Rhode Island Envirothon
Soil Science Section

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Soil Science (Pedology)

OBJECTIVE: To provide an introduction to soil science, discuss soil properties,and prepare students for the soil portion of the Envirothon.

- Soil definition, formation, and parent materials.
- Soil properties and interpretation.
- Using Soil Surveys.
- Special topic for this years competition.

Envirothon Soil Section

The soil station consists of hands-on exercises and questions, written questions (multiple choice/ true-false), and a soil judging test pit where you will be asked to describe and interpret the soil.

Study everything on the CD!

Special Topic

- Make sure you study the special topic for each years competition (visit www.envirothon.org) and research how the soil influences or impacts the topic. Try to think of how the study of soils relates to the topic. There will be questions relating to the topic on the exam.

Soil Science (Pedology)

The scientific study of soils, including their origins, characteristics, and uses.

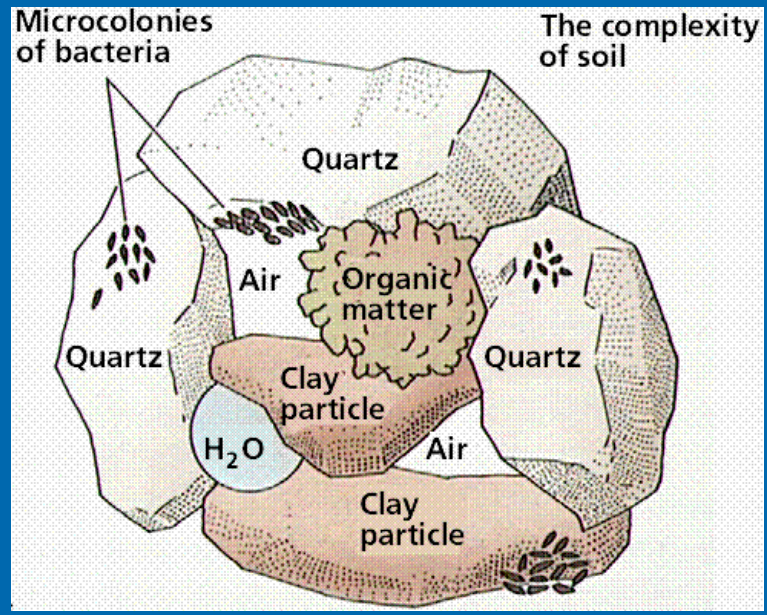
- Many different areas – soil chemistry, physics, genesis, classification, morphology.
- A soil scientist can read the layers of earth to tell what has occurred in the past.

Narragansett Silt Loam – The (Unofficial) State Soil of RI

Soil - Definition

Natural body that occurs on the land surface, occupies space, and is characterized by one or both of the following:

- Horizons formed by pedogenesis (additions, losses, translocations, transformations).
- The ability to support rooted plants in a natural environment.
- Non-Soil areas include beaches, dunes, glaciers, bedrock, urbanland, etc.



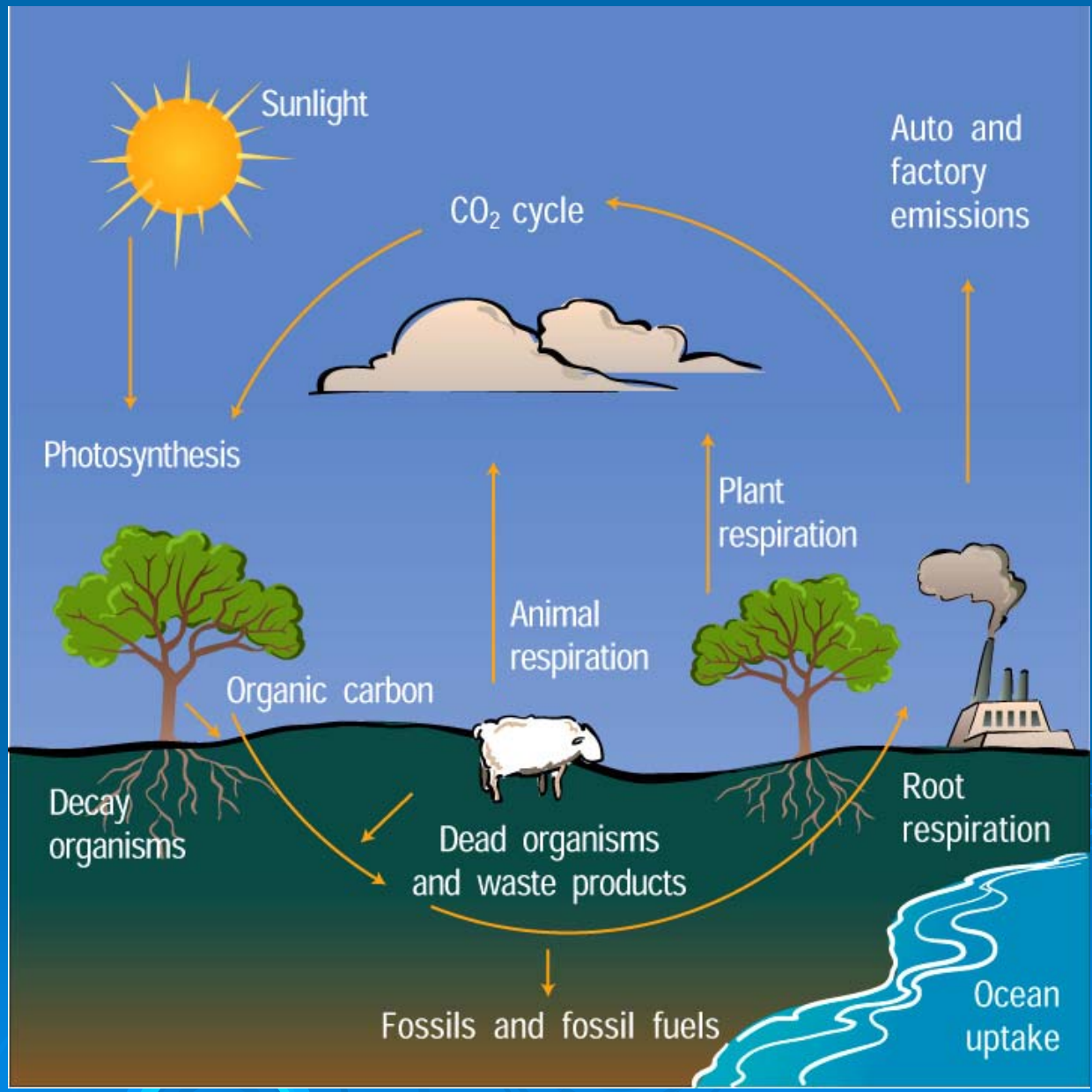
Why are Soils Important?

- **Importance to Society** – Food, fiber, woodland, waste disposal, filter of pollutants, used by most animals to live in and on, part of nutrient and hydrologic cycle.

Why are Soils Important?

- **Importance for Development** – how many houses can be built on a particular soil resource area, how wet is the soil, construction costs, septic system, land value, lawn and tree growth, erosion or other hazards, contamination hazards, long-term costs to owner, regulatory issues.

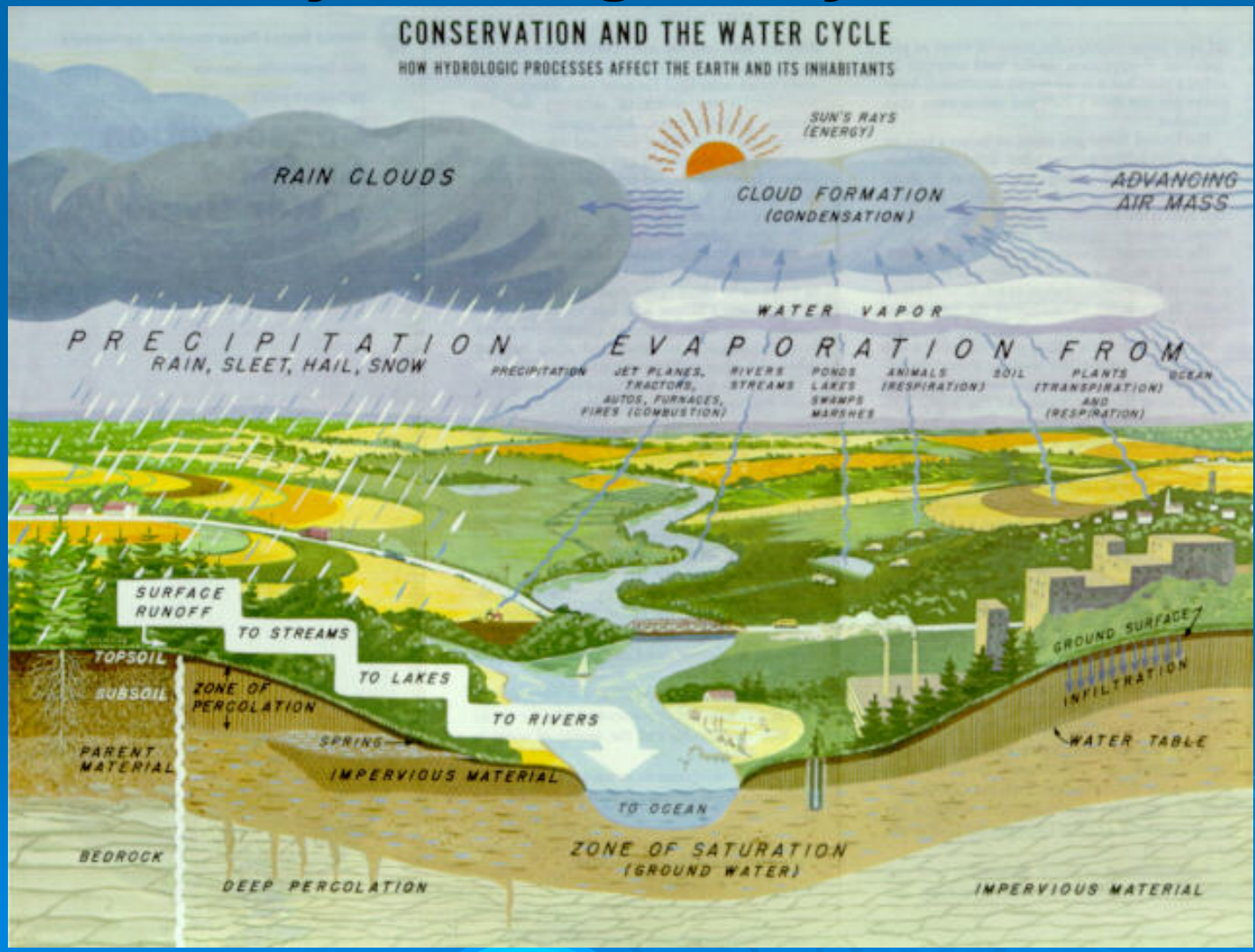
Soil Climate Relations:



Soil and Climate

- The estimated amount of carbon stored in world soils is about 1,100 to 1,600 petagrams (one petagram is one billion metric tons), more than twice the carbon in living vegetation (560 petagrams) or in the atmosphere (750 petagrams). Hence, even relatively small changes in soil carbon storage per unit area could have a significant impact on the global carbon balance.

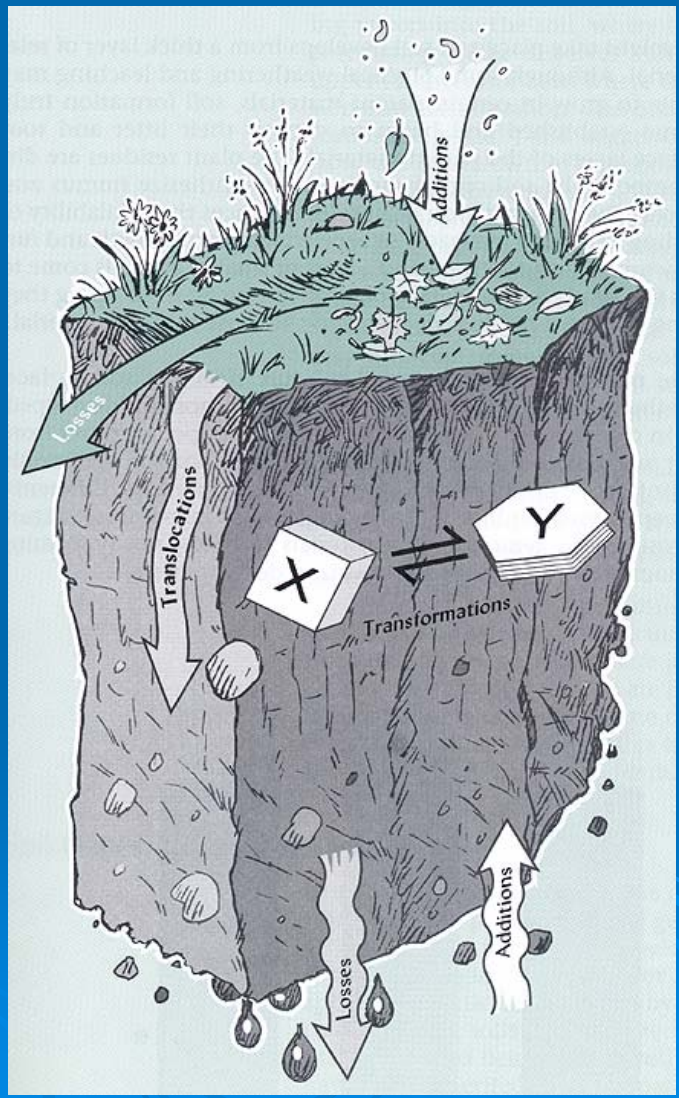
Hydrologic Cycle



Where do Soils Come from?

- **Soil Genesis** - The study of changes in soil bodies. The science of the evolution of soils which are conceived of as natural units in a dynamic three-dimensional continuum.

Five Factors of Soil Formation (Jenny, 1940)



Soil Formation

Biota

Climate

Topography

SOIL!

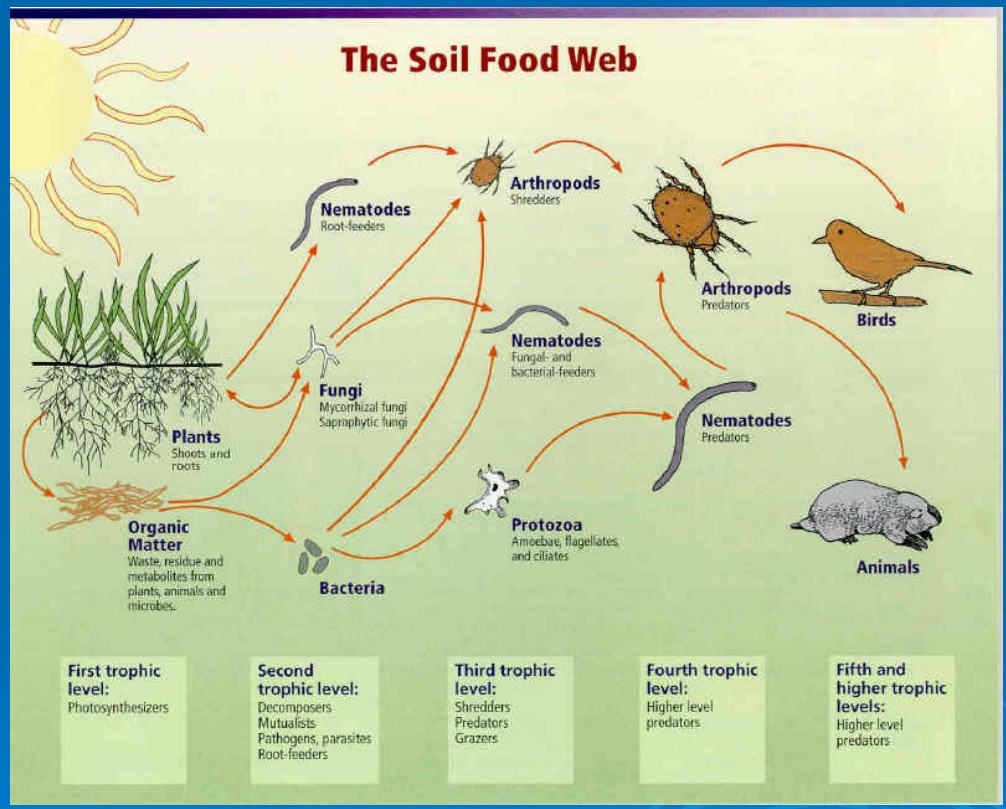
Parent Material

(The first four factors over) Time

These five factors work together to create a unique soil profile made of layers called horizons.

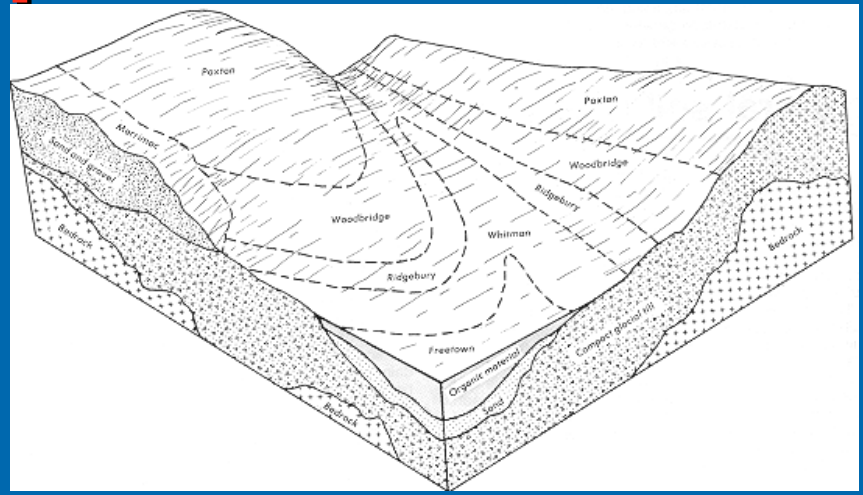
Soil Forming Factor: Organisms

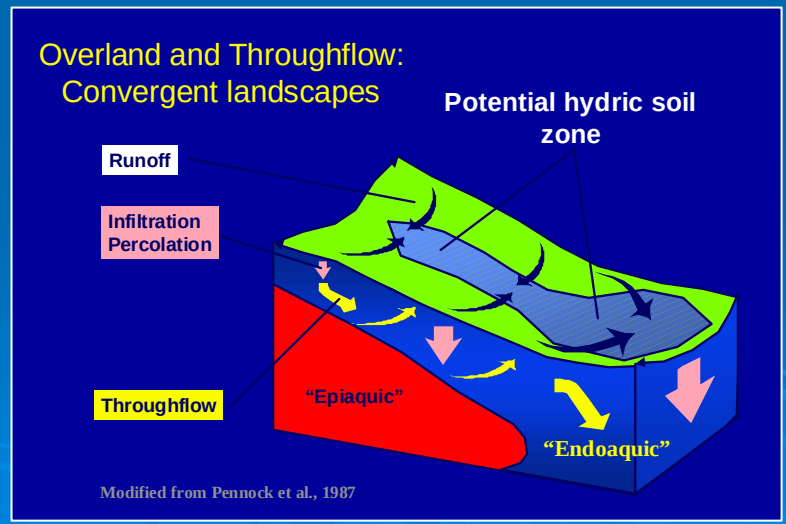
- Micro & Macroscopic.
- Decomposition of OM.
- Redoximorphic formation.
- Animals living in soil.
- Vegetation types.
- Human factors!



Soil Forming Factor: Relief and Landscape Factors

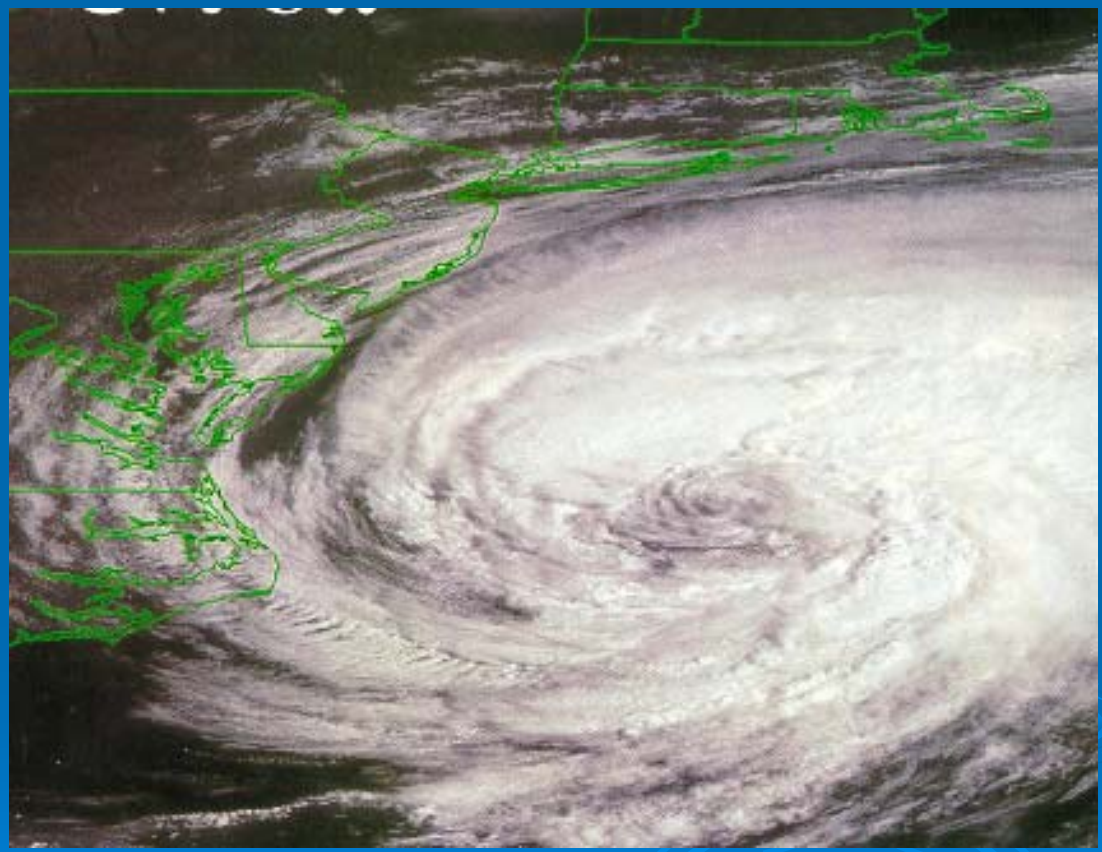
- Position on the landscape (convex/concave).
- Elevation.
- Aspect (north slope Vs. south).
- Slope – steep or level ground.
- Water movement





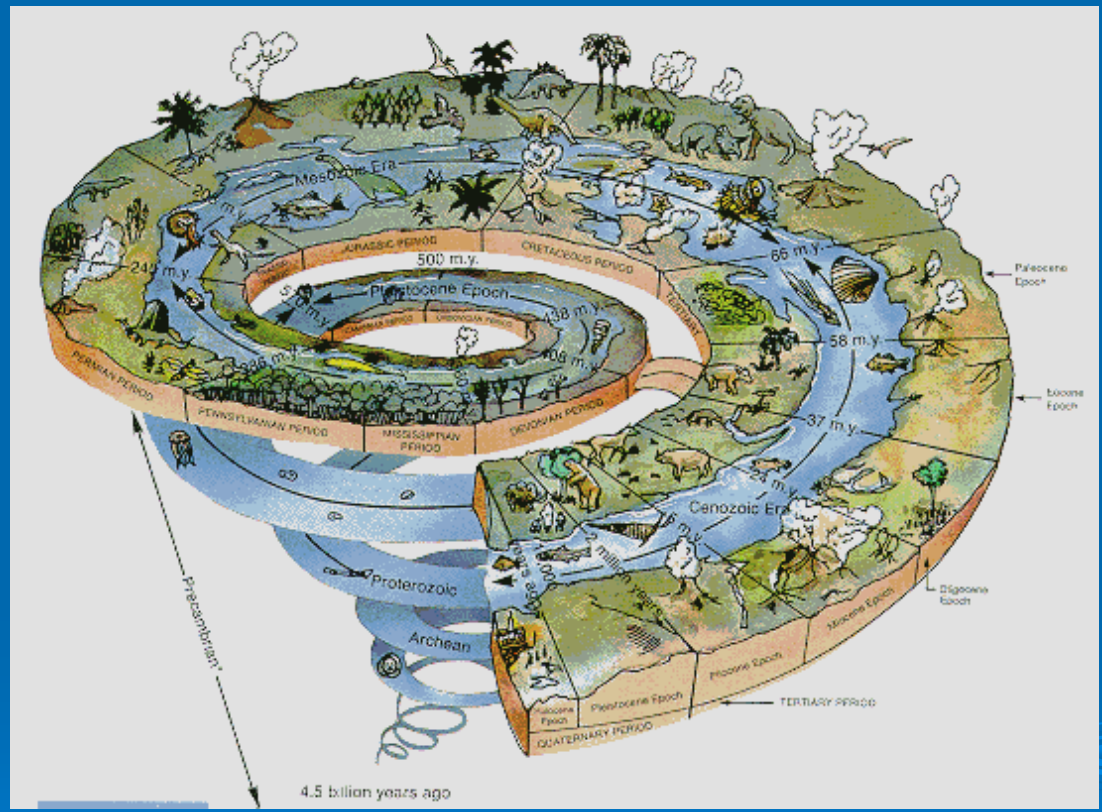
Soil Forming Factor: Climate

- Rainfall (~44”/year).
- Temperature (mesic/frigid line).
- Growing Season.
- Weathering factors (clay, minerals, organisms).
- Organic decomposition.



Soil Forming Factor: Time

- Time Zero: start of soil formation.
- Young Vs Old soils.
- Clay formation and movement.
- Time for Eluviation.
- Profile/Structure development.



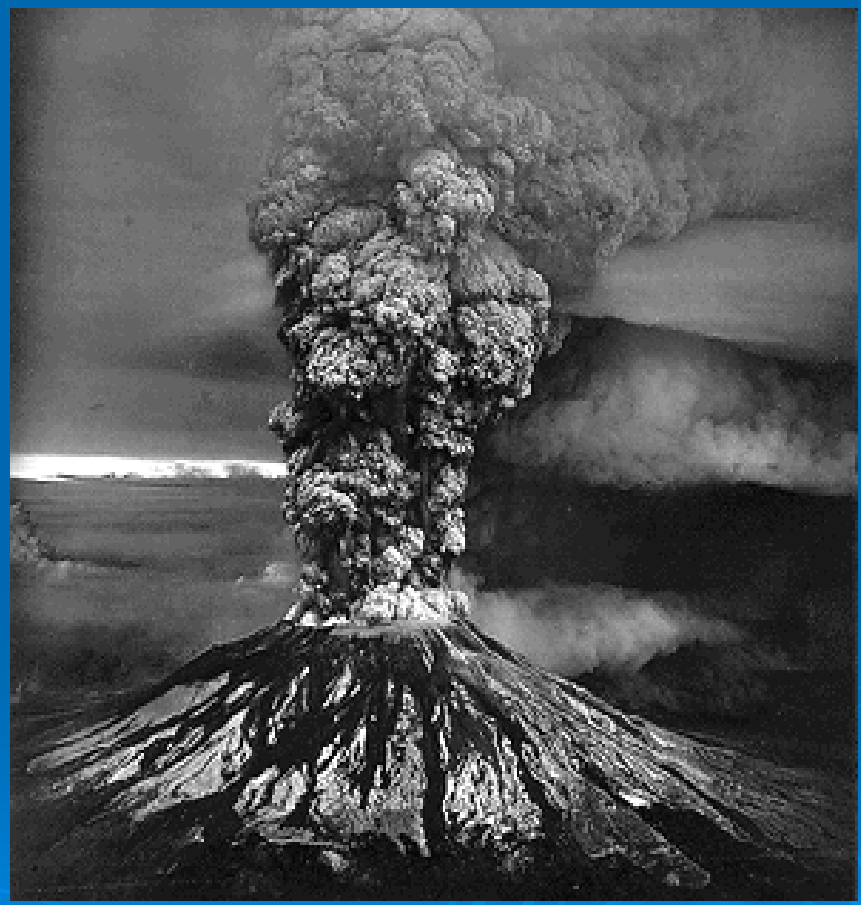
Geo Time:Eons, Eras, Period, Epoch, Age

Soil Forming Factor: **Parent Material**

Geologic Material the Soil Formed From (or in).

- Types of minerals.
- Reaction of soil.
- Soil Color.
- Chemical/physical properties

Types of PM: Bedrock, Glacial, Volcanic, Organic, Loess, Colluvium, Alluvium, Residuim, Karst, etc.



New England Parent Materials

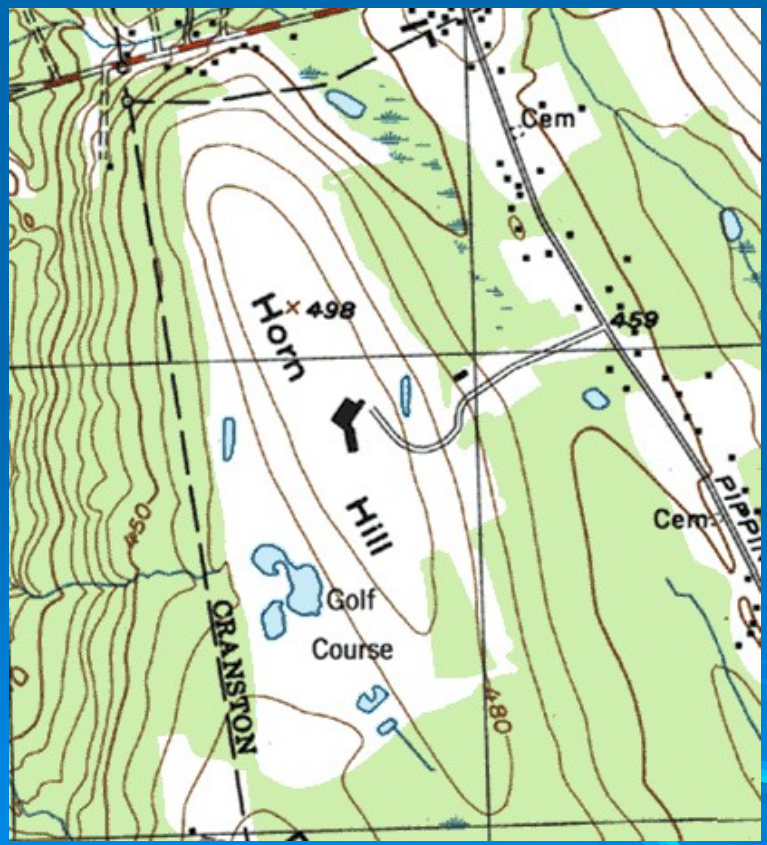
- Pleistocene Epoch (Ice Age) - 1.8 MYBP to 8 KYBP.
- 4 Major advances.
- Last- Wisconsinan advance covered all of NE.
- Soil parent materials - glacial & post glacial

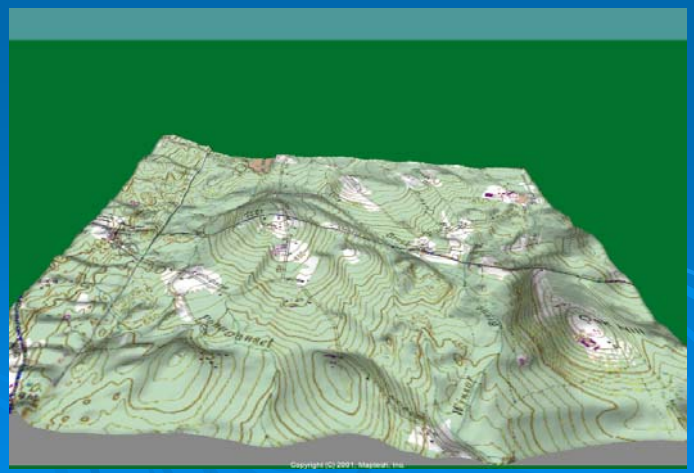
Parent Material: Glacial Till

- Unsorted/stratified material deposited beneath and within glacial ice.
- Heterogeneous mixture of all particle sizes (boulder to clay).
- Oldest surficial deposit overlying most bedrock areas.

RI Till Landscapes

Drumlins – **A smooth, elongated, oval-shaped hill typically composed of dense (lodgement) till. Most are oriented NW to SE – direction of ice flow.**

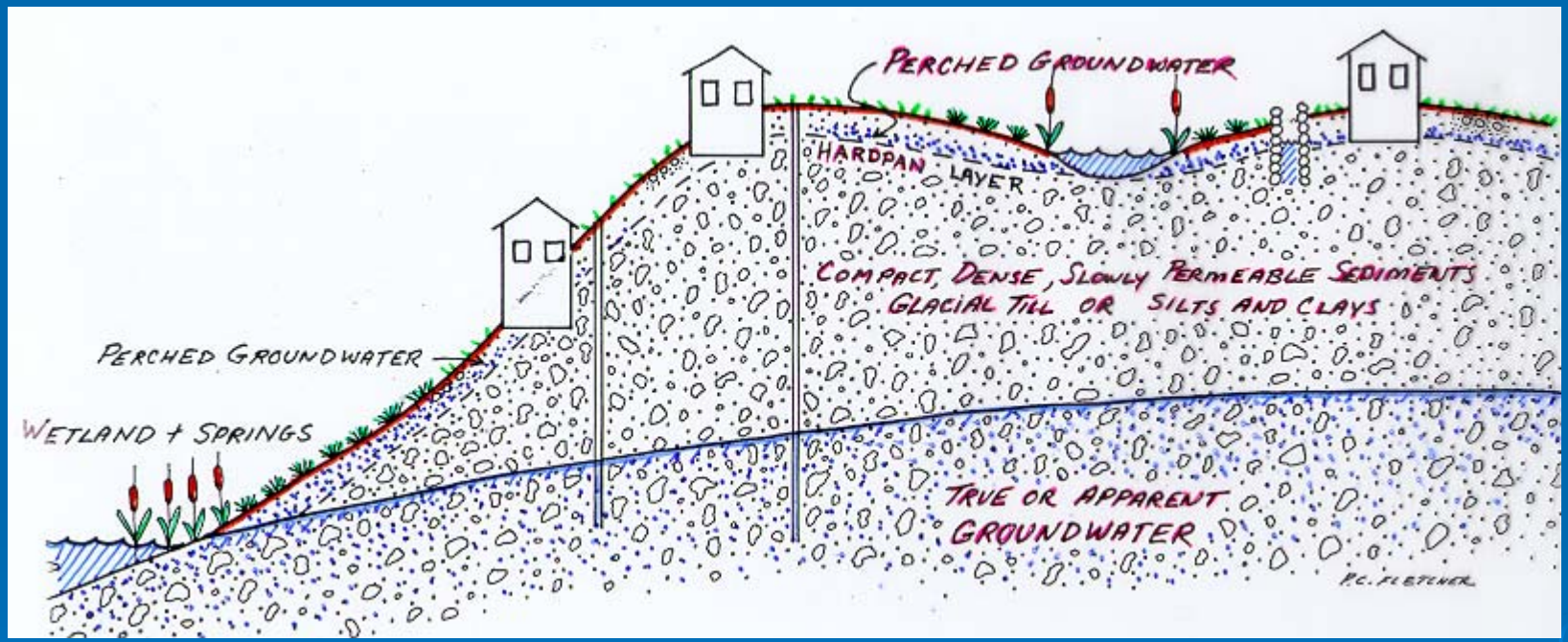




Till Properties

- Major Types: Basal and Ablation.
- Landforms: Drumlins, moraines, Ice contact.
- Basal till has a dense restrictive layer which impedes downward water movement.
- Large angular stones and boulders.

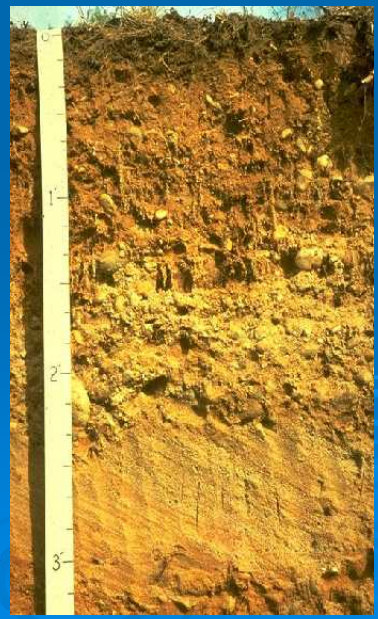
Hydrology in Tills



Hardpan (dense till) perches water causing wet basements, wetlands on hill tops and slopes – drainage driven by landscape position.

Parent Material: Glacial Fluvial (outwash)

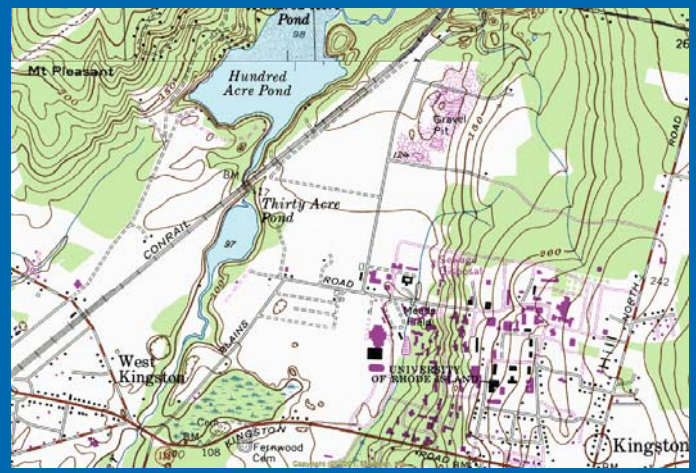
- Sediments deposited by glacial meltwater.
- Stratified layers of sand, gravel, and fines.
- Types: Proglacial and Proximal (ice contact).
- Landforms: Plains, eskers, kames, deltas.

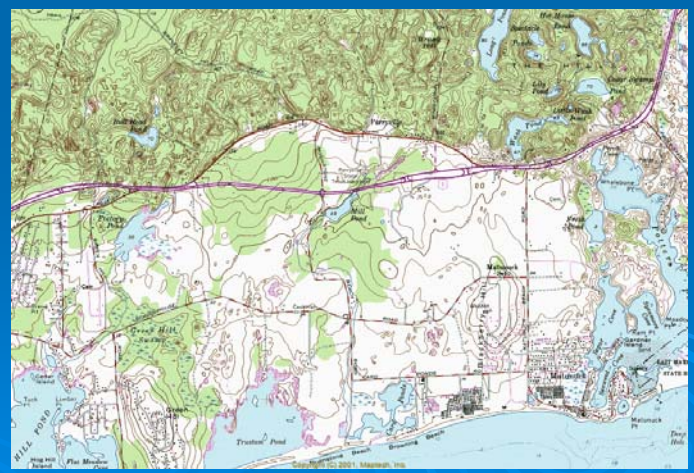


RI Fluvial Landscapes

Outwash Plains – Level to undulating areas composed of stratified sand and gravel.

End Moraines (outwash heads) – Hummocky to steep areas with bouldery surfaces composed of loose sandy till and ice-contact outwash.



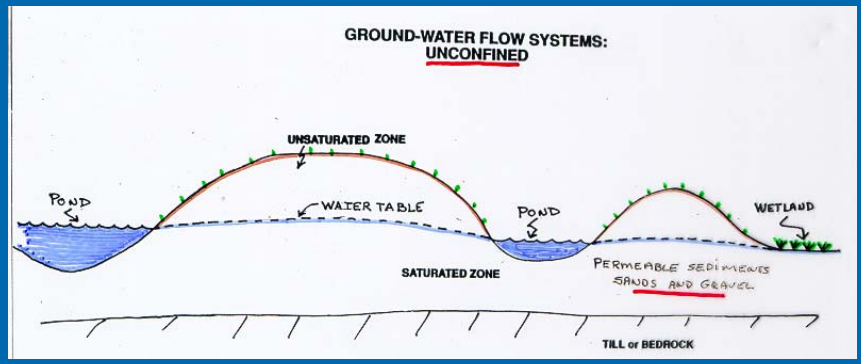


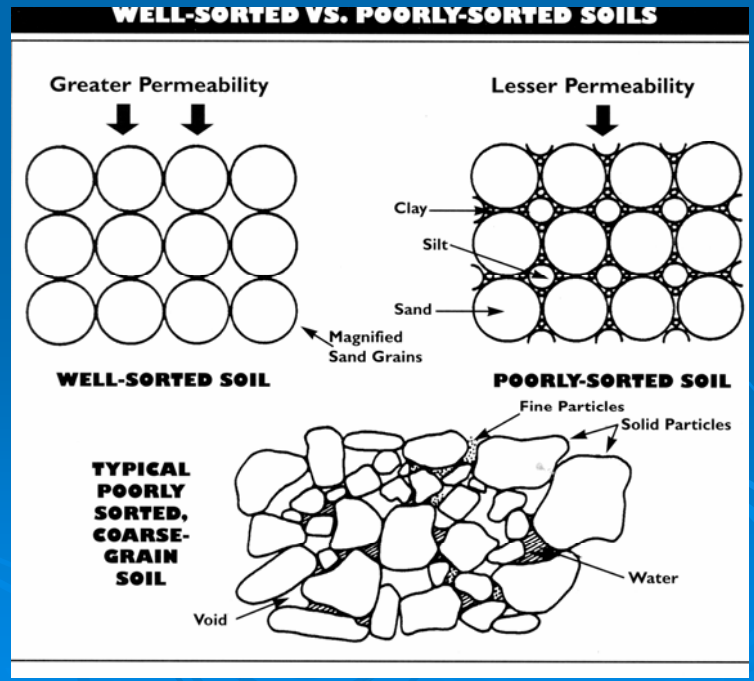
Outwash Properties

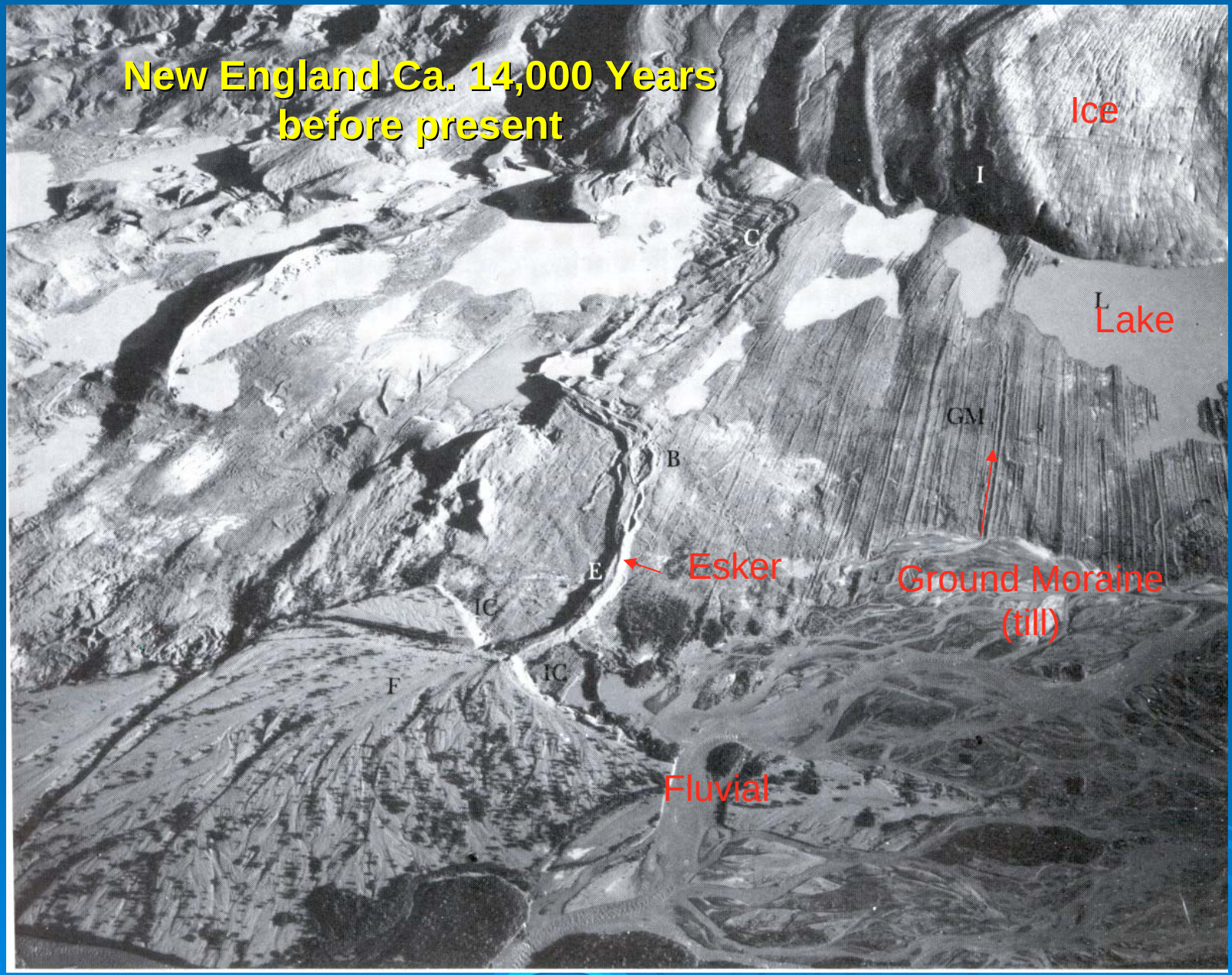
- Dominantly sand and gravel sized particles.
- Rapid water movement, associated with aquifers.
- Apparent watertable.
- Few limitations for most uses.

Outwash Hydrology Concerns

- Apparent watertables, generally easy to interpret hydrology.
- Large pore space causes rapid permeability.
- Aquifer recharge areas.
- Poor filtering capacity.



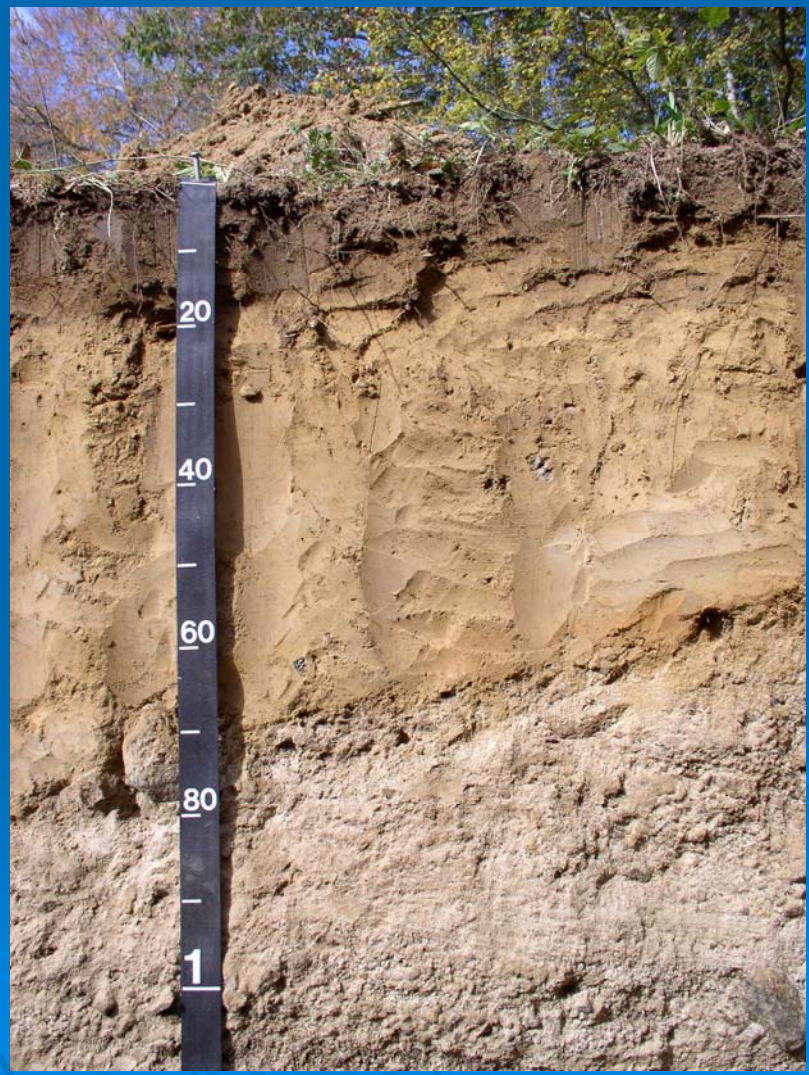



New England Ca. 14,000 Years before present
Ice
I
C
L
Lake
GM
B
E
Esker
Ground Moraine (till)
IC
IC
F
Fluvial

Post Glacial Parent Materials

- Material deposited after glacier left (Holocene-10K BP).
- Eolian - wind deposited sand to silt sized particles.

Most upland soils in NE have a thin 18-36 inch eolian cap. Deposited rapidly after ice left.



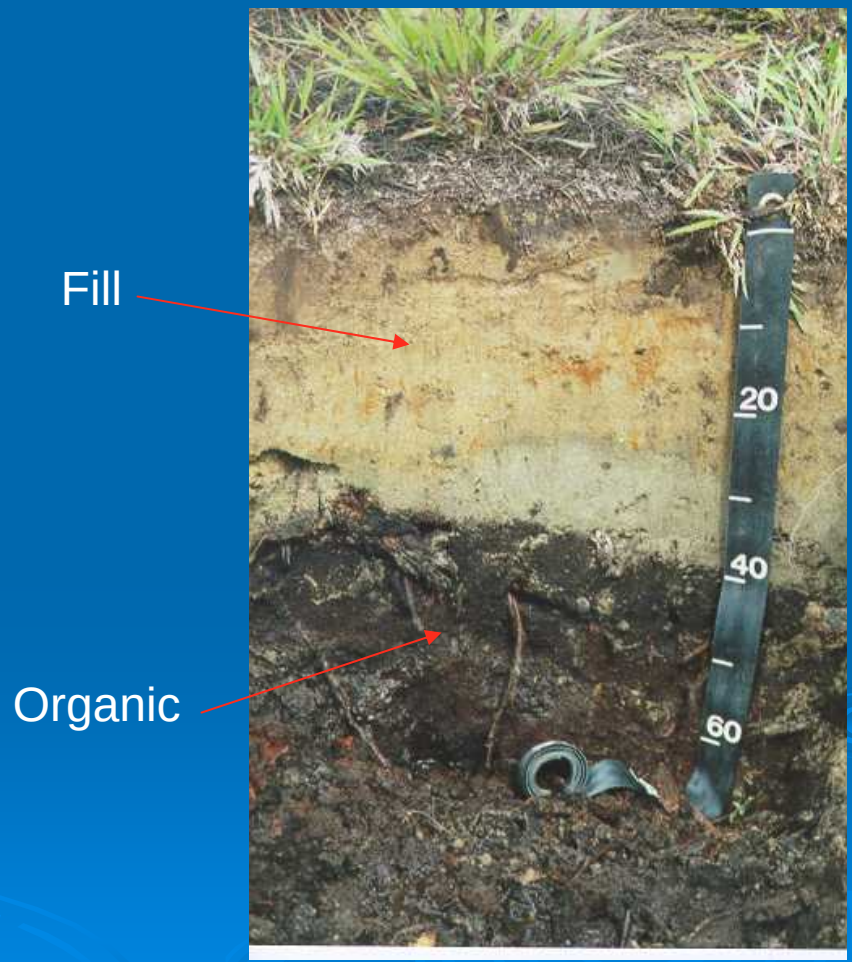
Post Glacial Deposits

- Alluvium - sediments deposited in modern-day floodplains.

  -Problem soil areas due to young age, natural buried horizons.
- Organic - material deposited by dead organisms. Wetlands.

Post Glacial Deposits

- Anthro-transported material (Cut and Fill)
  - recent sediments deposited or removed by human activity.
  - Lot of areas in the NE have been altered by humans.
  - Difficult morphology, often lacking horizons.



Soil Characteristics & Properties

Landscape Features:

1. Position
2. Slope
3. Stoniness
4. Rockiness
5. Drainage
6. Parent Material

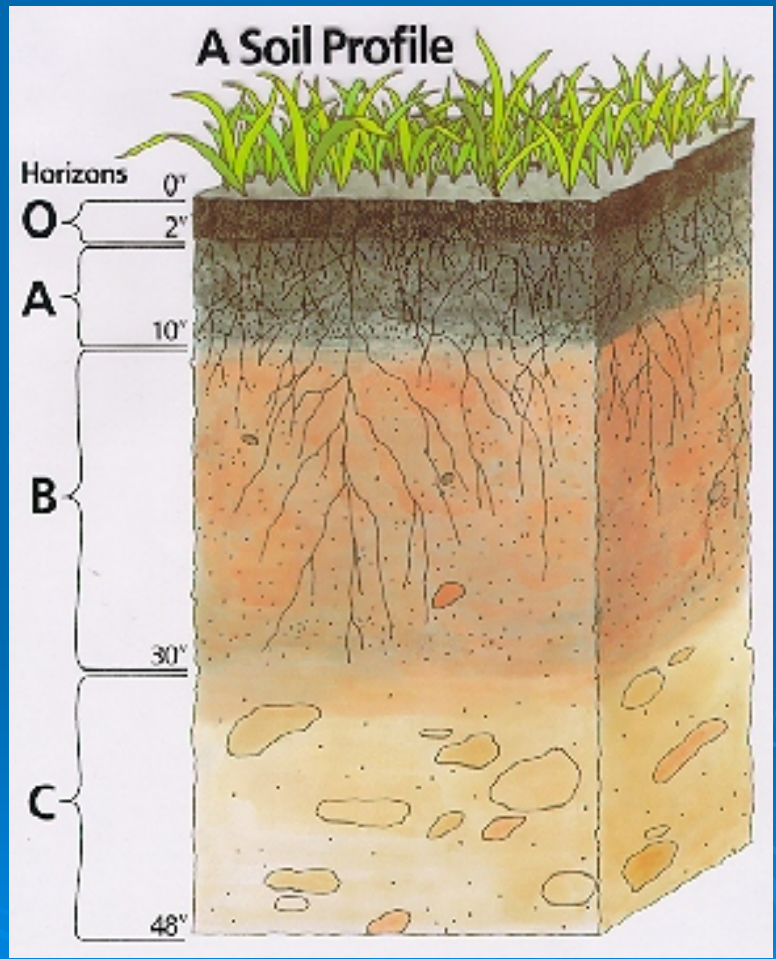
Soil Profile Features:

1. Horizons
2. Color
3. Texture
4. Permeability
5. Structure

Soil Horizons

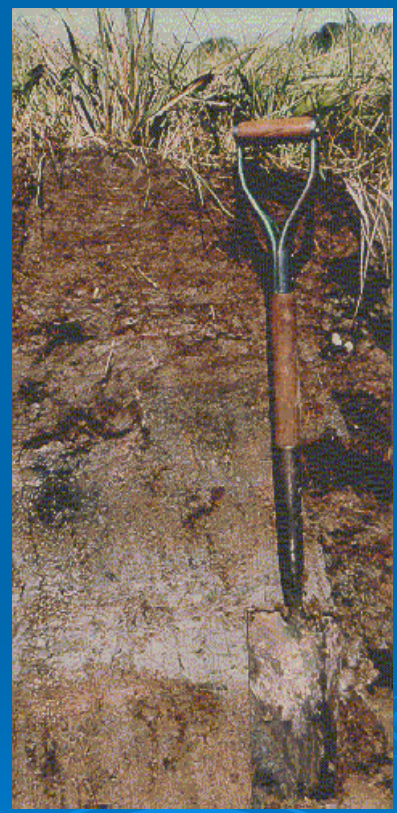
A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil forming processes.

Used to classify the soil and make interpretations.



O - Horizons

- **O**rganic layers of decaying plant and animal tissue (must be greater than 12-18 % organic carbon, excluding live roots).
- Wooded upland areas will have thin O horizons.
- Wetlands may have thick Organic horizons



A - Horizons (Topsoil)

- Mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material.
- Dark color due to mixing of humus.

B - Horizons (subsoil)

- Mineral horizon with evidence of pedogenesis or Illuviation (movement into the horizon).
- Yellowish-brown to reddish brown color in NE.
- Iron-oxide is a dominant mineral that gives B horizons color.

C - Horizon (substratum)

- The un-weathered geologic material the soil formed in. Shows little or no sign of soil formation.
- Glacial till, outwash, lacustrine.

Soil Color

- Easily identified property.
- Used to relate chemical/physical properties such as watertable depth, drainage, chemical constituents, formation, horizons.

Color Components

- **Organic Matter (carbon):** Very strong coloring agent. Makes soil dark or black colored such as in an A horizon or topsoil.
- **Compounds and elements:** Such as iron, sulfur, manganese, etc. Iron is a dominant element in soils, when well aerated iron-oxides coat particles giving the soil a yellowish-brown to reddish color.

Uses of Soil Color (wetness)

- Look for very dark colors, gray colors, or splotchy (mottled) colors.
- Very important to be able to determine the depth to water table!

Soil Properties: Texture

Soil Texture: The relative proportions of sand, silt, and clay particles in a mass of soil (material less than 2mm in size).

Very Coarse Sand	2.0-1.0 mm
Very Fine Sand	0.1-0.5 mm
Silt	0.05-0.002 mm
Clay	< 0.002 mm

Soil Texture (cont.)

- Material larger than 2 mm are coarse fragments (gravel, cobble, stone, boulder).
- **Importance:** Soil formation, mechanics, water movement, erosion, CEC, shrink-swell, etc.
- **Clay:** High specific surface, net negative charge (isomorphic), high pore, expansion.
- Most textures in NE have very little clay.

Soil Properties - related to texture

- **Porosity**: An index of the relative pore volume in the soil.
- **Infiltration:** The downward entry of water into the immediate surface of soil or other material.
- **Erodibility:** In general, large particles are less erodible, exceptions being clay.
- **Available Water Holding Capacity:** Silt loam textures have highest.
- **Shrink-Swell:** High activity clays have high factors.
- **Soil Formation:** **Clayey soils = older**.
- **Permeability:** The quality of the soil that enables water to move downward through the profile. Number of in/hr that water moves downward through saturated soil.

Soil Texture Triangle

Triangle is used if laboratory data is available:

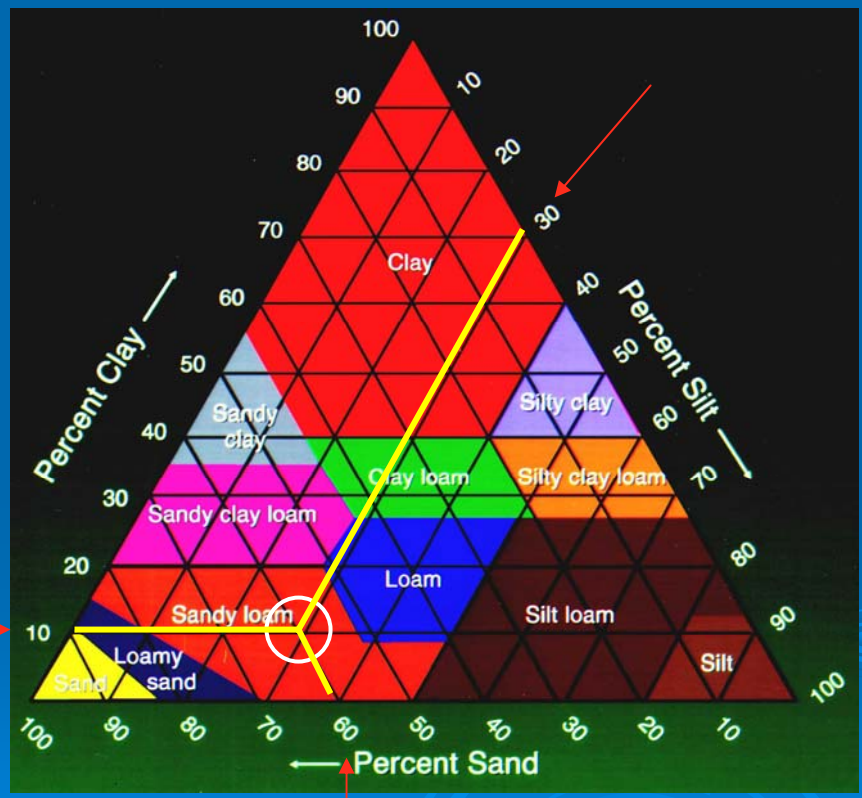
Example:

Sand = 60%

Silt = 30%

Clay = 10%

Soil Texture = Sandy Loam



Soil Drainage

- The frequency and duration of periods of saturation or partial saturation during soil formation.
- Depth to water.
- Classes: Excessively, well, moderately well, poorly, very poorly drained.

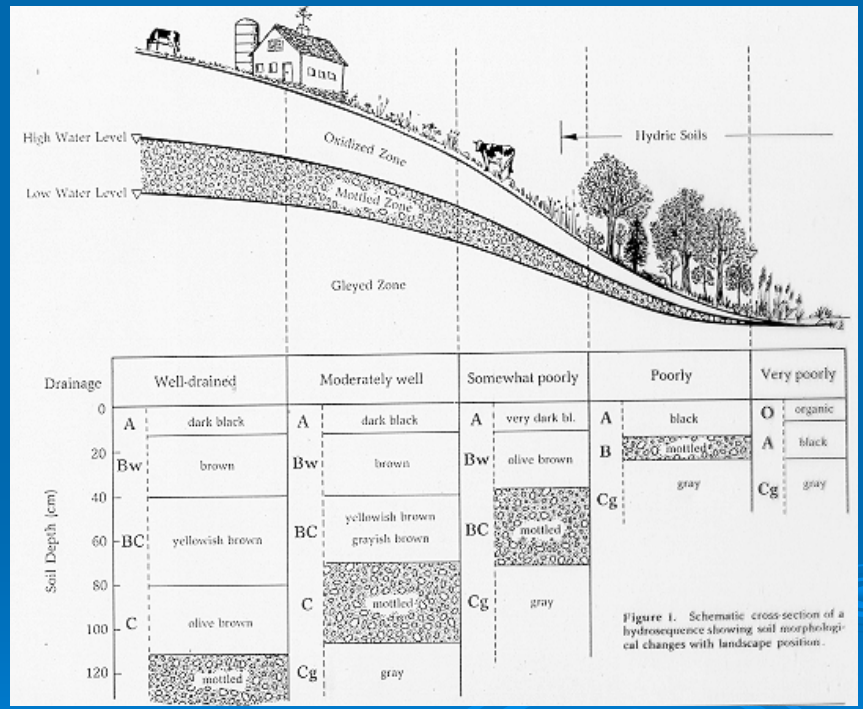


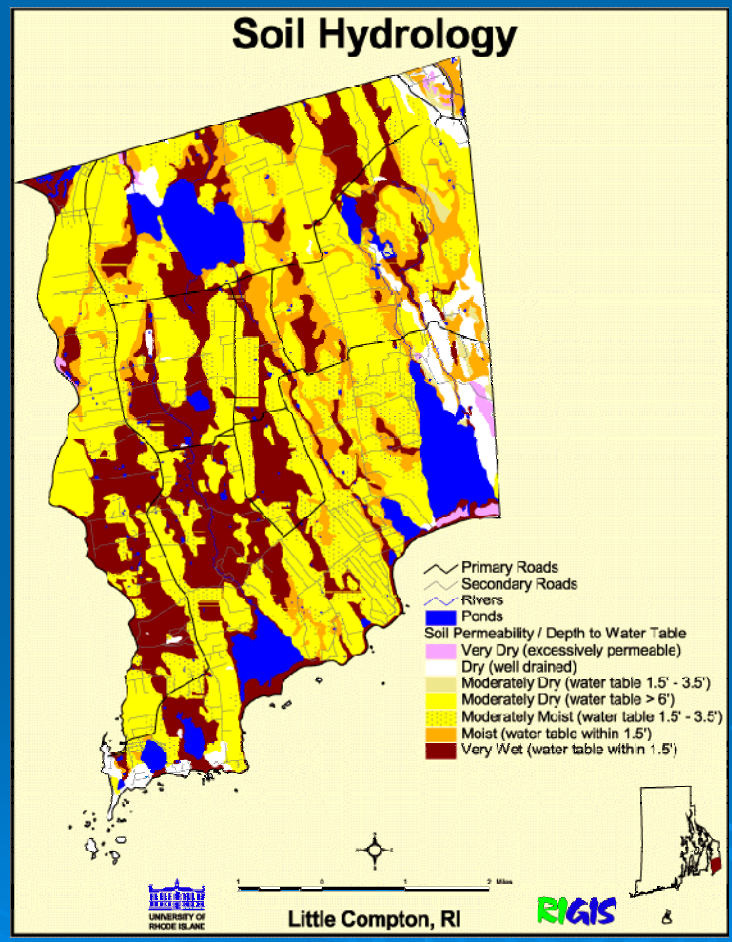
Figure 1. Schematic cross-section of a hydrosequence showing soil morphological changes with landscape position.

Soil Interpretations

Suitability of a soil for specific land uses such as agricultural, urban, forestry, environmental assessment, and development.

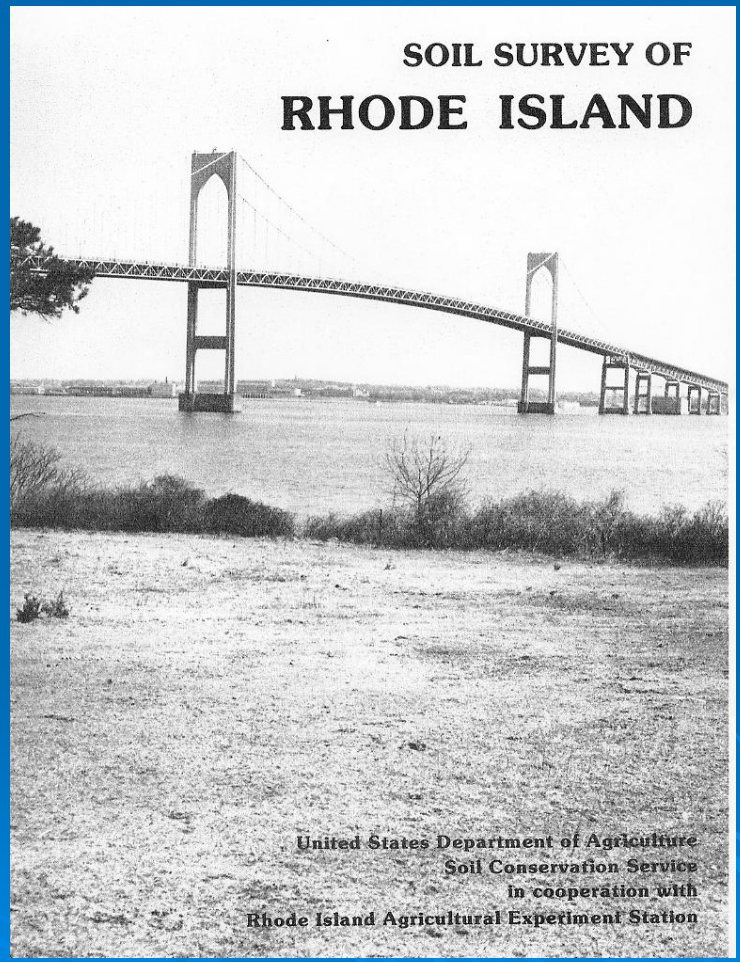
Envirothon Interps:

- Farmland
- Houses
- Septic Systems



Soil Surveys

- A soil survey describes the characteristics of the soils in a given area, classifies the soils according to a standard system of classification, plots the boundaries of the soils on a map, and makes predictions about the behavior of soils.
- Extensive field work!



Soil Survey Data

Hydric Soils

Physical Soil Properties

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

[Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of data were not estimated]

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors		
										Kw	Kf	T
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*			
BhA:												
Bridgehampton	0-8	---	---	2-6	1.05-1.20	4.23-14.11	0.20-0.26	0.0-2.9	2.0-7.0	.49	.49	3
	8-41	---	---	1-6	1.20-1.45	4.23-14.11	0.20-0.34	0.0-2.9	0.0-2.0	.64	.64	
	41-60	---	---	0-3	1.60-1.80	42.34-141.14	0.01-0.10	0.0-2.9	0.0-0.5	.10	.24	
Co:												
Carlisle	0-66	---	---	---	0.13-0.23	1.41-42.34	0.35-0.45	---	55-75	.05	.05	5
Nt:												
Ninigret	0-10	---	---	3-12	1.00-1.25	4.23-42.34	0.15-0.24	0.0-2.9	2.0-5.0	.32	.37	3
	10-30	---	---	3-12	1.35-1.60	4.23-42.34	0.14-0.22	0.0-2.9	0.5-2.0	.37	.43	
	30-60	---	---	0-2	1.45-1.70	42.34-141.14	0.01-0.10	0.0-2.9	0.0-0.5	.15	.17	
Sb:												
Scarboro	0-5	---	---	1-7	0.70-1.00	14.00-42.00	0.10-0.23	0.0-2.9	8.0-15	.17	.24	5
	5-24	---	---	1-5	1.15-1.35	42.00-705.00	0.04-0.13	0.0-2.9	0.5-2.0	.17	.20	
	24-60	---	---	0-2	1.35-1.55	42.00-705.00	0.02-0.13	0.0-2.9	0.0-0.5	.10	.17	
Wa:												
Walpole	0-7	---	---	2-6	1.00-1.25	14.11-42.34	0.10-0.18	0.0-2.9	2.0-8.0	.20	.24	3
	7-19	---	---	2-6	1.30-1.55	14.11-42.34	0.07-0.15	0.0-2.9	0.5-2.0	.24	.32	
	19-65	---	---	0-2	1.40-1.65	42.34-141.14	0.01-0.10	0.0-2.9	0.0-0.5	.10	.15	

Soil Suitability for Development

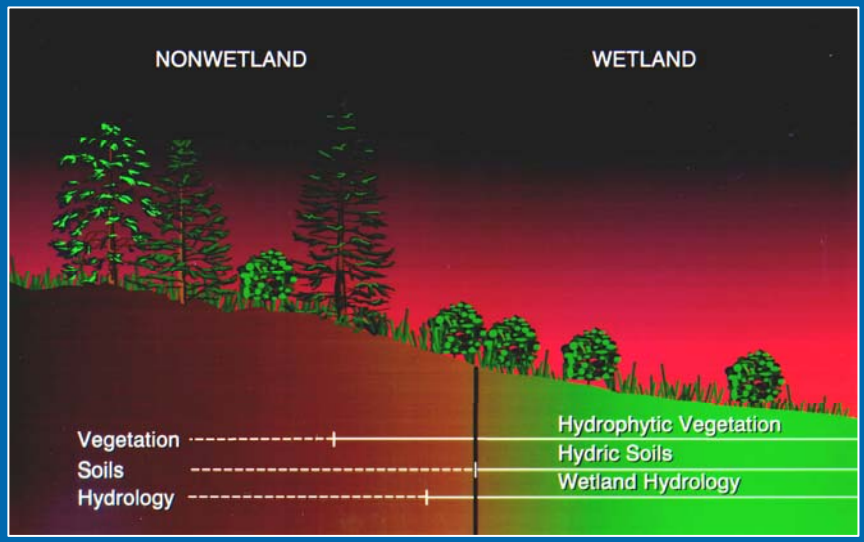
Alluvial Soil

Deep sandy Soil

Organic Soil

Wet till Soil

Regulatory Issues Related to Soil



Wetlands, ISDS Septic Systems, Erosion Protection, Stormwater Runoff, Zoning Issues.

Limitations for Houses

- No evidence of water within 6 feet.
- Not in a floodplain!!
- No wetlands within 100 feet.
- Deep soil (no rock).
- Not too steep.

A floodplain soils – poorly suited for houses.

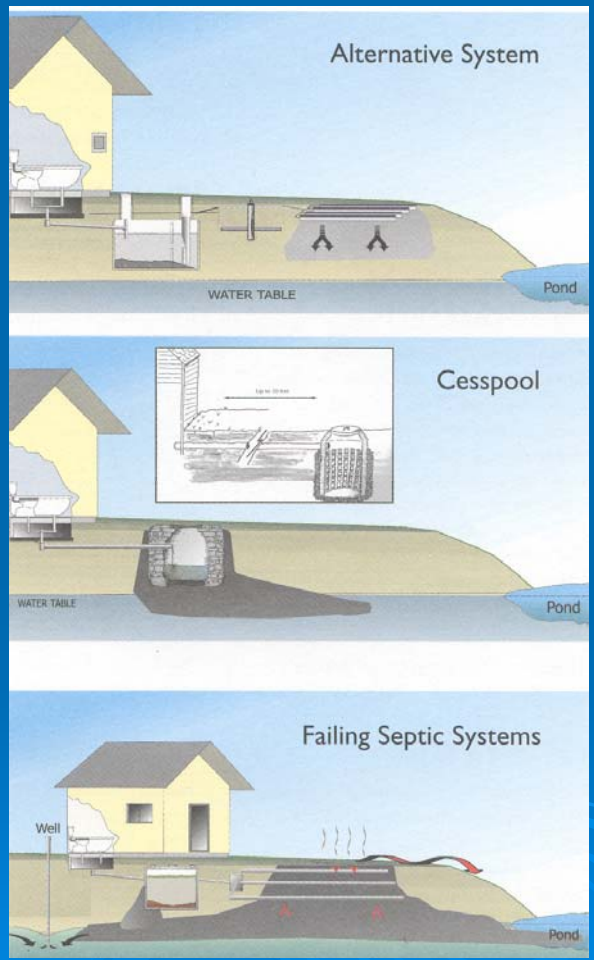
Limitations for Septic Systems

- State code: 3 feet of pervious material, depth to water is > 2 feet below system.
- Look for a restrictive layer of loamy soil.
- Look for signs of wetness (redox features).
- Not too sandy!

A septic system installed on Woodbridge soils – poorly suited due to wetness and slowly permeable layer.

Septic System Soil Concerns

- Need a 3 foot separation from bottom of drainfield to water table. Separation needed to kill pathogens.
- Need 5 foot separation from an impervious layer.
- Setbacks from wells, property lines, etc.



Farmland Interpretations

- Look for thick dark topsoil layer.
- Textures of upper 20 inches should not be too sandy.
- No large stones or boulders.
- Not too steep, slope < 8%.
- Site may be wooded.

Other Soil Development Issues

Erosion Hazards – most erosion caused when soil is dug up and stockpiled. Causes sedimentation, nutrient overload, loss of an important natural resource.

- Erosion control measures required sometimes.

Soil Erosion Concerns

- Types of Erosion:
  Sheet, Rill, Gully
- Highly Erodible Soils:
  - soil texture and slope
- Erosion Control:
  - Ag. - contour plowing, terracing, buffer strips, no till, cover crops in winter.
  - Urban – silt fences, hydro seed, limit stockpile size.

Drainage Problems

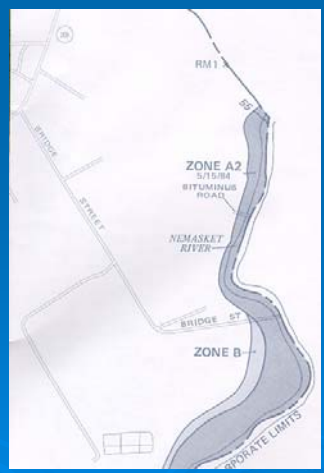
- Occurs when rainfall exceeds permeability (soils with restrictive layers).
- Occurs in areas with high water tables (land that is wet) and areas subject to flooding and ponding.
- Also caused by creating too much impervious ground.

Drainage problem hurts residents

Quality of life compromised for Common Fence Point

By HEATHER MACWILLIAMS

PORTSMOUTH – Originally plotted in 1924 for summer homes and affordability, Common Fence Point in Portsmouth remains a zoned R-10 area that contains lots averaging 4,000 square feet. These "lots of record" fall well beneath the standard size for its residential zone, but in 1924 they were accepted on the books as being legal. Over the years, these postage stamp-size lots, originally designed for summer use, have been grandfathered into year-round residential use, and today, their capacity to pro-



Resource inventory maps – FEMA, Soil Survey, NWI, etc.

Stormwater Runoff

- Need to control the effects of creating impervious material during the conversion of land use (woodland to sub-urban).
- 1,000 square feet of impervious ground generates 28, 000 gallons of run-off each year!
- Soils are used to determine the size of detention ponds to store run-off (soil hydrologic groups) in drainage calculations.

Impervious Surfaces

- Indicate intensive land uses
  that cause pollution
- Inhibit recharge of groundwater
- Prevent natural processing of pollutants in soil, plants
- Provide a surface for accumulation of pollutants
- Provide an express route for pollutants to waterways

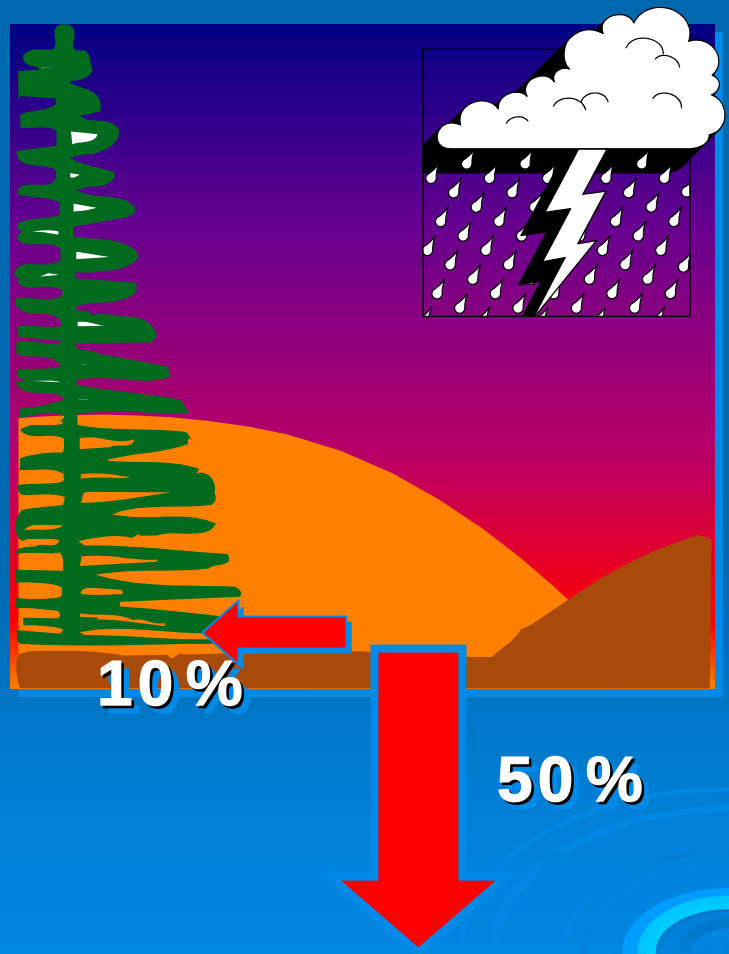
Development Impacts on Water Quality

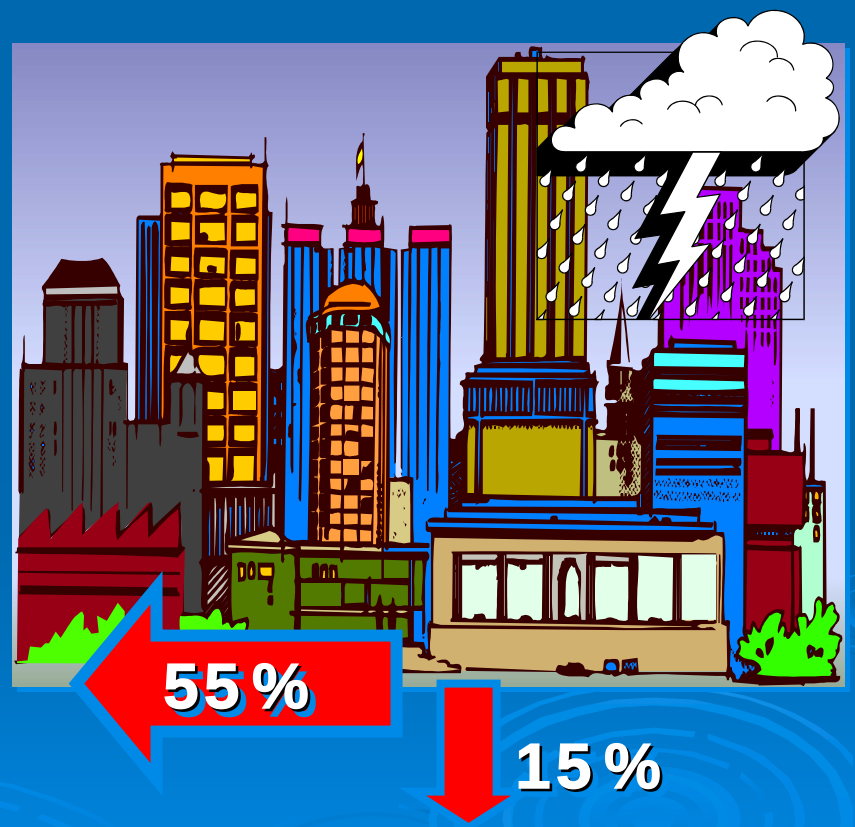
Increased quantity

Decreased quality

- Nutrients
- Pathogens
- Sediment
- Toxic Contaminants
- Debris
- Thermal Stress

Development Impacts on the Water Cycle





Local Example of Land-Use Change

Route 4 and 102 in North Kingstown

1997

Local Example of Land-Use Change

2005 New Building occupying 11 acres:

1. Loss of Prime Farmland Soils (Bridgehampton)
2. Loss of recharge to aquifer.
3. Runoff of 15 million gallons/year

Local Example of Land-Use Change

2007 Another building being constructed occupying 9.3 acres:

1. Loss of Prime Farmland.
2. 12.5 million gallons of runoff generated.

Soil Links

- USDA-NRCS Soil Education Links:
  - http://soils.usda.gov/education/
- Glossary of Soil Terms:
  - http://nesoil.com/gloss.htm
- The World of Soil:
  - http://soil.hostweb.org.uk/
- Geology formation of New England:
  - http://www.memorialhall.mass.edu/classroom/curriculum_6th/lesson1/bkgdessay.html
- The USGS and Science Education:
  - http://education.usgs.gov/
- NeSoil Soil Links:
  - http://nesoil.com/links.html

End