Title 210 – Engineering

PART 630 – Hydrology

Subpart C – Hydrologic Soil Groups

Amended June 2025

630.40 Introduction

A. General

1. This handbook represents a multi-year collaboration between soil scientists at the NRCS National Soil Survey Center and engineers in the Conservation Engineering Division to develop an agreed upon a model for classifying hydrologic soil groups. This subpart contains the official definitions of the various hydrologic soil groups.
2. Title 430 National Soil Survey Handbook (NSSH) references and refers users to this subpart as the official hydrologic soil group (HSG) reference. Updating the hydrologic soil groups was planned and developed based on this perspective.
3. Listing HSGs by soil map unit component and not by soil series is an updated concept. Past references contained lists of HSGs by soil series. Soil scientists continually define new soil series and refine existing soil series. As a result, soil series names change which makes the task of maintaining a single national list virtually impossible. Therefore, NRCS no longer maintains national HSG lists. All past references listing hydrologic soil series by map units are obsolete and their use should be discontinued.
4. Users of this subpart will note the use of both English and Système International (SI, or metric) throughout. While engineers typically work in English units, soil scientists work primarily in SI units, therefore this subpart includes both.

B. About This Subpart

1. This subpart defines four hydrologic soil groups, which along with land use, management practices, and hydrologic conditions, determine a soil's associated runoff curve number. Title 210 National Engineering Handbook Part 630 "Hydrology," Subpart E, "Runoff Curve Numbers," includes estimating watershed lag 210 NEH 630, Subpart F, "Time of Concentration," and estimating direct runoff from rainfall 210 NEH 630, Subpart D, "Land Use and Treatment Classes."

2. A map unit is a collection of areas defined and named the same in terms of their soil components or miscellaneous areas or both 430 NSSH § 627.03. Soil scientists assign map unit components to hydrologic soil groups which have similar physical and runoff characteristics. All soils in the United States, its territories, and Puerto Rico have been assigned to hydrologic soil groups. The assigned groups can be found by consulting the NRCS Field Office Technical Guide (FOTG); published soil survey data bases; and the NRCS Soil Data Mart web site.
3. Contact the NRCS State Soil Scientist if a soil survey does not exist for a given area or where hydrologic soil group assignments cannot be found.

630.41 Hydrologic Soil Groups

A. Hydrologic Soil Group Assignment

1. Soil scientists originally assigned soils to hydrologic soil groups based on measured rainfall, runoff, and infiltrometer data (Musgrave 1955, 151). Since the initial work was done to establish these groupings, assignment of soils to hydrologic soil groups has been based on the judgment of soil scientists. Assignments are made based on comparison of the characteristics of unclassified soil profiles with profiles of soils already placed into hydrologic soil groups. Most of the groupings are based on the premise that soils found within a climatic region that are similar in depth to a restrictive layer or water table, transmission rate of water, texture, structure, and degree of swelling when saturated, will have similar runoff responses. These classes are based on the following factors:
    a. intake and transmission of water under the conditions of maximum yearly wetness thoroughly wet
    b. soil not frozen
    c. bare soil surface
    d. maximum swelling of expansive clays
2. The slope of the soil surface is not considered when assigning hydrologic soil groups.
3. In its simplest form, hydrologic soil group is determined by the water transmitting soil layer with the lowest saturated hydraulic conductivity and depth to any layer that is water impermeable such as a fragipan or duripan or depth to a water table if present. The least transmissive layer can be any soil horizon that transmits water at a slower rate relative to those horizons above or below it. For example, a layer having a saturated hydraulic conductivity of 9.0 micrometers per second (μm/s) or 1.3 inches per hour (in/h) is the least transmissive layer in a soil if the layers above and below it has a saturated hydraulic conductivity of 23 μm/s (3.3 in/h).
4. Water impermeable soil layers are among those types of layers recorded in the component restriction table of the National Soil Information System database.

The saturated hydraulic conductivity of an impermeable or nearly impermeable layer may range from essentially 0 µm/s (0 in/h) to 0.9 µm/s (0.1 in/hr). For simplicity, either case is considered impermeable for hydrologic soil group purposes. In some cases, saturated hydraulic conductivity (a quantitatively measured characteristic) data is not always readily available or obtainable. In these situations, other soil properties such as texture, compaction (bulk density), strength of soil structure, clay mineralogy, and organic matter are used to estimate water movement. See figure 630C-1 for more information about saturated hydraulic conductivity

Figure 630C-1. Criteria for Assignment of Hydrologic Soil Group (HSG)

Depth to water impermeable layer [1/]	Depth to high water table [2/]	K_{sat} of least transmissive layer in depth range	K_{sat} depth range	HSG [3/]
<50 cm [<20 in]	None	None	None	D
50 to 100 cm [20 to 40 in]	<60 cm [<24 in]	>40.0 µm/s (>5.67 in/h)	0 to 60 cm [0 to 24 in]	A/D
50 to 100 cm [20 to 40 in]	60 cm [<24 in]	>10.0 to ≤ 40.0 µm/s (>1.42 to ≤ 5.67 in/h)	0 to 60 cm [0 to 24 in]	B/D
50 to 100 cm [20 to 40 in]	60 cm [<24 in]	>1.0 to ≤ 10.0 µm/s (>0.14 to ≤ 1.42 in/h)	0 to 60 cm [0 to 24 in]	C/D
50 to 100 cm [20 to 40 in]	60 cm [<24 in]	≤ 1.0 µm/s (≤ 0.14 in/h)	0 to 60 cm [0 to 24 in]	D
50 to 100 cm [20 to 40 in]	>60 cm [≥24 in]	>40.0 µm/s (>5.67 in/h)	0 to 50 cm [0 to 20 in]	A
50 to 100 cm [20 to 40 in]	>60 cm [≥24 in]	>10.0 to ≤ 40.0 µm/s (>1.42 to ≤ 5.67 in/h)	0 to 50 cm [0 to 20 in]	B
50 to 100 cm [20 to 40 in]	>60 cm [≥24 in]	>1.0 to ≤ 10.0 µm/s (>0.14 to ≤ 1.42 in/h)	0 to 50 cm [0 to 20 in]	C
50 to 100 cm [20 to 40 in]	>60 cm [≥24 in]	≤1.0 µm/s (≤ 0.14 in/h)	0 to 50 cm [0 to 20 in]	D
>100 cm [>40 in]	<60 cm [<24 in]	>10.0 µm/s (>1.42 in/h)	0 to 100 cm [0 to 40 in]	A/D
>100 cm [>40 in]	<60 cm [<24 in]	>4.0 to ≤10.0 µm/s (>0.57 to ≤1.42 in/h)	0 to 100 cm [0 to 40 in]	B/D
>100 cm [>40 in]	<60 cm [<24 in]	>0.40 to ≤4.0 µm/s (>0.06 to ≤0.57 in/h)	0 to 100 cm [0 to 40 in]	C/D
>100 cm [>40 in]	<60 cm [<24 in]	≤0.40 µm/s (≤0.06 in/h)	0 to 100 cm [0 to 40 in]	D
>100 cm [>40 in]	60 to 100 cm [24 to 40 in]	>40.0 µm/s (>5.67 in/h)	0 to 50 cm [0 to 20 in]	A
>100 cm [>40 in]	60 to 100 cm [24 to 40 in]	>10.0 to ≤40.0 µm/s (>1.42 to ≤5.67 in/h)	0 to 50 cm [0 to 20 in]	B
>100 cm [>40 in]	60 to 100 cm [24 to 40 in]	>1.0 to ≤10.0 µm/s (>0.14 to ≤1.42 in/h)	0 to 50 cm [0 to 20 in]	C
>100 cm	60 to 100 cm	≤1.0 µm/s	0 to 50 cm	D

Depth to water impermeable layer [1/]	Depth to high water table [2/]	K_{sat} of least transmissive layer in depth range	K_{sat} depth range	HSG [3/]
[>40 in]	[24 to 40 in]	(≤0.14 in/h)	[0 to 20 in]	
N/A	>100 cm [>40 in]	>10.0 µm/s (>1.42 in/h)	0 to 100 cm [0 to 40 in]	A
N/A	>100 cm [>40 in]	>4.0 to ≤10.0 µm/s (>0.57 to ≤1.42 in/h)	0 to 100 cm [0 to 40 in]	B
N/A	>100 cm [>40 in]	>0.40 to ≤4.0 µm/s (>0.06 to ≤0.57 in/h)	0 to 100 cm [0 to 40 in]	C
N/A	>100 cm [>40 in]	≤0.40 µm/s (≤0.06 in/h)	0 to 100 cm [0 to 40 in]	D

[1/] An impermeable layer has a Ksat less than 0.01 µm/s [0.0014 in/h] or a component restriction of fragipan; duripan; petrocalcic; orstein; petrogypsic; cemented horizon; densic material; placic; bedrock, paralithic; bedrock, lithic; bedrock, densic; or permafrost.
[2/] High water table during any month during the year.
[3/] Dual HSG classes are applied only for wet soils (water table less than 60 cm [24 in]). If these soils can be drained, a less restrictive HSG can be assigned, depending on the Ksat.

B. The Four Basic Hydrologic Soil Groups (HSGs)

1. Group A

a. Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam, or silt loam textures may be placed in this group if they are well aggregated (soil particles held together in small masses with pores that resist degradation thereby maintain pore spaces allowing water to pass through easily), of low bulk density (< 1.33 g/cm^3 (83.03 lb/ft$^{3)}$), or contain greater than 35 percent rock fragments.

b. The limits on the diagnostic physical characteristics of group A are as follows. The saturated hydraulic conductivity of all soil layers exceeds 40.0 µm/s (5.67 in/h). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer and a water table are in group A if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 10 µm/s (1.42 in/h).

2. Group B

a. Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

b. The limits on the diagnostic physical characteristics of group B are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] ranges from 10.0 µm/s (1.42 in/h) to 40.0 µm/s (5.67 in/h). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer and a water table are in group B if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 4.0 µm/s (0.57 in/h) but is less than or equal to 10.0 µm/s (1.42 in/h).

3. Group C

   a. Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
   b. The limits on the diagnostic physical characteristics of group C are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] is between 1.0 µm/s (0.14 in/h) and 10.0 µm/s (1.42 in/h). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a restriction and a water table are in group C if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 0.40 µm/s (0.06 in/h) but is less than or equal to 4.0 µm/s (0.57 in/h).

4. Group D

   a. Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, as described in the next section, if they can be adequately drained.
   b. Limits on the physical diagnostic characteristics of group D are as follows. For soils with a water impermeable layer at a depth between 50 centimeters and 100 centimeters [20 and 40 inches], the saturated hydraulic conductivity in the least transmissive soil layer is less than or equal to 1.0 µm/s (0.14 in/h). For soils that are deeper than 100 centimeters [40 inches] to a restriction or water table, the saturated

hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface is less than or equal to 0.40 µm/s (0.06 in/h).

C. Dual Hydrologic Soil Groups

1. Certain wet soils are placed in group D based solely on the presence of a water table within 60 centimeters [24 inches] of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high-water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state.

D. Matrix of Hydrologic Soil Group Assignment Criteria

Figure 630C-1 can be used to determine a soil's hydrologic soil group. If saturated hydraulic conductivity data are available and deemed to be reliable, then this data, along with water table depth information, should be used to place the soil into the appropriate hydrologic soil group. If this data is not available, the hydrologic soil group is determined by observing the properties of the soil in the field. Factors such as texture, compaction (bulk density), strength of soil structure, clay mineralogy, and organic matter are considered in estimating the hydraulic conductivity of each layer in the soil profile. The depth and hydraulic conductivity of any water impermeable layer and the depth to any high-water table are used to determine correct hydrologic soil group for the soil. The property that is most limiting to water movement generally determines the soil's hydrologic group. In anomalous situations, when adjustments to hydrologic soil group become necessary, they shall be made by the State Soil Scientist in consultation with the State Conservation Engineer.

630.42 Disturbed Soils

As a result of construction and other disturbances, the soil profile can be altered from its natural state and the listed group assignments generally no longer apply, nor can any supposition based on the natural soil be made that will accurately describe the hydrologic properties of the disturbed soil. In these circumstances, an onsite investigation should be made to determine the hydrologic soil group. A general set of guidelines for estimating saturated hydraulic conductivity from field observable characteristics is presented in the Soil Survey Manual.

630.44 Acknowledgements

A. G.W. Musgrave (deceased) largely prepared the original text for chapter 7, Hydrologic Soil Groups, as part of the USDA Soil Conservation Service (SCS, now NRCS), National Engineering Handbook, Section 4, Hydrology, Supplement A, issued in 1957.

B. Victor Mockus (deceased) updated chapter 7, which SCS published as NEH-4, Hydrology in 1964. In 1972, SCS reprinted chapter 7 with minor revisions.

C. In 2007, NRCS issued an update to release as NEH Part 630, Hydrology, chapter 7, developed under the guidance of Jon Werner (retired); with assistance from Donald E. Woodward (retired); Robert Nielsen (retired); Robert Dobos, soil scientist, NRCS; and Allen Hjelmfelt (retired), Agricultural Research Service.

D. With input from Steve Durgin (retired), NRCS issued an update to the 2007 chapter 7 to clarify the table containing the criteria for hydrologic soil group assignment in 2009. This work was finalized under the guidance of Claudia C. Hoeft (retired).

E. Claudia Hoeft updated the 2007 version of chapter 7, relabeled as NEH Part 630 Subpart C, to meet current NRCS directives formatting requirements, under the direction of Hong Wang, Ph.D., National Hydraulic Engineer, NRCS, Washington, D.C.

630.43 References

A. Musgrave, G.W. 1955. How much of the rain enters the soil? In Water: U.S. Department of Agriculture. Yearbook. Washington, DC. pp. 151–159.

B. Nielsen, R.D., and A.T. Hjelmfelt. 1998. Hydrologic soil group assessment. Water Resources Engineering 98. In Abt, Young-Pezeshk, and Watson (eds.), Proc. of Internat. Water Resources Eng. Conf., Am. Soc. Civil Engr: pp. 1297–1302.

C. Rawls, W.J., and D.L. Brakensiek. 1983. A procedure to predict Green-Ampt infiltration parameters. In Advances in infiltration. Proc. of the National Conference on Advances in Infiltration. Chicago, IL.

D. Soil Science Society of America. 2024. Glossary of Soil Science Terms. https://www.soils.org/publications/soils-glossary/browse/a. Madison, WI.

E. U.S. Department of Agriculture, Natural Resources Conservation Service. 1993. Soil Survey Manual. Agricultural Handbook No. 18, chapter 3. U.S. Government Printing Office, Washington, DC.

F. U.S. Department of Agriculture, Natural Resources Conservation Service. 2005. National Soil Survey Handbook, title 430–VI. Washington, DC. Available online at http://soils.usda.gov/technical/handbook.

G. U.S. Department of Agriculture, Natural Resources Conservation Service. 2008. Soil Quality Indicators Fact Sheet. Available online at: https://www.nrcs.usda.gov/sites/default/files/2022-10/nrcs142p2_051591.pdf