Native Soil Field Improvement

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The Ohio State University

THE OHIO STATE UNIVERSITY

SportsTurf MANAGERS ASSOCIATION

Experts on the Field, Partners in the Game.

SOIL VOLUMETRIC PROPORTIONS

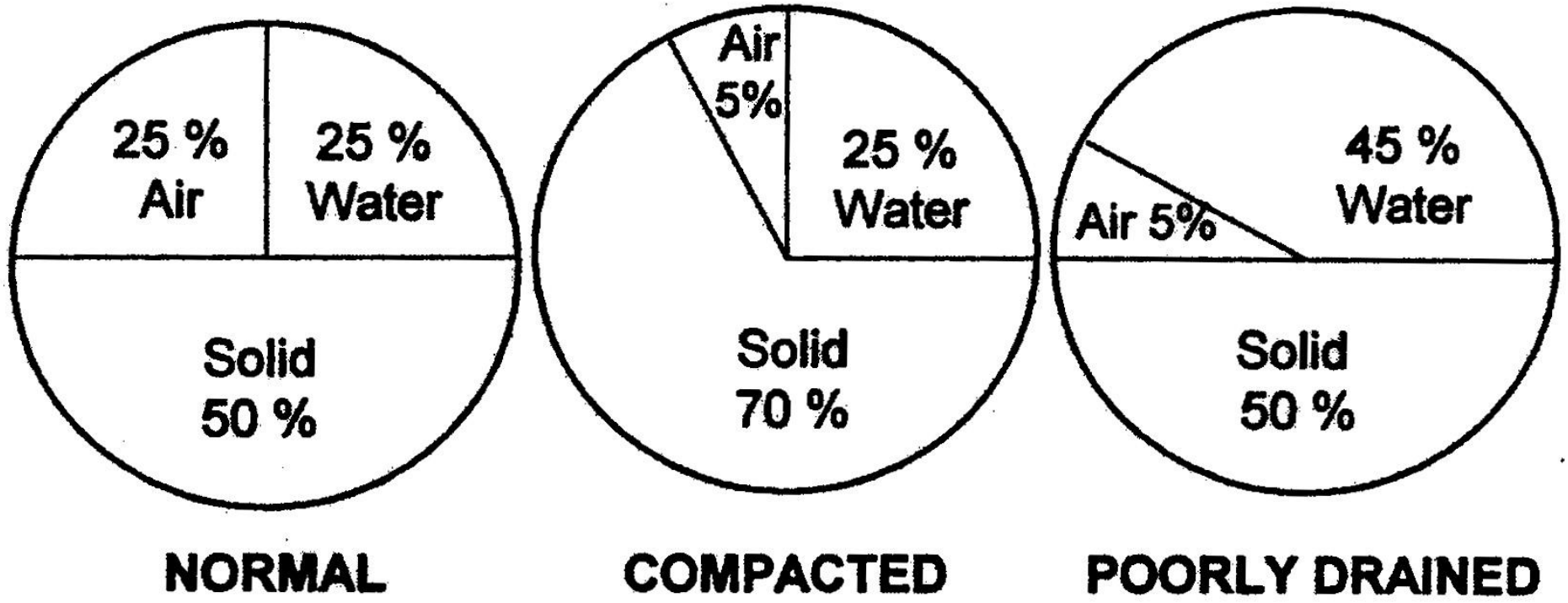
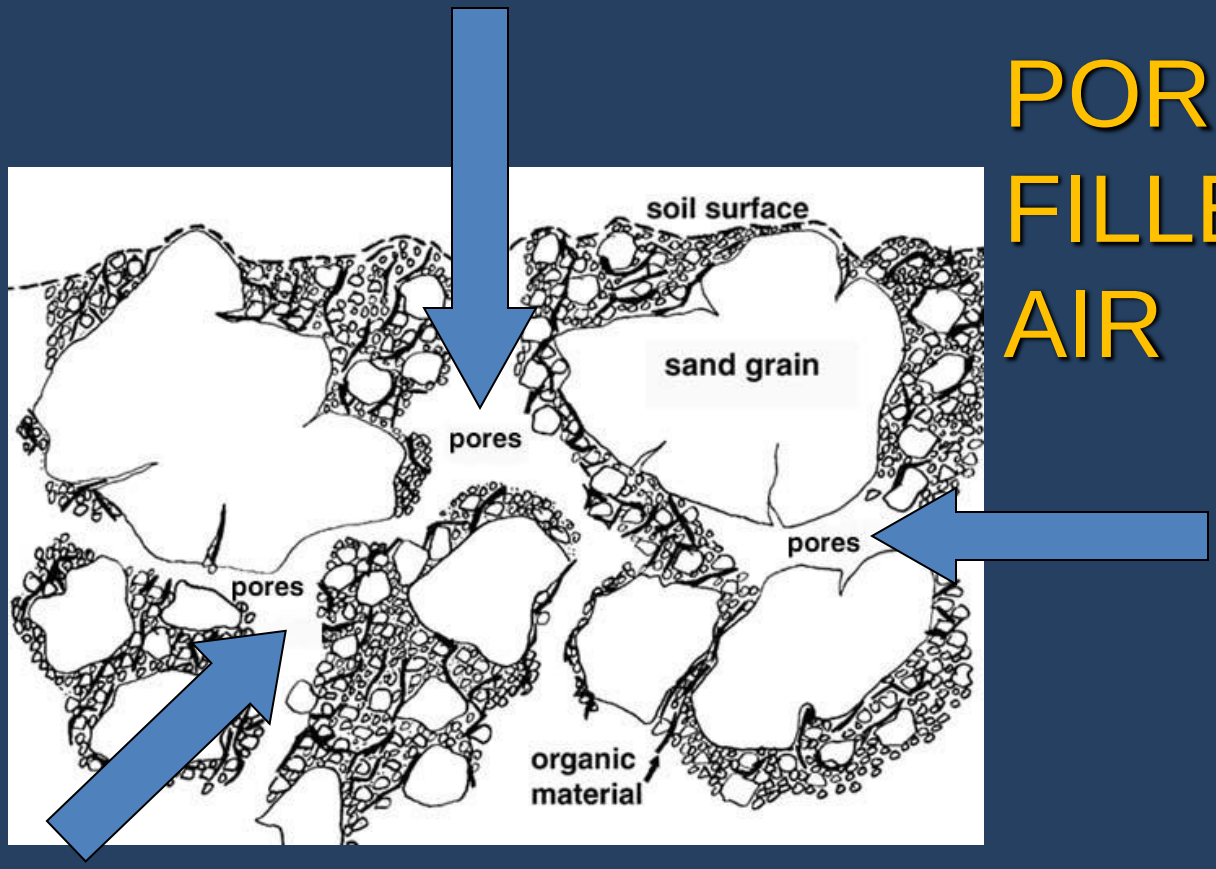


Table 1: The United States Department of Agriculture (USDA) Soil Texture Classification.

Name of soil separate	Diameter (mm)
Gravel	> 2.00
Very coarse sand	2.00-1.00
Coarse sand	1.00-0.50
Medium sand	0.50-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002

PORE SPACES FILLED WITH AIR



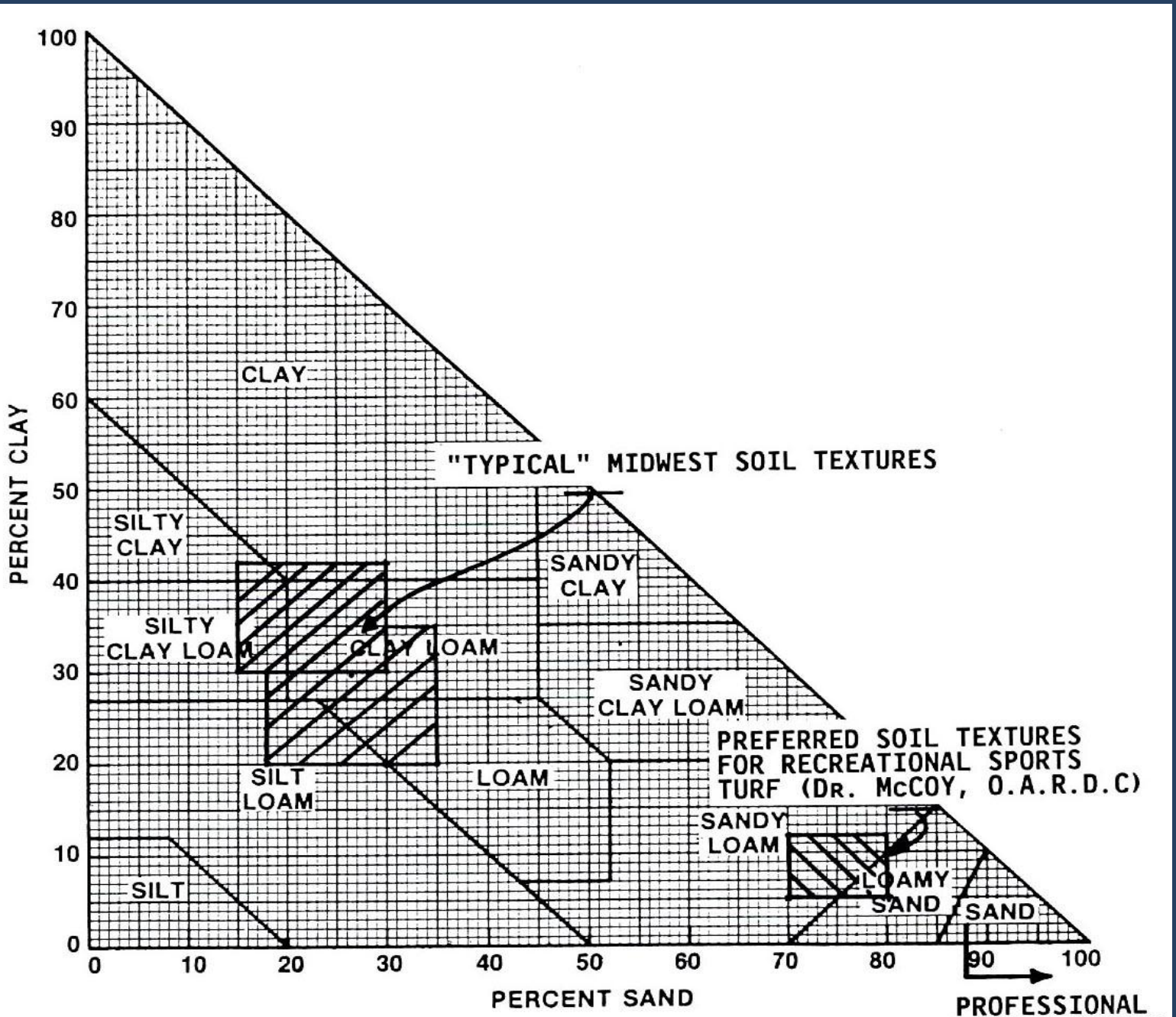


Fig. 15–3. Textural triangle for soil textural analysis using the USDA class.

Table 1: Effect of field type on hours of adult use*			
Type of Field	**Hours adult use per week**	**Games per year**	**Notes**
Undrained or basic pipe drain	1-2	50-80	Heavy clay soils at the lower end of the range
Sand slits/slit drained	6	95-125	Sand TD program must be in place
Sand-based field	8-9	400+	Very high maintenance

*** STRI Bulletin, January 2004**

Native Soils in Ohio

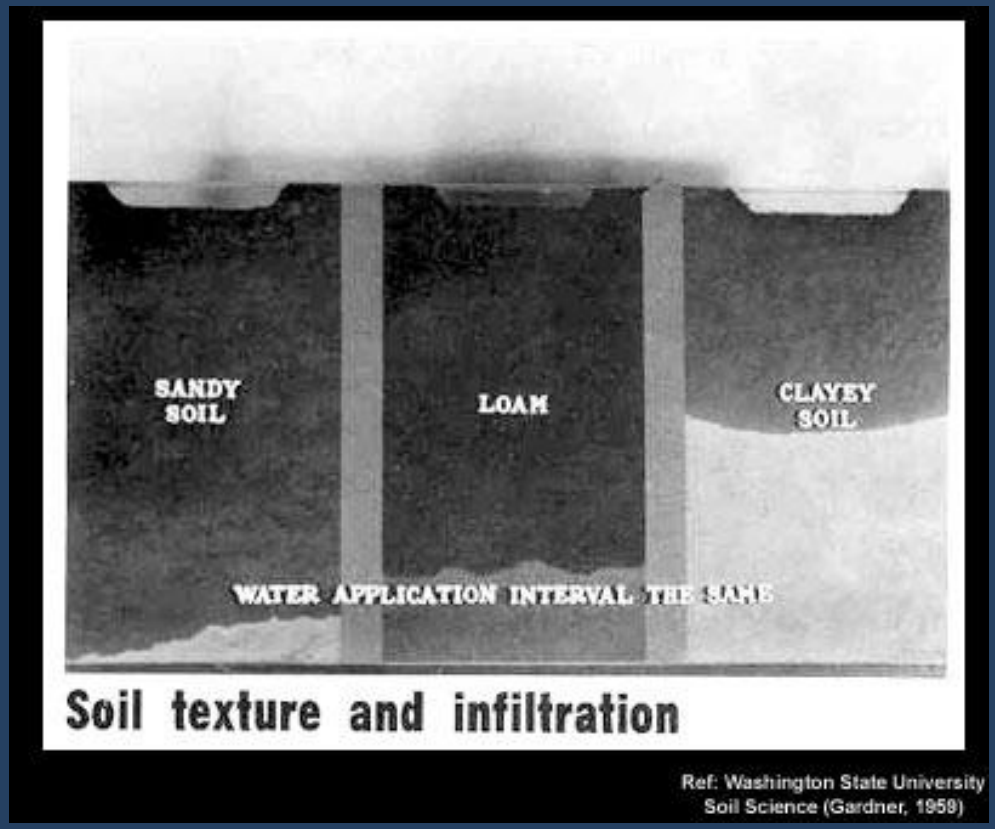
Pro's

- Nutrient availability (CEC)
- Water availability
- Inexpensive to maintain
- "Easy" to maintain

Cons

- Infiltration rates
- Compaction
  - Mud-bath when wet
  - Very hard when dry
- Poor soil quality (inadequate OM)

Soil Texture & Infiltration



Representative infiltration rates for different soil textures

	Infiltration rate*		
Soil texture	inches/hr		cm/hr.
Sand-coarse	1.00 - 8.00		2.50 - 20.00
Sand-very fine	0.50 - 3.10		1.25 - 8.00
Sandy loam	0.40 - 2.60		1.00 - 6.50
Loam	0.08 - 1.00		0.20 - 2.50
Clay loam	0.04 - 0.60		0.10 - 1.50
Clay	0.01 - 0.10		0.02 - 0.25

*These values are approximate. Infiltration rates can vary widely, depending on surface conditions and water content.

Date	Precipitation (rainfall - inches)
Sept. 16th	1.0 (2 hour period)
Sept. 19th	0.21
Sept. 23rd	0.21
Sept. 26th	0.82

Average Rainfall in Columbus, OH, 2005

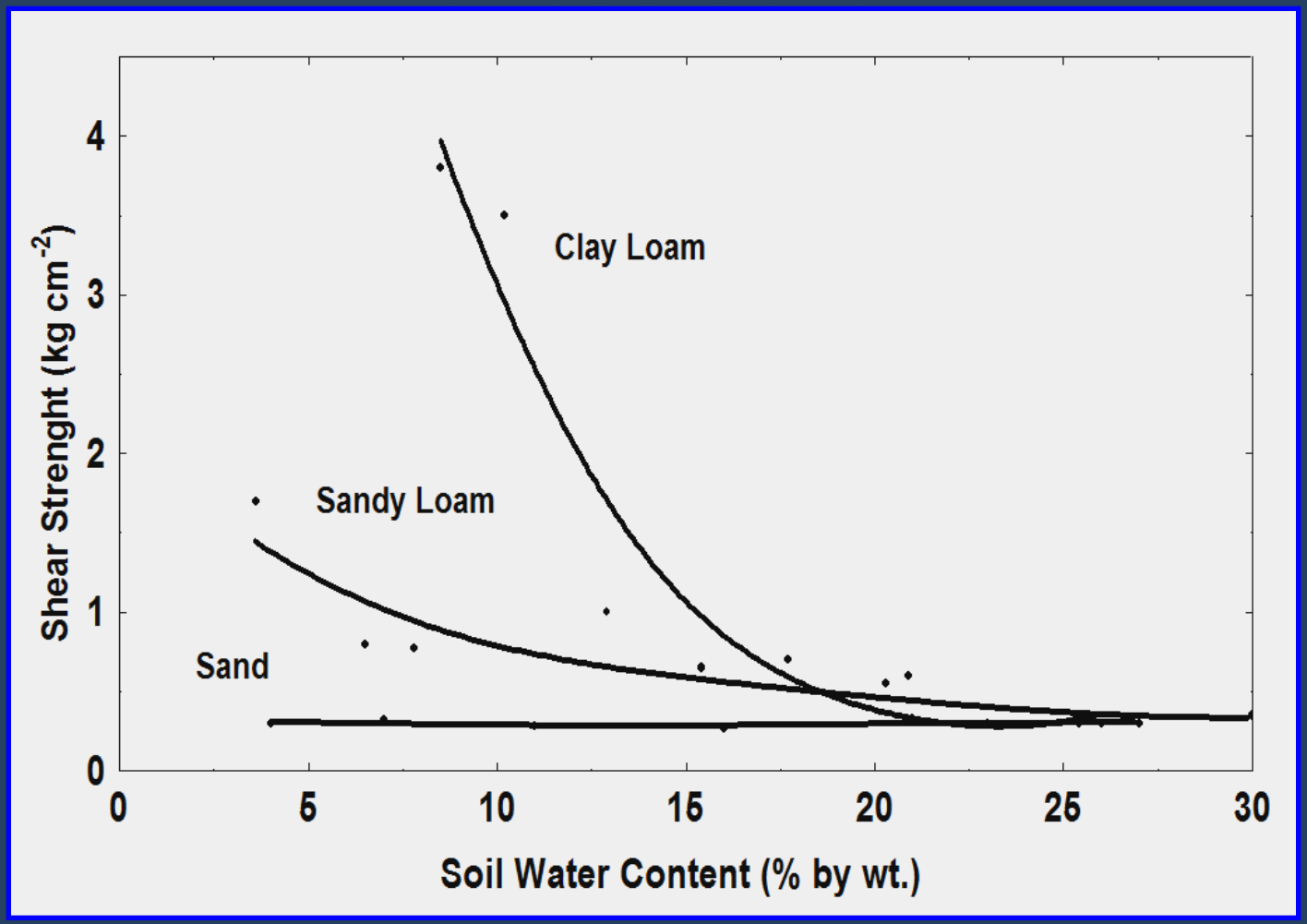
Field Style	Waterlogged Aeration Stress (days)	Drought Water Stress (days)
Native Soil, pipes at 20 ft	4	10+
4” sandy-loam cap, pipes at 20 ft.	2	7
4” sandy-loam cap, pipes at 10 ft.	1	6
10” sand-loam cap, pipes at 20 ft.	0	7

McCoy, 2006

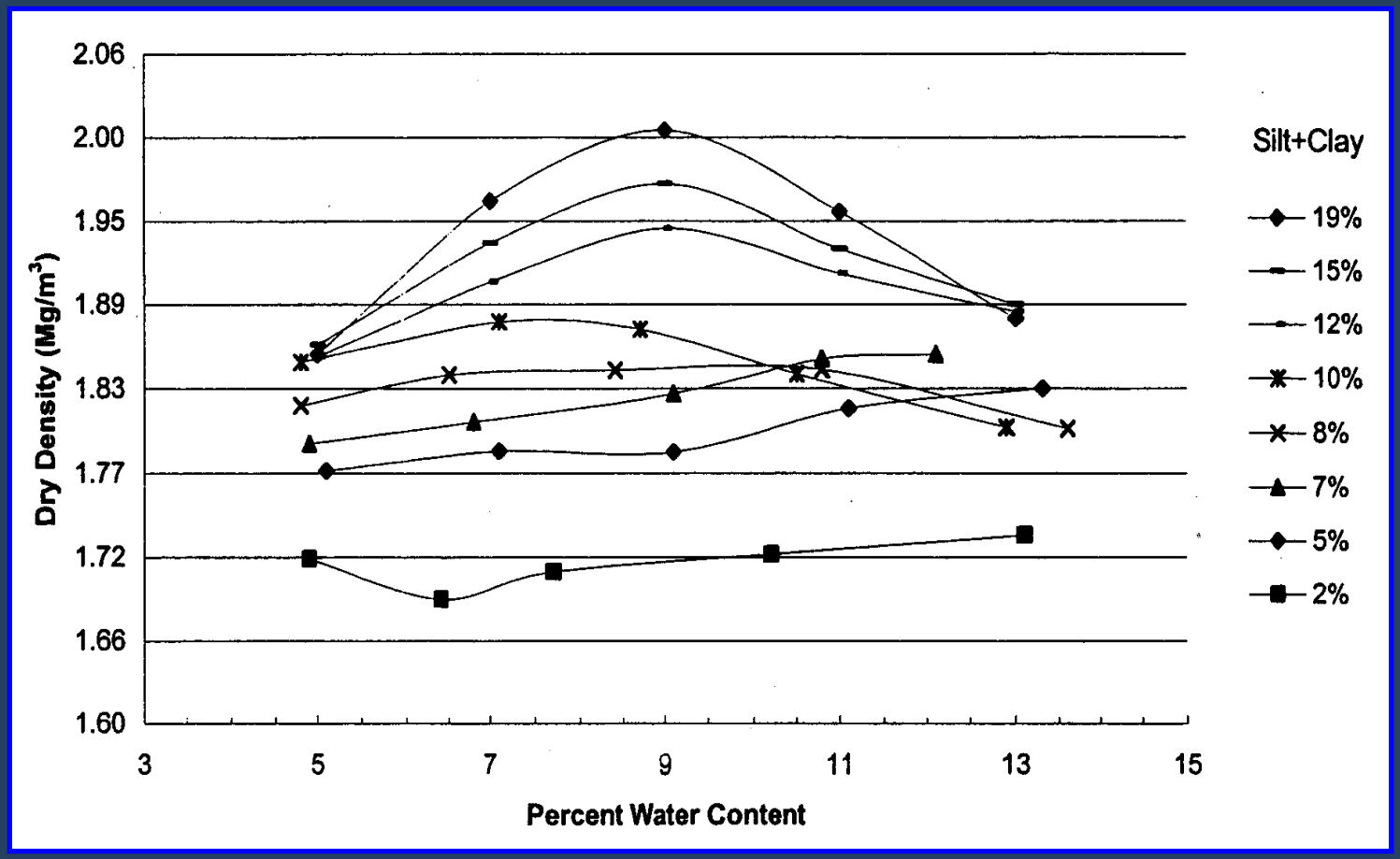
Saturated Soils

- Easily compacted
- Reduction in roots
  - Limited water and nutrient uptake
  - Loss of stability
- Weeds like Poa annua & nutsedge

The Effect of SWC on Shear Strength of Various Soils



The Relationship Between Soil Texture, Soil Moisture Content and Soil Compaction



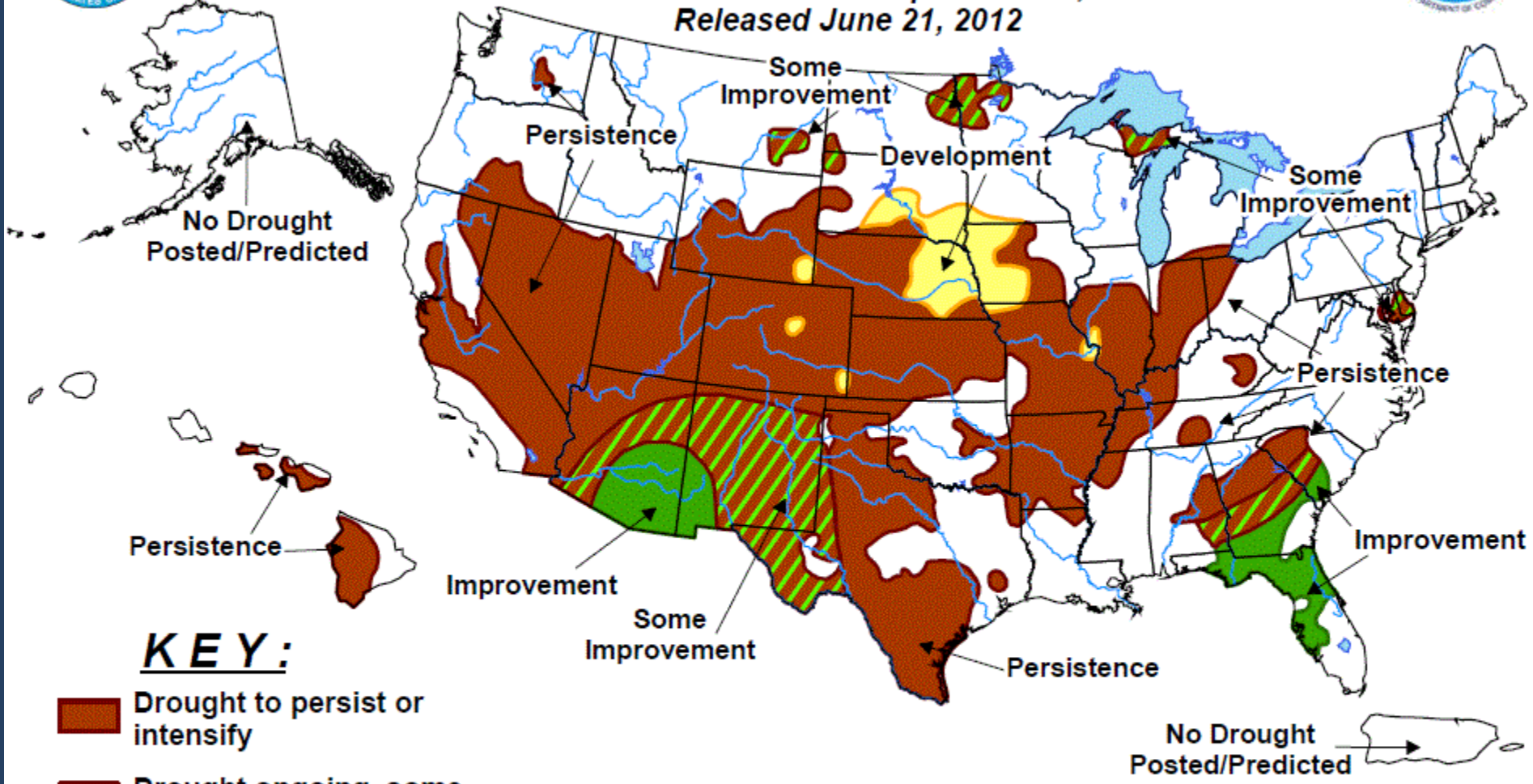

When Soil Fields are Dry …
• Very hard
• Limited growth & recovery
• Weeds like knotweed and clover

U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for June 21 -September 30, 2012

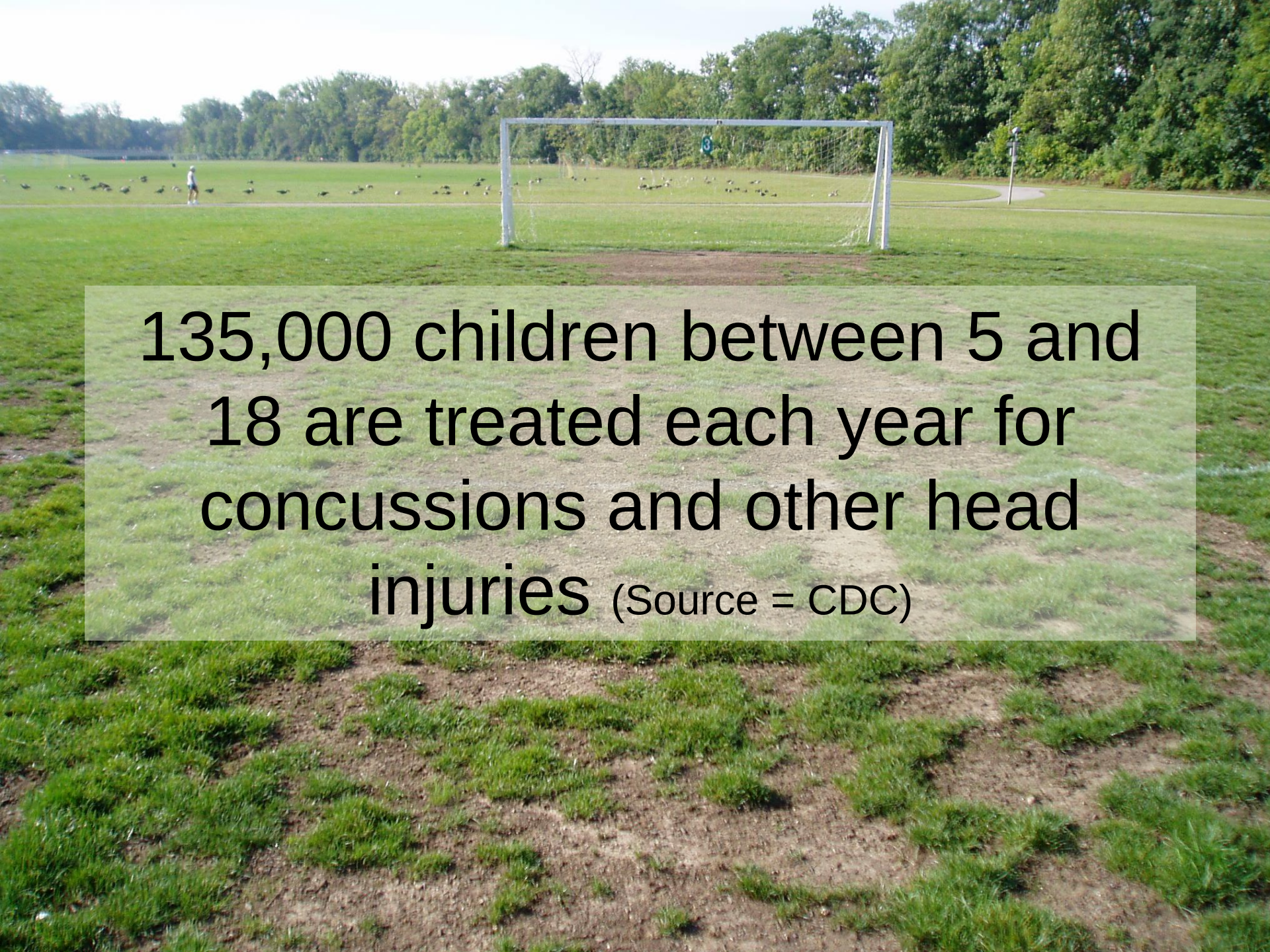
Released June 21, 2012



KEY:

- Drought to persist or intensify
- Drought ongoing, some improvement
- Drought likely to improve, impacts ease
- Drought development likely

Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.


135,000 children between 5 and 18 are treated each year for concussions and other head injuries (Source = CDC)

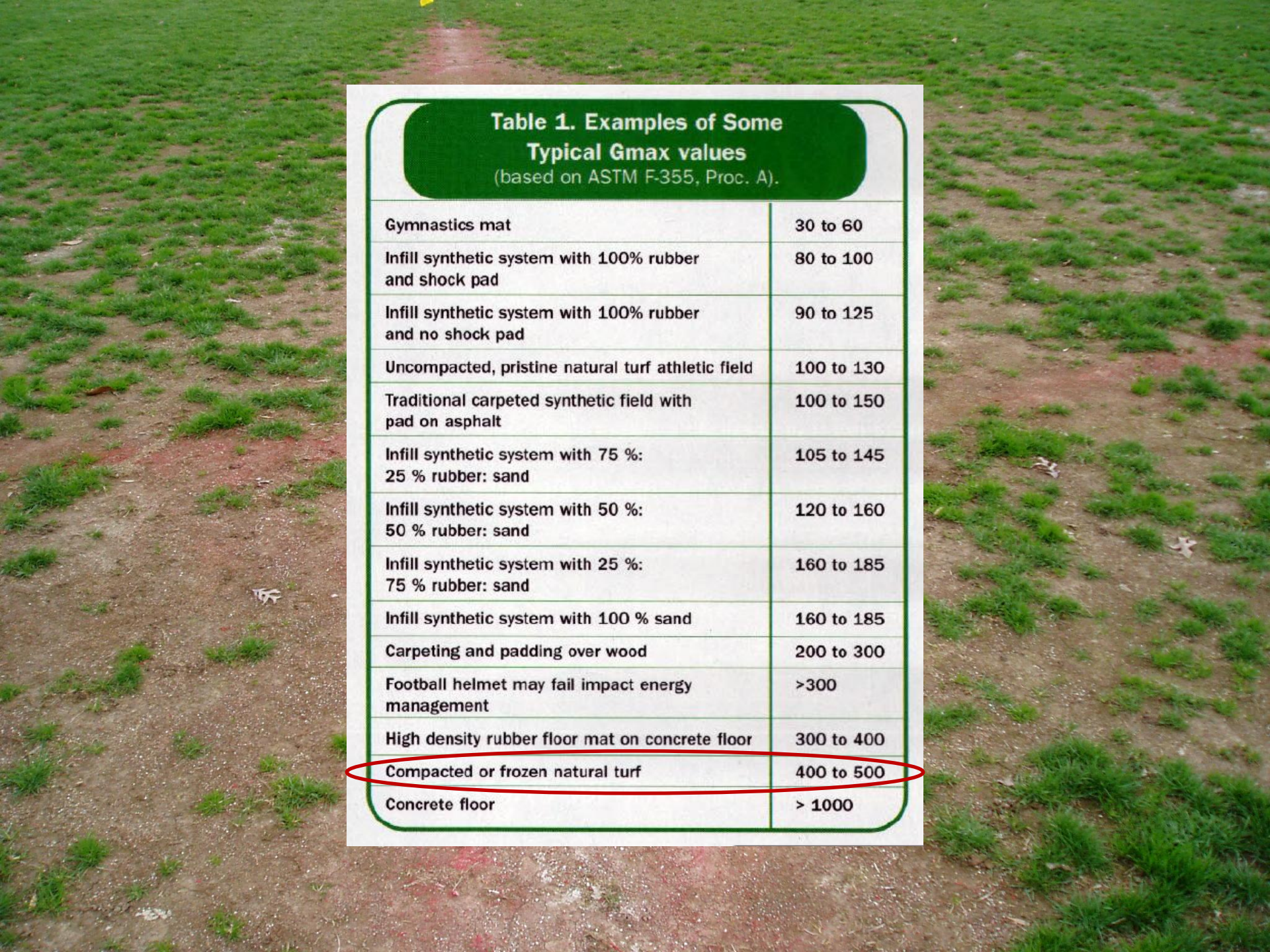


Table 1. Examples of Some Typical Gmax values
(based on ASTM F-355, Proc. A).

Gymnastics mat	30 to 60
Infill synthetic system with 100% rubber and shock pad	80 to 100
Infill synthetic system with 100% rubber and no shock pad	90 to 125
Uncompacted, pristine natural turf athletic field	100 to 130
Traditional carpeted synthetic field with pad on asphalt	100 to 150
Infill synthetic system with 75 %: 25 % rubber: sand	105 to 145
Infill synthetic system with 50 %: 50 % rubber: sand	120 to 160
Infill synthetic system with 25 %: 75 % rubber: sand	160 to 185
Infill synthetic system with 100 % sand	160 to 185
Carpeting and padding over wood	200 to 300
Football helmet may fail impact energy management	>300
High density rubber floor mat on concrete floor	300 to 400
Compacted or frozen natural turf	400 to 500
Concrete floor	> 1000

Improving Poor Native Soils

- Improve soil "Health"
  - Reduce Bulk Density (aeration & topdressing)
  - Add OM
  - Improve drainage capability (crown, install drains, topdress)
- Minimize injury
  - Prevent excessive surface hardness >200 Gmax
  - Maintain surface smoothness (topdressing)

Spacing and Tine Size Effect from Coring

Percent Surface Impacted

Tine Size	2x2	4x4	4x6	6x8
¼ inch	1.2	0.3	0.2	0.1
3/8 inch	2.8	0.7	0.5	0.2
½ inch	4.9	1.2	0.8	0.4
¾ inch	11.0	2.8	1.8	0.9
1 inch	19.6	4.9	3.3	1.6


VILLAGE
RENTAL


Aeration for the 21st Century
WARNING
WILLARD
DANGER


TURF
TIME
HINES
CAUTION

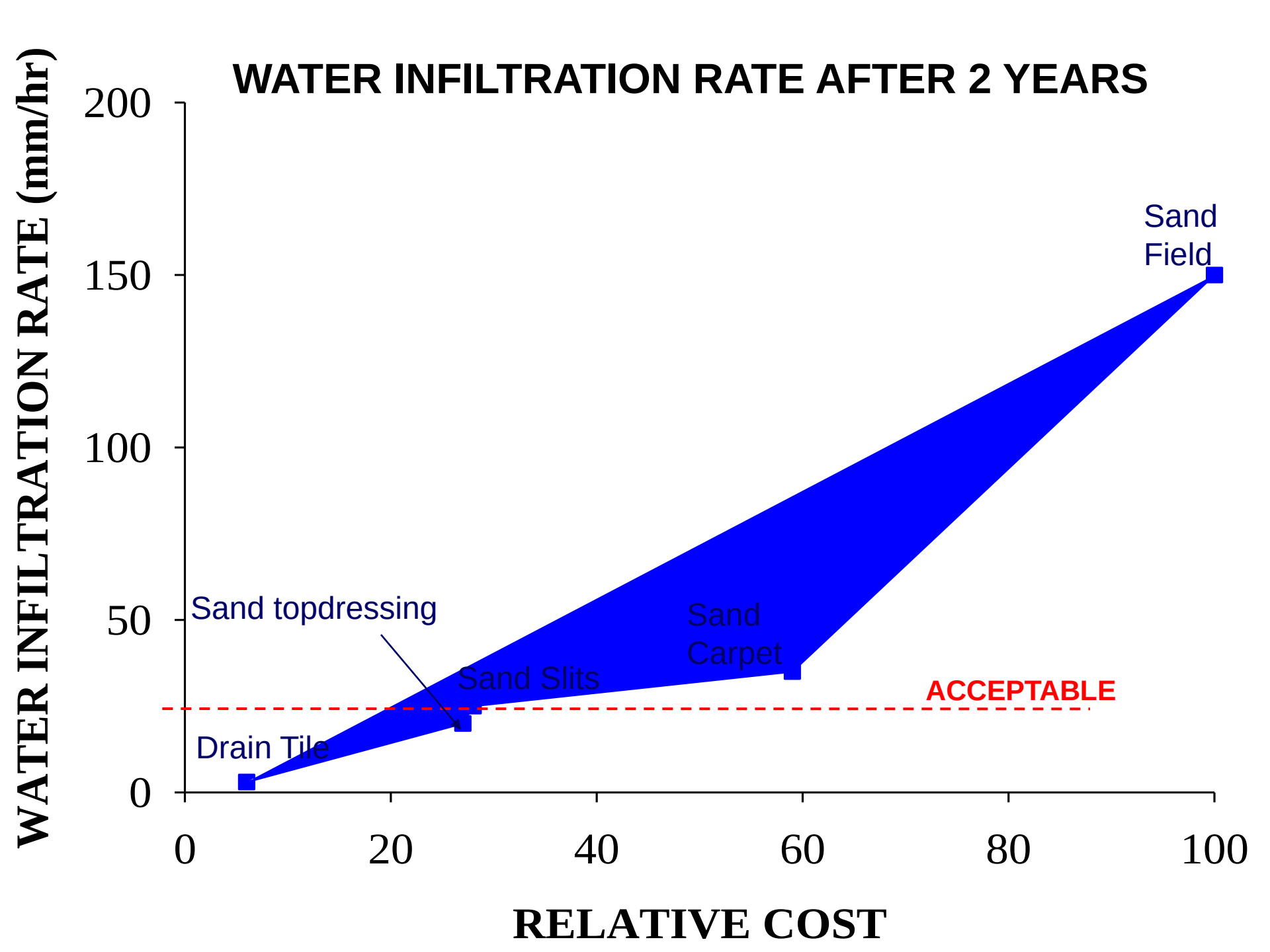
Field Construction/Renovation Options Using Sand

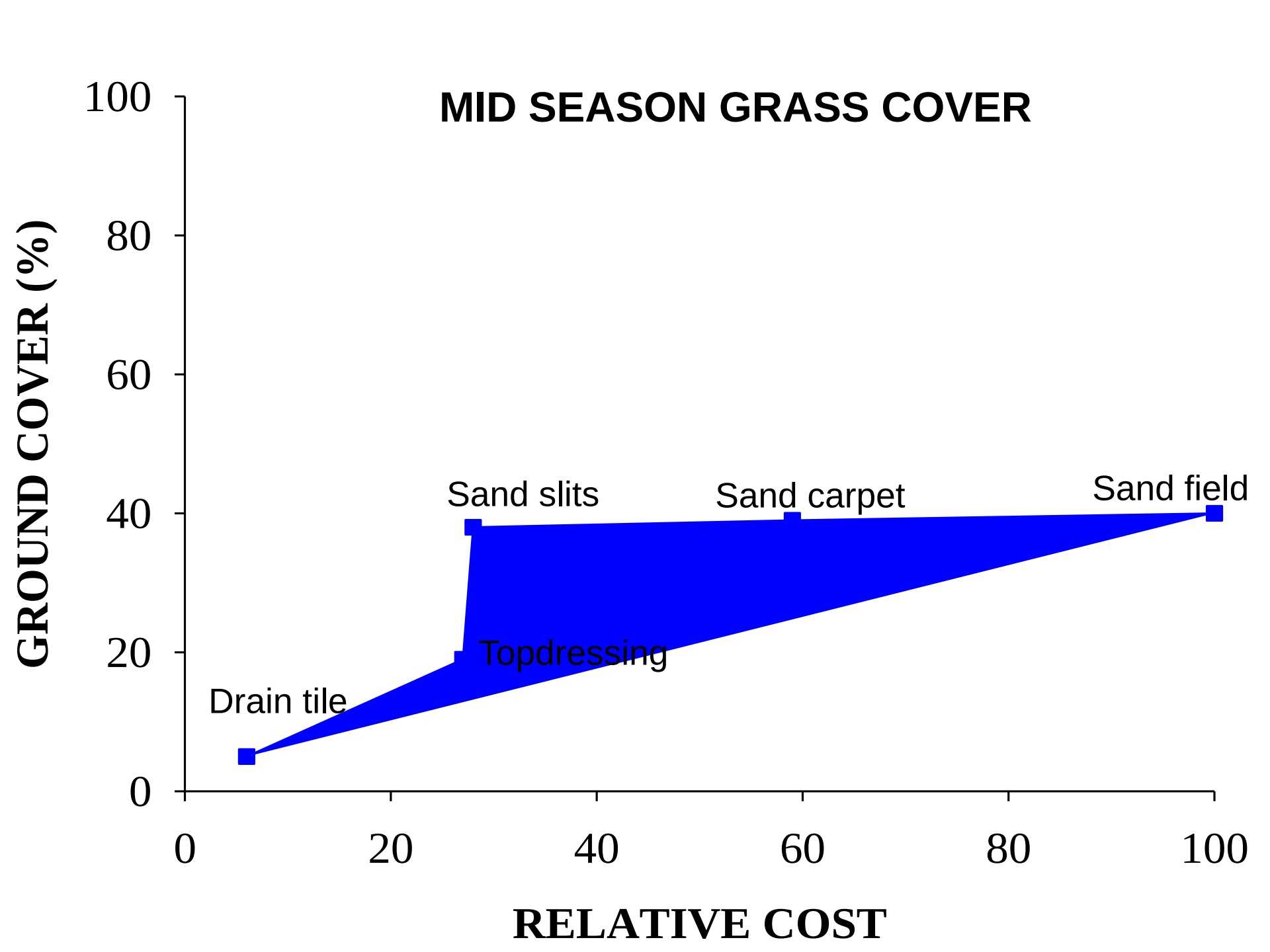
Public Fields

- Pipe drains plus heavy sand dressing
- Slit drainage
- Sand carpet
- Sand amendment

Professional Fields

- Sand dominated rootzone over gravel layer

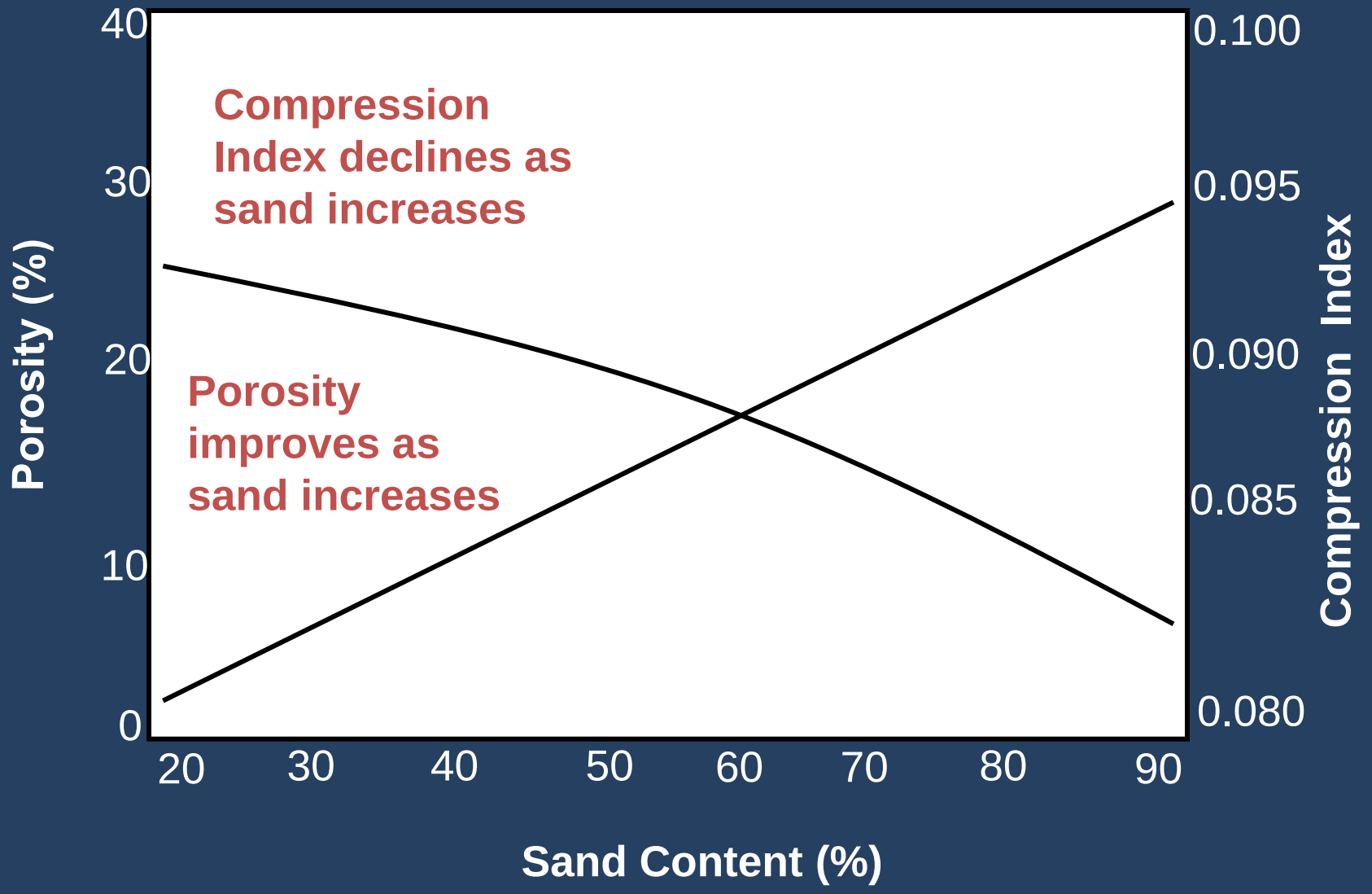

WATER INFILTRATION RATE AFTER 2 YEARS
WATER INFILTRATION RATE (mm/hr)
200
150
100
50
0
0
20
40
60
80
100
RELATIVE COST
Sand
Field
Sand topdressing
Sand
Carpet
Sand Slits
ACCEPTABLE
Drain Tile


MID SEASON GRASS COVER
GROUND COVER (%)
100
80
60
40
20
0
0
20
40
60
80
100
RELATIVE COST
Sand slits
Sand carpet
Sand field
Topdressing
Drain tile

Sand Topdressing

Benefits of Topdressing

- Improve drainage
- Dilute thatch
- Smooth playing surface


Compression Index declines as sand increases
Porosity improves as sand increases
Porosity (%)
Compression Index
Sand Content (%)
40
30
20
10
0
0.100
0.095
0.090
0.085
0.080
20
30
40
50
60
70
80
90

McCoy 1998

Sand Criteria

Particle Size Distribution

Uniformity of Particle Sizes

Predominant Particle Shape

Particle Size Distribution

Sand Particle Sizes (USDA Textural Analysis)

19 mm diameter

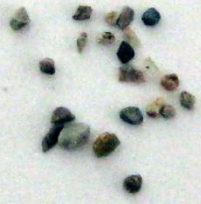
Fine Gravel

> 2 mm

V. Coarse Sand

1 - 2 mm

Coarse



0.50 - 1 mm

Medium

0.25 - 0.50

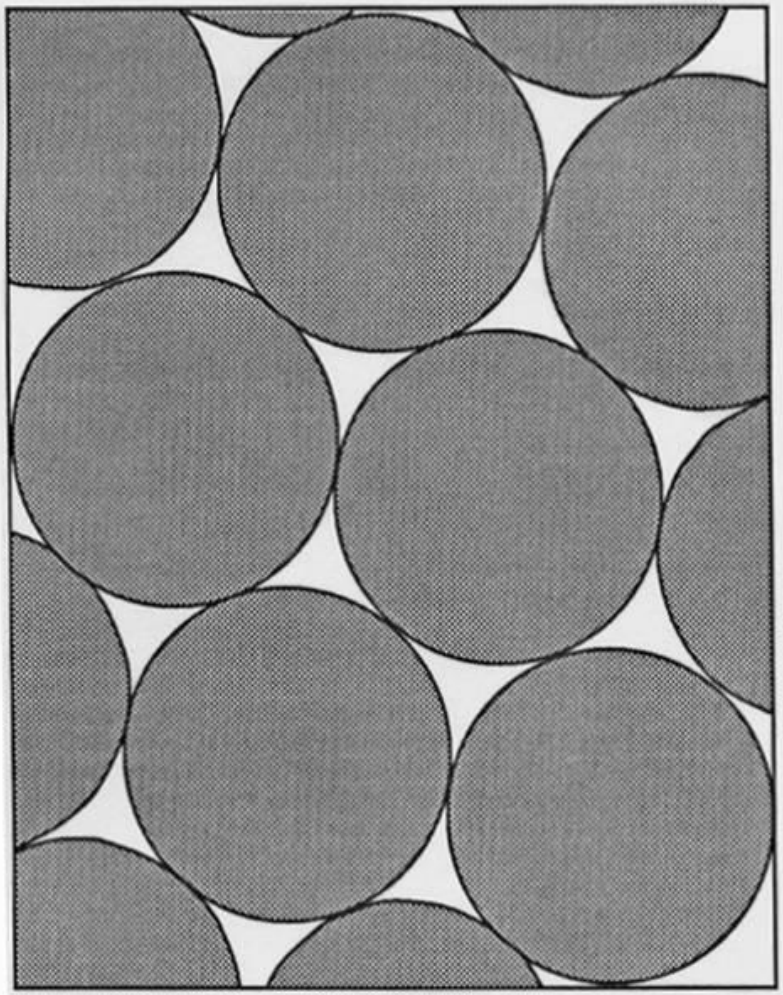
Fine

0.10 - 0.25

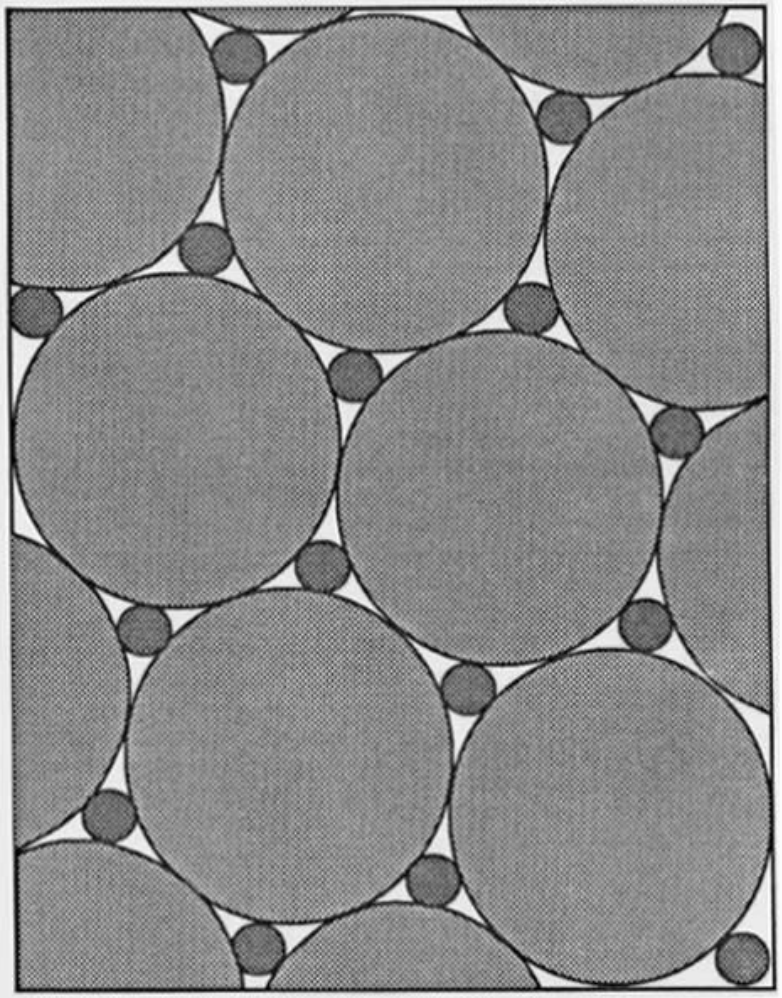
Sherratt 2009

UNIFORMITY

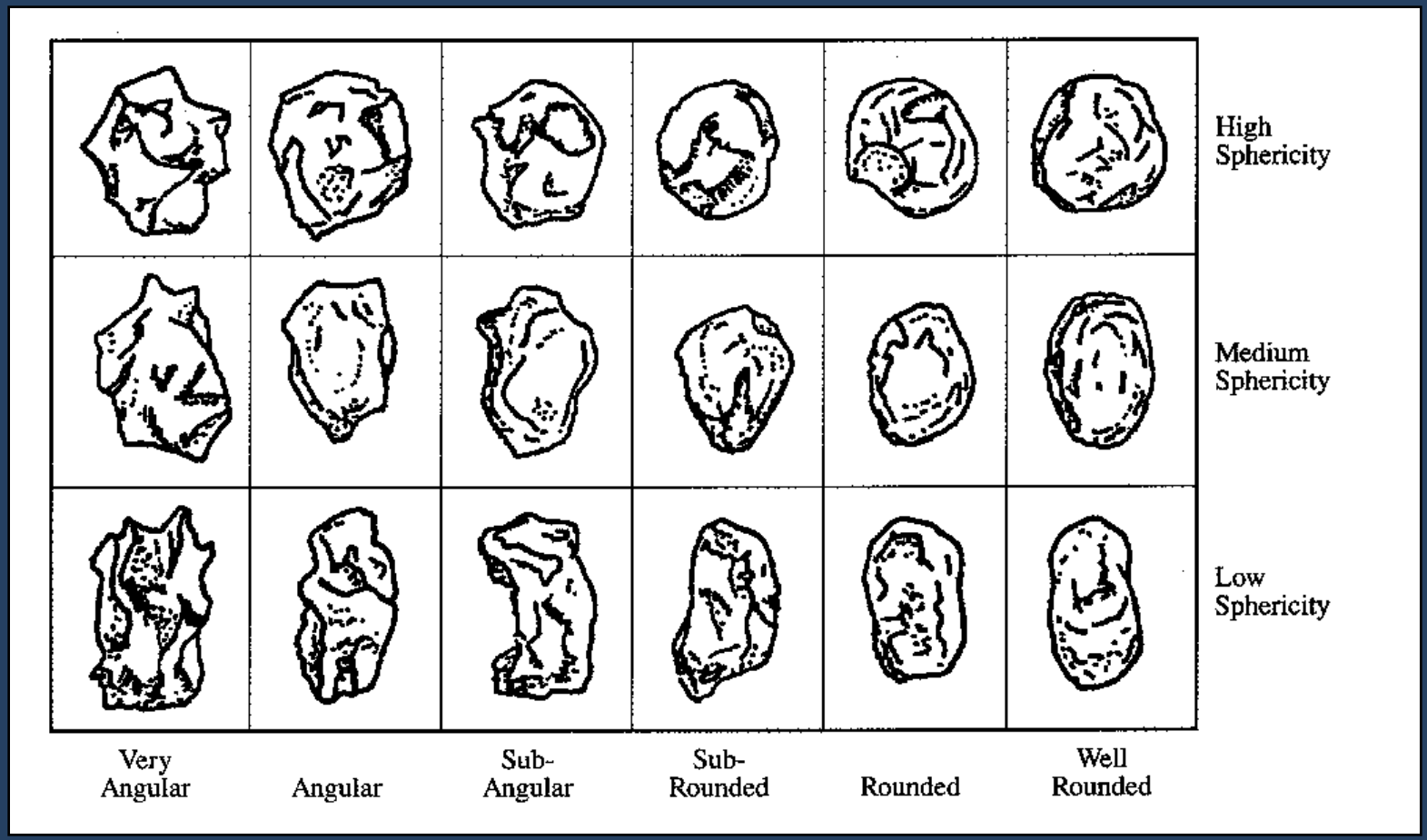
UNIFORM SIZE DISTRIBUTION



MIXED PARTICLE SYSTEM



Sand Shape Classification

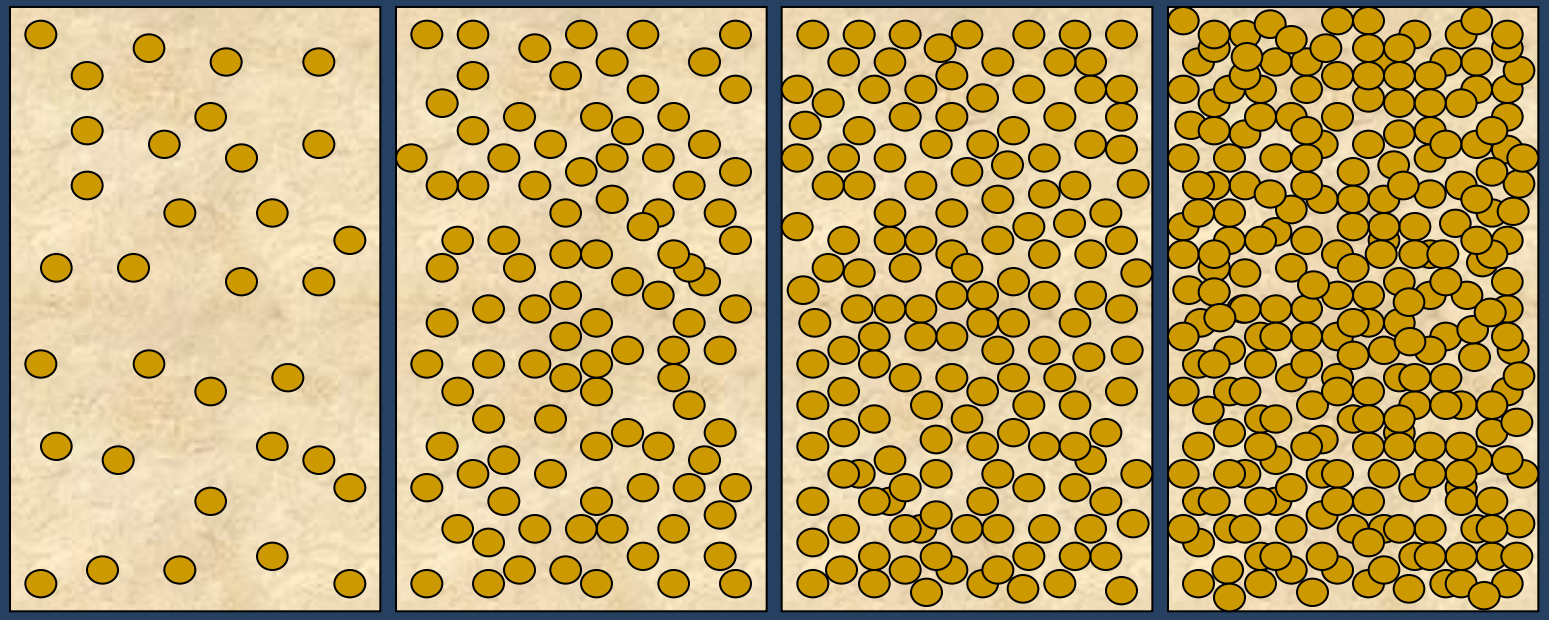


Recommended Particle Size Distributions for Sports Fields

Name	Fine Gravel > 2mm	Very Coarse Sand 1-2mm	Coarse 0.5-1mm	Medium 0.25-0.5mm	Fine 0.1-0.25mm	Very Fine 0.05-0.1mm	Silt 0.002-0.05mm	Clay <0.002mm
Penn State[a]		95% (60% should be in the medium range)						
Penn State[b]	<10%	<10%	50-75%		<25%	<10%	<15%	
Uni. Minn[c]	3% max		60% min		3% max			
USGA[d]	3% max	7% max	60% min		20% max	5% max*	5% max*	3% max*
Uni. Calif.[e]	<10%		82% min			8% max		
PAC.NW[f]	30% max		70% min		15% max	10% max	5% max	
Miss. State[g]	15% max		>60%		25% max		12% max	
PAT[h]	3% max	10% max	60-80%		5-20%	5-10%	6% max	6% max

Ref: Sports Field; A manual for design, construction and maintenance. (1999) Puhalla, Krans and Goatley.

The Bridging Effect



10% Sand

20% Sand

50% Sand

75-80% Sand

Frequency & rates

¼” depth 2 x year

50-100 tons per field

REPORT OF ANALYSIS

LAB. NO: 904140
SAMPLE ID: NOT GIVEN
TYPE OF ANALYSIS: SAND CLASSIFICATION & SOIL TEXTURE ANALYSIS

U.S.D.A. PARTICLE NAME	U.S. STD. SIEVE NO.	PARTICLE SIZE mm	RESULTS RETAINED %
Gravel	6	(> 3.34)	5
Fine Gravel	10	(2.00-3.34)	20
SAND FRACTIONS:			
Very Coarse Sand	18	(1.00-2.00)	35
Coarse Sand	35	(0.50-1.00)	23
Medium Sand	60	(0.25-0.50)	14
Fine Sand	140	(0.10-0.25)	8
Very Fine Sand	270	(0.05-0.10)	7
Total Sand		(0.05-2.00)	87
SILT AND CLAY FRACTIONS:			
Silt		(0.05-0.002)	9
Clay		(< 0.002-0.05)	4

U.S.D.A. Soil Texture Classification: GRAVELLY LOAMY SAND

REPORT OF ANALYSIS

LAB. NO: 82180
SAMPLE ID: SAND # 1
TYPE OF ANALYSIS: U.S.D.A. PARTICLE SIZE ANALYSIS WITH SILT & CLAY

U.S.D.A. PARTICLE NAME	U.S. STD. SIEVE NO.	PARTICLE SIZE mm	RESULTS RETAINED %
Gravel	6	(> 3.34)	12
Fine Gravel	10	(2.00-3.34)	11
SAND FRACTIONS:			
Very Coarse Sand	18	(1.00-2.00)	14
Coarse Sand	35	(0.50-1.00)	22
Medium Sand	60	(0.25-0.50)	25
Fine Sand	140	(0.10-0.25)	6
Very Fine Sand	270	(0.05-0.10)	3
Total Sand		(0.05-2.00)	70
SILT AND CLAY FRACTIONS:			
Silt		(0.05-0.002)	1
Clay		(< 0.002)	6

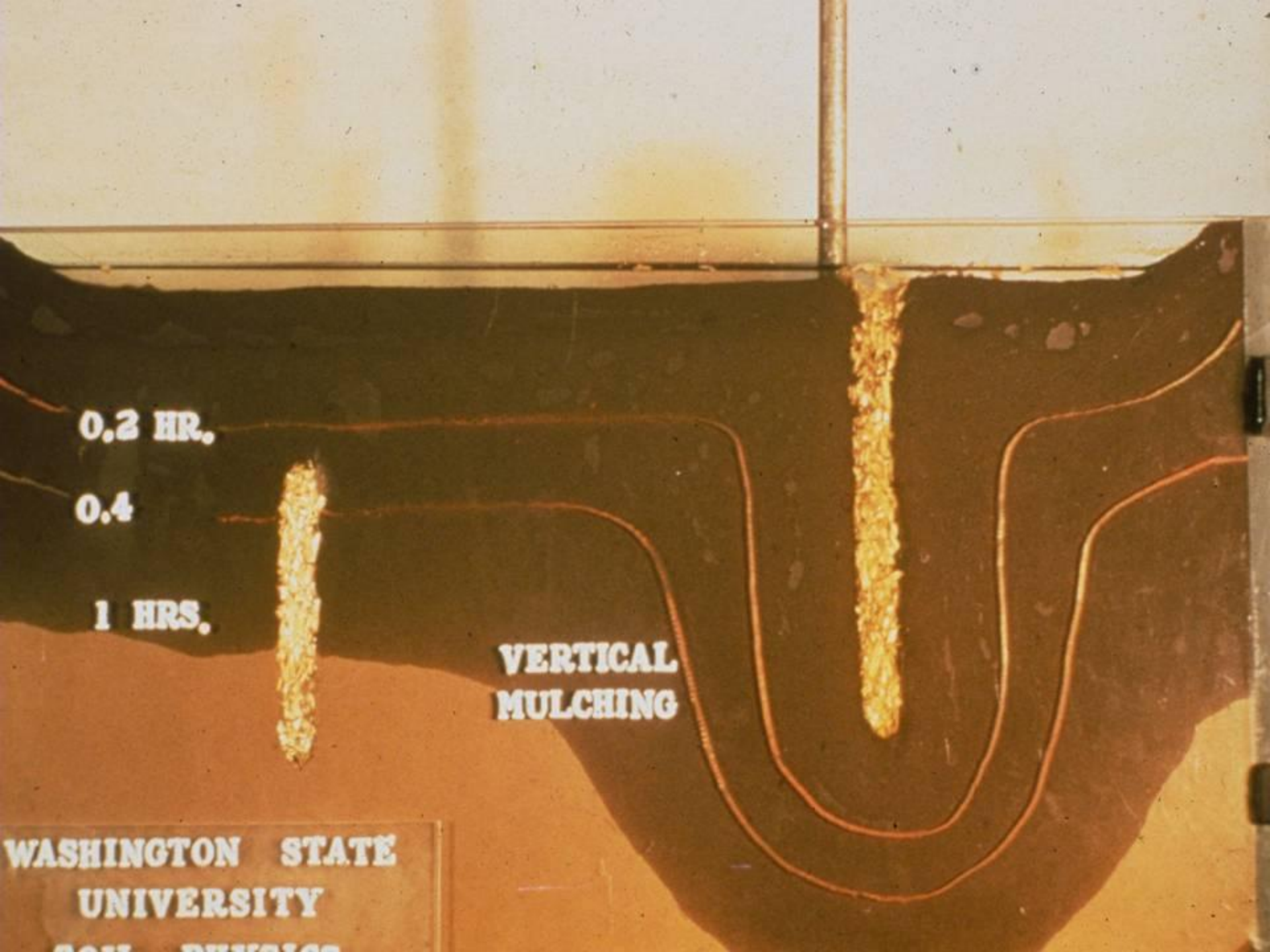
U.S.D.A. Soil Texture Classification: SAND

REPORT OF ANALYSIS

LAB. NO: 82181
SAMPLE ID: SAND # 2
TYPE OF ANALYSIS: U.S.D.A. PARTICLE SIZE ANALYSIS WITH SILT & CLAY

U.S.D.A. PARTICLE NAME	U.S. STD. SIEVE NO.	PARTICLE SIZE mm	RESULTS RETAINED %
Gravel	6	(> 3.34)	0
Fine Gravel	10	(2.00-3.34)	0
SAND FRACTIONS:			
Very Coarse Sand	18	(1.00-2.00)	11
Coarse Sand	35	(0.50-1.00)	53
Medium Sand	60	(0.25-0.50)	26
Fine Sand	140	(0.10-0.25)	4
Very Fine Sand	270	(0.05-0.10)	1
Total Sand		(0.05-2.00)	95
SILT AND CLAY FRACTIONS:			
Silt		(0.05-0.002)	1
Clay		(< 0.002)	4

U.S.D.A. Soil Texture Classification: SAND


0.2 HR.
0.4
1 HRS.
VERTICAL
MULCHING
WASHINGTON STATE
UNIVERSITY

SAND-SLITS
or By-pass system

COST = $4/LINEAR FT.

- RUN PERPENDICULAR TO DRAIN PIPE
- LINK SURFACE TO DRAIN TRENCH
- MUST BE KEPT AT THE SUFACE
- VERY POPULAR IN EUROPE

AMENDING THE SOIL OVER TIME

ULTIMATE GOAL = 75% SAND BY WT.

WITH THE RIGHT SAND


Compost/Soil
Amendment


SAND/COMTIL MIX


ClubCar


COMTIL


YARD Waste
YARD WASTE COMPOST


ClubCar

Pelletized Compost

Soil Amendment by Topdressing

Worthington Schools, Columbus, Ohio, USA

More than 20 years applying an 80/20 sand/compost mix (biosolid compost). Reduced fertilizers by 30%

Benefits of using compost in sports turf

- Soil physical, chemical, and biological properties improvements
  - Soil structure is improved (micro-macro aggregates)
  - Improved Aeration and plant root development
  - Nutrients, N available in slow release form
  - Water holding capacity increased
  - Erosion reduce
  - Prevention and suppression of disease
  - Organic Matter recycling
- Environmental benefit
  - Less landfill wastes.
  - Carbon sequestration (capture)
  - Fertilizers, pesticides, and herbicides decrease.
  - Decrease in N leaching (surface water)

Regulations

Federal Regulations

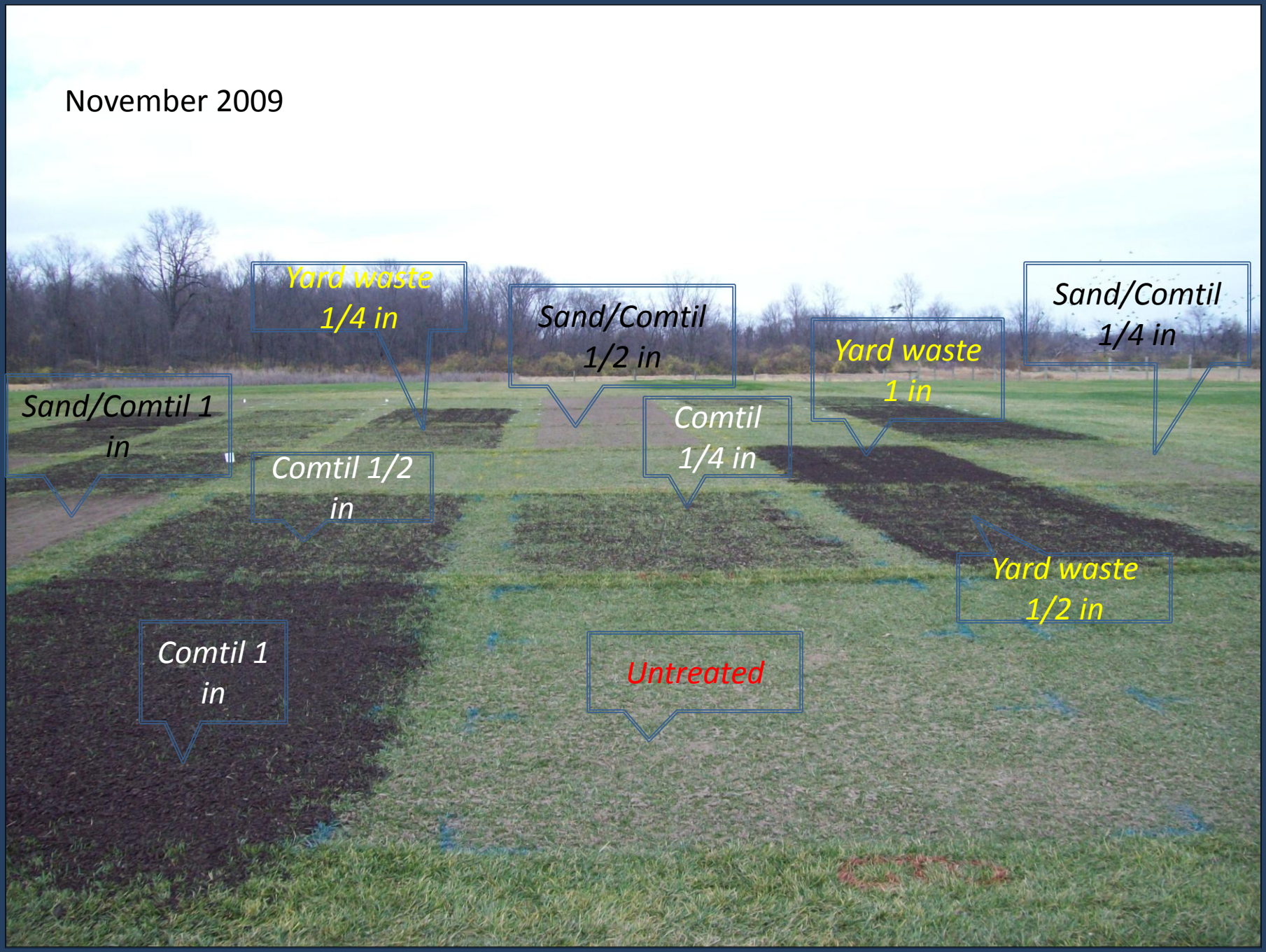
- Regulates biosolid compost. 503 USEPA regulations (40 CFR code) Special regulations for sewage sludge use and disposal (salmonella sp and fecal coliform)

State Regulations

- Composting Regulations OhioEPA (OAC 3745- 27-01 to OAC 3745-27-40)
- Limits for compost maturity, pH, heavy metals, salts, etc

Choosing a compost, physical and chemical properties

Color	**Brown to black**
Odor	Like earth
Particle size for topdressing	¼ to 3/8 inch
Moisture content	30 to 50%
Organic matter	Greater than 30%
Ash content	less than 70%
c/n ratio	Below or equal to 30:1
Nitrogen	0.5 to 3%
Phosphorus	Greater than 0.2%
pH	6.0-7.0
Metals	Determined by state or federal agencies
Soluble salts	Depending on tuf species, type of salt, concentration, and application method


November 2009
Yard waste 1/4 in
Sand/Comtil 1/2 in
Sand/Comtil 1/4 in
Yard waste 1 in
Sand/Comtil 1 in
Comtil 1/4 in
Comtil 1/2 in
Yard waste 1/2 in
Comtil 1 in
Untreated

Compost Considerations

- High N & P
- Odor
- Phytoxicity in summer
- Excessive mowing
- Mounding
- Compost teas? *(Henderson 2012)*

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