Landscaping at the water's edge and soils: why they matter to revegetation and erosion control work

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Landscaping at the water's edge: ecological designs for water quality and habitat improvement workshop

– April 14, 2009 / On the edge: enhancing ecological integrity of shorelines

22nd Annual National Conference – Enhancing the States' Lake Management Programs – Chicago, IL

Source: www.organicgardeninfo.com/soil.html

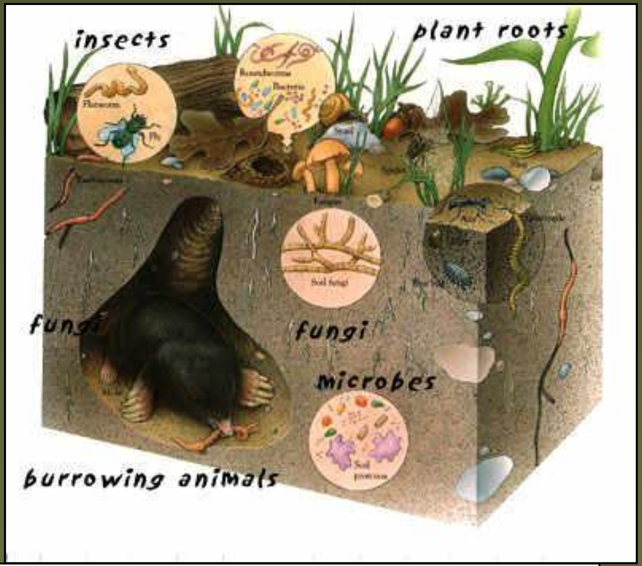
What is soil?

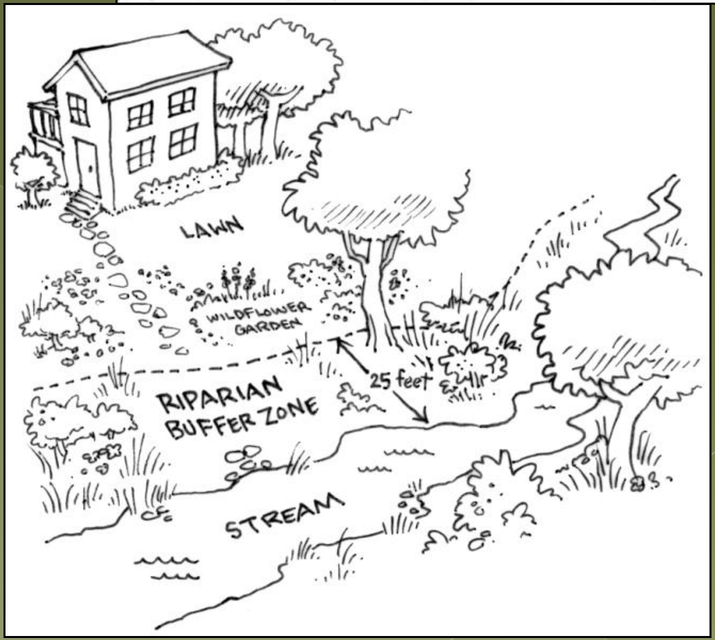
- You know that soil is <u>more than simply broken up rocks</u>.

- Rather than being an inert unchanging material, soil is a <u>dynamic living thing</u>.

- According to the Soil Science Society of America, soil is defined as, *"…the unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants."*

- <u>It holds stuff-water, air, critters;</u>
  <u>it grows stuff-fauna, flora, microscopic life;</u>
  <u>it cycles stuff-nutrients, minerals, & water.</u>





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Why care about soils?

Determining what type of soil(s) you have is essential:

- Soils in part dictate the hydrologic conditions on site
- Soils influence the types and species of plants that will grow on site
- Soils play into the erosion potential for a site

Soils can vary on a property (I.E., between near shore area and elsewhere in the uplands)

Soils vary across the landscape according to soil-forming factors, including:

- Parent material
- Climate (precipitation, temperature, wind)
- Topography
- Biological organisms
- Time

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Understanding your soil

- The ability to remove pollutants and nutrients from surface and ground water depends on the type of soil, its depth, and relation to the water table.

- The size of pore spaces in the ground is dependent on the soil type.

- Pore size determines how much water the soil can hold and how quickly it drains away.

- Compacted soil, where pore spaces are squeezed, can be a particular problem on some sites.

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Soil attributes-tell us about the soil conditions

- Soil type
- Native vs. urban
- Soil texture
- Soil horizons/geomorphology
- Soil infiltration
- Soil structure
- Soil depth/relation to water table
- Soil pH
- Aquatic substrates
- Soil moisture

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Soil type

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Divided into three basic classifications:
sands, loams and clays

Sandy soils:

- "Light" soils, contain large particle size that are loose and easy to work
- Drain readily and tend to be low in nutrients
- Tend to be more acidic

Loamy soils:

- Are "intermediate" between sands and clays
- Composed of many different sized soil particles
- Combine fertility and moisture-holding capacity with good drainage
- Suitable for growing most plants

Clay soils:

- "Heavy" soils consisting of very small, tightly packed soil particles
- Tend to be dense, hard to work, but can be very productive
- Generally rich in nutrients, have a high water-holding capacity, poor drainage

Source:
Prairie Nursery 2005 Native Plants and Seeds Catalog and Growing Guide < www.prairienursery.com >

Determining your soil type

"Feel test" > take soil moisten it, and rub back and forth in your hand

Sandy soils

- Will feel gritty and not stick together well
- Can be amended by adding organic matter like compost and dead leaves
- An effective technique is to plant a "green manure crop" such as buckwheat or winter wheat as these crops will bring nutrients and organic matter back into the soil

Loamy soils

- Will stick together easily but not as tenaciously as clay
- Will feel moderately gritty and have a component that feels like flour from the silt particles

Clay soils

- Will be slick and smooth, with little or no grittiness
- May have a floury feel to them but again lacks grit
- Adding organic matter helps "open up" clay soils by improving porosity or "breathability"
- There are many native plants that will gradually work their way down into the clay—use them

Source:
Prairie Nursery 2005 Native Plants and Seeds Catalog and Growing Guide < www.prairienursery.com >

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Native versus so-called landscape/urban soils

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Source:
Colorado Master Gardeners Program
Colorado Gardener Certificate Training
CMG Fact Sheet #S14

Figure 1: A well-managed native soil might have ~ 25% air, 25% water, 1-5% organic matter and 45-49% mineral solids.

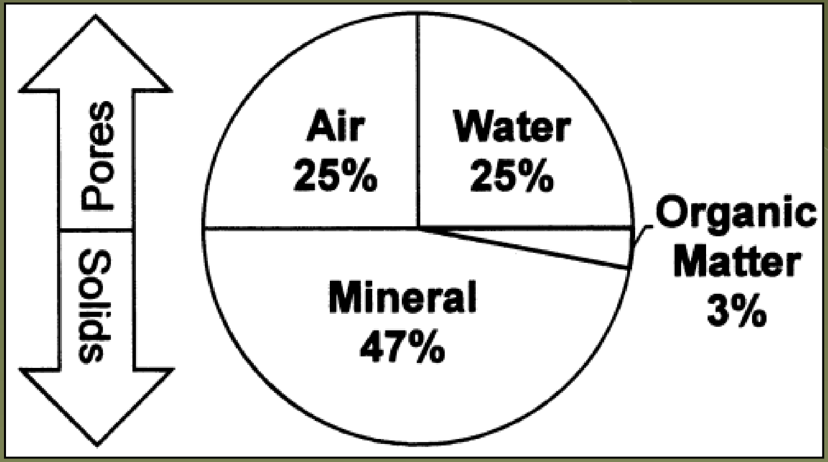
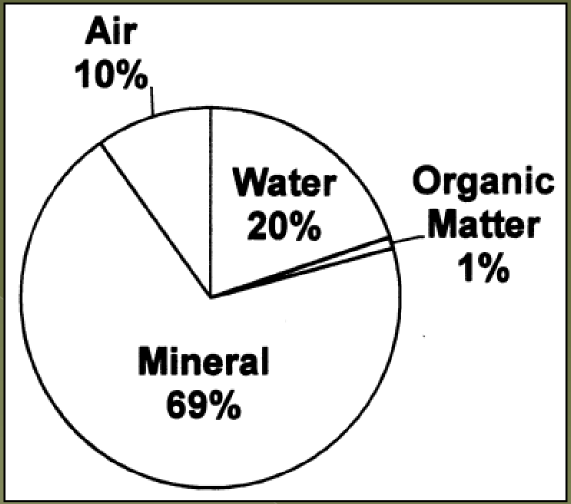


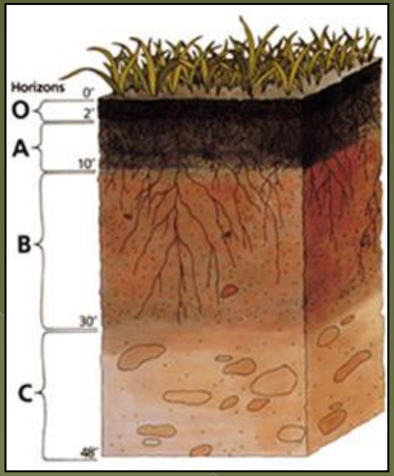
Figure 2: A typical compacted, unamended Landscape (urban) soil has ~10% air, 20% water, 1% organic matter and 69% mineral solids.

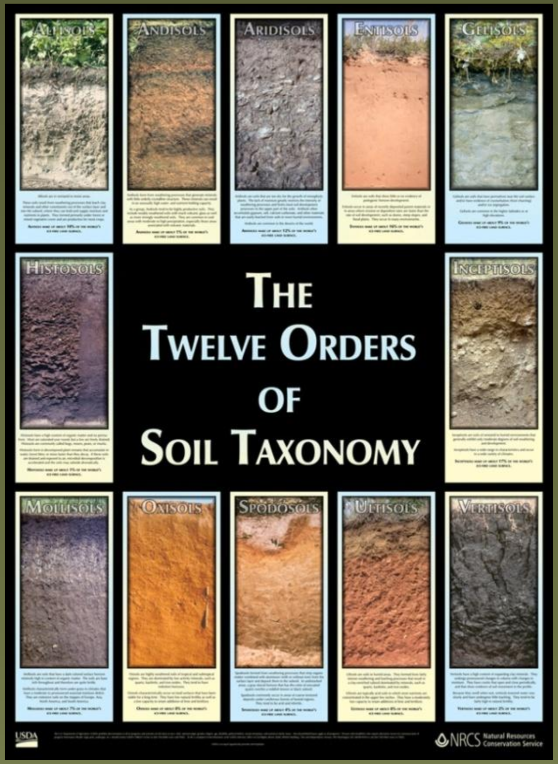


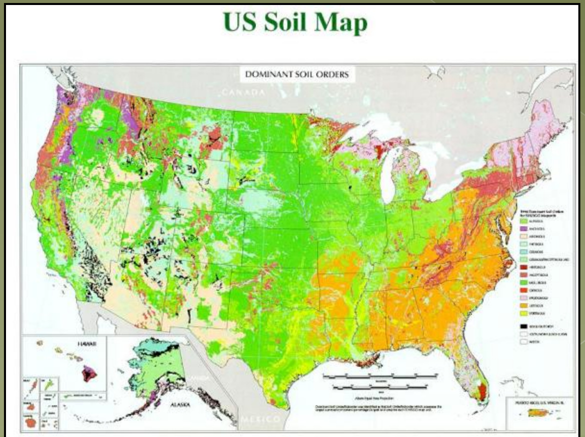
- Landscape soils differ significantly from agricultural or native soils.
- They are found in a typical neighborhood community around homes, parks, schools, offices, parking lots, and buildings. Soil scientists often refer to landscape soils as "urban" soils.
- During the construction process, soils in communities are often graded by moving large volumes of soil. This process often removes the A horizon, taking with it the vast majority of organic matter.

Soil horizons/geomorphology

- Different horizons have different hydrological properties.
- Knowing the soil geomorphology allows you to construct a more complete picture of the movement of water in the soil
- Plays into pH, nutrient availability, organic matter , mineral content, and other factors
- In order to more accurately determine what type of soil you are dealing with, the USDA NRCS has put thousands of their soil surveys online in an easy-to-use program called the Web Soil Survey : http://websoilsurvey.nrcs.usda.gov/app/







Source: USDA

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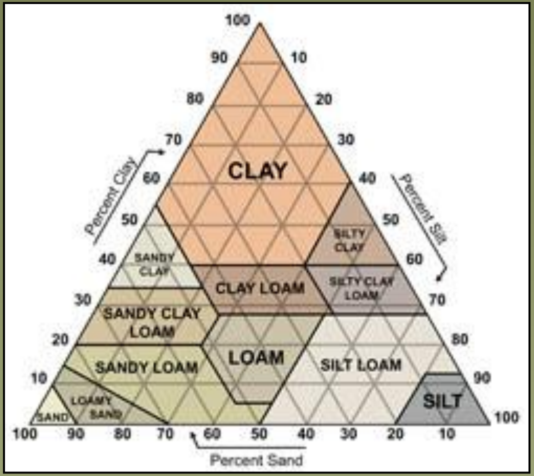
One way to help determine what type of soil you have is to simply feel it to determine texture

Soil texture

- Texture refers to the size of the particles that make up the soil.
- The terms sand, silt, and clay refer to relative sizes of the soil particles. Sand, being the larger size of particles, feels gritty.
- Clay, being the smaller size of particles, feels sticky; it takes 12,000 clay particles lined up to measure one inch.
- Silt, being moderate in size, has a smooth or floury texture.

Table 1. The Size of Sand, Silt and Clay

Name	particle diameter
Clay	Below 0.002 millimeters
Silt	0.002 to 0.05 millimeters
Very fine sand	0.05 to 0.10 millimeters
Fine sand	0.10 to 0.25 millimeters
Medium sand	0.25 to 0.5 millimeters
Coarse sand	0.5 to 1.0 millimeters
Very coarse sand	1.0 to 2.0 millimeters
Gravel	2.0 to 75.0 millimeters
Rock	Greater than 75.0 millimeters (~2")



Source:
Colorado Master Gardeners Program
Colorado Gardener Certificate Training
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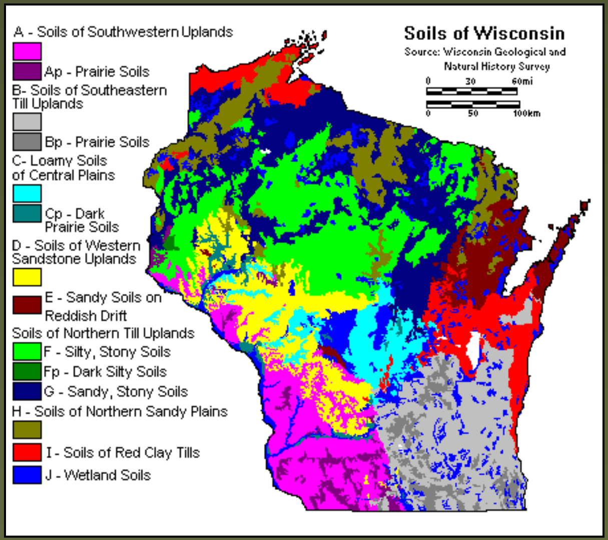
Infiltration rates

	Approximate infiltration rates of soils
Sand	1.2 to 3.0 inches or more per hour
Sandy loam	0.8 to 1.2 inches per hour
Loam	0.3 to 0.8 inches per hour
Clay loam	0.2 to 0.3 inches per hour
Clay	0.04 to 0.2 inches per hour



A simple hand testing method will provide an idea of soil texture:

1. Take a small handful of soil.
2. Make sure the soil is reasonably moist.
3. Form a small round ball with one hand.
4. Work the soil by pushing part of that ball between your thumb and forefinger.
5. This process should form ribbon. The ribbon should be long enough to measure with a small ruler.

Soil texture	Ribbon length
Sand	0 – ½ inch
Sandy loam	½" – 1.0 inch
Loam	1.0 inch
Clay loam	1.0 – 1.5 inch
Clay	2.0+ inches

Source: *Controlling runoff and erosion from your waterfront property: a guide for landowners*. by Burnett County LWCD, WI / June 2008.

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Measuring infiltration rates

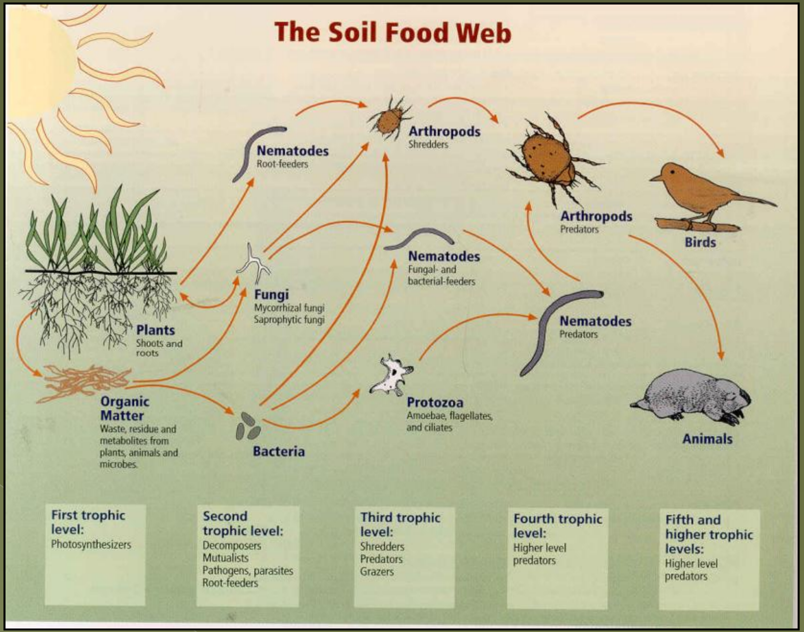
You can perform a simple infiltration
(or more accurately percolation) test by:

1. Digging a hole with straight, vertical sides to the depth where you want to infiltrate water and filling it with water to moisten the soil.

2. Allow this water to drain, and then fill the hole again.

3. Measure water depth after filling and every 15 minutes until the hole drains.

4. Measured every fifteen minutes, the infiltration rate per hour is four times the average decrease in water depth.



Source: Elaine Ingham, Associate Professor at Oregon State University

Source:
Controlling runoff and erosion from your waterfront property: a guide for landowners.
by Burnett County LWCD, WI / June 2008.

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Soil structure

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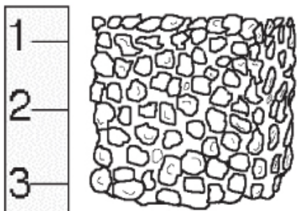
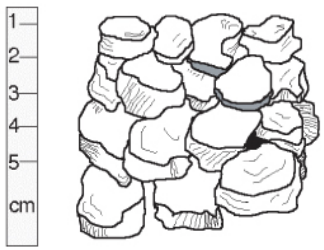
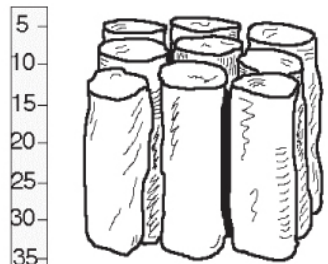
Soil structure is the shape that the soil takes based on its physical and chemical properties. Each individual unit of soil structure is called a **ped**. Take a sample of undisturbed soil in your hand (either from the pit or from the shovel or auger). Look closely at the soil in your hand and examine its structure. Possible choices of soil structure are:



Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.



Blocky: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.



Prismatic: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.

Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates

***Source*:**
Colorado Master Gardeners Program
Colorado Gardener Certificate Training
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Soil depth/relation to water table

A shallow soil depth overlying hard limestone and adjacent to a sensitive watershed, hill country lakes in central Texas.

Source: Community Environmental Services Inc. – Austin, TX

- It affects how much water the soil can hold
- If your soil is only a foot or so deep, with bedrock underneath or on top of the water table, the soil will not be able to hold much water before all the pore spaces become filled
- Once the pore spaces are filled, the water will likely runoff from the surface

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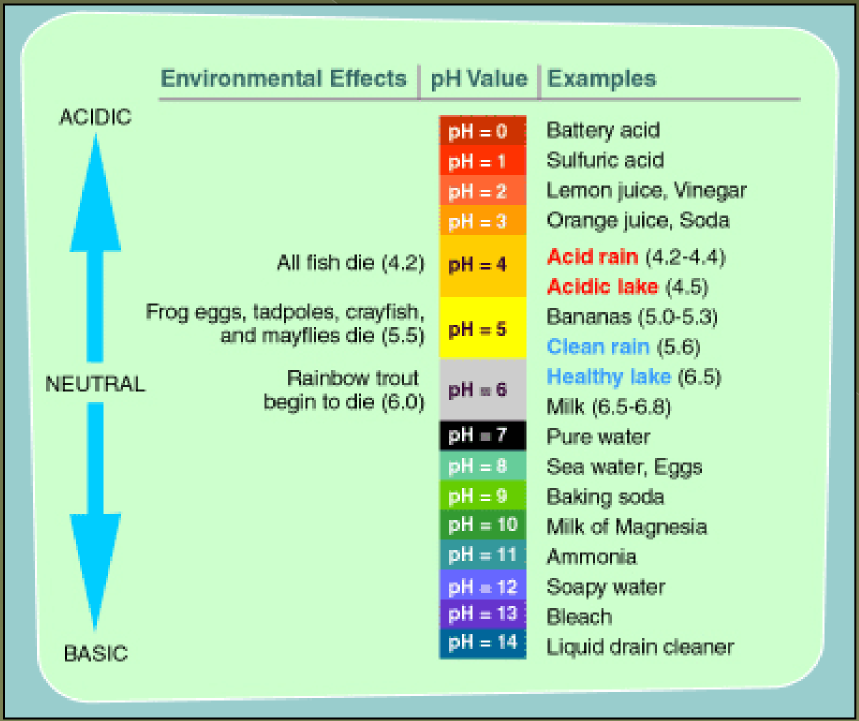
Source:
Shoreland Stewardship Series – Number 2; "Protecting and restoring shorelands" UWEX PUB-GWQ038

Soil pH



The pH of the soil (measured through soil solution) is very important:

- carries in it nutrients such as (N), (K), and (P) that plants need in specific amounts to grow, thrive, and fight off diseases;
- (N) in the form of nitrate is made available to plants at pH above 5.5;
- (P) is available to plants when soil pH is between 6.0 and 7.0.
- Can impact beneficial bacteria and fungi

- The scale range of soil pH goes from 0 to 14 with the lower end of the scale being **Acidic pH (0 to 6)** and the higher end of the scale being **Basic pH (8 to14)**.

- Most landscape plants prefer a ph in the range of **6 to 7.2** which is considered closer to **Neutral pH.**

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Aquatic substrates

Rock, cobble, sand, marl, muck, organic, etc.

Substrate Type	Size	Code Number
Bottom Mineral Substrate		
Marl	Deposits of calcium carbonate	1
Silt	<0.2 mm	2
Sand	0.2-6.3 mm	3
Gravel	6.4-76.0 mm	4
Cobble	76.1-149.9 mm	5
Rubble	150.0-303.9 mm	6
Small boulder	304.0-609.9 mm	7
Large boulder	>609.9 mm	8
Bedrock	Consolidated parent material	9
Coarse inorganic material	Calcified pieces of shell	10
Bottom Organic Substrates		
Fine organic material/muck	Fine particulate organic matter discernible	1
Coarse organic material	Coarse particulate organic matter discernible	10
Coarse Woody Structure		
Small woody structure	0-0.5 cm in diameter, any length	Type 1
Medium woody structure	0.6-10.0 cm in diameter, any length	Type 2
	≥10 cm in diameter, <1.0 m length	
Large woody structure	≥10 cm in diameter, ≥1.0 m length	Type 3

Substrate particle size by Schmidt (2009) modified from Platts et al. (1983) and Wentworth (1922) and coarse woody structure classification from McHenry et al. (1998) and Newbrey, M.G. et al.

- Organic detritus found in conjunction with mineral material has a big impact on plants and animals
- The size and amount of organic matter affects algal and microbial growth
- Arrowhead (*Sagittaria* spp.) or pickerelweed (*Pontederia cordata*) not practical for areas with a soft unconsolidated substrate.
- These species are better suited for sites with firm substrate enabling plants to firmly root and not allow bare root propagules or tubers to float away shortly after planting.

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Soil moisture

Important to deciding which plant species to plant

- Moist/wet soils have a generous amount of water in the subsoil throughout the growing season and may be anoxic (w/o air)
- Dry soils include sandy and gravelly soils that drain readily and never have standing water very long, even after a heavy rain
- Medium, or "mesic" soils include well-drained loam and clay; these soils may have standing water for short periods after a hard rain but drain readily

Source:
Prairie Nursery 2005 Native Plants and Seeds Catalog and Growing Guide < www.prairienursery.com >

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Soil amendment

Bringing in soil amendments can be an option:

- Adding compost and wood chips to plantings during installation
- Backfilling behind bioengineering techniques like fiber logs
- Augmenting rain gardens with clean peat
- Using clean fill for soil lifts and other techniques that require soil

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Native plants…

- Have deeper roots that stabilize soil
- Lessen raindrop impact and erosion
- Stay upright in runoff to filter sediment
- Provide food and shelter for wildlife

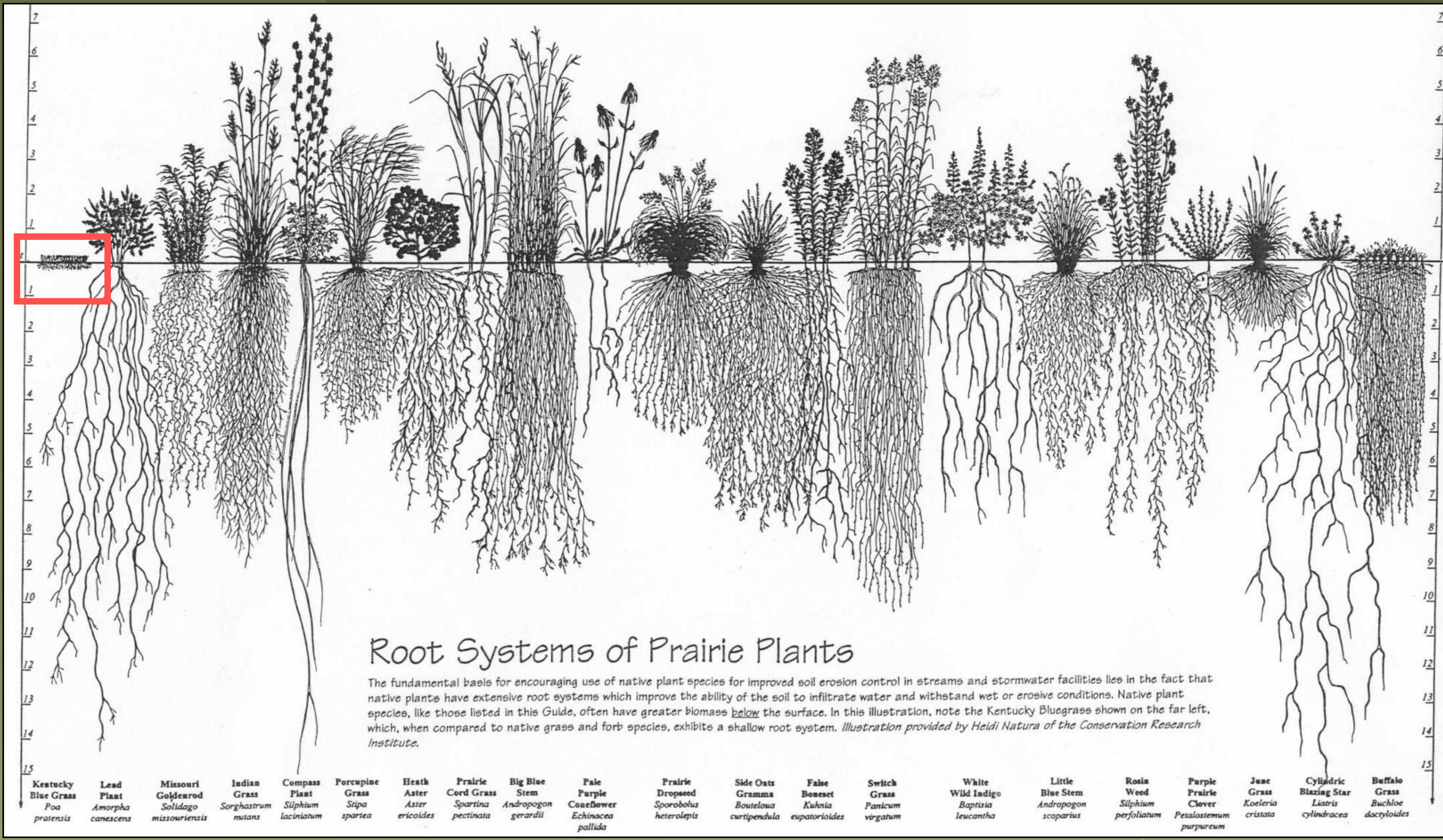

Illustration provided by Heidi Natura of the Conservation Research Institute.

Take home messages

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- Understand soils as a living ecosystem.
- Nurture soil organisms by providing their food source (organic matter) and improving aeration and drainage (oxygen and water).
- Understand the physical properties of texture, structure, and pore space as they relate to soil.
- Compaction is a reduction in total soil pore space, but more significantly a major reduction in large pore space where the air is located. This is key for plant root growth.

Lessons learned:

1. If your site has compacted soils or shallow soils, it will be important to have enough area available for the soil to treat runoff.
2. Rain gardens can be used to efficiently capture runoff, allowing more time for the water to soak into the soil rather than running off into the lake.
3. Trees for Tomorrow rain garden demo site.

Source:
Agrecol < www.agrecol.com >
Shoreline Wall, Rainwater Garden - McFarland, Wisconsin