

PROJECT REFERENCE NO. P-4900A SHEET NO. UC-3C
 UTILITY DESIGN ENGINEER
 NORTH CAROLINA PROFESSIONAL ENGINEER
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 1/21/2015
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BASED ON TEST PRESSURE OF 200 P.S.I.

HORIZONTAL RESTRAINT (ALL AREAS GIVEN ARE IN SQUARE FEET)										VERTICAL RESTRAINT (ALL VOLUMES GIVEN ARE IN CUBIC YARDS)**							
PIPE SIZE	DEGREE OF BEND	LBS. STATIC THRUST *	ALLOWABLE SOIL BEARING (PSF)								PIPE SIZE	RESTRAINING RODS		DEGREE OF BEND			
			1000	2000	3000	4000	5000	6000	7000	8000		NO. REQ'D	DIA.	11/4"	22 1/2"	45°	
4"	11/2°	816	1	1	1	1	1	1	1	1	1	4"	2	1/2"	0.25	0.50	0.75
	45°	2,405	2	1	1	1	1	1	1	1	1	6"	2	1/2"	0.50	1.0	1.75
	90°	4,810	3	2	2	2	2	2	2	2	2	8"	2	5/8"	0.75	1.50	3.0
	TEE/PLUG	3,614	3	2	2	2	2	2	2	2	2	10"	2	3/4"	1.25	2.25	4.50
6"	11/2°	1,488	2	2	2	2	2	2	2	2	2	12"	2	7/8"	1.75	3.25	6.50
	45°	4,464	3	2	2	2	2	2	2	2	2	14"	4	5/8"	2.25	4.50	8.75
	90°	8,928	4	3	3	3	3	3	3	3	3	16"	4	3/4"	3.0	6.0	11.50
	TEE/PLUG	6,693	4	3	3	3	3	3	3	3	3	24"	4	1"	7.0	13.0	24.0
8"	11/2°	2,484	3	3	3	3	3	3	3	3	3	**INCLUDES 1.50 SAFETY FACTOR AND CALCULATED USING THE NOMINAL DIAMETER OF PIPE.					
	45°	7,452	4	3	3	3	3	3	3	3							
	90°	14,904	5	4	4	4	4	4	4	4							
	TEE/PLUG	11,178	5	4	4	4	4	4	4	4							
10"	11/2°	3,816	4	4	4	4	4	4	4	4	4	**INCLUDES 1.25 SAFETY FACTOR AND CALCULATED USING THE NOMINAL DIAMETER OF PIPE.					
	45°	11,448	5	4	4	4	4	4	4	4							
	90°	22,896	6	5	5	5	5	5	5								
	TEE/PLUG	17,172	6	5	5	5	5	5	5								
12"	11/2°	5,544	5	5	5	5	5	5	5	5	5	**INCLUDES 1.25 SAFETY FACTOR AND CALCULATED USING THE NOMINAL DIAMETER OF PIPE.					
	45°	16,632	6	5	5	5	5	5	5	5							
	90°	33,264	7	6	6	6	6	6	6								
	TEE/PLUG	24,948	7	6	6	6	6	6	6								
14"	11/2°	7,452	6	6	6	6	6	6	6	6	6	**INCLUDES 1.25 SAFETY FACTOR AND CALCULATED USING THE NOMINAL DIAMETER OF PIPE.					
	45°	22,356	7	6	6	6	6	6	6	6							
	90°	44,712	8	7	7	7	7	7	7								
	TEE/PLUG	33,534	8	7	7	7	7	7	7								
16"	11/2°	9,888	7	7	7	7	7	7	7	7	7	**INCLUDES 1.25 SAFETY FACTOR AND CALCULATED USING THE NOMINAL DIAMETER OF PIPE.					
	45°	29,664	8	7	7	7	7	7	7	7							
	90°	59,328	9	8	8	8	8	8	8								
	TEE/PLUG	44,496	9	8	8	8	8	8	8								
24"	11/2°	22,416	10	10	10	10	10	10	10	10	10	**INCLUDES 1.25 SAFETY FACTOR AND CALCULATED USING THE NOMINAL DIAMETER OF PIPE.					
	45°	67,248	11	10	10	10	10	10	10	10							
	90°	134,496	12	11	11	11	11	11	11								
	TEE/PLUG	100,374	12	11	11	11	11	11	11								

GENERAL NOTES:
 1. CONCRETE SHALL BE CLASS "B".
 2. CONCRETE SHALL NOT CONTACT BOLT ENDS OF MECHANICAL JOINT FITTINGS.
 3. CONSULT WITH ENGINEER FOR CONCRETE REQUIREMENTS ON MAINS LARGER THAN 24 INCHES.
 (FOR VERTICAL & HORIZONTAL BENDS)
 4. ALLOWABLE SOIL BEARING SHALL BE DETERMINED BY THE ENGINEER.

REVISIONS	
NO.	DATE DESCRIPTION

THRUST RESTRAINT FOR WATER/SEWER MAINS
 STATE OF NORTH CAROLINA
 DIVISION OF HIGHWAYS
 RALEIGH, N.C.

PVC PIPE RESTRAINED JOINT DESIGN TABLE

FITTING	REQUIRED RESTRAINED LENGTH (FT) OF PVC PIPE BY DEPTH OF COVER							
	3 FT	4 FT	5 FT	6 FT	7 FT	8 FT	9 FT	10 FT
HORIZONTAL BENDS								
4 INCH DIA - 11.25 DEG	2	2	2	1	1	1	1	1
4 INCH DIA - 22.5 DEG	4	3	3	3	2	2	2	2
4 INCH DIA - 45 DEG	7	6	5	5	4	4	4	3
4 INCH DIA - 90 DEG	16	14	12	11	10	9	8	7
6 INCH DIA - 11.25 DEG	3	2	2	2	2	2	2	1
6 INCH DIA - 22.5 DEG	5	4	4	3	3	3	3	2
6 INCH DIA - 45 DEG	10	8	7	6	6	5	5	5
6 INCH DIA - 90 DEG	22	19	17	15	13	12	11	10
12 INCH DIA - 11.25 DEG	5	4	3	3	3	3	2	2
12 INCH DIA - 22.5 DEG	9	7	7	6	5	5	4	4
12 INCH DIA - 45 DEG	17	15	13	12	10	8	9	8
12 INCH DIA - 90 DEG	41	35	31	27	25	22	20	19
VERTICAL DOWN BENDS								
4 INCH DIA - 11.25 DEG	6	5	4	4	3	3	3	3
4 INCH DIA - 22.5 DEG	12	10	8	7	6	6	5	5
4 INCH DIA - 45 DEG	24	20	17	15	13	12	11	10
6 INCH DIA - 11.25 DEG	8	7	6	5	5	4	4	4
6 INCH DIA - 22.5 DEG	17	14	12	10	9	8	7	7
6 INCH DIA - 45 DEG	34	28	24	21	18	16	15	14
12 INCH DIA - 11.25 DEG	15	13	11	10	8	8	7	6
12 INCH DIA - 22.5 DEG	31	25	21	19	17	15	14	12
12 INCH DIA - 45 DEG	63	52	44	38	34	31	28	25
VERTICAL UP BENDS								
4 INCH DIA - 11.25 DEG	2	2	2	1	1	1	1	1
4 INCH DIA - 22.5 DEG	4	3	3	3	2	2	2	2
4 INCH DIA - 45 DEG	7	6	5	5	4	4	4	3
6 INCH DIA - 11.25 DEG	3	2	2	2	2	2	2	1
6 INCH DIA - 22.5 DEG	5	4	4	3	3	3	3	2
6 INCH DIA - 45 DEG	10	8	7	6	6	5	5	5
12 INCH DIA - 11.25 DEG	5	4	3	3	3	3	2	2
12 INCH DIA - 22.5 DEG	9	7	7	6	5	5	4	4
12 INCH DIA - 45 DEG	17	15	13	12	10	10	9	8
DEAD ENDS / VALVES								
4 INCH DIA	45	38	33	29	27	24	22	20
6 INCH DIA	63	54	47	42	37	34	31	29
12 INCH DIA	118	101	88	79	71	64	59	54

ASSUMPTIONS
 LAYING CONDITION = TYPE 4 DESIGN PRESSURE = 200 PSI (TEST PRESSURE)
 SOIL DESIGNATION = GC = COHESIVE-GRANULAR SAFETY FACTOR = 1.5

NOTES
 1. RL = RUN LENGTH BETWEEN FIRST JOINTS OF PIPE ALONG THE RUN LINE OF TEE.
 2. RESTRAINED LENGTH IS MEASURED AS FOLLOWS:

