UNIVERSITY OF MINNESOTA
ONSITE
SEWAGE
TREATMENT
PROGRAM

SEPTIC SYSTEM SOIL TREATMENT FOR MOUND AND SHALLOW SYSTEMS

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PRESENTATION OVERVIEW

- KEYS TO EFFECTIVE SOIL TREATMENT
- PROPER CONSTRUCTION OF SOIL TREATMENT SYSTEMS
- IDEAS FOR COMPACTED SITES
- METHODS TO PROTECTION SOIL TREATMENT SYSTEMS

KEYS TO EFFECTIVE SOIL TREATMENT

- UNSATURATED SOIL
- NATURAL SOIL
  - NOT:
    - SMEARED
    - COMPACTED
- SHALLOW DISPERSAL
  - MICROBIAL ACTIVITY
  - ROOT ACTIVITY
  - OXYGEN TRANSFER

Maintaining Natural Soil Conditions

Soil located at or near the soil surface is generally the best for:

- Treatment
- Dispersal
- Oxygen-transfer
- Evapotranspiration
- Natural biological activity

SOIL SMEARING

SMEARING: THE SPREADING AND SMOOTHING OF SOIL PARTICLES BY SLIDING PRESSURE

- ANY SANDY LOAM OR FINER TEXTURED SOIL CAN BE SUSCEPTIBLE TO SMEARING IF ENOUGH WATER IS PRESENT
- THIS IS WHY WE TEST THE PLASTIC LIMIT BEFORE CONSTRUCTION

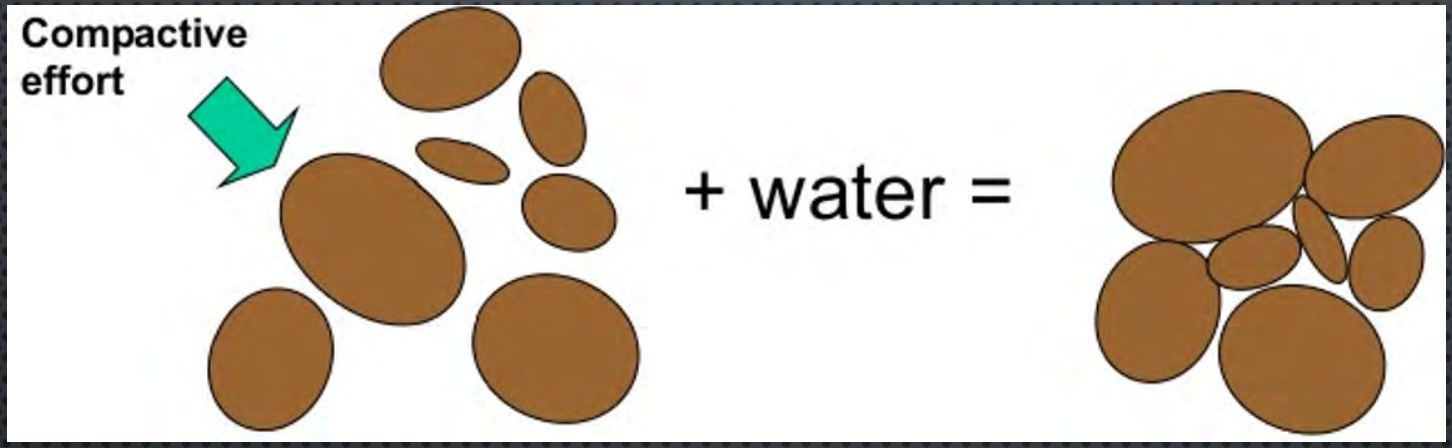
SOIL SMEARING CONTINUED

- SOIL SMEARING CAN BE RAKED OUT
  - SIDEWALLS AND BOTTOM OF SOIL TREATMENT AREA
- IF NOT SOIL INFILTRATION RATE WILL BE REDUCED
- LONGEVITY AFFECTED

SOIL COMPACTION 3 DIFFERENT THINGS

1. Compression is loss of soil volume
2. Compaction
   - Translocation and resorting sand, silt, and clay particles
   - Destruction of soil aggregates
   - Collapse of aeration pores

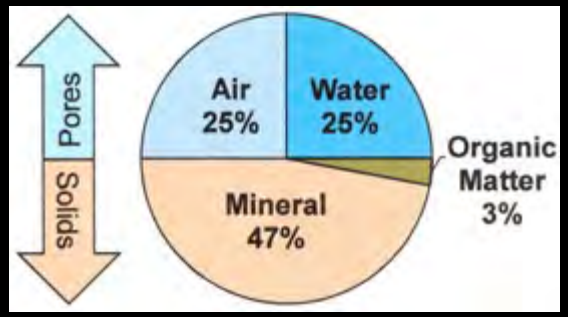
3. CONSOLIDATION

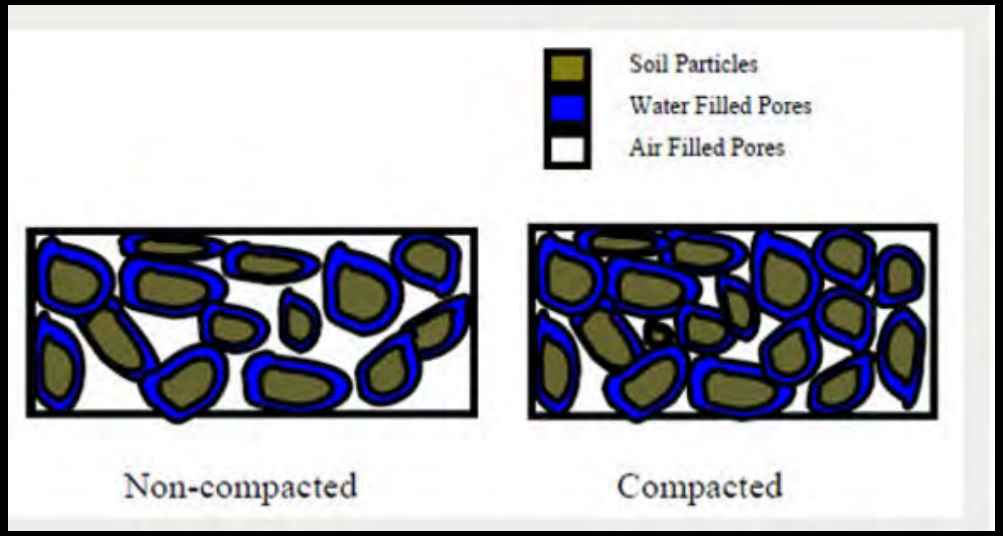


- DEFORMATION OF THE SOIL DESTROYING ANY PORE SPACE AND STRUCTURE
  - WATER IS SQUEEZED FROM THE SOIL
  - PROCESS LEADS TO INCREASED INTERNAL BONDING AND SOIL STRENGTH AS MORE PARTICLE TO PARTICLE CONTACTS ARE MADE AND PORE SPACE IS ELIMINATED

MAINTAIN PORE SPACE

- PORE SPACE IS ESSENTIAL FOR:
  - OXYGEN TRANSFER
  - WATER MOVEMENT

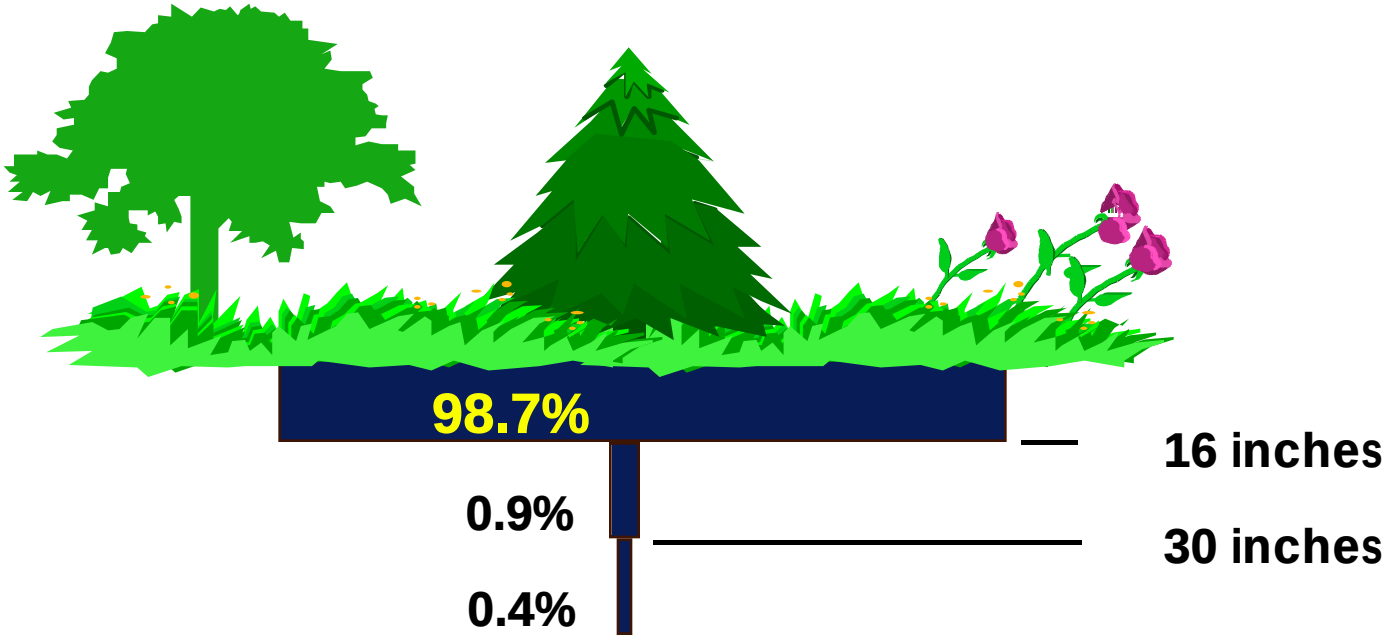




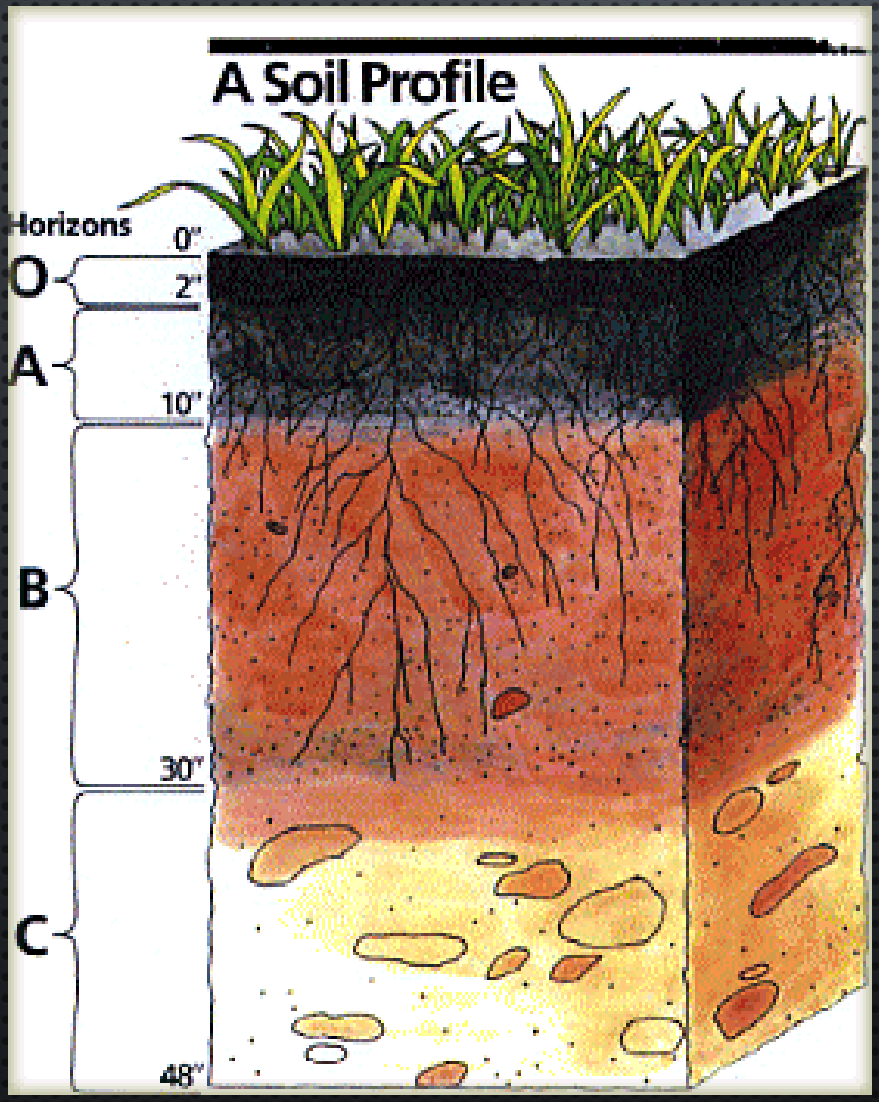
Shallow Dispersal - Topsoil Benefits

- Typically best soil for treatment and dispersal
- Removing increases likelihood of damaging soil
- May assist with nitrogen & other contaminant removal process

SOIL BIOTA POPULATION
VS
SOIL DEPTH



BACTERIA (AND OTHER MICROBES) – THE REAL WORKHORSES OF THE TERRESTRIAL ECOSYSTEMS



Bacteria/gram of soil

Billions

7-8 million

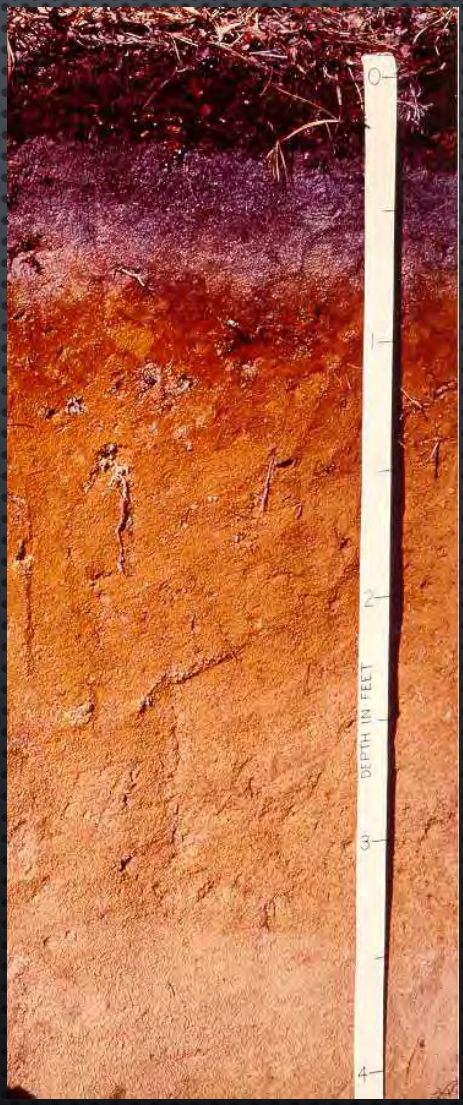
1- 2 million

400 – 500 thousand

~ 10 thousand

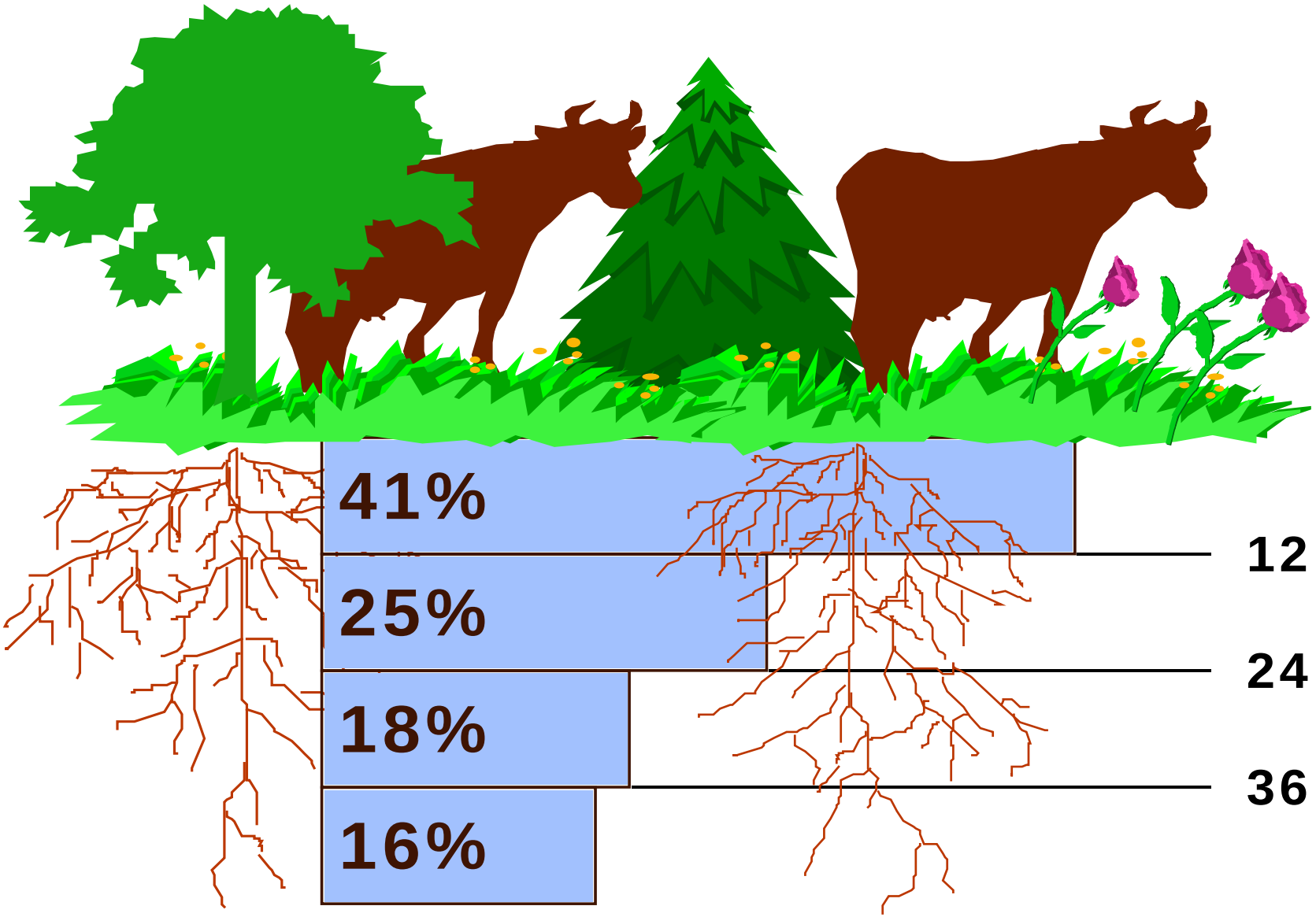
one thousand

hundreds



WATER USE

(WHERE ROOTS DRINK AND EAT)



Factors influencing oxygen levels – depth, pore size and saturation

- Depth: Oxygen levels generally decrease with depth in the soil profile due to slow diffusion rates of oxygen
- Pore size distribution: Soils with large pores promote more rapid oxygen diffusion into and through the soil
    - Sandy soils generally have low total porosity but large individual pores
    - Clay soils generally have high total porosity but small individual pores
- Soils with more pores filled with water have less space available for air

OXYGEN LEVELS WITH DEPTH CASE STUDY

Depth	Wet Time Periods	Dry Time Period
Inches	(%)	(%)
3.9	13.7	20.6
9.8	12.7	19.8
17.7	12.2	18.8
35.4	7.6	17.3
47.2	7.8	16.4

COMPACTION IS THE ENEMY OF OUR STA

- Prior actives
- During construction
- After construction
- Decreased:
  - Aeration into STA
  - Evaporation
  - Pores for water movement
  - Lesser quality vegetative

TECHNIQUES TO MAINTAIN NATURAL SOIL CONDITIONS OF INFILTRATIVE SURFACE

- Do not drive excavation equipment or other vehicles over
- Limit foot traffic
- Rake sidewalls of trenches and beds
- Use low ground pressure equipment
- Position equipment upslope of system when placing media

METHODS TO LIMIT COMPACTION DURING INSTALLATION

- Proper moisture conditions
- Reduce tire pressure to minimal allowable pressures
- Use tracks or duals to replace singles or larger diameter tires

Protecting Exposed Natural Soil

- If soil treatment area (STA) infiltrative surface has been exposed must be covered otherwise:
  - Damage
  - Contamination
- Raindrop impact – research shows a soil crust develops
  - Usually less than 1/2 inch thick at the soil surface

- Don't expose it unless media to over is available
- When you can't cover exposed soil immediately, protect area with tarp

STRATEGIES TO LIMIT COMPACTION

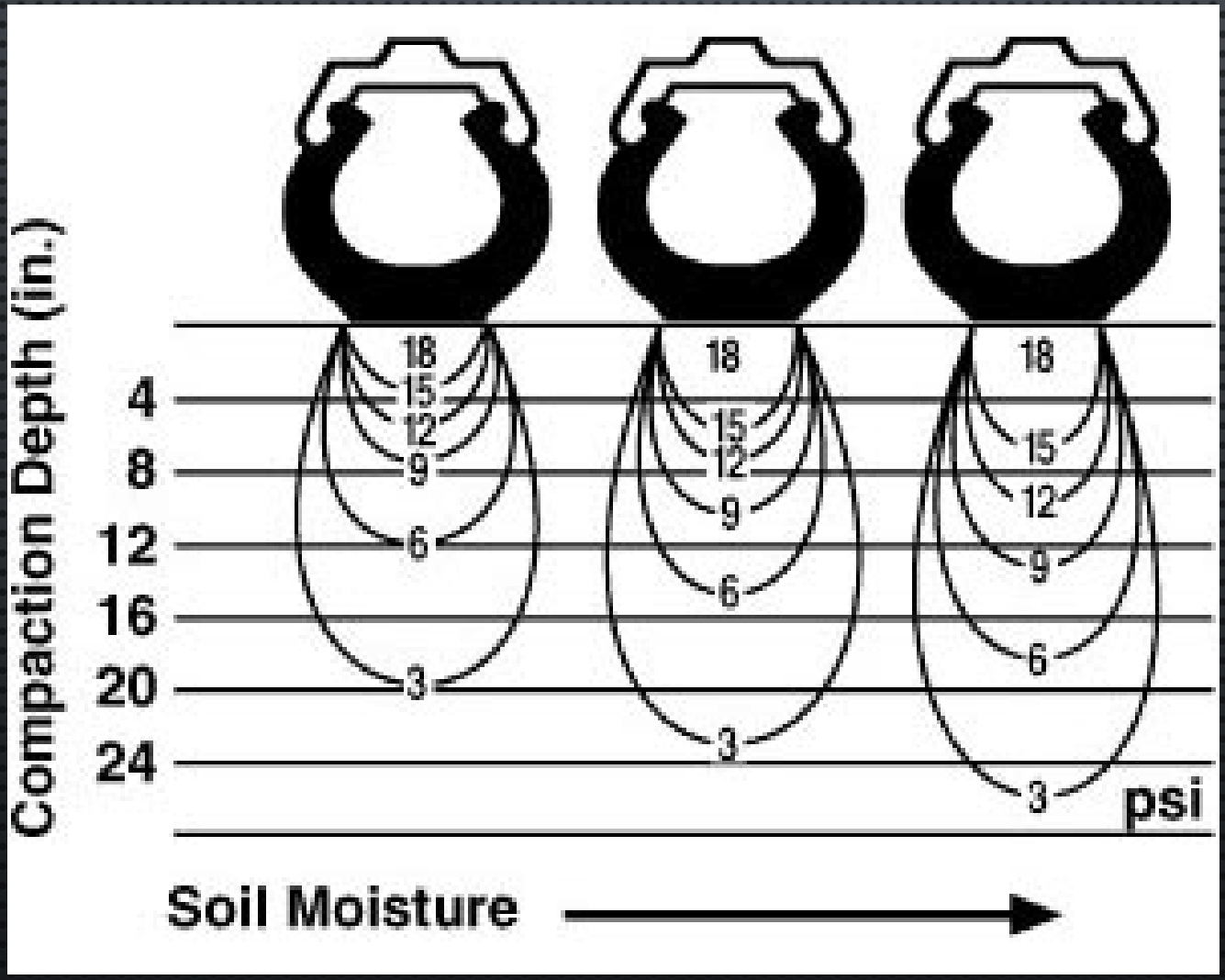
- WORK FROM UPSLOPE OF SOIL TREATMENT SYSTEM WHENEVER POSSIBLE
- USE SMALLER EQUIPMENT - AVOID OVERSIZED
- COMBINE FIELD OPERATIONS

Strategies to limit compaction – wet sites

- Dewatering may be needed
- Soil smearing and compaction more likely
  - Soil must be treated carefully
- Check weather before starting construction & be prepared

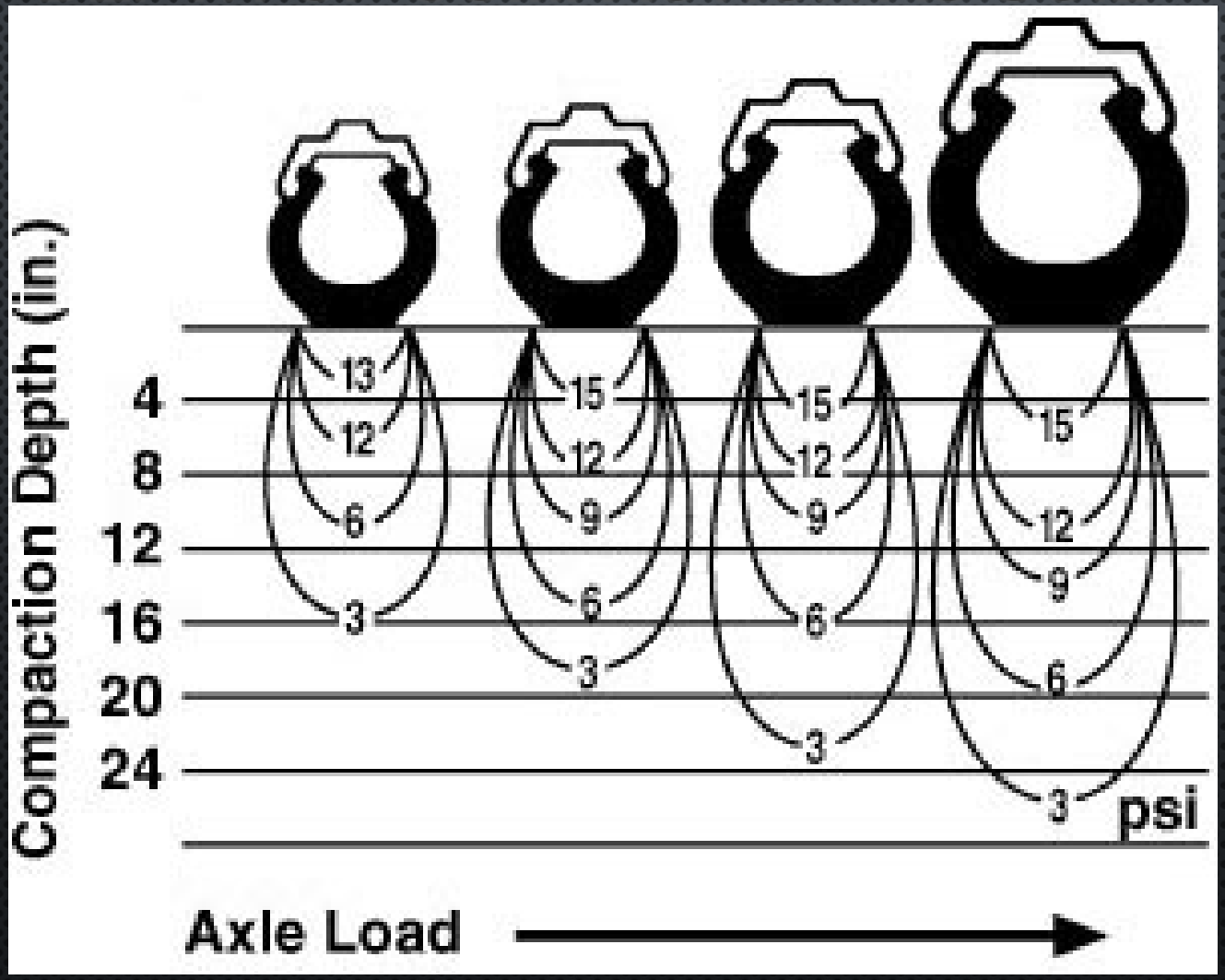
Too wet!

COMPACTION WITH: AXLE LOAD VERSUS SOIL MOISTURE



Tire pressure remained at 12 psi for all tire sizes.

DEPTH OF COMPACTION AS SOIL



Tire size 11x28, load 1,650 lbs., pressure 12 psi

COMPACTION UNDER DUAL TIRES

17 PSI, RUT DEPTH 6.5”

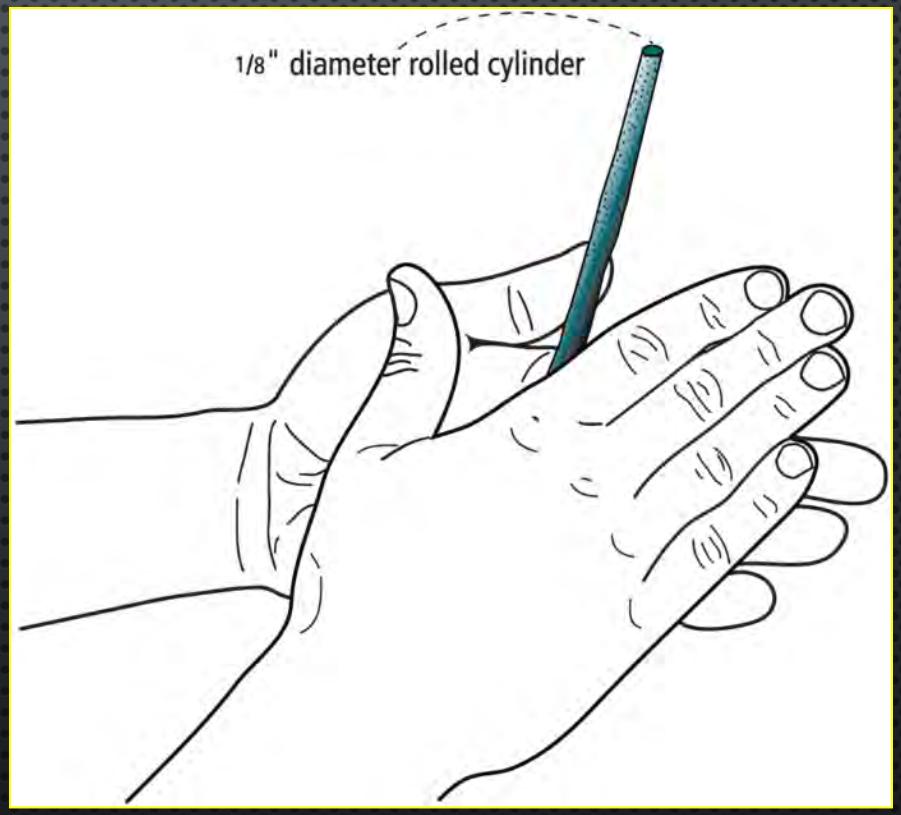
30 PSI, RUT DEPTH 10”

Soil considerations for installation on wet sites

- Excavation only when:
  - Soil is dry enough
  - Soil is below the plastic limit
    - Field check of moisture content

Field Testing of Soil Moisture

- Plastic limit procedure
  - Grab a ped/clump of soil
  - From the soil surface to the depth of installations
  - Do not add water
  - Try to roll into a wire/pencil



Field Testing of Soil Moisture

- If wire/pencil is:
  - 1/8 inch in diameter and
  - 2 inches long without crumbling
    - Moisture content is above plastic limit
    - Construction should NOT proceed

MARK OFF AREAS WHERE TRAFFIC NEEDS TO BE VOIDED

RESERVE AREA ?

VEGETATION REMOVAL

- WHO IS REMOVING?
- TREES – TO AVOID DAMAGING SOIL, CUT AS SHORT AS POSSIBLE AND LEAVE STUMPS IN PLACE TO DECOMPOSE
- CONSULT AN ARBORIST IF CONSTRUCTION IS OCCURRING CLOSE TO TREES
- FOR ABOVE-GRADE SYSTEMS
  - VEGETATION – CUT TO 2 INCHES OR LESS AND REMOVE
  - PURPOSE - NO BARRIER TO MOVEMENT OF EFFLUENT

ROUGHING

- Scarification - process of scratching the absorption area
  - Stake first
  - Proper elevations
  - Green side down
- Backhoe
  - Never drive on loosened soil
- Do not smear or compact soil
- Check if soil is too wet prior

SOIL COMPACTION

Person walking	8-12 psi
Bulldozer - D5 Cat.	7- 9 psi
- D7 Cat.	8-10 psi
- D8 Cat.	10-13 psi
Ag. Tractor - Rear	15-20 psi
- Front	35-45 psi
Rubber-tire Scraper	40-60 psi
Sheepsfoot Roller	> 300 psi
Person in high heels	> 860 psi

COMPACTION STUDY

- A PIECE OF EQUIPMENT RAN OVER A FIELD 10 CONSECUTIVE TIMES
- NATIVE SOILS WITH INTACT TOPSOIL
- MEASURED SOIL DENSITY AFTER EACH PASS & FOUND:
  - 70% OF TOTAL COMPACTION OF ALL 10 PASSES OCCUR WITH 1ST PASS
  - 10% OF TOTAL COMPACTION OF ALL 10 PASSES WITH THE 2ND PASS
  - 5% OF TOTAL COMPACTION OF ALL 10 PASSES WITH THE 3RD PASS

Compaction studies continued

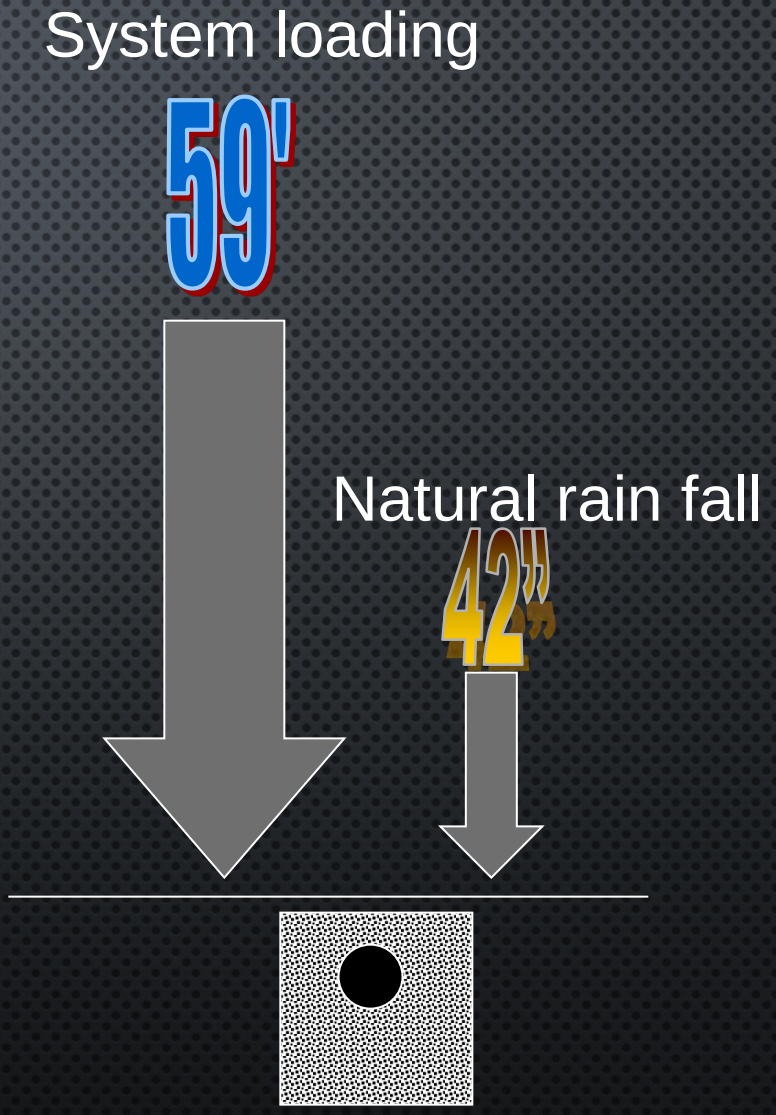
- Other studies have shown up to 90% on the first trip across the field
- These results will be consistent across soil types
  - Other soil condition (removed topsoil, fill, etc. will make this compaction worse)
- By controlling traffic, the travelled area will have a slightly deeper compaction
- Have dedicated construction paths on sites to protect the STA

WHO IS LANDSCAPING?

- Identify in the contract
- Not you?
- Potential negatives
  - Tillage
  - Traffic
  - Irrigation
  - Edible plants
  - Unacceptable plants

WATERING - IRRIGATION

- Light watering may be needed to establish vegetation
- In an average year 30- 42” of rainfall in (not all infiltrates)
- Typical household with 3-4 people puts out 75,000 gallon per year
- In a sandy soil 59’ of water is being added per year
- In a clay loam soil 22’ of water is being added per year
- No irrigation!



SIGNS OF COMPACTION, TOPSOIL AND VEGETATION PROBLEMS

SAND MEDIA INSTALLATION

- MOUNDS AND MEDIA FILTERS
- SAND INSTALLED IN LAYERS/LIFTS OF 6-8 INCHES
- FOOT COMPACTION AND LIGHT WATERING TO REDUCE VOLUME O PORE SPACES
- COMPACTION EQUIPMENT SHOULD NOT BE USED

DENSIFYING THE SAND FILL AREA – NOT COMPACTING!

“Track-in” the fill the width of the tracks to take the “fluff out”

ROCK AS THE DISTRIBUTION MEDIA

COMPACTED SITE – WHAT TO DO?

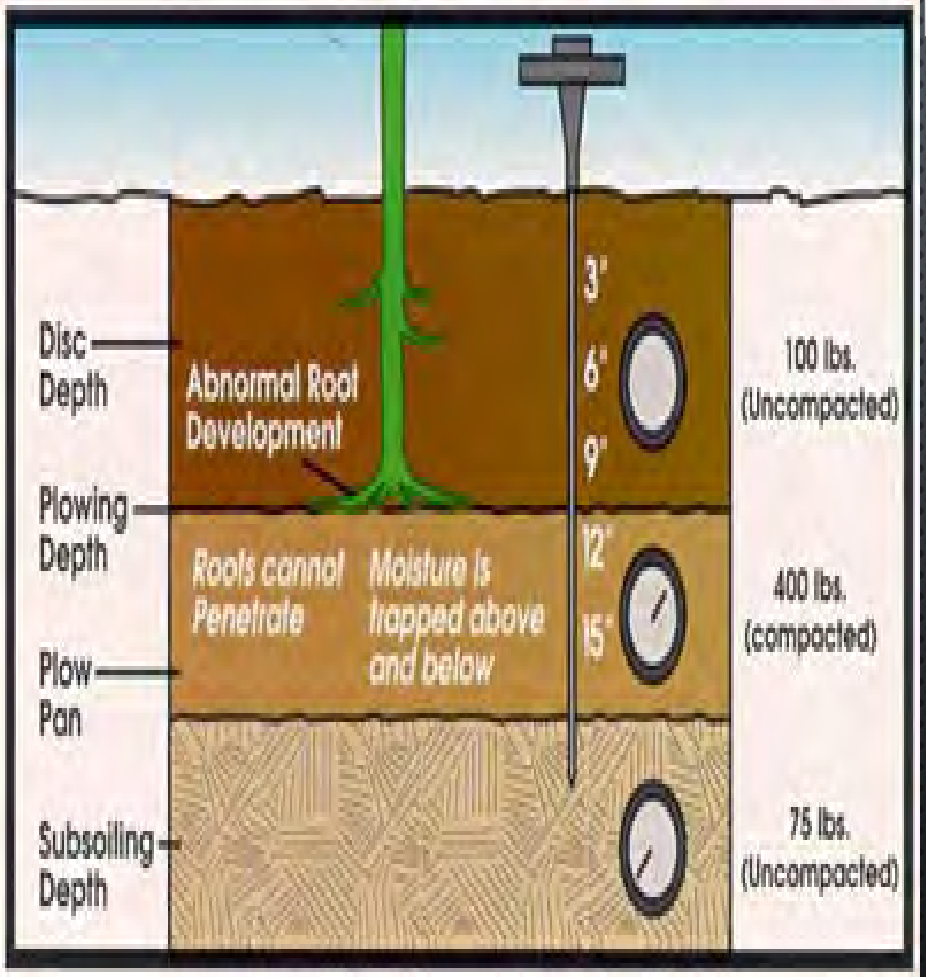
METHODS AND OPTIONS

- AVOID COMPACTION
- DISCUSS OPTIONS WITH DESIGNER/LOCAL UNIT OF GOVERNMENT
- DETERMINE SEVERITY
- MOVE SYSTEM LOCATION
- TIME WILL HELP
  - FREEZE/THAW
  - ROOT ACTIVITY
  - WEATHERING
- EXPERIMENTAL METHODS
  - LOWER LOADING RATES
  - MECHANICAL SOIL FRACTURING (NOT APPROVED IN OHIO)
  - DEEP PLOWING/RIPPING – SHANK IMPLEMENT
  - VEGETATION
  - REMOVING & BACKFILLING

OVERCOMING COMPACTION

- CAN NEVER RETURN TO NATURAL
- TILL/RIP/BUST WHEN DRY!
- TILL/RIP/BUST THROUGH THE WHOLE RESTRICTIVE ZONE!
- ADDITION OF ORGANIC MATTER WILL ASSIST IN THE LONG TERM TO PROVIDE STRUCTURAL STABILITY!

TILLAGE TECHNIQUES TO SHATTER COMPACTED LAYERS



Typical Compaction Situation

VEGETATION TO MITIGATE COMPACTION - NRCS

- Deep rooted crops with large taproots can alleviate the effects of soil compaction by
  - penetrating the compacted layer,
  - creating pore space that allows air, water and crop roots to penetrate deeper in the soil profile
- Reducing soil compaction through the use of deep rooted crops:
  - increases infiltration,
  - reduces surface runoff,
  - improves soil tilth and overall soil quality.
- Takes time

https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1249559&ext=pdf

MUST SHATTER COMPLETELY THROUGH ALL COMPACTED ZONES

METHODS TO LIMIT COMPACTION POST - INSTALLATION

After Install - Maintenance

- First visit should be within the first few weeks/months of use
  - To catch construction damage or errors
  - To be sure controls/alarms are set correctly for the use pattern
  - To check for leaks, including leaky tanks
  - To advise owner/resident on filter use
  - To be sure landscaping does not add depth, compact or cause other damage

Homeowner Challenges

- When the driveway is crowded, they park cars over the septic system
- They construct a wooden deck over the septic tank, hindering access
- They invite:
  - soil compaction, and
  - broken and damaged drainlines, and then
  - wonder why they're having problems with their septic system

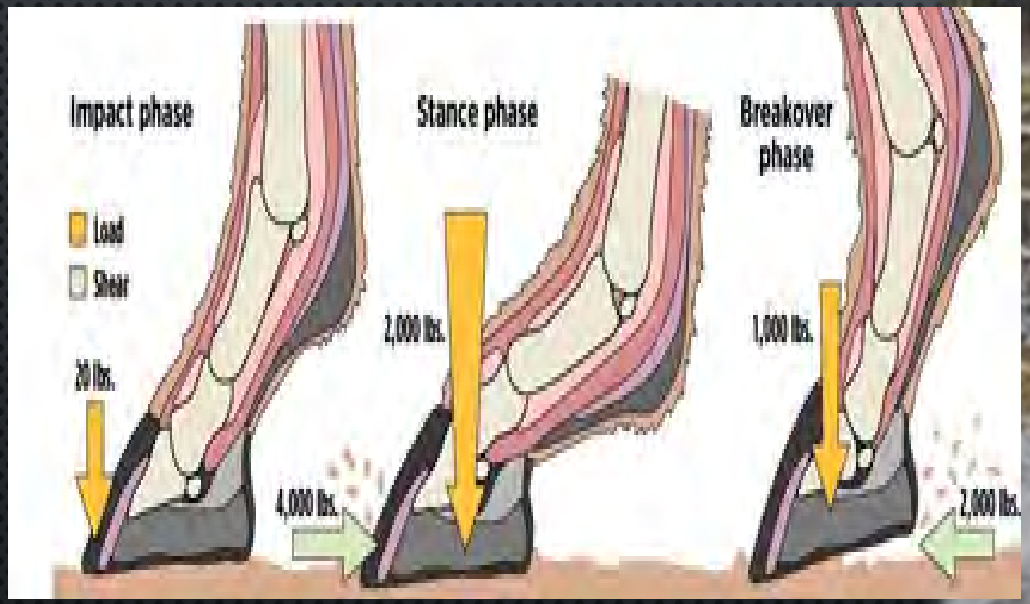
Homeowner Landscaping Dos and Don'ts

- Minimize traffic on the soil system, both human and animal, to avoid soil compaction
  - Do not exercise pets or allow them to play on septic system
  - Never drive a car or other vehicle across the system, and do not mow when the soil is wet
  - Compacted soil can lead to soil erosion and impedes the flow of air around the systems

COMPACTION ACTIVES

- HORSES EXERT 23.0 PSI/HOOF
  - CATTLE WOULD BE SIMILAR
- TYPICAL VEHICLES ~ 30 PSI
- MOWING

HORSE CAUSED COMPACTION



I got a septic system!

1500-gallon 2-compartment septic tank with a PL525 effluent filter (Polylock 525), a 1000-gallon time dosing tank with a Septilink panel (24/7 septic monitoring)

THANKS FOR HAVING ME BE PART OF YOUR CONFERENCE!

SARA HEGER

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