CMGT 235 – Electrical and Mechanical Systems

Department of Construction Management ⊗ California State University, Chico

Exam #2 [100 points]

You may work together as a group or individually. Every student SHALL complete their own answer sheet.

All problems refer to the California Plumbing Code 2016 [Unless Noted Otherwise]

Name: __Solution_____

30 pts
1. Determine the Meter and Street Service size and the Building Supply size for the Dwelling shown on the next page. MDSSPA = 80 psi. The highest water outlet in the building is 9 feet above the source of supply. Pressure loss due to the meter is 5 psi and the water softener has a pressure loss of 9 psi. The maximum length of the piping between the source of supply and the furthest fixture is 208 feet. Each side of the house has a ½" hose bibb (TWO HBs PER SUPPLY SEGMENT).

   Step 1. Calculate the Available Water Pressure

   Available Pressure = 80 psi – 0.433 psi/ft x 9 ft – 5 psi – 9 psi = 62 psi

   Step 2. Find the Effective Maximum Developed Length (DL) of Pipe

   DL = 208 ft x 1.5 = 312 ft

   Step 3. Calculate the total WSFU [Table 610.3]

QTY	FIXTURE	WSFU	TOTAL WSFU
6	WC	2.5	15.0
6	LAV	1.0	6.0
1	BT	4.0	4.0
3	SHW	2.0	6.0
2	KS	1.5	3.0
2	DW	1.5	3.0
3	BS	1.0	3.0
1	SS	1.5	1.5
1	LS	1.5	1.5
1	CW	4.0	4.0
4	HB	2.5 + 1.0 x2	7.0
		TOTAL WSFU	54.0

   Step 4. Use the 2016 CPC Table 610.4 complete the table below for your results:

Pressure Range	Over 60 psi
Maximum Allowable Length	400 ft
Distribution Piping	Pipe Size (inches)
Meter and Street Service	1"
Building Supply	1 ½ "

HUMBER HOUSE FLOOR PLAN
FIRST FLOOR PLAN

SHOP /FISHING 9' x 26'

2 CAR GARAGE 22' x 34'

COVERED PORCH 16' x 25'

FIREPLACE

KITCHEN 21' x 24'

4' x 11'

PAN. 7' x 7'

5' x 13'

2' x 5'

SEAT

REF

REF

MUD ROOM 7' x 25'

REF REF

DN

UP

LIN

FAMILY DINING 14' x 17'

COVERED PORCH 14' x 19'

HEARTH ROOM 15' x 25'

FIREPLACE

FIREPLACE

FAMILY ROOM 20' x 25'

WINE REF

BUTLER'S PAN. 10' x 15'

REF

BAR 6' x 10'

LAUNDRY 10' x 12'

5' x 6'

W

D

2 CAR GARAGE 26' x 38'

14' x 26'

DOG RUN

ELEVATOR

DINING 21' 23

BATH 8' x 11'

BEDROOM 3 17' x 23'

GALLERY

VESTIBULE 10' x 15'

4' x 9'

PORCH 9' x 17'

COVERED PORCH 12' x 30'

GRAND SALON 23' x 39'

FIREPLACE

LIBRARY 9' x 21'

6' x 7'

SITTING ROOM 14' x 15'

LIN

OFFICE 18' x 20'

HER W.I.C. 10' x 13'

2' x 4'

HIS W.I.C. 6' x 14'

5' x 12'

BEDROOM 2 15' x 16'

FIREPLACE

F

MASTER SUITE 18' x 21'

M. BATH 20' x 22'

SAUNA 5' x 7'

EXERCISE 15' x 19'

LIN

10 pts   2.   A local restaurant has an occupancy of 250 people.

        a.   Using the CPC 2016 complete the table for the required number of fixtures per person.

           Use 50 / 50 male / female

Water Closets		Urinals	Lavatories		Bathtubs or Showers	Drinking Fountains
Male	Female	Male	Male	Female		
2	4	1	1	1	0	1

        b.   Where is the CPC 2016 did you find the requirements?

           422.0 Maximum Number of Required Fixtures

           TABLE 422.1

        c.   What other fixtures are required?

           1 Service Sink or Laundry Tub

           Hand-washing facilities shall be available in the kitchen

6 pts   3.   The cold-water piping for a public female restroom is shown below. The water closets have flushometer valves.

        a.   What table is applicable to determining the WSFUs?

           610.10

   b.   Determine the total WSFU for the cold-water load.

149.0

4.0

1.0 LAV   **1.0** LAV   **1.0** LAV   **1.0** LAV

WC   WC   WC

+10.0   **+10.0**   **+10.0**   **115.0**

10 WC   **15** WC   **20** WC   **30** WC   **40** WC

Total WSFU = 4.0 + 115.0 + 30.0 = 149.0
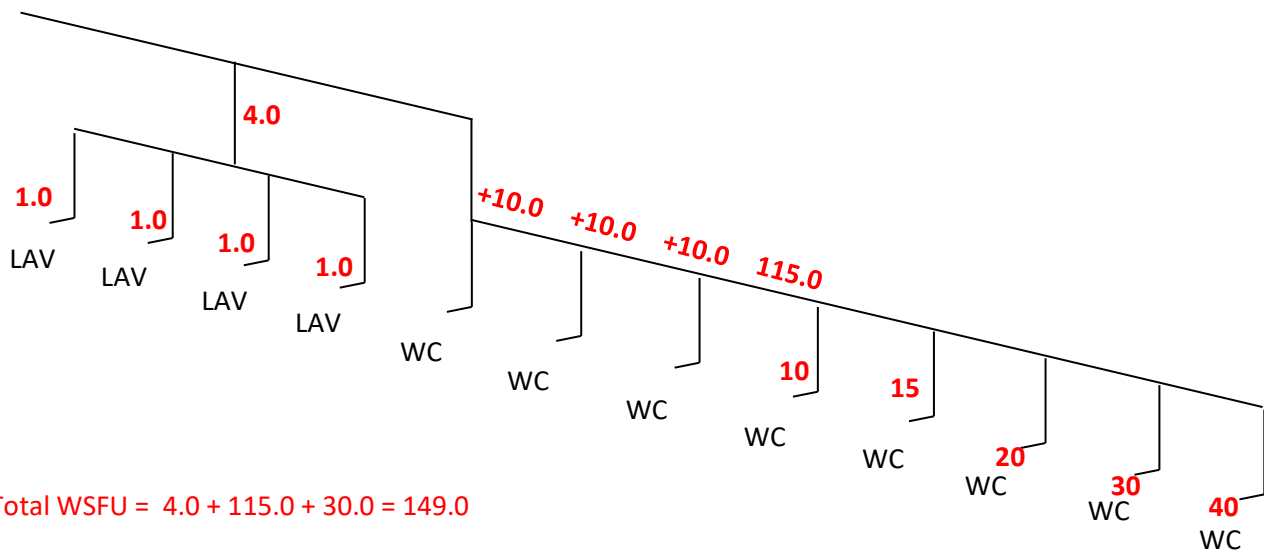
6 pts   4. For a public rest room what are the required ADA requirements for:
        a. Water closet height

            17" - 19" to top of toilet AFF

        b. Water closet flush control

            No more than 44" from mounting surface

8 pts   5. Determine the total DFU for the 8 public flushometer toilets and 6 lavatories. What size vent is required for
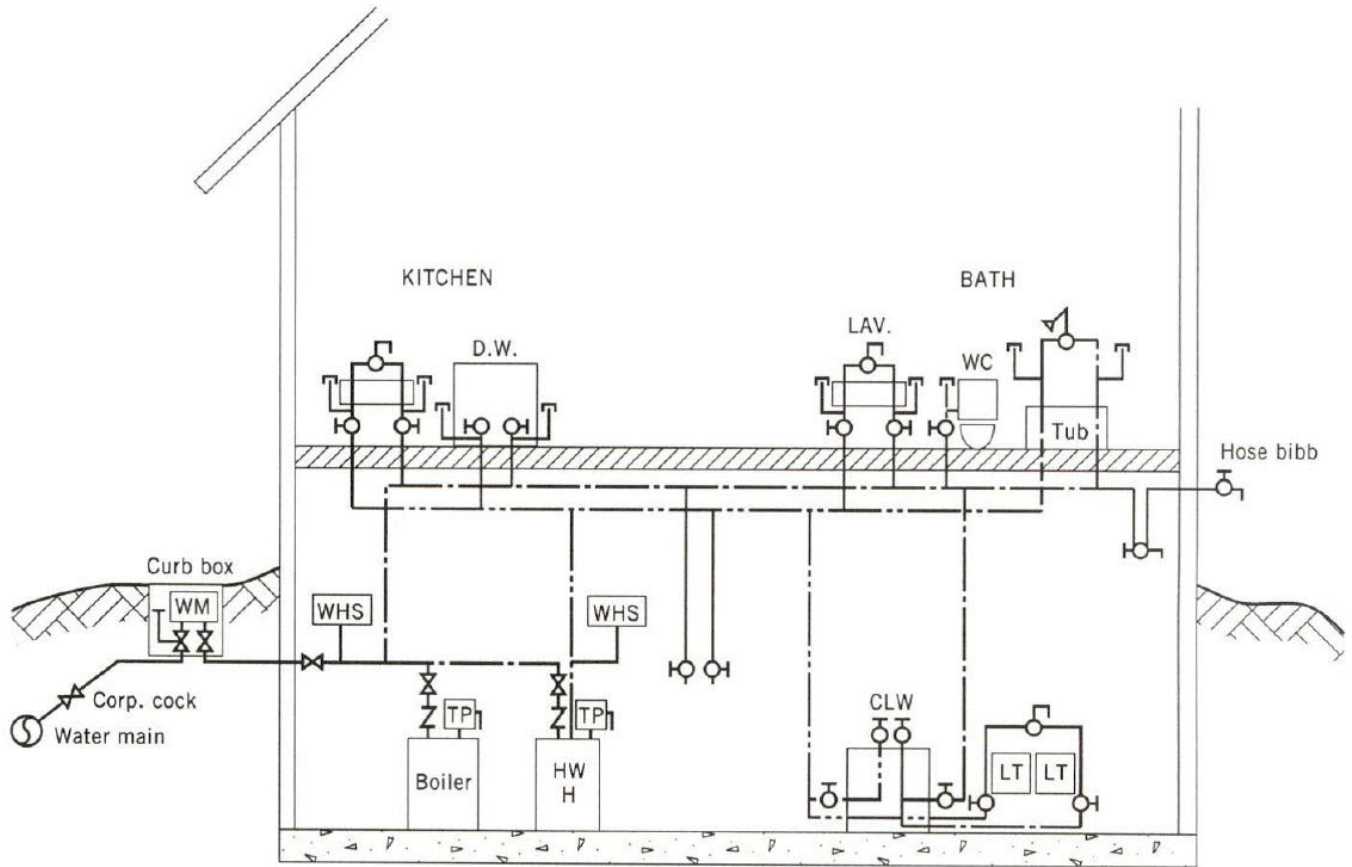   the total DFU and what is the maximum length the vent can be?
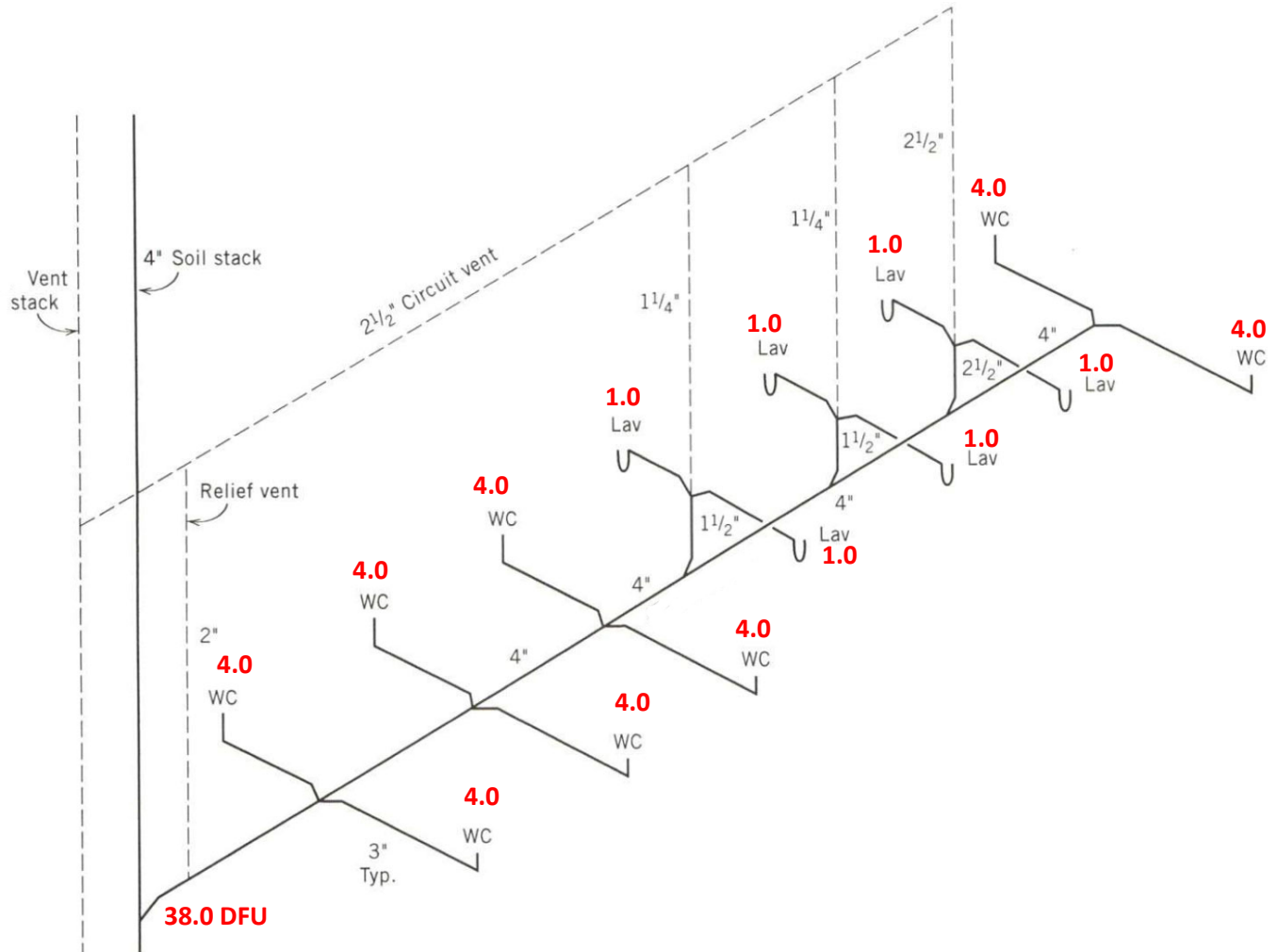
Total = 38 DFU

3" vent required
212 ft maximum length

4

10 pts 6. For the basic home shown complete the Hot, Cold, and Combines WSFU table shown below.

Water Supply Fixture Units							
Fixture	# of Fix.	HOT WSFU		COLD WSFU		TOTAL WSFU	
		EACH	THIS JOB	EACH	THIS JOB	EACH	THIS JOB
WC	1	---	---	2.5	2.5	2.5	2.5
LAV	1	0.75	0.75	0.75	0.75	1.0	1.0
BT/SHW	1	3.0	3.0	3.0	3.0	4.0	4.0
LT	1	1.125	1.125	1.125	1.125	1.5	1.5
CW	1	3.0	3.0	3.0	3.0	4.0	4.0
KS	1	1.125	1.125	1.125	1.125	1.5	1.5
DW	1	1.125	1.125	1.125	1.125	1.5	1.5
HB	1	---	---	2.5 _ 1.0	3.5	3.5	3.5
TOTALS			10.125		16.125		19.5

TOTAL GPM __13.75_____

G1=18 d1=13   d=13 + (19.5-18)/(20-18) x (14-13)
G2=20 d2=14   d=13.75 gpm

5

7. Determine the total DFU for the private residence shown.
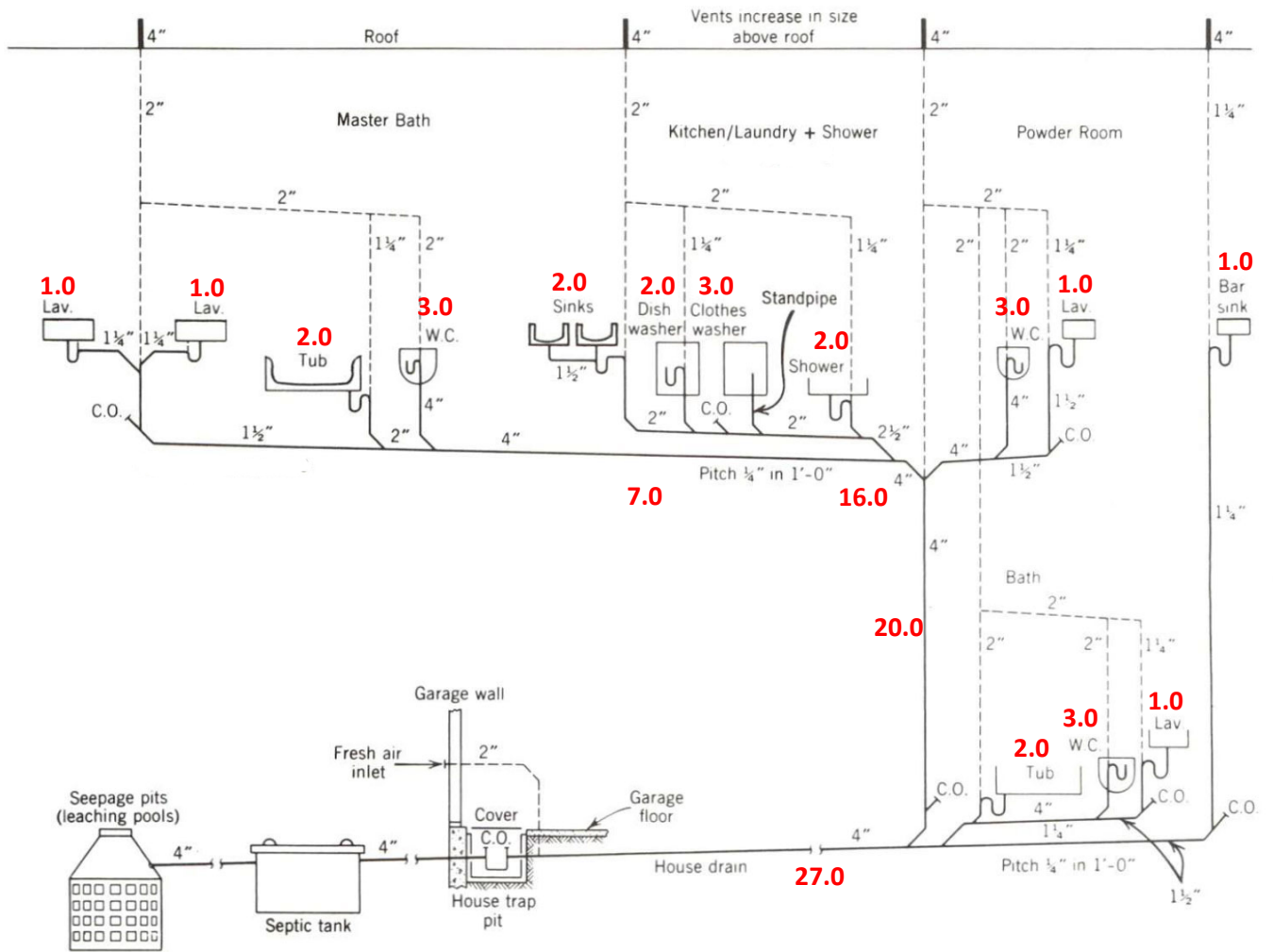
Total = 27.0 DFU

6 pts   8. The problem of accommodating thermal expansion of piping is particularly important for hot water and steam piping. Amount of expansion depends on:
1. Type of piping used
2. Temperature change

Linear expansion of a pipe is given by the equation: $\Delta L = C \times L \times \Delta T$
Where,
C = Expansion Coefficient
L = length of pipe
ΔT = temperature differential

Expansion Coefficients (C)

Material	10^{-6} in/in °F
Aluminum	12.8
Steel	6.5
Cast Iron	5.9
Copper	9.3
Stainless Steel	9.9
ABS Acrylonitrile butadiene styrene	35.0
HDPE High density polyethylene	67.0
PE Polyethylene	83.0
CPVC Chlorinated polyvinyl chloride	44.0
PVC Polyvinyl chloride	28.0

In a school building the distance between the hot water boiler and the cafeteria dishwasher is 175 ft. What is the increase in length of the hot water piping from a "resting" condition (shutdown) of 55°F to an operating condition carrying 140°F water using

(a) copper pipe?

$\Delta L = C \times L \times \Delta T = 9.3 \times 10^{-6}$ in. / in °F x 175 ft x (140°F - 55°F) = 1.66 in.

(b) CPVC plastic pipe?

$\Delta L = C \times L \times \Delta T = 44 \times 10^{-6}$ in. / in °F x 175 ft x (140°F - 55°F) = 7.85 in.

9. Determine the horizontal and vertical drainage pipe size for 5,000 square feet of roof area (1/8" slope per 12" of pipe) on a building located in Dallas, TX.

From Appendix D (2016 CPC) Dallas, TX has a rainfall rate of 4.2 inch per hour. However, the local code specifies that sizes of storm drains shall be based on a 6 inch per hour rainfall rate.

"**1106.1 General.** The size of the vertical conductors and leaders, building *storm drains*, building storm *sewers*, and any horizontal branches of such drains or *sewers* shall be based on ~~a 6 inch~~ (152.4 mm) per hour [~~the 100-year hourly~~] rainfall rate [~~indicated in Figure 1106.1 or on other rainfall rates determined from *approved* local weather data~~]."

Table 1101.8 – Sizing of Horizontal Rainwater Piping
1/8" per 12" of pipe slope, 5000 square feet of roof area
Required pipe size is 8 inches

TABLE 1101.8
SIZING OF HORIZONTAL RAINWATER PIPING[1, 2]

SIZE OF PIPE	FLOW (⅛ inch per foot slope)	MAXIMUM ALLOWABLE HORIZONTAL PROJECTED ROOF AREAS AT VARIOUS RAINFALL RATES (square feet)					
inches	gpm	1 (in/h)	2 (in/h)	3 (in/h)	4 (in/h)	5 (in/h)	6 (in/h)
3	34	3288	1644	1096	822	657	548
4	78	7520	3760	2506	1880	1504	1253
5	139	13 360	6680	4453	3340	2672	2227
6	222	21 400	10 700	7133	5350	4280	3566
8	478	46 000	23 000	15 330	11 500	9200	7670
10	860	82 800	41 400	27 600	20 700	16 580	13 800
12	1384	133 200	66 600	44 400	33 300	26 650	22 200
15	2473	238 000	119 000	79 333	59 500	47 600	39 650

Table 1101.12 Sizing Roof Drains, Leaders, and Vertical Rainwater Piping

TABLE 1101.12
SIZING ROOF DRAINS, LEADERS, AND VERTICAL RAINWATER PIPING[2, 3]

SIZE OF DRAIN, LEADER, OR PIPE	FLOW	MAXIMUM ALLOWABLE HORIZONTAL PROJECTED ROOF AREAS AT VARIOUS RAINFALL RATES (square feet)											
inches	gpm[1]	1 (in/h)	2 (in/h)	3 (in/h)	4 (in/h)	5 (in/h)	6 (in/h)	7 (in/h)	8 (in/h)	9 (in/h)	10 (in/h)	11 (in/h)	12 (in/h)
2	30	2880	1440	960	720	575	480	410	360	320	290	260	240
3	92	8800	4400	2930	2200	1760	1470	1260	1100	980	880	800	730
4	192	18 400	9200	6130	4600	3680	3070	2630	2300	2045	1840	1675	1530
5	360	34 600	17 300	11 530	8650	6920	5765	4945	4325	3845	3460	3145	2880
6	563	54 000	27 000	17 995	13 500	10 800	9000	7715	6750	6000	5400	4910	4500
8	1208	116 000	58 000	38 660	29 000	23 200	19 315	16 570	14 500	12 890	11 600	10 545	9600

Minimum leader size is 5 inches.
However, from the Texas Plumbing Code

1101.5 Continuous flow. The size of a drainage pipe shall not be reduced in the direction of flow.

Vertical pipe must be 8 inches

2 pts   10. For a 4-inch horizontal storm drain, what is the maximum projected roof area if the slope of the drain is ¼-inch per 1 ft of pipe? What table is used to find the answer?

Table 1101.8

SIZE OF PIPE	FLOW (¼ inch per foot slope)	MAXIMUM ALLOWABLE HORIZONTAL PROJECTED ROOF AREAS AT VARIOUS RAINFALL RATES (square feet)					
inches	gpm	1 (in/h)	2 (in/h)	3 (in/h)	4 (in/h)	5 (in/h)	6 (in/h)
3	48	4640	2320	1546	1160	928	773
4	110	10 600	5300	3533	2650	2120	1766

2 pts   11. Determine the number of 5" roof drains required for a roof area of 230,000 sq. ft located in Denver, Colorado.

Denver Amended Plumbing Code

SECTION 1106

SIZE OF CONDUCTORS, LEADERS AND STORM DRAINS

Section 1106.1 General is replaced in its entirety as follows:

1106.1 General. The size of the vertical conductors and leaders, building storm sewers and any horizontal branches of such drains shall be based on 3 inch (7.6 mm) rainfall per hour.

No. of Drains = 230,000 / 11,530 = 19.95 = 20 roof drains

From Appendix D = Table D 101.1
Denver, Colorado – 2.2 inches per hour rainfall rate

2 pts

No. of Drains = 230,000 / (34,600/2.2) = 14.6 = 15 roof drains

2 pts

    12. What is BMP an acronym for?
Best Management Practice

2 pts   13. What federal act was passed in 1972 to regulate the discharge of pollutants to receiving waters such as oceans, bays, rivers, and lakes?
Clean Water Act (CWA)

    14. What is a system that conveys both sewage and stormwater to sewage treatment plants before the treated effluent is discharged to receiving water bodies called?
Combined sewer system