Dealing With Urban Soils in Turf and Landscaping

See: http://pubs.ext.vt.edu/430/430-350/430-350_pdf.pdf
for more details on this topic!

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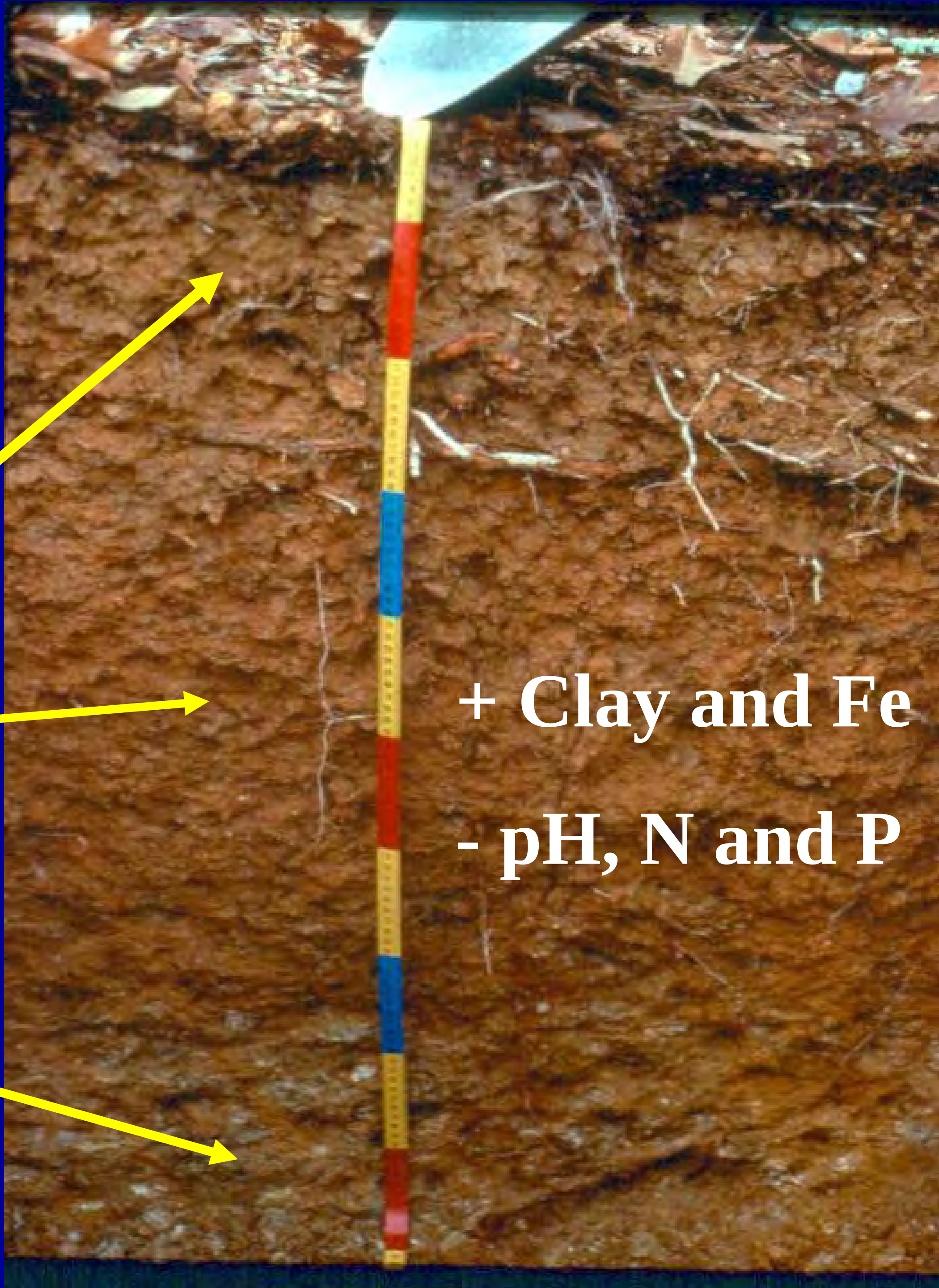
Natural undisturbed forest soil with loamy topsoil A horizon over clayey B horizon over loamy C horizon.



What's an Urban Soil?

- Soil and/or geologic materials that have been disturbed by earth-moving activities
- May occur in urban, suburban, or highway corridor environments
- Man influenced to a point that basic physical and chemical properties differ significantly from “natural soils”

Several general characteristics of the urban soil emerge, as contrasted to their natural counterparts (Craul, 1985). These include

1. Great vertical and spatial variability;
2. Modified soil structure leading to compaction;
3. Presence of a surface crust on bare soil that is usually hydrophobic;
4. Modified soil reaction, usually elevated;
5. Restricted aeration and water drainage;
6. Interrupted nutrient cycling and a modified soil organism population and activity;
7. Presence of anthropeic materials and other contaminants;
8. Highly modified soil temperature regimes.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Major Problems

- Compaction, Compaction, Compaction!
- Little or no topsoil layer
- Mixed horizons or layered zones (topsoil / subsoil / geologic materials)
- Altered or degraded structure
- Inclusions of debris & foreign material

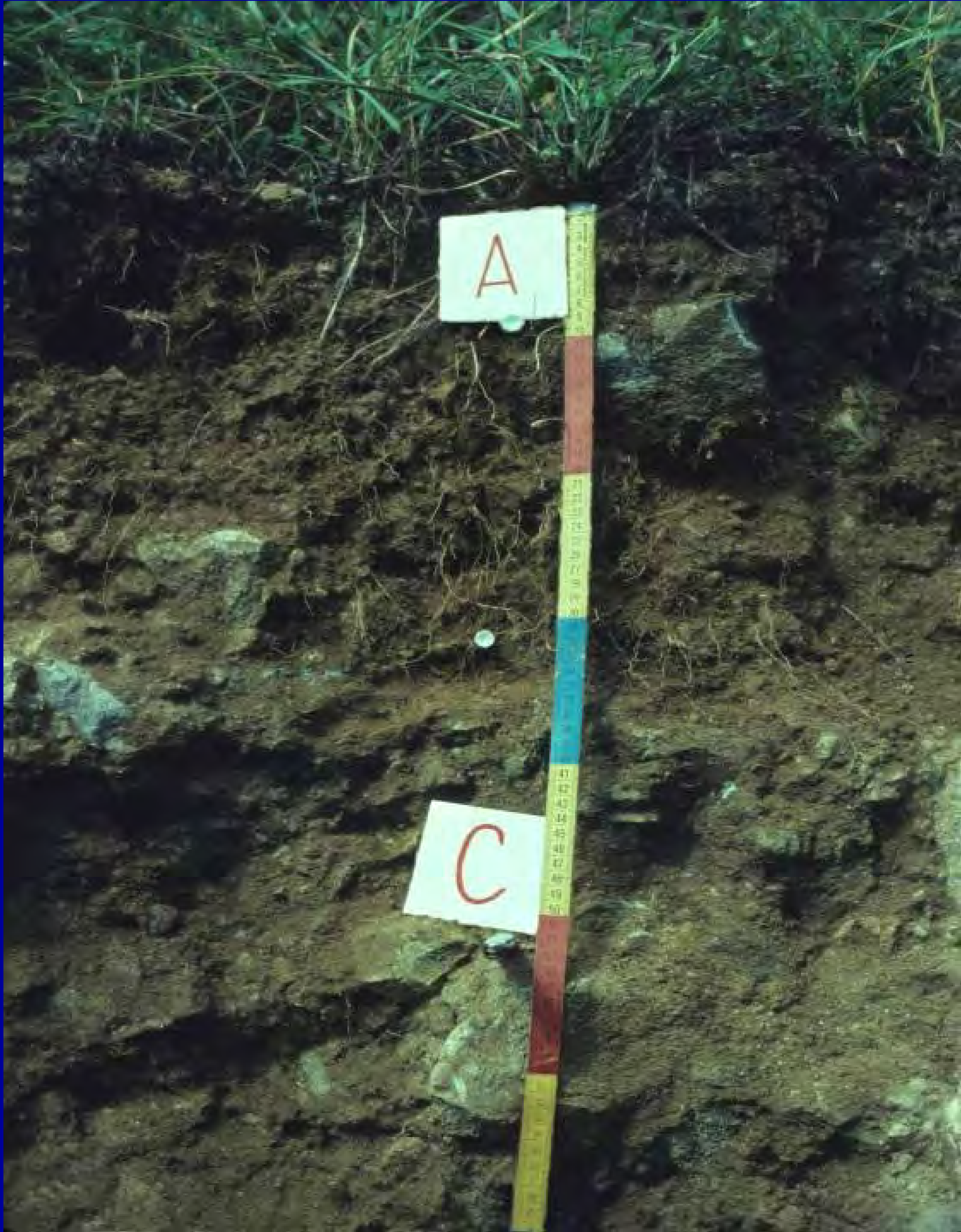
Compaction Problems

- Direct impedance of rooting
- Reduced aeration and gas exchange leading to low O_2 and elevated CO_2 or CH_4
- Poor infiltration & water holding

Surface Expression of Compaction; pH and other chemical properties here are just fine!

To an engineer, maximizing compaction is highly desirable for soil strength/bearing capacity and fill volume minimization.

High bulk density ($2.0\ g/cm^3$) traffic pan on a mining site under loose spoil materials. Roots cannot penetrate or loosen zones that are packed to B.D. > ~ 1.5 for a clay or 1.9 for a sandy textured soil.



This is the "appropriate ripper" for these kinds of soil problems! This company estimates that they can rip these soils for < $200 per acre, a very reasonable cost; less than seed plus fertilizer! At a smaller scale, use of roto-tiller and/or chisel plow is the only way to loosen compacted soils in the short term (years).

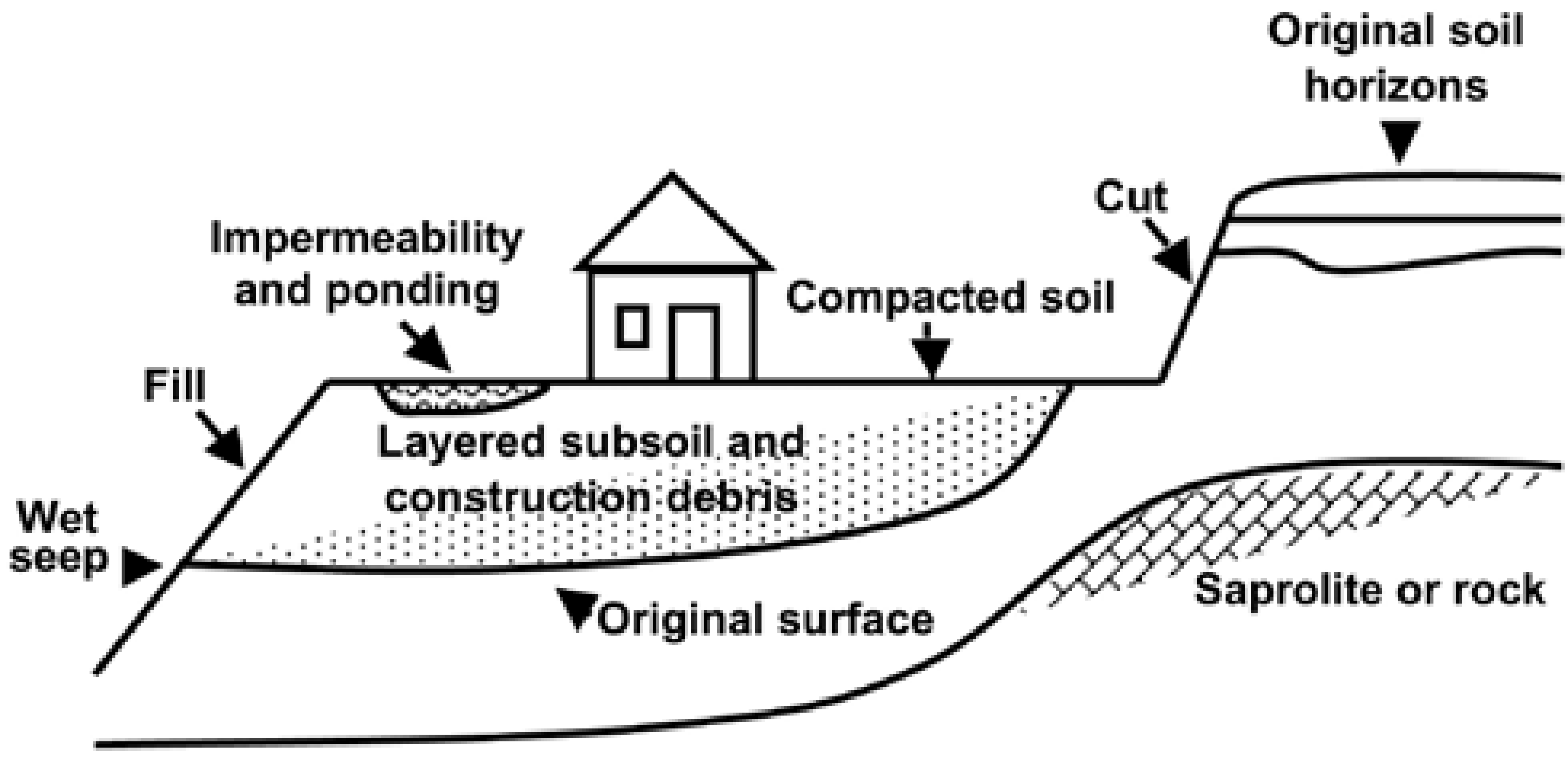


Figure 3.1. Diagram of urban soils and important plant growth limiting features. Note that the soil limitations in one portion of a home lot may be quite different from those encountered in another location of the same lot. *Diagram by Kathryn Haering*

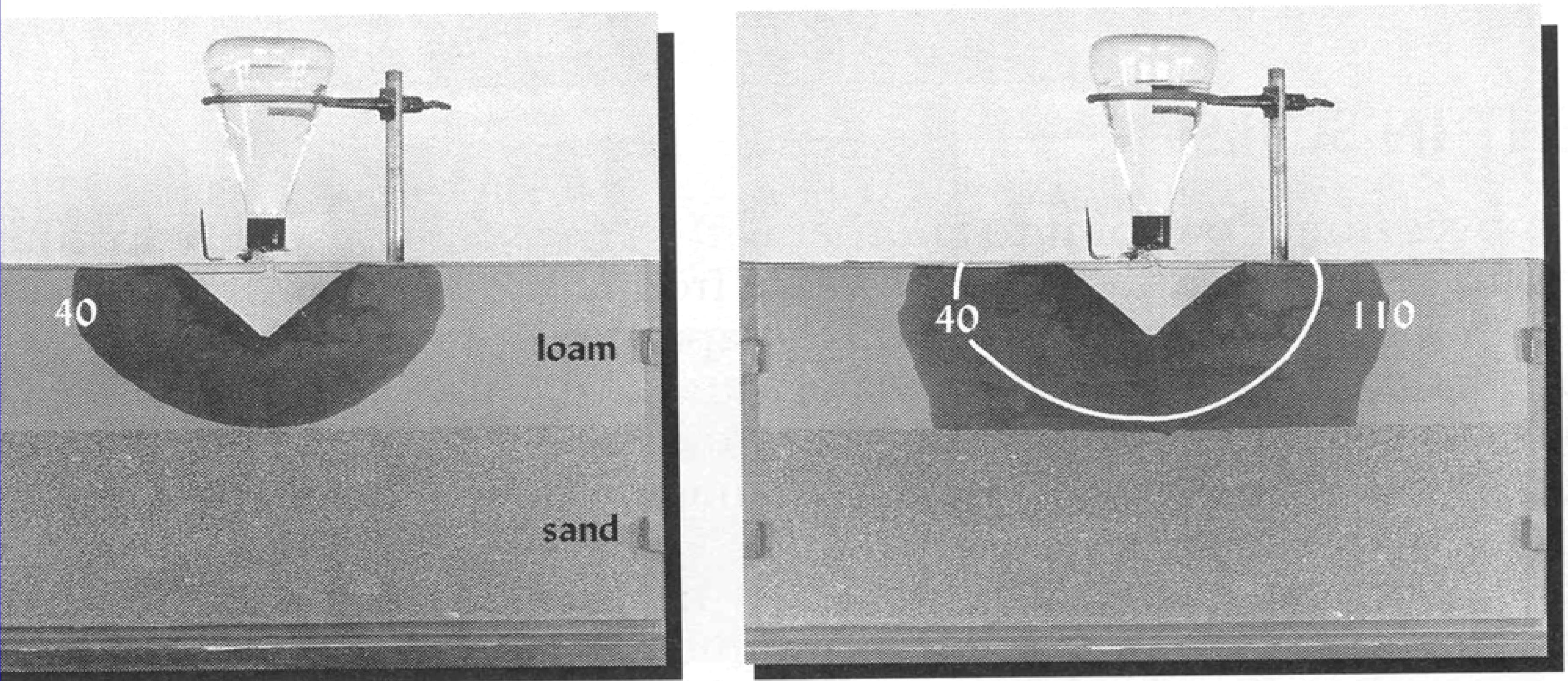
Layered Urban Soil Materials

- Water, roots, and air will not penetrate strongly contrasting zones of texture and density.

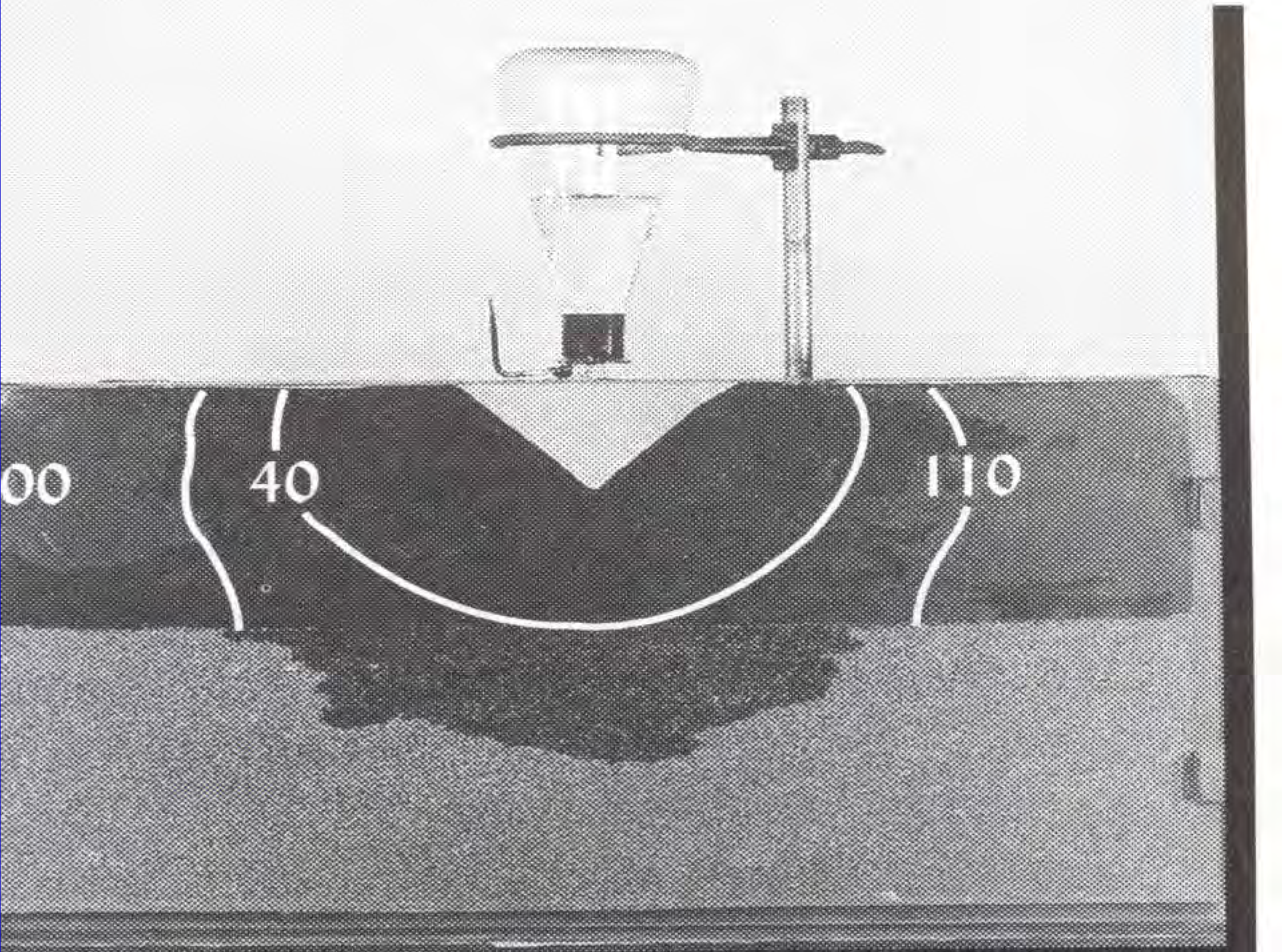
- Any linear boundary with a texture difference of > 2 texture classes (e.g. loam over clay) or B.D. difference > 0.33 g/cm^3 is subject to this problem

- This interface or “perching” effect is <u>invisible</u> to soil tests!

Figure 5.28: Effects of contrasting textural layers on water movement. Rule of thumb: anytime the textures varies by two texture classes or more (e.g. loamy sand over a clay loam), water will "back up" and saturate at the contact for some period of time. This phenomenon is also called "***perching***".



(a) (b)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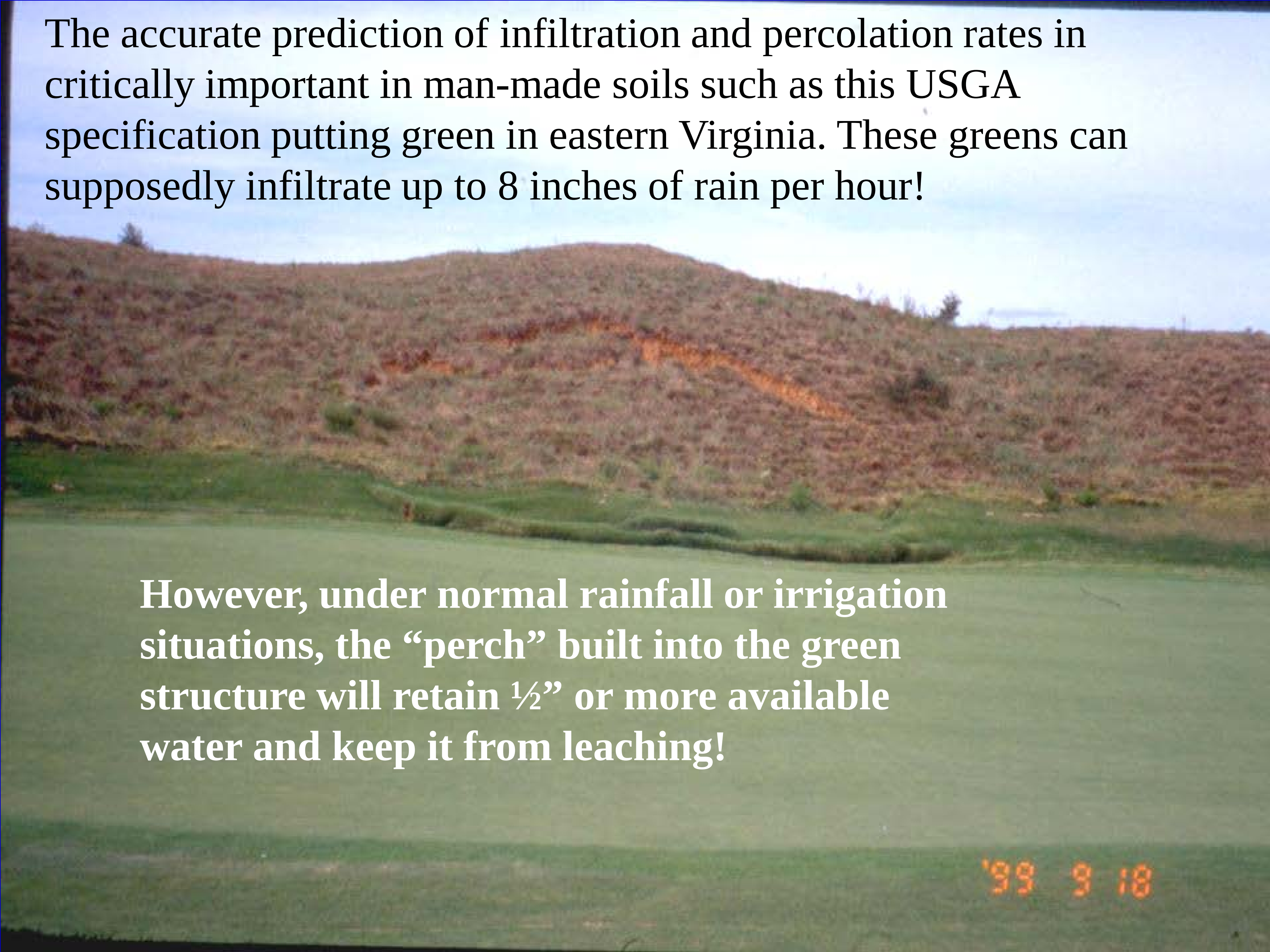
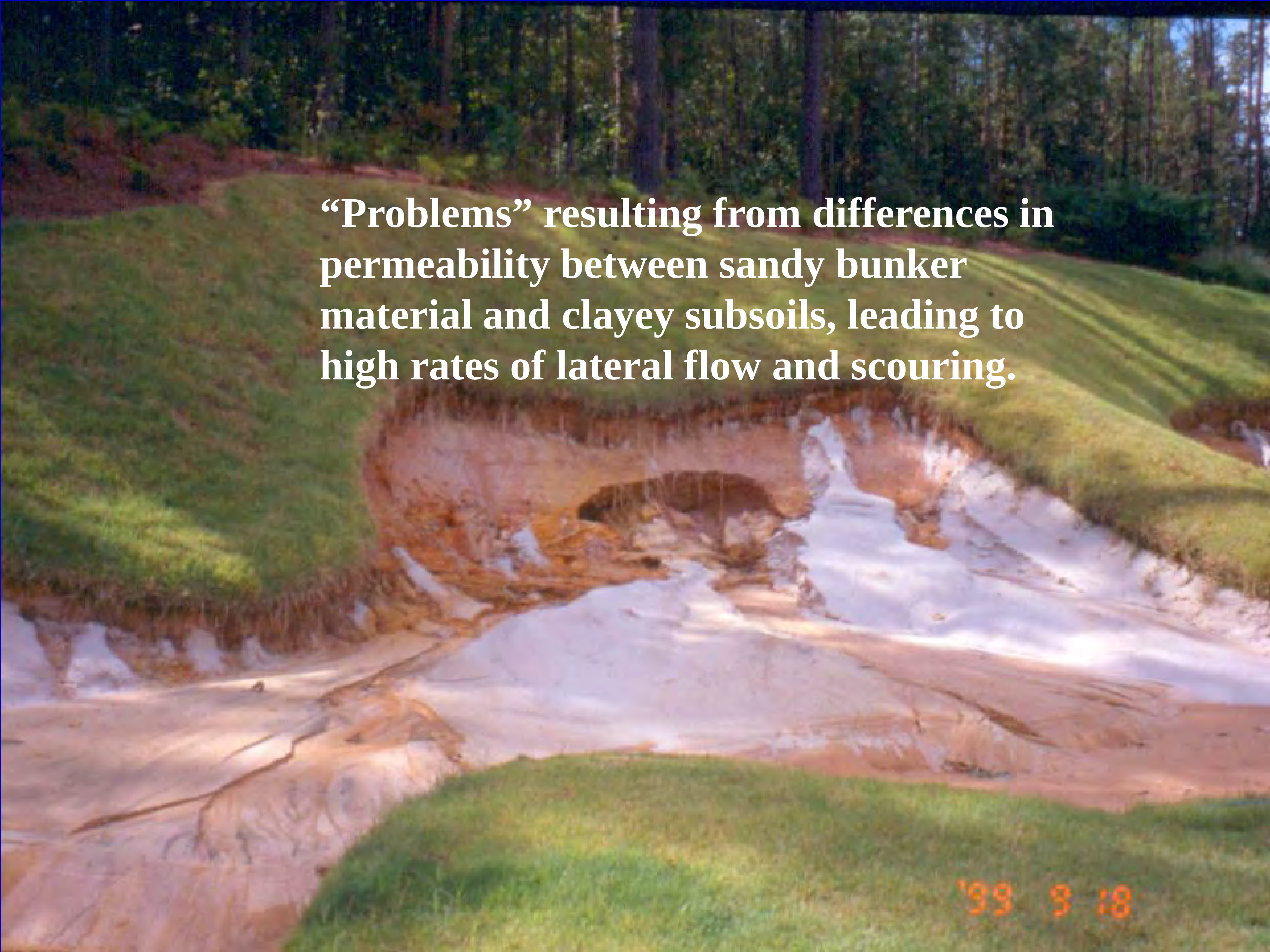
The accurate prediction of infiltration and percolation rates in critically important in man-made soils such as this USGA specification putting green in eastern Virginia. These greens can supposedly infiltrate up to 8 inches of rain per hour!



However, under normal rainfall or irrigation situations, the "perch" built into the green structure will retain ½" or more available water and keep it from leaching!


"Problems" resulting from differences in permeability between sandy bunker material and clayey subsoils, leading to high rates of lateral flow and scouring.
'99 9 18


Cut
Fill
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Problems with Cut Materials

- Typically subsoil and/or deeper geologic strata.
- May be very clayey and or quite coarse and rock-like.
- Cut clays will smear and seal
- Is the cut slope stable?
- In Virginia, typically very acid!

Problems with Fill Materials

- Usually compacted by design with attendant “problems”.
- Structure and permeability.
- Mixtures of different soil and non-soil materials.


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Why is Soil Structure Important?

- Particularly in clayey soils, the voids between the peds (clods) are the major rooting and gas exchange route.

- In sandy and loamy soils, structure enhances macro-porosity, water holding, gas exchange and rooting.

Moderate medium subangular blocky with larger prismatic macrostructure.

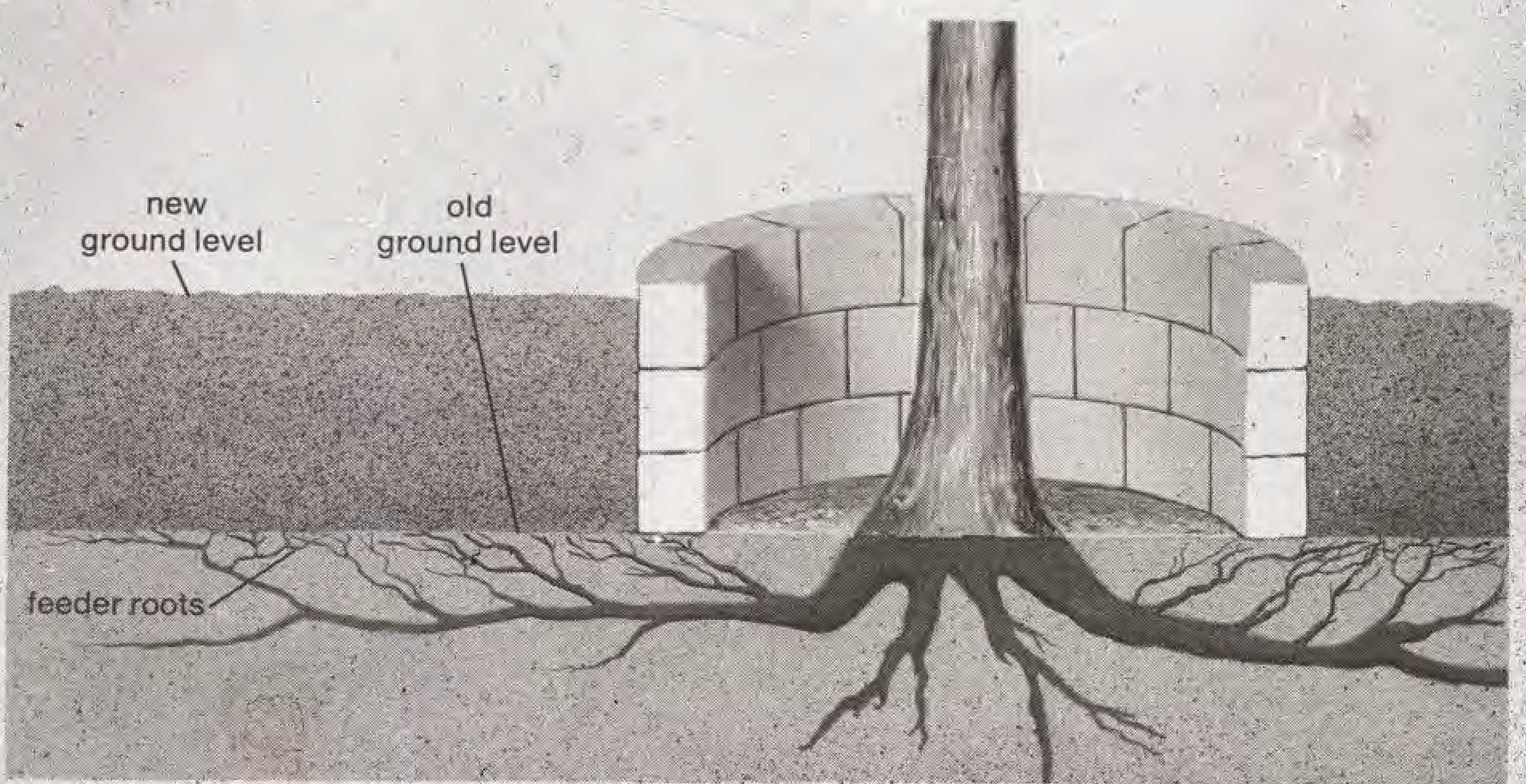
Note roots concentrated along macro-pores on ped faces.

Mixed Materials in Soils

- Foreign soils and geologic materials
- Gravel, sand and other aggregates
- Waste wood and mucky materials
- Concrete, mortar and gypsum
- Basically, anything the contractor doesn’t want to haul away!

Do not do this to established upland trees!

Figure 3.2 By constructing a dry well around the base of a tree sufficient feeder roots survive to keep the tree alive until it can develop new roots in the new soil back-filled against the wall.



Soil Chemical Problems

- Acidity from subsoil clays or weathered geologic strata. pH < 5.5 is typical of most Virginia subsoils due to Al^{+3}.
- Low N and P
- Low nutrient cations (Ca/Mg/K) unless deep weathered rocks are exposed
- High pH from concrete and cement

Organics being applied (Huck-Hen and Harrisonburg biosolids compost) at Staunton.

Dealing With Urban Soils

- **<u>Never</u> assume that the soil is intact and similar to surrounding natural soils.**

- **Check the soil with a spade, probe, or auger to determine overall depth and layering.**

- **Sample various locations and test each!**

The "odd balls" - lime stabilized and acid-sulfate soils!

We usually see soil pH between 4.0 and 8.2 in extremes under "normal soil conditions in Virginia. Anything higher or lower than this is due to something strange going on!

Just when you think you've seen it all, you end up at a site like this one, Tavistock Farms in Leesburg. Fill area comprised of Triassic shrink-swell clay materials (*fat clays* to the geotechs) treated with CaO for "stability".

At this site, the developer’s plan calls for the upper 0.5 m plus the soil excavated from footer excavations to be used on site for turf and some very high value landscape woody material plantings (e.g. large hardwood trees and tranplanted shrubs.


2. 9. 2004


2. 9. 2004

Here, the soil pH varies from 6.9 to > 9.5 in areas where the free CaO is unreacted or only partially carbonated. The challenge here will be to figure out how much S needs to be added and what physical processing will be necessary to get the cemented soil broken down to a fine enough size to hold water and support plant growth.

What are acid sulfate soils?

Soils formed from the weathering of sulfide-bearing parent materials, which results in extremely low pH (commonly < 3.0) and precipitation of sulfate salts.

$FeS_2 + 7/2O_2 + H_2O \rightarrow FeSO_4 + H_2SO_4$

$2FeSO_4 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2O$

$1/2Fe_2(SO_4)_3 + 2H_2O \rightarrow 1/3HFe_3(SO_4)_2(OH)_6 + 5/6H_2SO_4$

OR $\rightarrow KFe_3(SO_4)_2(OH)_6$ (jarosite)

$\rightarrow NaFe_3(SO_4)_2(OH)_6$ (natrojarosite)

Summing it up all up:

$FeS_2 + 15/4O_2 + 7/2H_2O \rightarrow 2H_2SO_4 + Fe(OH)_3$

1 mole of pyrite produces 2 moles of sulfuric acid

Or 1% pyritic S in a soil or sediment will generate acidity to require addition of 32 tons of lime per acre 6 inches deep (tons of lime per thousand tons soil).

Typical young acid-sulfate soil profile

Overlying oxidized material is typically a light yellowish brown with pH ~ 3.

Underlying reduced material is typically drab blue or gray, with pH > 5.5.

In the late summer of 2005 a homeowner in Fredericksburg contacted us…

… to find out how he could make his yard grow.

We tested the soil here and it yielded values for lime demand as high as 38 ton $CaCO_3$/ac. This was due to about 1.2% pyritic S content with no native lime in soil.

We recommended:

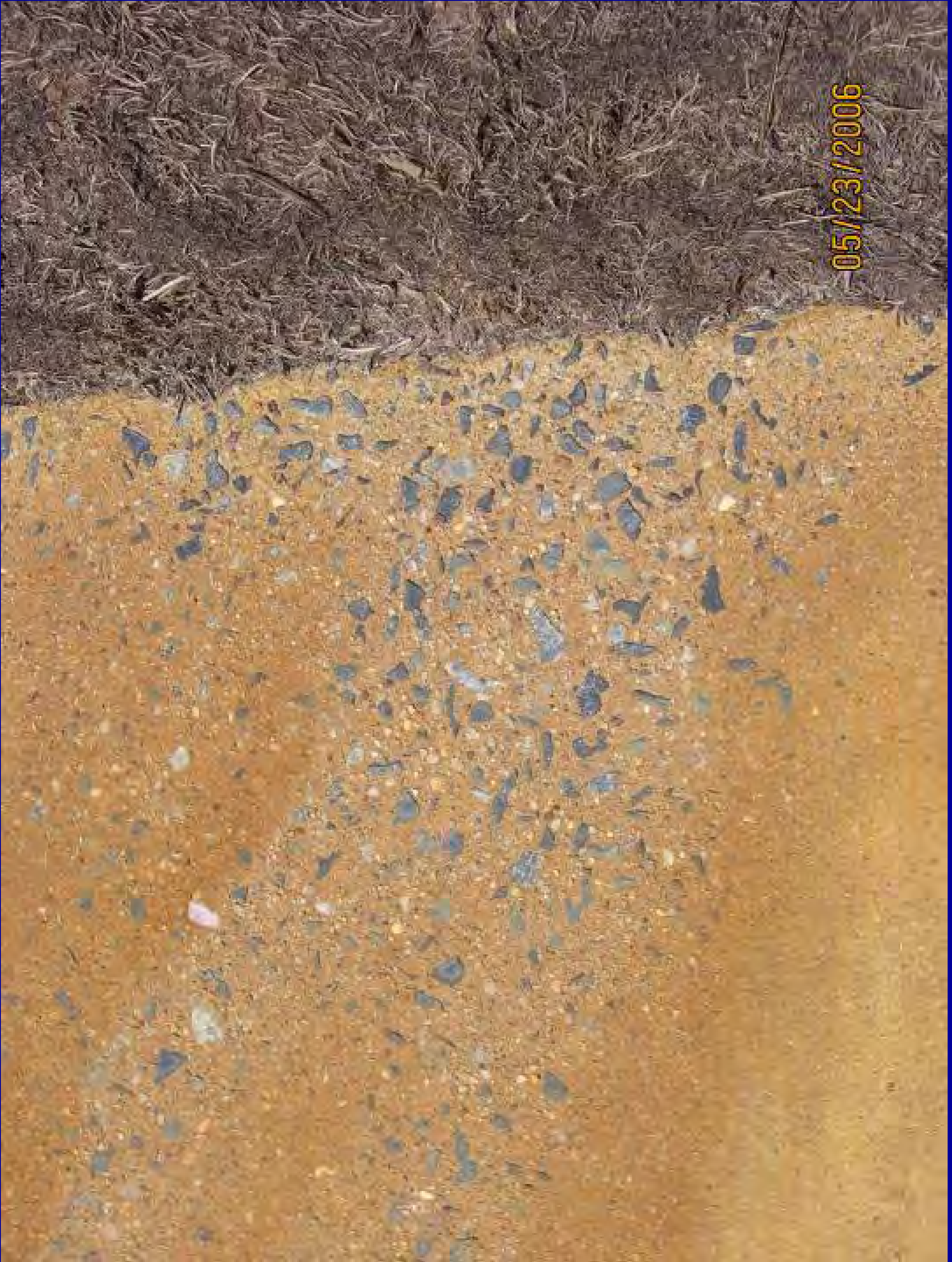
- 25 – 30 ton/ac lime
- 300 lbs/ac P
- compost if possible

Cost ~ $7000


Remediated yard, summer 2006

Neighbor's yard, Summer 2006


Second round of sod placed over pH 2.5 soils at Great Oaks.



Cement being stripped out of concrete; leaving aggregate exposed.


Stream draining
Great Oaks.

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