BLOOMINGTON FIRE STATION #4

STORMWATER CALCULATIONS

BY

LARSON ENGINEERING

AUGUST 17, 2021

CONTENTS:

T.J. Rose, P.E. | August 17, 2021 | 53681
Date | Registration No.

Engineering Division
Approved by: Bryan Gruidl
future off-site volume retention project required
03/01/2022 2:47:47 PM

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Bloomington Fire Station #4

SUMMARY OF STORMWATER RUNOFF

Introduction:
This project will consist of the demolition of the existing fire station, construction of a new fire station, parking low, and associated stormwater utilities.

Stormwater calculations were modeled using HydroCAD with Atlas 14 24-hour rainfall data.

Existing Conditions:
The existing site consists of a fire station. Existing runoff is captured in catch basins and routed to the storm sewer in either 84th Street or Irwin Road. The existing conditions were modeled as >75% Grass Cover, Type C soils, with a Curve Number of 74. Impervious areas were modeled with a Curve Number of 98.

Proposed Conditions:
The runoff from the new impervious surfaces will be routed to the proposed filtration basin on the north and east sides of the site. The system will outlet into the storm sewer in both 84th Street and Irwin Road.

The existing and proposed peak runoff rates leaving the site are listed in the table below.

Existing peak runoff rates (in cubic feet per second):

Area	2-year	10-year	100-year
84th Street W	1.14	1.82	3.44
Irwin Road	0.96	1.50	2.77
Offsite South	0.29	0.67	1.71

Proposed peak runoff rates (in cubic feet per second):

Area	2-year	10-year	100-year
84th Street W	0.03	0.07	3.31
Irwin Road	0.08	0.11	2.64
Offsite South	0.05	0.11	0.27

Water Quality Summary
Per City of Bloomington and Nine Mile Creek Watershed District (NMCWD) standards, a volume of runoff equivalent to 1.1" over the new and reconstructed impervious surfaces must be infiltrated. However, the site is located within the Emergency Response Zone, as defined in the Wellhead Protection Plan. Because of this, infiltration is prohibited on this site. An underground filtration system will be proposed to meet the water quality requirements. Per NMCWD standards, at least 60% annual removal efficiency of total phosphorus and at least 90% annual removal efficiency of total suspended solids must be removed from site runoff.

New/Reconstructed Impervious Area = 33,459 SF

Required Water Quality Volume = 33,459 SF x 1.1 in ÷ 12 = **3,067 CF**

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Proposed Water Quality Volume = **7,700 CF (OK)**

Pre-treatment for the filtration system will be provided with sumps in the upstream catch basins, as well as a pre-treatment row in the chamber system.

The proposed basin is required to drawdown within 48 hours.

Maximum Drawdown Depth = 0.8 in/hr x 48 hours ÷ 12 in/ft = 3.2 ft

The proposed filtration depth is 1.9 feet, which will drawdown in < 48 hours.

The MIDS Calculator was used to determine the TP and TSS removal efficiency. A Jellyfish Filter is proposed downstream of the filtration system to remove additional TP and TSS.

TP Removal = **69% (OK)**
TSS Removal = **97% (OK)**

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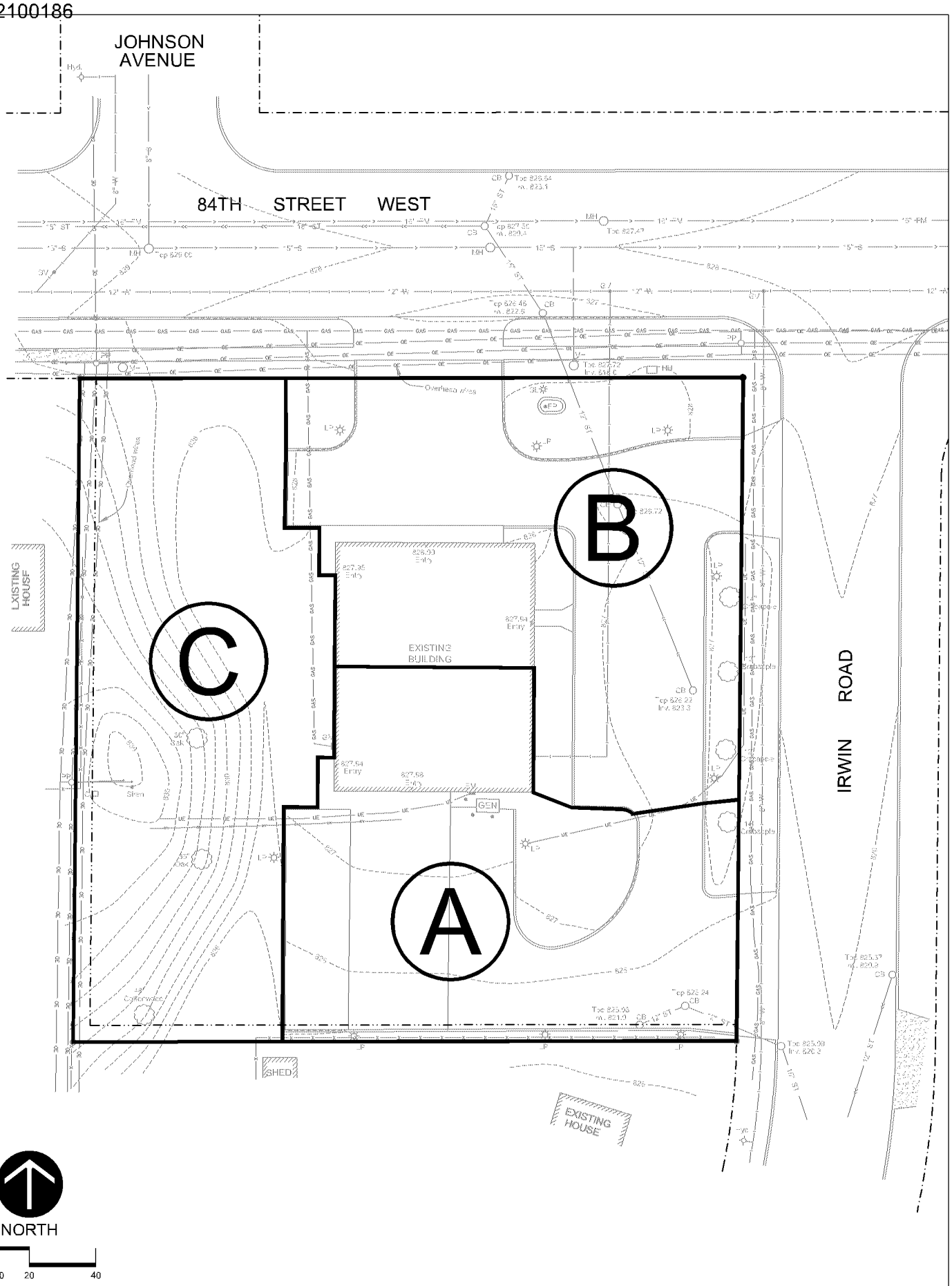

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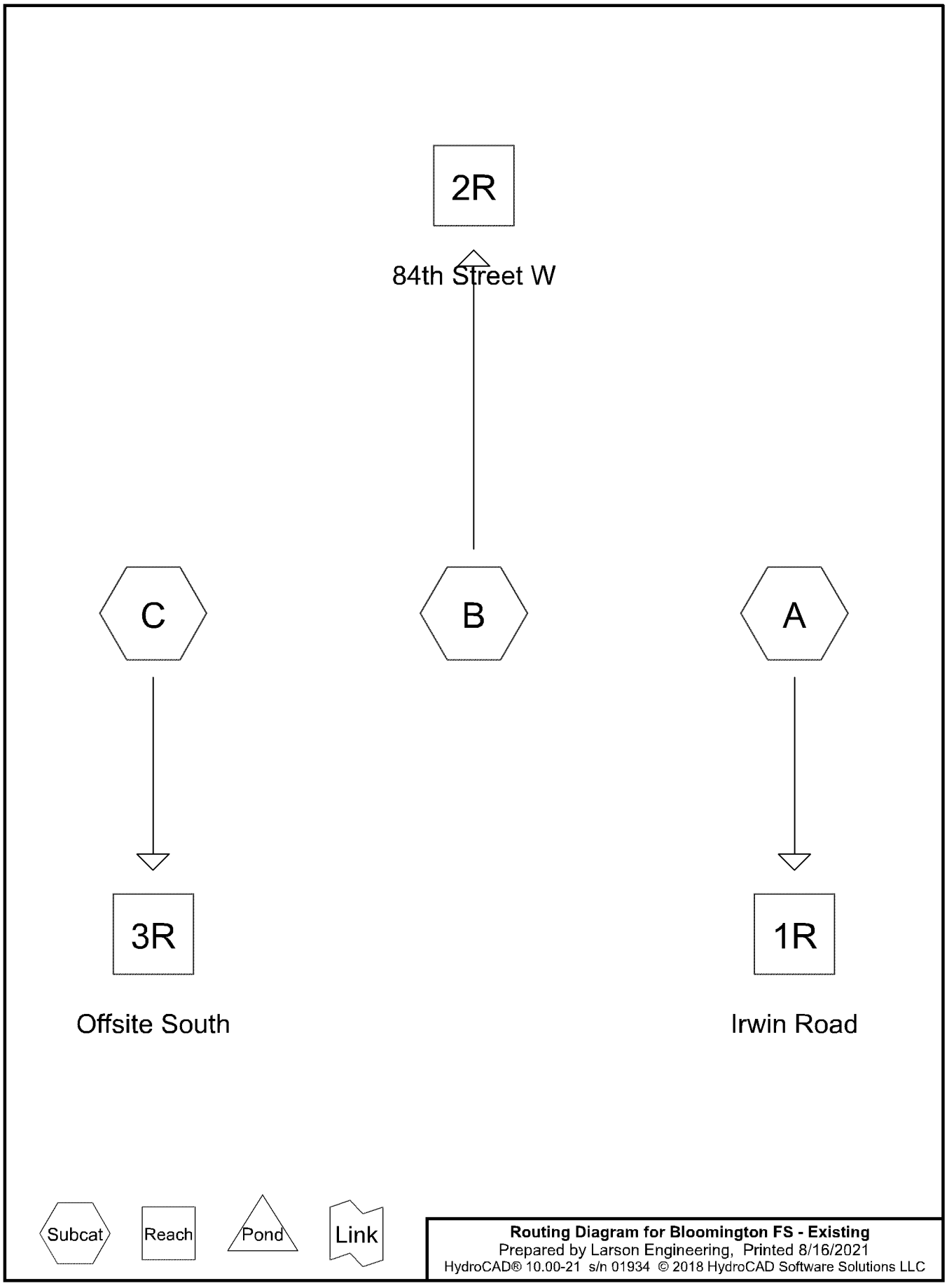
EXISTING DRAINAGE MAP



Routing Diagram for Bloomington FS - Existing
Prepared by Larson Engineering, Printed 8/16/2021

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
19,507	74	>75% Grass cover, Good, HSG C (A, B, C)
4,512	98	Existing Building (A, B)
15,977	98	Existing Impervious (A, B)
39,996	**86**	**TOTAL AREA**

Summary for Subcatchment A:

Runoff = 0.96 cfs @ 12.15 hrs, Volume= 2,343 cf, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 2-Year Rainfall=2.83"

	Area (sf)	CN	Description
*	7,897	98	Existing Impervious
*	2,256	98	Existing Building
	2,152	74	>75% Grass cover, Good, HSG C
	12,305	94	Weighted Average
	2,152	74	17.49% Pervious Area
	10,153	98	82.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	45	0.0222	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
0.5	35	0.0303	1.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.83"
8.2	80	Total			

Summary for Subcatchment B:

Runoff = 1.14 cfs @ 12.12 hrs, Volume= 2,486 cf, Depth= 2.13"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 2-Year Rainfall=2.83"

	Area (sf)	CN	Description
*	8,080	98	Existing Impervious
*	2,256	98	Existing Building
	3,696	74	>75% Grass cover, Good, HSG C
	14,032	92	Weighted Average
	3,696	74	26.34% Pervious Area
	10,336	98	73.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	24	0.0208	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
0.5	38	0.0337	1.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.83"
5.3	62	Total			

Summary for Subcatchment C:

Runoff = 0.29 cfs @ 12.28 hrs, Volume= 913 cf, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 2-Year Rainfall=2.83"

Area (sf)	CN	Description
13,659	74	>75% Grass cover, Good, HSG C
13,659	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	43	0.2209	0.24		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
13.9	93	0.0215	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
16.9	136	Total			

Summary for Reach 1R: Irwin Road

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12,305 sf, 82.51% Impervious, Inflow Depth = 2.28" for 2-Year event
Inflow = 0.96 cfs @ 12.15 hrs, Volume= 2,343 cf
Outflow = 0.96 cfs @ 12.15 hrs, Volume= 2,343 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: 84th Street W

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14,032 sf, 73.66% Impervious, Inflow Depth = 2.13" for 2-Year event
Inflow = 1.14 cfs @ 12.12 hrs, Volume= 2,486 cf
Outflow = 1.14 cfs @ 12.12 hrs, Volume= 2,486 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Offsite South

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 13,659 sf, 0.00% Impervious, Inflow Depth = 0.80" for 2-Year event
Inflow = 0.29 cfs @ 12.28 hrs, Volume= 913 cf
Outflow = 0.29 cfs @ 12.28 hrs, Volume= 913 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment A:

Runoff = 1.50 cfs @ 12.15 hrs, Volume= 3,706 cf, Depth= 3.61"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=4.24"

	Area (sf)	CN	Description
*	7,897	98	Existing Impervious
*	2,256	98	Existing Building
	2,152	74	>75% Grass cover, Good, HSG C
	12,305	94	Weighted Average
	2,152	74	17.49% Pervious Area
	10,153	98	82.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	45	0.0222	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
0.5	35	0.0303	1.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.83"
8.2	80	Total			

Summary for Subcatchment B:

Runoff = 1.82 cfs @ 12.12 hrs, Volume= 3,996 cf, Depth= 3.42"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=4.24"

	Area (sf)	CN	Description
*	8,080	98	Existing Impervious
*	2,256	98	Existing Building
	3,696	74	>75% Grass cover, Good, HSG C
	14,032	92	Weighted Average
	3,696	74	26.34% Pervious Area
	10,336	98	73.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	24	0.0208	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
0.5	38	0.0337	1.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.83"
5.3	62	Total			

Summary for Subcatchment C:

Runoff = 0.67 cfs @ 12.26 hrs, Volume= 2,020 cf, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=4.24"

Area (sf)	CN	Description
13,659	74	>75% Grass cover, Good, HSG C
13,659	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	43	0.2209	0.24		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
13.9	93	0.0215	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
16.9	136	Total			

Summary for Reach 1R: Irwin Road

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12,305 sf, 82.51% Impervious, Inflow Depth = 3.61" for 10-Year event
Inflow = 1.50 cfs @ 12.15 hrs, Volume= 3,706 cf
Outflow = 1.50 cfs @ 12.15 hrs, Volume= 3,706 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: 84th Street W

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14,032 sf, 73.66% Impervious, Inflow Depth = 3.42" for 10-Year event
Inflow = 1.82 cfs @ 12.12 hrs, Volume= 3,996 cf
Outflow = 1.82 cfs @ 12.12 hrs, Volume= 3,996 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Offsite South

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 13,659 sf, 0.00% Impervious, Inflow Depth = 1.77" for 10-Year event
Inflow = 0.67 cfs @ 12.26 hrs, Volume= 2,020 cf
Outflow = 0.67 cfs @ 12.26 hrs, Volume= 2,020 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment A:

Runoff = 2.77 cfs @ 12.15 hrs, Volume= 6,947 cf, Depth= 6.77"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=7.50"

	Area (sf)	CN	Description
*	7,897	98	Existing Impervious
*	2,256	98	Existing Building
	2,152	74	>75% Grass cover, Good, HSG C
	12,305	94	Weighted Average
	2,152	74	17.49% Pervious Area
	10,153	98	82.51% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	45	0.0222	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
0.5	35	0.0303	1.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.83"
8.2	80	Total			

Summary for Subcatchment B:

Runoff = 3.44 cfs @ 12.12 hrs, Volume= 7,634 cf, Depth= 6.53"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=7.50"

	Area (sf)	CN	Description
*	8,080	98	Existing Impervious
*	2,256	98	Existing Building
	3,696	74	>75% Grass cover, Good, HSG C
	14,032	92	Weighted Average
	3,696	74	26.34% Pervious Area
	10,336	98	73.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	24	0.0208	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
0.5	38	0.0337	1.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.83"
5.3	62	Total			

Summary for Subcatchment C:

Runoff = 1.71 cfs @ 12.26 hrs, Volume= 5,101 cf, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=7.50"

Area (sf)	CN	Description
13,659	74	>75% Grass cover, Good, HSG C
13,659	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0	43	0.2209	0.24		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
13.9	93	0.0215	0.11		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"
16.9	136	Total			

Summary for Reach 1R: Irwin Road

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12,305 sf, 82.51% Impervious, Inflow Depth = 6.77" for 100-Year event
Inflow = 2.77 cfs @ 12.15 hrs, Volume= 6,947 cf
Outflow = 2.77 cfs @ 12.15 hrs, Volume= 6,947 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: 84th Street W

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 14,032 sf, 73.66% Impervious, Inflow Depth = 6.53" for 100-Year event
Inflow = 3.44 cfs @ 12.12 hrs, Volume= 7,634 cf
Outflow = 3.44 cfs @ 12.12 hrs, Volume= 7,634 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Offsite South

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 13,659 sf, 0.00% Impervious, Inflow Depth = 4.48" for 100-Year event
Inflow = 1.71 cfs @ 12.26 hrs, Volume= 5,101 cf
Outflow = 1.71 cfs @ 12.26 hrs, Volume= 5,101 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

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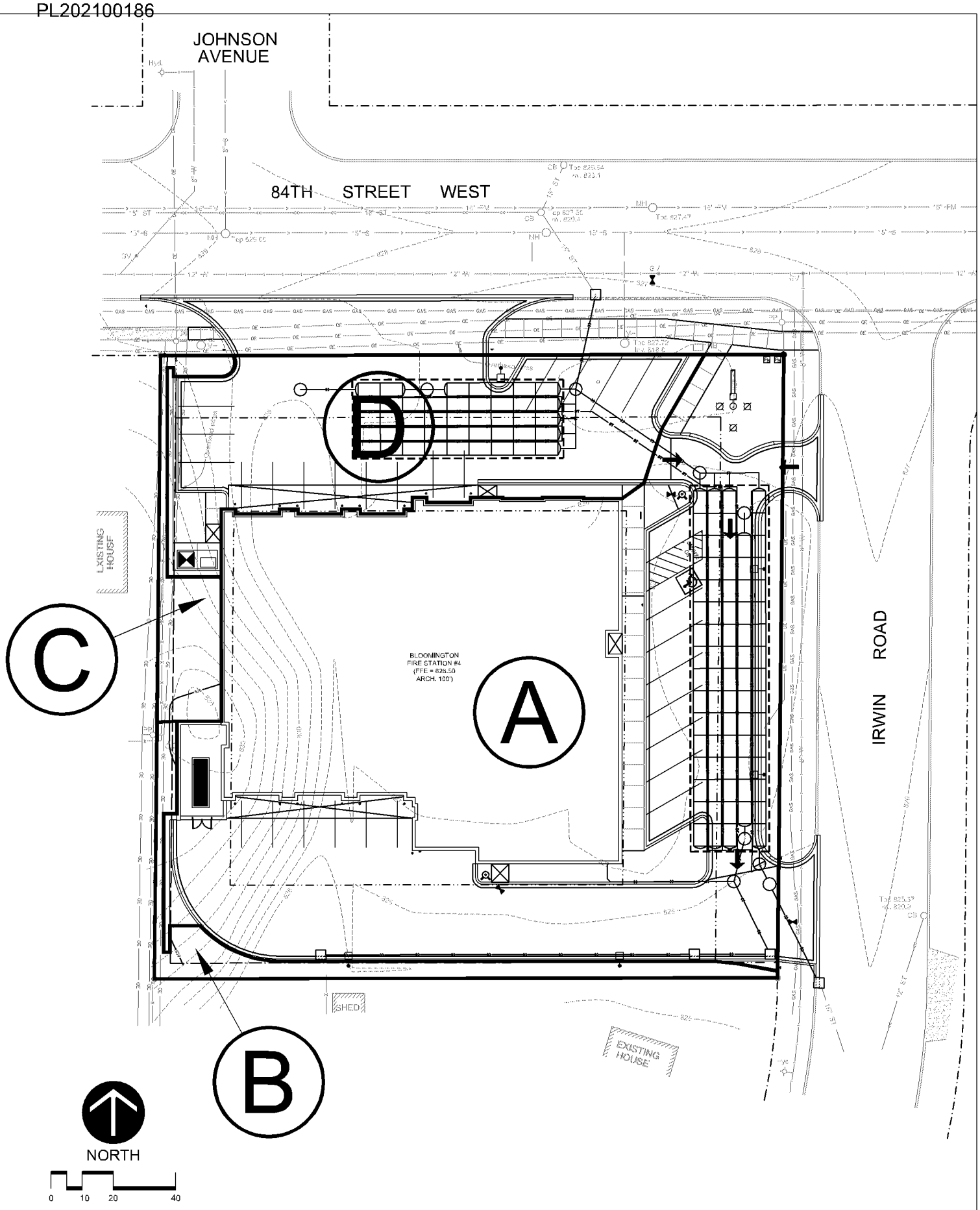

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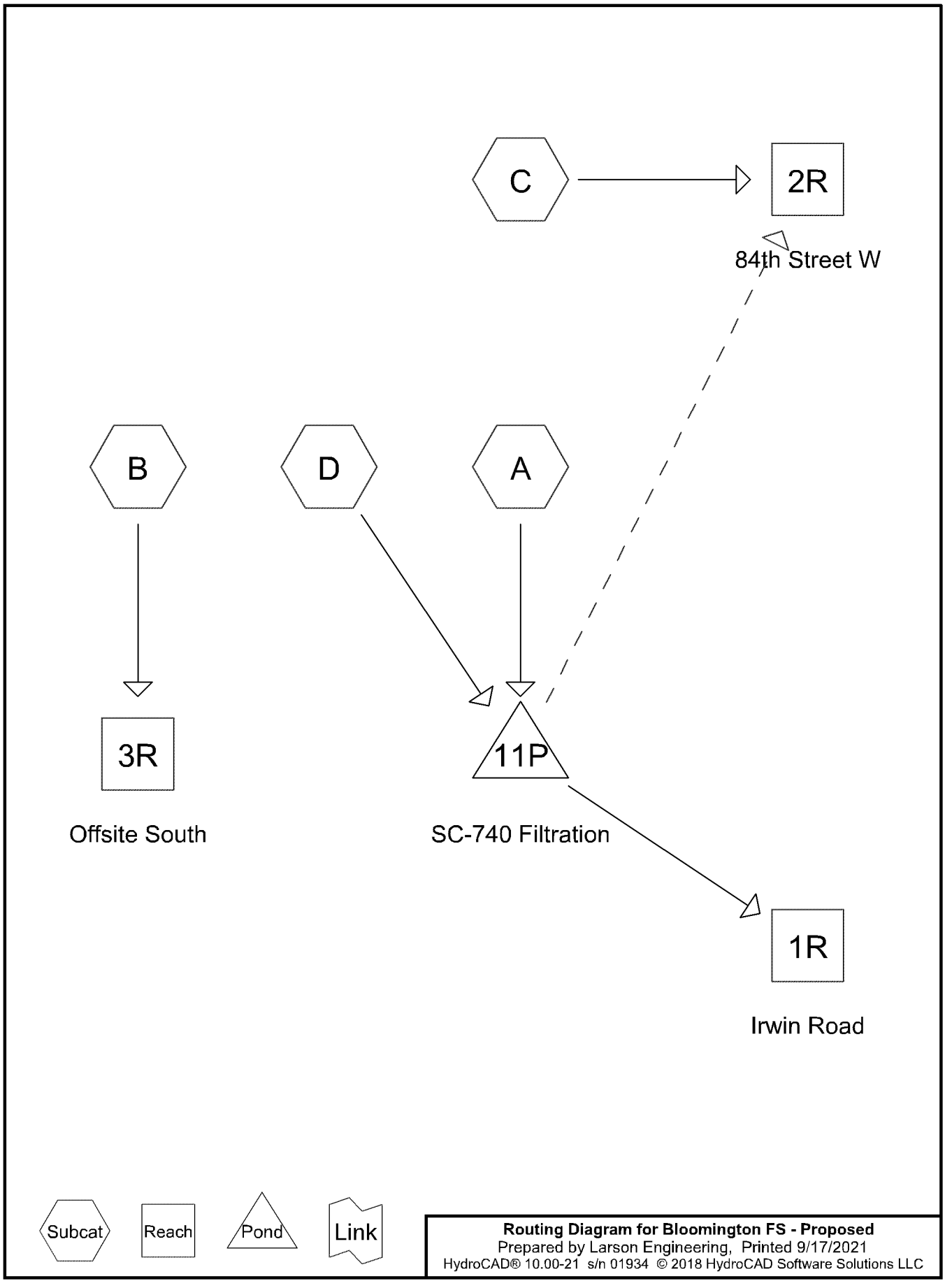
PROPOSED DRAINAGE MAP



Routing Diagram for Bloomington FS - Proposed
Prepared by Larson Engineering, Printed 9/17/2021
HydroCAD® 10.00-21 s/n 01934 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
6,539	74	>75% Grass cover, Good, HSG C (A, B, C, D)
13,361	98	Proposed Building (A)
20,098	98	Propsoed Pavement (A, D)
39,998	**94**	**TOTAL AREA**

Summary for Subcatchment A:

Runoff = 2.62 cfs @ 12.13 hrs, Volume= 5,898 cf, Depth= 2.42"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 2-Year Rainfall=2.83"

	Area (sf)	CN	Description
*	12,993	98	Propsoed Pavement
*	13,361	98	Proposed Building
	2,843	74	>75% Grass cover, Good, HSG C
	29,197	96	Weighted Average
	2,843	74	9.74% Pervious Area
	26,354	98	90.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment B:

Runoff = 0.05 cfs @ 12.17 hrs, Volume= 106 cf, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 2-Year Rainfall=2.83"

Area (sf)	CN	Description
1,589	74	>75% Grass cover, Good, HSG C
1,589	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	84	0.0595	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"

Summary for Subcatchment C:

Runoff = 0.03 cfs @ 12.21 hrs, Volume= 84 cf, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 2-Year Rainfall=2.83"

Area (sf)	CN	Description
1,256	74	>75% Grass cover, Good, HSG C
1,256	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	121	0.0496	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"

Summary for Subcatchment D:

Runoff = 0.71 cfs @ 12.13 hrs, Volume= 1,596 cf, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 2-Year Rainfall=2.83"

	Area (sf)	CN	Description
*	7,105	98	Propsoed Pavement
	851	74	>75% Grass cover, Good, HSG C
	7,956	95	Weighted Average
	851	74	10.70% Pervious Area
	7,105	98	89.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 1R: Irwin Road

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 37,153 sf, 90.06% Impervious, Inflow Depth > 2.42" for 2-Year event
Inflow = 0.08 cfs @ 10.98 hrs, Volume= 7,491 cf
Outflow = 0.08 cfs @ 10.98 hrs, Volume= 7,491 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: 84th Street W

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,256 sf, 0.00% Impervious, Inflow Depth = 0.80" for 2-Year event
Inflow = 0.03 cfs @ 12.21 hrs, Volume= 84 cf
Outflow = 0.03 cfs @ 12.21 hrs, Volume= 84 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Offsite South

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,589 sf, 0.00% Impervious, Inflow Depth = 0.80" for 2-Year event
Inflow = 0.05 cfs @ 12.17 hrs, Volume= 106 cf
Outflow = 0.05 cfs @ 12.17 hrs, Volume= 106 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Pond 11P: SC-740 Filtration

Inflow Area = 37,153 sf, 90.06% Impervious, Inflow Depth = 2.42" for 2-Year event
Inflow = 3.33 cfs @ 12.13 hrs, Volume= 7,494 cf
Outflow = 0.08 cfs @ 10.98 hrs, Volume= 7,491 cf, Atten= 98%, Lag= 0.0 min
Primary = 0.08 cfs @ 10.98 hrs, Volume= 7,491 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 822.71' @ 14.34 hrs Surf.Area= 4,451 sf Storage= 4,759 cf

Plug-Flow detention time= 525.6 min calculated for 7,491 cf (100% of inflow)
Center-of-Mass det. time= 525.3 min (1,281.9 - 756.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	821.00'	2,856 cf	**34.75'W x 81.94'L x 3.75'H Field A** 10,677 cf Overall - 3,537 cf Embedded = 7,140 cf x 40.0% Voids
#2A	821.75'	3,537 cf	**ADS_StormTech SC-740 +Cap** x 77 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 7 Rows of 11 Chambers
#3B	821.00'	1,634 cf	**30.00'W x 53.46'L x 3.75'H Field B** 6,014 cf Overall - 1,929 cf Embedded = 4,084 cf x 40.0% Voids
#4B	821.75'	1,929 cf	**ADS_StormTech SC-740 +Cap** x 42 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 6 Rows of 7 Chambers
		9,957 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	820.50'	**15.0" Round Culvert** L= 40.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 820.50' / 820.30' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Secondary	823.70'	**12.0" Round Culvert** L= 31.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 823.70' / 822.60' S= 0.0355 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 0.79 sf
#3	Device 1	824.30'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 1	823.65'	**6.0" Vert. Orifice/Grate** C= 0.600
#5	Device 1	821.00'	**6.0" Vert. 6" DT X 2.00** C= 0.600
#6	Device 5	821.00'	**0.800 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.08 cfs @ 10.98 hrs HW=821.15' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.08 cfs of 1.40 cfs potential flow)
↑—**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
—**4=Orifice/Grate** (Controls 0.00 cfs)
—**5=6" DT** (Passes 0.08 cfs of 0.13 cfs potential flow)
↑—**6=Exfiltration** (Exfiltration Controls 0.08 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=821.00' TW=0.00' (Dynamic Tailwater)
↑—**2=Culvert** (Controls 0.00 cfs)

Summary for Subcatchment A:

Runoff = 4.03 cfs @ 12.13 hrs, Volume= 9,215 cf, Depth= 3.79"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=4.24"

	Area (sf)	CN	Description
*	12,993	98	Propsoed Pavement
*	13,361	98	Proposed Building
	2,843	74	>75% Grass cover, Good, HSG C
	29,197	96	Weighted Average
	2,843	74	9.74% Pervious Area
	26,354	98	90.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment B:

Runoff = 0.11 cfs @ 12.16 hrs, Volume= 235 cf, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=4.24"

Area (sf)	CN	Description
1,589	74	>75% Grass cover, Good, HSG C
1,589	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	84	0.0595	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"

Summary for Subcatchment C:

Runoff = 0.07 cfs @ 12.21 hrs, Volume= 186 cf, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=4.24"

Area (sf)	CN	Description
1,256	74	>75% Grass cover, Good, HSG C
1,256	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	121	0.0496	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"

Summary for Subcatchment D:

Runoff = 1.09 cfs @ 12.13 hrs, Volume= 2,497 cf, Depth= 3.77"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 10-Year Rainfall=4.24"

	Area (sf)	CN	Description
*	7,105	98	Propsoed Pavement
	851	74	>75% Grass cover, Good, HSG C
	7,956	95	Weighted Average
	851	74	10.70% Pervious Area
	7,105	98	89.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 1R: Irwin Road

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 37,153 sf, 90.06% Impervious, Inflow Depth > 3.77" for 10-Year event
Inflow = 0.11 cfs @ 14.98 hrs, Volume= 11,670 cf
Outflow = 0.11 cfs @ 14.98 hrs, Volume= 11,670 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: 84th Street W

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,256 sf, 0.00% Impervious, Inflow Depth = 2.15" for 10-Year event
Inflow = 0.07 cfs @ 12.21 hrs, Volume= 225 cf
Outflow = 0.07 cfs @ 12.21 hrs, Volume= 225 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Offsite South

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,589 sf, 0.00% Impervious, Inflow Depth = 1.77" for 10-Year event
Inflow = 0.11 cfs @ 12.16 hrs, Volume= 235 cf
Outflow = 0.11 cfs @ 12.16 hrs, Volume= 235 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Pond 11P: SC-740 Filtration

Inflow Area = 37,153 sf, 90.06% Impervious, Inflow Depth = 3.78" for 10-Year event
Inflow = 5.12 cfs @ 12.13 hrs, Volume= 11,712 cf
Outflow = 0.12 cfs @ 14.98 hrs, Volume= 11,709 cf, Atten= 98%, Lag= 170.9 min
Primary = 0.11 cfs @ 14.98 hrs, Volume= 11,670 cf
Secondary = 0.01 cfs @ 14.98 hrs, Volume= 39 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 823.74' @ 14.98 hrs Surf.Area= 4,451 sf Storage= 7,941 cf

Plug-Flow detention time= 835.1 min calculated for 11,708 cf (100% of inflow)
Center-of-Mass det. time= 835.2 min (1,585.9 - 750.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	821.00'	2,856 cf	**34.75'W x 81.94'L x 3.75'H Field A** 10,677 cf Overall - 3,537 cf Embedded = 7,140 cf x 40.0% Voids
#2A	821.75'	3,537 cf	**ADS_StormTech SC-740 +Cap** x 77 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 7 Rows of 11 Chambers
#3B	821.00'	1,634 cf	**30.00'W x 53.46'L x 3.75'H Field B** 6,014 cf Overall - 1,929 cf Embedded = 4,084 cf x 40.0% Voids
#4B	821.75'	1,929 cf	**ADS_StormTech SC-740 +Cap** x 42 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 6 Rows of 7 Chambers
		9,957 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	820.50'	**15.0" Round Culvert** L= 40.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 820.50' / 820.30' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Secondary	823.70'	**12.0" Round Culvert** L= 31.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 823.70' / 822.60' S= 0.0355 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 0.79 sf
#3	Device 1	824.30'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 1	823.65'	**6.0" Vert. Orifice/Grate** C= 0.600
#5	Device 1	821.00'	**6.0" Vert. 6" DT X 2.00** C= 0.600
#6	Device 5	821.00'	**0.800 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.11 cfs @ 14.98 hrs HW=823.74' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Passes 0.11 cfs of 9.55 cfs potential flow)
- **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
- **4=Orifice/Grate** (Orifice Controls 0.02 cfs @ 1.01 fps)
- **5=6" DT** (Passes 0.08 cfs of 2.98 cfs potential flow)
  - ↑**6=Exfiltration** (Exfiltration Controls 0.08 cfs)

Secondary OutFlow Max=0.01 cfs @ 14.98 hrs HW=823.74' TW=0.00' (Dynamic Tailwater)
↑**2=Culvert** (Inlet Controls 0.01 cfs @ 0.91 fps)

Summary for Subcatchment A:

Runoff = 7.31 cfs @ 12.13 hrs, Volume= 17,007 cf, Depth= 6.99"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=7.50"

	Area (sf)	CN	Description
*	12,993	98	Propsoed Pavement
*	13,361	98	Proposed Building
	2,843	74	>75% Grass cover, Good, HSG C
	29,197	96	Weighted Average
	2,843	74	9.74% Pervious Area
	26,354	98	90.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment B:

Runoff = 0.27 cfs @ 12.16 hrs, Volume= 593 cf, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=7.50"

Area (sf)	CN	Description
1,589	74	>75% Grass cover, Good, HSG C
1,589	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	84	0.0595	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"

Summary for Subcatchment C:

Runoff = 0.18 cfs @ 12.20 hrs, Volume= 469 cf, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=7.50"

Area (sf)	CN	Description
1,256	74	>75% Grass cover, Good, HSG C
1,256	74	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	121	0.0496	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.83"

Summary for Subcatchment D:

Runoff = 1.99 cfs @ 12.13 hrs, Volume= 4,617 cf, Depth= 6.96"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
MSE 24-hr 3 100-Year Rainfall=7.50"

	Area (sf)	CN	Description
*	7,105	98	Propsoed Pavement
	851	74	>75% Grass cover, Good, HSG C
	7,956	95	Weighted Average
	851	74	10.70% Pervious Area
	7,105	98	89.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach 1R: Irwin Road

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 37,153 sf, 90.06% Impervious, Inflow Depth = 5.28" for 100-Year event
Inflow = 2.64 cfs @ 12.20 hrs, Volume= 16,342 cf
Outflow = 2.64 cfs @ 12.20 hrs, Volume= 16,342 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 2R: 84th Street W

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,256 sf, 0.00% Impervious, Inflow Depth = 54.91" for 100-Year event
Inflow = 3.31 cfs @ 12.20 hrs, Volume= 5,748 cf
Outflow = 3.31 cfs @ 12.20 hrs, Volume= 5,748 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Reach 3R: Offsite South

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,589 sf, 0.00% Impervious, Inflow Depth = 4.48" for 100-Year event
Inflow = 0.27 cfs @ 12.16 hrs, Volume= 593 cf
Outflow = 0.27 cfs @ 12.16 hrs, Volume= 593 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Pond 11P: SC-740 Filtration

Inflow Area = 37,153 sf, 90.06% Impervious, Inflow Depth = 6.98" for 100-Year event
Inflow = 9.30 cfs @ 12.13 hrs, Volume= 21,624 cf
Outflow = 5.77 cfs @ 12.20 hrs, Volume= 21,621 cf, Atten= 38%, Lag= 4.0 min
Primary = 2.64 cfs @ 12.20 hrs, Volume= 16,342 cf
Secondary = 3.13 cfs @ 12.20 hrs, Volume= 5,279 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 824.57' @ 12.20 hrs Surf.Area= 4,451 sf Storage= 9,632 cf

Plug-Flow detention time= 523.9 min calculated for 21,621 cf (100% of inflow)
Center-of-Mass det. time= 523.8 min (1,267.7 - 743.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	821.00'	2,856 cf	**34.75'W x 81.94'L x 3.75'H Field A** 10,677 cf Overall - 3,537 cf Embedded = 7,140 cf x 40.0% Voids
#2A	821.75'	3,537 cf	**ADS_StormTech SC-740 +Cap** x 77 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 7 Rows of 11 Chambers
#3B	821.00'	1,634 cf	**30.00'W x 53.46'L x 3.75'H Field B** 6,014 cf Overall - 1,929 cf Embedded = 4,084 cf x 40.0% Voids
#4B	821.75'	1,929 cf	**ADS_StormTech SC-740 +Cap** x 42 Inside #3 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 6 Rows of 7 Chambers
		9,957 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	820.50'	**15.0" Round Culvert** L= 40.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 820.50' / 820.30' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#2	Secondary	823.70'	**12.0" Round Culvert** L= 31.0' RCP, rounded edge headwall, Ke= 0.100 Inlet / Outlet Invert= 823.70' / 822.60' S= 0.0355 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 0.79 sf
#3	Device 1	824.30'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Device 1	823.65'	**6.0" Vert. Orifice/Grate** C= 0.600
#5	Device 1	821.00'	**6.0" Vert. 6" DT X 2.00** C= 0.600
#6	Device 5	821.00'	**0.800 in/hr Exfiltration over Surface area**

Primary OutFlow Max=2.63 cfs @ 12.20 hrs HW=824.57' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Passes 2.63 cfs of 10.96 cfs potential flow)
  - **3=Sharp-Crested Rectangular Weir** (Weir Controls 1.77 cfs @ 1.69 fps)
  - **4=Orifice/Grate** (Orifice Controls 0.77 cfs @ 3.93 fps)
  - **5=6" DT** (Passes 0.08 cfs of 3.44 cfs potential flow)
    - **6=Exfiltration** (Exfiltration Controls 0.08 cfs)

Secondary OutFlow Max=3.12 cfs @ 12.20 hrs HW=824.57' TW=0.00' (Dynamic Tailwater)
- **2=Culvert** (Inlet Controls 3.12 cfs @ 4.32 fps)

PL202100186

Project Information

Calculator Version:	Version 4: July 2020
Project Name:	Bloomington Fire Station #4
User Name / Company Name:	Larson Engineering, Inc.
Date:	September 16, 2021
Project Description:	
Construction Permit?:	No

Site Information

Retention Requirement (inches):	1.1
Site's Zip Code:	55437
Annual Rainfall (inches):	31
Phosphorus EMC (mg/l):	0.3
TSS EMC (mg/l):	54.5

Total Site Area

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed			0.1393		0.1393
				Impervious Area (acres)	0.7789
				Total Area (acres)	0.9182

Site Areas Routed to BMPs

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed			0.0709		0.0709
				Impervious Area (acres)	0.7789
				Total Area (acres)	0.8498

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	3110	ft3
Volume removed by BMPs towards performance goal:		ft^3
Percent volume removed towards performance goal		**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	1.7916	acre-ft
Annual runoff volume removed by BMPs:	0	acre-ft
Percent annual runoff volume removed:	**0**	**%**
Post development annual particulate P load:	0.8041	lbs
Annual particulate P removed by BMPs:	0.627	lbs
Post development annual dissolved P load:	0.658	lbs
Annual dissolved P removed by BMPs:	0.381	lbs
Total P removed by BMPs	1.008	lbs
Percent annual total phosphorus removed:	**69**	**%**
Post development annual TSS load:	265.6	lbs
Annual TSS removed by BMPs:	257.6	lbs
Percent annual TSS removed:	**97**	**%**

BMP Summary

Performance Goal Summary

BMP Name	BMP Volume Capacity (ft3)	Volume Recieved (ft3)	Volume Retained (ft3)	Volume Outflow (ft3)	Percent Retained (%)
0 - Sand filter	0	3110	0	3110	0
Jellyfish Filter	0	3110	0	3110	0

Annual Volume Summary

BMP Name	Volume From Direct Watershed (acre-ft)	Volume From Upstream BMPs (acre-ft)	Volume Retained (acre-ft)	Volume outflow (acre-ft)	Percent Retained (%)
0 - Sand filter	1.7567	0	0	1.7567	0
Jellyfish Filter	0	1.7567	0	1.7567	0

Particulate Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
0 - Sand filter	0.7884	0	0.3942	0.3942	50
Jellyfish Filter	0	0.3942	0.2326	0.1616	59

Dissolved Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
0 - Sand filter	0.645	0	0	0.645	0
Jellyfish Filter	0	0.645	0.3806	0.2644	59

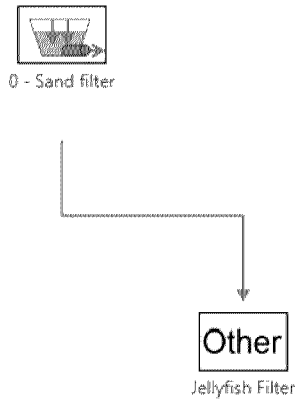
Total Phosphorus Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
0 - Sand filter	1.4334	0	0.3942	1.0392	25
Jellyfish Filter	0	1.0392	0.6132	0.426	59

TSS Summary

BMP Name	Load From Direct Watershed (lbs)	Load From Upstream BMPs (lbs)	Load Retained (lbs)	Outflow Load (lbs)	Percent Retained (%)
0 - Sand filter	260.41	0	234.37	26.04	90
Jellyfish Filter	0	26.04	23.18	2.8600000000	89

BMP Schematic


0 - Sand filter
Other
Jellyfish Filter