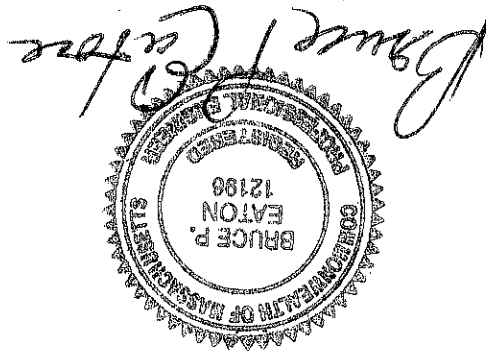


CIVIL ENVIRONMENTAL CONSULTANTS LLC, 8 OAK ST., PEABODY, MA 01960



JUNE 11, 2014

SOMERVILLE, MA

163 GLEN STREET

at

DRAINAGE REPORT

CITY CLERK'S OFFICE
SOMERVILLE, MA

2014 JUN 12 A 10:21

Drainage Report
244 Main Street
Medford, MA

JUNE 11, 2014

General

This report is enclosed to accompany the Drainage details shown on the site plan, submitted for the modification of an existing structure to a multilevel 11 unit Residential building at 163 Glen Street. The existing building will be remodeled and additional floors added with drainage connected to a drywells for storage and infiltration.

To provide adequate design, a test hole was dug to determine the type of soil to be used in the accompanying design work.

Due to the existing conditions of the site with 85% of the lot covered by either existing structure or pavement, there is a net reduction in peak flow.
The drainage analysis computed peak runoff for Pre and Post conditions for 2 yr, 10 yr, 25 yr, and 100 yr storms.

Methodology

The Soil Conservation Service (SCS) Auto-Desk Land Development Program was used to analyze Pre and Post Developed site conditions, to determine time of concentration, composite runoff numbers, intensity, and storm runoff.

The table below shows relative storms for Pre- and Post Developed conditions with the decreased flow differential.

Year Storm	Pre-Developed Q=cfs	Post-Developed Q=cfs	Difference cfs
2 yr.	1.06	0.93	0.13 lower
10 yr.	1.45	1.31	0.14 lower
25 yr.	1.82	1.66	0.16 lower
100 yr.	2.45	2.29	0.16 lower

Due to the reduction in flow in the proposed design, the first inch of rainfall will be infiltrated on site. Calculations as follows:

DRAINAGE DESIGN FIRST 1" RAINFALL

BUILDING FOOTPRINT 4,771 sq.ft.
PARKING LOT & WALKWAYS 7,708 sq.ft.
TOTAL IMPERVIOUS AREA 12,479sq.ft.

INFILTRATE 1" RUNOFF

1"=0.0833'

12,479 X 0.0833= 1,039.87 CU.FT. RUNOFF STORAGE REQUIRED

1000 GALLON DRYWELL WITH 10X10 STONE BOX SURROUND

7.4805 GALLONS PER CUBIC FOOT

1000/7.4805=133.7 CUBIC FEET OF STORAGE PER 1000 GALLON DRYWELL

VOLUME OF STONE SURROUND

10X10X7=700 CU.FT.STONE VOLUME

700 STONE VOLUME - 133.7 CHAMBER VOLUME= 566.3 CU.FT. STONE VOLUME

VOIDS CALCULATIONS - USE 0.3 VOID VOLUME

66.3 STORAGE VOLUME X 0.3 (VOIDS) = 169.89 CU.FT. VOID WATER STORAGE

TOTAL STORAGE VOLUME

169.89 VOID STORAGE + 133.7 DRYWELL STORAGE = 303.59 CU.FT. STORAGE PER DRYWELL

USE (4) 1000 GALLON DRYWELLS WITH 10X10 STONE BOX SURROUND

4 (DRYWELLS) X 303.59 (STORAGE VOLUME PER DRYWELL) = 1,214.36 CU.FT. STORAGE CAPACITY

1,214.36 CU.FT. STORAGE CAPACITY > 1,039.87 CU.FT. 1" RAIN RUNOFF STORAGE REQUIREMENT MET

PRE-DEVELOPED HYDROGRAPHS

tmp#8

TR-55 Tabular Hydrograph Method

Input Summary

Description
EXISTING CONDITIONS 2YR
Rainfall Distribution
Type III
off
Total Area
0.3886 ac
Peak Time
12.2000 hrs
Peak Flow
1.0627 cfs

Given Input Data:

Subarea	D/S Subareas	Area (ac)	CN	Tc (hrs)	Tt (hrs)	Rainfall (in)
163GLEN		0.3886	95	0.0726	0.0133	3.2000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description
Manning's n
0.0110
Flow Length
115.0000 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0173 ft/ft
Computed Sheet Flow time
> 0.0239 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description
Surface
Paved
Flow Length
100.0000 ft
Watercourse Slope
0.0200 ft/ft
Velocity
2.8748 fps
Computed Shallow Flow time
> 0.0097 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description
Manning's n
0.0500
Flow Length
61.3773 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0300 ft/ft
Computed Sheet Flow time
> 0.0390 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Total Time of Concentration
> 0.0726 hrs

```

Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.
*****
Total Time of Travel ..... > 0.0133 hrs
*****

Description .....
Surface .....
Flow Length .....
Watercourse Slope .....
Velocity .....
Computed Shallow Flow time ..... > 0.0133 hrs

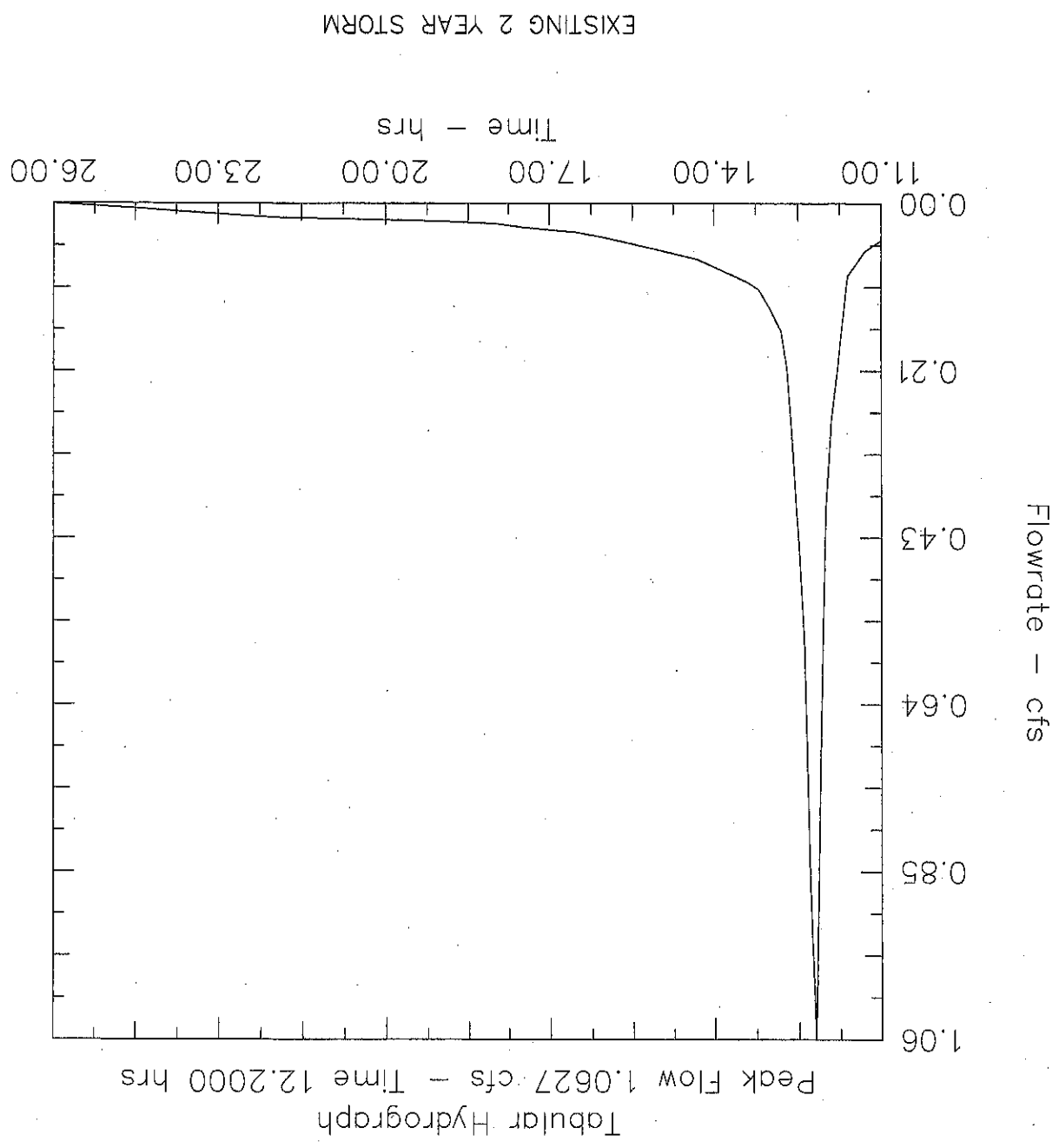
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Info: Time of Concentration rounded to 0.1000 hrs in row <1>.
*****
Total Time of Travel ..... > 0.0133 hrs
*****

Composite Runoff Curve Number Calculator

Description      Area (ac)      Curve Number
-----
BUILDING         0.1210         98
PAVEMENT         0.2060         98
LANDSCAPE        0.0616         79
Total Area -----> 0.3886         95 <----- weighted CN

Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

```



tmp#9

TR-55 Tabular Hydrograph Method

Input Summary

Description
EXISTING CONDITIONS 10YR
Rainfall Distribution
Type III
Ia/P Interpolation
Total Area
0.3886 ac
Peak Time
12.2000 hrs
Peak Flow
1.4579 cfs

Given Input Data:

Subarea	D/S Subareas	Area (ac)	CN	TC (hrs)	Tt (hrs)	Rainfall (in)
163GLEN		0.3886	95	0.0726	0.0133	4.2000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description
Manning's n
0.0110
Flow Length
115.0000 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0173 ft/ft
Computed Sheet Flow time
> 0.0239 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description
Surface
Paved
Flow Length
100.0000 ft
Watercourse Slope
0.0200 ft/ft
Velocity
2.8748 fps
Computed Shallow Flow time
> 0.0097 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description
Manning's n
0.0500
Flow Length
61.3773 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0300 ft/ft
Computed Sheet Flow time
> 0.0390 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Total Time of Concentration
> 0.0726 hrs

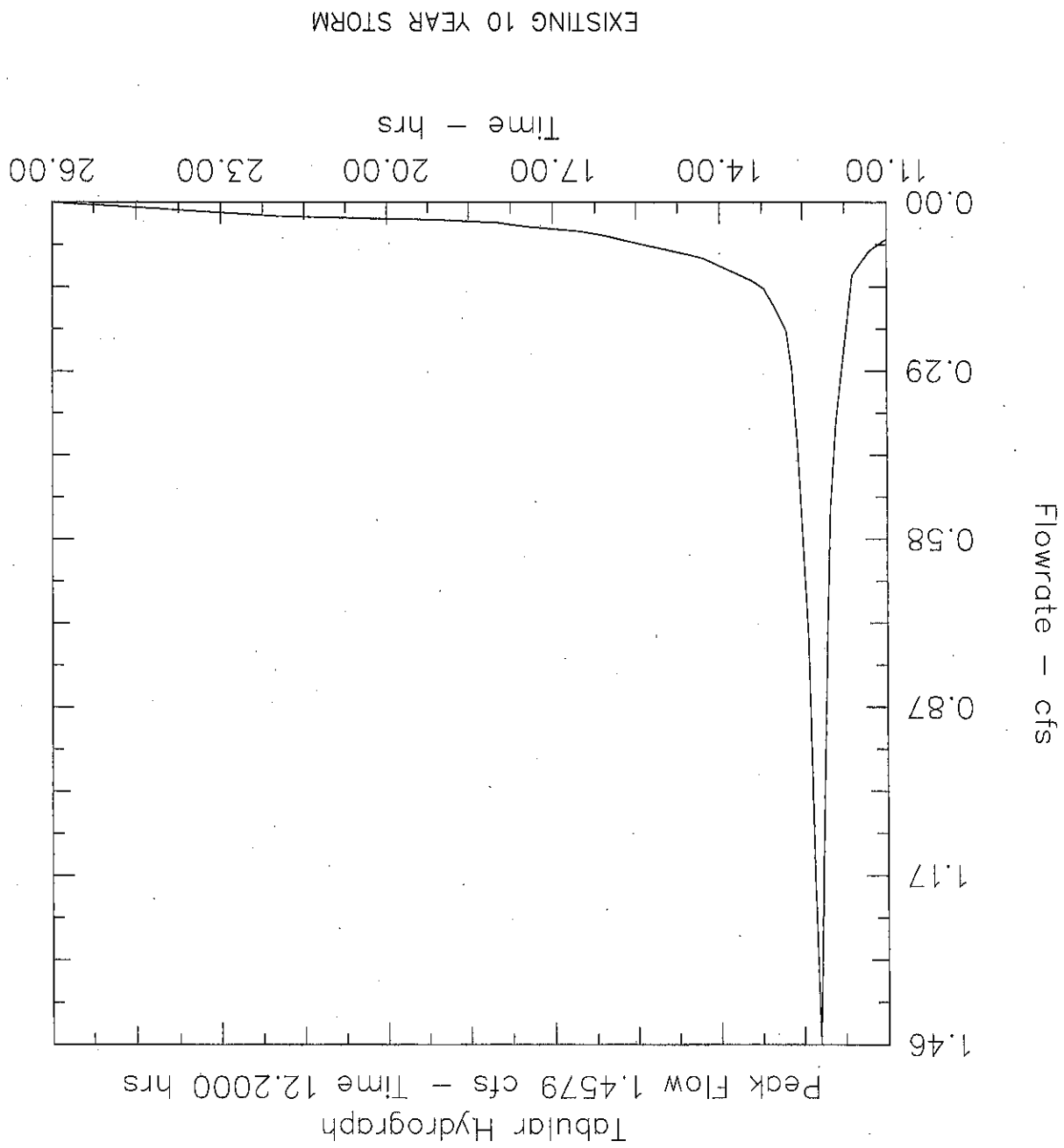
```

tmp#9
TRAVEL
Paved
Flow Length 115.0000 ft
Watercourse Slope 0.0140 ft/ft
Velocity 2.4053 fps
Computed shallow flow time .....> 0.0133 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.
*****
Total Time of Travel .....> 0.0133 hrs
*****

Composite Runoff Curve Number Calculator

Description      Area (ac)      Curve Number
-----
BUILDING         0.1210
PAVEMENT         0.2060
LANDSCAPE        0.0616
Total Area -----> 0.3886
95 -----> weighted CN
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

```



tmp#10

TR-55 Tabular Hydrograph Method

Input Summary

Description
EXISTING CONDITIONS 25YR
Rainfall Distribution
Type III
off
Total Area
0.3886 ac
Peak Time
12.2000 hrs
Peak Flow
1.8157 cfs

Given Input Data:

Subarea	D/S subareas	Area (ac)	CN	Tc (hrs)	Tt (hrs)	Rainfall (in)
163GLEN		0.3886	95	0.0726	0.0133	5.1000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description
Manning's n
0.0110
Flow Length
115.0000 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0173 ft/ft
Computed Sheet flow time
> 0.0239 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description
Surface
Paved
Flow Length
100.0000 ft
Watercourse Slope
0.0200 ft/ft
Velocity
2.8748 fps
Computed shallow flow time
> 0.0097 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description
Manning's n
0.0500
Flow Length
61.3773 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0300 ft/ft
Computed Sheet flow time
> 0.0390 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Total Time of Concentration
> 0.0726 hrs

```

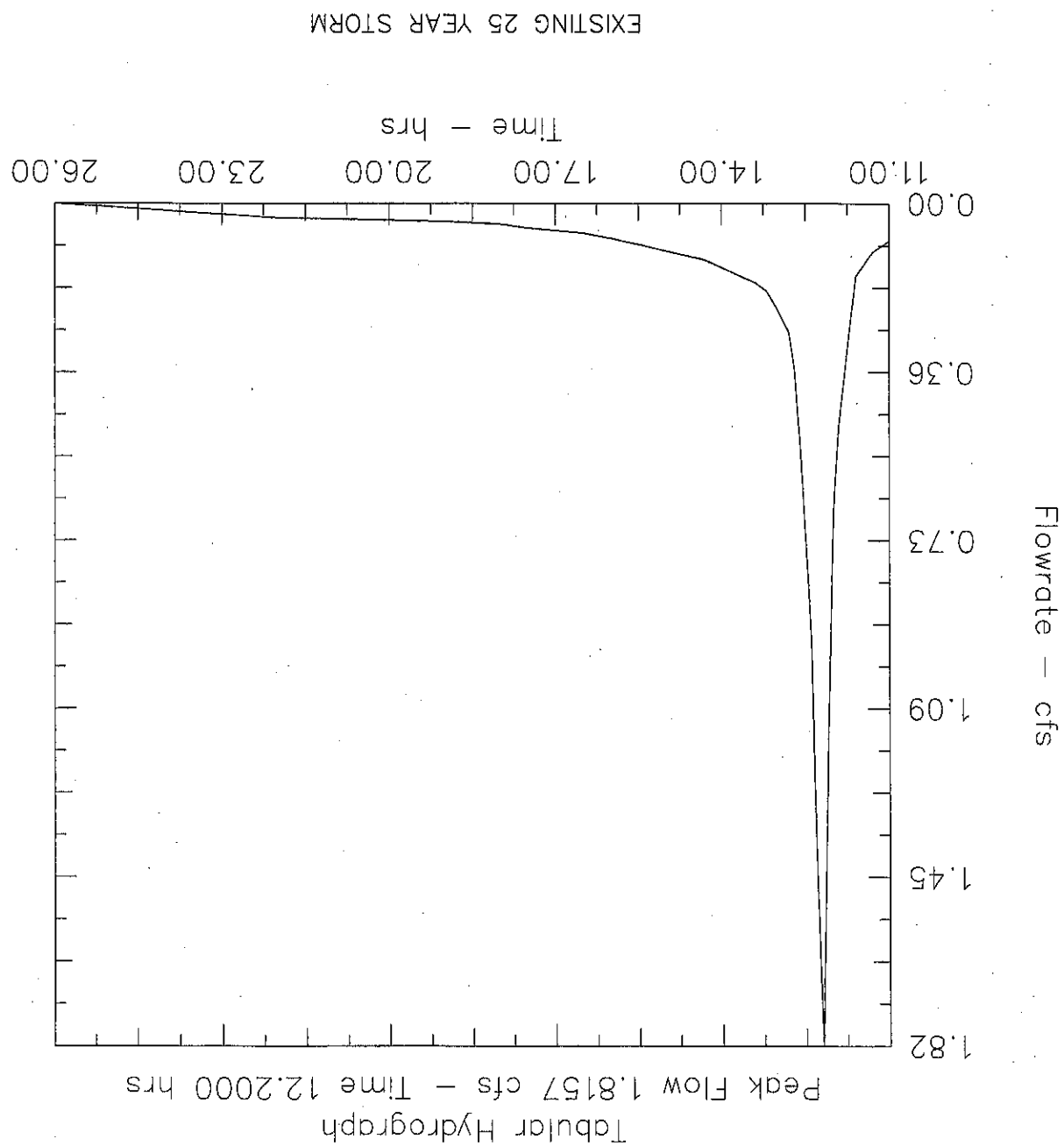
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.
*****
Total Time of Travel ..... > 0.0133 hrs
*****

Description .....
Surface .....
Paved .....
TRAVEL .....
tmp#10 .....
Flow Length ..... 115.0000 ft
Watercourse Slope ..... 0.0140 ft/ft
Velocity ..... 2.4053 fps
Computed Shallow flow time ..... > 0.0133 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.
*****
Total Time of Travel ..... > 0.0133 hrs
*****

Composite Runoff Curve Number Calculator

Description      Area (ac)      Curve Number
-----
BUILDING         0.1210
PAVEMENT         0.2060
LANDSCAPE        0.0616
Total Area -----> 0.3886
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

```



tmp#11

TR-55 Tabular Hydrograph Method

Input Summary

Description
EXISTING CONDITIONS 100YR
Rainfall Distribution
Type III
Off
Total Area
0.3886 ac
Peak Time
12.2000 hrs
Peak Flow
2.4543 cfs

Given Input Data:

Subarea	D/S Subareas	Area (ac)	CN	TC (hrs)	TT (hrs)	Rainfall (in)
163GLEN		0.3886	95	0.0726	0.0133	6.7000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description
Manning's n
0.0110
Flow Length
115.0000 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0173 ft/ft
Computed sheet flow time
> 0.0239 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description
Surface
Paved
Flow Length
100.0000 ft
Watercourse slope
0.0200 ft/ft
Velocity
2.8748 fps
Computed shallow flow time
> 0.0097 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description
Manning's n
0.0500
Flow Length
61.3773 ft
Two Yr, 24 hr Rainfall
3.2000 in
Land Slope
0.0300 ft/ft
Computed sheet flow time
> 0.0390 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

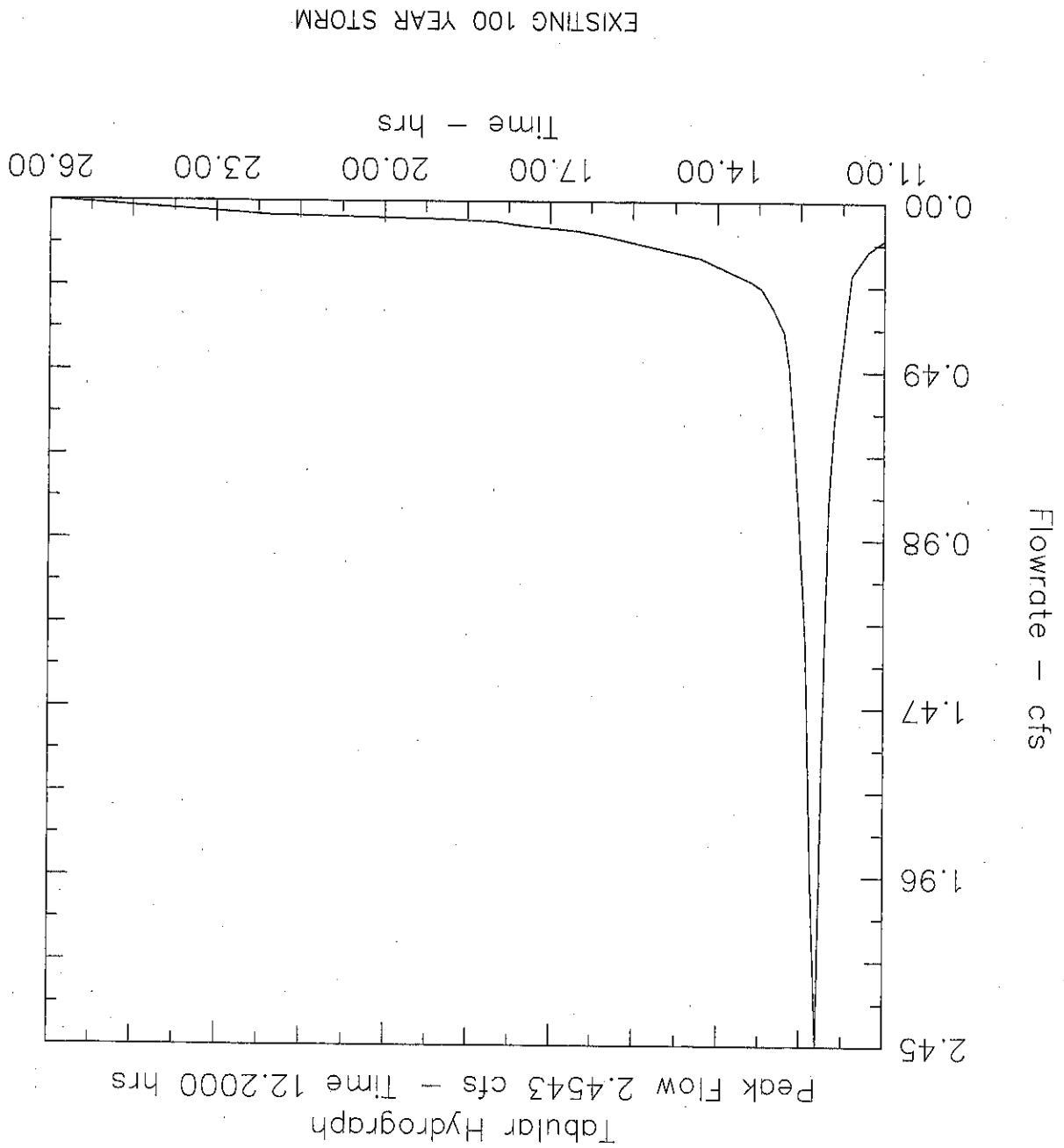
Shallow Concentrated Flow

Total Time of Concentration
> 0.0726 hrs

```

tmp#11
TRAVEL
Paved
Description .....
Surface .....
Flow Length .....
Flow Length .....
Watercourse Slope .....
Velocity .....
Computed shallow flow time .....
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.
..... > 0.0133 hrs
Total Time of Travel ..... > 0.0133 hrs
*****
*****
Composite Runoff Curve Number Calculator
Description      Area (ac)      Curve Number
-----
BUILDING         0.1210
PAVEMENT         0.2060
LANDSCAPE        0.0616
Total Area -----> 0.3886
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

```



POST-DEVELOPED HYDROGRAPHS

tmp#12

TR-55 Tabular Hydrograph Method

Input Summary

Description

PROPOSED CONDITIONS 2YR

Rainfall Distribution

Type III

Off

Total Area

0.3886 ac

Peak Time

12.2000 hrs

Peak Flow

0.9274 cfs

Given Input Data:

Subarea	D/S Subareas	Area (ac)	CN	TC (hrs)	Tt (hrs)	Rainfall (in)
163GLEN		0.3886	92	0.0726	0.0133	3.2000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description

Manning's n

Flow Length

115.0000 ft

0.0110

SHEET

Two Yr, 24 hr Rainfall

3.2000 in

Land Slope

0.0173 ft/ft

Computed Sheet flow time

> 0.0239 hrs

Messages:

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description

Surface

Paved

Flow Length

100.0000 ft

Watercourse Slope

0.0200 ft/ft

Velocity

2.8748 fps

Computed Shallow flow time

> 0.0097 hrs

Messages:

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description

Manning's n

Flow Length

61.3773 ft

0.0500

ROOF

Two Yr, 24 hr Rainfall

3.2000 in

Land Slope

0.0300 ft/ft

Computed Sheet flow time

> 0.0390 hrs

Messages:

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Total Time of Concentration

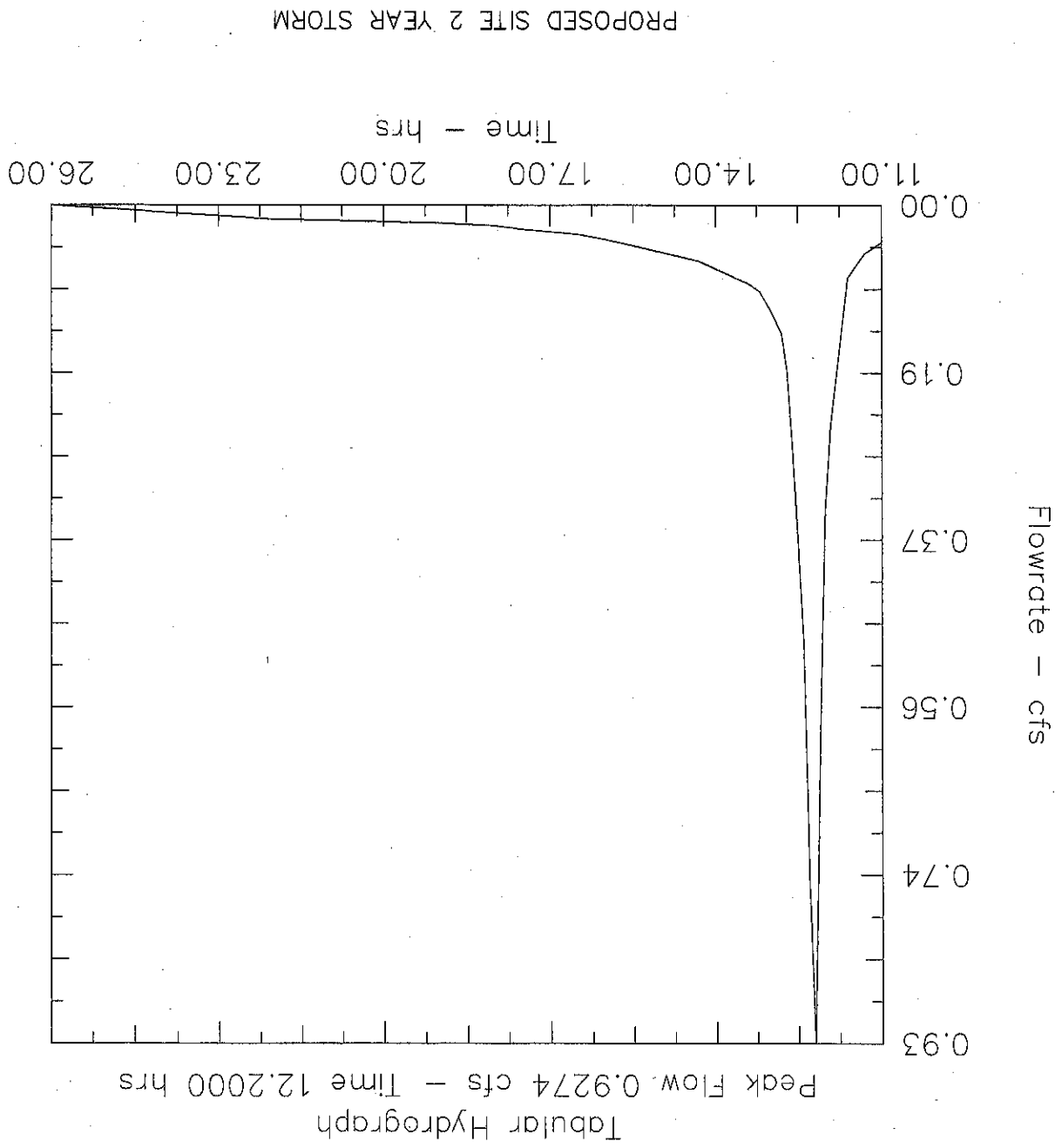
> 0.0726 hrs

Shallow Concentrated Flow

```

tmp#12
Description .....
Surface .....
Paved .....
Flow Length .....
Watercourse Slope .....
Velocity .....
Computed shallow flow time .....> 0.0133 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.
*****
Total Time of Travel .....> 0.0133 hrs
*****
Composite Runoff Curve Number Calculator
-----
Description      Area (ac)      Curve Number
-----
BUILDING         0.1110         98
PAVEMENT         0.1729         98
LANDSCAPE        0.1047         74
Total Area -----> 0.3886
Weighted CN -----> 92
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

```



tmp#13

TR-55 Tabular Hydrograph Method

Input Summary

PROPOSED CONDITIONS 10YR

Rainfall Distribution

Interpolation

Total Area

Peak Time

Peak Flow

Given Input Data:

Subarea	D/S Subareas	Area (ac)	CN	Tc (hrs)	Tt (hrs)	Rainfall (in)
163GLEN		0.3886	92	0.0726	0.0133	4.2000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description

Manning's n

Flow Length

Two Yr, 24 hr Rainfall

Land Slope

Computed Sheet Flow time

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description

Surface

Flow Length

Watercourse Slope

Velocity

Computed Shallow Flow time

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description

Manning's n

Flow Length

Two Yr, 24 hr Rainfall

Land Slope

Computed Sheet Flow time

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Total Time of Concentration

> 0.0726 hrs

Composite Runoff Curve Number Calculator

Description	Area (ac)	Curve Number
BUILDING	0.1110	98
PAVEMENT	0.1729	98
LANDSCAPE	0.1047	74
Total Area	0.3886	92

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Messages:

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Total Time of Travel > 0.0133 hrs

Messages:

Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Computed shallow flow time > 0.0133 hrs

Velocity 2.4053 fps

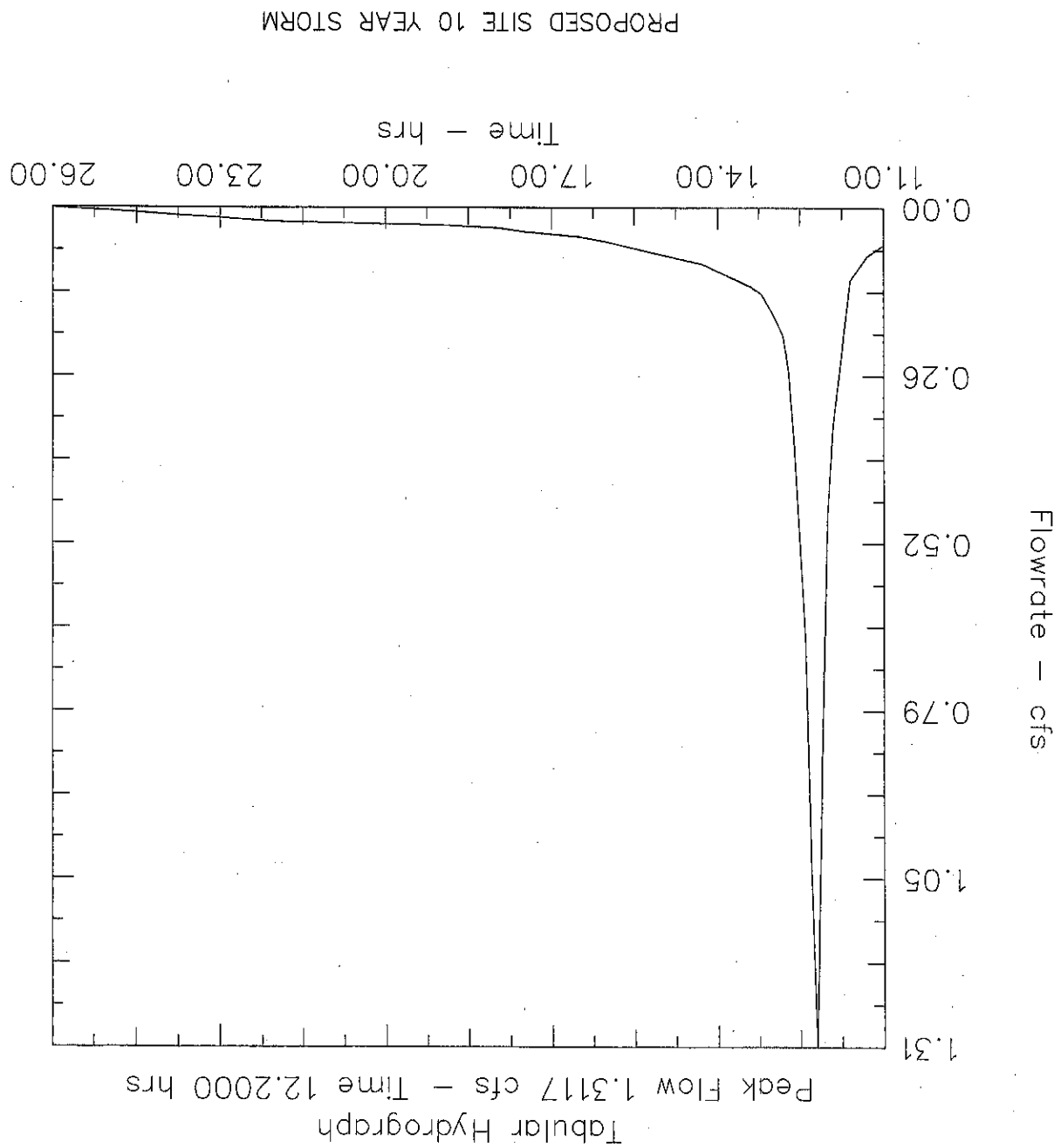
Watercourse Slope 0.0140 ft/ft

Flow Length 115.0000 ft

Surface Paved

TRAVEL

tmp#13



tmp#14

TR-55 Tabular Hydrograph Method

Input Summary

Description
PROPOSED CONDITIONS 25YR
Rainfall Distribution
Type III
off
Total Area 0.3886 ac
Peak Time 12.2000 hrs
Peak Flow 1.6627 cfs

Given Input Data:

Subarea	D/S Subareas	Area (ac)	CN	Tc (hrs)	Tt (hrs)	Rainfall (in)
163GLEN		0.3886	92	0.0726	0.0133	5.1000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description
Manning's n 0.0110
Flow Length 115.0000 ft
Two Yr, 24 hr Rainfall 3.2000 in
Land Slope 0.0173 ft/ft
Computed Sheet Flow time> 0.0239 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description
Surface Paved
Flow Length 100.0000 ft
Watercourse Slope 0.0200 ft/ft
Velocity 2.8748 fps
Computed Shallow Flow time> 0.0097 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description
Manning's n 0.0500
Flow Length 61.3773 ft
Two Yr, 24 hr Rainfall 3.2000 in
Land Slope 0.0300 ft/ft
Computed Sheet Flow time> 0.0390 hrs
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Total Time of Concentration> 0.0726 hrs

```

Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.
*****
Total Time of Travel] ..... > 0.0133 hrs
*****

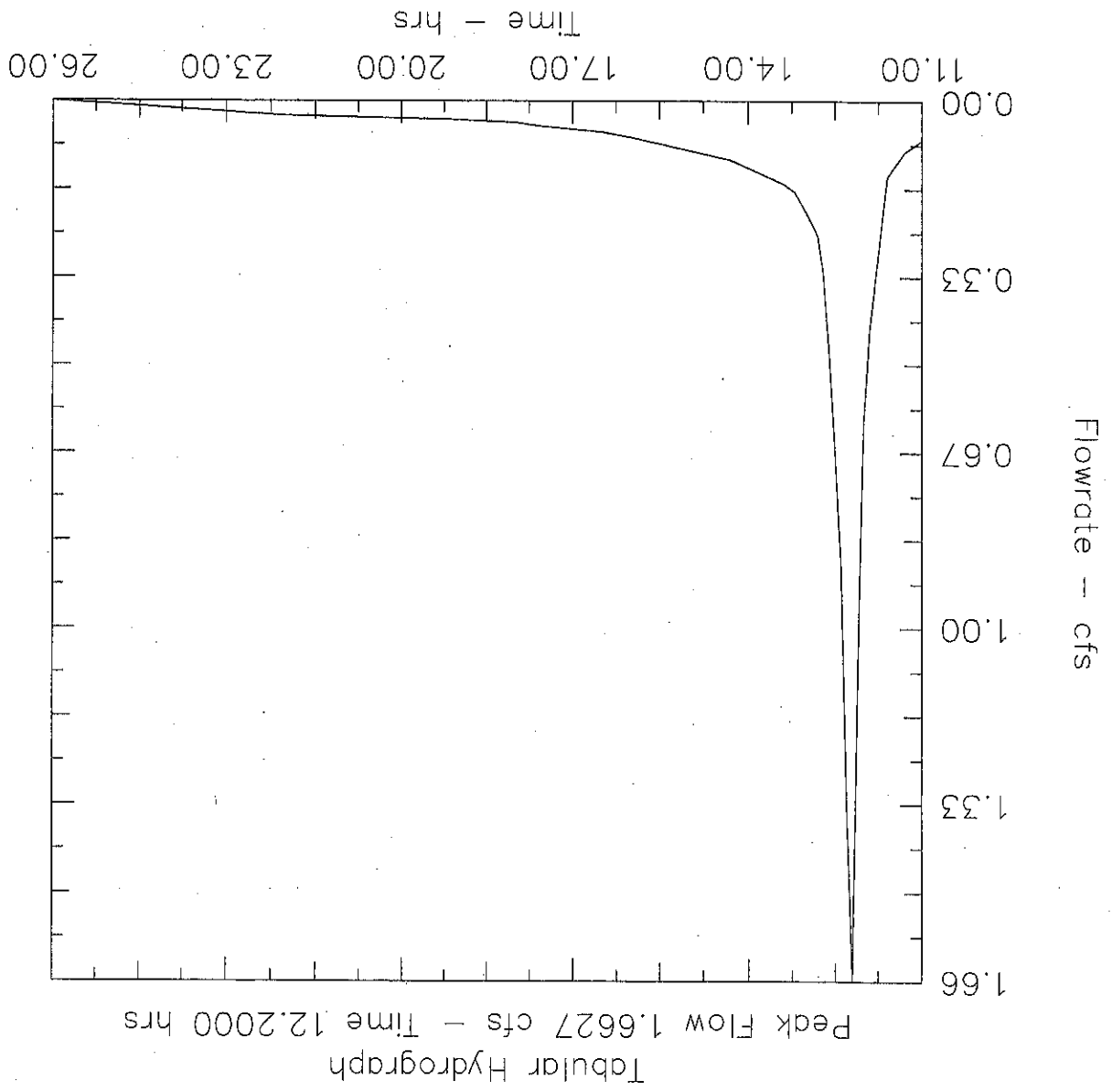
Description .....
Surface .....
Flow Length .....
Watercourse Slope .....
Velocity .....
Computed Shallow Flow time ..... > 0.0133 hrs
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.
Messages:
*****
Total Time of Travel] ..... > 0.0133 hrs
*****

Composite Runoff Curve Number Calculator

Description      Area (ac)      Curve Number
-----
BUILDING         0.1110         98
PAVEMENT         0.1729         98
LANDSCAPE        0.1047         74
Total Area      0.3886         92 <----- weighted CN
Messages:
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.

```

PROPOSED SITE 25 YEAR STORM



tmp#15

TR-55 Tabular Hydrograph Method

Input Summary

Description
PROPOSED CONDITIONS 100YR
Rainfall Distribution
Type III
Ia/P Interpolation
Total Area 0.3886 ac
Peak Time 12.2000 hrs
Peak Flow 2.2932 cfs

Given Input Data:

Subarea	D/S Subareas	Area (ac)	CN	TC (hrs)	TT (hrs)	Rainfall (in)
163GLEN		0.3886	92	0.0726	0.0133	6.7000

Support Data:

Subarea Name: 163GLEN, Row: 1

Sheet Flow

Description
Manning's n 0.0110
Flow Length 115.0000 ft
Two Yr, 24 hr Rainfall 3.2000 in
Land Slope 0.0173 ft/ft
Computed Sheet Flow time > 0.0239 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Description
Surface Paved
Flow Length 100.0000 ft
Watercourse Slope 0.0200 ft/ft
Velocity 2.8748 fps
Computed Shallow Flow time > 0.0097 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

Sheet Flow

Description
Manning's n 0.0500
Flow Length 61.3773 ft
Two Yr, 24 hr Rainfall 3.2000 in
Land Slope 0.0300 ft/ft
Computed Sheet Flow time > 0.0390 hrs
Messages:
Info: Time of concentration rounded to 0.1000 hrs in row <1>.

Shallow Concentrated Flow

Total Time of Concentration > 0.0726 hrs

```

tmp#15
Description .....
Surface .....
Flow Length .....
Watercourse Slope .....
Velocity .....
Computed shallow flow time .....
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.
Messages:
*****
Total Time of Travel ..... > 0.0133 hrs
*****
Composite Runoff Curve Number Calculator
Description      Area (ac)      Curve Number
-----
BUILDING         0.1110
PAVEMENT         0.1729
LANDSCAPE        0.1047
Total Area      0.3886
----->
Info: Time of Concentration rounded to 0.1000 hrs in row <1>.
Messages:
*****
Total Time of Travel ..... > 0.0133 hrs
*****

```

