Maricopa Association of Governments-MAG

Flood Control

and

Drainage Design Standards and Criteria

1973

MARICOPA•ASSOCIATION•OF•GOVERNMENTS
1820 WEST WASHINGTON PHOENIX, ARIZONA 85007 (602) 254-6308

June 25, 1973

TO: Members of the Public Works Subcommittee

FROM: Don Pierson, Tempe, Subcommittee Chairman

SUBJECT: MEETING NOTIFICATION.

Friday, June 29, 1973, at 10:00 A.M.
MAG Office (Downstairs Conference Room 103)
1820 West Washington Street
Phoenix, Arizona

The next meeting of the Subcommittee for Flood Control Criteria will be at the above time and place. Enclosed is a compilation of data produced by Ross Blakley of Phoenix, regarding regulations of MAG members. These regulations will be reviewed at the meeting. Please call the MAG office if you have any questions regarding the meeting.

Enclosure

CITY OF PHOENIX
ARIZONA

DATE June 6, 1973

TO Mr. Don Pierson, Chairman MAG Subcommittee

FROM Mr. Ross Blakley, Phoenix Representative

SUBJECT Flood Control and Drainage Design Standards and Criteria.

The following is a summarization of flood control and drainage design standards and criteria presently being used by various MAG members.

RUNOFF DETERMINATION

1. Maricopa County - Applicable Soil Conservation Service Method or Rational Method as outlined in the Arizona Highway Department Hydroligic Design Manual.

2. City of Mesa - Not specified.

3. City of Phoenix - Soil Conservation Service Method, Rational Method or Modified Rational Method. Use SCS and/or Rational for everything except City trunk lines or laterals and inlets into these trunks. The modified rational, i.e., Q=0.9(Ia-0.2)Ai+0.8(Ia-fc)Ap, shall be used for pipes to ultimately be a part of City system.

4. City of Scottsdale - Arizona State Highway Standards.

5. City of Tempe - Rational Method for subdivisions which have less than 0.50% average gradient.

RAINFALL INTENSITY

1. Highway Department isopluvials.

2. Not specified.

3. Rainfall intensity curves (see attachment #1).

4. Highway Department isopluvials.

5. Rainfall intensity curves (see attachment #2).

TIME OF CONCENTRATION (S.C.S. Method)

1. Applicable S.C.S. charts (see attachments #3 and #4).

2. Not specified.

3. Applicable S.C.S. charts (see attachments #3 and #4).

4. Applicable S.C.S. charts (see attachments #3 and #4).

5. Not specified.

TO: Mr. Don Pierson
RE: Flood Control and Drainage Design Standards and Criteria.

TIME OF CONCENTRATION (RATIONAL AND MODIFIED RATIONAL METHODS)

1. See attachment #5 for overland flow. Manning Equation for wash, channel, street and pipe flow.

2. Not specified.

3. See attachment #6 for overland flow. Manning Equation for wash, channel and pipe flow. Compute street flow using attachment #7 as follows:

   a. Determine length and slope of existing or proposed street system.

   b. Assume 3 c.f.s. flow and determine gutter velocity using slope determined in "a."

   c. Time of concentration $(\text{min.}) = \frac{\text{distance(ft.)}}{\text{velocity(ft./sec.)}60}$

4. See attachment #5 for overland flow. Manning Equation for wash, channel, street and pipe flow.

5. See attachment #6 for overland flow. Manning equation for wash, channel and pipe flow. Use attachment #8 to determine gutter velocity. From velocity calculate time of concentration.

RUNOFF COEFFICIENTS (RATIONAL METHOD)

1. See attachment #7a.

2. Not specified.

3. See attachment #8a.

4. See attachment #7a.

5. See attachment #8a.

MANNING'S "n"

1. Not specified.

2. Not specified.

3. Precast concrete pipe - 0.012
   Cast-in-place concrete pipe - 0.012
   Asbestos cement pipe - 0.012
   Fully lined C.M.P. - 0.012
   Unlined C.M.P. (2 2/3" X 1/2" corrugations) - 0.024
   Unlined C.M.P. (3" X 1" corrugations) - 0.028
   Unlined C.M.P. (6" X 2" corrugations) - 0.033

TO: Mr. Don Pierson
RE: Flood Control and Drainage Design Standards and Criteria.

MANNING'S "n", continued

3. Gunnite lined open channel - 0.015
Concrete lined open channel - 0.013
Rip-rap lined open channel - 0.033
Street flow - 0.015

4. Not Specified.

5. Reinforced concrete pipe - 0.012
Fully lined C.M.P. - 0.012
Cast in place concrete pipe - 0.013

DESIGN FREQUENCIES

1. Flow through development - 50-year.

2. Overall drainage system - 10-year.

   Detention - 50-year.

   Inlet design - 50-year or capacity of sewer at that point, whichever is less.

   Streets to top of curb - 10-year. If cannot carry runoff in street, underground drain pipes shall be installed.

   Finish floors - 100-year.

3. Underground drainage faciltities which will ultimately connect to City of Phoenix storm sewer system - 1 or 2 years.

   Inlets which will ultimately connect to City of Phoenix storm sewer system - 2 year.

   Detention - 10-year.

   Street to top of curb - 10-year. If cannot carry runoff in street, pipes, detention faciltities and/or open channels must be constructed.

   Channels - 50-year with 1.5 feet of freeboard.

   Culverts and bridges - 50-year.

   Finish floors - 100-year.

4. Street to top of curb or storm drain - 10-year.

   Finish floors - 100-year.

TO: Mr. Don Pierson
RE: Flood Control and Drainage Design Standards and Criteria.

5. Overall drainage system - 1-year. If cannot carry runoff to top of curb, subsurface drainage facilities will be required.

   Detention facilities - 2-year.

DETENTION FACILITIES

1. Not specified.

2. Residential developments required to detain 50-year design storm of 24-hour duration. Street runoff as well as lot runoff shall be retained. Lot runoff may be held on the individual lots or in a detention basin. Street runoff must be held in a detention basin within each section of land or within the development. These basins may be used as parks if size and location is satisfactory.

   Required volume = CIA, where C = runoff coefficient, I = 50-year, 24-hour intensity from Arizona Highway Department isopluvial, and A = development area.

   Commercial and industrial developments are not required to provide detention if developer is willing to pay a set fee per acre of impermeable surface into fund set up specifically for the construction of storm sewer system.

   Detention basins are to be discharged into storm sewer system at controlled low rates.

3. Developments to detain runoff which they generate. Use two hour time of concentration to determine intensity and four hour base time. Required volume $\doteq \frac{1}{2}4CiA\ 3600 = 7200Q$, where C = runoff coefficient, i = 10-year, 2-hour intensity and A = area (see attachment #9).

   When outlet from development is not adequate, larger detention volumes may be required. Detention may be waived by the City Engineer for commercial developments of .5 acre or less when no drainage problem will be created by additional runoff from development.

   Storage volume may be attained by various means. In subdivisions, dished and/or bermed yards may be used as well as detention basins. Planned Area Developments may use shallow ponding in open areas and/or detention basins. Commercial developments may pond water in landscaped areas and/or parking lots. When absolutely necessary dry wells are another alternative.

   See attachment #10 for detention basin requirements.

4. Not specified.

5. Retarding facility required when the existing outlet does not have adequate capacity to receive the calculated runoff from the development. Required volume $= \frac{1}{2}4CiA\ 3600 = 7200\ Q$, where C = runoff coefficient, i = 2-year, 2-hour intensity and A = area (see attachment #9).

   See attachment #10 for detention basin requirements.

TO: Mr. Don Pierson
RE: Flood Control and Drainage Design Standards and Criteria.

MINIMUM FINISH FLOORS

1. Not specified.

2. Above runoff from 100-year storm.

3. Above runoff from 100-year storm. Minimum 14-inches above outfall or six inches above upstream curb, whichever is greater.

4. Above runoff from 100-year storm.

5. Not specified.

STORM DRAIN DESIGN

1. Not specified.

2. Existing main street storm sewer is to be analyzed for 10-year capacity. If it cannot carry 10-year runoff, sewer in development shall be designed to carry the difference.

   Storm sewer will be required to carry all water from arterial streets from a storm of 10-year return frequency.

3. Storm drain outlets shall be designed to function as a part of the ultimate drainage system. Where major trunk or lateral lines are not available, a temporary outlet and a future connection to the proposed trunk or lateral shall be provided.

   Hydraulic grade line shall be at the top of the pipe for the design flow.

   Storm drain inlets shall be City of Phoenix Standards and capacity shall be computed using attachments #11, #12, and #13.

   Connector pipe size shall be computed using attachment #14.

   Minimum pipe size shall be 12-inches. If 5 f.p.s. velocity cannot be attained, minimum pipe size shall be 18-inches.

   Manhole spacing shall be as follows:

   D 30" or less, 330 feet.
   D 33" to 45", 440 feet.
   D 48" or greater, 660 feet.

4. Not specified.

5. Storm drain pipe lines shall be designed to provide required capacity without surcharging the line. Storm drain outlets shall be designed to function as a part of the ultimate drainage system. Where major trunk lines are not available, a temporary outlet and a future connection to the proposed trunk storm drain shall be provided.

TO: Mr. Don Pierson
RE: Flood Control and Drainage Design Standards and Criteria.

STORM DRAIN DESIGN, continued

5. Catch basins shall be designed to intercept a minimum of 80% of the total runoff delivered to the point in the street where depth of street flow reaches curb height. Sump catch basins shall be designed to receive all of the runoff at the catch basin. In situations where catch basins are sumped, the Engineer will verify that overland relief is available without damage to buildings. Catch basin capacities shall be determined from attachment #15.

STREET DESIGN

1. Streets may be used to carry runoff which originates within the development. Runoff that originates outside the development cannot be carried in the streets.

2. Residential streets shall be designed to carry runoff from 10-year storm between curbs. When runoff exceeds street capacity, underground drain pipes shall be installed.

3. Drainage shall not be concentrated in any street beyond the point at which the street will run full to the top of the curb, for the runoff from a 10-year storm.

   Culverts or bridges shall be provided when flooding of a dip section inconveniences the public. Capacity for culverts shall be determined in accordance with Bureau of Public Roads Hydraulic Engineering Circular Nos. 5, 10 and 13.

4. Streets or storm drains must carry runoff from 10-year storm.

5. Underground facilities will be required when runoff exceeds street capacity.

   Valley gutters will not be permitted across midsection collector streets or arterial streets. Valley gutters will be discouraged on other collector streets.

REQUIRED SUBMITTALS

1. Location by survey of streams, washes, canals, irrigation laterals, private ditches, culverts, lakes or other features, including direction of flow and water level elevations, and location and extent of areas subject to inundation and whether such inundation is frequent, periodic or occasional shall be given on preliminary plats.

   All existing drainage patterns effecting the tract must be shown. For washes indicate size of tributary area, average dimensions of tributary area, average slope of tributary area, description of terrain and approximate cross sectional area of wash. Sheet flow must indicate the tributary area, slope and terrain description.

   A definite indication must be shown as to the handling of surface drainage as it leaves the tract and its effect on neighboring property.

TO: Mr. Don Pierson
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REQUIRED SUBMITTALS, continued

1. continued

For underground drainage indicate location of inlets, tentative size and line of pipe and the outlet grade.

2. Not specified.

3. A hydrology report and grading and drainage plans shall be submitted for each development. These calculations and plans shall be sealed by an engineer registered in Arizona.

The hydrology report shall include the following items:

a. Tributary drainage area map
b. Calculations for required and supplied detention capacities
c. Design flow and capacity calculations for proposed drainage system
d. For underground drainage: line drawing of proposed line showing inlets, inlet stations and pipe sizes, a drainage map which shows flows at points of concentration and clearly identifies the limits of each drainage area and runoff analysis in tabular form.

The grading and drainage plans shall include the following items:

a. Sufficient information to determine outfall for each family unit
b. Sufficient information to determine drainage patterns (both existing and final)
c. Sufficient information to determine that adjacent property drainage patterns will not be adversely affected
d. When grading and drainage plans do not show details for all drainage facilities, copies of the off-site plans showing the facilities shall be submitted with the grading and drainage material.

4. Drainage study stamped by an engineer registered in Arizona accompanied by a topo map with tributary area outlined.

5. Preliminary hydrology calculations accompanied by a drainage area map shall be submitted with all preliminary subdivision plats. Final drainage calculations with the drainage map revised as necessary, will be submitted with the construction drawings.

All Hydrology and Storm Drain submittals shall include the following items:

a. A contour map which shows the Qs at points of concentration, clearly identifies the limits of each drainage area, and indicates the location and size of any proposed storm sewers and catch basins.

TO: Mr. Don Pierson
RE: Flood Control and Drainage Design Standards and Criteria.

REQUIRED SUBMITTALS, Continued

5. continued

   b. Calculations using the rational method with a one-year design storm.

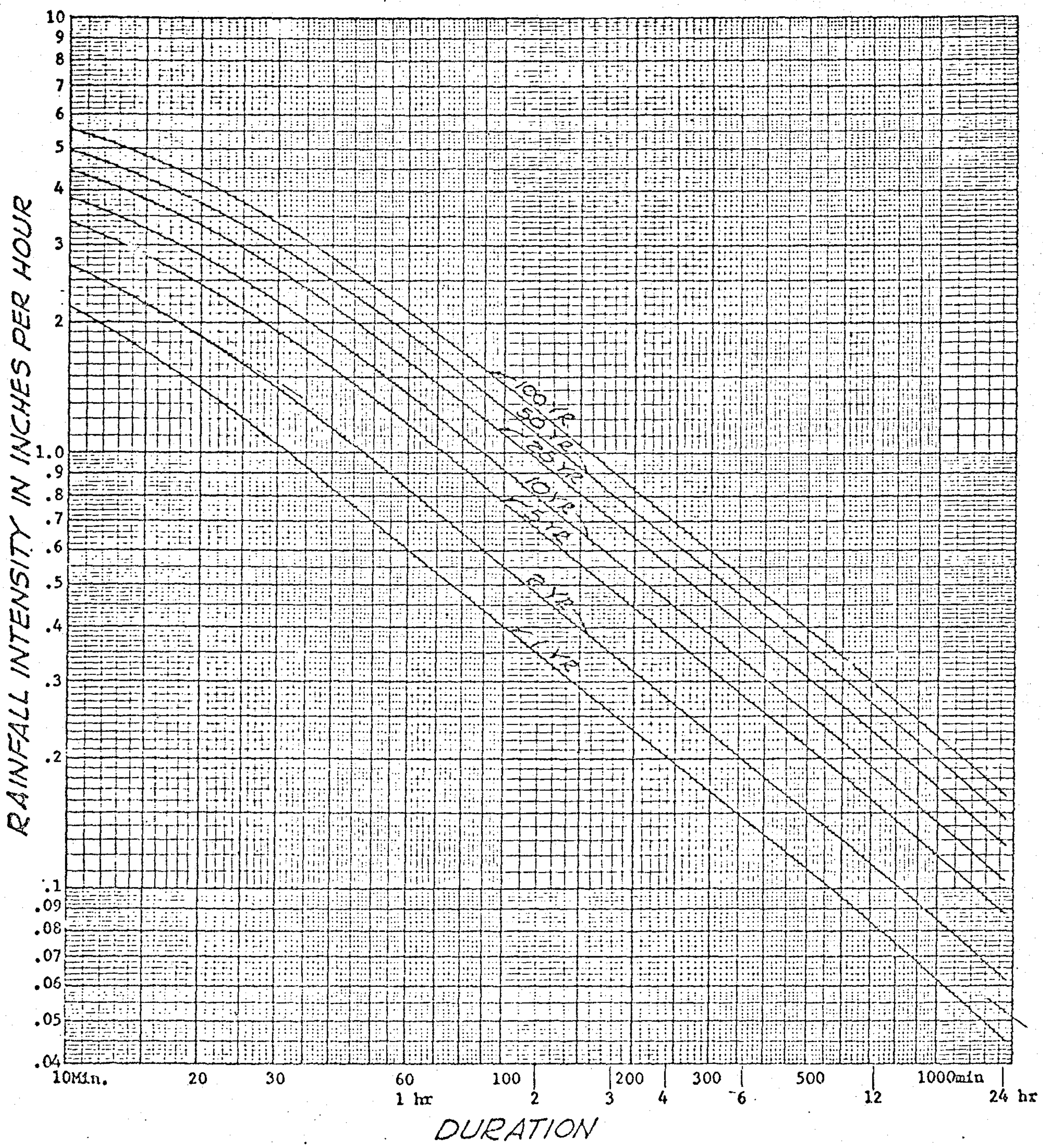
   c. A completed runoff analysis in tabular form.

   d. Retarding facility computations if onsite storage is required.

Ross D. Blakley

Ross D. Blakley
Civil Engineer III

RDB:jmh



RAINFALL INTENSITY-DURATION-FREQUENCY RELATION
FOR PHOENIX, ARIZONA
(Partial Duration Series)

Curves are based on methods of U.S. Weather Bureau Technical Papers Nos. 28 and 40 and rainfall data prepared by U.S. Weather Bureau Office of Hydrology for the Soil Conservation Service, March 1967

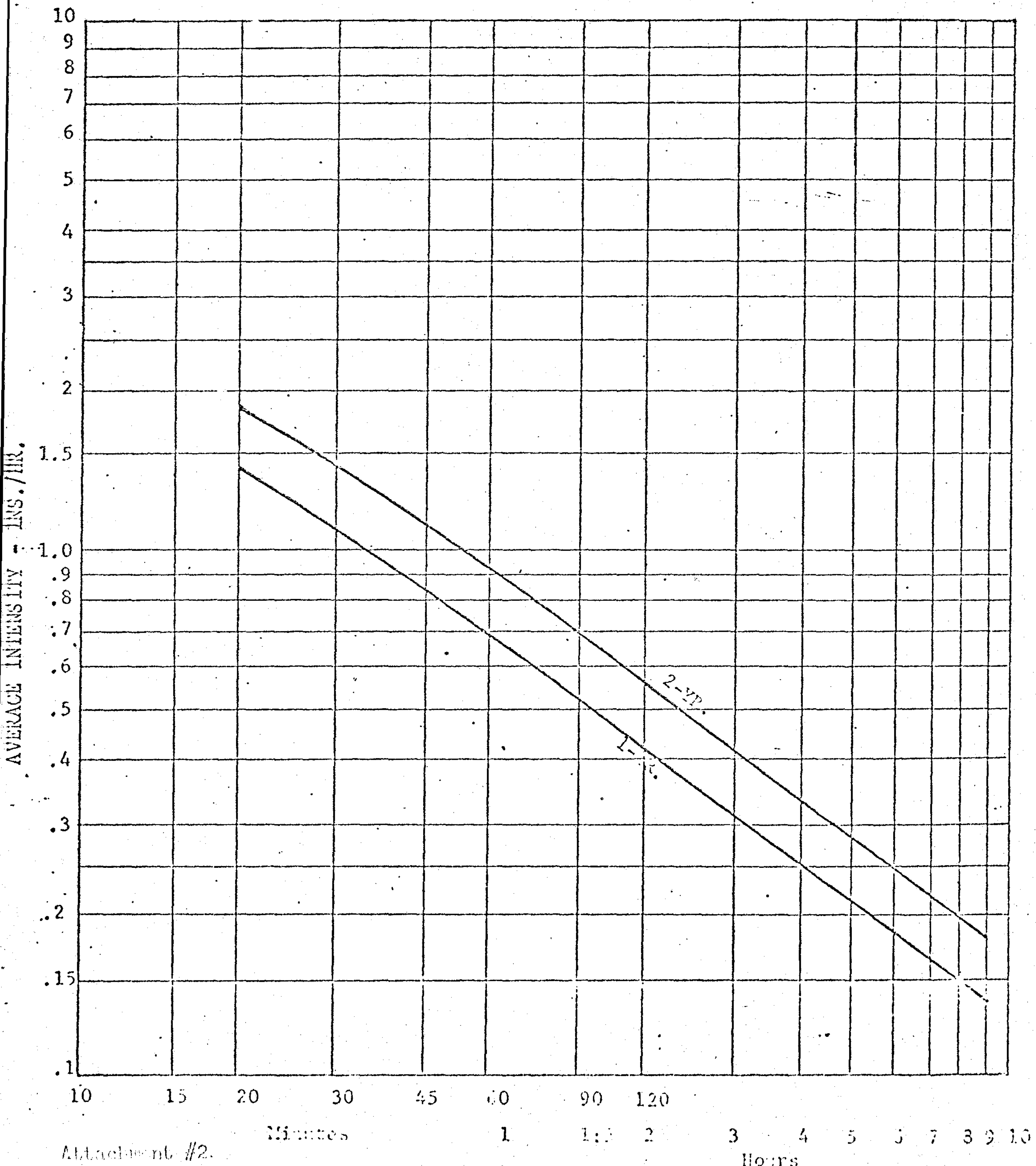
Attachment #1

2

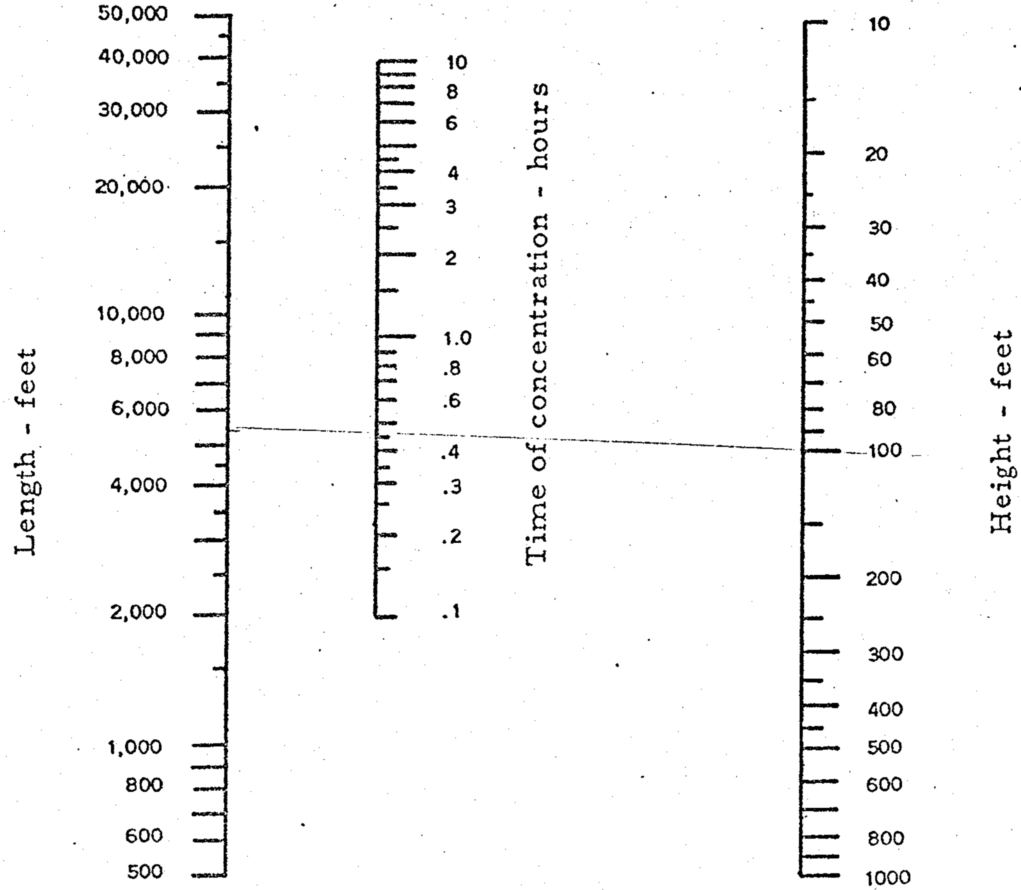
CHART III

INTENSITY - DURATION CURVES

BASED ON TECHNICAL PAPER NO. 40



Attachment #2.



$$T_c = \frac{L^{1.15}}{7700\ H^{.38}}$$

T_c = time of concentration - hours
L = length of drainage area - feet
H = elevation - feet

Fig. 2-7

TIME OF CONCENTRATION
FOR
DRAINAGE AREAS GREATER THAN 10 SQ. MILES

(A< 10 mi² if long and narrow)

Soil Conservation Service

Attachment #3

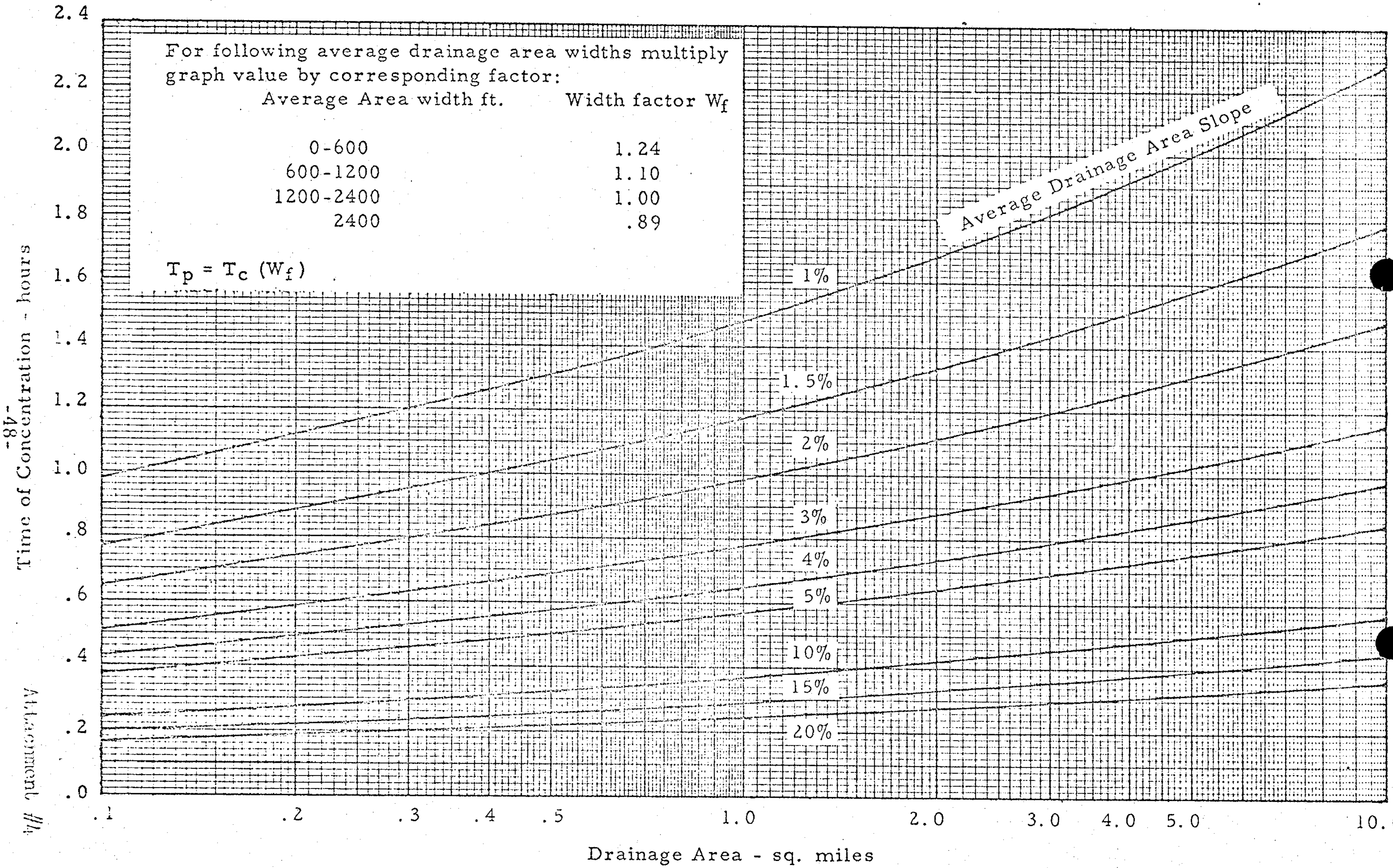
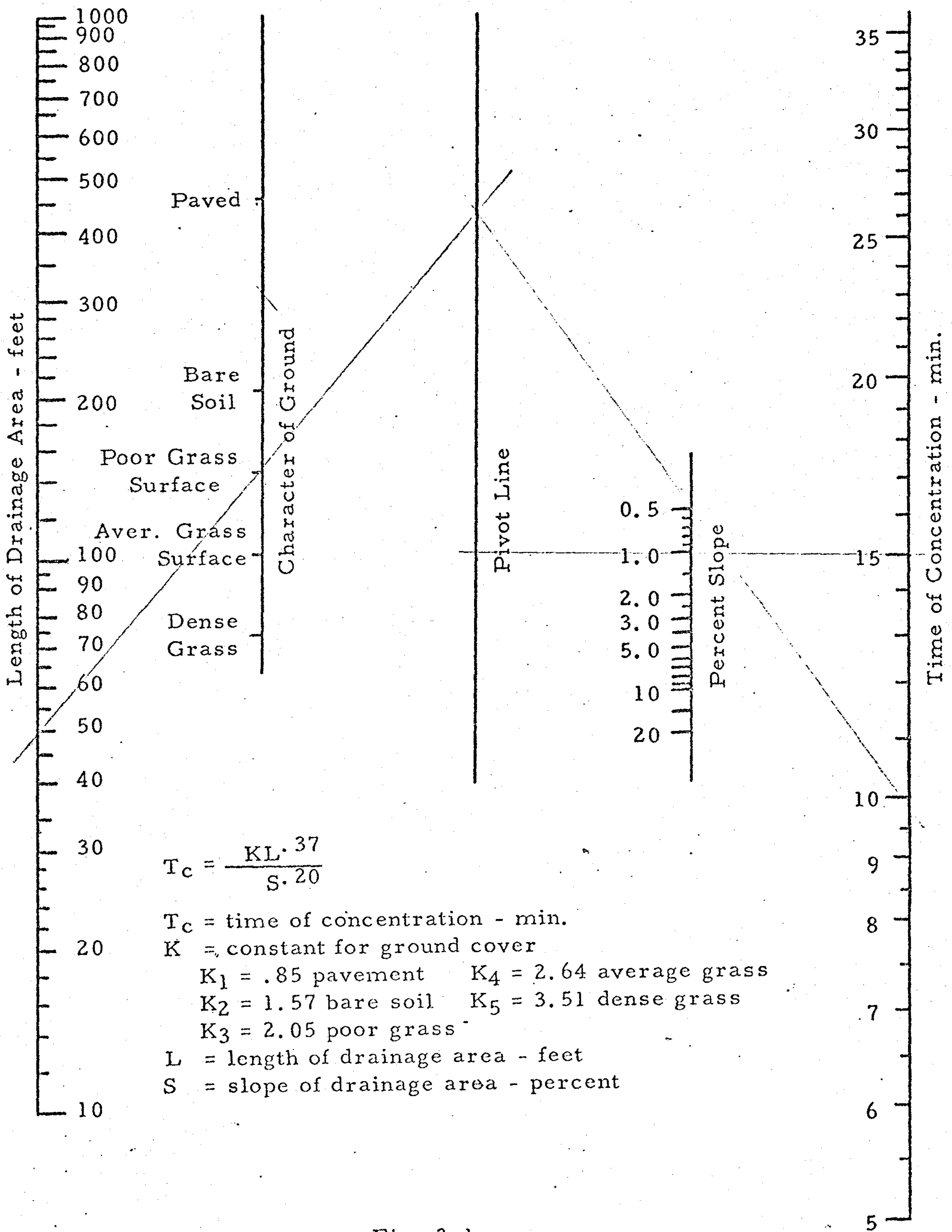


Fig. 2-5

TIME OF CONCENTRATION
FOR
DRAINAGE AREAS LESS THAN 10 SQ. MILES

Soil Conservation Service

Attachment #4



$$T_c = \frac{KL^{.37}}{S^{.20}}$$

T_c = time of concentration - min.

K = constant for ground cover

- K_1 = .85 pavement
- K_2 = 1.57 bare soil
- K_3 = 2.05 poor grass
- K_4 = 2.64 average grass
- K_5 = 3.51 dense grass

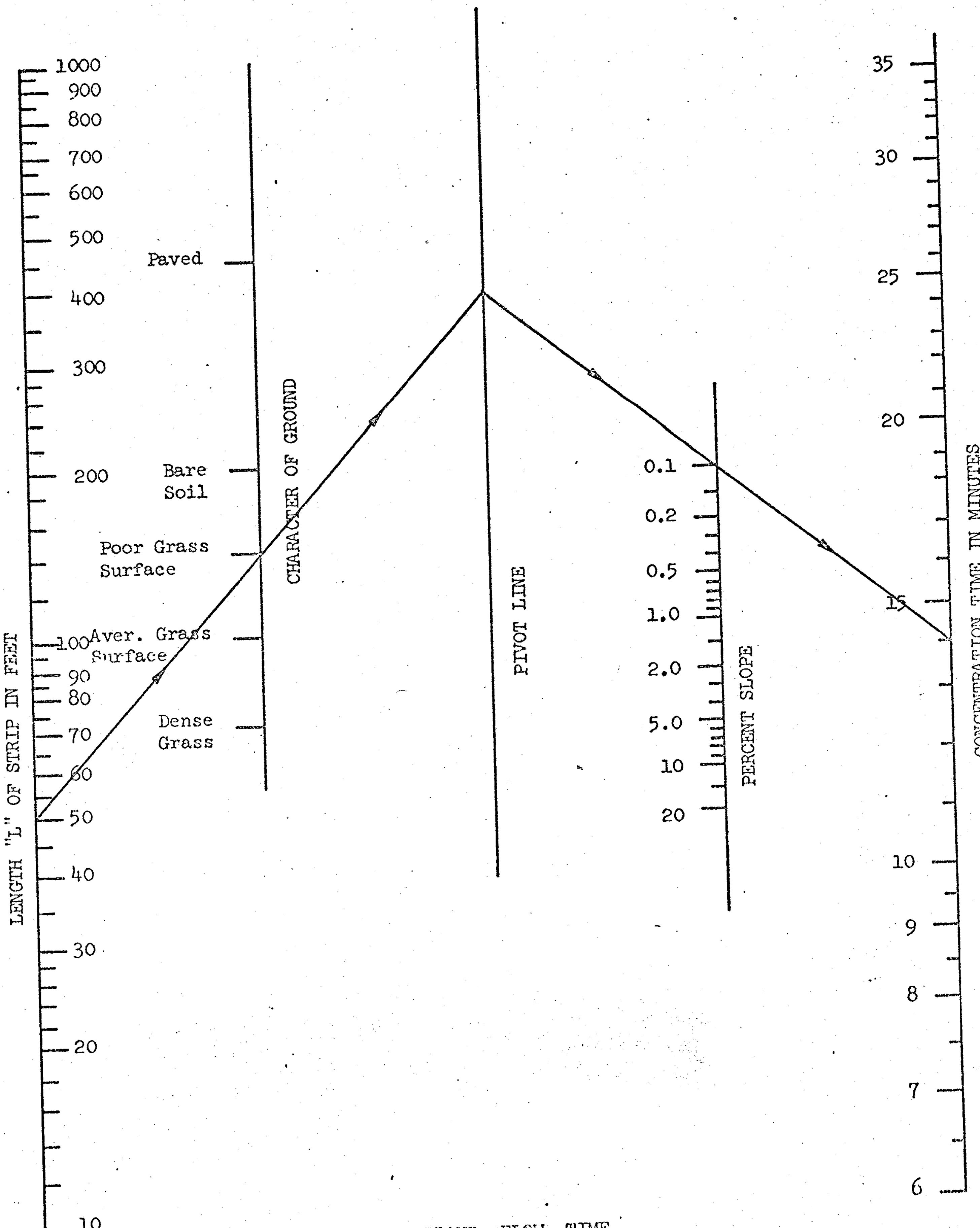
L = length of drainage area - feet

S = slope of drainage area - percent

Fig. 3-1

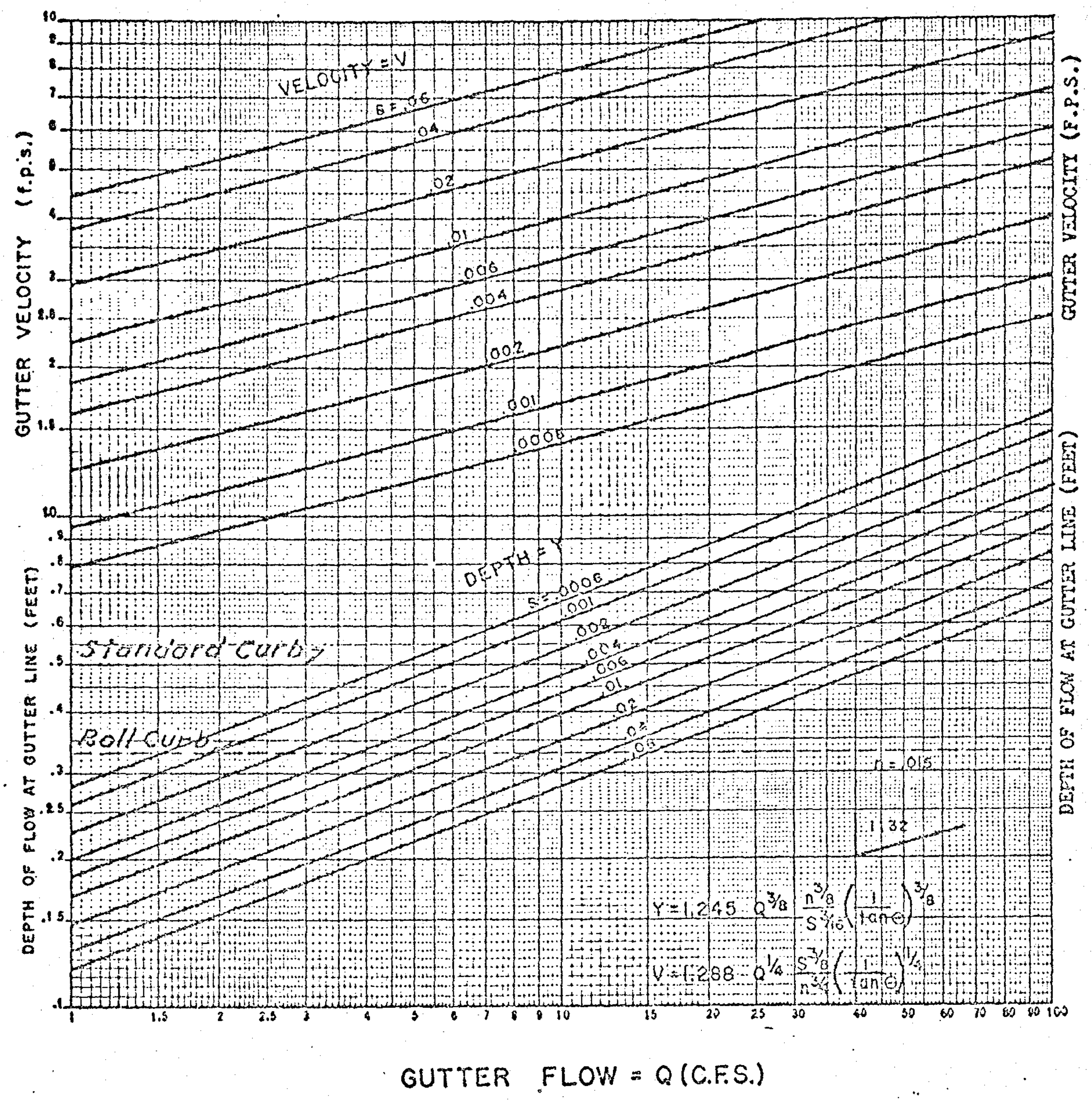
TIME OF CONCENTRATION
FOR
OVERLAND FLOW
(Rational)

Attachment #5



OVERLAND FLOW TIME

Attachment #6



$$Y = 1.245\ Q^{3/8} \frac{n^{3/8}}{S^{3/16}} \left(\frac{1}{\tan\Theta}\right)^{3/8}$$

$$V = 1.288\ Q^{1/4} \frac{S^{3/8}}{n^{3/4}} \left(\frac{1}{\tan\Theta}\right)^{1/4}$$

Attachment #7

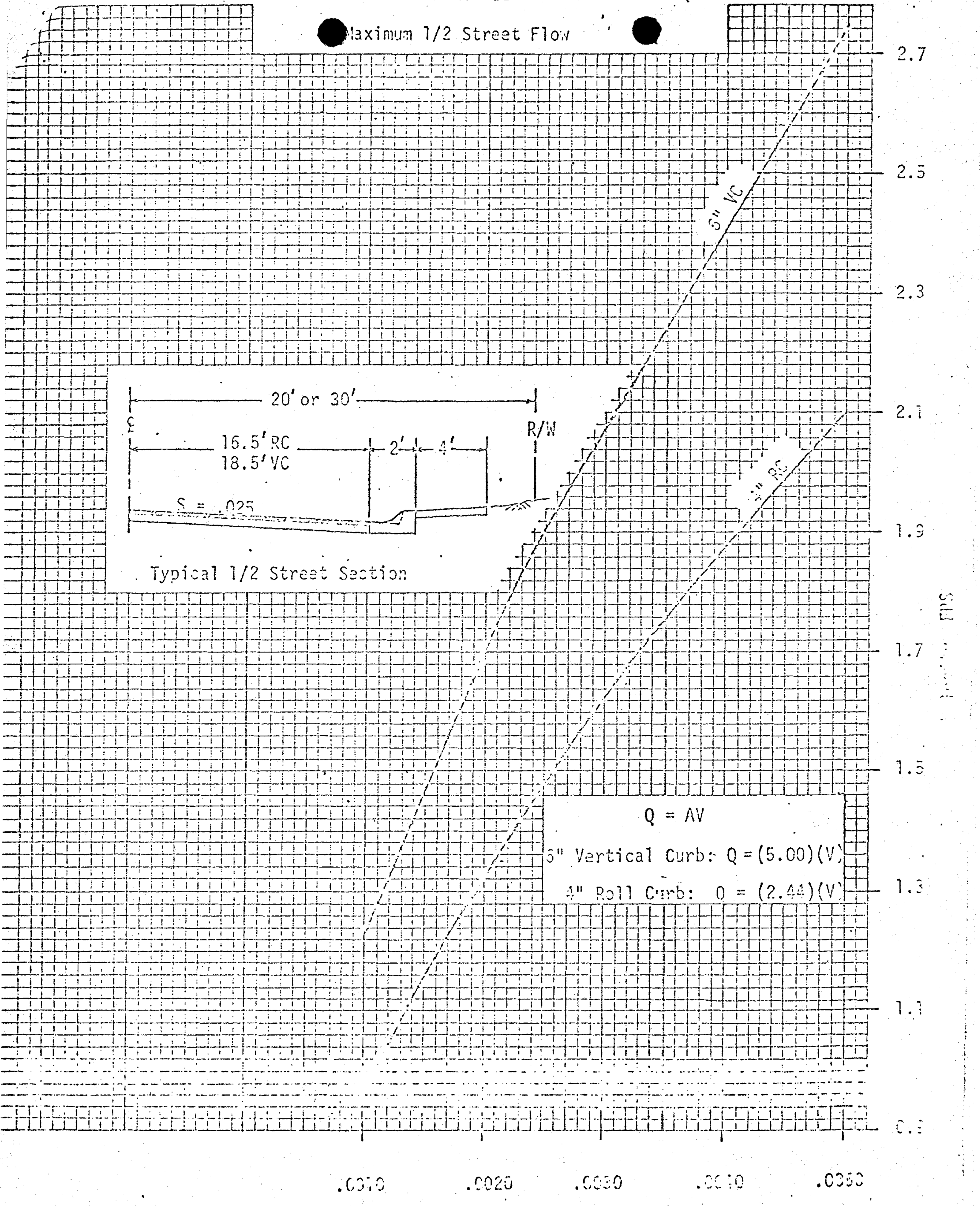
Streets	
Asphaltic	0.70 - 0.95
Concrete	0.80 - 0.95
Gravel roadways & shoulders	0.40 - 0.60
Industrial Areas	
Flat commercial - about 90% of area impervious	0.80
Heavy areas	0.60 - 0.90
Light areas	0.50 - 0.80
Business Areas	
Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential Areas	
Lawns - flat	0.05 - 0.15
- steep	0.15 - 0.35
Suburban areas	0.25 - 0.40
Single family areas	0.30 - 0.50
Multi-unit areas	0.40 - 0.60
Apartment areas	0.50 - 0.70
Parks, Cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.35

Fig. 3-3

VALUES OF RUNOFF COEFFICIENT C

Attachment #7a

CHART II



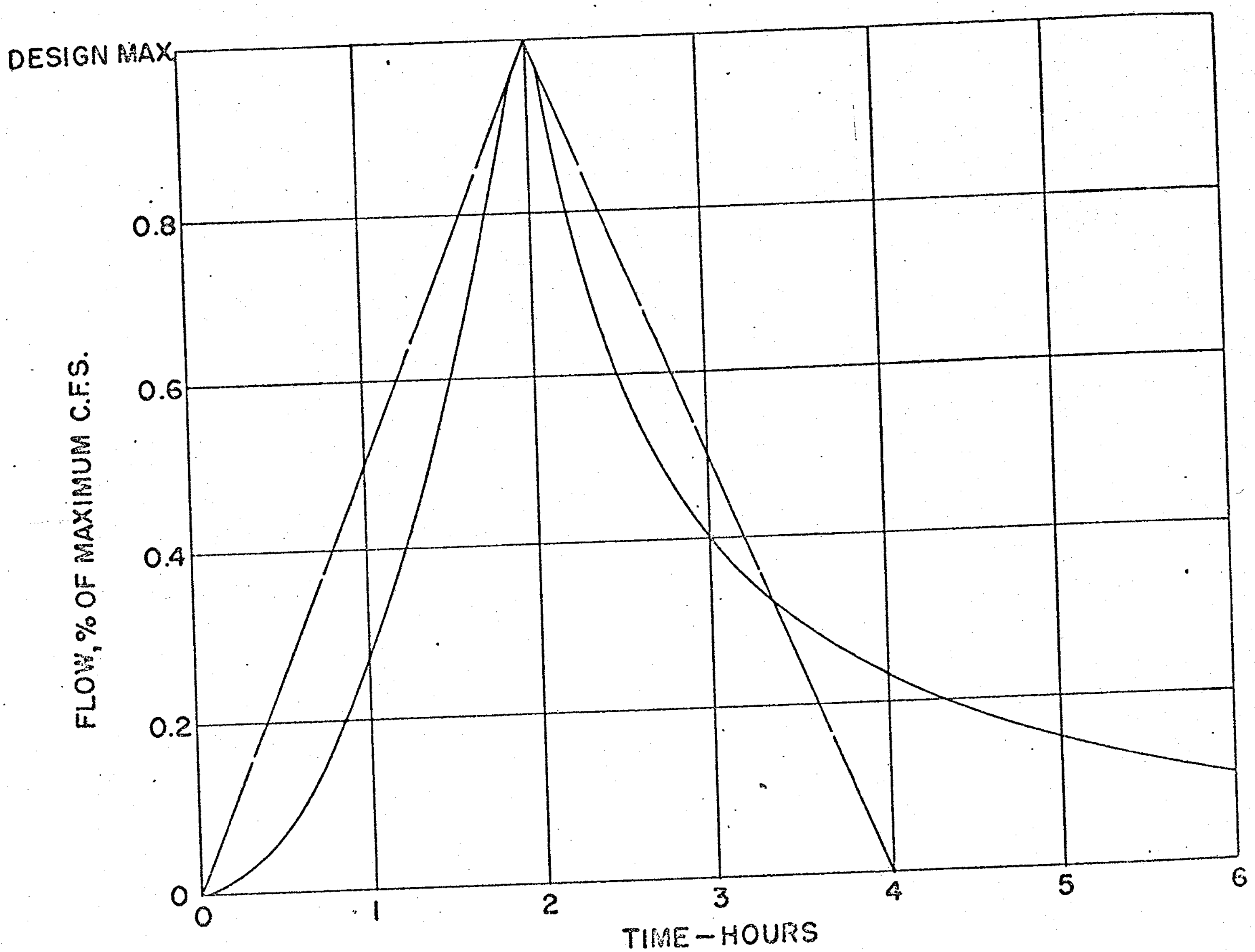
Attachment #8

RUNOFF CO-EFFICIENTS FOR USE WITH THE RATIONAL FORMULA Q=CIA

Land Use	"C" Value
Paved Street or Parking Lot	0.95
Commercial Areas	0.90
Residential Areas	0.30
Townhouses	0.45
Apartments	0.55
Parks & Grassed Areas (non-irrigation)	0.20
Railroad Yards	0.25
Undeveloped Desert	0.35

Attachment #3a

DETENTION BASIN VOLUME



1. RUNOFF COEFFICIENT C DEPENDS ON LAND USE.
2. USE THE 2 HOUR INTENSITY FROM PAGE 32.
3. USE Q=CIA (RATIONAL METHOD) OVER ENTIRE AREA.
4. RETARDING FACILITY CAPACITY: AREA UNDER TRIANGLE = 1/2(4)(Q)(3600) = 7200 Q ($FT.^3$).

Retarding Facility Design.

Retarding Facility shall be designed independently from the onsite storm drain system.

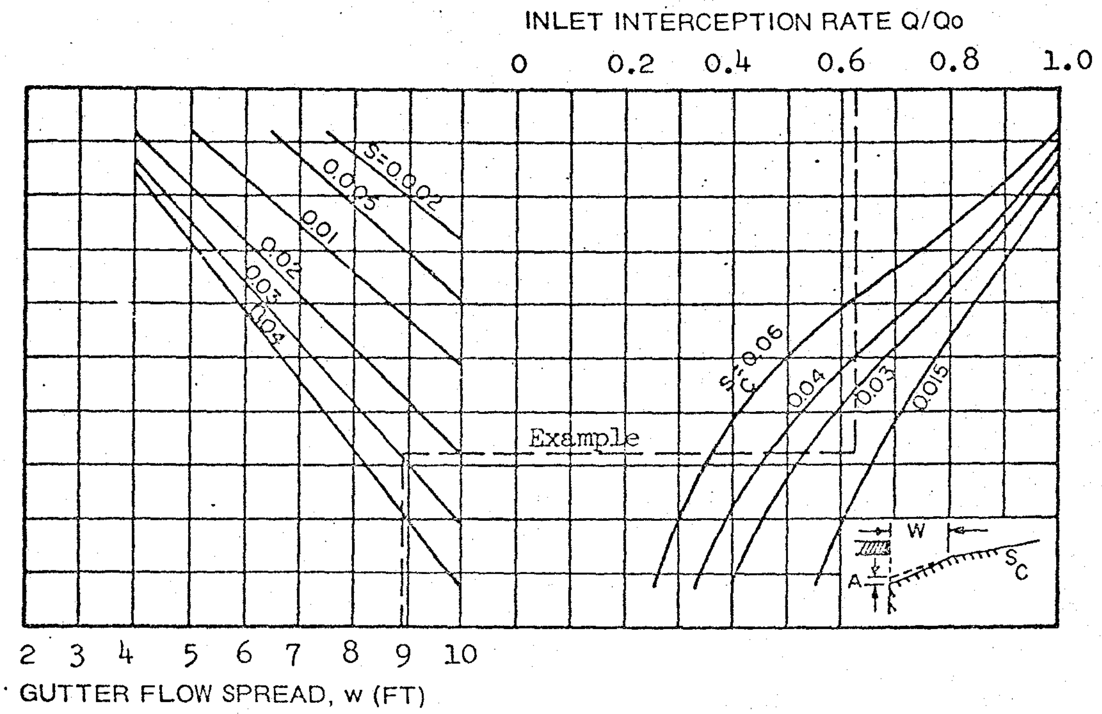
All areas of the Retarding Facility must slope toward pump inlet.

Minimum bottom grade = 1%; maximum side slope = 4:1.

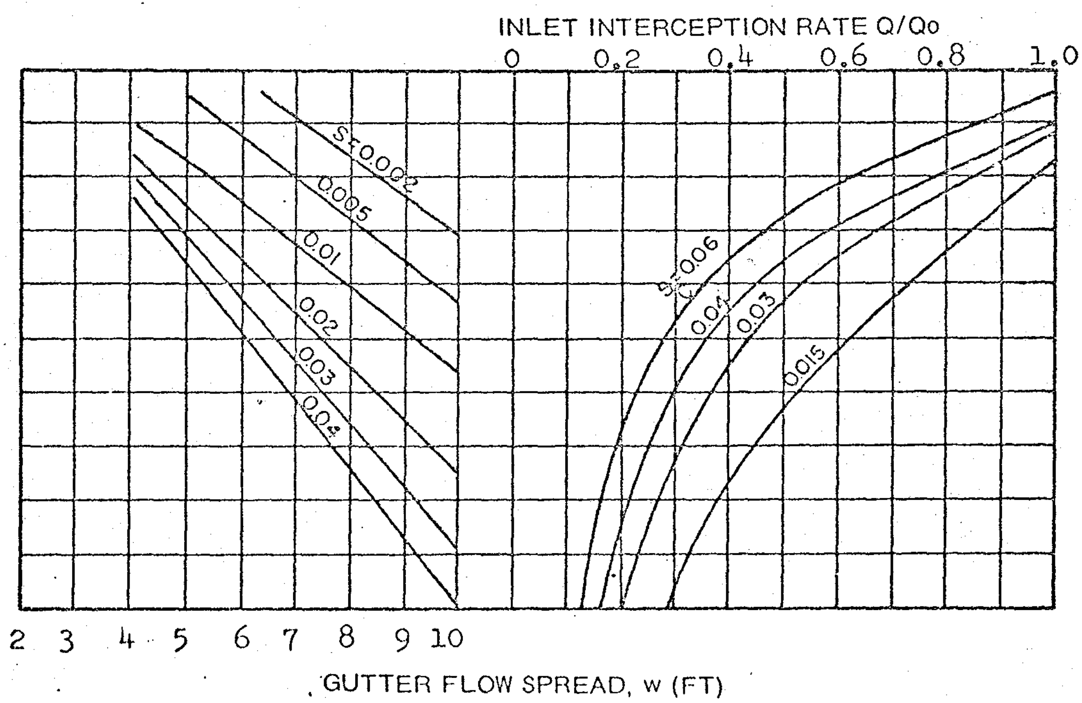
Retarding Facility areas where water depth may exceed 3 feet will be completely fenced with 5' chain-link equipped with a 12' driveway gate for access purposes.

Provide one-foot freeboard for Retarding Facility (from design water surface to lowest development gutter flow line) or 20% additional Retarding Facility capacity - whichever is greater.

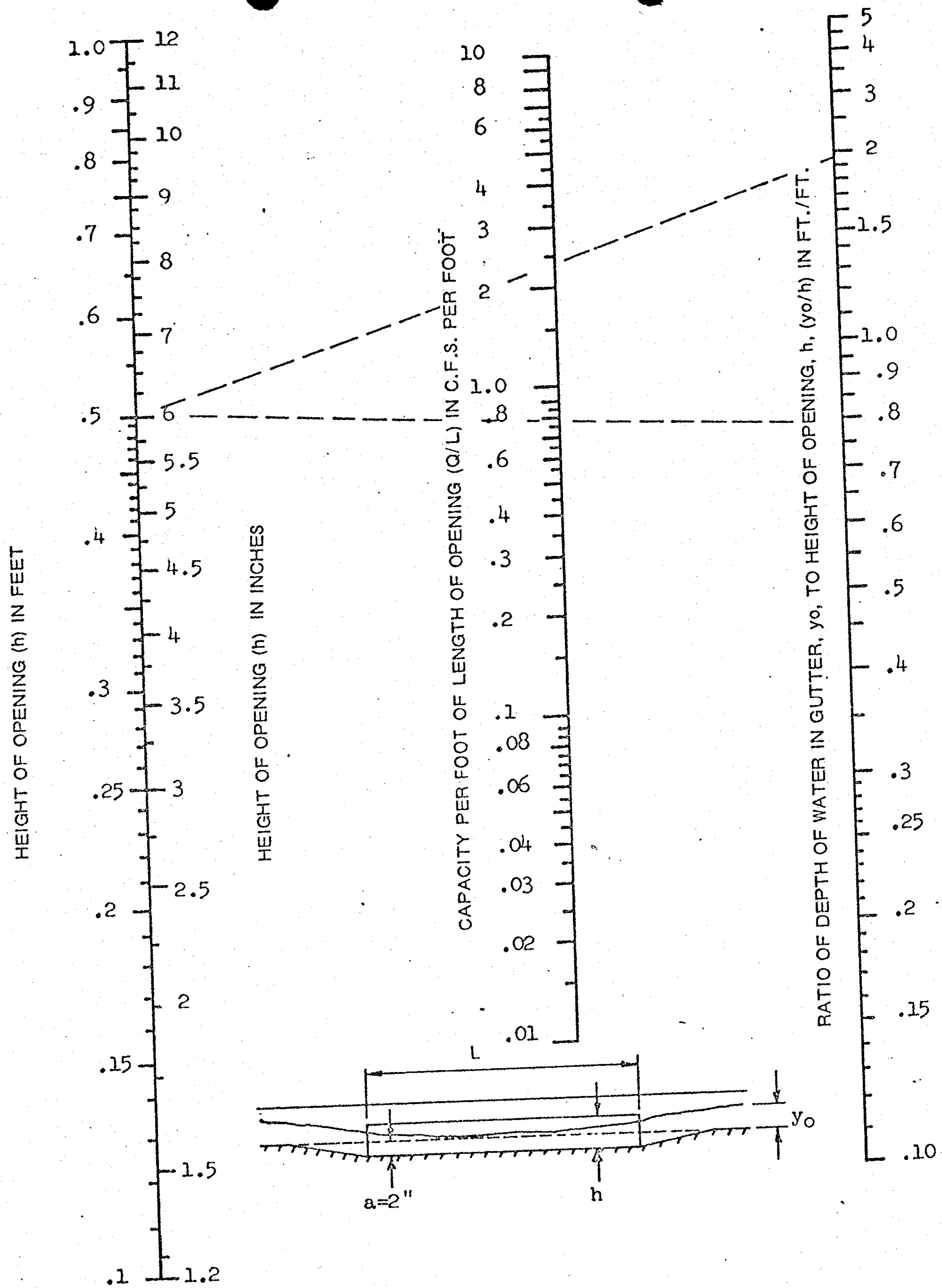
Overland relief must be available without damaging existing improvements.



CAPACITY OF CURB OPENING INLET ON CONTINUOUS GRADE W = 2 FT., a ≥ 2 IN., L = 10 FT., h ≥ yo

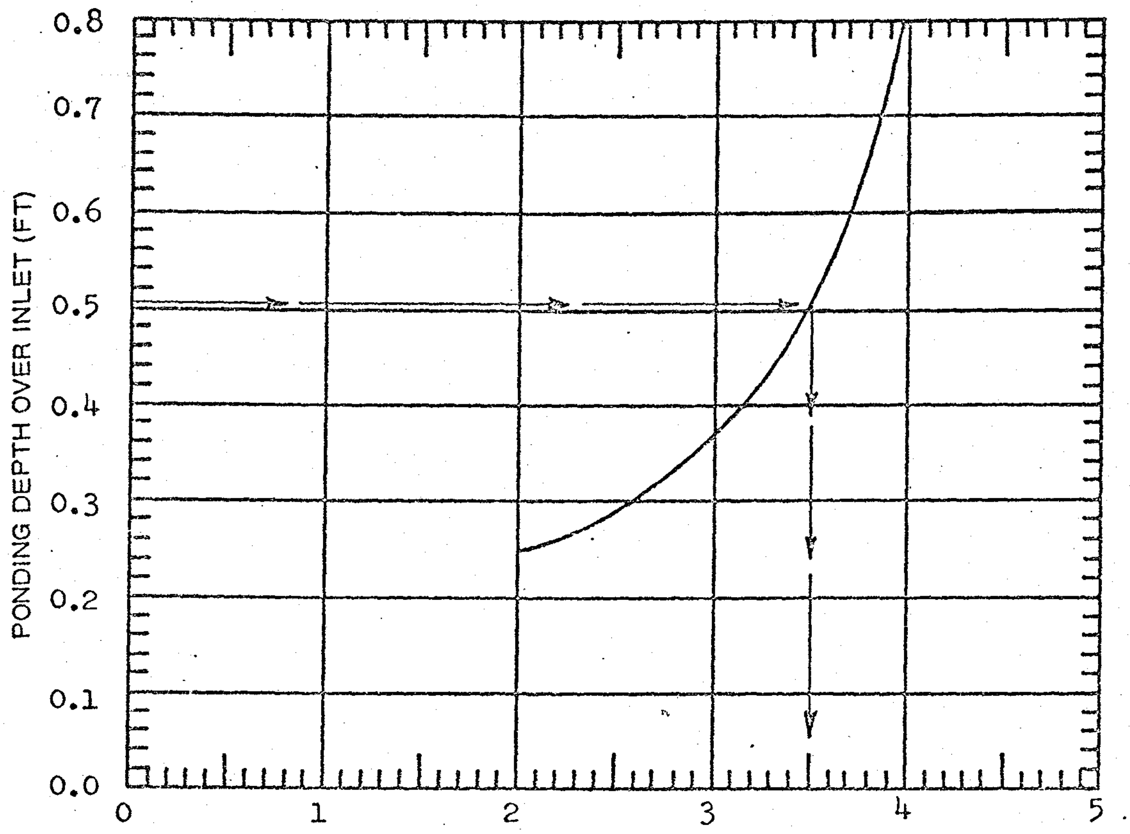


CAPACITY OF CURB OPENING INLET ON CONTINUOUS GRADE W = 2 Ft., a ≥ 2 In., L = 5 ft. h ≥ yo



NOMOGRAPH FOR CAPACITY OF CURB OPENING INLETS IN SUMPS, DEPRESSION DEPTH 2"

Attachment #12



FLOW INTO INLET PER SQ. FT. OF OPEN AREA (CFS/FT^2)

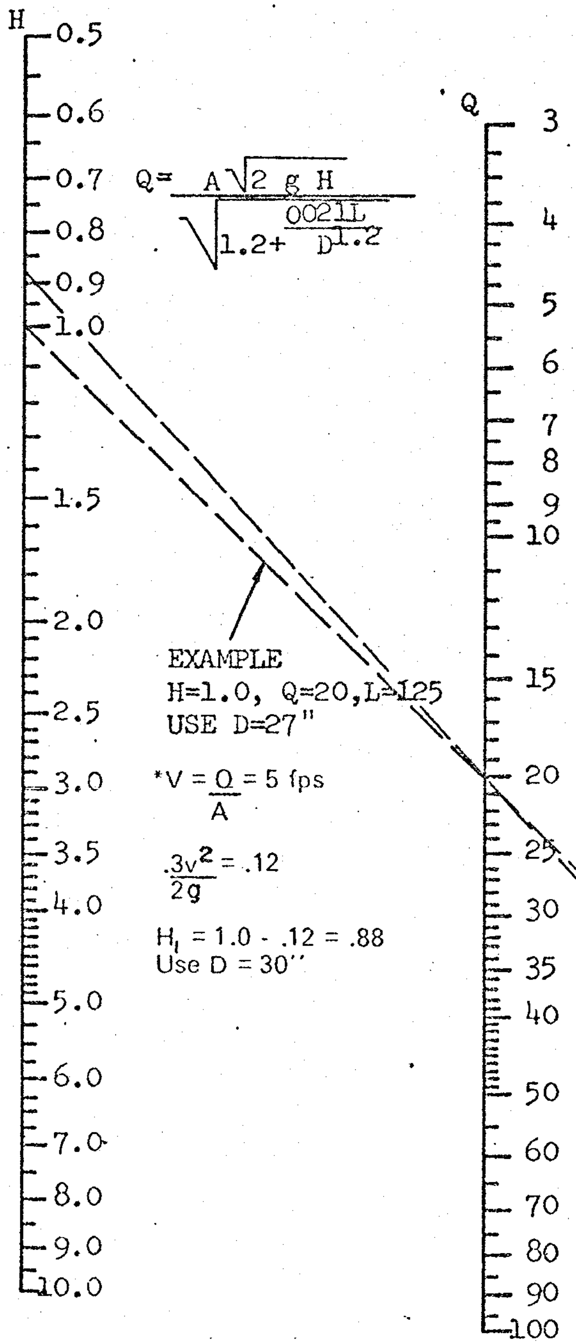
FIGURE 4 - 1. CAPACITY OF GRATED INLET IN SUMP

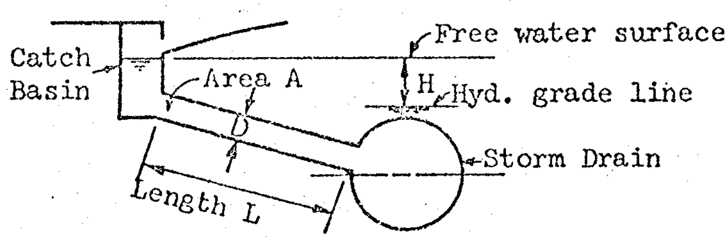
FOR TYPE 'E' AREA = 1.25 x 3.34 x 0.75 = 3.1 ft^2
FOR TYPE "F" AREA = 2.125 x 3.41 x 0.75 = 5.43

FOR TYPE "D" AREA = 2.125 x 3.34 x 0.65 = 4.6 ft^2
Capacity from this chart + 4' curb opening

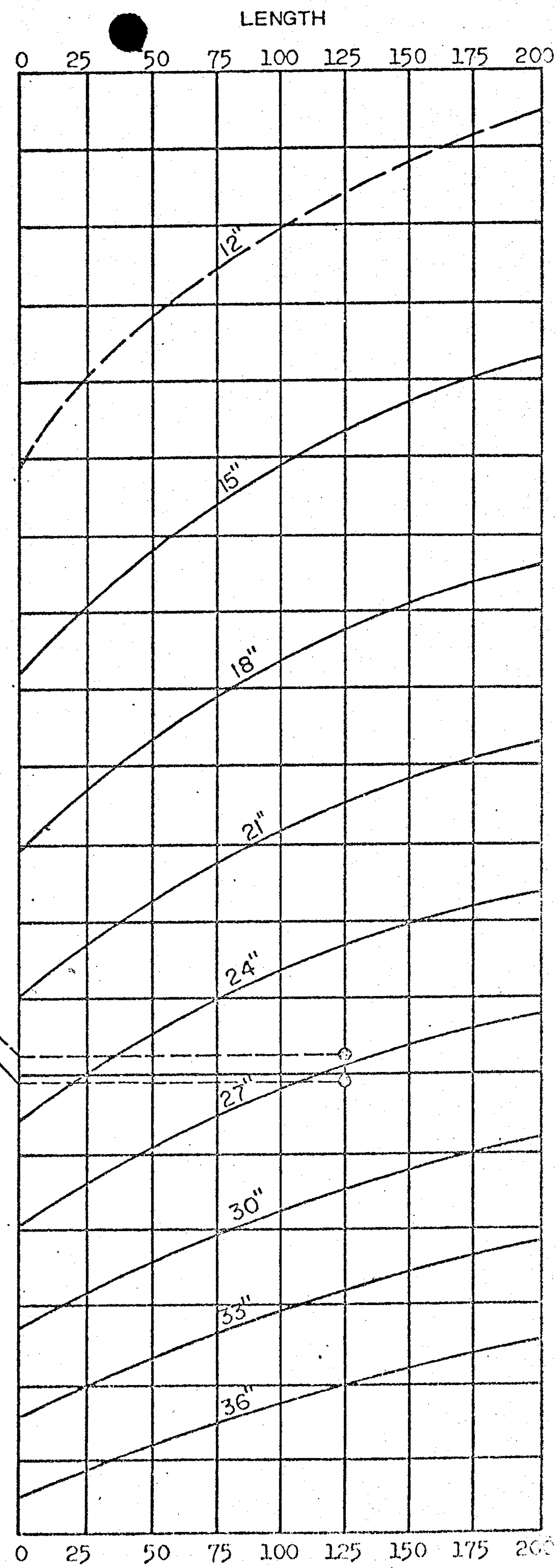
Attachment #13

DESIGN OF SPUN CONCRETE CONNECTOR PIPES FLOWING FULL





*Since City of Phoenix Inlets have higher entrance losses than allowed for in this chart the available head is adjusted as shown.

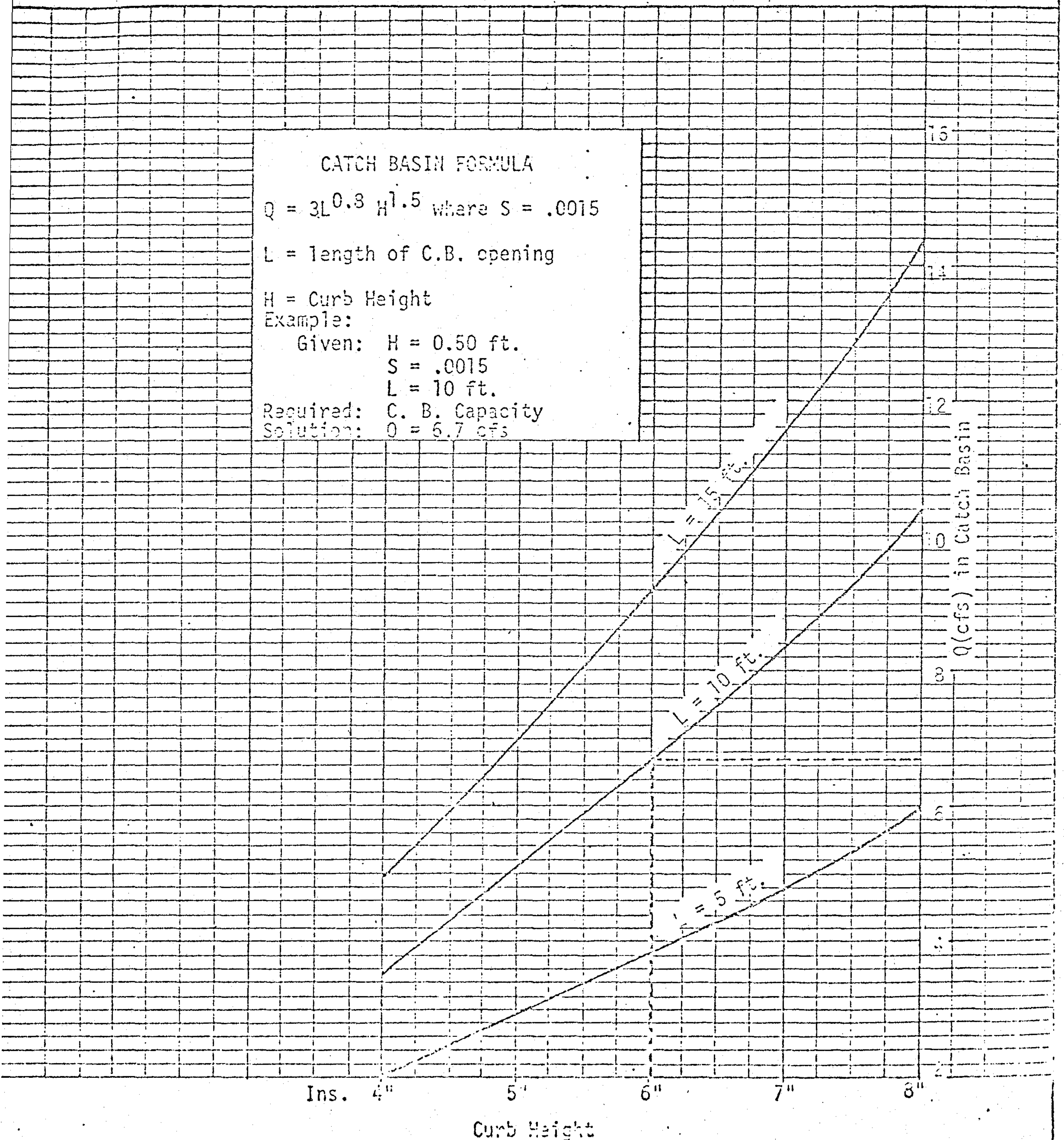


Attachment #14

CHART VI

Curb Opening Catch Basin Capacities

Design Curves



Note: Add 50% Q
for sump condition

Attachment #15