

## Coefficient of Roughness Values (Manning's n)

	<b>Diameters</b>	<b>Flowing Full Unpaved</b>	<b>Flowing Full 25% Paved</b>	<b>Flowing Part Full Unpaved</b>
Helical 38 mm x 6.5 mm (1 1/2 x 1/4 in.)	200 mm (8 in.)	0.012		
	250 mm (10 in.)	0.014		
Helical 68 mm x 13 mm (2 2/3 x 1/2 in.)	300 mm (12 in.)	0.011		0.012
	375 mm (15 in.)	0.012		0.013
	450 mm (18 in.)	0.013		0.015
	600 mm (24 in.)	0.015	0.014	0.017
	750 mm (30 in.)	0.017	0.016	0.019
	900 mm (36 in.)	0.018	0.017	0.02
	1050 mm (42 in.)	0.019	0.018	0.021
	1200 mm (48 in.)	0.02	0.02	0.022
	1350 mm (54 in.) and larger	0.021	0.019	0.023
Annular 68mm x 13 mm (2 2/3 x 1/2 in.)		0.024	0.021	0.027

	<b>Diameters</b>	<b>Flowing Full Unpaved</b>	<b>Flowing Part Full</b>
Pipe Arch		0.026	0.029
	430 mm x 330 mm ( 17 x 13 in.)	0.013	0.018
	530 mm x 380 mm (21 x 15 in.)	0.014	0.019
	710 mm x 510 m (28 x 20 in.)	0.016	0.021
	885 mm x 610 mm (35 x 24 in.)	0.018	0.023
	1060mm x 740 mm (42 x 29 in.)	0.019	0.024
	1240 mm x 840 mm (49 x 33 in.)	0.02	0.025
	1440 mm x 970 mm ) (57 x 38 in.)	0.021	0.025

	1620 mm x 1100 mm ( 64 x 43 in.) and larger	0.022	0.026
	<b>Diameters</b>	<b>Flowing Full Unpaved</b>	<b>25% Paved</b>
Helical 75 mm x 25 mm (3 x 1 in.)	900 (36 in.)	0.022	0.019
	1050 (42 in.)	0.022	0.019
	1200 (48 in.)	0.023	0.02
	1350 (54 in.)	0.023	0.02
	1500 (60 in.)	0.024	0.021
	1650 (66 in.)	0.025	0.022
	1800 (72 in.)	0.026	0.022
	1950 (78 in.) and larger	0.027	0.023
Annular 75 mm x 25 mm (3 x 1 in.)		0.027	0.023
	<b>Diameters</b>	<b>Flowing Full Unpaved</b>	<b>25% Paved</b>
Helical 125 mm x 25 mm (5 x 1 in.)	1200 (48 in.)	0.022	0.019
	1350 (54 in.)	0.022	0.019
	1500 (60 in.)	0.023	0.02
	1650 (66 in.)	0.024	0.021
	1800 (72 in.)	0.024	0.021
	1950 (78 in.) and larger	0.025	0.022
Annular 125 mm x 25 mm (5 x 1 in.)		0.025	0.022
All pipe with smooth interiors		All Diameters 0.012	

\* Includes full paved, concrete, lined, spiral rib and double wall pipe.  
Reference 13 modified for lower values of n for helical pipe.

## References

Bauer, W.J. , "Determination of Manning's n for 14-ft. Corrugated Steel Pipe"  
April 1969, Bauer Engineering, Inc., Chicao, IL, 27 pp.

Grace, J.L., Jr., "Freiction Factors for Hydraulic Design of Corrugated Metal Pipe"  
Department of Defense, U.S. Corps of Engineers, *Proceedings of the Highway Research Board*. U.S. Waterways Experiment Station, Vol. 44, 1965.

Normann, J.M., Houghtalen, R. J., and Johnston, W.J., "Hydraulic Design of Highway Culverts"

Hydraulic Design Series No. 5, Report No. FHWA-IP-85-15, September 1985

National Technical Information Service, Springfield, VA 22161.

Silberman, E. and Dahlin, W.Q., "Further Studies of Friction Factors for Corrugated Aluminum Pipes Flowing Full" Project Report No. 121, April 1971.

Silberman, Edward, "Effects of Helix Angle on Flow in Corrugated Pipes" *Journal of the Hydraulics Division American Society of Civil Engineers*, Vol. 85, 1959.

Tullis, J. Paul, "Friction factor Test on 24-Inch Helical Corrugated Pipe", Hydraulics Report No. 279, Utah Water Research Laboratory, Utah State University, Logan, Ut, April 1991."