United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Major Land
Resource
Region 17

Alaska

Field Indicators Of Hydric Soils In Alaska

A User Guide

Foreword

Field Indicators of Hydric Soils in Alaska is intended for use as a field guide to those hydric soil indicators that are applicable in Alaska. This guide presents those current indicators of the National Technical Committee for Hydric Soils (USDA, NRCS, 2005) that are known to work in Alaska. Discussion of additional indicators is also included. Considerable relevant explanatory text has been excerpted from the *Field Indicators of Hydric Soils in the United States* (USDA, NRCS, 2003). General information, non-technical descriptions, and user notes are also presented to help in the understanding and identification of each indicator as it occurs in Alaska. Color figures are presented to show the indicators as they occur in Alaska soils. Guidance is provided to assist in observing and documenting study sites and soils. It is hoped that this guide will be a useful to anyone studying hydric soils in Alaska.

Special thanks are given to those who helped develop the Alaska indicators and to the reviewers who have provided valuable input to the development of this guide. They include: Mark Clark, Dennis Moore, Michael Mungoven, Trudy Pink, and Ann Rippy *(USDA-Natural Resources Conservation Service)*; Dave D'Amore, Jackie DeMontigny, Patti Krosse, and Cole Mayn *(USDA-Forest Service)*; Mike Holley and Chris Noble *(U. S. Army, Corps of Engineers)*; and Chien Lu Ping *(University of Alaska Fairbanks)*.

Compiled by **Joseph P. Moore** (State Soil Scientist, USDA-NRCS, Palmer, Alaska)

Edited by **Pam Taber** (Editorial Assistant, USDA-NRCS, Palmer, Alaska)

ISSUED 2005

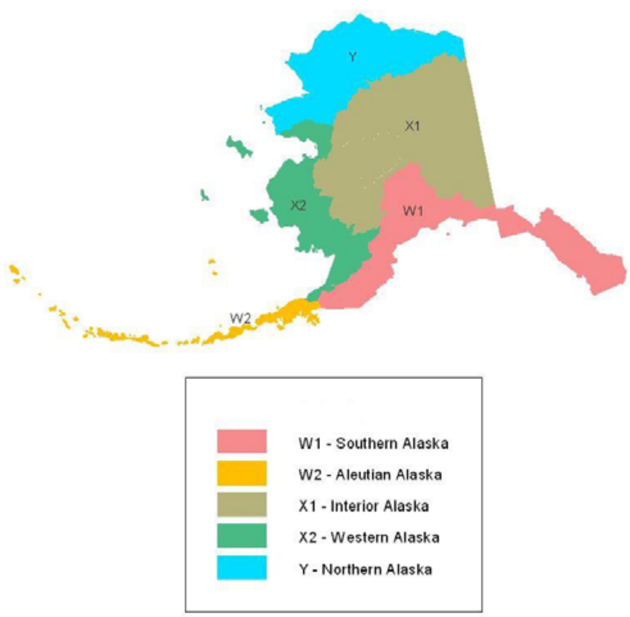
Contents

Introduction

Field Indicators of Hydric Soils in Alaska is a guide to help identify and delineate hydric soils in the field. Indicators are not intended to replace or relieve the requirements contained in the definition of a hydric soil. The list of Indicators is considered to be dynamic; changes and additions are anticipated with new research and field testing. The majority of the indicators are those officially adopted and used by the National Technical Committee for Hydric Soils (NTCHS). Additional indicators that are known to work in Alaska are also included. Those not approved by the NTCHS are noted as such. To properly use these indicators, a basic knowledge of soil and landform relationships and general soil morphology is necessary. Comments on these or other indicators used in Alaska can be sent to Joe Moore, State Soil Scientist, USDA-NRCS, 800 West Evergreen Avenue, Palmer, Alaska 99645.

Most of the indicators are applicable statewide although a few are specific to only certain regions of Alaska. This guidebook describes indicators based on the Land Resource Regions (LRRs) of Alaska (*Figure 1*). The geographic extent of all LRRs of the United States are defined in USDA Agriculture Handbook 296 (USDA, SCS, 1981, draft revision 2003). It is important to note that boundaries between LRRs are broad transition zones. Also, although an indicator may be noted as most relevant in a specific LRR, it may also be applicable in the other LRRs.

Figure 1. Land Resource Regions of Alaska



The indicators are used to identify the hydric soil component of wetlands; however, some hydric soils do not have any of the currently listed indicators. Therefore, the absence of any listed indicator does not exclude the soil from being classed as hydric. Such soils should be studied and their characteristic morphologies identified for inclusion in this guide.

Concept

Hydric soils are defined as *'soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part'* (Federal Register, July 13, 1994). The 'growing season' as used in the hydric soil definition is that portion of the year when soil temperatures are above biologic zero at 50 cm (19.7 inches), (USDA, NRCS, 2003). Biologic zero is defined as the soil temperature, at a depth of 50 cm (19.7 inches) below which the growth and function of locally adapted plants are negligible (USDA, NRCS, 2003).

Nearly all hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days. In a well drained soil, microbes function in an aerobic environment and consume available oxygen as well as organic matter in the soil. During periods of saturation or inundation, the soil microbes deplete what free oxygen is available and then they begin to function under anaerobic conditions. Microbes are less efficient in an anaerobic environment and so organic matter decomposition slows to the point that organic matter and carbon begins to accumulate. Biogeochemical processes also act upon nitrogen, manganese, iron, and sulfate in this anaerobic environment. Some of these processes result in characteristic morphologies in the soil that persist during both wet and dry periods. Those morphologies related to organic accumulation; iron reduction, translocation, and accumulation; and sulfate reduction form the basis for field indicators useful for identifying hydric soils in Alaska.

It is important to understand what the indicators look like and how they form. In many areas of Alaska accumulation of organic matter and the soil colors associated with translocation of iron in the soil are also present in well drained, oxidized soils. There are characteristics, however, which if carefully observed will help you clearly identify if hydric soil indicators are present.

Organic Accumulation

Saturated or inundated soils

Since the efficiency of soil microbes is considerably lower in an anaerobic environment, less organic matter and organic carbon is consumed by the microbes. Organic matter and carbon begin to accumulate. The result is the development of thick organic surfaces on the soil *(Figure 2)* or dark, organic-rich surface mineral layers.

Figure 2. A saturated organic soil or Histosol. In this profile, saturated organic material extends from the soil surface to a depth below 24 inches (60 cm).

Non-saturated or non-inundated soils

Cool temperatures and acid conditions also result in the slow decomposition of organic matter and carbon. Many well drained soils in Alaska, under aerobic conditions, will have thick organic surface layers. These layers are not an indication of diminished microbial activity in a saturated anaerobic environment. The key difference is that these organic layers are not saturated for significant periods during the growing season.

Iron Reduction, Translocation, and Accumulation

Saturated or inundated soils

In an anaerobic environment, soil microbes reduce ferric iron Fe_3^+ to ferrous iron Fe_2^+. Areas in the soil where iron is reduced develop characteristic bluish-gray or greenish-gray colors known as *gley*. Ferric iron is insoluble but ferrous iron easily enters the soil solution. Iron that is reduced in some areas of the soil enters into the soil solution and is moved or translocated to other areas of the soil. The areas that have lost iron develop characteristic whitish-gray or reddish-gray colors and are known as *iron depletions*. If a soil reverts back to an aerobic state, iron that is in solution will oxidize and become concentrated in patches and along pores and root channels. These areas of oxidized iron are called *redox concentrations*. Since water movement in these saturated or inundated soils can be multi-directional, iron depletions and redox concentrations can occur anywhere and have irregular shapes and sizes *(Figure 3).*

Non-saturated or non-inundated soils

In well drained, aerated soils, iron translocation is a normal process. Infiltration moves downward through the soil and together with the presence of organic acids, leaches iron from mineral layers near the top of the soil (A and E horizons). The iron is carried in solution downward and accumulates in lower layers (B horizons). As the near surface layers are continually leached, their colors become similar to that of *iron depletions*. The accumulation of iron in the lower horizons may often result in colors similar to *redox concentrations*. This coloration is most pronounced in Spodosols, which are further discussed in the section ***Other Problem Situations***. Since chemical weathering in an aerated soil is accomplished by the downward movement of water, the layers or horizons are relatively parallel to the soil surface and fairly consistent across the soil *(Figure 4).*

Figure 3. Iron depletions and redox concentrations in a hydric soil. Note the irregular patterns as water movement is multidirectional in the soil.

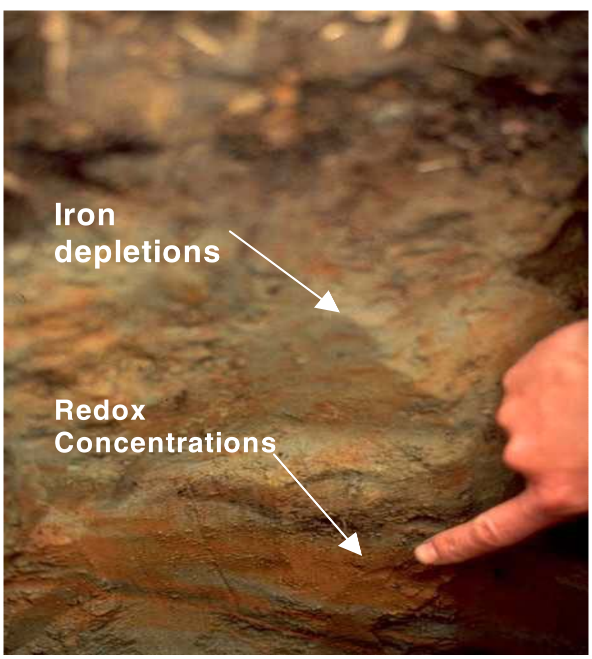
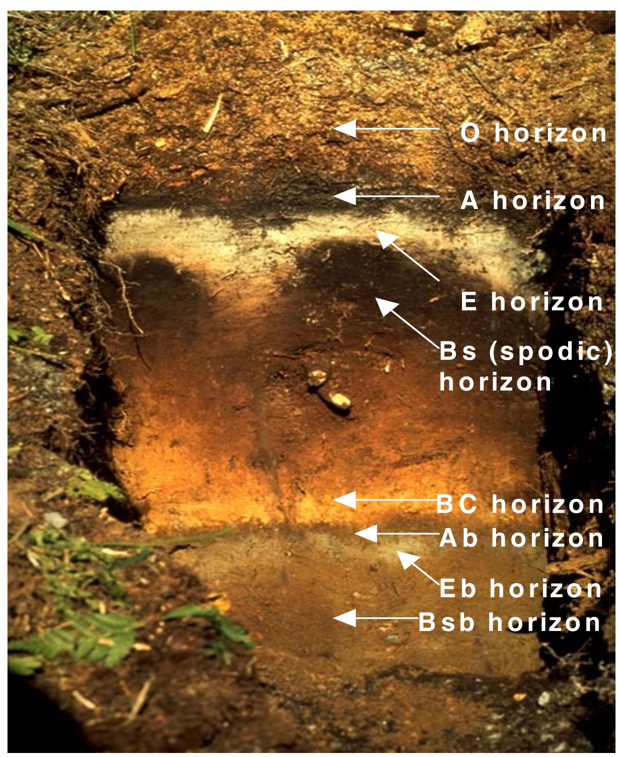


Figure 4. A well drained, oxidized soil. Downward movement of water has leached iron, alumina, and organic material from near surface mineral layers (E horizon) and deposited lower in the B horizon. Note the horizons are parallel to the soil surface. Lower in the soil, another sequence of A, E, and B horizons have been buried by either ash or loess deposition.

In this Spodosol, the horizons are very pronounced. In other oxidized soils, horizons may not be as distinct.



Tree throw and cryoturbation, however, can often mix and break these horizons *(Figure 5)*, so be careful to examine all site characteristics.

Sulfate Reduction

Saturated or inundated soils
Sulfur is the last of the elements to be reduced by soil microbes in an anaerobic environment. The microbes convert SO_4^- to H_2S, or hydrogen sulfide. This results in a very pronounced "rotten egg" odor.

Non-saturated or non-inundated soils
Sulfate is not reduced and there is no odor.

Figure 5. A well drained Spodosol with strong E and B (spodic) horizons. The horizons have been broken and mixed by tree throw. Do not confuse these with iron depletions and redox concentrations.

Cautions

Soils that are artificially drained or protected (for instance, by levees) are hydric if the soil in its undisturbed state would meet the definition of a hydric soil. To be determined hydric, these soils should also have at least one of the Indicators.

Morphological features of hydric soils indicate that saturation and anaerobic conditions have existed under either contemporary or former (recent) hydrologic regimes. Features that do not reflect contemporary or recent hydrologic conditions of saturation and anaerobiosis are relict features. Typically, contemporary and recent hydric soil features have diffuse boundaries; relict hydric soil features have abrupt boundaries. When soil morphology seems inconsistent with the landscape, vegetation, or observable hydrology, it may be necessary to obtain the assistance of an experienced soil or wetland scientist to determine whether the soil is hydric.

Procedures To Use In Alaska

Observe and Document the Site

The common temptation is to excavate a small hole in the soil, note the presence of any indicators, make a decision, and leave. Before any decision can be made, however, the overall site and how it interacts with the soil must be understood.

At each site look at the following site features, then look at the soil indicators. Use all of the evidence available to you. If the listed soil indicators are present, the soil is hydric. Use the additional information obtained from the site to clearly understand why the soil is hydric. If no soil indicators are present, use the additional site information to determine if the soil is indeed non-hydric or if it represents a ‘problem’ soil.

Additional Site Information

Hydrology–Is standing water observed on the site or is water observed in the soil pit? Do you know what the water table depth is in the area?

Slope–Is the site level or nearly level so that water may not readily run off the soil, or is it steeper where free water would run off from the soil?

Slope shape–Is the shape concave, where water would tend to collect and possibly saturate the soil or even pond on the surface? Is it plain or flat, where water would not readily run off? Is it convex where water would normally runoff?

Landform–Is the soil on a low terrace or flood plain that would be subject to seasonal high water tables or flooding? Is it at the toe of a slope where runoff may tend to collect?

Soil materials–Is there soil material deeper in the soil that would restrict the drainage of water? This could include permafrost, consolidated bedrock, layers of silt or substantial clay content, or dense glacial till. Or is there relatively loose soil material; sand, gravel, or rocks; or fractured bedrock that would allow the soil to readily drain?

Vegetation–Does the vegetation at the site indicate wetter conditions than at other nearby sites or is it similar to what is found at nearby upland sites?

The above questions should be answered at any site. Always look at the features of the immediate site and then compare them to the surrounding areas. Try to contrast the features of wet and dry sites that are in close proximity. When observing slope features, look at the immediate slope. Don’t confuse the small nearly level bench or depression at your immediate site with the overall hillslope on which it occurs.

Once you begin to understand the overall site, you will understand the presence or absence of indicators in the soil.

Observe and Document the Soil

To document a hydric soil, first remove any loose leaf matter, needles, or bark. Do not remove the organic surface layers of the soil, usually moss and other plant remains in varying stages of decomposition. Dig a hole and describe the soil profile to a depth of at least 20 inches (50 cm) from the soil surface. This allows you to observe any indicators, if present, within 12 inches (30 cm) of the soil surface, plus to examine some of the underlying material for clues.

Deeper examination of soil may be required when field indicators are not easily seen within 20 inches (50 cm) of the surface. It is always recommended that soils be excavated and described as deep as necessary to make reliable interpretations. For example, examination to less than 20 inches (50 cm) may suffice in soils with surface horizons of saturated organic material or mucky mineral material. Conversely, depth of excavation will often need to be greater than 20 inches (50 cm) in soils with thick dark surfaces because the upper horizons of these soils, due to the masking effect of organic material, often contain no easily visible redoximorphic features. In many sites it is necessary to make exploratory observations to a meter or more. These observations should be made with the intent of documenting and understanding the variability in soil properties and hydrologic relationships on the site.

It is preferred, when possible, to excavate the soil deep enough to determine if there are layers or materials present that might restrict the soil drainage. This will help you understand why the soil may or may not be hydric. One method is to excavate a hole to 20 inches (50 cm) and then use a bucket auger to examine the lower soil layers to a depth of 39 inches (1 m) or more. The bucket auger will work best in soils that do not contain cobbles and stones.

Carefully describe the soil. Pay special attention to the depth to various soil layers, differences between soil layers, and color variations within layers. Use standardized field data forms such as those provided by the USDA-NRCS or the U.S. Army Corps of Engineers. Take good photographs of both the soil and the overall site. You may not have the opportunity to return for more data.

Note which hydric soil indicators, if any, are present. Again, using all of the evidence now available to you, decide if the soil is hydric or non-hydric. Make sure that you have enough data to reasonably defend your decision.

Depth Measurement

All of the Indicators require the presence of certain soil colors or features within specified depths of the ***'soil surface.'*** If the soil has saturated organic material greater than 8 inches (20 cm) thick, the 'soil surface' for hydric description starts just below the living, green moss layer. For all other soils, the 'soil surface' for hydric description starts at the top of the first mineral or mixed mineral/organic layer.

Colors

All colors noted in this guide refer to moist Munsell® colors (Gretag/MacBeth 2000). Soil colors specified in the Indicators do not have decimal points listed; however, colors do occur between Munsell® chips. Soil chroma should not be rounded to qualify as meeting an indicator. For example: a soil matrix with a chroma between 2 and 3 should be listed as having a chroma of 2+. This soil material does not have a chroma 2 and would not meet any indicator that requires a chroma 2 or less. The above rule applies only to chroma. When making on-site determinations, values are rounded to nearest color chip.

Other

Particular attention should be paid to changes in microtopography over short distances. Small changes in slope configuration may result in repetitive sequences of hydric/non-hydric soils and the delineation of individual areas of hydric and non-hydric soils may be difficult. Often the dominant condition (hydric/non-hydric) is the only reliable interpretation. The shape of the local landform can greatly affect the movement of water through the landscape. Significant changes in parent material or lithologic discontinuities in the soil can affect the hydrologic properties of the soil. After sufficient exploratory observations have been made to understand the soil-hydrologic relationship at the site, subsequent excavations may then be shallower if identification of appropriate indicators allows.

FIELD INDICATORS

Saturated Organic Surfaces Greater than 40 cm. (16 in.) thick

General Description *(Figure 6)*
These are predominantly soils that have at least 16 inches (40 cm) or more of saturated organic material. The organic soil material must be saturated for at least 30 days each year. If the organic material is overlain by mineral soil material, the organic material must start within 16 inches (40 cm) of the soil surface. Some of these soils have permafrost at varying depths below the surface.

NTCHS Technical Description (Indicator A1)
Classifies as a Histosol or Histel

Corresponding 87 Manual Indicator
Combines concepts of a. (Organic soils—Histosols)

Applicable Regions (LRR)
Found in all regions of Alaska

Southern Alaska (W1)
Saturation is most likely to be observed during April-May and September-October. Saturated organic materials commonly occur in groundwater discharge zones and where restrictive layers (e.g., bedrock, glacial till) in the soil have perched water. These soils also occur in depressions and along tidal fringes.

Figure 6. A saturated organic soil. The saturated organic materials extend from just below the living plants to a depth greater than 24 inches (60 cm).

Northern Alaska (Y)
Saturation is most likely to be observed during June-August. Saturated organic materials commonly occur in depressions and on flood plains where restrictive layers (e.g., permafrost, glacial till) in the soil perch water.

Interior Alaska (X1
Saturation is most likely to be observed during May and late July-September. Saturated organic materials commonly occur in groundwater discharge zones in depressions and flats and also extensively across hillslopes, where restrictive layers (e.g., permafrost, glacial till) in the soil have perched water.

Western Alaska (X2)
Saturation is most likely to be observed during May-September. Saturated organic materials commonly occur in groundwater discharge zones in depressions and flats and also extensively

across hillslopes, where restrictive layers (e.g., permafrost, glacial till) in the soil have perched water.

Aleutians (W2)
Saturation is most likely to be observed throughout the year. Saturated organic materials commonly occur in depressions and flats.

Exceptions
Thick organic surfaces without evidence of saturation are excluded. It is quite unusual for a non-saturated soil to develop an organic surface thicker than 16 inches (40 cm). These may occur, however, where water tables in formerly saturated organic soils have dropped from natural causes. It may also occur in areas where ice lenses have heaved formerly saturated organic material into convex positions above the influence of a water table.

User Notes
This Indicator includes all Histosols and Histels, except Folists and Folistels, as defined in Soil *Taxonomy* (USDA-NRCS 1998). Measurement of thickness should start at the base of the living green moss material, unless there is an overlying mineral layer. If so, measure from the start of the buried organic material. These soils may or may not contain permafrost. Textures includes peat (fibric), mucky peat (hemic), and muck (sapric). Evidence of saturation is free flow of water from the soil matrix during at least part of the growing season. Saturation should be observed during peak periods within each region or inferred from the hydrology field indicators outside of the peak period. Thin mineral strata may be observed within the organic layers and mineral material may be observed under or over the organic material.

The organic material in these soils consists primarily of mosses and other plant remains in varying stages of decomposition. Usually the plant remains are not identifiable and can be easily broken down by rubbing them between the fingers. Organic soils may have permafrost within the soil profile (Histels).

To determine if an organic soil is actually hydric, make sure the materials are saturated or nearly saturated. They should be very moist and will usually either freely release moisture or release moisture with minimal squeezing. If there are mineral soil materials below the organic material, look for the presence of additional hydric soil indicators in the mineral layers.

Saturated Organic Surfaces Between 8 and 16 inches (20 and 40 cm) thick

General Description *(Figure 7)*

These are soils that have between 8 to 16 inches (20 and 40 cm) of **saturated** organic material at the soil surface. The organic material must be saturated for at least 30 days each year. The organic material is underlain by mineral soil material. Some of these soils have permafrost at varying depths below the surface.

NTCHS Technical Description (Indicator A2)
Histic Epipedon

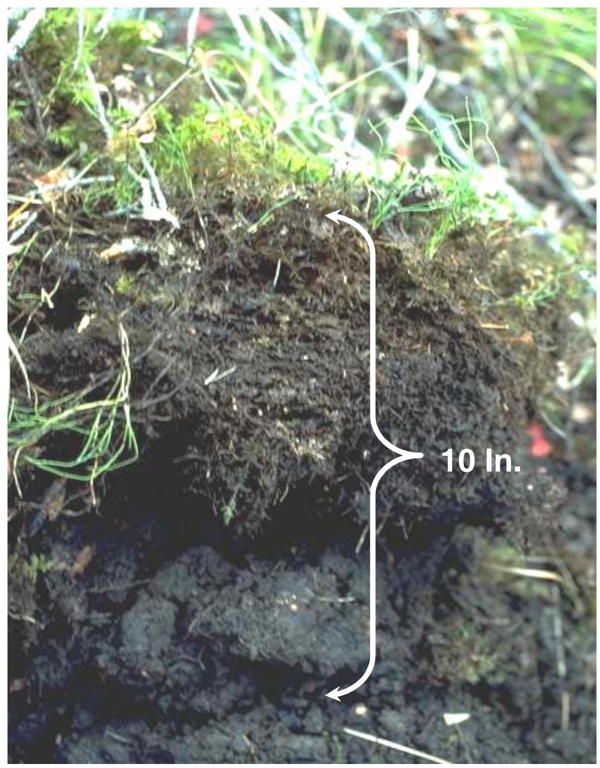
Corresponding 87 Manual Indicator
Histic Epipedon

Applicable Regions (LRR)
All regions of Alaska

Southern Alaska (W1)
Saturation is most likely to be observed during April-May and September-October. Saturated organic materials commonly occur in groundwater discharge zones along toeslopes and footslopes where restrictive layers (e.g., glacial till) in the soil have perched water. These soils also occur in depressions and along tidal fringes.

Northern Alaska (Y)
Saturation is most likely to be observed during June-August. Saturated organic materials commonly occur in depressions and on flood plains where restrictive layers (e.g., permafrost, glacial till) in the soil perch water.

Figure 7. Saturated organic material overlying mineral soil. The saturated organic material extends from just below the living plants to a depth of approximately 10 inches (25 cm).



Interior Alaska (X1
Saturation is most likely to be observed during May and late July-September. Saturated organic materials commonly occur in groundwater discharge zones in depressions and flats and also extensively across hillslopes, where restrictive layers (e.g., permafrost, glacial till) in the soil have perched water.

Western Alaska (X2)
Saturation is most likely to be observed during May-September. Saturated organic materials commonly occur in groundwater discharge zones in depressions and flats and also extensively across hillslopes, where restrictive layers (e.g., permafrost, glacial till) in the soil have perched water.

Aleutians (W2)
Saturation is most likely to be observed throughout the year. Saturated organic materials commonly occur in depressions and flats.

Exceptions
Thick organic surfaces without evidence of saturation are excluded. Non-saturated organic surfaces are most likely to be found on convex topography or where organic debris (e.g., forest litter) has accumulated on the mineral soil surface. Often, if the organic material is saturated, there will be a layer of dark colored highly decomposed organic or organic/mineral material (muck or mucky material) overlying the first mineral layer.

User Notes
These soils may or may not contain permafrost. Includes peat (fibric), mucky peat (hemic), and muck (sapric) textures. Evidence of saturation is free flow of water from the soil matrix during at least part of the growing season. Saturation should be observed during peak periods within each region or inferred from the hydrology field indicators outside of the peak period. Measurement of thickness should start at the base of the living green moss material. If the soil has a transitional layer of mixed organic and mineral material between the organic and mineral layers, it should be considered as organic material when measuring thickness.

The organic material in these soils consists primarily of mosses and other plant remains in varying stages of decomposition. Usually the plant remains are not identifiable and can be easily broken down by rubbing them between the fingers.

There are soils that have organic mats thicker than 8 inches (20 cm) which are not saturated. These soils usually occur on steeper slopes or over very coarse mineral material or fractured rock that prevents water from accumulating. Usually the plant remains are not very decomposed and so are identifiable even after rubbing them between the fingers. These non-hydric organic soils occur in coastal areas in southern Alaska, and on hill and mountain slopes throughout the state.

To determine if an organic soil is actually hydric, make sure the materials are saturated or nearly saturated. They should be very moist and will usually either freely release moisture or release moisture with minimal squeezing. Look for the presence of additional hydric soil indicators in the underlying mineral layers.

Hydrogen Sulfide Odor

General Description
The presence of a hydrogen sulfide (rotten egg) odor emitting from some part of the soil that occurs within 12 inches (30 cm) of the soil surface.

NTCHS Technical Description (Indicator A4)
A hydrogen sulfide odor within 12 inches (30 cm) of the soil surface,

Corresponding 87 Manual Indicator
Correlates to c. (Sulfidic material).

Applicable Regions (LRR)
All regions of Alaska

Exceptions
None.

User Notes
Any time you excavate the soil and smell hydrogen sulfide (rotten egg odor), sulfur is currently being reduced in the soil and the soil is definitely in an anaerobic state. In some soils the odor is well pronounced; in others it is very fleeting and the gas rapidly dissipates. If in doubt, quickly open several small holes in the area of concern to determine if a hydrogen sulfide odor is really present.

Alaska Gleyed

General Description *(Figures 8 and 9)*
The soils have a layer within 12 inches (30 cm) of the soil surface that, in over 50 percent of the layer, has a hue found on the Gleyed 1 or Gleyed 2 pages of the Munsell® soil color book, and a value of 4 or more. This gleyed layer must be underlain, within 60 inches (1.5 m) of the soil surface with similar soil material that is non-gleyed (hue 5Y or redder)

NTCHS Technical Description (Indicator A13)
A mineral layer with a gleyed matrix that occupies 50 percent or more of a layer that starts within 12 inches (30 cm) of the soil surface. The gleyed matrix is underlain within 60 inches (1.5 m) of the soil surface by soil material with hue 5Y or redder that is the same type of parent material.

Corresponding 87 Manual Indicator
Correlates to f(1). (Gleyed soils—gray color) and also covers concept of ‘Problem Soils—Soils with low chroma parent material’.

Figure 8. Note the bluish gray color of the upper soil material, indicating reduction. The dark color of the underlying material is the color of the parent material and not the result of saturation.

Figure 9. Note the bluish-gray band at approximately 8 inches (20 cm), which indicates the presence of reduced soil material. The material below 8 inches (20 cm) reflects both the color of the parent material and soil weathering under aerobic conditions.

Applicable Regions (LRR)
All regions of Alaska

Southern Alaska (W1)
More common in Southcentral Alaska than Southeast Alaska. In Southeast, found along hill and mountain slopes. In Southcentral, commonly found along transition zones between fens and bogs and adjacent uplands; groundwater discharge areas; and depressional areas within low floodplains. Saturation may be the result of a local riparian water table or water perched on restrictive layers within the soil.

Northern Alaska (Y)
Commonly found in depressions on flood plains, tidal flats, and foothills, and also drainage channels on foothills. Saturation may be the result of a local riparian water table or water perched on permafrost.

Interior Alaska (X1)
Commonly found along transition zones between fens and bogs and adjacent uplands; groundwater discharge areas; and depressional areas within low floodplains. Saturation may be the result of a local riparian water table or water perched on restrictive layers, especially permafrost, within the soil.

Western Alaska (X2)
Commonly found along transition zones between fens and bogs and adjacent uplands; groundwater discharge areas; broad depressional areas within low floodplains, and in deltaic areas. Saturation may be the result of a local riparian water table or water perched on restrictive layers, including permafrost, within the soil.

Aleutians (W2)
Commonly found in tidal flats and estuaries and upland depressions. May be difficult to apply because of a predominance of volcanic ash.

Exceptions
None.

User Notes
This indicator applies to all mineral soils throughout the state. These requirements provide evidence that the gleyed colors are truly due to reduction and are not the color of the parent material. If the gley colors extend beyond the depth of 60 inches (1.5 m), the true color of the parent material cannot be determined. In that case, try applying the *Alaska Redox* Indicator.

The indicator is looking for two things: First, that within 12 inches (30 cm) of the soil surface, one or more of the specified gleyed colors is present. These must be colors present on the gley page of the color book, not simply gray colors. Second, below these gleyed colors, the color of similar soil material is 5Y or redder (2.5Y, 10YR, 7.5YR, etc.).

The presence of the truly gleyed colors indicates that the soil has undergone reduction. The requirement for 5Y or redder colors lower in the profile is to insure that the gleyed colors are not simply the basic color of the soil parent material. Tidal sediments, lacustrine sediments, loess, and some glacial tills have base colors that appear as gleyed. On closer examination, their colors will normally not fit on the ‘gleyed’ color page.

This indicator proves that the near surface gleyed colors are not natural soil material colors, and that they are the result of reduced conditions.

Note: When comparing the near surface and underlying colors make sure that you are looking at the same type of soil material. Many soils in Alaska are composed of two or more types of materials (e.g., silty loess overlying gravelly glacial till or sand and gravel river deposits).

Alaska Redox

General Description *(Figures 10, 11, 12, and 13)*
Soils have a layer within 12 inches (30 cm) of the soil surface that has a dominant hue found on the Gleyed 1 and Gleyed 2 pages of the Munsell® soil color book, or have a hue of 5Y if the chroma is 3 or less. The layer must also contain at least 10 percent, by area, redox concentrations (reddish-orange iron coatings).

Figure 10. The overall matrix color is within the colors specified in the indicator. Reddish-orange redox concentrations are seen along channels of living roots and pores.

Figure 11. Looking down at the bottom of a soil pit, gleyed matrix colors and reddish-orange redox concentrations can be seen at the bottom of the active layer in a permafrost affected soil.

Figure 12. Gleyed matrix colors and reddish-orange concentrations. Note how the concentrations follow the root channels.

Figure 13. Note the gleyed matrix color and the redox concentrations surrounding root channels.

Figures 10, 12, and 13 courtesy University of Alaska Fairbanks

NTCHS Technical Description (Indicator A14)
A mineral layer that has dominant hue of 5Y with chroma of 3 or less, or hue of N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB; with 10 percent or more distinct or prominent redox concentrations as pore linings with value and chroma of 4 or more. The layer starts within 12 inches (30 cm) of the soil surface.

Corresponding 87 Manual Indicator
Correlates to f(1). (Gleyed soils—gray color).

Applicable Regions (LRR)
All regions of Alaska

Southern Alaska (W1)
May occur in any saturated mineral soil. May be found across all landforms, especially in depressions. Saturation may be the result of fluctuating water tables in riparian zones or fluctuating water tables perched on slowly permeable sediments.

Northern Alaska (Y)
Commonly found along foothills and micro-high positions (patterned ground) on coastal plains. Saturation is usually the result of fluctuating water tables perched on seasonal frost or permafrost.

Interior Alaska (X1)
Commonly found on most landforms. Saturation may be the result of fluctuating water tables in riparian zones or fluctuating water tables perched on slowly permeable materials, especially permafrost.

Western Alaska (X2)
Commonly found on most landforms. Saturation may be the result of fluctuating water tables in riparian zones or fluctuating water tables perched on slowly permeable materials.

Aleutians (W2)
Commonly found in tidal flats and upland depressions. May be difficult to apply because of a predominance of volcanic ash.

Exceptions
None.

User Notes
Unlike Indicator *Alaska Gleyed*, it does not prove whether or not the specified colors might be parent material colors. Thus, the additional requirement for redox concentrations.

In a soil layer that has been reduced, one of the first areas where oxygen will be re-introduced is along pores and the channels of live roots. As oxidation occurs in these areas, characteristic reddish-orange redox concentrations (value and chroma of 4 or more) will be apparent along the pores and linings. These will stand out in contrast to the matrix color of the overall soil layer.

First, note the dominant color(s) of the soil layer to see if it matches the gley colors required. Then break open pieces of the soil and look for reddish-orange redox concentrations, especially along pores and root linings. If these conditions are met, it indicates the soil has been reduced during periods of wetness, and now, while in a drier state, is undergoing oxidation.

Alaska Gleyed Pores

General Description *(Figure 14)*

Soils have a mineral layer within 12 inches (30 cm) of the soil surface that contains gleyed pores and root channels. These gleyed pores and root channels must comprise at least 10 percent of the overall layer. They must have a hue found on the Gleyed 1 and Gleyed 2 pages of the Munsell® soil color book and a value of 4 or more. The matrix or dominant color of the layer has a hue of 5Y or redder.

NTCHS Technical Description (Indicator A14)

A mineral layer that has 10 percent hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value 4 or more in pores and along root channels starting within 12 inches (30 cm) of the soil surface. The matrix has dominant color of 5Y or redder.

Corresponding 87 Manual Indicator

Correlates to f(1). (Gleyed soils—gray color).

Applicable Regions (LRR)

All regions of Alaska

Southern Alaska (W1)

May occur in any saturated mineral soil. May be found across all landforms, especially in riparian areas and in depressions where water tables perch on slowly permeable sediments. Where water tables fluctuate, redox concentrations may also be present.

Figure 14. Reduction occurs first along root channels where organic carbon is concentrated. Note the gleyed colors along the root channels.

(photo courtesy University of Alaska Fairbanks)

Northern Alaska (Y)

Commonly found along floodplains subject to fluctuating water tables and/or ponding.

Interior Alaska (X1)

Commonly found in riparian areas and in depressions on most landforms where water tables perch on slowly permeable sediments, primarily permafrost. Where water tables fluctuate, redox concentrations may also be present.

Western Alaska (X2)
Commonly found in riparian areas and in depressions on most landforms where water tables perch on slowly permeable material. Where water tables fluctuate, redox concentrations may also be present.

Aleutians (W2)
Commonly found in tidal flats and upland depressions. May be difficult to apply because of a predominance of volcanic ash.

Exceptions
None.

User Notes
In a soil layer that is turning anaerobic, reduced conditions will first occur where the soil microbes have an ample supply of organic carbon. Colder soils, as in Alaska, normally have low organic carbon, so microbes will congregate along the channels containing dead roots. It is along these channels that gleyed colors will first appear.

This indicator is intended to look for subtle evidence of active reduction in the soils. Because of the presence of organic carbon along root channels, visible evidence of reduction will first occur along the root channels. The evidence is thin coatings meeting the specified color (hue, value) requirements. Care must be taken to observe all of the color variations in the soil and not just the dominant color. Break pieces of soil open and closely look along the root channels. Many of these will be very thin or fine. Use of a hand lens will help.

See if you can observe thin coatings along the channels that match the gleyed colors listed in the indicator. If they are present, they indicate that the soil is beginning to go anaerobic.

Thick Dark Surface

Figure 15. Dark surface colors that extend below 12 inches (30 cm) may make it difficult to observe redox features. Look carefully for a reduced matrix or gley below the dark colors. Look carefully for other indicators.

General Description *(Figure 15)*

The mineral soil layers extending to at least 12 inches (30 cm) below the soil surface have dark colors which may mask or hide redox features such as gley and concentrations. The dark mineral layers have value of 2.5 or less. Underlying these dark layers, there is a mineral layer at least 6 inches (15 cm) thick that is dominated by gleyed colors.

NTCHS Technical Description (Indicator A12)

A mineral layer at least 6 inches (15 cm) thick with a depleted matrix that has 60 percent or more chroma 2 or less (or a gleyed matrix) starting below 12 inches (30 cm) of the surface. The layer(s) above the depleted or gleyed matrix have value 2.5 or less to a depth of 12 inches (30 cm) and value 3 or less and chroma 1 or less in the remainder of the epipedon. If the epipedons is sandy, at least 70 percent of the visible soil particles must be covered, coated, or similarly masked with organic material.

Corresponding 87 Manual Indicator

Covers concept of 'Problem soils—soils with thick dark A-horizons.'

Applicable Regions (LRR)

Southern Alaska (W1)

The Indicator has not been commonly observed to-date in the southeast Alaska. Elsewhere, saturation is most likely to be observed during April-May and September-October. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables.

Northern Alaska (Y)

Saturation is most likely to be observed during June-August. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables.

Interior Alaska (X1)
Saturation is most likely to be observed during April-May and September-October. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables. This indicator does not occur in permafrost affected soils.

Western Alaska (X2)
Saturation is most likely to be observed during April-May and September-October. This is a common indicator on mountain slopes where restrictive layers in the soil perch seasonal water tables. This indicator does not occur in permafrost affected soils.

Aleutians (W2)
Unknown.

Exceptions

User Notes
Used in mineral soils with thick, very dark surface mineral horizons that may mask reduction features. Visible evidence of gley may only be observed deeper in the soil. Look below 12 inches (30 cm) for evidence of a depleted or gleyed matrix. Redox concentrations may also be observed.

Accumulation of organic carbon in mineral soil layers results in dark colors. Thicker dark surfaces are common in depressional areas where moisture accumulates and plant growth is enhanced. The thicker dark surfaces do not necessarily indicate saturation. If saturation does occur, however, the thick dark surface may mask or hide evidence of reduction near the soil surface. Look for two things. One is evidence of a depleted matrix or gley below the dark surface material. The other is to look for a source of saturation. This may include a restrictive layer that perches precipitation and snowmelt, a nearby spring or seep, or snowfield that persist late into the summer. Use of this indicator requires close observation and an understanding of landform position and local sources of hydrology.

Since some soils with thick dark surfaces are Spodosols *(Figure 4),* extreme care must be taken not to confuse buried grayish colored E horizon material with depleted colors. Also some Alaska soils are underlain by glacial deposits or marine sediments. These parent materials have base colors that can easily be confused with gleyed colors. Look for redox concentrations along pores and root channels (*see Alaska Redox Gleyed*) and/or gleyed root channels *(see Alaska Gleyed Pores)* below 12 inches (30 cm).

Positive Reaction to Ferrous Iron Test

General Description *(Figure 16)*

When alpha-alpha dipyridyl dye is applied in several areas to mineral soil material in a layer which is at least 4 inches (10 cm) thick and occurs within a depth of 12 inches (30 cm) of the soil surface, a positive reaction results within 30 seconds. The positive reaction is evidenced by a pink or red coloration in the dye.

NTCHS Technical Description

None.

Note: This is not an approved positive hydric soil indicator by the NTCHS.

Corresponding 87 Manual Indicator

Correlates to e. (ferrous iron test) or 'reducing conditions.'

Applicable Regions (LRR)

All regions of Alaska.

Exceptions

A positive reaction will not be present in a soil that is currently not reduced or a soil that lacks soluble iron. This lack of positive reaction to the dye does not preclude the presence of a hydric soil.

Figure 16. When alpha-alpha dipyridyl dye is applied to a soil containing reduced iron, a positive reaction is indicated by a pink or red coloration to the treated area.

Courtesy of University of Alaska Fairbanks

User Notes

Apply a small amount of dye to the soil, using an eyedropper or spray bottle. Test several locations within the soil layer. Look closely at the treated soil for evidence of the color change. If in doubt, apply to material from a sample of known upland soil and compare the reaction to the sample of interest.

Note: Please follow the procedures and note the considerations in Hydric Soil Technical Note 8 (www:**soil**s.usda.gov/use/**hydric**/ntchs/tech_**note**s/**note8**.html). Alpha-alpha dipyridyl is a hazardous substance.

Abrupt Boundary Color

General Description *(Figure 17)*
A mineral layer at least 6 inches (15 cm) thick in which 60 percent or more of the layer has a hue of 2.5Y or yellower. This layer begins within 12 inches (30 cm) of the soil surface and is overlain by a layer that has a hue of 7.5YR or redder. The boundary between the two layers is less than 2 inches (5 cm) thick and is approximately horizontal.

Figure 17. The white line indicates the abrupt color change from a redder hue to a yellower hue. The boundary is less than 2 inches (5 cm) thick and within 12 inches (30 cm) of the surface. This boundary reflects the top of the average long-term water table.

Courtesy U.S. Forest Service

NTCHS Technical Description
None.
Note: The NTCHS has not approved this indicator for use or 'for testing' without further data.

Corresponding 87 Manual Indicator
None.

Applicable Regions (LRR)
Southern Alaska (W1)
Research data and field morphology is available to support this indicator in Southeast Alaska and parts of Southcentral Alaska. It has not been studied elsewhere in the state.

Exceptions
Many better drained soils in Southern Alaska have similar changes in color, however, the boundary is wider or transitional. The boundary may also be very wavy or irregular. It is the presence of the abrupt color boundary that gives evidence of a water table.

User Notes
The feature occurs where a change in either slope or the underlying slowly permeable layer raises the water table. The presence of a long-term water table is evidenced by a change in soil color within 12 inches (30 cm) of the soil surface. The color change occurs along a relatively abrupt smooth horizontal boundary. Above the boundary, matrix colors are primarily reddish. Below the boundary, matrix colors are primarily yellowish.

Many soils that develop in a cool, acid environment have mineral horizons or layers that change from redder colors to yellower colors with depth *(Figure 4—note color transition from Bs to BC horizon).* The reddish zone is the area where iron and organic materials, moving down from the soil surface material, accumulate. The yellower zones below have less iron and organic material. In a relatively well drained soil, the boundary between the two color zones is transitional; gradual, wide, and often wavy or irregular. In a poorly drained soil, the water table impacts soil chemistry and inhibits movement of iron below the level of the water table. Since the water table in the soil is a relatively abrupt horizontal surface, the corresponding color boundary in the soil is also abrupt and horizontal.

Color Change

General Description

A mineral layer which is 4 inches (10 cm) or more thick and starts within 12 inches (30 cm) of the soil surface and has a matrix value of 4 or more and chroma of 2 or less. The hue becomes redder by one or more pages and/or the chroma increases by one or more units following less than 30 minutes of exposure to the air.

NTCHS Technical Description (TA4)
A mineral layer 4 inches (10 cm) or more thick starting within 12 inches (30 cm) of the soil surface that has a matrix value of 4 or more and chroma of 2 or less that becomes redder by one or more in hue and/or decreases one or more in chroma when exposed to air within 30 minutes.
Note: This indicator is approved 'for testing' only by the NTCHS

Corresponding 87 Manual Indicator
None.

Applicable Regions (LRR)
All regions of Alaska

Exceptions
This indicator should not be used for soils that are not currently at or near saturation. It also should not be used if the sample will dry to any degree in the period between color observations.

User Notes
This indicator may be observed in some mineral soils that are currently at or near saturation. If the soil matrix is sufficiently reduced and has gleyed colors, reduced ion (Fe_2^+) in the soil can begin to oxidize into Fe_3^+ upon exposure to the air. If the soil contains sufficient iron, this can result in an observable color change, especially in hue or value.

The soils should be at or near saturation when examined. Care must be taken to immediately obtain an accurate Munsell® color of the soil sample upon excavation. The colors should then be closely examined again after several minutes. Do not allow the sample to begin drying as drying will also result in a color change. Care must be taken to closely observe the colors. As always, do not obtain colors while wearing sunglasses. Colors must be obtained in the field under natural lighting and not under artificial light. Look for the presence of other indicators also.

Alaska Alpine Swales

General Description *(Figures 18 and 19)*
On concave alpine landforms, a surface mineral layer at least 4 inches (10 cm) thick that has a hue of 10YR or yellower, value of 2.5 or less, and chroma of 2 or less. This dark surface layer is at least twice as thick as a surface mineral layer which has the same color and is located on an adjacent convex micro-position.

NTCHS Technical Description (TA5)
On concave landforms in alpine and subalpine areas, the presence of a surface mineral layer at least 4 inches (10 cm) or more thick having hue of 10YR or yellower, value 2.5 or less, and chroma 2 or less. The dark surface layer is at least twice as thick as the surface mineral layer of soils on adjacent convex micro-positions.
Note: This indicator is approved 'for testing' only by the NTCHS

Corresponding 87 Manual Indicator
Covers concept of 'Problem soils—soils with thick dark A-horizons.'

Applicable Regions (LRR)
Southern Alaska (W1)
Saturation is most likely to be observed during late May through early July. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

Figure 18. The arrows indicate areas of concave micro-positions where water from snowmelt accumulates during late spring and early summer.

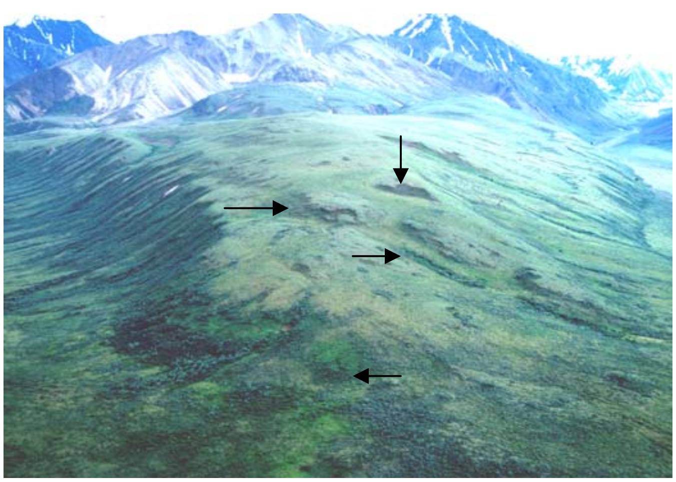


Figure 19. A typical soil profile illustrates the dark surface mineral layer over gray parent materials. Anaerobic conditions during late spring and early summer result in the accumulation of organic matter in the surface horizons. Redox features are absent or masked by the dark organic matter color.

Northern Alaska (Y)
Saturation is most likely to be observed during late May through mid-July. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

Interior Alaska (X1)
Saturation is most likely to be observed during late May through early July. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

Western Alaska (X2)
Saturation is most likely to be observed during late May through June. This is a common indicator in concave micro-positions on mountain slopes and plains where snow accumulates during the winter.

Aleutians (W2)
Unknown.

Exceptions
Application of this indicator is limited to alpine and sub-alpine areas adjacent to persistent snow packs.

User Notes
Used for mineral soils in concave micro-positions in alpine and subalpine areas. Seasonal saturation during early summer occurs beneath or immediately down slope from melting snowbeds. The seasonal saturation causes an accumulation of organic matter within the surface mineral layers. The soil has a dark, organic rich surface mineral layer that is at least twice as thick as the dark surface mineral layer on adjacent convex surfaces. Soils in these landscape positions lack redoximorphic features due to low soil temperatures and the masking effects of the high organic matter content. The period of saturation lasts two or more weeks during late May through June.

This indicator is similar to Indicator *Thick Dark Surface*. The soils occur in concave positions where moisture accumulates. Here the source of the hydrology is meltwater from adjacent snow packs that persist well into the growing season. The landscape is usually a complex micro-topography of concave depressions and adjacent convex “micro-highs.” Soils should be examined in both landscape positions and compared. If both positions have a mineral surface of the same color, but the layer is a least twice as thick in the concave position, the soil in the concave position is considered hydric. Make sure that there is reasonable evidence of the hydrology source. This includes either direct observation of the melting snow pack or aerial imagery that shows snow pack at that location earlier in the growing season.

Hydric Soils that Lack Indicators

Description
There are areas that have wetland hydrology and vegetation but no apparent hydric soil indicators. This can be due to several factors, including:

A.) Low organic carbon content *(Figure 20)*
Soil microbes require the presence of sufficient organic carbon in a soil in order to thrive. If there is little or no organic carbon present in a saturated soil, the microbial activity will often be insufficient to produce noticeable hydric soil indicators. This is especially true in young or recently formed soils. Examples include recently formed sandy and gravelly soils.

B.) Low weatherable iron-bearing materials
A soil may contain little or no weatherable iron-bearing materials due to the mineralogy of the parent material in which it formed. Gley colors, iron depletions, redox concentrations, and reaction to alpha-alpha dipyridyl dye all require the presence of weatherable iron. If sufficient weatherable iron-bearing materials are lacking in a saturated soil, these hydric soil indicators will be very weak or absent. Examples include soils formed in some types of volcanic ash or from diorite parent materials.

C.) High soil pH *(Figure 21)*
Formation of redox concentrations and depletions require that soluble iron is present in the soil.

Figure 20. The low organic carbon content and the coarse gravelly materials make it difficult to find hydric soil indicators in this soil. Note the vegetation and the obvious hydrology.

Figure 21. A poorly drained soil in the Copper River Basin. The soil contains permafrost that perches any infiltrating water. Note the gley colored patches. Redox concentrations are relatively faint due to the higher pH of the soil materials.

Iron readily enters into solution in acidic soils. In soils with higher pH levels, less iron enters into solution. As a result, redox concentrations may be very faint and difficult to observe in a soil with higher pH. Examples include soils in the Copper River Basin that have high pH due to the influence of parent material.

D.) Soils that do not meet the 'Alaska Redox' indicator only because they have Hue of 2.5Y.
Hue of 2.5Y is excluded from the Alaska Redox indicator. This is to avoid confusion with non-hydric soils that have both a hue of 2.5Y resulting from the parent material color and that also contain relict redox concentrations. Examples include soils formed in glacial tills and loess, especially if they were affected by seasonal frost or permafrost in the past.

There are, however, areas where a hue of 2.5Y, low chroma, and presence of redox concentrations does indicate a hydric soil. Such soils are often found on the fringes of wetlands as they transition to upland areas.

E.) Soils that do not meet the 'Alaska Gleyed' indicator only because they are not underlain by Hue 5Y or redder.
The Alaska Gleyed indicator requires that the gleyed zone of the soil be underlain by similar soil material having a hue of 5Y or redder. This requirement eliminates confusion with non-hydric soils that have parent material colors which are similar to gleyed colors.

There are, however, areas where continuous saturated conditions result in gleyed colors that are present to considerable depths in the soil profile. Such soils are continuously reduced and lack redox concentrations.

Recommended Procedure for Hydric Soils That Lack Indicators

The following is a recommendation only. It has been proposed for inclusion in an Alaska Regional Supplement to the Wetland Delineation Manual (US Army Corps of Engineers *in press*).

Any area having the conditions listed above in **Hydric Soils that Lack Indicators** should be identified as a wetland if it meets the following requirements:

a) Hydrophytic vegetation, ***and***

b) At least one <u>primary</u> hydrology indicator, ***and***

c) At least one of the following:

1) The slope shape is concave (depressional), ***or***
2) The slope gradient is nearly level or level (0 to 3 percent), ***or***
3) The landform is a low terrace or floodplain, ***or***
4) a restrictive layer or aquitard is present within 24 inches (60 cm) of the soil surface.

4. Applicable Regions: All

Other Problem Situations

Confusing Redox Concentrations

Some soils have obvious redox concentrations but the site has little or no evidence of wetland hydrology or vegetation. These include the following:

Seasonal frost affected soils (*Figure 22)*
Seasonal frost is prevalent in areas with little snow cover or where wind commonly removes the snow cover. The seasonal frost will form a nearly impermeable layer similar to permafrost. During breakup, melt water will perch on the seasonal frost layer, often resulting in near surface saturation or ponding. The seasonal frost will then rapidly degrade within one to two weeks and the soils normal permeability will resume. The saturated conditions will result in redoximorphic features in the soil. True gley colors rapidly alter to non-gley hues once oxidation is present, although redox concentrations remain.

Many of these soils do meet the criteria for hydric soils, although they occur on what are normally considered well-drained uplands. It is critical to carefully observe and note all of the other site characteristics before the overall site is classified as a wetland or non-wetland.

Figure 22. Redox concentrations formed as a result of melt water perching on seasonal frost. The soil is formed in loess and the regional water table is 75 feet below the surface.

Thawed permafrost affected soils *(Figure 23)*
In most soils affected by permafrost, the permafrost forms a restrictive layer that will perch water. In many such soils, the active layer above the permafrost table is saturated long enough

Figure 23. A thawed permafrost affected soil. The soil is formed in loess over glacial outwash on an outwash plain. The regional water table is over 30 feet below the surface. Redox concentrations remain 25 years after drainage improved.

during the growing season so that reduced conditions occur. Redoximorphic features and hydric soil indicators are often present.

If a natural or cultural activity such as wildfire or land clearing disturbs the surface organic layers, the temperature of permafrost affected soils may increase. This increase can result in enough thawing that the restrictive permafrost is either lowered in the soil profile or completely removed. If the soil occurs in an upland position and has no other restrictive layers, drainage can significantly improve. Similar to soils affected by seasonal frost, gley colors will alter to non-gley hues, but redox concentrations will remain. It is critical to carefully observe and note all site and soil characteristics before rating the soil as hydric or non-hydric. If there is no longer evidence of hydrology and the restrictive permafrost layer is no longer present, consider the redoximorphic features as being relict.

Spodosols

Spodosols *(Figure 4)* form in relatively acidic soil material. They are most common in forested areas or upper mountain slopes in Southcentral and Southeast Alaska. Organic carbon, iron, and aluminum are leached from a layer near the soil surface. This layer, known as the E horizon, has a bleached light gray appearance and consists of relatively clean particles of sand and silt. The materials leached from the E horizon are deposited lower in the soil in the Spodic horizon (Bhs or Bs horizon). If sufficient iron has been leached and then redeposited, the spodic horizon will have a reddish color. Both E horizon and spodic horizon colors may be confused with iron depletions and redox concentrations resulting from anaerobic soil conditions *(Figure 3).* An E horizon has colors similar to those found in soil materials where reduction has resulted in iron depletion. Spodic horizons may have colors similar to the colors of redox concentrations.

Normally, E horizon and spodic horizon material will be present in the soil in relatively continuous horizontal bands. If E horizons are thin or there are extensive plant roots, however, they may be discontinuous. Zones that are iron-depleted due to saturation and reduction will normally occur as irregular shaped or discontinuous patches and zones. Redox concentrations will normally occur either as discontinuous patches or along root channels and pores.

Use of Existing Soils Data

Soil Surveys

This guide book is intended to assist in the on-site examination of hydric soils. On-site data should be considered more definitive that data from other sources such as soil surveys. Soil surveys, however, may provide useful preliminary information to help understand the conditions in the area of interest. Soil surveys are available for many areas of Alaska. Soil surveys in Alaska, however, vary considerably in the mapping scale and the amount of ground-truthing used to document the survey. A list of available soil surveys is located at http://www.ak.nrcs.usda.gov/ technical/soils/soilsurveys.html. The most detailed surveys in the state are mapped at a scale of 1:24,000 (2.64 inches/mile). At this scale, the smallest soil areas delineated are about 5 acres in size. Map units do not contain only one soil type, but may have several inclusions of soil with similar properties and also soils that are quite dissimilar. Those soils that are hydric are noted in the *Hydric Soils List* published as part of the survey report. The survey will provide information as to whether an area contains predominantly hydric or non-hydric soils, but it does not provide site-specific information. The soil survey provides valuable information but it does not preclude the need for on-site examination of a site.

Several of the Alaska soil surveys are mapped at scales ranging from 1:63,360 to 1:250,000. Here the smallest areas delineated range anywhere from 25 to 100 acres in size. The surveys provides helpful information but cannot be used alone to make a hydric soil determination.

The *Exploratory Soil Survey of Alaska* provides coverage of the entire state at a scale of 1:1,000,000. The minimum size of areas delineated ranges from thousands to tens of thousands of acres. The *Exploratory Soil Survey of Alaska* provides a good overview of the major soil types in the various regions of the state. It does not, however, provide any information for hydric soil determinations. **The *Exploratory Soil Survey of Alaska* cannot be used for identifying hydric soils.**

Hydric Soil Lists

Hydric Soils Lists are developed for each of the 'detailed' or 1:24,000 scale soil surveys in Alaska. Using criteria approved by the National Technical Committee for Hydric Soils, these lists rate each soil component as either hydric or non-hydric based on soil property data. If the soil is rated as hydric, information is provided regarding which hydric criteria is met and on what landform the soil typically occurs. The Hydric Soil Lists are very useful for off-site work or as preliminary information for on-site work.. Remember, however, that these soil surveys only separate out different soil areas down to about five acres in size. They should only be relied on when on-site data collection is not possible.

The Hydric Soil Lists available for the individual 1:24,000 scale soil surveys are know as *Local Hydric Soil Lists*. They are available as part of the published report for each survey area. Local Hydric Soils Lists have been compiled into a *National Hydric Soils List*. Use of the Local Hydric Soils Lists is preferred since it is more current and reflects local variations in soil properties.

References

Unless otherwise noted the following references contain definitions of terms used throughout this document. They also contain additional information concerning the terms in the glossary of this document and relevant information regarding hydric soil conditions in Alaska.

Alexander, E. et al. 1991. Wetland soils of Alaska. *In* Kimble, J.M. *(ed.),* Proceedings of the VIII international soil correlation meeting, classification, and management of wet soils. USDA Soil Conservation Service. Washington, DC.

D'Amore, D.V. and W.C. Lynn. 2002. Classification of forested Histosols in southeast Alaska. Soil Science Society of America Journal. 66:554-562. Madison, WI.

Environmental Laboratory. 1987. Corps of Engineers Wetland Delineation Manual, Technical Report Y–87–1. U.S. Army Engineers Waterways Experiment Station, Vicksburg, MS.

Federal Register. 1994. Changes in hydric soils of the United States. Washington, DC, July 13 (current Hydric Soil definition)

Federal Register. 2002. Hydric soils of the United States. Washington, DC (current Hydric Soil criteria).

Gretag/Macbeth. 2000. Munsell® color. New Windsor, NY.

Mausbach, M.J., and J.L. Richardson. 1994. Biogeochemical processes in hydric soils. Current Topics in Wetland Biogeochemistry 1:68-127, Wetlands Biogeochemistry Institute, Louisiana State Univ. Baton Rouge, LA.

Ping, C.L. and J.P. Moore. 1991. Wetland properties of permafrost soils in Alaska. *In* Kimble, J.M. *(ed.),* Proceedings of the VIII international soil correlation meeting, classification and management of wet soils. USDA Soil Conservation Service. Washington, DC.

Ping, C.L. and J.P. Moore. 1993. Soil classification and climate zones of Alaska. *In* Proceedings of the VI international permafrost conference. Beijing, China.

National Research Council. 1995. Wetlands: characteristics and boundaries. National Academy Press, Washington, DC.

Richardson, J.L., and M.J. Vepraskas (eds.). 2000. Wetland soils: their genesis, morphology, hydrology, landscapes and classification. CRC Press, Boca Raton, FL.

Soil Science Society of America. 1987. Glossary of Soil Science Terms. Soil Science Society of America, Madison, WI.

Soil Science Society of America. 1993. Proceedings of the Symposium on Soil Color, October 21–26, 1990. San Antonio, TX. J.M. Bigham and E.J. Ciolkosz (eds.), Special Publ. #31, Soil Science Society of America, Madison, WI.

United States Department of Agriculture, Natural Resources Conservation Service. 1998. Keys to Soil taxonomy, *8th edition*. Soil Survey Staff. Washington, DC.

United States Department of Agriculture, Natural Resources Conservation Service. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. U.S. Dep. Agric. Handb. 436,Washington, DC.

United States Department of Agriculture, Natural Resources Conservation Service. 2002. Field book for describing and sampling soils (version 2.0). Compiled by P.J. Schoeneberger, D.A. Wysocki, E.C. Benham, and W.D. Broderson. National Soil Survey Center, Lincoln, NE.

United States Department of Agriculture, Natural Resources Conservation Service. 2003. Field indicators of hydric soils in the United States, Ver. 5.01. G.W. Hurt, P.M. Whited, and R.F. Pringle (eds.).

United States Department of Agriculture, Soil Conservation Service. 1981. Land resource Regions and major land resource areas of the United States. Agric. Handb. 296. US Govt. Printing Off., Washington, DC.

United States Department of Agriculture, Soil Conservation Service. 1991. Hydric soils of the United States. Soil Conservation Service in cooperation with the National Technical Committee for Hydric Soils, Washington, DC.

United States Department of Agriculture, Soil Conservation Service. 1992. Soil and Water Relationships of Florida's Ecological Communities. G.W. Hurt (ed.). Florida Soil Survey Staff, Gainesville, FL.

United States Department of Agriculture, Soil Conservation Service. 1993. National Soil Survey Handbook. Washington, DC.

United States Department of Agriculture, Soil Conservation Service. 1993. Soil Survey Manual. U.S. Dep. Agric. Handb. 18, Washington, DC.

US Army Corps of Engineers. In press. "Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region," J.S. Wakeley, R.W. Lichvar, and C.V. Noble, eds. US Army Engineer Research and Development Center, Vicksburg, MS.

Vepraskas, M.J. 1994. Redoximorphic Features for Identifying Aquic Conditions. Tech. Bulletin 301. North Carolina Ag. Research Service, North Carolina State Univ., Raleigh, NC.

Glossary

This glossary represents an edited version of the Glossary contained in the Field Indicators of Hydric Soils in the United States (USDA, NRCS, 2003). Only terms relevant to soil conditions in Alaska are defined here.

***These terms, as defined in this glossary, have definitions that are slightly different from the definitions in the referenced materials. These definitions are to assist users of this document and are not intended to add to or replace definitions in the referenced materials.**

A Horizon. A mineral horizon that formed at the surface or below an O horizon where organic material is accumulating. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Abrupt Boundary. Used to describe redoximorphic features that grade sharply from one color to another. The color grade is commonly less than 0.5 mm wide. Clear and gradual are used to describe boundary color gradations intermediate between abrupt and diffuse.

Accreting Areas. Landscape positions where soil material accumulates through deposition from higher elevations or upstream position more rapidly than is being lost through erosion.

Anaerobic. A condition in which molecular oxygen is virtually absent from the soil.

Anaerobiosis. Microbiological activity under anaerobic conditions.

Aquic Conditions. Conditions in the soil represented by: depth of saturation, occurrence of reduction, and redoximorphic features. See *Keys to Soil Taxonomy* (1998) for complete definition.

***Artificial Drainage.** The use of human efforts and devices to remove free water from the soil surface or from the ground, or the use of human efforts and devices to prevent surface or ground water from reaching the soil. Dams and levees are included as devices that are used to artificially drain soils. The natural or cultural disturbance or organic layers on permafrost affected soils is not considered as artificial drainage.

Closed Depressions. A low-lying area surrounded by higher ground with no natural outlet for surface drainage.

COE. U.S. Army Corps of Engineers

Common. When referring to redox concentrations and/or depletions common represents 2 to 20 percent of the observed surface.

Concave Landscapes. A landscape whose surface curves downward.

***Covered, Coated, Masked.** These are terms used to describe all of the redoximorphic processes by which the color of soil particles are hidden by organic material, silicate clay, iron, aluminum, or some combination of these.

Cryoturbation. The churning and mixing of soil horizons by frost processes.

Concave Landscapes. A landscape whose surface curves downward.

***Depleted Matrix.** A depleted matrix refers to the volume of a soil horizon or subhorizon from which iron has been removed or transformed by processes of reduction and translocation to create colors of low chroma and high value. A, E and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present. In some places the depleted matrix may change color upon exposure to air (reduced Matrix), this phenomena is included in the concept of depleted matrix. The following combinations of value and chroma identify a depleted matrix:

1. Matrix value 5 or more and chroma 1 or less with or without redox concentrations as soft

masses and/or pore linings; or
2. Matrix value 6 or more and chroma 2 or less with or without redox concentrations as soft masses and/or pore linings; or
3. Matrix value 4 or 5 and chroma 2 and has 2 percent or more distinct or prominent redox concentrations as soft masses and/or pore linings; or
4. Matrix value 4 and chroma 1 and has 2 percent or more distinct or prominent redox concentrations as soft masses and/or pore linings.

***Diffuse Boundary.** Used to describe redoximorphic features that grade gradually from one color to another. The color grade is commonly more than 2 mm wide. Clear and gradual are used to describe boundary color gradations intermediate between abrupt and diffuse.

***Distinct.** Readily seen but contrast only moderately with the color to which compared; a class of contrast intermediate between faint and prominent. The following contrast difference are distinct ("▲" signifies "difference in"): If

1. ▲ hue = 0, ▲ value <4, and ▯ chroma >1 and <4, or
2. ▲ hue = 0, ▲ value >2 to <4, and chroma <4, or
3. ▲ hue = 1, ▲ value >1 to <3, and ▲ chroma >1 to<3, or
4. ▲ hue = 2, ▲ value ≥0 to <2, and ▲ chroma ≥0 to <2 the contrast is distinct.

E Horizon. A mineral horizon in which the main dominant process is loss of silicate clay, iron, and/or aluminum, leaving a concentration of sand and silt particles. See *Keys to Soil Taxonomy* (1998) for a complete definition.

EPA. U.S. Environmental Protection Agency.

Epipedon. A horizon that has developed at the soil surface. See *Keys to Soil Taxonomy* (1998) for a complete definition.

***Faint.** Evident only on close examination. The following contrast differences are faint ("▲" signifies "difference in"): If

1. ▲ hue = 0, ▲ value ≤2 and ▲ chroma ≤1 or
2. ▲ hue = 1, ▲ value ≤1 and ▲ chroma = ≤1 the contrast is faint.

Fe/Mn Concretions. Firm to extremely firm irregularly shaped bodies with sharp to diffuse boundaries. When broken in half concretions have concentric layers. See *Vepraskas* (1994) for a complete discussion.

Fe/Mn Nodules. Firm to extremely firm irregularly shaped bodies with sharp to diffuse boundaries. When broken in half nodules do not have visibly organized internal structure. See *Vepraskas* (1994) for a complete discussion

Few. When referring to redox concentrations and/or depletions few represents less than 2 percent of the observed surface.

Folistels. Histels that are saturated with water for less than 30 cumulative days during normal years (and are not artificially drained). See *Keys to Soil Taxonomy* (1998) for a complete definition.

Folistic epipedon. Generally defined as an organic layer that is saturated for less than 30 days cumulative and is 15 cm. or more thick. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Folists. Histosols that are saturated with water for less than 30 cumulative days during normal years (and are not artificially drained). See *Keys to Soil Taxonomy* (1998) for a complete definition.

Any material, including soil, which has a continuous temperature of 0 degrees C. or below for a period of at least two years.

Fragmental soil material. Soil material that consists of 90 percent or more rock fragments. Less than 10 percent of the soil consists of particles 2mm or smaller.

Frequently Flooded or Ponded. A frequency class in which flooding or ponding is likely to occur often under usual weather conditions (more than 50 percent chance in any year, or more than 50 times in 100 years).

***Gleyed Matrix.** Soils with a gleyed matrix have the following combinations of hue, value, and chroma and the soils are not glauconitic;

1. 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value 4 or more and chroma is 1; or
2. 5G with value 4 or more and chroma is 1 or 2; or
3. N with value 4 or more; or
4. (for testing only) 5Y, value 4 or more, and chroma 1.

In some places the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of gleyed matrix.

Histic Epipedon. A thick (8-24 inches [20-60 cm]) organic soil horizon that is saturated with water at some period of the year unless artificially drained and that is at or near the surface of a mineral soil. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Histels. Organic soils that contain permafrost. See USDA, NRCS, Soil Taxonomy (1999) for complete definition.

Histosols. Organic soils that have organic soil materials in more than half of the upper 32 inches (80 cm), or that are of any thickness if they overly rock or fragmental materials that have interstices filled with organic soil materials. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Horizon. A layer, approximately parallel to the surface of the soil, distinguishable from adjacent layers by a distinctive set of properties produced by soil forming processes. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Hydric Soil Criteria (2000):

1. All Histels except Folistels and Histosols except Folists, or
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that are:
   a. somewhat poorly drained with a water table* equal to 0.0 foot from the surface during the growing season, or
   b. poorly drained or very poorly drained and have either:
      (1) water table equal to 0.0 foot during the growing season if textures are coarse sand, sand, or fine sand in all layers within 20 inches, or for other soils; or
      (2) water table at less than or equal to 0.5 foot from the surface during the growing season if permeability is equal to or greater than 6.0 inches per hour in all layers within 20 inches; or
      (3) water table at less than or equal to 1.0 foot from the surface during the growing season, if permeability is less than 6.0 inches per hour in any layer within 20 inches; or
3. Soils that are frequently ponded for long duration or very long duration during the growing season, or
4. Soils that are frequently flooded for long duration or very long duration during the growing season.

Hydric Soil Definition (1994). 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.

Hydrogen Sulfide Odor. The odor of H_2S, which is similar to rotten eggs.

Hydromorphic. Features in the soil caused or formed by water.

Layer(s). A horizon, subhorizon, or combination of contiguous horizons or subhorizons that share a property(s) referred to in the Indicators.

Lithologic Discontinuity. Occurs in a soil that has developed in more than one type of parent material. Commonly determined by a significant change in particle-size distribution, mineralogy, etc., that indicates a difference in material from which the horizons formed.

Land Resource Region (LRR). Land Resource Region. LRRs are geographic areas characterized by a particular pattern of soils, climates, water resources, and land uses. Each LRR has a different letter of the alphabet (A-Z). LRRs are defined in USDA Ag. Handbook 296.

Many. When referring to redox concentrations and/or depletions many represents more than 20 percent of the observed surface.

Marl. An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under fresh water lacustrine conditions. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Matrix. The dominant soil volume which is continuous in appearance and envelops microsites. When three colors exist, such as when a matrix, depletions, and concentrations are present, the matrix may represent less than 50 percent of the total soil volume.

MLRA. Major Land Resource Area. MLRAs are geographically associated divisions of Land Resource Regions. MLRAs are defined in USDA Ag. Handbook 296.

***Muck.** A sapric organic soil material in which virtually all of the organic material is decomposed not allowing for identification of plant forms. Bulk density is normally 0.2 or more. Muck has <1/6 fibers after rubbing, and sodium pyrophosphate solution extract color has lower value and chroma than 5/1, 6/2, and 7/3.

***Mucky Modified Texture.** A USDA soil texture modifier, e.g., mucky sand. Mucky modified mineral soil with 0 percent clay has between 5 and 12 percent organic carbon. Mucky modified mineral soil with 60 percent clay has between 12 and 18 percent organic carbon. Soils with an intermediate amount of clay have intermediate amounts of organic carbon.

***Mucky Peat.** A hemic organic material with decomposition intermediate between that of fibric and sapric organic material. Bulk density is normally between 0.1 and 0.2 g/cm3. Mucky peat does not meet fiber content (after rubbing) or sodium pyrophosphate solution extract color requirements for either fibric or sapric soil material.

Nodules. See Fe/Mn nodules.

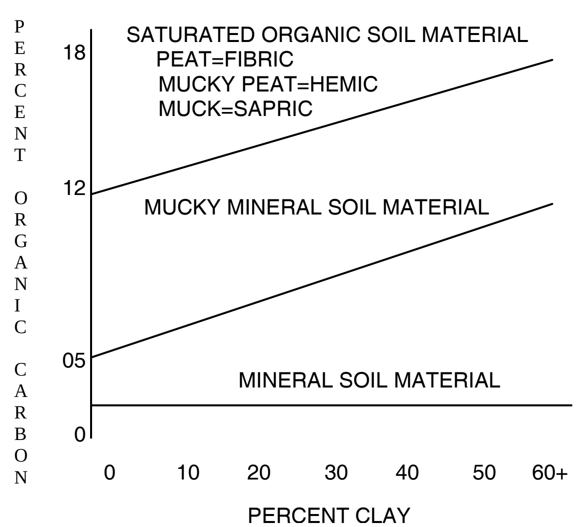
NRCS. Natural Resources Conservation Service (formerly Soil Conservation Service).

NTCHS. National Technical Committee for Hydric Soils.

Organic Matter. Plant and animal residue in the soil in various stages of decomposition.

Organic Soil Material. Soil material that, excluding live roots, has an organic carbon content of: 18 percent or more with 60 percent or more clay in the mineral fraction, or 12 percent or more organic carbon with 0 percent clay in the mineral fraction. Soils with an intermediate amount of clay in the mineral fraction have an intermediate amount of organic carbon. If the soil is never saturated for more than a few days, it contains 20 percent or more organic carbon. Saturated organic soil material includes *Muck, *Mucky Peat, and *Peat (*Figure 24).*

Figure 24. Percent organic carbon required for organic soil material, mucky mineral soil material, and mineral soil material as it relates to percent clay content.



***Peat.** A fibric organic soil material with virtually all of the organic material allowing for identification of plant forms. Bulk density is normally <0.1. Peat has 3/4 or more fibers after rubbing, or 2/5 or more fibers after rubbing and sodium pyrophosphate solution extract color of 7/1, 7/2, 8/2, or 8/3.

Permafrost. Any material, including soil, which has a continuous temperature of 0 degrees C. or below for a period of at least two years.

Ponding. Standing water in a closed depression that is removed only by percolation, evaporation, or transpiration. Duration is greater than seven days.

Pore Linings. Zones of accumulation that may be either coatings on a pore surface or impregnations of the matrix adjacent to the pore. See *Vepraskas* (1994) for a complete discussion.

***Prominent.** Contrasts strongly with the color to which they are compared. The following contrast differences are prominent ("▲" signifies "difference in"): If

1. ▲ hue = 0, ▲ value ≥4 or ▲ chroma ≥ 4, or
2. ▲ hue = 1, ▲ value ≥3, or ▲ chroma ≥3, or
3. ▲ hue = 2, ▲ value ≥2, or ▲ chroma ≥2, or
4. ▲ hue ≥3 the contrast is prominent.

Redox Concentrations. Bodies of apparent accumulation of Fe/Mn oxides. Redox concentrations include soft masses, pore linings, nodules, and concretions. For the purposes of the Indicators nodules and concretions are excluded from the concept of redox concentrations unless otherwise specified by specific Indicators. See *Vepraskas* (1994) for a complete discussion.

Redox Depletions. Bodies of low chroma (2 or less) having value 4 or more where Fe/Mn oxides have been stripped or where both Fe/Mn oxides and clay have been stripped. Redox depletions contrast distinctly or prominently with the matrix. See *Vepraskas* (1994) for a complete discussion.

Redoximorphic Features. Features formed by the processes of reduction, translocation, and/or oxidation of Fe and Mn oxides. Formerly called mottles and low chroma colors. See *Vepraskas* (1994) for a complete discussion.

Reduced Matrix. Soil matrices that have low chroma and high value, but whose color changes in hue or chroma when exposed to air. See *Vepraskas* (1994) for a complete discussion.

***Reduction.** For the purpose of the Indicators, when the redox potential (Eh) is below the ferric/ferrous iron threshold as adjusted for pH. In hydric soils, this is the point when the transformation of ferric iron (Fe+++) to ferrous iron (Fe++) occurs.

Relic Features. Soil morphological features that do not reflect recent hydrologic conditions of saturation and anaerobiosis. See *Vepraskas* (1994) for a complete discussion.

***Sapric.** See muck.

Saturation, When the soil water pressure is zero or positive. Most all the soil pores are filled with water.

Seasonal Frost. Any material, including soil, which has a continuous temperature of 0 degrees C. or below for a period of less than one year.

Soft Masses. Redox concentrations, that are not hard, frequently within the matrix, whose shape is variable. See *Vepraskas* (1994) for a complete discussion.

Soil Texture. The weight proportion of the soil separates for particles less than 2 mm.

Spodic Horizon. A mineral soil horizon that is characterized by the illuvial accumulation of amorphous materials composed of aluminum and organic carbon with or without iron. The spodic horizon has a certain minimum thickness, and minimum quantity of oxalate extractable carbon plus aluminum. It also has specific color requirements. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Spodosol. A mineral soil characterized by having an E horizon overlying a spodic horizon. These horizons can be confused with redoximorphic features. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Tree throw. The churning and mixing of soil horizons caused by the uplifted roots of wind felled trees.

Umbric Epipedon. A thick, dark mineral surface horizon with base saturation of less than 50 percent. See *Keys to Soil Taxonomy* (1998) for a complete definition.

Wetland. An area that has hydrophytic vegetation, hydric soils, and wetland hydrology, per the FSA Manual and the Corps of Engineers 1987 Wetland Delineation Manual.

Indicator Correlations

Alaska Indicators	1987 COE Manual	NTCHS Indicators
Saturated Organic Surfaces greater than 16 inches (40 cm) thick	a. Organic soils (Histosols)	A1 (Histosols)
Saturated Organic Surfaces between 8 and 16 inches (20 and 40 cm) thick	b. Histic Epipedons	A2 (Histic Epipedons)
Hydrogen Sulfide Odor	c. Sulfidic material	A4 (Hydrogen Sulfide)
Alaska Gleyed	f (1). Gleyed soils (gray color)	A13 (Alaska Gleyed)
Alaska Redox	f (1). Gleyed soils (gray color)	A14 (Alaska Redox)
Alaska Gleyed Pores	f (1). Gleyed soils (gray color)	A15 (Alaska Gleyed Pores)
Thick Dark Surface	Soils with thick dark A-horizons	A12 (Thick Dark Surface)
Positive Reaction to Ferrous iron test	e. ferrous iron test	none
Abrupt Boundary Change	none	none
Color Change	none	TA4 (Color Change)
Alaska Alpine Swales	Soils with thick dark A-horizons	TA5 (Alaska Alpine Swales)