Basic Soil Concepts

Overview
- Basics of Soil
  - Soil formation
- Landscape position
- Soil Properties
  - Texture
  - Color
- Hydric soil development
- Web Soil Survey
- Interpreting soil reports

What is Soil?
- Natural body that occurs on the land surface, occupies space, and is characterized by one or both of the following:
  - Horizons or layers, or
  - The ability to support rooted plants in a natural environment
- Upper limit is air or shallow (>2.5 m) water
- Lower limit is either bedrock or the limit of biological activity
- Lower limit for classification set at an arbitrary 2 m

Factors That Influence Soil Development
- Climate - weather conditions prevailing over long period of time
- Parent material - geologic material from which soils form
- Topography - landscape position and slope processes
- Organisms - essential role of microbes in the soil, includes humans
- Time - soil doesn’t “age”, it develops. vegetation, organisms and climate “act on” parent material and topography to develop soil.

Landscape Position
- Location relative to other landforms
- Critically influences water flow and soil formation
- Most wetlands, even groundwater seeps, are on some sort of concave surface

Soil Catena
- Wetland Boundary?
- Modified from Pennock et al., 1987

Divergent
Convergent
Slope Block Contour
Hill Slope Elements and Curvature
Upslope
Upslope
After Pennock et al., 1987

Overland and Throughflow:
- Convergent landscapes
- Throughflow
- Runoff
- Infiltration
- Percolation
- Potential hydric soil zone
  - “Epiaquic”
  - “Endoaquic”
- Modified from Pennock et al., 1987
Two Categories of Soil Material
- Mineral Soil/Horizons

Mineral horizons
- Primarily sand, silt, and clay, with varying amounts of organic matter

Organic horizon
- Consists of mostly decomposed organic material

Organic Matter Decomposition
- Fibric (peat)
  - Least decomposed
  - Plant fibers identifiable
  - >40% of fibers still visible
- Hemic (mucky peat)
  - Intermediate decomposition
- Sapric (muck)
  - Most decomposed: <2/3 of plant fibers
  - <1/6 of fibers visible after rubbing

Key Soil Properties
- Horizons - layer of soil with similar physical, chemical, and biologic properties
- Texture - relative proportion of soil particles (sand, silt, clay)
- Structure - arrangement of solid parts and of the pore spaces located between them
- Permeability - ability of water to move through a material
- Color - hue, value, chroma
- Organic matter - percent, thickness, and level of organic decomposition
- Drainage - presence of natural and human drainage on a landscape

Soil Horizon - layer of soil with similar physical, chemical, and biologic properties
- O horizon - Organic horizon, thickness varies
- A horizon - Organic accumulation (typically ~10%), ideally granular structure
- E horizon - Coloring agents (Fe, Organics) removed
- B horizon - Subsoil accumulation of minerals, organics, and sometimes chemicals, blocky structure
- C horizon - Similar to parent material, often less developed with little structure
- R horizon - Parent material

Soil Texture - Relative proportion of soil particles
- Sand (0.05-2.00 mm)
- Silt (0.002-0.05 mm)
- Clay (<0.002 mm)

Soil Structure
- Soil Structure - arrangement of solid parts and of the pore spaces located between them
- Aggregation - interaction and arrangement of soil particles
- Precipitation of oxides, carbonates and silicates
- Cementation
- Can decline under cultivation & irrigation
Permeability - ability of water or air to move through the soil profile

- Variables in permeability:
  - Structure - arrangement of soil characterized by size, shape (blocky, columnar, platy, etc), and grade (weak, strong)
  - Porosity - pore space of different particle sizes
  - Permeability is measured in inches per hour
  - Permeability is actually an estimated property
  - Larger grain sizes = higher permeability

Capillary Fringe

- Based upon permeability
- The zone above the free water table that is effectively saturated
  - Water held at tension
  - Theoretical values much higher than “real life”
  - Difficult to measure

Coloring Agents in Soil

- Organic matter
  - OM will mask all other coloring agents.
- Iron (Fe)
  - Brown colors are the result of Fe oxide staining individual particles.
- Manganese (Mn)
  - Resulting in a very dark black or purplish black color
- Calcium
  - Lack of coatings
  - Color of the mineral soil grains (stripped)

Soil Color

- Hue - the spectrum color
- Value - lightness or darkness
- Chroma - “purity” or grayness of color

Brightness or darkness is not the same as chroma, which is related to purity of color.

Matte (predominant) color
- Color of redoximorphic features
- Contrast, abundance, location, and size of redox features
Reading Soil Color

- **Optimum conditions**
  - Natural light
  - Clear, sunny day
  - Midday
  - Light at right angles
  - Soil moist

Increasing strength of color

Abundance and Size of Redox

**Abundance**
- Few -- less than 2%
- Common -- 2 to 20%
- Many -- more than 20%

**Size**
- Fine -- < 5 mm
- Medium -- 5 to 15 mm
- Coarse -- > 15 mm

Several indicators require at least 2% abundance

Contrast

- Contrast refers to the degree of visual distinction between associated colors
- Faint -- evident only on close examination
- Distinct -- readily seen at arms length
- Prominent -- contrast strongly

Several indicators require distinct or prominent contrast!

Definition of a Hydric Soil

- A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Landscape and formation of hydric soils

- **Landscape position**
  - Surface shape (linear, concave, convex)
  - Erosional or depositional
- **Hydraulics**
  - How water moves
  - Hydroperiod- seasonal pattern of water table depth in a wetland
  - Long-term - organic
  - Seasonal inundation - thick O, dark A
  - Seasonal saturation - thin D
  - Floodplain - thin, stratified layers

Hydric soils indicators develop in **anaerobic** conditions by the process of:

1. **Reduction** and Re-oxidation of Iron
2. **Organic Matter Accumulation**

Foundation of the Field Indicator Manual.
Soil microbes that drive reduction require:
1. Anaerobic conditions i.e. (saturated soil)
2. Organic matter (energy source)
3. Soil temperature warm enough for microbial respiration (>41°F)
4. Duration of conditions (Time)

In anaerobic conditions, decomposition slows and leads to organic accumulation.

- **Hydric Soil Development**

- **Order of Reduction**
  1. Oxygen
  2. Nitrate
  3. Manganese
  4. Iron
  5. Sulfate

- **Hydric Soil Indicators**
  1. Iron removed or re-organized in profile leaving Grey matrix
    - Value 4 or More
    - Chroma 2 or Less
  2. Gleyed Matrix
    - Iron Present, but in reduced state (Fe²⁺) Gleyed color with value ≥ 4

- **Gleyed Matrix Requirements**

- **Depleted Matrix Requirements**
  - Iron removed or re-organized in profile leaving Grey matrix
  - Value 4 or More
  - Chroma 2 or Less

- **Hydric Soil Indicators**
  - High Value (4 or more)
  - Low Chroma (2 or Less)
Field Indicators of Hydric Soils

Natural Resources Conservation Service

- National Technical Committee for Hydric Soils

Used for **on-site verification** of hydric soils

---

All Soils

- Use regardless of texture(s)
  - All Mineral
  - All Organic

- Typically organic matter influences near the surface
- Includes smell
  - Rotten egg

---

Diagnostic Zones

- Layers with:
  - Certain Colors
    - high value and low chroma
    - redoximorphic features
    - organic matter accumulations
  - Specific Depths from Surface
  - Thickness requirements

---

Diagnostic Zones for S and F indicator groups

Sandy (S)
- Upper 15 cm (6”)

Loamy / Clayey (F)
- Upper 30 cm (12”)

---

Soil Indicator Groups

- Sandy Soil Indicators (S):
  - Use when texture is:
    - Loamy Fine Sand or coarser

- Fine Grained Soil Indicators (F):
  - Use when texture is:
    - Loamy Very Fine Sand or finer
Couple of key terms to help interpret indicators:

- **Aquic** - moisture regime, reducing regime virtually free of dissolved oxygen
- **Histic** - saturated organic horizon
- **Epipedon** - horizon near the surface
- **Depletions** - areas of low chroma where oxides have been stripped away
- **Concentrations** - zones where oxides have accumulated

**Format of Indicator Descriptions**

- **Alpha-numeric designation**
- **A1**
- **Short name**
- **Histosol**
- **Applicable land resource regions (LRR)**
- **Use in all LRRs**
- **Description of the indicator**
- **User notes**
- **Additional information, explanation and guidance**
- **Supplement adds regional likelihood, locations**

**A1- Histosol**

- **Histosol:** Classifies as a Histosol. A Histosol has a layer of organic matter accumulation of ≥ 16 inches in the upper 32 inches of soil material.
- **Use in all LRRs**

**A2- Histic Epipedon**

- **Histic epipedon:** saturated, organic horizons 8 inches or more thick in the upper part
- **Applicable land resource regions (LRR)**
- **Use in all LRRs**

**A3- Black Histic**

- **A layer of peaty, mucky peat, or muck 8 in or more thick that starts at a depth of < 6 in from the soil surface; has hue of 10YR or yellower, value of 3 or less, and chroma of 1 or less; and is underlain by mineral soil material with chroma of 2 or less.**
- **Applicable land resource regions (LRR)**
- **Use in all LRRs**

**A11- Depleted Below Dark Surface**

- **Applicable land resource regions (LRR)**
- **Use in all MN LRRs**
A12 - Thick Dark Surface

- Applicable land resource regions (LRR)
- Use in all LRRs.
- User notes
  - Most often associated with overthickened soils in concave landscape positions.

F3 - Depleted Matrix

- Applicable land resource regions (LRR)
- Use in all LRRs.

F3 - Depleted Matrix. For use in all LRRs, except 2, 4, 5, 7, and 8 for labeling in LRRs 6, 7, and 8. A layer that has a depletion with 50 percent or more chernozem of 2 or less and that has a minimum thickness of at least:
  a. 5 cm (2 inches) if the 5 cm starts at a depth > 10 cm (4 inches) from the soil surface, or
  b. 15 cm (6 inches), starting at a depth > 5 cm (2 inches) from the soil surface.

F6 - Redox Dark Surface

- Applicable land resource regions (LRR)
- Use in all LRRs.

F7 - Depleted Dark Surface

- Applicable land resource regions (LRR)
- Use in all LRRs.
- User notes
  - Careful to not mistake an E horizon for depletions!

S5 - Sandy Redox

- Applicable land resource regions (LRR)
- Use in all LRRs.

SS - Sandy Redox. For use in all LRRs, except 2, 4, 5, 7, and 8 for labeling in LRRs 6, 7, and 8. A layer that has a matrix with 60 percent or more chernozem of 2 or less and 2 percent or more distinct or prominent radon concentrations exceeding 50 nls and/or pnu.

Data Sheet
Problematic Hydric Soils

- Covered in Chapter 5 of the regional supplements
- Problematic hydric soils are the norm in some landscapes

  - **Red** Parent Material *(inhibited, or difficult to see redox features)*
  - Active floodplains *(deposition of new material)*
  - Drained systems *(relict hydric indicators)*
  - **High Value** *(bright) / Low Chroma** *(grey)*
  - Thick prairie soils

Review

- Soil formation
  - Parent material, landscape position, horizons
- Soil Properties
  - Texture
    - Sand, silt, clay
  - Color
    - Hue, value, chroma
- Hydric soil development
  - Anaerobic conditions, reduction, organic accumulation
- Web Soil Survey
  - Interpreting soil reports

Reviewing Wetland Delineation Reports

- Field Notes
- Basic Report Components
- Report Contents
- Field Review
- Non-Routine Wetland Delineations

Wetland Delineation Reports

<table>
<thead>
<tr>
<th>Delineation Method</th>
<th>Review of offshore mapping resources</th>
<th>Site Visit</th>
<th>Sampling Approach</th>
<th>Complete Field Data Forms</th>
<th>Field Staking of Wetland Boundaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine Level 1</td>
<td>Yes</td>
<td>Yes</td>
<td>Olfact</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Routine Level 2</td>
<td>Yes</td>
<td>Yes</td>
<td>Olfact, quantitative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Yes</td>
<td>Yes</td>
<td>Olfact, quantitative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

WISCA Application Type Examples

- Temporary wetland under No Loss (Routine Level 2, Screening application - pre-application screening)
- Road Program: Wetland Impact Documentation - Road project through a large continuous wetland (Routine Level 2, Screening application - post application screening)

Guidance
Take Good Field Notes

What to Record

- Plant communities
  - Describe and sketch on aerial photograph
- Landscape settings
  - Topographic changes from wetland to upland
  - Gradual, abrupt?
- Vegetation
  - Dominant veg
  - Changes from wetland to upland
- Soil
  - Changes from wetland to upland
  - Textures, Colors
- Hydrology indicators
  - Changes from wetland to upland

What to Record

- Wetland type
  [Circular 39, Cowardin, Eggers & Reed]
- General site description
  - Buildings, ditches, culverts, etc...
- Field conditions
  - Raining, temperature, drought, etc.

Notes on Field Notes (cont.)

- Note taking skills improve with experience as you figure out what is important and what is not
- Take time to organize, refine, and augment field notes immediately following your field visit.
- Label and organize photos so you know where you took them and what they are intended to show.

Marking Wetland Boundaries

- Mark with:
  - Flags, lath, whatever works.
  - Will vary depending on situation.
- Locate via GPS or land survey methods (find out local requirements).
- Wetland boundaries must be usable for the regulatory purposes intended (grading plans, plat maps, etc.).

Guidance

St. Paul District
REGULATORY
US Army Corps
of Engineers

March 6, 2013

Guidance for Submission of Declaratory Reports to the St. Paul District Army Corps of Engineers and Wetland Conservation Act Local Governmental Units in Minnesota, Version 2.0

Introduction - Purpose and Background

This guidance provides specific standards and procedures for conducting written declaratory and submitting written declaratory reports for regulatory purposes in Minnesota. It supplements and modernizes information in the U.S. Army Corps of Engineers Wetland Determination Manual (WDM) and provides clarification on how to use the Wetland Determination Manual (WDM) and Wetland Determination Defense Manual (WDDM). The guidance includes guidelines for submitting Potentially Determinable to the St. Paul District Army Corps of Engineers and the rules of interpretation in the State of Minnesota, which would be the Minnesota Board of Water and Soil Resources (BWSR). Significant improvements to the guidance of the written declaratory and submission process are included, such as the use of wetland determination and wetland determination determination.
Typical Report Format

- Introduction
- Methods
- Results
- Discussion (optional)
- Figures
- Field Data Forms

Introduction

- Who did you do this for?
  - Developer, public entity
- Where is the project
  - General location and size of project area
  - General description of plant communities: Wooded, meadow, urban etc...
- Why are you doing it?
  - Identify wetlands on potential development site
  - Identify wetlands in road corridor
- When did you do it?

Methods

- Level 1 or 2?
- Off site aerial review?
- Monitoring data?
- Reference wetlands?
- Problem area or atypical procedures?

Results and Discussion

Describe wetlands AND uplands

- Wetland Type – Circular 39, Cowardin, Eggers & Reed
- Dominant Vegetation for each community/type

Text Examples

Wetland Type & Vegetation:

“Wetland 1 is a Type 3 (PEMC/F) with an interior shallow marsh community surrounded by a fringe of wet meadow.
Dominant vegetation in the shallow marsh includes broadleaf cattail, and water plantain.
The wet meadow fringe include reed canary grass, with a few scattered willow shrubs.”

Soils:

“Soils in the wetland consisted of a deep layer of organic sapric material overlying fine sand consistent with the mapped soil unit. Indicator A1 (histosol) was observed in the wetland.
Adjacent upland soils lacked the organic surface layer and consisted of high chroma loamy fine sand over sand. No hydric soil indicators were observed in the upland.”
1. Site Location
2. National Wetland Inventory (NWI)*
3. Soils
4. Public Waters Inventory (PWI)*
5. Wetland Boundary Map
*often combined

Identify all aquatic resources
Data Forms

- Completely filled out
- Correspond to sample locations indicated on a map
- Remember that sample locations should be representative
- Not needed if doing a Routine Level 1
- Do a complete job, but keep in mind that these are field assessments, not a scientific study, spend a reasonable amount of time.

Field Review

Who should conduct site review?

- At least 1 member of TEP
- LGU may request assistance from TEP (SWCD and BWSR) or other tech. prof.
- Corps invited/coordinating
- Delineator invited (but does not need to be present)

Non-Routine Wetland Delineations

- Informal Delineations
- Landowner wanted to fill an area mapped as non-hydric soil
- Site visit to estimate and stake wetland boundary

Delineation Class Summary
COURSE OVERVIEW

• Critical Definitions
• Classification Systems & Functions
• Wetland Delineation
  • Vegetation – hydrophyte, Dominance
  • Soil – hydric soil indicators
  • Hydrology – inputs/outputs, indicators, monitoring
• Chapter 5
• Delineation Methods
• Offsite Hydrology Methods
• Reviewing Delineations

What is a Wetland?

Definition: Those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions.

Hydrology + Vegetation + Soil = Wetland

Wetland Functions & Values

Wetland Functions: in scientific assessments means natural processes

Wetland Value: wetland goods and services providing monetary or social welfare benefit.

Wetland Functions

• Act as a natural “filter” to maintain water quality
• Facilitates infiltration recharging groundwater
• Stabilize base flow
• Decreases fluid velocity during high flow events which decreases turbidity
• Storm water retention (i.e. storage)
• Provides habitat
• Shoreline protection

Critical Definitions

• Wetlands
• Growing Season
• Atypical Situations
• Problem Areas
• Normal Circumstances

Functional Assessment Methods

• MN Routine Assessment Method (MNRAM)
  • Numeric model for assessing wetland functions and some values

Comprehensive General Guidance

9/15/2010

• Floristic Quality Assessment
  • Vegetation based ecological condition assessment method

BWSR Wetland Section | www.bwsr.state.mn.us/wetlands
Chapter 5

• Examples of difficult wetland situations:
  - Land use for agriculture and silviculture
  - Problematic Hydrophytic Vegetation
  - Problematic hydric soils
  - Wetlands that periodically lack hydrology indicators
  - Wetland/Non-wetland mosaic areas
  - Reference sites, aerial photography, hydrology data, climatic data

General Procedure:
1) Verify at least one hydric soil indicator and one primary or two secondary hydrology indicators are present
2) Consider landscape position: concave, floodplain, toe slope, flat, fringes wetland, restrictive soil layers, groundwater discharge
3) Procedures outlined in Chapter 5
4) Long-term monitoring

3-Parameter/Indicator Approach

1. Soils—Historic conditions, may not reflect current condition.
2. Hydrology—Current condition, but heavily influenced by recent climate conditions
3. Vegetation—Somewhere between

The 87 Manual requires 3 parameters because no one source typically gives the answer in all situations

Wetland Delineation Types

ROUTINE
• Level 1 - Onsite Inspection Unnecessary
• Level 2 - Onsite Inspection Necessary
• Level 3 - Combination of Levels 1 and 2

Land Resource Regions

• Regions dictate which indicators are used and how they are used

Sampling Location Should Be Representative

• Representative of soil changes (from upland to wetland)
• Representative of vegetation changes
• Representative of hydrology indicator changes
• Representative of landscape changes

Hydrology

...“inundated or saturated by surface or ground water at a frequency and duration”

• Technical standard of 14 or more consecutive days of flooding or ponding;
• Water table 12 in. or less below soil surface;
Hydrology Indicators

Evidence that there is continuing hydrology and confirms that an episode of inundation/saturation occurred recently.

Wetland hydrology indicators are divided into two categories:

Primary – provide stand-alone evidence of a current or recent hydrologic event; and

Secondary – provide evidence of recent hydrology when supported by one or more other hydrology indicators.

Hydrology Indicator Groups

Group A – direct observation of water
Group B – evidence of flooding/ponding
Group C – evidence of current or recent saturation
Group D – landscape and veg. characteristics that indicate contemporary wetland conditions.

Research Data Sources

- Aerial Photos (current and historic)
- Soil map (Web Soil Survey)
- Topographic LiDAR
- NWI Map (updated version in MN)
- DNR Protected Waters Map

Overview of Wetland Vegetation

- Hydrophytic Vegetation
  - Definition
  - Field indicators
  - Indicator status
  - Dominance
- Determining Hydrophytic Plant Community
  - Rapid Test
  - 50/20 Rule
  - Prevalence Index
  - Morphological Adaptations

Vegetation Sampling

The procedure for using hydrophytic vegetation indicators is as follows:

1. Apply Indicator 1 (Rapid Test for Hydrophytic Vegetation).
2. Apply Indicator 2 (Dominance Test).
3. Apply Indicator 3 (Prevalence Index). This and the following step assume that at least one indicator of hydric soil and one primary or two secondary indicators of wetland hydrology are present.
Hydrophytic Veg.

It’s all about the documentation!

Soil Concepts

- Basics of Soil
  - Soil formation
  - Landscape position
- Soil Properties
  - Texture
  - Color
- Hydric soil development
- Web Soil Survey
  - Interpreting soil reports

Hydric soil indicators
- All
- Fine
- Sandy
- Common soil indicators

Field Indicators of Hydric Soils

Field Delineation Reports

- Field Notes
- Basic Report Components
- Report Contents
- Field Review
- Non-Routine Wetland Delineations

Final Thoughts?

- Questions (last chance!)
Which of the following is a vegetation based ecological condition assessment method for wetlands:

a) MNRAM  
b) Cowardin  
c) Floristic Quality Assessment  
d) Eggers & Reed

A delineator utilizes air photos, soils map, topographic maps, and local wetland maps to identify and define a wetland boundary. This is an example of what?

a) A comprehensive level 3 delineation  
b) An unacceptable methodology under any circumstances  
c) A quantitative delineation approach  
d) A routine level 1 delineation

A Circular 39 Type 2 wetland, is most similar to what Cowardin Classification?

a) PEMB  
b) PUBF  
c) PSS1C  
d) PFO1B

A seasonally flooded wetland on agricultural land is normally plowed and planted in most years. For delineation purposes, which of the following conclusions is most likely true?

a) This is not a jurisdictional wetland  
b) Normal circumstances are not present  
c) Normal circumstances exist  
d) A level 1 delineation is required

A wetland good and services which provides monetary or social welfare benefit is known as:

a) wetland value  
b) Floristic Quality Assessment  
c) wetland function  
d) stormwater retention

What is the definition of depleted matrix? Describe what it looks like.

Value 4 or More  
Chroma 2 or Less

How deep do you need to dig a soil sample pit?

Deep enough to determine if an indicator is present or absent

Which of the following is the least important when conducting hydrology monitoring with shallow wells for determining if the wetland hydrology technical standard is met for an area?

a) Growing season.  
b) Depth to restrictive soil layer.  
c) "A" horizon thickness.  
d) Well installation methodology.

Which of the following tests is used for a wetland hydrology indicator?

a) 50/20 dominance  
b) FAC Neutral  
c) Prevalence Index  
d) Bulk density

When should the Prevalence Index be calculated?

When dominant vegetation (as determined by the 50/20 rule) is determined to be hydrophytic.

b) When non-dominant vegetation (as determined by the 50/20 rule) is determined to be hydrophytic.

c) When hydric soils and wetland hydrology indicators are absent and the wetland determination is made by vegetation alone.

d) When wetland plant communities fail the dominance test, but have indicators of hydric soils and wetland hydrology.
Based on the following vegetation sampling, how many dominant species are present?

<table>
<thead>
<tr>
<th>Herb Strata</th>
<th>Shrub Strata</th>
<th>Tree Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species A - 45%</td>
<td>Species A - 4%</td>
<td>Species A - 10%</td>
</tr>
<tr>
<td>Species B - 35%</td>
<td>Species B - 5%</td>
<td></td>
</tr>
<tr>
<td>Species C - 30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species D - 30%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which of the following does not qualify for a no-loss?

a) Activity that will not impact the wetland.
b) Excavation limited to sediment removal in wetlands that are utilized as a stormwater basin.
c) Excavation in wetlands that removes sediment which alters the original cross section of the wetland.
d) Seasonal water level management activities.