Hydrologic Report

for the

Proposed Residential Redevelopment

located at

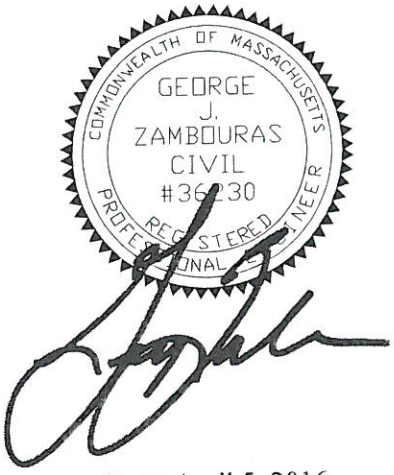
28 Lake Attitash Road

Amesbury, Massachusetts 01913

Prepared For

George & Kelly Norwood
18 Campion Road
North Andover, MA 01845

2, 10 & 100 Year Storm
24 Hour Duration



Date: April 5, 2016

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INTRODUCTION:

This report describes the pre and post hydraulic analysis and stormwater management measures to be implemented to mitigate the potential impacts to the environment and surrounding properties for the redevelopment of a single family dwelling on a parcel of land located at 21 Lake Attitash Road – Amesbury, Massachusetts.

The proposed redevelopment being a single family dwelling is except from DEP stormwater standards but no stormwater recharge; however this report is being prepared to address the Special Permit requirements within the Water Resources Protection District of the Town of Amesbury Zoning Regulations.

The pre and post hydraulic analysis and design of the proposed stormwater components are based on the hydraulic analysis performed utilizing "HydroCAD Storm water Modeling Software" for storm events of 2, 10 and 100-year storm frequencies.

EXISTING CONDITIONS:

The project site consists of an 8,298 s.f. parcel of land located on the easterly side of Lake Attitash Road and bounded by Lake Attitash to the east and residential properties to the north and south.
The site is a fully developed residential parcel containing an existing residential dwelling and shed.

PROPOSED CONDITIONS:

It is the intent of the property owner to demolish the existing structures and construct a new residential dwelling and garage. To assist in minimizing stormwater runoff the proposed driveway, patio and all walkways will be constructed of pervious pavers.

Additionally to mitigate the impacts of the added impervious surfaces and to comply with the Special Permit requirements all roof runoff will be directed to infiltration systems and an infiltration trench will be installed along a portion f the northerly property line to capture and infiltrate overland flow.

SITE SOILS:

The existing soils within the site are classified by NRCS as being of the Walpole soil group. Walpole soils are poorly drained sandy loams and belong to the hydrologic soil group B\D. For the purposes of pre and post site comparison all soils in this report have been identified as belong to the hydrologic soil group C.

SITE DRAIANGE and STORMWATER COMPNENTS:

Presently stormwater runoff flows across the parcel in a northwesterly direction. The proposed site design will enable the post development drainage patterns to mimic the pre-development patterns.

In accordance with the Special Permit *requirements any site alteration that increases the impervious area must provide a compensatory stormwater management area of at least 150% of the increase in impervious area.* To meet this requirement roof infiltration and storage units and proposed for all roof surfaces and an infiltration trench is provided to capture overland flow.

Pre-development impervious areas:

Driveway	715 s.f.
Concrete Slab	34 s.f.
Shed	160 s.f..
Existing Dwelling	637 s.f.
Existing Porch	358 s.f.
Existing Impervious Total	1,904 s.f.

Post-development impervious areas:

Proposed Dwelling	1,560 s.f.
Proposed Garage	576 s.f.
Proposed Impervious Total	2,136 s.f.

Net increase impervious area = 232 s.f.
Required compensatory stormwater management area = 232 x150% = 348 s.f.

Proposed Stormwater components:

Roof Infiltration Units – Infiltrator Systems Inc. Quick4 ISI 12" Chambers
These units will be installed in "Pairs" embedded in a crushed stone bed. The stone bedding will extend beyond the width and length of the chambers by 12-inches.
The effective bottom area of each pair of chambers to be 10' x 4.83' = 48.3 s.f.

Infiltration Trench - One infiltration trench is proposed along a portion of the northerly property line. The trench dimensions are: 45' x 1.5'= 67.5 s.f.

Compensatory stormwater management area provided:

Roof Infiltration Units Provided:
Garage Roof – 2 Pairs of infiltration chambers = 2 x 48.3 s.f. = 96.6 s.f.
Dwelling Roof – 4 Pairs of infiltration chambers = 4 x 48.3 s.f. = 193.2 s.f.

Infiltration Trench Provided = 67.5 s.f.

Total Compensatory Stormwater Management Area Provided = 357.3 s.f. > 348 s.f.

SUMMARY:

As indicated in the summary below the proposed stormwater components enables the post-development the stormwater runoff flow rates and volumes to be less than pre-development runoff flow rates and volumes for all storm modeled.

Hydraulic Analysis Summary

Single Family Residential Development – 21 Lake Attitash Road

Summary of Discharge Flows and Volumes to Northerly Design Point				
Design Storm	*Max. Discharge (CFS.)*	*Max. Discharge (CFS.)*	*Max. Volume (CU-FT.)*	*Max. Volume (CU-FT.)*
	Pre-Development.	*Post-Development*	*Pre-Development.*	*Post-Development*
2 Yr.	*0.27*	*0.23*	*872*	*766*
10 Yr.	*0.52*	*0.52*	*1,642*	*1,556*
100 Yr.	*0.90*	*0.87*	*2,853*	*2,749*

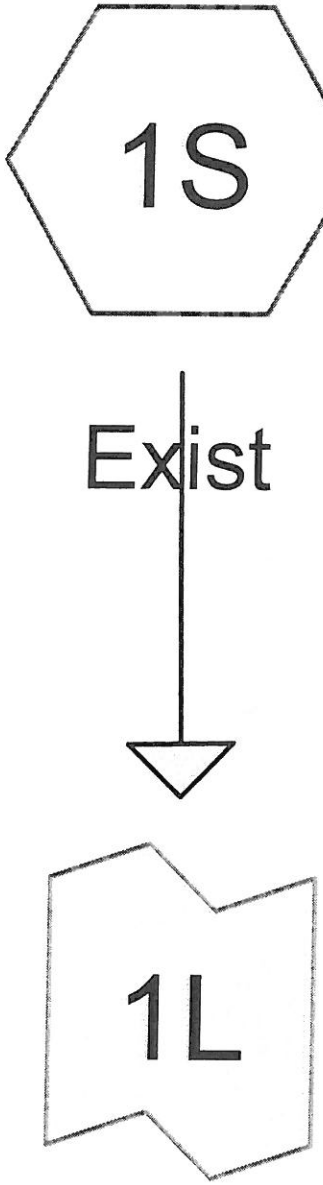
Assumptions:

The following assumptions are being used for design purposes:

1) *2, 10 & 100 year storm frequency.*
2) *24 hour storm duration (min.)*
3) *Hydrologic soils groups for runoff areas are classified class as "C" soils.*
4) *Existing and proposed Cn values are as noted in the report.*
5) *Within small drainage areas a minimum Tc value of 6 min. is used.*

Design Criteria:

1) *Runoff quantities are calculated using TR-20 intensity numbers*
2) *I = 3.1 for 2 yr / 24 hr. duration , 4.5 in./10 yr. & 6.5 in./100 yr.*
3) *Proposed Cn values are as noted in the report.*
4) *Hyetograph shape = S.C.S. III (eastern U.S.)*
5) *The maximum flow rate of run-off for the 2, 25 & 100 yr. design storms which are routed through drainage system will be equal or less than pre-development runoff.*



Total Site Exist

Subcat Reach Pond Link

Routing Diagram for Attitash
Prepared by George J. Zambouras, P.E.

Attitash
Prepared by George J. Zambouras, P.E.

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
6,394	74	>75% Grass cover, Good, HSG C (1S)
715	98	Paved parking, HSG C (1S)
1,155	98	Roofs, HSG C (1S)
34	98	Unconnected pavement, HSG C (1S)
8,298	**80**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Exist Runoff Area=8,298 sf 22.95% Impervious Runoff Depth>1.26"
Tc=6.0 min UI Adjusted CN=79 Runoff=0.27 cfs 872 cf

Link 1L: Total Site Exist Inflow=0.27 cfs 872 cf
Primary=0.27 cfs 872 cf

Total Runoff Area = 8,298 sf Runoff Volume = 872 cf Average Runoff Depth = 1.26"
77.05% Pervious = 6,394 sf 22.95% Impervious = 1,904 sf

Summary for Subcatchment 1S: Exist

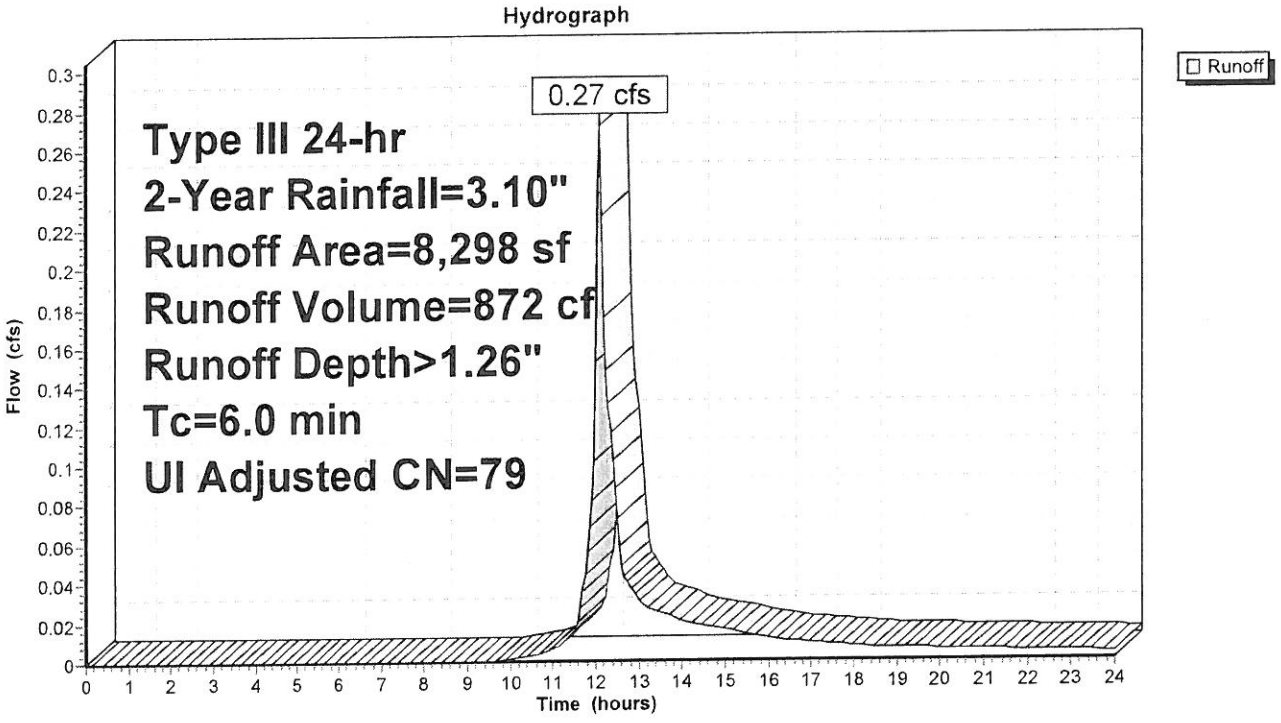
Runoff = 0.27 cfs @ 12.10 hrs, Volume= 872 cf, Depth> 1.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
6,394	74	>75% Grass cover, Good, HSG C
1,155	98	Roofs, HSG C
715	98	Paved parking, HSG C
34	98	Unconnected pavement, HSG C
8,298	80	Weighted Average, UI Adjusted CN = 79
6,394		77.05% Pervious Area
1,904		22.95% Impervious Area
34		1.79% Unconnected

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

Subcatchment 1S: Exist

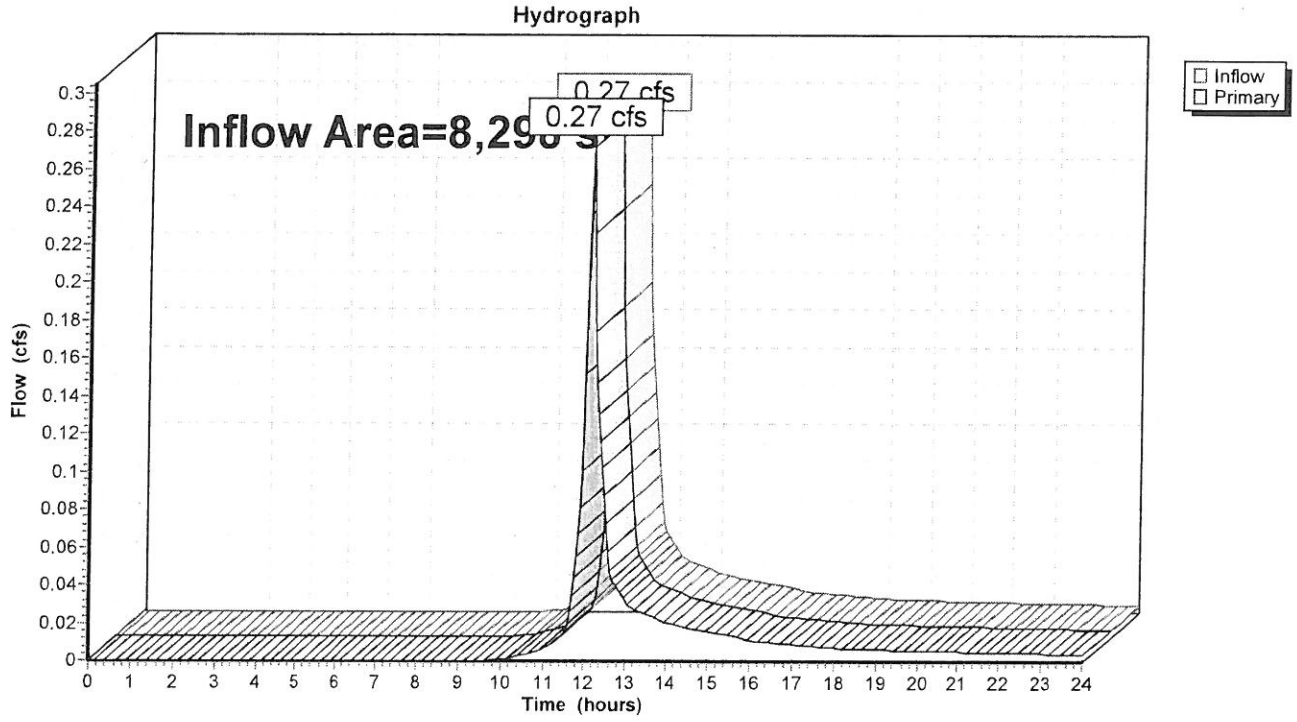


Summary for Link 1L: Total Site Exist

Inflow Area = 8,298 sf, 22.95% Impervious, Inflow Depth > 1.26" for 2-Year event
Inflow = 0.27 cfs @ 12.10 hrs, Volume= 872 cf
Primary = 0.27 cfs @ 12.10 hrs, Volume= 872 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 1L: Total Site Exist



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Exist Runoff Area=8,298 sf 22.95% Impervious Runoff Depth>2.37"
Tc=6.0 min UI Adjusted CN=79 Runoff=0.52 cfs 1,642 cf

Link 1L: Total Site Exist Inflow=0.52 cfs 1,642 cf
Primary=0.52 cfs 1,642 cf

Total Runoff Area = 8,298 sf Runoff Volume = 1,642 cf Average Runoff Depth = 2.37"
77.05% Pervious = 6,394 sf 22.95% Impervious = 1,904 sf

Summary for Subcatchment 1S: Exist

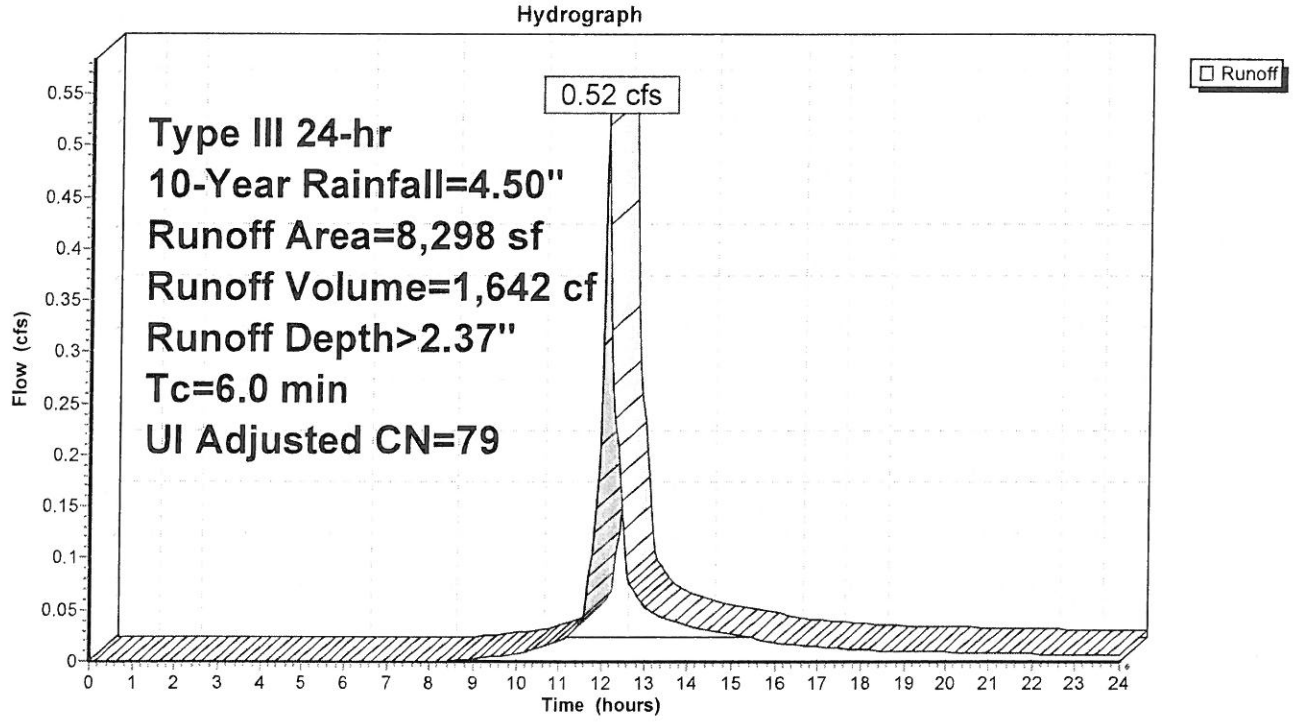
Runoff = 0.52 cfs @ 12.09 hrs, Volume= 1,642 cf, Depth> 2.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
6,394	74	>75% Grass cover, Good, HSG C
1,155	98	Roofs, HSG C
715	98	Paved parking, HSG C
34	98	Unconnected pavement, HSG C
8,298	80	Weighted Average, UI Adjusted CN = 79
6,394		77.05% Pervious Area
1,904		22.95% Impervious Area
34		1.79% Unconnected

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

Subcatchment 1S: Exist

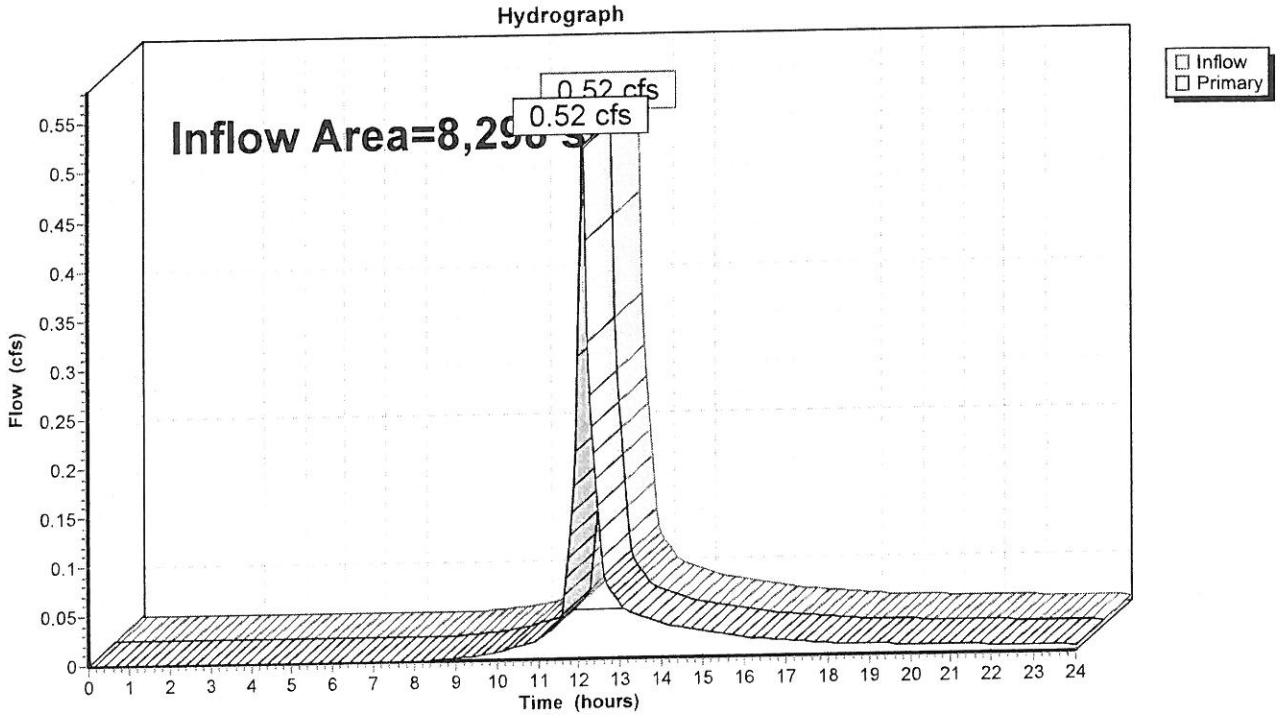


Summary for Link 1L: Total Site Exist

Inflow Area = 8,298 sf, 22.95% Impervious, Inflow Depth > 2.37" for 10-Year event
Inflow = 0.52 cfs @ 12.09 hrs, Volume= 1,642 cf
Primary = 0.52 cfs @ 12.09 hrs, Volume= 1,642 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 1L: Total Site Exist



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: Exist Runoff Area=8,298 sf 22.95% Impervious Runoff Depth>4.13"
Tc=6.0 min UI Adjusted CN=79 Runoff=0.90 cfs 2,853 cf

Link 1L: Total Site Exist Inflow=0.90 cfs 2,853 cf
Primary=0.90 cfs 2,853 cf

Total Runoff Area = 8,298 sf Runoff Volume = 2,853 cf Average Runoff Depth = 4.13"
77.05% Pervious = 6,394 sf 22.95% Impervious = 1,904 sf

Summary for Subcatchment 1S: Exist

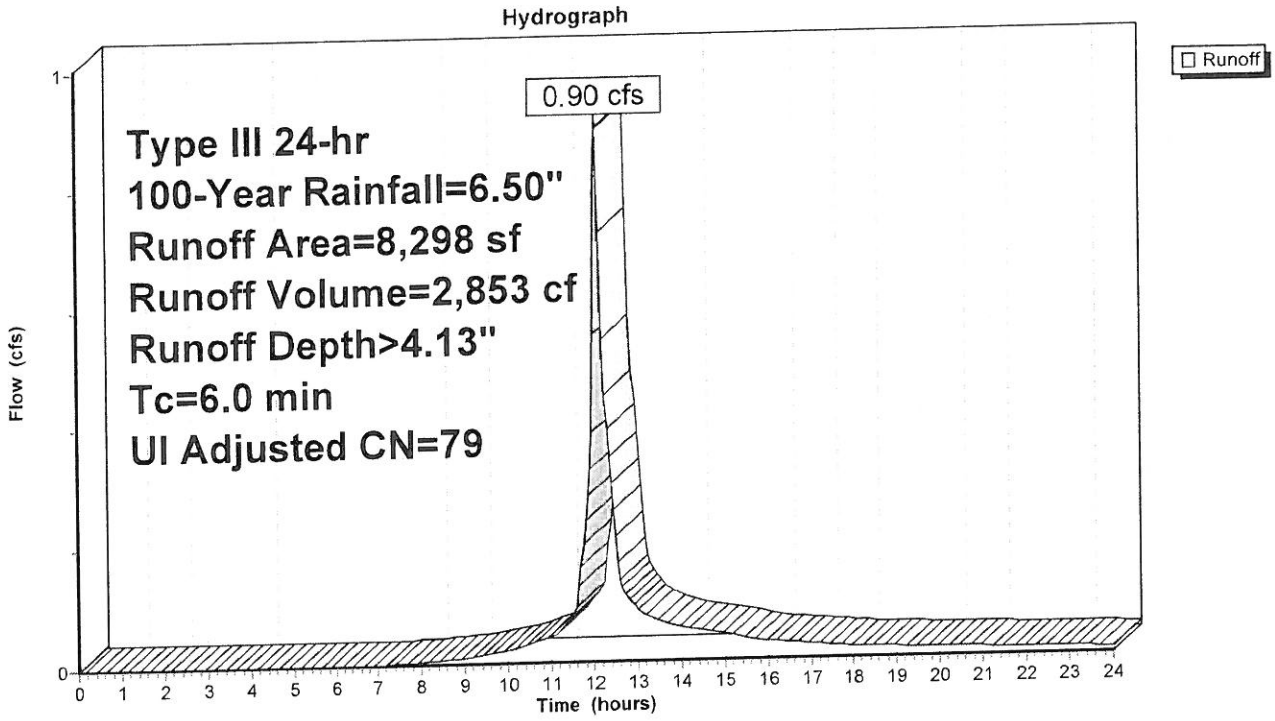
Runoff = 0.90 cfs @ 12.09 hrs, Volume= 2,853 cf, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
6,394	74	>75% Grass cover, Good, HSG C
1,155	98	Roofs, HSG C
715	98	Paved parking, HSG C
34	98	Unconnected pavement, HSG C
8,298	80	Weighted Average, UI Adjusted CN = 79
6,394		77.05% Pervious Area
1,904		22.95% Impervious Area
34		1.79% Unconnected

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

Subcatchment 1S: Exist

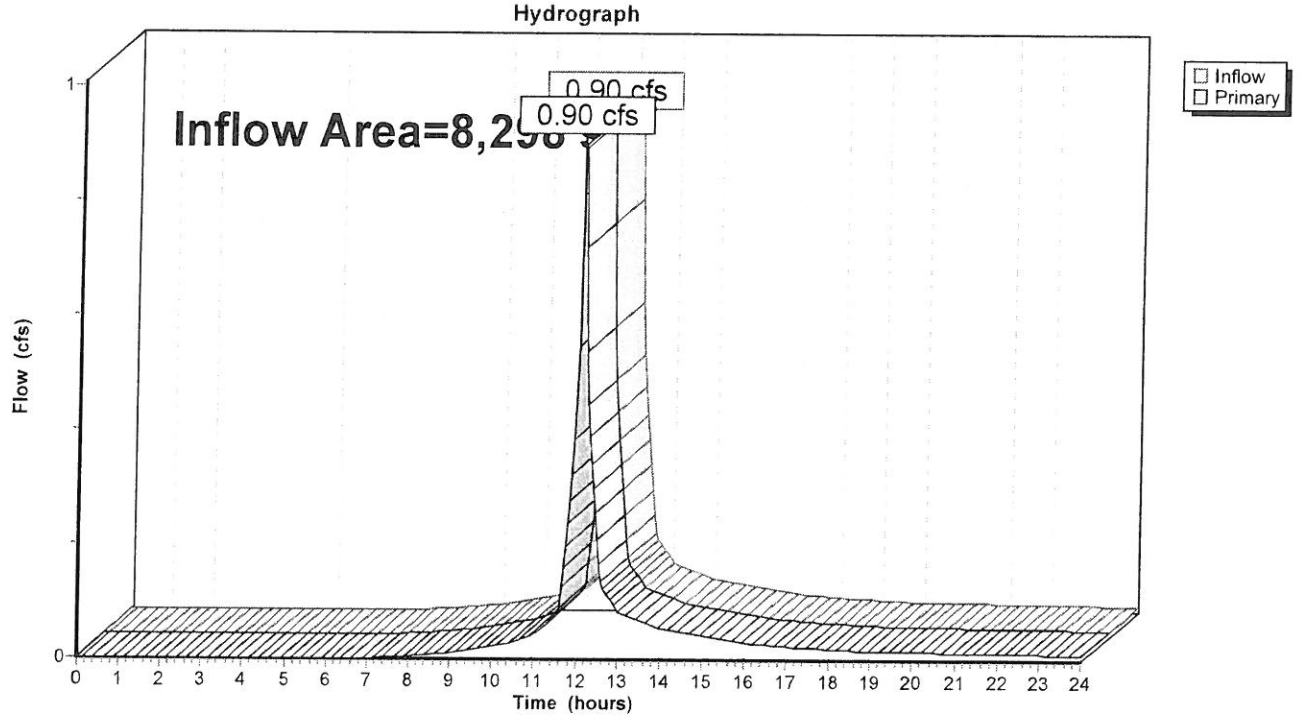


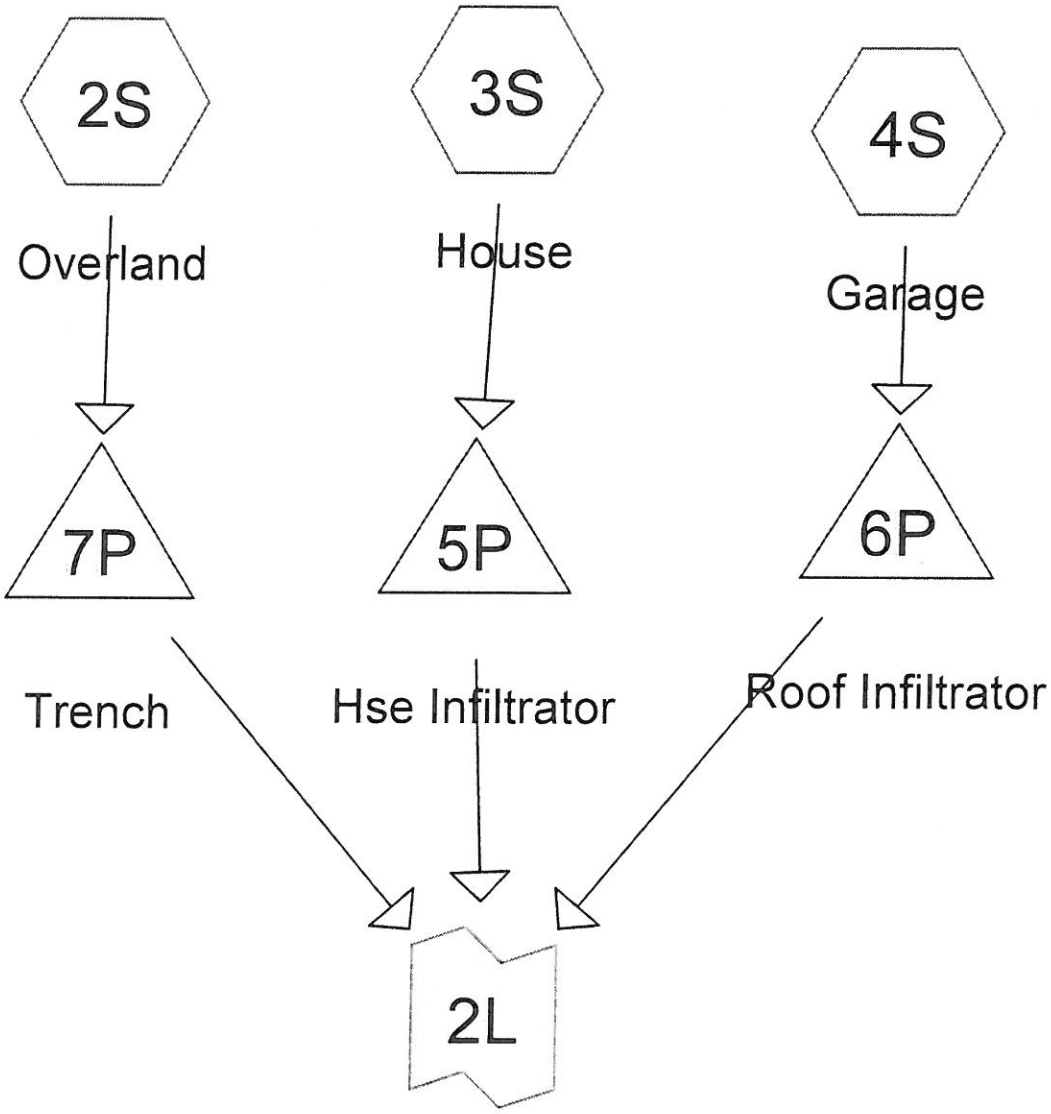
Summary for Link 1L: Total Site Exist

Inflow Area = 8,298 sf, 22.95% Impervious, Inflow Depth > 4.13" for 100-Year event
Inflow = 0.90 cfs @ 12.09 hrs, Volume= 2,853 cf
Primary = 0.90 cfs @ 12.09 hrs, Volume= 2,853 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 1L: Total Site Exist





Total Site Proposed

Subcat Reach Pond Link

Routing Diagram for Attitash
Prepared by George J. Zambouras, P.E.

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
6,034	74	>75% Grass cover, Good, HSG C (2S)
2,136	98	Roofs, HSG C (3S, 4S)
128	98	Unconnected pavement, HSG C (2S)
8,298	**81**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: Overland Runoff Area=6,162 sf 2.08% Impervious Runoff Depth>0.97"
Tc=6.0 min CN=74 Runoff=0.15 cfs 499 cf

Subcatchment 3S: House Runoff Area=1,560 sf 100.00% Impervious Runoff Depth>2.87"
Tc=6.0 min CN=98 Runoff=0.11 cfs 373 cf

Subcatchment 4S: Garage Runoff Area=576 sf 100.00% Impervious Runoff Depth>2.87"
Tc=6.0 min CN=98 Runoff=0.04 cfs 138 cf

Pond 5P: Hse Infiltrator Peak Elev=99.23' Storage=115 cf Inflow=0.11 cfs 373 cf
Outflow=0.10 cfs 270 cf

Pond 6P: Roof Infiltrator Peak Elev=99.11' Storage=70 cf Inflow=0.04 cfs 138 cf
Outflow=0.03 cfs 72 cf

Pond 7P: Trench Peak Elev=98.83' Storage=49 cf Inflow=0.15 cfs 499 cf
Outflow=0.12 cfs 424 cf

Link 2L: Total Site Proposed Inflow=0.23 cfs 766 cf
Primary=0.23 cfs 766 cf

Total Runoff Area = 8,298 sf Runoff Volume = 1,009 cf Average Runoff Depth = 1.46"
72.72% Pervious = 6,034 sf 27.28% Impervious = 2,264 sf

Summary for Subcatchment 2S: Overland

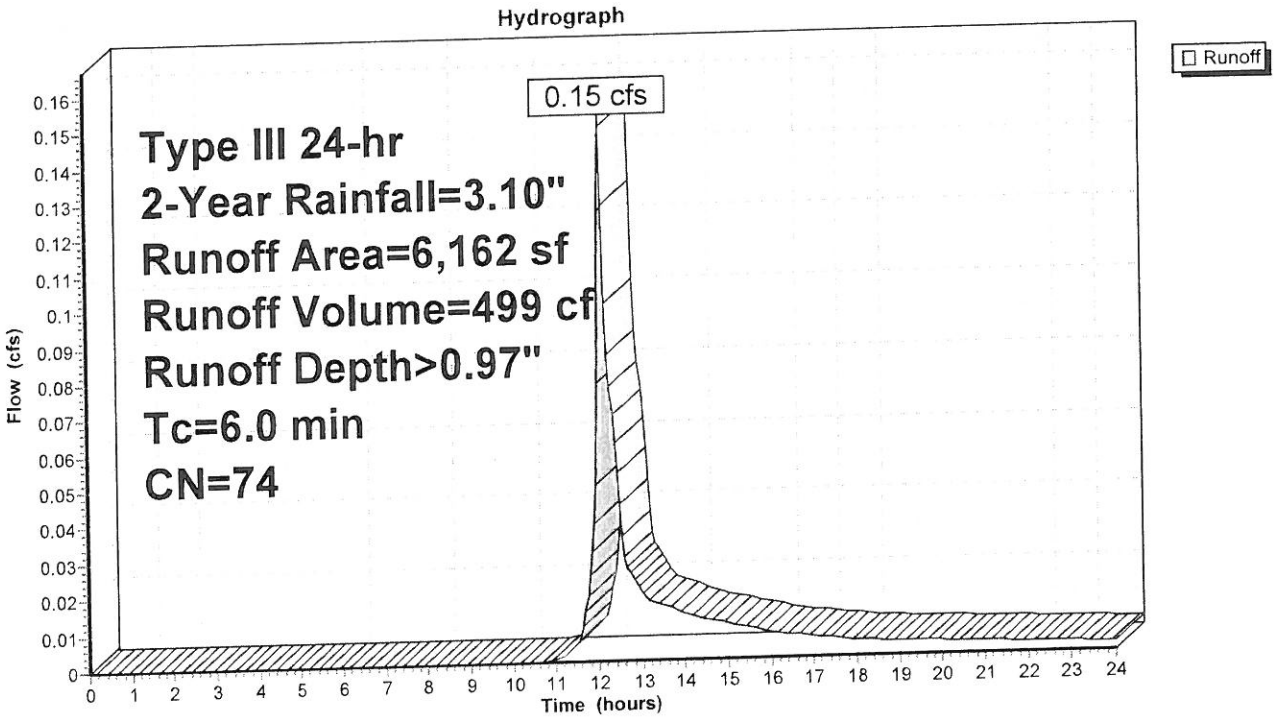
Runoff = 0.15 cfs @ 12.10 hrs, Volume= 499 cf, Depth> 0.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
6,034	74	>75% Grass cover, Good, HSG C
128	98	Unconnected pavement, HSG C
6,162	74	Weighted Average
6,034		97.92% Pervious Area
128		2.08% Impervious Area
128		100.00% Unconnected

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

Subcatchment 2S: Overland



Summary for Subcatchment 3S: House

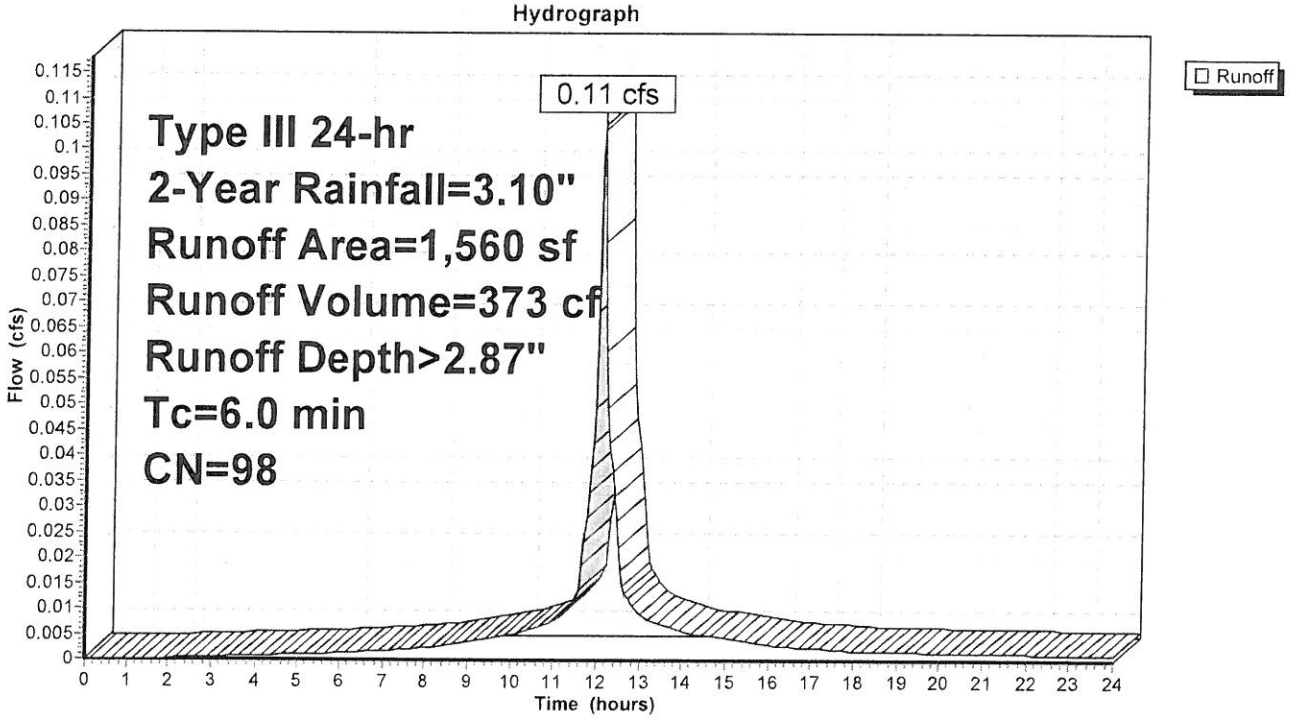
Runoff = 0.11 cfs @ 12.09 hrs, Volume= 373 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
1,560	98	Roofs, HSG C
1,560		100.00% Impervious Area

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

Subcatchment 3S: House



Summary for Subcatchment 4S: Garage

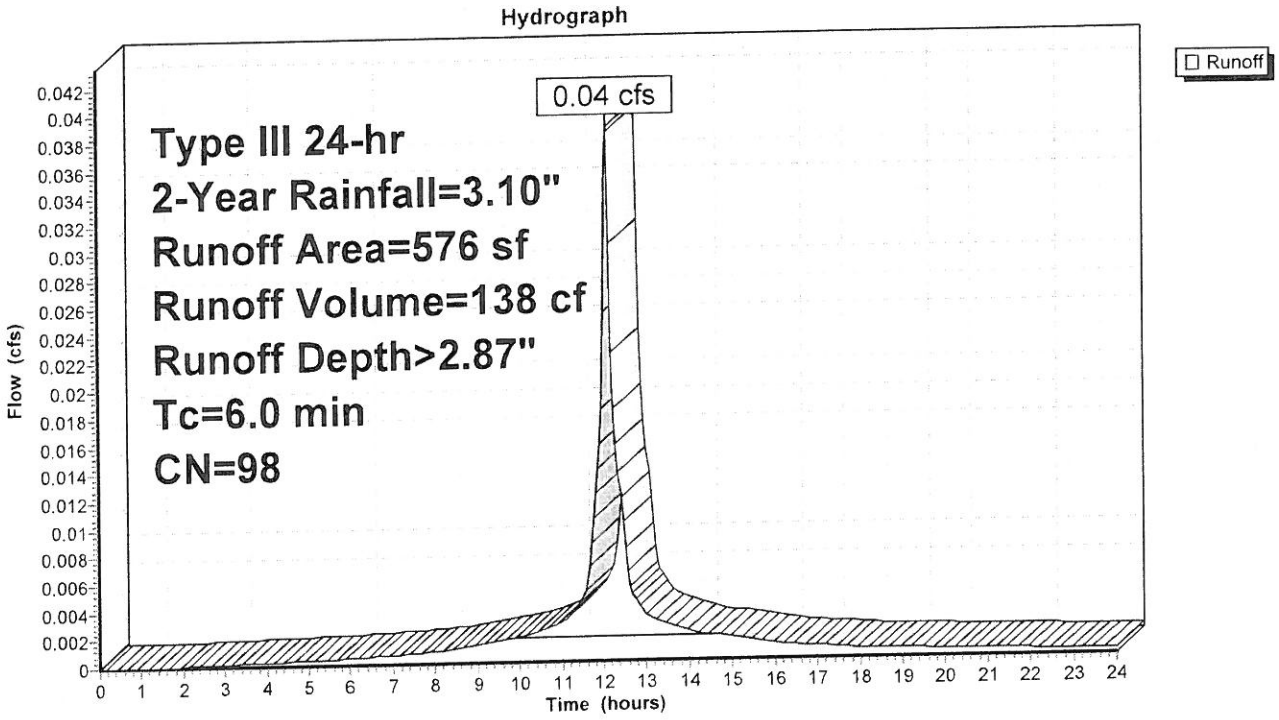
Runoff = 0.04 cfs @ 12.09 hrs, Volume= 138 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
576	98	Roofs, HSG C
576		100.00% Impervious Area

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

Subcatchment 4S: Garage



Summary for Pond 5P: Hse Infiltrator

Inflow Area = 1,560 sf,100.00% Impervious, Inflow Depth > 2.87" for 2-Year event
Inflow = 0.11 cfs @ 12.09 hrs, Volume= 373 cf
Outflow = 0.10 cfs @ 12.11 hrs, Volume= 270 cf, Atten= 3%, Lag= 1.3 min
Primary = 0.10 cfs @ 12.11 hrs, Volume= 270 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 99.23' @ 12.11 hrs Surf.Area= 0 sf Storage= 115 cf

Plug-Flow detention time= 165.4 min calculated for 269 cf (72% of inflow)
Center-of-Mass det. time= 77.2 min (833.8 - 756.6)

Volume	Invert	Avail.Storage	Storage Description
#1	97.50'	107 cf	**Stone Area** Listed below x 3 291 cf Overall - 24 cf Embedded = 267 cf x 40.0% Voids
#2	98.00'	24 cf	**Infiltrator Quick 4 - 8 units** Listed below x 4 Inside #1
		131 cf	Total Available Storage

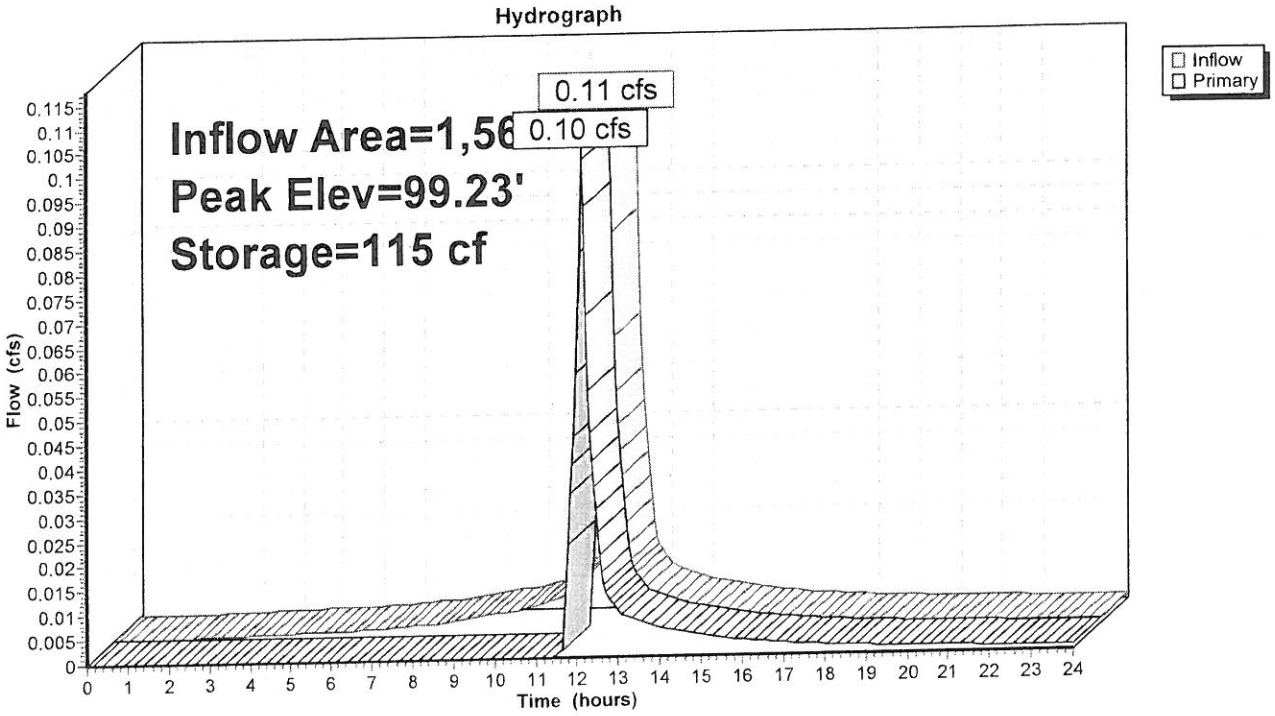
Elevation (feet)	Cum.Store (cubic-feet)
97.50	0
99.50	97

Elevation (feet)	Cum.Store (cubic-feet)
98.00	0
98.17	1
98.33	2
98.50	3
98.67	4
98.83	5
99.00	6

Device	Routing	Invert	Outlet Devices
#1	Primary	99.00'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.10 cfs @ 12.11 hrs HW=99.22' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.10 cfs @ 1.61 fps)

Pond 5P: Hse Infiltrator



Summary for Pond 6P: Roof Infiltrator

Inflow Area = 576 sf,100.00% Impervious, Inflow Depth > 2.87" for 2-Year event
Inflow = 0.04 cfs @ 12.09 hrs, Volume= 138 cf
Outflow = 0.03 cfs @ 12.19 hrs, Volume= 72 cf, Atten= 32%, Lag= 6.4 min
Primary = 0.03 cfs @ 12.19 hrs, Volume= 72 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 99.11' @ 12.19 hrs Surf.Area= 0 sf Storage= 70 cf

Plug-Flow detention time= 241.7 min calculated for 72 cf (52% of inflow)
Center-of-Mass det. time= 122.3 min (878.9 - 756.6)

Volume	Invert	Avail.Storage	Storage Description
#1	97.50'	73 cf	**Stone Area** Listed below x 2 194 cf Overall - 12 cf Embedded = 182 cf x 40.0% Voids
#2	98.00'	12 cf	**Infiltrator Quick 4 - 4 units** Listed below x 2 Inside #1
		85 cf	Total Available Storage

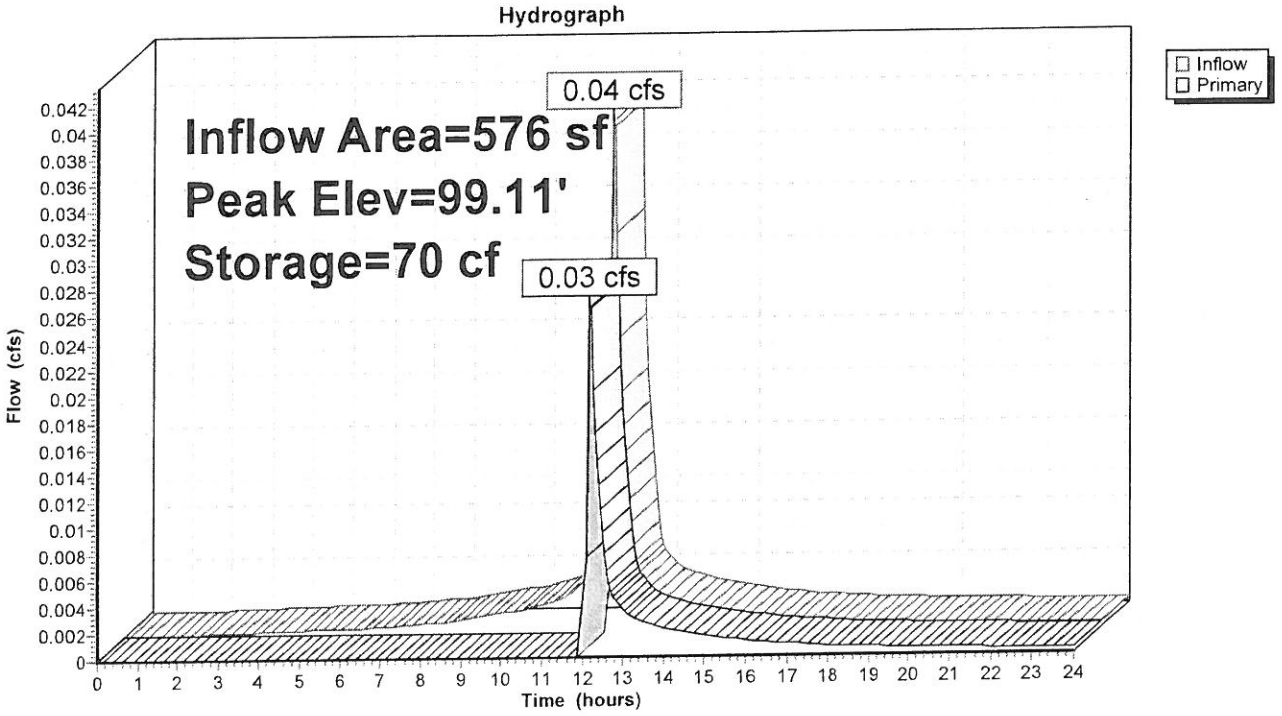
Elevation (feet)	Cum.Store (cubic-feet)
97.50	0
99.50	97

Elevation (feet)	Cum.Store (cubic-feet)
98.00	0
98.17	1
98.33	2
98.50	3
98.67	4
98.83	5
99.00	6

Device	Routing	Invert	Outlet Devices
#1	Primary	99.00'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.03 cfs @ 12.19 hrs HW=99.10' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.03 cfs @ 1.10 fps)

Pond 6P: Roof Infiltrator



Summary for Pond 7P: Trench

Inflow Area = 6,162 sf, 2.08% Impervious, Inflow Depth > 0.97" for 2-Year event
Inflow = 0.15 cfs @ 12.10 hrs, Volume= 499 cf
Outflow = 0.12 cfs @ 12.11 hrs, Volume= 424 cf, Atten= 17%, Lag= 0.6 min
Primary = 0.12 cfs @ 12.11 hrs, Volume= 424 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 98.83' @ 12.11 hrs Surf.Area= 68 sf Storage= 49 cf

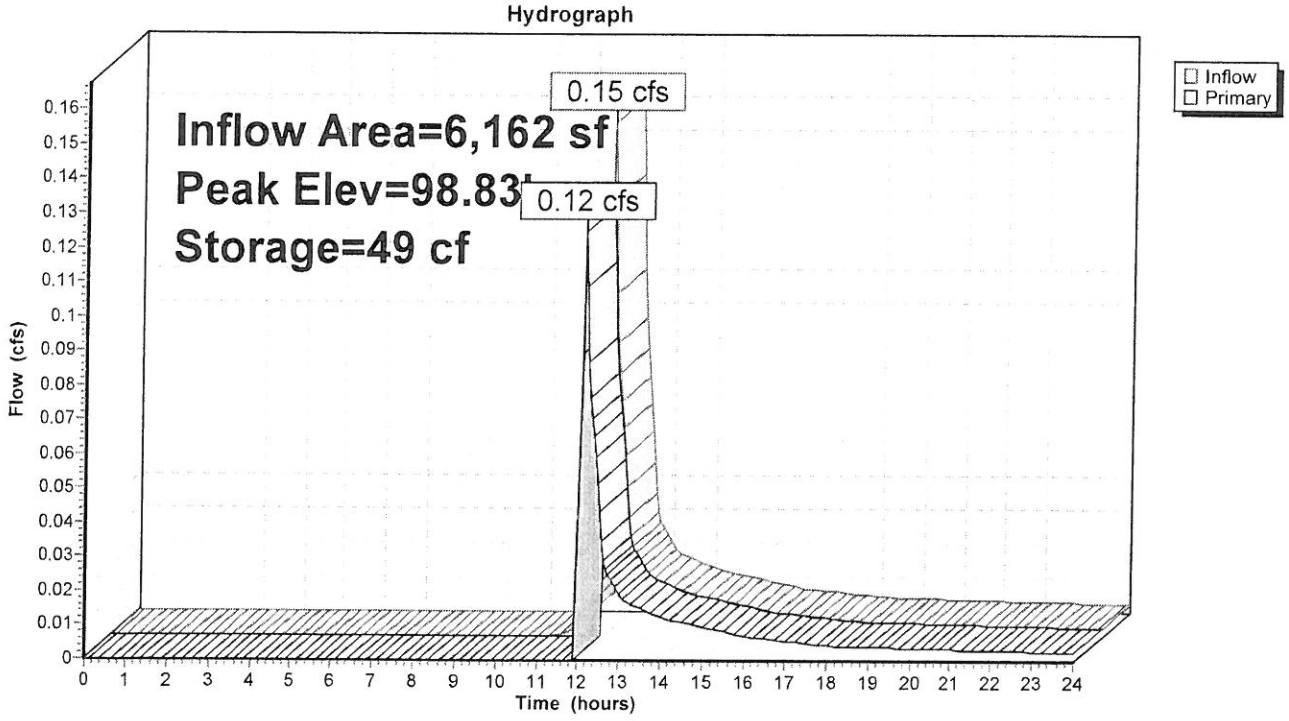
Plug-Flow detention time= 92.2 min calculated for 423 cf (85% of inflow)
Center-of-Mass det. time= 26.3 min (889.8 - 863.4)

Volume	Invert	Avail.Storage	Storage Description
#1	97.00'	54 cf	**1.50'W x 45.00'L x 2.00'H Prismatoid** 135 cf Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	98.80'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.12 cfs @ 12.11 hrs HW=98.83' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.12 cfs @ 0.44 fps)

Pond 7P: Trench

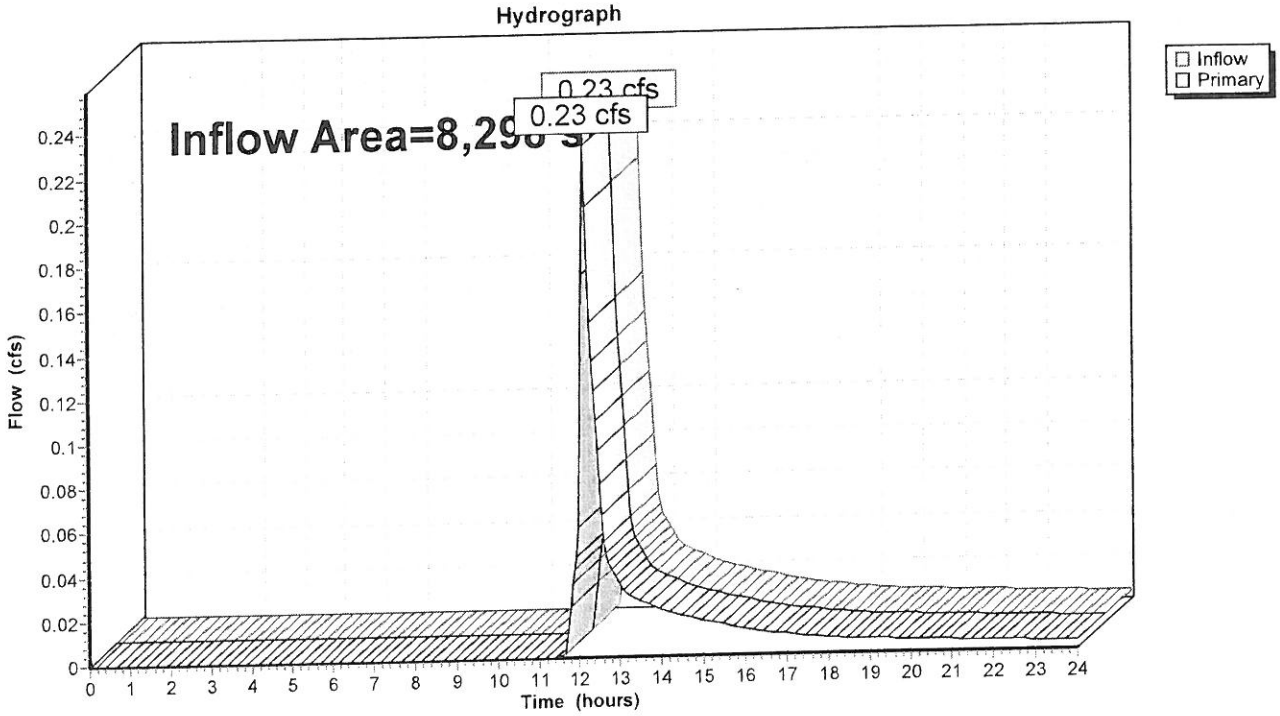


Summary for Link 2L: Total Site Proposed

Inflow Area = 8,298 sf, 27.28% Impervious, Inflow Depth > 1.11" for 2-Year event
Inflow = 0.23 cfs @ 12.12 hrs, Volume= 766 cf
Primary = 0.23 cfs @ 12.12 hrs, Volume= 766 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 2L: Total Site Proposed



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 2S: Overland Runoff Area=6,162 sf 2.08% Impervious Runoff Depth>1.97"
Tc=6.0 min CN=74 Runoff=0.32 cfs 1,012 cf

Subcatchment 3S: House Runoff Area=1,560 sf 100.00% Impervious Runoff Depth>4.26"
Tc=6.0 min CN=98 Runoff=0.15 cfs 554 cf

Subcatchment 4S: Garage Runoff Area=576 sf 100.00% Impervious Runoff Depth>4.26"
Tc=6.0 min CN=98 Runoff=0.06 cfs 205 cf

Pond 5P: Hse Infiltrator Peak Elev=99.29' Storage=119 cf Inflow=0.15 cfs 554 cf
Outflow=0.15 cfs 451 cf

Pond 6P: Roof Infiltrator Peak Elev=99.16' Storage=72 cf Inflow=0.06 cfs 205 cf
Outflow=0.06 cfs 139 cf

Pond 7P: Trench Peak Elev=98.85' Storage=50 cf Inflow=0.32 cfs 1,012 cf
Outflow=0.32 cfs 966 cf

Link 2L: Total Site Proposed Inflow=0.52 cfs 1,556 cf
Primary=0.52 cfs 1,556 cf

Total Runoff Area = 8,298 sf Runoff Volume = 1,770 cf Average Runoff Depth = 2.56"
72.72% Pervious = 6,034 sf 27.28% Impervious = 2,264 sf

Summary for Subcatchment 2S: Overland

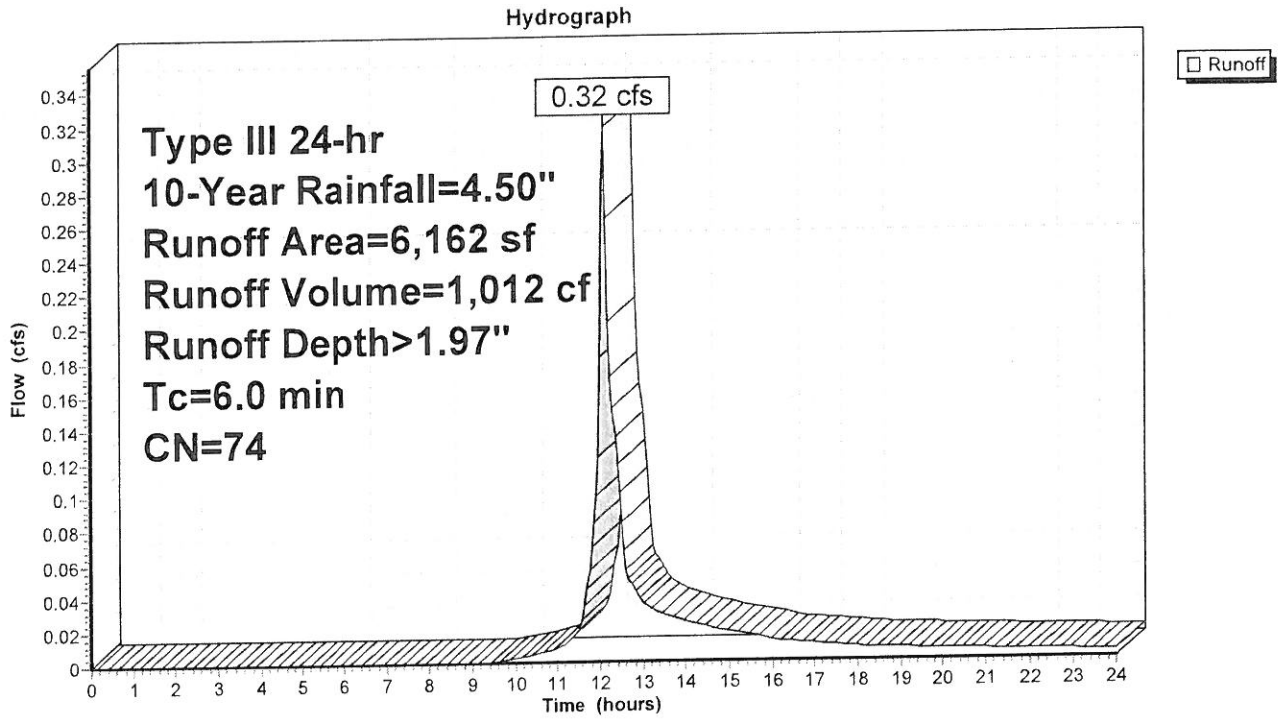
Runoff = 0.32 cfs @ 12.10 hrs, Volume= 1,012 cf, Depth> 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
6,034	74	>75% Grass cover, Good, HSG C
128	98	Unconnected pavement, HSG C
6,162	74	Weighted Average
6,034		97.92% Pervious Area
128		2.08% Impervious Area
128		100.00% Unconnected

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

Subcatchment 2S: Overland



Summary for Subcatchment 3S: House

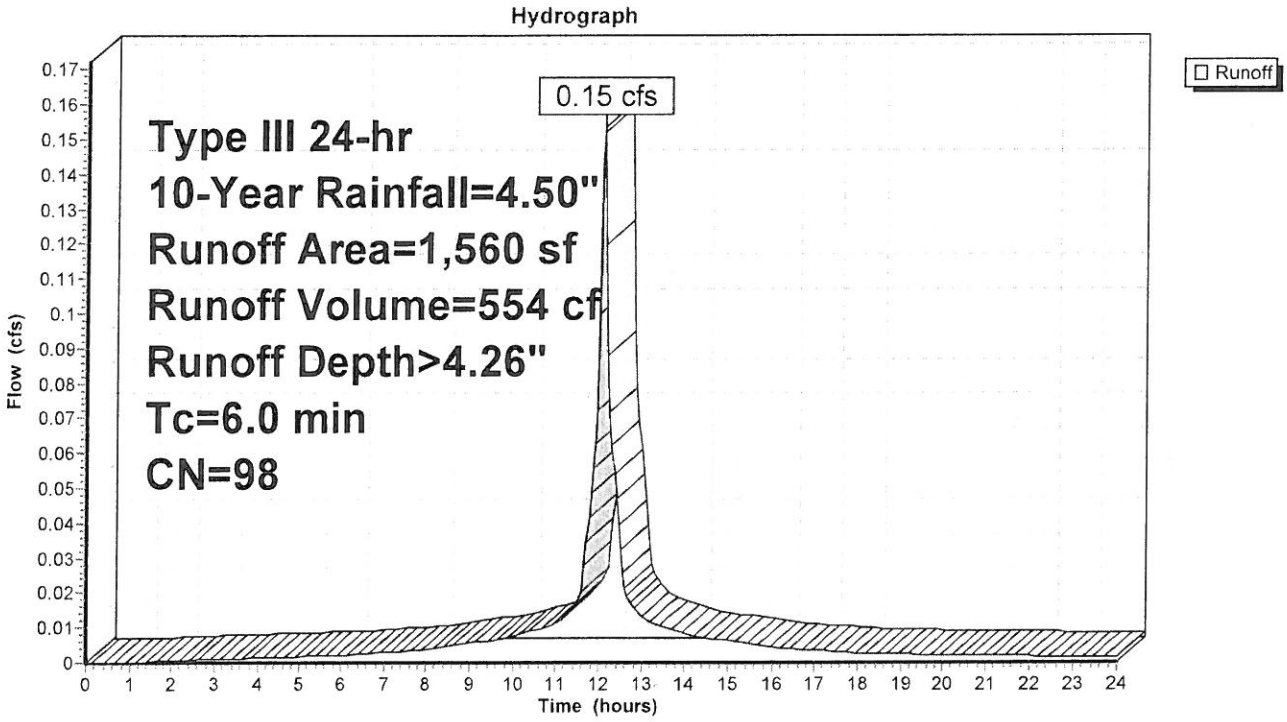
Runoff = 0.15 cfs @ 12.09 hrs, Volume= 554 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
1,560	98	Roofs, HSG C
1,560		100.00% Impervious Area

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

Subcatchment 3S: House



Summary for Subcatchment 4S: Garage

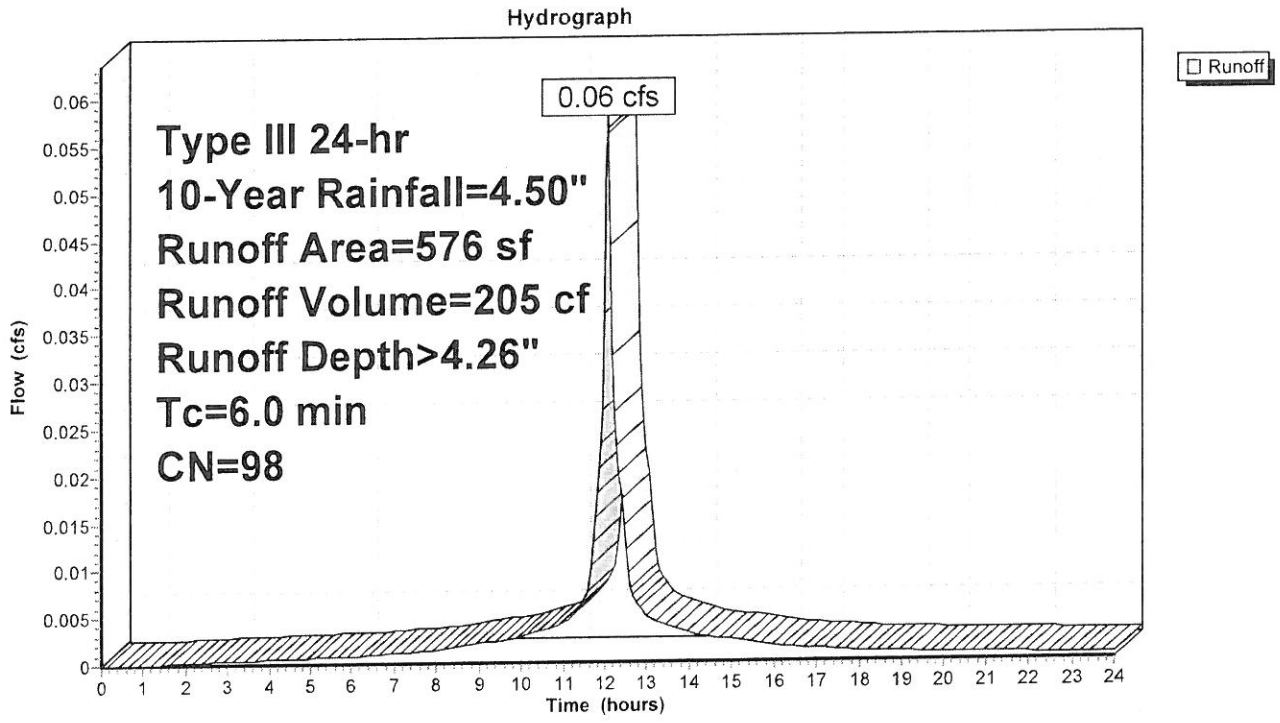
Runoff = 0.06 cfs @ 12.09 hrs, Volume= 205 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
576	98	Roofs, HSG C
576		100.00% Impervious Area

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

Subcatchment 4S: Garage



Summary for Pond 5P: Hse Infiltrator

Inflow Area = 1,560 sf,100.00% Impervious, Inflow Depth > 4.26" for 10-Year event
Inflow = 0.15 cfs @ 12.09 hrs, Volume= 554 cf
Outflow = 0.15 cfs @ 12.11 hrs, Volume= 451 cf, Atten= 3%, Lag= 1.3 min
Primary = 0.15 cfs @ 12.11 hrs, Volume= 451 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 99.29' @ 12.11 hrs Surf.Area= 0 sf Storage= 119 cf

Plug-Flow detention time= 137.5 min calculated for 451 cf (81% of inflow)
Center-of-Mass det. time= 64.5 min (813.9 - 749.4)

Volume	Invert	Avail.Storage	Storage Description
#1	97.50'	107 cf	**Stone Area** Listed below x 3 291 cf Overall - 24 cf Embedded = 267 cf x 40.0% Voids
#2	98.00'	24 cf	**Infiltrator Quick 4 - 8 units** Listed below x 4 Inside #1
		131 cf	Total Available Storage

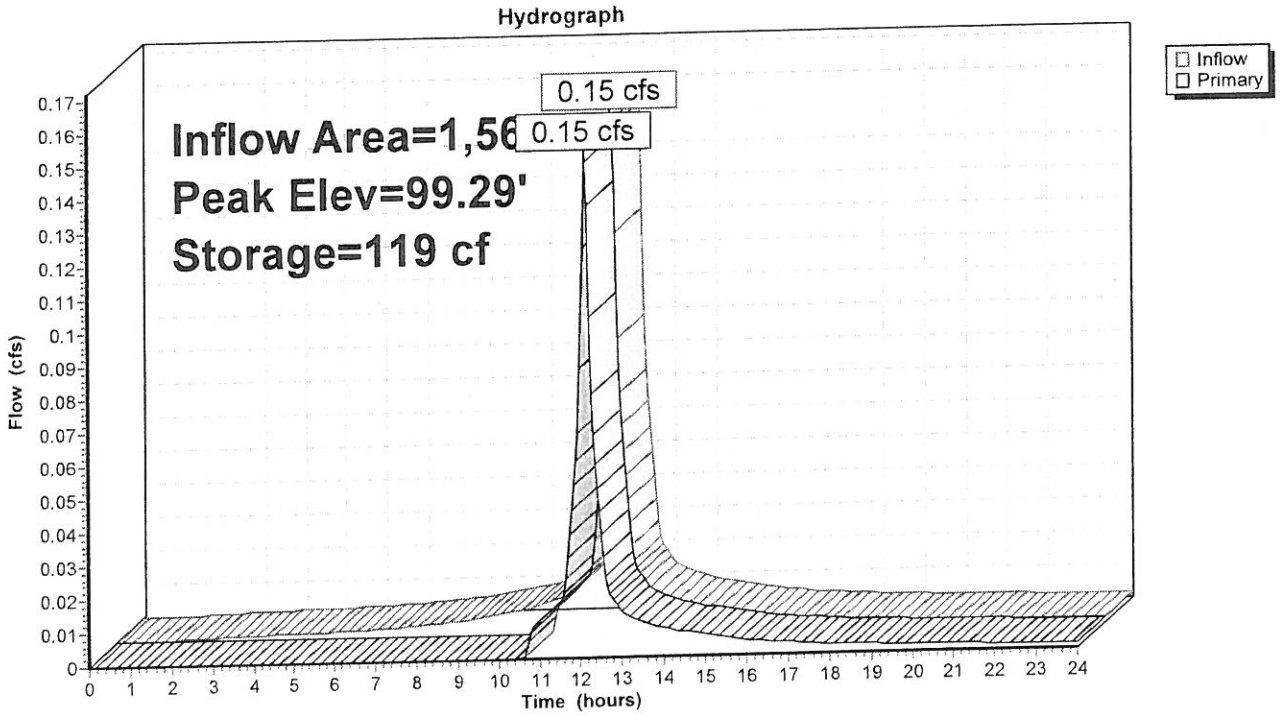
Elevation (feet)	Cum.Store (cubic-feet)
97.50	0
99.50	97

Elevation (feet)	Cum.Store (cubic-feet)
98.00	0
98.17	1
98.33	2
98.50	3
98.67	4
98.83	5
99.00	6

Device	Routing	Invert	Outlet Devices
#1	Primary	99.00'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.15 cfs @ 12.11 hrs HW=99.29' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.15 cfs @ 1.83 fps)

Pond 5P: Hse Infiltrator



Summary for Pond 6P: Roof Infiltrator

Inflow Area = 576 sf,100.00% Impervious, Inflow Depth > 4.26" for 10-Year event
Inflow = 0.06 cfs @ 12.09 hrs, Volume= 205 cf
Outflow = 0.06 cfs @ 12.10 hrs, Volume= 139 cf, Atten= 2%, Lag= 1.1 min
Primary = 0.06 cfs @ 12.10 hrs, Volume= 139 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 99.16' @ 12.10 hrs Surf.Area= 0 sf Storage= 72 cf

Plug-Flow detention time= 187.5 min calculated for 139 cf (68% of inflow)
Center-of-Mass det. time= 90.2 min (839.6 - 749.4)

Volume	Invert	Avail.Storage	Storage Description
#1	97.50'	73 cf	**Stone Area** Listed below x 2 194 cf Overall - 12 cf Embedded = 182 cf x 40.0% Voids
#2	98.00'	12 cf	**Infiltrator Quick 4 - 4 units** Listed below x 2 Inside #1
		85 cf	Total Available Storage

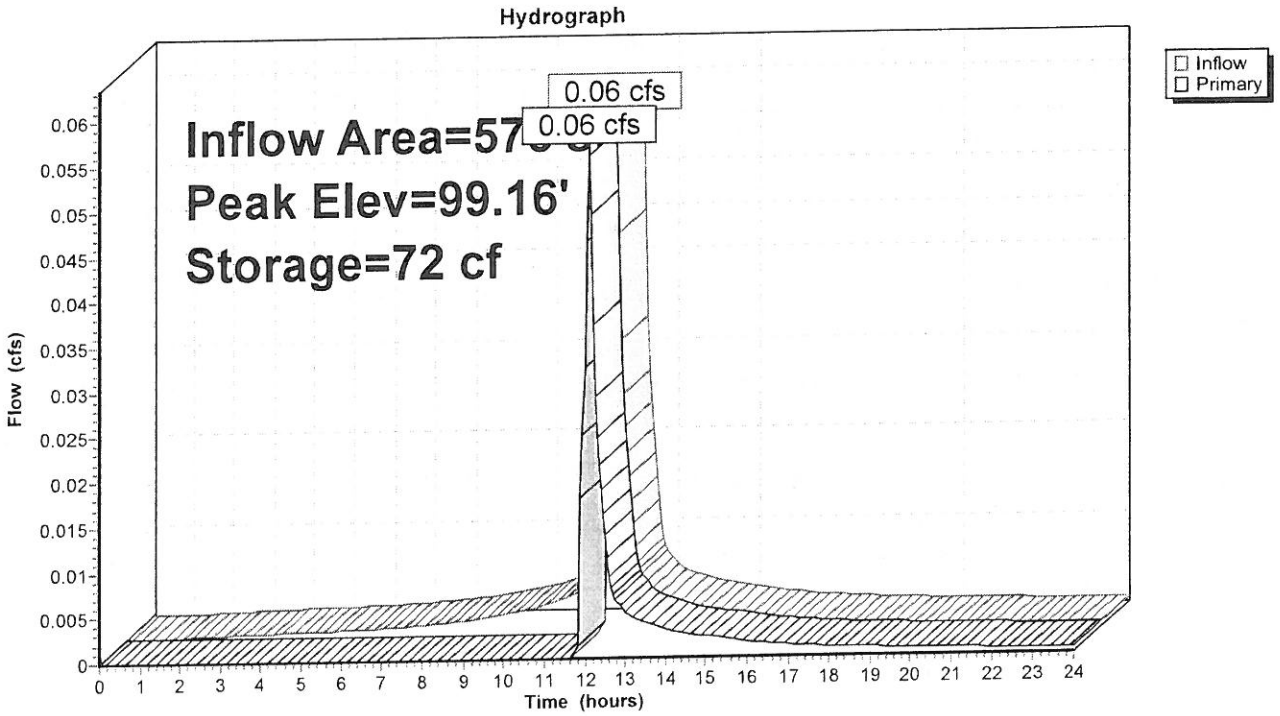
Elevation (feet)	Cum.Store (cubic-feet)
97.50	0
99.50	97

Elevation (feet)	Cum.Store (cubic-feet)
98.00	0
98.17	1
98.33	2
98.50	3
98.67	4
98.83	5
99.00	6

Device	Routing	Invert	Outlet Devices
#1	Primary	99.00'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.06 cfs @ 12.10 hrs HW=99.16' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.06 cfs @ 1.35 fps)

Pond 6P: Roof Infiltrator



Summary for Pond 7P: Trench

Inflow Area = 6,162 sf, 2.08% Impervious, Inflow Depth > 1.97" for 10-Year event
Inflow = 0.32 cfs @ 12.10 hrs, Volume= 1,012 cf
Outflow = 0.32 cfs @ 12.10 hrs, Volume= 966 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.32 cfs @ 12.10 hrs, Volume= 966 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 98.85' @ 12.10 hrs Surf.Area= 68 sf Storage= 50 cf

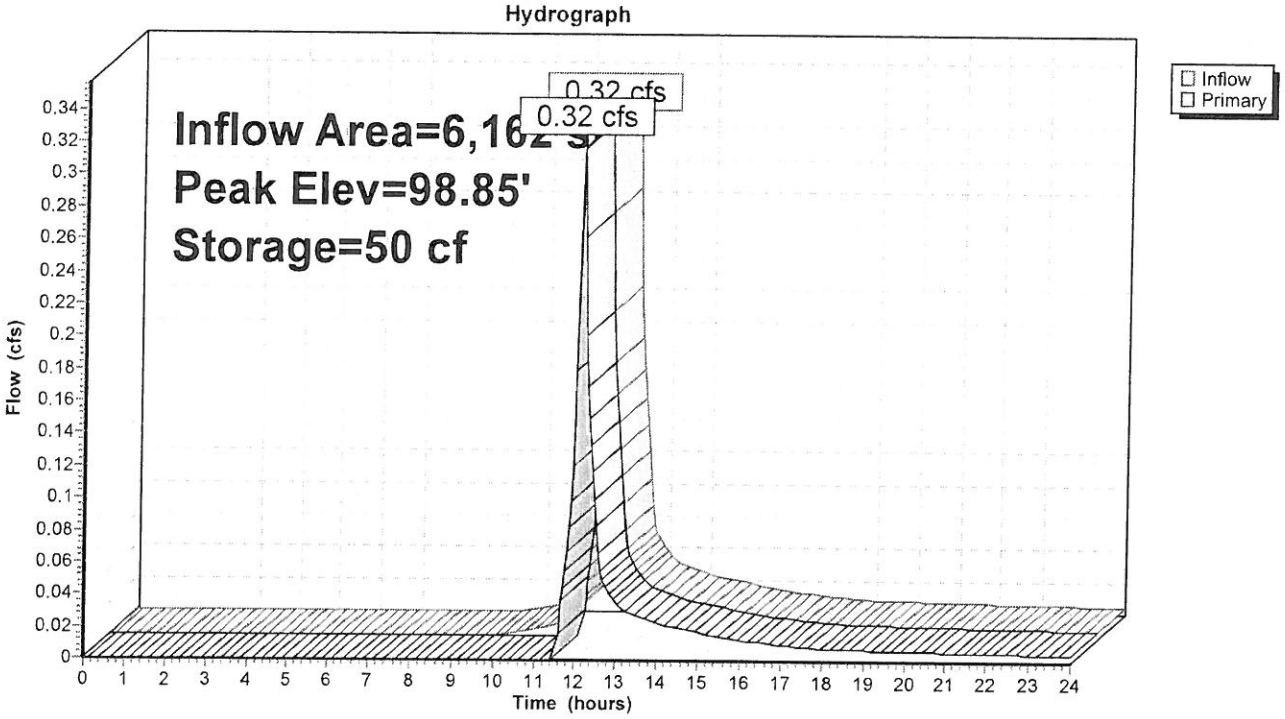
Plug-Flow detention time= 33.3 min calculated for 966 cf (95% of inflow)
Center-of-Mass det. time= 8.9 min (851.0 - 842.1)

Volume	Invert	Avail.Storage	Storage Description
#1	97.00'	54 cf	**1.50'W x 45.00'L x 2.00'H Prismatoid** 135 cf Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	98.80'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.31 cfs @ 12.10 hrs HW=98.85' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.31 cfs @ 0.61 fps)

Pond 7P: Trench

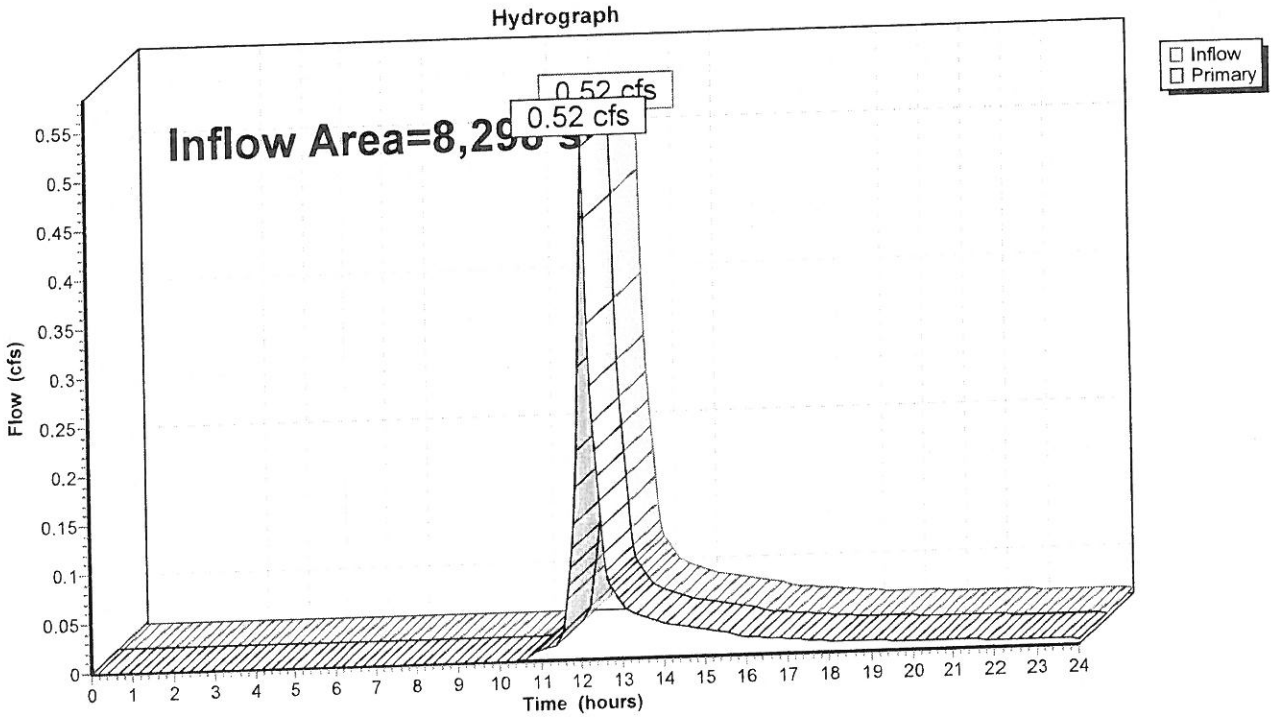


Summary for Link 2L: Total Site Proposed

Inflow Area = 8,298 sf, 27.28% Impervious, Inflow Depth > 2.25" for 10-Year event
Inflow = 0.52 cfs @ 12.10 hrs, Volume= 1,556 cf
Primary = 0.52 cfs @ 12.10 hrs, Volume= 1,556 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 2L: Total Site Proposed



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2S: Overland Runoff Area=6,162 sf 2.08% Impervious Runoff Depth>3.61"
Tc=6.0 min CN=74 Runoff=0.59 cfs 1,852 cf

Subcatchment3S: House Runoff Area=1,560 sf 100.00% Impervious Runoff Depth>6.26"
Tc=6.0 min CN=98 Runoff=0.22 cfs 813 cf

Subcatchment4S: Garage Runoff Area=576 sf 100.00% Impervious Runoff Depth>6.26"
Tc=6.0 min CN=98 Runoff=0.08 cfs 300 cf

Pond 5P: Hse Infiltrator Peak Elev=99.41' Storage=126 cf Inflow=0.22 cfs 813 cf
Outflow=0.21 cfs 710 cf

Pond 6P: Roof Infiltrator Peak Elev=99.20' Storage=73 cf Inflow=0.08 cfs 300 cf
Outflow=0.08 cfs 234 cf

Pond 7P: Trench Peak Elev=98.88' Storage=51 cf Inflow=0.59 cfs 1,852 cf
Outflow=0.59 cfs 1,805 cf

Link 2L: Total Site Proposed Inflow=0.87 cfs 2,749 cf
Primary=0.87 cfs 2,749 cf

Total Runoff Area = 8,298 sf Runoff Volume = 2,966 cf Average Runoff Depth = 4.29"
72.72% Pervious = 6,034 sf 27.28% Impervious = 2,264 sf

Summary for Subcatchment 2S: Overland

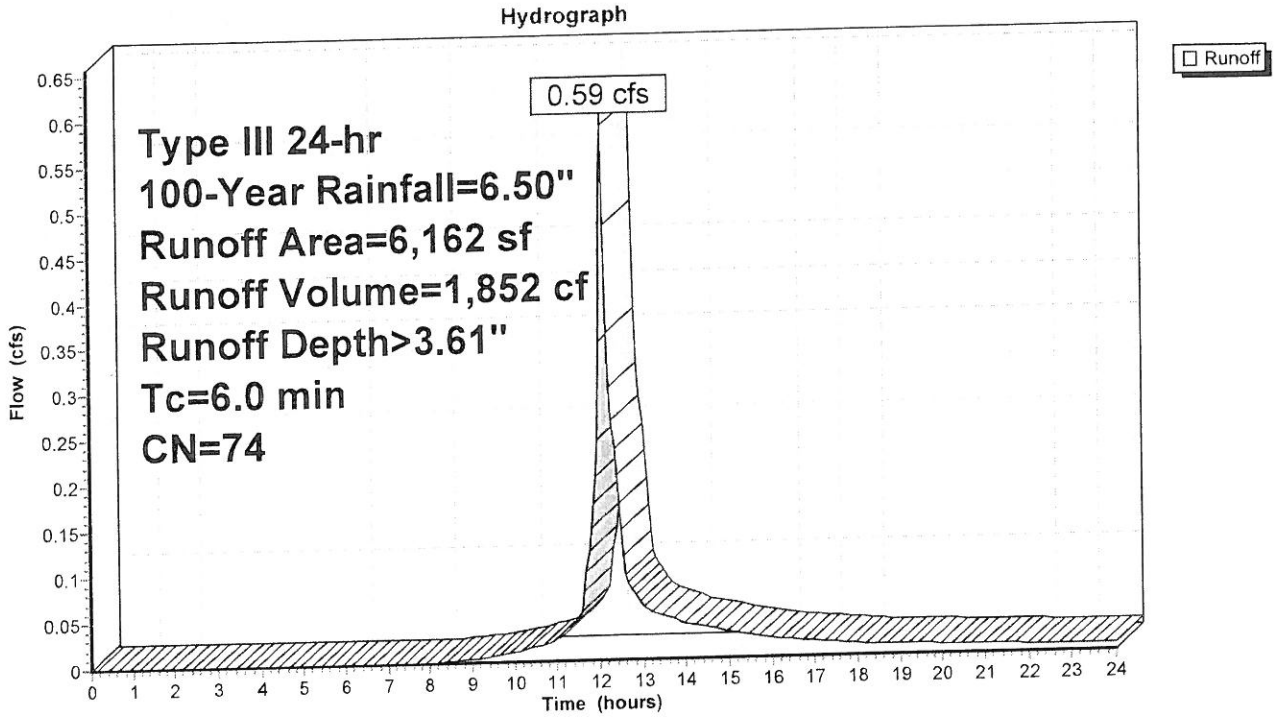
Runoff = 0.59 cfs @ 12.09 hrs, Volume= 1,852 cf, Depth> 3.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
6,034	74	>75% Grass cover, Good, HSG C
128	98	Unconnected pavement, HSG C
6,162	74	Weighted Average
6,034		97.92% Pervious Area
128		2.08% Impervious Area
128		100.00% Unconnected

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

Subcatchment 2S: Overland



Summary for Subcatchment 3S: House

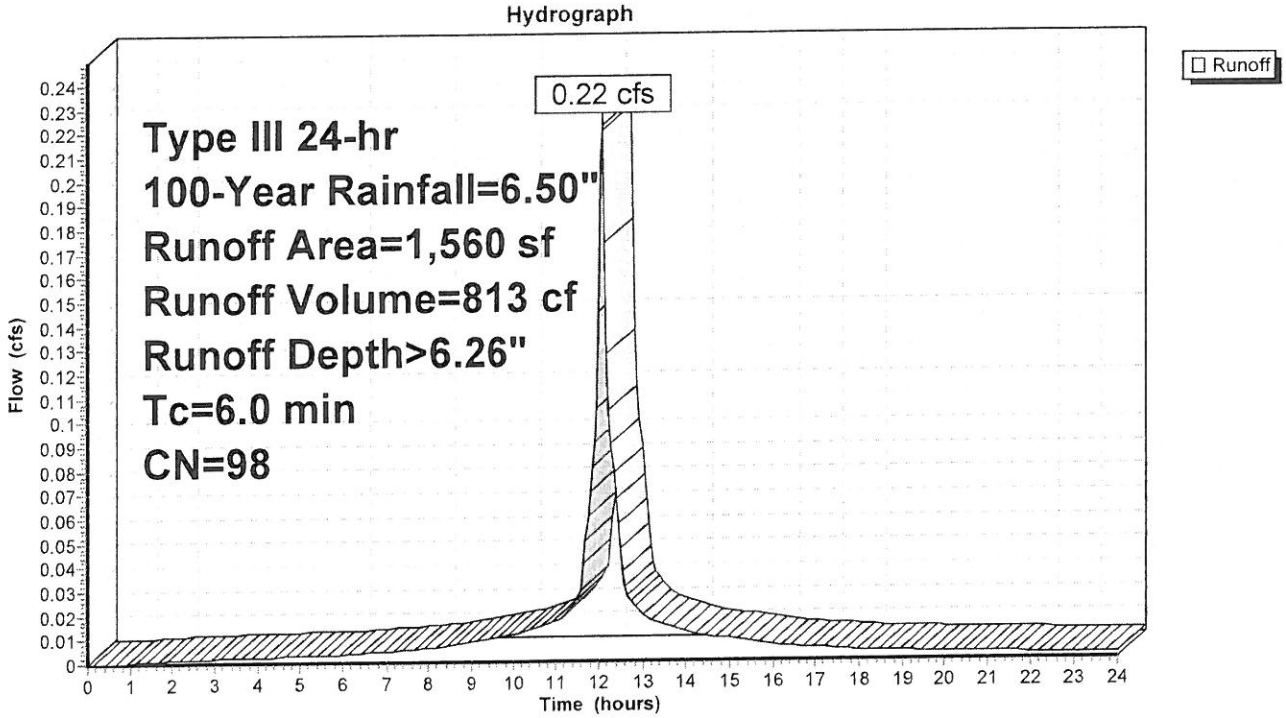
Runoff = 0.22 cfs @ 12.09 hrs, Volume= 813 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
1,560	98	Roofs, HSG C
1,560		100.00% Impervious Area

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

Subcatchment 3S: House



Summary for Subcatchment 4S: Garage

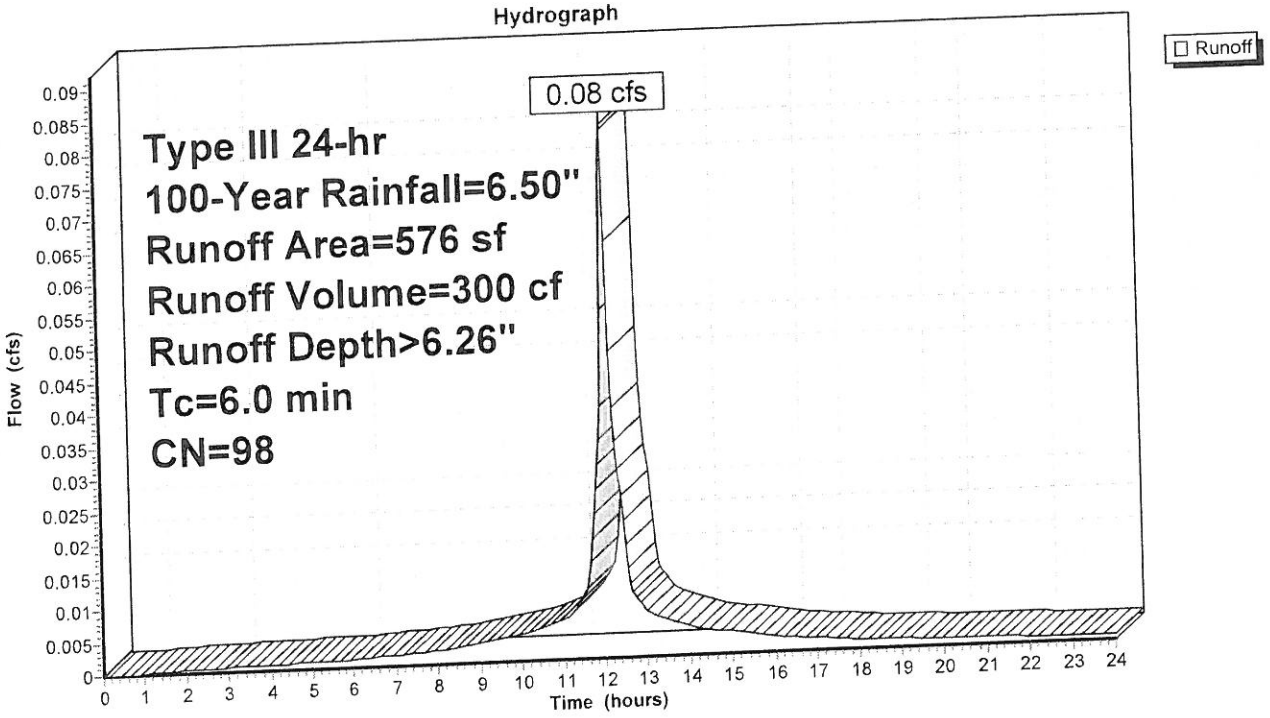
Runoff = 0.08 cfs @ 12.09 hrs, Volume= 300 cf, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
576	98	Roofs, HSG C
576		100.00% Impervious Area

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

Subcatchment 4S: Garage



Summary for Pond 5P: Hse Infiltrator

Inflow Area = 1,560 sf,100.00% Impervious, Inflow Depth > 6.26" for 100-Year event
Inflow = 0.22 cfs @ 12.09 hrs, Volume= 813 cf
Outflow = 0.21 cfs @ 12.12 hrs, Volume= 710 cf, Atten= 6%, Lag= 1.7 min
Primary = 0.21 cfs @ 12.12 hrs, Volume= 710 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 99.41' @ 12.11 hrs Surf.Area= 0 sf Storage= 126 cf

Plug-Flow detention time= 110.7 min calculated for 709 cf (87% of inflow)
Center-of-Mass det. time= 53.3 min (796.9 - 743.6)

Volume	Invert	Avail.Storage	Storage Description
#1	97.50'	107 cf	**Stone Area** Listed below x 3 291 cf Overall - 24 cf Embedded = 267 cf x 40.0% Voids
#2	98.00'	24 cf	**Infiltrator Quick 4 - 8 units** Listed below x 4 Inside #1
		131 cf	Total Available Storage

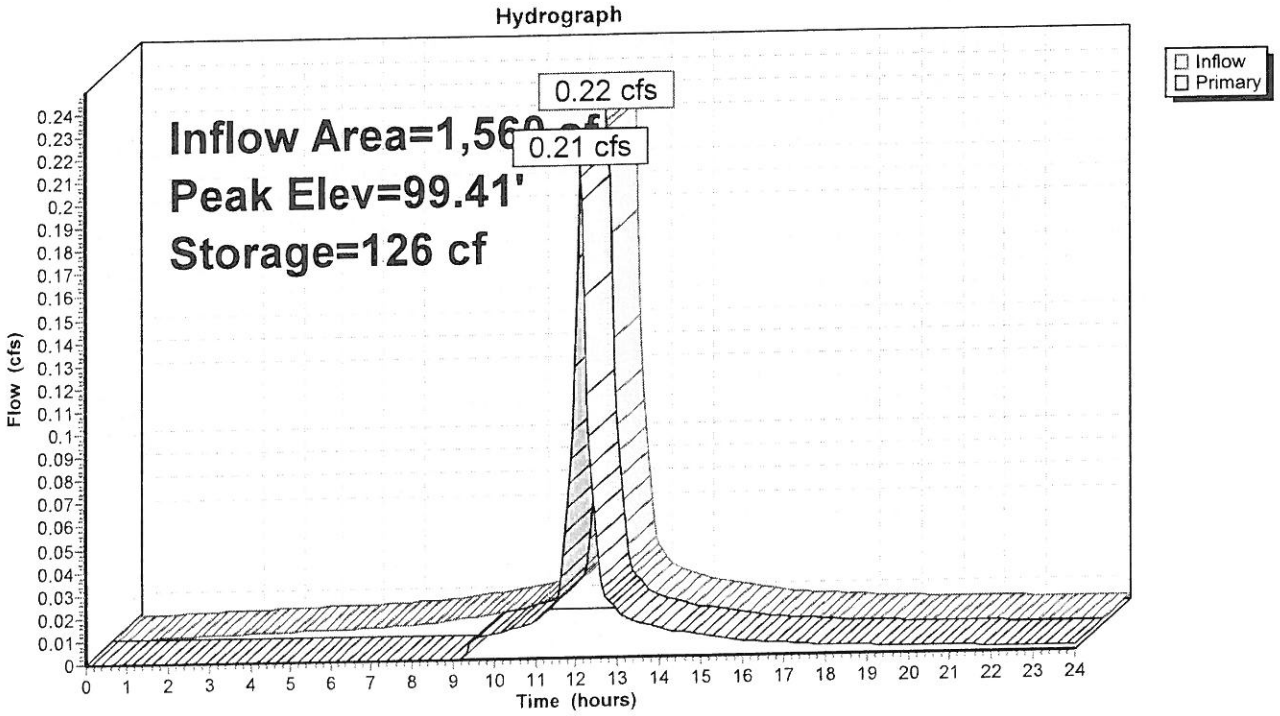
Elevation (feet)	Cum.Store (cubic-feet)
97.50	0
99.50	97

Elevation (feet)	Cum.Store (cubic-feet)
98.00	0
98.17	1
98.33	2
98.50	3
98.67	4
98.83	5
99.00	6

Device	Routing	Invert	Outlet Devices
#1	Primary	99.00'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.20 cfs @ 12.12 hrs HW=99.40' (Free Discharge)
↑**1=Orifice/Grate** (Orifice Controls 0.20 cfs @ 2.35 fps)

Pond 5P: Hse Infiltrator



Summary for Pond 6P: Roof Infiltrator

Inflow Area = 576 sf, 100.00% Impervious, Inflow Depth > 6.26" for 100-Year event
Inflow = 0.08 cfs @ 12.09 hrs, Volume= 300 cf
Outflow = 0.08 cfs @ 12.10 hrs, Volume= 234 cf, Atten= 1%, Lag= 1.0 min
Primary = 0.08 cfs @ 12.10 hrs, Volume= 234 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 99.20' @ 12.10 hrs Surf.Area= 0 sf Storage= 73 cf

Plug-Flow detention time= 155.5 min calculated for 234 cf (78% of inflow)
Center-of-Mass det. time= 74.7 min (818.2 - 743.6)

Volume	Invert	Avail.Storage	Storage Description
#1	97.50'	73 cf	**Stone Area** Listed below x 2 194 cf Overall - 12 cf Embedded = 182 cf x 40.0% Voids
#2	98.00'	12 cf	**Infiltrator Quick 4 - 4 units** Listed below x 2 Inside #1
		85 cf	Total Available Storage

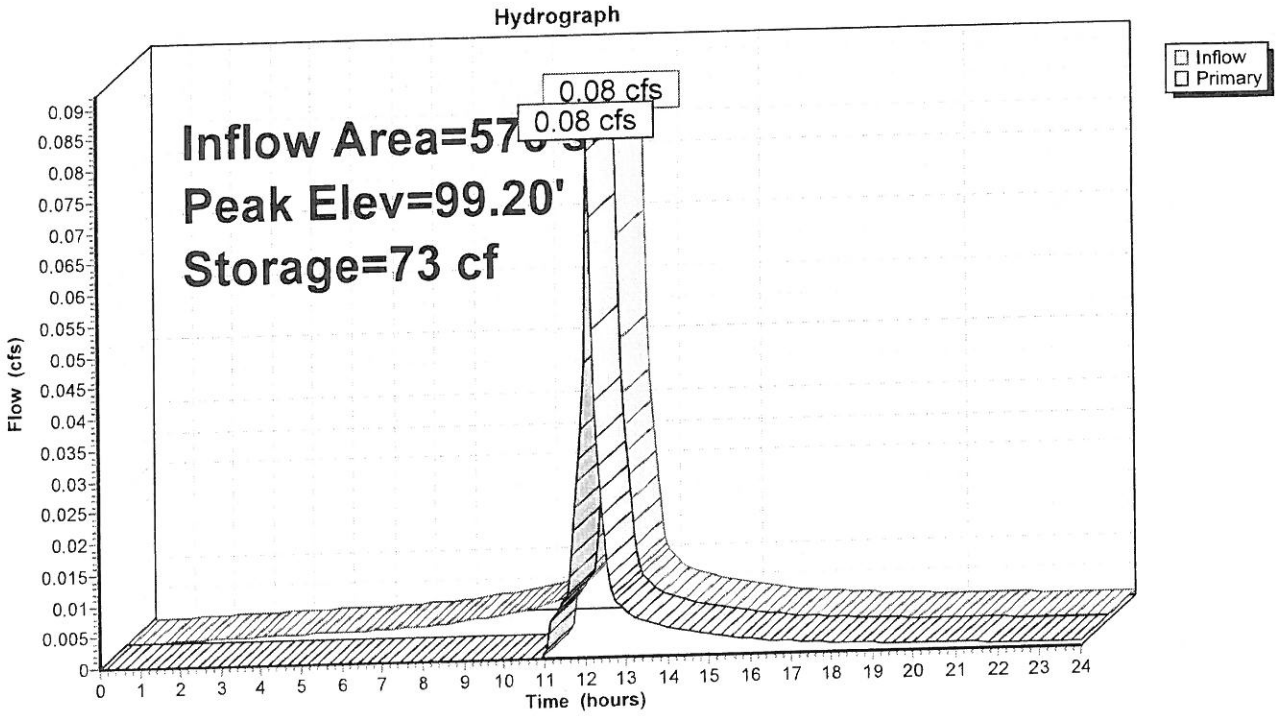
Elevation (feet)	Cum.Store (cubic-feet)
97.50	0
99.50	97

Elevation (feet)	Cum.Store (cubic-feet)
98.00	0
98.17	1
98.33	2
98.50	3
98.67	4
98.83	5
99.00	6

Device	Routing	Invert	Outlet Devices
#1	Primary	99.00'	**4.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.08 cfs @ 12.10 hrs HW=99.20' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.08 cfs @ 1.51 fps)

Pond 6P: Roof Infiltrator



Summary for Pond 7P: Trench

Inflow Area = 6,162 sf, 2.08% Impervious, Inflow Depth > 3.61" for 100-Year event
Inflow = 0.59 cfs @ 12.09 hrs, Volume= 1,852 cf
Outflow = 0.59 cfs @ 12.09 hrs, Volume= 1,805 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.59 cfs @ 12.09 hrs, Volume= 1,805 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 98.88' @ 12.09 hrs Surf.Area= 68 sf Storage= 51 cf

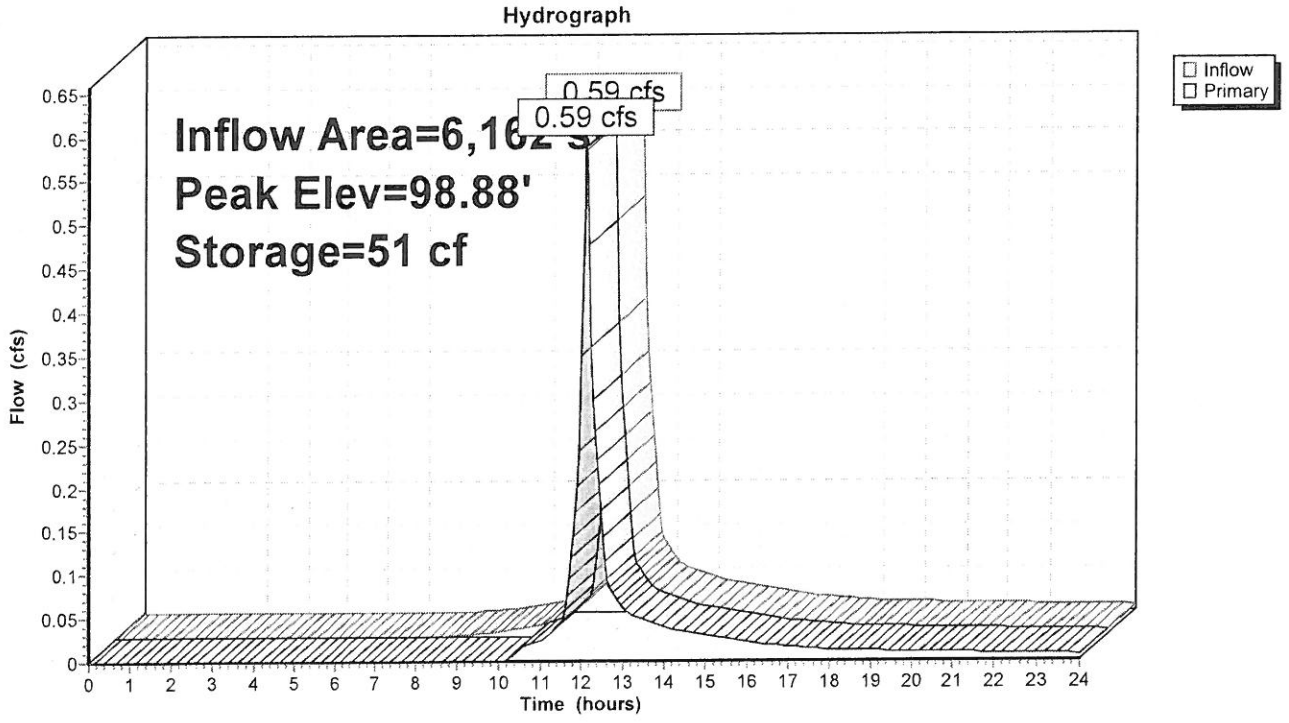
Plug-Flow detention time= 21.0 min calculated for 1,801 cf (97% of inflow)
Center-of-Mass det. time= 6.5 min (831.2 - 824.6)

Volume	Invert	Avail.Storage	Storage Description
#1	97.00'	54 cf	**1.50'W x 45.00'L x 2.00'H Prismatoid** 135 cf Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	98.80'	**10.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=0.57 cfs @ 12.09 hrs HW=98.88' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 0.57 cfs @ 0.75 fps)

Pond 7P: Trench

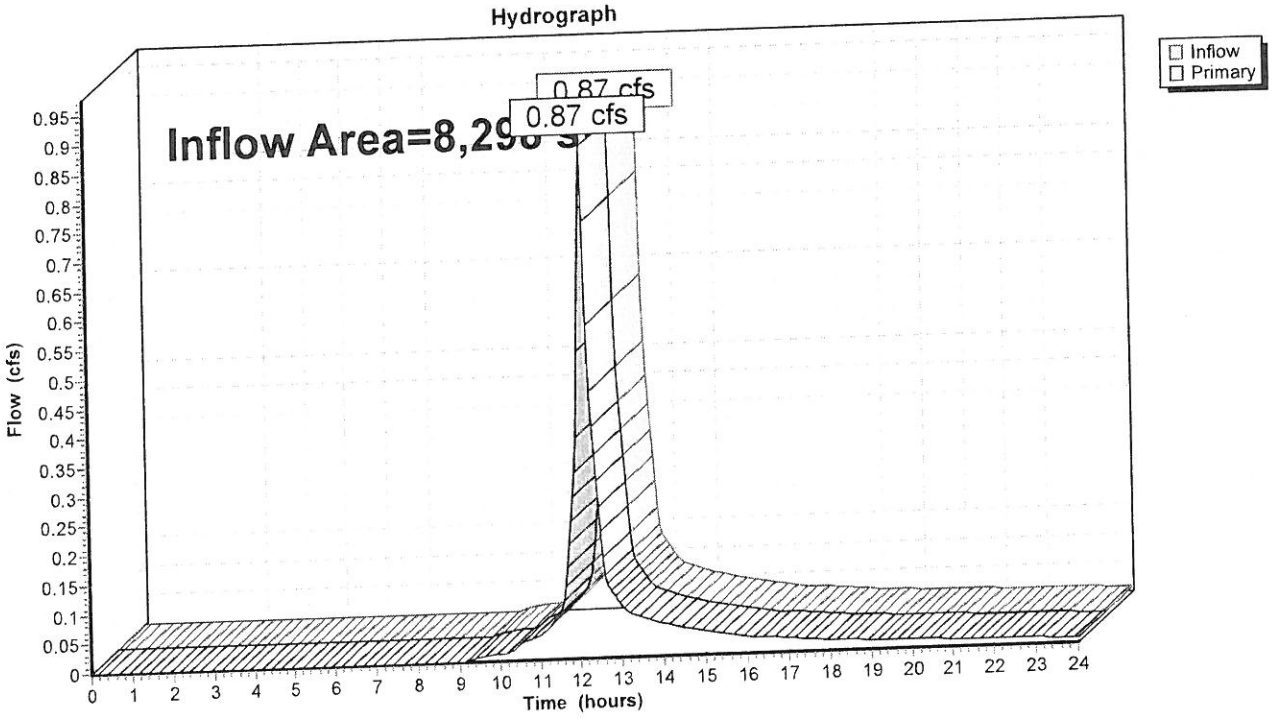


Summary for Link 2L: Total Site Proposed

Inflow Area = 8,298 sf, 27.28% Impervious, Inflow Depth > 3.98" for 100-Year event
Inflow = 0.87 cfs @ 12.10 hrs, Volume= 2,749 cf
Primary = 0.87 cfs @ 12.10 hrs, Volume= 2,749 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 2L: Total Site Proposed



United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Essex County, Massachusetts, Northern Part

March 21, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:269 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 3 7 14 21

Feet: 0 10 20 40 60

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 11, Sep 28, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 30, 2011—Apr 8, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Essex County, Massachusetts, Northern Part (MA605)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	0.0	0.9%
31A	Walpole sandy loam, 0 to 3 percent slopes	0.2	99.1%
Totals for Area of Interest		**0.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Essex County, Massachusetts, Northern Part

1—Water

Map Unit Setting

National map unit symbol: vjx4
Frost-free period: 125 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

31A—Walpole sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkl
Elevation: 0 to 1,020 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Walpole and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Walpole

Setting

Landform: Depressions, outwash plains, outwash terraces, deltas, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip, talf
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy glaciofluvial deposits derived from igneous, metamorphic and sedimentary rock

Typical profile

Oe - 0 to 1 inches: mucky peat
A - 1 to 7 inches: sandy loam
Bg - 7 to 21 inches: sandy loam
BC - 21 to 25 inches: gravelly sandy loam
C - 25 to 65 inches: very gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 4 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 6.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D

Minor Components

Scarboro

Percent of map unit: 10 percent
Landform: Deltas, outwash plains, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave

Sudbury

Percent of map unit: 10 percent
Landform: Deltas, outwash plains, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear

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