AOSS Systems in Marginal Sites
Soil Science Elements
Introduction

May 15, 2023

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REHS, LPSS, MAOSE

GUIDANCE MEMORANDA AND POLICY (GMP) 2022-XX

Evaluation of Soils with Shallow Permeability Limiting Features to Address 12VAC5-613.80.12.a.iii

OEHS – Technical Services, Division of Onsite Sewage and Water, Environmental Engineering and Marina Programs

Purpose of Job Aid

The purpose of this job aid is to explain how to identify a permeability limiting feature (PLF) and when does that permeability limiting feature trigger a water mounding evaluation as required by subsection 12VAC5-613-80.12.a.

<u>USDA Natural Resources Conservation Service</u> (NRCS)

A ***<u>job aid</u>*** is, simply put, *<u>something that can be used on the job to improve performance</u>*.

** Input provided from Public and Private Sector Practitioners / Summer 2020

** Extensive review, discussion, and revision.

** Updates provided to SHADAC

NEXT? Vetted through SHADAC
Public Comment

WHEN?

1982

Commonwealth of Virginia
State Board of Health

Sewage Handling and Disposal Regulations

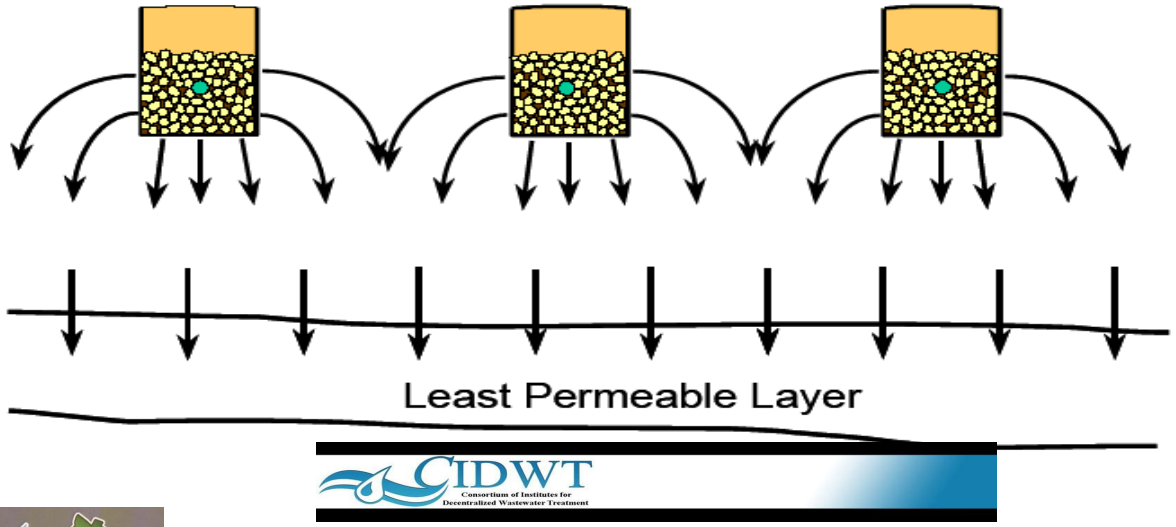
12 VAC – 5-610

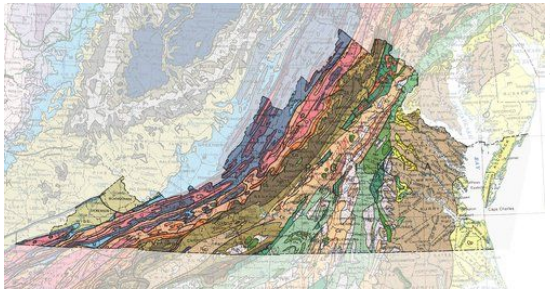
"***Treatment works***" means any device or system used in the storage, treatment, disposal or reclamation of sewage or combinations of sewage and industrial wastes, including but not limited to pumping, power and other equipment and appurtenances, septic tanks and any works, including land, *that are 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.*

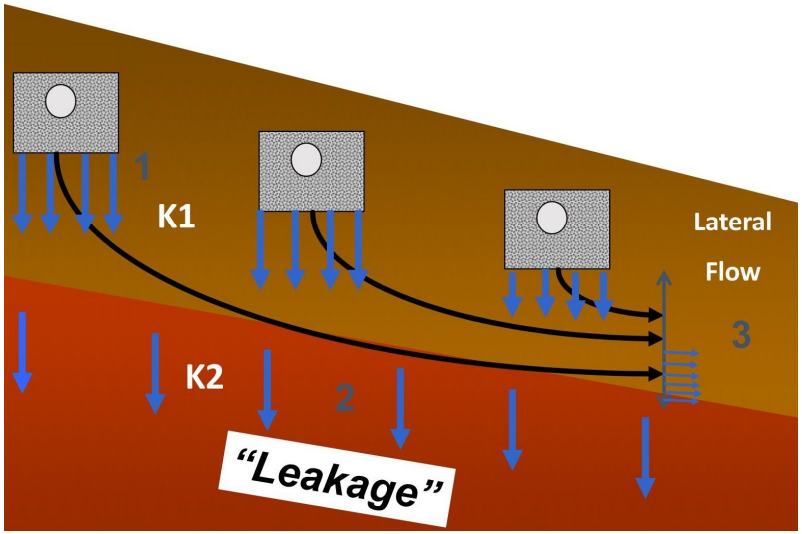
INTRODUCTION

** STU "Soil Treatment Unit"
SITE / SOIL component
as a ***Material Specification***

AOSS DESIGN





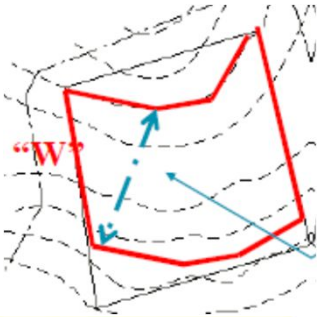


The Soil Treatment Unit (STU)

The STU (component) is the basis for the permit.

- **- The SITE / SOIL characteristics determine what type / DESIGN of Treatment and Dispersal system is required.**
- **- The STU is the Primary Point of system compliance, with effluent not to surface, or pollute surface and groundwater resources.**
- **- The AOSS 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 ("PLF").**
- **- The AOSS STU site evaluation represents a System *DESIGN* Component *Specification* requiring detailed site specific Preliminary Design.**

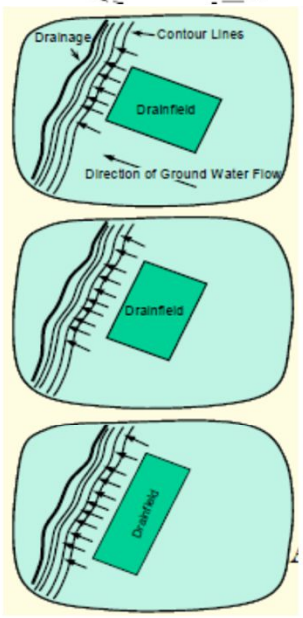
AOSS's WHAT WE SEE



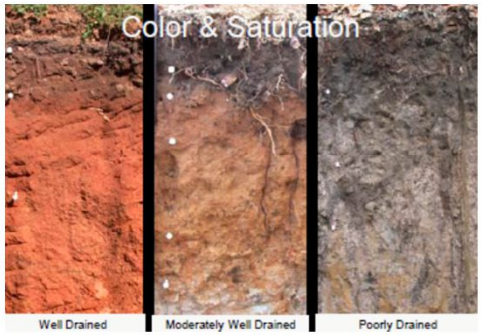
"Best Spot?"

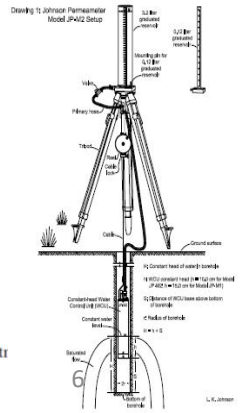
* **Lack of Knowledge / Understanding of the Regs**
* **Drive to Shallow Gravity Trenches / PADS**
* **Lack of Site Delineation / Area**
* **Minimal consideration for Geometry**
* **Minimal Slope**
* **Chroma II Depletions at shallow depths**
  Lack of Redox Description / Interpretation
  GROUP III+ Soils at <12"
* **Limited or NO Infiltration, Percolation, Ksat DATA**
* **Insufficient / Improper Ksat's testing**

  Duration / No K-2



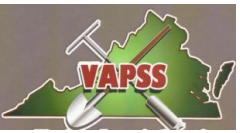
$$Q = \frac{K_{sat} \; A \; \Delta P}{L}$$





Virginia Cooperative Extension
Virginia Tech • Virginia State University

Publication CSES-141P



Measuring Saturated Hydraulic Conductivity in Soil

2018

Johnson Permeameter
Instruction Manual

"Performance"

2011

Professional Engineer design required.

CHAPTER 613
REGULATIONS FOR ALTERNATIVE ONSITE SEWAGE SYSTEMS

10. Maximum trench bottom hydraulic loading rates for pressure-dosed systems using TL-2 and TL-3 effluent are found in Table 1 and are to be used as follows:

- a. The designer is responsible for reducing loading rates according to the features and properties of the soils in the soil treatment area as well as for reducing loading rates for other types of dispersal;

- b. Adherence to the maximum trench bottom hydraulic loading rate criteria herein does not assure or guarantee that other performance requirements of this chapter, including effluent dispersal or ground water quality, will be met. It is the designer's responsibility to ensure that the proposed design is adequate to achieve all performance requirements of this chapter;

No "Prescriptive" *deemed to comply*

RISK ASSESMENT

CHAPTER 613
REGULATIONS FOR ALTERNATIVE ONSITE SEWAGE SYSTEMS

12VAC6-613-80.12.:

Whenever the depth to a **permeability limiting feature** on the naturally occurring site is less than 18 inches as measured from the ground surface, whenever the treatment works does not provide at least 18 inches of vertical separation to a permeability limiting feature, or whenever the design is for a large AOSS, then the following shall apply:

*a. The designer shall demonstrate that (i) the site is **not flooded during the wet season**, (ii) there is a **hydraulic gradient** sufficient to move the applied effluent off the site, and (iii) **water mounding** will not adversely affect the functioning of the soil treatment area or create ponding on the surface;*

- Not "Flooded" during the wet season

- Effluent will move off site once "applied"

- "Mounding" addressed ie. Standoff to Limitation / Ponding

RISK ASSESMENT

"PLFs" <18" below point of application require characterization

RISK ASSESMENT

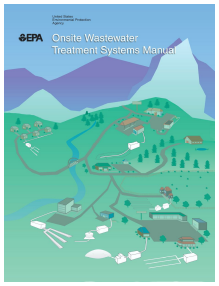
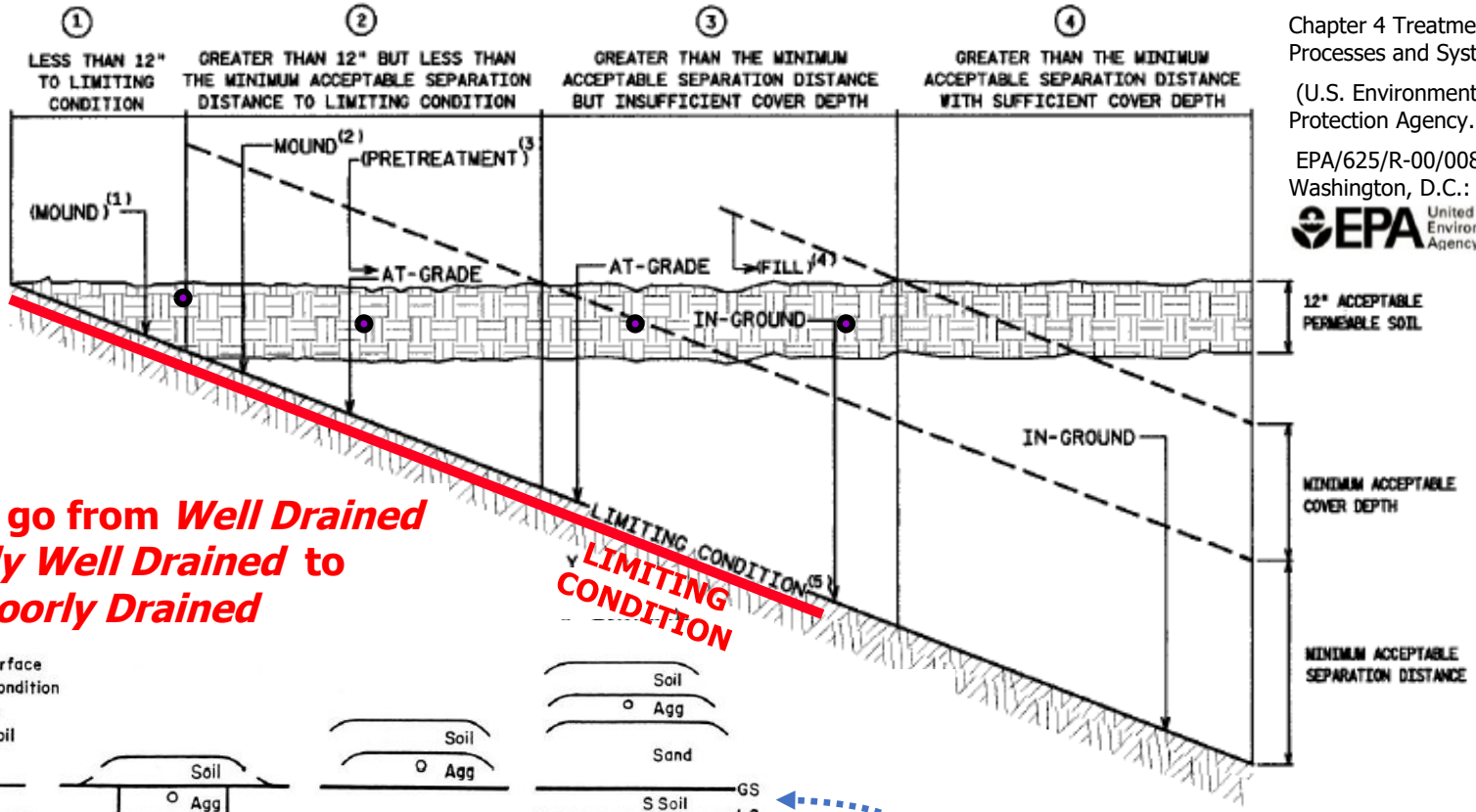
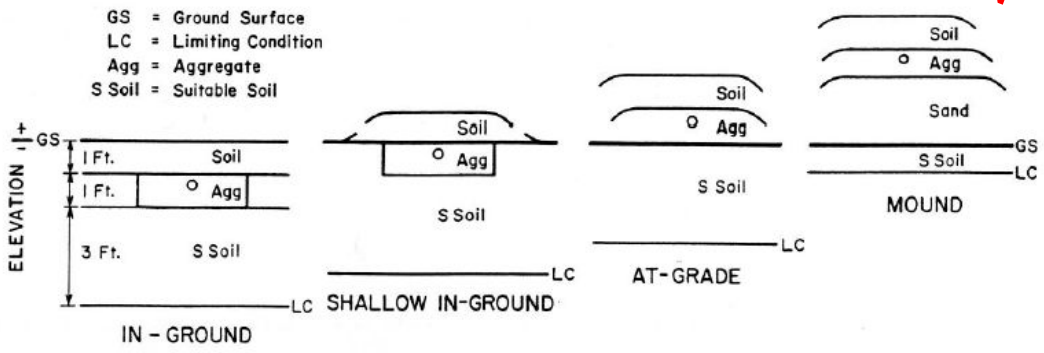


Figure 4-3. Suggested subsurface infiltration system design versus depth (below the original ground surface) to a limiting condition



Soils utilized go from *Well Drained* to *Moderately Well Drained* to *Somewhat Poorly Drained*

LIMITING CONDITION



Narrow Hydraulic & Remediation "WINDOW"

On-Site Wastewater Treatment Systems Manual

Chapter 4 Treatment Processes and Systems

(U.S. Environmental Protection Agency.

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

EPA United States Environmental Protection Agency

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).

Conventional Trench

Shallow Trench

Drip / Elevated

Depth to "Chroma 2 Mottles"

10" to 20" to 40"

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.

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.

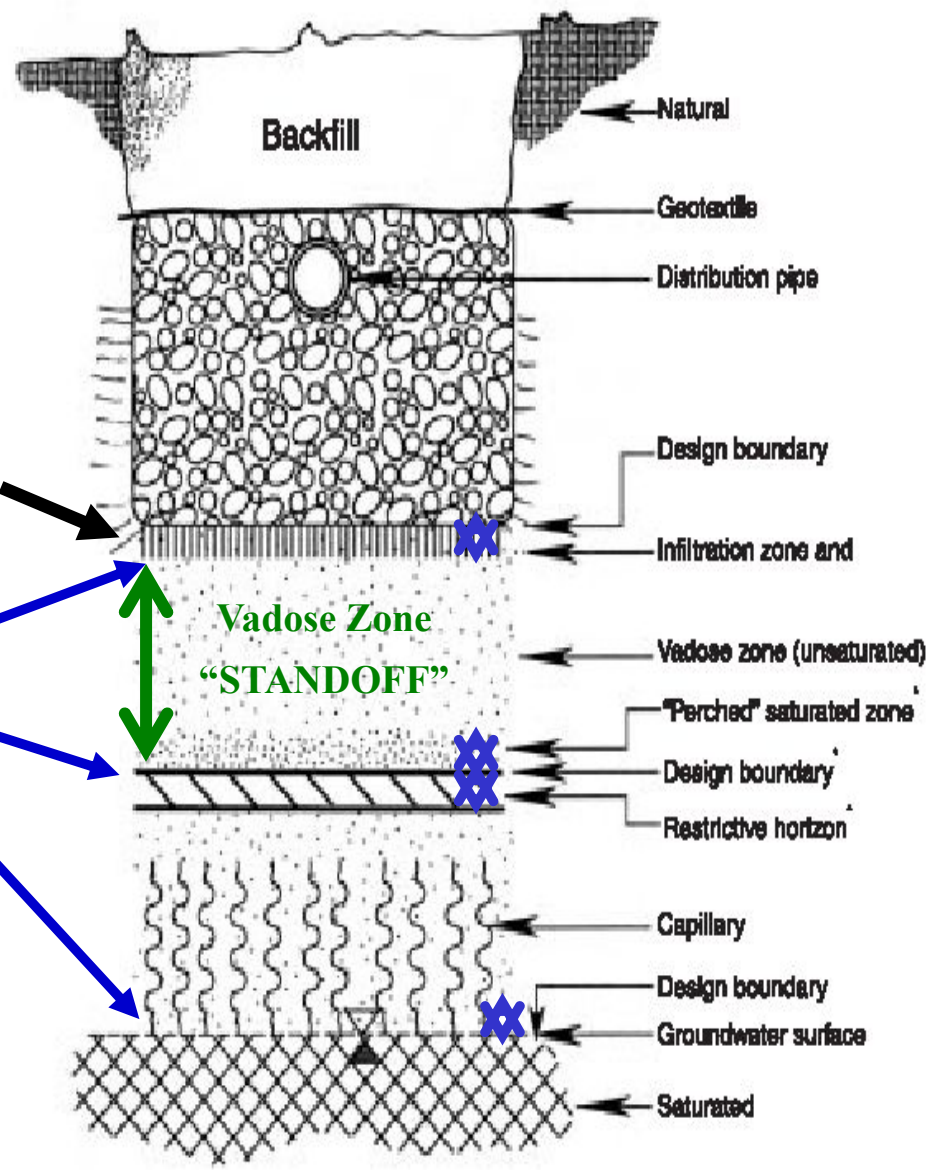
Design Boundaries

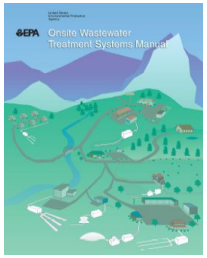
NOTE: "Infiltration Zone"

"Design Boundary"

On-Site Wastewater Treatment Systems Manual

<u>Chapter 5</u> Treatment Processes and Systems (U.S. Environmental Protection Agency. EPA/625/R-00/008 Washington, D.C.: 2002)





Loading rate, hydraulic:

quantity of water applied to a given treatment component, usually expressed as volume per unit of infiltrative surface area per unit time, 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

2007

Effluent Quality?

Peak Daily Design Flow?

Average Flow?

INFILTRATIVE SURFACE

610 SH&DR STE Trench Bottom Loading Rates

Increased LOADING RATES for Dispersal

SOIL TEXTURE GROUP	TEXTURE SOIL MORPHOLOGY	TRENCH BOTOM LOADING RATE Gal. / Ft² / Day		MINUTES Per INCH
		STE / (Gravity)	STE / (LPD)	
I SANDS	Sand (Sd) Loamy Sand (LSd)	.91 - 76	.91 - .76	<15
IIA COARSE LOAMS IIB	Sandy Loam (SdL) Structurless	.68- .63	.68 - .63	20 - 25
	Sandy Loam (SdL) Loam (L) Sandy Clay Loam (SdCL)	.57 - .44	.61 - .54	30 – 45
IIIA FINE LOAMS IIIB	Silt Loam (SiL) Sandy Clay Loam (SdCL)	.4 - .28	.52 - .42	50 – 70
	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

Commonwealth of Virginia
State Board of Health

Sewage Handling and Disposal Regulations

Table 5.4.
Area Requirements for Absorption Trenches.

Percolation Rate (Minutes/Inch)	Area Required (Ft²/100 Gals)		Area Required (Ft²/Bedroom)	
	Gravity	Low Pressure Distribution	Gravity	Low Pressure Distribution
5	110	110	165	165
10	120	120	180	180
15	132	132	198	198
20	146	146	218	218
25	158	158	237	237
30	174	164	260	255
35	191	170	286	260
40	209	176	314	264
45	229	185	344	279
50	251	193	376	293
55	275	206	412	309
60	302	217	452	325
65	331	228	496	342
70	363	240	544	359
75	398	251	596	375
80	437	262	656	394
85	479	273	718	409
90	525	284	786	424
95	575	288	862	431
100	631	316	946	473
105	692	346	1038	519
110	759	379	1138	569
115	832	416	1248	624
120	912	456	1368	684

Decentralized Wastewater Glossary

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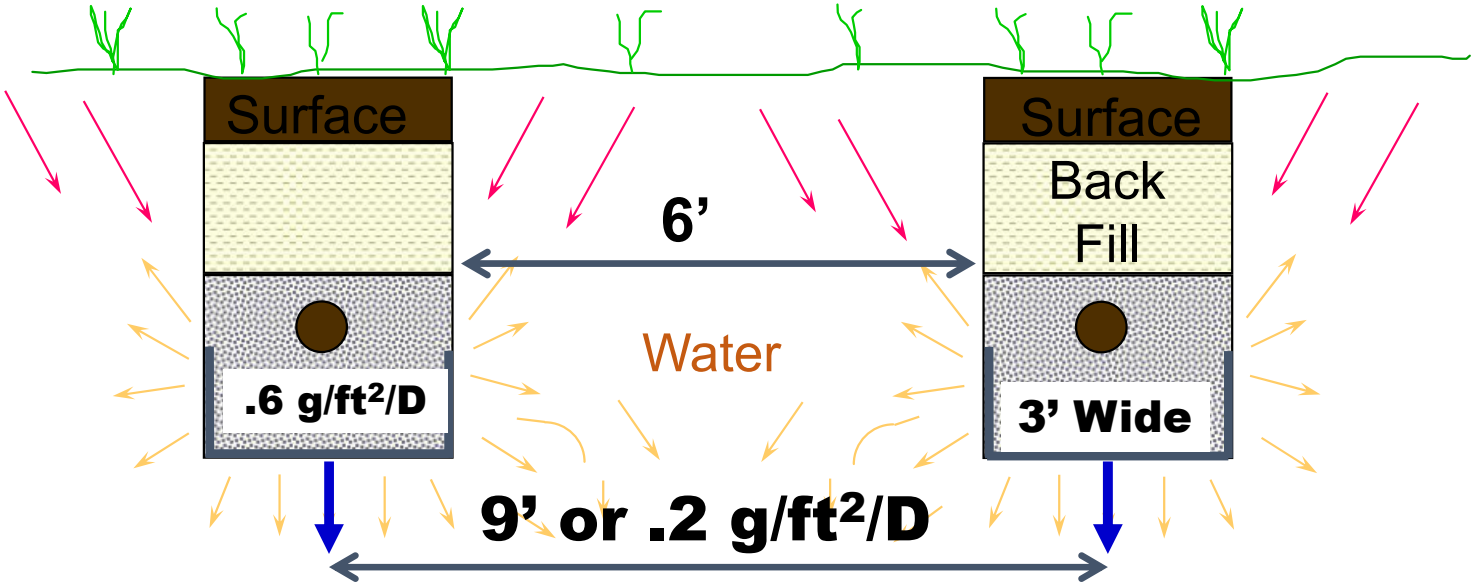
2007

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 LOADING RATES
Trench Spacing (footprint)



Assume 3’ trench, with 9’ center

Trenches installed on centers 3X width

EPA United States Environmental Protection Agency

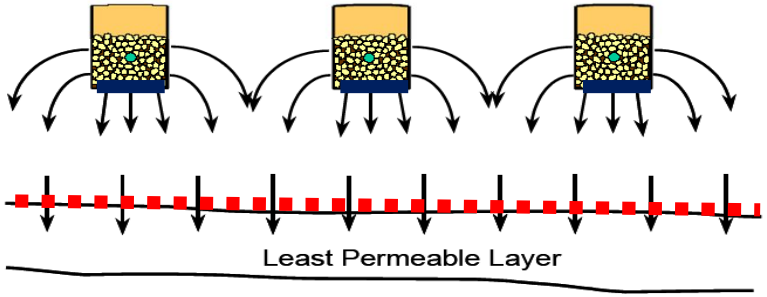
Soil Characteristics			Infiltration Loading Rate gal/day/ft²	
	Structure		>30 mg/l	<30 mg/l
Texture	Shape	Grade	BOD	BOD
COS, S, LCOS, LS	--	0SG	0.8	1.6
FS, VFS, LFS, LVFS	--	0SG	0.4	1.0
CLS, SL	--	0M	0.2	0.6
	PL	1	0.2	0.5
		2,3	0.0	0.0
	PR/BK /GR	1	0.4	0.7
		2,3	0.6	1.0
FSL, VFSL	--	0M	0.2	0.5
	PL	1,2,3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

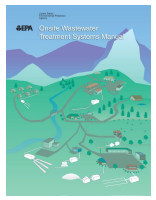


K-2 → **.2**

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	.13	.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

What are Permeability Limiting Features?

The term **'permeability limiting feature' (PLF)** is used to describe a soil feature that impedes water movement and may affect the design, but ***no regulatory definition exists for PLF***. The *Sewage Handling and Disposal Regulations (**SHDR**)* includes the definition for "impervious strata" as **"soil or soil materials with an estimated or measured percolation rate in excess of 120 minutes per inch."** The **SHDR** also defines "a soil restriction" as "**a feature in the soil that impedes the percolation of water**". Soil restrictions include pans, plinthic horizons, and stoniness. However, neither the *Regulations for Alternative Onsite Sewage Systems (**AOSS Regulations**)* or the *Sewage Handling and Disposal Regulations (SHDR)*, defines a 'permeability limiting feature."

Permeability Limiting Feature (PLF)
DEFINITION PROPOSED in Policy

"**Permeability limiting feature**" means a soil feature within the project ***boundary of the soil treatment area*** that may ***impede*** the ease of vertical water flow from the point of effluent application in an overlying horizon to the extent such that the feature *may* ***affect*** the design, function, or performance of the soil treatment component of the AOSS.

Permeability Limiting Features (PLF)

PLFs *may* include, but are not limited to:

- **restrictive** features such as fragic, plinthic, or densic layers, hard bedrock (R horizon) or soft bedrock (Cr horizon), and soils with mixed, vermiculitic, or smectitic mineralogy;
- abrupt textural changes or lithologic **discontinuities**;
- **boundary conditions** including varying permeability rates between the installation horizon and an underlying horizon within 18 inches of the soil infiltrative surface (below grade system) or the ground surface (above grade system)

A site evaluator and designer should characterize the cause of the limitation when considering a PLF. A water table is not a PLF, but what causes the water table may be. If the feature results in a perched or seasonal water table, it indicates problems with water movement and if the separation from the permeability limiting feature (but not necessarily the water table) is less than 18 inches as defined for in-ground and above grade designs, water mounding modeling with calculations are required to show that water will move away from the site and not create a water mound under the system that would encroach on the vertical separation required under Table 2 (12VAC5-613.80.13) in the *AOSS Regulations*.

Permeability Limiting Features (PLF)
Hydraulic Assessment Required – K2
7 CONDITIONS

"A soil professional can estimate the K1 and K2 with reasonable accuracy when the horizons have a perc rate of less than a 120 mpi rate. The *SHDR* consider soils with greater than 120 mpi 'impervious' and prohibit their use as an infiltrative surface (K1)."

"While the *AOSS Regulations* do not prohibit the use of soils with greater than a 120 mpi rate, there is limited experience with using such soils in Virginia. Reliably estimating a percolation rate from a traditional field textural and morphological characterization is difficult in such slow rate soils. Further characterization is necessary to ascertain the suitability of such soils for onsite systems."

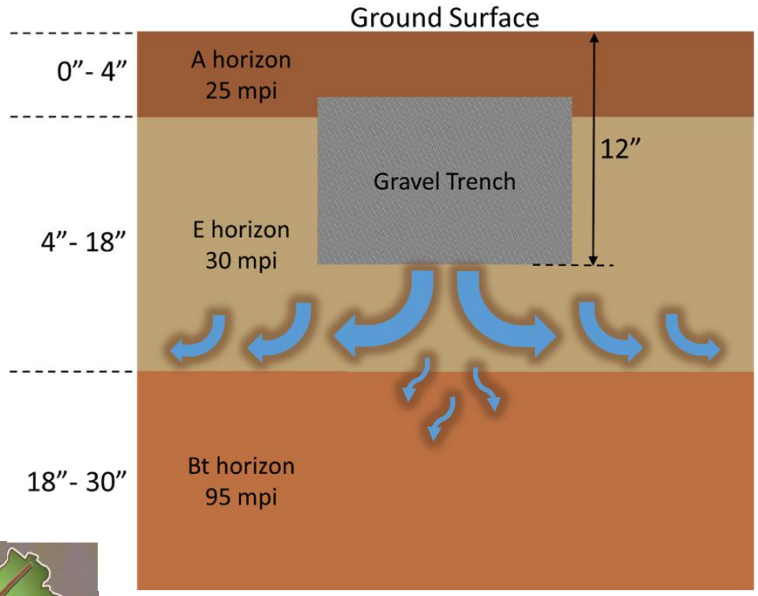
"For small AOSS sites, Ksat testing (to determine appropriate K2 values for modeling of water mounding) shall be conducted when any of the following characteristics are present in a PLF found within 18 inches of the soil surface for an above grade system or within 18 inches of the effluent application point for a below ground system."

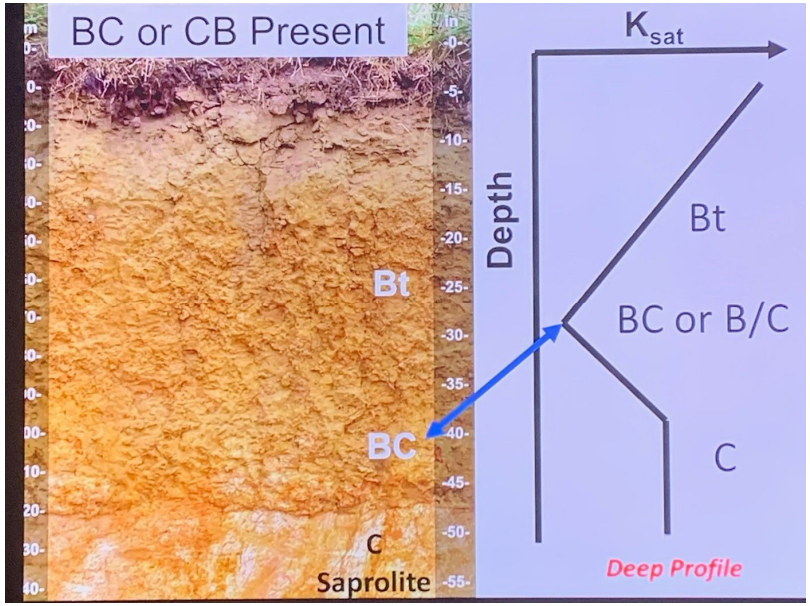
Permeability Limiting Features (PLF)

Hydraulic Assessment Required – K2

7 CONDITIONS

- **(1) The PLF is a Texture Group IV and the K1 (in the install area) is Texture Group I, IIa, or IIb soil.**



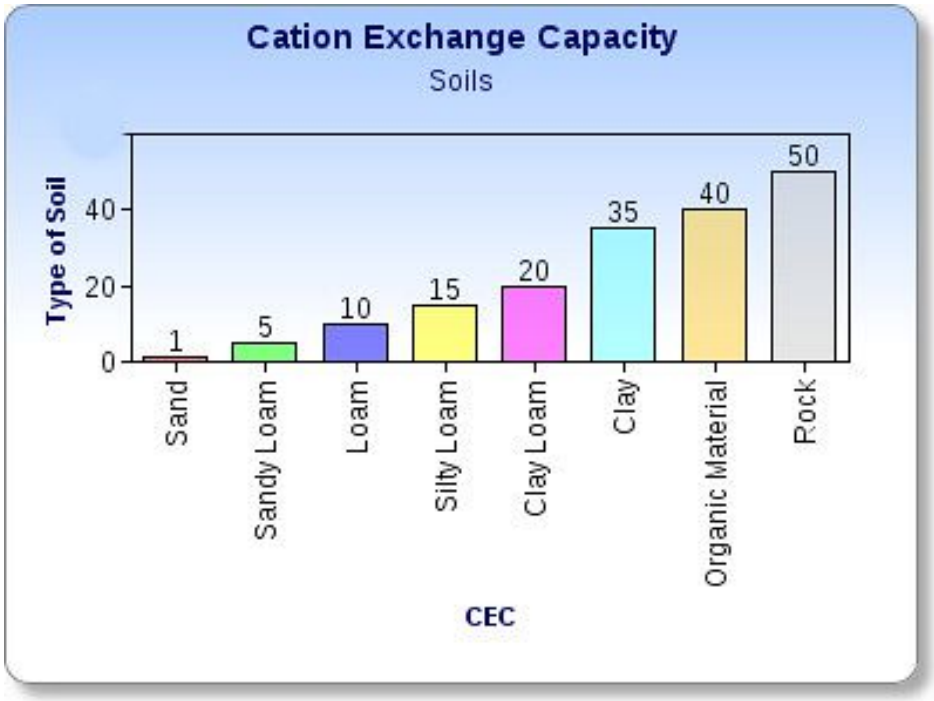


Permeability Limiting Features (PLF)

Hydraulic Assessment Required – K2 *Knowledge of* ***TAXONOMY***

7 CONDITIONS

- **(2) Particle size classes of fine or very fine and mixed, vermiculitic, or smectitic mineralogy is indicated by the USDA NRCS Soil Survey soil mapping.**



"ACTIVITY"

Permeability Limiting Features (PLF)

Hydraulic Assessment Required – K2

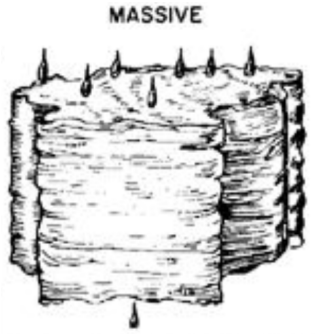
7 CONDITIONS

- **(3) Field consistence is firm, moderately sticky and/or moderately plastic, or greater.**

Permeability Limiting Features (PLF)

Hydraulic Assessment Required – K2

7 CONDITIONS



- **(4) <u>The soil has densic or fragic properties.</u>**

  - •**d**: <u>Densic</u> layer (physically root restrictive).
  - •**x**: <u>Fragipan</u> characteristics.

<u>fragic horizon</u> (from L. fragilis, frangere, to break) *is a natural noncemented subsurface horizon with a pedality and a porosity pattern such that roots and percolating water penetrate the soil only along interped faces and streaks.*

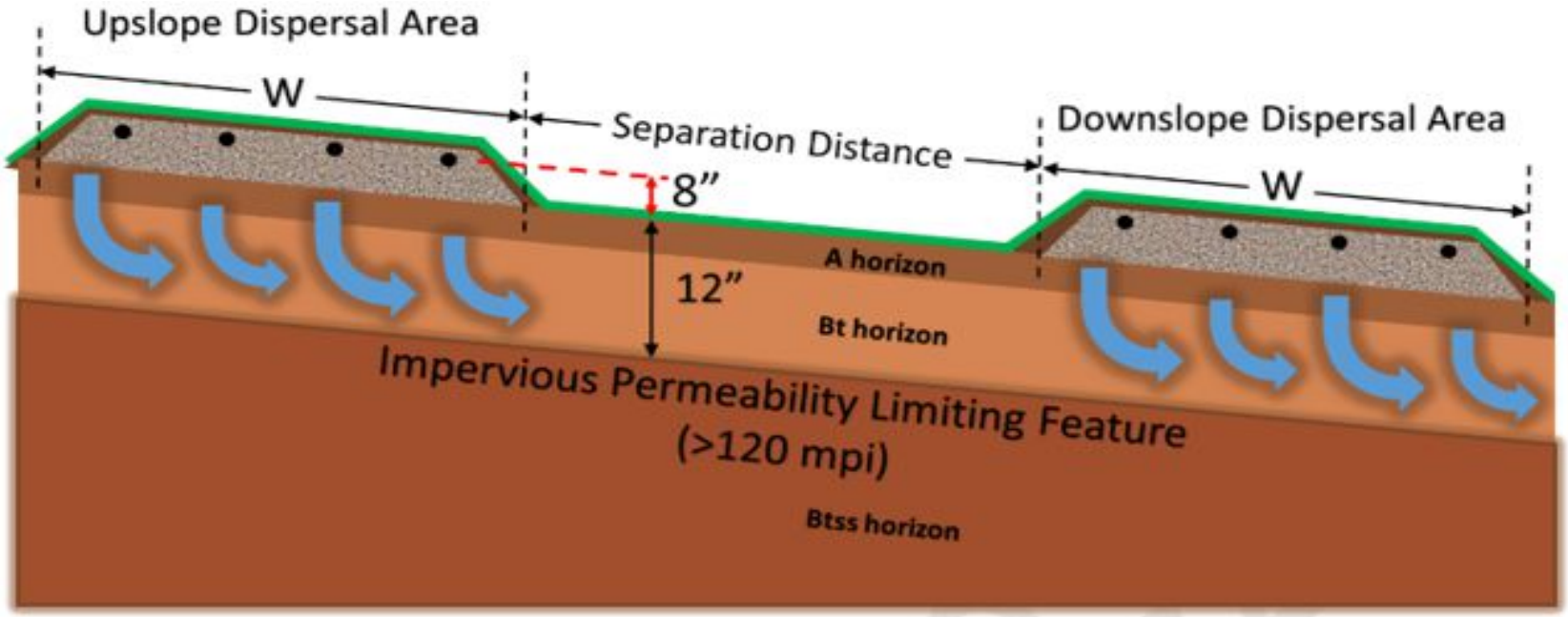
Knowledge of **TAXONOMY**

Permeability Limiting Features (PLF)

Hydraulic Assessment Required – K2

7 CONDITIONS

- **(5) The percolation rate based on a field textural and morphological evaluation is estimated at slower than 120 mpi.**



Permeability Limiting Features (PLF)
Hydraulic Assessment Required – K2
7 CONDITIONS

- **(6) When any of the soil horizons directly above Cr (soft bedrock) or R (hard bedrock) are texture group III or IV. Performing Ksats in Cr or R horizons is impractical and the results are highly variable due to the hydraulic characteristics of Cr and R being rock structure controlled. Testing should be done in the Texture Group III or IV soil material and not the Cr or R horizons.**

  "If hard or soft bedrock or the PLF is encountered at depths less than 12 inches, or the soil horizon boundary requirements above cannot be met; it is impractical to perform traditional Ksat testing. When the PLF does not have shrink-swell properties, conservatively estimate the K2 value based on texture, structure, consistence and experience. Establish a K2 value by dividing the K1 value by at least 5. Values should be in in/day, ft/day or cm/day."

AOSS Systems in Marginal Sites
Soil Science Elements / Introduction

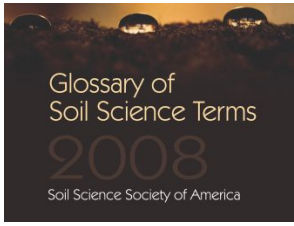
SOIL INTERPRETATIONS **Predictions of soil behavior in response to specific uses or management based on inferences from soil characteristics and qualities. They are either qualitative or quantitative estimates or ratings of soil productivities, potentials, or limitations.**

AQUIC CONDITIONS **Continuous or periodic saturation and reduction. The presence of aquic conditions is indicated by redoximorphic features and can be verified by measurement of saturation and reduction.**

OXYAQUIC CONDITIONS **Pertaining to soils that are saturated but are not reduced and do not contain redoximorphic features.**

ENDOSATURATION **The soil is saturated with water in all layers from the upper boundary of saturation to a depth of 200 cm or more from the mineral soil surface.**

EPISATURATION **The soil is saturated with water in one or more layers within 200 cm of the mineral soil surface and also has one or more unsaturated layers with an upper boundary above 200 cm depth, below the saturated layer(s) (a perched water table).**

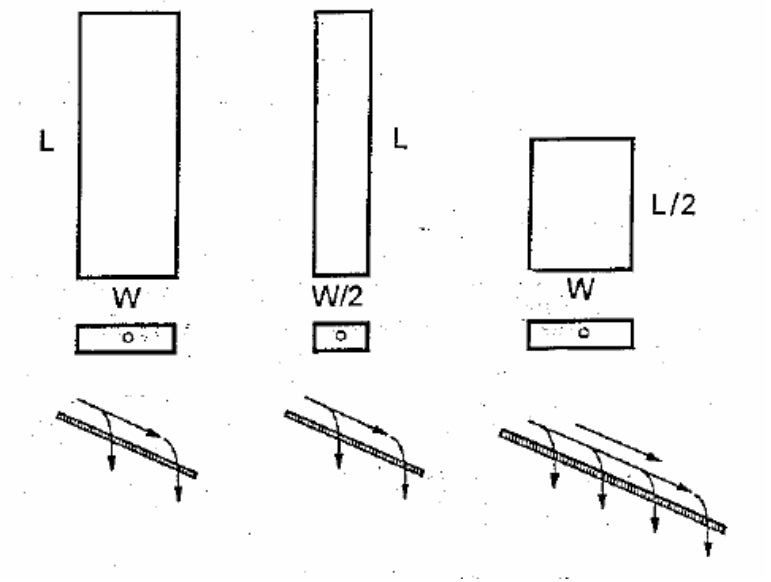


Permeability Limiting Features (PLF)

Hydraulic Assessment Required – K2

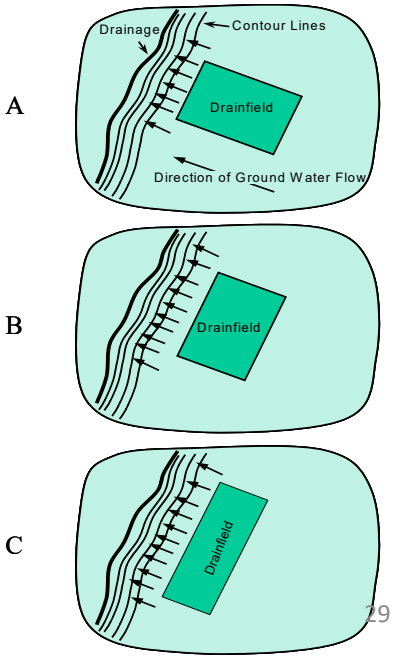
7 CONDITIONS

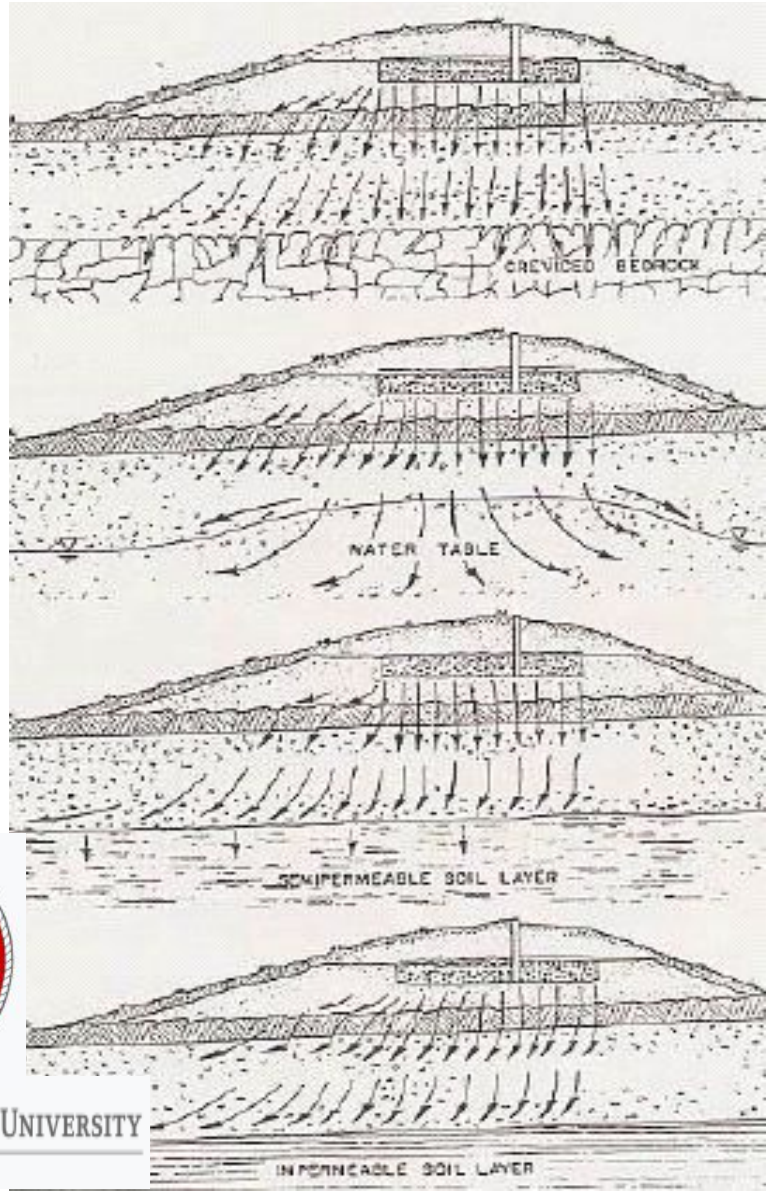
- **(7) The design hydraulic linear loading rate (HLLR) of shallow placed and elevated designs with a PLF is equal to or greater than 5 gpd/lf. Please see Appendix for further discussion of Hydraulic Linear Loading Rate.**



Loading rate, contour:

cumulative total of effluent applied to the soil profile at the down gradient end of a dispersal system installed on a slope, expressed as volume per unit length per unit time along the contour (e.g., gpd/ft.).





MOUND 2000

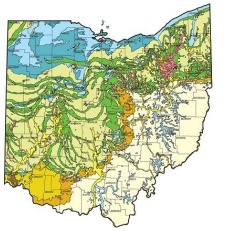
FOUR MODELS

- **Creviced Bedrock (vertical flow)**

  8 – 10 gal. / lin. ft. / day

- **Apparent Water table (mounding)**

  3 – 4 gal. / lin. ft. / day



- **Semi permeable Layer (Leakage)**

  5 – 6 gal. / lin.ft. / day

- **Impermeable Layer (horizontal flow)**

  3 – 4 gal. lin. ft. / day

THE OHIO STATE UNIVERSITY

GUIDANCE MEMORANDA AND POLICY (GMP) 2022-XX

Evaluation of Soils with Shallow Permeability Limiting Features to Address 12VAC5-613.80.12.a.iii

"The requirement of 12.a is specific to applications for all construction permits, certification letters, and subdivision approvals. For certification letters and subdivision *approvals issued prior to the adoption of this policy, this policy shall apply to any construction permit issued for the site after the adoption of this policy.*"

GUIDANCE MEMORANDA AND POLICY (GMP) 2022-XX

Evaluation of Soils with Shallow Permeability Limiting Features to Address 12VAC5-613.80.12.a.iii

"In order to conduct a water mounding evaluation, the designer must know the saturated hydraulic conductivity (Ksat) of the installation (natural soil infiltration) zone (K1) and of the PLF (K2). Field interpretation of landscape characteristics (12VAC5-613.80.12a.i & ii) and interpretation of redoximorphic features aid in determining the extent and degree of effect of an identified PLF."

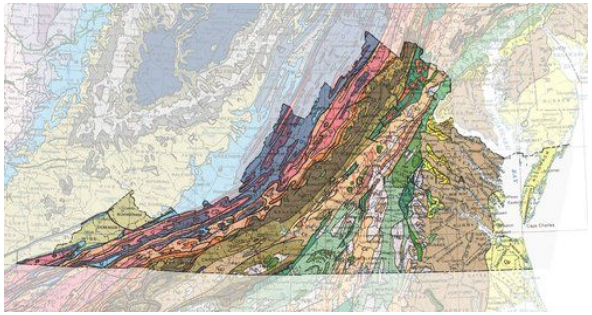
"Utilizing these suggested K2 rates for design purposes does not ensure successful functioning of dispersal systems in soils with severe limitations such as shrink-swell horizons and very shallow depth to R or Cr. The success rate with such type designs is limited and it may be best to avoid dispersal system designs in soils having these characteristics."

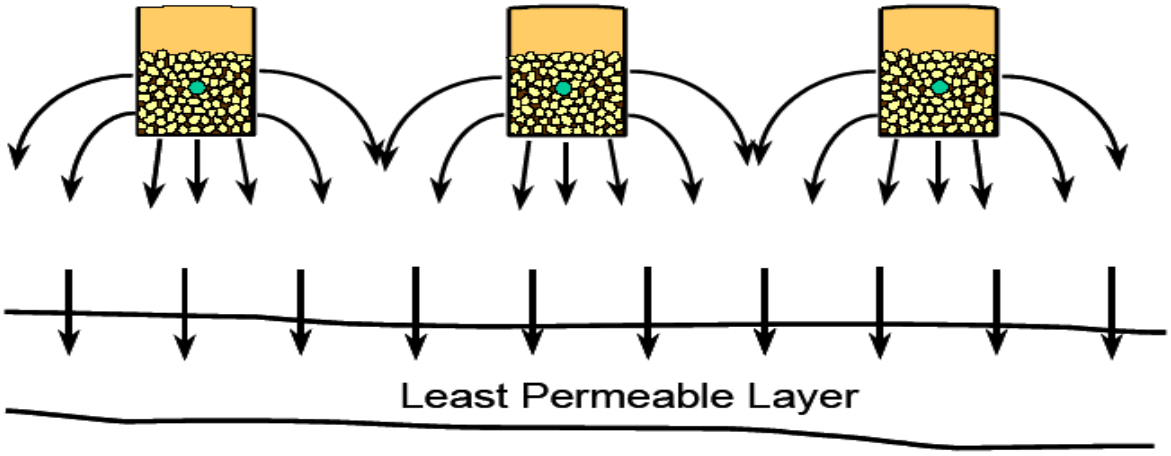
APPENDIX **"**The identification, characterization, and quantification of PLFs in the soil absorption area require an increased detail of investigation. As outlined in the guidance *"Water mounding calculations should be performed by professional engineers or Master Alternative Onsite Soil Evaluators (MAOSE) who have an understanding of the parameters of the various mathematical solutions".* It is very important that all practitioners perform within their expertise."

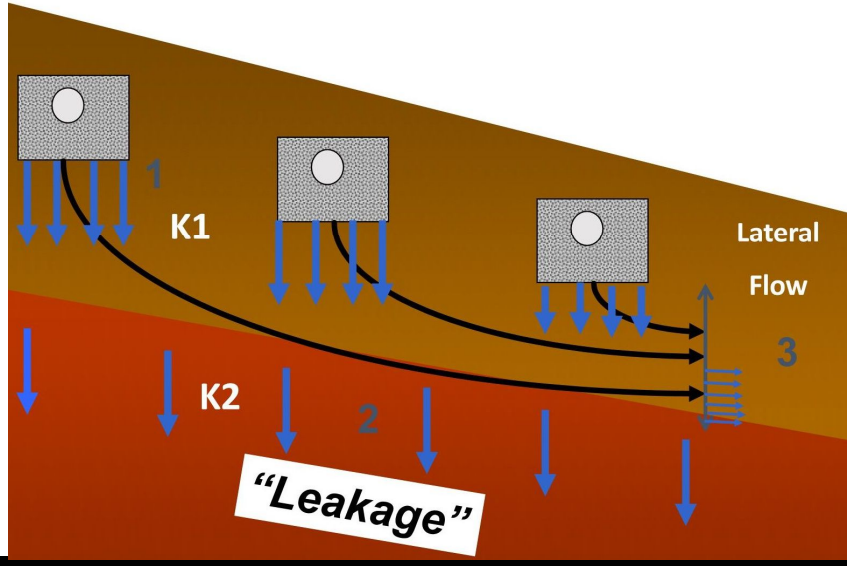
12VOC5-613 AOSS REGULATIONS

** Soil & Site Characterization

Hydraulic Assessment







Soil Texture	Ksat (1) (cm/day)	Percolation Rate (mpi)	Soil Type	Septic Tank Effluent (2)				TL-2 Effluent				TL-3 Effluent			
				Gravity Trench Loading (gpd/sqft)	LPD Trench Loading (gpd/sqft)	Gravity Gravelless Loading (gpd/sqft)	Drip Loading (3) (gpd/sqft)	Pressure Trench Loading (4,5) (gpd/sqft)	Gravity Trench Loading (6) (gpd/sqft)	Drip Loading (3) (gpd/sqft)	Pad Loading (7) (gpd/sqft)	Pressure Trench Loading (4,5) (gpd/sqft)	Gravity Trench Loading (6) (gpd/sqft)	Drip Loading (3) (gpd/sqft)	Pad Loading (8) (gpd/sqft)
Sand & Loamy Sand	>17	5	I	**0.91**	**0.91**	**1.20**	0.30	**1.8**	1.80	0.60	1.20	**3.0**	3.00	1.00	1.66
		10	I	**0.83**	**0.83**	**1.11**	0.28	1.67	1.67	0.56	1.11	2.67	2.67	0.89	1.66
		15	I	**0.76**	**0.76**	**1.01**	0.25	1.53	1.53	0.51	1.02	2.33	2.33	0.78	1.66
Sandy Loam	15 to 17	20	IIa	**0.68**	**0.68**	**0.91**	0.23	**1.4**	1.40	0.47	0.93	**2.0**	2.00	0.67	1.66
		25	IIa	**0.63**	**0.63**	**0.84**	0.21	1.30	1.30	0.43	0.86	1.75	1.75	0.58	1.33
Loam & Sandy Clay Loam	10 to <15	30	IIb	**0.57**	**0.61**	**0.76**	0.20	**1.2**	1.13	0.40	0.80	**1.5**	1.41	0.50	1.11
		35	IIb	**0.52**	**0.59**	**0.70**	0.20	1.10	0.98	0.37	0.73	1.38	1.22	0.46	0.95
		40	IIb	**0.48**	**0.57**	**0.64**	0.19	1.00	0.84	0.33	0.66	1.25	1.05	0.42	0.83
		45	IIb	**0.44**	**0.54**	**0.58**	0.18	0.90	0.73	0.30	0.60	1.13	0.91	0.38	0.74
Silt Loam, Clay Loam & Silty Clay Loam	4 to <10	50	III	**0.40**	**0.52**	**0.53**	0.17	**0.8**	0.62	0.27	0.53	**1.0**	0.77	0.33	0.67
		55	III	**0.36**	**0.49**	**0.49**	0.16	0.76	0.57	0.25	0.50	0.94	0.71	0.31	0.61
		60	III	**0.33**	**0.46**	**0.44**	0.15	0.71	0.51	0.24	0.47	0.89	0.64	0.30	0.55
		65	III	**0.30**	**0.44**	**0.40**	0.15	0.67	0.46	0.22	0.44	0.83	0.57	0.28	0.51
		70	III	**0.28**	**0.42**	**0.37**	0.14	0.62	0.41	0.21	0.41	0.78	0.51	0.26	0.48
		75	III	**0.25**	**0.40**	**0.33**	0.13	0.58	0.36	0.19	0.38	0.72	0.46	0.24	0.44
		80	III	**0.23**	**0.38**	**0.30**	0.13	0.53	0.32	0.18	0.35	0.67	0.40	0.22	0.42
		85	III	**0.21**	**0.37**	**0.28**	0.12	0.49	0.28	0.16	0.33	0.61	0.35	0.20	0.39
		90	III	**0.19**	**0.35**	**0.25**	0.12	0.44	0.24	0.15	0.30	0.56	0.30	0.19	0.37
Sandy Clay, Silty Clay & Clay	<4	95	IV	**0.17**	**0.35**	**0.20**	0.12	**0.4**	0.20	0.13	0.27	**0.5**	0.25	0.17	0.35
		100	IV	**0.16**	**0.32**	**0.19**	0.11	0.37	0.19	0.12	0.25	0.46	0.23	0.15	0.33
		105	IV	**0.14**	**0.29**	**0.17**	0.10	0.34	0.17	0.11	0.23	0.43	0.21	0.14	0.32
		110	IV	**0.13**	**0.26**	**0.16**	0.09	0.31	0.16	0.10	0.21	0.39	0.19	0.13	0.30
		115	IV	**0.12**	**0.24**	**0.14**	0.08	0.28	0.14	0.09	0.19	0.35	0.18	0.12	0.29
		120	IV	**0.11**	**0.22**	**0.13**	0.07	0.25	0.13	0.08	0.17	0.32	0.16	0.11	0.28

Bolded loading rates represent regulatory maximums
Non-bolded loading rates represent interpolated/extrapolated recommendations

Footnotes:
(1) Per Peacock and Table 1 of the AOSS Regulations
(2) Regulatory maximum rates from Table 5.4 of the SH&DR
(3) Derived from Pressure rates per 12VAC5-610-955.C
(4) Regulatory maximum rates from Table 1 of the AOSS Regulations
(5) Intra-range rates interpolated/extrapolated from regulatory rate
(6) Derived from Pressure rates using Gravity/LPD ratio from Table 5.4 of the SH&DR
(7) Derived from Pressure rates using ratio from Table 1 of GMP #147 (rescinded)
(8) From GMP #147 (rescinded)

VDH Loading Rate Guidance

Created: 2/7/2017
Format changes dfc 7/5/17

Table 1
Maximum Pressure-Dosed Trench Bottom Hydraulic Loading Rates

Percolation Rate (MPI)	Saturated hydraulic conductivity (cm/day)	TL-2 Effluent (gpd/sf)	TL-3 Effluent (gpd/sf)
≤15	> 17	1.8	3.0
15 to 25	15 to 17	1.4	2.0
>25 to 45	10 to < 15	1.2	1.5
>45 to 90	4 to < 10	0.8	1.0
>90	< 4	0.4	0.5

** 24 Loading Rates
5 – 120 MPI

** 4 Dispersal Methods
Conv. Trench / "Gravelless"
LPD
Drip

** 3 Infiltration Configurations
- Trench ("Graveless")
- Drip
- PAD (Mound?)

**Ksat cm / day

613 AOSS REGS Pressure Trench Bottom Loading Rates

SOIL TEXTURE GROUP	TEXTURE SOIL MORPHOLOGY	TRENCH BOTOM LOADING RATE Gal. / Ft² / Day				MINUTES Per INCH
		STE / (LPD)	TL - 2 NSF 40	TL – 3 10 / 10		
I SANDS	Sand (Sd) Loamy Sand (LSd)	.91 - .76	1.8 – 1.53	3.0 - 2.33	3x	<15
IIA COARSE LOAMS IIB	Sandy Loam (SdL) Structureless	.68 - .63	1.4- 1.3	2.00–1.75		20 - 25
	Sandy Loam (SdL) Loam (L) Sandy Clay Loam (SdCL)	.61 - .54	1.2 – .9	1.5 – 1.13		30 – 45
IIIA FINE LOAMS IIIB	Silt Loam (SiL) Sandy Clay Loam (SdCL)	.52 - .42	.8 - .62	1.0 – .78	2x	50 – 70
	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

"PEACOCK" Chart

Soil Texture	Ksat (1) (cm/day)	Percolation Rate (mpi)	Soil Type	"PEACOCK" Ksat TRENCH cm / day		MPI
Sand & Loamy Sand	>17	5	I	*>50* **	I	5
		10	I	25 - 50		10
		15	I	17.4 - 25		15
Sandy Loam	15 to 17	20	IIa	15.9 - *17.4* **	IIA	20
		25	IIa	14.6 - 15.9		25
Loam & Sandy Clay Loam	10 to <15	30	IIb	13.3 - *14.6* **	IIB	30
		35	IIb	12.0 - 13.3		35
		40	IIb	11.0 - 12.0		40
		45	IIb	10.0 - 11.0		45
Silt Loam, Clay Loam & Silty Clay Loam	4 to <10	50	III	9.1 - *10.0* **	IIIA	50
		55	III	8.3 - 9.1		55
		60	III	7.6 - 8.3		60
		65	III	6.9 - 7.6		65
		70	III	6.4 - 6.9		70
		75	III	5.8 - *6.4* **	IIIB	75
		80	III	5.2 - 5.8		80
		85	III	4.8 - 5.2		85
		90	III	4.4 - 4.8		90
Sandy Clay, Silty Clay & Clay	<4	95	IV	4.0 - *4.4* **	IV	95
		100	IV	3.6 - 4.0		100
		105	IV	3.3 - 3.6		105
		110	IV	3.0 - 3.3		110
		115	IV	2.6 - 3.0		115
		120	IV	*2.2* * - 2.6		120

- **Developed over several years MID 1990's. Based on experience and comparisons.**
- **Consultation with Azis Ammoozagar NCSU**
- **Informal Peer Review**
- **Most evaluators accepted that values somewhat agreed with morphological MPI estimates (610) for Infiltrative Surfaces (STE)**
- **Adjustment of Ksat values to CM / Day ranges meshed well with MPI Ranges (Trench Bottom)**
- **Affirmed by incorporation into 613 Regulations for AOSS 2011**

"Apples & Oranges"

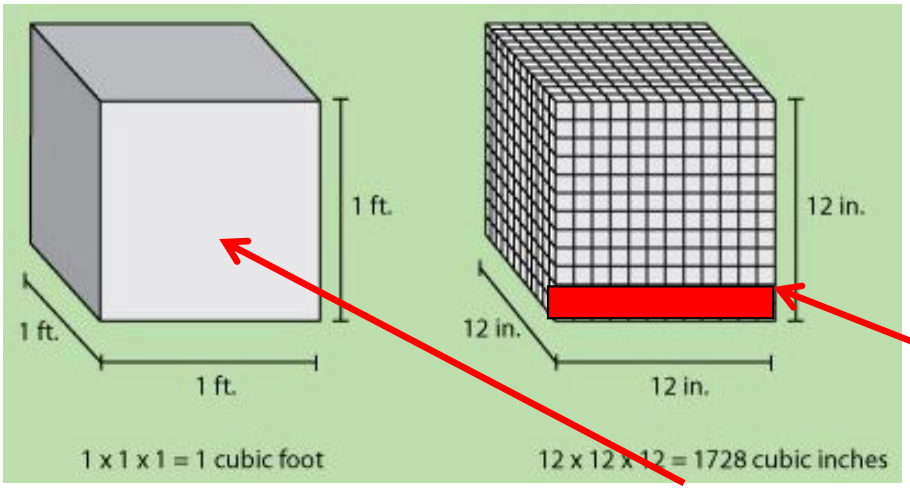
EXAMPLE: TL-3 50 MPI

Krat (1) (cm/day)	Percolation Rate (mpi)	Soil Type	TL-3 Effluent: Pressure Trench Loading (4,5) (gpd/sqft)	Gravity Trench Loading (6) (gpd/sqft)	Drip Loading (3) (gpd/sqft)	Pad Loading (8) (gpd/sqft)
>17	5	I	**3.0**	3.00	1.00	1.66
	10	I	2.67	2.67	0.89	1.66
	15	I	2.33	2.33	0.78	1.66
15 to 17	20	IIa	**2.0**	2.00	0.67	1.66
	25	IIa	1.75	1.75	0.58	1.33
10 to <15	30	IIb	**1.5**	1.41	0.50	1.11
	35	IIb	1.38	1.22	0.46	0.95
	40	IIb	1.25	1.05	0.42	0.83
	45	IIb	1.13	0.91	0.38	0.74
	50	III	**1.0**	0.77	0.33	0.67
	55	III	0.94	0.71	0.31	0.61
	60	III	0.89	0.64	0.30	0.55

PRESSURE
TRENCH BOTTOM LOADNG RATE

II

1 Gal. / Ft² / Day



7.48 Gallons

÷

12 in.

||

.6233 Gal. per Inch

K-1

One Ft.^{3} of water = 7.48 Gallons

1" = 2.54 cm

50 MPI TL-3 PRESSURE LOADING RATE

1 Gal. / Ft.^{2} / D Trench Bottom

÷

.6233 Gal. / In. / Ft.^{3} water

||

1.6 Inches per Day

1.6 Inches per Day

X

2.54 cm / Inch

||

4.1 cm per Day

TL-3 LPD
Trench Bottom
50 MPI

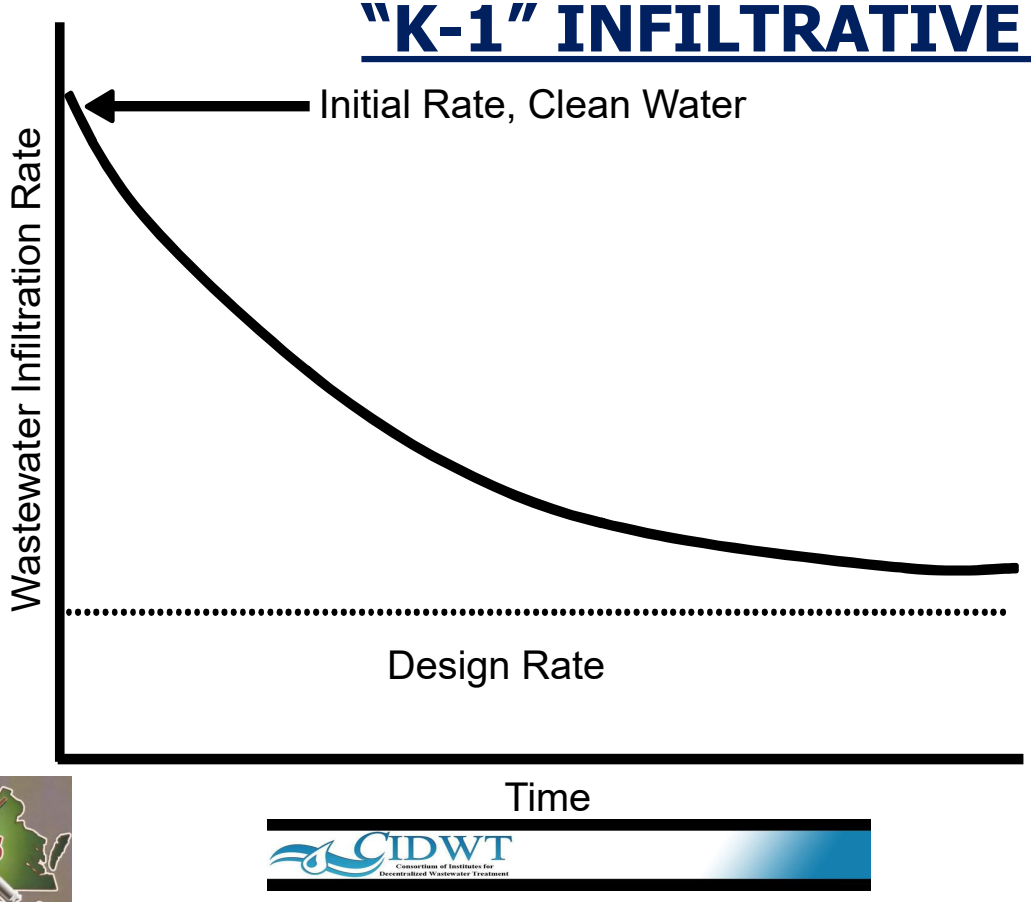
NOT A "Peacock Value"

Degradation of Wastewater *Infiltration* Rate

LTAR

Long **T**erm **A**cceptance **R**ate

"K-1" INFILTRATIVE SURFACE



LTAR of Infiltrative Surfaces (Trench Bottoms) traditionally loaded at some smaller percentage of Saturated Hydraulic Conductivity.

General Numbers

** *10% for STE*

** *25% for Pretreated*

Higher values (%) for Pretreated Effluent now routinely used nationwide

EXAMPLE: TL-3 50 MPI

TL-3 Effluent				"PEACOCK"		
Pressure Trench Loading (4,5) (gpd/sqft)	Gravity Trench Loading (6) (gpd/sqft)	Drip Loading (3) (gpd/sqft)	Pad Loading (8) (gpd/sqft)	Ksat TRENCH cm / day		MPI
3.0	3.00	1.00	1.66	*>50* **	I	5
2.67	2.67	0.89	1.66	25 - 50		10
2.33	2.33	0.78	1.66	17.4 - 25		15
2.0	2.00	0.67	1.66	15.9 - *17.4* **	IIA	20
1.75	1.75	0.58	1.33	14.6 - 15.9		25
1.5	1.41	0.50	1.11	13.3 - *14.6* **	IIB	30
1.38	1.22	0.46	0.95	12.0 - 13.3		35
1.25	1.05	0.42	0.83	11.0 - 12.0		40
1.13	0.91	0.38	0.74	10.0 - 11.0		45
1.0	0.77	0.33	0.67	9.1 - *10.0* **	IIIA	50
0.94	0.71	0.31	0.61	8.3 - 9.1		55
0.89	0.64	0.30	0.55	7.6 - 8.3		60

"K-1" INFILTRATIVE SURFACE / ZONE

1 Gal. / Ft.^{2} / D Trench Bottom

||

4.1 cm per Day

"PEACOCK" Value = 9.5 cm / day

4.1 cm per Day TRENCH Loading Rate

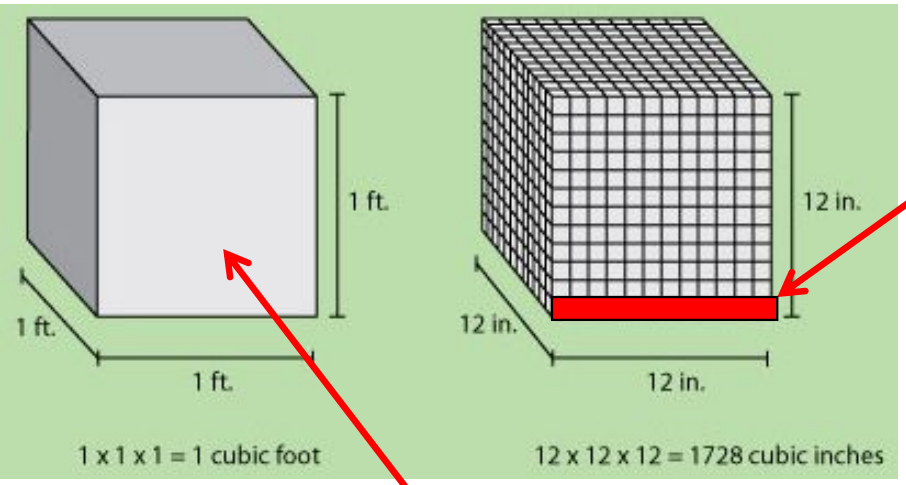
÷

9.5 cm / day "PEACOCK" Value

||

.43

TL-3 Pressure Trench Bottom Loading Rate at 50 MPI is 43% of Ksat "Peacock" Value



7.48 Gallons / 12 in. = .6233 Gal. per In.

"60 MPI"
8 cm / day "Peacock" Value
1.96 Gallons

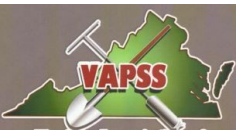
K-1

One Ft.^{3} of water = 7.48 Gallons

.33 g/ft²/d	**.46 g/ft²/d**	**.89 g/ft²/d**
STE Trench Bottom CONVENTIONAL Gravity	STE LPD Trench Bottom Loaded at	TL-3 LPD Trench Bottom Loaded at
16.8%	23.5 % of kSat	45.4 % of kSat

EXAMPLE: TL-3 50 MPI

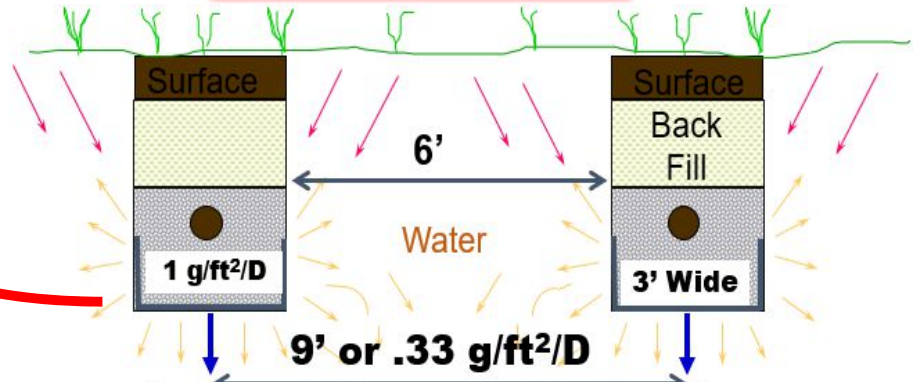
Ksat (1) (cm/day)	Percolation Rate (mpi)	Soil Type	TL-3 Effluent: Pressure Trench Loading (4,5) (gpd/sqft)	Gravity Trench Loading (6) (gpd/sqft)	Drip Loading (3) (gpd/sqft)	Pad Loading (8) (gpd/sqft)
>17	5	I	**3.0**	3.00	1.00	1.66
	10	I	2.67	2.67	0.89	1.66
	15	I	2.33	2.33	0.78	1.66
15 to 17	20	IIa	**2.0**	2.00	0.67	1.66
	25	IIa	1.75	1.75	0.58	1.33
10 to <15	30	IIb	**1.5**	1.41	0.50	1.11
	35	IIb	1.38	1.22	0.46	0.95
	40	IIb	1.25	1.05	0.42	0.83
	45	IIb	1.13	0.91	0.38	0.74
	50	III	**1.0**	0.77	0.33	0.67
	55	III	0.94	0.71	0.31	0.61
	60	III	0.89	0.64	0.30	0.55



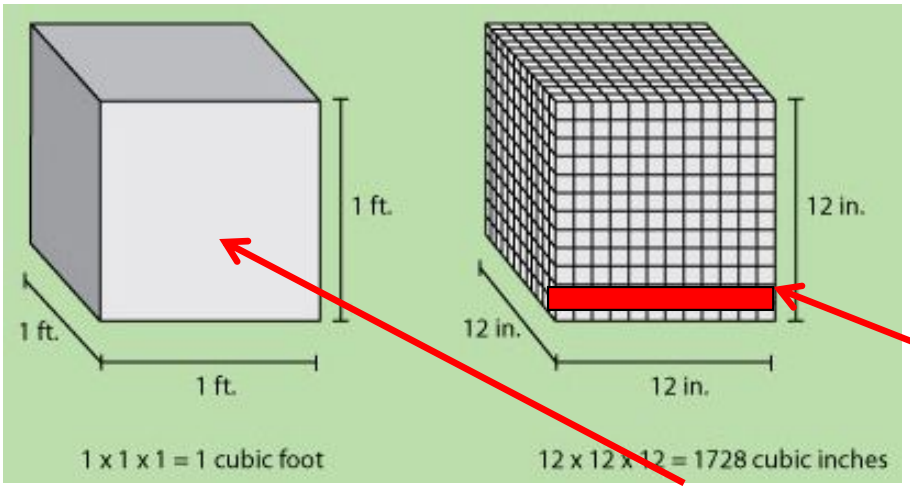
"K-2"
PERMEABILITY LIMITING FEATURE
"PLF"

Areal Loading Rate
or
1/3 TRENCH Bottom Loading Rate

.33 Gal. / Ft.²



Trenches installed on centers 3X Trench width



7.48 Gallons

÷

12 in.

||

.6233 Gal. per Inch

K-2

One Ft.^{3} of water = 7.48 Gallons

1" = 2.54 cm

50 MPI TL-3 PRESSURE LOADING RATE

.33 Gal. / Ft.^{2} / D Trench Bottom

÷

.6233 Gal. / In. / Ft.^{3} water

||

.529 Inches per Day

.529 Inches per Day

X

2.54 cm / Inch

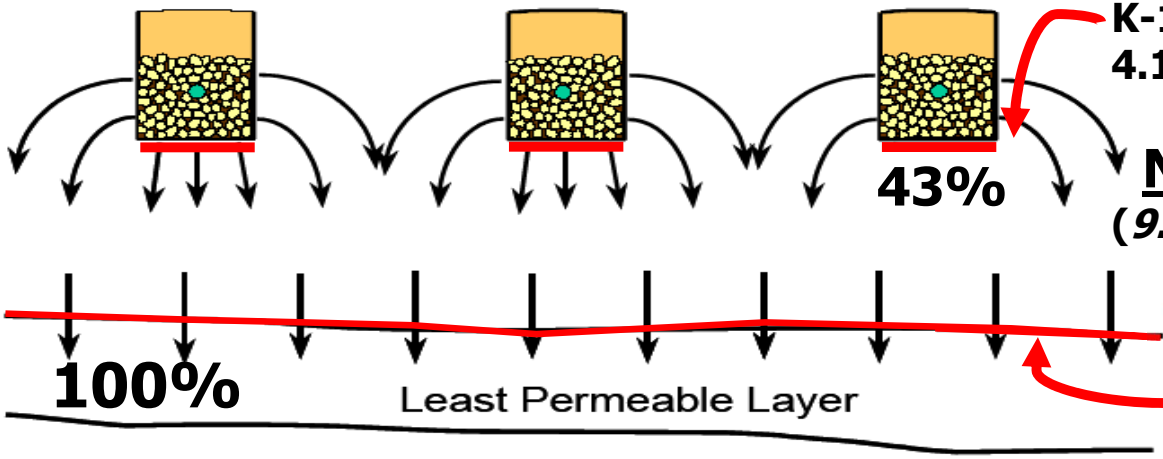
||

1.34 cm per Day

TL-3 LPD
Area "Footprint"
50 MPI

NOT A "Peacock Value"

HYDRAULIC ASSESSMENT



K-1 Infiltrative Surface 1 gal/Ft.^{2}/Day
4.1 CM / Day

K-1

NOT the "Peacock" Value
(*9.5 CM / Day*)

PERMEABILTY LIMITING FEATURE (PLF)
K-2 foot print .33 gal/Ft.^{2}/Day
1.34 CM / Day

K-2

"PEACOCK" Value gets you to MPI that gets you to the Prescriptive Infiltrative Surface Loading Rate Charts

PERMEABILITY LIMITING FEATURE (PLF) calculated maximum 100% before "Mounding" occurs

DRIP?

MOUNDS?

PADS?

12VOC5-613 AOSS REGULATIONS

*12a. The **designer** shall demonstrate that (i) the site is **not flooded during the wet season**, (ii) there is a **hydraulic gradient** sufficient to move the applied effluent off the site, and (iii) **water mounding** will not adversely affect the functioning of the soil treatment area or create ponding on the surface;*

GUIDANCE MEMORANDA AND POLICY (GMP) 2022-XX

APPENDIX "Although not specifically addressed in the guidance, 12a (i) & (ii), represent critical elements of a site's suitability. The three elements 12VAC5-613-80.12 all are interrelated, equally important, critical to ascertaining the attributes and limitations of a site for application in design.

Water entering and leaving the site, the importance of slope, and depth of and consistence of the infiltration zone need to be identified, characterized, and addressed in design.

"Flooding" includes the depth and duration seasonal saturation / seeping etc."

GENERAL OBSERVATIONS / CONSIDERATIONS

APPENDIX "Although the information in the guidance addresses all AOSS absorption areas, the guidance readily applies to shallow placed or elevated small flow AOSS systems (<1000 GPD) utilizing pretreatment, primarily sites with <24 - 30" below ground surface to limiting feature(s). Waste strength and flow patterns would be known and accepted, for example as would be the case in a typical single-family home."

- **PLF's <12" from point of application or ground surface (elevated systems) require a higher degree of site / soil characterization and analysis. K2 values verified.**
- **AOSS designs with slopes with a <5% may require a higher degree of site / soil characterization and analysis.**
- **With all shallow placed designs in sites with <12" to PLF, it is recommended that pressure distribution be utilized to ensure even effluent distribution across the absorption area.**
- **In all AOSS designs requiring pumping, time dosing and adequate flow equalization is recommended.**