

## **APPENDIX E**

### **Flows Comparison between FEMA FIS and Final HEC- HMS Model**

The FIS reported peak discharge was computed using the TR-20 model (5). The flows generated from the TR-20 model used for the LOMR, when compared to the StreamStats results, were high as shown in Table 1. Therefore, the backup TR-20 data was requested and reviewed against other data to determine where a discrepancy may exist. The StreamStats program printouts at the locations in Table 1 are contained in the end of this appendix.

**Table 1 – Comparison of FEMA Flow and StreamStats Flows**

<b>Flooding Location</b>	<b>DA (mi<sup>2</sup>)</b>	<b>FIS 100-yr flow</b>	<b>DA (mi<sup>2</sup>)</b>	<b>NSS 100-yr flow</b>	<b>diff % (NSS-FIS) / FIS x 100</b>
SHALLCROSS LAKE					
BRANCH NO. 1 at confluence with Shallcross Lake	1.9	2,200	1.9	712	-68%
BRANCH NO.2 at confluence with Shallcross Lake Branch No.1	0.2	200	0.2	141	-30%
BRANCH NO.3 at confluence with Shallcross Lake Branch No.1	0.2	420	0.2	148	-65%
BRANCH NO.4 at confluence with Shallcross Lake	0.2	300	0.1	88	-71%
BRANCH NO.5 at confluence with Shallcross Lake	1.2	1,200	0.9	461	-62%
BRANCH NO.6 at confluence with Shallcross Lake Branch No. 5	0.5	450	0.6	288	-36%
<b>SPRING MILL BRANCH at the confluence with Shallcross Lake</b>	<b>0.42*</b>	<b>449</b>	<b>2.2</b>	<b>841</b>	<b>87%</b>
SPRING MILL BRANCH at a point approximately 2,500 feet upstream of Cedar Land Road	1.4	1,116	1.3	539	-52%

\*This drainage area appears to be incorrect. The drainage area should be greater than 1.4 square miles since this location is downstream of Cedar Lane.

In the FIS, the drainage area (0.42\*) for the location “SPRING MILL BRANCH at the confluence with Shallcross Lake” appears to be in error since it is downstream of Cedar Lane Road, which has a drainage area to it greater than 1.4 square miles according to the FIS. StreamStats calculated a drainage area of 2.2 square miles to “SPRING MILL BRANCH at the confluence with Shallcross Lake.” The 100-year 24-hour rainfall amount utilized in the TR-20 model was 7.5 inches, whereas the new data supplied by DNREC is 8.0 inches. On the surface, based upon the discrepancy in drainage area and less precipitation, one would expect the TR-20 flows to be low.

In analyzing the data, there was no evidence that the TR-20 model had been calibrated. Curve numbers and lag times were generated and input directly into the model. How the curve numbers and lag times were determined could also not be verified. In comparing the lag time of each subbasin in the TR-20 model to the lag time calculated using the lag equation published in the National Engineering Handbook (NEH) Section 4 Chapter 15 (6), it was found that the Lag

time used in the TR-20 model was fairly short. Table 2 lists the lag time values for the above mentioned two sources.

**Table 2 – Lag Time**

<b>TR-20 Subbasin ID</b>	<b>Lag Time*, hr Reported by TR-20 (hr)</b>	<b>Lag Time calculated using Lag Equation reported by NEH (hr)</b>
Runoff 001	0.60	0.96
Runoff 002	0.60	1.39
Runoff 005	0.30	0.83
Runoff 008	0.48	

\*In TR-20, Time of Concentration ( $T_c$ ) is used as input. Lag time is  $0.6 * T_c$ .

A comparison of the HMS results with the FIS and StreamStats results can be found in Table 3. Subwatersheds were not created at each FIS location, since this would have created too many subwatersheds to be manageable, and the goal of this modeling is to create a watershed-wide stormwater management plan. The drainage area to “BRANCH NO. 1 at confluence with Shallcross Lake” is slightly lower than the drainage area calculated by StreamStats. The reason for this discrepancy is that StreamStats calculates drainage areas somewhat differently than GeoHMS does.

**Table 3 – Comparison of FIS, StreamStats and HMS 100-year flows**

Flooding Location	FEMA		NSS		HMS		
	DA (mi2)	FIS 100-yr Flow (cfs)	DA (mi2)	NSS 100-yr Flow (cfs)	HMS ID	DA (mi2)	Estimation 100-yr HMS Flow (cfs)
SHALLCROSS LAKE							
BRANCH NO. 1 at confluence with Shallcross Lake	1.9	2,200	1.9	712	R20	1.4	1,116
BRANCH NO.2 at confluence with Shallcross Lake Branch No.1	0.2	200	0.2	141	NA	NA	NA
BRANCH NO.3 at confluence with Shallcross Lake Branch No.1	0.2	420	0.2	148	NA	NA	NA
BRANCH NO.4 at confluence with Shallcross Lake	0.2	300	0.1	88	NA	NA	NA
BRANCH NO.5 at confluence with Shallcross Lake	1.2	1,200	0.9	461	W590	1.0	612
BRANCH NO.6 at confluence with Shallcross Lake Branch No. 5	0.5	450	0.6	288	NA	NA	NA
SPRING MILL BRANCH at the confluence with Shallcross Lake	0.4*	449	2.2	841	R60	2.0	892
SPRING MILL BRANCH at a point approximately 2,500 feet upstream of Cedar Land Road	1.4	1,116	1.3	539	NA	NA	NA

cfs = cubic feet per second

N/A – Data not available

\*This drainage area appears to be incorrect. The drainage area should be greater than 1.4 square miles since this location is downstream of Cedar Lane.

## **StreamStats Results at FEMA FIS Location for Comparative Purposes**



# StreamStats

## Streamflow Statistics Report

Shallcross Lake Br. No. 1  
 @ Shallcross Lake

Date: Wed Jun 11 2008 07:20:01

Site Location: Delaware

Latitude: 39.4874

Longitude: -75.6857

Drainage Area: 1.89 mi<sup>2</sup>

Peak Flow Basin Characteristics			
100% Coastal Plain Region (1.89 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	1.89	0.51	117
Mean Basin Slope from 10m DEM (percent)	1.22	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	155		0.8		
PK5	262		1.6		
PK10	350		2.4		
PK25	480		3.5		
PK50	590		4.2		
PK100	712		4.8		
PK200	849		5.2		
PK500	1050		5.6		



## Basin Characteristics Report

Shelcross Lake Br No 1  
@ Shelcross Lake

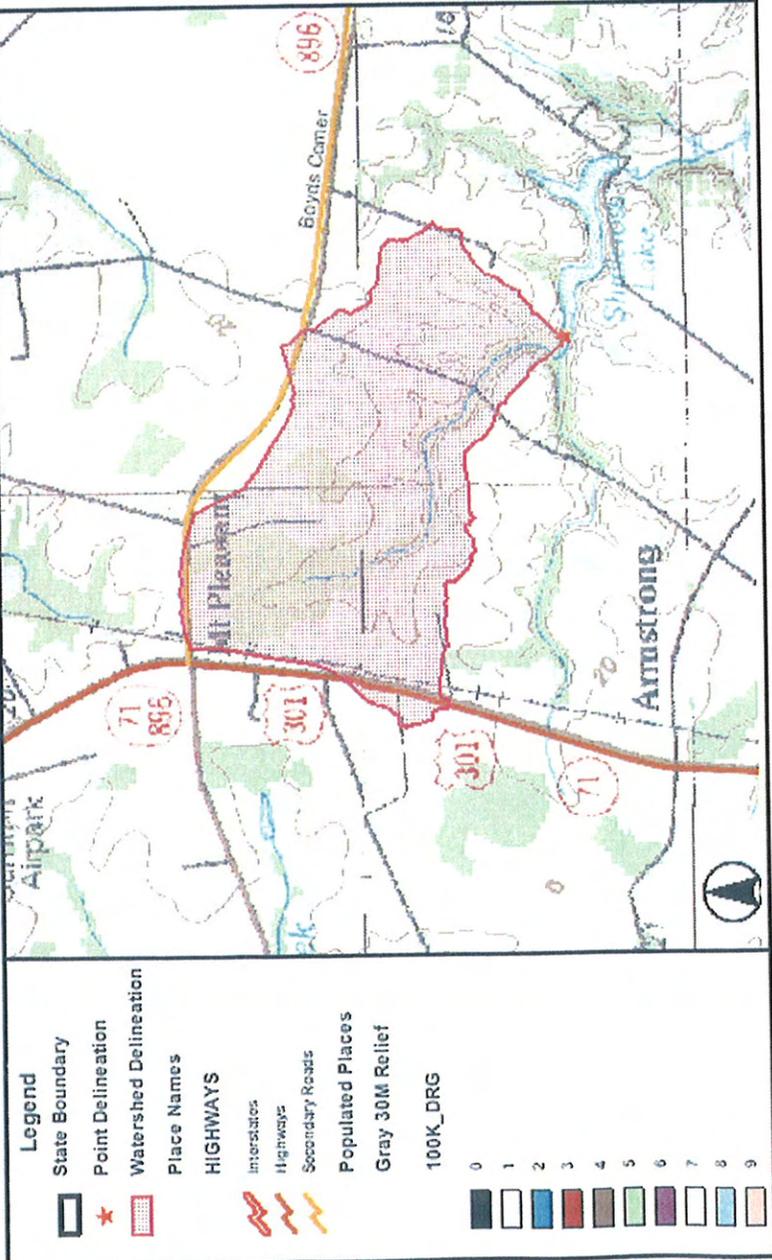
Date: Wed Jun 11 2008 07:20:48

Latitude (NAD83): 39.4874 (39 29 14)

Longitude (NAD83): -75.6857 (-75 41 08)

Parameter	Value
Area that drains to a point on a stream, in square miles	1.89
Mean basin slope computed from 10 m DEM	1.22
Percentage of area covered by forest	13
_2000 housing density in homes per acre	0.0794
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	0.61
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	2.17

# Shallcross Lake Br. No. 1 @ Shallcross Lake



**Legend**

- State Boundary
- Point Delineation
- Watershed Delineation
- Place Names

**HIGHWAYS**

- Interstates
- Highways
- Secondary Roads

**Populated Places**

**Gray 30M Relief**

**100K\_DRG**

0
1
2
3
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5
6
7
8
9



# StreamStats

## Streamflow Statistics Report

Shallcross Lake Br. No. 2 @  
confluence w/ Br. No. 1

Date: Wed Jun 11 2008 08:02:19

Site Location: Delaware

Latitude: 39.4923

Longitude: -75.6881

Drainage Area: 0.2 mi<sup>2</sup>

Peak Flow Basin Characteristics			
100% Coastal Plain Region (0.2 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	0.2 (below min value 0.51)	0.51	117
Mean Basin Slope from 10m DEM (percent)	1.16	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	31		0.8		
PK5	52.3		1.6		
PK10	70.1		2.4		
PK25	95.8		3.5		
PK50	117		4.2		
PK100	141		4.8		
PK200	167		5.2		
PK500	205		5.6		



## Basin Characteristics Report

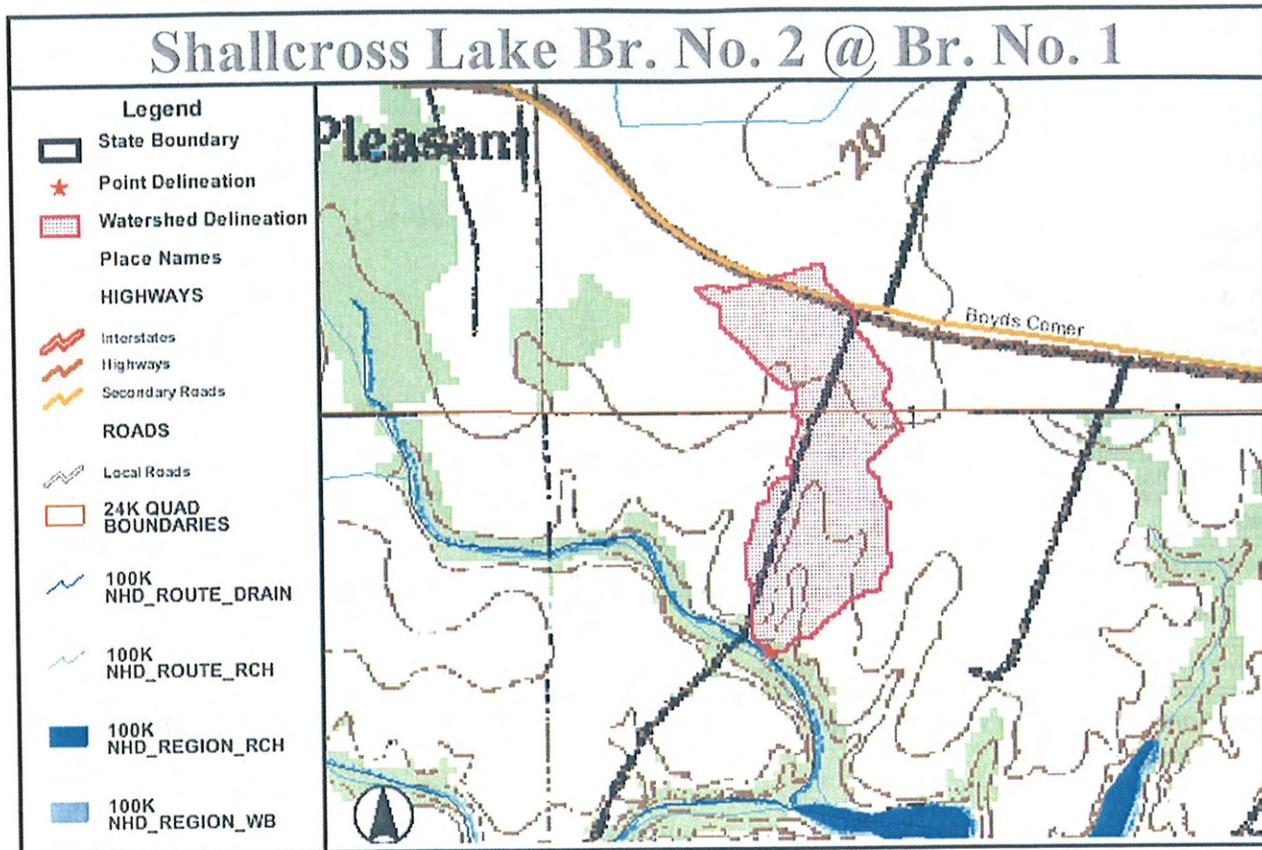
Shallcross Lake Br No 2. B  
Confluence w/ Br. No 1.

Date: Wed Jun 11 2008 08:03:42

Latitude (NAD83): 39.4923 (39 29 32)

Longitude (NAD83): -75.6881 (-75 41 16)

Parameter	Value
Area that drains to a point on a stream, in square miles	0.21
Mean basin slope computed from 10 m DEM	1.16
Percentage of area covered by forest	4.26
_2000 housing density in homes per acre	0.0794
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	1.3
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0





# StreamStats

## Streamflow Statistics Report

Shallcross Lake Br. No 3 @  
confluence w/ br. No 1.

Date: Wed Jun 11 2008 08:12:31

Site Location: Delaware

Latitude: 39.4892

Longitude: -75.6857

Drainage Area: 0.2 mi<sup>2</sup>

Peak Flow Basin Characteristics			
100% Coastal Plain Region (0.2 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	0.2 (below min value 0.51)	0.51	117
Mean Basin Slope from 10m DEM (percent)	1.38	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	32.6		0.8		
PK5	55		1.6		
PK10	73.6		2.4		
PK25	101		3.5		
PK50	123		4.2		
PK100	148		4.8		
PK200	176		5.2		
PK500	217		5.6		



# StreamStats

## Basin Characteristics Report

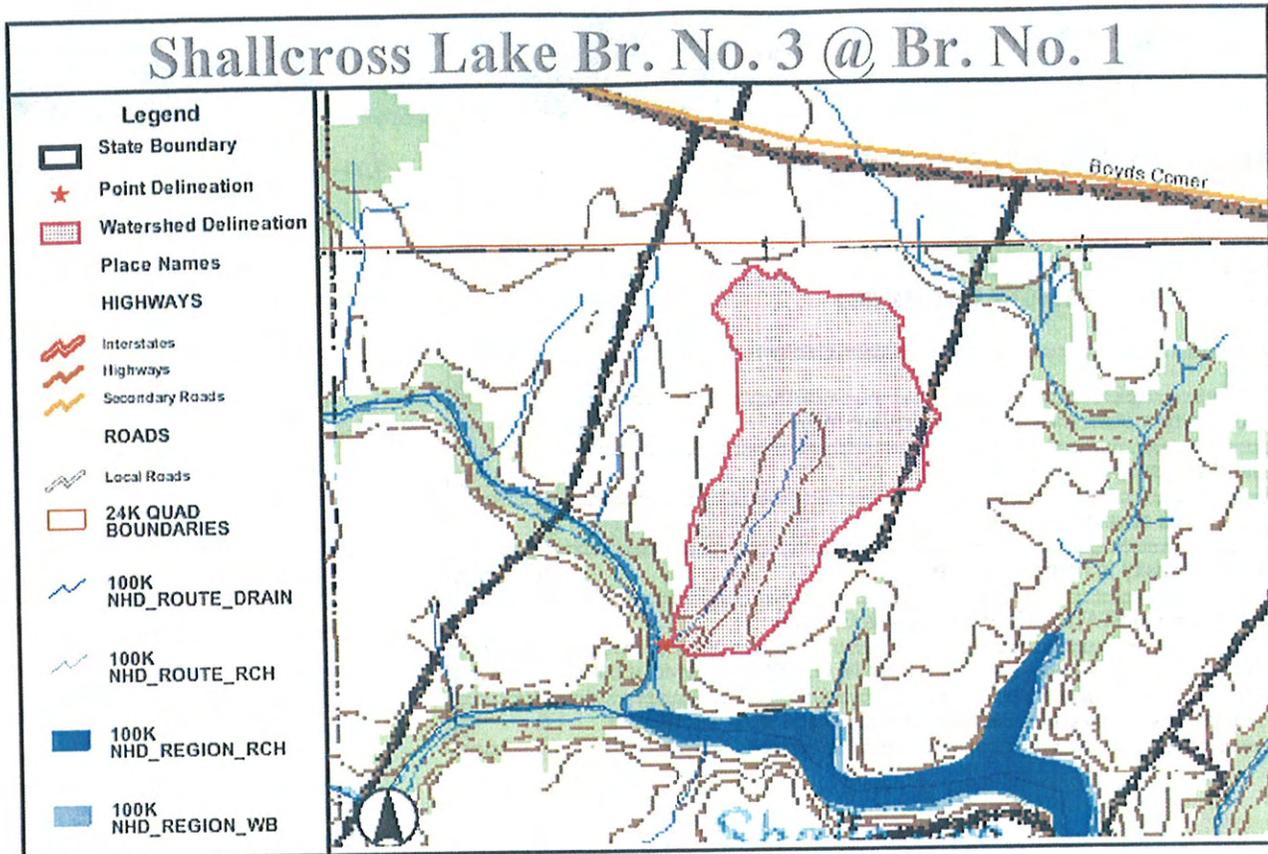
Shallowcross Lake for No. 3 @  
Confluence of Br. No 1.

Date: Wed Jun 11 2008 08:13:50

Latitude (NAD83): 39.4892 (39 29 21)

Longitude (NAD83): -75.6857 (-75 41 08)

Parameter	Value
Area that drains to a point on a stream, in square miles	0.21
Mean basin slope computed from 10 m DEM	1.38
Percentage of area covered by forest	6.3
_2000 housing density in homes per acre	0.0797
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	0.27
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0





## Streamflow Statistics Report

Shallcross Lake Dr. No. 4  
 Confluence of Shallcross Lake

Date: Wed Jun 11 2008 07:51:05

Site Location: Delaware

Latitude: 39.4873

Longitude: -75.6800

Drainage Area: 0.07 mi<sup>2</sup>

Peak Flow Basin Characteristics			
100% Coastal Plain Region (0.07 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	0.07 (below min value 0.51)	0.51	117
Mean Basin Slope from 10m DEM (percent)	2.92	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	19.4		0.8		
PK5	32.5		1.6		
PK10	43.4		2.4		
PK25	59.4		3.5		
PK50	73.1		4.2		
PK100	87.8		4.8		
PK200	105		5.2		
PK500	129		5.6		



## Basin Characteristics Report

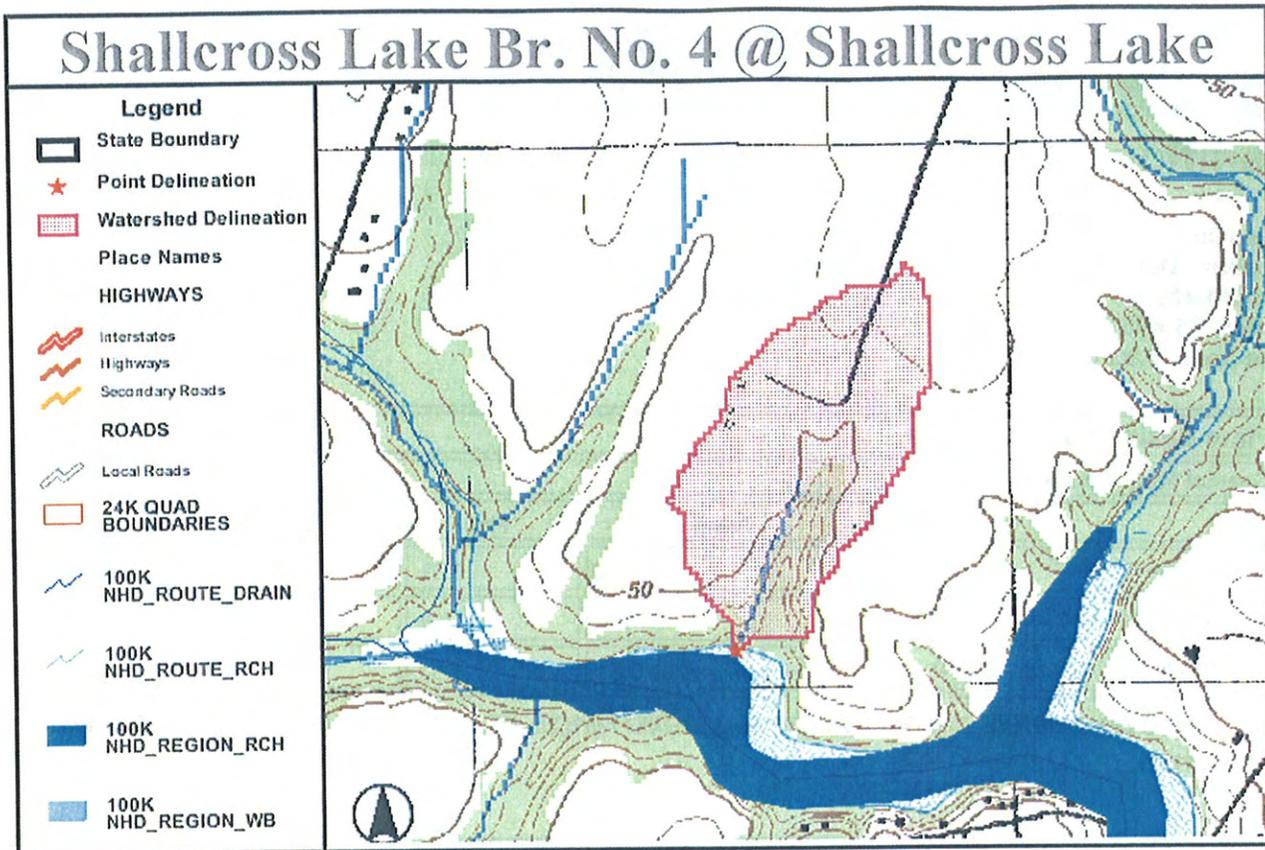
*Shallcross Lake Br. No. 4 @  
confluence of Shallcross Lake*

Date: Wed Jun 11 2008 07:53:12

Latitude (NAD83): 39.4873 (39 29 14)

Longitude (NAD83): -75.6800 (-75 40 48)

Parameter	Value
Area that drains to a point on a stream, in square miles	0.0773
Mean basin slope computed from 10 m DEM	2.92
Percentage of area covered by forest	15.6
_2000 housing density in homes per acre	0.0797
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	0
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0.0499





# Streamflow Statistics Report - Shallcross Lake - Trib. 5 at Confluence w/ Shall Cross Lake

**Date:** Wed Jun 11 2008 06:43:04  
**Site Location:** Delaware  
**Latitude:** 39.4894  
**Longitude:** -75.6719  
**Drainage Area:** 0.92 mi<sup>2</sup>

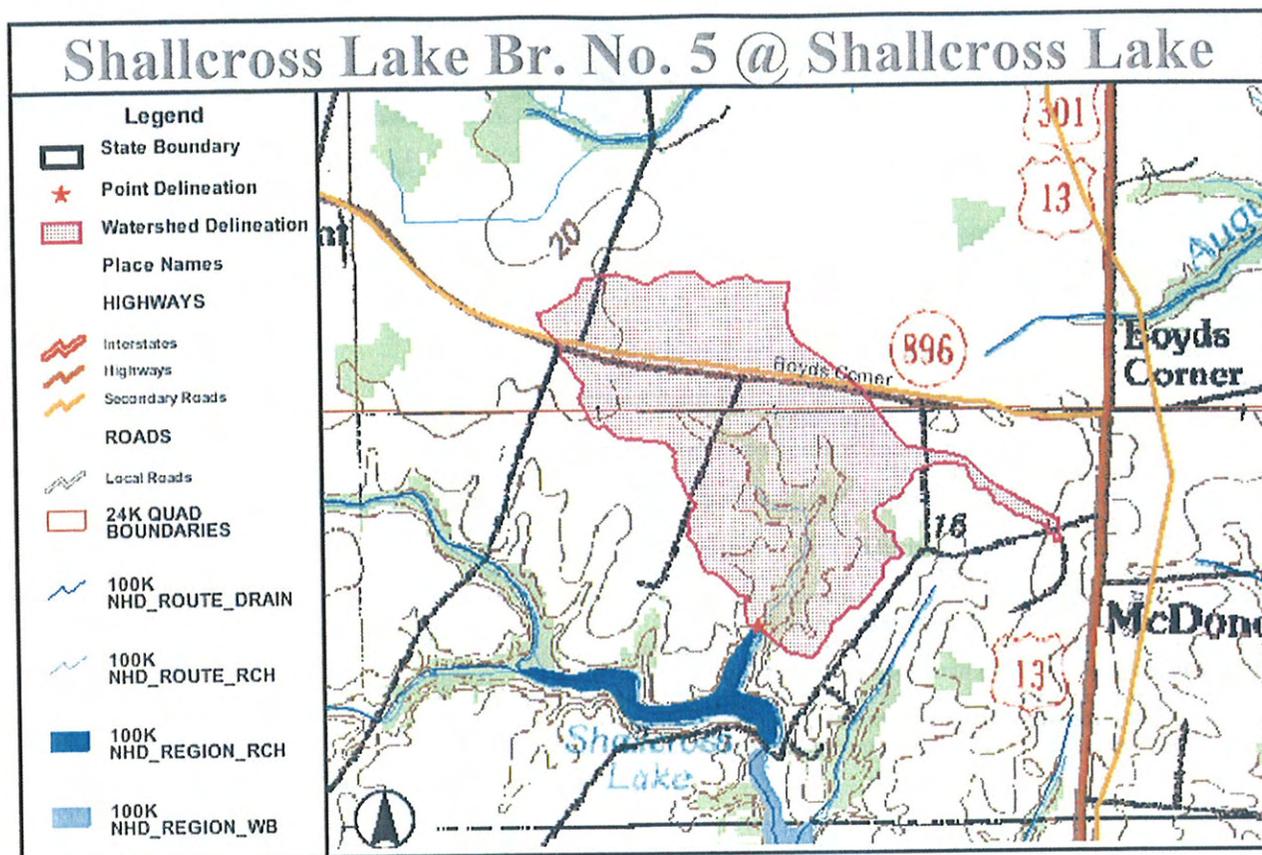
Peak Flow Basin Characteristics			
100% Coastal Plain Region (0.92 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	0.92	0.51	117
Mean Basin Slope from 10m DEM (percent)	1.59	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	101		0.8		
PK5	169		1.6		
PK10	226		2.4		
PK25	311		3.5		
PK50	382		4.2		
PK100	461		4.8		
PK200	549		5.2		
PK500	681		5.6		

**StreamStats****Basin Characteristics Report***Shallcross Lake Trib No 5 at  
Confluence w/ Shallcross Lake***Date: Wed Jun 11 2008 07:32:30****Latitude (NAD83): 39.4893 (39 29 21)****Longitude (NAD83): -75.6718 (-75 40 18)**

Parameter	Value
Area that drains to a point on a stream, in square miles	0.92
Mean basin slope computed from 10 m DEM	1.59
Percentage of area covered by forest	4.3
_2000 housing density in homes per acre	0.0771
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	0.49
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0.0669





# StreamStats

## Streamflow Statistics Report

Shall Cross Lake Br No. 6 @  
Br. No. 5

Date: Wed Jun 11 2008 07:35:48

Site Location: Delaware

Latitude: 39.4949

Longitude: -75.6689

Drainage Area: 0.57 mi<sup>2</sup>

Peak Flow Basin Characteristics			
100% Coastal Plain Region (0.57 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	0.57	0.51	117
Mean Basin Slope from 10m DEM (percent)	1.05	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	63.1		0.8		
PK5	107		1.6		
PK10	143		2.4		
PK25	196		3.5		
PK50	240		4.2		
PK100	288		4.8		
PK200	342		5.2		
PK500	422		5.6		



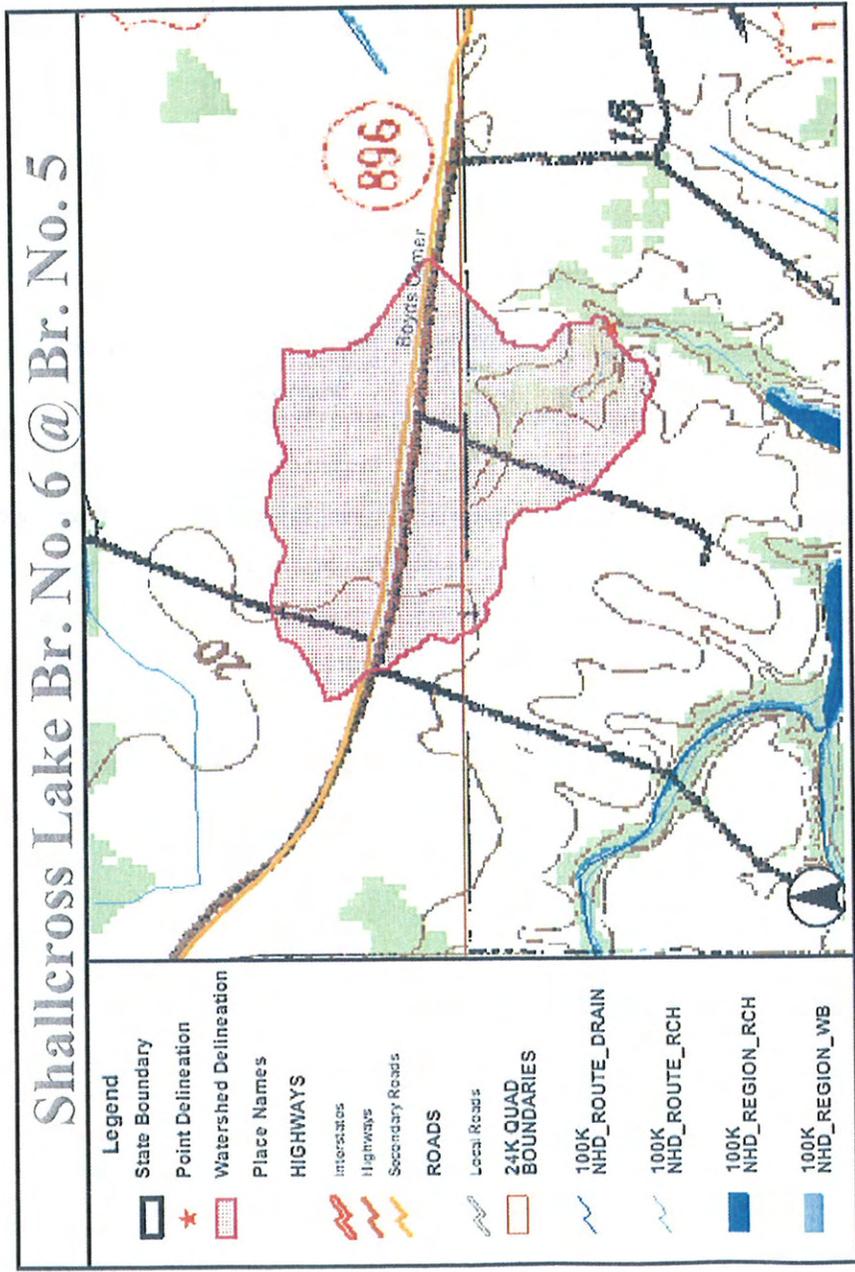
## Basin Characteristics Report

Date: Wed Jun 11 2008 07:36:28

Latitude (NAD83): 39.4949 (39 29 41)

Longitude (NAD83): -75.6689 (-75 40 08)

Parameter	Value
Area that drains to a point on a stream, in square miles	0.57
Mean basin slope computed from 10 m DEM	1.05
Percentage of area covered by forest	0.54
_2000 housing density in homes per acre	0.0756
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	0.76
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0





# Streamflow Statistics Report

Spring Mill Br. @  
Shallcross Lake

Date: Wed Jun 11 2008 08:58:14  
 Site Location: Delaware  
 Latitude: 39.4873  
 Longitude: -75.6872  
 Drainage Area: 2.24 mi<sup>2</sup>

Peak Flow Basin Characteristics			
100% Coastal Plain Region (2.24 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	2.24	0.51	117
Mean Basin Slope from 10m DEM (percent)	1.42	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	183		0.8		
PK5	308		1.6		
PK10	412		2.4		
PK25	566		3.5		
PK50	696		4.2		
PK100	841		4.8		
PK200	1000		5.2		
PK500	1250		5.6		

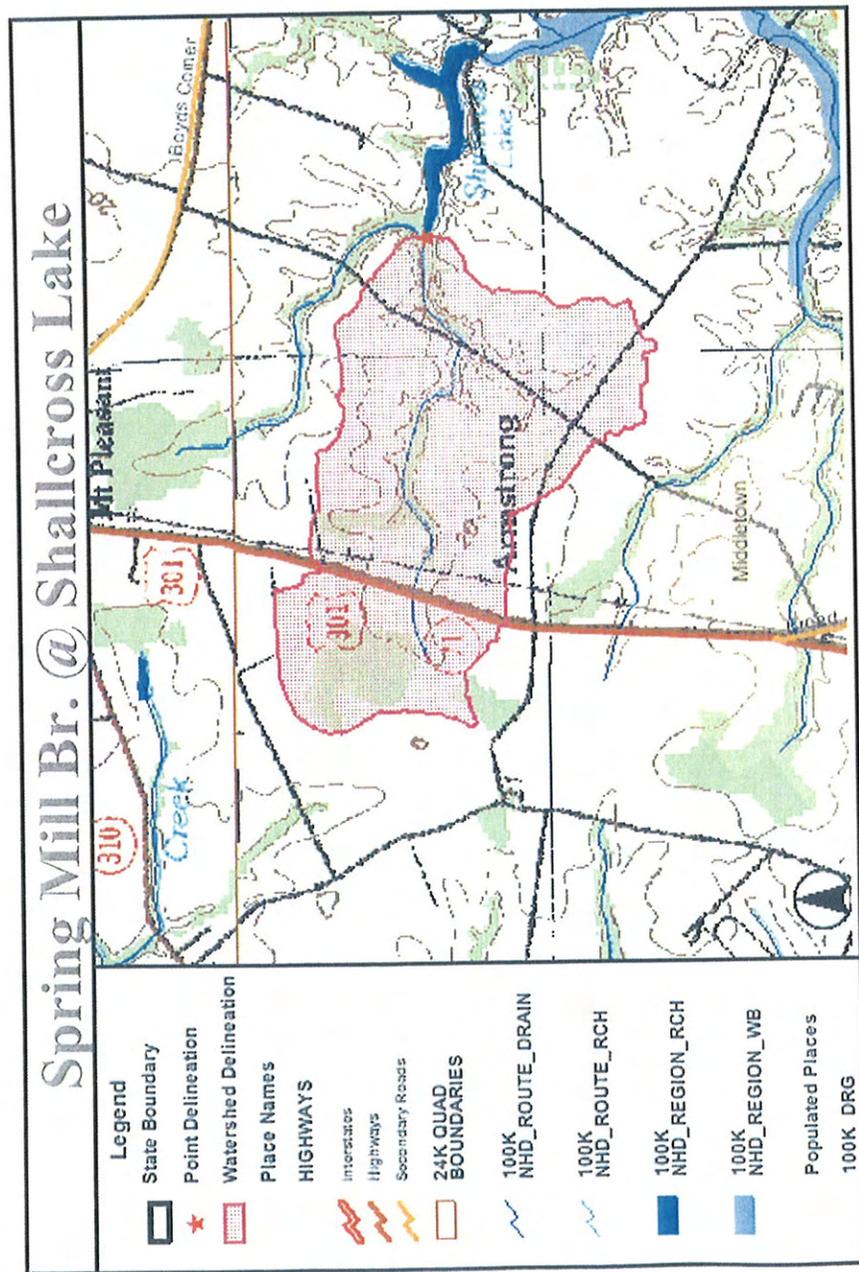
**StreamStats**

## Basin Characteristics Report

Spring Mill Br B  
Shallcross Lake

**Date: Wed Jun 11 2008 08:59:52****Latitude (NAD83): 39.4873 (39 29 14)****Longitude (NAD83): -75.6872 (-75 41 13)**

Parameter	Value
Area that drains to a point on a stream, in square miles	2.24
Mean basin slope computed from 10 m DEM	1.42
Percentage of area covered by forest	8.61
_2000 housing density in homes per acre	0.0773
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	0.33
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0.58





# Streamflow Statistics Report

Spring Mill Br. @  
2500' US of Cedar Lane

**Date:** Wed Jun 11 2008 09:02:33  
**Site Location:** Delaware  
**Latitude:** 39.4856  
**Longitude:** -75.6999  
**Drainage Area:** 1.32 mi<sup>2</sup>

Peak Flow Basin Characteristics			
100% Coastal Plain Region (1.32 mi <sup>2</sup> )			
Parameter	Value	Min	Max
Drainage Area (square miles)	1.32	0.51	117
Mean Basin Slope from 10m DEM (percent)	1.14	0.3	3.69
Percent Hydrologic Soil Type A (percent)	0 (below min value 0.53)	0.53	60

*Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.*

Streamflow Statistics					
Statistic	Flow (ft <sup>3</sup> /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	118		0.8		
PK5	199		1.6		
PK10	266		2.4		
PK25	365		3.5		
PK50	447		4.2		
PK100	539		4.8		
PK200	642		5.2		
PK500	794		5.6		



## Basin Characteristics Report

Spring Mill Br B  
2500 W.S. of Cedar Lane

Date: Wed Jun 11 2008 09:03:15  
Latitude (NAD83): 39.4856 (39 29 08)  
Longitude (NAD83): -75.6999 (-75 41 59)

Parameter	Value
Area that drains to a point on a stream, in square miles	1.32
Mean basin slope computed from 10 m DEM	1.14
Percentage of area covered by forest	10.8
_2000 housing density in homes per acre	0.0756
Percentage of area in STATSGO Hydrologic Soils Group A	0
Percentage of impervious area determined from NLCD 2001 impervious dataset	0.52
Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0.76

