

Soils and Urbanization



What Is Soil?

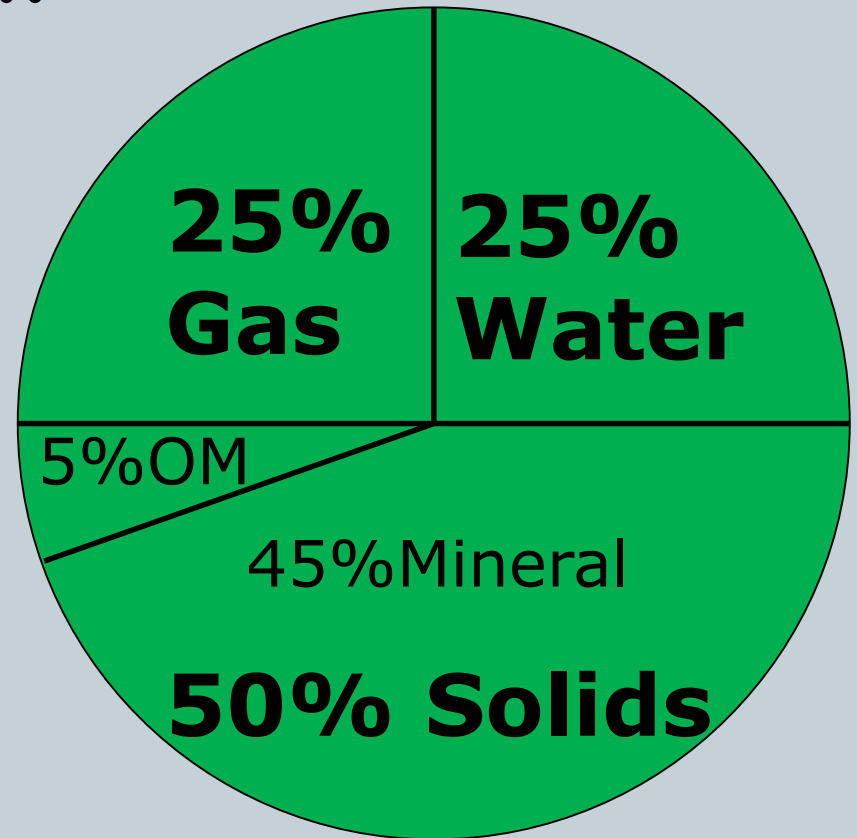


- A combination of...

- air

- water

- gas



What Is Soil?

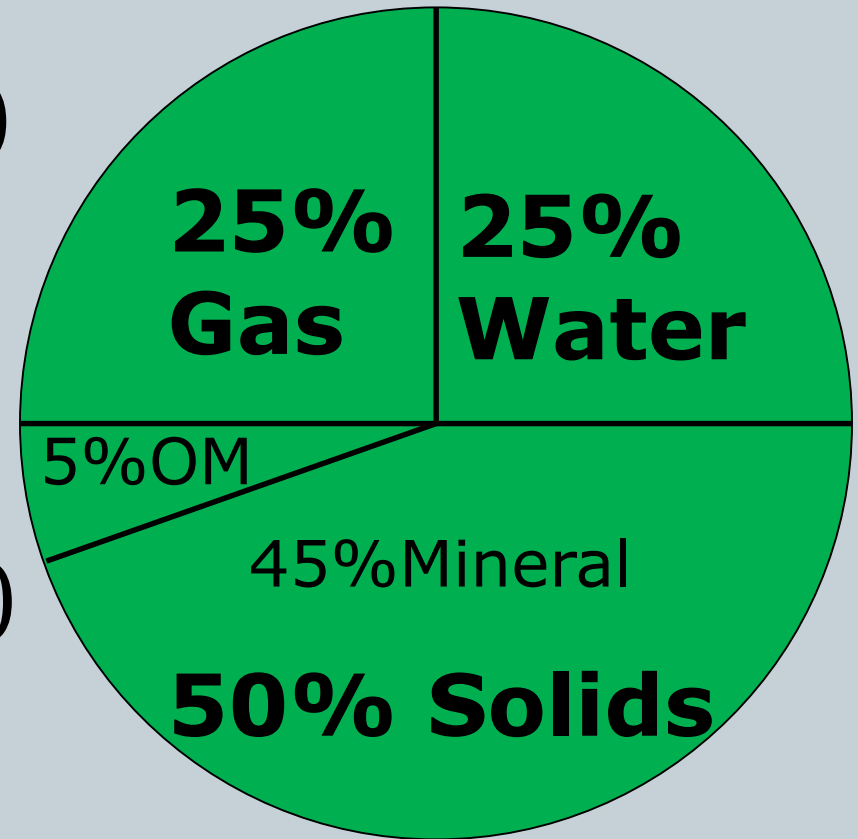


Mineral Fraction (45%)

- Sand
- Silt
- Clay

Organic Fraction (5%)

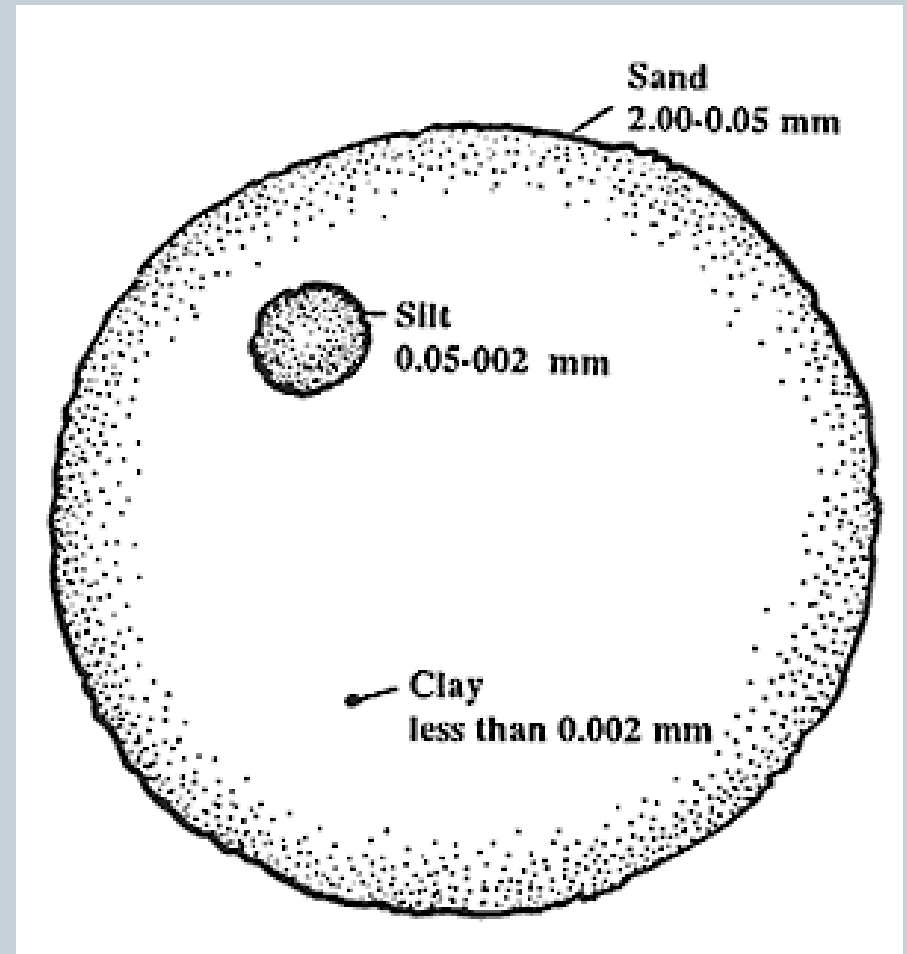
- Living organisms
- Dead organisms



What Is In Soil?



- **Soil Solids:
Mineral Fraction**
 - Sand (2 – 0.05mm)
 - Silt (0.05-0.002mm)
 - Clay (<0.002mm)



What Is In Soil?



- **Soil Solids:
Organic Fraction**

- Living Material →



- Dead Material



What Is In Soil?

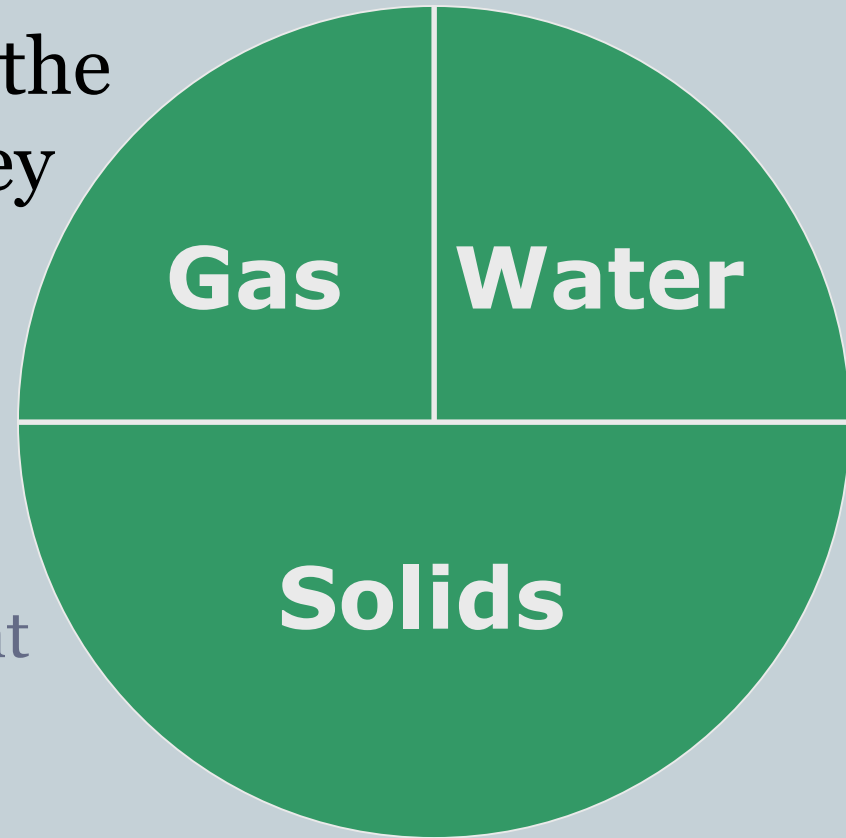


- Air and Water
 - Different than our surface waters and atmosphere
 - ✦ More heterogeneous - lots of spatial variation
 - ✦ Highly dependent on the activity of surrounding organisms
 - ✦ Generally lower oxygen content

Importance of Solids, Air, Water



- In natural soil, division of the three gives plants what they need
 - Enough solid material for physical support
 - Enough water and air to keep the roots healthy and the plant hydrated
 - Enough water and air to keep the microbes happy and active



Soil Formation

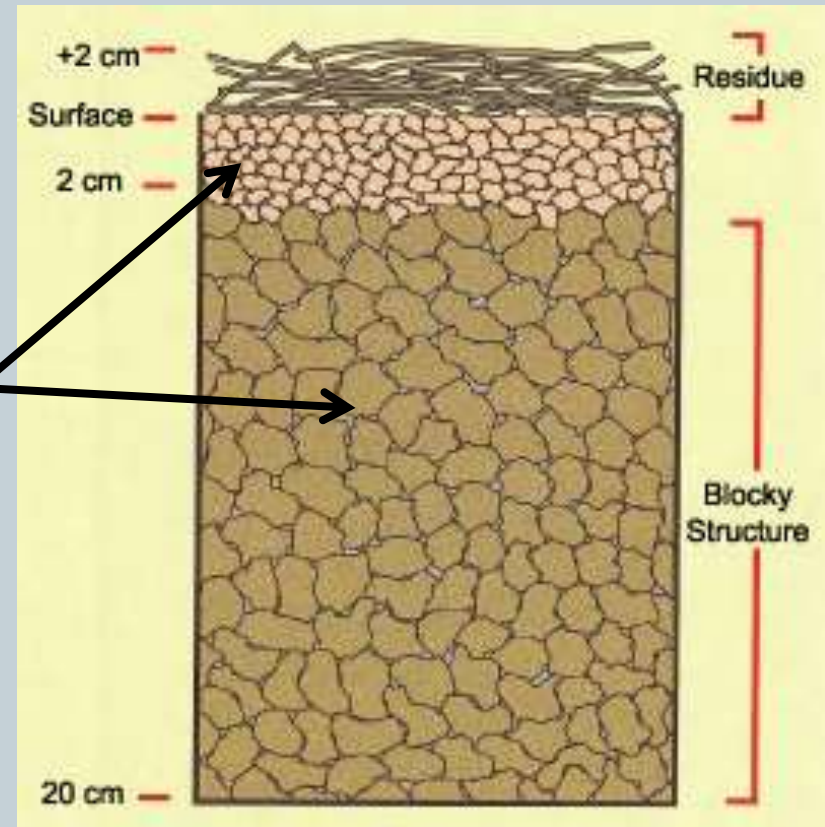
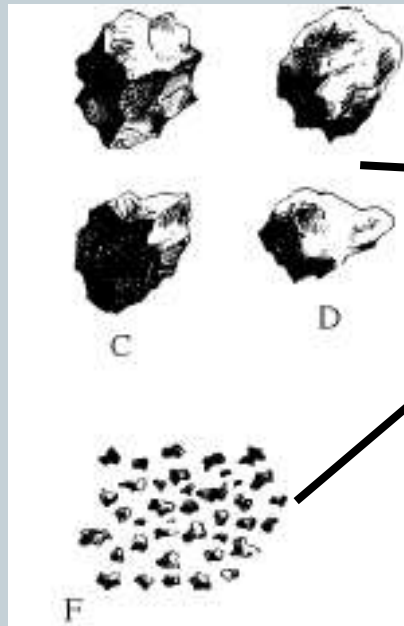


- **The Five Soil Forming Processes: CLORPT!**
 - Climate: Temp and precip
 - Organisms: breakdown of organics
 - Relief: Erosion and deposition
 - Parent Material: Chem and phys traits
 - Time: Master variable

Soil Formation



- How does a soil attain a balance of 50% solids, 25% water and 25% gas?
 - **Soil Structure:** How the soil solids are arranged together



Soil Formation



- **And how is soil structure created?**
 - **Binding agents: Cause aggregation**
 - ✦ Clay and organic matter
 - ✦ Microbial decomposition
 - ✦ Fine root hairs
 - **Burrowing agents: Create pore spaces**
 - ✦ Worms
 - ✦ Roots
 - ✦ Other burrowing organisms
 - ✦ Wetting/drying, shrinking/swelling, freeze/thaw

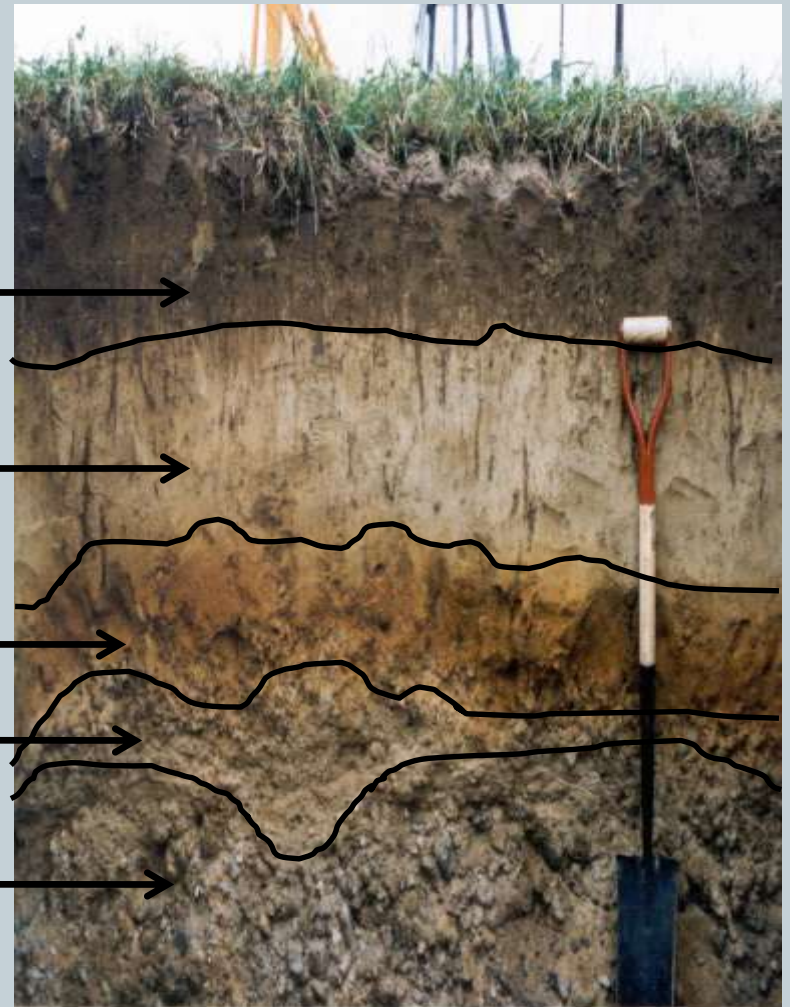
Soil Formation



- Appearance: A layered system

- Consists of “horizons”

- ✦ **A horizon:** surface layer, organic rich, fertile, center of biological activity
- ✦ **E horizon:** leached, pale, low fertility, rare in VA
- ✦ **B horizon:** clayey layer, colorful sticky
- ✦ **C horizon:** border layer between soil and rock, very low fertility
- ✦ **R horizon:** solid bedrock



A Healthy Soil-Plant System



- “A” horizon with lots of organic matter and granular structure
 - Lots of microbes breakdown OM and release mineral nutrients
 - Good crumb structure allows in plenty of O₂ and water
 - Water dissolves nutrients and allows for root uptake
 - Well fed plant adds OM back to soil and cycle continues



A Healthy Soil-Plant System



- **“B” horizon with lots of clay**
 - Clay retains significant water for uptake by deeper roots
 - Some microbial breakdown of OM and nutrient release
 - Soluble materials leached from top soil filter out
- **“C” horizon: sandy, gritty**
 - Water retention – accessible by deepest roots
 - Filters out soluble materials
 - Groundwater recharge



Urban Effects



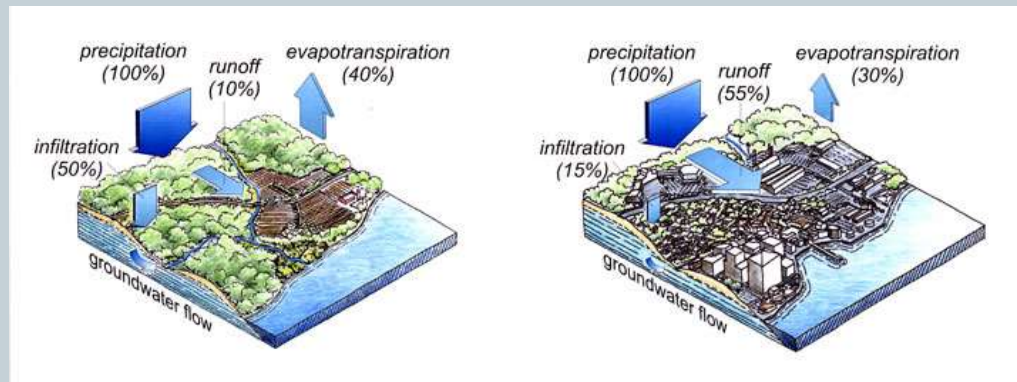
- Development causes many changes in soils, almost all of them bad.

- Compaction

- Causes significant loss in pore space

- Reduces the ability of air and water to infiltrate into the soil

- ✦ Impervious “light”



Urban Effects

○ Compaction

- Creates a much denser/stronger soil
 - ✦ Difficult for roots to penetrate
 - ✦ Trees may remain stunted



Urban Effects



○ Soil Mixing

- Soil layers are mixed together
- Causes fertile topsoil to be dispersed/spread throughout depth of soil profile
- Loss of productive topsoil=loss of microbes
- Topsoil is stockpiled in many construction sites
 - ✦ Some is still lost to mixing
 - ✦ Some of the rest is oxidized
 - ✦ Structure is damaged or lost



Urban Effects

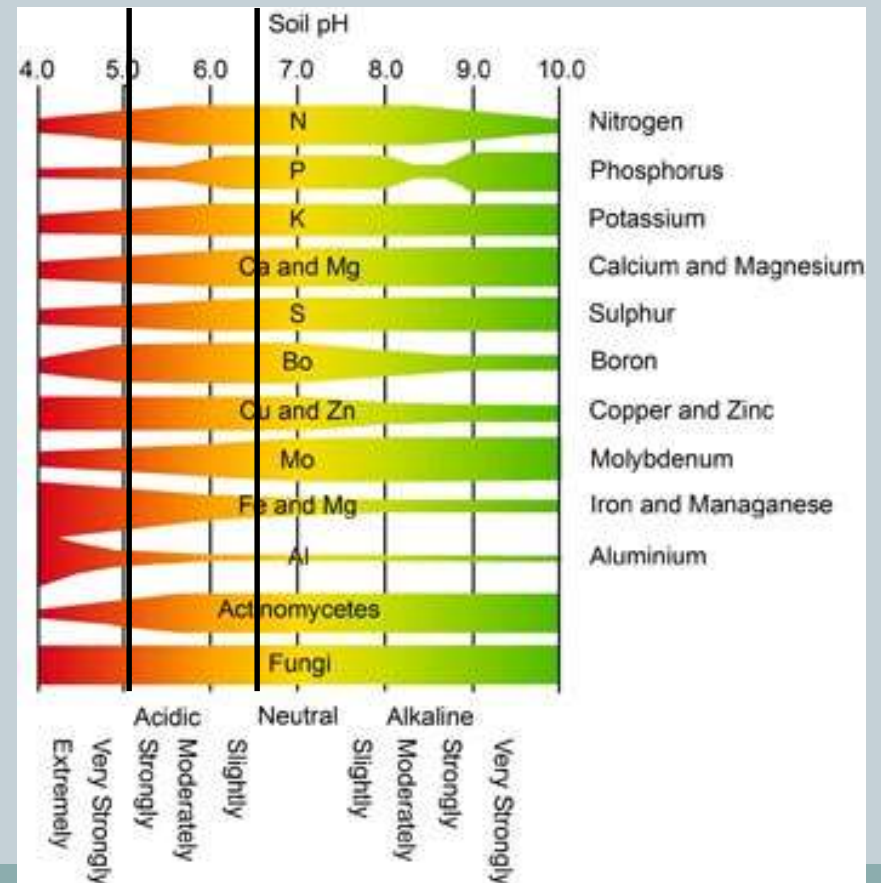
○ pH Changes

- Sometimes due to local land use: concrete walkways, roadways can raise pH
- Many fertilizers can lower pH, especially those with ammonium or sulfur
- pH is important because it affects the availability of nutrients

○ Salt

- Salt can wilt plants and destroy soil structure

Typical pH range of NOVA soils



Urban Soil and Water Quality



- Poor soil leads to poor water quality
 - Natural soil acts as a filter and sponge
 - ✦ OM and Clay have small electric charges that attract dissolved ions and bind them in the soil
 - ✦ Water itself is attracted to clay and OM and much is retained in the soil
 - ✦ Soil filters water and retains a good portion of its volume
 - Urban soil is too dense
 - ✦ Less water enters the soil and more becomes runoff



Urban Effects Recap



- Urban development tends to
 - Create a dense soil
 - Reduce the amount of pore space in soil
 - ✦ Reduction in O₂ and water available to roots/microbes
 - ✦ Increase in surface runoff and erosion
 - Create a strong soil
 - ✦ May restrict root growth
 - Disperse and degrade topsoil/humus content
 - Change the soil pH
 - Add salt to the soil

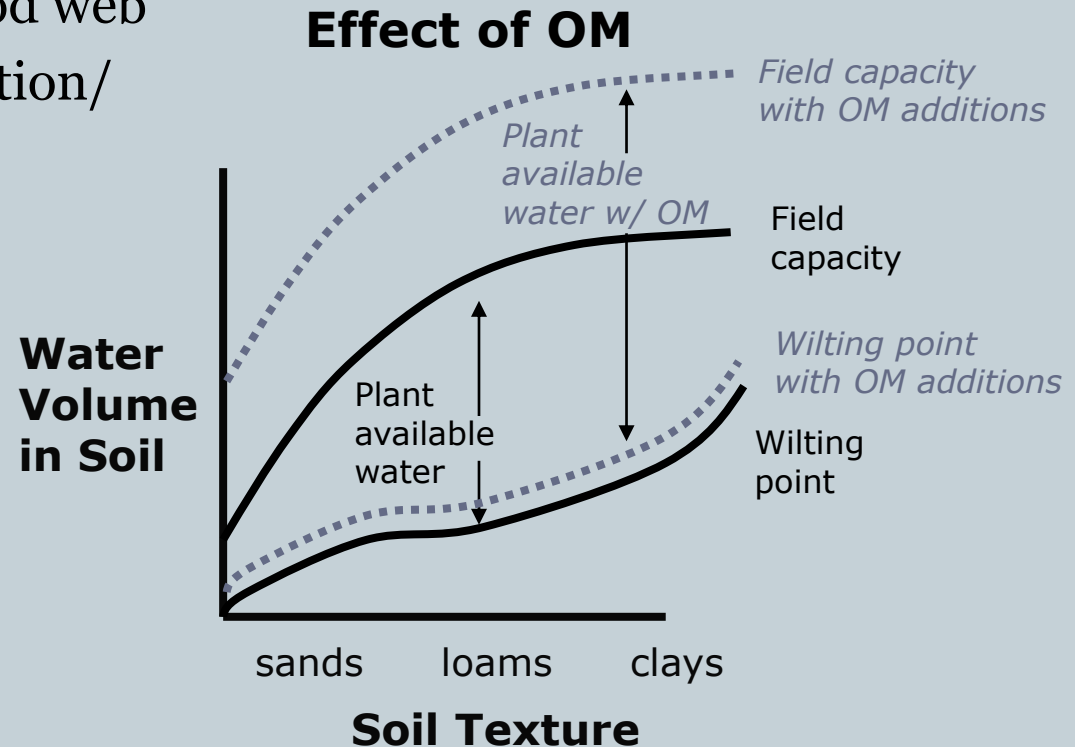


All in all, urbanization typically degrades the fertility and ecological functioning of soil.....

.....if we do nothing to correct the damage

Restoring Urban Soil

- Kick start the soil biology/food web
 - How? Add organic matter!
 - ✦ OM is the base of the food web
 - ✦ It promotes soil aggregation/structural development
 - ✦ It increases water and nutrient holding capacity



Restoring Urban Soil



- Kick start the soil biology/food web
 - How? Add organic matter!
 - How to do it?
 - ✦ Leafcycle
 - ✦ Compost Topdressing
 - ✦ Tillage



What Soil Do You Have?

- Check the soil survey!

- Web soil survey:

<http://websoilsurvey.nrcs.usda.gov/app/>

- Arlington County GIS:

<http://maps.arlingtonva.us/>



Questions/Comments?



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