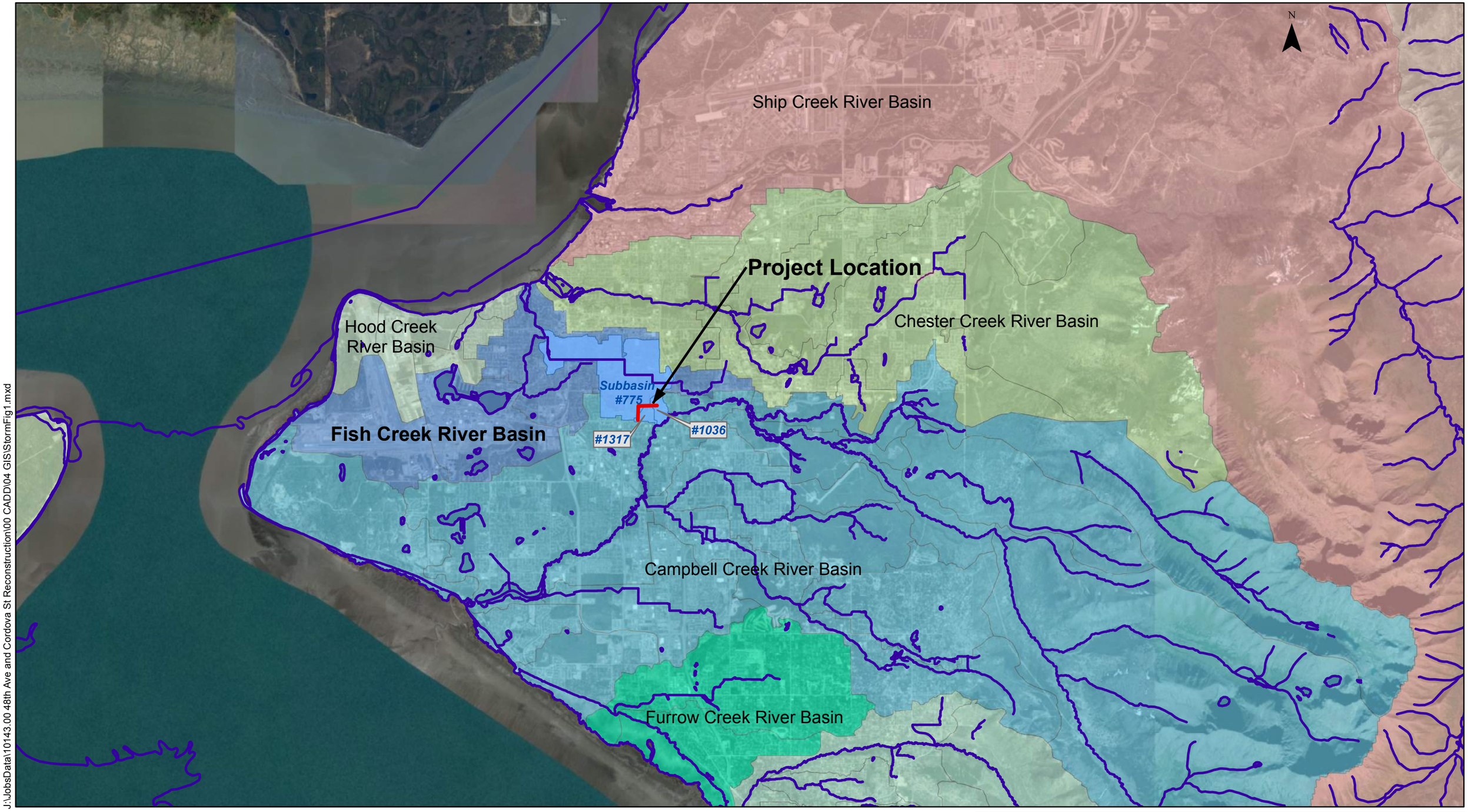
Storm Drain Modeling Data

Appendix E



Project Location and Subbasin **48th Avenue and Cordova Street Design Study Report**	**Date: July 2019** **Figure: 1**

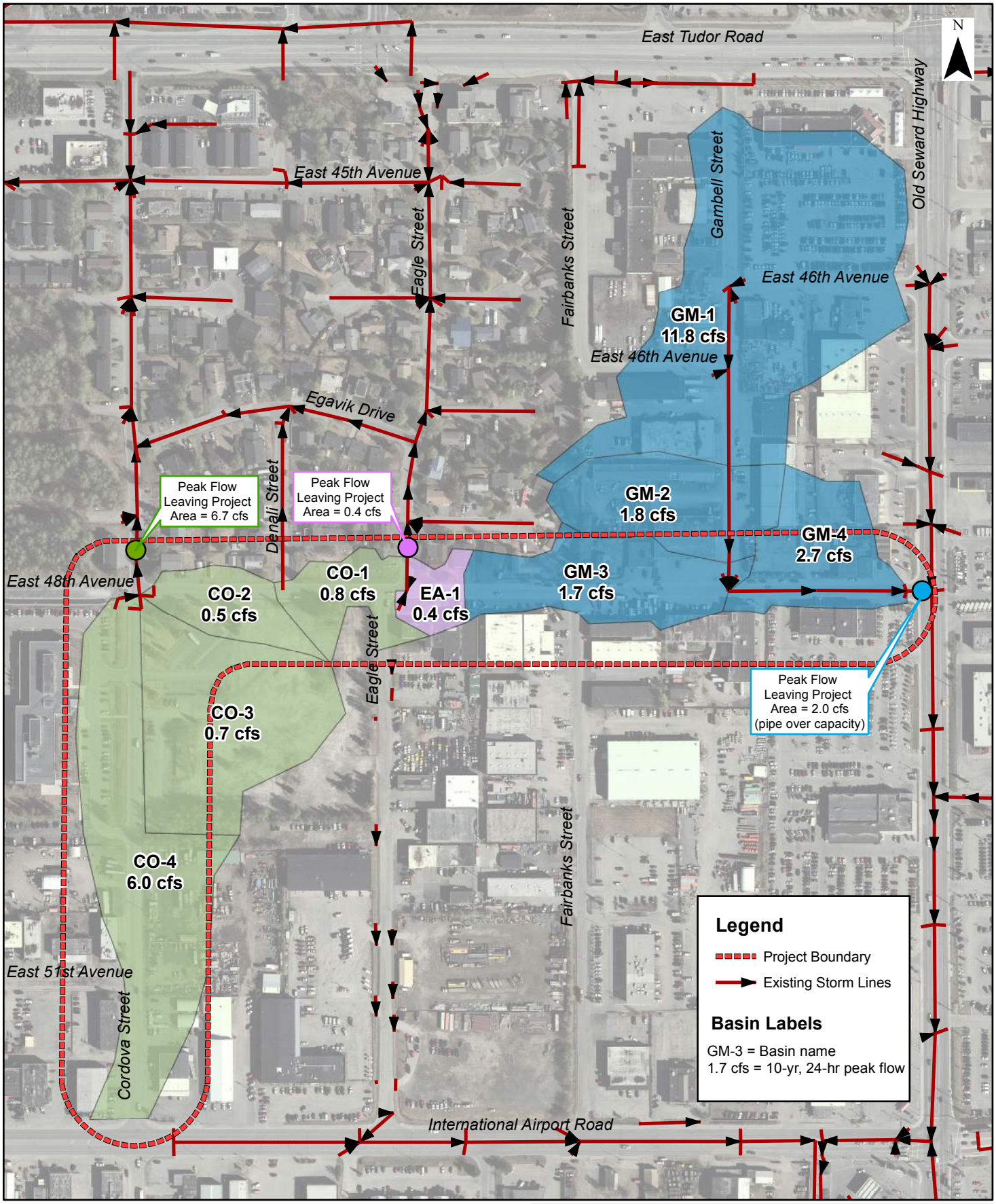
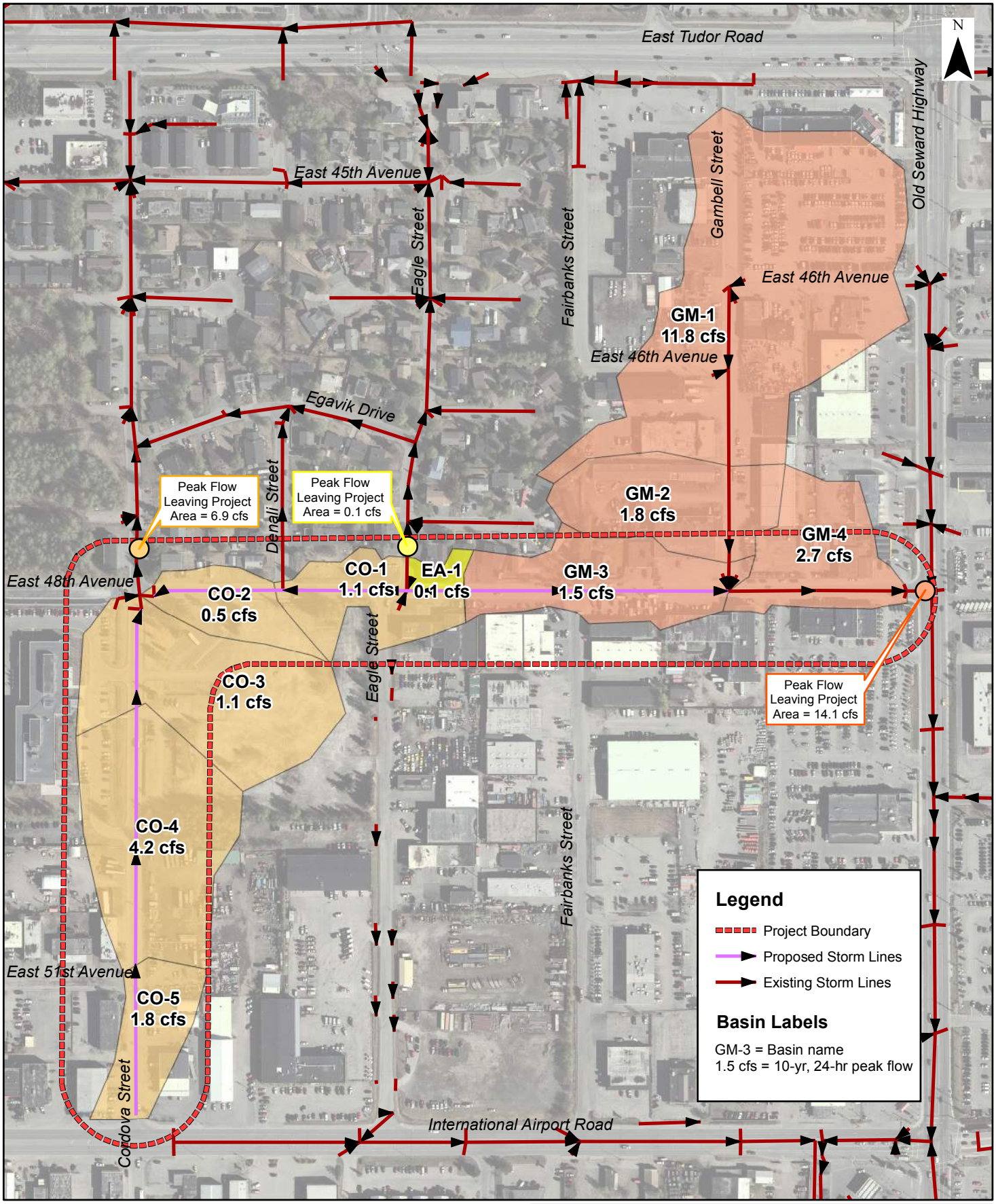


Figure 2
Existing Stormwater System
48th Avenue and Cordova Street

CRW ENGINEERING GROUP, LLC

Date: July 2019



0 125 250 500 Feet

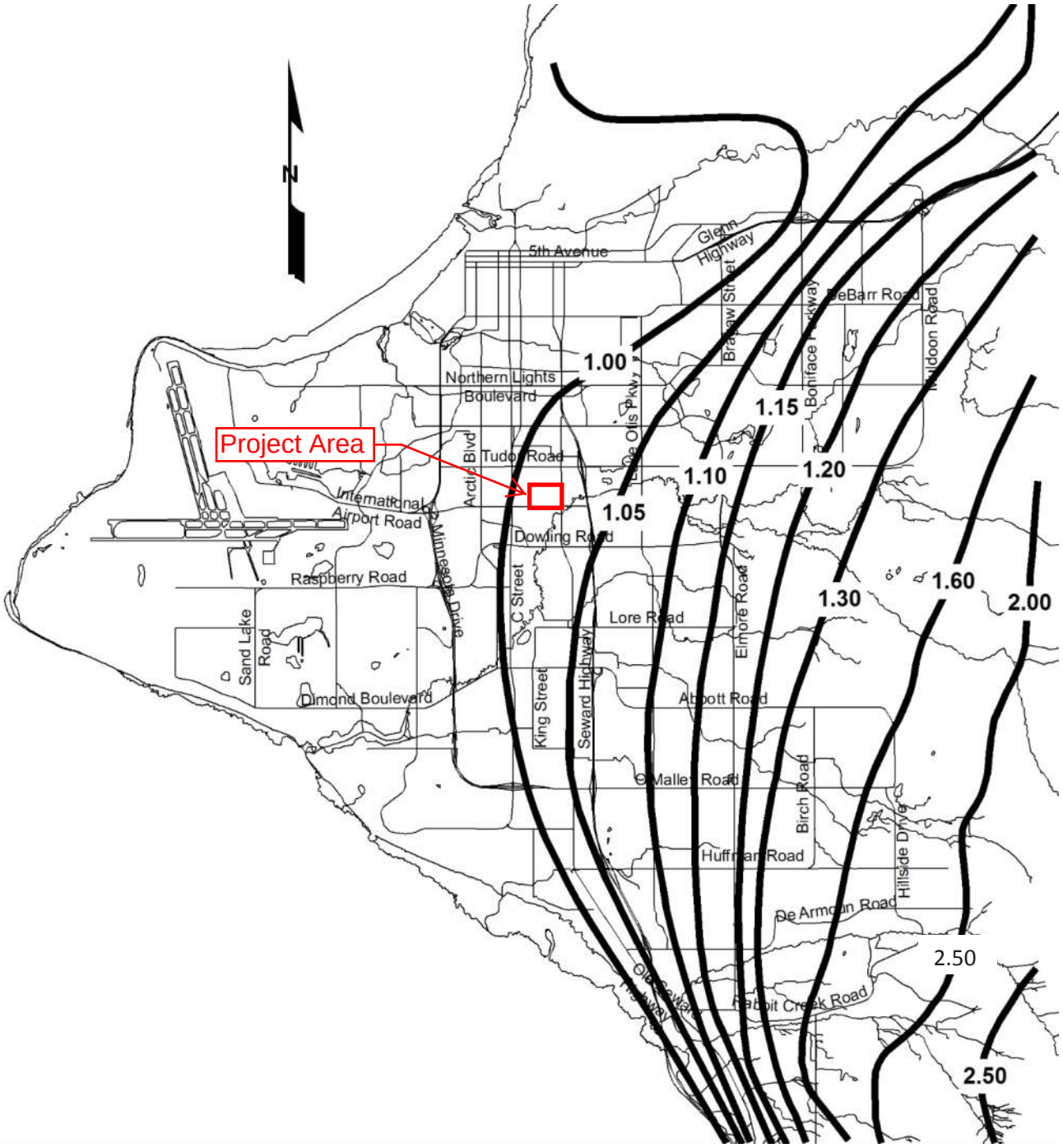
Figure 3
Proposed Stormwater System
48th Avenue and Cordova Street

CRW ENGINEERING GROUP, LLC

Date: July 2019

based on NOAA Atlas 14 data from AIA. A second distribution was developed for Girdwood based on data from the Alyeska station. The resulting hyetographs are presented in Appendix D.

Figure 4.2-3: Orographic Factor Map (Anchorage)



Project Description

File Name ..... 10143 Existing SSA Storm Model.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Nov 12, 2018	00:00:00
End Analysis On	Nov 13, 2018	00:00:00
Start Reporting On	Nov 12, 2018	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	9
Nodes	15
Junctions	12
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	12
Channels	0
Pipes	12
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	10-yr, 24-hr	Cumulative	inches				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	CO-1	1.20	82.40	2.33	0.89	1.07	0.84	0 00:05:00
2	CO-2	1.20	81.80	2.33	0.86	1.03	0.45	0 00:23:49
3	CO-3	4.20	77.00	2.33	0.63	2.66	0.65	0 00:58:34
4	CO-4	5.30	94.00	2.33	1.70	9.03	6.03	0 00:08:46
5	EA-1	0.60	83.00	2.33	0.93	0.56	0.44	0 00:05:00
6	GM-1	9.30	93.70	2.33	1.68	15.60	11.79	0 00:05:24
7	GM-2	2.50	92.35	2.33	1.56	3.90	1.78	0 00:22:37
8	GM-3	2.50	89.60	2.33	1.35	3.37	1.66	0 00:19:43
9	GM-4	2.10	94.00	2.33	1.70	3.58	2.73	0 00:05:00

Subbasin Hydrology

Subbasin : CO-1

Input Data

Area (ac) 1.20
Weighted Curve Number 82.40
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	1.08	C	83.00
Brush, Poor	0.12	C	77.00
Composite Area & Weighted CN	1.20		82.40

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 0.89
Peak Runoff (cfs) 0.84
Weighted Curve Number 82.40
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : CO-2

Input Data

Area (ac) 1.20
Weighted Curve Number 81.80
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	0.96	C	83.00
Brush, Poor	0.24	C	77.00
Composite Area & Weighted CN	1.20		81.80

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.2	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	1.5	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.08	0.00	0.00
Computed Flow Time (min) :	20.21	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	200	0.00	0.00
Slope (%) :	2.5	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.11	0.00	0.00
Computed Flow Time (min) :	3.00	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Channel Slope (%) :	2.7	0.00	0.00
Cross Section Area (ft^2) :	.21	0.00	0.00
Wetted Perimeter (ft) :	1.7	0.00	0.00
Velocity (ft/sec) :	4.05	0.00	0.00
Computed Flow Time (min) :	0.62	0.00	0.00

Total TOC (min) 23.83

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 0.86
Peak Runoff (cfs) 0.45
Weighted Curve Number 81.80
Time of Concentration (days hh:mm:ss) 0 00:23:50

Subbasin : CO-3

Input Data

Area (ac) 4.20
Weighted Curve Number 77.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	0.00	C	94.00
Brush, Poor	4.20	C	77.00
Composite Area & Weighted CN	4.20		77.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Slope (%) :	.7	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.05	0.00	0.00
Computed Flow Time (min) :	52.45	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	250	0.00	0.00
Slope (%) :	.7	0.00	0.00
Surface Type :	Bare & untilled	Unpaved	Unpaved
Velocity (ft/sec) :	0.84	0.00	0.00
Computed Flow Time (min) :	4.96	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	220	0.00	0.00
Channel Slope (%) :	.85	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	3.13	0.00	0.00
Computed Flow Time (min) :	1.17	0.00	0.00

Total TOC (min) 58.58

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 0.63
Peak Runoff (cfs) 0.65
Weighted Curve Number 77.00
Time of Concentration (days hh:mm:ss) 0 00:58:35

Subbasin : CO-4

Input Data

Area (ac) 5.30
Weighted Curve Number 94.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	5.30	C	94.00
Composite Area & Weighted CN	5.30		94.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.01	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	1.02	0.00	0.00
Computed Flow Time (min) :	1.64	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	1300	0.00	0.00
Channel Slope (%) :	.8	0.00	0.00
Cross Section Area (ft²) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	3.04	0.00	0.00
Computed Flow Time (min) :	7.13	0.00	0.00

Total TOC (min) 8.77

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.70
Peak Runoff (cfs) 6.03
Weighted Curve Number 94.00
Time of Concentration (days hh:mm:ss) 0 00:08:46

Subbasin : EA-1

Input Data

Area (ac) 0.60
Weighted Curve Number 83.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	0.60	C	83.00
Composite Area & Weighted CN	0.60		83.00

Time of Concentration

User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 0.93
Peak Runoff (cfs) 0.44
Weighted Curve Number 83.00
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : GM-1

Input Data

Area (ac) 9.30
Weighted Curve Number 93.70
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	8.74	C	94.00
Gravel roads	0.56	C	89.00
Composite Area & Weighted CN	9.30		93.70

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.01	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Slope (%) :	2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	1.10	0.00	0.00
Computed Flow Time (min) :	2.27	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	30	0.00	0.00
Slope (%) :	2	0.00	0.00
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.87	0.00	0.00
Computed Flow Time (min) :	0.17	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	270	0.00	0.00
Channel Slope (%) :	.2	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	1.52	0.00	0.00
Computed Flow Time (min) :	2.96	0.00	0.00

Total TOC (min) 5.40

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.68
Peak Runoff (cfs) 11.79
Weighted Curve Number 93.70
Time of Concentration (days hh:mm:ss) 0 00:05:24

Subbasin : GM-2

Input Data

Area (ac) 2.50
Weighted Curve Number 92.35
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	2.13	C	94.00
1/4 acre lots, 38% impervious	0.38	C	83.00
Composite Area & Weighted CN	2.51		92.35

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	6	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.08	0.00	0.00
Computed Flow Time (min) :	20.21	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	320	0.00	0.00
Slope (%) :	3.4	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.98	0.00	0.00
Computed Flow Time (min) :	1.79	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	90	0.00	0.00
Channel Slope (%) :	.5	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	2.40	0.00	0.00
Computed Flow Time (min) :	0.62	0.00	0.00

Total TOC (min) 22.63

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.56
Peak Runoff (cfs) 1.78
Weighted Curve Number 92.35
Time of Concentration (days hh:mm:ss) 0 00:22:38

Subbasin : GM-3

Input Data

Area (ac) 2.50
Weighted Curve Number 89.60
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	1.50	C	94.00
1/4 acre lots, 38% impervious	1.00	C	83.00
Composite Area & Weighted CN	2.50		89.60

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	80	0.00	0.00
Slope (%) :	6	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.08	0.00	0.00
Computed Flow Time (min) :	16.91	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	590	0.00	0.00
Channel Slope (%) :	2	0.00	0.00
Cross Section Area (ft^2) :	.21	0.00	0.00
Wetted Perimeter (ft) :	1.7	0.00	0.00
Velocity (ft/sec) :	3.48	0.00	0.00
Computed Flow Time (min) :	2.82	0.00	0.00

Total TOC (min) 19.73

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.35
Peak Runoff (cfs) 1.66
Weighted Curve Number 89.60
Time of Concentration (days hh:mm:ss) 0 00:19:44

Subbasin : GM-4

Input Data

Area (ac) 2.10
Weighted Curve Number 94.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	2.10	C	94.00
Composite Area & Weighted CN	2.10		94.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.01	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Slope (%) :	1.3	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.93	0.00	0.00
Computed Flow Time (min) :	2.69	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	120	0.00	0.00
Slope (%) :	2.5	0.00	0.00
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	3.21	0.00	0.00
Computed Flow Time (min) :	0.62	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	220	0.00	0.00
Channel Slope (%) :	.9	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	3.22	0.00	0.00
Computed Flow Time (min) :	1.14	0.00	0.00

Total TOC (min) 4.46

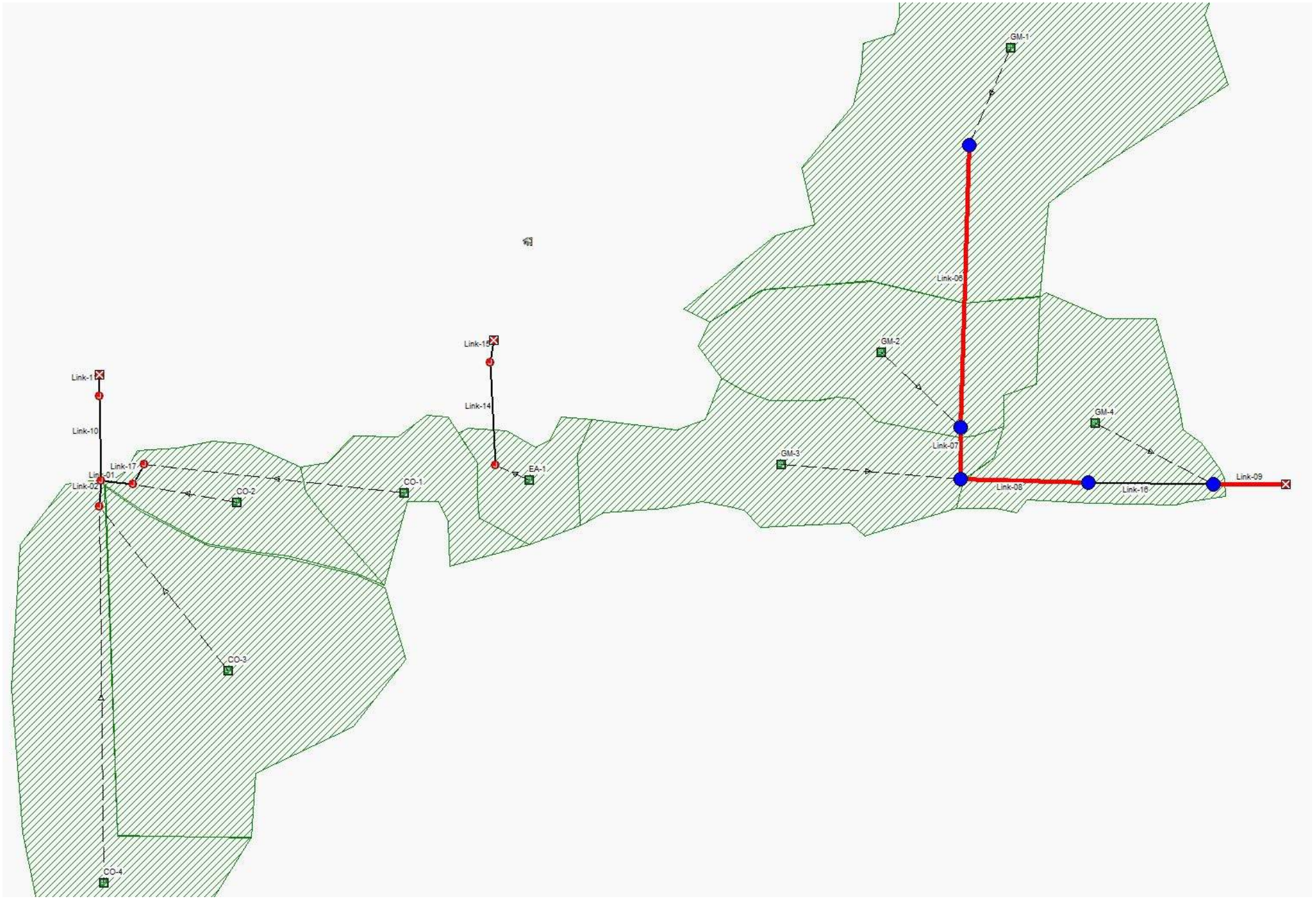
Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.70
Peak Runoff (cfs) 2.73
Weighted Curve Number 94.00
Time of Concentration (days hh:mm:ss) 0 00:04:28

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-01	0.99	0 12:10	12.31	0.08	4.20	0.15	0.29	0.19	0.00		Calculated
2	Link-02	5.87	0 12:15	11.63	0.50	6.60	0.07	0.75	0.50	0.00		Calculated
3	Link-06	1.88	0 11:51	1.74	1.08	1.71	4.31	1.25	1.00	46.00		SURCHARGED
4	Link-07	1.97	0 11:48	1.84	1.07	1.78	0.81	1.25	1.00	68.00		SURCHARGED
5	Link-08	2.51	0 12:08	2.32	1.08	2.22	1.57	1.25	1.00	38.00		SURCHARGED
6	Link-09	2.00	0 13:42	1.87	1.07	1.77	0.52	1.25	1.00	133.00		SURCHARGED
7	Link-10	6.72	0 12:15	11.77	0.57	6.90	0.19	0.81	0.54	0.00		Calculated
8	Link-11	6.72	0 12:15	7.59	0.89	4.85	0.07	1.10	0.73	0.00		Calculated
9	Link-14	0.38	0 12:11	1.06	0.36	1.27	2.12	0.41	0.41	0.00		Calculated
10	Link-15	0.38	0 12:11	3.07	0.12	2.66	0.13	0.22	0.24	0.00		Calculated
11	Link-16	2.47	0 12:51	2.30	1.07	2.26	1.61	1.15	0.93	0.00		> CAPACITY
12	Link-17	0.76	0 12:10	5.20	0.15	2.12	0.29	0.39	0.26	0.00		Calculated

Existing Model Pipe Layout



Project Description

File Name	10143 Proposed SSA Storm Model.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Jun 24, 2019	00:00:00
End Analysis On	Jun 25, 2019	00:00:00
Start Reporting On	Jun 24, 2019	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	10
Nodes	39
Junctions	37
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	37
Channels	0
Pipes	37
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	10-yr, 24-hr storm	Cumulative	inches				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	CO-1	1.50	82.52	2.33	0.90	1.35	1.06	0 00:05:00
2	CO-2	1.20	81.80	2.33	0.86	1.03	0.45	0 00:23:39
3	CO-3	4.00	84.31	2.33	1.00	4.00	1.11	0 00:55:56
4	CO-4	4.10	89.24	2.33	1.32	5.42	4.23	0 00:05:22
5	CO-5	1.40	94.00	2.33	1.70	2.39	1.82	0 00:05:00
6	EA-1	0.20	83.00	2.33	0.92	0.18	0.14	0 00:05:00
7	GM-1	9.30	93.70	2.33	1.68	15.60	11.79	0 00:05:24
8	GM-2	2.50	92.35	2.33	1.56	3.90	1.78	0 00:22:37
9	GM-3	2.50	89.60	2.33	1.35	3.37	1.53	0 00:23:22
10	GM-4	2.10	94.00	2.33	1.70	3.58	2.73	0 00:05:00

Subbasin Hydrology

Subbasin : CO-1

Input Data

Area (ac) 1.50
Weighted Curve Number 82.52
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	1.38	C	83.00
Brush, Poor	0.12	C	77.00
Composite Area & Weighted CN	1.50		82.52

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.01	0.00	0.00
Flow Length (ft) :	90	0.00	0.00
Slope (%) :	2.2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	1.03	0.00	0.00
Computed Flow Time (min) :	1.45	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	70	0.00	0.00
Slope (%) :	2.8	0.00	0.00
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	3.40	0.00	0.00
Computed Flow Time (min) :	0.34	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	225	0.00	0.00
Channel Slope (%) :	2.2	0.00	0.00
Cross Section Area (ft²) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	5.04	0.00	0.00
Computed Flow Time (min) :	0.74	0.00	0.00

Total TOC (min) 2.54

Subbasin Runoff Results

Total Rainfall (in)	2.33
Total Runoff (in)	0.90
Peak Runoff (cfs)	1.06
Weighted Curve Number	82.52
Time of Concentration (days hh:mm:ss)	0 00:02:32

Subbasin : CO-2

Input Data

Area (ac) 1.20
Weighted Curve Number 81.80
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	0.96	C	83.00
Brush, Poor	0.24	C	77.00
Composite Area & Weighted CN	1.20		81.80

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.2	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	1.5	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.08	0.00	0.00
Computed Flow Time (min) :	20.21	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	200	0.00	0.00
Slope (%) :	2.5	0.00	0.00
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.11	0.00	0.00
Computed Flow Time (min) :	3.00	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Channel Slope (%) :	2.7	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	5.58	0.00	0.00
Computed Flow Time (min) :	0.45	0.00	0.00

Total TOC (min) 23.66

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 0.86
Peak Runoff (cfs) 0.45
Weighted Curve Number 81.80
Time of Concentration (days hh:mm:ss) 0 00:23:40

Subbasin : CO-3

Input Data

Area (ac) 4.00
Weighted Curve Number 84.31
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Brush, Poor	2.28	C	77.00
Urban commercial, 85% imp	1.72	C	94.00
Composite Area & Weighted CN	4.00		84.31

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.3	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Slope (%) :	.7	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.05	0.00	0.00
Computed Flow Time (min) :	52.45	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	290	0.00	0.00
Slope (%) :	2.8	0.00	0.00
Surface Type :	Bare & untilled	Unpaved	Unpaved
Velocity (ft/sec) :	1.67	0.00	0.00
Computed Flow Time (min) :	2.89	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Channel Slope (%) :	1.5	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	4.16	0.00	0.00
Computed Flow Time (min) :	0.60	0.00	0.00

Total TOC (min) 55.94

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.00
Peak Runoff (cfs) 1.11
Weighted Curve Number 84.31
Time of Concentration (days hh:mm:ss) 0 00:55:56

Subbasin : CO-4

Input Data

Area (ac) 4.10
Weighted Curve Number 89.24
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	2.95	C	94.00
Brush, Poor	1.15	C	77.00
Composite Area & Weighted CN	4.10		89.24

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.01	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Slope (%) :	1.3	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.93	0.00	0.00
Computed Flow Time (min) :	2.69	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	520	0.00	0.00
Channel Slope (%) :	.9	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	3.22	0.00	0.00
Computed Flow Time (min) :	2.69	0.00	0.00

Total TOC (min) 5.38

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.32
Peak Runoff (cfs) 4.23
Weighted Curve Number 89.24
Time of Concentration (days hh:mm:ss) 0 00:05:23

Subbasin : CO-5

Input Data

Area (ac) 1.40
Weighted Curve Number 94.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	1.40	C	94.00
Composite Area & Weighted CN	1.40		94.00

Time of Concentration

User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.70
Peak Runoff (cfs) 1.82
Weighted Curve Number 94.00
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : EA-1

Input Data

Area (ac) 0.20
Weighted Curve Number 83.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	0.20	C	83.00
Composite Area & Weighted CN	0.20		83.00

Time of Concentration

User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 0.92
Peak Runoff (cfs) 0.14
Weighted Curve Number 83.00
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : GM-1

Input Data

Area (ac) 9.30
Weighted Curve Number 93.70
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	8.74	C	94.00
Gravel roads	0.56	C	89.00
Composite Area & Weighted CN	9.30		93.70

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.01	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Slope (%) :	2	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	1.10	0.00	0.00
Computed Flow Time (min) :	2.27	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	30	0.00	0.00
Slope (%) :	2	0.00	0.00
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	2.87	0.00	0.00
Computed Flow Time (min) :	0.17	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	270	0.00	0.00
Channel Slope (%) :	.2	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	1.52	0.00	0.00
Computed Flow Time (min) :	2.96	0.00	0.00

Total TOC (min) 5.40

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.68
Peak Runoff (cfs) 11.79
Weighted Curve Number 93.70
Time of Concentration (days hh:mm:ss) 0 00:05:24

Subbasin : GM-2

Input Data

Area (ac) 2.50
Weighted Curve Number 92.35
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	2.13	C	94.00
1/4 acre lots, 38% impervious	0.38	C	83.00
Composite Area & Weighted CN	2.51		92.35

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	100	0.00	0.00
Slope (%) :	6	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.08	0.00	0.00
Computed Flow Time (min) :	20.21	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	320	0.00	0.00
Slope (%) :	3.4	0.00	0.00
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	2.98	0.00	0.00
Computed Flow Time (min) :	1.79	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	90	0.00	0.00
Channel Slope (%) :	.5	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	2.40	0.00	0.00
Computed Flow Time (min) :	0.62	0.00	0.00

Total TOC (min) 22.63

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.56
Peak Runoff (cfs) 1.78
Weighted Curve Number 92.35
Time of Concentration (days hh:mm:ss) 0 00:22:38

Subbasin : GM-3

Input Data

Area (ac) 2.50
Weighted Curve Number 89.60
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	1.50	C	94.00
1/4 acre lots, 38% impervious	1.00	C	83.00
Composite Area & Weighted CN	2.50		89.60

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.4	0.00	0.00
Flow Length (ft) :	80	0.00	0.00
Slope (%) :	6	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.08	0.00	0.00
Computed Flow Time (min) :	16.91	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	590	0.00	0.00
Channel Slope (%) :	.2	0.00	0.00
Cross Section Area (ft²) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	1.52	0.00	0.00
Computed Flow Time (min) :	6.47	0.00	0.00

Total TOC (min) 23.38

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.35
Peak Runoff (cfs) 1.53
Weighted Curve Number 89.60
Time of Concentration (days hh:mm:ss) 0 00:23:23

Subbasin : GM-4

Input Data

Area (ac) 2.10
Weighted Curve Number 94.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	2.10	C	94.00
Composite Area & Weighted CN	2.10		94.00

Time of Concentration

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.01	0.00	0.00
Flow Length (ft) :	150	0.00	0.00
Slope (%) :	1.3	0.00	0.00
2 yr, 24 hr Rainfall (in) :	1.50	0.00	0.00
Velocity (ft/sec) :	0.93	0.00	0.00
Computed Flow Time (min) :	2.69	0.00	0.00

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	120	0.00	0.00
Slope (%) :	2.5	0.00	0.00
Surface Type :	Paved	Unpaved	Unpaved
Velocity (ft/sec) :	3.21	0.00	0.00
Computed Flow Time (min) :	0.62	0.00	0.00

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	.015	0.00	0.00
Flow Length (ft) :	220	0.00	0.00
Channel Slope (%) :	.9	0.00	0.00
Cross Section Area (ft^2) :	.5	0.00	0.00
Wetted Perimeter (ft) :	2.5	0.00	0.00
Velocity (ft/sec) :	3.22	0.00	0.00
Computed Flow Time (min) :	1.14	0.00	0.00

Total TOC (min) 4.46

Subbasin Runoff Results

Total Rainfall (in) 2.33
Total Runoff (in) 1.70
Peak Runoff (cfs) 2.73
Weighted Curve Number 94.00
Time of Concentration (days hh:mm:ss) 0 00:04:28

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Link-02	6.85	0 12:12	7.27	0.94	4.54	0.29	1.12	0.80	0.00		Calculated
2	Link-03	11.25	0 12:12	11.68	0.96	4.71	0.18	1.17	0.49	0.00		Calculated
3	Link-04	10.36	0 12:11	11.35	0.91	2.83	2.60	1.68	0.70	0.00		Calculated
4	Pipe - (1)	5.58	0 12:11	11.71	0.48	5.27	0.10	0.86	0.63	0.00		Calculated
5	Pipe - (10)	0.44	0 12:20	3.22	0.14	2.61	0.17	0.27	0.27	0.00		Calculated
6	Pipe - (2)	1.29	0 12:11	10.33	0.12	3.55	0.17	0.37	0.26	0.00		Calculated
7	Pipe - (20)	0.00	0 00:00	10.91	0.00	0.00		0.00	0.00	0.00		Calculated
8	Pipe - (20) (1)	0.00	0 00:00	7.85	0.00	0.00		0.21	0.14	0.00		Calculated
9	Pipe - (21)	1.60	0 12:11	6.72	0.24	3.10	1.33	0.49	0.33	0.00		Calculated
10	Pipe - (21) (1)	1.60	0 12:11	10.93	0.15	4.14	0.38	0.39	0.27	0.00		Calculated
11	Pipe - (23)	1.59	0 12:11	12.52	0.13	3.54	1.40	0.45	0.31	0.00		Calculated
12	Pipe - (24)	5.23	0 12:10	13.81	0.38	5.69	0.62	0.75	0.52	0.00		Calculated
13	Pipe - (25)	1.50	0 12:20	19.08	0.08	2.68	1.86	0.70	0.47	0.00		Calculated
14	Pipe - (26)	12.21	0 12:13	19.82	0.62	6.01	0.73	1.21	0.62	0.00		Calculated
15	Pipe - (27)	12.21	0 12:13	21.41	0.57	5.47	0.48	1.32	0.67	0.00		Calculated
16	Pipe - (28)	14.13	0 12:13	22.61	0.62	6.44	0.16	1.30	0.66	0.00		Calculated
17	Pipe - (29)	11.25	0 12:12	48.72	0.23	7.18	0.10	0.99	0.51	0.00		Calculated
18	Pipe - (30)	0.00	0 00:00	14.00	0.00	0.00		0.09	0.06	0.00		Calculated
19	Pipe - (31)	0.00	0 00:00	10.90	0.00	0.00		0.01	0.00	0.00		Calculated
20	Pipe - (32)	0.13	0 12:10	11.87	0.01	2.16	0.43	0.11	0.07	0.00		Calculated
21	Pipe - (32) (1)	0.13	0 12:11	12.59	0.01	1.79	2.28	0.13	0.09	0.00		Calculated
22	Pipe - (33)	1.04	0 12:11	16.77	0.06	5.18	0.97	0.25	0.17	0.00		Calculated
23	Pipe - (40)	0.00	0 00:00	8.84	0.00	0.00		0.37	0.39	0.00		Calculated
24	Pipe - (42)	0.02	0 12:09	5.89	0.00	0.11	2.73	0.52	0.56	0.00		Calculated
25	Pipe - (43)	0.00	0 00:00	11.94	0.00	0.00		0.43	0.44	0.00		Calculated
26	Pipe - (44)	0.00	0 00:00	11.23	0.00	0.00		0.00	0.00	0.00		Calculated
27	Pipe - (45)	0.00	0 00:00	12.40	0.00	0.00		0.00	0.00	0.00		Calculated
28	Pipe - (46)	0.00	0 00:00	18.62	0.00	0.00		0.03	0.03	0.00		Calculated
29	Pipe - (47)	0.00	0 00:00	10.61	0.00	0.00		0.00	0.00	0.00		Calculated
30	Pipe - (48)	0.00	0 00:00	21.64	0.00	0.00		0.03	0.03	0.00		Calculated
31	Pipe - (49)	0.00	0 00:00	14.17	0.00	0.00		0.32	0.34	0.00		Calculated
32	Pipe - (50)	0.00	0 00:00	4.58	0.00	0.00		0.00	0.00	0.00		Calculated
33	Pipe - (51)	0.00	0 00:00	13.71	0.00	0.00		0.00	0.00	0.00		Calculated
34	Pipe - (52)	0.00	0 00:00	12.60	0.00	0.00		0.43	0.44	0.00		Calculated
35	Pipe - (54)	0.00	0 00:00	26.44	0.00	0.00		0.00	0.00	0.00		Calculated
36	Pipe - (8)	0.08	0 12:16	3.65	0.02	0.19	4.71	0.80	0.85	0.00		Calculated
37	Pipe - (9)	1.11	0 12:45	3.88	0.29	3.74	0.13	0.40	0.40	0.00		Calculated

Proposed Model Pipe Layout