TECHNICAL MEMORANDUM

Taylor Run Watershed Analysis: The Effects of Implementing Stormwater Facility Best Management Practices (BMPs) in the Watershed on the Stream Channel

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Purpose

This technical memorandum (TM) was prepared in response to suggestions by the Taylor Run Census Building Group (CBG) for staff to explore whether the implementation of green infrastructure stormwater facility best management practices (BMPs) that provide water quality and runoff reduction benefits would improve the portion of the Taylor Run Watershed that drains to the approximate 1,900 linear feet of stream segment by addressing the a subset of the goals of the restoration project focused on addressing ongoing erosion and stabilization of the exposed sanitary sewer infrastructure. This TM analyzes the removal of impervious area in the sub-watershed as a surrogate for the implementation of these BMPs, with the results determining if BMPs would illicit a sufficient positive impact to address the ongoing erosion of the channel and protect the exposed sanitary sewer infrastructure from potential failures, aside for the water quality benefits. This analysis also looks at the effectiveness adding a large detention facility before runoff enters Taylor Run.

Background

The Taylor Run Stream Restoration project was prioritized for implementation based on the City's Phase III Stream Assessment: Stream Restoration and Outfall Stabilization Feasibility Study (February 2019) that assessed conditions of five separate streams and three storm sewer outfall locations and prioritized these using a multi-decision criteria matrix. The Taylor Run stream was the second priority project out of the five locations. The Phase III Stream Assessment built on stream identification and assessment of problem areas in the Phase I Stream Assessment (2004) and Phase II Stream Assessment (2008). The project location for the potential stream restoration is approximately 1,900 linear feet that extends from the culvert at Chinquapin Recreation Center for approximately 1,000 linear feet where it reaches the First Baptist Church of Alexandria property and extends an additional approximate 900 linear feet and terminates at the dual culvert downstream.

Staff commenced outreach on the draft results of the Phase III Stream Assessment and this proposed project in September 2018 and with the approval of City Council, applied for a FY 2019 Virginia Stormwater Local Assistance Fund (SLAF) grant later that month; with outreach continuing through February 2020. While design slowly progressed during the COVID global pandemic, public engagement around the projects was interrupted and restarted in September 2020 and continued through April

2021. A stream restoration work session was held at the April 27, 2021, City Council legislative session that included a presentation on the stream restoration progress and a public comment period. At this session, City Council directed staff to pause progress on the stream restoration project and collaborate further with the community on alternative methods to the proposed method of Natural Channel Design (NCD), an approach used and endorsed by Virginia Department of Environmental Quality (VDEQ) and revised in 2021.

To facilitate the collaboration, City staff engaged the neutral third party – the Institute of Engagement and Negotiation (IEN) with the University of Virginia – in July 2021 to begin working with the community on these alternatives. Throughout the engagement, community stakeholders, staff, and consultants have discussed the efficacy of BMP implementation to address project goals. The current phase of this collaboration includes working with the Taylor Run Consensus Building Group (CBG) where discussions have focused on alternative methods to meet the project goals, to include whether the implementation of BMPs can meet those goals to reduce urban runoff and flows into the stream to reduce erosion. The CBG has requested further information about the near and long-term feasibility of these upstream BMPs and their efficacy to meet the runoff reduction goals.

Beginning in the early 1990s, all development and redevelopment must meet state water quality and water quantity requirements in the zoning ordinance, in addition to treating the first ½" of stormwater runoff over all impervious surfaces. Because of this, about 51% of the 244-acre upper Taylor Run watershed currently drains to BMPs. See more information in Appendix D.

While the City has shared the existing conditions, the CBG has requested a more in-depth analysis for the potential of implementing BMPs to address project goals. To accomplish this analysis, a hydrologic and hydraulic (H&H) model was developed to provide quantitative results to help determine the level of substantive changes needed in the sub-watershed to reduce erosion along the project reach. The analysis compares existing conditions for flow and velocity in the Taylor Run stream channel with reductions in impervious surface in the watershed as a surrogate for the implementation of BMPs.

General Approach and Assumptions

The most general question this technical memo attempts to address is that if nothing is done to stabilize the stream banks of Taylor Run, how much change can be affected on the flows in the Taylor Run channel by only making changes to the upstream watershed?

The general approach was to choose an accepted model for the hydrologic and hydraulic analysis of rainfall, runoff, and channel flow/velocity. Therefore, the US Army Corps of Engineers' Hydrologic Engineering Center's (HEC) Hydrologic Modeling System (HMS), or HEC-HMS version 4.10 was selected to perform this study. This model also provided an opportunity to incorporate as much previously studied data and modeling parameters determined by other authorities, such as the FEMA Cameron Run Watershed Study (2007), as was appropriate for the purposes of the comparisons developed below. FEMA's previous study is still valid in so far as it is considered the effective regulatory source for the flood data shown on the FEMA FIRM maps used by the city to regulate development in the Special Flood Hazard Areas (SFHA).

It is recognized that since 2007 there are anomalies apparent in the local weather patterns that are not yet incorporated in FEMA's models. However, for the purposes of this study and comparisons of qualitative changes in the Taylor Run watershed, it was considered acceptable. In other words, a working model with reasonable results for existing conditions should also return reasonable results for change scenarios in the watershed. It was also assumed, much like FEMA's runoff HEC-HMS model, that there is no storm sewer in the model and is as such a pure runoff model with routing the travel of runoff from the individual sub-watersheds to the outfall.

Two separate configurations of HEC-HMS were run to determine effectiveness of two methodologies for reducing runoff potential in the upper Taylor Run watershed. The first analysis focused on the overall runoff reduction by altering the land surface and reducing the percentage of impervious surface from the existing conditions found today. The second analysis focused on the reduction of peak erosive velocities entering Taylor run by short circuiting the runoff in a detention type storage facility which controlled the release of runoff into Taylor Run.

It should be noted that only the tributary sub-watersheds contributing runoff to the outfall point were analyzed. In addition, only a short section of Taylor Run was analyzed for flow/velocity observations. In addition, a single cross section was used to calculate the velocity in Taylor Run. It is recognized that the velocities produced by this analysis do not represent every point along the reach of Taylor Run in question. As in a natural channel, velocity will vary from place to place. However, the cross section selected is in the location where the highest known velocities occur. Hence, various scenarios considering different land imperviousness conditions were entered into the model to see how flow and velocity are affected by BMPs and a large detention facility.

An additional analysis was added to PART1 using the Virginia Runoff Reduction Method was also performed to determine the scope, scale and cost of implementing water quality BMPs for a given area.

For the purposes of this analysis and comparisons of changes in the land surface, it was assumed that a conversion from impervious to pervious areas by a percentage of the whole land surface was an acceptable allegory to adding water quality BMPs to the watershed when looking at a reduction to runoff potential.

Based on the US Department of Agriculture's Natural Resources Conservation Service's Stream Restoration Design National Engineering Handbook, Chapter 8 – Threshold Channel Design, a target maximum velocity range in Taylor Run was selected between 4-feet-per-second and 6-feet-per-second. This is the target allowable velocity to reduce runoff given the soil material present in the stream banks. It was assumed that these maximum allowable velocities, if achieved for storms equal to or greater than the 10-yr 24-hr storm, would significantly reduce the erosive potential of the flow in the channel effecting the banks of Taylor Run.

Model Setup and Parameters

The primary model program used for this analysis was the US Army Corps of Engineers Hydrologic Engineering Center (HEC) Hydrologic Modeling System (HMS), latest version. For the first look at how BMPs effect the runoff potential from the upper Taylor Run watershed, we take the existing conditions and create a baseline for comparison. The first step involved in setting up the HMS model was to define and introduce the scope of the problem to the model with required data input that included City's most updated LiDAR imagery data for the upper sub-watershed of Taylor Run. A 1' x 1' resolution Digital Elevation Model (DEM) for sub-watershed was used to delineate sub-basins tributaries to the sub-watershed for hydrological analysis. The main components of HMS model consist of a basin model, meteorological model, and control section. The precipitation used in the HMS meteorological model was taken from FEMA's "Hydrologic and Hydraulic Analysis for the Cameron Run Watershed in Northern Virginia" (2007) study. The precipitation from that study remains the basis of analysis for the effective FEMA Flood Insurance Rate Maps (FIRMs) in Alexandria and surrounding municipalities. Using this data gives us a direct comparison for existing conditions developed by FEMA for verifying our baseline. FEMA's precipitation, or design storms, were used to create the meteorological model using the storm frequency method. The selected storms were the 10-yr, 24-hr and 100-yr, 24-hr storms.

The runoff computations in the model were performed through using the Soil Conservation Service (SCS) TR-55 Curve Number methodology, a widely accepted runoff methodology and is considered an industry standard. The SCS curve number method is a simple, widely used and efficient method for determining the approximate amount of runoff from a rainfall event in a particular area. The Curve Number is a dimensionless parameter indicating the runoff response characteristic of a drainage basin. In the Curve Number Method, this parameter is related to land use, land treatment, hydrological condition, hydrological soil group, and antecedent soil moisture condition in the drainage basin. More information on the SCS TR-55 Curve Number method is included in Appendix BA. The model is a dynamic model that computes runoff at defined timesteps to a concentration point for each sub-watershed. The model also computes routing of runoff for each sub-watershed as the runoff travels downstream and intersects with other sub-watersheds' concentration points before being released into Taylor Run at Chinquapin Park. FEMA's effective HEC-HMS model developed a single drainage area for Taylor Run in the area of interest. This was too coarse for the purposes of this study. We separately determined a set of individual drainage areas, or sub-watersheds (refer to Table 1), that included parameters for land cover type (SCS Curve Number) and impervious surface for each from the city's Geographic Information System (GIS) data. A schematic of the determined drainage areas is shown below in Figure 1.

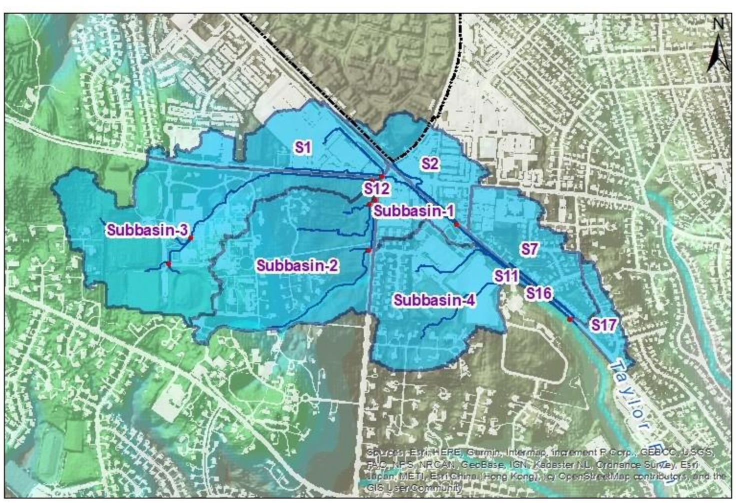


Figure 1. Upper Taylor Run Watershed

All the sub-watersheds drain to a single discharge point, coincidental with the culvert discharge into Taylor Run south of the Chinquapin Park.

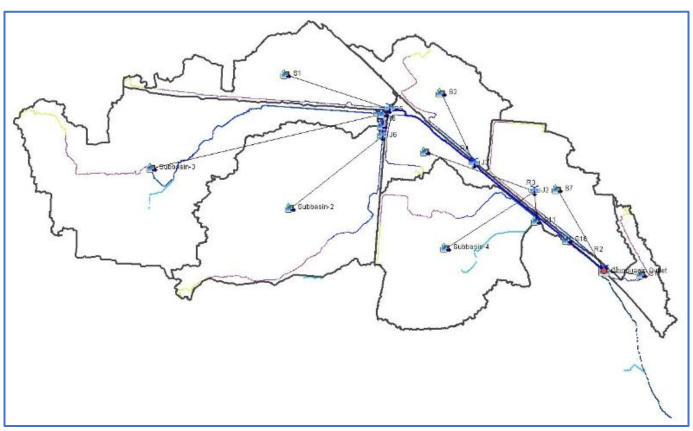
Existing Conditions:

The following Table 1 shows the basic parameters of each sub-watershed in the model.

Table 1 – Sub-Watershed Details

Sub-Basin	Area (Acre)	Longest Flow Path (FT)	Basin Slope (FT/FT)
Subbasin-1	10.62	2967.73	0.011
Subbasin-2	52.78	3529.68	0.021
Subbasin-3	66.02	5345.47	0.016
Subbasin-4	40.97	2899.09	0.013
S1	24.77	2997.46	0.027
S2	18.62	2146.27	0.010
S7	22.34	2782.24	0.019
S11	0.06	90.66	0.027
S12	0.26	263.58	0.012
S13	0.19	209.77	0.014
S16	0.96	1007.53	0.025
S17	6.91	1623.81	0.028

Figure 2. Model Schematic



Storm Events:

Rainfall data from FEMA's previous flood insurance study (2007) was used to analyze runoff in the watershed based on 10-Year, 24-Hour and 100-Year, 24-Hour storm events. Table 2 and Table 3 represent rainfall depth with respect to its duration for both storm events.

Table 2: 10-Year, 24-Hour Storm Event

Rainfall Duration	Rainfall Depth (in)
5 Minutes	0.57
15 Minutes	1.16
1 Hour	2.18
2 Hours	2.57
3 Hours	2.57
6 Hours	3.34
12 Hours	4.09
24 Hours	4.84

Table 3: 100-Year, 24-Hour Storm Event

Rainfall Duration	Rainfall Depth (in)
5 Minutes	0.76
15 Minutes	1.53
1 Hour	3.23
2 Hours	3.93
3 Hours	4.27
6 Hours	5.34
12 Hours	6.82
24 Hours	8.37

Proposed Scenarios:

PART 1: Water Quality BMPs

In the first part of this study, six scenarios were introduced to the model to observe how the change in impervious surface affects streamflow in the outlet point (located in Chinquapin Park) in the upper Taylor Run sub-watershed. Change in impervious surface will be synonymous in this exercise for BMPs implementation in the watershed. Table 4 shows all scenarios with respect to reduction in the impervious surface. The existing condition as it is known today, shows the sub-watershed as 37% impervious of the 244 acres. This existing condition is Scenario 1.

For Scenario 6, the final configuration of the upper Taylor Run watershed was 100% converted to pervious surface, and a Curve Number associated with a natural area was used. This last scenario is to show ideal conditions where no development has occurred.

Table 4 - A Summary of BMP Scenarios for Taylor Run Sub-Watershed

Scenario	Total Sub-Watershed Area (Acre)	Impervious Surface (Acre)	Impervious Surface (%)	Impervious Surface Reduction (%)
1	244	91	37	0
2	244	74	30	7
3	244	67	27	10
4	244	43	17	20
5	244	18	7	30
6	244	0.00	0	37

PART 1: Results

Based on the different imperviousness scenarios considered for hydrological analysis of the upper Taylor Run watershed, following results are summarized below in Table 5.

Stormwater discharges were simulated for each upper Taylor Run sub-watershed leading to the total flow to Taylor Run in Chinquapin Park. Six scenarios (Table 2) were observed for variations in streamflow characteristics. Maximum discharge and velocity at the outlet of the upper Taylor Run watershed entering Taylor Run were calculated for each scenario.

Table 5 - Summary of BMP Scenarios Results for **10-Year**, 24-Hour Storm Event

Scenario	Hydrologic Element	Percent Impervious	Peak Discharge (cfs)	Peak Velocity (fps)
1	Watershed Runoff to Taylor Run	37	579.10	7.41
2	Watershed Runoff to Taylor Run	30	554.80	7.28
3	Watershed Runoff to Taylor Run	27	544.60	7.24
4	Watershed Runoff to Taylor Run	17	511.60	7.11
5	Watershed Runoff to Taylor Run	7	480.40	6.99
6	Watershed Runoff to Taylor Run	0	238.00	5.71

Table 6 - Summary of BMP Scenarios Results for **100-Year**, 24-Hour Storm Event

Scenario	Hydrologic Element	Percent Impervious	Peak Discharge (cfs)	Peak Velocity (fps)
1	Watershed Runoff to Taylor Run	37	954.10	8.66
2	Watershed Runoff to Taylor Run	30	932.80	8.55
3	Watershed Runoff to Taylor Run	27	924.20	8.52
4	Watershed Runoff to Taylor Run	17	897.40	8.45
5	Watershed Runoff to Taylor Run	7	871.50	8.37
6	Watershed Runoff to Taylor Run	0	596.60	7.47

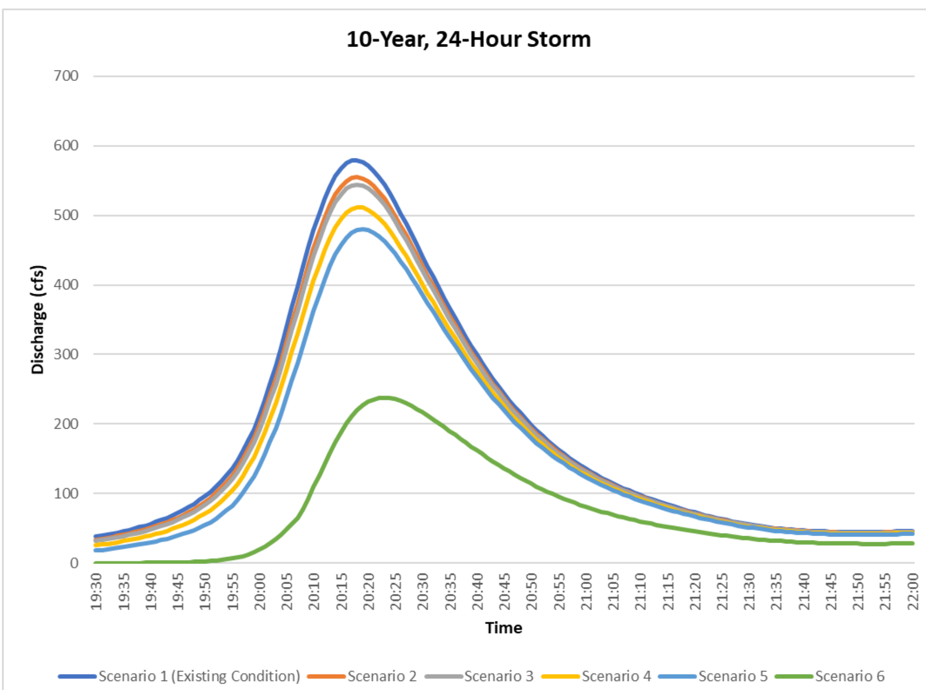


Figure 2. Simulated Peak Discharge at Chinquapin Outlet for 10-Year, 24-Hour Storm

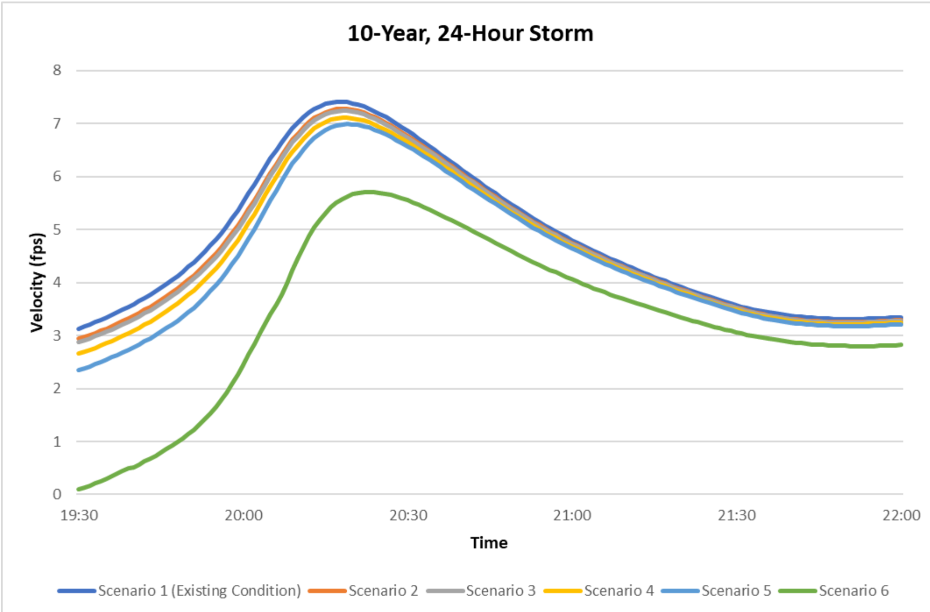


Figure 3. Simulated Peak Velocity Upstream Chinquapin Outlet for 10-Year, 24-Hour Storm

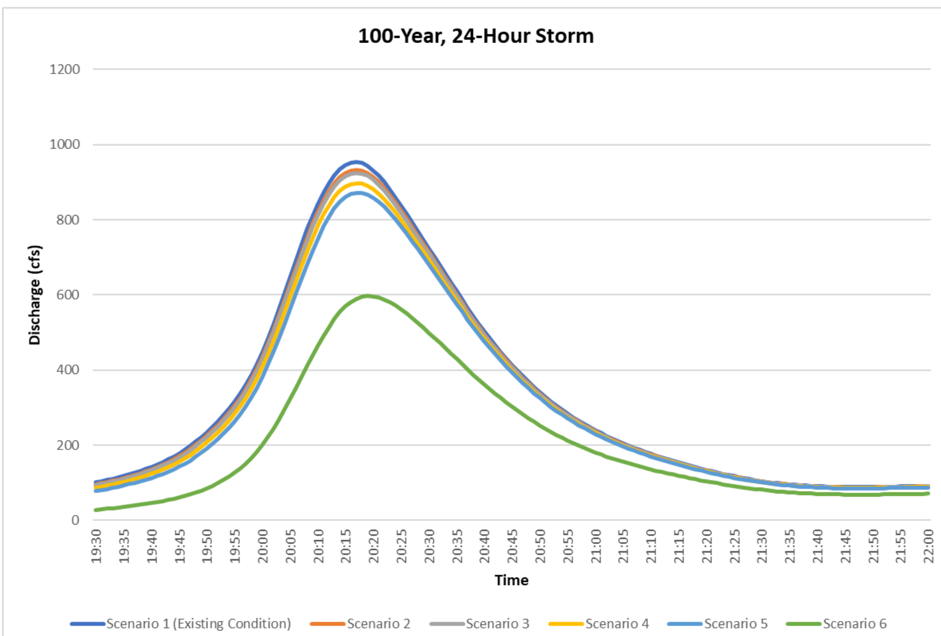


Figure 4. Simulated Peak Discharge at Chinquapin Outlet for 100-Year, 24-Hour Storm

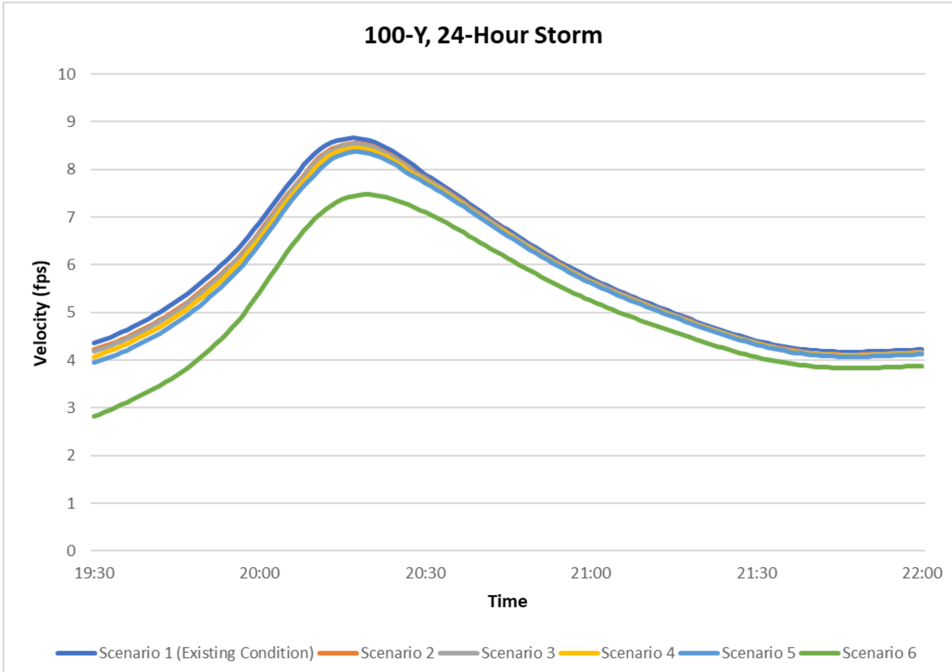


Figure 5. Simulated Peak Velocity Upstream of Chinquapin Outlet for 100-Year, 24-Hour Storm

PART 1: Modeling Conclusions

The purpose of PART 1 of this study was to develop a HEC-HMS based hydrological model to observe streamflow characteristics under different impervious conditions in the Taylor Run upper sub-watershed. The study focused on how and to what extent water quality BMPs may affect the streamflow characteristics in Taylor Run for scouring and erosion prevention purposes in the watershed.

The results from all six scenarios including existing impervious conditions of the upper Taylor Run watershed indicate that even adopting BMPs into an extent of 90.94-acres may not stop scouring and erosion along the Taylor Run stream because velocity based on the simulated model is more than still outside the range of acceptable velocities in the Taylor Run channel, being between 4-fps and 6-fps.

1. These results lead to a conclusion that there must be other factors involved that act as constraints limiting the overall effects of these drastic changes to the watershed. In fact, there are two factors at play in this analysis that do limit the effects of the changes modeled: Soils Type. This modeling technique uses factors associated with soils type and the soils' ability to infiltrate rainfall before it becomes runoff. The ability of several differing soil classes to infiltrate rainfall is calculated as part of the model's computations for every timestep. In Alexandria, the soils are very resistant to infiltration and lack capacity to infiltrate rainfall for medium to large storms. Once that capacity is reached, every following raindrop hits impervious surface and runs off. The modeling factor for a specific type of land use, such as Urban Residential, has four Curve Numbers based on four soils classes determined by the National Soils Conservation Service (NRCS) from A to D. A being highly permeable, to D being highly non-permeable. It's easy to imagine that water passes much easier through sand rather than clay.

FEMA generously used a Curve Number based on Class B soils in their study and this analysis copies those parameters. However, the conversion of concrete or asphalt surfaces to pervious still has a limited effect when the permeability of the soils is accounted for in reducing runoff.

2. Channel Cross Section. Velocity in any channel is based on three variables: Flow (cfs), the cross-sectional area of the cross section and channel slope.

   The equation: Q(flow) = V(velocity)*A(area)

   In a deep and narrow channel with the same slope as a shallow channel with a wide overbank area, the velocities in the deep channel are much higher than the shallow channel with the wide overbank, due to the cross-sectional area being much bigger than the wide channel. In the case of Taylor Run, the channel is deep and narrow, and the cross-sectional area doesn't change much with a change in flow, leading to small changes in velocity.

   The figure below, used only for illustrative purposes, shows an actual surveyed cross section of Taylor Run with the cross-sectional area for both the 10-year and 100-year flows. The respective velocities were 8.5-fps and 10.1-fps in this HEC-RAS hydraulic model.

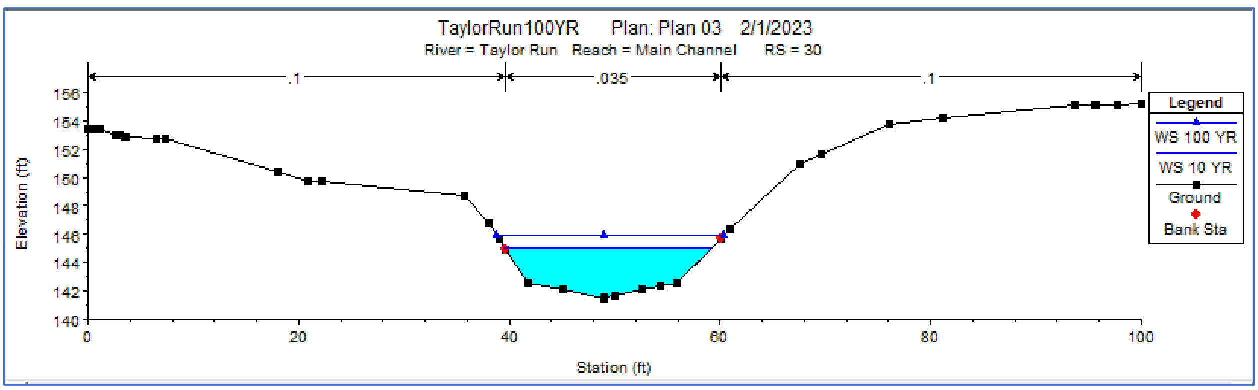


Figure 6 – Actual surveyed cross section from a recent hydraulics model of Taylor Run

PART 1: BMPs – Using Virginia Runoff Reduction Method (VRRM)

A theoretical reduction in impervious surface is perhaps difficult to imagine in a built-out watershed. To gauge the scope and scale of achieving this by implementing BMPs, the VRRM spreadsheet method may give us some basis for understanding the feasibility of big changes in the watershed for general discussion without consideration of feasibility of siting of these practices.

There are currently 51 BMPs in the upstream Taylor Run watershed due to the requirements in place since that early 1990's that any development or redevelopment must meet requirements to implement BMPs. The correlation between the analyzed reduction of impervious surface and the implementation of water quality BMPs can be somewhat estimated using the VDEQ Virginia Runoff Reduction Method (VRRM) water quality spreadsheet used in the design of water quality BMPs for a lesser design storm.

The VRRM also calculates the amount of runoff reduction achieved through green infrastructure BMPs. Using the VRRM, the 51 existing BMPs previously installed as a condition of development capture 38.68 acres of impervious area and reduce 51.09 lbs./year of Total Phosphorus (TP), 307.09 lbs./year of Total Nitrogen (TN), and 23,971.43 lbs./year of Total Suspended Sediment (TSS), while reducing the runoff volume by 0.8 acre-ft. With a total of 90.94 acres of impervious area in the upstream watershed and existing BMPs capturing 38.68 acres leaves 52.26 acres of impervious area uncaptured. Using the above model approach, these BMPs effectively reduce the impervious area to 21% for the upstream watershed.

Given that about 40 acres of impervious area are currently treated with BMPs and the upstream watershed has 90 acres of impervious, it leaves about 50 acres of impervious area untreated. The VRRM was used to analyze the runoff reduction provided by green infrastructure (GI) BMPs. This general discussion uses Bioretention Level 1 (or Urban Bioretention) with ½ acre draining to each BMP for a total of 100 BMPs implemented overall to treat the remaining 50 acres of impervious area. The VRRM calculates the 50 impervious acres would reduce 59.52 lbs./year of TP, 495.44 lbs./year of TN, and 27,926.78 lbs./year of TSS in stormwater runoff. The runoff reduction provided by these additional BMPs equals 1.58 acre-ft. The cost of the 100 urban bioretention systems using approximately $250,000 per facility would be about $25 million dollars.

Additional information on this method may be found in Appendix D.

PART 1: BMPs Conclusions

This general consideration of BMPs shows the value of GI to provide water quality benefits. There are also co-benefits such as reduced heat island effect, creation of micro-habitats, and overall greening and increase in the City's tree canopy associated with implementing GI. While there is a great water quality and 'greening' benefits from implementing these BMPs, the reduction in runoff is minimal compared to the detention discussion in Part 2. Based upon the above model, we could consider that existing plus additional BMPs effectively reduces impervious area to 0% by implementing BMPs on the total 90 acres of impervious and provides a total of 2.38 ac-ft of runoff reduction for the design storm. However, BMPs are designed to capture runoff from the first 1" of rainfall that drains to the facility and are not meant to mitigate flooding. Any additional runoff generated beyond the first 1" is designed to bypass the BMP facility. The first 1" in a 10-year storm and a 100-year storm occurs within about the first 15 minutes of those storms (see Tables 2 and 3, respectively). So the reminder of the stormwater runoff from those storms are not treated nor reduced by the implementation of BMPs. Given this information, implementing the 100 GI BMPs at a cost of $25M would not address the continued erosion impacting critical sanitary sewers and other infrastructure.

PART 2: Detention and Runoff Reduction

The second part of this study looked at the modeling of storage to detain and control the release of runoff into Taylor Run from the watershed. A storage basin was added between the final junction and the Taylor Run reach to the existing conditions model discussed above.

The storage basin was sized to accommodate a large range of runoff between the 10yr and 100yr storm model runs and configured to allow overflow from the storage given a reasonable depth constraint of 12-feet maximum storage and would begin to overflow at a depth of 8-feet. The following table was used in the model controlling the discharge out of the detention facility. A 2-acre initial footprint of the storage pond was selected. However, there only appears to be approximately 1.5-acre footprint currently available at the Chinquapin Park. See Figure 7, below.

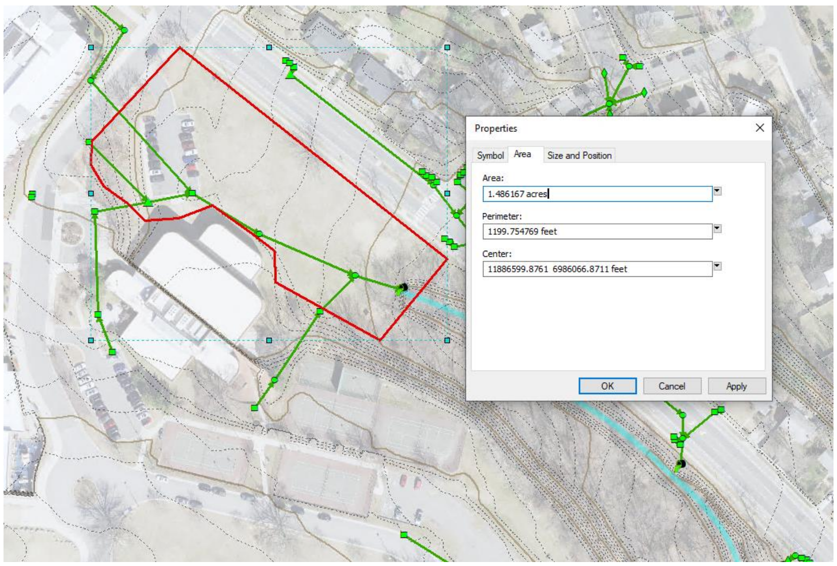


Figure 7 – Map of Chinquapin Park Available Area

Table 5 – Storage Outlet Rating Table

Headwater Elevation (ft)	Total Discharge (cfs)	48" Outlet Discharge (cfs)	Spillway Discharge (cfs)
132.50	0.00	0.00	0.00
137.21	90.00	90.00	0.00
140.95	180.00	152.29	27.71
141.50	250.00	159.19	90.81
142.15	360.00	167.03	192.96
142.60	450.00	172.28	277.71
143.01	540.00	176.89	363.11
143.39	630.00	181.08	448.92
143.74	720.00	184.81	535.19
144.08	810.00	188.33	621.66
144.39	900.00	191.64	708.35
140.50	146.30	146.30	0.00 - Overflow Point

The table above was used to create the second table used is the relationship between depth, storage volume and discharge and input into the HEC-HMS model, shown below in Table 6.

Table 6 – Storage Rating Table

DEPTH	Storage (acre-ft)	Outlet Q (cfs)
0	**0**	**0**
4	**8**	**90**
8	**16**	**180**
9	**18**	**250**
10	**20**	**450**
11	**22**	**720**
12	**24**	**900**

Details of the storage calculations may be found in Appendix B.

PART 2: Results

The two points of interest in this part of the analysis are the velocities in Taylor Run and the amount of storage needed. The following table shows the resulting changes in Taylor Run vs the existing conditions for both the 10-yr and 100-yr storms.

The target maximum velocities to reduce erosive forces in the channel at Taylor Run is between 4-fps and 6-fps.

Table 7 – Storage Results

DETENTION STORAGE

10-YR	**Storage (acre-ft)**	**Peak Flow into Storage (cfs)**	**Peak Flow to Taylor (cfs)**	**Velocity in TR (fps)**	**Existing V (fps)**
	19	**562**	**315**	**6.1**	**7.2**

100-YR	**Storage (acre-ft)**	**Peak Flow into Storage (cfs)**	**Peak Flow to Taylor (cfs)**	**Velocity in TR (fps)**	**Existing V (fps)**
	23	**925**	**799**	**8.1**	**8.5**

Part 2: Conclusions

These results show some improvement in the Taylor Run channel where significant storage is provided in the watershed before the runoff reaches Taylor Run. The nearly 23-acre-ft analyzed for the 100-yr storm may not be feasible or have a favorable benefit/cost ratio. As modeled the 23-acre-ft facility is approximately 11-ft deep and would have a footprint of 2-acres, yet only reduces the peak velocity about 12% for the 10-year and about 8% for the 100-year storm and only reaches the target maximum velocity in Taylor Run for the 10-year storm. Under this scenario, any storm event larger than the 10-year storm would bring erosive velocities to the channel and may continue to erode the banks of Taylor Run.

This analysis shows that a reduction in peak velocities is possible in theory, without considering any practical applications or cost. For example, Arlington County completed installation of 12-acre-ft of stormwater storage at Cardinal School in 2022 at a cost of $18M. Using that project as a baseline cost of $1.5M per acre-ft, the 19-acre-ft storage to control the 10-year is estimated to cost $28.5M and the 23-acre-ft storage, as a single facility, has an overall estimated cost of approximately $34.5M, nearly an order of magnitude greater than the total cost of any of the proposed work to stabilize the stream banks of Taylor Run.

According to the VRRM, the existing BMPs provide about 0.8-acre-feet of stormwater runoff reduction. Also, according to the VRRM, additional BMPs to treat the remaining 90 acres of impervious would provide an additional 1.58-acre-feet of runoff reduction, for a total of 2.38-acre-feet of runoff reduction. are calculated. the implementation of numerous water quality BMPs may not be the right tool to achieve the goal as stated, which is to reduce erosive velocities in Taylor Run for the storm events that deliver those erosive velocities. Given this information, implementing the 100 GI BMPs at a cost of $25M would not address the continued erosion impacting critical sanitary sewers and other infrastructure.

However, it is clear that the major benefit for water quality BMPs is nutrient and sediment pollution, along with the co-benefits in an urban setting of reducing heat island effects, creating micro-habitats, and increasing canopy coverage. Because of this, staff will continue to pursue opportunities to implement BMPs in the Taylor Run Watershed to enhance water quality in the stream and downstream.

References

US Department of Agriculture's Natural Resources Conservation Service's Stream Restoration Design National Engineering Handbook, Chapter 8 – Threshold Channel Design - https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17784.wba

US Army Corps of Engineer's Hydrologic and Hydraulic Analysis for the Cameron Run Watershed in Northern Virginia (2007) Available upon request.

US Army Corps of Engineer's Hydrologic Engineering Center's Hydrologic Modeling System software https://www.hec.usace.army.mil/software/hec-hms/

US Army Corps of Engineer's Hydrologic Engineering Center's Hydrologic modeling system HEC-HMS, Technical Reference Manual https://www.hec.usace.army.mil/confluence/hmsdocs/hmstrm

US Army Corps of Engineer's Hydrologic Engineering Center's Hydrologic modeling system HEC-HMS, User's Manual https://www.hec.usace.army.mil/confluence/hmsdocs/hmsum/4.10

US Department of Transportation Federal Highway Administration Bridges and Structures HY-8 software https://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/

NOAA Atlas 14 Point Precipitation Frequency Estimates https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=va

Texas A&M University's Soil & Water Assessment Tool (SWAT) https://swat.tamu.edu/

Virginia Department of Environmental Quality – Virginia Runoff Reduction Method https://www.deq.virginia.gov/water/stormwater/stormwater-construction/guidance-vrrm

Virginia Department of Environmental Quality – BMP Design Specifications https://www.deq.virginia.gov/water/stormwater/stormwater-construction/bmp-design-specifications

Appendix

Appendix A
SCS Curve Number Method and Rainfall

Appendix B
Detention Pond Stage Storage Discharge

Appendix C
Model Output

Appendix D
Existing BMPs and Cost Estimates

APPENDIX A – SCS CURVE NUMBER METHOD AND RAINFALL

USACE Developed Parameters for Cameron Run Watershed (Includes Taylor Run)

Land Use

Aerial photography (dated 2004) and existing land use GIS layers were used to determine land use for the watershed. Land use was divided into the following categories for the Cameron Run watershed: impervious; commercial; industrial; heavy residential; medium residential; light residential; open space; cropland; open water; and forest (Figure 3.3).

Soils

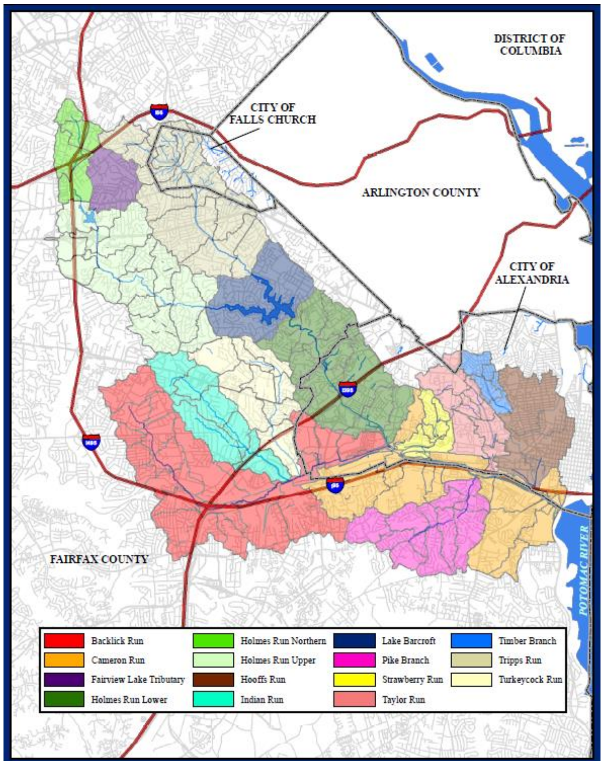
A Hydrologic Soil Group (HSG) classification was developed by the National Resource Conservation Service (NRCS) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The hydrologic soil groups are named A, B, C, and D, with Group A having low runoff potential and Group D having high runoff potential.

At the time of this study, detailed soil data for the majority of the Cameron Run watershed was not available. Fairfax County provided detailed soil data, in GIS format, for approximately 10-percent of the watershed. The remainder of the watershed was labeled "unmapped" in the county data set. For the unmapped areas, soil information was obtained from the NRCS STATSGO database. The STATSGO data indicates that all unmapped areas in the detailed soil information contain Group B soils. Figure 3.4 shows the hydrologic soil groups within the Cameron Run watershed.

Runoff Curve Numbers (CN)

The SCS Curve Number Loss Method was chosen for the HEC-HMS basin model. This method was chosen for this watershed for the following reasons: (1) it is a widely used method in floodplain studies throughout the United States; (2) all previously documented flood investigations that utilized rainfall-runoff models in this watershed used this method; and (3) because many frequency events were being modeled, establishing an antecedent runoff condition (ARC) for each event would be challenging. The calculated CN value considers an average ARC at a site as taken from sample rainfall and runoff data. Therefore, the CN values established through the calibration process were adopted for use for the synthetic storm modeling. Note that the percent impervious area and initial abstraction were left blank in the model. The impervious area was considered in the CN calculations, and the initial abstraction was left blank in order to allow the program to calculate the standard values.

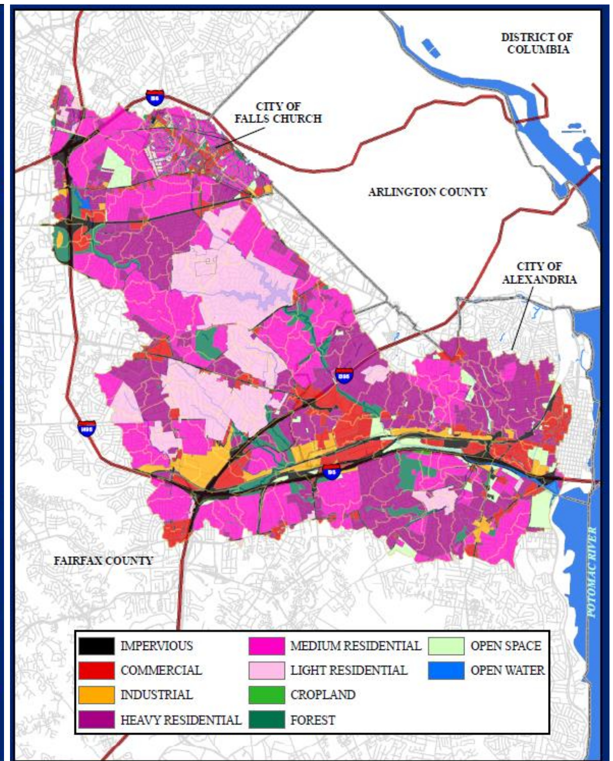
A GIS utility was used to calculate the composite CN for each sub-basin within the model. Because of the coarse nature of the soil information for most of the watershed, the calibration of the model relied heavily on the adjustment of the CN to account for the lack of reliable soil data (discussed in future sections).



US Army Corps of Engineers
Baltimore District

Figure 3.2
Sub-basins of the Cameron Run Watershed

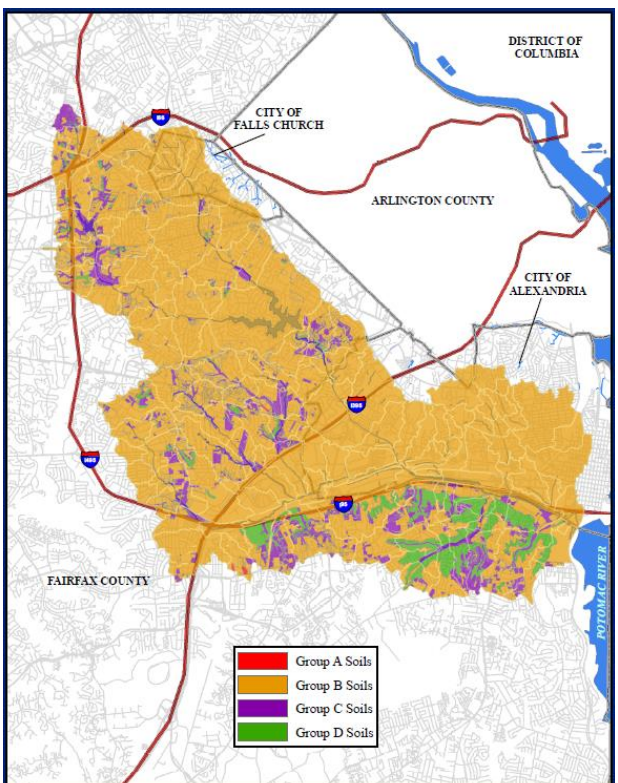
1 inch equals 8,000 feet



US Army Corps of Engineers
Baltimore District

Figure 3.3
Existing Land Use in the Cameron Run Watershed

1 inch equals 8,000 feet



US Army Corps of Engineers
Baltimore District

Figure 3.4
Hydrologic Soil Groups (HSG) within the Cameron Run Watershed

1 inch equals 8,000 feet

SCS Curve Number Loss Model

Basic Concepts and Equations

The Soil Conservation Service (SCS) Curve Number (CN) model estimates precipitation excess as a function of cumulative precipitation, soil cover, land use, and antecedent moisture, using the following equation:

$$P_e = \frac{(P - I_a)^2}{P - I_a + S} \qquad (15)$$

where P_e = accumulated precipitation excess at time t; P = accumulated rainfall depth at time t; I_a = the initial abstraction (initial loss); and S = potential maximum retention, a measure of the ability of a watershed to abstract and retain storm precipitation. Until the accumulated rainfall exceeds the initial abstraction, the precipitation excess, and hence the runoff, will be zero.

From analysis of results from many small experimental watersheds, the SCS developed an empirical relationship of I_a and S:

$$I_a = 0.2\,S \qquad (16)$$

Therefore, the cumulative excess at time t is:

APPENDIX A

CN Tables

The four pages in this section are reproduced from the SCS (now NRCS) report *Urban hydrology for small watersheds*. This report is commonly known as *TR-55*. The tables provide estimates of the curve number (CN) as a function of hydrologic soil group (HSG), cover type, treatment, hydrologic condition, antecedent runoff condition (ARC), and impervious area in the catchment.

TR-55 provides the following guidance for use of these tables:

- Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. Appendix A [of TR-55] defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

- There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

- Treatment is a cover type modifier (used only in Table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

- Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. Good hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are: (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

- The index of runoff potential before a storm event is the antecedent runoff condition (ARC). The CN for the average ARC at a site is the median value as taken from sample rainfall and runoff data. The curve numbers in table 2-2 are for the average ARC, which is used primarily for design applications.

- The percentage of impervious area and the means of conveying runoff from impervious areas to the drainage systems should be considered in computing CN for urban areas. An impervious area is considered connected if runoff from it flows directly into the drainage systems. It is also considered connected if runoff from it occurs as shallow concentrated shallow flow that runs over a pervious area and then into a drainage system. Runoff from unconnected impervious areas is spread over a pervious area as sheet flow.

SCS TR-55 Table 2-2a – Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acre	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c					

[1] Average runoff condition, and $I_a = 0.2S$.
[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (imperviousness area percentage) and the CN's for the newly graded pervious areas.

SCS TR-55 Table 2-2b – Runoff curve numbers for cultivated agricultural lands[1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil	–	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C & T)	Poor	66	74	80	82
		Good	62	71	78	81
	C & T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	838
	C & T	Poor	61	72	79	82
		Good	59	70	78	81
	C & T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C & T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and Ia = 0.2S.
[2] *Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.
[3] Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Good: Factors impair infiltration and tend to increase runoff.

Poor. Factors encourage average and better than average infiltration and tend to decrease runoff.

SCS TR-55 Table 2-2c – Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Hydrologic condition	A	B	C	D
Pasture, grassland, or range – continuous forage for graving.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay.	–	30	58	71	78
Brush – brush-weed mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods – grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots.	–	59	74	82	86

[1] Average runoff condition, and $I_a = 0.2S$.

[2] *Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3] *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4] Actual curve number is less than 30; use CN=30 for runoff computations.

[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

SCS TR-55 Table 2-2d – Runoff curve numbers for arid and semiarid rangelands[1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition[2]	A[3]	B	C	D
Herbaceous – mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen – mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper – pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1] Average runoff condition, and $I_a = 0.2S$.

[2] *Poor:* <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: >70% ground cover.

[3] Curve numbers for group A have been developed only for desert shrub.

RAINFALL – Excerpt from the USACE Cameron Run Study (2007)

3.3.1 SELECTION OF CRITICAL STORM DURATION

The critical storm is the design storm (total amount, duration, and temporal distribution), which provides the highest flood discharge for the flooding source. According to *Appendix C of Guidelines and Specifications for Flood Hazard Mapping Partners*, published by FEMA, the critical storm shall be determined through a sensitivity analysis of various storm durations to determine which storm produces the most conservative flood discharges. Typically, a 6-hour duration or 24-hour duration are common durations used in these sensitivity analyses, although the rainfall duration must exceed the time of concentration for the watershed and must be large enough to capture all excess runoff.

Two separate meteorological models (6-hour and 24-hour) were developed for each storm frequency to compare and determine the critical storm duration for the Cameron Run watershed. These models were developed as "frequency storms" in HEC-HMS. The frequency storm method is designed to produce a synthetic storm from statistical precipitation data. The most common source of the statistical data is the National Weather Service (NWS). For this investigation, precipitation data was taken from the NWS (or National Oceanic and Atmospheric Administration (NOAA)) Atlas 14, Volume 2, Version 3, at the latitude and longitude of Lake Barcroft (38.84N, 77.14W) (Reference 19). The precipitation data used is shown in Table 3.7.

Results from initial 6-hour and 24-hour runs of the HEC-HMS model were compared. As expected given the rainfall data input, the 24-hour duration produces the highest flood discharge values at the USGS gage and other locations in the watershed, when compared to the 6-hour duration storm. However, historical rainfall data and previous investigations warrant the use of a 6-hour duration as the critical storm to produce realistic, rather than over-conservative, estimates for the peak flows in the watershed. The justification for using a 6-hour duration in the Cameron Run watershed rather than a 24-hour duration is outlined below.

The City elected to use the 24-hour duration storms for this analysis.

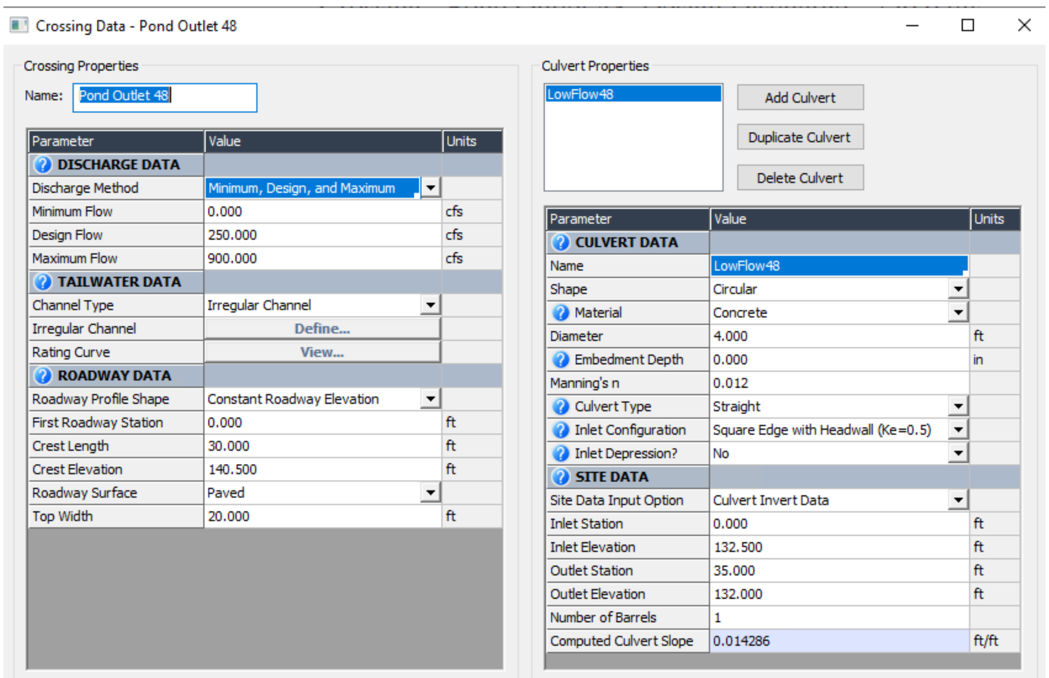
Table 3.7: Precipitation Data used for 6-Hour and 24-Hour Synthetic Storms

NWS Precipitation Estimates (inches)					
Time Interval	Recurrence Interval (years)				
	10	25	50	100	500
5 min.	0.57	0.65	0.70	0.76	0.89
10 min.	0.92	1.03	1.12	1.21	1.40
15 min.	1.16	1.31	1.42	1.53	1.77
30 min.	1.68	1.94	2.14	2.34	2.81
60 min.	2.18	2.58	2.90	3.23	4.03
120 min.	2.57	3.08	3.49	3.93	5.04
3 hr.	2.75	3.31	3.78	4.27	5.56
6 hr.	3.34	4.06	4.67	5.34	7.12
12 hr.	4.09	5.05	5.89	6.82	9.45
24 hr.	4.84	6.06	7.14	8.37	11.9

APPENDIX B – DETENTION POND

Outlet pipe and spillway:

From FHWA HY-8 https://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/
Version 7.80.0.2



Crossing Data - Pond Outlet 48

Crossing Properties

Name: Pond Outlet 48

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	0.000	cfs
Design Flow	250.000	cfs
Maximum Flow	900.000	cfs
TAILWATER DATA		
Channel Type	Irregular Channel	
Irregular Channel	Define...	
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	ft
Crest Length	30.000	ft
Crest Elevation	140.500	ft
Roadway Surface	Paved	
Top Width	20.000	ft

Culvert Properties

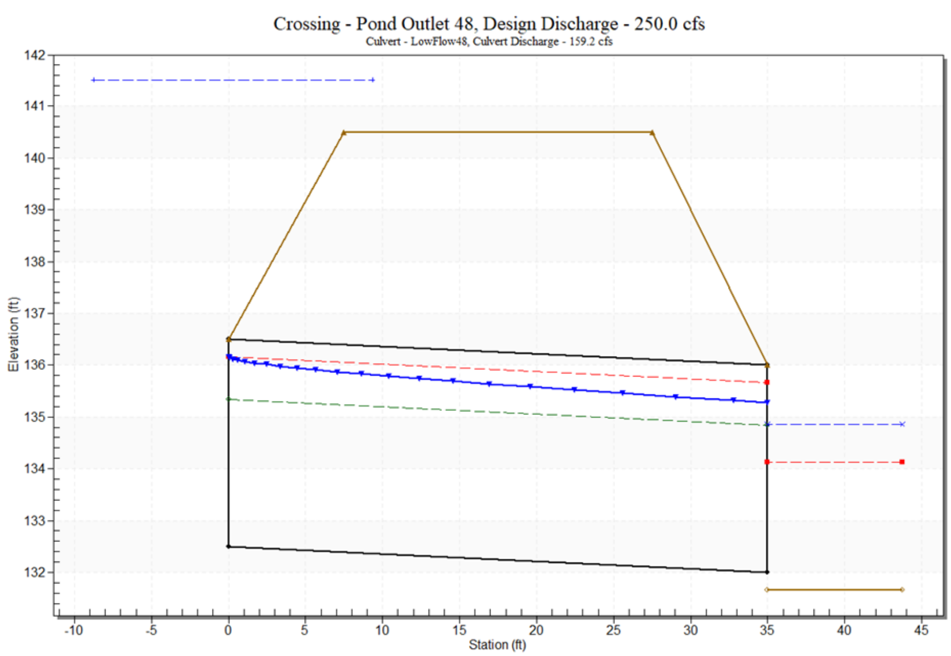
LowFlow48

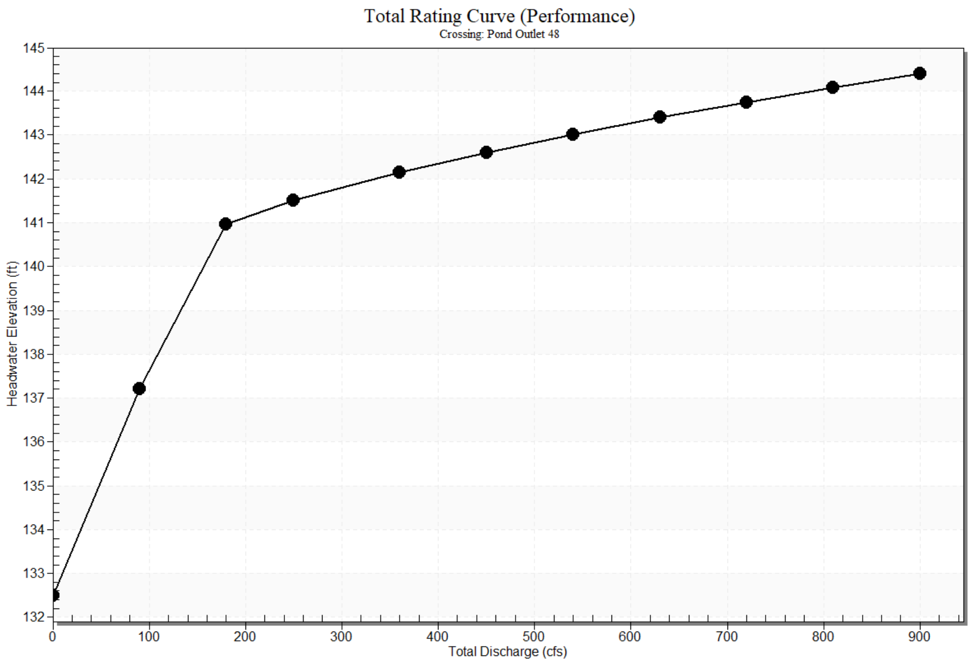
Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	LowFlow48	
Shape	Circular	
Material	Concrete	
Diameter	4.000	ft
Embedment Depth	0.000	in
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge with Headwall (Ke=0.5)	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	ft
Inlet Elevation	132.500	ft
Outlet Station	35.000	ft
Outlet Elevation	132.000	ft
Number of Barrels	1	
Computed Culvert Slope	0.014286	ft/ft





Culvert Crossing: Pond Outlet 48

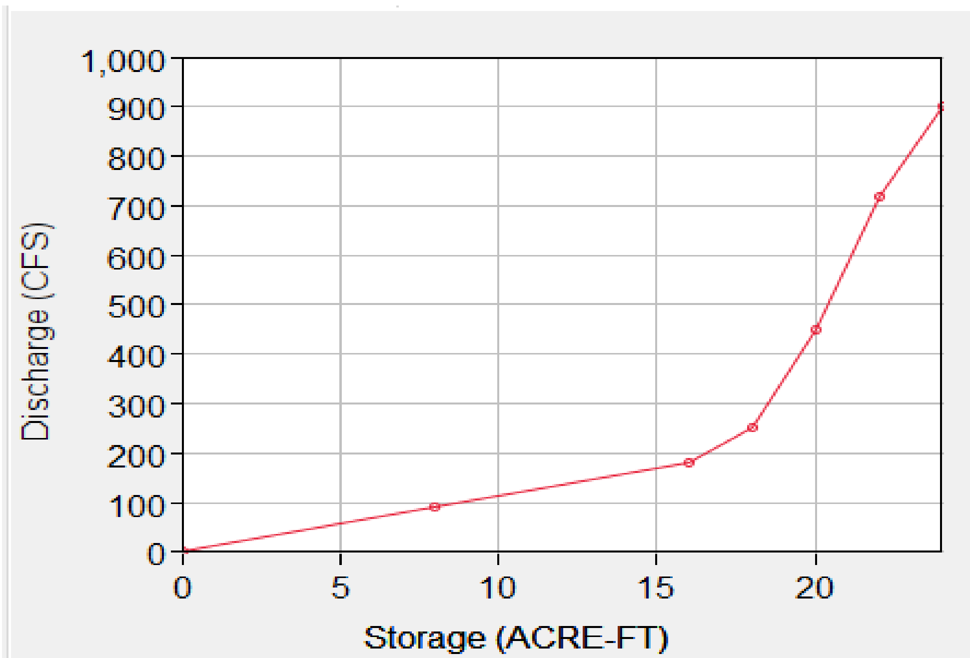
Crossing Summary Table

Headwater Elevation (ft)	Total Discharge (cfs)	LowFlow48 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
132.50	0.00	0.00	0.00	1
137.21	90.00	90.00	0.00	1
140.95	180.00	152.29	27.71	9
141.50	250.00	159.19	90.81	5
142.15	360.00	167.03	192.96	4
142.60	450.00	172.28	277.71	4
143.01	540.00	176.89	363.11	5
143.39	630.00	181.08	448.92	5
143.74	720.00	184.81	535.19	4
144.08	810.00	188.33	621.66	4
144.39	900.00	191.64	708.35	4
140.50	146.30	146.30	0.00	Overtopping

Rating Curve for Storage vs Discharge in HEC-HMS – **2-ACRE Footprint**

Storage (ACRE-FT)	Discharge (CFS)
0.0	0
8.0	90
16.0	180
18.0	250
20.0	450
22.0	720
24.0	900

DEPTH	Storage (acre-ft)	Q OUT (cfs)
0	**0**	**0**
4	**8**	**90**
8	**16**	**180**
9	**18**	**250**
10	**20**	**450**
11	**22**	**720**
12	**24**	**900**



APPENDIX C – MODEL OUTPUT

HEC-HMS MODEL OUTPUT

An Overview of the Model Setup:

The methodology can be divided into three major tasks: (1) obtaining geographic location of the studied watershed using a 1’ x 1’ high resolution LiDAR 2018 imagery data and crafting its DEM in GIS for further analysis in the HEC-HMS model; (2) importing watershed’s DEM to HEC-HMS in order to delineate watershed and streams characteristics, terrain processing, and basin processing; (3) importing observed storm events and streams cross sectional data with the processed DEM for model simulations.

The HEC-HMS components included a basin model, a meteorological model, and control specifications model components. The basin model and basin features were created in the shape of a background map file imported to HMS from the data derived from GIS (Figure 1). NOAA Atlas 14 rainfall data for 10-Year and 100-Year, 24-Hour storm events was used for creating the meteorological model using the storm frequency method. Afterwards, determining the time pattern for the simulation, a 24-Hour control model with one minute interval was setup. Figure x is a representation of all the three models’ setup on HEC-HMS platform.

The Soil Conservation Service (SCS) TR-55 Curve Number method was used to model the transformation of precipitation excess into direct surface runoff. For routing analysis, the Muskingum-Cunge method was employed to model the reaches.

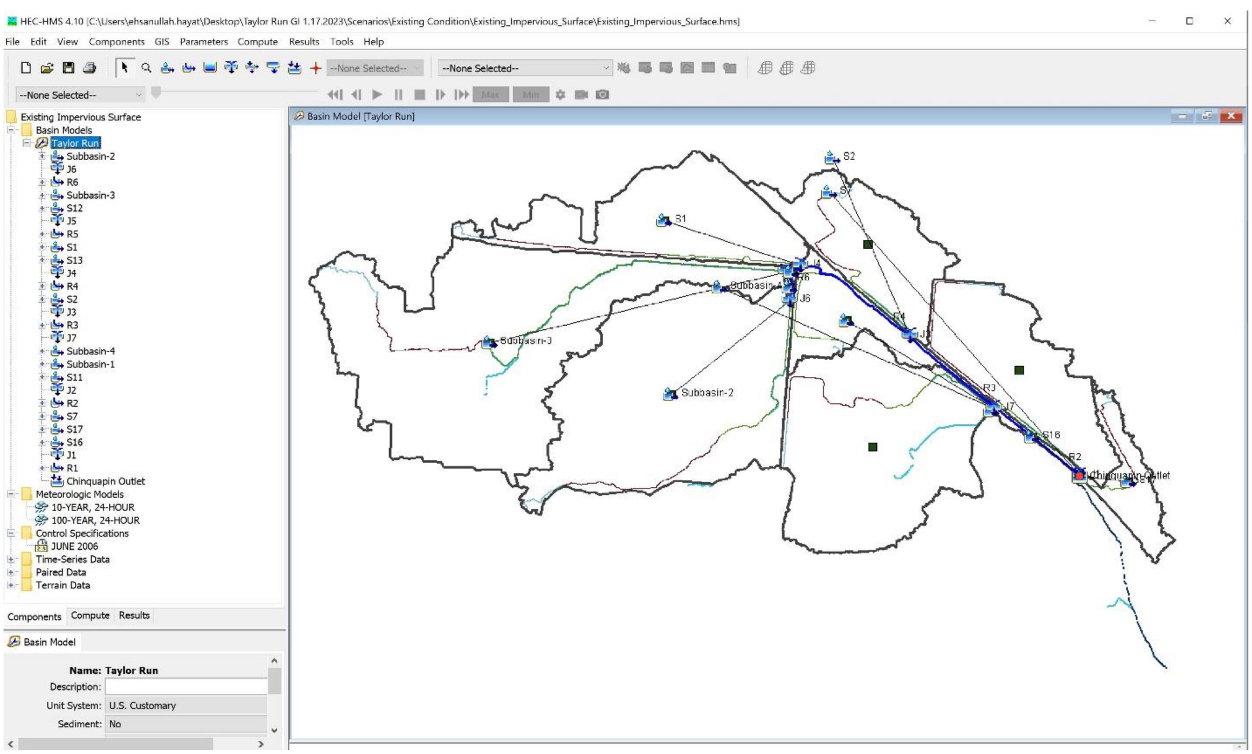


Figure 1. Model Setup and Schematic

Subbasin Characteristics [Taylor Run]

Filter: --None--

Sorting: Hydrologic

Subbasin	Longest Flowpath Length (MI)	Longest Flowpath Slope (FT/FT)	Centroidal Flowpath Length (MI)	Centroidal Flowpath Slope (FT/FT)	10-85 Flowpath Length (MI)	10-85 Flowpath Slope (FT/FT)	Basin Slope (FT/FT)	Basin Relief (FT)	Relief Ratio	Elongation Ratio	Drainage Density (MI/MI²)
Subbasin-2	0.66850	0.02164	0.29088	0.00807	0.50138	0.02393	0.09391	79.48851	0.02252	0.48472	3.31094
Subbasin-3	1.01240	0.01640	0.58194	0.02087	0.75930	0.01746	0.08315	89.00594	0.01665	0.35796	6.94065
S12	0.04992	0.01230	0.02443	0.01192	0.03744	0.01052	0.14033	9.83488	0.03731	0.45401	111.37699
S1	0.56770	0.02725	0.21567	0.01527	0.42577	0.03022	0.07605	82.90855	0.02766	0.39085	0.37136
S13	0.03973	0.01430	0.01968	0.00357	0.02980	0.01159	0.06721	3.23277	0.01541	0.45892	110.43550
S2	0.40649	0.01024	0.15569	0.00779	0.30487	0.00992	0.07889	24.88776	0.01160	0.47348	4.83866
Subbasin-4	0.54907	0.01287	0.21287	0.01192	0.41180	0.01129	0.07445	37.27684	0.01286	0.51994	5.93031
Subbasin-1	0.56207	0.01108	0.52552	0.01095	0.42155	0.00885	0.07948	33.64223	0.01134	0.25856	22.86849
S11	0.01717	0.02727	0.00757	0.01758	0.01288	0.02735	0.06212	2.47234	0.02727	0.48607	70.03504
S7	0.52694	0.01928	0.18751	0.02161	0.39520	0.02188	0.11343	53.88707	0.01937	0.40027	5.07949
S17	0.30754	0.02801	0.09478	0.07175	0.23065	0.03470	0.12949	46.78693	0.02881	0.38212	0.01235
S16	0.19082	0.02524	0.09307	0.01847	0.14312	0.02585	0.07354	25.43425	0.02524	0.22620	110.50666

Figure 2. Taylor Run Subbasins Characteristics

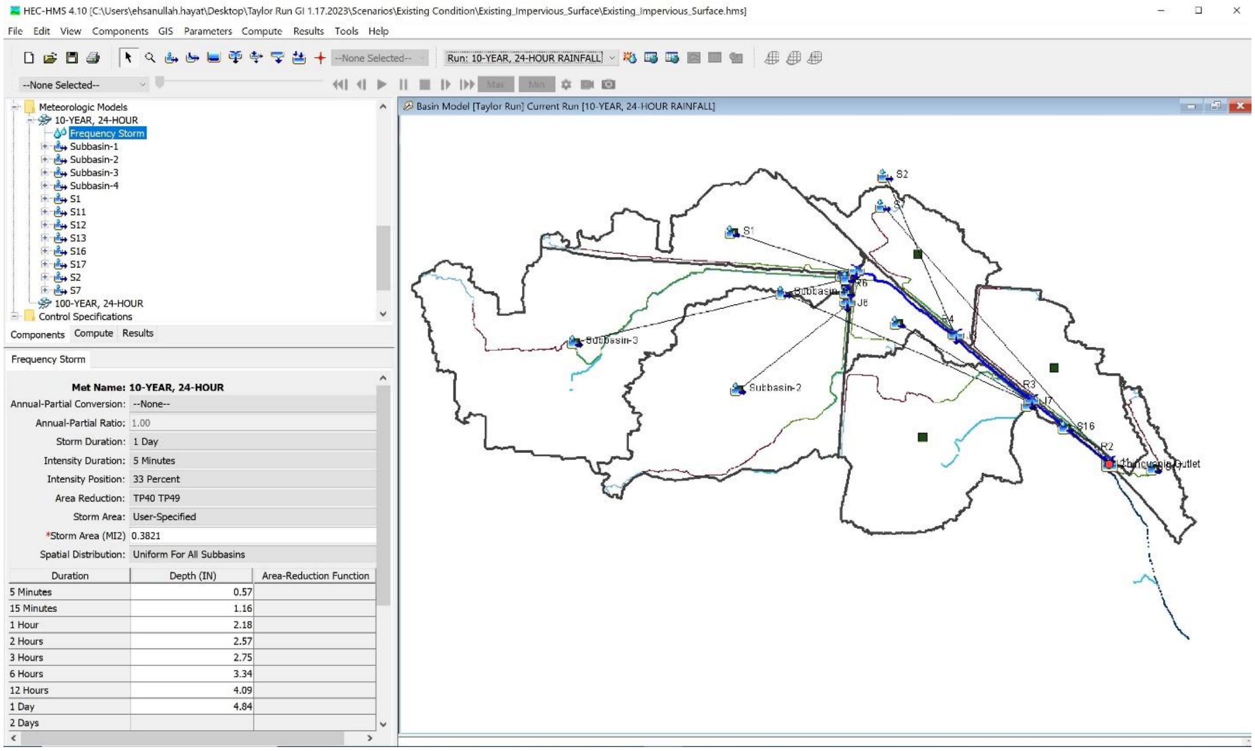


Figure 3. A view of the 10-Year, 24-Hour Storm Meteorological Model

Scenario 1. 10-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S17	0.01
S16	0

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S17	J1
S16	J1

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

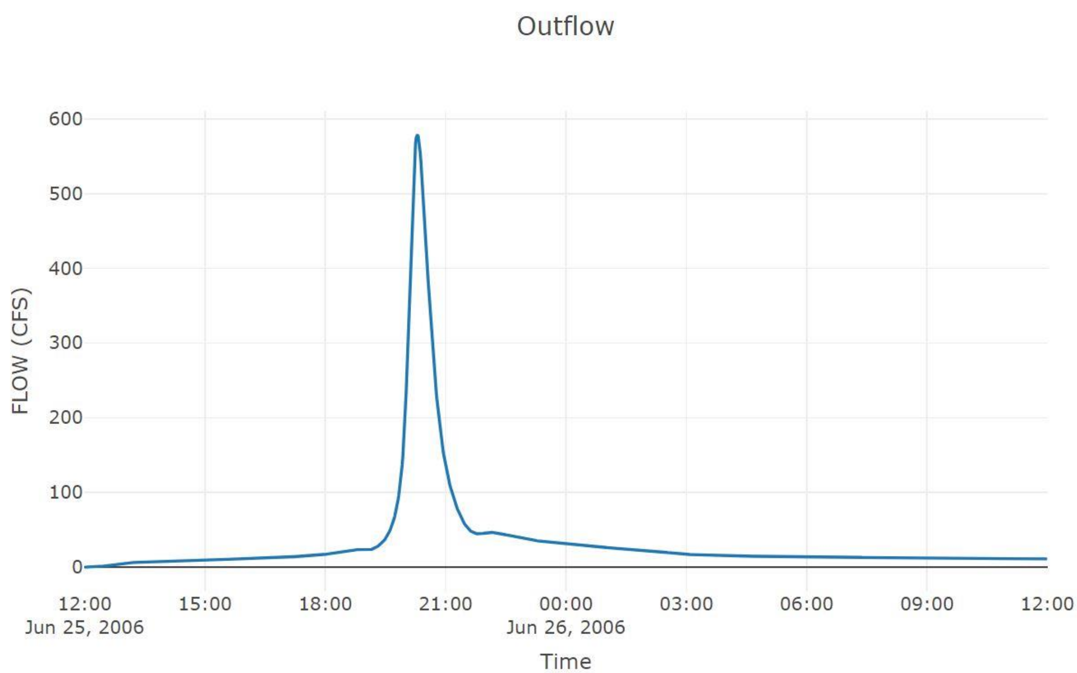
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	133.53	25Jun2006, 20:11	2.99
J6	0.08	133.53	25Jun2006, 20:11	2.99
R6	0.08	133.42	25Jun2006, 20:12	2.99
Subbasin - 3	0.1	139.35	25Jun2006, 20:18	3.05
S12	0	1.45	25Jun2006, 19:58	3.86
J5	0.19	264.23	25Jun2006, 20:15	3.03
R5	0.19	264.18	25Jun2006, 20:15	3.03
S1	0.04	76.49	25Jun2006, 20:13	4.16
S13	0	1.21	25Jun2006, 19:58	4.47
J4	0.23	340.18	25Jun2006, 20:15	3.22
R4	0.23	339.16	25Jun2006, 20:17	3.22
S2	0.03	65.6	25Jun2006, 20:07	3.76
J3	0.25	382.01	25Jun2006, 20:16	3.28
R3	0.25	381.54	25Jun2006, 20:17	3.27
J7	0.06	109.77	25Jun2006, 20:13	3.51
Subbasin - 4	0.06	109.77	25Jun2006, 20:13	3.51
Subbasin - 1	0.02	36.39	25Jun2006, 20:10	4.15
S11	0	0.43	25Jun2006, 19:58	4.77
J2	0.33	518.24	25Jun2006, 20:16	3.36
R2	0.33	518.1	25Jun2006, 20:18	3.35
S7	0.03	74.68	25Jun2006, 20:07	3.58
S17	0.01	26.11	25Jun2006, 20:04	3.65
S16	0	4.48	25Jun2006, 20:02	4.08
J1	0.38	579.45	25Jun2006, 20:17	3.39
R1	0.38	579.09	25Jun2006, 20:18	3.38
Chinquapin Outlet	0.38	579.09	25Jun2006, 20:18	3.38

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	579.09
Time of Peak Discharge	25Jun2006, 20:18
Volume (IN)	3.38
Peak Inflow (CFS)	579.45
Inflow Volume (AC - FT)	69



Scenario 1. 100-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S17	0.01
S16	0

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S17	J1
S16	J1

Global Parameter Summary - Reach

	Downstream
Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

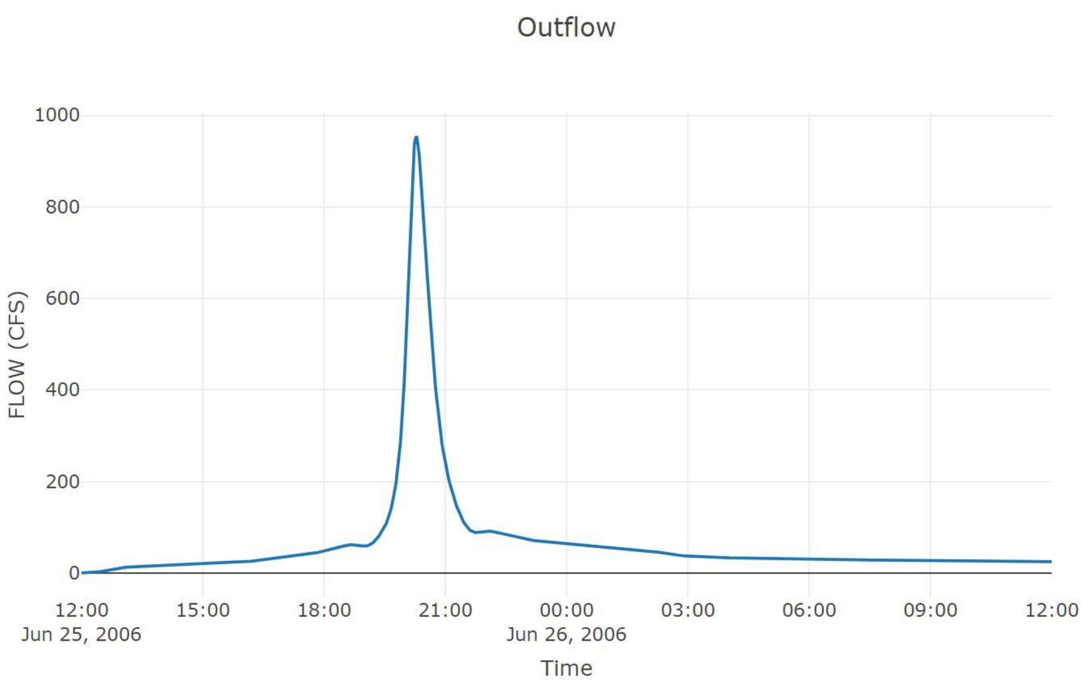
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	224.14	25Jun2006, 20:11	6.2
J6	0.08	224.14	25Jun2006, 20:11	6.2
R6	0.08	223.93	25Jun2006, 20:11	6.2
Subbasin - 3	0.1	238.12	25Jun2006, 20:18	6.27
S12	0	2.1	25Jun2006, 19:58	7.23
J5	0.19	449.79	25Jun2006, 20:14	6.24
R5	0.19	449.34	25Jun2006, 20:15	6.24
S1	0.04	112.54	25Jun2006, 20:13	7.56
S13	0	1.66	25Jun2006, 19:58	7.94
J4	0.23	562.01	25Jun2006, 20:14	6.47
R4	0.23	560.98	25Jun2006, 20:16	6.45
S2	0.03	98.18	25Jun2006, 20:06	7.1
J3	0.25	632.33	25Jun2006, 20:15	6.53
R3	0.25	632.27	25Jun2006, 20:16	6.52
J7	0.06	173.6	25Jun2006, 20:13	6.8
Subbasin - 4	0.06	173.6	25Jun2006, 20:13	6.8
Subbasin - 1	0.02	52.9	25Jun2006, 20:10	7.55
S11	0	0.58	25Jun2006, 19:58	8.28
J2	0.33	849.83	25Jun2006, 20:15	6.62
R2	0.33	849.79	25Jun2006, 20:17	6.61
S7	0.03	114.15	25Jun2006, 20:07	6.89
S17	0.01	39.31	25Jun2006, 20:04	6.98
S16	0	6.39	25Jun2006, 20:02	7.48
J1	0.38	954.2	25Jun2006, 20:16	6.65
R1	0.38	954.07	25Jun2006, 20:17	6.65
Chinquapin Outlet	0.38	954.07	25Jun2006, 20:17	6.65

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	954.07
Time of Peak Discharge	25Jun2006, 20:17
Volume (IN)	6.65
Peak Inflow (CFS)	954.2
Inflow Volume (AC - FT)	135.49



Scenario 2. 10-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

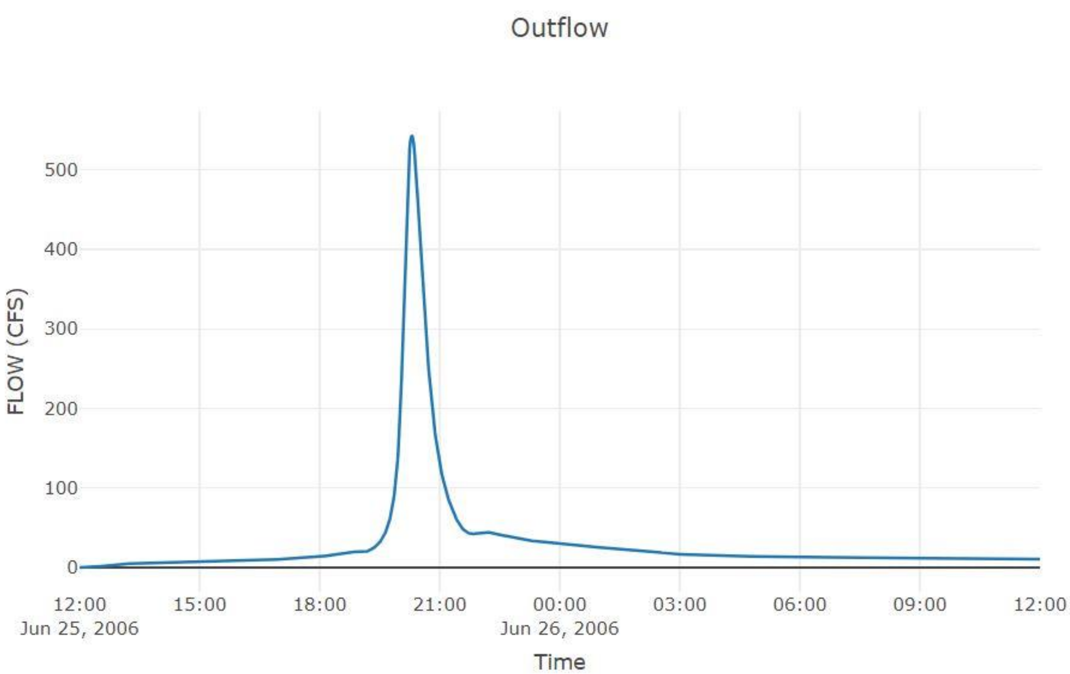
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	127.67	25Jun2006, 20:11	2.83
J6	0.08	127.67	25Jun2006, 20:11	2.83
R6	0.08	127.61	25Jun2006, 20:12	2.83
Subbasin - 3	0.1	133.34	25Jun2006, 20:19	2.89
S12	0	1.4	25Jun2006, 19:58	3.7
J5	0.19	252.72	25Jun2006, 20:15	2.87
R5	0.19	252.58	25Jun2006, 20:15	2.87
S1	0.04	73.9	25Jun2006, 20:13	4.01
S13	0	1.17	25Jun2006, 19:58	4.32
J4	0.23	326.09	25Jun2006, 20:15	3.07
R4	0.23	324.92	25Jun2006, 20:17	3.06
S2	0.03	63.25	25Jun2006, 20:07	3.61
J3	0.25	366.17	25Jun2006, 20:16	3.12
R3	0.25	365.8	25Jun2006, 20:18	3.12
J7	0.06	105.49	25Jun2006, 20:13	3.35
Subbasin - 4	0.06	105.49	25Jun2006, 20:13	3.35
Subbasin - 1	0.02	35.17	25Jun2006, 20:10	3.99
S11	0	0.42	25Jun2006, 19:58	4.61
J2	0.33	496.93	25Jun2006, 20:16	3.2
R2	0.33	496.74	25Jun2006, 20:18	3.2
S7	0.03	71.87	25Jun2006, 20:07	3.42
S16	0	4.33	25Jun2006, 20:02	3.93
J1	0.37	543.31	25Jun2006, 20:17	3.22
R1	0.37	543.23	25Jun2006, 20:18	3.22
S17	0.01	25.14	25Jun2006, 20:04	3.49
Chinquapin Outlet	0.38	554.78	25Jun2006, 20:18	3.23

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	543.23
Time of Peak Discharge	25Jun2006, 20:18
Volume (IN)	3.22
Peak Inflow (CFS)	543.31
Inflow Volume (AC - FT)	63.77



Scenario 2. 100-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

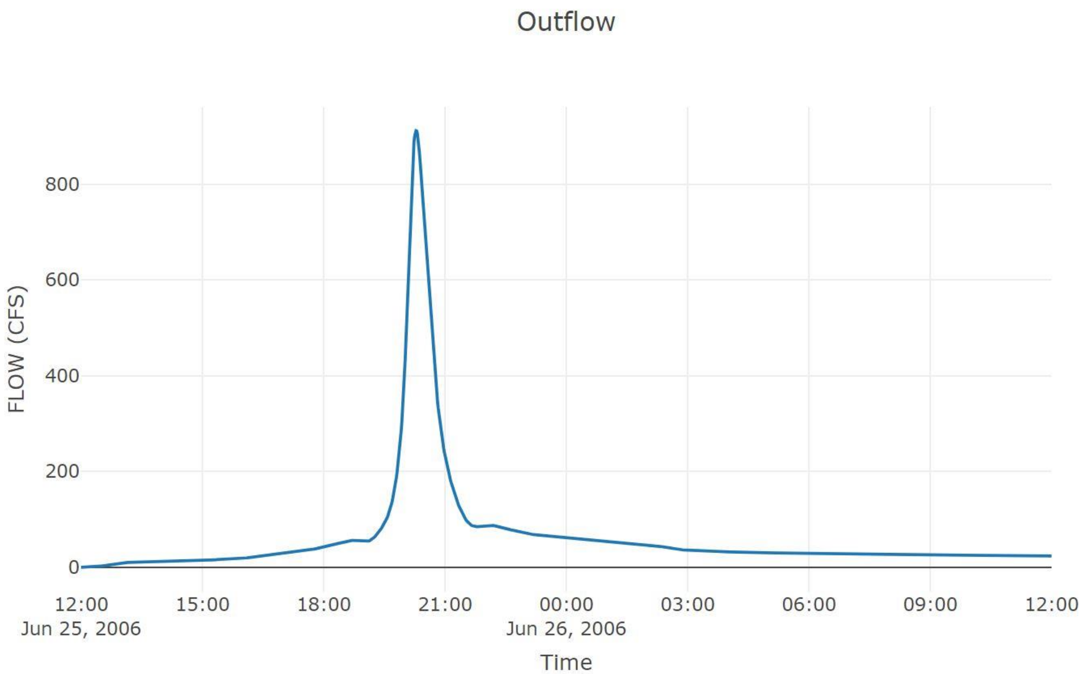
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	219.62	25Jun2006, 20:11	6.02
J6	0.08	219.62	25Jun2006, 20:11	6.02
R6	0.08	219.35	25Jun2006, 20:11	6.01
Subbasin - 3	0.1	233.26	25Jun2006, 20:18	6.08
S12	0	2.07	25Jun2006, 19:58	7.04
J5	0.19	440.55	25Jun2006, 20:14	6.05
R5	0.19	440.23	25Jun2006, 20:15	6.05
S1	0.04	110.53	25Jun2006, 20:13	7.38
S13	0	1.63	25Jun2006, 19:58	7.76
J4	0.23	550.73	25Jun2006, 20:14	6.28
R4	0.23	549.74	25Jun2006, 20:16	6.27
S2	0.03	96.36	25Jun2006, 20:06	6.92
J3	0.25	620.17	25Jun2006, 20:15	6.34
R3	0.25	619.55	25Jun2006, 20:17	6.33
J7	0.06	170.27	25Jun2006, 20:13	6.62
Subbasin - 4	0.06	170.27	25Jun2006, 20:13	6.62
Subbasin - 1	0.02	51.97	25Jun2006, 20:10	7.36
S11	0	0.57	25Jun2006, 19:58	8.1
J2	0.33	832.42	25Jun2006, 20:16	6.44
R2	0.33	831.72	25Jun2006, 20:18	6.43
S7	0.03	112.02	25Jun2006, 20:07	6.71
S16	0	6.28	25Jun2006, 20:02	7.3
J1	0.37	912.16	25Jun2006, 20:17	6.46
R1	0.37	911.77	25Jun2006, 20:17	6.45
S17	0.01	38.58	25Jun2006, 20:04	6.79
Chinquapin Outlet	0.38	932.78	25Jun2006, 20:17	6.46

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	911.77
Time of Peak Discharge	25Jun2006, 20:17
Volume (IN)	6.45
Peak Inflow (CFS)	912.16
Inflow Volume (AC - FT)	127.82



Scenario 3. 10-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
S12	0
S1	0.04
S13	0
Subbasin - 3	0.1
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
S12	J5
S1	J4
S13	J4
Subbasin - 3	J5
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

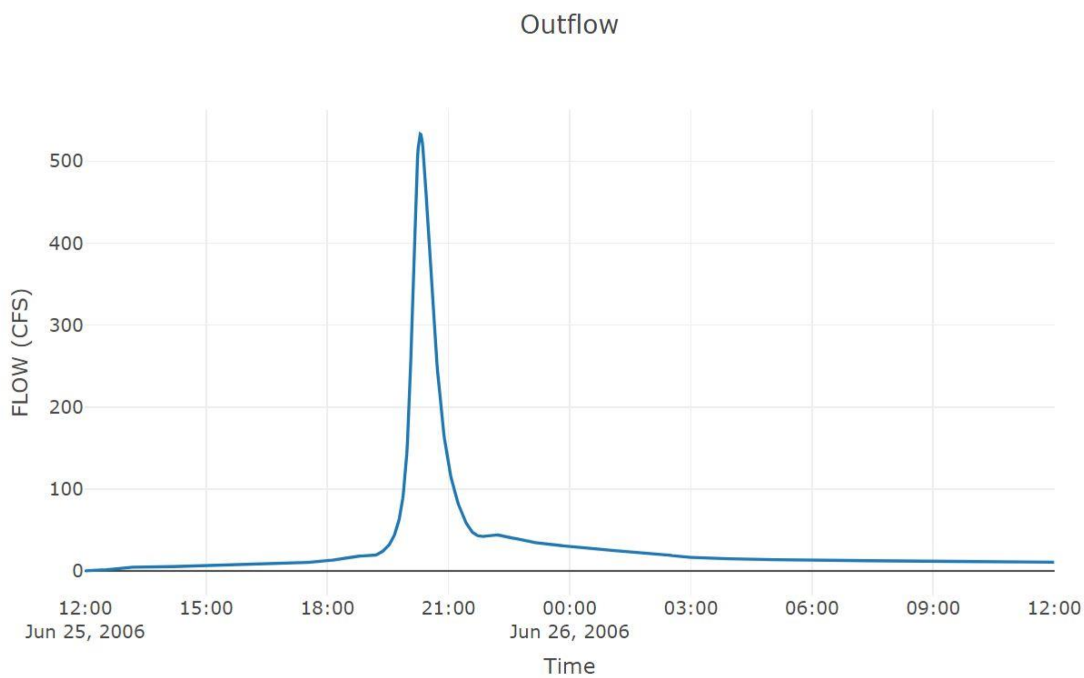
Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	125.16	25Jun2006, 20:11	2.77
J6	0.08	125.16	25Jun2006, 20:11	2.77
R6	0.08	125.12	25Jun2006, 20:12	2.76
S12	0	1.38	25Jun2006, 19:58	3.64
J5	0.19	247.78	25Jun2006, 20:15	2.8
R5	0.19	247.6	25Jun2006, 20:15	2.8
S1	0.04	72.8	25Jun2006, 20:13	3.94
S13	0	1.16	25Jun2006, 19:58	4.25
J4	0.23	320.06	25Jun2006, 20:15	3
R4	0.23	318.81	25Jun2006, 20:17	2.99
Subbasin - 3	0.1	130.76	25Jun2006, 20:19	2.83
S2	0.03	62.24	25Jun2006, 20:07	3.54
J3	0.25	359.37	25Jun2006, 20:16	3.05
R3	0.25	359.07	25Jun2006, 20:18	3.05
J7	0.06	103.68	25Jun2006, 20:14	3.28
Subbasin - 4	0.06	103.68	25Jun2006, 20:14	3.28
Subbasin - 1	0.02	34.65	25Jun2006, 20:10	3.92
S11	0	0.42	25Jun2006, 19:58	4.54
J2	0.33	487.79	25Jun2006, 20:16	3.14
R2	0.33	487.56	25Jun2006, 20:18	3.13
S7	0.03	70.67	25Jun2006, 20:07	3.36
S16	0	4.27	25Jun2006, 20:02	3.86
J1	0.37	533.25	25Jun2006, 20:17	3.15
R1	0.37	533.22	25Jun2006, 20:18	3.15
S17	0.01	24.73	25Jun2006, 20:04	3.43
Chinquapin Outlet	0.38	544.64	25Jun2006, 20:18	3.16

Reach: R1

Downstream : Chinquapin Outlet

Results: R1	
Peak Discharge (CFS)	533.22
Time of Peak Discharge	25Jun2006, 20:18
Volume (IN)	3.15
Peak Inflow (CFS)	533.25
Inflow Volume (AC - FT)	62.43



Scenario 3. 100-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
S12	0
S1	0.04
S13	0
Subbasin - 3	0.1
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
S12	J5
S1	J4
S13	J4
Subbasin - 3	J5
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

	Downstream
Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

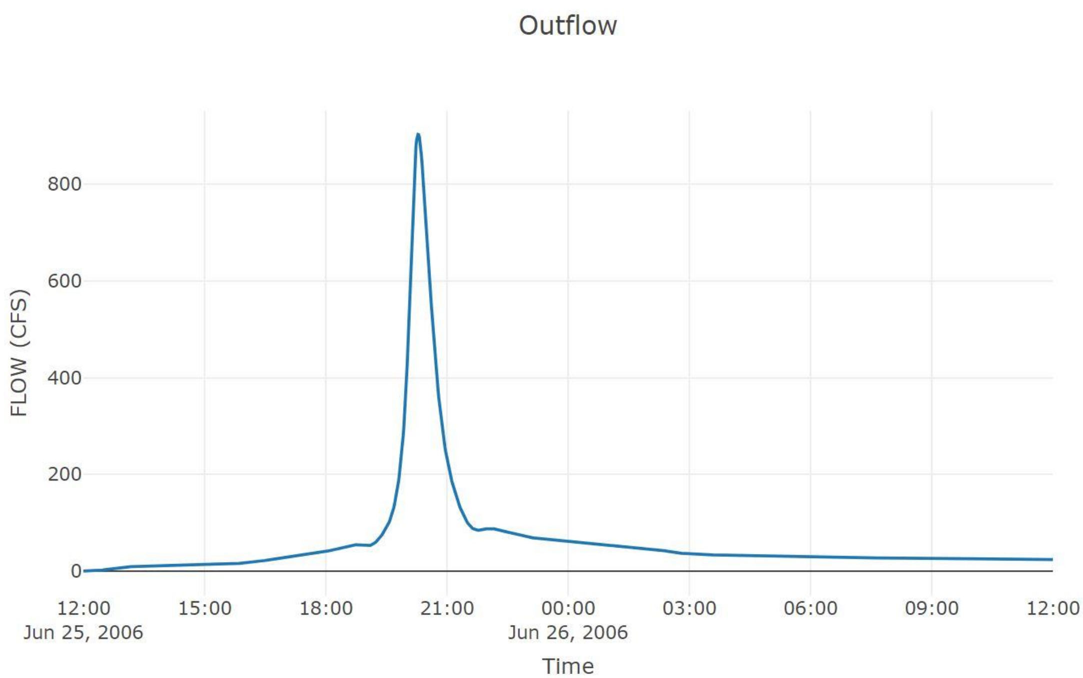
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	217.69	25Jun2006, 20:11	5.94
J6	0.08	217.69	25Jun2006, 20:11	5.94
R6	0.08	217.39	25Jun2006, 20:11	5.93
S12	0	2.05	25Jun2006, 19:58	6.97
J5	0.19	436.59	25Jun2006, 20:14	5.97
R5	0.19	436.33	25Jun2006, 20:15	5.97
S1	0.04	109.67	25Jun2006, 20:13	7.3
S13	0	1.62	25Jun2006, 19:58	7.68
J4	0.23	545.9	25Jun2006, 20:14	6.2
R4	0.23	545	25Jun2006, 20:16	6.19
Subbasin - 3	0.1	231.18	25Jun2006, 20:18	6
S2	0.03	95.58	25Jun2006, 20:06	6.84
J3	0.25	614.92	25Jun2006, 20:15	6.26
R3	0.25	614.23	25Jun2006, 20:17	6.25
J7	0.06	168.84	25Jun2006, 20:13	6.54
Subbasin - 4	0.06	168.84	25Jun2006, 20:13	6.54
Subbasin - 1	0.02	51.57	25Jun2006, 20:10	7.28
S11	0	0.57	25Jun2006, 19:58	8.02
J2	0.33	824.66	25Jun2006, 20:16	6.36
R2	0.33	824.05	25Jun2006, 20:18	6.35
S7	0.03	111.11	25Jun2006, 20:07	6.63
S16	0	6.23	25Jun2006, 20:02	7.22
J1	0.37	903.66	25Jun2006, 20:17	6.38
R1	0.37	903.34	25Jun2006, 20:17	6.37
S17	0.01	38.27	25Jun2006, 20:04	6.71
Chinquapin Outlet	0.38	924.22	25Jun2006, 20:17	6.38

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	903.34
Time of Peak Discharge	25Jun2006, 20:17
Volume (IN)	6.37
Peak Inflow (CFS)	903.66
Inflow Volume (AC - FT)	126.26



Scenario 4. 10-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

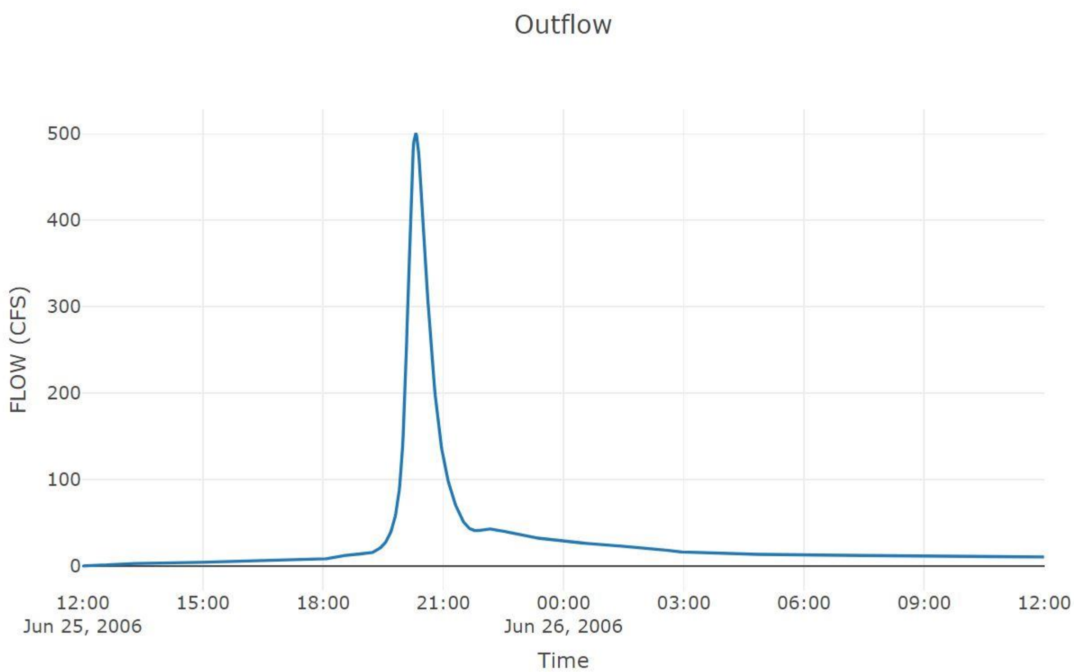
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	117.67	25Jun2006, 20:12	2.56
J6	0.08	117.67	25Jun2006, 20:12	2.56
R6	0.08	117.65	25Jun2006, 20:12	2.56
Subbasin - 3	0.1	122.17	25Jun2006, 20:19	2.6
S12	0	1.31	25Jun2006, 19:58	3.41
J5	0.19	232.08	25Jun2006, 20:15	2.58
R5	0.19	231.77	25Jun2006, 20:15	2.58
S1	0.04	69.11	25Jun2006, 20:13	3.71
S13	0	1.11	25Jun2006, 19:58	4.02
J4	0.23	300.68	25Jun2006, 20:15	2.78
R4	0.23	299.53	25Jun2006, 20:18	2.77
S2	0.03	58.89	25Jun2006, 20:07	3.31
J3	0.25	337.49	25Jun2006, 20:16	2.83
R3	0.25	337.4	25Jun2006, 20:18	2.83
J7	0.06	97.69	25Jun2006, 20:14	3.06
Subbasin - 4	0.06	97.69	25Jun2006, 20:14	3.06
Subbasin - 1	0.02	32.92	25Jun2006, 20:10	3.69
S11	0	0.4	25Jun2006, 19:58	4.32
J2	0.33	458.33	25Jun2006, 20:17	2.92
R2	0.33	458.36	25Jun2006, 20:19	2.91
S7	0.03	66.65	25Jun2006, 20:07	3.13
S16	0	4.05	25Jun2006, 20:02	3.63
J1	0.37	501.3	25Jun2006, 20:18	2.93
R1	0.37	500.97	25Jun2006, 20:19	2.93
S17	0.01	23.35	25Jun2006, 20:05	3.2
Chinquapin Outlet	0.38	511.59	25Jun2006, 20:18	2.94

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	500.97
Time of Peak Discharge	25Jun2006, 20:19
Volume (IN)	2.93
Peak Inflow (CFS)	501.3
Inflow Volume (AC - FT)	58.06



Scenario 4. 100-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

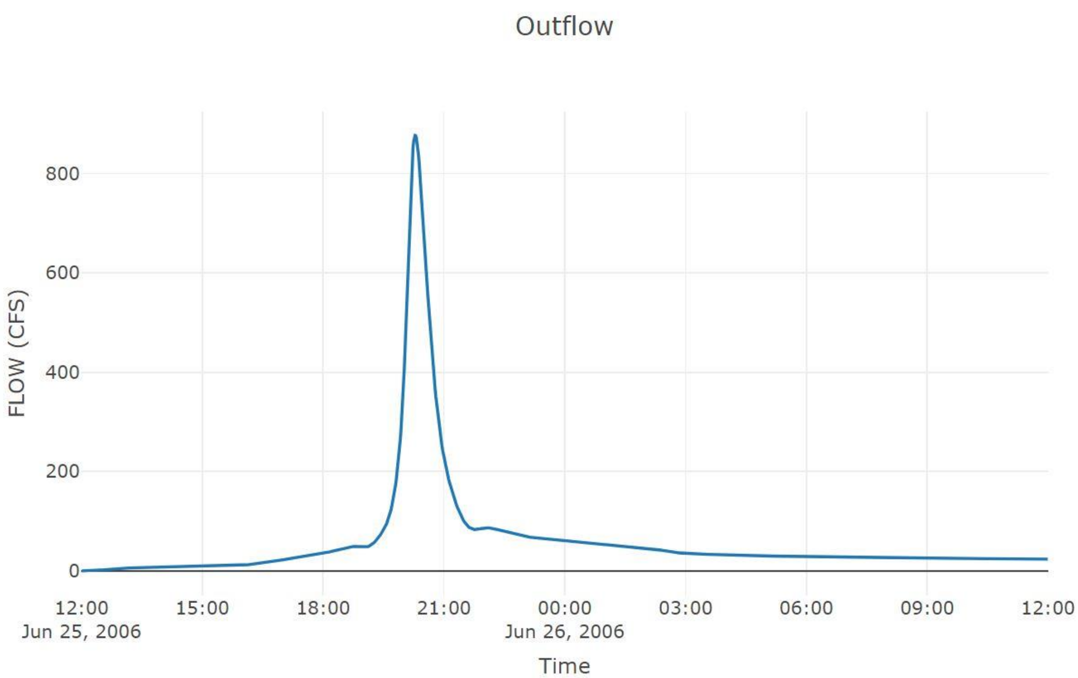
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	211.88	25Jun2006, 20:11	5.7
J6	0.08	211.88	25Jun2006, 20:11	5.7
R6	0.08	211.64	25Jun2006, 20:12	5.7
Subbasin - 3	0.1	224.25	25Jun2006, 20:18	5.74
S12	0	2	25Jun2006, 19:58	6.7
J5	0.19	423.99	25Jun2006, 20:14	5.72
R5	0.19	423.89	25Jun2006, 20:15	5.72
S1	0.04	106.79	25Jun2006, 20:13	7.04
S13	0	1.58	25Jun2006, 19:58	7.41
J4	0.23	530.44	25Jun2006, 20:15	5.95
R4	0.23	529.15	25Jun2006, 20:17	5.93
S2	0.03	92.97	25Jun2006, 20:06	6.58
J3	0.25	595.18	25Jun2006, 20:16	6.01
R3	0.25	595.02	25Jun2006, 20:17	6
J7	0.06	164.07	25Jun2006, 20:13	6.28
Subbasin - 4	0.06	164.07	25Jun2006, 20:13	6.28
Subbasin - 1	0.02	50.24	25Jun2006, 20:10	7.02
S11	0	0.56	25Jun2006, 19:58	7.76
J2	0.33	799.5	25Jun2006, 20:16	6.1
R2	0.33	799.17	25Jun2006, 20:18	6.09
S7	0.03	108.07	25Jun2006, 20:07	6.37
S16	0	6.07	25Jun2006, 20:02	6.96
J1	0.37	877.17	25Jun2006, 20:17	6.12
R1	0.37	876.9	25Jun2006, 20:17	6.12
S17	0.01	37.23	25Jun2006, 20:04	6.45
Chinquapin Outlet	0.38	897.37	25Jun2006, 20:17	6.12

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	876.9
Time of Peak Discharge	25Jun2006, 20:17
Volume (IN)	6.12
Peak Inflow (CFS)	877.17
Inflow Volume (AC - FT)	121.16



Scenario 5. 10-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

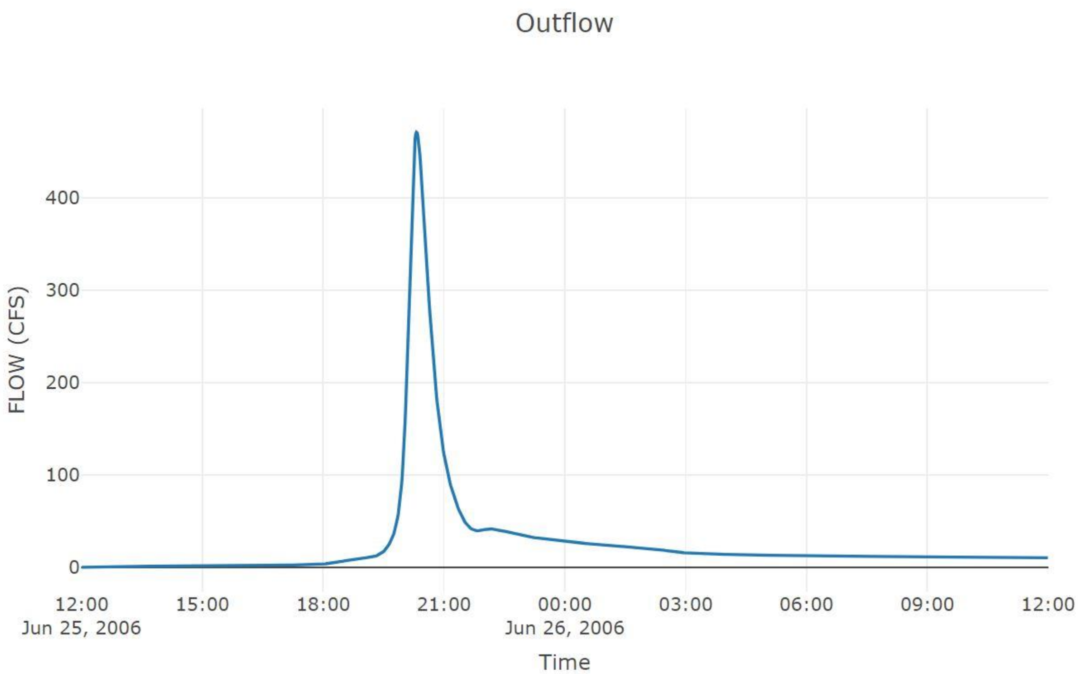
Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	123.48	25Jun2006, 20:11	2.72
J6	0.08	123.48	25Jun2006, 20:11	2.72
R6	0.08	123.46	25Jun2006, 20:12	2.72
Subbasin - 3	0.1	126.47	25Jun2006, 20:19	2.71
S12	0	1.11	25Jun2006, 19:58	2.73
J5	0.19	241.76	25Jun2006, 20:15	2.72
R5	0.19	241.55	25Jun2006, 20:15	2.71
S1	0.04	53.18	25Jun2006, 20:14	2.72
S13	0	0.82	25Jun2006, 19:58	2.73
J4	0.23	294.86	25Jun2006, 20:15	2.72
R4	0.23	293.79	25Jun2006, 20:18	2.71
S2	0.03	50.17	25Jun2006, 20:07	2.72
J3	0.25	326.91	25Jun2006, 20:17	2.71
R3	0.25	326.63	25Jun2006, 20:18	2.7
J7	0.06	88.7	25Jun2006, 20:14	2.72
Subbasin - 4	0.06	88.7	25Jun2006, 20:14	2.72
Subbasin - 1	0.02	25.49	25Jun2006, 20:11	2.72
S11	0	0.28	25Jun2006, 19:58	2.73
J2	0.33	433.42	25Jun2006, 20:17	2.71
R2	0.33	433.25	25Jun2006, 20:19	2.7
S7	0.03	59.43	25Jun2006, 20:07	2.72
S16	0	3.21	25Jun2006, 20:02	2.73
J1	0.37	471.14	25Jun2006, 20:18	2.7
R1	0.37	471.07	25Jun2006, 20:19	2.7
S17	0.01	20.53	25Jun2006, 20:05	2.73
Chinquapin Outlet	0.38	480.43	25Jun2006, 20:19	2.7

Reach: R1

Downstream : Chinquapin Outlet

Results: R1	
Peak Discharge (CFS)	471.07
Time of Peak Discharge	25Jun2006, 20:19
Volume (IN)	2.7
Peak Inflow (CFS)	471.14
Inflow Volume (AC - FT)	53.52



Scenario 5. 100-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S16	0
S17	0.01

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S16	J1
S17	Chinquapin Outlet

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

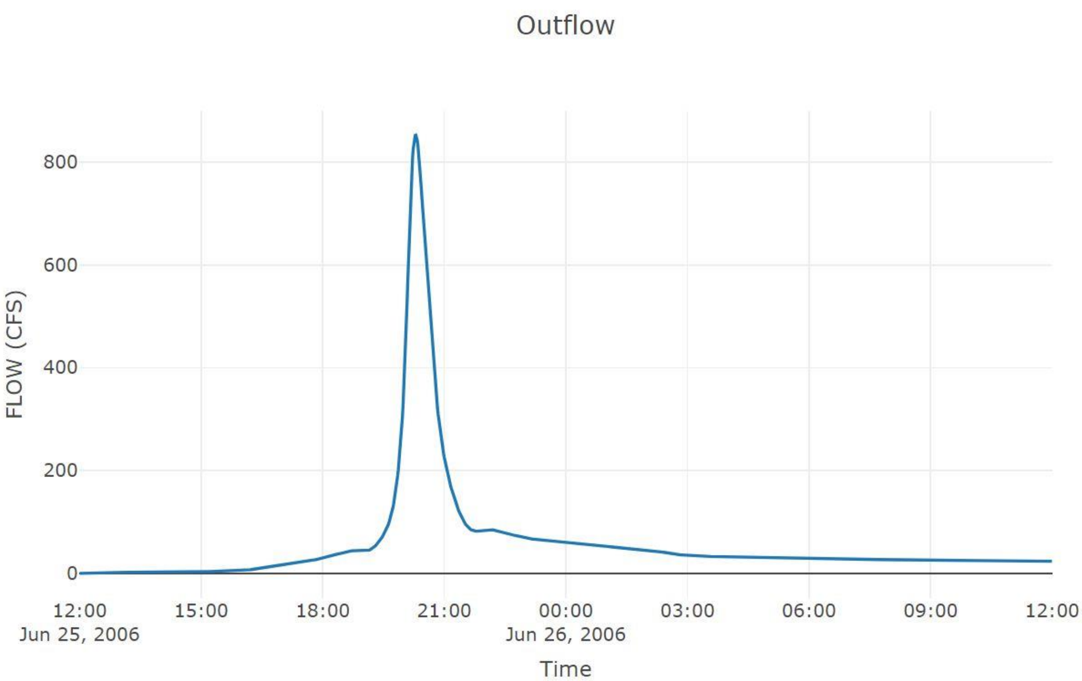
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	216.4	25Jun2006, 20:11	5.89
J6	0.08	216.4	25Jun2006, 20:11	5.89
R6	0.08	216.11	25Jun2006, 20:12	5.88
Subbasin - 3	0.1	227.72	25Jun2006, 20:18	5.87
S12	0	1.85	25Jun2006, 19:58	5.91
J5	0.19	431.76	25Jun2006, 20:14	5.88
R5	0.19	431.53	25Jun2006, 20:15	5.87
S1	0.04	94.31	25Jun2006, 20:14	5.88
S13	0	1.37	25Jun2006, 19:58	5.91
J4	0.23	525.92	25Jun2006, 20:15	5.87
R4	0.23	524.6	25Jun2006, 20:17	5.86
S2	0.03	86.34	25Jun2006, 20:07	5.89
J3	0.25	586.65	25Jun2006, 20:16	5.86
R3	0.25	586.31	25Jun2006, 20:17	5.86
J7	0.06	157.01	25Jun2006, 20:14	5.88
Subbasin - 4	0.06	157.01	25Jun2006, 20:14	5.88
Subbasin - 1	0.02	44.52	25Jun2006, 20:10	5.89
S11	0	0.47	25Jun2006, 19:58	5.91
J2	0.33	779.26	25Jun2006, 20:16	5.86
R2	0.33	779.09	25Jun2006, 20:18	5.85
S7	0.03	102.59	25Jun2006, 20:07	5.89
S16	0	5.44	25Jun2006, 20:02	5.9
J1	0.37	852.92	25Jun2006, 20:17	5.85
R1	0.37	852.43	25Jun2006, 20:18	5.85
S17	0.01	35.05	25Jun2006, 20:04	5.9
Chinquapin Outlet	0.38	871.51	25Jun2006, 20:17	5.85

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	852.43
Time of Peak Discharge	25Jun2006, 20:18
Volume (IN)	5.85
Peak Inflow (CFS)	852.92
Inflow Volume (AC - FT)	115.88



Scenario 6. 10-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S17	0.01
S16	0

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S17	J1
S16	J1

Global Parameter Summary - Reach

	Downstream
Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

Global Results Summary

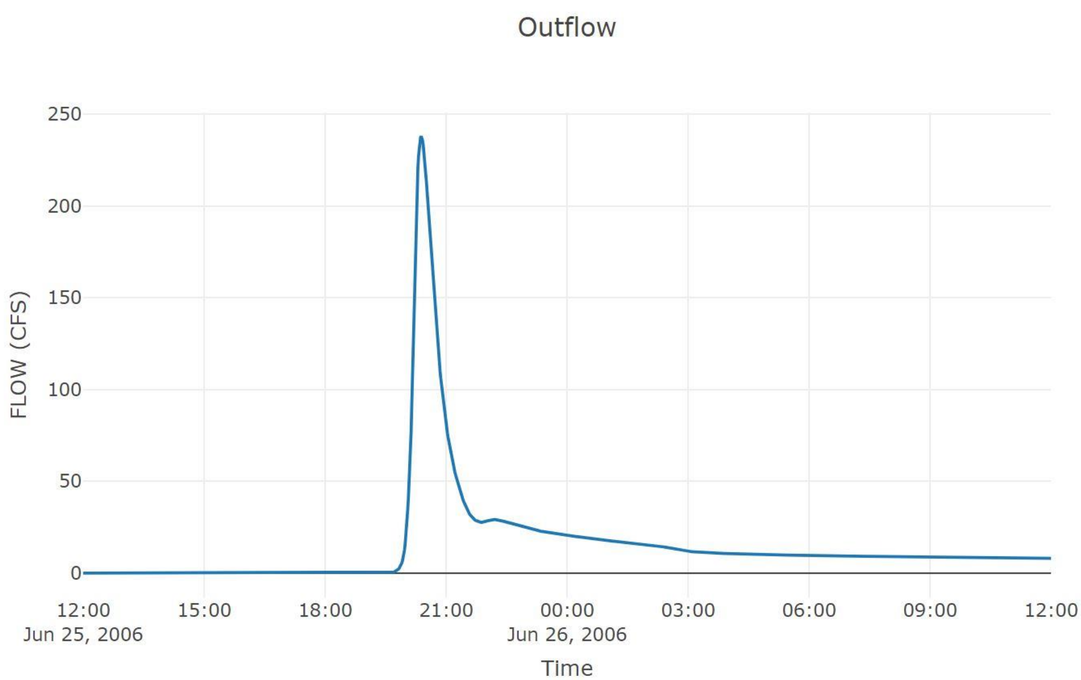
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	62.01	25Jun2006, 20:13	1.54
J6	0.08	62.01	25Jun2006, 20:13	1.54
R6	0.08	61.96	25Jun2006, 20:14	1.54
Subbasin - 3	0.1	63.35	25Jun2006, 20:21	1.53
S12	0	0.57	25Jun2006, 19:58	1.55
J5	0.19	120.71	25Jun2006, 20:17	1.53
R5	0.19	120.56	25Jun2006, 20:18	1.53
S1	0.04	26.67	25Jun2006, 20:16	1.53
S13	0	0.42	25Jun2006, 19:59	1.55
J4	0.23	147.27	25Jun2006, 20:17	1.53
R4	0.23	146.78	25Jun2006, 20:21	1.53
S2	0.03	25.15	25Jun2006, 20:08	1.54
J3	0.25	163.09	25Jun2006, 20:20	1.53
R3	0.25	162.98	25Jun2006, 20:22	1.52
J7	0.06	44.49	25Jun2006, 20:16	1.53
Subbasin - 4	0.06	44.49	25Jun2006, 20:16	1.53
Subbasin - 1	0.02	12.8	25Jun2006, 20:12	1.54
S11	0	0.15	25Jun2006, 19:58	1.55
J2	0.33	215.1	25Jun2006, 20:20	1.53
R2	0.33	215.06	25Jun2006, 20:23	1.52
S7	0.03	29.87	25Jun2006, 20:09	1.54
S17	0.01	10.32	25Jun2006, 20:06	1.54
S16	0	1.62	25Jun2006, 20:03	1.54
J1	0.38	238.07	25Jun2006, 20:22	1.52
R1	0.38	237.98	25Jun2006, 20:23	1.52
Chinquapin Outlet	0.38	237.98	25Jun2006, 20:23	1.52

Reach: R1

Downstream : Chinquapin Outlet

Results: R1

Peak Discharge (CFS)	237.98
Time of Peak Discharge	25Jun2006, 20:23
Volume (IN)	1.52
Peak Inflow (CFS)	238.07
Inflow Volume (AC - FT)	31.05



Scenario 6. 100-Year, 24-Hour Storm Event:

Global Parameter Summary - Subbasin

Area (MI2)

Element Name	Area (MI2)
Subbasin - 2	0.08
Subbasin - 3	0.1
S12	0
S1	0.04
S13	0
S2	0.03
Subbasin - 4	0.06
Subbasin - 1	0.02
S11	0
S7	0.03
S17	0.01
S16	0

Downstream

Element Name	Downstream
Subbasin - 2	J6
Subbasin - 3	J5
S12	J5
S1	J4
S13	J4
S2	J3
Subbasin - 4	J7
Subbasin - 1	J2
S11	J2
S7	J1
S17	J1
S16	J1

Global Parameter Summary - Reach

Downstream

Element Name	Downstream
R6	J5
R5	J4
R4	J3
R3	J2
R2	J1
R1	Chinquapin Outlet

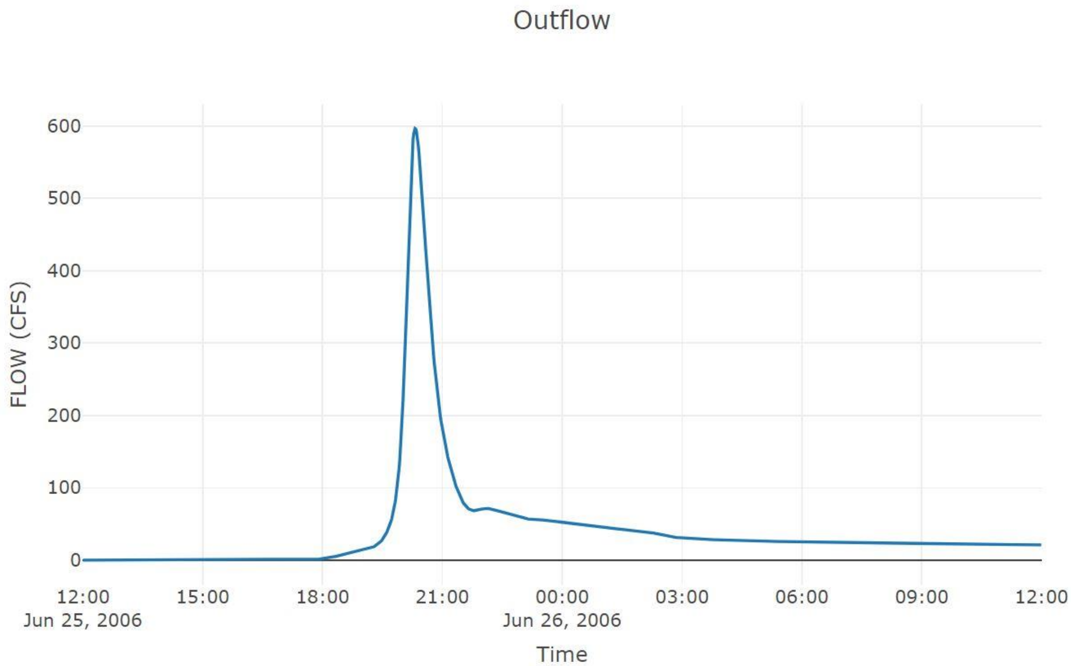
Global Results Summary

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin - 2	0.08	148.88	25Jun2006, 20:12	4.17
J6	0.08	148.88	25Jun2006, 20:12	4.17
R6	0.08	148.7	25Jun2006, 20:13	4.16
Subbasin - 3	0.1	156.55	25Jun2006, 20:20	4.15
S12	0	1.3	25Jun2006, 19:58	4.19
J5	0.19	296.22	25Jun2006, 20:16	4.16
R5	0.19	296.14	25Jun2006, 20:16	4.16
S1	0.04	64.88	25Jun2006, 20:15	4.16
S13	0	0.95	25Jun2006, 19:58	4.19
J4	0.23	361.14	25Jun2006, 20:16	4.16
R4	0.23	359.99	25Jun2006, 20:18	4.14
S2	0.03	59.38	25Jun2006, 20:07	4.17
J3	0.25	402.45	25Jun2006, 20:17	4.15
R3	0.25	402.27	25Jun2006, 20:19	4.14
J7	0.06	108.04	25Jun2006, 20:15	4.16
Subbasin - 4	0.06	108.04	25Jun2006, 20:15	4.16
Subbasin - 1	0.02	30.63	25Jun2006, 20:11	4.17
S11	0	0.33	25Jun2006, 19:58	4.19
J2	0.33	533.61	25Jun2006, 20:18	4.15
R2	0.33	533.54	25Jun2006, 20:20	4.13
S7	0.03	70.47	25Jun2006, 20:08	4.17
S17	0.01	24.12	25Jun2006, 20:05	4.18
S16	0	3.75	25Jun2006, 20:02	4.18
J1	0.38	596.59	25Jun2006, 20:18	4.14
R1	0.38	596.58	25Jun2006, 20:19	4.13
Chinquapin Outlet	0.38	596.58	25Jun2006, 20:19	4.13

Reach: R1

Downstream : Chinquapin Outlet

Results: R1	
Peak Discharge (CFS)	596.58
Time of Peak Discharge	25Jun2006, 20:19
Volume (IN)	4.13
Peak Inflow (CFS)	596.59
Inflow Volume (AC - FT)	84.31



APPENDIX D

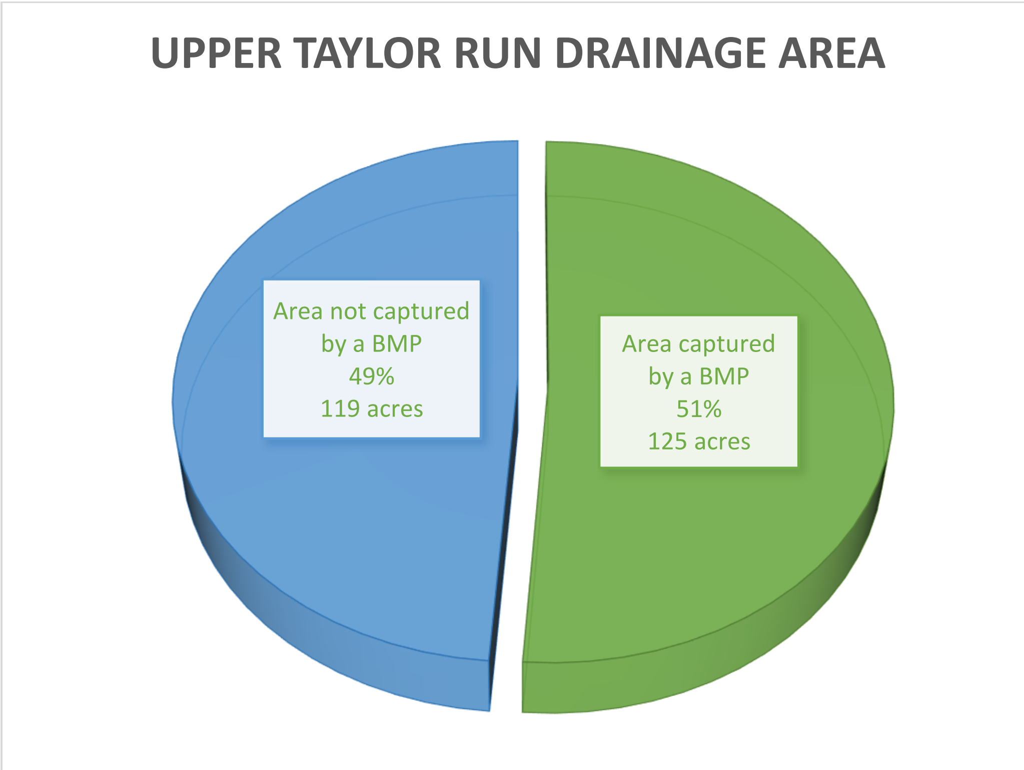


Figure D-1. Percent of BMP capture in Upper Taylor Run Drainage Area

Table D-1. Existing BMPs in the Upper Taylor Run Watershed

BMP Type	Total Impervious Area (acres)	Total Drainage Area (acres)
Bioretention Filter	0.096	0.125
Bioretention Filter	0.070	0.141
Bioretention Filter	0.060	0.200
Bioretention Filter	0.213	0.277
Bioretention Filter	0.100	0.399
Bioretention Filter	0.172	0.517
Bioretention Filter	0.439	0.643
Bioretention Filter	0.200	0.800
Bioretention Filter	0.270	0.870
Bioretention Filter	0.010	2.790
Bioretention Filter	1.489	3.190
Cistern	5.892	5.892
D.C. Sand Filter	0.820	0.828

D.C. Sand Filter	0.820	0.828
D.C. Sand Filter	0.940	1.410
D.C. Sand Filter	1.590	2.240
Delaware Sand Filter	0.198	0.211
Delaware Sand Filter	0.280	0.350
Delaware Sand Filter	0.364	0.364
Detention	0.490	0.900
Downstream Defender® Stormwater Treatment Vortex *	0.503	0.755
Downstream Defender® Stormwater Treatment Vortex *	0.573	1.000
Downstream Defender® Stormwater Treatment Vortex *	0.889	1.190
Downstream Defender® Stormwater Treatment Vortex *	0.862	1.220
Dry Detention Pond	4.400	30.300
Grass Swale	0.090	0.200
Green Roof	0.182	0.182
Infiltration System	0.302	0.370
Infiltration System	0.000	2.100
Infiltration System	0.000	4.086
Permeable Pavement	0.009	0.009
Permeable Pavement	0.009	0.009
Permeable Pavement	0.050	0.050
Permeable Pavement	0.050	0.050
Rain Barrel	0.024	0.024
Stormceptor® Stormwater Treatment System	0.534	0.550
StormFilter™ Stormwater Treatment System	2.512	2.898
Stormwater Storage Tank	0.320	0.770
Tree Box Filter	0.120	0.200
Trench Sand Filter	0.039	0.039
Vegetated Filter Strip	0.005	0.005
Vegetated Filter Strip	0.024	0.024
Vegetated Filter Strip	0.048	0.048
Vegetated Filter Strip	0.060	0.300
Vegetated Filter Strip	0.160	0.360
Vegetated Filter Strip	0.420	0.480
Vegetated Filter Strip	0.100	0.500
Vegetated Filter Strip	0.520	1.020
Vegetated Filter Strip	0.110	1.650
Wet Pond	0.090	0.090
Wet Pond	11.160	51.800
Total	38.678	125.253

Total Phosphorus

FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	133.17
TP LOAD REDUCTION REQUIRED (lb/yr)	26.63
TP LOAD REDUCTION ACHIEVED (lb/yr)	51.09
TP LOAD REMAINING (lb/yr):	82.09
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr):	0.00 **

** TARGET TP REDUCTION EXCEEDED BY 24.45 LB/YEAR **

Total Nitrogen (For Information Purposes)

POST-DEVELOPMENT LOAD (lb/yr)	952.70
NITROGEN LOAD REDUCTION ACHIEVED (lb/yr)	307.09
REMAINING POST-DEVELOPMENT NITROGEN LOAD (lb/yr)	645.61

Figure D-2. VRRM Water Quality Compliance Spreadsheet for Existing BMPs

Total Phosphorus

FINAL POST-DEVELOPMENT TP LOAD (lb/yr)	108.33
TP LOAD REDUCTION REQUIRED (lb/yr)	21.67
TP LOAD REDUCTION ACHIEVED (lb/yr)	59.52
TP LOAD REMAINING (lb/yr):	48.82
REMAINING TP LOAD REDUCTION REQUIRED (lb/yr):	0.00 **

** TARGET TP REDUCTION EXCEEDED BY 37.85 LB/YEAR **

Total Nitrogen (For Information Purposes)

POST-DEVELOPMENT LOAD (lb/yr)	775.01
NITROGEN LOAD REDUCTION ACHIEVED (lb/yr)	495.44
REMAINING POST-DEVELOPMENT NITROGEN LOAD (lb/yr)	279.56

Figure D-3. VRRM Water Quality Compliance Spreadsheet for Additional 50 Impervious Acres

Appendix D: VRRM Existing BMPs

Drainage Area A

CLEAR BMP AREAS

Drainage Area A Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals	Land Cover Rv
Forest/Open Space (acres)					0.00	0.00
Managed Turf (acres)				86.58	86.58	0.25
Impervious Cover (acres)				38.68	38.68	0.95
				Total	125.26	

Total Phosphorus Available for Removal in D.A. A (lb/yr)	133.17
Post Development Treatment Volume in D.A. A (ft^3)	211,959

Stormwater Best Management Practices (RR = Runoff Reduction)

--Select from dropdown lists--

Practice	Runoff Reduction Credit (%)	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	Volume from Upstream Practice (ft^3)	Runoff Reduction (ft^3)	Remaining Runoff Volume (ft^3)	Total BMP Treatment Volume (ft^3)	Phosphorus Removal Efficiency (%)	Phosphorus Load from Upstream Practices (lb)	Untreated Phosphorus Load to Practice (lb)	Phosphorus Removed By Practice (lb)	Remaining Phosphorus Load (lb)	Downstream Practice to be Employed
6. Bioretention (RR)													
6.a. Bioretention #1 or Micro-Bioretention #1 or Urban Bioretention (Spec #9)	40	6.83	3.12	0	6,783	10,174	16,957	25	0.00	10.64	5.85	4.79	
6.b. Bioretention #2 or Micro-Bioretention #2 (Spec #9)	80			0	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration (RR)													
7.a. Infiltration #1 (Spec #8)	50	6.25	0.30	0	3,359	3,359	6,718	25	0.00	4.22	2.63	1.58	
7.b. Infiltration #2 (Spec #8)	90			0	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond (RR)													
8.a. ED #1 (Spec #15)	0			0	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	15	0.41	0.49	0	309	1,753	2,062	15	0.00	1.29	0.36	0.93	
9. Sheetflow to Filter/Open Space (RR)													
9.a. Sheetflow to Conservation Area, A/B Soils (Spec #2)	75			0	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area, C/D Soils (Spec #2)	50	2.94	1.45	0	3,828	3,828	7,656	0	0.00	4.80	2.40	2.40	
9.c. Sheetflow to Vegetated Filter Strip, A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	

	Nitrogen Removal Efficiency (%)	Nitrogen Load from Upstream Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs)	Remaining Nitrogen Load (lbs)
6. Bioretention (RR)					
6.a.	40	0.00	76.13	48.72	27.41
6.b.	60	0.00	0.00	0.00	0.00
7. Infiltration (RR)					
7.a.	15	0.00	30.16	17.34	12.82
7.b.	15	0.00	0.00	0.00	0.00
8. Extended Detention Pond (RR)					
8.a.	10	0.00	0.00	0.00	0.00
8.b.	10	0.00	9.26	2.18	7.08
9. Sheetflow to Filter/Open Space (RR)					
9.a.	0	0.00	0.00	0.00	0.00
9.b.	0	0.00	34.37	17.19	17.19
9.c.	0	0.00	0.00	0.00	0.00

TOTAL IMPERVIOUS COVER TREATED (ac)	16.84	AREA CHECK: OK.
TOTAL MANAGED TURF AREA TREATED (ac)	42.45	AREA CHECK: OK.
TOTAL RUNOFF REDUCTION IN D.A. A (ft^3)	34,871	

TOTAL PHOSPHORUS AVAILABLE FOR REMOVAL IN D.A. A (lb/yr)	133.17
TOTAL PHOSPHORUS REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	27.16
TOTAL PHOSPHORUS REMAINING AFTER APPLYING RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	106.02

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

TOTAL RUNOFF REDUCTION IN D.A. A (ft^3)	34,871
NITROGEN REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	204.51

SEE WATER QUALITY COMPLIANCE TAB FOR SITE CALCULATIONS (Information Only)

Appendix D: VRRM Additional 50 Acre with BMPs

Drainage Area A

CLEAR BMP AREAS

Drainage Area A Land Cover (acres)

	A Soils	B Soils	C Soils	D Soils	Totals	Land Cover Rv
Forest/Open Space (acres)					0.00	0.00
Managed Turf (acres)				0.00	0.00	0.00
Impervious Cover (acres)				50.00	50.00	0.95
				Total	50.00	

Total Phosphorus Available for Removal in D.A. A (lb/yr)	108.33
Post Development Treatment Volume in D.A. A (ft^3)	172,425

Stormwater Best Management Practices (RR = Runoff Reduction)

--Select from dropdown lists--

Practice	Runoff Reduction Credit (%)	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	Volume from Upstream Practice (ft3)	Runoff Reduction (ft3)	Remaining Runoff Volume (ft3)	Total BMP Treatment Volume (ft3)	Phosphorus Removal Efficiency (%)	Phosphorus Load from Upstream Practices (lb)	Untreated Phosphorus Load to Practice (lb)	Phosphorus Removed By Practice (lb)	Remaining Phosphorus Load (lb)	Downstream Practice to be Employed
Soils as per specs (see Spec #4)													
5. Dry Swale (RR)													
5.a. Dry Swale #1 (Spec #10)	40			0	0	0	0	20	0.00	0.00	0.00	0.00	
5.b. Dry Swale #2 (Spec #10)	60			0	0	0	0	40	0.00	0.00	0.00	0.00	
6. Bioretention (RR)													
6.a. Bioretention #1 or Micro-Bioretention #1 or Urban Bioretention (Spec #9)	40	0.00	50.00	0	68,970	103,455	172,425	25	0.00	108.21	59.52	48.70	
6.b. Bioretention #2 or Micro-Bioretention #2 (Spec #9)	80			0	0	0	0	50	0.00	0.00	0.00	0.00	
7. Infiltration (RR)													
7.a. Infiltration #1 (Spec #8)	50			0	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	90			0	0	0	0	25	0.00	0.00	0.00	0.00	
8. Extended Detention Pond (RR)													
8.a. ED #1 (Spec #15)	0			0	0	0	0	15	0.00	0.00	0.00	0.00	
8.b. ED #2 (Spec #15)	15			0	0	0	0	15	0.00	0.00	0.00	0.00	
9. Sheetflow to Filter/Open Space (RR)													
9.a. Sheetflow to Conservation Area, A/B Soils (Spec #2)	75			0	0	0	0	0	0.00	0.00	0.00	0.00	
9.b. Sheetflow to Conservation Area, C/D Soils (Spec #2)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	
9.c. Sheetflow to Vegetated Filter Strip, A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	50			0	0	0	0	0	0.00	0.00	0.00	0.00	

Nitrogen Removal Efficiency (%)	Nitrogen Load from Upstream Practices (lbs)	Untreated Nitrogen Load to Practice (lbs)	Nitrogen Removed By Practice (lbs)	Remaining Nitrogen Load (lbs)
5. Dry Swale (RR)				
25	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
6. Bioretention (RR)				
40	0.00	774.13	495.44	278.69
60	0.00	0.00	0.00	0.00
7. Infiltration (RR)				
15	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00
8. Extended Detention Pond (RR)				
10	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
9. Sheetflow to Filter/Open Space (RR)				
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00
0	0.00	0.00	0.00	0.00

TOTAL IMPERVIOUS COVER TREATED (ac)	50.00	AREA CHECK: OK.
TOTAL MANAGED TURF AREA TREATED (ac)	0.00	AREA CHECK: OK.
TOTAL RUNOFF REDUCTION IN D.A. A (ft^3)	68,970	

TOTAL PHOSPHORUS AVAILABLE FOR REMOVAL IN D.A. A (lb/yr)	108.33
TOTAL PHOSPHORUS REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	59.52
TOTAL PHOSPHORUS REMAINING AFTER APPLYING RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	48.82

SEE WATER QUALITY COMPLIANCE TAB FOR SITE COMPLIANCE CALCULATIONS

TOTAL RUNOFF REDUCTION IN D.A. A (ft^3)	68,970
NITROGEN REMOVED WITH RUNOFF REDUCTION PRACTICES IN D.A. A (lb/yr)	495.44

SEE WATER QUALITY COMPLIANCE TAB FOR SITE CALCULATIONS (Information Only)