

DEAD-END WATER QUALITY SPECIFICATION GUIDE

A QUICK REFERENCE GUIDE FOR WATER QUALITY



www.hydrants.com

800-231-3990

ABOUT THIS GUIDE*

This guide is designed to assist engineers, distribution superintendents and water quality managers in specifying and/or identifying dead-end potable water mains that may have potential water quality issues based on water age. Aging potable water can pose a health threat to consumers. As potable water ages two dynamics begin to occur:

- Dissipation of chlorine residual
- Formation of Disinfection Byproducts (DBPs)

When initially added to water, chlorine maintains a steady residual level for about the first 150-200 hours (6-8 days). After this initial period of time the dissipation rates on average for free chlorine and chloramines are 1.5 ppm per week and .625 ppm per week respectively. Most states require a minimum of .2 ppm. Additionally, disinfection byproducts (DBPs) may begin to form in as little as 4-7 days and DBPs have been shown to cause such health issues as heart disease, cancer, etc.

The cells in the spreadsheet tables show the number of days on average that it takes the amount of the service connections on a water line (of various pipe sizes) to turn over the water in the line. This calculated data is based on the following:

- Number of gallons of water in a one-mile pipe (by pipe size)
- 350 per day average household usage of water

Kupferle manufactures a full line of automatic flushing stations that can easily assist in turning waterlines with aging water issues over on a consistent basis keeping chlorine residual levels steadily safe and removing old water *before* disinfection byproducts can form. These stations have been bench tested and approved by the EPA as a water conservation device under the EPA Green Project Reserve Funding Program and have been shown to keep water safe while flushing up to 50% less water compared to manual hydrants.



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ENGINEERING DEAD-END MAIN SPEC GUIDE

LENGTH OF DEAD-END 10" MAIN (in miles)

10"	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0				
# 1	6	12	18	25	31	37	43	49	55	62	68	74	80	86	92	98	105	111	117	123	129	135	142	148	154	160	166	172	178	185	191	197	203	209	215	222	228	234	240	246	252	259	265	271	277	283	289	295	302	308				
2	3	6	9	12	15	18	22	25	28	31	34	37	40	43	46	49	52	55	58	62	65	68	71	74	77	80	83	86	89	92	95	98	102	105	108	111	114	117	120	123	126	129	132	135	138	142	145	148	151	154				
3	2	4	6	8	10	12	14	16	18	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	101	103				
4	2	3	5	6	8	9	11	12	14	15	17	18	20	22	23	25	26	28	29	31	32	34	35	37	38	40	42	43	45	46	48	49	51	52	54	55	57	58	60	62	63	65	66	68	69	71	72	74	75	77				
5	1	2	4	5	6	7	9	10	11	12	14	15	16	17	18	20	21	22	23	25	26	27	28	30	31	32	33	34	36	37	38	39	41	42	43	44	46	47	48	49	50	52	53	54	55	57	58	59	60	62				
# 6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51				
7	1	2	3	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51		
O 8	1	2	2	3	4	5	5	6	7	8	8	9	10	11	12	13	14	15	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	40	41	42	43	44					
F 9	1	1	2	3	3	4	5	5	6	7	8	8	9	10	10	11	12	13	14	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44				
S 10	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	10	11	12	12	13	14	15	15	16	17	17	18	18	19	20	21	22	23	24	25	25	26	27	28	29	30	31	32	33	34	35	36	37	38	38			
R 11	1	1	2	2	3	3	4	4	5	6	6	7	7	8	8	9	10	10	11	11	12	13	13	14	15	15	16	16	17	17	18	18	19	20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
E 12	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	20	21	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
V 13	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	24	25	26	27	28		
I 14	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	23	24	25	26	27	28			
C 15	0	1	1	2	2	2	3	3	4	4	5	5	6	6	7	7	8	8	8	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	23	24	25	26			
E 16	0	1	1	2	2	2	3	3	3	4	4	5	5	5	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	12	12	12	13	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22		
S 17	0	1	1	1	2	2	3	3	3	4	4	4	5	5	5	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	12	12	12	13	13	13	14	14	14	15	15	16	16	17	17	18	18	19	19	20			
C 18	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15	15	16	16	17	17	18	18	19	19		
O 19	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15	15	16	16	16	16	16			
N 20	0	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15	15	15	15			
E 21	0	1	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	6	7	7	7	8	8	8	8	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	14	15	15	15		
S 22	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	6	7	7	7	8	8	8	8	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	14	15	15		
C 23	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15	15		
T 24	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	14	15	15	
I 25	0	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	14		
O 26	0	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	14		
N 27	0	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	14		
S 28	0	0	1	1	1	1	2	2	2	2	2	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	
C 29	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
O 30	0	0	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
N 31	0	0	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
S 32	0	0	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
C 33	0	0	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
O 34	0	0	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8											

ENGINEERING DEAD-END MAIN SPEC GUIDE

LENGTH OF DEAD-END 12" MAIN (in miles)

12"	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0						
#	1	9	18	27	35	44	53	62	71	80	89	97	106	115	124	133	142	151	160	168	177	186	195	204	213	222	230	239	248	257	266	275	284	292	301	310	319	328	337	346	355	363	372	381	390	399	408	417	425	434	443					
	2	4	9	13	18	22	27	31	35	40	44	49	53	58	62	66	71	75	80	84	89	93	97	102	106	111	115	120	124	129	133	137	142	146	151	155	160	164	168	173	177	182	186	191	195	199	204	208	213	217	222					
	3	3	6	9	12	15	18	21	24	27	30	32	35	38	41	44	47	50	53	56	59	62	65	68	71	74	77	80	83	86	89	92	95	97	100	103	106	109	112	115	118	121	124	127	130	133	136	139	142	145	148					
	4	2	4	7	9	11	13	16	18	20	22	24	27	29	31	33	35	38	40	42	44	47	49	51	53	55	58	60	62	64	66	69	71	73	75	78	80	82	84	86	89	91	93	95	97	100	102	104	106	109	111					
	5	2	4	5	7	9	11	12	14	16	18	19	21	23	25	27	28	30	32	34	35	37	39	41	43	44	46	48	50	51	53	55	57	58	60	62	64	66	67	69	71	73	74	76	78	80	82	83	85	87	89					
	6	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24	25	27	28	30	31	32	34	35	37	38	40	41	43	44	46	47	49	50	52	53	55	56	58	59	61	62	64	65	66	68	69	71	72	74					
	7	1	3	4	5	6	8	9	10	11	13	14	15	16	18	19	20	22	23	24	25	27	28	29	30	32	33	34	35	37	38	39	41	42	43	44	46	47	48	49	51	52	53	54	56	57	58	60	61	62	63					
O	8	1	2	3	4	6	7	8	9	10	11	12	13	14	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	32	33	34	35	37	38	39	41	42	43	44	45	47	48	49	50	51	52	53	54	55						
F	9	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49					
	10	1	2	3	4	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19	19	20	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	35	36	37	38	39	40	41	42	43	44						
S	11	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13	14	15	15	16	17	18	19	19	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	35	35	36	37	38	39	40						
E	12	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11	12	13	14	15	16	16	17	18	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	32	33	34	35	35	36	37	37					
R	13	1	1	2	3	3	4	5	5	6	7	7	8	9	10	10	11	12	13	14	15	16	16	17	18	18	19	20	20	21	22	22	23	24	25	25	26	27	27	28	29	29	30	31	31	32	33	33	34							
V	14	1	1	2	3	3	4	4	5	6	6	7	8	8	9	9	10	11	11	12	13	13	14	15	15	16	16	17	18	18	19	20	20	21	22	22	23	23	24	25	25	26	27	27	28	28	29	30	30	31	32					
I	15	1	1	2	2	3	4	4	5	5	6	6	7	8	8	9	9	10	11	11	12	12	13	14	14	15	15	16	17	17	18	18	19	19	20	21	21	22	22	23	24	24	25	25	26	27	27	28	28	29	30					
C	16	1	1	2	2	3	3	4	4	5	6	6	7	7	8	8	9	9	10	11	11	12	12	13	13	14	14	15	16	16	17	17	18	18	19	19	20	20	21	22	22	23	23	24	24	25	25	26	27	27	28					
E	17	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	25	25	26	26					
C	18	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25					
O	19	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	21	22	22	23	23	23						
N	20	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	16	17	17	17	18	18	18	19	19	19	20	20	21	21	22	22					
N	21	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	16	17	17	17	18	18	18	19	19	19	20	20	21	21	21						
E	22	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	8	8	8	9	9	10	10	10	11	11	12	12	12	13	13	14	14	15	15	15	16	16	17	17	17	18	18	18	19	19	20	20					
C	23	0	1	1	2	2	2	3	3	3	4	4	5	5	5	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	12	12	12	13	13	13	14	14	15	15	15	16	16	16	17	17	17	18	18	18	19	19				
T	24	0	1	1	1	2	2	3	3	3	4	4	4	5	5	6	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	11	12	12	13	13	13	14	14	14	15	15	16	16	16	17	17	17	18	18	18					
I	25	0	1	1	1	2	2	2	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	15	15	15	16	16	16	17	17	17	18				
O	26	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15	15	15	16	16	16	17	17				
N	27	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	8	9	9	9	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14	14	15	15	15	16	16	16				
S	28	0	1	1	1	2	2	2	3	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15	15	15	16	16				
	29	0	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	8	8	9	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15	15	15				
	30	0	1	1	1	1	2	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	6	6	7	7	7	8	8	8	8	8	8	9	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	14	15			
	31	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	8	8	8	9	9	9	9	10	10	10	11	11	11	11	12	12	12	13	13	13	14	14		
	32	0	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	7	7	8	8	8	8	8	8	8	8	8	9	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14
	33	0	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8		
	34	0	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	4	4	5	5	5	5	5	6	6	6																												

ENGINEERING DEAD-END MAIN SPEC GUIDE

LENGTH OF DEAD-END 14" MAIN (in miles)

#	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0			
1	12	24	36	48	60	72	84	97	109	121	133	145	157	169	181	193	205	217	229	241	253	265	277	290	302	314	326	338	350	362	374	386	398	410	422	434	446	458	470	483	495	507	519	531	543	555	567	579	591	603			
2	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	97	103	109	115	121	127	133	139	145	151	157	163	169	175	181	187	193	199	205	211	217	223	229	235	241	247	253	259	265	271	277	283	290	296	302			
3	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	97	101	105	109	113	117	121	125	129	133	137	141	145	149	153	157	161	165	169	173	177	181	185	189	193	197	201			
4	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84	87	90	93	97	100	103	106	109	112	115	118	121	124	127	130	133	136	139	142	145	148	151			
5	2	5	7	10	12	14	17	19	22	24	27	29	31	34	36	39	41	43	46	48	51	53	55	58	60	63	65	68	70	72	75	77	80	82	84	87	89	92	94	97	99	101	104	106	109	111	113	116	118	121			
6	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	97	99	101			
7	2	3	5	7	9	10	12	14	16	17	19	21	22	24	26	28	29	31	33	34	36	38	40	41	43	45	47	48	50	52	53	55	57	59	60	62	64	65	67	69	71	72	74	76	78	79	81	83	84	86			
8	2	3	5	6	8	9	11	12	14	15	17	18	20	21	23	24	26	27	29	30	32	33	35	36	38	39	41	42	44	45	47	48	50	51	53	54	56	57	59	60	62	63	65	66	68	69	71	72	74	75			
9	1	3	4	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	25	27	28	29	31	32	34	35	36	38	39	40	42	43	44	46	47	48	50	51	52	54	55	56	58	59	60	62	63	64	66	67			
10	1	2	4	5	6	7	8	10	11	12	13	14	16	17	18	19	21	22	23	24	25	27	28	29	30	31	33	34	35	36	37	39	40	41	42	43	45	46	47	48	49	51	52	53	54	55	57	58	59	60			
11	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	18	19	20	21	22	23	24	25	26	27	29	30	31	32	33	34	35	36	37	38	39	41	42	43	44	45	46	47	48	49	50	52	53	54	55			
12	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50			
13	1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	18	19	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	33	34	35	36	37	38	39	40	41	42	43	44	45	45	46			
14	1	2	3	3	4	5	6	7	8	9	9	10	11	12	13	14	15	16	16	17	18	19	20	21	22	22	23	24	25	26	27	28	28	29	30	31	32	33	34	34	35	36	37	38	39	40	40	41	42	43			
15	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13	14	14	15	16	17	18	18	19	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	35	35	36	37	38	39	39	40			
16	1	2	2	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	14	15	16	17	17	18	19	20	20	21	22	23	23	24	25	26	26	27	28	29	29	30	31	32	32	33	34	35	35	36	37	38			
17	1	1	2	3	4	4	5	6	6	7	8	9	9	10	11	11	12	13	13	14	15	16	16	17	18	18	19	20	21	21	22	23	23	24	25	26	26	27	28	28	29	30	31	31	32	33	33	34	35	35			
18	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16	17	17	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27	28	29	29	30	31	31	32	33	34			
19	1	1	2	3	3	4	4	5	6	6	7	8	8	9	10	10	11	11	12	13	13	14	15	15	16	17	17	18	18	19	20	20	21	22	22	23	23	24	25	25	26	27	27	28	29	29	30	30	31	32			
20	1	1	2	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	11	12	13	13	14	14	15	16	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	25	26	27	27	28	28	29	30	30			
21	1	1	2	2	3	3	4	5	5	6	6	7	7	8	9	9	10	10	11	11	12	13	13	14	14	15	16	16	17	17	18	18	19	20	20	21	21	22	22	23	24	24	25	25	26	26	27	28	28	29			
22	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	10	11	12	12	13	13	14	14	15	15	16	16	17	18	18	19	19	20	20	21	21	22	22	23	24	24	25	25	26	26	27	27			
23	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	22	22	23	23	24	24	25	25	26	26			
24	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25			
25	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24			
26	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24			
27	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	8	9	9	10	10	11	11	12	12	13	13	14	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24			
28	0	1	1	2	2	3	3	4	4	5	5	6	6	6	7	7	8	8	8	9	9	9	10	10	11	11	11	12	12	12	13	13	14	14	15	15	16	16	16	17	17	18	18	19	19	19	20	20	21	21	22		
29	0	1	1	2	2	2	3	3	4	4	5	5	5	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	11	12	12	12	13	13	14	14	15	15	15	16	16	17	17	18	18	19	19	20	20	20	21		
30	0	1	1	2	2	2	3	3	4	4	4	5	5	6	6	6	7	7	7	8	8	8	9	9	10	10	10	11	11	11	12	12	12	13	13	14	14	14	15	15	16	16	16	17	17	18	18	18	19	19	20	20	
31	0	1	1	2	2	2	3	3	4	4	4	5	5	5	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	14	14	14	15	15	16	16	16	17	17	18	18	18	19	19		
32	0	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	14	14	14	15	15	15	16	16	17	17	17	18	18	18	19
33	0	1	1	1	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	12	12	12	13	13	14	14	14	15	15	15	16	16	16	17	17	18	18	18
34	0	1	1	1	2	2	2	3	3	4	4	4	4	5	5	5</																																					

ENGINEERING DEAD-END MAIN SPEC GUIDE

LENGTH OF DEAD-END 16" MAIN (in miles)

16"	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0			
# 1	16	32	47	63	79	95	110	126	142	158	173	189	205	221	236	252	268	284	299	315	331	347	362	378	394	410	425	441	457	473	488	504	520	536	551	567	583	599	615	630	646	662	678	693	709	725	741	756	772	788			
2	8	16	24	32	39	47	55	63	71	79	87	95	102	110	118	126	134	142	150	158	165	173	181	189	197	205	213	221	228	236	244	252	260	268	276	284	291	299	307	315	323	331	339	347	355	362	370	378	386	394			
3	5	11	16	21	26	32	37	42	47	53	58	63	68	74	79	84	89	95	100	105	110	116	121	126	131	137	142	147	152	158	163	168	173	179	184	189	194	200	205	210	215	221	226	231	236	242	247	252	257	263			
4	4	8	12	16	20	24	28	32	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	95	98	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	165	169	173	177	181	185	189	193	197			
5	3	6	9	13	16	19	22	25	28	32	35	38	41	44	47	50	54	57	60	63	66	69	72	76	79	82	85	88	91	95	98	101	104	107	110	113	117	120	123	126	129	132	136	139	142	145	148	151	154	158			
6	3	5	8	11	13	16	18	21	24	26	29	32	34	37	39	42	45	47	50	53	55	58	60	63	66	68	71	74	76	79	81	84	87	89	92	95	97	100	102	105	108	110	113	116	118	121	123	126	129	131			
7	2	5	7	9	11	14	16	18	20	23	25	27	29	32	34	36	38	41	43	45	47	50	52	54	56	59	61	63	65	68	70	72	74	77	79	81	83	86	88	90	92	95	97	99	101	104	106	108	110	113			
8	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95	97	98			
9	2	4	5	7	9	11	12	14	16	18	19	21	23	25	26	28	30	32	33	35	37	39	40	42	44	46	47	49	51	53	54	56	58	60	61	63	65	67	68	70	72	74	75	77	79	81	82	84	86	88			
10	2	3	5	6	8	9	11	13	14	16	17	19	20	22	24	25	27	28	30	32	33	35	36	38	39	41	43	44	46	47	49	51	53	54	56	58	60	61	63	65	66	68	69	71	72	74	76	77	79				
11	1	3	4	6	7	9	10	11	13	14	16	17	19	20	21	23	24	26	27	29	30	32	33	34	36	37	39	40	42	43	44	46	47	49	50	52	53	54	56	57	59	60	62	63	64	66	67	69	70	72			
12	1	3	4	5	7	8	9	11	12	13	14	16	17	18	20	21	22	24	25	26	28	29	30	32	33	34	35	37	38	39	41	42	43	45	46	47	49	50	51	53	54	55	56	58	59	60	62	63	64	66			
13	1	2	4	5	6	7	8	10	11	12	13	15	16	17	18	19	21	22	23	24	25	27	28	29	30	32	33	34	35	36	38	39	40	41	42	44	45	46	47	48	50	51	52	53	55	56	57	58	59	61			
14	1	2	3	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21	23	24	25	26	27	28	29	30	32	33	34	35	36	37	38	39	41	42	43	44	45	46	47	48	50	51	52	53	54	55	56			
15	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	53			
16	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49			
17	1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	18	19	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46				
18	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	18	19	20	21	22	23	24	25	25	26	27	28	29	30	31	32	32	33	34	35	36	37	38	39	39	40	41	42	43	44			
19	1	2	2	3	4	5	6	7	7	8	9	10	11	12	12	13	14	15	16	17	17	18	19	20	21	22	22	23	24	25	26	27	27	28	29	30	31	32	32	33	34	35	36	36	37	38	39	40	41	41			
20	1	2	2	3	4	5	6	6	7	8	9	9	10	11	12	13	13	14	15	16	17	17	18	19	20	20	21	22	23	24	24	25	26	27	28	28	29	30	31	32	32	33	34	35	35	36	37	38	39				
21	1	2	2	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	14	15	16	17	17	18	19	20	20	21	22	23	23	24	25	26	26	27	28	29	29	30	31	32	32	33	34	35	35	36	37	38			
22	1	1	2	3	4	4	5	6	6	7	8	9	9	10	11	11	12	13	14	14	15	16	16	17	18	19	19	20	21	21	22	23	24	24	25	26	26	27	28	29	29	30	31	32	32	33	34	34	35	36			
23	1	1	2	3	3	4	5	5	6	7	8	8	9	10	10	11	12	12	13	14	14	15	16	16	17	18	18	19	20	21	21	22	23	23	24	25	25	26	27	27	28	29	29	30	31	32	32	33	34	34			
24	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	12	13	14	14	15	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	32	32	33			
25	1	1	2	3	3	4	4	5	6	6	7	8	8	9	9	10	11	11	12	13	13	14	14	15	16	16	17	18	18	19	20	20	21	21	22	23	23	24	25	25	26	26	27	28	28	29	30	30	31	32			
26	1	1	2	2	3	4	4	5	5	6	7	7	8	8	9	10	10	11	12	12	13	13	14	15	15	16	16	17	18	18	19	19	20	20	21	21	22	22	23	24	24	25	25	26	27	27	28	28	29	30	30		
27	1	1	2	2	3	4	4	5	5	6	6	7	8	8	9	9	10	10	11	11	12	12	13	13	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	25	25	26	26	27	27	28	28	
28	1	1	2	2	3	3	4	5	5	6	6	7	7	8	8	9	10	10	11	11	12	12	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28
29	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	26	26	27	27		
30	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	22	22	23	23	24	24	25	25	26	26		
31	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25	25			
32	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24	25			
33	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	21	22	22	23	23				