A to Z
Soil and Site Evaluation

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2019 Northeast Onsite Wastewater Short Course

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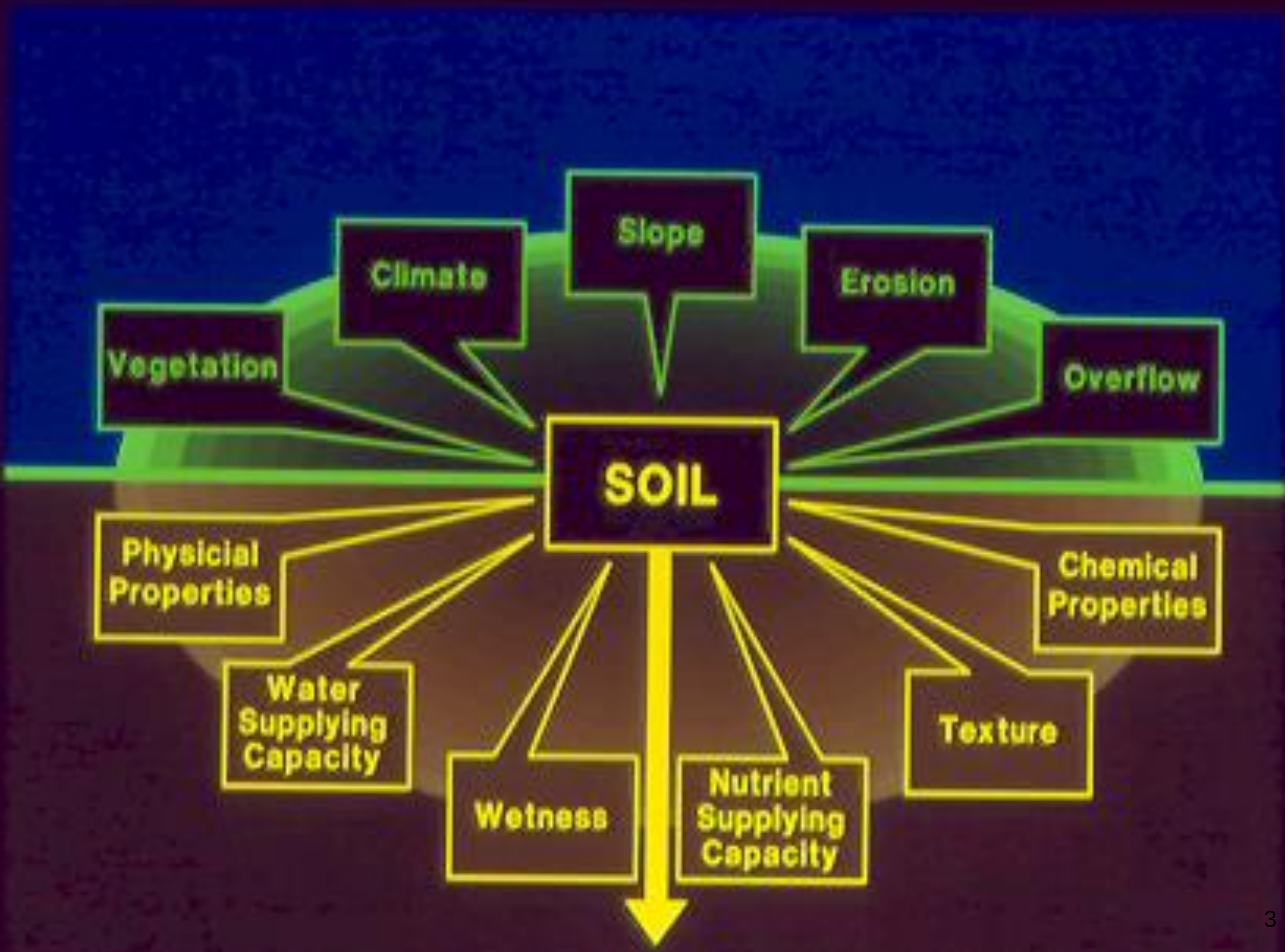
Principles of Soil and Site Assessment for Decentralized Wastewater Systems

- Characterize the soil, hydrology, and landscape of the site.
- Predict water flow over and through the soil and into the subsoil materials within the soil landscape.
- To provide basic information for specific use Best Management Practices (BMPs) based on the intended land use.


Slope
Climate
Erosion
Vegetation
Overflow
SOIL
Physicial Properties
Chemical Properties
Water Supplying Capacity
Texture
Wetness
Nutrient Supplying Capacity

Problems with On-Site Wastewater Systems

- **Poor Soils**
- **Small Lot**
- **Poor Location of House**
- **Don't Want to Spend Money**
- **POOR PLANNING**

Role of Soil in an On-Site Wastewater System

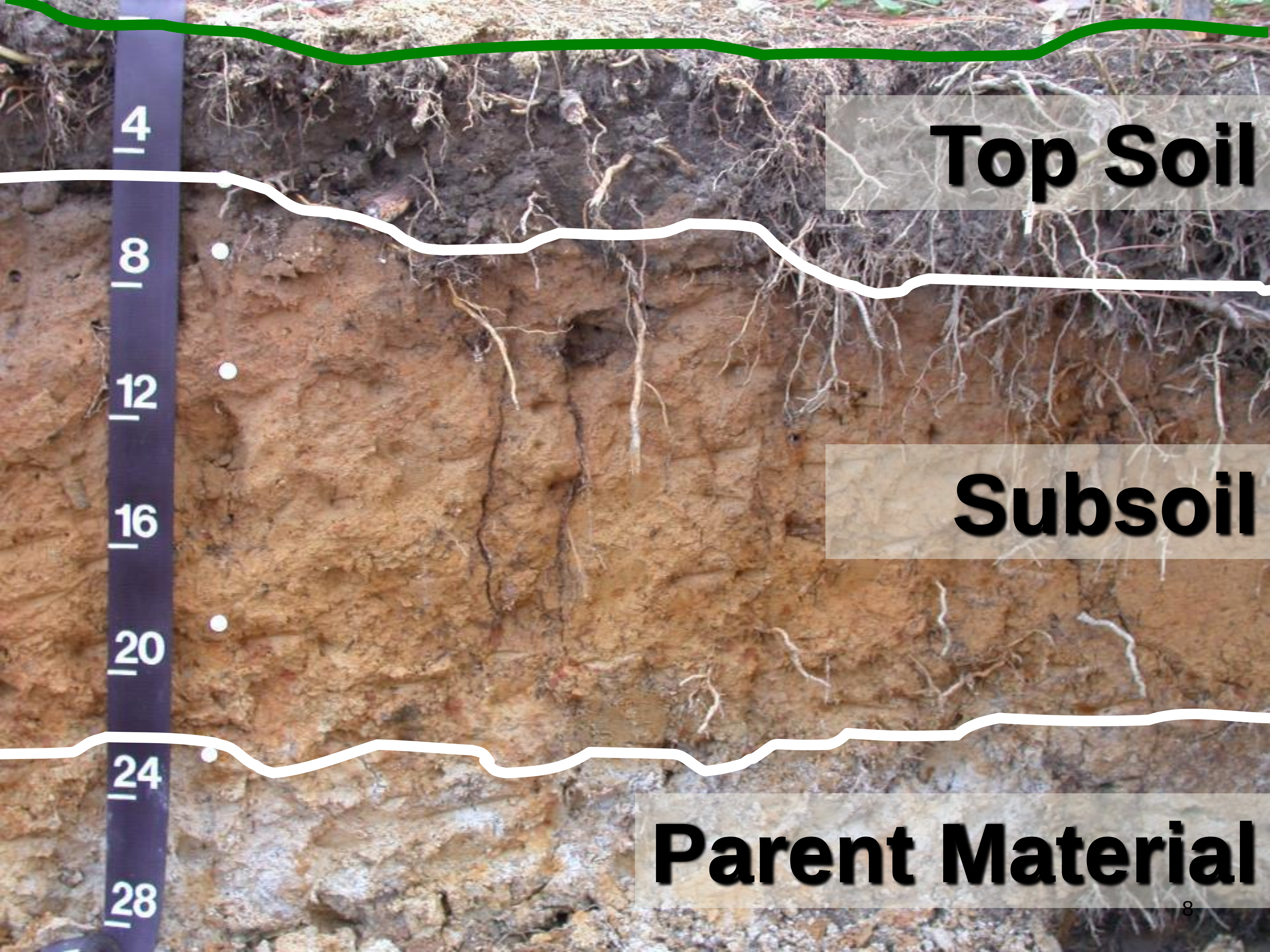
- Provide Treatment for Public Health and Environment
- Successfully Handle Large Volumes of Water on a Continuous Basis
- Repository for Recycling/Reuse of Water

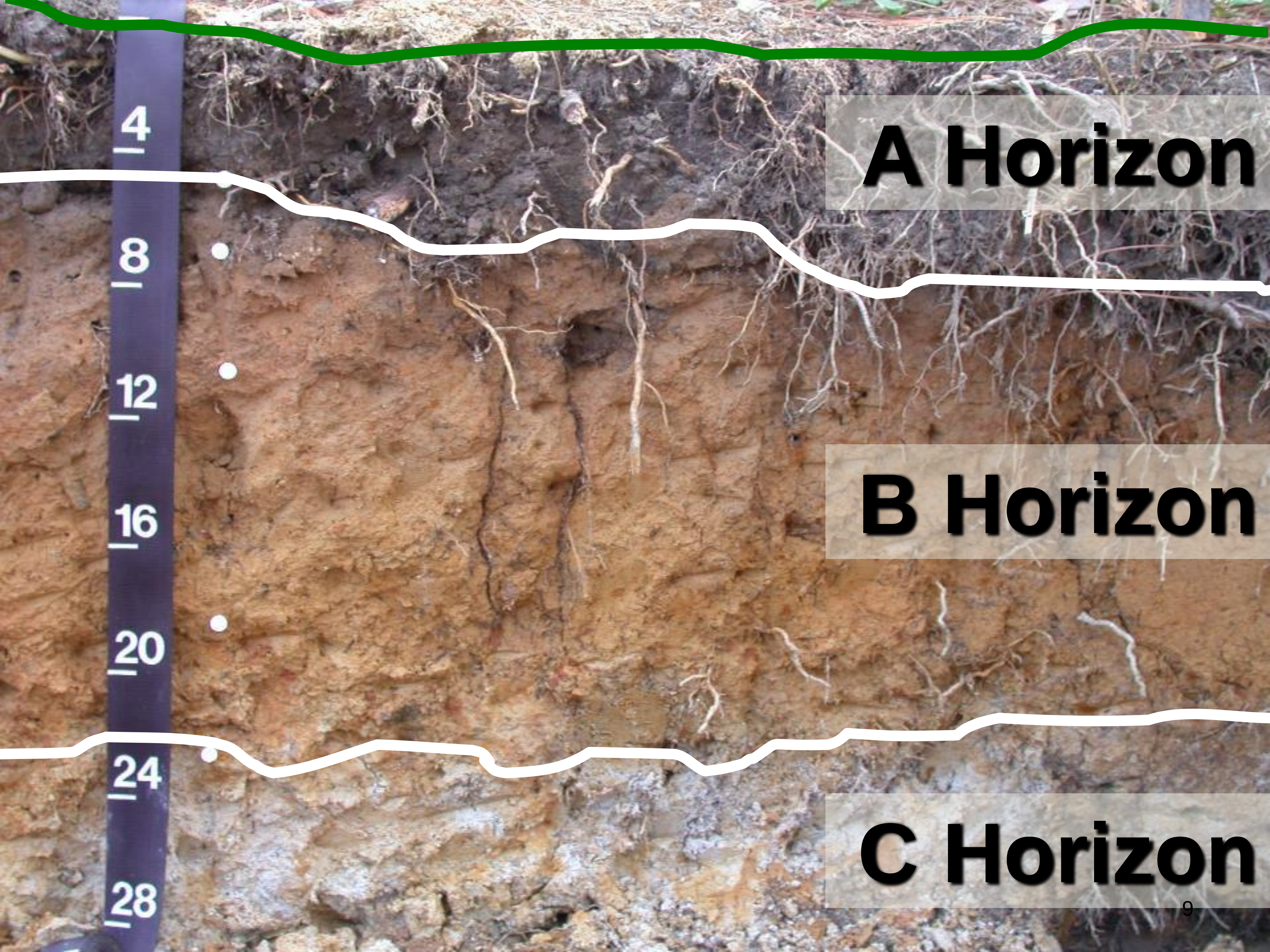
Soil/Site Evaluations

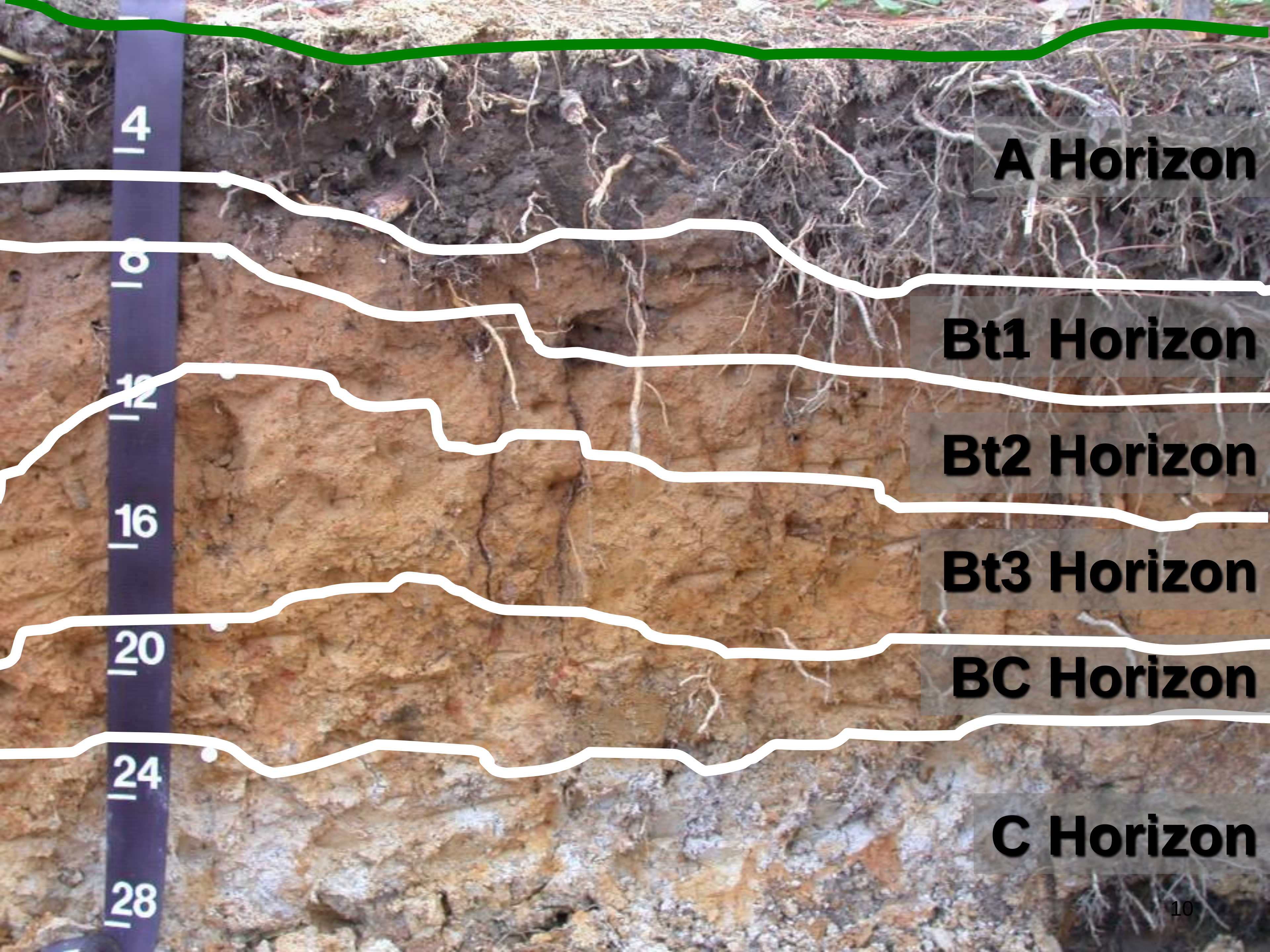
- Most important phase of system design
- Soil is a
  - physical,
  - biological, and
  - chemical treatment system.
- Need for standard procedures and reporting methods
- Soil and site evaluations tells you soil description and depth to limiting condition

Soil Profile Descriptions

- Soil horizon - A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil forming processes.
- Soil profile - A vertical section of the soil extending through all its horizons and into the parent material.


4
8
12
16
20
24
28
Top Soil
Subsoil
Parent Material


4
8
12
16
20
24
28
A Horizon
B Horizon
C Horizon

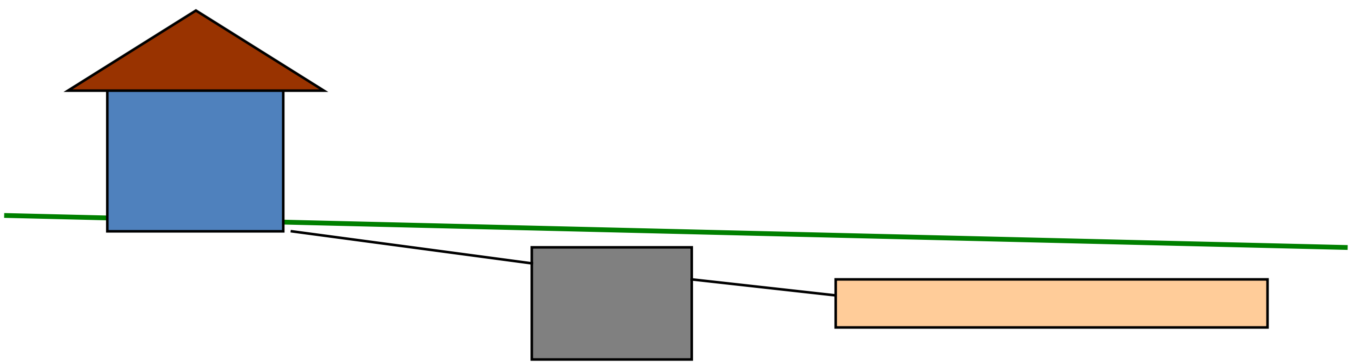

A Horizon
Bt1 Horizon
Bt2 Horizon
Bt3 Horizon
BC Horizon
C Horizon

Main Components of a Soil Descriptions

- Horizon
- Depth
- Texture
- Structure
- Color

Onsite Soil Evaluation

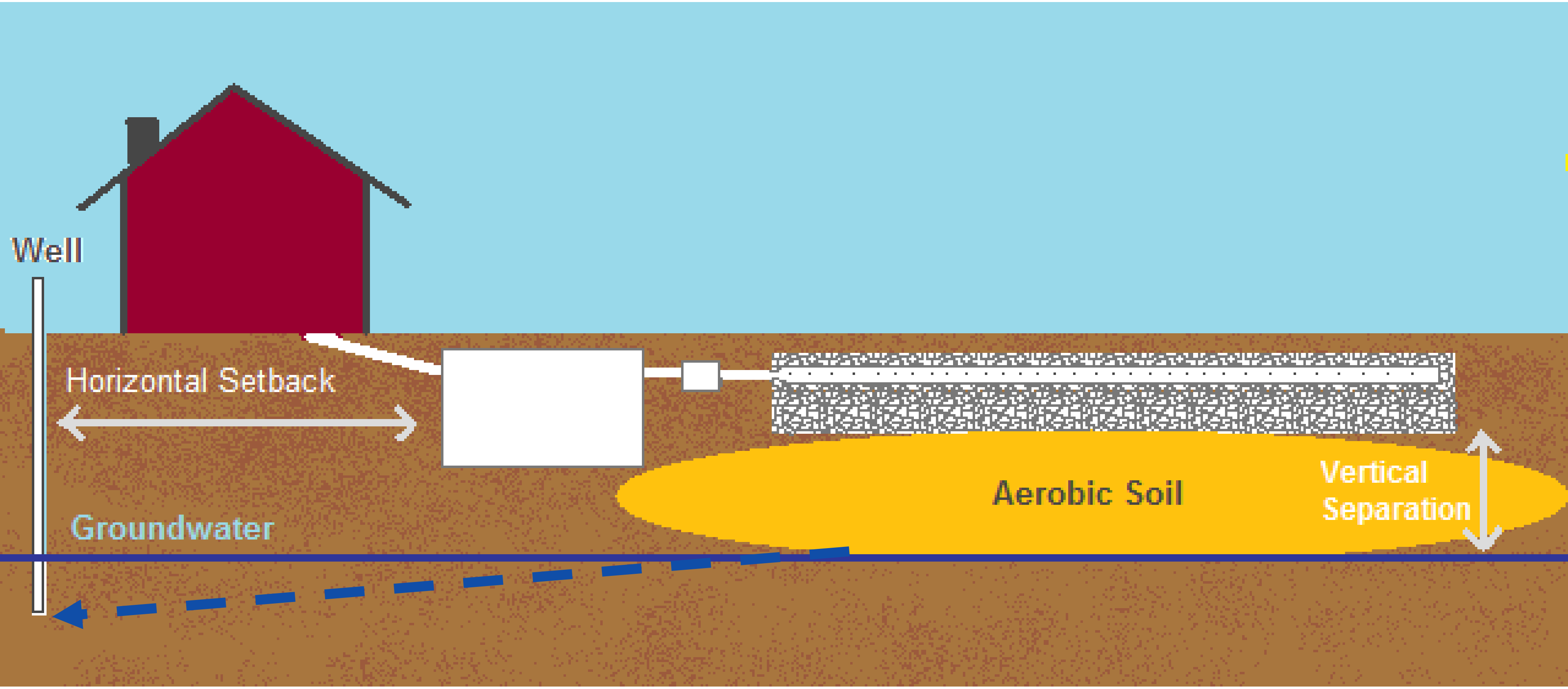
Source → System Pretreatment/distribution → Soil dispersal/ Final treatment



Flow → System design ← Soil evaluation

Accurately describe the site/soil and report limitations

How does soil treat wastewater?



- Aerobic soil is needed to treat – remove pathogens – and disperse treated wastewater back into the environment

Soil color

Soil Color

An Indicator of Past Environmental Conditions

- Organic Matter
- Type of Minerals
- Mineral Weathering
- Present Moisture Content
- Oxidation – Reduction of Iron Minerals

Soil Color

An Indicator of Past Environmental Conditions

The Soil Munsell Color System is used to characterize Soil Color.

Soil

Munsell

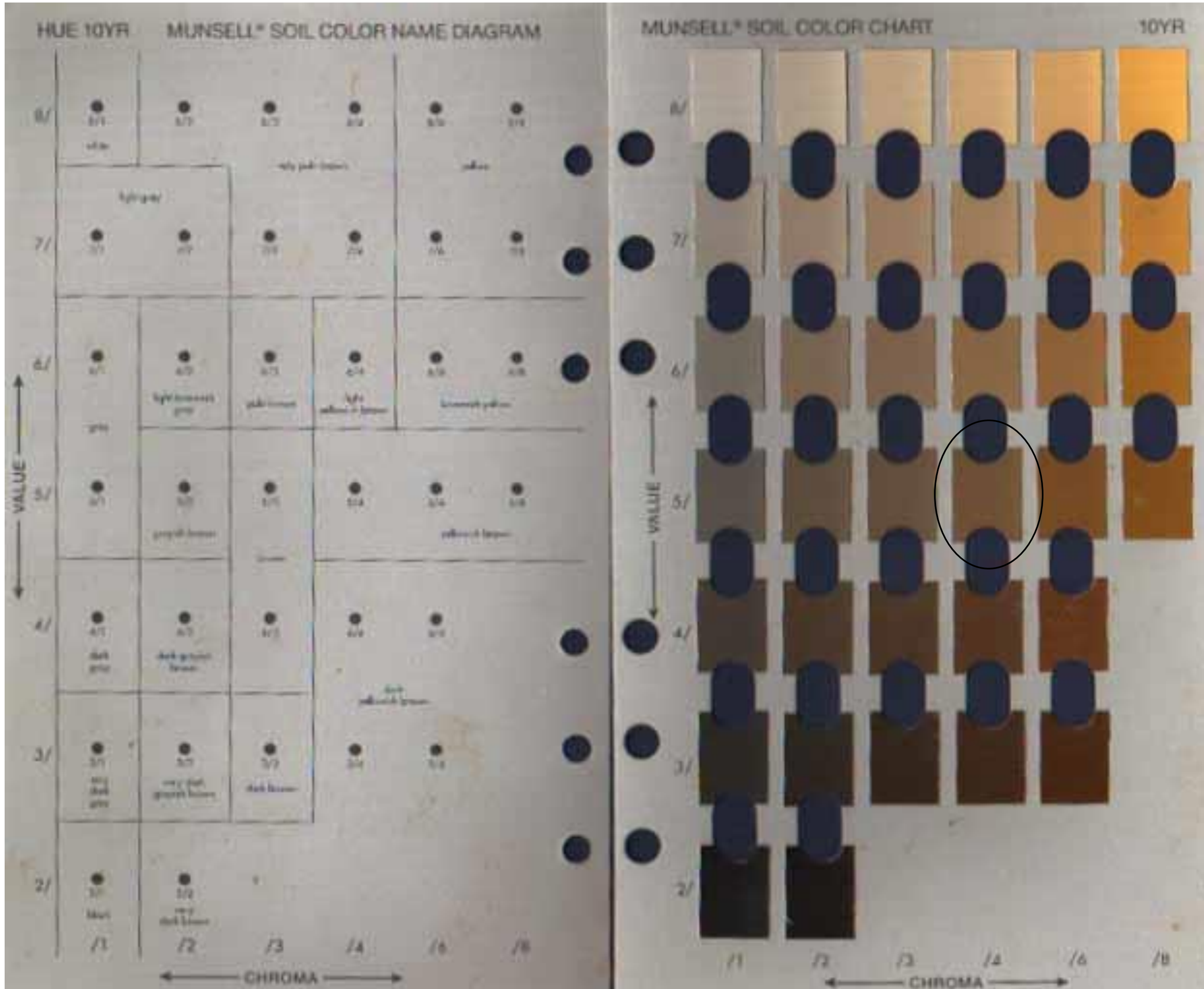
Color

Chart

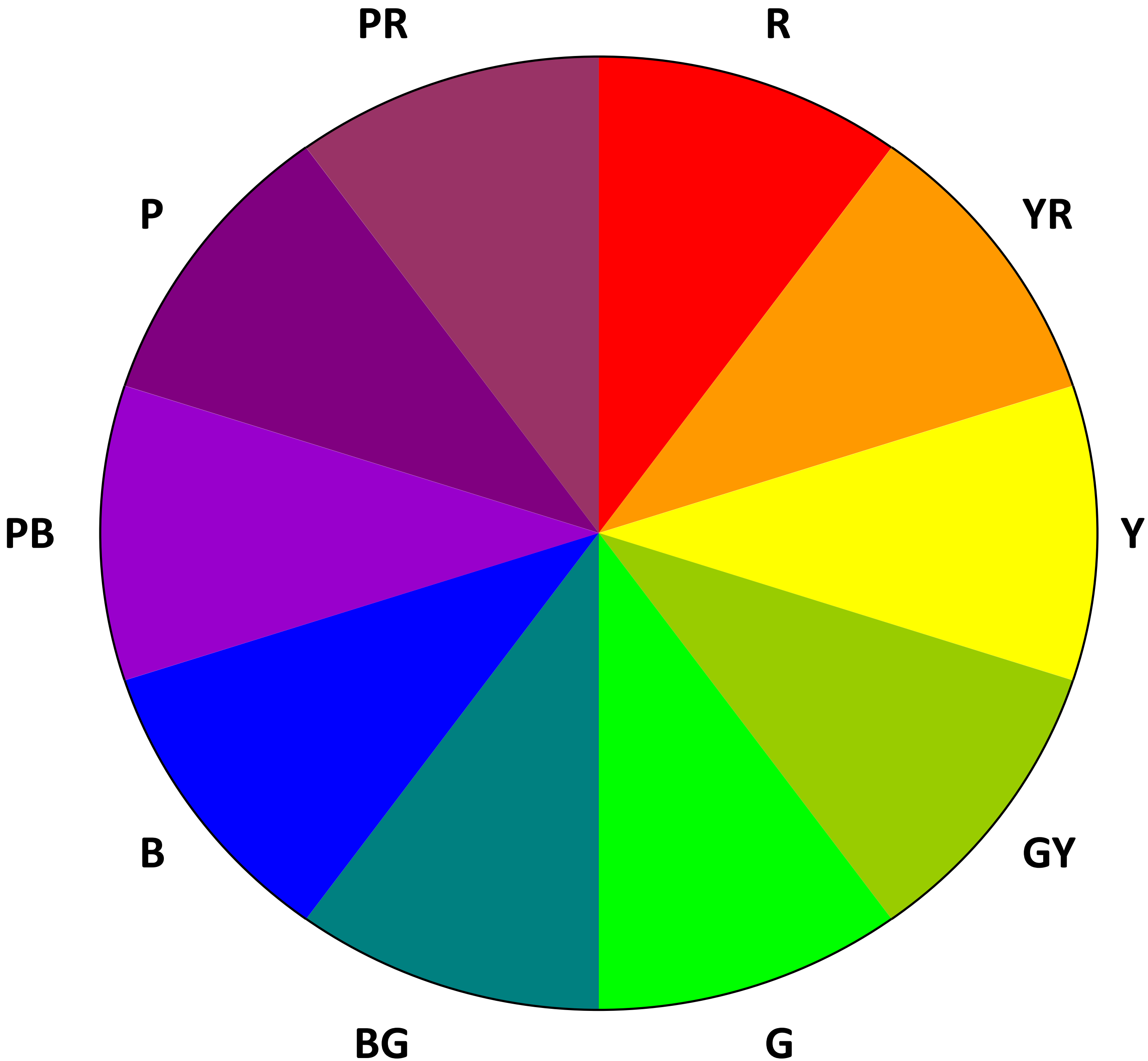
10YR 5/4

Yellowish

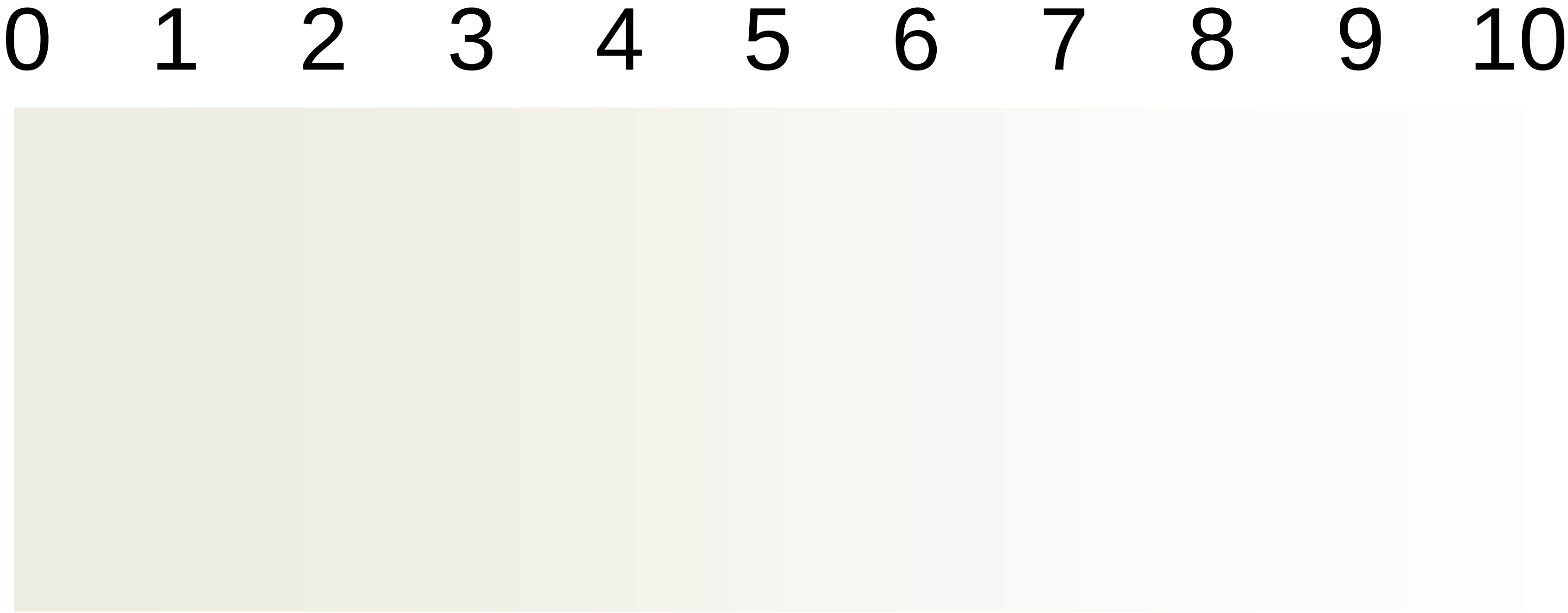
Brown



Hue



Value



Chroma

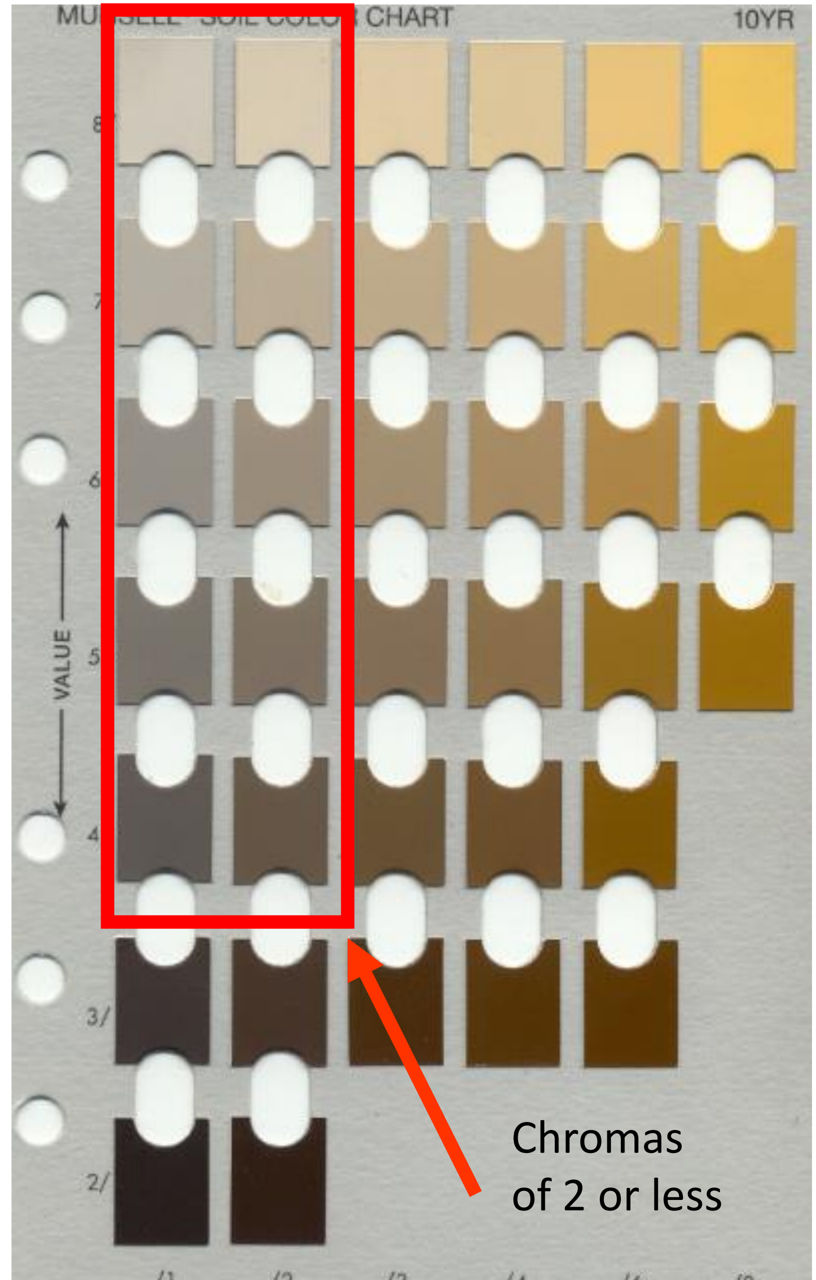
Soil Color Components

- Matrix Color - The dominant color of a soil material.

- Mottle Color - Splotches or flecks of color embedded in the matrix color.

What's Most Important?

- Gray (low chroma) colors indicates the soil saturates
- Saturated soils reduce treatment of wastewater



Fe masses

Generalized Soil Drainage Class

Drainage Class	Subsoil Matrix	Subsoil Mottle
Well drained	Bright	(Bright)
Moderately well	Bright	Dull
Somewhat Poorly	Dull	Bright
Poorly	Dull	(Dull)

Well Drained Soil

Somewhat Poorly Drained Soil

Poorly Drained Soil

Perched Water Table

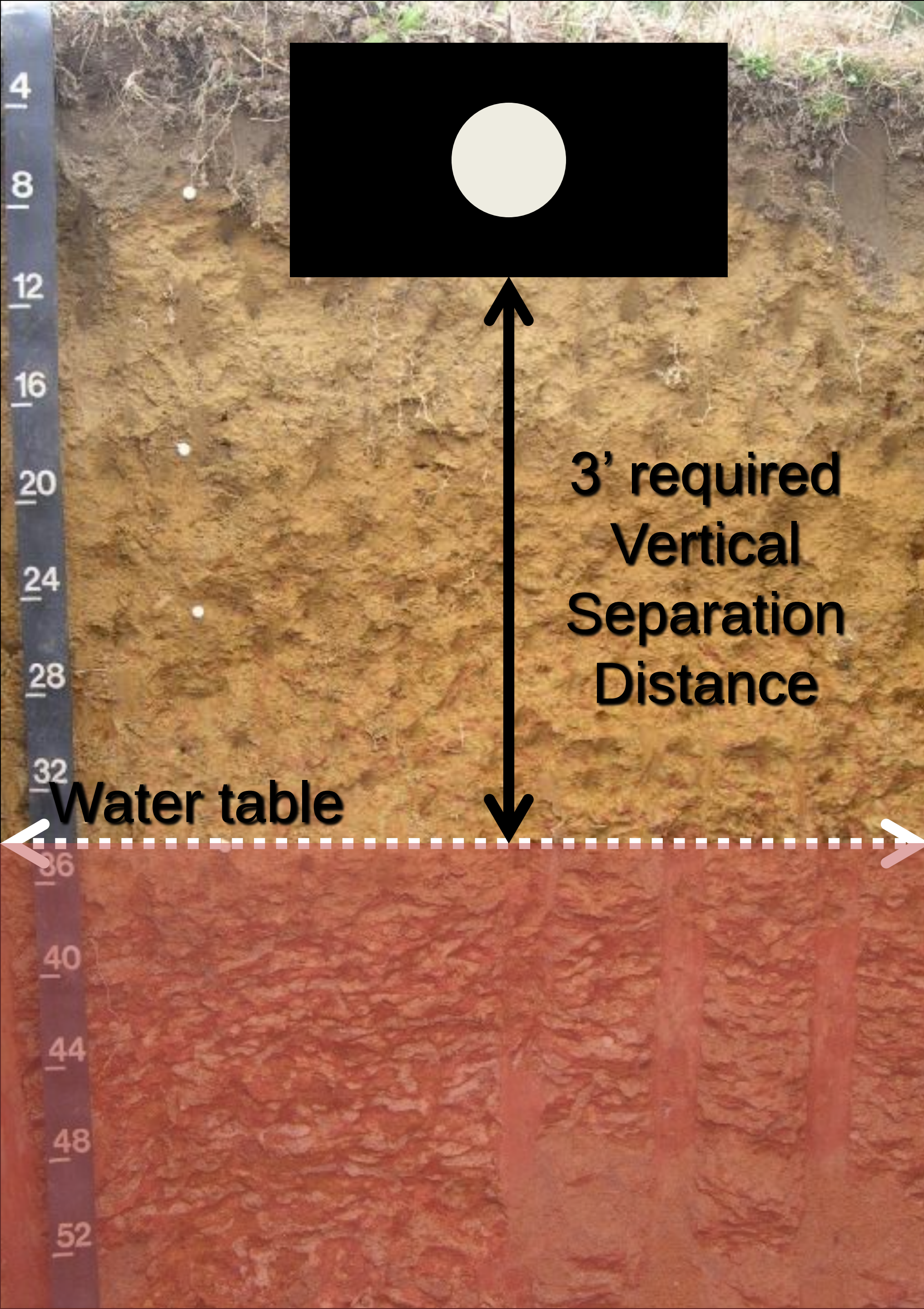
A Sandy Soil That is Poorly Drained

Soils on Slope

Up slope

Down slope

Color helps identify the water table



- Gray = water table
- Water table = saturation
- Poor treatment in saturated soil
- Keep infiltrative surface above water table
- Treatment is ensured by proper separation distance

- For An Onsite System, Bright, Well-Drained (Well-Aerated) Soils are Desirable.

- Aeration Provides Better Treatment Than Anaerobic Conditions.

Soil Texture

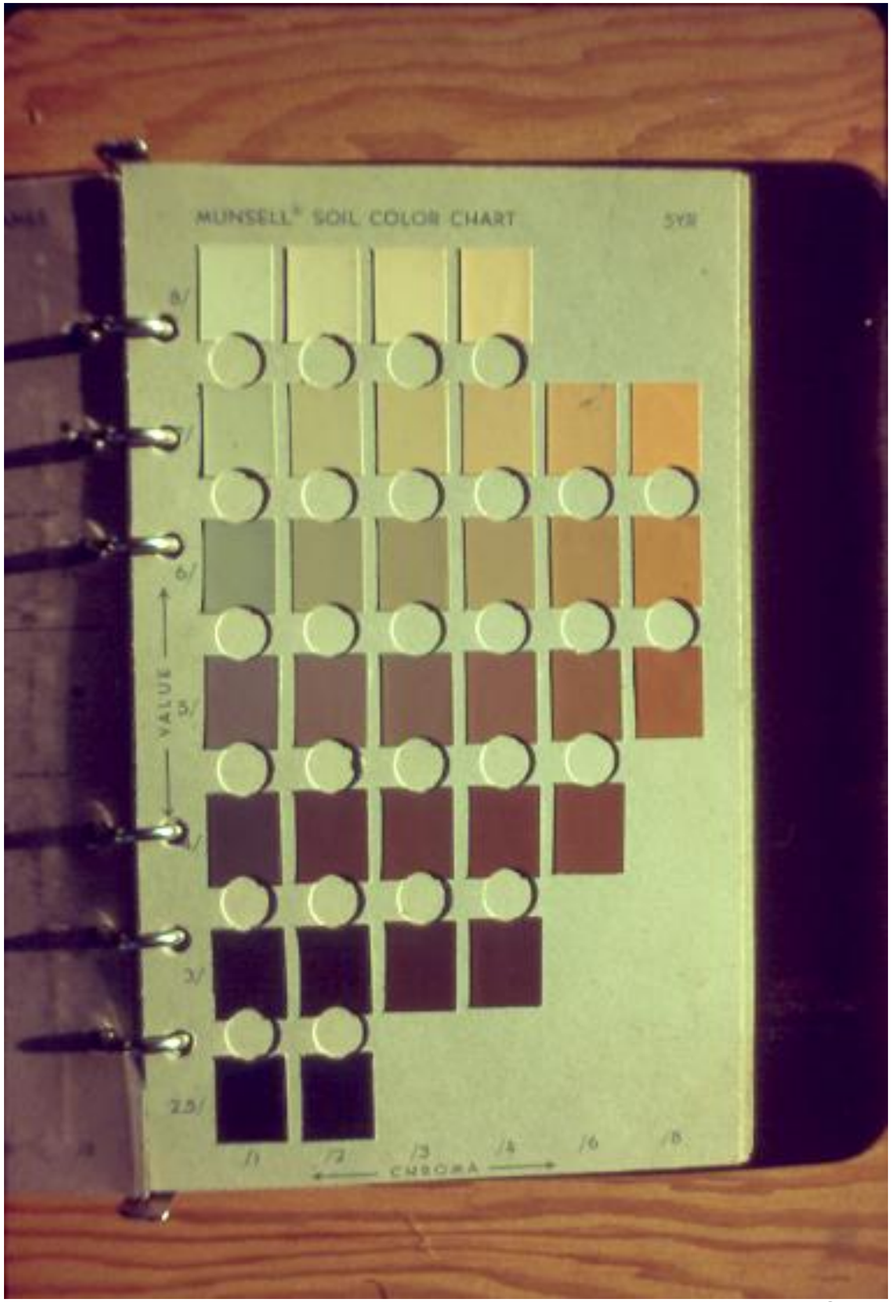
The Single Most Important Soil Property

- The size distribution of the inorganic primary particles less than 2 mm equivalent spherical diameter.

- Particles greater than 2 mm e.s.d. are called coarse fragments.

Soil texture

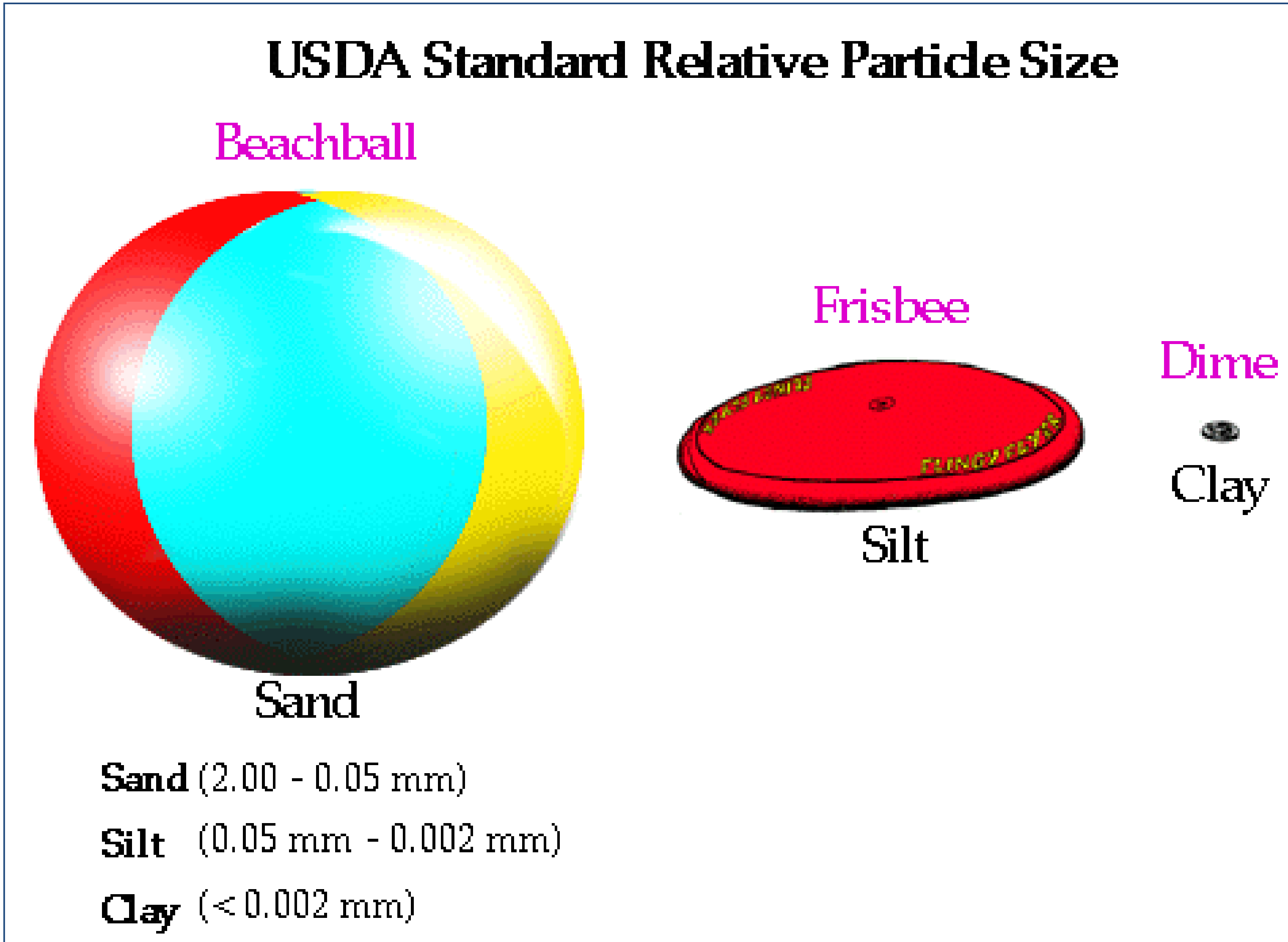
Soil Color vs Texture



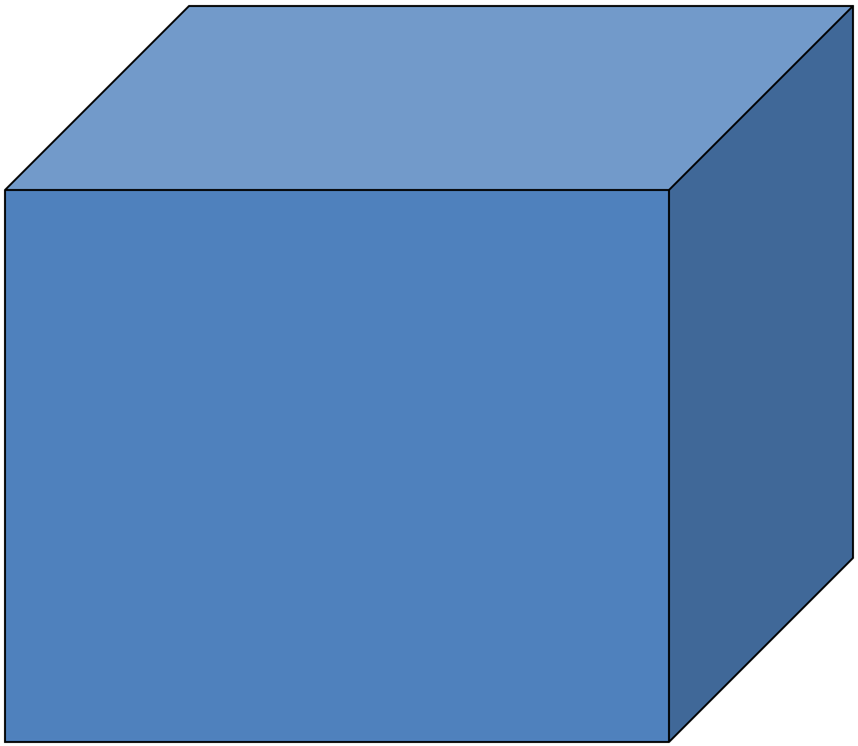
Soil Textural Separation

Separate	Size mm e.s.d.	Surface Area	Chemical Activity
Sand	2.0-.05	Least	Small
Silt	.05-.002	Intermediate	Intermediate
Clay	<.002	Most	Large

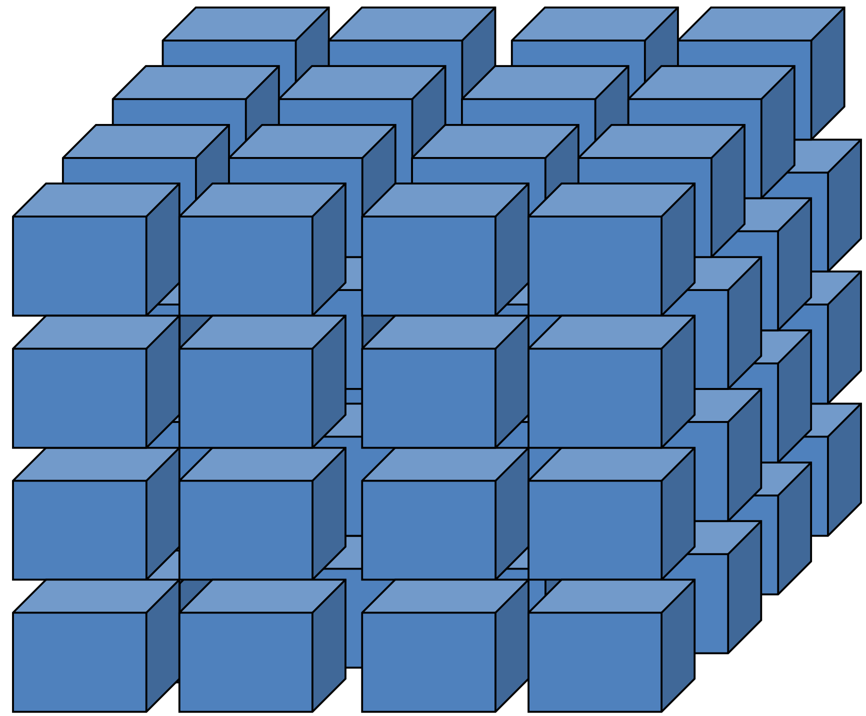
Soil Texture



Surface area vs particle size



- **Surface area = 6**
- **Volume = 1**
- **Size = 1**



- **Surface area = 24**
- **Volume = 1**
- **Size = 1/4**

Soil Textural Class

A grouping of various percentages of sand, silt, and clay such that each class possesses unique management properties relative to all other groupings. Twelve (12) soil textural classes. Uses 4 fundamental terms.

TERMS USED ARE:

Sand

Silt

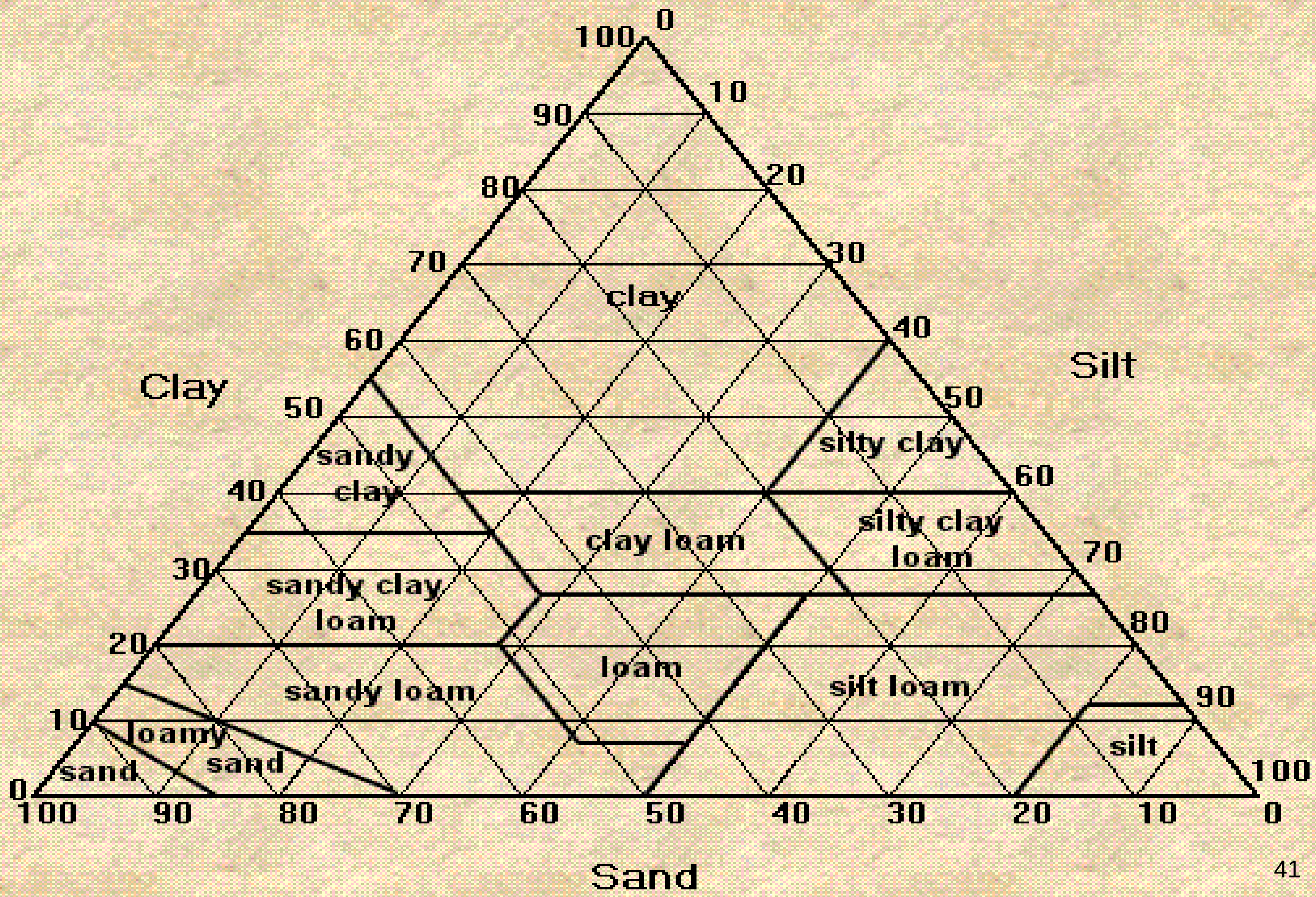
Clay

Loam

Loam

Mixture of sand, silt, and clay such that each separate has nearly equal influence on soil properties.

Textural Triangle



12 Soil Textural Classes

Monolithic

- Sand
- Loamy Sand
- Silt
- Clay
- Sandy Clay
- Silty Clay

Balanced

- Loam
- Sandy Loam
- Silt Loam
- Clay Loam
- Sandy Clay Loam
- Silty Clay Loam

Sand vs Clay

Sand	Clay
• Large pores	• Small pores
• Water moves fast	• Water moves slow
• Low surface area	• High surface area
• Less treatment capacity	• More treatment capacity

Onsite systems need to balance water movement with wastewater treatment

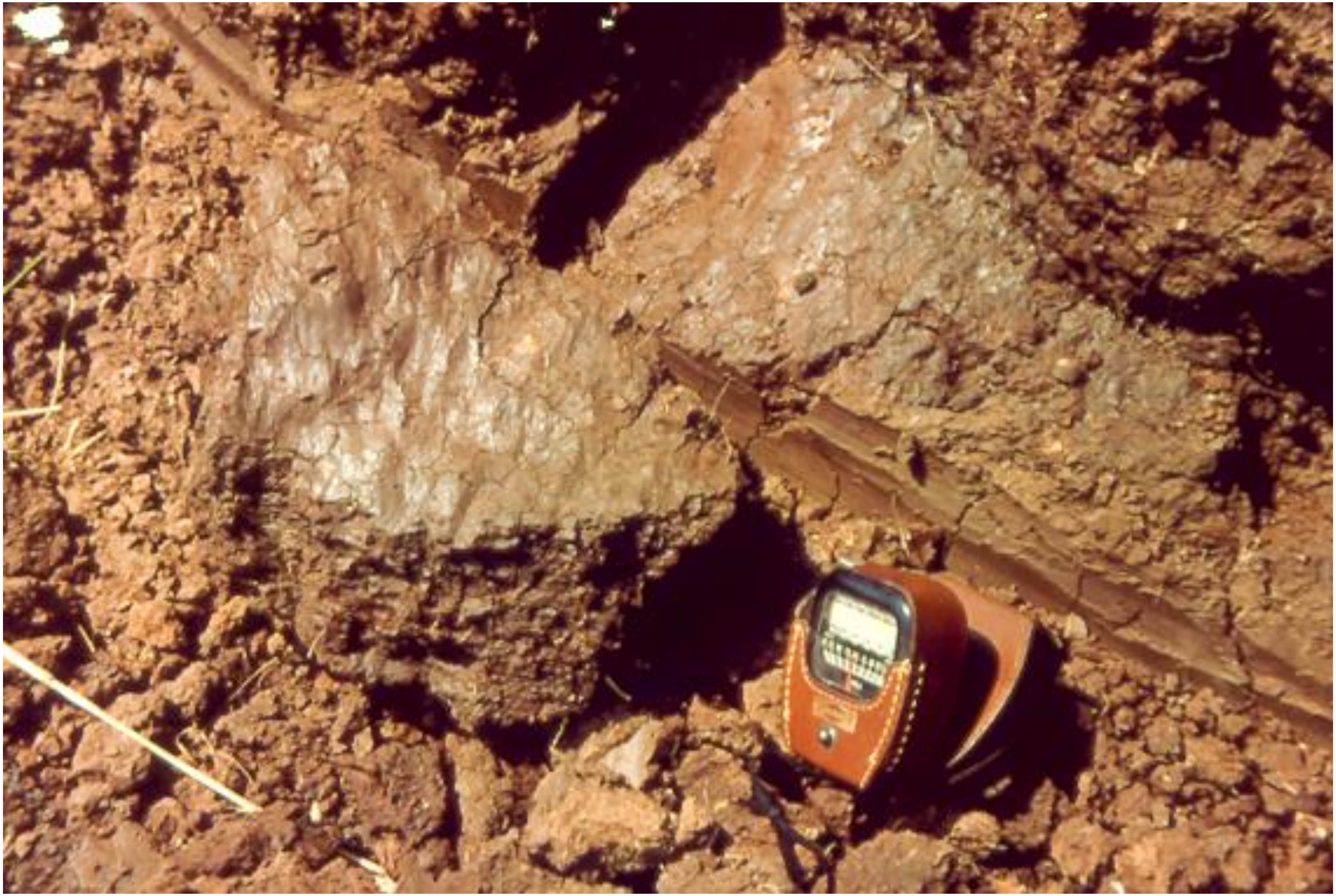
Soil Texture

- Coarse fragments modify texture.
- Coarse fragments can increase water flow and decrease soil treatment.
- In some cases coarse fragments can restrict water movement

Very Gravelly Soil

Soil Texture

- Texture relates to pore size
- Pore size relates to treatment
- Pore size relates to water movement
- Both treatment and water movement need to be maintained
- Properties related to texture can be changed due to installation
  - Compaction
  - Smearing



High Shrink-Swell Clay

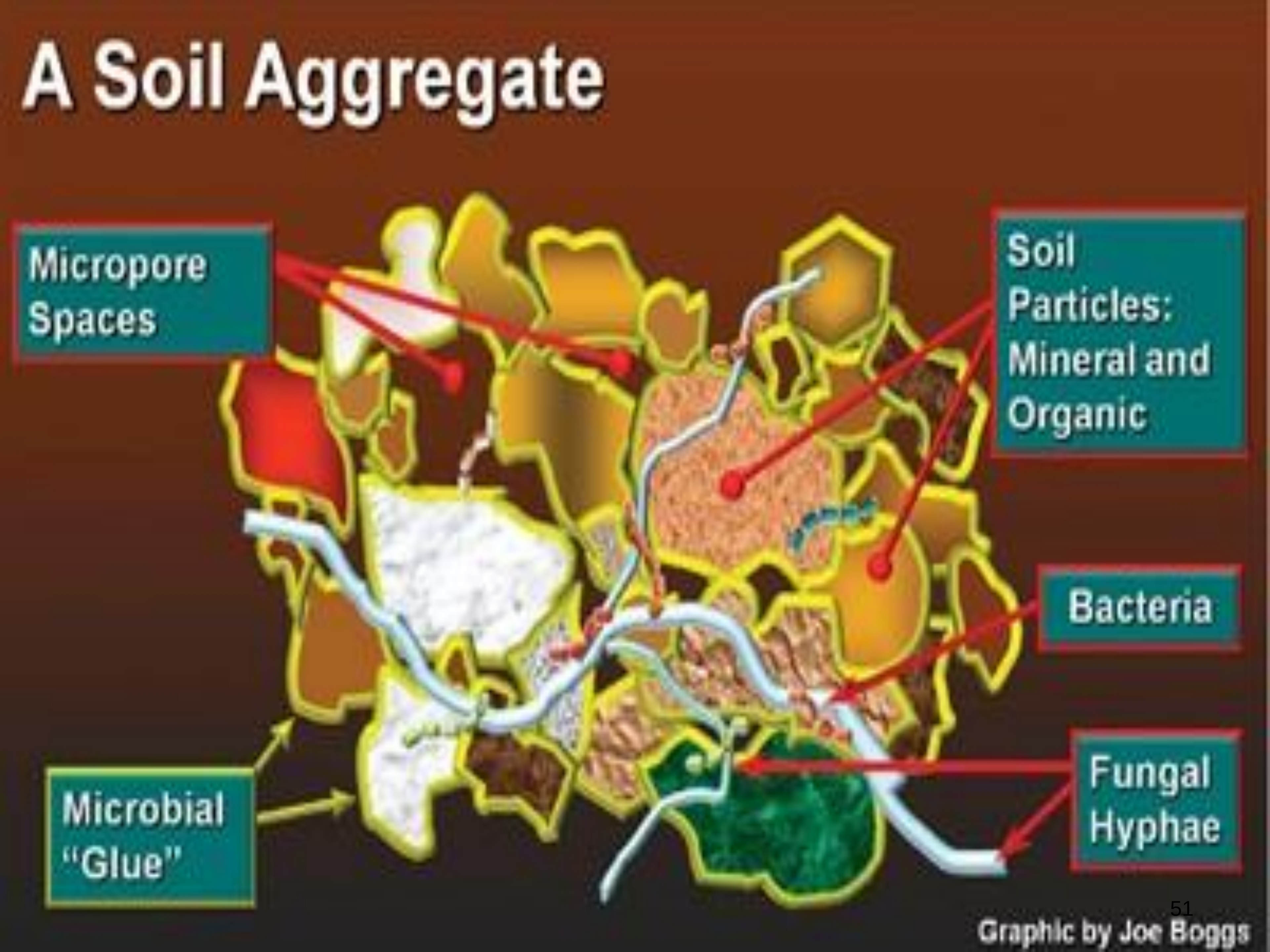
Soil Structure

- Grouping or arrangement of individual soil particles into a larger unit. (Also called aggregate, ped).
- Greatly affects how wastewater moves.
- Greatly affects aeration and treatment.

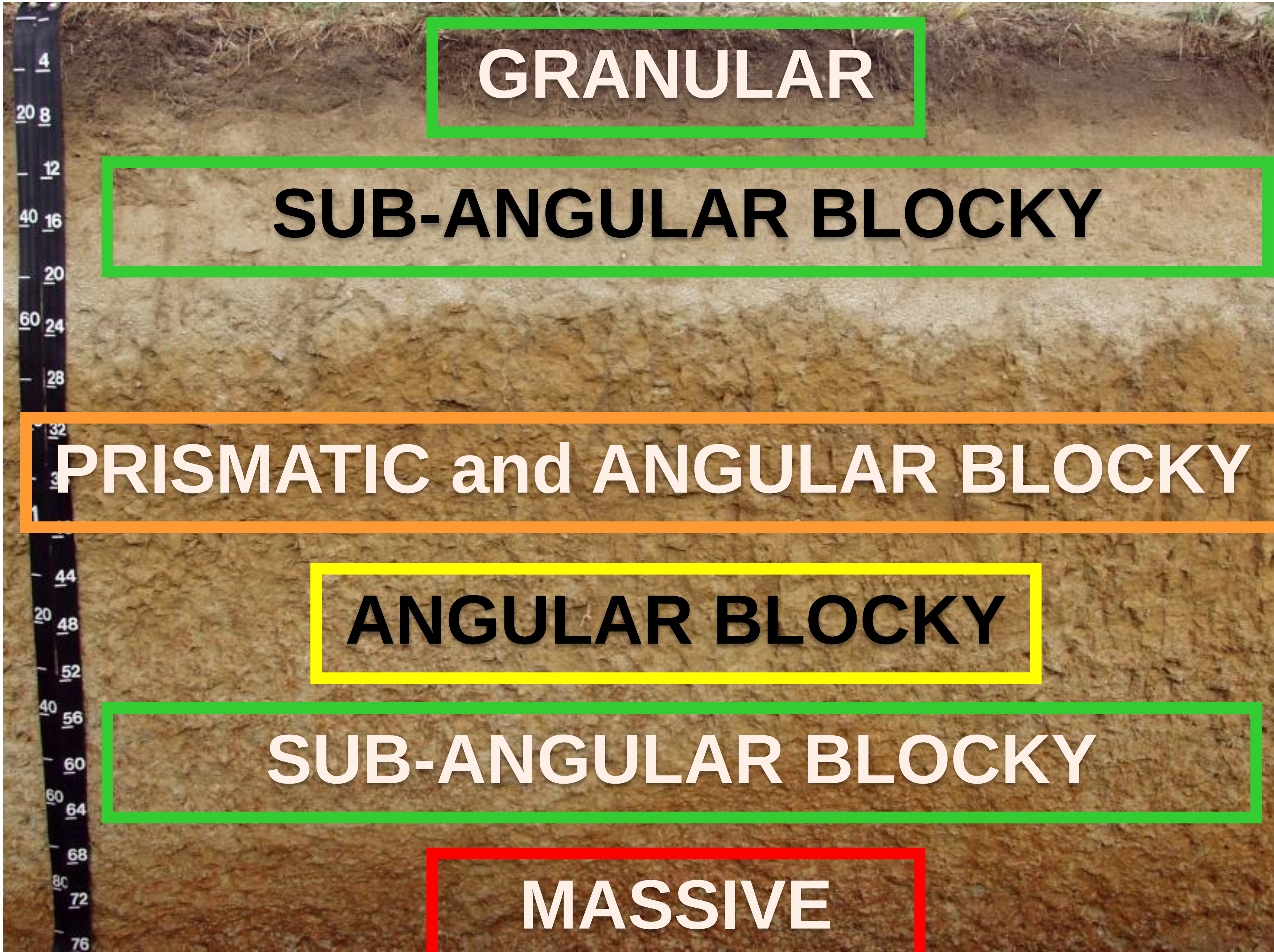
Structural Type

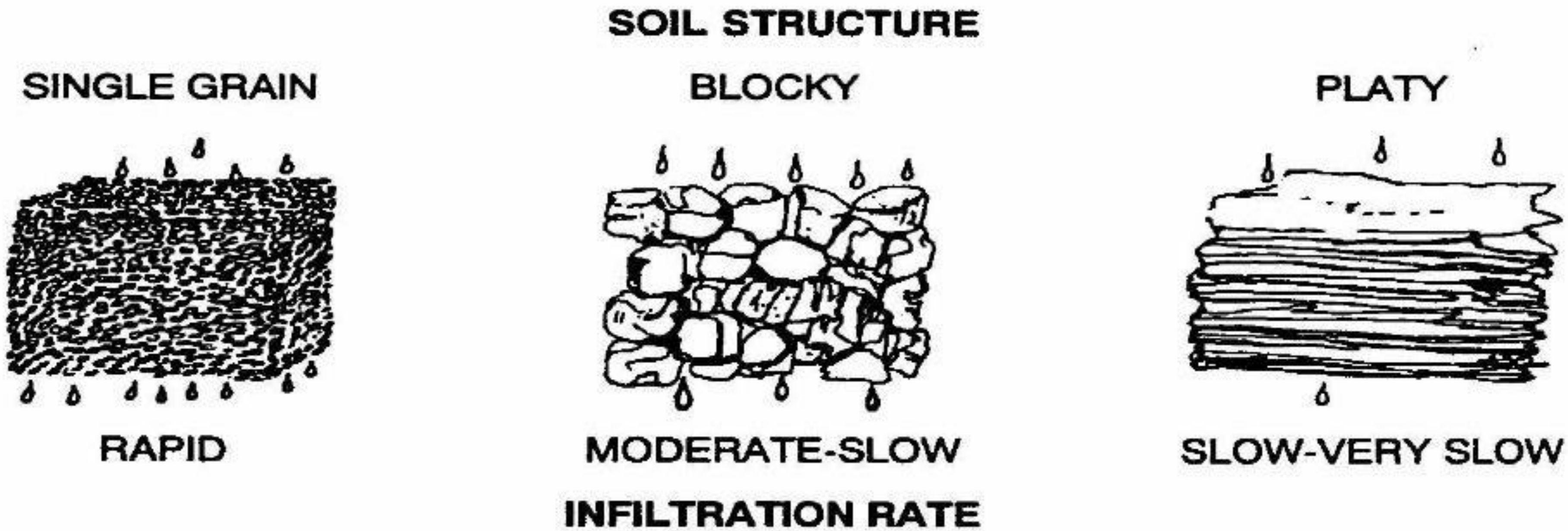
(shape)

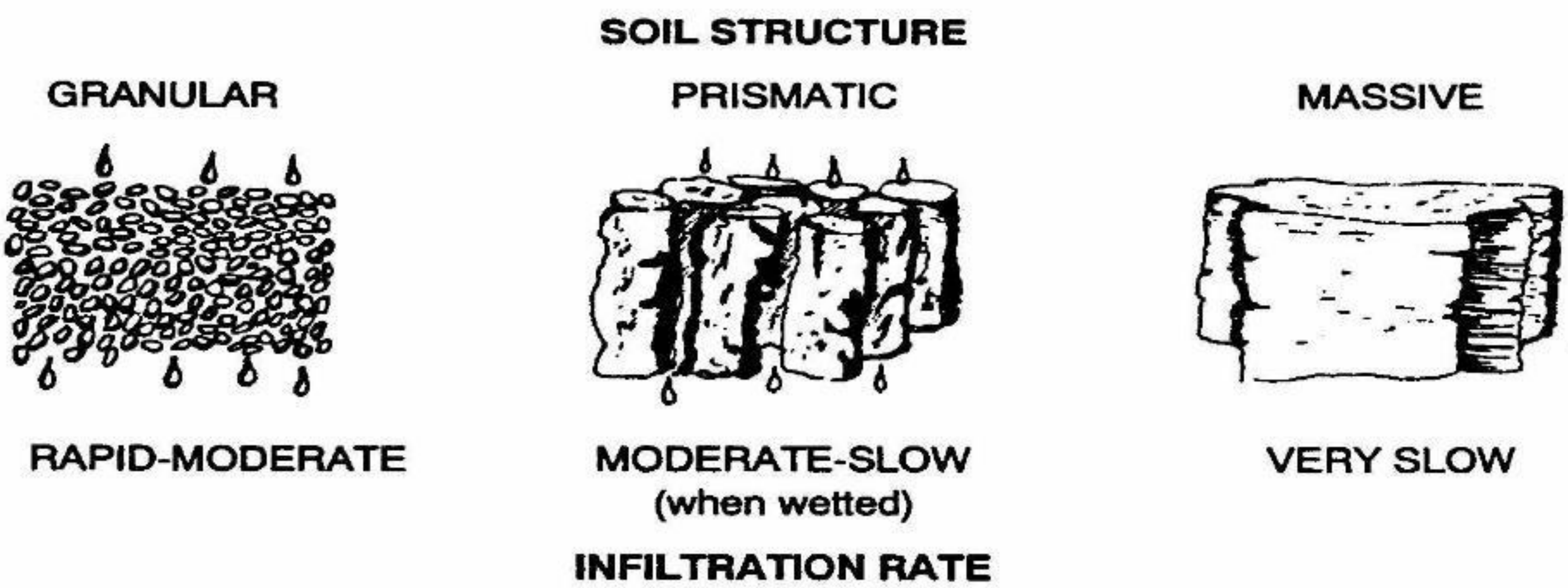
Most Porous	■Granular (crumb)
↓	■Cube-Like
	–Subangular Blocky
	–Angular Blocky
	■Prism-Like
	–Prismatic
	–Columnar
Least Porous	■Platy


A Soil Aggregate
Micropore Spaces
Soil Particles: Mineral and Organic
Bacteria
Fungal Hyphae
Microbial "Glue"
Graphic by Joe Boggs

Variability of Structure in the Soil

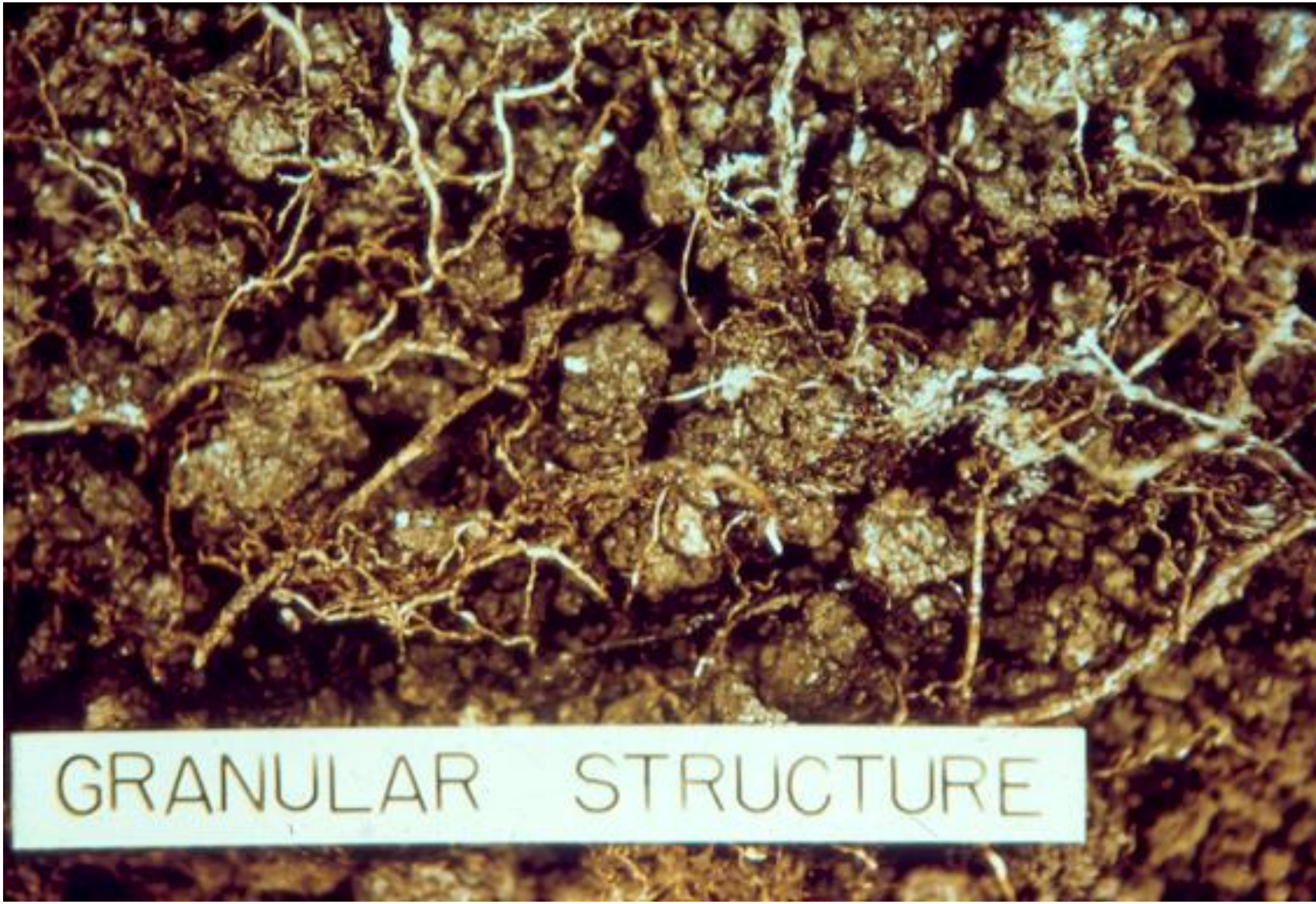


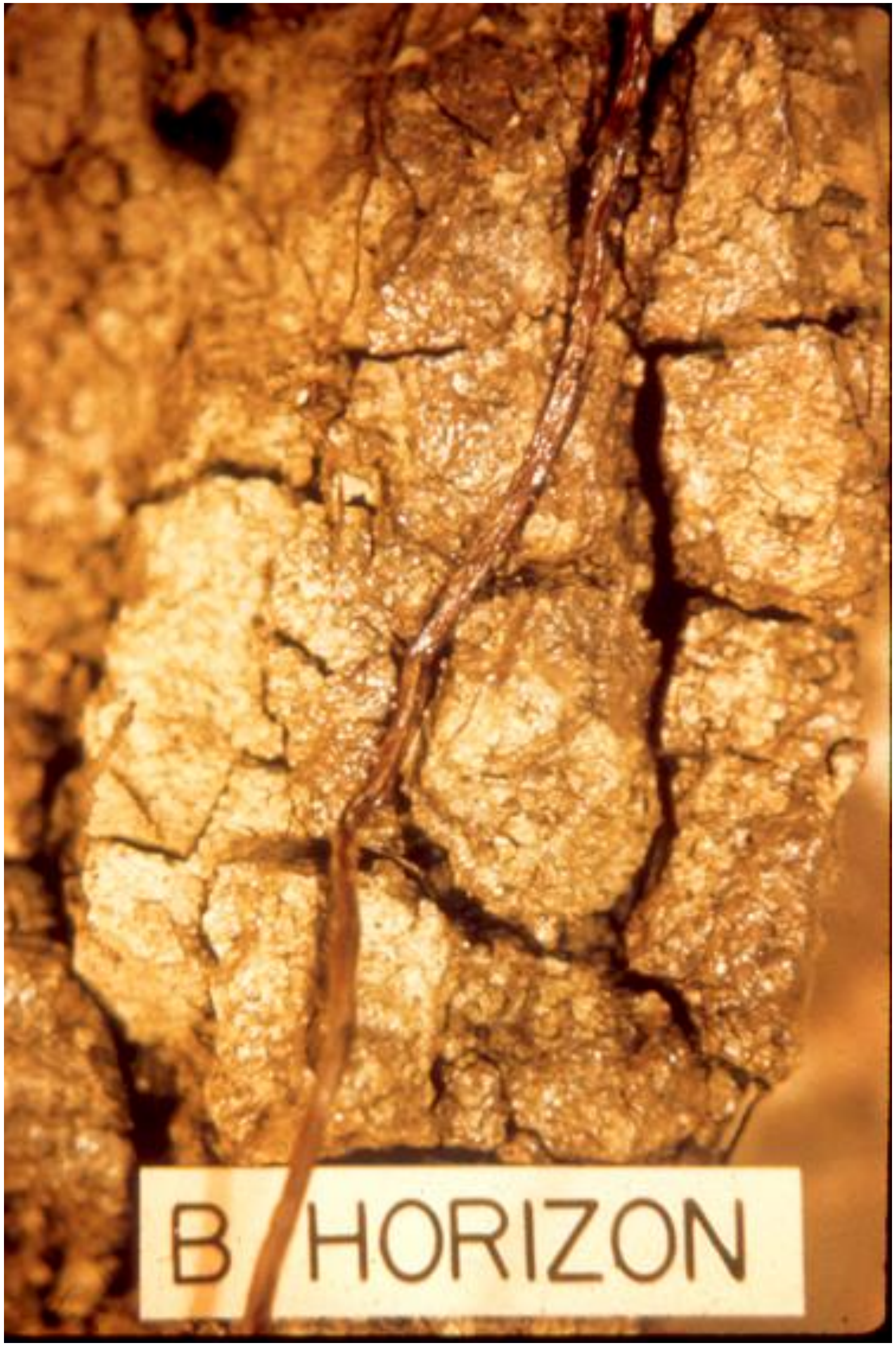

SOIL STRUCTURE
SINGLE GRAIN
BLOCKY
PLATY
RAPID
MODERATE-SLOW
SLOW-VERY SLOW
INFILTRATION RATE

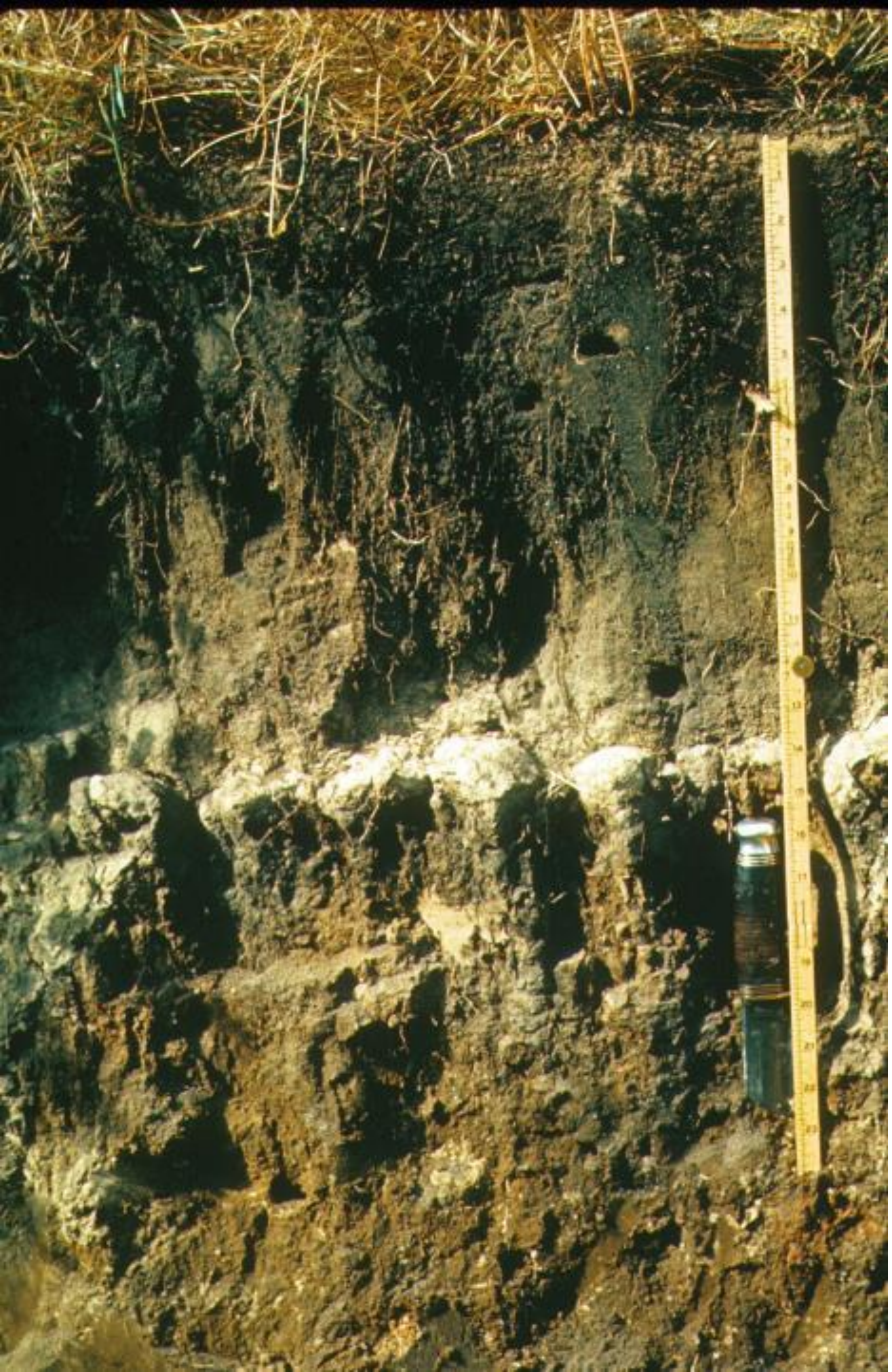

SOIL STRUCTURE
GRANULAR
PRISMATIC
MASSIVE
RAPID-MODERATE
MODERATE-SLOW
(when wetted)
VERY SLOW
INFILTRATION RATE

Structures

- Structureless-single grain and soils with a granular structure have the most rapid infiltration rate.
- Blocky and prismatic have a moderate to slow infiltration rate
- Subangular blocky faster that angular blocky
- Soils with platy and structureless-massive (soil retains the shape of the bucket) have the slowest infiltration rates


GRANULAR STRUCTURE

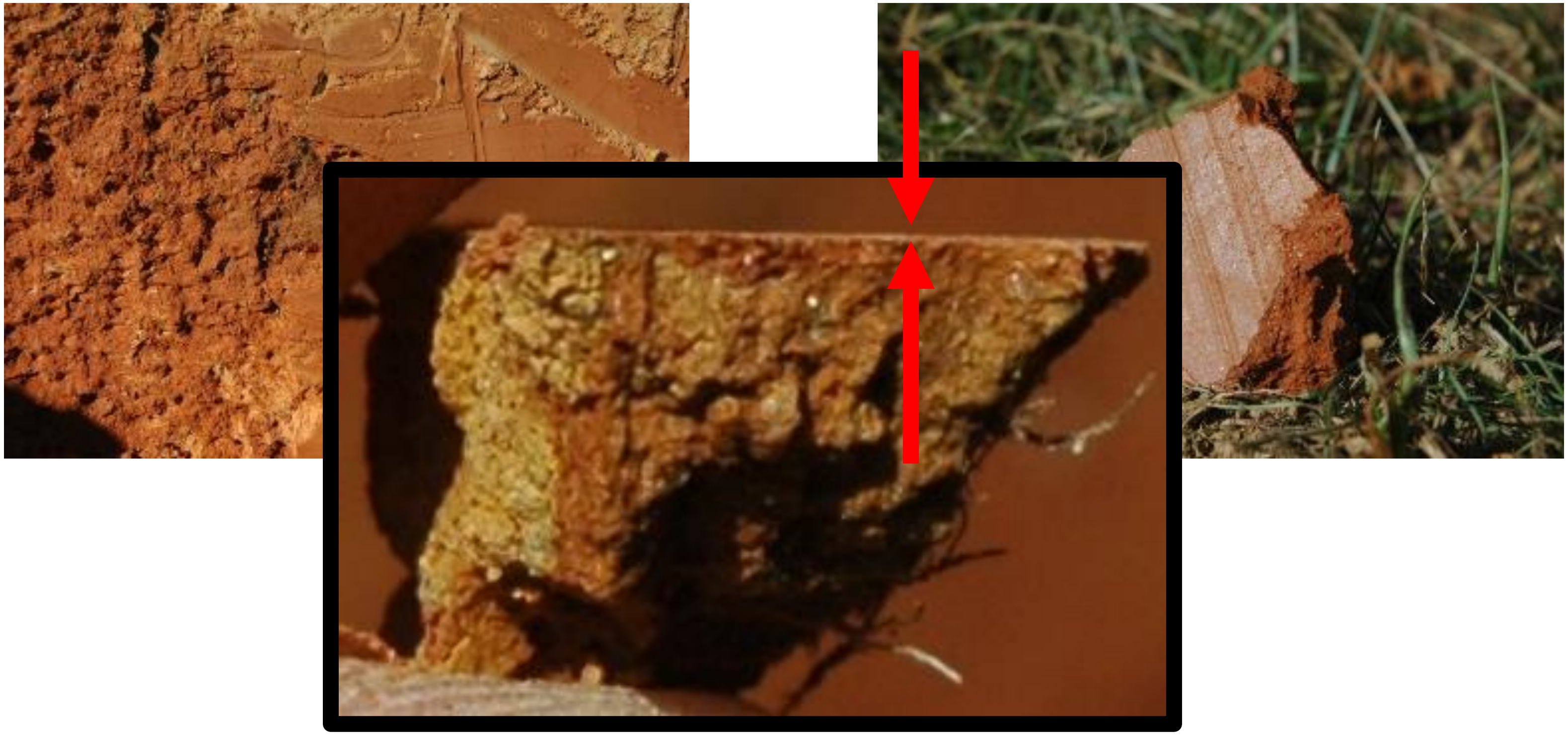

B HORIZON



Strong, coarse columnar

Perched Water Table Due to Platy Structure in Subsoil

Smearing



Compaction

Mechanical disruption - smearing

Trench and bed construction

- Take care to disturb STA as little as possible
- Leave bottom infiltrative surface rough
- Minimize walking on infiltration surface
- Construct when soil is of proper moisture to minimize smearing and compaction

Compaction of Soil Treatment Area

- Less aeration into STA
- Less evaporation from STA
- Lesser quality vegetative cover in lawn

Soil abuse

	Smearing	Compaction

Structure Modifies the Influence of Texture

- **Combined influence of soil texture and soil structure**
  - Water movement
  - Aeration
  - Water retention
  - Root penetration
- **Texture plays a major role with micropores.**
- **Structure plays a major role with macropores.**

SOIL PROFILE DESCRIPTION

Date : 12/02/2010

LOCATION : 15023 S. Beach Front Rd. Crystal Lakes LATITUDE : N 39 . 36208 LONGITUDE : W 094 . 18405

PIT : 1 DEPTH 48" SLOPE 2% VEGETATION lawn SEASON. WATER TABLE : 27"

WEATHER : Clear 55 PARENT MATERIAL : Residuum DESCRIBED by [signature]

BEDROOMS 2 GPD : 300 Clay P. Dyer # 10058

	DESIG.	(1) DEPTH BOUND.	MUNSELL COLOR (moist)	(2) REDOX FEATURES	TEXTURE (3) USDA	TEXTURE % CLAY	% Course Fragments by volume < 3"	% Course Fragments by volume > 3"	consis-tence (4)	Structure (5)	(6) roots pores	shrink swell	Soil Group	APPLICATION RATE CONV.	APPLICATION RATE ALT.
	Ap	0 - 4" GS	10YR3/4		sicl	33	5	5	ss-sp fr	2 f GR	m-fmc	mod	3	0.35	0.15
	FILL	4" - 21" GS	10YR4/4 10YR6/1		FILL	50	10	15	vs-vp vfi	3 f MA	f-f	high		NS	NS
	Ap	21" - 27" GS	10YR2/1		sicl	30			ss-sp fr	3f GR	f-f	low	3	0.45	0.35
	Bt3	27" - 35" GS	10YR4/3	10YR4/1	c	55			vs-vp vfi	3 m SBK	f-f	high	4b	NS	NS
	BC	35" - 48"	10YR4/4	10YR6/1	c	58	2		vs-vp vfi	3 f ABK	f-f	high	4b	NS	NS

NOTES: This site has considerable fill present and will require an elevated system. This should be designed by an engineer. The site has limited available space for a system and may require insurance that all interior water usage i.e.. Toilet , shower... are all low flow.

Topography

- Important to record and note during initial walk-through.
- Influences distribution and types of soils as well as hydrology.
- Influences water in a divergent and convergent manner: slope type and shape are important.

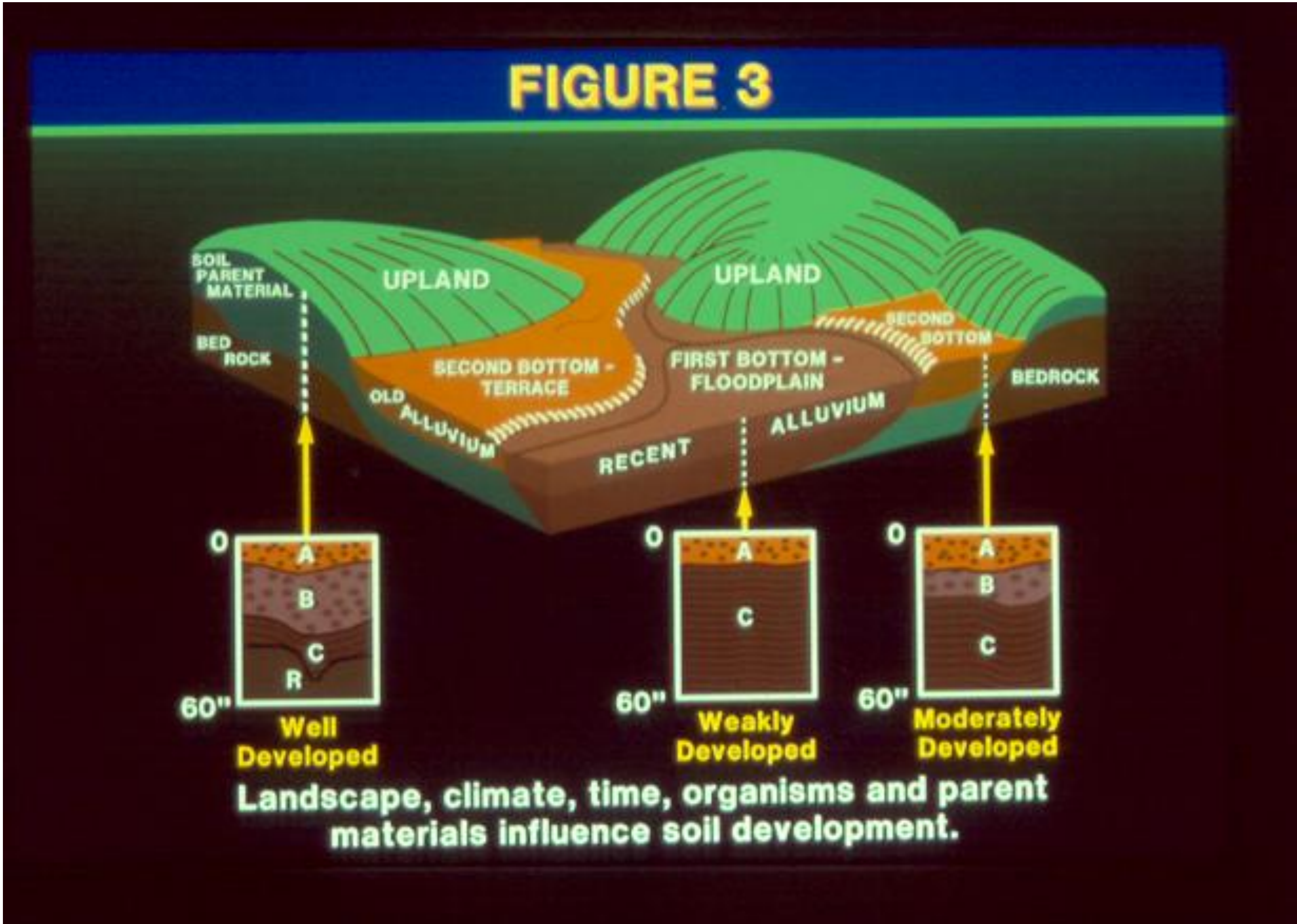
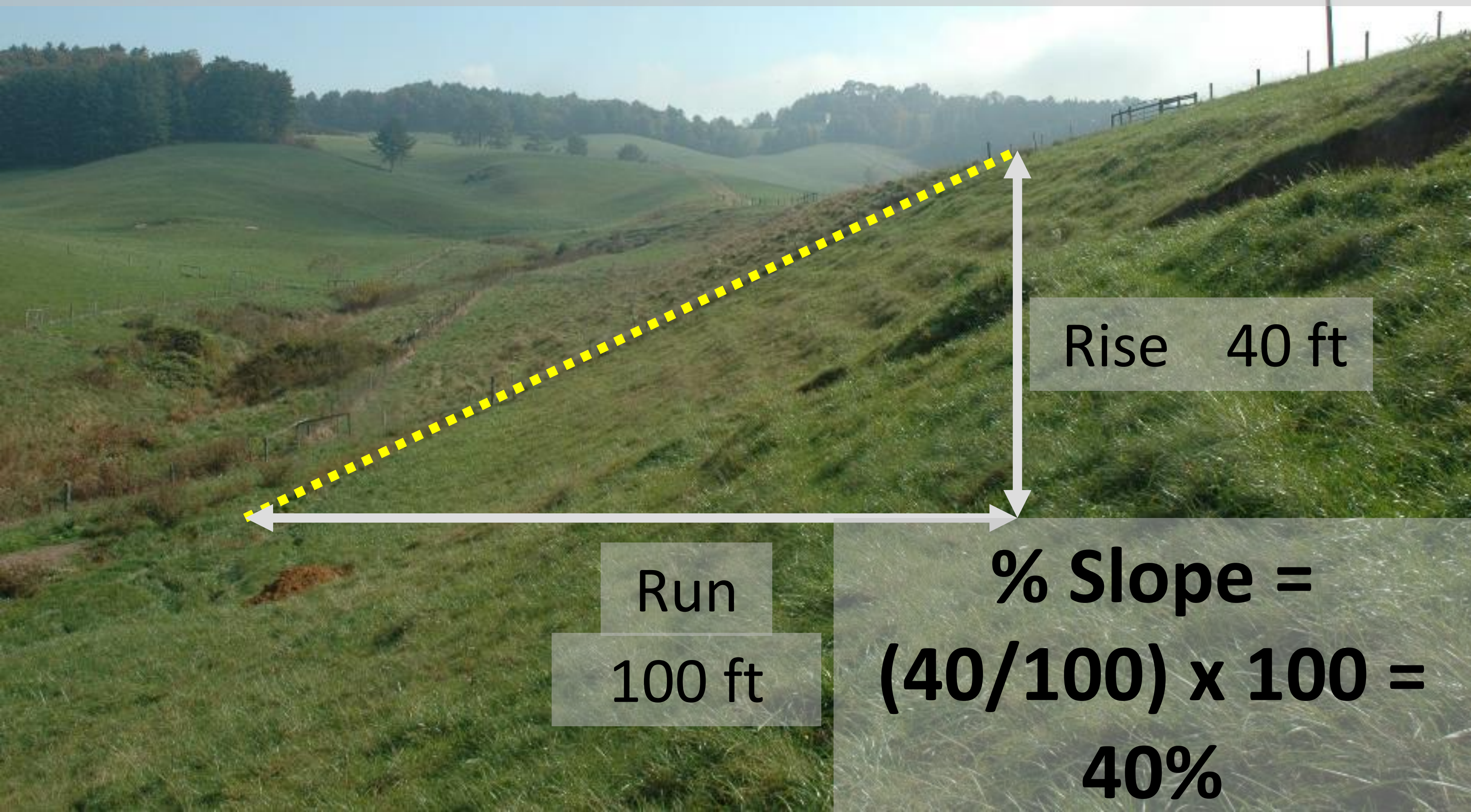


FIGURE 3
SOIL PARENT MATERIAL
BED ROCK
UPLAND
UPLAND
SECOND BOTTOM - TERRACE
OLD ALLUVIUM
FIRST BOTTOM - FLOODPLAIN
RECENT ALLUVIUM
SECOND BOTTOM
BEDROCK
0
A
B
C
R
60"
Well Developed
0
A
C
60"
Weakly Developed
0
A
B
C
60"
Moderately Developed
Landscape, climate, time, organisms and parent materials influence soil development.

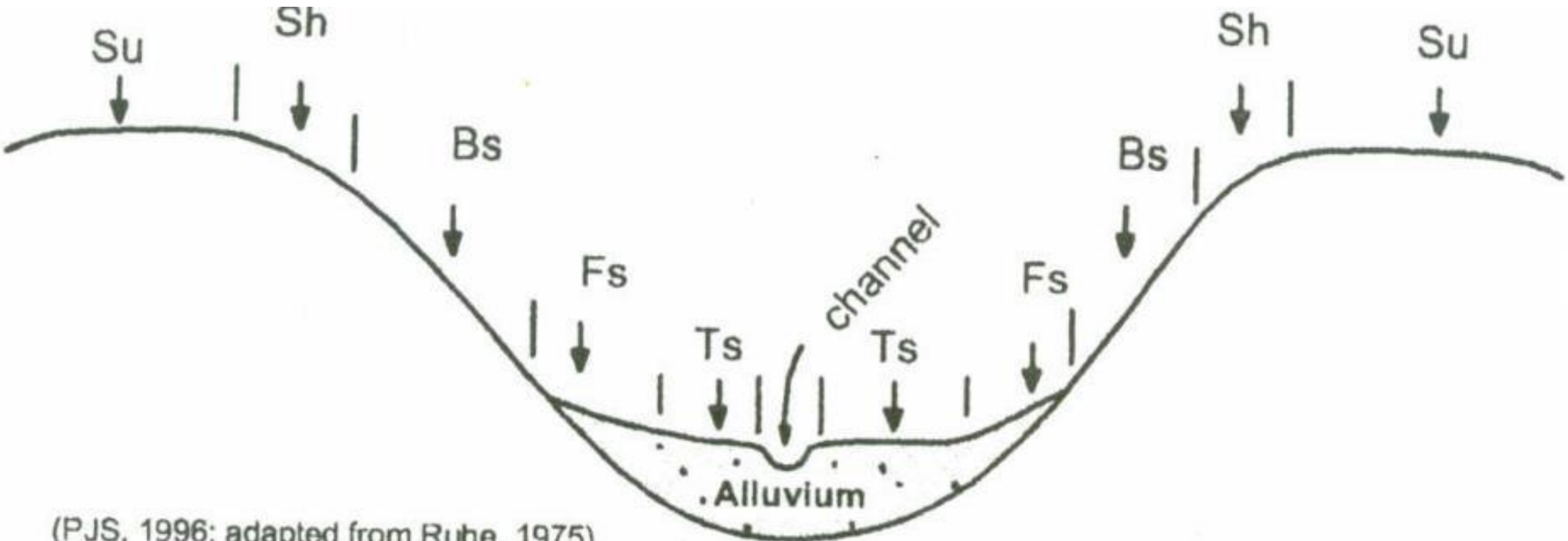
What is the Slope?

% Slope = (Rise ÷ Run) x 100

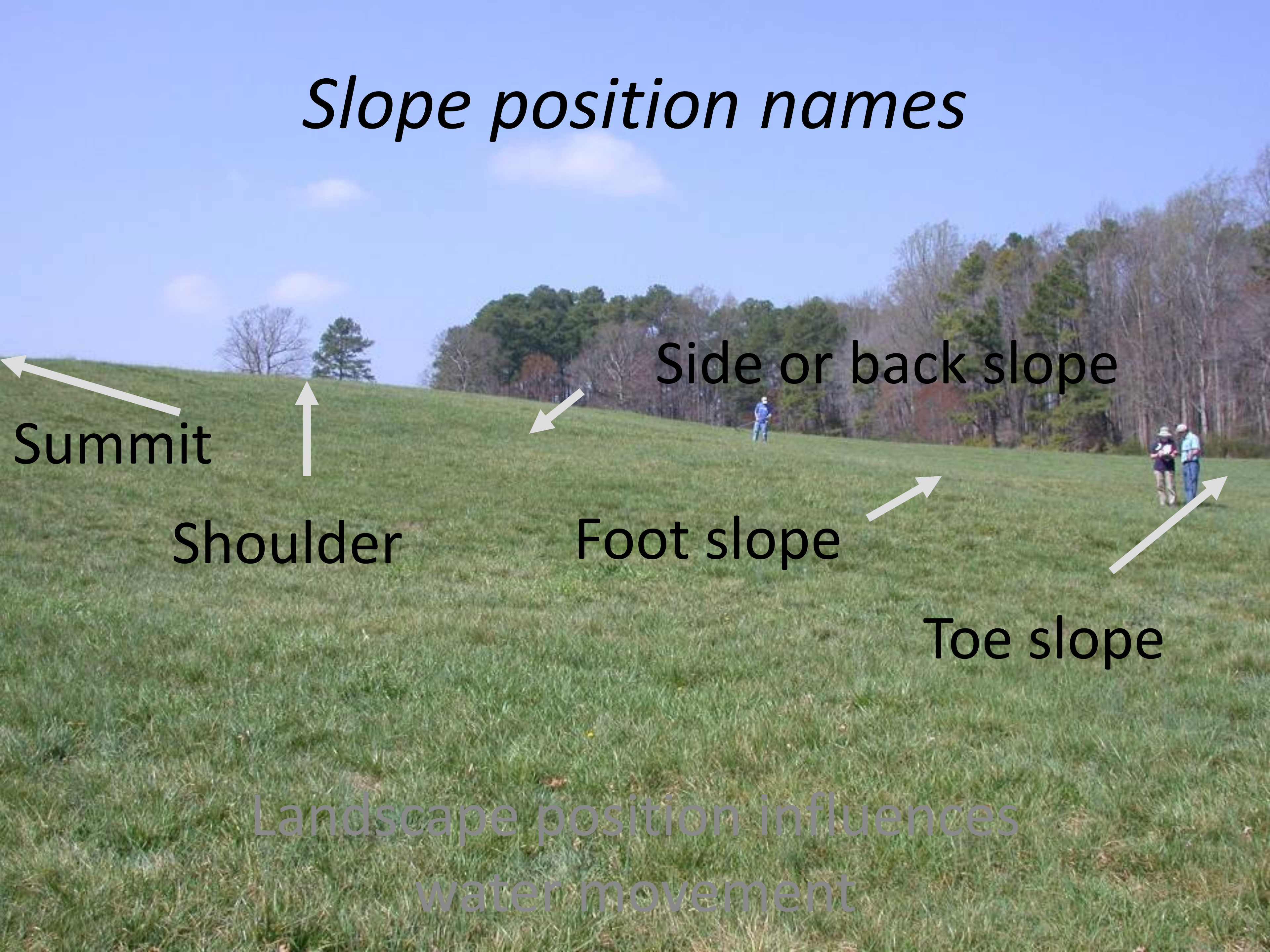


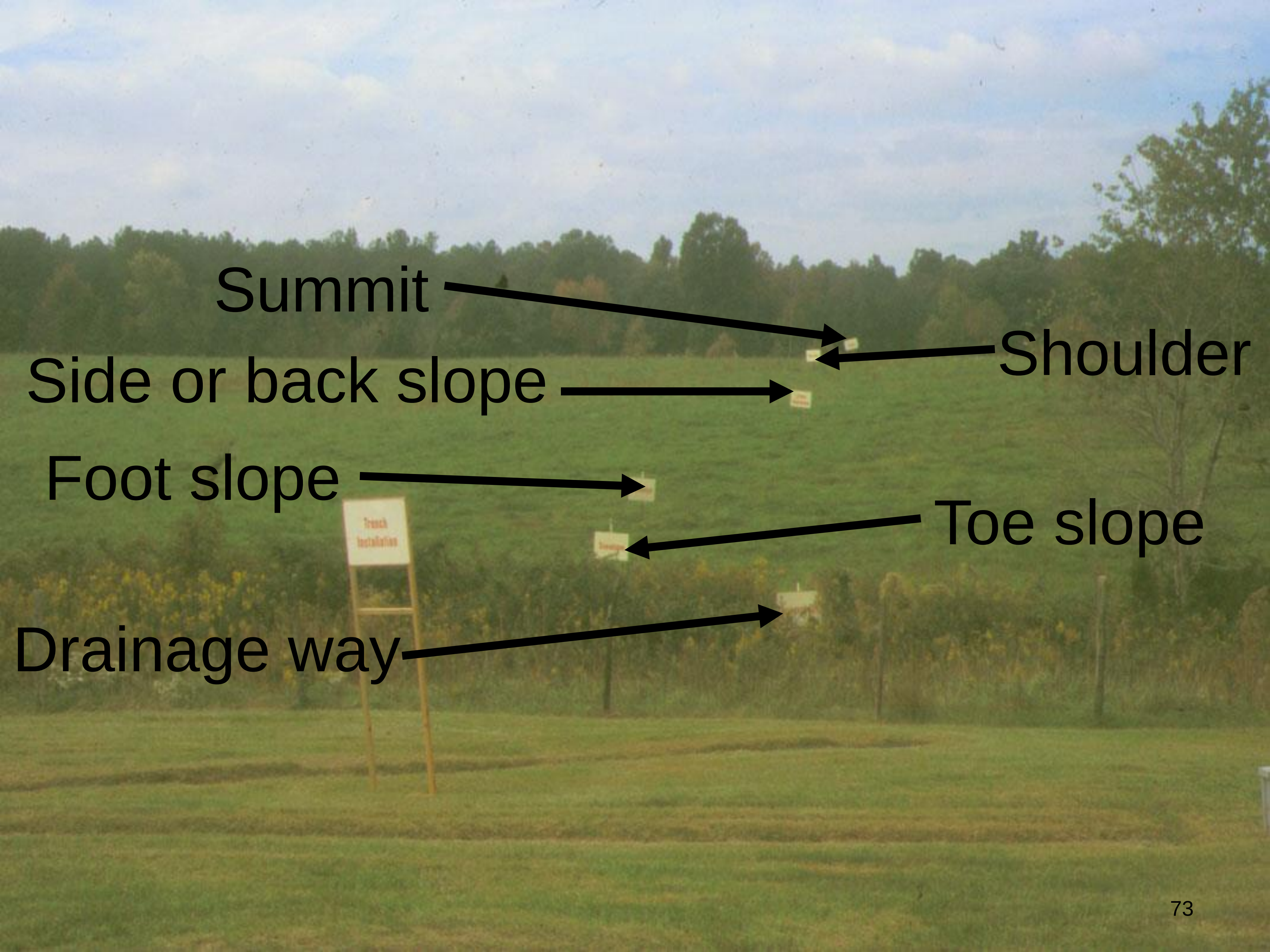
% Slope = (40/100) x 100 = 40%


Is landscape only the percent slope?

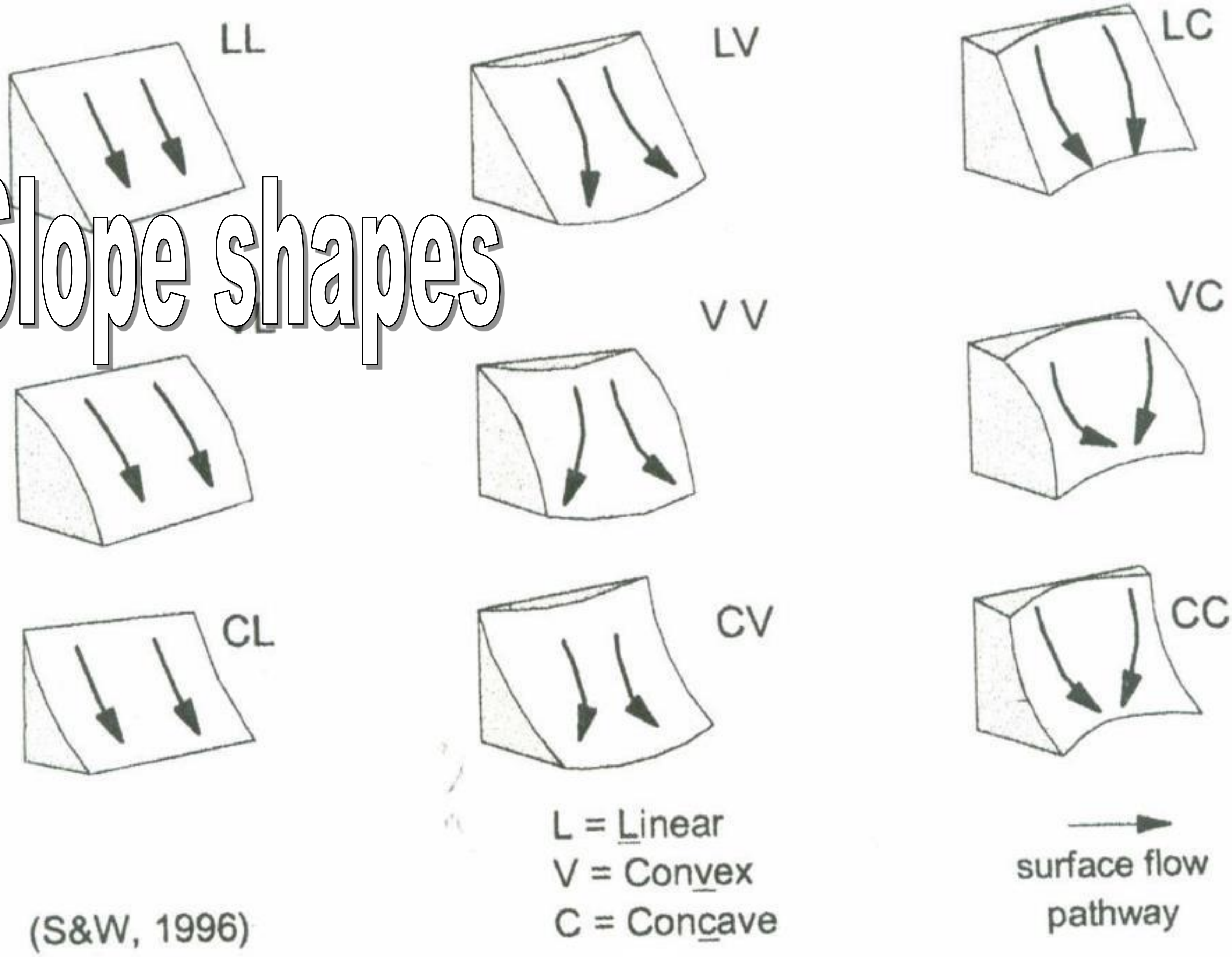


(PJS, 1996; adapted from Ruhe, 1975)


Slope position names
Summit
Shoulder
Side or back slope
Foot slope
Toe slope
Landscape position influences
water movement

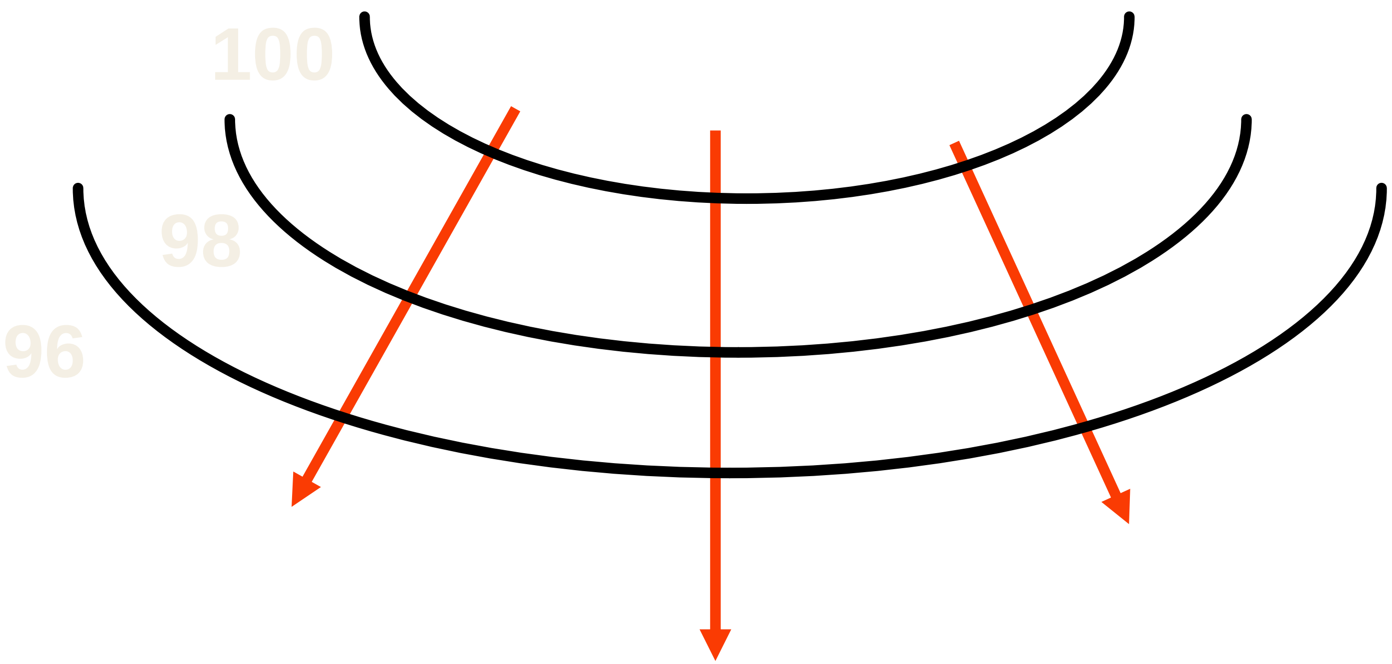

Summit
Shoulder
Side or back slope
Foot slope
Toe slope
Drainage way

Slope shapes

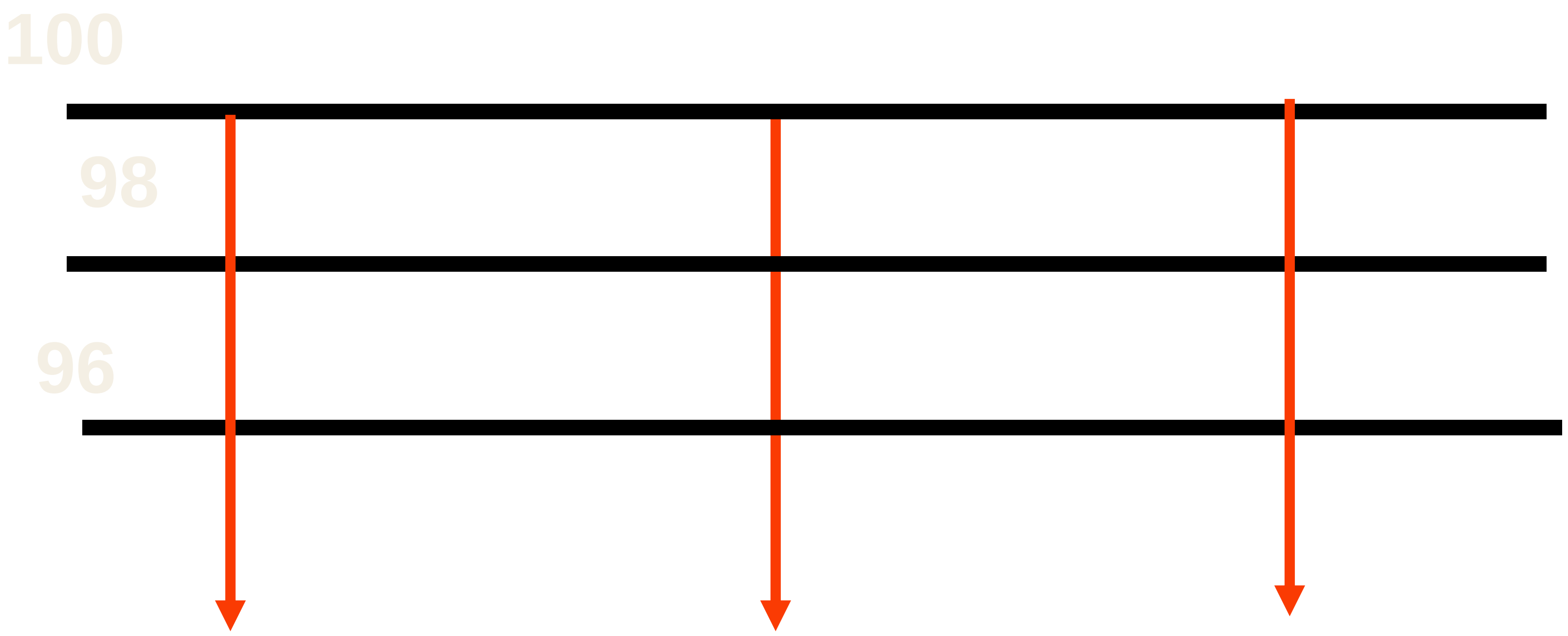


Slope type (plan view)

Convex

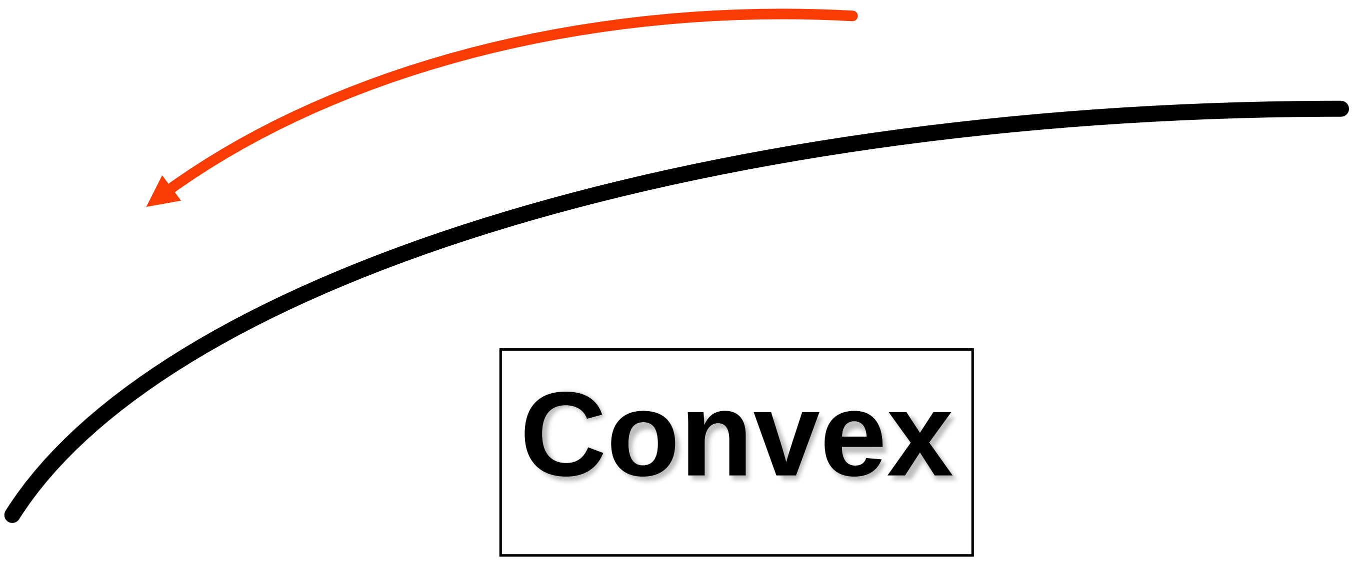


Slope type (plan view)

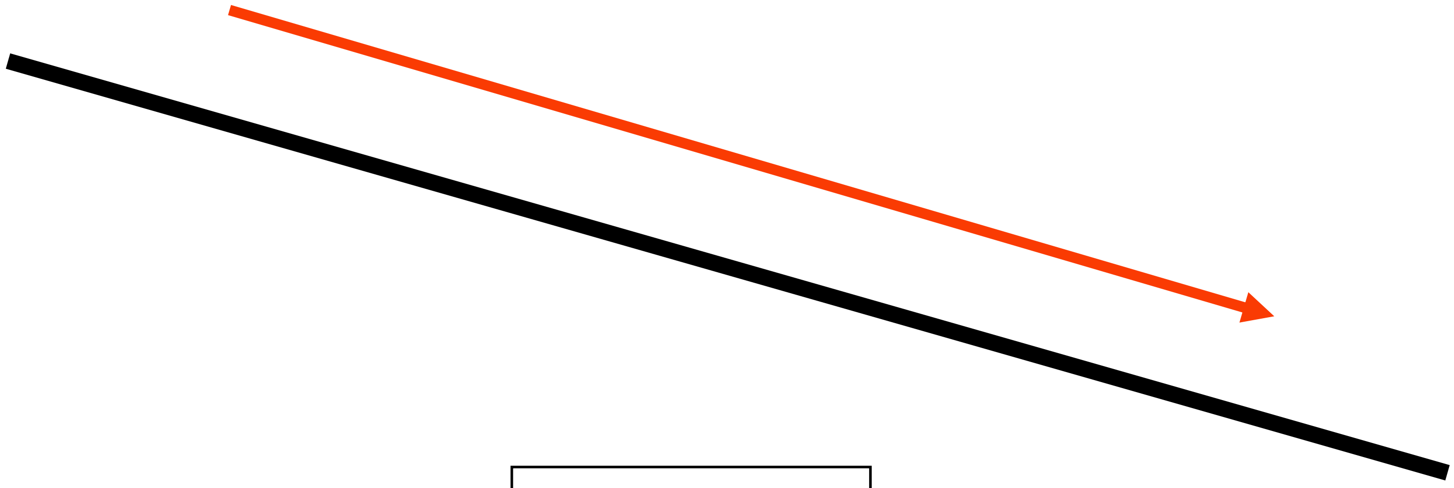


Plane

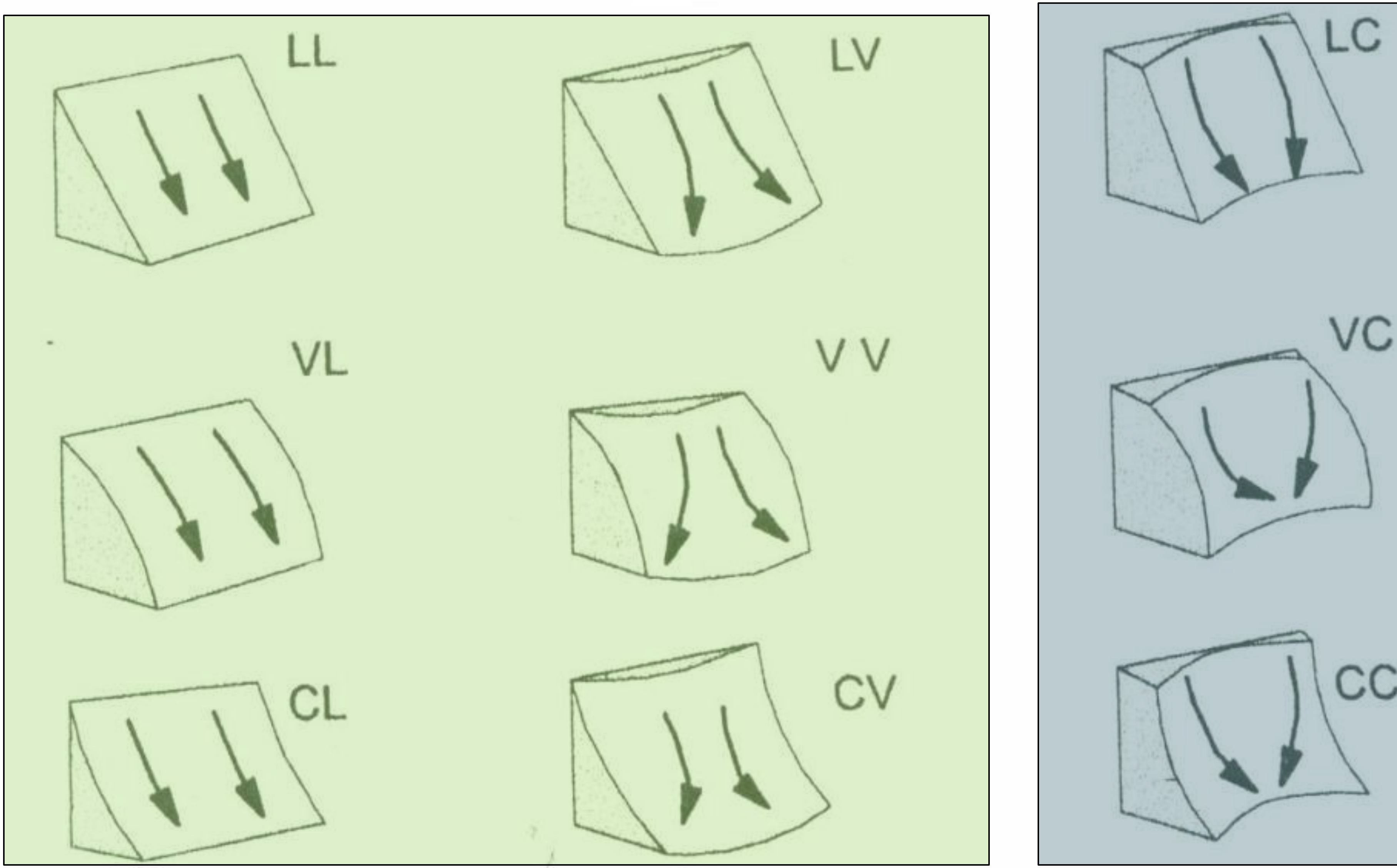
Slope curvature (profile view)



Slope curvature (profile view)



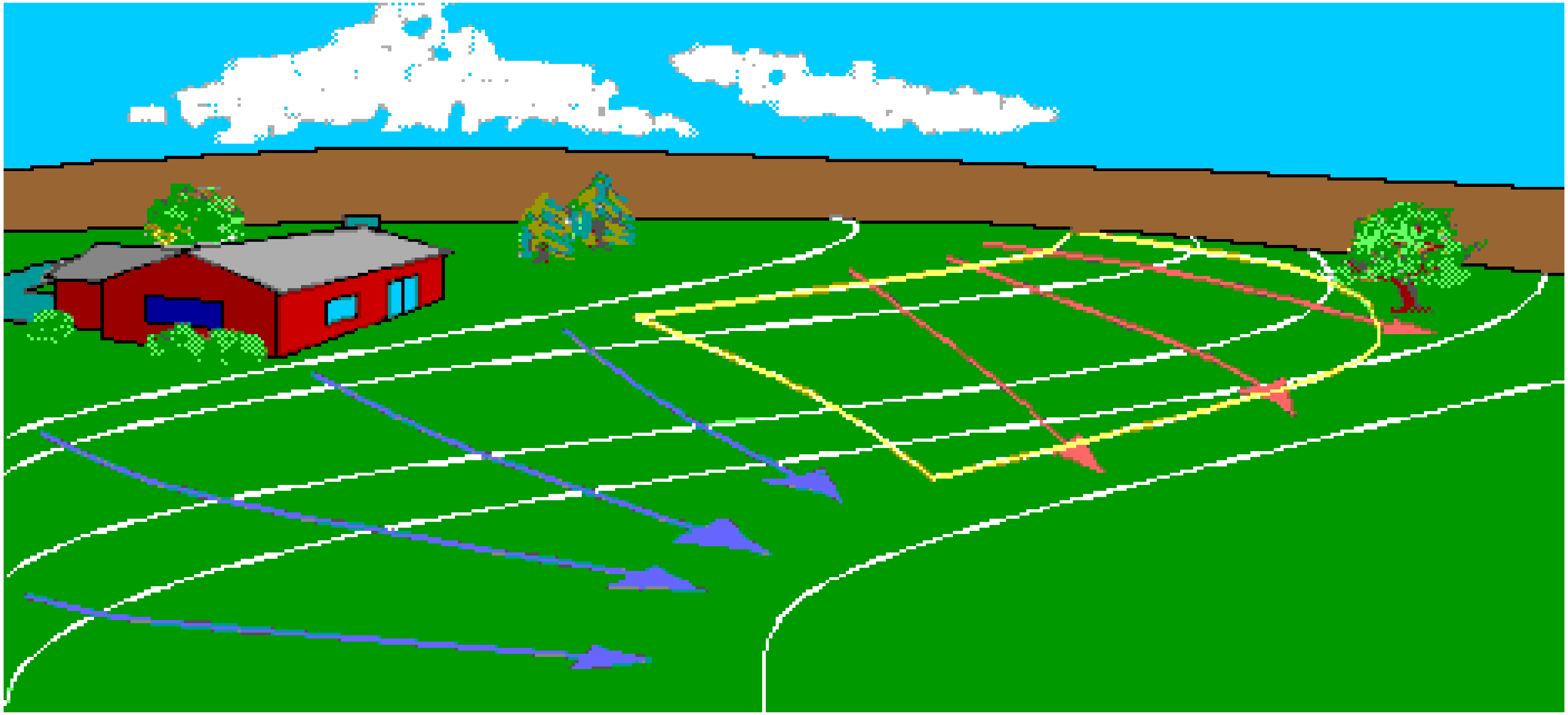
Plane



L = Linear
V = Convex
C = Concave

→ surface flow pathway

(S&W, 1996)



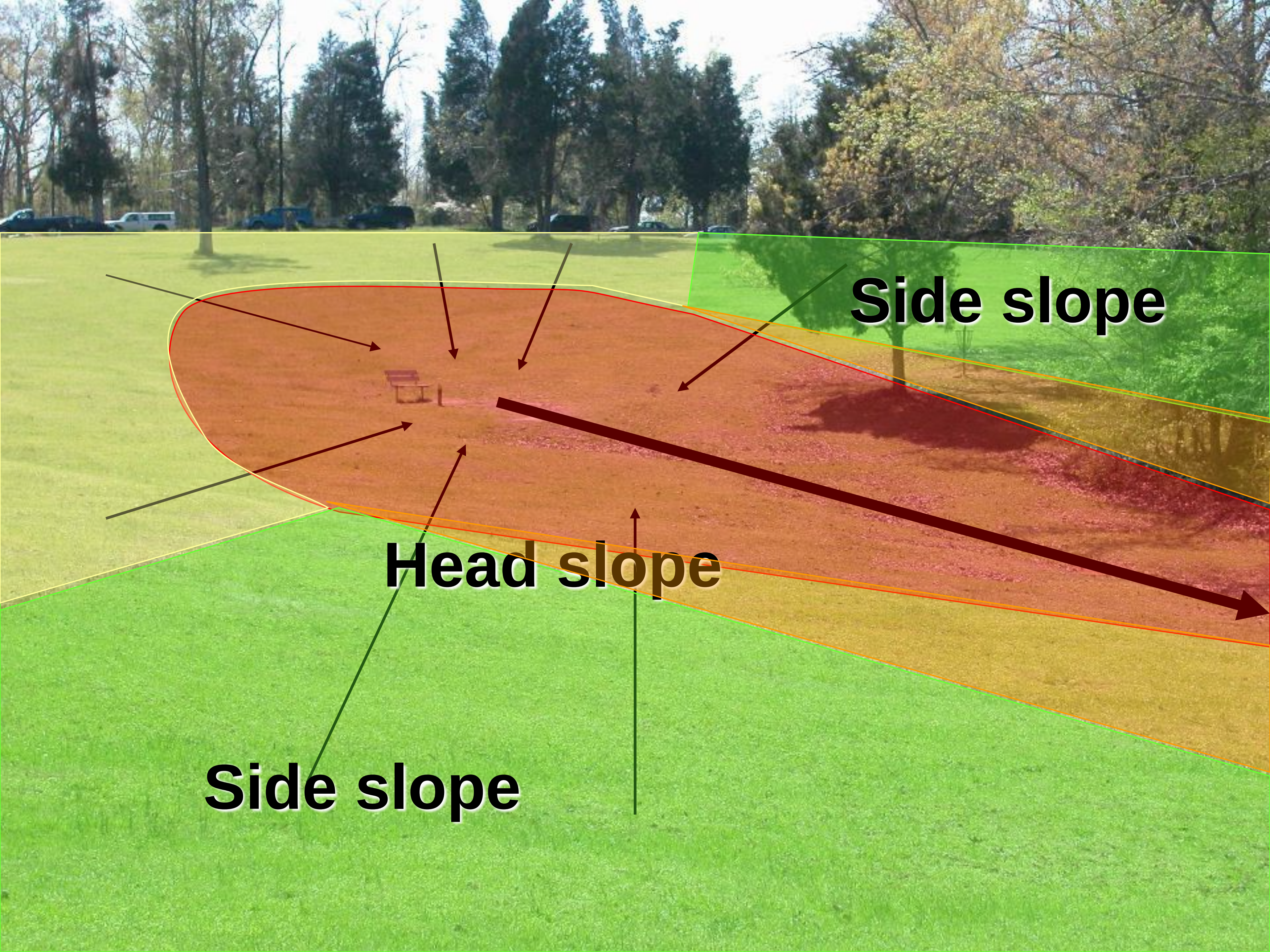
- The best location for an absorption field on the site is where flow will diverge (note the red flow lines). Areas where water naturally converges (note blue flow lines) should be avoided.

Consider this lot

1. Good soil
2. Slope < 10%

Is topography OK?

System designed in a bad landscape position - head slope


Side slope
Head slope
Side slope

Topography controls external drainage

Good external drainage	Poor external drainage
Summit	Toe
Ridge	Foot
Shoulder	Flat
Steep (>20%)	Bottom of linear slope
Nose slope	Head slope

Soil Summary

- Internal drainage can be related to ***all*** soil properties, not just texture
- Internal drainage can be destroyed
  - smearing and compaction
- Use color to determine soil wetness
  - Vertical separation distance
- Determine long term acceptance rate (LTAR) based on the soil profile description

Role of Soil in an On-Site Wastewater System

- Provide Treatment for Public Health and Environment
- Successfully Handle Large Volumes of Water on a Continuous Basis
- Repository for Recycling/Reuse of Water

Soil/Site Evaluations

- Most Important Phase of Designing the System
- Soil is a Physical, Biological, and Chemical Treatment System.
- Need for Standard Procedures and Reporting Methods

Principles of Soil and Site Assessment for Decentralized Wastewater Systems

- Characterize the soil, hydrology, and landscape of the site.
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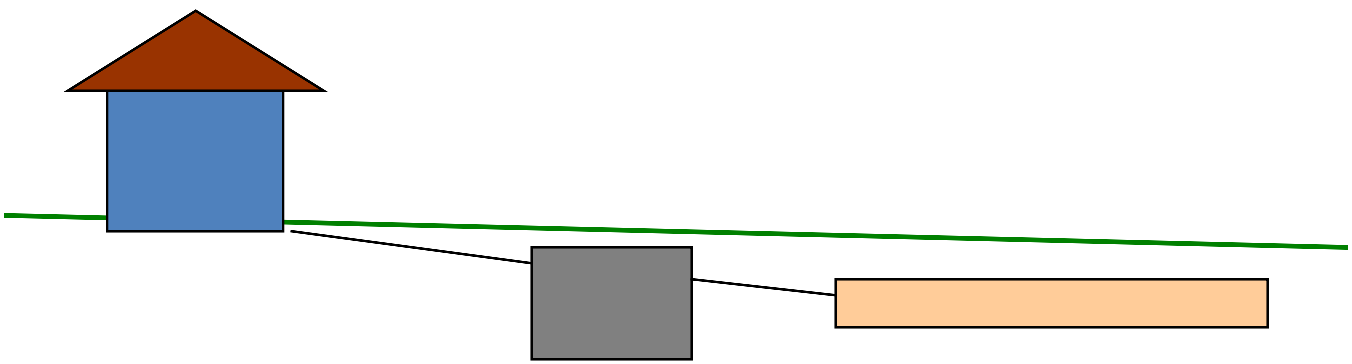
Onsite Soil Evaluation

Source → System Pretreatment/distribution → Soil dispersal/ Final treatment



Flow → System design ← Soil evaluation

Accurately describe the site/soil and report limitations

Hydrologic Cycle