



Soils and Water Movement

From Landscape Level to Site Specific

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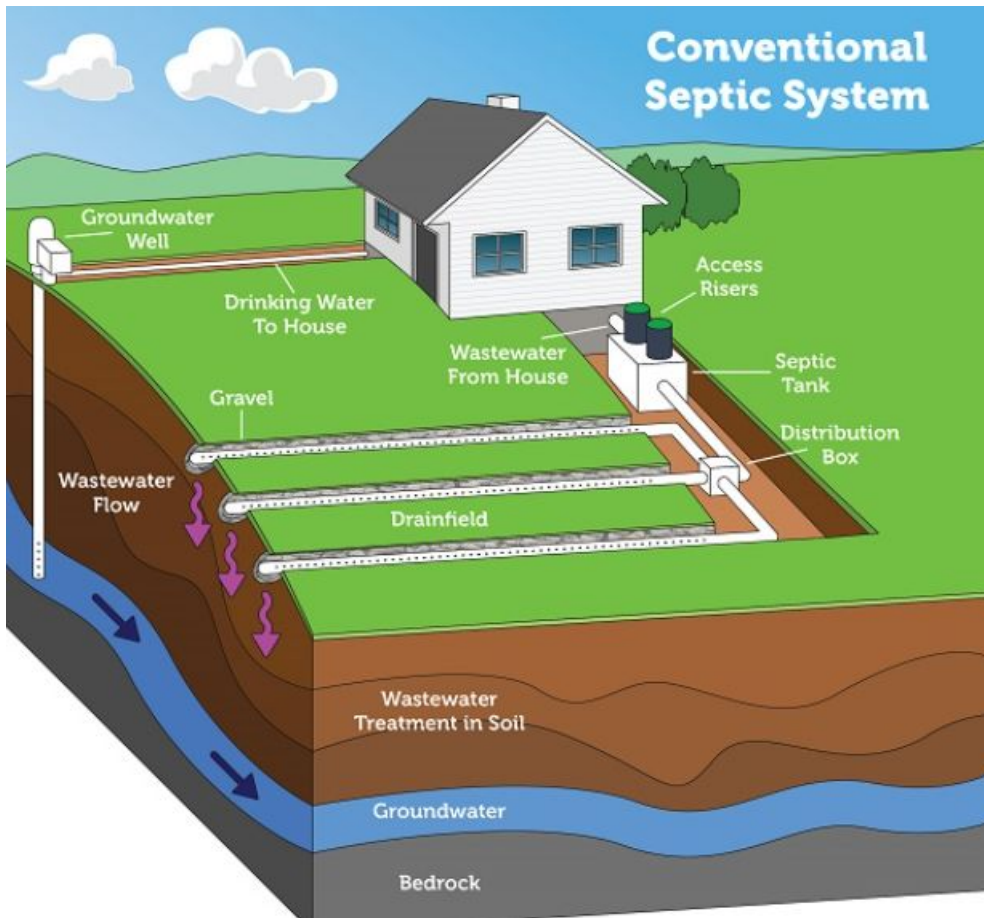
Overview

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

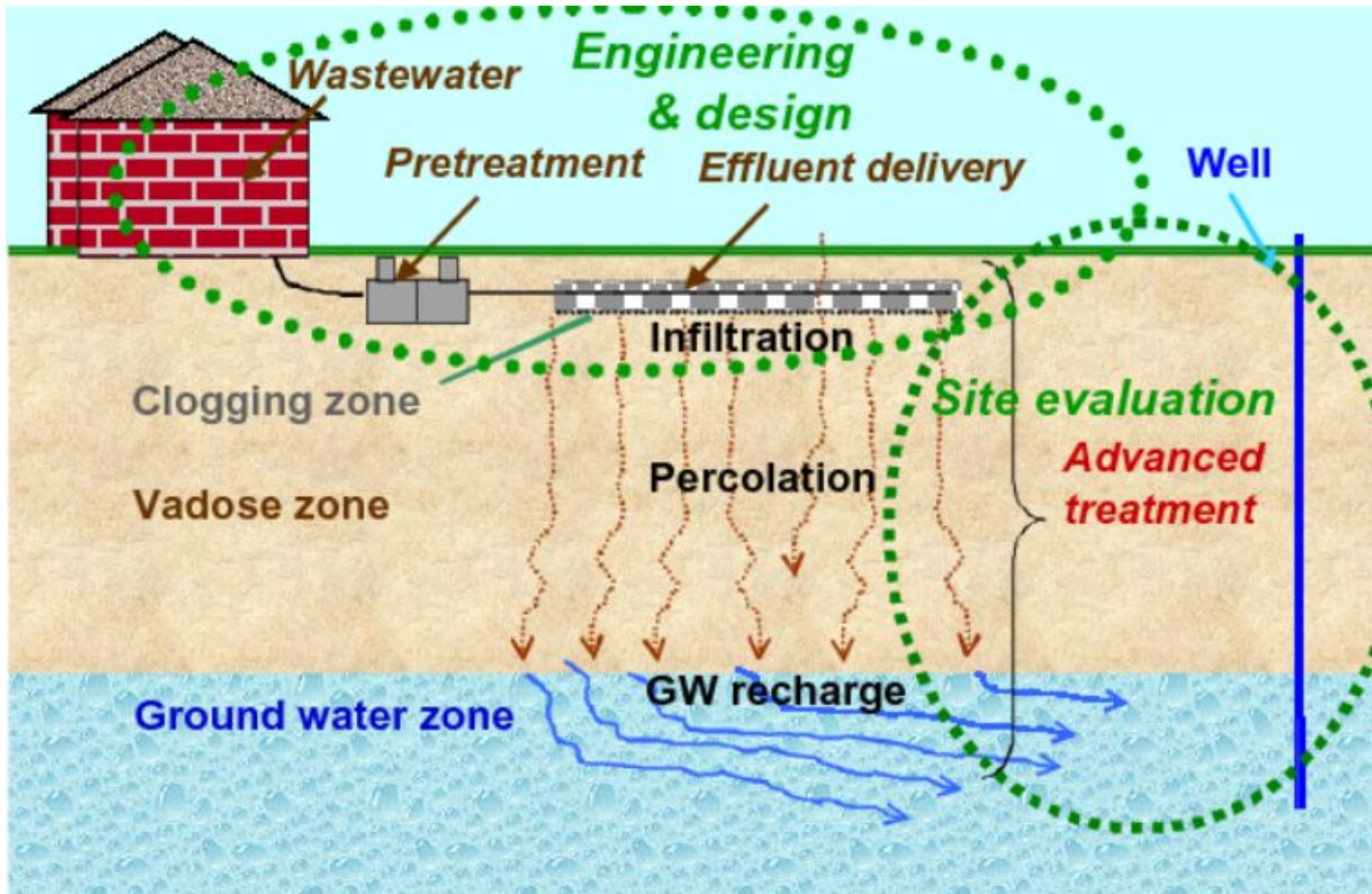


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Onsite wastewater Treatment

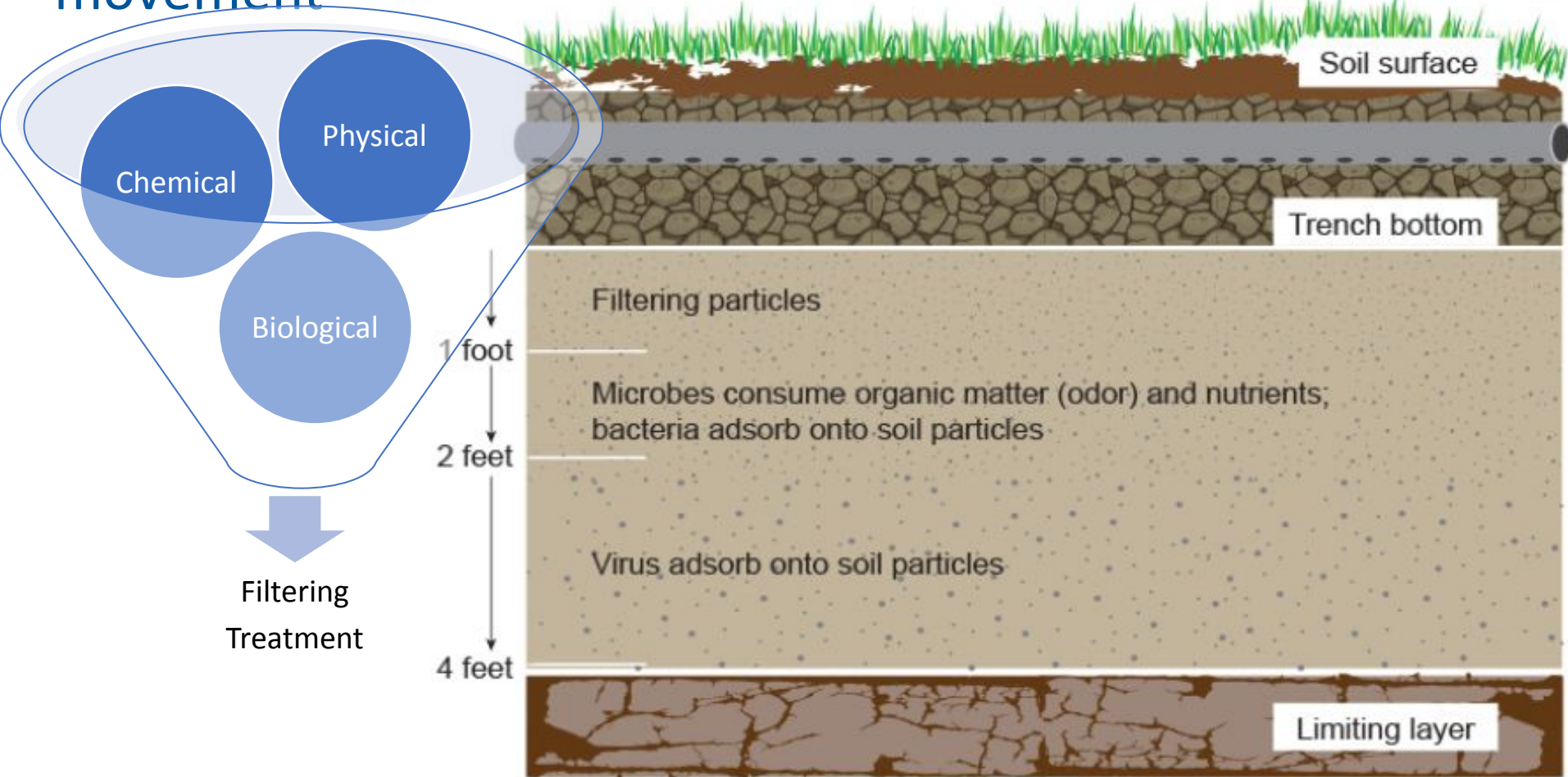


35% of MA homes use onsite wastewater treatment



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



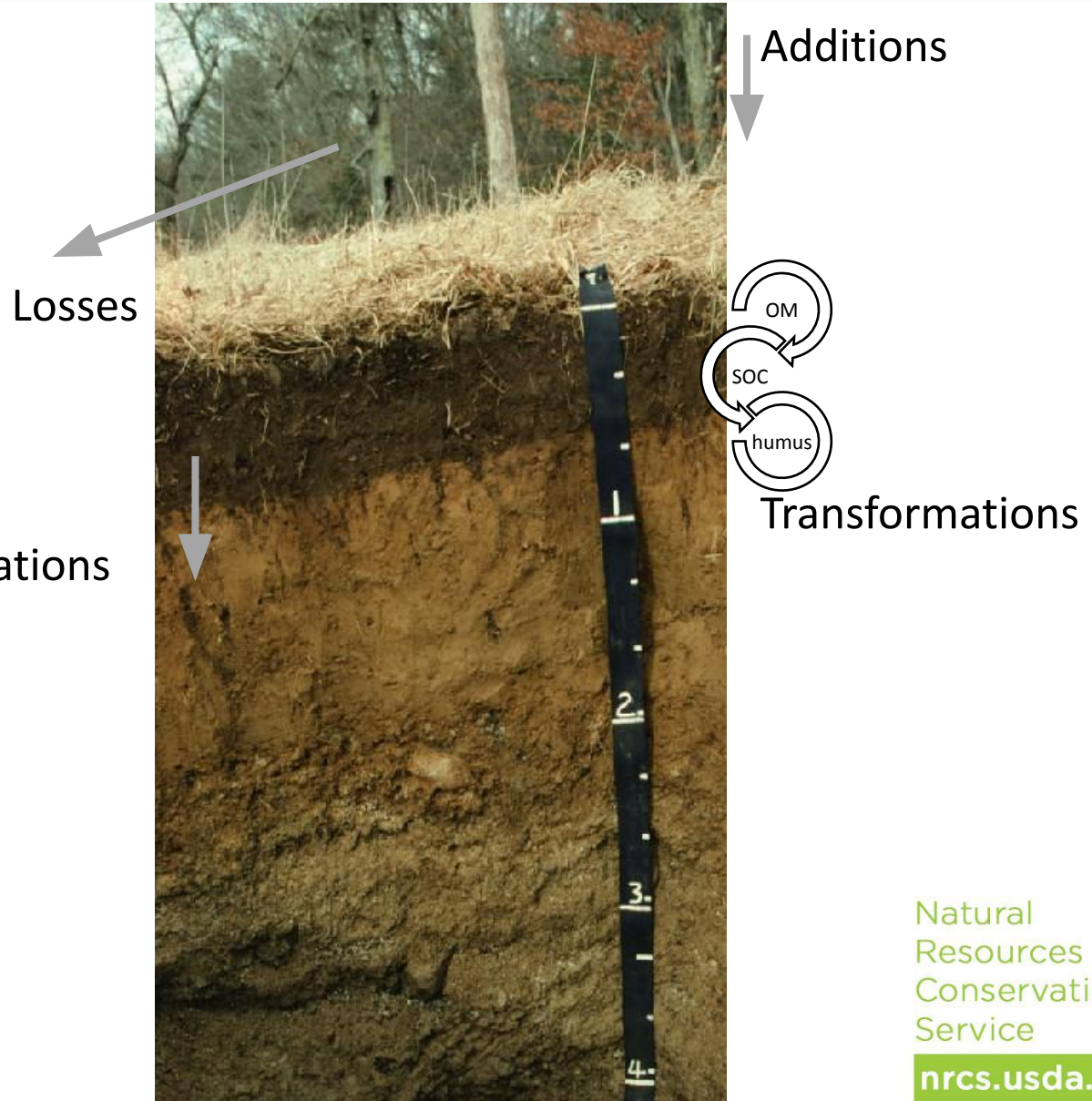
Understanding soil information is key to a successful system

- 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.





BEDROCK GEOLOGIC MAP OF MASSACHUSETTS

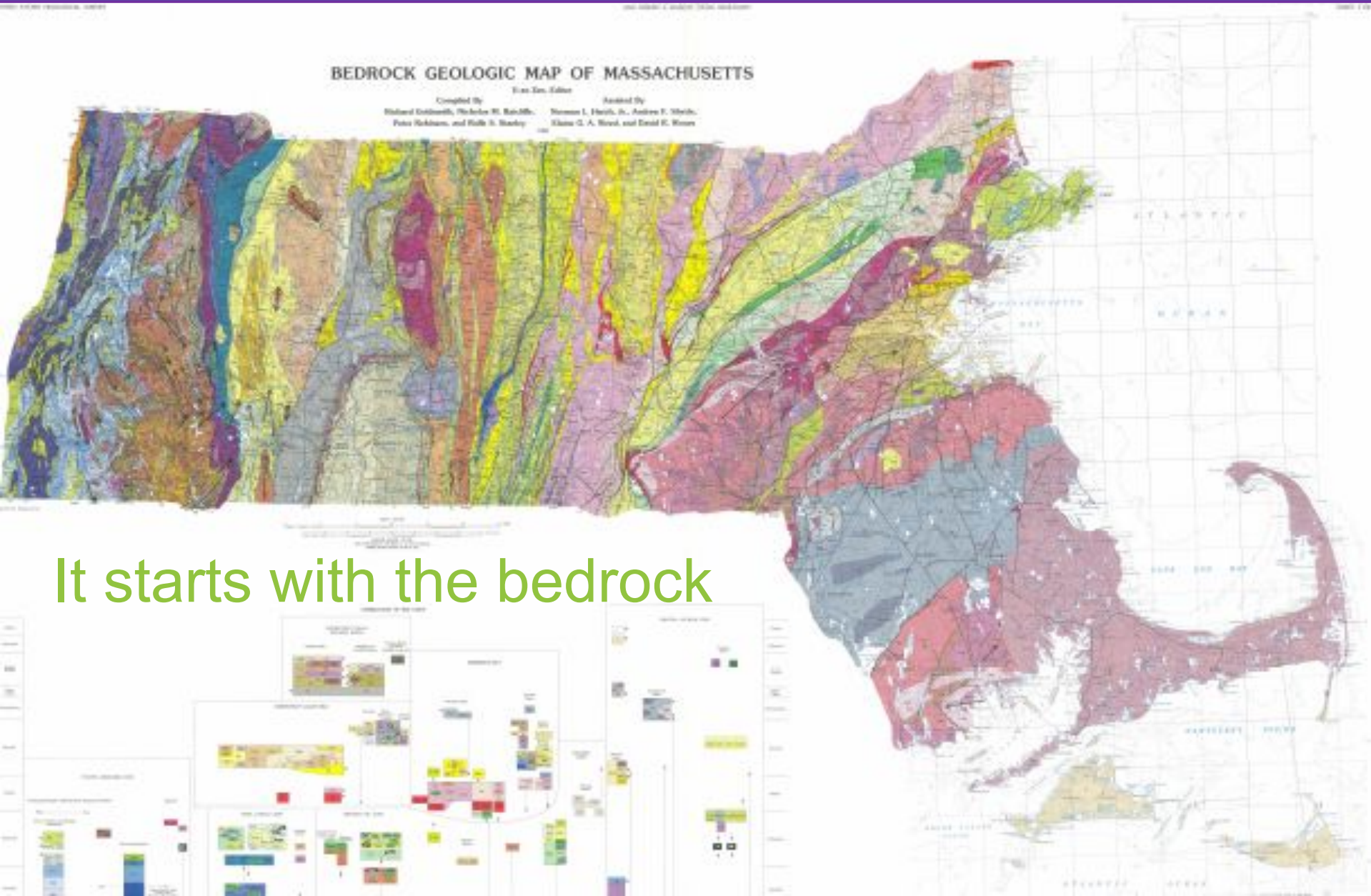
First Edition

Compiled by

Richard Goldsmith, Nicholas W. Basile,
Peter Robinson, and Ralph S. Stucky

Assisted by

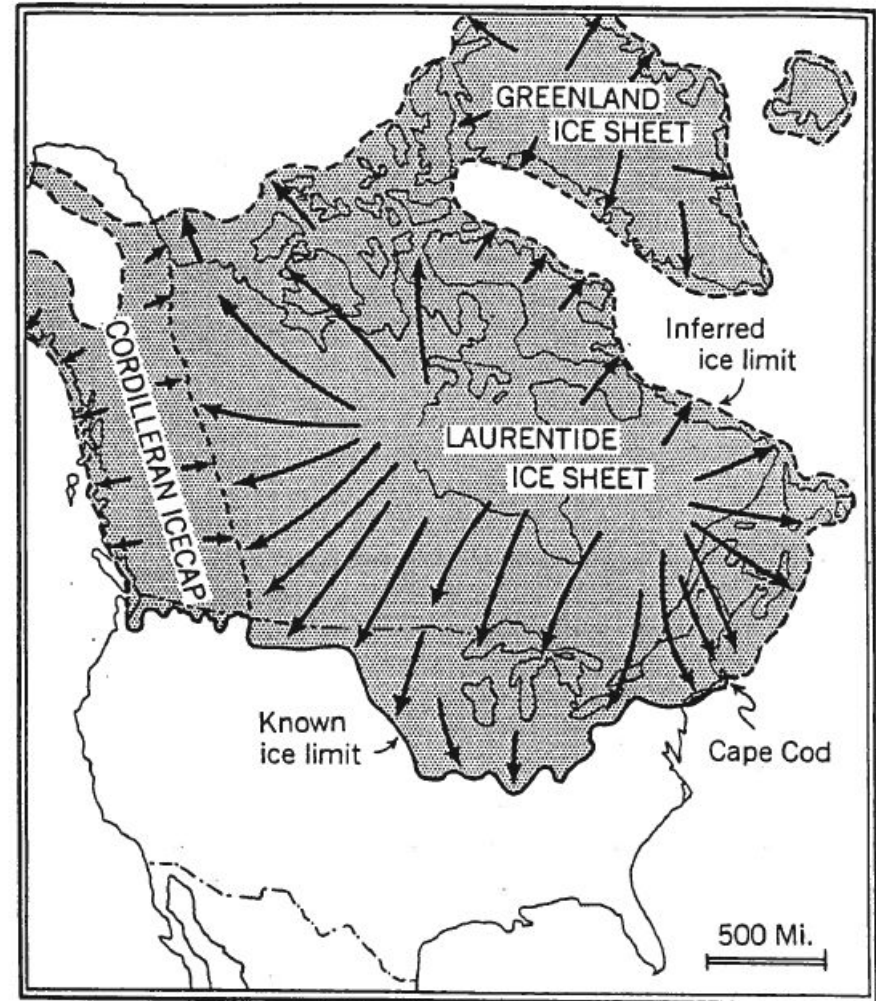
Thomas L. Harsh, Jr., Andrew F. Strick,
Klaus G. A. Bruch, and David C. Wynn



It starts with the bedrock

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



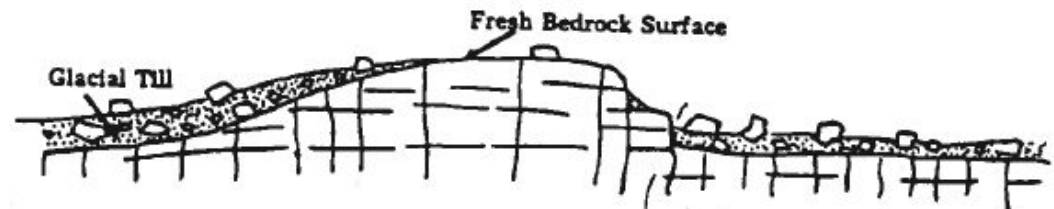
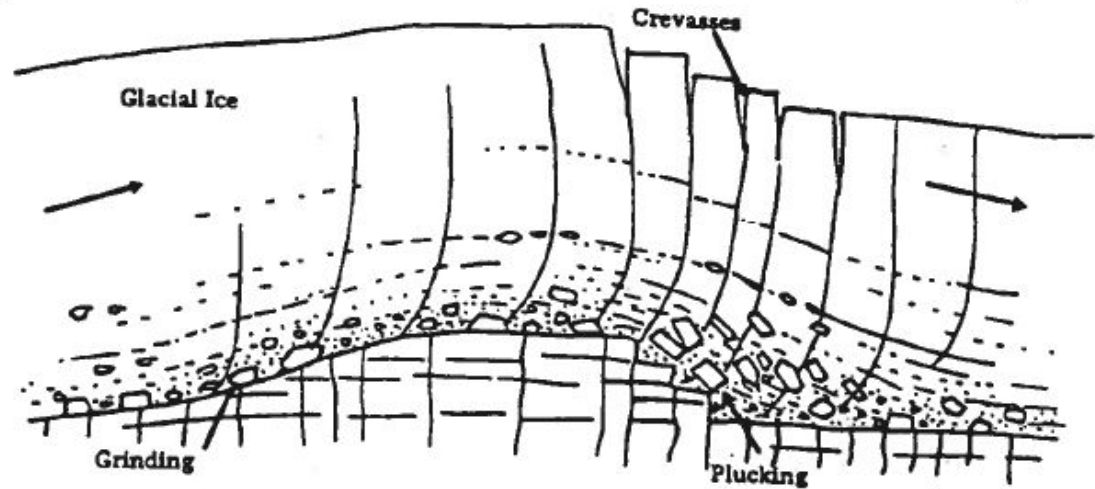
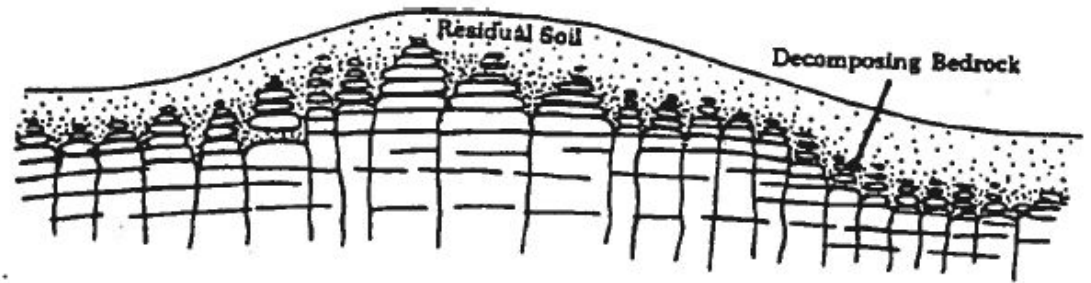
Resulting in: Glacial Parent Materials

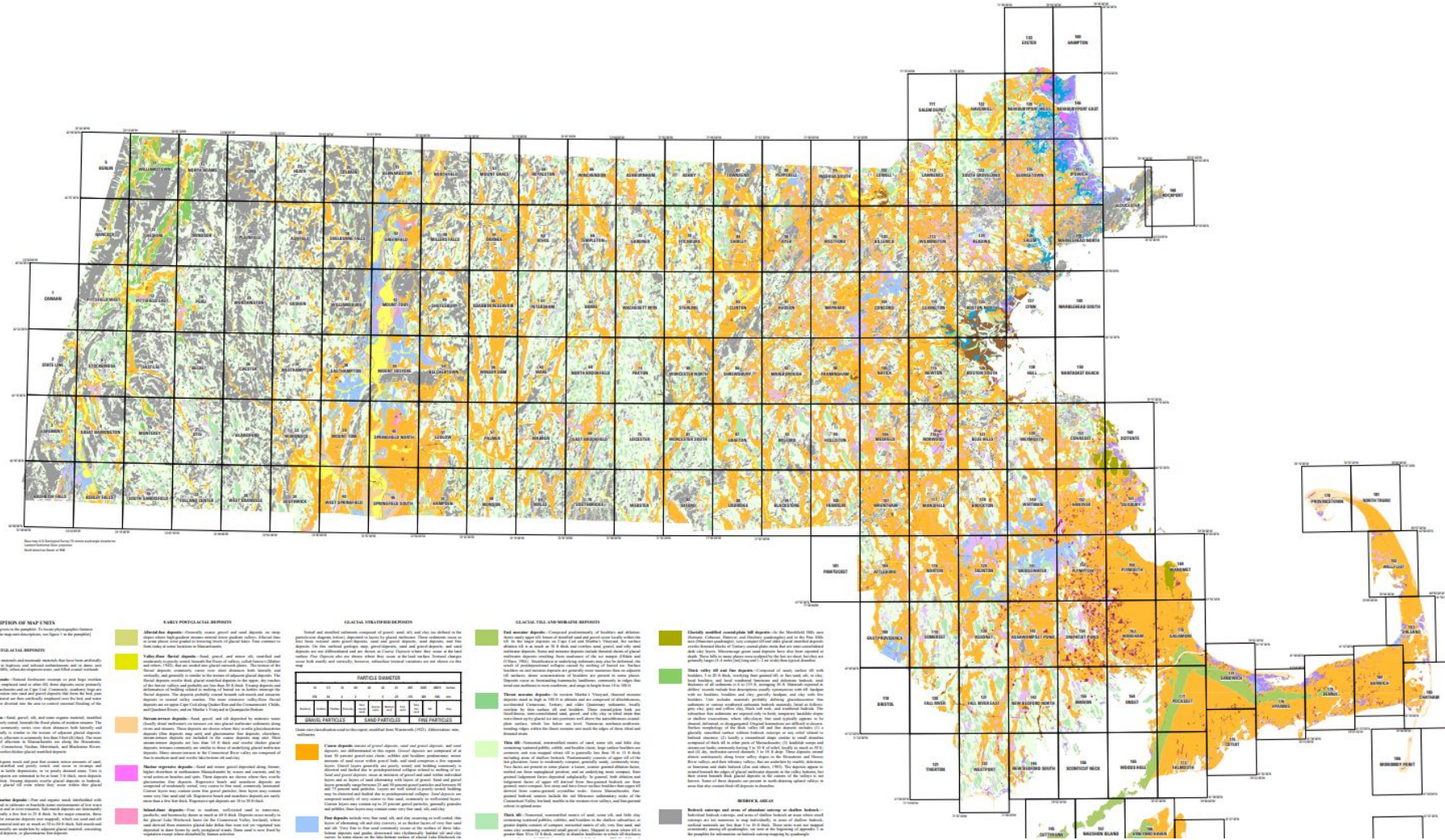
GLACIAL

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

POST-GLACIAL

- Eolian
- Organic
- Alluvium





REMARKS ON MAP EXPANS
(Full details for addresses are given in the appendix. To locate this map in the appendix, see the Appendix on the back cover.)

REMARKS ON MAP EXPANS

Vertical axis: Shows vertical scale and elevation. The vertical axis is in feet. The elevation is shown in feet above sea level. The vertical axis is in feet. The elevation is shown in feet above sea level.

Horizontal axis: Shows horizontal scale and distance. The horizontal axis is in feet. The distance is shown in feet. The horizontal axis is in feet. The distance is shown in feet.

Scale: The scale is 1 inch = 1 mile. The scale is 1 inch = 1 mile.

UNITARY PORTCULCACI DEPOSITS

Blackish-brown deposits: Generally consist of fine-grained, silty, and clayey, unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

Yellowish-brown deposits: Generally consist of fine-grained, silty, and clayey, unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

Orange deposits: Generally consist of fine-grained, silty, and clayey, unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

CLASTIC VOLCANIC DEPOSITS

Basalt and modified volcanic: Unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

Flow deposits: Unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

GLACIAL TILL AND MODIFIED DEPOSITS

Clayey till: Unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

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FLUVIACIAL AND MARINE DEPOSITS

Coastal plain deposits: Unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

Flow deposits: Unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

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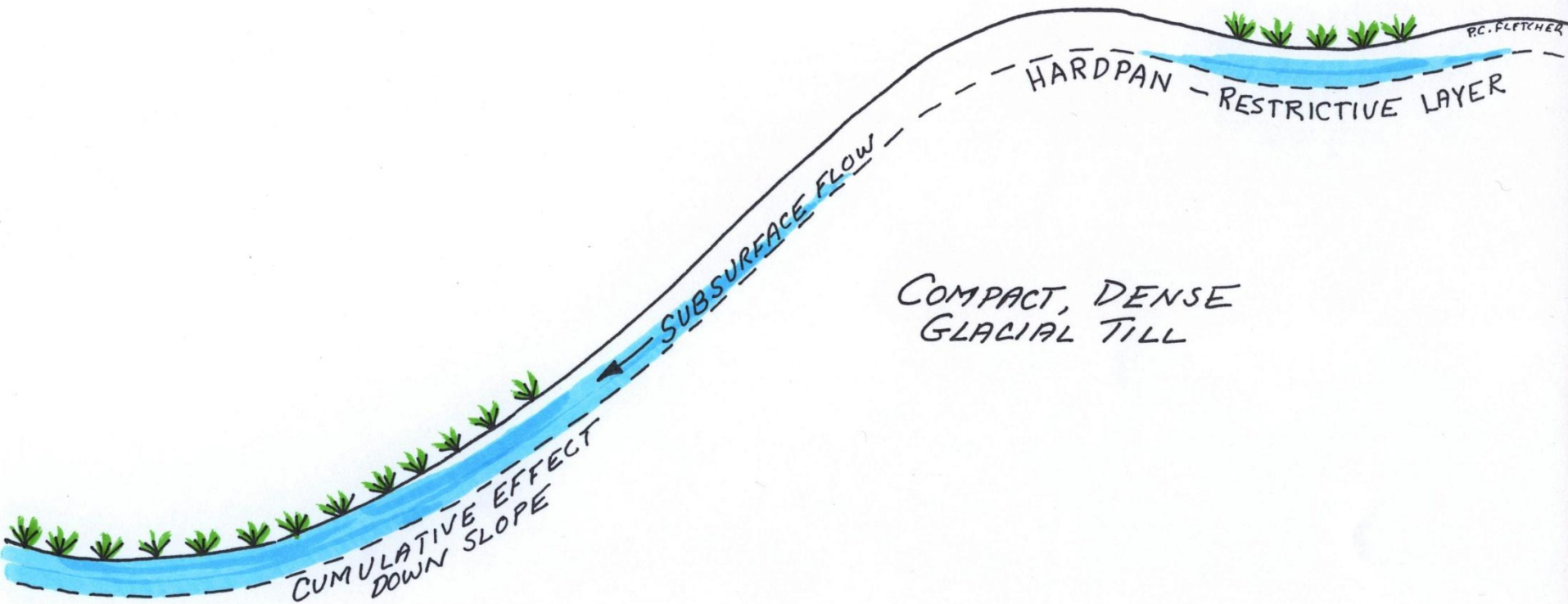
Flow deposits: Unconsolidated, and poorly sorted, sand, silt, and clay, with a matrix of fine sand, silt, and clay, and a matrix of fine sand, silt, and clay.

Surficial Materials of Massachusetts

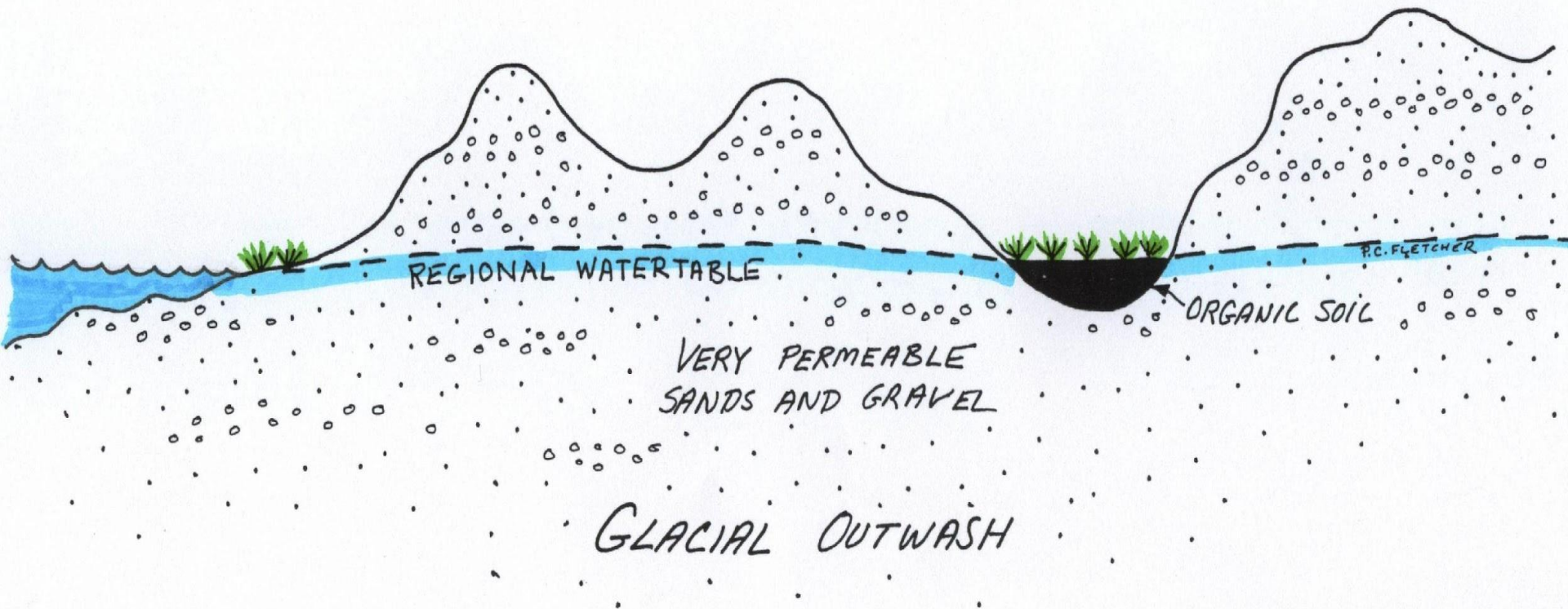
<https://pubs.usgs.gov/publication/sim3402>

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Compact Till Landscape – restrictive layer



Glacial Outwash - permeable sands and gravel





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- ▶ Official Soil Series Descriptions (OSD)
- ▶ Soil Series Extent Mapping Tool
- ▶ Geospatial Data Gateway
- ▶ eFOTG
- ▶ National Soil Characterization Data
- ▶ Soil Quality
- ▶ Soil Geography

The simple yet powerful way to access and use soil data.



Welcome to Web Soil Survey (WSS)



Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Soil surveys can be used for general farm, local, and wider area planning. Onsite investigation is needed in some cases, such as soil quality assessments and certain conservation and engineering applications. For more detailed information, contact your local [USDA Service Center](#) or your [NRCS State Soil Scientist](#).

Four Basic Steps

1 Define.

Area of Interest (AOI) Use the Area of Interest tab

I Want To...

- [Start Web Soil Survey \(WSS\)](#)
- [Know the requirements for running Web Soil Survey – will Web Soil Survey work in my web browser?](#)
- [Know the Web Soil Survey hours of operation](#)
- [Find what areas of the U.S. have soil data](#)
- [Find information by topic](#)
- [Know how to hyperlink from other documents to Web Soil Survey](#)
- [Know the SSURGO data structure](#)

Announcements/Events

- [Web Soil Survey 3.1 has been released! View description of new features and fixes.](#)
- [Web Soil Survey Release History](#)

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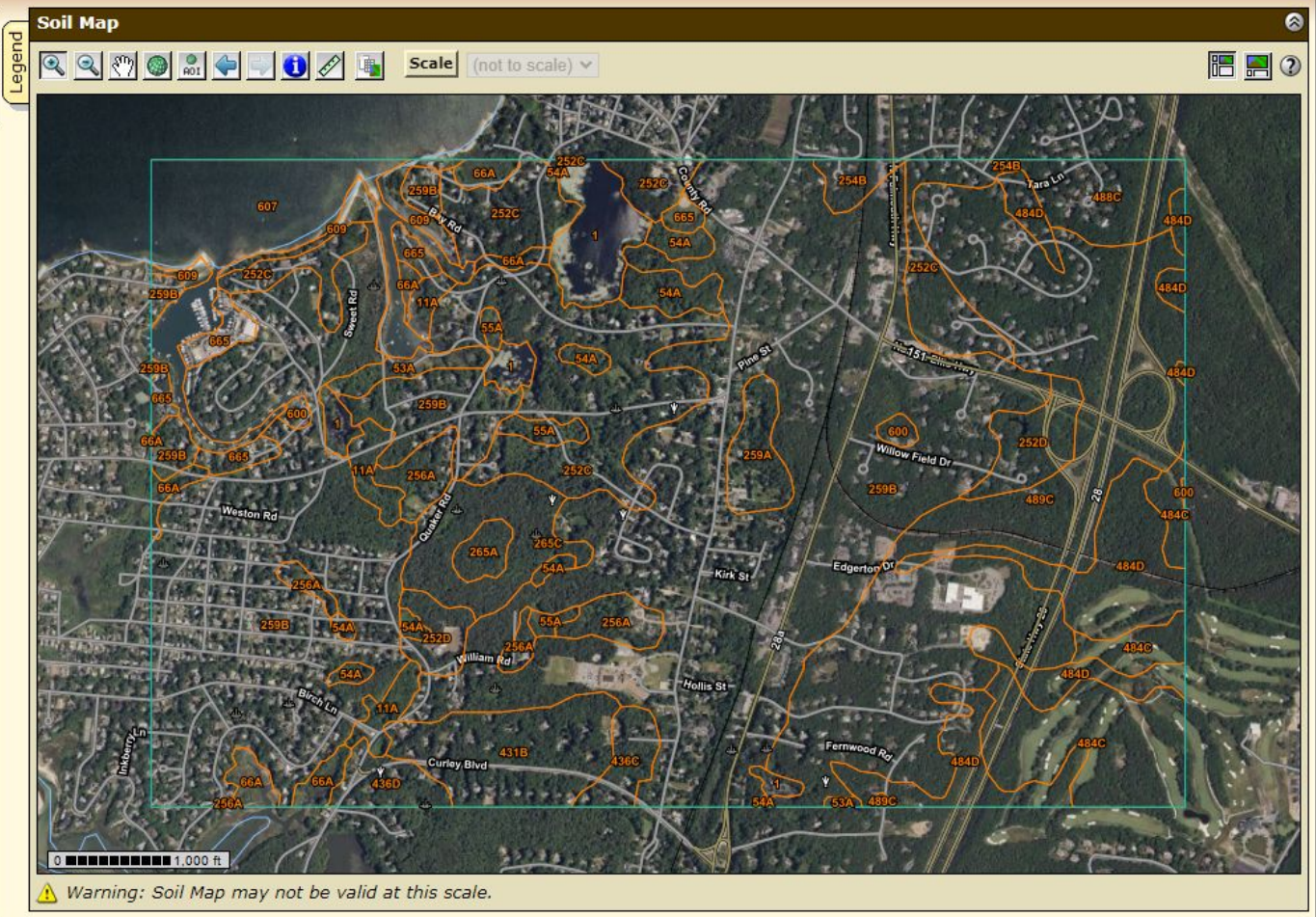
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Search

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%



Search

Properties and Qualities Ratings

Open All Close All ?

Soil Chemical Properties ?

Soil Erosion Factors ?

Soil Health Properties ?

Soil Physical Properties ?

Soil Qualities and Features ?

Water Features

Depth to Water Table

View Description View Rating

View Options

Map

Table

Description of Rating

Rating Options

Detailed Description

Advanced Options

Aggregation Method **Dominant Component**

Component Percent Cutoff

Tie-break Rule Lower Higher

Interpret Nulls as Zero Yes

Map — Depth to Water Table

Scale (not to scale)



Map Legend

Layer Properties Menu

- Area of Interest (AOI)
 - Area of Interest (AOI)
 - Location Marker
- Soils
 - Soil Survey Areas
 - Soil Map Unit Polygons
 - Soil Map Unit Lines
 - Soil Map Unit Points
 - Soil Rating Polygons
 - 0 - 25
 - 25 - 50
 - 50 - 100
 - 100 - 150
 - 150 - 200
 - > 200
 - Not rated or not available
 - Soil Rating Lines
 - 0 - 25
 - 25 - 50
 - 50 - 100
 - 100 - 150
 - 150 - 200
 - > 200
 - Not rated or not available

Groundwater

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

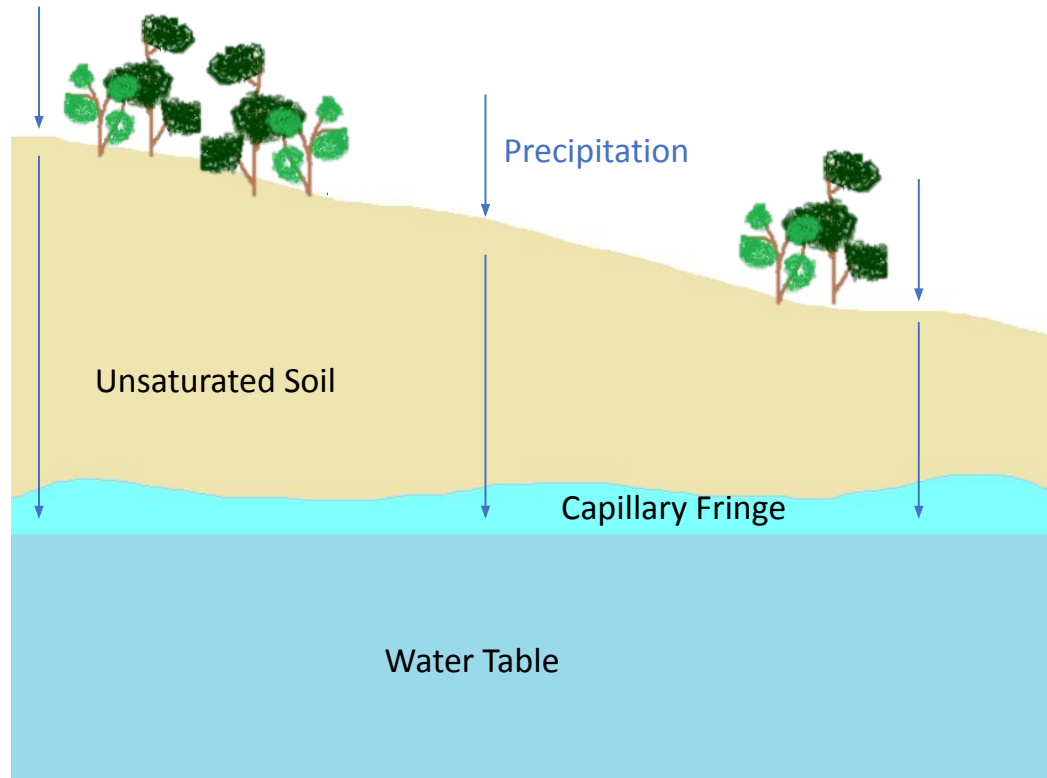
Kinds of Groundwater Systems

Unconfined, true or apparent water table

Perched water table

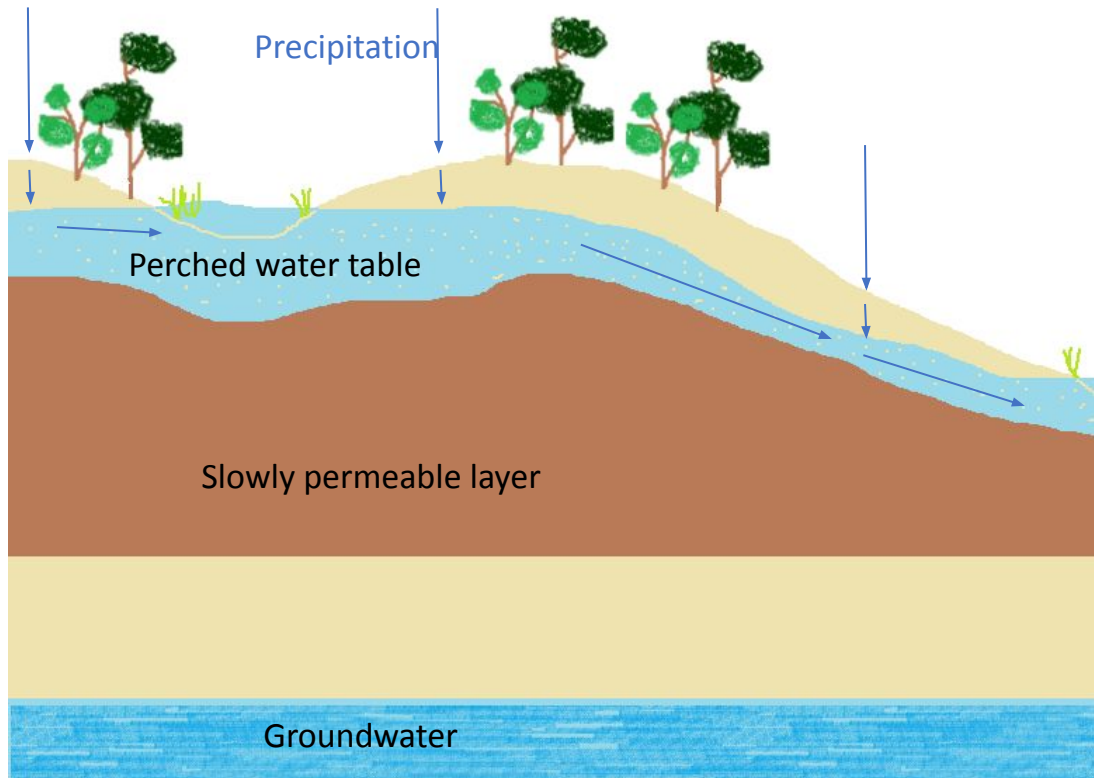
Confined, artesian effect

Unconfined Groundwater System



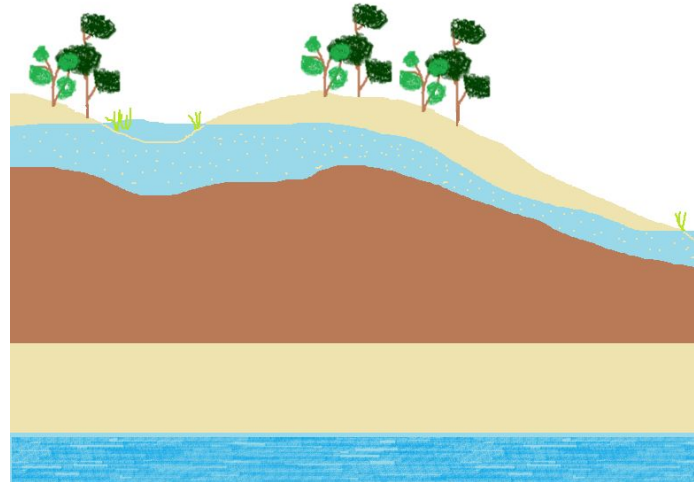
Perched groundwater system

Soils with a limiting layer – dense till/ impermeable bedrock



Soil Properties affecting water movement

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

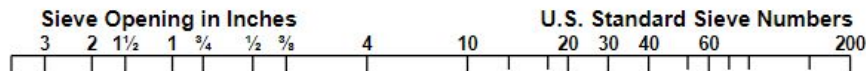
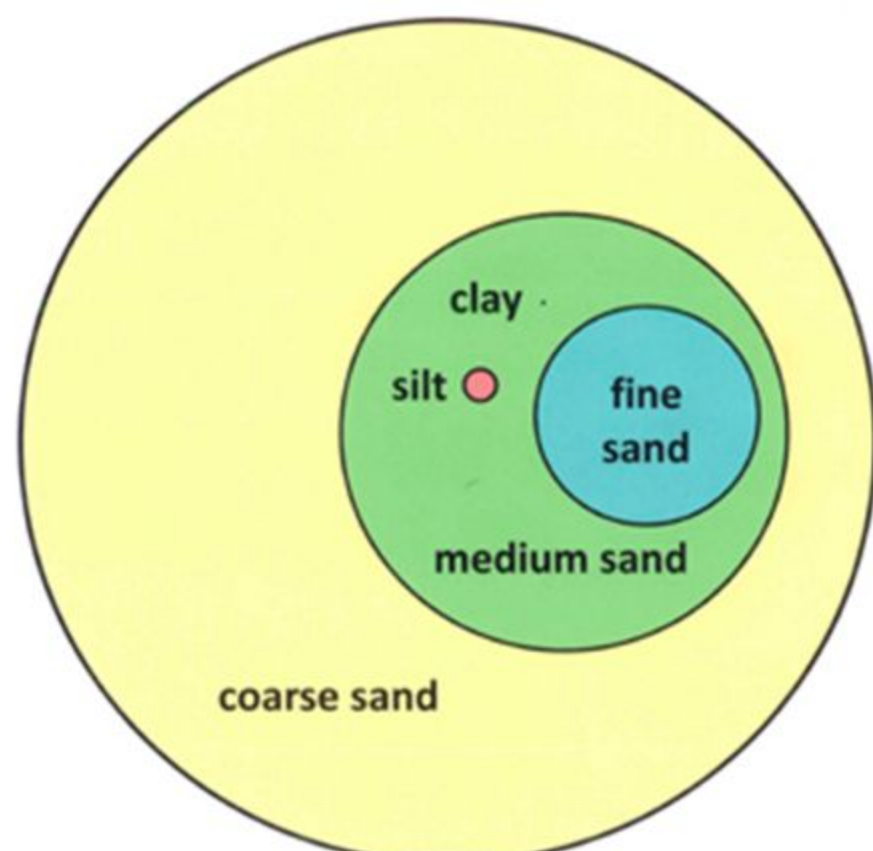


Soil Texture

The proportion of

- Sand (0.05-2.0 mm)
- Silt (0.002-0.05 mm)
- Clay (<0.002 mm)

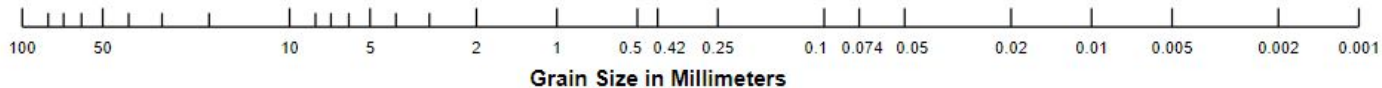
Anything larger is gravel, stones, boulders



USDA	GRAVEL		SAND					SILT	CLAY
			Very Coarse	Coarse	Medium	Fine	Very Fine		

UNIFIED	GRAVEL		SAND			SILT OR CLAY	
	Coarse	Fine	Coarse	Medium	Fine		

AASHO	GRAVEL OR STONE			SAND		SILT - CLAY	
	Coarse	Medium	Fine	Coarse	Fine	Silt	Clay



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

- <math><0.002\text{ mm}</math>
- 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

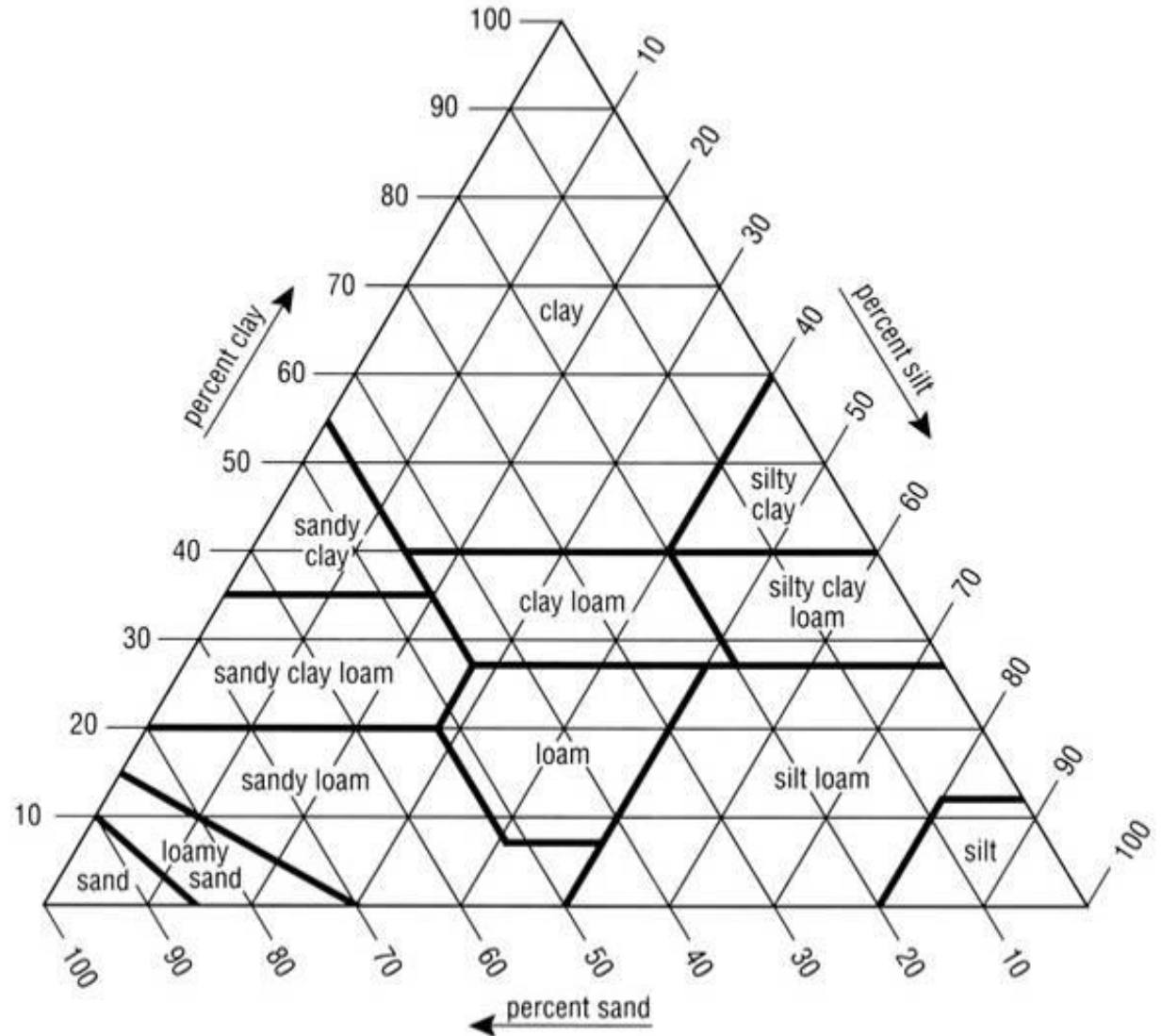
Silt size particles

- 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



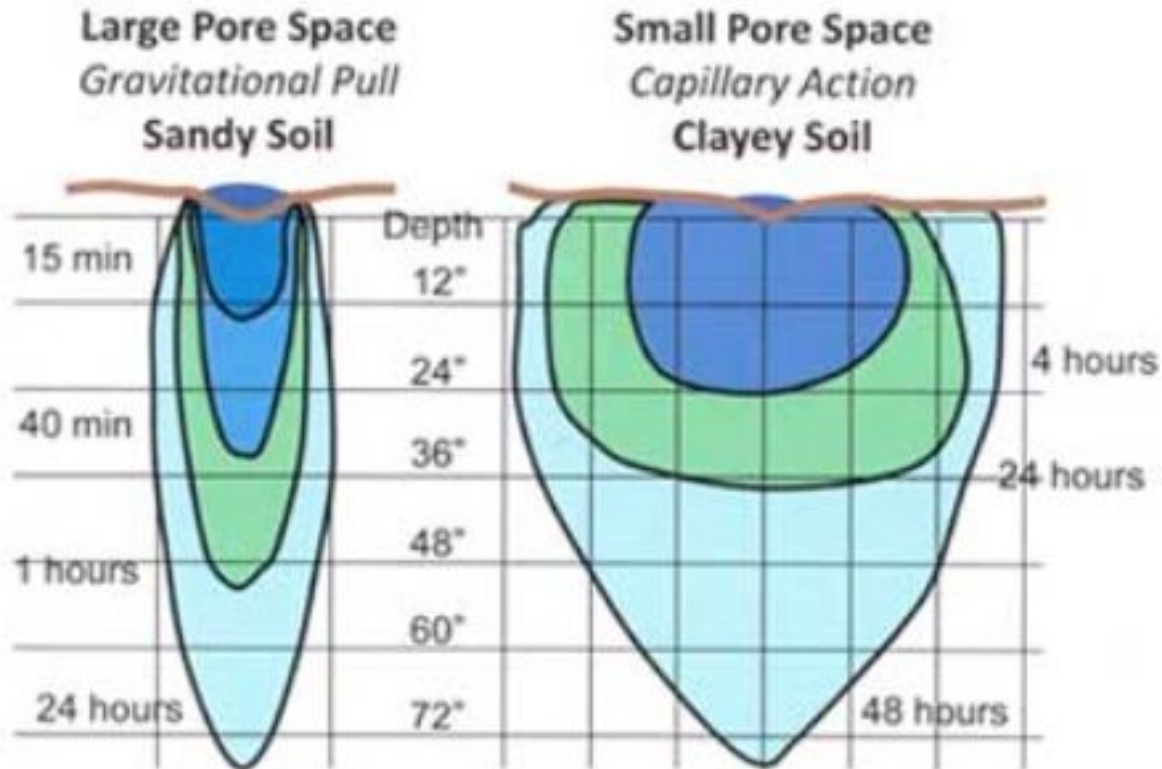
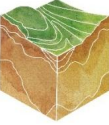




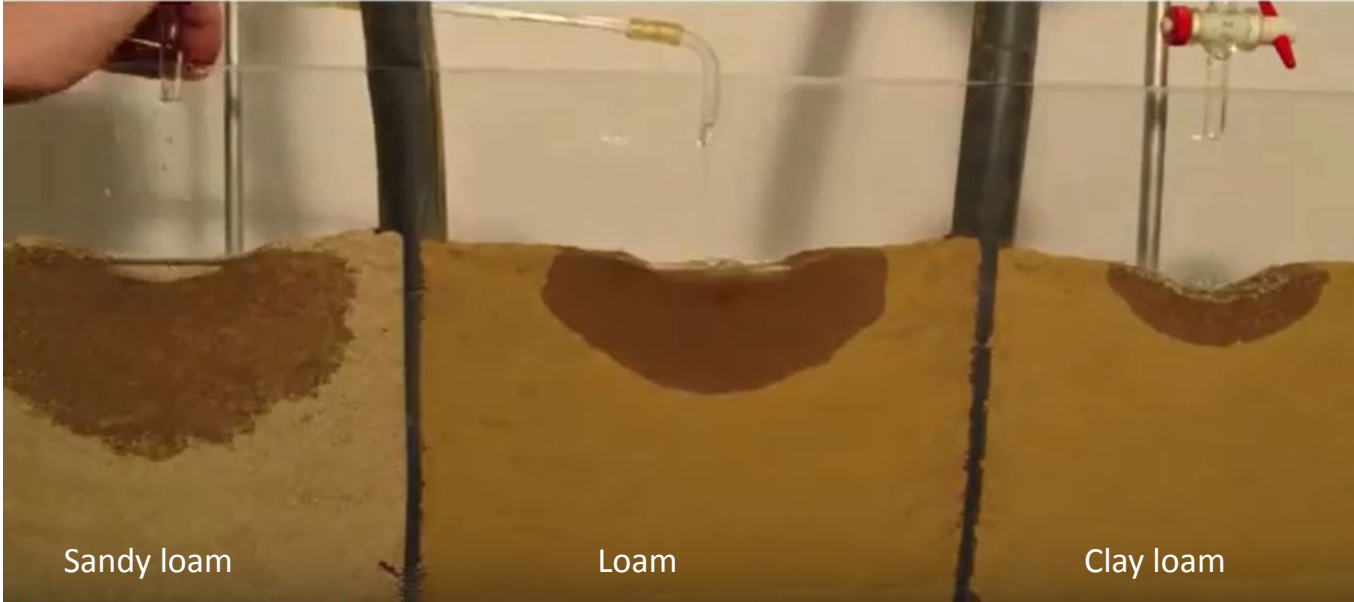
Figure 1: Comparison of water movement in sandy versus clayey soils. Water moves more quickly through sandy soils due to larger pore spaces and the force of gravity. In finer textured soils, water moves more slowly and is drawn through by capillary action. Figure: Colorado State Extension

Water movement in soils: texture



ULG / GEMBOUX AGRO BIO TECH / SOIL - WATER SYSTEMS

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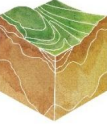


Sandy loam Loam Clay loam



4:03 / 16:25

Video player controls: play, volume, 4:03 / 16:25, loam, CC, settings, full screen, expand

Water movement in soils: texture



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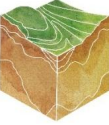


The image shows a laboratory experiment with three soil columns. Each column has a different soil texture: Sandy loam (left), Loam (middle), and Clay loam (right). A red line indicates the water level in each column. The water level is highest in the Sandy loam column and lowest in the Clay loam column, demonstrating that water moves more easily through sandy soils than through clayey soils.

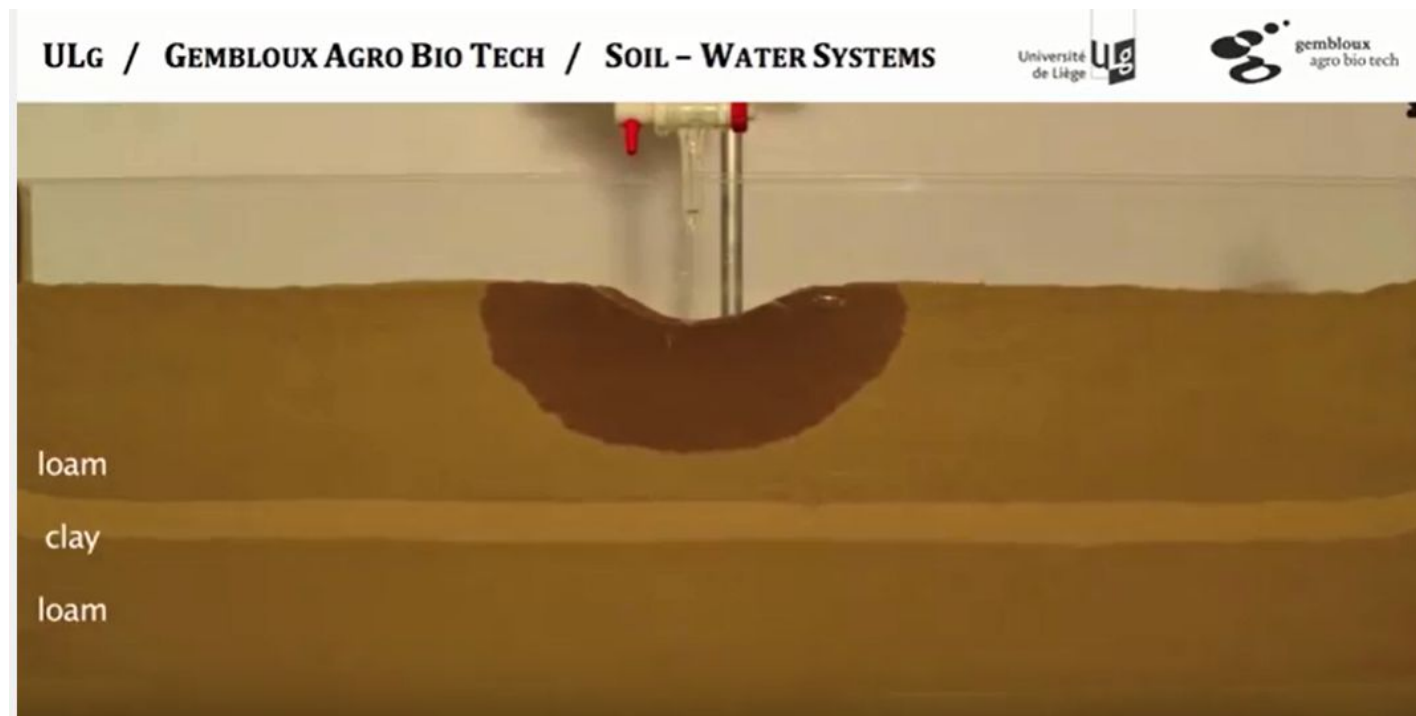
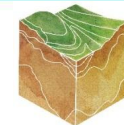
Sandy loam Loam Clay loam

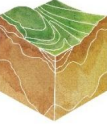
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Water movement in soils: texture

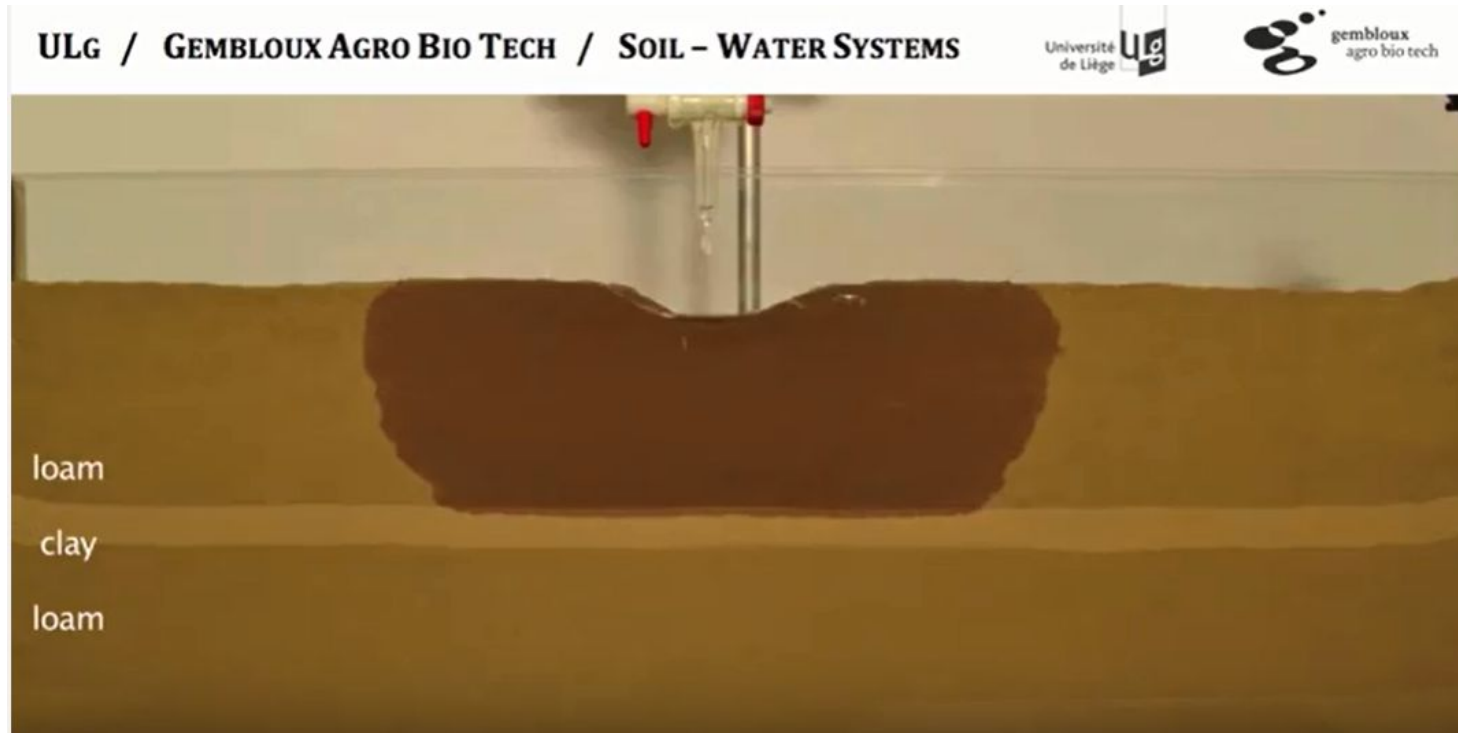


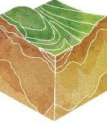
Water movement in soils: clay layer





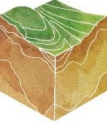
Water movement in soils: clay layer



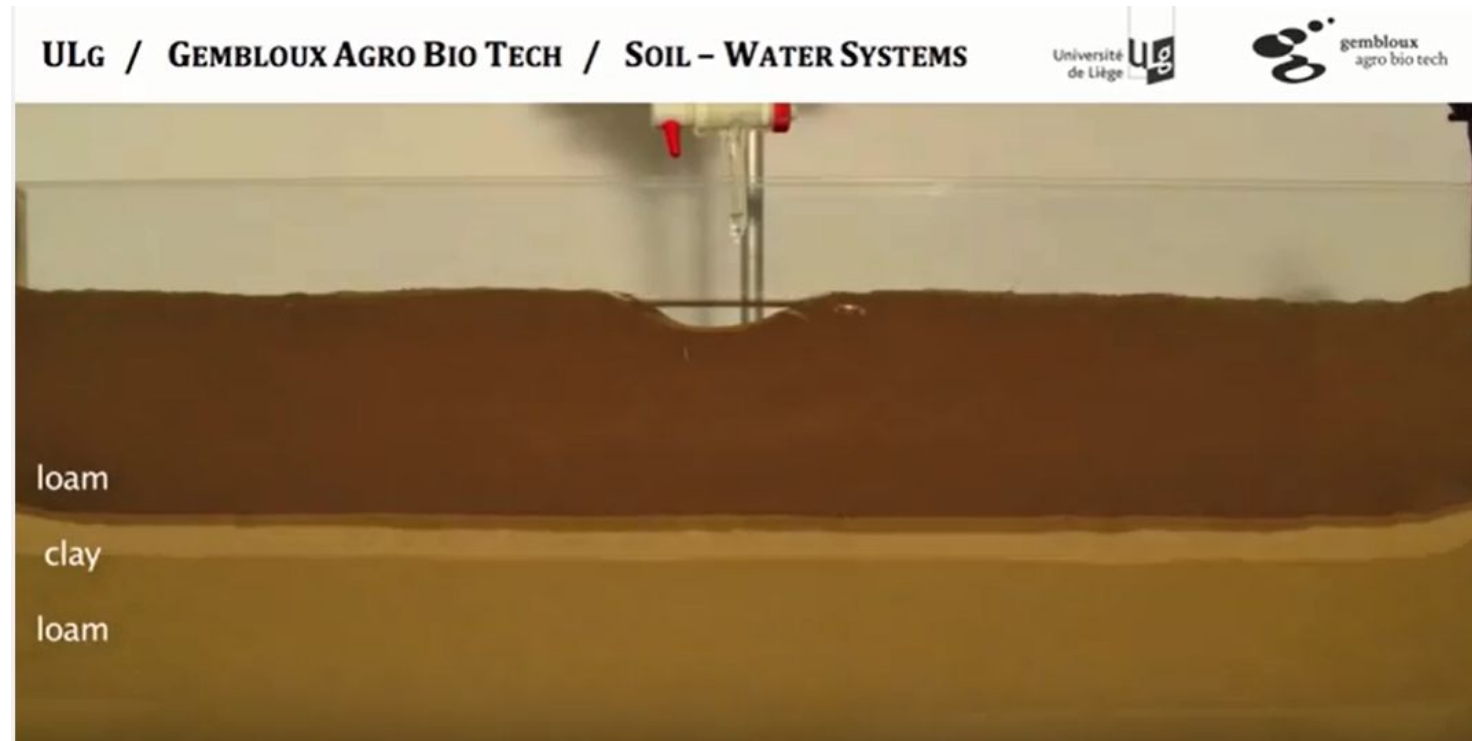


Water movement in soils: clay layer





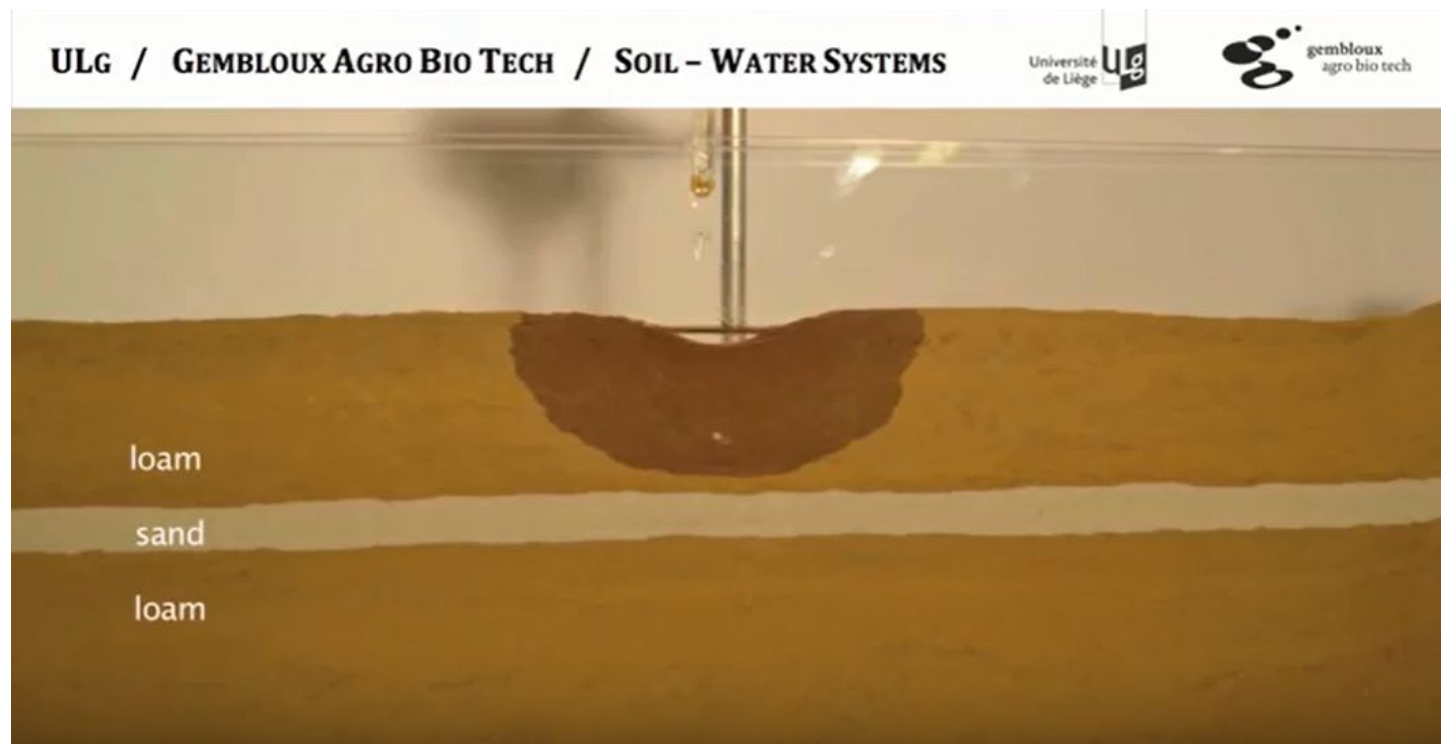
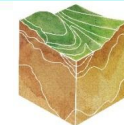
Water movement in soils: clay layer



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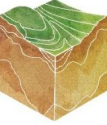
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Water movement in soils: sandy layer



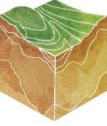
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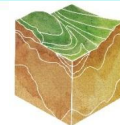
Water movement in soils: sandy layer



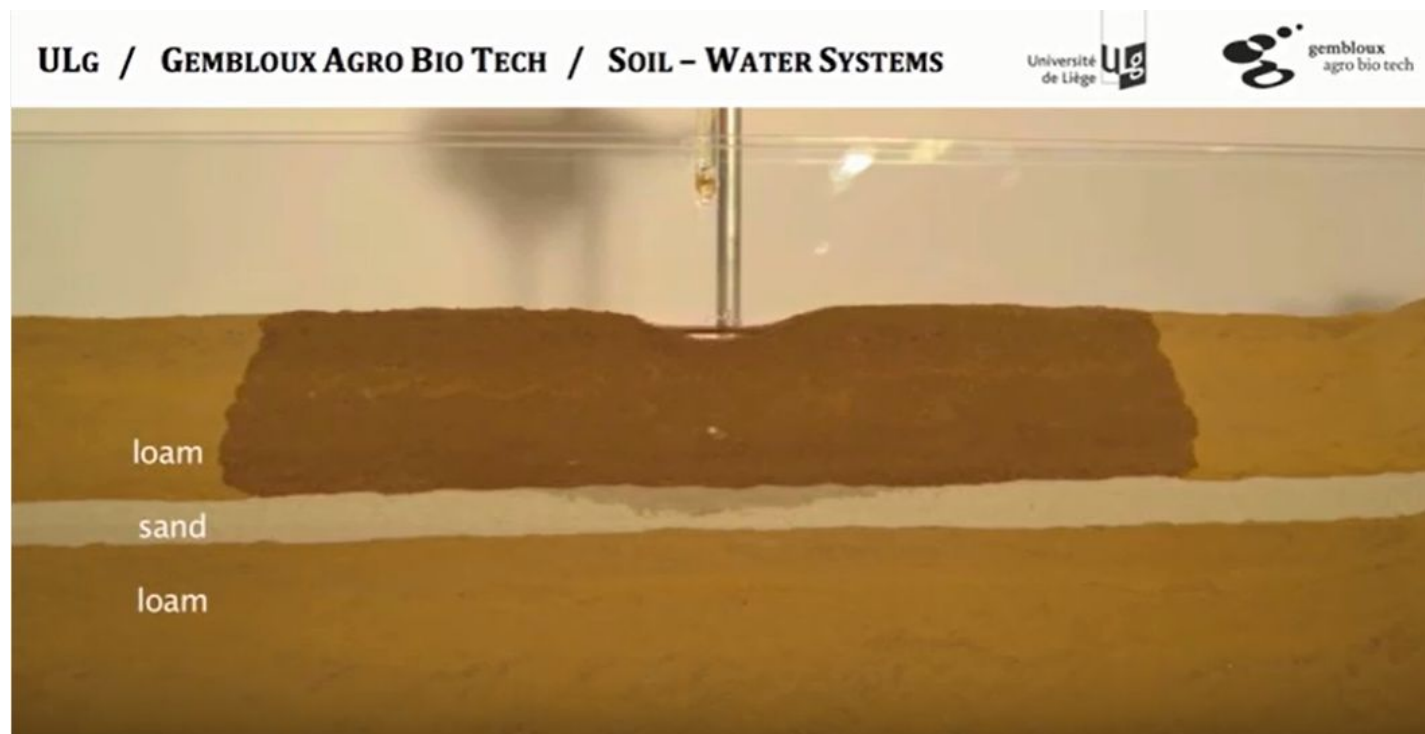


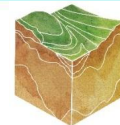
Water movement in soils: sandy layer



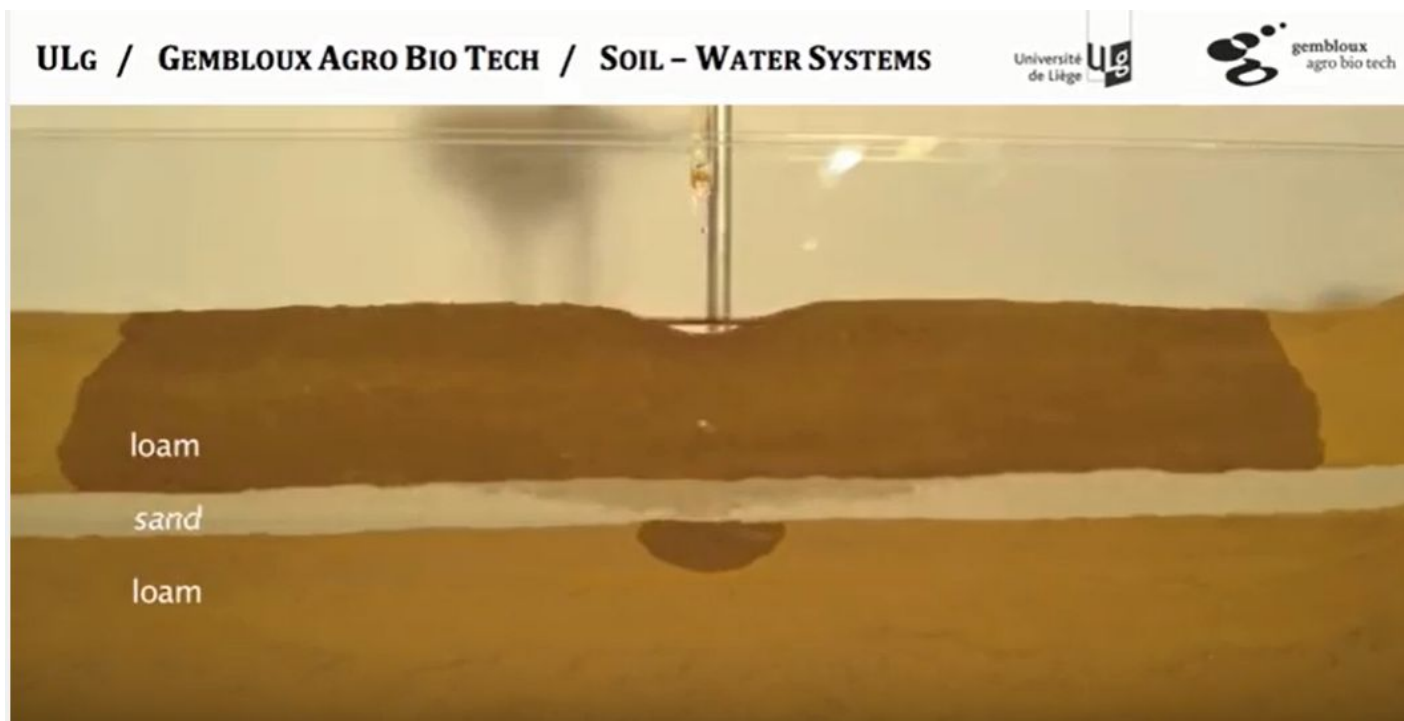


Water movement in soils: sandy layer





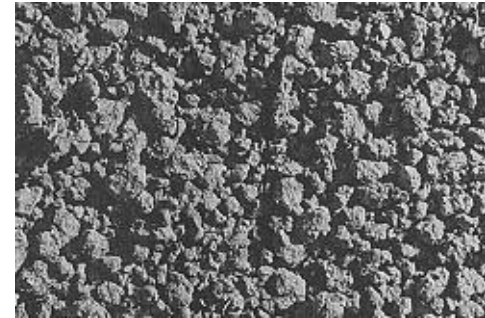
Water movement in soils: sandy layer



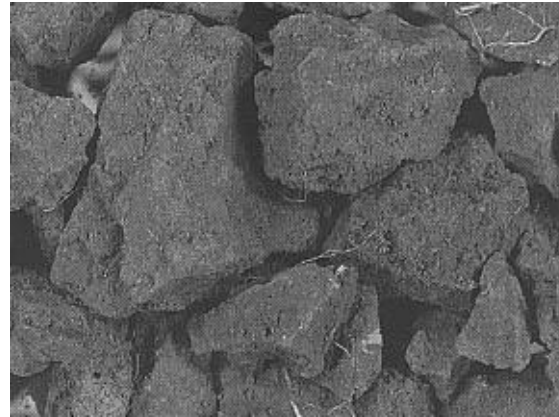
Structure

- Cohesion of particles into larger units = PEDS

Granular



Blocky



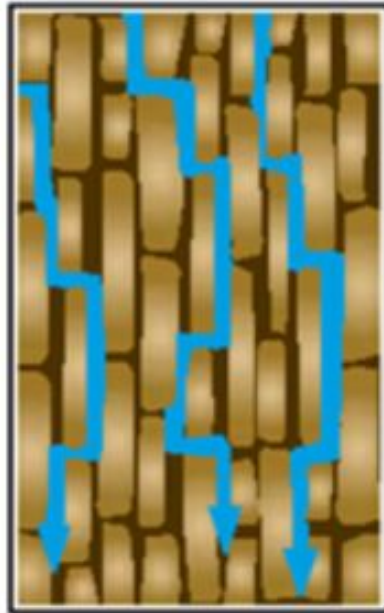
Single-Grain



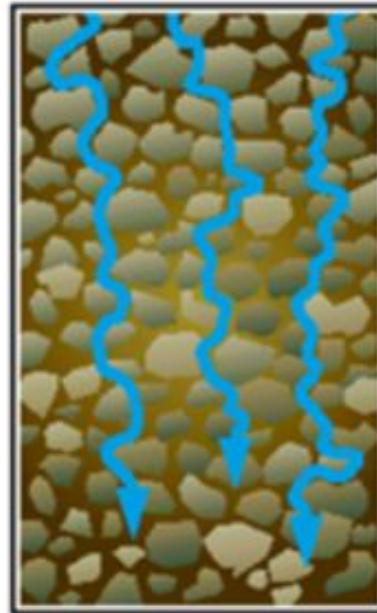
Structure



Granular



Prismatic



Subangular
blocky

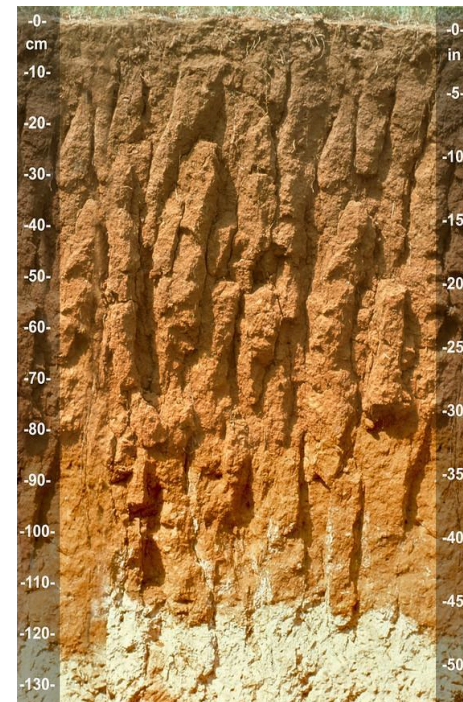
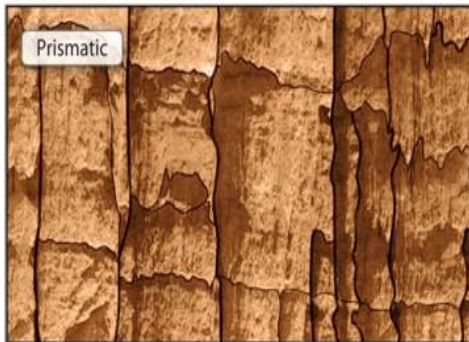
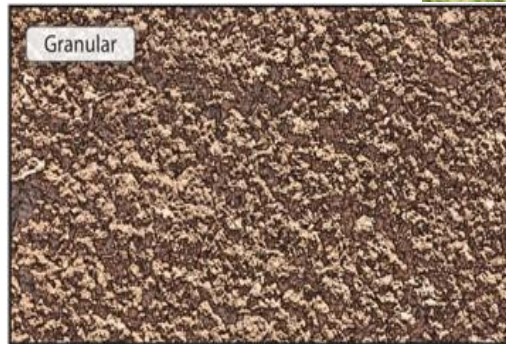


Platy

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

Structure

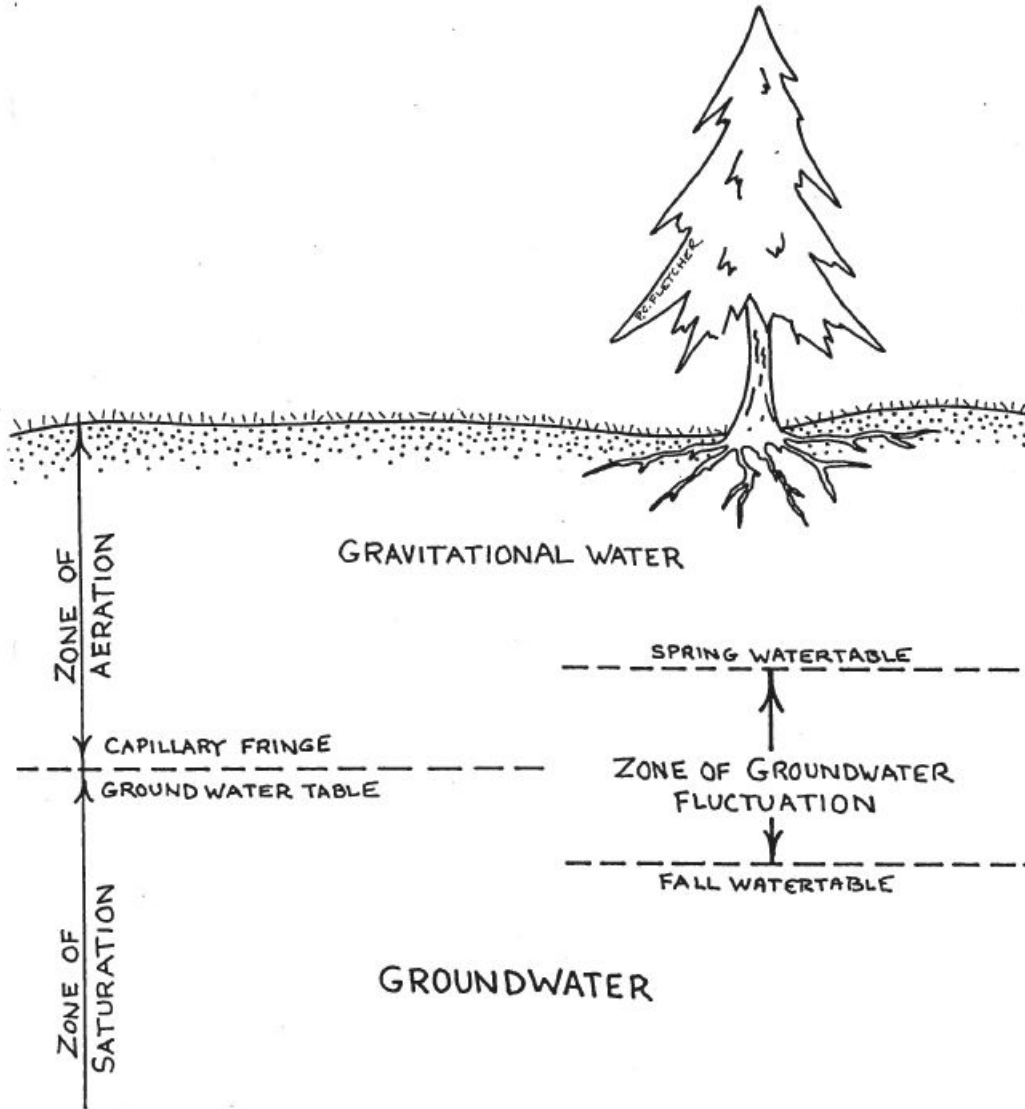
Granular, blocky, platy, prismatic



Photos courtesy of John Kelley

Pearson Education, Inc 2011



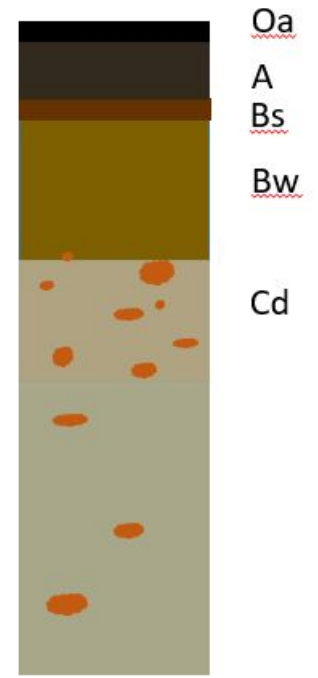
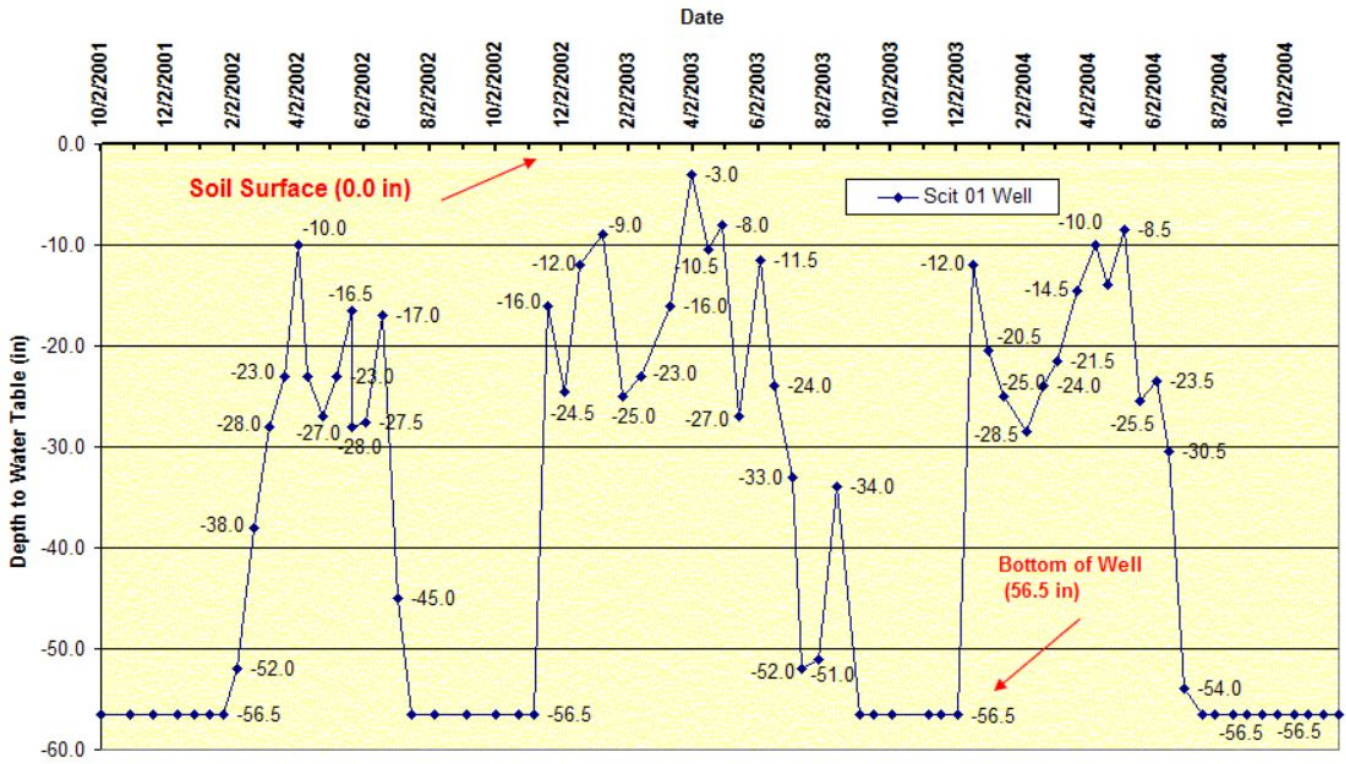


Observed Groundwater Elevation

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

Scit 01 Well - Water table, Oct. 2001 to Nov. 2004



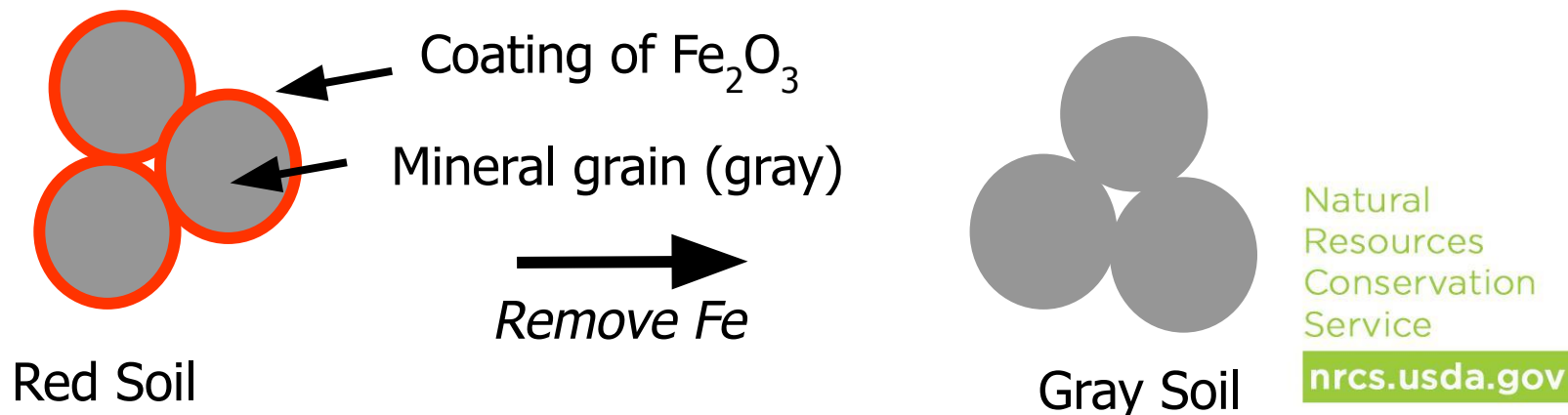
Redoximorphic Features

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.





United States
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Agriculture





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

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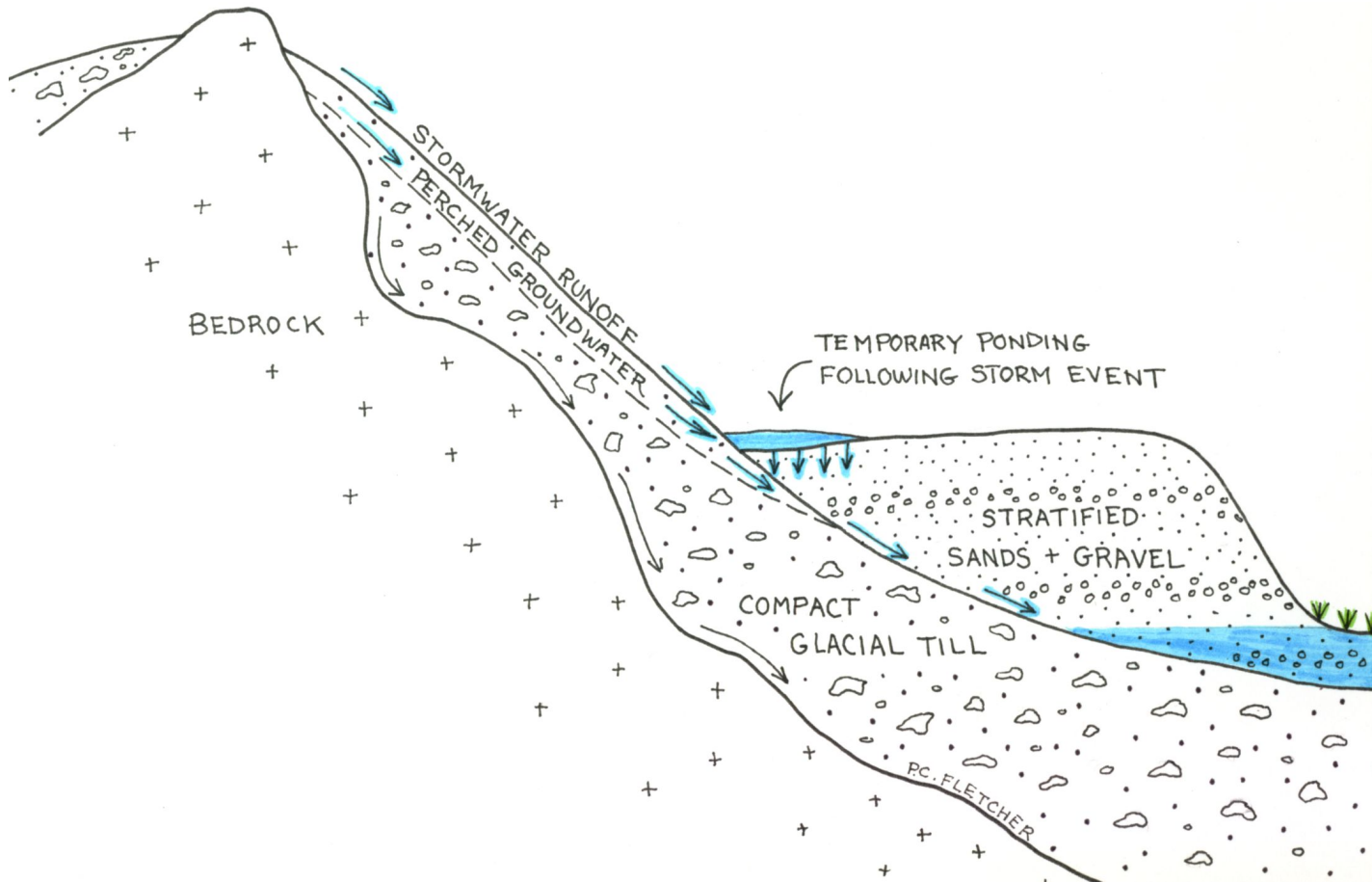


Freetown Muck (wetland soil)

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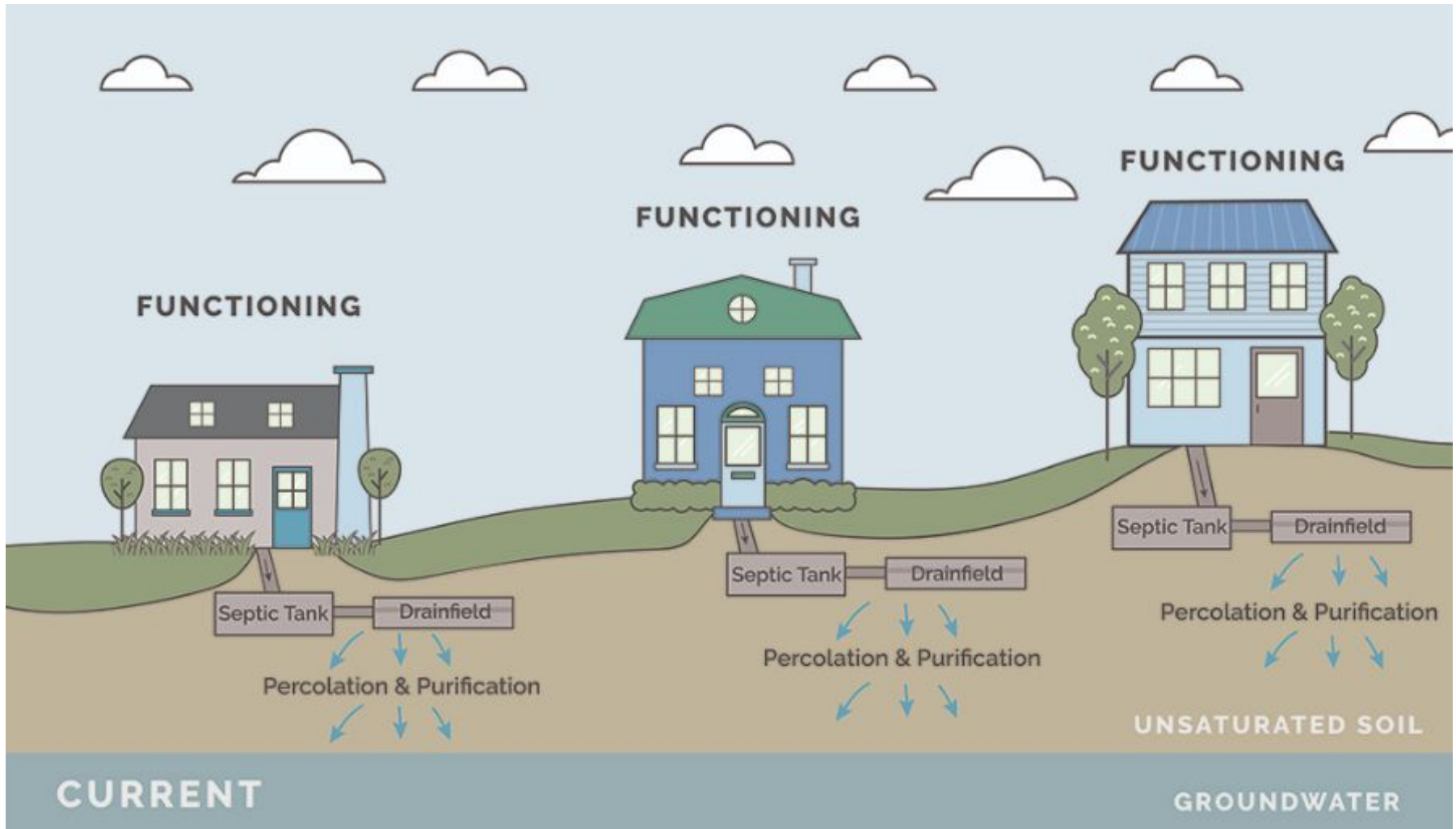
Consider your soil and your landscape



Use common sense: A failed system waiting to be installed



Photo by PC Fletcher

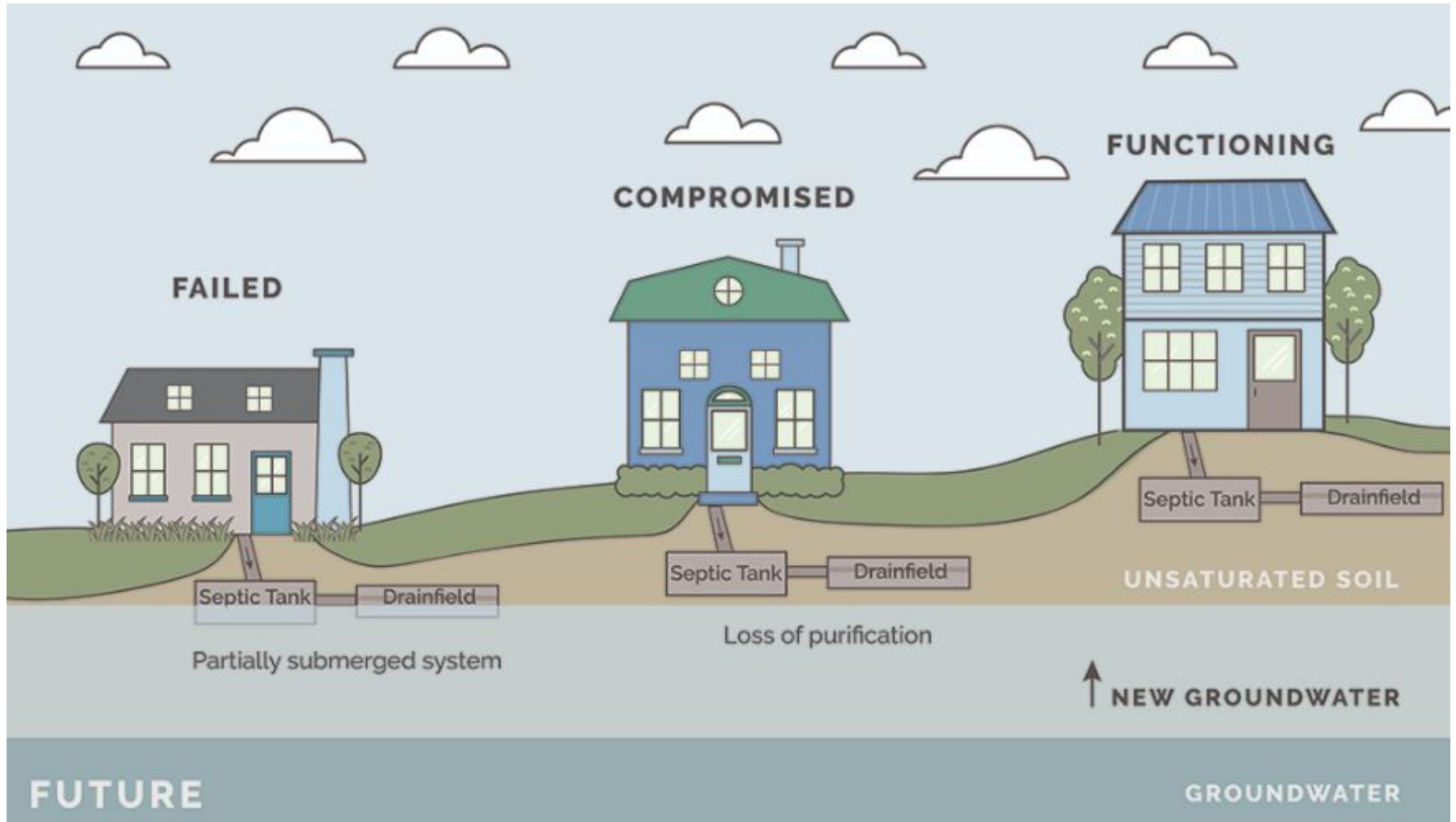


Consider the future

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

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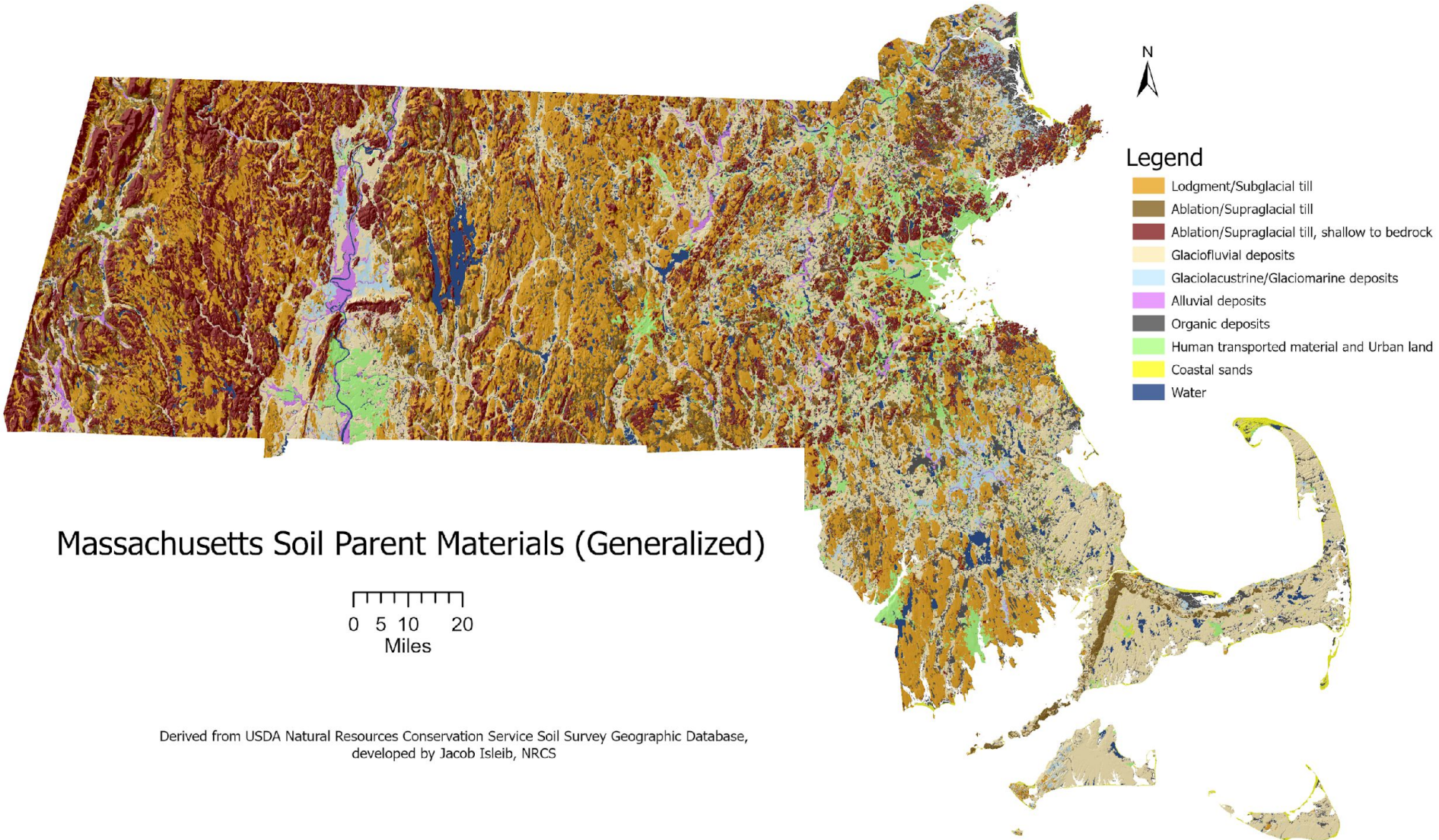
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Massachusetts Soil Parent Materials (Generalized)

0 5 10 20
Miles

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