Soil Evaluations, Non-Gravel Drainfield Products, and Drainfield Size Reduction

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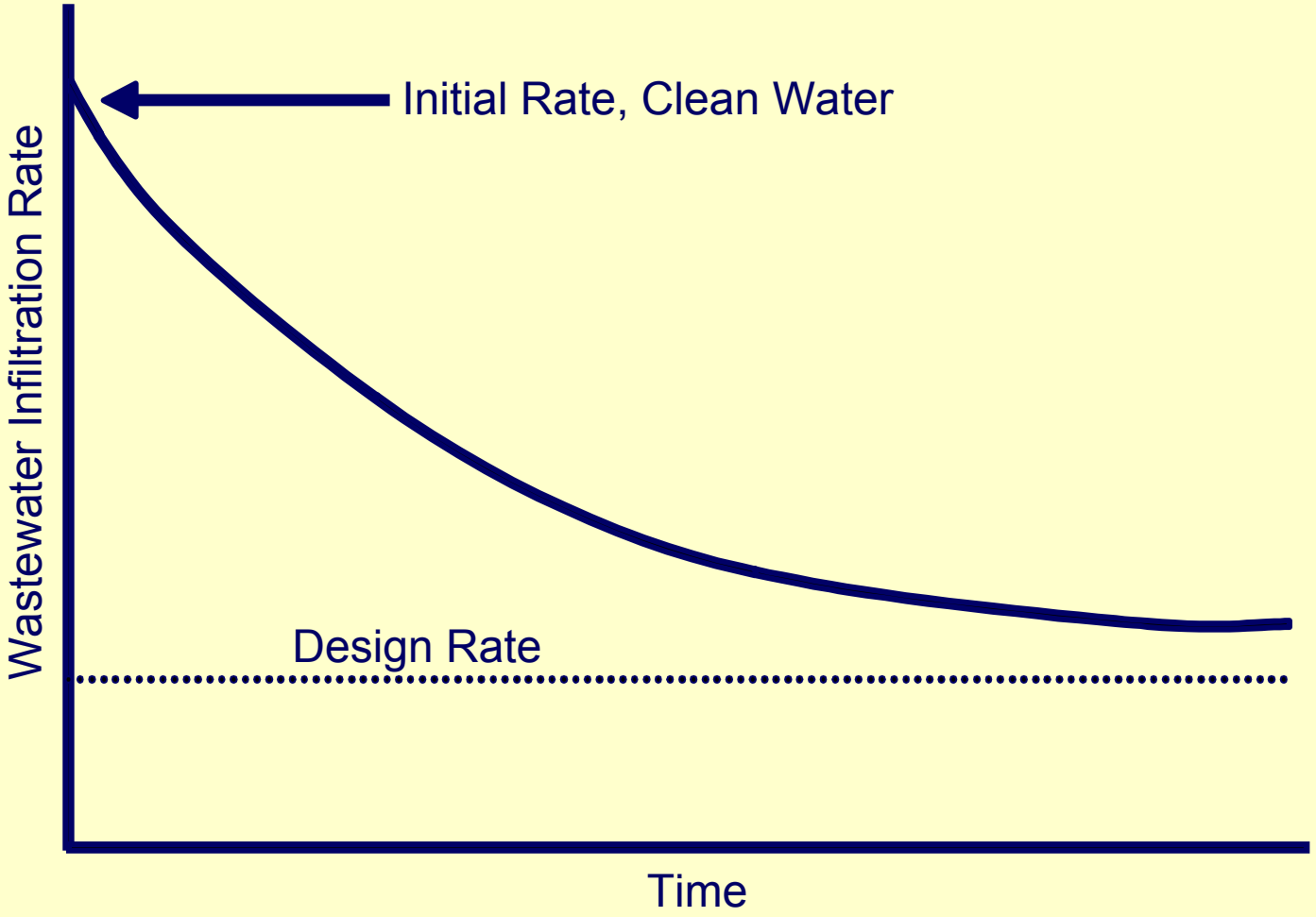
Onsite System Sizing

- Based on estimate of long-term acceptance rate
  - Measures of K_s are with clean water
    - Wastewater is not clean
  - Estimates are empirical
- LTAR cannot be measured
  - Estimate from K_s and amount of reduction due to soil changes at trench interface
  - LTAR = K_s X reduction factor X safety factor

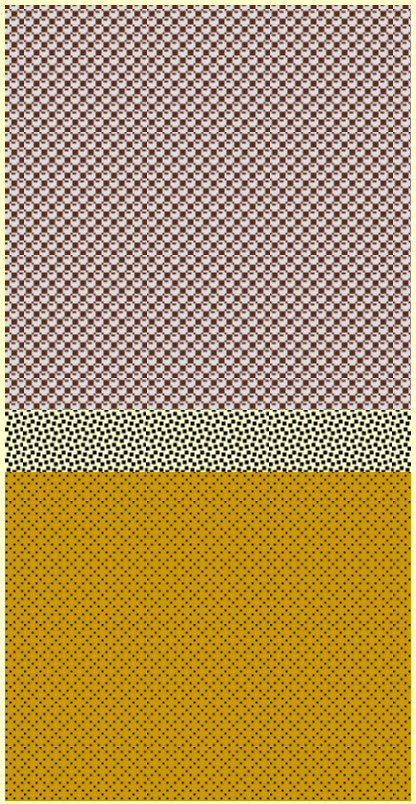
Wastewater Infiltration

- K_s is measured with clean water
- Wastewater is not clean
  - Total suspended solids – 50-100 mg/l
  - BOD – 50 to 150 mg/l
  - High Na
- Soil is altered at trench interface
  - Slaking
  - Dispersion
  - Organic matter clogging of pores (biomat formation)

Degradation of Wastewater Infiltration Rate



Direct Estimate of LTAR from K_s?



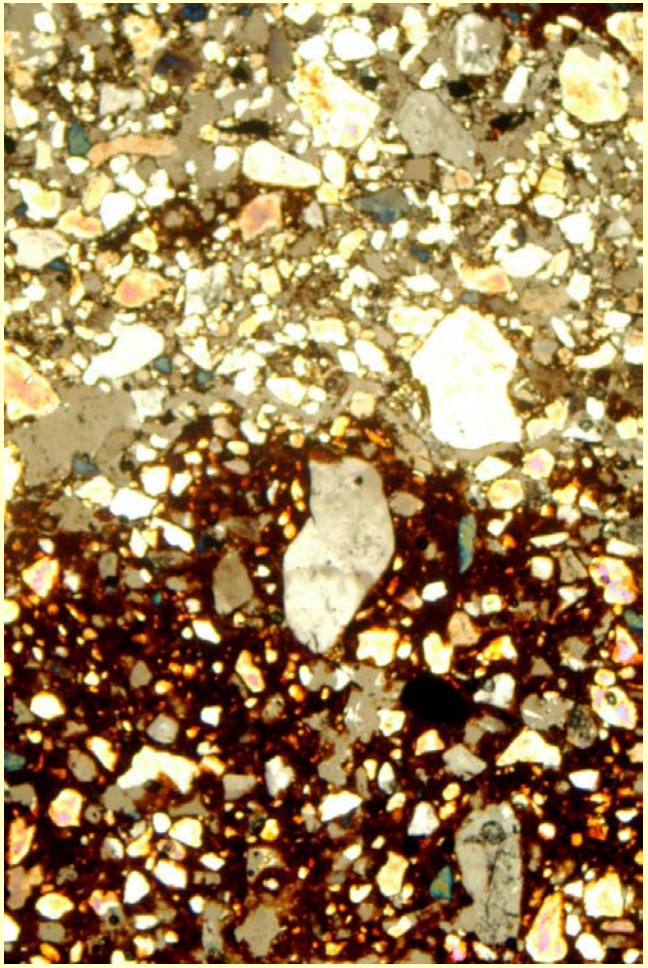
$R_{eff} = R_g + R_b + R_s$

$K_{eff} = L_{total} / R_{eff}$

- Hydraulic properties of interface difficult to measure
- Total length is unknown
- K_{unsat} of soil is difficult to measure and is variable
  - Spatially
  - Varies with water content
- LTAR estimated from soil properties

Degradation of Soil Acceptance Rate

Soil Alteration at Soil-Trench Interface



Wastewater Rates over Time

Initial K_s (clean water)	Wastewater Infiltration Rate			
	1 year	2 years	3 years	4 years
in/day	in/day	in/day	in/day	in/day
453	4.3	2.0	0.8	0.3
22	1.6	0.8	0.5	0.3
7.9	0.8	0.6	0.4	0.3
1.5	0.7	0.4	0.4	0.3

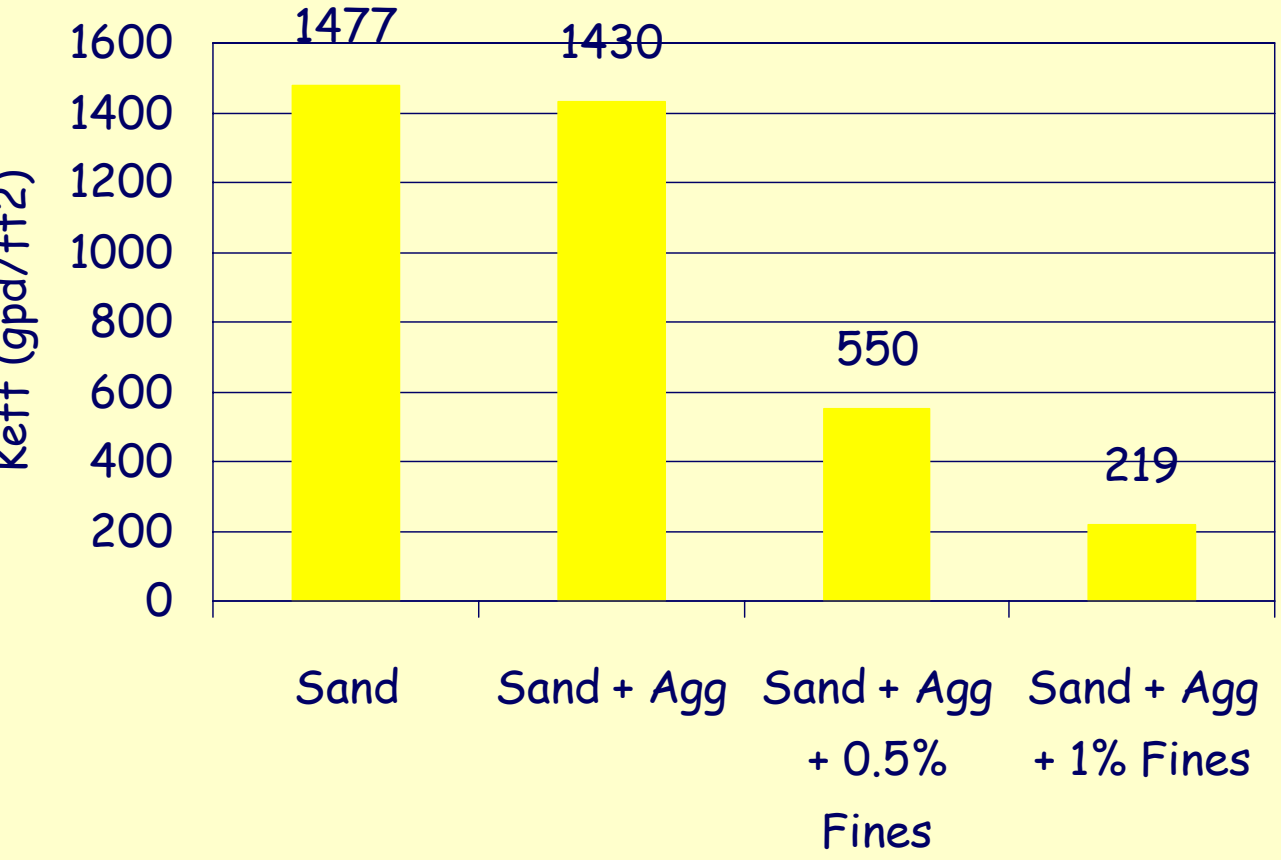
Wastewater Infiltration Rates over Time

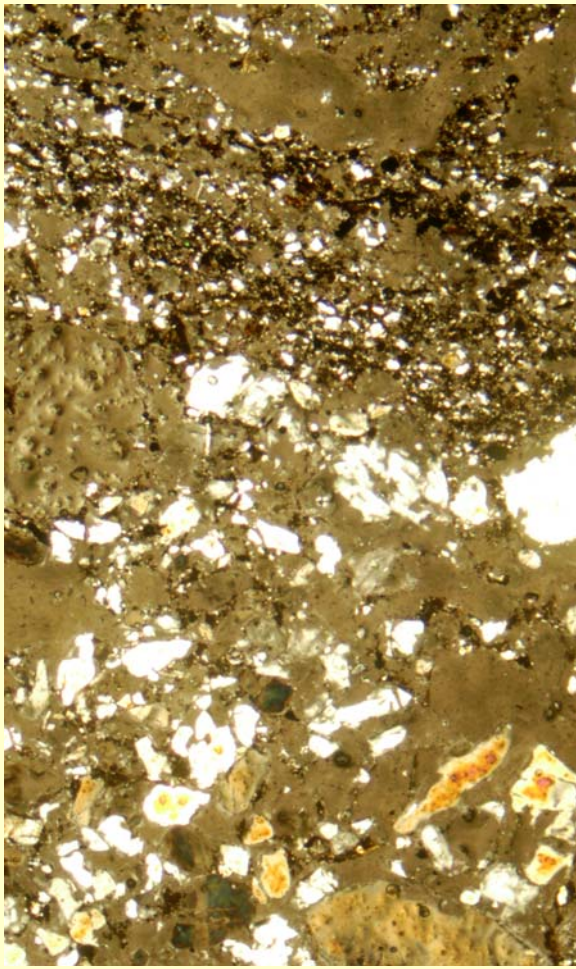
Soil K_s (clean water)	Wastewater Infiltration Rate (mature system)
cm/day	cm/day
41	2.9
3.2	0.5
1.1	0.7

Why Reductions for Non-Gravel Products?

- Fine particles from gravel forming restrictive layer
- Gravel (with biomat) impacts on wastewater infiltration rate
- Compaction from gravel?

Impact of Gravel Fines





Impact of Embedded Gravel

Gravel Impacts

	K_{eff} - Ratio to Open Architecture	
	Bt1	BC
Gravel at surface	1.34	1.15
Embedded gravel	1.98	1.50
Embedded gravel w/ sidewall	1.70	1.33
K_s (cm/d)	258	0.8

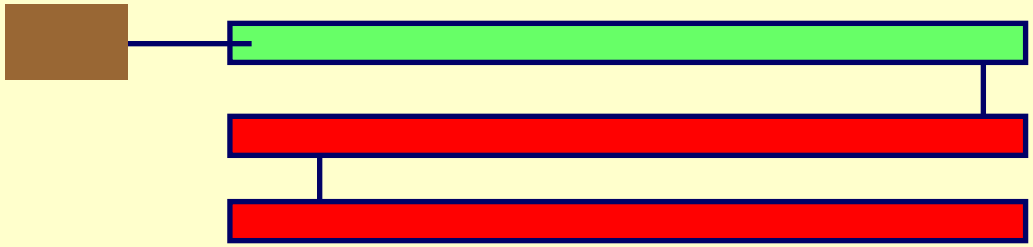
Reductions and Soil Evaluations

- Is the estimate conservative or liberal?

Estimated LTAR	LTAR w/ 25% reduction
gpd/ft^2	gpd/ft^2
0.2	0.27
0.4	0.53
0.6	0.8
0.8	1.07

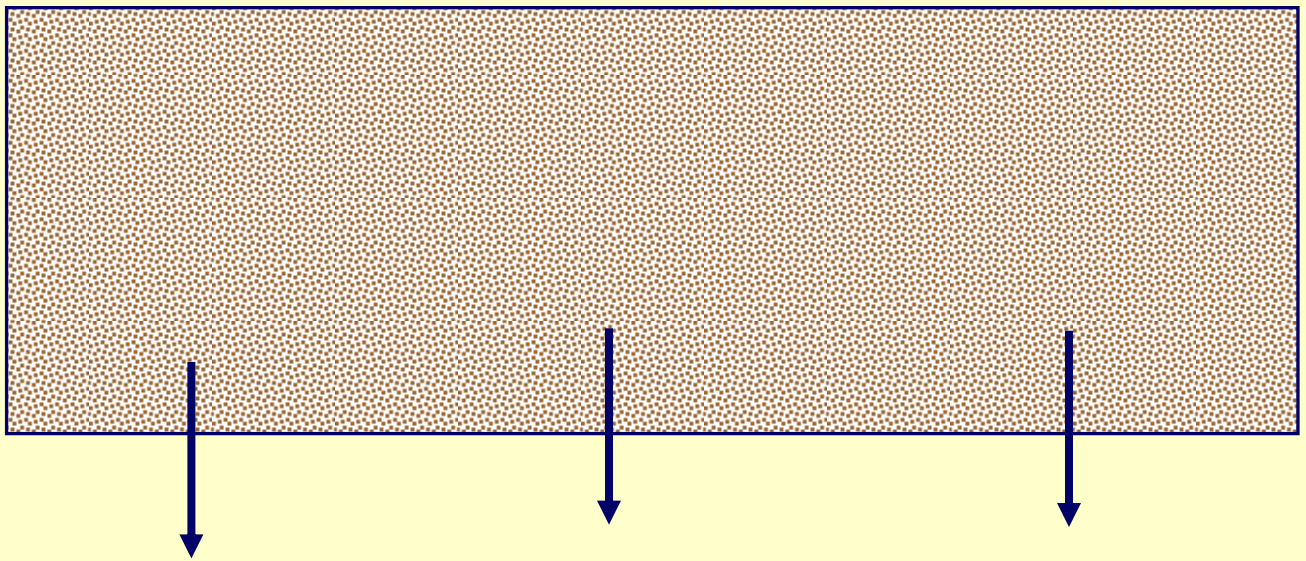
Reductions and Serial Distribution

- One line loaded until failure



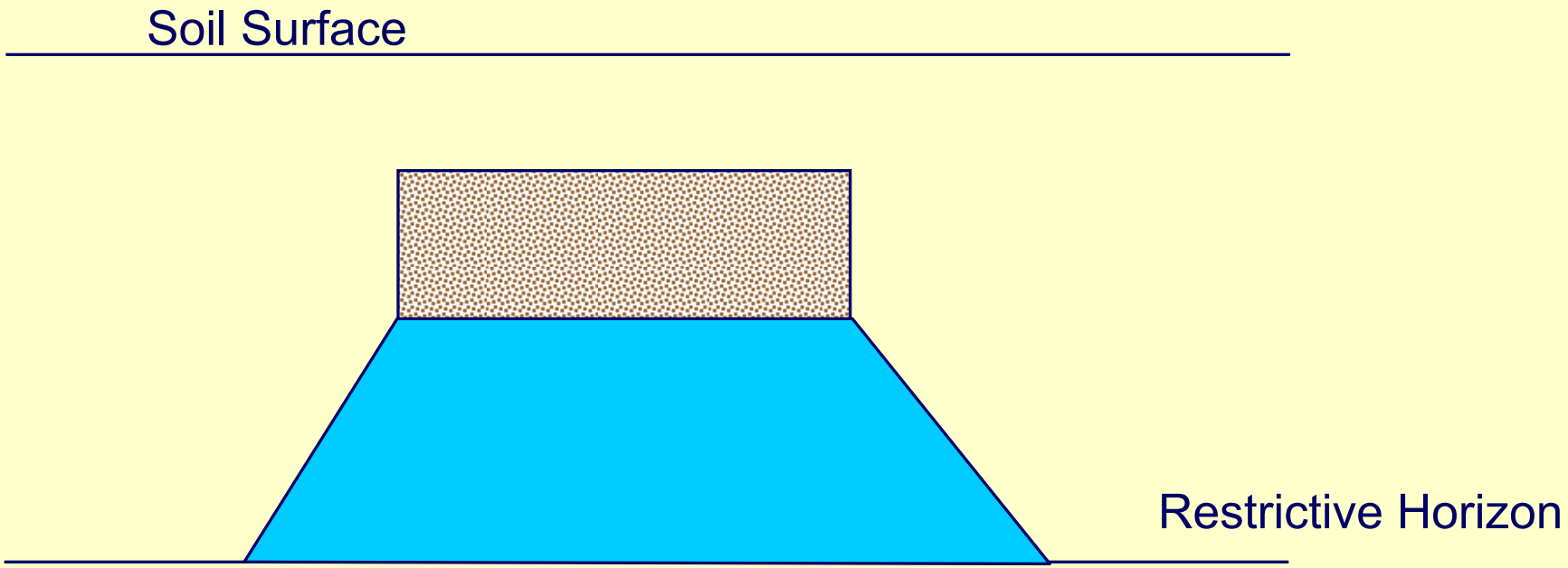
- LTAR = 0.4 gpd/ft^2
- With 25% reduction, loading rate = 0.53 gpd/ft^2
- With reduction and serial distribution, loading rate = 1.6 gpd/ft^2

Reductions only Addresses Trench Exfiltration



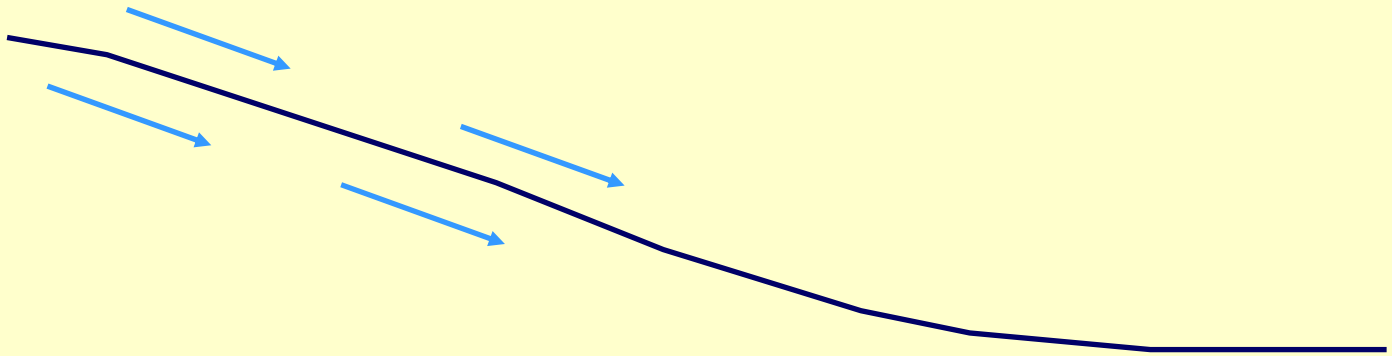
Other Things Happen in the Soil

Restrictive Horizons

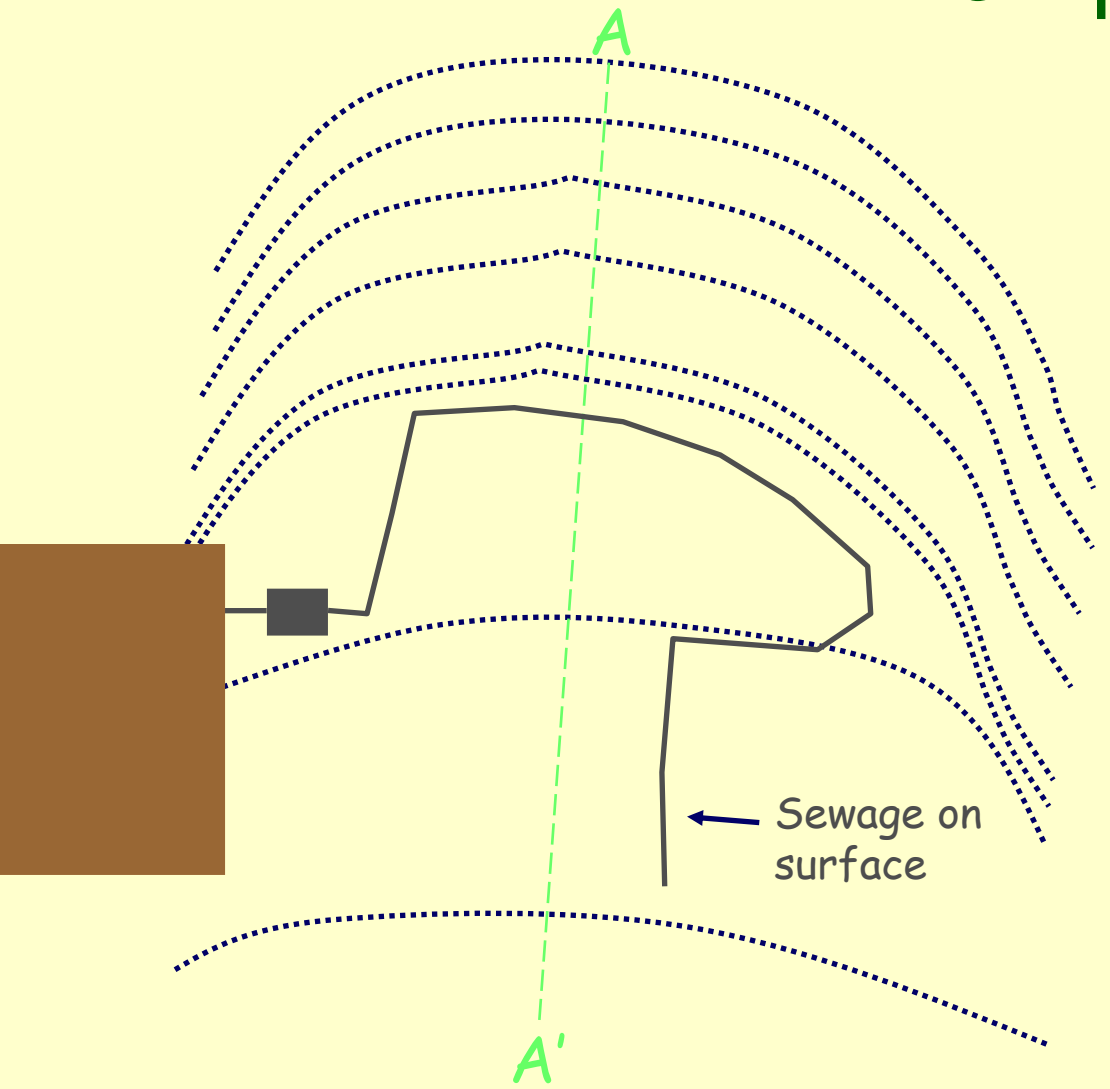


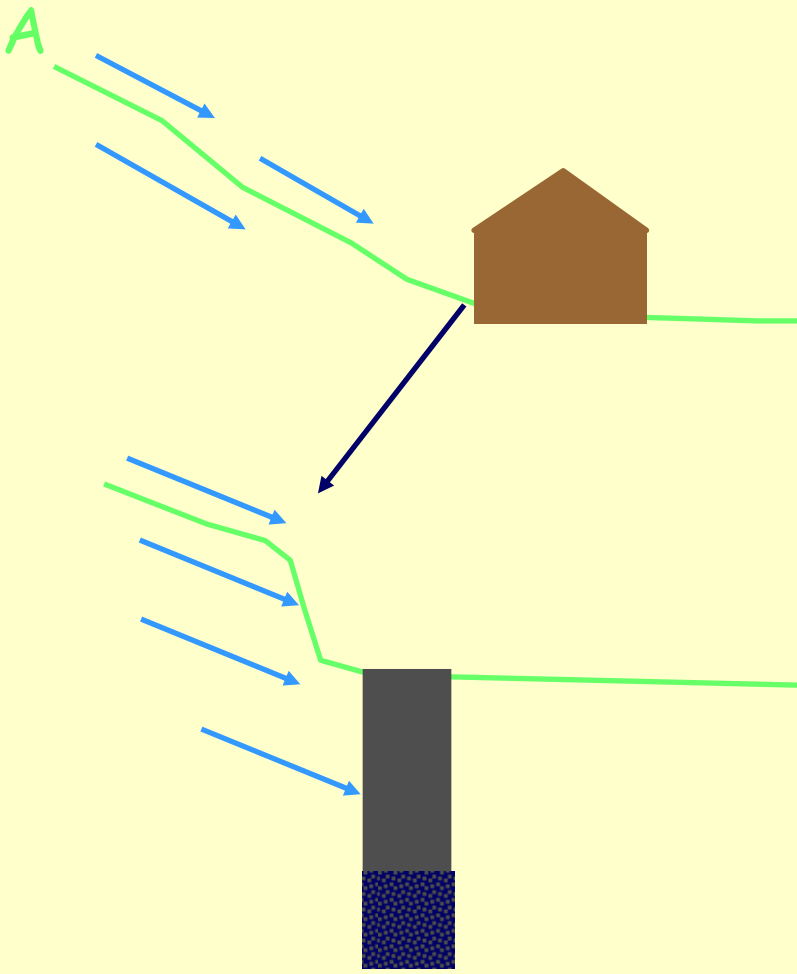
- Reduced length increases hydraulic load on restrictive horizons
- Linear loading evaluation

Landscape Loading



An Example





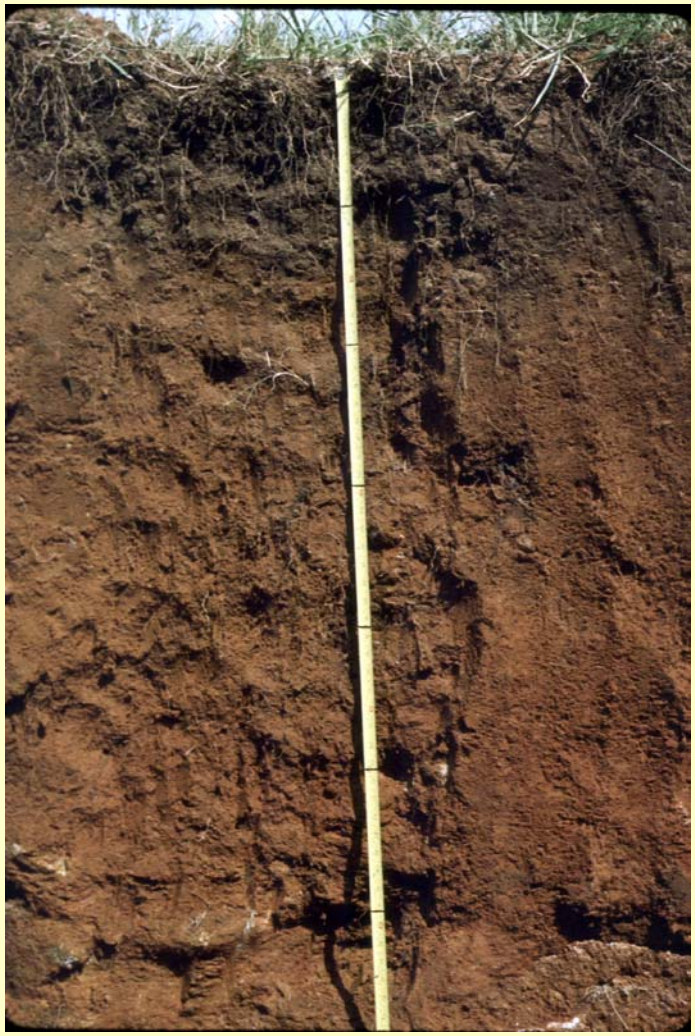
Absorption trench
Or curtain drain?

Organic Loading

- Organic loading <0.00015 lbs BOD/ft^2/d may prevent biomat development
- Hydraulic load of 0.4 gpd/ft^2 = 0.00033 lbs BOD/ft^2/d
- 25% reduction
  - Organic load = 0.00047 lbs BOD/ft^2/d
  - With serial distribution – 0.00141 lbs BOD/ft^2/d
- More hydraulically restrictive biomat?

P Loading

- Ecological concern about P additions to surface water
- Mobility of P is function of soil volume and soil adsorption capacity
- Most soils in southeast effectively bind P
  - Fe and Al oxides
- P adsorption capacity is finite
  - Especially for soils low in Fe

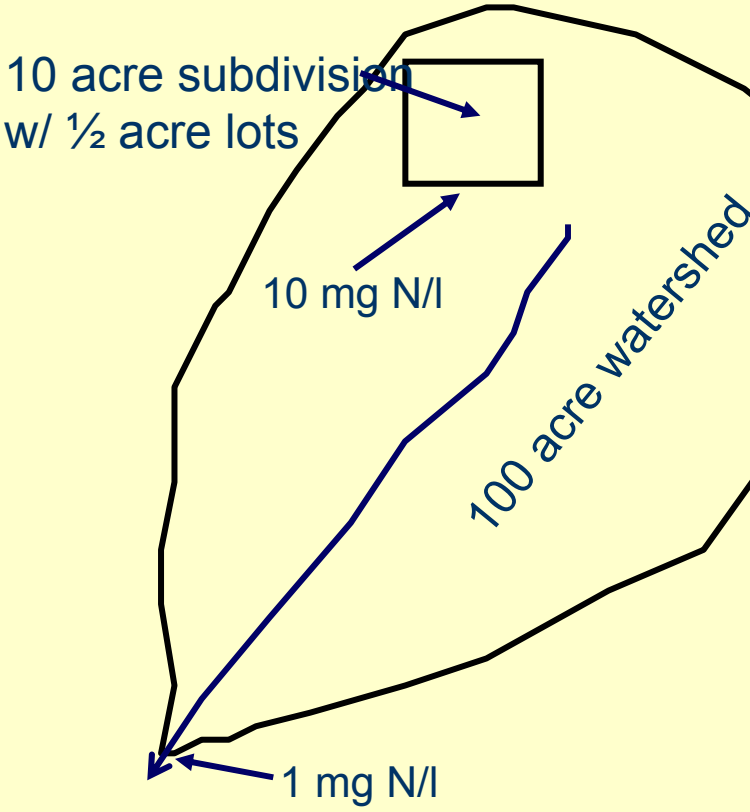


P Loading

- Typical P load to onsite system
  - Hydraulic load = 0.4 gpd/ft^2
  - P load = 0.012 lbs/ft^2/year
    - Equivalent to 530 lbs/acre/year
- With 25% reduction
  - P load = 0.016 lbs/ft^2/year
    - Equivalent to 700 lbs/acre/year
- With serial distribution
  - P load = 0.048 lbs/ft^2/year
    - Equivalent to 2100 lbs/acre/year

N Loading

- Reduced size will increase NO_3^- concentration in soil solution and groundwater immediately under drainfield
- Where is point of concern?
  - Under drainfield?
  - Edge of lot?
  - Edge of subdivision?
  - Edge of stream?
  - Watershed outlet?



Summary

- Research supports greater hydraulic efficiency of non-gravel drainfield products
  - Fine particles
  - Gravel embedment
- Greater efficiency is only for wastewater exfiltration from drainfield trench
- Other soil and landscape properties must be considered
  - Linear loading
  - Upslope water
- Increased organic and nutrient loading may impact system performance and environmental consequences