Kimley»Horn

MEMORANDUM

To:	City of Bloomington Lower Minnesota River WMO
From:	Benjamin Johnson, PE Kimley-Horn and Associates, Inc.
Date:	12/20/2019
Subject:	Oppidan – Bank Development – 611 W 98th St – Stormwater Management Report

The proposed site is located at 611 W 98th St in Bloomington, Hennepin County, Minnesota. The ±1.18-acre Site is currently developed and consists of an approximate 4,869 square foot Baker's square restaurant. The proposed development will consist of a new ±4,020 square foot bank building. The development will incorporate an underground infiltration BMP to accommodate City and Watershed stormwater requirements. The total disturbance area is under 1 acre at 0.60 acres, but the reconstructed impervious area is 19,951 square feet that exceeds the 5,000 square foot threshold.

Kimley-Horn has prepared a preliminary drainage analysis of the existing and proposed conditions through the assistance of HydroCAD Version 10. The Site has been designed to comply the City of Bloomington and Lower Minnesota River WMO standards.

EXISTING DRAINAGE CONDITIONS

The existing 1.18-acre Site is approximately 88% (1.04 acres) impervious and 12% (0.14 acres) pervious. The impervious portion of the site drains to on-site storm catch basins that discharge to the existing storm sewer main in West 98th Street. The site elevations range from 830 to 833. A portion of the site drains to an existing on-site catch basin along the north curb line that connects to the main in West 98th Street, and the southern half of the site drains off-site into adjacent private storm catch basins that ultimately discharge to the same storm manhole within West 98th Street. Soil borings indicate a fill layer varying in depth below the developed portions of the site, and the fill is underlain by native sandy soils (SP) soils which are HSG type A.

Direct Entry Time of concentration was utilized in determining runoff rates. Per the MnDOT drainage manual, a minimum 7-minute time of concentration is to be utilized. For the existing conditions, a 7-minute minimum time of concentration was utilized for all drainage areas when the calculations determined a value less than the minimum.

PROPOSED DRAINAGE CONDITIONS

The proposed Site will be approximately 88% (1.04 acres) impervious and 12% (0.14 acres) pervious. The new/reconstructed impervious area is approximately 19,951 square feet which will be used to determine the water quality volume. The proposed site will consist of a new ±4,000 square foot bank building. The building will be on the north part of the site with impervious parking areas and drive areas bordering the building on the east, south, and west sides along with associated landscaping areas.

The proposed building and parking lot will drain to on-site catch basins that will drain to the underground infiltration system located underneath the western portion of the reconstructed parking lot area. The infiltration BMP will help meet rate control, volume control, and water quality requirement. The BMP will be designed to treat the new/reconstructed impervious areas and will help provide rate control from the contributing drainage area before discharging to storm sewer located on the north side of the site. This is the same existing storm pipe that ultimately captures the runoff from the northern portion of the existing site. This existing storm sewer discharges to the junction manhole in West 98th Street. The BMP will capture about 0.60 acres of the site area, the remaining undisturbed site areas that don't contribute to the underground infiltration system will drain off-site as in the existing conditions.

The underlying soil type is HSG type A that the underground infiltration system will utilize for its design infiltration rate of 0.80 in/hr. Direct Entry Time of concentration was utilized when the calculated time of concentrations did not exceed the minimum time of concentration of 7 minutes outlined by the MnDOT drainage manual. As a result, all proposed drainage areas utilized a 7-minute time of concentration. See the below table for the runoff rate control summary for the existing versus proposed conditions.

Discharge Location		**2-Year (CFS)**	**10-Year (CFS)**	**100-Year (CFS)**
Site Total–Private system and W 98th Street Junction (Reach 4R)	Existing Conditions	4.75	7.54	13.90
	Proposed Conditions	***1.99***	**6.25**	***10.60***

Table 1: RATE CONTROL SUMMARY

VOLUME CONTROL SUMMARY

The proposed new and reconstructed impervious area of the development is approximately 19,951 square feet. Based on the 1.1" volume control requirement, the water quality volume required for the site is 1,829 cubic feet. The proposed infiltration basin is designed assuming HSG type A soils and an infiltration rate of 0.80 in/hr. The maximum allowable drawdown depth is 3.2 feet per the MN Stormwater manual guidance with this assumed infiltration rate. The proposed infiltration basin bottom is at elevation 826.00 with the water quality volume at elevation at 828.15 totaling 2.15 feet of infiltration depth. The storage volume within this depth totals 2,004 cubic feet which is greater than the required water quality volume stated above. See the below calculation demonstrating a drawdown of less than 48 hours.

$$t = \frac{d}{i} = \left(\frac{2.20\,ft}{0.8\frac{in.}{hr}}\right)\left(\frac{12\,in}{1\,ft.}\right) = 32.25\,hr < 48\,hr$$

t – Drawdown Time
i – Infiltration Rate
d- Depth of Draw Down

WATER QUALITY ANALYSIS

Pretreatment is a required stormwater management practice for infiltration practices. Flow-through water quality structures will be included on site to remove coarse sediment and attached nutrients as well as extend the life of the downstream underground infiltration system. Stormwater captured on the disturbed portion of the site will be routed through one of two- 4' sump manholes with a SAFL Baffle. The SAFL Baffle will help prevent the resuspension of sediment, especially during high flows. These structures will be placed directly before the underground infiltration system.

Infiltration provides 100% efficiency in removing TSS and TP. The infiltration basin captures 95% of the proposed new and reconstructed impervious areas, but will provide sufficient water quality volume treatment through infiltration to account for all new and reconstructed impervious areas. Since the volume control requirement is exceeded with the proposed infiltration basin, the water quality requirements of 90% TSS reduction and 60% TP reduction are met.

Please contact me at (612) 326-9506 if you have any questions.

Sincerely,

KIMLEY-HORN AND ASSOCIATES, INC.

Benjamin Johnson

Ben Jonhson, P.E.

Exhibits

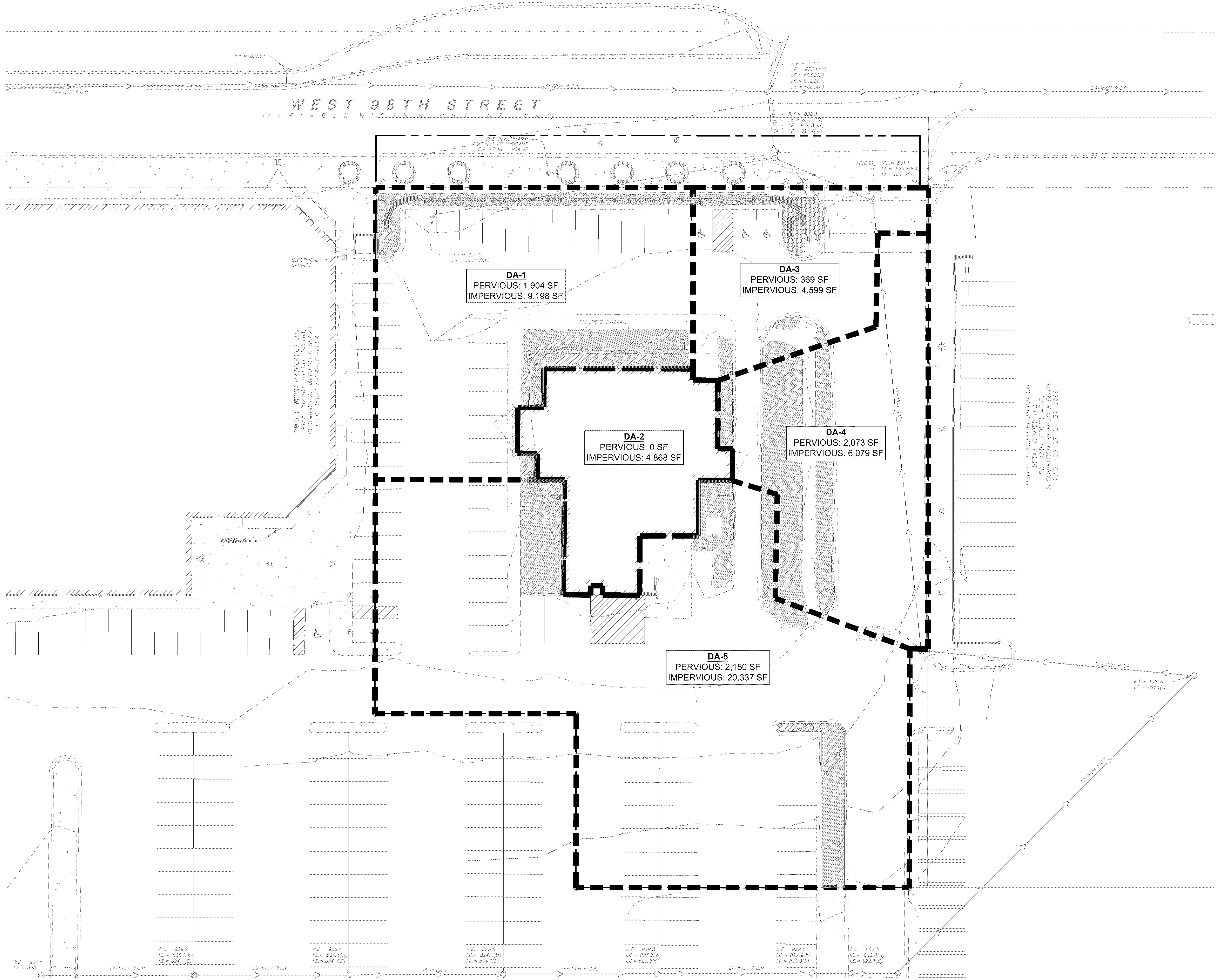
Exhibit 1. Existing Drainage Exhibit

CASE #PL2020-14

LEGEND

- PROPERTY LINE
- DRAINAGE AREA BOUNDARY
- PERVIOUS AREA

PROPERTY DRAINAGE AREA TABLE	
PROPERTY AREA	51,581 SF (1.18 AC)
PRE-DEVELOPMENT PERVIOUS AREA	6,496 SF (0.14 AC)
PRE-DEVELOPMENT IMPERVIOUS AREA	45,085 SF (1.04 AC)
POST-DEVELOPMENT PERVIOUS AREA	6,212 SF (0.14 AC)
POST-DEVELOPMENT IMPERVIOUS AREA	45,369 SF (1.04 AC)



REVISIONS	DATE	BY
No.		

Kimley»Horn
2018 KIMLEY-HORN AND ASSOCIATES, INC.
767 EUSTIS STREET, SUITE 100, ST. PAUL, MN 55114
PHONE: 651-645-4197
WWW.KIMLEY-HORN.COM

KHA PROJECT	160774046
DATE	12/20/2019
SCALE	AS SHOWN
DESIGNED BY	BPG
DRAWN BY	BPG
CHECKED BY	BRJ

EXISTING DRAINAGE MAP

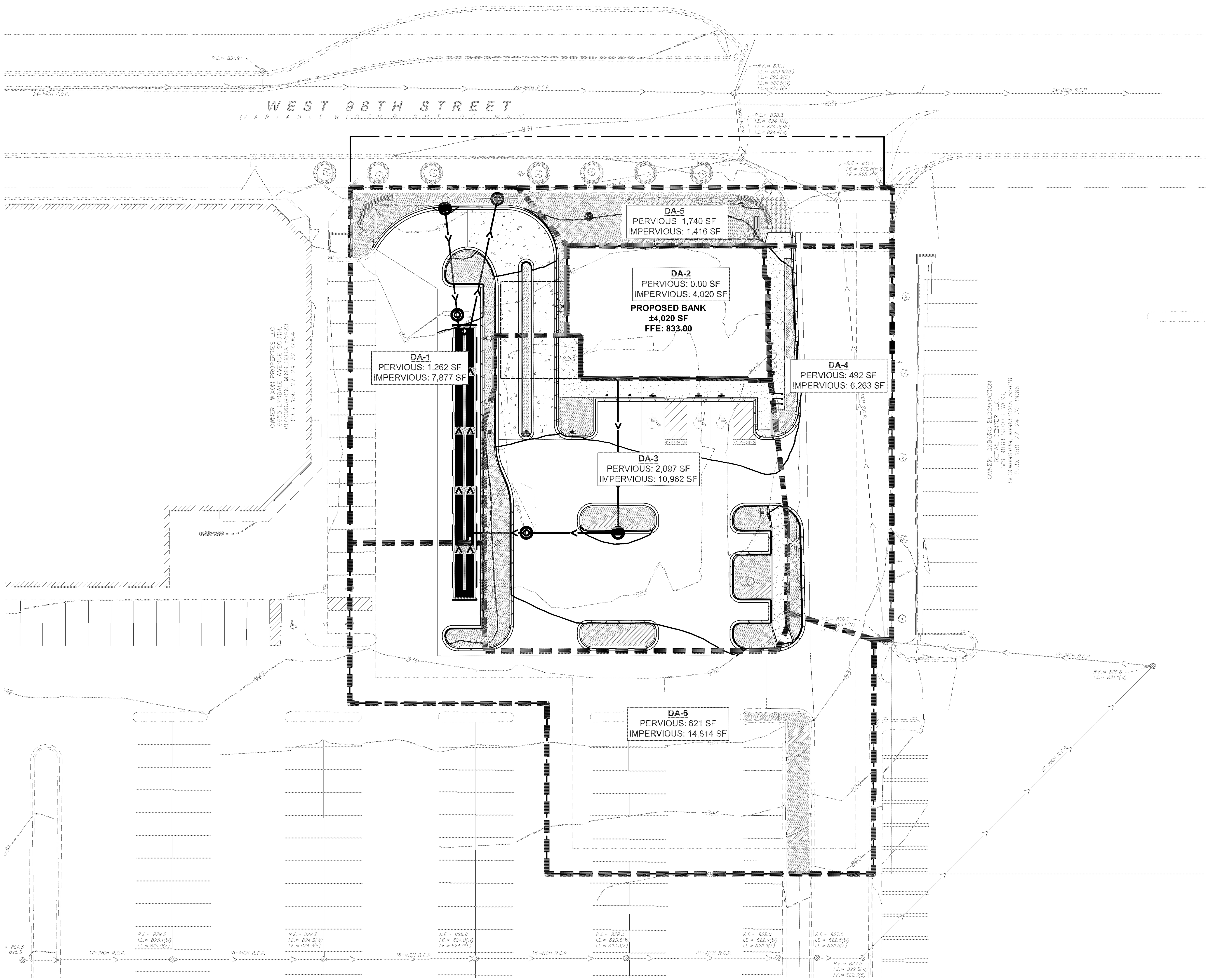
BANK OF AMERICA
PREPARED FOR
OPPIDAN
BLOOMINGTON MN

SHEET NUMBER
EX-A

K:\TWC_LDEV\OPPIDAN\Bloomington - Bank\3 Design\CAD\Exhibits\EX-A Existing Drainage Map.dwg December 18, 2019 - 2:45pm

Exhibit 2. Proposed Drainage Exhibit

CASE #PL2020-14

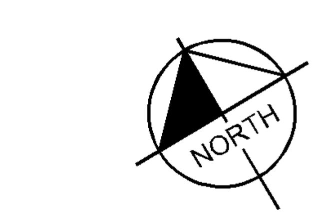


PROPERTY LINE

DRAINAGE AREA BOUNDARY

PERVIOUS AREA

PROPERTY DRAINAGE AREA TABLE	
PROPERTY AREA	51,581 SF (1.18 AC)
PRE-DEVELOPMENT PERVIOUS AREA	6,496 SF (0.14 AC)
PRE-DEVELOPMENT IMPERVIOUS AREA	45,085 SF (1.04 AC)
POST-DEVELOPMENT PERVIOUS AREA	6,212 SF (0.14 AC)
POST-DEVELOPMENT IMPERVIOUS AREA	45,369 SF (1.04 AC)



GRAPHIC SCALE IN FEET

No.	REVISIONS	DATE	BY

Kimley»Horn

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KHA PROJECT	160774046
DATE	12/20/2019
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PROPOSED DRAINAGE MAP

BANK OF AMERICA
PREPARED FOR
OPPIDAN
BLOOMINGTON MN

SHEET NUMBER
EX-B

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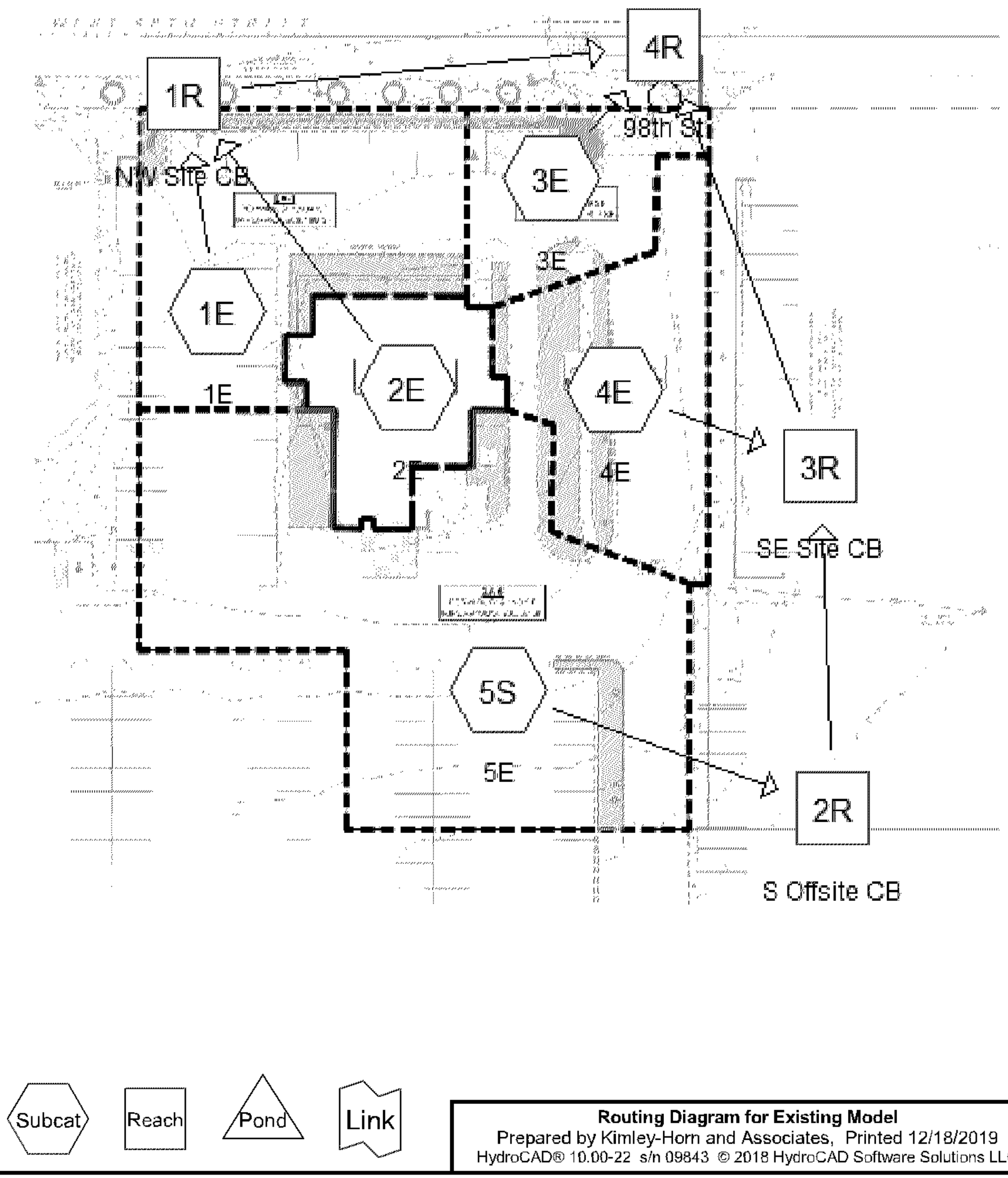
Appendices

Appendix 1. Existing HydroCAD Model Analysis



Routing Diagram for Existing Model
Prepared by Kimley-Horn and Associates, Printed 12/18/2019
HydroCAD® 10.00-22 s/n 09843 © 2018 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.149	61	>75% Grass cover, Good, HSG B (1E, 3E, 4E, 5S)
1.035	98	Paved parking, HSG B (1E, 2E, 3E, 4E, 5S)

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
1.184	HSG B	1E, 2E, 3E, 4E, 5S
0.000	HSG C	
0.000	HSG D	
0.000	Other	

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.149	0.000	0.000	0.000	0.149	>75% Grass cover, Good	1E, 3E, 4E, 5S
0.000	1.035	0.000	0.000	0.000	1.035	Paved parking	1E, 2E, 3E, 4E, 5S

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1E: 1E	Runoff Area=11,102 sf 82.85% Impervious Runoff Depth=2.00" Tc=0.0 min CN=92 Runoff=0.99 cfs 0.042 af
Subcatchment 2E: 2E	Runoff Area=4,868 sf 100.00% Impervious Runoff Depth=2.60" Tc=0.0 min CN=98 Runoff=0.50 cfs 0.024 af
Subcatchment 3E: 3E	Runoff Area=4,968 sf 92.57% Impervious Runoff Depth=2.28" Tc=0.0 min CN=95 Runoff=0.48 cfs 0.022 af
Subcatchment 4E: 4E	Runoff Area=8,152 sf 74.57% Impervious Runoff Depth=1.75" Tc=0.0 min CN=89 Runoff=0.65 cfs 0.027 af
Subcatchment 5S: 5E	Runoff Area=22,487 sf 90.44% Impervious Runoff Depth=2.19" Tc=0.0 min CN=94 Runoff=2.13 cfs 0.094 af
Reach 1R: NW Site CB	Inflow=1.49 cfs 0.067 af Outflow=1.49 cfs 0.067 af
Reach 2R: S Offsite CB	Inflow=2.13 cfs 0.094 af Outflow=2.13 cfs 0.094 af
Reach 3R: SE Site CB	Inflow=2.78 cfs 0.121 af Outflow=2.78 cfs 0.121 af
Reach 4R: 98th St	Inflow=4.75 cfs 0.210 af Outflow=4.75 cfs 0.210 af

Summary for Subcatchment 1E: 1E

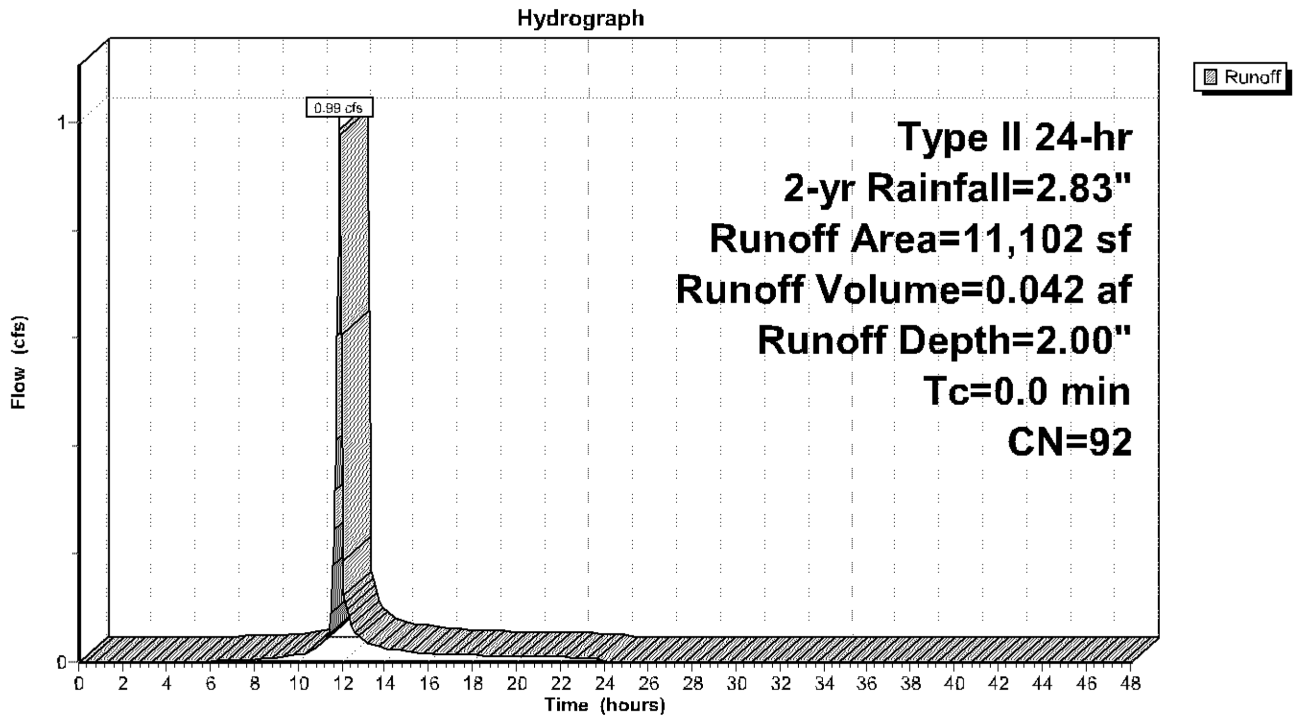
Runoff = 0.99 cfs @ 11.89 hrs, Volume= 0.042 af, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
1,904	61	>75% Grass cover, Good, HSG B
9,198	98	Paved parking, HSG B
11,102	92	Weighted Average
1,904		17.15% Pervious Area
9,198		82.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 1E: 1E



Summary for Subcatchment 2E: 2E

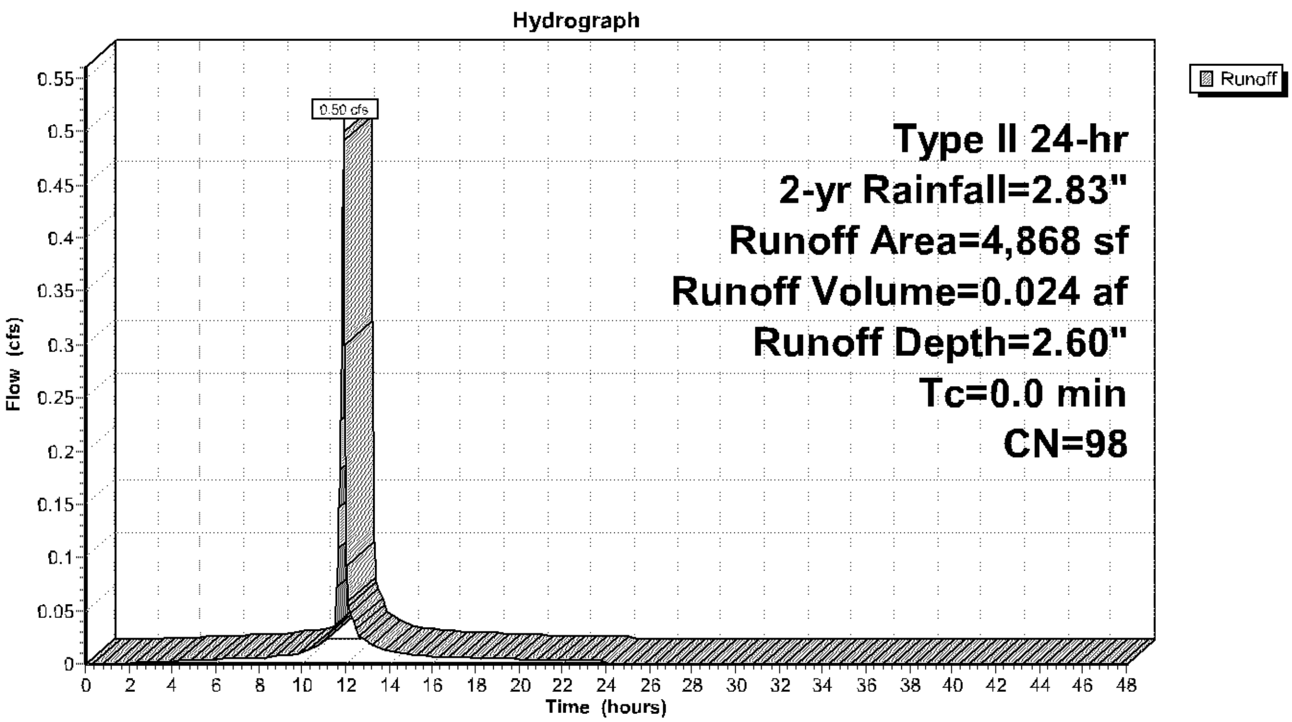
Runoff = 0.50 cfs @ 11.89 hrs, Volume= 0.024 af, Depth= 2.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
0	61	>75% Grass cover, Good, HSG B
4,868	98	Paved parking, HSG B
4,868	98	Weighted Average
4,868		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 2E: 2E



Summary for Subcatchment 3E: 3E

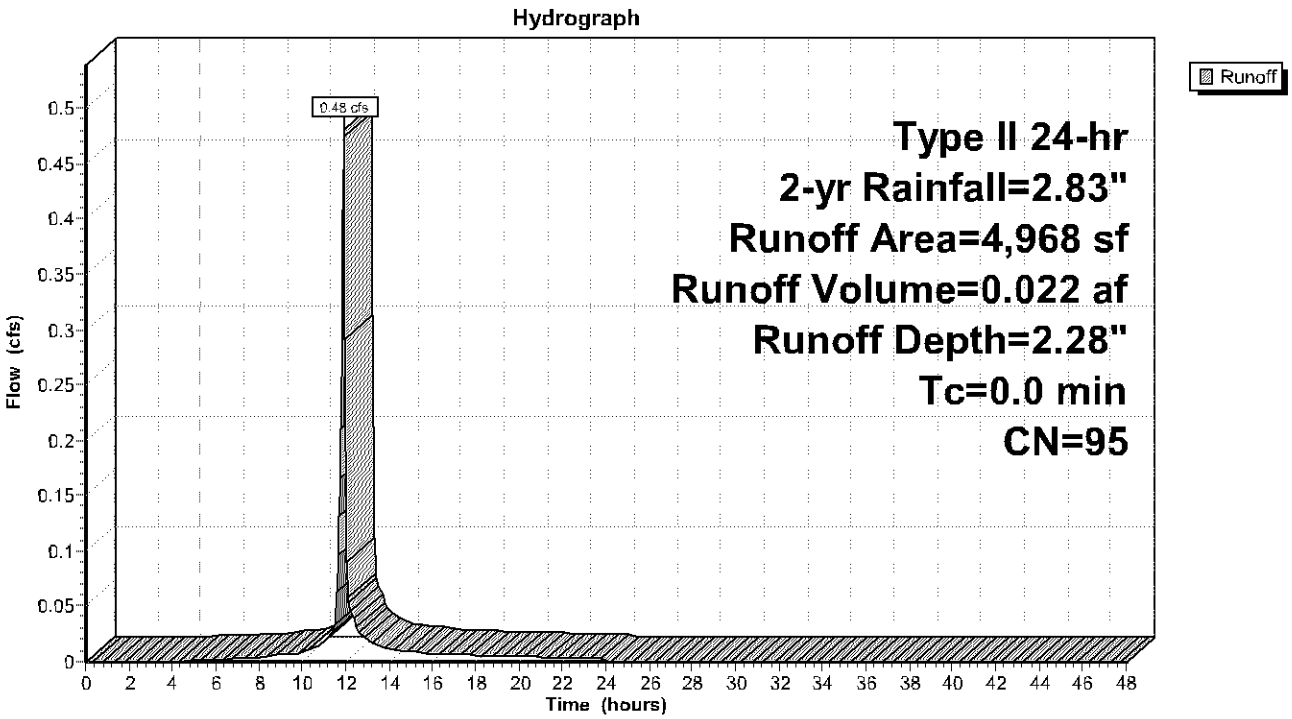
Runoff = 0.48 cfs @ 11.89 hrs, Volume= 0.022 af, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
369	61	>75% Grass cover, Good, HSG B
4,599	98	Paved parking, HSG B
4,968	95	Weighted Average
369		7.43% Pervious Area
4,599		92.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 3E: 3E



Summary for Subcatchment 4E: 4E

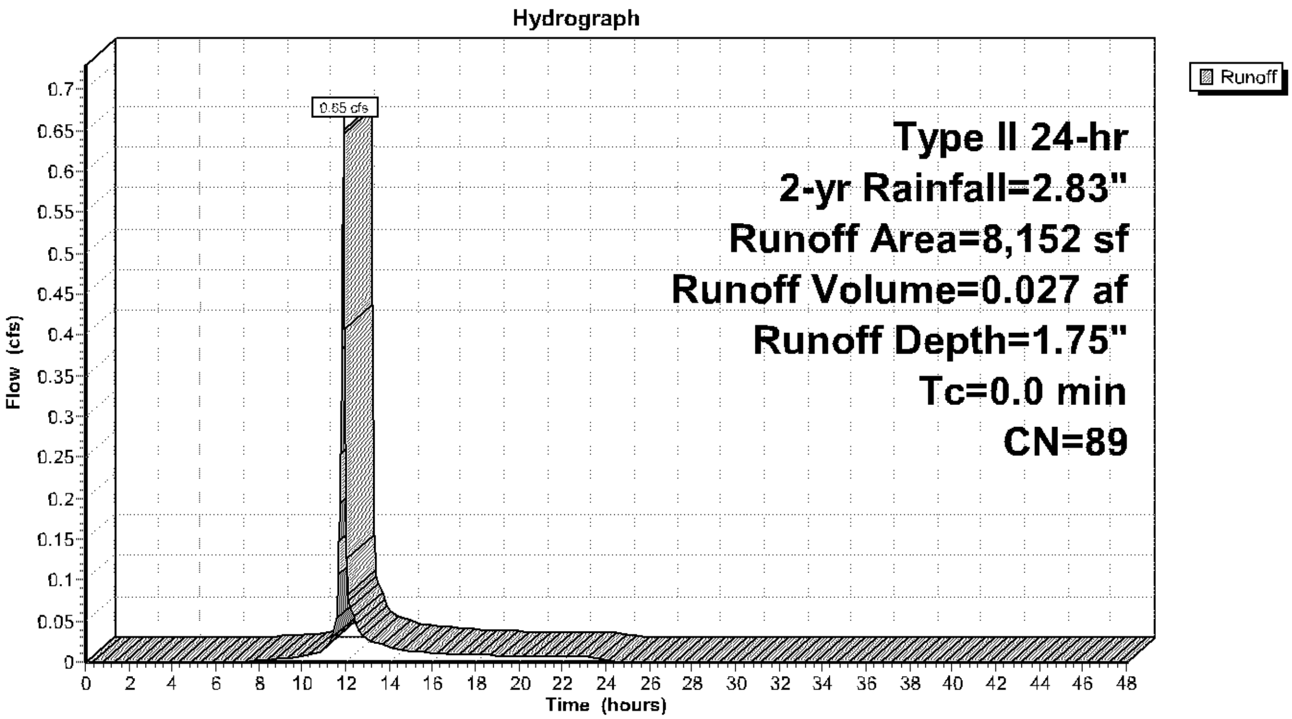
Runoff = 0.65 cfs @ 11.89 hrs, Volume= 0.027 af, Depth= 1.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
2,073	61	>75% Grass cover, Good, HSG B
6,079	98	Paved parking, HSG B
8,152	89	Weighted Average
2,073		25.43% Pervious Area
6,079		74.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 4E: 4E



Summary for Subcatchment 5S: 5E

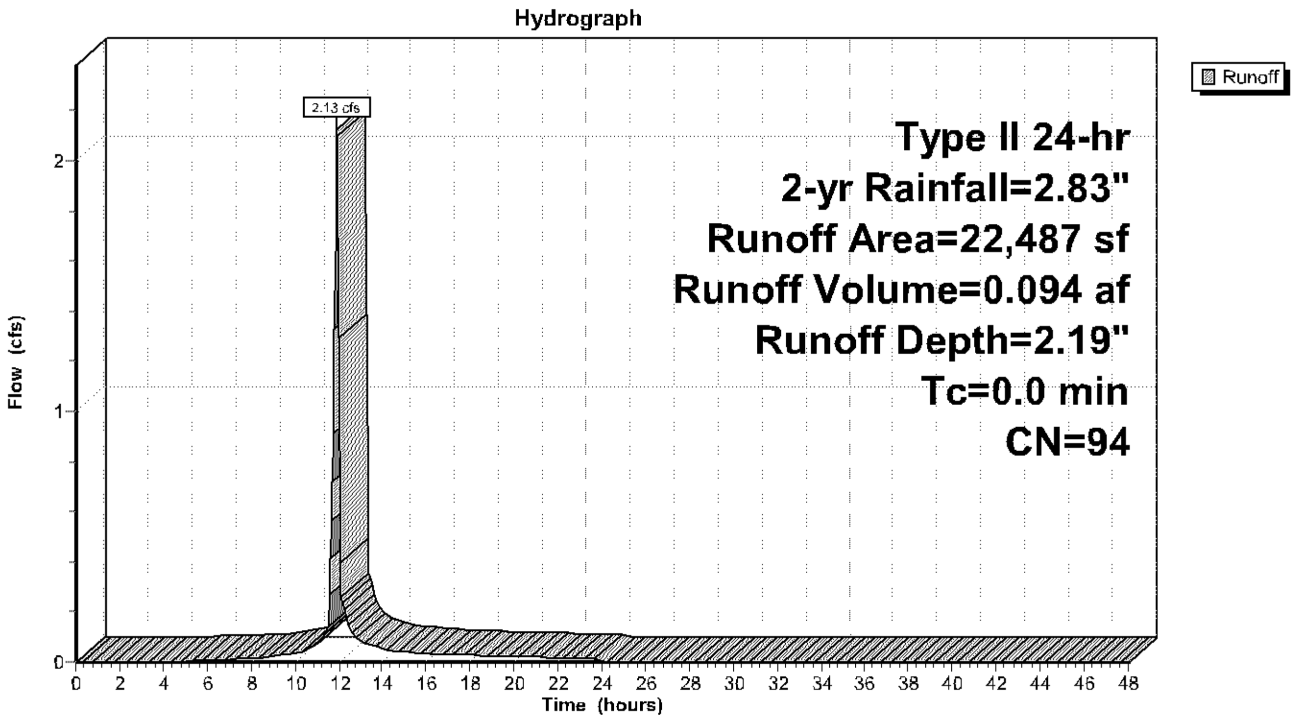
Runoff = 2.13 cfs @ 11.89 hrs, Volume= 0.094 af, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
2,150	61	>75% Grass cover, Good, HSG B
20,337	98	Paved parking, HSG B
22,487	94	Weighted Average
2,150		9.56% Pervious Area
20,337		90.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 5S: 5E

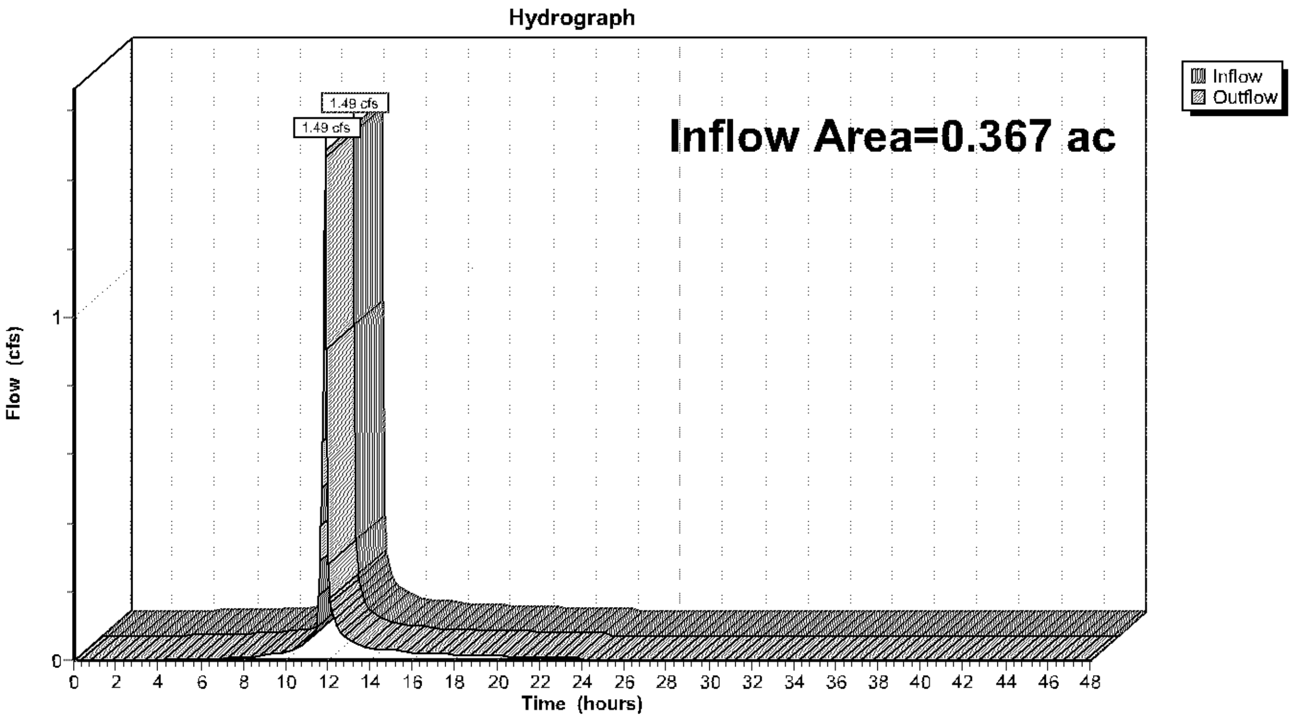


Summary for Reach 1R: NW Site CB

Inflow Area =	0.367 ac, 88.08% Impervious,	Inflow Depth = 2.18"	for 2-yr event	
Inflow =	1.49 cfs @	11.89 hrs, Volume=	0.067 af	
Outflow =	1.49 cfs @	11.89 hrs, Volume=	0.067 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 1R: NW Site CB

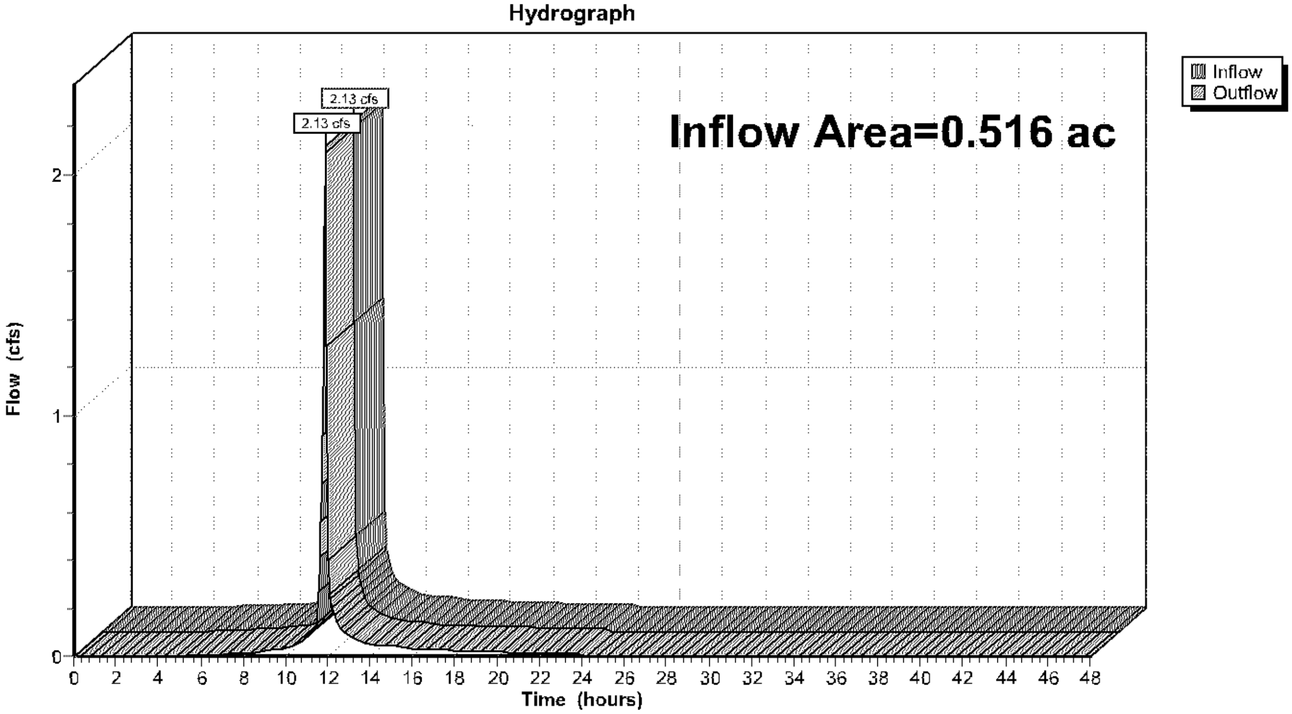


Summary for Reach 2R: S Offsite CB

Inflow Area = 0.516 ac, 90.44% Impervious, Inflow Depth = 2.19" for 2-yr event
Inflow = 2.13 cfs @ 11.89 hrs, Volume= 0.094 af
Outflow = 2.13 cfs @ 11.89 hrs, Volume= 0.094 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 2R: S Offsite CB

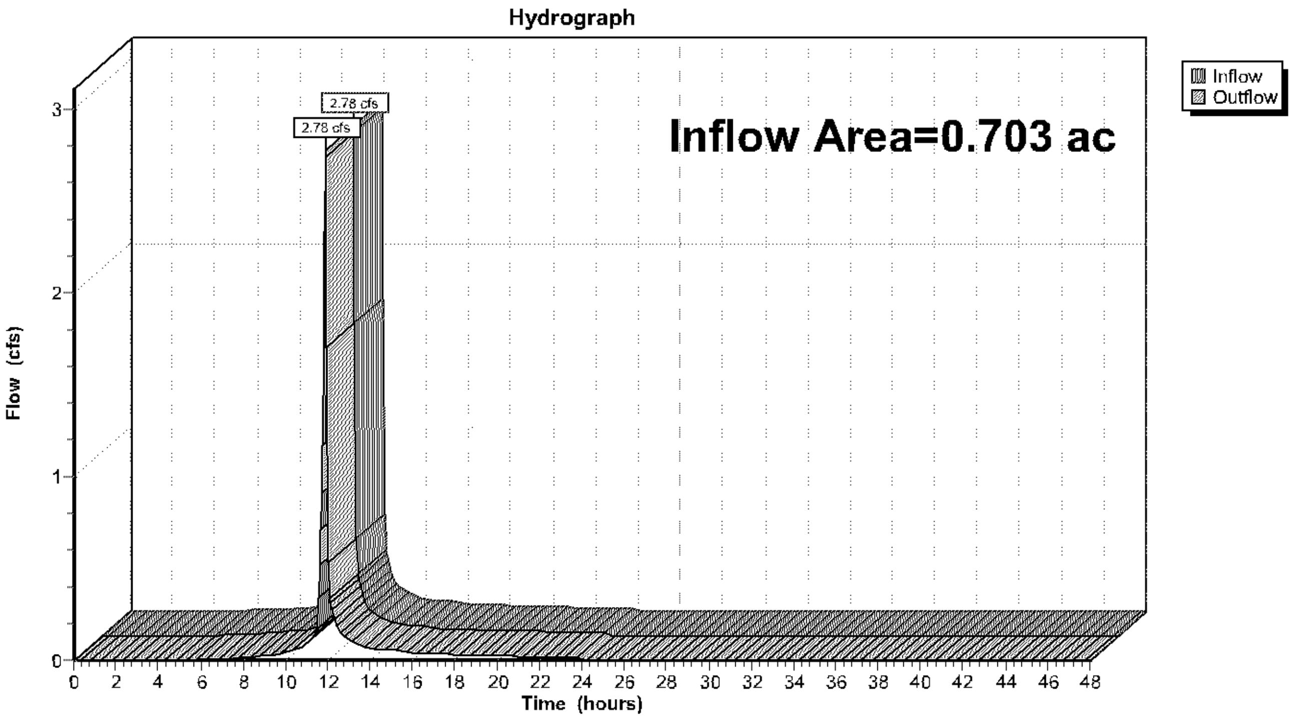


Summary for Reach 3R: SE Site CB

Inflow Area =	0.703 ac, 86.22% Impervious, Inflow Depth = 2.07" for 2-yr event	
Inflow =	2.78 cfs @ 11.89 hrs, Volume=	0.121 af
Outflow =	2.78 cfs @ 11.89 hrs, Volume=	0.121 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 3R: SE Site CB

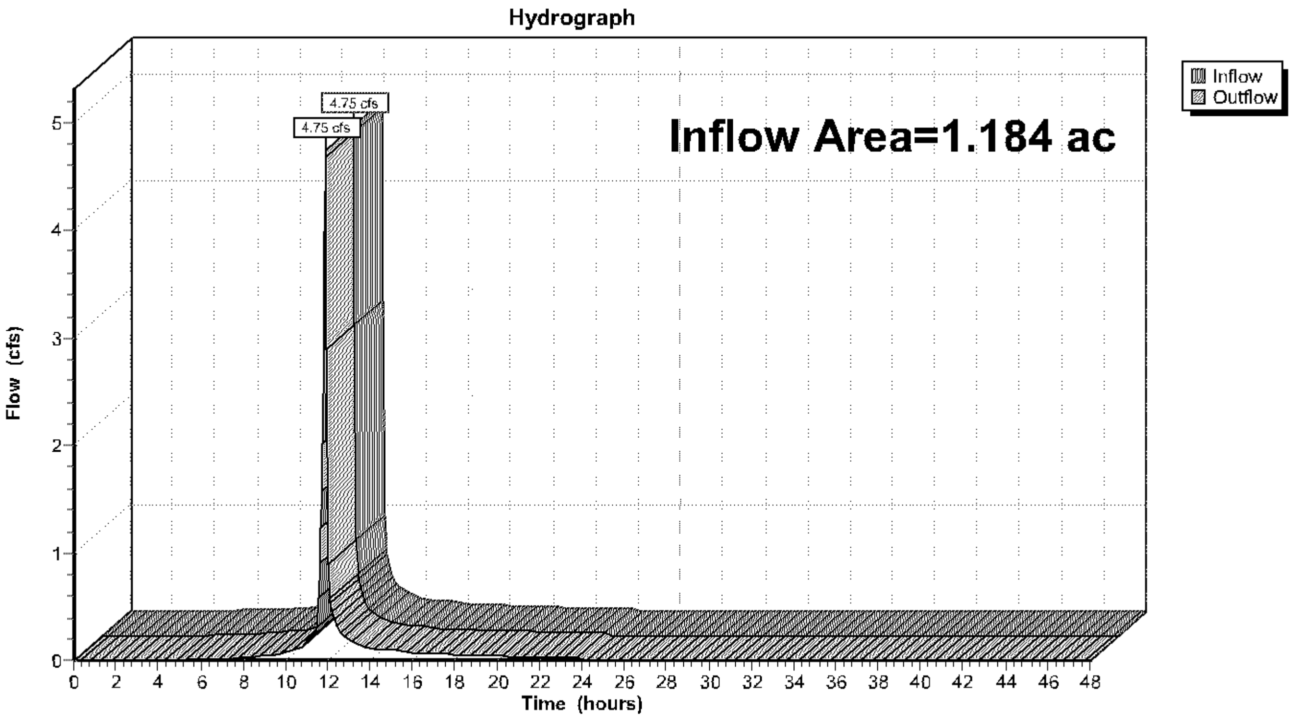


Summary for Reach 4R: 98th St

Inflow Area = 1.184 ac, 87.41% Impervious, Inflow Depth = 2.13" for 2-yr event
Inflow = 4.75 cfs @ 11.89 hrs, Volume= 0.210 af
Outflow = 4.75 cfs @ 11.89 hrs, Volume= 0.210 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 4R: 98th St



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1E: 1E Runoff Area=11,102 sf 82.85% Impervious Runoff Depth=3.35"
Tc=0.0 min CN=92 Runoff=1.59 cfs 0.071 af

Subcatchment 2E: 2E Runoff Area=4,868 sf 100.00% Impervious Runoff Depth=4.00"
Tc=0.0 min CN=98 Runoff=0.76 cfs 0.037 af

Subcatchment 3E: 3E Runoff Area=4,968 sf 92.57% Impervious Runoff Depth=3.67"
Tc=0.0 min CN=95 Runoff=0.75 cfs 0.035 af

Subcatchment 4E: 4E Runoff Area=8,152 sf 74.57% Impervious Runoff Depth=3.05"
Tc=0.0 min CN=89 Runoff=1.10 cfs 0.048 af

Subcatchment 5S: 5E Runoff Area=22,487 sf 90.44% Impervious Runoff Depth=3.56"
Tc=0.0 min CN=94 Runoff=3.34 cfs 0.153 af

Reach 1R: NW Site CB Inflow=2.35 cfs 0.108 af
Outflow=2.35 cfs 0.108 af

Reach 2R: S Offsite CB Inflow=3.34 cfs 0.153 af
Outflow=3.34 cfs 0.153 af

Reach 3R: SE Site CB Inflow=4.44 cfs 0.201 af
Outflow=4.44 cfs 0.201 af

Reach 4R: 98th St Inflow=7.54 cfs 0.344 af
Outflow=7.54 cfs 0.344 af

Summary for Subcatchment 1E: 1E

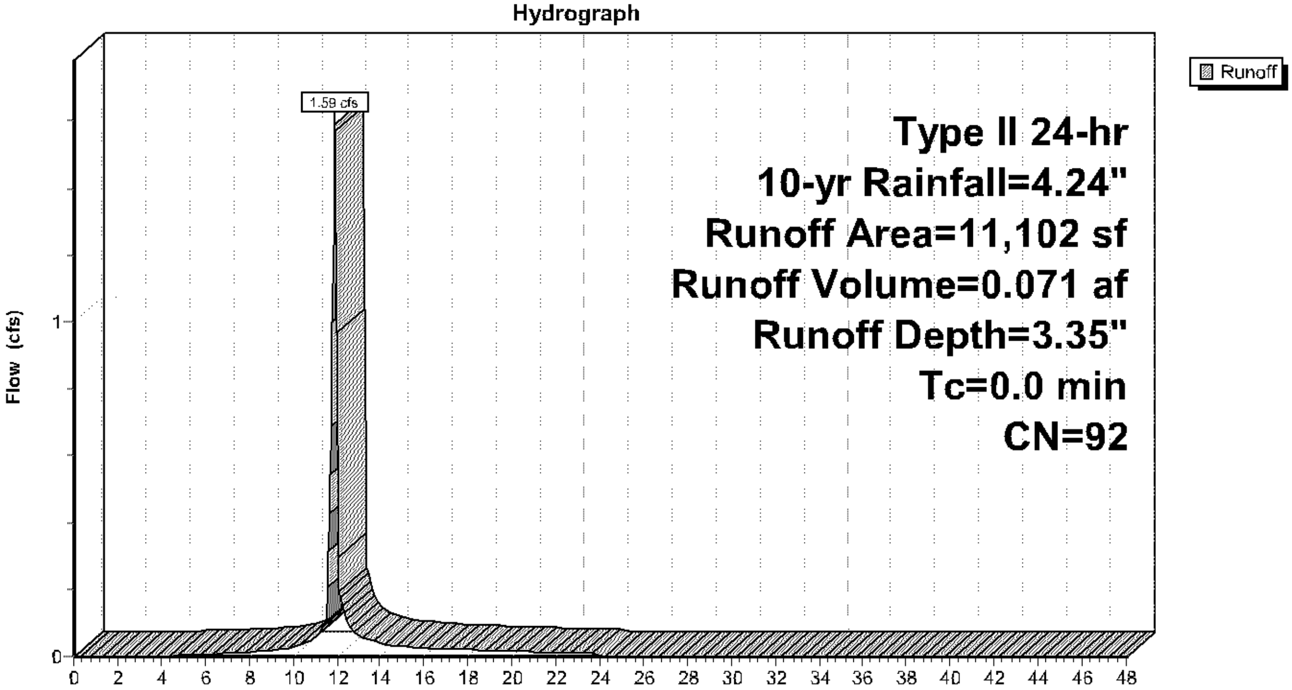
Runoff = 1.59 cfs @ 11.89 hrs, Volume= 0.071 af, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
1,904	61	>75% Grass cover, Good, HSG B
9,198	98	Paved parking, HSG B
11,102	92	Weighted Average
1,904		17.15% Pervious Area
9,198		82.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 1E: 1E



Summary for Subcatchment 2E: 2E

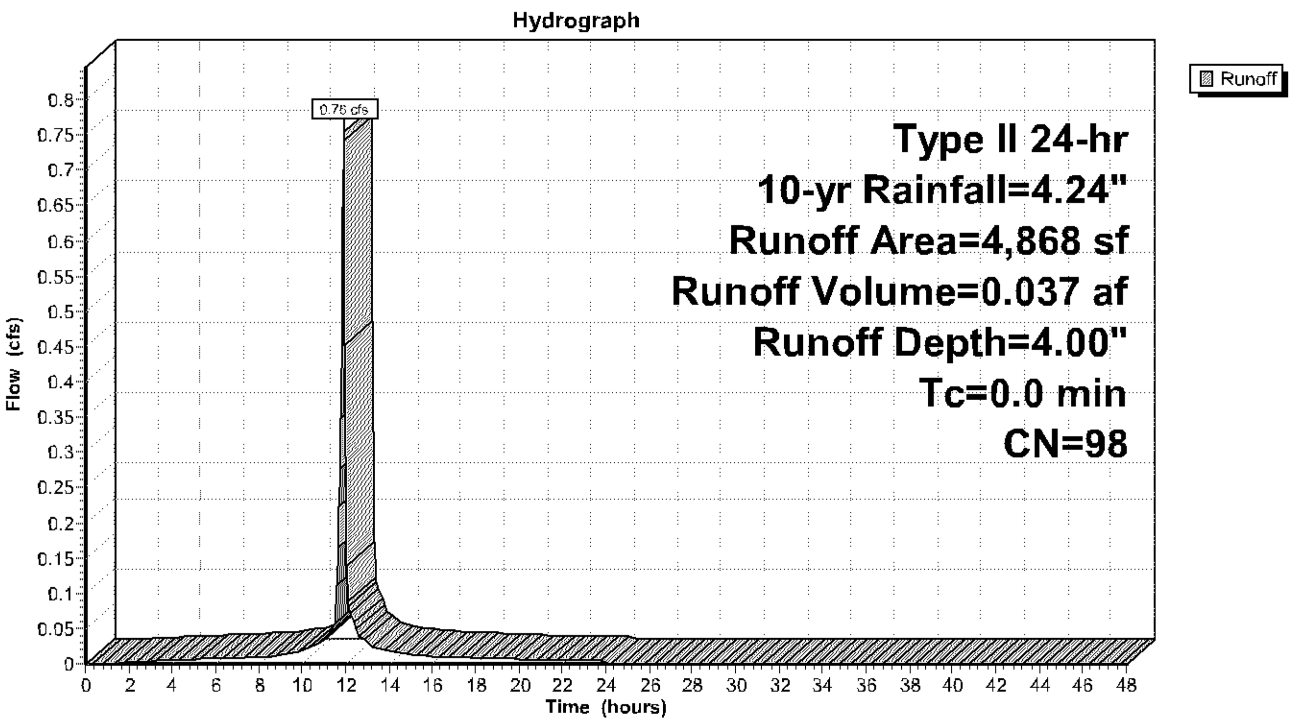
Runoff = 0.76 cfs @ 11.89 hrs, Volume= 0.037 af, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
0	61	>75% Grass cover, Good, HSG B
4,868	98	Paved parking, HSG B
4,868	98	Weighted Average
4,868		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 2E: 2E



Summary for Subcatchment 3E: 3E

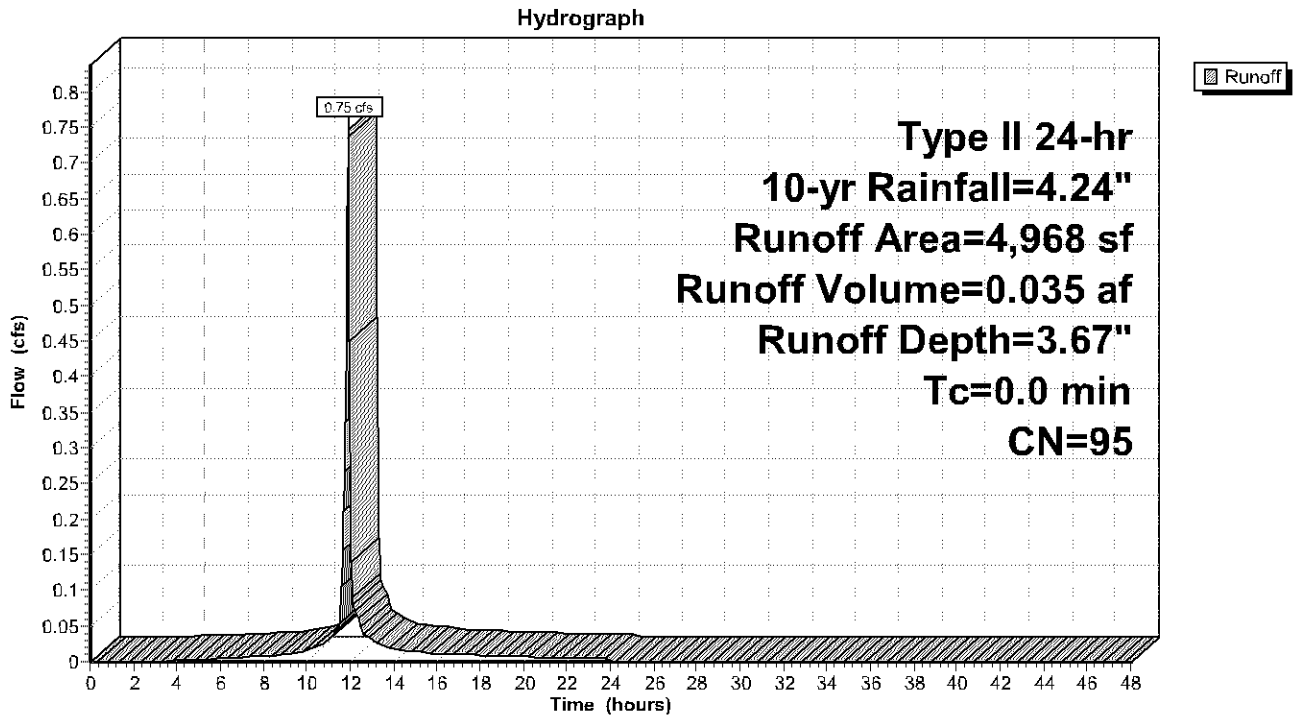
Runoff = 0.75 cfs @ 11.89 hrs, Volume= 0.035 af, Depth= 3.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
369	61	>75% Grass cover, Good, HSG B
4,599	98	Paved parking, HSG B
4,968	95	Weighted Average
369		7.43% Pervious Area
4,599		92.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 3E: 3E



Summary for Subcatchment 4E: 4E

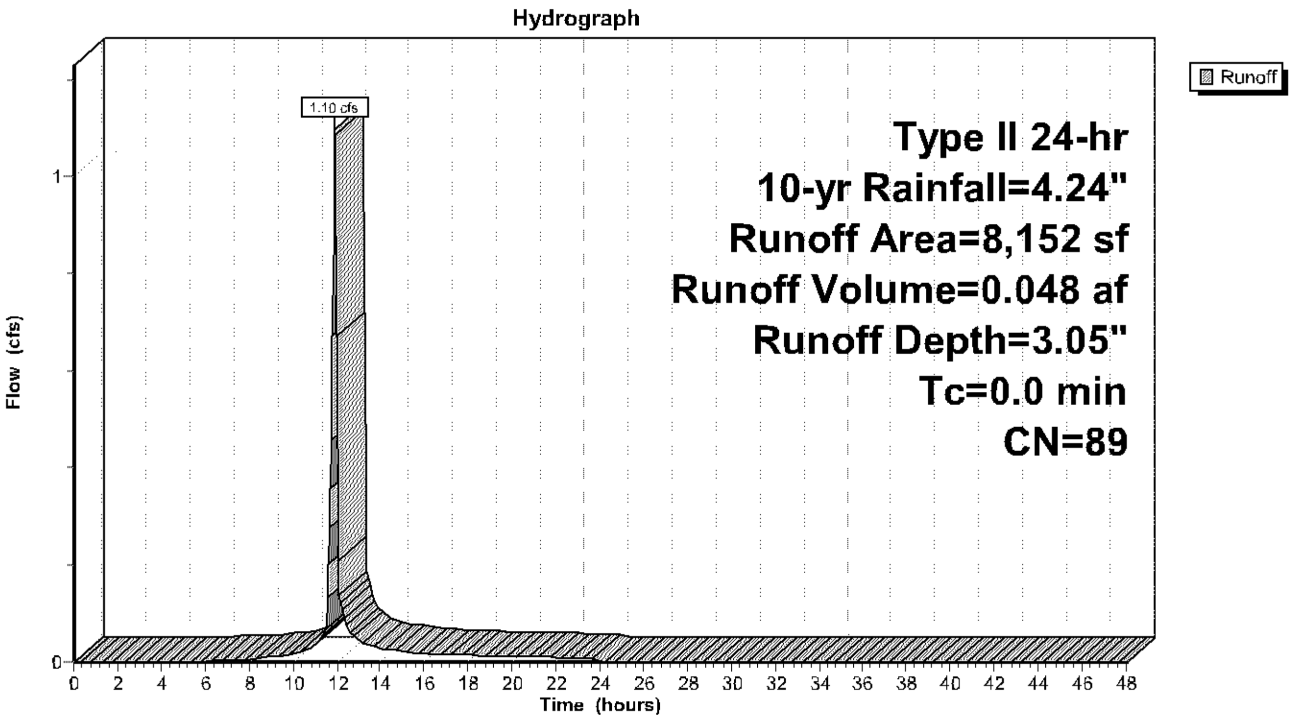
Runoff = 1.10 cfs @ 11.89 hrs, Volume= 0.048 af, Depth= 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
2,073	61	>75% Grass cover, Good, HSG B
6,079	98	Paved parking, HSG B
8,152	89	Weighted Average
2,073		25.43% Pervious Area
6,079		74.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 4E: 4E



Summary for Subcatchment 5S: 5E

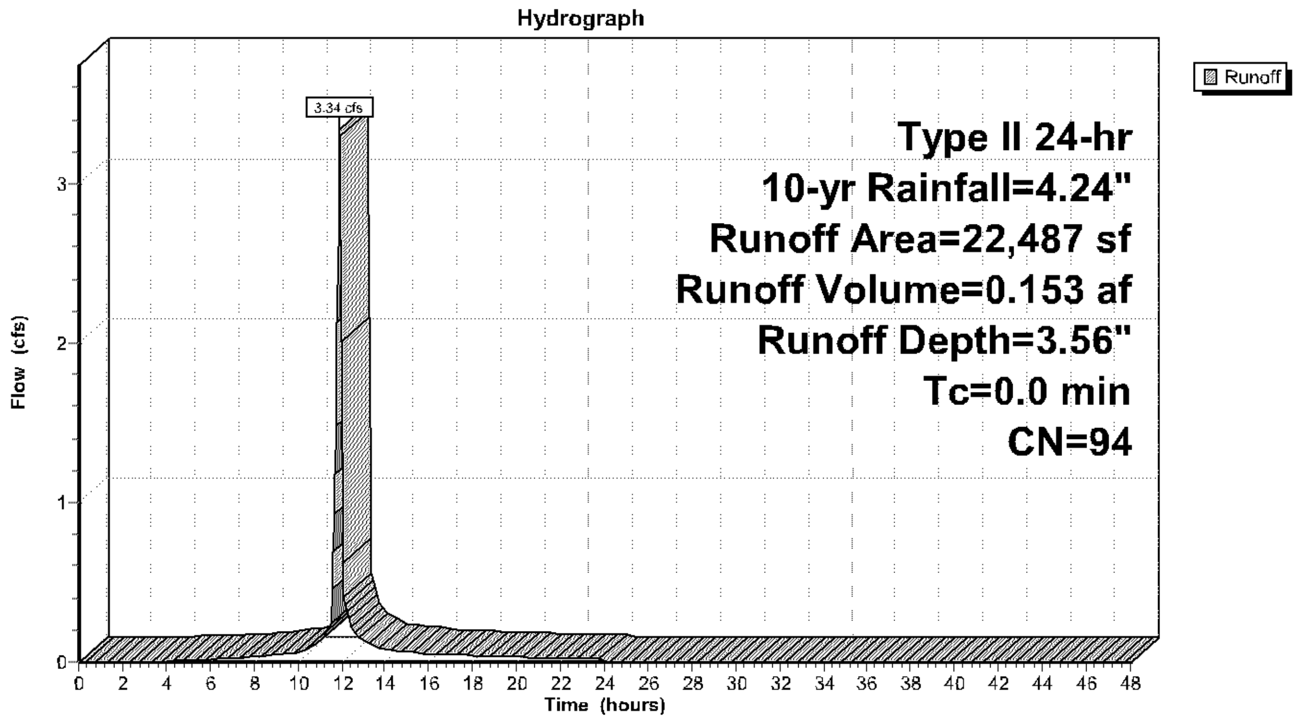
Runoff = 3.34 cfs @ 11.89 hrs, Volume= 0.153 af, Depth= 3.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
2,150	61	>75% Grass cover, Good, HSG B
20,337	98	Paved parking, HSG B
22,487	94	Weighted Average
2,150		9.56% Pervious Area
20,337		90.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 5S: 5E

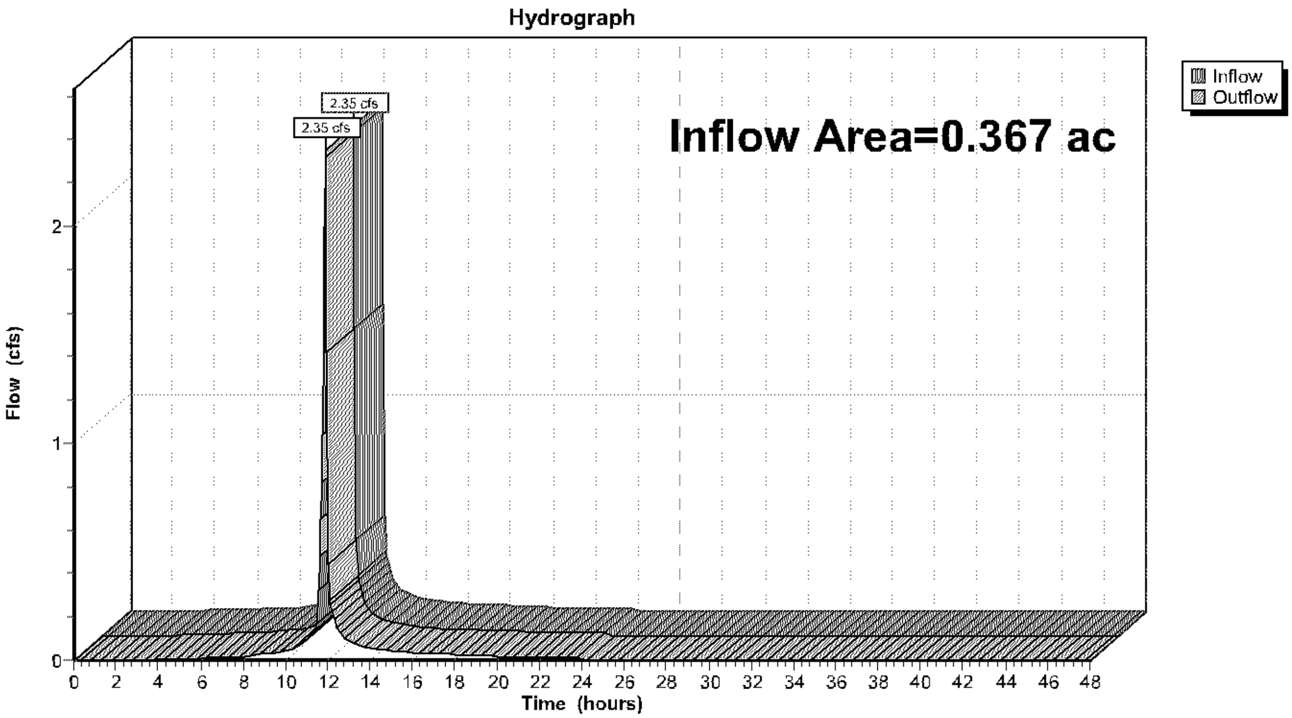


Summary for Reach 1R: NW Site CB

Inflow Area = 0.367 ac, 88.08% Impervious, Inflow Depth = 3.55" for 10-yr event
Inflow = 2.35 cfs @ 11.89 hrs, Volume= 0.108 af
Outflow = 2.35 cfs @ 11.89 hrs, Volume= 0.108 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 1R: NW Site CB

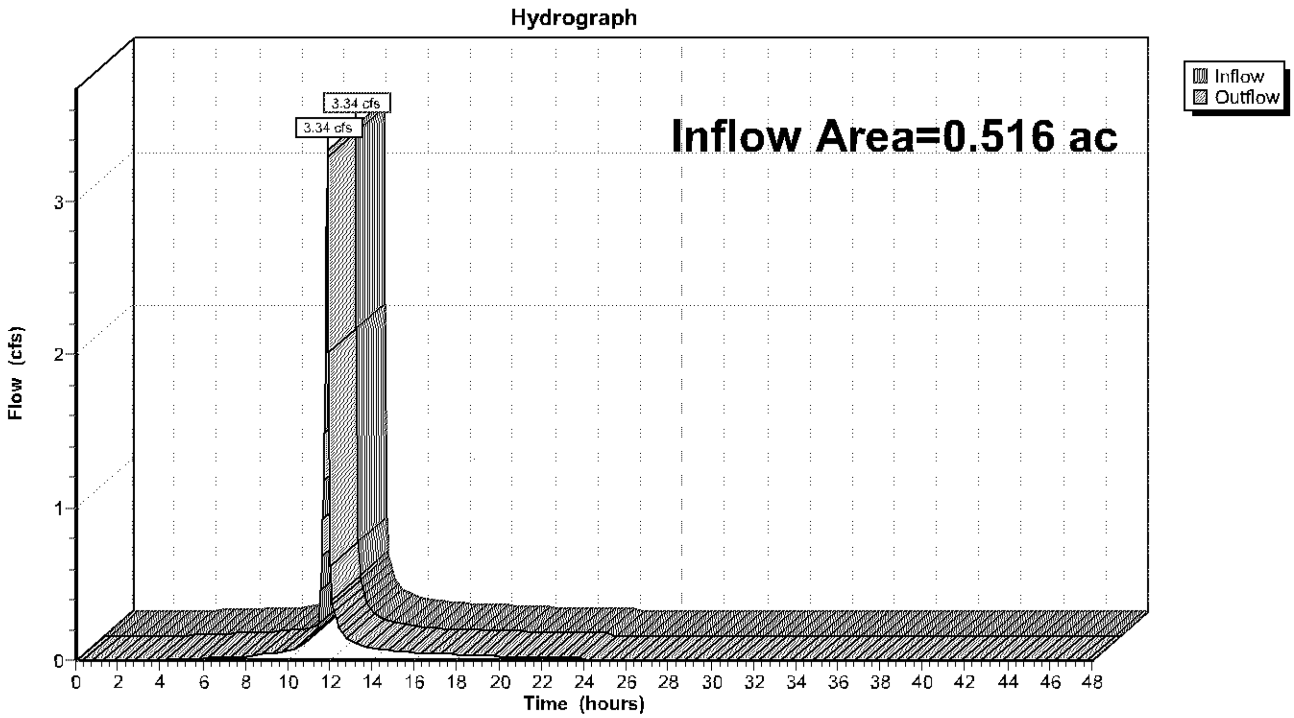


Summary for Reach 2R: S Offsite CB

Inflow Area =	0.516 ac,	90.44% Impervious,	Inflow Depth = 3.56"	for 10-yr event
Inflow =	3.34 cfs @	11.89 hrs, Volume=	0.153 af	
Outflow =	3.34 cfs @	11.89 hrs, Volume=	0.153 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 2R: S Offsite CB

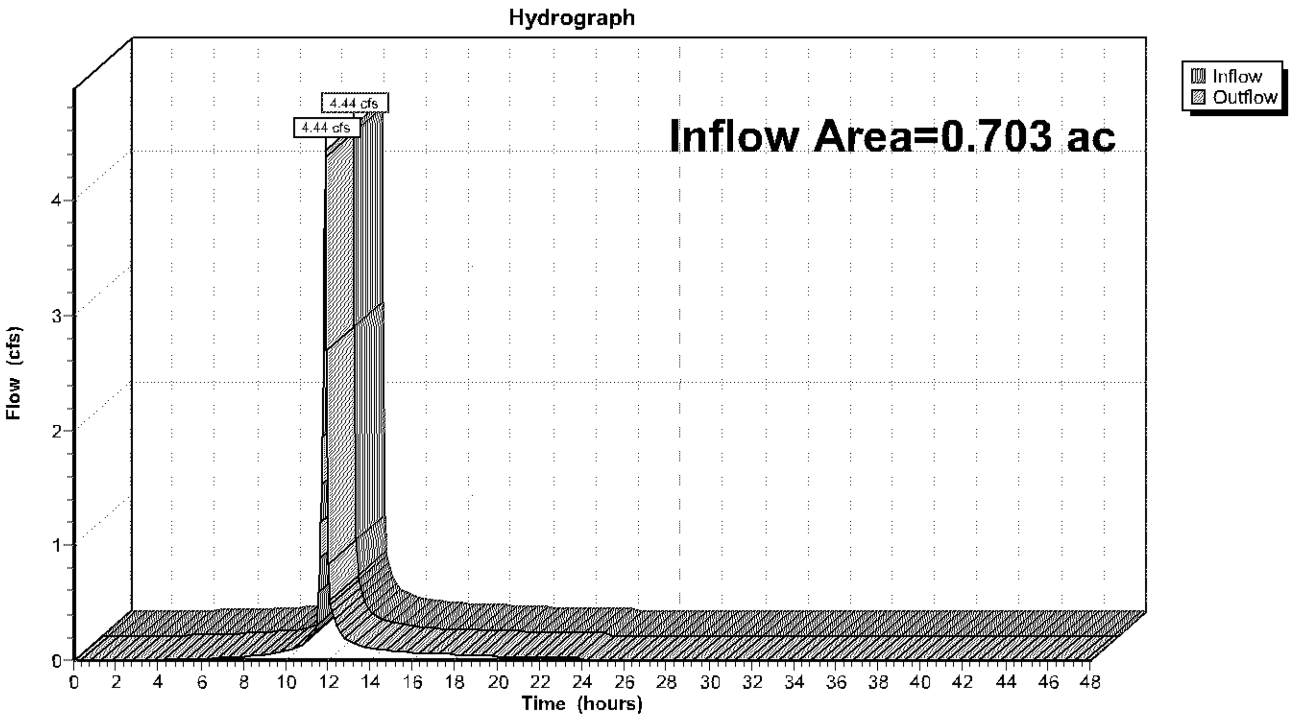


Summary for Reach 3R: SE Site CB

Inflow Area =	0.703 ac,	86.22% Impervious,	Inflow Depth = 3.42"	for 10-yr event	
Inflow =	4.44 cfs @	11.89 hrs,	Volume=	0.201 af	
Outflow =	4.44 cfs @	11.89 hrs,	Volume=	0.201 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 3R: SE Site CB

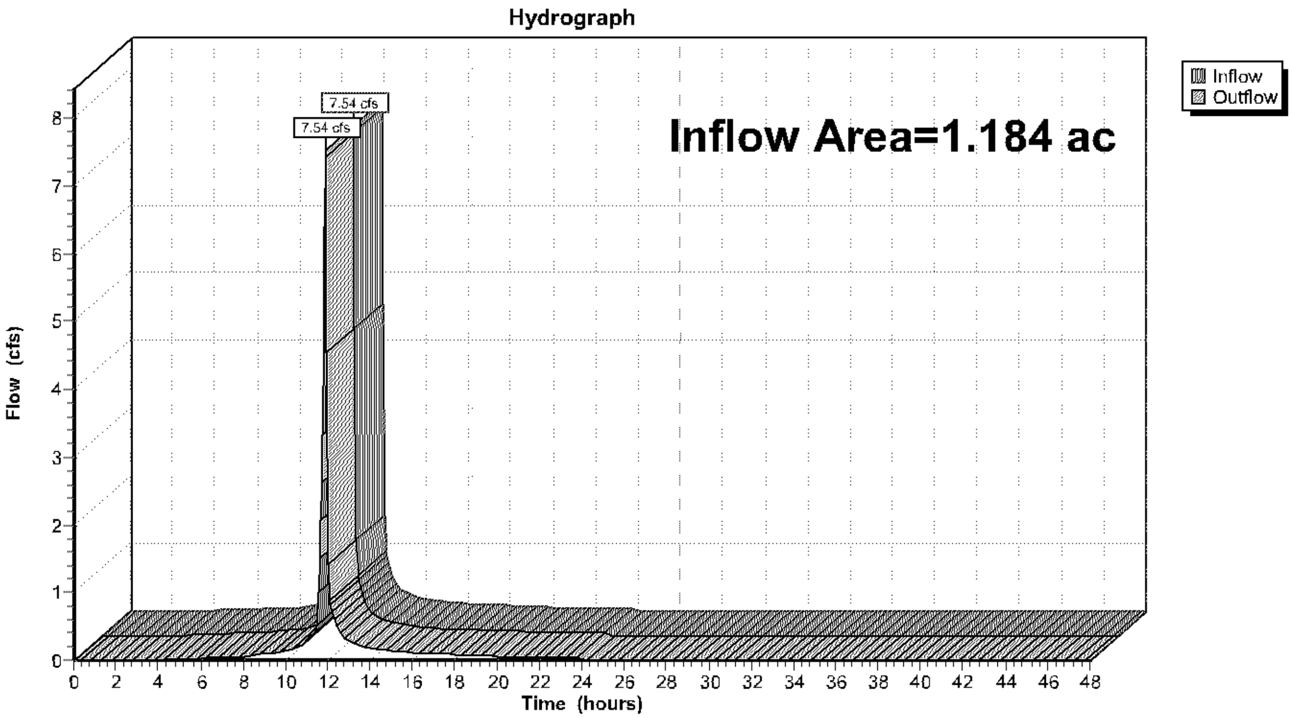


Summary for Reach 4R: 98th St

Inflow Area =	1.184 ac,	87.41% Impervious,	Inflow Depth = 3.49"	for 10-yr event	
Inflow =	7.54 cfs @	11.89 hrs,	Volume=	0.344 af	
Outflow =	7.54 cfs @	11.89 hrs,	Volume=	0.344 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 4R: 98th St



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1E: 1E Runoff Area=11,102 sf 82.85% Impervious Runoff Depth=6.55"
Tc=0.0 min CN=92 Runoff=2.97 cfs 0.139 af

Subcatchment 2E: 2E Runoff Area=4,868 sf 100.00% Impervious Runoff Depth=7.26"
Tc=0.0 min CN=98 Runoff=1.34 cfs 0.068 af

Subcatchment 3E: 3E Runoff Area=4,968 sf 92.57% Impervious Runoff Depth=6.90"
Tc=0.0 min CN=95 Runoff=1.36 cfs 0.066 af

Subcatchment 4E: 4E Runoff Area=8,152 sf 74.57% Impervious Runoff Depth=6.20"
Tc=0.0 min CN=89 Runoff=2.12 cfs 0.097 af

Subcatchment 5S: 5E Runoff Area=22,487 sf 90.44% Impervious Runoff Depth=6.78"
Tc=0.0 min CN=94 Runoff=6.11 cfs 0.292 af

Reach 1R: NW Site CB Inflow=4.32 cfs 0.207 af
Outflow=4.32 cfs 0.207 af

Reach 2R: S Offsite CB Inflow=6.11 cfs 0.292 af
Outflow=6.11 cfs 0.292 af

Reach 3R: SE Site CB Inflow=8.23 cfs 0.389 af
Outflow=8.23 cfs 0.389 af

Reach 4R: 98th St Inflow=13.90 cfs 0.661 af
Outflow=13.90 cfs 0.661 af

Summary for Subcatchment 1E: 1E

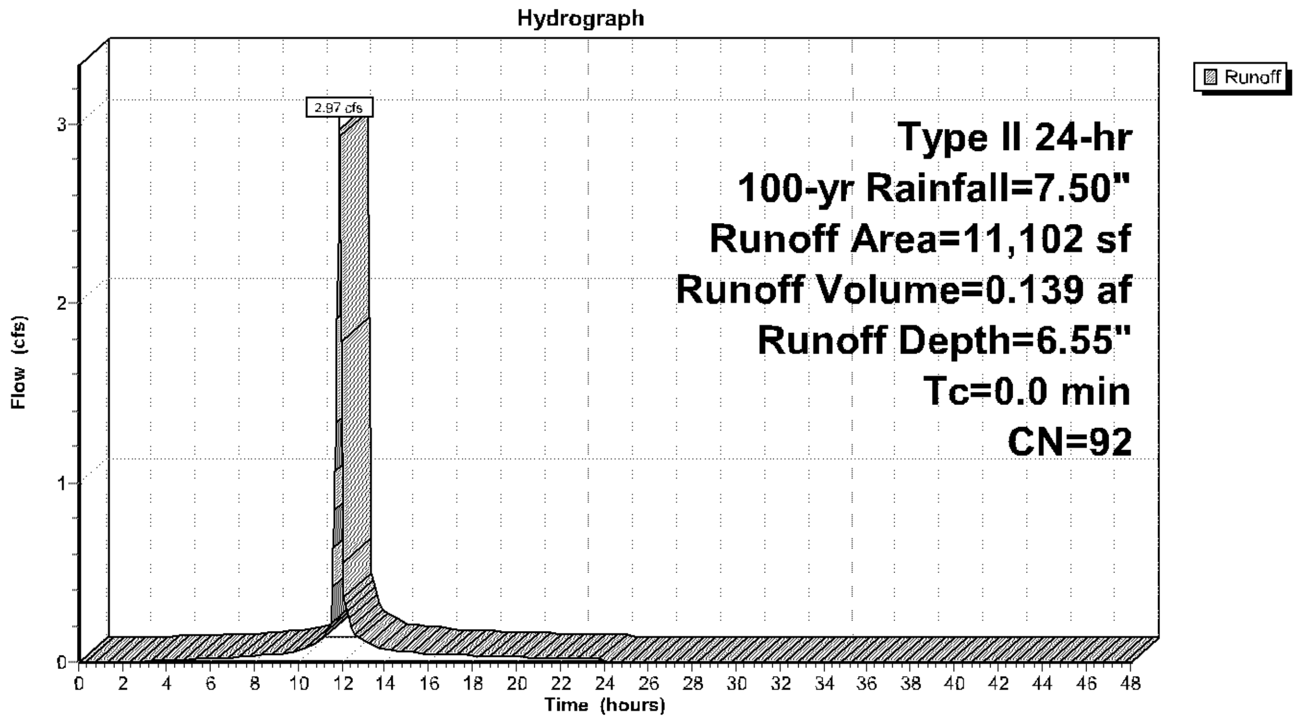
Runoff = 2.97 cfs @ 11.89 hrs, Volume= 0.139 af, Depth= 6.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
1,904	61	>75% Grass cover, Good, HSG B
9,198	98	Paved parking, HSG B
11,102	92	Weighted Average
1,904		17.15% Pervious Area
9,198		82.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 1E: 1E



Summary for Subcatchment 2E: 2E

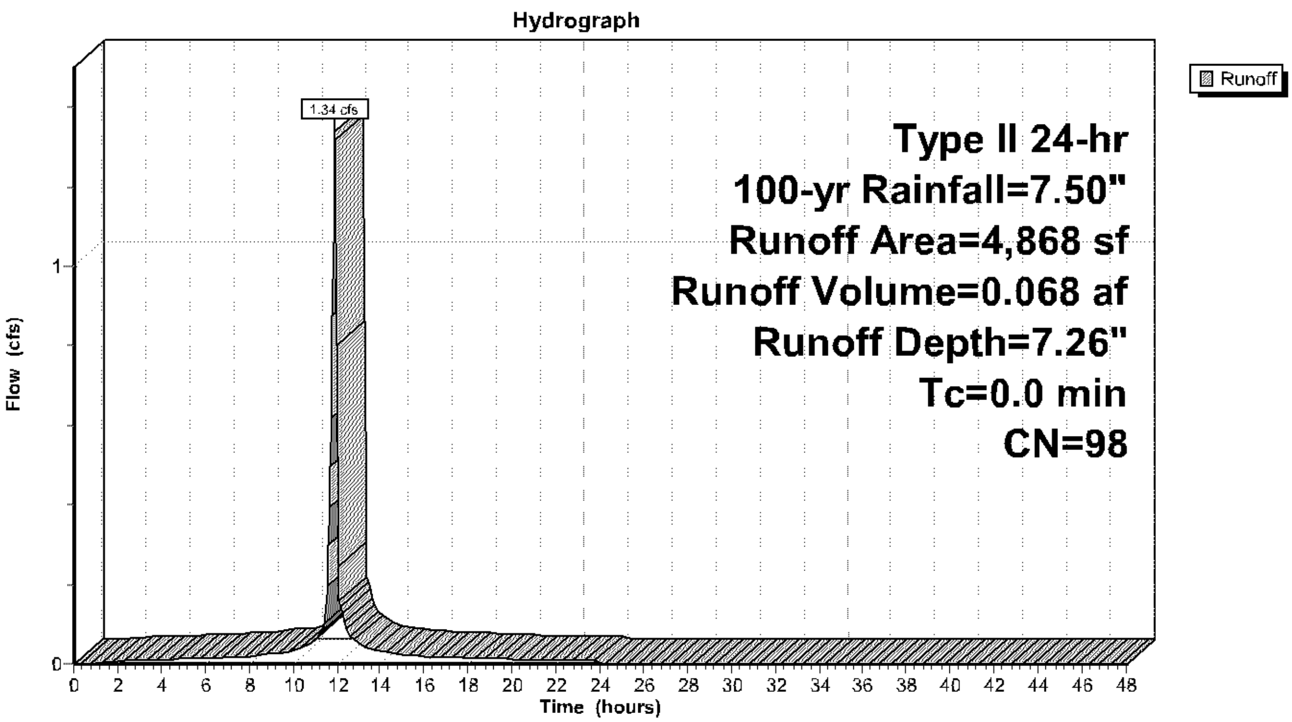
Runoff = 1.34 cfs @ 11.89 hrs, Volume= 0.068 af, Depth= 7.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
0	61	>75% Grass cover, Good, HSG B
4,868	98	Paved parking, HSG B
4,868	98	Weighted Average
4,868		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 2E: 2E



Summary for Subcatchment 3E: 3E

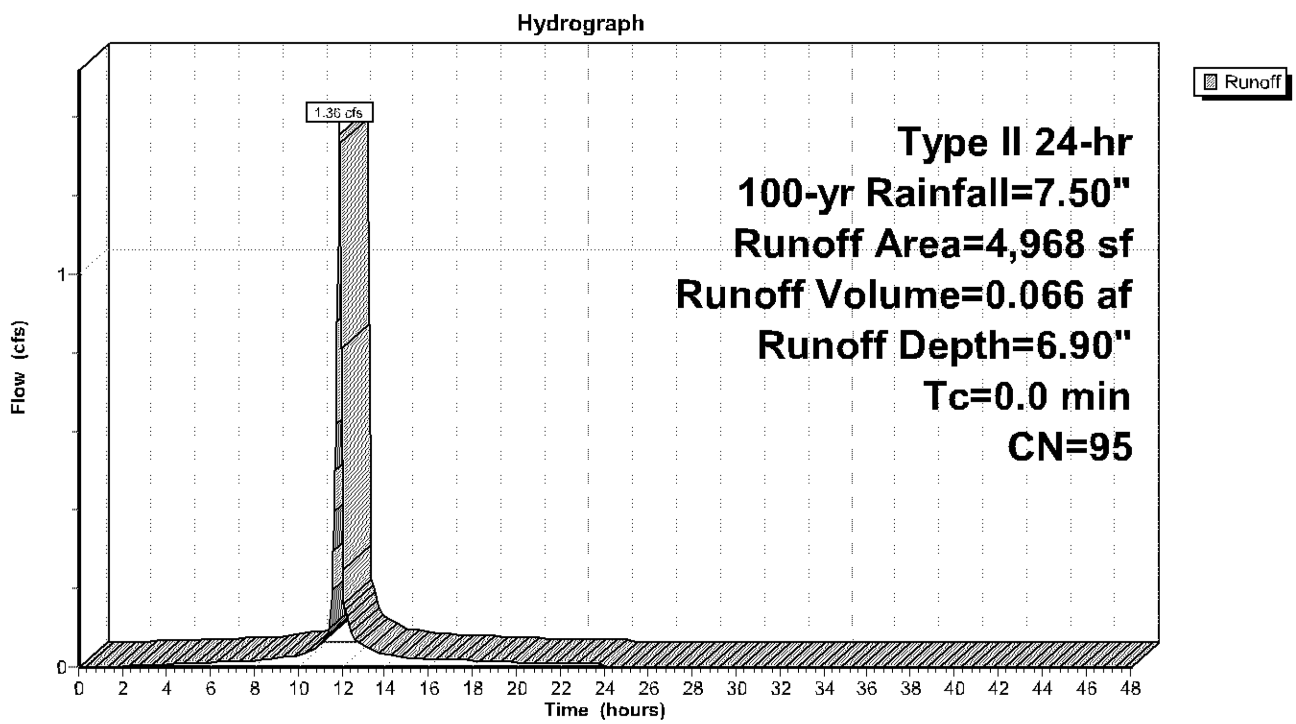
Runoff = 1.36 cfs @ 11.89 hrs, Volume= 0.066 af, Depth= 6.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
369	61	>75% Grass cover, Good, HSG B
4,599	98	Paved parking, HSG B
4,968	95	Weighted Average
369		7.43% Pervious Area
4,599		92.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 3E: 3E



Summary for Subcatchment 4E: 4E

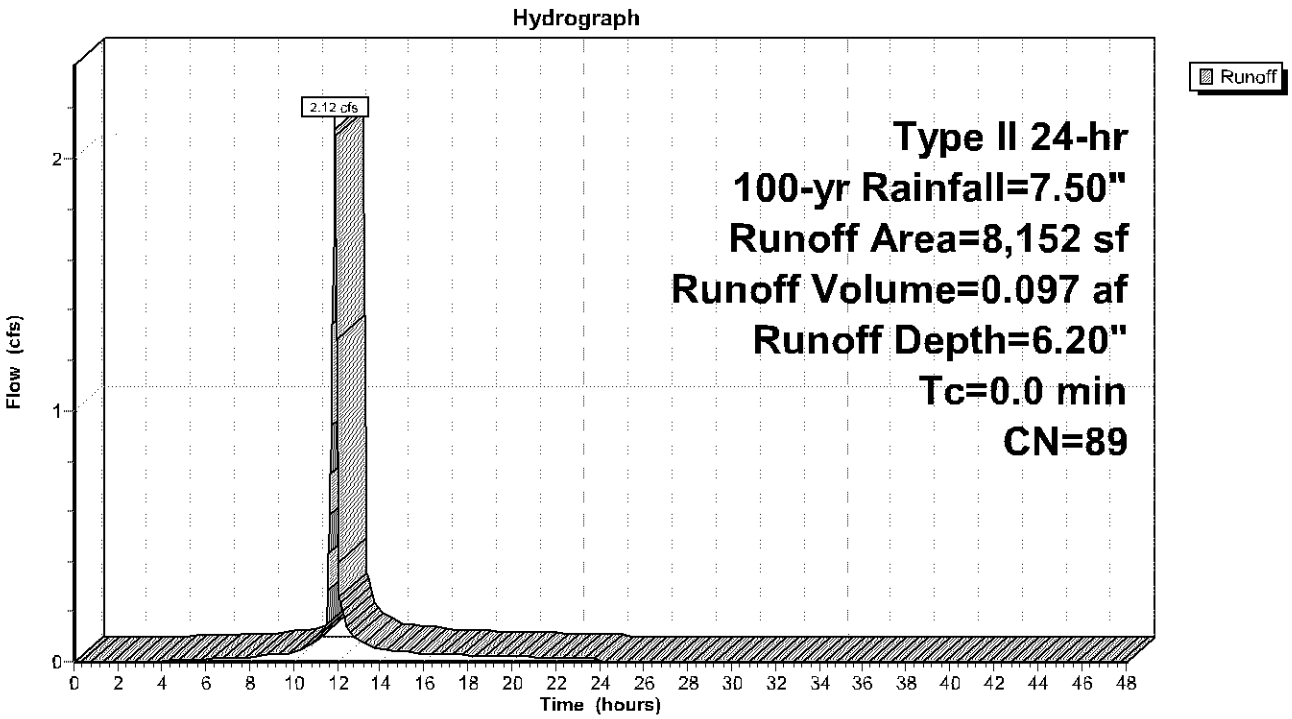
Runoff = 2.12 cfs @ 11.89 hrs, Volume= 0.097 af, Depth= 6.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
2,073	61	>75% Grass cover, Good, HSG B
6,079	98	Paved parking, HSG B
8,152	89	Weighted Average
2,073		25.43% Pervious Area
6,079		74.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 4E: 4E



Summary for Subcatchment 5S: 5E

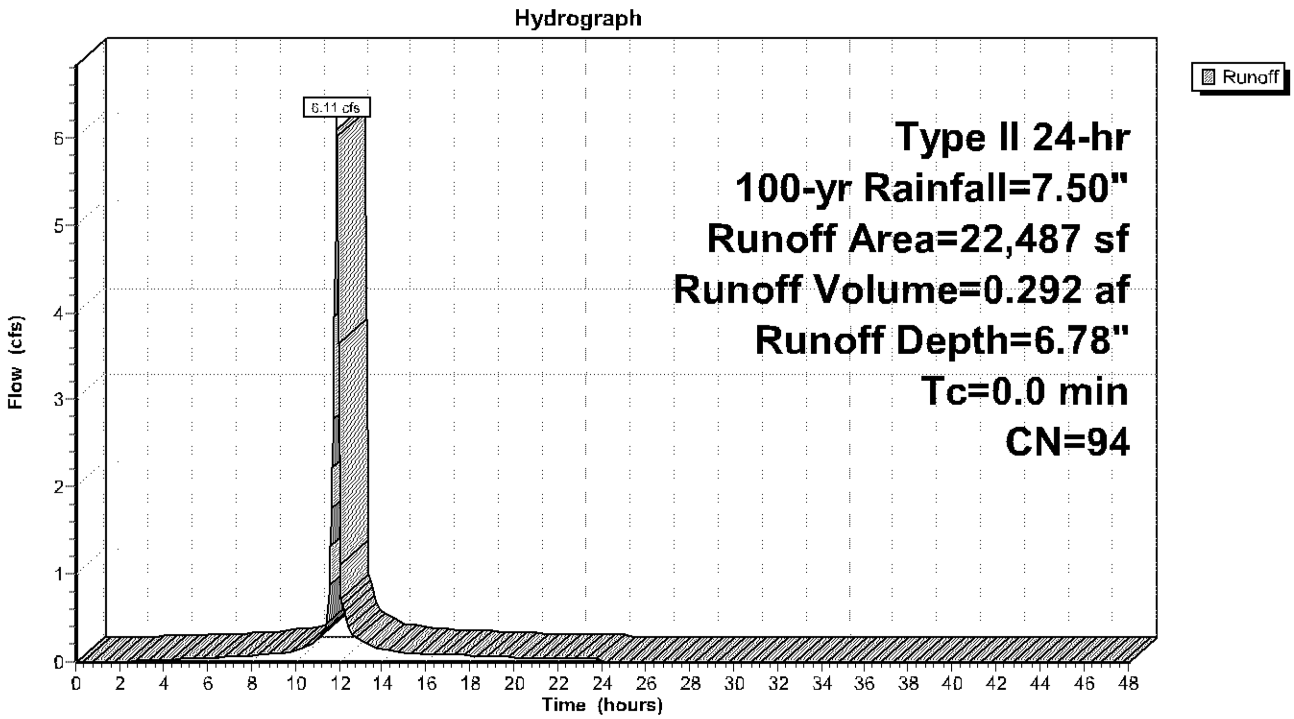
Runoff = 6.11 cfs @ 11.89 hrs, Volume= 0.292 af, Depth= 6.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
2,150	61	>75% Grass cover, Good, HSG B
20,337	98	Paved parking, HSG B
22,487	94	Weighted Average
2,150		9.56% Pervious Area
20,337		90.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, 7**

Subcatchment 5S: 5E

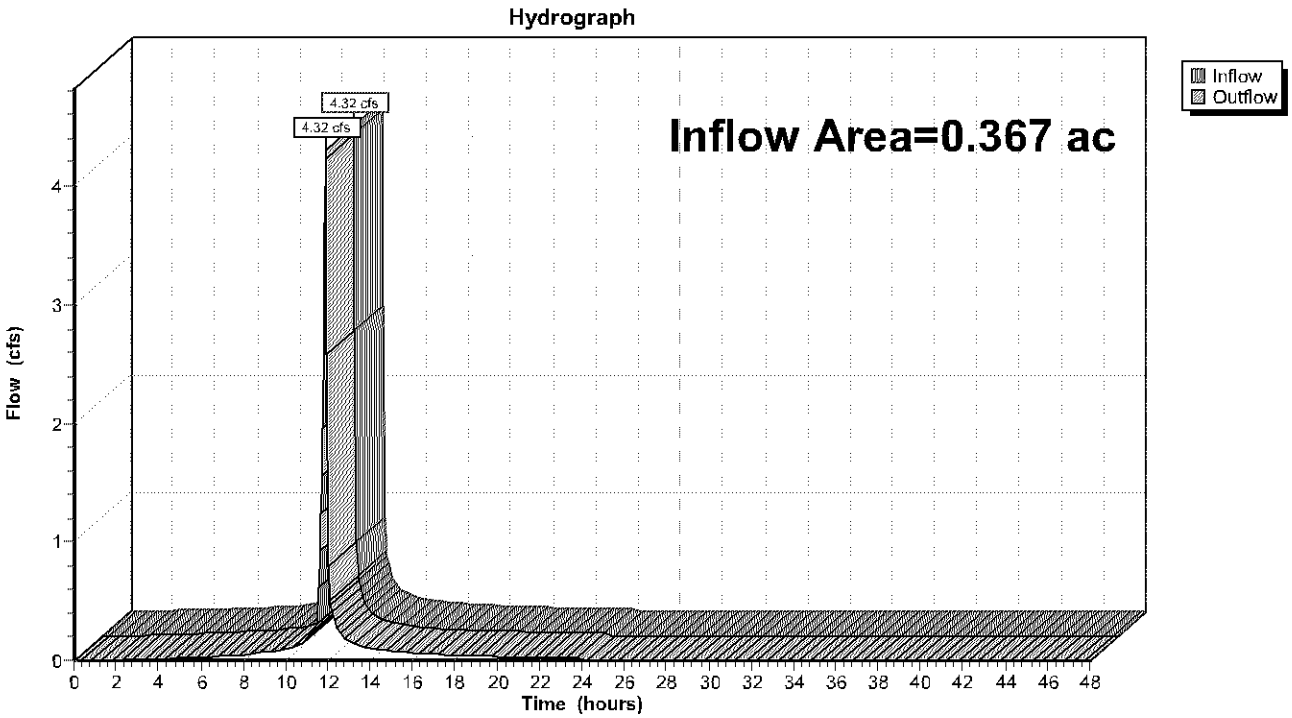


Summary for Reach 1R: NW Site CB

Inflow Area = 0.367 ac, 88.08% Impervious, Inflow Depth = 6.77" for 100-yr event
Inflow = 4.32 cfs @ 11.89 hrs, Volume= 0.207 af
Outflow = 4.32 cfs @ 11.89 hrs, Volume= 0.207 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 1R: NW Site CB

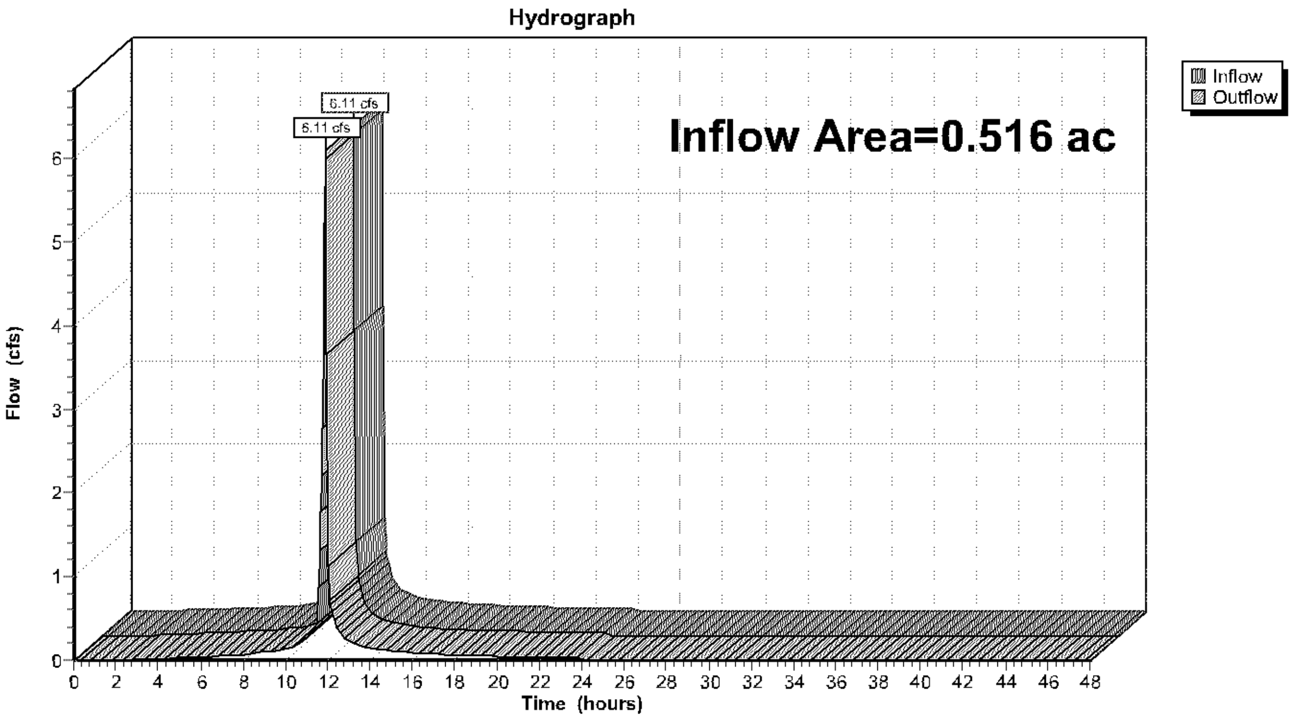


Summary for Reach 2R: S Offsite CB

Inflow Area =	0.516 ac,	90.44% Impervious,	Inflow Depth = 6.78"	for 100-yr event
Inflow =	6.11 cfs @	11.89 hrs, Volume=	0.292 af	
Outflow =	6.11 cfs @	11.89 hrs, Volume=	0.292 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 2R: S Offsite CB

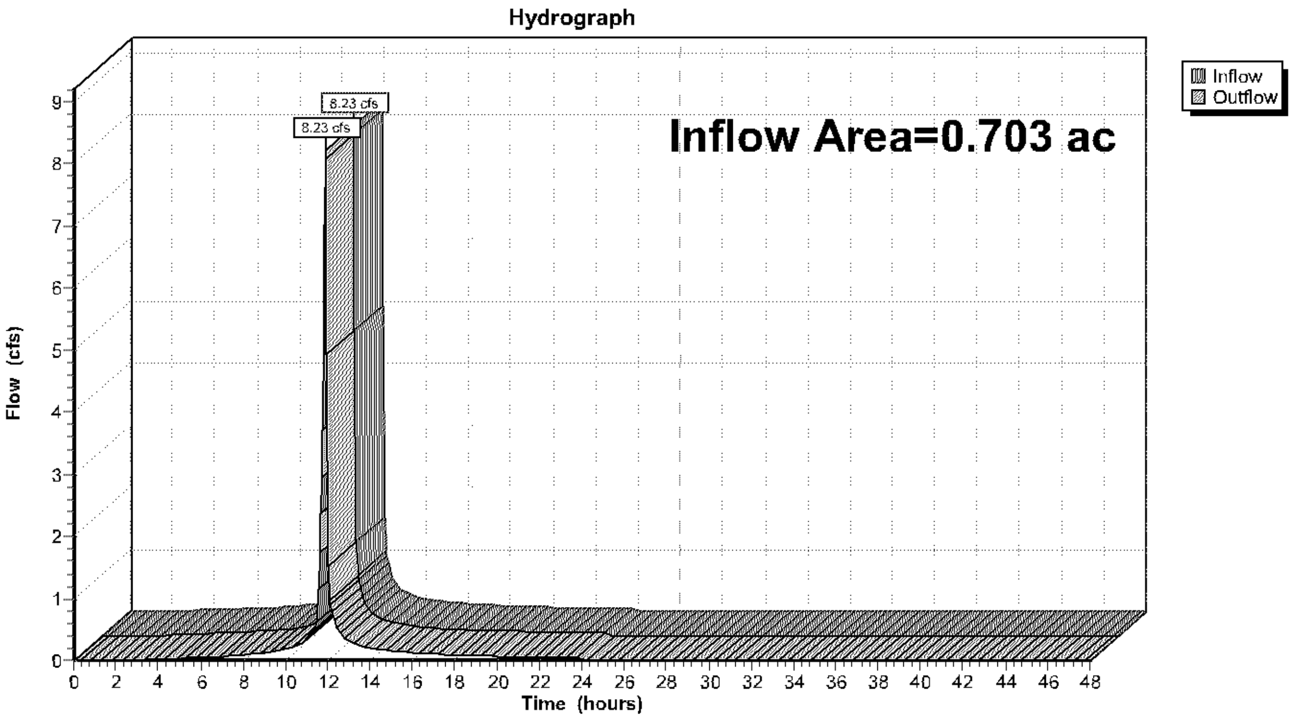


Summary for Reach 3R: SE Site CB

Inflow Area =	0.703 ac,	86.22% Impervious,	Inflow Depth = 6.63"	for 100-yr event	
Inflow =	8.23 cfs @	11.89 hrs,	Volume=	0.389 af	
Outflow =	8.23 cfs @	11.89 hrs,	Volume=	0.389 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

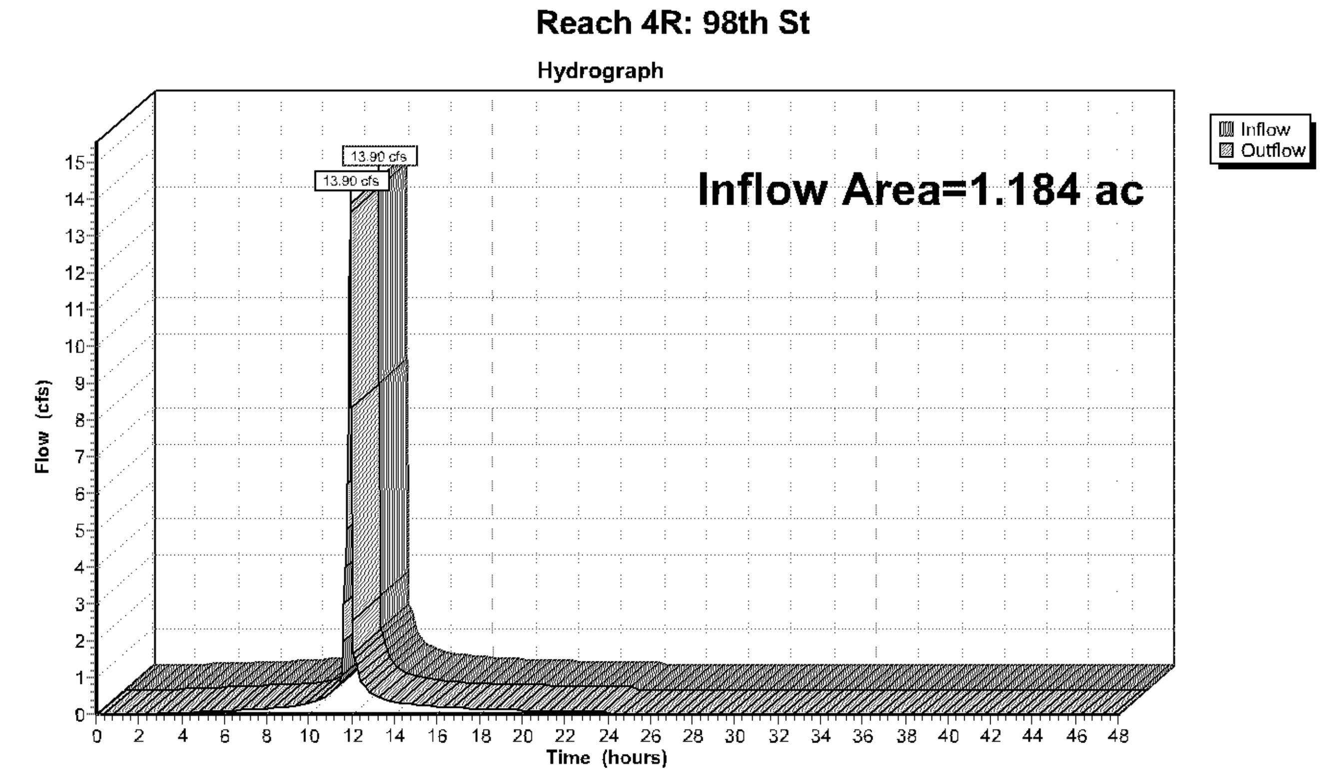
Reach 3R: SE Site CB



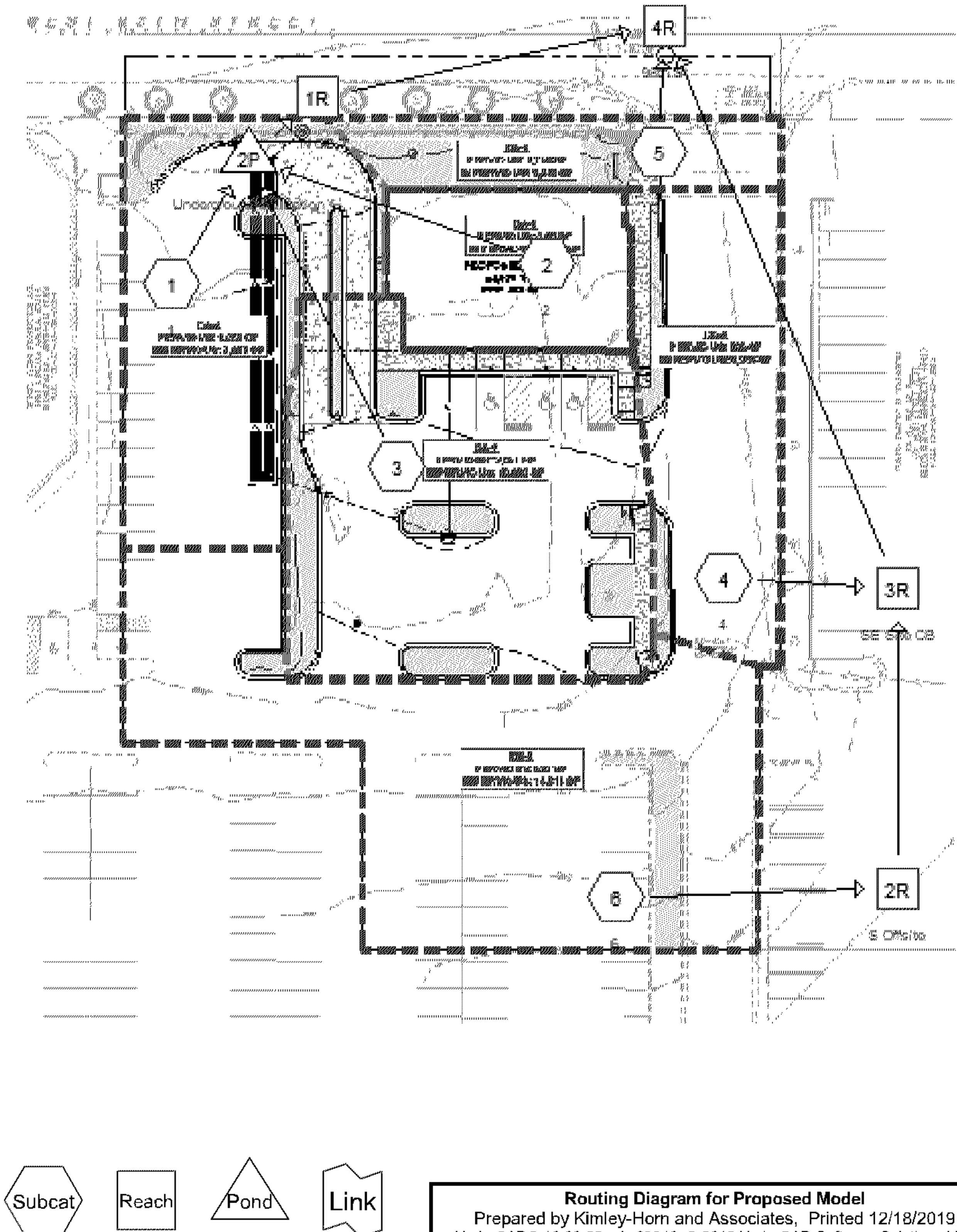
Summary for Reach 4R: 98th St

Inflow Area =	1.184 ac,	87.41% Impervious,	Inflow Depth = 6.70"	for 100-yr event
Inflow =	13.90 cfs @	11.89 hrs, Volume=	0.661 af	
Outflow =	13.90 cfs @	11.89 hrs, Volume=	0.661 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs



Appendix 2. Proposed HydroCAD Model Analysis



Routing Diagram for Proposed Model
Prepared by Kimley-Horn and Associates, Printed 12/18/2019
HydroCAD® 10.00-22 s/n 09843 © 2018 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.143	61	>75% Grass cover, Good, HSG B (1, 3, 4, 5, 6)
1.041	98	Paved parking, HSG B (1, 2, 3, 4, 5, 6)

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
1.184	HSG B	1, 2, 3, 4, 5, 6
0.000	HSG C	
0.000	HSG D	
0.000	Other	

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.143	0.000	0.000	0.000	0.143	>75% Grass cover, Good	1, 3, 4, 5, 6
0.000	1.041	0.000	0.000	0.000	1.041	Paved parking	1, 2, 3, 4, 5, 6

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: 1 Runoff Area=9,139 sf 86.19% Impervious Runoff Depth=2.09"
Tc=7.0 min CN=93 Runoff=0.70 cfs 0.037 af

Subcatchment 2: 2 Runoff Area=4,020 sf 100.00% Impervious Runoff Depth=2.60"
Tc=7.0 min CN=98 Runoff=0.35 cfs 0.020 af

Subcatchment 3: 3 Runoff Area=13,059 sf 83.94% Impervious Runoff Depth=2.00"
Tc=7.0 min CN=92 Runoff=0.97 cfs 0.050 af

Subcatchment 4: 4 Runoff Area=6,755 sf 92.72% Impervious Runoff Depth=2.28"
Tc=7.0 min CN=95 Runoff=0.55 cfs 0.030 af

Subcatchment 5: 5 Runoff Area=3,156 sf 44.87% Impervious Runoff Depth=1.01"
Tc=7.0 min CN=78 Runoff=0.12 cfs 0.006 af

Subcatchment 6: 6 Runoff Area=15,435 sf 95.98% Impervious Runoff Depth=2.49"
Tc=7.0 min CN=97 Runoff=1.32 cfs 0.074 af

Reach 1R: N CB Inflow=0.87 cfs 0.033 af
Outflow=0.87 cfs 0.033 af

Reach 2R: S Offsite Inflow=1.32 cfs 0.074 af
Outflow=1.32 cfs 0.074 af

Reach 3R: SE Site CB Inflow=1.87 cfs 0.103 af
Outflow=1.87 cfs 0.103 af

Reach 4R: 98th St Inflow=1.99 cfs 0.142 af
Outflow=1.99 cfs 0.142 af

Pond 2P: Underground Infiltration Peak Elev=828.34' Storage=2,148 cf Inflow=2.03 cfs 0.107 af
Discarded=0.02 cfs 0.065 af Primary=0.87 cfs 0.033 af Outflow=0.89 cfs 0.098 af

Summary for Subcatchment 1: 1

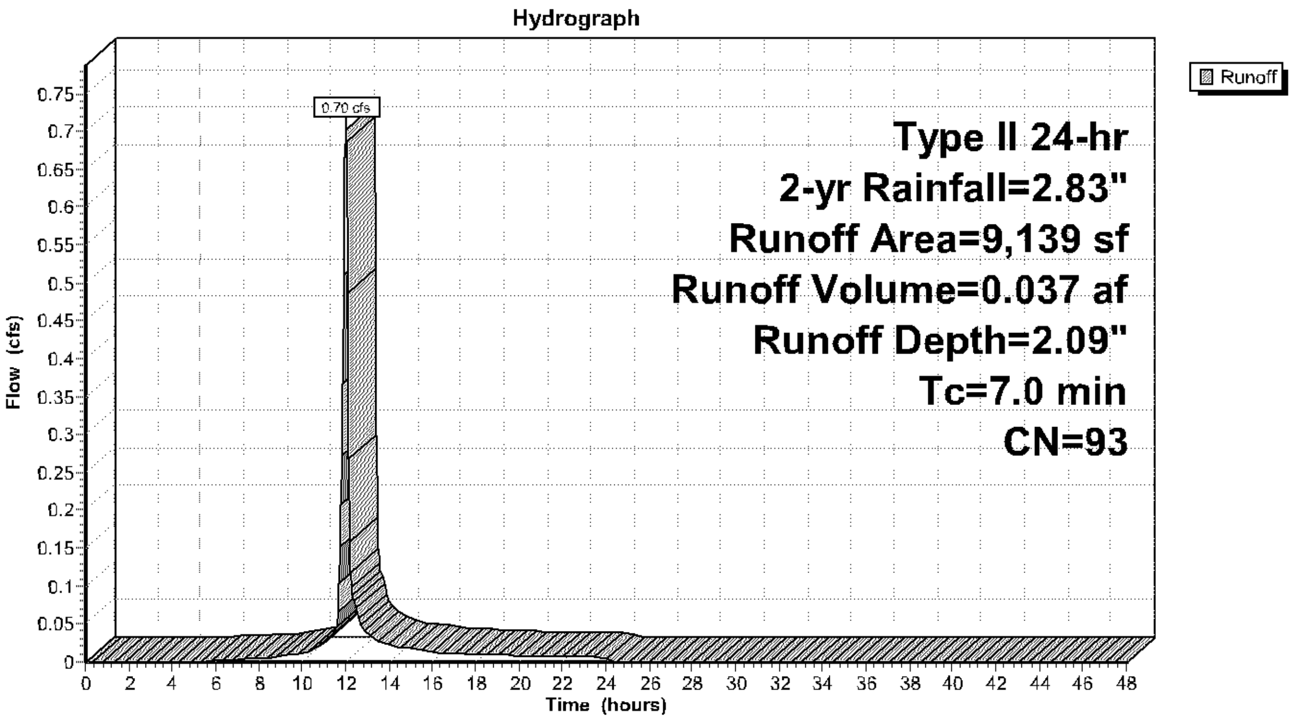
Runoff = 0.70 cfs @ 11.98 hrs, Volume= 0.037 af, Depth= 2.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
1,262	61	>75% Grass cover, Good, HSG B
7,877	98	Paved parking, HSG B
9,139	93	Weighted Average
1,262		13.81% Pervious Area
7,877		86.19% Impervious Area

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

Subcatchment 1: 1



Summary for Subcatchment 2: 2

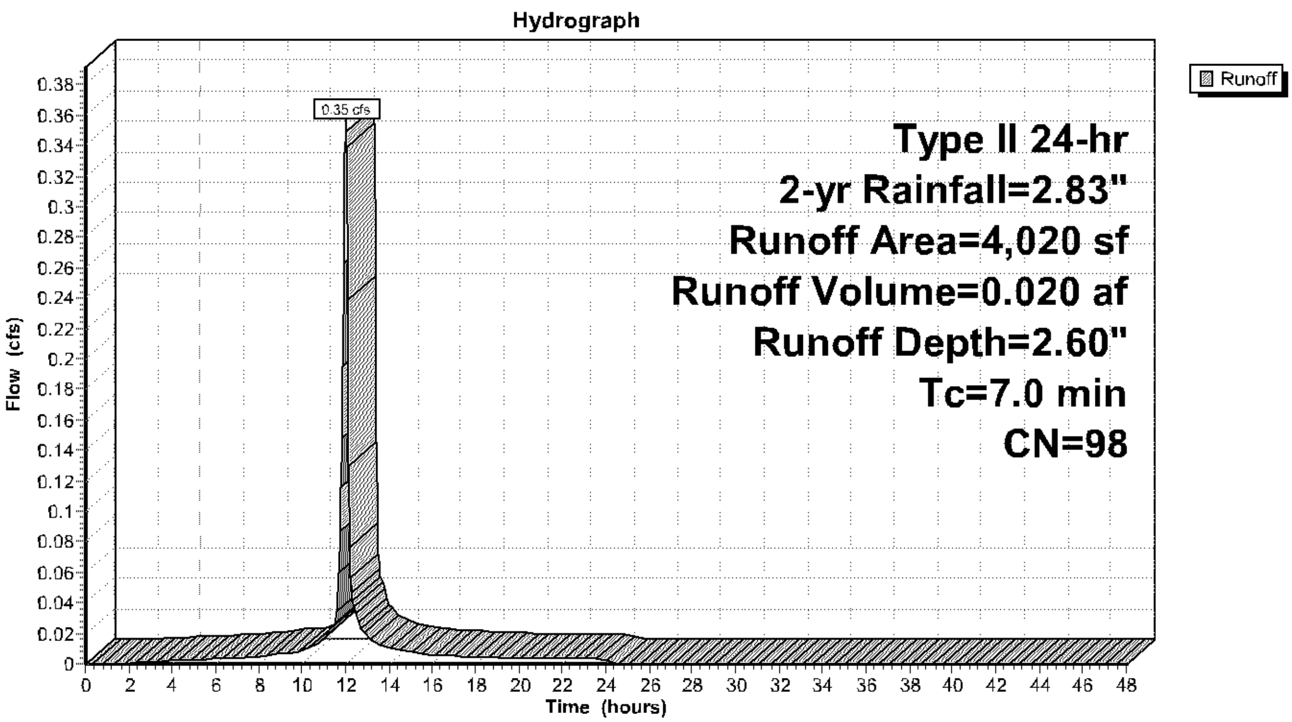
Runoff = 0.35 cfs @ 11.98 hrs, Volume= 0.020 af, Depth= 2.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
0	61	>75% Grass cover, Good, HSG B
4,020	98	Paved parking, HSG B
4,020	98	Weighted Average
4,020		100.00% Impervious Area

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

Subcatchment 2: 2



Summary for Subcatchment 3: 3

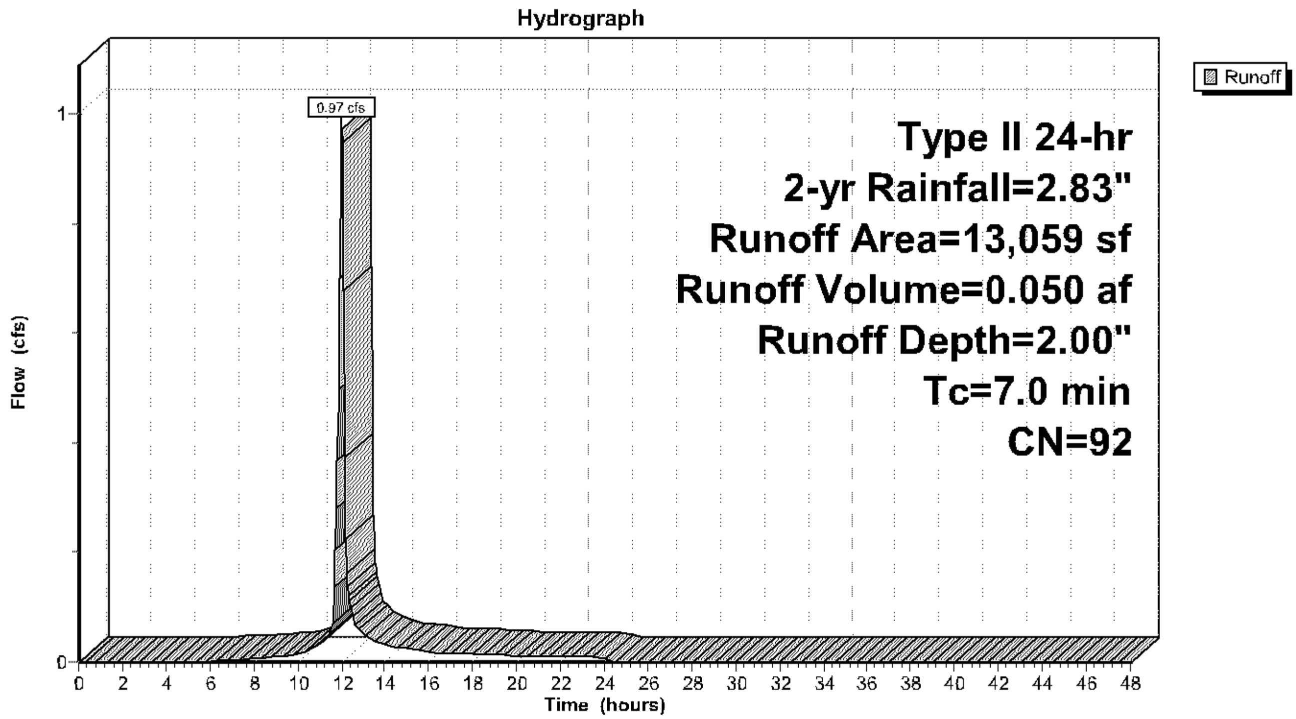
Runoff = 0.97 cfs @ 11.98 hrs, Volume= 0.050 af, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
2,097	61	>75% Grass cover, Good, HSG B
10,962	98	Paved parking, HSG B
13,059	92	Weighted Average
2,097		16.06% Pervious Area
10,962		83.94% Impervious Area

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

Subcatchment 3: 3



Summary for Subcatchment 4: 4

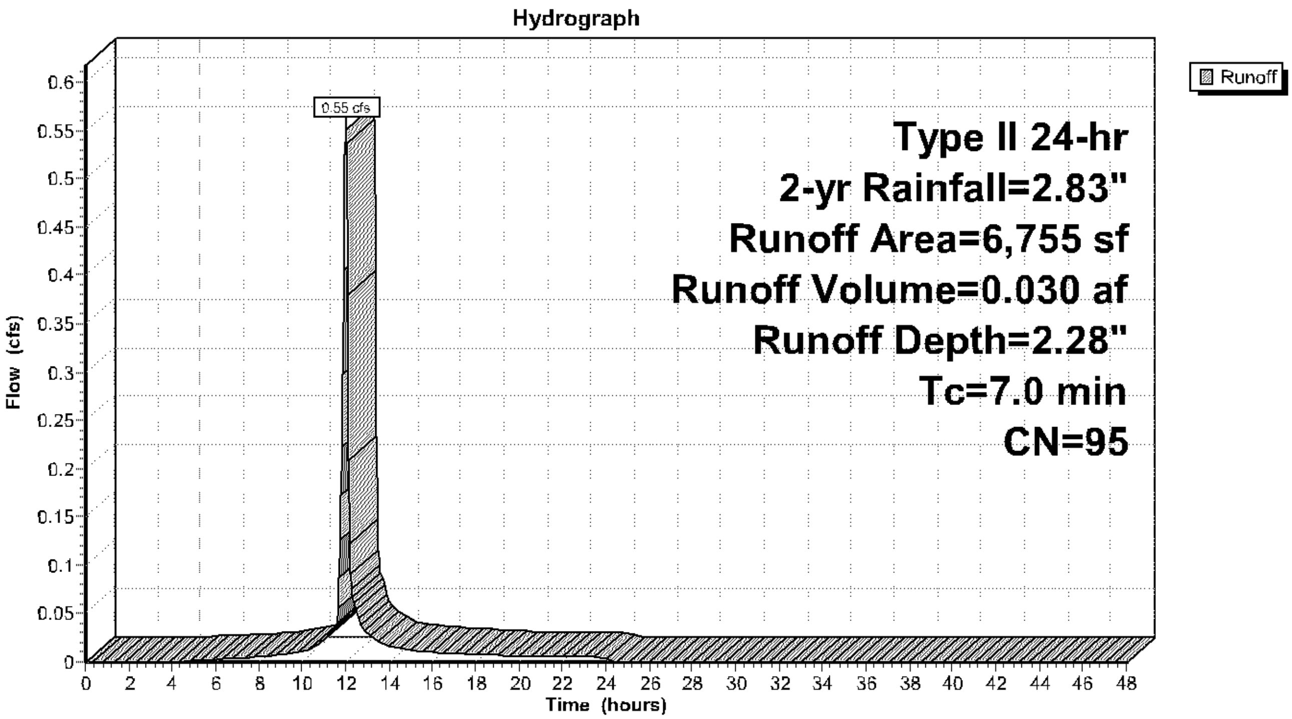
Runoff = 0.55 cfs @ 11.98 hrs, Volume= 0.030 af, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
492	61	>75% Grass cover, Good, HSG B
6,263	98	Paved parking, HSG B
6,755	95	Weighted Average
492		7.28% Pervious Area
6,263		92.72% Impervious Area

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

Subcatchment 4: 4



Summary for Subcatchment 5: 5

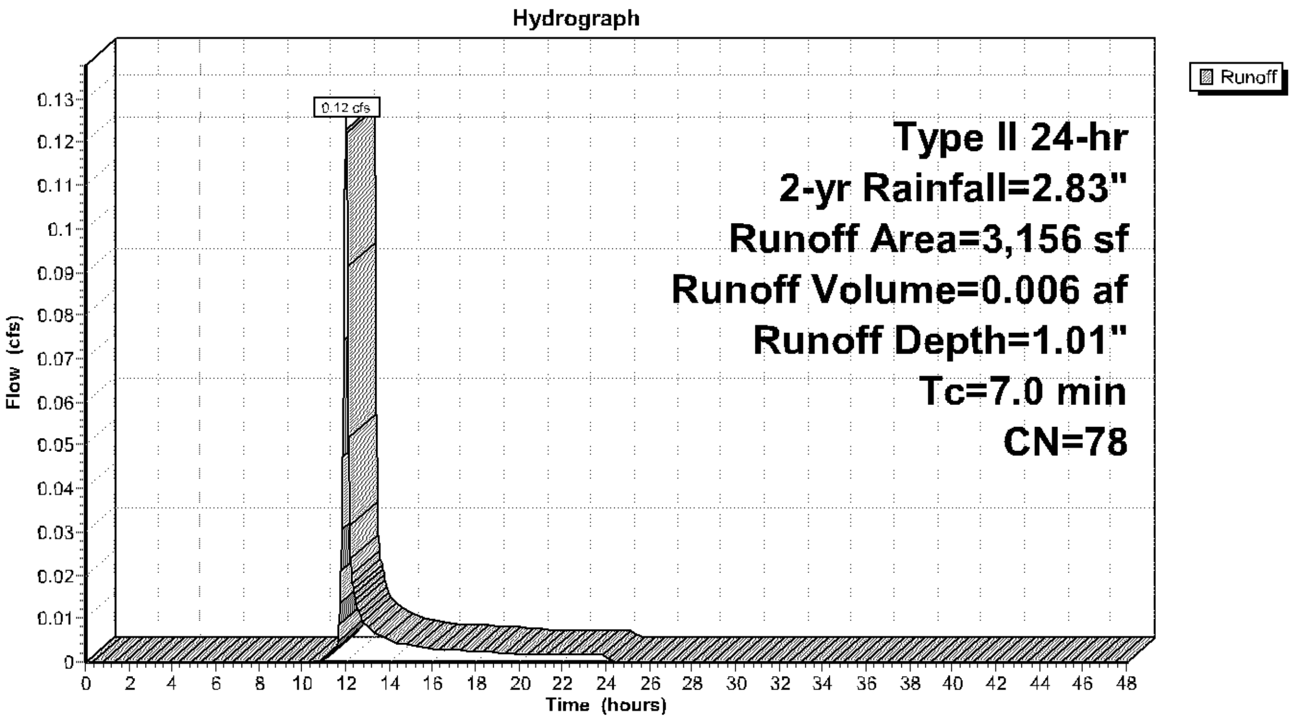
Runoff = 0.12 cfs @ 11.99 hrs, Volume= 0.006 af, Depth= 1.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
1,740	61	>75% Grass cover, Good, HSG B
1,416	98	Paved parking, HSG B
3,156	78	Weighted Average
1,740		55.13% Pervious Area
1,416		44.87% Impervious Area

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

Subcatchment 5: 5



Summary for Subcatchment 6: 6

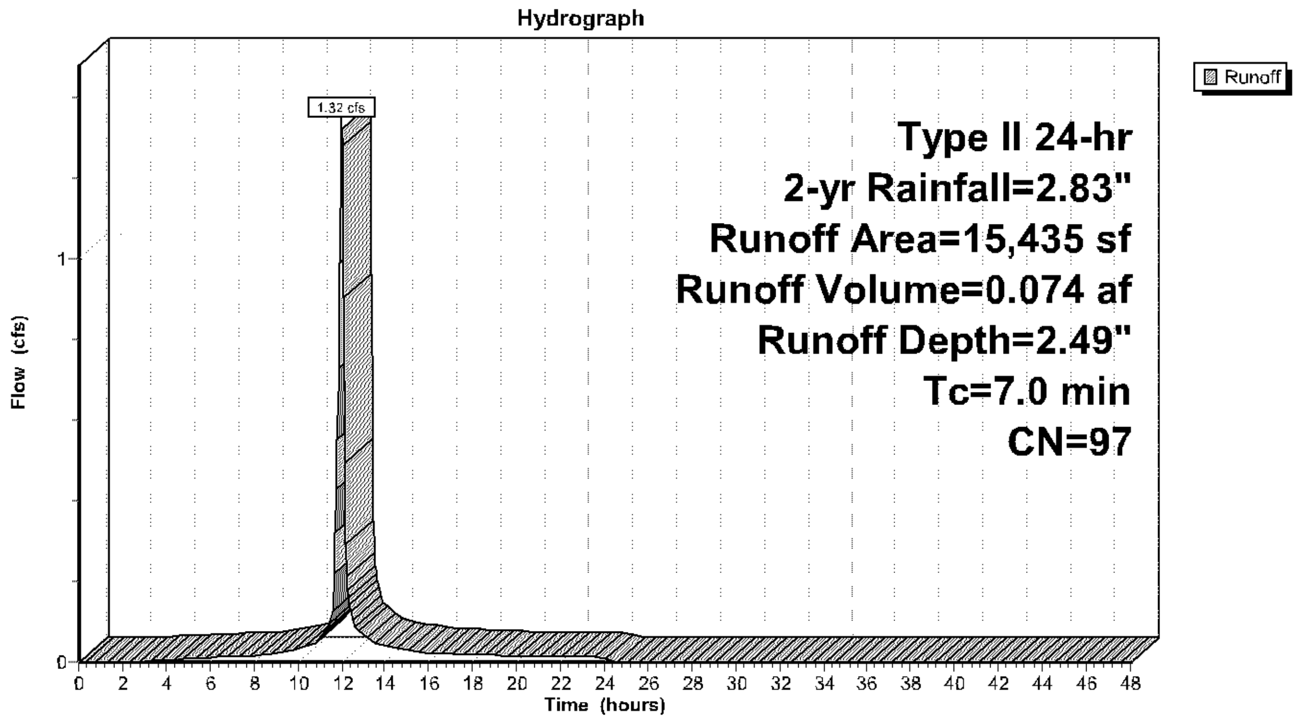
Runoff = 1.32 cfs @ 11.98 hrs, Volume= 0.074 af, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=2.83"

Area (sf)	CN	Description
621	61	>75% Grass cover, Good, HSG B
14,814	98	Paved parking, HSG B
15,435	97	Weighted Average
621		4.02% Pervious Area
14,814		95.98% Impervious Area

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

Subcatchment 6: 6

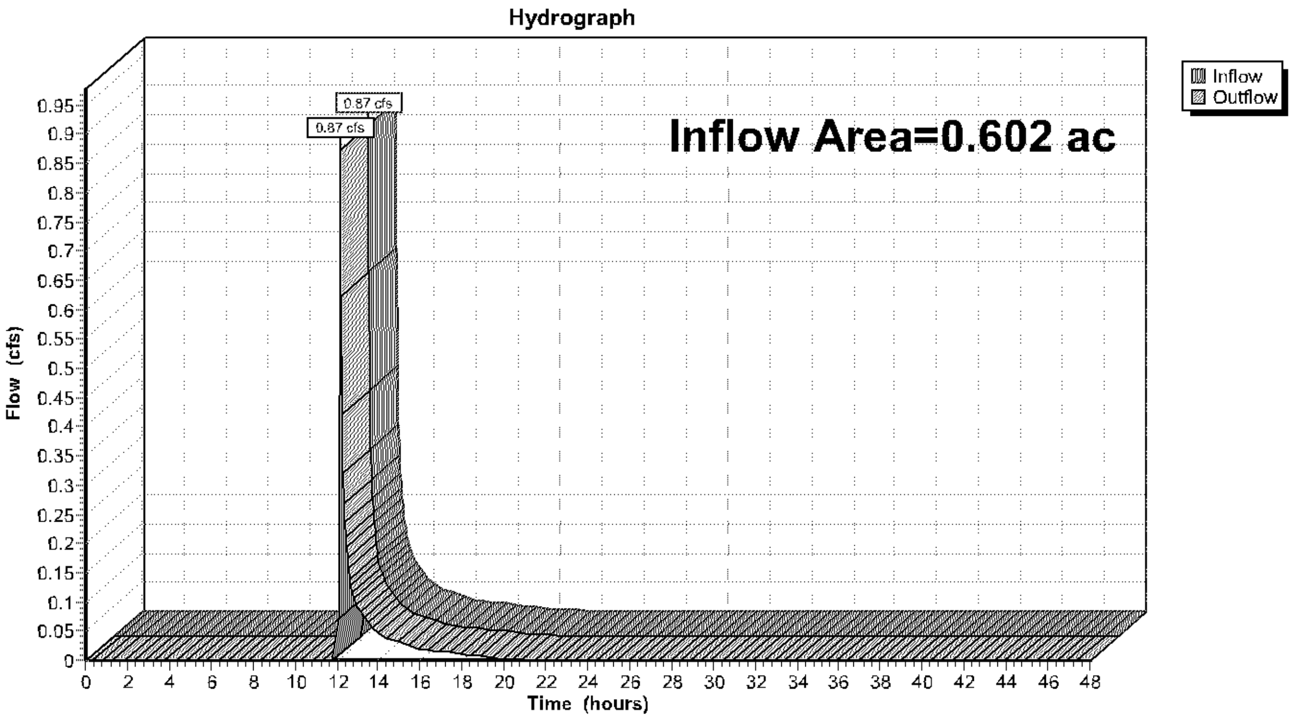


Summary for Reach 1R: N CB

Inflow Area =	0.602 ac, 87.19% Impervious,	Inflow Depth = 0.66" for 2-yr event		
Inflow =	0.87 cfs @	12.11 hrs, Volume=	0.033 af	
Outflow =	0.87 cfs @	12.11 hrs, Volume=	0.033 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 1R: N CB

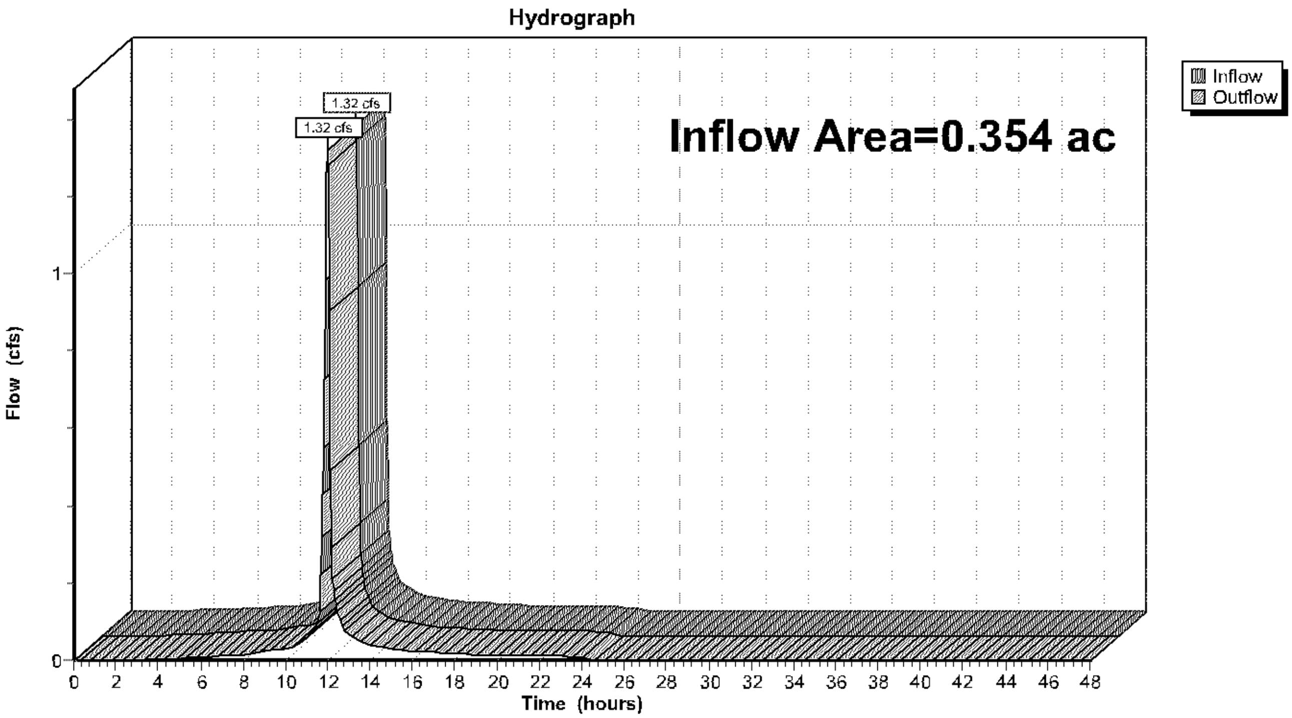


Summary for Reach 2R: S Offsite

Inflow Area = 0.354 ac, 95.98% Impervious, Inflow Depth = 2.49" for 2-yr event
Inflow = 1.32 cfs @ 11.98 hrs, Volume= 0.074 af
Outflow = 1.32 cfs @ 11.98 hrs, Volume= 0.074 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 2R: S Offsite

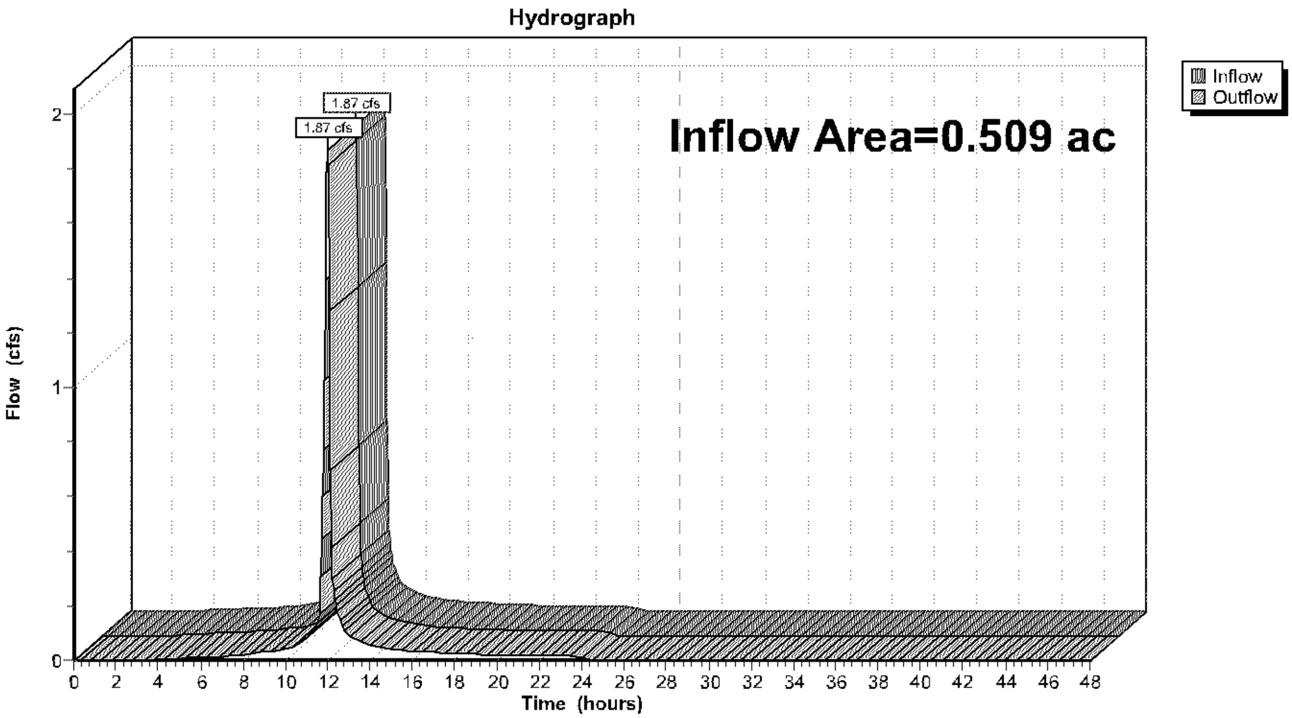


Summary for Reach 3R: SE Site CB

Inflow Area =	0.509 ac,	94.98% Impervious,	Inflow Depth = 2.43"	for 2-yr event
Inflow =	1.87 cfs @	11.98 hrs, Volume=	0.103 af	
Outflow =	1.87 cfs @	11.98 hrs, Volume=	0.103 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 3R: SE Site CB

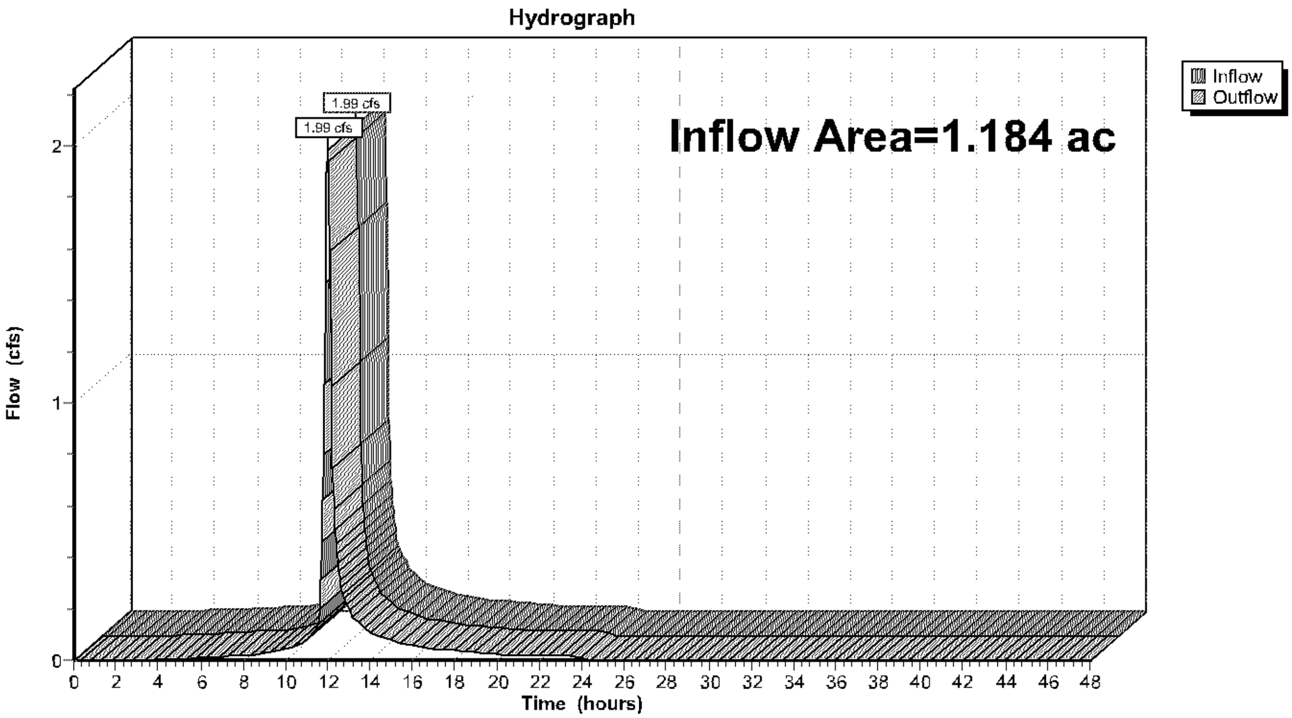


Summary for Reach 4R: 98th St

Inflow Area =	1.184 ac, 87.95% Impervious, Inflow Depth = 1.44" for 2-yr event		
Inflow =	1.99 cfs @ 11.98 hrs, Volume=	0.142 af	
Outflow =	1.99 cfs @ 11.98 hrs, Volume=	0.142 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 4R: 98th St



Summary for Pond 2P: Underground Infiltration

```
Inflow Area =      0.602 ac, 87.19% Impervious, Inflow Depth = 2.12"   for 2-yr event
Inflow      =      2.03 cfs @  11.98 hrs, Volume=       0.107 af
Outflow     =      0.89 cfs @  12.11 hrs, Volume=       0.098 af, Atten= 56%, Lag= 8.1 min
Discarded   =      0.02 cfs @   8.75 hrs, Volume=       0.065 af
Primary     =      0.87 cfs @  12.11 hrs, Volume=       0.033 af
```

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 828.34' @ 12.12 hrs Surf.Area= 1,026 sf Storage= 2,148 cf

Plug-Flow detention time= 613.1 min calculated for 0.098 af (92% of inflow)
Center-of-Mass det. time= 570.3 min (1,360.4 - 790.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	825.50'	1,034 cf	**9.50'W x 108.00'L x 4.00'H Field A** 4,104 cf Overall - 1,520 cf Embedded = 2,584 cf x 40.0% Voids
#2A	826.00'	1,520 cf	**CMP Round 36** x 10 Inside #1 Effective Size= 36.0"W x 36.0"H => 7.07 sf x 20.00'L = 141.4 cf Overall Size= 36.0"W x 36.0"H x 20.00'L 2 Rows of 5 Chambers 7.50' Header x 7.07 sf x 2 = 106.0 cf Inside
#3	826.00'	163 cf	**24.0" Round Pipe Storage** -Impervious L= 52.0'
#4	826.00'	101 cf	**4.00'D x 4.00'H MH** x 2 -Impervious
		2,817 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	827.22'	**12.0" Round Culvert** L= 97.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 827.22' / 824.40' S= 0.0291 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	828.15'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Discarded	825.50'	**0.800 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 8.75 hrs HW=825.55' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.77 cfs @ 12.11 hrs HW=828.32' (Free Discharge)
↑—**1=Culvert** (Passes 0.77 cfs of 2.92 cfs potential flow)
  ↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 0.77 cfs @ 1.15 fps)

Pond 2P: Underground Infiltration - Chamber Wizard Field A

Chamber Model = CMP Round 36 (Round Corrugated Metal Pipe)
Effective Size= 36.0"W x 36.0"H => 7.07 sf x 20.00'L = 141.4 cf
Overall Size= 36.0"W x 36.0"H x 20.00'L

36.0" Wide + 18.0" Spacing = 54.0" C-C Row Spacing

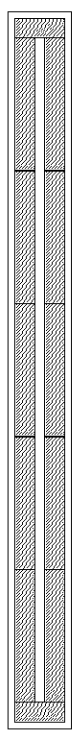
5 Chambers/Row x 20.00' Long +3.00' Header x 2 = 106.00' Row Length +12.0" End Stone x 2 = 108.00' Base Length
2 Rows x 36.0" Wide + 18.0" Spacing x 1 + 12.0" Side Stone x 2 = 9.50' Base Width
6.0" Base + 36.0" Chamber Height + 6.0" Cover = 4.00' Field Height

10 Chambers x 141.4 cf + 7.50' Header x 7.07 sf x 2 = 1,519.7 cf Chamber Storage

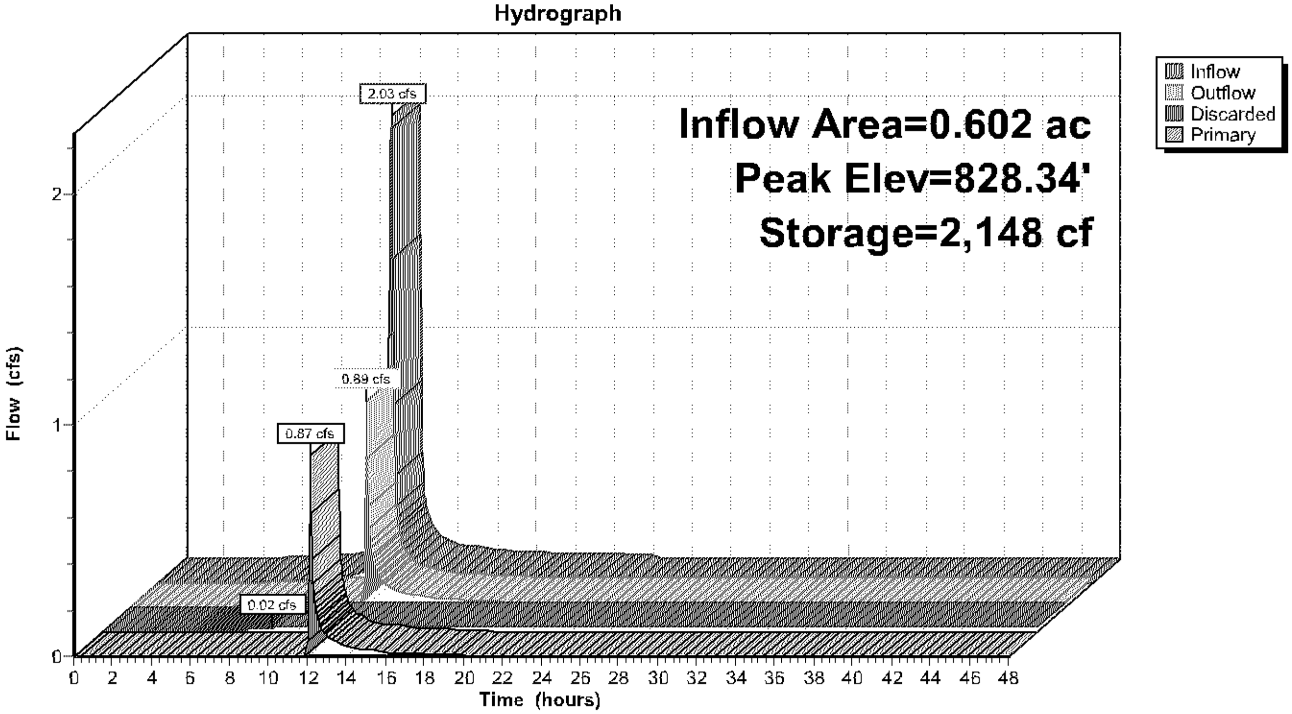
4,104.0 cf Field - 1,519.7 cf Chambers = 2,584.3 cf Stone x 40.0% Voids = 1,033.7 cf Stone Storage

Chamber Storage + Stone Storage = 2,553.4 cf = 0.059 af
Overall Storage Efficiency = 62.2%
Overall System Size = 108.00' x 9.50' x 4.00'

10 Chambers
152.0 cy Field
95.7 cy Stone



Pond 2P: Underground Infiltration



Stage-Area-Storage for Pond 2P: Underground Infiltration

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
825.50	**1,026**	0	828.10	1,026	1,965
825.55	1,026	21	828.15	1,026	2,004
825.60	1,026	41	828.20	1,026	2,043
825.65	1,026	62	828.25	1,026	2,082
825.70	1,026	82	828.30	1,026	2,120
825.75	1,026	103	828.35	1,026	2,158
825.80	1,026	123	828.40	1,026	2,196
825.85	1,026	144	828.45	1,026	2,233
825.90	1,026	164	828.50	1,026	2,269
825.95	1,026	185	828.55	1,026	2,305
826.00	1,026	205	828.60	1,026	2,341
826.05	1,026	231	828.65	1,026	2,375
826.10	1,026	261	828.70	1,026	2,409
826.15	1,026	293	828.75	1,026	2,442
826.20	1,026	327	828.80	1,026	2,474
826.25	1,026	362	828.85	1,026	2,505
826.30	1,026	399	828.90	1,026	2,534
826.35	1,026	436	828.95	1,026	2,562
826.40	1,026	475	829.00	1,026	2,587
826.45	1,026	514	829.05	1,026	2,609
826.50	1,026	555	829.10	1,026	2,631
826.55	1,026	596	829.15	1,026	2,652
826.60	1,026	638	829.20	1,026	2,674
826.65	1,026	680	829.25	1,026	2,696
826.70	1,026	723	829.30	1,026	2,718
826.75	1,026	766	829.35	1,026	2,739
826.80	1,026	810	829.40	1,026	2,761
826.85	1,026	854	829.45	1,026	2,783
826.90	1,026	899	829.50	1,026	2,805
826.95	1,026	943	829.55	1,026	2,806
827.00	1,026	988	829.60	1,026	2,807
827.05	1,026	1,034	829.65	1,026	2,809
827.10	1,026	1,079	829.70	1,026	2,810
827.15	1,026	1,125	829.75	1,026	2,811
827.20	1,026	1,171	829.80	1,026	2,812
827.25	1,026	1,217	829.85	1,026	2,814
827.30	1,026	1,263	829.90	1,026	2,815
827.35	1,026	1,308	829.95	1,026	2,816
827.40	1,026	1,354	830.00	1,026	**2,817**
827.45	1,026	1,400			
827.50	1,026	1,446			
827.55	1,026	1,491			
827.60	1,026	1,537			
827.65	1,026	1,582			
827.70	1,026	1,627			
827.75	1,026	1,671			
827.80	1,026	1,715			
827.85	1,026	1,759			
827.90	1,026	1,802			
827.95	1,026	1,844			
828.00	1,026	1,885			
828.05	1,026	1,925			

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: 1 Runoff Area=9,139 sf 86.19% Impervious Runoff Depth=3.45"
Tc=7.0 min CN=93 Runoff=1.13 cfs 0.060 af

Subcatchment 2: 2 Runoff Area=4,020 sf 100.00% Impervious Runoff Depth=4.00"
Tc=7.0 min CN=98 Runoff=0.53 cfs 0.031 af

Subcatchment 3: 3 Runoff Area=13,059 sf 83.94% Impervious Runoff Depth=3.35"
Tc=7.0 min CN=92 Runoff=1.58 cfs 0.084 af

Subcatchment 4: 4 Runoff Area=6,755 sf 92.72% Impervious Runoff Depth=3.67"
Tc=7.0 min CN=95 Runoff=0.86 cfs 0.047 af

Subcatchment 5: 5 Runoff Area=3,156 sf 44.87% Impervious Runoff Depth=2.08"
Tc=7.0 min CN=78 Runoff=0.25 cfs 0.013 af

Subcatchment 6: 6 Runoff Area=15,435 sf 95.98% Impervious Runoff Depth=3.89"
Tc=7.0 min CN=97 Runoff=2.01 cfs 0.115 af

Reach 1R: N CB Inflow=3.16 cfs 0.098 af
Outflow=3.16 cfs 0.098 af

Reach 2R: S Offsite Inflow=2.01 cfs 0.115 af
Outflow=2.01 cfs 0.115 af

Reach 3R: SE Site CB Inflow=2.87 cfs 0.162 af
Outflow=2.87 cfs 0.162 af

Reach 4R: 98th St Inflow=6.25 cfs 0.273 af
Outflow=6.25 cfs 0.273 af

Pond 2P: Underground Infiltration Peak Elev=828.57' Storage=2,317 cf Inflow=3.23 cfs 0.175 af
Discarded=0.02 cfs 0.068 af Primary=3.16 cfs 0.098 af Outflow=3.18 cfs 0.166 af

Summary for Subcatchment 1: 1

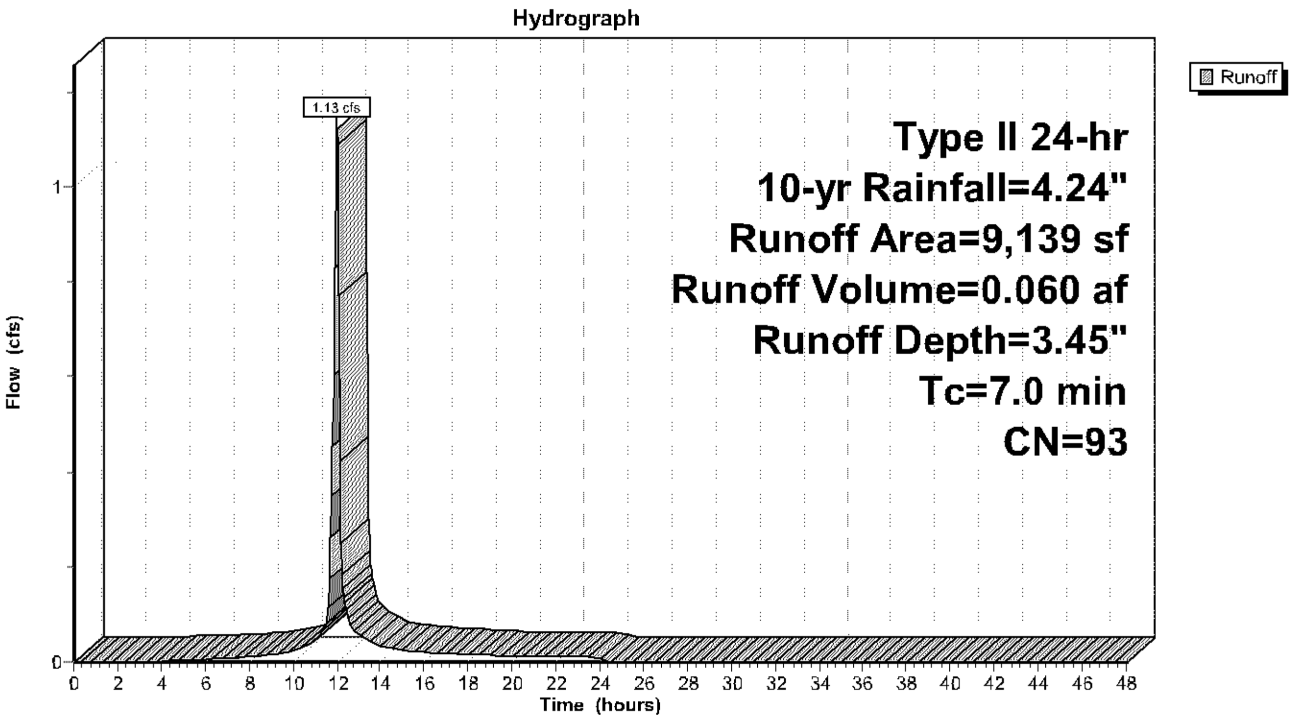
Runoff = 1.13 cfs @ 11.98 hrs, Volume= 0.060 af, Depth= 3.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
1,262	61	>75% Grass cover, Good, HSG B
7,877	98	Paved parking, HSG B
9,139	93	Weighted Average
1,262		13.81% Pervious Area
7,877		86.19% Impervious Area

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

Subcatchment 1: 1



Summary for Subcatchment 2: 2

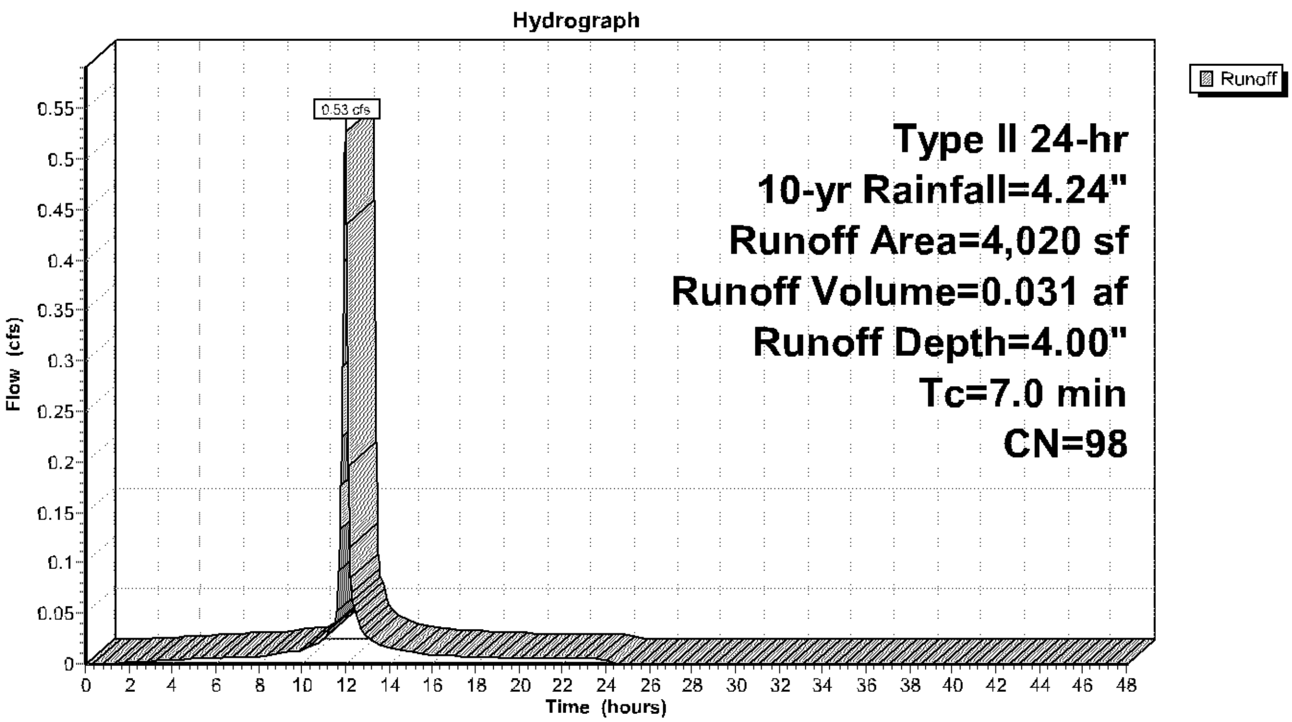
Runoff = 0.53 cfs @ 11.98 hrs, Volume= 0.031 af, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
0	61	>75% Grass cover, Good, HSG B
4,020	98	Paved parking, HSG B
4,020	98	Weighted Average
4,020		100.00% Impervious Area

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

Subcatchment 2: 2



Summary for Subcatchment 3: 3

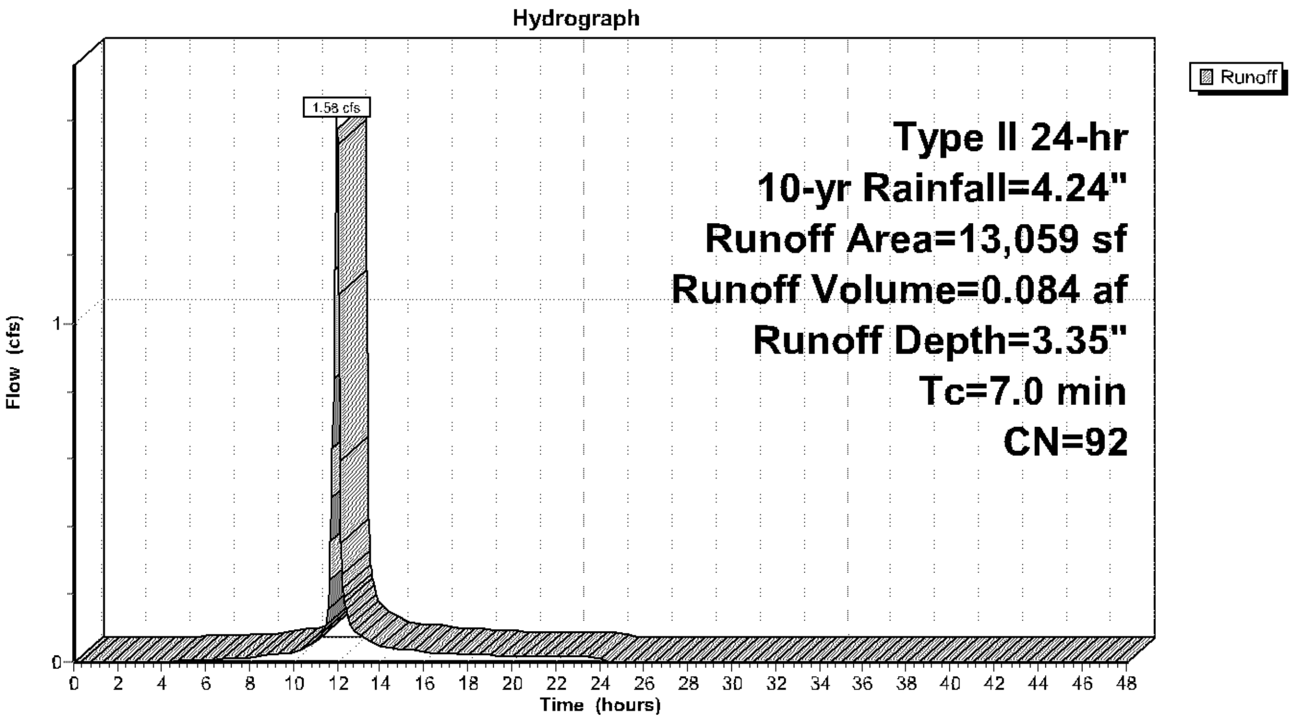
Runoff = 1.58 cfs @ 11.98 hrs, Volume= 0.084 af, Depth= 3.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
2,097	61	>75% Grass cover, Good, HSG B
10,962	98	Paved parking, HSG B
13,059	92	Weighted Average
2,097		16.06% Pervious Area
10,962		83.94% Impervious Area

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

Subcatchment 3: 3



Summary for Subcatchment 4: 4

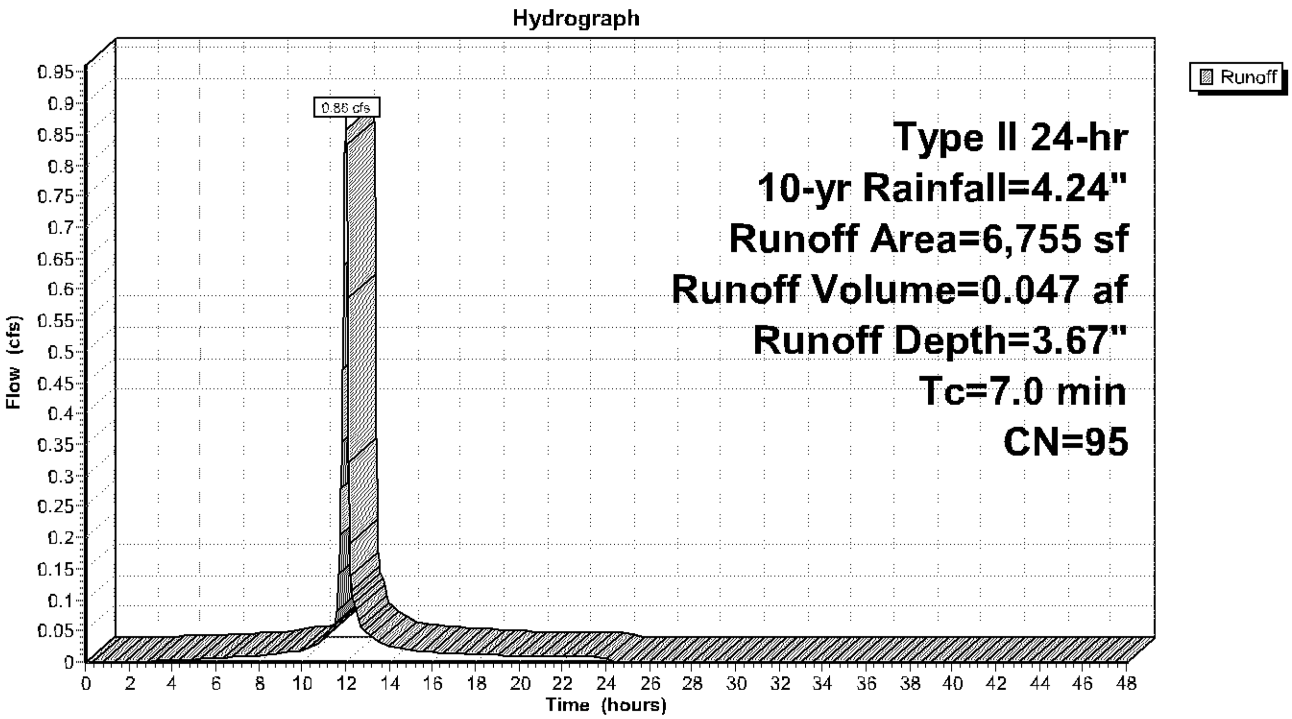
Runoff = 0.86 cfs @ 11.98 hrs, Volume= 0.047 af, Depth= 3.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
492	61	>75% Grass cover, Good, HSG B
6,263	98	Paved parking, HSG B
6,755	95	Weighted Average
492		7.28% Pervious Area
6,263		92.72% Impervious Area

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

Subcatchment 4: 4



Summary for Subcatchment 5: 5

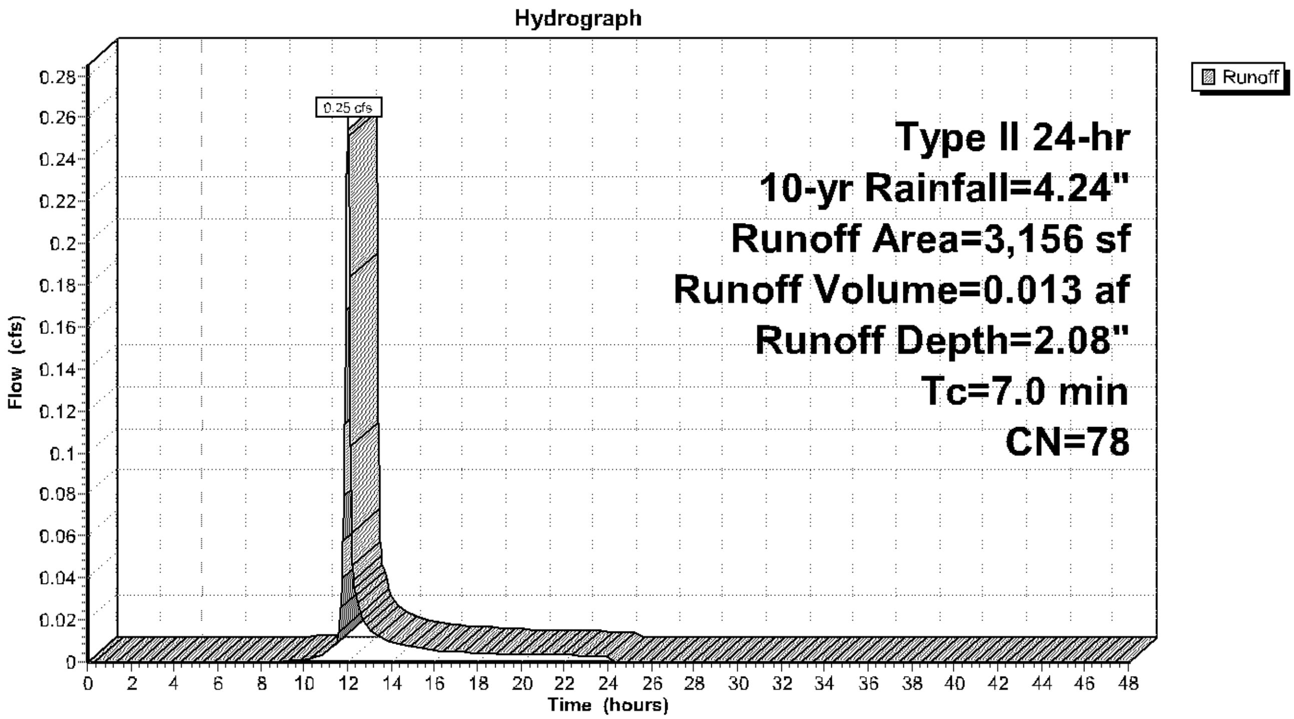
Runoff = 0.25 cfs @ 11.99 hrs, Volume= 0.013 af, Depth= 2.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
1,740	61	>75% Grass cover, Good, HSG B
1,416	98	Paved parking, HSG B
3,156	78	Weighted Average
1,740		55.13% Pervious Area
1,416		44.87% Impervious Area

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

Subcatchment 5: 5



Summary for Subcatchment 6: 6

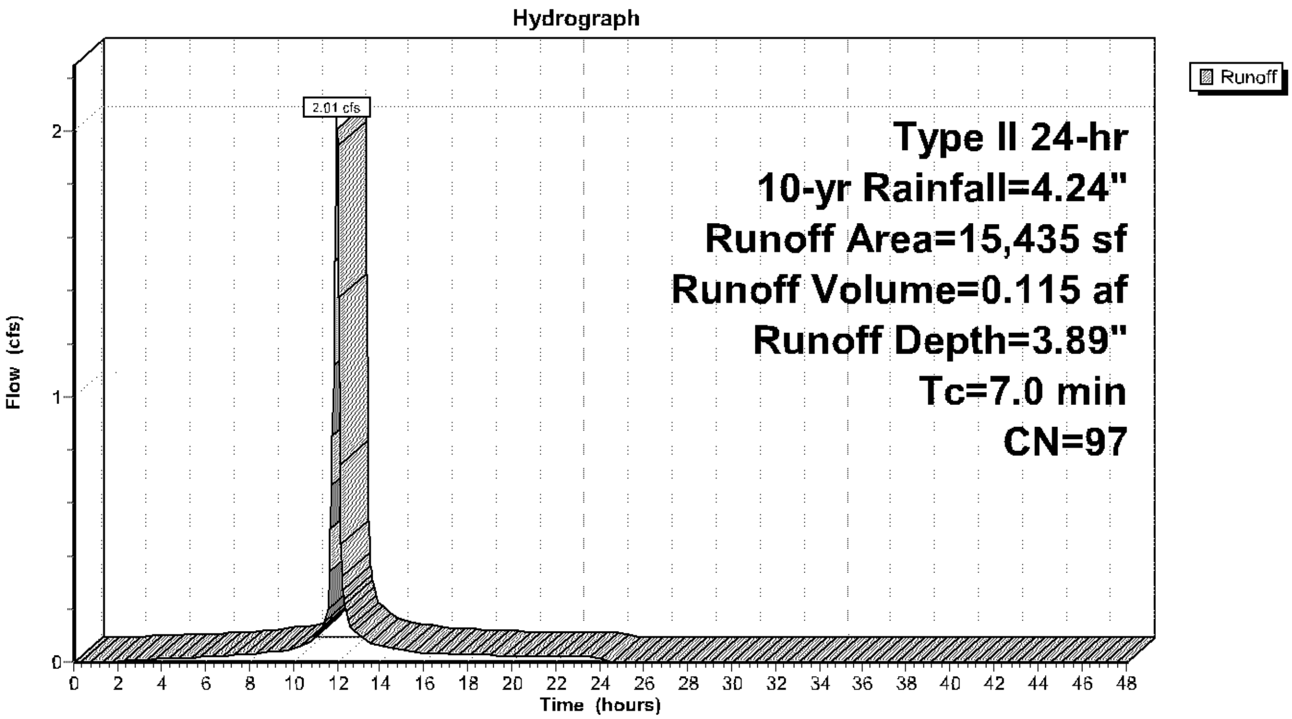
Runoff = 2.01 cfs @ 11.98 hrs, Volume= 0.115 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=4.24"

Area (sf)	CN	Description
621	61	>75% Grass cover, Good, HSG B
14,814	98	Paved parking, HSG B
15,435	97	Weighted Average
621		4.02% Pervious Area
14,814		95.98% Impervious Area

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

Subcatchment 6: 6

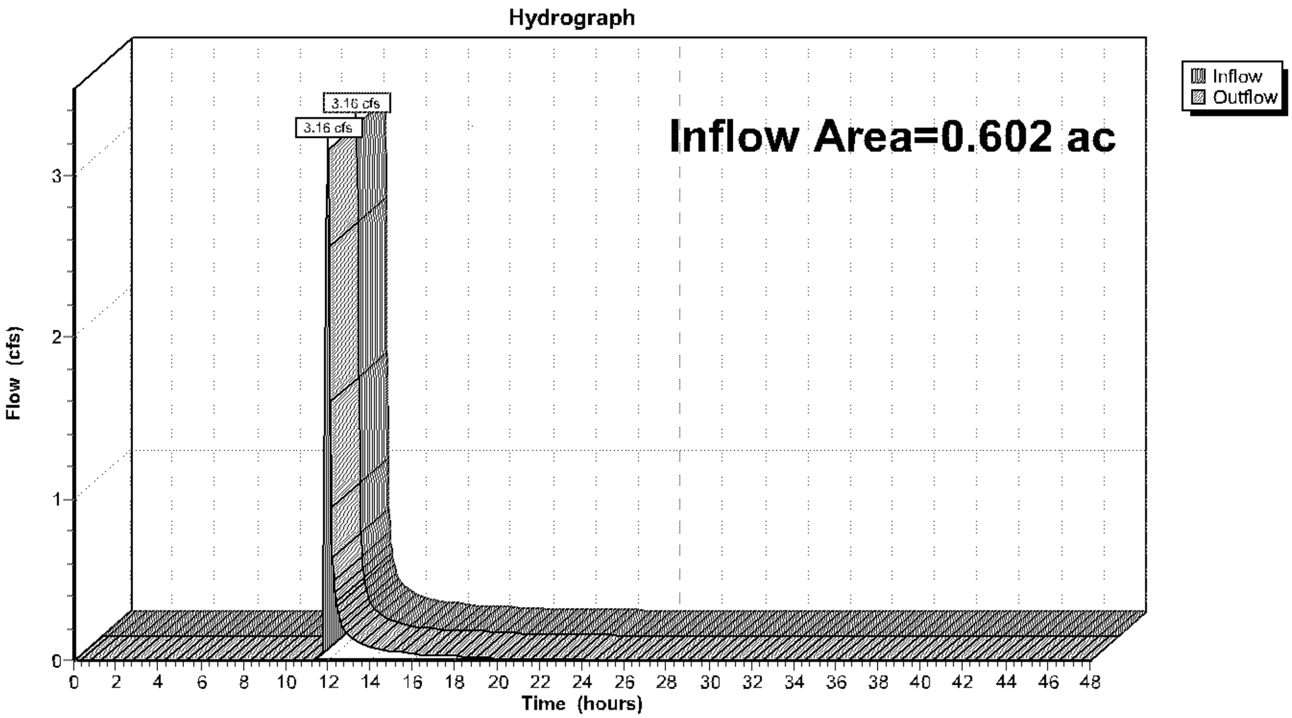


Summary for Reach 1R: N CB

Inflow Area =	0.602 ac,	87.19% Impervious,	Inflow Depth = 1.96"	for 10-yr event
Inflow =	3.16 cfs @	12.00 hrs, Volume=	0.098 af	
Outflow =	3.16 cfs @	12.00 hrs, Volume=	0.098 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 1R: N CB

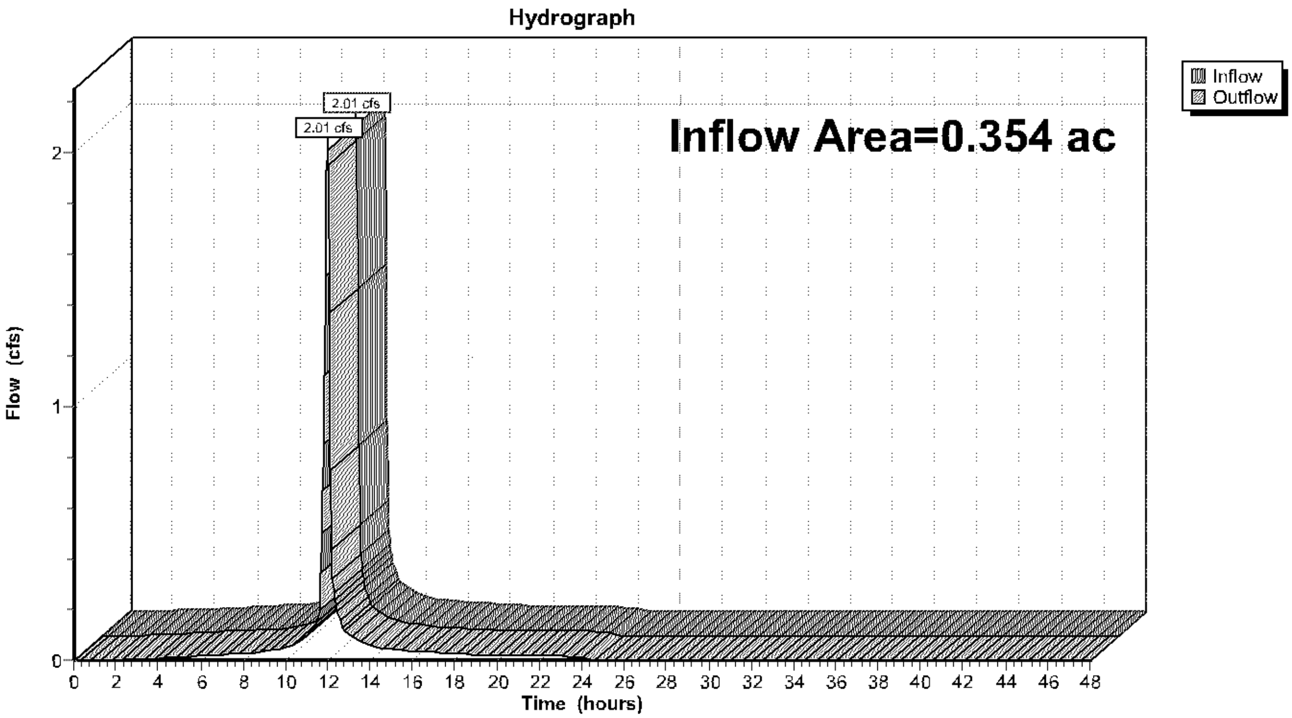


Summary for Reach 2R: S Offsite

Inflow Area =	0.354 ac,	95.98% Impervious,	Inflow Depth = 3.89"	for 10-yr event
Inflow =	2.01 cfs @	11.98 hrs, Volume=	0.115 af	
Outflow =	2.01 cfs @	11.98 hrs, Volume=	0.115 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 2R: S Offsite

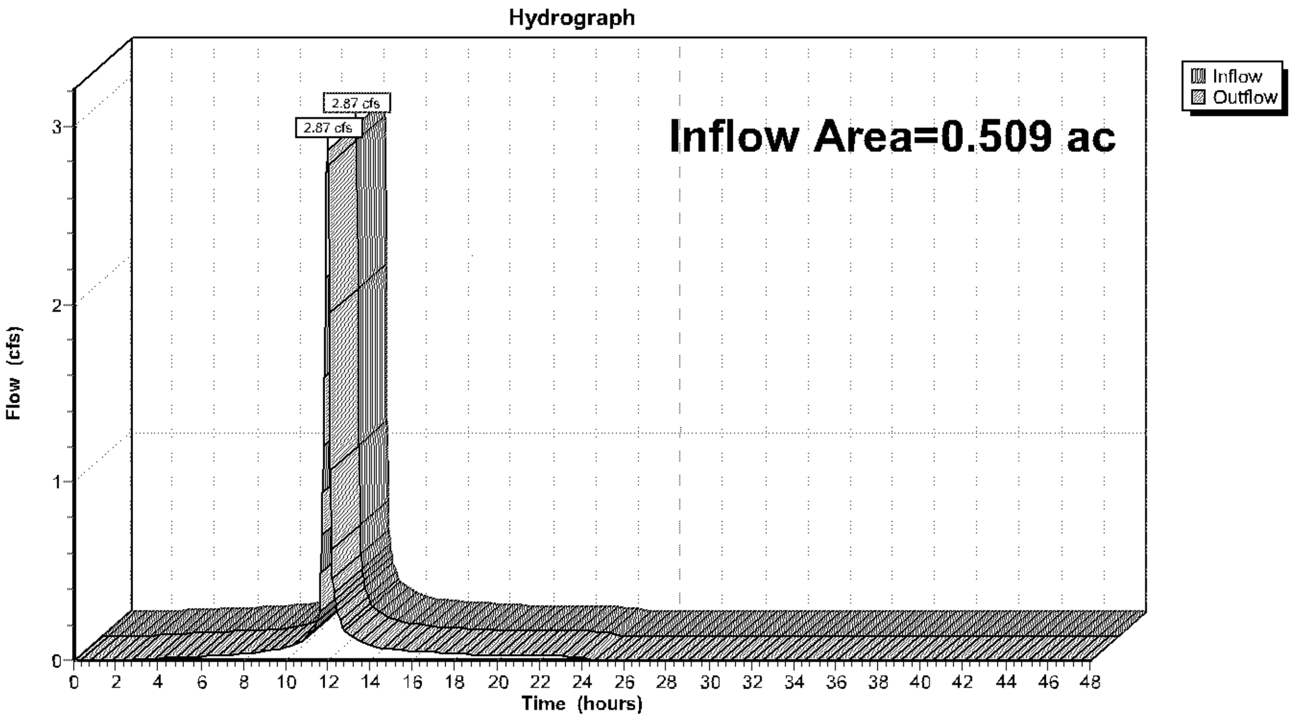


Summary for Reach 3R: SE Site CB

Inflow Area =	0.509 ac,	94.98% Impervious,	Inflow Depth = 3.82"	for 10-yr event
Inflow =	2.87 cfs @	11.98 hrs, Volume=	0.162 af	
Outflow =	2.87 cfs @	11.98 hrs, Volume=	0.162 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 3R: SE Site CB

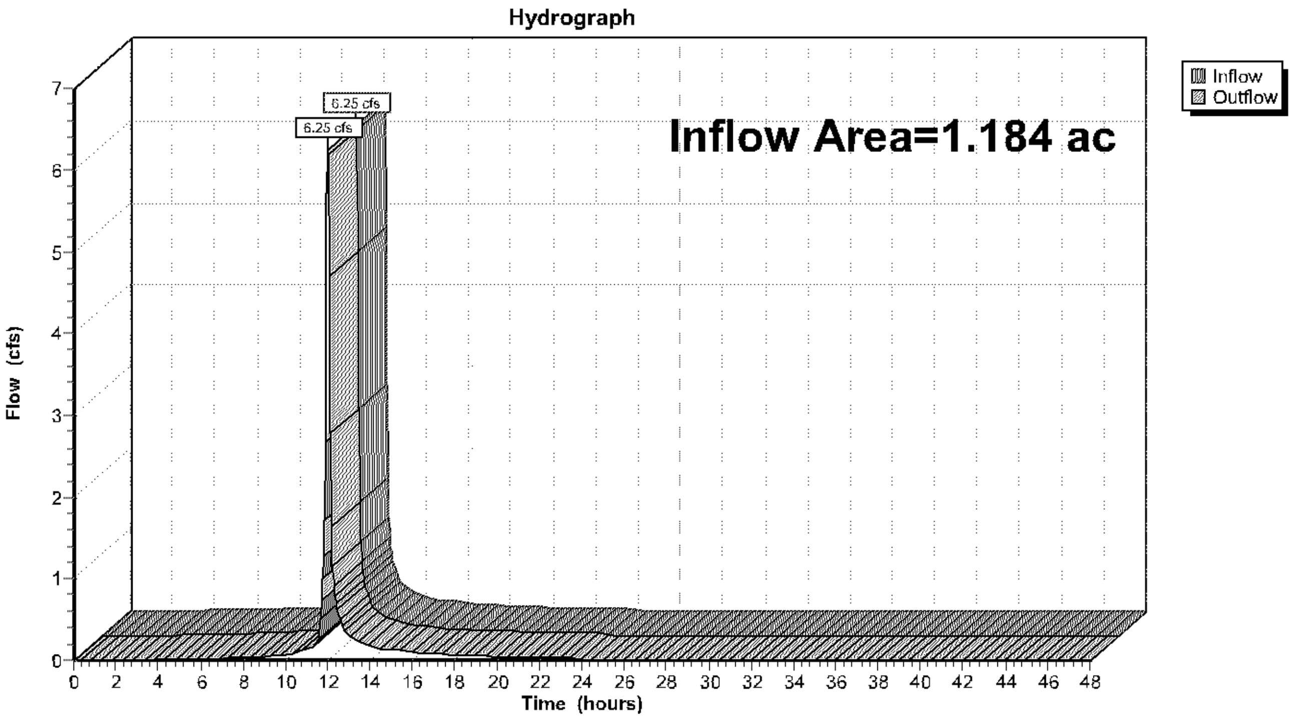


Summary for Reach 4R: 98th St

Inflow Area =	1.184 ac,	87.95% Impervious,	Inflow Depth = 2.77"	for 10-yr event	
Inflow =	6.25 cfs @	11.99 hrs,	Volume=	0.273 af	
Outflow =	6.25 cfs @	11.99 hrs,	Volume=	0.273 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 4R: 98th St



Summary for Pond 2P: Underground Infiltration

Inflow Area =	0.602 ac,	87.19% Impervious,	Inflow Depth = 3.49"	for 10-yr event
Inflow =	3.23 cfs @	11.98 hrs, Volume=	0.175 af	
Outflow =	3.18 cfs @	12.00 hrs, Volume=	0.166 af,	Atten= 2%, Lag= 1.1 min
Discarded =	0.02 cfs @	6.45 hrs, Volume=	0.068 af	
Primary =	3.16 cfs @	12.00 hrs, Volume=	0.098 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 828.57' @ 12.00 hrs Surf.Area= 1,026 sf Storage= 2,317 cf

Plug-Flow detention time= 374.8 min calculated for 0.166 af (95% of inflow)
Center-of-Mass det. time= 345.7 min (1,123.1 - 777.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	825.50'	1,034 cf	**9.50'W x 108.00'L x 4.00'H Field A** 4,104 cf Overall - 1,520 cf Embedded = 2,584 cf x 40.0% Voids
#2A	826.00'	1,520 cf	**CMP Round 36** x 10 Inside #1 Effective Size= 36.0"W x 36.0"H => 7.07 sf x 20.00'L = 141.4 cf Overall Size= 36.0"W x 36.0"H x 20.00'L 2 Rows of 5 Chambers 7.50' Header x 7.07 sf x 2 = 106.0 cf Inside
#3	826.00'	163 cf	**24.0" Round Pipe Storage** -Impervious L= 52.0'
#4	826.00'	101 cf	**4.00'D x 4.00'H MH** x 2 -Impervious
		2,817 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	827.22'	**12.0" Round Culvert** L= 97.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 827.22' / 824.40' S= 0.0291 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	828.15'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Discarded	825.50'	**0.800 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 6.45 hrs HW=825.55' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=3.12 cfs @ 12.00 hrs HW=828.56' (Free Discharge)
↑—**1=Culvert** (Passes 3.12 cfs of 3.47 cfs potential flow)
  ↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 3.12 cfs @ 1.88 fps)

Pond 2P: Underground Infiltration - Chamber Wizard Field A

Chamber Model = CMP Round 36 (Round Corrugated Metal Pipe)
Effective Size= 36.0"W x 36.0"H => 7.07 sf x 20.00'L = 141.4 cf
Overall Size= 36.0"W x 36.0"H x 20.00'L

36.0" Wide + 18.0" Spacing = 54.0" C-C Row Spacing

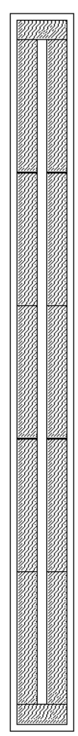
5 Chambers/Row x 20.00' Long +3.00' Header x 2 = 106.00' Row Length +12.0" End Stone x 2 = 108.00' Base Length
2 Rows x 36.0" Wide + 18.0" Spacing x 1 + 12.0" Side Stone x 2 = 9.50' Base Width
6.0" Base + 36.0" Chamber Height + 6.0" Cover = 4.00' Field Height

10 Chambers x 141.4 cf + 7.50' Header x 7.07 sf x 2 = 1,519.7 cf Chamber Storage

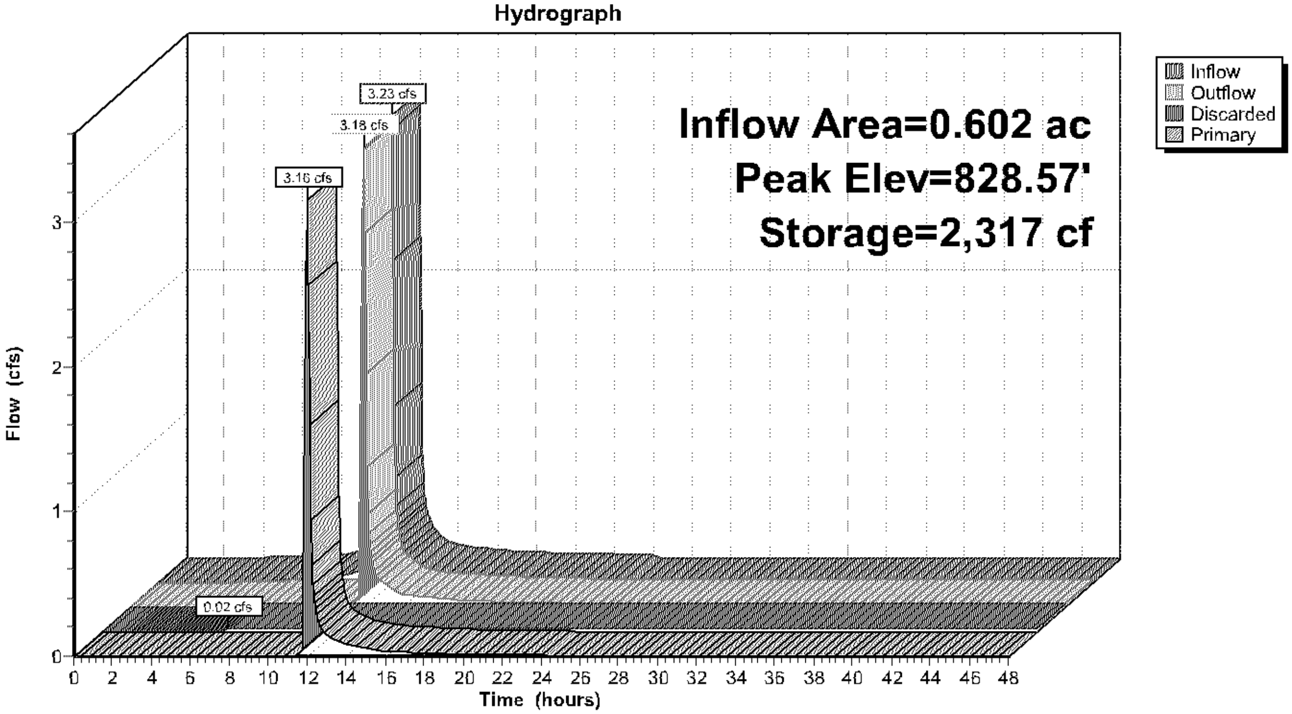
4,104.0 cf Field - 1,519.7 cf Chambers = 2,584.3 cf Stone x 40.0% Voids = 1,033.7 cf Stone Storage

Chamber Storage + Stone Storage = 2,553.4 cf = 0.059 af
Overall Storage Efficiency = 62.2%
Overall System Size = 108.00' x 9.50' x 4.00'

10 Chambers
152.0 cy Field
95.7 cy Stone



Pond 2P: Underground Infiltration



Stage-Area-Storage for Pond 2P: Underground Infiltration

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
825.50	**1,026**	0	828.10	1,026	1,965
825.55	1,026	21	828.15	1,026	2,004
825.60	1,026	41	828.20	1,026	2,043
825.65	1,026	62	828.25	1,026	2,082
825.70	1,026	82	828.30	1,026	2,120
825.75	1,026	103	828.35	1,026	2,158
825.80	1,026	123	828.40	1,026	2,196
825.85	1,026	144	828.45	1,026	2,233
825.90	1,026	164	828.50	1,026	2,269
825.95	1,026	185	828.55	1,026	2,305
826.00	1,026	205	828.60	1,026	2,341
826.05	1,026	231	828.65	1,026	2,375
826.10	1,026	261	828.70	1,026	2,409
826.15	1,026	293	828.75	1,026	2,442
826.20	1,026	327	828.80	1,026	2,474
826.25	1,026	362	828.85	1,026	2,505
826.30	1,026	399	828.90	1,026	2,534
826.35	1,026	436	828.95	1,026	2,562
826.40	1,026	475	829.00	1,026	2,587
826.45	1,026	514	829.05	1,026	2,609
826.50	1,026	555	829.10	1,026	2,631
826.55	1,026	596	829.15	1,026	2,652
826.60	1,026	638	829.20	1,026	2,674
826.65	1,026	680	829.25	1,026	2,696
826.70	1,026	723	829.30	1,026	2,718
826.75	1,026	766	829.35	1,026	2,739
826.80	1,026	810	829.40	1,026	2,761
826.85	1,026	854	829.45	1,026	2,783
826.90	1,026	899	829.50	1,026	2,805
826.95	1,026	943	829.55	1,026	2,806
827.00	1,026	988	829.60	1,026	2,807
827.05	1,026	1,034	829.65	1,026	2,809
827.10	1,026	1,079	829.70	1,026	2,810
827.15	1,026	1,125	829.75	1,026	2,811
827.20	1,026	1,171	829.80	1,026	2,812
827.25	1,026	1,217	829.85	1,026	2,814
827.30	1,026	1,263	829.90	1,026	2,815
827.35	1,026	1,308	829.95	1,026	2,816
827.40	1,026	1,354	830.00	1,026	**2,817**
827.45	1,026	1,400			
827.50	1,026	1,446			
827.55	1,026	1,491			
827.60	1,026	1,537			
827.65	1,026	1,582			
827.70	1,026	1,627			
827.75	1,026	1,671			
827.80	1,026	1,715			
827.85	1,026	1,759			
827.90	1,026	1,802			
827.95	1,026	1,844			
828.00	1,026	1,885			
828.05	1,026	1,925			

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: 1 Runoff Area=9,139 sf 86.19% Impervious Runoff Depth=6.67"
Tc=7.0 min CN=93 Runoff=2.08 cfs 0.117 af

Subcatchment 2: 2 Runoff Area=4,020 sf 100.00% Impervious Runoff Depth=7.26"
Tc=7.0 min CN=98 Runoff=0.94 cfs 0.056 af

Subcatchment 3: 3 Runoff Area=13,059 sf 83.94% Impervious Runoff Depth=6.55"
Tc=7.0 min CN=92 Runoff=2.95 cfs 0.164 af

Subcatchment 4: 4 Runoff Area=6,755 sf 92.72% Impervious Runoff Depth=6.90"
Tc=7.0 min CN=95 Runoff=1.56 cfs 0.089 af

Subcatchment 5: 5 Runoff Area=3,156 sf 44.87% Impervious Runoff Depth=4.93"
Tc=7.0 min CN=78 Runoff=0.59 cfs 0.030 af

Subcatchment 6: 6 Runoff Area=15,435 sf 95.98% Impervious Runoff Depth=7.14"
Tc=7.0 min CN=97 Runoff=3.60 cfs 0.211 af

Reach 1R: N CB Inflow=5.07 cfs 0.256 af
Outflow=5.07 cfs 0.256 af

Reach 2R: S Offsite Inflow=3.60 cfs 0.211 af
Outflow=3.60 cfs 0.211 af

Reach 3R: SE Site CB Inflow=5.16 cfs 0.300 af
Outflow=5.16 cfs 0.300 af

Reach 4R: 98th St Inflow=10.60 cfs 0.586 af
Outflow=10.60 cfs 0.586 af

Pond 2P: Underground Infiltration Peak Elev=829.51' Storage=2,805 cf Inflow=5.97 cfs 0.336 af
Discarded=0.02 cfs 0.071 af Primary=5.07 cfs 0.256 af Outflow=5.08 cfs 0.327 af

Summary for Subcatchment 1: 1

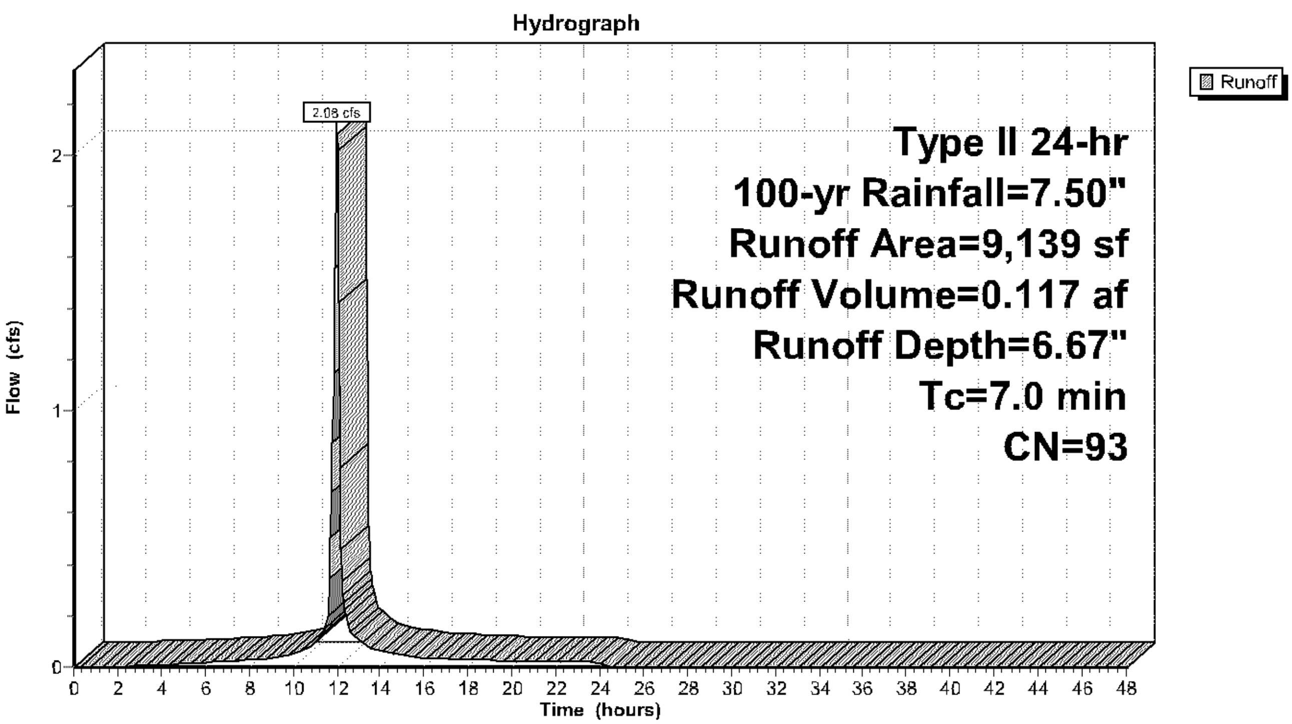
Runoff = 2.08 cfs @ 11.98 hrs, Volume= 0.117 af, Depth= 6.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
1,262	61	>75% Grass cover, Good, HSG B
7,877	98	Paved parking, HSG B
9,139	93	Weighted Average
1,262		13.81% Pervious Area
7,877		86.19% Impervious Area

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

Subcatchment 1: 1



Summary for Subcatchment 2: 2

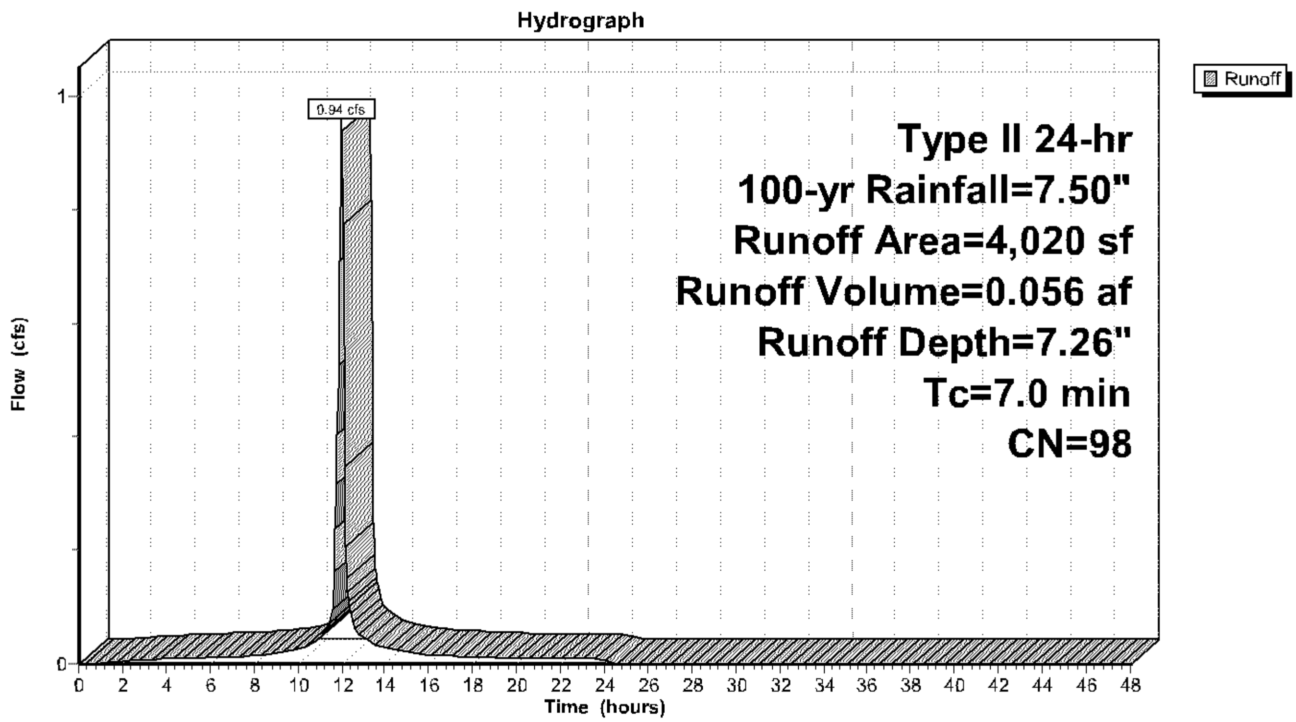
Runoff = 0.94 cfs @ 11.98 hrs, Volume= 0.056 af, Depth= 7.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
0	61	>75% Grass cover, Good, HSG B
4,020	98	Paved parking, HSG B
4,020	98	Weighted Average
4,020		100.00% Impervious Area

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

Subcatchment 2: 2



Summary for Subcatchment 3: 3

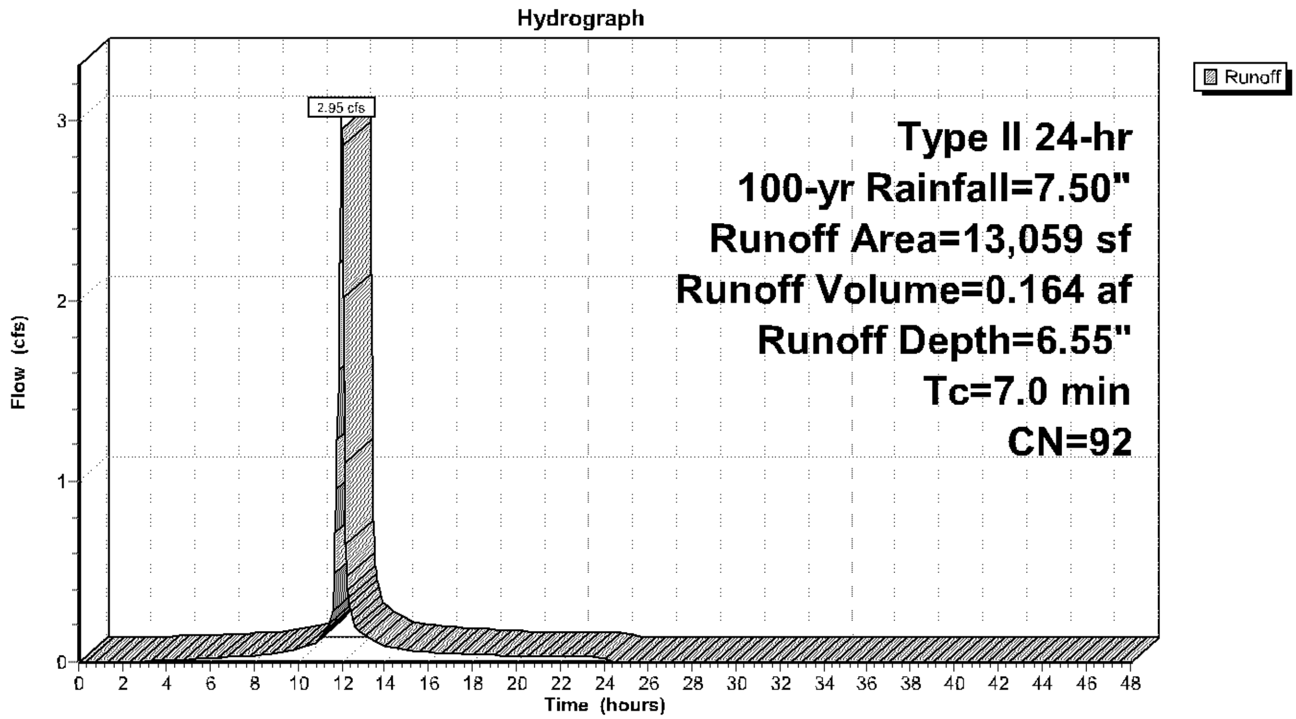
Runoff = 2.95 cfs @ 11.98 hrs, Volume= 0.164 af, Depth= 6.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
2,097	61	>75% Grass cover, Good, HSG B
10,962	98	Paved parking, HSG B
13,059	92	Weighted Average
2,097		16.06% Pervious Area
10,962		83.94% Impervious Area

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

Subcatchment 3: 3



Summary for Subcatchment 4: 4

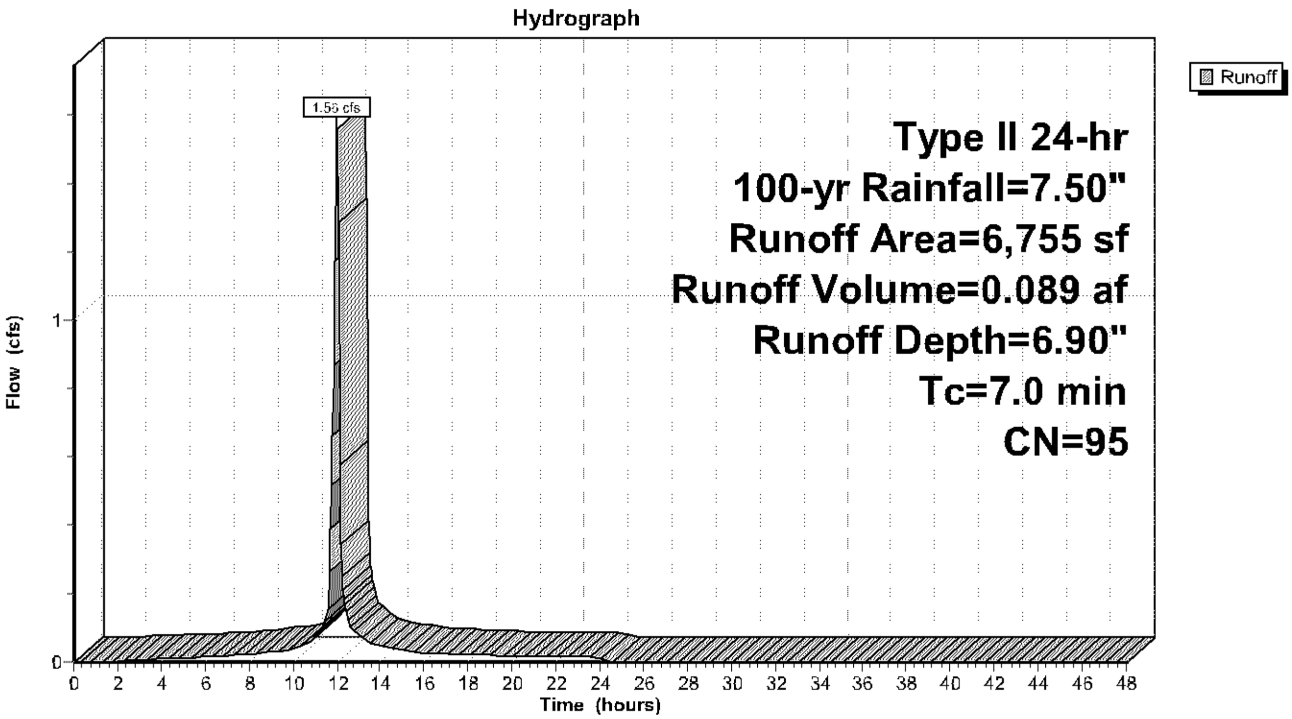
Runoff = 1.56 cfs @ 11.98 hrs, Volume= 0.089 af, Depth= 6.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
492	61	>75% Grass cover, Good, HSG B
6,263	98	Paved parking, HSG B
6,755	95	Weighted Average
492		7.28% Pervious Area
6,263		92.72% Impervious Area

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

Subcatchment 4: 4



Summary for Subcatchment 5: 5

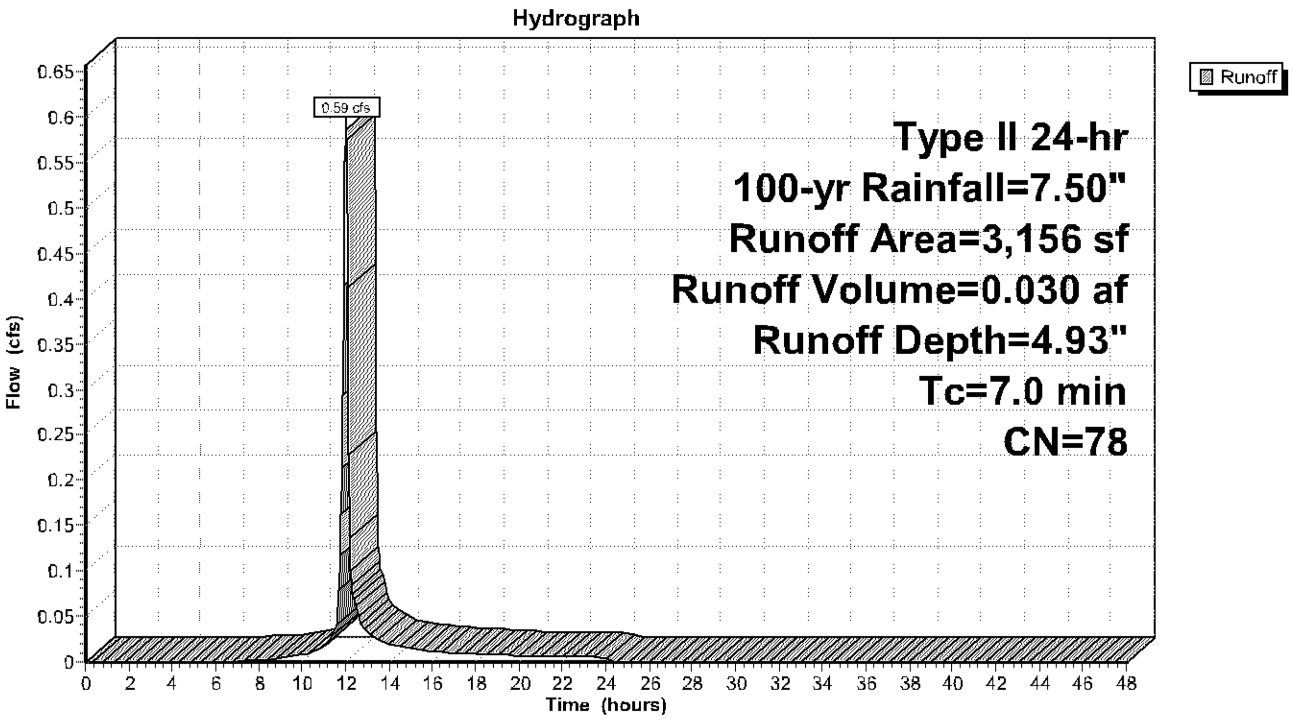
Runoff = 0.59 cfs @ 11.98 hrs, Volume= 0.030 af, Depth= 4.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
1,740	61	>75% Grass cover, Good, HSG B
1,416	98	Paved parking, HSG B
3,156	78	Weighted Average
1,740		55.13% Pervious Area
1,416		44.87% Impervious Area

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

Subcatchment 5: 5



Summary for Subcatchment 6: 6

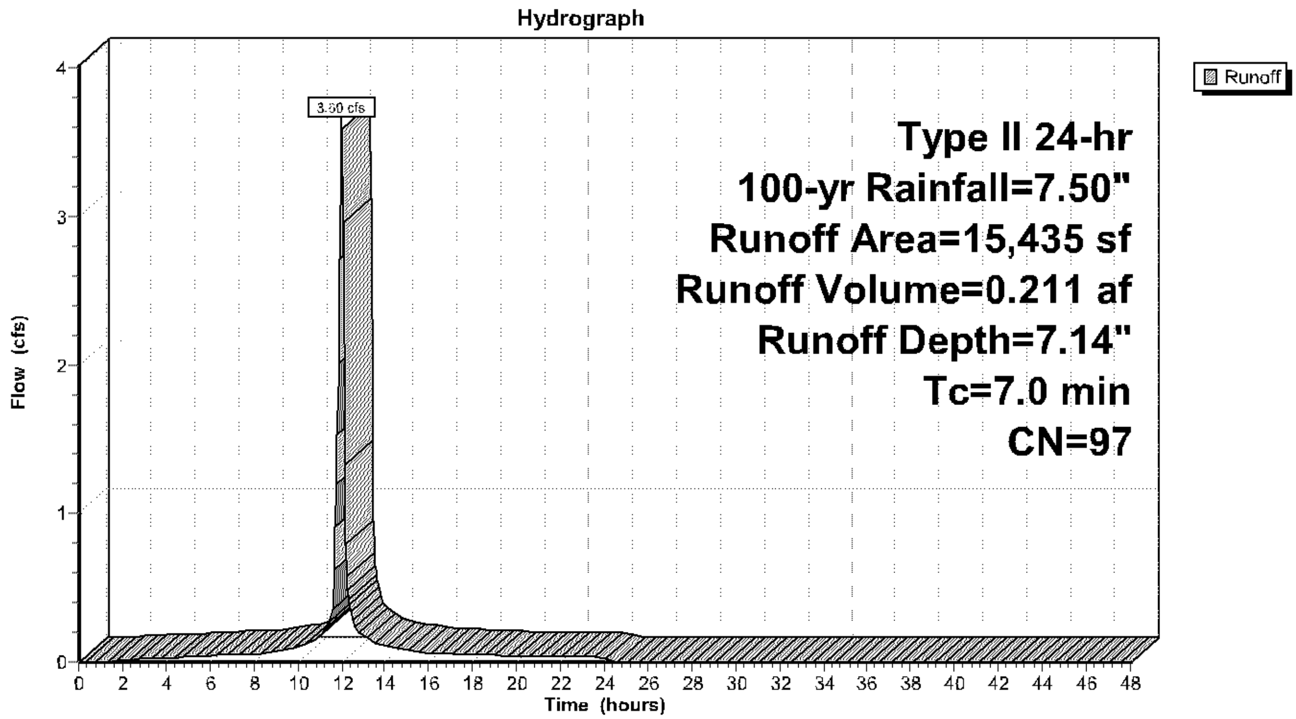
Runoff = 3.60 cfs @ 11.98 hrs, Volume= 0.211 af, Depth= 7.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=7.50"

Area (sf)	CN	Description
621	61	>75% Grass cover, Good, HSG B
14,814	98	Paved parking, HSG B
15,435	97	Weighted Average
621		4.02% Pervious Area
14,814		95.98% Impervious Area

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

Subcatchment 6: 6

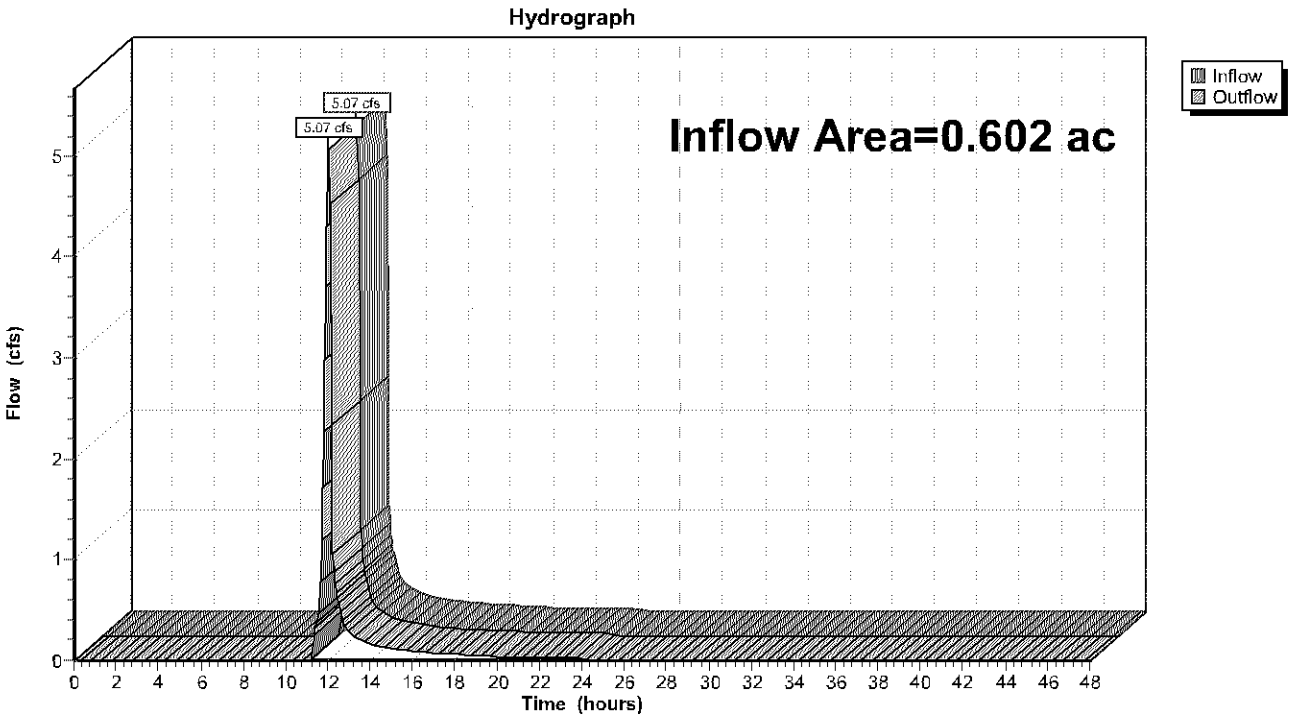


Summary for Reach 1R: N CB

Inflow Area =	0.602 ac,	87.19% Impervious,	Inflow Depth = 5.10"	for 100-yr event
Inflow =	5.07 cfs @	12.02 hrs, Volume=	0.256 af	
Outflow =	5.07 cfs @	12.02 hrs, Volume=	0.256 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 1R: N CB

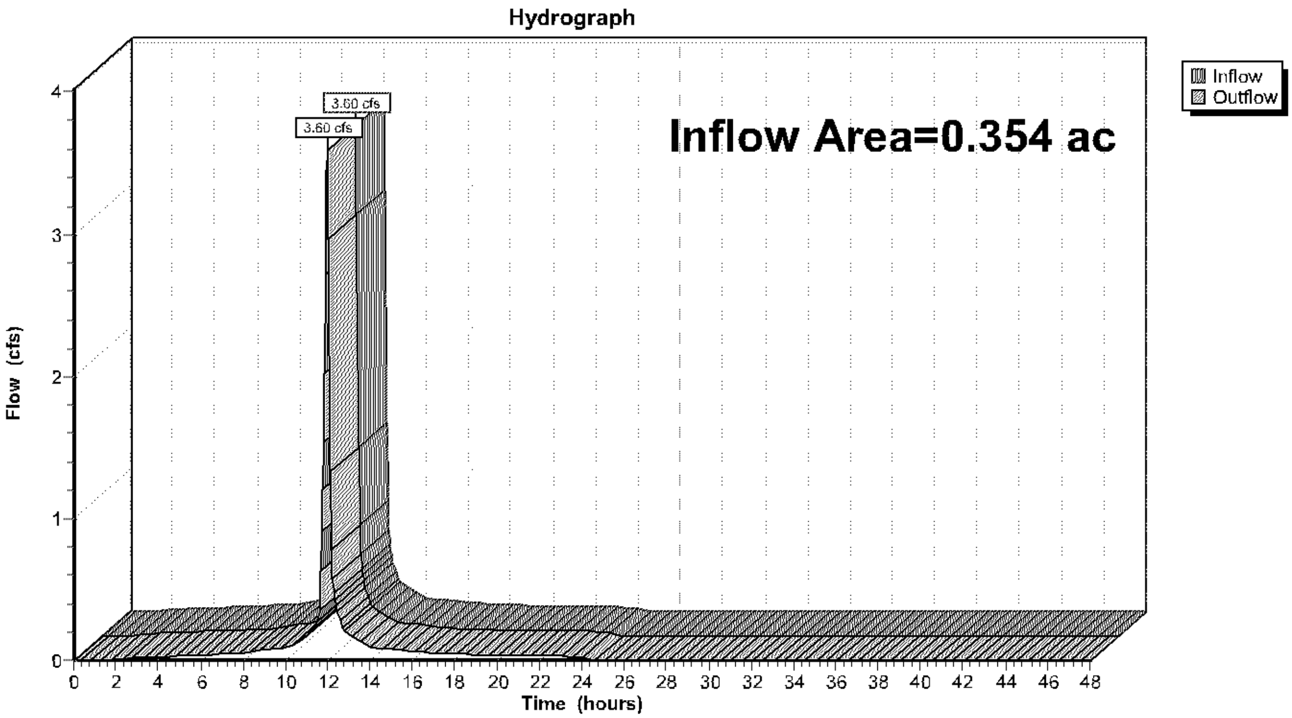


Summary for Reach 2R: S Offsite

Inflow Area =	0.354 ac, 95.98% Impervious,	Inflow Depth = 7.14"	for 100-yr event	
Inflow =	3.60 cfs @ 11.98 hrs,	Volume=	0.211 af	
Outflow =	3.60 cfs @ 11.98 hrs,	Volume=	0.211 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 2R: S Offsite

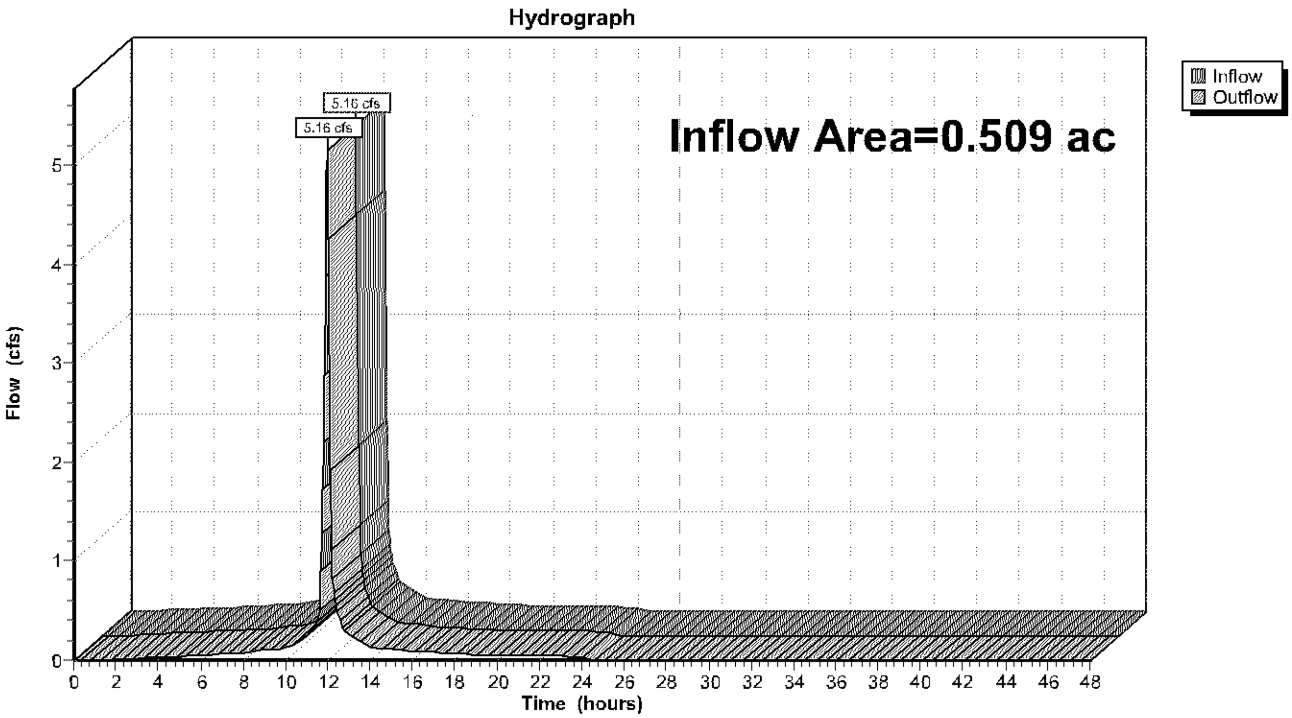


Summary for Reach 3R: SE Site CB

Inflow Area =	0.509 ac,	94.98% Impervious,	Inflow Depth = 7.07"	for 100-yr event	
Inflow =	5.16 cfs @	11.98 hrs,	Volume=	0.300 af	
Outflow =	5.16 cfs @	11.98 hrs,	Volume=	0.300 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 3R: SE Site CB

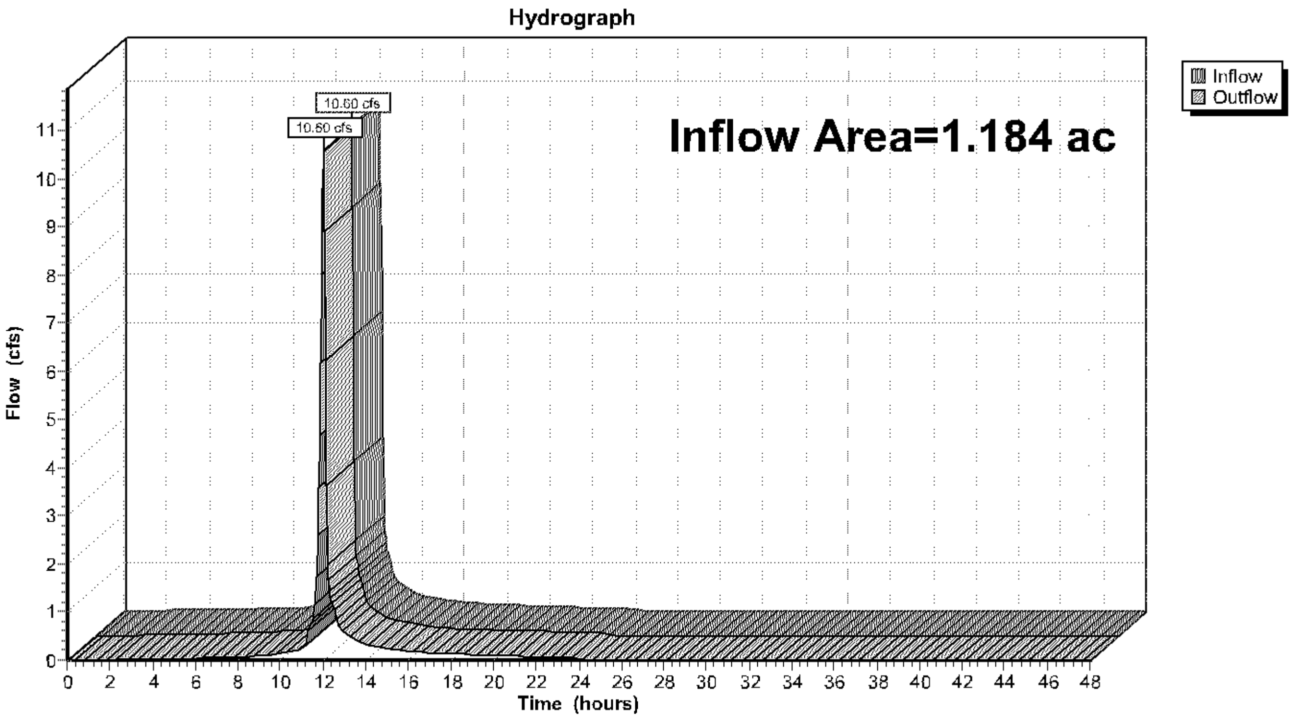


Summary for Reach 4R: 98th St

Inflow Area =	1.184 ac,	87.95% Impervious,	Inflow Depth = 5.94"	for 100-yr event
Inflow =	10.60 cfs @	11.99 hrs, Volume=	0.586 af	
Outflow =	10.60 cfs @	11.99 hrs, Volume=	0.586 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach 4R: 98th St



Summary for Pond 2P: Underground Infiltration

Inflow Area =	0.602 ac, 87.19% Impervious,	Inflow Depth = 6.70"	for 100-yr event	
Inflow =	5.97 cfs @ 11.98 hrs,	Volume=	0.336 af	
Outflow =	5.08 cfs @ 12.02 hrs,	Volume=	0.327 af,	Atten= 15%, Lag= 2.7 min
Discarded =	0.02 cfs @ 3.60 hrs,	Volume=	0.071 af	
Primary =	5.07 cfs @ 12.02 hrs,	Volume=	0.256 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 829.51' @ 12.02 hrs Surf.Area= 1,026 sf Storage= 2,805 cf

Plug-Flow detention time= 209.4 min calculated for 0.327 af (97% of inflow)
Center-of-Mass det. time= 192.9 min (954.8 - 761.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	825.50'	1,034 cf	**9.50'W x 108.00'L x 4.00'H Field A**
			4,104 cf Overall - 1,520 cf Embedded = 2,584 cf x 40.0% Voids
#2A	826.00'	1,520 cf	**CMP Round 36** x 10 Inside #1
			Effective Size= 36.0"W x 36.0"H => 7.07 sf x 20.00'L = 141.4 cf
			Overall Size= 36.0"W x 36.0"H x 20.00'L
			2 Rows of 5 Chambers
			7.50' Header x 7.07 sf x 2 = 106.0 cf Inside
#3	826.00'	163 cf	**24.0" Round Pipe Storage** -Impervious
			L= 52.0'
#4	826.00'	101 cf	**4.00'D x 4.00'H MH** x 2 -Impervious
		2,817 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	827.22'	**12.0" Round Culvert**
			L= 97.0' RCP, sq.cut end projecting, Ke= 0.500
			Inlet / Outlet Invert= 827.22' / 824.40' S= 0.0291 '/' Cc= 0.900
			n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Device 1	828.15'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Discarded	825.50'	**0.800 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 3.60 hrs HW=825.55' (Free Discharge)
↑—**3=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=4.98 cfs @ 12.02 hrs HW=829.45' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 4.98 cfs @ 6.34 fps)
  ↑—**2=Broad-Crested Rectangular Weir** (Passes 4.98 cfs of 19.71 cfs potential flow)

Pond 2P: Underground Infiltration - Chamber Wizard Field A

Chamber Model = CMP Round 36 (Round Corrugated Metal Pipe)
Effective Size= 36.0"W x 36.0"H => 7.07 sf x 20.00'L = 141.4 cf
Overall Size= 36.0"W x 36.0"H x 20.00'L

36.0" Wide + 18.0" Spacing = 54.0" C-C Row Spacing

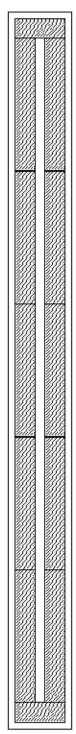
5 Chambers/Row x 20.00' Long +3.00' Header x 2 = 106.00' Row Length +12.0" End Stone x 2 = 108.00' Base Length
2 Rows x 36.0" Wide + 18.0" Spacing x 1 + 12.0" Side Stone x 2 = 9.50' Base Width
6.0" Base + 36.0" Chamber Height + 6.0" Cover = 4.00' Field Height

10 Chambers x 141.4 cf + 7.50' Header x 7.07 sf x 2 = 1,519.7 cf Chamber Storage

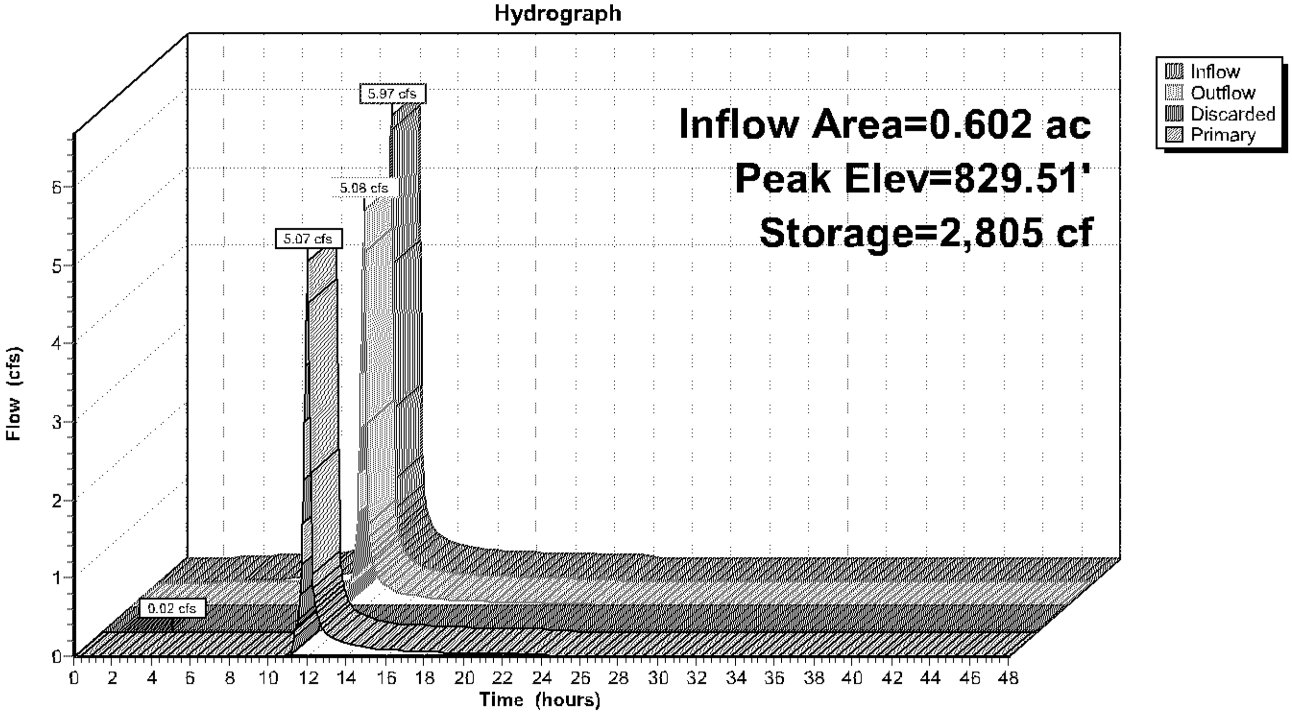
4,104.0 cf Field - 1,519.7 cf Chambers = 2,584.3 cf Stone x 40.0% Voids = 1,033.7 cf Stone Storage

Chamber Storage + Stone Storage = 2,553.4 cf = 0.059 af
Overall Storage Efficiency = 62.2%
Overall System Size = 108.00' x 9.50' x 4.00'

10 Chambers
152.0 cy Field
95.7 cy Stone



Pond 2P: Underground Infiltration



Stage-Area-Storage for Pond 2P: Underground Infiltration

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
825.50	**1,026**	0	828.10	1,026	1,965
825.55	1,026	21	828.15	1,026	2,004
825.60	1,026	41	828.20	1,026	2,043
825.65	1,026	62	828.25	1,026	2,082
825.70	1,026	82	828.30	1,026	2,120
825.75	1,026	103	828.35	1,026	2,158
825.80	1,026	123	828.40	1,026	2,196
825.85	1,026	144	828.45	1,026	2,233
825.90	1,026	164	828.50	1,026	2,269
825.95	1,026	185	828.55	1,026	2,305
826.00	1,026	205	828.60	1,026	2,341
826.05	1,026	231	828.65	1,026	2,375
826.10	1,026	261	828.70	1,026	2,409
826.15	1,026	293	828.75	1,026	2,442
826.20	1,026	327	828.80	1,026	2,474
826.25	1,026	362	828.85	1,026	2,505
826.30	1,026	399	828.90	1,026	2,534
826.35	1,026	436	828.95	1,026	2,562
826.40	1,026	475	829.00	1,026	2,587
826.45	1,026	514	829.05	1,026	2,609
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826.55	1,026	596	829.15	1,026	2,652
826.60	1,026	638	829.20	1,026	2,674
826.65	1,026	680	829.25	1,026	2,696
826.70	1,026	723	829.30	1,026	2,718
826.75	1,026	766	829.35	1,026	2,739
826.80	1,026	810	829.40	1,026	2,761
826.85	1,026	854	829.45	1,026	2,783
826.90	1,026	899	829.50	1,026	2,805
826.95	1,026	943	829.55	1,026	2,806
827.00	1,026	988	829.60	1,026	2,807
827.05	1,026	1,034	829.65	1,026	2,809
827.10	1,026	1,079	829.70	1,026	2,810
827.15	1,026	1,125	829.75	1,026	2,811
827.20	1,026	1,171	829.80	1,026	2,812
827.25	1,026	1,217	829.85	1,026	2,814
827.30	1,026	1,263	829.90	1,026	2,815
827.35	1,026	1,308	829.95	1,026	2,816
827.40	1,026	1,354	830.00	1,026	**2,817**
827.45	1,026	1,400			
827.50	1,026	1,446			
827.55	1,026	1,491			
827.60	1,026	1,537			
827.65	1,026	1,582			
827.70	1,026	1,627			
827.75	1,026	1,671			
827.80	1,026	1,715			
827.85	1,026	1,759			
827.90	1,026	1,802			
827.95	1,026	1,844			
828.00	1,026	1,885			
828.05	1,026	1,925			

Appendix 3. Geotechnical Report

CASE #PL2020-14

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
- ENVIRONMENTAL
- GEOTECHNICAL
- MATERIALS
- FORENSICS

REPORT OF GEOTECHNICAL EXPLORATION

Oppidan Baker's Square Site

Lyndale Avenue & West 98th Street
Bloomington, Minnesota

AET No. 01-20541

Date:

October 16, 2019

Prepared for:

Oppidan Investment Company
400 Water Street; Suite 200
Excelsior, Minnesota 55331

www.amengtest.com

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
• ENVIRONMENTAL
• GEOTECHNICAL
• MATERIALS
• FORENSICS

October 16, 2019

Oppidan Investment Company
400 Water Street; Suite 200
Excelsior, Minnesota 55331

Attn: Greg LaVere (Greg@oppidan.com)

RE: Report of Geotechnical Exploration
Oppidan Baker's Square Site
Lyndale Avenue & West 98th Street
Bloomington, Minnesota
AET No. 01-20541

Dear Mr. LaVere;

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the proposed building at the Oppidan Baker's Square site in Bloomington, Minnesota. These services were performed according to our proposal to you, dated June 27, 2019, which was authorized on July 1, 2019.

We are submitting one electronic (.pdf) copy of this report to you. Additional electronic copies are being issued as noted below.

Please contact me if you have any questions about the report or if I can be of further assistance. Please contact Rob Flickinger (651-659-1301 or rflickinger@amengtest.com) to arrange construction testing and special inspection services.

American Engineering Testing, Inc.

Michael P. McCarthy

Michael P. McCarthy, PE
Principal Geotechnical Engineer
Phone: (651) 659-1364
mmccarthy@amengtest.com

pc: Oppidan Investment Co. – Attn: Ian Halker (IanH@oppidan.com)
Oppidan Investment Co. – Attn: Pat Barrett (PatB@oppidan.com)

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SIGNATURE PAGE

Prepared for:

Oppidan Investment Company
400 Water Street; Suite 200
Bloomington, Minnesota 55331

Attn: Greg LaVere

Prepared by:

American Engineering Testing, Inc.
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Authored by:

Michael P. McCarthy, PE
Principal Engineer

Reviewed by:

Robin L. Flickinger
Senior Engineer/Manager

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under Minnesota Statute Section 326.02 to 326.15

Michael P. McCarthy

Date: 10/16/2019 License #16688

TABLE OF CONTENTS

1.0 INTRODUCTION

Oppidan Investment Company (Oppidan) is considering construction of a new building at the existing Baker's Square site in Bloomington, Minnesota. To assist with planning and design, Oppidan authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration program at the site, perform soil laboratory testing, and prepare a geotechnical engineering report for the project. This report presents the results of the above services and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET's services were performed according to our proposal to Oppidan, dated June 27, 2019. That proposal was authorized on July 1, 2019. The authorized scope consisted of the following:

- Drilling six standard penetration test (SPT) borings, each to a depths of 14 to 14½ feet.
- Performing soil laboratory testing.
- Performing a geotechnical engineering review based on the obtained data and preparing this report.

3.0 PROJECT INFORMATION

No definitive plans are available regarding the proposed construction. As we know it now, the new building will consist of a 4,000 square foot, single-story, slab-on-grade building. The building will have concrete foundations and either structural steel framing with steel studs or wood framing with a wood truss roof. If structural steel framing will be used, the roof will consist of steel joists and metal deck roofing. Based on this information, we estimate the column loads will be 100 kips or less, and bearing wall loads will be about 2 to 4 kips per linear foot of wall. Floor slab live loads are expected to be less than 250 pounds per square foot (psf).

The approximate new building location will be situated over the footprint of the existing Baker's Square building. Finished floor elevation for the building has not been established at the time of this report, but is expected to be very close to existing site elevations. We assume the finished floor elevation will be about 832.0, based on the existing site grades.

Our foundation design assumptions include a minimum factor of safety of three with respect to the ultimate bearing capacity. We assume the building will be able to tolerate total settlements of up to 1-inch and differential settlements over a 30-foot distance of up to ½-inch.

Pavements will be reconstructed around the building. Most of these pavements will be used by automobiles and light trucks having axle loads less than 3 tons. Heavier truck traffic will use designated pavements, possibly including a loading dock on the south side of the building. We anticipate the heavier truck traffic will have axle loads up to 9 tons.

We understand that an underground infiltration basin will be provided, most likely on the south side of the new structure. Other locations are also being considered on the west and north sides of the new building. It is unknown at what depth the infiltration basin will be installed; however, we estimate it will be approximately 6 to 8 feet deep.

The above stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration Program

The subsurface exploration program performed for the project consisted of six standard penetration test (SPT) borings. The number of borings and their locations were selected by Oppidan. The logs of the borings, and standard sheets outlining the details concerning the drilling and soil classification methods used, are included in Appendix A. The logs contain information concerning soil layering, soil classification, geologic origin, and moisture condition. Relative density or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value).

The boring locations are shown on Figure 1 in Appendix A. The borings were spotted in the field by AET personnel using existing site features as well as to avoid known/marked underground utilities. After drilling, the boring locations were determined by AET using our GPS equipment. The latitudes and longitudes of the boring locations are shown on the respective boring logs. These coordinates were used to prepare Figure 1. The ground surface elevations at the boring locations were also determined using our GPS equipment.

4.2 Laboratory Testing

The laboratory testing program included several water content tests and two sieve analysis tests. The test results appear on the individual boring logs in Appendix A, adjacent to the samples upon which the tests were performed. The sieve test results are also shown graphically on the Gradation Curves report in Appendix A.

5.0 SITE CONDITIONS.

5.1 Surface Observations

The site is located east of Lyndale Avenue and south of West 98th Street in Bloomington, Minnesota. A one-story, slab-on-grade Baker's Square building currently occupies the site. The remainder of the property is covered by bituminous pavements. The site is relatively flat to gradually sloping. The ground surface elevations measured at the boring locations range from 831.5 at Boring B-5 up to 833.4 at Boring B-2. An existing strip mall is located to the south of the Baker's Square building and a Duluth Trading Company building is located to the west of the existing building.

5.2 Subsurface Soils/Geology

5.2.1 General Profile

The generalized soil profile shown by the logs of the borings consists of bituminous or concrete pavements overlying fill soils and then naturally deposited coarse alluvial silty sands and sands to the termination depths of the borings.

5.2.2 Fill

Bituminous pavements were present at the surface of Borings B-1, B-3, B-4, B-5, and B-6 and concrete pavement was present at the surface of Boring B-2. The bituminous ranged in thickness from 4 to 4½ inches. The concrete was 6 inches thick. Fill is present below the pavements, extending to depths of 4 to 4½ feet at the boring locations. The depths of fill can be expected to vary away from the boring locations.

The fill soils consist of silty sands and clayey sands below the aggregate base layer. Some of the silty sands and clayey sands are slightly organic, and contain organic fines. The N-values recorded in the fill and possible natural soils ranged from 7 blows per foot (bpf) to 22 bpf. Generally, the higher N-values were recorded near the surface and the lower N-values were recorded in the lower fill zones. Based on the N-values, we judge the fill to have moderately low to moderately high strength and compressibility. The clayey sand fill soils are slower draining soils and the silty sands are moderately slow draining soils. The clayey sands and silty sands are judged to have moderate to moderately high susceptible to freeze-thaw movements.

At some borings, we may have encountered naturally deposited alluvial soils at depths of about 1½ to 2 feet. These soils are classified as "Fill or Alluvium" because we could not definitively identify them as natural soils from the limited amount of sample obtained.

5.2.3 Alluvium

Some of the clayey sands identified as "Fill or Mixed Alluvium" could actually be naturally deposited soils. These soils are judged to have moderate to moderately high strength and moderate to moderately low compressibility. The clayey sands are slow draining and are judged to have moderately high susceptibility to freeze-thaw movements.

Coarse alluvial silty sands and sands exist below the fill and possible natural soils, to the depths of the borings. These soils consist of silty sands and sands. The coarse alluvium is judged to have moderate to moderately high strength and moderate to low compressibility. The silty sands are moderately slow draining and are judged to have moderate susceptibility to freeze-thaw movements. The sands are fast draining and are judged to have low susceptibility to freeze-thaw movements.

Fine alluvial sandy silts exist at Boring B-6, above the coarse alluvial silty sands. The silts are judged to have moderately low strength and moderate compressibility. The silts are slow draining and are highly susceptible to freeze-thaw movements.

5.3 Groundwater

Groundwater levels were not measured in any of the borings. Because the sands at the bottoms of the borings are judged to be fast draining and non-waterbearing, it is our judgment that the hydrostatic groundwater level is below the depths of our borings. Groundwater levels do not remain static and tend to fluctuate due to varying seasonal and annual rainfall and snow melt amounts, as well as other factors.

6.0 RECOMMENDATIONS

6.1 Building Grading

6.1.1 Excavation

To prepare for new building foundation and slab support, we recommend completely removing all bituminous and concrete pavements, all existing fill soils, and any softer underlying alluvial clayey soils from beneath the outline of the new building. Demolition of the existing Baker's Square building will occur; therefore, we recommend all building debris and rubble associated with the demolition be removed from below all future building areas. Any utilities that may exist within the outline of the future building should be removed and be rerouted around the new structure. Recommended excavation depths and estimated excavation bottom elevations at the boring locations are shown in Table 6.1.1 below.

Table 6.1.1 – Recommended Minimum Excavation Depths and Bottom Elevations

Boring Location	Surface Elevation (ft)	Recommended Excavation Depth (ft)	Estimated Excavation Elevation (ft)
B-1	832.0	4	828
B-2	833.4	4½	829
B-3	832.4	4½	828
B-4	832.0	4	828
B-5	831.5	4½*	827*
B-6	831.8	4*	827½*

**Shallower excavation can be performed if the "Fill or Coarse Alluvium" soils are observed and judged to be naturally deposited soils.*

The depths and elevations indicated in Table 6.1.1 are based on the soil conditions at each specific boring location. Since conditions will vary away from the boring locations, we recommend that AET geotechnical personnel observe and confirm the competency of the soils in the excavation bottoms prior to new fill or footing placement.

To improve soil density and bearing pressures, and to provide a more consistent excavation base, we recommend surface compacting the sands and silty sands in the excavation bottom. We recommend a self-propelled roller make 5 passes over the entire excavation bottom in a non-vibratory mode to avoid disturbing the silty sands and sandy silts. The vibratory roller should have a drum diameter of at least 3 feet.

Where the excavations extend below foundation grades, the excavation bottoms and resultant engineered fill systems must be oversized laterally beyond the planned outside edges of the foundations to properly support the loads exerted by the foundations. The excavation and engineered fill lateral extensions should be equal to the vertical depth of fill needed to attain foundation grade at the specific locations (i.e., 1:1 lateral oversize).

6.1.2 Fill Placement and Compaction

Fill placed to re-attain grades for foundation and floor slab support should consist of inorganic sands or silty sands that contain no more than 20% of the particles (by weight) finer than the #200 sieve. Fill soils should not contain particles larger than 2 inches. It appears that the silty sand fill present at the site should be suitable for reuse as structural fill. The silty sands should be placed and compacted at moisture contents within ±2% of their respective optimum water contents, as determined by their respective Standard Proctor tests (ASTM: D698). Sands can be placed at a wider range of moisture contents. Fill should not be placed over frozen soils and frozen soils should not be used as fill.

The fill placed below building footings should be compacted in thin lifts such that every lift achieves a minimum compaction level of 98% of their respective Standard Proctor maximum dry densities. Fill placed above footings, which will support floor slab loads, should be compacted to a minimum of 95%. This includes wall backfill and utility trench backfill.

Where fill is placed on a sloping excavation, we recommend benching or terracing the sloped surface (benches cut parallel to the slope contour) prior to placing the fill. Benching is recommended where slopes are steeper than 4:1 (H:V) to reduce the potential for a slope failure.

6.2 Foundation Design

After the site preparation has been performed as recommended in Section 6.1 above, it is our opinion that the new building can be supported on conventional spread footing foundations. We recommend that perimeter foundations bordering heated building spaces be placed at least 42 inches below exterior grade for frost protection. We recommend foundations for unheated building spaces, such as for canopy or loading dock foundations, bear a minimum of 60 inches below exterior grade.

We recommend the building footings be designed using a net maximum allowable soil bearing pressure of 3,000 pounds per square foot (psf) after the previously recommended corrective earthwork and compaction. This refers to the pressure that may be transmitted to the bearing stratum in excess of the pressure from the surrounding depth of overburden. It is our judgment that this design pressure will have a factor of safety of at least three with respect to the ultimate soil bearing capacity.

We estimate that total settlements under this loading should not exceed 1-inch, provided the base soils are not soft, wet, frozen, or disturbed at the time of footing construction. We estimate that differential settlements of conditions depicted by the borings should not exceed ½-inch.

The contractor must avoid disturbing the bearing soils or allowing the soils to freeze before and after construction of footings and slabs, and until the building is heated. The contractor should have appropriate frost protection equipment on the site, such as insulating blankets, to protect the foundation and slab bearing soils from freezing.

6.3 Floor Slab Subgrade

Backfill that is placed around new foundations, in utility trenches below the slabs, and as wall backfill, should consist of sands or silty sands having no more than 20% of the particles (by weight) finer than the #200 sieve. The sand and silty sand backfill should be placed in loose lifts of about 9 inches thick. Each lift should be compacted using manually-operated equipment that will adequately compact the entire lift. All backfill should be compacted to at least 95% of the maximum Standard Proctor dry density (ASTM: D698).

Assuming the majority of the fill below the building floor slabs will consist of silty sand, we recommend that the slabs be designed using a modulus of subgrade reaction (k-value) of 175 pounds per cubic inch (pci). If a 4-inch or thicker layer of base aggregate or sand and gravel is placed immediately below the slab, the k-value can be increased to 200 pci. Fill soils placed below floor slab areas should not contain particles larger than 2 inches in the largest dimension.

For recommendations pertaining to moisture and vapor protection of interior floor slabs, we refer you to the attached standard sheet entitled "Floor Slab Moisture/Vapor Protection."

6.4 Exterior Building Backfilling

Existing pavements, organic fill soils, surface vegetation, and soils containing rubble or debris, should be removed from below all exterior slabs, sidewalks, and stoops. Clayey soils should also be removed from within 2 feet of the bottoms of the slabs or stoops. Clayey sands and silty sands are moderately frost-susceptible and may cause some freeze-thaw movements of exterior slabs, sidewalks, and stoops above them. Refer to the standard sheet "Freezing Weather Effects on Building Construction" at the end of this report for more details.

All backfill placed around the new building which will support sidewalks, stoops or exterior slabs should be compacted to at least 95% of their respective Standard Proctor maximum dry densities. Fill placed in landscaped areas should be compacted to a minimum level of 90%. If the backfill will be below pavements, we recommend increasing the compaction level to 100% if the soils are in the top 3 feet of the subgrade. Care should be taken not to over-compact the backfill against the walls, or use large equipment which could damage the foundation walls or cause excessive lateral pressures.

6.5 Pavements

6.5.1 Subgrade Excavation

We recommend pavement grading include the removal of all existing pavements, surface vegetation, organic "topsoil type" fill, and any wet or unstable clayey or silty soils from within the upper 3 feet of the subgrade (referred to as the *critical subgrade zone*). All debris and rubble associated with the demolition of the existing building should be removed from within 4 feet of the new pavements. This excavation should also include ½:1 (H:V) lateral oversizing outside the curb lines or edges of the pavements. After this excavation, the exposed clayey sands and silty sands should be scarified to a depth of about 12 inches, moisture conditioned and blended, and then be recompacted to a minimum of 100% of the Standard Proctor maximum dry density. If the scarified soils are more than 3 feet below the pavement subgrade, the compaction can be reduced to 95%.

6.5.2 Subgrade Fill and Compaction

Fill that is needed to establish subgrade elevations should consist of sands and silty sands that contain no more than 15% of the particles (by weight) finer than the #200 sieve. The fill soils should be placed and compacted per the requirements of MnDOT Specification 2105.3F.1 (Specified Density Method). This specification requires that soils placed in the upper 3 feet of the subgrade be compacted to a minimum of 100% of the Standard Proctor maximum dry density

(ASTM: D698). Fill placed 3 feet or more below finished subgrade elevation should be compacted to a minimum of 95% of the Standard Proctor maximum dry density. MnDOT Specification 2105.3F.1 also requires soils to be compacted at water contents between 65% and 102% of their respective optimum water contents (based on the Standard Proctor optimum moisture contents). Refer to the sheet "Bituminous Pavement Subgrade Preparation and Design" at the end of this report for details.

We caution that the silty sands are moisture sensitive; therefore, they must be placed within the aforementioned moisture content ranges to be properly compacted, especially if used as fill in the *critical subgrade zone.* If slow draining clayey soils exist below the faster draining sands and silty sands, we recommend that drain tiles be installed to drain the faster draining soils. The slower draining soils should be graded and sloped in the directions of catch basins and manholes where "finger drains" can be tapped into these structures to collect and remove subsurface water.

6.5.3 Subgrade Stability and Test Roll

Subgrade stability within the *critical subgrade zone* is important for pavement support, construction, and performance. The stability of subgrade soils should be evaluated by test rolling the subgrade with a loaded tandem axle dump truck before placement of the aggregate base layer. The test roll will help to delineate any unstable soils that will not be acceptable as subgrade soils. These unstable soils should be removed and replaced; or be aerated, dried and recompacted back into place. After the subgrade soils pass a test roll procedure, the aggregate base can be placed and compacted.

6.5.4 Section Thicknesses

Table 6.5.4 below presents pavement designs based on two potential traffic situations (light- and heavy-duty), and assumes that the pavement subgrade will consist of stable and well compacted silty sands. The light-duty design refers to pavements which are intended only for automobiles and passenger trucks/vans. The heavy-duty design is for drive lanes and pavements which will experience the heavier truck traffic (up to 9-ton design load).

Table 6.5.4 – Pavement Thickness Designs (Silty Sand Subgrade)

Material	Section Thicknesses	
	Light Duty	**Heavy Duty**
Bituminous Wear Layer	1½ inches	2 inches
Bituminous Base Layer	2 inches	2½ inches
Class 5 or 6 Aggregate Base	8 inches	10 inches

6.5.5 Pavement Maintenance

Even if placed and compacted properly on stable subgrade conditions, bituminous pavements will still experience cracking in 1 to 3 years, primarily due to temperature-related expansion and shrinkage. We recommend that a regularly scheduled maintenance program consisting of patching of cracks and local distressed areas be implemented. Seal coating of the pavement surface after 3 to 5 years often helps prolong the pavement life.

6.6 Storm Water Treatment

Underground infiltration basins are planned below the pavements, most likely to the south of the new building, in the vicinity of Boring B-1. The soils from about 4 feet to 10 feet consist of slower draining silty sands (44% of material finer than the #200 sieve). Presuming that another infiltration basin will be installed to the north or west sides of the new building, we also performed a sieve test on material from Boring B-6, from about 6 to 8 feet. These soils consisted of slow draining sandy silts (55% of material finer than the #200 sieve).

According to the Minnesota Pollution Control Agency's Minnesota Stormwater Manual (MSM), revised August 2018, their recommended design infiltration rates for various soil types range from about 0.06 inches per hour (in/hr) for clays and clayey sands, to 0.2 inches per hour for silts and sandy silts, to 0.45 in/hr for silty sands, to 0.8 in/hr for sands (SP or SP-SM).

To determine actual infiltration rates, we recommend infiltration testing using the Double-Ring Infiltrometer (DRI). This testing should be conducted at or just below the bottom elevations of the proposed infiltration structures/devices. This testing can be of assistance to the engineer designing the infiltration basins.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Potential Difficulties

7.1.1 Runoff Water in Excavation

Water may collect in the excavations during times of inclement weather or snow melt. To reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavations as soon as possible during construction. Based on the soils encountered, we anticipate the runoff water can be handled with conventional sump pumping; however, the selection and installation of the dewatering system is solely the responsibility of the contractor.

7.1.2 Disturbance of Soils

The existing fill, silty sands, and clayey sands can become disturbed under construction traffic, especially if they are wet. If the soils become disturbed, they should be subcut to the underlying undisturbed soils. The subcut soils can then be dried and recompacted back into place, or they can be removed and replaced with drier imported fill.

7.1.3 Rubble, Debris, Cobbles and Boulders

Although not noted on the boring logs, some of the fill soils may contain miscellaneous rubble and debris (especially after demolition), and the alluvial sands may contain cobbles and possibly boulders. These oversized particles will make excavating procedures more difficult. The earthwork contractor should account for these difficulties.

7.2 Excavation Backsloping

If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on www.osha.gov). Even with the required OSHA sloping, water seepage or surface runoff can potentially induce sideslope erosion or running which could require slope maintenance.

7.3 Observations and Testing

The recommendations in this report are based on the subsurface conditions found at our boring locations. Due to the limited number of borings, and since the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observations be performed by AET geotechnical personnel during construction to evaluate these potential changes.

The soils in all excavations should be observed, tested, and evaluated for load bearing capabilities. Soil density testing should also be performed on new fill placed, to document that project specifications for compaction have been satisfied. Sieve tests should also be performed to verify that the recommended soil types are used as fill.

8.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, express or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix B entitled "Geotechnical Report Limitations and Guidelines for Use."

FLOOR SLAB MOISTURE/VAPOR PROTECTION

Floor slab design relative to moisture/vapor protection should consider the type and location of two elements, a granular layer and a vapor membrane (vapor retarder, water resistant barrier or vapor barrier). In the following sections, the pros and cons of the possible options regarding these elements will be presented, such that you and your specifier can make an engineering decision based on the benefits and costs of the choices.

GRANULAR LAYER

In American Concrete Institute (ACI) 302.1R-04, a "base material" is recommended over the vapor membrane, rather than the conventional clean "sand cushion" material. The base layer should be a minimum of 4 inches (100 mm) thick, trimmable, compactable, granular fill (not sand), a so-called crusher-run material. Usually graded from 1½ inches to 2 inches (38 to 50 mm) down to rock dust is suitable. Following compaction, the surface can be choked off with a fine-grade material. We refer you to ACI 302.1R-04 for additional details regarding the requirements for the base material.

In cases where potential static water levels or significant perched water sources appear near or above the floor slab, an under floor drainage system may be needed wherein a draintile system is placed within a thicker clean sand or gravel layer. Such a system should be properly engineered depending on subgrade soil types and rate/head of water inflow.

VAPOR MEMBRANE

The need for a vapor membrane depends on whether the floor slab will have a vapor sensitive covering, will have vapor sensitive items stored on the slab, or if the space above the slab will be a humidity controlled area. If the project does not have this vapor sensitivity or moisture control need, placement of a vapor membrane may not be necessary. Your decision will then relate to whether to use the ACI base material or a conventional sand cushion layer. However, if any of the above sensitivity issues apply, placement of a vapor membrane is recommended. Some floor covering systems (adhesives and flooring materials) require installation of a vapor membrane to limit the slab moisture content as a condition of their warranty.

VAPOR MEMBRANE/GRANULAR LAYER PLACEMENT

A number of issues should be considered when deciding whether to place the vapor membrane above or below the granular layer. The benefits of placing the slab on a granular layer, with the vapor membrane placed **below** the granular layer, include **reduction** of the following:

- Slab curling during the curing and drying process.
- Time of bleeding, which allows for quicker finishing.
- Vapor membrane puncturing.
- Surface blistering or delamination caused by an extended bleeding period.
- Cracking caused by plastic or drying shrinkage.

The benefits of placing the vapor membrane over the granular layer include the following:

- A lower moisture emission rate is achieved faster.
- Eliminates a potential water reservoir within the granular layer above the membrane.
- Provides a "slip surface", thereby reducing slab restraint and the associated random cracking.

If a membrane is to be used in conjunction with a granular layer, the approach recommended depends on slab usage and the construction schedule. The vapor membrane should be placed above the granular layer when:

- Vapor sensitive floor covering systems are used or vapor sensitive items will be directly placed on the slab.
- The area will be humidity controlled, but the slab will be placed before the building is enclosed and sealed from rain.
- Required by a floor covering manufacturer's system warranty.

The vapor membrane should be placed below the granular layer when:

- Used in humidity controlled areas (without vapor sensitive coverings/stored items), with the roof membrane in place, and the building enclosed to the point where precipitation will not intrude into the slab area. Consideration should be given to slight sloping of the membrane to edges where draintile or other disposal methods can alleviate potential water sources, such as pipe or roof leaks, foundation wall damp proofing failure, fire sprinkler system activation, etc.

There may be cases where membrane placement may have a detrimental effect on the subgrade support system (e.g., expansive soils). In these cases, your decision will need to weigh the cost of subgrade options and the performance risks.

FREEZING WEATHER EFFECTS ON BUILDING CONSTRUCTION

GENERAL

Because water expands upon freezing and soils contain water, soils which are allowed to freeze will heave and lose density. Upon thawing, these soils will not regain their original strength and density. The extent of heave and density/strength loss depends on the soil type and moisture condition. Heave is greater in soils with higher percentages of fines (silts/clays). High silt content soils are most susceptible, due to their high capillary rise potential which can create ice lenses. Fine grained soils generally heave about 1/4" to 3/8" for each foot of frost penetration. This can translate to 1" to 2" of total frost heave. This total amount can be significantly greater if ice lensing occurs.

DESIGN CONSIDERATIONS

Clayey and silty soils can be used as perimeter backfill, although the effect of their poor drainage and frost properties should be considered. Basement areas will have special drainage and lateral load requirements which are not discussed here. Frost heave may be critical in doorway areas. Stoops or sidewalks adjacent to doorways could be designed as structural slabs supported on frost depth footings with void spaces below. With this design, movements may then occur between the structural slab and the adjacent on-grade slabs. Non-frost susceptible sands (with less than 40% by weight passing a #40 sieve and no more than 5% by weight passing a #200 sieve) can be used below such areas. Depending on the function of surrounding areas, the sand layer may need a thickness transition away from the area where movement is critical. With sand placement over slower draining soils, subsurface drainage would be needed for the sand layer. High density extruded polystyrene insulation could be used within the sand to reduce frost penetration, thereby reducing the sand thickness needed. We caution that insulation placed near the surface can increase the potential for ice glazing of the surface.

The possible effects of adfreezing should be considered if clayey or silty soils are used as backfill. Adfreezing occurs when backfill adheres to rough surfaced foundation walls and lifts the wall as it freezes and heaves. This occurrence is most common with masonry block walls, unheated or poorly heated building situations and clay backfill. The potential is also increased where backfill soils are poorly compacted and become saturated. The risk of adfreezing can be decreased by placing a low friction separating layer between the wall and backfill.

Adfreezing can occur on exterior piers (such as deck, fence, or other similar pier footings), even if a smooth surface is provided. This is more likely in poor drainage situations where soils become saturated. Additional footing embedment and/or widened footings below the frost zones (which include tensile reinforcement) can be used to resist uplift forces. Specific designs would require individual analysis.

CONSTRUCTION CONSIDERATIONS

Foundations, slabs and other improvements which may be affected by frost movements should be insulated from frost penetration during freezing weather. If filling takes place during freezing weather, all frozen soils, snow and ice should be stripped from areas to be filled prior to new fill placement. The new fill should not be allowed to freeze during transit, placement or compaction. This should be considered in the project scheduling, budgeting and quantity estimating. It is usually beneficial to perform cold weather earthwork operations in small areas where grade can be attained quickly rather than working larger areas where a greater amount of frost stripping may be needed. If slab subgrade areas freeze, we recommend the subgrade be thawed prior to floor slab placement. The frost action may also require reworking and recompaction of the thawed subgrade.

BITUMINOUS PAVEMENT SUBGRADE PREPARATION AND DESIGN

GENERAL

Bituminous pavements are considered layered "flexible" systems. Dynamic wheel loads transmit high local stresses through the bituminous/base onto the subgrade. Because of this, the upper portion of the subgrade requires high strength/stability to reduce deflection and fatigue of the bituminous/base system. The wheel load intensity dissipates through the subgrade such that the high level of soil stability is usually not needed below about 2 feet to 4 feet (depending on the anticipated traffic and underlying soil conditions). This is the primary reason for specifying a higher level of compaction within the upper subgrade zone versus the lower portion. Moderate compaction is usually desired below the upper critical zone, primarily to avoid settlements/sags of the roadway. However, if the soils present below the upper 3 feet subgrade zone are unstable, attempts to properly compact the upper 3 feet zone to the 100% level may be difficult or not possible. Therefore, control of moisture just below the 3 feet level may be needed to provide a non-yielding base upon which to compact the upper subgrade soils.

Long-term pavement performance is dependent on the soil subgrade drainage and frost characteristics. Poor to moderate draining soils tend to be susceptible to frost heave and subsequent weakening upon thaw. This condition can result in irregular frost movements and "pop-outs," as well as an accelerated softening of the subgrade. Frost problems become more pronounced when the subgrade is layered with soils of varying permeability. In this situation, the free-draining soils provide a pathway and reservoir for water infiltration which exaggerates the movements. The placement of a well-drained sand subbase layer as the top of subgrade can minimize trapped water, smooth frost movements and significantly reduce subgrade softening. In wet, layered and/or poor drainage situations, the long-term performance gain should be significant. If a sand subbase is placed, we recommend it be a "Select Granular Material" which meets Mn/DOT Specification 3149.2B.2.

PREPARATION

Subgrade preparation should include stripping surficial vegetation and organic soils; where the exposed soils are within the upper "critical" subgrade zone (generally 2 feet deep for "auto only" areas and 3 feet deep for "heavy duty" areas), they should be evaluated for stability. Excavation equipment may make such areas obvious due to deflection and rutting patterns. Final evaluation of soils within the critical subgrade zone should be done by test rolling with heavy rubber-tired construction equipment, such as a loaded dump truck. Soils which rut or deflect 1" or more under the test roll should be corrected by either subcutting or replacement; or by scarification, drying, and recompaction. Reworked soils and new fill should be compacted per the "Specified Density Method" outlined in Mn/DOT Specification 2105.3F.1 (a minimum of 100% of Standard Proctor density in the upper 3 feet subgrade zone, and a minimum of 95% below this).

Subgrade preparation scheduling can be an important consideration. Fall and Spring seasons usually have unfavorable weather for soil drying. Stabilizing non-sand subgrades during these seasons may be difficult, and attempts often result in compromising the pavement quality. Where construction scheduling requires subgrade preparation during these times, the use of a sand subbase becomes even more beneficial for constructability reasons.

SUBGRADE DRAINAGE

If a sand subbase layer is used, it should be provided with a means of subsurface drainage to prevent water build-up. This can be in the form of draintile lines which dispose into storm sewer systems, or outlets into ditches. Where sand subbase layers include sufficient sloping and water can migrate to lower areas, draintile lines can be limited to finger drains at the catch basins. Even if a sand layer is not placed, strategically placed draintile lines can aid in improving pavement performance. This would be most important in areas where adjacent non-paved areas slope towards the pavement. Perimeter edge drains can aid in intercepting water which may infiltrate below the pavement.

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Figure 1 - Boring Locations
Subsurface Boring Logs
Gradation Curves

Appendix A
Geotechnical Field Exploration and Testing
Report No. 01-20541

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling 6 standard penetration test borings. The locations of the borings appear on Figure 1, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS) - Calibrated to N_{60} Values

Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586 with one primary modification. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. After an initial set of 6 inches, the number of hammer blows to drive the sampler the next 12 inches is known as the standard penetration resistance or N-value.

In the past, standard penetration N-value tests were performed using a rope and cathead for the lift and drop system. The energy transferred to the split-spoon sampler was typically limited to about 60% of its potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

Most drill rigs today incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N_{60} values. We use a Pile Driving Analyzer (PDA) and an instrumented rod to measure the actual energy generated by the automatic hammer system. The drill rig (AET rig number 57) we used for this project has a measured energy transfer ratio of 89%. The N-values reported on the boring logs and the corresponding relative densities and consistencies are from the field blow counts and have not been adjusted to N_{60} values.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of "topsoil" layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests

Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

A.5.2 Sieve Analysis of Soils (thru #200 Sieve)

Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

A.6 TEST STANDARD LIMITATIONS

Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
AR:	Sample of material obtained from cuttings blown out the top of the borehole during air rotary procedure.
B, H, N:	Size of flush-joint casing
CAS:	Pipe casing, number indicates nominal diameter in inches
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
DP:	Direct push drilling; a 2.125 inch OD outer casing with an inner 1½ inch ID plastic tube is driven continuously into the ground.
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RDA:	Rotary drilling with compressed air and roller or drag bit.
RDF:	Rotary drilling with drilling fluid and roller or drag bit
REC:	In split-spoon (see notes), direct push and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
SS:	Standard split-spoon sampler (steel; 1.5" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TH	Test hole; usually excavated with backhoe
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q_p:	Pocket Penetrometer strength, tsf (approximate)
q_c:	Static cone bearing pressure, psf
q_u:	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remolded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES
(Calibrated Hammer Weight)

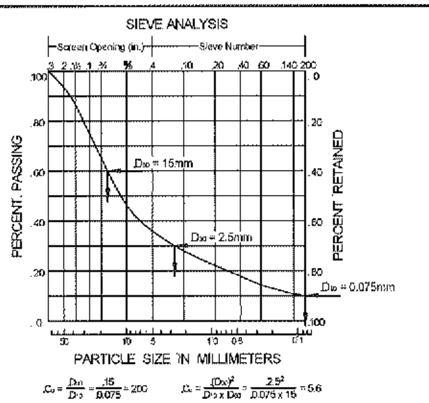
The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N_{60} values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM: D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

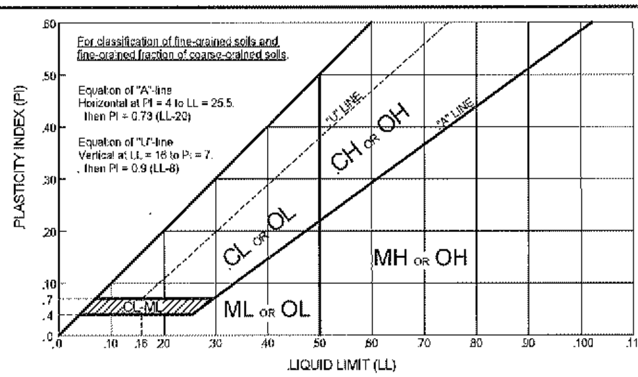
The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well graded gravel[F]
			$Cu<4$ and/or $1>Cc>3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines more than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu<6$ and/or $1>Cc>3$[E]	SP	Poorly-graded sand[I]
		Sands with Fines more than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat[R]





Plasticity Chart

Notes

[A]Based on the material passing the 3-in (75-mm) sieve.

[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C]Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D]Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E]$Cu = D_{60} / D_{10}$, $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F]If soil contains $\geq$15% sand, add "with sand" to group name.

[G]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H]If fines are organic, add "with organic fines" to group name.

[I]If soil contains $\geq$15% gravel, add "with gravel" to group name.

[J]If Atterberg limits plot is hatched area, soil is a CL-ML silty clay.

[K]If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.

[L]If soil contains $\geq$30% plus No. 200, predominantly sand, add "sandy" to group name.

[M]If soil contains $\geq$30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N]$PI \geq 4$ and plots on or above "A" line.

[O]$PI<4$ or plots below "A" line.

[P]PI plots on or above "A" line.

[Q]PI plots below "A" line.

[R]Fiber Content description shown below.

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

Term	Particle Size
Boulders	Over 12"
Cobbles	3" to 12"
Gravel	#4 sieve to 3"
Sand	#200 to #4 sieve
Fines (silt & clay)	Pass #200 sieve

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

Term	N-Value, BPF
Very Soft	less than 2
Soft	2 - 4
Firm	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	Greater than 30

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition (MC Column)

- D (Dry): Absence of moisture, dusty, dry to touch.
- M (Moist): Damp, although free water not visible. Soil may still have a high water content (over "optimum").
- W (Wet/ Waterbearing): Free water visible, intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.
- F (Frozen): Soil frozen

Layering Notes

- Laminations: Layers less than ½" thick of differing material or color.
- Lenses: Pockets or layers greater than ½" thick of differing material or color.

Peat Description

Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

Organic Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the Liquid Limit properties. *Slightly organic* used for borderline cases.

Root Inclusions

- With roots: Judged to have sufficient quantity of roots to influence the soil properties.
- Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

GPS latitude and longitude coordinates for the boring locations are shown on the boring logs.

AMERICAN ENGINEERING TESTING, INC.	**Project:**	Oppidan Baker's Square Site Bloomington, Minnesota		**AET Proj. No.:** 01-20541
	Subject:	Boring Locations		**Date:** 10/15/2019
	Scale: None	**Drawn By:** MPM	**Checked By:** RLF	**Figure 1**

CASE #PL2020-14

CASE #PL2020-14

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-20541** LOG OF BORING NO. **B-1 (p. 1 of 1)**

PROJECT: **Oppidan Baker's Square Site; Lyndale Avenue & West 98th Street; Bloomington, MN**

SURFACE ELEVATION: **832.0** LATITUDE: **44.8255943** LONGITUDE: **-93.2872228**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
	4" Bituminous pavement	FILL			DS		9				
1	FILL, 6" mostly crushed limestone, light brown										
	FILL, mostly clayey sand with organic fines, a little gravel, black		22	M	SS	11	12				
2											
3			10	M	SS	12	13				
4	SILTY SAND, fine grained, light brown, moist, loose to medium dense (SM)	COARSE ALLUVIUM									
5			9	M	SS	12					
6											
7			7	M	SS	13					
8											
9			11	M	SS	18					44
10	SAND WITH SILT, fine grained, light brown, moist, medium dense (SP-SM)										
11			11	M	SS	15					
12											
13			11	M	SS	15					
14	**END OF BORING**										

DEPTH:	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-12'	3.25" HSA	10/2/19	12:55	14.0	12.0			None

(Water Level Measurements)

BORING COMPLETED: **10/2/19**

DR: **SG** LG: **JJ** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-LAT-LONG 01-20541.GPJ AET+CPT+WELL_20181012_JG.GDT 10/16/19

03/2011 01-DHR-060

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: 01-20541 LOG OF BORING NO. B-2 (p. 1 of 1)

PROJECT: Oppidan Baker's Square Site; Lyndale Avenue & West 98th Street; Bloomington, MN

SURFACE ELEVATION: 833.4 LATITUDE: 44.8257466 LONGITUDE: -93.2872216

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
	6" Concrete	FILL			DS						
1–2	FILL, mostly silty sand, a little gravel, brown		14	M	SS	8					
2–4.5	FILL, mostly silty sand, some organic fines, a little gravel, brown and dark brown		12	M	SS	11	8				
4.5–10	SILTY SAND, fine grained, light brown, moist, loose to medium dense (SM)	COARSE ALLUVIUM	8	M	SS	16					
			13	M	SS	15					
10–14.5	SAND WITH SILT, fine grained, light brown, moist, loose to medium dense (SP-SM)		9	M	SS	16					
			12	M	SS	17					
	END OF BORING										

DEPTH:	DRILLING METHOD
0-12½'	3.25" HSA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/2/19	1:40	14.5	12.5			None

BORING COMPLETED: 10/2/19

DR: SG LG: JJ Rig: 91C

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN ENGINEERING TESTING, INC.

CASE #PL2020-14

SUBSURFACE BORING LOG

AET JOB NO: **01-20541** LOG OF BORING NO. **B-3 (p. 1 of 1)**

PROJECT: **Oppidan Baker's Square Site; Lyndale Avenue & West 98th Street; Bloomington, MN**

SURFACE ELEVATION: **832.4** LATITUDE: **44.8257383** LONGITUDE: **-93.2875272**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
	4" Bituminous pavement	FILL			DS						
1	FILL, mostly crushed limestone, light brown										
	FILL, mostly clayey sand, some organic fines, a little gravel, brown and dark brown		13	M	SS	11	9				
2–4	FILL, mostly clayey sand, a little gravel, brown (may be natural soil)	FILL OR MIXED ALLUVIUM	7	M	SS	16	11				
5–10	SILTY SAND, fine grained, light brown, moist, loose (SM)	COARSE ALLUVIUM	9	M	SS	17					
			7	M	SS	17					
			10	M	SS	17					
11–14	SAND WITH SILT, fine grained, light brown, moist, loose to medium dense (SP-SM)										
			15	M	SS	18					
	END OF BORING										

DEPTH:	DRILLING METHOD
0-12½'	3.25" HSA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/2/19	11:50	14.5	12.5			None

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

BORING COMPLETED: **10/2/19**

DR: **SG** LG: **JJ** Rig: **91C**

AET_CORP W-LAT-LONG 01-20541.GPJ AET+CPT+WELL_20181012_JG.GDT 10/16/19

03/2011 01-DHR-060

AMERICAN ENGINEERING TESTING, INC.

CASE #PL2020-14

SUBSURFACE BORING LOG

AET JOB NO: **01-20541** LOG OF BORING NO. **B-4 (p. 1 of 1)**

PROJECT: **Oppidan Baker's Square Site; Lyndale Avenue & West 98th Street; Bloomington, MN**

SURFACE ELEVATION: **832.0** LATITUDE: **44.8258824** LONGITUDE: **-93.2875359**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
	4.5" Bituminous pavement	FILL			DS						
1	FILL, mostly crushed limestone, a little silty sand with organic fines, brown with dark brown		18	M	SS	13					
2	FILL, mostly silty sand with organic fines, a little crushed limestone, dark brown and brown	FILL OR MIXED ALLUVIUM									
3	FILL, mostly clayey sand, brown (may be natural soil)		10	M	SS	14	15				
4	SILTY SAND, fine grained, light brown, moist, loose (SM)	COARSE ALLUVIUM									
5			8	M	SS	16					
6	SAND WITH SILT, fine grained, light brown, moist, loose to medium dense (SP-SM)										
7			10	M	SS	15					
8											
9			15	M	SS	16					
10											
11			14	M	SS	18					
12											
13			18	M	SS	17					
14	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-12'	**3.25" HSA**

BORING COMPLETED: **10/2/19**

DR: **SG** LG: **JJ** Rig: **91C**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/2/19	**11:20**	**14.0**	**12.0**			**None**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-LAT-LONG 01-20541.GPJ AET+CPT+WELL_20181012_JG.GDT 10/16/19

03/2011

01-DHR-060

AMERICAN ENGINEERING TESTING, INC.

CASE #PL2020-14

SUBSURFACE BORING LOG

AET JOB NO: 01-20541 LOG OF BORING NO. B-5 (p. 1 of 1)

PROJECT: Oppidan Baker's Square Site; Lyndale Avenue & West 98th Street; Bloomington, MN

SURFACE ELEVATION: 831.5 LATITUDE: 44.8260554 LONGITUDE: -93.2873818

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
	4" Bituminous pavement	FILL			DS						
1	13" FILL, mostly crushed limestone, light brown		21	M	SS	13	15				
2	FILL, mostly clayey sand, a little gravel, dark brown (may be natural soil)	FILL OR MIXED ALLUVIUM									
3	FILL, mostly silty sand, brown (may be natural soil)	FILL OR COARSE ALLUVIUM	9	M	SS	14					
4											
5	SILTY SAND, fine grained, light brown, moist, loose to medium dense (SM)	COARSE ALLUVIUM	7	M	SS	13					
6											
7											
8			11	M	SS	15					
9											
10	SAND WITH SILT, fine grained, light brown, moist, loose to medium dense (SP-SM)		10	M	SS	16					
11											
12											
13			15	M	SS	13					
14											
	END OF BORING										

DEPTH:	DRILLING METHOD
0-12½'	3.25" HSA

BORING COMPLETED: 10/2/19

DR: SG LG: JJ Rig: 91C

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/2/19	10:20	14.5	12.5			None

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

CASE #PL2020-14

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **01-20541** LOG OF BORING NO. **B-6 (p. 1 of 1)**

PROJECT: **Oppidan Baker's Square Site; Lyndale Avenue & West 98th Street; Bloomington, MN**

SURFACE ELEVATION: **831.8** LATITUDE: **44.8260540** LONGITUDE: **-93.2871449**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DEN	LL	PL	%-#200
	4" Bituminous pavement	FILL			DS						
1	13" FILL, mostly crushed limestone, light brown		18	M	SS	15	14				
2	FILL, mostly clayey sand with organic fines, a little gravel, dark brown (may be natural soil)	FILL OR MIXED ALLUVIUM									
3	FILL, mostly silty sand, brown (may be natural soil)	FILL OR COARSE ALLUVIUM	14	M	SS	18					
4	SANDY SILT, light brown, moist, loose (ML)	FINE ALLUVIUM									
5			9	M	SS	16					
6											
7			8	M	SS	16					55
8	SILTY SAND, fine grained, light brown, moist, medium dense (SM)	COARSE ALLUVIUM									
9			14	M	SS	15					
10											
11			12	M	SS	15					
12											
13			11	M	SS	14					
14	**END OF BORING**										

DEPTH:	DRILLING METHOD
0-12'	3.25" HSA

WATER LEVEL MEASUREMENTS

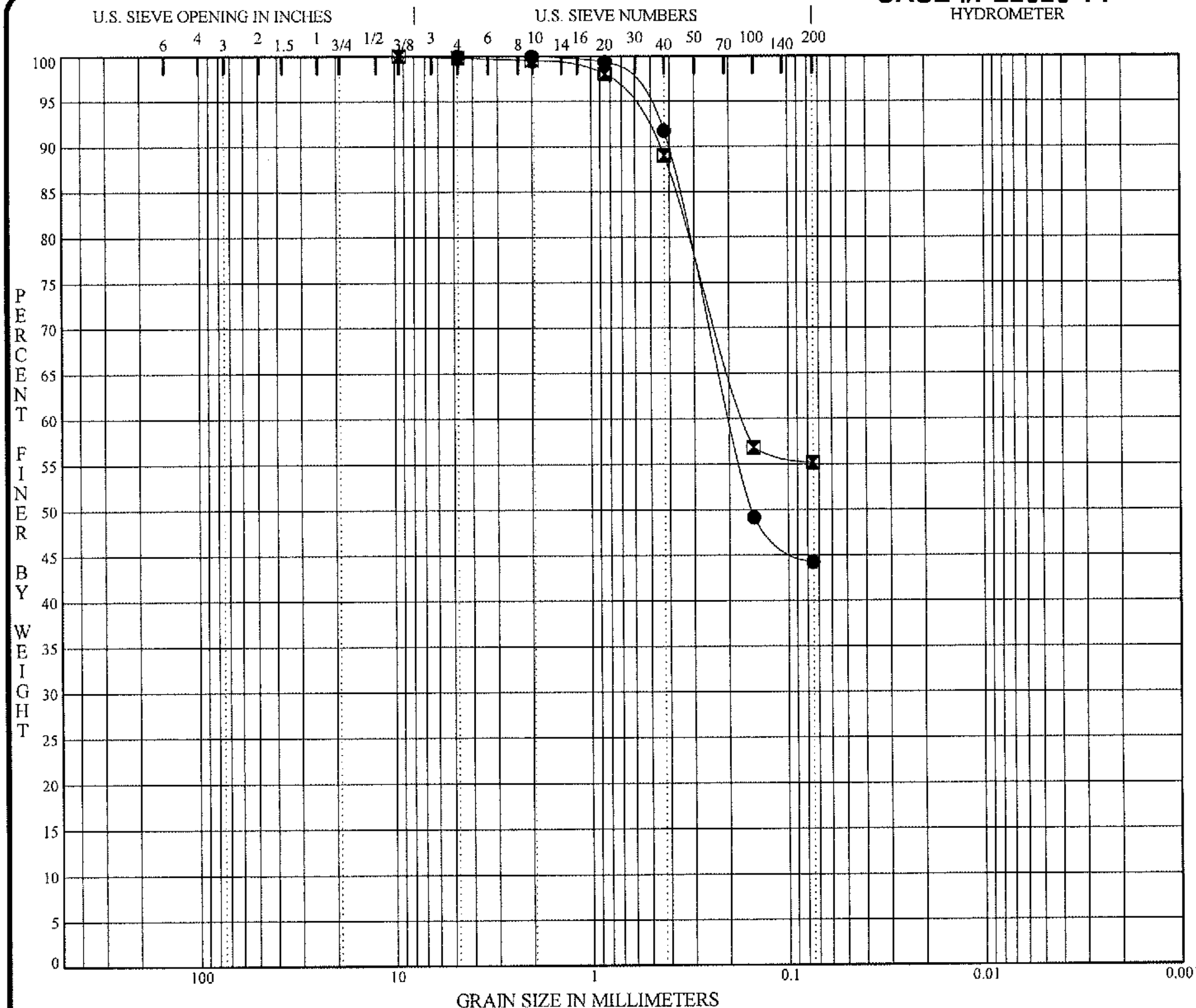
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/2/19	10:55	14.0	12.0			None

BORING COMPLETED: **10/2/19**

DR: **SG** LG: **JJ** Rig: **91C**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-LAT-LONG 01-20541.GPJ AET+CPT+WELL_20181012_JG.GDT 10/16/19



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	B-1	8.0'	SILTY SAND (SM)						
⧗	B-6	6.0'	SANDY SILT (ML)						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	8.0'	4.75	0.20			0.0	55.8	44.2	
⧗	B-6	6.0'	9.50	0.17			0.2	44.7	55.2	

PROJECT **Oppidan Baker's Square Site; Lyndale Avenue & West 98th Street; Bloomington, MN**

AET JOB NO. **01-20541**
DATE **10/2/19**

AMERICAN ENGINEERING TESTING, INC.

GRADATION CURVES

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Appendix B
Geotechnical Report Limitations and Guidelines for Use
Report No. 01-20541

B.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by GBA[1], of which, we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. And no one, not even you, should apply the report for any purpose or project except the one originally contemplated.

B.2.2 Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

B.2.3 A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typically factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

B.2.4 Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

[1] Geoprofessional Business Association, 1300 Piccard Drive, LL14, Rockville, MD 20850
Telephone: 301/565-2733; www.geoprofessional.org

Appendix B
Geotechnical Report Limitations and Guidelines for Use
Report No. 01-20541

B.2.5 Most Geotechnical Findings Are Professional Opinions
Site exploration identified subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

B.2.6 A Report's Recommendations Are Not Final
Do not over rely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

B.2.7 A Geotechnical Engineering Report Is Subject to Misinterpretation
Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

B.2.8 Do Not Redraw the Engineer's Logs
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognizes that separating logs from the report can elevate risk.

B.2.9 Give Contractors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

B.2.10 Read Responsibility Provisions Closely
Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.11 Geoenvironmental Concerns Are Not Covered
The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.

Appendix 4. O&M PLAN

EXHIBIT

BMP Maintenance Requirements

Name & Location
Project Name: Oppidan – Bank Development
Address: 611 W 98th St– Bloomington, MN

Site Data
Total Site Area: 1.18 AC
Impervious Area Before Construction: 1.04 AC
Impervious Area After Construction: 1.04 AC

BMP Information
The designer shall provide, on the plan set, the following information on post-construction stormwater BMPs:

BMP ID	TYPE OF BMP	Northing/Easting
BMP 1	Underground Infiltration System	44° 49' 33.00" N/ -93° 17' 14.87" E

MAINTENANCE OF INFILTRATION BASIN

Regular inspection and maintenance are critical to the effective operation of the underground infiltration system. It is the responsibility of the property owner to maintain all stormwater BMPs in accordance with the minimum design standards and other guidance provided in this manual.

Inspection Schedule

One inspection form shall be completed for the infiltration basin on a monthly or annual basis as specified on the checklist. Inspection reports should be completed and kept on file with the Inspector or Owner. Reports should be kept for a minimum of five years

Activity	Frequency
Inspect soil and repair eroded areas	Monthly
Inspect integrity of storm sewer castings and remove accumulated debris from grates	As needed
Remove litter and debris	Monthly
36" Pipe System (BMP 1)	Once per year

Erosion

The soil and mulch on the property shall be inspected for eroded areas. Eroded areas shall be filled with soil or mulch and vegetated. In the event that erosion persists in a particular area, compacted aggregate shall be used to further stabilize the slope and to mitigate future erosion. Scouring at inlets to be maintained by coring earthwork to promote non-erosive flows that are evenly distributed.

Sediment Accumulation & Clogging
Sediment accumulation within the facility may reduce the infiltration capacity and impair proper performance of the facility. The facility shall be inspected for accumulation of sediment as part of the inspection. Excessive sediment accumulation shall be removed.

Outlet Structure Maintenance
The Owner will be responsible for outlet structure maintenance. Periodically, the outlet pipe may clog with debris. Debris should be removed and appropriately disposed of off-site.

Pretreatment Manhole Maintenance – Manhole Structures – STMH-200 & STMH-300
Remove sediment from the manhole and pretreatment device by using a vacuum truck. Visual inspection to ensure no pipe blockage should occur at the time of cleaning. Prior to entry into the storm sewer manhole, the user shall follow all applicable OSHA and local safety regulations. The pretreatment manholes shall be inspected at least three times during the first two years to inspect the amount accumulated sediment and screen/baffle clogging over the first two years following installation. From the frequent inspections a structure specific maintenance program can be developed. Sediment shall be cleaned once one foot of sediment has accumulated in the manhole sumps. At a minimum the structures containing pretreatment device shall be fully cleaned once a year.

BMP 1 (36" Pipe System)

Visual inspection of the pipe chamber system shall occur once per year until a cleaning schedule can be established based on the amount of sediment that is left within the system. Prior to entry into the pipe system, the user shall follow all applicable OSHA and local safety regulations.

Inspections should occur at least 2-3 days after the most recent rainfall event. The system should be visually inspected at all manhole locations. Utilizing a sediment pole, measure and document the amount of silt at each manhole locations. Inspect each pipe opening to ensure that the silt level or any foreign objects are not blocking the pipes. The sediment level should be measured and recorded during the inspection process. The system should be cleaned once the available clear space between the sediment and the ceiling of the system is less than 4 feet 6 inches. Cleaning of the system can be done by a vacuum truck every 3-5 years based on actual sediment accumulation.

To clean, remove the manhole cover at the top of the system and lower a vacuum hose into one of the rows of the pipe system. Open the manhole at the opposite end of the system and use sewer jetting equipment to force water in the same row from one end of the pipe system row to the opposite side. Place the vacuum hose and the sewer jetting equipment in the next row and repeat the process.

INSPECTION FORM

Infiltration Basin		
Date:	**Time:**	**Weather:**
Inspector:		
Maintenance Item	**Comments on Condition**	**Actions to be Taken**
As Needed		
Remove Trash and debris		
Stabilize tributary drainage area when erosion is evident		
Inflow and outflow pipes are clean		
Catch Basins are functioning properly and free of litter and debris		
Prune and weed to maintain appearance		
Renew Mulch and replace vegetation whenever percent cover of acceptable vegetation falls below 90 percent		
Semi Annually (Or After several storm events/extreme storm events)		
Inspect inflow/outflow and pre-treatment systems for clogging (off-line systems) and remove any sediment		
Vegetation, Trees, and shrubs to be inspected to evaluate their health and replanted as needed		
Remove any dead or diseased vegetation		
Annually in Fall		
Inspect and remove any sediment and debris build up in pretreatment areas		
Inspect inflow points and infiltration surface for buildup of road sand associated with spring melt, remove as needed, and replant areas that have been impacted by sand/salt build up		
Note signs of pollution, such as oil sheens, discolored water, or unpleasant odors.		
Annually in Spring		
Cut back and remove previous year's plant material and remove accumulated leaves if needed		
Comments and Actions Required:		