Overburden, Topsoil Substitutes, Topsoil Handling: Influence on Tree Growth

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Office of Surface Mining

Virginia Tech Forestry

University of Kentucky Forestry

Forestry Reclamation Approach Step 1

Create a suitable rooting medium for good tree growth that is no less than 4 feet deep,comprised of topsoil, weathered sandstone, and/or the best available material

Ohio

Kentucky
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West Virginia

Tennessee

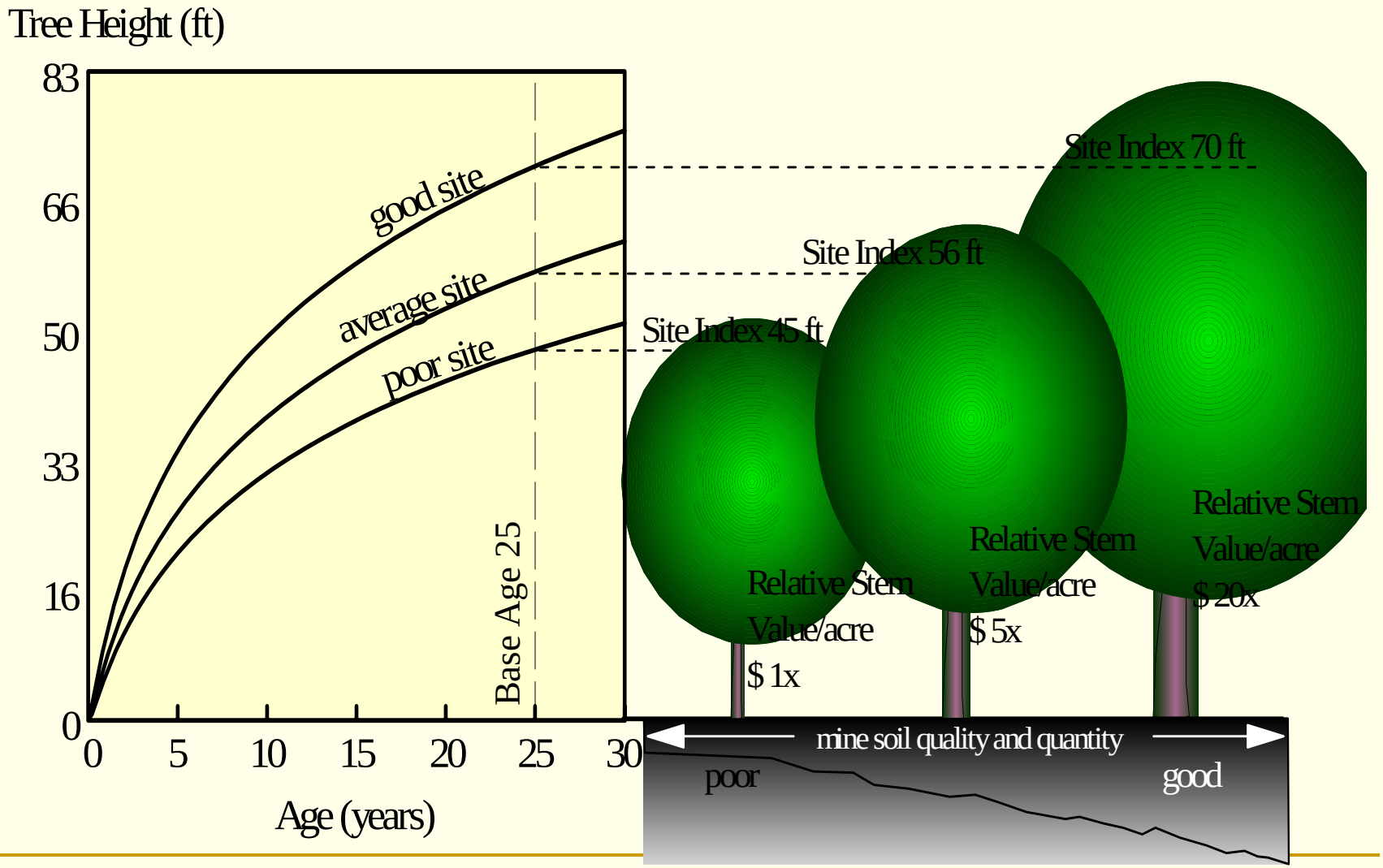
Virginia Tech Mine Soil / Tree Growth Correlation Studies

- Torbert et al. 1988. *Journal Environmental Quality*
  White pine, 36 mined sites, VA
  - Rooting volume (+)
  - Soluble salts (-)
  - Phosphorus (+)
- Andrews et al. 1998. *Journal Environmental Quality*
  White pine, 78 mined sites, KY, WV, VA
  - Depth to restrictive layer (+)
  - Phosphorus (+)
  - Soluble salts (-)
  - Manganese (-)
  - Slope steepness (+)
- Rodrigue and Burger. *Soil Science Society America J. (2004)*
  Hardwoods and Pines, 56 mined sites, IL, IN, KY, OH, WV, VA , PA
  - Base saturation (+)
  - Coarse fragment content (-)
  - Total available water (+)
  - Soluble salts (-)

What do trees want?

- Physical properties
  - At least 4 feet deep
  - Non-compacted
  - Rock easily weatherable
  - A sandy loam texture
- Chemical properties
  - Low to moderate levels of soluble salts
  - An equilibrium pH of 5.5 to 6.5
  - Low pyritic sulfur
- Fertility
  - Adequate levels of N, P, K and other essential nutrients

How do mine soils affect tree growth? (Burger, 2000)



Building the Mine soil Composition Study,1982

Joint project of Virginia Tech
Crop and Soil Environmental Sciences
and Forestry Departments

Funded by
Office of Surface Mining
& Powell River Project

15-year response of trees and forages

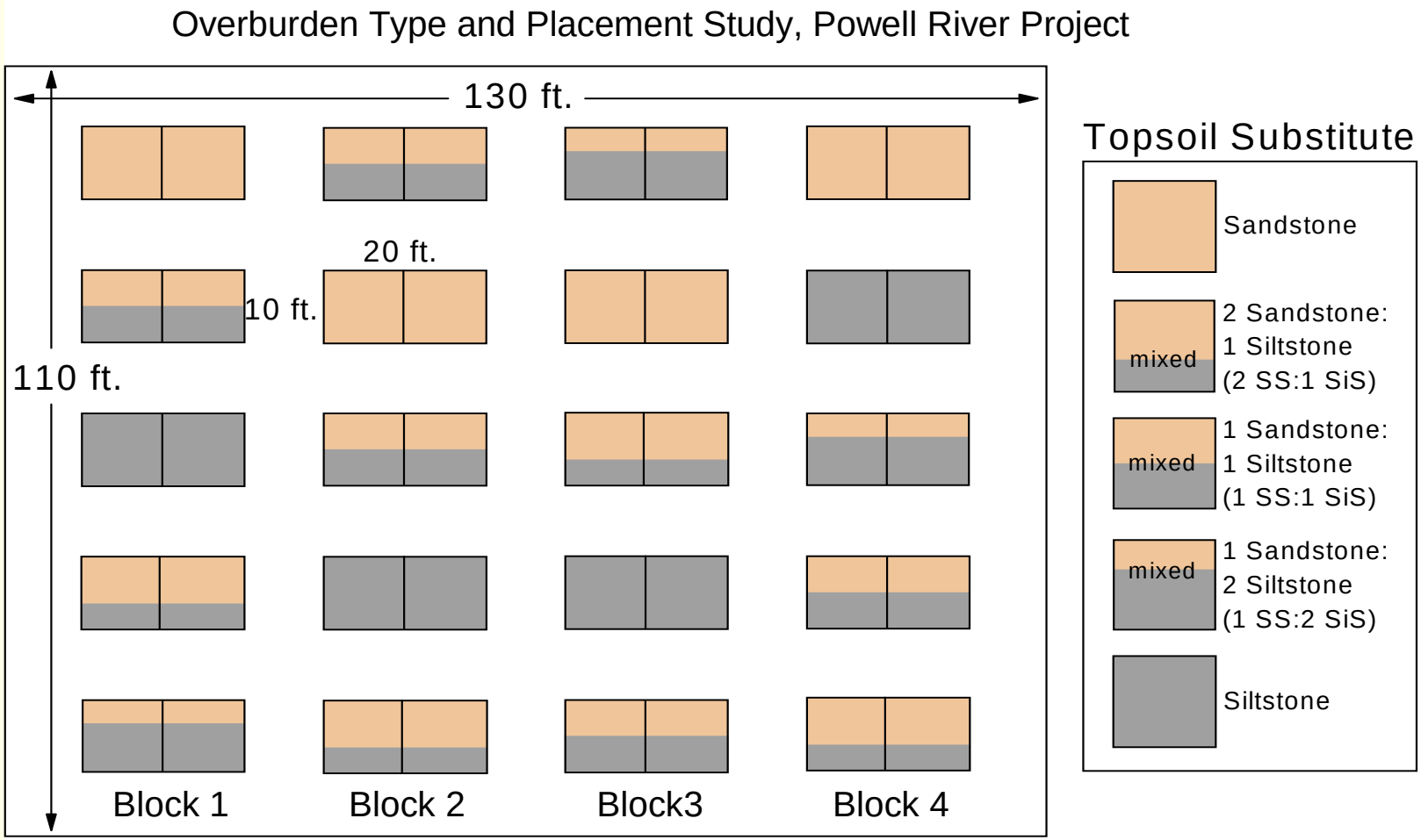


Figure 1. Map of Topsoil Substitute Study

Plot layout for the overburden type and placement study showing the different amounts of sandstone and siltstone that made up the topsoil substitutes.

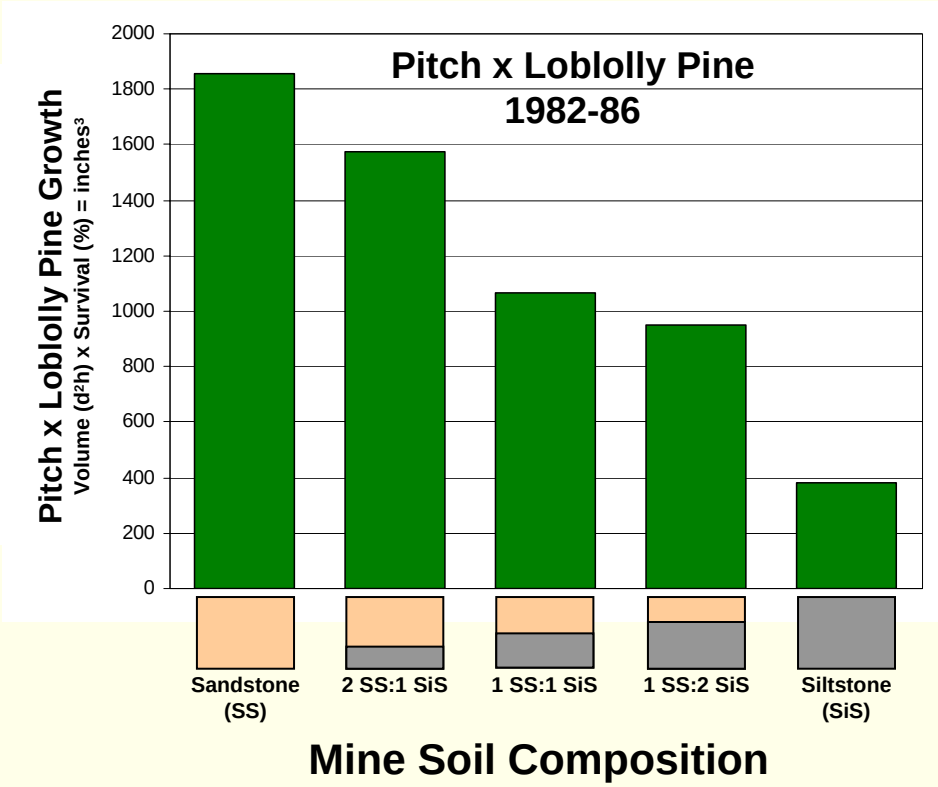
Sandstone Mine Soil

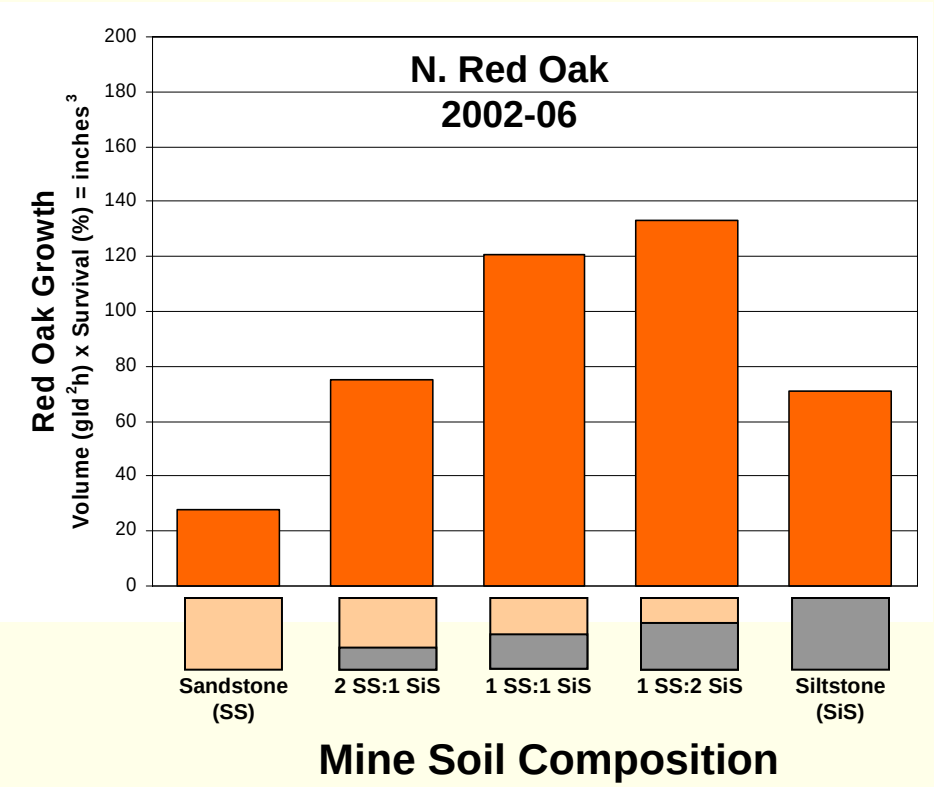
Siltstone Mine Soil

Age 15

Mine Soil Effects on Tree Growth at Age 5

Torbert et al., 1990, J. Environ. Qual.



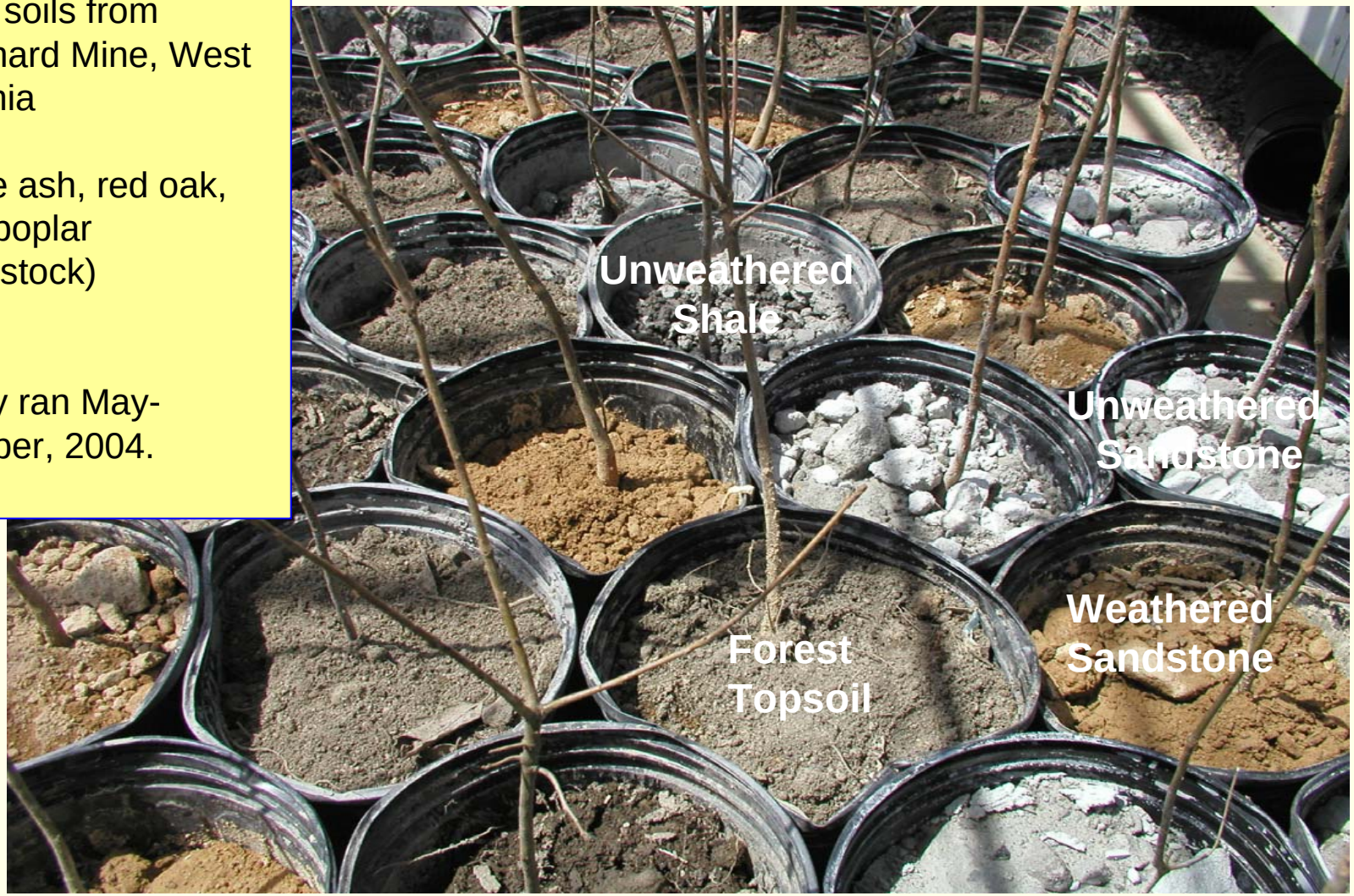


Mine soil suitability for trees and forestry

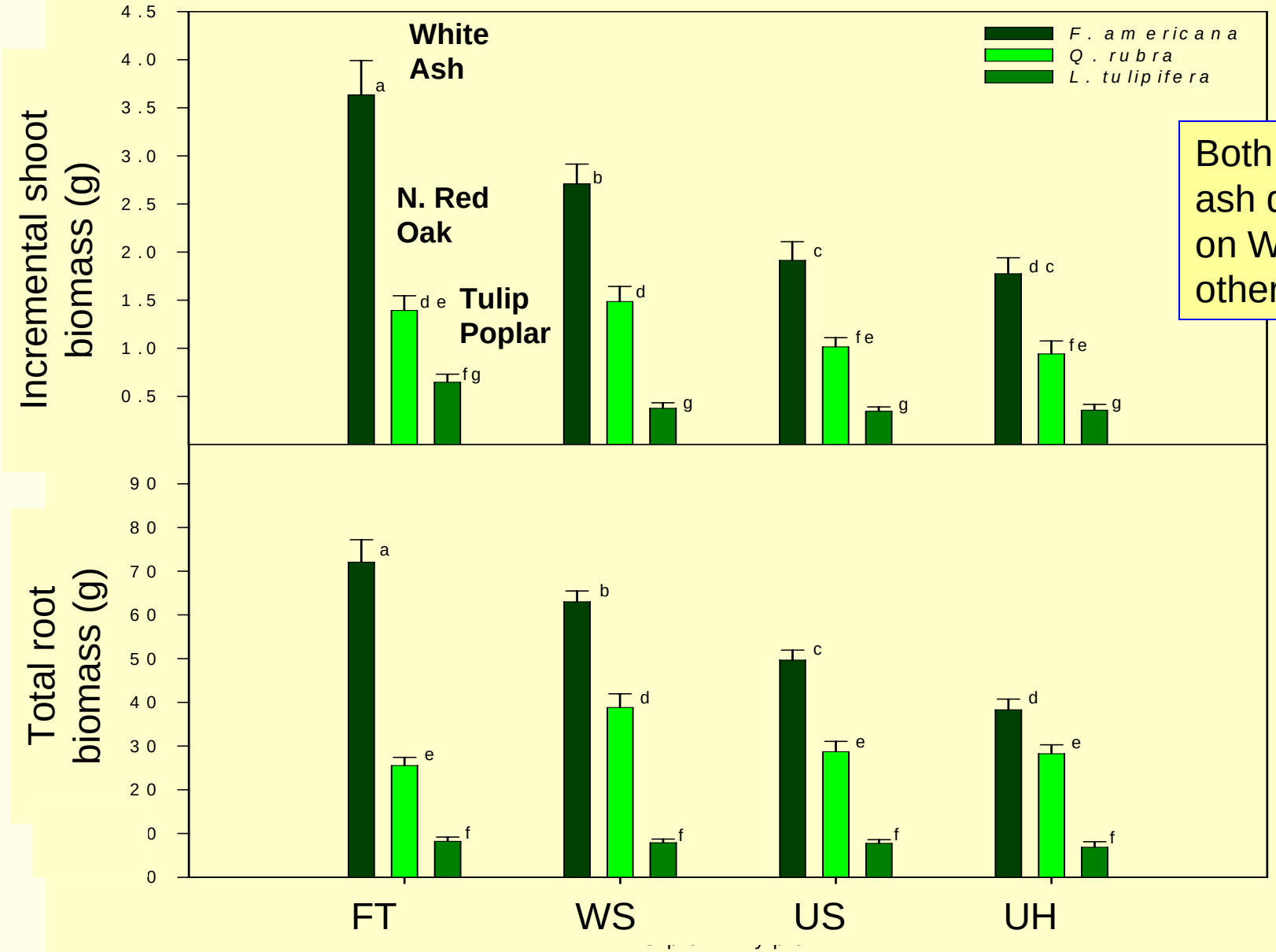
Mine soils from Pritchard Mine, West Virginia

White ash, red oak, tulip poplar
(2-yr stock)

Study ran May-October, 2004.

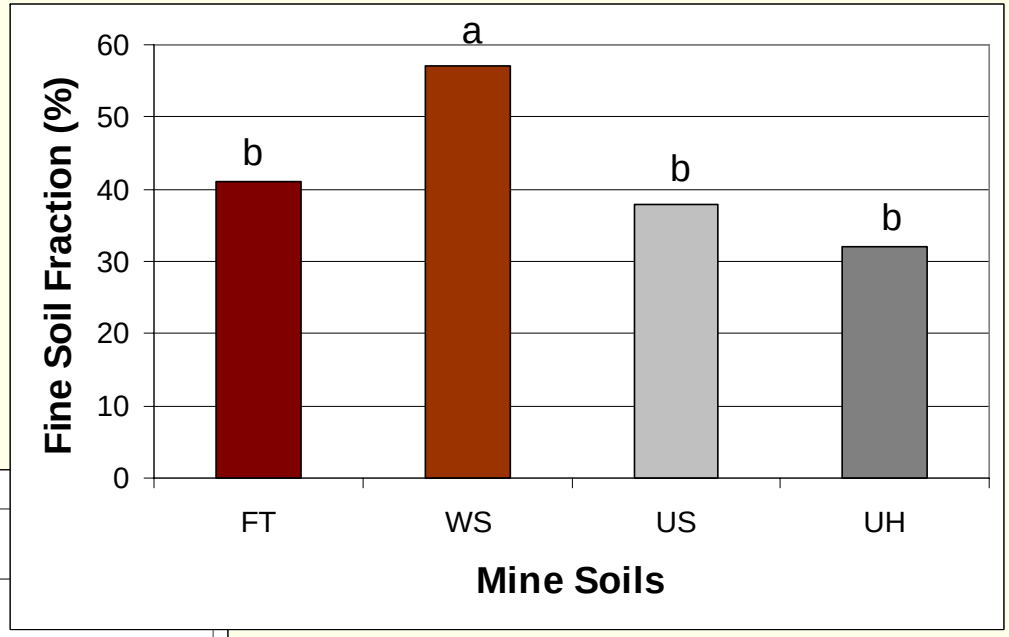


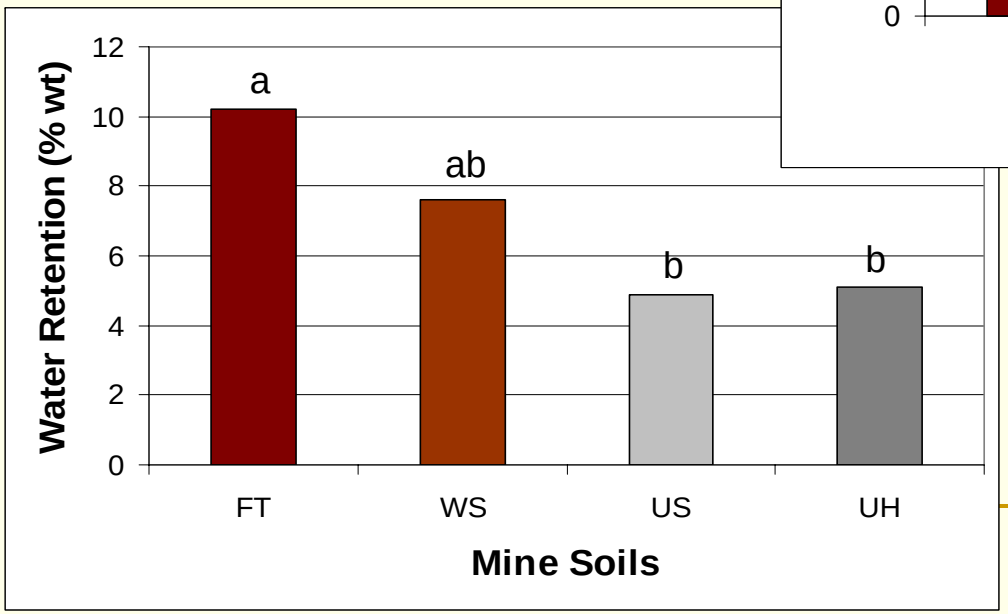
Tree growth on different spoil types



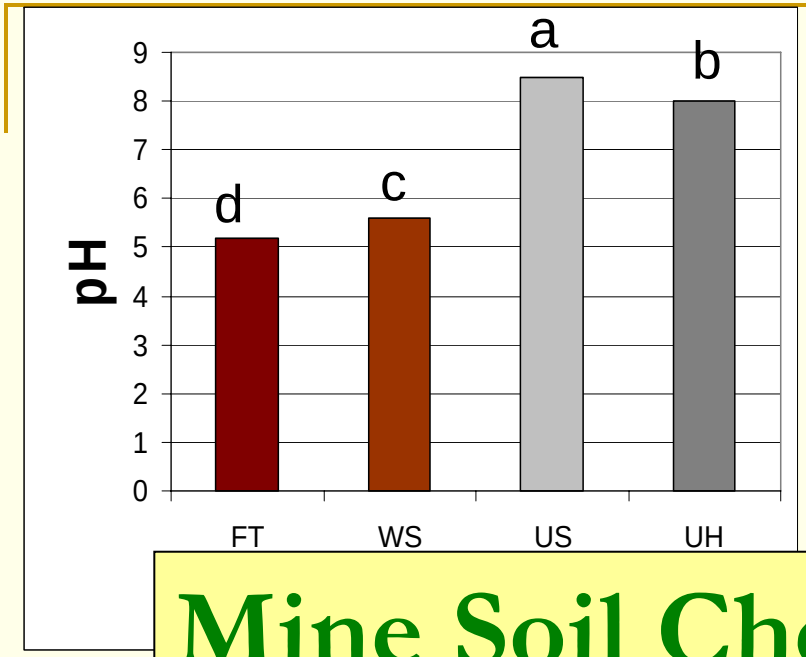
Both oak and ash did better on WS than other spoils.

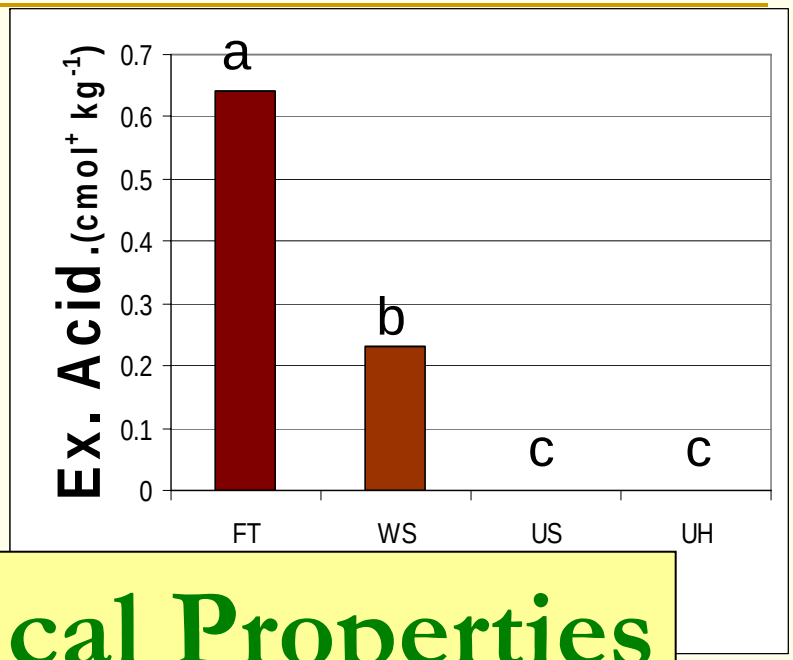
Mine Soil Physical Properties

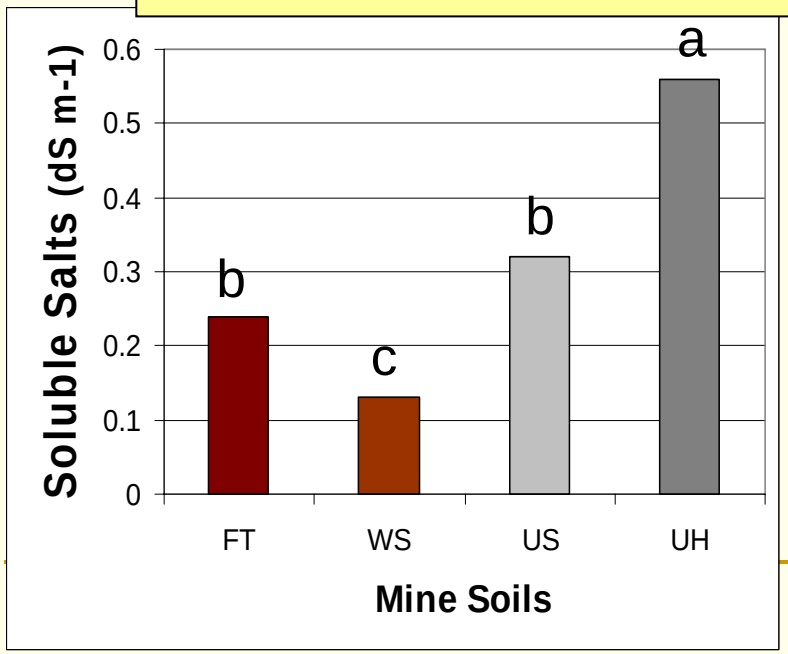


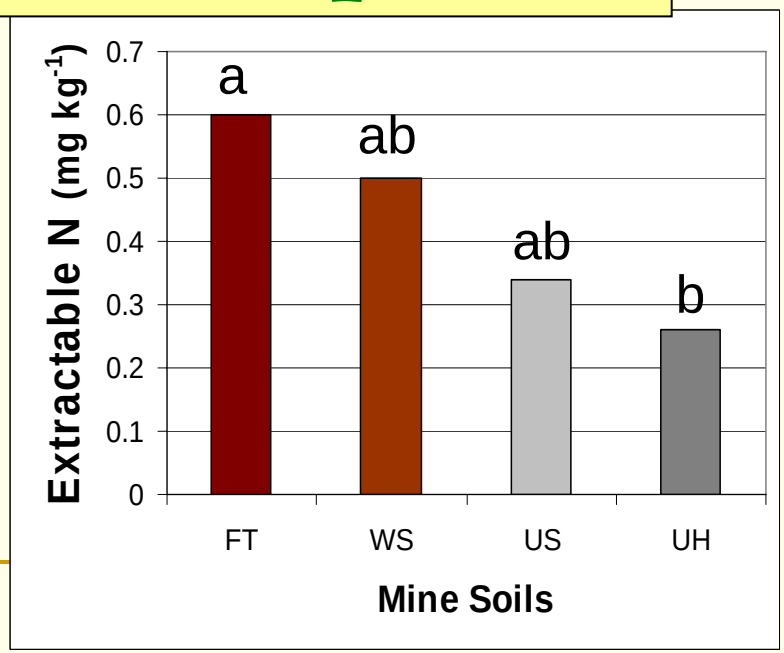


Mine Soil Chemical Properties









2006 9 15

2006 9 15

Preliminary Findings

General Spoil Characteristics

Parameter	Brown	Gray	Mixed
pH (1:1)	6.0	8.0	8.3
CEC (cmol kg^{-1})	8.2	2.5	3.3
Total Ca (mg kg^{-1})	780	3,901	2,613
Total Mg (mg kg^{-1})	2,291	2,844	2,422
Total Fe (mg kg^{-1})	20,825	16,797	17,951
Sand (%)	60.8	77.7	73.9
Clay (%)	11.9	6.5	7.7
Moisture (%)	7.1	3.6	4.2

Preliminary Findings

Natural regeneration

Brown	Mixed	Gray
42.3%	2.6%	<1%
40 species	21 species	6 species

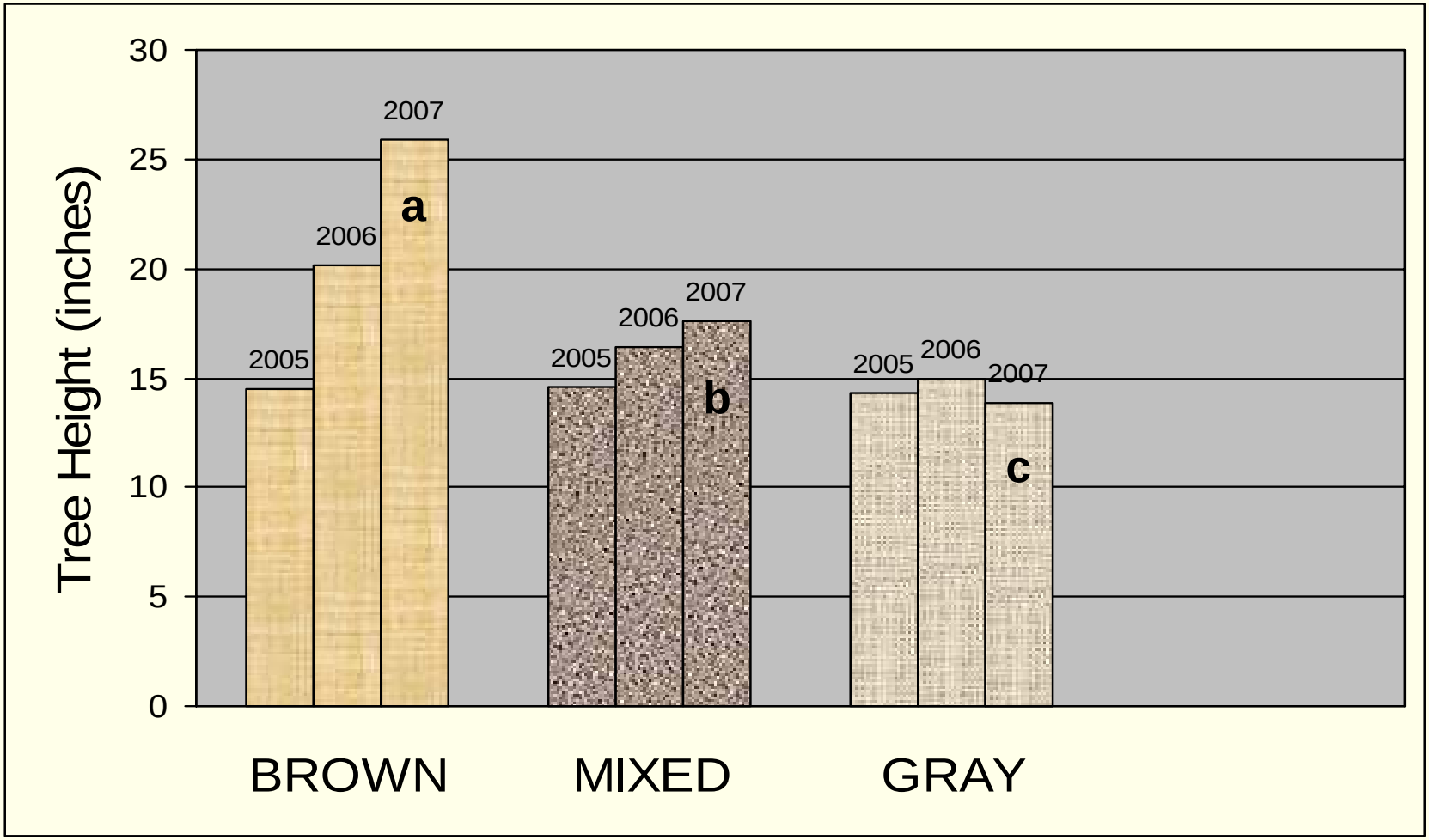
Preliminary Findings

Percent survival by spoil type from 2006 to 2007 for all species

	Percent Survival		
	Brown	**Mixed**	**Gray**
All species	100 (a)	95 (b)	91 (b)
White Oak	100	95	100
Red Oak	90	90	78
Yellow Poplar	100	95	85
Green Ash	100	100	100

Preliminary Findings

Tree performance: Height of all species combined



Summary:
What has our research taught us?

- Mine soil suitability for trees and grass is different: Trees require, deep, un-compacted sandy loam, slightly acid, low salt spoils that drain well and with adequate level of fertility.

- Based on the early data, topsoil substitutes consisting of brown weathered sandstone or gray un-weathered sandstone mixed with finer-textured siltstones or shales appears to be best for forest land.

- These materials allow rapid rainfall infiltration, reduce erosion, are easy to plant, are good for tree survival and growth, and allow native plants to emerge and grow.

- These materials are usually available on mined sites at no extra cost to the operator.

Mine soil selection
And placement
Variety of un-weathered mine spoils commonly used as topsoil substitutes.
Woody plants sprouting from Weathered sandstone.

TAKE HOME MESSAGES

- Create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered sandstone and/or the best available material
- The brown weathered sandstone or the gray un-weathered sandstone mixed with the finer-textured siltstones or shales appears to be best for forest land
- Mixed spoil may be the best available material when it is not practical or economically feasible to recover topsoil

Questions