

Principles of Xeriscape

Step 2: Soil Preparation

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Soil Characteristics

- ❖ There are several ways to describe soil. Understanding the characteristics of soil helps the gardener amend soil.
- ❖ Urban soil is often quite different from the native soil. The native soil may have been compacted by heavy equipment and traffic. It may be removed before construction and sold as TOPSOIL. Subsoil excavated from basements is often dumped on the surface.

Soil Science 101

❖ Soil Texture

- Soil texture is the relative volume of SAND, SILT and CLAY particles in a soil.
- Soil texture affects the water-holding capacity of soil, movement of water through the soil and ease of cultivation.

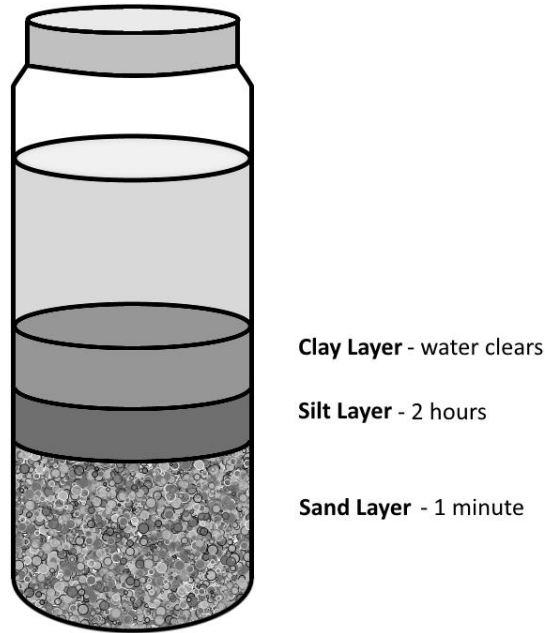
Particle Size

- Sand particles are the largest, between 0.05 and 2 mm in diameter (visible to the naked eye).
- Silt particles are between 0.002 and 0.05 mm in size (the size of talc).
- Mineral particles smaller than 0.002 mm in diameter are called clay (these particles are microscopic).

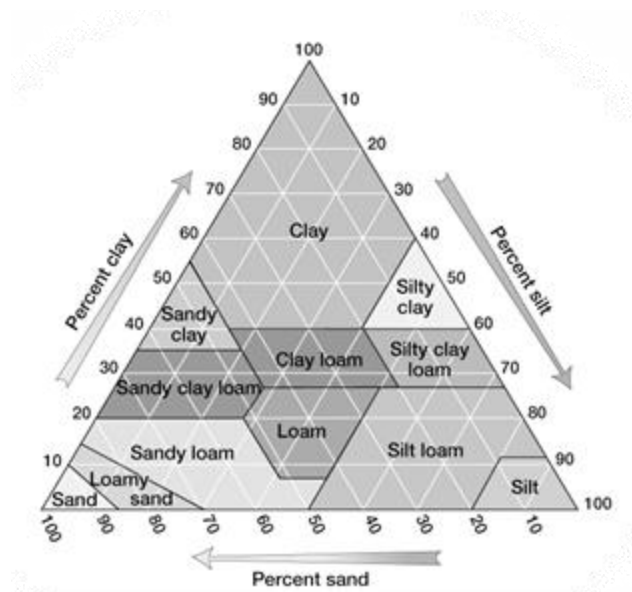
Textural Classes

- Sand is obviously the largest particle. Soils that are coarsely textured are sandy.
- Medium-textured soils have equal parts sand, silt and clay.
- Finely textured soils are mostly clay or clay and silt.
 - The same weight of clay can hold 50 times as much water as very fine sand particles.
 - Soils containing a high percentage of clay are undesirable because the small particles pack tightly together, leaving little pore space for air and available water. This type of texture makes digging difficult.

- Even though clay is usually nutrient rich, nutrients are too tightly bound to be easily released.
- Ideal garden soil, called LOAM, is a mixture of all three particle sizes.
- Soil texture is important because it affects how easily soil can be worked, how well it holds water, and how quickly it warms.
- For example, coarsely textured, or sandy soils, allow water to enter and pass through more quickly. Sandy soils warm up more quickly than finer soils and can be tilled more easily; however, they dry out more quickly and are not as rich in nutrients.
- To experience soil texture, wet a small handful of soil and rub it between your thumb and forefinger:
 - A gritty feel indicates the presence of sand.
 - A silky or a smooth feel indicates silt.
 - A sticky sensation indicates clay.
- Moisten a small amount of soil to the consistency of putty, and roll it into a ½" diameter ball. Press the ball:
 - If it breaks apart, the soil is sandy.
 - Clay can be worked to form a ribbon of soil.
 - Loam, which contains approximately 40% sand and silt and 20% clay, will stick together when pressed, but will not form a ribbon of more than ½" in length.
- Jar Separation Method
 - Spread soil on a newspaper to dry. Remove all rocks, trash, roots, etc. Crush lumps and clods.
 - Finely pulverize the soil.
 - Fill a tall, slender jar (like a quart jar) one-half full of soil.
 - Add water until the jar is three-quarters full.
 - Add a teaspoon of powdered, non-foaming dishwasher detergent.
 - Put on a tight fitting lid and shake hard for 10 to 15 minutes. This shaking breaks apart the soil aggregates and separates the soil into individual mineral particles.
 - Set the jar where it will not be disturbed for 2 to 3 days.
 - Soil particles will settle out according to size. After 1 minute, mark on the jar the depth of the sand.
 - After 2 hours, mark on the jar the depth of the silt.
 - When the water clears mark on the jar the clay level. This typically takes 1 to 3 days, but with some soils it may take weeks.
 - Measure the thickness of the sand, silt, and clay layers.
 - Calculate the percentage of sand, silt, and clay by dividing each layers thickness by the thickness of all layers.



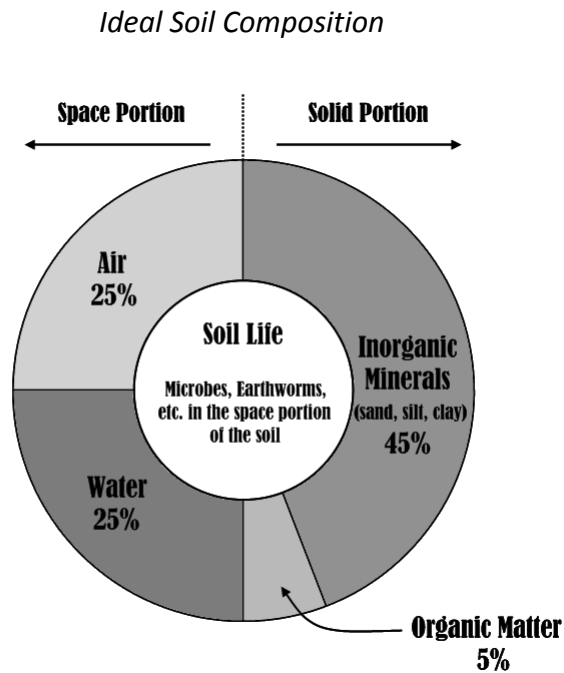
The Soil Textural Triangle:



❖ Soil Structure

- Soil structure describes the arrangement of the solid parts of the soil and the pore space located between them.
- Soil structure results from the binding together of soil particles into aggregates or clumps of varying sizes and shapes. Aggregates can be as small as a grain of sand or as large as a pea.
- A well-structured soil is made up of aggregates of varying sizes that allow maximum space for air and water (ideally about 20 to 25% for each by volume).
- These aggregates form as a result of physical forces: freezing and thawing cycles, wetting and drying cycles.
- Organic matter promotes stabilization of the aggregate particles. Decaying organic matter acts like a glue to hold soil particles together, much like flour moistened and used as paste.

- Unnecessary digging or rototilling may break down aggregates into a fine powder, reducing pore space.



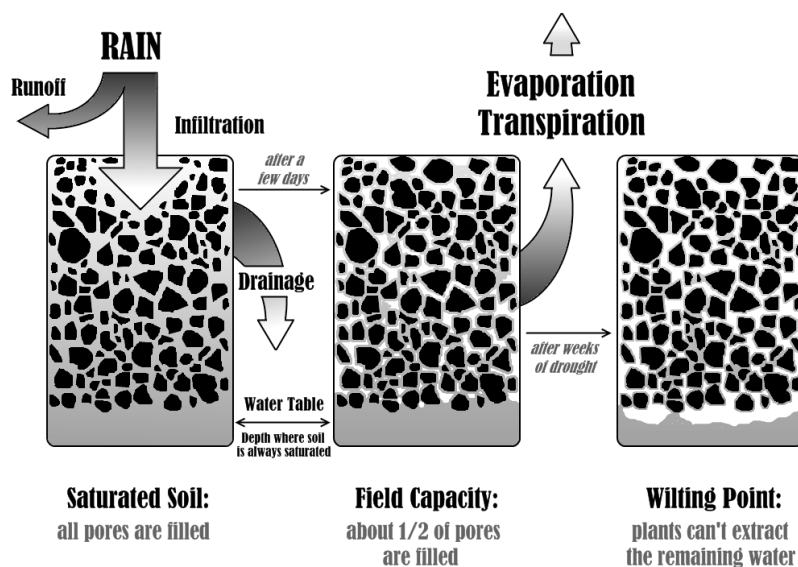
- Soil structure is critical to plant health because it affects root development.
- Soil structure is more important than texture, color or parent material. It is also more important than any fertilizers that can be applied.
- Good soil structure allows water and air movement, and it provides channels through which roots grow.
- Overworked, compact soils show a very indistinct soil structure. Aggregates do not exist, so there are few air spaces between particles.
- Roots can suffocate and die where large amounts of water have forced air out of the space.
- TILTH is a term gardeners use to describe how easily soil can be tilled. Soil with good tilth allows seedlings to emerge easily. It allows roots to penetrate soil. Soil with good tilth has good structure.

Biological Impact

- Living organisms impact soil structure.
- Organic matter attracts earthworms that drill channels deep into the subsoil. These channels provide needed space for plant roots, air and water.
- Worms leave behind "castings" as they tunnel, which improve nutrient levels in the soil.
- In addition to earthworms, microbes live in soil. Microbes break some nutrients and organic matter into simpler units that plants can use. The organic remains of microbes improve soil structure.
- Even growing plants change soil structure as they send their roots down into the soil. Roots enlarge openings in the soil and provide organic matter when they die and decay.

Drainage

- Drainage is the RATE and AMOUNT of water movement through and across soil.
- Water is a solvent for vital plant nutrients. The presence and movement of water through the soil affects the availability of these nutrients to the plant.
- Water will drain quickly across a sloped surface. This is called surface drainage.
- Additionally, there is internal drainage. Gravity moves water vertically through the soil.
- Even in highly sloped terrain, water drains internally through the soil as well as over the surface. Texture, structure and physical condition of surface and subsoil layers affect vertical drainage and capacity of soil to store water.
- The ideal moisture level is reached when water occupies one half of the pore space in the soil.
- Soil is *saturated* when all the pore space is filled with water. Saturated soil has no oxygen in its pore spaces. This dramatically reduces root growth because roots require oxygen for growth. If saturation continues for extended periods, roots will die.
- Gravity will pull a certain amount of water out of saturated soils if there is somewhere for it to go.
- The water remaining after gravity removes what it can is called the *field capacity*.
- Water also evaporates or is taken up by plants.
- The *wilting point* is the point at which plants cannot absorb any more water from the soil to remain turgid. Any water remaining in the soil is unavailable because it is strongly adhering to the soil particles.



- A certain amount of water is not available to plants because it adheres to the surface of soil particles. Clay soils have a higher moisture-holding capacity than sand; many fine particles of clay have more surface area to which water can adhere.
- Soils with high available water normally have a high organic matter content. Any organic matter increases the water-holding capacity of soil. Peat moss, for instance, retains more than 100 percent of its weight in water. Peat moss must be worked into the soil to be effective.
- Gardeners can alter soil to improve drainage. Adding organic matter may improve drainage by improving soil structure. In low areas, drainage ditches, drain tile, swales or dry wells help drain overly wet areas.
- Soil depth has a direct effect on drainage. A deep, well-structured soil provides plenty of space for vertical and horizontal drainage. Deep soils with a large capacity for water and nutrients have a positive effect on plant growth and health.

- Improving soil structure is an ongoing goal of gardeners. Soil structure cannot be changed easily. However, the addition of organic matter and working the soil at the proper moisture level improves soil structure.
- Correct soil moisture level exists when soil crumbles easily when turned over with a fork or spade. Soil should not stick to the fork or spade.

Working wet soil compacts structure and reduces air and water spaces!

❖ Soil pH

- The pH scale is a measure of the degree of acidity or alkalinity of the soil. The pH scale has 14 divisions ranging from 1 to 14. At the midpoint of this scale, 7, soil is neutral (neither acid nor alkaline).
- Acid soils, those between 1 and 6.9, are sometimes called "sour." Soils that measure 7.1 to 14 are increasingly alkaline or "sweet."
- Increments between each number represent a tenfold increase. For example, at pH 5 it is 10 times more acidic than at pH 6.
- Soil pH of 6.0 to 7.0 is suitable for most plant growth.
- A soil test is necessary to determine pH of soil.
- Gardeners should know the pH of their soil because it affects the availability of plant nutrients.
- Nutrients become less available at pH extremes.
- Some plants, mostly broadleaf evergreens (azalea, rhododendron, holly, blueberry, etc.), require acidic soils for proper growth.
- Changing pH is a very slow process – there is no quick fix.
- Overly alkaline soil interferes with plant uptake of iron.
- Chelated iron sulfate has an acid reaction and is commonly added to correct *chlorosis* or yellowing of leaves. It can help reduce soil alkalinity and adds iron.
- Specific plants affected by chlorosis include evergreen shrubs, raspberries, roses, aspen, red and silver maples and currants.
- The pH of soil along the Front Range is predominately on the alkaline side, making some nutrients (especially iron) unavailable to plants.

Concentration of Hydrogen ions compared to distilled water	1/10,000,000	14	Liquid drain cleaner, caustic soda	Examples of solutions and their respective pH
	1/1,000,000	13	Bleaches, oven cleaner	
	1/100,000	12	Soapy water	
	1/10,000	11	Household Ammonia (11.9)	
	1/1,000	10	Milk of magnestum (10.5)	
	1/100	9	Toothpaste (9.9)	
	1/10	8	Baking soda (8.4), Seawater, Eggs	
	0	7	"Pure" water (7)	
	10	6	Milk (6.6)	
	100	5	Acid rain (5.6) Black coffee (5)	
	1,000	4	Tomato juice (4.1)	
	10,000	3	Grapefruit & Orange juice, Soft drink	
	100,000	2	Lemon juice (2.3) Vinegar (2.9)	
	1,000,000	1	Hydrochloric acid secreted from the stomach lining (1)	
10,000,000		Battery acid		

Soil Testing

- ❖ **Routine soil test:** pH, soluble salts, organic matter, nitrate, phosphorus, potassium, zinc, iron, copper, manganese, boron and lime and texture estimates. (This is a basic evaluation for characterizing the soil fertility status for growing lawns, gardens and topsoil. Normally this test is sufficient unless a special problem is suspected.)
- ❖ Cost is \$35.00
- ❖ http://www.soiltestinglab.colostate.edu/documents/soilsample_horticulture.pdf

Soil Modification

❖ Mechanical

- Mechanical modification is a means of improving soil structure by digging, in one form or another. A shovel, spade, garden fork or rototiller mechanically modifies soil. Dig or till when soil is neither too wet nor too dry.
- COMPACTION reduces pore space in soil. It can result from improper digging or tilling.
- When preparing to install a lawn or garden, avoid use of heavy machinery.
- Digging in or walking on wet soils causes compaction. Once organic matter has been tilled into the soil, keep off the soil. Use paths or lay down boards that distribute weight more evenly over an area.
- A good rule is to work the soil no more than necessary to achieve desired soil structure.
- Some gardeners DOUBLE DIG to increase soil pore space. This is a very labor-intensive method of cultivation. When double digging, it is wise to add amendments recommended in a soil test.

❖ Amendments

- Another way to improve the quality of soil is by the addition of various amendments, such as peat moss, compost, aged manure, worms, mulches and sewage sludge.
- Organic compost, peat moss, sludge and manures will increase water-holding capacity of sandy soil by increasing surface area to which moisture can cling. They also can be used to break up clay by forming aggregates.
 - *CAUTION: Sewage sludge may contain heavy metals such as copper, zinc, nickel, lead and cadmium. Carefully read the label. These products should not be used in vegetable gardens. Some "organic fertilizer" products contain sewage sludge.*

❖ How much soil amendment should you use?

- Most planting specifications require 3 cubic yards of organic matter per 1000 square feet, incorporated (rototilled) to a depth of 4 to 6"
- But what does that mean?

1" of organics spread evenly over the area to be amended = 3 cubic yards/1000 sq. ft.

❖ My recommendation for the Front Range

- A minimum of 5 to 6 cubic yards of organic matter per 1000 square feet

1 2/3" to 2" of organics spread evenly over the area to be amended = 5 to 6 cubic yards/1000 sq. ft.

(7 to 10 cubic yards is better, but must be properly incorporated!)

- GREEN MANURES or cover crops are another means of protecting and improving soil quality. For example, annual ryegrass, red clover, and/or mustard can be planted in fall to be turned into the soil in spring.
 - provide organic matter
 - hold nutrients that may be lost over winter
 - reduce erosion and loss of topsoil
- A deep-rooted cover crop allowed to grow for a season in hard soil (HARDPAN) greatly improves the soil's tilth
- Green manures do not necessarily add nutrients, but remove them as they grow. Their decomposition, after being turned, again takes nitrogen from the soil.
- Green manures will hold animal manure nutrients in the soil. Turn these cover crops into the soil at least two weeks before planting. Never allow them to go to seed.