Plan Preparation Guide

Chapter 9

Drainage Structures – R.C. Box Culverts – Ditches - Gutters - Curbs

1. **Plans For Hydrology**

Submit to Hydrology all plans (including 'C') that have ditches with slopes greater than 3%.

Printouts of existing drainage elevations, outfall ditches and any other pertinent information will be supplied by SCDOT Road Design Section as needed.

The "view only" access will be provided by the Hydraulic Engineering Office in order to share files over the network. Design Groups will copy necessary files to the ftp server for on-call consultants.

Consultants should add new pipe, drainage structures, outfall ditches, and notes to plan sheets in red and new NPDES items and text in green. Department personnel will place those new additions onto the original plans upon return to Road Design.

Drainage design and NPDES can be shown on the same plan sheet. If sheets become cluttered, this can be reviewed on a per case basis.

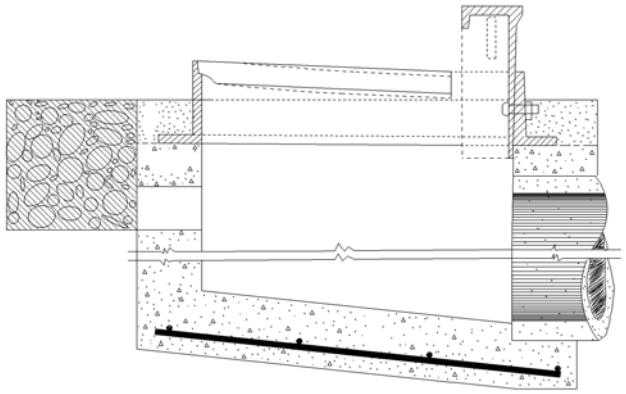
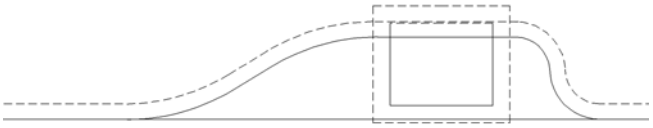
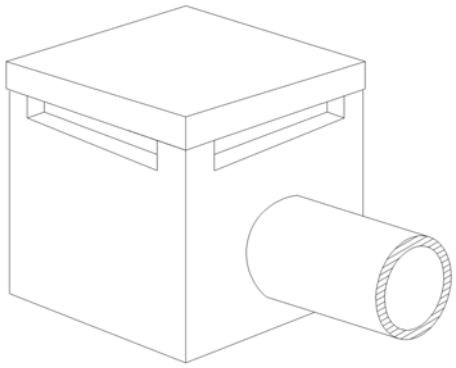
New drainage shall be included in the design file. Road Design will merge the hydrology information into their original design file.

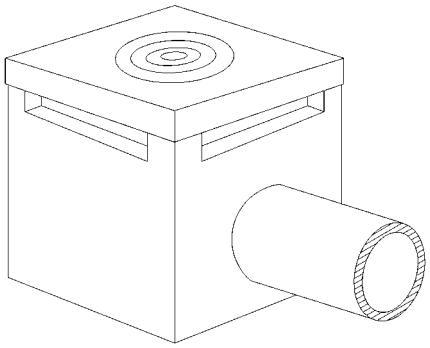
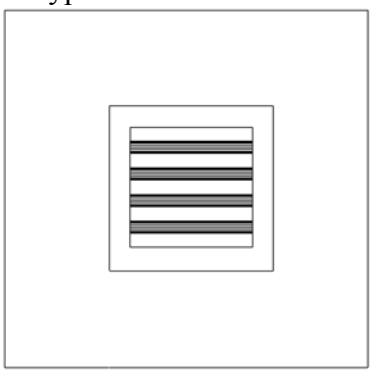
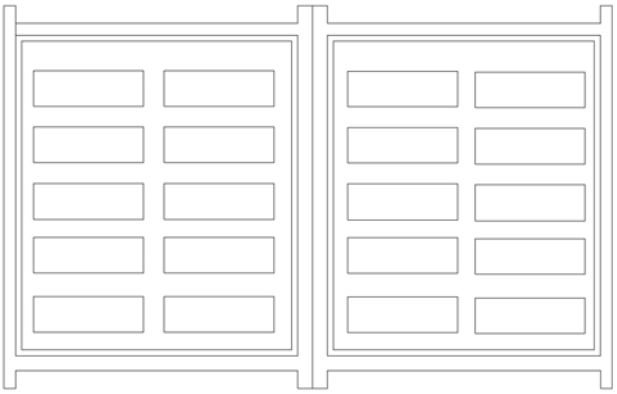
Design information for pipes and drainage boxes will be stored in a '.gdf' file created by the Hydraulic Engineering Office or on-call consultants. Road Design will use GEOPAK Drainage tools to automate the drafting. The current process of merging graphics will be eliminated.

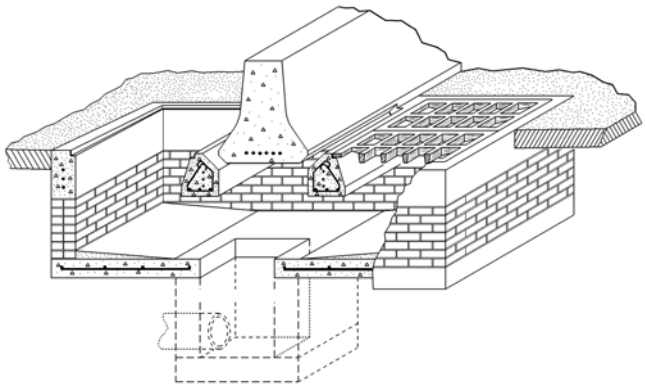
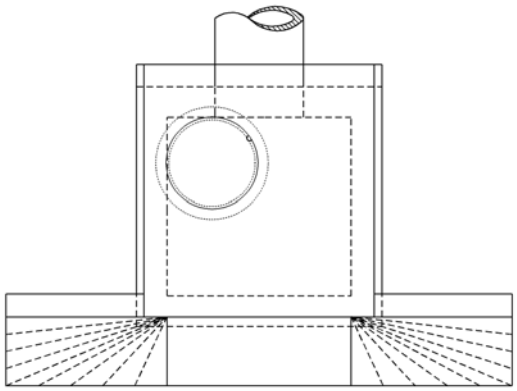
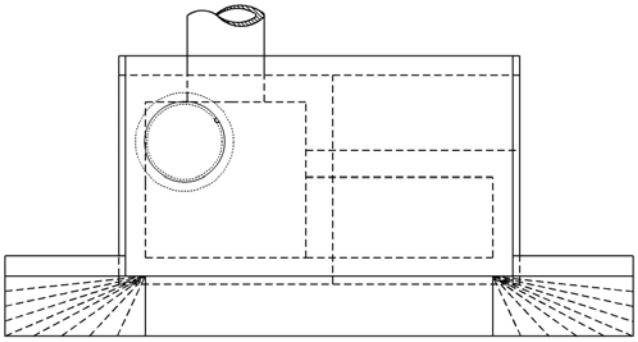
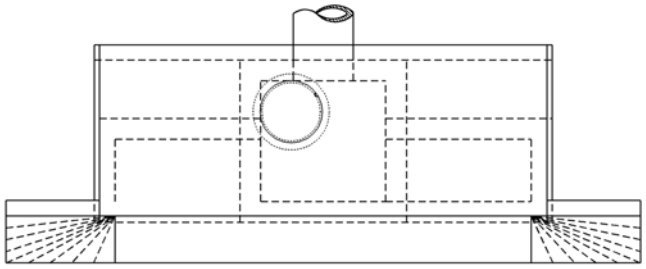
Pipe lengths will be automatically calculated along the pipe slope from center of box to center of box. The individual pipe length will be accurate to the nearest foot. The total pipe quantity will be rounded up to the nearest length divisible by four.

Drainage design changes can be made by the road designer as directed in Instructional Bulletin 98-10. Drainage notes can be updated automatically for most of the design changes. In lieu of using MicroStation, both the Hydraulic Engineering Office and Road Design must use GEOPAK Drainage to make all drainage design changes.

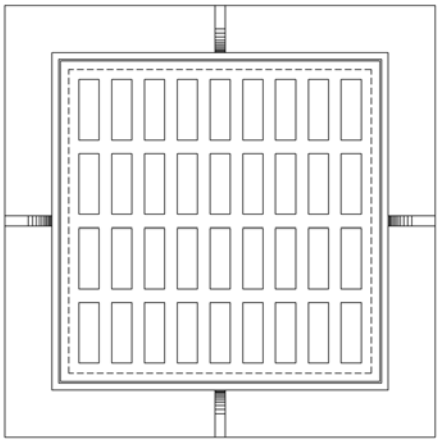
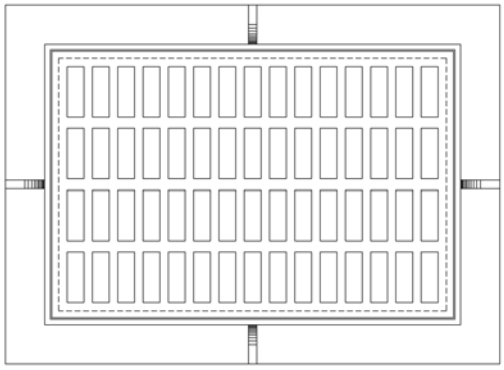
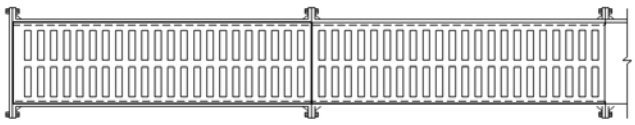
2. Catch Basin Types & Uses

Catch Basin	Uses
Catch Basin Type 1 	With Catch Basin Type 1 (Special) Concrete Medians Curbed grass medians On Curb and Gutter where it does not protrude into the travel lane Standard Drawing 719-1
Catch Basin Type 1 (Special)  See Catch Basin Type1 For Detail of Basin	Concrete Medians Curbed Grass Medians Standard Drawing 719-2
Catch Basin Type 9 	In Ditches Outside of the Clear Zone In Low Areas Outside of the Clear Zone Standard Drawing 719-3

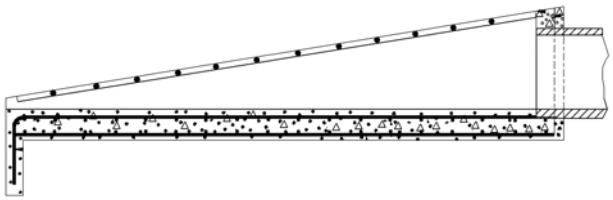
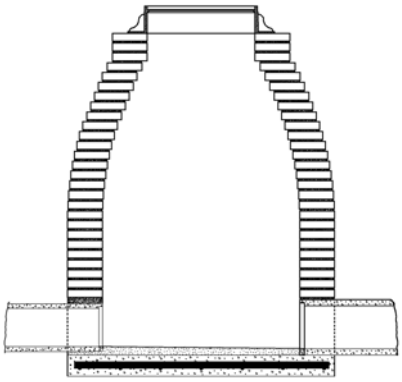
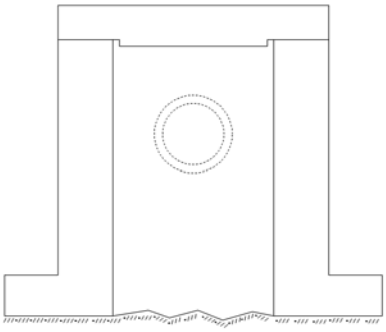
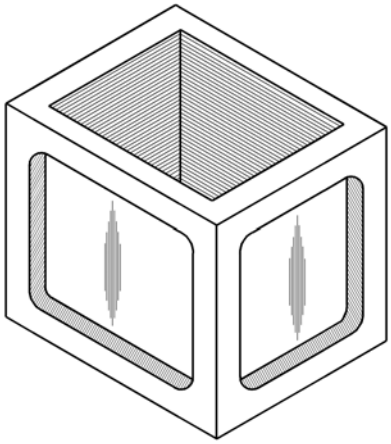
Catch Basin	Uses
Catch Basin Type 9-MH 	Same as Catch Basin Type 9 with Manhole added for access Standard Drawing 719-4
Catch Basin Type 12  See Catch Basin Type1 For Detail of Basin	Median ditches on dual lane roadways w/earth median Side ditches on controlled access highway Low areas on controlled access highways where there should be no pedestrian traffic Standard Drawing 719-6
Catch Basin Type 14 	In ditches, valleys or low areas where pedestrian traffic is unlikely Not to be used in the path of vehicular traffic Standard Drawing 719-8

Catch Basin	Uses
Catch Basin Type 15 	In paved medians with concrete median barrier May be a single basin or double basin Standard Drawing 719-9
Catch Basin Type 16 	On curb and gutter roadways On valley gutter sections with the face of catch basin at the back of paved lip NOTE: Deduct 10' from curb and gutter length. Standard Drawing 719-18
Catch Basin Type 17 	On curb and gutter roadways On valley gutter sections with the face of catch basin at the back of paved lip NOTE: Deduct 14' from curb and gutter length. Standard Drawing 719-19
Catch Basin Type 18 	In low point on curb and gutter roadway In low point on valley gutter sections with face of catch basin at the back of paved lip NOTE: Deduct 18' from curb and gutter length. Standard Drawing 719-20

3. Drop Inlet Types & Uses

Drop Inlet	Uses
Drop Inlet (24” x 24”) 	Yard Drains Standard Drawing 719-10
Drop Inlet (24” x 36”) 	Yard Drains Paved and earth valleys Low areas where pedestrian traffic is likely Also Standard Drawing 719-10
Drop Inlet (Multiple Grate) 	In driveways and parking lots where water is to be intercepted over a wide area Standard Drawing 719-11

4. Pipe End Structure & Uses

Pipe End Structure	Uses
Pipe End Structure 	Pipe ends facing traffic within the clear zone Standard Drawing 719-15
Manhole 	For access to pipe for maintenance Standard Drawing 719-3
Springbox 	For drainage of underground springs within roadway Standard Drawing 719-14
Precast Concrete Drainage Box 	For use when normal boxes are not acceptable Standard Drawing 719-17

5. Catch Basin Spacing for Types 16, 17, & 18 Catch Basin

CATCH BASIN TYPE 16 - Standard curb type basin, 4' inlet opening.

CATCH BASIN TYPE 17 - Expanded curb type basin, 8' inlet opening. May be used when the volume of water exceeds the capacity for Catch Basin Type 16.

CATCH BASIN TYPE 18 - Curb type basin, 8' inlet opening. Used primarily for low points.

INSTRUCTIONS FOR USE OF THE SPACING TABLES

A. Find the correct region from the outline map.

B. Select the correct chart for the Catch Basin Type and pavement cross slope.

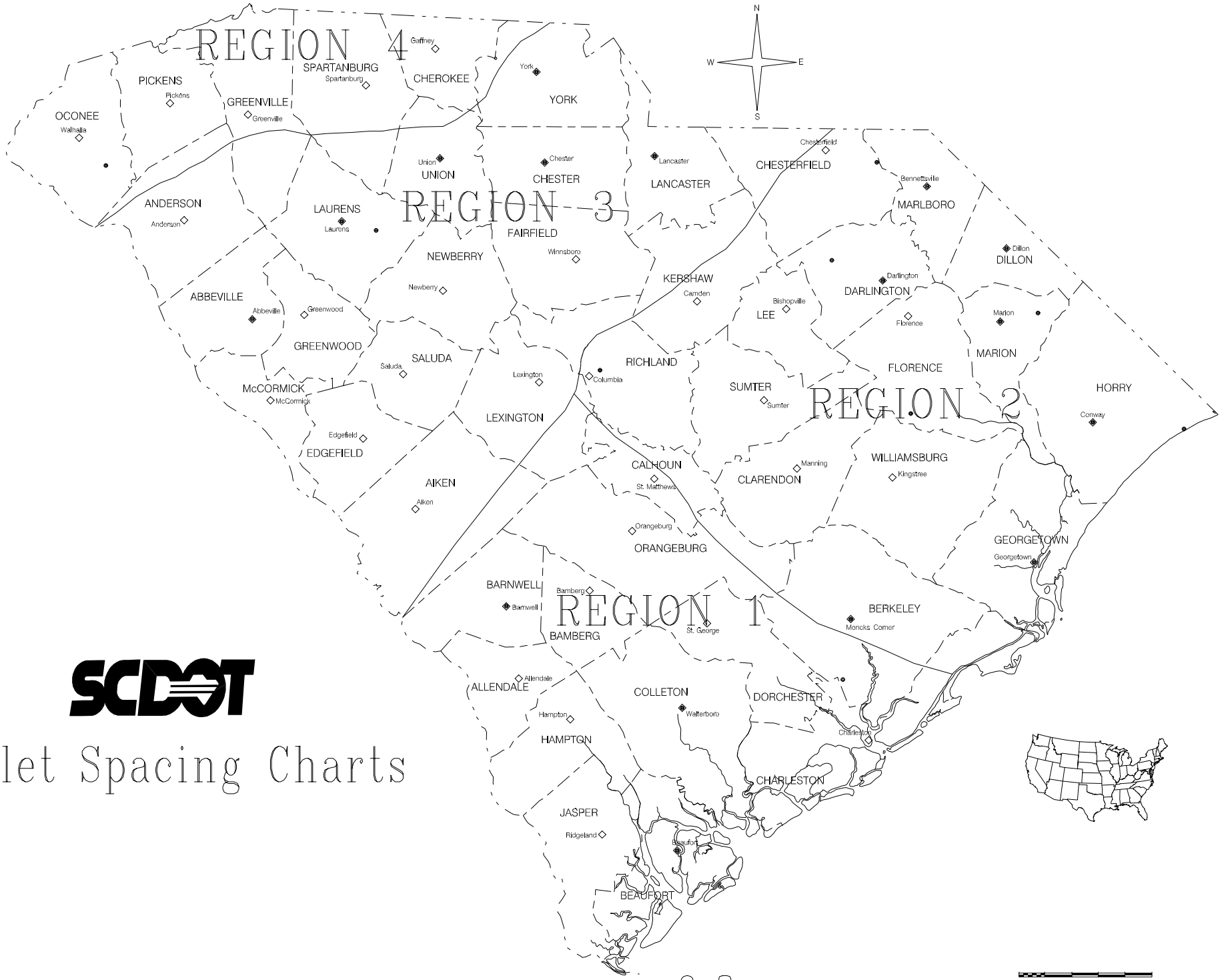
C. Find the proper road grade along the bottom of the chart and place a vertical line to intersect with the correct drainage profile. Use the inset if the grade is less than one (1) percent.

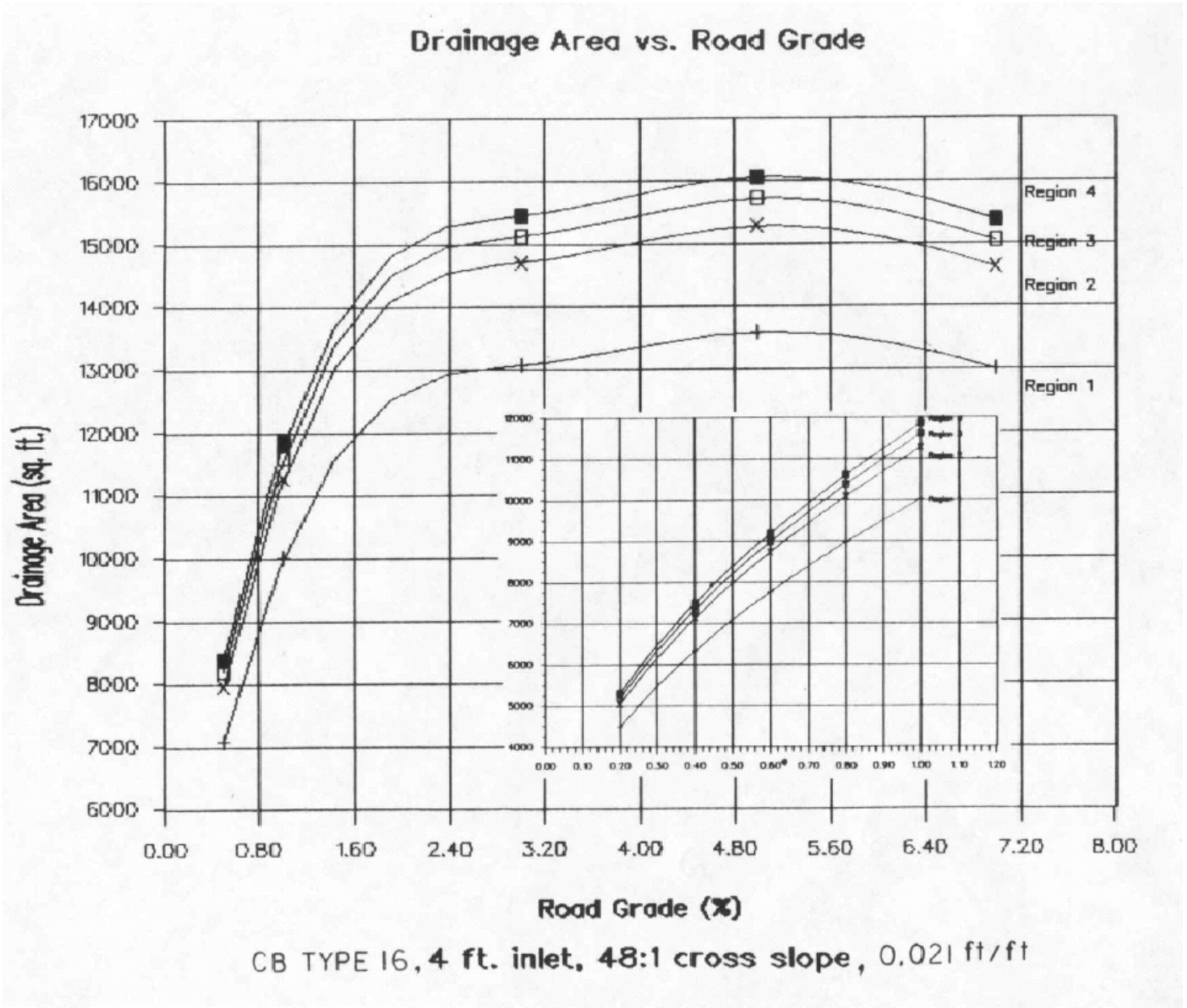
D. Place a horizontal line from the vertical intersection to the left column and read the drainage area.

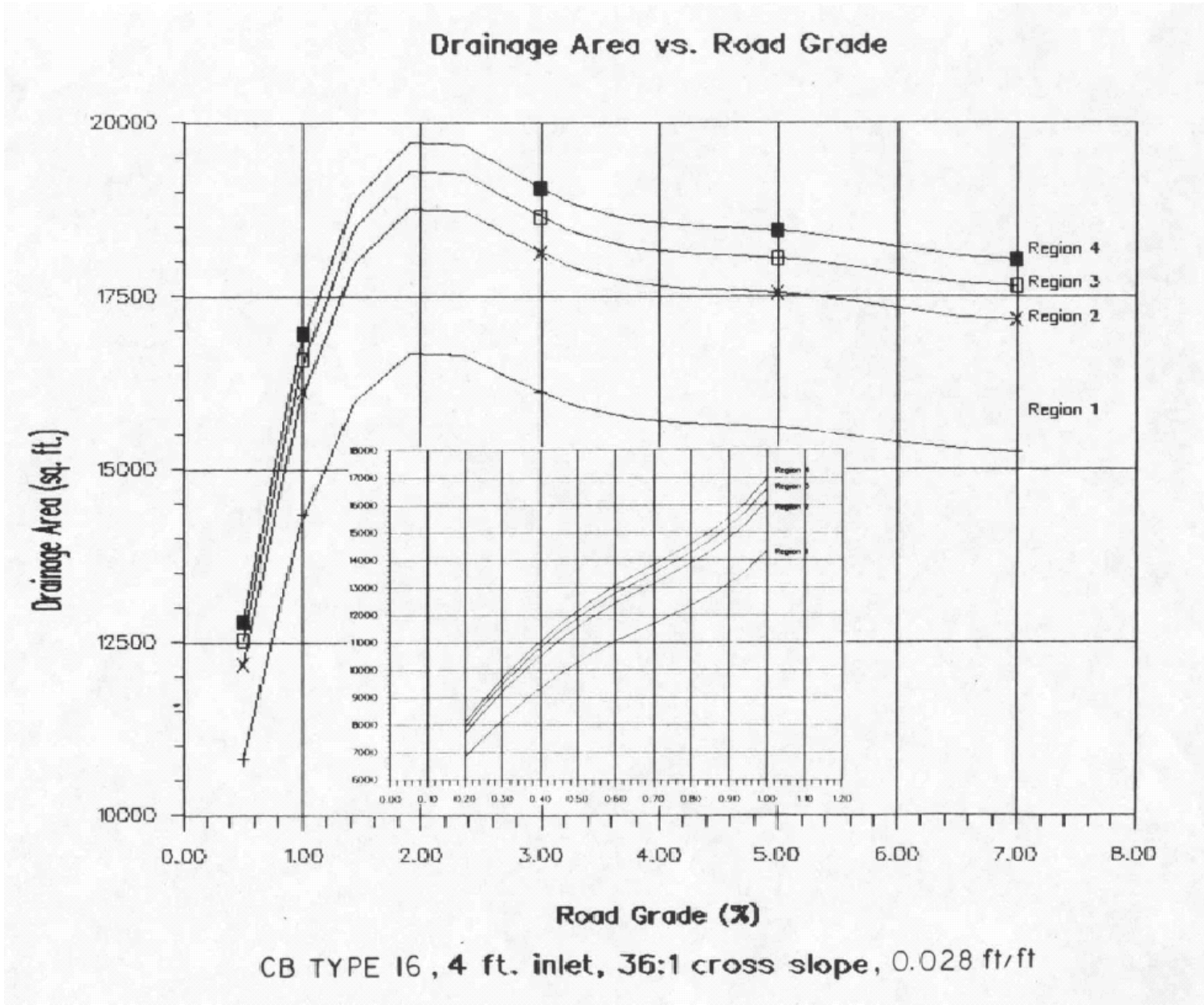
E. Divide the drainage area by the width of roadway draining to the gutter. Do not forget to include the sidewalk area. This figure is the spacing between catch basin.

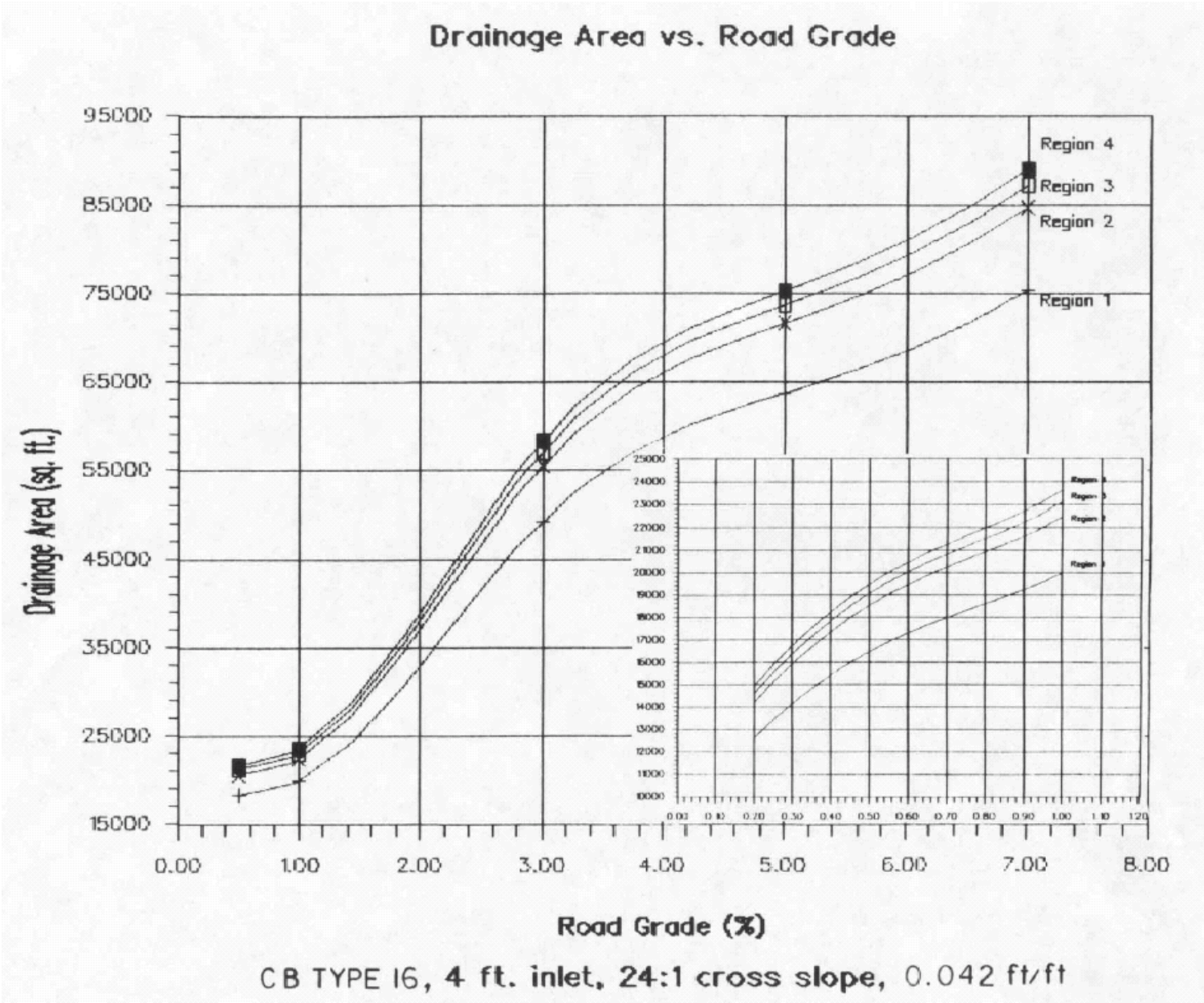
NOTE: MINIMUM BASIN SPACING - 150 LF
MAXIMUM BASIN SPACING - 400 LF

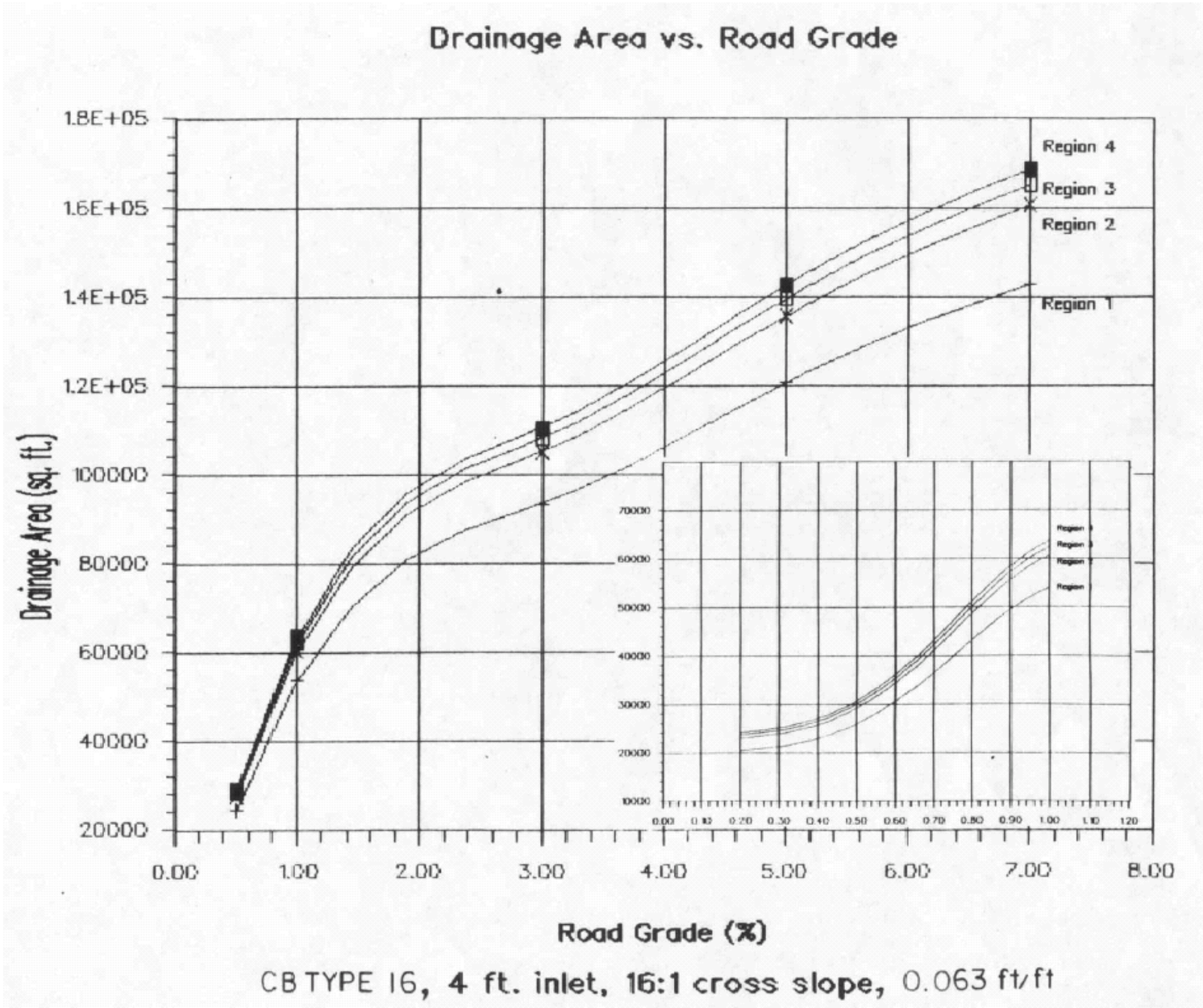
Examples of computing catch basin spacing follow the spacing charts.

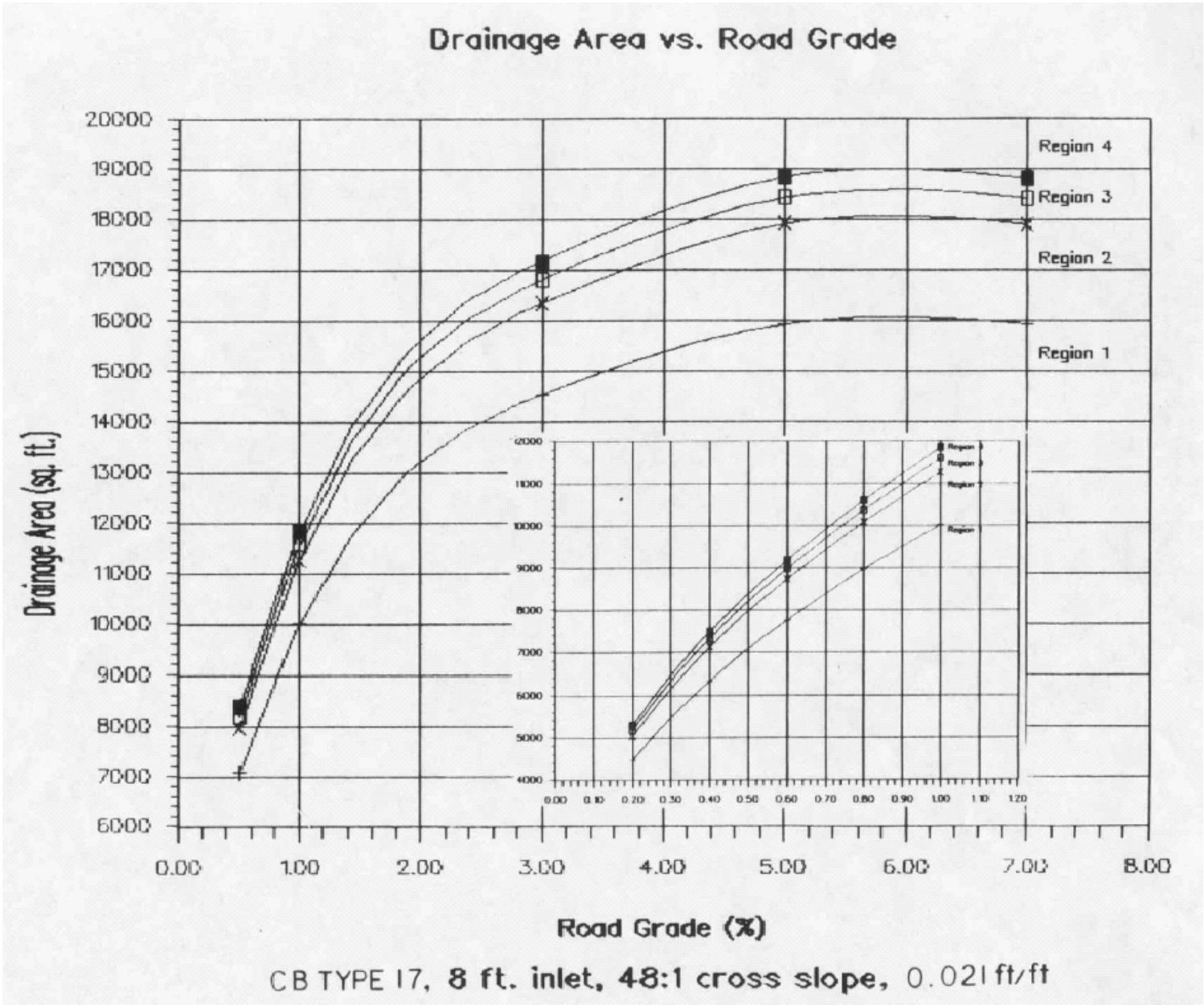

REGION 4
REGION 3
REGION 2
REGION 1
N
W
E
S
PICKENS
Pickens
GREENVILLE
Greenville
SPARTANBURG
Spartanburg
Gaffney
CHEROKEE
York
YORK
OCONEE
Walhalla
ANDERSON
Anderson
LAURENS
Laurens
Union
UNION
Chester
CHESTER
FAIRFIELD
Lancaster
LANCASTER
Chesterfield
CHESTERFIELD
Bennettsville
MARLBORO
NEWBERRY
Newberry
Winnsboro
KERSHAW
Camden
Dillon
DILLON
Darlington
DARLINGTON
Bishopville
LEE
Florence
Marion
MARION
ABBEVILLE
Abbeville
Greenwood
GREENWOOD
SALUDA
Saluda
RICHLAND
Columbia
Lexington
LEXINGTON
SUMTER
Sumter
FLORENCE
HORRY
Conway
McCORMICK
McCormick
Edgefield
EDGEFIELD
AIKEN
Aiken
CALHOUN
St. Matthews
CLARENDON
Manning
WILLIAMSBURG
Kingstree
Orangeburg
ORANGEBURG
GEORGETOWN
Georgetown
BARNWELL
Barnwell
Bamberg
BAMBERG
St. George
BERKELEY
Moncks Corner
ALLENDALE
Allendale
COLLETON
Walterboro
DORCHESTER
Hampton
HAMPTON
Charleston
CHARLESTON
JASPER
Ridgeland
Beaufort
BEAUFORT
SCDOT
Inlet Spacing Charts

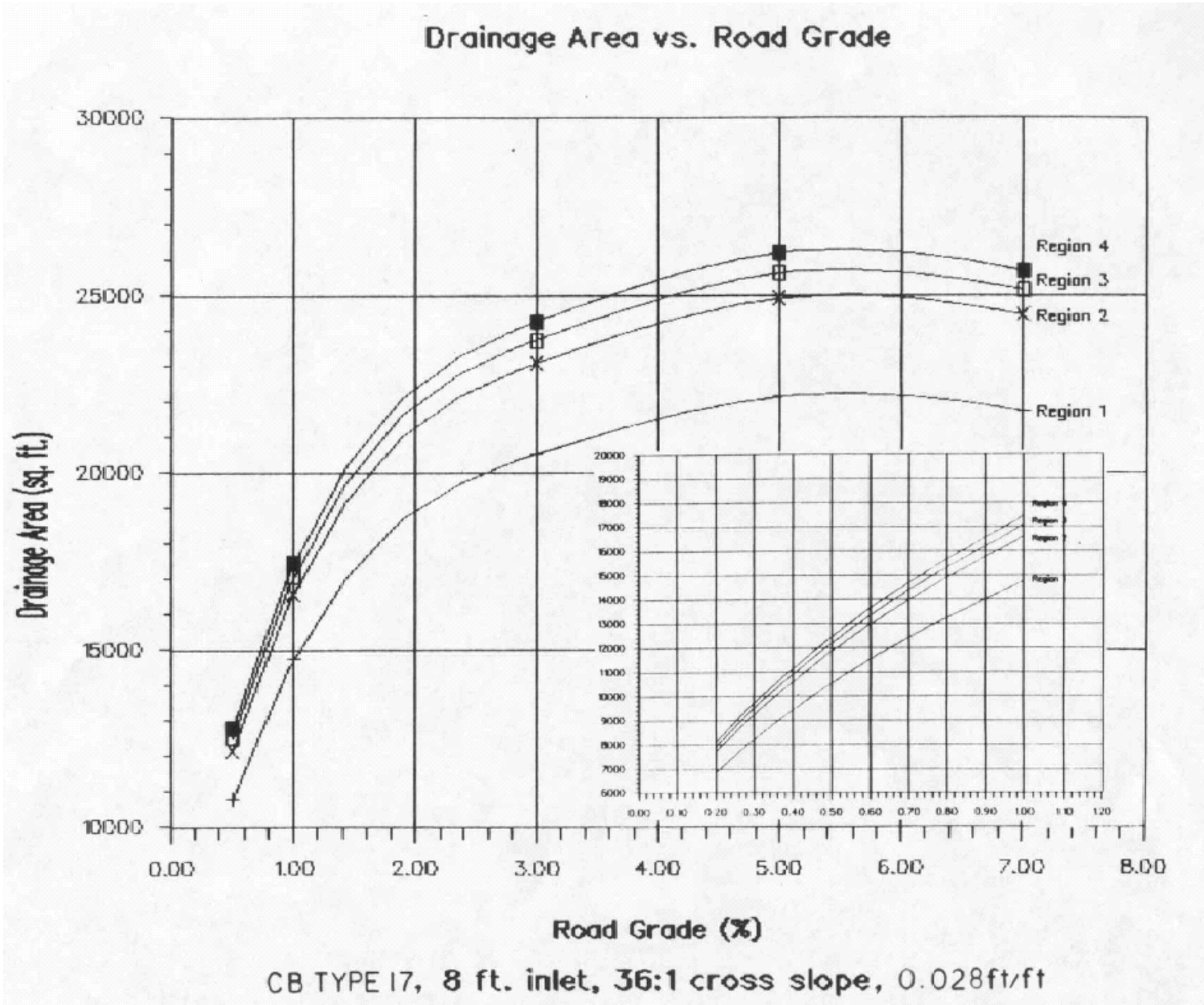

Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
0.00
0.80
1.60
2.40
3.20
4.00
4.80
5.60
6.40
7.20
8.00
Road Grade (%)
Region 4
Region 3
Region 2
Region 1
CB TYPE 16, 4 ft. inlet, 48:1 cross slope, 0.021 ft/ft

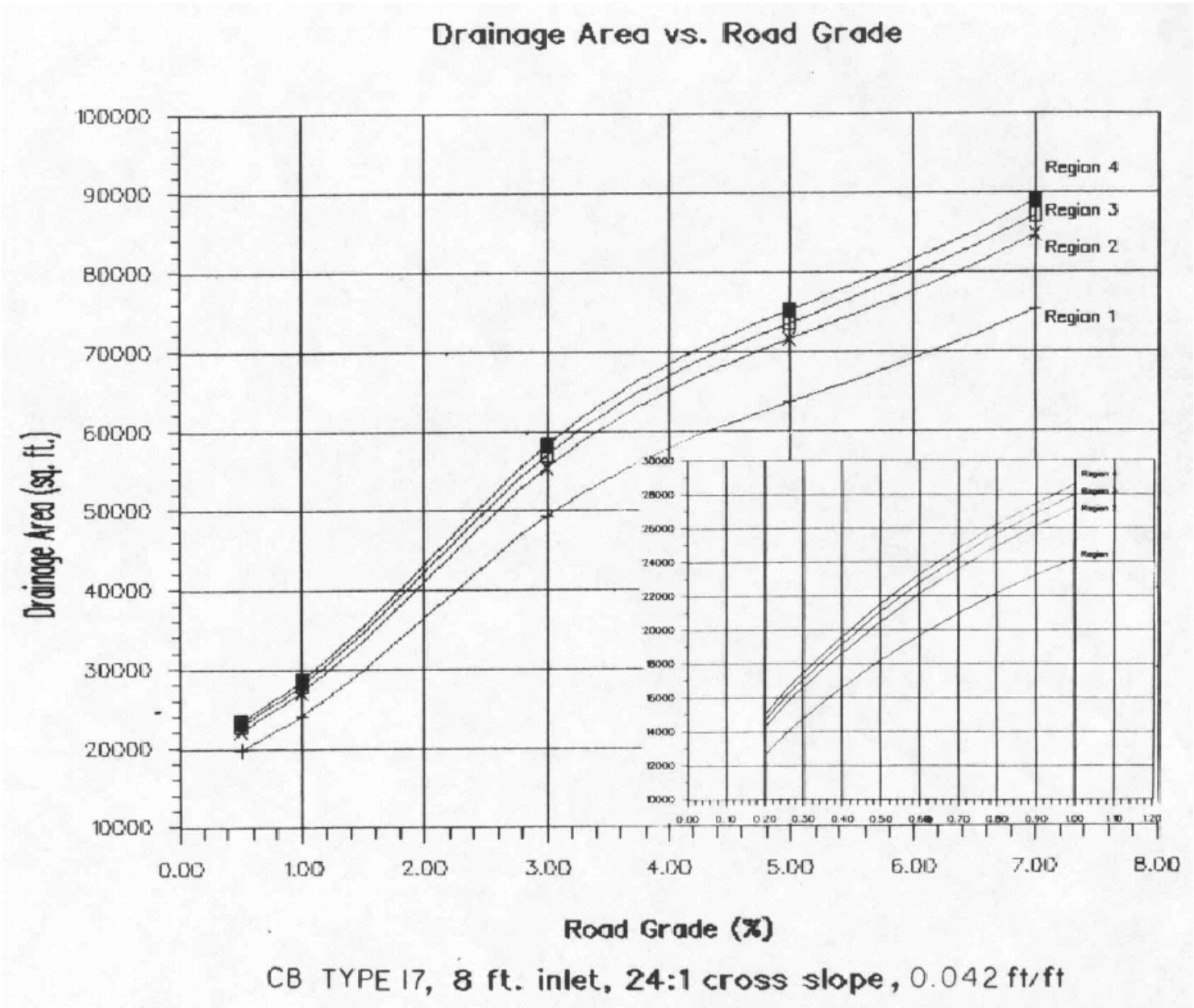

Drainage Area vs. Road Grade
20000
17500
15000
12500
10000
Drainage Area (sq. ft.)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Road Grade (%)
Region 4
Region 3
Region 2
Region 1
CB TYPE 16 , 4 ft. inlet, 36:1 cross slope, 0.028 ft/ft

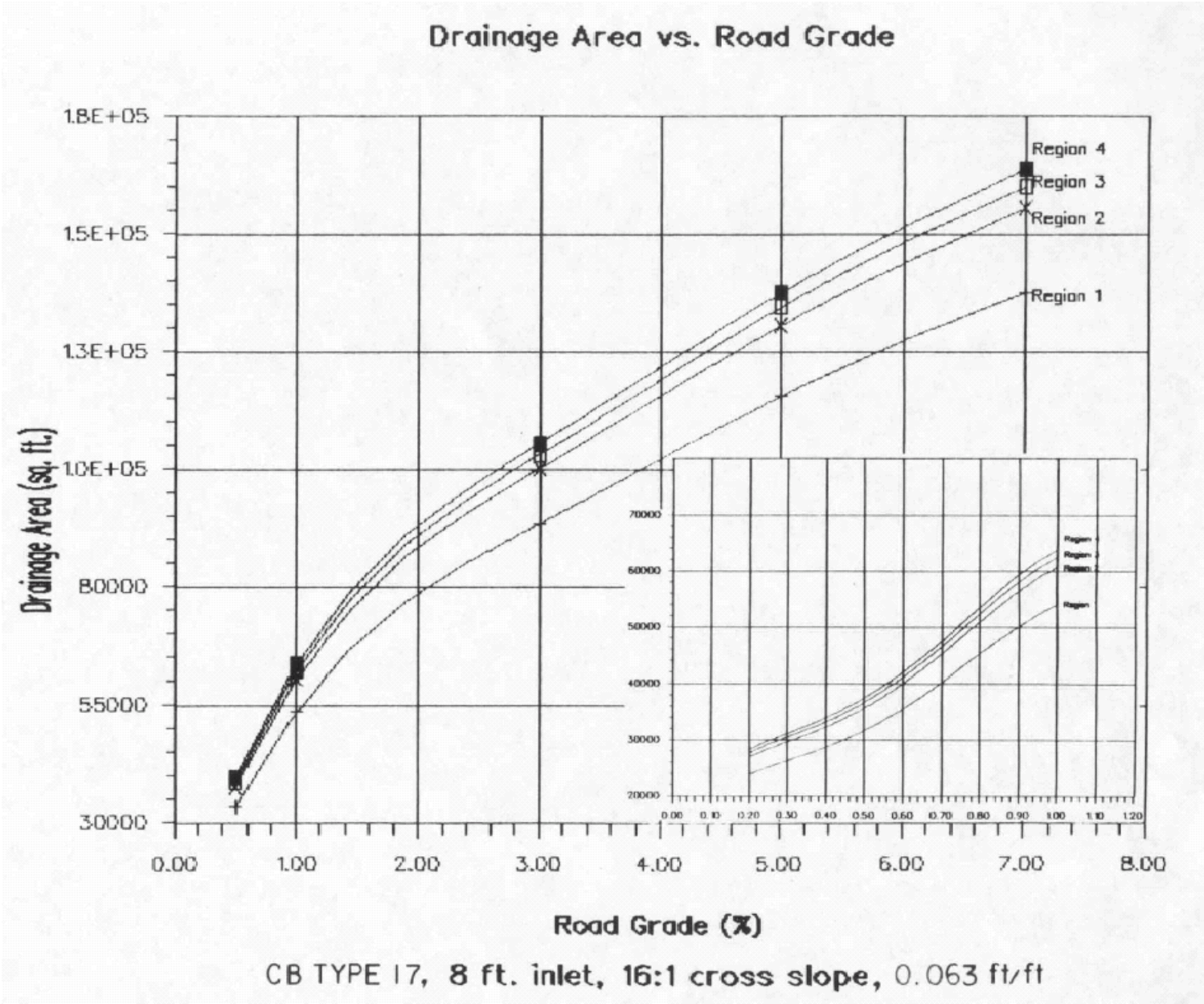

Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
95000
85000
75000
65000
55000
45000
35000
25000
15000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Region 4
Region 3
Region 2
Region 1
Road Grade (%)
CB TYPE 16, 4 ft. inlet, 24:1 cross slope, 0.042 ft/ft

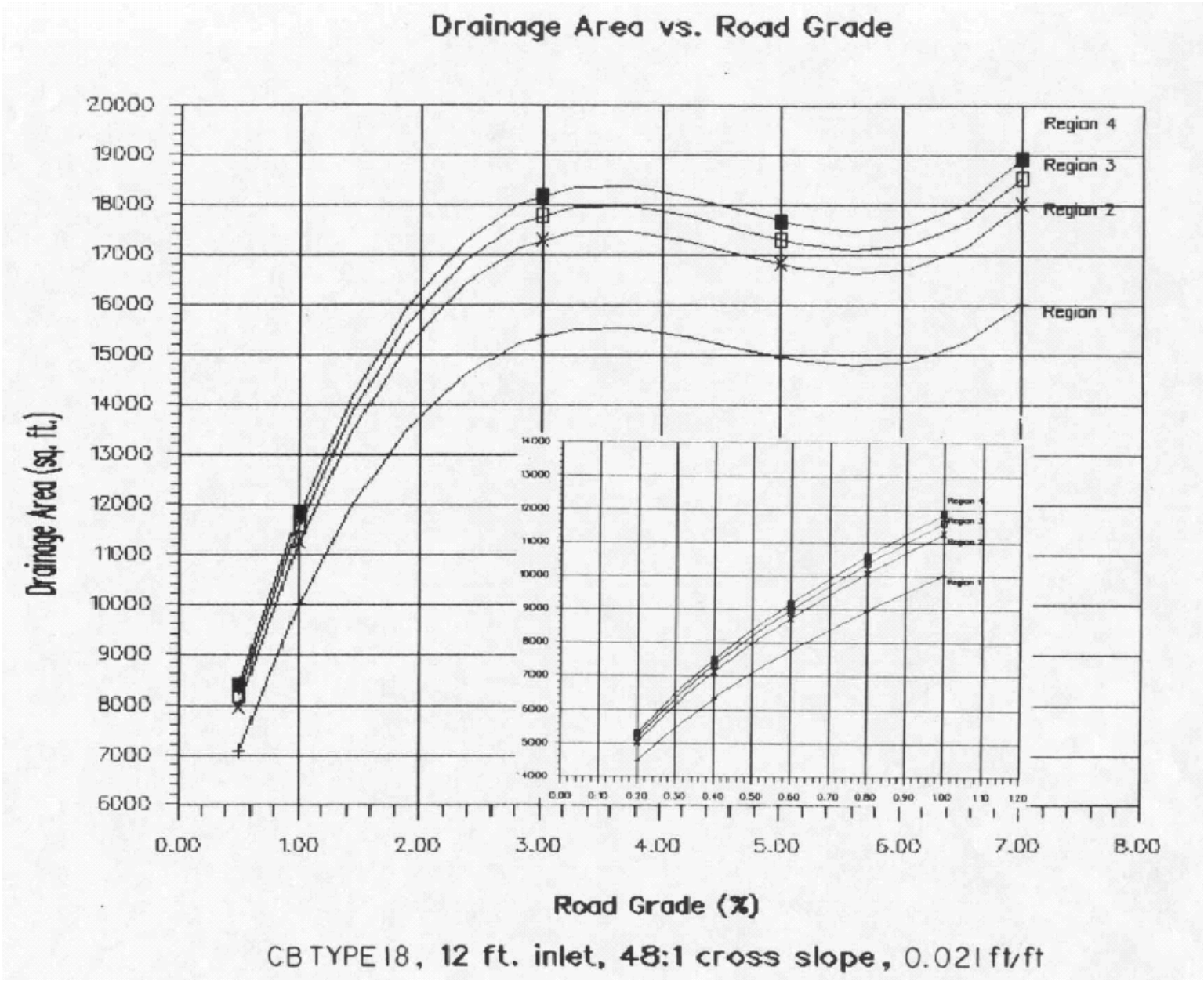

Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
1.8E+05
1.6E+05
1.4E+05
1.2E+05
100000
80000
60000
40000
20000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Region 4
Region 3
Region 2
Region 1
Road Grade (%)
CB TYPE 16, 4 ft. inlet, 16:1 cross slope, 0.063 ft/ft

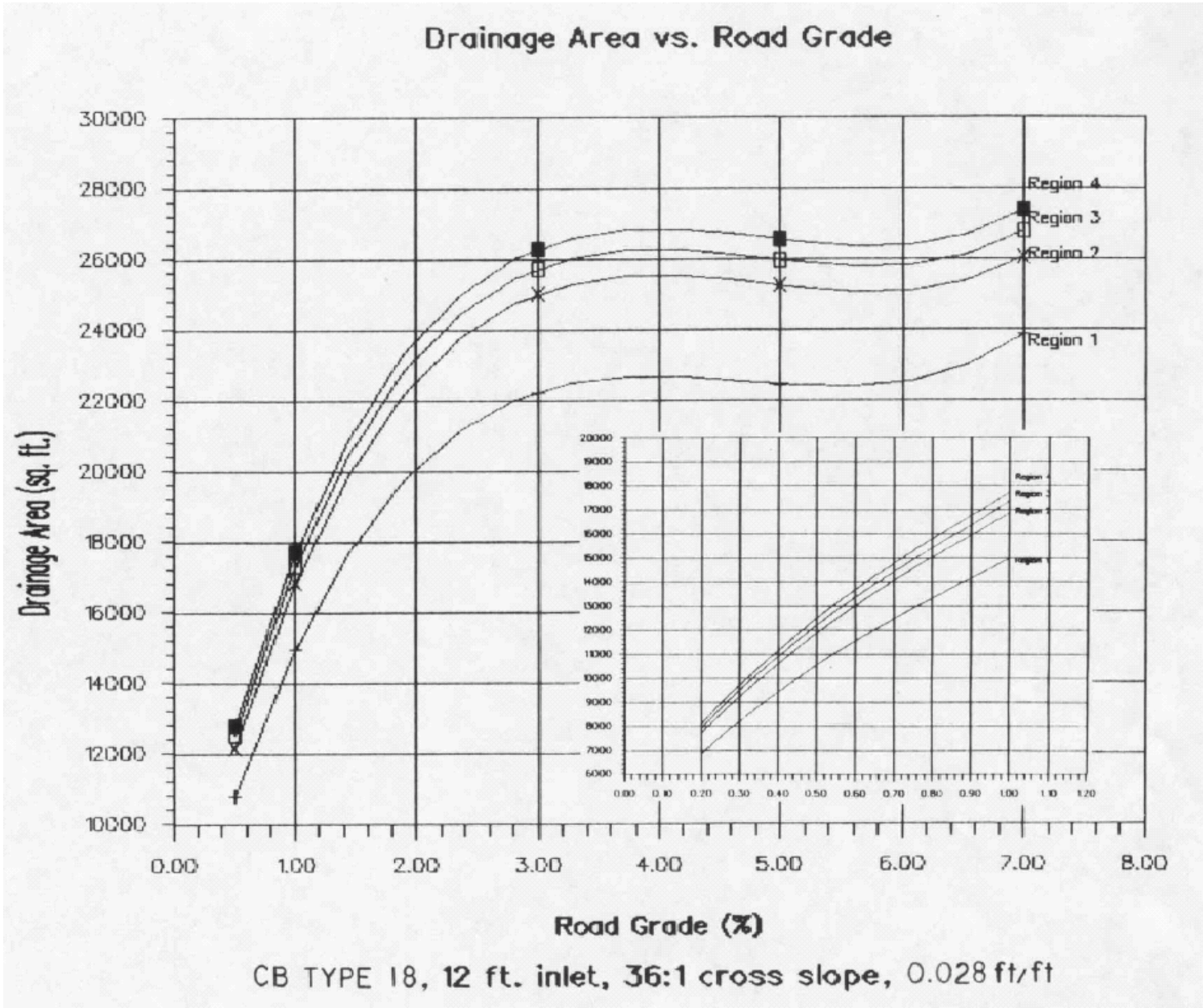

Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Region 4
Region 3
Region 2
Region 1
Road Grade (%)
CB TYPE 17, 8 ft. inlet, 48:1 cross slope, 0.021 ft/ft

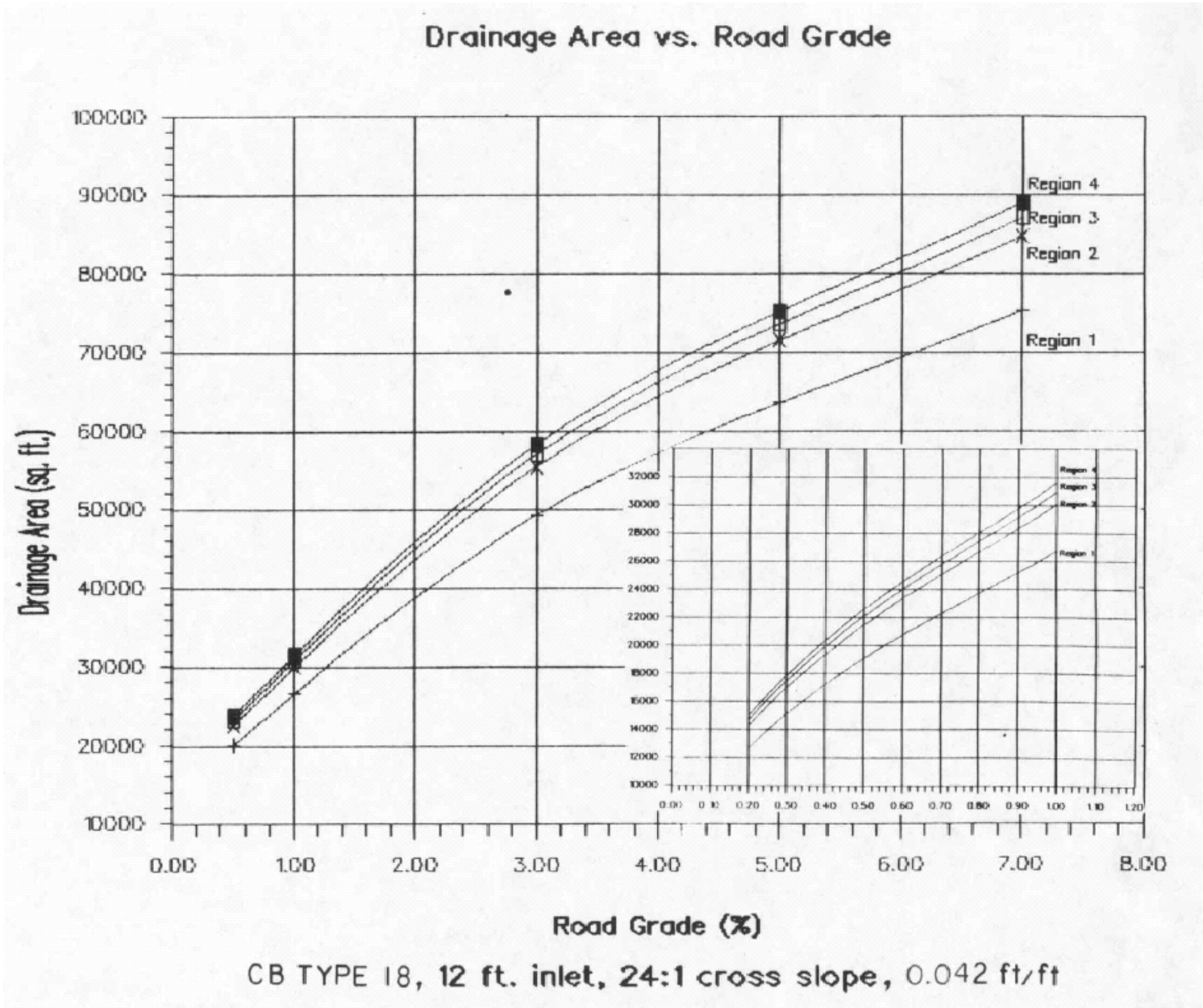

Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
30000
25000
20000
15000
10000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Road Grade (%)
Region 4
Region 3
Region 2
Region 1
CB TYPE 17, 8 ft. inlet, 36:1 cross slope, 0.028ft/ft

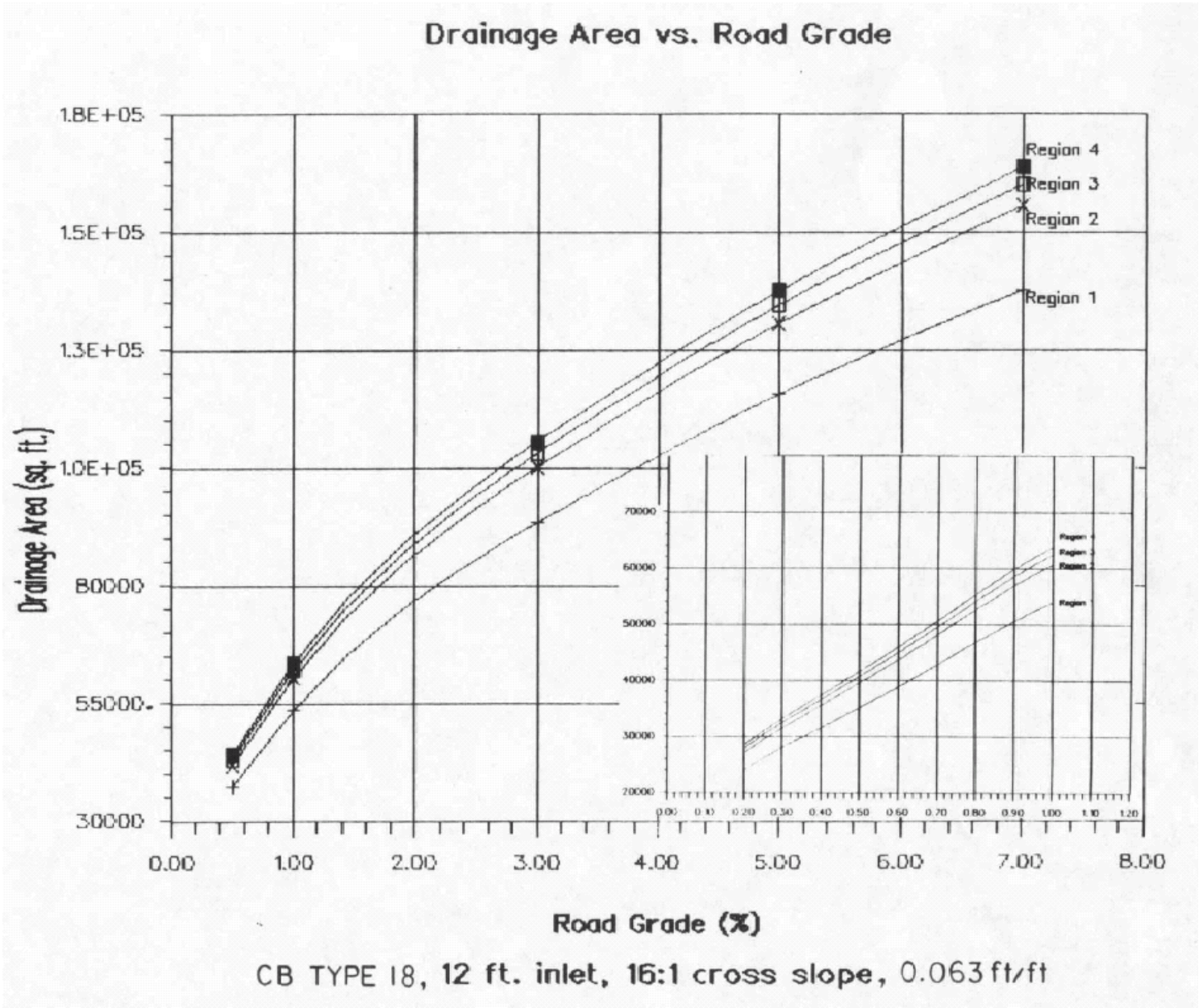

Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Road Grade (%)
Region 4
Region 3
Region 2
Region 1
CB TYPE I7, 8 ft. inlet, 24:1 cross slope, 0.042 ft/ft


Drainage Area vs. Road Grade
1.8E+05
1.5E+05
1.3E+05
1.0E+05
80000
55000
30000
Drainage Area (sq. ft.)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Road Grade (%)
Region 4
Region 3
Region 2
Region 1
CB TYPE 17, 8 ft. inlet, 16:1 cross slope, 0.063 ft/ft


Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
Road Grade (%)
Region 4
Region 3
Region 2
Region 1
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
CB TYPE 18, 12 ft. inlet, 48:1 cross slope, 0.021 ft/ft

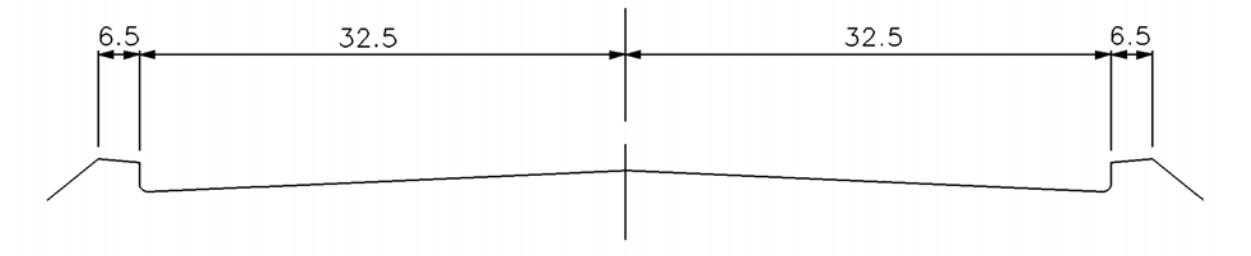

Drainage Area vs. Road Grade
Drainage Area (SQ. FT.)
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Region 4
Region 3
Region 2
Region 1
Road Grade (%)
CB TYPE 18, 12 ft. inlet, 36:1 cross slope, 0.028 ft/ft


Drainage Area vs. Road Grade
Drainage Area (sq. ft.)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Region 4
Region 3
Region 2
Region 1
Road Grade (%)
CB TYPE 18, 12 ft. inlet, 24:1 cross slope, 0.042 ft/ft


Drainage Area vs. Road Grade
1.8E+05
1.5E+05
1.3E+05
1.0E+05
80000
55000
30000
Drainage Area (sq. ft.)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Road Grade (%)
Region 4
Region 3
Region 2
Region 1
CB TYPE 18, 12 ft. inlet, 16:1 cross slope, 0.063 ft/ft

EXAMPLE OF COMPUTING CATCH BASIN SPACING
(CATCH BASIN TYPES 16, 17 & 18)

EXAMPLE A: Newberry County
48:1 Normal Cross Slope
2.5 % Grade



65’ Curb and gutter Section

The drainage charts for this example are shown on the following sheet.

1. Find the correct Region from the Outline Map. (Region 3)

2. Select Catch Basin Type 16, 48:1 Chart.

3. Find 2.5% grade at the bottom of the chart.

4. Draw a vertical line to the Region 3 line.

5. Draw a horizontal line to the left column.

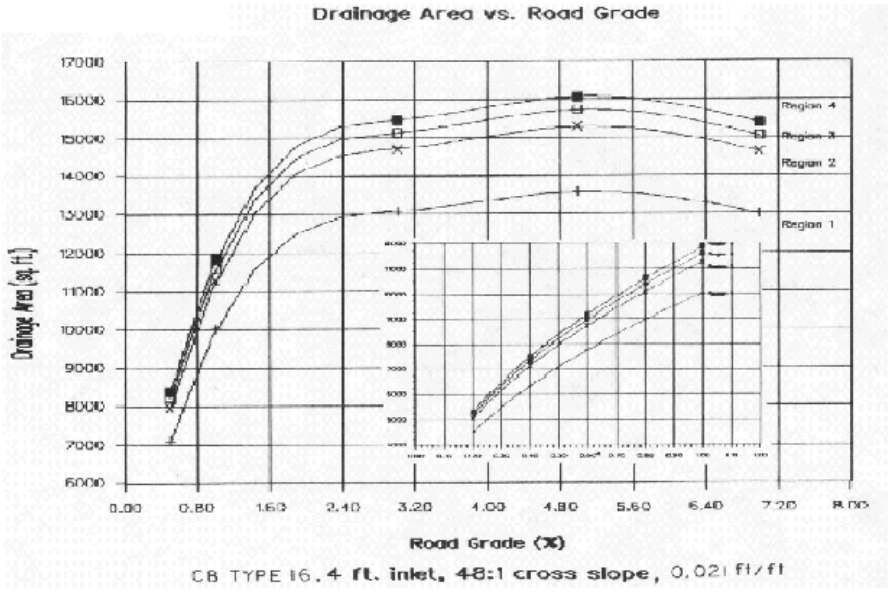
6. Read the drainage area, 15,000 sq. ft.

7. Divide the drainage area by width of roadway draining to the catch basin.
   (15,000/38.5 = 389.6′) 390 LF between Catch Basin Type 16.

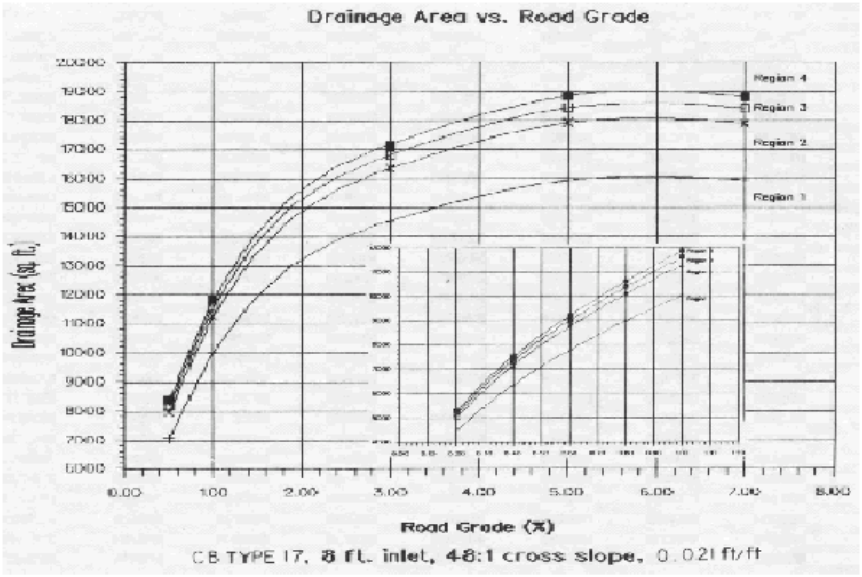
   Using the above steps check the spacing for a Catch Basin Type 17.

   Drainage area = 16,200 sq. ft.
   (16,200/38.5 = 420.8′)
   The maximum spacing is 400 LF, use 400 LF.

It would be more economically feasible to use Catch Basins Type 16 at 390 LF spacing than Catch Basins Type 17 at 400 LF spacing.



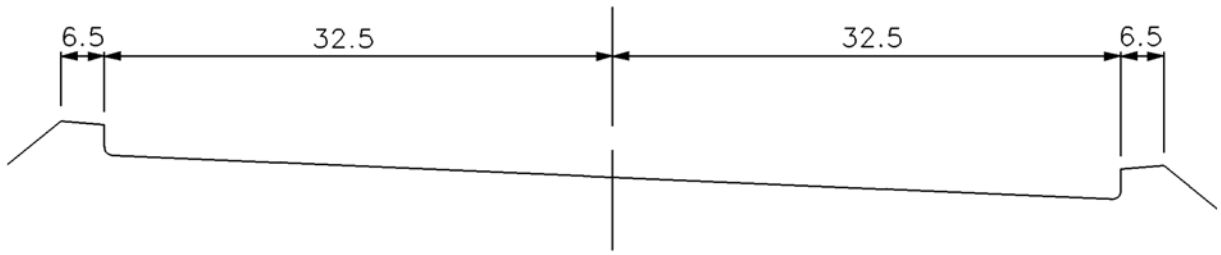
CB TYPE 16, 4 ft. inlet, 4:1 cross slope, 0.021 ft/ft



CB TYPE 17, 8 ft. inlet, 4:1 cross slope, 0.021 ft/ft

EXAMPLE OF COMPUTING CATCH BASIN SPACING
(CATCH BASIN TYPES 16, 17 & 18)

EXAMPLE B: Dorchester County
Superelevation e=0.045
0.3% Grade



65’ Superelevated Curb and Gutter Section

The drainage charts for this example are shown on the following sheet.

1. Find the correct Region from the Outline Map. (Region 1)

2. Select chart with cross slope nearest to the superelevation rate for Catch Basin Type 16. (24:1 cross slope)

3. Find 0.3% grade at the bottom of the chart. Use the inset when the grade is less than 1%.

4. Draw a vertical line to the Region 1 line.

5. Draw a horizontal line to the left column.

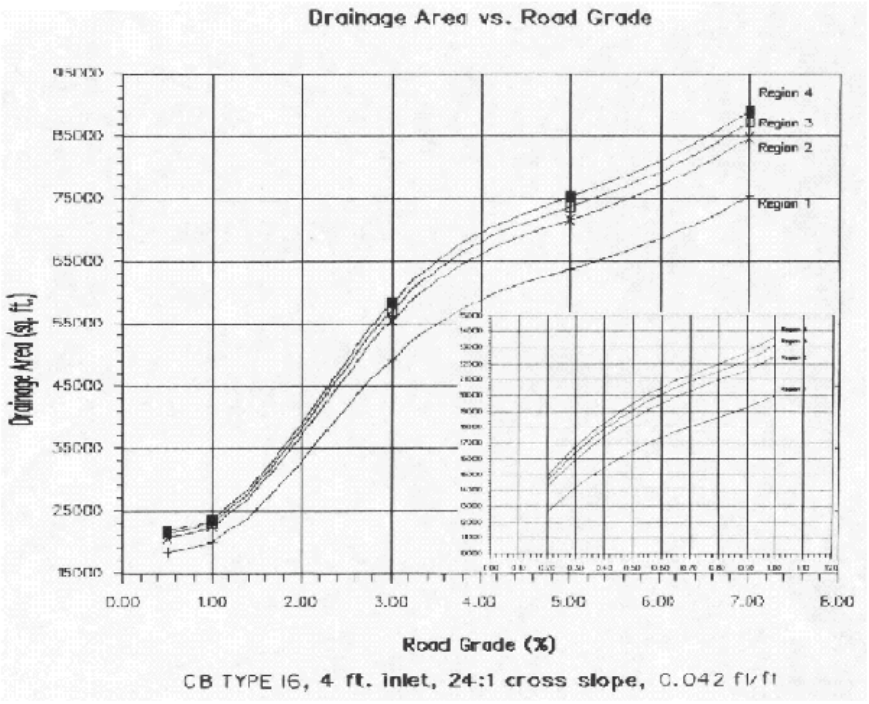
6. Read the drainage area, 14,100 sq. ft.

7. Divide the drainage area by width of roadway draining to the catch basin.
   914,100/77 = 183.1′) 185 LF between Catch Basins Type 16.

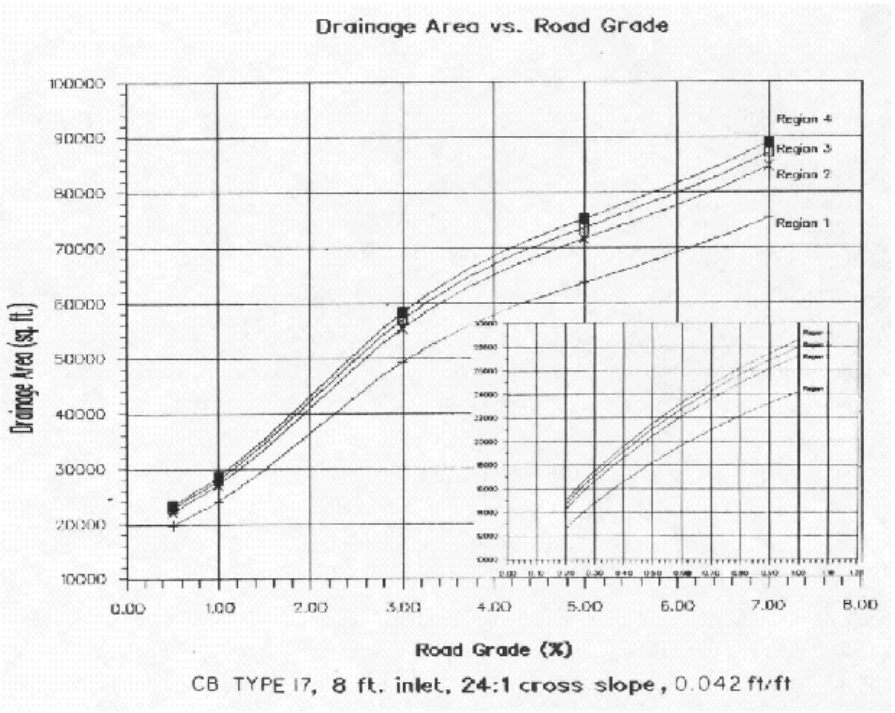
   Using the above steps check the spacing for a Catch Basin Type 17.

   Drainage area = 14.900 sq. ft.
   (14,900/77 = 193.5’)
   195 LF between Catch Basins Type 17.

It would be more economically feasible to use Catch Basins Type 16 at 185 LF spacing than Catch Basins Type 17 at 195 LF spacing.



CB TYPE 16, 4 ft. inlet, 24:1 cross slope, 0.042 ft/ft



CB TYPE 17, 8 ft. inlet, 24:1 cross slope, 0.042 ft/ft

6. Catch Basin Spacing for Type 15 Catch Basins

The following tables are for 30′ of roadway (**Table I**), and 66’ of roadway (**Table II**), sloping toward the barrier.

INSTRUCTIONS FOR USE OF THE SPACING TABLES

A. Select the chart for the correct width of roadway.

B. Find the percent of grade along the left (Vertical) column and place a horizontal line across to the graph line.

C. Place a vertical line from the point of intersection to the bottom of the chart. The figures along the bottom of the chart are the spacing between catch basins.

NOTE: MINIMUM BASIN SPACING - 150 LF
MAXIMUM BASIN SPACING - 400 LF

(TABLE I)

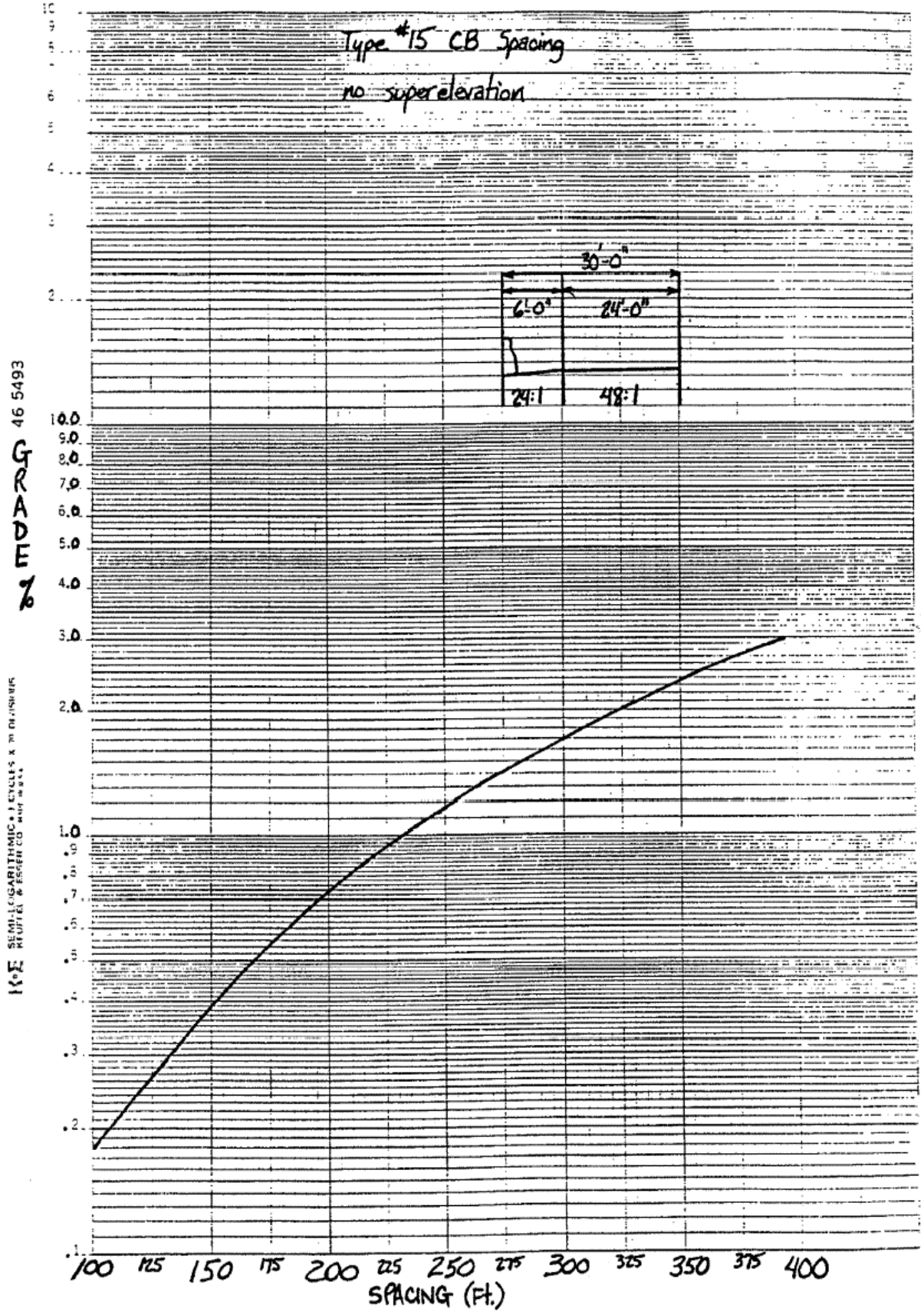
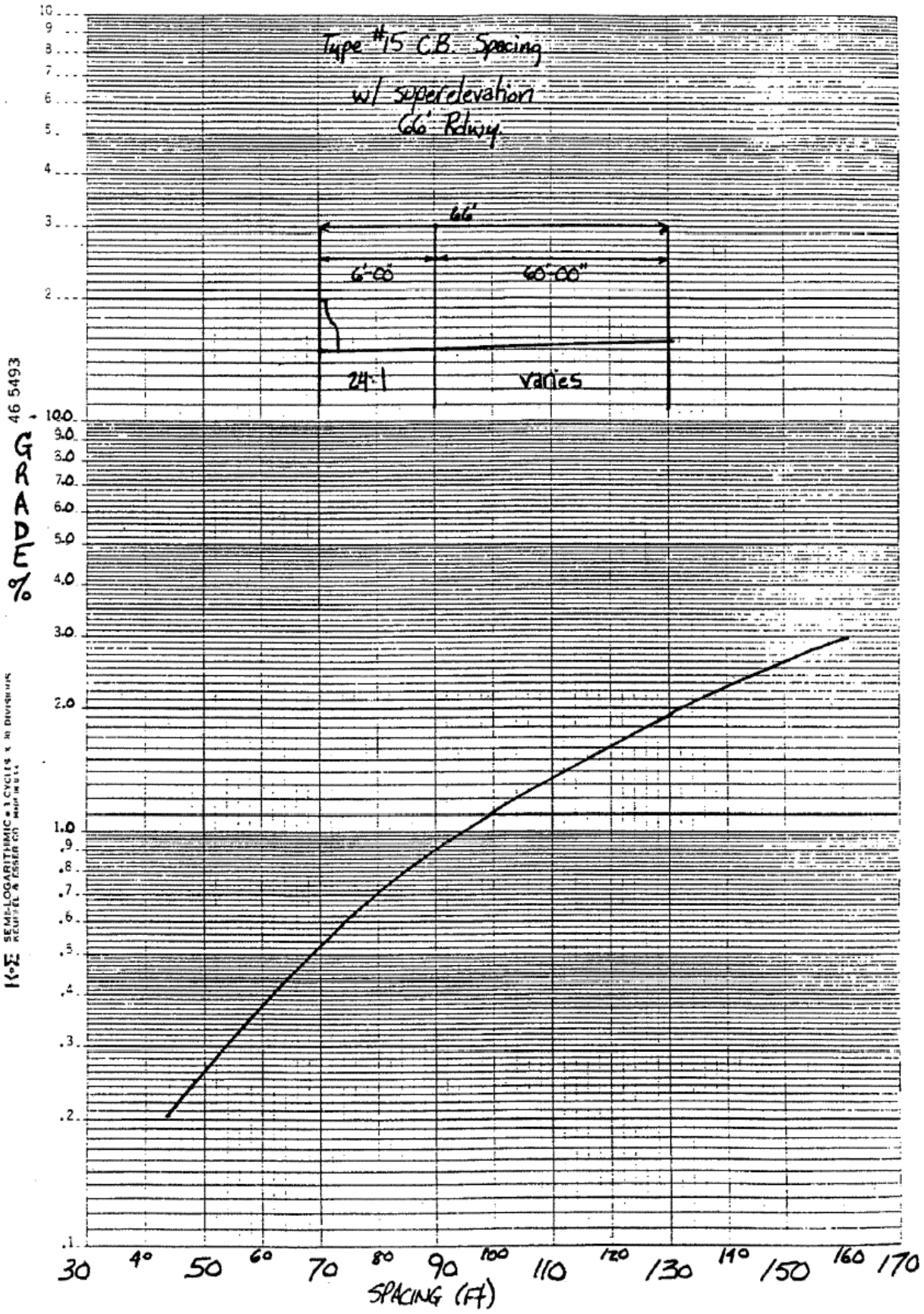

Type #15 CB Spacing
no superelevation
30'-0"
6'-0"
24'-0"
24:1
48:1
GRADE %
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.7
.6
.5
.4
.3
.2
.1
100
125
150
175
200
225
250
275
300
325
350
375
400
SPACING (Ft.)
46 5493
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO

TABLE II


Type #15 C.B. Spacing
w/ superelevation
66' Rdwy.
66'
6'-00
60'-00"
24:1
varies
GRADE %
SPACING (FT)
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
10
9
8
7
6
5
4
3
2
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1

7. Precast Drainage Structures

1. On 60” and 72” base structures, it is generally most economical and practical to run the same size risers as the base to the top.

2. On larger bases, 84” and 96”, it is usually best to transition to smaller risers as soon as possible.

3. If a pipe intersects the structure near the top, it is usually best not to transition to smaller risers until you are above the highest pipe.

4. Allow a minimum of 8” of concrete area in the base and/or riser above or below the pipe opening.

5. The top 72” (six feet) of structure is paid for in the cost of catch basin, drop inlet, or manhole. The 6’ measurement is from the bottom of the flat slab adapter to the top of the manhole cover, top of concrete masonry, top of the hood or top of the grate.

6. The base height is measured from top of the bottom slab to the top of the full wall thickness.

7. Precast drainage structures are required for the following applications:
   A. On drainage structures with a depth equal to or greater than 12 feet.
   B. On drainage structures where the flow line elevation of the inlet pipe is equal to or higher than the inside top of the outlet pipe.
   C. As required by the plans.

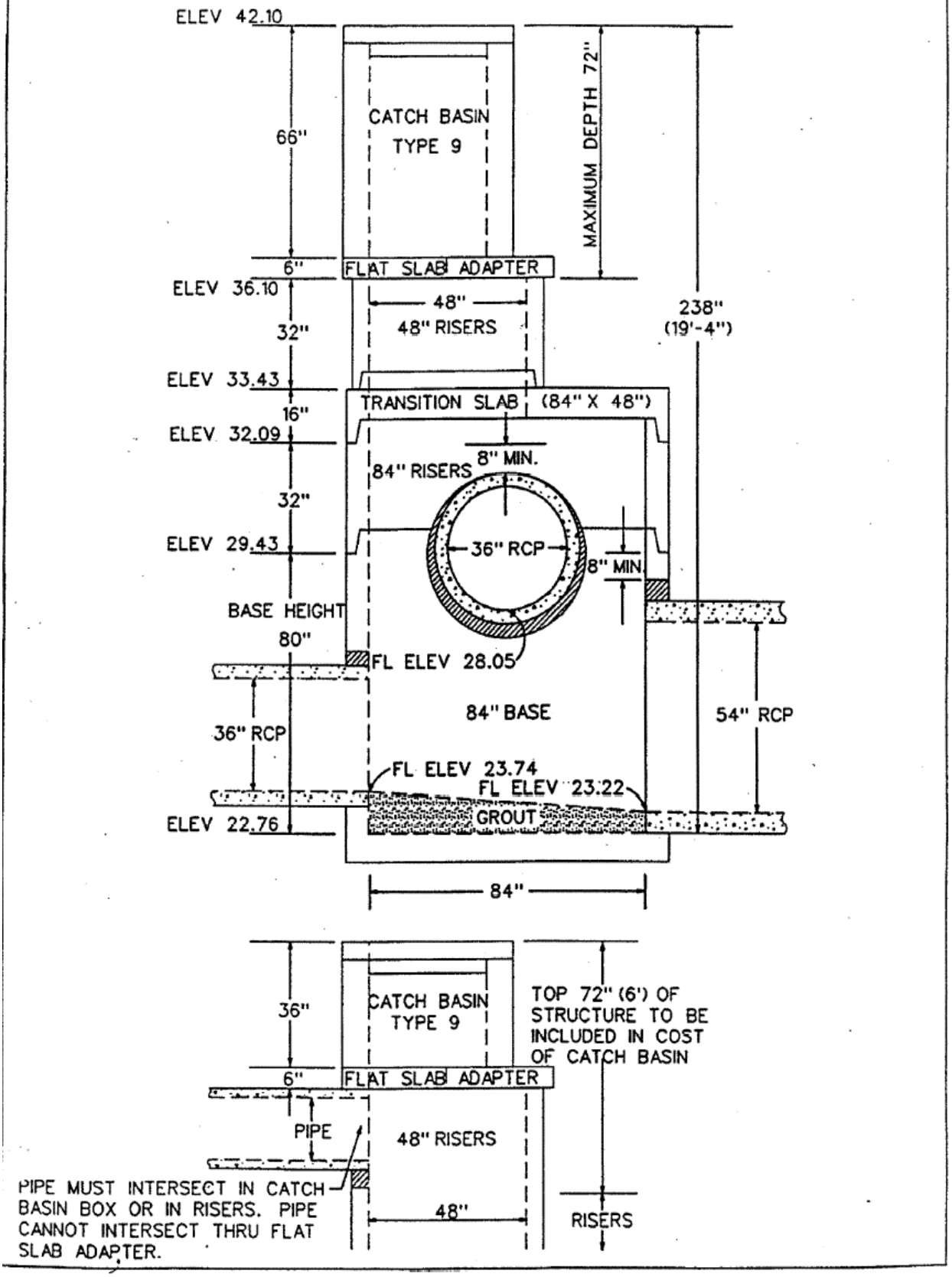
8. Precast concrete structures may be used at the option of the contractor on any other application unless prohibited by the plans or special provisions.

Drainage Base Diameter A	Drainage Base Height B	Minimum Bottom Thickness C	Maximum Pipe Diameter D
48”	48”	6”	24”
60”	60”	8”	36”
72”	72”	8”	48”
84”	80”	8”	54”
96”	88”	8”	60”
120”	96”	10”	72”

Drainage Base and/or Riser Diameter	Flat Slab Adapter Size
48”	5′-4” x 5′-4”
60”	6′-4” x 6′-4”
72”	7′-0” diameter
84”	8′-2” diameter
96”	9′-4” diameter
120”	11′-8” diameter

Maximum Pipe Openings in Precast Components			
Inside Pipe Diameter (D)	Maximum Opening (H)	Inside Pipe Diameter (D)	Maximum Opening (H)
15	24	48	64
18	28	54	72
24	34	60	78
30	42	66	84
36	48	72	92
48	55		

EXAMPLE OF PRECAST DRAINAGE STRUCTURE



8. Pipe Requirements

Pipe on Federal Aid Projects. Federal Aid Projects require alternate pipe material. Below are the acceptable criteria for specifying types of pipe.

Type of drainage installation	Alternates Required	Material
Cross drains under high type pvt. (Asph. Conc. Surf. Cr. or Concrete Pvt.)	None	Reinf. Concrete Pipe
Other cross drains	Yes (3 min.)	Reinf. Concrete Pipe Corr. Aluminum Pipe Corr. Polyethylene Pipe
Side Lines	Yes (3 min.)	Reinf. Concrete Pipe Corr. Aluminum Pipe Corr. Polyethylene Pipe
Special drainage systems (Storm Drains)	None	Reinf. Concrete Pipe
Special installation conditions	None	Specified to meet conditions

Other Materials Due to the high acidity of the South Carolina soils that corrode the walls of corrugated galvanized steel pipe, corrugated galvanized steel pipe (coated or uncoated) is not permitted in permanent installations on Department-maintained roads. However, corrugated galvanized steel pipe may be used in temporary drainage applications. When used, it shall meet the specifications of AASHTO M 36.

Polyvinyl chloride (PVC) pipe, AASHTO M 304, has been reviewed and presently will not be used on Department highway construction projects, except for underdrain applications.

End Protection All pipe must have some form of end protection. Riprap should be used for end protection on all reinforced concrete pipe. For all other types of pipe, either riprap or reinforced concrete pads may be used. Generally, for non-R.C. pipe with diameters of 36 inches and above, riprap should be placed at each end unless another approved system is specified. For non-R.C. pipe with diameters less than 36 inches, cast-in-place concrete pads should be used for end protection. See Standard Drawing No. 802-1 for more details on concrete pads.

When using riprap for end protection, a minimum of two feet of riprap should be placed on each side of the opening of the pipe and a minimum of one foot on top above the opening. Riprap will be estimated at one ton for each pipe sizes 30” and under. Riprap for pipe over 30” and under 84” will be estimated at 3 tons for each end. Riprap for larger diameters will be calculated separately.

R. C. Pipe may be used on all applications. Class III shall be used on Interstate Projects with cover up to 15 feet and up to 20 feet on other roads. Class IV is to be used with cover over 15 feet on Interstate and over 20 feet on other roads. Class V is specified under Railroads.

When corrugated aluminum pipe is specified, the following procedures should be followed.

1) In crossline applications, corrugated aluminum pipe diameters will be one standard pipe size larger than reinforced concrete pipe.

2) Any application, including those above, of a corrugated aluminum pipe in a critical or sensitive drainage area should be sized by Hydrology.

3) Storm sewer applications of corrugated aluminum pipe must be sized by Hydrology.

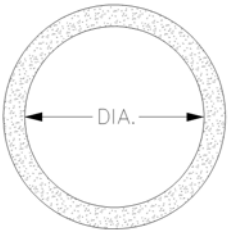
Minimum cover during construction for CAA pipe is required and varies according to size. These figures are included in a fill height table on Standard Drawing No. 714-2.

Side Line Pipe. In addition to the previous requirements a minimum length of 24 feet of usable pipe shall be installed in driveways.
Pipe Line Parallel to Railroad Tracks. A minimum 24" diameter pipe shall be used when pipe installations are parallel to railroad tracks, on railroad Right of Way.
Cross Line Pipe on Profile. At the pipe station draw an ellipse representing the pipe at the correct elevation and dimension on the profile. Show drainage information only if received from the Hydrology Section. Do not use Talberts Formula.
Cross Line pipe under Railroad. Cross Line pipe under railroads shall be Class V or what may be required by the railroad company.
Minimum Cover For Pipe. Minimum cover for all pipe should be one foot.

Corrugated high-density polyethylene (HDPE) pipe (Type S) meeting AASHTO M 294 may be selected for use on a construction project. Smooth interior wall (Type S) is the only HDPE pipe approved for permanent applications by the Department. Type C (single wall) may be used in temporary applications. HDPE pipe may be used under embankments of up to twenty feet high. If fill heights are greater than twenty feet, a special review of the HDPE pipe application should be done.

9. Concrete Pipe Data

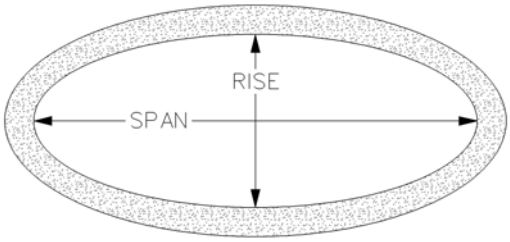
Round Concrete Pipe



Reinforced Concrete Pipe Class III

ASTM- C-76 Dia.	ASSHTO M-170 (Wall B) Wall Thickness	Area (SF)
15”	2¼” (0.1875’)	1.23
18”	2½” (0.2083’)	1.77
24”	3” (0.2500’)	3.14
30”	3½” (0.2917’)	4.91
36”	4” (0.3333’)	7.07
42”	4½” (0.3750’)	9.62
48”	5” (0.4167’)	12.6
54”	5½” (0.4583’)	15.9
60”	6” (0.5000’)	19.6
72”	7” (0.5833’)	28.3
84”	8” (0.6667’)	38.5
96”	9” (0.7500’)	50.3

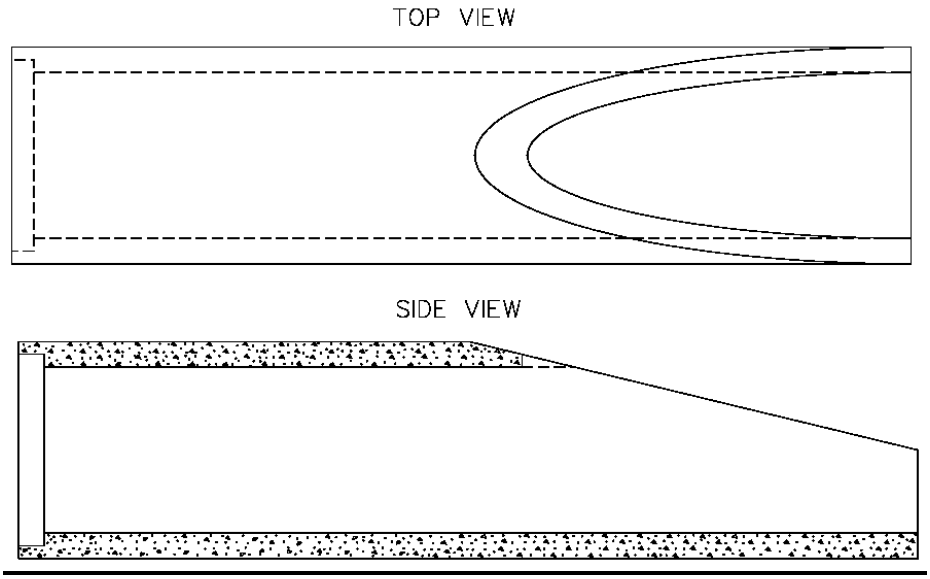
Horizontal Elliptical Pipe



Reinforced Concrete Pipe Class HE-III

Diameter, Equivalent Round Size, in.	ASTM- C-507 Designated rise, in. x span, in.	ASSHTO M-207 Minimum wall thickness in.	Full flow water area Sq. Ft.
18	14 x 23	2¾	1.83
24	19 x 30	3¼	3.28
30	24 x 38	3¾	5.10
36	29 x 45	4½	7.36
42	34 x 53	5	10.2
48	38 x 60	$5^{1/5}$	12.9
54	43 x 68	6	16.7
60	48 x 76	6½	20.5
72	58 x 91	7½	29.4
84	68 x 106	8½	40.1
96	77 x 121	9½	52.4

10. Beveled End Sections



Cross line pipe: Cross line pipe on primary projects shall have beveled end sections. In figuring the length of pipe required to span the fill wherein beveled end sections are to be used, consideration should be given to the usable length of a beveled end section. All beveled end sections are 8′ long with varying lengths of solid pipe (usable). For estimating purposes, the usable and non-usable lengths are as follows:

Pipe Diameter (in.)	Usable Length (ft.)	Non-Usable Length (ft.)
15	6	2
18	5	3
24	4	4
30	3	5
36	2	6
42	2	6
48	2	6

For example, 32’ of 18” R.C Pipe is to be added to existing R.C. Pipe to span a fill. The contractor will only need 22’ of 18” R.C. Pipe since 2 beveled end sections of 18” R.C. Pipe yields 10’ of usable pipe. Rounding 22’ up to 24’ (making length divisible by 4), the note in the plans should state:

ADD (or, PLACE) 24’ – 18” R.C. PIPE AND PLACE 2 – 18” BEVELED END SECTIONS

Sideline Pipe: Sideline installations with beveled end sections may be bid in one of two methods: 1) simply R.C. Pipe or 2) as an alternate – R.C. Pipe. Corrugated Aluminum Alloy Pipe or Corrugated High Density Polyethylene Pipe can also be used for sideline installations. If method 1 is used, the same procedure for estimating crossline pipe as detailed above should be used. If method 2 is used, the total length of pipe includes the beveled end section and the length of non-usable pipe must be considered.

For example, the length of 15" pipe needed for a driveway installation is 28'. However, the contractor will need 32' in this instance since 2 beveled end sections of 15" R.C. Pipe yields 4' of non-usable pipe. The note in the plans should state:

PLACE 32' – 15" ALT. PIPE WHICH INCLUDES 2 – 15" BEVELED END SECTIONS

For more information about beveled end sections and usable lengths, see Standard Drawing No. 714-1.

In summary, crossline pipe and sideline pipe not bid as an alternate shall have beveled end sections set up as a separate bid item. The beveled end sections have varying lengths of usable pipe that must be deducted from the length of pipe normally required. When sideline pipe is bid in the alternate format, the length of pipe includes the total length of pipe and the beveled end sections which include that portion that is non-usable. The beveled end sections have varying lengths of non-usable pipe that must be added to the length of pipe normally required.

The Federal Highway Administration has recommended the use of "Beveled End Pipe" on all crossline and sideline installations within the 30′ clear zone on federally funded projects. In the case of a stub pipe behind a curb and gutter section, it will not be necessary to use "Beveled End Pipe" where a vehicle is not likely to come into contact with the pipe. Another situation might be a crossline under a high fill protected by guardrail. These situations need to be determined on a case-by-case basis.

Alternate sideline pipe bids will also be used and set up as follows:

Example for General Construction Note for additional pipe:

____L. F. of _____" ( ) Alternate Pipe --- _____L. F. for side lines (includes two beveled end pipes per location) No separate payment will be made for the beveled end pipes.

Example of pipe note on plan sheets:

Place ____L. F. of ____" or ( ) Alternate Pipe (includes _____ Beveled End Sections)

When using alternate sideline pipe, place a note on the outside of the cover notifying the Specification and Estimate Group to include an explanation in the Contract Special Provisions.

A note will be shown on the General Construction Note as follows:

Alternate Pipe Selection Notes:

When Corrugated Aluminum Alloy Pipe is selected for use, the diameters will be one standard pipe size larger than Reinforced Concrete Pipe.

Alternate Pipe for sidelines must have each end beveled to match the adjacent slopes. No separate payment will be made for providing these beveled ends.

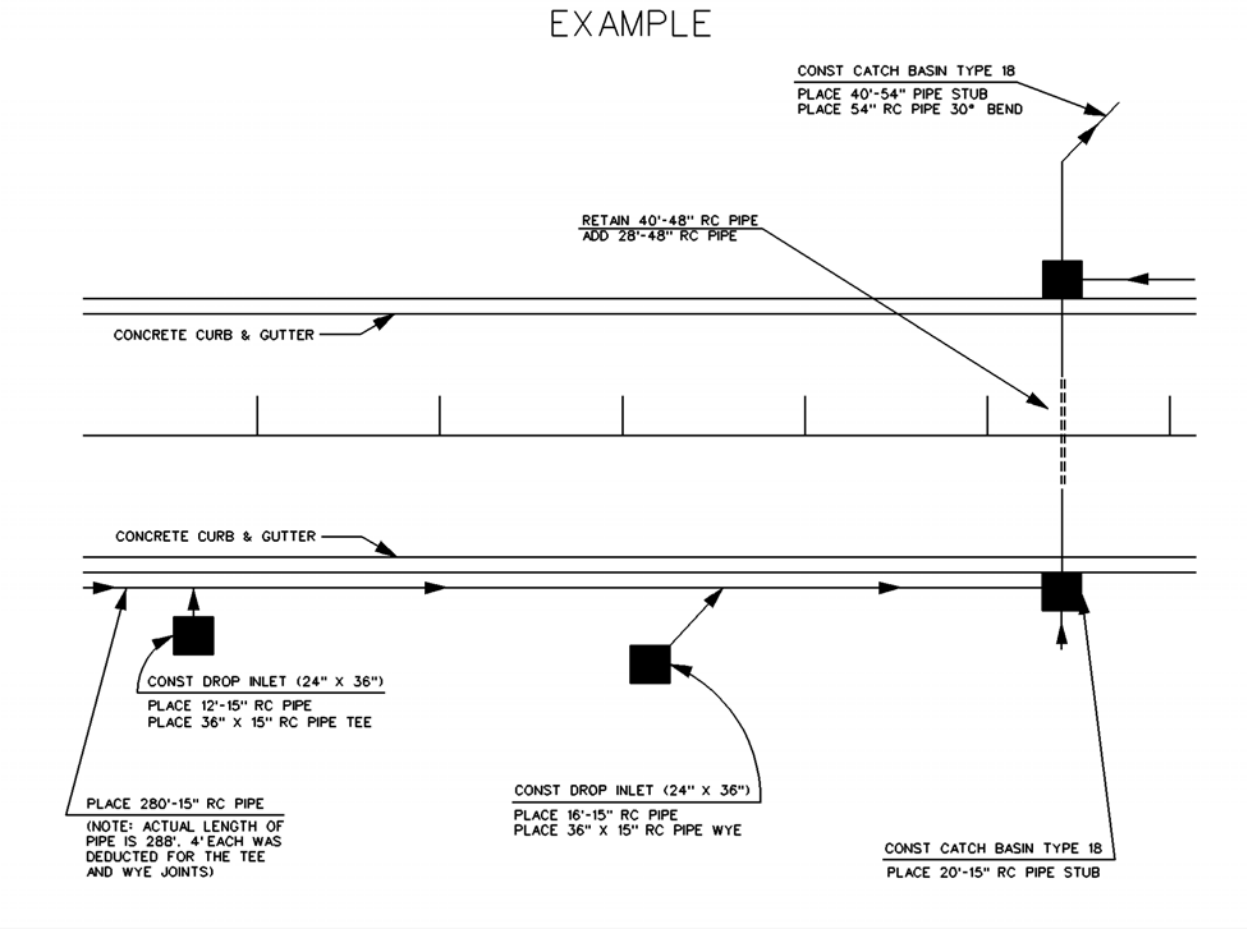
Corrugated Aluminum Alloy Pipe & Corrugated High Density Polyethylene Pipe for sidlines must have cast in place concrete pads to match the adjacent slopes as shown in Standard Drawing No. 802-1. No separate payment will be made for providing these cast in place concrete pads.

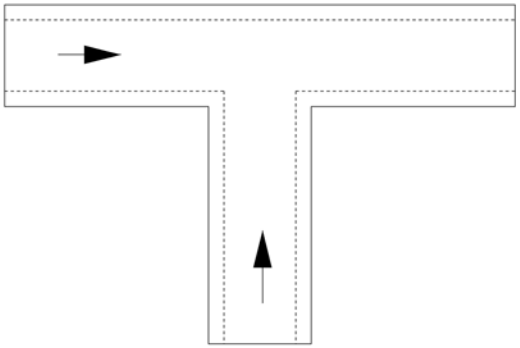
11. Pipe Tee Joints, WYE Joints and Bends

The bid items on quantity sheets shall be:
_____ x _____" R. C. Pipe Culvert Tee (Class III) ------Each
The first diameter of the tee joint shall be the thru or larger pipe and the second diameter shall be the tee joint.

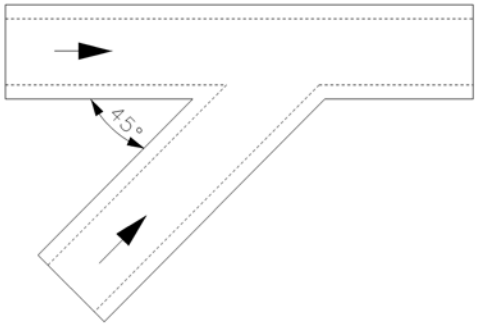
_____ x _____" R. C. Pipe Culvert WYE (Class III) ------Each
The first diameter of the Wye Joint shall be the thru or larger pipe and the second diameter shall be the WYE Joint.

_____" R. C. Pipe _____ DEG. BEND (Class III) ------EACH
The degree of bends are 30°, 45°, and 90°.

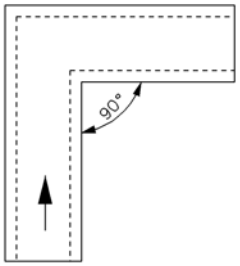




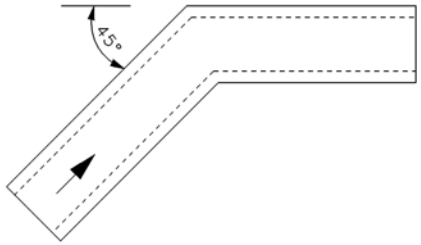
TEE JOINT



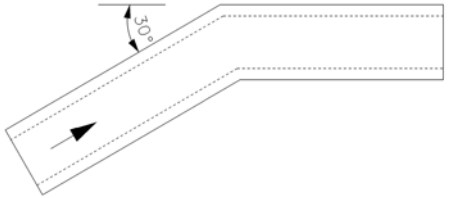
WYE JOINT (45°)



BEND (90°)



BEND (45°)



BEND (30°)

12. Criteria for Placing Paved Gutter

PERCENT OF GRADE	DISTANCE TO CARRY WATER BEFORE BEGINNING PAVED GUTTER
0.00% - 0.49%	NO PAVED GUTTER
0.50% - 0.99%	1000 LF
1.00% - 1.99%	500 LF
2.00% +	250 LF

13. Culvert Sketches

Culvert sketches are required by the Structural Design Group. Road Design needs to furnish the Structural Design Group with a plan and profile sheet, typical section and culvert information. The Structural Design Group will incorporate this information into their culvert plans that will be returned to Road Design to put into our final construction plans. Road Design Group Coordinators are to see that excavation for culverts are calculated within their Design Group.

14. Curb Profile

In order to acquire proper drainage, especially at low points in sag vertical curves and in superelevated sections, it is requested that curb profiles be provided in the plans for all curb and gutter projects when the length of any section of curb and gutter is three hundred feet long or greater. Curb profiles will not be required for radius returns, unless it is deemed necessary for placing drainage in those areas. Vertical curve data for curbs and/or sidewalks will still be placed on the "Reference Sheet" in the plans.

15. Green Areas

Curbs in Green Areas in center of roadways will be 2.5' sloping curb and gutter unless otherwise directed by the Road Design Engineer. Curb Grades will be provided and shown in plans for these Green Areas. Attention will be given to eliminate areas that trap water in transition from normal to superelevated sections. Cross Slopes in median will be 12:1 or follow the rate of superelevation. If sloping curbs are recommended, they are to be constructed in accordance to Standard Drawing 720-1.

Types of curbs are affected by design speed. 9" x 15" curbs are not allowed due to constructability problems.

16. Trench Drain Applications

Trench drains should be considered when surface flows are suspected to interfere with traffic operations. Water draining from an adjacent property through a drive toward the roadway can be intercepted by a trench drain installed across the driveway and deposited into the parallel ditch or into a drainage box. In this case, the Trench Drain – 8" Interior Dimension (Driveway Application) may be used.

In curb and gutter sections, the typical section provides for water to get to the gutter. However, when rehabilitating and widening a section of roadway that was previously a ditch section but is now a curb and gutter section, grades, vertical curves and superelevation rotation can create obstacles in getting water to the desired catch basins and storm sewers. Typically, the minimum desired gutter grade is 0.5%; however, 0.3% may be used with adequate cross-slope. Under close scrutiny, 0.2% has been used on short distances and occasionally assisted by increasing the cross-slope. The length of curve can create relatively flat locations on a crest and in a sag vertical curve. Where feasible, catch basin spacing may be reduced to facilitate drainage.

When additional pipe and catch basins are not feasible or the area is not conducive to a catch basin, such as in a driveway, then trench drains may be installed in the gutters to enhance the drainage of the roadway. Trench drains in gutters will reduce potential ponding in the gutter area caused by inherent near flat grades occurring in areas being superelevated and in vertical curves. Typically, the flow line of a trench drain is fixed at 0.6%, but will vary according to the grade of the gutter. Trench drains can be placed in an opposing direction to the gutter grade, as long as the gutter grade does not exceed 0.2% in the opposite direction. For example, this would yield a trench drain flow line grade of 0.4% in a gutter with an opposing grade of 0.2%. This composite grade of the trench drain flow line should not be less than 0.4%.

The guidelines for trench drain use in gutters are:

1. When grades in the gutter are $\leq 0.1\%$. Actual elevations on profile must be checked to determine percent grade in vertical curves.
2. Drainage box within 96 LF to outlet the trench drain.
3. Trench drain must be designed in 16 foot increments. Maximum length of trench drain in one run is 96 LF.
4. Place location and quantity information on "General Construction Note" Sheet as shown on page 9-40.

Quantities for trench drain and curb and gutter will not overlap. When trench drain is extended through a driveway in the gutter, measurement of the trench drain will be made only where the curb and gutter normally is measured. This is typically in drives where the curb drops to the gutter elevation and does not turn away from the roadway on a radius to follow the edge of the driveway. In cases of a driveway where the curb follows a radius away from the roadway, and the trench drain extends into or through the driveway, then the trench drain that is not in the curb and gutter will be measured and paid for as Trench Drain (Driveway). The width of the trench drain including the standard concrete width for the drain will be deducted from the area measurement for concrete driveway.

The pay items for trench drains are:

7192091	Trench Drain – 4” Interior Dimension with 1.5’ curb & gutter	LF
7192092	Trench Drain – 4” Interior Dimension with 2.0’ curb & gutter	LF
7192093	Trench Drain – 4” Interior Dimension with 2.5’ curb & gutter	LF
719209A	Trench Drain – 4” Interior Dimension (Driveway Application)	LF
719209E	Trench Drain – 8” Interior Dimension (Driveway Application)	LF

GENERAL CONSTRUCTION NOTE

CHANGES INVOLVING INCREASED COST OF PROJECT OR CHANGES IN ALIGNMENT MUST BE SPECIFICALLY AUTHORIZED BY THE STATE HIGHWAY ENGINEER. DISTRICT ENGINEERING ADMINISTRATOR MAY AUTHORIZE MINOR ALTERATIONS NOT IN CONFLICT WITH THE STANDARD PRACTICES OF THE DEPARTMENT AND NOT INVOLVING INCREASES IN COST. FORWARD INFORMATION ON ANY CHANGE IN ALIGNMENT TO THE COLUMBIA OFFICE AS SOON AS THE REVISION IS COMPLETED.

SEE INDIVIDUAL CURVES ON PLANS FOR SUPERELEVATION RATE AND DESIGN SPEED.

THE FOLLOWING QUANTITIES ARE NOT SHOWN IN DETAIL ON THE PLANS BUT ARE INCLUDED IN THE SUMMARY OF ESTIMATED QUANTITIES AND MAY BE VARIED DURING CONSTRUCTION AS DIRECTED BY THE ENGINEER:

CLEARING AND GRUBBING DITCHES	2.0 ACRE	FOR OUTFALL DITCHES
REMOVAL AND DISPOSAL OF EXISTING PAVEMENT	385 S.Y.	WHERE DIRECTED BY THE ENGINEER
REMOVAL AND DISPOSAL OF EXISTING ASPHALT PAVEMENT	9240 S.Y.	ALL REMOVAL AND DISPOSAL OF EXISTING ASPHALT PAVEMENT WILL BE MEASURED AND PAID FOR AS DESCRIBED IN THE SPECIAL PROVISIONS
GEOGRID REINF. (BIAXIAL)	6000 S.Y.	WHERE DIRECTED BY THE ENGINEER
UNCLASSIFIED EXCAVATION	59,500 C.Y.	FOR REMOVAL AND DISPOSAL OF UNSTABLE MATERIAL
BORROW EXCAVATION	83,300 C.Y.	FOR REPLACEMENT OF UNSTABLE MATERIAL
FLOWABLE FILL	52 C.Y.	FOR PLUGGING ABANDONED PIPES
MAINTENANCE STONE	250 TON	FOR MAINTENANCE OF DRIVES
PORTLAND CEMENT	1241 TON	FOR CEMENT STABILIZED EARTH BASE (8" UNIF.)
ASHP.AGG. BASE COURSE	327 TON	FOR WIDENING 6' OR LESS
LIQUID ASPHALT BINDER PG.64-22	242 TON	FOR DRIVES AND LEVELING
	14 TON	FOR WIDENING 6' OR LESS
MILLING EXISTING ASPHALT PAVEMENT (VAR.)	670 S.Y.	WHERE DIRECTED BY THE ENGINEER
ASPH. CONC. BINDER COURSE	4637 TON	FOR BUILD-UP AND LEVELING
ASPH. CONC. SURF. COURSE	189 TON	FOR DRIVES AND SIDE ROAD TIE-INS (@ 200 LBS/SY)
CONCRETE FOR STRUCTURES (CLASS 3000)	60 C.Y.	WHERE DIRECTED BY THE ENGINEER
CONCRETE FOR STRUCTURES (CLASS 2500)	1 C.Y.	WHERE DIRECTED BY THE ENGINEER
ARCH. FINISH FOR RET. WALL	4950 SF	FOR CONC. MEDIAN BARRIER AT U.S. RTE. I-95
REINFORCING STEEL FOR STRUCTURES (ROADWAY)	5543 LBS	WHERE DIRECTED BY THE ENGINEER
15" R.C. PIPE CULVERT	150 L.F.	FOR ADDITIONAL SIDE LINES
18" R.C. PIPE CULVERT	150 L.F.	FOR ADDITIONAL SIDE LINES
24" R.C. PIPE CULVERT	150 L.F.	FOR ADDITIONAL SIDE LINES
15"X15" R.C. PIPE CULVERT TEE	5 EA.	WHERE DIRECTED BY THE ENGINEER
TYPE 18 CATCH BASIN	1 EA.	WHERE DIRECTED BY THE ENGINEER
DROP INLET (24"X36")	5 EA.	WHERE DIRECTED BY THE ENGINEER
TRENCH DRAINS 4"ID (GUTTER)	1221 L.F.	TO ENHANCE DRAINAGE
MANHOLE	5 EA.	WHERE DIRECTED BY THE ENGINEER
CONCRETE DRIVEWAY (6" UNIFORM)	2050 S.Y.	FOR DRIVES
AGGREGATE UNDERDRAIN	65 C.Y.	FOR ADDITIONAL UNDERDRAIN TRENCH BACKFILL
6" PERFORATED PIPE UNDERDRAIN	500 L.F.	FOR SUBSURFACE DRAINAGE
RIP-RAP (CLASS B)	100 TON	WHERE DIRECTED BY THE ENGINEER
GEOTEX./EROS. CONTROL UNDER RIP-RAP (UNPROTECTED)-CL2	200 S.Y.	TO BE PLACED UNDER RIP-RAP
ADDITIONAL LENGTH GUARDRAIL POST	230 L.F.	WHERE DIRECTED BY THE ENGINEER
RESET FENCE	2080 L.F.	FOR RESETTING EXISTING FENCE
RESET CHAIN LINK FENCE	1500 L.F.	FOR RESETTING EXISTING FENCE
RESET RIGHT OF WAY MARKER	4 EA.	WHERE DIRECTED BY THE ENGINEER

EROSION CONTROL ITEMS

SEEDING (UNMULCHED)	46.160 M.S.Y.	FOR ALL DISTURBED AREAS
TEMPORARY SEEDING	23.080 M.S.Y.	FOR ALL DISTURBED AREAS
FERTILIZER (10-10-10)	5.966 TON	FOR ALL DISTURBED AREAS
LIME	9.547 TON	FOR ALL DISTURBED AREAS
NITROGEN	458 LBS.	FOR ALL DISTURBED AREAS
MOWING	69.240 M.S.Y.	WHERE DIRECTED BY THE ENGINEER
SODDING	50 S.Y.	FOR TEMPORARY EROSION CONTROL
BALED STRAW	579 EA.	FOR TEMPORARY EROSION CONTROL
SILT FENCE	2000 L.F.	FOR TEMPORARY EROSION CONTROL
SILT BASINS	1000 C.Y.	FOR TEMPORARY EROSION CONTROL

TRENCH DRAINS 4" ID (GUTTER) LOCATIONS

STATION	STATION	LT.OR RT.	LF
84+88	50' R	RT.	64
85+36	50' R	RT.	90
86+54	87+50	RT.	96
87+54	88+50	RT.	96
112+35	112+83	LT.	48
112+35	112+83	RT.	48
140+97	40' R	LT.	84
143+11	141+75	RT.	64
141+75	142+23	RT.	48
142+16	40' R	LT.	64
150+04	151+00	LT.	96
151+00	151+32	LT.	32
151+36	151+52	LT.	16
151+00	151+32	RT.	32
151+36	151+52	RT.	16
156+53	157+13	RT.	60
156+52	157+12	LT.	60
169+19	40' R	RT.	84
169+25	169+41	LT.	16
190+60	191+08	RT.	48
190+54	191+18	LT.	64
SUBTOTAL			1216
INCLUSION			192
TOTAL			1408

NOTE:
TO BE PLACED IN MULTIPLES OF 16' UP TO 96' MAX. LENGTH.

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
4			
3			
2			
1			

TOPO. _____ DATE _____
DWG. _____ DATE _____ SQUAD ____ - ____
R/W _____ DATE _____

SOUTH CAROLINA
DEPARTMENT OF TRANSPORTATION
ROAD DESIGN COLUMBIA, S.C.

SCALE 1"= DWG. NO. PNI