SECTION 7

DRAINAGE CRITERIA

Estimating Storm Runoff

The Rational Method of estimating the storm runoff shall be utilized for all waterway openings equal to or less than 19 square feet. The proposed method for computing the storm runoff requiring a waterway opening greater than 19 square feet shall be approved by the Division of Highways. The Rational Method of design is as follows:

$$Q = C\, i\, A$$

Q   =Rate of runoff in cubic feet per second

where

C   =Weighted runoff coefficient (average of the coefficients assigned to the different types of contributing areas)

i   =Average rainfall intensity, inches per hour, for the selected frequency and for duration equal to the time of concentration.

A   =drainage area, in acres, tributary to the point under design.

The following values of C for various types of contributing areas shall be utilized in the solution of this method of design:

Values of Runoff Coefficients (C)
for Use in the Rational Method

Type of surface	Runoff coefficient (C) [1]
Rural Areas	
Concrete or sheet asphalt pavement	0.8-0.9
Asphalt macadam pavement	0.6-0.8
Gravel roadways or shoulders	0.4-0.6
Bare earth	0.2-0.9
Steep grassed areas (2:1)	0.5-0.7
Turf meadows	0.1-0.4
Forested areas	0.1-0.3
Cultivated fields	0.2-0.4

[1]
For flat slopes or permeable soil, use the lower values.
For steep slopes or impermeable soil, use the higher values.

coefficient

Type of surface	(C) 1

Rural Areas

Flat residential, with about 30 percent of area impervious	0.40
Flat residential, with about 60 percent of area impervious	0.55
Moderately steep residential, with about 50 percent of area impervious	0.65
Moderately steep built up area, with about 70 percent of area impervious	0.80
Flat commercial, with about 90 percent of area impervious	0.80

Contributing drainage areas shall be evaluated based on the fully developed land in accordance with the existing or proposed zoning.

For a more detailed explanation of the Rational Method of design see "Design of Roadside Drainage Channels" published by U.S. Department of Transportation, Federal Highway Administration.

Hydraulics of Drainage Channels

The Manning equation shall be utilized to express the flow of water in open channels. The Manning equation is as follows:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

where
- v = Velocity in feet per second (f.p.s.)
- n = Manning coefficient of channel roughness
- r = Hydraulic radius, in feet
- s = Slope, in feet per foot

The following values of n for various types of channel linings shall be utilized in the solution this equation:

<u>Manning Roughness Coefficients (n)</u>

1.   Closed Conduits

Reinforced Concrete Pipe   0.012
        Corrugated Metal Pipe or Pipe Arch
            Plain or Fully Coated (Unpaved)   0.024
            25% of circumference paved   0.021
            Fully Paved   0.012

2.   Lined Open Channels

    Concrete (float finish)   0.014
    Plain Rip Rap   0.040
    Grouted Rip Rap   0.035

3.   Swales and CHannels with Maintained Vegetation

    Grass (mowed to 2")   0.045
    Grass (good stand - 12" height)   0.09

4.   Street Gutters

    Concrete   0.012
    Asphalt   0.013

For additional values see "Design Charts for Open-Channel
    FLow" published by U.S. Department of Transportation,
    Federal Highways Administration.

<u>Drainage Criteria</u>

        -Culverts: 25 year storm frequency. Check the
            design to verify that the headwater elevation
            is no higher than 1'=0" below the edge of the
            proposed shoulder and that the resulting
            ponding is not detrimental to the highway or
            the adjacent property.

        -For the purpose of this section a culvert is a
            drainage facility which transports water from
            a natural drainage course.

        -See "Hydraulic Charts For The Selection of
            Highway Culverts", Hydraulic Engineering
            Circular No. 5, December 1965, U.S. Dept. of
            Transportation,   Federal   Highway
            Administration.

-Storm Sewers: 10 year storm frequency. Check the design to insure the hydraulic gradient is no higher than 1'-0" below the top of the inlet.

-See "Design of Urban Highway Drainage - The State of the Art," August 1979, U.S. Department of Transportation, Federal Highway Administration.

-Inlet Design (10 year Frequency): Check the design to insure the spread of water is no greater than 8 feet from the flow line of the curb. Maximum spacing of inlets is not to exceed 300'.

-Parallel Ditching: (5 year Frequency): Check the design to insure the depth of the water in the ditch is no higher than 0'-6" below the edge of the proposed shoulder.

-Drainage Design Report: A drainage design report containing the following minimum data shall be prepared for each project (See Figure X-1 to X-6 for various drainage charts that are to be used in the preparation of the drainage report):

a)   Time of Concentration
b)   Weighted runoff coefficient
c)   Design discharge
d)   Type and slope of drainage facility
e)   Spacing of drainage inlets
f)   Erosion protection
g)Drainage area plan to accompany storm drainage calculations.

General Requirements

-Culverts: Minimum pipe size - 18" diameter or equivalent. Minimum velocity (full flow) - 2 feet per second. Investigations shall be made to determine required protection at the outfall to prevent erosion of the outlet channel.

-Storm Sewers: Minimum pipe size (full flow) - 15" diameter or equivalent. Minimum velocity - 2 feet per second. Investigations shall be made to determine required protection at the outfall to prevent erosion of the outlet channel. Maximum spacing of clean out facilities is not to exceed 300'.

-Parallel Ditching: Investigations shall be made
    to determine if protection of the ditch from
    erosion is necessary. Maximum permissible
    velocities for channels lined with vegetation
    are as follows:

	Permissible Velocity Erosion Resistant Soils	(FPS) Easily Eroded Soils
Slope Range		
0-5%	5	4
5-10%	4	3

-Culvert and Storm Sewer Outlet Velocity: The
    treatment of the outlets for culverts and
    storm sewers to control erosion shall be in
    accordance, with "Hydraulic Design of Energy
    Dissipators For Culverts and Channels",
    Hydraulic Engineering Circular No. 14, U.S.
    Department of Transportation, Federal Highway
    Administration.

-Drainage Easements: Drainage easements are
    required for all drainage facilities not
    within a dedicated right of way. Underground
    drainage facilities will require 20 foot
    drainage easements. Open drainage facilities
    will require a width equal to the width of
    the facility at the proposed ground level
    plus 5 feet on either side of the facility.

-Offsite Easements: Drainage easements are
    required for offsite drainage facilities in
    order to provide positive drainage from the
    development to the point of discharge.
    Development drainage must be carried to a
    natural or existing drainage course. Copies
    of drainage easements are to be provided the
    Department and referenced on the record plan.

-Drainage Discharge: The outfall shall be carried
    to a point of positive outfall in order to
    prevent downstream flooding.