DEPARTMENT OF ENGINEERING
PARISH OF JEFFERSON
STATE OF LOUISIANA

GUIDELINES FOR PARKING LOT STORM RUN-OFF DETENTION

June, 2007

Parking Lot Storm Run-Off Detention

Whenever the runoff of a Commercial Development (0.25 acre or larger) is discharged into an existing drainage system which is designed for less than a 10 year frequency storm, drainage design calculations should be submitted with provisions for detention of runoff in order to reduce the impact on the existing drainage system.

The following two examples contain the detailed design of parking lot detention basins. Example 1 is calculated using a 0.25 acre watershed. Example 2 uses a 0.5 acre watershed. The results of these designs are shown in Step 8 of the examples.

Detailed Design Procedures

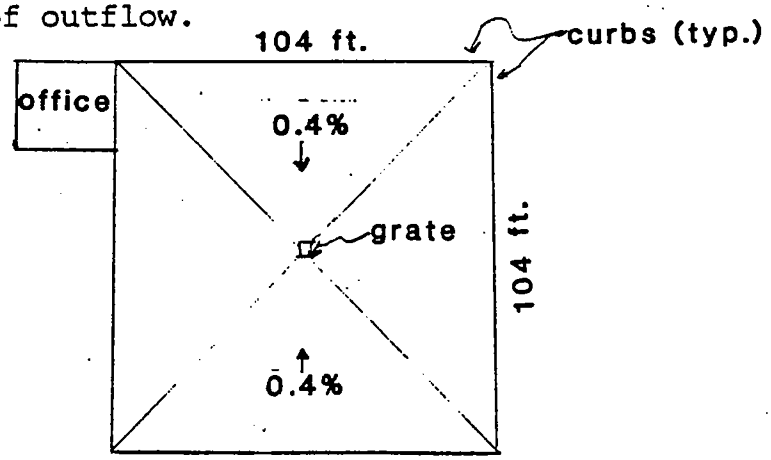
The design of parking lot detention basins involve the following steps. These steps are explained in detail in Example 1.

1. Determine volume of storage for specified increment of depth.
2. Determine depth-storage curve for the basin.
3. Select the outlet structure types based on the volume of storage needed as determined in steps 1 and 2.
4. Determine the depth-outflow curve for chosen outlet structure.
5. Determine the routing curve.
6. Determine the inflow hydrograph.
7. Perform the routing.
8. Interpreting the results.

EXAMPLE 1

Assume that a commercial development consists of ±0.25 acre with office building and parking lot as shown in Figure below. The size of the parking lot is 104 feet by 104 feet. The parking lot slopes to the center at a 0.4 percent grade and is surrounded by a 6-inch high curb.

The design of the parking lot is intended to keep the peak outflow rate as low as possible so that the existing storm sewers in the area can more efficiently handle the given amount of outflow.



STEP 1 Determine volume of storage for specified increment of depth

The basin is comprised of two sections:

A) Lower - truncated pyramid
B) Upper - cubical section

Lower Volume:

$$\text{Volume} = 1/3\ h_1(A_1 + A_2 + \text{SQRT}(A_1 \times A_2))$$

h_1 = Depth of water in lower section
A_1 = Area in lower section at grate
A_2 = Area at depth of water (h_1)

Upper Volume:

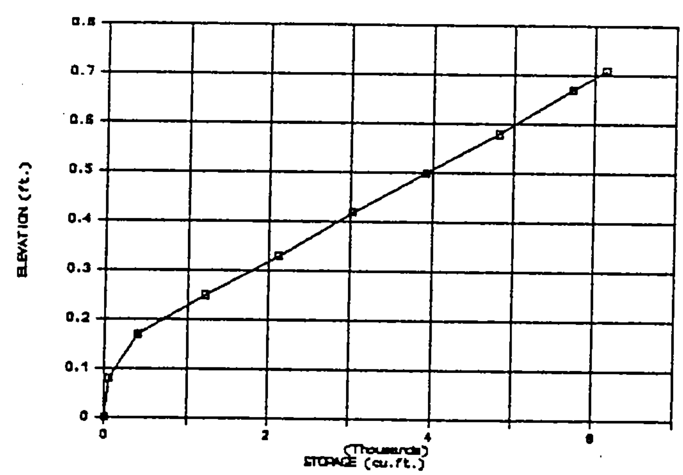
$$\text{Volume} = \text{Area} * h_2$$

A = Area at the curbline
h_2 = Depth of water in upper section

Calculate volume associated with 1 inch increments of depth up to overflow depth. After such water will overflow curbs.

STEP 2 Determine Depth-Storage curve

Figure 1

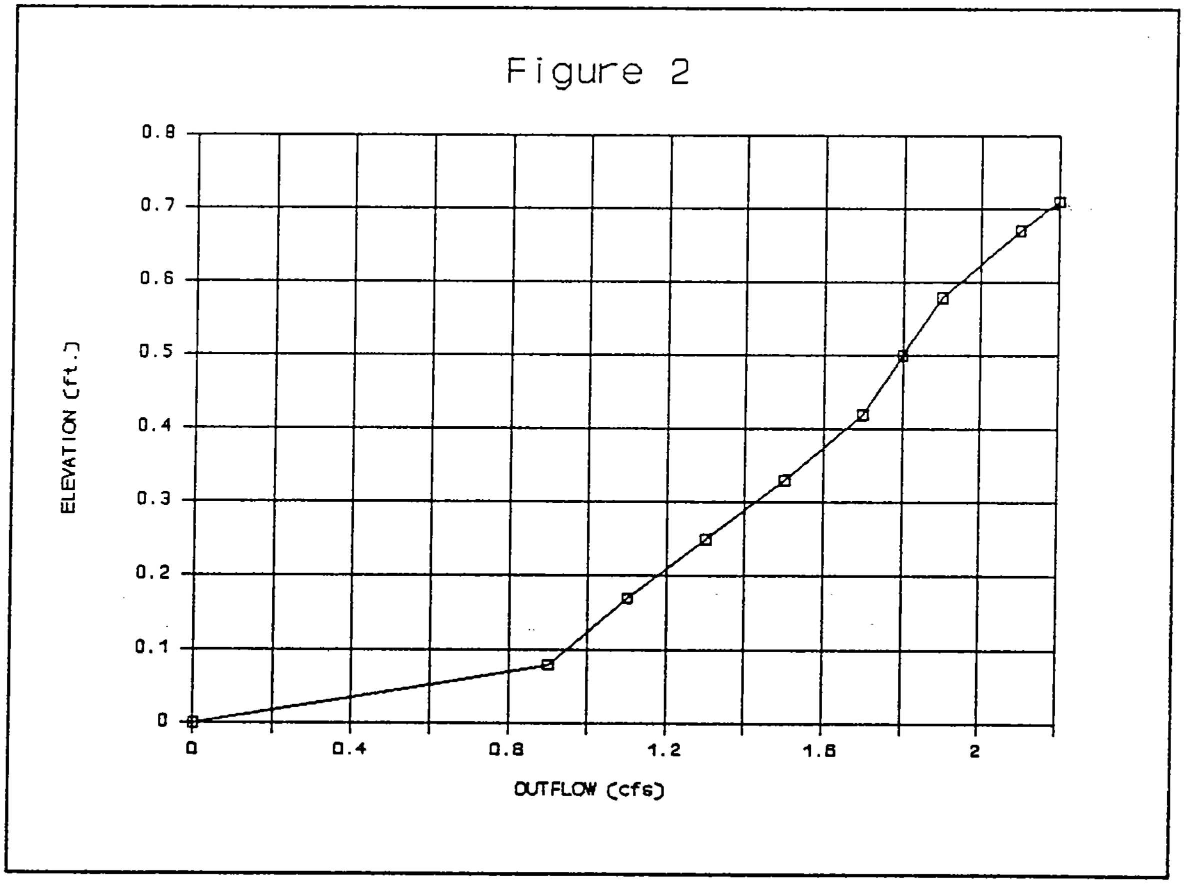


STEP 3 Select outlet structure

For Example 1, a 12" x 12" grate inlet is chosen.

STEP 4 Determine the Depth-Outflow curve for chosen outlet

Using Reference Figure (usually supplied by manufacturer), a Depth-Outflow curve can be drawn using an open area for a 12" x 12" grate of 67 inches^2.



STEP 5 Determine routing curve

The routing curve is based on the following:

1. Choose routing period (T), (set time = 1/4 to 1/6 Time of Concentration, T_c = 10 minutes).

   For Example 1, The routing period (T) is assumed to be 1/4 of T_c = 2.5 min. or 150 seconds.

2. For every increment of depth there is a specific storage and outflow.

3. From this information, we can calculate 2S/T + O

4. Outflow Vs. 2S/T + O is now graphed.

See Routing Curve Calculations (See Table 1)

Figure 3

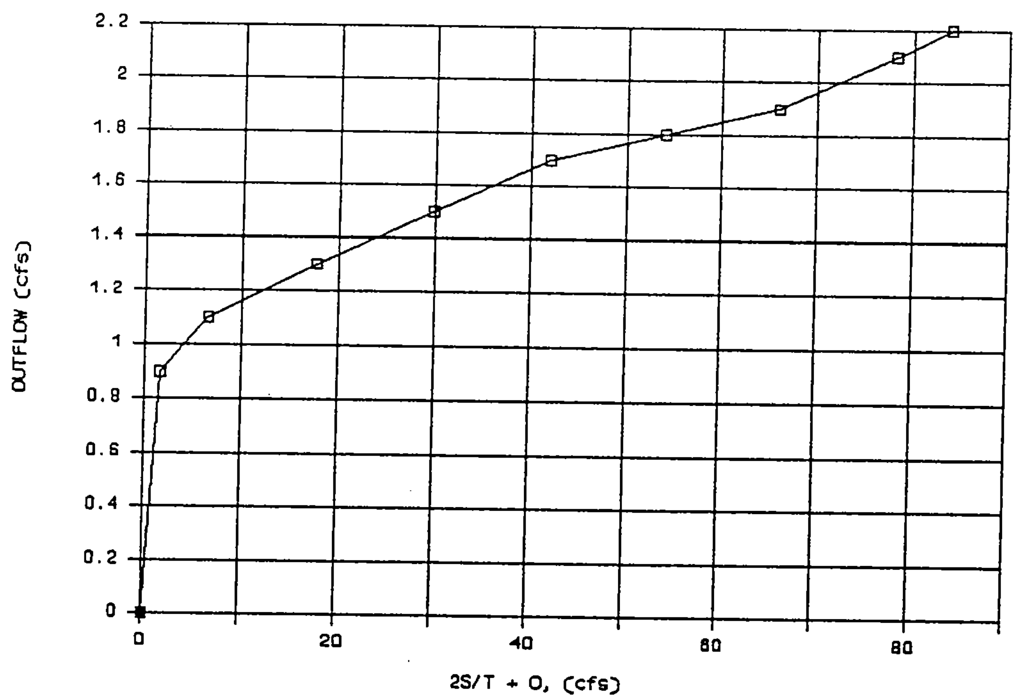


TABLE 1

ROUTING CURVE CALCULATIONS

Routing Period (T) - 150 seconds

Elevation,ft.	Storage,cu.ft.	Outflow,cfs	2S/T + O ,cfs
0.00	0.00	0.00	0.00
0.08	51.18	0.90	1.58
0.17	402.18	1.10	6.46
0.25	1,225.81	1.30	17.64
0.33	2,123.54	1.50	29.81
0.42	3,021.27	1.70	41.98
0.50	3,919.00	1.80	54.05
0.58	4,816.73	1.90	66.12
0.67	5,714.46	2.10	78.29
0.71	6,136.28	2.20	84.02

Step 6 Determine inflow hydrographs

Using methods to determine inflow (Detailed in section 2 of Jefferson Parish Storm Drainage Design Manual).

For Example 1, the Rational Method is used.

Area = 0.25 acres
Runoff Coefficient = 0.9
Time of concentration (Tc) = 10 minutes
10 year frequency storm with Tc = 10 min, from Figure 2-3 pg 2-18 JPSDDM
Rainfall Intensity (I) = 7.0 inches/hour

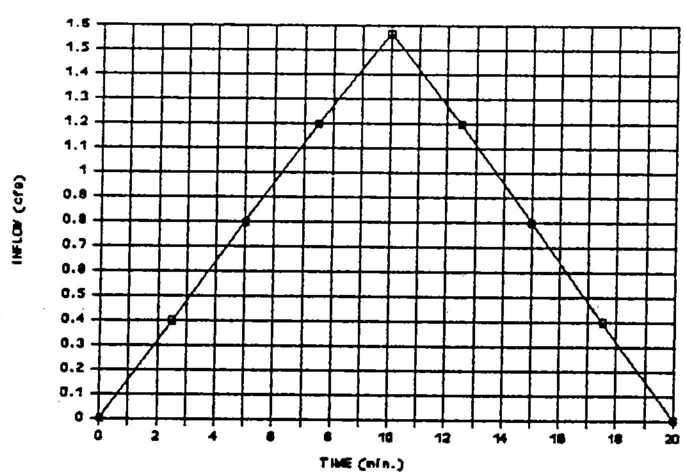
$$Q = C\ i\ A$$

$$Q_{10} = (0.9)\ (7.0\ \text{in/hr})\ (0.25\ \text{acres})$$

$$Q_{10} = 1.57\ \text{cfs}$$

Referring to Section 2 of the JPSDDM, the inlet hydrograph is drawn:

Figure 4



STEP 7 Perform Routing

Using Routing Equation:

$$I_1 + I_2 + (2(S_1)/T - O_1) = 2(S_2)/T + O_2 \quad \text{Equation (1)}$$

Now perform routing for Example 1.
For results see Table 2.

1. Line 1 - Set all initial inflow and outflow = 0

2. Line 2: Column 1 - From inflow hydrograph at t = 150 sec. increments

   Column 2: column 1,line 1 + column 1,line 2

   Column 3: column 4,line 2 - 2*column 5,line 2

   Column 4: column 2,line 2 + column 3,line 1

   Column 5: Take value from Column 4 to Routing Curve (Fig. 4) and find Outflow (O_2)

3. Line 3: Column 1: From inflow hydrograph

   Column 2: column 1,line 2 + column 1,line 3

   Column 3: column 4,line 3 - 2*column 5, line 3

   Column 4: column 2,line 3 + column 3,line 2

   Column 5: Take value from Column 4,line 3 to Routing Curve (Fig. 3) and find Outflow

3. Continue this process with previous line O_2 becoming current line O_1.

4. This process can be terminated when values of Outflow (O) begin to fall.

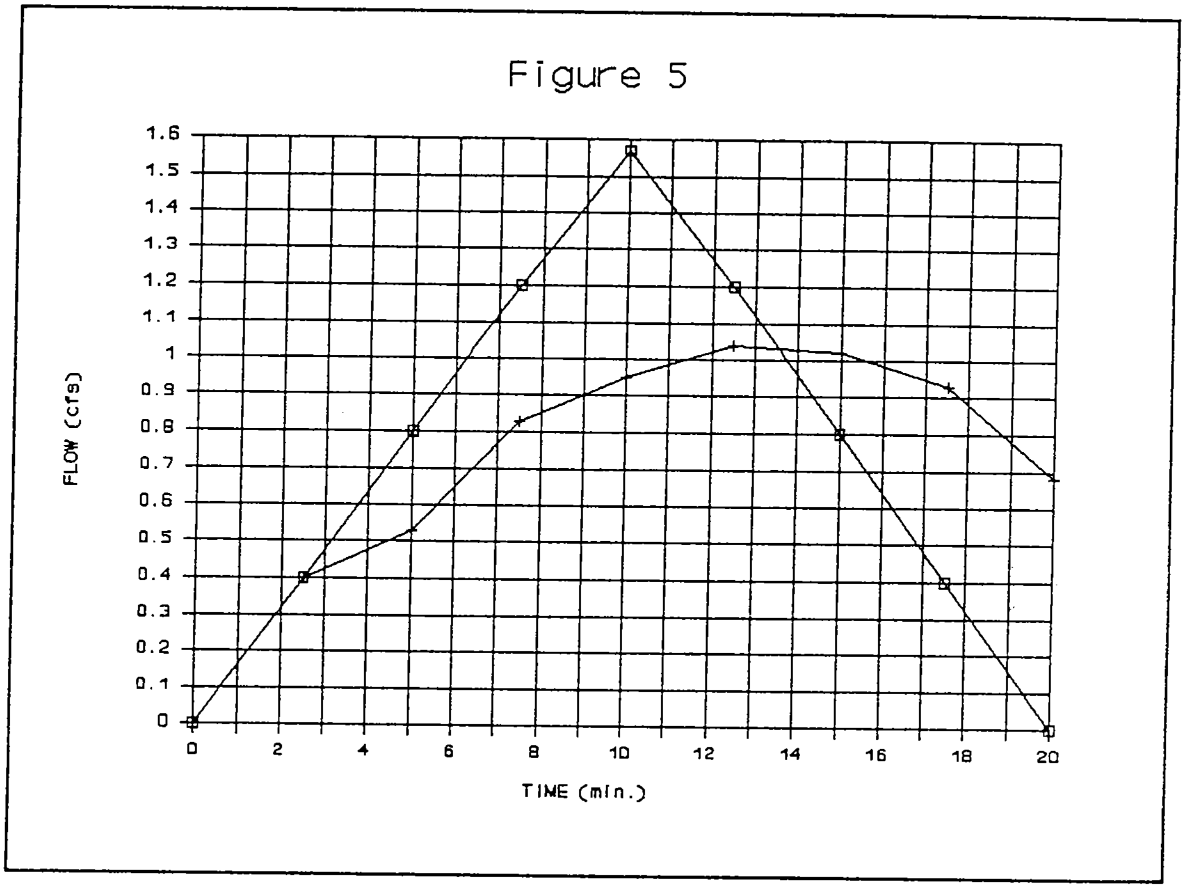
TABLE 2

ROUTING FORM

Line\Column	(1)	(2)	(3)	(4)	(5)
	I (Inflow)	I1 + I2	2S/T - O	2S/T + O	O (outflow)
(1)	0.00	0.00	0.00	0.00	0.00
(2)	0.40	0.40	-0.40	0.40	0.40
(3)	0.80	1.20	-0.26	0.80	0.53
(4)	1.20	2.00	0.08	1.74	0.83
(5)	1.57-PEAK	2.77	0.95	2.85	0.95
(6)	1.20	2.77	1.64	3.72	1.04-PEAK
(7)	0.80	2.00	1.60	3.64	1.02
(8)	0.40	1.20	0.94	2.80	0.93
(9)	0.00	0.40	-0.02	1.34	0.68

STEP 8 Interpreting Results

1. Comparison of inflow hydrograph with outflow hydrograph:



2. The difference between the peak of the inflow hydrograph and the peak of the outflow hydrograph is the reduction in peak flow due to detention.

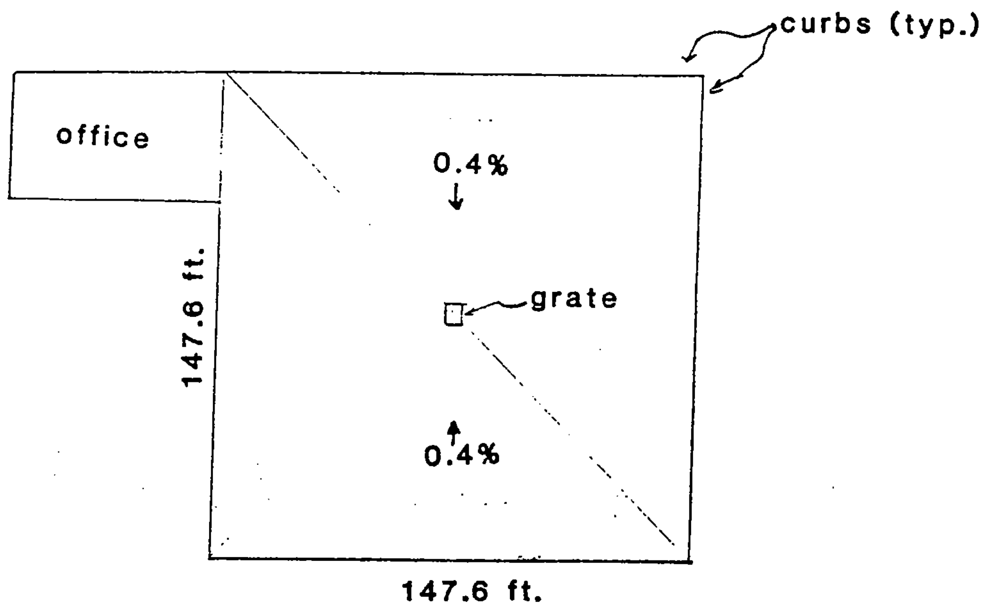
   This can be shown by comparing Column 1 and Column 5 of of Table 2.

3. For Example 1, the Peak Flow was reduced from 1.57 cfs to 1.04 cfs. A reduction of ± 34%.

EXAMPLE 2

Assume that a commercial development consists of ±0.5 acre with office building and parking lot as shown in Figure below. The size of the parking lot is 147.6 feet by 147.6 feet. The parking lot slopes to the center at a 0.4 percent grade and is surrounded by a 6-inch high curb.

The design of the parking lot is intended to keep the peak outflow rate as low as possible so that the existing storm sewers in the area can more efficiently handle the given amount outflow.



STEP 1 Determine volume of storage for specified increment of depth

The basin is comprised of two sections:

A) Lower - truncated pyramid
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Lower Volume:

$$Volume = 1/3\ h_1(A_1 + A_2 + SQRT(A_1 \times A_2))$$

h_1 = Depth of water in lower section
A_1 = Area in lower section at grate
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Upper Volume:

$$Volume = Area * h_2$$

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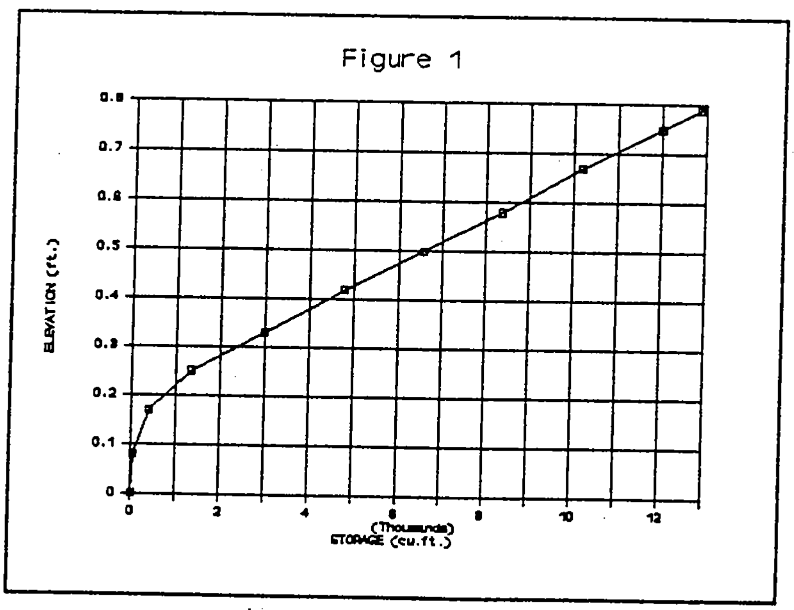
STEP 2 Determine Depth-Storage curve



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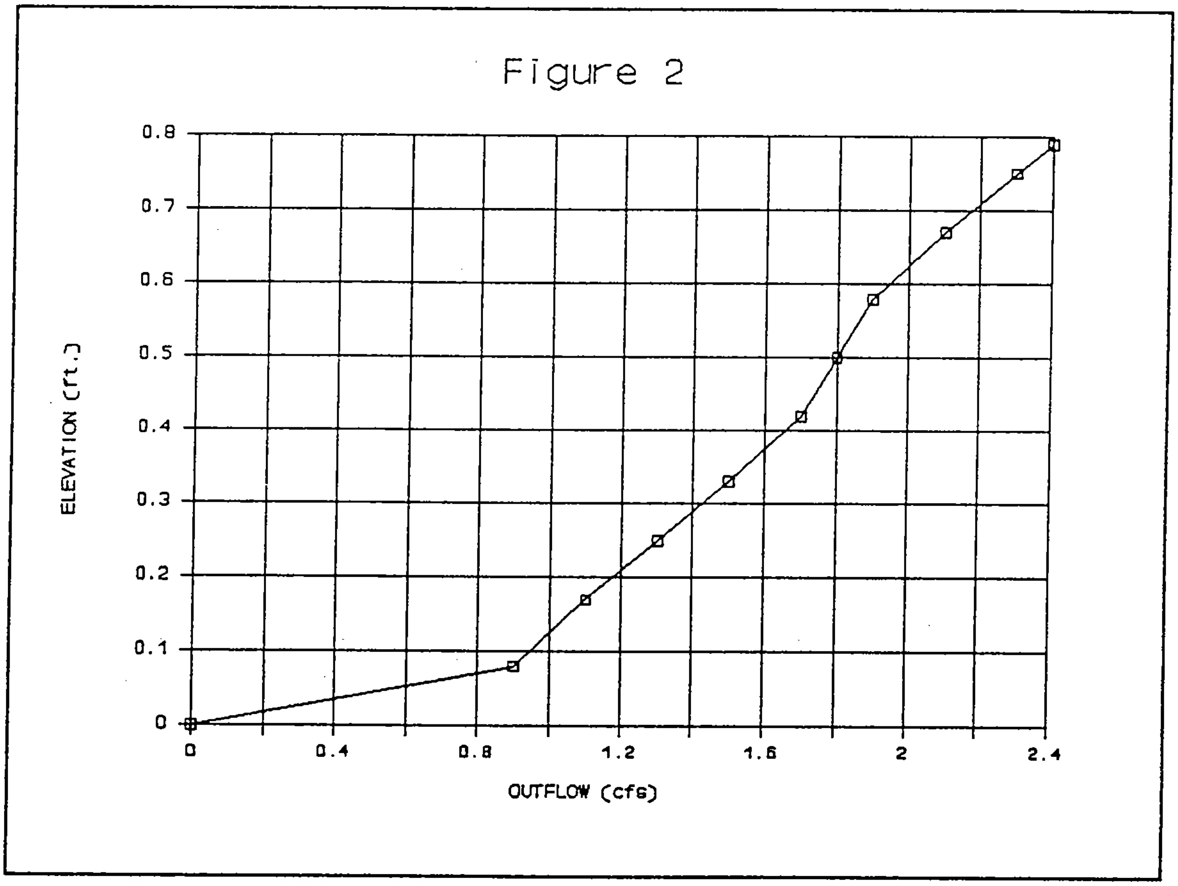
For Example 2, a 12" x 12" grate inlet is chosen.

STEP 4 Determine the Depth-Outflow curve for chosen outlet

Using Reference Figure (usually supplied by manufacturer), a Depth-Outflow curve can be drawn using an open area for a 12" x 12" grate of 67 inches^2.



STEP 5 Determine routing curve

The routing curve is based on the following:

1. Choose routing period (T), (set time = 1/4 to 1/6 Time of Concentration, T_c = 10 minutes).

   For Example 2, The routing period (T) is assumed to be 1/4 of T_c = 2.5 min. or 150 seconds.

2. For every increment of depth there is a specific storage and outflow.

3. From this information, we can calculate 2S/T + O

4. Outflow Vs. 2S/T + O is now graphed.

See Routing Curve Calculations (See Table 1)

Figure 3

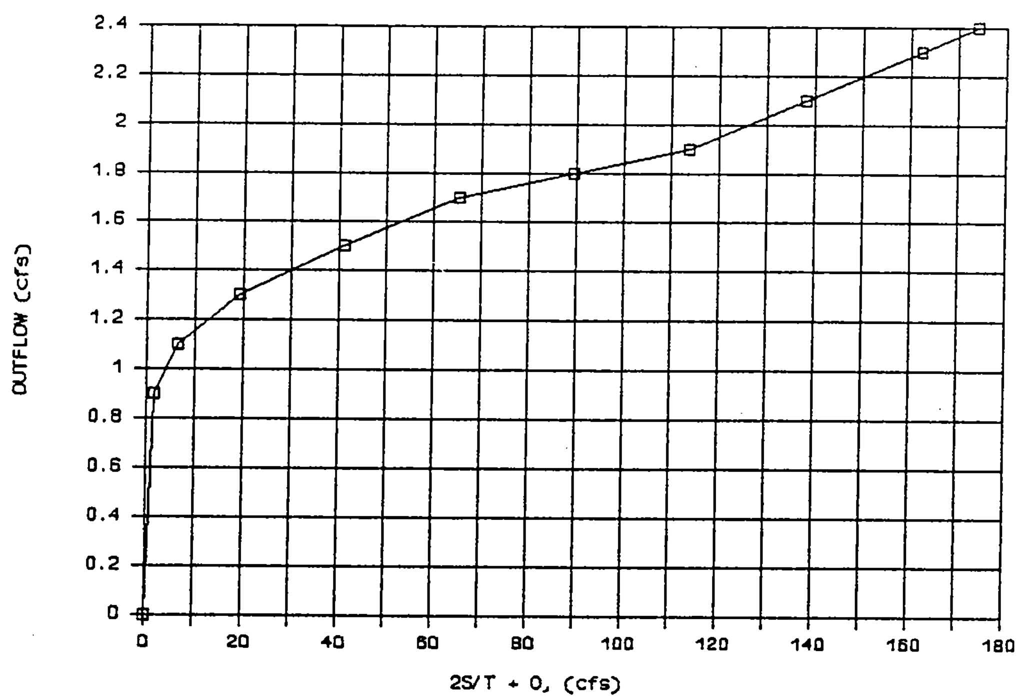


TABLE 1

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Routing Period - 150 seconds

Elevation,ft.	Storage,cu.ft.	Outflow,cfs	2S/T + O , cfs
0.00	0.00	0.00	0.00
0.08	51.18	0.90	1.58
0.17	402.18	1.10	6.46
0.25	1,333.58	1.30	19.08
0.33	2,964.35	1.50	41.02
0.42	4,772.57	1.70	65.33
0.50	6,580.79	1.80	89.54
0.58	8,389.01	1.90	113.75
0.67	10,197.23	2.10	138.06
0.75	12,005.45	2.30	162.37
0.79	12,876.88	2.40	174.09

Step 6 Determine inflow hydrographs

Using methods to determine inflow (Detailed in section 2 of Jefferson Parish Storm Drainage Design Manual).

For Example 2, the Rational Method is used.

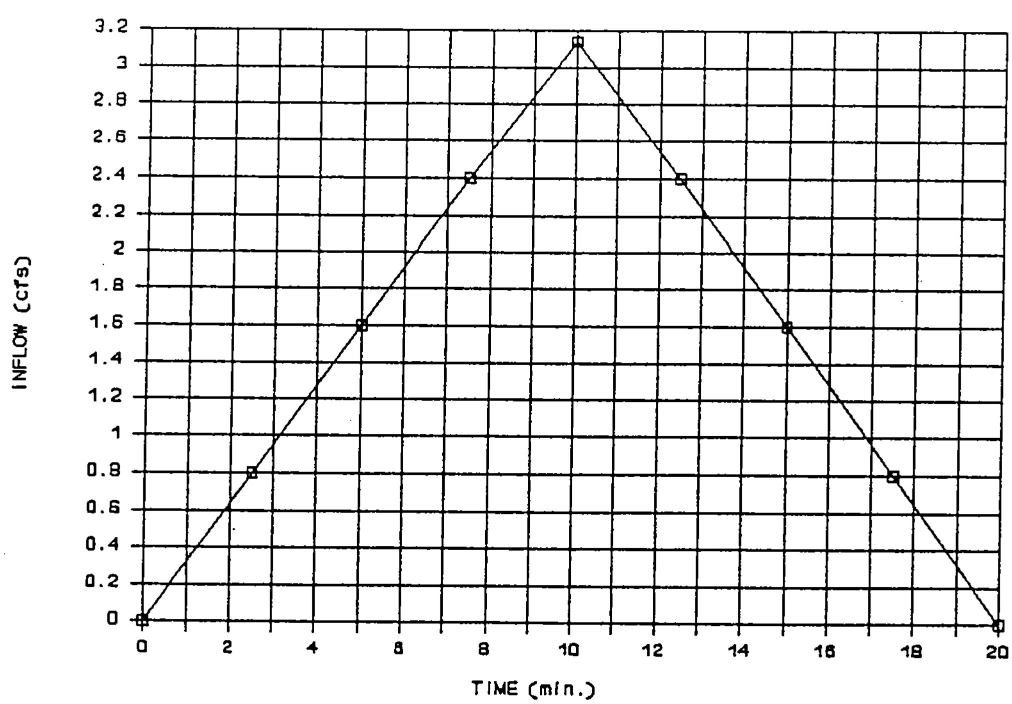
Area = 0.5 acres
Runoff Coefficient = 0.9
Time of concentration (Tc) = 10 minutes
10 year frequency storm with Tc = 10 min, from Figure 2-3 pg 2-18 JPSDDM
Rainfall Intensity (I) = 7.0 inches/hour

$Q = C\ i\ A$
$Q_{10} = (0.9)\ (7.0\ \text{in/hr})\ (0.5\ \text{acres})$

$Q_{10} = 3.14$ cfs

Referring to Section 2 of the JPSDDM, the inlet hydrograph is drawn:

Figure 4



STEP 7 Perform Routing

Using Routing Equation:

$$I_1 + I_2 + (2(S_1)/T - O_1) = 2(S_2)/T + O_2 \quad \text{Equation (1)}$$

Now perform routing for Example 2.
For results see Table 2.

1. Line 1 - Set all initial inflow and outflow = 0

2. Line 2: Column 1 - From inflow hydrograph at t = 150 sec. increments

   Column 2: column 1,line 1 + column 1,line 2

   Column 3: column 4,line 2 - 2*column 5,line 2

   Column 4: column 2,line 2 + column 3,line 1

   Column 5: Take value from Column 4 to Routing Curve (Fig. 4) and find Outflow (O_2)

3. Line 3: Column 1: From inflow hydrograph

   Column 2: column 1,line 2 + column 1,line 3

   Column 3: column 4,line 3 - 2*column 5,line 3

   Column 4: column 2,line 3 + column 3,line 2

   Column 5: Take value from Column 4,Line 3 to Routing Curve (Fig. 4) and find Outflow

3. Continue this process with previous line O_2 becoming current line O_1

4. This process can be terminated when values of Outflow (O) begin to fall.

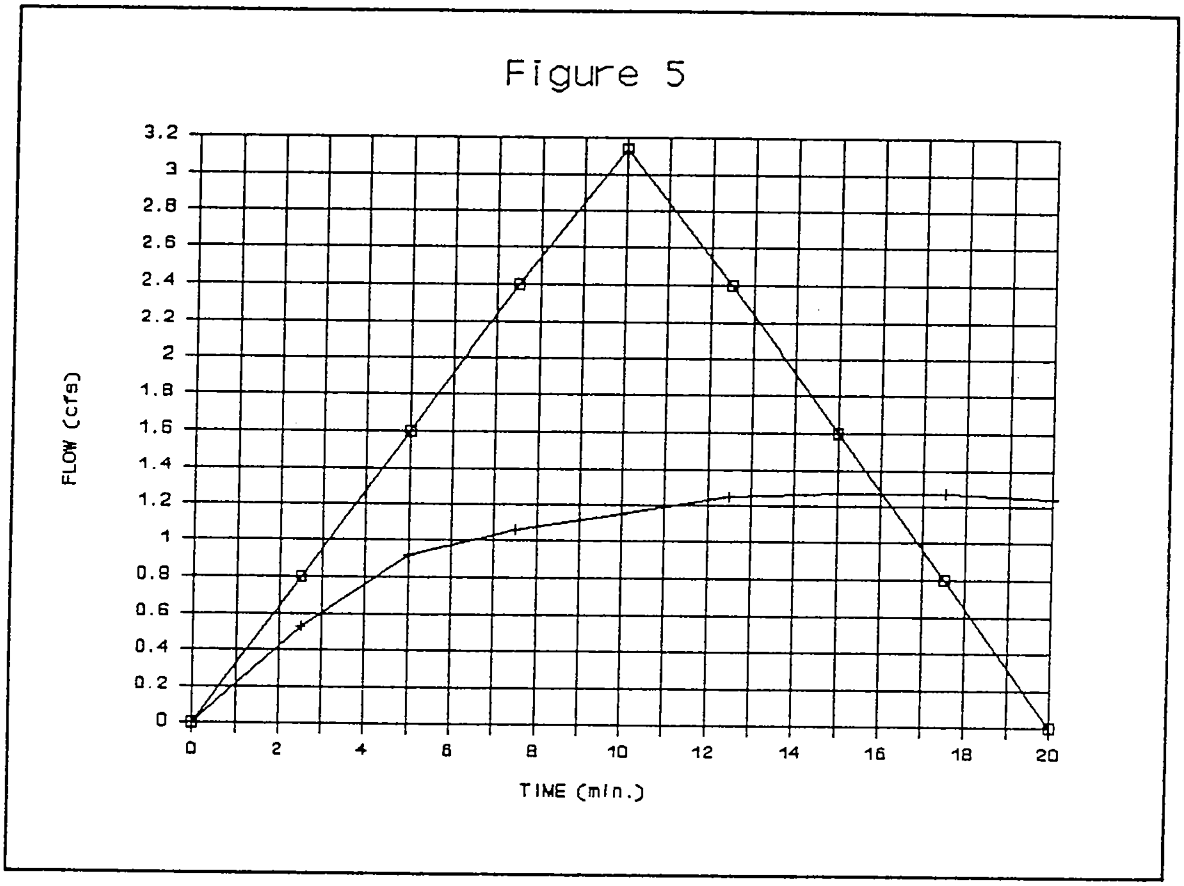
TABLE 2

ROUTING FORM

Line/Column	(1) I (Inflow)	(2) I1 + I2	(3) 2S/T - O	(4) 2S/T + O	(5) O (outflow)
(1)	0.00	0.00	0.00	0.00	0.00
(2)	0.80	0.80	-0.26	0.80	0.53
(3)	1.60	2.40	0.30	2.14	0.92
(4)	2.40	4.00	2.18	4.30	1.06
(5)	3.14-PEAK	5.54	5.42	7.72	1.15
(6)	2.40	5.54	8.46	10.96	1.25
(7)	1.60	4.00	9.92	12.46	1.27-PEAK
(8)	0.80	2.40	9.78	12.32	1.27
(9)	0.00	0.80	8.10	10.58	1.24

STEP 8 Interpreting Results

1. Comparison of inflow hydrograph with outflow hydrograph:



2. The difference between the peak of the inflow hydrograph and the peak of the outflow hydrograph is the reduction in peak flow due to detention.

   This can be shown by comparing Column 1 and Column 5 of Table 2.

3. For Example 1, the Peak Flow was reduced from 3.14 cfs to 1.27 cfs. A reduction of ± 59%.