# SOIL SCIENCE 101 for STORM WATER INFILTRATION

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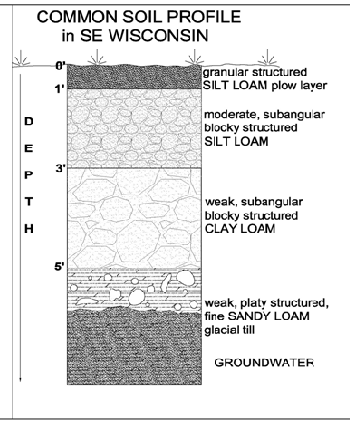



## MORPHOLOGICAL ESTIMATES
(SOIL EVALUATIONS)

- DETERMINE FLOW CAPABILITIES OF SOIL FOR EACH LAYER/HORIZON
- DETERMINE LIMITING LAYERS
- DEPTH TO LIMITING FACTORS
- EFFECTIVE BASIN SIZE
- EFFECTIVE BASIN DEPTH

## SITE EVALUATIONS

- DETERMINE SETBACK LIMITATIONS
- LANDSCAPE ORIENTATION/CONTOURS
- ESTABLISH VERTICAL AND HORIZONTAL REFERENCES FOR EXACT LOCATION OF DRAIN FIELD

## STORMWATER SUBSURFACE INFILTRATION SYSTEMS SOIL & SITE EVALUATION
SPS 382.365(2)

SOIL EVALUATION - as per SPS 385.30(1)(c)

SITE EVALUATION - as per SPS 385.40(3)(a)

EVALUATION BY: Certified Professional Soil Scientist (PSS) or Certified Soil Tester (CST)

## SPS 385.30(1)(c) SOIL EVALAUTION

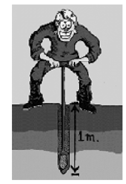
- SOIL HORIZONS
- HORIZON THICKNESS
- MUNSELL SOIL COLORS
- SOIL TEXTURE
- ROCK FRAGMENT PERCENTAGE
- SOIL STRUCTURE
- SOIL CONSISTENCE
- HORIZON BOUNDARY
- REDOXIMORPHIC FEATURES
- SATURATION ZONES

## SPS 385.40(3)(a)
## SITE EVALAUTION

- LEGAL DESCRIPTION (WITHIN 40 ACRES)
- DATE OF OBSERVATION
- SCALED OR DIMENSIONED SITE PLAN
- EXTENT OF TESTED AREA
- SLOPE, TOPOGRAPHY
- LOCATION OF SOIL TESTS, ELEVATIONS
- STRUCTURES, PROPERTY LINES, NON SOIL AREAS
- VERTICAL AND HORIZONTAL REFERENCE POINTS
- ANY FLOODPLAIN ELEVATIONS

## START WITH TEST HOLES

- BACKHOE PITS (PREFERRED)
- 1 or 2 PITS/BORINGS MINIMUM (varies)
- MINIMUM 5 FEET DEEP (OR MIN. 3 FOOT BELOW PROPOSED INFILTRATION DEVICE ELEVATION (but varies with type of infiltration)




| INFILTRATION DEVICE | MIN. NUMBER OF TESTS (BORINGS vs PITS) | MIN. DEPTH BELOW INFILTR. SYSTEM |
|---|---|---|
| INFILTRATION TRENCHES <2000 SQ.FT. | 1 (EITHER) PER 100 LINEAR FT. MIN.2 | 5 FT. OR LIMITING LAYER |
| INFILTRATION TRENCHES >2000 SQ.FT. | 1 PIT PER 100 LINEAR FT. + ADD. PIT OR BORING | PITS TO 5 FT. BORINGS TO 15 FT. OR LIMITING LAYER |
| BIORETENTION | 1 (EITHER) PER 50 LINEAR FT. MIN.2 | 5 FT. OR LIMITING LAYER |
| GRASSED SWALES | 1 (EITHER) PER 1000 LINEAR FT. MIN.2 | 5 FT. OR LIMITING LAYER |
| SURFACE INFILTRATION BASINS | 2 PITS/AREA + ADD. PIT OR BORING/10,000 SQ.FT. | PITS TO 10 FT. BORINGS TO 20 FT. OR LIMITING LAYER |

| INFILTRATION DEVICE | MIN. NUMBER OF TESTS (BORINGS vs PITS) | MIN. DEPTH BELOW INFILTR. SYSTEM |
|---|---|---|
| SUBSURFACE INFILTRATION BASINS >15' WIDE | 2 PITS/AREA + ADD. PIT OR BORING/10,000 SQ.FT. | PITS TO 10 FT. BORINGS TO 20 FT. OR LIMITING LAYER |

SOIL EVALUATION - STORM

Page 1 of 3

County: WAUKESHA

Property Owner: RIVER GLEN CHRISTIAN CHURCH

Property Location: NE 1/4, NW 1/4, S 15, T 6 N, R 18 E

Property Owner's Mailing Address: S31 W30601 SUNSET DR.

Lot # 1

City, State, Zip Code: WAUKESHA, WI 53189 | Phone Number: 262 968-5252

Town: GENESEE | Nearest Road: SUNSET DR.

Drainage area: 1.00 ☐ sqft. ☒ acres

☒ Morphological Evaluation

1 Obs. # ☐ Boring ☒ Pit | Ground surface elev. 961.68' | Depth to limiting factor N/A

| Horizon | Depth inches | Dominant Color Munsell | Redox Description Qu. Sz. Cont. Color | Texture | Structure Gr.Sz.Sh. | Consistence (Moist) | Boundary | % Rock Fragmts | Hydraulic App. Rate Inches/Hr |
|---|---|---|---|---|---|---|---|---|---|
| Ap | 0-10 | 10YR3/3 | | sl | 2mgr | vfr | as | 4 | 0.5 |
| C1 | 10-36 | 10YR5/4 | | vf sl | 1fsbk | vfr | cs | 8 | 0.5 |
| C2 | 36-96 | 10YR5/6 | | sl | 1fpl | vfr | | 10 | 0.5 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

2 Obs. # ☐ Boring ☒ Pit | Ground surface elev. 966.0' | Depth to limiting factor 82"

| Horizon | Depth inches | Dominant Color Munsell | Redox Description Qu. Sz. Cont. Color | Texture | Structure Gr.Sz.Sh. | Consistence (Moist) | Boundary | % Rock Fragmts | Hydraulic App. Rate Inches/Hr |
|---|---|---|---|---|---|---|---|---|---|
| FILL 1 | 0-6 | 10YR3/3 | | sl | 2fsbk | vfr | as | 7 | 0.5 |
| FILL 2 | 6-82 | 10YR5/4 | | sl | 1fsbk | vfr | ai | 10 | 0.5 |
| C | 82-96 | 10YR5/3 | c3f10YR5/3 | vf sl | 1fpl | vfr | | 10 | 0.5 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

CST Name: JEFFREY L. HAMMES | Signature: | CST Number 223300
Address: 820 WILLIAMSON ST. #401, MADISON, WI 53703 | Date Evaluation Conducted | Telephone No. (608)276-9000

1 Obs.# ☐ Boring ☒ Pit | Ground surface elev. 961.68' | Depth to limiting factor N/A

| Horizon | Depth inches | Dominant Color Munsell | Redox Description Qu. Sz. Cont. Color | Texture | Structure Gr.Sz.Sh. | Consistence (Moist) | Boundary | % Rock Fragmts | Hydraulic App. Rate Inches/Hr |
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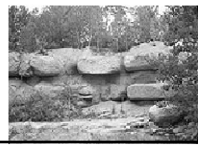
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

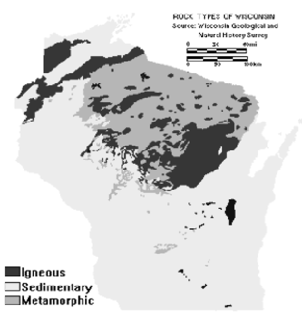
# PARENT MATERIAL OF SOIL

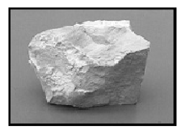
- FROM WEATHERING OF ROCK IN PLACE
- TRANSPORTED MATERIAL
  - BY WATER
  - BY GRAVITY/ EROSION
  - BY WIND
  - BY GLACIERS
- ORGANIC MATERIAL



- Soil is the outermost layer of our planet.
- Soil is formed from rocks and decaying plants and animals.
- An average soil sample is 45 percent minerals, 25 percent water, 25 percent air, and five percent organic matter (living & dead organisms).
- Natural processes can take >500 years to form one inch of topsoil.
- There are over 70,000 kinds of soil in the United States.

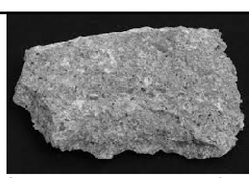
# MATERIAL PRODUCED BY WEATHERING OF ROCK IN PLACE



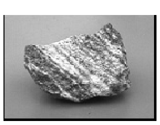



**Limestone** rocks are sedimentary rocks that are made from the mineral calcite which came from the beds of evaporated seas and lakes and from sea animal shells.

**Sandstone** rocks are sedimentary rocks made from small grains of the minerals quartz and feldspar. They often form in layers



**Granite** is an example of igneous rock that formed by the solidification of molten material within the earth.



**Gneiss** is an example of metamorphic rocks. These rocks may have been an igneous rock such as granite or a sedimentary rock such as sandstone, but heat and pressure reformed them. The mineral grains in the rock are flattened through tremendous heat and pressure and arranged in alternating patterns.

# WEATHERING OF ROCKS

| Original Mineral | | Weathering |
|---|---|---|
| Iron silicates | ⇨ | Clay & Iron Oxide |
| Feldspar | ⇨ | Clay & K,Na,Ca ions |
| Quartz | ⇨ | Sand |
| Mica | ⇨ | Clay & K ions |
| Calcite | ⇨ | Calcium ions |
| Shale | ⇨ | Clay |
| Sandstone | ⇨ | Sand |
| Limestone | ⇨ | Clay & Sand |

SOIL IMPORTED BY WATER

**ALLUVIUM**

**SOIL FORMED FROM GRAVITY**

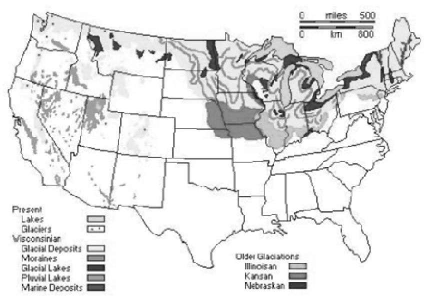
**COLLUVIUM**

**(EROSION)**

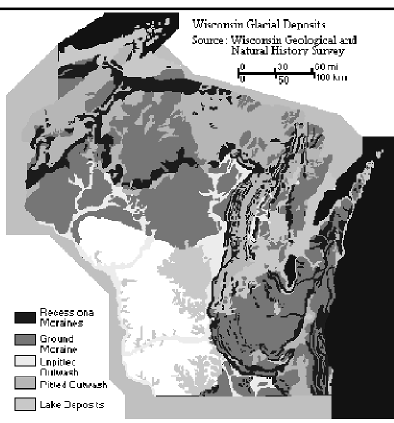
WIND BLOWN DEPOSITS

**LOESS**

**VOLCANIC ASH**




GLACIERS




GLACIER

# SOME GLACIAL TERMS

DRUMLIN – CIGAR SHAPED HILL FORMED FROM LARGE ICE CHUNKS SCAPING AND MELTING. THEY ALWAYS POINT THE DIRECTION OF THE GLACIER
ESKER – NARROW, SINUOUS RIDGES OF SAND AND GRAVEL FROM ELEVATED STREAM BED
KETTLE – SHALLOW BASIN FORMED BY A BURIED LARGE ICE CHUNK
LACUSTRINE – MATERIAL LEFT FROM GLACIAL LAKES – FINE SEDIMENT
MORAINE –GENTLE ROLLING HILL OF DEPOSITED GLACIAL TILL
OUTWASH – SAND AND GRAVEL WASHED OUT FROM GLACIAL MELTWATER STEAMS
TILL – DIRECTLY DEPOSITED GLACIAL DEBRIS WITH MIXED TEXTURES

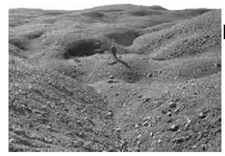

DRUMLIN

KETTLE



ESKER

OUTWASH PLAIN



MORAINE

# ORGANIC SOURCES OF SOIL

**LEAF LITTER** INTO **PEAT**


## The SOIL SERIES

- The basic mapping unit for soils
- Soils of similar characteristics : color, texture, structure, horizons, pedogenesis
- Named after town where first identified
- Abbreviations indicate name/slope/erosion: e.g. HmB2 = Hochheim loam (Hm), 2-6% slope (B) and eroded (2)
- Abbreviation name ( Hm) not same in every county

## NEW SOIL CLASSIFICATION --SIMPLE DESCRIPTIVE NAMES--

e.g. HOCHHEIM LOAM:

OLD DESCRIPTION: MIXED, MESIC BRUNIZEM
NEW CLASSIFICATION: TYPIC ARGIUDOLL

TYPIC = A SOIL TYPICAL TO ALL THE OTHERS IN THAT SOIL SERIES GROUPING (mixed)
ARGIUDOLL = HUMUS & CLAY ACCUMMULATION (brunizem)
ARGIUDOLL = FOUND IN HUMID CLIMATES (mesic)
ARGIUDOLL = OF THE SOIL ORDER: MOLLISOLS (FORMED UNDER PRAIRIE GRASSES WITH FERTILE UPPER LOAMY HORIZON)

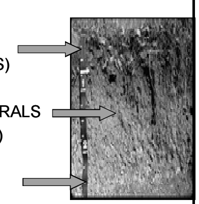
## SOIL HORIZONS

LAYERS OF SOIL THAT HAVE SIMILAR COLOR, TEXTURE AND STRUCTURE

"A" HORIZON (TOPSOIL MINERAL HORIZON WHERE ORGANIC MATTER ACCUMULATES)

"B" HORIZON (ACCUMULATION OF CLAY MINERALS FROM "A" HORIZON, BLOCKY STRUCTURE)

"C" HORIZON (MINERAL HORIZON SIMILAR TO PARENT MATERIAL SUCH AS BEDROCK, GLACIAL DEPOSITS OR SEDIMENTS)



## SOIL HORIZONS HAVE SUB-HORIZONS

SOME COMMON SUB-HORIZONS

- “p” = PLOW LAYER
- “t” = HIGHER CLAY CONTENT
- “b” = BURIED HORIZON

Ap = TOPSOIL HORIZON FROM PLOWING
Bt = SUBSOIL HIGHER IN CLAY
Ab = BURIED “A” HORIZON

## SOIL COLOR

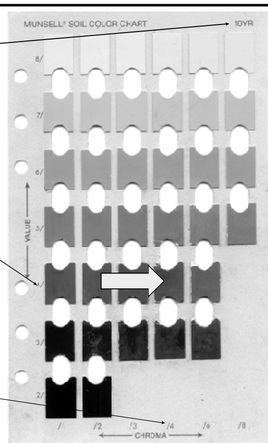
- BASED ON MUNSELL SOIL COLOR CHARTS USING MOIST SOIL SAMPLES
- HUE, VALUE AND CHROMA (10YR 4/4)
  - HUE (10YR) = SPECTRAL COLOR
  - VALUE (4/) = LIGHTNESS OF HUE
  - CHROMA (/4) = CONCENTRATION OF HUE
- PROPER LIGHT CONDITIONS

- DARKER – ORGANIC MATTER
- RED, YELLOW – IRON OXIDES
- REDOXIMORPHIC COLORS – SATURATION

10YR

4/

/4




## SOIL TEXTURE

- SOIL SEPARATES ARE SAND, SILT & CLAY
- DEFINITION: THE RELATIVE PROPORTION (%) OF SOIL SEPARATES IN THE SOIL
- STRONG INFLUENCE ON WATER MOVEMENT
- 12 TEXTURAL IDENTIFICATIONS
- PARTICLE SIZE MODIFIER (FINE, COARSE)

## SOIL TEXTURE PARTICLES–SIZE COMPARISON

SAND = 0.05 mm to 2.0 mm

(2 mm = + 1/16 inch)

Very coarse = 1.0 – 2.0 mm

Coarse = 0.5 – 1.0 mm

Medium = 0.25 - 0.5 mm

Fine = 0.1 – 0.25 mm

Very fine = 0.05 – 0.1 mm

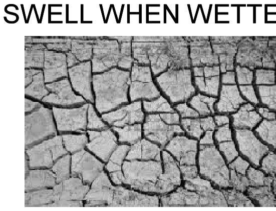
SILT = 0.002 mm to 0.05 mm

marble

CLAY = < 0.002 mm . ⟵ a pinhole

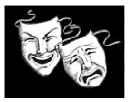
## CLAY

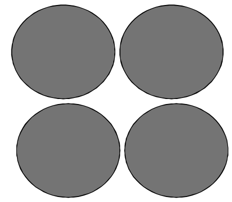
- MASSIVE SURFACE AREA
- HOLDS WATER TIGHTLY
- CAN SHRINK WHEN DRIED
- CAN SWELL WHEN WETTED



## CLAY PARTICLES IN THE SOIL

- LARGE SURFACE AREA
- CLAY IMPROVES TREATMENT
- CLAY RESTRICTS WATER MOVEMENT
- 28% CLAY = CLAY LOAM SOIL
- 40% CLAY = CLAY SOIL (NOT LOAM)

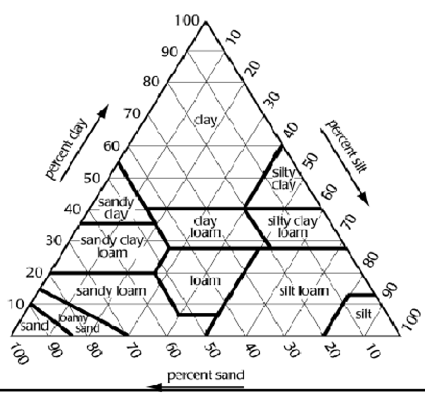




Sand: large particles, large pores

Clay: little particles, tiny pores

THE TEXTURAL TRIANGLE




## SOIL STRUCTURE

- A **MAJOR** EFFECT ON WATER MOVEMENT (HYDRAULIC FLOW)
- DEFINITION: THE AGGREGATION OF SOIL PARTICLES INTO PEDS
- LARGE AND SMALL PORES
- DESCRIBED AS: GRANULAR
  - BLOCKY
  - PRISMATIC
  - PLATY
  - SINGLE GRAINED
  - MASSIVE

## SOIL STRUCTURE

Soil structure determines the **amount and arrangement of empty spaces in the soil**, influencing on how readily water moves through the soil and where plant roots can grow.

A PED IS TO A SOIL PARTICLE IS LIKE A MOLECULE TO AN ATOM

-an individual aggregate of soil

-usually the end result of applying slight hand force to a clump of soil

-not to be confused with a soil "pedon" which is a larger unit (1 to 10 square meters) of a soil body in the root zone

## WHAT “MAKES” SOIL STRUCTURE?

- COLLOIDAL MATTER
- WATER
- MICRO-ORGANISMS
- TEMPERATURE
- VEGETATION
- INSECTS,WORMS,ANIMALS
- HUMAN ACTIVITY

## COLLOIDAL MATTER THE CEMENT

- STICKY CLAY MINERALS
- OXIDES OF IRON AND MANGANESE
- MICROBIAL GUMS FROM ORGANIC MATTER

## **WATER MAKES SOIL STRUCTURE**

- **WATER MOLECULES COLLECT COLLOIDAL PARTICLES AS THEY JOURNEY THROUGH THE SOIL**
- **EVAPORATING WATER DEPOSITS THE COLLOIDAL PARTICLES AND THE SOIL PARTICLES ARE DRAWN TOGETHER**
- **REPEATED WETTING AND DRYING CYCLES ENHANCE SOIL PARTICLE AGGREGATION**

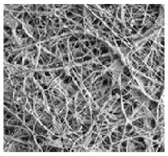
## RAINDROP IMPACT

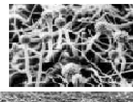
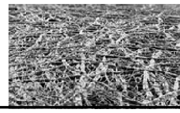
SHATTERS FINE SOIL PARTICLES CAUSING EROSION ON SLOPES

FINE PARTICLES AND HYDRATES CAN CREATE CRUST (CEMENTATION) ON SURFACE

## MICRO-ORGANISMS MAKE STRUCTURE

- THREADLIKE FUNGAL MYCELIUM BIND SOIL PARTICLES
- GUMS, FATS AND WAXES SLOUGHED OFF RESIST WETTING AND ACT LIKE CEMENT



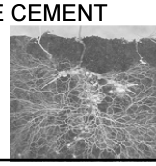



## HOW DOES TEMPERATURE CREATE SOIL STRUCTURE?

- REPEATED FREEZING AND THAWING OF WATER IN THE SOIL
- ICE CRYSTALS COMPRESS SURROUNDING SOIL PARTICLES TOGETHER. FREEZING INCREASES VOLUME BY 9%
- FREEZING REMOVES LIQUID WATER DRAWING SOIL PARTICLES TOGETHER USING THE CEMENTING COLLOIDAL MATTER

## VEGETATION AND SOIL STRUCTURE

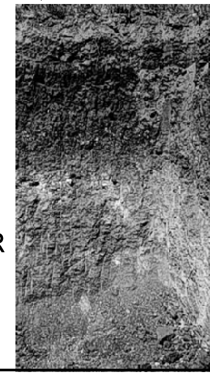
- ROOTS PENETRATE THE SOIL AND PRODUCE LINES OF WEAKNESS AMONG SOIL PARTICLES
- EXPANDING ROOTS PUSH PARTICLES TOGETHER
- ROOT SECRETIONS ACT LIKE CEMENT
- ROOTS REMOVE WATER FROM SOIL / AGGREGATION THROUGH SHRINKAGE



## ANIMALS, WORMS, INSECTS

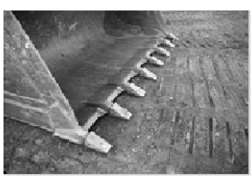
- BURROWING,
- CHANNELING
- EXCRETING

PRESS AND CEMENT PARTICLES TOGETHER



## HUMAN ACTIVITY

- EXCAVATION, FILLING
- COMPACTION
- AGRICULTURAL PRACTICES



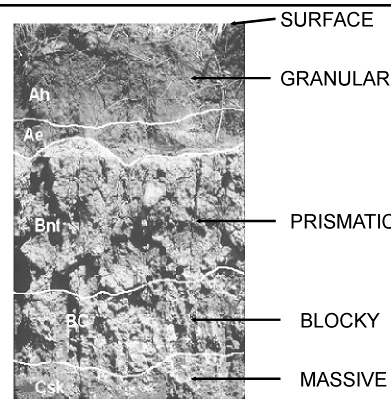
## SOIL STRUCTURE DESCRIBED

**GRANULAR**
**BLOCKY**
**PRISMATIC**
**PLATY**
**SINGLE GRAINED**
**MASSIVE**

## STRUCTURE GRADES

(excluding massive)

- WEAK
  - PEDS ARE BARELY VISABLE IN PLACE
  - PARTIAL AGGREGATION
- MODERATE
  - PEDS ARE WELL FORMED AND EVIDENT
  - WHOLE PEDS CAN BE REMOVED FROM PROFILE
- STRONG
  - PEDS ARE VERY DISTINCT IN PLACE
  - PEDS ARE RIGID AND DURABLE WHEN IN HAND



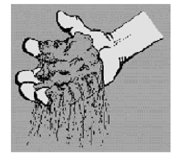
## SOIL CONSISTENCE

- **DEFINITION: RESISTANCE OF SOIL TO DEFORMATION OR RUPTURE.**
- **THE COHESION AND ADHESION OF SOIL**
- **DESCRIBED (MOIST SOIL) AS:**
  - **LOOSE**
  - **VERY FRIABLE**
  - **FRIABLE**
  - **FIRM**
  - **VERY FIRM**
  - **EXTREMELY FIRM**
- **SOIL DENSITY AFFECTS WATER MOVEMENT**

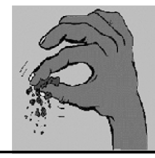
DETERMINING MOIST SOIL CONSISTENCE

MOISTEN SOIL

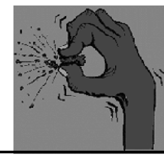
LOOSE



FRIABLE?



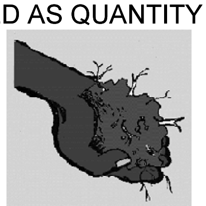
FIRM?



EXCESSIVELY FIRM?
COMPACTED?

ROOTS (NOT REQUIRED TO REPORT) BUT

- HELPS TO DECIDE WHAT IS "SOIL"
- HELPS TO INCORPORATE FILL SOIL
- HELPS TO AERATE SOIL
- VERIFICATION OF SOIL STRUCTURE
- MEASURED AS QUANTITY AND SIZE



## BOUNDARY

- DEFINED: THE TRANSITION BETWEEN HORIZONS
- THICKNESS IS EITHER ABRUPT (<1"), CLEAR (1 – 3"), GRADUAL (3 – 6") OR DIFFUSE (>6")
- BOUNDARY TOPOGRAPHY IS SMOOTH, WAVY, IRREGULAR OR BROKEN

## % ROCK FRAGMENTS

- Specification under SPS 382.365 for piped subsurface infiltration
- DEFINED: Unattached pieces of rock 2mm in diameter or larger
- Content is measured by volume, not weight
- Used in determining soil suitability for stormwater infiltration

MIN. 3 FEET SUITABLE SOIL, +20%FINES (PASS #200 SIEVE)

| SOIL TEXTURE | MAX. ROCK FRAGMENT (VOL.) | SUITABILTY |
|---|---|---|
| COARSE SAND (cos)<br>LOAMY C. SAND (lcos)<br>SAND (s)<br>LOAMY SAND (ls)<br>FINE SAND (fs)<br>LOAMY FINE SAND (lfs) | ------------- | NOT SUITABLE IF <20% FINES BY LAB ANALYSIS (excluding coarse sand) |
| VERY FINE SAND (vfs) | <20% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>20% |
| LOAMY VERY FINE SAND (lvfs) | <63% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>63% |

## MIN. 3 FEET SUITABLE SOIL, +20%FINES (PASS #200 SIEVE)

| SOIL TEXTURE | MAX. ROCK FRAGMENT (VOL.) | SUITABILTY |
|---|---|---|
| CO. SANDY LOAM (cosl)<br>SANDY LOAM (sl)<br>FINE SANDY LOAM (fsl) | <13% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>13% |
| VERY FINE SANDY LOAM (vfsl) | <47% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>47% |
| LOAM (l) | <58% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>58% |

## MIN. 3 FEET SUITABLE SOIL, +20%FINES (PASS #200 SIEVE)

| SOIL TEXTURE | MAX. ROCK FRAGMENT (VOL.) | SUITABILTY |
|---|---|---|
| SILT LOAM (sil) | <68% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>68% |
| SILT (si) | <75% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>75% |

## MIN. 3 FEET SUITABLE SOIL, +20%FINES (PASS #200 SIEVE)

| SOIL TEXTURE | MAX. ROCK FRAGMENT (VOL.) | SUITABILTY |
|---|---|---|
| SANDY CLAY LOAM (scl) | <43% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>43% |
| CLAY LOAM (cl) | <63% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>63% |
| SILTY CLAY LOAM (sicl) | <75% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>75% |

## MIN. 3 FEET SUITABLE SOIL, +20%FINES (PASS #200 SIEVE)

| SOIL TEXTURE | MAX. ROCK FRAGMENT (VOL.) | SUITABILTY |
|---|---|---|
| SANDY CLAY (sc) | <56% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>56% |
| CLAY (c) | <63% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>63% |
| SILTY CLAY (sic) | <75% | LAB ANALYSIS REQ. TO VERIFY % FINES IF ROCK FRAG.>75% |

| | MIN. 3' SOIL SEPARATION | | MIN. 5' SOIL SEPARATION | |
|---|---|---|---|---|
| TEXTURE | MAX. ROCK FRAG. | SUITABILTY | MAX. ROCK FRAG. | SUITABILTY |
| cos,s,fs, lcos, ls, lfs | ------------------ | No | ------------------ | No |
| vfs | <20% | Yes | <60% | Yes |
| lvfs | <63% | Yes | <82% | Yes |
| cosl,sl,fsl | <13% | Yes | <56% | Yes |
| vfsl | <47% | Yes | <74% | Yes |
| l | <58% | Yes | <79% | Yes |
| sil | <68% | Yes | <84% | Yes |
| si | <75% | Yes | <88% | Yes |
| scl | <43% | Yes | <71% | Yes |
| sicl | <75% | Yes | <88% | Yes |
| cl | <63% | Yes | <81% | Yes |
| sc | <56% | Yes | <78% | Yes |
| sic | <75% | Yes | <88% | Yes |
| c | <63% | Yes | <82% | Yes |

## METHODS FOR ESTIMATING % ROCK FRAGMENTS

- AREAL TRANSECT
- SHOVEL SAMPLE
- PILE ESTIMATE
- WEIGHT CORRELATION to VOLUME

## REDOXIMORPHIC FEATURES

- PRIMARY INDICATORS OF SATURATION, HIGH GROUNDWATER OR POOR HYDRAULICS
- ANAEROBIC CONDITIONS
- IRON DEPLETIONS MOST PROMINENT
- CONSTANT REDUCED CONDITIONS = GLEYED
- FORMATION DEPENDENT ON TEMPERATURE, pH, PRESENCE OF IRON AND MANGANESE, BACTERIA
- CALLED "REDOX FEATURES" OR "MOTTLES"

## REDOX FEATURE DESCRIPTIONS

- QUANTITY
  - FEW < 2%
  - COMMON 2 – 20 %
  - MANY >20%
- SIZE
  - FINE <5 mm
  - MEDIUM 5 - 15mm
  - COARSE >15 mm
- CONTRAST
  - FAINT – DIFFICULT TO SEE
  - DISTINCT – READILY SEEN
  - PROMINENT – CONSPICUOUS
- MUNSELL COLORS USED

## In Wisconsin a detailed SOIL INTERPRETATION is required

WHEN REDOXIMORPHIC FEATURES ARE NOT INDICATIVE OF RECENT SEASONAL SATURATION

## SOIL INTERPRETATION IS:

- VERY DETAILED SOIL MORPHOLOGY
- HISTORICAL INFORMATION: HYDROLOGY, SOIL MAPS
- PREDICTING THE HYDRAULIC CAPABILITY AND UNIFORMITY OF THE SOIL
- BEST STORMWATER TREATMENT OPTIONS
- DESCRIPTIVE EVIDENCE; e.g. VEGETATION, DRAINAGE, TOPOGRAPHY, REDOX FEATURES, GROUNDWATER, ETC.
- HAS MOSTLY REPLACED THE USE OF MONITOR WELLS SINCE 2000

## OBSERVED GROUNDWATER

- MAY NOT BE DISCERNABLE WITH REDOX FEATURES
- FLUCTUATION DEPENDENT ON SOIL TYPES, PRECIPITATION EVENTS
- ALL SOIL PORES ARE FILLED WITH WATER
- WATER FLOWS OUT OF THE SOIL INTO PITS AND BORINGS

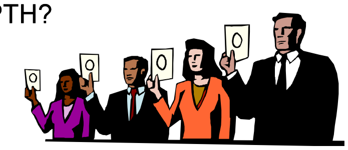
## THE RESULTS: DESIGN INFILTRATION RATES for SOIL TEXTURES RECEIVING STORMWATER

- RATES BASED ON SOIL TEXTURE
- OTHER SOIL FEATURES MAY BE CONSIDERED
- RATES IN INCHES/HOUR
- RANGE IS 0.3 FOR CLAY LOAM TO 3.6 FOR SANDY SOILS
- COARSER SOILS ELIMINATED DUE TO LACK OF FINES
- ROCK FRAGMENT CONTENT SIGNIFICANT for SUBSURFACE PIPED INFILTRATION

| SOIL TEXTURE | DESIGN INFILTRATION RATE (IN/HR) |
|---|---|
| SAND, CO. SAND, LOAMY CO. SAND | 3.60 |
| LOAMY SAND | 1.63 |
| SANDY LOAM, F. SAND, LOAMY F. SAND, V.F.SAND, LOAMY V.F.SAND | 0.50 |
| LOAM | 0.24 |
| SILT LOAM | 0.13 |
| SANDY CLAY LOAM | 0.11 |
| CLAY LOAM | 0.03 |
| SILTY CLAY LOAM | 0.04 |
| SANDY CLAY | 0.04 |
| SILTY CLAY | 0.07 |
| CLAY | 0.07 |

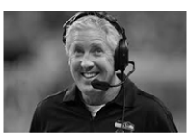
## WHAT IS THE IDEAL SOIL FOR STORMWATER INFILTRATION?

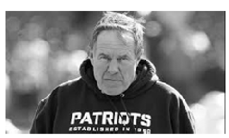
- TEXTURE?
- STRUCTURE?
- CONSISTENCE?
- HORIZONIZATION?
- DEPTH?



## CONFLICTS OF TREATMENT VS. HYDRAULICS OBJECTIVES

| TREATMENT | HYDRAULICS |
|---|---|
| **FINE TEXTURED SOILS** | **COARSE TEXTURED SOILS** |
| **CARBON SOURCE** | **LOW ORGANIC MATTER** |
| **LONG RETENTION TIME** | **NO RETENTION** |
| **SMALL PORES** | **LARGE PORES** |






## HORIZONALIZATION - LAYERS

- AVOID LAYING INFILTRATION SYSTEMS ACROSS STRONGLY CONTRASTING SOIL TEXTURES OR HORIZONS
- USE INFILTRATION RATES BASED ON MOST RESTRICTIVE SOIL WITHIN EFFECTIVE APPLICATION ZONE

## HOW TO DO SIMPLE FIELD TOPOGRAPHY

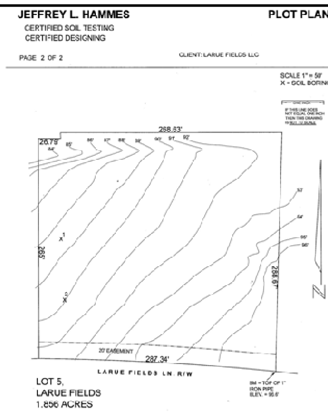
1. Find a BASELINE (building, straight fence, road edge, two permanent points)
2. MARK the borings with flag at points for measuring
3. Create and equal GRID around the borings with flags , then locate all borings and flags
4. SHOOT elevations
5. DRAW contour lines

## SOIL AND SITE EVALUATION REPORTS

- **PUTS ALL THE SOIL INFORMATION TOGETHER**
- **STANDARDIZED FORMS FOR WISCONSIN**
- **INFILTRATION RATES STATED**
- **USED FOR SURFACE OR SUBSURFACE INFILTRATION DESIGNS**

1 Obs. # ☐ Boring ☒ Pit Ground surface elev. 961.68' Depth to limiting factor N/A

| Horizon | Depth Inches | Dominant Color Munsel | Redox Description Qu. Sz. Cont. Color | Texture | Structure Gr.Sz.Sh. | Consistence (Moist) | Boundary | % Rock Fragmts. | Hydraulic App. Rate Inches/Hr |
|---|---|---|---|---|---|---|---|---|---|
| Ap | 0-10 | 10YR3/3 | | sl | 2mgr | vfr | as | 4 | 0.5 |
| C1 | 10 36 | 10YR5/4 | | vf sl | 1fsbk | vfr | cs | 8 | 0.5 |
| C2 | 36-96 | 10YR5/5 | | sl | 1fpl | vfr | | 10 | 0.5 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |




## ISSUES WITH DESIGN INFILTRATION RATES

DO ROCK FRAGMENTS AFFECT SUBSURFACE FLOW?

WHAT ABOUT SOIL STRUCTURE?

INFILTRATION RATES: CLAY vs CLAY LOAM

SOIL ENGINEERING vs SOIL SCIENCE

## SOIL SURVEY IFORMATION ON COUNTY WEBSITES

- PROBLEM WITH OLDER AREAL PHOTOS (PRE-1975)
- PROBLEM WITH EXTRAPOLATION OF SOIL SURVEY INFORMATION TO GIS WEBSITES EXPANDABLE TO LARGE SCALES
- PROBLEM WITH SOIL SURVEY GENERALIZATIONS USED FOR PLANNING