(b) The preferred design avoids longitudinal joints. However, if included, longitudinal joints should be on side slope at least one foot vertically above channel invert.

(c) All joints shall be designed to prevent differential displacement and shall be watertight.

(d) Construction joints are normally appropriate at the end of a day's run, where lining thickness changes, and any time concrete placement stops for more than 45 minutes.

8. Reinforcing Steel for Continuously Reinforced Channels

(a) Ratio of longitudinal steel area to concrete area

$$\frac{A_s}{\text{long}} \Big/ \frac{A_c}{\text{long.}} \geq .005$$

(b) Ratio of transverse steel area to concrete area

$$\frac{A_s}{\text{transv.}} \Big/ \frac{A_c}{\text{transv.}} \geq .0025$$

Note: *In (a) and (b) above A_s = crossectional area of steel in the direction indicated; Ac = crossectional area of concrete in the direction indicated. Longitudinal = long.; transverse = transv.*

(c) Steel Placement: Temperature and shrinkage steel shall be placed so as to be in the top of the middle third of the slab, but at least 3" from the bottom of the slab. Longitudinal steel shall be on tip of the transverse steel. (NOTE: Inspectors must insure this requirement is not violated by contractors during pouring operations.)

Section will begin at the top of the page in Final format

22.8 Street Hydraulics

22.8.1 A secondary use of the street network is the conveyance of stormwater runoff. This secondary use must always be subsidiary to the primary function of streets which is the safe conveyance of people and vehicles. The goals of street hydraulic design are therefore:

a. To provide an economical means of transporting stormwater runoff.

b. To ensure that the safety and convenience of the public are preserved.

c. To prevent stormwater runoff, once collected by the street system, from leaving the street right-of-way except at specially designated locations.

22.8.2 Street hydraulic design critical are as follows:

a. Manning's roughness coefficient is 0.017.

b. The calculated HGL for the 100-year design discharge may not exceed curb height and the calculated EGL shall be contained within the street right-of-way.

c. For a sump condition, the HGL for the 100-year storm may extend to the street right-of-way.

d. Flow depths in the event of the 10-year design discharge may not exceed 0.5 feet in any collector or arterial street. One lane free of flowing or standing water in each traffic direction must be preserved on arterial streets.

e. The product of depth times velocity shall not exceed 6.5 in any location in any street in the event of a 10-year design storm (with velocity calculated as the average velocity measured in feet per second and depth measured at the gutter flowline in feet.)

f. Gutter pan slope should be accommodated in the street cross-section.

g. The street cross section should be shown graphically. T-intersections, radical slope changes and intersections are potential locations for hydraulic jumps when upstream slopes are steeper than critical slope.

h. The assumption of equal flow distribution between gutters on undivided streets and between street sections on divided streets is only valid where its validity can be demonstrated.

22.8.3. For arterial streets with a median, the street cross-section may be changed to drain the street in the median rather than to the outside edges of the roadway.

22.8.4 When conditions indicate that a hydraulic jump or that the effects of superelevation will allow runoff to exceed street hydraulic design criteria, provisions must be made to for treatment of the problem. The warping of street sections and the construction of deflector walls for these purposes is prohibited unless specifically authorized by the City Engineer.

22.8.5 Intersections and other radical changes in street cross section and slope require special consideration whenever the flow depth/street slope relationship results in flows occurring in the supercritical flow regime. The critical slope line shown on the street rating curves is used to determine on which side of critical depth the flow occurs and if slope or cross section changes will allow the flow to cross through critical depth from supercritical.

If flow is likely to cross into the subcritical flow range, the height and length of hydraulic jump must be demonstrated in the drainage report. T

22.8.6 Drainage Design Criteria in Street Design.

a. Nuisance flows will not be conveyed across arterial or collector streets on the surface by valley gutters or other means. Valley gutters conveyance of nuisance flows across major local streets is discouraged. Provisions for storm drainage inlets to meet this requirement must be included at all intersections of major streets (collector or above) as defined by the Long Range Roadway System Plan.

b. The use of quarter point crown (i.e. high point of crown at mid-lane on high side of street) is preferred over the use of full side-hill street configuration to prevent sheet flow across pavement surfaces.
c. Transitional pavement surface approaches to intersections must be designed to contain nuisance flows within gutter lines; valley gutters must be provided to accommodate flows across intersections suitably, parallel to the major traffic carrying street.
d. Arterial, collector and sole access streets to subdivisions may not employ at-grade or dip section crossings of arroyos. Specific criteria for design of these crossings is given in Chapter 22.
e. For undesignated roadways, valley gutters will be required to convey flows across the roadway.

f. Dip or overflow sections will only be permitted on local streets with the approval of the Traffic Engineer and the City Engineer.

Dip or overflow sections may only be used where the depth of flow times the velocity of flow over the roadway including sidewalks will not exceed 6.5 for that portion of the 10-year storm runoff crossing over the street. Velocity is to be calculated as the velocity measured in feet per second and the flow depth is to be measured in feet at the upstream edge of the roadway including sidewalk.

If dip sections are permitted, vertical alignment must satisfy the requirements in Chapter 23 for sight distances considering the design speed of the street in question.

22.8.7 Inlet Placement and Design Criteria

Inlets should be placed to meet the street flow criteria discussed above.

Size and type of inlets should be determined by physical requirements and by grate and flow capacities given in Plates 22.8 D-1 and 22.8 D-2, inclusive. Criteria used, if other than those recommended in this section, must be cited and accompanied by appropriate calculations. Inlet spacing should be per Plate 22.8 D-3.

22.8.7.1 Standard Inlets

The selection of type, number, and spacing of inlets should be based on Plates 22.8 D-l through 22.8 D-3 and the following instructions.

City standard inlets "Type A and C" are combination basins with both curb opening and grading. Inlet "Type D" is a grating only basin. Basin gratings tend to accumulate debris and clog. The curb opening both limits debris accumulation and offsets lost capacity due to clogging of the grating. Except for certain valley applications, combination basins should be used. Due to main line clogging, grating only basins should be used in valley applications where main line pipe diameters are 24" or less or where quarter full pipe velocities are less than 2.5 f.p.s.

"Type A" basins should be used for single basin applications and as the first basin in a battery of basins. The "Type A" basin performs the function of sweeping debris of the street upstream of the grating and minimizing clogging. "Type A" basins are used with standard 8" curb and gutter.

"Type C" basins are generally placed downstream of and/or in conjunction with "Type A" basins. If "Type C" basins are used without a "Type A" within 150 feet upstream, the capacity shown in Plates 22.8 D-1 and 22.8 D-2 should be reduced 15% for clogging. "Type C" basins are used with standard 8" curb and gutter.

"Type D" basins are generally used on streets with slope greater than 5%, in driveways and in certain valley areas as described above. "Type D" basins can be used with either standard 8" curb and gutter or with mountable curb. The capacity shown in Plates 22.8 D-1 and 22.8 D-2 should be reduced 15% for clogging.

The number of catch basins to be connected in series should not exceed two. If the connection of more than two catch basins in series is unavoidable, consideration should be given to designing a lateral drain.

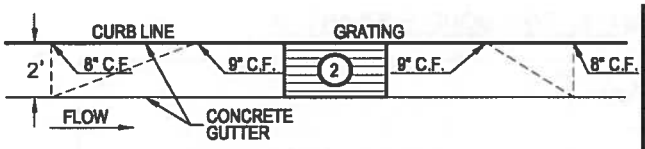
The capacity of the lateral storm drain is to be considered when placing inlets as the grate capacity may be limited by the lateral storm drain.

If there is a conflict with an existing Type “A” or “C” inlet with a proposed plan the following criteria should apply:

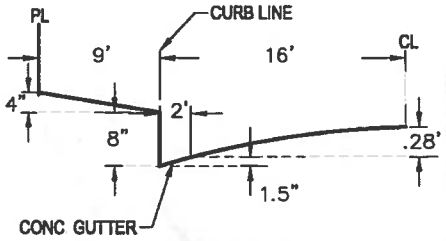
1. The conversions of type A's, or C's to Type D inlets will be permitted if a throated inlet is within 150 feet upstream.
2. If there is not a throated inlet within 150 feet upstream, the conversions of type A's, or C's to Type D inlets will be permitted if a throated inlet is added within 150 feet upstream.
3. Or the inlet shall be removed and replaced with an inlet outside the conflict zone.

The engineer should verify there is adequate clearance for proposed driveways near inlets. If an apparent conflict exists the proposed driveways near inlets should be shown on the grading plan and shall be shown on the DRC construction plans.

GRATING CAPACITIES FOR TYPE "A", "C" AND "D"



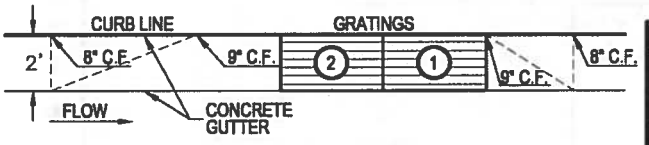
GRATING & GUTTER PLAN



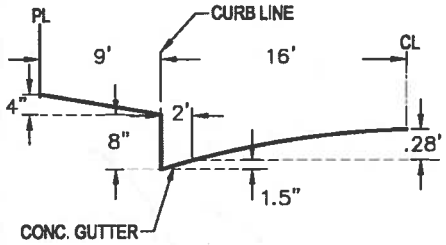
TYPICAL HALF STREET SECTION (ABOVE BASIN)

Plate 22.8 D-1

GRATING CAPACITIES FOR TYPE DOUBLE "C" AND "D"



GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)

Plate 22.8 D-2

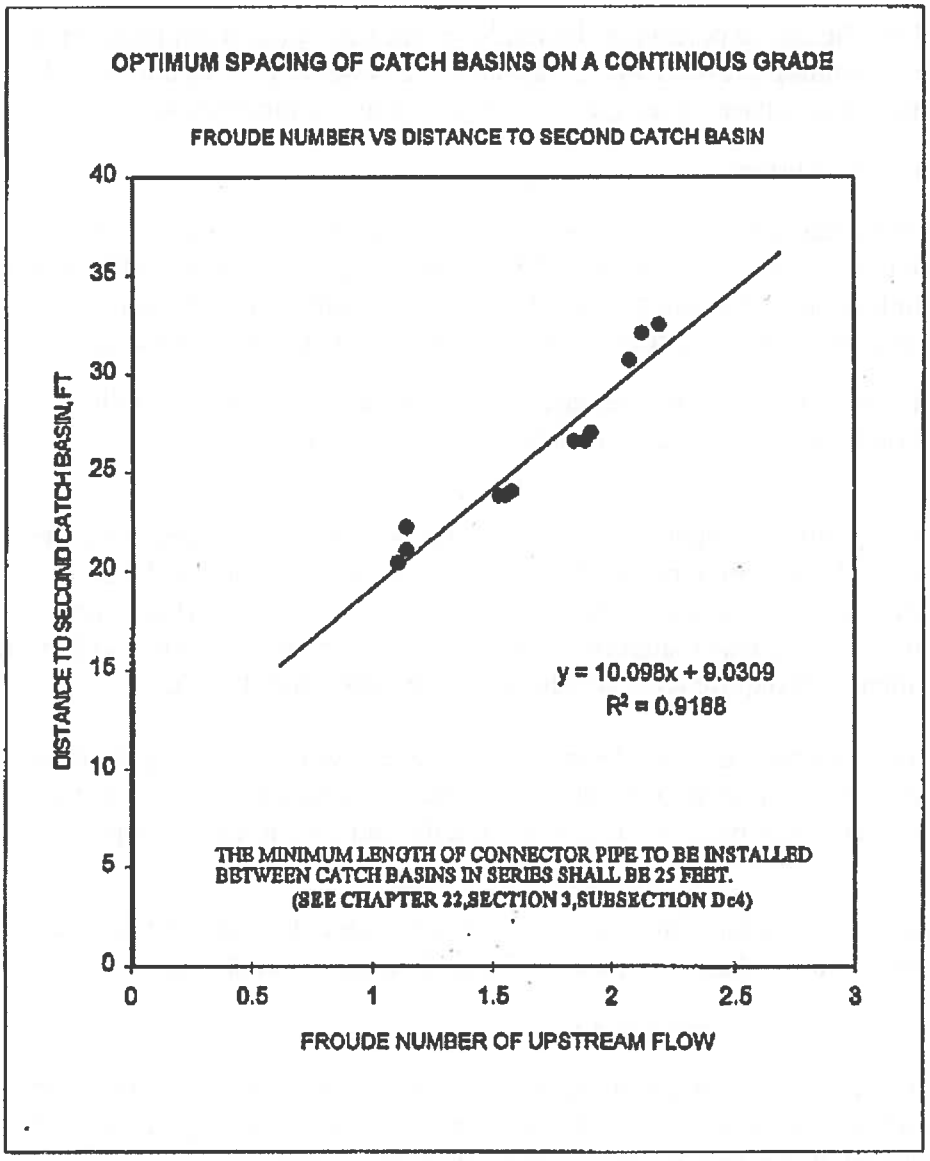


Plate 22.8 D-3

22.8.7.2 Cattle-Guard and Median inlets

Standard drawings are available for cattle-guard and median inlets. Plates presented earlier in this section were for the capacity of Type A, C and D inlets. The engineer shall provide calculations when proposing cattle-guard and median inlets.

22.8.7.3 Publicly maintained Inlets to be located within street Rights-of-way

Inlets will be located within street rights-of-way unless otherwise approved by the City Engineer. Inlets located outside of Right-of-way require an easement with beneficiary and maintenance responsibilities defined.

Construction of inlets that will be located outside constructed streets to accommodate future street widenings is discouraged. However, the lateral storm drain stub shall be constructed past the permanent pavement section.

Inlets to be constructed off the paved portion of the roadway but within the street property lines must be made operable by grading the roadway to permit storm water to flow to the inlet. The area around the inlet shall be adequately protected from erosion and sedimentation.

22.8.7.5 Inlets in a Sump Condition

Sump designs for should normally be limited to local streets and only those situations where terrain or grading considerations warrant their use. When specifying a sump inlet(s) the designer shall ensure that surrounding properties are protected from the occurrence of inlet and lateral clogging by demonstrating that one of the following emergency backup conditions exist:

1. The design storm peak flow rate will release to either a public R.O.W. or public easement without rising above any adjacent structure pad elevations.

   When relying on public easements across private property for this option, the easement language creating the encumbrance shall specify that said easement is a Public Drainage Easement and no structural improvements which would interfere with conveyance or storage of water shall be allowed. Any surface modification within the drainage easement will require an encroachment agreement from the City.

   If the subdivision or street network design does not lend itself to releasing the drainage as stated above, it is acceptable to double the number of sump inlets. The additional inlet(s) are an emergency overflow in case the inlet(s) required to carry the peak flow are clogged.

2. Sufficient storage is available within a combination of public R.O.W., public easement, to hold 100% of the design event volume, without inflicting damage to structures.

22.8.8 Inlet Lateral and Connector Pipe Capacity

When designing inlets to capture stormwater from the street, the capacity of the lateral (pipe connecting inlet to main line) pipe and the capacity of connector (inlet to inlet) pipes must be determined. Calculations are to be included in the drainage report or plan.

The capacity can be shown with gravity flow using manning's equation or by pressure flow using an acceptable modelling program. The program must meet the following criteria to be accepted:

1. Be able to produce an illustration of the HGL and EGL.

2. Have the ability to include major and minor losses.

3. Meet technical requirements of this chapter.

4. If requested by the City Engineer, the design engineer shall provide a description of how the model meets the requirements of this chapter.

22.8.8.1 Connector and Lateral Pipe Criteria

(1) The minimum diameter of connector and lateral pipes is 18 inches.

(2) The horizontal alignment of lateral and connector pipes must not contain angle points or bends, unless approved by the City Engineer.

(3) Lateral connections to the main line are preferred at manholes or junction structures. Exceptions to this criterion must be approved by the City Engineer. Lateral pipes connecting to a main line from both sides of a street (not using a manhole) should be offset 8 feet or more at the main line and require City Engineer approval.

(4) The inlet spacing shall be a minimum of 30 feet center of downstream grate to center of upstream grate.

(5) Catch basin connector pipes shall outlet at the downstream end of the catch basins, unless prevented by field conditions. Downstream, in this paragraph, refers to the directions of the gutter slope at the catch basin in question.

22.8.8.2 Consideration of Existing Drainage Systems during Construction

(1) Existing drainage systems which are not required to carry any portion of the design Q of a proposed system may be designated to be abandoned in place upon completion of the proposed drain. Such existing drainage systems should not be sealed or removed before completion of the proposed system, if needed to carry off storm water during the construction period. It is the designer's responsibility to ascertain the necessity of maintaining existing drainage systems in place.

Existing street or sidewalk culverts may be designated to have the interfering portions removed and the inlets sealed, or the culverts may be kept in operation and connected to the storm drain or to the back of a proposed catch basin. If the culvert is to be connected, a structural detail should be provided. Refer to the City Engineer for instructions.

Existing street or sidewalk culverts that do not interfere with construction should be maintained in place.

If the existing culvert is located in, or its required to drain a sump, the designer should make every effort to avoid removal of the culvert, especially in instances where the capacity of the proposed drain is less than that required for the correct design frequency.