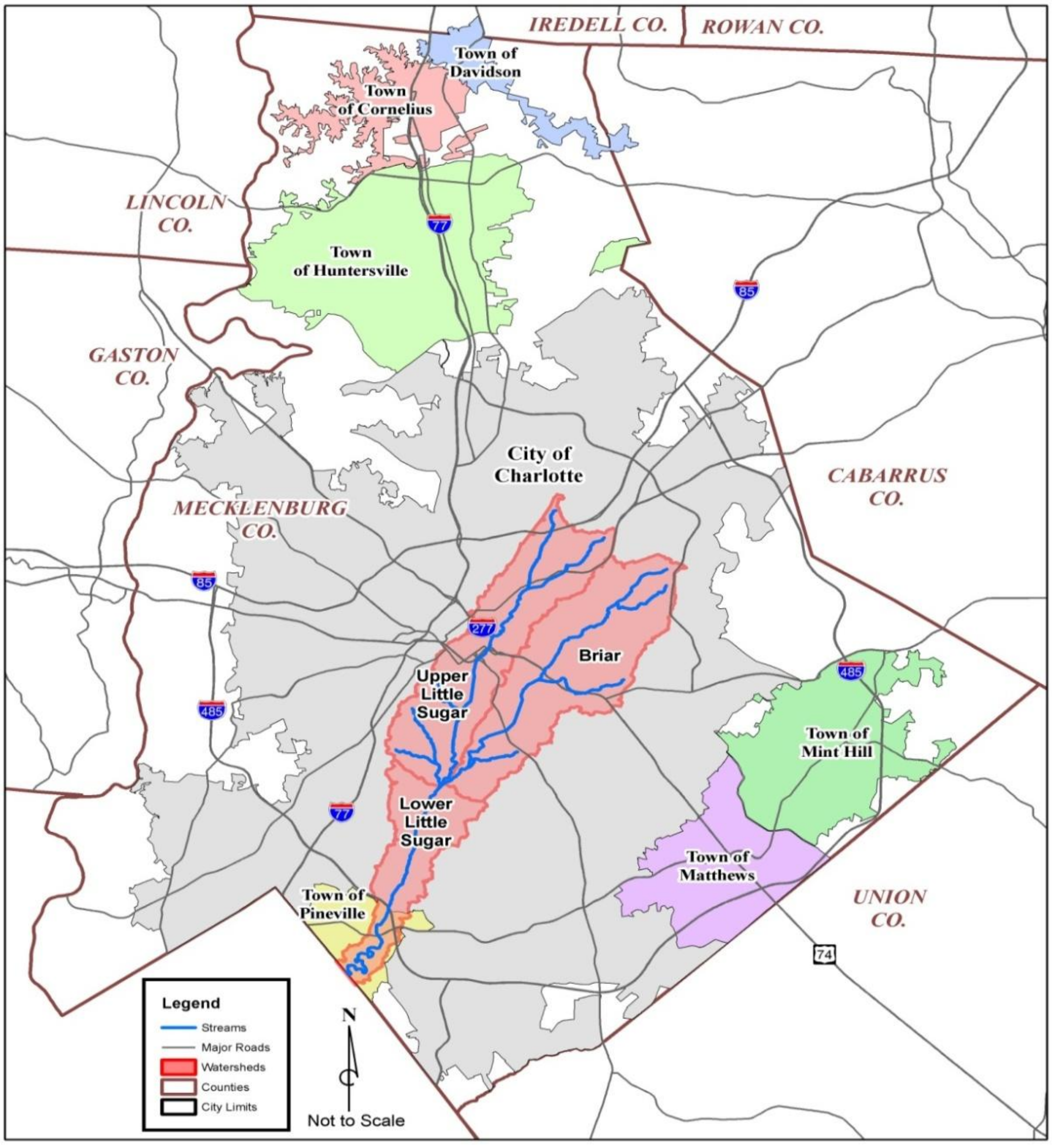
Little Sugar Creek and Briar Creek Subbasin HEC-HMS Model

Mecklenburg County, NC



July 2009

Table of Contents

Table of Figures

Table of Tables

1.0 Introduction

Dewberry & Davis, Inc. (Dewberry) was selected by Charlotte-Mecklenburg County Storm Water Services (CMSWS), to update the landuses and floodplain maps/models for 9 streams within the highly urbanized Little Sugar Creek and Briar Creek watersheds. The areas identified for the Hydrologic and Hydraulic (H&H) analysis is the drainage basin draining at approximately 3 miles downstream of NC-51 at the southern boundary of Mecklenburg County on Little Sugar Creek. The drainage basin is urban with densely populated residential areas and is approximately 51 square miles in area (Figure 1).

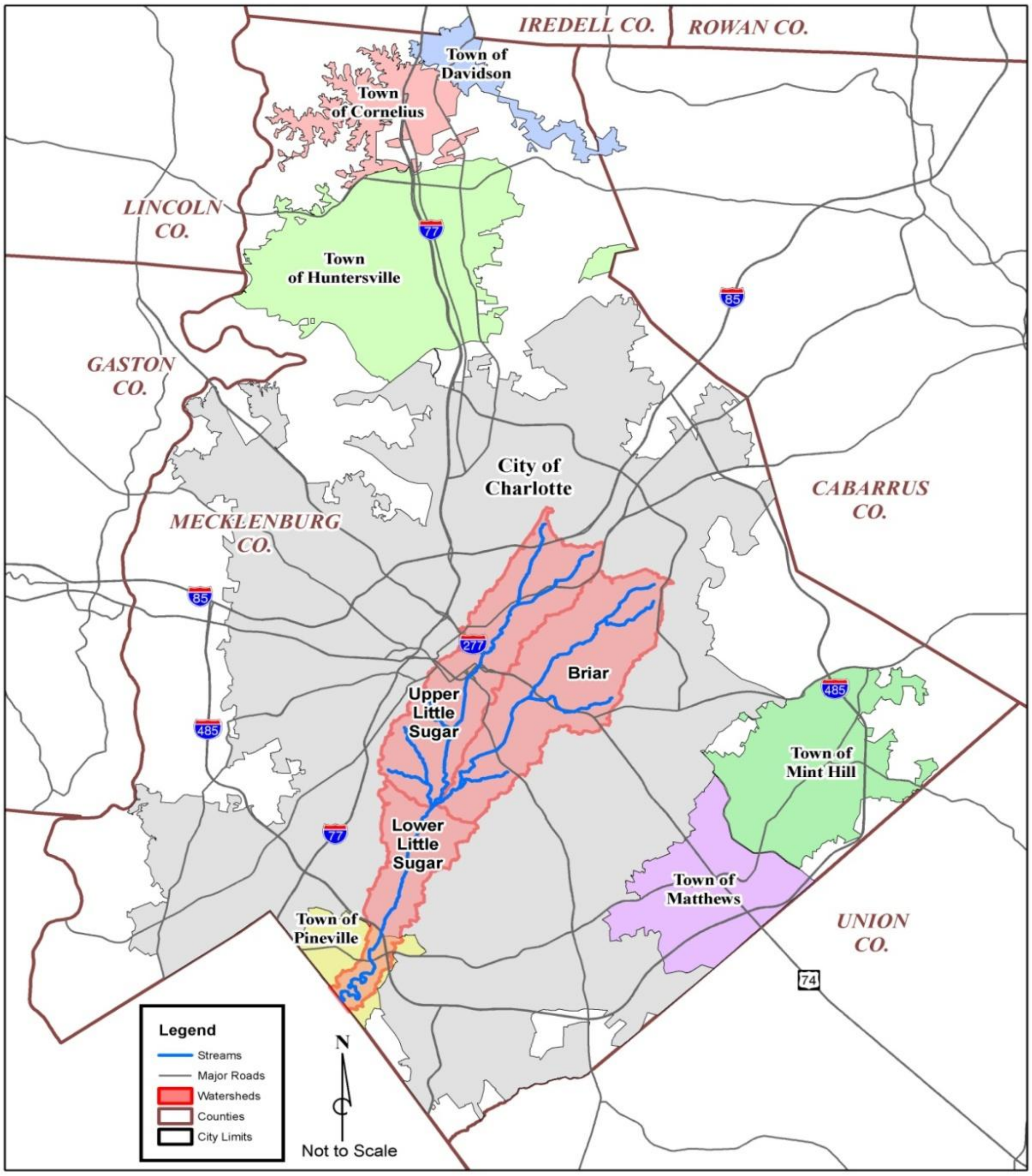


Figure 1. Little Sugar Creek and Briar Creek Subbasin Location map

Hydrologic and Hydraulic analyses for within the watershed were performed Federal Emergency Management Agency (FEMA) Guidelines and Specifications' (G&S) and County's 'Floodplain Analysis and Mapping Standards Guidance Document' (Standards Document). A hydrologic analysis was conducted to calculate peak surface runoff flows and to assess the general hydrologic response of the watershed for a range of rainfall events for existing and future land use conditions. The analysis was conducted for the 2-, 10-, 25-, 50-, 100-, and 500-year storm events for existing and future land use conditions, using Soil Conservation Services (SCS) Technical Release 55 (TR-55, 1986) methodology within the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS version 3.3) rainfall-runoff model. These flows will be used in the open channel hydraulics modeling for nine (9) streams within the basin, using the Hydrologic Engineering Center's River Analysis System (HEC-RAS version 4.0).

Hydraulic analysis will include creating existing and proposed floodplains for all of nine (9) modeled streams within Little Sugar Creek and Briar Creek (LSCBC) subbasins. Basin characteristics such as land use, soils, topography, basin and subbasin delineation, time of concentration, and curve numbers were developed for the analysis. Discharges derived from HEC-HMS, utilizing GIS support data will be used in the HEC-RAS models.

2.0 HEC-HMS Model

A systematic approach to creating the peak flows for use in the hydraulic models was applied based on the SCS TR-55 methodology due to the level of detail required for this analysis. The overall watershed for LSCBC subbasins was subdivided into smaller basins.

The soil type and land use that is found in each basin was used to determine the precipitation losses associated with each basin, which is referred to as the curve number (CN) of the basin. The longest flow paths for each basin were determined using TR-55 methodology, which was created from ArcHydro tool in GIS. These longest flow paths were then manually adjusted based on the stormwater inventory and topographic data. The time of concentration (T_c) and lag times were then calculated using Manning's and SCS Lag time equations. During model calibration process, modified lag times (= 1.8 * T_c) were used to calibrated the model to a low-end and high end events. This modification in lag time accounts for errors associated with calculation of T_c due approximations in land cover and pipe/overland flows. Precipitation depths for 24- hour precipitation events were obtained from the combined NOAA dataset plus aggregated USGS site representing the CRN initial dataset family with no area reduction factors, as specified in the July 2008 version of the 'Floodplain Analysis and Mapping Standards Guidance Document' (Standards document)prepared by the County .

This section is organized in the general order of analyses followed during discharge determination. Section 2.1 provides information for inputs used in the HEC-HMS model, Section 2.2 gives HEC-HMS calibration description results, and Section 2.3 gives HEC-HMS output and comparison with effective data.

2.1 Basin Characteristics

The four main inputs that are required for HEC-HMS to determine the peak flow of a sub-basin are the basin area, curve number, lag time, and the storms precipitation depth.

2.1.1 Subbasin Delineation

A nominal subbasin area of 60 acres was targeted during delineation. Additional subbasin delineation criteria were also considered including division at critical locations such as stream confluences or road crossings. The drainage area thresholds were chosen based on the Standards Document and modified based on the conference call on Aug 19, 2008 with the County officials. This resulted in the following guidelines:

- At most of the subbasins along the studied streams, a target value of 60-acre subbasin is used along with a tolerance of +/-20%.
- For non-studied tributaries, a wider tolerance of +/-200% is used.

The flow change locations were chosen based on the need for detail in hydrologic and hydraulic models. Most of these were placed upstream of the major road/railroad crossings and bridges. At some locations, the drainage points were placed based on the presence of stream confluences. Selection of drainage points was closely evaluated based on sound engineering judgment and the need for detail in the hydrologic and hydraulic model and was based on the standards discussed with the County.

The overall watershed for LSCBC was delineated into three 342 smaller basins. Table 1 below provides the statistics for the subbasins.

Table 1. HEC-HMS Model Subbasins

Subbasin Area	Number of Subbasins
Less than 20 acres	21
Between 20 and 60 acres	68
Between 60 and 100 acres	99
Between than 100 - 140 acres	86
Greater than 140 acres	68
Total	**342**

To delineate smaller subbasins, a GIS tool Archydro was used along with manual adjustments based on the stormwater and topographic data. ArcHydro provides a flexible set of tools in GIS environment that allow a user to do much of the pre-processing work needed to perform hydrologic and hydraulic modeling associated with urban watersheds, including delineating basins and other useful processes.

A 10-ft elevation grid obtained from the ‘terrain’ dataset provided by the County was used in GIS analysis. The next sequence of automated procedures was conducted using ArcHydro. These steps consisted of “burning in” streams/pipes, filling sinks, calculating flow direction and flow accumulation, creating streams and stream links, creating outlets and finally delineating basins. This step enforces flow connectivity based on the hydrography and pipe network into the GIS flow network. These basins were delineated with basin breaks at major points of interest, such as road crossings and confluences using the same automated routines and manually adding outlets at specific points of interest. To add further detail, the basins for the entire system were manually modified to have drainage points at critical analysis location identified by the County (e.g. upstream of the CSX Railroad Bridge). Appendix A1 and A2 contain subbasin boundary map and drainage areas for LSCBC. Table 2 below shows the summary statistics for the drainage areas. As shown in the table 2, there are total 342 subbasins with average drainage area of 95 acres.

Table 2. Drainage Area Summary Statistics (Acres)

Mean	95
Standard Error	2.6
Median	95
Mode	104
Standard Deviation	48.1
Skewness	0.1
Range	204
Minimum	0
Maximum	204
Count	342

2.1.2 Hydrologic Soil Groups

Hydrologic soil groups are necessary for quantifying the amount of water that can infiltrate into the soil to reduce the quantity of runoff in a particular watershed. There are seven (7) hydrologic soil groups, A, B, C, C/D, D, U, and W, each representing different infiltration characteristics. To determine the hydrologic soils present in the study area, a raw soil shapefile was obtained from Natural Resources Conservation Service (NRCS) website. The hydrologic soil group information which was absent from the raw soils shapefile was attributed by matching the soil map symbol and the corresponding hydrologic soil group information from the NRCS's published soil survey information which can be downloaded at http://soils.usda.gov/survey/printed_surveys/north_carolina.html.

2.1.3 Land Use and Curve Number

Land use classifications generally show the degree to which a particular parcel is undeveloped or built-out based on a land use type. Land use information was previously finalized after task force meeting, as GIS layer for the existing and future conditions. The existing land use shapefile has twelve (12) unique land use classifications while the future land use shapefile has fifty eight (58) unique land use classifications.

The CN values were determined based on information compiled about the soils and land use, and results in a value that represents the precipitation losses associated with each basin. CN lookup table was created by assigning CNs to each land use-soil group condition using information from NRCS shapefile, USGS Landuse, and sampled data with CNs calculated based on percent impervious. After development of the CN lookup tables, the land use, soils, and the subbasins were spatially intersected in GIS to obtain polygons representing every unique combination of land use and soils within each subbasin. The CNs were assigned to each polygon using the CN lookup tables described in the paragraph above. Finally, a composite CN was calculated for each subbasin by computing the area-weighted average of the individual CN polygons within the subbasin. Appendix A2 contains composite CNs for all subbasins within LSCBC. Table 3 shows a summary statistics for composite CNs for existing and future conditions. As shown in the table 3, the mean value of existing and future conditions CNs is approximately 80.3 and 83.5, respectively.

Table 3. Curve Numbers' Summary Statistics

	Existing Conditions	Future Conditions
Mean	80.3	83.5
Standard Error	0.3	0.3
Median	80	83
Standard Deviation	5.6	5.1
Skewness	-0.1	-0.1
Range	33.8	30.4
Minimum	60	67
Maximum	94	97
Count	342	342

Furthermore, an area weighted CN was calculated for whole LSCBC watershed. The area weighted CNs are 80 and 84 for existing and future conditions, respectively. Based on Technical Report 55 (TR 55) documentation, these values correspond to an initial abstraction value of 0.7 inches.

2.1.4 Times of Concentration and Lag Times

To determine lag time, the T_c value for a particular basin must be determined, after which a simplistic conversion factor is multiplied by the T_c to determine the lag time. Lag time is typically referred to as the difference in time from the centroid of the rainfall excess (the water that is available for runoff after interception, infiltration, and depression storage have been accounted for) to the peak of the hydrograph, or peak flow of the storm, which is commonly calculated by multiplying the T_c by 0.6. The T_cs for this project were calculated using the methods described in TR-55 (SCS, 1986). This method entails subdividing the T_c flow path (i.e. flow path from the hydraulically farthest point to the outlet) into distinct flow regimes/segments, calculating travel times for each segment based on physical characteristics, and then summing up the individual segment travel times to obtain a T_c for a given drainage area. The longest flow paths are divided into the following flow regimes:

Sheet Flow – flow over plan surfaces occurring in the headwater of a given drainage area

Shallow Concentrated Flow – concentrated flow through gutters, and other shallow features

Piped Flow – flow through pipes

Open Channel Flow – flow through defined open channels

The Manning's and SCS equations were used for calculating sheet, shallow concentrated and open channel flow travel times. Closed and open channel flow travel times were determined by assuming full flow in pipes and a reasonable depth for open channels depending on the side slope and bottom width. Average slopes for pipes and channels and channel geometry information were verified in GIS. For cases with no inventory data, reasonable values based on topography and results were assumed.

The longest flow paths for T_c were drawn in GIS using ArcHydro and manually subdivided into the different flow regime segments. In some cases, a flow path with smaller channel segment was chosen over longer piped segment due to longer times of travel in the channel sections. Furthermore, the volume of the flow was considered while selecting flow path for a subbasin. The segment conveying larger flows is considered to be determining segment in cases where flow is occurring by two models, i.e. shallow concentrated flow and piped flow. Once the 'longest flow paths' are finalized, length and slope for each segment were calculated in GIS. Sheet flow segments were restricted to 100 feet or less in length, per the TR-55 methodology. Value of 3.06 inches was used for the 2-year, 24-hour rainfall (P2) for input parameters for sheet flow. Velocities for open channel segments were calculated using Manning's equation, bank-full conditions and using channel geometries derived from field surveyed open system inventory data. Travel time for each individual flow segment was calculated using equations/parameters specified in TR-55. The T_c for each subbasin was then calculated by summing the travel times of the individual T_c flow path segments. Finally, T_c values for each basin were multiplied by '1.8' to convert them to lag times. The value of (1.8*Tc) is used instead of (0.6*Tc) for lag time to accounts for errors associated with calculation of T_c due approximations in land cover and pipe/overland flows. Appendix B1 and B2 contain longest flow path maps and lag times for all subbasins within LSCBC. Table 4 provides the summary statistics for T_c and lag times for LSCBC watershed. As shown in the table, mean Tc and lag time values are 29.92 minutes and 53.85 minutes, respectively.

Table 4. Time of Concentrations and Lag Times Summary Statistics (minutes)

	Tc	Lag time
Mean	29.92	53.85
Standard Error	0.84	1.52
Median	28.69	51.64
Standard Deviation	15.58	28.05
Skewness	3.90	3.90
Range	169.76	305.57
Minimum	4.64	8.36
Maximum	174.40	313.92
Count	342	342

2.1.5 Precipitation

Precipitation depths for 24- hour precipitation events were obtained from the combined NOAA dataset plus aggregated USGS site representing the CRN initial dataset family with no area reduction factors, as specified in the 'Standards' document prepared by the County (Table 5).

Table 5. Precipitation Depths

Storm Event	Precipitation Depths[1] (inches)
2-year	3.06
10-year	4.80
25-year	5.76
50-year	6.51
100-year	7.29
500-year	9.23

[1] Precipitation values taken from combined "NOAA dataset plus aggregated USGS site" IDF presented in SIR 2006-5017

For loss and transform methods, SCS Curve Number and SCS Unit Hydrograph methods were selected, respectively. A skeleton (spatially-correct base plan view) for HEC-HMS model was created manually by placing subbasins, junctions, reaches, and reservoirs. The preliminary HMS model required basin area, curve numbers, lag times and reach lengths populated for each subbasin.

2.1.6 Routing

'Modified Puls' and 'Muskingham-Cunge' were used as reach routing methods for studied and non-studied streams, respectively. Since the HEC-RAS models are being created for the studied streams, 'Modified Puls' routing method was chosen for studied streams to account for the storage in the channel by creating a storage-outflow curve for each reach. Due to unavailability of the stream flow data for non-studied streams, 'Muskingham Cunge' routing method was used for non-studied streams.

For reaches with 'Modified Puls' approach, the storage-discharge curves were created from HEC-RAS model output for a series of discharges. For reaches with 'Muskingham Cunge' approach, the channel dimensions (bottom width, length, slope etc.) were obtained from the stormwater inventory data and/or terrain data. The Manning's n values for channels were assigned using aerial photos and field data.

Pond routing was also performed for impoundments which provide significant attenuation in the model. The database provide by the County (thru Baker) was used to determine the size and dimensions of the ponds and outlet structure. In total, pond routing was performed on five ponds in the HMS model.

The meteorological model used in HMS was the frequency storm for the 2-, 10-, 25-, 50-, 100-, and 500-year storm events. The control specifications for the simulation are one (1) minute time steps and the duration of rainfall is 72-hours. The simulation was run to obtain discharges for the various storm events for existing and future conditions, required for the hydraulic analysis.

2.2 HEC-HMS Calibration

A hydrologic model benefits from being calibrated with the historical data before finalization. During calibration process, a comparison between the historical event(s) and model output are made. The model parameters are revised to ensure reasonable results.

Level 1 – Calibration using only low-end events

It was initially decided through discussions with the County that hydrologic calibration will be performed using one low-end and one high-end event. A review of well documented storm events was performed with the assistance of USGS and our Peer Review team member CDM. The intent was to identify storms that had densely populated rainfall and flow records in the subject watersheds and were considered to have exhibited evenly distributed rainfall intensity. The data for March 1, 2007, September 13, 2006, (low volume events) and August 27, 2008 (high volume event) were obtained from USGS. The March 1, 2007 and September 13, 2006 were found to be homogeneous events producing relatively similar responses across the watershed. Since September 13, 2006 and March 1, 2007 each produced a total precipitation of approximately 3 inches (close to 2 year event based on precipitation totals), they were used as events for low-end calibration for HMS model. The high event of August 2008 produced rainfall in the range of 7-11 inches across the Mecklenburg County, which is higher than 100 year precipitation total of 7.29 inches. The data for August 1, 2008 was initially discarded and deemed insufficient and unreasonable for use as a high-end calibration on account of high variability in the rainfall intensity data and inconsistent response shown in the flow record at various locations within the basin. No other reasonably homogeneous events could be identified from the available record for larger volume storm events.

For September 13, 2006 and March 01, 2007 events, the hyetographs were available for rain gages at six (6) different locations in the subbasins. Appendix C contains a map showing the location of the rain gages along with corresponding weights to develop combined hyetograph to perform low-end calibration. These events have relatively similar precipitation totals across the watershed but they produce different responses. The moisture conditions prior to both the events were evaluated and both events appear to have different antecedent soil conditions. March 2007 event was determined to have saturated soil hence allowing minimal loss due to soil infiltration. On the other hand, September 2006 event was determined to have dry conditions hence significant minimal loss due to soil infiltration. Based on the known information from both events, it was considered unreasonable to achieve calibration with only one of the two events. Hence, low-end calibration was achieved using the data from both events.

For both low-end calibration events (September 13, 2006 and March 01, 2007), various scenarios were created by changing initial abstraction values and curve numbers corresponding to different antecedent moisture conditions (AMCs). Overall, fourteen (14) scenarios (seven (7) scenarios for each event) were created and evaluated to achieve a low-end calibration.

Out of these scenarios, two scenarios with initial abstraction values of 1.0 inch and 0.05 inch yield results closet the gage record for Sept 2006 and March 2007 events respectively. Therefore, the calibrated model was produced using an initial abstraction value of 1.00 inches and curve numbers corresponding to AMC II conditions. At this point, a submittal was made to the County and Baker (QA/QC reviewer) for external QA/QC review.

Level 2 – Validation and Calibration using only August, 2008 Event

A meeting was held between the County, Baker, and Dewberry, to discuss the QA/QC comments. Since the model was calibrated to only low-end events, it was agreed by all parties that the model may be producing high discharges for events with higher recurrence intervals (e.g. 100 year, 500 year etc). Since the intended use of the model includes the ability to accurately predict flood levels for 100 year events as part of the County's CTP with FEMA it was decided that the use of the Aug 2008 event to at least validate the model results was also necessary. ..

To validate the model results using Aug 2008 event, 5-minute interval hyetographs were created for 6 gages. These hyetographs were applied to the corresponding subbasins with the zone of influence based on the isohyetal map for Aug 27, 2008 event released by the USGS. The HMS model was executed using an initial abstraction value of 1.0 inch. The HMS model produced significantly higher peak discharges and volumes compared to the gage records.

At this point, changes were made to the model to incorporate the comments received by the County/Baker. The changes suggested in external QA/QC comments (such as inclusion of ponds, revision to CNs, and routing parameters) caused minimal change (~2-3%) to the peak discharges. In an effort to reduce the discharges, all the parameters (such as modeling methods, lag time, initial abstraction, routing parameters etc) were further evaluated. Based on the evaluation, it was found that:

- SCS Unit Hydrograph Method is very much acceptable in this region

- Peak rate factor 484 was proven acceptable for the years of practice in this region
- Runoff curve numbers seem within relatively agreeable ranges
- Modified Puls channel routing data for the main studied streams, storage-discharge relationships, are from directly HEC-RAS modeling
- Secondary channel routing data for Muskingum-Cunge trapezoidal have not been tested how sensitive by comparing to the 8-points option

It was decided that the lag time was the only remaining parameter with significant judgment involved in the selection of values (i.e. this could reasonably be increased to better account for inaccuracies in estimation of T_c due to pipe flow vs. surface flow, centroid selection, ignoring routing within the subbasins and land cover). A value of 1.2*Tc was used along with initial abstraction value of 1.0 inches. The model results hence obtained were significantly lower than previous results and were closer to gage data but, they were still higher in terms of total volume and peak discharges.

Level 3 – Final Calibration using low-end and high-end events

Based on results from six (6) iterations performed during previous steps, it was decided that lag time should be further increased to 1.8*Tc while using reasonable initial abstraction values to achieve a better match with Aug 2008 event. Drainage area weighted curve numbers for the whole watershed were calculated as approximately 80 and 83 for existing and future conditions, respectively. These values correspond to initial abstraction value of 0.7 inch according to TR-55 documentation. The model with these revisions (lag time = 1.8*Tc and initial abstraction = 0.7 inch) resulted in peak discharges and volumes which were a closer match to the Aug 2008 event.

In an effort to comply with the original plan of achieving the calibration using low-end and high-end events, three scenarios were considered for three events (August 2008, March 2007, and Sept 2006) by varying initial abstraction values. Table 6 shows all the three scenarios (Scenario A, B, and C) that were considered during the calibration.

Table 6. Calibration Scenarios

Rain event	Scenario Description	Rain gages	Initial Abstraction	Curve Numbers
August 27, 2008	**Scenario A:** Hyetograph from rain gages were placed on corresponding subbasins. Initial Abstraction of 0.7 inches, CN values corresponding to AMC II Conditions, and lag time of 1.8 *Tc were used.	Specified to each drainage basin	0.7 inches	AMC II Conditions
March 1, 2007	**Scenario B:** Hyetographs from the rain gages were weighted based on drainage area, to come up with combined hyetograph. Initial Abstraction of 0.0 inches, CN values corresponding to AMC II Conditions, lag time of 1.8 *Tc (Time of Concentration) were used.	Weighted based on drainage area	0.0 inches	AMC II Conditions

September 13, 2006	**Scenario C:** Hyetographs from the rain gages were weighted based on drainage area, to come up with combined hyetograph. Initial Abstraction of 1.2 inches, CN values corresponding to AMC II Conditions, lag time of 1.8 *Tc (Time of Concentration) were used.	Weighted based on drainage area	1.2 inches	AMC II Conditions

The results from all of the scenarios were evaluated and compared with the peak discharges, time to peak, and volume from the gage data. For August 27, 2008 event, the scenario A (hyetograph for corresponding subbasins, initial abstraction of 0.7 inch and curve numbers corresponding to AMC II conditions) produced results which were comparable to the stream gage readings at corresponding gage locations. As shown in Table 7 and graphs in Figure 2, peak discharges, time to peaks, and total volumes show a good relationship at most locations. The hydrographs for all gage locations show double peaks, a condition which is being captured in the model. A good match in terms of peak discharges, time to peak, and total volume indicates reasonable curve numbers and times of concentration in the model.

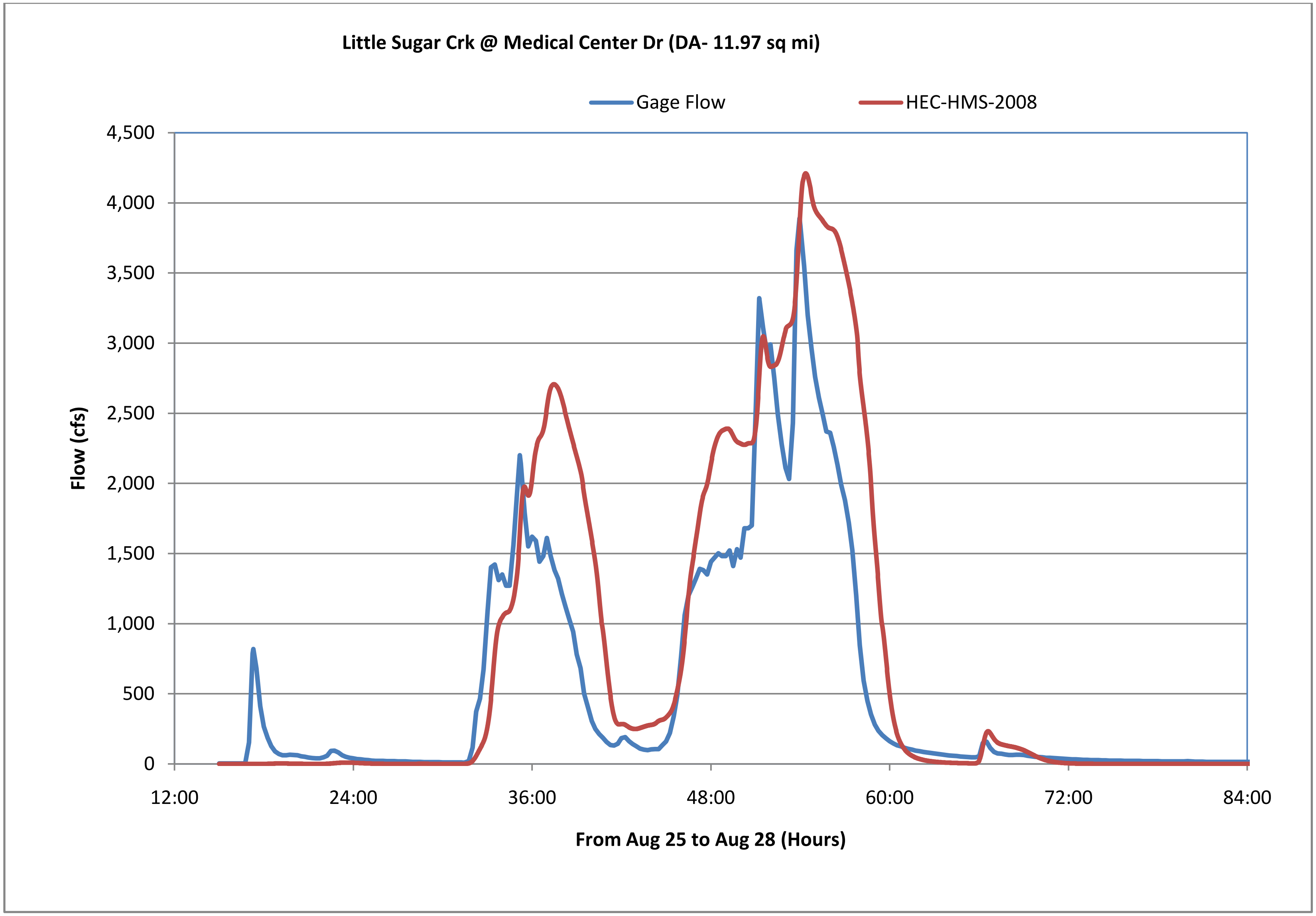
During evaluation of results for Aug 2008 event, a comparison of 100 year event and Aug 2008 event peak discharges was performed. The synthetic storm for 100 year event had total 24-hour precipitation of 7.29 inches while the Aug 2008 event produced 7-11 inches of precipitation though out the watershed over 36 hour period. It was anticipated that the peak discharge for Aug 2008 event will be significantly larger than 100 year event. But, as shown in the Table 8 the model produces higher peak discharges for 100 year event compared to Aug 2008. To further analyze the phenomenon behind that discrepancy, a hyetograph was created 100 year (SCS Type II) event. The comparison of hyetographs for 100 year and Aug 2008 events is shown in Figure 3. The hyetographs show that 100 year has a much higher peak compared to Aug 2008 event. Though the total precipitation in Aug 2008 event is larger than 100 year event, it is scattered over 36 hour duration with two distinct peaks. Figure 4 shows hydrographs for the two events at two different gage locations. As anticipated from the hyetograph, the 100 year produces higher peak discharges with low total volume while Aug 2008 event has two lower peak discharges with high total volume. As evident from the hyetograph and hydrograph comparisons, the timing associated with the peaks provides time to the watershed to recover from previous peak and produce lower discharges for Aug 2008 event.

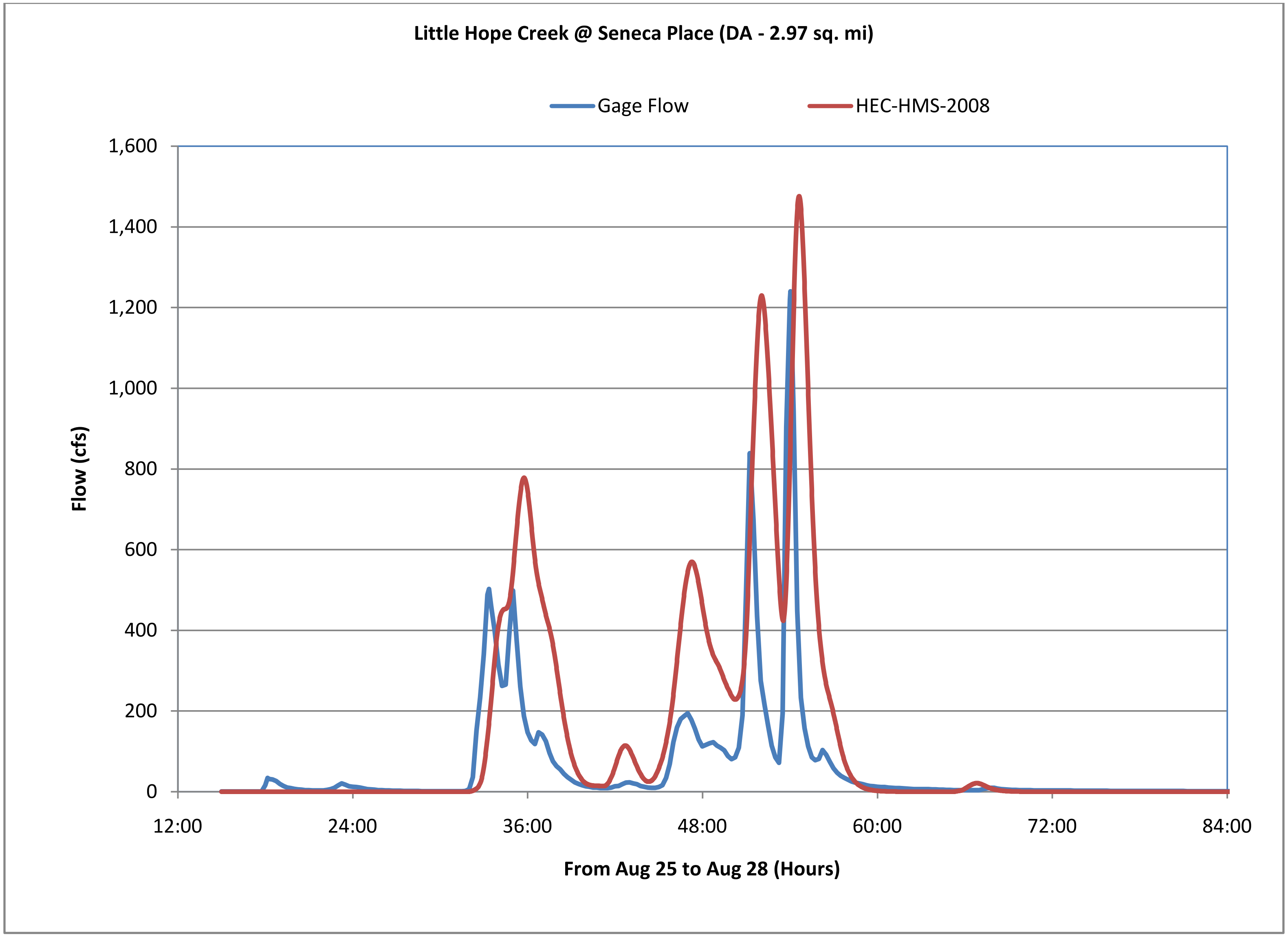
March 2007 event was determined to have saturated soil hence allowing minimal loss due to soil infiltration. On the other hand, September 2006 event was determined to have dry conditions hence significant minimal loss due to soil infiltration. To represent this phenomenon, a small value (0.0 inch) of initial abstraction was used for March 2007 event while a larger value (1.2 inches) was used for September 2006 event. For March 1, 2007 event, the scenario B (hyetograph using gage weights, initial abstraction of 0.0 inch and curve numbers corresponding to AMC II conditions) produced results which were comparable to the stream gage readings at corresponding gage locations. As shown in Table 9, peak discharges are approximately 15-30% lower than peak discharges at most of gage locations. For Sept 13, 2006 event, the scenario C (hyetograph using equal gage weights, initial abstraction of 1.2 inches and curve numbers corresponding to AMC II conditions) produced results which were produced on both sides of stream gage readings at corresponding gage locations. As shown in Table 10, peak discharges at some locations were approximately 10-15% below the gage discharges while others were approximately 10-15% higher. For both scenarios some difference can also be attributed to the change in drainage area.

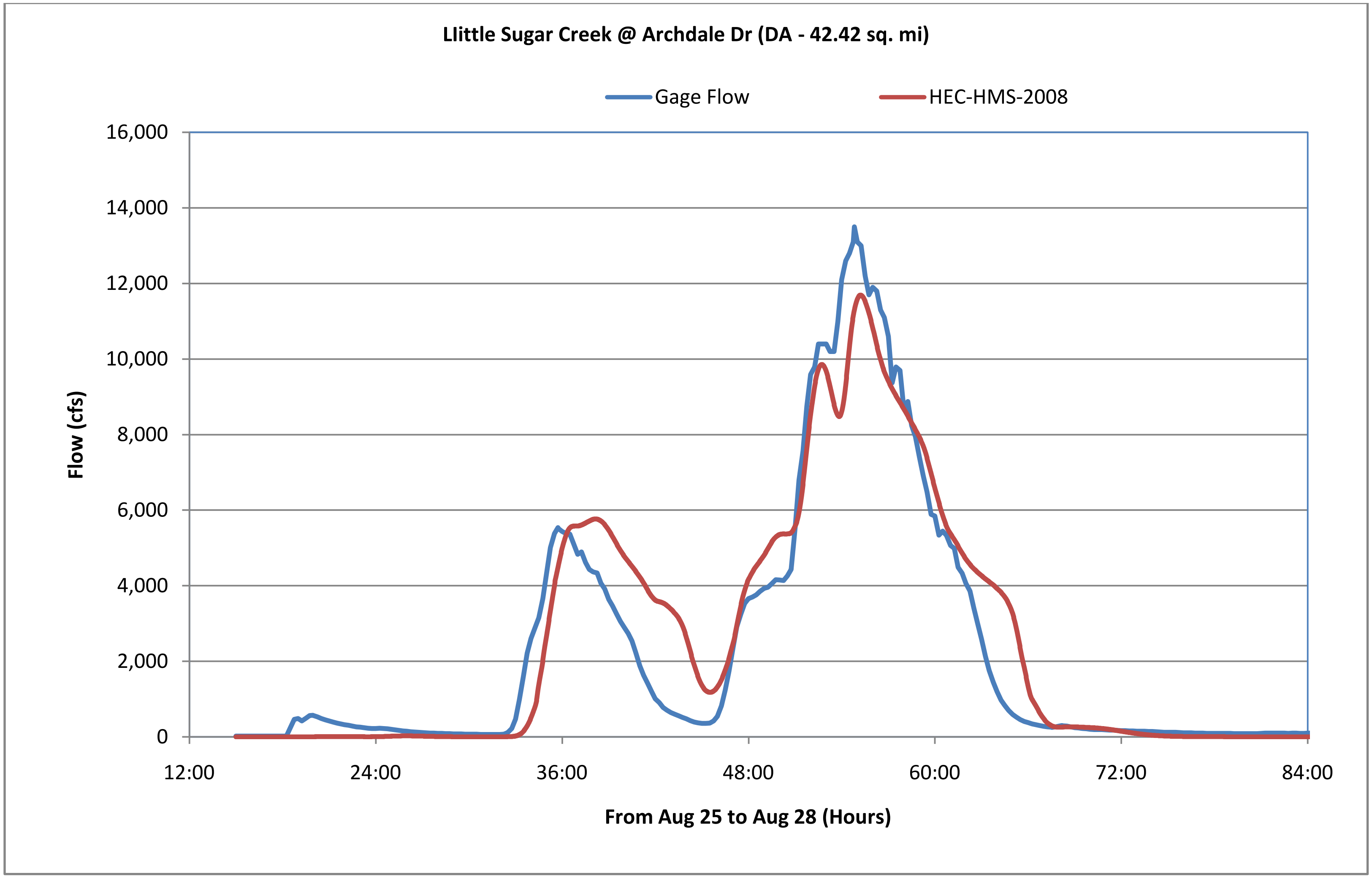
From the calibration process, it appears reasonable to conclude that curve numbers and time of concentration values are represented well in the model. Since the responses for three events in the analysis are being captured using different values of initial abstraction, it is believed that model is highly sensitive to values of initial abstraction. Based on the careful evaluation of all the scenarios, an initial abstraction value of 0.7 inches and curve numbers corresponding to AMC II appear to most appropriately reflect the response of storm events within the subbasin for the breadth of storm events we are trying to simulate. Therefore, an initial abstraction value of 0.7 inches, lag time of 1.8*Tc and curve numbers corresponding to AMC II are proposed to be used for the calibrated model.

Table 7. Calibration results – August 27, 2008 Event (Scenario A)

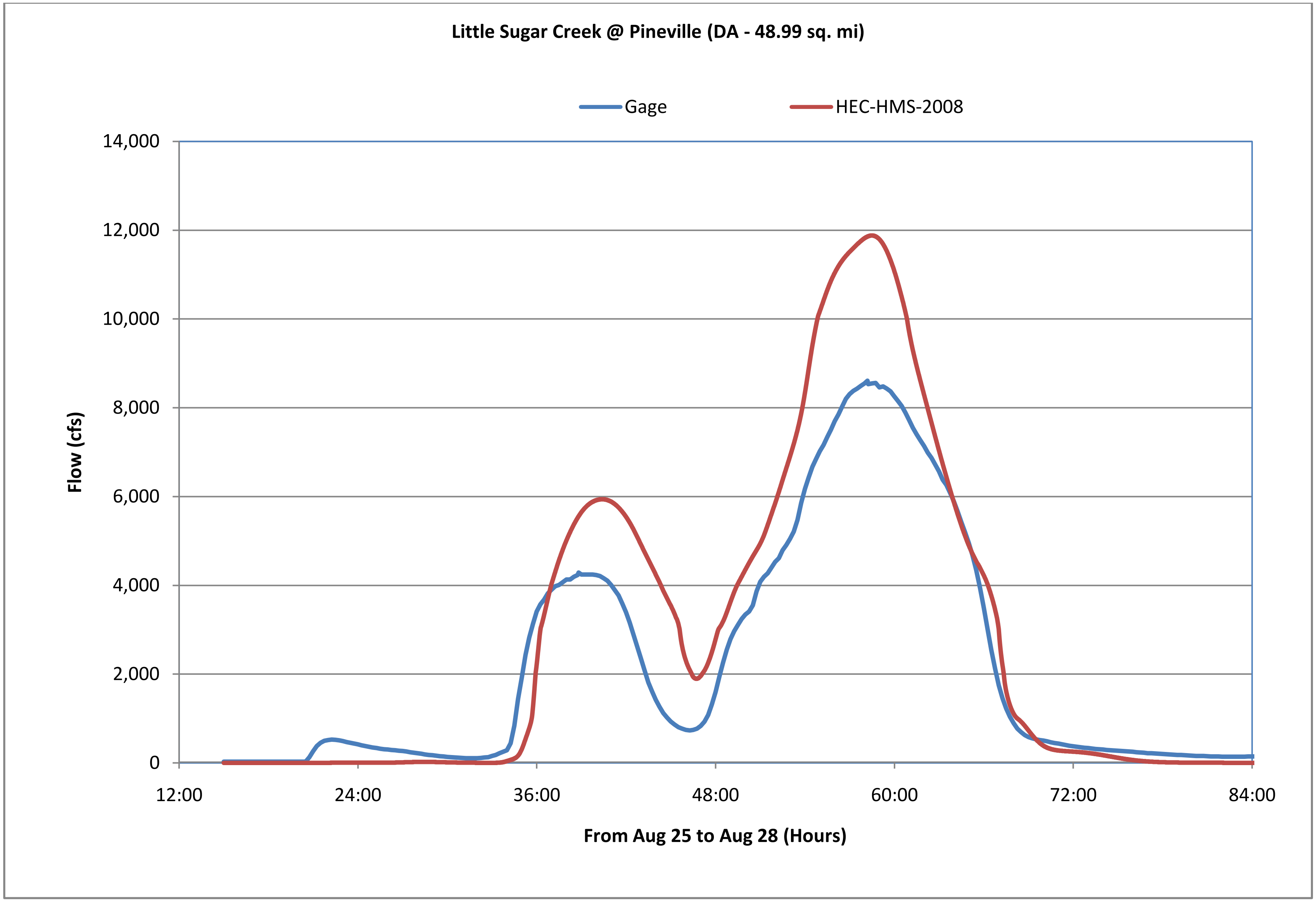
Station Number	Station Name	Gage Drainage Area (sq.miles)	Model Drainage Area (sq.miles)	Gage Data		Model (HEC-HMS) Data		Percent Difference	
				Peak Flow (cfs)	Time to Peak (hrs)	Peak Flow (cfs)	Time to Peak (hrs)	Flow	DA
214643820	Edwards Branch @ Sheffield Drive	1.0	1.0	-	-	896	28:21:00	-	-3
214642825	Briar Creek @ Shamrock Drive	5.2	6.0	3480	29:30:00	3784	29:09:00	9	16
214640410	Little Sugar Creek @ 36th Street	3.4	5.2	-	-	3051	29:17:00	-	53
2146470	Little Hope Creek at Seneca Place	2.6	3.0	1240	30:02:00	1476	30:38:00	19	13
2146409	Little Sugar Creek @ Medical Center Dr	11.8	12.0	3890	29:57:00	4211	30:22:00	8	1
214645022	Briar Creek Above Colony Road	19.0	18.9	3550	34:06:00	4339	36:05:00	22	-1
2146507	Little Sugar Creek @ Archdale Drive	42.6	42.4	13500	30:49:00	11692	31:13:00	-13	0
2146530	Little Sugar Creek @ Pineville	49.2	49.0	8610	34:12:00	11880	34:30:00	38	0
214643860	Briar Creek Below Edwards Branch	14.2	14.5	-	-	4351	33:38:00	-	2
2146449	Briar Creek @ Providence Road	17.6	18.0	-	-	4342	35:27:00	-	2
2146420	Little Sugar Creek @ Hillside Avenue	15.0	15.1	-	-	4926	31:19:00	-	0


Little Sugar Crk @ Medical Center Dr (DA- 11.97 sq mi)
Gage Flow
HEC-HMS-2008
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Flow (cfs)
12:00
24:00
36:00
48:00
60:00
72:00
84:00
From Aug 25 to Aug 28 (Hours)

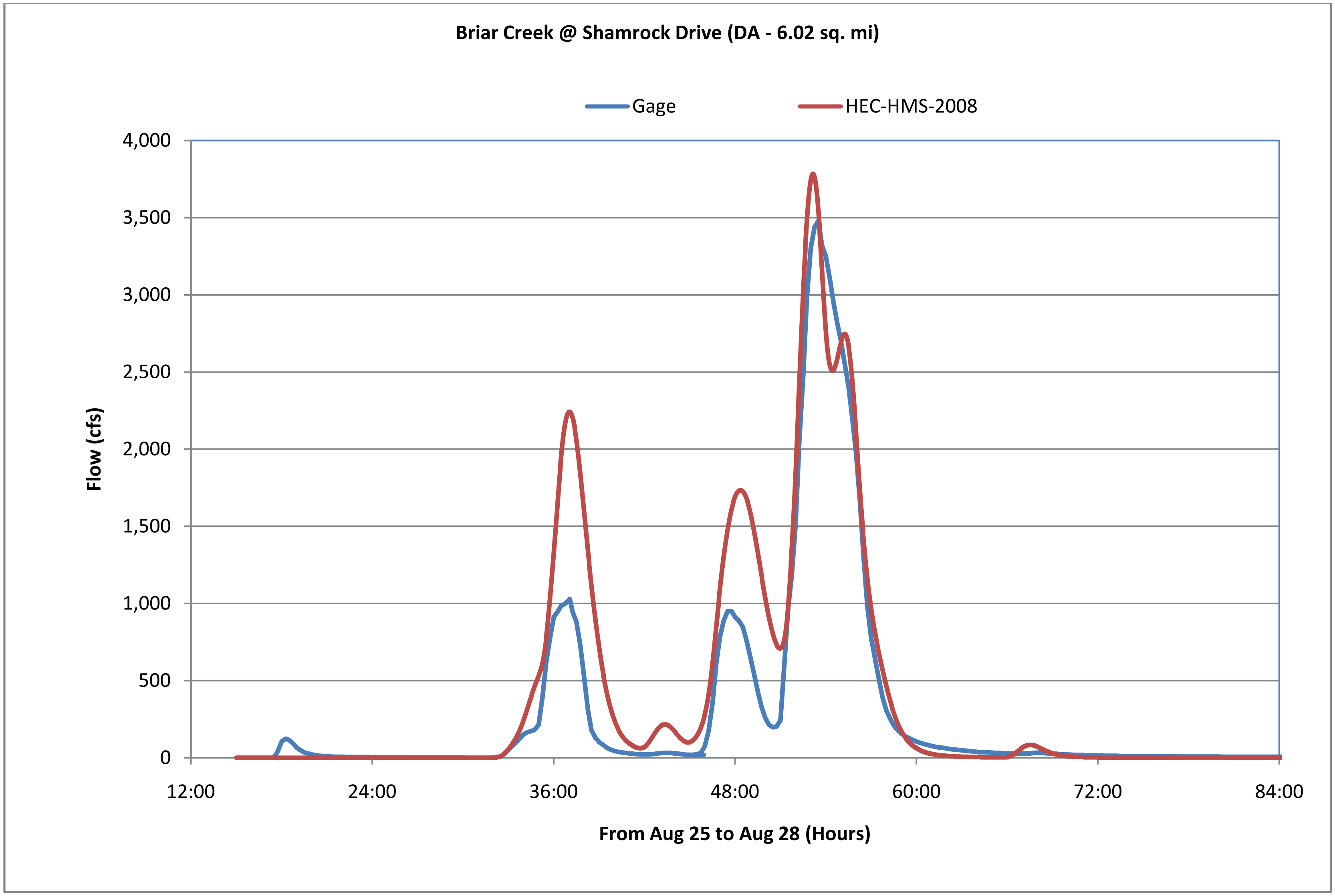

Little Hope Creek @ Seneca Place (DA - 2.97 sq. mi)
Gage Flow
HEC-HMS-2008
Flow (cfs)
1,600
1,400
1,200
1,000
800
600
400
200
0
12:00
24:00
36:00
48:00
60:00
72:00
84:00
From Aug 25 to Aug 28 (Hours)



Llittle Sugar Creek @ Archdale Dr (DA - 42.42 sq. mi)
Gage Flow
HEC-HMS-2008
Flow (cfs)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
12:00
24:00
36:00
48:00
60:00
72:00
84:00
From Aug 25 to Aug 28 (Hours)



Little Sugar Creek @ Pineville (DA - 48.99 sq. mi)
Gage
HEC-HMS-2008
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Flow (cfs)
12:00
24:00
36:00
48:00
60:00
72:00
84:00
From Aug 25 to Aug 28 (Hours)


Briar Creek @ Shamrock Drive (DA - 6.02 sq. mi)
Gage
HEC-HMS-2008
Flow (cfs)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
12:00
24:00
36:00
48:00
60:00
72:00
84:00
From Aug 25 to Aug 28 (Hours)

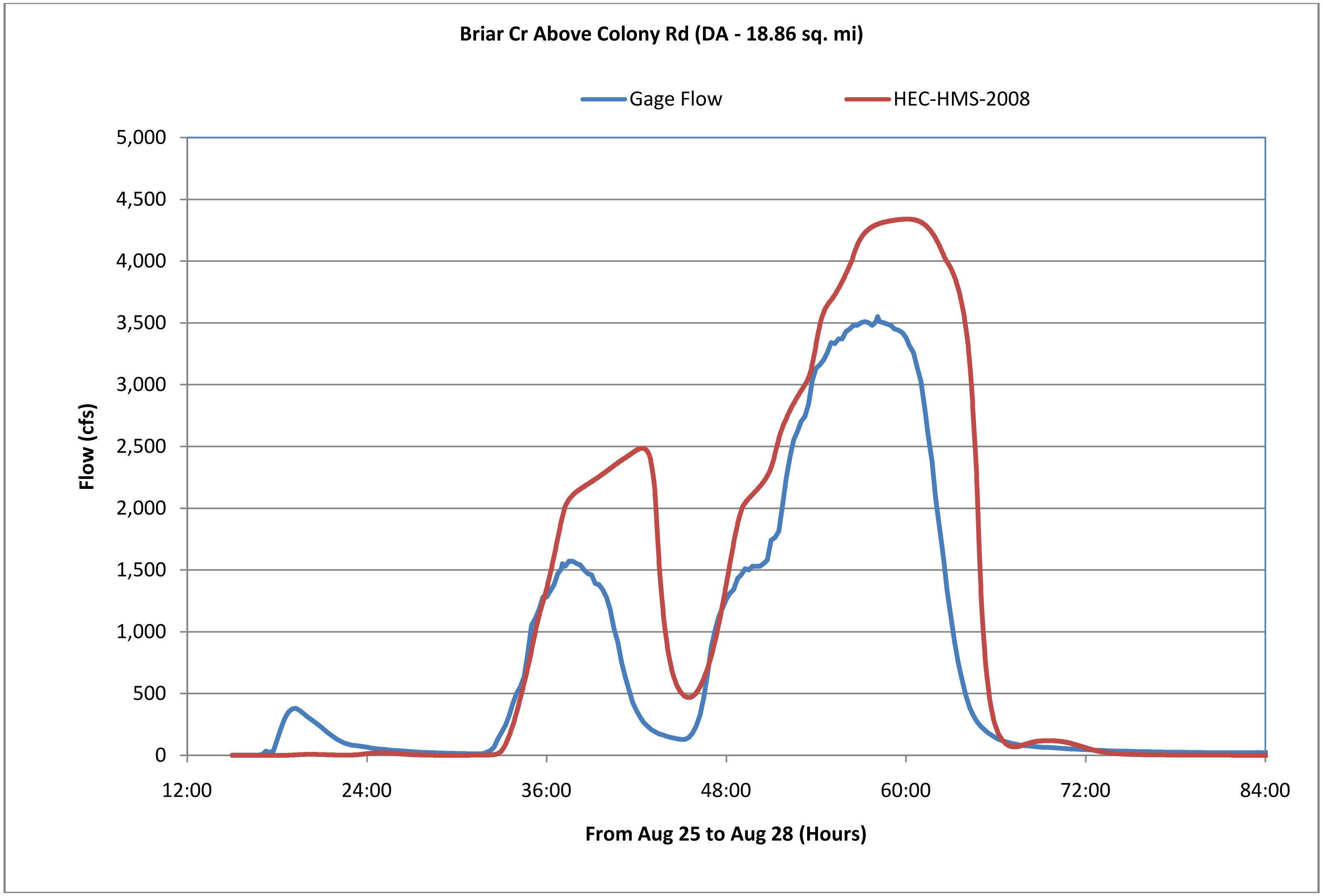


Figure 2. Hydrograph Comparison of Aug 2008 event with HEC-HMS model results (Lag time = 1.8 Tc, Ia = 0.7 inches)

Table 8. 100-Year and Aug 27 2008 Event Comparison

Station Number	Station Name	HEC-HMS Element	Drainage Area	Peak Flow (cfs)		% Diff
			(sq. miles)	100 Year	Aug-08	Flow
214643820	Edwards Branch @ Sheffield Drive	J_BC_225	1.0	1234	896.1	27
214642825	Briar Creek @ Shamrock Drive	J_BC_50	6.0	4909.1	3784.2	23
214640410	Little Sugar Creek @ 36th Street	J_ULS_34	5.2	3927.1	3051.4	22
2146470	Little Hope Creek at Seneca Place	J_LLS_130	3.0	3170.5	1475.5	53
2146409	Little Sugar Creek @ Medical Center Dr	J_ULS_256	12.0	5871.9	4210.9	28
214645022	Briar Creek Above Colony Road	J_BC_179	18.9	4531	4339.1	4
2146507	Little Sugar Creek @ Archdale Drive	J_LLS_139	42.4	13851.4	11692.3	16
2146530	Little Sugar Creek @ Pineville	J_LLS_157	49.0	13635.1	11879.5	13
214643860	Briar Creek Below Edwards Branch	J_BC_2	14.5	4313.5	4350.6	-1
2146449	Briar Creek @ Providence Road	J_BC_232	18.0	4490.4	4342.3	3
2146420	Little Sugar Creek @ Hillside Avenue	J_ULS_403	15.1	7133.3	4925.7	31

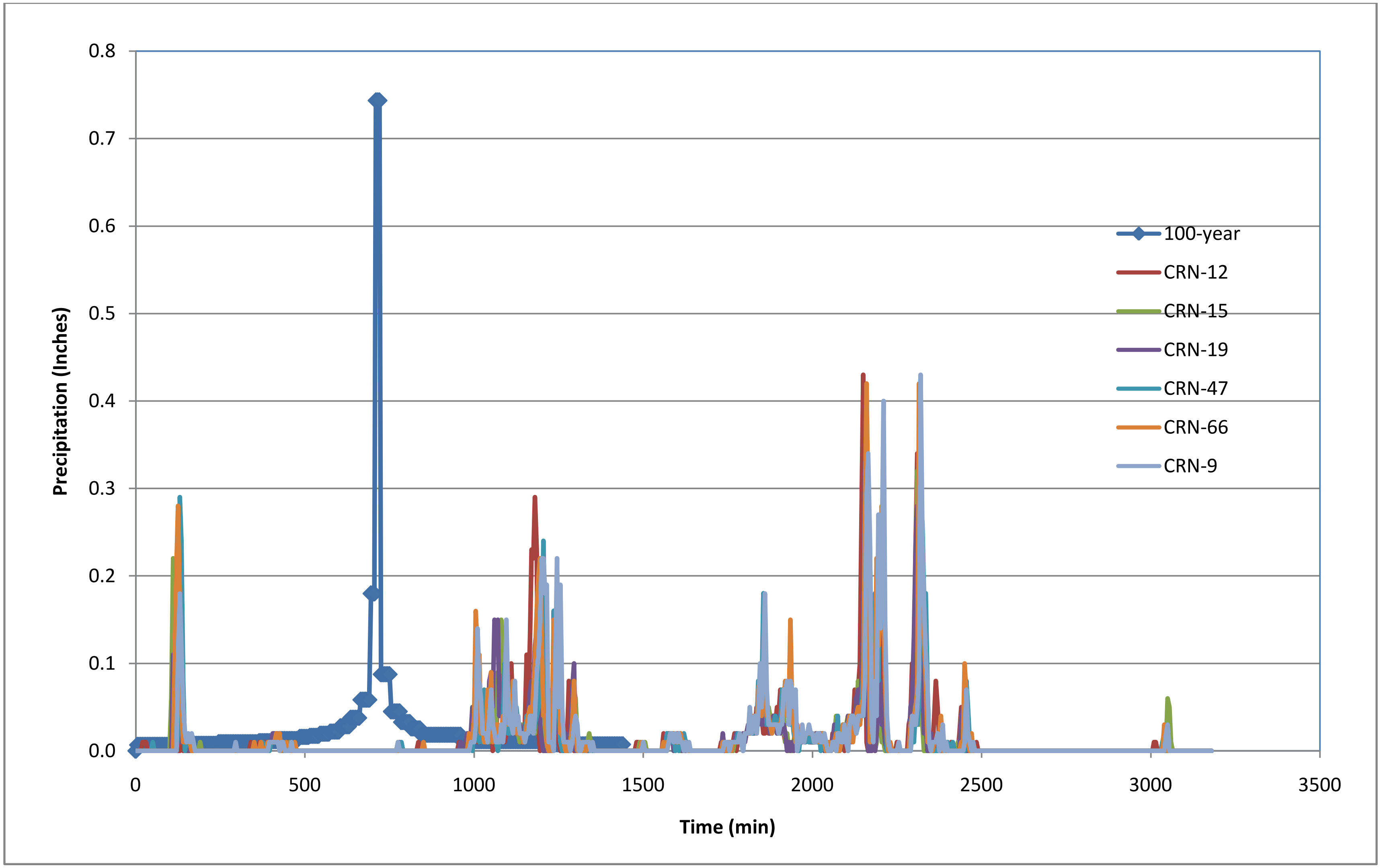
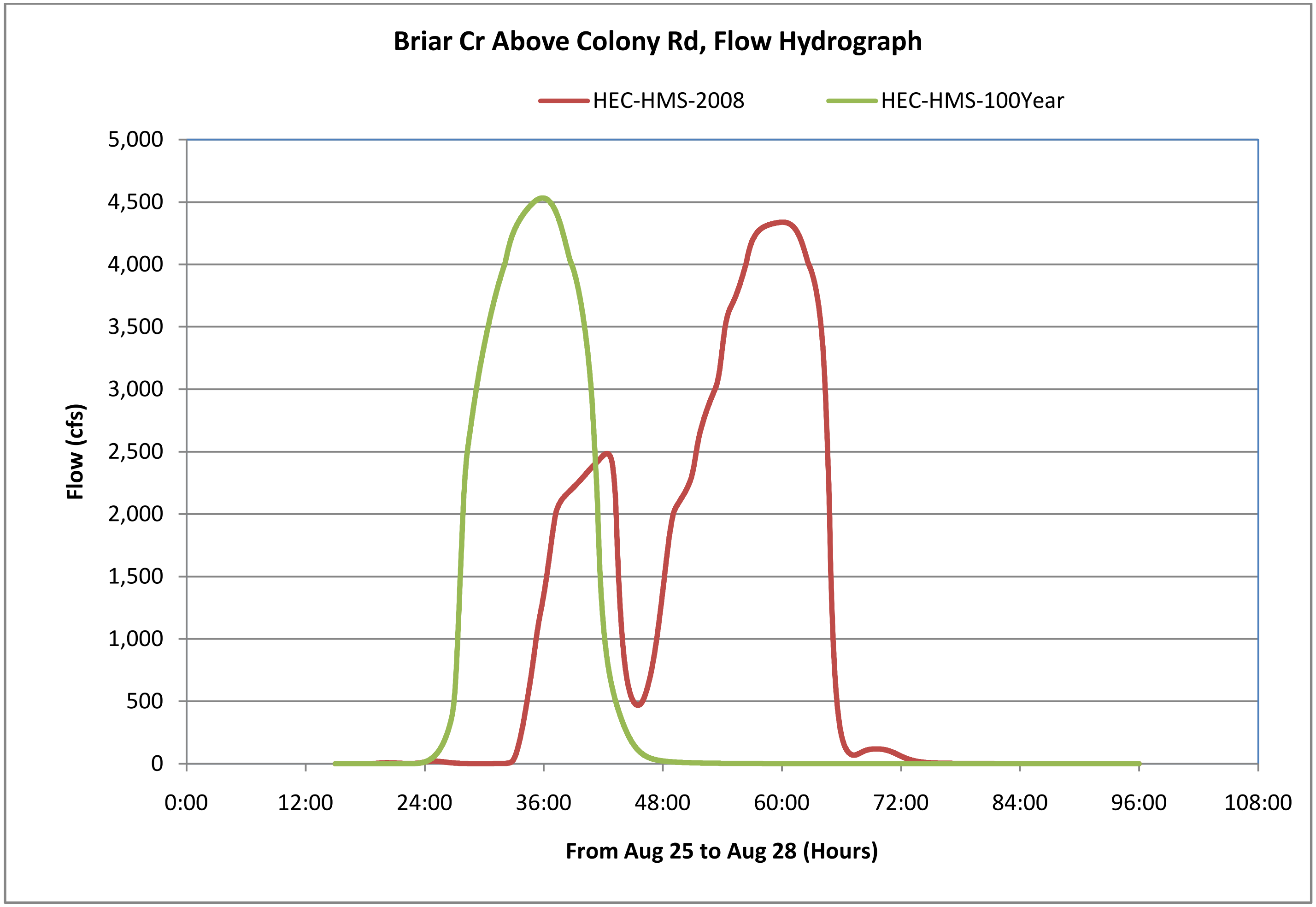


Figure 3. Hyetograph Comparison – 100 Year vs Aug 25-28 2008 Event



Briar Cr Above Colony Rd, Flow Hydrograph
HEC-HMS-2008
HEC-HMS-100Year
Flow (cfs)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0:00
12:00
24:00
36:00
48:00
60:00
72:00
84:00
96:00
108:00
From Aug 25 to Aug 28 (Hours)

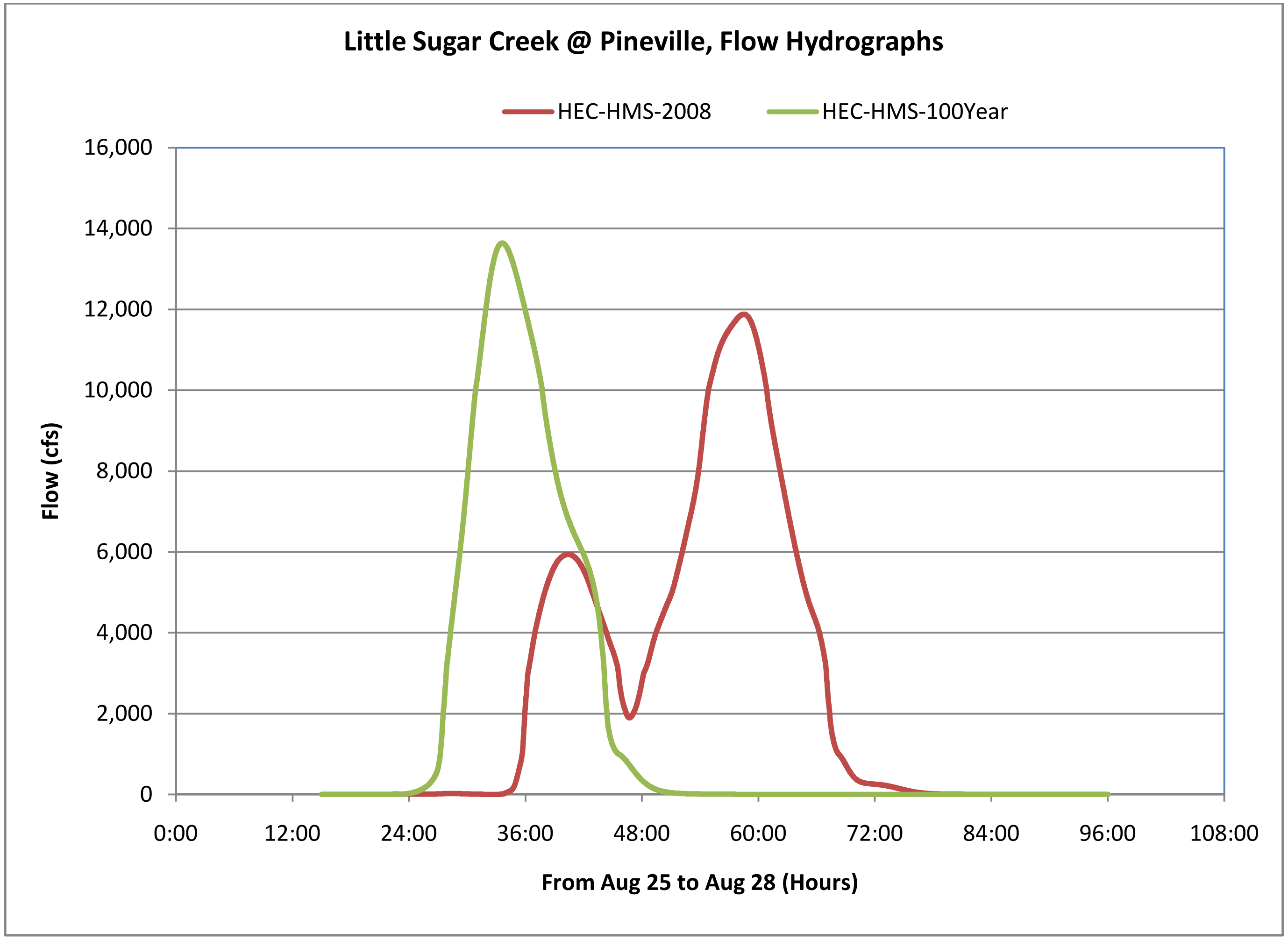


Figure 4. Hydrograph Comparison – 100 Year vs Aug 25-28 2008 Event

Table 9. Calibration results - March 01, 2007 Event (Scenario B)

Station Number	Station Name	Gage Drainage Area (sq.miles)	Model Drainage Area (sq.miles)	Gage Data		Model (HEC-HMS)		Percent Difference	
				Peak Flow (cfs)	Time to Peak (hrs)	Peak Flow (cfs)	Time to Peak (hrs)	Flow	DA
214643820	Edwards Branch @ Sheffield Drive	1.0	1.0	220	26:00:00	191	25:03:00	-13	-3
214642825	Briar Creek @ Shamrock Drive	5.2	6.0	1160	26:15:00	945	26:04:00	-19	16
214640410	Little Sugar Creek @ 36th Street	3.4	5.2	-	27:00:00	896	25:47:00	-	53
2146470	Little Hope Creek at Seneca Place	2.6	3.0	-	24:30:00	531	25:20:00	-	13
2146409	Little Sugar Creek @ Medical Center Dr	11.8	12.0	2410	23:20:00	1981	26:32:00	-18	1
214645022	Briar Creek Above Colony Road	19.0	18.9	2600	27:30:00	2076	28:48:00	-20	-1
2146507	Little Sugar Creek @ Archdale Drive	42.6	42.4	7480	26:30:00	5153	27:24:00	-31	0
2146530	Little Sugar Creek @ Pineville	49.2	49.0	4910	29:30:00	5203	29:40:00	6	0
214643860	Briar Creek Below Edwards Branch	14.2	14.5	-	26:30:00	1874	27:31:00	-	2
2146449	Briar Creek @ Providence Road	17.6	18.0	-	26:40:00	2102	27:23:00	-	2
2146420	Little Sugar Creek @ Hillside Avenue	15.0	15.1	-	27:00:00	2347	27:01:00	-	0

Table 10. Calibration results – September 13, 2006 Event (Scenario C)

Station Number	Station Name	Gage Drainage Area (sq.miles)	Model Drainage Area (sq.miles)	Gage Data		Model (HEC-HMS)		Percent Difference	
				Peak Flow (cfs)	Time to Peak (hrs)	Peak Flow (cfs)	Time to Peak (hrs)	Flow	DA
214643820	Edwards Branch @ Sheffield Drive	1.0	1.0	100	23:18	109	24:01:00	9	-3
214642825	Briar Creek @ Shamrock Drive	5.2	6.0	379	24:30:00	533	24:52:00	41	16
214640410	Little Sugar Creek @ 36th Street	3.4	5.2	-	24:12:00	522	24:37:00	-	53
2146470	Little Hope Creek at Seneca Place	2.6	3.0	262	23:36	309	24:19:00	18	13
2146409	Little Sugar Creek @ Medical Center Dr	11.8	12.0	1240	23:24	1012	24:08:00	-18	1
214645022	Briar Creek Above Colony Road	19.0	18.9	1040	25:00:00	1218	26:19:00	17	-1
2146507	Little Sugar Creek @ Archdale Drive	42.6	42.4	3650	24:24:00	2924	25:10:00	-20	0
2146530	Little Sugar Creek @ Pineville	49.2	49.0	2920	25:18:00	3150	26:55:00	8	0
214643860	Briar Creek Below Edwards Branch	14.2	14.5	-	24:12:00	1017	25:13:00	-	2
2146449	Briar Creek @ Providence Road	17.6	18.0	-	24:30:00	1217	25:42:00	-	2
2146420	Little Sugar Creek @ Hillside Avenue	15.0	15.1	-	24:00:00	1272	24:43:00	-	0

2.3 Results and Comparisons

Model comparison refers to comparing the results of a given study to previous/parallel studies and/or known results (e.g. gage data). This is often done to ensure that model results are reasonable and/or representative of known conditions. Differences in model results do not necessarily indicate that a given model is incorrect, especially for hydrologic modeling, where there are many variables (e.g. scale of study, model, design precipitation, storm event, etc.) and inherent assumptions.

The effective study was used for the model comparison to create the flow comparisons. The comparison of 1% annual chance existing and future conditions discharges from calibrated HEC-HMS model with the effective discharges is shown in the Table 11 below. Also, Table 12 shows the summary of discharges obtained from calibrated HEC-HMS model.

The comparisons of HEC-HMS model with effective discharges generally show that flows determined from this study are approximately 20-30% lower than the flows found in the previous studies. Significant effort was made in the development of this model to correctly account for channel and basin storage, further attention will be given during HEC-RAS calibration processes.

Table 11. Comparison of HEC-HMS Discharges with Effective Discharges

Stream	Flow Change Location	Drainage Area (sq. mi.)		Existing Peak Discharges (cfs)		New Peak Discharges (cfs)		Percent Difference		
		Effective Study	New Study	1%	1% Fut.	1%	1% Fut.	1%	1% Fut.	DA
Briar Creek	At Confluence with Little Sugar Creek	21.6	21.6	5326	8760	4691	4846	-12	-45	0
	Approx. 900 ft. upstream of Bramlet Rd.	11.5	14.2	4642	5807	5856	6176	26	6	24
	Approx. 400 ft. upstream of Commonwealth Avenue	9.9	11.2	5396	7212	4698	4960	-13	-31	13
	Approx. 2500 ft. downstream of Country Club Drive	8.1	9.0	6393	8060	6122	6741	-4	-16	11
	Approx. 1500 ft. downstream of Country Club Drive	7.5	8.1	6292	7918	5725	6312	-9	-20	8
	Approx. 100 ft. upstream of Eastway Drive	6.0	6.9	6270	7562	5265	5774	-16	-24	15
	Approx. 100 ft. upstream of Shamrock Drive	5.2	6.0	5810	6953	4909	5377	-16	-23	15
	Approx. 2500 ft. downstream of Shannonhouse Dr	3.8	4.9	4340	5155	4508	4939	4	-4	28
	Approx. 1400 ft. downstream of Shannonhouse Dr	1.9	3.8	2331	2636	3748	4037	61	53	103
	Approx. 200 ft. upstream of Plaza Road	1.1	1.5	1778	2023	1955	2117	10	5	35
Briar Creek Tributary 1	At Confluence with Briar Creek	1.3	1.2	1924	2077	1174	1253	-39	-40	-7
Briar Creek Tributary 2	At Confluence with Briar Creek	1.9	1.7	2761	3459	1541	1655	-44	-52	-9
	Approx. 200 ft. downstream of Galway Drive	0.7	1.7	1249	1447	1717	1852	38	28	151
Dairy Branch	At Confluence with Little Sugar Creek	1.1	1.1	2029	2099	1414	1520	-30	-28	-1
Derita Branch	At Confluence with Little Sugar Creek	2.2	2.1	2367	2658	1781	1986	-25	-25	-7
	Approx. 2200 ft. downstream of West Craighead Rd	1.7	1.7	1898	2163	1591	1755	-16	-19	-1
	Approx. 100 ft. downstream of West Craighead Road	1.4	1.2	1635	1898	1175	1334	-28	-30	-12
	Approx. 900 ft. upstream of West Craighead Road	1.1	0.9	1340	1556	916	1074	-32	-31	-15
	Approx. 2400 ft. upstream of West Craighead Road	0.9	0.9	1150	1315	878	1032	-24	-22	-1
Edwards Branch	At Confluence with Briar Creek	2.8	2.6	2232	3107	2136	2384	-4	-23	-7
	Approx. 500 ft. upstream of Eastway Road	1.9	1.9	2009	3030	1865	2022	-7	-33	1
	Approx. 1800 ft. upstream of Eastway Road	1.2	1.2	1471	2522	1157	1265	-21	-50	-3
	Approx. 500 ft. downstream of Sheffield Drive	1.0	1.2	2213	--	1157	1265	-48	--	19

Little Hope Creek	At Confluence with Little Sugar Creek	3.2	3.0	3929	4131	3137	3297	-20	-20	-5
	Approx. 1300 ft. downstream of Seneca Place	2.7	3.0	3712	3906	3171	3338	-15	-15	11
	Approx. 100 ft. downstream of Mockingbird Lane	1.2	2.6	1688	1865	3001	3155	78	69	108
Little Hope Creek Tributary 1	At Confluence with Little Hope Creek	1.4	1.2	2285	2348	1683	1752	-26	-25	-8
	Approx. 100 ft. downstream of Bradbury Drive	0.6	1.2	1138	1176	1753	1828	54	55	113
Little Sugar Creek	Approx. 16000 ft. downstream of South Polk Street	50.8	50.6	13208	14162	12849	13368	-3	-6	-1
	Approx. 2000 ft. downstream of Princeton Avenue	14.2	15.0	7077	7609	7138	7443	1	-2	6
	Approx. 100 ft. downstream of Access Road	11.2	11.7	6729	7023	5597	5876	-17	-16	5
	Approx. 300 ft. downstream of Independence Boulevard	9.6	9.2	5659	6063	4130	4233	-27	-30	-4
	Approx. 700 ft. downstream of Belmont Avenue	9.0	8.6	4950	5264	4044	4196	-18	-20	-4
	Approx. 850 ft. upstream of Brevard Street	6.8	7.1	2988	3100	3411	3655	14	18	4
	Approx. 1100 ft. downstream of E. 36th Street	5.7	5.2	2681	3077	3927	4218	46	37	-7
	Approx. 1200 ft. upstream of E. 36th Street	3.2	2.9	2044	2238	2611	2805	28	25	-9
	Approx. 850 ft. downstream of N. Tryon Street	2.4	2.1	2036	2242	1899	2076	-7	-7	-13
	Approx. 950 ft. upstream of N. Tryon Street	1.8	1.6	1664	1824	1664	1851	0	2	-13
	Approx. 3000 ft. upstream of N. Tryon Street	1.0	1.1	1131	1329	1240	1376	10	4	10

Table 12. Summary of Discharges from HEC-HMS Model

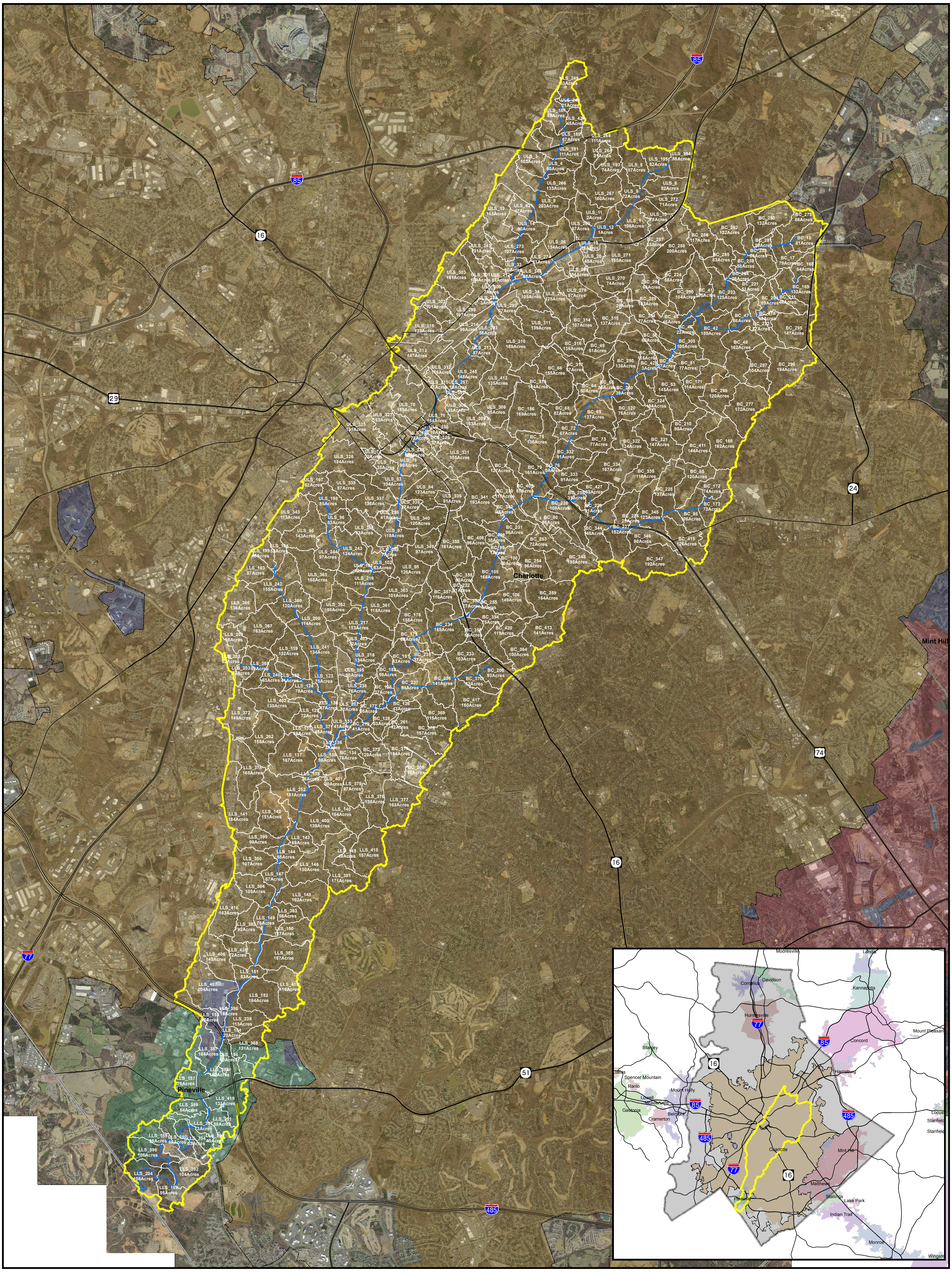
Stream	Drainage Area	Existing Conditions Peak Flow (cfs)						Future Conditions Peak Flows (cfs)					
	Sq. Miles	2 Yr	10 Yr	25 yr	50 Yr	100 Yr	500 Yr	2 Yr	10 Yr	25 yr	50 Yr	100 Yr	500 Yr
Briar Creek	0.4	118	286	385	464	547	754	135	315	418	499	583	792
	1.0	294	701	940	1129	1328	1822	358	802	1050	1244	1445	1943
	1.5	433	1033	1384	1663	1955	2684	519	1169	1535	1821	2117	2840
	1.7	431	1032	1385	1666	1961	2783	513	1163	1531	1820	2119	2969
	3.8	811	1955	2634	3178	3748	5211	950	2183	2894	3453	4037	5539
	4.9	982	2358	3168	3822	4508	6251	1194	2700	3559	4236	4939	6728
	6.0	1090	2609	3473	4152	4909	6775	1335	2982	3879	4605	5377	7290
	6.9	1173	2742	3640	4386	5265	7324	1429	3121	4062	4920	5774	7879
	7.4	1221	2834	3756	4546	5465	7650	1485	3221	4212	5099	6014	8274
	8.1	1280	2963	3924	4757	5725	8066	1556	3364	4402	5338	6312	8714
	9.0	1373	3145	4153	5074	6122	8661	1657	3551	4673	5687	6741	9326
	9.8	1409	3212	4219	5059	6054	7730	1694	3613	4671	5623	6446	8205
	10.0	1411	3191	4169	4933	5848	7227	1694	3585	4574	5443	6202	7608
	11.2	1410	2928	3795	4257	4698	5860	1676	3245	4089	4479	4960	6086
	14.2	1692	3586	4363	5092	5856	7536	1999	3827	4708	5489	6176	7943
	14.7	1670	3013	3617	3983	4329	5030	1884	3229	3778	4152	4486	5162
	15.2	1696	3046	3657	4024	4374	5082	1912	3263	3818	4194	4531	5215
	16.1	1742	3080	3700	4066	4419	5143	1961	3293	3863	4232	4577	5275
	17.2	1794	3091	3723	4102	4459	5202	2014	3299	3892	4266	4617	5333
	18.0	1827	3096	3732	4124	4490	5244	2045	3301	3905	4292	4648	5375
	18.5	1821	3081	3718	4137	4513	5274	2037	3283	3894	4311	4670	5406
	18.9	1830	3092	3731	4153	4531	5297	2046	3294	3908	4327	4688	5429
	18.9	1832	3094	3734	4156	4534	5301	2047	3296	3910	4330	4691	5433
	19.1	1837	3102	3742	4166	4546	5316	2053	3304	3919	4340	4703	5447
	21.2	1916	3191	3844	4282	4672	6040	2131	3392	4020	4457	4827	6308
	21.6	1925	3204	3858	4297	4691	6175	2143	3404	4033	4473	4846	6449
	21.6	1925	3203	3858	4297	4691	6170	2142	3404	4033	4473	4846	6444

Briar Creek Trib 1	0.7	183	451	613	742	879	1225	205	491	659	792	933	1283
	1.2	302	670	855	1011	1198	1818	331	704	899	1058	1283	1905
	1.2	298	663	846	999	1174	1776	326	697	889	1045	1253	1861
Briar Creek Trib 2	0.4	93	222	298	358	422	579	106	244	323	384	449	608
	0.9	231	550	737	884	1039	1416	265	606	800	951	1109	1489
	1.7	382	908	1216	1461	1717	2387	445	1010	1330	1581	1852	2519
	1.7	339	807	1086	1309	1541	2159	394	898	1190	1418	1655	2293
Dairy Branch	0.2	92	217	290	348	409	560	119	257	333	392	454	605
	0.7	223	531	711	854	1003	1376	266	600	787	933	1085	1457
	0.9	269	638	845	1013	1189	1657	317	708	926	1099	1287	1747
	1.1	318	761	1012	1214	1415	1952	370	842	1105	1305	1521	2054
	1.1	315	758	1010	1213	1414	1951	367	839	1104	1304	1520	2044
Derita Branch	0.2	25	59	80	96	113	157	39	81	104	121	139	184
	0.4	89	217	294	355	420	583	136	292	378	444	512	679
	0.9	194	463	621	746	878	1204	278	593	764	896	1032	1361
	0.9	202	482	647	779	916	1261	287	614	793	931	1074	1423
	1.2	264	625	834	1000	1175	1609	349	756	980	1154	1334	1773
	1.7	378	873	1144	1358	1591	2163	467	1002	1289	1519	1755	2340
	2.1	437	856	1099	1477	1788	2532	527	958	1356	1669	1994	2725
	2.1	436	855	1097	1466	1781	2527	526	957	1345	1663	1986	2720
Edward Branch	0.2	72	163	214	253	294	395	80	174	226	266	307	407
	0.6	175	413	552	662	777	1063	202	459	604	716	833	1122
	1.0	269	645	869	1047	1234	1702	317	731	969	1155	1349	1828
	1.2	261	625	822	984	1157	1580	309	702	916	1088	1265	1702
	1.9	429	1048	1349	1609	1865	2525	509	1169	1493	1753	2022	2710
	2.1	484	1188	1531	1807	2097	2815	582	1345	1704	1981	2283	3049
	2.4	500	1177	1522	1777	2063	2919	605	1328	1674	1942	2306	3170
	2.6	518	1237	1589	1847	2136	3032	631	1386	1738	2010	2384	3279
	2.6	518	1237	1589	1847	2136	3032	631	1386	1738	2010	2384	3279

Little Hope Creek	0.3	78	178	235	280	327	443	92	200	259	305	352	468
	0.5	132	315	422	507	596	820	151	344	455	542	633	857
	1.1	253	618	836	1010	1193	1676	290	684	911	1091	1279	1770
	2.6	684	1619	2155	2583	3001	4105	763	1749	2301	2730	3155	4276
	3.0	728	1735	2309	2725	3171	4456	813	1879	2450	2884	3338	4661
	3.0	723	1725	2296	2710	3137	4366	809	1870	2439	2870	3297	4569
	3.0	723	1725	2296	2710	3137	4364	808	1870	2439	2870	3297	4568
Little Hope Creek Trib 1	0.3	107	231	299	351	405	539	120	248	316	368	422	554
	0.4	146	331	436	518	605	818	163	356	464	548	635	848
	1.2	410	948	1258	1502	1753	2385	451	1011	1328	1573	1828	2463
	1.2	399	936	1225	1460	1683	2276	439	998	1291	1524	1752	2350
Little Sugar Creek	0.3	102	220	285	336	388	517	112	232	298	348	401	530
	0.9	253	587	781	935	1097	1500	303	667	871	1030	1195	1603
	1.6	369	881	1184	1420	1664	2310	457	1027	1350	1586	1851	2507
	2.1	469	1107	1425	1652	1899	2554	574	1280	1570	1812	2076	2700
	2.3	509	1197	1546	1781	2042	2738	622	1383	1693	1948	2228	2907
	2.5	562	1312	1706	1965	2241	2958	695	1522	1877	2153	2426	3153
	2.9	649	1518	1985	2298	2611	3423	795	1748	2180	2491	2805	3603
	5.2	1128	2248	2879	3443	3927	5032	1365	2523	3245	3756	4218	5314
	6.4	1209	2079	2528	2892	3295	4304	1325	2258	2726	3104	3532	4590
	7.1	1285	2173	2632	3009	3411	4413	1404	2348	2829	3209	3655	4673
	7.3	1286	2188	2650	3029	3425	4396	1410	2361	2845	3223	3666	4633
	8.6	1463	2611	3154	3598	4044	5040	1603	2740	3315	3768	4196	5200
	9.2	1498	2688	3241	3691	4130	5045	1640	2827	3397	3861	4233	5163
	9.6	1546	2831	3425	3898	4374	5270	1691	2977	3574	4061	4468	5406
	10.8	1654	3088	3757	4262	4763	6227	1813	3259	3912	4435	4992	6488
	11.7	1737	3313	4109	4846	5597	7466	1904	3484	4374	5122	5876	7749
	12.0	1757	3387	4321	5078	5872	7836	1925	3630	4580	5361	6160	8130
	12.5	1804	3603	4623	5386	6134	8098	1976	3879	4869	5626	6416	8389
	13.8	1927	4270	5481	6335	7207	9416	2117	4588	5785	6644	7539	9783

	14.2	1950	4320	5498	6338	7196	9380	2148	4633	5789	6641	7522	9732
	14.8	2010	4575	5808	6693	7602	9926	2219	4906	6111	7012	7946	10299
	15.0	2019	4371	5502	6304	7138	9216	2229	4651	5771	6594	7443	9543
	15.3	2042	4388	5464	6233	7041	9041	2256	4659	5719	6512	7332	9353
	15.4	2050	4404	5481	6251	7061	9067	2266	4676	5736	6531	7352	9379
	15.6	2068	4434	5510	6278	7088	9094	2285	4701	5762	6556	7377	9404
	40.5	3874	7940	9868	11251	12672	16308	4265	8451	10300	11763	13226	16929
	41.4	3921	8168	10219	11668	13194	17126	4321	8706	10701	12241	13801	17830
	42.4	4007	8466	10658	12218	13851	18034	4413	9020	11182	12817	14487	18779
	43.8	4085	8752	11054	12708	14436	18954	4505	9342	11641	13356	15127	19771
	45.4	4149	8943	11207	12839	14564	19133	4574	9547	11779	13473	15247	19946
	46.2	4210	9061	11250	12826	14505	18773	4639	9668	11792	13431	15165	19535
	47.3	4232	8746	10990	12504	14107	18252	4662	9307	11507	13068	14721	18970
	48.5	4267	8688	10935	12452	14045	18257	4699	9237	11455	13010	14649	18975
	49.0	4255	8488	10622	12108	13635	17909	4680	9013	11130	12639	14206	18629
	49.6	4264	8480	10588	12072	13593	17604	4689	9002	11091	12600	14159	18308
	50.6	4042	7794	9837	11393	12849	16597	4441	8258	10391	11903	13368	17274

Appendix A1 - Subbasin Delineation Map



Legend

- Major Roads
- Streams
- Subbasins
- City Limits
- County Limits

Mecklenburg County (Little Sugar Creek & Briar Creek Subbasins) - Subbasins

CHARLOTTE.

Dewberry®

N W E S

3,000 1,500 0 3,000 6,000 Feet

Appendix A2- Subbasin Drainage Area Table

Stream	Subbasin ID	Drainage Area	
		Acres	Sq. Miles
Briar Creek	BC_2	127	0.20
Briar Creek	BC_16	81	0.13
Briar Creek	BC_17	79	0.12
Briar Creek	BC_41	125	0.20
Briar Creek	BC_42	159	0.25
Briar Creek	BC_45	46	0.07
Briar Creek	BC_46	22	0.03
Briar Creek	BC_47	66	0.10
Briar Creek	BC_48	162	0.25
Briar Creek	BC_49	51	0.08
Briar Creek	BC_50	80	0.12
Briar Creek	BC_51	77	0.12
Briar Creek	BC_52	27	0.04
Briar Creek	BC_53	145	0.23
Briar Creek	BC_64	50	0.08
Briar Creek	BC_65	56	0.09
Briar Creek	BC_66	155	0.24
Briar Creek	BC_68	82	0.13
Briar Creek	BC_69	137	0.21
Briar Creek	BC_72	67	0.11
Briar Creek	BC_73	77	0.12
Briar Creek	BC_75	136	0.21
Briar Creek	BC_76	0	0.00
Briar Creek	BC_79	161	0.25
Briar Creek	BC_80	94	0.15
Briar Creek	BC_85	120	0.19
Briar Creek	BC_86	106	0.17
Briar Creek	BC_99	1	0.00
Briar Creek	BC_100	60	0.09
Briar Creek	BC_105	168	0.26
Briar Creek	BC_106	149	0.23
Briar Creek	BC_125	37	0.06
Briar Creek	BC_126	43	0.07
Briar Creek	BC_127	5	0.01
Briar Creek	BC_128	53	0.08
Briar Creek	BC_134	76	0.12
Briar Creek	BC_168	54	0.08
Briar Creek	BC_169	132	0.21
Briar Creek	BC_171	114	0.18

Briar Creek	BC_172	74	0.12
Briar Creek	BC_173	73	0.11
Briar Creek	BC_177	55	0.09
Briar Creek	BC_178	156	0.24
Briar Creek	BC_179	60	0.09
Briar Creek	BC_181	82	0.13
Briar Creek	BC_182	59	0.09
Briar Creek	BC_185	29	0.05
Briar Creek	BC_186	169	0.26
Briar Creek	BC_188	162	0.25
Briar Creek	BC_206	93	0.14
Briar Creek	BC_208	71	0.11
Briar Creek	BC_209	31	0.05
Briar Creek	BC_210	80	0.13
Briar Creek	BC_211	48	0.07
Briar Creek	BC_219	41	0.06
Briar Creek	BC_221	51	0.08
Briar Creek	BC_222	77	0.12
Briar Creek	BC_223	125	0.20
Briar Creek	BC_224	58	0.09
Briar Creek	BC_225	137	0.21
Briar Creek	BC_226	25	0.04
Briar Creek	BC_227	152	0.24
Briar Creek	BC_228	108	0.17
Briar Creek	BC_229	91	0.14
Briar Creek	BC_230	117	0.18
Briar Creek	BC_231	96	0.15
Briar Creek	BC_232	31	0.05
Briar Creek	BC_233	103	0.16
Briar Creek	BC_234	165	0.26
Briar Creek	BC_235	37	0.06
Briar Creek	BC_236	141	0.22
Briar Creek	BC_237	94	0.15
Briar Creek	BC_250	136	0.21
Briar Creek	BC_253	72	0.11
Briar Creek	BC_254	96	0.15
Briar Creek	BC_255	5	0.01
Briar Creek	BC_259	58	0.09
Briar Creek	BC_260	39	0.06
Briar Creek	BC_261	12	0.02
Briar Creek	BC_277	172	0.27

Briar Creek	BC_278	19	0.03
Briar Creek	BC_279	88	0.14
Briar Creek	BC_280	132	0.21
Briar Creek	BC_281	29	0.05
Briar Creek	BC_282	122	0.19
Briar Creek	BC_283	85	0.13
Briar Creek	BC_284	26	0.04
Briar Creek	BC_285	83	0.13
Briar Creek	BC_286	117	0.18
Briar Creek	BC_287	53	0.08
Briar Creek	BC_288	200	0.31
Briar Creek	BC_289	103	0.16
Briar Creek	BC_290	104	0.16
Briar Creek	BC_291	68	0.11
Briar Creek	BC_294	89	0.14
Briar Creek	BC_295	147	0.23
Briar Creek	BC_296	194	0.30
Briar Creek	BC_297	104	0.16
Briar Creek	BC_298	120	0.19
Briar Creek	BC_304	77	0.12
Briar Creek	BC_305	105	0.16
Briar Creek	BC_314	107	0.17
Briar Creek	BC_315	137	0.21
Briar Creek	BC_316	136	0.21
Briar Creek	BC_317	57	0.09
Briar Creek	BC_319	104	0.16
Briar Creek	BC_320	76	0.12
Briar Creek	BC_321	147	0.23
Briar Creek	BC_322	124	0.19
Briar Creek	BC_323	115	0.18
Briar Creek	BC_324	104	0.16
Briar Creek	BC_332	91	0.14
Briar Creek	BC_333	91	0.14
Briar Creek	BC_334	167	0.26
Briar Creek	BC_335	118	0.18
Briar Creek	BC_341	193	0.30
Briar Creek	BC_342	45	0.07
Briar Creek	BC_344	148	0.23
Briar Creek	BC_345	123	0.19
Briar Creek	BC_346	80	0.12
Briar Creek	BC_347	192	0.30

Briar Creek	BC_348	195	0.30
Briar Creek	BC_353	27	0.04
Briar Creek	BC_354	75	0.12
Briar Creek	BC_355	80	0.12
Briar Creek	BC_356	66	0.10
Briar Creek	BC_357	116	0.18
Briar Creek	BC_358	161	0.25
Briar Creek	BC_359	164	0.26
Briar Creek	BC_364	100	0.16
Briar Creek	BC_369	115	0.18
Briar Creek	BC_370	62	0.10
Briar Creek	BC_373	129	0.20
Briar Creek	BC_374	184	0.29
Briar Creek	BC_375	157	0.25
Briar Creek	BC_405	85	0.13
Briar Creek	BC_408	98	0.15
Briar Creek	BC_409	38	0.06
Briar Creek	BC_411	144	0.22
Briar Creek	BC_413	141	0.22
Briar Creek	BC_415	126	0.20
Briar Creek	BC_417	160	0.25
Briar Creek	BC_420	119	0.19
Briar Creek	BC_425	3	0.00
Briar Creek	BC_427	53	0.08
Upper Little Sugar Creek	ULS_1	106	0.17
Upper Little Sugar Creek	ULS_3	103	0.16
Upper Little Sugar Creek	ULS_4	60	0.09
Upper Little Sugar Creek	ULS_5	107	0.17
Upper Little Sugar Creek	ULS_6	82	0.13
Upper Little Sugar Creek	ULS_8	203	0.32
Upper Little Sugar Creek	ULS_9	72	0.11
Upper Little Sugar Creek	ULS_10	78	0.12
Upper Little Sugar Creek	ULS_11	2	0.12
Upper Little Sugar Creek	ULS_12	1	0.15
Upper Little Sugar Creek	ULS_13	155	0.24
Upper Little Sugar Creek	ULS_14	90	0.14
Upper Little Sugar Creek	ULS_19	23	0.04
Upper Little Sugar Creek	ULS_20	45	0.07
Upper Little Sugar Creek	ULS_26	134	0.21
Upper Little Sugar Creek	ULS_33	10	0.02
Upper Little Sugar Creek	ULS_34	105	0.16

Upper Little Sugar Creek	ULS_70	158	0.25
Upper Little Sugar Creek	ULS_71	164	0.26
Upper Little Sugar Creek	ULS_74	22	0.03
Upper Little Sugar Creek	ULS_77	35	0.05
Upper Little Sugar Creek	ULS_78	90	0.14
Upper Little Sugar Creek	ULS_83	104	0.16
Upper Little Sugar Creek	ULS_84	123	0.19
Upper Little Sugar Creek	ULS_95	143	0.22
Upper Little Sugar Creek	ULS_96	53	0.08
Upper Little Sugar Creek	ULS_97	118	0.18
Upper Little Sugar Creek	ULS_98	126	0.20
Upper Little Sugar Creek	ULS_101	12	0.02
Upper Little Sugar Creek	ULS_102	63	0.10
Upper Little Sugar Creek	ULS_133	41	0.06
Upper Little Sugar Creek	ULS_187	69	0.11
Upper Little Sugar Creek	ULS_189	67	0.11
Upper Little Sugar Creek	ULS_191	111	0.17
Upper Little Sugar Creek	ULS_193	74	0.12
Upper Little Sugar Creek	ULS_194	88	0.14
Upper Little Sugar Creek	ULS_195	82	0.13
Upper Little Sugar Creek	ULS_196	72	0.09
Upper Little Sugar Creek	ULS_197	62	0.10
Upper Little Sugar Creek	ULS_198	85	0.13
Upper Little Sugar Creek	ULS_207	71	0.11
Upper Little Sugar Creek	ULS_212	85	0.13
Upper Little Sugar Creek	ULS_213	57	0.09
Upper Little Sugar Creek	ULS_214	99	0.15
Upper Little Sugar Creek	ULS_215	41	0.06
Upper Little Sugar Creek	ULS_216	111	0.17
Upper Little Sugar Creek	ULS_217	153	0.24
Upper Little Sugar Creek	ULS_218	134	0.21
Upper Little Sugar Creek	ULS_238	76	0.12
Upper Little Sugar Creek	ULS_243	124	0.19
Upper Little Sugar Creek	ULS_244	97	0.15
Upper Little Sugar Creek	ULS_245	148	0.23
Upper Little Sugar Creek	ULS_246	38	0.06
Upper Little Sugar Creek	ULS_247	131	0.21
Upper Little Sugar Creek	ULS_248	21	0.03
Upper Little Sugar Creek	ULS_249	83	0.13
Upper Little Sugar Creek	ULS_256	41	0.06
Upper Little Sugar Creek	ULS_257	10	0.02

Upper Little Sugar Creek	ULS_258	3	0.01
Upper Little Sugar Creek	ULS_263	56	0.09
Upper Little Sugar Creek	ULS_264	31	0.05
Upper Little Sugar Creek	ULS_265	111	0.17
Upper Little Sugar Creek	ULS_266	133	0.21
Upper Little Sugar Creek	ULS_267	160	0.25
Upper Little Sugar Creek	ULS_268	87	0.13
Upper Little Sugar Creek	ULS_269	104	0.16
Upper Little Sugar Creek	ULS_270	74	0.12
Upper Little Sugar Creek	ULS_271	150	0.23
Upper Little Sugar Creek	ULS_272	71	0.11
Upper Little Sugar Creek	ULS_273	107	0.17
Upper Little Sugar Creek	ULS_274	61	0.10
Upper Little Sugar Creek	ULS_275	125	0.20
Upper Little Sugar Creek	ULS_276	97	0.15
Upper Little Sugar Creek	ULS_292	1	0.00
Upper Little Sugar Creek	ULS_293	67	0.10
Upper Little Sugar Creek	ULS_299	107	0.17
Upper Little Sugar Creek	ULS_300	7	0.01
Upper Little Sugar Creek	ULS_301	104	0.16
Upper Little Sugar Creek	ULS_302	101	0.16
Upper Little Sugar Creek	ULS_303	161	0.25
Upper Little Sugar Creek	ULS_306	45	0.07
Upper Little Sugar Creek	ULS_307	11	0.02
Upper Little Sugar Creek	ULS_308	95	0.15
Upper Little Sugar Creek	ULS_309	163	0.25
Upper Little Sugar Creek	ULS_310	189	0.30
Upper Little Sugar Creek	ULS_311	139	0.22
Upper Little Sugar Creek	ULS_312	116	0.18
Upper Little Sugar Creek	ULS_313	147	0.23
Upper Little Sugar Creek	ULS_318	123	0.19
Upper Little Sugar Creek	ULS_325	191	0.30
Upper Little Sugar Creek	ULS_326	194	0.30
Upper Little Sugar Creek	ULS_327	153	0.24
Upper Little Sugar Creek	ULS_328	100	0.16
Upper Little Sugar Creek	ULS_329	37	0.06
Upper Little Sugar Creek	ULS_330	10	0.03
Upper Little Sugar Creek	ULS_331	155	0.24
Upper Little Sugar Creek	ULS_336	81	0.13
Upper Little Sugar Creek	ULS_337	138	0.22
Upper Little Sugar Creek	ULS_338	27	0.04

Upper Little Sugar Creek	ULS_339	87	0.14
Upper Little Sugar Creek	ULS_340	120	0.19
Upper Little Sugar Creek	ULS_343	113	0.18
Upper Little Sugar Creek	ULS_349	97	0.15
Upper Little Sugar Creek	ULS_351	93	0.14
Upper Little Sugar Creek	ULS_352	7	0.01
Upper Little Sugar Creek	ULS_361	118	0.19
Upper Little Sugar Creek	ULS_362	95	0.15
Upper Little Sugar Creek	ULS_363	101	0.16
Upper Little Sugar Creek	ULS_365	168	0.26
Upper Little Sugar Creek	ULS_395	90	0.14
Upper Little Sugar Creek	ULS_403	32	0.05
Upper Little Sugar Creek	ULS_412	135	0.21
Upper Little Sugar Creek	ULS_421	47	0.07
Upper Little Sugar Creek	ULS_424	45	0.07
Lower Little Sugar	LLS_103	87	0.14
Lower Little Sugar	LLS_104	52	0.08
Lower Little Sugar	LLS_119	132	0.21
Lower Little Sugar	LLS_120	41	0.06
Lower Little Sugar	LLS_123	75	0.12
Lower Little Sugar	LLS_124	78	0.12
Lower Little Sugar	LLS_129	72	0.11
Lower Little Sugar	LLS_130	47	0.07
Lower Little Sugar	LLS_135	68	0.11
Lower Little Sugar	LLS_136	3	0.00
Lower Little Sugar	LLS_137	167	0.26
Lower Little Sugar	LLS_138	98	0.15
Lower Little Sugar	LLS_139	26	0.04
Lower Little Sugar	LLS_140	164	0.26
Lower Little Sugar	LLS_141	184	0.29
Lower Little Sugar	LLS_142	151	0.24
Lower Little Sugar	LLS_143	69	0.11
Lower Little Sugar	LLS_144	65	0.10
Lower Little Sugar	LLS_145	49	0.08
Lower Little Sugar	LLS_146	130	0.20
Lower Little Sugar	LLS_147	67	0.11
Lower Little Sugar	LLS_148	162	0.25
Lower Little Sugar	LLS_149	76	0.12
Lower Little Sugar	LLS_150	127	0.20
Lower Little Sugar	LLS_151	53	0.08
Lower Little Sugar	LLS_152	164	0.26

Lower Little Sugar	LLS_154	23	0.04
Lower Little Sugar	LLS_155	95	0.15
Lower Little Sugar	LLS_156	50	0.08
Lower Little Sugar	LLS_157	79	0.12
Lower Little Sugar	LLS_159	95	0.15
Lower Little Sugar	LLS_162	95	0.15
Lower Little Sugar	LLS_199	46	0.07
Lower Little Sugar	LLS_200	114	0.18
Lower Little Sugar	LLS_201	59	0.09
Lower Little Sugar	LLS_202	62	0.10
Lower Little Sugar	LLS_203	42	0.07
Lower Little Sugar	LLS_204	106	0.17
Lower Little Sugar	LLS_205	40	0.06
Lower Little Sugar	LLS_239	113	0.18
Lower Little Sugar	LLS_240	63	0.10
Lower Little Sugar	LLS_241	134	0.21
Lower Little Sugar	LLS_242	155	0.24
Lower Little Sugar	LLS_251	59	0.09
Lower Little Sugar	LLS_252	181	0.28
Lower Little Sugar	LLS_262	158	0.25
Lower Little Sugar	LLS_360	120	0.19
Lower Little Sugar	LLS_366	136	0.21
Lower Little Sugar	LLS_367	163	0.25
Lower Little Sugar	LLS_368	93	0.15
Lower Little Sugar	LLS_371	45	0.07
Lower Little Sugar	LLS_372	149	0.23
Lower Little Sugar	LLS_376	138	0.22
Lower Little Sugar	LLS_377	163	0.25
Lower Little Sugar	LLS_378	168	0.26
Lower Little Sugar	LLS_379	97	0.15
Lower Little Sugar	LLS_380	107	0.17
Lower Little Sugar	LLS_381	171	0.27
Lower Little Sugar	LLS_382	92	0.14
Lower Little Sugar	LLS_383	56	0.09
Lower Little Sugar	LLS_384	109	0.17
Lower Little Sugar	LLS_385	167	0.26
Lower Little Sugar	LLS_386	18	0.03
Lower Little Sugar	LLS_387	104	0.16
Lower Little Sugar	LLS_388	121	0.19
Lower Little Sugar	LLS_389	64	0.10
Lower Little Sugar	LLS_390	66	0.10

Lower Little Sugar	LLS_392	104	0.16
Lower Little Sugar	LLS_394	63	0.10
Lower Little Sugar	LLS_396	106	0.17
Lower Little Sugar	LLS_397	73	0.11
Lower Little Sugar	LLS_398	160	0.25
Lower Little Sugar	LLS_399	99	0.16
Lower Little Sugar	LLS_400	139	0.22
Lower Little Sugar	LLS_401	40	0.06
Lower Little Sugar	LLS_402	130	0.20
Lower Little Sugar	LLS_406	145	0.23
Lower Little Sugar	LLS_407	204	0.32
Lower Little Sugar	LLS_410	157	0.24
Lower Little Sugar	LLS_416	163	0.26
Lower Little Sugar	LLS_418	116	0.18
Lower Little Sugar	LLS_419	131	0.21
Lower Little Sugar	LLS_426	72	0.11

Curve Numbers (Existing & Future Conditions) for Subbasins

Stream	Subbasin ID	Curve Numbers for AMCII conditions	
		Existing Conditions	Future Conditions
Briar Creek	BC_2	82	80
Briar Creek	BC_16	81	84
Briar Creek	BC_17	77	80
Briar Creek	BC_41	75	78
Briar Creek	BC_42	76	79
Briar Creek	BC_45	73	84
Briar Creek	BC_46	71	75
Briar Creek	BC_47	77	81
Briar Creek	BC_48	77	80
Briar Creek	BC_49	76	83
Briar Creek	BC_50	84	86
Briar Creek	BC_51	78	83
Briar Creek	BC_52	76	82
Briar Creek	BC_53	80	84
Briar Creek	BC_64	69	67
Briar Creek	BC_65	67	68
Briar Creek	BC_66	73	79
Briar Creek	BC_68	75	76
Briar Creek	BC_69	70	71
Briar Creek	BC_72	77	79
Briar Creek	BC_73	77	84
Briar Creek	BC_75	81	83
Briar Creek	BC_76	70	70
Briar Creek	BC_79	83	83
Briar Creek	BC_80	85	89
Briar Creek	BC_85	79	85
Briar Creek	BC_86	78	81
Briar Creek	BC_99	86	79
Briar Creek	BC_100	81	78
Briar Creek	BC_105	77	77
Briar Creek	BC_106	81	85
Briar Creek	BC_125	84	85
Briar Creek	BC_126	82	84
Briar Creek	BC_127	79	80
Briar Creek	BC_128	80	82
Briar Creek	BC_134	83	83
Briar Creek	BC_168	83	85
Briar Creek	BC_169	79	83

Briar Creek	BC_171	68	81
Briar Creek	BC_172	86	89
Briar Creek	BC_173	86	88
Briar Creek	BC_177	81	82
Briar Creek	BC_178	76	78
Briar Creek	BC_179	78	79
Briar Creek	BC_181	77	79
Briar Creek	BC_182	82	83
Briar Creek	BC_185	81	85
Briar Creek	BC_186	82	82
Briar Creek	BC_188	74	78
Briar Creek	BC_206	76	80
Briar Creek	BC_208	94	96
Briar Creek	BC_209	79	85
Briar Creek	BC_210	75	79
Briar Creek	BC_211	81	84
Briar Creek	BC_219	78	81
Briar Creek	BC_221	84	87
Briar Creek	BC_222	82	84
Briar Creek	BC_223	77	80
Briar Creek	BC_224	76	85
Briar Creek	BC_225	67	78
Briar Creek	BC_226	81	84
Briar Creek	BC_227	77	81
Briar Creek	BC_228	88	89
Briar Creek	BC_229	74	81
Briar Creek	BC_230	81	86
Briar Creek	BC_231	77	86
Briar Creek	BC_232	77	79
Briar Creek	BC_233	77	79
Briar Creek	BC_234	75	77
Briar Creek	BC_235	72	73
Briar Creek	BC_236	80	81
Briar Creek	BC_237	82	83
Briar Creek	BC_250	75	78
Briar Creek	BC_253	83	86
Briar Creek	BC_254	82	87
Briar Creek	BC_255	69	76
Briar Creek	BC_259	77	80
Briar Creek	BC_260	66	67
Briar Creek	BC_261	84	86

Briar Creek	BC_277	75	79
Briar Creek	BC_278	80	84
Briar Creek	BC_279	80	84
Briar Creek	BC_280	82	90
Briar Creek	BC_281	79	81
Briar Creek	BC_282	84	89
Briar Creek	BC_283	78	81
Briar Creek	BC_284	77	80
Briar Creek	BC_285	77	80
Briar Creek	BC_286	83	88
Briar Creek	BC_287	89	94
Briar Creek	BC_288	73	89
Briar Creek	BC_289	88	91
Briar Creek	BC_290	73	79
Briar Creek	BC_291	78	82
Briar Creek	BC_294	83	84
Briar Creek	BC_295	79	85
Briar Creek	BC_296	85	90
Briar Creek	BC_297	79	83
Briar Creek	BC_298	71	79
Briar Creek	BC_304	79	85
Briar Creek	BC_305	74	77
Briar Creek	BC_314	79	83
Briar Creek	BC_315	80	83
Briar Creek	BC_316	78	81
Briar Creek	BC_317	77	76
Briar Creek	BC_319	79	80
Briar Creek	BC_320	78	81
Briar Creek	BC_321	71	76
Briar Creek	BC_322	76	82
Briar Creek	BC_323	75	81
Briar Creek	BC_324	75	80
Briar Creek	BC_332	81	81
Briar Creek	BC_333	82	85
Briar Creek	BC_334	77	82
Briar Creek	BC_335	77	80
Briar Creek	BC_341	80	83
Briar Creek	BC_342	82	85
Briar Creek	BC_344	79	86
Briar Creek	BC_345	71	77
Briar Creek	BC_346	82	88

Briar Creek	BC_347	78	82
Briar Creek	BC_348	86	90
Briar Creek	BC_353	75	76
Briar Creek	BC_354	77	81
Briar Creek	BC_355	75	78
Briar Creek	BC_356	74	79
Briar Creek	BC_357	75	78
Briar Creek	BC_358	81	83
Briar Creek	BC_359	77	81
Briar Creek	BC_364	78	81
Briar Creek	BC_369	81	84
Briar Creek	BC_370	77	80
Briar Creek	BC_373	85	89
Briar Creek	BC_374	90	92
Briar Creek	BC_375	86	89
Briar Creek	BC_405	86	84
Briar Creek	BC_408	74	78
Briar Creek	BC_409	82	86
Briar Creek	BC_411	76	79
Briar Creek	BC_413	79	82
Briar Creek	BC_415	82	83
Briar Creek	BC_417	77	80
Briar Creek	BC_420	75	79
Briar Creek	BC_425	86	90
Briar Creek	BC_427	73	78
Upper Little Sugar Creek	ULS_1	76	85
Upper Little Sugar Creek	ULS_3	85	90
Upper Little Sugar Creek	ULS_4	71	81
Upper Little Sugar Creek	ULS_5	75	79
Upper Little Sugar Creek	ULS_6	82	85
Upper Little Sugar Creek	ULS_8	83	85
Upper Little Sugar Creek	ULS_9	76	80
Upper Little Sugar Creek	ULS_10	77	89
Upper Little Sugar Creek	ULS_11	78	82
Upper Little Sugar Creek	ULS_12	76	86
Upper Little Sugar Creek	ULS_13	90	90
Upper Little Sugar Creek	ULS_14	83	85
Upper Little Sugar Creek	ULS_19	91	94
Upper Little Sugar Creek	ULS_20	91	93
Upper Little Sugar Creek	ULS_26	85	92
Upper Little Sugar Creek	ULS_33	82	83

Upper Little Sugar Creek	ULS_34	85	85
Upper Little Sugar Creek	ULS_70	88	90
Upper Little Sugar Creek	ULS_71	90	89
Upper Little Sugar Creek	ULS_74	90	91
Upper Little Sugar Creek	ULS_77	86	88
Upper Little Sugar Creek	ULS_78	91	92
Upper Little Sugar Creek	ULS_83	88	87
Upper Little Sugar Creek	ULS_84	84	88
Upper Little Sugar Creek	ULS_95	80	83
Upper Little Sugar Creek	ULS_96	76	83
Upper Little Sugar Creek	ULS_97	83	86
Upper Little Sugar Creek	ULS_98	77	79
Upper Little Sugar Creek	ULS_101	75	77
Upper Little Sugar Creek	ULS_102	74	76
Upper Little Sugar Creek	ULS_133	86	88
Upper Little Sugar Creek	ULS_187	82	88
Upper Little Sugar Creek	ULS_189	80	93
Upper Little Sugar Creek	ULS_191	82	90
Upper Little Sugar Creek	ULS_193	74	78
Upper Little Sugar Creek	ULS_194	91	93
Upper Little Sugar Creek	ULS_195	80	82
Upper Little Sugar Creek	ULS_196	86	90
Upper Little Sugar Creek	ULS_197	84	91
Upper Little Sugar Creek	ULS_198	77	82
Upper Little Sugar Creek	ULS_207	88	88
Upper Little Sugar Creek	ULS_212	83	87
Upper Little Sugar Creek	ULS_213	76	77
Upper Little Sugar Creek	ULS_214	90	90
Upper Little Sugar Creek	ULS_215	82	84
Upper Little Sugar Creek	ULS_216	73	77
Upper Little Sugar Creek	ULS_217	78	80
Upper Little Sugar Creek	ULS_218	81	84
Upper Little Sugar Creek	ULS_238	89	89
Upper Little Sugar Creek	ULS_243	78	81
Upper Little Sugar Creek	ULS_244	81	83
Upper Little Sugar Creek	ULS_245	77	81
Upper Little Sugar Creek	ULS_246	81	84
Upper Little Sugar Creek	ULS_247	84	86
Upper Little Sugar Creek	ULS_248	77	83
Upper Little Sugar Creek	ULS_249	79	91
Upper Little Sugar Creek	ULS_256	87	83

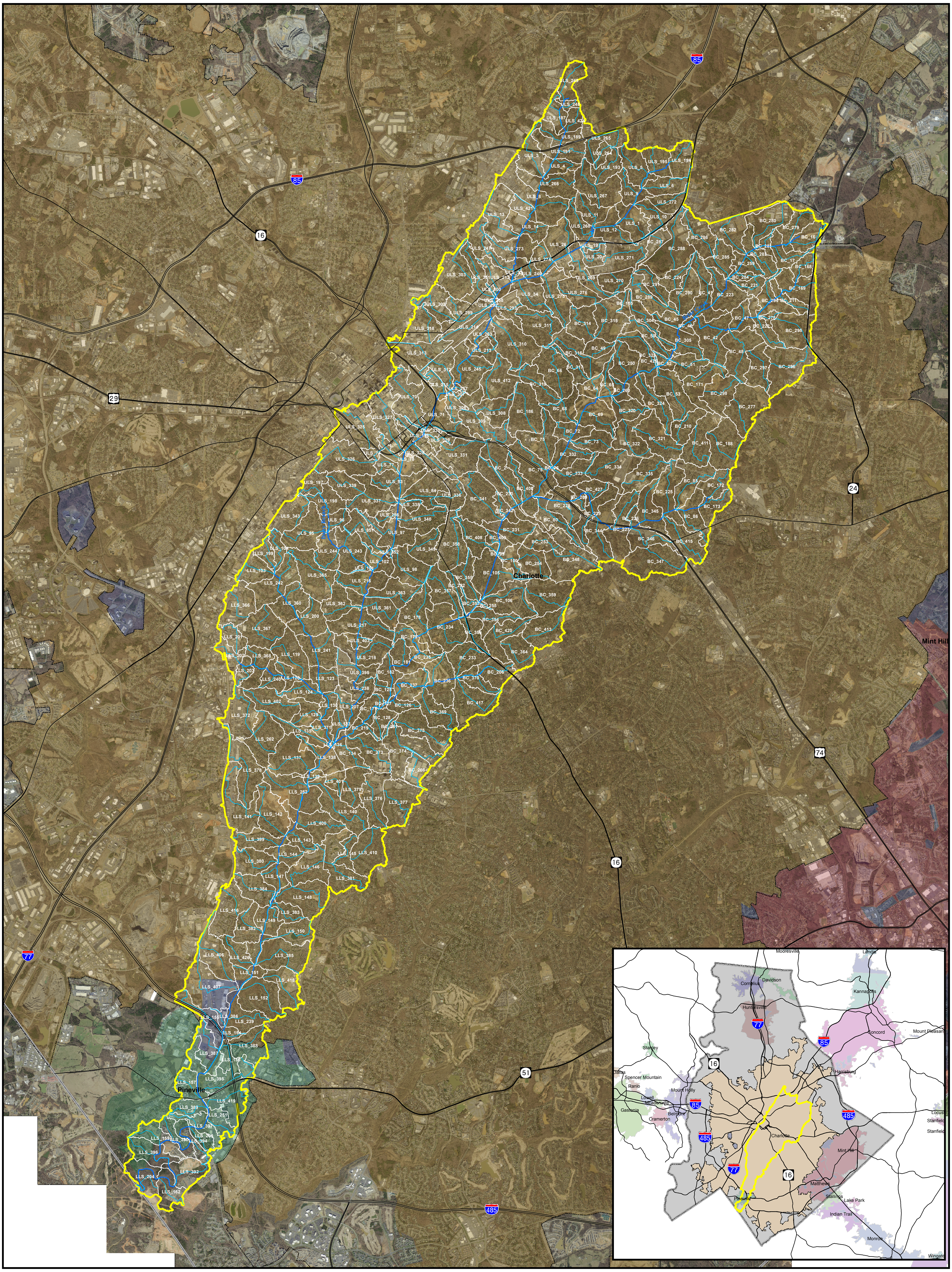
Upper Little Sugar Creek	ULS_257	76	82
Upper Little Sugar Creek	ULS_258	82	82
Upper Little Sugar Creek	ULS_263	88	88
Upper Little Sugar Creek	ULS_264	78	81
Upper Little Sugar Creek	ULS_265	84	86
Upper Little Sugar Creek	ULS_266	75	81
Upper Little Sugar Creek	ULS_267	75	79
Upper Little Sugar Creek	ULS_268	76	87
Upper Little Sugar Creek	ULS_269	86	90
Upper Little Sugar Creek	ULS_270	76	81
Upper Little Sugar Creek	ULS_271	85	88
Upper Little Sugar Creek	ULS_272	77	85
Upper Little Sugar Creek	ULS_273	83	88
Upper Little Sugar Creek	ULS_274	84	87
Upper Little Sugar Creek	ULS_275	84	85
Upper Little Sugar Creek	ULS_276	82	88
Upper Little Sugar Creek	ULS_292	91	91
Upper Little Sugar Creek	ULS_293	85	88
Upper Little Sugar Creek	ULS_299	88	90
Upper Little Sugar Creek	ULS_300	87	88
Upper Little Sugar Creek	ULS_301	83	85
Upper Little Sugar Creek	ULS_302	86	89
Upper Little Sugar Creek	ULS_303	83	85
Upper Little Sugar Creek	ULS_306	88	87
Upper Little Sugar Creek	ULS_307	78	83
Upper Little Sugar Creek	ULS_308	81	85
Upper Little Sugar Creek	ULS_309	88	90
Upper Little Sugar Creek	ULS_310	79	83
Upper Little Sugar Creek	ULS_311	78	82
Upper Little Sugar Creek	ULS_312	84	88
Upper Little Sugar Creek	ULS_313	88	91
Upper Little Sugar Creek	ULS_318	86	87
Upper Little Sugar Creek	ULS_325	90	92
Upper Little Sugar Creek	ULS_326	81	88
Upper Little Sugar Creek	ULS_327	88	94
Upper Little Sugar Creek	ULS_328	89	91
Upper Little Sugar Creek	ULS_329	84	88
Upper Little Sugar Creek	ULS_330	88	91
Upper Little Sugar Creek	ULS_331	84	84
Upper Little Sugar Creek	ULS_336	85	85
Upper Little Sugar Creek	ULS_337	81	83

Upper Little Sugar Creek	ULS_338	78	82
Upper Little Sugar Creek	ULS_339	77	79
Upper Little Sugar Creek	ULS_340	78	81
Upper Little Sugar Creek	ULS_343	85	87
Upper Little Sugar Creek	ULS_349	78	80
Upper Little Sugar Creek	ULS_351	77	81
Upper Little Sugar Creek	ULS_352	81	81
Upper Little Sugar Creek	ULS_361	77	80
Upper Little Sugar Creek	ULS_362	78	82
Upper Little Sugar Creek	ULS_363	77	79
Upper Little Sugar Creek	ULS_365	78	80
Upper Little Sugar Creek	ULS_395	89	92
Upper Little Sugar Creek	ULS_403	80	82
Upper Little Sugar Creek	ULS_412	81	82
Upper Little Sugar Creek	ULS_421	86	88
Upper Little Sugar Creek	ULS_424	70	86
Lower Little Sugar Creek	LLS_103	86	90
Lower Little Sugar Creek	LLS_104	78	83
Lower Little Sugar Creek	LLS_119	83	84
Lower Little Sugar Creek	LLS_120	75	78
Lower Little Sugar Creek	LLS_123	84	85
Lower Little Sugar Creek	LLS_124	77	79
Lower Little Sugar Creek	LLS_129	67	73
Lower Little Sugar Creek	LLS_130	81	83
Lower Little Sugar Creek	LLS_135	69	82
Lower Little Sugar Creek	LLS_136	78	80
Lower Little Sugar Creek	LLS_137	67	80
Lower Little Sugar Creek	LLS_138	76	82
Lower Little Sugar Creek	LLS_139	78	74
Lower Little Sugar Creek	LLS_140	77	80
Lower Little Sugar Creek	LLS_141	83	88
Lower Little Sugar Creek	LLS_142	75	84
Lower Little Sugar Creek	LLS_143	76	79
Lower Little Sugar Creek	LLS_144	78	80
Lower Little Sugar Creek	LLS_145	77	79
Lower Little Sugar Creek	LLS_146	76	80
Lower Little Sugar Creek	LLS_147	76	78
Lower Little Sugar Creek	LLS_148	80	82
Lower Little Sugar Creek	LLS_149	84	83
Lower Little Sugar Creek	LLS_150	90	90
Lower Little Sugar Creek	LLS_151	76	78

Lower Little Sugar Creek	LLS_152	81	82
Lower Little Sugar Creek	LLS_154	82	84
Lower Little Sugar Creek	LLS_155	86	89
Lower Little Sugar Creek	LLS_156	89	90
Lower Little Sugar Creek	LLS_157	89	90
Lower Little Sugar Creek	LLS_159	86	82
Lower Little Sugar Creek	LLS_162	70	74
Lower Little Sugar Creek	LLS_199	83	87
Lower Little Sugar Creek	LLS_200	75	80
Lower Little Sugar Creek	LLS_201	90	90
Lower Little Sugar Creek	LLS_202	90	94
Lower Little Sugar Creek	LLS_203	80	84
Lower Little Sugar Creek	LLS_204	60	68
Lower Little Sugar Creek	LLS_205	81	91
Lower Little Sugar Creek	LLS_239	80	82
Lower Little Sugar Creek	LLS_240	76	78
Lower Little Sugar Creek	LLS_241	77	80
Lower Little Sugar Creek	LLS_242	77	79
Lower Little Sugar Creek	LLS_251	92	96
Lower Little Sugar Creek	LLS_252	78	83
Lower Little Sugar Creek	LLS_262	76	79
Lower Little Sugar Creek	LLS_360	81	85
Lower Little Sugar Creek	LLS_366	88	90
Lower Little Sugar Creek	LLS_367	76	79
Lower Little Sugar Creek	LLS_368	75	78
Lower Little Sugar Creek	LLS_371	66	76
Lower Little Sugar Creek	LLS_372	88	90
Lower Little Sugar Creek	LLS_376	82	86
Lower Little Sugar Creek	LLS_377	82	83
Lower Little Sugar Creek	LLS_378	79	83
Lower Little Sugar Creek	LLS_379	80	81
Lower Little Sugar Creek	LLS_380	82	86
Lower Little Sugar Creek	LLS_381	81	81
Lower Little Sugar Creek	LLS_382	90	89
Lower Little Sugar Creek	LLS_383	80	82
Lower Little Sugar Creek	LLS_384	84	88
Lower Little Sugar Creek	LLS_385	84	85
Lower Little Sugar Creek	LLS_386	94	97
Lower Little Sugar Creek	LLS_387	86	90
Lower Little Sugar Creek	LLS_388	88	86
Lower Little Sugar Creek	LLS_389	89	91

Lower Little Sugar Creek	LLS_390	82	80
Lower Little Sugar Creek	LLS_392	74	78
Lower Little Sugar Creek	LLS_394	85	81
Lower Little Sugar Creek	LLS_396	72	76
Lower Little Sugar Creek	LLS_397	88	92
Lower Little Sugar Creek	LLS_398	91	91
Lower Little Sugar Creek	LLS_399	78	81
Lower Little Sugar Creek	LLS_400	78	82
Lower Little Sugar Creek	LLS_401	84	83
Lower Little Sugar Creek	LLS_402	75	78
Lower Little Sugar Creek	LLS_406	81	86
Lower Little Sugar Creek	LLS_407	85	92
Lower Little Sugar Creek	LLS_410	76	79
Lower Little Sugar Creek	LLS_416	92	93
Lower Little Sugar Creek	LLS_418	87	88
Lower Little Sugar Creek	LLS_419	93	95
Lower Little Sugar Creek	LLS_426	83	88

Appendix B1: Longest Flow Path Map



Legend

- Longest Flow Paths
- Major Roads
- Streams
- Subbasins
- City Limits
- County Limits

Mecklenburg County (Little Sugar Creek & Briar Creek Subbasins) - Longest flow paths

CHARLOTTE.

Dewberry®

N
W E
S

3,000 1,500 0 3,000 6,000
Feet

Appendix B2: Time of Concentration and Lag Time Table

Stream	Subbasin ID	Tc Minutes	Lag Time (1.8*Tc) Minutes
Briar Creek	W_BC_100	31.52	56.73
Briar Creek	W_BC_105	64.09	115.37
Briar Creek	W_BC_106	28.83	51.89
Briar Creek	W_BC_125	23.34	42.01
Briar Creek	W_BC_126	21.75	39.15
Briar Creek	W_BC_127	10.97	19.74
Briar Creek	W_BC_128	14.56	26.20
Briar Creek	W_BC_134	28.18	50.72
Briar Creek	W_BC_16	29.98	53.97
Briar Creek	W_BC_168	21.65	38.97
Briar Creek	W_BC_169	37.28	67.10
Briar Creek	W_BC_17	18.57	33.42
Briar Creek	W_BC_171	36.37	65.46
Briar Creek	W_BC_172	42.55	76.59
Briar Creek	W_BC_173	21.58	38.84
Briar Creek	W_BC_177	32.70	58.86
Briar Creek	W_BC_178	27.96	50.32
Briar Creek	W_BC_179	21.00	37.80
Briar Creek	W_BC_181	22.54	40.56
Briar Creek	W_BC_182	18.24	32.83
Briar Creek	W_BC_185	13.97	25.15
Briar Creek	W_BC_186	37.56	67.61
Briar Creek	W_BC_188	174.40	313.92
Briar Creek	W_BC_2	27.03	48.65
Briar Creek	W_BC_206	16.73	30.11
Briar Creek	W_BC_208	47.13	84.83
Briar Creek	W_BC_209	23.61	42.50
Briar Creek	W_BC_210	26.64	47.95
Briar Creek	W_BC_211	41.68	75.03
Briar Creek	W_BC_219	18.74	33.72
Briar Creek	W_BC_221	30.92	55.66
Briar Creek	W_BC_222	31.38	56.49
Briar Creek	W_BC_223	31.70	57.06
Briar Creek	W_BC_224	33.32	59.98
Briar Creek	W_BC_225	30.62	55.11
Briar Creek	W_BC_226	21.20	38.16
Briar Creek	W_BC_227	29.86	53.74
Briar Creek	W_BC_228	25.50	45.89
Briar Creek	W_BC_229	22.68	40.82

Briar Creek	W_BC_230	25.73	46.32
Briar Creek	W_BC_231	34.96	62.93
Briar Creek	W_BC_232	21.85	39.33
Briar Creek	W_BC_233	26.35	47.43
Briar Creek	W_BC_234	28.98	52.17
Briar Creek	W_BC_235	27.01	48.62
Briar Creek	W_BC_236	25.09	45.16
Briar Creek	W_BC_237	43.35	78.03
Briar Creek	W_BC_250	22.07	39.72
Briar Creek	W_BC_253	27.08	48.75
Briar Creek	W_BC_254	28.79	51.81
Briar Creek	W_BC_255	19.18	34.52
Briar Creek	W_BC_259	31.29	56.32
Briar Creek	W_BC_260	27.37	49.26
Briar Creek	W_BC_261	20.90	37.62
Briar Creek	W_BC_277	24.15	43.46
Briar Creek	W_BC_278	21.24	38.23
Briar Creek	W_BC_279	25.45	45.81
Briar Creek	W_BC_280	22.07	39.72
Briar Creek	W_BC_281	19.40	34.92
Briar Creek	W_BC_282	38.67	69.61
Briar Creek	W_BC_283	25.72	46.29
Briar Creek	W_BC_284	23.04	41.47
Briar Creek	W_BC_285	33.03	59.45
Briar Creek	W_BC_286	32.63	58.74
Briar Creek	W_BC_287	5.25	9.46
Briar Creek	W_BC_288	34.59	62.27
Briar Creek	W_BC_289	50.89	91.59
Briar Creek	W_BC_290	21.55	38.80
Briar Creek	W_BC_291	44.66	80.39
Briar Creek	W_BC_294	28.85	51.92
Briar Creek	W_BC_295	34.13	61.43
Briar Creek	W_BC_296	36.77	66.19
Briar Creek	W_BC_297	78.31	140.96
Briar Creek	W_BC_298	27.25	49.05
Briar Creek	W_BC_304	44.02	79.24
Briar Creek	W_BC_305	26.78	48.20
Briar Creek	W_BC_314	36.12	65.02
Briar Creek	W_BC_315	28.96	52.12
Briar Creek	W_BC_316	36.10	64.97
Briar Creek	W_BC_317	32.30	58.14

Briar Creek	W_BC_319	31.87	57.37
Briar Creek	W_BC_320	26.69	48.03
Briar Creek	W_BC_321	49.83	89.70
Briar Creek	W_BC_322	42.41	76.34
Briar Creek	W_BC_323	41.08	73.94
Briar Creek	W_BC_324	44.35	79.83
Briar Creek	W_BC_332	28.24	50.82
Briar Creek	W_BC_333	26.87	48.36
Briar Creek	W_BC_334	14.53	26.15
Briar Creek	W_BC_335	50.28	90.50
Briar Creek	W_BC_341	31.34	56.41
Briar Creek	W_BC_342	23.46	42.22
Briar Creek	W_BC_344	29.54	53.17
Briar Creek	W_BC_345	28.70	51.67
Briar Creek	W_BC_346	30.80	55.44
Briar Creek	W_BC_347	29.11	52.40
Briar Creek	W_BC_348	35.99	64.79
Briar Creek	W_BC_353	32.42	58.35
Briar Creek	W_BC_354	27.81	50.06
Briar Creek	W_BC_355	27.22	49.00
Briar Creek	W_BC_356	34.31	61.76
Briar Creek	W_BC_357	32.58	58.64
Briar Creek	W_BC_358	35.87	64.57
Briar Creek	W_BC_359	36.53	65.76
Briar Creek	W_BC_364	27.90	50.22
Briar Creek	W_BC_369	27.05	48.70
Briar Creek	W_BC_370	24.45	44.01
Briar Creek	W_BC_373	27.33	49.19
Briar Creek	W_BC_374	26.98	48.57
Briar Creek	W_BC_375	26.37	47.46
Briar Creek	W_BC_405	25.57	46.02
Briar Creek	W_BC_408	31.06	55.91
Briar Creek	W_BC_409	17.76	31.96
Briar Creek	W_BC_41	41.37	74.46
Briar Creek	W_BC_411	29.34	52.82
Briar Creek	W_BC_413	43.14	77.65
Briar Creek	W_BC_415	31.59	56.86
Briar Creek	W_BC_417	30.63	55.13
Briar Creek	W_BC_42	50.95	91.71
Briar Creek	W_BC_420	49.10	88.38
Briar Creek	W_BC_425	12.15	21.86

Briar Creek	W_BC_427	12.25	22.06
Briar Creek	W_BC_45	23.99	43.18
Briar Creek	W_BC_46	9.14	16.44
Briar Creek	W_BC_47	17.30	31.13
Briar Creek	W_BC_48	34.83	62.70
Briar Creek	W_BC_49	12.85	23.12
Briar Creek	W_BC_50	34.13	61.43
Briar Creek	W_BC_51	38.55	69.39
Briar Creek	W_BC_52	9.81	17.65
Briar Creek	W_BC_53	27.04	48.68
Briar Creek	W_BC_64	29.46	53.03
Briar Creek	W_BC_65	35.60	64.09
Briar Creek	W_BC_66	34.42	61.96
Briar Creek	W_BC_68	27.81	50.05
Briar Creek	W_BC_69	29.55	53.19
Briar Creek	W_BC_72	19.68	35.42
Briar Creek	W_BC_73	26.22	47.19
Briar Creek	W_BC_75	27.73	49.92
Briar Creek	W_BC_76	4.77	8.58
Briar Creek	W_BC_79	35.89	64.59
Briar Creek	W_BC_80	34.62	62.32
Briar Creek	W_BC_85	29.67	53.40
Briar Creek	W_BC_86	19.74	35.53
Briar Creek	W_BC_99	9.98	17.97
Lower Little Sugar Creek	W_LLS_103	36.20	65.17
Lower Little Sugar Creek	W_LLS_104	50.14	90.26
Lower Little Sugar Creek	W_LLS_119	23.68	42.63
Lower Little Sugar Creek	W_LLS_120	43.15	77.66
Lower Little Sugar Creek	W_LLS_123	12.67	22.80
Lower Little Sugar Creek	W_LLS_124	36.81	66.26
Lower Little Sugar Creek	W_LLS_129	31.62	56.92
Lower Little Sugar Creek	W_LLS_130	16.34	29.41
Lower Little Sugar Creek	W_LLS_135	50.14	90.25
Lower Little Sugar Creek	W_LLS_136	10.13	18.23
Lower Little Sugar Creek	W_LLS_137	37.18	66.93
Lower Little Sugar Creek	W_LLS_138	46.89	84.40
Lower Little Sugar Creek	W_LLS_139	6.26	11.27
Lower Little Sugar Creek	W_LLS_140	44.45	80.00
Lower Little Sugar Creek	W_LLS_141	41.74	75.14
Lower Little Sugar Creek	W_LLS_142	28.57	51.43
Lower Little Sugar Creek	W_LLS_143	24.35	43.82

Lower Little Sugar Creek	W_LLS_144	22.65	40.78
Lower Little Sugar Creek	W_LLS_145	19.26	34.66
Lower Little Sugar Creek	W_LLS_146	27.26	49.07
Lower Little Sugar Creek	W_LLS_147	43.45	78.21
Lower Little Sugar Creek	W_LLS_148	24.83	44.70
Lower Little Sugar Creek	W_LLS_149	26.03	46.85
Lower Little Sugar Creek	W_LLS_150	43.22	77.80
Lower Little Sugar Creek	W_LLS_151	38.63	69.53
Lower Little Sugar Creek	W_LLS_152	45.29	81.53
Lower Little Sugar Creek	W_LLS_154	26.11	47.00
Lower Little Sugar Creek	W_LLS_155	34.16	61.49
Lower Little Sugar Creek	W_LLS_156	11.11	19.99
Lower Little Sugar Creek	W_LLS_157	53.86	96.95
Lower Little Sugar Creek	W_LLS_159	33.61	60.50
Lower Little Sugar Creek	W_LLS_162	29.98	53.97
Lower Little Sugar Creek	W_LLS_199	33.77	60.78
Lower Little Sugar Creek	W_LLS_200	19.97	35.95
Lower Little Sugar Creek	W_LLS_201	25.95	46.71
Lower Little Sugar Creek	W_LLS_202	30.45	54.80
Lower Little Sugar Creek	W_LLS_203	20.08	36.15
Lower Little Sugar Creek	W_LLS_204	17.71	31.88
Lower Little Sugar Creek	W_LLS_205	31.49	56.68
Lower Little Sugar Creek	W_LLS_239	40.09	72.16
Lower Little Sugar Creek	W_LLS_240	9.59	17.27
Lower Little Sugar Creek	W_LLS_241	27.62	49.72
Lower Little Sugar Creek	W_LLS_242	25.95	46.71
Lower Little Sugar Creek	W_LLS_251	14.69	26.44
Lower Little Sugar Creek	W_LLS_252	24.04	43.28
Lower Little Sugar Creek	W_LLS_262	46.28	83.31
Lower Little Sugar Creek	W_LLS_360	17.85	32.13
Lower Little Sugar Creek	W_LLS_366	23.39	42.10
Lower Little Sugar Creek	W_LLS_367	25.37	45.66
Lower Little Sugar Creek	W_LLS_368	19.93	35.87
Lower Little Sugar Creek	W_LLS_371	10.54	18.98
Lower Little Sugar Creek	W_LLS_372	34.01	61.21
Lower Little Sugar Creek	W_LLS_376	52.66	94.78
Lower Little Sugar Creek	W_LLS_377	28.84	51.91
Lower Little Sugar Creek	W_LLS_378	45.29	81.53
Lower Little Sugar Creek	W_LLS_379	23.74	42.73
Lower Little Sugar Creek	W_LLS_380	40.12	72.21
Lower Little Sugar Creek	W_LLS_381	30.22	54.40

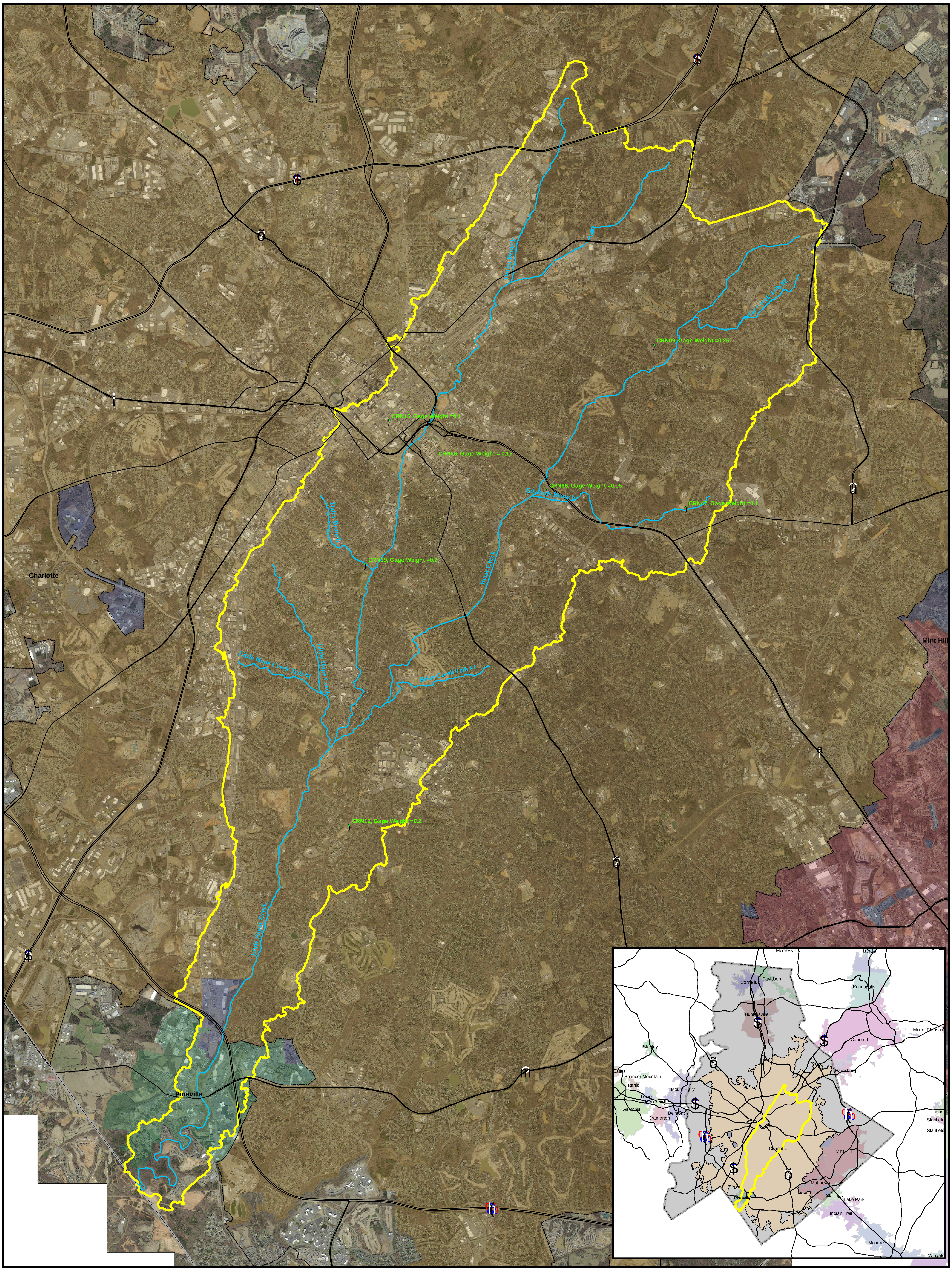
Lower Little Sugar Creek	W_LLS_382	30.04	54.08
Lower Little Sugar Creek	W_LLS_383	25.32	45.57
Lower Little Sugar Creek	W_LLS_384	39.05	70.30
Lower Little Sugar Creek	W_LLS_385	32.18	57.92
Lower Little Sugar Creek	W_LLS_386	18.09	32.56
Lower Little Sugar Creek	W_LLS_387	35.46	63.83
Lower Little Sugar Creek	W_LLS_388	20.60	37.08
Lower Little Sugar Creek	W_LLS_389	38.19	68.75
Lower Little Sugar Creek	W_LLS_390	22.35	40.23
Lower Little Sugar Creek	W_LLS_392	27.25	49.05
Lower Little Sugar Creek	W_LLS_394	22.35	40.23
Lower Little Sugar Creek	W_LLS_396	21.65	38.97
Lower Little Sugar Creek	W_LLS_397	20.30	36.54
Lower Little Sugar Creek	W_LLS_398	27.58	49.64
Lower Little Sugar Creek	W_LLS_399	33.74	60.73
Lower Little Sugar Creek	W_LLS_400	90.45	162.81
Lower Little Sugar Creek	W_LLS_401	38.06	68.51
Lower Little Sugar Creek	W_LLS_402	32.35	58.24
Lower Little Sugar Creek	W_LLS_406	43.29	77.92
Lower Little Sugar Creek	W_LLS_407	43.44	78.20
Lower Little Sugar Creek	W_LLS_410	24.72	44.49
Lower Little Sugar Creek	W_LLS_416	83.09	149.56
Lower Little Sugar Creek	W_LLS_418	29.46	53.02
Lower Little Sugar Creek	W_LLS_419	22.26	40.06
Lower Little Sugar Creek	W_LLS_426	28.44	51.19
Upper Little Sugar Creek	W_ULS_1	28.68	51.62
Upper Little Sugar Creek	W_ULS_10	35.06	63.11
Upper Little Sugar Creek	W_ULS_101	23.25	41.85
Upper Little Sugar Creek	W_ULS_102	30.26	54.46
Upper Little Sugar Creek	W_ULS_11	31.70	57.06
Upper Little Sugar Creek	W_ULS_12	29.46	53.03
Upper Little Sugar Creek	W_ULS_13	29.32	52.78
Upper Little Sugar Creek	W_ULS_133	20.45	36.81
Upper Little Sugar Creek	W_ULS_14	23.19	41.75
Upper Little Sugar Creek	W_ULS_187	27.45	49.41
Upper Little Sugar Creek	W_ULS_189	18.24	32.84
Upper Little Sugar Creek	W_ULS_19	6.89	12.41
Upper Little Sugar Creek	W_ULS_191	12.76	22.97
Upper Little Sugar Creek	W_ULS_193	51.69	93.04
Upper Little Sugar Creek	W_ULS_194	23.00	41.41
Upper Little Sugar Creek	W_ULS_195	35.79	64.41

Upper Little Sugar Creek	W_ULS_196	19.80	35.64
Upper Little Sugar Creek	W_ULS_197	14.03	25.25
Upper Little Sugar Creek	W_ULS_198	21.56	38.80
Upper Little Sugar Creek	W_ULS_20	26.30	47.33
Upper Little Sugar Creek	W_ULS_207	21.32	38.38
Upper Little Sugar Creek	W_ULS_212	23.76	42.76
Upper Little Sugar Creek	W_ULS_213	16.49	29.68
Upper Little Sugar Creek	W_ULS_214	33.40	60.13
Upper Little Sugar Creek	W_ULS_215	34.52	62.14
Upper Little Sugar Creek	W_ULS_216	43.53	78.36
Upper Little Sugar Creek	W_ULS_217	21.15	38.07
Upper Little Sugar Creek	W_ULS_218	39.64	71.35
Upper Little Sugar Creek	W_ULS_238	31.93	57.48
Upper Little Sugar Creek	W_ULS_243	27.64	49.74
Upper Little Sugar Creek	W_ULS_244	24.73	44.51
Upper Little Sugar Creek	W_ULS_245	24.66	44.39
Upper Little Sugar Creek	W_ULS_246	20.20	36.36
Upper Little Sugar Creek	W_ULS_247	39.51	71.12
Upper Little Sugar Creek	W_ULS_248	21.92	39.45
Upper Little Sugar Creek	W_ULS_249	58.39	105.10
Upper Little Sugar Creek	W_ULS_256	18.32	32.97
Upper Little Sugar Creek	W_ULS_257	4.64	8.36
Upper Little Sugar Creek	W_ULS_258	12.74	22.93
Upper Little Sugar Creek	W_ULS_26	34.63	62.34
Upper Little Sugar Creek	W_ULS_263	21.91	39.44
Upper Little Sugar Creek	W_ULS_264	23.28	41.90
Upper Little Sugar Creek	W_ULS_265	145.50	261.89
Upper Little Sugar Creek	W_ULS_266	36.11	65.00
Upper Little Sugar Creek	W_ULS_267	43.82	78.88
Upper Little Sugar Creek	W_ULS_268	39.40	70.92
Upper Little Sugar Creek	W_ULS_269	29.82	53.67
Upper Little Sugar Creek	W_ULS_270	33.31	59.95
Upper Little Sugar Creek	W_ULS_271	44.33	79.79
Upper Little Sugar Creek	W_ULS_272	18.27	32.88
Upper Little Sugar Creek	W_ULS_273	15.53	27.96
Upper Little Sugar Creek	W_ULS_274	24.00	43.21
Upper Little Sugar Creek	W_ULS_275	55.50	99.89
Upper Little Sugar Creek	W_ULS_276	31.66	56.98
Upper Little Sugar Creek	W_ULS_292	6.03	10.86
Upper Little Sugar Creek	W_ULS_293	30.37	54.67
Upper Little Sugar Creek	W_ULS_299	31.53	56.75

Upper Little Sugar Creek	W_ULS_3	33.72	60.70
Upper Little Sugar Creek	W_ULS_300	6.94	12.50
Upper Little Sugar Creek	W_ULS_301	53.47	96.25
Upper Little Sugar Creek	W_ULS_302	44.70	80.45
Upper Little Sugar Creek	W_ULS_303	30.48	54.87
Upper Little Sugar Creek	W_ULS_306	22.99	41.38
Upper Little Sugar Creek	W_ULS_307	11.74	21.13
Upper Little Sugar Creek	W_ULS_308	28.88	51.98
Upper Little Sugar Creek	W_ULS_309	49.99	89.99
Upper Little Sugar Creek	W_ULS_310	40.97	73.75
Upper Little Sugar Creek	W_ULS_311	30.61	55.11
Upper Little Sugar Creek	W_ULS_312	28.85	51.93
Upper Little Sugar Creek	W_ULS_313	42.89	77.21
Upper Little Sugar Creek	W_ULS_318	25.33	45.60
Upper Little Sugar Creek	W_ULS_325	30.09	54.16
Upper Little Sugar Creek	W_ULS_326	17.52	31.54
Upper Little Sugar Creek	W_ULS_327	13.05	23.49
Upper Little Sugar Creek	W_ULS_328	29.28	52.71
Upper Little Sugar Creek	W_ULS_329	10.85	19.54
Upper Little Sugar Creek	W_ULS_33	10.62	19.12
Upper Little Sugar Creek	W_ULS_330	7.49	13.48
Upper Little Sugar Creek	W_ULS_331	42.53	76.56
Upper Little Sugar Creek	W_ULS_336	18.18	32.72
Upper Little Sugar Creek	W_ULS_337	42.50	76.51
Upper Little Sugar Creek	W_ULS_338	25.40	45.72
Upper Little Sugar Creek	W_ULS_339	42.01	75.62
Upper Little Sugar Creek	W_ULS_34	38.03	68.45
Upper Little Sugar Creek	W_ULS_340	28.71	51.67
Upper Little Sugar Creek	W_ULS_343	30.37	54.66
Upper Little Sugar Creek	W_ULS_349	20.64	37.15
Upper Little Sugar Creek	W_ULS_351	32.87	59.17
Upper Little Sugar Creek	W_ULS_352	16.36	29.45
Upper Little Sugar Creek	W_ULS_361	35.98	64.76
Upper Little Sugar Creek	W_ULS_362	17.89	32.21
Upper Little Sugar Creek	W_ULS_363	34.72	62.50
Upper Little Sugar Creek	W_ULS_365	44.95	80.90
Upper Little Sugar Creek	W_ULS_395	12.31	22.15
Upper Little Sugar Creek	W_ULS_4	46.69	84.03
Upper Little Sugar Creek	W_ULS_403	19.86	35.75
Upper Little Sugar Creek	W_ULS_412	31.53	56.76
Upper Little Sugar Creek	W_ULS_421	8.92	16.06

Upper Little Sugar Creek	W_ULS_424	28.14	50.66
Upper Little Sugar Creek	W_ULS_5	33.35	60.02
Upper Little Sugar Creek	W_ULS_6	31.78	57.20
Upper Little Sugar Creek	W_ULS_70	15.14	27.26
Upper Little Sugar Creek	W_ULS_71	8.25	14.85
Upper Little Sugar Creek	W_ULS_74	12.23	22.02
Upper Little Sugar Creek	W_ULS_77	18.46	33.23
Upper Little Sugar Creek	W_ULS_78	12.87	23.17
Upper Little Sugar Creek	W_ULS_8	48.19	86.74
Upper Little Sugar Creek	W_ULS_83	24.74	44.52
Upper Little Sugar Creek	W_ULS_84	14.05	25.29
Upper Little Sugar Creek	W_ULS_9	32.54	58.57
Upper Little Sugar Creek	W_ULS_95	32.02	57.64
Upper Little Sugar Creek	W_ULS_96	20.11	36.20
Upper Little Sugar Creek	W_ULS_97	19.99	35.98
Upper Little Sugar Creek	W_ULS_98	57.64	103.76

Appendix C: Precipitation Gage Location Map



Legend

CRN_Gages

Major Roads

Streams

Subbasins

City Limits

County Limits

Mecklenburg County Gage Weights - Little Sugar Creek & Briar Creek Subbasins

CHARLOTTE.

Dewberry®

3,000 1,500 0 3,000 6,000 Feet