NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE FIELD STORAGE AREA

(Each)

CODE 749

DEFINITION

Waste Field Storage Area is the temporary outside storage of solid or semi-solid animal manure at predetermined locations.

PURPOSE

Waste Field Storage Area is used to temporarily store manure in locations in an environmentally safe and cost effective manner when field application and storage of waste is not possible.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where a Comprehensive Nutrient Management Plan (CNMP) has been developed and where temporary storage of manure is required because:

- Land area is limited and split applications of manure are required for proper nutrient management and water quality protection.
- Land area available for waste application is not available due to the crops rotation.
- No other facility is available to store manure during the period from December 15 to April 1, when manure can not be applied to fields in accordance to Vermont Accepted Agricultural Practices.

CRITERIA

The following are design criteria for Field Waste Stacking Areas and adjoining filter/buffer areas:

1. Field Waste Stacking Areas are not intended for freestall dairy operations, unless manure solids are separated mechanically. Manure should be no less than 20% solid content and be able to stack at least four feet high.
2. Field Waste Stacking Areas must be planned, located, and installed to meet all federal, state, and local laws and regulations. These include Vermont Accepted Agricultural Practices and Large Farm Operation Regulations.
3. Field Waste Stacking Areas shall be located so that the potential impacts from accidental release and liner failure are minimized, and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.
4. The Waste Field Storage Area shall be located in areas to minimize the risk of surface and ground water contamination. The general landscape shall be convex in shape and higher in position, such as a rise or knoll.
5. To the fullest extent possible, all clean or unpolluted water shall be excluded from the stacking area.
6. Geology Technical Note 5, SEEPPAGE: A System for Early Evaluation of the Pollution Potential of Agricultural Groundwater Environments (Dec. 1989) may be used to determine the sensitivity or the pollution potential of a site. Sites scoring “high” or “very high” are not recommended for Field Waste Stacking Areas.
7. Sites being considered for development as Field Waste Stacking Areas must be approved and/or modified by a Soil Scientist or NRCS employee with the appropriate engineering job approval.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service State Office or visit the electronic Field Office Technical Guide.

8. To minimize the potential for contamination of streams, Field Waste Stacking Areas should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 25-year flood event, or larger if required by laws, rules, and regulations.

9. A soils investigation shall be made of the proposed Waste Field Storage Area and adjoining filter/buffer area. As a minimum, the underlying soil shall be observed to a depth greater than 40 inches to determine if the site meets the requirements set forth in Table 1. A soil auger is adequate to perform the soil investigation. The investigation shall be documented on the *Vermont Waste Field Storage Area – Soil and Site Evaluation Form* (attached).

10. Saturated Hydraulic Conductivity (Ksat) is synonymous with permeability. Use the *Vermont Guide for estimating Saturated Hydraulic Conductivity from Soil Properties* (attached) to estimate the approximate Ksat for the soil textural layers.

Table 1 – Soil Criteria for Field Waste Stacking Areas and adjoining Filter Area

Property	Limits	Units
Maximum Slope	8	Percent
Maximum Flooding Frequency	1 in 25	Years
Minimum Depth to Bedrock	40	Inches
Minimum Depth to Seasonal High Water Table	18	Inches
Maximum Saturated Hydraulic Conductivity (Ksat) (based on the least permeable horizon over 12 inches thick)	14 2	Micrometers/Sec or Inches/Hour

11. Soils that do not meet the criteria in Table 1 must be modified or an alternate site should be found that meets the criteria. Field Waste Stacking Areas shall never be located in areas where bedrock is less than 30 inches or the seasonal high water table is less than 12 inches below the natural soil surface. Some possible modifications to Field Waste Stacking Areas include, but are not limited to:

    - Increase setback distances from the resource concerns shown in Table 2. (This will primarily be used to deal with water table and slope limitations).
    - Cover the stack.
    - Install a berm around the stack.
    - Mechanically compact upper layers of the soil to reduce pore size and lower the Ksat.
    - Install surface runoff diversions.
    - Place additional soil to increase the separation distance from bedrock or seasonal water table.
    - Install a tile drain to lower the seasonal high water table.
    - Install a liner.

12. Planning for the location of the Waste Field Storage Area shall consider distances from resource concerns to minimize surface and subsurface water pollution and odor problems (minimum distances are shown in Table 2). Local, state and federal regulations may require greater distances. Deviation from these distance guidelines requires documented planning rational that locating facilities closer to the resource concerns will not cause surface and subsurface water pollution or odor problems. Field Waste Stacking Areas shall also be located where access is practicable during poor weather conditions such as excessive snow or ice, or muddy conditions.

Table 2 - Minimum Distances from Waste Field Storage Area to Resource Concerns

Resource Concern	Minimum Downslope Distance From FWSA (a)	Minimum Upslope Distance From FWSA (a)
Public Water Supply (b)	1000 feet	1000 feet
Neighboring Dwelling or Water Supply	500 feet	500 feet
Adjoining Property Line	200 feet	100 feet
On-Farm Well or Spring	300 feet	100 feet
Lake/Pond/River/Water Body	300 feet	100 feet
Diversion (c)	100 feet	25 feet
Gully/Swale/Ravine (c)	100 feet	25 feet
(a) Distances are horizontal		
(b) Contact VT Agency of Natural Resources, Water Supply Division		
(c) Sensitivity of waterway or diversion outlet shall be considered		

14. Field Waste Stacking Areas shall be located a minimum of 300 feet up gradient and/or 100 feet down gradient from all wells, springs and other potable water sources. These distances shall be greater in environmentally sensitive locations such as wellhead protection areas.
15. If the facility poses a health or safety hazard, fencing that meets Conservation Practice Standard 382 shall be installed.
16. The Comprehensive Nutrient Management Plan (CNMP) shall show the locations of all Field Waste Stacking Areas and access routes to them. If sufficient sites exist, rotate sites yearly to decrease potential build up of nutrients in the field stacking areas.
17. Manure shall be removed at least yearly from the Field Waste Stacking Areas in accordance to the Nutrient Management Conservation Practice Standard 590.

CONSIDERATIONS

Field Waste Stacking Areas should be located in remote locations close to or in fields that the manure will be applied and access is practicable.

Consider covering piles with plastic to reduce the amount of rainfall that enters the manure.

Visual impacts of field waste stacking areas should be considered.

This practice may adversely affect cultural resources. Planning, installation and maintenance must comply with GM 420, Part 401.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for the Waste Field Storage Area and any other associated conservation practices. Maintenance needs are to be discussed with the landowner or operator who is responsible for maintaining the practices installed with NRCS assistance. Any hazards must be brought to the attention of the responsible person. Prior to construction, sufficient copies of the O&M plan shall be provided to the owner/operator, designer, and approving agencies. The owner shall sign the O&M plan to indicate an understanding of the requirements and a commitment to operate and maintain the area as specified.

An operation and maintenance (O&M) plan shall be developed that is consistent with the purposes of the practice; it's intended life, safety requirements, and the criteria for its design. The O&M plan shall also be consistent with the Comprehensive Nutrient Management Plan (CNMP).

The plan shall contain the operational requirement that waste shall be removed from the area and utilized at locations, times, rates, and volume in accordance with the CNMP.

VERMONT WASTE FIELD STORAGE AREA – SOIL & SITE EVALUATION FORM

For Conservation Practice 749, Updated October 2006

STAFF PERSON(S): _____	**DATE:** _____
LANDOWNER/USER: _____	**TOWN/COUNTY:** _____
FIELD IDENTIFICATION: _____	**BASE MAP/APPROX. SCALE:** _____ **(Located Stops on Base Map and Attach to Form)**

Manure Type: **Dairy** **Poultry** **Other** _____

SOIL & SITE LIMITATIONS

SOIL PROPERTY	VT STANDARD	STOP1	STOP2	STOP3	STOP4
Depth to Seasonal High Water Table	18” or Deeper 12” w/ Modifications				
Depth to Bedrock	36” or Deeper 30” w/ Modifications				
Percent Slope	8% or Less				
Saturated Hydraulic Conductivity (Ksat) (based on least permeable horizon > 12 inches thick)	14 µm/sec or less (= 2 in/hr or less freq.)				
Flooding Frequency	Once in 25 Years				
Soil Survey Field Sheet: _____	**Map Unit**				
	Soil Type				

SETBACKS FROM RESOURCE CONCERNS

RESOURCE CONCERN	DOWNSLOPE	UPSLOPE	STOP1	STOP2	STOP3	STOP4
Public Water Supply	1000’	1000’				
Neighboring Residence or Well	500’	500’				
Adjoining Property Line	200’	100’				
On-Farm Well or Spring	300’	100’				
Lake/Pond/River/Water Body	300’	100’				
Diversion	100’	25’				
Gully/Swale/Ravine	100’	25’				

MEETS ALL VT NRCS SPECIFICATIONS ABOVE?	**YES**	**NO**	**MODIFICATIONS REQUIRED?**	**YES**	**NO**
APPROVED?	**YES**	**NO**	**APPROVED WITH MODIFICATIONS?**	**YES**	**NO**

MODIFICATIONS REQUIRED

Do Setbacks Far Exceed the Minimum Distances from Resource Concerns to Compensate for Soil/Site Limitations?

YES **NO**

Document Distances:

Other Modifications Required:

NOTES:

Vermont Guide for estimating Saturated Hydraulic Conductivity (Ksat) from Soil Properties

(based on National Soil Survey Handbook, Exhibit 618-9, and other sources)

The term **permeability**, as used in soil surveys, indicates **saturated hydraulic conductivity**, or ***Ksat***. This term refers to the ease in which pores in a saturated soil transmit water. Older estimates of permeability indicate the rate of water movement when the soil horizon is saturated in **inches per hour (in/hr)**. Newer surveys give estimated rates of saturated hydraulic conductivity for each horizon in **micrometers per second (µm/sec)**. A conversion table is included in this report (see Table 3-8).

Researchers have attempted to estimate saturated hydraulic conductivity, or Ksat, based on various soil properties. These estimation methods usually use one or more of the following soil physical properties: surface area, texture, structure, bulk density, and micro-morphology. The success of the individual methods varies. Often a method does fairly well in a localized area, but no one method works really well for all soils. Sometimes, measurement of the predictor variables is more difficult than measurement of hydraulic conductivity. Generally, adjustments must be made for unusual circumstances such as the presence of coarse fragments, fragipans, and other miscellaneous features.

The method presented here is very general (Rawls and Brakensiek, 1983). It has been developed from a statistical analysis of several thousand measurements in a variety of soils. Because the method is intended for a wide application, it must be used locally with caution. The results often must be adjusted based on experience and local conditions.

To estimate the saturated hydraulic conductivity (Ksat) from soil texture, use the textural triangles on pages 8, 9, and 10 -

1. First select the **bulk density class** of **medium, low** or **high** for the appropriate soil texture and horizon. Bulk density values are in grams per cubic centimeter (g/cc).
    a. Topsoil (A horizon) is typically either low or medium density, depending on compaction.
    b. Subsoil (B horizon) is typically medium density.
    c. The substratum (C horizon) is typically medium density if it is friable or loose material, and high density if it is firm to very firm material like basal till or if it has moderate or strong platy structure.
2. Then use the corresponding textural triangle to select the range of saturated hydraulic conductivity in $\mu m/s^{-1}$ (micrometers per second).

The K_{sat} class can be determined immediately from the shading of the triangle. A numerical value of K_{sat} can be estimated by interpolating between the iso-K_{sat} lines; however, the values should be used with caution. The values should be used only to compare classes of soils and not as an indication of the K_{sat} of a particular site. If site values are needed, it is always best to make several measurements at the site.

The K_{sat} values given by the above procedure may need to be adjusted based on other known soil properties. Currently, there is little information available to provide adequate guidelines for adjusting the estimated K_{sat}. The soil scientist must use best judgment based on experience and the observed behavior of the particular soil.

Hydraulic conductivity can be given for the soil as a whole, for a particular horizon, or for a combination of horizons. **The horizon with the lowest value determines the hydraulic conductivity classification for the whole soil.** If an appreciable thickness of soil above or below the horizon with the lowest value has significantly higher conductivity, then estimates for both parts are usually given.

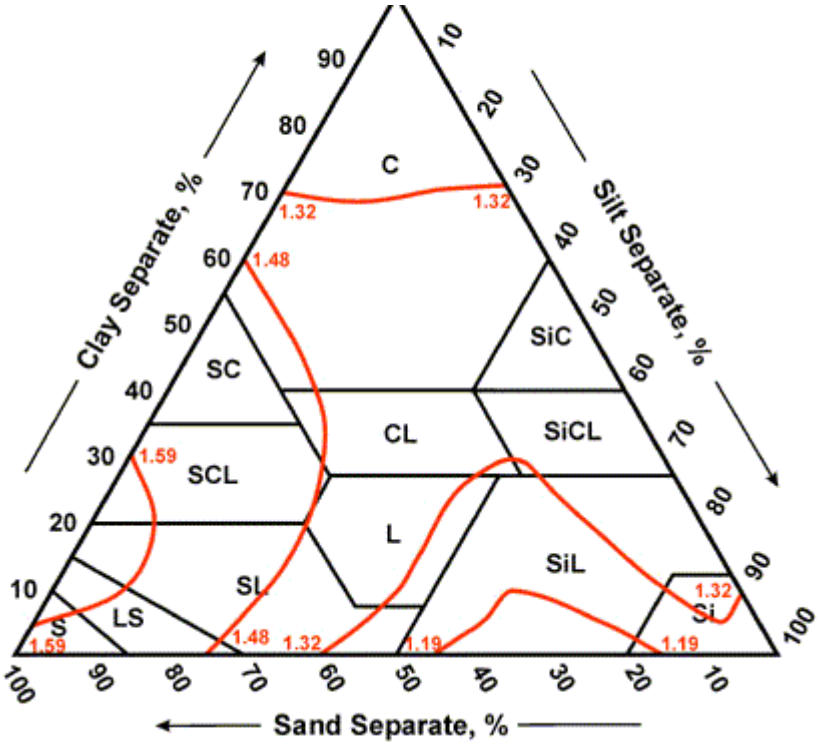
Use these overrides in lieu of the textural guides when these conditions exist. A single property statement is sufficient for an override from the textural guide.

Overriding Condition	Saturated hydraulic conductivity (µm s^{-1})
Many medium or coarser vertical pores that extend through the layer.	≥ 100
When moderately moist or wetter, structure that is moderate or strong granular, strong blocky or prismatic smaller that is very coarse and no stress surfaces or slickensides.	10 -100
Common medium or coarser vertical pores that extend through the layer.	10 - 100
≥ 35 percent clay, soft, slightly hard, very friable or friable, no stress surfaces or slickensides and the clay is subactive after subtracting the quantity (2 x (OC x 1.7))	1 -10
Massive and very firm or extremely firm, or weakly cemented.	0.1 -1
Continuously moderately cemented.	0.1 - 1

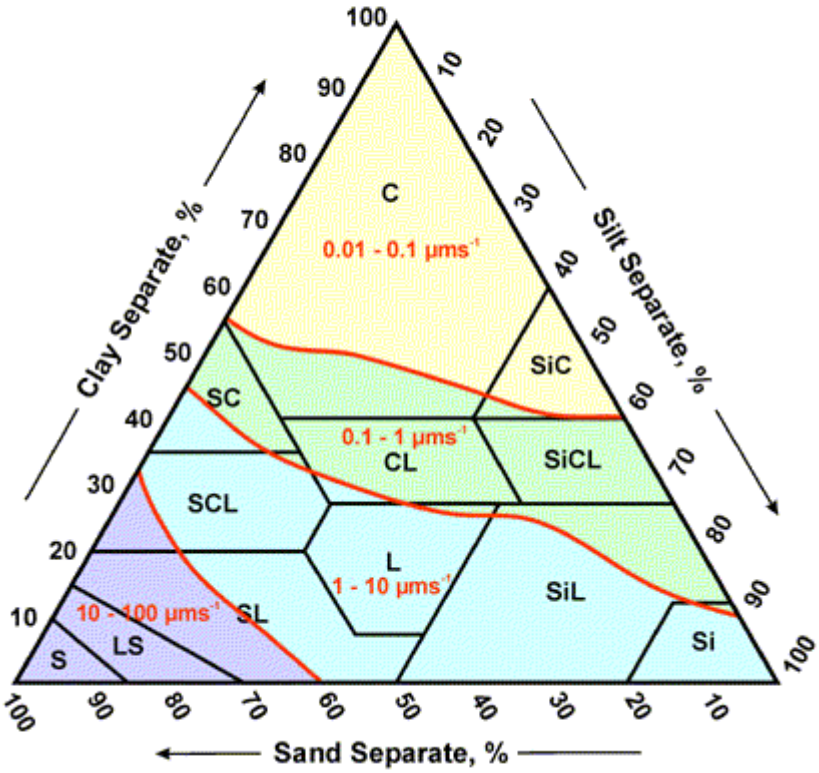
- Clay content may need to be recalculated if the ratio of 15-bar water to measured clay is 0.25 or less or 0.6 or more. The formula to recalculate clay content is percent clay equals 2.5 times 15-bar water content minus percent organic carbon.

Medium Density

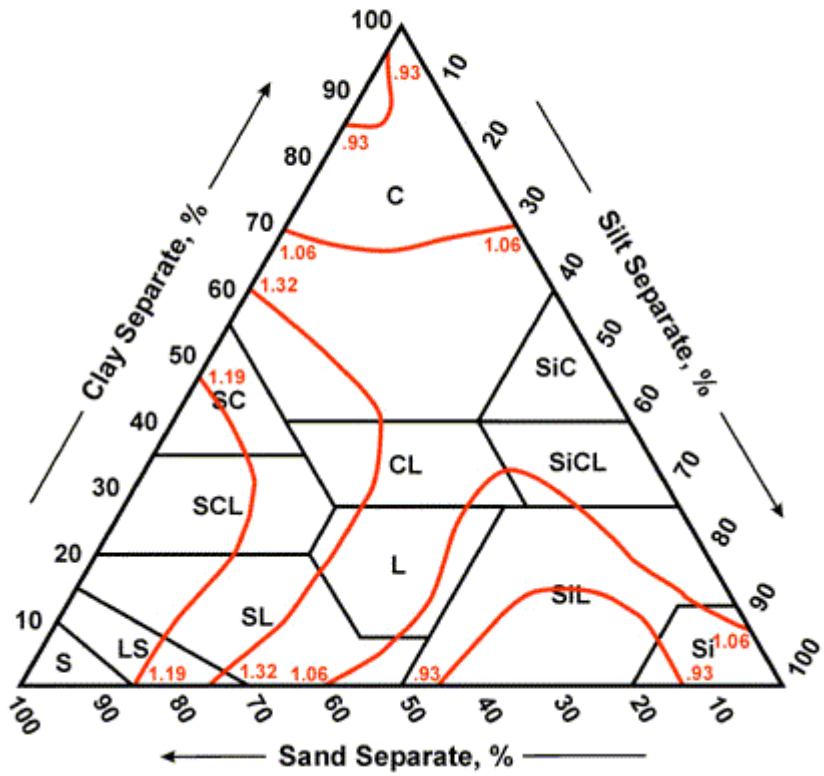
Medium Bulk Density Values for Soil Textures, g/cc



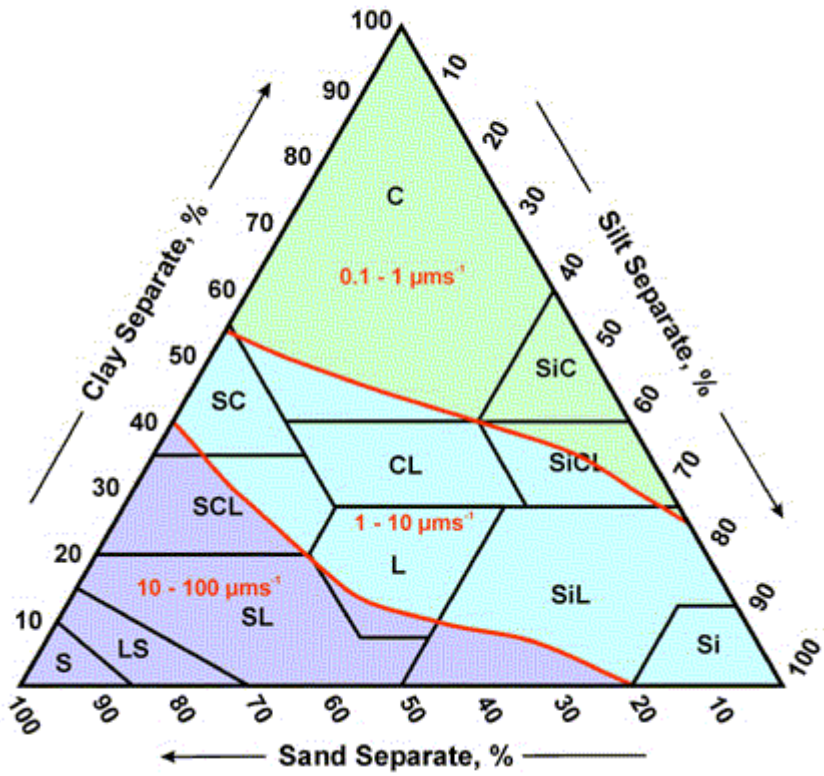
Ksat for Medium Bulk Density



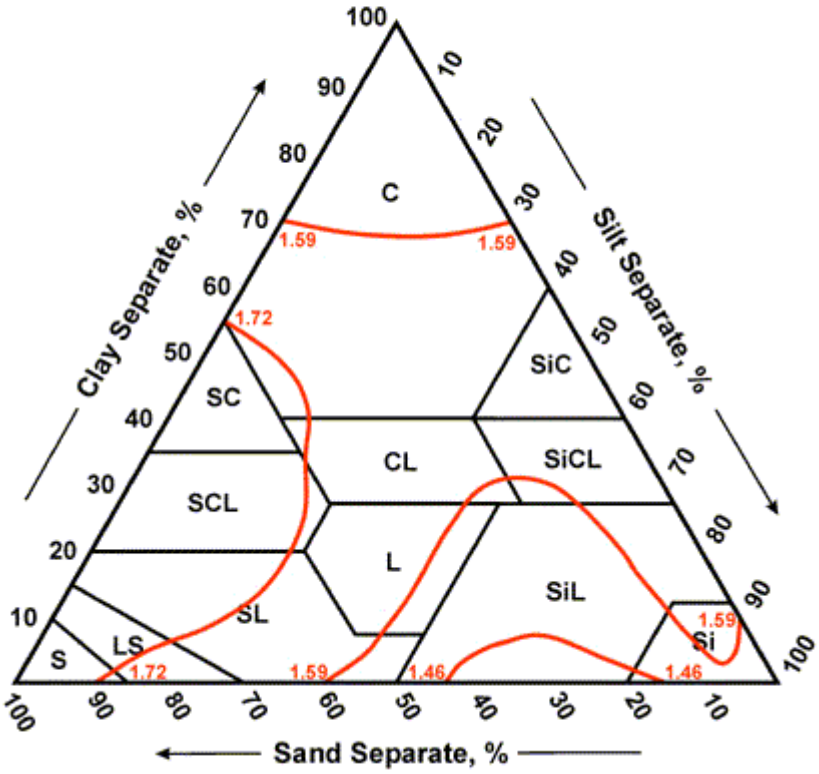
Low Bulk Density Values for Soil Textures, g/cc



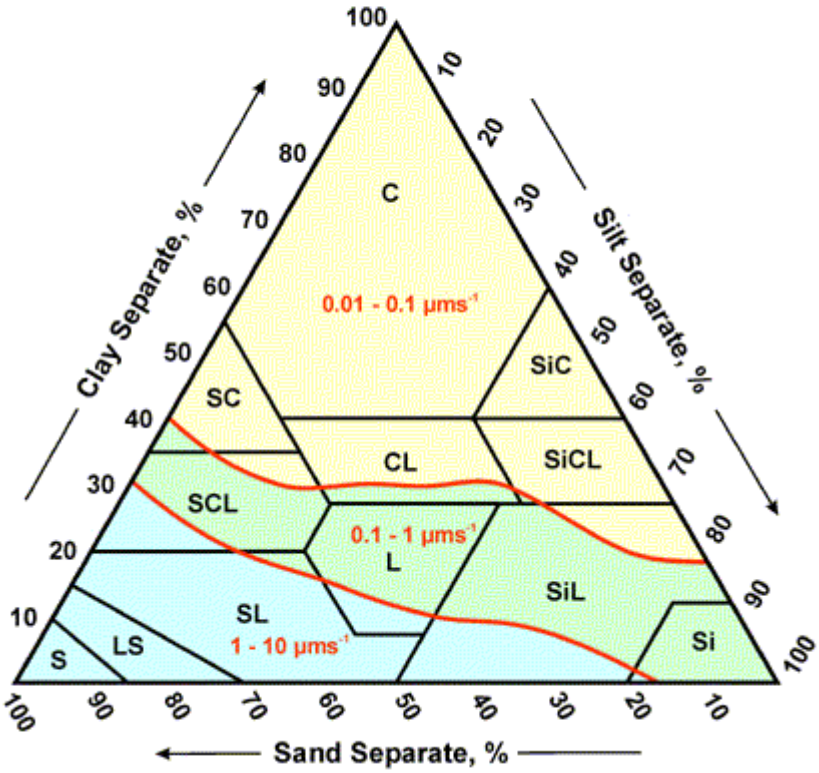
Ksat for Low Bulk Density



High Bulk Density Values for Soil Textures, g/cc



Ksat for High Bulk Density



Discussion

Saturated Hydraulic Conductivity (from Chapter 3, Soil Survey Manual)

Water movement in soil is controlled by two factors: 1) the resistance of the soil matrix to water flow and 2) the forces acting on each element or unit of soil water. Darcy's law, the fundamental equation describing water movement in soil, relates the flow rate to these two factors. Mathematically, the general statement of Darcy's law for vertical, saturated flow is:

$$Q/At = -K_{sat}\, dH/dz$$

where the flow rate **Q/At** is what soil physicists call the flux density, i.e., the quantity of water **Q** moving past an area **A**, perpendicular to the direction of flow, in a time **t**. The vertical saturated hydraulic conductivity $\mathbf{K_{sat}}$ is the reciprocal, or inverse, of the resistance of the soil matrix to water flow. The term **dH/dz** is the hydraulic gradient, the driving force causing water to move in soil, the net result of all forces acting on the soil water. Rate of water movement is the product of the hydraulic conductivity and the hydraulic gradient.

A distinction is made between saturated and unsaturated hydraulic conductivity. Saturated flow occurs when the soil water pressure is positive; that is, when the soil matric potential is zero (satiated wet condition). In most soils this situation takes place when about 95 percent of the total pore space is filled with water. The remaining 5 percent is filled with entrapped air. If the soil remains saturated for a long time (several months or longer) the percent of the total pore space filled with water may approach 100. **Saturated hydraulic conductivity cannot be used to describe water movement under unsaturated conditions.**

The vertical saturated hydraulic conductivity K_{sat} is of interest here; it is the factor relating soil water flow rate (flux density) to the hydraulic gradient and is a measure of the ease of water movement in soil. K_{sat} is the reciprocal of the resistance of soil to water movement. As the resistance increases, the hydraulic conductivity decreases. **Resistance to water movement in saturated soil is primarily a function of the arrangement and size distribution of pores.** Large, continuous pores have a lower resistance to flow (and thus a higher conductivity) than small or discontinuous pores. Soils with high clay content generally have lower hydraulic conductivities than sandy soils because the pore size distribution in sandy soil favors large pores even though sandy soils usually have higher bulk densities and lower total porosities (total pore space) than clayey soils. As illustrated by Poiseuille's law, the resistance to flow in a tube varies as the square of the radius. Thus, as a soil pore or channel doubles in size, its resistance to flow is reduced by a factor of 4; in other words its hydraulic conductivity increases 4-fold.

Hydraulic conductivity is a highly variable soil property. Measured values easily may vary by 10-fold or more for a particular soil series. Values measured on soil samples taken within centimeters of one another may vary by 10-fold or more. In addition, measured hydraulic conductivity values for a soil may vary dramatically with the method used for measurement. Laboratory determined values rarely agree with field measurements, the differences often being on the order of 100-fold or more. Field methods generally are more reliable than laboratory methods.

Because of the highly variable nature of soil hydraulic conductivity, a single measured value is an unreliable indicator of the hydraulic conductivity of a soil. An average of several values will give a reliable estimate which can be used to place the soil in a particular hydraulic conductivity class. Log averages (geometric means) should be used rather than arithmetic averages because hydraulic conductivity is a log normally distributed property. The antilog of the average of the logarithms of individual conductivity values is the log average, or geometric mean, and should be used to place a soil into the appropriate hydraulic conductivity class. Log averages are lower than arithmetic averages.

Hydraulic conductivity classes in this manual are defined in terms of vertical, saturated hydraulic conductivity. Table 3-7 defines the vertical, saturated hydraulic conductivity classes. The saturated hydraulic conductivity classes in this manual have a wider range of values than the classes of either the 1951 *Soil Survey Manual* or the 1971 *Engineering Guide*. The dimensions of hydraulic conductivity vary depending on whether the hydraulic gradient and flux density have mass, weight, or volume bases. Values can be converted from one basis to another with the appropriate conversion factor. Usually, the hydraulic gradient is given on a weight basis and the flux density on a volume basis and the dimensions of K_{sat} are length per time. The correct SI units thus are meters per second[3]. **Micrometers per second (µm/s) are also acceptable SI units and are more convenient (**table 3-7). Table 3-8 gives the class limits in commonly used units.

Table 3-7. Saturated hydraulic conductivity classes

Class	Ksat (µm/s)	Ksat (in/hr equivalent)
Very High	≥ 100	≥ 14.2
High	10 - 100	1.42 – 14.2
Moderately High	1 - 10	0.142 – 1.42
Moderately Low	0.1 -1	0.014 – 0.142
Low	0.01 - 0.1	0.0014 – 0.014
Very Low	< 0.01	< 0.0014

Guidelines for K_{sat} Class Placement

Measured values of K_{sat} are available from the literature or from researchers working on the same or similar soils. If measured values are available, their geometric means should be used for class placement. If measured values are unavailable, a project to make measurements should be considered. Saturated hydraulic conductivity is a fairly easy, inexpensive, and straightforward measurement. Field methods are the most reliable. Standard methods for measurement of K_{sat} are described in Agronomy Monograph No. 9 (Klute and Dirksen, 1986, and Amoozegar and Warrick, 1986) and in SSIR 38 (Bouma et al., 1982).

Table 3-8. Conversion Table - saturated hydraulic conductivity class limits in equivalent units

µm/s		in/hr	m/s	cm/day	cm/hr
100	=	14.2	10^{-4}	864.0	36.0
10	=	1.42	10^{-5}	86.4	3.60
1	=	0.142	10^{-6}	8.64	0.360
0.1	=	0.014	10^{-7}	0.864	0.0360
0.01	=	0.0014	10^{-8}	0.0864	0.00360

Hydraulic conductivity does not describe the capacity of soils in their natural setting to dispose of water internally. A soil placed in a very high class may contain free water because there are restricting layers below the soil or because the soil is in a depression where water from surrounding areas accumulates faster than it can pass through the soil. The water may actually move very slowly despite a high K_{sat}.