"The nation that destroys its soil, destroys itself."
- Franklin Delano Roosevelt

Trees & Soil

Managing Damaged Soils

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Horticulture Agent

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What is Soil?

It depends…

- Geologist – Earth's surface, composed of weathered bedrock.
- Hydrologist – filters and purifies water.
- Engineer – foundation for structures.
- Horticulturist – medium in which plants grow.

Most urban/suburban soils are damaged and need repairing for optimal plant growth.

Soil Properties

- Physical
  - Layers (horizons)
  - Texture
  - Structure
- Chemical
  - pH
  - Cation Exchange Capacity (CEC)
- Biological
  - micro- and macro- organisms
    - bacteria, fungi, nematodes, worms, insects, etc.

All of these properties work together and influence each other, making soil an incredibly complex, dynamic, and living substance.

Soil Horizons

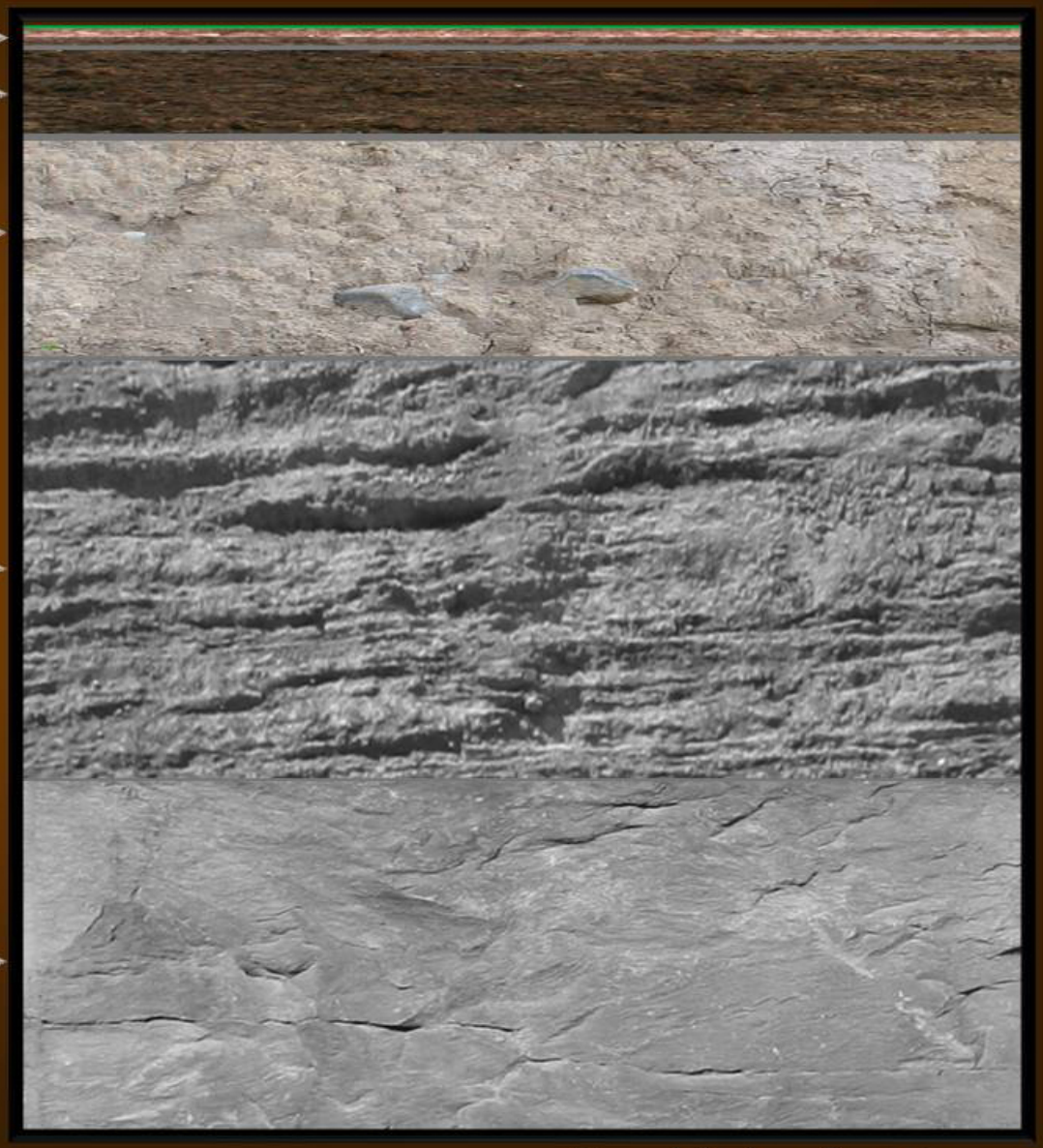
O: Organic

A: Topsoil

B: Subsoil

C: Parent Material

D: Bedrock



Graphic by Joe Boggs

What is Topsoil?

- No official definition
- The soil on top (A horizon).
- Typically removed during construction.
- Damaged topsoil can be repaired.
- Subsoil cannot be turned into topsoil. (It can be improved)
- Topsoil should be replaced with topsoil similar to that removed.

Physical Components of an Ideal Soil

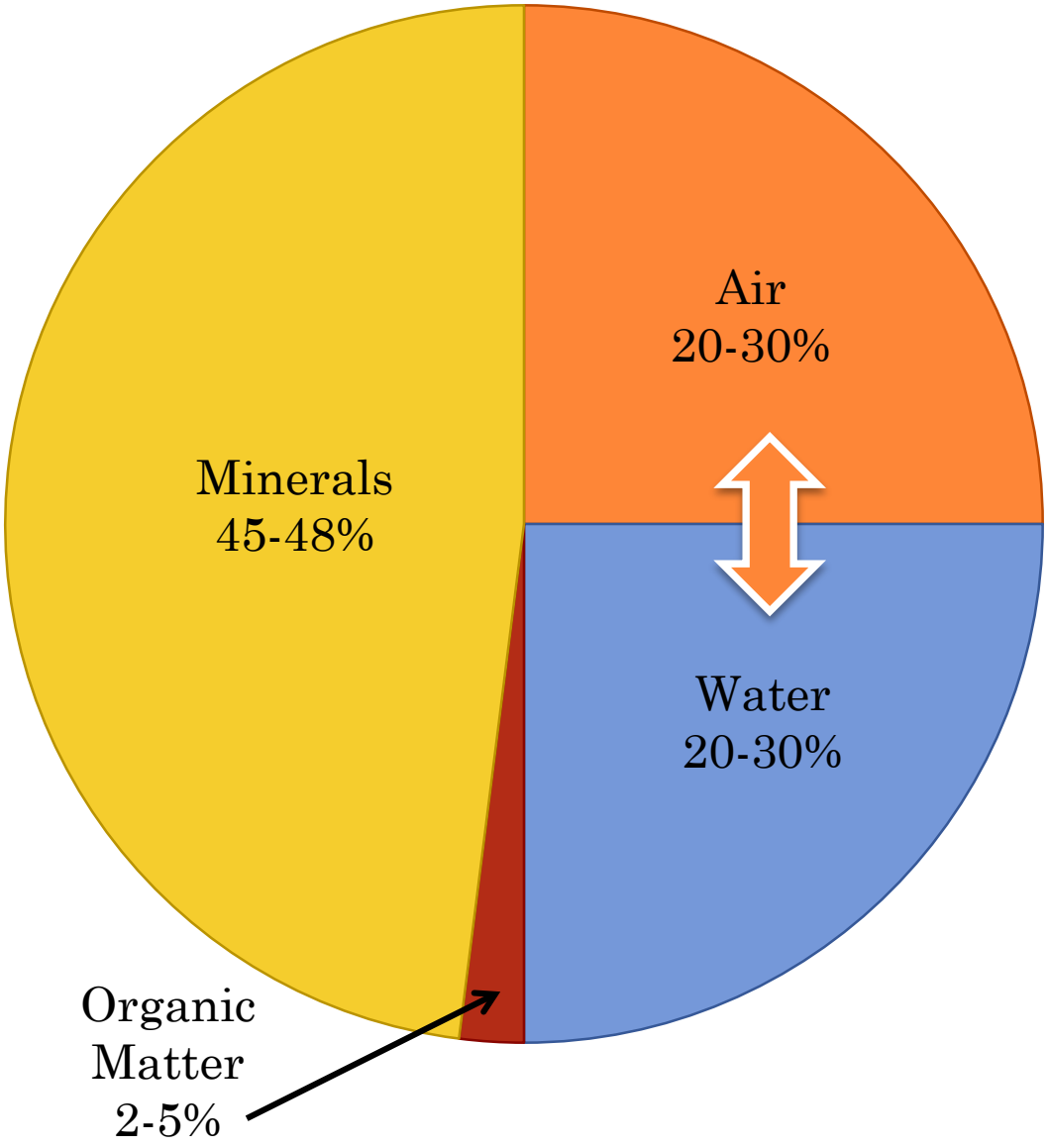
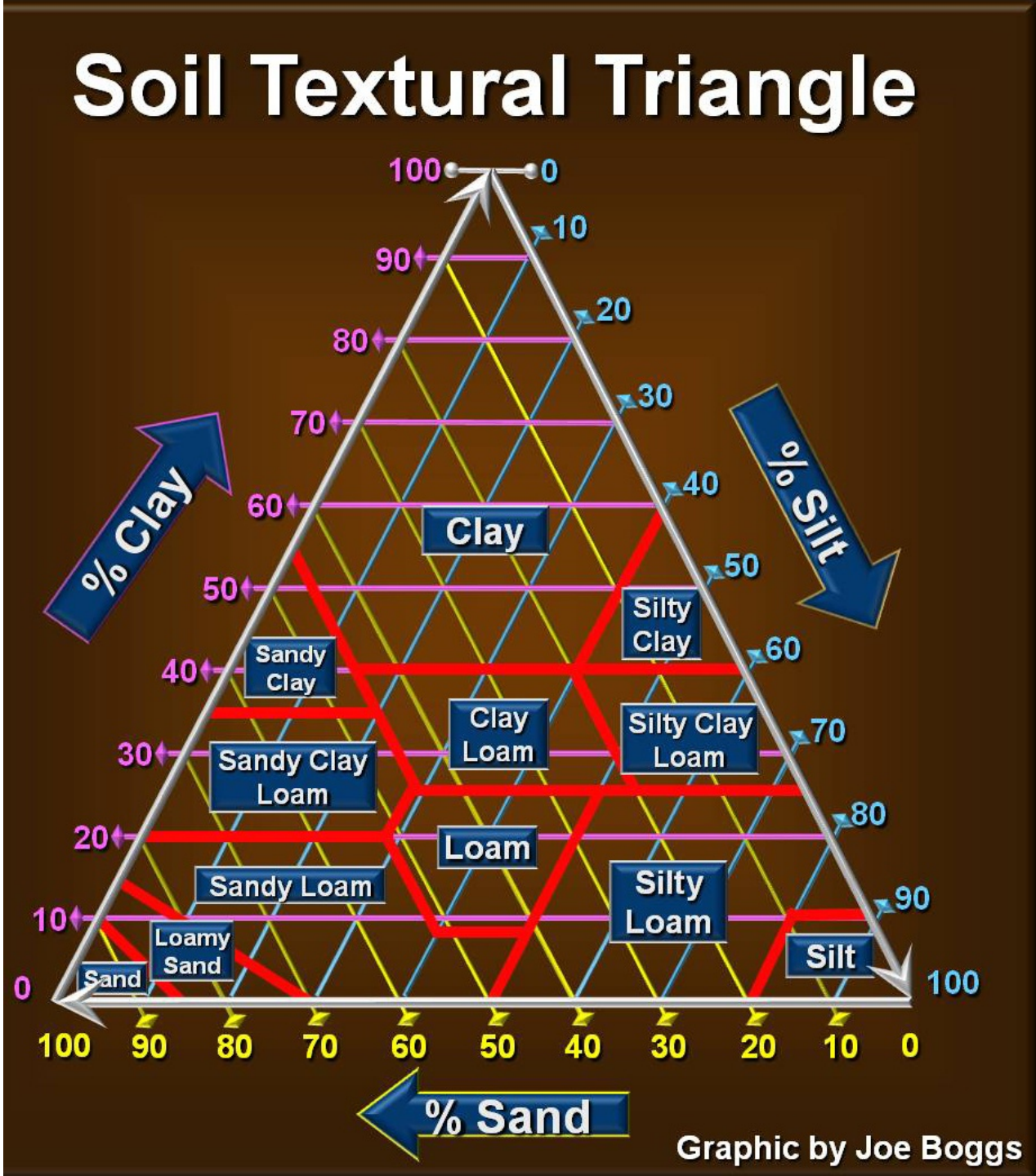



Photo by Susan D. Day

Soil Minerals

- Consist of:
  - Sand - largest
  - Silt
  - Clay - smallest
- Relative % determines soil texture.
- Affects soil drainage



Soil Texture and Soil Moisture: Non-Aggregated Soil

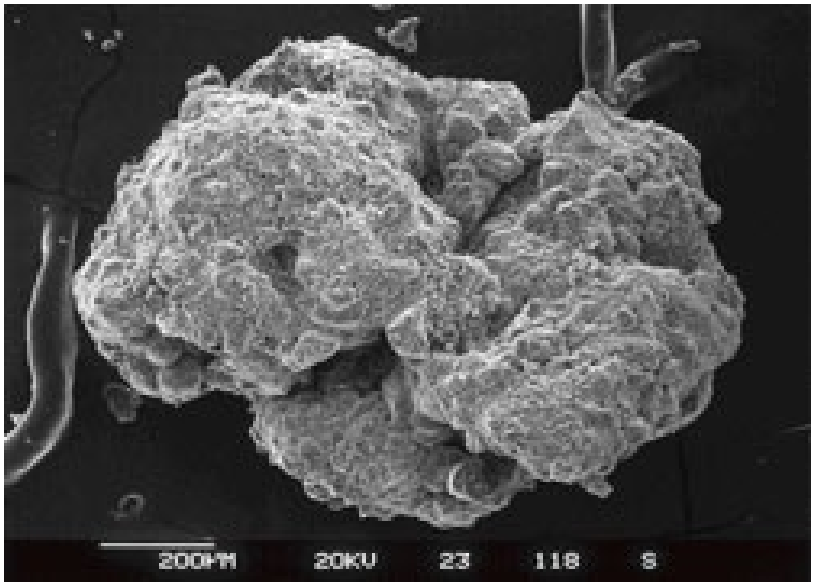
Graphic by Joe Boggs

Soil Incompatibility

- Water movement is disrupted in soils of drastically different textures (particle sizes).
- For instance, adding a sandy soil on top of a clay soil will create a situation where water can't easily flow from the sand into the clay.
- Forms a "perched water table". I.e. it *creates* a drainage problem instead of correcting it.
- This is also why we don't amend backfill soil when planting. (Amend **sites**, not holes.)

Soil Structure

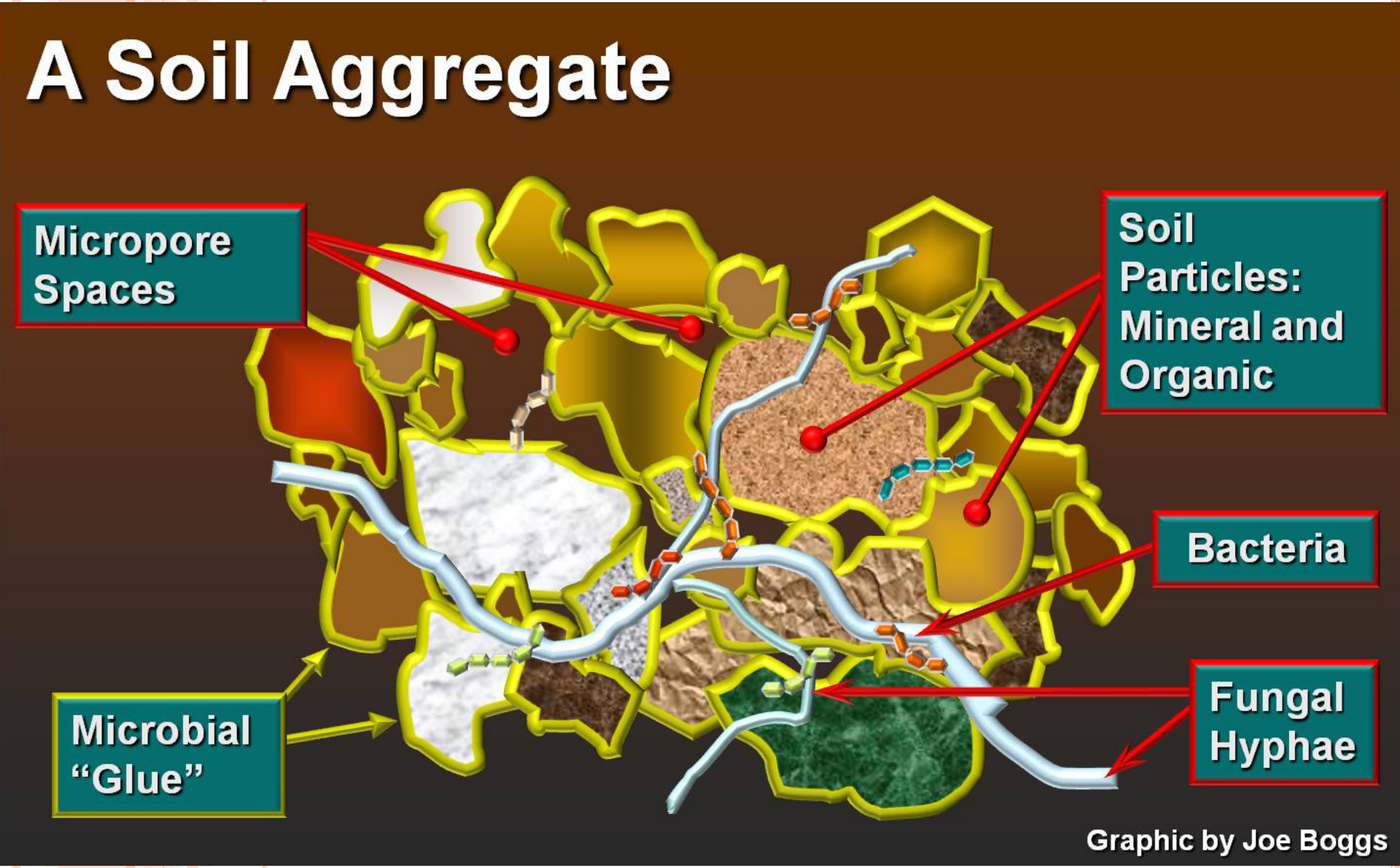
- Built from the actions of soil organisms on soil particles.
- "Microbial glue" creates soil aggregates.
- Easily destroyed by compaction or tilling; esp. when soil is wet.
- OM feeds microbes



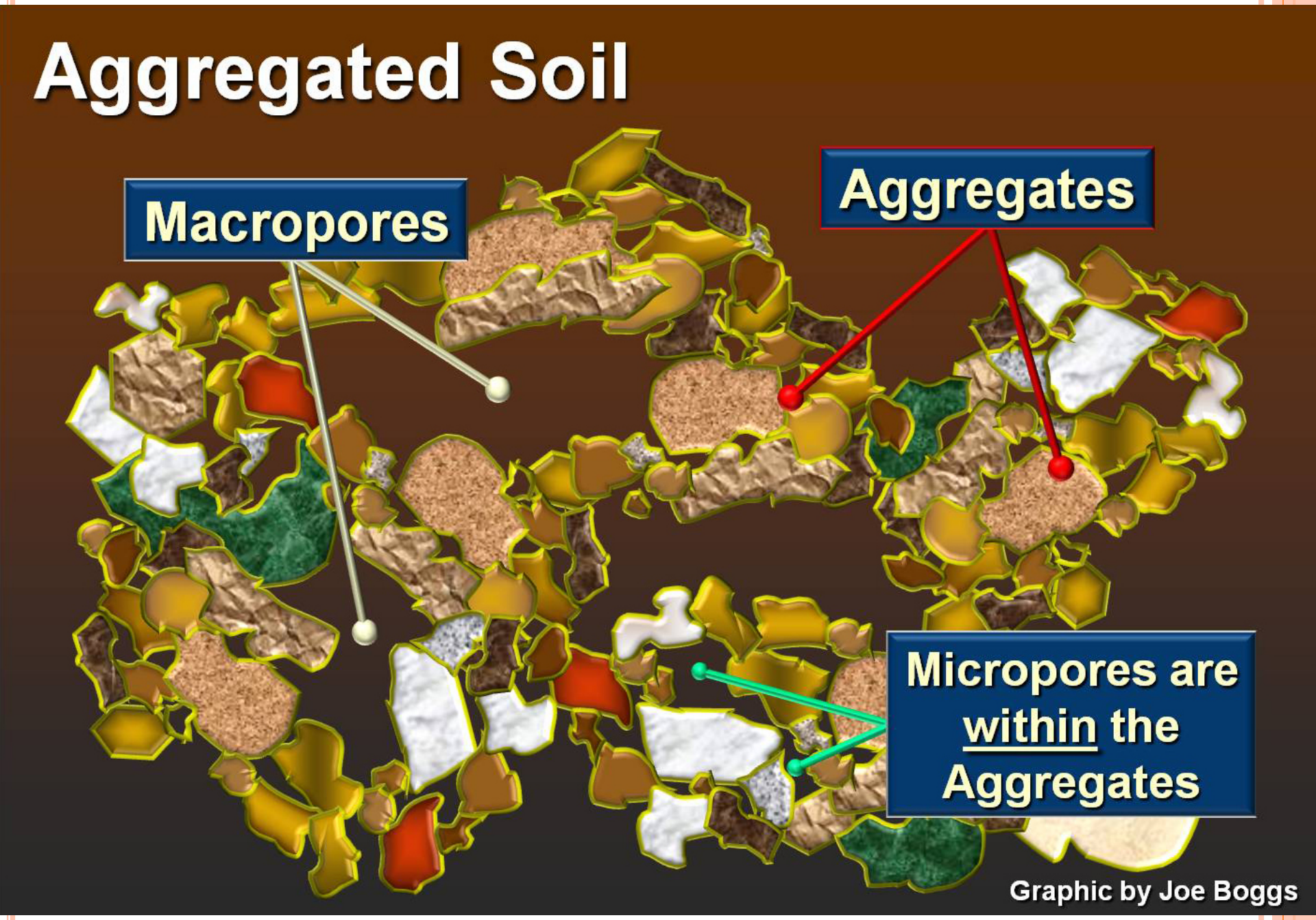
Good structured soil has:

- Micropores – pores within aggregates (nutrient retention and exchange)
- Macropores – pores between aggregates (plant available air and water)

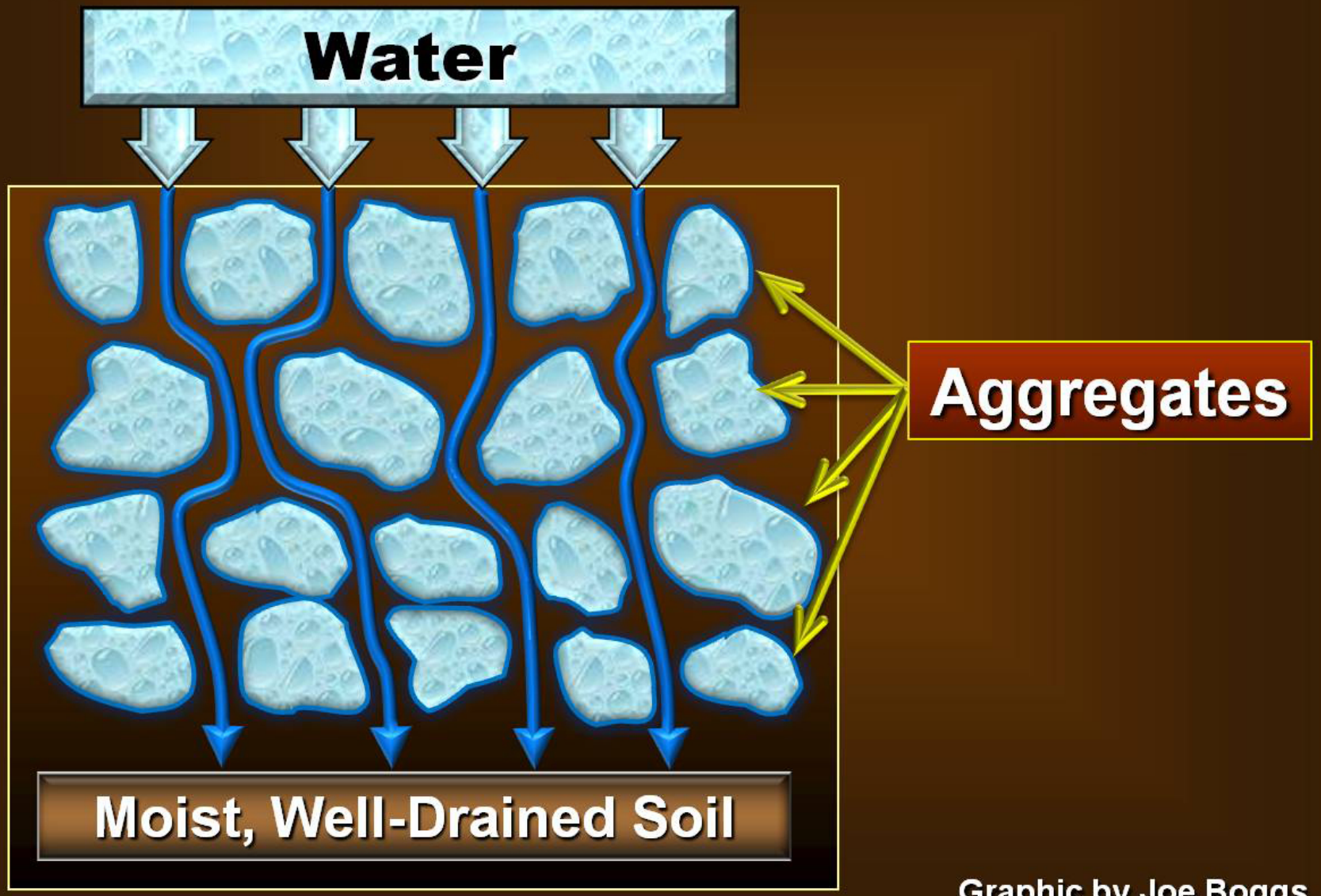
A Soil Aggregate



Aggregated Soil



Water Infiltration Through an Aggregated Clay Soil



Organic ... Matters!

Add organic matter

Increases biological activity (& diversity)

Reduced soil-borne diseases

Aggregation Increased

Decomposition

Pore structure improved

Nutrients released

Humus and other growth promoting substances

Improved tilth & water storage

Harmful substances detoxified

Healthy Plants

Modified from C. Oshins, 1999, "*An Introduction to Soil Health*"

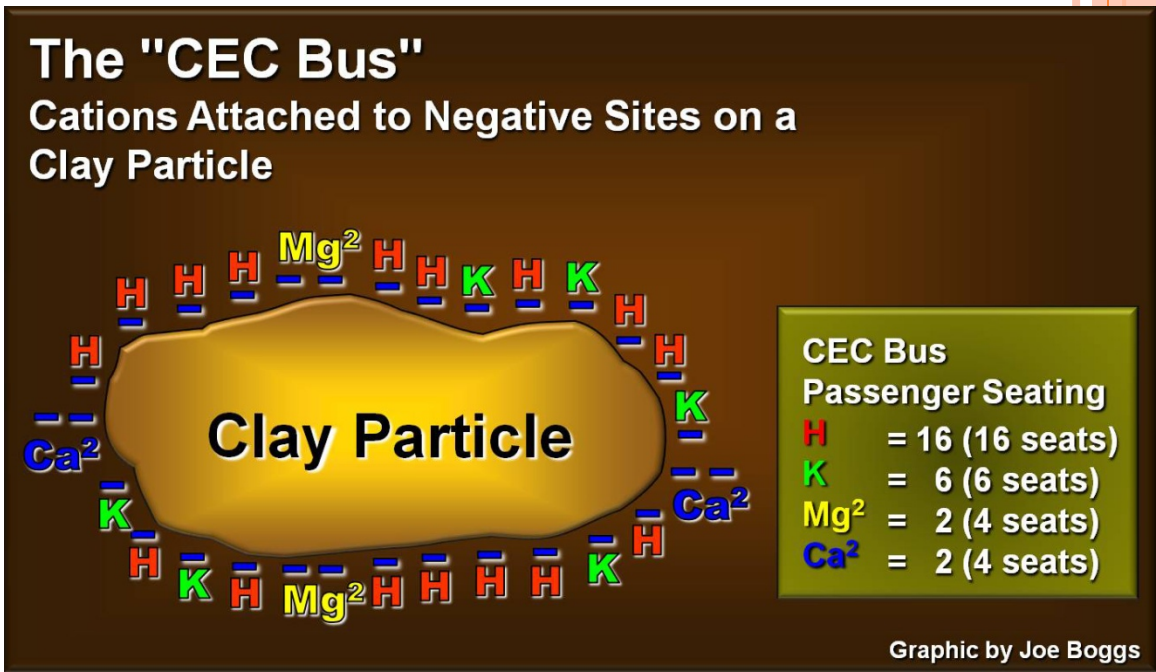
Not All Compost is Created Equal

Quality Compost

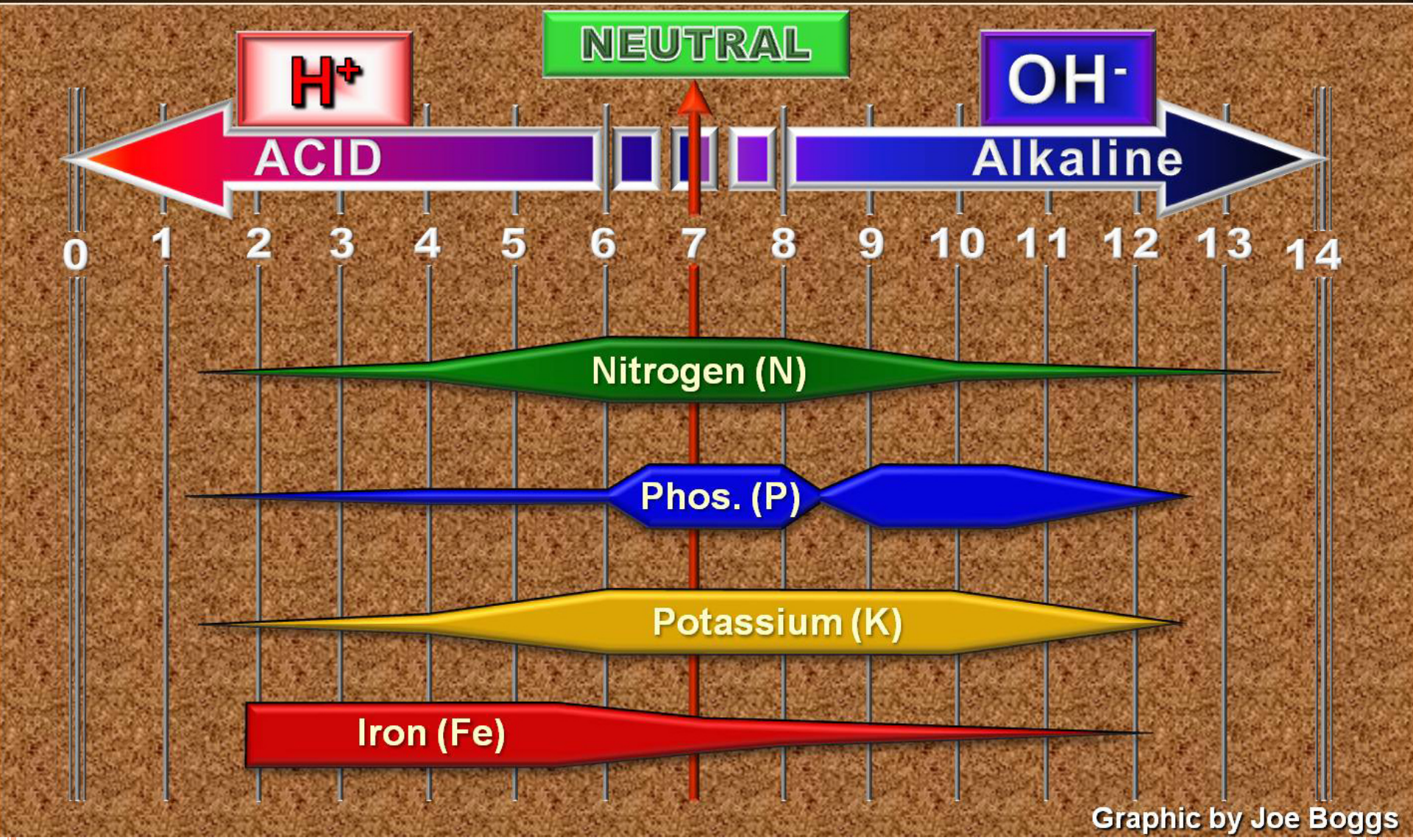
- C/N Ratio <20
- pH of 6 to 7.8
- Low salts (EC < 4 mmhos/cm)
- Appropriate N & P levels
- Low phytotoxicity
- Mature & stable
- Free of weeds & pathogens
- Supplied by a professional composting operation

Chemical Properties

- Soil pH
  - 5.5 to 6.5 best
- CEC
  - Measures the soil's ability to hold nutrients.
  - Based on clay and OM content.
  - Higher is better



Relationship Between Soil pH and Nutrients Available to Plants



Soil Testing Tools

CLEMSON UNIVERSITY

Agricultural Service Laboratory
171 Old Cherry Road, Clemson, SC 29634
Phone: 864-656-2068 Fax: 864-656-2069

Date: 3/9/2009

Soil Report for:

Doe, John
555 Garden Way
GREENVILLE SC , 29601

Lab Number: ***123456***
Account: ***COGRNVL***
Farm Id: ***DOE, JANE***
Sample Id: ***BACK***
Soil Code: ***4***

Analysis	Results		Low	Medium	Sufficient	High	Excessive
Soil pH	5.2						
Buffer pH	7.40						
Phosphorus (P)	33	*lbs/acre*					
Potassium (K)	196	*lbs/acre*					
Calcium (Ca)	1250	*lbs/acre*					
Magnesium (Mg)	126	*lbs/acre*					
Zinc (Zn)	12.4	*lbs/acre*					
Manganese (Mn)	33	*lbs/acre*					
Boron (B)	1.4	*lbs/acre*					
Copper (Cu)	5.8	*lbs/acre*					
Sodium (Na)	35	*lbs/acre*					
Sulfur (S)		*lbs/acre*					
Soluble Salts		*mmhos/cm*					
Nitrate Nitrogen		*ppm*					
Organic Matter		*% (LOI)*					

Calculations

Cation Exchange Capacity (CEC)	Acidity	Base Saturation Ca	Mg	K	Na	Total
8.8 meq/100g	4.8 meq/100g	36%	6%	3%	1%	45%

Recommendations

Crop	Lime
Centipedegrass(sq ft)	87 lbs/1000sq ft
See Comments: 321,436,437,535,654,700	
WarmSeasonGrsMaint(sq ft)	103 lbs/1000sq ft
See Comments: 428,429,535,654,700	

Comments

321 *Do not over-fertilize with nitrogen or apply nitrogen fertilizer after August 15. To achieve darker green color, broadcast iron containing product or foliar apply on the turf a liquid solution of iron sulfate (dissolve 2 ounces iron sulfate in 4 gallons of water) including a surfactant (5 drops of a dishwasher detergent) per 1,000 square feet, or foliar apply a chelated iron source following label instructions. An iron solution treatment should be made as needed for green turf color between regular fertilizer applications in April and July for locations in the Piedmont and in March, July and September for the Coastal Plains (consider turf fertilizers that contain iron). Foliar apply the iron-containing solution in the late afternoon only when the air temperature is greater than 80oF and soil moisture is adequate for good turf growth.*

428 *When growth begins in the spring, broadcast 3 lbs 34-0-0 per 1,000 square feet. In July, broadcast 3 lbs 34-0-0 per 1,000 square feet.*

429 *The extent of growth can be controlled by the amount of nitrogen fertilizer applied, low maintenance at a rate between 1 to 2 lbs nitrogen per 1,000 square feet per year, high maintenance, between 3 to 5 lbs nitrogen per 1,000 square feet per year. If the grass clippings are removed, the amount of fertilizer applied should be increased by 25% and the turf soil tested every other fall to determine what levels of phosphate and/or potash will be needed to sustain vigorous growth.*

436 *When growth begins in the spring, broadcast 1 lb 34-0-0 or equivalent fertilizer per 1,000 square feet, and repeat the application in July.*

437 *The extent of growth can be controlled by the amount of nitrogen fertilizer applied, low maintenance at a rate less than 1 lb nitrogen per 1,000 square feet per year, high maintenance, between 1 and 2 lbs nitrogen per 1,000 square feet per year. If the grass clippings are removed, the amount of fertilizer applied should be increased by 25% and the turf soil tested every other fall to determine what addition of phosphate and/or potash fertilizer will be needed to sustain vigorous growth.*

535 *Broadcast dolomitic limestone as recommended, either in the fall or early spring.*

654 *Soil test again next year if either phosphorus (P) or potassium (K) is high or excessive to monitor levels.*

700 *The phosphorus and/or potassium results(s) were high, however, the recommendation given above is needed for maintenance or to compensate for crop removal.*

What can be Done?

1. Protect the soil!
   - Work with contractor to protect, stockpile and replace native topsoil
   - Setup Tree Protection Zones (TPZ)


TREE PROTECTION AREA
NO DISTURBANCE PERMITTED BEYOND THIS POINT
AREA DE PROTECCION DE ARBOLES
NO SE PERMITE TRABAJAR, NI DEJAR MATERIALES EN EL AREA ATRAS DE ESTE ROTULO

What can be Done?

2. Repair damaged soil
   - Decompact – rototilling, air spading, radial trenching, etc.
   - Correct soil pH and nutrient deficiencies
   - Amend planting *area* (not planting hole) with organic matter.
   - Mulch appropriately

What can be Done?

3. Soil Replacement (extreme amending?)
   - Remove existing soil
   - Replace with “better” soil or structural soils
   - May create soil texture conflicts
   - May not support healthy soil biology

What can be Done?

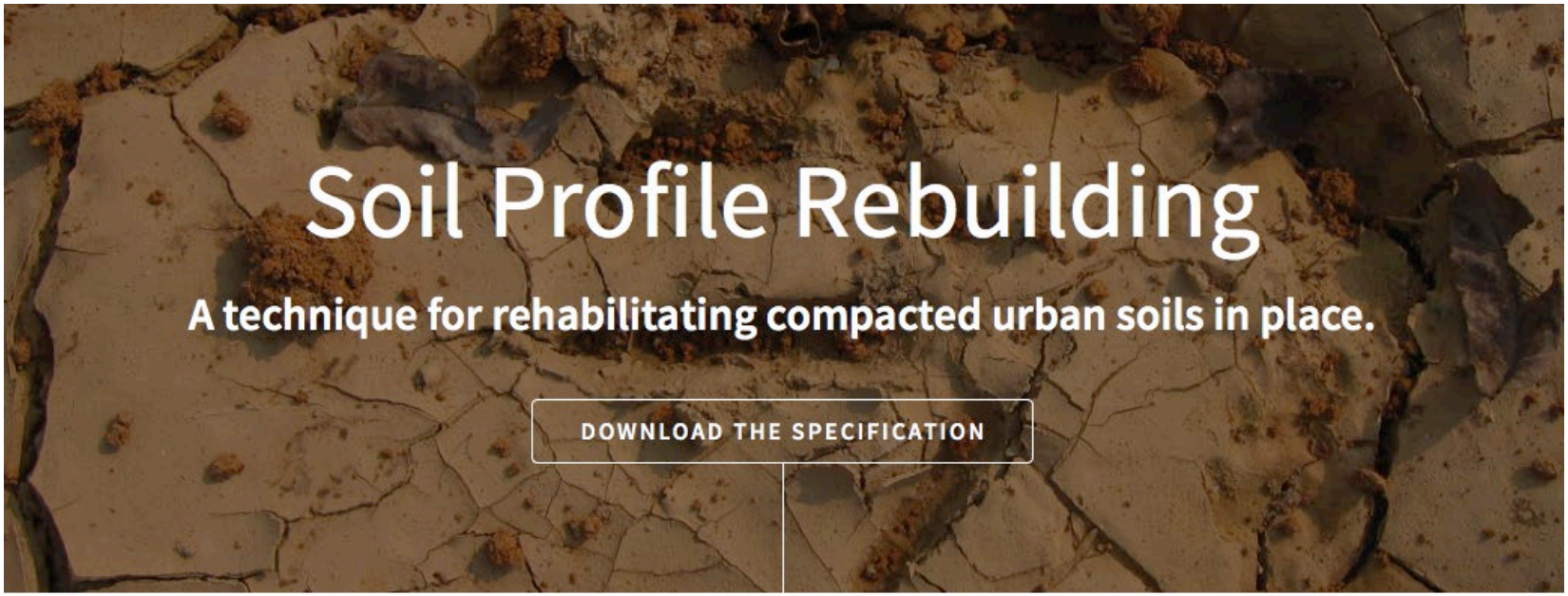
4. Soil Profile Rebuilding
   - Pre-plant soil treatment
   - Use on degraded urban soils
     - Extreme, deep compaction
     - Low organic matter
   - Applied to the entire planting **site**

Has been shown to:

- Reduce soil bulk density
- Increase establishment rate, canopy growth and trunk diameter
- Increase water infiltration

Soil Profile Rebuilding

urbanforestry.frec.vt.edu/SRES/



Land development and soils

Urban development often results in stripped and compacted soils that cannot sustainably support trees and landscapes and provide little in terms of environmental benefits. Soil Profile Rebuilding is a cost-effective technique that can help rehabilitate these soils to provide documented increases in tree growth and ecosystem services such as carbon sequestration and stormwater management.

Soil Profile Rebuilding

Basic Process

1. Apply 4 inches of compost
2. Incorporate it to 24 inch depth with a backhoe

   "Scoop, lift, and drop"
3. Apply 4-8 inches of quality top soil and rototill
4. Plant
5. Mulch

Thank You!

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