PLUMBING SEMINAR

Prepared by Russ Meier

June 3,1995

Reference Specification Section 15410

DEFINITIONS:

Invert Depth of bottom of pipe to surface of ground.

STORM SEWERS AND ROOF DRAINAGE SYSTEMS:

1. The sizing of roof drains and piping is based on the area each drain served and the intensity and duration of the rainfall. KJWW typically designs roof drainage systems to handle **4" of rain per hour.** Review code requirements in the area where the building is being constructed to determine the design rate of rainfall for the area.

2. If large quantities of water build up on the roof it may cause damage due to excessive deflection or the roof may collapse. Scuppers are openings in the walls that allow excess water to escape off the roof. In some cases a second totally separate roof drainage system may have to be installed to meet code requirements.

3. The drainage capacity of a given pipe diameter is far less in the horizontal than it is in the vertical. Always check to be sure that when changing directions the horizontal pipe has adequate capacity for the area it serves. Once a specific pipe size is required in the horizontal that same pipe size should be used in the vertical.

4. Clean outs should be installed at the base of stacks and upon exiting the building. Locate clean outs in NON-TRAFFIC areas. Such as off to the side in corridors.

5. Storm sewers must be designed to produce a minimum velocity of 2 ft/sec. At lower velocities the solids present in the water settle out and restrict the flow of storm water.

6. Label pipe inverts ("I.E.= **'-**" or " Ⓦ -2'-7") where pipes begin, cross other pipes and exit the building. Determine local frost depths and do not install pipes with less than 42" of cover.

7. Pipes 3" and smaller than should slope 1/4" per foot inside the building. Pipes 4" and larger should slope 1/8" per foot.

8. 5" pipe is not commonly handled by suppliers so it may be cheaper to design around the 6" pipe that suppliers will

have in stock.

9. Review structural drawings to locate footings, foundations, grade beams and other obstructions.

10. Area drains are installed in air intake shafts and or equipment access shafts. These drains should be connected to the storm sewer system. The connection to the area drain is most likely the lowest drain in the system. Drains require a minimum depth of 1' below the floor for installation.

11. Roof drains do not require traps.

12. Storm drains are meant to dispose of rain water. Condensate from cooling coils, cooling towers, and area drains may not be acceptable to discharge into storm sewer systems. Verify local code requirements and EPA guidelines for information regarding chemicals and the level of water quality that is required for discharge to storm sewers.

13. Continuous flows of water can be converted to roof areas as follows:

    (1) 96 sqft = 1 GPM @ 1 inch of rain per hour.

    (2) 24 sqft =1 GPM @ 4 inches of rain per hour.

14. Combined storm and sanitary sewers are not legal anymore. However some are still in use in existing structures.

KJWW ENGINEERING CONSULTANTS

PROJECT	DATE	BY	PROJECT NO.
MISC.	6/8/95	RJM	7000

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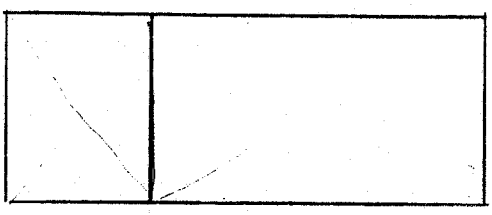

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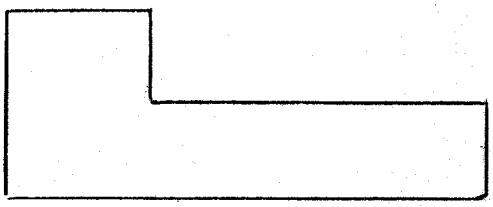

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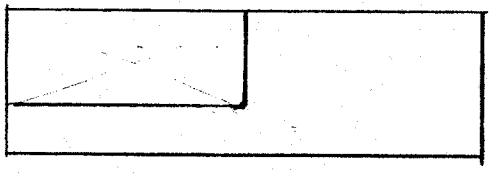

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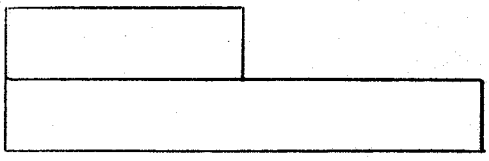

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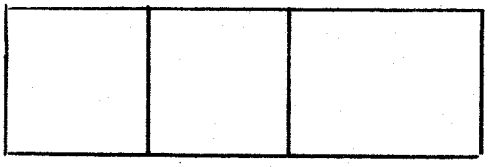

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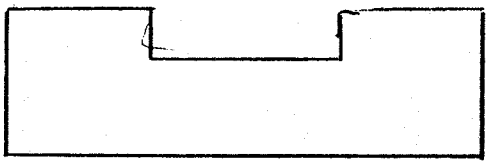

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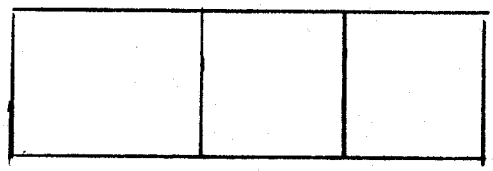

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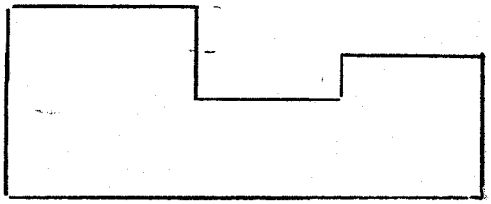

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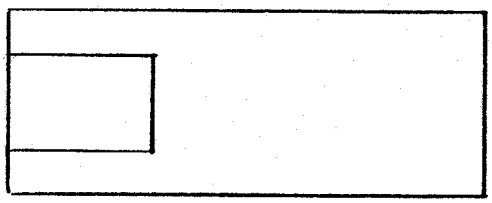

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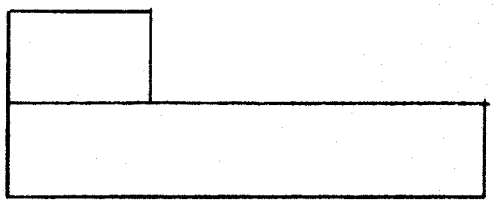

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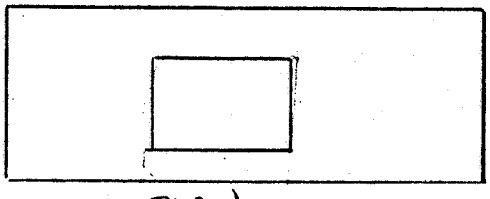

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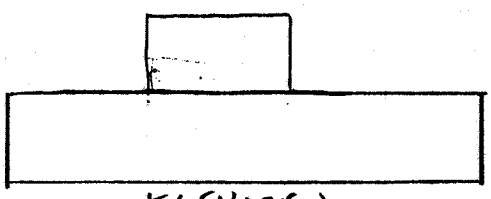

ELEVATION

APPENDIX D

Rainwater Systems

General

The purpose of this Appendix is to provide drainage from roof areas, courts, and courtyards where it is necessary to collect storm water and deliver to an approved point of disposal not in conflict with other ordinances or regulations.

Part A

Rainwater Systems

D 1 Materials:

(a) Rainwater piping placed within the interior of a building or run within a vent or shaft shall be of cast iron, galvanized steel, wrought iron, brass, copper, lead, Schedule 40 ABS DWV, Schedule 40 PVC DWV or other approved materials. ABS and PVC DWV piping installations shall be limited to structures not exceeding three floors above grade. For the purpose of this subsection, the first floor of a building shall be that floor that has fifty (50) percent or more of the exterior wall surface area level with or above finished grade. One (1) additional level that is the first level and not designed for human habitation and used only for vehicle parking, storage, or similar use shall be permitted.

(b) Rainwater piping located on the exterior of a building shall be not less than 26 ga. galvanized sheet metal. When the conductor is connected to a building storm drain or storm sewer, a drain connection shall be extended above the finished grade and jointed at a point protected from injury.

(c) Rainwater piping located underground within a building shall be of service weight cast iron soil pipe, Type DWV copper tube, Schedule 40 ABS DWV, Schedule 40 PVC DWV, extra strength vitrified clay pipe, or other approved materials.

(d) Rainwater piping commencing two (2) feet (.6 m) from the exterior of a building may be of any approved material permitted in the Installation Requirements of this Code.

D 1.1

(a) Rainwater piping shall not be used as soil, waste or vent pipes nor shall a soil, waste or vent line be used as a rainwater pipe.

(b) Rainwater piping installed in locations where they may be subjected to damage shall be protected.

(c) Roof drains, overflow drains, and rainwater piping installed within the construction of the building shall be tested in conformity with the provisions of this Code for testing drain, waste, and vent systems.

Part B

Roof Drains

D 2 Materials: Roof drains shall be of cast iron, copper, lead, or other corrosion resisting material.

D 2.1 Strainers:

(a) Roof drains shall be equipped with strainers extending not less than four (4) inches (101.6 mm) above the surface of the roof immediately adjacent to the drain. Strainers shall have minimum inlet area one and one-half (1-1/2) times the pipe to which it is connected.

(b) Roof deck strainers for use on sun decks, parking decks, and similar occupied areas may be of an approved flat-surface type which is level with the deck. Such drains shall have an inlet area not less than two (2) times the area of the pipe to which the drain is connected.

(c) Roof drains passing through the roof into the interior of a building shall be made watertight at the roof line by the use of a suitable flashing material.

Part C

Sizing of Rainwater Piping

D 3.1 Vertical rainwater piping shall be sized in accordance with Table D-1. Table D-1 is based upon maximum inches (mm) of rainfall per hour falling upon a given roof area in square feet (m^2). Consult local rainfall figures to determine maximum rainfall per hour.

D 3.2 Vertical Wall Areas. Where vertical walls project above a roof so as to permit storm water to drain to the roof area below the adjacent roof area may be computed from Table D-1 as follows:

(a) For one (1) wall – add fifty (50) percent of the wall area to the roof area figures.

(b) For two (2) adjacent walls – add thirty-five (35) percent of the total wall areas.

(c) Two (2) walls opposite of same heights – add no additional area.

(d) Two (2) walls opposite of differing heights – add fifty (50) percent of wall area above top of lower wall.

(e) Walls on three (3) sides – add fifty (50) percent of area of the inner wall below the top of the lowest wall, plus allowance for area of wall above top of lowest wall per (b) and (d).

(f) Walls on four (4) sides – no allowance for wall areas below top of lowest wall – add for areas above top of lowest wall per (a), (b), (d), and (e).

TABLE D-1

Sizing of Roof Drains and Rainwater Piping for Varying Rainfall
Quantities are Horizontal Projected Roof Areas in Square Feet

Rain Fall	Size of Drain or Leader in Inches*					
in Inches	2	3	4	5	6	8
1	2880	8800	18400	34600	54000	116000
2	1440	4400	9200	17300	27000	58000
3	960	2930	6130	11530	17995	38660
4	720	2200	4600	8650	13500	29000
5	575	1760	3680	6920	10800	23200
6	480	1470	3070	5765	9000	19315
7	410	1260	2630	4945	7715	16570
8	360	1100	2300	4325	6750	14500
9	320	980	2045	3845	6000	12890
10	290	880	1840	3460	5400	11600
11	260	800	1675	3145	4910	10545
12	240	730	1530	2880	4500	9660

TABLE D-1
(metric)

Sizing of Roof Drains and Rainwater Piping for Varying Rainfall
Quantities are Horizontal Projected Roof Areas in meters^2

Rain Fall	Size of Drain or Leader in Millimeters*					
in mm	50.8	76.2	101.6	127	152.4	203.2
25.4	267.6	817.5	1709.4	3214.3	5016.6	10776.4
50.8	133.8	408.8	854.7	1607.2	2508.3	5388.2
76.2	89.2	272.2	569.5	1071.1	1671.7	3591.5
101.6	66.9	204.4	427.3	803.6	1254.2	2694.1
127	53.4	163.5	341.8	642.9	1003.3	2155.3
152.4	44.6	136.6	285.2	535.6	836.1	1794.4
177.8	38.1	117.1	244.3	459.4	716.7	1539.4
203.2	33.4	102.2	213.7	401.8	627.1	1347.1
228.6	29.7	91	190	357.2	557.4	1197.5
254	26.9	81.8	170.9	321.4	501.7	1077.6
279.4	24.2	74.3	155.6	292.2	456.1	979.6
304.8	22.3	67.8	142.1	267.6	418.1	897.4

**Round, square, or rectangular rainwater pipe may be used and are considered equivalent when enclosing a scribed circle equivalent to the leader diameter.*

D 3.3 Horizontal Rainwater Piping. The size of a building rainwater piping or any of its horizontal branches shall be sized in accordance with Table D-2 (Based upon maximum roof areas to be drained).

Example: Table D-2
Roof Area – 5900 sq. ft. (548.1 m²)
Max. Rainfall/hr. – 5 inches (127 mm)
Pipe Laid at 1/4" (20.9 mm/m) slope

Find roof area in column under 5" (127 mm) rainfall (6040 sq. ft. (561.1 m²) is closest), read 6" (152.4 mm) as size of piping in left hand column.

D3.4 Roof Gutter. The size of semi-circular roof gutters shall be based on the maximum roof area, in accordance with Table D-3.

Example: Table D-3
Roof Area – 2000 sq. ft. (186 m²)
Max. Rainfall/hr. – 4" (101.6 mm)
Gutter set at 1/8" (10.4 mm/m) slope

Find roof area in column under 4" (101.6 mm) rainfall 1950 sq. ft. (181.4 m²) is closest), read 7" (177.8 mm) diameter gutter in left hand column.

D3.5 If the rainfall is more or less than those shown in Table D-2 and D-3, then adjust the figures in the 2" (50.8 mm) rainfall column by multiplying by two (2) and dividing by the maximum rate of rainfall in inches/hr. (mm/hour).

Example: In Table D-2 with an 1/8" (10.4 mm/m) slope and an 8" (203.2 mm) rainfall, find the number of square feet (m²) a 4" (101.6 mm) pipe will carry.

$$\frac{2 \times 3760}{8} = 940 \text{ sq. ft. } (87.4 \text{ m}^2)$$

TABLE D-2
Size of Horizontal Rainwater Piping

Size of Pipe in Inches 1/8" Slope	Maximum Rainfall in Inches per Hour 2	3	4	5	6
3	1644	1096	822	657	548
4	3760	2506	1800	1504	1253
5	6680	4453	3340	2672	2227
6	10700	7133	5350	4280	3566
8	23000	15330	11500	9200	7600
10	41400	27600	20700	16580	13800
12	66600	44400	33300	26650	22200
15	109000	72800	59500	47600	39650

Size of Pipe in Inches 1/4" Slope	Maximum Rainfall in Inches per Hour 2	3	4	5	6
3	2320	1546	1160	928	773
4	5300	3533	2650	2120	1766
5	9440	6293	4720	3776	3146
6	15100	10066	7550	6040	5033
8	32600	21733	16300	13040	10866
10	58400	38950	29200	23350	19450
12	94000	62600	47000	37600	31350
15	168000	112000	84000	67250	56000

Size of Pipe in Inches 1/2" Slope	Maximum Rainfall in Inches per Hour 2	3	4	5	6
3	3288	2295	1644	1310	1096
4	7520	5010	3760	3010	2500
5	13360	8900	6680	5320	4450
6	21400	13700	10700	8580	7140
8	46000	30650	23000	18400	15320
10	85800	55200	41400	33150	27600
12	133200	88800	66600	53200	44400
15	238000	158800	119000	95300	79250

TABLE D-2
(metric)
Size of Horizontal Rainwater Piping

Size of Pipe in mm 10.4 mm/m Slope	Maximum Rainfall in Millimeters per Hour				
	50.8	76.2	101.6	127	152.4
76.2	152.7	101.8	76.4	61	50.9
101.6	349.3	232.8	174.7	139.7	116.4
127	620.6	413.7	310.3	248.2	206.9
152.4	994	662.7	497	397.6	331.3
203.2	2136.7	1424.2	1068.4	854.7	706
254	3846.1	2564	1923	1540.3	1282
279.4	6187.1	4124.8	3093.6	2475.8	2062.4
381	10126.1	6763.1	5527.6	4422	3683.5

Size of Pipe in mm 20.9 mm/m Slope	Maximum Rainfall in Millimeters per Hour				
	50.8	76.2	101.6	127	152.4
76.2	215.5	143.6	107.8	86.2	71.8
101.6	492.4	328.2	246.2	197	164.1
127	877	584.1	438.5	350.8	292.3
152.4	1402.8	935.1	701.4	561.1	467.6
203.2	3028.5	2019	1514.3	1211.4	1009.5
254	5425.4	3618.5	2712.7	2169.2	1806.9
304.8	8732.6	5815.5	4366.3	3493	2912.4
381	15607.2	10404.8	7803.6	6247.5	5202.4

Size of Pipe in mm 41.7 mm/m Slope	Maximum Rainfall in Millimeters per Hour				
	50.8	76.2	101.6	127	152.4
76.2	305.5	213.2	152.7	121.7	101.8
101.6	698.6	465.4	349.3	279.6	232.3
127	1241.1	826.8	620.6	494.2	413.4
152.4	1988.1	1272.3	994	797.1	663.3
203.2	4274.4	2847.4	2136.7	1709.4	1423.2
254	7692.1	5128.1	3846.1	3079.6	2564
304.8	12374.3	8249.5	6187.1	4942.3	4124.8
381	22110.2	14752.5	11055.1	8853.4	7362.3

Table D-3
Size of Gutters

Diameter of Gutter 1/16" Slope	Maximum Rainfall in Inches per Hour				
	2	3	4	5	6
3	340	226	170	136	113
4	720	480	360	288	240
5	1250	834	625	500	416
6	1920	1280	960	768	640
7	2760	1840	1380	1100	918
8	3980	2655	1990	1590	1325
10	7200	4800	3600	2880	2400

Diameter of Gutter 1/8" Slope	Maximum Rainfall in Inches per Hour				
	2	3	4	5	6
3	480	320	240	192	160
4	1020	681	510	408	340
5	1760	1172	880	704	587
6	2720	1815	1360	1085	905
7	3900	2600	1950	1560	1300
8	5600	3740	2800	2240	1870
10	10200	6800	5100	4080	3400

Diameter of Gutter 1/4" Slope	Maximum Rainfall in Inches per Hour				
	2	3	4	5	6
3	680	454	340	272	226
4	1440	960	720	576	480
5	2500	1668	1250	1000	834
6	3840	2560	1920	1536	1280
7	5520	3680	2760	2205	1840
8	7960	5310	3980	3180	2655
10	14400	9600	7200	5750	4800

Diameter of Gutter 1/2" Slope	Maximum Rainfall in Inches per Hour				
	2	3	4	5	6
3	960	640	480	384	320
4	2040	1360	1020	816	680
5	3540	2360	1770	1415	1180
6	5540	3695	2770	2220	1850
7	7800	5200	3900	3120	2600
8	11200	7460	5600	4480	3730
10	20000	13330	10000	8000	6660

TABLE D-3
(metric)
Size of Gutters

Diameter of Gutter 5.2 mm/m	Maximum Rainfall in Millimeters per Hour				
Slope	50.8	76.2	101.6	127	152.4
76.2	31.6	21	15.8	12.6	10.5
101.6	66.9	44.6	33.4	26.8	22.3
127	116.1	77.5	58.1	46.5	38.7
152.4	178.4	119.1	89.2	71.4	59.5
177.8	256.4	170.9	128.2	102.2	85.3
203.2	369.7	246.7	184.9	147.7	123.1
254	668.9	445.9	334.4	267.6	223

Diameter of Gutter 10.4 mm/m	Maximum Rainfall in Millimeters per Hour				
Slope	50.8	76.2	101.6	127	152.4
76.2	44.6	29.7	22.3	17.8	14.9
101.6	94.8	63.3	47.4	37.9	31.6
127	163.5	108.9	81.8	65.4	54.5
152.4	252.7	168.6	126.3	100.8	84.1
177.8	362.3	241.5	181.2	144.9	120.8
203.2	520.2	347.5	260.1	208.1	173.7
254	947.6	631.7	473.8	379	315.9

Diameter of Gutter 20.9 mm/m	Maximum Rainfall in Millimeters per Hour				
Slope	50.8	76.2	101.6	127	152.4
76.2	63.2	42.2	31.6	25.3	21
101.6	133.8	89.2	66.9	53.5	44.6
127	232.3	155	116.1	92.9	77.5
152.4	356.7	237.8	178.4	142.7	118.9
177.8	512.8	341.9	256.4	204.9	170.9
203.2	739.5	493.3	369.7	295.4	246.7
254	133.8	891.8	668.9	534.2	445.9

Diameter of Gutter 41.7 mm/m	Maximum Rainfall in Millimeters per Hour				
Slope	50.8	76.2	101.6	127	152.4
76.2	89.2	59.5	44.6	35.7	29.7
101.6	189.5	126.3	94.8	75.8	63.2
127	328.9	219.2	164.4	131.5	109.6
152.4	514.7	343.3	257.3	206.2	171.9
177.8	724.6	483.1	362.3	289.9	241.4
203.2	1040.5	693	520.2	416.2	346.5
254	1858	1238.4	929	743.2	618.7

CHAPTER 8

STORM DRAINAGE SYSTEMS

SECTION P-801.0 GENERAL

P-801.1 Scope: This chapter shall govern methods of installation of storm drains, maximum projected roof area for drains of various slopes, size of roof gutters and vertical leaders, size of combined *building drains* and *sewers*, *building subdrains*, methods of installation, roof drains and general utilization.

SECTION P-802.0 DEFINITIONS

P-802.1 General: The following words and terms shall, for the purposes of this chapter and as stated elsewhere in this code, have the meanings shown herein.

Area drain: A receptacle designed to collect surface or storm water from an open area.

Building drain

Combined: A *building drain* that conveys both sewage and storm water or other drainage.

Storm: A *building drain* that conveys storm water or other drainage, but not sewage.

Building sewer

Combined: A *building sewer* that conveys both sewage and storm water or other drainage.

Storm: A *building sewer* that conveys storm water or other drainage, but not sewage.

Conductor: A pipe inside the building which conveys storm water from the roof to a storm or combined *building drain*.

Drainage system

Storm: A *drainage system* that carries rainwater, surface water, condensate, cooling water or similar liquid wastes.

Leader: An exterior drainage pipe for conveying storm water from roof or gutter drains.

Roof drain: A drain installed to receive water collecting on the surface of a roof and to discharge such water into a leader or a conductor.

Sewer

Sanitary sewer: A *sewer* that carries sewage and excludes storm, surface and ground water.

Storm sewer: A *sewer* that conveys rainwater, surface water, condensate, cooling water, or similar liquid wastes.

Subsoil drain: A drain that collects subsurface water and conveys such water to a place of disposal.

Sump pump: An automatic water pump powered by an electric motor for the removal of drainage, except raw sewage, from a sump, pit or low point.

SECTION P-803.0 WHERE REQUIRED

P-803.1 General: All roofs, paved areas, yards, courts and courtyards shall drain into a separate storm *sewer* system, or a combined *sewer* system, or to an approved place of disposal. For one- and two-family dwellings, and where approved, storm water is permitted to discharge onto flat areas, such as streets or lawns, provided that the storm water flows away from the building.

P-803.2 Cleanouts required: *Cleanouts* shall be installed in the storm *drainage system* and shall comply with the provisions of this code for drainage pipe *cleanouts*.

SECTION P-804.0 STORM WATER DRAINAGE SYSTEM INSTALLATION

P-804.1 General: Storm water shall not be drained into sanitary *sewers*.

P-804.2 Slope of horizontal drainage piping: Horizontal drainage piping, excluding gutters, shall be installed with a minimum slope of ⅛ inch per foot unless otherwise approved.

P-804.3 Continuous flow: The size of a drainage pipe shall not be reduced in the direction of flow.

P-804.4 Flood hazard: All drainage piping located in a flood-hazard zone (A Zone) or a high-hazard zone (V Zone) shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

P-804.5 Fittings and connections: All connections and changes in direction of the storm *drainage system* shall be made with approved drainage-type fittings in accordance with Table P-605.2. The fittings shall not obstruct or retard flow in the system.

SECTION P-805.0 SIZE OF BUILDING STORM DRAINS, BUILDING STORM SEWERS AND LEADERS

P-805.1 Size of horizontal drains and sewers: The size of the *building storm drains*, *building storm sewers* and any *horizontal branches* of such drains or *sewers* shall be based upon the maximum projected roof or paved area to be drained. The size shall be determined in accordance with Table P-805.1, and adjusted to local rainfall rates listed in Appendix A.

Table P-805.1
SIZE OF HORIZONTAL BUILDING STORM DRAINS AND BUILDING STORM SEWERS[a]

Diameter of drain (inches)	Maximum projected area, in square feet, and flow, in gallons per minute, for various slopes[b]					
	1/8 inch per foot slope		1/4 inch per foot slope		1/2 inch per foot slope	
	Square feet[a]	Gallons per minute	Square feet[a]	Gallons per minute	Square feet[a]	Gallons per minute
3	3,288	34	4,640	48	6,576	68
4	7,520	78	10,600	110	15,040	156
5	13,360	139	18,880	196	26,720	278
6	21,400	222	30,200	314	42,800	445
8	46,000	478	65,200	677	92,000	956
10	82,800	860	116,800	1,214	165,600	1,721
12	133,200	1,384	188,000	1,953	266,400	2,768
15	238,000	2,473	336,000	3,491	476,000	4,946

Note a. Table P-805.1 is based upon a maximum rate of rainfall of 1 inch per hour for a 1-hour duration and a 100-year return period. The figure for drainage area shall be adjusted to local conditions by dividing by the local rate in inches per hour. See Appendix A.
Note b. 1 inch per foot = 83.3 mm/m; 1 square foot = 0.093 m^2; 1 gallon per minute = 3.78 l/m; 1 inch = 25.4 mm.

P-805.2 Size of vertical conductors and leaders: The size of vertical leaders shall be based on the maximum projected roof area in accordance with Table P-805.2, and adjusted to local rainfall rates listed in Appendix A.

Table P-805.2
SIZE OF VERTICAL CONDUCTORS AND LEADERS[a]

Size of leader or conductor[b] (inches)	Maximum projected roof area	
	Square feet[a,c]	Gallons per minute[c]
2	2,176	23
2½	3,948	41
3	6,440	67
4	13,840	144
5	25,120	261
6	40,800	424
8	88,000	913

Note a. Table P-805.2 is based upon a maximum rate of rainfall of 1 inch per hour for a 1-hour duration and a 100-year return period. The figure for drainage area shall be adjusted to local conditions by dividing by the local rate in inches per hour. See Appendix A.
Note b. The area of rectangular leaders shall be equivalent to the circular leader or conductor required. The width-to-depth ratio of rectangular leaders shall not exceed 3:1.
Note c. 1 inch per foot = 83.3 mm/m; 1 square foot = 0.093 m^2; 1 gallon per minute = 3.78 l/m; 1 inch = 25.4 mm.

P-805.3 Size of roof gutters: The size of semicircular gutters shall be based on the maximum projected roof area in accordance with Table P-805.3, and adjusted to local rainfall rates listed in Appendix A.

P-805.4 Size of combined drains and sewers: The size of a combination sanitary and storm drain or *sewer* shall be computed in accordance with the method in Section P-805.1. The *fixture units* shall be converted into an equivalent projected roof or paved area. Where the total fixture load on the combined drain is less than 256 *fixture units*, the equivalent drainage area in horizontal projection shall be taken as 4,000 square feet (372 m^2). Where the total fixture load exceeds 256 units, each additional *fixture unit* shall be considered the equivalent of 15.6 square feet (1.5 m^2) of drainage area.

P-805.5 Values for continuous flow: Where there is a continuous or semicontinuous discharge into the *building storm drain* or *building storm sewer*, such as from a pump, ejector, air conditioning plant or similar device, each gallon per minute of such discharge shall be computed as being equivalent to 96 square feet (9 m^2) of roof area, based upon a 1-inch (25 mm) rainfall.

Table P-805.3
SIZE OF SEMICIRCULAR ROOF GUTTERS[a]

Diameter of gutter[b] (inches)	Maximum projected roof area for gutters of various slopes[c]							
	1/16 inch per foot slope		1/8 inch per foot slope		1/4 inch per foot slope		1/2 inch per foot slope	
	Square feet[a]	Gallons per minute	Square feet[a]	Gallons per minute	Square feet[a]	Gallons per minute	Square feet[a]	Gallons per minute
3	680	7	960	10	1,360	14	1,920	20
4	1,440	15	2,040	21	2,880	30	4,080	42
5	2,500	26	3,520	37	5,000	52	7,080	74
6	3,840	40	5,440	57	7,680	80	11,080	115
7	5,520	57	7,800	81	11,040	115	15,600	162
8	7,960	83	11,200	116	14,400	165	22,400	233
10	14,400	150	20,400	212	28,800	299	40,000	416

Note a. Table P-805.3 is based upon a maximum rate of rainfall of 1 inch per hour for a 1-hour duration and a 100-year return period. The figure for drainage area shall be adjusted to local conditions by dividing by the local rate in inches per hour. See Appendix A.
Note b. Gutters, other than semicircular, shall have an equivalent cross-sectional area.
Note c. 1 inch per foot = 83.3 mm/m; 1 square foot = 0.093 m^2; 1 gallon per minute = 3.78 l/m; 1 inch = 25.4 mm.

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SECTION P-806.0 BUILDING SUBDRAINS

P-806.1 Sump: *Building subdrains* located below the public *sewer* level shall discharge into a sump or receiving tank, the contents of which shall be automatically lifted and discharged into the *drainage system* as required for building sumps, or into another type of approved disposal system. The subsoil sump shall not be required to have either a gas-tight cover or a vent.

P-806.2 Sump pump systems: A sump pump system shall include the sump pump, pit, discharge piping, and an individual branch electrical circuit. The system shall include a pump with a capacity and head appropriate for the anticipated application requirements.

P-806.3 Sump pit: The size of the sump pit shall be as specified by the sump pump manufacturer. The pit shall be topped by a removable cover adequate to support anticipated loads in the area of installation. The pit floor shall provide permanent support for the sump pump. The pit shall be constructed of tile, concrete, steel, plastic or other approved material.

P-806.4 Discharge piping: Where discharging into a storm or sanitary *sewer* system, a suitable antisiphon device or free-flow check valve shall be installed. Where discharge to separate sanitary and storm *sewers* is required, two independent sump pump systems shall be required. Discharge pipe size and fittings shall be the same size as, or larger than, the sump pump discharge tapping.

SECTION P-807.0 SUBSOIL DRAINS

P-807.1 General: Where the subsoil drain for a structure is subject to *backflow*, such subsoil drain shall be protected by a backwater valve. *Access* shall be provided to the backwater valve. Subsoil drains shall discharge to a trapped area drain, sump, dry well or approved location above grade.

SECTION P-808.0 TRAPS ON STORM DRAINS AND LEADERS

P-808.1 Where required: Leaders, conductors and storm drains, where connected to a combined *sewer*, shall be trapped.

P-808.2 Trap size: Traps for individual conductors shall be the same size as the horizontal drain to which the traps are connected.

P-808.3 Method of installation: Individual storm water traps shall be installed on the storm drain *branch* serving each storm water inlet, or a single trap shall be installed in the main storm drain before connection of the main storm drain with the combined *building sewer* or public *sewer*. Such traps shall be provided with a *cleanout*. *Access* shall be provided to the *cleanout*.

SECTION P-809.0 CONDUCTORS AND CONNECTIONS

P-809.1 Improper utilization prohibited: Conductors shall not be utilized as soil, waste or vent pipes, nor shall drainage or vent pipes be utilized as conductors.

P-809.2 Protection of leaders: Leaders installed along alleyways, driveways or other locations exposed to damage shall be recessed into the wall or otherwise protected by metal guards.

P-809.3 Separate storm and sanitary drainage: The sanitary and storm *drainage systems* of a structure shall be entirely separate.

Exception: Where a combined *sewer* is utilized, the *building storm drain* shall be connected in the same horizontal plane through a single-wye fitting to the combined *sewer* at least 10 feet (3048 mm) downstream from any soil stack.

P-809.4 Double connections of storm drains: Where the sanitary and storm drains are connected on both sides of the combined *sewer*, single wyes shall be utilized and the requirements of Section P-809.3 shall apply to the location of connections.

SECTION P-810.0 ROOF DRAINS

P-810.1 General: All roof areas, except those draining to hanging gutters, shall be equipped with roof drains with strainers extending not less than 4 inches (102 mm) above the surface of the roof, and shall have an available inlet area not less than two times the area of the conductor or leader to which the drain is connected.

P-810.2 Roof design: Roofs shall be designed for the maximum possible depth of water that will pond thereon as determined by the relative levels of roof deck and overflow weirs, scuppers, edges or serviceable drains in combination with the deflected structural elements. In determining the maximum possible depth of water, all primary roof drainage means shall be assumed to be blocked.

P-810.3 Flat decks: Roof drain strainers for utilization on sun decks, parking decks and similar areas normally serviced and maintained, are permitted to be of a flat-surface type and level with the deck, and shall have an available inlet area not less than two times the area of the conductor or leader to which the drain is connected.

P-810.4 Roof drain flashings required: The connection between roofs and roof drains passing through the roof and into the interior of the structure shall be made water tight by an approved flashing material.

SECTION P-811.0 CONTROLLED FLOW ROOF DRAIN SYSTEMS

P-811.1 General: The roof of a structure shall be designed for the storage of water where the storm *drainage system* is engineered for controlled flow. The controlled flow system shall be designed based on the local rainfall rate listed in Appendix A.

P-811.2 Control devices: The control devices shall be installed so that the rate of discharge of water per minute shall not exceed the rates indicated in Tables P-805.1 and P-805.2 and utilizing values for continuous flow as indicated in Section P-805.5.

P-811.3 Installation: Runoff control shall be by control devices. Control devices shall be protected by strainers.

P-811.4 Sizing: Not less than two roof drains shall be installed in roof areas 10,000 square feet (930 m^2) or less and not less than four roof drains shall be installed in roofs over 10,000 square feet (930 m^2) in area.

SUBSOIL DRAINAGE:

1. Subsoil drains are usually constructed out of perforated drainage tile and installed around the perimeter of a building. If the buildings storm sewer is deep enough the subsoil drainage system can be connected to the buildings storm sewer directly. If the drainage tile is to deep than a sump pit with a pump will be required.

2. The architect ~~may and~~ OR site engineers will usually determine if the subsoil drainage is required based on the water table and soil conditions around the structure. The drain tile should be lower than the floor of the structure. Usually, the drain tile is installed next to the footing outside the building perimeter in a loop.

3. A filter material should be wrapped around the tile and the tile should be installed on a bedding of clean gravel. Gravel should be placed all around the tile to minimize the amount of soil in contact with the filter media.

4. Most footings are designed to be at the same elevation around the perimeter of the structure. This may make it impossible to slope the drain tile appreciably. 4" drain tile should be used as a minimum review this with the site engineer. Just before the pipe enters the building the drain tile should be replaced by under ground storm piping. Sleeve the pipe where it passes through the footing and slope the pipe at 1/8" minimum toward the sump pit. Review the wall penetration with the structural engineer.

5. Label pipe inverts ("I.E.= **'-**" or "(47)-2'-7") where pipes begin, cross other pipes and exit the building. Determine local frost depths and do not install pipes with less than 42" of cover.

6. Review structural drawings to locate footings, foundations, grade beams and other obstructions. Coordinate drain tile depth with footing depth.

7. Area drains are installed in air intake shafts and or equipment access shafts. The area drain is most likely the lowest storm sewer system and it is in many cases best to connect the area drain to the subsoil drainage system. However, do not use drain tile to make this connection.

8. Where sump pumps are required, a duplex package of 1 horse power pumps is a good starting point. Review this with site engineer.

9. Where subsoil drains are subject to back flow a back water valve should be installed. Access shall be provided to the back water valve.

SITE DRAINAGE:

The run off of storm water from land areas is calculated using the following equation.

$$Q = CIA$$

Where:

Q = The flow of water generated (Cubic feet per second)
C = Area factor

Roof or parking lot	C=1.0
Rolling lawns	C=0.5
Timber land	C=0.4
Corn Field	C=0.2

I = Inches of rain per hour (Assume 4 inches per hour)
A= Acres (1 Acre = 43,560 Ft^2)

For roofs and parking lots at 4 inches of rain per hour.

$$GPM = ft^2 \; X \; 0.041$$

The state of Wisconsin has its own area factors included in its plumbing code.

1. The sizing of site drainage piping is based on the area to be drained and the intensity and duration of the rainfall. KJWW typically designs drainage systems to handle 4" of rain per hour. Review code requirements in the area where the building is being constructed to determine the design rate of rainfall for the area.

2. The natural flow of water from a property can not be changed by new construction. Water flowing from parking lots drains faster so retention ponds may be needed.

3. Size pipes based on the chart included in this seminar. Storm sewers must be designed to produce a minimum velocity of 2 ft/sec. At lower velocities the solids present in the water settle out and restrict the flow of storm water.

4. Yard clean outs should be installed upon exiting the building. Locate clean outs in NON-TRAFFIC areas. Manholes are to be provided at changes in direction.

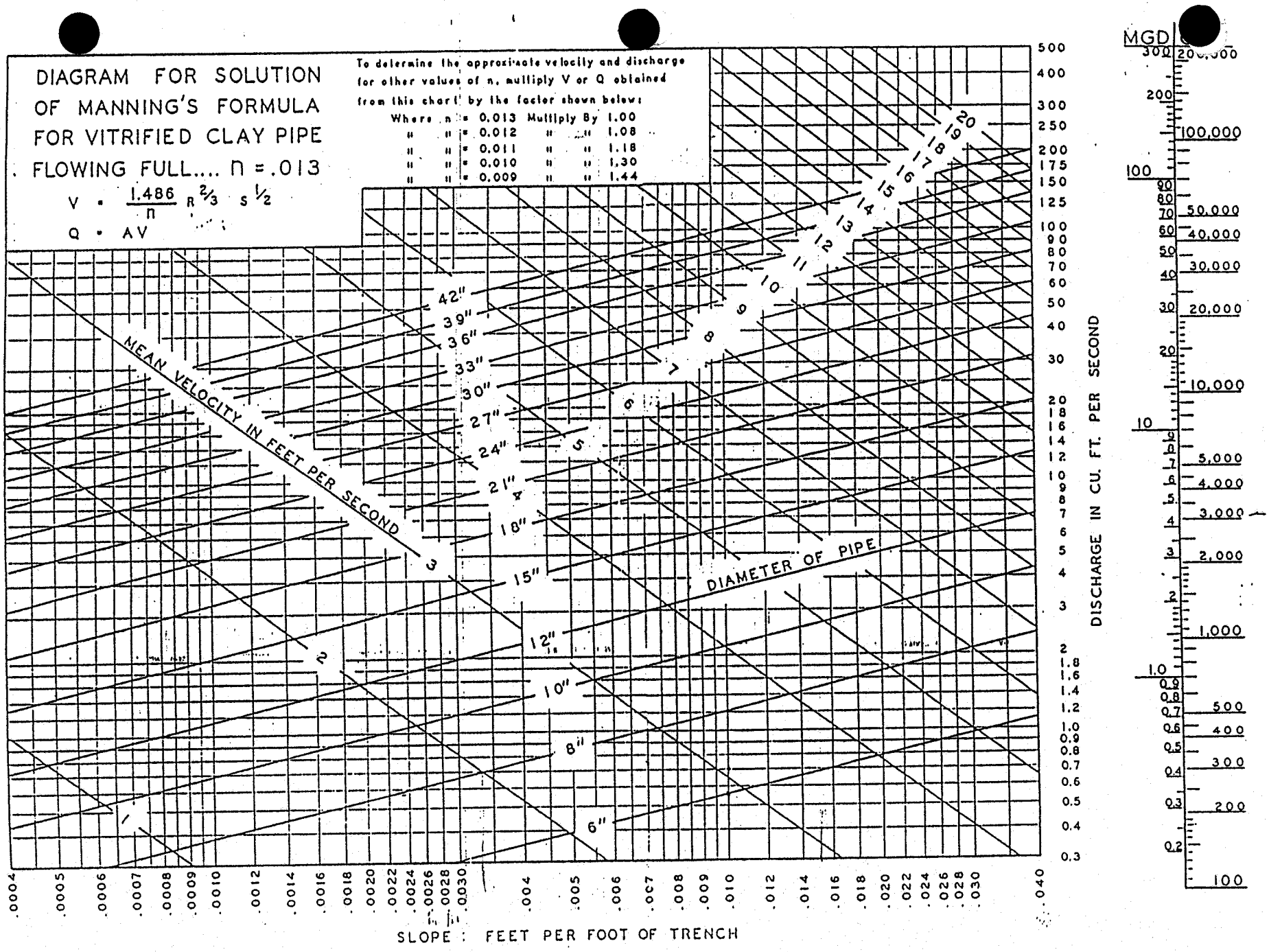
5. Label pipe inverts ("I.E.= **'-**" or "Ⓐ-2'-7") where pipes begin, cross other pipes and exit the building. Determine local frost depths and do not install pipes with less than 42" of cover.

6. Storm drains are meant to dispose of rain water. Condensate from cooling coils, cooling towers, and area drains may not be acceptable to discharge into storm sewer systems. Verify local code requirements and EPA guidelines for information regarding chemicals and the level of water quality that is required for discharge to storm sewers.

7. Continuous flows of water can be converted to roof areas as follows:

   (1) 96 sqft = 1 GPM @ 1 inch of rain per hour.

   (2) 24 sqft =1 GPM @ 4 inches of rain per hour.



Courtesy National Clay Pipe Institute