

TENNESSEE GAS PIPELINE COMPANY, L.L.C.



**Tennessee Gas Pipeline
Company, L.L.C.**
a Kinder Morgan company

**HYDROLOGIC AND HYDRAULIC CALCULATIONS
FOR TEMPORARY DIVERSION SWALES ALONG THE**

CONNECTICUT PIPELINE EXPANSION PROJECT

CONNECTICUT LOOP

Submitted by:

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APRIL 2015

The attached hydrologic and hydraulic calculations were performed for all temporary diversion swales proposed to be installed by the Connecticut Pipeline Extension (Project) Hartford County Connecticut. The Project would consist of installing approximately 13.3 miles of pipeline looping: 1.4 Miles of 36-inch Pipeline Loop in Albany County, New York (“NY Loop”) 3.8 Miles of 36-inch Pipeline Loop in Berkshire County, Massachusetts (“MA Loop”). 8.15 Miles of 24-inch Pipeline Loop in Hampden County, Massachusetts and Hartford County, Connecticut (“CT Loop”).

The primary objective of the attached calculations is to evaluate the amount of stormwater runoff contributory to the proposed temporary diversion swales in order to confirm the diversion swale size and lining are adequate for the anticipated flow rates. A typical temporary diversion swale will consist of a graded trapezoidal channel with erosion control blankets installed to protect bare soils until permanent vegetation becomes established.

DESIGN CRITERIA AND METHODOLOGY

The following design criteria and methodology was used to perform the calculations:

1. Hydrologic Calculation Methodology

Hydrologic calculations were performed using the Rational Method with HydroCAD v.10.0. The specific method used to calculate the design flows for each watershed varied based on parameters such as the watershed size and slope, and ground cover type (e.g. pasture, forest, urban).

a. Rational Method: $Q=CIA$

- Q = flow (cubic feet per second - cfs)
 C = runoff coefficient
 A = drainage area (acres – ac)
 I = rainfall intensity (inches per hour – in/hr)
- This method was used for drainage areas up to 200 acres in size
- NOAA Technical Memorandum NWS Hydro-35 was used to determine “ I ” in Connecticut County of Hartford.
- The following Runoff Coefficients were used:

Cover Type	Slope Range (%)	Hydrologic Soil Group*	Runoff Coefficient
Pasture	0% - 6%	D	0.20
Forest	0% – 20 %	D	0.32
Forest	> 20 %	D	0.38

*Hydrologic Soil Group D was used for a conservative approach.

- Time of Concentrations were calculated using the following:
 - **Sheet Flow:**
 Manning’s Kinematic Solution
 Maximum (max) sheet flow length of 150ft

- **Shallow Concentrated Flow**

The travel time for shallow concentrated flow was calculated by dividing the travel path length by a calculated velocity. The velocity for specific cover types were calculated using Manning's equation.

- **Channel Flow**

As upstream channel morphology is not constant, the travel time for Channel flow was calculated by assuming a channel velocity of 15.00 ft/s and applying it to the shallow concentrated flow formula.

b. Design Frequency:

The design frequency utilized in the design varied based on the U.S. Weather Bureau Technical Paper 40. A 2-year, a 5-year, and a 10-year storm event were analyzed for each watershed.

2. Hydraulic Calculation Methodology

The temporary diversion swales were sized using Manning's equation. To simplify the construction documents, a consistent swale size was selected. The swale has a 2 foot bottom width, a 6 foot top width, and a 1 foot depth. North American Green's Erosion Control Materials Design Software was utilized to perform hydraulic calculations for each swale. The swale design flow rate, geometry, slope, and lining are provided as inputs to the software. The software calculates the swale capacity and shear stress for the design flow with the unvegetated temporary erosion control blanket scenario, and the vegetated scenario. The software performs calculations in accordance with FHWA Hydraulic Engineering Circular #15 (HEC-15) and the USDA Agricultural Handbook No. 667.

3. Summary and Results

The temporary diversion swales are sized appropriately for the analyzed storm events. The erosion control blankets selected will protect the bare soils from erosion while vegetation is being established, and once established the vegetation will protect the swales from erosion. The following table summarizes the results of the analysis and design.

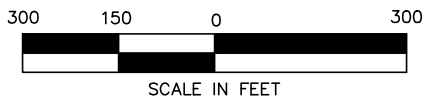


CONNECTICUT EXPANSION PROJECT - CONNECTICUT LOOP

SWALE I.D.	CHANNEL NO. STATIONING	BOTTOM WIDTH B (FT)	DEPTH D (FT)	TOP WIDTH W (FT)	Z1 (FT)	Z2 (FT)	TEMPORARY LINING*	PERMANENT LINING	Design Flow (CFS)	Cross Pipe Approx. Sta.	Cross Pipe Size (in.)	Number of Pipes	Pipe Length (FT)	Pipe Inv. (In)	Pipe Inv. (Out)	Level Spreader Length (FT.)**	Level Spreader Entrance Width (FT.)	Level Spreader End Width (FT.)	Level Spreader Depth (FT.)	Notes
1	92+00	2	1.0	6.0	2	2	SC150	UNREINFORCED VEGETATION	2.16	N/A						10	10	3	0.5	
2	102+50	2	1.0	6.0	2	2	SC150	UNREINFORCED VEGETATION	1.85	N/A						10	10	3	0.5	
3	128+00	2	1.0	6.0	2	2	SC150	UNREINFORCED VEGETATION	1.50	N/A						10	10	3	0.5	
4	295+50	2	1.0	6.0	2	2	SC150	UNREINFORCED VEGETATION	4.10	N/A						10	10	3	0.5	
6	297+50	2	1.0	6.0	2	2	SC150	UNREINFORCED VEGETATION	3.04	N/A						10	10	3	0.5	
7	306+00	2	1.0	6.0	2	2	SC150	UNREINFORCED VEGETATION	4.03	N/A						10	10	3	0.5	
8	390+00	2	1.0	6.0	2	2	SC150	UNREINFORCED VEGETATION	4.10	N/A						10	10	3	0.5	

* SEE DETAIL IN CALCULATIONS FOR PRODUCT INFORMATION

** LEVEL SPREADER TO BE DESIGNED TO CONSTRUCTION BEST MANAGEMENT PRACTICES FIGURE NUMBER 28



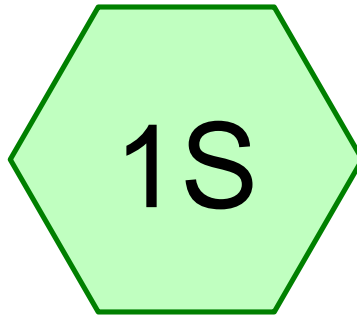
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REVISIONS					

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Section:		Township:	Range:
Dft: JR	Date: 07/17/14	Project ID:	
Chk: JD	Date: 05/27/14	Scale: 1"=300'	
Appr: RE	Date: 05/27/14	Filename: SK14C4781CT04_swales.dwg	

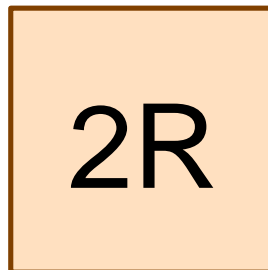
CONNECTICUT EXPANSION
 CONNECTICUT LOOP 300
 PROPOSED 24" NATURAL GAS PIPELINE
 DIVERSION SWALE AT STA. 92+00
 TOWN OF SUFFIELD
 HARTFORD COUNTY, CONNECTICUT



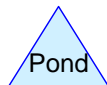
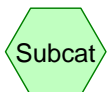
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Type:



CT-92+00



Diversion Swale



Summary for Subcatchment 1S: CT-92+00

Runoff = 1.76 cfs @ 0.77 hrs, Volume= 0.112 af, Depth= 0.35"

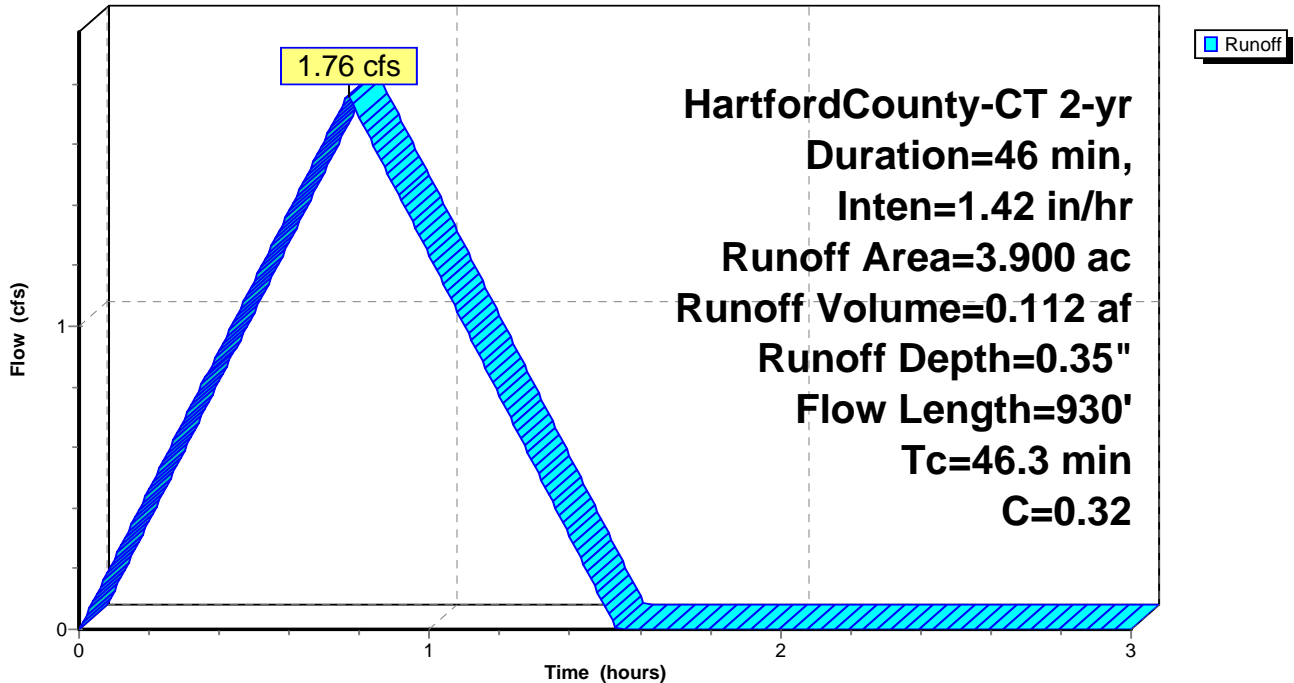
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 2-yr Duration=46 min, Inten=1.42 in/hr

Area (ac)	C	Description
3.900	0.32	Forest, 0-20%, D Soil
3.900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	150	0.0667	0.07		Sheet Flow, Sheet 1 Woods: Dense underbrush n= 0.800 P2= 2.88"
12.6	780	0.0423	1.03		Shallow Concentrated Flow, SCF Woodland Kv= 5.0 fps
46.3	930	Total			

Subcatchment 1S: CT-92+00

Hydrograph



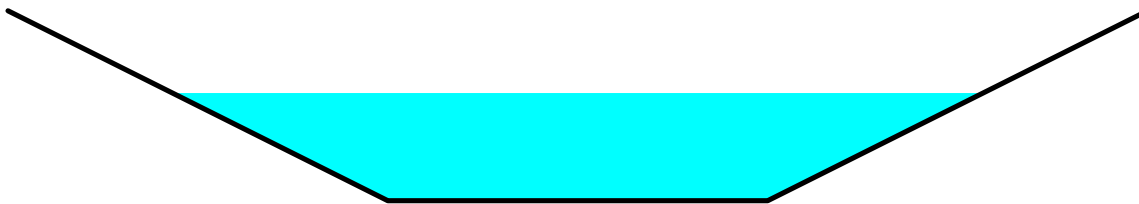
Summary for Reach 2R: Diversion Swale

Inflow Area = 3.900 ac, 0.00% Impervious, Inflow Depth = 0.35" for 2-yr event
 Inflow = 1.76 cfs @ 0.77 hrs, Volume= 0.112 af
 Outflow = 1.71 cfs @ 0.85 hrs, Volume= 0.112 af, Atten= 3%, Lag= 5.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.96 fps, Min. Travel Time= 3.3 min
 Avg. Velocity = 0.44 fps, Avg. Travel Time= 7.2 min

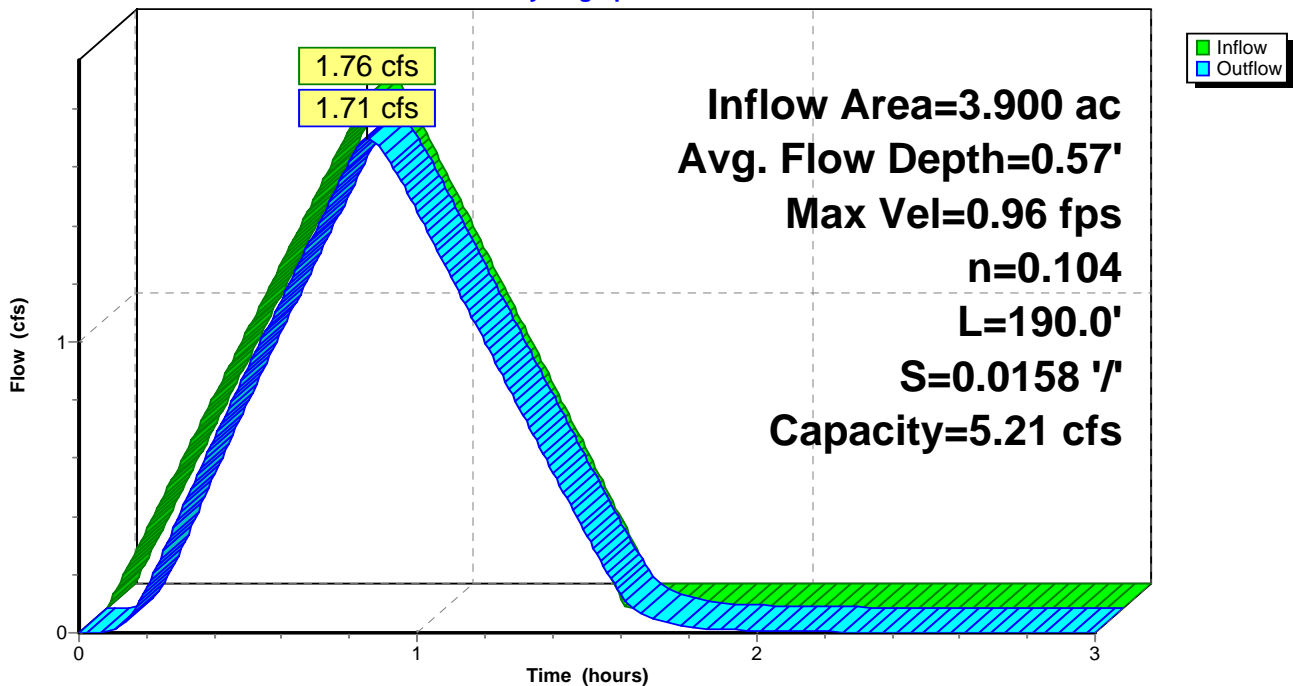
Peak Storage= 337 cf @ 0.79 hrs
 Average Depth at Peak Storage= 0.57'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 5.21 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 190.0' Slope= 0.0158 '/
 Inlet Invert= 170.00', Outlet Invert= 167.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-92+00

Runoff = 2.16 cfs @ 0.77 hrs, Volume= 0.138 af, Depth= 0.42"

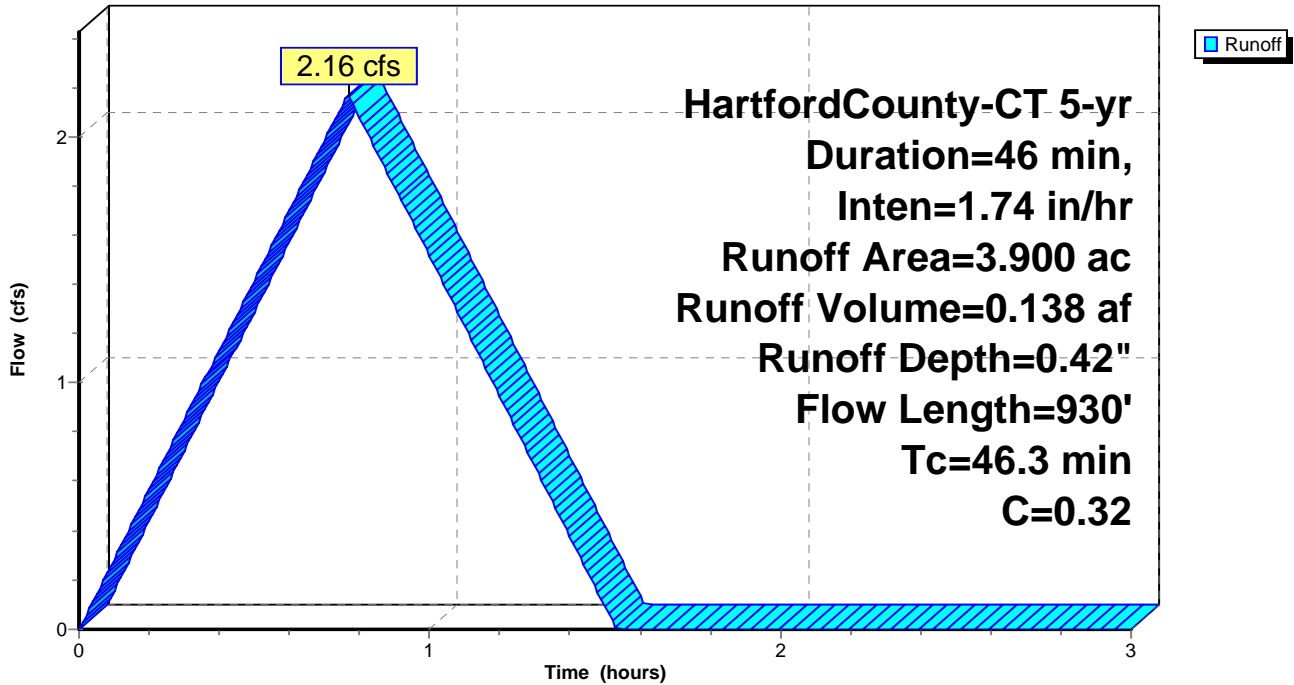
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 5-yr Duration=46 min, Inten=1.74 in/hr

Area (ac)	C	Description
3.900	0.32	Forest, 0-20%, D Soil
3.900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	150	0.0667	0.07		Sheet Flow, Sheet 1 Woods: Dense underbrush n= 0.800 P2= 2.88"
12.6	780	0.0423	1.03		Shallow Concentrated Flow, SCF Woodland Kv= 5.0 fps
46.3	930	Total			

Subcatchment 1S: CT-92+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 3.900 ac, 0.00% Impervious, Inflow Depth = 0.42" for 5-yr event
 Inflow = 2.16 cfs @ 0.77 hrs, Volume= 0.138 af
 Outflow = 2.10 cfs @ 0.85 hrs, Volume= 0.138 af, Atten= 3%, Lag= 4.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.02 fps, Min. Travel Time= 3.1 min
 Avg. Velocity = 0.47 fps, Avg. Travel Time= 6.8 min

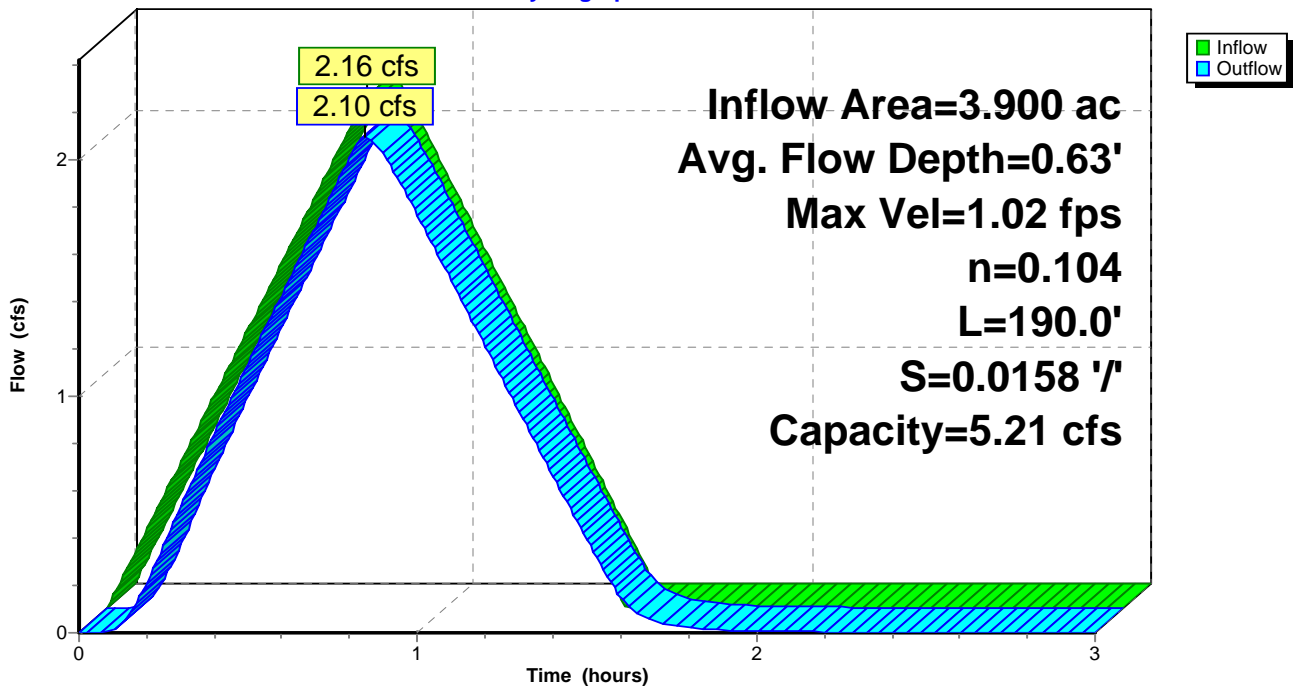
Peak Storage= 391 cf @ 0.79 hrs
 Average Depth at Peak Storage= 0.63'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 5.21 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 190.0' Slope= 0.0158 '/
 Inlet Invert= 170.00', Outlet Invert= 167.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-92+00

Runoff = 2.53 cfs @ 0.77 hrs, Volume= 0.161 af, Depth= 0.50"

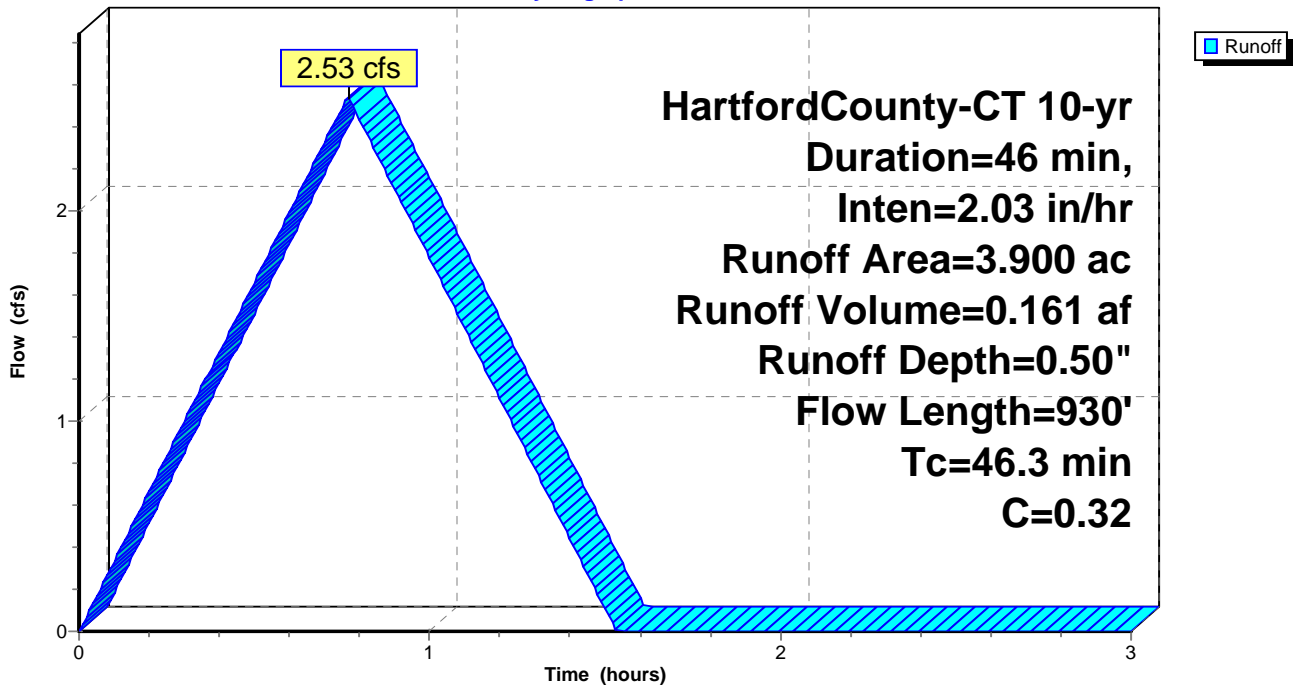
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 10-yr Duration=46 min, Inten=2.03 in/hr

Area (ac)	C	Description
3.900	0.32	Forest, 0-20%, D Soil
3.900		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	150	0.0667	0.07		Sheet Flow, Sheet 1 Woods: Dense underbrush n= 0.800 P2= 2.88"
12.6	780	0.0423	1.03		Shallow Concentrated Flow, SCF Woodland Kv= 5.0 fps
46.3	930	Total			

Subcatchment 1S: CT-92+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 3.900 ac, 0.00% Impervious, Inflow Depth = 0.50" for 10-yr event
 Inflow = 2.53 cfs @ 0.77 hrs, Volume= 0.161 af
 Outflow = 2.46 cfs @ 0.84 hrs, Volume= 0.161 af, Atten= 3%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.06 fps, Min. Travel Time= 3.0 min
 Avg. Velocity = 0.49 fps, Avg. Travel Time= 6.5 min

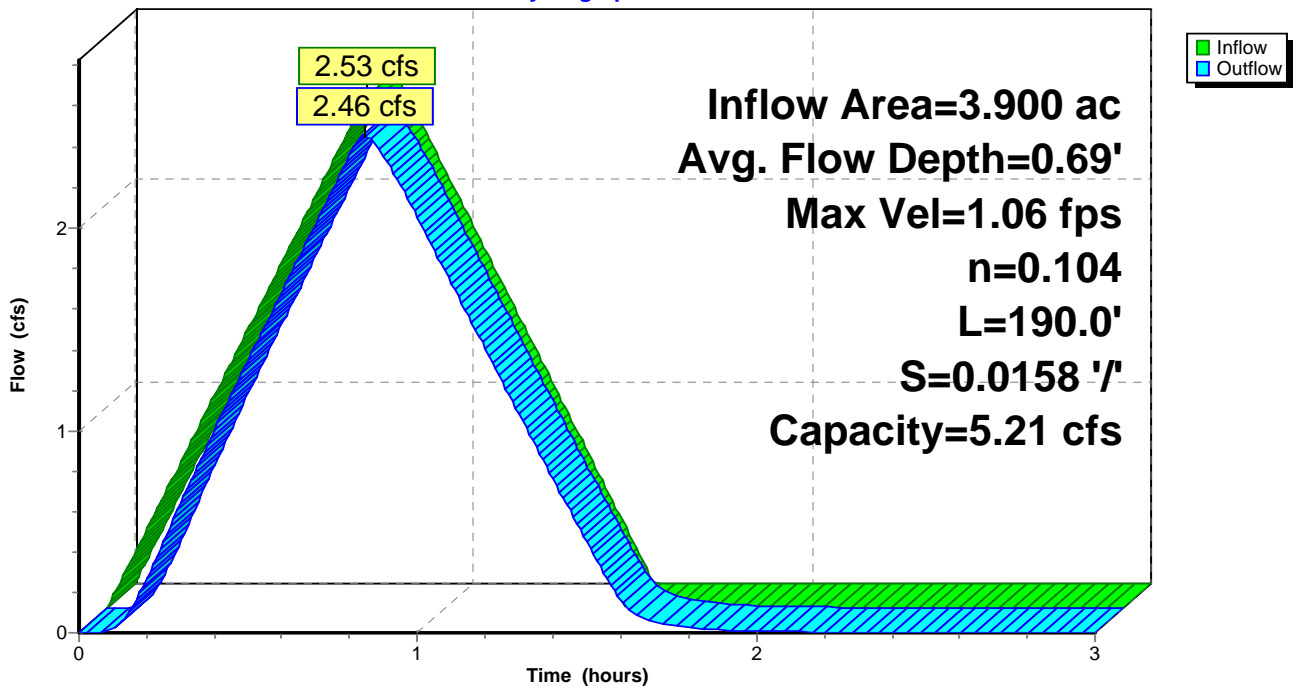
Peak Storage= 439 cf @ 0.79 hrs
 Average Depth at Peak Storage= 0.69'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 5.21 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 190.0' Slope= 0.0158 '/
 Inlet Invert= 170.00', Outlet Invert= 167.00'



Reach 2R: Diversion Swale

Hydrograph





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 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Kinder Morgan-CT
 Project Number: 49018
 Channel Name: 92+00**

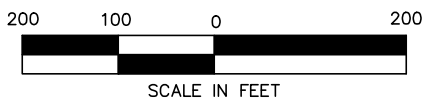
Discharge	2.16
Peak Flow Period	2
Channel Slope	0.015789
Channel Bottom Width	2
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

SC150

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
SC150 Unvegetated	Straight	2.16 cfs	1.73 ft/s	0.43 ft	0.05	2 lbs/ft ²	0.43 lbs/ft ²	4.67	STABLE	D

Unreinforced Vegetation - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	2.16 cfs	0.87 ft/s	0.72 ft	0.131	4.2 lbs/ft ²	0.71 lbs/ft ²	5.91	STABLE	--
Underlying Substrate	Straight	2.16 cfs	0.87 ft/s	0.72 ft	--	0.04 lbs/ft ²	0.003 lbs/ft ²	13.8	STABLE	--



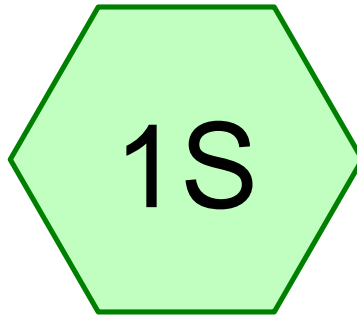
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Section:		Township:	Range:
Dft: JR	Date: 07/17/14	Project ID:	
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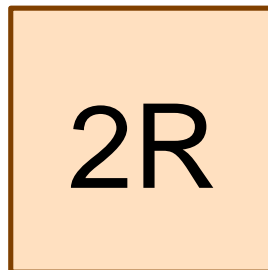
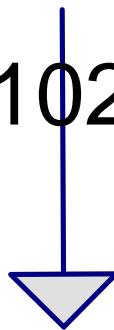
CONNECTICUT EXPANSION
 CONNECTICUT LOOP 300
 PROPOSED 24" NATURAL GAS PIPELINE
 DIVERSION SWALE AT STA. 102+50
 TOWN OF SUFFIELD
 HARTFORD COUNTY, CONNECTICUT



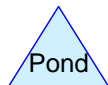
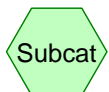
Sheet: 1 of 1
Type:



CT-102+50



Diversion Swale



Summary for Subcatchment 1S: CT-102+50

Runoff = 1.53 cfs @ 0.45 hrs, Volume= 0.057 af, Depth= 0.29"

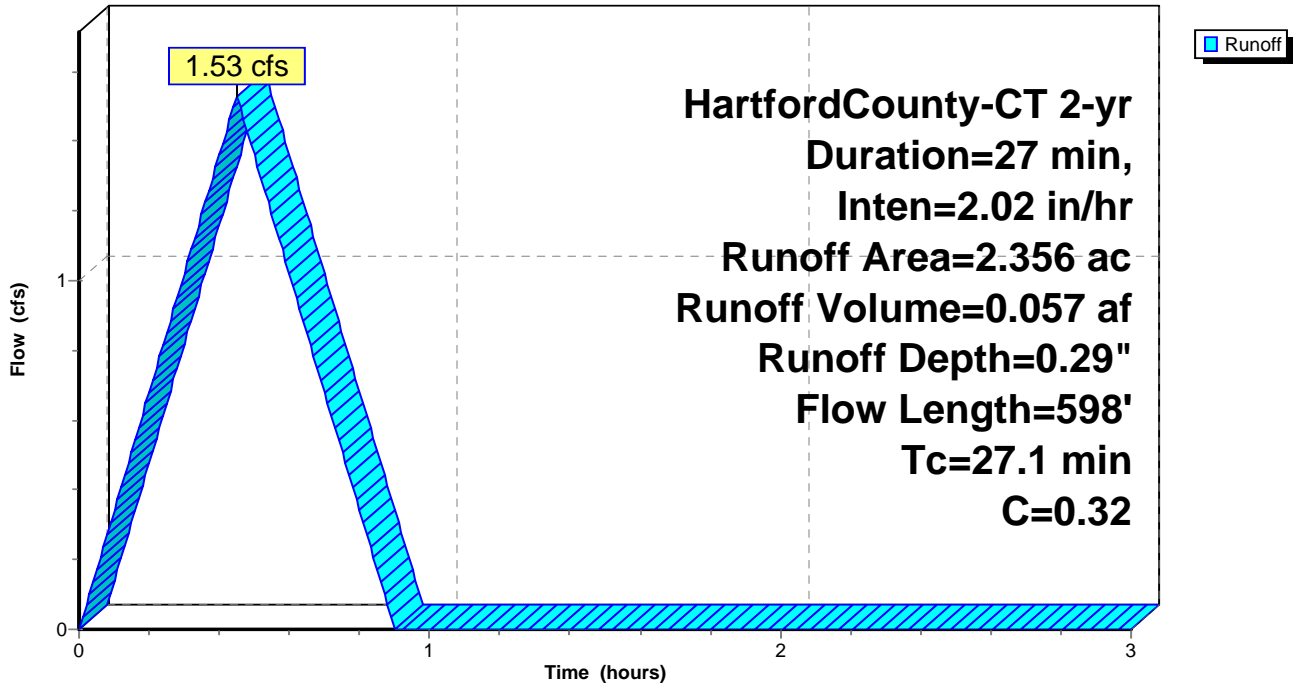
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 2-yr Duration=27 min, Inten=2.02 in/hr

Area (ac)	C	Description
2.356	0.32	Forest, 0-20%, D Soil
2.356		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6	150	0.0733	0.13		Sheet Flow, Sheet 1 Woods: Light underbrush n= 0.400 P2= 2.88"
8.5	448	0.0156	0.87		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
27.1	598	Total			

Subcatchment 1S: CT-102+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 2.356 ac, 0.00% Impervious, Inflow Depth = 0.29" for 2-yr event
 Inflow = 1.53 cfs @ 0.45 hrs, Volume= 0.057 af
 Outflow = 1.36 cfs @ 0.59 hrs, Volume= 0.057 af, Atten= 11%, Lag= 8.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.80 fps, Min. Travel Time= 5.6 min
 Avg. Velocity = 0.28 fps, Avg. Travel Time= 16.0 min

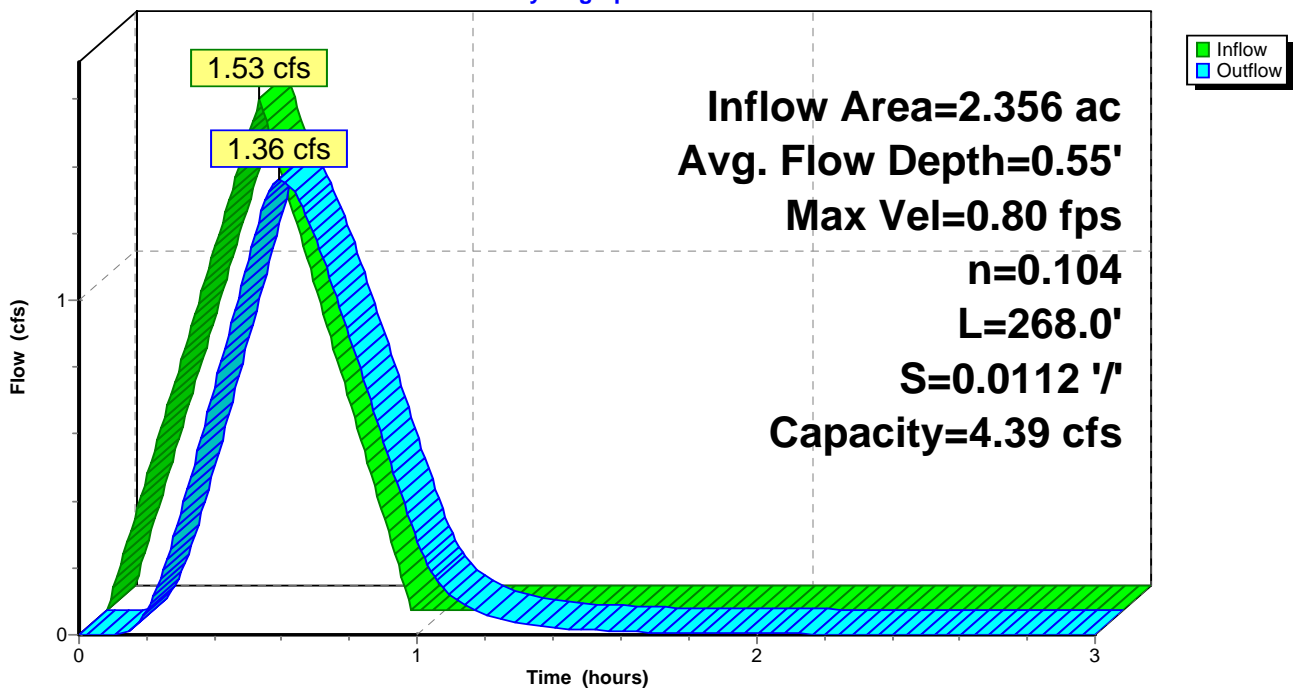
Peak Storage= 458 cf @ 0.50 hrs
 Average Depth at Peak Storage= 0.55'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.39 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 268.0' Slope= 0.0112 '/
 Inlet Invert= 160.00', Outlet Invert= 157.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-102+50

Runoff = 1.85 cfs @ 0.45 hrs, Volume= 0.069 af, Depth= 0.35"

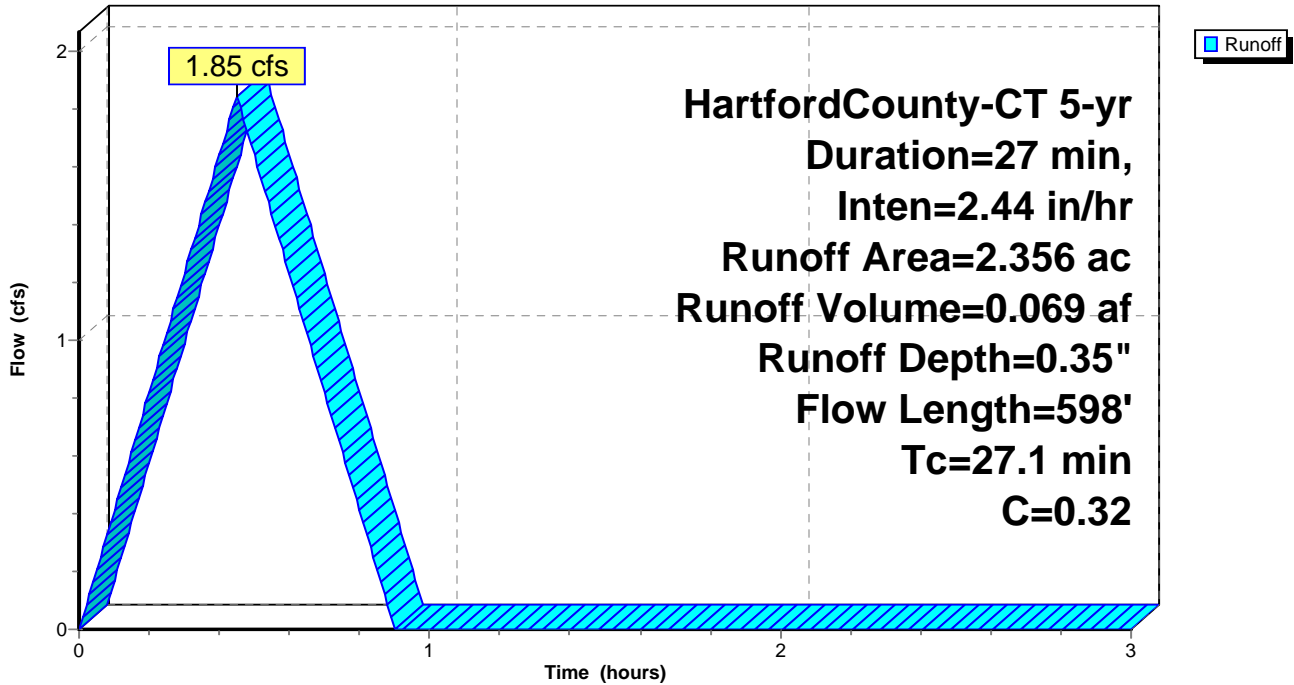
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 5-yr Duration=27 min, Inten=2.44 in/hr

Area (ac)	C	Description
2.356	0.32	Forest, 0-20%, D Soil
2.356		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6	150	0.0733	0.13		Sheet Flow, Sheet 1 Woods: Light underbrush n= 0.400 P2= 2.88"
8.5	448	0.0156	0.87		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
27.1	598	Total			

Subcatchment 1S: CT-102+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 2.356 ac, 0.00% Impervious, Inflow Depth = 0.35" for 5-yr event
 Inflow = 1.85 cfs @ 0.45 hrs, Volume= 0.069 af
 Outflow = 1.65 cfs @ 0.59 hrs, Volume= 0.069 af, Atten= 10%, Lag= 8.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.84 fps, Min. Travel Time= 5.3 min
 Avg. Velocity = 0.29 fps, Avg. Travel Time= 15.3 min

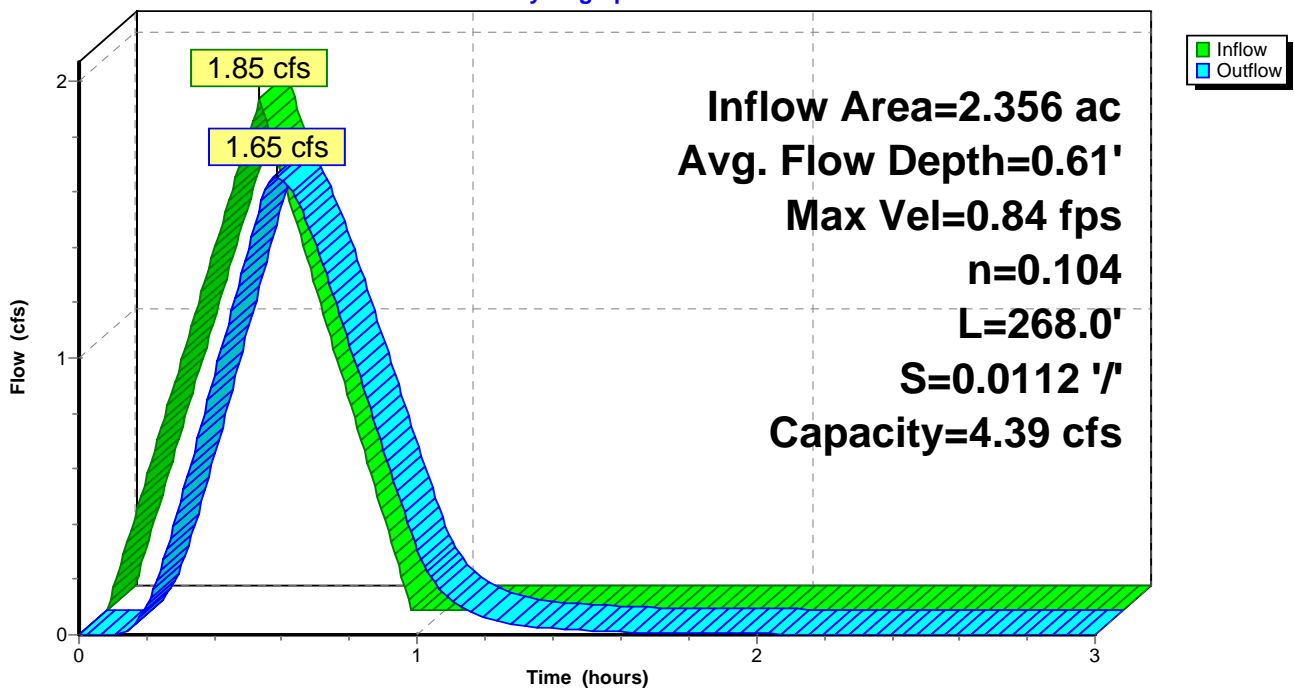
Peak Storage= 526 cf @ 0.50 hrs
 Average Depth at Peak Storage= 0.61'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.39 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 268.0' Slope= 0.0112 '/
 Inlet Invert= 160.00', Outlet Invert= 157.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-102+50

Runoff = 2.13 cfs @ 0.45 hrs, Volume= 0.079 af, Depth= 0.40"

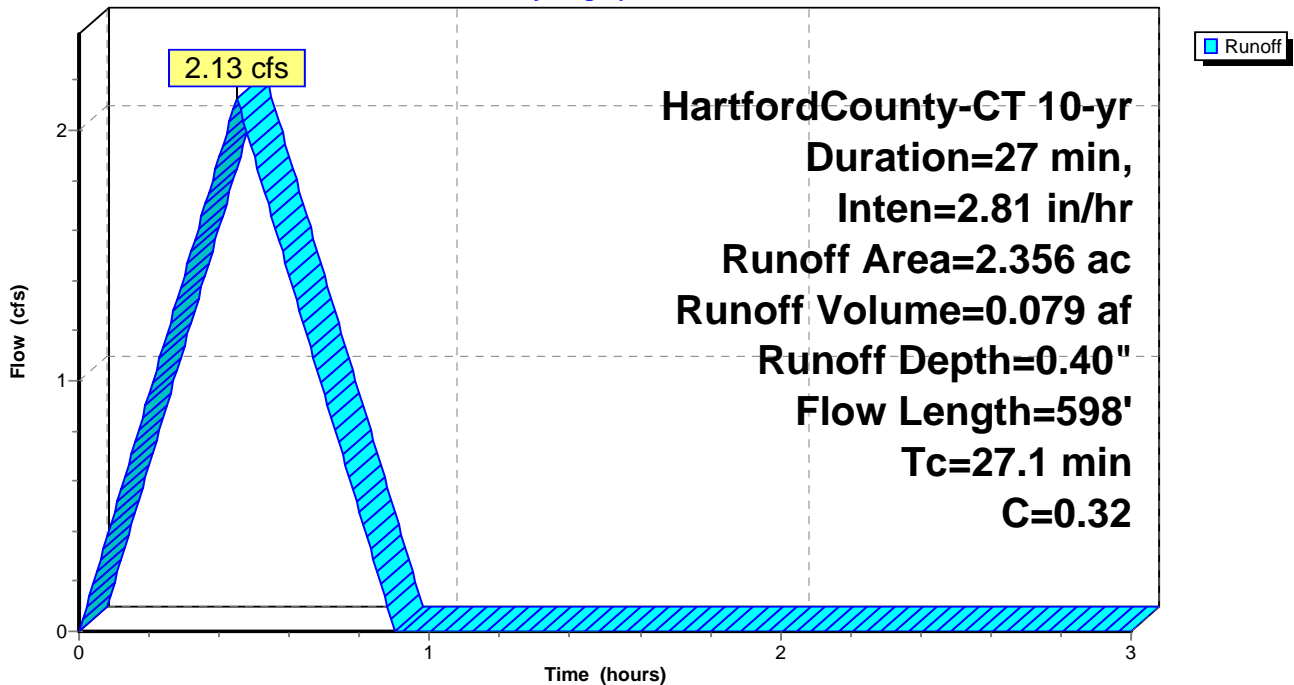
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 10-yr Duration=27 min, Inten=2.81 in/hr

Area (ac)	C	Description
2.356	0.32	Forest, 0-20%, D Soil
2.356		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6	150	0.0733	0.13		Sheet Flow, Sheet 1 Woods: Light underbrush n= 0.400 P2= 2.88"
8.5	448	0.0156	0.87		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
27.1	598	Total			

Subcatchment 1S: CT-102+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 2.356 ac, 0.00% Impervious, Inflow Depth = 0.40" for 10-yr event
 Inflow = 2.13 cfs @ 0.45 hrs, Volume= 0.079 af
 Outflow = 1.91 cfs @ 0.58 hrs, Volume= 0.079 af, Atten= 10%, Lag= 7.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.88 fps, Min. Travel Time= 5.1 min
 Avg. Velocity = 0.30 fps, Avg. Travel Time= 14.8 min

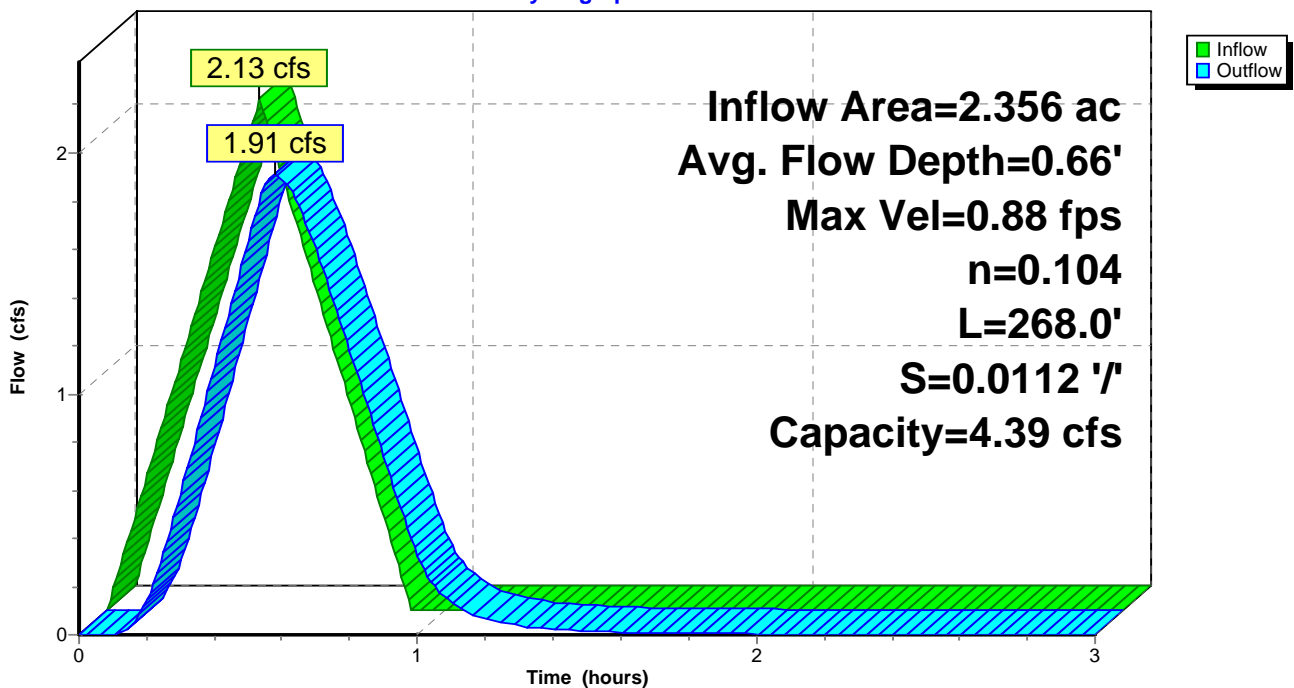
Peak Storage= 585 cf @ 0.50 hrs
 Average Depth at Peak Storage= 0.66'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.39 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 268.0' Slope= 0.0112 '/
 Inlet Invert= 160.00', Outlet Invert= 157.00'



Reach 2R: Diversion Swale

Hydrograph





Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Kinder Morgan-CT
 Project Number: 49018
 Channel Name: 102+50**

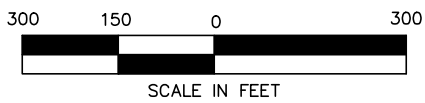
Discharge	1.85
Peak Flow Period	2
Channel Slope	0.0112
Channel Bottom Width	2
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

SC150

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
SC150 Unvegetated	Straight	1.85 cfs	1.47 ft/s	0.44 ft	0.05	2 lbs/ft ²	0.31 lbs/ft ²	6.53	STABLE	D

Unreinforced Vegetation - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	1.85 cfs	0.68 ft/s	0.77 ft	0.144	4.2 lbs/ft ²	0.54 lbs/ft ²	7.85	STABLE	--
Underlying Substrate	Straight	1.85 cfs	0.68 ft/s	0.77 ft	--	0.04 lbs/ft ²	0.002 lbs/ft ²	22.44	STABLE	--



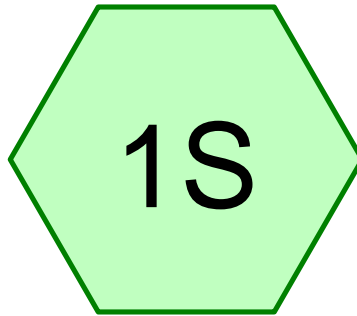
NO.	DATE	BY	DESCRIPTION	PROJ. ID	APPR.
REVISIONS					

Division:		Op. Area:	
St.: CT		Co./Par.: HARTFORD	
Section:		Township:	Range:
Dft: JR	Date: 07/17/14	Project ID:	
Chk: JD	Date: 05/27/14	Scale: 1"=300'	
Appr: RE	Date: 05/27/14	Filename: SK14C4781CT04_swales.dwg	

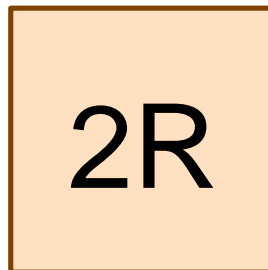
CONNECTICUT EXPANSION
CONNECTICUT LOOP 300
PROPOSED 24" NATURAL GAS PIPELINE
DIVERSION SWALE AT STA. 128+00
TOWN OF SUFFIELD
HARTFORD COUNTY, CONNECTICUT



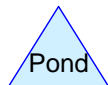
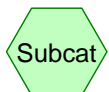
Sheet: 1 of 1
Type:



CT-128+00



Diversion Swale



Summary for Subcatchment 1S: CT-128+00

Runoff = 1.22 cfs @ 0.83 hrs, Volume= 0.084 af, Depth= 0.36"

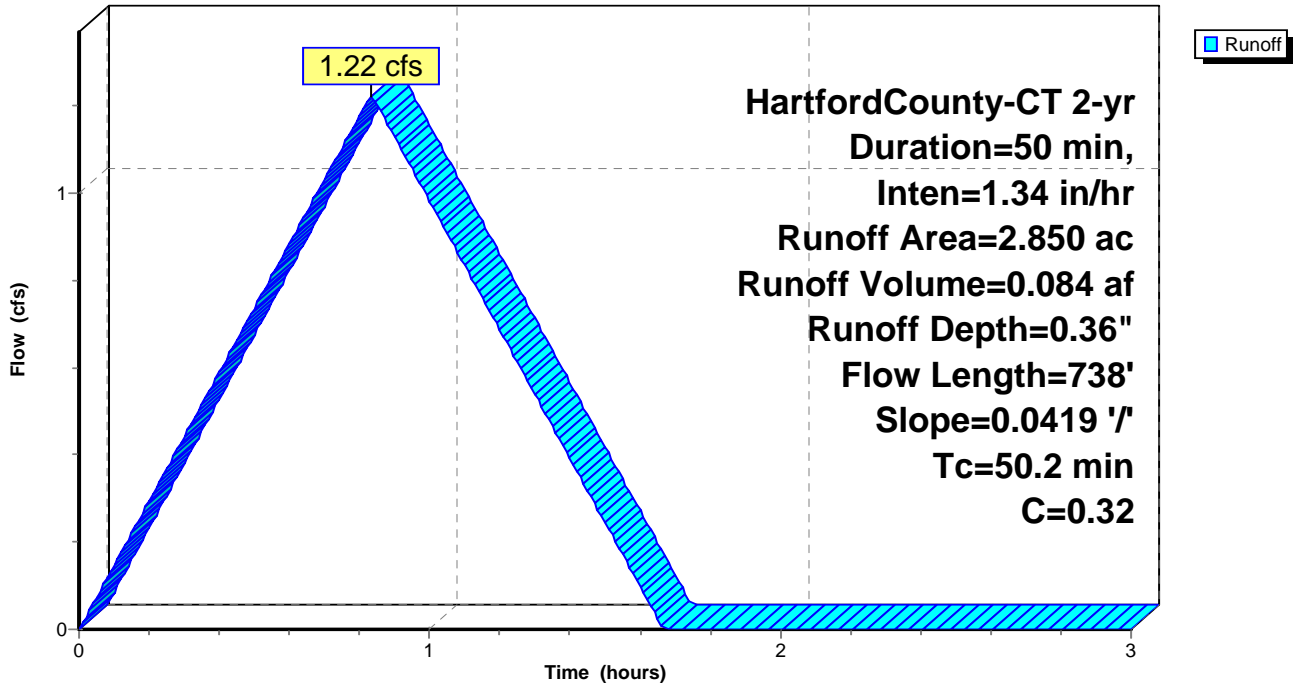
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 2-yr Duration=50 min, Inten=1.34 in/hr

Area (ac)	C	Description
2.850	0.32	Forest, 0-20%, D Soil
2.850		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.6	150	0.0419	0.06		Sheet Flow, Sheet 1 Woods: Dense underbrush n= 0.800 P2= 2.88"
9.6	588	0.0419	1.02		Shallow Concentrated Flow, SCF Woodland Kv= 5.0 fps
50.2	738	Total			

Subcatchment 1S: CT-128+00

Hydrograph



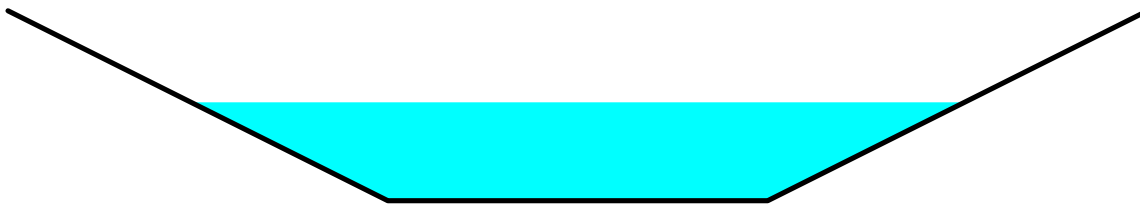
Summary for Reach 2R: Diversion Swale

Inflow Area = 2.850 ac, 0.00% Impervious, Inflow Depth = 0.36" for 2-yr event
 Inflow = 1.22 cfs @ 0.83 hrs, Volume= 0.084 af
 Outflow = 1.15 cfs @ 0.97 hrs, Volume= 0.084 af, Atten= 5%, Lag= 8.5 min

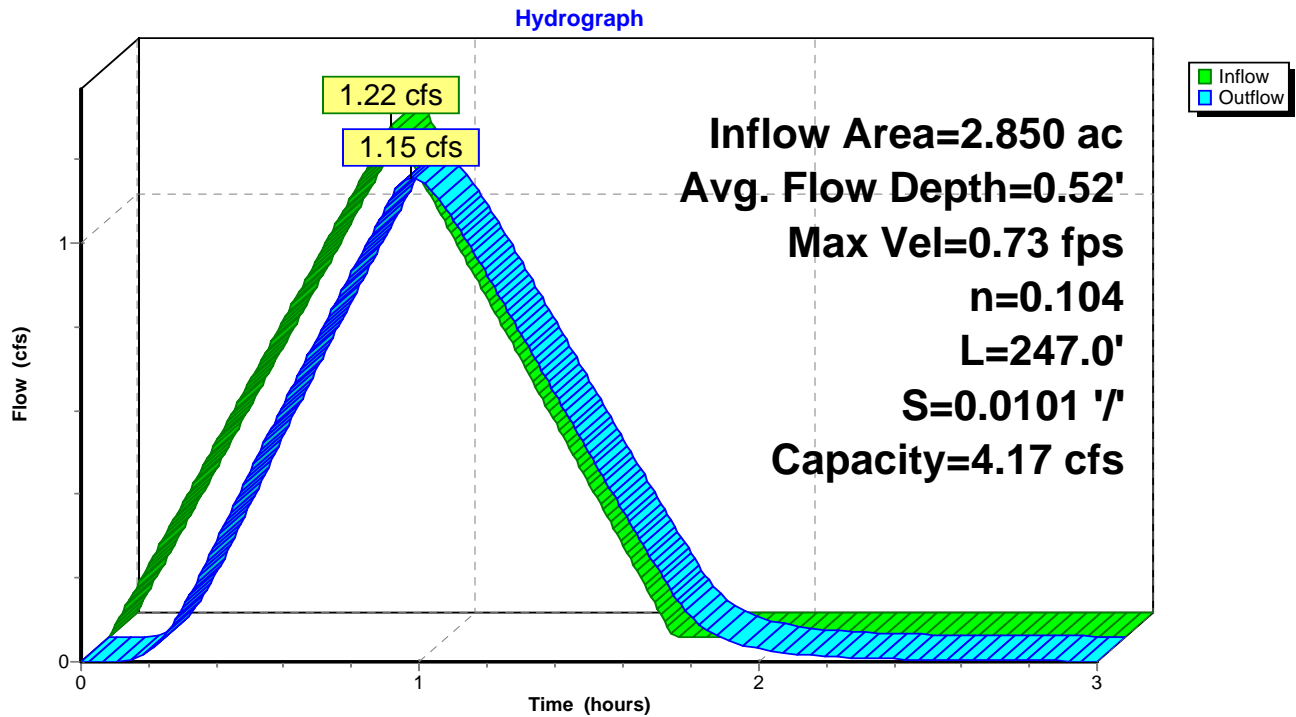
Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.73 fps, Min. Travel Time= 5.6 min
 Avg. Velocity = 0.38 fps, Avg. Travel Time= 10.9 min

Peak Storage= 389 cf @ 0.88 hrs
 Average Depth at Peak Storage= 0.52'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.17 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 247.0' Slope= 0.0101 '/
 Inlet Invert= 168.00', Outlet Invert= 165.50'



Reach 2R: Diversion Swale



Summary for Subcatchment 1S: CT-128+00

Runoff = 1.50 cfs @ 0.83 hrs, Volume= 0.104 af, Depth= 0.44"

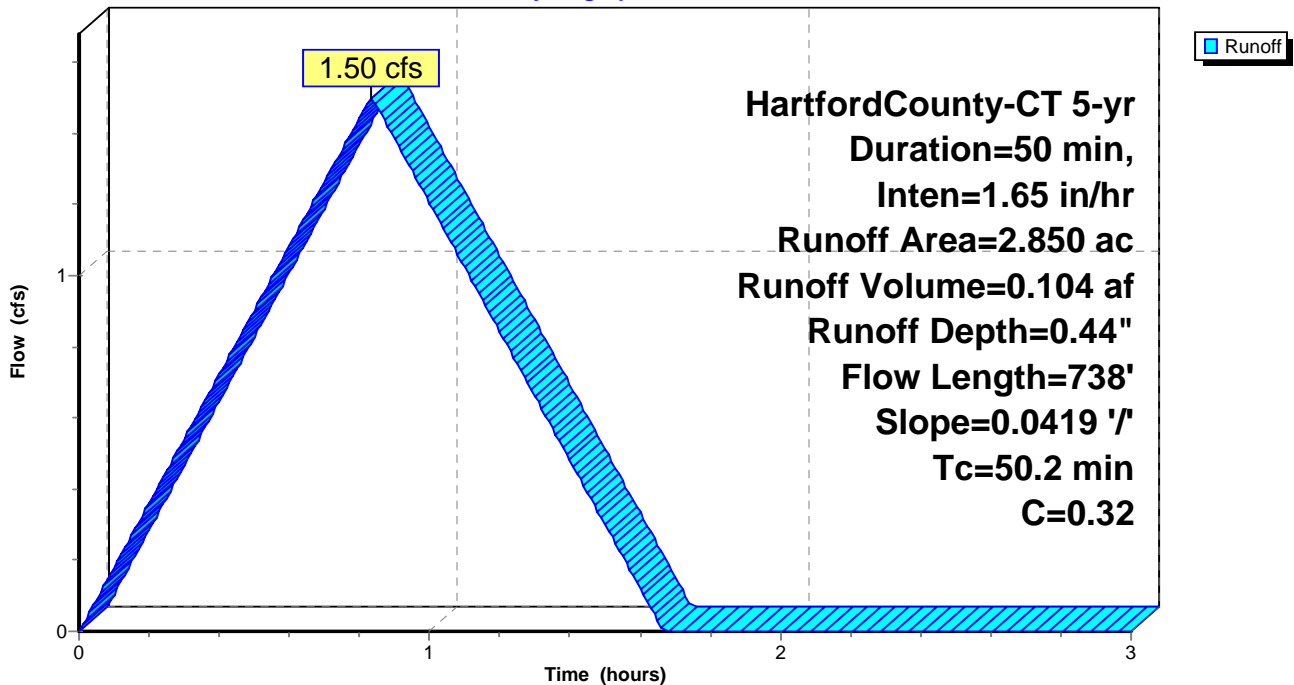
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 5-yr Duration=50 min, Inten=1.65 in/hr

Area (ac)	C	Description
2.850	0.32	Forest, 0-20%, D Soil
2.850		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.6	150	0.0419	0.06		Sheet Flow, Sheet 1 Woods: Dense underbrush n= 0.800 P2= 2.88"
9.6	588	0.0419	1.02		Shallow Concentrated Flow, SCF Woodland Kv= 5.0 fps
50.2	738	Total			

Subcatchment 1S: CT-128+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 2.850 ac, 0.00% Impervious, Inflow Depth = 0.44" for 5-yr event
 Inflow = 1.50 cfs @ 0.83 hrs, Volume= 0.104 af
 Outflow = 1.43 cfs @ 0.97 hrs, Volume= 0.104 af, Atten= 5%, Lag= 8.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.78 fps, Min. Travel Time= 5.3 min
 Avg. Velocity = 0.40 fps, Avg. Travel Time= 10.3 min

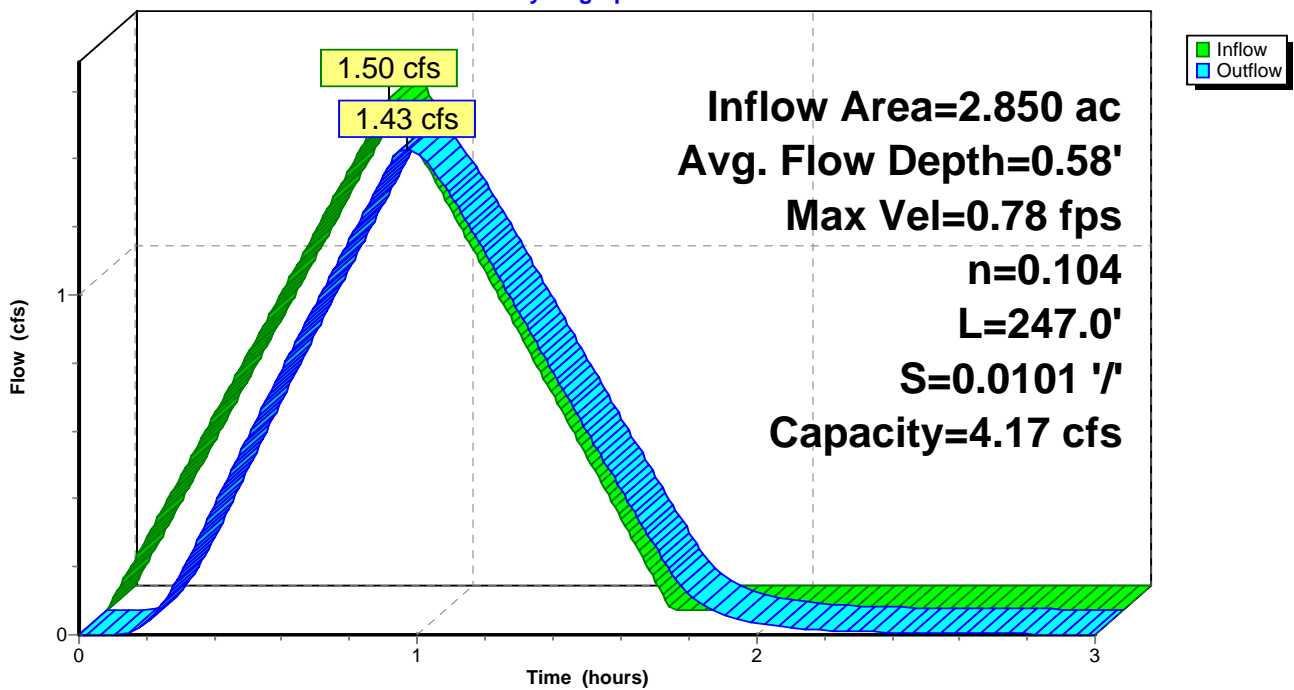
Peak Storage= 452 cf @ 0.88 hrs
 Average Depth at Peak Storage= 0.58'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.17 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 247.0' Slope= 0.0101 '/
 Inlet Invert= 168.00', Outlet Invert= 165.50'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-128+00

Runoff = 1.76 cfs @ 0.83 hrs, Volume= 0.122 af, Depth= 0.51"

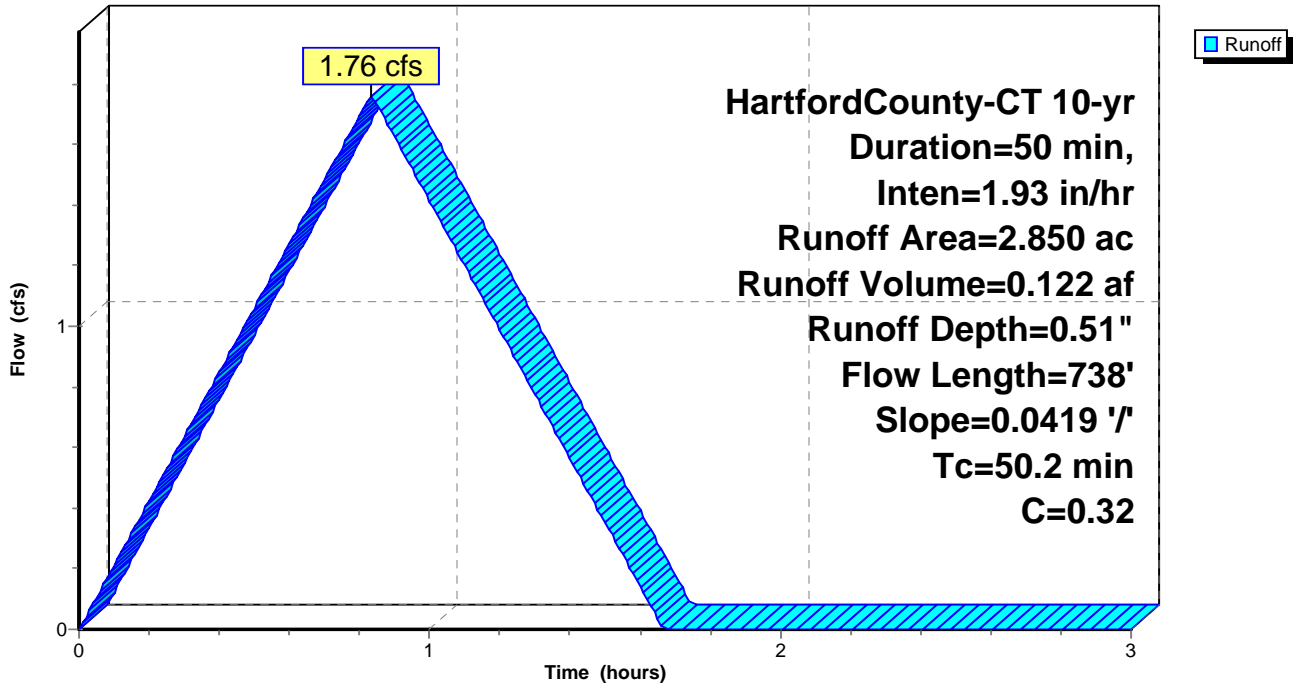
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 10-yr Duration=50 min, Inten=1.93 in/hr

Area (ac)	C	Description
2.850	0.32	Forest, 0-20%, D Soil
2.850		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.6	150	0.0419	0.06		Sheet Flow, Sheet 1 Woods: Dense underbrush n= 0.800 P2= 2.88"
9.6	588	0.0419	1.02		Shallow Concentrated Flow, SCF Woodland Kv= 5.0 fps
50.2	738	Total			

Subcatchment 1S: CT-128+00

Hydrograph



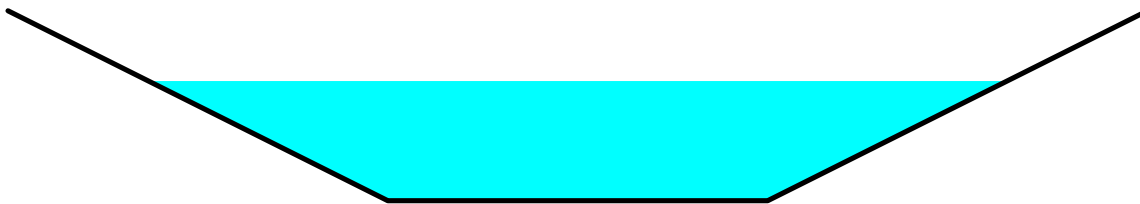
Summary for Reach 2R: Diversion Swale

Inflow Area = 2.850 ac, 0.00% Impervious, Inflow Depth = 0.51" for 10-yr event
 Inflow = 1.76 cfs @ 0.83 hrs, Volume= 0.122 af
 Outflow = 1.67 cfs @ 0.96 hrs, Volume= 0.122 af, Atten= 5%, Lag= 7.7 min

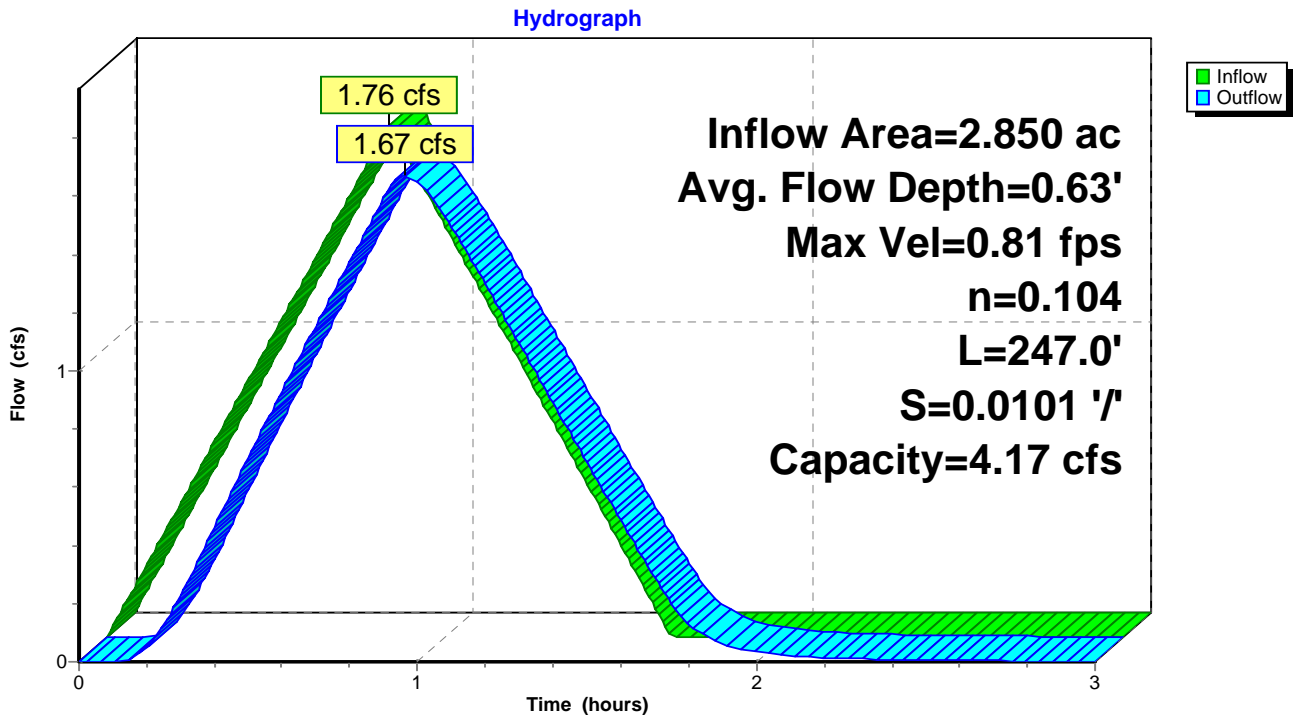
Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.81 fps, Min. Travel Time= 5.1 min
 Avg. Velocity = 0.42 fps, Avg. Travel Time= 9.9 min

Peak Storage= 508 cf @ 0.88 hrs
 Average Depth at Peak Storage= 0.63'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.17 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 247.0' Slope= 0.0101 '/
 Inlet Invert= 168.00', Outlet Invert= 165.50'



Reach 2R: Diversion Swale





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 5401 St. Wendel-Cynthiana Road
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 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Kinder Morgan-CT
 Project Number: 49018
 Channel Name: 128+00**

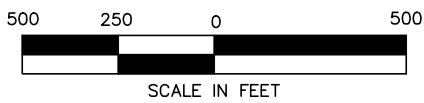
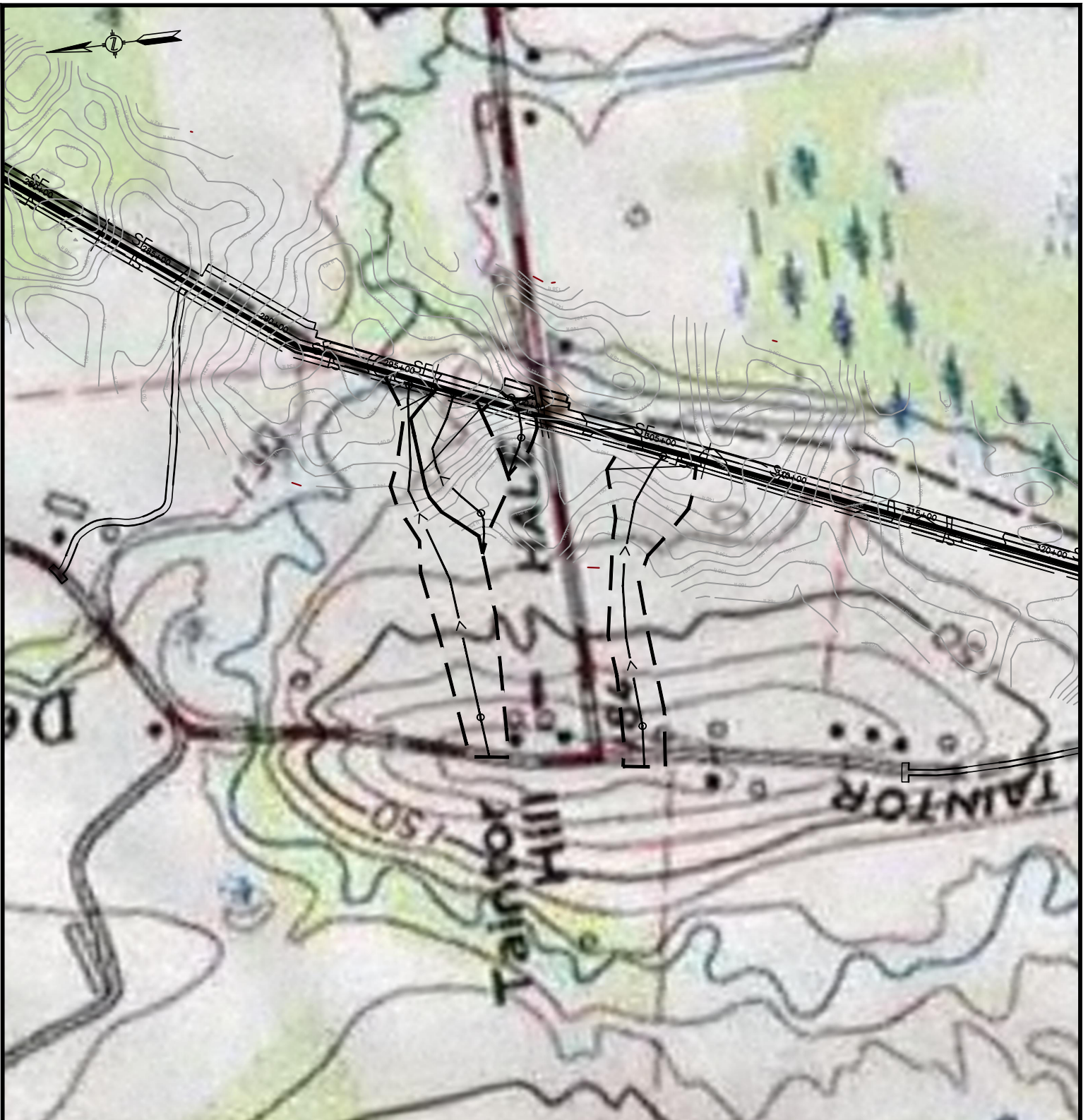
Discharge	1.50
Peak Flow Period	2
Channel Slope	0.0101
Channel Bottom Width	2
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

SC150

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
SC150 Unvegetated	Straight	1.5 cfs	1.33 ft/s	0.4 ft	0.05	2 lbs/ft ²	0.25 lbs/ft ²	7.89	STABLE	D

Unreinforced Vegetation - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	1.5 cfs	0.58 ft/s	0.74 ft	0.16	4.2 lbs/ft ²	0.47 lbs/ft ²	8.95	STABLE	--
Underlying Substrate	Straight	1.5 cfs	0.58 ft/s	0.74 ft	--	0.04 lbs/ft ²	0.001 lbs/ft ²	31.48	STABLE	--



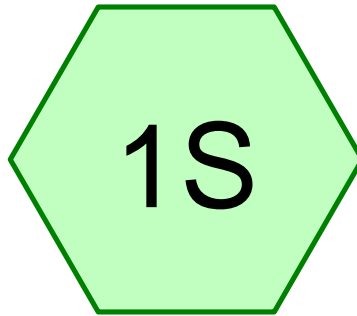
NO.	DATE	BY	DESCRIPTION	PROJ. ID	APPR.
REVISIONS					

Division:		Op. Area:	
St.:	CT	Co./Par.:	HARTFORD
Section:	Township:	Range:	
Dft:	JR	Date:	07/17/14
Project ID:			
Chk:	JD	Date:	05/27/14
Scale:	1"=500'		
Appr:	RE	Date:	05/27/14
Filename:	SK14C4781CT04_swales.dwg		

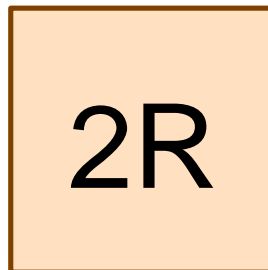
CONNECTICUT EXPANSION
 CONNECTICUT LOOP 300
 PROPOSED 24" NATURAL GAS PIPELINE
 DIV. SWALE AT STA. 295+50, 297+50& 306+00
 TOWN OF SUFFIELD
 HARTFORD COUNTY, CONNECTICUT



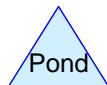
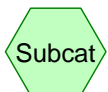
Sheet:	1 of 1
Type:	



CT-295+50



Diversion Swale



Summary for Subcatchment 1S: CT-295+50

Runoff = 3.40 cfs @ 0.45 hrs, Volume= 0.126 af, Depth= 0.29"

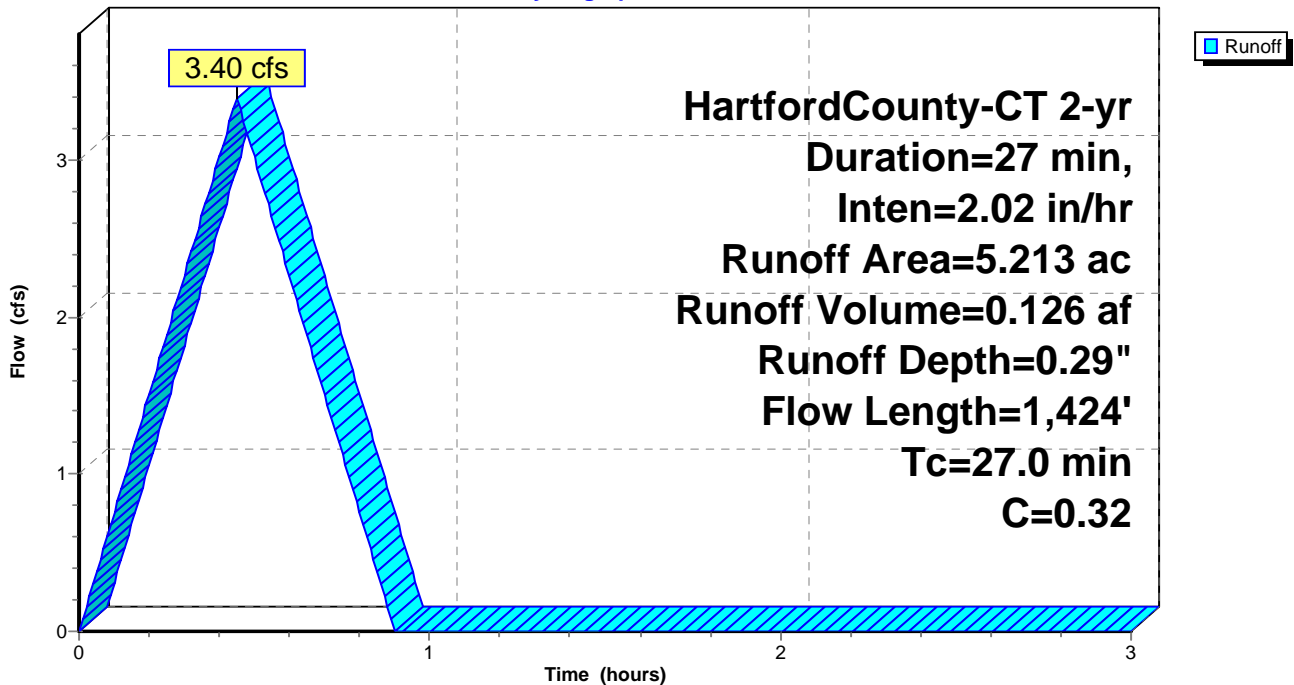
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 2-yr Duration=27 min, Inten=2.02 in/hr

Area (ac)	C	Description
5.213	0.32	Forest, 0-20%, D Soil
5.213		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	150	0.0600	0.27		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
17.8	1,274	0.0290	1.19		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
27.0	1,424	Total			

Subcatchment 1S: CT-295+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 5.213 ac, 0.00% Impervious, Inflow Depth = 0.29" for 2-yr event
 Inflow = 3.40 cfs @ 0.45 hrs, Volume= 0.126 af
 Outflow = 3.29 cfs @ 0.49 hrs, Volume= 0.126 af, Atten= 3%, Lag= 2.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.48 fps, Min. Travel Time= 1.6 min
 Avg. Velocity = 0.45 fps, Avg. Travel Time= 5.3 min

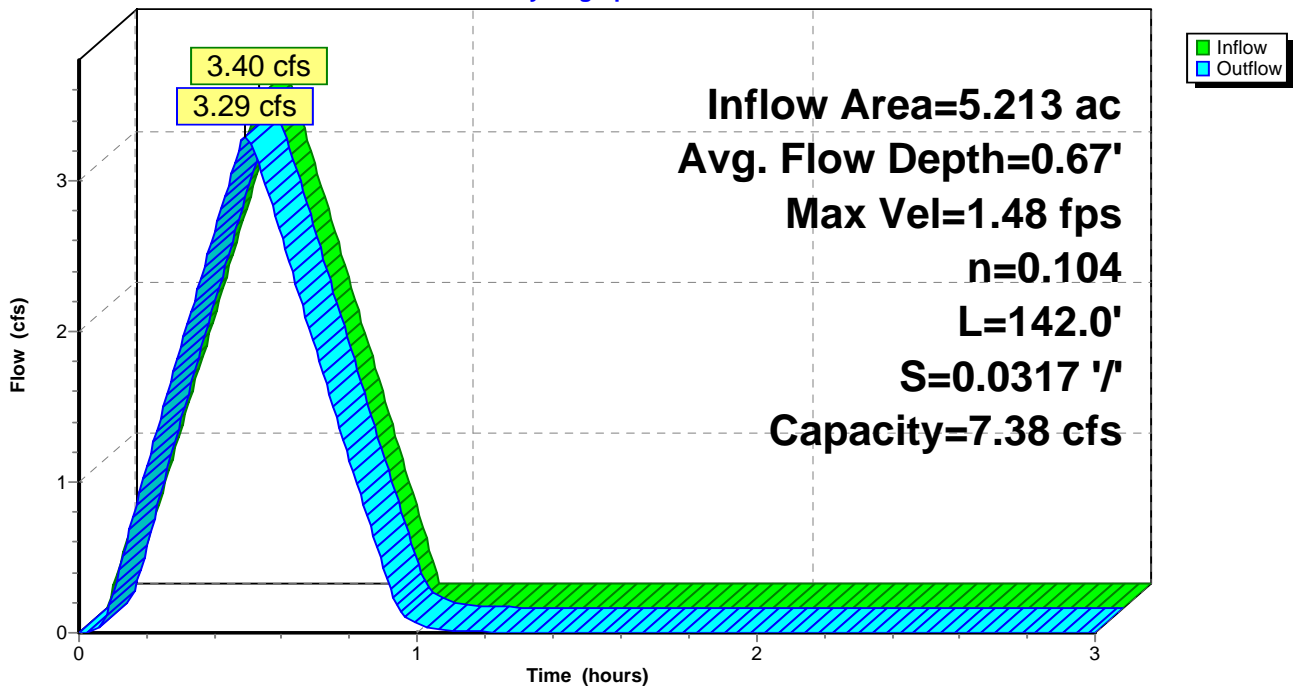
Peak Storage= 315 cf @ 0.46 hrs
 Average Depth at Peak Storage= 0.67'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 7.38 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/' Top Width= 6.00'
 Length= 142.0' Slope= 0.0317 '/'
 Inlet Invert= 140.50', Outlet Invert= 136.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-295+50

Runoff = 4.10 cfs @ 0.45 hrs, Volume= 0.152 af, Depth= 0.35"

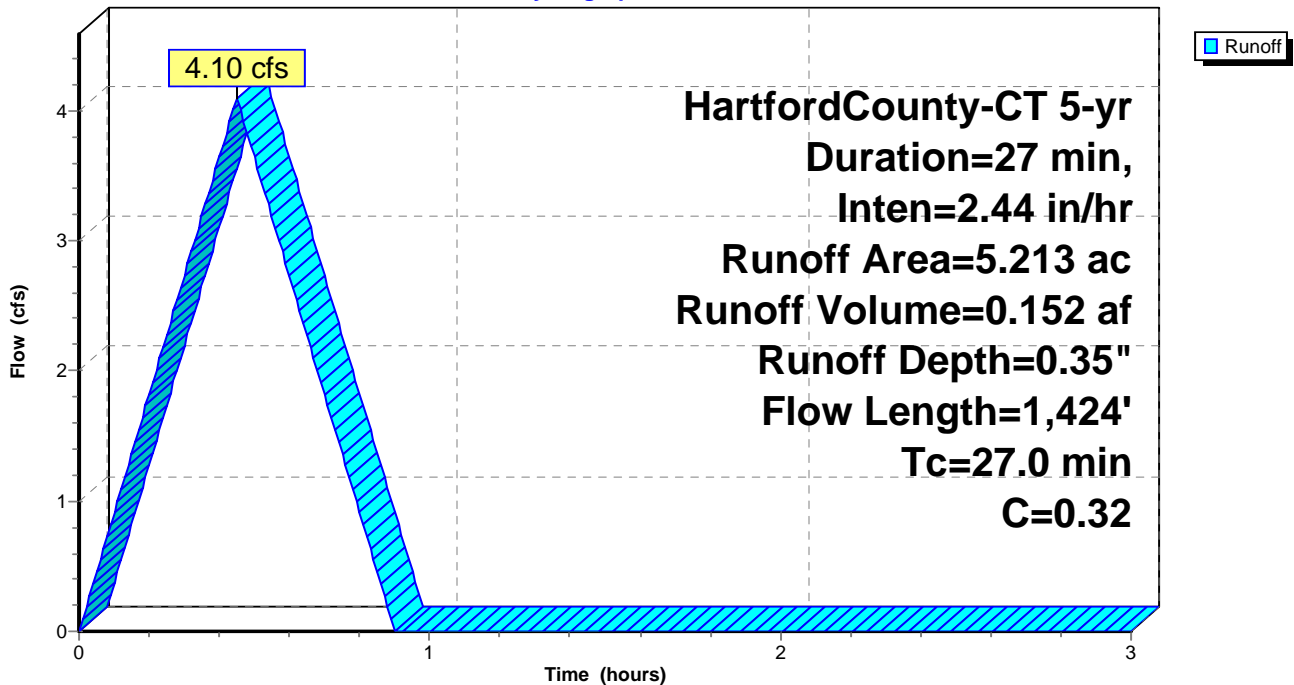
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 5-yr Duration=27 min, Inten=2.44 in/hr

Area (ac)	C	Description
5.213	0.32	Forest, 0-20%, D Soil
5.213		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	150	0.0600	0.27		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
17.8	1,274	0.0290	1.19		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
27.0	1,424	Total			

Subcatchment 1S: CT-295+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 5.213 ac, 0.00% Impervious, Inflow Depth = 0.35" for 5-yr event
 Inflow = 4.10 cfs @ 0.45 hrs, Volume= 0.152 af
 Outflow = 3.98 cfs @ 0.49 hrs, Volume= 0.152 af, Atten= 3%, Lag= 2.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.56 fps, Min. Travel Time= 1.5 min
 Avg. Velocity = 0.47 fps, Avg. Travel Time= 5.1 min

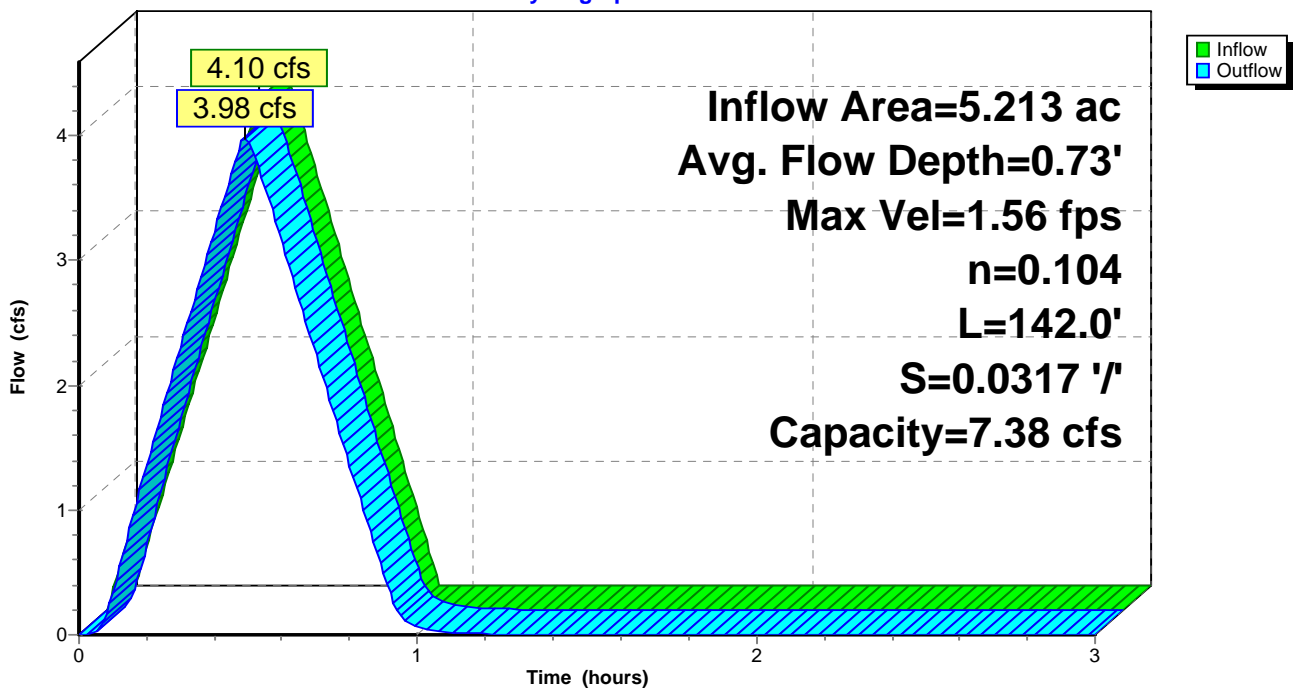
Peak Storage= 362 cf @ 0.46 hrs
 Average Depth at Peak Storage= 0.73'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 7.38 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/' Top Width= 6.00'
 Length= 142.0' Slope= 0.0317 '/'
 Inlet Invert= 140.50', Outlet Invert= 136.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-295+50

Runoff = 4.72 cfs @ 0.45 hrs, Volume= 0.176 af, Depth= 0.40"

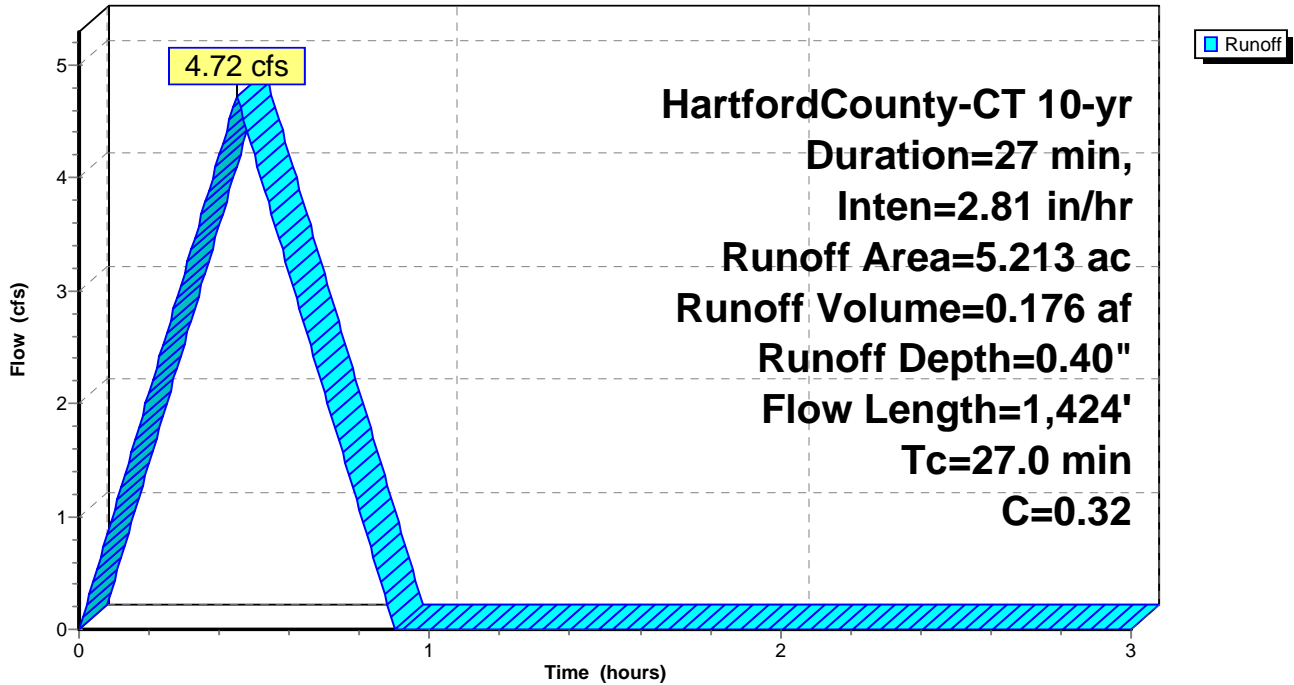
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 10-yr Duration=27 min, Inten=2.81 in/hr

Area (ac)	C	Description
5.213	0.32	Forest, 0-20%, D Soil
5.213		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	150	0.0600	0.27		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
17.8	1,274	0.0290	1.19		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
27.0	1,424	Total			

Subcatchment 1S: CT-295+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 5.213 ac, 0.00% Impervious, Inflow Depth = 0.40" for 10-yr event
 Inflow = 4.72 cfs @ 0.45 hrs, Volume= 0.176 af
 Outflow = 4.59 cfs @ 0.49 hrs, Volume= 0.176 af, Atten= 3%, Lag= 2.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.63 fps, Min. Travel Time= 1.5 min
 Avg. Velocity = 0.48 fps, Avg. Travel Time= 4.9 min

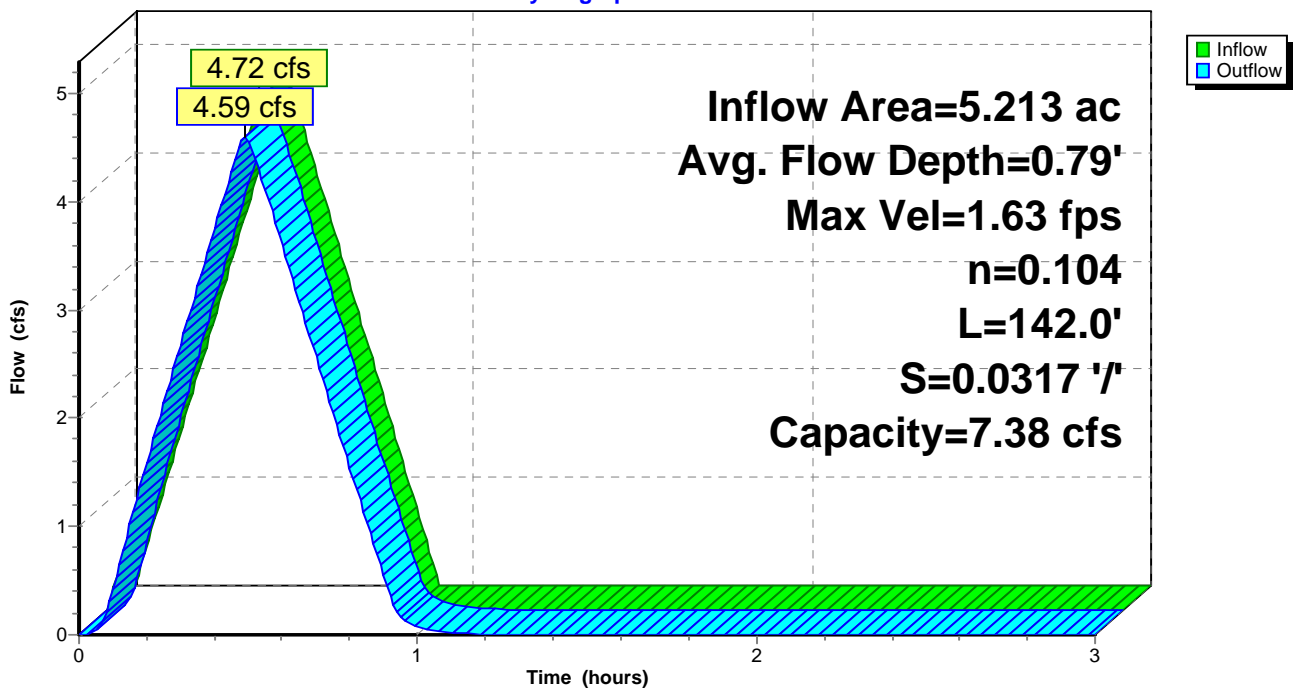
Peak Storage= 402 cf @ 0.46 hrs
 Average Depth at Peak Storage= 0.79'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 7.38 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/' Top Width= 6.00'
 Length= 142.0' Slope= 0.0317 '/'
 Inlet Invert= 140.50', Outlet Invert= 136.00'



Reach 2R: Diversion Swale

Hydrograph





Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Kinder Morgan-CT
 Project Number: 49018
 Channel Name: 295+50**

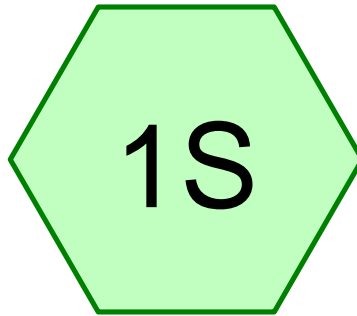
Discharge	4.10
Peak Flow Period	2
Channel Slope	0.0317
Channel Bottom Width	2
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

SC150

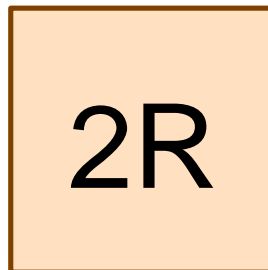
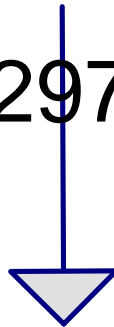
Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
SC150 Unvegetated	Straight	4.1 cfs	2.68 ft/s	0.51 ft	0.05	2 lbs/ft ²	1 lbs/ft ²	1.99	STABLE	D

Unreinforced Vegetation - Class C - Mix (Sod & Bunch) - Good 75-95%

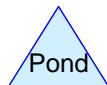
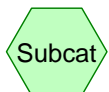
Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	4.1 cfs	1.68 ft/s	0.71 ft	0.095	4.2 lbs/ft ²	1.41 lbs/ft ²	2.98	STABLE	--
Underlying Substrate	Straight	4.1 cfs	1.68 ft/s	0.71 ft	--	0.04 lbs/ft ²	0.009 lbs/ft ²	3.69	STABLE	--



CT-297+50



Diversion Swale



Summary for Subcatchment 1S: CT-297+50

Runoff = 2.56 cfs @ 0.28 hrs, Volume= 0.060 af, Depth= 0.24"

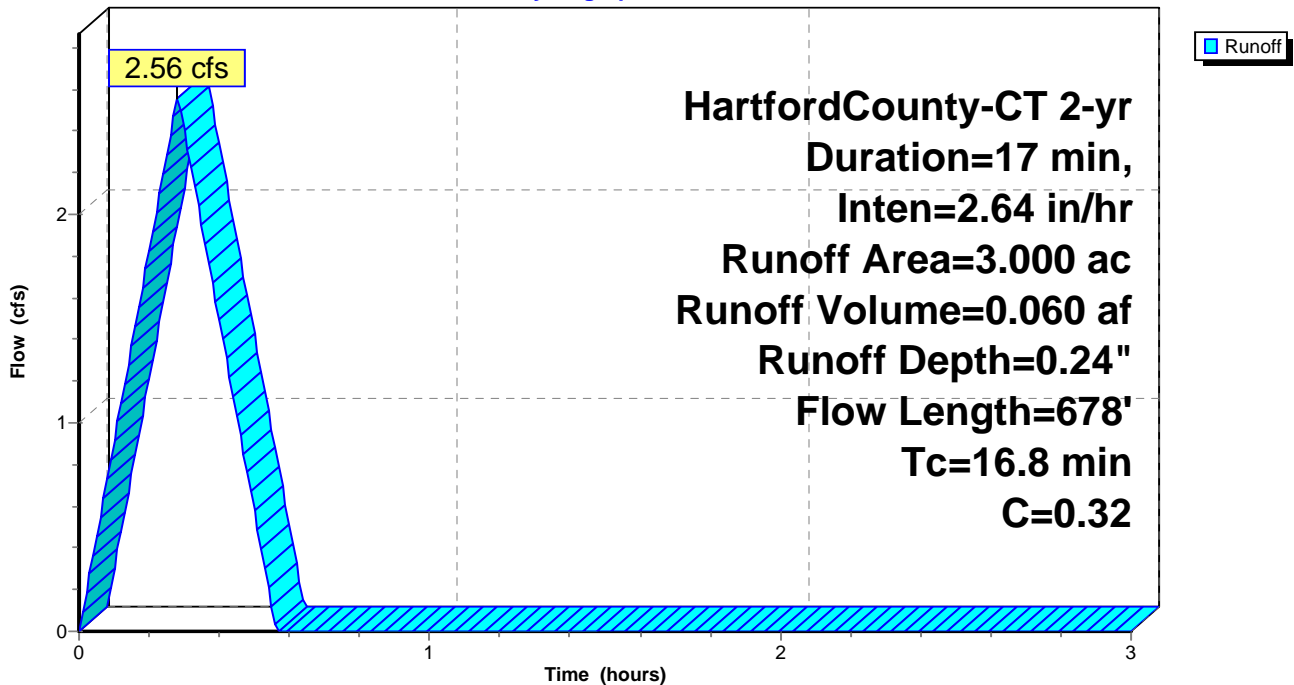
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 2-yr Duration=17 min, Inten=2.64 in/hr

Area (ac)	C	Description
3.000	0.32	Forest, 0-20%, D Soil
3.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	150	0.0467	0.25		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
6.6	528	0.0360	1.33		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
16.8	678	Total			

Subcatchment 1S: CT-297+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 3.000 ac, 0.00% Impervious, Inflow Depth = 0.24" for 2-yr event
 Inflow = 2.56 cfs @ 0.28 hrs, Volume= 0.060 af
 Outflow = 2.09 cfs @ 0.43 hrs, Volume= 0.060 af, Atten= 18%, Lag= 8.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.94 fps, Min. Travel Time= 5.6 min
 Avg. Velocity = 0.27 fps, Avg. Travel Time= 19.9 min

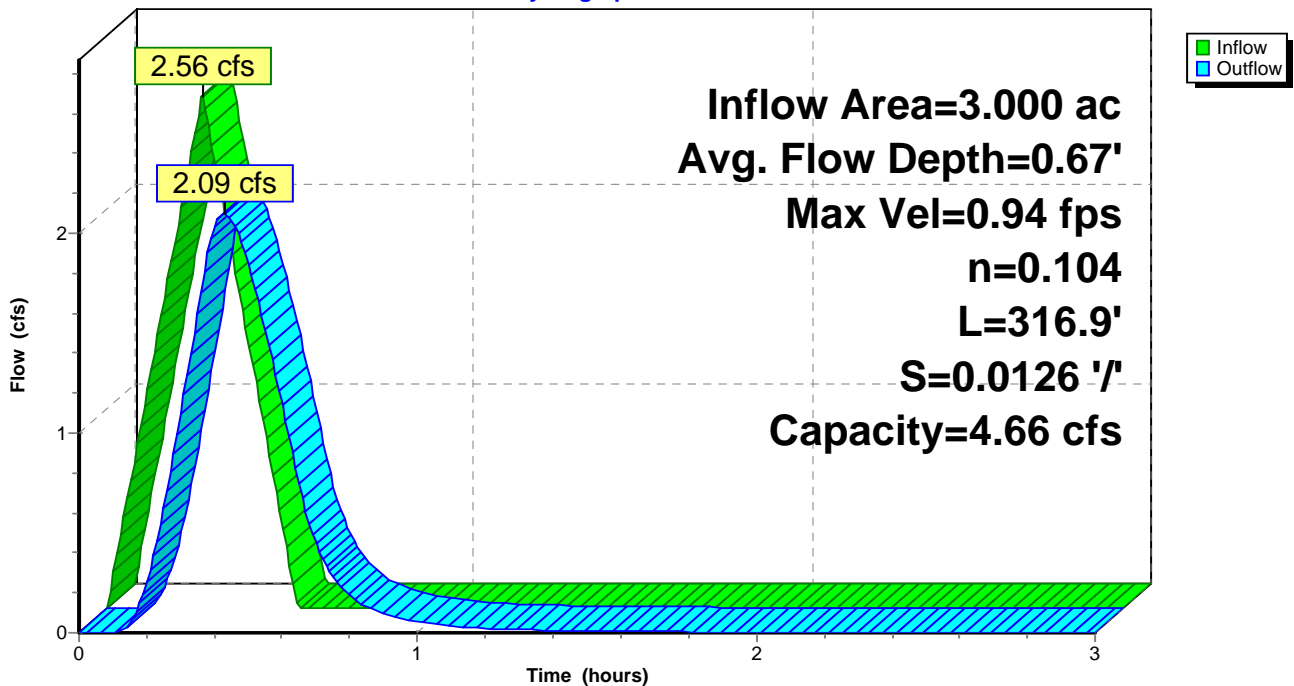
Peak Storage= 707 cf @ 0.33 hrs
 Average Depth at Peak Storage= 0.67'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.66 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 316.9' Slope= 0.0126 '/
 Inlet Invert= 142.00', Outlet Invert= 138.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-297+50

Runoff = 3.04 cfs @ 0.28 hrs, Volume= 0.071 af, Depth= 0.28"

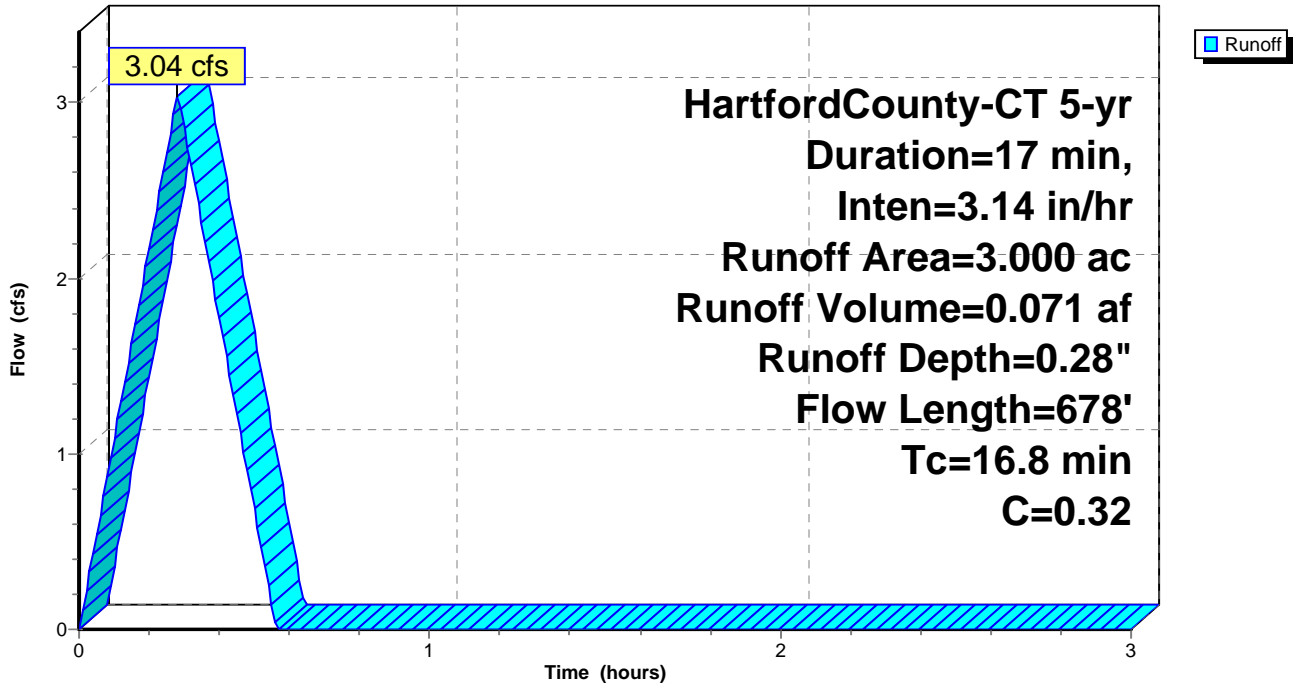
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 5-yr Duration=17 min, Inten=3.14 in/hr

Area (ac)	C	Description
3.000	0.32	Forest, 0-20%, D Soil
3.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	150	0.0467	0.25		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
6.6	528	0.0360	1.33		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
16.8	678	Total			

Subcatchment 1S: CT-297+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 3.000 ac, 0.00% Impervious, Inflow Depth = 0.28" for 5-yr event
 Inflow = 3.04 cfs @ 0.28 hrs, Volume= 0.071 af
 Outflow = 2.52 cfs @ 0.42 hrs, Volume= 0.071 af, Atten= 17%, Lag= 8.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.99 fps, Min. Travel Time= 5.4 min
 Avg. Velocity = 0.28 fps, Avg. Travel Time= 19.1 min

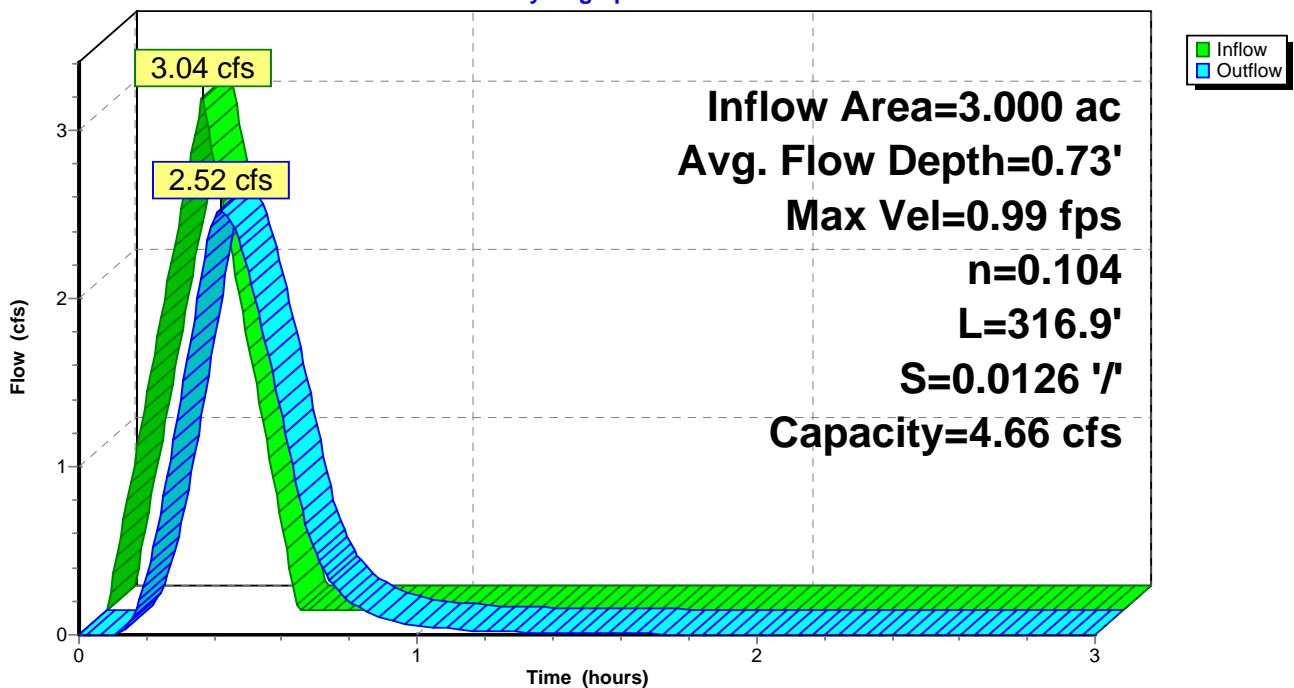
Peak Storage= 808 cf @ 0.33 hrs
 Average Depth at Peak Storage= 0.73'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.66 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 316.9' Slope= 0.0126 '/
 Inlet Invert= 142.00', Outlet Invert= 138.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-297+50

Runoff = 3.45 cfs @ 0.28 hrs, Volume= 0.081 af, Depth= 0.32"

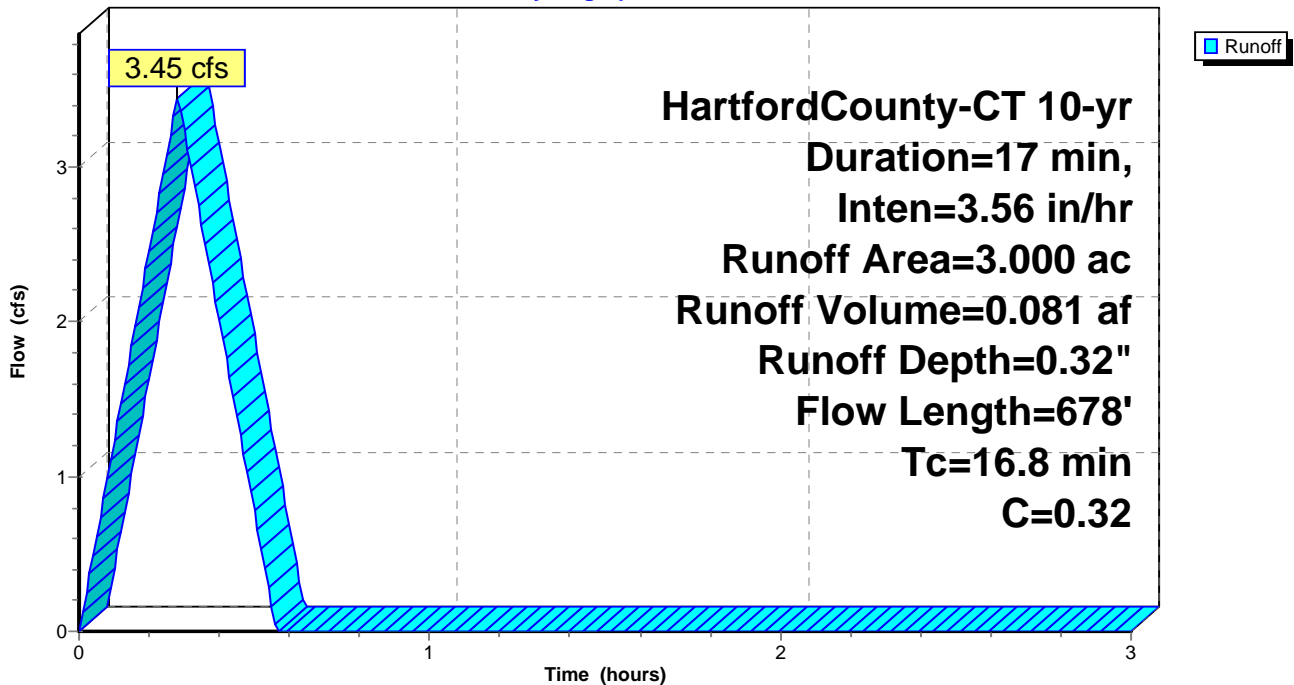
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 10-yr Duration=17 min, Inten=3.56 in/hr

Area (ac)	C	Description
3.000	0.32	Forest, 0-20%, D Soil
3.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	150	0.0467	0.25		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
6.6	528	0.0360	1.33		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
16.8	678	Total			

Subcatchment 1S: CT-297+50

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 3.000 ac, 0.00% Impervious, Inflow Depth = 0.32" for 10-yr event
 Inflow = 3.45 cfs @ 0.28 hrs, Volume= 0.081 af
 Outflow = 2.88 cfs @ 0.42 hrs, Volume= 0.081 af, Atten= 17%, Lag= 8.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.02 fps, Min. Travel Time= 5.2 min
 Avg. Velocity = 0.28 fps, Avg. Travel Time= 18.6 min

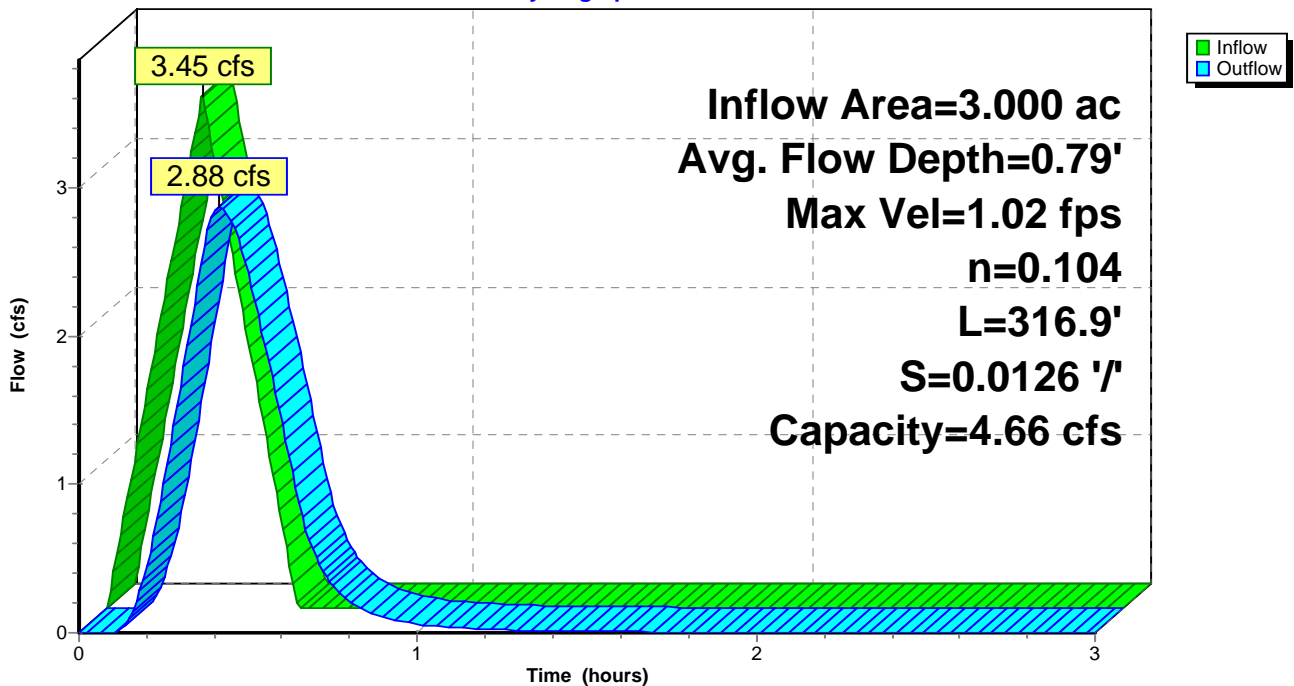
Peak Storage= 891 cf @ 0.33 hrs
 Average Depth at Peak Storage= 0.79'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.66 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 316.9' Slope= 0.0126 '/
 Inlet Invert= 142.00', Outlet Invert= 138.00'



Reach 2R: Diversion Swale

Hydrograph





Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Kinder Morgan-CT
 Project Number: 49018
 Channel Name: 297+50**

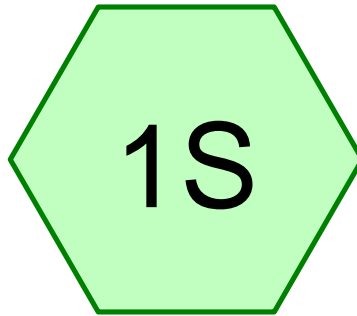
Discharge	3.04
Peak Flow Period	2
Channel Slope	0.0126
Channel Bottom Width	2
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

SC150

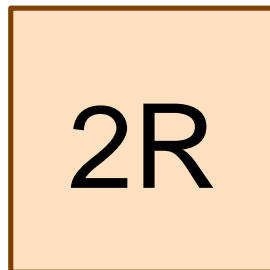
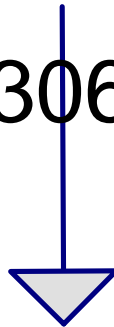
Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
SC150 Unvegetated	Straight	3.04 cfs	1.79 ft/s	0.55 ft	0.049	2 lbs/ft ²	0.43 lbs/ft ²	4.64	STABLE	D

Unreinforced Vegetation - Class C - Mix (Sod & Bunch) - Good 75-95%

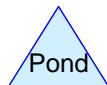
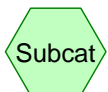
Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	3.04 cfs	0.95 ft/s	0.86 ft	0.117	4.2 lbs/ft ²	0.68 lbs/ft ²	6.21	STABLE	--
Underlying Substrate	Straight	3.04 cfs	0.95 ft/s	0.86 ft	--	0.04 lbs/ft ²	0.003 lbs/ft ²	11.73	STABLE	--



CT-306+00



Diversion Swale



Summary for Subcatchment 1S: CT-306+00

Runoff = 3.36 cfs @ 0.38 hrs, Volume= 0.107 af, Depth= 0.27"

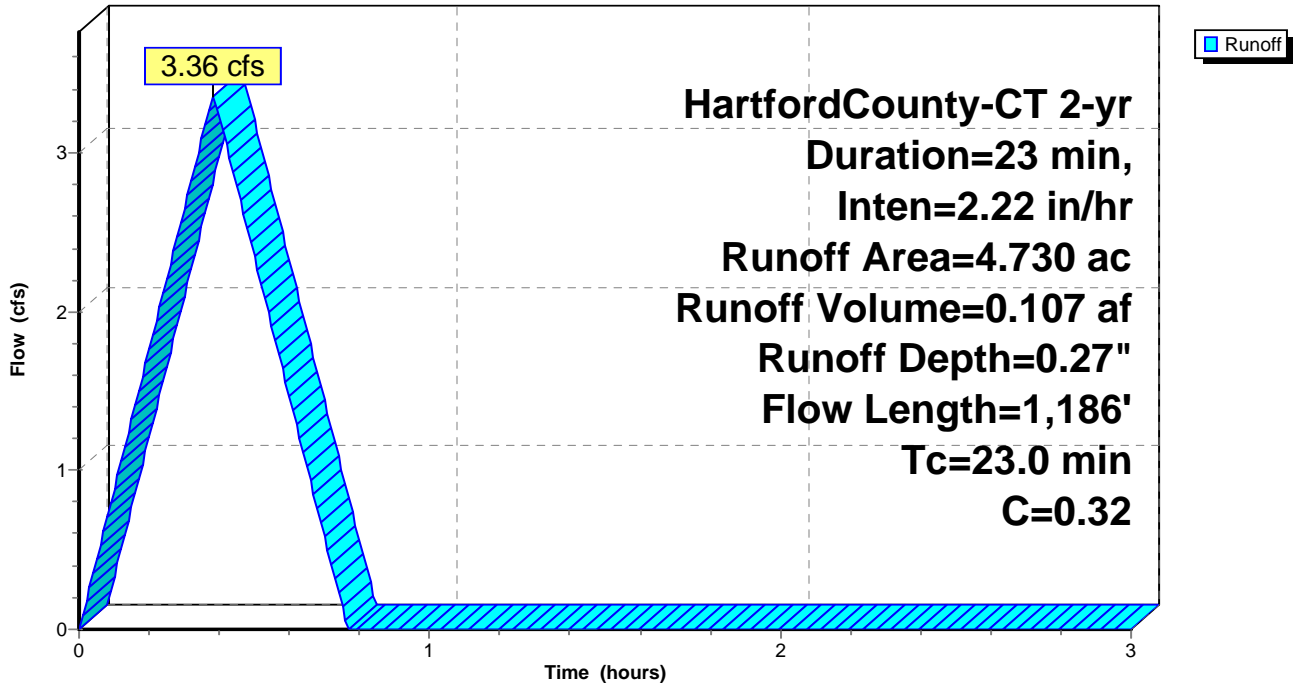
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 2-yr Duration=23 min, Inten=2.22 in/hr

Area (ac)	C	Description
4.730	0.32	Forest, 0-20%, D Soil
4.730		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	150	0.0733	0.29		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
14.5	1,036	0.0290	1.19		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
23.0	1,186	Total			

Subcatchment 1S: CT-306+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 4.730 ac, 0.00% Impervious, Inflow Depth = 0.27" for 2-yr event
 Inflow = 3.36 cfs @ 0.38 hrs, Volume= 0.107 af
 Outflow = 2.95 cfs @ 0.52 hrs, Volume= 0.107 af, Atten= 12%, Lag= 8.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.02 fps, Min. Travel Time= 5.4 min
 Avg. Velocity = 0.33 fps, Avg. Travel Time= 16.7 min

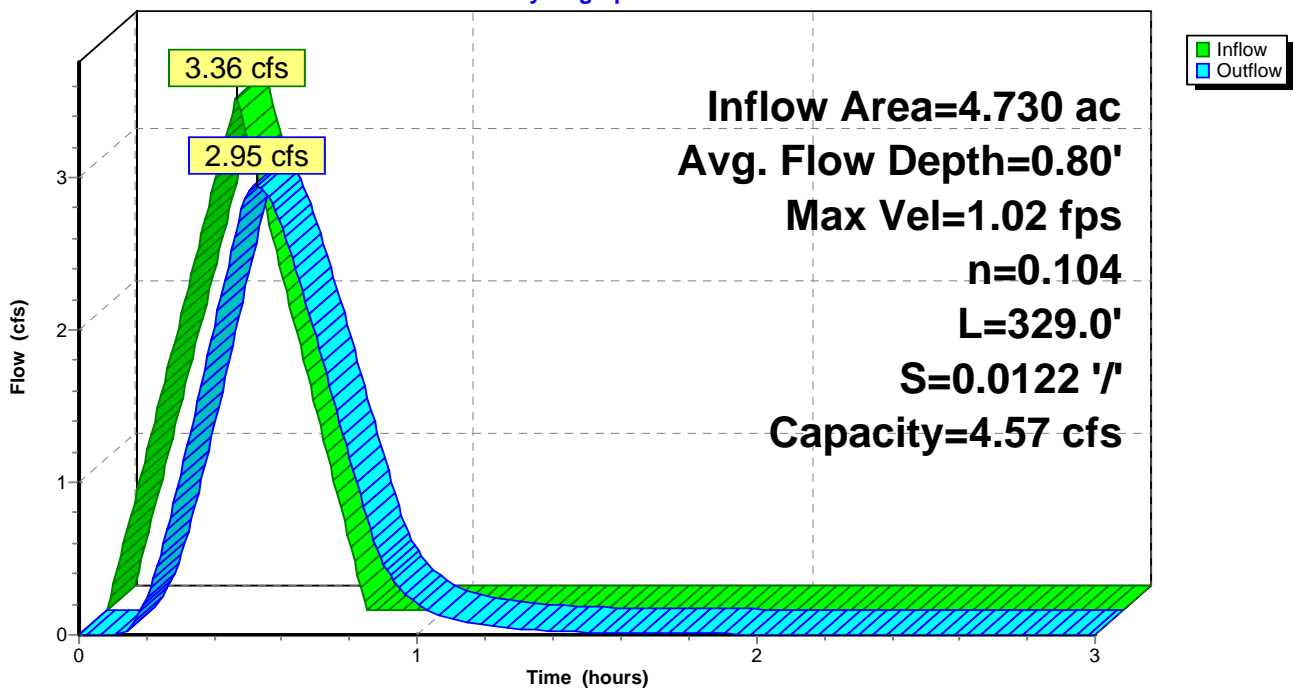
Peak Storage= 954 cf @ 0.43 hrs
 Average Depth at Peak Storage= 0.80'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.57 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 329.0' Slope= 0.0122 '/
 Inlet Invert= 148.00', Outlet Invert= 144.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-306+00

Runoff = 4.03 cfs @ 0.38 hrs, Volume= 0.129 af, Depth= 0.33"

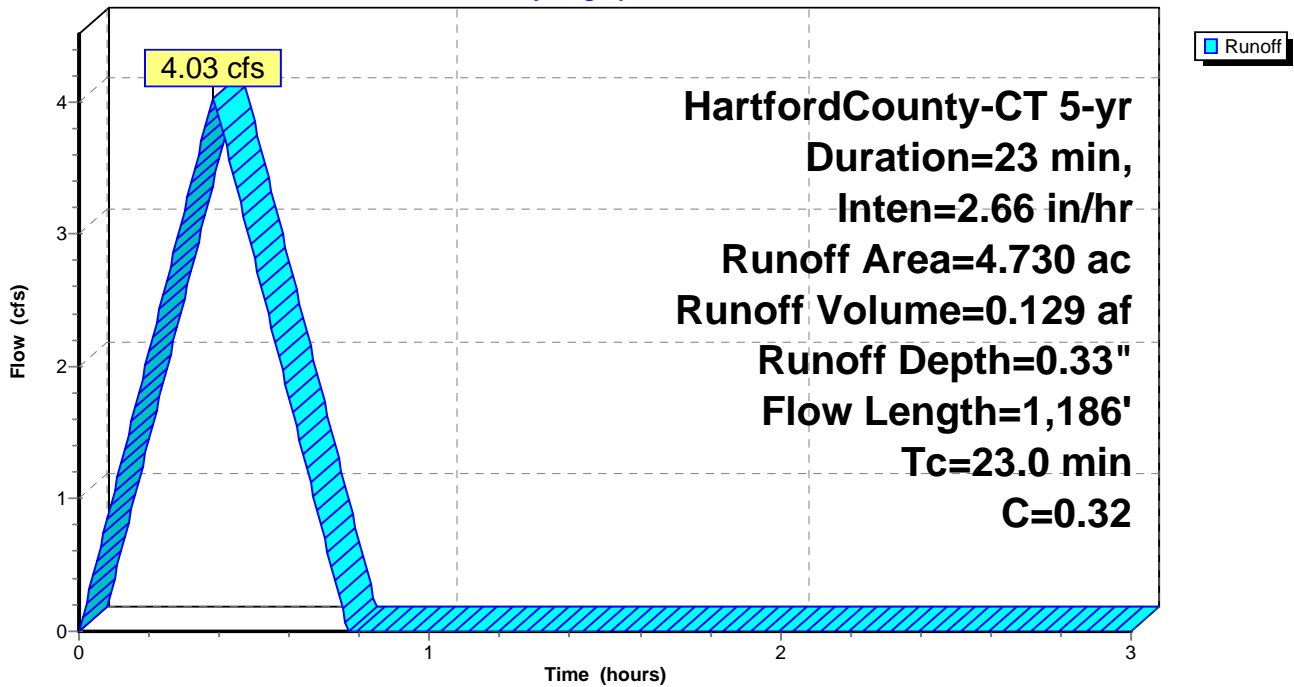
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 5-yr Duration=23 min, Inten=2.66 in/hr

Area (ac)	C	Description
4.730	0.32	Forest, 0-20%, D Soil
4.730		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	150	0.0733	0.29		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
14.5	1,036	0.0290	1.19		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
23.0	1,186	Total			

Subcatchment 1S: CT-306+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 4.730 ac, 0.00% Impervious, Inflow Depth = 0.33" for 5-yr event
 Inflow = 4.03 cfs @ 0.38 hrs, Volume= 0.129 af
 Outflow = 3.56 cfs @ 0.52 hrs, Volume= 0.128 af, Atten= 12%, Lag= 8.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.07 fps, Min. Travel Time= 5.1 min
 Avg. Velocity = 0.34 fps, Avg. Travel Time= 16.0 min

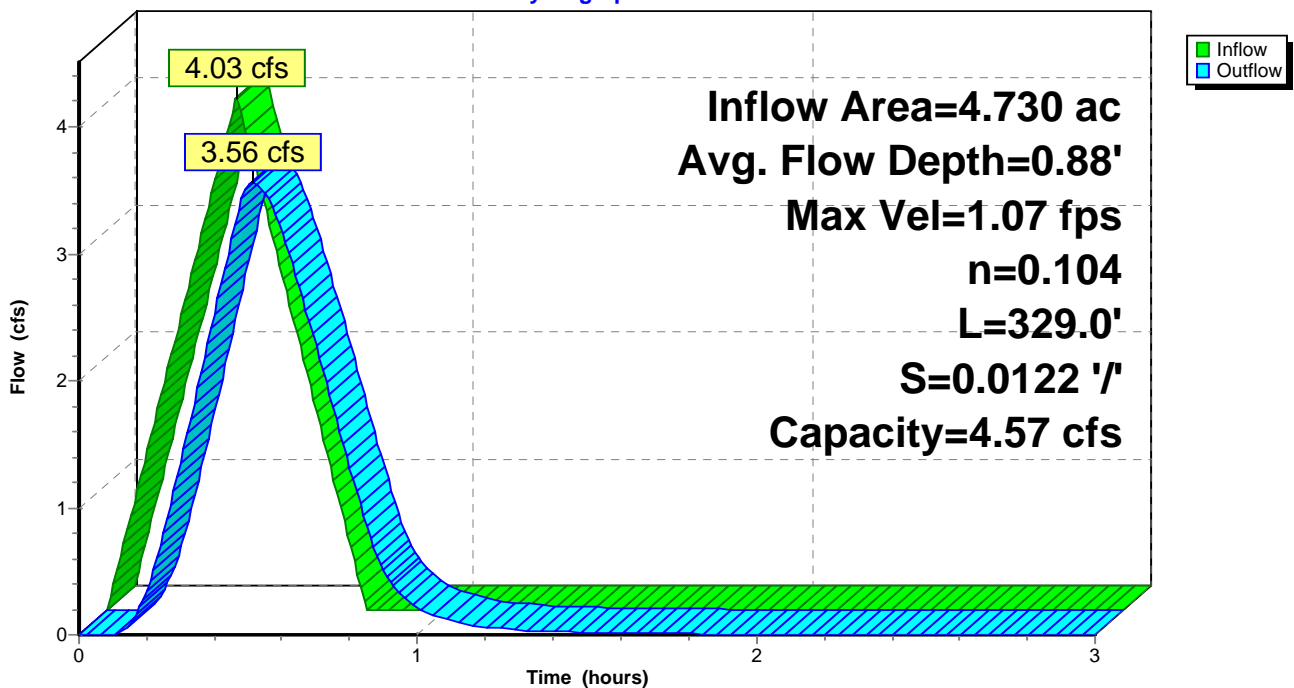
Peak Storage= 1,096 cf @ 0.43 hrs
 Average Depth at Peak Storage= 0.88'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.57 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 329.0' Slope= 0.0122 '/
 Inlet Invert= 148.00', Outlet Invert= 144.00'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-306+00

Runoff = 4.62 cfs @ 0.38 hrs, Volume= 0.147 af, Depth= 0.37"

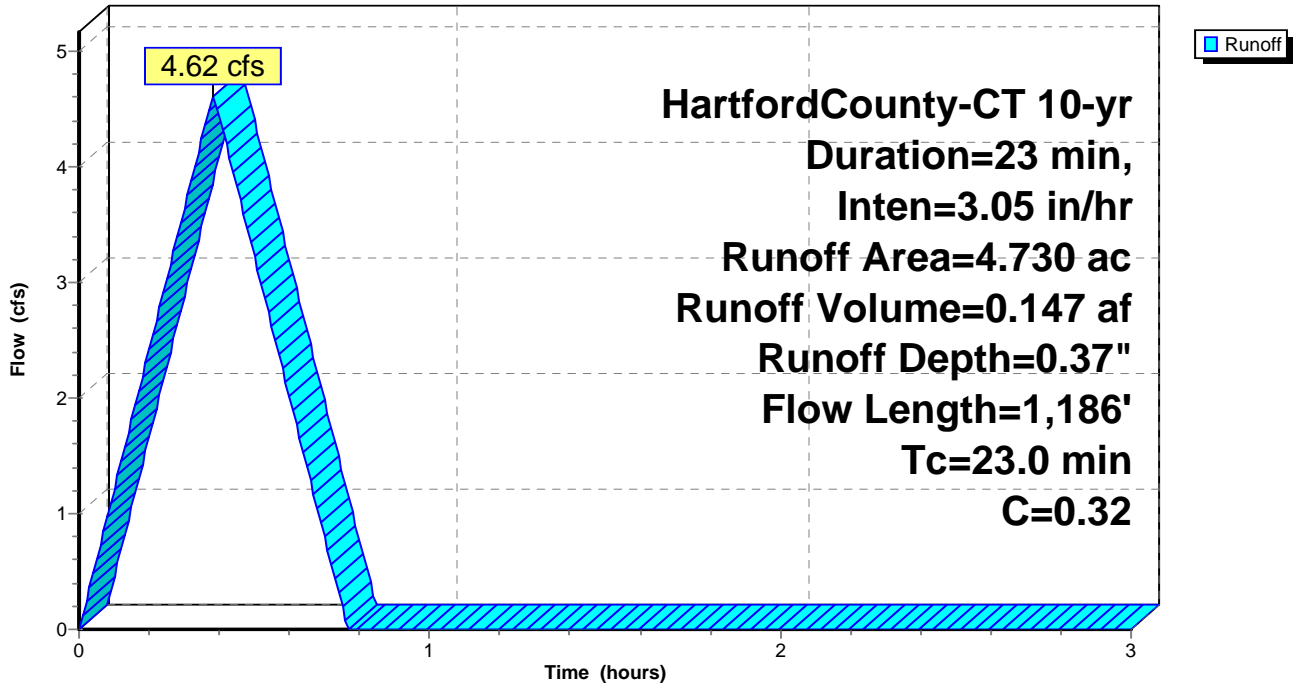
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 10-yr Duration=23 min, Inten=3.05 in/hr

Area (ac)	C	Description
4.730	0.32	Forest, 0-20%, D Soil
4.730		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	150	0.0733	0.29		Sheet Flow, Sheet 1 Grass: Short n= 0.150 P2= 2.88"
14.5	1,036	0.0290	1.19		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
23.0	1,186	Total			

Subcatchment 1S: CT-306+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 4.730 ac, 0.00% Impervious, Inflow Depth = 0.37" for 10-yr event
 Inflow = 4.62 cfs @ 0.38 hrs, Volume= 0.147 af
 Outflow = 4.11 cfs @ 0.51 hrs, Volume= 0.147 af, Atten= 11%, Lag= 7.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.11 fps, Min. Travel Time= 4.9 min
 Avg. Velocity = 0.35 fps, Avg. Travel Time= 15.5 min

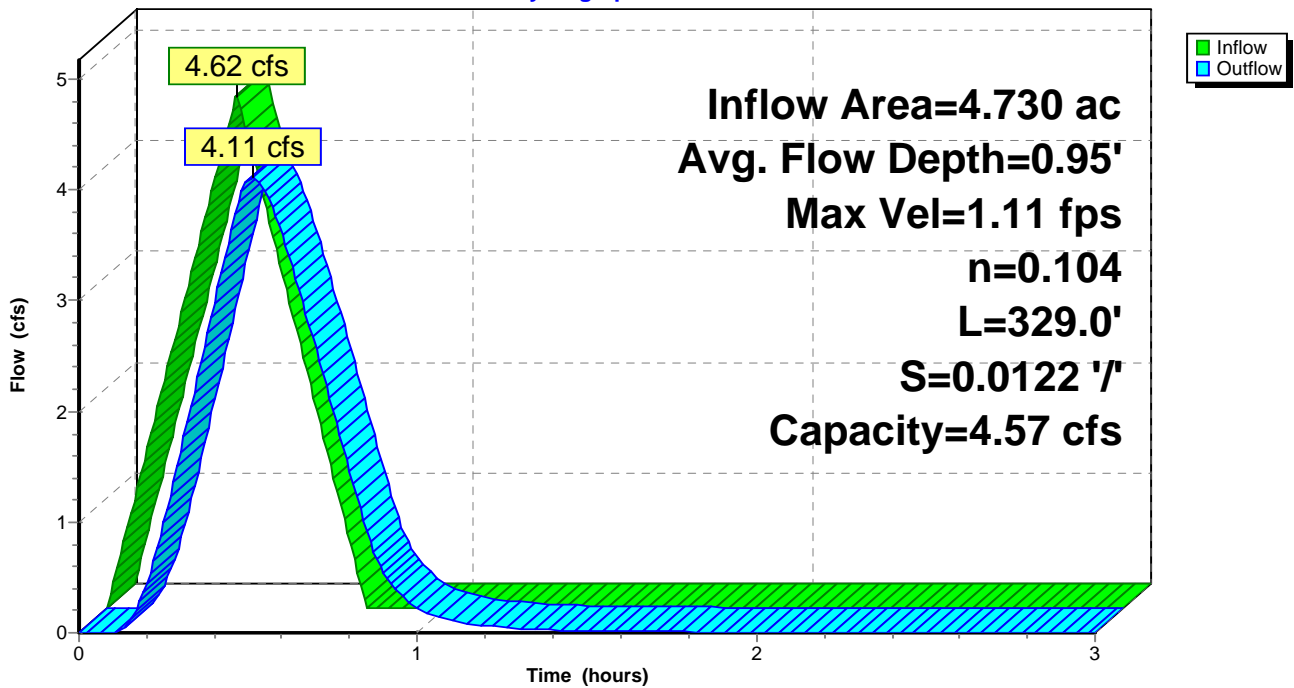
Peak Storage= 1,217 cf @ 0.43 hrs
 Average Depth at Peak Storage= 0.95'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.57 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 329.0' Slope= 0.0122 '/
 Inlet Invert= 148.00', Outlet Invert= 144.00'



Reach 2R: Diversion Swale

Hydrograph





Tensar International Corporation
 5401 St. Wendel-Cynthiana Road
 Poseyville, Indiana 47633
 Tel. 800.772.2040
 Fax 812.867.0247
 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Kinder Morgan-CT
 Project Number: 49018
 Channel Name: 306+00**

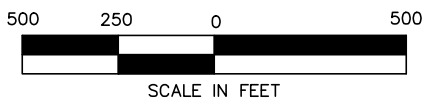
Discharge	4.03
Peak Flow Period	2
Channel Slope	0.0122
Channel Bottom Width	2
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

SC150

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
SC150 Unvegetated	Straight	4.03 cfs	1.97 ft/s	0.63 ft	0.047	2 lbs/ft ²	0.48 lbs/ft ²	4.18	STABLE	D

Unreinforced Vegetation - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	4.03 cfs	1.09 ft/s	0.95 ft	0.106	4.2 lbs/ft ²	0.72 lbs/ft ²	5.82	STABLE	--
Underlying Substrate	Straight	4.03 cfs	1.09 ft/s	0.95 ft	--	0.04 lbs/ft ²	0.004 lbs/ft ²	8.97	STABLE	--



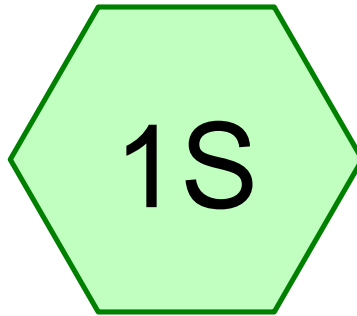
NO.	DATE	BY	DESCRIPTION	PROJ. ID	APPR.
REVISIONS					

Division:		Op. Area:	
St.:	CT	Co./Par.:	HARTFORD
Section:	Township:	Range:	
Dft:	JR	Date:	07/17/14
Project ID:			
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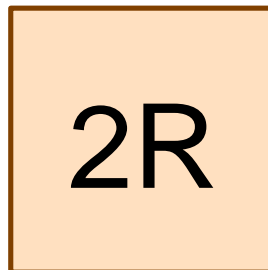
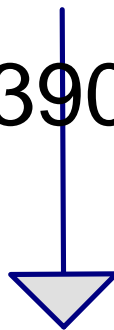
CONNECTICUT EXPANSION
CONNECTICUT LOOP 300
PROPOSED 24" NATURAL GAS PIPELINE
DIVERSION SWALE AT STA. 390+00
TOWN OF SUFFIELD
HARTFORD COUNTY, CONNECTICUT



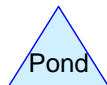
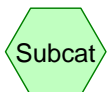
Sheet:	1 of 1
Type:	



CT-390+00



Diversion Swale



Summary for Subcatchment 1S: CT-390+00

Runoff = 3.36 cfs @ 0.65 hrs, Volume= 0.180 af, Depth= 0.33"

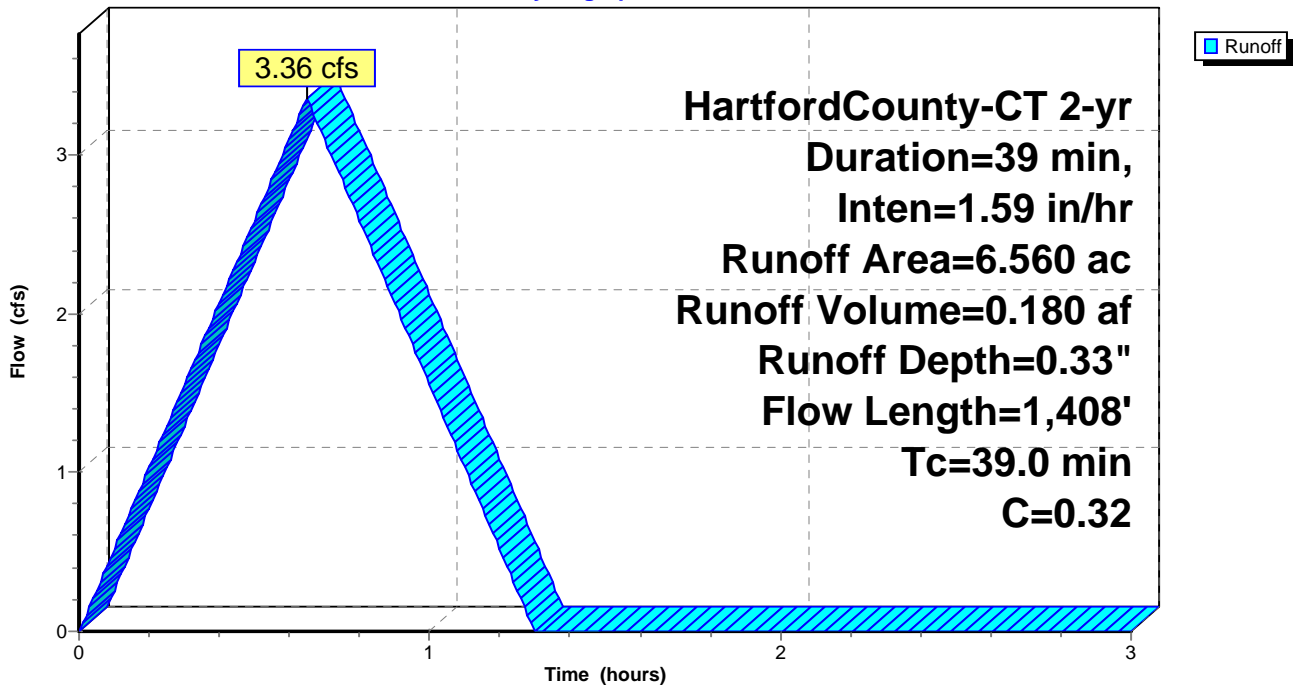
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 2-yr Duration=39 min, Inten=1.59 in/hr

Area (ac)	C	Description
6.560	0.32	Forest, 0-20%, D Soil
6.560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.4	150	0.1000	0.15		Sheet Flow, Sheet 1 Woods: Light underbrush n= 0.400 P2= 2.88"
22.6	1,258	0.0175	0.93		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
39.0	1,408	Total			

Subcatchment 1S: CT-390+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 6.560 ac, 0.00% Impervious, Inflow Depth = 0.33" for 2-yr event
 Inflow = 3.36 cfs @ 0.65 hrs, Volume= 0.180 af
 Outflow = 3.21 cfs @ 0.73 hrs, Volume= 0.180 af, Atten= 4%, Lag= 5.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.04 fps, Min. Travel Time= 3.3 min
 Avg. Velocity = 0.43 fps, Avg. Travel Time= 8.0 min

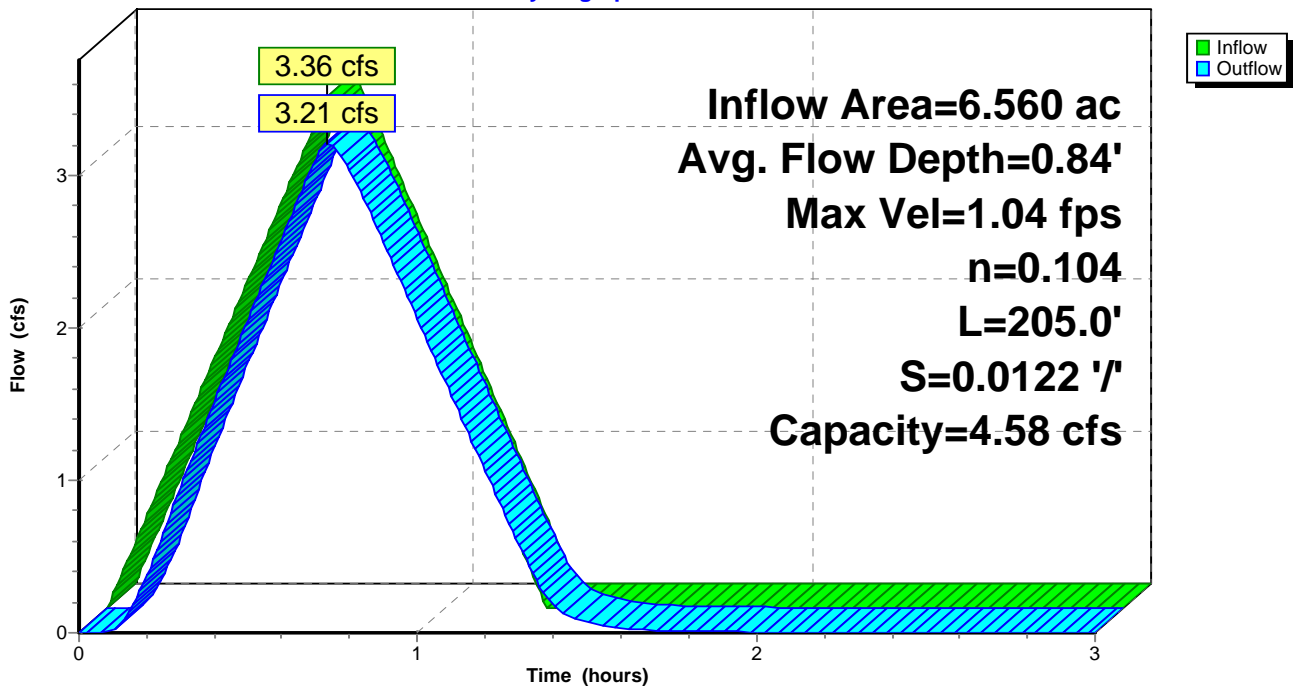
Peak Storage= 632 cf @ 0.68 hrs
 Average Depth at Peak Storage= 0.84'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.58 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 205.0' Slope= 0.0122 '/
 Inlet Invert= 160.00', Outlet Invert= 157.50'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-390+00

Runoff = 4.10 cfs @ 0.65 hrs, Volume= 0.220 af, Depth= 0.40"

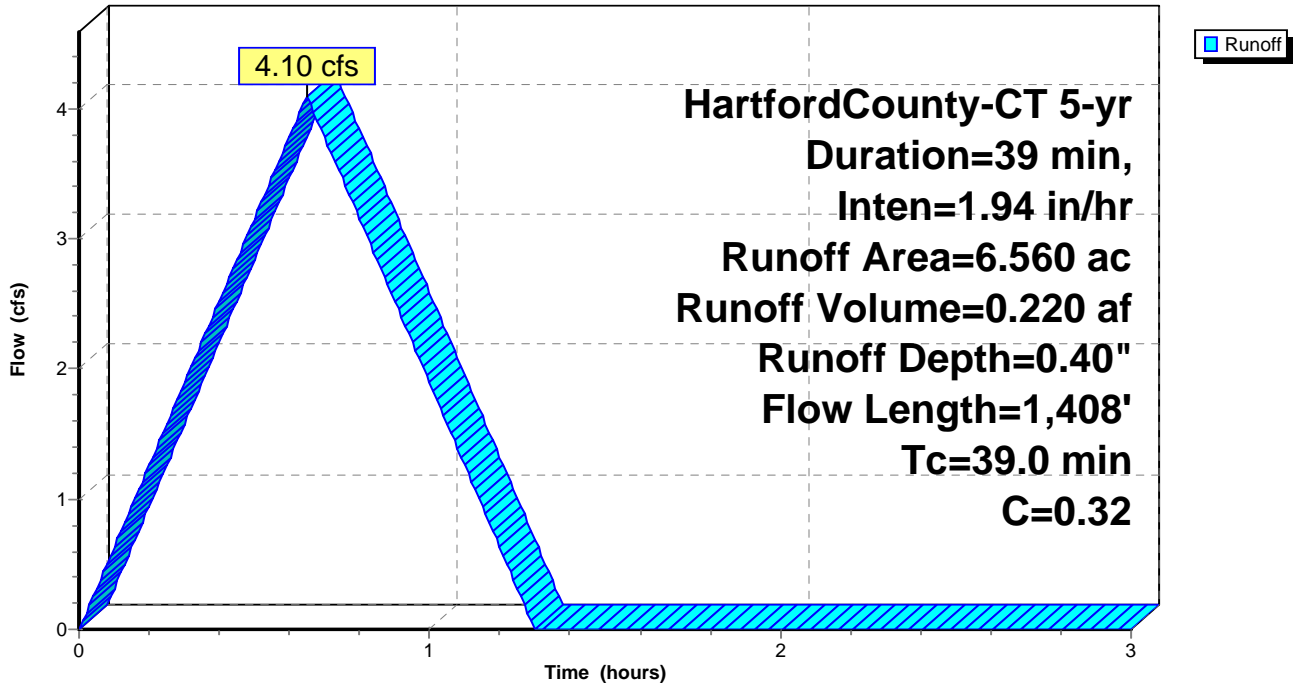
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 5-yr Duration=39 min, Inten=1.94 in/hr

Area (ac)	C	Description
6.560	0.32	Forest, 0-20%, D Soil
6.560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.4	150	0.1000	0.15		Sheet Flow, Sheet 1 Woods: Light underbrush n= 0.400 P2= 2.88"
22.6	1,258	0.0175	0.93		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
39.0	1,408	Total			

Subcatchment 1S: CT-390+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 6.560 ac, 0.00% Impervious, Inflow Depth = 0.40" for 5-yr event
 Inflow = 4.10 cfs @ 0.65 hrs, Volume= 0.220 af
 Outflow = 3.93 cfs @ 0.73 hrs, Volume= 0.220 af, Atten= 4%, Lag= 4.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.10 fps, Min. Travel Time= 3.1 min
 Avg. Velocity = 0.45 fps, Avg. Travel Time= 7.6 min

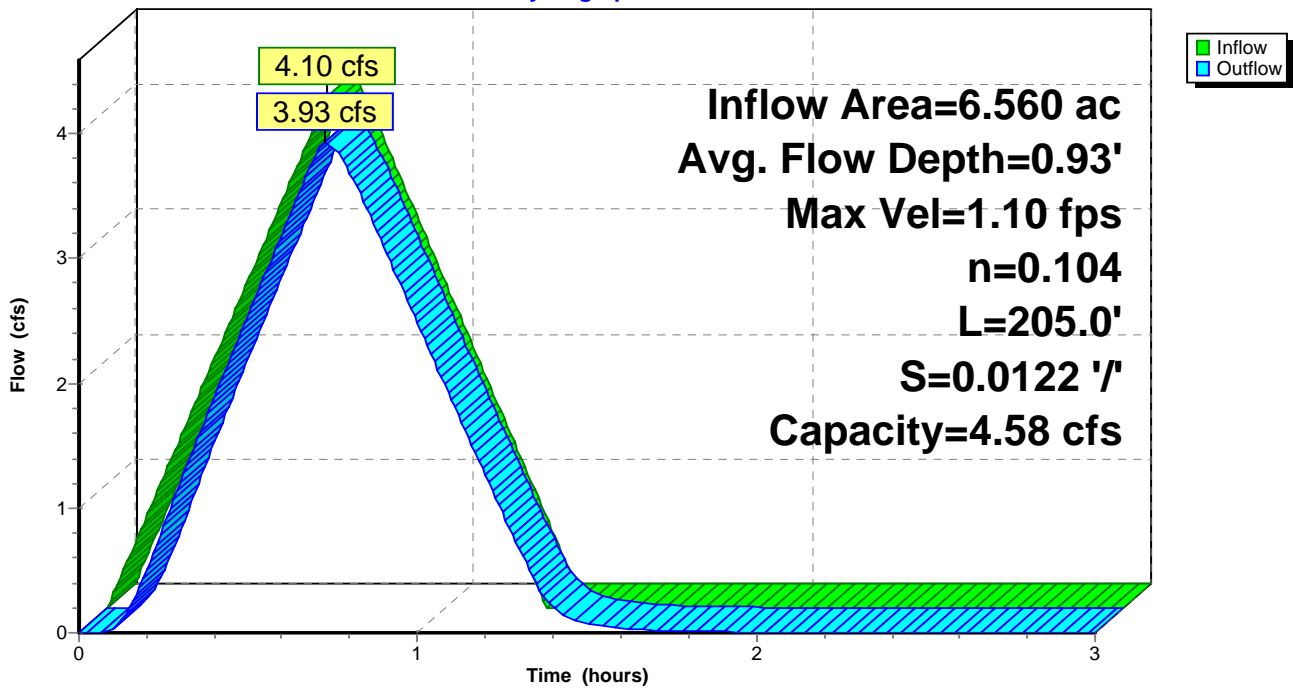
Peak Storage= 733 cf @ 0.68 hrs
 Average Depth at Peak Storage= 0.93'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.58 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 205.0' Slope= 0.0122 '/
 Inlet Invert= 160.00', Outlet Invert= 157.50'



Reach 2R: Diversion Swale

Hydrograph



Summary for Subcatchment 1S: CT-390+00

Runoff = 4.77 cfs @ 0.65 hrs, Volume= 0.256 af, Depth= 0.47"

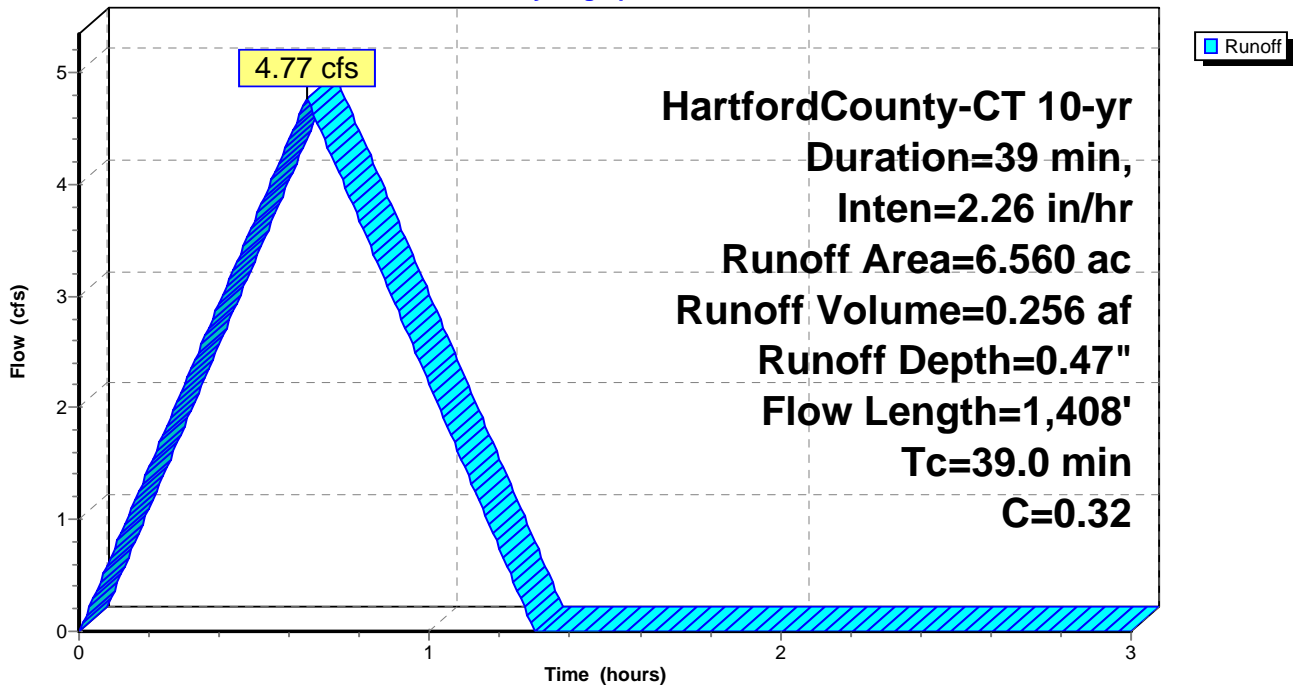
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 HartfordCounty-CT 10-yr Duration=39 min, Inten=2.26 in/hr

Area (ac)	C	Description
6.560	0.32	Forest, 0-20%, D Soil
6.560		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.4	150	0.1000	0.15		Sheet Flow, Sheet 1 Woods: Light underbrush n= 0.400 P2= 2.88"
22.6	1,258	0.0175	0.93		Shallow Concentrated Flow, SCF Short Grass Pasture Kv= 7.0 fps
39.0	1,408	Total			

Subcatchment 1S: CT-390+00

Hydrograph



Summary for Reach 2R: Diversion Swale

Inflow Area = 6.560 ac, 0.00% Impervious, Inflow Depth = 0.47" for 10-yr event
 Inflow = 4.77 cfs @ 0.65 hrs, Volume= 0.256 af
 Outflow = 4.59 cfs @ 0.73 hrs, Volume= 0.256 af, Atten= 4%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
 Max. Velocity= 1.15 fps, Min. Travel Time= 3.0 min
 Avg. Velocity = 0.47 fps, Avg. Travel Time= 7.3 min

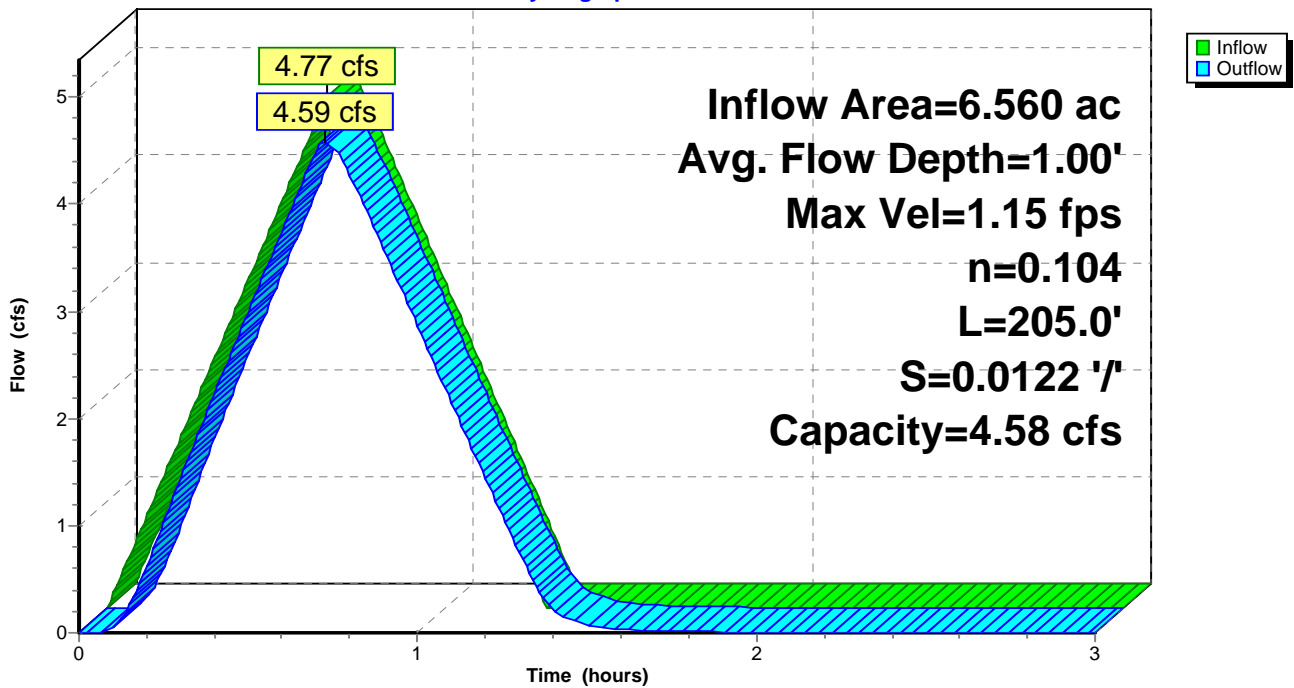
Peak Storage= 821 cf @ 0.68 hrs
 Average Depth at Peak Storage= 1.00'
 Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 4.58 cfs

2.00' x 1.00' deep channel, n= 0.104
 Side Slope Z-value= 2.0 '/ Top Width= 6.00'
 Length= 205.0' Slope= 0.0122 '/
 Inlet Invert= 160.00', Outlet Invert= 157.50'



Reach 2R: Diversion Swale

Hydrograph





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 www.nagreen.com

**Erosion Control Materials Design Software
 Version 5.0**

**Project Name: Kinder Morgan-CT
 Project Number: 49018
 Channel Name: 390+00**

Discharge	4.1
Peak Flow Period	2
Channel Slope	.0122
Channel Bottom Width	2
Left Side Slope	2
Right Side Slope	2
Low Flow Liner	
Retardance Class	C
Vegetation Type	Mix (Sod & Bunch)
Vegetation Density	Good 75-95%
Soil Type	Silt Loam

SC150

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
SC150 Unvegetated	Straight	4.1 cfs	1.98 ft/s	0.63 ft	0.047	2 lbs/ft ²	0.48 lbs/ft ²	4.14	STABLE	D

Unreinforced Vegetation - Class C - Mix (Sod & Bunch) - Good 75-95%

Phase	Reach	Discharge	Velocity	Normal Depth	Mannings N	Permissible Shear Stress	Calculated Shear Stress	Safety Factor	Remarks	Staple Pattern
Unreinforced Vegetation	Straight	4.1 cfs	1.1 ft/s	0.95 ft	0.105	4.2 lbs/ft ²	0.73 lbs/ft ²	5.79	STABLE	--
Underlying Substrate	Straight	4.1 cfs	1.1 ft/s	0.95 ft	--	0.04 lbs/ft ²	0.004 lbs/ft ²	8.81	STABLE	--