TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE

ENGINEERING #7 **SPOKANE, WASHINGTON**

August 2004

USE OF SOIL FEATURES TO DETERMINE DEPTH TO SEASONAL HIGH WATER TABLE

PURPOSE

This note will provide guidance on using soil features to determine depth to seasonal high water tables to NRCS-WA and Conservation District staff involved with the planning and design of waste storage ponds.

BACKGROUND

NRCS specification Waste Storage Facility, WA 313 states that waste storage ponds must not be excavated into the seasonal high water table. There is no definitive procedure to determine depth to seasonal high water table written into the specification. This procedure was compiled by Alan Walters while he was in the position as the Resource Soil Scientist in the Washington NW Team. This Field Guide will provide consistent, accurate documentation using scientifically based principals of soil science. Field training in the use of this Guide should be provided by NRCS Resource Soil Scientists. Resource soil scientists should also be available to make site visits to problem areas.

WASHINGTON STATE REGIONAL FIELD GUIDE FOR DETERMINING SEASONAL HIGHWATER TABLE USING SOIL FEATURES

NOTE: The upper boundary of the indicator colors identifies the depth to the anaerobic seasonal high water table.

MINERAL SOILS:

All soils EXCEPT organic soils with unified classification OL and OH. Mineral soils having the following colors indicate the presence of a seasonal high water table and are considered to have developed under conditions of saturation for a sufficient period of time to induce anaerobic conditions in the soil.

- **Munsell Color Charts (1994 edition), MOIST COLORS, ANY HUE (page) ALL SOILS**
  5/1, 6/1, 7/1, 8/1, 6/2, 7/2, 8/2, with or without mottles (redox features)
  or
  4/1, 4/2, 5/2 with 2 percent or more redox features
- **Any chroma or gley page with value 4 or more chroma 1 or 2 ,with or without mottles (redox features)**
- **The layer containing these colors should be at least 6 inches thick.**

Sandy Soils

Sands may have low chroma colors (chroma 1 or 2) due to materials they originated from (parent material). Because sands are usually low in organic matter and iron, mottles are usually not as pronounced. Indicators of the anaerobic seasonal high water table in sandy soils include:

- sand grains covered by organic matter or thin organic surface layer.
- splotchy color pattern; mineral grains stripped of iron and organic matter or materials that have moved and clumped into masses of 2 or more colors. The stripped areas should occupy at least 10% of the horizon and be at least 1-3 cm in diameter.
- Layer of muck at least 2 inches thick within 6 inches of surface.

Additionally, for sandy soils with matrix chroma of 3 or more, the depth to the seasonal high water table is the depth to 2 percent or more redox concentrations with the following colors:

- 10YR 5/6, 5/8, 6/6, 6/8, 7/6, 7/8, 8/6, 8/8
- 7.5YR 5/6, 5/8, 6/6, 6/8, 7/6, 7/8, 8/6
- 5YR 5/6, 5/8, 6/6, 6/8, 7/6, 7/8
- 2.5YR 5/6, 5/8, 6/6, 6/8, 7/6, 7/8
- 10YR 5/6, 5/8, 6/6, 6/8, 7/6, 7/8

ORGANIC SOILS:

Soils formed under conditions of almost constant saturation. These soils will not show redoximorphic features. The fact that you have organic soils, or a mineral soil with a thick (8-16 inches) surface organic mat, indicates the presence of hydrology at some time (past or present). However, the depth to the seasonal high water table may be difficult to ascertain because you have nothing to see. One indicator to use is a rotten egg smell (hydrogen sulfide gas). This means that the soils are saturated and reduced (anaerobic conditions are present).

Organic soils may be mixed with mineral soil and still be classified as organic soil and be in Unified class OH or OL.

FIELD PROCEDURES

- **A minimum of 2 holes** per pond site or per acre, whichever is smaller, should be examined to determine depth to seasonal high water table. **The actual number of holes to be dug will depend on landscape, size of project, soil type and other factors.**

- Holes should be dug (with a tile spade or auger) **at lease 12 inches below** where indicator colors are first encountered**.**

- Colors should be taken under natural light.

- Position yourself so that the light is coming from behind you.

- Round color to the closest matching chip. If you think that the color lies in between value or chroma, use a +; ie. 10YR 3+/2 or 5Y 4/2+.

- Remember that chroma 2+ is not chroma 2.

- Record soil color using a sequence of hue, value and chroma (ie: 5Y 6/3) or relate the chip color to the color name (opposite the chip page).

- Be sure to use the hue when using a soil color name so you know what page the chip was on (ie: Hue 10YR, light brown).

- Record dominant soil color (matrix) for each different layer of soil encountered. If there is no dominant color, record the relative percentages of each color.

- Use chart (located in color book) to estimate volume (percent) of redox features in each layer and record.

- Soil must be moist, not saturated. If the soil is glistening it is too wet and will skew the color reading. Let it drain or air dry until the glistening disappears. (See attached diagram on how to read the Munsell Color Chart).

CAUTIONS

- If drainage is present the effectiveness of the drainage must be assessed. Soil features associated with saturation will persist in the soil after drainage is installed.
- Soils with colors of (any hue) 3/1, 3/2, 2/1, 2/2 and 2.5/1 may be dark enough to mask redox features. Drying the soils out may make the redox features visible.
- Ashy soils may lack indicator colors.
- Soils inherently low in organic **AND/OR IRON** matter may lack indicator colors.
- Soil color may be a function of parent material, such as volcanic ash or glacial material, rather than a function of the hydrologic regime.
- Rapidly fluctuating water tables may not result in anaerobic conditions long enough for redox features to form.
- Wet soils that have water moving through (oxygenated water) may not have indicator colors.
- Soil should be moist, not saturated, to read color.
- Depth to seasonal high water table, duration of flooding and ponding and frequency listed in the water features table contained in soil surveys are interpretations, not facts. There is no substitute for a site visit to see if interpretations are correct.
- Beware of perched water tables. There may be a perched water table and an apparent (ground) water table. If a perched water table is suspected, be sure to dig deep enough to verify.

ADDITIONAL INFORMATION

MOTTLES (Redoximorphic Features or Redox Features)

- Formed by reduction, translocation and oxidation of iron and manganese (little manganese in glaciated areas)
- Large enough to be seen with the naked eye
- Redox features should be easily seen (distinct or prominent in relation to the matrix color).
- Redox features , if present, should be expressed as soft masses and NOT just as hard concretions.
- Redox features can be reddish-yellow (high chroma concentrations) or grayish (low chroma depletions)
- Redox features should have diffuse boundaries rather than abrupt or sharp. Redox features with abrupt or sharp boundaries are thought to be relict features

DISCUSSION

- Redox features show where Fe/Mn reduction and oxidation has occurred in the soil.
- Conditions needed to reduce iron and manganese:
  -soil is waterlogged
  -soil temperature above 41F.
  -no dissolved oxygen in the water
  organic matter (to drive the process). It is the source of electrons. IF ORGANIC MATTER IS NOT PRESENT, THEN OXIDATION - REDUCTION REACTIONS DO NOT OCCUR.
- In order for indicator features to be present, the soil must have been saturated for a sufficient period of time to cause anaerobic conditions to exist. If anaerobic conditions exist long enough iron and manganese become reduced and go into solution. They are colorless in solution. When oxygen re-enters the soil, iron and manganese become oxidized and visible as segregated, soft masses.
- The upper boundary of the indicator colors (features) can identify the upper boundary of the seasonal high water table in situations where the hydrology has not been altered. Alteration of hydrology would include subsurface and/or surface drainage, or such things as a new road or modifications to culverts on or off site.
- If the hydrology has been altered you may be looking at relict features. It can be difficult to tell if the features you are looking at are contemporary or relict.
- Soils with Munsell colors (any hue) 3/2, 3/1, 2/1, 2/2, 2.5/1, 2.5/2 may be dark enough to mask redox features. Drying out a dark layer may make redox features easier to see.
- Moving water carries oxygen which prevents iron and manganese from being reduced therefore no redox features.
- Saturation can occur without the formation of redox features**.**
- Cold soil temperatures will slow microbial action inhibiting formation of redox features. Under laboratory conditions an average of 5 weeks was required to obtain reduction of iron in a high organic carbon (7.5%) surface horizon of a mineral soil at a temperature of 9 degrees C, typical spring soil temperature (Cogger and Kennedy, 1992). Over 3 months was required for similar reduction in the moderate organic carbon (2.5%) surface and subsoil (0.8% organic carbon).
- Iron or manganese concretions by themselves, are the least reliable indicator to determine depth to anaerobic seasonal high water table.
- Ash influenced soils may not show redox features. Many Washington soils contain significant amounts of volcanic ash.

TERMINOLOGY

Abrupt boundary - used to describe redox features that grade abruptly from one color to another.

Anaerobic conditions - condition in which molecular oxygen is absent in the soil. Anaerobic conditions must be present in order to form redox features.

Contemporary redox feature - a soil feature that has been formed as a result of current hydrologic conditions.

Concretions - firm to very firm irregularly shaped bodies with diffuse or distinct boundaries.

Diffuse boundary - used to describe redox features that grade gradually from one color to another.

Distinct - readily seen but contrast only moderately with color to which compared. (see Printed Chart)

Dominant soil color - the color that occupies the greatest volume of the layer.

Macropores - large pores in the soil, such as root channels, and the spaces in between soil aggregates.

Organic Soils - soils containing at least 16 inches of organic material in the upper 32 inches of the soil profile.

Prominent - contrasts strongly with color to which compared (see printed chart)

Redox Features (Redoximorphic Features) - soil features formed by reduction, translocation and oxidation of iron and manganese oxides.. Require organic matter, bacteria, no oxygen and temperatures above biologic zero to form. Redox features are large enough to be seen with the naked eye. The features may be in the form of low chroma depletions or high chroma concentrations of iron and /or manganese.

(Redox) Depletions - zones of low chroma (chroma 2 or less) caused by removal of iron and manganese - oxides.

Redox Concentrations- bodies of apparent accumulation of iron-manganese oxides.

Reduction - in the soil, relates to the transformation of ferric iron to ferrous iron under anaerobic conditions. Ferrous iron is soluble, ferric is not. Reduced (ferrous) iron is colorless.

Relict features - soil morphological features that do not reflect recent hydrologic conditions of saturation and anaerobic conditions.

Saturation - under ideal circumstances, all soil pores are filled with water. Rarely, if ever, occurs in the field. For a soil horizon to be considered saturated for anaerobic conditions to occur, it is not necessary that all pores be filled with water.

Soft masses – mottles, that are not hard, with a variable shape**. GENERALLY USED TO DESCRIBE IRON/MANGANESE CONCENTRATIONS**

REFERENCES

- Field Indicators of Hydric Soils of the US, version 4.0
- Florida Guidance for the Use of Soil Morphology for Hydrologic Evidence (Wade Hurt, personal communication)
- Seasonally Saturated Soils in the Puget Lowland: Saturation, Reduction and Color Patterns by C.G. Cogger and P.E. Kennedy
- Redoximorphic Features for Identifying Aquic Conditions, North Carolina State University Technical Bulletin 301
- Waste Storage Facility, WA 313 April 1999

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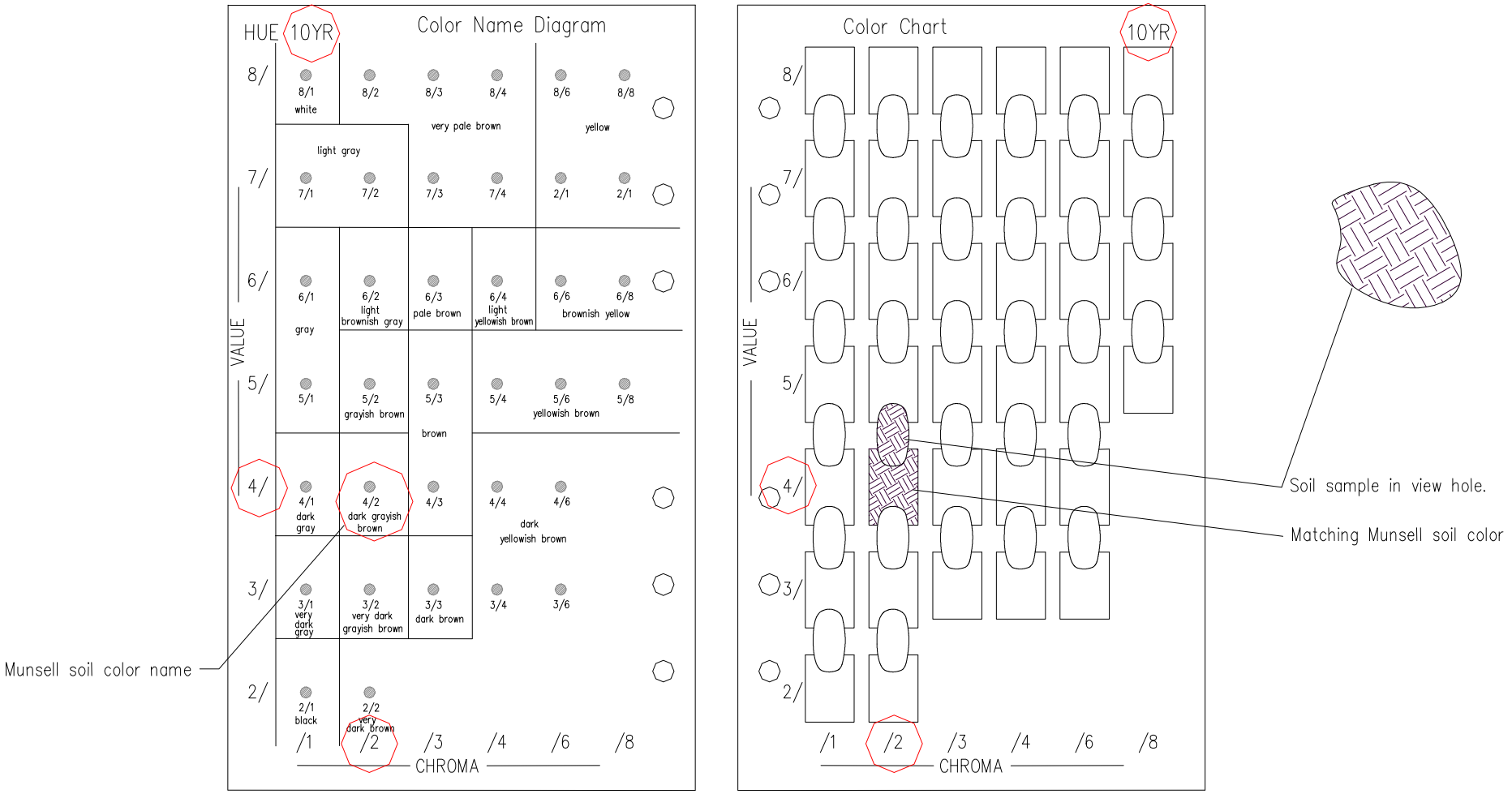

Munsell soil color: HUE=10YR, VALUE=4, CHROMA=2, a dark grayish brown.

Written: HUE VALUE/CHROMA

Written: 10YR 4/2

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HYDRIC SOIL DOCUMENTATION PROFILE DESCRIPTION

Soil Map Unit (Symbol and Name):				**File No.:**			**Stop No.:**	
Soil Component (Series, Inclusions, etc.):								
Area:				**Date:**			**Recorder:**	
Location:				**Soil Temperature Regime:**				
Classification:				**Slowest Permeability (upper 12 inches):**				
Native Vegetation (or crop):				**Depth to Estimated Seasonal Saturation:**				
Depth to Measured Saturation:		**Depth to Estimated Anaerobiosis:**		**Slope (%):**			**Aspect:**	
Additional Soil and Site Description Notes:			**Land Surface Shapes:**			**Landform:**		
Horizon	**Depth**	**Texture**	**Matrix Color**	**(Record: Percent, Size, Color and Location) Redox Masses**	**Redox Depletions**	**Pore Linings**	Boun-dary	**Notes**

Additional Remarks:

Is this soil a hydric soil? **Why/Why Not?**