Land Application Wastewater Systems

- Provides 2º Treatment (Biological)
- Used in combination with pretreatment and primary treatment
- Often called Natural Treatment Systems

Typical Treatment Systems

- Leach field (combined with septic tank for home systems)
- Overland Flow
- Rapid Rate Infiltration
- Slow Rate Infiltration – treatment and irrigation

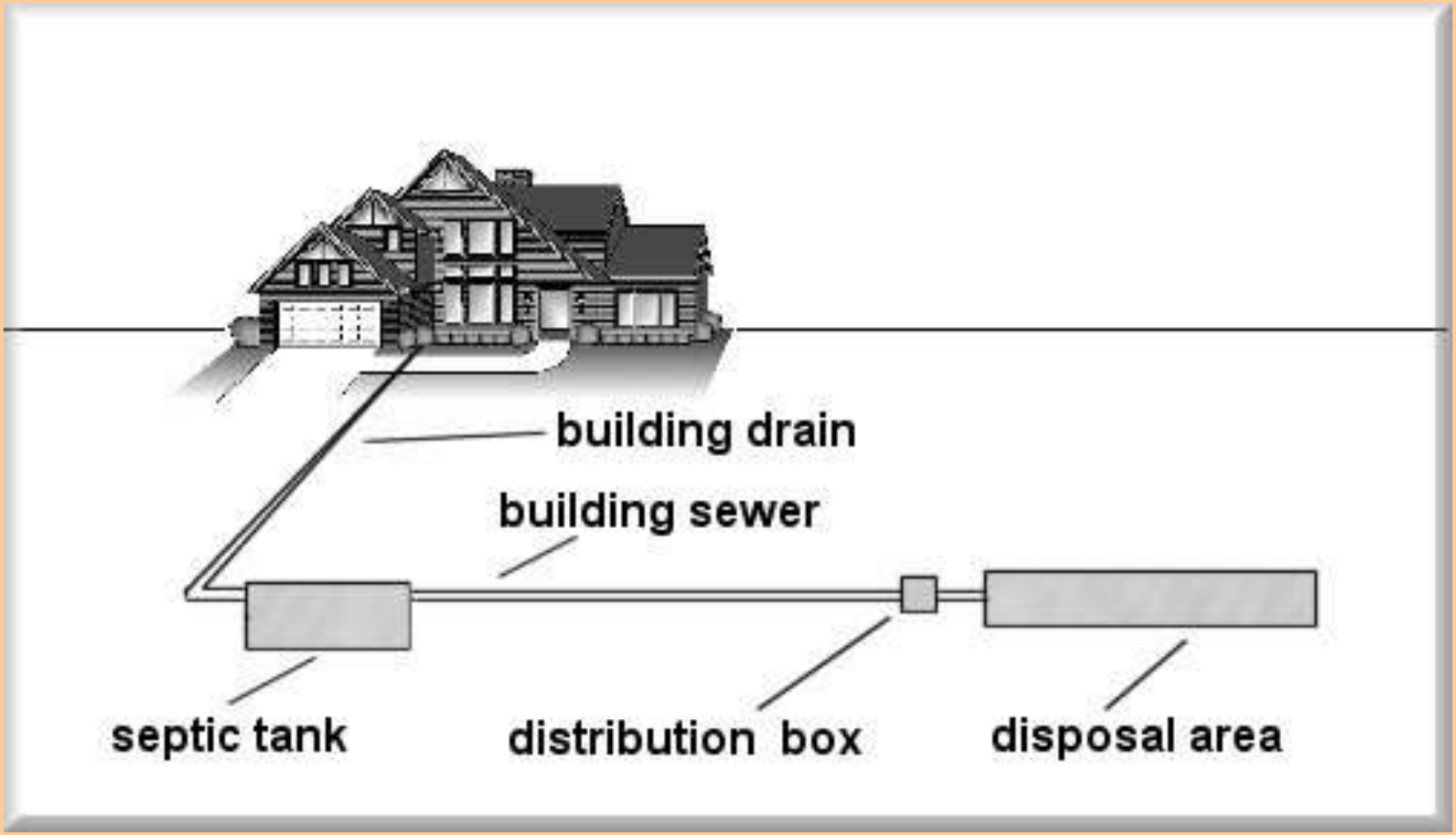
Summary of WW Characteristics and Removal Mechanisms in Land Applications

Wastewater Constituent	Mechanisms for Removal
Suspended Solids	Typical pretreatment and primary treatment methods, filtration through soil
Organic Matter (BOD)	Microbial degradation by attached biofilms on soil, rocks, vegetation
Organic Nitrogen	Microbial degradation by attached biofilms on soil, rocks, vegetation to ammonia
Ammonia	Nitrification, plant uptake, some volatilization, soil adsorption
Phosphorus	Adsorption to soil, plant uptake, chemical precipitation in soil (natural)
Pathogens	Die off, filtration, dessication, predation, radiation
Trace metals	Adsorption to soil, plant uptake, chemical precipitation in soil (natural)

Leach Field, Tile Field, Soil Absorption System

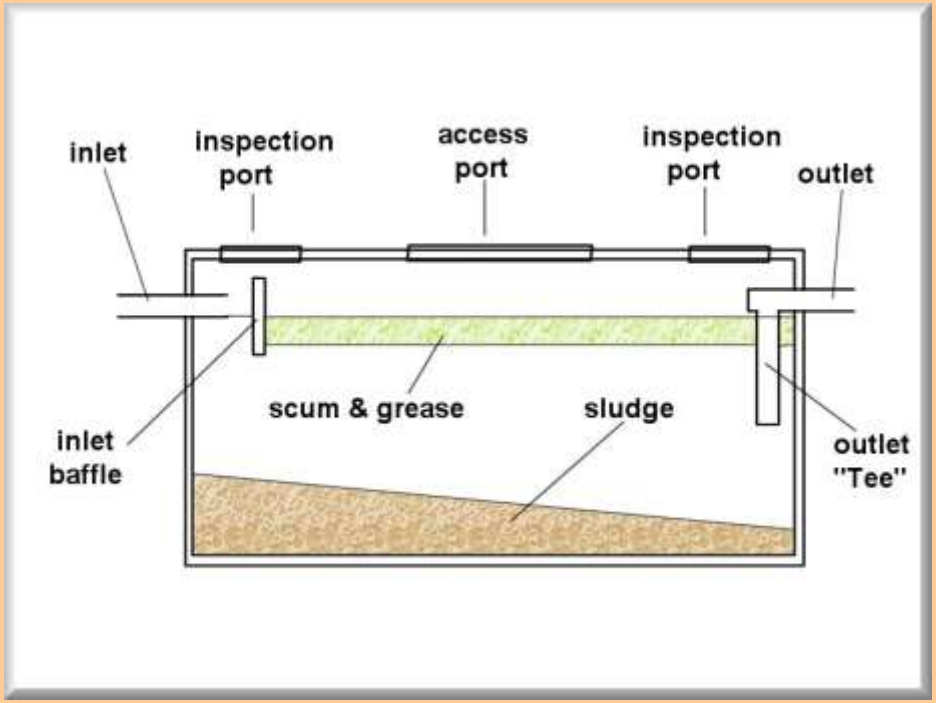
- Combined with septic tank for home treatment
- Trenches filled with gravel or plastic chambers in unsaturated zone
- Gravel or plastic chambers allows WW to infiltrate into soil (aerobic), above water table
- Bacteria growing in soil consume organic matter
- Nitrification can also occur
- Filtration of solids in soil including pathogenic organisms
- Pathogens die in soil because not a conducive environment
- Phosphorus adsorption to soil

Schematic of Septic Tank/Leach Field

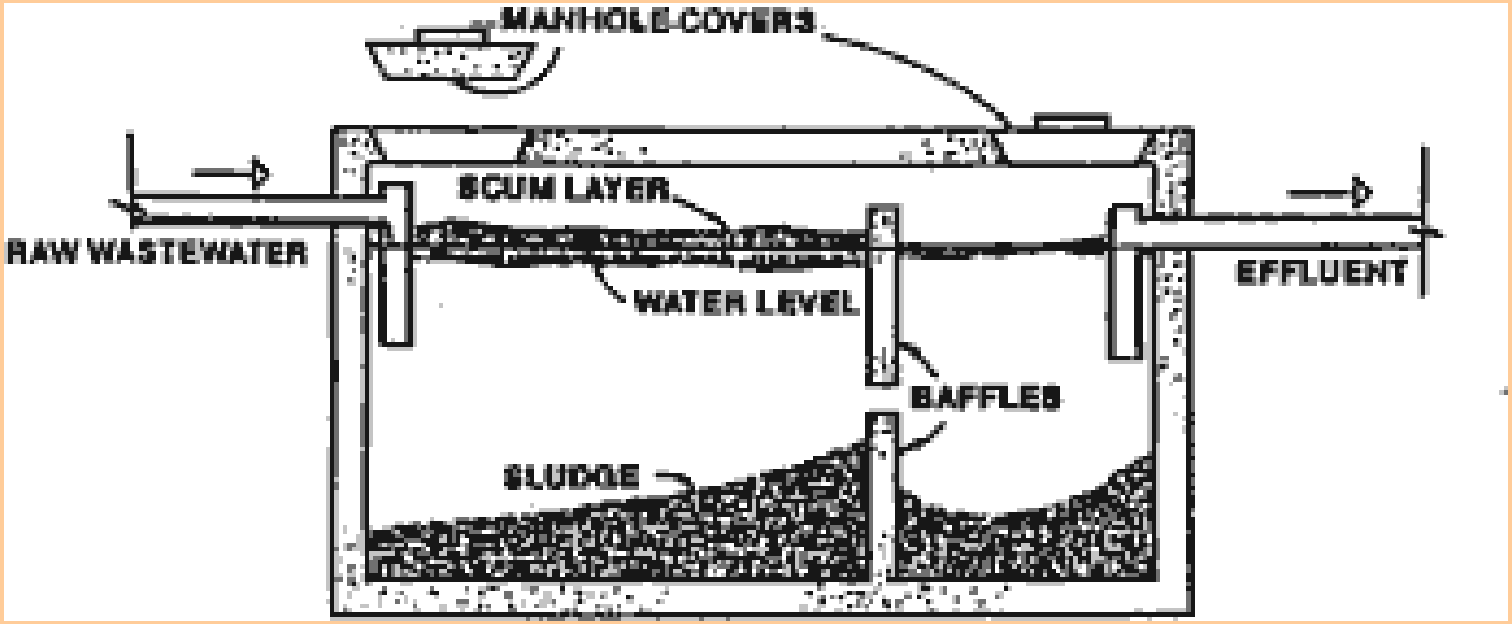


Septic Tank

- Septic tank acts as settling basin, oil/water separator and unheated, unmixed anaerobic digester
- Contrary to popular belief it is not a water storage tank
- Typical detention times
  2+ days
- Design based on number of bedrooms, minimum size 1000 gallons in VT
- Pre-cast concrete or fiberglass typical



Septic Tank with Baffle




1250
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Distribution Box

Critical for maintaining uniform flow to leach field

Leach Field

- Series of trenches filled with gravel or plastic chambers
- Gravel/chambers maintain structure of trenches and distribute effluent to soil
- Trenches provide storage during high flows
- Bacterial biofilm primarily in soil environment

Infiltrator™ System

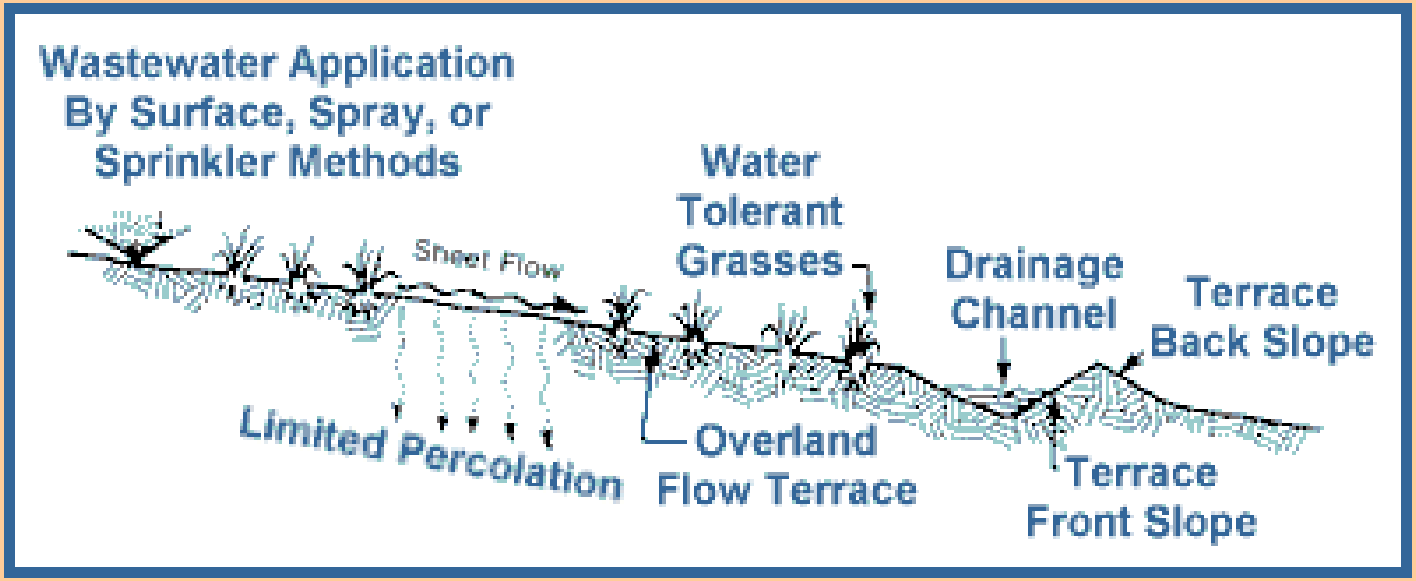
- Alternative to traditional gravel leach field systems
- Placed in trenches and backfilled
- Easy to install

Biomat Inside Chamber

- Biomat grows on soil at bottom of chamber
- Chamber provides storage for WW and allows WW infiltration

Overland Flow

- Wastewater flows through a vegetative mat down slope and is collected in trenches
- Biofilm in the vegetative mat treats WW
- Filtration and settling of solids also occurs in mat
- Some nutrient uptake by vegetation

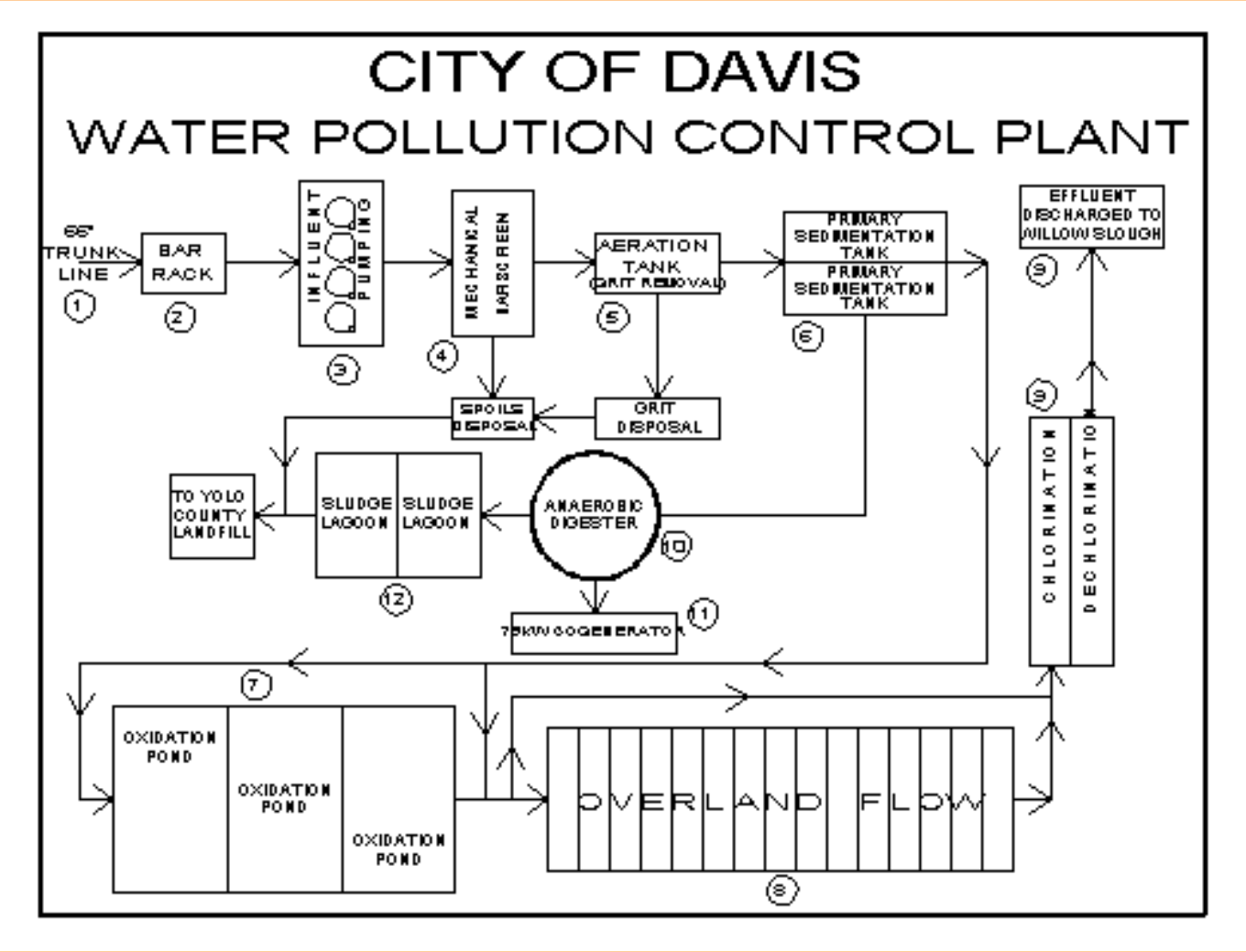


Easton, MD

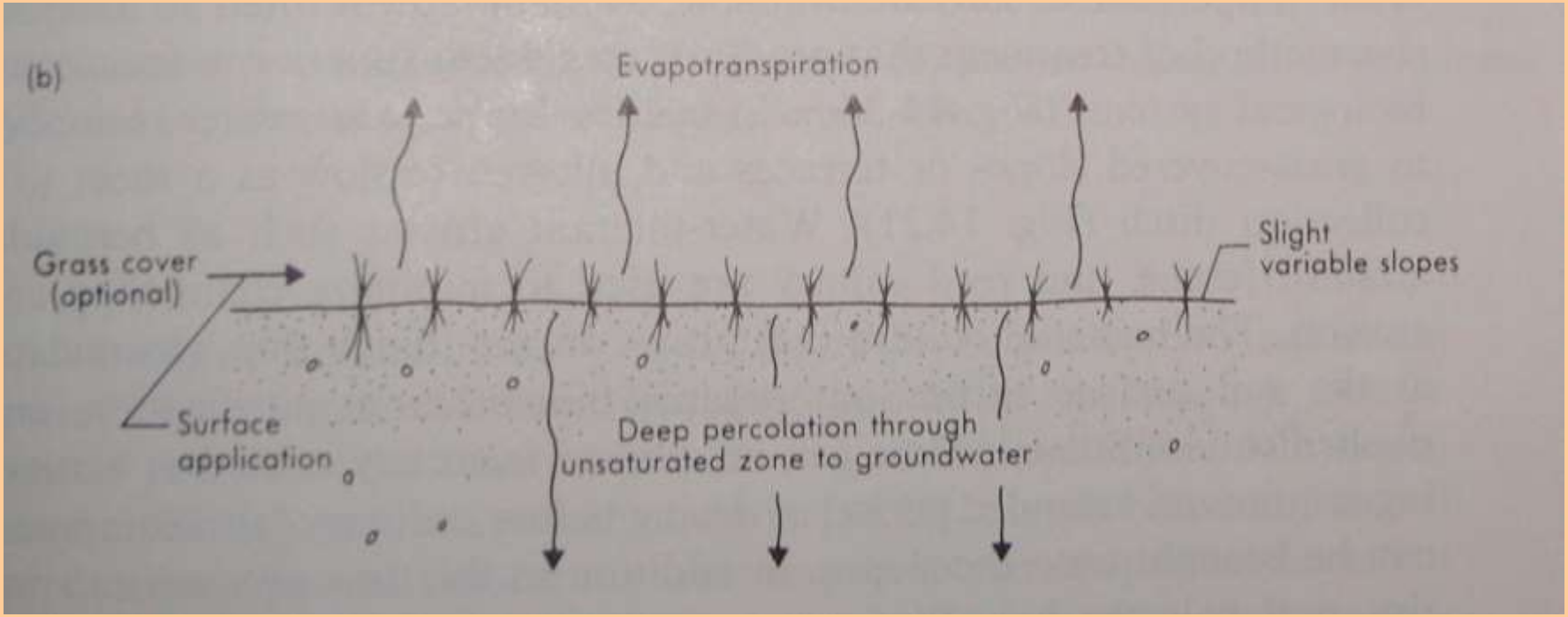
- Facultative Lagoons for pre and primary treatment
- 68 acre overland flow
- Chlorine disinfection

Sprinklers common method of WW application

Schematic of WWTP with Overland Flow



Rapid Rate Infiltration



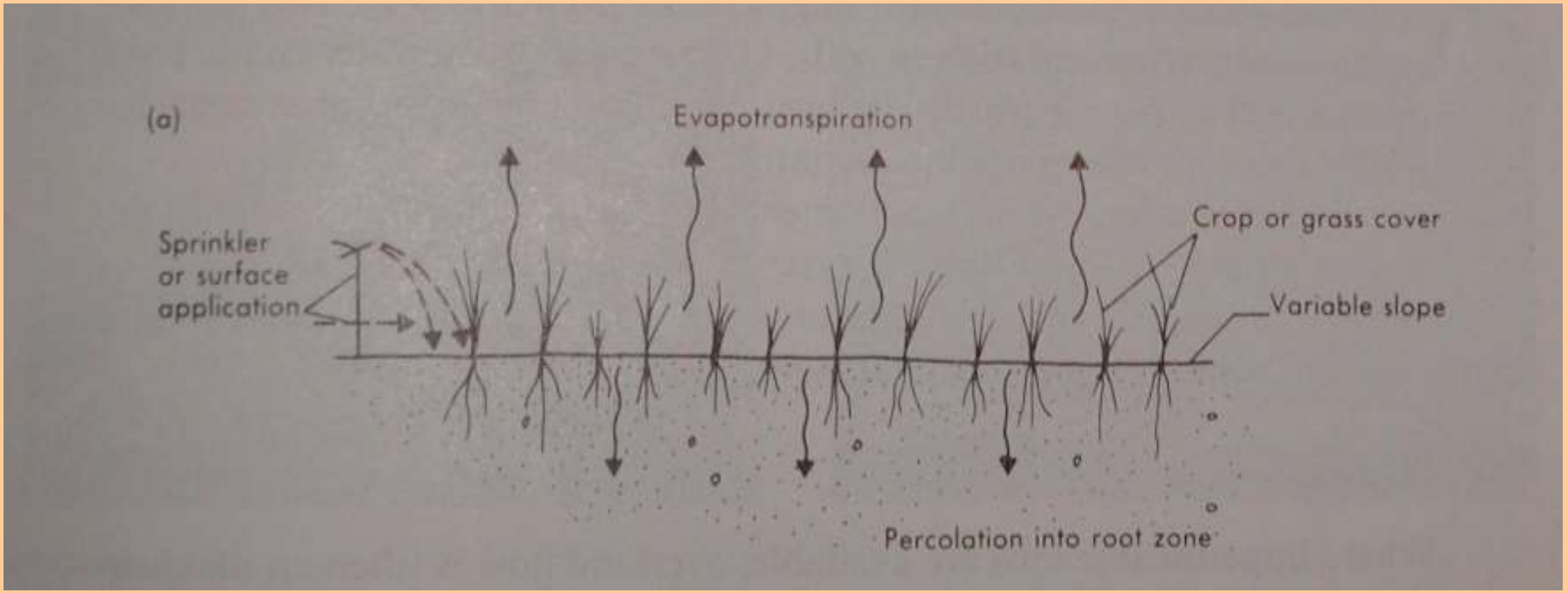
HLR and OLR Design Parameters (T&S)

TABLE 14.7

Design Parameters and Operating Characteristics of Land Treatment Systems

CHARACTERISTICS	SLOW RATE	RAPID INFILTRATION	OVERLAND FLOW	WETLANDS	SEPTIC TANK-LEACH FIELD
Hydraulic loading rate, $m^3/m^2 \cdot wk$	0.01–0.1	0.1–2.0	0.1–0.3		
Organic loading rate, g $BOD_5/m^2 \cdot wk$	2–20	50–400	20–60	60–80	
Application method	Sprinkler or surface	Surface	Sprinkler or surface	Surface	Subsurface
Minimum preapplication treatment	Sedimentation	Sedimentation	Grit removal and comminution	Screening and/or sedimentation	Sedimentation
Need for vegetation	Required	Optional	Required	Required	
Disposition of wastewater	Evapotranspiration and percolation	Percolation	Surface runoff and evapotranspiration	Surface runoff and evapotranspiration	Percolation
Effluent BOD_5, g/m^3	2–5	5–10	10–15	5–20	
Effluent SS, g/m^3	1–5	2–5	10–20	5–20	

Slow Rate Infiltration



Slow Rate Infiltration Principal Steps in Design

- Site evaluation and selection, regulatory requirements
- Necessary pretreatment levels
- Crop selection
- Distribution system selection
- Loading rates (HLR and OLR)
- Land requirements, Storage volume required
- Monitoring requirements
- Economics

Muskegon WWTF, Muskegon, MI

- Slow rate system
- Opened 1975
- Design capacity 42 mgd
- 5000 acres
- 3 – 8 acre aerated lagoons for settling
- 2 WW storage lagoons (850 acres each holds 5.1 billion gallons), additional settling
- April-Nov water taken for irrigation of corn and other animal feed
- WW applied by 54 center pivot irrigation machines
- 350 monitoring wells to monitor groundwater
- Construction costs $42.7 million (12 mil for sewer and pumping)
- Corn, wheat revenue offsets O&M costs