HEALTHY TREES HEALTHY SOILS

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SITE ANALYSIS

Right tree right place

Photo by Al Watson

Perform a site analysis and determine

- Sun exposure zones
- **Soil texture zones**
- **Water flow zones**
- Trees of merit e.g. natives, drought tolerant, pest resistant, animal habitat, size, soil stabilizers, shade, etc.

SITE ANALYSIS

Right tree right place

- Locate zoning ordinances and code restrictions
- Utility conflicts
- Available above ground and below ground space (so mature trees will not require pruning for size reduction and **roots can spread)**.

Photo: Steve Jeffers

SITE ANALYSIS

What **not** to do

Photo: Steve Jeffers

SITE ANALYSIS

What **not** to do

http://www.na.fs.fed.us/spfo/pubs/uf/techguide/pg11_restricted.jpg

PLANT SELECTION

- **Pest prevention involves maintaining healthy soil** with compost and mulch, selecting pest resistant plants, and planting them in the sun/shade and soil conditions they are best suited to.

Photo: Ellen Vincent

PLANT SELECTION: PEST RESISTANT PLANTS

Plants that do not normally succumb to annual disease and insect infestations

Resistance does not imply immunity

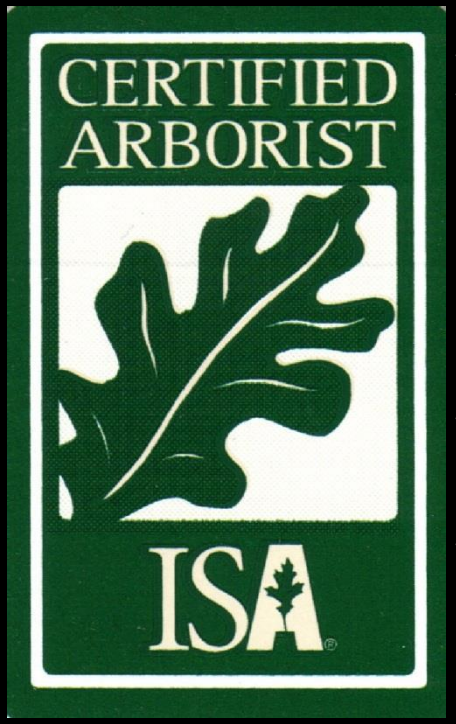
Resources:

- Books
- University publications
- Botanical gardens (regional) recommendations
- Industry professional experience (regional)

Photo: Ellen Vincent

PEST RESISTANCE RESOURCES

- Tree information resources for SC
  - ISA Certified Arborists
  - SCNLA Certified Landscape Technicians
  - SCLTA Environmental Landscape Certified Professional
  - Clemson Home & Garden Information Center
  - *Urban Tree Species Guide* free from SC Forestry Commission
  - *Manual of Woody Landscape Plants* by Michael Dirr
  - *Trees for Urban and Suburban Landscapes* by Ed Gilman



http://powerranchtreeservice.com/wp-content/uploads/2010/10/ISA-logo.jpg

PLANT SELECTION: DROUGHT TOLERANT PLANTS

- Drought tolerance possible ***once established***
- Establishment occurs when the roots grow at the same rate as they did prior to transplant.
- Trees typically take **1-5 years** to establish normal growth after planting.

Photo: Ellen Vincent

Ellen Vincent

DROUGHT TOLERANCE RESOURCES

- ***Tree Selection for Drought Resistance*** by Kim Coder University of GA http://warnell.forestry.uga.edu/service/library/for99-008/for99-008.pdf

- ***Plants that Tolerate Drought***
- Clemson University HGIC 1717 http://www.clemson.edu/extension/hgic/plants/other/landscaping/hgic1717.html
- *Manual of Woody Landscape Plants* by Michael Dirr

- *Trees for Urban and Suburban Landscapes* by Ed Gilman

Photo: Ellen Vincent

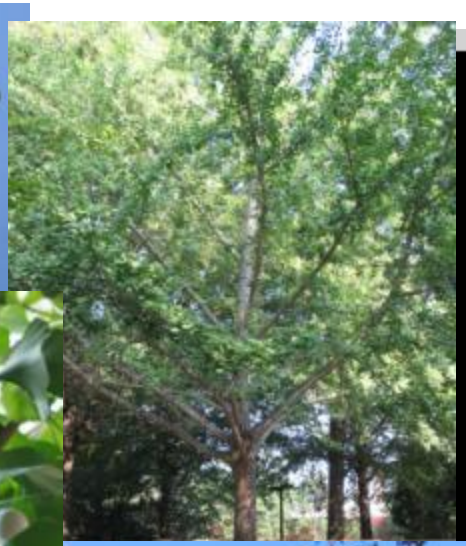
Ellen Vincent

TAXODIUM DISTICHUM

- **Bald cypress**
- Sun to part shade
- 60-80’ h x 25-30’ w
- Feathery foliage
- Deciduous conifer
- Fast grower
- Drought & wet tolerant; forms ‘knees’
- Tolerates compaction
- Zones 4-11
- Native

GINKGO BILOBA

- **Ginkgo**
- Sun to part shade
- 50-75’ h x 50-60’ w
- Fan-like foliage
- Slow grower
- Deciduous
- Soil texture, pH, & drought tolerant once established
- Bright yellow fall color
- Zones 4-8
- Asia


ULMUS PARVIFOLIA 'DRAKE'

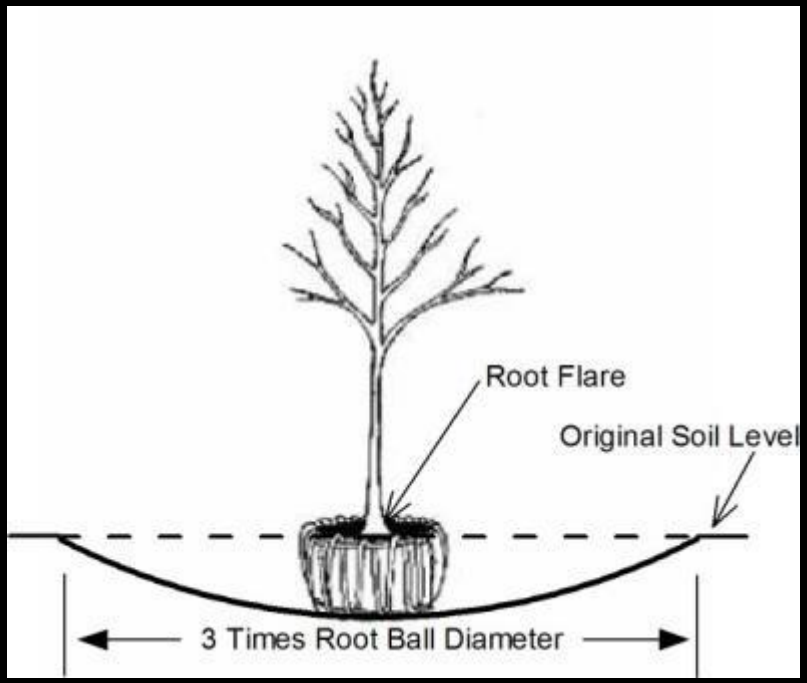
- **Lacebark elm**
- Sun to part shade
- 40-50' h x 35-50' w
- Fast grower
- Deciduous
- Soil adaptable, drought tolerant once established
- Exfoliating thin bark
- Zones 5-9
- Urban tolerant
- Asia

QUERCUS MYRSINIFOLIA

- **Chinese evergreen oak**
- Sun to part shade
- 20-40’ h x 20-30’ w
- Slow grower
- Evergreen
- Soil adaptable, drought tolerant once established
- Smooth bark, beech-like
- Zones 7-9
- New foliage purple-bronze
- China

PROPER TREE PLANTING SOIL BMPS

- Place the tree in the hole so that the top of the ball (root flare) is even with the surrounding soil level or an inch or so higher.
- **Do not loosen the soil in the bottom of the hole**, as that may cause the root ball to settle and the tree to be planted too deep.



SHOW ME YOUR ROOT FLARE!

Photo by Ellen Vincent

PROPER SOIL AT PLANTING

- Backfill with existing soil whenever possible.

Photo by Ellen Vincent

SOIL AMENDING AT PLANTING

- **Adding sand to improve drainage is risky.**
- Small quantities of sand decrease porosity (macropores and micropores) of amended soils.
- **80%** of the final amended soil must be sand before sand begins to increase macropore space which is not usually practical due to huge volume.
  (Cook & VanDerZanden, 2011, p. 125).

http://foodstorageandbeyond.com/wp-content/uploads/2011/03/types-of-soil.jpg

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

SOIL AMENDING

http://blog.hermeslandscaping.com/tag/healthy-landscape-kansas-city/

- **Adding compost to soils is a healthy practice.**
- Compost should be fully decomposed (usually takes one year).
- Partially composted material will continue to decompose and will shrink over time.
- Decomposing compost may not release nutrients for plant roots.
- Composting on site is the preferred practice.

(Cook & VanDerZanden, 2011, p 125.).

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

SOIL AMENDING

- **Amend entire bed, not the hole.**
- Adding coarse soil to a clay lined planting hole creates a potential **bathtub effect**
- Excess water results in decreased oxygen and root damage.
- Placing gravel in the bottom of holes, containers, or pits also creates **bathtub effect** as water remains in finer textured soil.

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

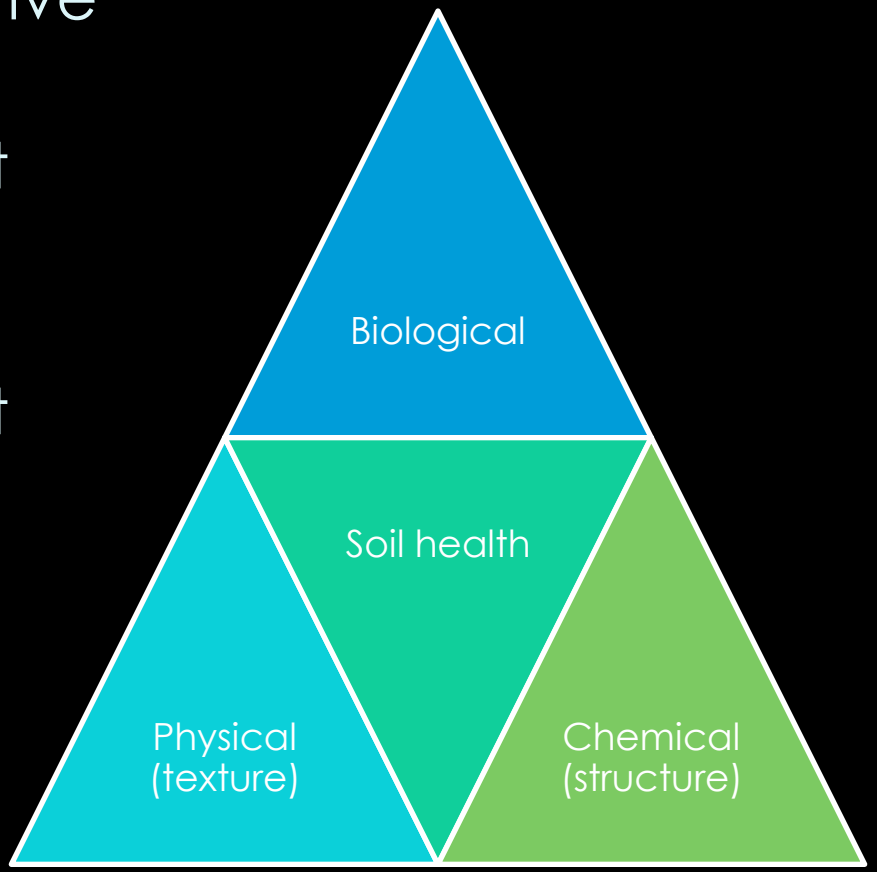
PROPER PLANTING MULCH BMPS

- Apply 2-4" of vegetative mulch
  - Out to the dripline of mature trees
  - At least 12" beyond the root ball for newly planted trees
- The goal is to maximize the area of soil under mulch that the roots can penetrate
- Keep mulch 3-6" away from the trunks of trees.
- In wet or poorly drained sites avoid fine textured mulches- use coarse textured mulches or none at all.

Photo by Ellen Vincent

HEALTHY LANDSCAPE SOILS DESCRIPTION

- Are **biologically** active
- Have **texture** that promotes plant root growth (**physical**).
- Have **structure** that promotes plant root growth (**chemical**).



Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

BIOLOGICAL SOIL HEALTH INDICATORS

Biological indicators:

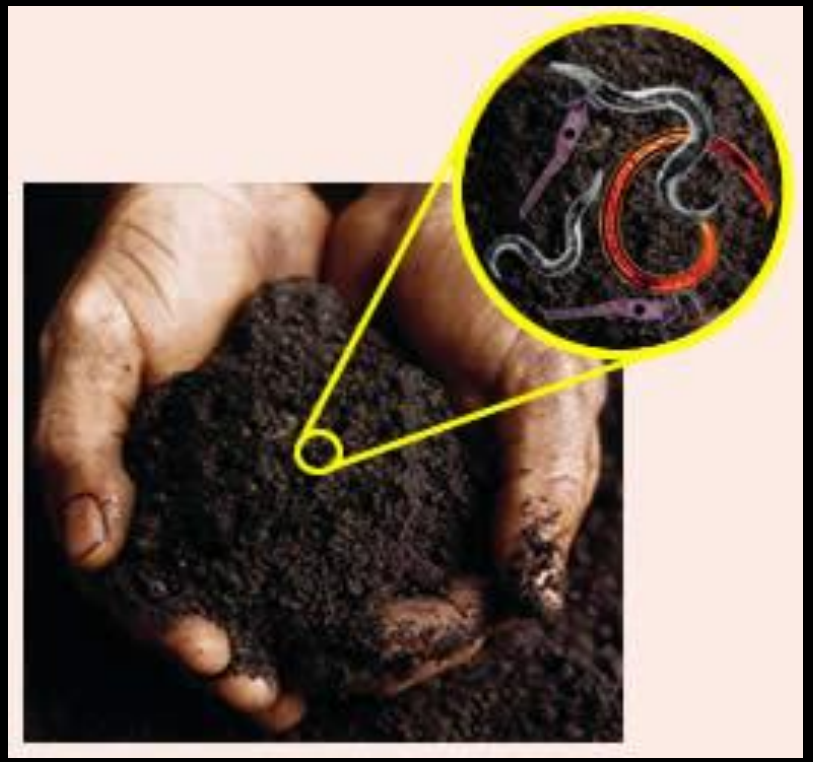
- Are difficult to assess.
- Research is ongoing to better understand the interactions of soil organisms.
- Current practice is to look at the **numbers** of microorganisms, and the **diversity** of microorganisms (Cook & VanDerZanden, 2011, p. 121).

http://cdn.theatlantic.com/static/mt/assets/food/PICT0065_2inset.jpg

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

BIOLOGICAL SOIL COMPONENTS

- Living biological components involved in wide range of soil activities/processes
  - Nutrient recycling
  - Organic matter decomposition
  - Soil structure development
  - Remediation (or not) of soil contaminants

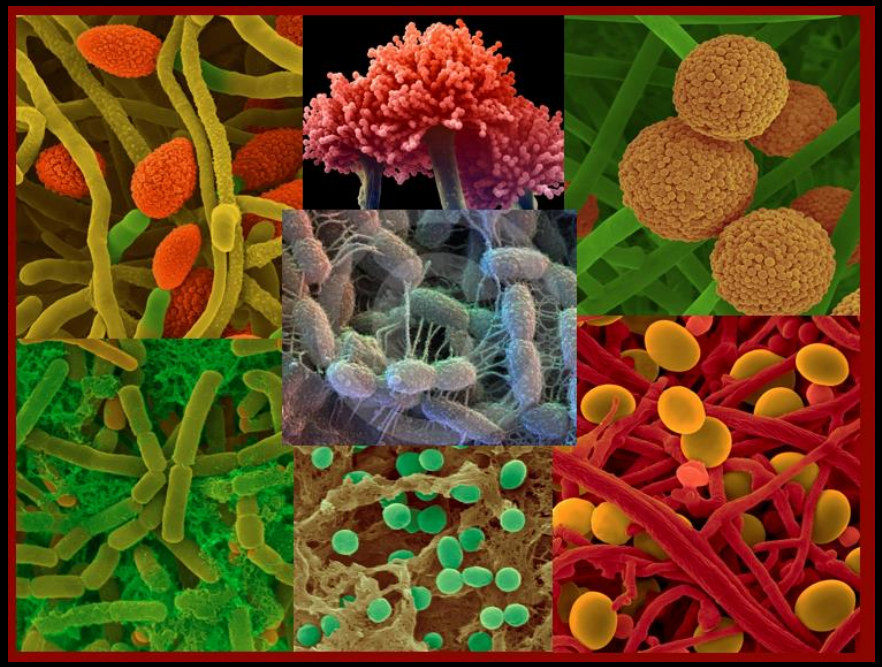


http://www.usu.edu/weeds/research/research_images/IFAFS/soil_microbes.jpg

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

BIOLOGICAL SOIL COMPONENTS

- Biological components include:
  - Living roots
  - Bacteria and fungi
  - Nematodes, protozoa,
  - Mites
  - Spiders, larger insects, earthworms, ants, termites
- Bacteria and fungi make up 75-90% of the total.



https://piremongolia.files.wordpress.com/2011/07/soil-microbes.png

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

BIOLOGICAL SOIL COMPONENTS

- Most biological organisms in the soil are directly or indirectly **beneficia**l.
- Organisms that inhabit the soil and litter layer **increase aeration and accelerate decay** by decomposing organic matter.

http://www.bigblogofgardening.com/wp-content/uploads/2011/02/soil-life-300x265.jpg

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

BIOLOGICAL SOIL COMPONENTS

Earthworms

- Contribute to healthy soils in constructed landscapes.
- They help aggregate the soil (fragmentation and mixing).
- They help increase pore spaces.
- Some insecticides and fungicides are toxic to earthworms.
- High soil organic matter and moist soils promote earthworm populations.

(Cook & VanDerZanden, 2011, p. 122).

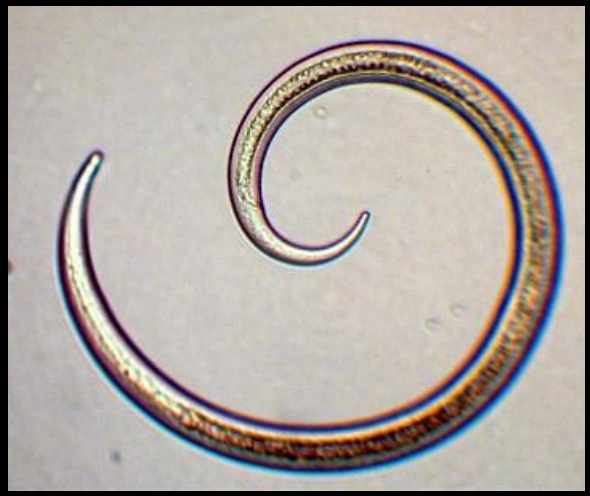
Google_earhtworms

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

BIOLOGICAL SOIL COMPONENTS

Nematodes:

- Microscopic roundworms that can parasitize tree roots and transmit disease.
- Most nematodes are beneficial and feed on pathogenic organisms.



http://www.reefkeeping.com/issues/2005-12/rs/images/image001.jpg

BIOLOGICAL SOIL COMPONENTS

Beneficial nematodes:

- *Steinernema feltiae*
- *Steinernema carpocapsae*
- *Heterorhabditis bacteriophora*
- *Heterorhabditis indica*

Fungus gnat larvae that is infected with *Steinernema feltiae*

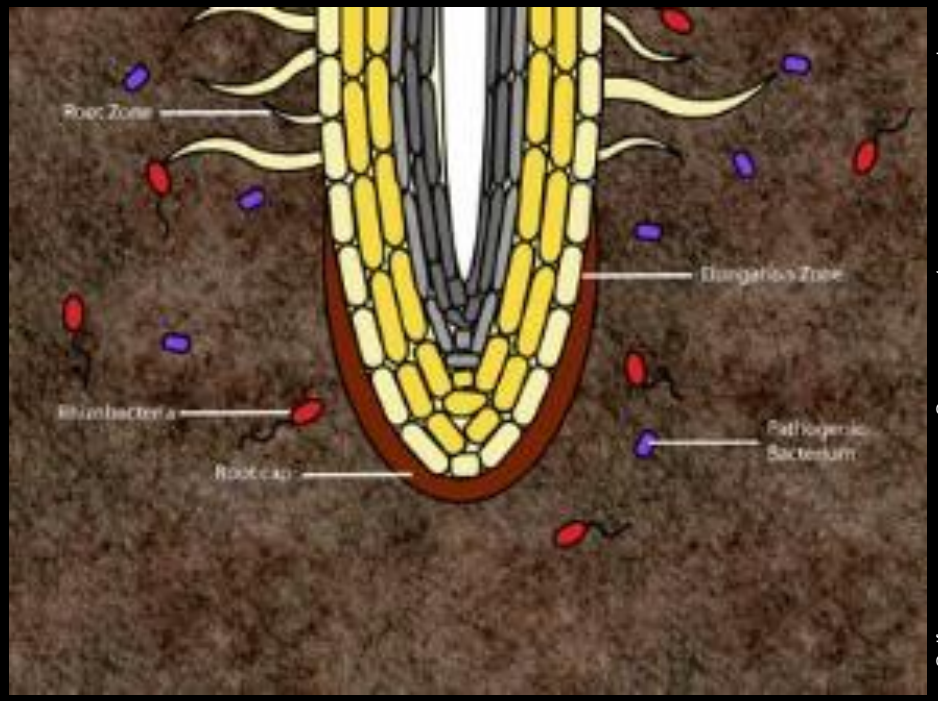
Courtesy of Allison Justice 3/2/2015

Bred by Allison Justice
Hope Greenhouses
at hopegreenhouses@gmail.com Fair Play, SC 864.903.0227

BIOLOGICAL SOIL COMPONENTS

Rhizophere

- Is a **zone of biological activity** surrounding actively growing roots.
- As root caps and roots move in soil **external layers are sloughed off and materials (sugars)** are released into the soil.
- This material is a constant **source of organic matter** that provides **food for microorganisms**.



https://microbewiki.kenyon.edu/images/thumb/6/6c/Root.jpg/400px-Root.jpg

BIOLOGICAL SOIL COMPONENTS

Mycorrhizae

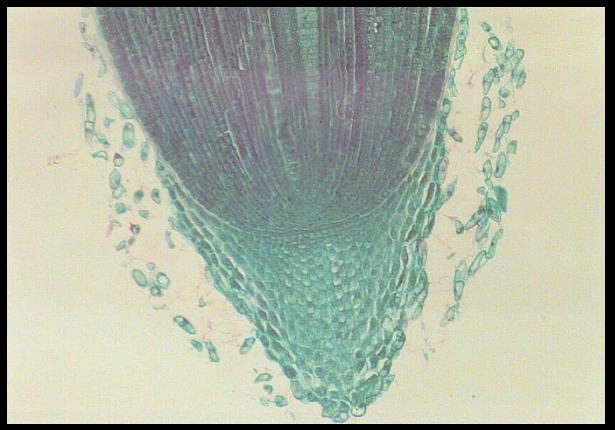
- Fungi that have a **symbiotic relationship** with a specific host plant.
- Fungi and roots both benefit.
- Fungi increase roots capacity to **absorb water** and nutrients and **protect against some disease** causing fungi.
- Helps increase tree capacity to **handle stress**.

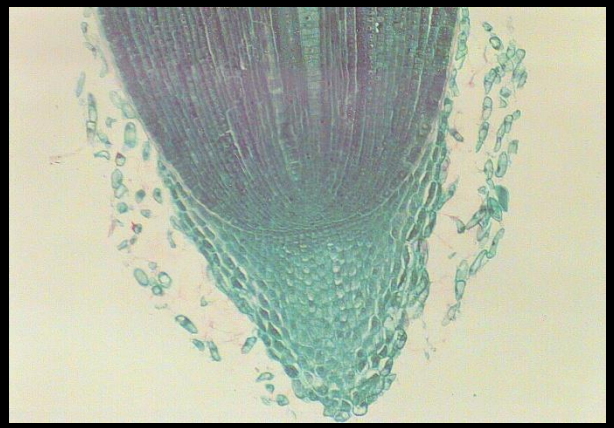
http://www.dirtdoctor.com/pics/content_img.4258.img.jpg

http://agramarketing.com/page/_files/Mycorrhizal-hyphae-radiating-out-from-a-feeder-root-tip.jpg

ROOT CAP

- **Root caps** of both dicots and monocots produce large numbers of metabolically active root "border" cells, which are programmed to separate from the root into the surrounding soil. In soil, border cells play important roles in **protecting the roots from the soil-borne disease**s (Hawes et al, 1998).





http://quorumsensing.ifas.ufl.edu/HCS200/images/stems&roots/root.jpg

http://sols.unlv.edu/Schulte/Anatomy/Roots/CornRootCap.jpg

WEB TRAVELS: INNOVATIONS

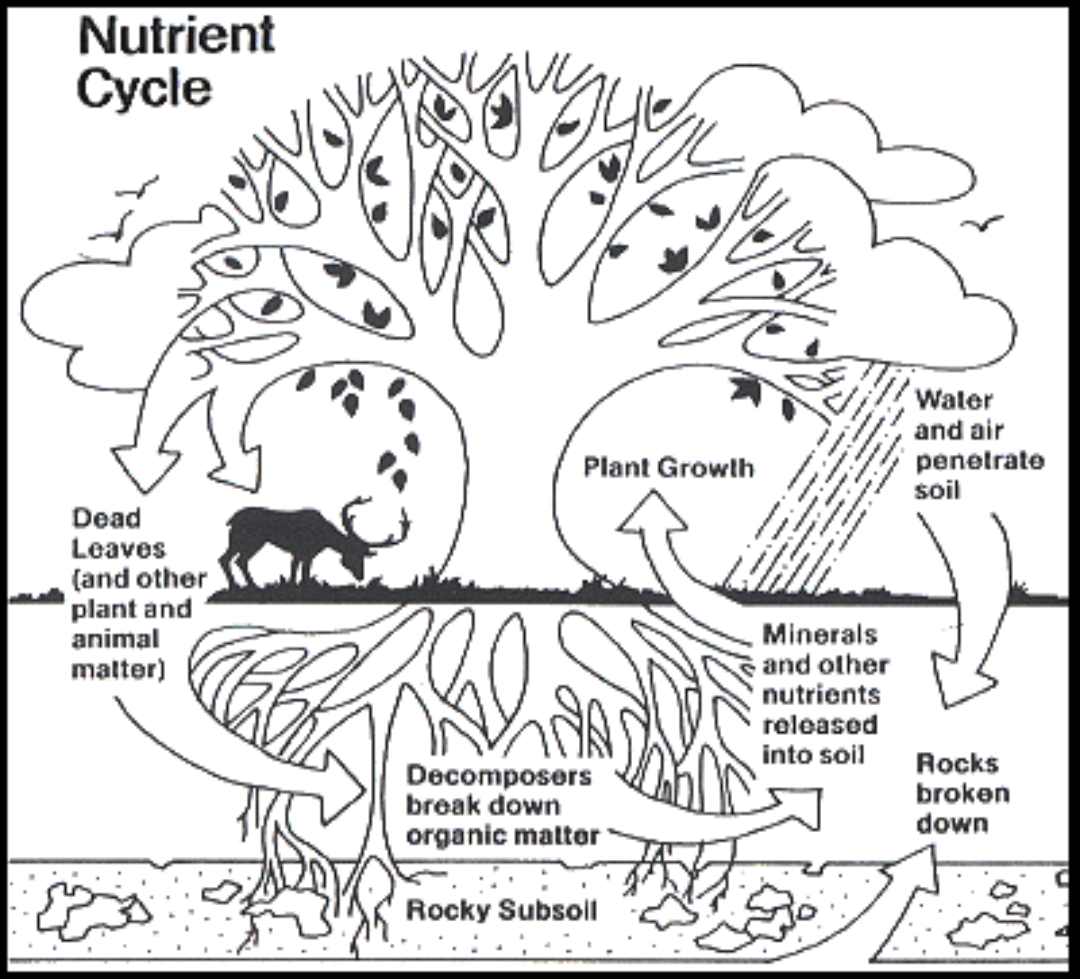
- New ideas inspired by nature:
- BioMimicry Institute
- http://biomimicry.org/
- Ask Nature
- http://www.asknature.org/article/view/why_asknature

BIOLOGICAL SOIL FUNCTION

- **Nutrient Cycling**:
  - **Micoorganism activity** (they may consume each other) and short life cycles result in a storehouse of **nutrients for plant roots**.

http://3.bp.blogspot.com/-xfKgxzrDaSc/TIF-q_2eFKI/AAAAAAAAAAA/FRmTONBTnAM/s400/IMG_6881.jpg
http://magazine.cog.ca/wp-content/uploads/2012/06/leaves-300x168.jpg

BIOLOGICAL SOIL COMPONENTS



http://www.pikeconservation.org/images/NutrientCycle.gif

PHYSICAL: SOIL HEALTH INDICATORS

Physical indicators:,

- **High water-holding capacity** to support plant growth between rain events or irrigation applications.
- **Suitable pore space** (macropores) to hold oxygen (aerobic) necessary for root growth
- **Texture** that promotes plant root growth

Physical

(Cook & VanDerZanden, 2011, p. 121)

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

PHYSICAL SOIL PROPERTIES
SOIL TEXTURE

Sand

clay

loam

http://www.ndsu.edu/pubweb/chiwonlee/plsc211/student%20papers/articles11/amandour/images/soil1.jpg

http://img2.timeinc.net/health/img/web/2012/04/slides/hand-sand-400x400.jpg

Soil texture is the size distribution of particles

Harris, R. W. Clark, J. R. & Matheny, N. P. (2004). *Arboriculture*. New Jersey: Prentice Hall
Chart adapted from page 77

http://www.junglemusic.net/images/Clay%20Soil,%20Finger%20impressions%20(Small).JPG

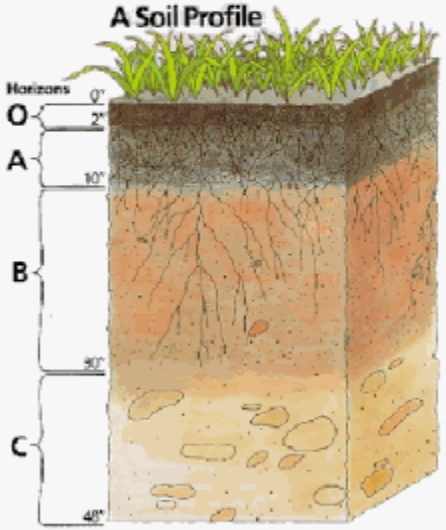
PHYSICAL SOIL PROPERTIES

- Soil profile is due to weathering and soil horizons result.

Soil Horizons

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

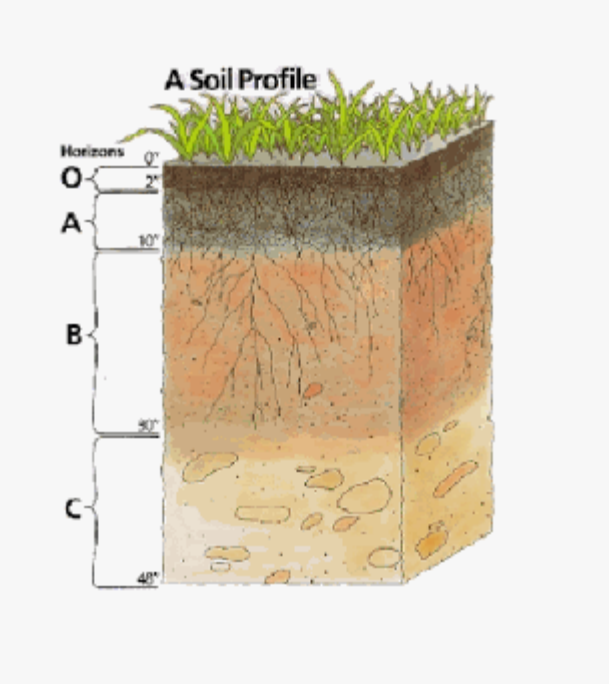
Used to classify the soil and make interpretations.



http://search.tb.ask.com/search/AJimage.jhtml?&searchfor=soil+horizon&p2=%5EBDG%5Exdm043%5ETTAB01%5Eus&n=781acdaf&ptb=E01929C0-8DCE-4C34-8736-2EF5AEB9B0AD&si=pconverter&ss=sub&st=tab&tpr=sbt&imgsize=all&safeSearch=on&imgDetail=true

PHYSICAL SOIL PROPERTIES

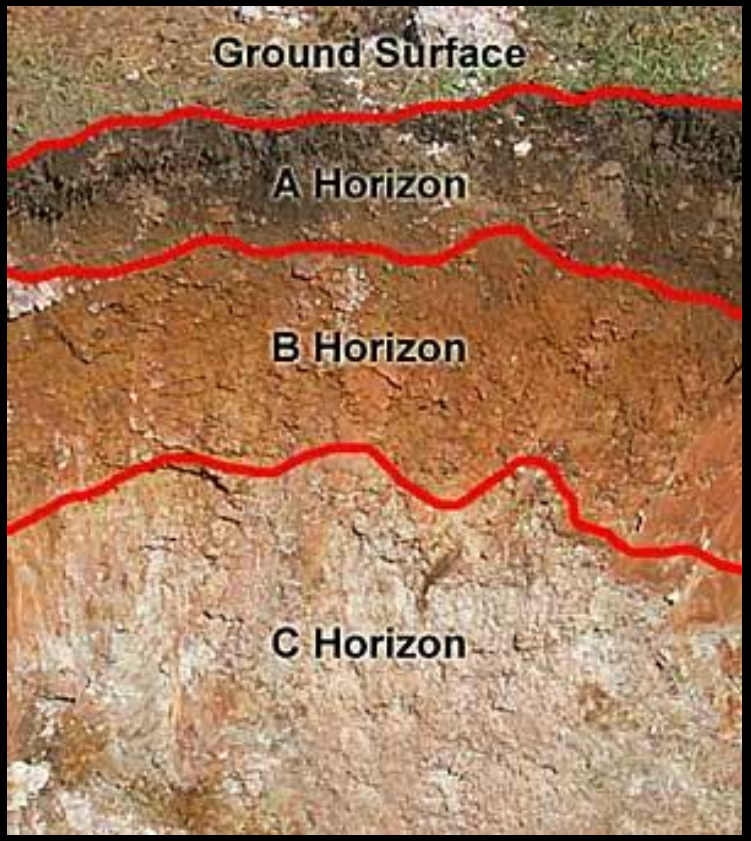
- The top layer (O), is a thin layer of **decomposing organic matter**. The organic layer influences the biological characteristics of the soil.



http://search.tb.ask.com/search/AJimage.jhtml?&searchfor=soil+horizon&p2=%5EBDG%5Exdm043%5ETTAB01%5Eus&n=781acdaf&ptb=E01929C0-8DCE-4C34-8736-2EF5AEB9B0AD&si=pconverter&ss=sub&st=tab&tpr=sbt&imgsize=all&safeSearch=on&imgDetail=true

PHYSICAL SOIL PROPERTIES

- The 'A' horizon is very biologically active; rich in organic matter which results in dark coloring.
- Contains most of the fine absorbing roots of trees.



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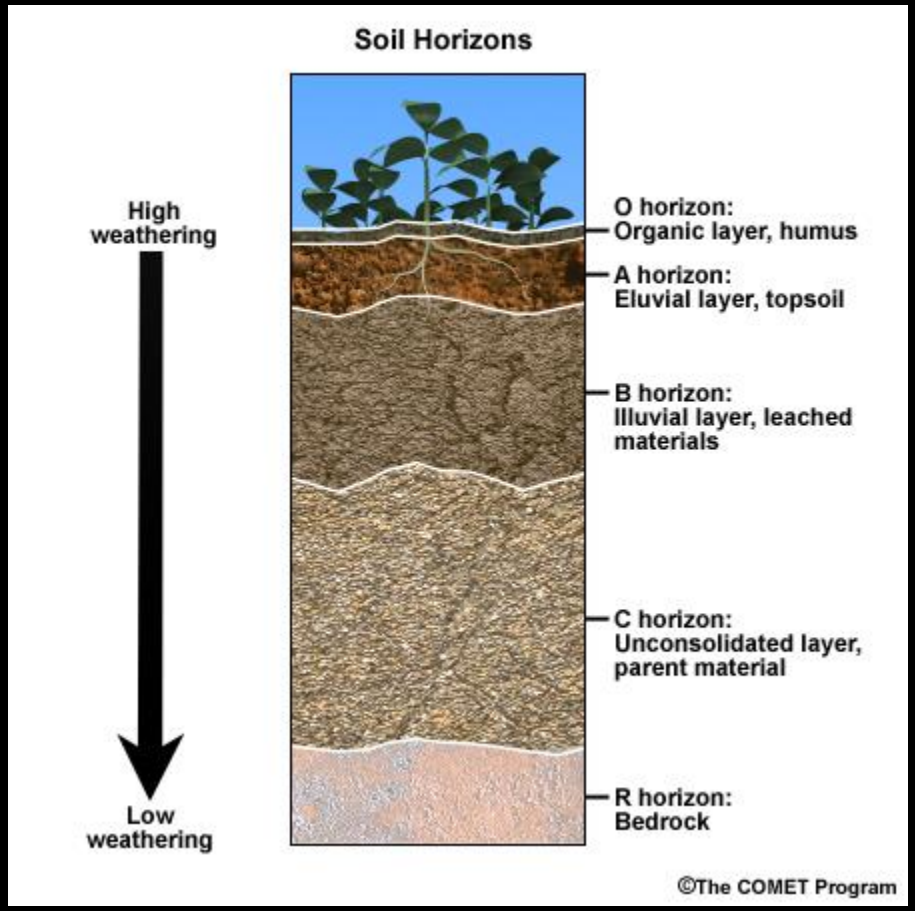
PHYSICAL SOIL PROPERTIES

- The 'B' horizon contains fine-textured materials from 'A' and soil particles from 'C'.
- 'C' horizon is partially weathered parent material located just above bedrock.

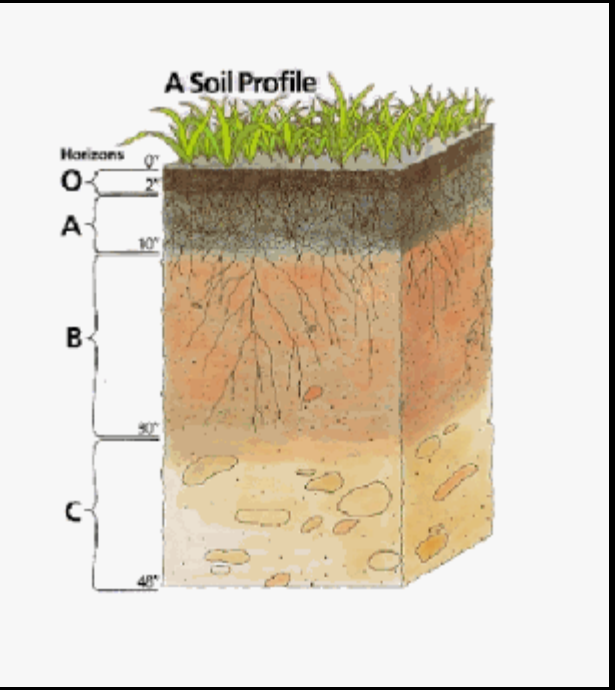


Online Soil and Water.:Physical Properties, slides 4 and 6 of 13

http://search.tb.ask.com/search/AJimage.jhtml?&searchfor=soil+horizons+&p2=%5EBDG%5Exdm043%5ETTAB01%5Eus&n=781acdaf&ptb=E01929C0-8DCE-4C34-8736-2EF5AEB9B0AD&si=pconverter&ss=sub&st=tab&tpr=sbt&imgsize=all&safeSearch=on&imgDetail=true

PHYSICAL SOIL PROPERTIES

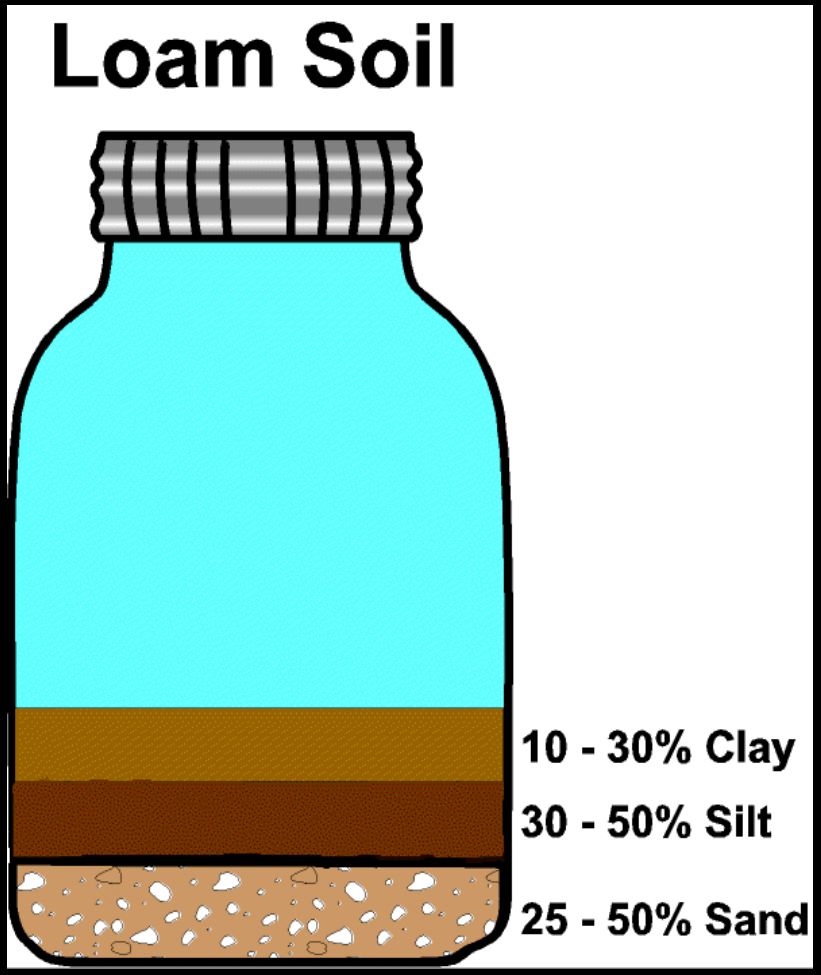
- The upper layers of ‘O’, ‘A’, and ‘B’ may be referred to as ‘topsoil’.
- In urban settings they may not be distinct due to soil destruction during construction.



http://search.tb.ask.com/search/AJimage.jhtml?&searchfor=soil+horizon&p2=%5EBDG%5Exdm043%5ETTAB01%5Eus&n=781acdaf&ptb=E01929C0-8DCE-4C34-8736-2EF5AEB9B0AD&si=pconverter&ss=sub&st=tab&tpr=sbt&imgsize=all&safeSearch=on&imgDetail=true

SOILS: TEXTURE

- Soil structure and texture determine soil's ability to hold water and provide oxygen to plant roots.



http://www.rain.org/global-garden/soil-types-and-testing_files/quart_jar_with_loam_soil.gif

SOIL TEXTURE

	Particle size	Particle shape	Feel	Water infiltration
Sand	Largest	Angular or spherical	Gritty	Rapid
Silt	Medium Visible with microscope	Angular or spherical	Wet-slippery Dry-smooth	Slow
Clay	Smallest Visible with electron microscope	Wafer or plate-like	Wet-sticky	Moderate to poor (depending on structure)

Soil texture is the size distribution of particles

Harris, R. W. Clark, J. R. & Matheny, N. P. (2004). *Arboriculture*. New Jersey: Prentice Hall
Chart adapted from page 77

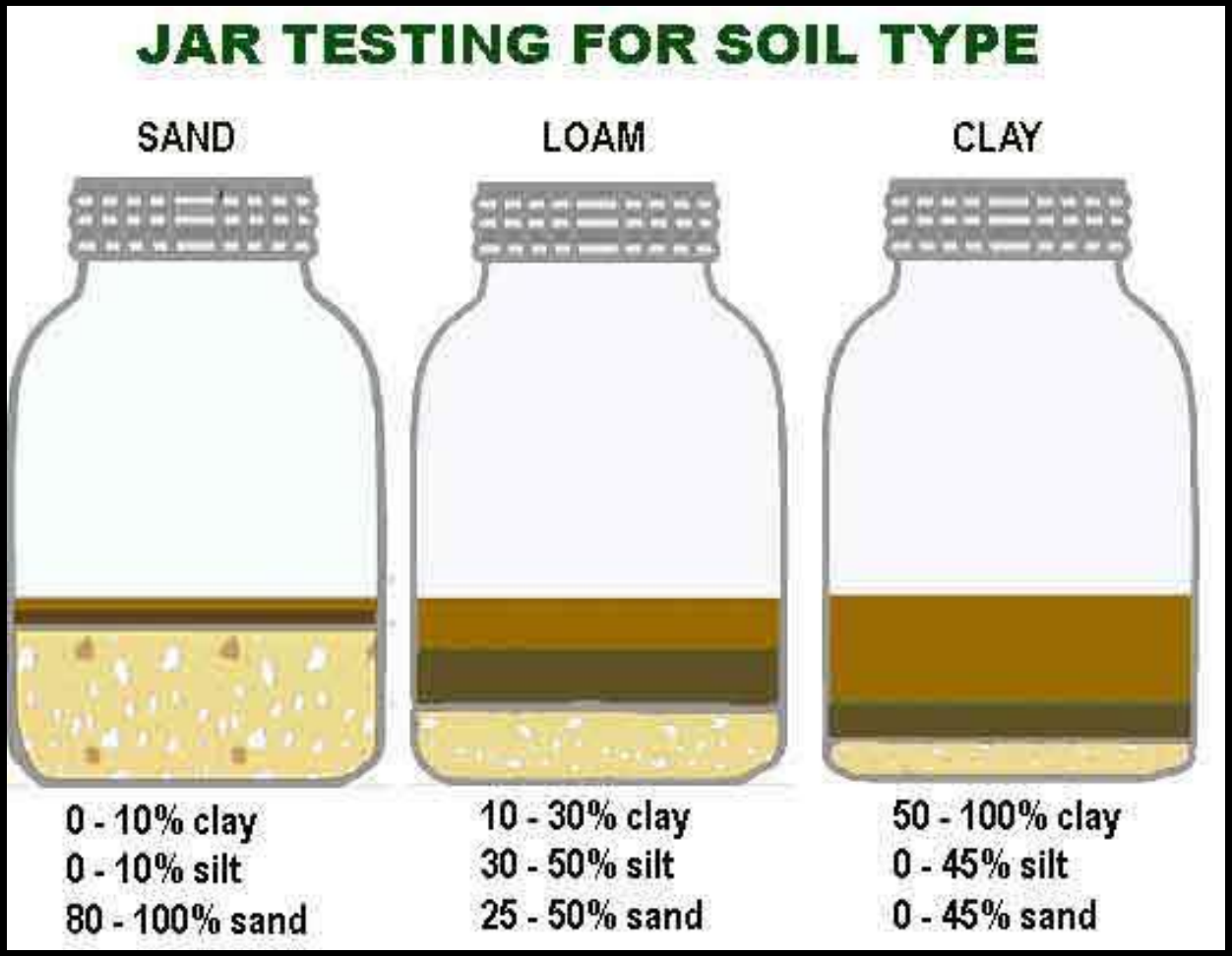
SOIL TEXTURE

	Aeration	Water holding capacity	Nutrient storage capacity	Ability to aggregate
Sand	Good	Low	Low	Low
Silt	Poor	Moderate	Moderate	Low
Clay	Moderate to poor depending on structure	High	High	High

Soil texture is determined by feel or by a soil laboratory test.

Harris, R. W. Clark, J. R. & Matheny, N. P. (2004). *Arboriculture*. New Jersey: Prentice Hall
Chart adapted from page 77

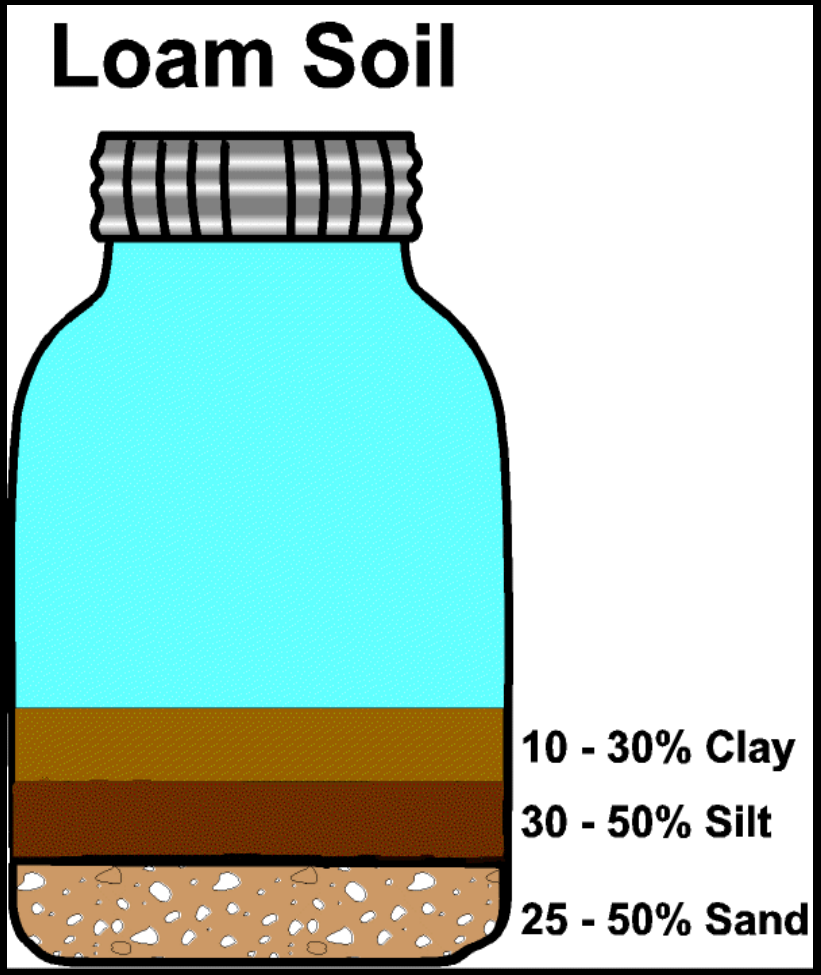
PHYSICAL SOIL TYPES: STRUCTURE



http://4.bp.blogspot.com/-QoGI9seauTk/UHw72irJucI/AAAAAAAAA8s/vgEMHbgrjgM/s1600/soil_types_diagram3.jpg

SOILS: TEXTURE

- **Loam**: a soil texture classification
- Rich, *friable* (crumbly) soil with nearly equal parts of sand and silt, and somewhat less clay.
- Combines the desirable qualities of each particle size.
- Considered the **ideal soil texture** for most plants.



http://www.rain.org/global-garden/soil-types-and-testing_files/quart_jar_with_loam_soil.gif

WEB TRAVELS: SOIL TEXTURE ANALYSIS

- Clemson Ag Service Laboratory

http://www.clemson.edu/public/regulatory/ag_svc_lab/soil_testing

http://www.clemson.edu/public/regulatory/ag_svc_lab/tour/lab_tour/bags_labels.jpg

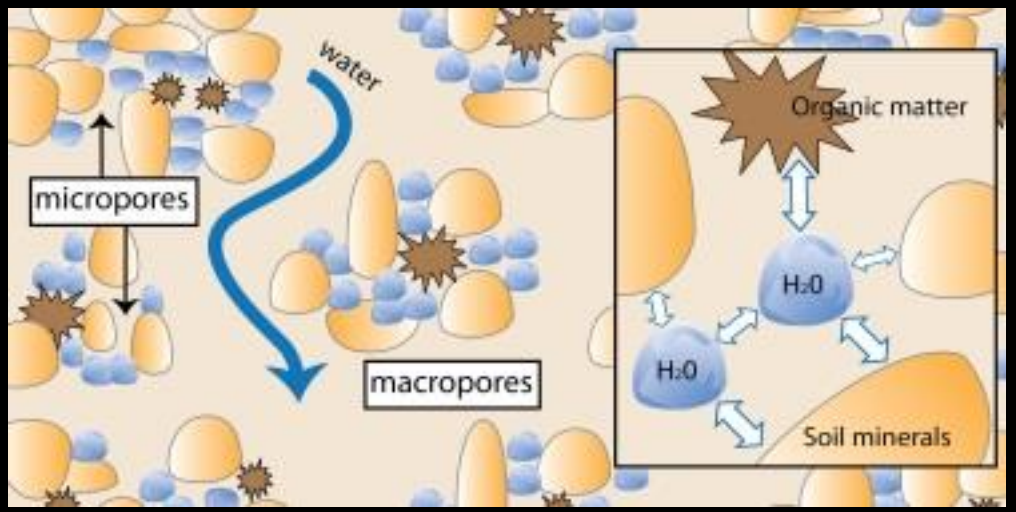
HEALTHY SOIL, AGGREGATES

- **Aggregates** are groups (clumps) of particles in the soil
- Aggregates are soil particles held in a clod, crumb, or block
- Between the aggregates are macropores
- Macropores are areas for air and water movement and root growth

http://www.dot.ca.gov/hq/LandArch/research/sre/images/sls_crs/scsoilagg.jpg

HEALTHY SOIL, PORE SPACE

- **Macropores** are larger pores between aggregates and commonly hold air. Coarse textured soils (sands) have more macropores
- **Micropores** are smaller spaces between soil particles that hold mostly water. Fine textured soils (clays) have more micropores.



https://www.qld.gov.au/environment/assets/images/land/soil/soil-water.jpg

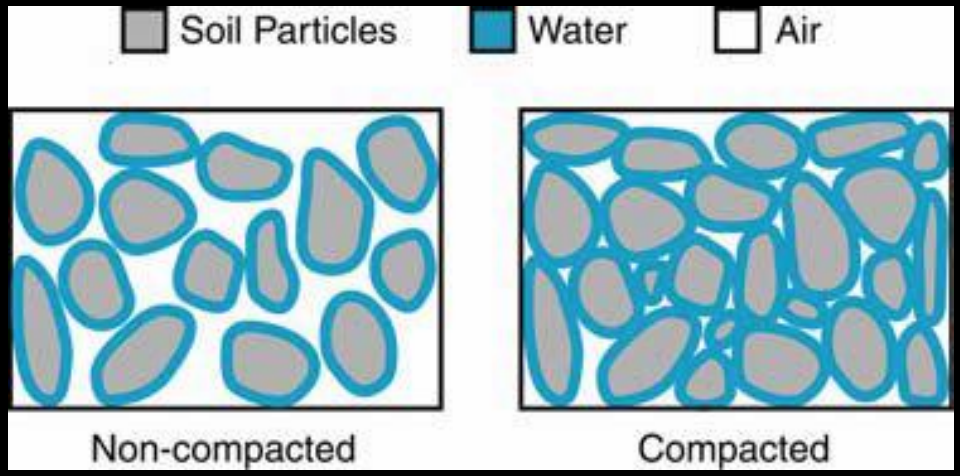
SOIL, PORE SPACE

- **Ideal soils** for trees and other plants contain both **macropores** (air spaces) and **micropores** (water spaces).

http://www.grow-it-organically.com/images/soil-handful02-lg.jpg

SOIL HEALTH DESTRUCTION

- **Soil compaction** destroys macropores, aggregates, and impedes water flow (infiltration and percolation) through the soil.
- Soil compaction destroys reduces soil pores and harms soil structure.



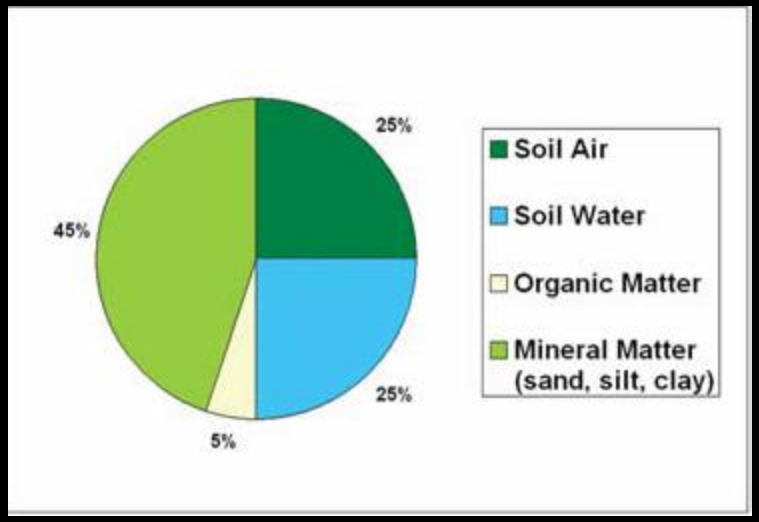
http://soils.usda.gov/use/urban/downloads/primer(screen).pdf

SOIL HEALTH DESTRUCTION

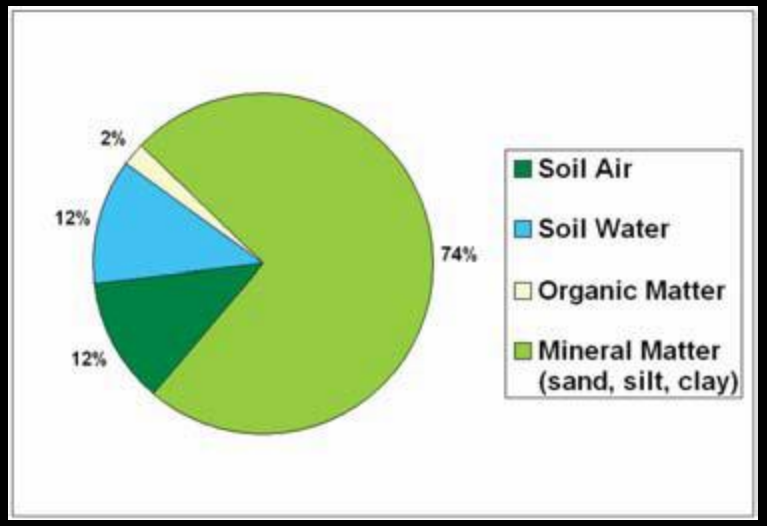
- **Soil compaction** can seriously damage the physical structure of fertile soil.
- **Pressure (weight) is a primary cause of compaction**.
- **Macropores**, large air-filled pore spaces **are crushed**.
- Most commonly occurs in soils under **wet conditions**.

http://www.soils.umn.edu/academics/classes/soil2125/img/7bdtrl.jpg

SOIL COMPACTION



Composition of a natural soil, by weight.



Composition of a compacted soil, by weight.

Images:
http://soils.usda.gov/use/urban/downloads/primer(screen).pdf

PROTECT SOIL DURING CONSTRUCTION

- Establish tree protection zone.
- Develop soil protection policies.
- Implement enforcement (warnings, fines).

Photo:
images.google.com
www.thegreentheory.com

MAINTAIN SOIL DURING CONSTRUCTION

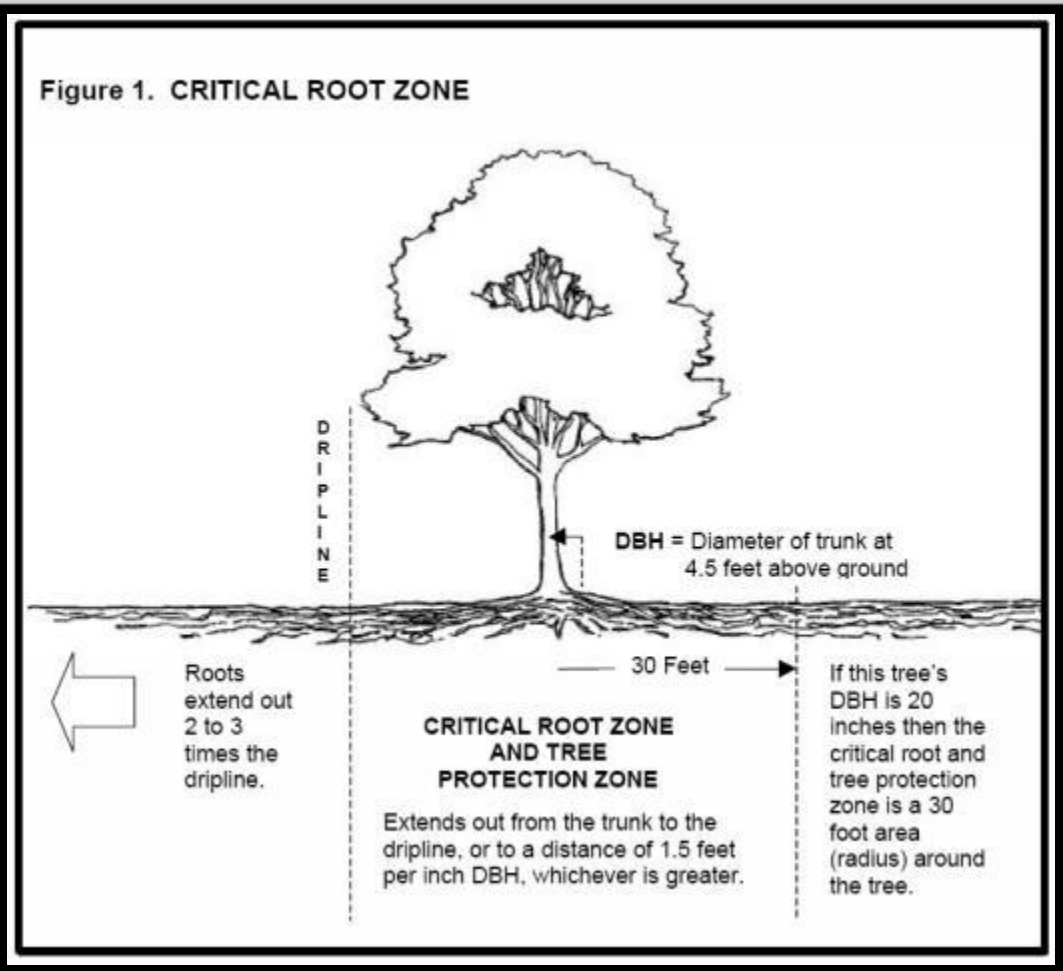


Photo: images.google.com www.thegreentheory.com

http://forestry.about.com/b/2010/03/04/critical-root-zone-and-veritcal-mulching.htm

REMEDIATING COMPACTION

- Compacted soil around established trees may be improved by using an **air spade** (air compression device) that breaks up soil.
- Root system is not usually harmed.
- **Adding organic matter** to the soil at this time improves soil health.

https://takingplaceinthetrees.files.wordpress.com/2013/02/121204-umass-katsura01.jpg

REMEDIATING COMPACTION

- Adding 2-3" of vegetative mulch builds organic matter as it decays.

https://blakelandscapes.files.wordpress.com/2013/03/mulch-bed-finished-product.jpg

CHEMICAL: SOIL HEALTH INDICATORS

Chemical indicators:

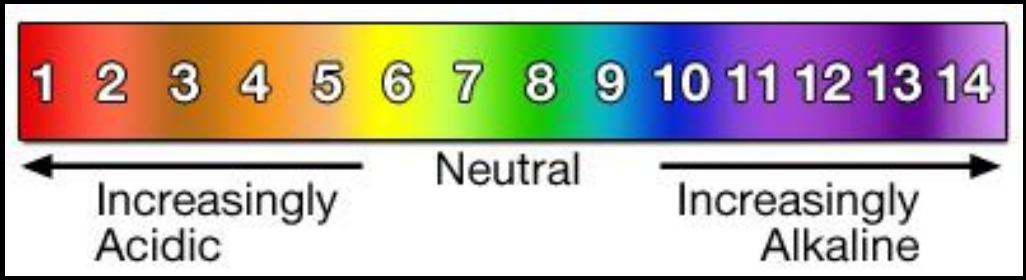
- pH range of 5 to 7.5
- Cation exchange capacity adequate to retain nutrients.
- Organic matter levels **high** enough to support microbial activity.
- Presence of major nutrient elements.
- Absence of heavy metals.

(Cook & VanDerZanden, 2011, p. 121).

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

SOIL STRUCTURE (CHEMICAL)

- Have structure that promotes plant root growth. (Cook & VanDerZanden, 2011, p. 121).
- Soil pH is the measure of acidity or alkalinity in the soil.
- Less than 7 is acid
- More than 7 or higher is alkaline
- Most plants prefer a range of **6.0-6.5**



http://www.garden.com/ContentFiles/6754/9985/the_ph_scale.jpg

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

SOIL STRUCTURE (CHEMICAL)

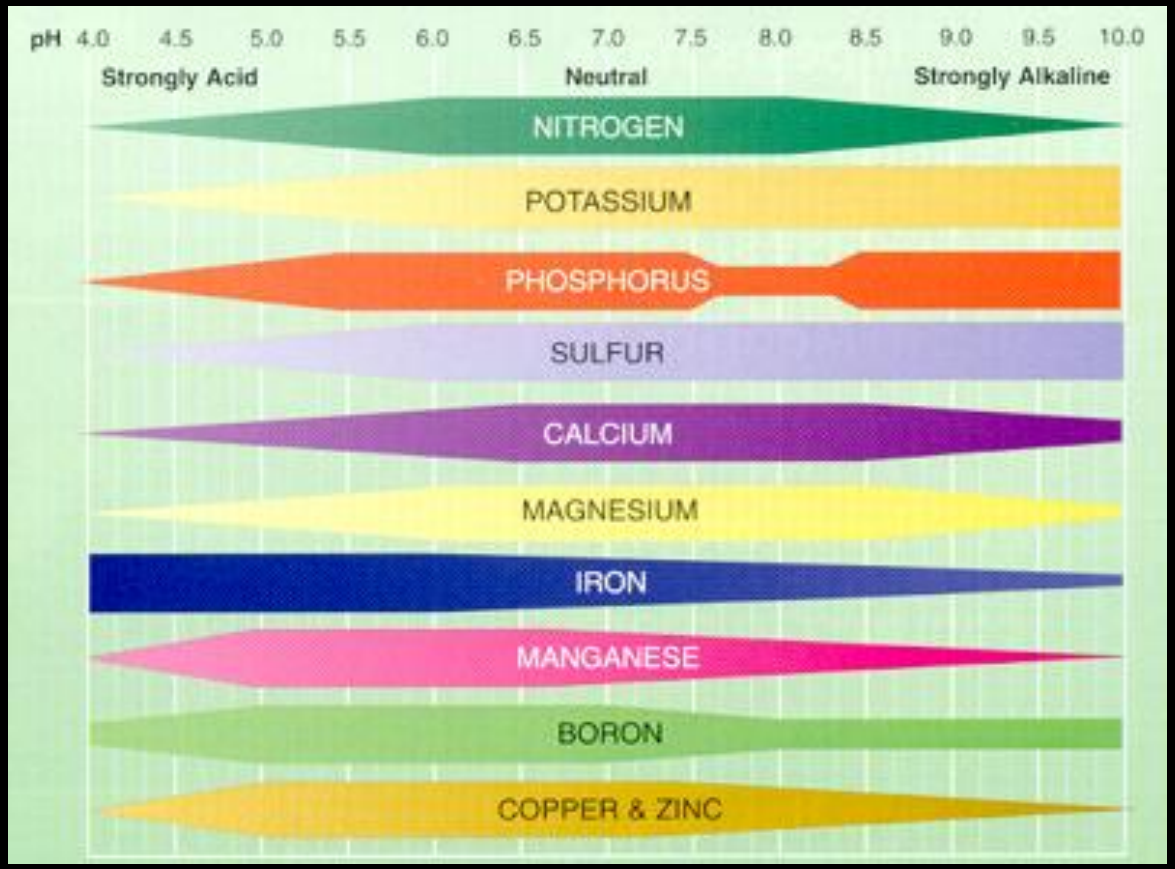
- Soil pH may affect which species will grow and which soil organisms are present.
- Soil pH determines nutrient availability.

Iron chlorosis on Sweetgum (*Liquidambar*) which may occur on alkaline soils

http://www.missouribotanicalgarden.org/Portals/0/Gardening/Gardening%20Help/images/Pests/Iron_Chlorosis576.jpg

SOIL STRUCTURE (CHEMICAL)

- In **alkaline soils** iron, zinc, and manganese may be restricted. Calcium, magnesium, and potassium availability may increase.
- In **highly acidic** soils phosphorus may be restricted.



http://www.extension.org/sites/default/files/w/c/c6/PHandavailability.jpg

SOIL STRUCTURE (CHEMICAL)

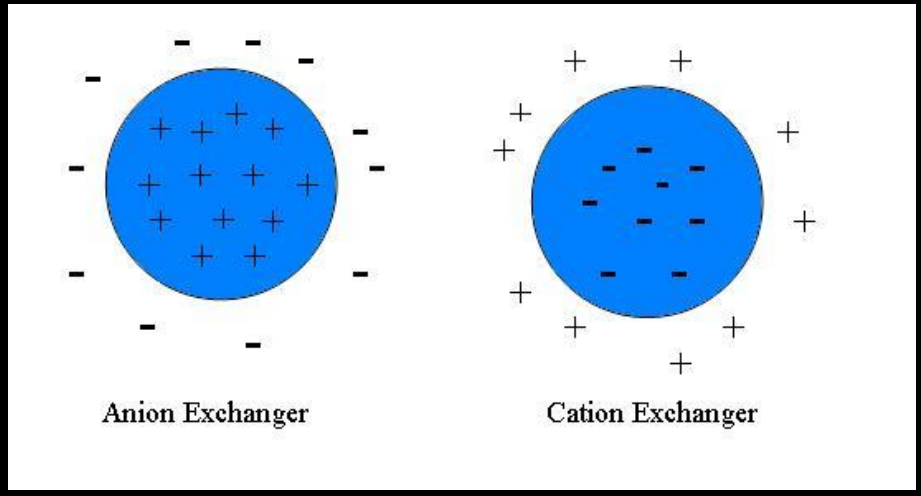
- **Changing pH** is easy for top layer of soil and may be **short lived**.
- Sulfur may lower pH and lime may raise pH.

- **High buffering capacity** resists changes in pH.
- **High buffering capacity** is found in clay soils and high organic matter soils.

http://www.gardenscapeinc.com/products/images/dolimitic1.jpg

SOIL STRUCTURE (CHEMICAL)

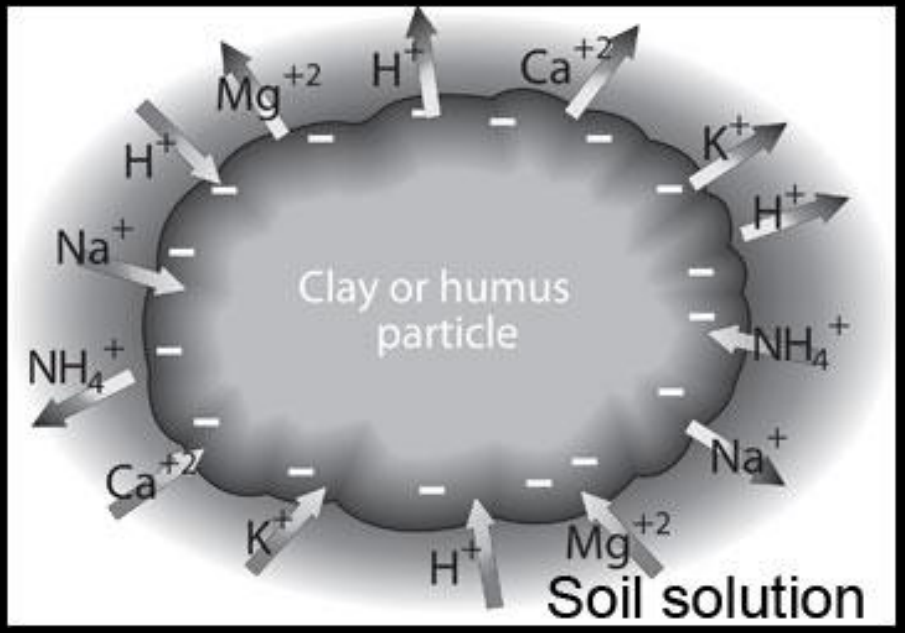
- Essential elements required for tree growth (minerals) dissolve in water, making them available for **absorption** by tree roots.
- In water these elements are charged particles called ions.
- **Negatively charged ions are called anions**.
- **Positively charged ions are called cations**.



http://upload.wikimedia.org/wikipedia/commons/1/13/Cation%2Banion_exchanger.JPG

SOIL STRUCTURE (CHEMICAL)

- **Organic matter and clay particles normally carry a negative charge**
- Negatively charged ions attract and hold cations (positive charged) resulting in **high cation exchange capacity**.
- Fine textured soils that contain high % of clay and/or organic matter will be more fertile than coarse textured (sand) soils



http://extension.missouri.edu/explore/images/mg0004art04.jpg

SOIL STRUCTURE (CHEMICAL)

- **Soil salinity** measures the quantity of mineral ions dissolved in the water.
- Certain soil types retain soil salts which can damage plants.
- Flushing with low salinity water is recommended to leach them.

http://soilweb.landfood.ubc.ca/labmodules/images/stories/salinity/cracked-surface.jpg

SOIL STRUCTURE, ORGANIC MATTER

- Soils that are primarily sand or silt aggregate poorly.
- Decomposing organic matter aids in the development and stability of soil aggregates.
- Humus is the dark colored layer of decomposing organic matter

Photo: images.google.com
www.thegreentheory.com

SOIL STRUCTURE, ORGANIC MATTER

- Organic matter (o.m.) in soils comes from plant and animal residues and wastes.
- Compost is o.m.
- OM decay releases nutrients for use by organisms in the soil and for uptake by plant roots.
- **5% ideal***

Photo: images.google.com
www.thegreentheory.com

Harris, R. W. Clark, J. R. & Matheny, N. P. (2004). *Arboriculture*. New Jersey: Prentice Hall

*http://extension.missouri.edu/publications/DisplayPub.aspx?P=G6955

ALTERED LANDSCAPE SOILS

- Urban soils and other altered soils may possess materials that are not agricultural (Cook & VanDerZanden, 2011, p. 119).
- The artificial layer found in altered soils may be 20" or more deep.
- Taxonomists struggle over how to classify these soils because they are quite diverse (Cook & VanDerZanden, 2011, p. 120).

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

ALTERED SOILS

- Soils may be damaged during construction
  - Due to compaction
  - Due to removal
  - Due to improper placement or storage

http://www.google.com/imgres?q=landscape+construction&start=54&num=10&hl=en&client=firefox-a&rls=org.mozilla:en-US:official&gbv=2&biw=1440&bih=707&tbm=isch&tbnid=NM1YqyKb3rmRRM:&imgrefurl=http://www.mclaughlinlandscaping.com/landscape_construction.html&docid=86vefWArzzGDzM&imgurl=http://www.mclaughlinlandscaping.com/images/landscaping_const.jpg&w=500&h=248&ei=4-ilTvmrEsaWtwf0wKCUBQ&zoom=1&iact=hc&vpx=1080&vpy=378&dur=61&hovh=158&hovw=319&tx=249&ty=106&sig=105866139933167536295&sqi=2&page=4&tbnh=100&tbnw=202&ndsp=18&ved=1t:429,r:17,s:54

ALTERED SOILS: TOPSOIL & COMPOST

- New soil may be purchased as replacement
  - To ensure smooth water flow (capillary action) the Interface between old and new soils must be blended, like the dry ingredients in cake batter, not layered like lasagna.
  - New soil should be of high quality, often it is not.
  - Purchased compost should be fully composted (usually takes 1 full year).
  - Partially composted material will shrink in volume and may tie up nutrients if microorganisms have to break down material high in cellulose or carbon.
  - Structural soils should be purchased from a reliable source.

ALTERED SOILS

Structural Soils

Silva Cells

http://www.deeproot.com/blog/pdfs/Comparing_Silva_Cells_and_Structural_Soil.pdf

ALTERED: SILVA CELL

- Suspended pavement system.
- Flexible yet durable.
- Used by City of Greenville.

Photo courtesy of Dale Westermeier, City of Greenville

ALTERED: SILVA CELL

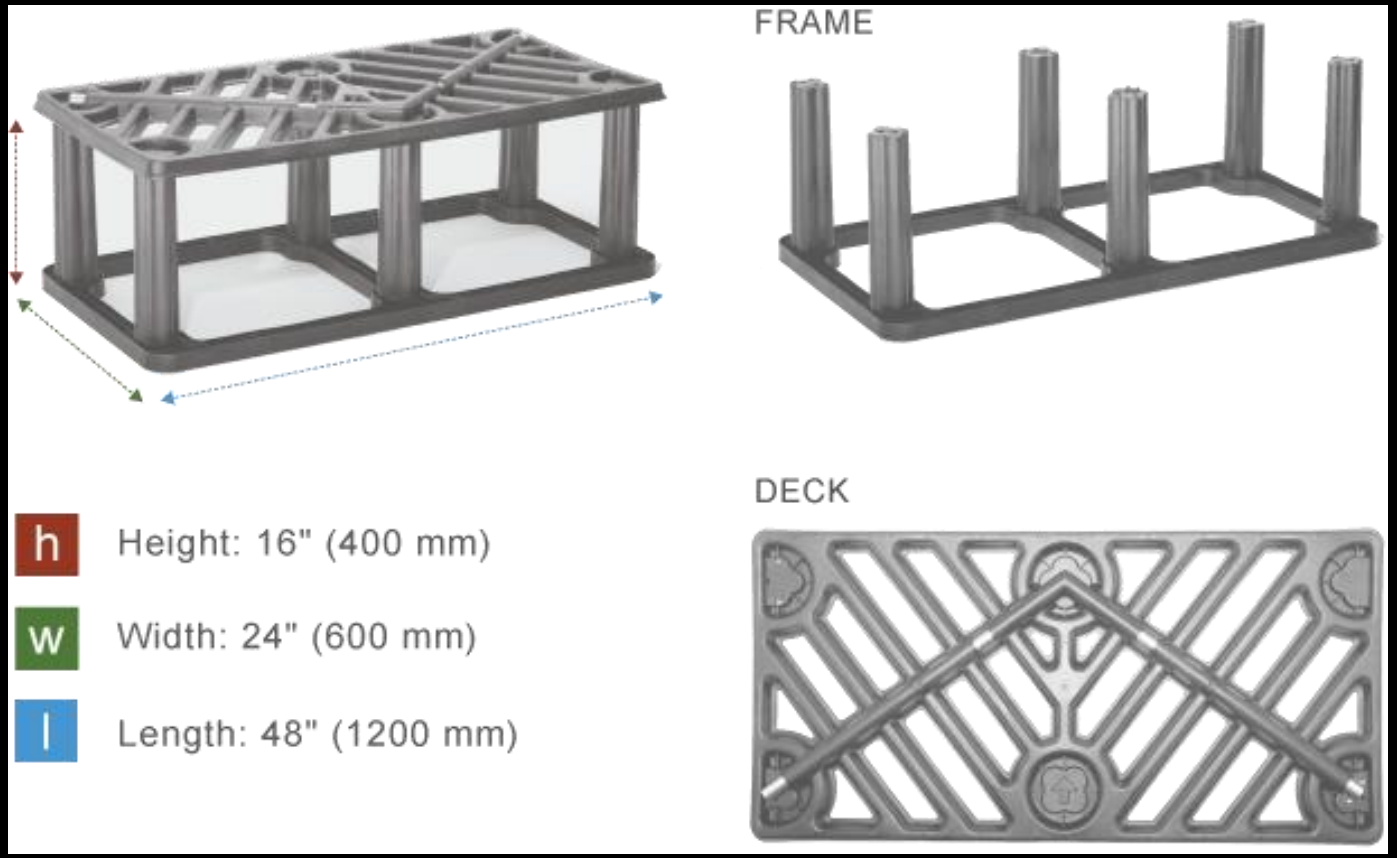
- Silva cell is a frame and deck construction 48" long, 24" wide, and 16" high.
- Each unit contain 10 cu ft of soil.
- May be stacked up to 3 units high. Deck is placed at top. May be stacked as wide as wanted.
- Uses lightly compacted loam soil.

http://www.greenmax.eu/cms/uploads/images/afbeeldingen/Silva%20Cell/Toepassing%20-%20Silva%20Cell%20-%20New%20parking%20lot.jpg

http://www.archello.com/sites/default/files/imagecache/header_detail_large/product/media/deeproot_structural_cell_2.jpg

http://www.deeproot.com/products/silva-cell/overview

ALTERED: SILVA CELL

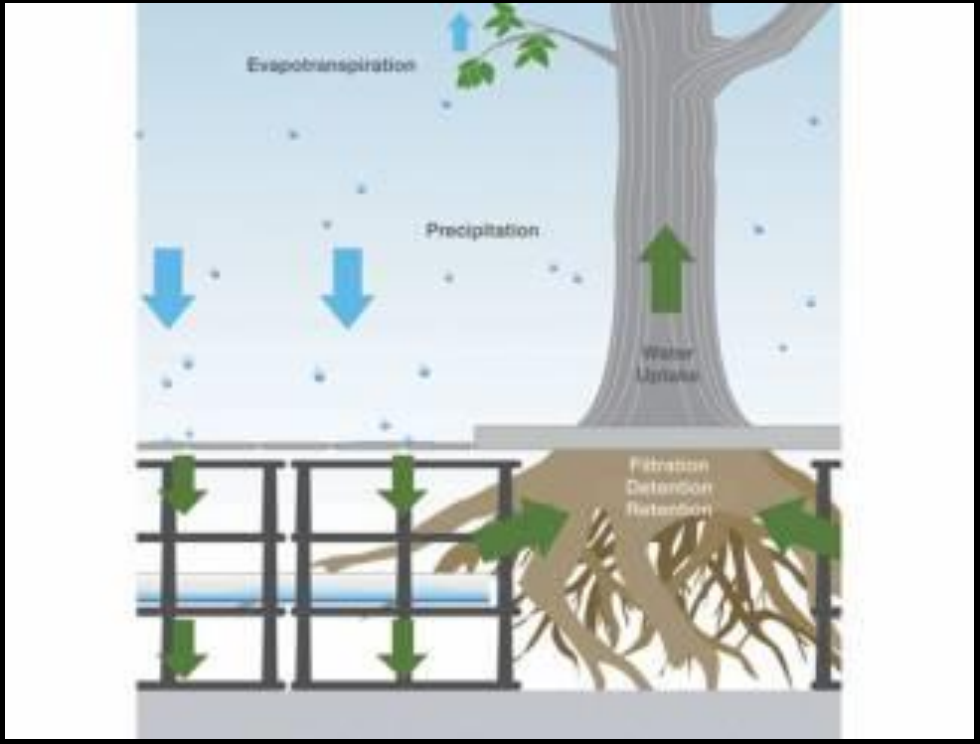


http://www.deeproot.com/products/silva-cell/overview

ALTERED: SILVA CELL

Native soil can be used or specified soil mixes to optimize root growth, stormwater management, or a combination of the two.

http://www.deeproot.com/products/silva-cell/faqs.html



http://www.google.com/imgres?q=silva+cell+soil&hl=en&client=firefox-a&rls=org.mozilla:en-US:official&gbv=2&biw=1440&bih=707&tbm=isch&tbnid=JCh-EBj4AH9DvM:&imgrefurl=http://www.landscapeonline.com/products/listing.php%3Fid%3D4306&docid=CGEuytQi8GsD4M&imgurl=http://www.landscapeonline.com/products/images/prod_fe2b9553468a923ee3516567a582e688.jpg&w=325&h=247&ei=iAKmTvPvMc-EtgeJivkQ&zoom=1&iact=rc&dur=446&sig=105866139933167536295&page=2&tbnh=141&tbnw=186&start=18&ndsp=18&ved=1t:429,r:13,s:18&tx=99&ty=82

SILVA CELL

http://www.google.com/imgres?q=Jim+Urban+silva+cells&um=1&hl=en&biw=1440&bih=707&tbm=isch&tbnid=lOent2CivzBZwM:&imgrefurl=http://www.deeproot.com/blog/blog-entries/photos-from-silva-cell-installation-at-1111-lincoln-road-mall-miami-fl&docid=kS_f6JAVhbtaaM&imgurl=http://www.deeproot.com/blog/wp-content/themes/twentyten/images/stories/Installation_Photos/1111.01-optimized.jpg&w=500&h=375&ei=teqlTvSEDMa1tgfF7oioBQ&zoom=1&iact=hc&vpx=204&vpy=163&dur=3&hovh=194&hovw=259&tx=124&ty=132&sig=105866139933167536295&page=1&tbnh=161&tbnw=227&start=0&ndsp=19&ved=1t:429,r:0,s:0

WEB TRAVELS: SILVA CELL

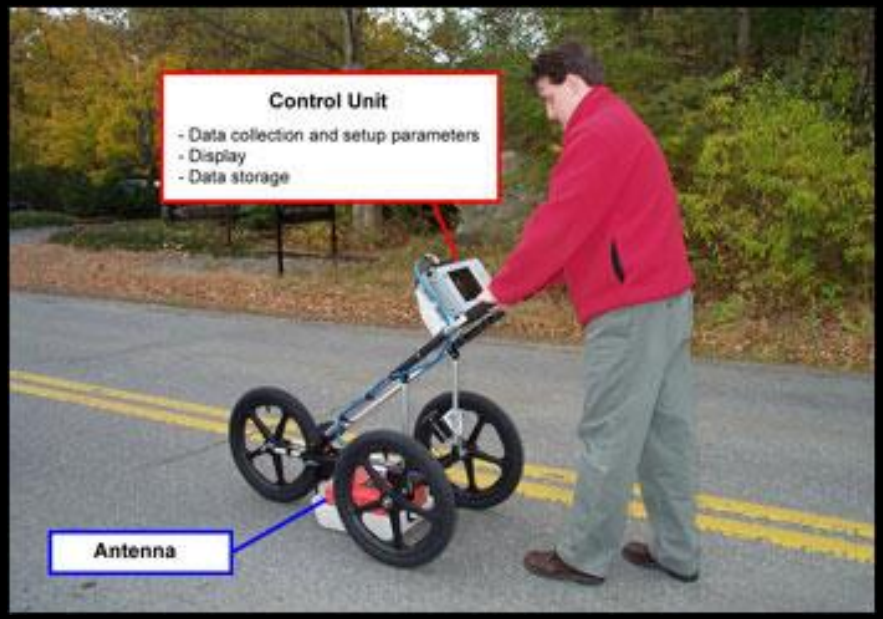
http://www.hort.cornell.edu/uhi/outreach/index.htm#soil

- Deep Root
- Jim Urban, Consultant, *Up By Roots* author
- http://www.deeproot.com/products/silva-cell/overview

https://media.licdn.com/mpr/mpr/shrink_200_200/p/1/000/105/08d/2b979c5.jpg

ALTERED: CU STRUCTURAL SOIL™

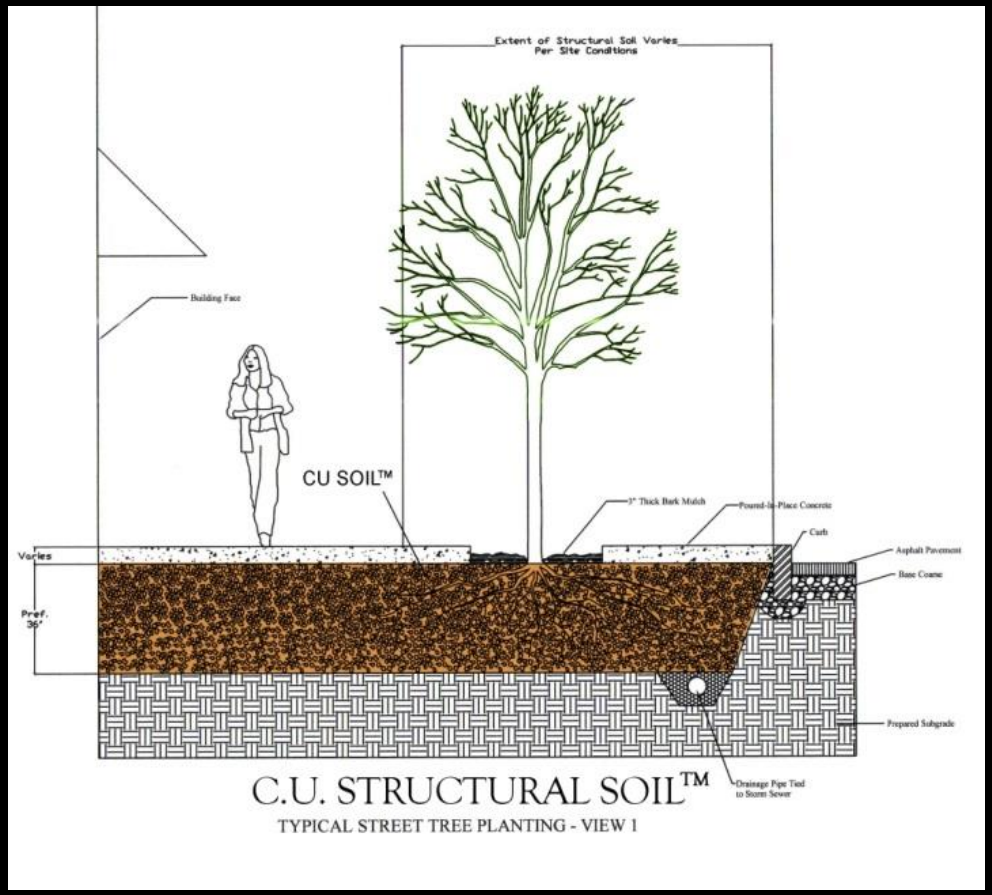
- Avoid traditional "Tree in a coffin" planting (tree pit in sidewalk)
- Air spade to uncover roots under pavement
- Ground penetrating radar used to measure roots under pavement.
- (http://www.hort.cornell.edu/uhi/research/articles/JArb37%284%29.pdf)
- Depth of 36" preferred, 24" minimum.
- Ideally combined with porous asphalt.
- Can be trenched after installation.



http://www.geophysical.com/Images/GPRfigure1.jpg

ALTERED: CU STRUCTURAL SOIL™

- CU Structural Soil™ in urban areas.
- Use only with compacted soils (sidewalks and pavements).
- Proper plant selection essential- drought tolerant plants preferred.
- Only Amereq Inc. authorized sales.



http://www.markcerrone.com/images/fig1a.jpg

ALTERED: CU STRUCTURAL SOIL™

- Uses angular crushed stone(¾" to 1.5") ensures pore space (tree root needs) and compaction for load bearing (engineering needs).
- Screened topsoil: 20% clay loam ensures high cation exchange capacity (2-5% organic matter).
- Mix together and add a slurry of Gelscape® hydrogel (tackifier) to stone-helps stone hold nutrients-uniform mix

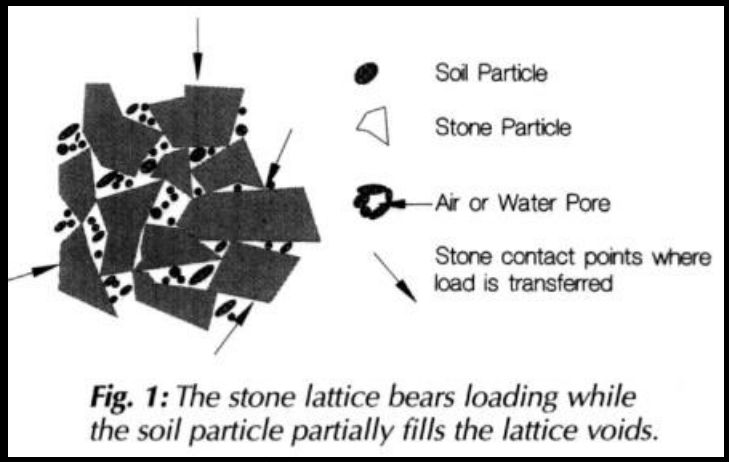


Fig. 1: *The stone lattice bears loading while the soil particle partially fills the lattice voids.*

http://www.landtechsoils.ie/wp-content/uploads/2013/09/F1.png

http://www.ecolandscaping.org/wp-content/uploads/2014/01/City-of-Austin-CU-SOIL-10.420..jpg

WEB TRAVELS: STRUCTURAL SOILS

- Nina Bassuk, Professor Cornell University
- Urban Horticulture Institute
- http://www.hort.cornell.edu/uhi/outreach/index.htm#soil

http://www.hort.cornell.edu/uhi/outreach/index.htm#soil

HEALTHY LANDSCAPE SOILS DEFINITION

- "Continued capacity of soil to function as a vital living system, within ecosystem and land use boundaries, to sustain biological productivity, promote the quality of air and water environments, and maintain plant, animal, and human health" (definition by Doran & Safley, 1997, found in Cook & VanDerZanden, 2011, p. 121).

http://landscapeforlife.org/new/wp-content/uploads/2011/10/soil_worms.jpg

Cook, T. W. & VanDerZanden, A. (2011). *Sustainable landscape management*. Hoboken, NJ: John Wiley & Sons.

WEB TRAVELS: INNOVATIONS

- Urban Forestry Today Webinars
- ISA publications & podcasts

http://www.isa-arbor.com/

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Photo by Craig Mehaffey

http://www.clemson.edu/cafls/research/vincent/

http://www.clemson.edu/cafls/demo/