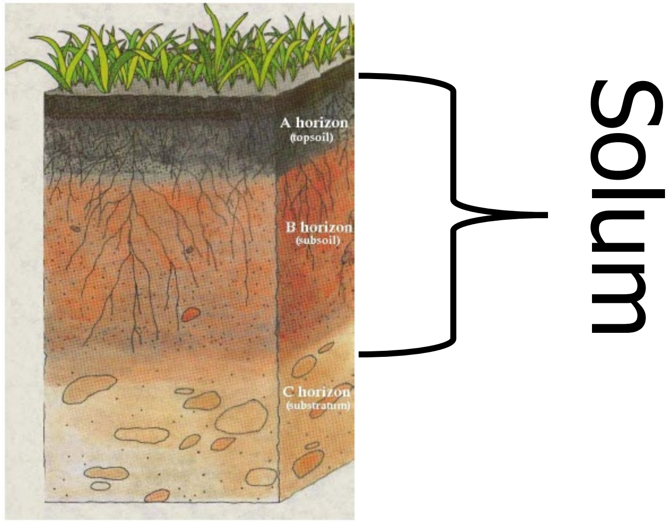
Models for Field Determination of Saturated Hydraulic Conductivity by Aziz Amoozegar, Professor, NCSU Soil Science Dept., Raleigh, NC

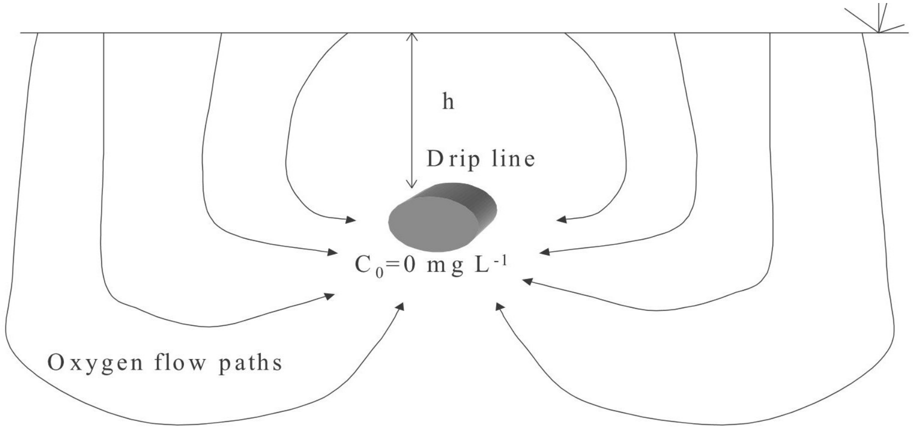
Published in Soil Science Society of North Carolina Proceedings, Vol. XLV (2002)

TENNESSEE VALLEY AUTHORITY

Advantages of Shallow Systems

- Most biologically active soil
- More sorptive sites encountered
- Better gas exchange (aeration)
- More permeable





A MODEL FOR SOIL OXYGEN DELIVERY TO WASTEWATER INFILTRATION SURFACES J. Erickson, E. J. Tyler 9 th International Symposium on Individual and Small Community Sewage Systems. ASAE

Drip Dispersal as a Nitrogen BMP

Executive Order

13508

May 12, 2009

Chesapeake Bay

Protection

and

Restoration

Reduce *all* Nitrogen Discharges 50% from *current practice*

FEBRUARY 2014

Recommendations of the On-Site Wastewater Treatment Systems Nitrogen Reduction Technology Expert Review Panel

FINAL REPORT

Submitted by:

Robert Adler, Eric Aschenbach, Jason Baumgartner, Jay Conta, Marcia Degen, Robert Goo, Joyce Hudson, Jeff Moeller, Dave Montali, Rich Piluk, Jay Prager

Submitted to:

Wastewater Treatment Workgroup
Chesapeake Bay Partnership

Report version: February 2014
Report and Appendix G Approved by WQGIT: July 14, 2014
Prepared by:

TETRA TECH

Tetra Tech, Inc.
10306 Eaton Place, Suite 340
Fairfax, VA 22030-2201

3.9 SHALLOW-PLACED, PRESSURE-DOSED DISPERSAL

**** Twelve papers cited.**

**** Seven Papers Specific to Drip Dispersal**

**** Two papers reflect *"controlled application"* at trench bottom loading rates. Instantaneous dose volume and frequency only achievable in field application with Drip Dispersal.**

<u>Anderson, Otis, Apfel</u>

(six doses per day, .125 - .25 gallons per dose.)

<u>Duncan, Reneau, Hagedorn</u> (six doses a day,

.083 gallons per dose.)

BMPS address Domestic Waste < 1500 GPD

Drip Irrigation and Peat Treatment System
On-site Wastewater Nutrient Removal BMP
Expert Panel Report

Chesapeake Bay Program
Science. Restoration. Partnership.

APRIL 2018

April 2018

Conclusion

Drip irrigation should be recognized as a BMP achieving a net 50% TN reduction when either septic tank effluent or treated effluent is applied to a drip irrigation system designed under the following design criteria.

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Detailed Definition of Practice – Key Points

- Install in a natural surface horizon no deeper than 12 inches.
- No credit where TG 1 soils predominate within 12 inches below
- 18 inches unsaturated zone beneath
- Either septic tank effluent or treated effluent

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April 2018

Detailed Definition of Practice

- Filtration system on effluent
- Automatic flush cycle
- Equalize and time dosing over 24 hours
- Dose volume minimum 3.5 times drip network, 5X recommended

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April 2018

NOWRA National Onsite Wastewater Recycling Association

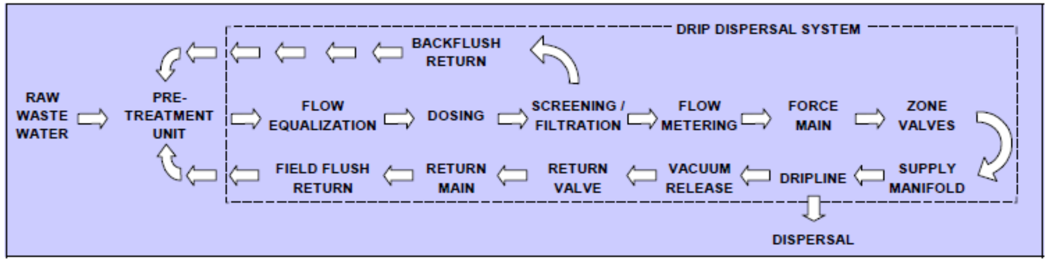
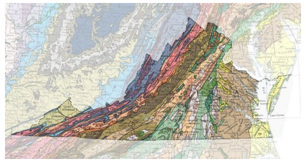


Figure 1: Drip Dispersal System Component Train

Detailed Definition of Practice

- A/V release valves at high points
- Max emitter spacing 2 ft : normal tube spacing 2 ft
- Minimum drip tube length = ½ dispersal area
- Maximum loading rates per Texture Group
  - TG II 0.27 gpd/sf
  - TG III 0.17 gpd/sf
  - TG IV 0.12 gpd/sf



Loading Rates for Drip Nitrogen BMP Septic Tank, TL-2, or TL-3 Effluent		
SOIL GROUP	Percolation Rate (mpi)	Area Loading Rate, gallons per day per square foot (gpd/ft^2)
I	<20	N/A
IIA	20	0.23
IIB	30	0.20
IIIA	45	0.17
IIB	70	0.14
IV	90	0.12
	120	0.07

Loading rate chart from proposed VDH BMP Policy.

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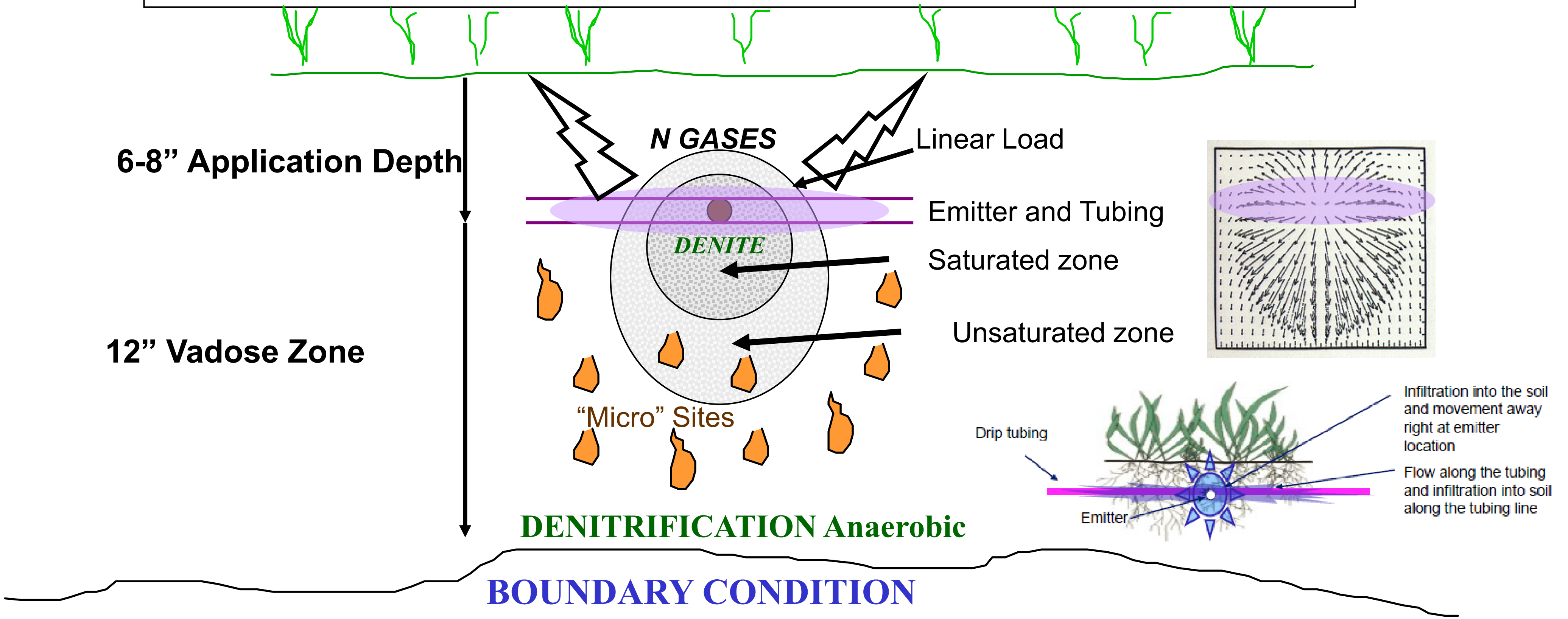
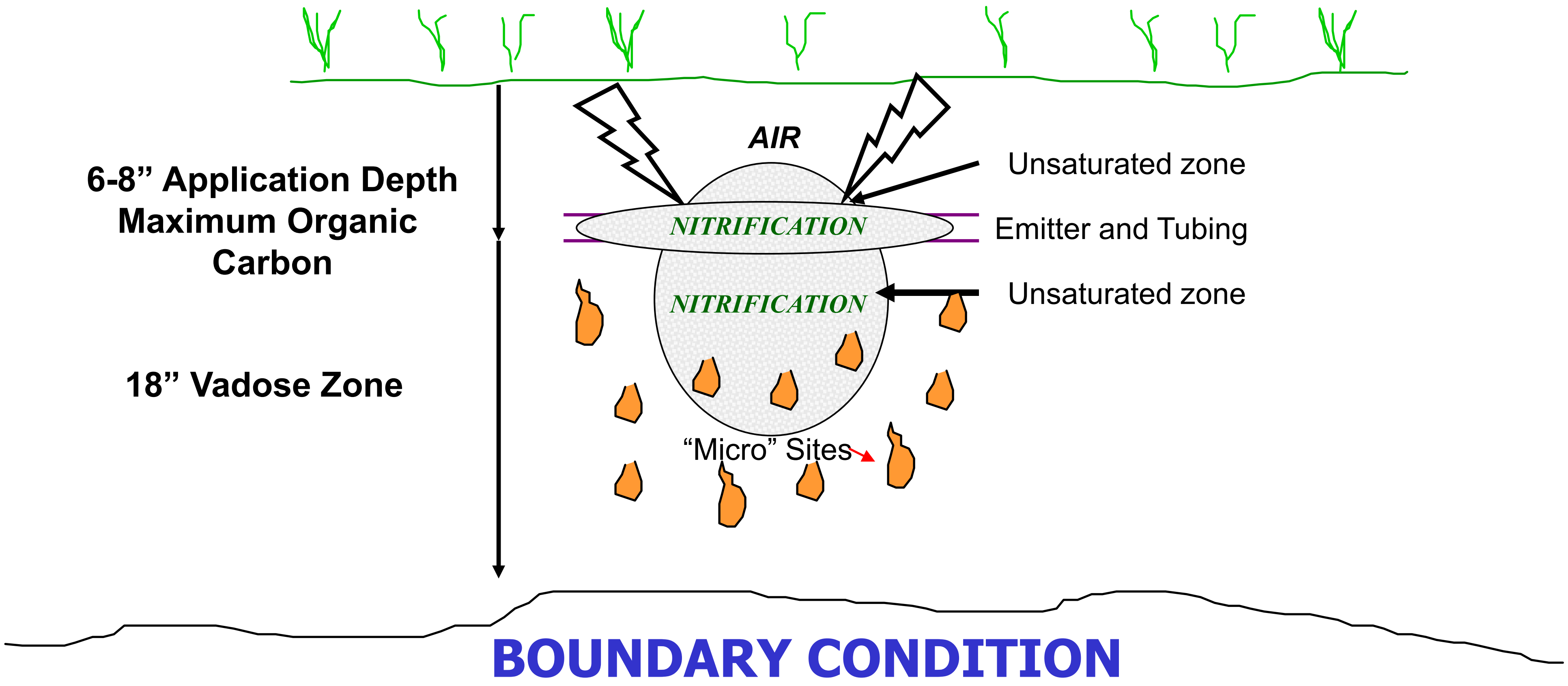
DOSE / DENITRIFICATION



Saturated Porosity 15 minutes+ / ANAEROBIC Conditions dose delivery .01 GPM, >60% water filled porosity

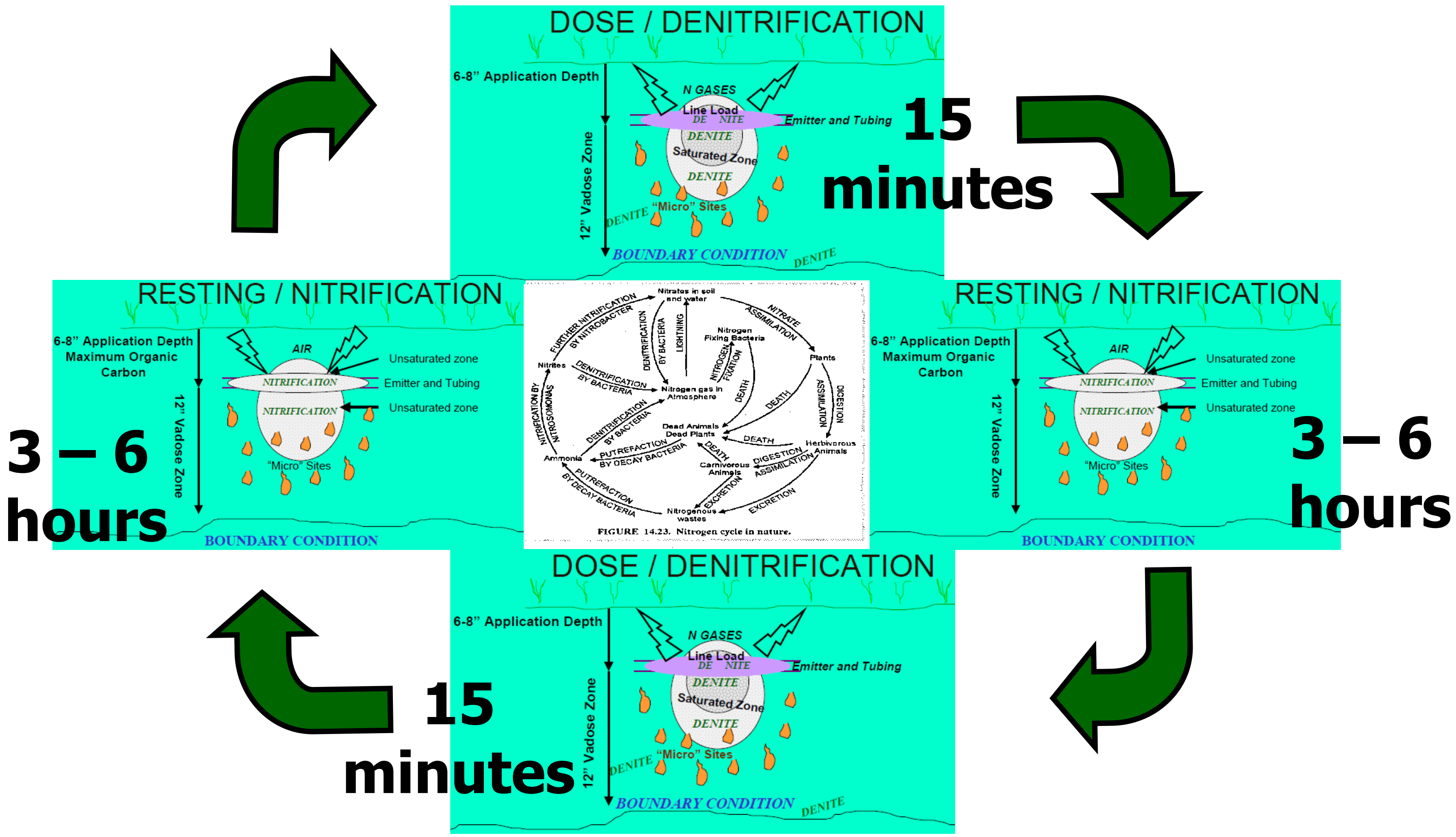
“Linear Load” provides relief along tubing when exceeding the instantaneous soil dose

RESTING / NITRIFICATION



Rest time between doses typically 3 – 6 hours

The Soil "Bio-Reactor" Continuum



Nitrification / Denitrification **in the same soil volume**

Table 1. Percent Nitrogen Reductions for New Septic System Treatment BMPs

NEIEN BMP Name	Scenario Builder BMP Name	Percent Nitrogen Reduction
Septic Effluent with Shallow Pressure	Septic Effluent with Enhanced In Situ	38%
Septic Effluent with Elevated Mound	Septic Effluent with Enhanced In Situ	38%
Septic Effluent with Advanced Drip Dispersal	Septic Effluent with Advanced In Situ	50%
NSF 40	Secondary Treatment with Conventional In Situ	20%
NSF 40 with Shallow Pressure	Secondary Treatment with Enhanced In Situ	50%
NSF 40 with Elevated Mound	Secondary Treatment with Enhanced In Situ	50%
NSF 40 with Advanced Drip Dispersal	Secondary Treatment with Advanced In Situ	60%
IMF	Secondary Treatment with Conventional In Situ	20%
IMF with Shallow Pressure	Secondary Treatment with Enhanced In Situ	50%
IMF with Elevated Mound	Secondary Treatment with Enhanced In Situ	50%
IMF with Advanced Drip Dispersal	Secondary Treatment with Advanced In Situ	60%
RMF with Advanced Drip Dispersal	50% Denitrification Unit with Advanced In Situ	75%
IFAS	50% Denitrification Unit with conventional In Situ	50%
IFAS with Shallow Pressure	50% Denitrification Unit with Enhanced In Situ	69%
IFAS with Elevated Mound	50% Denitrification Unit with Enhanced In Situ	69%
IFAS with Advanced Drip Dispersal	50% Denitrification Unit with Advanced In Situ	75%
Proprietary Ex Situ	50% Denitrification Unit with Conventional In Situ	50%
Proprietary Ex Situ with Shallow Pressure	50% Denitrification Unit with Enhanced In Situ	69%
Proprietary Ex Situ with Elevated Mound	50% Denitrification Unit with Enhanced In Situ	69%
Proprietary Ex Situ with Advanced Drip Dispersal	50% Denitrification Unit with Advanced In Situ	75%

Technical Requirements to Enter Advanced On-Site Wastewater Treatment Practices into Scenario Builder and the Phase 6 Watershed Model

< 1500 GPD

STE to Drip 50%

NSF 40 to Drip 60%

Intermit. Media to Drip 60%

Recirc. Media to Drip 75%

Fixed Film Activated Sludge to Drip 75%

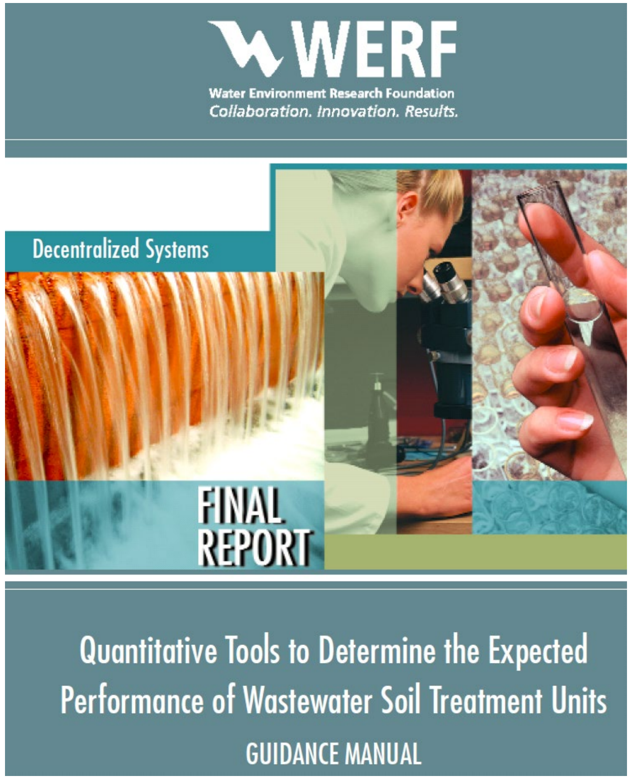
NSF 245 to Drip 75%

Chesapeake Assessment Scenario Tool CAST

The Soil Treatment Unit (STU)

“State of the Science”

“Quantitative Tools”



Likely the most exhaustive characterization of the soil treatment unit (STU) to date

670 total pages.

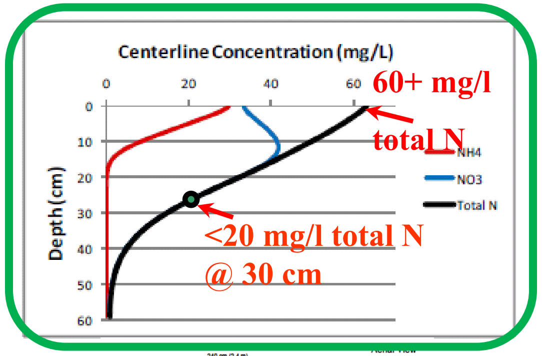
2010

“Tool Kit” HYDRUS

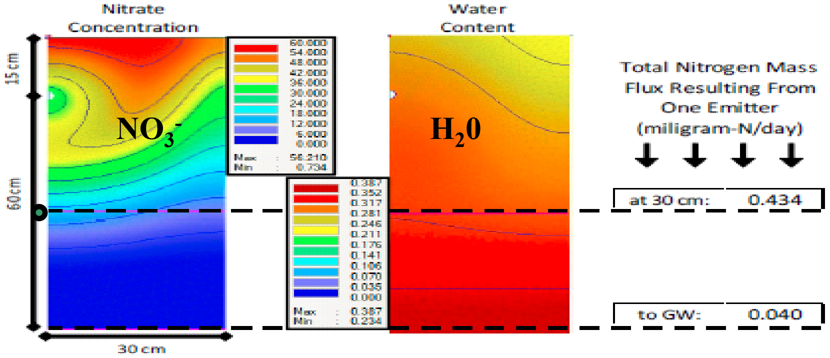
Soil type:	Sandy Loam
Effluent Qaulity:	STE
Dosing Duration:	7 minutes
Dosings Per Day:	5

.095 gal/ft^2/Day

.076 gal/emit/Dose



	NH_4	NO_3	Total N
% Removal at 30cm	100.0%	99.3%	99.4%
% Removal at 60cm	100.0%	99.9%	99.9%
% Uptake by plant	3.6%	81.6%	82.4%



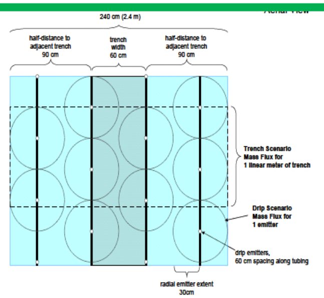
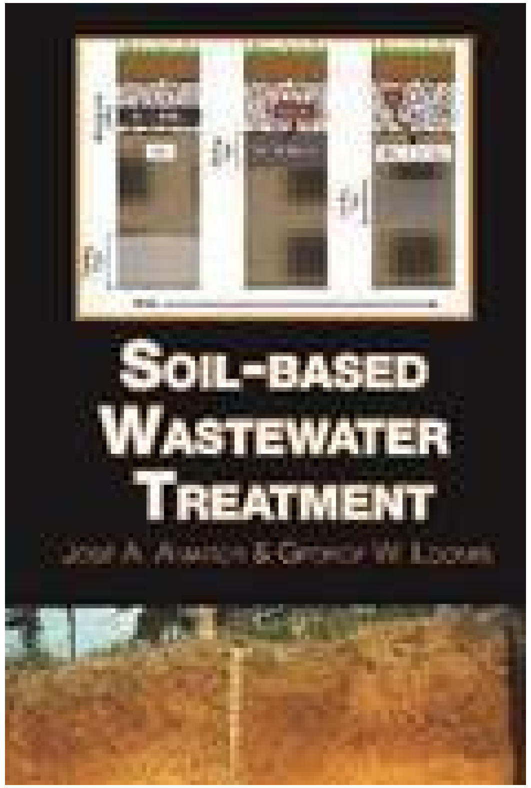


Figure 3-33. Illustration of Comparable Scenario “Footprints”.

“…… Specific for this project, HYDRUS was modified to account for the effect of <u>water filled porosity</u>, carbon content, and temperature on treatment to improve its ability to simulate nitrogen transformation under a variety of OWTS loading conditions…..

“For <u>drip dispersal systems</u>, the HLR is a function of the frequency and duration of doses each day for a given length of dispersal tubing……”



From the FORWARD

"….although there are excellent texts on particular aspects of soil-based treatment systems, few texts address-and few practitioners understand - the full nature and complexity of soil-based wastewater treatment and dispersal systems.

Admitting this lack of understanding is the first step to making changes…."

David L. Lindbo
Professor Emeritus, Soil Science, NCSU

Former President Soil Science Society of America

Director, Soil and Plant Science, Diversion USDA-Natural Resources Conservation Service

Jose A. Amador

George W. Loomis

2018

SUMMARY

Narrow ~~Trench~~ TUBING Width

Shallow Depth

Increase soil contact

GAS Exchange

Equal Distribution

Controlled Application

SHALLOW DISPERSAL

Oxygen / Carbon

Biofilms / Microsites

SIZE *TIME* *DIVERSITY*

RISK ASSESEMENT

NOWRA

To strengthen and promote the decentralized wastewater industry.

For More Information

Tom Ashton

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