North Central Texas Council of Governments

Integrating Transportation and Stormwater Infrastructure

Hydrology Modeling Updates for the Village Creek Watershed

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integrating Transportation & Stormwater Infrastructure

Integrating Transportation and Stormwater Infrastructure (TSI)

HEC-HMS Modeling for the Village Creek Watershed

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1 Executive Summary

NOTE: The goal of this study was to enhance the InFRM Trinity WHA HEC-HMS model by incorporating additional subbasins and reach locations to better calculate flows for the TSI project. The process will unfold in several stages:

1. First, using the WHA model as a baseline, a 2016 existing conditions model was developed in HEC-HMS version 4.11. This 2016 existing conditions model divides 2 of the 3 large WHA basins that make up the Village Creek Watershed (Village_CK_S010 & Village_CK_S020) into 105 smaller subbasins. Only the basin encompassing Lake Arlington (Lake_Arlington_S010) was left with the same area as the WHA basins as Lake Arlington is downstream of the TSI study area. After this model was developed, it was then ran and calibrated to align with the InFRM WHA HEC-HMS results at a shared location.

2. After the 2016 model was calibrated, it was then used as a baseline in creating the 2020 model. The main difference being that the impervious cover was updated to match 2020 conditions.

3. Lastly, a future conditions model was created using 2070 land use projections and an future lag time calculations.

These models will serve two primary purposes: (1) to provide flow inputs for the TSI HEC-RAS models, and (2) to help optimize project alternatives, such as potential detention locations.

2 Data Sources

Many different data types were used in the effort to complete this modeling. The data and the description of the data used can be found in the table below.

2.1 GIS Data

Table 2-1. GIS Data Sources

Data Type	Data Source	Description of the Data
Terrain – DEM tiff file of the West TSI study area with a 30-ft cell that was generated from the 2021 TWDB seamless statewide LiDAR data.		
Stream Centerlines – There were 2 different kind of stream centerlines that was considered while creating the model. One shapefile is a terrain derived stream centerline layer from the Trinity FFRD study while the other is from the NHD flow lines. The NHD was the shapefile that was used for the main stem, however the FFRD shapefile was considered for the unnamed tributaries within the study region.		
Roads – Future conditions 2045 TX DOT roads, which included the existing TSDOT roads as well as planned future roads.		
Bridges – Location of existing TXDOT bridges.		
Percent Impervious – There were 3 different kinds of impervious covers used to complete the model. The 2016 impervious cover raster that was used in the InFRM WHA. The 2020 impervious raster provided by NCTCOG for the TSI project & The 2070 percent impervious raster, made from the combined land use data from the NCTCOG and EPA ICLUS. In addition to this, a future percent urban raster developed from the same NCTCOG and EPA ICLUS land use data was used to help estimate lag time in 2070 conditions.		
Dams – Existing Dam locations from the National Inventory of Dams.		
Reservoirs – A polygon shapefile of the major lakes and reservoirs in the Trinity River basin.		

2.2 HEC-HMS data from Existing models

As mentioned earlier the Trinity InFRM WHA model was used as a baseline in developing this portion of the TSI Village Creek model. There are 289 basins in the Trinity InFRM WHA model and out of those 289 basins, 3 of them were extracted and studied in greater detail as a part of this study for Village Creek.

3 HEC-HMS Initial Model Development

3.1 HEC-HMS Subbasin Locations

Potential subbasin outlet locations were identified and positioned based on the guidelines and priorities outlined below. These locations were reviewed and approved by the TSI H&H team, including representatives from UTA, TRWD, and NCTCOG. A point was placed at the intersection of each feature with the stream centerlines layer. Engineering judgment was used to ensure that the drainage areas and number of subbasins remained reasonable. Efforts were made to keep the subbasin areas between 1 and 5 square miles, with smaller subbasins being designated for areas with higher urban development, both for existing and future conditions.

Priorities for Subbasin Locations:

1. USGS Gages and/or WHA subbasin outlets
2. Above Significant Stream Confluences – points were placed on each stream just above the confluences, according to the stream centerlines file.
3. At Existing Dams – points were placed at the locations of existing dams, according to the NID layer, unless the dam did not appear to significantly impact flow or the NID attributes showed negligible flood storage capacity.
4. At Existing Bridges - points were placed where the streams intersected with the Existing TxDOT bridge layer. Engineering judgement was used to select bridge locations with the potential for upstream detention.
5. At Future Roads - points were placed where the streams intersected with the Future Road locations 2045 layer. Engineering judgement was used to select bridge locations with the potential for upstream detention.

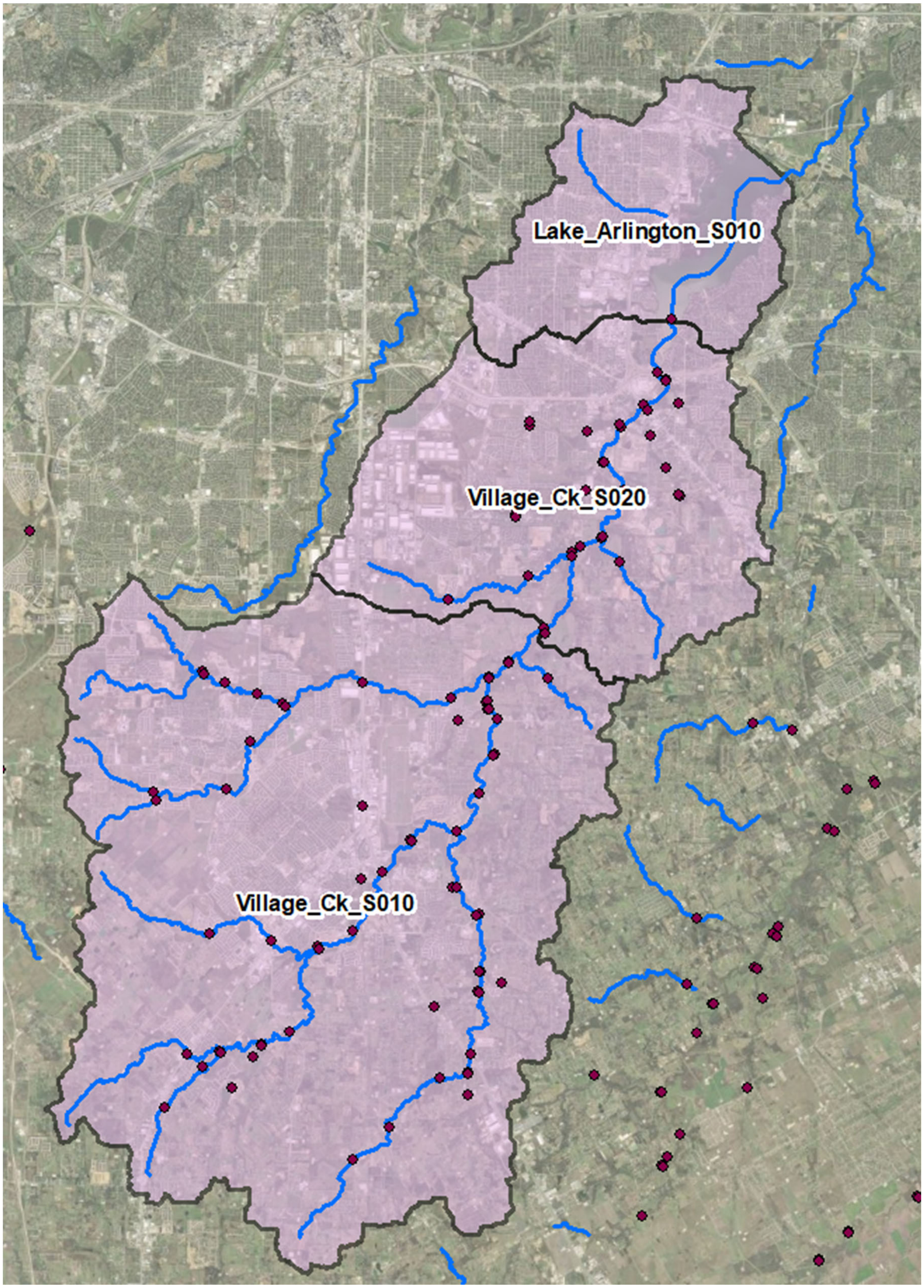


Figure 3-1. HEC-HMS Subbasin Locations for TSI Village Creek

3.2 HEC-HMS Subbasin Delineations

After identifying the desired subbasin outlet locations, the subbasins for Village Creek were delineated using the GIS tools in HEC-HMS version 4.11. The three WHA basins in the Village Creek study area were Village_CK_S010, Village_CK_S020 & Lake_Arlington_S010. Village_CK_S010 was broken up into 73 smaller subbasins while Village_CK_S020 was divided into 32 subbasins. Along with additional subbasins, additional reaches were also inserted to better calculate the peak flows within the model. Figure 3-2 shows the WHA model subbasins vs the final TSI subbasins for Village Creek.

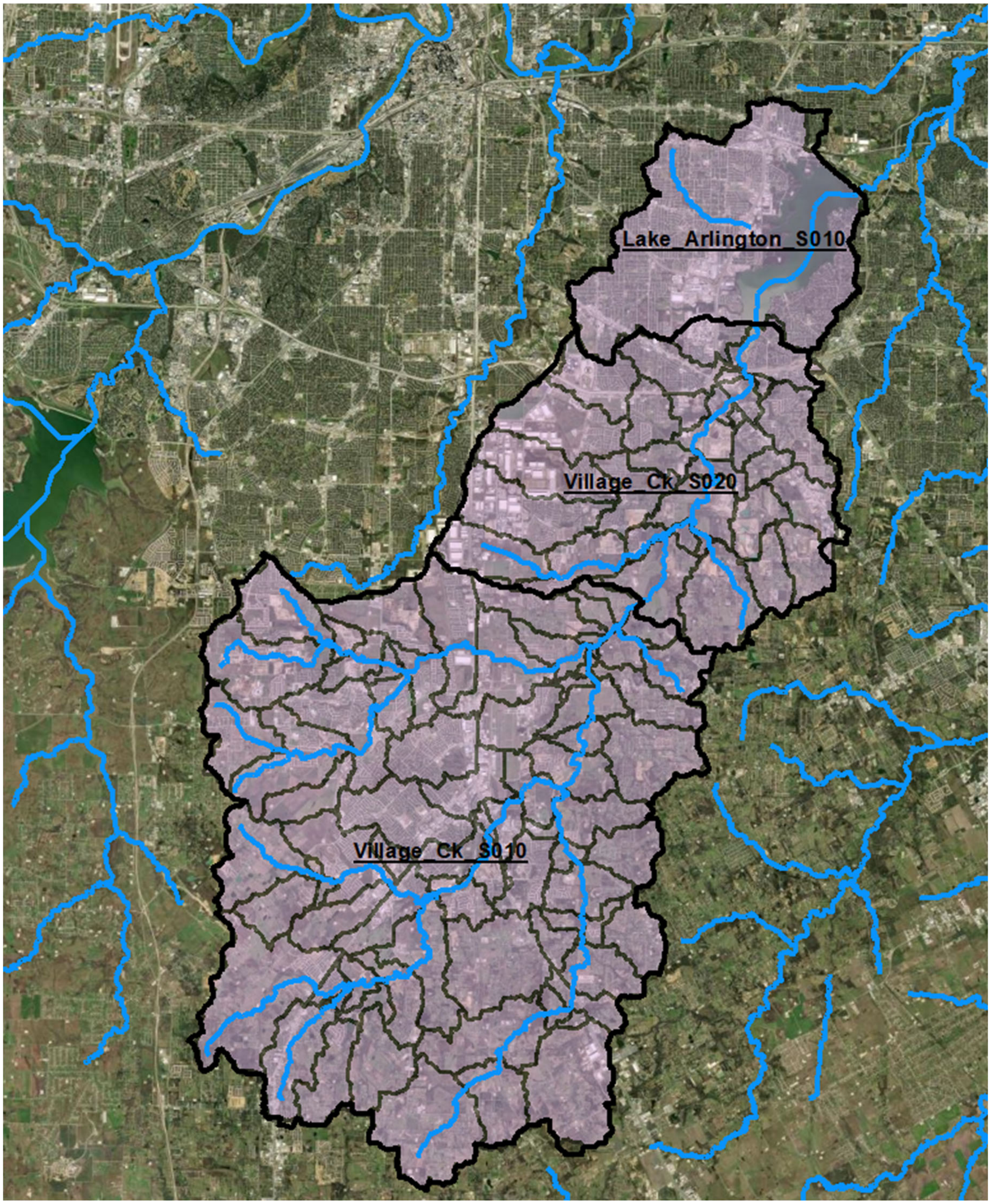


Figure 3-2. HEC-HMS Final Subbasin Delineation for TSI's Village Creek area.

Table 3-2. Village Creek HEC-HMS Subbasins

Subbasin	Area, mi^2	Subbasin	Area, mi^2	Subbasin	Area, mi^2	Subbasin	Area, mi^2
VILLAGE_CK_S101	2.69	Blue_Cr_S40	1.29	West_Fork_S90	0.18	West_Fork_S120	0.60
VILLAGE_CK_S102	3.88	Blue_Cr_S50	0.12	West_Fork_S100	0.22	West_Fork_S140	3.97
VILLAGE_CK_S100	1.51	Blue_Cr_S60	0.71	Dry_Fork_S10	0.82	West_Fork_S130	2.18
WILLOW_CK_S110	1.56	West_Fork_S50	1.04	Dry_Fork_S20	0.98	Derrett_Cr_S30	3.41
VILLAGE_CK_S110	1.17	West_Fork_S60	4.14	West_Fork_S110	1.68	Derrett_Cr_S40	0.63
VILLAGE_CK_S120	0.06	West_Fork_S70	2.78	Oates_Branch_S10	1.66	Derrett_Cr_S50	0.77
VILLAGE_CK_S125	3.28	West_Fork_S80	0.84	Oates_Branch_S20	0.84	Derrett_Cr_S60	1.50
VILLAGE_CK_S130	2.07	Hog_Branch_S10	1.82	Oates_Brannch_S30	1.62	Briar_Cr_S10	5.48
VILLAGE_CK_S140	0.92	Hog_Branch_S20	4.57	Oates_Branch_S40	1.03	Briar_Cr_S20	2.72
SHANNON_CK_S100	2.37	Hog_Brach_S30	3.94	Oates_Branch_S50	1.84	West_Fork_S160	1.79
SHANNON_CK_S101	2.69	Blue_Cr_S40	1.29	West_Fork_S90	0.18	West_Fork_S120	0.60
SHANNON_CK_S110	3.88	Blue_Cr_S50	0.12	West_Fork_S100	0.22	West_Fork_S140	3.97
SHANNON_CK_S120	1.51	Blue_Cr_S60	0.71	Dry_Fork_S10	0.82	West_Fork_S130	2.18
SHANNON_CK_S125	1.56	West_Fork_S50	1.04	Dry_Fork_S20	0.98	Derrett_Cr_S30	3.41
SHANNON_CK_S126	1.17	West_Fork_S60	4.14	West_Fork_S110	1.68	Derrett_Cr_S40	0.63
SHANNON_CK_S130	0.06	West_Fork_S70	2.78	Oates_Branch_S10	1.66	Derrett_Cr_S50	0.77
VILLAGE_CK_S150	3.28	West_Fork_S80	0.84	Oates_Branch_S20	0.84	Derrett_Cr_S60	1.50
VILLAGE_CK_S151	2.07	Hog_Branch_S10	1.82	Oates_Brannch_S30	1.62	Briar_Cr_S10	5.48
VILLAGE_CK_S155	0.92	Hog_Branch_S20	4.57	Oates_Branch_S40	1.03	Briar_Cr_S20	2.72
VILLAGE_CK_S160	2.37	Hog_Brach_S30	3.94	Oates_Branch_S50	1.84	West_Fork_S160	1.79
West_Fork_S170	1.42						
WILLOW_CK_S100	2.69	Blue_Cr_S40	1.29	West_Fork_S90	0.18	West_Fork_S120	0.60
VILLAGE_CK_S180	3.88	Blue_Cr_S50	0.12	West_Fork_S100	0.22	West_Fork_S140	3.97
VILLAGE_CK_S178	1.51	Blue_Cr_S60	0.71	Dry_Fork_S10	0.82	West_Fork_S130	2.18
VILLAGE_CK_S179	1.56	West_Fork_S50	1.04	Dry_Fork_S20	0.98	Derrett_Cr_S30	3.41
VILLAGE_CK_S190	1.17	West_Fork_S60	4.14	West_Fork_S110	1.68	Derrett_Cr_S40	0.63

3.3 HEC-HMS Initial Parameters

3.3.1 Initial Subbasin Parameters

Percent Imperviousness

The percent impervious for the new subbasins was determined using the WHA's Percent Impervious Data (2016 NLCD percentage). This allowed for an accurate comparison between the existing WHA model and the new detailed model. Later, this percentage was updated with the 2020 and 2070 data from the NCTCOG and EPA ICLUS. A raster file containing the 2016 WHA percent impervious percentage was used with polygon shapefiles of the updated subbasins to calculate a unique percent impervious foreach new subbasin.

Initial and Constant Losses

The same initial and constant losses that were used in the WHA subbasins was assumed in the updated model.

Table 3-2. HEC-HMS Subbasin Loss Parameters

SUBBASIN NAME	100-YR INITIAL LOSS (in)	CONSTANT LOSS (in)	PERCENT IMPERVIOUS (2016)
DEER_CK_S100	0.99	0.09	29
DEER_CK_S105	0.99	0.09	6
DEER_CK_S110	0.99	0.09	22
DEER_CK_S120	0.99	0.09	18
DEER_CK_S130	0.99	0.09	12
ELM_BRANCH_CK_S100	0.83	0.09	4
ELM_BRANCH_CK_S110	0.83	0.09	2
N_DEER_CK_S100	0.99	0.09	16
N_DEER_CK_S101	0.99	0.09	7
N_DEER_CK_S110	0.99	0.09	3
N_DEER_CK_S120	0.99	0.09	19
N_DEER_CK_S130	0.99	0.09	26
QUIL_MILLER_CK_S100	0.99	0.09	2
QUIL_MILLER_CK_S110	0.99	0.09	2
QUIL_MILLER_CK_S120	0.99	0.09	1
QUIL_MILLER_CK_S125	0.99	0.09	4
QUIL_MILLER_CK_S130	0.99	0.09	2
QUIL_MILLER_CK_S135	0.99	0.09	6
QUIL_MILLER_CK_S140	0.99	0.09	10
QUIL_MILLER_CK_S145	0.99	0.09	4

SUBBASIN NAME	100-YR INITIAL LOSS (in)	CONSTANT LOSS (in)	PERCENT IMPERVIOUS (2016)
QUIL_MILLER_CK_S150	0.99	0.09	5
QUIL_MILLER_CK_S155	0.99	0.09	8
QUIL_MILLER_CK_S160	0.99	0.09	2
QUIL_MILLER_CK_S162	0.99	0.09	5
QUIL_MILLER_CK_S165	0.99	0.09	6
QUIL_MILLER_CK_S166	0.99	0.09	3
QUIL_MILLER_CK_S170	0.99	0.09	10
QUIL_MILLER_CK_S175	0.99	0.09	23
QUIL_MILLER_CK_S180	0.99	0.09	6
QUIL_MILLER_CK_S190	0.99	0.09	6
SHANNON_CK_S100	0.99	0.09	1
SHANNON_CK_S101	0.99	0.09	2
SHANNON_CK_S110	0.99	0.09	4
SHANNON_CK_S120	0.99	0.09	18
SHANNON_CK_S125	0.99	0.09	9
SHANNON_CK_S126	0.99	0.09	43
SHANNON_CK_S130	0.99	0.09	19
S_DEER_CK_S100	0.99	0.09	8
S_DEER_CK_S110	0.99	0.09	8
S_DEER_CK_S115	0.99	0.09	7
S_DEER_CK_S120	0.99	0.09	32
S_DEER_CK_S130	0.99	0.09	31
S_Subbasin-LA	0.82	0.08	43
VILLAGE_CK_S100	0.99	0.09	19
VILLAGE_CK_S101	0.99	0.09	4
VILLAGE_CK_S102	0.99	0.09	1
VILLAGE_CK_S110	0.99	0.09	2
VILLAGE_CK_S120	0.99	0.09	6
VILLAGE_CK_S125	0.99	0.09	6
VILLAGE_CK_S130	0.99	0.09	4
VILLAGE_CK_S140	0.99	0.09	4
VILLAGE_CK_S150	0.99	0.09	17
VILLAGE_CK_S151	0.99	0.09	41
VILLAGE_CK_S155	0.99	0.09	29
VILLAGE_CK_S160	0.99	0.09	16
VILLAGE_CK_S170	0.99	0.09	40
VILLAGE_CK_S178	0.99	0.09	38
VILLAGE_CK_S179	0.99	0.09	42
VILLAGE_CK_S180	0.99	0.09	34
VILLAGE_CK_S190	0.99	0.09	7
VILLAGE_CK_S200	0.99	0.09	5

SUBBASIN NAME	100-YR INITIAL LOSS (in)	CONSTANT LOSS (in)	PERCENT IMPERVIOUS (2016)
VILLAGE_CK_S205	0.99	0.09	6
VILLAGE_CK_S210	0.99	0.09	4
VILLAGE_CK_S220	0.99	0.09	2
VILLAGE_CK_S225	0.99	0.09	21
VILLAGE_CK_S230	0.99	0.09	16
VILLAGE_CK_S235	0.99	0.09	7
VILLAGE_CK_S236	0.99	0.09	6
VILLAGE_CK_S237	0.99	0.09	2
VILLAGE_CK_S240	0.99	0.09	6
VILLAGE_CK_S245	0.99	0.09	10
VILLAGE_CK_S250	0.99	0.09	0
VILLAGE_CK_S260	0.99	0.09	3
VILLAGE_CK_S270	0.99	0.09	1
VILLAGE_CK_S280	0.83	0.09	3
VILLAGE_CK_S287	0.83	0.09	16
VILLAGE_CK_S288	0.83	0.09	8
VILLAGE_CK_S289	0.83	0.09	8
VILLAGE_CK_S290	0.83	0.09	1
VILLAGE_CK_S293	0.83	0.09	23
VILLAGE_CK_S294	0.83	0.09	37
VILLAGE_CK_S295	0.83	0.09	16
VILLAGE_CK_S300	0.83	0.09	2
VILLAGE_CK_S305	0.83	0.09	4
VILLAGE_CK_S310	0.83	0.09	7
VILLAGE_CK_S320	0.83	0.09	10
VILLAGE_CK_S326	0.83	0.09	23
VILLAGE_CK_S327	0.83	0.09	36
VILLAGE_CK_S328	0.83	0.09	22
VILLAGE_CK_S329	0.83	0.09	23
VILLAGE_CK_S330	0.83	0.09	37
VILLAGE_CK_S333	0.83	0.09	8
VILLAGE_CK_S334	0.83	0.09	6
VILLAGE_CK_S335	0.83	0.09	5
VILLAGE_CK_S336	0.83	0.09	25
VILLAGE_CK_S337	0.83	0.09	14
VILLAGE_CK_S338	0.83	0.09	23
VILLAGE_CK_S339	0.83	0.09	38
VILLAGE_CK_S340	0.83	0.09	29
VILLAGE_CK_S349	0.83	0.09	23
VILLAGE_CK_S350	0.83	0.09	8
VILLAGE_CK_S358	0.83	0.09	34

SUBBASIN NAME	100-YR INITIAL LOSS (in)	CONSTANT LOSS (in)	PERCENT IMPERVIOUS (2016)
VILLAGE_CK_S359	0.83	0.09	69
VILLAGE_CK_S360	0.83	0.09	38

Snyder's Transform Parameters

Snyder's lag time were calculated for the new subbasins. The new Snyder lag times for the subbains were developed using a regional Snyder's unit hydrograph equation that is based on the calibrated WHA lag times. A screen shot of the equation used can be seen below. Essentially, a new regional Ct value was calculated using the WHA data to input into the Lag Time equation. Then, using the calculated watershed properties from the new subbasins (L, Lca, and S), the Lag Time (hours) for each subbasin was computed. The data for L, Lca, and Sst was extracted from the HEC-HMS model, specifically from the Subbasin Characteristics table under the Parameters, Characteristics, and Subbasins sections. The calculated Snyder's lag times for the Village Creek subbasins are shown in Table 3-3.

$$T_L = C_T(L \cdot L_{CA}/S^{0.5})^{0.38}$$

T_L = Lag Time (hr)
C_T = coefficient
L = hydraulic length of watershed along the longest flow path (mi)
L_{CA} = hydraulic length along the longest water course from the point under consideration to a point opposite the centroid of the drainage basin (mi)
S = weighted slope of the basin (ft/mi), measured from the 85% to the 10% points along the longest stream path in the basin (EM 1110-2-1405)

Equation 1 – Snyder Unit Hydrograph Equation

Table 3-3. HEC-HMS Subbasin Snyder's Transform Parameters

SUBBASIN NAME	LAG TIME (HR)	PEAKING COEFF
DEER_CK_S100	0.89	0.6
DEER_CK_S105	1.32	0.6
DEER_CK_S110	0.86	0.6
DEER_CK_S120	1.23	0.6
DEER_CK_S130	1.12	0.6
ELM_BRANCH_CK_S100	0.27	0.72
ELM_BRANCH_CK_S110	0.13	0.72
N_DEER_CK_S100	1.33	0.6
N_DEER_CK_S101	1.59	0.6
N_DEER_CK_S110	0.49	0.6
N_DEER_CK_S120	0.72	0.6
N_DEER_CK_S130	0.42	0.6
QUIL_MILLER_CK_S100	1.23	0.6
QUIL_MILLER_CK_S110	0.92	0.6
QUIL_MILLER_CK_S120	1.46	0.6
QUIL_MILLER_CK_S125	1.09	0.6
QUIL_MILLER_CK_S130	0.55	0.6
QUIL_MILLER_CK_S135	0.29	0.6
QUIL_MILLER_CK_S140	0.64	0.6
QUIL_MILLER_CK_S145	1.03	0.6
QUIL_MILLER_CK_S150	0.99	0.6
QUIL_MILLER_CK_S155	0.73	0.6
QUIL_MILLER_CK_S160	0.59	0.6
QUIL_MILLER_CK_S162	0.94	0.6
QUIL_MILLER_CK_S165	0.87	0.6
QUIL_MILLER_CK_S166	0.56	0.6
QUIL_MILLER_CK_S170	0.7	0.6
QUIL_MILLER_CK_S175	1.05	0.6
QUIL_MILLER_CK_S180	0.56	0.6
QUIL_MILLER_CK_S190	1	0.6
SHANNON_CK_S100	1.13	0.6
SHANNON_CK_S101	0.99	0.6
SHANNON_CK_S110	0.48	0.6
SHANNON_CK_S120	1.38	0.6
SHANNON_CK_S125	1.31	0.6
SHANNON_CK_S126	0.87	0.6
SHANNON_CK_S130	1.02	0.6
S_DEER_CK_S100	1.05	0.6
S_DEER_CK_S110	1.34	0.6
S_DEER_CK_S115	1.33	0.6

SUBBASIN NAME	LAG TIME (HR)	PEAKING COEFF
S_DEER_CK_S120	0.85	0.6
S_DEER_CK_S130	0.83	0.6
S_Subbasin-LA	0.84	0.72
VILLAGE_CK_S100	1.21	0.6
VILLAGE_CK_S101	1.16	0.6
VILLAGE_CK_S102	1.16	0.6
VILLAGE_CK_S110	0.44	0.6
VILLAGE_CK_S120	0.69	0.6
VILLAGE_CK_S125	0.69	0.6
VILLAGE_CK_S130	0.7	0.6
VILLAGE_CK_S140	1.58	0.6
VILLAGE_CK_S150	0.46	0.6
VILLAGE_CK_S151	1.47	0.6
VILLAGE_CK_S155	1.01	0.6
VILLAGE_CK_S160	0.81	0.6
VILLAGE_CK_S170	0.32	0.6
VILLAGE_CK_S178	1.01	0.6
VILLAGE_CK_S179	1.27	0.6
VILLAGE_CK_S180	0.89	0.6
VILLAGE_CK_S190	0.82	0.6
VILLAGE_CK_S200	0.71	0.6
VILLAGE_CK_S205	1.3	0.6
VILLAGE_CK_S210	0.67	0.6
VILLAGE_CK_S220	0.88	0.6
VILLAGE_CK_S225	1.52	0.6
VILLAGE_CK_S230	0.62	0.6
VILLAGE_CK_S235	1.21	0.6
VILLAGE_CK_S236	0.85	0.6
VILLAGE_CK_S237	0.59	0.6
VILLAGE_CK_S240	0.43	0.6
VILLAGE_CK_S245	1.6	0.6
VILLAGE_CK_S250	0.5	0.6
VILLAGE_CK_S260	0.7	0.6
VILLAGE_CK_S270	0.72	0.6
VILLAGE_CK_S280	0.31	0.72
VILLAGE_CK_S287	0.39	0.72
VILLAGE_CK_S288	0.34	0.72
VILLAGE_CK_S289	0.21	0.72
VILLAGE_CK_S290	0.11	0.72
VILLAGE_CK_S293	0.43	0.72
VILLAGE_CK_S294	0.46	0.72
VILLAGE_CK_S295	0.31	0.72

SUBBASIN NAME	LAG TIME (HR)	PEAKING COEFF
VILLAGE_CK_S300	0.26	0.72
VILLAGE_CK_S305	0.2	0.72
VILLAGE_CK_S310	0.18	0.72
VILLAGE_CK_S320	0.11	0.72
VILLAGE_CK_S326	0.32	0.72
VILLAGE_CK_S327	0.33	0.72
VILLAGE_CK_S328	0.2	0.72
VILLAGE_CK_S329	0.13	0.72
VILLAGE_CK_S330	0.1	0.72
VILLAGE_CK_S333	0.28	0.72
VILLAGE_CK_S334	0.26	0.72
VILLAGE_CK_S335	0.24	0.72
VILLAGE_CK_S336	0.25	0.72
VILLAGE_CK_S337	0.12	0.72
VILLAGE_CK_S338	0.13	0.72
VILLAGE_CK_S339	0.1	0.72
VILLAGE_CK_S340	0.14	0.72
VILLAGE_CK_S349	0.23	0.72
VILLAGE_CK_S350	0.12	0.72
VILLAGE_CK_S358	0.34	0.72
VILLAGE_CK_S359	0.1	0.72
VILLAGE_CK_S360	0.28	0.72
WILLOW_CK_S100	1.36	0.6
WILLOW_CK_S110	0.46	0.6

Baseflows

The same Baseflows that were used for the WHA subbasins were assumed in this model for the corresponding areas, as shown in Table 3-4.

Table 3-4. HEC-HMS Subbasin Baseflow Parameters

SUBBASIN NAME	INITIAL LOSS (cfs/sq mi)	RECESSION CONSTANT	RATIO TO PEAK
DEER_CK_S100	0.49	0.3	0.05
DEER_CK_S105	0.49	0.3	0.05
DEER_CK_S110	0.49	0.3	0.05
DEER_CK_S120	0.49	0.3	0.05
DEER_CK_S130	0.49	0.3	0.05
ELM_BRANCH_CK_S100	0.77	0.64	0.02
ELM_BRANCH_CK_S110	0.77	0.64	0.02
N_DEER_CK_S100	0.49	0.3	0.05
N_DEER_CK_S101	0.49	0.3	0.05

SUBBASIN NAME	INITIAL LOSS (cfs/sq mi)	RECESSION CONSTANT	RATIO TO PEAK
N_DEER_CK_S110	0.49	0.3	0.05
N_DEER_CK_S120	0.49	0.3	0.05
N_DEER_CK_S130	0.49	0.3	0.05
QUIL_MILLER_CK_S100	0.49	0.3	0.05
QUIL_MILLER_CK_S110	0.49	0.3	0.05
QUIL_MILLER_CK_S120	0.49	0.3	0.05
QUIL_MILLER_CK_S125	0.49	0.3	0.05
QUIL_MILLER_CK_S130	0.49	0.3	0.05
QUIL_MILLER_CK_S135	0.49	0.3	0.05
QUIL_MILLER_CK_S140	0.49	0.3	0.05
QUIL_MILLER_CK_S145	0.49	0.3	0.05
QUIL_MILLER_CK_S150	0.49	0.3	0.05
QUIL_MILLER_CK_S155	0.49	0.3	0.05
QUIL_MILLER_CK_S160	0.49	0.3	0.05
QUIL_MILLER_CK_S162	0.49	0.3	0.05
QUIL_MILLER_CK_S165	0.49	0.3	0.05
QUIL_MILLER_CK_S166	0.49	0.3	0.05
QUIL_MILLER_CK_S170	0.49	0.3	0.05
QUIL_MILLER_CK_S175	0.49	0.3	0.05
QUIL_MILLER_CK_S180	0.49	0.3	0.05
QUIL_MILLER_CK_S190	0.49	0.3	0.05
SHANNON_CK_S100	0.49	0.3	0.05
SHANNON_CK_S101	0.49	0.3	0.05
SHANNON_CK_S110	0.49	0.3	0.05
SHANNON_CK_S120	0.49	0.3	0.05
SHANNON_CK_S125	0.49	0.3	0.05
SHANNON_CK_S126	0.49	0.3	0.05
SHANNON_CK_S130	0.49	0.3	0.05
S_DEER_CK_S100	0.49	0.3	0.05
S_DEER_CK_S110	0.49	0.3	0.05
S_DEER_CK_S115	0.49	0.3	0.05
S_DEER_CK_S120	0.49	0.3	0.05
S_DEER_CK_S130	0.49	0.3	0.05
S_Subbasin-LA	0.77	0.65	0.02
VILLAGE_CK_S100	0.49	0.3	0.05
VILLAGE_CK_S101	0.49	0.3	0.05
VILLAGE_CK_S102	0.49	0.3	0.05
VILLAGE_CK_S110	0.49	0.3	0.05
VILLAGE_CK_S120	0.49	0.3	0.05

SUBBASIN NAME	INITIAL LOSS (cfs/sq mi)	RECESSION CONSTANT	RATIO TO PEAK
VILLAGE_CK_S125	0.49	0.3	0.05
VILLAGE_CK_S130	0.49	0.3	0.05
VILLAGE_CK_S140	0.49	0.3	0.05
VILLAGE_CK_S150	0.49	0.3	0.05
VILLAGE_CK_S151	0.49	0.3	0.05
VILLAGE_CK_S155	0.49	0.3	0.05
VILLAGE_CK_S160	0.49	0.3	0.05
VILLAGE_CK_S170	0.49	0.3	0.05
VILLAGE_CK_S178	0.49	0.3	0.05
VILLAGE_CK_S179	0.49	0.3	0.05
VILLAGE_CK_S180	0.49	0.3	0.05
VILLAGE_CK_S190	0.49	0.3	0.05
VILLAGE_CK_S200	0.49	0.3	0.05
VILLAGE_CK_S205	0.49	0.3	0.05
VILLAGE_CK_S210	0.49	0.3	0.05
VILLAGE_CK_S220	0.49	0.3	0.05
VILLAGE_CK_S225	0.49	0.3	0.05
VILLAGE_CK_S230	0.49	0.3	0.05
VILLAGE_CK_S235	0.49	0.3	0.05
VILLAGE_CK_S236	0.49	0.3	0.05
VILLAGE_CK_S237	0.49	0.3	0.05
VILLAGE_CK_S240	0.49	0.3	0.05
VILLAGE_CK_S245	0.49	0.3	0.05
VILLAGE_CK_S250	0.49	0.3	0.05
VILLAGE_CK_S260	0.49	0.3	0.05
VILLAGE_CK_S270	0.49	0.3	0.05
VILLAGE_CK_S280	0.77	0.64	0.02
VILLAGE_CK_S287	0.77	0.64	0.02
VILLAGE_CK_S288	0.77	0.64	0.02
VILLAGE_CK_S289	0.77	0.64	0.02
VILLAGE_CK_S290	0.77	0.64	0.02
VILLAGE_CK_S293	0.77	0.64	0.02
VILLAGE_CK_S294	0.77	0.64	0.02
VILLAGE_CK_S295	0.77	0.64	0.02
VILLAGE_CK_S300	0.77	0.64	0.02
VILLAGE_CK_S305	0.77	0.64	0.02
VILLAGE_CK_S310	0.77	0.64	0.02
VILLAGE_CK_S320	0.77	0.64	0.02
VILLAGE_CK_S326	0.77	0.64	0.02
VILLAGE_CK_S327	0.77	0.64	0.02
VILLAGE_CK_S328	0.77	0.64	0.02

SUBBASIN NAME	INITIAL LOSS (cfs/sq mi)	RECESSION CONSTANT	RATIO TO PEAK
VILLAGE_CK_S329	0.77	0.64	0.02
VILLAGE_CK_S330	0.77	0.64	0.02
VILLAGE_CK_S333	0.77	0.64	0.02
VILLAGE_CK_S334	0.77	0.64	0.02
VILLAGE_CK_S335	0.77	0.64	0.02
VILLAGE_CK_S336	0.77	0.64	0.02
VILLAGE_CK_S337	0.77	0.64	0.02
VILLAGE_CK_S338	0.77	0.64	0.02
VILLAGE_CK_S339	0.77	0.64	0.02
VILLAGE_CK_S340	0.77	0.64	0.02
VILLAGE_CK_S349	0.77	0.64	0.02
VILLAGE_CK_S350	0.77	0.64	0.02
VILLAGE_CK_S358	0.77	0.64	0.02
VILLAGE_CK_S359	0.77	0.64	0.02
VILLAGE_CK_S360	0.77	0.64	0.02
WILLOW_CK_S100	0.49	0.3	0.05
WILLOW_CK_S110	0.49	0.3	0.05

3.3.2 Initial Routing Parameters

Modified Puls Routing

Modified Puls routing was used for all reaches in the HEC-HMS model. For this method, a storage-discharge table and the number of Subreaches per reach were required. The storage-discharge relationships were calculated from HEC-RAS models, including a 2D BLE HEC-RAS model and several 1D effective FEMA Flood Insurance Study (FIS) models. With the 2D model, this process was achieved by first developing a stepped inflow hydrograph that covered the range of expected flows at each new reach. Within the RAS Mapper function of HEC-RAS, cross-section like profile lines were added at the downstream end of each HEC-HMS reach. Within the 1D HEC-RAS models, a range of steady flow profiles were run, and the storage volume versus flow relationships for each reach were exported to HEC-DSS. Because of their relatively short length, all reaches were given a subreach value of 1.

Table 3-5. HEC-HMS Modified Puls Routing Parameters

Reach Name	Reach Length (mi)	Model Source	Storage-Discharge Curve	Subreaches
DEER_CK_R100	1	2D BLE	DEER_CK_R100	1
DEER_CK_R110	1.02	2D BLE	DEER_CK_R110	1
DEER_CK_R120	1.95	2D BLE	DEER_CK_R120	1
DEER_CK_R130	0.96	2D BLE	DEER_CK_R130	1

Reach Name	Reach Length (mi)	Model Source	Storage-Discharge Curve	Subreaches
ELM_BRANCH_CK_R100	0.71		ELM_BRANCH_CK_R100	1
N_DEER_CK_R100	0.63	1D FIS	N_DEER_CK_R100	1
N_DEER_CK_R110	0.91	1D FIS	N_DEER_CK_R110	1
N_DEER_CK_R120	0.54	1D FIS	N_DEER_CK_R120	1
QUIL_MILLER_CK_R100	1.1	2D BLE	Quil_Miller_CK_R100	1
QUIL_MILLER_CK_R110	1.77	2D BLE	Quil_Miller_CK_R110	1
QUIL_MILLER_CK_R120	0.66	2D BLE	Quil_Miller_CK_R120	1
QUIL_MILLER_CK_R125	0.41	2D BLE	Quil_Miller_CK_R125	1
QUIL_MILLER_CK_R130	0.37	2D BLE	Quil_Miller_CK_R130	1
QUIL_MILLER_CK_R140	1.7	1D FIS	Quil_Miller_CK_R140	1
QUIL_MILLER_CK_R145	1.22	2D BLE	Quil_Miller_CK_R145	1
QUIL_MILLER_CK_R150	0.45	2D BLE	Quil_Miller_CK_R150	1
QUIL_MILLER_CK_R156	0.6	2D BLE	Quil_Miller_CK_R156	1
QUIL_MILLER_CK_R160	1.19	2D BLE	Quil_Miller_CK_R160	1
QUIL_MILLER_CK_R170	0.7	2D BLE	Quil_Miller_CK_R170	1
QUIL_MILLER_CK_R190	1.38	2D BLE	Quil_Miller_CK_R190	1
S_DEER_CK_R100	1.76	1D FIS	S_DEER_CK_R100	1
S_DEER_CK_R110	1.46	2D BLE	S_DEER_CK_R110	1
S_DEER_CK_R120	1.21	2D BLE	S_DEER_CK_R120	1
VILLAGE_CK_R100	1.42	2D BLE	VILLAGE_CK_R100	1
VILLAGE_CK_R101	0.89	2D BLE	VILLAGE_CK_R101	1
VILLAGE_CK_R102	0.15	2D BLE	VILLAGE_CK_R102	1
VILLAGE_CK_R105	0.53	1D FIS	VILLAGE_CK_R105	1
VILLAGE_CK_R125	0.5	2D BLE	VILLAGE_CK_R125	1
VILLAGE_CK_R130	0.97	1D FIS	VILLAGE_CK_R130	1
VILLAGE_CK_R135	0.74	2D BLE	VILLAGE_CK_R135	1
VILLAGE_CK_R140	0.93	1D FIS	VILLAGE_CK_R140	1
VILLAGE_CK_R145	1.24	2D BLE	VILLAGE_CK_R145	1
VILLAGE_CK_R150	2.5	1D FIS	VILLAGE_CK_R150	1
VILLAGE_CK_R160	0.85	2D BLE	VILLAGE_CK_R160	1
VILLAGE_CK_R165	0.26	1D FIS	VILLAGE_CK_R165	1
VILLAGE_CK_R170	1.28	2D BLE	VILLAGE_CK_R170	1
VILLAGE_CK_R180	0.22	1D FIS	VILLAGE_CK_R180	1
VILLAGE_CK_R185	1.52	1D FIS	VILLAGE_CK_R185	1
VILLAGE_CK_R190	1	1D FIS	VILLAGE_CK_R190	1
VILLAGE_CK_R195	1.24	2D BLE	VILLAGE_CK_R195	1
VILLAGE_CK_R200	1.25	1D FIS	VILLAGE_CK_R200	1
VILLAGE_CK_R210	0.99	2D BLE	VILLAGE_CK_R210	1
VILLAGE_CK_R220	1.07	1D FIS	VILLAGE_CK_R220	1

Reach Name	Reach Length (mi)	Model Source	Storage-Discharge Curve	Subreaches
VILLAGE_CK_R235	0.79	2D	VILLAGE_CK_R235	1
VILLAGE_CK_R250	0.44	2D BLE	VILLAGE_CK_R250	1
VILLAGE_CK_R260	0.48	1D FIS	VILLAGE_CK_R260	1
VILLAGE_CK_R270	0.27	1D FIS	VILLAGE_CK_R270	1
VILLAGE_CK_R280	0.74	2D BLE	VILLAGE_CK_R280	1
VILLAGE_CK_R290	1.16	1D FIS	VILLAGE_CK_R290	1
VILLAGE_CK_R308	2.35	1D FIS	VILLAGE_CK_R308	1
VILLAGE_CK_R309	1.45	1D FIS	VILLAGE_CK_R309	1
VILLAGE_CK_R310	0.21	1D FIS	VILLAGE_CK_R310	1
VILLAGE_CK_R325	0.67	2D BLE	VILLAGE_CK_R325	1
VILLAGE_CK_R330	1.44	1D FIS	VILLAGE_CK_R330	1
VILLAGE_CK_R340	0.76	1D FIS	VILLAGE_CK_R340	1
VILLAGE_CK_R348	1.9	1D FIS	VILLAGE_CK_R348	1
VILLAGE_CK_R349	0.78	1D FIS	VILLAGE_CK_R349	1
VILLAGE_CK_R350	0.84	1D FIS	VILLAGE_CK_R350	1
VILLAGE_CK_R357	1.36	1D FIS	VILLAGE_CK_R357	1
VILLAGE_CK_R359	0.88	1D FIS	VILLAGE_CK_R359	1
VILLAGE_CK_R360	0.57	1D FIS	VILLAGE_CK_R360	1
VILLAGE_CK_R370	0.7	1D FIS	VILLAGE_CK_R370	1
VILLAGE_CK_R375	1.11	2D BLE	VILLAGE_CK_R375	1
VILLAGE_CK_R376	0.71	1D FIS	VILLAGE_CK_R376	1
VILLAGE_CK_R377	0.76	1D FIS	VILLAGE_CK_R377	1
VILLAGE_CK_R378	0.49	1D FIS	VILLAGE_CK_R378	1
VILLAGE_CK_R389	0.53	2D BLE	VILLAGE_CK_R389	1
VILLAGE_CK_R390	0.22	1D FIS	VILLAGE_CK_R390	1
VILLAGE_CK_R400	1.08	2D BLE	VILLAGE_CK_R400	1

4 HEC-HMS Model Calibration to WHA Results

4.1 Calibration Methodology

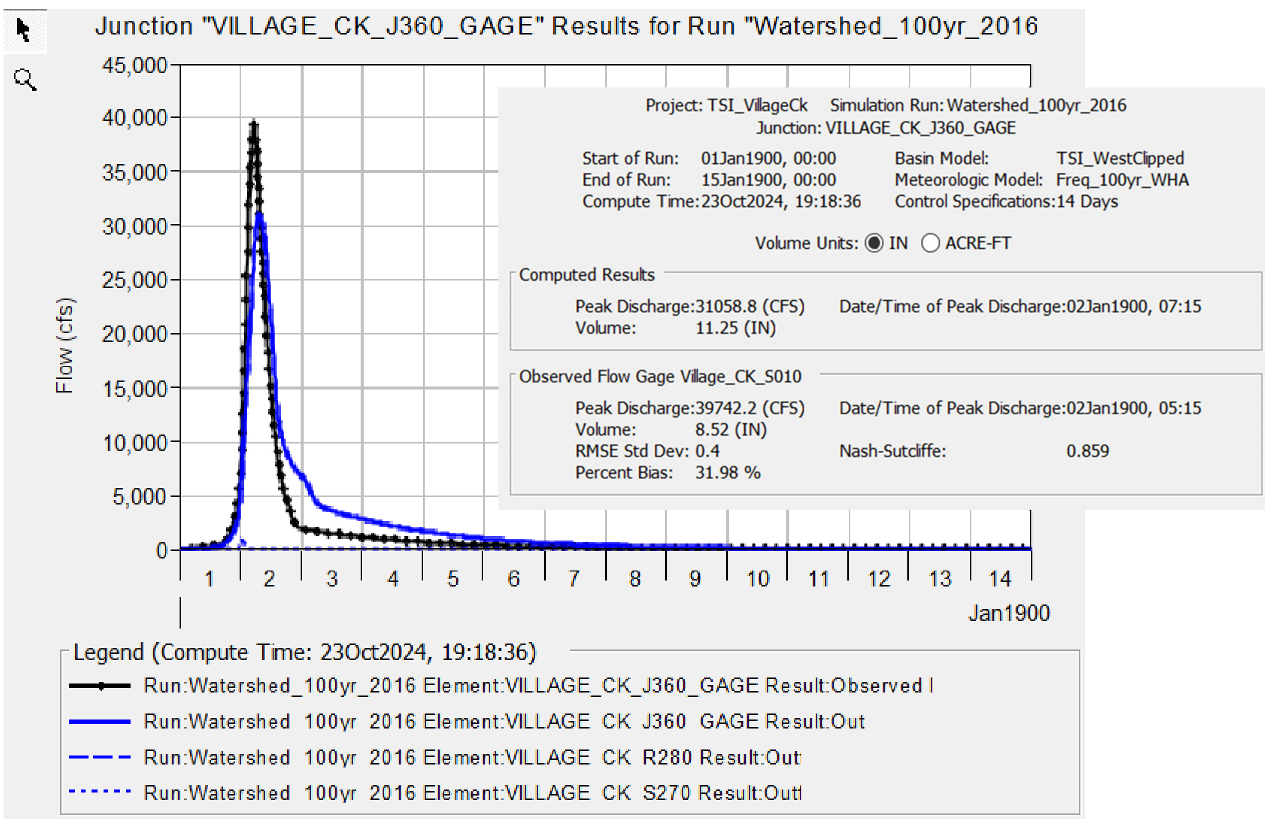
After determining the initial model parameters, they were adjusted to ensure that the final outcomes of the detailed HEC-HMS model closely align with the results of the original InFRM WHA HEC-HMS model. In this process, the 100-year uniform rainfall event from the InFRM model was used as the reference point for comparison. The model was calibrated in two locations. One of the locations “VILLAGE_CK_J360_GAGE” is a junction that encompasses approximately the entire WHA basin “Village_CK_S010” area. The other location being “Lake Arlington” which has the same name and area as it’s WHA counterpart. During calibrations, the loss parameters (initial loss and constant loss) remained consistent because they were taken from the WHA model. For the VILLAGE_CK_J360_GAGE, only the recession constant had to be changed. For Lake Arlington, the recession constant, lag time and peaking coefficient all had to be adjusted to achieve a good calibration. The rubric below describes the rating of a calibration.

Performance Rating	NSE	RSR	PBIAS
Very Good	0.80 ≤ NSE < 1.00	0 ≤ RSR ≤ 0.50	0 ≤ PBIAS ≤ ±5
Good	0.70 ≤ NSE < 0.80	0.50 < RSR ≤ 0.60	±5 < PBIAS < ±10
Satisfactory	0.50 ≤ NSE < 0.70	0.60 < RSR ≤ 0.70	±10 ≤ PBIAS ≤ ±25
Unsatisfactory	NSE < 0.50	RSR > 0.70	PBIAS > ±25

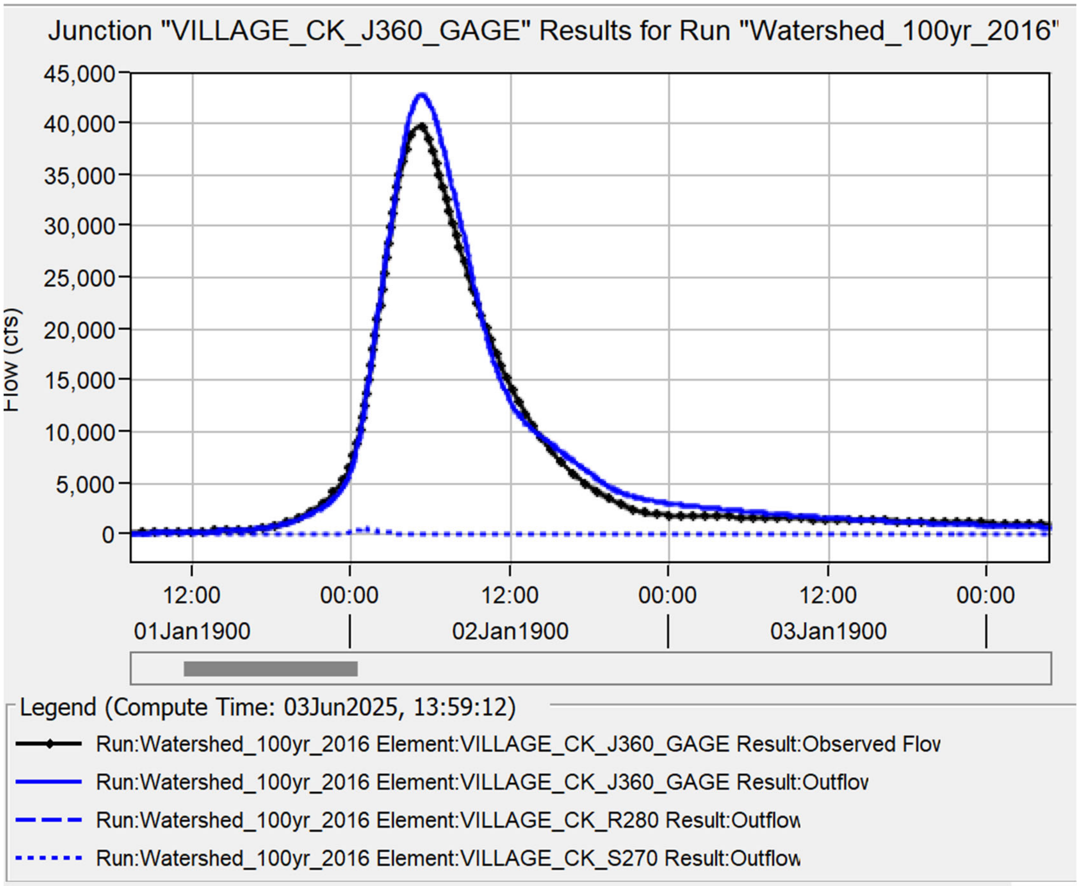
NSE stands for the Nash-Sutcliffe number, RSR is the standard deviation, PBIAS is the percent bias. The results of the calibrations can be found below.

4.2 Calibration Results

Results from Initial Parameters of: VILLAGE_CK_J360



Results from Calibrated Parameters of: VILLAGE_CK_J360



Project: TSI_VillageCk Simulation Run: Watershed_100yr_2016
Junction: VILLAGE_CK_J360_GAGE

Start of Run:	01Jan1900, 00:00	Basin Model:	TSI_WestClipped
End of Run:	15Jan1900, 00:00	Meteorologic Model:	Freq_100yr_WHA
Compute Time:	03Jun2025, 13:59:12	Control Specifications:	14 Days

Volume Units: IN ACRE-FT

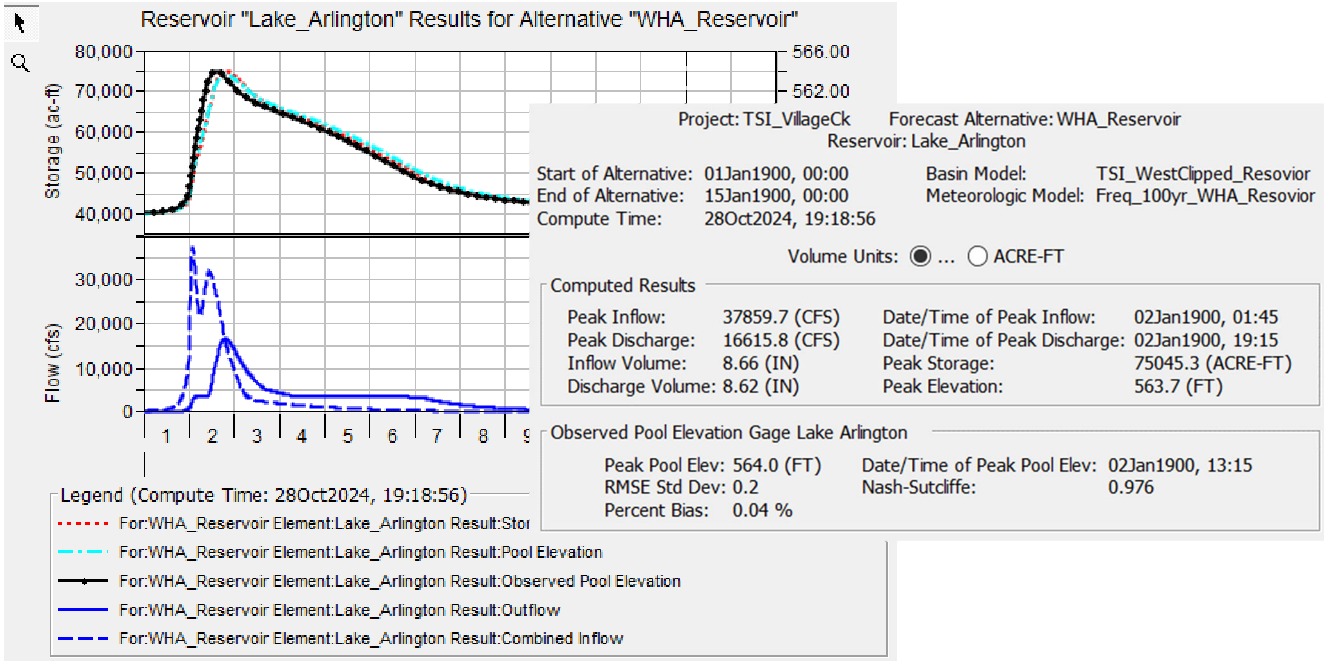
Computed Results

Peak Discharge:	42814.3 (CFS)	Date/Time of Peak Discharge:	02Jan1900, 05:20
Volume:	8.43 (IN)		

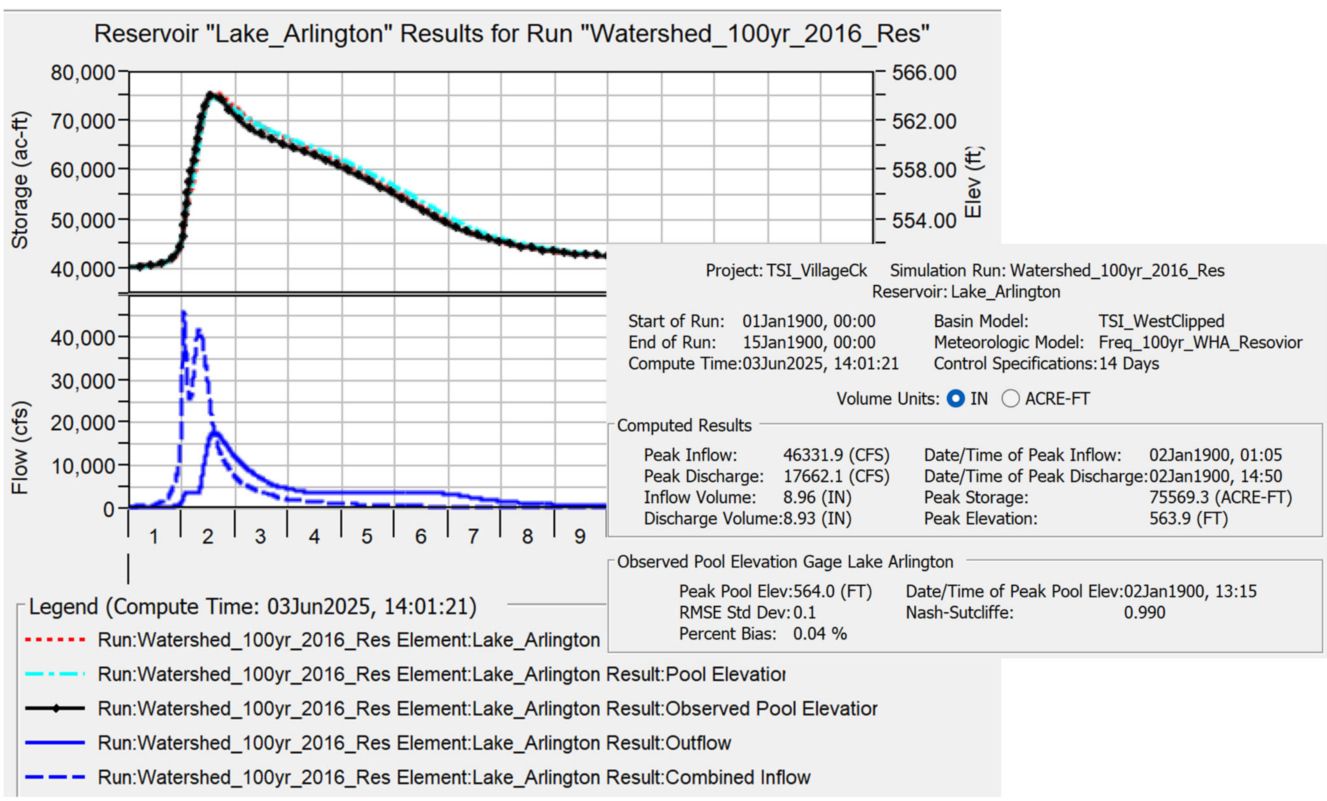
Observed Flow Gage Village_CK_S010

Peak Discharge:	39742.2 (CFS)	Date/Time of Peak Discharge:	02Jan1900, 05:15
Volume:	8.52 (IN)		
RMSE Std Dev:	0.1	Nash-Sutcliffe:	0.991
Percent Bias:	-1.03 %		

Results from Initial Parameters of: Lake Arlington



Results from Calibrated Parameters of: Lake Arlington



4.3 Calibrated HEC-HMS Parameters

Below are the Calibrated HEC-HMS Parameters for only what was modified. The modified components will be highlighted in orange.

Calibrated Baseflows from Village_CK_J360_Gage

SUBBASIN NAME	INITIAL (cfs/sq mi)	RECESSION CONSTANT	RATIO TO PEAK
DEER_CK_S100	0.49	0.300	0.05
DEER_CK_S105	0.49	0.300	0.05
DEER_CK_S110	0.49	0.300	0.05
DEER_CK_S120	0.49	0.300	0.05
DEER_CK_S130	0.49	0.300	0.05
N_DEER_CK_S100	0.49	0.300	0.05
N_DEER_CK_S101	0.49	0.300	0.05
N_DEER_CK_S110	0.49	0.300	0.05
N_DEER_CK_S120	0.49	0.300	0.05
N_DEER_CK_S130	0.49	0.300	0.05
QUIL_MILLER_CK_S100	0.49	0.300	0.05
QUIL_MILLER_CK_S110	0.49	0.300	0.05
QUIL_MILLER_CK_S120	0.49	0.300	0.05
QUIL_MILLER_CK_S125	0.49	0.300	0.05
QUIL_MILLER_CK_S130	0.49	0.300	0.05
QUIL_MILLER_CK_S135	0.49	0.300	0.05
QUIL_MILLER_CK_S140	0.49	0.300	0.05
QUIL_MILLER_CK_S145	0.49	0.300	0.05
QUIL_MILLER_CK_S150	0.49	0.300	0.05
QUIL_MILLER_CK_S155	0.49	0.300	0.05
QUIL_MILLER_CK_S160	0.49	0.300	0.05
QUIL_MILLER_CK_S162	0.49	0.300	0.05
QUIL_MILLER_CK_S165	0.49	0.300	0.05
QUIL_MILLER_CK_S166	0.49	0.300	0.05
QUIL_MILLER_CK_S170	0.49	0.300	0.05
QUIL_MILLER_CK_S175	0.49	0.300	0.05
QUIL_MILLER_CK_S180	0.49	0.300	0.05
QUIL_MILLER_CK_S190	0.49	0.300	0.05
SHANNON_CK_S100	0.49	0.300	0.05
SHANNON_CK_S101	0.49	0.300	0.05
SHANNON_CK_S110	0.49	0.300	0.05
SHANNON_CK_S120	0.49	0.300	0.05
SHANNON_CK_S125	0.49	0.300	0.05
SHANNON_CK_S126	0.49	0.300	0.05
SHANNON_CK_S130	0.49	0.300	0.05

Calibrated Baseflows from Village_CK_J360_Gage (continued)

SUBBASIN NAME	INITIAL (cfs/sq mi)	RECESSION CONSTANT	RATIO TO PEAK
S_DEER_CK_S100	0.49	0.300	0.05
S_DEER_CK_S110	0.49	0.300	0.05
S_DEER_CK_S115	0.49	0.300	0.05
S_DEER_CK_S120	0.49	0.300	0.05
S_DEER_CK_S130	0.49	0.300	0.05
VILLAGE_CK_S100	0.49	0.300	0.05
VILLAGE_CK_S101	0.49	0.300	0.05
VILLAGE_CK_S102	0.49	0.300	0.05
VILLAGE_CK_S110	0.49	0.300	0.05
VILLAGE_CK_S120	0.49	0.300	0.05
VILLAGE_CK_S125	0.49	0.300	0.05
VILLAGE_CK_S130	0.49	0.300	0.05
VILLAGE_CK_S140	0.49	0.300	0.05
VILLAGE_CK_S150	0.49	0.300	0.05
VILLAGE_CK_S151	0.49	0.300	0.05
VILLAGE_CK_S155	0.49	0.300	0.05
VILLAGE_CK_S160	0.49	0.300	0.05
VILLAGE_CK_S170	0.49	0.300	0.05
VILLAGE_CK_S178	0.49	0.300	0.05
VILLAGE_CK_S179	0.49	0.300	0.05
VILLAGE_CK_S180	0.49	0.300	0.05
VILLAGE_CK_S190	0.49	0.300	0.05
VILLAGE_CK_S200	0.49	0.300	0.05
VILLAGE_CK_S205	0.49	0.300	0.05
VILLAGE_CK_S210	0.49	0.300	0.05
VILLAGE_CK_S220	0.49	0.300	0.05
VILLAGE_CK_S225	0.49	0.300	0.05
VILLAGE_CK_S230	0.49	0.300	0.05
VILLAGE_CK_S235	0.49	0.300	0.05
VILLAGE_CK_S236	0.49	0.300	0.05
VILLAGE_CK_S237	0.49	0.300	0.05
VILLAGE_CK_S240	0.49	0.300	0.05
VILLAGE_CK_S245	0.49	0.300	0.05
VILLAGE_CK_S250	0.49	0.300	0.05
VILLAGE_CK_S260	0.49	0.300	0.05
VILLAGE_CK_S270	0.49	0.300	0.05
WILLOW_CK_S100	0.49	0.300	0.05
WILLOW_CK_S110	0.49	0.300	0.05

Calibrated Baseflows from Lake Arlington

SUBBASIN NAME	INITIAL (cfs/sq mi)	RECESSION CONSTANT	RATIO TO PEAK
ELM_BRANCH_CK_S100	0.77	0.640	0.02
ELM_BRANCH_CK_S110	0.77	0.640	0.02
S_Subbasin-LA	0.77	0.650	0.02
VILLAGE_CK_S280	0.77	0.640	0.02
VILLAGE_CK_S287	0.77	0.640	0.02
VILLAGE_CK_S288	0.77	0.640	0.02
VILLAGE_CK_S289	0.77	0.640	0.02
VILLAGE_CK_S290	0.77	0.640	0.02
VILLAGE_CK_S293	0.77	0.640	0.02
VILLAGE_CK_S294	0.77	0.640	0.02
VILLAGE_CK_S295	0.77	0.640	0.02
VILLAGE_CK_S300	0.77	0.640	0.02
VILLAGE_CK_S305	0.77	0.640	0.02
VILLAGE_CK_S310	0.77	0.640	0.02
VILLAGE_CK_S320	0.77	0.640	0.02
VILLAGE_CK_S326	0.77	0.640	0.02
VILLAGE_CK_S327	0.77	0.640	0.02
VILLAGE_CK_S328	0.77	0.640	0.02
VILLAGE_CK_S329	0.77	0.640	0.02
VILLAGE_CK_S330	0.77	0.640	0.02
VILLAGE_CK_S333	0.77	0.640	0.02
VILLAGE_CK_S334	0.77	0.640	0.02
VILLAGE_CK_S335	0.77	0.640	0.02
VILLAGE_CK_S336	0.77	0.640	0.02
VILLAGE_CK_S337	0.77	0.640	0.02
VILLAGE_CK_S338	0.77	0.640	0.02
VILLAGE_CK_S339	0.77	0.640	0.02
VILLAGE_CK_S340	0.77	0.640	0.02
VILLAGE_CK_S349	0.77	0.640	0.02
VILLAGE_CK_S350	0.77	0.640	0.02
VILLAGE_CK_S358	0.77	0.640	0.02
VILLAGE_CK_S359	0.77	0.640	0.02
VILLAGE_CK_S360	0.77	0.640	0.02

Calibrated Transform Parameters from Village_CK_J360_Gage

Subbasin	Lag Time (hr)	Peak Coeff
DEER_CK_S100	1.08	0.60
DEER_CK_S105	1.60	0.60
DEER_CK_S110	1.04	0.60
DEER_CK_S120	1.49	0.60
DEER_CK_S130	1.36	0.60
N_DEER_CK_S100	1.62	0.60
N_DEER_CK_S101	1.93	0.60
N_DEER_CK_S110	0.60	0.60
N_DEER_CK_S120	0.87	0.60
N_DEER_CK_S130	0.51	0.60
QUIL_MILLER_CK_S100	1.49	0.60
QUIL_MILLER_CK_S110	1.12	0.60
QUIL_MILLER_CK_S120	1.77	0.60
QUIL_MILLER_CK_S125	1.32	0.60
QUIL_MILLER_CK_S130	0.67	0.60
QUIL_MILLER_CK_S135	0.35	0.60
QUIL_MILLER_CK_S140	0.78	0.60
QUIL_MILLER_CK_S145	1.25	0.60
QUIL_MILLER_CK_S150	1.20	0.60
QUIL_MILLER_CK_S155	0.89	0.60
QUIL_MILLER_CK_S160	0.72	0.60
QUIL_MILLER_CK_S162	1.14	0.60
QUIL_MILLER_CK_S165	1.06	0.60
QUIL_MILLER_CK_S166	0.68	0.60
QUIL_MILLER_CK_S170	0.85	0.60
QUIL_MILLER_CK_S175	1.28	0.60
QUIL_MILLER_CK_S180	0.68	0.60
QUIL_MILLER_CK_S190	1.22	0.60
SHANNON_CK_S100	1.37	0.60
SHANNON_CK_S101	1.20	0.60
SHANNON_CK_S110	0.58	0.60
SHANNON_CK_S120	1.68	0.60
SHANNON_CK_S125	1.59	0.60
SHANNON_CK_S126	1.06	0.60
SHANNON_CK_S130	1.24	0.60
S_DEER_CK_S100	1.28	0.60
S_DEER_CK_S110	1.63	0.60
S_DEER_CK_S115	1.62	0.60
S_DEER_CK_S120	1.03	0.60
S_DEER_CK_S130	1.01	0.60

Subbasin	Lag Time (hr)	Peak Coeff
VILLAGE_CK_S100	1.47	0.60
VILLAGE_CK_S101	1.41	0.60
VILLAGE_CK_S102	1.41	0.60
VILLAGE_CK_S110	0.53	0.60
VILLAGE_CK_S120	0.84	0.60
VILLAGE_CK_S125	0.84	0.60
VILLAGE_CK_S130	0.85	0.60
VILLAGE_CK_S140	1.92	0.60
VILLAGE_CK_S150	0.56	0.60
VILLAGE_CK_S151	1.79	0.60
VILLAGE_CK_S155	1.23	0.60
VILLAGE_CK_S160	0.98	0.60
VILLAGE_CK_S170	0.39	0.60
VILLAGE_CK_S178	1.23	0.60
VILLAGE_CK_S179	1.54	0.60
VILLAGE_CK_S180	1.08	0.60
VILLAGE_CK_S190	1.00	0.60
VILLAGE_CK_S200	0.86	0.60
VILLAGE_CK_S205	1.58	0.60
VILLAGE_CK_S210	0.81	0.60
VILLAGE_CK_S220	1.07	0.60
VILLAGE_CK_S225	1.85	0.60
VILLAGE_CK_S230	0.75	0.60
VILLAGE_CK_S235	1.47	0.60
VILLAGE_CK_S236	1.03	0.60
VILLAGE_CK_S237	0.72	0.60
VILLAGE_CK_S240	0.52	0.60
VILLAGE_CK_S245	1.94	0.60
VILLAGE_CK_S250	0.61	0.60
VILLAGE_CK_S260	0.85	0.60
VILLAGE_CK_S270	0.87	0.60
WILLOW_CK_S100	1.65	0.60
WILLOW_CK_S110	0.56	0.60

Calibrated Transform Parameters from Lake Arlington (continued)

SUBBASIN NAME	LAG TIME (HR)	PEAKING COEFF
ELM_BRANCH_CK_S100	0.27	**0.72**
ELM_BRANCH_CK_S110	0.13	**0.72**
S_Subbasin-LA	0.84	**0.72**
VILLAGE_CK_S280	0.31	**0.72**
VILLAGE_CK_S287	0.39	**0.72**
VILLAGE_CK_S288	0.34	**0.72**
VILLAGE_CK_S289	0.21	**0.72**
VILLAGE_CK_S290	0.11	**0.72**
VILLAGE_CK_S293	0.43	**0.72**
VILLAGE_CK_S294	0.46	**0.72**
VILLAGE_CK_S295	0.31	**0.72**
VILLAGE_CK_S300	0.26	**0.72**
VILLAGE_CK_S305	0.20	**0.72**
VILLAGE_CK_S310	0.18	**0.72**
VILLAGE_CK_S320	0.11	**0.72**
VILLAGE_CK_S326	0.32	**0.72**
VILLAGE_CK_S327	0.33	**0.72**
VILLAGE_CK_S328	0.20	**0.72**
VILLAGE_CK_S329	0.13	**0.72**
VILLAGE_CK_S330	0.10	**0.72**
VILLAGE_CK_S333	0.28	**0.72**
VILLAGE_CK_S334	0.26	**0.72**
VILLAGE_CK_S335	0.24	**0.72**
VILLAGE_CK_S336	0.25	**0.72**
VILLAGE_CK_S337	0.12	**0.72**
VILLAGE_CK_S338	0.13	**0.72**
VILLAGE_CK_S339	0.10	**0.72**
VILLAGE_CK_S340	0.14	**0.72**
VILLAGE_CK_S349	0.23	**0.72**
VILLAGE_CK_S350	0.12	**0.72**
VILLAGE_CK_S358	0.34	**0.72**
VILLAGE_CK_S359	0.10	**0.72**
VILLAGE_CK_S360	0.28	**0.72**

5 Final Existing Conditions HEC-HMS Model for TSI

5.1 TSI 2020 Existing Conditions HEC-HMS Model

The 2016 existing conditions basin model, which includes additional subbasins and has been calibrated to align with the InFRM WHA HEC-HMS results at their shared locations, served as the foundation for creating new basin models representing the 2020 TSI existing conditions. To begin, the existing conditions basin model will be updated to reflect the 2020 conditions. For 2020 existing conditions, all HMS model parameters remained unchanged, except for the percent impervious area and the loss rates.

5.1.1 2020 Conditions Percent Imperiousness

The updated 2020 impervious cover percentage raster data was provided by the NCTCOG. This is what was used to update the values in the HEC-HMS model.

Table 5-1. 2020 Existing Conditions Percent Imperviousness

SUBBASIN NAME	PERCENT IMPERVIOUS (2016)	PERCENT IMPERVIOUS (2020)
DEER_CK_S100	29	33
DEER_CK_S105	6	14
DEER_CK_S110	22	24
DEER_CK_S120	18	30
DEER_CK_S130	12	20
ELM_BRANCH_CK_S100	4	11
ELM_BRANCH_CK_S110	2	6
N_DEER_CK_S100	16	21
N_DEER_CK_S101	7	12
N_DEER_CK_S110	3	5
N_DEER_CK_S120	19	24
N_DEER_CK_S130	26	35
QUIL_MILLER_CK_S100	2	5
QUIL_MILLER_CK_S110	2	5
QUIL_MILLER_CK_S120	1	5
QUIL_MILLER_CK_S125	4	7
QUIL_MILLER_CK_S130	2	8
QUIL_MILLER_CK_S135	6	8
QUIL_MILLER_CK_S140	10	13
QUIL_MILLER_CK_S145	4	10
QUIL_MILLER_CK_S150	5	13

SUBBASIN NAME	PERCENT IMPERVIOUS (2016)	PERCENT IMPERVIOUS (2020)
QUIL_MILLER_CK_S155	8	17
QUIL_MILLER_CK_S160	2	7
QUIL_MILLER_CK_S162	5	10
QUIL_MILLER_CK_S165	6	11
QUIL_MILLER_CK_S166	3	6
QUIL_MILLER_CK_S170	10	12
QUIL_MILLER_CK_S175	23	29
QUIL_MILLER_CK_S180	6	22
QUIL_MILLER_CK_S190	6	12
SHANNON_CK_S100	1	4
SHANNON_CK_S101	2	6
SHANNON_CK_S110	4	11
SHANNON_CK_S120	18	18
SHANNON_CK_S125	9	12
SHANNON_CK_S126	43	48
SHANNON_CK_S130	19	19
S_DEER_CK_S100	8	10
S_DEER_CK_S110	8	13
S_DEER_CK_S115	7	11
S_DEER_CK_S120	32	37
S_DEER_CK_S130	31	35
S_Subbasin-LA	43	59
VILLAGE_CK_S100	19	19
VILLAGE_CK_S101	4	9
VILLAGE_CK_S102	1	5
VILLAGE_CK_S110	2	3
VILLAGE_CK_S120	6	8
VILLAGE_CK_S125	6	7
VILLAGE_CK_S130	4	15
VILLAGE_CK_S140	4	10
VILLAGE_CK_S150	17	17
VILLAGE_CK_S151	41	46
VILLAGE_CK_S155	29	36
VILLAGE_CK_S160	16	16
VILLAGE_CK_S170	40	48
VILLAGE_CK_S178	38	44
VILLAGE_CK_S179	42	44
VILLAGE_CK_S180	34	34
VILLAGE_CK_S190	7	16
VILLAGE_CK_S200	5	7
VILLAGE_CK_S205	6	11

SUBBASIN NAME	PERCENT IMPERVIOUS (2016)	PERCENT IMPERVIOUS (2020)
VILLAGE_CK_S210	4	13
VILLAGE_CK_S220	2	10
VILLAGE_CK_S225	21	29
VILLAGE_CK_S230	16	16
VILLAGE_CK_S235	7	13
VILLAGE_CK_S236	6	13
VILLAGE_CK_S237	2	6
VILLAGE_CK_S240	6	6
VILLAGE_CK_S245	10	21
VILLAGE_CK_S250	0	10
VILLAGE_CK_S260	3	15
VILLAGE_CK_S270	1	10
VILLAGE_CK_S280	3	10
VILLAGE_CK_S287	16	16
VILLAGE_CK_S288	8	11
VILLAGE_CK_S289	8	17
VILLAGE_CK_S290	1	6
VILLAGE_CK_S293	23	26
VILLAGE_CK_S294	37	44
VILLAGE_CK_S295	16	21
VILLAGE_CK_S300	2	7
VILLAGE_CK_S305	4	14
VILLAGE_CK_S310	7	15
VILLAGE_CK_S320	10	10
VILLAGE_CK_S326	23	30
VILLAGE_CK_S327	36	43
VILLAGE_CK_S328	22	29
VILLAGE_CK_S329	23	31
VILLAGE_CK_S330	37	37
VILLAGE_CK_S333	8	13
VILLAGE_CK_S334	6	13
VILLAGE_CK_S335	5	18
VILLAGE_CK_S336	25	25
VILLAGE_CK_S337	14	19
VILLAGE_CK_S338	23	28
VILLAGE_CK_S339	38	38
VILLAGE_CK_S340	29	31
VILLAGE_CK_S349	23	28
VILLAGE_CK_S350	8	12
VILLAGE_CK_S358	34	44
VILLAGE_CK_S359	69	69

SUBBASIN NAME	PERCENT IMPERVIOUS (2016)	PERCENT IMPERVIOUS (2020)
VILLAGE_CK_S360	38	41
WILLOW_CK_S100	4	7
WILLOW_CK_S110	33	33

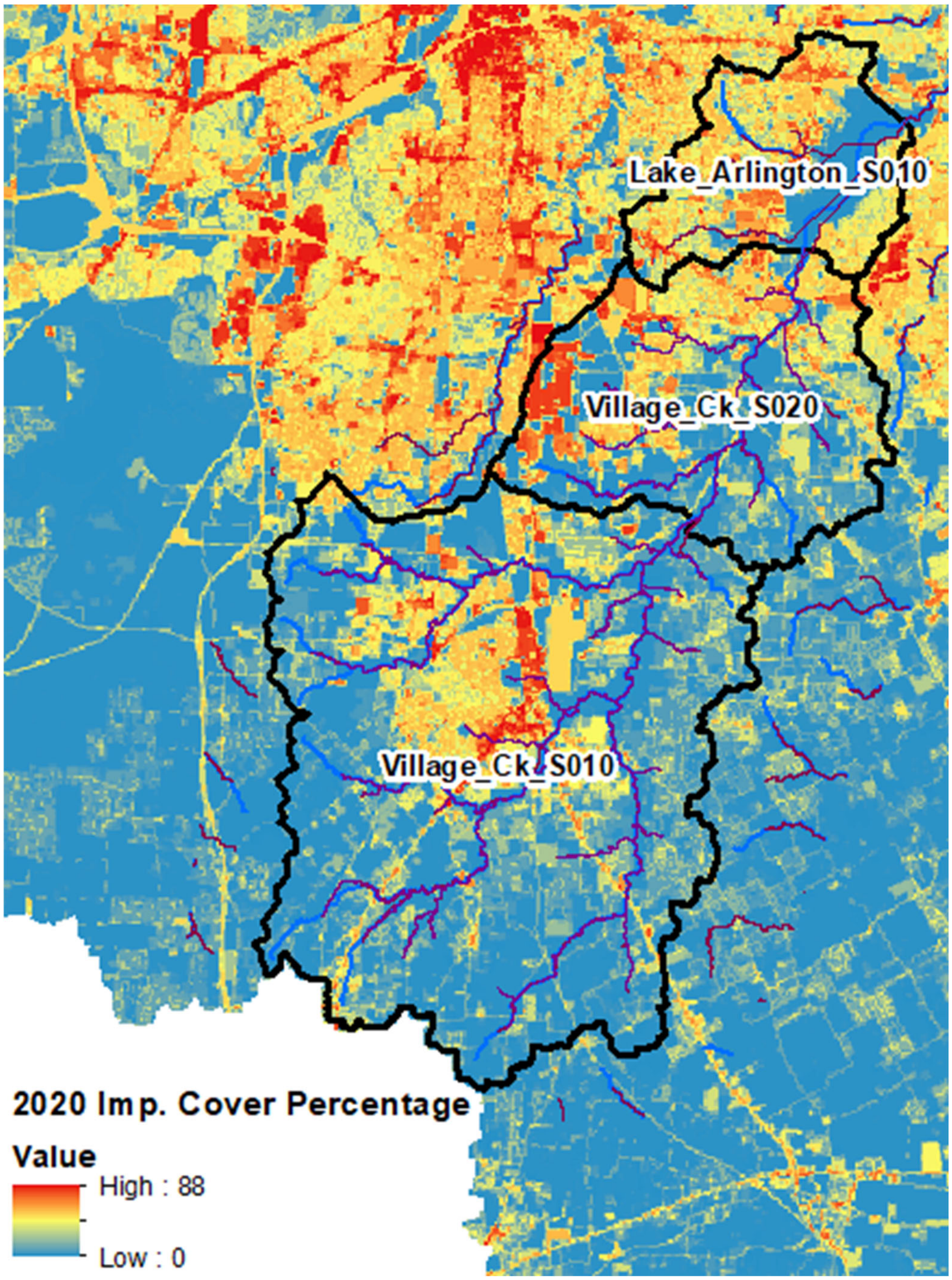


Figure 5-1. Map of Existing 2020 Percent Imperviousness

Table 5-2. 2020 Existing Conditions Loss Rates for 2 through 50-year Return Intervals

	2 YEAR		10 YEAR		50 YEAR	
Subbasin	INITIAL (in)	CONSTANT (in/hr)	INITIAL (in)	CONSTANT (in/hr)	INITIAL (in)	CONSTANT (in/hr)
VILLAGE_CK_S101	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S102	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S100	1.83	0.23	1.33	0.16	0.98	0.12
WILLOW_CK_S110	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S110	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S120	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S125	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S130	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S140	1.83	0.23	1.33	0.16	0.98	0.12
SHANNON_CK_S100	1.83	0.23	1.33	0.16	0.98	0.12
SHANNON_CK_S101	1.83	0.23	1.33	0.16	0.98	0.12
SHANNON_CK_S110	1.83	0.23	1.33	0.16	0.98	0.12
SHANNON_CK_S120	1.83	0.23	1.33	0.16	0.98	0.12
SHANNON_CK_S125	1.83	0.23	1.33	0.16	0.98	0.12
SHANNON_CK_S126	1.83	0.23	1.33	0.16	0.98	0.12
SHANNON_CK_S130	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S150	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S151	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S155	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S160	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S170	1.83	0.23	1.33	0.16	0.98	0.12
WILLOW_CK_S100	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S180	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S178	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S179	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S190	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S100	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S110	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S120	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S130	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S125	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S135	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S140	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S150	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S145	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S155	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S160	1.83	0.23	1.33	0.16	0.98	0.12

	2 YEAR		10 YEAR		50 YEAR	
Subbasin	INITIAL (in)	CONSTANT (in/hr)	INITIAL (in)	CONSTANT (in/hr)	INITIAL (in)	CONSTANT (in/hr)
QUIL_MILLER_CK_S165	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S166	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S170	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S162	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S180	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S175	1.83	0.23	1.33	0.16	0.98	0.12
QUIL_MILLER_CK_S190	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S200	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S205	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S210	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S220	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S225	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S230	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S235	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S240	1.83	0.23	1.33	0.16	0.98	0.12
S_DEER_CK_S100	1.83	0.23	1.33	0.16	0.98	0.12
S_DEER_CK_S110	1.83	0.23	1.33	0.16	0.98	0.12
S_DEER_CK_S115	1.83	0.23	1.33	0.16	0.98	0.12
S_DEER_CK_S120	1.83	0.23	1.33	0.16	0.98	0.12
S_DEER_CK_S130	1.83	0.23	1.33	0.16	0.98	0.12
N_DEER_CK_S101	1.83	0.23	1.33	0.16	0.98	0.12
N_DEER_CK_S100	1.83	0.23	1.33	0.16	0.98	0.12
N_DEER_CK_S110	1.83	0.23	1.33	0.16	0.98	0.12
N_DEER_CK_S120	1.83	0.23	1.33	0.16	0.98	0.12
N_DEER_CK_S130	1.83	0.23	1.33	0.16	0.98	0.12
DEER_CK_S105	1.83	0.23	1.33	0.16	0.98	0.12
DEER_CK_S100	1.83	0.23	1.33	0.16	0.98	0.12
DEER_CK_S110	1.83	0.23	1.33	0.16	0.98	0.12
DEER_CK_S120	1.83	0.23	1.33	0.16	0.98	0.12
DEER_CK_S130	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S250	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S245	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S236	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S237	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S260	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S270	1.83	0.23	1.33	0.16	0.98	0.12
VILLAGE_CK_S280	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S289	1.81	0.23	1.31	0.16	0.97	0.12

	2 YEAR		10 YEAR		50 YEAR	
Subbasin	**INITIAL (in)**	**CONSTANT (in/hr)**	**INITIAL (in)**	**CONSTANT (in/hr)**	**INITIAL (in)**	**CONSTANT (in/hr)**
VILLAGE_CK_S287	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S288	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S290	1.81	0.23	1.31	0.16	0.97	0.12
ELM_BRANCH_CK_S100	1.81	0.23	1.31	0.16	0.97	0.12
ELM_BRANCH_CK_S110	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S300	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S310	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S294	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S293	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S295	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S305	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S320	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S327	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S326	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S328	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S329	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S330	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S333	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S334	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S335	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S336	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S337	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S338	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S339	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S340	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S349	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S350	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S358	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S359	1.81	0.23	1.31	0.16	0.97	0.12
VILLAGE_CK_S360	1.81	0.23	1.31	0.16	0.97	0.12
S_Subbasin-LA	1.78	0.23	1.30	0.16	0.96	0.11

Table 5-3. 2020 Existing Conditions Loss Rates for 100 and 500-year Return Intervals

	100 YEAR		500 YEAR	
Subbasin	**INITIAL (in)**	**CONSTANT (in/hr)**	**INITIAL (in)**	**CONSTANT (in/hr)**
VILLAGE_CK_S101	0.83	0.09	0.55	0.07
VILLAGE_CK_S102	0.83	0.09	0.55	0.07
VILLAGE_CK_S100	0.83	0.09	0.55	0.07
WILLOW_CK_S110	0.83	0.09	0.55	0.07
VILLAGE_CK_S110	0.83	0.09	0.55	0.07
VILLAGE_CK_S120	0.83	0.09	0.55	0.07
VILLAGE_CK_S125	0.83	0.09	0.55	0.07
VILLAGE_CK_S130	0.83	0.09	0.55	0.07
VILLAGE_CK_S140	0.83	0.09	0.55	0.07
SHANNON_CK_S100	0.83	0.09	0.55	0.07
SHANNON_CK_S101	0.83	0.09	0.55	0.07
SHANNON_CK_S110	0.83	0.09	0.55	0.07
SHANNON_CK_S120	0.83	0.09	0.55	0.07
SHANNON_CK_S125	0.83	0.09	0.55	0.07
SHANNON_CK_S126	0.83	0.09	0.55	0.07
SHANNON_CK_S130	0.83	0.09	0.55	0.07
VILLAGE_CK_S150	0.83	0.09	0.55	0.07
VILLAGE_CK_S151	0.83	0.09	0.55	0.07
VILLAGE_CK_S155	0.83	0.09	0.55	0.07
VILLAGE_CK_S160	0.83	0.09	0.55	0.07
VILLAGE_CK_S170	0.83	0.09	0.55	0.07
WILLOW_CK_S100	0.83	0.09	0.55	0.07
VILLAGE_CK_S180	0.83	0.09	0.55	0.07
VILLAGE_CK_S178	0.83	0.09	0.55	0.07
VILLAGE_CK_S179	0.83	0.09	0.55	0.07
VILLAGE_CK_S190	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S100	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S110	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S120	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S130	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S125	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S135	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S140	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S150	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S145	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S155	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S160	0.83	0.09	0.55	0.07

	100 YEAR		500 YEAR	
Subbasin	**INITIAL (in)**	**CONSTANT (in/hr)**	**INITIAL (in)**	**CONSTANT (in/hr)**
QUIL_MILLER_CK_S165	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S166	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S170	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S162	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S180	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S175	0.83	0.09	0.55	0.07
QUIL_MILLER_CK_S190	0.83	0.09	0.55	0.07
VILLAGE_CK_S200	0.83	0.09	0.55	0.07
VILLAGE_CK_S205	0.83	0.09	0.55	0.07
VILLAGE_CK_S210	0.83	0.09	0.55	0.07
VILLAGE_CK_S220	0.83	0.09	0.55	0.07
VILLAGE_CK_S225	0.83	0.09	0.55	0.07
VILLAGE_CK_S230	0.83	0.09	0.55	0.07
VILLAGE_CK_S235	0.83	0.09	0.55	0.07
VILLAGE_CK_S240	0.83	0.09	0.55	0.07
S_DEER_CK_S100	0.83	0.09	0.55	0.07
S_DEER_CK_S110	0.83	0.09	0.55	0.07
S_DEER_CK_S115	0.83	0.09	0.55	0.07
S_DEER_CK_S120	0.83	0.09	0.55	0.07
S_DEER_CK_S130	0.83	0.09	0.55	0.07
N_DEER_CK_S101	0.83	0.09	0.55	0.07
N_DEER_CK_S100	0.83	0.09	0.55	0.07
N_DEER_CK_S110	0.83	0.09	0.55	0.07
N_DEER_CK_S120	0.83	0.09	0.55	0.07
N_DEER_CK_S130	0.83	0.09	0.55	0.07
DEER_CK_S105	0.83	0.09	0.55	0.07
DEER_CK_S100	0.83	0.09	0.55	0.07
DEER_CK_S110	0.83	0.09	0.55	0.07
DEER_CK_S120	0.83	0.09	0.55	0.07
DEER_CK_S130	0.83	0.09	0.55	0.07
VILLAGE_CK_S250	0.83	0.09	0.55	0.07
VILLAGE_CK_S245	0.83	0.09	0.55	0.07
VILLAGE_CK_S236	0.83	0.09	0.55	0.07
VILLAGE_CK_S237	0.83	0.09	0.55	0.07
VILLAGE_CK_S260	0.83	0.09	0.55	0.07
VILLAGE_CK_S270	0.83	0.09	0.55	0.07
VILLAGE_CK_S280	0.83	0.09	0.55	0.07
VILLAGE_CK_S289	0.83	0.09	0.55	0.07

	100 YEAR		500 YEAR	
Subbasin	**INITIAL (in)**	**CONSTANT (in/hr)**	**INITIAL (in)**	**CONSTANT (in/hr)**
VILLAGE_CK_S287	0.83	0.09	0.55	0.07
VILLAGE_CK_S288	0.83	0.09	0.55	0.07
VILLAGE_CK_S290	0.83	0.09	0.55	0.07
ELM_BRANCH_CK_S100	0.83	0.09	0.55	0.07
ELM_BRANCH_CK_S110	0.83	0.09	0.55	0.07
VILLAGE_CK_S300	0.83	0.09	0.55	0.07
VILLAGE_CK_S310	0.83	0.09	0.55	0.07
VILLAGE_CK_S294	0.83	0.09	0.55	0.07
VILLAGE_CK_S293	0.83	0.09	0.55	0.07
VILLAGE_CK_S295	0.83	0.09	0.55	0.07
VILLAGE_CK_S305	0.83	0.09	0.55	0.07
VILLAGE_CK_S320	0.83	0.09	0.55	0.07
VILLAGE_CK_S327	0.83	0.09	0.55	0.07
VILLAGE_CK_S326	0.83	0.09	0.55	0.07
VILLAGE_CK_S328	0.83	0.09	0.55	0.07
VILLAGE_CK_S329	0.83	0.09	0.55	0.07
VILLAGE_CK_S330	0.83	0.09	0.55	0.07
VILLAGE_CK_S333	0.83	0.09	0.55	0.07
VILLAGE_CK_S334	0.83	0.09	0.55	0.07
VILLAGE_CK_S335	0.83	0.09	0.55	0.07
VILLAGE_CK_S336	0.83	0.09	0.55	0.07
VILLAGE_CK_S337	0.83	0.09	0.55	0.07
VILLAGE_CK_S338	0.83	0.09	0.55	0.07
VILLAGE_CK_S339	0.83	0.09	0.55	0.07
VILLAGE_CK_S340	0.83	0.09	0.55	0.07
VILLAGE_CK_S349	0.83	0.09	0.55	0.07
VILLAGE_CK_S350	0.83	0.09	0.55	0.07
VILLAGE_CK_S358	0.83	0.09	0.55	0.07
VILLAGE_CK_S359	0.83	0.09	0.55	0.07
VILLAGE_CK_S360	0.83	0.09	0.55	0.07
S_Subbasin-LA	0.82	0.08	0.55	0.06

5.2 TSI 2070 Future Conditions HEC-HMS Model

5.2.1 Future Conditions 2070 Percent Impervious

For the 2070 conditions, the NCTCOG data indicates more concentrated development along transportation corridors, while the EPA ICLUS data shows significantly more residential development in the outer regions of our study area, along with a higher overall imperviousness. The combined 2070 land use layer uses the higher imperviousness estimate for each cell, selecting between the NCTCOG and EPA ICLUS data. This approach applies the NCTCOG data near the transportation corridors, where it is more accurate, and the EPA ICLUS data in the more distant areas. Table 5-4 compares the calculated 2070 future percent impervious values to the 2020 existing conditions values.

Table 5-4. 2070 Future Conditions Percent Imperviousness

SUBBASIN NAME	EXISTING PERCENT IMPERVIOUS (2020)	FUTURE PERCENT IMPERVIOUS (2070)
DEER_CK_S100	33	53
DEER_CK_S105	14	56
DEER_CK_S110	24	58
DEER_CK_S120	30	66
DEER_CK_S130	20	50
ELM_BRANCH_CK_S100	11	46
ELM_BRANCH_CK_S110	6	49
N_DEER_CK_S100	21	49
N_DEER_CK_S101	12	45
N_DEER_CK_S110	5	47
N_DEER_CK_S120	24	63
N_DEER_CK_S130	35	51
QUIL_MILLER_CK_S100	5	39
QUIL_MILLER_CK_S110	5	33
QUIL_MILLER_CK_S120	5	38
QUIL_MILLER_CK_S125	7	43
QUIL_MILLER_CK_S130	8	41
QUIL_MILLER_CK_S135	8	42
QUIL_MILLER_CK_S140	13	42
QUIL_MILLER_CK_S145	10	45
QUIL_MILLER_CK_S150	13	43
QUIL_MILLER_CK_S155	17	41
QUIL_MILLER_CK_S160	7	31
QUIL_MILLER_CK_S162	10	42

SUBBASIN NAME	EXISTING PERCENT IMPERVIOUS (2020)	FUTURE PERCENT IMPERVIOUS (2070)
QUIL_MILLER_CK_S165	11	42
QUIL_MILLER_CK_S166	6	42
QUIL_MILLER_CK_S170	12	41
QUIL_MILLER_CK_S175	29	56
QUIL_MILLER_CK_S180	22	44
QUIL_MILLER_CK_S190	12	44
SHANNON_CK_S100	4	35
SHANNON_CK_S101	6	32
SHANNON_CK_S110	11	59
SHANNON_CK_S120	18	55
SHANNON_CK_S125	12	54
SHANNON_CK_S126	48	54
SHANNON_CK_S130	19	68
S_DEER_CK_S100	10	42
S_DEER_CK_S110	13	43
S_DEER_CK_S115	11	39
S_DEER_CK_S120	37	56
S_DEER_CK_S130	35	50
S_Subbasin-LA	59	80
VILLAGE_CK_S100	19	44
VILLAGE_CK_S101	9	44
VILLAGE_CK_S102	5	42
VILLAGE_CK_S110	3	27
VILLAGE_CK_S120	8	57
VILLAGE_CK_S125	7	58
VILLAGE_CK_S130	15	57
VILLAGE_CK_S140	10	48
VILLAGE_CK_S150	17	48
VILLAGE_CK_S151	46	61
VILLAGE_CK_S155	36	52
VILLAGE_CK_S160	16	34
VILLAGE_CK_S170	48	65
VILLAGE_CK_S178	44	68
VILLAGE_CK_S179	44	78
VILLAGE_CK_S180	34	71
VILLAGE_CK_S190	16	40
VILLAGE_CK_S200	7	31
VILLAGE_CK_S205	11	46

SUBBASIN NAME	EXISTING PERCENT IMPERVIOUS (2020)	FUTURE PERCENT IMPERVIOUS (2070)
VILLAGE_CK_S210	13	44
VILLAGE_CK_S220	10	47
VILLAGE_CK_S225	29	56
VILLAGE_CK_S230	16	51
VILLAGE_CK_S235	13	44
VILLAGE_CK_S236	13	42
VILLAGE_CK_S237	6	39
VILLAGE_CK_S240	6	43
VILLAGE_CK_S245	21	51
VILLAGE_CK_S250	10	32
VILLAGE_CK_S260	15	46
VILLAGE_CK_S270	10	43
VILLAGE_CK_S280	10	37
VILLAGE_CK_S287	16	78
VILLAGE_CK_S288	11	50
VILLAGE_CK_S289	17	46
VILLAGE_CK_S290	6	44
VILLAGE_CK_S293	26	82
VILLAGE_CK_S294	44	71
VILLAGE_CK_S295	21	57
VILLAGE_CK_S300	7	41
VILLAGE_CK_S305	14	65
VILLAGE_CK_S310	15	48
VILLAGE_CK_S320	10	53
VILLAGE_CK_S326	30	65
VILLAGE_CK_S327	43	68
VILLAGE_CK_S328	29	71
VILLAGE_CK_S329	31	75
VILLAGE_CK_S330	37	86
VILLAGE_CK_S333	13	46
VILLAGE_CK_S334	13	45
VILLAGE_CK_S335	18	53
VILLAGE_CK_S336	25	62
VILLAGE_CK_S337	19	46
VILLAGE_CK_S338	28	56
VILLAGE_CK_S339	38	60
VILLAGE_CK_S340	31	85
VILLAGE_CK_S349	28	61

SUBBASIN NAME	EXISTING PERCENT IMPERVIOUS (2020)	FUTURE PERCENT IMPERVIOUS (2070)
VILLAGE_CK_S350	12	88
VILLAGE_CK_S358	44	79
VILLAGE_CK_S359	69	93
VILLAGE_CK_S360	41	77
WILLOW_CK_S100	7	38
WILLOW_CK_S110	33	40

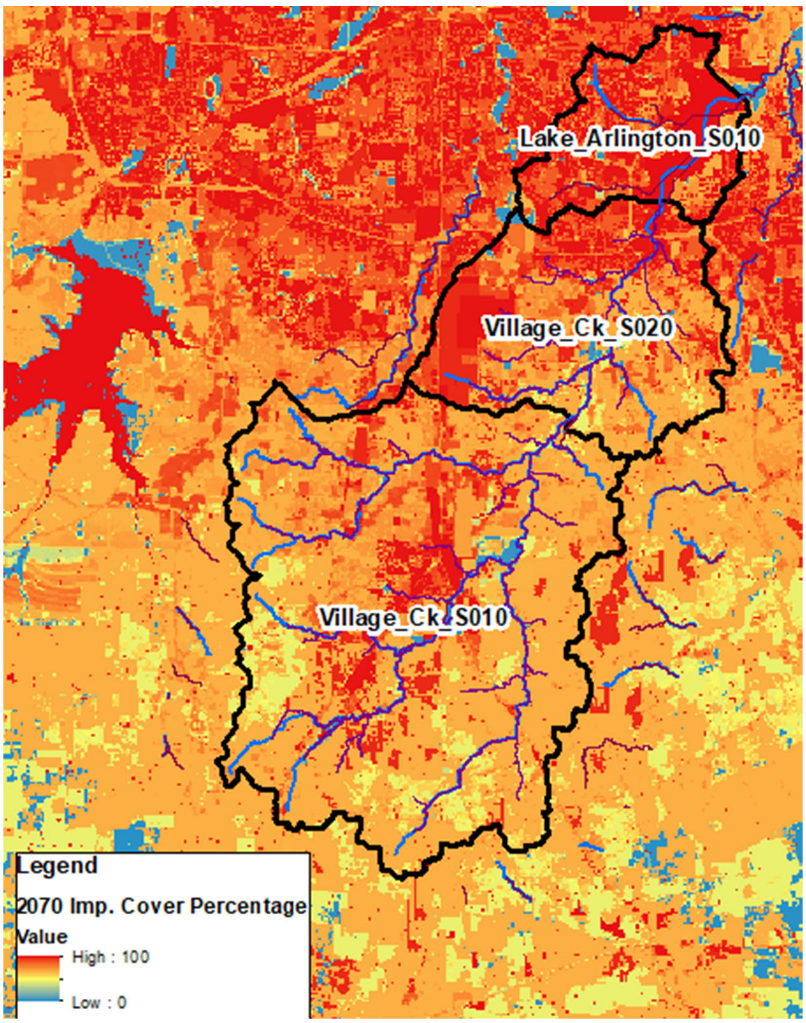


Figure 5-2. Map of Future 2070 Percent Imperviousness

5.2.2 Future Conditions 2070 Lag Times

Regional studies in North Texas have indicated that as a watershed shifts from rural to urban, its Snyder lag time decreases. As a result, reduction ratios were applied to the current lag times for each subbasin. The reduction ratios, which are based on the percent of urbanization increases, were developed from the Fort Worth District urban studies (Nelson, 1979) (Rodman, 1977) (USACE, 1989).

Table 5-5. Future Conditions Snyder's Lag Times

SUBBASIN NAME	2020 EXISTING LAG TIME (HR)	2070 FUTURE LAG TIME (HR)	PEAKING COEFF
DEER_CK_S100	1.08	0.84	0.6
DEER_CK_S105	1.60	1.22	0.6
DEER_CK_S110	1.04	0.78	0.6
DEER_CK_S120	1.49	1.09	0.6
DEER_CK_S130	1.36	1.04	0.6
ELM_BRANCH_CK_S100	0.27	0.21	0.72
ELM_BRANCH_CK_S110	0.13	0.10	0.72
N_DEER_CK_S100	1.62	1.26	0.6
N_DEER_CK_S101	1.93	1.49	0.6
N_DEER_CK_S110	0.60	0.48	0.6
N_DEER_CK_S120	0.87	0.65	0.6
N_DEER_CK_S130	0.51	0.39	0.6
QUIL_MILLER_CK_S100	1.49	1.11	0.6
QUIL_MILLER_CK_S110	1.12	0.86	0.6
QUIL_MILLER_CK_S120	1.77	1.32	0.6
QUIL_MILLER_CK_S125	1.32	0.98	0.6
QUIL_MILLER_CK_S130	0.67	0.50	0.6
QUIL_MILLER_CK_S135	0.35	0.27	0.6
QUIL_MILLER_CK_S140	0.78	0.59	0.6
QUIL_MILLER_CK_S145	1.25	0.93	0.6
QUIL_MILLER_CK_S150	1.20	0.91	0.6
QUIL_MILLER_CK_S155	0.89	0.69	0.6
QUIL_MILLER_CK_S160	0.72	0.58	0.6
QUIL_MILLER_CK_S162	1.14	0.86	0.6
QUIL_MILLER_CK_S165	1.06	0.80	0.6
QUIL_MILLER_CK_S166	0.68	0.51	0.6
QUIL_MILLER_CK_S170	0.85	0.65	0.6
QUIL_MILLER_CK_S175	1.28	0.95	0.6
QUIL_MILLER_CK_S180	0.68	0.52	0.6

SUBBASIN NAME	2020 EXISTING LAG TIME (HR)	2070 FUTURE LAG TIME (HR)	PEAKING COEFF
QUIL_MILLER_CK_S190	1.22	0.93	0.6
SHANNON_CK_S100	1.37	1.10	0.6
SHANNON_CK_S101	1.20	0.94	0.6
SHANNON_CK_S110	0.58	0.43	0.6
SHANNON_CK_S120	1.68	1.25	0.6
SHANNON_CK_S125	1.59	1.19	0.6
SHANNON_CK_S126	1.06	0.78	0.6
SHANNON_CK_S130	1.24	0.91	0.6
S_DEER_CK_S100	1.28	0.99	0.6
S_DEER_CK_S110	1.63	1.27	0.6
S_DEER_CK_S115	1.62	1.27	0.6
S_DEER_CK_S120	1.03	0.78	0.6
S_DEER_CK_S130	1.01	0.80	0.6
S_Subbasin-LA	0.84	0.61	0.72
VILLAGE_CK_S100	1.47	1.13	0.6
VILLAGE_CK_S101	1.41	1.07	0.6
VILLAGE_CK_S102	1.41	1.08	0.6
VILLAGE_CK_S110	0.53	0.52	0.6
VILLAGE_CK_S120	0.84	0.62	0.6
VILLAGE_CK_S125	0.84	0.62	0.6
VILLAGE_CK_S130	0.85	0.64	0.6
VILLAGE_CK_S140	1.92	1.45	0.6
VILLAGE_CK_S150	0.56	0.44	0.6
VILLAGE_CK_S151	1.79	1.33	0.6
VILLAGE_CK_S155	1.23	0.93	0.6
VILLAGE_CK_S160	0.98	0.92	0.6
VILLAGE_CK_S170	0.39	0.31	0.6
VILLAGE_CK_S178	1.23	0.90	0.6
VILLAGE_CK_S179	1.54	1.11	0.6
VILLAGE_CK_S180	1.08	0.79	0.6
VILLAGE_CK_S190	1.00	0.83	0.6
VILLAGE_CK_S200	0.86	0.75	0.6
VILLAGE_CK_S205	1.58	1.21	0.6
VILLAGE_CK_S210	0.81	0.63	0.6
VILLAGE_CK_S220	1.07	0.82	0.6
VILLAGE_CK_S225	1.85	1.42	0.6
VILLAGE_CK_S230	0.75	0.56	0.6
VILLAGE_CK_S235	1.47	1.12	0.6
VILLAGE_CK_S236	1.03	0.78	0.6
VILLAGE_CK_S237	0.72	0.57	0.6

SUBBASIN NAME	2020 EXISTING LAG TIME (HR)	2070 FUTURE LAG TIME (HR)	PEAKING COEFF
VILLAGE_CK_S240	0.52	0.40	0.6
VILLAGE_CK_S245	1.94	1.48	0.6
VILLAGE_CK_S250	0.61	0.48	0.6
VILLAGE_CK_S260	0.85	0.65	0.6
VILLAGE_CK_S270	0.87	0.68	0.6
VILLAGE_CK_S280	0.31	0.26	0.72
VILLAGE_CK_S287	0.39	0.29	0.72
VILLAGE_CK_S288	0.34	0.27	0.72
VILLAGE_CK_S289	0.21	0.17	0.72
VILLAGE_CK_S290	0.11	0.10	0.72
VILLAGE_CK_S293	0.43	0.32	0.72
VILLAGE_CK_S294	0.46	0.35	0.72
VILLAGE_CK_S295	0.31	0.24	0.72
VILLAGE_CK_S300	0.26	0.22	0.72
VILLAGE_CK_S305	0.20	0.15	0.72
VILLAGE_CK_S310	0.18	0.14	0.72
VILLAGE_CK_S320	0.11	0.10	0.72
VILLAGE_CK_S326	0.32	0.25	0.72
VILLAGE_CK_S327	0.33	0.25	0.72
VILLAGE_CK_S328	0.20	0.15	0.72
VILLAGE_CK_S329	0.13	0.10	0.72
VILLAGE_CK_S330	0.10	0.10	0.72
VILLAGE_CK_S333	0.28	0.22	0.72
VILLAGE_CK_S334	0.26	0.20	0.72
VILLAGE_CK_S335	0.24	0.18	0.72
VILLAGE_CK_S336	0.25	0.19	0.72
VILLAGE_CK_S337	0.12	0.10	0.72
VILLAGE_CK_S338	0.13	0.10	0.72
VILLAGE_CK_S339	0.10	0.10	0.72
VILLAGE_CK_S340	0.14	0.10	0.72
VILLAGE_CK_S349	0.23	0.17	0.72
VILLAGE_CK_S350	0.12	0.10	0.72
VILLAGE_CK_S358	0.34	0.25	0.72
VILLAGE_CK_S359	0.10	0.10	0.72
VILLAGE_CK_S360	0.28	0.20	0.72
WILLOW_CK_S100	1.65	1.26	0.72
WILLOW_CK_S110	0.56	0.45	0.72

5.2.3 Future Conditions 2070 Loss Rates

The same loss rates were used for 2070 conditions as were used for 2020 conditions.

5.2.4 Future Conditions 2070 Routing Parameters

For the Modified Puls routing reaches, the storage-discharge curves were modified to account for the valley storage that could be lost due to future development. effective FEMA FIS floodway models in the Village Creek watershed were used to estimate a future conditions storage-discharge curve by assuming that floodway encroachments represent the portion of the floodplain that could be lost to future development. For stream reaches without a regulatory floodway, a typical percent difference in storage was calculated from multiple nearby reaches of similar drainage area that did have floodway models, and that percent difference curve was then applied to the stream reaches without regulatory floodways to estimate the future conditions storage-discharge curves.

Figures 5-3 and 5-4 show the Percent Difference curves that were calculated from the regulatory floodway models as well as the average percent difference curves that were applied to the other stream reaches with up to 12 square miles in drainage area. For mainstem reaches with drainage areas greater than 12 square miles, percent difference curves from the nearest mainstem reaches with similar drainage areas were applied. The percent difference curves for the mainsteam reaches are shown in Figure 5-5. Table 5-6 shows the reaches with the updated future conditions storage-discharge curves.

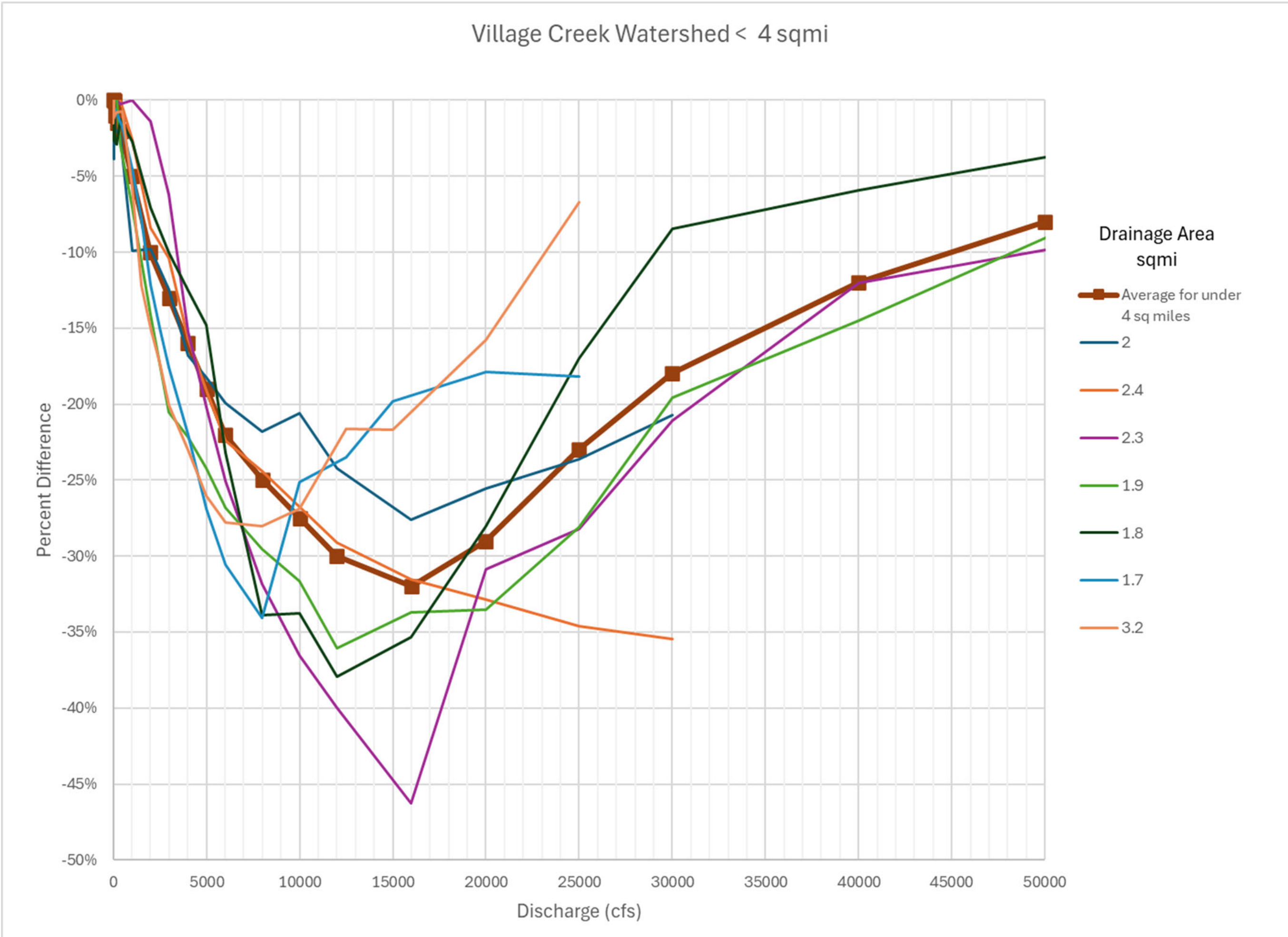


Figure 5-3. Percent Reduction Curves for Future Conditions Valley Storage for Reaches with less than 4 square miles of Drainage Area

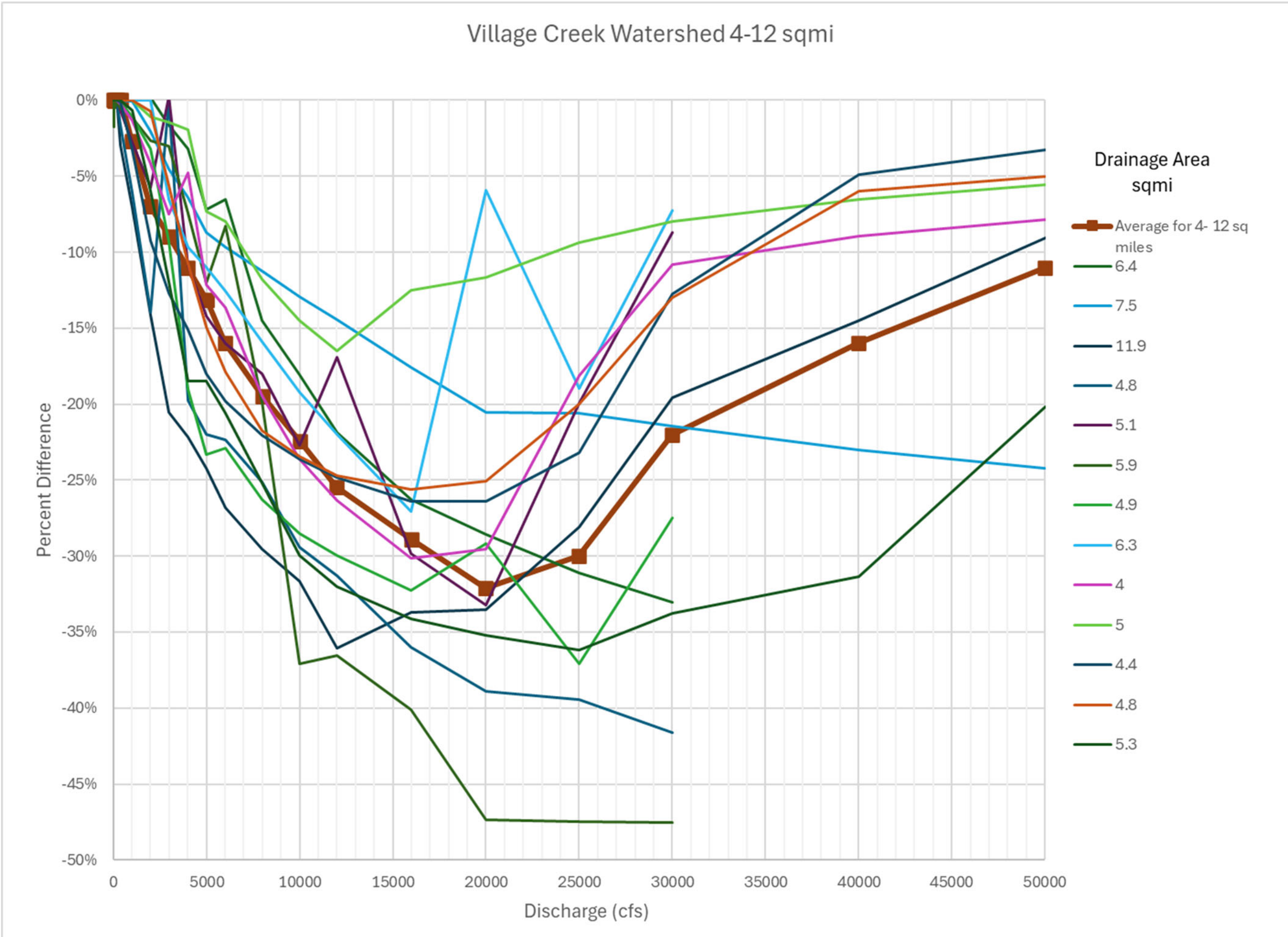


Figure 5-4. Percent Reduction Curves for Future Conditions Valley Storage for Reaches with 4 - 12 square miles of Drainage Area

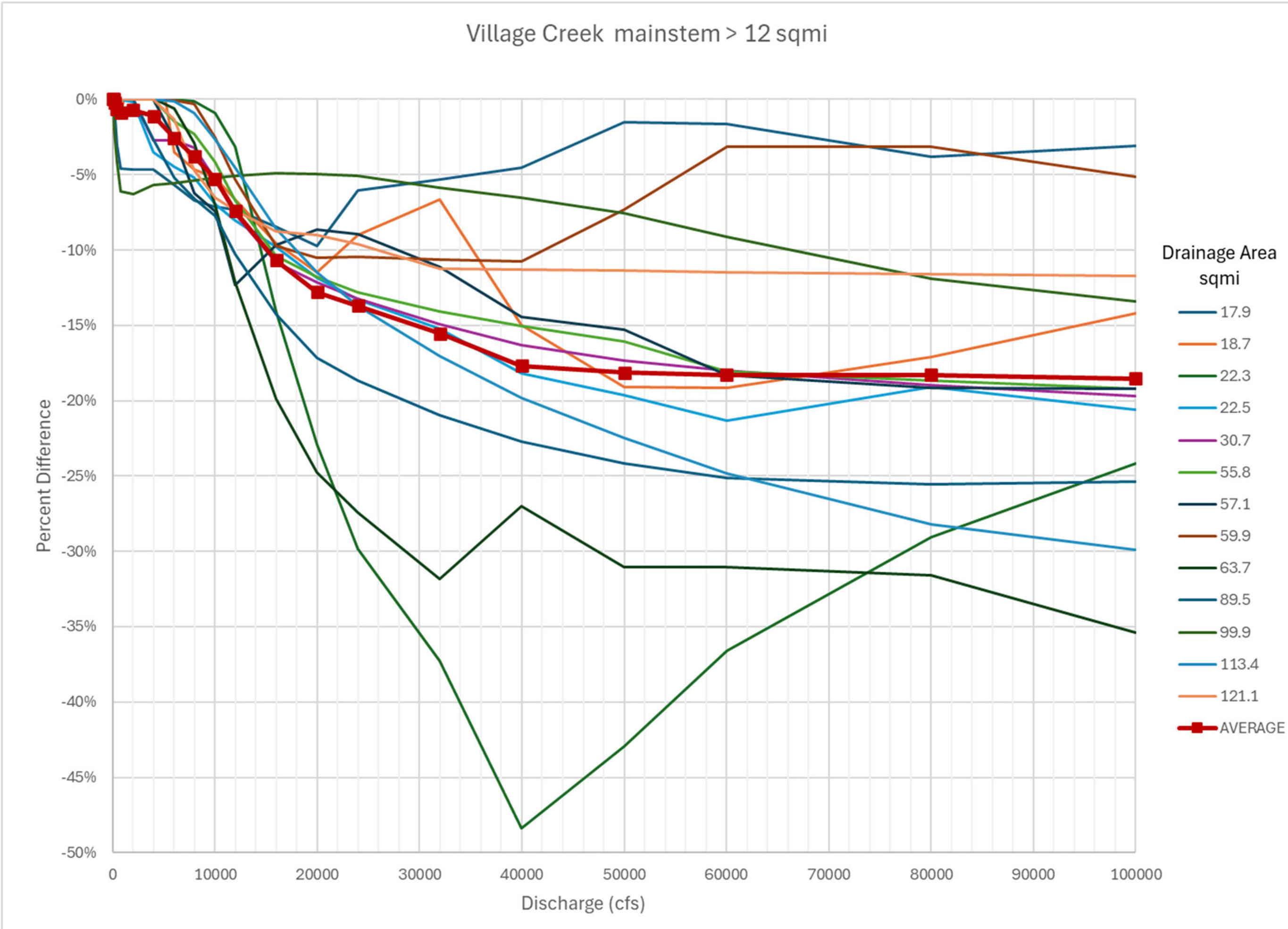


Figure 5-5. Percent Reduction Curves for Future Conditions Valley Storage for Village Creek Reaches with more than 12 square miles of Drainage Area

6 Final HEC-HMS Results

The final discharge frequency results for the 2020 and 2070 watersheds (existing and future conditions) are illustrated in the following sections.

6.1 Frequency Storms

The WHA study uniform storms with NOAA Atlas 14 precipitation depths were applied to the entire watershed. For this study, The precipitation depths from the WHA subbasins Village_CK_S010, Village_CK_S020 and Lake_Arlington_S010 were applied to the corresponding Village Creek TSI subbasins with a 2-day storm duration. The final 2020 and 2070 frequency storm runs used the point precipitation values without any area reduction to provide more conservative answers for the initial alternatives screening. Five frequencies were generated for this study: 50% ACE (2-year), 10% ACE (10-year), 2% ACE (50-year), 1%ACE (100-year), and 0.2% ACE (500-year).

6.2 Frequency Discharge Results for Existing 2020 Conditions

Table 6-1. Summary of Existing 2020 Conditions Discharges for Village Creek

		Frequency and Peak Discharge (cfs)				
HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
Mountain_Valley_Dam2	1.5	322	1,078	1,590	1,838	2,428
VILLAGE_CK_J136	1.5	322	1,078	1,590	1,838	2,428
VILLAGE_CK_J139	3.2	488	1,311	2,473	3,096	4,085
Mountain_Valley_Dam1	2	472	1,337	2,046	2,377	3,152
VILLAGE_CK_J105	2	472	1,337	2,046	2,377	3,152
VILLAGE_CK_J110	0.3	202	413	580	658	848
VILLAGE_CK_J120	2.4	465	1,388	2,141	2,533	3,429
VILLAGE_CK_J130	2.8	442	1,332	2,141	2,570	3,569
VILLAGE_CK_J140	6.4	884	2,610	4,823	5,770	7,887
VILLAGE_CK_J150	7.5	1,114	3,109	5,116	6,324	8,860
VILLAGE_CK_J160	9.5	1,303	3,604	5,969	7,320	10,420
SHANNON_CK_J100	3.3	1,002	2,617	3,838	4,431	5,835
SHANNON_CK_J110	3.5	1,042	2,726	3,985	4,599	6,113
SHANNON_CK_J120	6.8	1,757	4,604	6,915	8,044	10,743
SHANNON_CK_J130	7.2	1,893	4,883	7,333	8,524	11,375
SHANNON_CK_J140	8.4	1,608	4,519	7,038	8,295	11,238
J_VillageCK_blw_ShannonCk	17.9	2,898	8,121	12,884	15,454	21,521
VILLAGE_CK_J170	18.7	2,211	6,700	11,588	14,286	20,913
VILLAGE_CK_J179	2.3	745	1,519	2,196	2,524	3,320

HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
VILLAGE_CK_J180	22.3	2,473	7,374	12,773	15,831	22,568
VILLAGE_CK_J190	22.5	2,479	7,385	12,772	15,821	22,530
VILLAGE_CK_J200	27.6	2,979	8,559	14,937	18,507	26,861
VILLAGE_CK_J195	1.9	801	1,627	2,324	2,657	3,470
VILLAGE_CK_J205	1.9	661	1,415	2,061	2,373	3,143
VILLAGE_CK_J210	30.7	3,809	9,678	16,527	20,441	29,681
VILLAGE_CK_J215	31.7	3,442	8,966	16,648	20,742	30,025
QUIL_MILLER_CK_J100	3.5	947	2,499	3,690	4,271	5,643
QUIL_MILLER_CK_J110abv	5.1	1,098	3,371	5,156	6,008	8,034
QUIL_MILLER_CK_J110blw	5.1	1,098	3,371	5,156	6,008	8,034
QUIL_MILLER_CK_J120	7.4	1,079	3,952	6,566	7,864	10,791
QUIL_MILLER_CK_J130	7.7	1,083	3,982	6,589	7,936	10,885
QUIL_MILLER_CK_J125	3.3	1,024	2,621	3,838	4,429	5,830
QUIL_MILLER_CK_J135	3.5	978	2,609	3,850	4,454	5,885
QUIL_MILLER_CK_J140	11.2	1,778	5,963	9,642	11,658	16,000
QUIL_MILLER_CK_J150	11.9	1,525	5,921	9,857	11,955	16,370
QUIL_MILLER_CK_J160	13.2	1,494	5,651	9,850	12,056	16,767
QUIL_MILLER_CK_J155	3.1	1,017	2,531	3,690	4,250	5,583
QUIL_MILLER_CK_J165	3.6	834	2,444	3,761	4,406	5,933
QUIL_MILLER_CK_J170	16.8	2,079	7,255	12,678	15,505	21,560
QUIL_MILLER_CK_J180	17.1	1,742	7,171	12,678	15,495	21,383
QUIL_MILLER_CK_J175	1.3	483	1,173	1,695	1,945	2,545
QUIL_MILLER_CK_J176	1.6	542	1,399	2,051	2,358	3,100
QUIL_MILLER_CK_J190	18.6	1,813	7,625	13,631	16,666	23,006
QUIL_MILLER_CK_J200	19.9	1,802	7,276	13,276	16,519	23,475
QUIL_MILLER_J200blw	21.2	1,840	7,550	13,905	17,350	24,747
QUIL_MILLER_CK_J210abv	21.5	1,840	7,380	13,766	17,227	24,701
QUIL_MILLER_CK_J210blw	22.7	1,961	7,652	14,362	18,005	25,899
QUIL_MILLER_CK_J230	24.2	1,982	7,808	14,910	18,755	27,093
VILLAGE_CK_BLW_QUIL_MILLER	55.8	5,421	16,584	31,338	39,359	56,591
VILLAGE_CK_J230	57.1	5,358	15,928	30,702	38,811	56,345
VILLAGE_CK_J245	2.3	629	1,600	2,360	2,731	3,609
VILLAGE_CK_J250	59.9	5,219	16,232	31,650	40,136	58,467
VILLAGE_CK_J270	60.9	5,231	15,952	30,844	38,550	58,403
VILLAGE_CK_J275	1.4	383	866	1,270	1,467	1,940
VILLAGE_CK_J290	62.5	5,423	16,333	31,493	39,364	59,752
VILLAGE_CK_J300	63.7	5,464	16,452	31,866	39,856	60,658
VILLAGE_CK_J310	63.8	5,384	16,247	30,737	38,252	56,581

HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
S_DEER_CK_J100	1.8	569	1,424	2,079	2,396	3,150
S_DEER_CK_J110	4.1	1,017	2,722	4,065	4,716	6,274
S_DEER_CK_J120	5.2	1,302	3,444	5,132	5,952	7,909
S_DEER_CK_J130	7.3	1,856	4,888	7,219	8,295	11,042
S_DEER_CK_J140	8.1	1,953	4,870	7,668	8,882	11,596
N_DEER_CK_J100	2.8	642	1,654	2,465	2,865	3,807
N_DEER_CK_J110	4.8	1,191	2,973	4,403	5,105	6,766
N_DEER_CK_J120	5.1	1,181	3,121	4,518	5,291	7,058
N_DEER_CK_J130	5.9	1,263	3,453	4,875	5,735	7,655
N_DEER_CK_J140	6.1	1,287	3,547	4,983	5,875	7,851
DEER_CK_J010	14.2	3,221	8,388	12,571	14,691	19,417
DEER_CK_J100	16.8	3,609	9,535	14,508	16,918	22,424
DEER_CK_J110	19.1	3,735	10,040	15,534	18,219	24,638
DEER_CK_J120	21.1	3,785	10,758	16,691	19,622	26,628
DEER_CK_J130	22	3,883	10,965	17,188	20,199	27,511
VILLAGE_CK_BLW_DEER_CK	85.8	8,406	22,257	40,982	50,828	76,010
VILLAGE_CK_J330	86	8,363	22,171	40,798	50,738	75,750
VILLAGE_CK_J340	87.4	8,533	22,506	41,324	51,458	76,831
VILLAGE_CK_J236	1.2	463	1,109	1,599	1,834	2,397
VILLAGE_CK_J237	1.7	695	1,684	2,424	2,778	3,627
VILLAGE_CK_J350	89.5	8,597	22,620	41,459	51,750	77,394
VILLAGE_CK_J360_GAGE	90	8,348	22,374	40,744	50,836	76,285
VILLAGE_CK_J410	92.6	8,162	22,229	40,151	50,117	73,386
VILLAGE_CK_J407	1.7	1,650	3,439	4,727	5,315	6,711
VILLAGE_CK_J408	3.2	1,654	3,795	5,390	6,154	7,915
VILLAGE_CK_J409	3.2	920	2,250	3,407	3,980	5,290
VILLAGE_CK_J420	95.7	8,281	22,484	40,555	50,687	74,272
VILLAGE_CK_J430	96	8,286	22,488	40,546	50,671	74,244
ELM_BRANCH_CK_J100	2.4	2,730	5,656	7,742	8,697	10,938
VILLAGE_CK_J440	98.4	8,341	22,602	40,707	50,861	74,549
VILLAGE_CK_J450	99.9	7,293	21,933	39,417	48,998	71,208
VILLAGE_CK_J460	100.3	6,998	21,720	38,996	48,464	70,254
VILLAGE_CK_J466	2.6	2,535	4,835	6,618	7,426	9,376
VILLAGE_CK_J467	4.9	4,608	9,022	12,365	13,884	17,532
VILLAGE_CK_J468	6.3	3,287	6,181	9,003	10,287	13,639
VILLAGE_CK_J469	6.9	3,598	7,210	9,670	11,193	14,807
VILLAGE_CK_J470	107.3	7,127	21,983	39,376	48,936	70,952
VILLAGE_CK_J480	107.9	7,021	21,886	39,316	48,868	70,839

HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
VILLAGE_CK_J486	1.6	1,892	3,442	4,690	5,256	6,610
VILLAGE_CK_J485	4	4,658	8,720	11,905	13,353	16,804
VILLAGE_CK_J488	5	3,284	7,079	9,884	11,140	14,328
VILLAGE_CK_J489	5.4	3,071	6,797	9,599	10,907	14,142
VILLAGE_CK_J490	113.4	7,349	22,128	39,657	49,266	71,383
VILLAGE_CK_J500	113.6	7,184	22,129	39,653	49,262	71,379
VILLAGE_CK_J503	2.2	2,594	5,325	7,286	8,183	10,291
VILLAGE_CK_J504	3.2	2,292	5,498	7,938	9,054	11,707
VILLAGE_CK_J505	4.4	3,707	8,195	11,650	13,240	16,993
VILLAGE_CK_J506	4.8	2,406	5,936	9,071	10,525	14,082
VILLAGE_CK_J507	5.3	2,278	5,546	8,471	9,971	13,530
VILLAGE_CK_J508	5.4	2,236	5,463	8,280	9,697	13,302
VILLAGE_CK_J510	119	9,415	22,387	40,016	49,681	71,935
VILLAGE_CK_J520	119.4	7,615	22,357	39,992	49,662	71,925
VILLAGE_CK_J528	1.6	2,234	4,130	5,628	6,312	7,919
VILLAGE_CK_J529	1.7	1,354	3,048	4,093	4,555	5,646
VILLAGE_CK_J530	121.1	7,880	22,439	40,108	49,796	72,100
VILLAGE_CK_J540	122.7	7,623	22,447	40,148	49,846	72,180
J_LA	124.1	7,511	22,470	40,163	49,842	72,219
LA_INFLOW	142.8	17,388	35,764	54,312	64,412	91,107
Lake_Arlington	142.8	3,308	4,290	15,467	24,762	49,064

6.3 Frequency Discharge Results for Future 2070 Conditions

Table 6-2. Summary of Future 2070 Conditions Discharges for Village Creek

		Frequency and Peak Discharge (cfs)				
HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
Mountain_Valley_Dam2	1.5	668	1,369	1,957	2,236	2,920
VILLAGE_CK_J136	1.5	668	1,369	1,957	2,236	2,920
VILLAGE_CK_J139	3.2	806	1,789	3,268	3,721	4,810
Mountain_Valley_Dam1	2	767	1,664	2,467	2,836	3,729
VILLAGE_CK_J105	2	767	1,664	2,467	2,836	3,729
VILLAGE_CK_J110	0.3	240	474	661	749	962
VILLAGE_CK_J120	2.4	785	1,720	2,624	3,068	4,150
VILLAGE_CK_J130	2.8	725	1,676	2,603	3,080	4,342

HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
VILLAGE_CK_J140	6.4	1,540	3,472	5,838	6,813	9,329
VILLAGE_CK_J150	7.5	1,833	3,944	6,393	7,680	10,739
VILLAGE_CK_J160	9.5	2,114	4,505	7,407	8,926	12,680
SHANNON_CK_J100	3.3	1,500	3,189	4,556	5,207	6,790
SHANNON_CK_J110	3.5	1,560	3,318	4,743	5,458	7,203
SHANNON_CK_J120	6.8	2,759	5,858	8,556	9,872	12,893
SHANNON_CK_J130	7.2	2,932	6,200	9,066	10,463	13,665
SHANNON_CK_J140	8.4	2,645	5,855	8,981	10,489	14,418
J_VillageCK_blw_ShannonCk	17.9	4,753	10,323	16,111	19,093	26,734
VILLAGE_CK_J170	18.7	3,463	8,710	14,555	18,391	24,042
VILLAGE_CK_J179	2.3	1,031	1,929	2,735	3,118	4,067
VILLAGE_CK_J180	22.3	3,723	9,542	16,083	19,597	25,683
VILLAGE_CK_J190	22.5	3,731	9,546	16,087	19,613	25,715
VILLAGE_CK_J200	27.6	4,610	11,107	18,761	23,413	30,859
VILLAGE_CK_J195	1.9	1,159	2,074	2,902	3,289	4,256
VILLAGE_CK_J205	1.9	938	1,815	2,628	3,004	3,968
VILLAGE_CK_J210	30.7	5,945	12,220	20,626	25,807	34,695
VILLAGE_CK_J215	31.7	4,783	12,156	21,016	26,080	35,413
QUIL_MILLER_CK_J100	3.5	1,563	3,240	4,626	5,286	6,897
QUIL_MILLER_CK_J110abv	5.1	1,953	4,480	6,638	7,646	10,014
QUIL_MILLER_CK_J110blw	5.1	1,953	4,480	6,638	7,646	10,014
QUIL_MILLER_CK_J120	7.4	2,001	5,442	8,770	10,277	13,863
QUIL_MILLER_CK_J130	7.7	2,018	5,426	8,871	10,405	14,075
QUIL_MILLER_CK_J125	3.3	1,676	3,388	4,806	5,477	7,122
QUIL_MILLER_CK_J135	3.5	1,614	3,408	4,867	5,566	7,247
QUIL_MILLER_CK_J140	11.2	3,256	8,014	12,940	15,243	20,609
QUIL_MILLER_CK_J150	11.9	2,714	8,279	13,348	15,686	20,968
QUIL_MILLER_CK_J160	13.2	2,622	8,145	13,681	16,259	22,106
QUIL_MILLER_CK_J155	3.1	1,632	3,243	4,589	5,225	6,785
QUIL_MILLER_CK_J165	3.6	1,425	3,231	4,831	5,637	7,530
QUIL_MILLER_CK_J170	16.8	3,396	10,529	17,580	20,879	28,349
QUIL_MILLER_CK_J180	17.1	3,384	10,440	17,361	20,526	27,786
QUIL_MILLER_CK_J175	1.3	725	1,462	2,063	2,346	3,040
QUIL_MILLER_CK_J176	1.6	822	1,730	2,461	2,811	3,655
QUIL_MILLER_CK_J190	18.6	3,664	11,225	18,679	22,116	29,964
QUIL_MILLER_CK_J200	19.9	3,612	10,906	18,884	22,549	30,765
QUIL_MILLER_J200blw	21.2	3,783	11,402	19,845	23,737	32,448
QUIL_MILLER_CK_J210abv	21.5	3,747	11,318	19,709	23,658	32,549

HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
QUIL_MILLER_CK_J210blw	22.7	3,926	11,793	20,611	24,785	34,156
QUIL_MILLER_CK_J230	24.2	4,077	12,287	21,414	25,838	35,480
VILLAGE_CK_BLW_QUIL_MILLER	55.8	8,815	23,685	42,129	50,830	70,751
VILLAGE_CK_J230	57.1	8,648	23,095	41,456	50,620	70,860
VILLAGE_CK_J245	2.3	1,019	2,045	2,917	3,332	4,348
VILLAGE_CK_J250	59.9	8,637	23,766	43,036	52,595	73,841
VILLAGE_CK_J270	60.9	8,572	23,018	40,796	51,782	73,141
VILLAGE_CK_J275	1.4	571	1,096	1,562	1,784	2,332
VILLAGE_CK_J290	62.5	8,831	23,484	41,695	52,940	74,897
VILLAGE_CK_J300	63.7	8,891	23,726	42,248	53,727	76,119
VILLAGE_CK_J310	63.8	8,774	23,302	40,115	51,007	72,202
S_DEER_CK_J100	1.8	878	1,781	2,529	2,883	3,750
S_DEER_CK_J110	4.1	1,593	3,382	4,902	5,644	7,439
S_DEER_CK_J120	5.2	2,021	4,280	6,190	7,118	9,368
S_DEER_CK_J130	7.3	2,721	6,214	8,686	10,010	13,797
S_DEER_CK_J140	8.1	2,861	6,425	9,345	10,696	14,591
N_DEER_CK_J100	2.8	1,035	2,110	3,034	3,477	4,558
N_DEER_CK_J110	4.8	1,870	3,762	5,392	6,172	8,080
N_DEER_CK_J120	5.1	1,906	3,915	5,632	6,463	8,501
N_DEER_CK_J130	5.9	2,060	4,251	5,910	6,277	9,186
N_DEER_CK_J140	6.1	2,098	4,350	6,102	6,633	9,434
DEER_CK_J010	14.2	4,958	10,754	15,431	17,184	23,605
DEER_CK_J100	16.8	5,703	12,438	18,202	20,478	27,026
DEER_CK_J110	19.1	5,861	13,481	20,316	23,073	30,004
DEER_CK_J120	21.1	6,164	14,340	21,731	24,962	32,737
DEER_CK_J130	22	6,120	14,772	22,456	25,854	33,953
VILLAGE_CK_BLW_DEER_CK	85.8	12,756	31,504	53,136	68,120	96,438
VILLAGE_CK_J330	86	12,688	31,434	53,025	67,796	96,057
VILLAGE_CK_J340	87.4	12,921	31,872	53,852	68,748	97,485
VILLAGE_CK_J236	1.2	689	1,380	1,945	2,211	2,864
VILLAGE_CK_J237	1.7	1,034	2,082	2,931	3,330	4,309
VILLAGE_CK_J350	89.5	13,009	32,039	54,282	69,182	98,339
VILLAGE_CK_J360_GAGE	90	12,841	31,766	53,448	68,173	97,315
VILLAGE_CK_J410	92.6	12,616	31,467	52,818	66,184	95,364
VILLAGE_CK_J407	1.7	2,510	4,120	5,571	6,226	7,805
VILLAGE_CK_J408	3.2	2,461	4,447	6,233	7,076	9,151
VILLAGE_CK_J409	3.2	1,449	2,917	4,430	5,137	7,090
VILLAGE_CK_J420	95.7	12,886	31,948	53,605	67,165	96,743

HEC-HMS ELEMENT NAME	Drainage Area (sqmi)	2 YR	10 YR	50 YR	100 YR	500 YR
VILLAGE_CK_J430	96	12,894	31,947	53,601	67,146	96,685
ELM_BRANCH_CK_J100	2.4	3,494	6,340	8,607	9,640	12,075
VILLAGE_CK_J440	98.4	12,969	32,083	53,838	67,477	97,196
VILLAGE_CK_J450	99.9	11,962	30,982	52,242	64,387	92,921
VILLAGE_CK_J460	100.3	11,766	30,473	51,618	63,317	91,538
VILLAGE_CK_J466	2.6	3,418	5,732	7,769	8,688	10,912
VILLAGE_CK_J467	4.9	6,505	10,690	14,470	16,173	20,301
VILLAGE_CK_J468	6.3	4,595	8,209	12,002	13,808	18,377
VILLAGE_CK_J469	6.9	5,106	8,694	12,840	14,781	18,964
VILLAGE_CK_J470	107.3	11,972	30,879	52,262	64,155	92,800
VILLAGE_CK_J480	107.9	11,845	30,678	52,112	63,909	92,500
VILLAGE_CK_J486	1.6	2,412	4,003	5,417	6,057	7,585
VILLAGE_CK_J485	4	6,083	10,142	13,727	15,351	19,227
VILLAGE_CK_J488	5	4,422	8,493	12,201	13,948	18,306
VILLAGE_CK_J489	5.4	4,061	8,221	12,000	13,532	17,561
VILLAGE_CK_J490	113.4	12,019	30,977	52,587	64,522	93,412
VILLAGE_CK_J500	113.6	12,023	30,978	52,591	64,523	93,412
VILLAGE_CK_J503	2.2	3,302	5,990	8,131	9,107	11,407
VILLAGE_CK_J504	3.2	3,145	6,642	9,590	10,903	14,113
VILLAGE_CK_J505	4.4	4,938	9,561	13,542	15,324	19,652
VILLAGE_CK_J506	4.8	3,414	7,676	11,624	13,470	17,820
VILLAGE_CK_J507	5.3	3,223	7,298	11,157	12,924	17,373
VILLAGE_CK_J508	5.4	3,172	7,196	11,072	12,888	17,220
VILLAGE_CK_J510	119	13,126	31,280	53,036	65,107	94,332
VILLAGE_CK_J520	119.4	12,114	31,218	52,993	65,057	94,252
VILLAGE_CK_J528	1.6	2,894	4,795	6,484	7,255	9,062
VILLAGE_CK_J529	1.7	2,117	3,613	4,882	5,459	6,851
VILLAGE_CK_J530	121.1	12,172	31,318	53,139	65,239	94,522
VILLAGE_CK_J540	122.7	12,160	31,333	53,209	65,322	94,652
J_LA	124.1	12,183	31,369	53,260	65,393	94,671
LA_IFLOW	142.8	25,855	44,811	67,790	80,362	116,942
Lake_Arlington	142.8	3,551	7,671	21,400	31,440	57,792

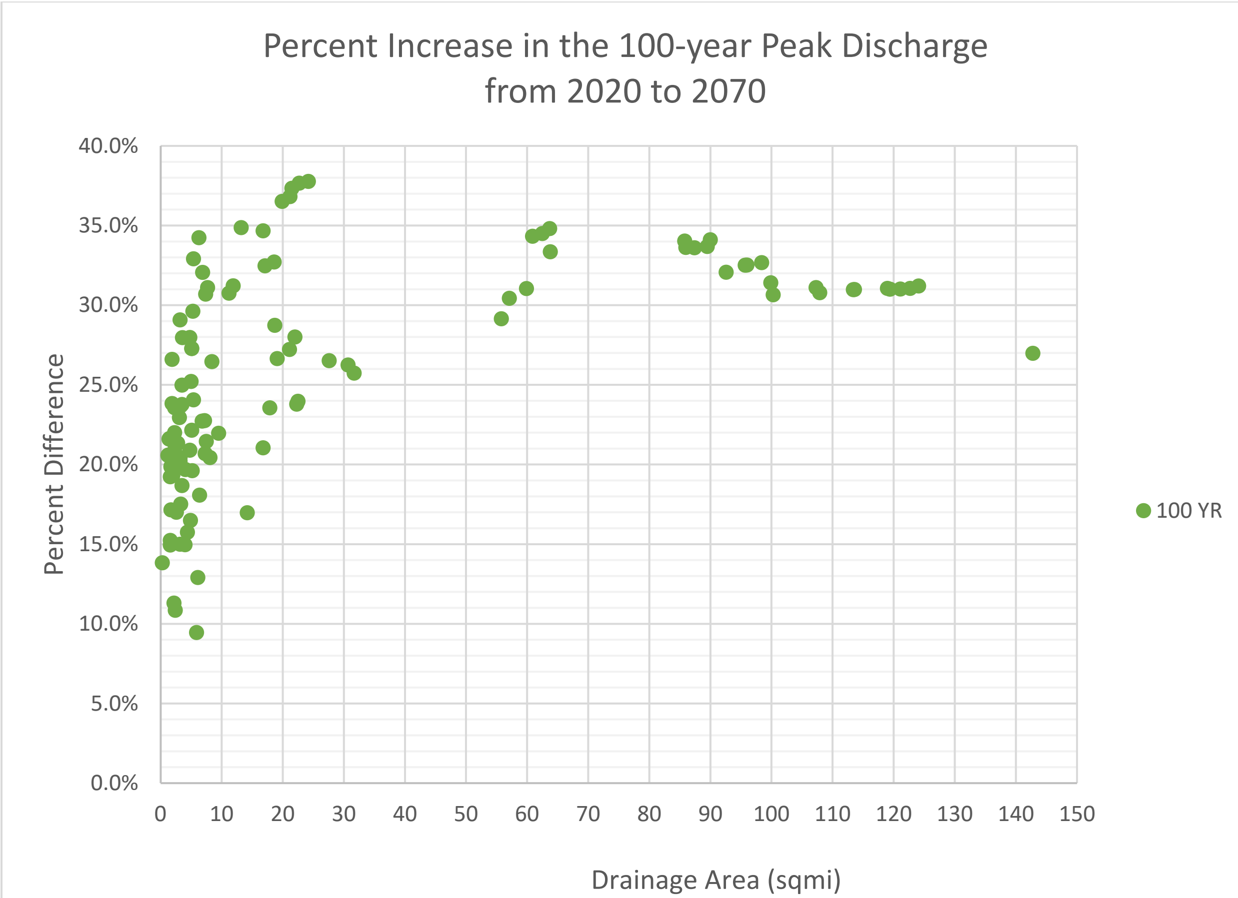


Figure 6-1. Percent Increase in the 100-year Peak Discharges from 2020 to 2070

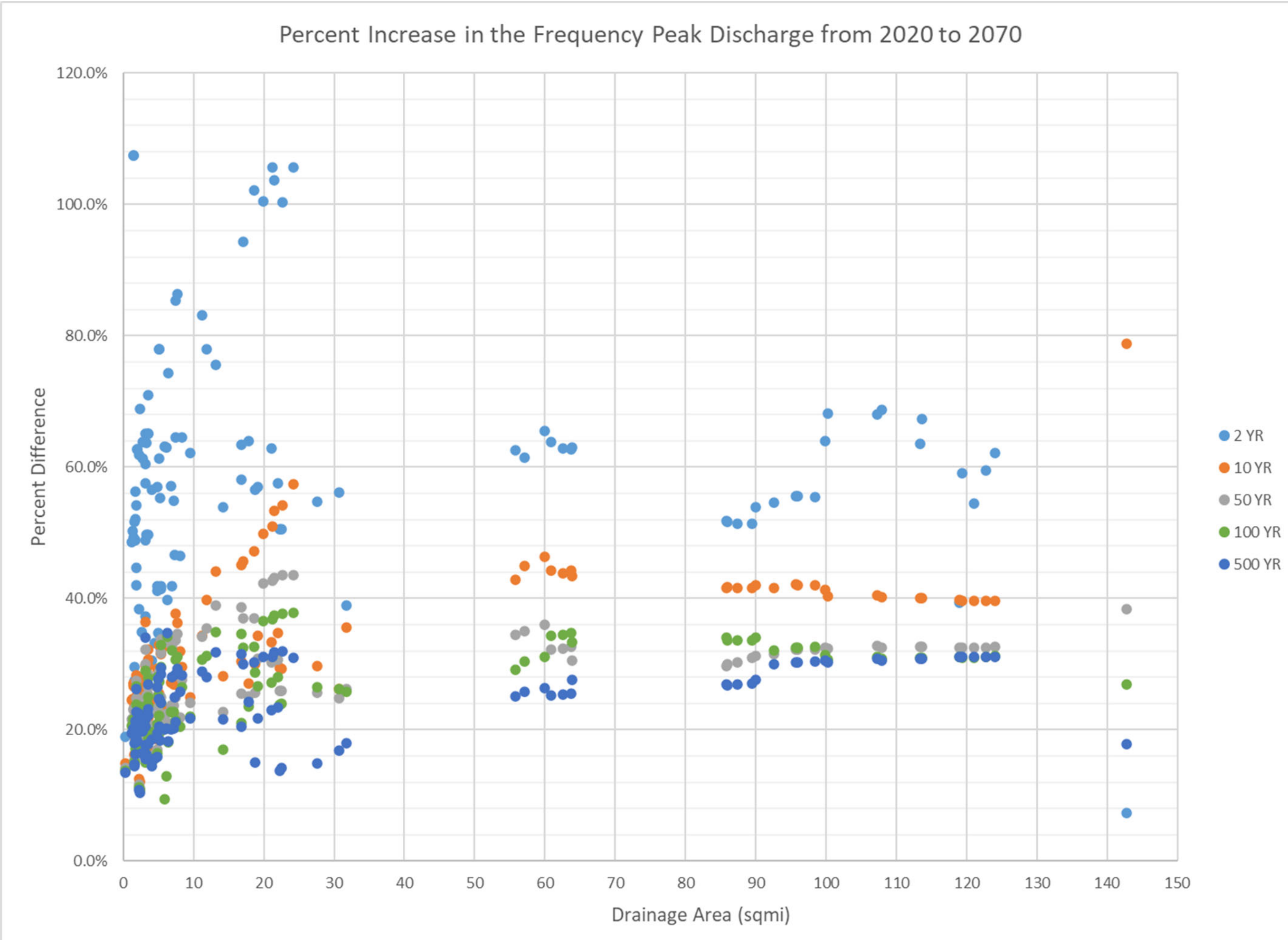


Figure 6-2. Percent Increase in Frequency Peak Discharge from 2020 to 2070

7 Conclusions

Without proactive intervention, the results show that increases in urbanization under future conditions will lead to increases in the frequency discharge peaks on the watershed. Figures 6-1 and 6-2 illustrate the percent increase in future conditions frequency peak discharges as compared to existing conditions. The results showed that for most locations, the 50% ACE (2-year) event had the highest percent increases while the 0.2% ACE (500-year) event had the lowest percent increases. However, all of the percent increases were significant, ranging from 20% to 65% for most locations across all frequencies. For the 100-year event, percent increases generally ranged from 10% to 35%. For drainage areas greater than 40 square miles, the percent increases in the 100-year peak discharge stayed consistently between 30% and 35%. The effects of future urbanization on flow frequency are further illustrated in Figures 7-1 and 7-2.

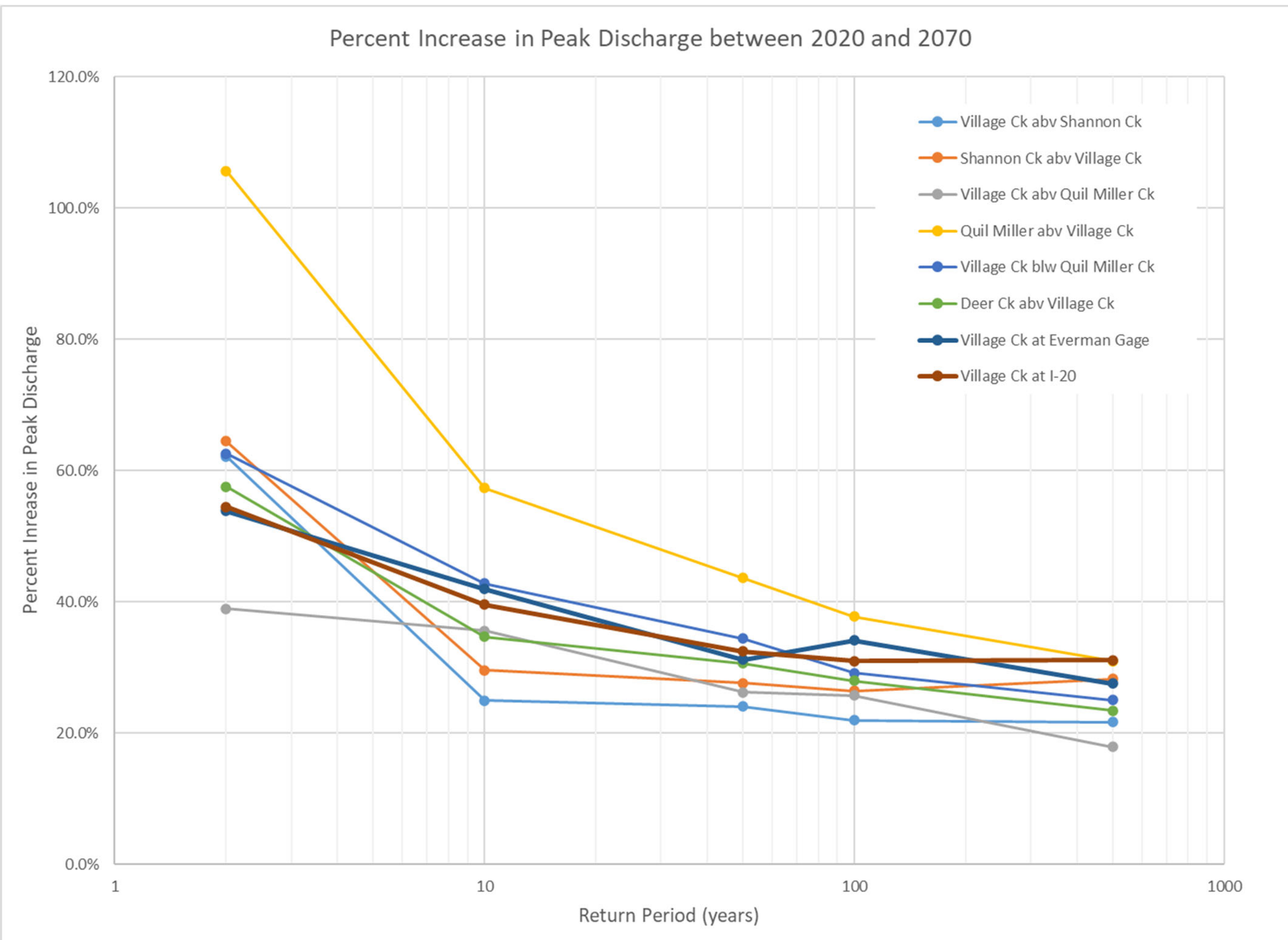


Figure 7-1. Percent Increase in Peak Discharges from 2020 to 2070 versus Frequency

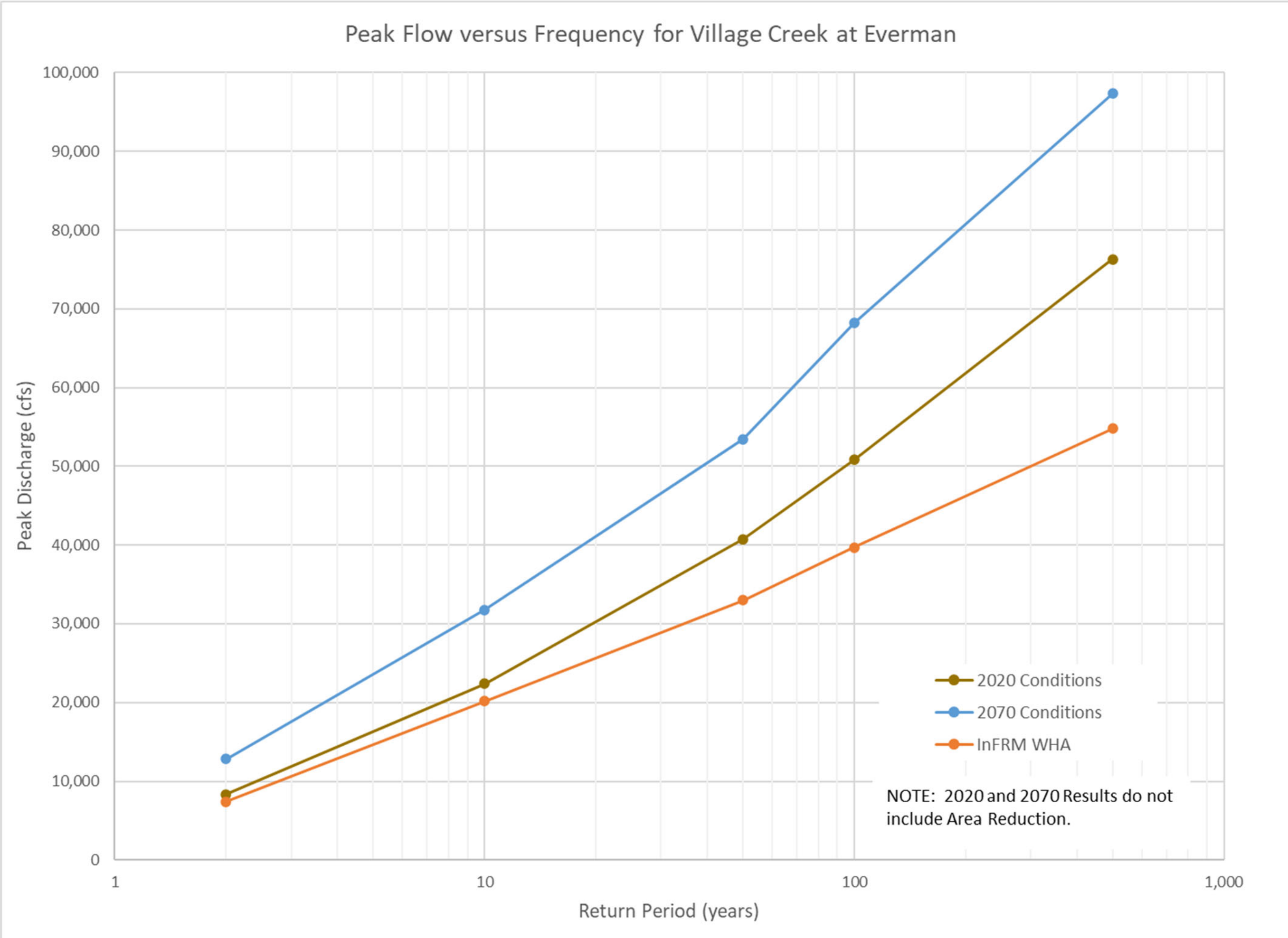


Figure 7-2. Peak Discharge versus Frequency for Village Creek at Everman USGS Gage

These figures illustrate that future urban development in the Village Creek watershed could drive significant increases in flooding, with the 100-year peak discharge potentially increasing from 50,800 cfs to 68,200 cfs at the Village Creek at Everman USGS gage, a 34% increase. However, it should be noted that these flows are meant to represent a 2070 future condition that would exist if none of the TSI project recommendations are implemented. Implementing any of the TSI project recommendations such as Green Stormwater Infrastructure (GSI), detention, the Corridor Development Certificate (CDC) process, or adopting higher floodplain standards (i.e. no rise or no loss of valley storage requirements), could potentially help the communities in the Village Creek watershed avoid a significant portion of these potential future increases in streamflow.

8 References

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