# Day Two

MN Wetland Professional Certification Program
Introduction Class- Day 2

BOARD OF WATER AND SOIL RESOURCES

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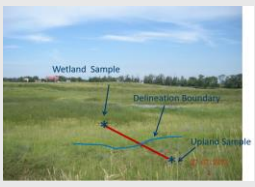
## Quiz

1) Sampling transects should be?

a) Used when conducting a routine level 1 delineation
b) Representative of wetland-upland transition areas
c) Located systematically using an established grid
d) Randomly located throughout the evaluation area




Minnesota Wetland Professional Certification Program

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2) What is the maximum average water depth for a special aquatic site to be classified as a wetland?

a) 1 foot below the surface

b) 8.2 feet below the surface

c) 1 foot above the surface

d) 3 feet below the surface

3) Wetland boundaries must be delineated using:

a) Only the US Army Corps of Engineers 1987 manual for identifying and delineating jurisdictional wetlands

b) The hydrogeomorphic method

c) The WCA Rulebook

d) US Army Corps of Engineers 1987 manual & Regional Supplements

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4) 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 2 delineation is required


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5) Explain the concept of a Problem area

- Indicators absent to seasonal, or annual variability; or permanent due to the nature of the soils or species
- Including seasonal wetlands, prairie soils, red parent material etc.

6) Explain the concept of an Atypical Situation

- One or more Indicators absent due to human activity or natural events (beavers, fire, river changing course)

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7) Which of the following can be used for determining the start of the growing season?

a) Soil temperature at 41 inches below the surface
b) Soil temperature at the soil surface
c) Soil temperature at 18 inches below the surface
d) Soil temperature at 12 inches below the surface

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8) What classification system uses Systems, Sub-systems and Classes?

a)HGM
b)Eggers and Reed
c)Cowardin
d)Circular 39

9) Which of the following plant communities would be characteristic of a Circular 39 type 6 wetland?

a) Sedge meadow
b) Bog
c) Alder thicket
d) Shallow marsh

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10) Which of the follow is not a parameter of the Hydrogeomorphic Method classification system?:

a) geomorphology
b) plant community
c) hydrology
d) hydraulics

11) A natural process in a wetland that can be scientifically assessed can also be described as a:

a) wetland value
b) routine assessment method
c) exemption
d) wetland function

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## Antecedent Precipitation Analysis

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## Precip

- Hydrology and Antecedent Precipitation


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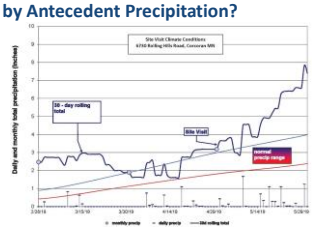
## Precip.

### What do we mean by Antecedent Precipitation?

The prior or preceding precipitation events or conditions, leading up to the site visit or when aerial photography was taken.

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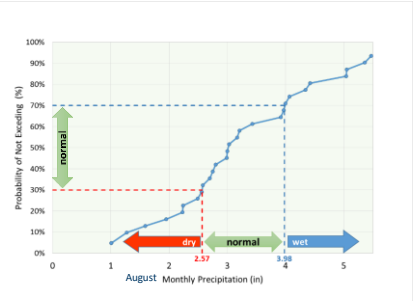
**What does NORMAL mean? What does WET or DRY mean?**

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## When in the process is it needed?

Off-site/Level 1 wetland delineation

On-site/Level 2

- Recommend this be done prior to site visit if possible
- Puts better perspective on site data collection

Other Observations Types

- For interpreting Well or Stage Gauge Data
- Establish baseline conditions for a potential wetland bank/monitoring post construction
- Further defining a wetland boundary/questionable wetland area in difficult/are cases
- May not be needed in advance but will be when interpreting data set.

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## How to do it…


Evaluating Antecedent Precipitation Conditions

Using Climate Data Available in Minnesota

May, 2015

**Purpose:** This document describes procedures that can be used to evaluate antecedent precipitation using climate data and tools available in Minnesota.

**Audience:** Those involved in jurisdictional wetland delineation, restoration, mitigation, regulation, or any other activity requiring the use of hydrologic data, observations, or imagery.

**Use:** These accepted methods can be used to compare antecedent precipitation conditions between different dates for sites in Minnesota. They make the best use of data and tools readily available via the web from the Minnesota State Climatology Office. The ability to compare antecedent precipitation conditions is often relevant to assessing wetland hydrology.

- **Three-Prior Month Method**
  - Using State Climatology Tool
  - Manual Completion
- **Thirty Day Rolling Total**
  - Summing the prior 30-day precipitation totals for each day and plotting this "rolling total" on a daily basis
- **Hybrid Method**
  - Essentially combines above methods

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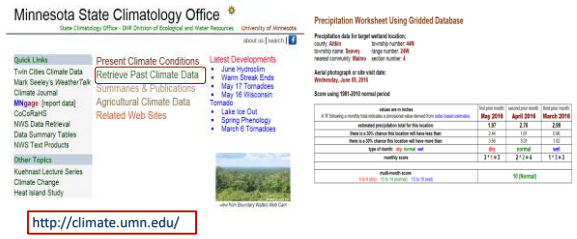
## With the State Climatology Tool




http://climate.umn.edu/

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## Hybrid Method

30-day rolling total

with

3-prior-month method

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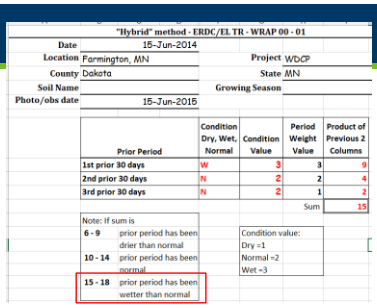
## Precip.



"Hybrid" method - ERDC/EL TR - WRAP 00 - 01

| | | | |
|---|---|---|---|
| Date | 15-Jun-2014 | | |
| Location | Farmington, MN | Project | WDCP |
| County | Dakota | State | MN |
| Soil Name | | Growing Season | |
| Photo/obs date | 15-Jun-2015 | | |

| Prior Period | Condition Dry, Wet, Normal | Condition Value | Period Weight Value | Product of Previous 2 Columns |
|---|---|---|---|---|
| 1st prior 30 days | W | 3 | 3 | 9 |
| 2nd prior 30 days | N | 2 | 2 | 4 |
| 3rd prior 30 days | N | 2 | 1 | 2 |
| | | | Sum | 15 |

| Note: If sum is | | Condition value: |
|---|---|---|
| 6 - 9 | prior period has been drier than normal | Dry =1 |
| 10 - 14 | prior period has been normal | Normal =2 |
| 15 - 18 | prior period has been wetter than normal | Wet =3 |

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## Precipitation Analysis - Farmington MN 6/15/15


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## Corps Antecedent Precipitation Tool



https://www.epa.gov/wotus/antecedent-precipitation-tool-apt

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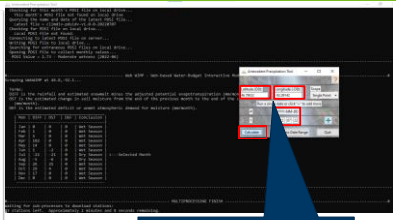
## Enter Lat-Long, Date and Calculate

Note: Decimal Degrees format = '46.79032'
And Include the "-" in Longitude

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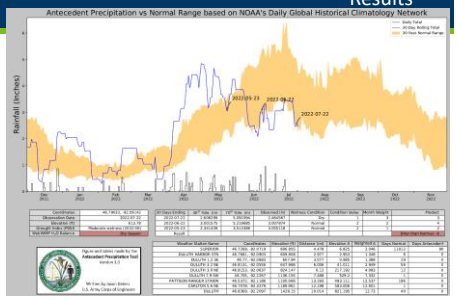
## Results

- Tool opens pdf in a temporary folder on desktop

- Open pdf to view results:

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## Antecedent Precipitation Evaluation Review

- Important for accurate interpretations/observations
- Done by the delineator
- Included in the report
- Should support your conclusion.
- Not always clear…Best Professional Judgement needed.
- Several methods available, each with certain strengths/weaknesses…
- Discussed in detail via BWSR and other Guidance Documents.

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## Aerial Photo Interpretation and Offsite Methods

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## Overview

'87 Manual Definitions:
- Normal Circumstances
- Atypical area
- Problem area

Midwest and NC/NE require aerial review per Chapter 5:
- "Agricultural lands"
- "Wetlands that periodically lack indicators of wetland hydrology"

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## Guidance

St. Paul District REGULATORY
US Army Corps of Engineers®

Minnesota Board of Water & Soil Resources

March 4, 2015

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

**3.7.6 Using Aerial Imagery to Assess Wetland Hydrology**

Procedures have been updated and improved for the assessment of wetland hydrology based on aerial imagery. The interagency approach to off-site wetland determinations on agricultural lands (also referred to as the state ~~"Mapping Conventions"~~) is **required** for CWA and WCA purposes. Refer to the guidance

Guidance for Offsite Hydrology

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## Guidance

US Army Corps of Engineers®
St. Paul District

Minnesota Board of Water & Soil Resources

July 1, 2016

**Guidance for Offsite Hydrology/Wetland Determinations**

This document replaces all previous Minnesota Board of Water and Soil Resources (BWSR) and St Paul

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## Guidance

- Always use all* imagery in putting the pieces together, and place greatest reliance on more recent years; they tend to best reflect current conditions.

*Use only high quality/good resolution slides. Much better to focus on image quality than normalcy of antecedent conditions.

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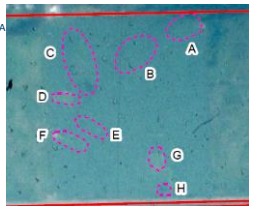
## Guidance

Moving away from FSA images 1979 – 2000

Using more recent and clearer images: 5 normal years

1997 FSA




2010 MnGEO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## Variables

Vegetation Tolerance

Hydrophytic Veg.

Soybeans

Corn

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## Guidance

Vigor and stress responses to wetland conditions

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## Evaluating Images

Signatures:

- CS: Crop stress
- DO: Drowned Out
- NC: Not cropped
- SW: Standing water
- NV: Normal vegetative cover
- NSS: No soil wetness
- AP: Altered pattern
- SS: Soil wetness signature
- CS/DO… (can have multiple, use the /)

Wetland Signatures are a positive "hit"

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## Evaluating Images

Crop Stress (CS)

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## Evaluating Images

Drowned Out (DO)

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## Evaluating Images

NC – not cropped.

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## Evaluating Images

Standing Water (SW)

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AP – altered pattern

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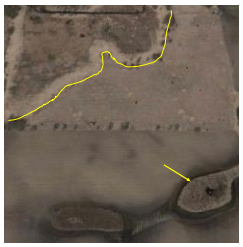
## Evaluating Images

WS – wetland signature.



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## Evaluating Images

Normal Vegetative Cover (NV) or No Soil Wetness (NSS)

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## Evaluating Images

### Soil Wetness Signature-SS

- In Bare soil images, dark, or wet-appearing photo tone from early growing season
- May even include some standing water
- Note the drift lines around the edge of the basin

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## What signature(s) do you see?


| | |
|---|---|
| Crop Stress (CS) | |
| Drowned Out (DO) | |
| Not Cropped (NC) | |
| Standing Water (SW) | |
| Altered Pattern (AP) | |
| Wetland Signature (WS) | |

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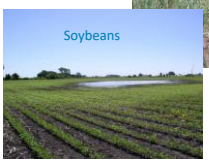
## Variables

Stem Density

Alfalfa

Corn

Soybeans



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## Variables

Topography

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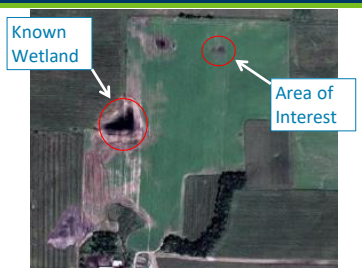
## Variables

Reference Areas

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## Variables

Deep Peat Soils

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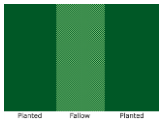
## Variables

Iron Chlorosis

Winter Freeze

Business Decisions

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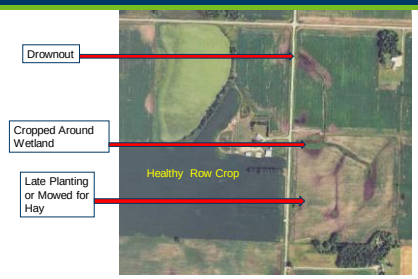
## Wet Signatures

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## Recording on Data Sheet

**HYDROLOGY**

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ~~___ Iron Deposits (B5)~~
- X Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ~~___ Crayfish Burrows (C8)~~
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

**Field Observations:**

Surface Water Present? Yes ____ No ____ Depth (inches):
Water Table Present? Yes ____ No ____ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ____ No ____ Depth (inches):

**Wetland Hydrology Present?** Yes ____ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:
2016 Joint Guidance for Offsite Hydrology was used.

Remarks:

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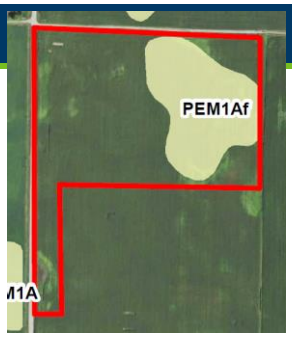
## Example: AOI NWI

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## AOI Soils


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## AOI Topography


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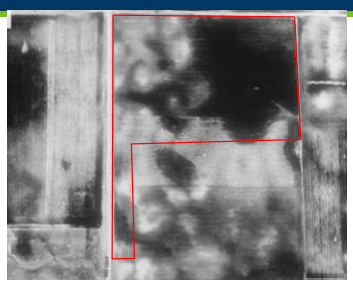
## Pick wet or current year



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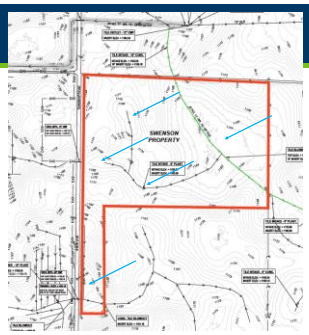
## AOI Detailed Topo

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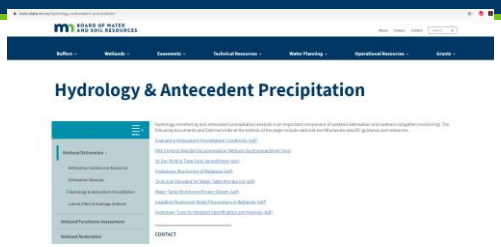
## Antecedent Precip




bwsr.state.mn.us/hydrology-antecedent-precipitation

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## 2018-Dry


| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | | | | | |
| 2015 | | | | | |
| 2013 | | | | | |
| 2012 | | | | | |
| 2011 | | | | | |
| 2010 | | | | | |
| 2008 | | | | | |
| 2007 | | | | | |
| 2004 | | | | | |
| 2003 | | | | | |

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## 2017-Dry


| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | | | | | |
| 2013 | | | | | |
| 2012 | | | | | |
| 2011 | | | | | |
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| 2004 | | | | | |
| 2003 | | | | | |

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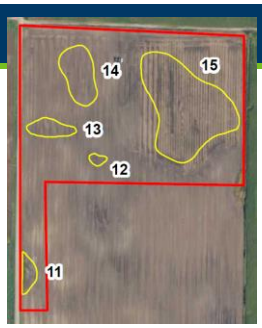
## 2015-Normal




| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | | | | | |
| 2012 | | | | | |
| 2011 | | | | | |
| 2010 | | | | | |
| 2008 | | | | | |
| 2007 | | | | | |
| 2004 | | | | | |
| 2003 | | | | | |

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## 2013-Normal


| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | | | | | |
| 2011 | | | | | |
| 2010 | | | | | |
| 2008 | | | | | |
| 2007 | | | | | |
| 2004 | | | | | |
| 2003 | | | | | |

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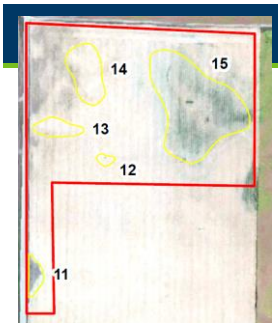
## 2012-Dry




| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | DO | NSS | NV | NV | CS |
| 2011 | | | | | |
| 2010 | | | | | |
| 2008 | | | | | |
| 2007 | | | | | |
| 2004 | | | | | |
| 2003 | | | | | |

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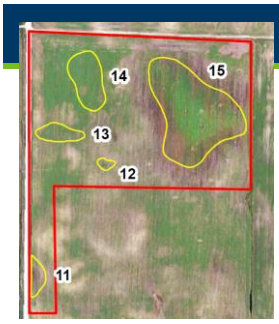
## 2011-Normal




| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | DO | NSS | NV | NV | CS |
| 2011 | DO | CS | NV | NV | CS |
| 2010 | | | | | |
| 2008 | | | | | |
| 2007 | | | | | |
| 2004 | | | | | |
| 2003 | | | | | |

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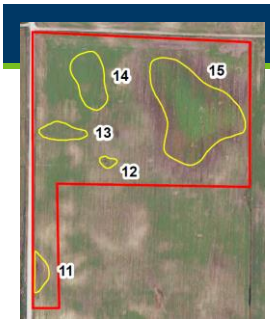
## 2010-Normal




| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | DO | NSS | NV | NV | CS |
| 2011 | DO | CS | NV | NV | CS |
| 2010 | DO | CS | NV | NV | CS |
| 2008 | | | | | |
| 2007 | | | | | |
| 2004 | | | | | |
| 2003 | | | | | |

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## 2008-Dry


| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | DO | NSS | NV | NV | CS |
| 2011 | DO | CS | NV | NV | CS |
| 2010 | DO | CS | NV | NV | CS |
| 2008 | NV | NV | NV | NV | NV |
| 2007 | | | | | |
| 2004 | | | | | |
| 2003 | | | | | |

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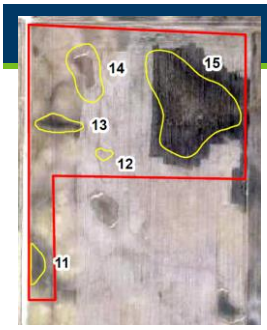
## 2007-Wet




| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | DO | NSS | NV | NV | CS |
| 2011 | DO | CS | NV | NV | CS |
| 2010 | DO | CS | NV | NV | CS |
| 2008 | NV | NV | NV | NV | NV |
| 2007 | SS | NV | SS | SS | DO |
| 2004 | | | | | |
| 2003 | | | | | |

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## 2004-Normal


| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | DO | NSS | NV | NV | CS |
| 2011 | DO | CS | NV | NV | CS |
| 2010 | DO | CS | NV | NV | CS |
| 2008 | NV | NV | NV | NV | NV |
| 2007 | SS | NV | SS | SS | DO |
| 2004 | CS | NV | NV | NV | NV |
| 2003 | | | | | |

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## 2003-Wet


| Year | Area 11 | Area 12 | Area 13 | Area 14 | Area 15 |
|---|---|---|---|---|---|
| 2018 | SS | NV | NSS | NSS | SS |
| 2017 | DO | NV | NV | NV | NV |
| 2015 | SS | NSS | NSS | NSS | AP |
| 2013 | CS | NV | NV | NV | CS |
| 2012 | DO | NSS | NV | NV | CS |
| 2011 | DO | CS | NV | NV | CS |
| 2010 | DO | CS | NV | NV | CS |
| 2008 | NV | NV | NV | NV | NV |
| 2007 | SS | NV | SS | SS | DO |
| 2004 | CS | NV | NV | NV | NV |
| 2003 | NV | NV | NV | NV | CS |

65

## Let's do the math.

Review Summary Table

| Image Date (M/D/Y) | Image Source | Climate Condition | Image Interpretation Areas(s) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 11 | 12 | 13 | 14 | 15 |
| 5/15/2018 | County | Dry | SS | NV | NSS | NSS | SS |
| 7/1/2017 | FSA | Dry | DO | NV | NV | NV | NV |
| 7/1/2015 | FSA | Normal | SS | NSS | NSS | NSS | AP |
| 7/1/2013 | FSA | Normal | CS | NV | NV | NV | CS |
| 8/10/2012 | County | Dry | DO | NSS | NV | NV | CS |
| 7/1/2011 | County | Normal | DO | CS | NV | NV | CS |
| 7/1/2010 | FSA | Normal | DO | CS | NV | NV | CS |
| 7/1/2009 | FSA | Dry | NV | NV | NV | NV | CS |
| 7/1/2008 | FSA | Dry | NV | NV | NV | NV | NV |
| 10/1/2007 | County | Wet | SS | NV | SS | SS | DO |
| 7/1/2006 | County | Dry | NV | NV | NV | NV | CS |
| 8/1/2004 | County | Normal | CS | NV | NV | NV | NV |
| 7/1/2003 | FSA | Wet | NV | NV | NV | NV | CS |
| Number of Normal Years | | | 5 | 5 | 5 | 5 | 5 |
| Normal Years with Wet Signature | | | 5 | 2 | 0 | 0 | 4 |
| Percent Normal with Wet Signature | | | 100 | 40 | 0 | 0 | 80 |

66

## Document

| Hydric Soils present[1] | Identified on NWI or other wetland map[2] | Percent with wet signatures from Exhibit 1 | Field verification required[3] | Wetland? |
|---|---|---|---|---|
| Yes | Yes | >50% | No | Yes |
| Yes | Yes | 30-50% | No | Yes |
| Yes | Yes | <30% | Yes | Yes, if other hydrology indicators present |
| Yes | No | >50% | No | Yes |
| Yes | No | 30-50% | Yes | Yes, if other hydrology indicators present |
| Yes | No | <30% | No | No |
| No | Yes | >50% | No | Yes |
| No | Yes | 30-50% | No | Yes |
| No | Yes | <30% | No | No |
| No | No | >50% | Yes | Yes, if other hydrology indicators present |
| No | No | 30-50% | Yes | Yes, if other hydrology indicators present |
| | | | | |
| No | No | <30% | No | No |

| Area | Hydric Soils Present | Identified on NWI or other wetland map | Percent with wet signatures from Exhibit 1 | Other hydrology indicators present: | Wetland? |
|---|---|---|---|---|---|
| 11 | Yes | No | 100 | NA | Yes |
| 12 | Yes | No | 40 | NA | No |
| 13 | Yes | No | 0 | NA | No |
| 14 | Yes | No | 0 | NA | No |
| 15 | Yes | Yes | 80 | NA | Yes |

67

## Document

| Hydric Soils present[1] | Identified on NWI or other wetland map[2] | Percent with wet signatures from Exhibit 1 | Field verification required[3] | Wetland? |
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| | | | | |
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|---|---|---|---|---|---|
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| 12 | Yes | No | 40 | NA | No |
| 13 | Yes | No | 0 | NA | No |
| 14 | Yes | No | 0 | NA | No |
| 15 | Yes | Yes | 80 | NA | Yes |

68

## Document

| Hydric Soils present[1] | Identified on NWI or other wetland map[2] | Percent with wet signatures from Exhibit 1 | Field verification required[3] | Wetland? |
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| | | | | |
| Yes | No | >50% | No | Yes |
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| Yes | No | <30% | No | No |
| No | Yes | >50% | No | Yes |
| No | Yes | 30-50% | No | Yes |
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| No | No | >50% | Yes | Yes, if other hydrology indicators present |
| No | No | 30-50% | Yes | Yes, if other hydrology indicators present |
| | | | | |
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| 12 | Yes | No | 40 | NA | No |
| 13 | Yes | No | 0 | NA | No |
| 14 | Yes | No | 0 | NA | No |
| 15 | Yes | Yes | 80 | NA | Yes |

69

## Document

| Hydric Soils present[1] | Identified on NWI or other wetland map[2] | Percent with wet signatures from Exhibit 1 | Field verification required[3] | Wetland? |
|---|---|---|---|---|
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| Yes | No | <30% | No | No |
| No | Yes | >50% | No | Yes |
| No | Yes | 30-50% | No | Yes |
| No | Yes | <30% | No | No |
| No | No | >50% | Yes | Yes, if other hydrology indicators present |
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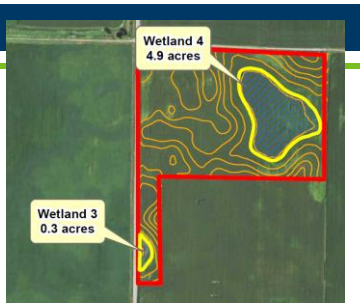
| 12 | Yes | No | 40 | NA | No |
| 13 | Yes | No | 0 | NA | No |
| 14 | Yes | No | 0 | NA | No |
| 15 | Yes | Yes | 80 | NA | Yes |

70

## Conclusion: Final Determination




71

## Other uses

Level 1 Delineations

| Delineation Method | Review of offsite mapping resources | Site Visit | Sampling Approach | Complete Field Data Forms | Field Staking of Wetland Boundaries |
|---|---|---|---|---|---|
| Routine Level 1 | Yes | Sometimes | Offsite | No | No |
| Routine Level 2 | Yes | Yes | Onsite, qualitative | Yes | Yes |
| Comprehensive | Yes | Yes | Onsite, quantitative | Yes | Yes |

| WCA Application Type Examples | *Commonly Used* Delineation Method |
|---|---|
| Temporary impact under No-Loss | Routine Level 1 |
| Banking application: pre-application scoping | Routine Level 1 |
| Banking application: full application | Routine Level 2 |
| Road Program Wetland Impact Documentation—Road project through a large continuous wetland | Routine Level 1 |
| Road Program Wetland Impact Documentation—Scattered wetlands within construction corridor | Routine Level 2 |
| Replacement plan | Routine Level 2 |
| Enforcement actions | Routine Level 2 or Comprehensive |
| Wetland boundary approval (no project application) | Routine Level 2 |
| Agricultural exemption determination (8420.0420, Subpart 2A) | Routine Level 1 |

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## Other uses

Level 1 Delineations

73

## Incidental

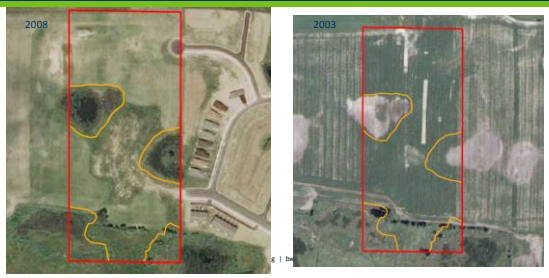
2015


74

## Incidental

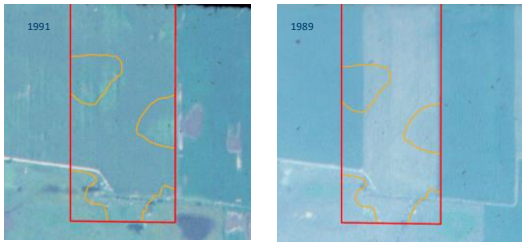

75

## Incidental




76

## Incidental




77

## Incidental

78

## Final Point

- Except for Level 1 delineations, the results of aerial imagery review are not necessarily the final determination.
- Other data to support conclusions.
- Results do not override site specific data (Level 2, Level 3, Comprehensive).



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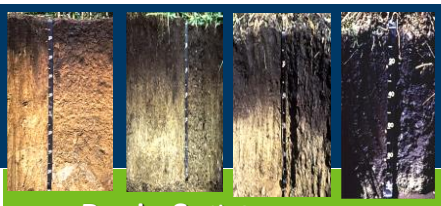

# Basic Soil Concepts

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

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## Overview

- 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

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## 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

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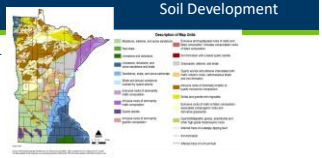
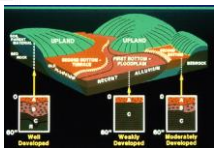
## Factors That Influence Soil Development

- 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.

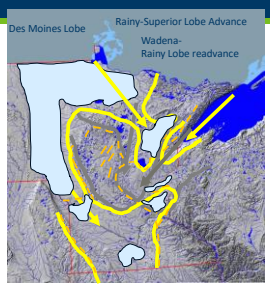





83

## Parent Material Relates to Glacial Geology

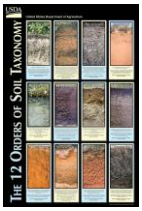
Recent Glacial Geology of MN




84

## Soil Taxonomy

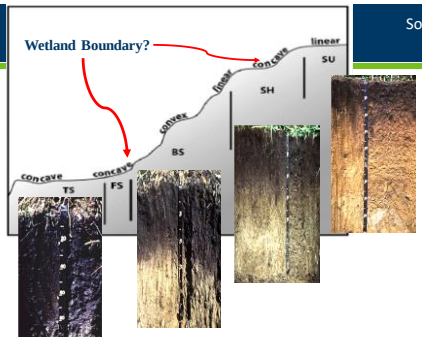
- 12 orders of soil taxonomy
- Which ones are common in MN




- **Alfisols:** wide range of climate, forest soils, clay in subsoil
- Andisols: volcanic, high nutrient
- Aridisols: desert soils
- **Entisols:** recent deposition, dunes, slopes, floodplains, sandy
- Gelisols: permafrost, high latitudes and/or elevation
- **Histosols:** high organic, most saturated year round
- **Inceptisols**: wide range of climate, moderate weathering
- **Mollisols:** "prairie soils", dark colored, high organic
- Oxisols: highly weathered tropical, stable, low fertility
- **Spodosols:** coarse-textured, acidic, conifer forests
- Ultisols: humid climate, weathered, clay-rich
- **Vertisols**: high content of expanding clays, Red River Valley

85

## Soil Catena




86

## 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

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## Organic Matter Decomposition

- Fibric (peat)
  - Least decomposed
  - Plant fibers identifiable
  - After rub – >40% of fibers still visibl (2/3)
- Hemic (mucky peat)
  - Intermediate decomposition
- Sapric (muck)
  - Most decomposed, <1/3 ID of plant fibers
  - <1/6 of fibers visible after rubbing

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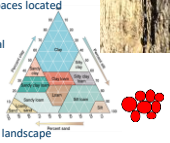
## Key Soil Properties

Properties that are important to hydric soil development and recognition:

- 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





89

## 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

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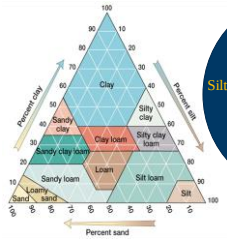
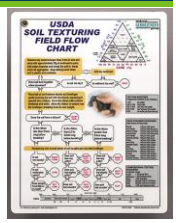
## Soil Texture- Relative proportion of soil particles



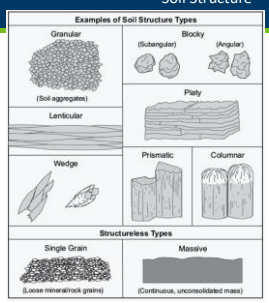





91

## 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




92

## 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)
  - Texture- pore space of different particle sizes
- Permeability is “measured” in inches per hour
  - Permeability is an estimated property
- Larger grain sizes= higher permeability

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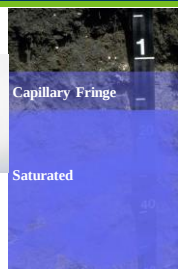
## Capillary Fringe

- 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



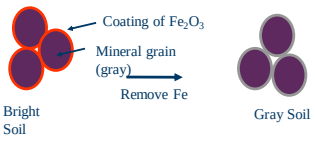

94

## Coloring Agents in Soil

- Organic matter
  - OM will mask all other coloring agents.
- Iron (Fe)
  - brown colors are the result of Fe oxide stains coating 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)

95

## Soil Color

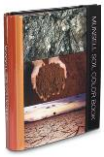



"Bright-colored" soil is bright because the gray-colored mineral grains are coated with a thin layer of "paint" formed by Fe oxides. Stripping the paint off the particles leaves the mineral grains exposed.

96

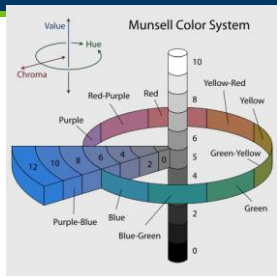
## Color

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



Hue Value Chroma

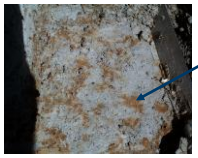
10YR 2/1




97

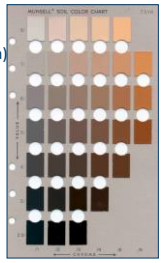
## Color

- Matrix (predominant) color
- Color of redoximorphic features (concentration or depletion)
  - Contrast, abundance, location, and size of redox features



What is the percent of redox?

30%



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## Reading Soil Color

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


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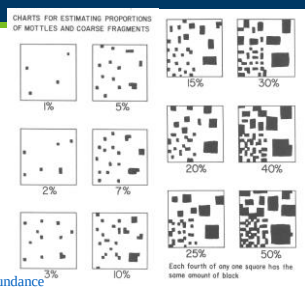
## Abundance and Size of Redox

**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

100

## 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

| Contrast Class | Code | Difference in Color Between Matrix and RMF (Δ means "difference between") | | | | |
|---|---|---|---|---|---|---|
| | | Hue (h) | Value (v) | | | *Chroma (c)* |
| Faint [1] | F | Δh = 0; | Δv ≤ 2 | and | | Δc ≤ 1 |
| | | Δh = 1; | Δv ≤ 1 | and | | Δc ≤ 1 |
| | | Δh = 2; | Δv = 0 | and | | Δc = 0 |
| Distinct [1] | D | Δh = 0; | Δv ≤ 2 | and | | Δc > 1 to < 4 |
| | | | or Δv > 2 to < 4 | and | | Δc < 4 |
| | | Δh = 1; | Δv ≤1 | and | | Δc > 1 to < 3 |
| | | | or Δv > 1 to < 3 | and | | Δc < 3 |
| | | Δh = 2; | Δv = 0 | and | | Δc > 0 to < 2 |
| | | | or Δv > 0 to < 2 | and | | Δc < 2 |
| Prominent [1] | P | Δh = 0; | Δv ≥ 4 | or | | Δc ≥ 4 |
| | | Δh = 1; | Δv ≥ 3 | or | | Δc ≥ 3 |
| | | Δh = 2; | Δv ≥ 2 | or | | Δc ≥ 2 |
| | | Δh ≥ 3; | | | | |

[1] If compared colors have both a value ≤3 and a chroma of ≤2, the contrast is *Faint*, regardless of hue differences.

Several indicators require distinct or prominent contrast!

101

## 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**.



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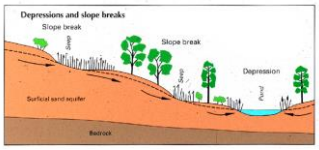
## Landscape and formation of hydric soils

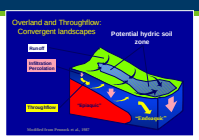
- Landscape position
  - Surface shape (linear, concave, convex)
  - Erosional or depositional
- Hydraulics
  - How water moves
- Hydroperiod- seasonal pattern of water table depth in a wetland
  - Long term- organic
  - Seasonal inundation- thick O, dark A
  - Seasonal saturation- thin O
  - Floodplain-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

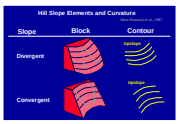


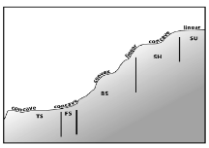

103

## 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

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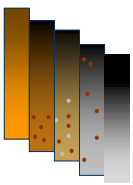
## Hydric Soil Development

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.



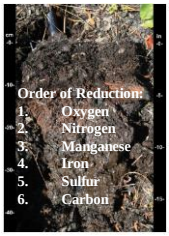
105

## Hydric Soil Development

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 (>41F)
4. Duration of conditions (Time)

In anaerobic conditions decomposition slows and leads to organic accumulation




106

## Conceptual overview of aquic conditions

- Here's what happens when water moves into a soil profile:
  - Downward movement
  - Lateral movement
  - Lose some things
  - Changes in chemical state in others

Think old car left in the elements- chemical reactions leave "rust in the soil"

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## Change in the state of iron

- Available $O_2$, $NO_3$, and Mn depleted
- $Fe^{3+} \longrightarrow Fe^{2+}$ (Mobile)
- **Bluish Grey** when **reduced**
- **Grey** when **depleted** from soil
- **Orange** or **Red** when **oxidized**

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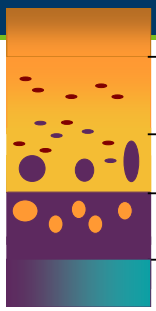
## Anaerobic process



Never Saturated
Oxidized Matrix

Infrequently Saturated
Oxidized Matrix with few concentrations

Frequently Saturated
Oxidized Matrix with depletions And concentrations

Very Frequently Saturated
Depleted or Reduced Matrix
With concentrations

Permanently Saturated - depleted
Or reduced matrix

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## Depleted Matrix

**Iron removed or re-organized in profile leaving Grey matrix**

- **Value 4 or More**
- **Chroma 2 or Less**

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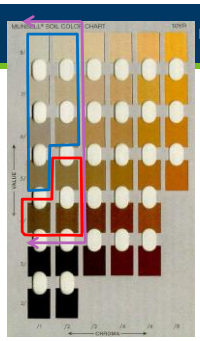
## Depleted Matrix Requirement



**Do Not Need Concentrations**

**Need Concentrations (2%)**

High Value (4 or more)

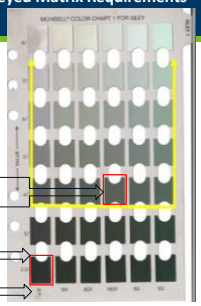
Low Value (2 or Less)

111

## Gleyed Matrix Requirements

**Gleyed Matrix**

- **Iron Present, but in reduced state (Fe2+) Gleyed color with value > = 4**

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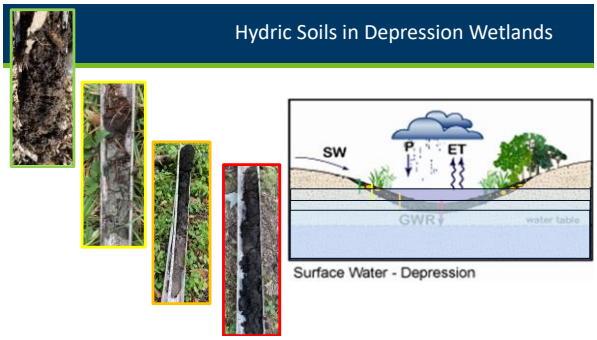
## Hydric Soils in Depression Wetlands






Surface Water - Depression

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## Hydric Soil Indicators

BOARD OF WATER AND SOIL RESOURCES

Minnesota Wetland Professional Certification Program

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## Field Indicators of Hydric Soils

Natural Resources Conservation Service

- National Technical Committee for Hydric Soils

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

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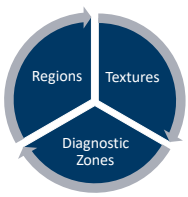
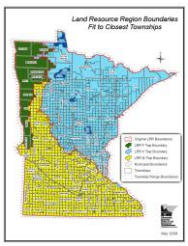
## Field Indicator Organization- Regions





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## Field Indicator Organization- Texture

- Use regardless of texture(s)
  - All Mineral
  - All Organic
- Typically, organic matter influences near the surface
- Includes smell
  - Rotten egg


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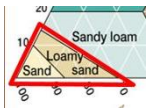
## Soil Indicator Groups- Texture

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

A group- all textures

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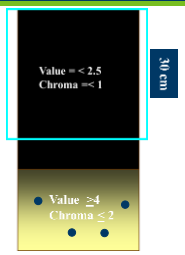
## Diagnostic Zones

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

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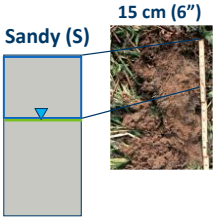
## Diagnostic Zones for S and F indicator groups

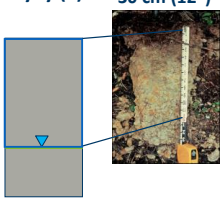
**Sandy (S)**

**Upper 15 cm (6”)**



**Loamy / Clayey (F)**

**Upper 30 cm (12”)**



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Credit: USDA & NRCS for following pictures

## 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

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## Format of Indicator Descriptions

**A1.—Histosol** *(for use in all LRRs)* or **Histel** *(for use in LRRs with permafrost)*. Classifies as a Histosol (except Folist) or as a Histel (except Folistel).
**User Notes:** In a Histosol, typically 40 cm (16 inches) or more of the upper 80 cm (32 inches) is organic soil material (fig. 7). Organic soil materials have organic carbon contents (by weight) of 12 to 18 percent or more, depending on the clay content of the soil. These materials include muck (sapric soil material), mucky peat (hemic soil material), and peat (fibric soil material). See *Keys to Soil Taxonomy* (Soil Survey Staff, 2014) for a complete definition.

- 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

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## A1- Histosol

- **A1. 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

**A1.—Histosol** *(for use in all LRRs)* or **Histel** *(for use in LRRs with permafrost)*. Classifies as a Histosol (except Folist) or as a Histel (except Folistel).
**User Notes:** In a Histosol, typically 40 cm (16 inches) or more of the upper 80 cm (32 inches) is organic soil material (fig. 7). Organic soil materials have organic carbon contents (by weight) of 12 to 18 percent or more, depending on the clay content of the soil. These materials include muck (sapric soil material), mucky peat (hemic soil material), and peat (fibric soil material). See *Keys to Soil Taxonomy* (Soil Survey Staff, 2014) for a complete definition.

Figure 7.—Indicator A1 (Histosol or Histel). This soil has more than 40 cm (16 inches) of organic material, starting at the soil surface

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## 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

**A2.—Histic Epipedon.** *For use in all LRRs.* A histic epipedon underlain by mineral soil material with chroma of 2 or less.

**User Notes:** Most histic epipedons are surface horizons 20 cm (8 inches) or more thick of organic soil material (fig. 8). Aquic conditions or artificial drainage is required. See *Keys to Soil Taxonomy* (Soil Survey Staff, 2014) for a complete definition.

Figure 8.—Indicators A2 (Histic Epipedon) and A3 (Black Histic). This soil meets the depth criterion of A2 and the color and depth criteria of A3. The black color, a requirement of A3, results from the accumulation of organic matter when the soil is saturated and anaerobic.

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## A3- Black Histic

- A layer of peat, 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

**A3.—Black Histic.** *For use in all LRRs.* A layer of peat, mucky peat, or muck 20 cm (8 inches) or more thick that starts at a depth of ≤15 cm (6 inches) 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.

**User Notes:** Unlike indicator A2, this indicator does not require proof of aquic conditions or artificial drainage (fig. 8).

Figure 8.—Indicators A2 (Histic Epipedon) and A3 (Black Histic). This soil meets the depth criterion of A2 and the color and depth criteria of A3. The black color, a requirement of A3, results from the accumulation of organic matter when the soil is saturated and anaerobic.

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## A11- Depleted Below Dark Surface

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

**A11.—Depleted Below Dark Surface.** *For use in all LRRs, except for W, X, and Y; for testing in LRRs W, X, and Y.* A layer with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less, starting at a depth ≥30 cm (12 inches) from the soil surface, and having a minimum thickness of either:

a. 15 cm (6 inches), or

b. 5 cm (2 inches) if the 5 cm consists of fragmental soil material.

Organic, loamy, or clayey layer(s) above the depleted or gleyed matrix must have value of 3 or less and chroma of 2 or less starting at a depth <15 cm (6 inches) from the soil surface and extend to the depleted or gleyed matrix. Any sandy material above the depleted or gleyed matrix must have value of 3 or less and chroma of 1 or less starting at a depth ≥15 cm (6 inches) from the soil surface and extend to the depleted or gleyed matrix. Viewed through a 10x or 15x hand lens, at least 70 percent of the visible sand particles must be masked with organic material. Observed without a hand lens, the sand particles appear to be close to 100 percent masked.

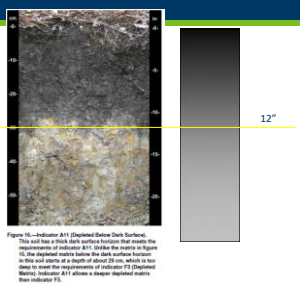


Figure 10.—Indicator A11 (Depleted Below Dark Surface). This soil has a thick dark surface horizon that meets the requirements of indicator A11. Unlike the matrix in figure 10, the depleted matrix below the dark surface horizon in this soil starts at a depth of about 29 cm, which is too deep to meet the requirements of indicator F3 (Depleted Matrix). Indicator A11 allows a deeper depleted matrix than indicator F3.

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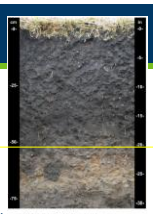
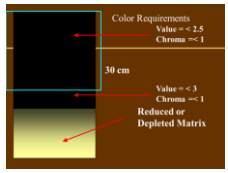
## A12- Thick Dark Surface

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






21"

**A12.—Thick Dark Surface.** *For use in all LRRs:* A layer at least 15 cm (6 inches) thick with a depleted or gleyed matrix that has 60 percent or more chroma of 2 or less starting below 30 cm (12 inches) of the surface. The layer(s) above the depleted or gleyed matrix and starting at a depth <15 cm (6 inches) from the soil surface must have value of 2.5 or less and chroma of 1 or less to a depth of at least 30 cm (12 inches) and value of 3 or less and chroma of 1 or less in any remaining layers above the depleted or gleyed matrix. In any sandy material above the depleted or gleyed matrix, at least 70 percent of the visible soil particles must be masked with organic material, viewed through a 10x or 15x hand lens. Observed without a hand lens, the particles appear to be close to 100 percent masked.

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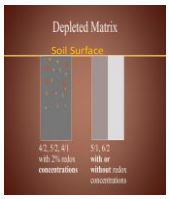
## F3- Depleted Matrix

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

**F3.—Depleted Matrix.** *For use in all LRRs, except W, X, and Y; for testing in LRRs W, X, and Y:* A layer that has a depleted matrix with 60 percent or more chroma of 2 or less and that has a minimum thickness of either:

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 ≤25 cm (10 inches) from the soil surface.

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## F6- Redox Dark Surface

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

**F6.—Redox Dark Surface.** *For use in all LRRs, except W, X, and Y; for testing in LRRs W, X, and Y:* A layer that is at least 10 cm (4 inches) thick, starting at a depth ≤20 cm (8 inches) from the mineral soil surface, and has:

a. Matrix value of 3 or less and chroma of 1 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings, or

b. Matrix value of 3 or less and chroma of 2 or less and 5 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings.

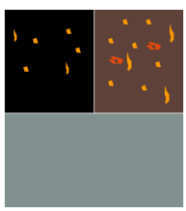

Figure 31.—Indicators F6 (Redox Dark Surface) and F7 (Depleted Dark Surface). A soil that meets the requirements of indicator F7 commonly also meets the requirements of indicator F6. If the dark surface layer has depletions, it most likely also has concentrations.

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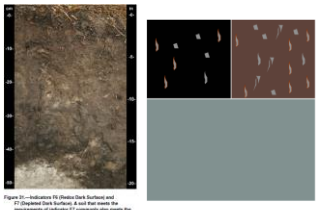
## F7- Depleted Dark Surface

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

**F7.—Depleted Dark Surface.** *For use in all LRRs, except W, X, and Y; for testing in LRRs W, X, and Y.* Redox depletions with value of 5 or more and chroma of 2 or less in a layer that is at least 10 cm (4 inches) thick, starting at a depth ≥20 cm (8 inches) from the mineral soil surface, and has:

a. Matrix value of 3 or less and chroma of 1 or less and 10 percent or more redox depletions, or

b. Matrix value of 3 or less and chroma of 2 or less and 20 percent or more redox depletions.





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## S5- Sandy Redox

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

**S5.—Sandy Redox.** *For use in all LRRs, except for Q, V, W, X, and Y.* A layer starting at a depth ≤15 cm (6 inches) from the soil surface that is at least 10 cm (4 inches) thick and has a matrix with 60 percent or more chroma of 2 or less and 2 percent or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings.

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## Data Sheet

SOIL Sampling Point: W1-DP2W

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

| Depth (inches) | Matrix Color (moist) | % | Redox Features Color (moist) | % | Type¹ | Loc² | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-3 | 10yr 2/1 | 100 | | | | | Clay Loam | |
| 3-22 | 10yr 5/2 | 80 | 7.5yr 5/6 | 20 | C | M | Loamy clay | |

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 5 cm Mucky Peat or Peat (S3)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils³:

- ☐ Coast Prairie Redox (A16)
- ☐ Iron-Manganese Masses (F12)
- ☐ Other (Explain in Remarks)

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

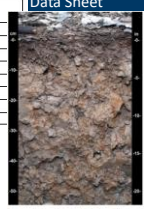
Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:



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## 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
- Sandy soils

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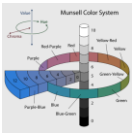
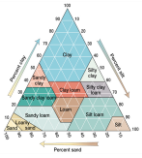
## Review

- 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

- Hydric soil indicators
  - All, Fine, Sandy
- Common soil indicators
  - Organic Indicators (A1, A2, A3)
  - Depleted Matrix (A11, A12, F3)
  - Redoximorphic features (F6, S3)



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## Soil Survey Overview


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## Attributes from Soil Survey to help understand Functions

- Geomorphic description
  - Landform
  - Slope shape
  - Parent material
- Typical profile
  - Textures
  - Depths
- Properties and qualities
  - Slope
  - Restrictive layer
  - Drainage class
  - Depth to water table
  - Frequency of flooding/ponding

**Description of Normanna**

**Setting**
*Landform:* Moraines
*Landform position (two-dimensional):* Summit, backslope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy material over dense loamy till

**Typical profile**
*A - 0 to 4 inches:* loam
*Bw - 4 to 45 inches:* gravelly sandy loam
*2Bw,BC,2BC - 45 to 48 inches:* gravelly sandy loam
*2BCd - 48 to 80 inches:* gravelly sandy loam

**Properties and qualities**
*Slope:* 3 to 8 percent
*Depth to restrictive feature:* 30 to 60 inches to densic material
*Natural drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.06 in/hr)
*Depth to water table:* About 18 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Low (about 5.2 inches)

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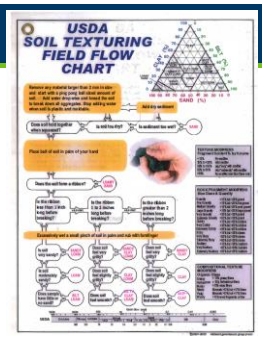
## Texture by Feel

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