

Manning's *n* Values for Various Land Covers To Use for Dam Breach Analyses by NRCS in Kansas

(See Recommendations and Cautions on Page 2)

NLCD ¹ Value	Normal Manning's <i>n</i> Value	Allowable Range of <i>n</i> values	Land Cover Definition	Reference
11	0.040	0.025--0.05	Open Water - All areas of open water, generally with less than 25% cover or vegetation or soil	¹² Table 5-6 D-1.a.3
21	0.040	0.03--0.05	Developed, Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.	¹³ Figure 3-19
22	0.100	0.08--0.12	Developed, Low Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.	¹³ Figure 3-19
23	0.080	0.06--0.14	Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.	¹³ Figure 3-19
24	0.150	0.12-0.20	Developed, High Intensity - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.	¹³ Figure 3-19
31	0.025	0.023--0.030	Barren Land (Rock/Sand/Clay) - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.	¹² Table 5-6 C.b.1
41	0.160	0.10--0.16	Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.	¹² Table 5-6 D-2.d.5 Max. Debris
42	0.160	0.10--0.16	Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.	¹² Table 5-6 D-2.d.5 Max. Debris
43	0.160	0.10--0.16	Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.	¹² Table 5-6 D-2.d.5 Max. Debris
52	0.100	0.07--0.16	Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.	¹² Table 5-6 D-2.c.5
71	0.035	0.025--0.050	Grassland/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.	¹² Table 5-6 D-2.a.2
81	0.030	0.025--0.050	Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.	¹² Table 5-6 D-2.a.1
82	0.035	0.025--0.050	Cultivated Crops - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.	¹² Table 5-6 D-2.b.2
90	0.120	0.045--0.15	Woody Wetlands - Areas Where forest or shrub land vegetation accounts for greater than 20 percent of r substrate is periodically saturated with or covered with water.	¹² Table 5-6 D-1.a.8
95	0.070	0.05--0.085	Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	¹² Table 5-6 D-1.a.7

¹ 2011 National Land Cover Data Set (NLCD)

² Open-Channel Hydraulics, by Chow, Ven Te, 1959

³ HEC-RAS River Analysis System 2D Modeling User's Manual, Version 5.0, February 2016, Figure 3-19

Recommendations and Cautions

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Introduction

This table is intended to be used to build a Land Cover data set with spatially-varying roughness coefficients within 2D HECRAS 5.0 RAS Mapper for dam breach analysis. Since Manning's n roughness values can have a significant effect on modeled flows, a consistent approach is needed. The table on Page 1 provides recommended normal Manning's n values associated with the National Land Cover Dataset (NLCD) values found in Kansas. This table was developed by NRCS-Kansas and adopted by State Conservation Engineer Curtis Janssen in July 2016. The adoption of this table was made after consultation and review by engineers at the National Design Construction and Soil Mechanics Center in Fort Worth, Texas.

Recommendations and Cautions

The roughness coefficient values in the Normal Manning's n column are recommended to be used as default inputs for most dam breach models in Kansas. This will help improve consistency in modeling products produced by NRCS as well as contractors. For sites that warrant other n values, the Allowable Range of n Values column provides recommended minimum and maximum n values for inundation areas in Kansas. The modeling engineer should justify any deviations from the Normal Manning's n Values in writing for the dam's breach analysis documentation file.

The user must input a default Manning's n value for NoData cells. This is done in the Geometry Data Editor. For the eastern half of Kansas $n=0.08$ is recommended. For the western half of Kansas $n=0.06$ is recommended.

Site visits are recommended when possible to view and assess the reach below a dam. These visits are especially important for applications of this data for lower flow situations. The NLCD data is fundamentally a good, broad-based classification but conditions may change. The table values represent "starting" Manning's n values that can be changed as warranted to better describe conditions in the inundation area.

Calibration of hydraulic models is recommended but can be difficult. Breach flows are fortunately rare events. However, the user should be encouraged to examine high flows if data is available.

The user should be discouraged from viewing the table as hard criterion that will produce a "right" answer every time. It is recommended that the modeler assess the hydraulic model results for reasonableness. If the model predicts excessively high velocities or high Froude numbers (larger than 1.5-2) then all of the assumptions inherent in the model, including Manning's n , should be re-examined. The user is encouraged to use the range of Manning's n values to conduct a sensitivity analysis on this parameter.

The modeler is encouraged to review the following references as needed.

- HECRAS 5.0 HEC-RAS River Analysis System 2D Modeling User's Manual (February 2016)
- HECRAS 5.0 HEC-RAS River Analysis System Hydraulic Reference Manual (February 2016)
- NEH 654.6 Stream Restoration Design Handbook Chapter 6 Hydraulics
- NEH 650.3 Engineering Field Handbook Chapter 3 Hydraulics
- NEH 650.13 Engineering Field Handbook Chapter 13 Wetland Restoration Enhancement or Creation. Dated 1997
- TR-55 Urban Hydrology for Small Watersheds
- Chow (1959) Open Channel Hydraulics
- Barnes (1987) Roughness Characteristics of Natural Channels
- Fread (1992), Flood Routing Models and the Manning's n . National Weather Service, NOAA, Water Resources Publications
- Philips and Tadayon (2007), Selection of Manning's Roughness Coefficient for natural and Constructed Vegetated and Non-Vegetated Channels and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona, USGS SIR 2006-5108
- Jarrett (1985), Determination of Roughness Coefficients for Stream in Colorado. USGS Water Resources Investigation report 85-4004
- Arcement and Schneider (1989) Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains, USGS Water Supply Paper 2339