Urban Soils & Water Quality

Rebuilding Brown Infrastructure

Cuyahoga Soil and Water **Conservation** District

excellence in conservation

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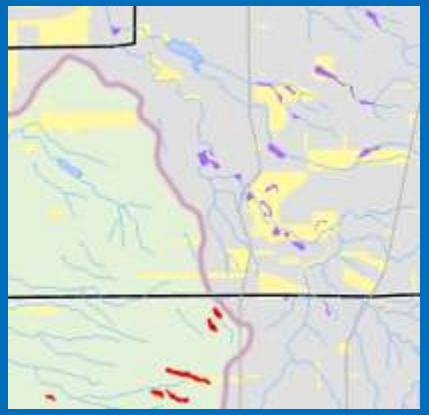
What is Brown Infrastructure?

Gray



Blue

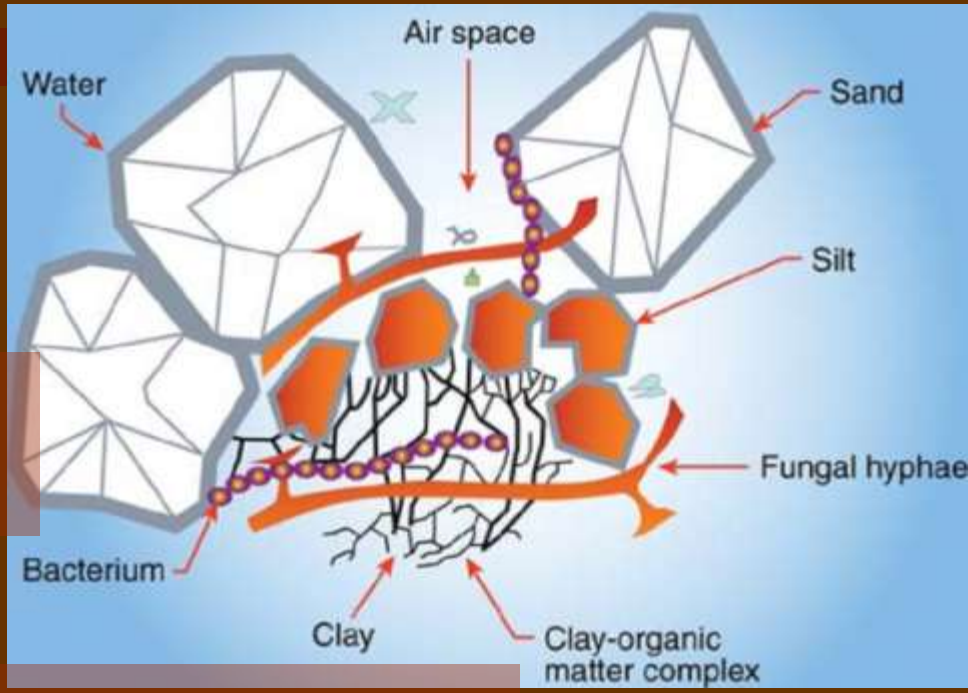
Green

soil survey of **Cuyahoga**

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Ohio Department of Natural Resources
Division of Lands and Soil
and
Ohio Agricultural Research and Development Center

Brown

Soil defined…



A dynamic natural body composed of mineral, organic materials and living organisms in which plants grow. (Brady et al.)

Urban soils…

- High variability
- Mostly *carbon starved*
- Mostly *compacted*
  - massive or degraded soil structure
- Nutrient and pH imbalanced (can be phytotoxic)
- Profile may be buried, removed or mixed
- Low microbial biomass

Urban Soil Functions

- Pollutant sorption & degradation
- Waste and nutrient recycling
- Urban landscaping & wildlife habitat
- Soil carbon sequestration
- High-intensity urban agriculture
- Heat and storm water volume reduction

Soil Quality

- The capacity of a soil to function within an ecosystem to sustain biological productivity, maintain environmental quality, and promote plant and animal health (Soil. Sci. Soc. Am., 1996).

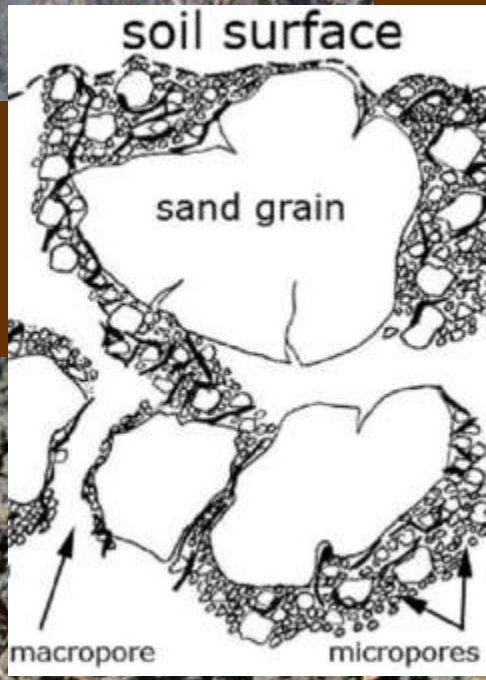
Most urban soils have degraded quality…

How do we rebuild *brown infrastructure?*

…Begin with evaluation of soil quality indicators.

Soil Quality Indicators

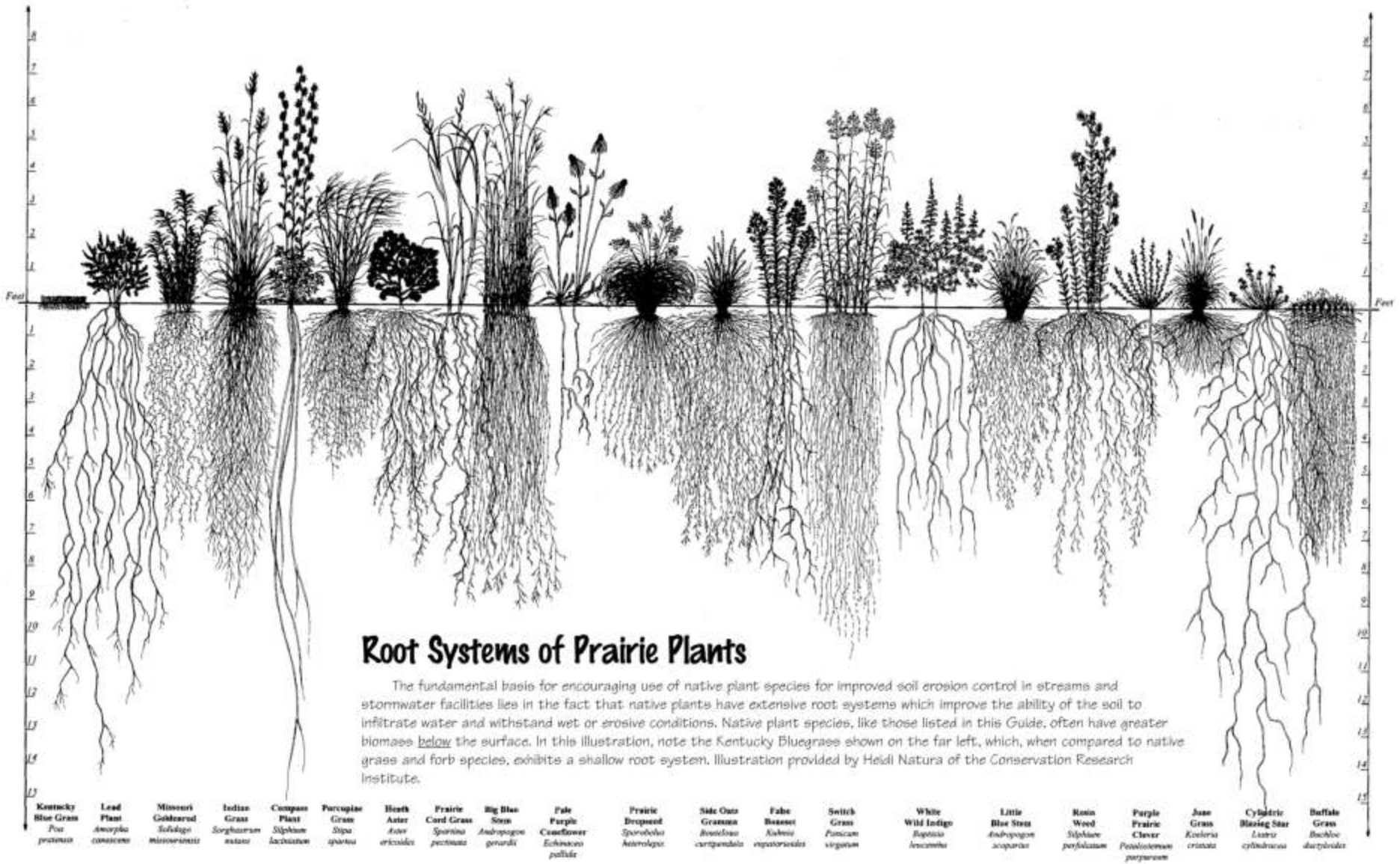
- Total organic carbon
- Bulk density (compaction)
- Available water capacity
- Aggregate stability
- Respiration
- Electrical conductivity & pH
- Soil structure and macro-pores
- Infiltration
- Earthworms



Then, implement
the right practices…

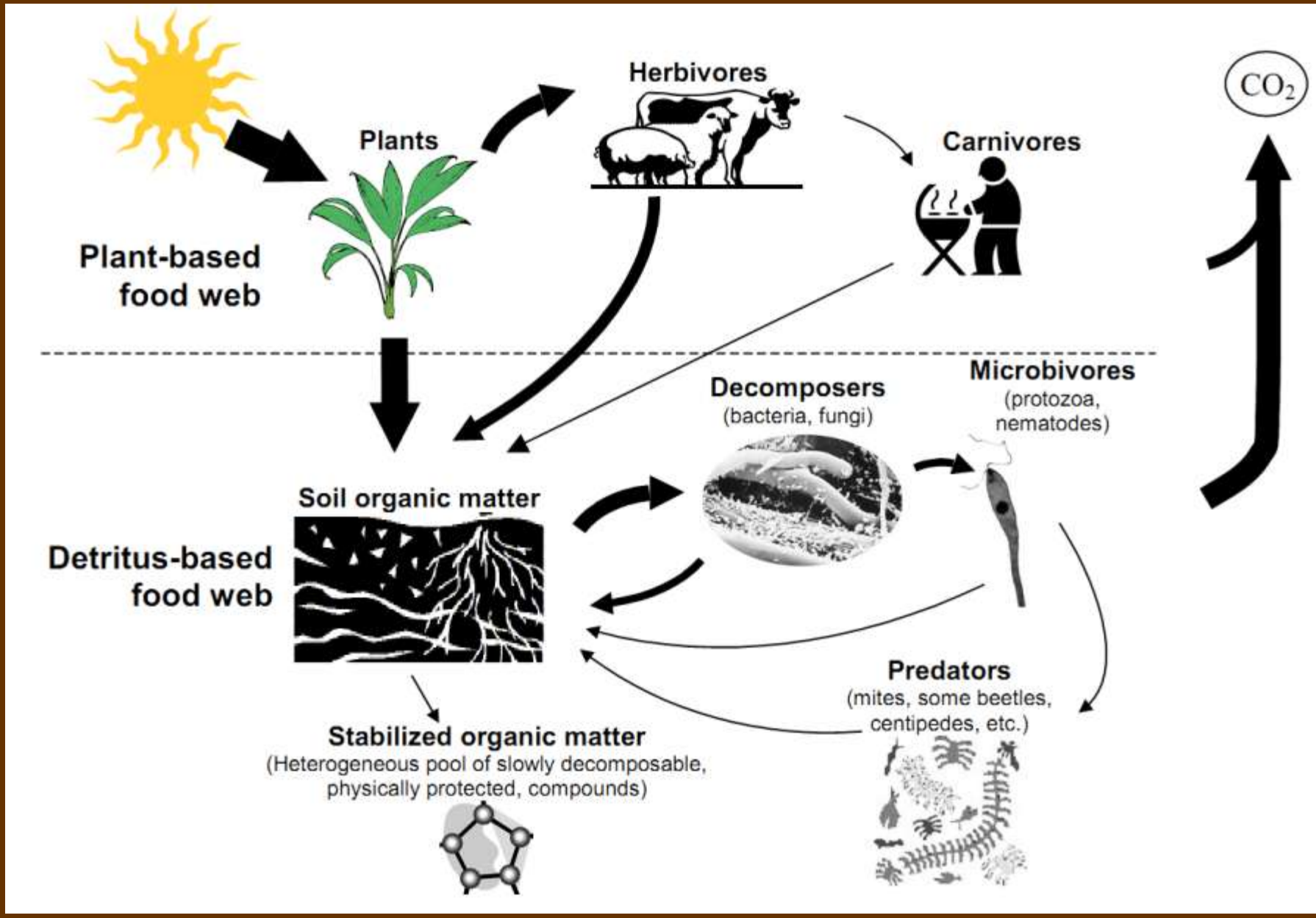
Soil Rehabilitation

- Reduce impervious surfaces
- Loosen compacted soils
- Reduce luxury fertilization
- Reduce over-liming
- Use compost-filled trenches & vertical mulching
- Plant deep-rooted, herbaceous vegetative treatments & cover crops



Root Systems of Prairie Plants

The fundamental basis for encouraging use of native plant species for improved soil erosion control in streams and stormwater facilities lies in the fact that native plants have extensive root systems which improve the ability of the soil to infiltrate water and withstand wet or erosive conditions. Native plant species, like those listed in this Guide, often have greater biomass below the surface. In this illustration, note the Kentucky Bluegrass shown on the far left, which, when compared to native grass and forb species, exhibits a shallow root system. Illustration provided by Heidi Natura of the Conservation Research Institute.


Herbivores
Plants
Carnivores
CO_2
Plant-based food web
Decomposers
(bacteria, fungi)
Microbivores
(protozoa, nematodes)
Soil organic matter
Detritus-based food web
Predators
(mites, some beetles, centipedes, etc.)
Stabilized organic matter
(Heterogeneous pool of slowly decomposable, physically protected, compounds)

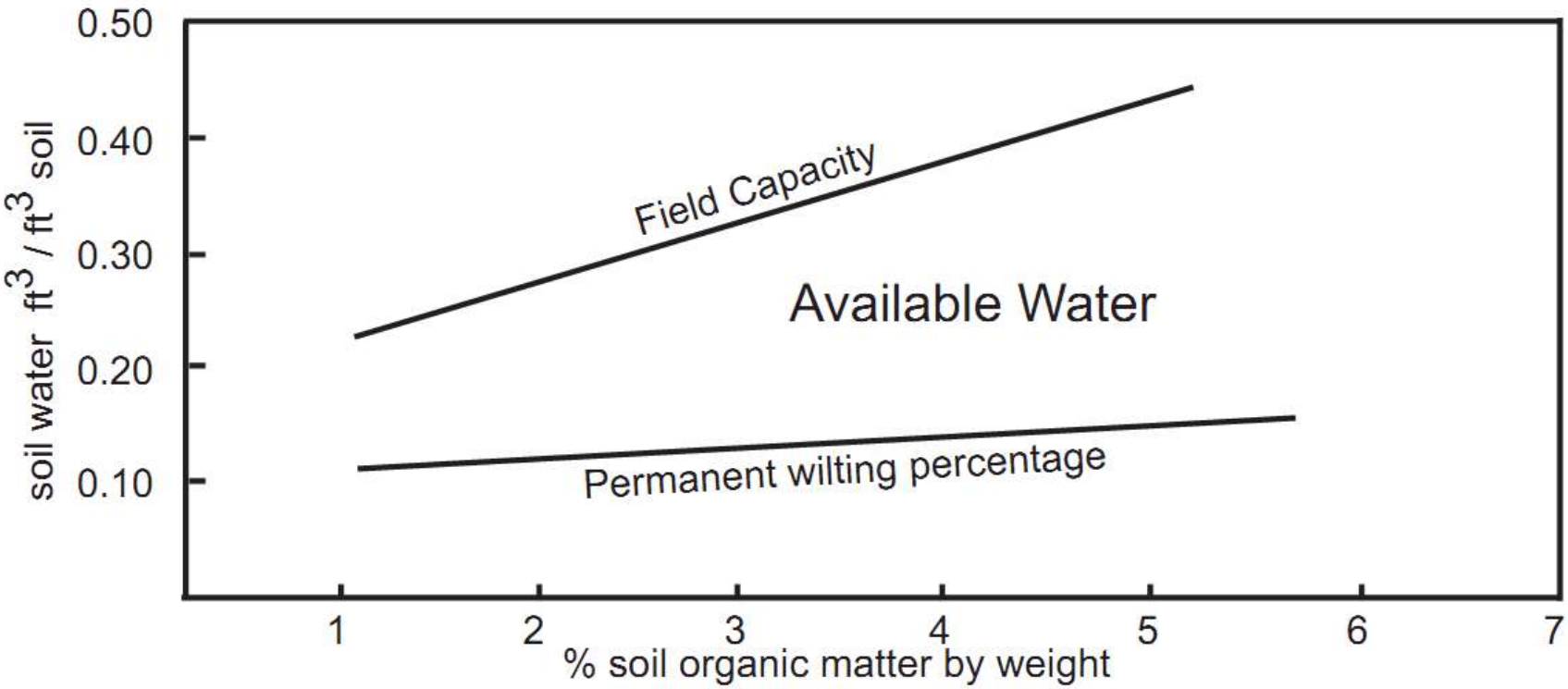


Figure 2. Effect of increasing organic matter on available water capacity of silt loam soils. Adapted from Hudson, SWCS, 1994.

Platy Structure


Water-Stable Aggregates

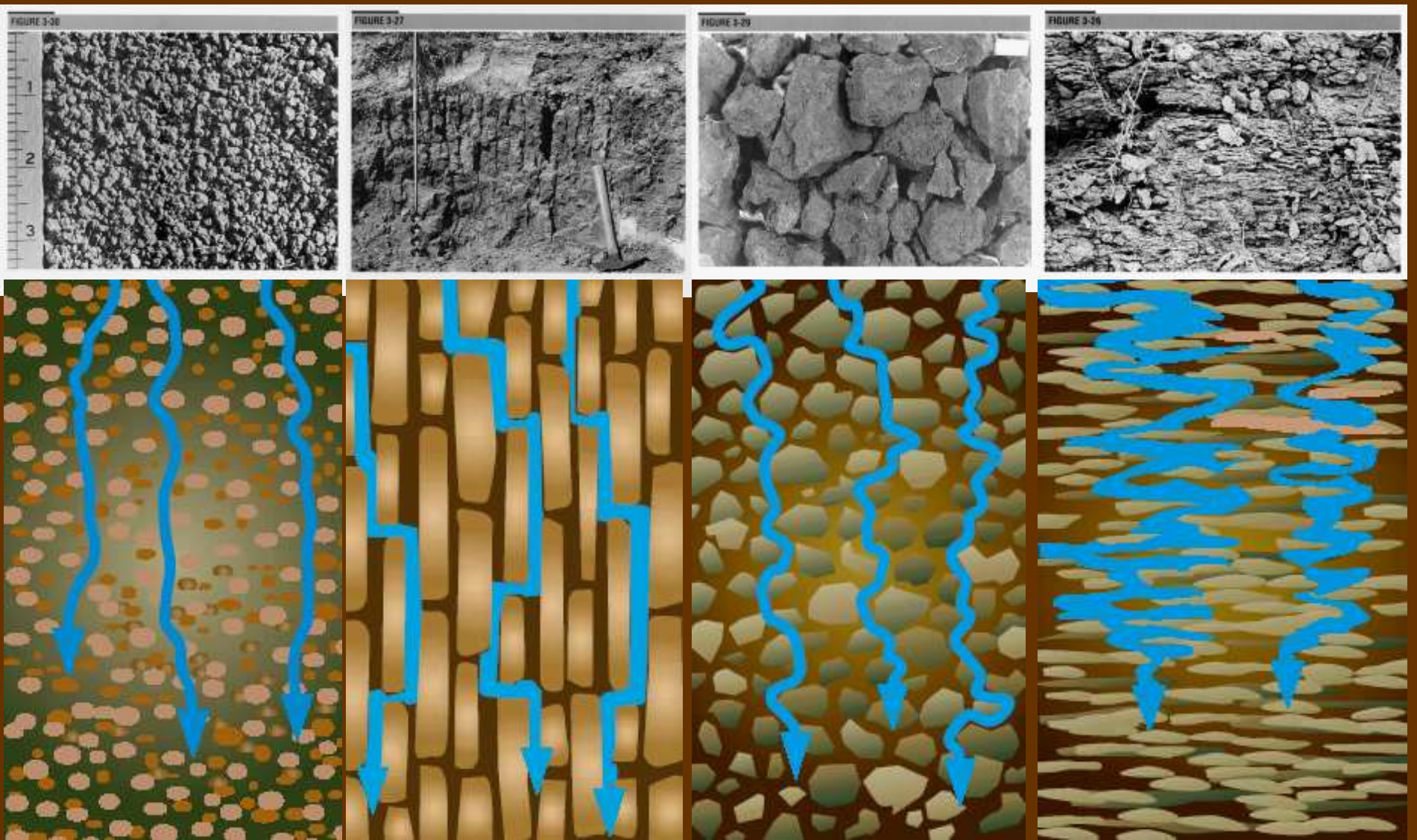
Protecting Urban Soil Quality:

Examples for Landscape Codes and Specifications

Soil texture	Ideal bulk densities (g/cm3)	Bulk densities that may affect root growth (g/cm3)	Bulk densities that restrict root growth (g/ cm3)
Sands, loamy sands	<1.60	1.69	>1.80
Sandy loams, loams	<1.40	1.63	>1.80
Sandy clay loams, loams, clay loams	<1.40	1.60	>1.75
Silts, silt loams	<1.30	1.60	>1.75
Silt loams, silty clay loams	<1.10	1.55	>1.65
Sandy clays, silty clays, some clay loams (35-45% clay)	<1.10	1.49	>1.58
Clays (>45% clay)	<1.10	1.39	>1.47

http://soils.usda.gov/sqi/management/files/protect_urban_sq.pdf

Improved Soil Structure = ⇧ K_{sat}



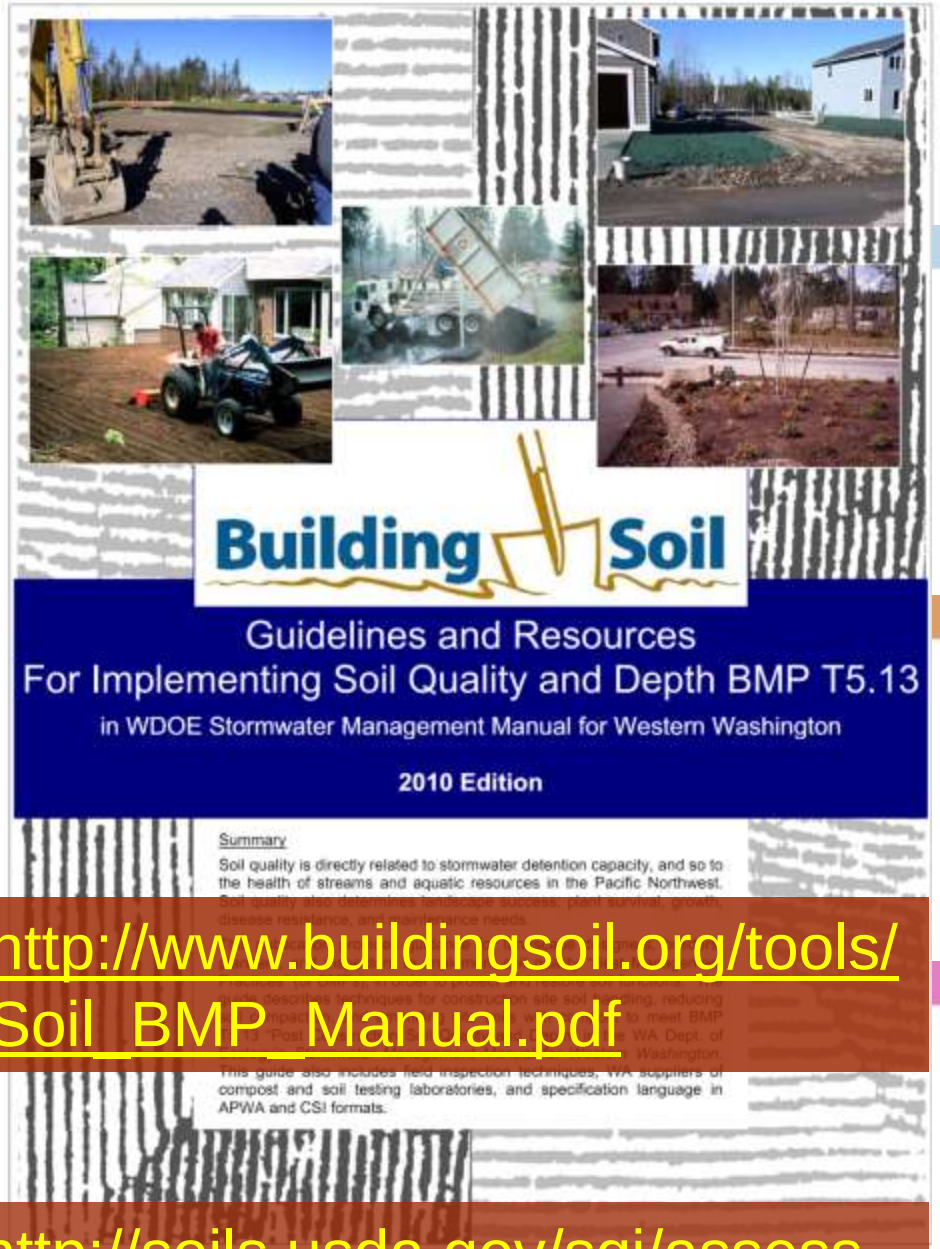
Target K_{sat} of 1.5-2.6 in. hr^{-1} for planting media (http://www.dnr.state.oh.us/tabid/9186/default.aspx)

Target of penetration resistance of <200 psi for planting media (http://soils.usda.gov/sqi/management/files/protect_urban_sq.pdf)

Compaction limits rooting and hydraulic conductivity

Brown Infrastructure

- Can improve water quality
- Can help minimize long-term costs
- Can improve aesthetics and habitat quality
- Can increase productivity of urban agriculture
- Can help mitigate channel erosion



http://www.buildingsoil.org/tools/Soil_BMP_Manual.pdf

http://soils.usda.gov/sqi/assessment/assessment.html

Photograph Credits

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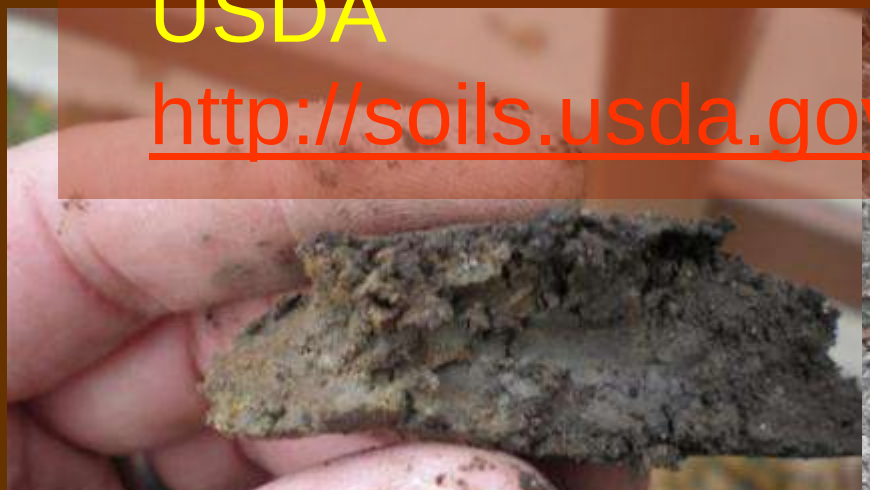
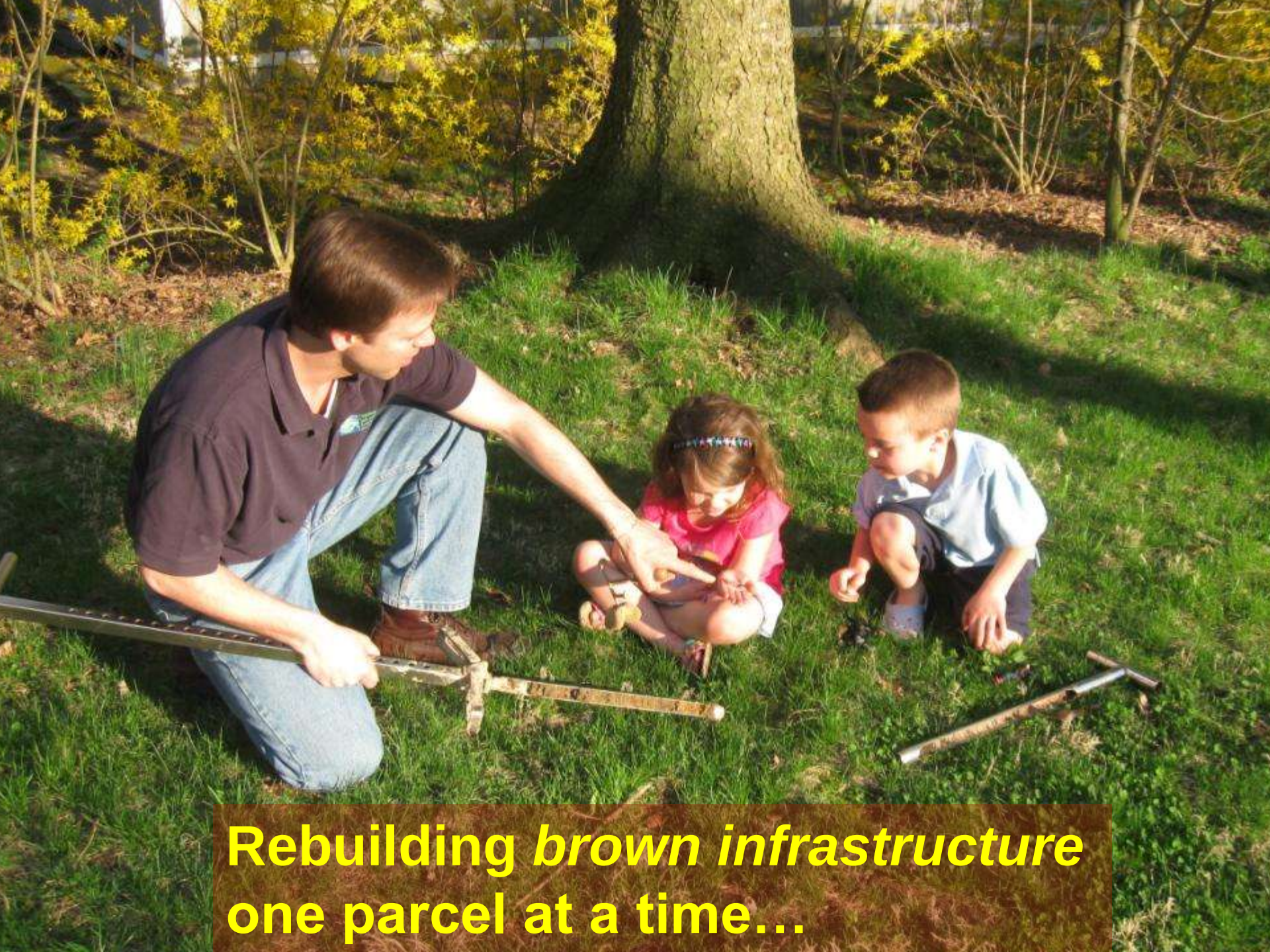
- Natural Resources Conservation Service, USDA http://soils.usda.gov/




Rebuilding *brown infrastructure*
one parcel at a time…