USDA

United States Department of Agriculture

Natural Resources Conservation Service

Soil Forming Factors and Processes

October 27 2018 – Jacob Isleib, USDA Soil Scientist

Natural Resources Conservation Service

nrcs.usda.gov/

Learning Objectives

- Part 1: What is Soil?
- Part 2: Why is Soil Important?
- Part 3: Soil Degradation
- **Part 4: Soil Formation**
- Part 5: Soil Properties
- Part 6: Soil Surveys

Soil Formation:

A Unique Soil =

***f*(Soil Forming Factors, Soil Forming Processes)**

Wethersfield soil

Deerfield soil

Laguardia soil

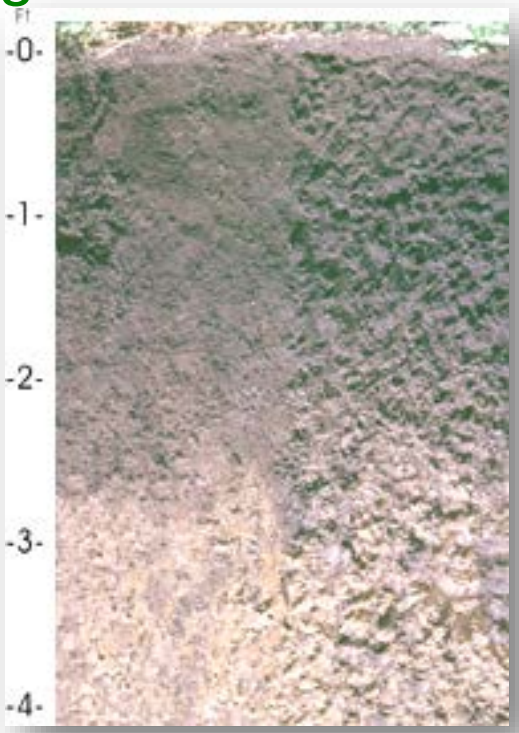
Soil Formation, continued

And the word of the day is…

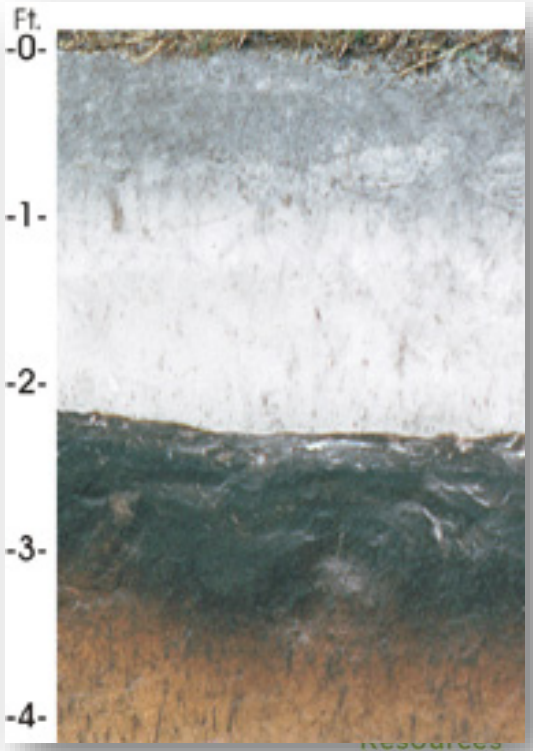
ClORPT!

…AKA Five Soil Forming Factors

- Climate
- Organisms
- Relief (Topography)
- Parent Material
- Time



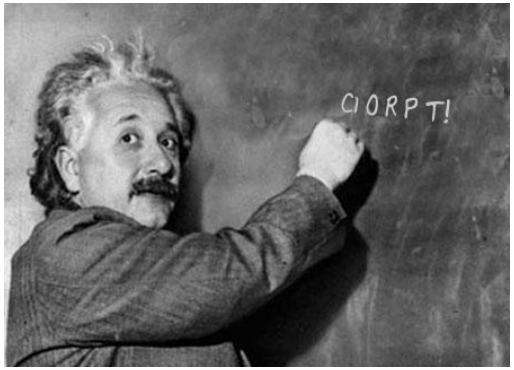
Drummer Soil, IL



Myakka Series, FL

5 Soil Forming Factors:

- **Climate**
- Organisms
- Relief (Topography)
- Parent Material
- Time

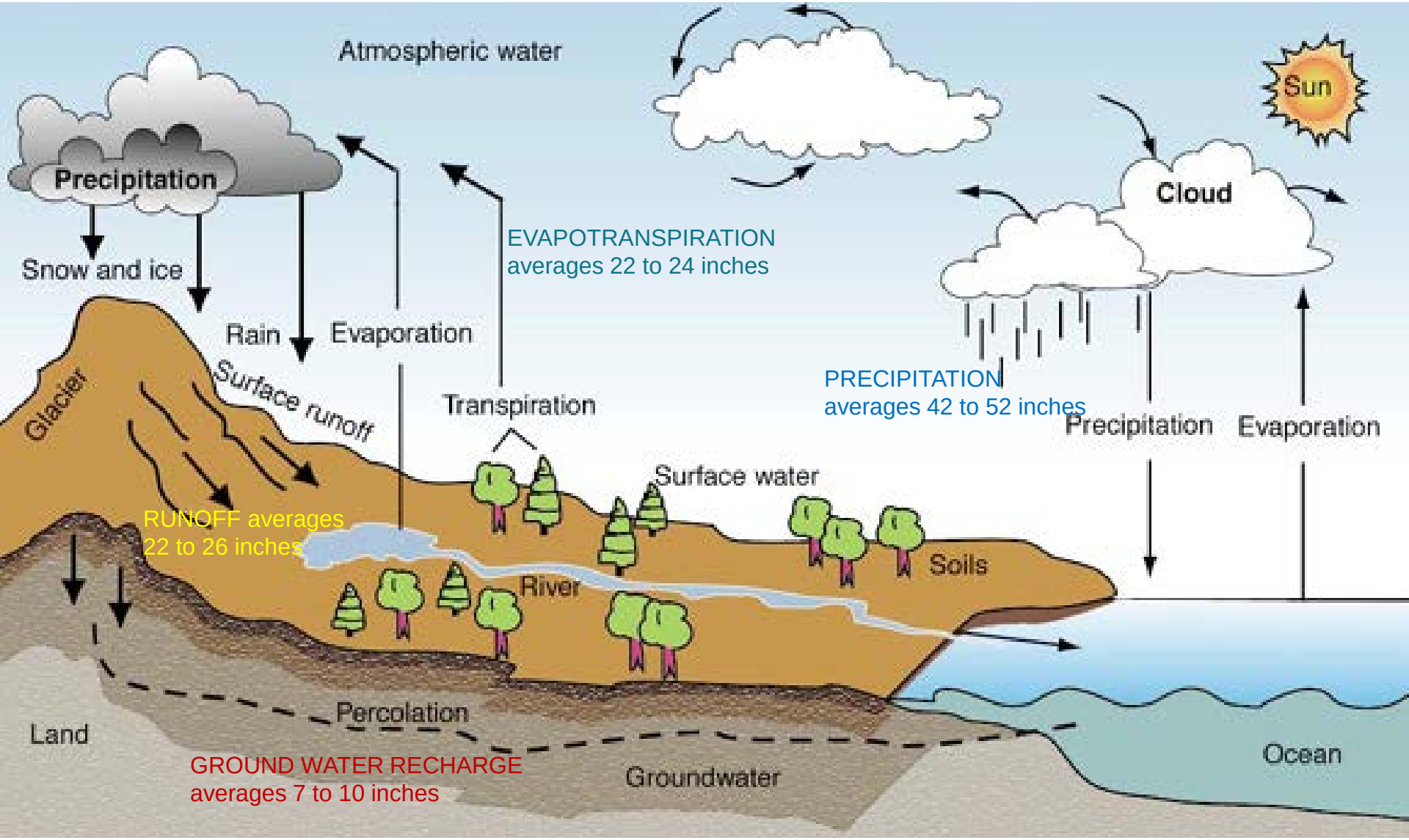


Soil Forming Factors:

Climate

- **Effective precipitation**
  i.e., amt. of water infiltrating soil and fate of water in soil
  - Essential for:
    - translocation (soluble and suspended materials)
    - losses (leaching salts and carbonates)
- **Temperature**
  - Warmer climates lead to faster soil development

Hydrologic cycle with average annual amounts for Connecticut

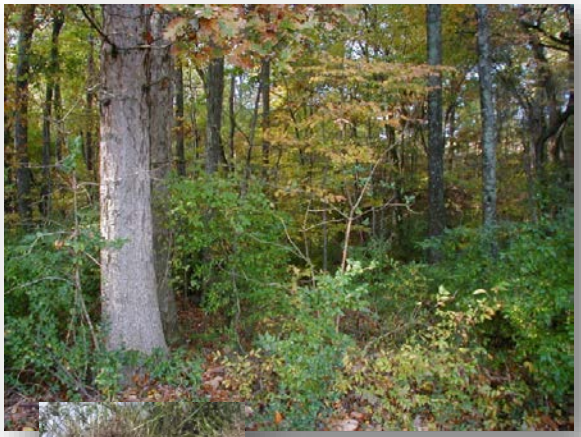


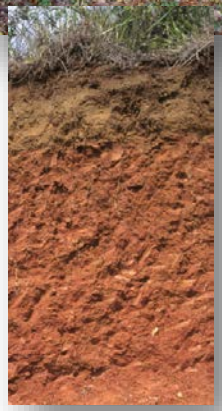
Soil Forming Factors: **Climate**

Hot, Dry
(Arid)
Eg. Southwest

Cool, Wet

Eg. New England



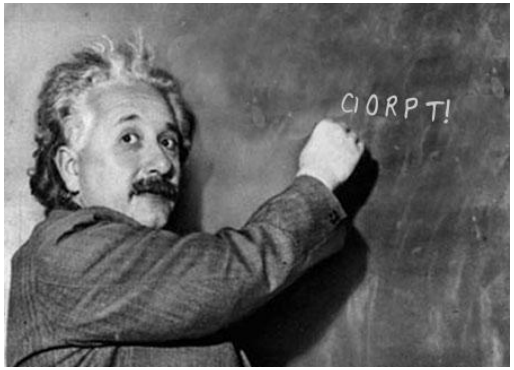


Warm, Wet
(Humid)
Eg. Southeast

Think: Combinations of (**Warm** / **Cool**) and(**Wet** / **Dry**)...

Soil Forming Factors

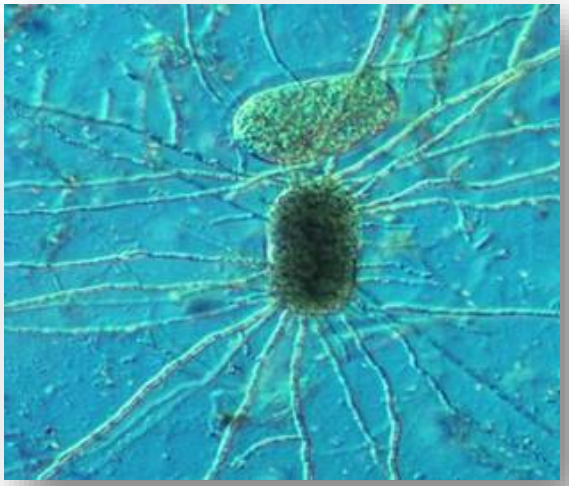
- Climate
- **Organisms**
- Relief (Topography)
- Parent Material
- Time



Soil Forming Factors: Organisms

Trillions of them give soil life!

- Animals, plants, insects, microbes, humans
- Break down organic matter
- Increase soil porosity
- Affect soil chemistry

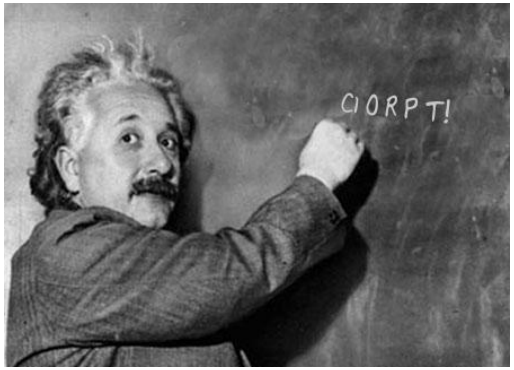


Typical Number of Soil Organisms in Healthy Ecosystems

		Agricultural Soils	Prairie Soils	Forest Soils
Bacteria	**Per Teaspoon of soil (1 gram dry)**	100 million to 1 billion	100 million to 1 billion	100 million to 1 billion
Fungi		Several yards	Tens to hundreds of yards	Several hundred yards in deciduous forests. 1 to 40 **miles** in coniferous forests!
Protozoa		Several thousand flagellates and amoebae, 100 to several hundred ciliates.	Several thousand flagellates and amoebae, 100 to several hundred ciliates.	Several hundred thousand amoebae, fewer flagellates.
Nematodes		10 to 20 bacterial-feeders. A few fungal-feeders. Few predatory nematodes.	10 to several hundreds..	Several hundred bacterial- and fungal-feeders. Many predatory nematodes.
Arthropods	**Per Square Foot**	Up to 100.	500 to 2,000	10,000 to 25,000. Many more species than in agricultural soils
Earthworms		5 to 30. More in soils with high organic matter	10 to 50. Arid or semi-arid areas may have none.	10 to 50 in deciduous woodlands. Very few in coniferous forests.

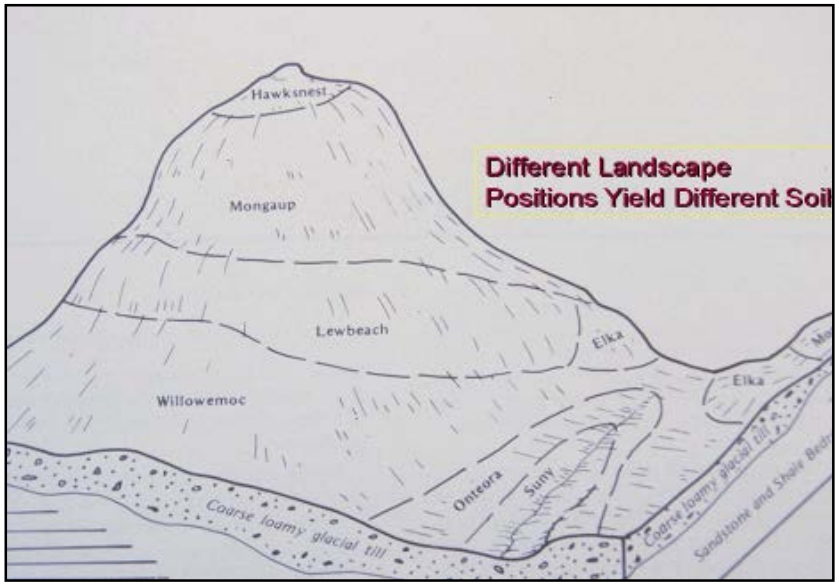
Soil Forming Factors

- Climate
- Organisms
- **Relief (Topography)**
- Parent Material
- Time



Soil Forming Factors:

Relief / Topography



shape / configuration of the land

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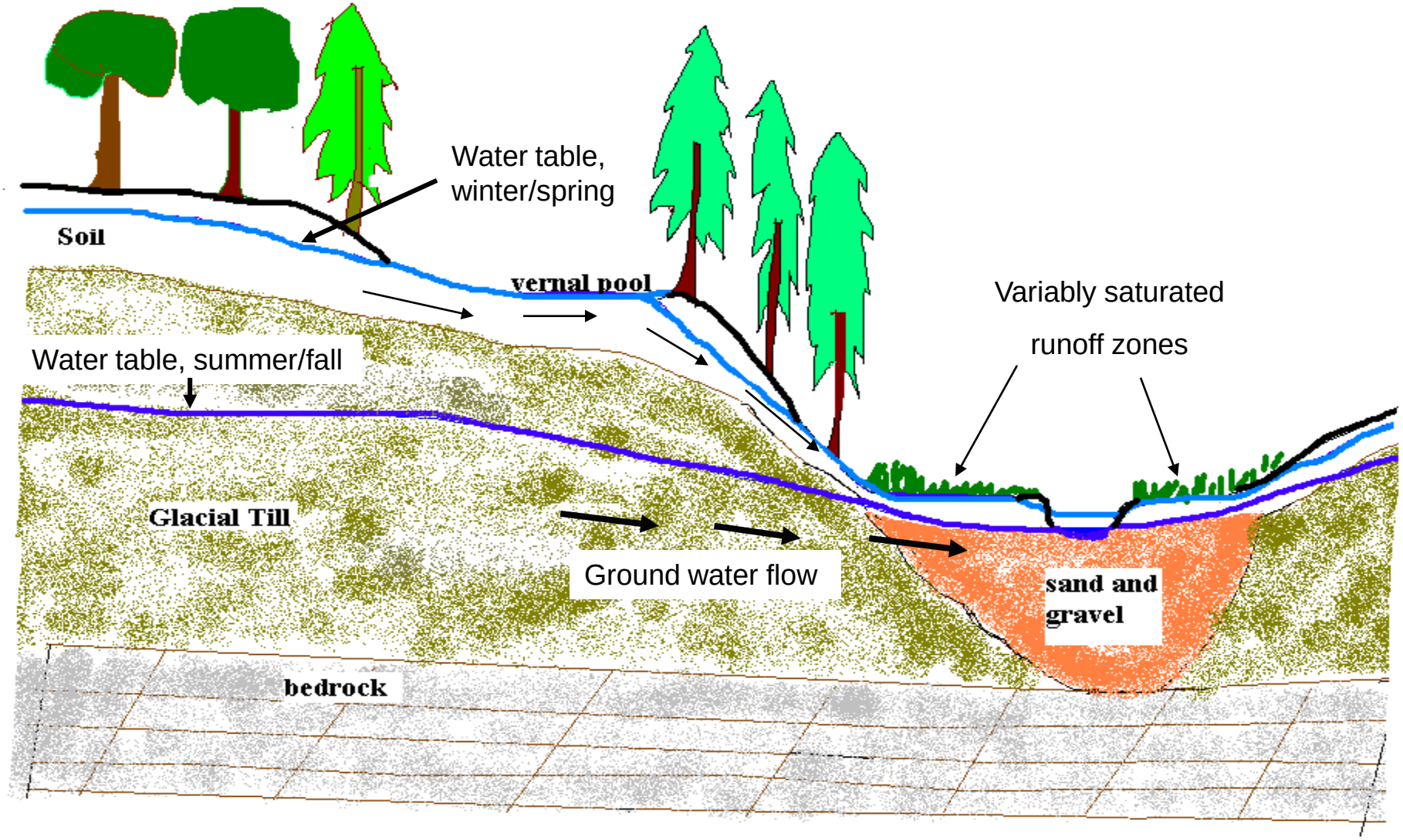
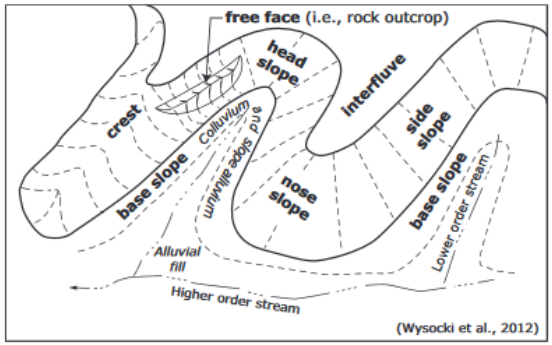
Typical Connecticut Natural Landscape

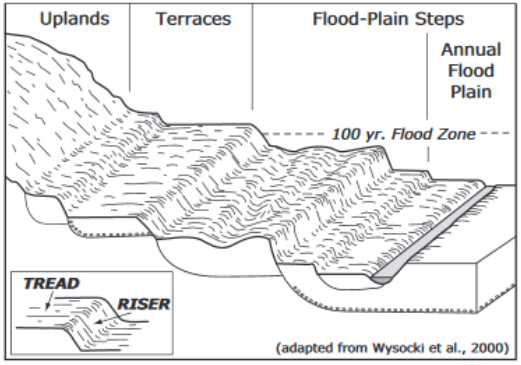


Landscape Position

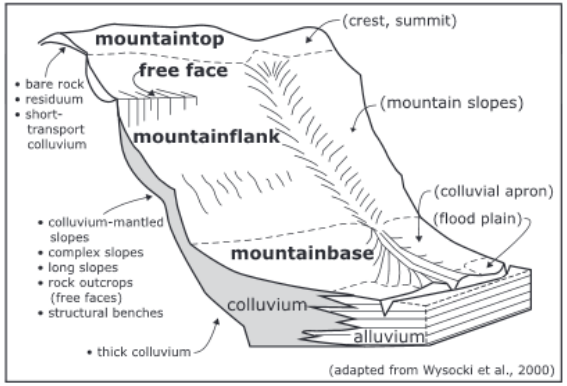
1) Hills	Code
interfluve	IF
crest	CT
head slope	HS
nose slope	NS
side slope	SS
free face	FF
base slope	BS



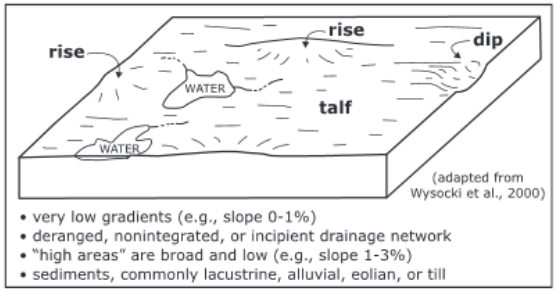
2) Terraces and Stepped Landforms	Code
riser	RI
tread	TR



3) Mountains	Code
mountaintop	MT
mountainflank	MF
upper third – mountainflank	UT
center third – mountainflank	CT
lower third – mountainflank	LT
free face	FF
mountainbase	MB

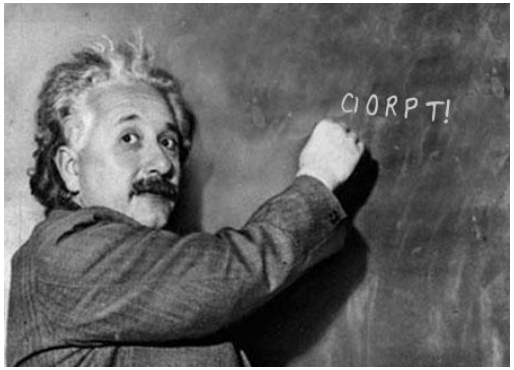


4) Flat Plains	Code
dip	DP
rise	RI
talf	TF



Soil Forming Factors

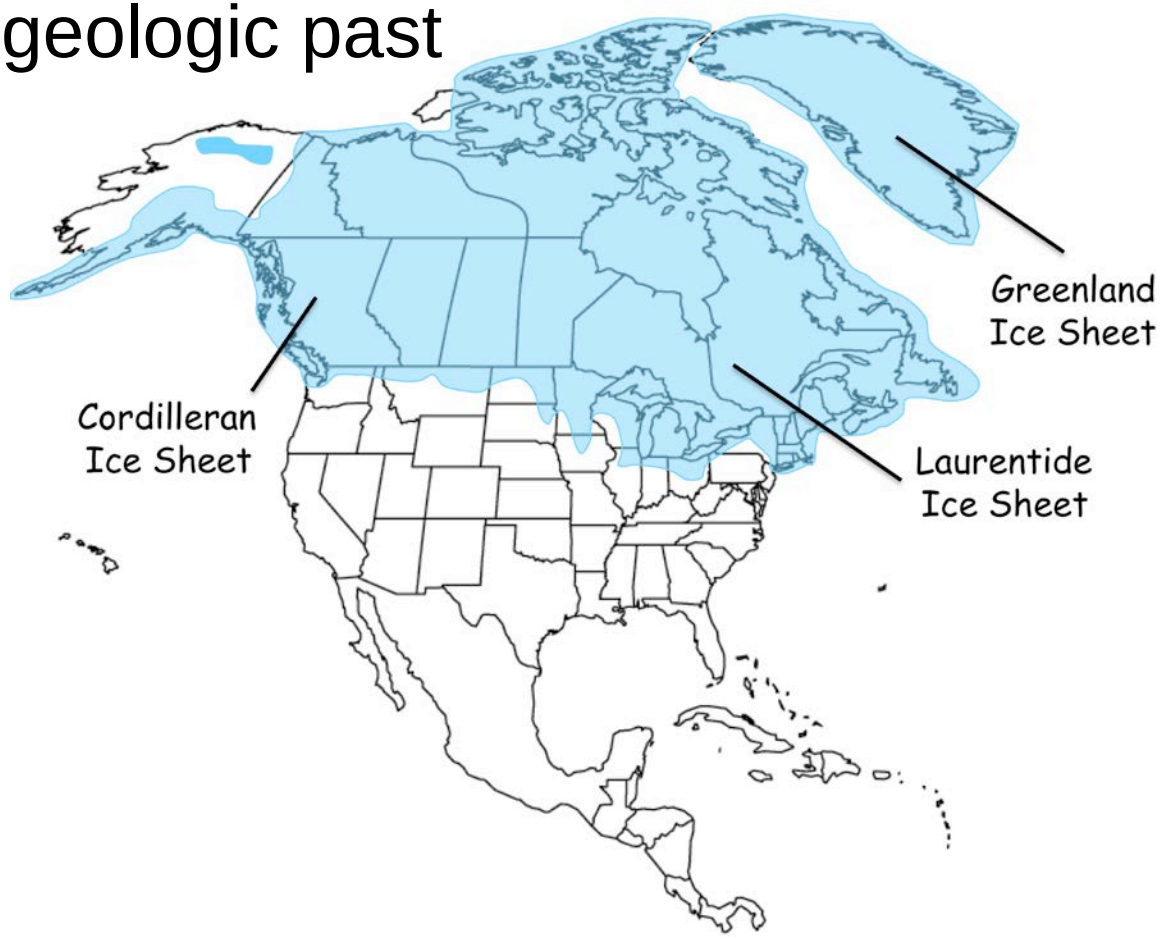
- Climate
- Organisms
- Relief (Topography)
- **Parent Material**
- Time



Soil Forming Factors:

Parent Material

Glaciers: the biggest thing to happen to CT soils in recent geologic past



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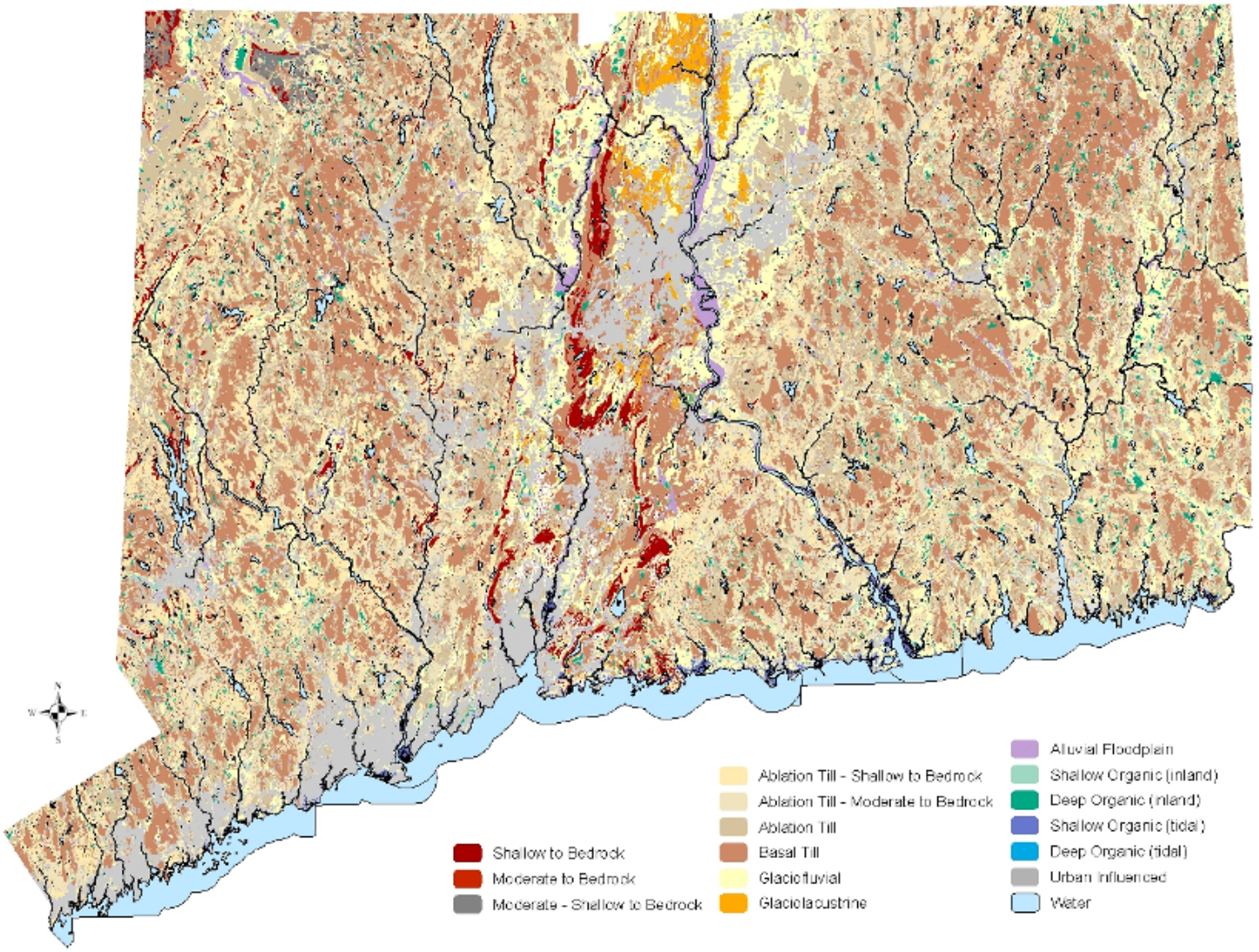
Parent Materials of CT



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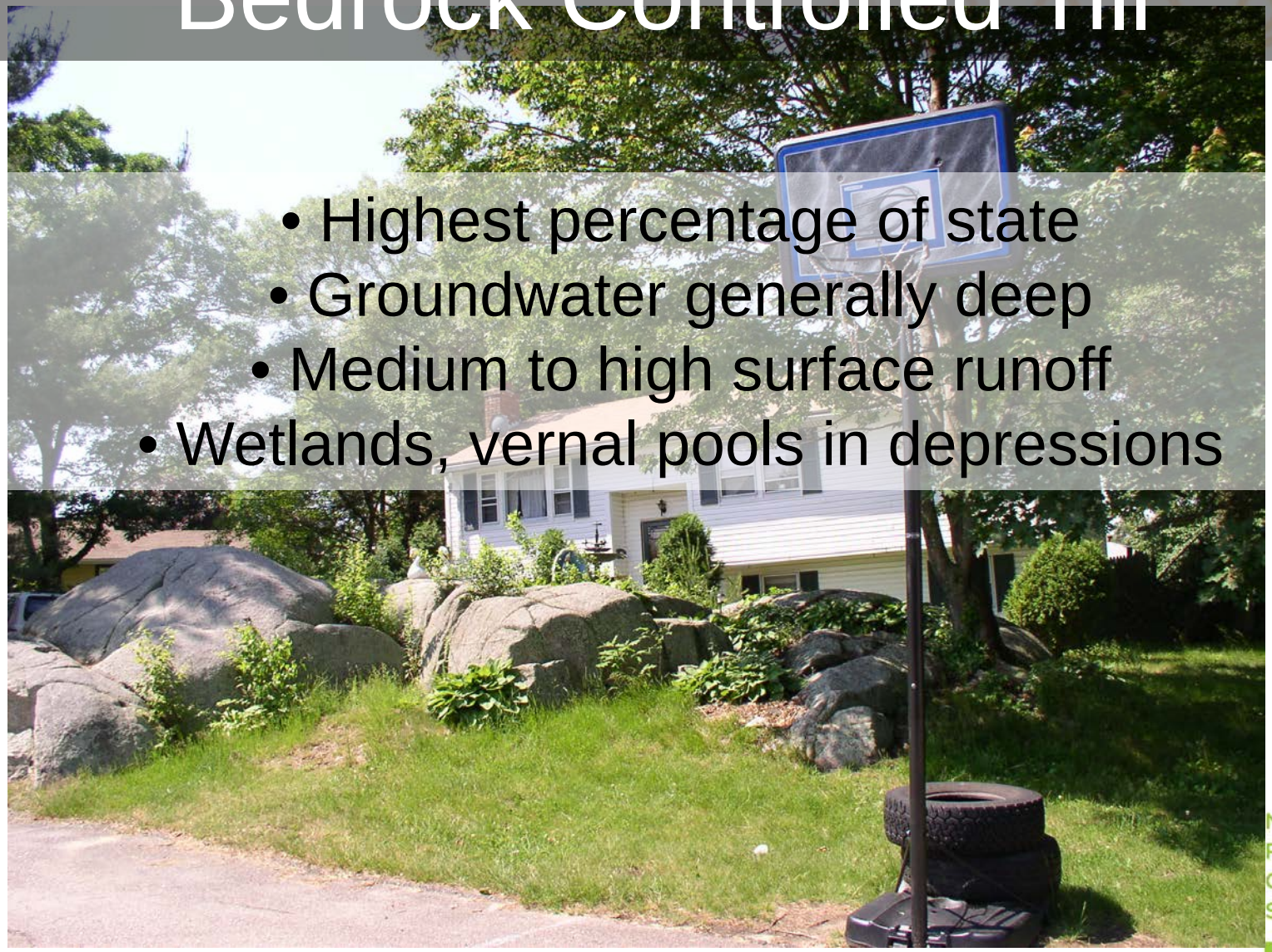
Soil Forming Factors, continued

Parent Materials:

Glacial Till

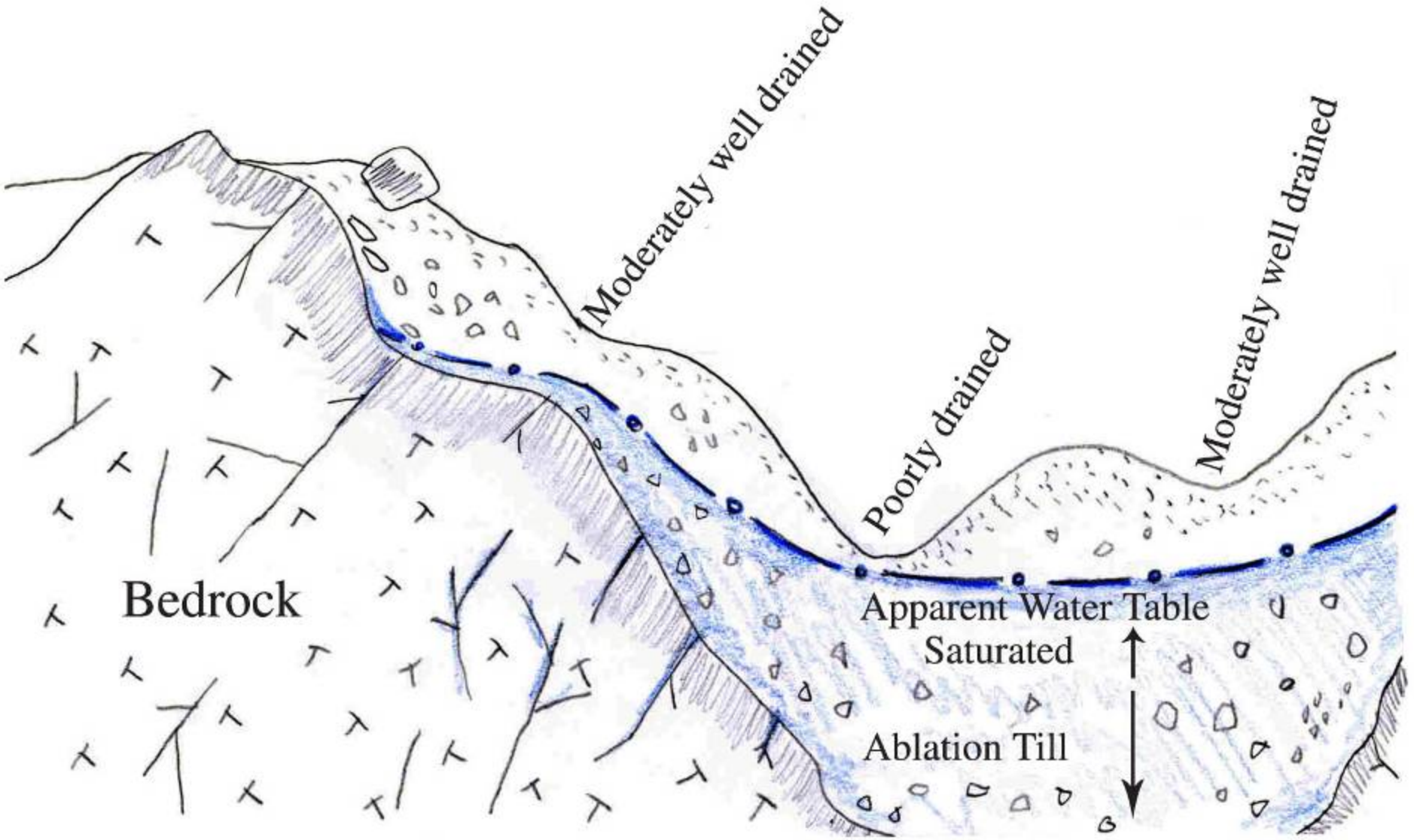
- Deposited directly by glacial ice
- Heterogenous
- Unstratified
- Angular fragments
- Gravel, cobbles, stones are common

Bedrock Controlled Till



- Highest percentage of state
- Groundwater generally deep
- Medium to high surface runoff
- Wetlands, vernal pools in depressions

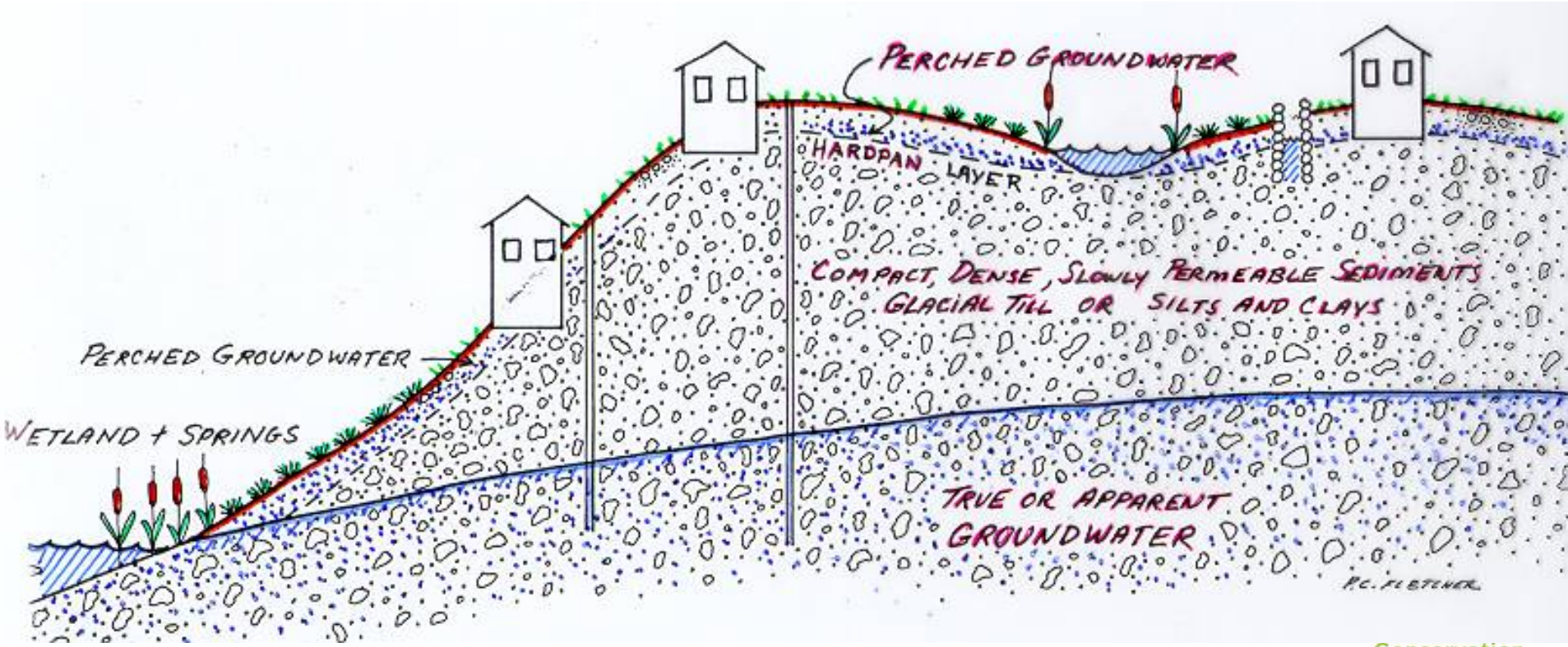
Hydrology in Bedrock Controlled Till



Lodgment Till
(AKA basal till, dense till)

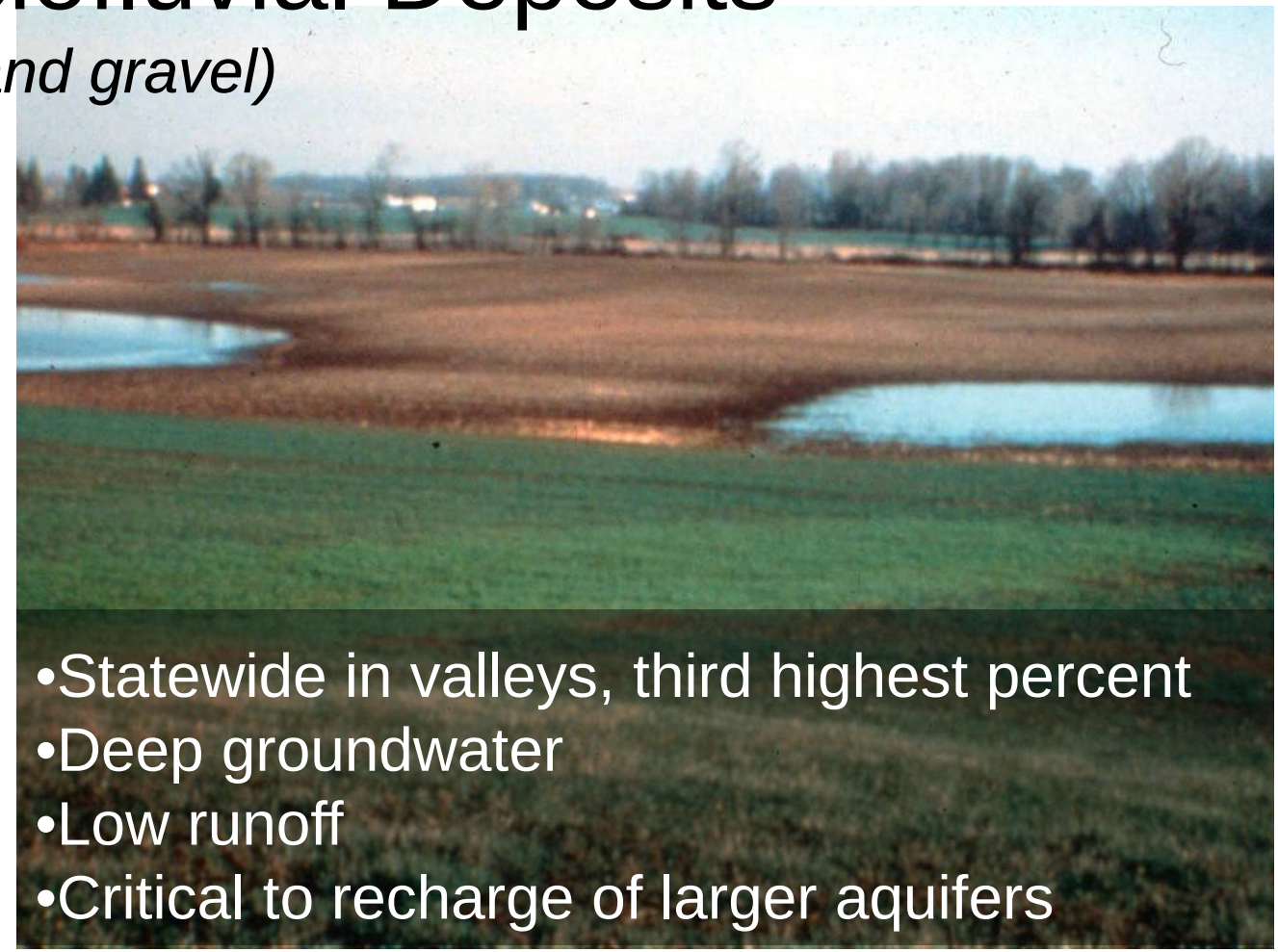
- Occurs statewide, second highest percentage
- Medium surface runoff from side slopes
- Shallow, perched groundwater flow follows contours of dense till
- Wetlands in depressions and seeps

Hydrology in Lodgment Till



Glacial Outwash / Glaciofluvial Deposits

(sand and gravel)

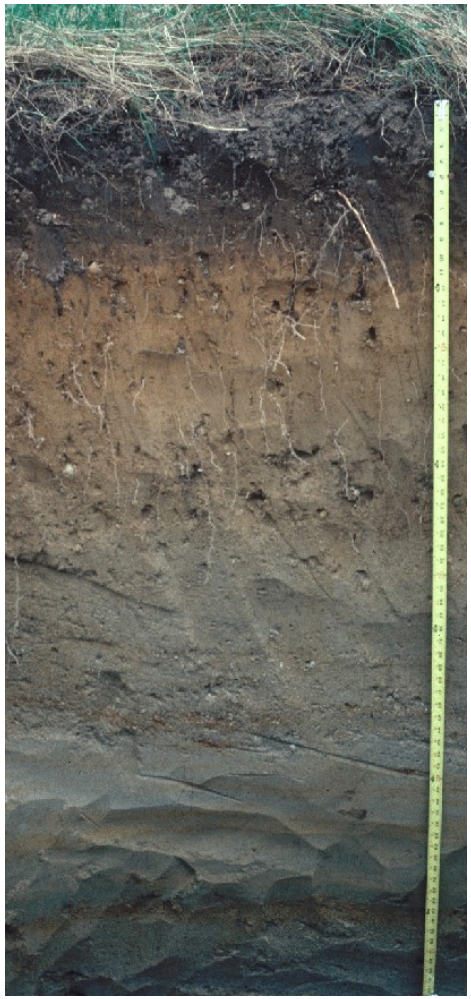


- Statewide in valleys, third highest percent
- Deep groundwater
- Low runoff
- Critical to recharge of larger aquifers

Soil Forming Factors, continued

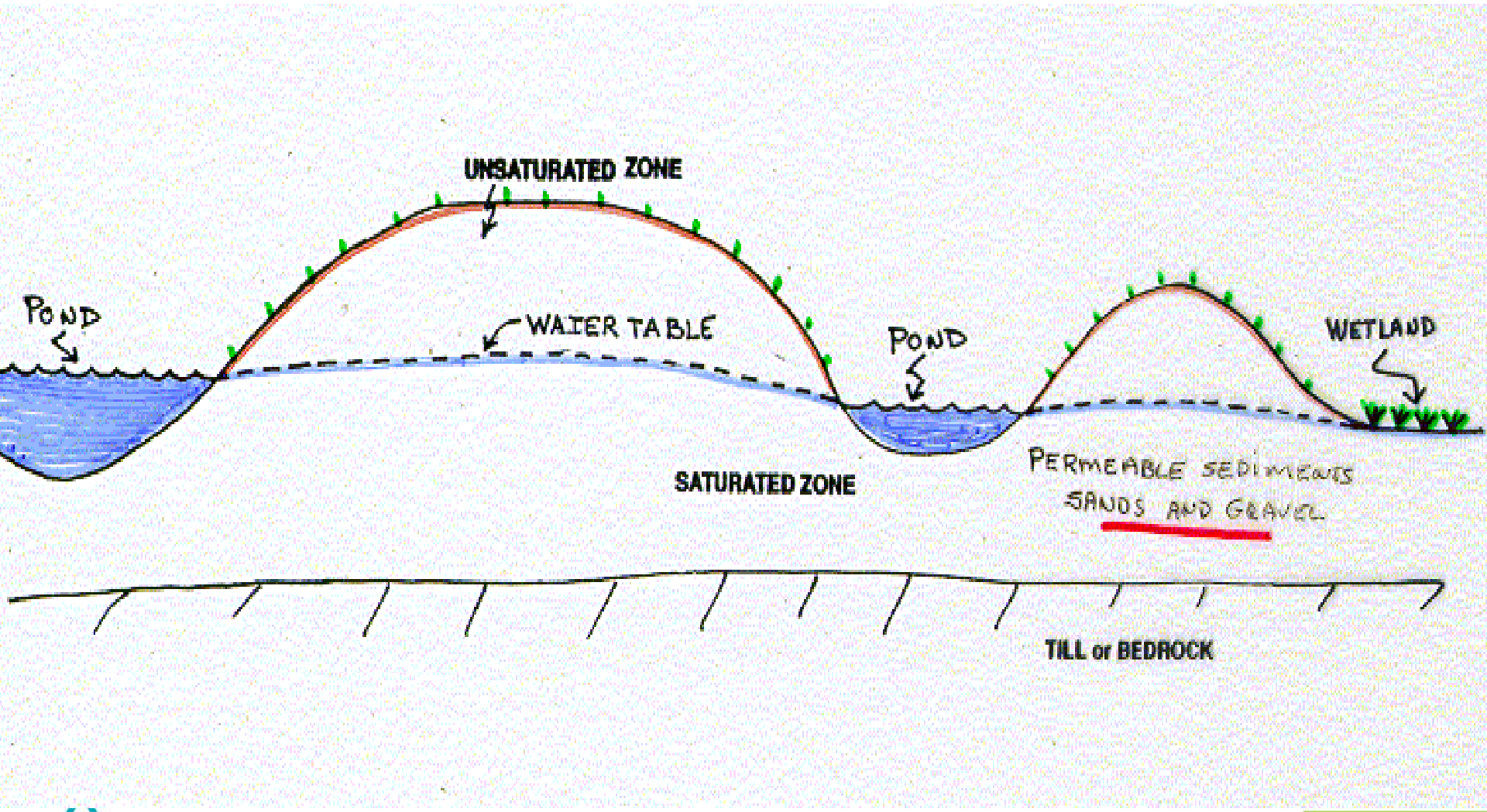
Parent Materials:

Outwash / Glaciofluvial

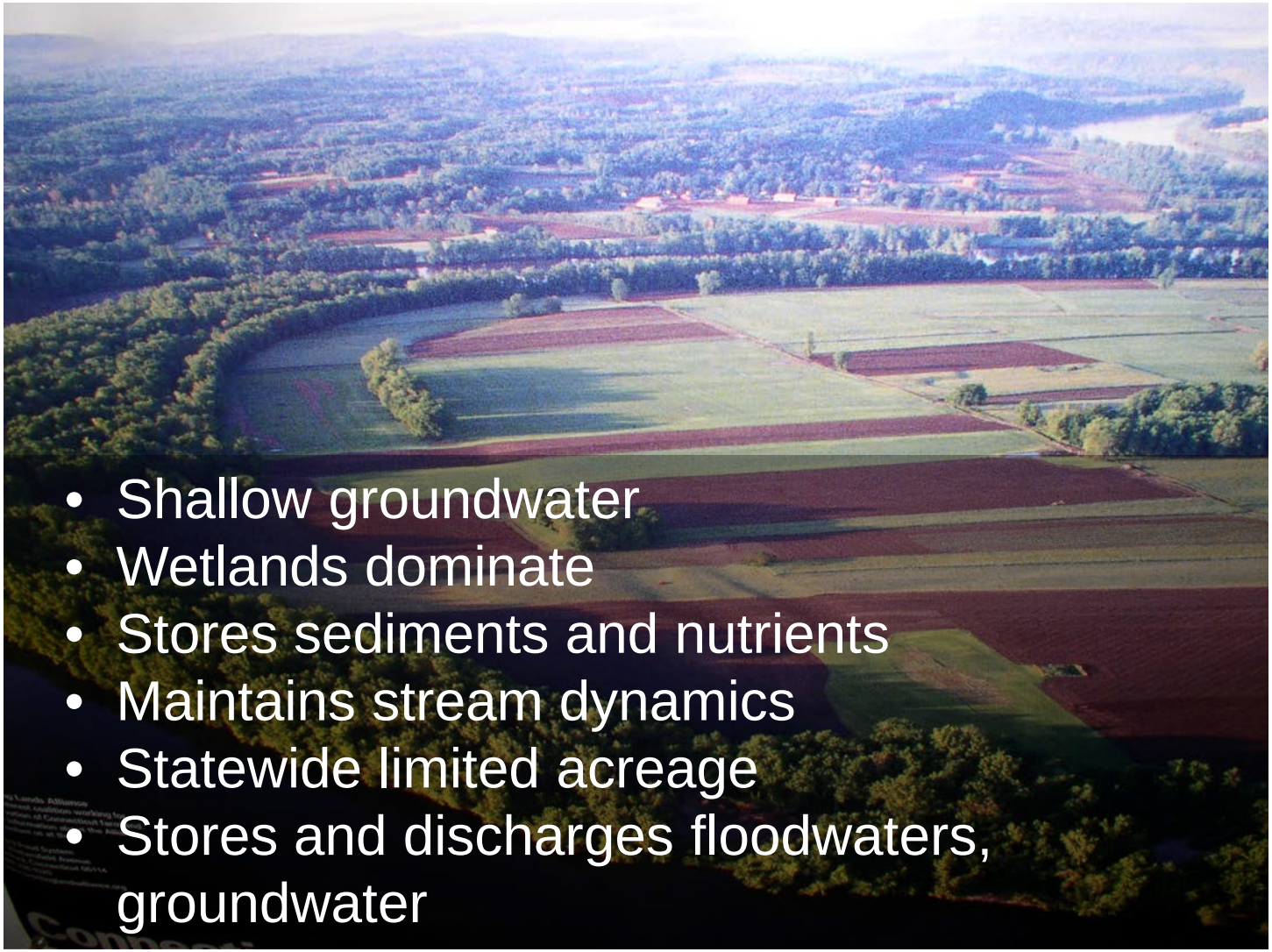


- Deposited by glacial meltwater
- Sandy and gravelly
- very low amounts of silt & clay
- Stratification often visible

Outwash / Glaciofluvial Hydrology

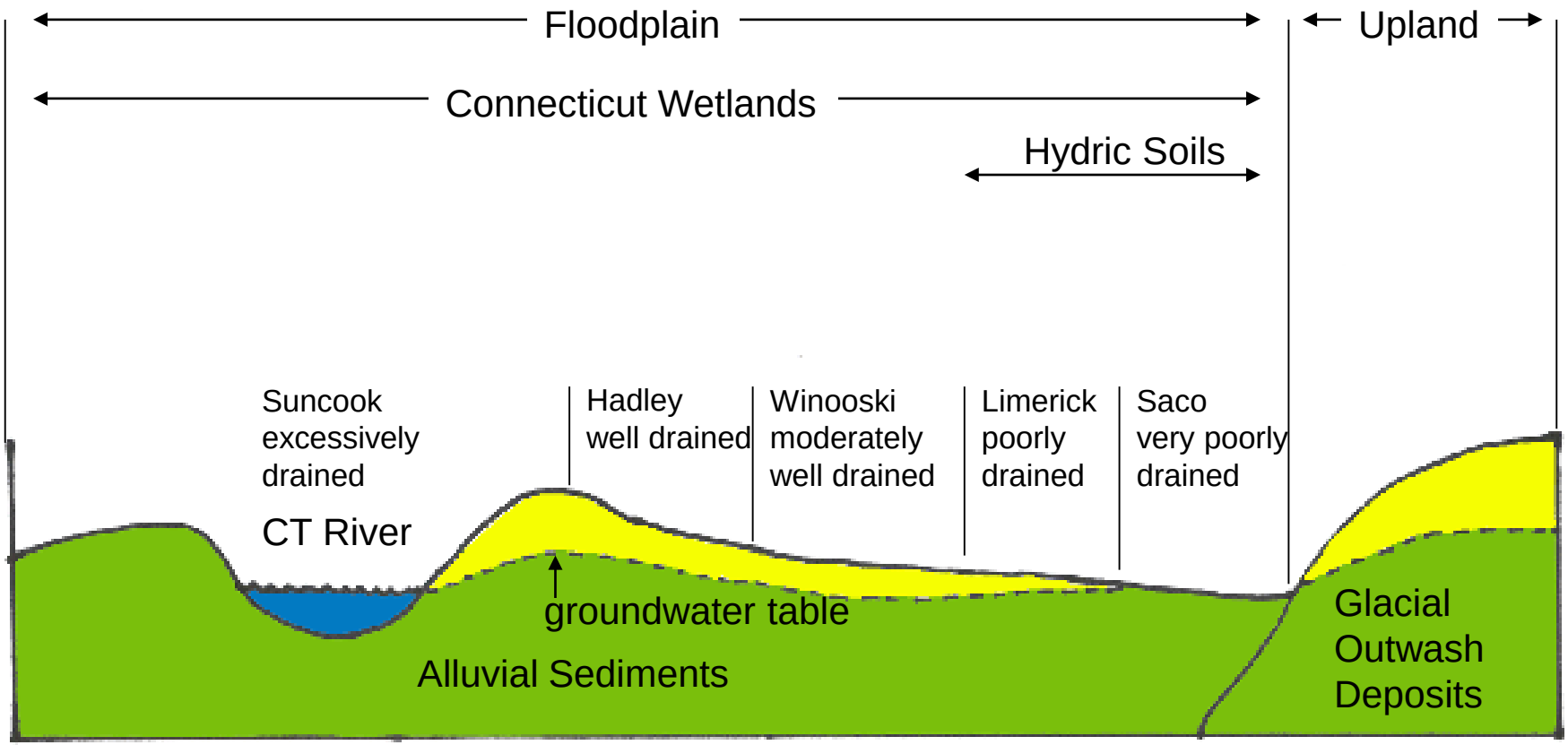


Floodplain and Riparian

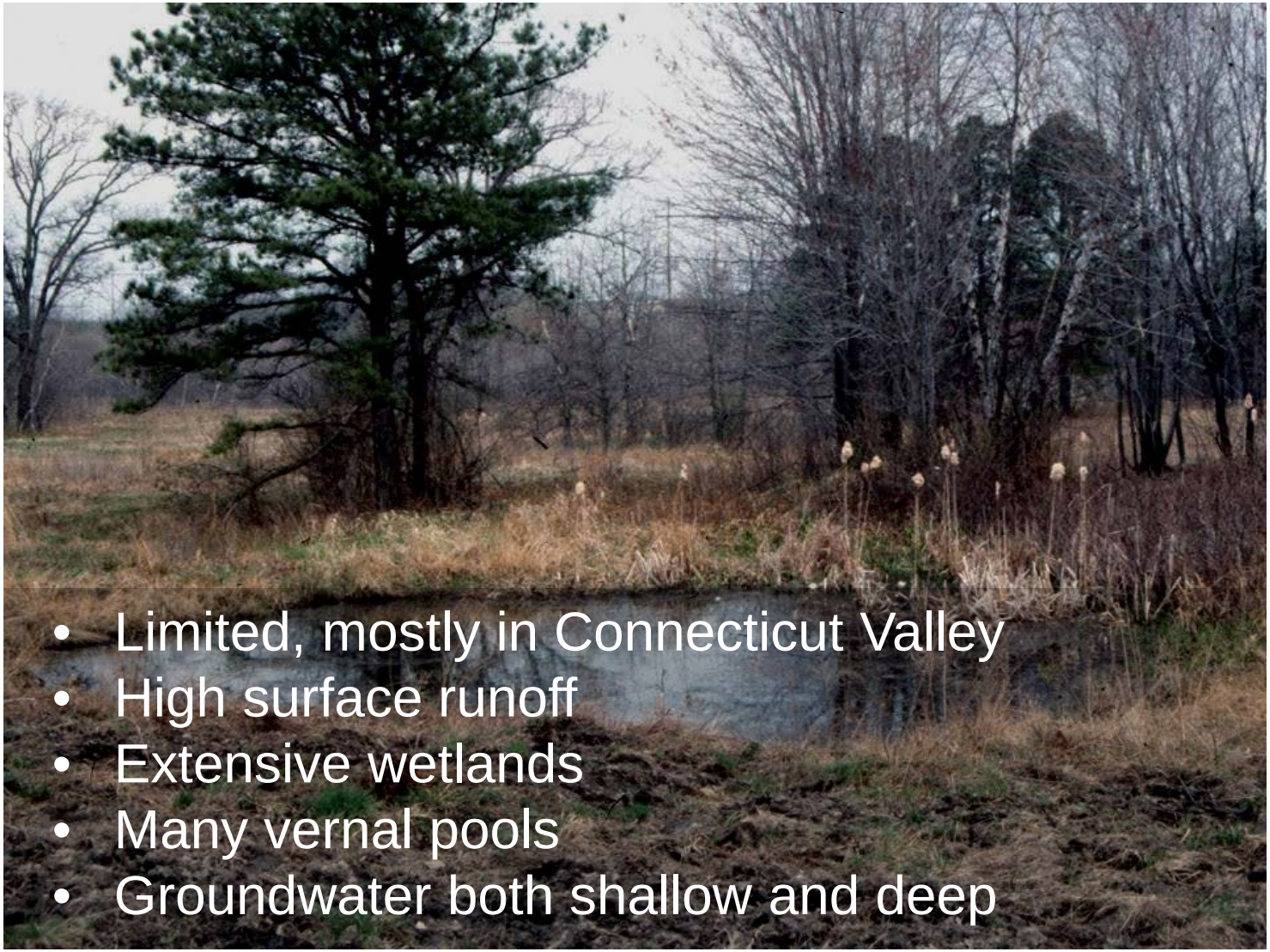


- Shallow groundwater
- Wetlands dominate
- Stores sediments and nutrients
- Maintains stream dynamics
- Statewide limited acreage
- Stores and discharges floodwaters, groundwater

A Topodrainage Sequence on the Connecticut River Floodplain



Glaciolacustrine *(silts and clays)*



- Limited, mostly in Connecticut Valley
- High surface runoff
- Extensive wetlands
- Many vernal pools
- Groundwater both shallow and deep

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Historical Map of Glacial Lakes in Connecticut

GLACIAL LAKES
arrow indicates spillway position, number is spillway altitude.

ICE-DAMMED LAKES

- In - Lake Norfolk
- Icw - Lake Cornwall
- Ih - Lake Hollenbeck
- Id - Lake Danbury
- Ipt - Lake Pootatuck
- Iw - Lake Winsted
- Inp - Lake Nepaug
- Ibr - Lake Bristol
- Icg - Lake Coginchaug
- Ima - Lake Manchester
- Isb - Lake Salmon Brook
- Irb - Lake Roaring Brook
- Ic - Lake Colchester
- Iex - Lake Essex
- Ion - Lake Oneco
- Ivo - Lake Voluntown
- Ip - Lake Pachaug

SEDIMENT-DAMMED LAKES

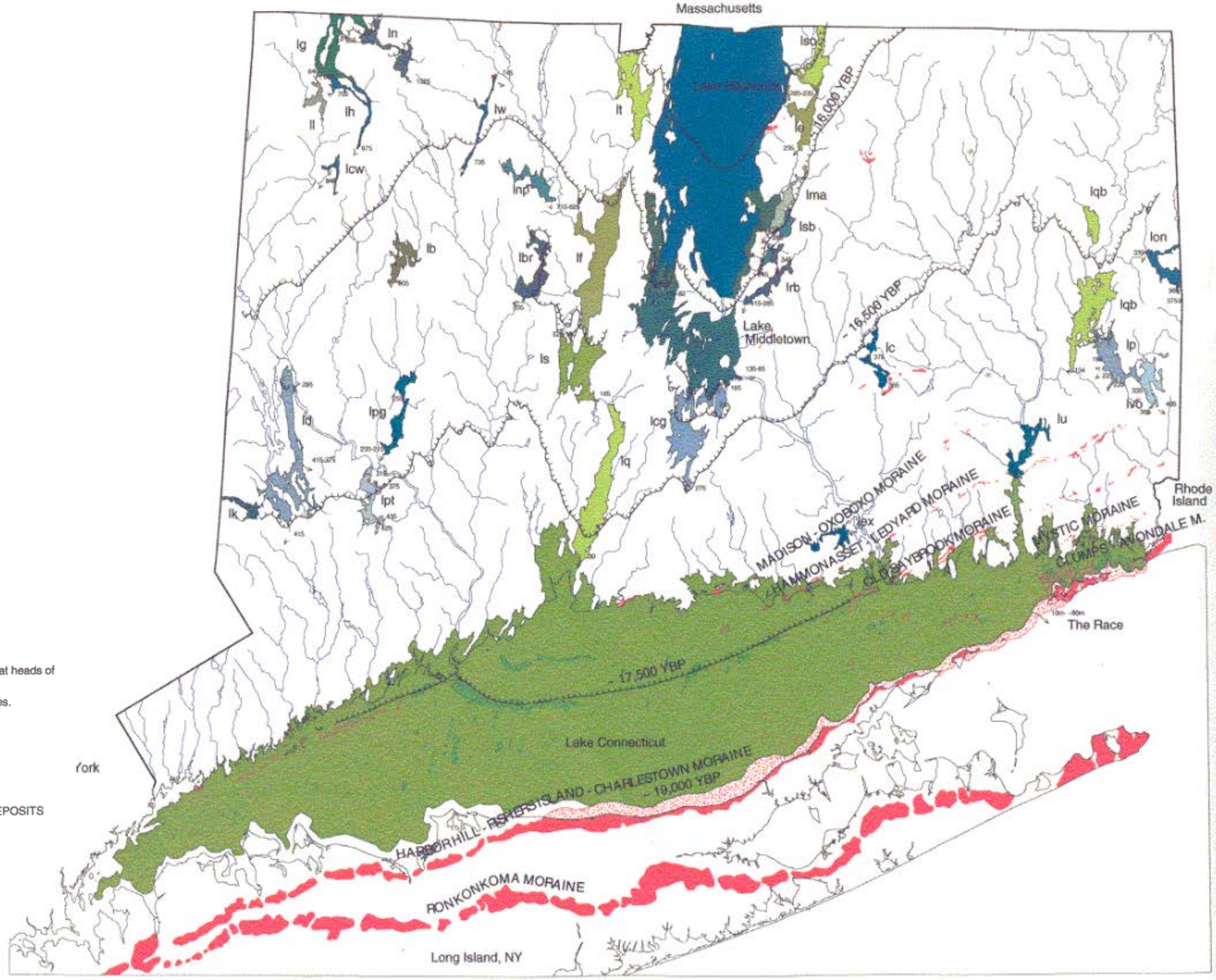
- Lake Hitchcock
- Lake Middletown
- Lake Connecticut
- Ig - Lake Great Falls
- Il - Lake Limerock
- Ik - Lake Kenosia
- Ib - Lake Bantam
- Ipg - Lake Pomperaug
- It - Lake Tariffville
- If - Lake Farmington
- Is - Lake Southington
- Iq - Lake Quinnipiac
- Iso - Lake Somers
- Ie - Lake Ellington
- Iu - Lake Uncasville
- Iqb - Lake Quinebaug

RETREATAL ICE-MARGIN POSITION at heads of glacial lake deposits; number is approximate time before present based on regional radiocarbon dates.

RECESSIONAL MORAINES (onland)

SUBMERGED MORAINE

ICE-MARGINAL LACUSTRINE FAN DEPOSITS



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Varves *annual lake sediments*

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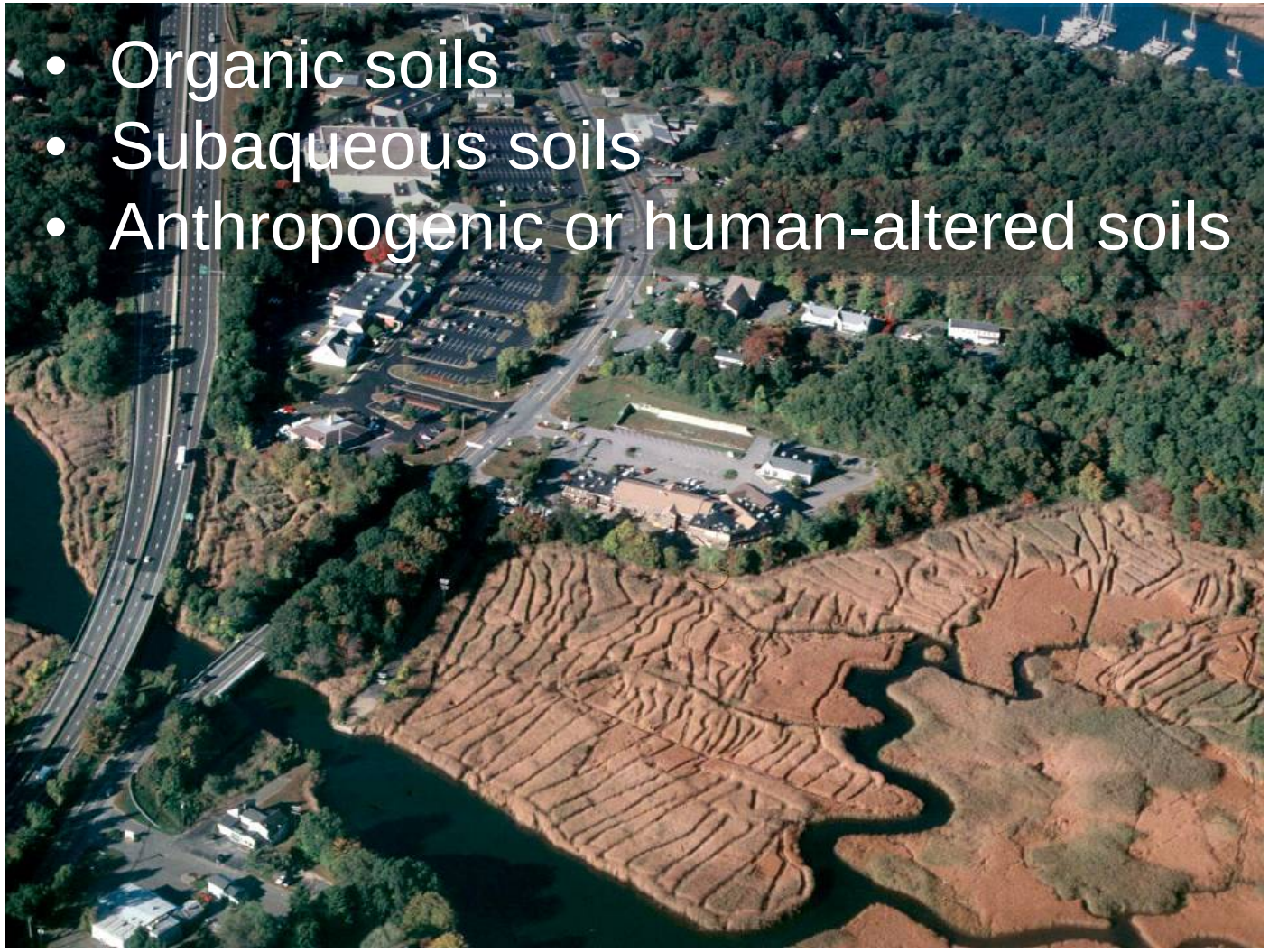
Other Landscapes



- Organic soils
- Subaqueous soils
- Anthropogenic or human-altered soils

Soil Formation, continued

Organic Deposits

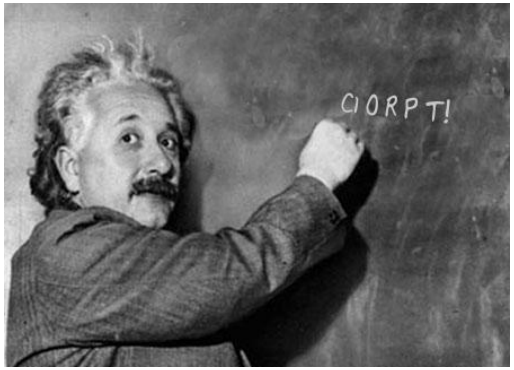
Tidal Marsh soils

also found in freshwater wetland interiors

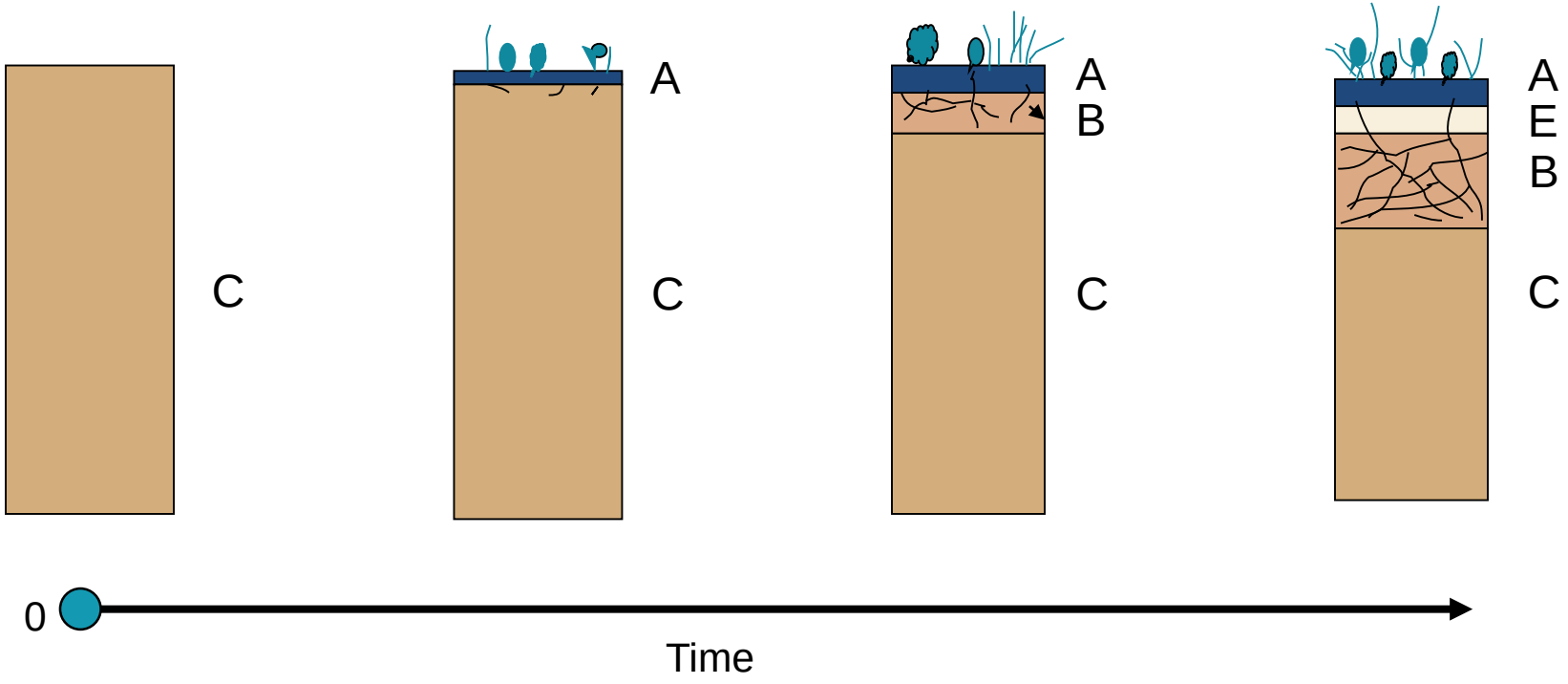
Formed by accumulation of organic matter

Soil Forming Factors

- Climate
- Organisms
- Relief (Topography)
- Parent Material
- **Time**



Soil Forming Factors:
Time



Soil development as a function of time

(parent material, topography, climate and biota being held equal)

Soil Forming Processes

- Translocations
- Transformations
- Additions
- Losses