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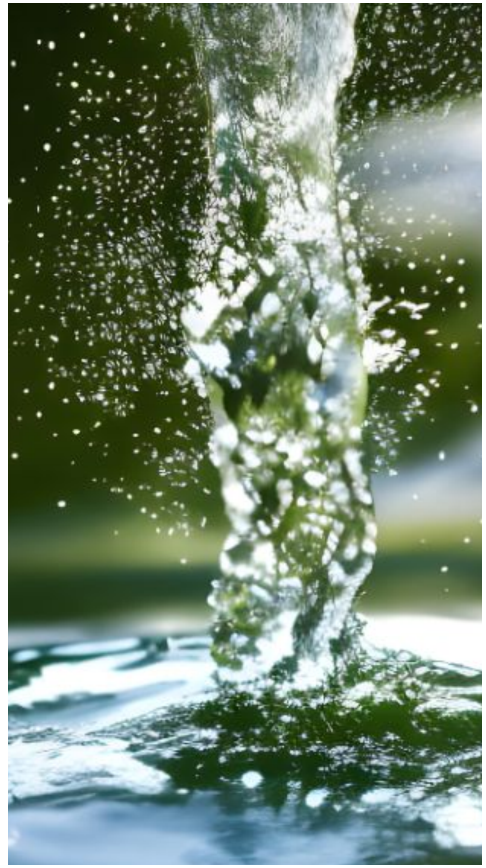
Massachusetts Health Officers Association Annual Conference
October 25-27, 2023
North Falmouth, MA



Soils and Water Movement

From Landscape Level to Site Specific

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Overview

- Soils and onsite septic systems
- Landscape Level: Soils of Massachusetts
    - Parent materials
    - Soil Survey
- On-site: Describing soil properties
    - Texture
    - Structure
    - Redoximorphic features

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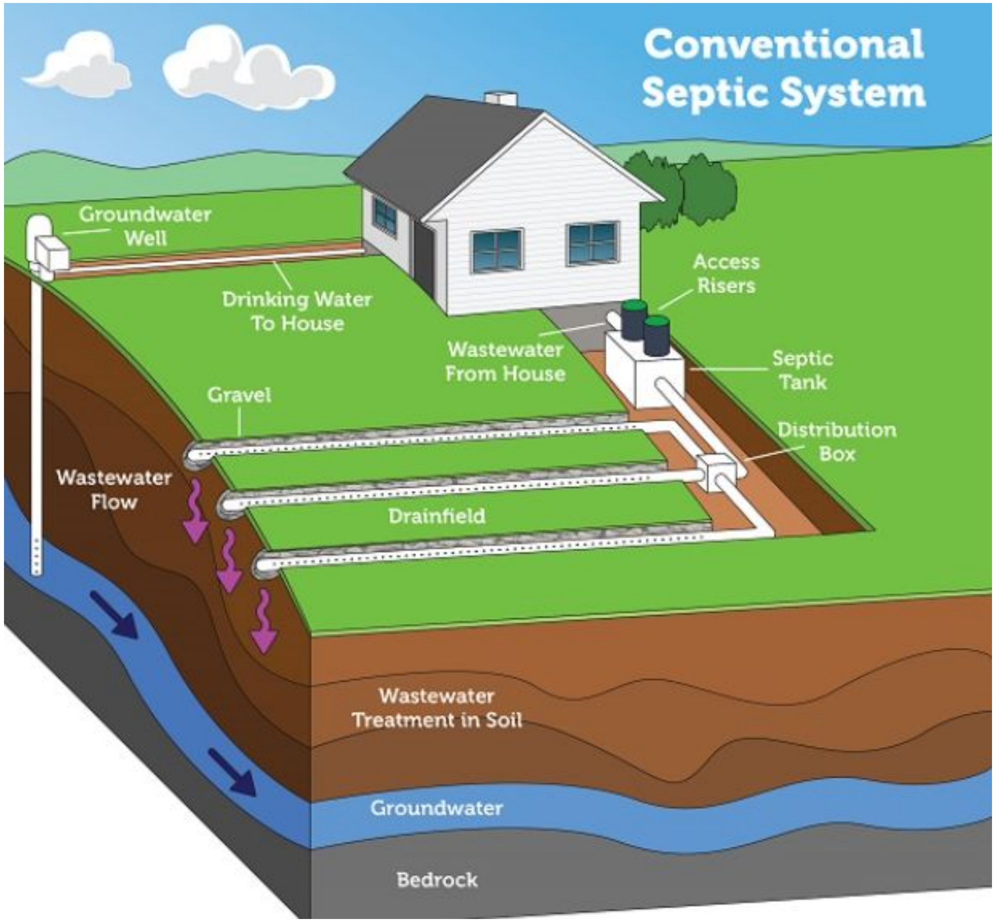
Onsite wastewater Treatment



US EPA

35% of MA homes use onsite wastewater treatment

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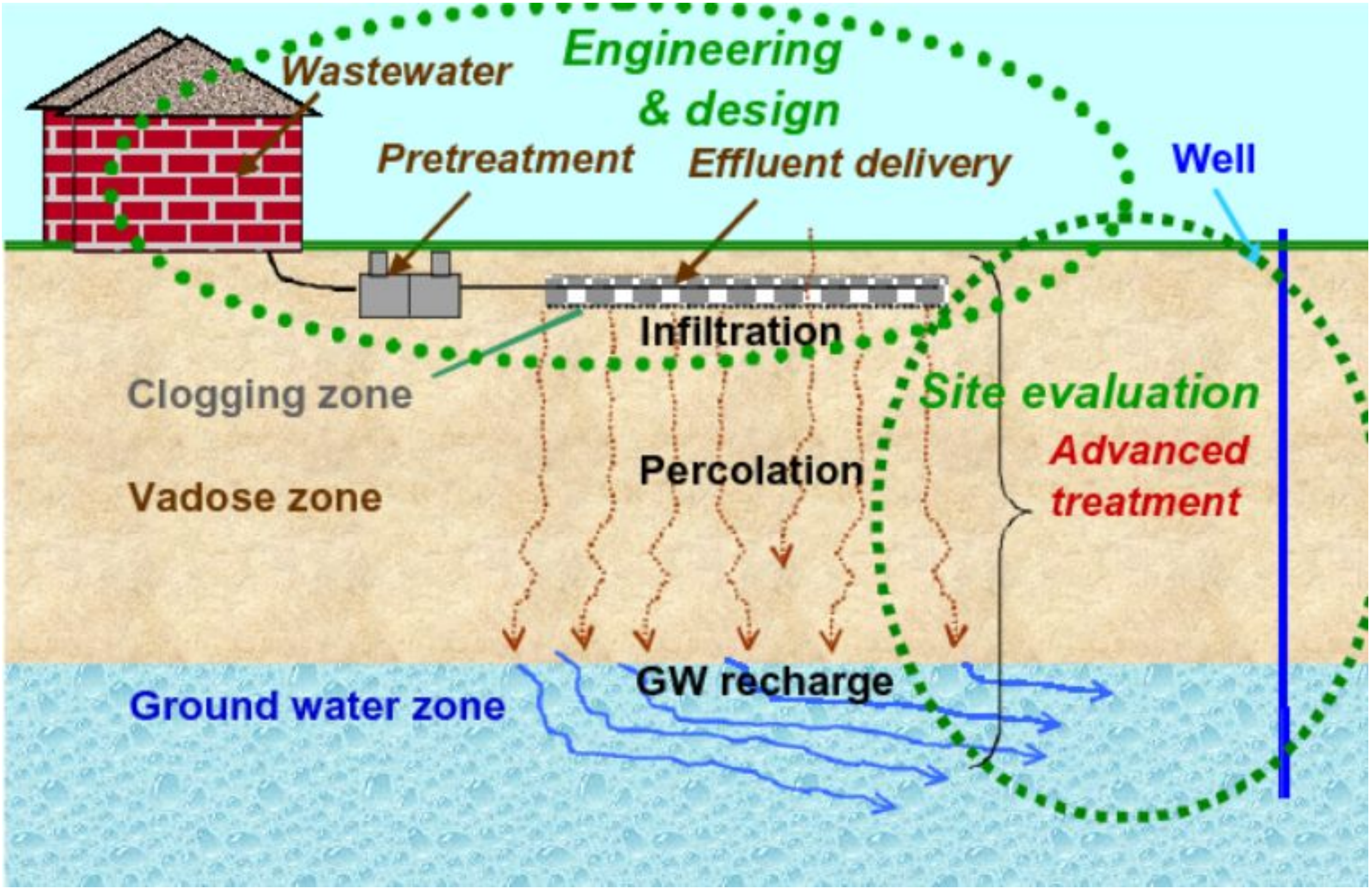
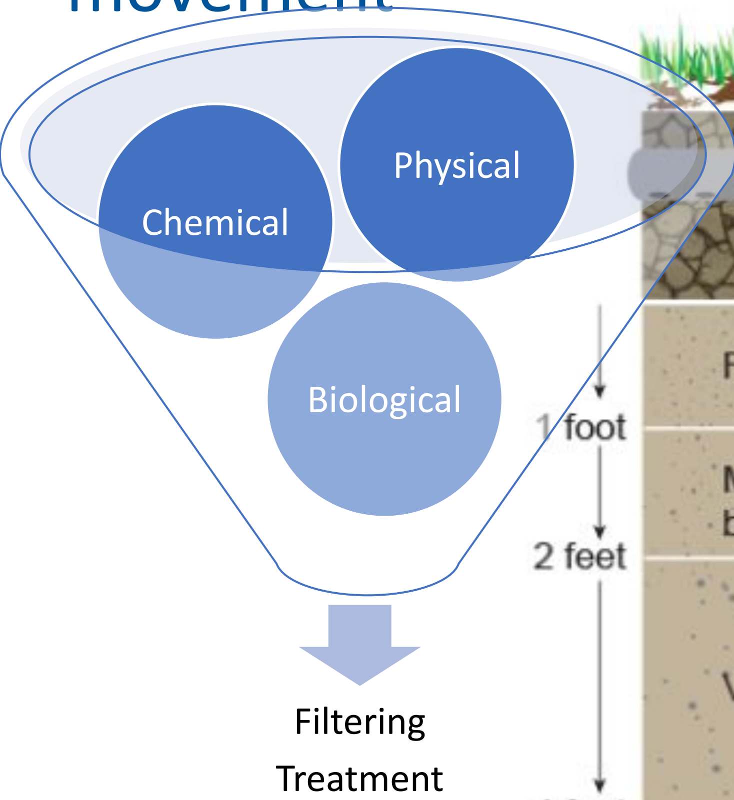
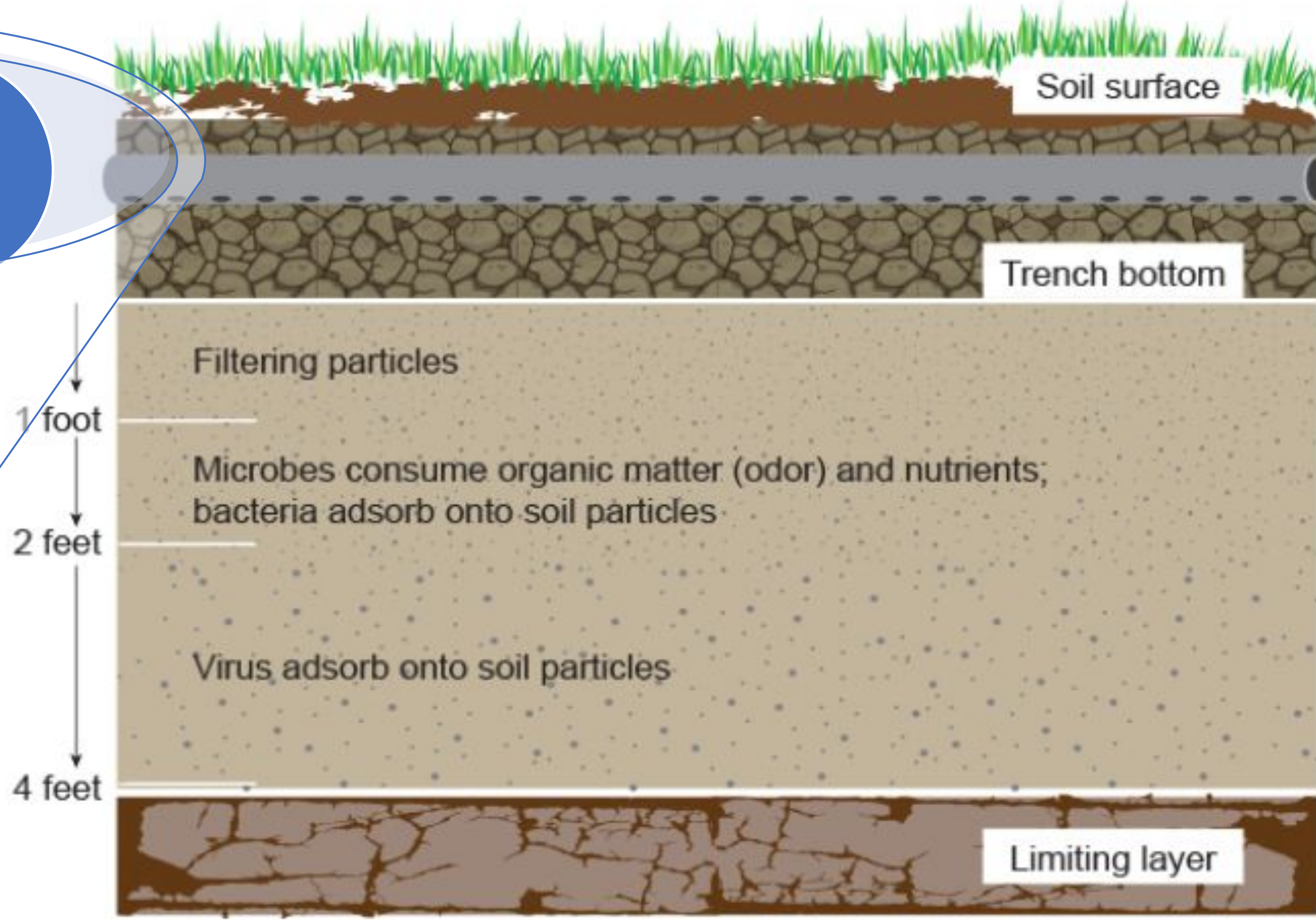


Siegrist, Robert L. et al. “Design and Performance of Onsite Wastewater Soil Absorption Systems Prepared.” (2000).

Treatment in the soil depends on soil properties and water movement





OSU extension
https://ohioline.osu.edu/factsheet/aex-745

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Understanding soil information is key to a successful system

- Vertical separation to water table
- Soil properties affecting treatment
  - High groundwater
  - Impermeable layers
  - Excessive permeability
  - Shallow bedrock
  - Texture
  - Structure
  - Consistence
  - Landscape position

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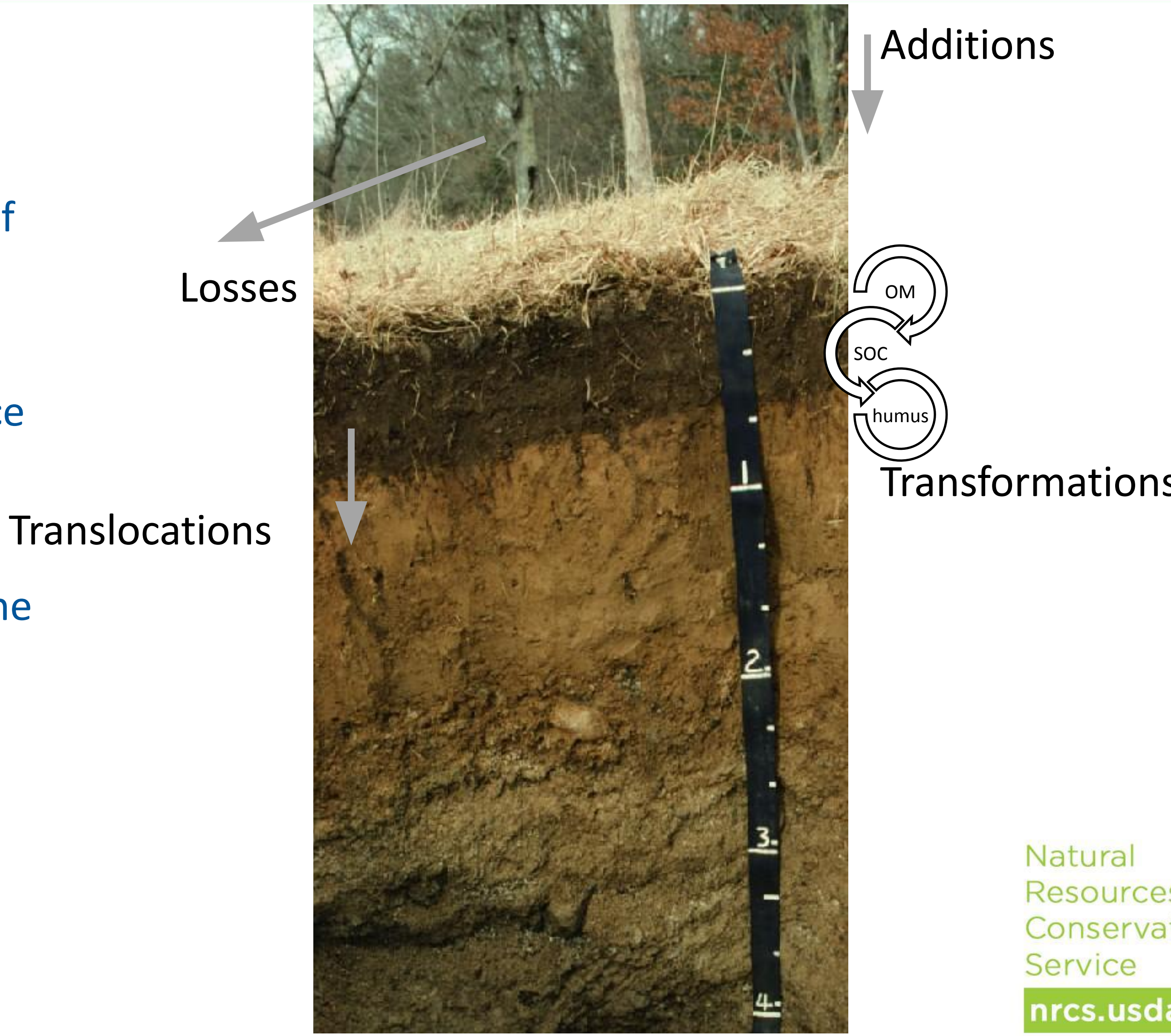
Soil: A natural body comprised of mineral and organic matter, liquids and gases, on the land surface that has layers distinguishable from the initial material and/or the ability to support rooted plants in a natural environment.



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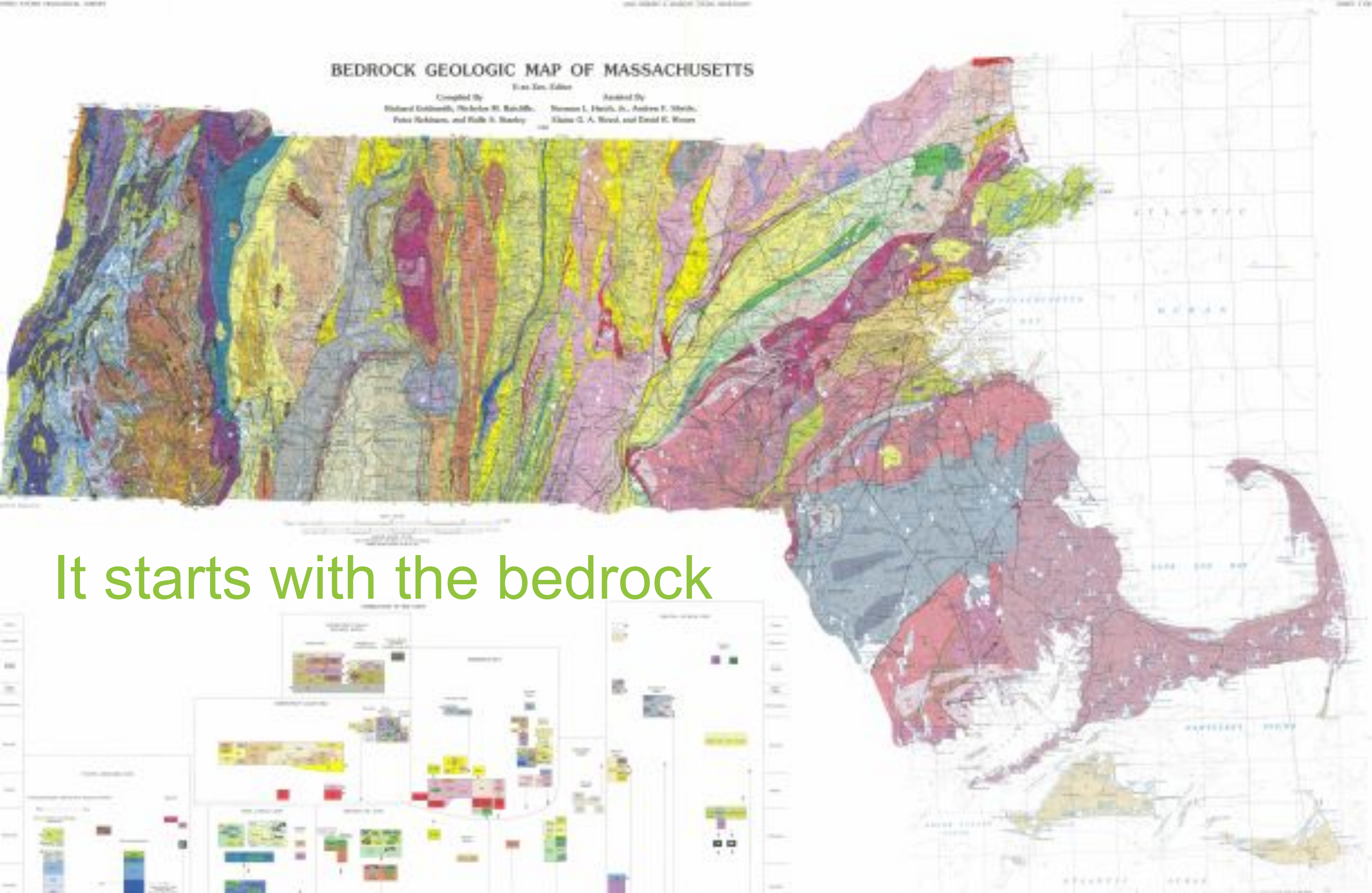

It starts with the bedrock

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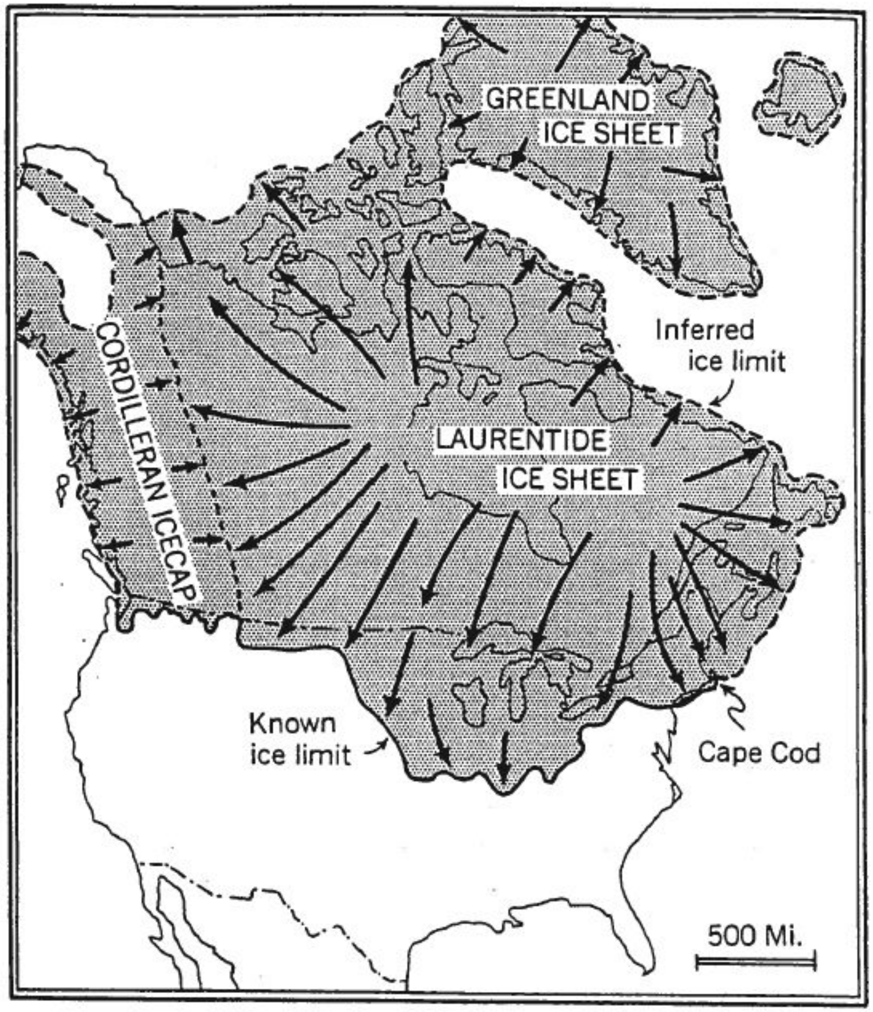
And then…

- Pleistocene Epoch (Ice Age) - 1.8 MYBP to 8 KYBP.
  - Maximum extent aprox. 20,000 YBP
  - Ended aprox. 10,000 YBP
- Wisconsinan advance covered all of New England to Long Island



A Geologist's View of Cape Cod - Authur N. Strahler

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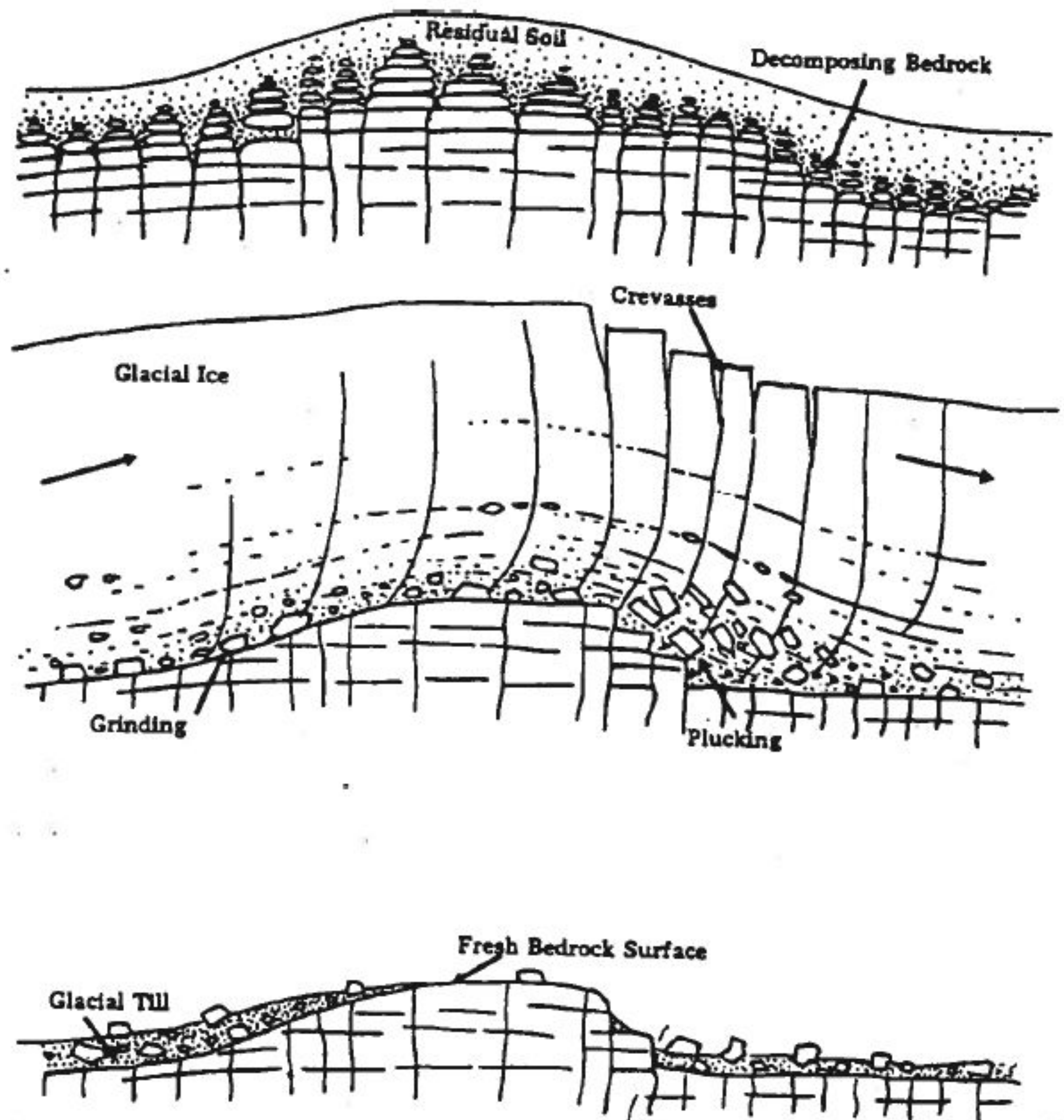
Resulting in: Glacial Parent Materials

GLACIAL

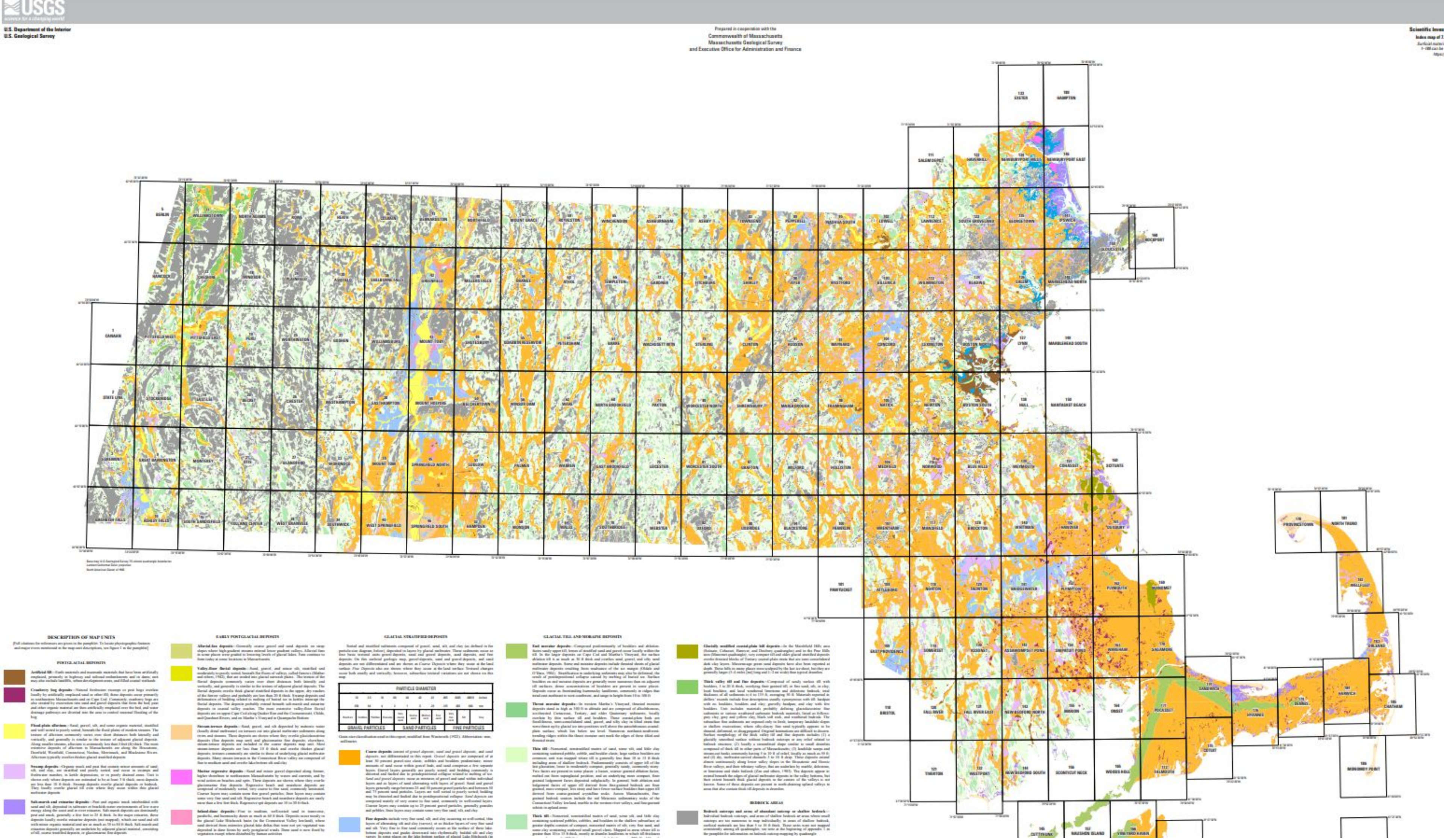
- Till
  - subglacial/lodgment
  - supraglacial/ablation
- Glaciofluvial
- Glaciolacustrine/ Glaciomarine

POST-GLACIAL

- Eolian
- Organic
- Alluvium



A Guide to New England's Landscape - Neil Jorgensen



Surficial Materials of Massachusetts

https://pubs.usgs.gov/publication/sim3402

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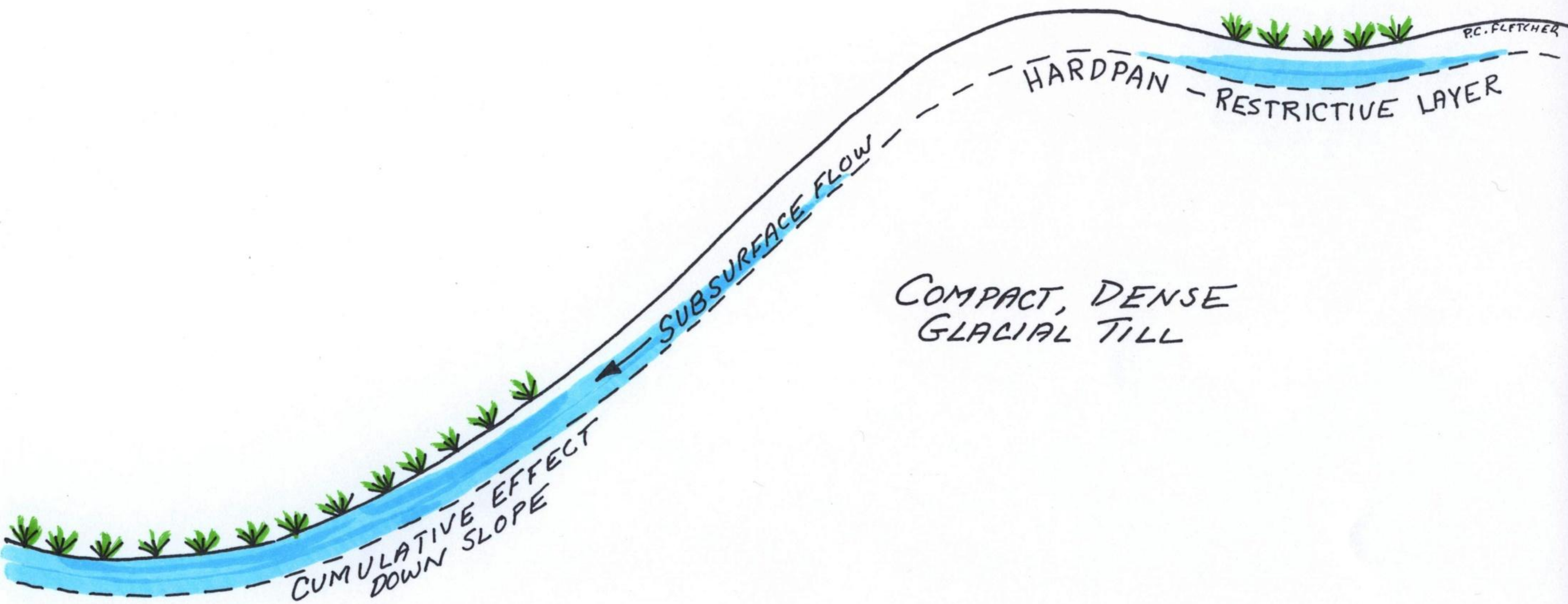
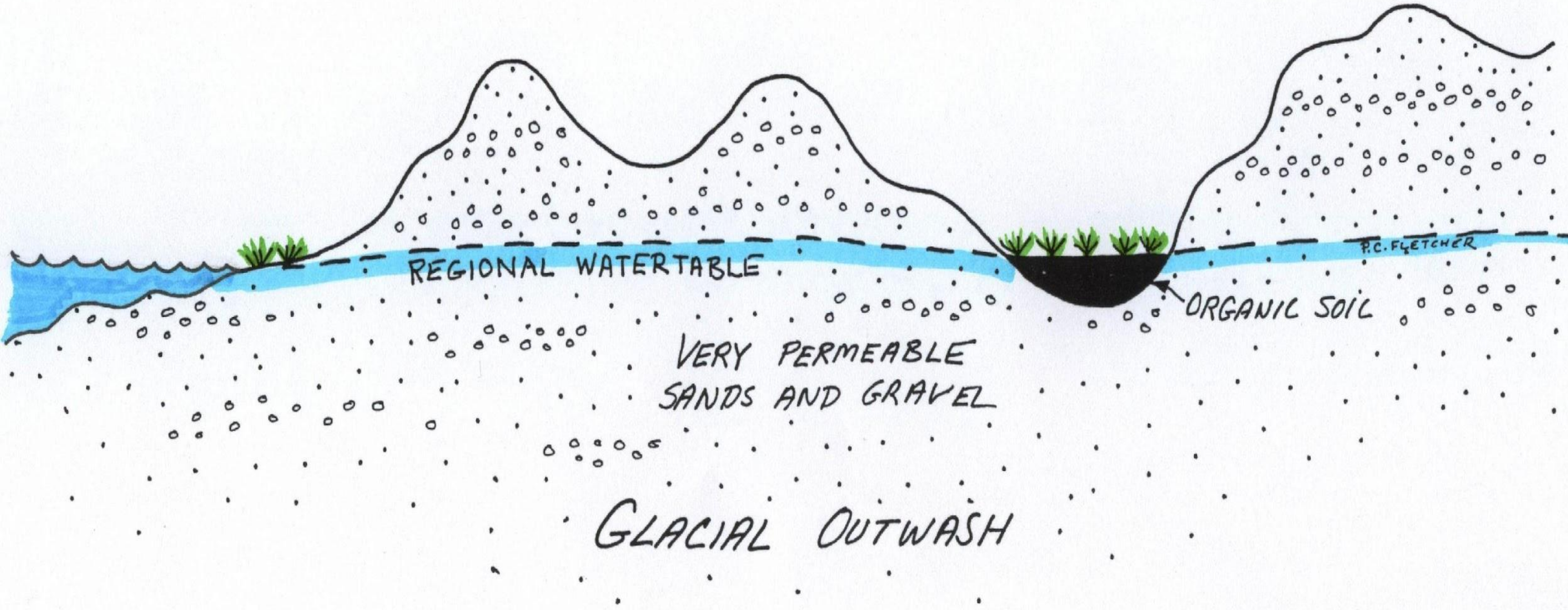
Compact Till Landscape – restrictive layer



Glacial Outwash - permeable sands and gravel



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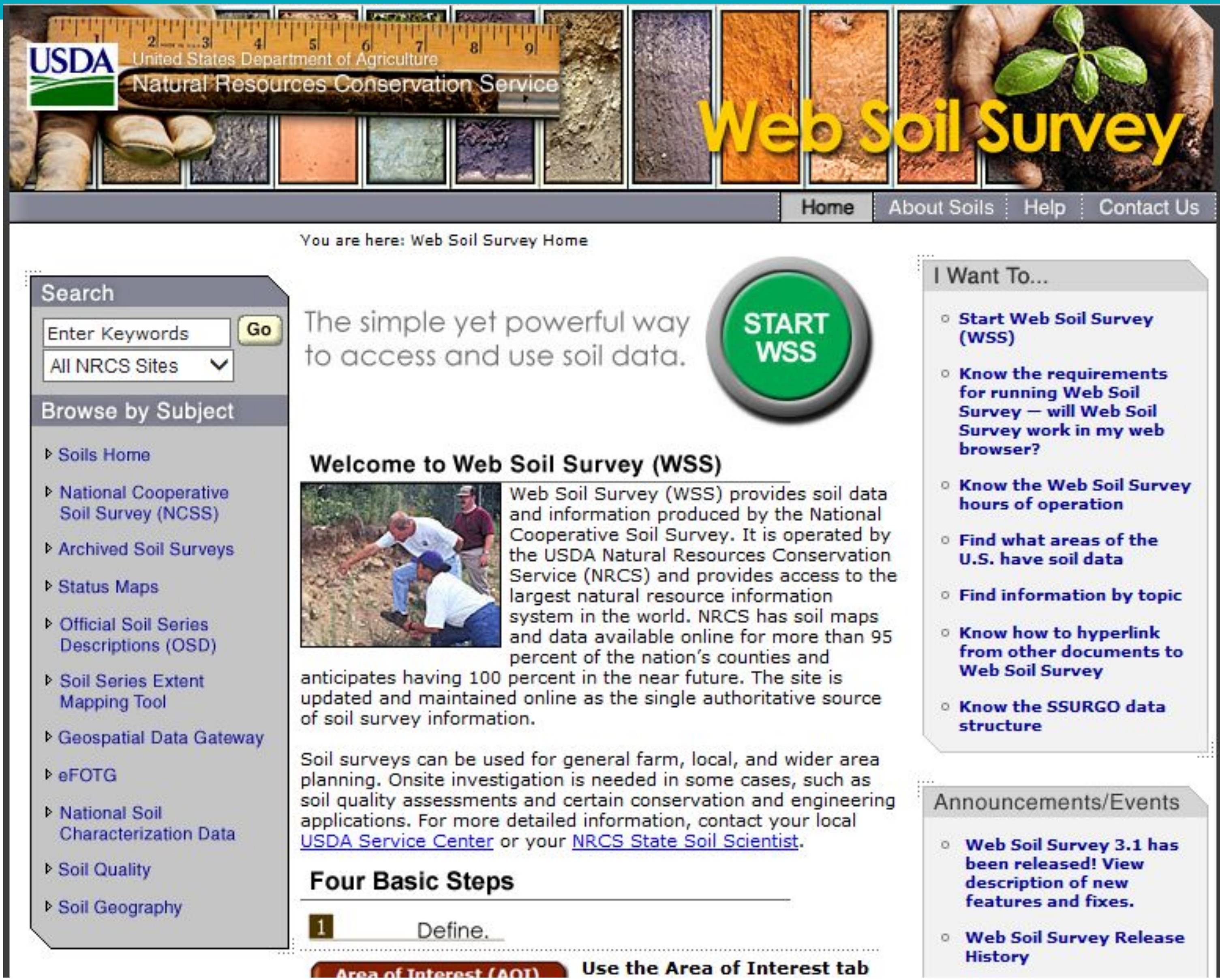

https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

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Web Soil Survey

websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

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Web Soil Survey

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Area of Interest (AOI) | **Soil Map** | Soil Data Explorer | Download Soils Data | Shopping Cart (Free)

Printable Version | Add to Shopping Cart

Search

Map Unit Legend

Barnstable County, Massachusetts (MA001)

Barnstable County, Massachusetts (MA001)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	29.3	2.1%
11A	Berryland mucky loamy coarse sand, 0 to 2 percent slopes	15.3	1.1%
53A	Freetown muck, ponded, coastal lowland, 0 to 1 percent slopes	7.5	0.5%
54A	Freetown and Swansea mucks, coastal lowland, 0 to 1 percent slopes	19.0	1.4%
55A	Freetown coarse sand, 0 to 3 percent slopes, sanded surface	7.0	0.5%

Legend

Soil Map

Scale (not to scale)

Warning: Soil Map may not be valid at this scale.

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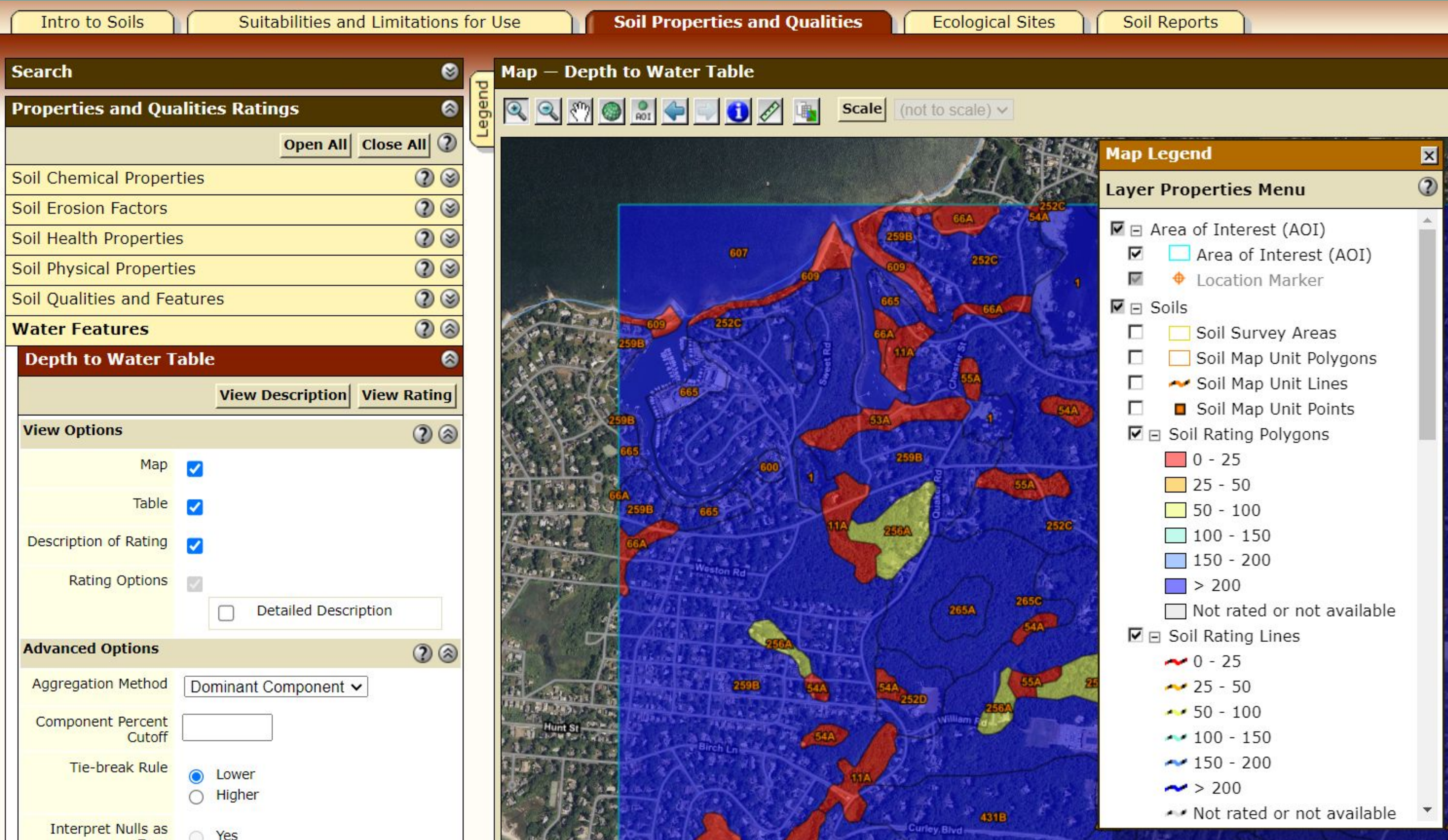

Groundwater

Water found in cracks, fissures, and pore spaces in the saturated zone below the ground surface, including but not limited to perched groundwater.

Kinds of Groundwater Systems

Unconfined, true or apparent water table

Perched water table

Confined, artesian effect

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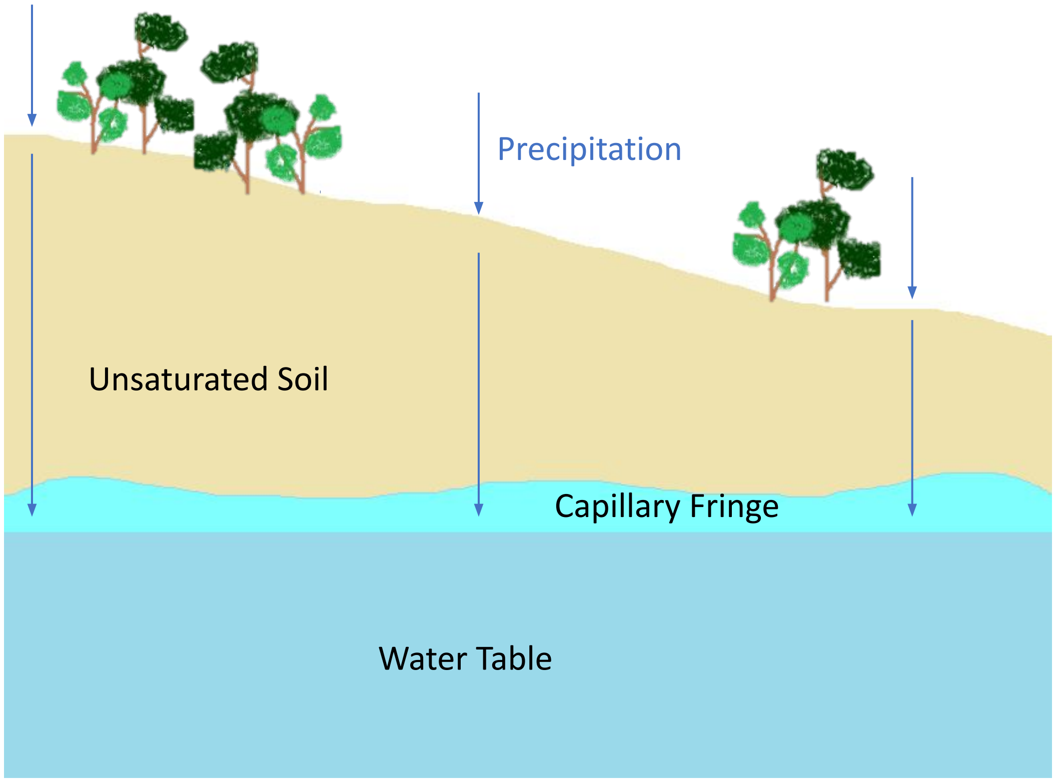
Unconfined Groundwater System



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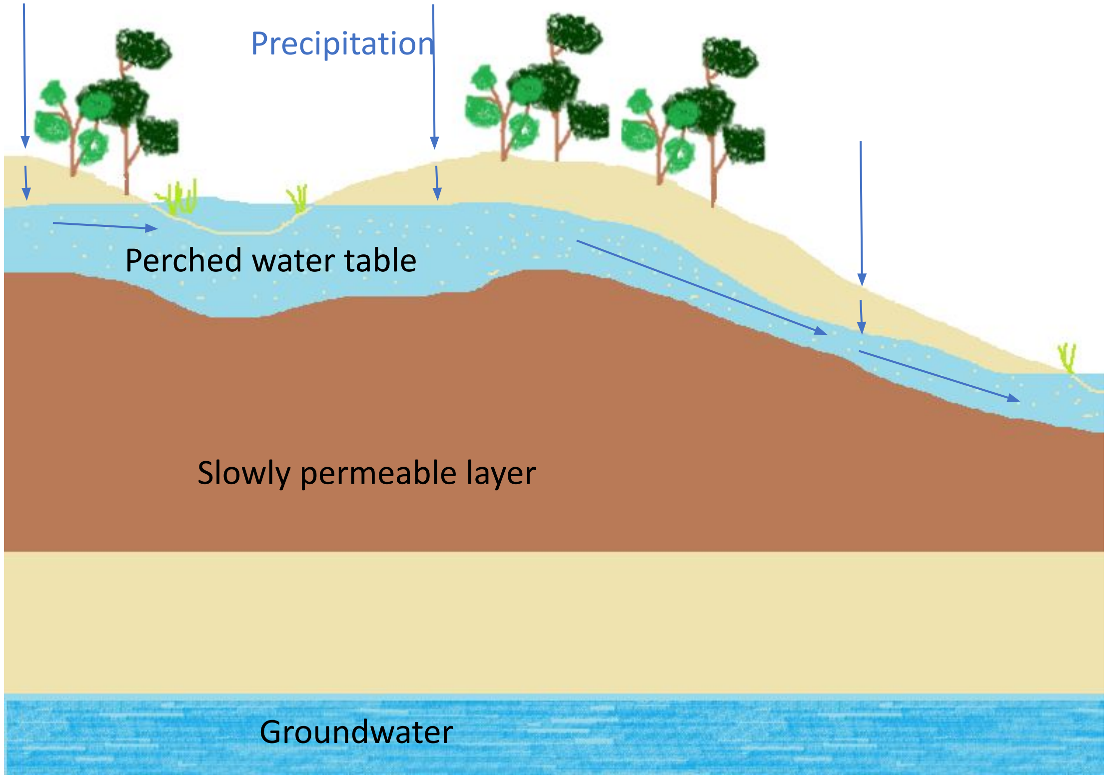
Perched groundwater system
Soils with a limiting layer – dense till/ impermeable bedrock



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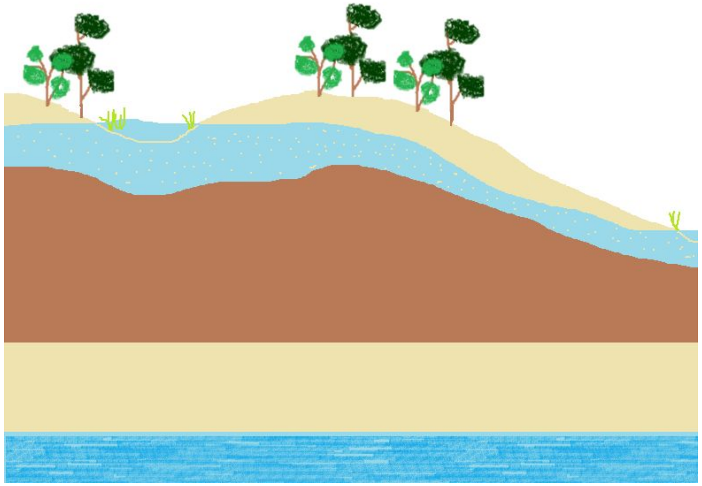
Soil Properties affecting water movement

- Texture
- Structure
- Depth
  - To water
  - To impermeable or less permeable layer



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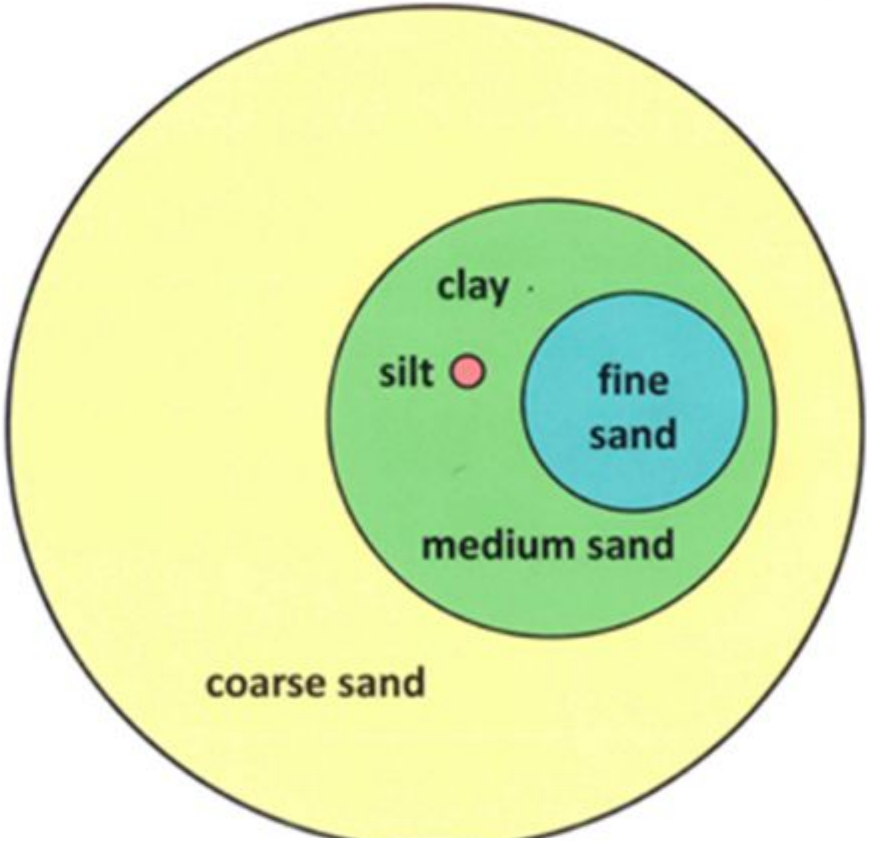
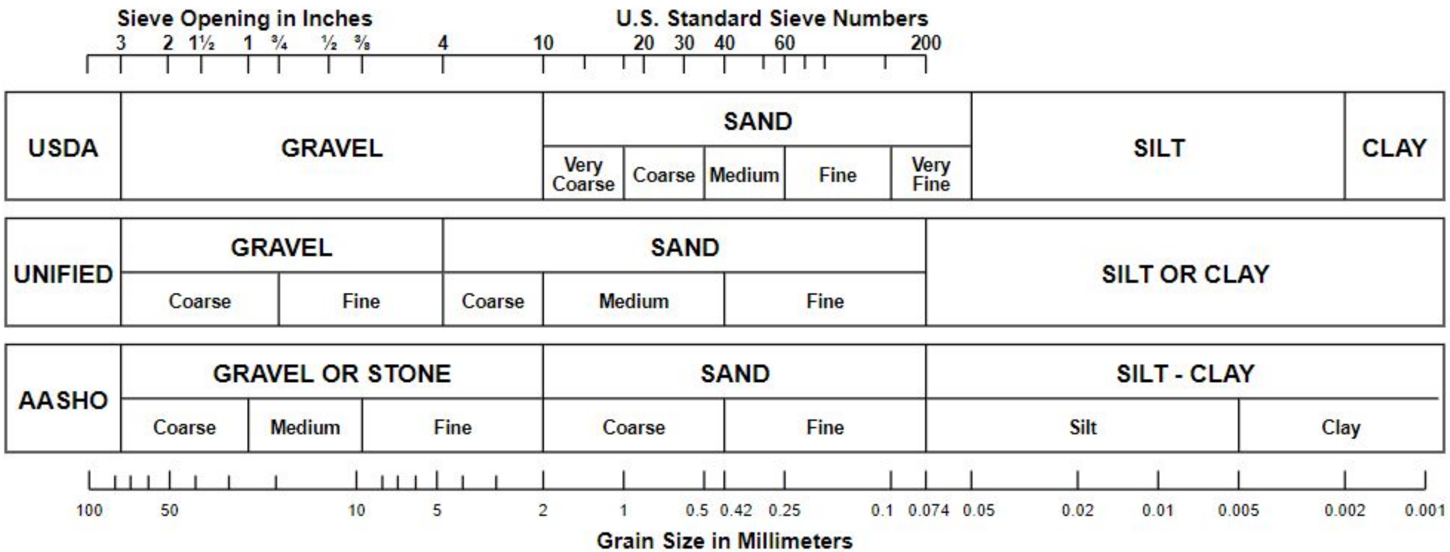
Soil Texture

The proportion of
- Sand (0.05-2.0 mm)
- Silt (0.002-0.05 mm)
- Clay (<0.002 mm)

Anything larger is gravel, stones, boulders





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Clay size particles

- <0.002 mm
- When wet – very smooth, sticky, forms a strong ribbon
- When dry – extremely firm and requires strong pressure to crush
- Dirties pores of one’s hands
- Particles stay suspended in water for long periods of time

Clay size particles

- <0.002 mm
- When wet – very smooth, sticky, forms a strong ribbon
- When dry – extremely firm and requires strong pressure to crush
- Dirties pores of one's hands
- Particles stay suspended in water for long periods of time

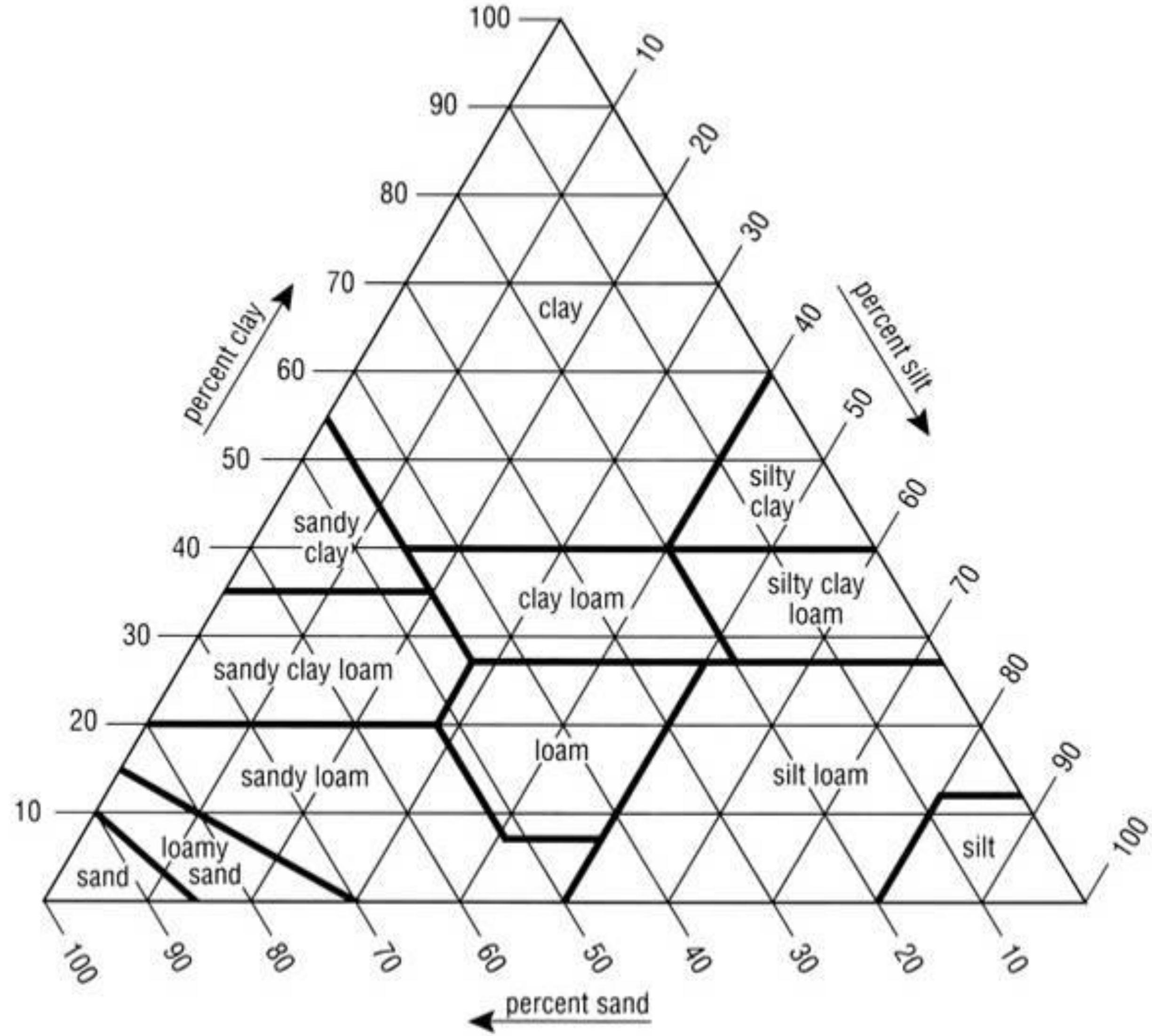
Silt size particles

- 0.002 to 0.05 mm
- Very smooth, non gritty feel like flour or talcum powder
- When wet – slightly to non sticky, forms a weak ribbon
- When dry – crushes with moderate pressure
- Dirties pores of one’s hands
- Particle will suspend in water when mixed

Sand size particles

- 0.05 to 2 mm
- Largest size class and is further divided into subcategories.
  - Very coarse sand (1 to 2 mm)
  - Coarse sand (0.5 to 1 mm)
  - Medium sand (0.25 to 0.5 mm)
  - Fine Sand (0.1 to 0.25 mm)
  - Very fine sand (0.05 to 0.1 mm)
- Composed mainly of weathered grains of quartz.
  - Sand is gritty to the touch.
  - Sand grains will not stick to each other.
- Non sticky
- Hands can be wiped clean
- Particles do not suspend in water

Texture = Relative proportion of sand, silt, and clay sized particles



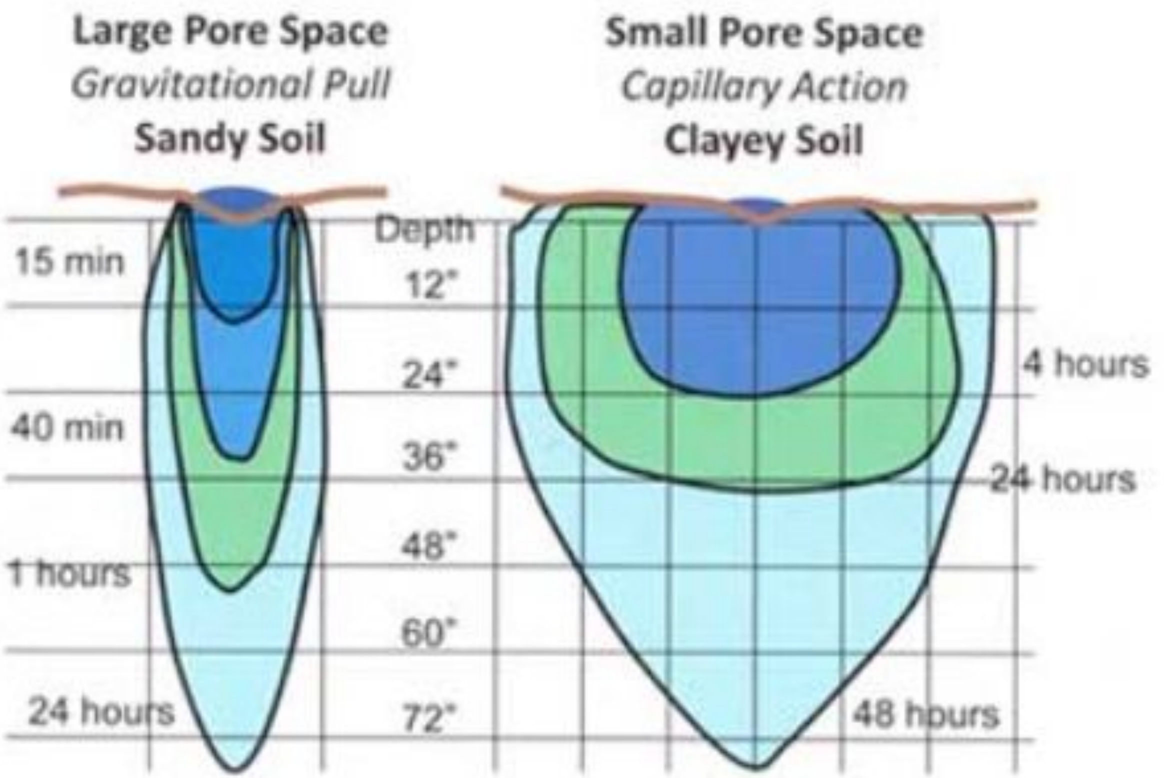
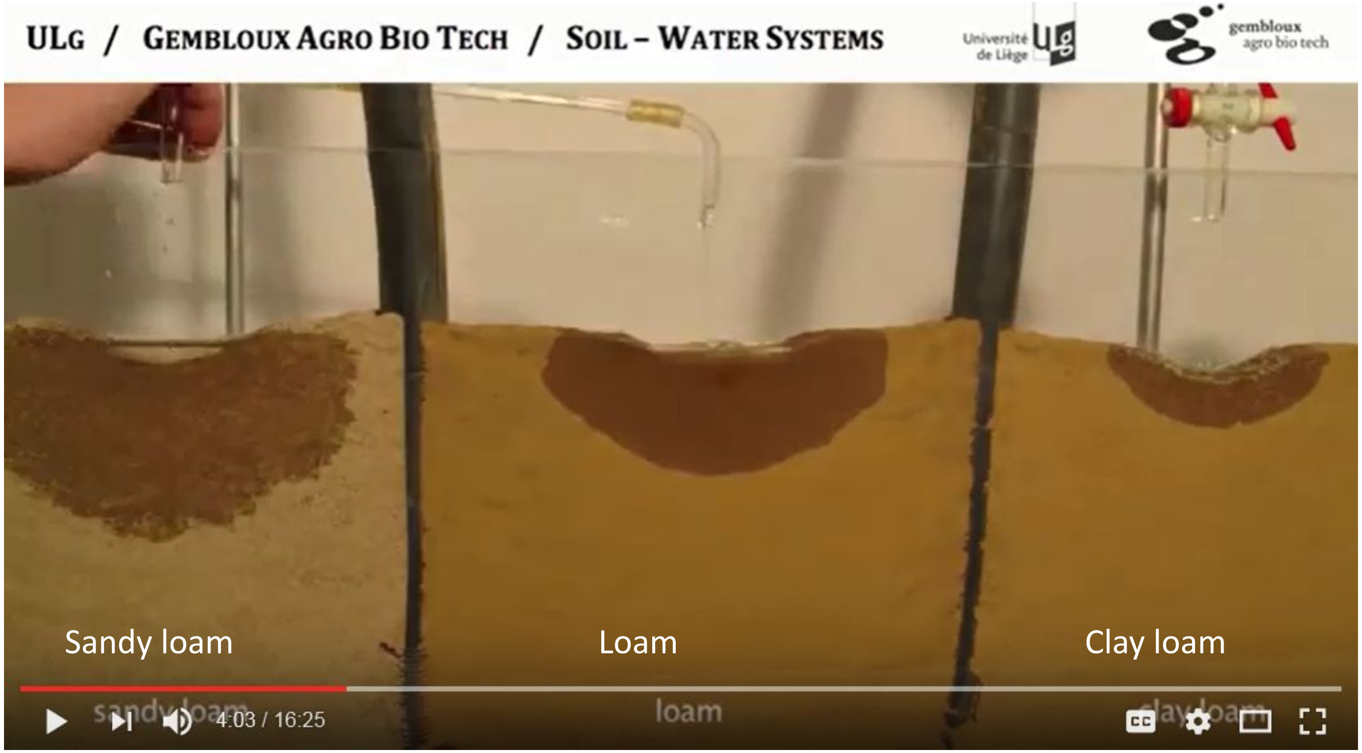


Figure 1: Comparison of water movement in sandy versus clayey soils. Water moves more quickly through sandy soils due to larger pore spaces and the force of gravity. In finer textured soils, water moves more slowly and is drawn through by capillary action. Figure: Colorado State Extension

Water movement in soils: texture



Water movement in soils: texture

Water movement in soils: texture

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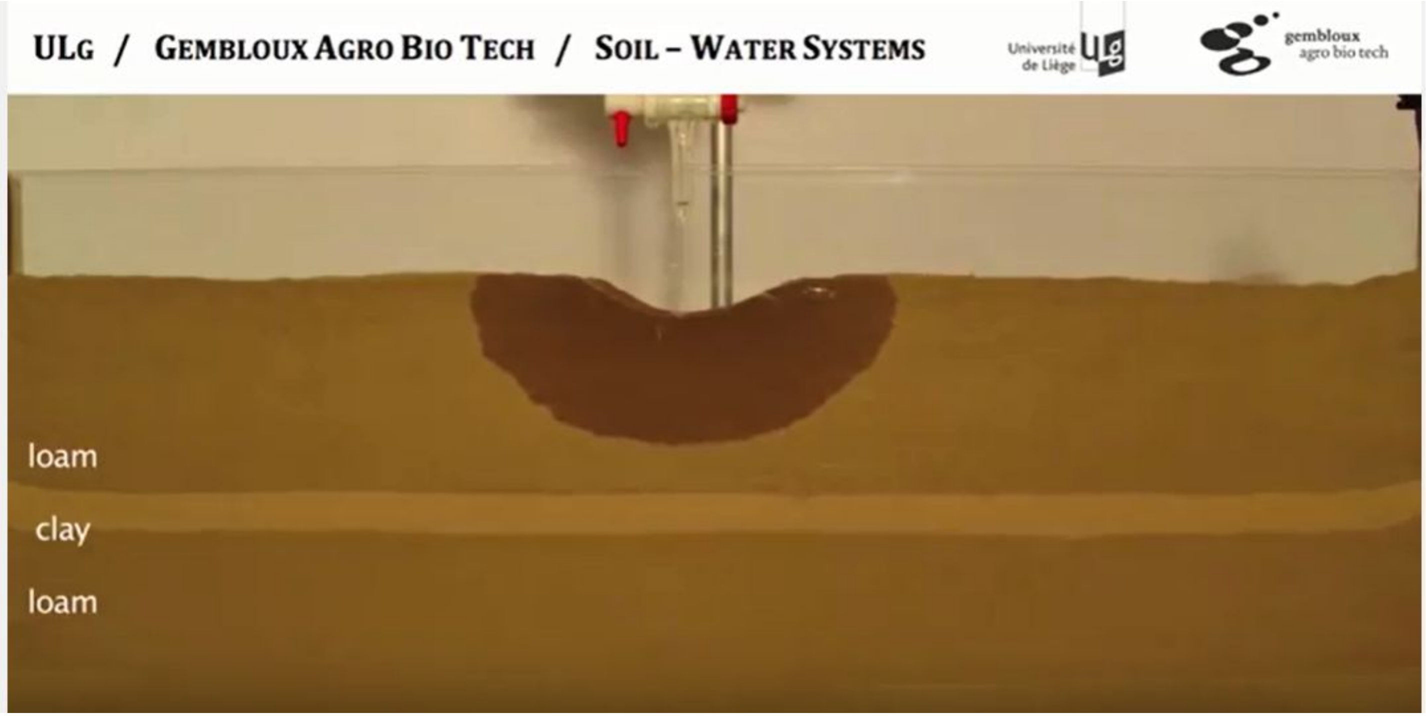
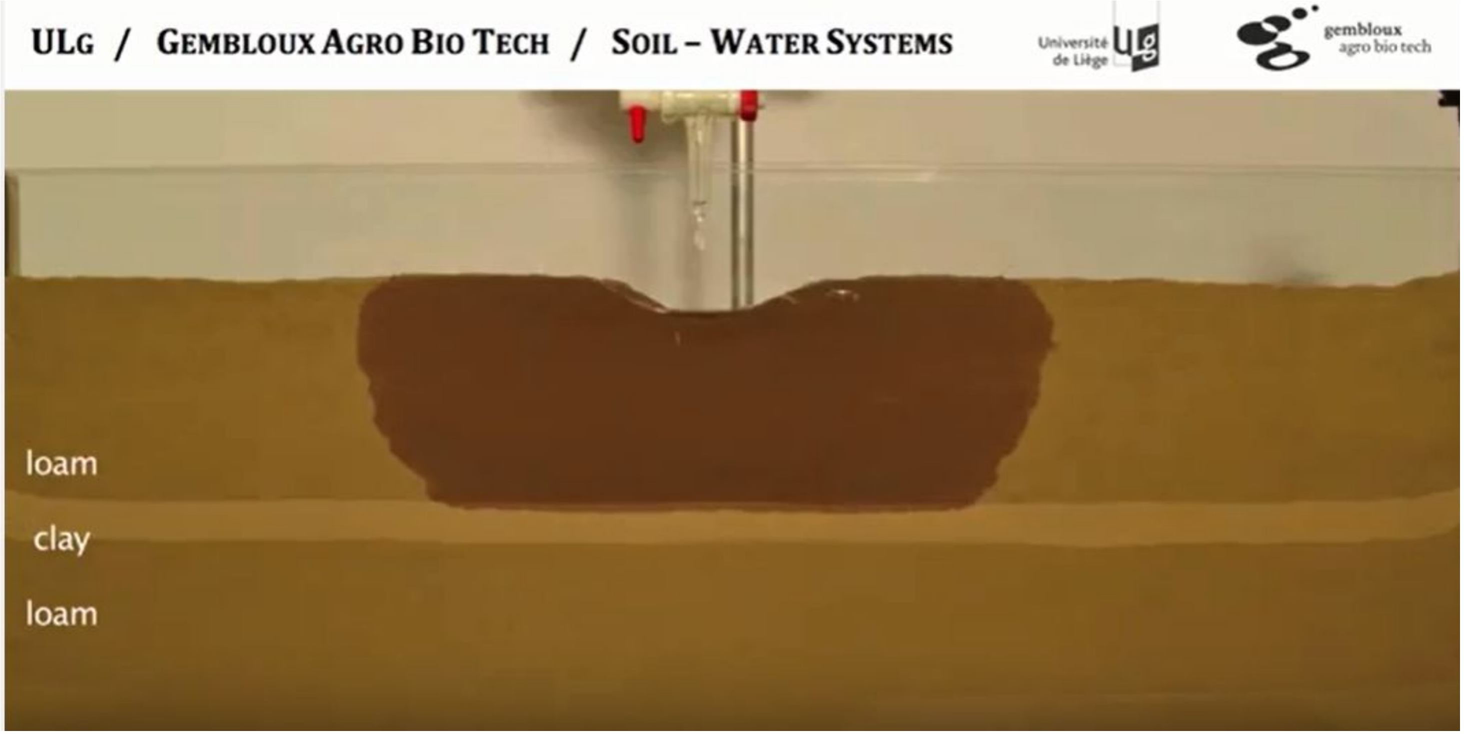
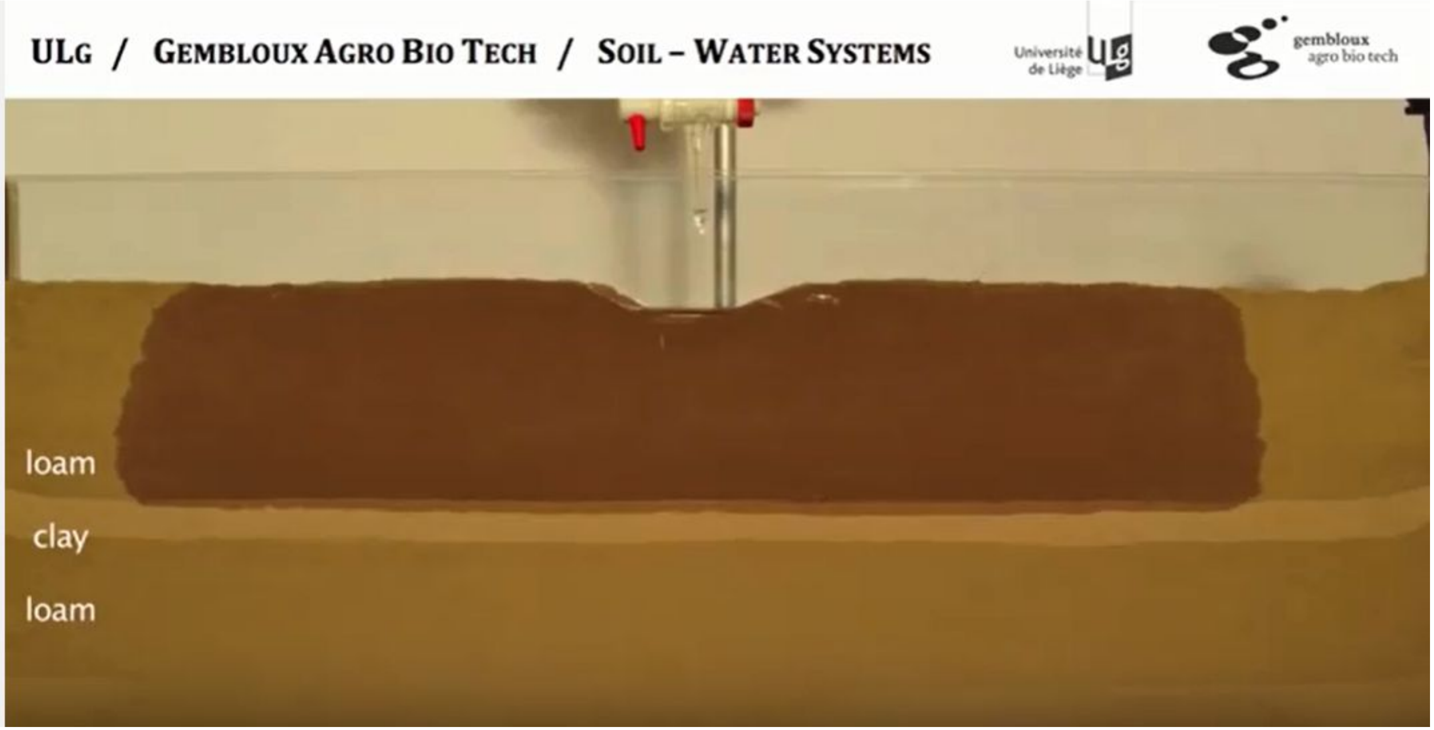
Water movement in soils: clay layer



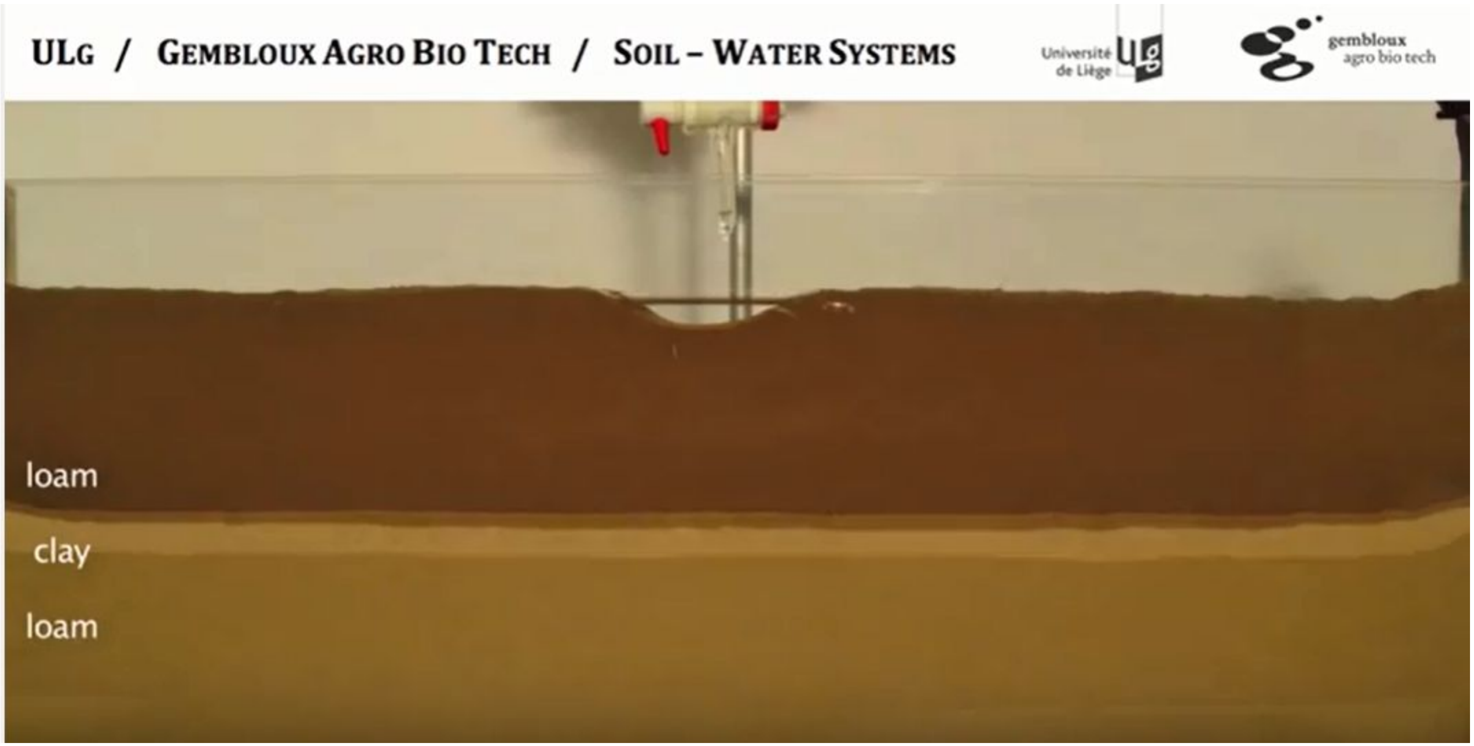
Water movement in soils: clay layer



Water movement in soils: clay layer



Water movement in soils: clay layer



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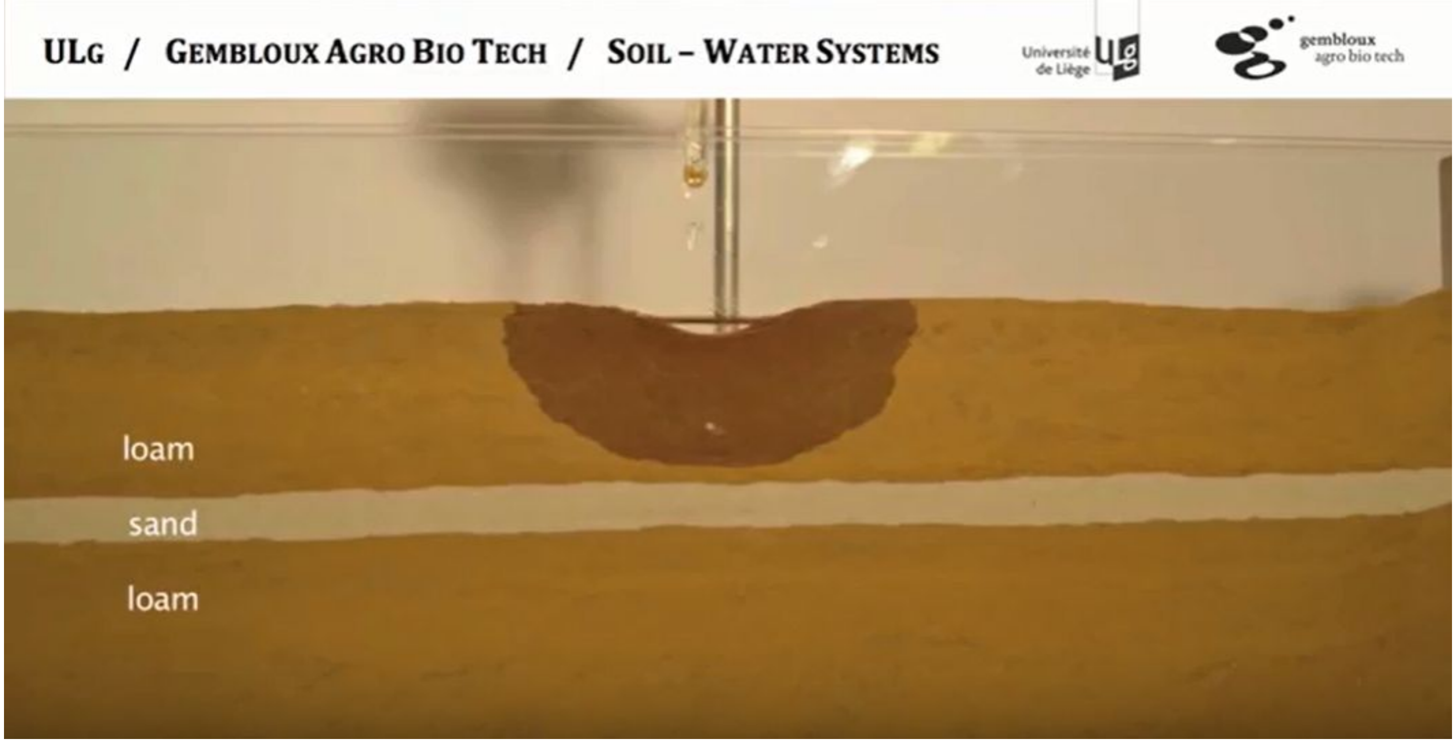
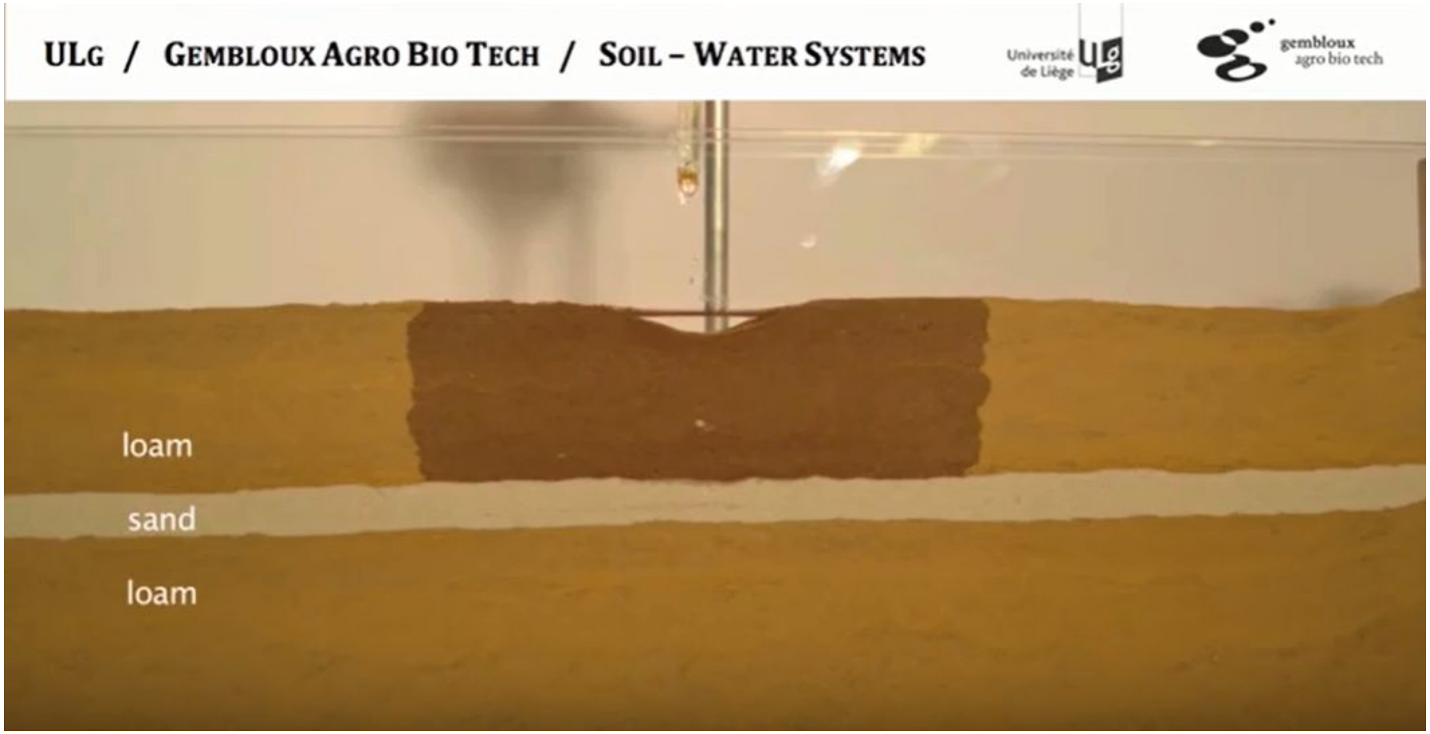
Water movement in soils: sandy layer

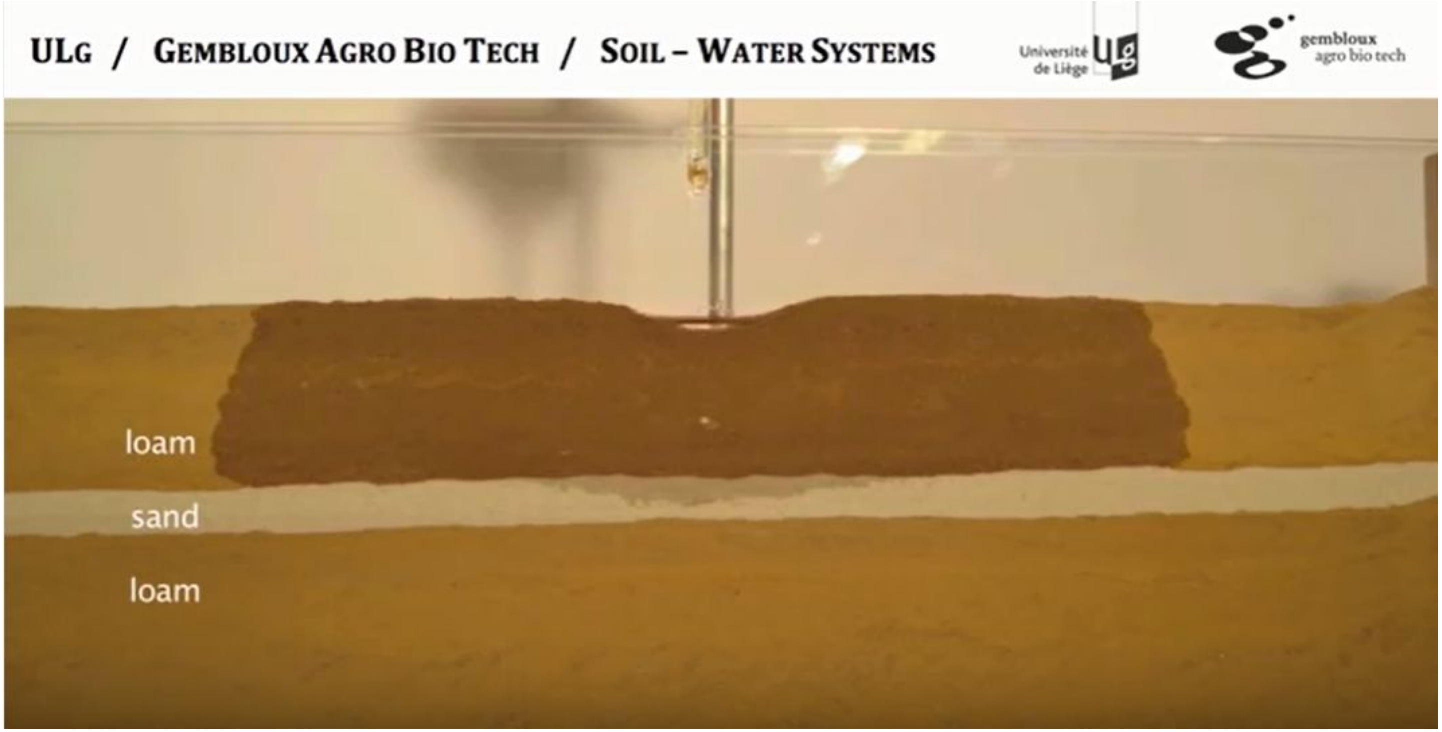


Water movement in soils: sandy layer

Water movement in soils: sandy layer



Water movement in soils: sandy layer



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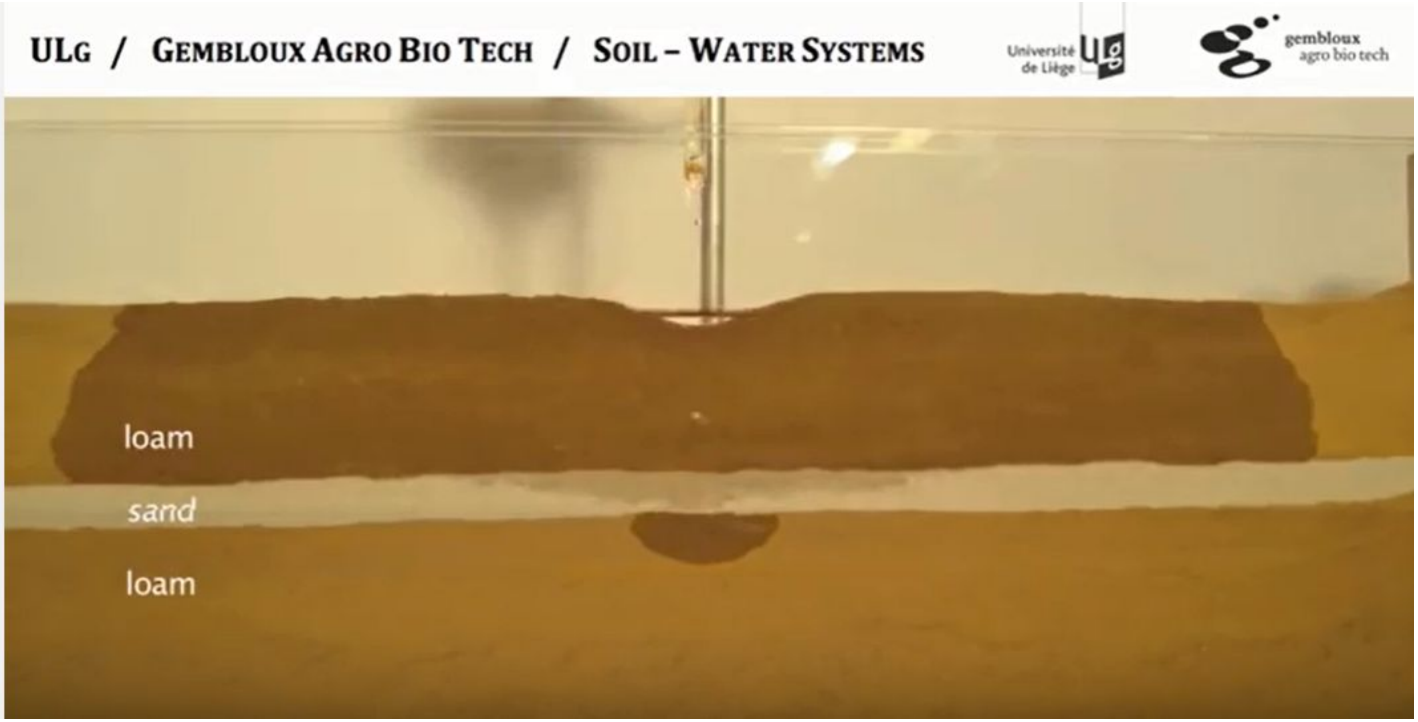
Water movement in soils: sandy layer



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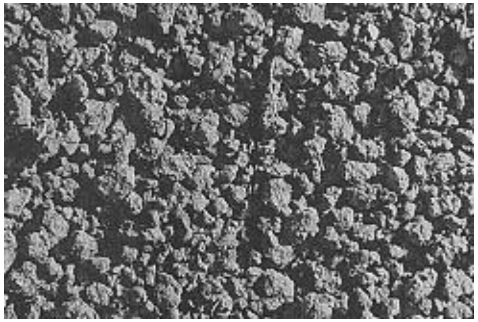
Structure

- Cohesion of particles into larger units = PEDS

Granular



Blocky

Single-Grain

USDA-NRCS Davis, CA

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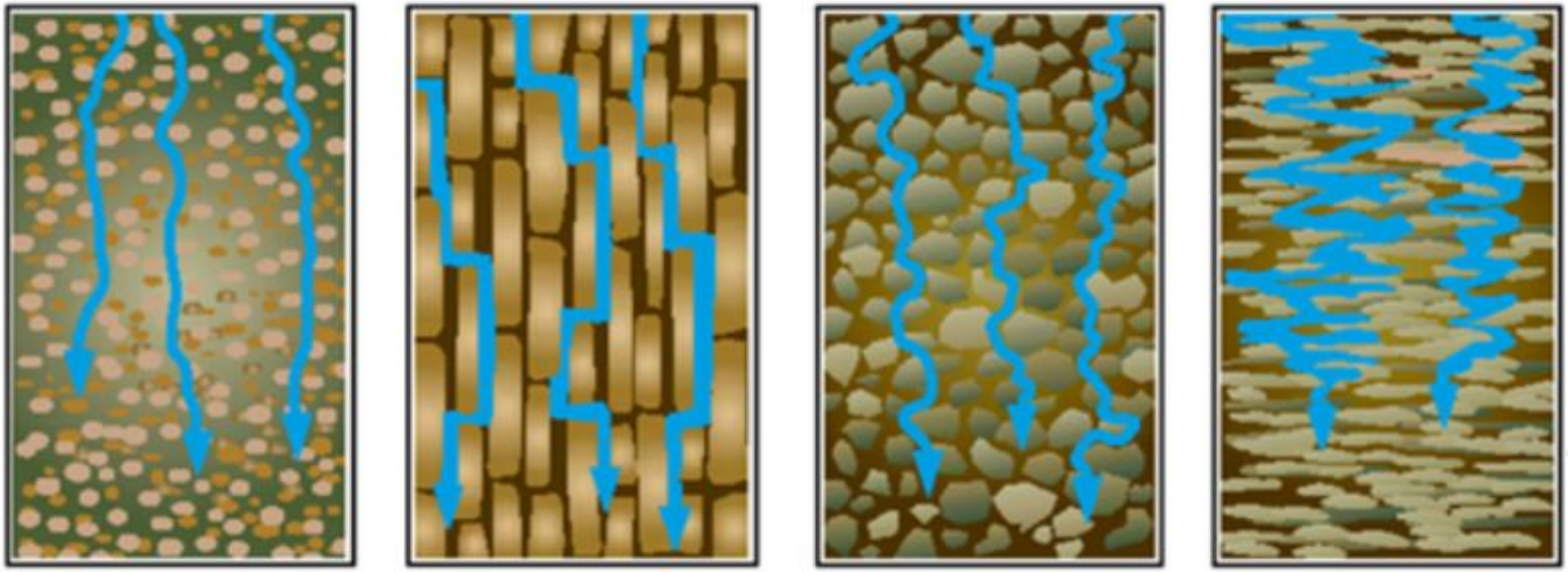
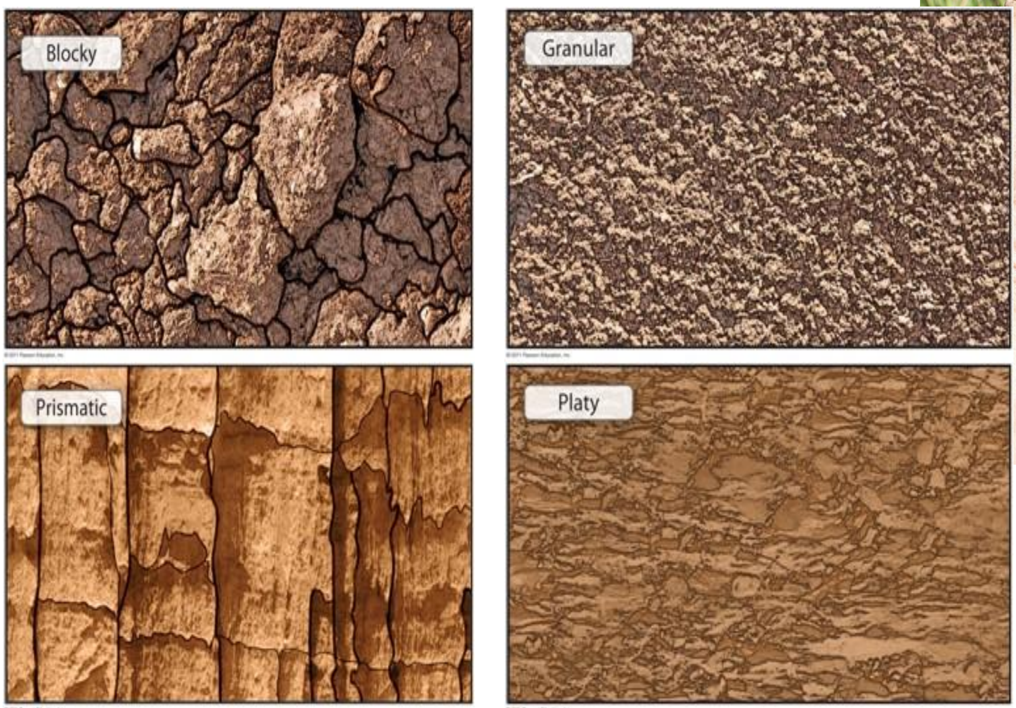
Structure



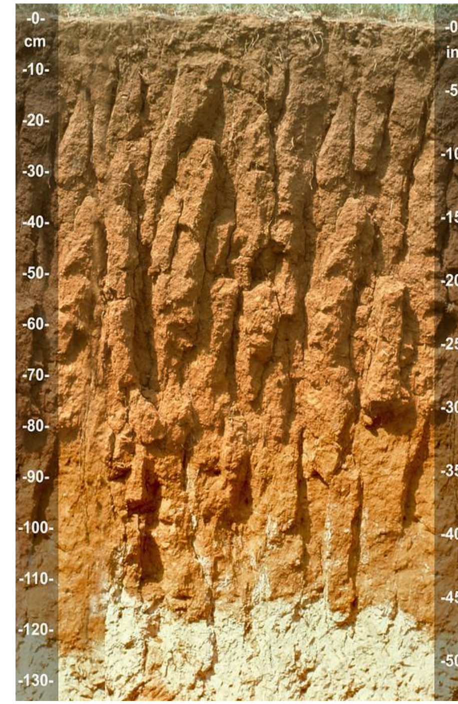
Water movement through different soil structure shapes. Developed by USDA-NRCS.

Structure

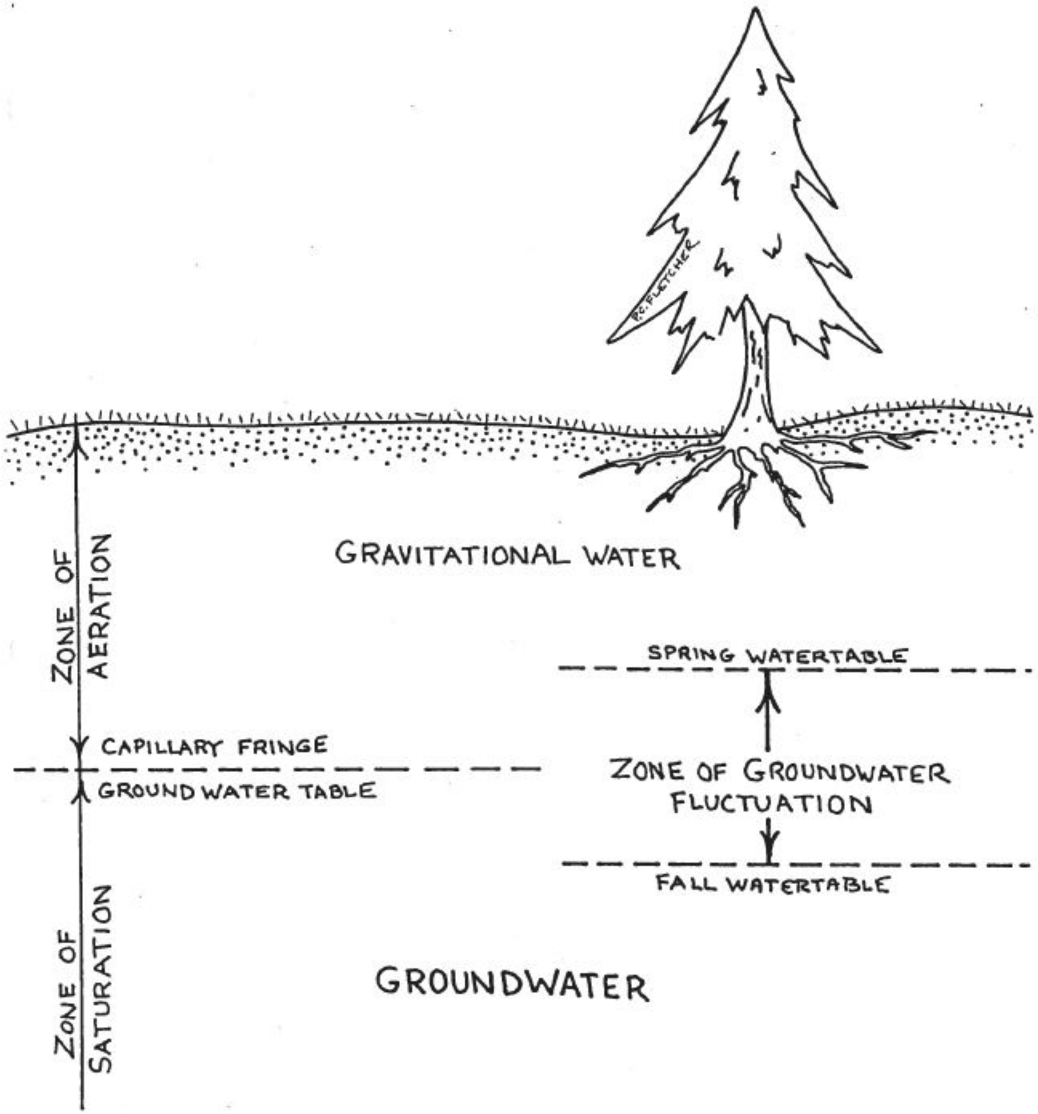
Granular, blocky, platy, prismatic



Pearson Education, Inc 2011



Photos courtesy of John Kelley

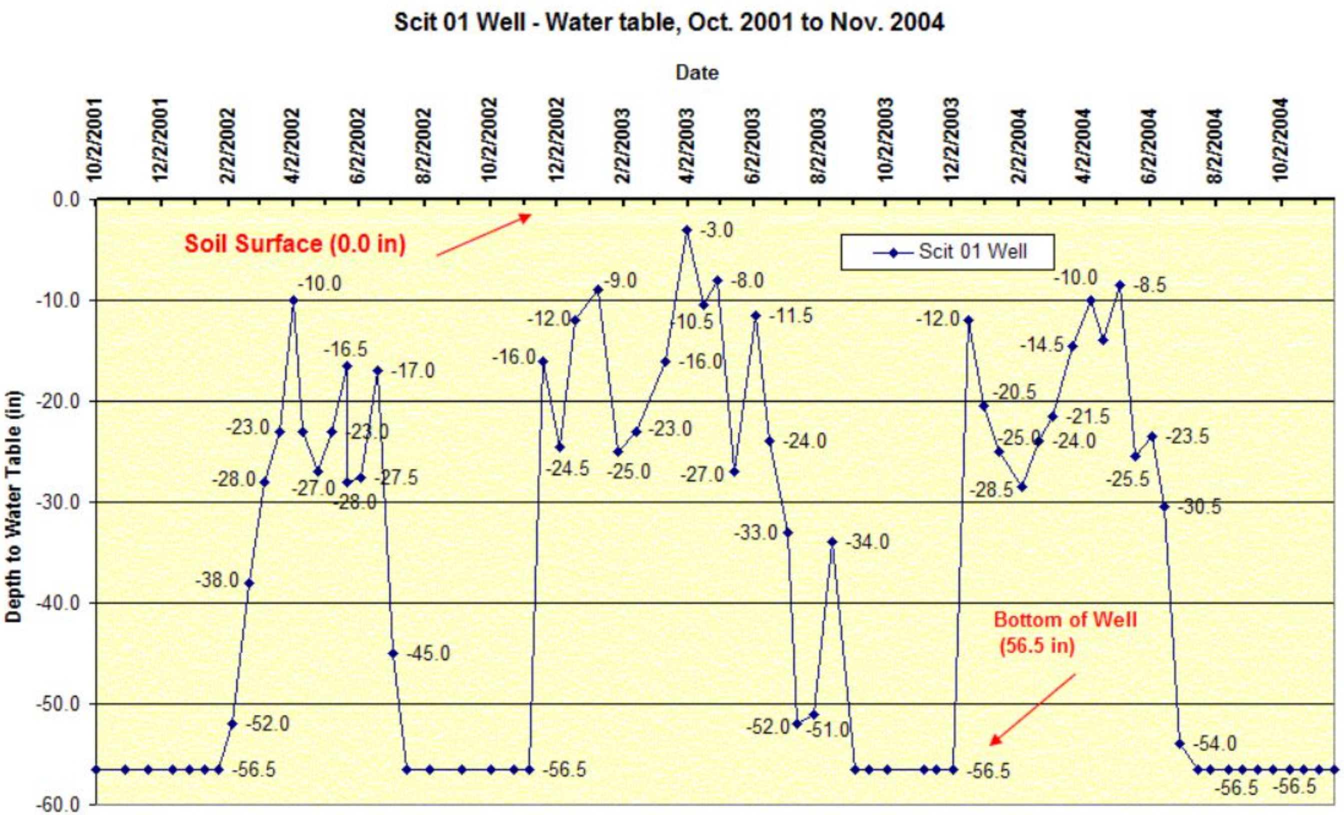

GRAVITATIONAL WATER
ZONE OF AERATION
CAPILLARY FRINGE
GROUND WATER TABLE
SPRING WATERTABLE
ZONE OF GROUNDWATER FLUCTUATION
FALL WATERTABLE
ZONE OF SATURATION
GROUNDWATER
P.C. FLETCHER

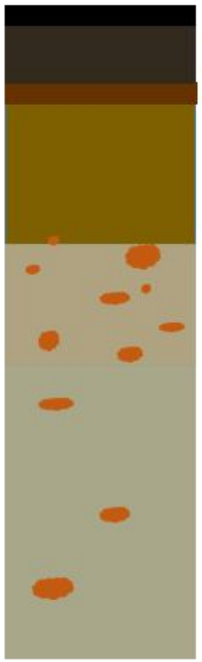
PC Fletcher

Observed Groundwater Elevation

That elevation below the ground surface at which water is observed weeping, flowing from the walls of, or standing in a deep observation hole.

Water table fluctuations





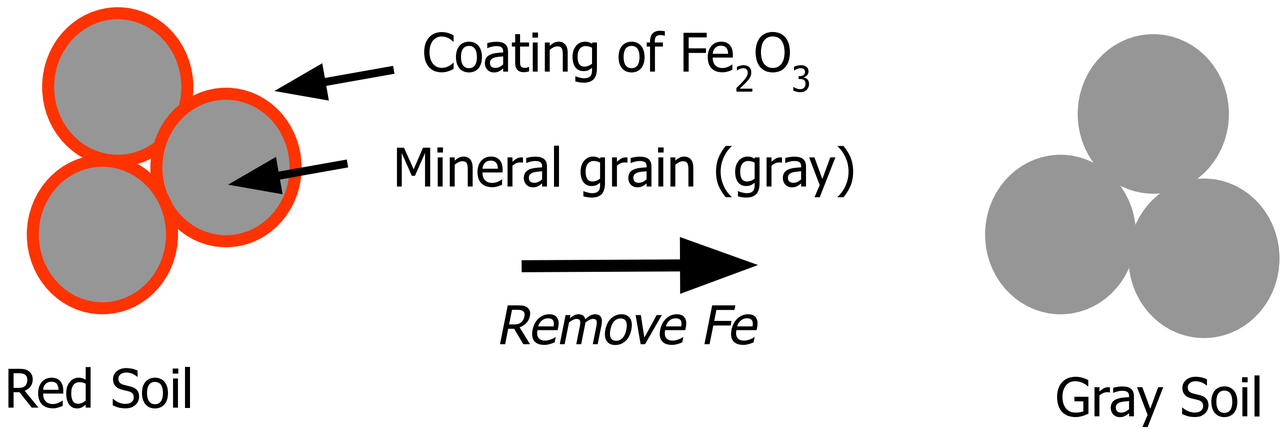
Redoximorphic Features

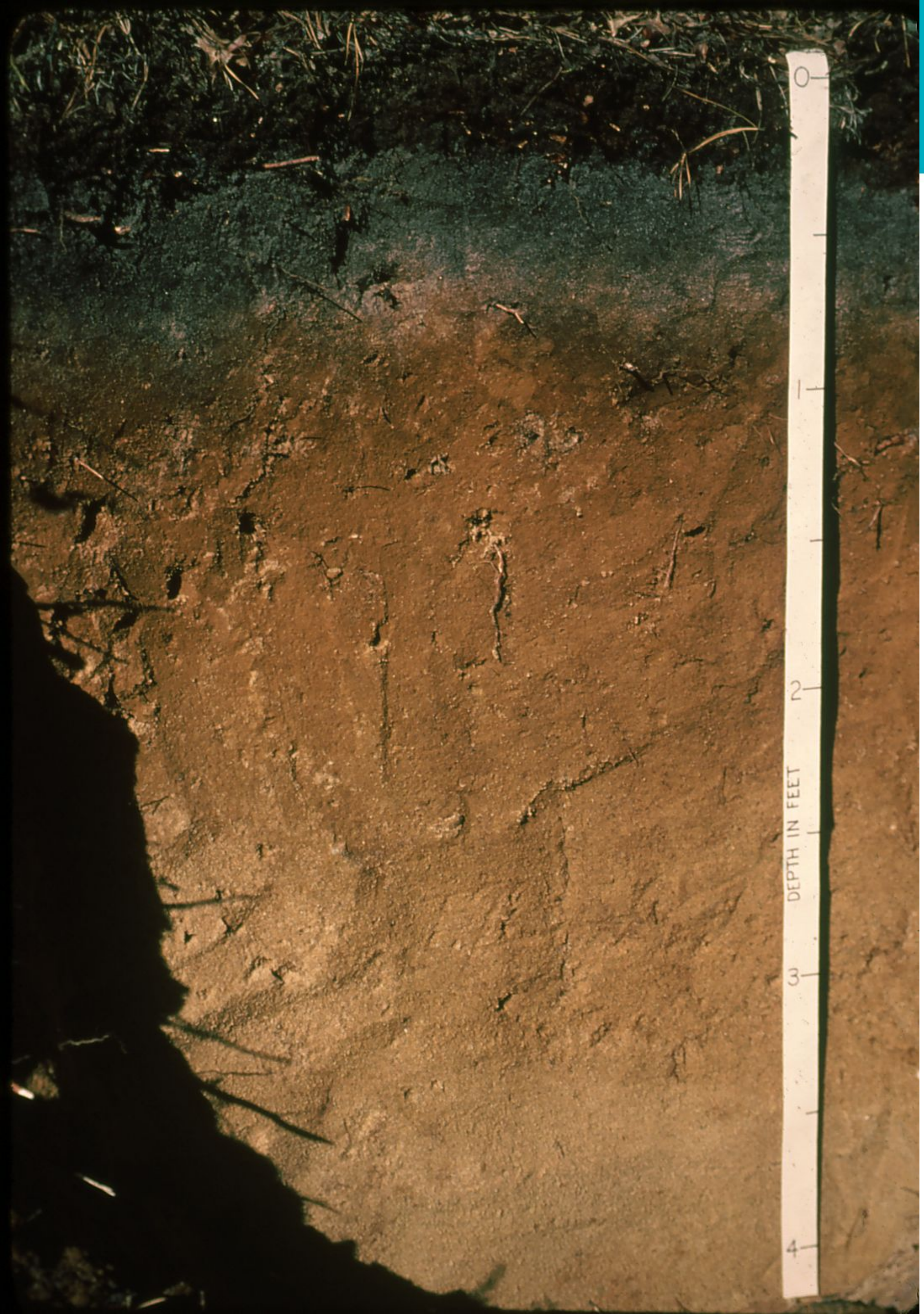
Features formed by

the processes of reduction, translocation, and/or oxidation of Iron (Fe) and Manganese (Mn) oxides

Oxidation/Reduction and Soil Color

- In subsoil horizons, Fe and Mn oxides give soils their characteristic brown, red, and yellow colors.
- When saturated and reduced, Fe and Mn are mobile and can be stripped from soil particles.
- This leaves the characteristic mineral grain color, usually a neutral gray.





Windsor Soil

Formed in thick deposits of sand

Seasonal high groundwater greater than 5 feet

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Amostown Soil

Seasonal high perched water table at 1.5 to 5 feet

Formed in sands over silts

Freetown Muck
(wetland soil)

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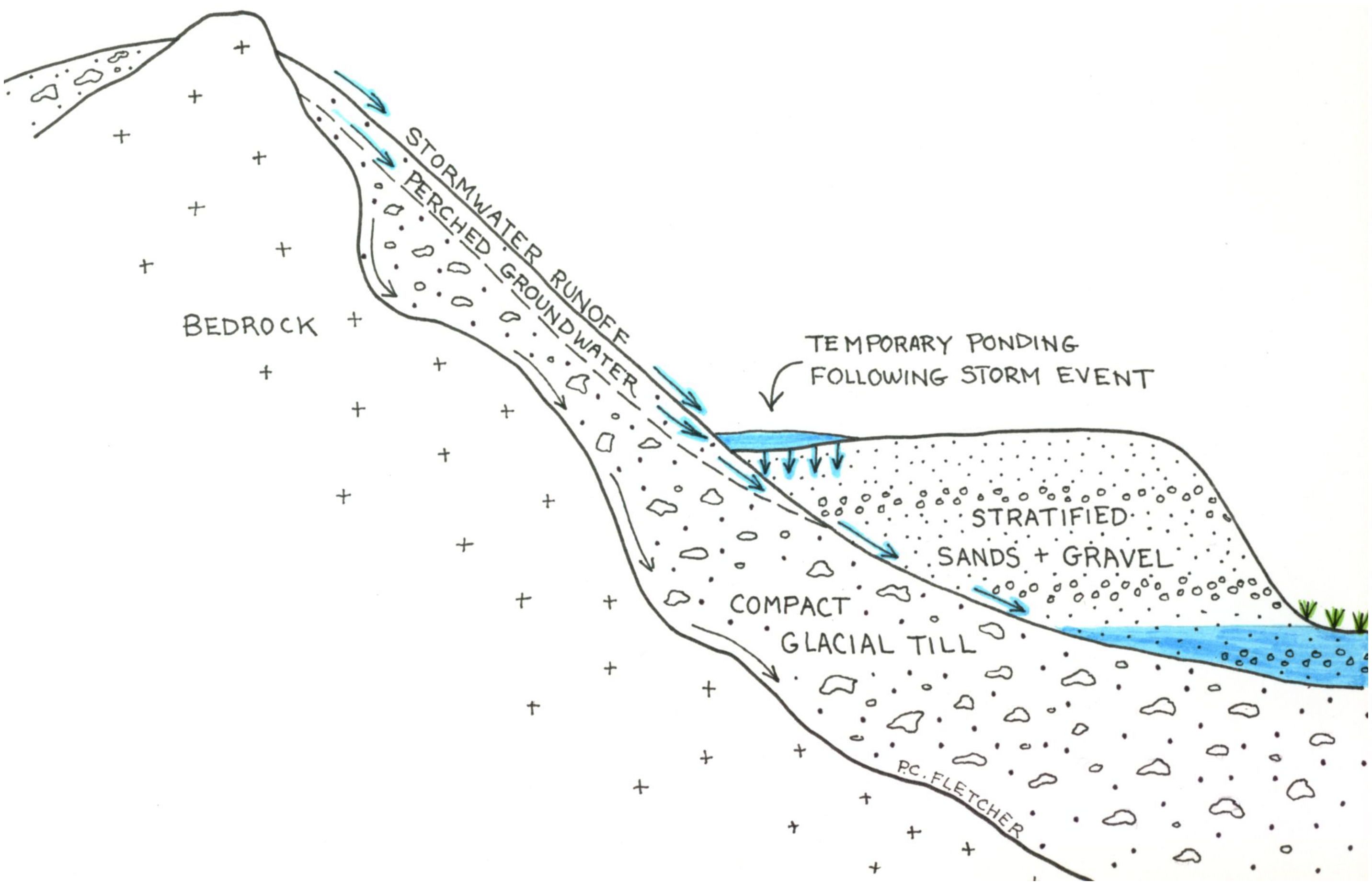
Consider your soil and your landscape



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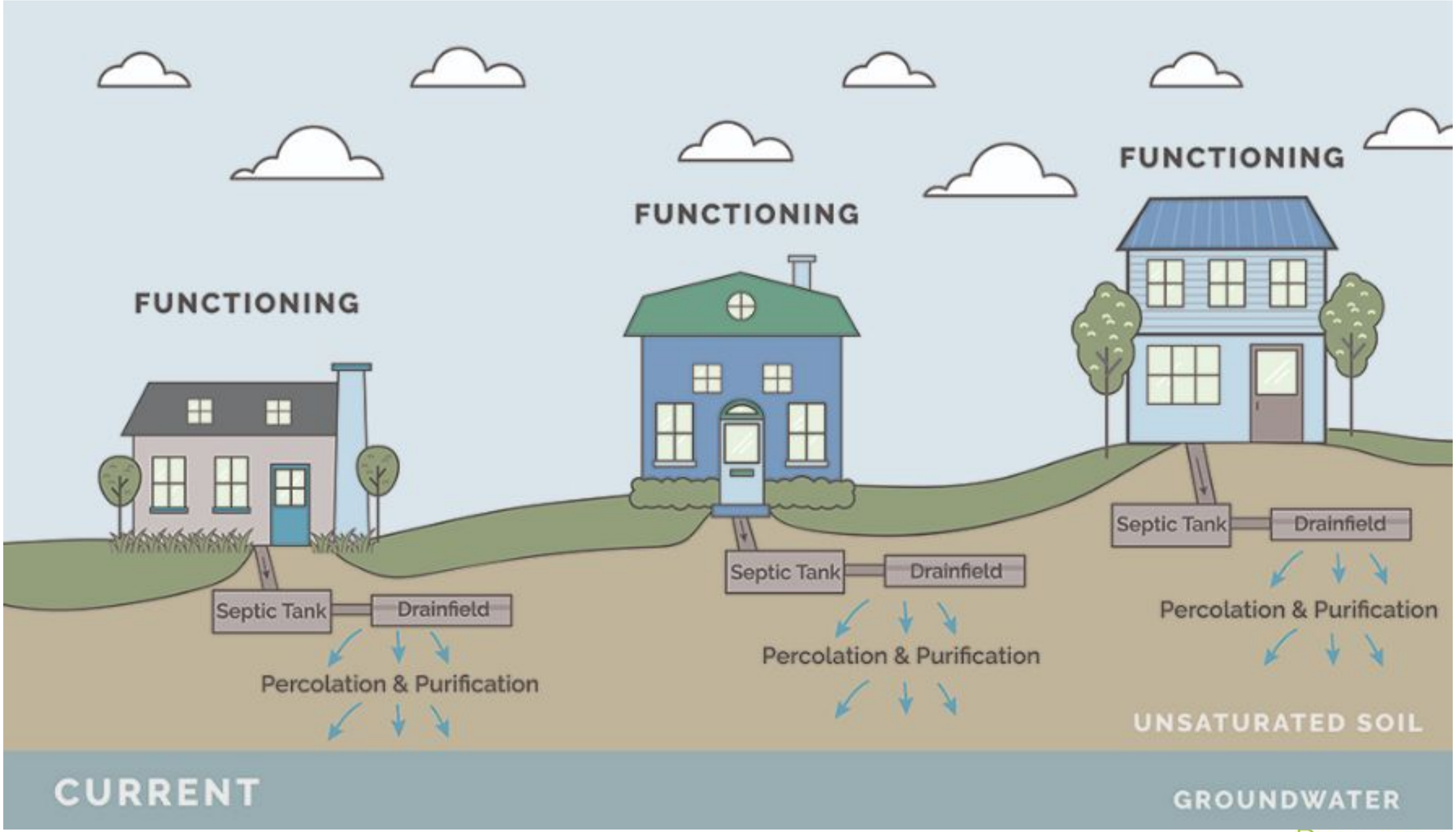
Use common sense: A failed system waiting to be installed

Photo by PC Fletcher



Consider the future

University of Georgia
https://outreach.uga.edu/uga-helps-coastal-communities-septic-tank-crisis/

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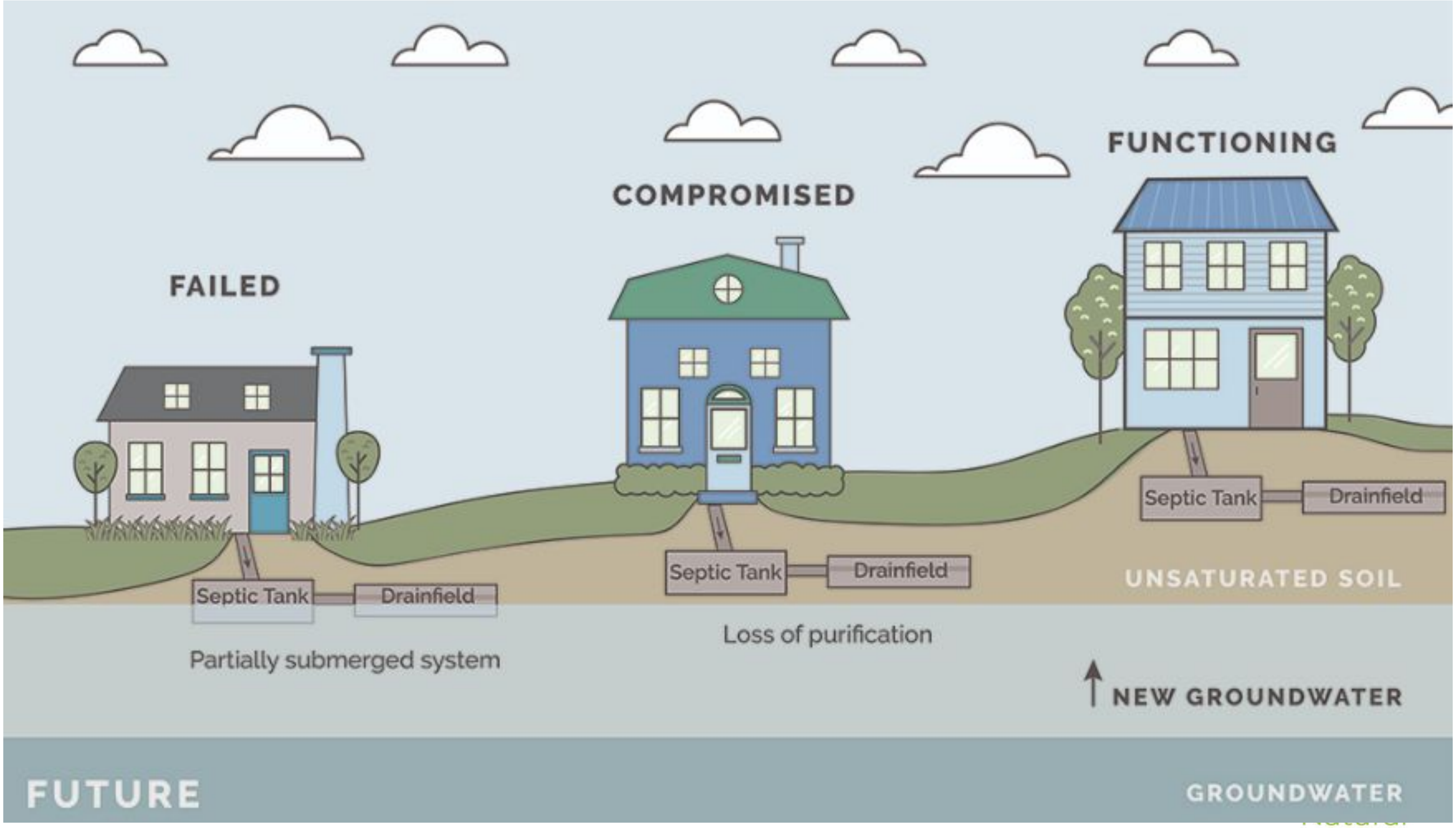

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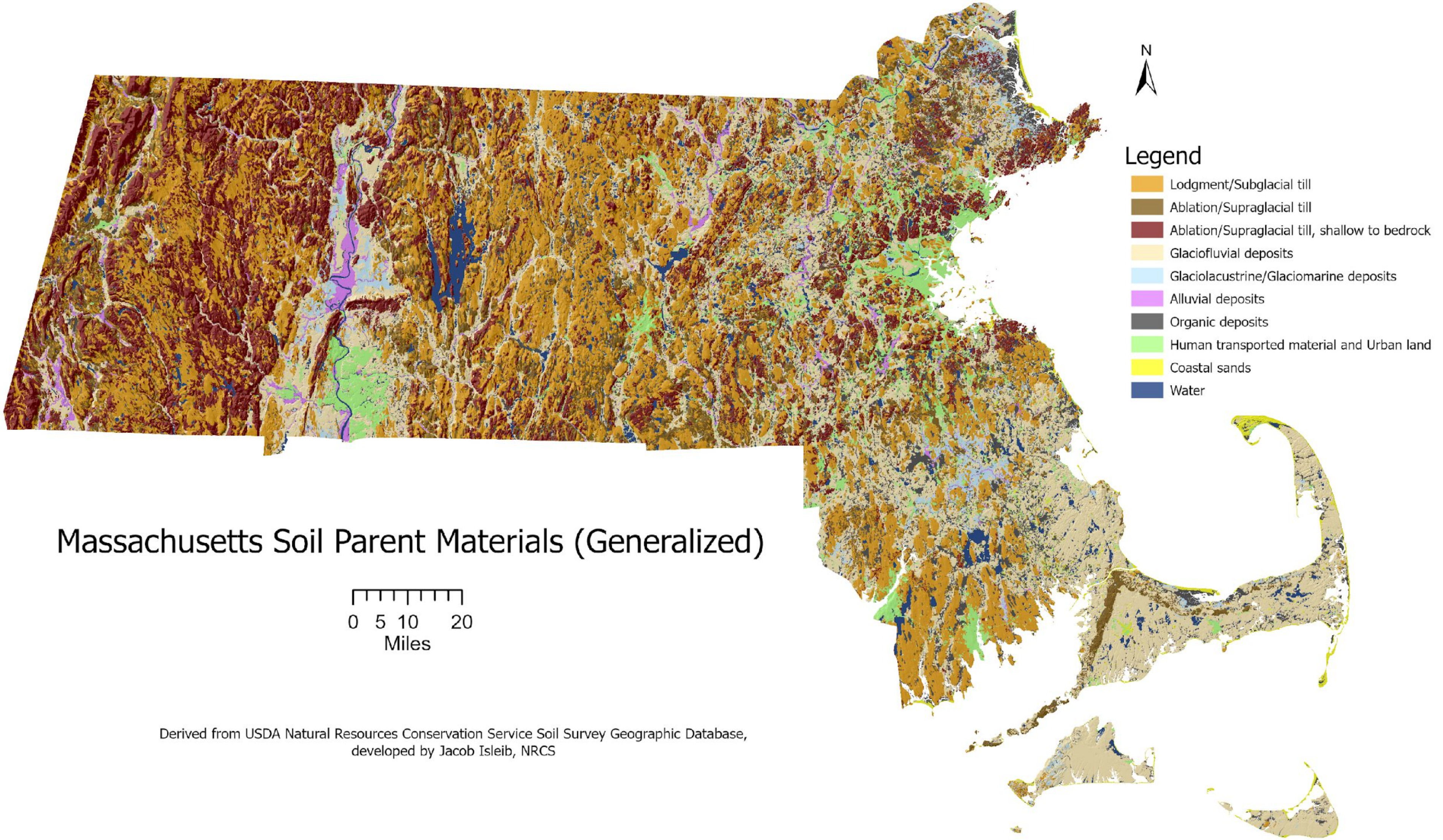

Massachusetts Soil Parent Materials (Generalized)

Derived from USDA Natural Resources Conservation Service Soil Survey Geographic Database, developed by Jacob Isleib, NRCS