North Central Texas Council of Governments

Integrating Transportation and Stormwater Infrastructure

Hydrology Modeling Updates for the Upper Clear Fork Trinity River Watershed

June 2026

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integrating Transportation & Stormwater Infrastructure

Integrating Transportation and Stormwater Infrastructure (TSI)

HEC-HMS Modeling for the Upper Clear Fork Trinity River Watershed

U.S. Army Corps of Engineers

1 Executive Summary

An agreement between the Department of the Army represented by the US Army Corps of Engineers (USACE), Fort Worth District, and the North Central Texas Council of Governments (NCTCOG) in connection with the Integrated Watershed Based Planning for Regional Transportation and Stormwater Management in the Upper Trinity River Basin, Texas, was established to perform a study in the Upper Clear Fork Trinity (UCFT) area. The hydrologic study for the UCFT Watershed will be to add detail to the Interagency Flood Risk Management (InFRM) Trinity Watershed Hydrologic Assessment (WHA) Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) model by adding additional subbasin and reach locations where flows will be developed with the additional subbasins and calibrated to match the InFRM WHA HEC-HMS results at their common locations. Then, the existing conditions basin model will be updated to match 2020 impervious conditions, and one future condition basin model will be created representing the year 2070, based on future conditions data provided by the NCTCOG and Environmental Protection Agency Integrated Climate and Land use Scenarios (EPA ICLUS). These models will be used for two purposes: (1) to feed flows into the TSI Hydrologic Engineering Center-River Analysis System (HEC-RAS) models, and (2) to optimize project alternatives such as possible detention locations. The alternatives analysis will be performed by the University of Texas Arlington (UTA).

2 Data Sources

This section describes the data that was collected /reviewed for the hydrologic study effort, including geospatial and climatic information, field observations and previous reports for the study area.

2.1 GIS Data

Data from different sources were gathered and processed using the latest Geographic Information System (GIS) tool.

Table 2-1. GIS Data Sources

Data Type	Data Source	Description of the Data
Study Area	Subbasins from the Trinity InFRM WHA HEC-HMS model	Used as rough outline of the study area.
Terrain	Texas Water Development Board (TWDB)	Digital Elevation Model (DEM) of the West TSI study area with a 30-ft cell size that was generated from the 2021 TWDB seamless statewide LiDAR data.
Stream Centerlines	Future of Flood Risk Data (FFRD) National Hydrography Dataset (NHD)	Stream centerlines layers from the Trinity FFRD study and the NHD database.
Roads	Texas Department of Transportation (TXDOT)	Locations of current and future TXDOT roads
Bridges	Texas Department of Transportation (TXDOT)	Locations of current and future TXDOT bridges
Percent Impervious	North Central Texas Council of Governments (NCTCOG) and EPA	Percent impervious raster for the current and future years generated from NCTCOG and EPA ICLUS land use data for the TSI project.
Percent Urban	North Central Texas Council of Governments (NCTCOG) and EPA	Percent urban raster for the current and future years generated from NCTCOG and EPA ICLUS land use data for the TSI project.
Dams	National Inventory of Dams (NID)	Dam locations from the National Inventory of Dams
Reservoirs	US Army Corps of Engineers, Fort Worth District Database (USACE-SWF)	A polygon shapefile of the major lakes and reservoirs in the Trinity River basin.

2.2 HEC-HMS data from Existing models

A watershed model was built for the Trinity River Basin with input parameters that represented the physical characteristics of the watershed. The rainfall-runoff model for the UCFT area was completed using the basin-wide HEC-HMS model developed for the 2021 Interagency Flood Risk Management (InFRM) Watershed Hydrology Assessment (WHA) for the Trinity River as a starting point. The InFRM model was calibrated to multiple recent flood events, including those similar in magnitude to a 1% annual chance (100-yr) storm. Finally, frequency storms were incorporated into the InFRM HEC-HMS model using the latest published frequency rainfall depths from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (NOAA, 2018). These frequency storms were run through the verified model, yielding consistent estimates of the 1% annual chance (100-yr) and other frequency peak flows at various locations throughout the basin (InFRM, WHA for the Trinity River Basin, July 2021).

3 HEC-HMS Initial Model Development

For this study, additional detail was added to the InFRM Trinity WHA HEC-HMS model by adding additional subbasins and reach locations, where flows will be calculated for the TSI hydraulic modeling. First, an existing conditions (2016) basin model was developed with the additional subbasins and “calibrated” to match the InFRM WHA HEC-HMS results at their common locations. Then, the existing conditions basin model was updated to match 2020 impervious conditions, and one future condition basin model was created representing the year 2070, based on future conditions data provided by the NCTCOG. These models will be used for two purposes: (1) to feed flows into the TSI HEC-RAS models, and (2) to optimize project alternatives such as possible detention locations. The alternatives analysis will be performed by UTA.

3.1 HEC-HMS Subbasin Locations

Approximate points for subbasin outlet locations were developed prior to the initiation of the UCFT Creek modeling. These subbasin locations were reviewed and approved by the rest of the TSI H&H team, including UTA, Tarrant Regional Water District (TRWD) and the NCTCOG. The guidelines and priorities for placing subbasin outlet locations are described below.

A subbasin outlet point was placed where each of the features listed below intersected with the stream centerlines layer. Engineering judgment was applied to keep the relative drainage areas and number of subbasins reasonable. At attempt was made to keep the subbasin areas in the range of 1 to 5 square miles with subbasins at the smaller end of that range being used in the areas with more urban development for existing or 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.

The resulting points shapefile of subbasin outlets was used as a guide for the approximate number and desired locations of the subbasin outlets for the UCFT area, as shown in Figure 3-1.

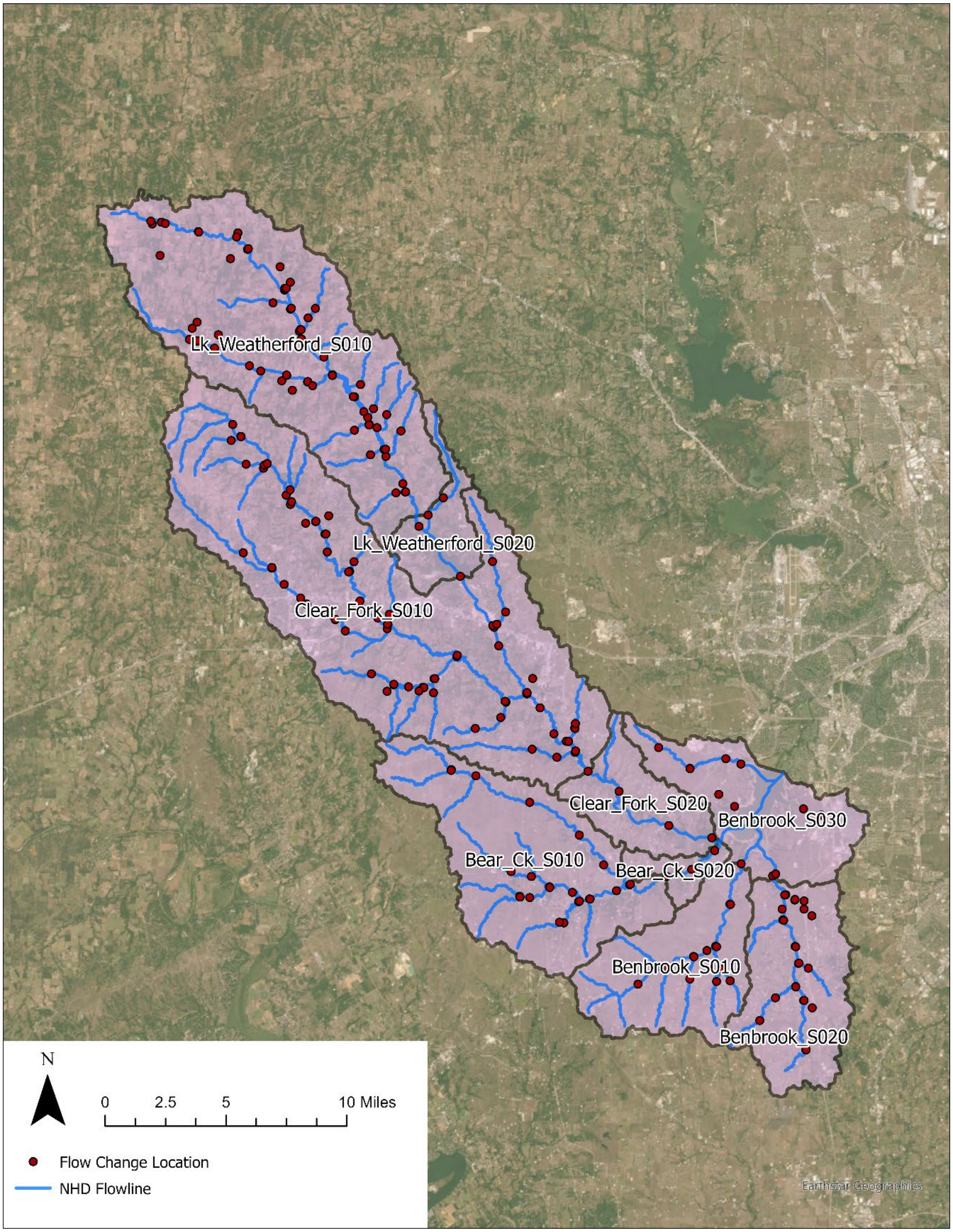

Figure 3-1. HEC-HMS WHA Subbasins for TSI UCFT Area

3.2 HEC-HMS Subbasin Delineations

After identifying the desired subbasin outlet locations, the subbasins for UCFT were delineated using the GIS tools in HEC-HMS version 4.11. The nine WHA basins in the UCFT study area were divided into 229 subbasins. Along with additional subbasins, additional reaches were also inserted to better calculate the peak flows within the model. Table 3-1 shows the number of subbasins added to UCFT for each corresponding WHA basin Figure 3-2 shows the WHA model subbasins vs the final TSI subbasins for UCFT.

Table 3-1. WHA vs UCFT subbasins

WHA Basin	Number of UCFT subbasins
Bear_Ck_S010	24
Bear_Ck_S020	2
Benbrook_S010	17
Benbrook_S020	25
Benbrook_S030	10
Clear_Fork_S010	79
Clear_Fork_S020	3
Lk_Weatherford_S010	66
Lk_Weatherford_S020	3

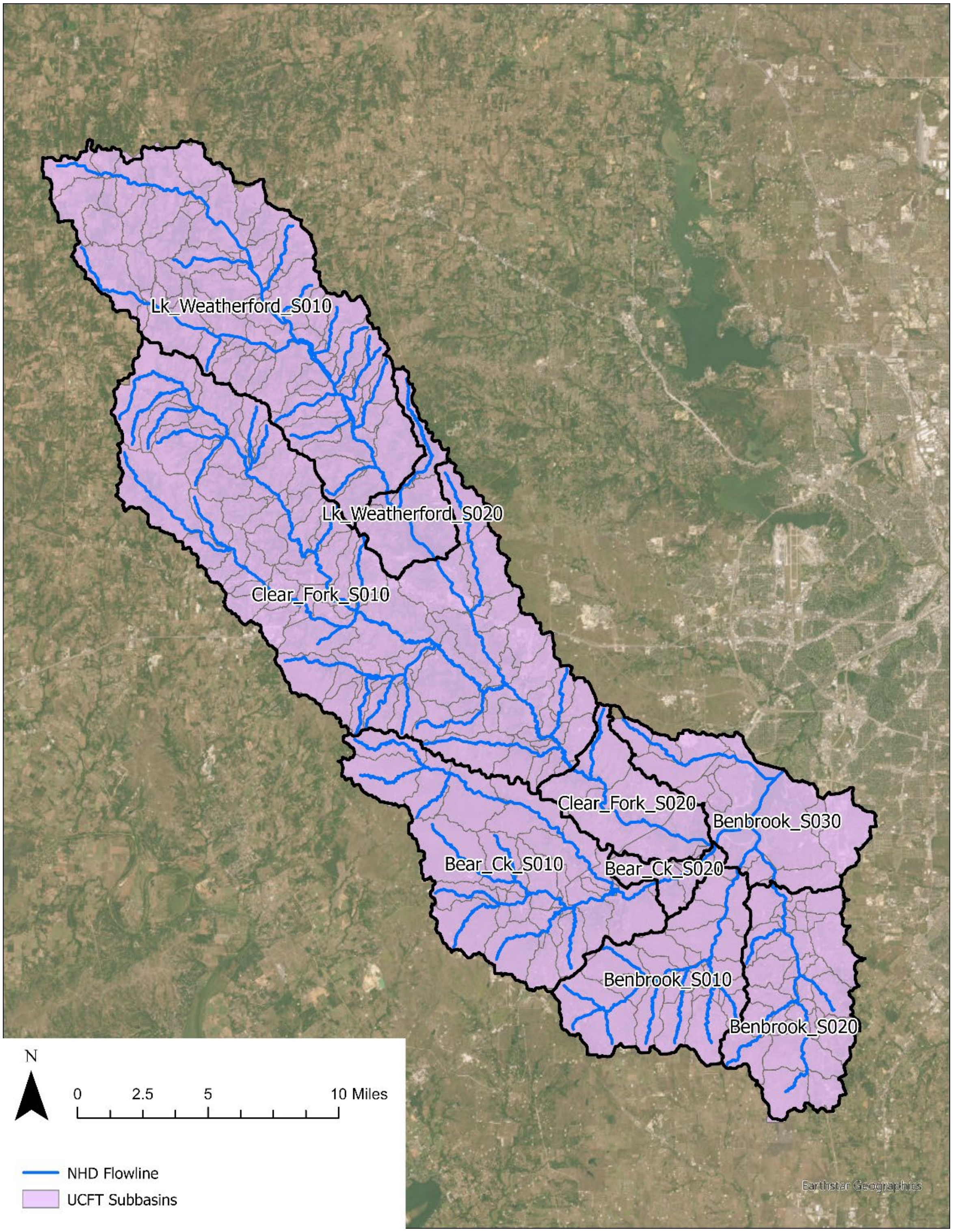

Figure 3-2. HEC-HMS Final Subbasin Delineation for TSI's UCFT area.

Table 3-2. UCFT HEC-HMS Subbasins

Subbasin Name	Area (Sq. Miles)	Subbasin Name	Area (Sq. Miles)	Subbasin Name	Area (Sq. Miles)	Subbasin Name	Area (Sq. Miles)
Bear_Cr_S001	4.31	Bear_Cr_S002	2.62	Bear_Cr_S003	2.84	Bear_Cr_S004	4.22
Bear_Cr_S005	4.44	Bear_Cr_S006	3.6	Bear_Cr_S007	1.19	Bear_Cr_S008	3.98
Bear_Cr_S009	3.73	Bear_Cr_S010	1.42	Beeman_Br_S001	1.6	Belknap_Br_S001	2.74
Belknap_Br_S002	0.45	Benbrook_S001	4.41	Benbrook_S002	0.69	Benbrook_S003	1.01
Benbrook_S004	0.7	Benbrook_S005	15.89	Brown_Br_S001	1.38	Burgess_Cr_S001	3.17
Burgess_Cr_S002	1.2	Burgess_Cr_S003	1.3	Burgess_Cr_S004	0.17	Burgess_Cr_S005	1.59
Burgess_Cr_S006	0.5	Burgess_Cr_S007	0.36	Burgess_Cr_S008	0.99	Carter_Cr_S001	2.28
Carter_Cr_S002	0.43	Clear_Fork_Tr_Rv_S001	2.25	Clear_Fork_Tr_Rv_S002	2.63	Clear_Fork_Tr_Rv_S003	0.93
Clear_Fork_Tr_Rv_S004	0.7	Clear_Fork_Tr_Rv_S005	1.9	Clear_Fork_Tr_Rv_S006	2.26	Clear_Fork_Tr_Rv_S007	1.44
Clear_Fork_Tr_Rv_S008	2.16	Clear_Fork_Tr_Rv_S009	4.25	Clear_Fork_Tr_Rv_S010	1.91	Clear_Fork_Tr_Rv_S011	0.6
Clear_Fork_Tr_Rv_S012	0.38	Clear_Fork_Tr_Rv_S013	1.37	Clear_Fork_Tr_Rv_S014	1.26	Clear_Fork_Tr_Rv_S015	0.49
Clear_Fork_Tr_Rv_S016	0.06	Clear_Fork_Tr_Rv_S017	3.84	Clear_Fork_Tr_Rv_S018	0.98	Clear_Fork_Tr_Rv_S019	2.35
Clear_Fork_Tr_Rv_S020	0.92	Clear_Fork_Tr_Rv_S021	0.64	Clear_Fork_Tr_Rv_S022	3.66	Clear_Fork_Tr_Rv_S023	0.63
Clear_Fork_Tr_Rv_S024	1.2	Clear_Fork_Tr_Rv_S025	3.55	Clear_Fork_Tr_Rv_S026	1.25	Clear_Fork_Tr_Rv_S027	0.26
Clear_Fork_Tr_Rv_S028	1.29	Clear_Fork_Tr_Rv_S029	1.19	Clear_Fork_Tr_Rv_S030	2.51	Clear_Fork_Tr_Rv_S031	6.83
Clear_Fork_Tr_Rv_S032	9.39	Clear_Fork_Tr_Rv_S033	4.96	Clear_Fork_Tr_Rv_S034	0.27	Clear_Fork_Tr_Rv_S035	0.27
Clear_Fork_Tr_Rv_S036	2.24	Clear_Fork_Tr_Rv_S037	0.65	Clear_Fork_Tr_Rv_S038	3.63	Clear_Fork_Tr_Rv_S039	3.36
Clear_Fork_Tr_Rv_S040	2.5	Clear_Fork_Tr_Rv_S041	1.33	Clear_Fork_Tr_Rv_S042	1.33	Clear_Fork_Tr_Rv_S043	0.09
Clear_Fork_Tr_Rv_S044	0.56	Clear_Fork_Tr_Rv_S045	0.45	Clear_Fork_Tr_Rv_S046	0.52	Clear_Fork_Tr_Rv_S047	2.29
Clear_Fork_Tr_Rv_S048	6.32	Clear_Fork_Tr_Rv_S049	8.03	Clear_Fork_Tr_Rv_S050	4.5	Cottonwood_Cr_S001	2.24
Cottonwood_Cr_S002	0.52	Dickeys_Br_S001	3.52	Dickeys_Br_S002	1.83	Dickeys_Br_S003	1.25
Dobbs_Br_S001	1.56	Dobbs_Br_S002	0.43	Dutch_Br_S001	1.5	Dutch_Br_S002	0.96
Dutch_Br_S003	4.1	Dutch_Br_S004	0.55	Gourdneck_Cr_S001	4.15	Gourdneck_Cr_S002	1.6
Gourdneck_Cr_S003	0.4	Gourdneck_Cr_S004	0.17	Gourdneck_Cr_S005	0.96	Gourdneck_Cr_S006	0.57
Gourdneck_Cr_S007	0.2	Gourdneck_Cr_S008	4.09	Gourdneck_Cr_S009	1.29	Gourdneck_Cr_S010	1.02
Gourdneck_Cr_S011	2	Gourdneck_Cr_S012	0.27	Gourdneck_Cr_S013	1.03	Gourdneck_Cr_S014	0.86
Gourdneck_Cr_S015	0.23	Gourdneck_Cr_S016	0.76	Gourdneck_Cr_S017	0.19	Gourdneck_Cr_S018	0.71
Graham_Br_S001	1.72	Graham_Br_S002	0.13	Green_Br_S001	2.12	Green_Br_S002	0.17
Hale_Br_S001	1.84	Hale_Br_S002	0.22	Hays_Br_S001	2.79	Hays_Br_S002	0.24
Heiffel_Br_S001	1.75	Holder_Br_S001	1.3	Holder_Br_S002	0.21	Johnson_Br_S001	1.2
McKnight_Br_S001	1.89	Mustang_Cr_S001	6.87	Mustang_Cr_S002	2.66	Mustang_Cr_S003	1.34
Mustang_Cr_S004	2.14	Mustang_Cr_S005	2.29	Mustang_Cr_S006	0.92	Mustang_Cr_S007	1.2
Mustang_Cr_S008	2.06	Mustang_Cr_S009	0.46	Mustang_Cr_S010	3.06	Mustang_Cr_S011	1.05
Mustang_Cr_S012	0.7	Mustang_Cr_S013	1.17	Mustang_Cr_S014	0.39	Mustang_Cr_S015	3.04
Mustang_Cr_S016	1.66	Mustang_Cr_S017	3.13	Patterson_Br_S001	1.25	Patton_Br_S001	1.65
Patton_Br_S002	0.81	Pogue_Br_S001	1.89	Rankin_Br_S001	1.98	Rankin_Br_S002	0.18
Rock_Cr_S001	2.97	Rock_Cr_S002	1.66	Rock_Cr_S003	3.95	Rock_Cr_S004	2.25

Subbasin Name	Area (Sq. Miles)	Subbasin Name	Area (Sq. Miles)	Subbasin Name	Area (Sq. Miles)	Subbasin Name	Area (Sq. Miles)
Rock_Cr_S005	0.32	Rock_Cr_S006	2.58	Rock_Cr_S007	1.34	Rock_Cr_S008	1.69
Rock_Cr_S009	0.67	Rock_Cr_S010	2.11	Rock_Cr_S011	0.96	Rock_Cr_S012	0.44
Rock_Cr_S013	1.66	Rock_Cr_S014	0.64	Rock_Cr_S015	1.71	Rock_Cr_S016	1.37
Rock_Cr_S017	0.37	Rock_Cr_S018	3.08	Rock_Cr_S019	0.28	Rock_Cr_S020	1.28
Rock_Cr_S021	0.13	Rock_Cr_S022	0.37	Rock_Cr_S023	0.4	Rock_Cr_S024	0.3
Rock_Cr_S025	1.96	Rock_Cr_S026	2.98	S_Bear_Cr_S001	5.65	S_Bear_Cr_S002	1.85
S_Bear_Cr_S003	3.99	S_Bear_Cr_S004	0.6	S_Bear_Cr_S005	2.77	S_Bear_Cr_S006	0.51
S_Bear_Cr_S007	0.87	S_Bear_Cr_S008	2.6	S_Bear_Cr_S009	0.2	S_Bear_Cr_S010	0.6
S_Bear_Cr_S011	2.35	S_Bear_Cr_S012	2.73	S_Bear_Cr_S013	0.42	Squaw_Cr_S001	3.36
Squaw_Cr_S002	3.61	Squaw_Cr_S003	0.22	Strickland_Br_S001	2.35	Strickland_Br_S002	0.21
Strickland_Br_S003	0.21	Town_Cr_S001	6.83	Town_Cr_S002	1.54	Town_Cr_S003	1.67
Town_Cr_S004	1.52	Town_Cr_S005	0.6	Town_Cr_S006	1.29	Town_Cr_S007	1.41
Town_Cr_S008	1.66	Town_Cr_S009	0.78	Town_Cr_S010	3.97	Town_Cr_S011	6.49
Town_Cr_S012	0.69	Town_Cr_S013	4.8	Town_Cr_S014	1.63	Town_Cr_S015	1.09
Town_Cr_S016	0.82	Town_Cr_S017	0.12	Turkey_Cr_S001	3.61	Turkey_Cr_S002	1.77
Turkey_Cr_S003	0.91	Underwood_Br_S001	2.28	Underwood_Br_S002	0.28	Willow_Cr_S001	6.89
Willow_Cr_S002	0.57	Willow_Cr_S003	3	Willow_Cr_S004	1.99	Willow_Cr_S005	1.91
Willow_Cr_S006	0.11	Willow_Cr_S007	1.41	Willow_Cr_S008	2.64	Willow_Cr_S009	0.09
Willow_Cr_S010	1.26	Willow_Cr_S011	0.29	Willow_Cr_S012	0.19	Willow_Cr_S013	2.07
Willow_Cr_S014	1.45	Willow_Cr_S015	2.34	Willow_Cr_S016	2.71	Willow_Cr_S017	1.99
Willow_Cr_S018	0.52						

3.3 HEC-HMS Initial Parameters

First, an existing conditions (2016) basin model was developed with the new subbasin delineation and "calibrated" to match the InFRM WHA HEC-HMS results at their common locations. The 1% Annual Chance of Exceedance (ACE) or 100-year HEC-HMS initial hydrologic parameters were copied from the calibrated WHA HEC-HMS models and presented in the tables below. WHA larger basins were overlayed on top of the delineated subbasins to validate the use of copied parameters for the new model. The following parameter tables in this section reflect 2016 conditions that coincide with the 100-yr WHA HEC-HMS model. These parameters were later updated for 2020 and 2070 conditions.

3.3.1 *Initial Subbasin Parameters*

Percent Imperviousness

Imperviousness for the entire watershed was extracted from the NLCD database for 2016 conditions, which was the same dataset used in the InFRM WHA. then applied to the individual subbasins. Table 3-3 shows the calculated subbasin impervious values for 2016.

Initial and Constant Losses

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

Table 3-3. HEC-HMS Subbasin 100-yr Loss Parameters for 2016 (WHA) conditions

Subbasin Name	Initial Loss (in)	Constant Loss (in)	Percent Impervious	Subbasin Name	Initial Loss (in)	Constant Loss (in)	Percent Impervious
Bear_Cr_S001	1.11	0.09	0.33	Bear_Cr_S002	1.11	0.09	1.57
Bear_Cr_S003	1.11	0.09	0.41	Bear_Cr_S004	1.11	0.09	0.46
Bear_Cr_S005	1.11	0.09	0.5	Bear_Cr_S006	1.11	0.09	1.14
Bear_Cr_S007	1.11	0.09	6.45	Bear_Cr_S008	1.11	0.09	0.47
Bear_Cr_S009	0.85	0.09	1.45	Bear_Cr_S010	0.85	0.09	7.05
Beeman_Br_S001	2.48	0.1	0.51	Belknap_Br_S001	2.48	0.1	0.9
Belknap_Br_S002	2.48	0.1	0.79	Benbrook_S001	0.82	0.08	25.65
Benbrook_S002	0.82	0.08	1.96	Benbrook_S003	0.82	0.08	1.23
Benbrook_S004	0.82	0.08	2.49	Benbrook_S005	0.82	0.08	37
Brown_Br_S001	2.61	0.1	1.53	Burgess_Cr_S001	2.48	0.1	0.62
Burgess_Cr_S002	2.48	0.1	0.71	Burgess_Cr_S003	2.48	0.1	0.39
Burgess_Cr_S004	2.48	0.1	0.86	Burgess_Cr_S005	2.48	0.1	0.43
Burgess_Cr_S006	2.48	0.1	0.5	Burgess_Cr_S007	2.48	0.1	0.46
Burgess_Cr_S008	2.48	0.1	3.32	Carter_Cr_S001	2.61	0.1	0.96
Carter_Cr_S002	2.61	0.1	0.04	Clear_Fork_Tr_Rv_S001	2.61	0.1	0.25
Clear_Fork_Tr_Rv_S002	2.61	0.1	0.16	Clear_Fork_Tr_Rv_S003	2.61	0.1	0.37
Clear_Fork_Tr_Rv_S004	2.61	0.1	0.2	Clear_Fork_Tr_Rv_S005	2.61	0.1	0.2
Clear_Fork_Tr_Rv_S006	2.61	0.1	0.65	Clear_Fork_Tr_Rv_S007	2.61	0.1	1
Clear_Fork_Tr_Rv_S008	2.61	0.1	0.9	Clear_Fork_Tr_Rv_S009	2.61	0.1	0.68
Clear_Fork_Tr_Rv_S010	2.61	0.1	0.28	Clear_Fork_Tr_Rv_S011	2.61	0.1	0.1
Clear_Fork_Tr_Rv_S012	2.61	0.1	0.73	Clear_Fork_Tr_Rv_S013	2.61	0.1	0.56
Clear_Fork_Tr_Rv_S014	2.61	0.1	0.23	Clear_Fork_Tr_Rv_S015	2.61	0.1	0.31
Clear_Fork_Tr_Rv_S016	2.61	0.1	0	Clear_Fork_Tr_Rv_S017	2.61	0.1	0.36
Clear_Fork_Tr_Rv_S018	2.61	0.1	0.04	Clear_Fork_Tr_Rv_S019	2.61	0.1	0.32
Clear_Fork_Tr_Rv_S020	2.61	0.1	0.29	Clear_Fork_Tr_Rv_S021	2.61	0.1	0.08
Clear_Fork_Tr_Rv_S022	2.61	0.1	0.36	Clear_Fork_Tr_Rv_S023	2.61	0.1	0.03
Clear_Fork_Tr_Rv_S024	2.61	0.1	1.54	Clear_Fork_Tr_Rv_S025	2.61	0.1	0.3
Clear_Fork_Tr_Rv_S026	2.61	0.1	0.78	Clear_Fork_Tr_Rv_S027	2.61	0.1	0.43
Clear_Fork_Tr_Rv_S028	2.61	0.1	0.82	Clear_Fork_Tr_Rv_S029	2.61	0.1	0.56
Clear_Fork_Tr_Rv_S030	2.61	0.1	0.45	Clear_Fork_Tr_Rv_S031	2.61	0.1	0.46
Clear_Fork_Tr_Rv_S032	1.7	0.09	22.88	Clear_Fork_Tr_Rv_S033	2.48	0.1	15.52
Clear_Fork_Tr_Rv_S034	2.48	0.1	21.04	Clear_Fork_Tr_Rv_S035	2.48	0.1	13.24
Clear_Fork_Tr_Rv_S036	2.48	0.1	24.17	Clear_Fork_Tr_Rv_S037	2.48	0.1	5.03
Clear_Fork_Tr_Rv_S038	2.48	0.1	4.17	Clear_Fork_Tr_Rv_S039	2.48	0.1	8.41
Clear_Fork_Tr_Rv_S040	2.48	0.1	6.68	Clear_Fork_Tr_Rv_S041	2.48	0.1	5.81
Clear_Fork_Tr_Rv_S042	2.48	0.1	0.86	Clear_Fork_Tr_Rv_S043	2.48	0.1	8.53
Clear_Fork_Tr_Rv_S044	2.48	0.1	14.82	Clear_Fork_Tr_Rv_S045	2.48	0.1	1.22
Clear_Fork_Tr_Rv_S046	2.48	0.1	1.24	Clear_Fork_Tr_Rv_S047	2.48	0.1	2.64
Clear_Fork_Tr_Rv_S048	0.87	0.09	1.9	Clear_Fork_Tr_Rv_S049	0.87	0.09	4.99
Clear_Fork_Tr_Rv_S050	0.87	0.09	7.95	Cottonwood_Cr_S001	2.61	0.1	0.27
Cottonwood_Cr_S002	2.61	0.1	0.16	Dickeys_Br_S001	1.11	0.09	0.69
Dickeys_Br_S002	1.11	0.09	3.13	Dickeys_Br_S003	1.11	0.09	3.4
Dobbs_Br_S001	2.61	0.1	0.16	Dobbs_Br_S002	2.61	0.1	0.22
Dutch_Br_S001	0.82	0.08	0.45	Dutch_Br_S002	0.82	0.08	0

Subbasin Name	Initial Loss (in)	Constant Loss (in)	Percent Impervious	Subbasin Name	Initial Loss (in)	Constant Loss (in)	Percent Impervious
Dutch_Br_S003	0.82	0.08	6.6	Dutch_Br_S004	0.82	0.08	4.76
Gourdneck_Cr_S001	2.61	0.1	0.47	Gourdneck_Cr_S002	2.61	0.1	0.15
Gourdneck_Cr_S003	2.61	0.1	0.86	Gourdneck_Cr_S004	2.61	0.1	0.91
Gourdneck_Cr_S005	2.61	0.1	0.37	Gourdneck_Cr_S006	2.61	0.1	0.61
Gourdneck_Cr_S007	2.61	0.1	0.09	Gourdneck_Cr_S008	2.61	0.1	0.36
Gourdneck_Cr_S009	2.61	0.1	0.6	Gourdneck_Cr_S010	2.61	0.1	0.03
Gourdneck_Cr_S011	2.61	0.1	0.31	Gourdneck_Cr_S012	2.61	0.1	0
Gourdneck_Cr_S013	2.61	0.1	0.1	Gourdneck_Cr_S014	2.61	0.1	0.52
Gourdneck_Cr_S015	2.61	0.1	0	Gourdneck_Cr_S016	2.61	0.1	0.34
Gourdneck_Cr_S017	2.61	0.1	0.17	Gourdneck_Cr_S018	2.61	0.1	0.07
Graham_Br_S001	2.48	0.1	0.87	Graham_Br_S002	2.48	0.1	0
Green_Br_S001	2.61	0.1	0.94	Green_Br_S002	2.61	0.1	0.4
Hale_Br_S001	2.48	0.1	2.15	Hale_Br_S002	2.48	0.1	0.44
Hays_Br_S001	1.7	0.09	0.33	Hays_Br_S002	2.61	0.1	0.1
Heiffel_Br_S001	2.48	0.1	0.51	Holder_Br_S001	2.48	0.1	1.69
Holder_Br_S002	2.48	0.1	4.5	Johnson_Br_S001	2.48	0.1	1.54
McKnight_Br_S001	2.61	0.1	1.32	Mustang_Cr_S001	0.84	0.09	1.39
Mustang_Cr_S002	0.84	0.09	0.53	Mustang_Cr_S003	0.84	0.09	0.09
Mustang_Cr_S004	0.84	0.09	1.03	Mustang_Cr_S005	0.84	0.09	1.24
Mustang_Cr_S006	0.84	0.09	0.61	Mustang_Cr_S007	0.84	0.09	0
Mustang_Cr_S008	0.84	0.09	0.3	Mustang_Cr_S009	0.84	0.09	2.52
Mustang_Cr_S010	0.84	0.09	2.77	Mustang_Cr_S011	0.84	0.09	3.89
Mustang_Cr_S012	0.84	0.09	1.15	Mustang_Cr_S013	0.84	0.09	0
Mustang_Cr_S014	0.84	0.09	0.06	Mustang_Cr_S015	0.84	0.09	0.3
Mustang_Cr_S016	0.84	0.09	0.15	Mustang_Cr_S017	0.84	0.09	3.48
Patterson_Br_S001	2.48	0.1	0.53	Patton_Br_S001	2.61	0.1	0.83
Patton_Br_S002	2.61	0.1	0.73	Pogue_Br_S001	2.48	0.1	3.08
Rankin_Br_S001	2.61	0.1	1.31	Rankin_Br_S002	2.61	0.1	0.32
Rock_Cr_S001	0.83	0.09	3.09	Rock_Cr_S002	0.83	0.09	5.43
Rock_Cr_S003	0.83	0.09	2.89	Rock_Cr_S004	0.83	0.09	2.54
Rock_Cr_S005	0.83	0.09	5.78	Rock_Cr_S006	0.83	0.09	0.86
Rock_Cr_S007	0.83	0.09	3.37	Rock_Cr_S008	0.83	0.09	3.55
Rock_Cr_S009	0.83	0.09	3.38	Rock_Cr_S010	0.83	0.09	2.41
Rock_Cr_S011	0.83	0.09	6.88	Rock_Cr_S012	0.83	0.09	2.58
Rock_Cr_S013	0.83	0.09	3	Rock_Cr_S014	0.83	0.09	4.64
Rock_Cr_S015	0.83	0.09	3.16	Rock_Cr_S016	0.83	0.09	0.12
Rock_Cr_S017	0.83	0.09	1.34	Rock_Cr_S018	0.83	0.09	5.84
Rock_Cr_S019	0.83	0.09	4.93	Rock_Cr_S020	0.83	0.09	2.15
Rock_Cr_S021	0.83	0.09	1.71	Rock_Cr_S022	0.83	0.09	5.14
Rock_Cr_S023	0.83	0.09	0.02	Rock_Cr_S024	0.83	0.09	0.78
Rock_Cr_S025	0.83	0.09	1.11	Rock_Cr_S026	0.82	0.08	7.98
Squaw_Cr_S001	2.48	0.1	0.42	Squaw_Cr_S002	2.48	0.1	0.36
Squaw_Cr_S003	2.48	0.1	1.9	Strickland_Br_S001	2.61	0.1	0.1
Strickland_Br_S002	2.61	0.1	0.46	Strickland_Br_S003	1.11	0.09	1.43
S_Bear_Cr_S001	1.11	0.09	0.33	S_Bear_Cr_S002	1.11	0.09	1.59
S_Bear_Cr_S003	1.11	0.09	10.21	S_Bear_Cr_S004	1.11	0.09	6
S_Bear_Cr_S005	1.11	0.09	1.3	S_Bear_Cr_S006	1.11	0.09	1.23
S_Bear_Cr_S007	1.11	0.09	2.78	S_Bear_Cr_S008	1.11	0.09	0.82
S_Bear_Cr_S009	1.11	0.09	3.95	S_Bear_Cr_S010	1.11	0.09	6.78
S_Bear_Cr_S011	1.11	0.09	0.45	S_Bear_Cr_S012	1.11	0.09	0.1
S_Bear_Cr_S013	1.11	0.09	0.36	Town_Cr_S001	2.48	0.1	0.64

Subbasin Name	**Initial Loss (in)**	**Constant Loss (in)**	**Percent Impervious**	**Subbasin Name**	**Initial Loss (in)**	**Constant Loss (in)**	**Percent Impervious**
Town_Cr_S002	2.48	0.1	2.69	Town_Cr_S003	2.48	0.1	15.94
Town_Cr_S004	2.48	0.1	32.54	Town_Cr_S005	2.48	0.1	42.05
Town_Cr_S006	2.48	0.1	31.49	Town_Cr_S007	2.48	0.1	29.44
Town_Cr_S008	2.48	0.1	36.71	Town_Cr_S009	2.48	0.1	20.02
Town_Cr_S010	2.48	0.1	7.13	Town_Cr_S011	2.48	0.1	5.57
Town_Cr_S012	2.48	0.1	10.48	Town_Cr_S013	2.48	0.1	2.7
Town_Cr_S014	2.48	0.1	2.22	Town_Cr_S015	2.48	0.1	9.45
Town_Cr_S016	2.48	0.1	5.58	Town_Cr_S017	2.48	0.1	4.55
Turkey_Cr_S001	2.48	0.1	3.58	Turkey_Cr_S002	2.48	0.1	0.26
Turkey_Cr_S003	2.48	0.1	0.42	Underwood_Br_S001	2.48	0.1	16.01
Underwood_Br_S002	2.48	0.1	9.63	Willow_Cr_S001	2.48	0.1	1.27
Willow_Cr_S002	2.48	0.1	1.47	Willow_Cr_S003	2.48	0.1	0.44
Willow_Cr_S004	2.48	0.1	0.31	Willow_Cr_S005	2.48	0.1	0.51
Willow_Cr_S006	2.48	0.1	0	Willow_Cr_S007	2.48	0.1	0.8
Willow_Cr_S008	2.48	0.1	2.93	Willow_Cr_S009	2.48	0.1	3.86
Willow_Cr_S010	2.48	0.1	3.38	Willow_Cr_S011	2.48	0.1	0.63
Willow_Cr_S012	2.48	0.1	0.92	Willow_Cr_S013	2.48	0.1	3.56
Willow_Cr_S014	2.48	0.1	8	Willow_Cr_S015	2.48	0.1	2.17
Willow_Cr_S016	2.48	0.1	8.8	Willow_Cr_S017	2.48	0.1	10.69
Willow_Cr_S018	2.48	0.1	6.83				

Snyder's Transform Parameters

The Snyder's Unit Hydrograph method was used to route excess precipitation to the outlet of each subbasin. Initial estimates for unit hydrograph parameters for the subbasins were made using a Snyder's lag time equation which utilizes measured watershed characteristics in addition to a calibrated coefficient (Ct). The below equation from the Texas Commission on Environmental Quality (TCEQ), Hydrologic and Hydraulic Guidelines for Dams in Texas, was used to estimate the Snyder lag time based on measurable watershed characteristics and the coefficient C_t that is assumed to be consistent for a watershed and can thus be used to develop lag times for any additional subbasins within the watershed. The calculated Snyder's lag times for the UCFT Creek subbasins are shown in Table 3-4.

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

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

The calibrated C_t and peaking coefficient for this watershed were back calculated from the InFRM WHA calibrated HEC-HMS model for the Trinity River Basin. The Snyder Unit Hydrograph (UH) parameters were transformed from the WHA basins by utilizing the calibrated C_t coefficient values to recompute lag time for each delineated subbasin with the new physical hydrologic parameters (L, Lcs and S) for each new subbasin.

Table 3-4. HEC-HMS Subbasin Snyder's Transform Parameters

Subbasin Name	Lag Time (Hr)	Peaking Coefficient	Subbasin Name	Lag Time (Hr)	Peaking Coefficient
Bear_Cr_S001	1.08	0.76	Bear_Cr_S002	1.15	0.76
Bear_Cr_S003	0.62	0.76	Bear_Cr_S004	0.85	0.76
Bear_Cr_S005	1.05	0.76	Bear_Cr_S006	0.87	0.76
Bear_Cr_S007	0.66	0.76	Bear_Cr_S008	0.88	0.76
Bear_Cr_S009	0.59	0.76	Bear_Cr_S010	0.43	0.76
Beeman_Br_S001	1.8	0.65	Belknap_Br_S001	1.32	0.65
Belknap_Br_S002	0.73	0.65	Benbrook_S001	1.5	0.63
Benbrook_S002	0.74	0.63	Benbrook_S003	0.91	0.63
Benbrook_S004	0.79	0.63	Benbrook_S005	3	0.63
Brown_Br_S001	0.74	0.64	Burgess_Cr_S001	1.44	0.65
Burgess_Cr_S002	1.19	0.65	Burgess_Cr_S003	0.98	0.65
Burgess_Cr_S004	0.52	0.65	Burgess_Cr_S005	1.37	0.65
Burgess_Cr_S006	0.59	0.65	Burgess_Cr_S007	0.74	0.65
Burgess_Cr_S008	1.09	0.65	Carter_Cr_S001	1.15	0.64
Carter_Cr_S002	0.69	0.64	Clear_Fork_Tr_Rv_S001	1.36	0.64
Clear_Fork_Tr_Rv_S002	1.43	0.64	Clear_Fork_Tr_Rv_S003	0.75	0.64
Clear_Fork_Tr_Rv_S004	0.85	0.64	Clear_Fork_Tr_Rv_S005	0.83	0.64
Clear_Fork_Tr_Rv_S006	1.03	0.64	Clear_Fork_Tr_Rv_S007	1.21	0.64
Clear_Fork_Tr_Rv_S008	0.94	0.64	Clear_Fork_Tr_Rv_S009	1.47	0.64
Clear_Fork_Tr_Rv_S010	1.16	0.64	Clear_Fork_Tr_Rv_S011	0.56	0.64
Clear_Fork_Tr_Rv_S012	0.63	0.64	Clear_Fork_Tr_Rv_S013	0.87	0.64
Clear_Fork_Tr_Rv_S014	0.87	0.64	Clear_Fork_Tr_Rv_S015	0.68	0.64
Clear_Fork_Tr_Rv_S016	0.25	0.64	Clear_Fork_Tr_Rv_S017	1.41	0.64
Clear_Fork_Tr_Rv_S018	0.86	0.64	Clear_Fork_Tr_Rv_S019	1.24	0.64
Clear_Fork_Tr_Rv_S020	0.74	0.64	Clear_Fork_Tr_Rv_S021	0.78	0.64
Clear_Fork_Tr_Rv_S022	1.32	0.64	Clear_Fork_Tr_Rv_S023	0.88	0.64
Clear_Fork_Tr_Rv_S024	0.73	0.64	Clear_Fork_Tr_Rv_S025	1.73	0.64
Clear_Fork_Tr_Rv_S026	1.1	0.64	Clear_Fork_Tr_Rv_S027	0.5	0.64
Clear_Fork_Tr_Rv_S028	0.87	0.64	Clear_Fork_Tr_Rv_S029	0.94	0.64
Clear_Fork_Tr_Rv_S030	1.44	0.64	Clear_Fork_Tr_Rv_S031	1.85	0.64
Clear_Fork_Tr_Rv_S032	1.22	0.66	Clear_Fork_Tr_Rv_S033	1.92	0.65
Clear_Fork_Tr_Rv_S034	0.62	0.65	Clear_Fork_Tr_Rv_S035	1.38	0.65
Clear_Fork_Tr_Rv_S036	1.36	0.65	Clear_Fork_Tr_Rv_S037	0.94	0.65
Clear_Fork_Tr_Rv_S038	2.34	0.65	Clear_Fork_Tr_Rv_S039	1.22	0.65
Clear_Fork_Tr_Rv_S040	1.3	0.65	Clear_Fork_Tr_Rv_S041	1.1	0.65
Clear_Fork_Tr_Rv_S042	1.29	0.65	Clear_Fork_Tr_Rv_S043	0.37	0.65
Clear_Fork_Tr_Rv_S044	0.77	0.65	Clear_Fork_Tr_Rv_S045	1.04	0.65
Clear_Fork_Tr_Rv_S046	0.7	0.65	Clear_Fork_Tr_Rv_S047	1.5	0.65

Subbasin Name	Lag Time (Hr)	Peaking Coefficient	Subbasin Name	Lag Time (Hr)	Peaking Coefficient
Clear_Fork_Tr_Rv_S048	1.28	0.64	Clear_Fork_Tr_Rv_S049	1.76	0.64
Clear_Fork_Tr_Rv_S050	1.43	0.64	Cottonwood_Cr_S001	1.13	0.64
Cottonwood_Cr_S002	0.9	0.64	Dickeys_Br_S001	0.73	0.76
Dickeys_Br_S002	0.72	0.76	Dickeys_Br_S003	0.6	0.76
Dobbs_Br_S001	1.05	0.64	Dobbs_Br_S002	0.75	0.64
Dutch_Br_S001	1.07	0.63	Dutch_Br_S002	1.12	0.63
Dutch_Br_S003	1.77	0.63	Dutch_Br_S004	0.85	0.63
Gourdneck_Cr_S001	1.6	0.64	Gourdneck_Cr_S002	0.96	0.64
Gourdneck_Cr_S003	0.53	0.64	Gourdneck_Cr_S004	0.4	0.64
Gourdneck_Cr_S005	0.68	0.64	Gourdneck_Cr_S006	0.76	0.64
Gourdneck_Cr_S007	0.39	0.64	Gourdneck_Cr_S008	1.2	0.64
Gourdneck_Cr_S009	0.69	0.64	Gourdneck_Cr_S010	0.83	0.64
Gourdneck_Cr_S011	1.21	0.64	Gourdneck_Cr_S012	0.57	0.64
Gourdneck_Cr_S013	0.86	0.64	Gourdneck_Cr_S014	0.67	0.64
Gourdneck_Cr_S015	0.48	0.64	Gourdneck_Cr_S016	0.83	0.64
Gourdneck_Cr_S017	0.27	0.64	Gourdneck_Cr_S018	0.73	0.64
Graham_Br_S001	1.36	0.65	Graham_Br_S002	0.44	0.65
Green_Br_S001	1.06	0.64	Green_Br_S002	0.45	0.64
Hale_Br_S001	1.14	0.65	Hale_Br_S002	0.49	0.65
Hays_Br_S001	1.67	0.66	Hays_Br_S002	0.5	0.66
Heiffel_Br_S001	1.13	0.65	Holder_Br_S001	0.93	0.65
Holder_Br_S002	0.48	0.65	Johnson_Br_S001	1.08	0.65
McKnight_Br_S001	1.03	0.64	Mustang_Cr_S001	0.76	0.76
Mustang_Cr_S002	0.92	0.76	Mustang_Cr_S003	0.64	0.76
Mustang_Cr_S004	0.89	0.76	Mustang_Cr_S005	0.77	0.76
Mustang_Cr_S006	0.54	0.76	Mustang_Cr_S007	0.76	0.76
Mustang_Cr_S008	0.88	0.76	Mustang_Cr_S009	0.41	0.76
Mustang_Cr_S010	0.86	0.76	Mustang_Cr_S011	0.49	0.76
Mustang_Cr_S012	0.48	0.76	Mustang_Cr_S013	0.61	0.76
Mustang_Cr_S014	0.26	0.76	Mustang_Cr_S015	0.79	0.76
Mustang_Cr_S016	0.82	0.76	Mustang_Cr_S017	0.81	0.76
Patterson_Br_S001	1.32	0.65	Patton_Br_S001	0.93	0.64
Patton_Br_S002	0.64	0.64	Pogue_Br_S001	1.56	0.65
Rankin_Br_S001	0.9	0.64	Rankin_Br_S002	0.48	0.64
Rock_Cr_S001	1.1	0.63	Rock_Cr_S002	0.82	0.63
Rock_Cr_S003	1.04	0.63	Rock_Cr_S004	0.75	0.63
Rock_Cr_S005	0.45	0.63	Rock_Cr_S006	0.64	0.63
Rock_Cr_S007	0.54	0.63	Rock_Cr_S008	0.72	0.63
Rock_Cr_S009	0.41	0.63	Rock_Cr_S010	0.77	0.63
Rock_Cr_S011	0.47	0.63	Rock_Cr_S012	0.47	0.63

Subbasin Name	Lag Time (Hr)	Peaking Coefficient	Subbasin Name	Lag Time (Hr)	Peaking Coefficient
Rock_Cr_S013	0.86	0.63	Rock_Cr_S014	0.34	0.63
Rock_Cr_S015	0.62	0.63	Rock_Cr_S016	0.8	0.63
Rock_Cr_S017	0.28	0.63	Rock_Cr_S018	0.96	0.63
Rock_Cr_S019	0.28	0.63	Rock_Cr_S020	0.69	0.63
Rock_Cr_S021	0.29	0.63	Rock_Cr_S022	0.42	0.63
Rock_Cr_S023	0.43	0.63	Rock_Cr_S024	0.32	0.63
Rock_Cr_S025	0.78	0.63	Rock_Cr_S026	1.12	0.63
Squaw_Cr_S001	1.9	0.65	Squaw_Cr_S002	1.34	0.65
Squaw_Cr_S003	0.65	0.65	Strickland_Br_S001	1.01	0.64
Strickland_Br_S002	0.4	0.64	Strickland_Br_S003	0.37	0.64
S_Bear_Cr_S001	1.02	0.76	S_Bear_Cr_S002	0.82	0.76
S_Bear_Cr_S003	0.84	0.76	S_Bear_Cr_S004	0.33	0.76
S_Bear_Cr_S005	0.76	0.76	S_Bear_Cr_S006	0.42	0.76
S_Bear_Cr_S007	0.38	0.76	S_Bear_Cr_S008	0.85	0.76
S_Bear_Cr_S009	0.33	0.76	S_Bear_Cr_S010	0.56	0.76
S_Bear_Cr_S011	0.85	0.76	S_Bear_Cr_S012	0.64	0.76
S_Bear_Cr_S013	0.58	0.76	Town_Cr_S001	2.31	0.65
Town_Cr_S002	1.24	0.65	Town_Cr_S003	0.77	0.65
Town_Cr_S004	0.8	0.65	Town_Cr_S005	0.88	0.65
Town_Cr_S006	1.18	0.65	Town_Cr_S007	1.36	0.65
Town_Cr_S008	1.31	0.65	Town_Cr_S009	0.79	0.65
Town_Cr_S010	2.13	0.65	Town_Cr_S011	3.41	0.65
Town_Cr_S012	0.79	0.65	Town_Cr_S013	2.35	0.65
Town_Cr_S014	1.02	0.65	Town_Cr_S015	0.82	0.65
Town_Cr_S016	0.95	0.65	Town_Cr_S017	1.72	0.65
Turkey_Cr_S001	1.54	0.65	Turkey_Cr_S002	1.15	0.65
Turkey_Cr_S003	1.23	0.65	Underwood_Br_S001	1.13	0.65
Underwood_Br_S002	0.78	0.65	Willow_Cr_S001	2.22	0.65
Willow_Cr_S002	0.7	0.65	Willow_Cr_S003	1.56	0.65
Willow_Cr_S004	1.27	0.65	Willow_Cr_S005	1.2	0.65
Willow_Cr_S006	0.34	0.65	Willow_Cr_S007	1.4	0.65
Willow_Cr_S008	1.39	0.65	Willow_Cr_S009	0.38	0.65
Willow_Cr_S010	0.98	0.65	Willow_Cr_S011	0.57	0.65
Willow_Cr_S012	0.69	0.65	Willow_Cr_S013	1.15	0.65
Willow_Cr_S014	1.08	0.65	Willow_Cr_S015	1.89	0.65
Willow_Cr_S016	1.17	0.65	Willow_Cr_S017	1.31	0.65
Willow_Cr_S018	0.72	0.65			

Baseflows

The same Baseflows that were used for the WHA subbasins were assumed in this model for the corresponding areas, as shown in Table 3-5.

Table 3-5. HEC-HMS Subbasin Baseflow Parameters

Subbasin Name	Initial Discharge (cfs/sq mi)	Recession Constant	Ratio to Peak
Bear_Cr_S001	0.77	0.67	0.06
Bear_Cr_S002	0.77	0.67	0.06
Bear_Cr_S003	0.77	0.67	0.06
Bear_Cr_S004	0.77	0.67	0.06
Bear_Cr_S005	0.77	0.67	0.06
Bear_Cr_S006	0.77	0.67	0.06
Bear_Cr_S007	0.77	0.67	0.06
Bear_Cr_S008	0.77	0.67	0.06
Bear_Cr_S009	0.77	0.67	0.05
Bear_Cr_S010	0.77	0.67	0.05
Beeman_Br_S001	0.77	0.67	0.07
Belknap_Br_S001	0.77	0.67	0.07
Belknap_Br_S002	0.77	0.67	0.07
Benbrook_S001	0.77	0.67	0.06
Benbrook_S002	0.77	0.67	0.06
Benbrook_S003	0.77	0.67	0.06
Benbrook_S004	0.77	0.67	0.06
Benbrook_S005	0.77	0.67	0.06
Brown_Br_S001	0.43	0.7	0.05
Burgess_Cr_S001	0.77	0.67	0.07
Burgess_Cr_S002	0.77	0.67	0.07
Burgess_Cr_S003	0.77	0.67	0.07
Burgess_Cr_S004	0.77	0.67	0.07
Burgess_Cr_S005	0.77	0.67	0.07
Burgess_Cr_S006	0.77	0.67	0.07
Burgess_Cr_S007	0.77	0.67	0.07
Burgess_Cr_S008	0.77	0.67	0.07
Carter_Cr_S001	0.43	0.7	0.05
Carter_Cr_S002	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S001	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S002	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S003	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S004	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S005	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S006	0.43	0.7	0.05

Subbasin Name	Initial Discharge (cfs/sq mi)	Recession Constant	Ratio to Peak
Clear_Fork_Tr_Rv_S007	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S008	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S009	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S010	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S011	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S012	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S013	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S014	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S015	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S016	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S017	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S018	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S019	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S020	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S021	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S022	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S023	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S024	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S025	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S026	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S027	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S028	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S029	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S030	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S031	0.43	0.7	0.05
Clear_Fork_Tr_Rv_S032	0.37	0.7	0.05
Clear_Fork_Tr_Rv_S033	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S034	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S035	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S036	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S037	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S038	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S039	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S040	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S041	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S042	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S043	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S044	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S045	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S046	0.77	0.67	0.07

Subbasin Name	Initial Discharge (cfs/sq mi)	Recession Constant	Ratio to Peak
Clear_Fork_Tr_Rv_S047	0.77	0.67	0.07
Clear_Fork_Tr_Rv_S048	0.77	0.67	0.06
Clear_Fork_Tr_Rv_S049	0.77	0.67	0.06
Clear_Fork_Tr_Rv_S050	0.77	0.67	0.06
Cottonwood_Cr_S001	0.43	0.7	0.05
Cottonwood_Cr_S002	0.43	0.7	0.05
Dickeys_Br_S001	0.77	0.67	0.06
Dickeys_Br_S002	0.77	0.67	0.06
Dickeys_Br_S003	0.77	0.67	0.06
Dobbs_Br_S001	0.43	0.7	0.05
Dobbs_Br_S002	0.43	0.7	0.05
Dutch_Br_S001	0.77	0.67	0.06
Dutch_Br_S002	0.77	0.67	0.06
Dutch_Br_S003	0.77	0.67	0.06
Dutch_Br_S004	0.77	0.67	0.06
Gourdneck_Cr_S001	0.43	0.7	0.05
Gourdneck_Cr_S002	0.43	0.7	0.05
Gourdneck_Cr_S003	0.43	0.7	0.05
Gourdneck_Cr_S004	0.43	0.7	0.05
Gourdneck_Cr_S005	0.43	0.7	0.05
Gourdneck_Cr_S006	0.43	0.7	0.05
Gourdneck_Cr_S007	0.43	0.7	0.05
Gourdneck_Cr_S008	0.43	0.7	0.05
Gourdneck_Cr_S009	0.43	0.7	0.05
Gourdneck_Cr_S010	0.43	0.7	0.05
Gourdneck_Cr_S011	0.43	0.7	0.05
Gourdneck_Cr_S012	0.43	0.7	0.05
Gourdneck_Cr_S013	0.43	0.7	0.05
Gourdneck_Cr_S014	0.43	0.7	0.05
Gourdneck_Cr_S015	0.43	0.7	0.05
Gourdneck_Cr_S016	0.43	0.7	0.05
Gourdneck_Cr_S017	0.43	0.7	0.05
Gourdneck_Cr_S018	0.43	0.7	0.05
Graham_Br_S001	0.77	0.67	0.07
Graham_Br_S002	0.77	0.67	0.07
Green_Br_S001	0.43	0.7	0.05
Green_Br_S002	0.43	0.7	0.05
Hale_Br_S001	0.77	0.67	0.07
Hale_Br_S002	0.77	0.67	0.07
Hays_Br_S001	0.37	0.7	0.05

Subbasin Name	Initial Discharge (cfs/sq mi)	Recession Constant	Ratio to Peak
Hays_Br_S002	0.37	0.7	0.05
Heiffel_Br_S001	0.77	0.67	0.07
Holder_Br_S001	0.77	0.67	0.07
Holder_Br_S002	0.77	0.67	0.07
Johnson_Br_S001	0.77	0.67	0.07
McKnight_Br_S001	0.43	0.7	0.05
Mustang_Cr_S001	0.77	0.67	0.06
Mustang_Cr_S002	0.77	0.67	0.06
Mustang_Cr_S003	0.77	0.67	0.06
Mustang_Cr_S004	0.77	0.67	0.06
Mustang_Cr_S005	0.77	0.67	0.06
Mustang_Cr_S006	0.77	0.67	0.06
Mustang_Cr_S007	0.77	0.67	0.06
Mustang_Cr_S008	0.77	0.67	0.06
Mustang_Cr_S009	0.77	0.67	0.06
Mustang_Cr_S010	0.77	0.67	0.06
Mustang_Cr_S011	0.77	0.67	0.06
Mustang_Cr_S012	0.77	0.67	0.06
Mustang_Cr_S013	0.77	0.67	0.06
Mustang_Cr_S014	0.77	0.67	0.06
Mustang_Cr_S015	0.77	0.67	0.06
Mustang_Cr_S016	0.77	0.67	0.06
Mustang_Cr_S017	0.77	0.67	0.06
Patterson_Br_S001	0.77	0.67	0.07
Patton_Br_S001	0.43	0.7	0.05
Patton_Br_S002	0.43	0.7	0.05
Pogue_Br_S001	0.77	0.67	0.07
Rankin_Br_S001	0.43	0.7	0.05
Rankin_Br_S002	0.43	0.7	0.05
Rock_Cr_S001	0.77	0.67	0.06
Rock_Cr_S002	0.77	0.67	0.06
Rock_Cr_S003	0.77	0.67	0.06
Rock_Cr_S004	0.77	0.67	0.06
Rock_Cr_S005	0.77	0.67	0.06
Rock_Cr_S006	0.77	0.67	0.06
Rock_Cr_S007	0.77	0.67	0.06
Rock_Cr_S008	0.77	0.67	0.06
Rock_Cr_S009	0.77	0.67	0.06
Rock_Cr_S010	0.77	0.67	0.06
Rock_Cr_S011	0.77	0.67	0.06

Subbasin Name	Initial Discharge (cfs/sq mi)	Recession Constant	Ratio to Peak
Rock_Cr_S012	0.77	0.67	0.06
Rock_Cr_S013	0.77	0.67	0.06
Rock_Cr_S014	0.77	0.67	0.06
Rock_Cr_S015	0.77	0.67	0.06
Rock_Cr_S016	0.77	0.67	0.06
Rock_Cr_S017	0.77	0.67	0.06
Rock_Cr_S018	0.77	0.67	0.06
Rock_Cr_S019	0.77	0.67	0.06
Rock_Cr_S020	0.77	0.67	0.06
Rock_Cr_S021	0.77	0.67	0.06
Rock_Cr_S022	0.77	0.67	0.06
Rock_Cr_S023	0.77	0.67	0.06
Rock_Cr_S024	0.77	0.67	0.06
Rock_Cr_S025	0.77	0.67	0.06
Rock_Cr_S026	0.77	0.67	0.06
Squaw_Cr_S001	0.77	0.67	0.07
Squaw_Cr_S002	0.77	0.67	0.07
Squaw_Cr_S003	0.77	0.67	0.07
Strickland_Br_S001	0.43	0.7	0.05
Strickland_Br_S002	0.43	0.7	0.05
Strickland_Br_S003	0.43	0.7	0.05
S_Bear_Cr_S001	0.77	0.67	0.06
S_Bear_Cr_S002	0.77	0.67	0.06
S_Bear_Cr_S003	0.77	0.67	0.06
S_Bear_Cr_S004	0.77	0.67	0.06
S_Bear_Cr_S005	0.77	0.67	0.06
S_Bear_Cr_S006	0.77	0.67	0.06
S_Bear_Cr_S007	0.77	0.67	0.06
S_Bear_Cr_S008	0.77	0.67	0.06
S_Bear_Cr_S009	0.77	0.67	0.06
S_Bear_Cr_S010	0.77	0.67	0.06
S_Bear_Cr_S011	0.77	0.67	0.06
S_Bear_Cr_S012	0.77	0.67	0.06
S_Bear_Cr_S013	0.77	0.67	0.06
Town_Cr_S001	0.77	0.67	0.07
Town_Cr_S002	0.77	0.67	0.07
Town_Cr_S003	0.77	0.67	0.07
Town_Cr_S004	0.77	0.67	0.07
Town_Cr_S005	0.77	0.67	0.07
Town_Cr_S006	0.77	0.67	0.07

Subbasin Name	Initial Discharge (cfs/sq mi)	Recession Constant	Ratio to Peak
Town_Cr_S007	0.77	0.67	0.07
Town_Cr_S008	0.77	0.67	0.07
Town_Cr_S009	0.77	0.67	0.07
Town_Cr_S010	0.77	0.67	0.07
Town_Cr_S011	0.77	0.67	0.07
Town_Cr_S012	0.77	0.67	0.07
Town_Cr_S013	0.77	0.67	0.07
Town_Cr_S014	0.77	0.67	0.07
Town_Cr_S015	0.77	0.67	0.07
Town_Cr_S016	0.77	0.67	0.07
Town_Cr_S017	0.77	0.67	0.07
Turkey_Cr_S001	0.77	0.67	0.07
Turkey_Cr_S002	0.77	0.67	0.07
Turkey_Cr_S003	0.77	0.67	0.07
Underwood_Br_S001	0.77	0.67	0.07
Underwood_Br_S002	0.77	0.67	0.07
Willow_Cr_S001	0.77	0.67	0.07
Willow_Cr_S002	0.77	0.67	0.07
Willow_Cr_S003	0.77	0.67	0.07
Willow_Cr_S004	0.77	0.67	0.07
Willow_Cr_S005	0.77	0.67	0.07
Willow_Cr_S006	0.77	0.67	0.07
Willow_Cr_S007	0.77	0.67	0.07
Willow_Cr_S008	0.77	0.67	0.07
Willow_Cr_S009	0.77	0.67	0.07
Willow_Cr_S010	0.77	0.67	0.07
Willow_Cr_S011	0.77	0.67	0.07
Willow_Cr_S012	0.77	0.67	0.07
Willow_Cr_S013	0.77	0.67	0.07
Willow_Cr_S014	0.77	0.67	0.07
Willow_Cr_S015	0.77	0.67	0.07
Willow_Cr_S016	0.77	0.67	0.07
Willow_Cr_S017	0.77	0.67	0.07
Willow_Cr_S018	0.77	0.67	0.07

3.3.2 *Initial Routing Parameters*

Modified Puls Routing

Modified Puls routing was used for most of the subreaches in the HEC-HMS model. For this method, a storage-discharge table and the number of Subreaches per reach were required. The storage-discharge relationship was calculated using a 2D BLE model in HEC-RAS. 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.

Table 3-6. HEC-HMS Modified Puls Routing Parameters

Reach Name	Reach Length (mi)	Storage-Discharge Curve	Subreaches
Bear_Cr_R001	1.21	Bear_Cr_R001	2
Bear_Cr_R002	3.18	Bear_Cr_R002	4
Bear_Cr_R003	3.19	Bear_Cr_R003	4
Bear_Cr_R004	2.22	Bear_Cr_R004	3
Bear_Cr_R005	1.87	Bear_Cr_R005	2
Bear_Cr_R006	2.23	Bear_Cr_R006	3
Bear_Cr_R007	1.34	Bear_Cr_R007	2
Bear_Cr_R008	1.60	Bear_Cr_R008	2
Belknap_Br_R001	1.10	Belknap_Br_R001	1
Burgess_Cr_R001	1.42	Burgess_Cr_R001	2
Burgess_Cr_R002	0.52	Burgess_Cr_R002	1
Burgess_Cr_R004	0.79	Burgess_Cr_R004	1
Burgess_Cr_R005	0.84	Burgess_Cr_R005	1
Burgess_Cr_R006	1.56	Burgess_Cr_R006	2
Clear_Fork_Tr_Rv_R003	1.68	Clear_Fork_Tr_Rv_R003	1
Clear_Fork_Tr_Rv_R004	1.83	Clear_Fork_Tr_Rv_R004	2
Clear_Fork_Tr_Rv_R005	2.16	Clear_Fork_Tr_Rv_R005	2
Clear_Fork_Tr_Rv_R007	0.92	Clear_Fork_Tr_Rv_R007	3
Clear_Fork_Tr_Rv_R008	1.17	Clear_Fork_Tr_Rv_R008	1
Clear_Fork_Tr_Rv_R009	2.90	Clear_Fork_Tr_Rv_R009	1
Clear_Fork_Tr_Rv_R010	1.12	Clear_Fork_Tr_Rv_R010	1
Clear_Fork_Tr_Rv_R012	0.92	Clear_Fork_Tr_Rv_R012	4
Clear_Fork_Tr_Rv_R013	1.08	Clear_Fork_Tr_Rv_R013	1
Clear_Fork_Tr_Rv_R014	0.42	Clear_Fork_Tr_Rv_R014	1
Clear_Fork_Tr_Rv_R015	1.44	Clear_Fork_Tr_Rv_R015	1
Clear_Fork_Tr_Rv_R016	1.05	Clear_Fork_Tr_Rv_R016	1
Clear_Fork_Tr_Rv_R017	0.96	Clear_Fork_Tr_Rv_R017	1
Clear_Fork_Tr_Rv_R019	0.87	Clear_Fork_Tr_Rv_R019	2
Clear_Fork_Tr_Rv_R020	0.79	Clear_Fork_Tr_Rv_R020	1
Clear_Fork_Tr_Rv_R021	0.33	Clear_Fork_Tr_Rv_R021	1
Clear_Fork_Tr_Rv_R022	0.30	Clear_Fork_Tr_Rv_R022	2

Reach Name	Reach Length (mi)	Storage-Discharge Curve	Subreaches
Clear_Fork_Tr_Rv_R023	2.58	Clear_Fork_Tr_Rv_R023	1
Clear_Fork_Tr_Rv_R024	2.16	Clear_Fork_Tr_Rv_R024	1
Clear_Fork_Tr_Rv_R027	3.07	Clear_Fork_Tr_Rv_R027	1
Clear_Fork_Tr_Rv_R028	0.94	Clear_Fork_Tr_Rv_R028	1
Clear_Fork_Tr_Rv_R029	3.28	Clear_Fork_Tr_Rv_R029	3
Clear_Fork_Tr_Rv_R031	0.91	Clear_Fork_Tr_Rv_R031	3
Clear_Fork_Tr_Rv_R032	2.06	Clear_Fork_Tr_Rv_R032	4
Clear_Fork_Tr_Rv_R033	1.32	Clear_Fork_Tr_Rv_R033	1
Clear_Fork_Tr_Rv_R034	0.26	Clear_Fork_Tr_Rv_R034	4
Clear_Fork_Tr_Rv_R035	0.95	Clear_Fork_Tr_Rv_R035	1
Clear_Fork_Tr_Rv_R036	0.69	Clear_Fork_Tr_Rv_R036	1
Clear_Fork_Tr_Rv_R037	1.92	Clear_Fork_Tr_Rv_R037	3
Clear_Fork_Tr_Rv_R038	2.30	Clear_Fork_Tr_Rv_R038	2
Clear_Fork_Tr_Rv_R039	4.02	Clear_Fork_Tr_Rv_R039	1
Clear_Fork_Tr_Rv_R040	2.32	Clear_Fork_Tr_Rv_R040	1
Clear_Fork_Tr_Rv_R048	1.10	Clear_Fork_Tr_Rv_R048	2
Cottonwood_Cr_R001	1.07	Cottonwood_Cr_R001	3
Dickeys_Br_R002	1.76	Dickeys_Br_R002	5
Dobbs_Br_R001	1.33	Dobbs_Br_R001	3
Gourdneck_Cr_R001	0.42	Gourdneck_Cr_R001	2
Gourdneck_Cr_R002	0.67	Gourdneck_Cr_R002	2
Gourdneck_Cr_R003	0.85	Gourdneck_Cr_R003	3
Gourdneck_Cr_R004	0.66	Gourdneck_Cr_R004	2
Gourdneck_Cr_R005	1.89	Gourdneck_Cr_R005	1
Gourdneck_Cr_R006	0.63	Gourdneck_Cr_R006	1
Gourdneck_Cr_R007	1.24	Gourdneck_Cr_R007	1
Gourdneck_Cr_R009	1.07	Gourdneck_Cr_R009	1
Gourdneck_Cr_R010	0.86	Gourdneck_Cr_R010	2
Gourdneck_Cr_R011	0.27	Gourdneck_Cr_R011	1
Gourdneck_Cr_R012	1.14	Gourdneck_Cr_R012	2
Graham_Br_R001	0.62	Graham_Br_R001	1
Hale_Br_R001	0.71	Hale_Br_R001	1
Hays_Br_R001	1.14	Hays_Br_R001	1
Holder_Br_R001	0.65	Holder_Br_R001	1
Mustang_Cr_R001	1.53	Mustang_Cr_R001	1
Mustang_Cr_R003	1.48	Mustang_Cr_R003	1
Mustang_Cr_R004	1.29	Mustang_Cr_R004	1
Mustang_Cr_R005	0.65	Mustang_Cr_R005	1
Mustang_Cr_R006	0.55	Mustang_Cr_R006	1
Mustang_Cr_R007	0.79	Mustang_Cr_R007	2
Mustang_Cr_R008	0.84	Mustang_Cr_R008	1

Reach Name	Reach Length (mi)	Storage-Discharge Curve	Subreaches
Mustang_Cr_R009	1.38	Mustang_Cr_R009	2
Mustang_Cr_R010	2.25	Mustang_Cr_R010	2
Mustang_Cr_R011	2.30	Mustang_Cr_R011 Cal	1
Patton_Br_R001	0.84	Patton_Br_R001	1
Rock_Cr_R001	2.70	Rock_Cr_R001	1
Rock_Cr_R002	0.73	Rock_Cr_R002	2
Rock_Cr_R003	0.91	Rock_Cr_R003	3
Rock_Cr_R004	1.64	Rock_Cr_R004	3
Rock_Cr_R005	1.41	Rock_Cr_R005	1
Rock_Cr_R006	1.27	Rock_Cr_R006	1
Rock_Cr_R007	0.56	Rock_Cr_R007	3
Rock_Cr_R008	0.79	Rock_Cr_R008	1
Rock_Cr_R009	1.49	Rock_Cr_R009	1
Rock_Cr_R010	0.61	Rock_Cr_R010	2
Rock_Cr_R011	0.87	Rock_Cr_R011	2
Rock_Cr_R012	0.63	Rock_Cr_R012	2
Rock_Cr_R013	0.84	Rock_Cr_R013	1
Rock_Cr_R014	0.57	Rock_Cr_R014	1
Rock_Cr_R015	0.65	Rock_Cr_R015	2
Rock_Cr_R016	1.33	Rock_Cr_R016 Cal	1
S_Bear_Cr_R001	1.22	S_Bear_Cr_R001	1
S_Bear_Cr_R002	1.18	S_Bear_Cr_R002	2
S_Bear_Cr_R003	0.49	S_Bear_Cr_R003	2
S_Bear_Cr_R004	1.19	S_Bear_Cr_R004	1
S_Bear_Cr_R005	1.30	S_Bear_Cr_R005	1
S_Bear_Cr_R006	1.02	S_Bear_Cr_R006	1
S_Bear_Cr_R007	0.56	S_Bear_Cr_R007	2
S_Bear_Cr_R008	1.54	S_Bear_Cr_R008	1
S_Bear_Cr_R009	0.98	S_Bear_Cr_R009	1
Squaw_Cr_R001	2.73	Squaw_Cr_R001	1
Squaw_Cr_R002	0.93	Squaw_Cr_R002	1
Strickland_Br_R001	0.68	Strickland_Br_R001	1
Strickland_Br_R002	0.78	Strickland_Br_R002	1
Town_Cr_R001	1.16	Town_Cr_R001	1
Town_Cr_R002	1.06	Town_Cr_R002	3
Town_Cr_R003	0.40	Town_Cr_R003	1
Town_Cr_R004	2.16	Town_Cr_R004	1
Town_Cr_R005	1.02	Town_Cr_R005	1

Reach Name	Reach Length (mi)	Storage-Discharge Curve	Subreaches
Town_Cr_R006	2.49	Town_Cr_R006	3
Town_Cr_R007	5.72	Town_Cr_R007	1
Town_Cr_R008	0.70	Town_Cr_R008	1
Town_Cr_R009	4.37	Town_Cr_R009	1
Town_Cr_R010	1.49	Town_Cr_R010	3
Town_Cr_R011	0.84	Town_Cr_R011	1
Town_Cr_R012	1.10	Town_Cr_R012	1
Turkey_Cr_R002	0.82	Turkey_Cr_R002	2
Willow_Cr_R001	2.27	Willow_Cr_R001	1
Willow_Cr_R002	2.01	Willow_Cr_R002	2
Willow_Cr_R003	0.54	Willow_Cr_R003	2
Willow_Cr_R004	1.73	Willow_Cr_R004	1
Willow_Cr_R005	0.75	Willow_Cr_R005	1
Willow_Cr_R007	0.88	Willow_Cr_R007	3
Willow_Cr_R008	1.00	Willow_Cr_R008	3
Willow_Cr_R009	1.46	Willow_Cr_R009	1
Willow_Cr_R010	0.96	Willow_Cr_R010	2
Willow_Cr_R012	2.12	Willow_Cr_R012	1
Willow_Cr_R013	1.86	Willow_Cr_R013	1
Willow_Cr_R014	0.73	Willow_Cr_R014	1
Willow_Cr_R015	1.16	Willow_Cr_R015	1

Non-Standard Routing Reaches

No routing method was applied to the reaches "Beeman_Br_R001," "Clear_Fork_Tr_Rv_R026," and "Clear_Fork_Tr_Rv_R030" due to their proximity to adjacent reservoirs. Applying routing to these reaches will account storage twice and lead to inaccurate flow results.

The Lag Time method was applied to reaches "Clear_Fork_Tr_Rv_R011" and "Clear_Fork_Tr_Rv_R041," as they are primarily located within the floodplain area of the main channel, where the volume of the reach is controlled by the mainstem. The lag time was calculated using the following equation:

$$t_{ch} = L_{ch} \Big/ \left(\left(3600 \frac{1.49}{n} R^{\frac{2}{3}} S_{ch}^{\frac{1}{2}}\right) \right)$$

Where:

t_{ch} = channel flow time (hr.)

L_{ch} = channel flow length (ft)

S_{ch} = channel flow slope (ft/ft)

n = Manning's roughness coefficient

Channel flow length and slope were obtained from the HMS model and incorporated into the equation to calculate lag time.

Table 3-7 presents the lag time for the reaches using lag time routing method.

Table 3-7. HEC-HMS Lag Time Parameters

Reach Name	Lag Time (min)
Clear_Fork_Tr_Rv_R011	1.36
Clear_Fork_Tr_Rv_R041	13.5

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. A performance rating of statistics was also used as an indicator of how well the model performed during calibration. The following calibration performance metrics from the WHA were used as a guide to give results the appropriate rating

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

Below highlights the results for the 1% ACE (100-yr) calibrations results at available computation points. These computation points from the Upper Clear Fork Trinity River model were calibrated to match the results of the Trinity River Basin model at similar computation points.

The calibrated parameters included the Loss, Transform, and Baseflow components, and adjustments were limited to no more than 20 percent relative to the original model. The calibrated values for the Constant Loss parameter were determined to fall within the typical range for Hydrologic Soil Groups B and C, which are the predominant soil groups in the watershed, as summarized in the table in TxDOT Hydrologic Design Manual, Chapter 4, Section 13, shown below:

Soil group	Description	Soil type	Range of loss rates (in./hr.)	(mm/hr.)
A	Low runoff potential due to high infiltration rates even when saturated	Deep sand, deep loess, aggregated silts	0.30-0.45	7.6-11.4
B	Moderately low runoff potential due to moderate infiltration rates when saturated	Shallow loess, sandy loam	0.15-0.30	3.8-7.6
C	Moderately high runoff potential due to slow infiltration rates Soils in which a layer near the surface impedes the downward movement of water or soils with moderately fine to fine texture	Clay loams, shallow sandy loam, soils low in organic content, and soils usually high in clay	0.05-0.15	1.3-3.8
D	High runoff potential due to very slow infiltration rates	Soils that swell significantly when wet, heavy plastic clays, and certain saline soils	0.00-0.05	1.3

For better performance ratings, some of the Modified Puls Routing data were adjusted. The reaches are Clear_Fork_Tr_Rv_R040, Mustang_Cr_R011 and Rock_Cr_R016 and the storm area parameter in the met Model used the total WHA drainage area for each junction being calibrated. Storm area used for the calibration points are listed below:

Table 4-1. Storm Area per Calibration Point

Calibration Point	Storm Area (Sq mi)
CFTR_J033_abv_Lk_Weatherford	96.6
Lake_Weatherford	109
Clear_Fork_Tr_Rv_J047	243.4
CFTR_J050_abv_Benbrook	262.3
Bear_Cr_J007	58.9
Bear_Cr_J010_abv_Benbrook	64.1
Rock_Cr_J022_abv_Benbrook	37.5
Mustang_Cr_J014_abv_Benbrook	34.1
Benbrook_Lake	427.8

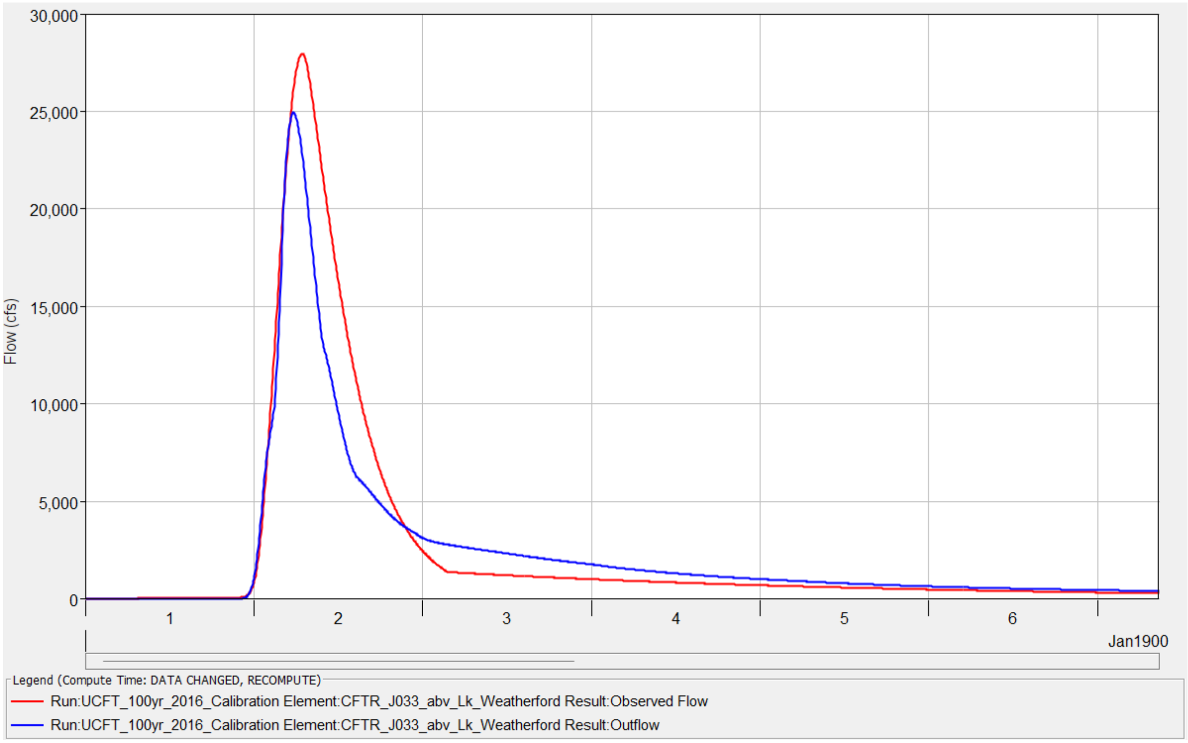

Figure 4-1. Calibrated Hydrograph at CFTR_J033_abv_Lk_Weatherford

Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.3	0.908	-0.89%

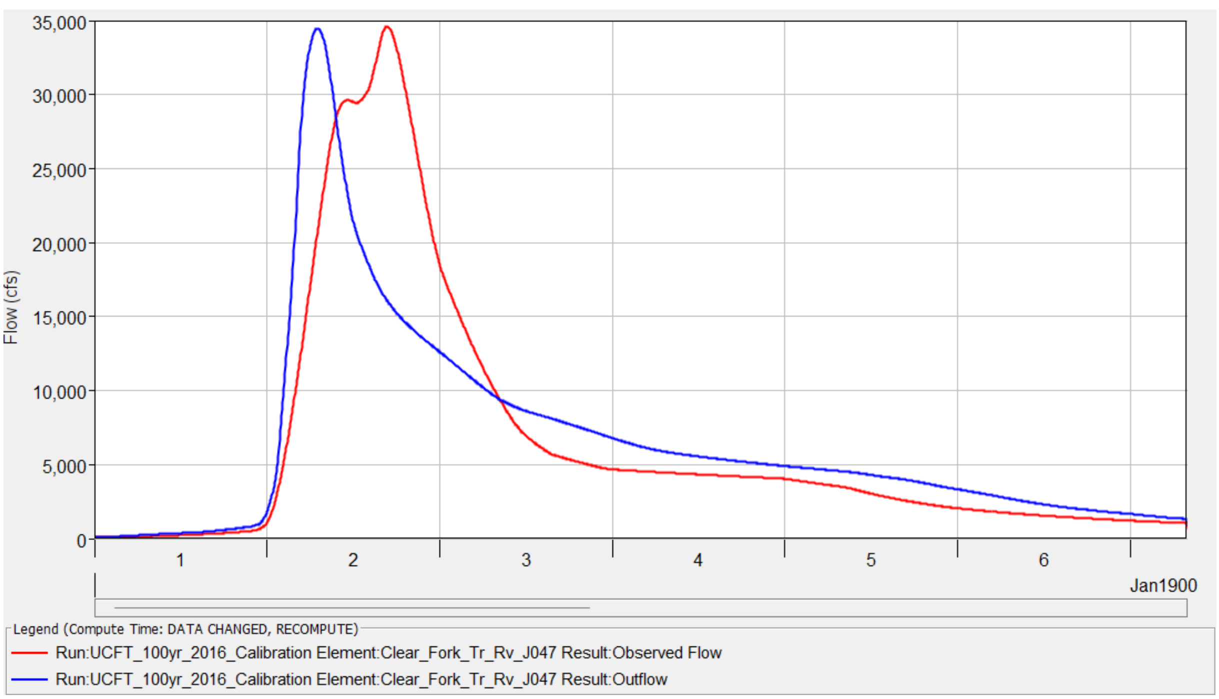

Figure 4-2. Calibrated Hydrograph at Clear_Fork_Tr_Rv_J047

Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Good	0.5	0.756	4.59%

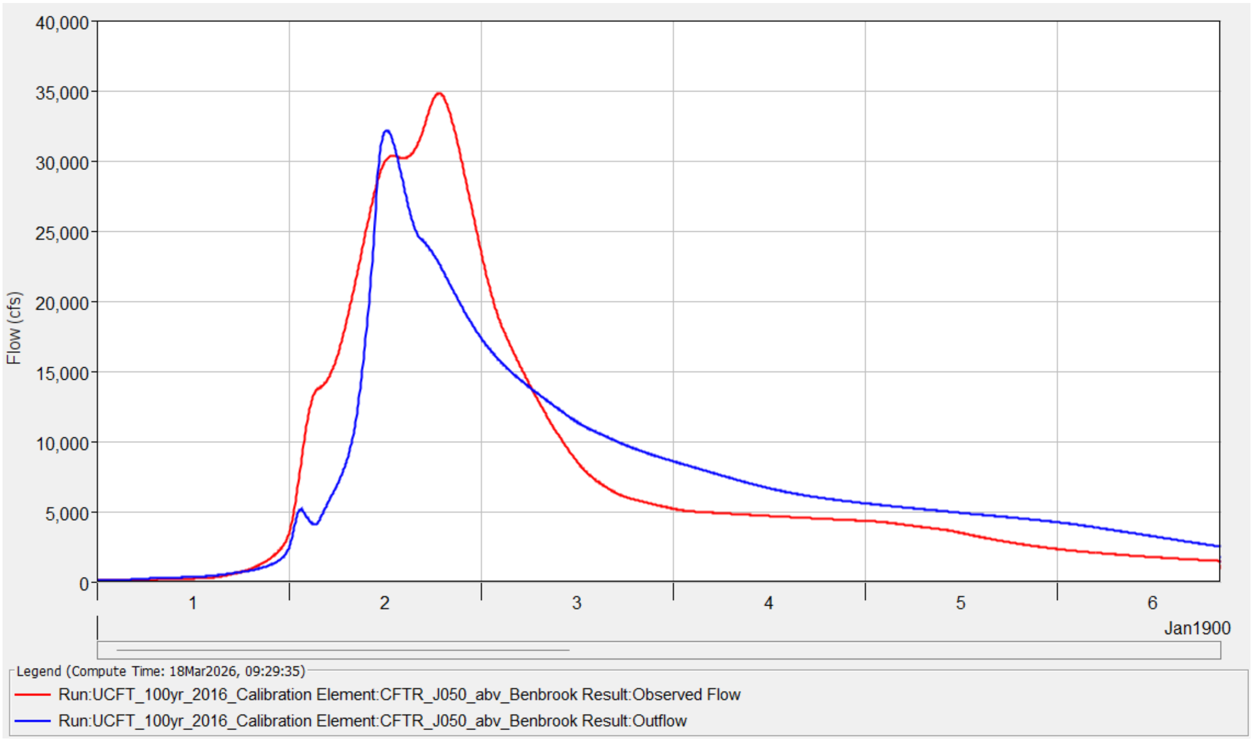

Figure 4-3. Calibrated Hydrograph at CFTR_J050_abv_Benbrook

Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.4	0.874	3.85%

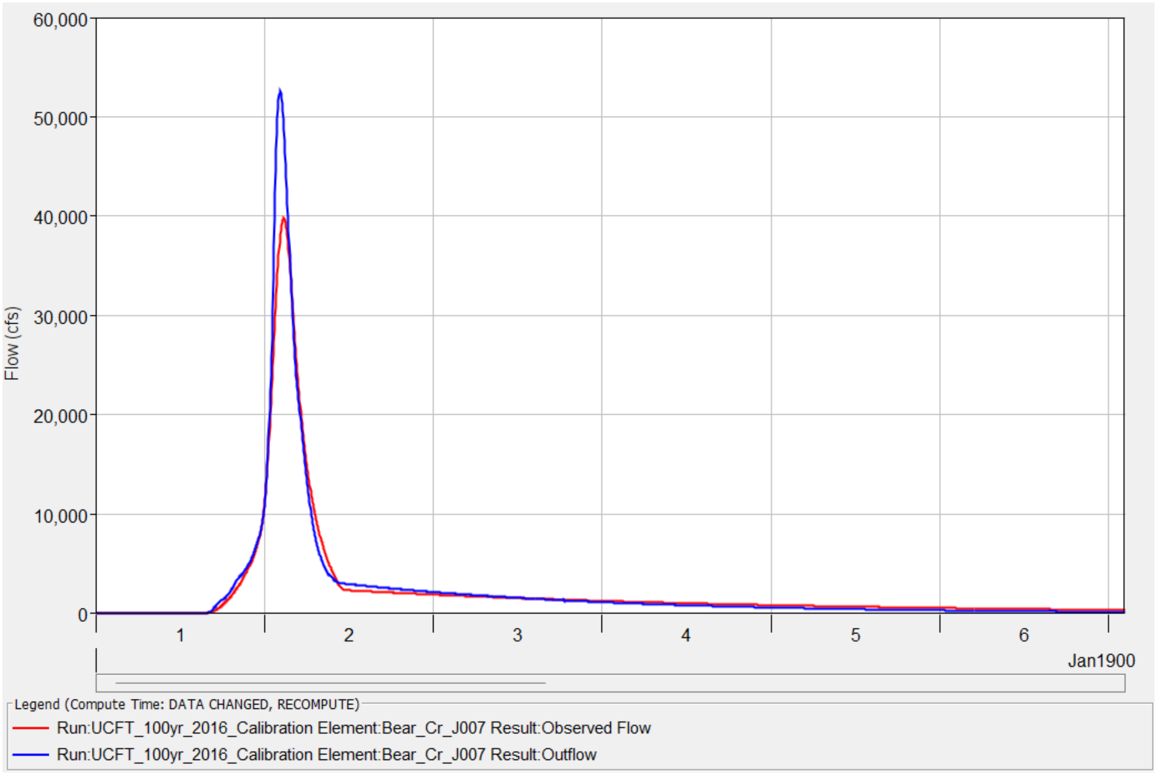

Figure 4-4. Calibrated Hydrograph at Bear_Cr_J007

Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.2	0.938	-1.06%

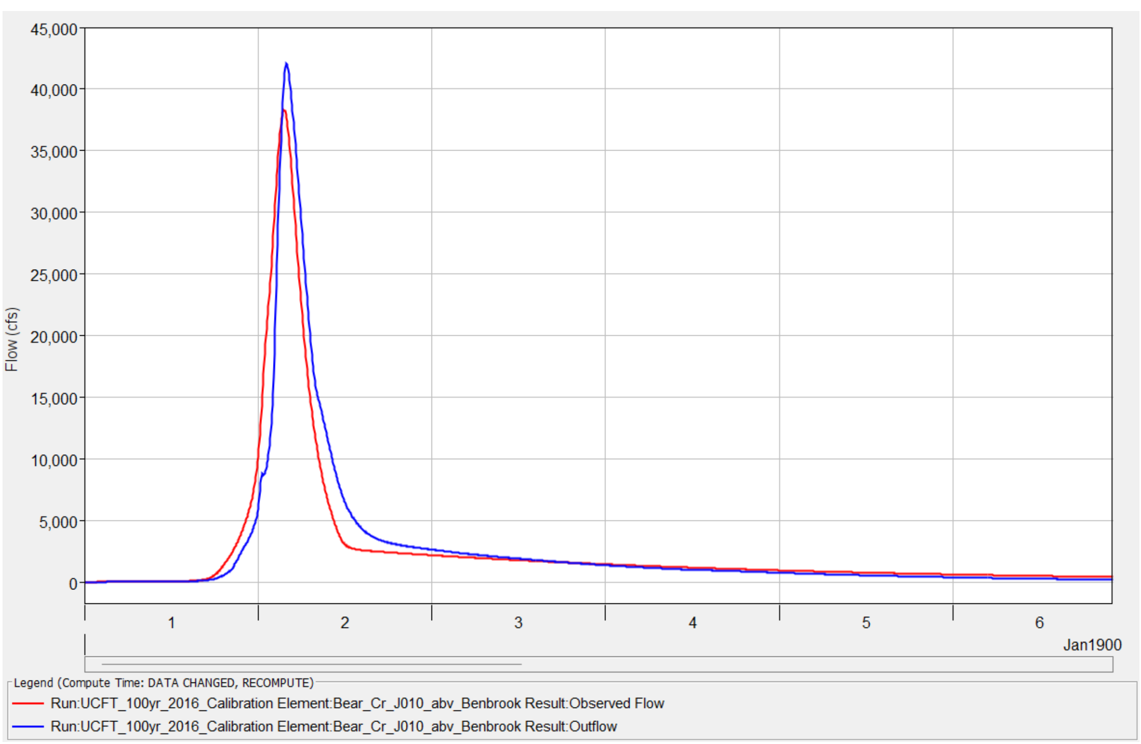

Figure 4-5. Calibrated Hydrograph at Bear_Cr_J010_abv_Benbrook

Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.3	0.904	-1.97%

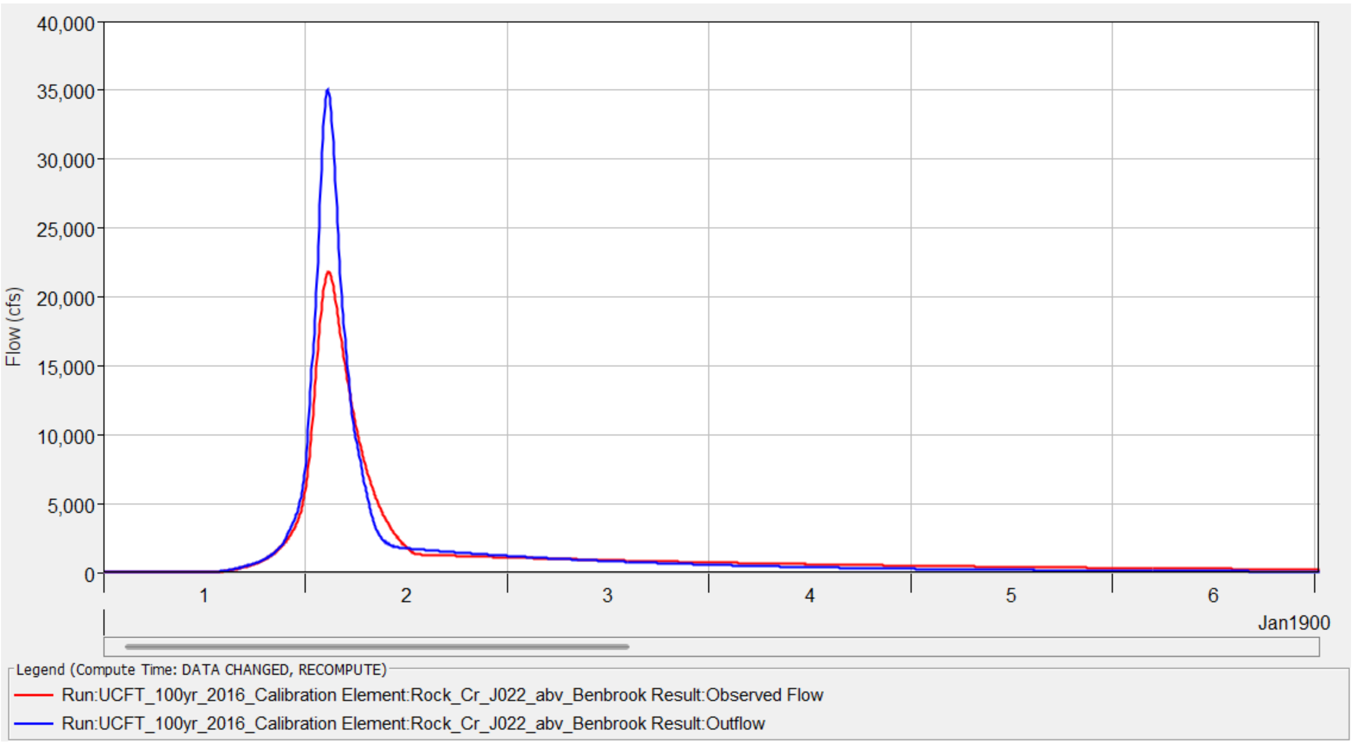

Figure 4-6. Calibrated Hydrograph at Rock_Cr_J022_abv_Benbrook

Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.4	0.806	3.20%

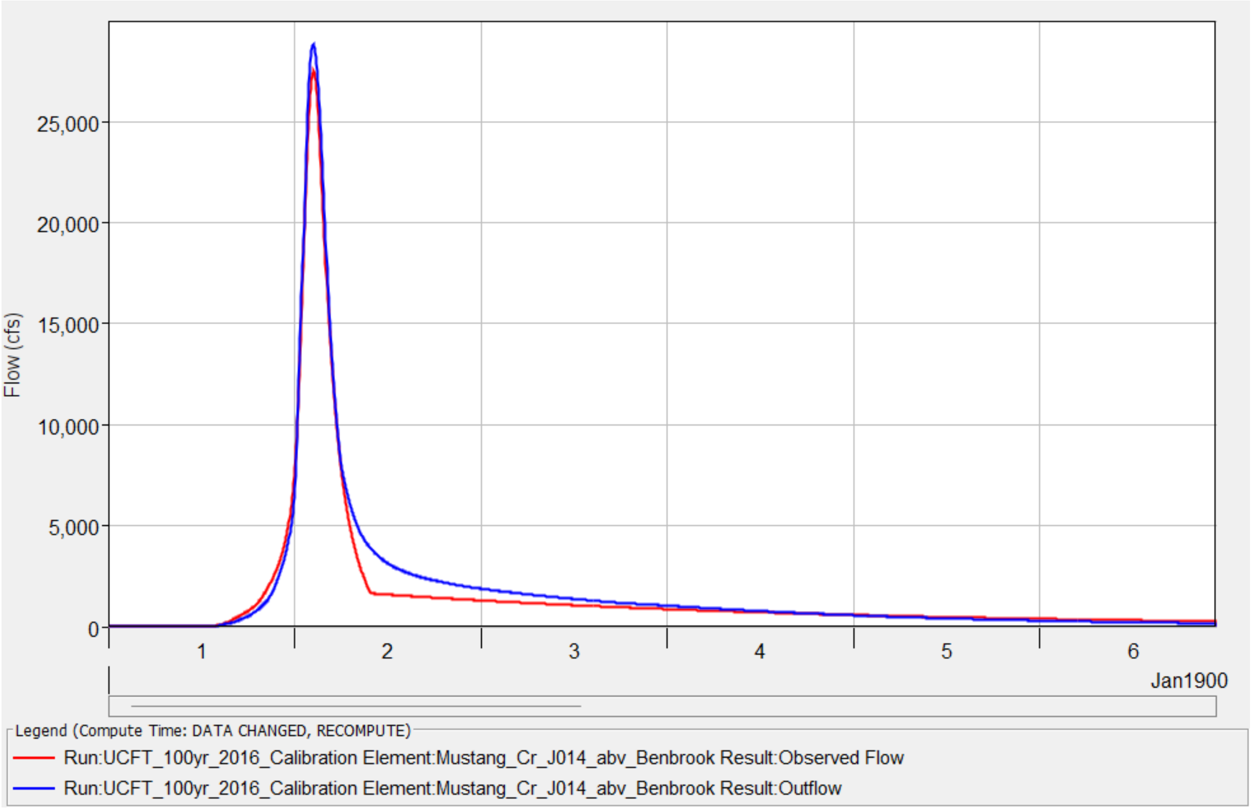

Figure 4-7. Calibrated Hydrograph at Mustang_Cr_J014_abv_Benbrook

Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Good	0.1	0.982	7.64%

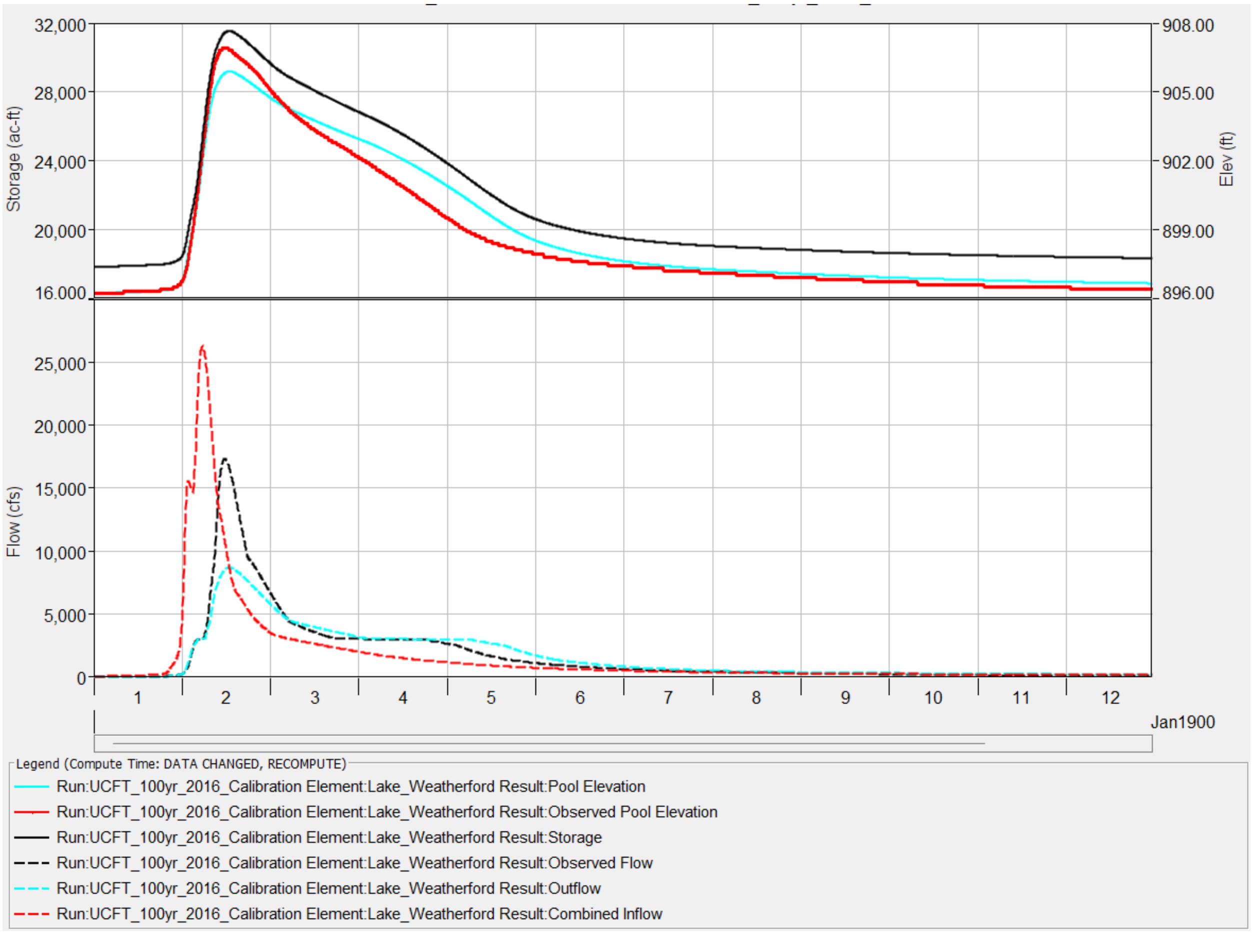

Figure 4-8. Calibration Plot for Pool Elevations at Lake Weatherford

Discharge Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.4	0.830	-2.07%

Stage Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.2	0.963	0.03%

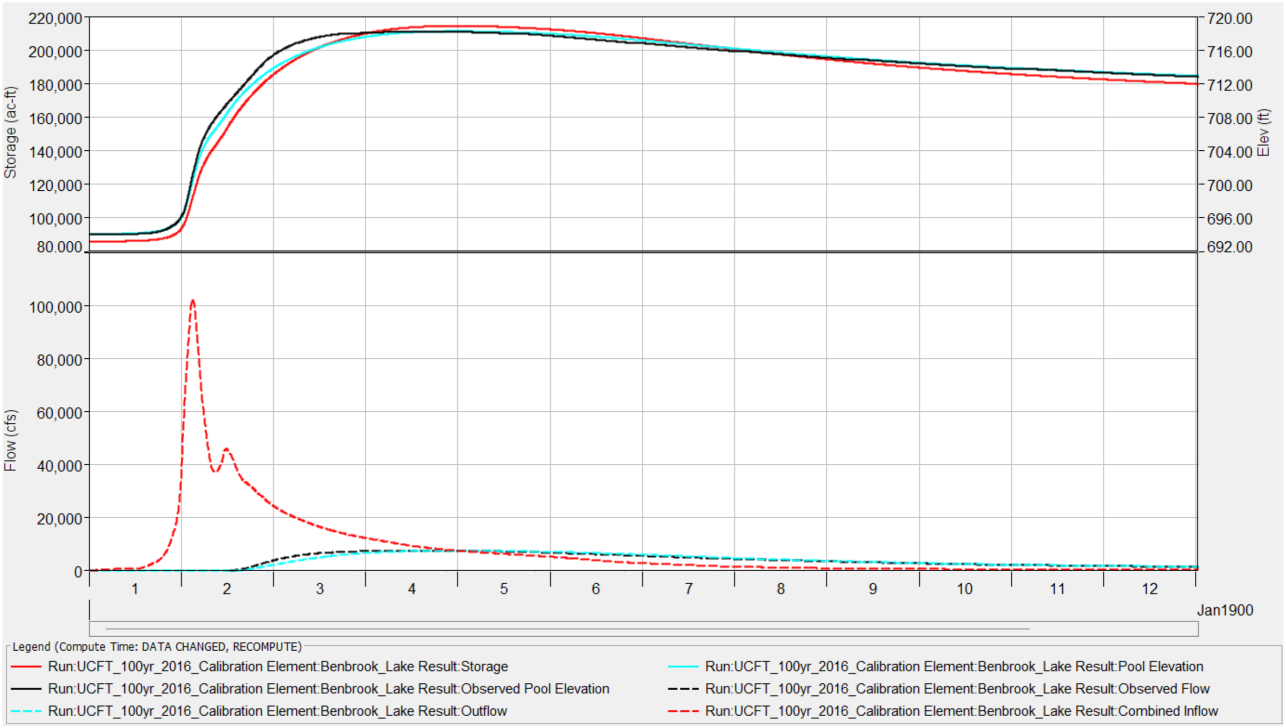

Figure 4-9. Calibration Plot for Pool Elevations at Benbrook Lake

Discharge Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.2	0.951	-0.45%

Stage Performance Rating	RMSE Std Dev	Nash-Sutcliffe	Percent Bias
Very Good	0.1	0.994	-0.01%

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.

Table 4-2. 2016 Calibrated Parameters

Subbasin Name	Initial Loss (in)	Constant Rate (in/hr)	Lag Time (hr)	Peaking Coefficient	Recession Constant	Ratio to Peak
Bear_Cr_S001	1.11	0.09	1.30	0.71	0.54	0.04
Bear_Cr_S002	1.11	0.09	1.38	0.71	0.54	0.04
Bear_Cr_S003	1.11	0.09	0.74	0.71	0.54	0.04
Bear_Cr_S004	1.11	0.09	1.02	0.71	0.54	0.04
Bear_Cr_S005	1.11	0.09	1.26	0.71	0.54	0.04
Bear_Cr_S006	1.11	0.09	1.04	0.71	0.54	0.04
Bear_Cr_S007	1.11	0.09	0.79	0.71	0.54	0.04

Subbasin Name	Initial Loss (in)	Constant Rate (in/hr)	Lag Time (hr)	Peaking Coefficient	Recession Constant	Ratio to Peak
Bear_Cr_S008	1.11	0.09	1.06	0.71	0.54	0.04
Bear_Cr_S009	0.85	0.09	0.59	0.76	0.54	0.05
Bear_Cr_S010	0.85	0.09	0.43	0.76	0.54	0.05
Beeman_Br_S001	2.48	0.10	2.34	0.6	0.54	0.07
Belknap_Br_S001	2.48	0.10	1.71	0.6	0.54	0.07
Belknap_Br_S002	2.48	0.10	0.95	0.6	0.54	0.07
Benbrook_S001	0.82	0.08	1.20	0.76	0.54	0.14
Benbrook_S002	0.82	0.08	0.59	0.76	0.54	0.14
Benbrook_S003	0.82	0.08	0.73	0.76	0.54	0.14
Benbrook_S004	0.82	0.08	0.63	0.76	0.54	0.14
Benbrook_S005	0.82	0.08	2.40	0.76	0.54	0.14
Brown_Br_S001	2.61	0.10	0.89	0.59	0.56	0.04
Burgess_Cr_S001	2.48	0.10	1.87	0.6	0.54	0.07
Burgess_Cr_S002	2.48	0.10	1.55	0.6	0.54	0.07
Burgess_Cr_S003	2.48	0.10	1.28	0.6	0.54	0.07
Burgess_Cr_S004	2.48	0.10	0.67	0.6	0.54	0.07
Burgess_Cr_S005	2.48	0.10	1.78	0.6	0.54	0.07
Burgess_Cr_S006	2.48	0.10	0.77	0.6	0.54	0.07
Burgess_Cr_S007	2.48	0.10	0.96	0.6	0.54	0.07
Burgess_Cr_S008	2.48	0.10	1.42	0.6	0.54	0.07
Carter_Cr_S001	2.61	0.10	1.38	0.59	0.56	0.04
Carter_Cr_S002	2.61	0.10	0.83	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S001	2.61	0.10	1.63	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S002	2.61	0.10	1.72	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S003	2.61	0.10	0.90	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S004	2.61	0.10	1.02	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S005	2.61	0.10	1.00	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S006	2.61	0.10	1.24	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S007	2.61	0.10	1.45	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S008	2.61	0.10	1.13	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S009	2.61	0.10	1.76	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S010	2.61	0.10	1.39	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S011	2.61	0.10	0.67	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S012	2.61	0.10	0.76	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S013	2.61	0.10	1.04	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S014	2.61	0.10	1.04	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S015	2.61	0.10	0.82	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S016	2.61	0.10	0.30	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S017	2.61	0.10	1.69	0.59	0.56	0.04

Subbasin Name	Initial Loss (in)	Constant Rate (in/hr)	Lag Time (hr)	Peaking Coefficient	Recession Constant	Ratio to Peak
Clear_Fork_Tr_Rv_S018	2.61	0.10	1.03	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S019	2.61	0.10	1.49	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S020	2.61	0.10	0.89	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S021	2.61	0.10	0.94	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S022	2.61	0.10	1.58	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S023	2.61	0.10	1.06	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S024	2.61	0.10	0.88	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S025	2.61	0.10	2.08	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S026	2.61	0.10	1.32	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S027	2.61	0.10	0.60	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S028	2.61	0.10	1.04	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S029	2.61	0.10	1.13	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S030	2.61	0.10	1.73	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S031	2.61	0.10	2.22	0.59	0.56	0.04
Clear_Fork_Tr_Rv_S032	1.70	0.09	1.22	0.61	0.56	0.05
Clear_Fork_Tr_Rv_S033	2.48	0.10	2.49	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S034	2.48	0.10	0.80	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S035	2.48	0.10	1.80	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S036	2.48	0.10	1.77	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S037	2.48	0.10	1.22	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S038	2.48	0.10	3.04	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S039	2.48	0.10	1.58	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S040	2.48	0.10	1.69	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S041	2.48	0.10	1.43	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S042	2.48	0.10	1.68	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S043	2.48	0.10	0.48	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S044	2.48	0.10	1.00	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S045	2.48	0.10	1.35	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S046	2.48	0.10	0.91	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S047	2.48	0.10	1.95	0.6	0.54	0.07
Clear_Fork_Tr_Rv_S048	0.87	0.09	1.28	0.64	0.54	0.06
Clear_Fork_Tr_Rv_S049	0.87	0.09	1.76	0.64	0.54	0.06
Clear_Fork_Tr_Rv_S050	0.87	0.09	1.43	0.64	0.54	0.06
Cottonwood_Cr_S001	2.61	0.10	1.36	0.59	0.56	0.04
Cottonwood_Cr_S002	2.61	0.10	1.08	0.59	0.56	0.04
Dickeys_Br_S001	1.11	0.09	0.88	0.71	0.54	0.04
Dickeys_Br_S002	1.11	0.09	0.86	0.71	0.54	0.04
Dickeys_Br_S003	1.11	0.09	0.72	0.71	0.54	0.04
Dobbs_Br_S001	2.61	0.10	1.26	0.59	0.56	0.04

Subbasin Name	Initial Loss (in)	Constant Rate (in/hr)	Lag Time (hr)	Peaking Coefficient	Recession Constant	Ratio to Peak
Dobbs_Br_S002	2.61	0.10	0.90	0.59	0.56	0.04
Dutch_Br_S001	0.82	0.08	0.86	0.76	0.54	0.14
Dutch_Br_S002	0.82	0.08	0.90	0.76	0.54	0.14
Dutch_Br_S003	0.82	0.08	1.42	0.76	0.54	0.14
Dutch_Br_S004	0.82	0.08	0.68	0.76	0.54	0.14
Gourdneck_Cr_S001	2.61	0.10	1.92	0.59	0.56	0.04
Gourdneck_Cr_S002	2.61	0.10	1.15	0.59	0.56	0.04
Gourdneck_Cr_S003	2.61	0.10	0.64	0.59	0.56	0.04
Gourdneck_Cr_S004	2.61	0.10	0.48	0.59	0.56	0.04
Gourdneck_Cr_S005	2.61	0.10	0.82	0.59	0.56	0.04
Gourdneck_Cr_S006	2.61	0.10	0.91	0.59	0.56	0.04
Gourdneck_Cr_S007	2.61	0.10	0.47	0.59	0.56	0.04
Gourdneck_Cr_S008	2.61	0.10	1.44	0.59	0.56	0.04
Gourdneck_Cr_S009	2.61	0.10	0.83	0.59	0.56	0.04
Gourdneck_Cr_S010	2.61	0.10	1.00	0.59	0.56	0.04
Gourdneck_Cr_S011	2.61	0.10	1.45	0.59	0.56	0.04
Gourdneck_Cr_S012	2.61	0.10	0.68	0.59	0.56	0.04
Gourdneck_Cr_S013	2.61	0.10	1.03	0.59	0.56	0.04
Gourdneck_Cr_S014	2.61	0.10	0.8	0.59	0.56	0.04
Gourdneck_Cr_S015	2.61	0.10	0.58	0.59	0.56	0.04
Gourdneck_Cr_S016	2.61	0.10	1.00	0.59	0.56	0.04
Gourdneck_Cr_S017	2.61	0.10	0.32	0.59	0.56	0.04
Gourdneck_Cr_S018	2.61	0.10	0.88	0.59	0.56	0.04
Graham_Br_S001	2.48	0.10	1.77	0.6	0.54	0.07
Graham_Br_S002	2.48	0.10	0.57	0.6	0.54	0.07
Green_Br_S001	2.61	0.10	1.27	0.59	0.56	0.04
Green_Br_S002	2.61	0.10	0.54	0.59	0.56	0.04
Hale_Br_S001	2.48	0.10	1.48	0.6	0.54	0.07
Hale_Br_S002	2.48	0.10	0.64	0.6	0.54	0.07
Hays_Br_S001	1.7	0.09	1.67	0.61	0.56	0.05
Hays_Br_S002	2.61	0.10	0.50	0.61	0.56	0.05
Heiffel_Br_S001	2.48	0.10	1.47	0.6	0.54	0.07
Holder_Br_S001	2.48	0.10	1.21	0.6	0.54	0.07
Holder_Br_S002	2.48	0.10	0.63	0.6	0.54	0.07
Johnson_Br_S001	2.48	0.10	1.41	0.6	0.54	0.07
McKnight_Br_S001	2.61	0.10	1.24	0.59	0.56	0.04
Mustang_Cr_S001	0.84	0.09	0.72	0.78	0.54	0.04
Mustang_Cr_S002	0.84	0.09	0.87	0.78	0.54	0.04
Mustang_Cr_S003	0.84	0.09	0.61	0.78	0.54	0.04

Subbasin Name	Initial Loss (in)	Constant Rate (in/hr)	Lag Time (hr)	Peaking Coefficient	Recession Constant	Ratio to Peak
Mustang_Cr_S004	0.84	0.09	0.85	0.78	0.54	0.04
Mustang_Cr_S005	0.84	0.09	0.73	0.78	0.54	0.04
Mustang_Cr_S006	0.84	0.09	0.51	0.78	0.54	0.04
Mustang_Cr_S007	0.84	0.09	0.72	0.78	0.54	0.04
Mustang_Cr_S008	0.84	0.09	0.84	0.78	0.54	0.04
Mustang_Cr_S009	0.84	0.09	0.39	0.78	0.54	0.04
Mustang_Cr_S010	0.84	0.09	0.82	0.78	0.54	0.04
Mustang_Cr_S011	0.84	0.09	0.47	0.78	0.54	0.04
Mustang_Cr_S012	0.84	0.09	0.46	0.78	0.54	0.04
Mustang_Cr_S013	0.84	0.09	0.58	0.78	0.54	0.04
Mustang_Cr_S014	0.84	0.09	0.25	0.78	0.54	0.04
Mustang_Cr_S015	0.84	0.09	0.75	0.78	0.54	0.04
Mustang_Cr_S016	0.84	0.09	0.78	0.78	0.54	0.04
Mustang_Cr_S017	0.84	0.09	0.77	0.78	0.54	0.04
Patterson_Br_S001	2.48	0.10	1.71	0.6	0.54	0.07
Patton_Br_S001	2.61	0.10	1.12	0.59	0.56	0.04
Patton_Br_S002	2.61	0.10	0.77	0.59	0.56	0.04
Pogue_Br_S001	2.48	0.10	2.03	0.6	0.54	0.07
Rankin_Br_S001	2.61	0.10	1.08	0.59	0.56	0.04
Rankin_Br_S002	2.61	0.10	0.58	0.59	0.56	0.04
Rock_Cr_S001	0.83	0.09	0.99	0.58	0.47	0.03
Rock_Cr_S002	0.83	0.09	0.74	0.58	0.47	0.03
Rock_Cr_S003	0.83	0.09	0.94	0.58	0.47	0.03
Rock_Cr_S004	0.83	0.09	0.68	0.58	0.47	0.03
Rock_Cr_S005	0.83	0.09	0.41	0.58	0.47	0.03
Rock_Cr_S006	0.83	0.09	0.58	0.58	0.47	0.03
Rock_Cr_S007	0.83	0.09	0.49	0.58	0.47	0.03
Rock_Cr_S008	0.83	0.09	0.65	0.58	0.47	0.03
Rock_Cr_S009	0.83	0.09	0.37	0.58	0.47	0.03
Rock_Cr_S010	0.83	0.09	0.69	0.58	0.47	0.03
Rock_Cr_S011	0.83	0.09	0.42	0.58	0.47	0.03
Rock_Cr_S012	0.83	0.09	0.42	0.58	0.47	0.03
Rock_Cr_S013	0.83	0.09	0.77	0.58	0.47	0.03
Rock_Cr_S014	0.83	0.09	0.31	0.58	0.47	0.03
Rock_Cr_S015	0.83	0.09	0.56	0.58	0.47	0.03
Rock_Cr_S016	0.83	0.09	0.72	0.58	0.47	0.03
Rock_Cr_S017	0.83	0.09	0.25	0.58	0.47	0.03
Rock_Cr_S018	0.83	0.09	0.86	0.58	0.47	0.03
Rock_Cr_S019	0.83	0.09	0.25	0.58	0.47	0.03

Subbasin Name	Initial Loss (in)	Constant Rate (in/hr)	Lag Time (hr)	Peaking Coefficient	Recession Constant	Ratio to Peak
Rock_Cr_S020	0.83	0.09	0.62	0.58	0.47	0.03
Rock_Cr_S021	0.83	0.09	0.26	0.58	0.47	0.03
Rock_Cr_S022	0.83	0.09	0.38	0.58	0.47	0.03
Rock_Cr_S023	0.83	0.09	0.39	0.58	0.47	0.03
Rock_Cr_S024	0.83	0.09	0.29	0.58	0.47	0.03
Rock_Cr_S025	0.83	0.09	0.7	0.58	0.47	0.03
Rock_Cr_S026	0.82	0.08	1.01	0.58	0.47	0.03
Squaw_Cr_S001	2.48	0.10	2.47	0.6	0.54	0.07
Squaw_Cr_S002	2.48	0.10	1.74	0.6	0.54	0.07
Squaw_Cr_S003	2.48	0.10	0.85	0.6	0.54	0.07
Strickland_Br_S001	2.61	0.10	1.21	0.59	0.56	0.04
Strickland_Br_S002	2.61	0.10	0.48	0.59	0.56	0.04
Strickland_Br_S003	1.11	0.09	0.44	0.59	0.56	0.04
S_Bear_Cr_S001	1.11	0.09	1.22	0.71	0.54	0.04
S_Bear_Cr_S002	1.11	0.09	0.98	0.71	0.54	0.04
S_Bear_Cr_S003	1.11	0.09	1.01	0.71	0.54	0.04
S_Bear_Cr_S004	1.11	0.09	0.40	0.71	0.54	0.04
S_Bear_Cr_S005	1.11	0.09	0.91	0.71	0.54	0.04
S_Bear_Cr_S006	1.11	0.09	0.50	0.71	0.54	0.04
S_Bear_Cr_S007	1.11	0.09	0.46	0.71	0.54	0.04
S_Bear_Cr_S008	1.11	0.09	1.02	0.71	0.54	0.04
S_Bear_Cr_S009	1.11	0.09	0.40	0.71	0.54	0.04
S_Bear_Cr_S010	1.11	0.09	0.67	0.71	0.54	0.04
S_Bear_Cr_S011	1.11	0.09	1.02	0.71	0.54	0.04
S_Bear_Cr_S012	1.11	0.09	0.77	0.71	0.54	0.04
S_Bear_Cr_S013	1.11	0.09	0.70	0.71	0.54	0.04
Town_Cr_S001	2.48	0.10	3.00	0.6	0.54	0.07
Town_Cr_S002	2.48	0.10	1.61	0.6	0.54	0.07
Town_Cr_S003	2.48	0.10	1.00	0.6	0.54	0.07
Town_Cr_S004	2.48	0.10	1.04	0.6	0.54	0.07
Town_Cr_S005	2.48	0.10	1.15	0.6	0.54	0.07
Town_Cr_S006	2.48	0.10	1.54	0.6	0.54	0.07
Town_Cr_S007	2.48	0.10	1.77	0.6	0.54	0.07
Town_Cr_S008	2.48	0.10	1.70	0.6	0.54	0.07
Town_Cr_S009	2.48	0.10	1.03	0.6	0.54	0.07
Town_Cr_S010	2.48	0.10	2.77	0.6	0.54	0.07
Town_Cr_S011	2.48	0.10	4.43	0.6	0.54	0.07
Town_Cr_S012	2.48	0.10	1.03	0.6	0.54	0.07
Town_Cr_S013	2.48	0.10	3.06	0.6	0.54	0.07

Subbasin Name	Initial Loss (in)	Constant Rate (in/hr)	Lag Time (hr)	Peaking Coefficient	Recession Constant	Ratio to Peak
Town_Cr_S014	2.48	0.10	1.32	0.6	0.54	0.07
Town_Cr_S015	2.48	0.10	1.06	0.6	0.54	0.07
Town_Cr_S016	2.48	0.10	1.24	0.6	0.54	0.07
Town_Cr_S017	2.48	0.10	2.23	0.6	0.54	0.07
Turkey_Cr_S001	2.48	0.10	2.00	0.6	0.54	0.07
Turkey_Cr_S002	2.48	0.10	1.50	0.6	0.54	0.07
Turkey_Cr_S003	2.48	0.10	1.60	0.6	0.54	0.07
Underwood_Br_S001	2.48	0.10	1.47	0.6	0.54	0.07
Underwood_Br_S002	2.48	0.10	1.02	0.6	0.54	0.07
Willow_Cr_S001	2.48	0.10	2.88	0.6	0.54	0.07
Willow_Cr_S002	2.48	0.10	0.91	0.6	0.54	0.07
Willow_Cr_S003	2.48	0.10	2.03	0.6	0.54	0.07
Willow_Cr_S004	2.48	0.10	1.65	0.6	0.54	0.07
Willow_Cr_S005	2.48	0.10	1.56	0.6	0.54	0.07
Willow_Cr_S006	2.48	0.10	0.44	0.6	0.54	0.07
Willow_Cr_S007	2.48	0.10	1.82	0.6	0.54	0.07
Willow_Cr_S008	2.48	0.10	1.81	0.6	0.54	0.07
Willow_Cr_S009	2.48	0.10	0.50	0.6	0.54	0.07
Willow_Cr_S010	2.48	0.10	1.28	0.6	0.54	0.07
Willow_Cr_S011	2.48	0.10	0.74	0.6	0.54	0.07
Willow_Cr_S012	2.48	0.10	0.90	0.6	0.54	0.07
Willow_Cr_S013	2.48	0.10	1.50	0.6	0.54	0.07
Willow_Cr_S014	2.48	0.10	1.41	0.6	0.54	0.07
Willow_Cr_S015	2.48	0.10	2.46	0.6	0.54	0.07
Willow_Cr_S016	2.48	0.10	1.52	0.6	0.54	0.07
Willow_Cr_S017	2.48	0.10	1.70	0.6	0.54	0.07
Willow_Cr_S018	2.48	0.10	0.93	0.6	0.54	0.07

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 percentage 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)	Subbasin Name	Percent Impervious (2016)	Percent Impervious (2020)
Bear_Cr_S001	0.33	2.06	Bear_Cr_S002	1.57	2.5
Bear_Cr_S003	0.41	1.48	Bear_Cr_S004	0.46	1.54
Bear_Cr_S005	0.5	1.66	Bear_Cr_S006	1.14	2.38
Bear_Cr_S007	6.45	6.45	Bear_Cr_S008	0.47	3.37
Bear_Cr_S009	1.45	3.63	Bear_Cr_S010	7.05	8.63
Beeman_Br_S001	0.51	3.36	Belknap_Br_S001	0.9	4.93
Belknap_Br_S002	0.79	3.37	Benbrook_S001	25.65	29
Benbrook_S002	1.96	5.69	Benbrook_S003	1.23	2.75
Benbrook_S004	2.49	3.34	Benbrook_S005	37	37.49
Brown_Br_S001	1.53	4.68	Burgess_Cr_S001	0.62	2.32
Burgess_Cr_S002	0.71	2.64	Burgess_Cr_S003	0.39	1.42
Burgess_Cr_S004	0.86	1.48	Burgess_Cr_S005	0.43	2.13
Burgess_Cr_S006	0.5	2.34	Burgess_Cr_S007	0.46	1.81
Burgess_Cr_S008	3.32	5.9	Carter_Cr_S001	0.96	3.49
Carter_Cr_S002	0.04	1.61	Clear_Fork_Tr_Rv_S001	0.25	2.3
Clear_Fork_Tr_Rv_S002	0.16	1.77	Clear_Fork_Tr_Rv_S003	0.37	1.58
Clear_Fork_Tr_Rv_S004	0.2	2.62	Clear_Fork_Tr_Rv_S005	0.2	1.65
Clear_Fork_Tr_Rv_S006	0.65	3.86	Clear_Fork_Tr_Rv_S007	1	2.54
Clear_Fork_Tr_Rv_S008	0.9	3.84	Clear_Fork_Tr_Rv_S009	0.68	2.6
Clear_Fork_Tr_Rv_S010	0.28	1.56	Clear_Fork_Tr_Rv_S011	0.1	1.51
Clear_Fork_Tr_Rv_S012	0.73	2.49	Clear_Fork_Tr_Rv_S013	0.56	2.79
Clear_Fork_Tr_Rv_S014	0.23	2.53	Clear_Fork_Tr_Rv_S015	0.31	1.88
Clear_Fork_Tr_Rv_S016	0	1.51	Clear_Fork_Tr_Rv_S017	0.36	2.28
Clear_Fork_Tr_Rv_S018	0.04	1.64	Clear_Fork_Tr_Rv_S019	0.32	1.97

Subbasin Name	Percent Impervious (2016)	Percent Impervious (2020)	Subbasin Name	Percent Impervious (2016)	Percent Impervious (2020)
Clear_Fork_Tr_Rv_S020	0.29	1.81	Clear_Fork_Tr_Rv_S021	0.08	1.55
Clear_Fork_Tr_Rv_S022	0.36	2.43	Clear_Fork_Tr_Rv_S023	0.03	1.64
Clear_Fork_Tr_Rv_S024	1.54	5.56	Clear_Fork_Tr_Rv_S025	0.3	2.2
Clear_Fork_Tr_Rv_S026	0.78	2.85	Clear_Fork_Tr_Rv_S027	0.43	5.61
Clear_Fork_Tr_Rv_S028	0.82	3.23	Clear_Fork_Tr_Rv_S029	0.56	2.78
Clear_Fork_Tr_Rv_S030	0.45	2.42	Clear_Fork_Tr_Rv_S031	0.46	2.02
Clear_Fork_Tr_Rv_S032	22.88	25.87	Clear_Fork_Tr_Rv_S033	15.52	18.17
Clear_Fork_Tr_Rv_S034	21.04	21.04	Clear_Fork_Tr_Rv_S035	13.24	14.28
Clear_Fork_Tr_Rv_S036	24.17	24.17	Clear_Fork_Tr_Rv_S037	5.03	9.6
Clear_Fork_Tr_Rv_S038	4.17	7.13	Clear_Fork_Tr_Rv_S039	8.41	9.88
Clear_Fork_Tr_Rv_S040	6.68	12.91	Clear_Fork_Tr_Rv_S041	5.81	7.19
Clear_Fork_Tr_Rv_S042	0.86	2.33	Clear_Fork_Tr_Rv_S043	8.53	24.83
Clear_Fork_Tr_Rv_S044	14.82	15.27	Clear_Fork_Tr_Rv_S045	1.22	6.3
Clear_Fork_Tr_Rv_S046	1.24	4.27	Clear_Fork_Tr_Rv_S047	2.64	6.15
Clear_Fork_Tr_Rv_S048	1.9	4.79	Clear_Fork_Tr_Rv_S049	4.99	5.39
Clear_Fork_Tr_Rv_S050	7.95	10.48	Cottonwood_Cr_S001	0.27	1.89
Cottonwood_Cr_S002	0.16	1.51	Dickeys_Br_S001	0.69	2.25
Dickeys_Br_S002	3.13	4.85	Dickeys_Br_S003	3.4	7.26
Dobbs_Br_S001	0.16	1.65	Dobbs_Br_S002	0.22	2.26
Dutch_Br_S001	0.45	6.61	Dutch_Br_S002	0	1.36
Dutch_Br_S003	6.6	10.34	Dutch_Br_S004	4.76	9.02
Gourdneck_Cr_S001	0.47	2.42	Gourdneck_Cr_S002	0.15	1.59
Gourdneck_Cr_S003	0.86	1.15	Gourdneck_Cr_S004	0.91	1.22
Gourdneck_Cr_S005	0.37	2.10	Gourdneck_Cr_S006	0.61	2.62
Gourdneck_Cr_S007	0.09	1.38	Gourdneck_Cr_S008	0.36	2.13
Gourdneck_Cr_S009	0.6	2.63	Gourdneck_Cr_S010	0.03	1.24
Gourdneck_Cr_S011	0.31	1.99	Gourdneck_Cr_S012	0	1.26
Gourdneck_Cr_S013	0.1	1.6	Gourdneck_Cr_S014	0.52	2.32
Gourdneck_Cr_S015	0	1.2	Gourdneck_Cr_S016	0.34	3.11
Gourdneck_Cr_S017	0.17	1.73	Gourdneck_Cr_S018	0.07	1.62
Graham_Br_S001	0.87	3.56	Graham_Br_S002	0	1.27
Green_Br_S001	0.94	1.96	Green_Br_S002	0.4	2.35
Hale_Br_S001	2.15	2.7	Hale_Br_S002	0.44	1.89
Hays_Br_S001	0.33	1.35	Hays_Br_S002	0.1	1.62
Heiffel_Br_S001	0.51	1.81	Holder_Br_S001	1.69	2.84
Holder_Br_S002	4.5	4.67	Johnson_Br_S001	1.54	4.4
McKnight_Br_S001	1.32	3.64	Mustang_Cr_S001	1.39	2.87
Mustang_Cr_S002	0.53	1.82	Mustang_Cr_S003	0.09	1.39
Mustang_Cr_S004	1.03	1.78	Mustang_Cr_S005	1.24	2.94

Subbasin Name	Percent Impervious (2016)	Percent Impervious (2020)	Subbasin Name	Percent Impervious (2016)	Percent Impervious (2020)
Mustang_Cr_S006	0.61	2.01	Mustang_Cr_S007	0	1.37
Mustang_Cr_S008	0.3	2.68	Mustang_Cr_S009	2.52	5.42
Mustang_Cr_S010	2.77	6.28	Mustang_Cr_S011	3.89	5.94
Mustang_Cr_S012	1.15	2.96	Mustang_Cr_S013	0	1.37
Mustang_Cr_S014	0.06	1.72	Mustang_Cr_S015	0.3	3.23
Mustang_Cr_S016	0.15	1.89	Mustang_Cr_S017	3.48	4.64
Patterson_Br_S001	0.53	2.06	Patton_Br_S001	0.83	2.51
Patton_Br_S002	0.73	2.28	Pogue_Br_S001	3.08	5.41
Rankin_Br_S001	1.31	3.06	Rankin_Br_S002	0.32	2.91
Rock_Cr_S001	3.09	7.46	Rock_Cr_S002	5.43	9.64
Rock_Cr_S003	2.89	6.65	Rock_Cr_S004	2.54	6.77
Rock_Cr_S005	5.78	12.31	Rock_Cr_S006	0.86	2.33
Rock_Cr_S007	3.37	6.02	Rock_Cr_S008	3.55	5.86
Rock_Cr_S009	3.38	4.98	Rock_Cr_S010	2.41	4.22
Rock_Cr_S011	6.88	8.7	Rock_Cr_S012	2.58	3.76
Rock_Cr_S013	3	5.3	Rock_Cr_S014	4.64	5.57
Rock_Cr_S015	3.16	4.04	Rock_Cr_S016	0.12	1.37
Rock_Cr_S017	1.34	3.16	Rock_Cr_S018	5.84	8.01
Rock_Cr_S019	4.93	8.77	Rock_Cr_S020	2.15	5.77
Rock_Cr_S021	1.71	3.69	Rock_Cr_S022	5.14	7.58
Rock_Cr_S023	0.02	1.38	Rock_Cr_S024	0.78	2.14
Rock_Cr_S025	1.11	3.66	Rock_Cr_S026	7.98	11.61
Squaw_Cr_S001	0.42	2.29	Squaw_Cr_S002	0.36	5.55
Squaw_Cr_S003	1.9	11.54	Strickland_Br_S001	0.1	2.13
Strickland_Br_S002	0.46	1.55	Strickland_Br_S003	1.43	3.22
S_Bear_Cr_S001	0.33	1.58	S_Bear_Cr_S002	1.59	1.59
S_Bear_Cr_S003	10.21	10.21	S_Bear_Cr_S004	6	6
S_Bear_Cr_S005	1.3	1.3	S_Bear_Cr_S006	1.23	1.23
S_Bear_Cr_S007	2.78	2.78	S_Bear_Cr_S008	0.82	3.55
S_Bear_Cr_S009	3.95	12.27	S_Bear_Cr_S010	6.78	6.78
S_Bear_Cr_S011	0.45	2.55	S_Bear_Cr_S012	0.1	2.9
S_Bear_Cr_S013	0.36	5.75	Town_Cr_S001	0.64	2.96
Town_Cr_S002	2.69	4.51	Town_Cr_S003	15.94	25.28
Town_Cr_S004	32.54	32.54	Town_Cr_S005	42.05	44.29
Town_Cr_S006	31.49	37.62	Town_Cr_S007	29.44	37.53
Town_Cr_S008	36.71	39.15	Town_Cr_S009	20.02	28.34
Town_Cr_S010	7.13	10.24	Town_Cr_S011	5.57	8.73
Town_Cr_S012	10.48	10.48	Town_Cr_S013	2.7	6.14
Town_Cr_S014	2.22	4.44	Town_Cr_S015	9.45	12.04

Subbasin Name	Percent Impervious (2016)	Percent Impervious (2020)	Subbasin Name	Percent Impervious (2016)	Percent Impervious (2020)
Town_Cr_S016	5.58	10.08	Town_Cr_S017	4.55	4.55
Turkey_Cr_S001	3.58	5.53	Turkey_Cr_S002	0.26	1.64
Turkey_Cr_S003	0.42	1.96	Underwood_Br_S001	16.01	16.01
Underwood_Br_S002	9.63	12.54	Willow_Cr_S001	1.27	3.65
Willow_Cr_S002	1.47	3.87	Willow_Cr_S003	0.44	2.38
Willow_Cr_S004	0.31	2.71	Willow_Cr_S005	0.51	3.41
Willow_Cr_S006	0	1.49	Willow_Cr_S007	0.8	3.06
Willow_Cr_S008	2.93	4.41	Willow_Cr_S009	3.86	6.28
Willow_Cr_S010	3.38	4.86	Willow_Cr_S011	0.63	2.55
Willow_Cr_S012	0.92	3.51	Willow_Cr_S013	3.56	5.2
Willow_Cr_S014	8	13.04	Willow_Cr_S015	2.17	4.93
Willow_Cr_S016	8.8	14.43	Willow_Cr_S017	10.69	16.42
Willow_Cr_S018	6.83	10.27			

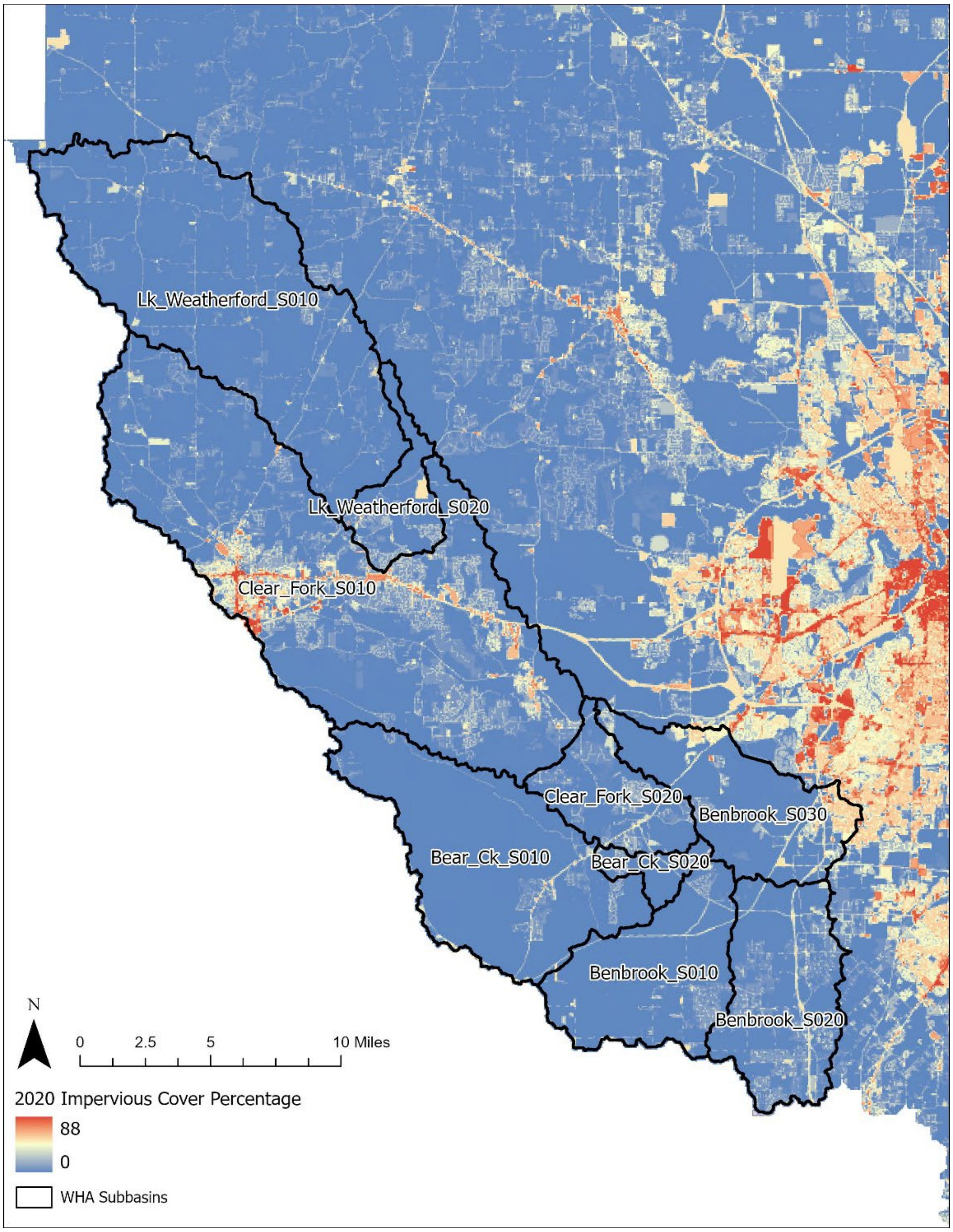

Figure 5-1. Map of Existing 2020 Percent Imperviousness

5.1.2 2020 Conditions Loss Rates

The default frequency loss rates are used for the 2020 basin models for the 1% ACE (100-yr) frequency storms as well as the 2% ACE (50-yr) and 0.2% ACE (500-yr) storms. For the 50% ACE (2-yr) and 10% ACE (10-yr) storms, the final WHA frequency loss rates are used since those were calibrated to the Bulletin 17C results at the downstream gages.

Table 5-2. 2020 Existing Conditions Loss Rates for 2 through 500-year Return Intervals

Subbasin	2-year		10-year		50-year		100-year		500-year	
	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)
Bear_Cr_S001	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S002	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S003	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S004	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S005	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S006	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S007	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S008	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Bear_Cr_S009	1.92	0.24	1.38	0.17	1.02	0.12	0.85	0.09	0.57	0.07
Bear_Cr_S010	1.92	0.24	1.38	0.17	1.02	0.12	0.85	0.09	0.57	0.07
Beeman_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Belknap_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Belknap_Br_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Benbrook_S001	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Benbrook_S002	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Benbrook_S003	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Benbrook_S004	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Benbrook_S005	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Brown_Br_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Burgess_Cr_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Burgess_Cr_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Burgess_Cr_S003	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Burgess_Cr_S004	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Burgess_Cr_S005	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Burgess_Cr_S006	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Burgess_Cr_S007	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Burgess_Cr_S008	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Carter_Cr_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Carter_Cr_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S003	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S004	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S005	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08

Subbasin	2-year		10-year		50-year		100-year		500-year	
	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)
Clear_Fork_Tr_Rv_S006	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S007	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S008	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S009	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S010	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S011	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S012	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S013	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S014	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S015	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S016	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S017	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S018	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S019	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S020	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S021	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S022	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S023	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S024	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S025	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S026	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S027	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S028	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S029	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S030	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S031	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Clear_Fork_Tr_Rv_S032	1.86	0.24	2.03	0.17	1.03	0.12	0.85	0.09	0.57	0.07
Clear_Fork_Tr_Rv_S033	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S034	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S035	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S036	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S037	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S038	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S039	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S040	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S041	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S042	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08

Subbasin	2-year		10-year		50-year		100-year		500-year	
	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)
Clear_Fork_Tr_Rv_S043	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S044	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S045	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S046	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S047	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Clear_Fork_Tr_Rv_S048	1.97	0.25	1.42	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Clear_Fork_Tr_Rv_S049	1.97	0.25	1.42	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Clear_Fork_Tr_Rv_S050	1.97	0.25	1.42	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Cottonwood_Cr_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Cottonwood_Cr_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Dickeys_Br_S001	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Dickeys_Br_S002	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Dickeys_Br_S003	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Dobbs_Br_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Dobbs_Br_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Dutch_Br_S001	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Dutch_Br_S002	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Dutch_Br_S003	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Dutch_Br_S004	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
Gourdneck_Cr_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S003	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S004	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S005	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S006	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S007	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S008	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S009	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S010	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S011	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S012	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S013	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S014	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S015	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S016	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S017	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Gourdneck_Cr_S018	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08

Subbasin	2-year		10-year		50-year		100-year		500-year	
	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)
Graham_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Graham_Br_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Green_Br_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Green_Br_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Hale_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Hale_Br_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Hays_Br_S001	1.86	0.24	2.03	0.17	1.03	0.12	0.86	0.09	0.57	0.07
Hays_Br_S002	1.86	0.24	2.03	0.17	1.03	0.12	0.86	0.09	0.57	0.07
Heiffel_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Holder_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Holder_Br_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Johnson_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
McKnight_Br_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Mustang_Cr_S001	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S002	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S003	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S004	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S005	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S006	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S007	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S008	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S009	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S010	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S011	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S012	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S013	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S014	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S015	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S016	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Mustang_Cr_S017	1.87	0.24	1.36	0.16	1	0.12	0.84	0.09	0.56	0.07
Patterson_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Patton_Br_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Patton_Br_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Pogue_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Rankin_Br_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Rankin_Br_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Rock_Cr_S001	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07

Subbasin	2-year		10-year		50-year		100-year		500-year	
	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)
Rock_Cr_S002	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S003	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S004	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S005	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S006	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S007	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S008	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S009	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S010	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S011	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S012	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S013	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S014	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S015	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S016	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S017	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S018	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S019	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S020	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S021	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S022	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S023	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S024	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S025	1.81	0.23	1.32	0.16	0.98	0.12	0.83	0.09	0.55	0.07
Rock_Cr_S026	1.79	0.23	1.3	0.16	0.96	0.11	0.82	0.08	0.55	0.06
S_Bear_Cr_S001	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S002	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S003	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S004	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S005	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S006	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S007	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S008	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S009	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S010	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S011	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
S_Bear_Cr_S012	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07

Subbasin	2-year		10-year		50-year		100-year		500-year	
	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)
S_Bear_Cr_S013	2.03	0.25	1.61	0.17	1.05	0.12	0.87	0.09	0.58	0.07
Squaw_Cr_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Squaw_Cr_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Squaw_Cr_S003	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Strickland_Br_S001	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Strickland_Br_S002	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Strickland_Br_S003	2.11	0.26	2.78	0.18	1.09	0.13	0.89	0.1	0.6	0.08
Town_Cr_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S003	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S004	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S005	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S006	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S007	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S008	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S009	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S010	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S011	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S012	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S013	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S014	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S015	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S016	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Town_Cr_S017	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Turkey_Cr_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Turkey_Cr_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Turkey_Cr_S003	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Underwood_Br_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Underwood_Br_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S001	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S002	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S003	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S004	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S005	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S006	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S007	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S008	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08

Subbasin	2-year		10-year		50-year		100-year		500-year	
	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)	Initial (in)	Constant (in/hr)
Willow_Cr_S009	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S010	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S011	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S012	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S013	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S014	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S015	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S016	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S017	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08
Willow_Cr_S018	2.25	0.25	2.64	0.17	1.06	0.13	0.88	0.1	0.59	0.08

5.2 TSI 2070 Future Conditions HEC-HMS Model

For the 2070 future conditions basin model, all HMS model parameters will remain the same as were completed for 2020 conditions except for the percent impervious, the Snyder's lag times and the routing storage volumes. For the percent impervious, the 2070 impervious data provided by the NCTCOG and EPA ICLUS was used to update the impervious values in the HEC-HMS detailed model for future conditions.

The Snyder's lag times were reduced to account for the 2070 future conditions percent urbanization. Regional studies in North Texas have shown that as a watershed is transformed from rural to urban, its Snyder' lag time also decreases. Therefore, reduction ratios were applied to the existing conditions lag times for each subbasin.

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 watershed were used to estimate future conditions storage-discharge curves by assuming that the floodway encroachments represent the portion of the floodplain that could be lost to future development. As UCFT watershed didn't have the continuous FEMA data, we used the neighbor watershed's (Village Creek) storage-discharge curves to account for the lost storage for 2070 simulations.

5.2.1 Future Conditions 2070 Percent Imperiousness

The watershed 2070 percent imperviousness was extracted from ArcMap GIS. The future values are listed in Table 5.3.

Table 5-3. 2070 Future Conditions Percent Imperviousness

Subbasin Name	Existing Percent Impervious (2020)	Future Percent Impervious (2070)	Subbasin Name	Existing Percent Impervious (2020)	Future Percent Impervious (2070)
Bear_Cr_S001	2.06	65.03	Bear_Cr_S002	2.5	76.31
Bear_Cr_S003	1.48	58.55	Bear_Cr_S004	1.54	75.48
Bear_Cr_S005	1.66	81.56	Bear_Cr_S006	2.38	87.2
Bear_Cr_S007	6.45	69.3	Bear_Cr_S008	3.37	69.04
Bear_Cr_S009	3.63	74.55	Bear_Cr_S010	8.63	81.65
Beeman_Br_S001	3.36	60.38	Belknap_Br_S001	4.93	53.42
Belknap_Br_S002	3.37	50.21	Benbrook_S001	29	82.94
Benbrook_S002	5.69	76.67	Benbrook_S003	2.75	78.55
Benbrook_S004	3.34	67.78	Benbrook_S005	37.49	81.14
Brown_Br_S001	4.68	46.28	Burgess_Cr_S001	2.32	81.29
Burgess_Cr_S002	2.64	79.84	Burgess_Cr_S003	1.42	80.52
Burgess_Cr_S004	1.48	81.89	Burgess_Cr_S005	2.13	79.7
Burgess_Cr_S006	2.34	79.81	Burgess_Cr_S007	1.81	73.81
Burgess_Cr_S008	5.9	77.42	Carter_Cr_S001	3.49	44.34
Carter_Cr_S002	1.61	13.17	Clear_Fork_Tr_Rv_S001	2.3	38.93
Clear_Fork_Tr_Rv_S002	1.77	7.09	Clear_Fork_Tr_Rv_S003	1.58	21.01
Clear_Fork_Tr_Rv_S004	2.62	15.77	Clear_Fork_Tr_Rv_S005	1.65	8.6
Clear_Fork_Tr_Rv_S006	3.86	13.34	Clear_Fork_Tr_Rv_S007	2.54	15.02
Clear_Fork_Tr_Rv_S008	3.84	52.96	Clear_Fork_Tr_Rv_S009	2.6	29
Clear_Fork_Tr_Rv_S010	1.56	16.29	Clear_Fork_Tr_Rv_S011	1.51	25.15
Clear_Fork_Tr_Rv_S012	2.49	28.98	Clear_Fork_Tr_Rv_S013	2.79	42.78
Clear_Fork_Tr_Rv_S014	2.53	46.22	Clear_Fork_Tr_Rv_S015	1.88	36.52
Clear_Fork_Tr_Rv_S016	1.51	11.74	Clear_Fork_Tr_Rv_S017	2.28	33.05
Clear_Fork_Tr_Rv_S018	1.64	29.1	Clear_Fork_Tr_Rv_S019	1.97	26.95
Clear_Fork_Tr_Rv_S020	1.81	22.18	Clear_Fork_Tr_Rv_S021	1.55	36.34
Clear_Fork_Tr_Rv_S022	2.43	38.97	Clear_Fork_Tr_Rv_S023	1.64	51.55
Clear_Fork_Tr_Rv_S024	5.56	60.52	Clear_Fork_Tr_Rv_S025	2.2	49.05
Clear_Fork_Tr_Rv_S026	2.85	41.61	Clear_Fork_Tr_Rv_S027	5.61	68.46
Clear_Fork_Tr_Rv_S028	3.23	43.79	Clear_Fork_Tr_Rv_S029	2.78	51.65
Clear_Fork_Tr_Rv_S030	2.42	47.35	Clear_Fork_Tr_Rv_S031	2.02	60.6
Clear_Fork_Tr_Rv_S032	25.87	83.53	Clear_Fork_Tr_Rv_S033	18.17	82.04
Clear_Fork_Tr_Rv_S034	21.04	83.89	Clear_Fork_Tr_Rv_S035	14.28	81.97
Clear_Fork_Tr_Rv_S036	24.17	84.81	Clear_Fork_Tr_Rv_S037	9.6	81.39
Clear_Fork_Tr_Rv_S038	7.13	80.24	Clear_Fork_Tr_Rv_S039	9.88	79.7
Clear_Fork_Tr_Rv_S040	12.91	76.71	Clear_Fork_Tr_Rv_S041	7.19	80.85

Subbasin Name	Existing Percent Impervious (2020)	Future Percent Impervious (2070)	Subbasin Name	Existing Percent Impervious (2020)	Future Percent Impervious (2070)
Clear_Fork_Tr_Rv_S042	2.33	78.06	Clear_Fork_Tr_Rv_S043	24.83	77.03
Clear_Fork_Tr_Rv_S044	15.27	69.47	Clear_Fork_Tr_Rv_S045	6.3	77.05
Clear_Fork_Tr_Rv_S046	4.27	75.29	Clear_Fork_Tr_Rv_S047	6.15	73.09
Clear_Fork_Tr_Rv_S048	4.79	76.4	Clear_Fork_Tr_Rv_S049	5.39	75.99
Clear_Fork_Tr_Rv_S050	10.48	86.63	Cottonwood_Cr_S001	1.89	22.25
Cottonwood_Cr_S002	1.51	4.66	Dickeys_Br_S001	2.25	82.57
Dickeys_Br_S002	4.85	76.24	Dickeys_Br_S003	7.26	77.4
Dobbs_Br_S001	1.65	37.44	Dobbs_Br_S002	2.26	54.94
Dutch_Br_S001	6.61	78.13	Dutch_Br_S002	1.36	82.98
Dutch_Br_S003	10.34	74.26	Dutch_Br_S004	9.02	76.9
Gourdneck_Cr_S001	2.42	21.21	Gourdneck_Cr_S002	1.59	12.69
Gourdneck_Cr_S003	1.15	3.04	Gourdneck_Cr_S004	1.22	11.21
Gourdneck_Cr_S005	2.1	17.55	Gourdneck_Cr_S006	2.62	23.66
Gourdneck_Cr_S007	1.38	39.52	Gourdneck_Cr_S008	2.13	22.03
Gourdneck_Cr_S009	2.63	44.25	Gourdneck_Cr_S010	1.24	17
Gourdneck_Cr_S011	1.99	39.32	Gourdneck_Cr_S012	1.26	2
Gourdneck_Cr_S013	1.6	34.05	Gourdneck_Cr_S014	2.32	21.53
Gourdneck_Cr_S015	1.2	20.78	Gourdneck_Cr_S016	3.11	55.9
Gourdneck_Cr_S017	1.73	36.5	Gourdneck_Cr_S018	1.62	12.75
Graham_Br_S001	3.56	55.93	Graham_Br_S002	1.27	33.53
Green_Br_S001	1.96	56.3	Green_Br_S002	2.35	46.25
Hale_Br_S001	2.7	75.97	Hale_Br_S002	1.89	72.87
Hays_Br_S001	1.35	50.99	Hays_Br_S002	1.62	66.94
Heiffel_Br_S001	1.81	77.37	Holder_Br_S001	2.84	68.6
Holder_Br_S002	4.67	76.4	Johnson_Br_S001	4.4	70.36
McKnight_Br_S001	3.64	39.82	Mustang_Cr_S001	2.87	69.89
Mustang_Cr_S002	1.82	70.64	Mustang_Cr_S003	1.39	72.58
Mustang_Cr_S004	1.78	72.12	Mustang_Cr_S005	2.94	71.46
Mustang_Cr_S006	2.01	80.54	Mustang_Cr_S007	1.37	65.64
Mustang_Cr_S008	2.68	75.3	Mustang_Cr_S009	5.42	77.35
Mustang_Cr_S010	6.28	78.04	Mustang_Cr_S011	5.94	80.55
Mustang_Cr_S012	2.96	88.17	Mustang_Cr_S013	1.37	84.94
Mustang_Cr_S014	1.72	68.17	Mustang_Cr_S015	3.23	75.78
Mustang_Cr_S016	1.89	76.41	Mustang_Cr_S017	4.64	79.96
Patterson_Br_S001	2.06	60.78	Patton_Br_S001	2.51	41.8
Patton_Br_S002	2.28	36.74	Pogue_Br_S001	5.41	65.96
Rankin_Br_S001	3.06	52.76	Rankin_Br_S002	2.91	63.64
Rock_Cr_S001	7.46	82.7	Rock_Cr_S002	9.64	82.96
Rock_Cr_S003	6.65	81.43	Rock_Cr_S004	6.77	82.41
Rock_Cr_S005	12.31	83.96	Rock_Cr_S006	2.33	85.1

Subbasin Name	Existing Percent Impervious (2020)	Future Percent Impervious (2070)	Subbasin Name	Existing Percent Impervious (2020)	Future Percent Impervious (2070)
Rock_Cr_S007	6.02	82.37	Rock_Cr_S008	5.86	76.92
Rock_Cr_S009	4.98	81.25	Rock_Cr_S010	4.22	82.05
Rock_Cr_S011	8.7	83.49	Rock_Cr_S012	3.76	82.85
Rock_Cr_S013	5.3	82.7	Rock_Cr_S014	5.57	81.3
Rock_Cr_S015	4.04	82.28	Rock_Cr_S016	1.37	79.56
Rock_Cr_S017	3.16	72.55	Rock_Cr_S018	8.01	81.01
Rock_Cr_S019	8.77	86.82	Rock_Cr_S020	5.77	78.58
Rock_Cr_S021	3.69	82.5	Rock_Cr_S022	7.58	84.41
Rock_Cr_S023	1.38	87.12	Rock_Cr_S024	2.14	88.2
Rock_Cr_S025	3.66	81.81	Rock_Cr_S026	11.61	78.78
Squaw_Cr_S001	2.29	79.46	Squaw_Cr_S002	5.55	81.13
Squaw_Cr_S003	11.54	78.63	Strickland_Br_S001	2.13	43.1
Strickland_Br_S002	1.55	36.26	Strickland_Br_S003	3.22	28.85
S_Bear_Cr_S001	1.58	12.98	S_Bear_Cr_S002	1.59	30.99
S_Bear_Cr_S003	10.21	74.36	S_Bear_Cr_S004	6	28.45
S_Bear_Cr_S005	1.3	31.57	S_Bear_Cr_S006	1.23	5.8
S_Bear_Cr_S007	2.78	22.61	S_Bear_Cr_S008	3.55	79.56
S_Bear_Cr_S009	12.27	75.05	S_Bear_Cr_S010	6.78	82.52
S_Bear_Cr_S011	2.55	71.47	S_Bear_Cr_S012	2.9	68.73
S_Bear_Cr_S013	5.75	74.72	Town_Cr_S001	2.96	60.11
Town_Cr_S002	4.51	69.48	Town_Cr_S003	25.28	81.9
Town_Cr_S004	32.54	80.19	Town_Cr_S005	44.29	82.23
Town_Cr_S006	37.62	78.61	Town_Cr_S007	37.53	83.38
Town_Cr_S008	39.15	82.44	Town_Cr_S009	28.34	79.31
Town_Cr_S010	10.24	78.89	Town_Cr_S011	8.73	78.68
Town_Cr_S012	10.48	79.82	Town_Cr_S013	6.14	78.49
Town_Cr_S014	4.44	78.42	Town_Cr_S015	12.04	81.99
Town_Cr_S016	10.08	80.23	Town_Cr_S017	4.55	57.95
Turkey_Cr_S001	5.53	79.65	Turkey_Cr_S002	1.64	80.73
Turkey_Cr_S003	1.96	80.29	Underwood_Br_S001	16.01	82.56
Underwood_Br_S002	12.54	80.56	Willow_Cr_S001	3.65	49.79
Willow_Cr_S002	3.87	50.62	Willow_Cr_S003	2.38	50.43
Willow_Cr_S004	2.71	45	Willow_Cr_S005	3.41	55.29
Willow_Cr_S006	1.49	29.44	Willow_Cr_S007	3.06	71.67
Willow_Cr_S008	4.41	61.39	Willow_Cr_S009	6.28	56.52
Willow_Cr_S010	4.86	73.33	Willow_Cr_S011	2.55	64.08
Willow_Cr_S012	3.51	69.48	Willow_Cr_S013	5.2	68.37
Willow_Cr_S014	13.04	81	Willow_Cr_S015	4.93	68.53
Willow_Cr_S016	14.43	80.27	Willow_Cr_S017	16.42	84.12
Willow_Cr_S018	10.27	75.9			

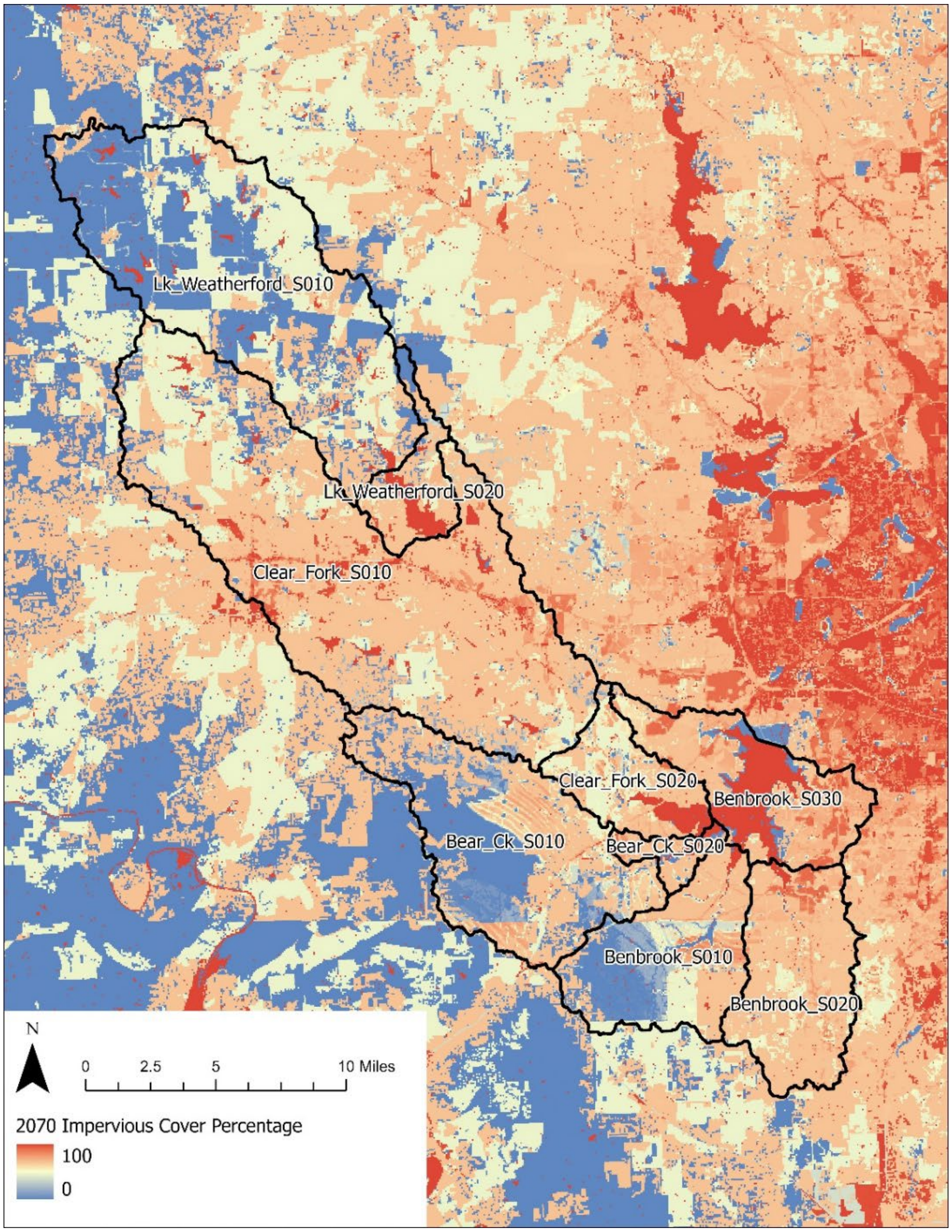

Figure 5-2. Map of Future 2070 Percent Imperviousness

5.2.2 *Future Conditions 2070 Lag Times*

Estimates of future conditions Lag Times are anticipated to be reduced due to urbanization, where future imperiousness will increase. Future Lag Times are estimated by utilizing a reduction that can be obtained from a Lag Time reduction ratio table, which relates the urbanization percentage to a ratio of lag time over 0% urban lag time. The reduction rations were based on percent of urbanization increase, which were developed from the Fort Worth District urban studies (Nelson, 1979) (Rodman, 1977) (USACE, 1989).

Table 5-4. Future Conditions Snyder's Lag Times

Subbasin Name	2020 Lag Time (hr)	2070 Lag Time (hr)	Peaking Coefficient	Subbasin Name	2020 Lag Time (hr)	2070 Lag Time (hr)	Peaking Coefficient
Bear_Cr_S001	1.3	0.77	0.71	Bear_Cr_S002	1.38	0.76	0.71
Bear_Cr_S003	0.74	0.45	0.71	Bear_Cr_S004	1.02	0.56	0.71
Bear_Cr_S005	1.26	0.66	0.71	Bear_Cr_S006	1.04	0.53	0.71
Bear_Cr_S007	0.79	0.47	0.71	Bear_Cr_S008	1.06	0.61	0.71
Bear_Cr_S009	0.59	0.39	0.76	Bear_Cr_S010	0.43	0.27	0.76
Beeman_Br_S001	2.34	1.33	0.6	Belknap_Br_S001	1.71	1.02	0.6
Belknap_Br_S002	0.95	0.57	0.6	Benbrook_S001	1.2	1.07	0.76
Benbrook_S002	0.59	0.49	0.76	Benbrook_S003	0.73	0.59	0.76
Benbrook_S004	0.63	0.55	0.76	Benbrook_S005	2.4	1.92	0.76
Brown_Br_S001	0.89	0.6	0.59	Burgess_Cr_S001	1.87	0.91	0.6
Burgess_Cr_S002	1.55	0.77	0.6	Burgess_Cr_S003	1.28	0.62	0.6
Burgess_Cr_S004	0.67	0.32	0.6	Burgess_Cr_S005	1.78	0.87	0.6
Burgess_Cr_S006	0.77	0.38	0.6	Burgess_Cr_S007	0.96	0.5	0.6
Burgess_Cr_S008	1.42	0.72	0.6	Carter_Cr_S001	1.38	0.93	0.59
Carter_Cr_S002	0.83	0.66	0.59	Clear_Fork_Tr_Rv_S001	1.63	1.12	0.59
Clear_Fork_Tr_Rv_S002	1.72	1.39	0.59	Clear_Fork_Tr_Rv_S003	0.9	0.69	0.59
Clear_Fork_Tr_Rv_S004	1.02	0.8	0.59	Clear_Fork_Tr_Rv_S005	1	0.81	0.59
Clear_Fork_Tr_Rv_S006	1.24	0.99	0.59	Clear_Fork_Tr_Rv_S007	1.45	1.15	0.59
Clear_Fork_Tr_Rv_S008	1.13	0.73	0.59	Clear_Fork_Tr_Rv_S009	1.76	1.29	0.59
Clear_Fork_Tr_Rv_S010	1.39	1.08	0.59	Clear_Fork_Tr_Rv_S011	0.67	0.5	0.59
Clear_Fork_Tr_Rv_S012	0.76	0.55	0.59	Clear_Fork_Tr_Rv_S013	1.04	0.71	0.59
Clear_Fork_Tr_Rv_S014	1.04	0.69	0.59	Clear_Fork_Tr_Rv_S015	0.82	0.57	0.59
Clear_Fork_Tr_Rv_S016	0.3	0.24	0.59	Clear_Fork_Tr_Rv_S017	1.69	1.21	0.59
Clear_Fork_Tr_Rv_S018	1.03	0.75	0.59	Clear_Fork_Tr_Rv_S019	1.49	1.1	0.59
Clear_Fork_Tr_Rv_S020	0.89	0.67	0.59	Clear_Fork_Tr_Rv_S021	0.94	0.66	0.59
Clear_Fork_Tr_Rv_S022	1.58	1.09	0.59	Clear_Fork_Tr_Rv_S023	1.06	0.68	0.59
Clear_Fork_Tr_Rv_S024	0.88	0.54	0.59	Clear_Fork_Tr_Rv_S025	2.08	1.36	0.59
Clear_Fork_Tr_Rv_S026	1.32	0.9	0.59	Clear_Fork_Tr_Rv_S027	0.6	0.35	0.59
Clear_Fork_Tr_Rv_S028	1.04	0.7	0.59	Clear_Fork_Tr_Rv_S029	1.13	0.72	0.59
Clear_Fork_Tr_Rv_S030	1.73	1.14	0.59	Clear_Fork_Tr_Rv_S031	2.22	1.35	0.59
Clear_Fork_Tr_Rv_S032	1.22	0.77	0.61	Clear_Fork_Tr_Rv_S033	2.49	1.3	0.6
Clear_Fork_Tr_Rv_S034	0.8	0.42	0.6	Clear_Fork_Tr_Rv_S035	1.8	0.92	0.6
Clear_Fork_Tr_Rv_S036	1.77	0.92	0.6	Clear_Fork_Tr_Rv_S037	1.22	0.62	0.6
Clear_Fork_Tr_Rv_S038	3.04	1.53	0.6	Clear_Fork_Tr_Rv_S039	1.58	0.81	0.6
Clear_Fork_Tr_Rv_S040	1.69	0.89	0.6	Clear_Fork_Tr_Rv_S041	1.43	0.72	0.6
Clear_Fork_Tr_Rv_S042	1.68	0.84	0.6	Clear_Fork_Tr_Rv_S043	0.48	0.27	0.6
Clear_Fork_Tr_Rv_S044	1	0.57	0.6	Clear_Fork_Tr_Rv_S045	1.35	0.69	0.6
Clear_Fork_Tr_Rv_S046	0.91	0.47	0.6	Clear_Fork_Tr_Rv_S047	1.95	1.03	0.6
Clear_Fork_Tr_Rv_S048	1.28	0.85	0.64	Clear_Fork_Tr_Rv_S049	1.76	1.17	0.64
Clear_Fork_Tr_Rv_S050	1.43	0.89	0.64	Cottonwood_Cr_S001	1.36	1.02	0.59

Subbasin Name	2020 Lag Time (hr)	2070 Lag Time (hr)	Peaking Coefficient	Subbasin Name	2020 Lag Time (hr)	2070 Lag Time (hr)	Peaking Coefficient
Cottonwood_Cr_S002	1.08	0.89	0.59	Dickeys_Br_S001	0.88	0.46	0.71
Dickeys_Br_S002	0.86	0.48	0.71	Dickeys_Br_S003	0.72	0.4	0.71
Dobbs_Br_S001	1.26	0.88	0.59	Dobbs_Br_S002	0.9	0.57	0.59
Dutch_Br_S001	0.86	0.71	0.76	Dutch_Br_S002	0.9	0.7	0.76
Dutch_Br_S003	1.42	1.23	0.76	Dutch_Br_S004	0.68	0.58	0.76
Gourdneck_Cr_S001	1.92	1.46	0.59	Gourdneck_Cr_S002	1.15	0.91	0.59
Gourdneck_Cr_S003	0.64	0.52	0.59	Gourdneck_Cr_S004	0.48	0.38	0.59
Gourdneck_Cr_S005	0.82	0.63	0.59	Gourdneck_Cr_S006	0.91	0.69	0.59
Gourdneck_Cr_S007	0.47	0.32	0.59	Gourdneck_Cr_S008	1.44	1.09	0.59
Gourdneck_Cr_S009	0.83	0.56	0.59	Gourdneck_Cr_S010	1	0.77	0.59
Gourdneck_Cr_S011	1.45	1	0.59	Gourdneck_Cr_S012	0.68	0.56	0.59
Gourdneck_Cr_S013	1.03	0.73	0.59	Gourdneck_Cr_S014	0.8	0.61	0.59
Gourdneck_Cr_S015	0.58	0.43	0.59	Gourdneck_Cr_S016	1	0.62	0.59
Gourdneck_Cr_S017	0.32	0.22	0.59	Gourdneck_Cr_S018	0.88	0.7	0.59
Graham_Br_S001	1.77	1.03	0.6	Graham_Br_S002	0.57	0.37	0.6
Green_Br_S001	1.27	0.8	0.59	Green_Br_S002	0.54	0.36	0.59
Hale_Br_S001	1.48	0.76	0.6	Hale_Br_S002	0.64	0.33	0.6
Hays_Br_S001	1.67	1.29	0.61	Hays_Br_S002	0.5	0.35	0.61
Heiffel_Br_S001	1.47	0.74	0.6	Holder_Br_S001	1.21	0.64	0.6
Holder_Br_S002	0.63	0.32	0.6	Johnson_Br_S001	1.41	0.75	0.6
McKnight_Br_S001	1.24	0.86	0.59	Mustang_Cr_S001	0.72	0.52	0.78
Mustang_Cr_S002	0.87	0.63	0.78	Mustang_Cr_S003	0.61	0.43	0.78
Mustang_Cr_S004	0.85	0.6	0.78	Mustang_Cr_S005	0.73	0.53	0.78
Mustang_Cr_S006	0.51	0.34	0.78	Mustang_Cr_S007	0.72	0.53	0.78
Mustang_Cr_S008	0.84	0.58	0.78	Mustang_Cr_S009	0.39	0.27	0.78
Mustang_Cr_S010	0.82	0.57	0.78	Mustang_Cr_S011	0.47	0.31	0.78
Mustang_Cr_S012	0.46	0.29	0.78	Mustang_Cr_S013	0.58	0.37	0.78
Mustang_Cr_S014	0.25	0.18	0.78	Mustang_Cr_S015	0.75	0.52	0.78
Mustang_Cr_S016	0.78	0.54	0.78	Mustang_Cr_S017	0.77	0.53	0.78
Patterson_Br_S001	1.71	0.96	0.6	Patton_Br_S001	1.12	0.76	0.59
Patton_Br_S002	0.77	0.54	0.59	Pogue_Br_S001	2.03	1.12	0.6
Rankin_Br_S001	1.08	0.69	0.59	Rankin_Br_S002	0.58	0.35	0.59
Rock_Cr_S001	0.99	0.71	0.58	Rock_Cr_S002	0.74	0.53	0.58
Rock_Cr_S003	0.94	0.67	0.58	Rock_Cr_S004	0.68	0.48	0.58
Rock_Cr_S005	0.41	0.3	0.58	Rock_Cr_S006	0.58	0.4	0.58
Rock_Cr_S007	0.49	0.34	0.58	Rock_Cr_S008	0.65	0.48	0.58
Rock_Cr_S009	0.37	0.26	0.58	Rock_Cr_S010	0.69	0.49	0.58
Rock_Cr_S011	0.42	0.3	0.58	Rock_Cr_S012	0.42	0.3	0.58
Rock_Cr_S013	0.77	0.55	0.58	Rock_Cr_S014	0.31	0.22	0.58

Subbasin Name	2020 Lag Time (hr)	2070 Lag Time (hr)	Peaking Coefficient	Subbasin Name	2020 Lag Time (hr)	2070 Lag Time (hr)	Peaking Coefficient
Rock_Cr_S015	0.56	0.39	0.58	Rock_Cr_S016	0.72	0.51	0.58
Rock_Cr_S017	0.25	0.19	0.58	Rock_Cr_S018	0.86	0.63	0.58
Rock_Cr_S019	0.25	0.17	0.58	Rock_Cr_S020	0.62	0.45	0.58
Rock_Cr_S021	0.26	0.19	0.58	Rock_Cr_S022	0.38	0.27	0.58
Rock_Cr_S023	0.39	0.26	0.58	Rock_Cr_S024	0.29	0.19	0.58
Rock_Cr_S025	0.7	0.49	0.58	Rock_Cr_S026	1.01	0.73	0.58
Squaw_Cr_S001	2.47	1.22	0.6	Squaw_Cr_S002	1.74	0.87	0.6
Squaw_Cr_S003	0.85	0.44	0.6	Strickland_Br_S001	1.21	0.82	0.59
Strickland_Br_S002	0.48	0.33	0.59	Strickland_Br_S003	0.44	0.33	0.59
S_Bear_Cr_S001	1.22	0.97	0.71	S_Bear_Cr_S002	0.98	0.7	0.71
S_Bear_Cr_S003	1.01	0.56	0.71	S_Bear_Cr_S004	0.4	0.29	0.71
S_Bear_Cr_S005	0.91	0.65	0.71	S_Bear_Cr_S006	0.5	0.41	0.71
S_Bear_Cr_S007	0.46	0.34	0.71	S_Bear_Cr_S008	1.02	0.55	0.71
S_Bear_Cr_S009	0.4	0.23	0.71	S_Bear_Cr_S010	0.67	0.36	0.71
S_Bear_Cr_S011	1.02	0.58	0.71	S_Bear_Cr_S012	0.77	0.44	0.71
S_Bear_Cr_S013	0.7	0.39	0.71	Town_Cr_S001	3	1.7	0.6
Town_Cr_S002	1.61	0.87	0.6	Town_Cr_S003	1	0.54	0.6
Town_Cr_S004	1.04	0.6	0.6	Town_Cr_S005	1.15	0.69	0.6
Town_Cr_S006	1.54	0.91	0.6	Town_Cr_S007	1.77	1.02	0.6
Town_Cr_S008	1.7	1	0.6	Town_Cr_S009	1.03	0.58	0.6
Town_Cr_S010	2.77	1.42	0.6	Town_Cr_S011	4.43	2.27	0.6
Town_Cr_S012	1.03	0.52	0.6	Town_Cr_S013	3.06	1.56	0.6
Town_Cr_S014	1.32	0.67	0.6	Town_Cr_S015	1.06	0.54	0.6
Town_Cr_S016	1.24	0.63	0.6	Town_Cr_S017	2.23	1.28	0.6
Turkey_Cr_S001	2	1	0.6	Turkey_Cr_S002	1.5	0.73	0.6
Turkey_Cr_S003	1.6	0.78	0.6	Underwood_Br_S001	1.47	0.75	0.6
Underwood_Br_S002	1.02	0.52	0.6	Willow_Cr_S001	2.88	1.74	0.6
Willow_Cr_S002	0.91	0.54	0.6	Willow_Cr_S003	2.03	1.21	0.6
Willow_Cr_S004	1.65	1.02	0.6	Willow_Cr_S005	1.56	0.91	0.6
Willow_Cr_S006	0.44	0.29	0.6	Willow_Cr_S007	1.82	0.95	0.6
Willow_Cr_S008	1.81	1.02	0.6	Willow_Cr_S009	0.5	0.29	0.6
Willow_Cr_S010	1.28	0.67	0.6	Willow_Cr_S011	0.74	0.41	0.6
Willow_Cr_S012	0.9	0.48	0.6	Willow_Cr_S013	1.5	0.81	0.6
Willow_Cr_S014	1.41	0.72	0.6	Willow_Cr_S015	2.46	1.32	0.6
Willow_Cr_S016	1.52	0.79	0.6	Willow_Cr_S017	1.7	0.87	0.6
Willow_Cr_S018	0.93	0.49	0.6				

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

Future urbanization is also expected to reduce the flood storage capacity (also known as valley storage) of the stream. In the HEC-HMS model, this is represented through a reduction in the routing storage values in the Modified Puls storage-discharge curves. For this purpose, effective FEMA FIS floodway models in the 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. For UCFT watershed, there was no continuation of FEMA Floodway data. Therefore, storage-discharge curves from the neighboring Village Creek watershed were utilized to develop the future routing curves.

Figures 5-3 to 5-5 show the Percent Difference curves that were calculated from the regulatory floodway models on the Village Creek as well as the average percent difference curves that were applied to the other stream reaches of varying drainage areas. Table 5-5 shows the reaches with the updated future conditions storage-discharge curves.

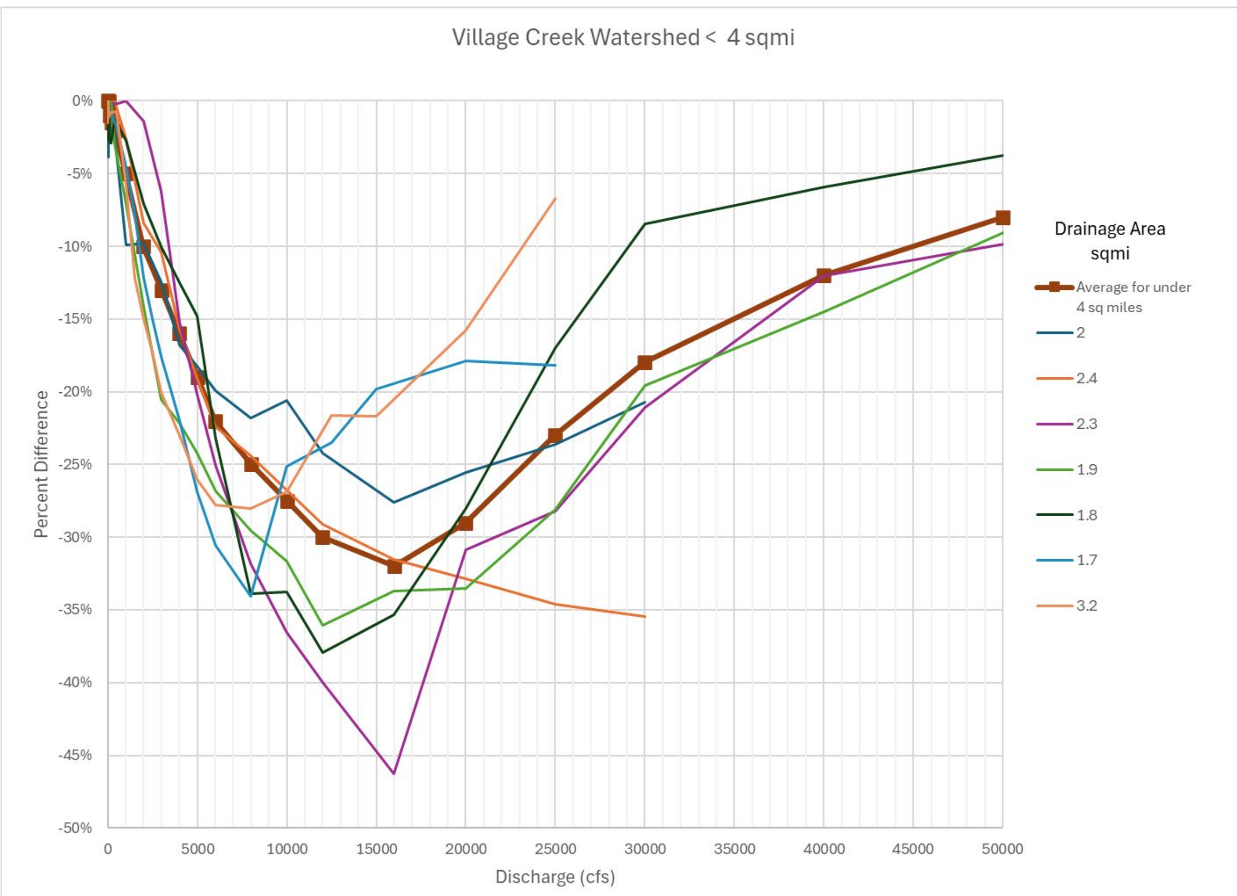

Figure 5-3. Percent Reduction Curves for Future Conditions Valley Storage for Stream Reaches with less than 4 square miles of Drainage Area

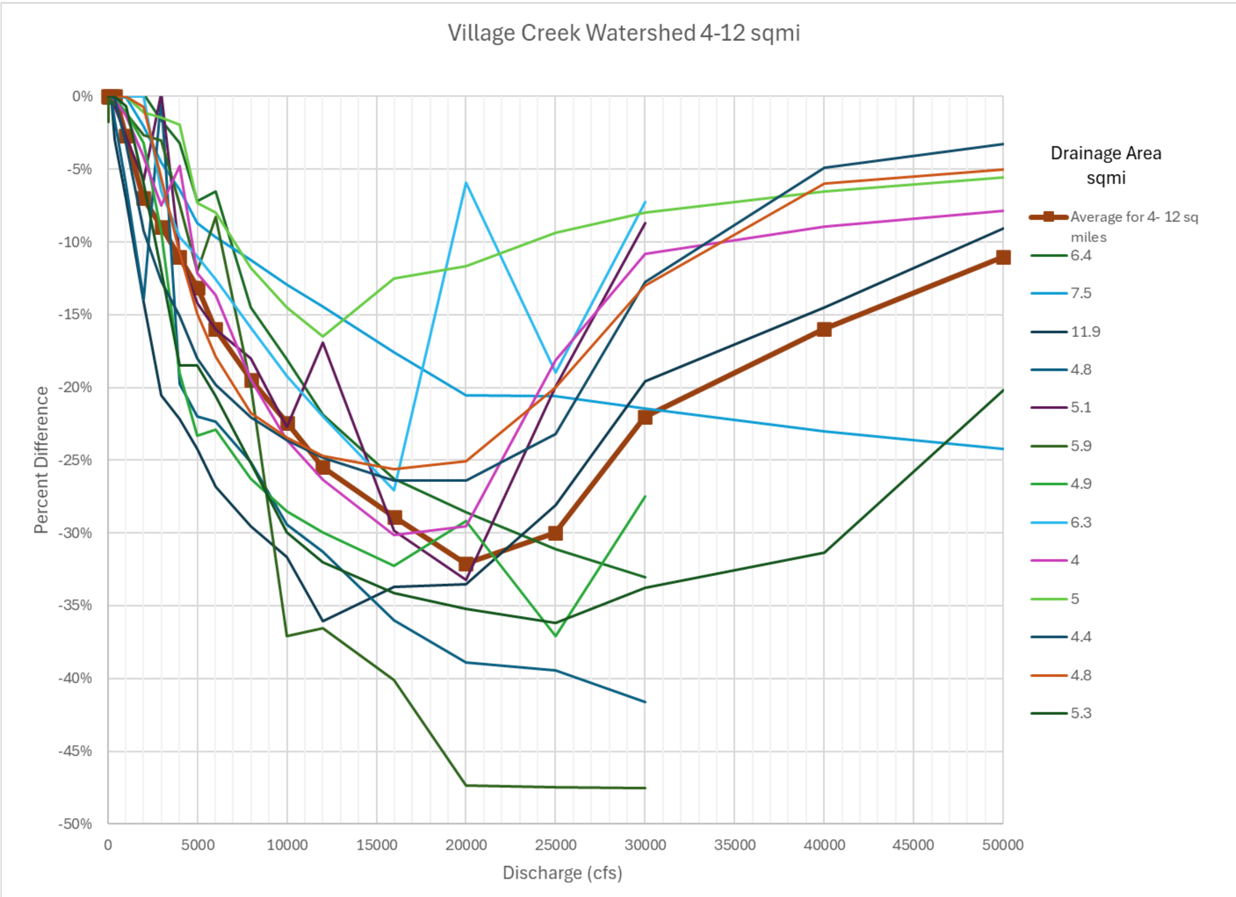

Figure 5-4. Percent Reduction Curves for Future Conditions Valley Storage for Stream Reaches with 4-12 square miles of Drainage Area

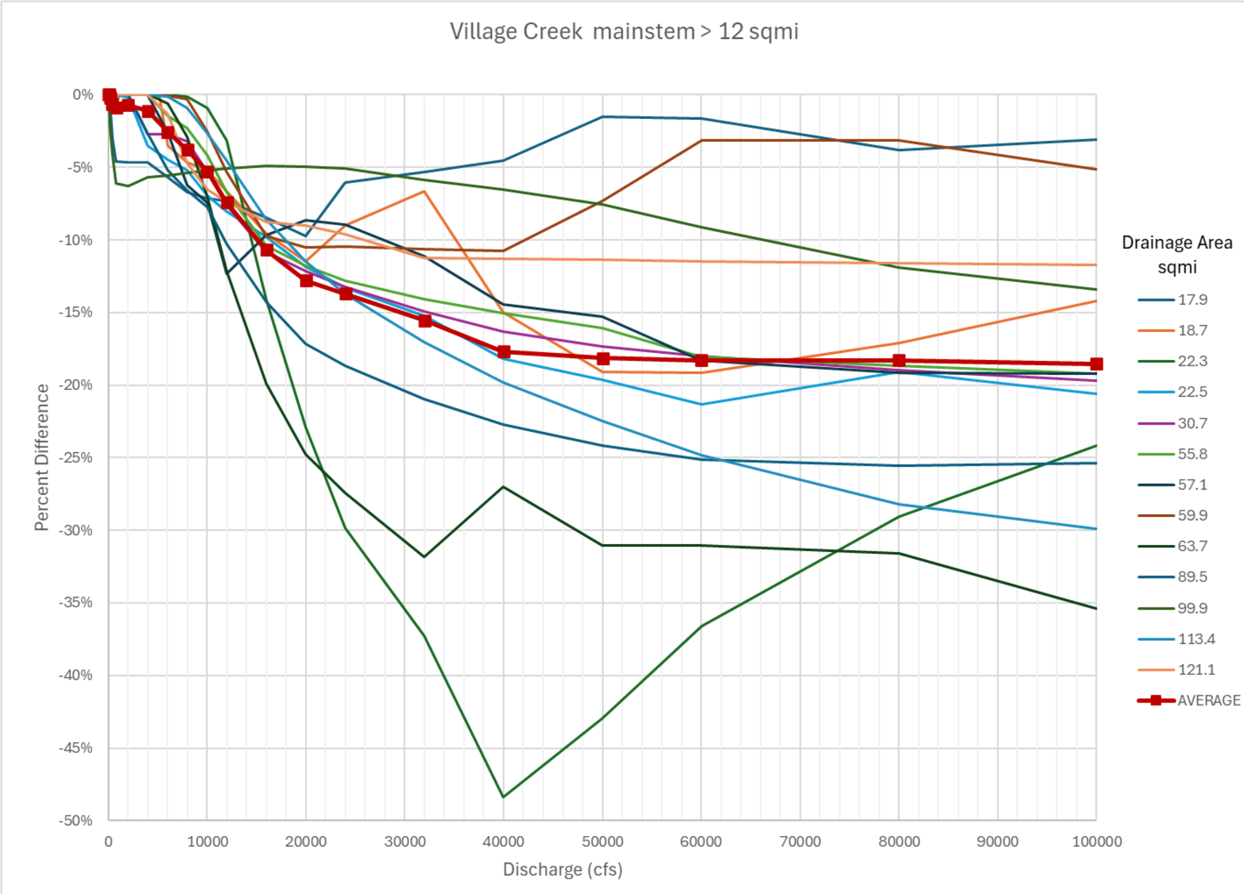

Figure 5-5. Percent Reduction Curves for Future Conditions Valley Storage for Village Creek Reaches with greater than 12 square miles of Drainage Area

Table 5-5. Future Conditions Routing Storage-Discharge Curves.

Reach Name	Storage-Discharge Curve	Subreaches
Bear_Cr_R001	Bear_Cr_R001_Encroach	2
Bear_Cr_R002	Bear_Cr_R002_Encroach	4
Bear_Cr_R003	Bear_Cr_R003_Encroach	4
Bear_Cr_R004	Bear_Cr_R004_Encroach	3
Bear_Cr_R005	Bear_Cr_R005_Encroach	2
Bear_Cr_R006	Bear_Cr_R006_Encroach	1
Bear_Cr_R007	Bear_Cr_R007_Encroach	1
Bear_Cr_R008	Bear_Cr_R008_Encroach	2
Belknap_Br_R001	Belknap_Br_R001_Encroach	1
Burgess_Cr_R001	Burgess_Cr_R001_Encroach	2
Burgess_Cr_R002	Burgess_Cr_R002_Encroach	1
Burgess_Cr_R004	Burgess_Cr_R004_Encroach	1
Burgess_Cr_R005	Burgess_Cr_R005_Encroach	1
Burgess_Cr_R006	Burgess_Cr_R006_Encroach	2
Clear_Fork_Tr_Rv_R003	Clear_Fork_Tr_Rv_R003Encroac	1
Clear_Fork_Tr_Rv_R004	Clear_Fork_Tr_Rv_R004Encroac	2
Clear_Fork_Tr_Rv_R005	Clear_Fork_Tr_Rv_R005Encroac	2
Clear_Fork_Tr_Rv_R007	Clear_Fork_Tr_Rv_R007Encroac	3
Clear_Fork_Tr_Rv_R008	Clear_Fork_Tr_Rv_R008Encroac	1
Clear_Fork_Tr_Rv_R009	Clear_Fork_Tr_Rv_R009Encroac	3
Clear_Fork_Tr_Rv_R010	Clear_Fork_Tr_Rv_R010Encroac	1
Clear_Fork_Tr_Rv_R012	Clear_Fork_Tr_Rv_R012Encroac	4
Clear_Fork_Tr_Rv_R013	Clear_Fork_Tr_Rv_R013Encroac	1
Clear_Fork_Tr_Rv_R014	Clear_Fork_Tr_Rv_R014Encroac	1
Clear_Fork_Tr_Rv_R015	Clear_Fork_Tr_Rv_R015Encroac	1
Clear_Fork_Tr_Rv_R016	Clear_Fork_Tr_Rv_R016Encroac	1
Clear_Fork_Tr_Rv_R017	Clear_Fork_Tr_Rv_R017Encroac	1
Clear_Fork_Tr_Rv_R019	Clear_Fork_Tr_Rv_R019Encroac	2
Clear_Fork_Tr_Rv_R020	Clear_Fork_Tr_Rv_R020Encroac	1
Clear_Fork_Tr_Rv_R021	Clear_Fork_Tr_Rv_R021Encroac	1
Clear_Fork_Tr_Rv_R022	Clear_Fork_Tr_Rv_R021Encroac	2
Clear_Fork_Tr_Rv_R023	Clear_Fork_Tr_Rv_R023Encroac	1
Clear_Fork_Tr_Rv_R024	Clear_Fork_Tr_Rv_R024Encroac	2
Clear_Fork_Tr_Rv_R027	Clear_Fork_Tr_Rv_R027Encroac	1
Clear_Fork_Tr_Rv_R028	Clear_Fork_Tr_Rv_R028Encroac	1
Clear_Fork_Tr_Rv_R029	Clear_Fork_Tr_Rv_R029Encroac	3
Clear_Fork_Tr_Rv_R031	Clear_Fork_Tr_Rv_R031Encroac	1
Clear_Fork_Tr_Rv_R032	Clear_Fork_Tr_Rv_R032Encroac	1
Clear_Fork_Tr_Rv_R033	Clear_Fork_Tr_Rv_R033Encroac	1
Clear_Fork_Tr_Rv_R034	Clear_Fork_Tr_Rv_R034Encroac	1
Clear_Fork_Tr_Rv_R035	Clear_Fork_Tr_Rv_R035Encroac	1
Clear_Fork_Tr_Rv_R036	Clear_Fork_Tr_Rv_R036Encroac	1
Clear_Fork_Tr_Rv_R037	Clear_Fork_Tr_Rv_R037Encroac	3

Reach Name	Storage-Discharge Curve	Subreaches
Clear_Fork_Tr_Rv_R038	Clear_Fork_Tr_Rv_R038Encroac	2
Clear_Fork_Tr_Rv_R039	Clear_Fork_Tr_Rv_R039Encroac	4
Clear_Fork_Tr_Rv_R040	Clear_Fork_Tr_Rv_R040Encroac	4
Clear_Fork_Tr_Rv_R048	Clear_Fork_Tr_Rv_R048Encroac	2
Cottonwood_Cr_R001	Cottonwood_Cr_R001_Encroach	3
Dickeys_Br_R002	Dickeys_Br_R002_Encroach	5
Dobbs_Br_R001	Dobbs_Br_R001_Encroach	3
Gourdneck_Cr_R001	Gourdneck_Cr_R001_Encroach	2
Gourdneck_Cr_R002	Gourdneck_Cr_R002_Encroach	2
Gourdneck_Cr_R003	Gourdneck_Cr_R003_Encroach	3
Gourdneck_Cr_R004	Gourdneck_Cr_R004_Encroach	2
Gourdneck_Cr_R005	Gourdneck_Cr_R005_Encroach	2
Gourdneck_Cr_R006	Gourdneck_Cr_R006_Encroach	1
Gourdneck_Cr_R007	Gourdneck_Cr_R007_Encroach	2
Gourdneck_Cr_R009	Gourdneck_Cr_R009_Encroach	2
Gourdneck_Cr_R010	Gourdneck_Cr_R010_Encroach	2
Gourdneck_Cr_R011	Gourdneck_Cr_R011_Encroach	1
Gourdneck_Cr_R012	Gourdneck_Cr_R012_Encroach	2
Graham_Br_R001	Graham_Br_R001_Encroach	1
Hale_Br_R001	Hale_Br_R001_Encroach	1
Hays_Br_R001	Hays_Br_R001_Encroach	1
Holder_Br_R001	Holder_Br_R001_Encroach	1
Mustang_Cr_R001	Mustang_Cr_R001_Encroach	1
Mustang_Cr_R003	Mustang_Cr_R003_Encroach	1
Mustang_Cr_R004	Mustang_Cr_R004_Encroach	1
Mustang_Cr_R005	Mustang_Cr_R005_Encroach	1
Mustang_Cr_R006	Mustang_Cr_R006_Encroach	1
Mustang_Cr_R007	Mustang_Cr_R007_Encroach	2
Mustang_Cr_R008	Mustang_Cr_R008_Encroach	1
Mustang_Cr_R009	Mustang_Cr_R009_Encroach	2
Mustang_Cr_R010	Mustang_Cr_R010_Encroach	2
Mustang_Cr_R011	Mustang_Cr_R011_Encroach	1
Patton_Br_R001	Patton_Br_R001_Encroach	1
Rock_Cr_R001	Rock_Cr_R001_Encroach	1
Rock_Cr_R002	Rock_Cr_R002_Encroach	2
Rock_Cr_R003	Rock_Cr_R003_Encroach	3
Rock_Cr_R004	Rock_Cr_R004_Encroach	3
Rock_Cr_R005	Rock_Cr_R005_Encroach	1
Rock_Cr_R006	Rock_Cr_R006_Encroach	1
Rock_Cr_R007	Rock_Cr_R007_Encroach	3
Rock_Cr_R008	Rock_Cr_R008_Encroach	1
Rock_Cr_R009	Rock_Cr_R009_Encroach	1
Rock_Cr_R010	Rock_Cr_R010_Encroach	2
Rock_Cr_R011	Rock_Cr_R011_Encroach	3

Reach Name	Storage-Discharge Curve	Subreaches
Rock_Cr_R012	Rock_Cr_R012_Encroach	2
Rock_Cr_R013	Rock_Cr_R013_Encroach	1
Rock_Cr_R014	Rock_Cr_R014_Encroach	1
Rock_Cr_R015	Rock_Cr_R015_Encroach	2
Rock_Cr_R016	Rock_Cr_R016_Encroach	1
Squaw_Cr_R001	Squaw_Cr_R001_Encroach	1
Squaw_Cr_R002	Squaw_Cr_R002_Encroach	1
Strickland_Br_R001	Strickland_Br_R001_Encroach	1
Strickland_Br_R002	Strickland_Br_R002_Encroach	1
S_Bear_Cr_R001	S_Bear_Cr_R001_Encroach	1
S_Bear_Cr_R002	S_Bear_Cr_R002_Encroach	2
S_Bear_Cr_R003	S_Bear_Cr_R003_Encroach	2
S_Bear_Cr_R004	S_Bear_Cr_R004_Encroach	1
S_Bear_Cr_R005	S_Bear_Cr_R005_Encroach	1
S_Bear_Cr_R006	S_Bear_Cr_R006_Encroach	1
S_Bear_Cr_R007	S_Bear_Cr_R007_Encroach	2
S_Bear_Cr_R008	S_Bear_Cr_R008_Encroach	1
S_Bear_Cr_R009	S_Bear_Cr_R009_Encroach	1
Town_Cr_R001	Town_Cr_R001_Encroach	2
Town_Cr_R002	Town_Cr_R002_Encroach	1
Town_Cr_R003	Town_Cr_R003_Encroach	3
Town_Cr_R004	Town_Cr_R004_Encroach	1
Town_Cr_R005	Town_Cr_R005_Encroach	1
Town_Cr_R006	Town_Cr_R006_Encroach	1
Town_Cr_R007	Town_Cr_R007_Encroach	5
Town_Cr_R008	Town_Cr_R008_Encroach	1
Town_Cr_R009	Town_Cr_R009_Encroach	1
Town_Cr_R010	Town_Cr_R010_Encroach	1
Town_Cr_R011	Town_Cr_R011_Encroach	5
Town_Cr_R012	Town_Cr_R012_Encroach	1
Turkey_Cr_R002	Turkey_Cr_R002_Encroach	1
Willow_Cr_R001	Willow_Cr_R001_Encroach	2
Willow_Cr_R002	Willow_Cr_R002_Encroach	1
Willow_Cr_R003	Willow_Cr_R003_Encroach	2
Willow_Cr_R004	Willow_Cr_R004_Encroach	2
Willow_Cr_R005	Willow_Cr_R005_Encroach	1
Willow_Cr_R007	Willow_Cr_R007_Encroach	1
Willow_Cr_R008	Willow_Cr_R008_Encroach	3
Willow_Cr_R009	Willow_Cr_R009_Encroach	3
Willow_Cr_R010	Willow_Cr_R010_Encroach	1
Willow_Cr_R012	Willow_Cr_R012_Encroach	2
Willow_Cr_R013	Willow_Cr_R013_Encroach	1
Willow_Cr_R014	Willow_Cr_R014_Encroach	1
Willow_Cr_R015	Willow_Cr_R015_Encroach	1

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 were applied to the corresponding UCFT 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 illustrates 2020 existing conditions discharge frequency peaks for the UCFT Watershed.

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

Frequency and Peak Discharge (cfs)

HEC-HMS Element Name	DA (sq mi)	2-yr	10-yr	50-yr	100-yr	500-yr
Bear_Cr_J001	6.9	1663.9	5793.9	8528.2	9780.1	12561.4
Bear_Cr_J002	9.8	1957.8	7349.3	11058.4	12950.5	16711.2
Bear_Cr_J003	14.0	2898.2	10121.8	15007.8	17182.5	22469.3
Bear_Cr_J004	18.4	3781.3	12737.8	18686.4	21585.9	28211.0
Bear_Cr_J005	22.0	4183.8	14402.2	21170.6	24531.9	32126.9
Bear_Cr_J006_abv_S_Bear_Cr	23.2	4138.6	14427.5	21453.9	24979.9	32840.0
Bear_Cr_J006_blw	55.0	9879.4	35841.1	54888.7	64137.2	84769.9
Bear_Cr_J007	58.9	8800.8	32870.4	53010.4	62438.0	85147.8
Bear_Cr_J008	62.7	7615.8	26982.4	44707.9	53192.4	75380.0
Bear_Cr_J010_abv_Benbrook	64.1	5522.6	23445.5	40780.5	49999.1	68742.6
Beeman_Br_J001	2.8	0.5	1.9	182.2	649.6	1547.9
Belknap_Br_J001	2.7	2.0	6.9	156.6	733.7	1918.6
Belknap_Br_J002	4.4	249.5	902.3	1749.0	2015.5	2706.2
Benbrook_J001	4.4	2119.7	4542.4	6418.2	7274.7	9348.0
Benbrook_J002	5.1	2333.8	5094.5	7221.9	8194.5	10545.9
Benbrook_J003	1.0	603.7	1413.0	1980.7	2238.8	2853.5
Benbrook_J004	1.7	1063.9	2475.7	3464.5	3913.7	4983.5
Benbrook_Lake_INFLOW	427.8	19929.5	60476.4	108549.5	133226.8	180424.9

HEC-HMS Element Name	DA (sq mi)	2-yr	10-yr	50-yr	100-yr	500-yr
Benbrook_Lake_OUTFLOW	427.8	0.0	1665.5	9061.5	13738.7	29881.8
Brown_Br_J001	1.4	12.0	34.0	462.0	1029.1	2116.0
Burgess_Cr_J001	3.2	0.7	335.7	1081.9	1697.3	2404.3
Burgess_Cr_J002	1.3	191.1	727.7	1413.9	1628.5	2100.8
Burgess_Cr_J003	5.8	199.2	1363.6	2706.2	3124.4	4623.7
Burgess_Cr_J004	7.4	8.0	44.3	304.3	895.5	2740.8
Burgess_Cr_J005_abv_Heiffel	7.9	116.6	428.1	788.6	942.7	2802.2
Burgess_Cr_J005_blw	9.7	121.0	440.2	849.5	1379.9	3225.3
Burgess_Cr_J006_abv_Hale_Br	10.0	151.0	612.5	1215.4	1416.0	3256.8
Burgess_Cr_J006_blw	12.1	193.9	773.7	1521.6	2473.0	5053.8
Burgess_Cr_J007	13.1	330.8	1234.6	2305.6	2667.2	5230.5
Carter_Cr_J001	2.3	401.1	1114.8	2329.5	2688.4	3474.7
Carter_Cr_J002	2.7	482.2	1349.4	2815.3	3247.6	4196.2
CFTR_J018_abv_Cottonwood_Cr	29.4	1679.0	4216.1	10234.2	13638.4	20956.0
CFTR_J019_abv_Strickland_Br	33.1	1662.0	4246.7	10461.5	14134.4	23347.6
CFTR_J022_abv_Gourdneck_Cr	43.1	1430.1	4721.9	13210.2	17991.4	29363.9
CFTR_J025_abv_Carter_Cr	68.4	2335.3	7529.1	22056.1	28721.5	44325.3
CFTR_J027_abv_McKnight_Br	72.6	2497.6	7831.3	23487.9	30496.7	46769.1
CFTR_J028_abv_Patton_Br	74.5	2496.9	7823.1	23909.1	31408.0	48012.4
CFTR_J029_abv_Dobbs_Br	77.0	2558.0	7926.4	24473.9	32204.4	49151.3
CFTR_J030_abv_Rankin_Br	80.3	2584.8	7949.6	24820.8	32709.3	51042.0
CFTR_J032_abv_Green_Br	87.5	2551.7	7906.9	25848.4	34616.7	54298.2
CFTR_J033_abv_Lk_Weatherford	96.6	2610.5	7699.7	27651.5	37661.3	59150.2
CFTR_J034_abv_Squaw_Cr	114.0	1224.2	3098.7	9478.5	20436.3	44910.6
CFTR_J040_abv_Town_Cr	128.2	1632.6	4201.3	10100.3	20753.0	46483.0
CFTR_J050_abv_Benbrook	262.3	3723.3	11877.9	29933.4	41976.5	81913.2
Clear_Fork_Tr_Rv_J001	2.6	365.1	1055.0	2277.1	2645.8	3441.1
Clear_Fork_Tr_Rv_J002	2.3	332.1	948.3	2029.1	2353.6	3056.2
Clear_Fork_Tr_Rv_J004	5.8	24.8	45.0	401.9	1452.1	3115.2
Clear_Fork_Tr_Rv_J005	1.9	3.2	9.4	138.1	572.2	1470.1
Clear_Fork_Tr_Rv_J006	2.6	156.7	430.6	877.5	1005.8	1668.5
Clear_Fork_Tr_Rv_J008	8.4	163.5	449.2	910.7	1974.8	4734.0
Clear_Fork_Tr_Rv_J009	12.1	827.8	2283.7	4587.3	5273.5	6942.6
Clear_Fork_Tr_Rv_J010	2.2	6.0	17.0	390.3	1000.7	2173.8
Clear_Fork_Tr_Rv_J011	18.5	1311.4	3531.1	7662.1	8925.3	13660.1
Clear_Fork_Tr_Rv_J012	1.9	1.5	4.4	428.6	901.3	1705.4
Clear_Fork_Tr_Rv_J013	21.4	1369.3	3751.2	8208.6	9585.7	15220.7
Clear_Fork_Tr_Rv_J014	1.4	2.4	6.9	396.4	844.4	1646.9
Clear_Fork_Tr_Rv_J015	1.3	2.1	6.0	237.2	669.6	1474.7

HEC-HMS Element Name	DA (sq mi)	2-yr	10-yr	50-yr	100-yr	500-yr
Clear_Fork_Tr_Rv_J016	3.2	144.9	400.8	801.7	1728.3	3647.0
Clear_Fork_Tr_Rv_J017	28.4	1602.0	4096.9	9862.0	13155.8	20299.1
Clear_Fork_Tr_Rv_J018_blw	32.2	1725.7	4295.7	10461.1	14185.1	23336.1
Clear_Fork_Tr_Rv_J019_blw	38.2	1899.1	4734.5	12098.8	16886.1	27528.5
Clear_Fork_Tr_Rv_J020	38.8	1854.8	4788.9	12212.3	17035.9	27821.6
Clear_Fork_Tr_Rv_J021	42.5	1867.2	5131.2	13329.0	18222.7	29714.2
Clear_Fork_Tr_Rv_J022_blw	63.6	2268.4	7299.9	20151.2	26481.5	41229.2
Clear_Fork_Tr_Rv_J023	1.2	0.6	13.1	798.6	1126.4	1966.0
Clear_Fork_Tr_Rv_J024	64.8	2096.2	7013.3	20282.7	26598.9	41591.7
Clear_Fork_Tr_Rv_J025_blw	71.1	2476.7	7788.3	23129.6	30028.6	46019.8
Clear_Fork_Tr_Rv_J026	72.4	2501.0	7854.5	23520.4	30518.9	46747.0
Clear_Fork_Tr_Rv_J027_blw	74.5	2499.3	7836.4	23947.0	31440.0	48031.6
Clear_Fork_Tr_Rv_J028_blw	77.0	2558.0	7926.4	24473.9	32204.4	49151.3
Clear_Fork_Tr_Rv_J029_blw	79.0	2567.9	7942.9	24572.6	32344.8	50472.0
Clear_Fork_Tr_Rv_J030_blw	82.4	2589.8	7963.9	25506.3	33701.7	52451.5
Clear_Fork_Tr_Rv_J031	2.6	248.1	686.5	1424.2	1953.1	3870.2
Clear_Fork_Tr_Rv_J032	85.0	2634.4	8043.8	26201.3	34658.2	53903.4
Clear_Fork_Tr_Rv_J032_blw	89.8	2563.6	7942.7	26387.7	35430.5	55493.1
Clear_Fork_Tr_Rv_J035_blw	121.4	1282.8	3338.7	9955.5	21003.4	45633.3
Clear_Fork_Tr_Rv_J036	121.4	1282.8	3338.7	9955.5	21003.4	45633.3
Clear_Fork_Tr_Rv_J037	121.7	1285.0	3343.9	9924.8	20869.9	45499.4
Clear_Fork_Tr_Rv_J038	2.2	410.0	1087.1	1969.7	2272.5	2939.9
Clear_Fork_Tr_Rv_J039	2.9	513.7	1421.1	2610.1	3011.1	3895.2
Clear_Fork_Tr_Rv_J040_blw	224.7	4991.4	15057.4	35052.2	44120.6	84676.6
Clear_Fork_Tr_Rv_J041	228.1	4603.5	15067.3	35412.3	44629.6	84789.7
Clear_Fork_Tr_Rv_J042	230.6	4343.9	14887.1	35348.4	44534.8	84260.3
Clear_Fork_Tr_Rv_J043	1.3	205.4	702.3	1345.2	1551.5	2004.6
Clear_Fork_Tr_Rv_J044	2.8	368.7	1318.6	2577.3	2982.9	3864.9
Clear_Fork_Tr_Rv_J045	234.4	4345.6	14980.4	35677.2	45024.2	84510.3
Clear_Fork_Tr_Rv_J046_blw	241.2	4435.3	15434.3	37022.7	46900.3	85531.0
Clear_Fork_Tr_Rv_J046_Turkey	234.9	4327.7	14979.3	35677.0	45011.9	84443.2
Clear_Fork_Tr_Rv_J047	243.4	4421.7	15466.0	37248.8	47209.7	85587.5
Clear_Fork_Tr_Rv_J048	249.8	4228.3	15573.0	37403.4	47309.4	85636.5
Clear_Fork_Tr_Rv_J049	257.8	4181.2	15281.8	36907.7	46723.5	84525.6
Clear_Fork_Tr_Rv_J050_blw	326.4	6284.0	24773.8	43234.5	53195.8	89378.6
Cottonwood_Cr_J001	2.2	0.6	1.8	373.8	1024.7	2019.2
Cottonwood_Cr_J002	2.8	108.6	303.9	627.5	1172.6	2384.6
Dickeys_Br_J001	3.5	1206.8	3996.2	5743.9	6534.0	8325.1
Dickeys_Br_J002	5.4	1868.7	6105.6	8768.6	9972.3	12703.1

HEC-HMS Element Name	DA (sq mi)	2-yr	10-yr	50-yr	100-yr	500-yr
Dickeys_Br_J004	6.6	2061.6	6904.1	10114.5	11578.6	14983.3
Dobbs_Br_J001	1.6	2.2	6.6	44.3	298.1	1182.3
Dobbs_Br_J002	2.0	107.9	296.9	599.8	686.4	1380.3
Dutch_Br_J001	1.5	811.2	1899.7	2675.5	3029.0	3873.2
Dutch_Br_J002	2.5	1293.4	3073.2	4335.0	4910.5	6282.8
Dutch_Br_J003	6.6	2518.4	6228.3	8934.2	10178.4	13138.6
Dutch_Br_J004	7.1	2780.1	6844.4	9805.8	11166.6	14403.6
Gourdneck_Cr_J001	4.1	2.3	6.8	97.3	761.0	2401.6
Gourdneck_Cr_J002	1.6	1.4	4.1	98.3	391.5	1026.8
Gourdneck_Cr_J003	6.3	191.4	524.9	1019.2	1159.1	3406.5
Gourdneck_Cr_J004	1.0	0.6	1.9	50.0	336.1	1008.3
Gourdneck_Cr_J005	8.0	354.7	962.8	1954.9	2234.4	3954.7
Gourdneck_Cr_J006	12.1	991.5	2716.3	5669.9	6553.4	8511.1
Gourdneck_Cr_J007	13.4	1170.3	3221.8	6806.0	7901.0	10330.3
Gourdneck_Cr_J008	1.0	6.0	18.1	498.2	875.7	1583.3
Gourdneck_Cr_J009	16.7	1430.8	3921.6	8662.3	10775.7	14847.6
Gourdneck_Cr_J010	1.0	16.8	51.3	339.5	724.8	1499.3
Gourdneck_Cr_J011	18.8	1529.6	4074.4	9307.9	11813.1	17378.6
Gourdneck_Cr_J012	0.8	4.5	12.9	100.2	376.6	941.1
Gourdneck_Cr_J013	19.8	1507.8	4052.5	9300.1	11790.2	18313.4
Gourdneck_Cr_J014	19.8	1507.8	4052.5	9300.1	11790.2	18313.4
Gourdneck_Cr_J015	20.5	1537.5	4130.9	9640.2	12148.0	18900.8
Graham_Br_J001	1.7	9.1	31.6	70.9	524.9	1468.3
Graham_Br_J002	1.9	39.0	142.8	257.8	529.4	1481.9
Green_Br_J001	2.1	10.3	30.5	574.2	1294.5	2678.9
Green_Br_J002	2.3	65.3	176.9	588.8	1338.3	2812.6
Hale_Br_J001	1.8	3.4	12.8	510.9	1045.4	2087.0
Hale_Br_J002	2.1	57.3	212.3	534.3	1086.3	2206.4
Hays_Br_J001	2.8	2.9	8.4	68.3	191.6	853.3
Hays_Br_J002_abv_Weatherford	3.0	137.0	345.2	500.8	567.7	877.7
Heiffel_Br_J001	1.8	27.2	108.6	598.3	1156.2	2231.0
Holder_Br_J001	1.3	7.0	26.3	227.0	611.0	1459.0
Holder_Br_J002	1.5	58.3	205.5	370.2	655.9	1595.0
Johnson_Br_J001	1.2	174.8	630.3	1219.7	1407.3	1818.7
Lake_Weatherford_INFLOW	109.0	4106.4	9434.3	29225.1	40133.6	63559.6
Lake_Weatherford_OUTFLOW	109.0	1182.4	2989.5	9392.3	20975.4	44699.6
McKnight_Br_J001	1.9	2.6	7.3	514.5	1073.9	1945.7
McKnight_Br_J002	1.9	2.6	7.3	514.5	1073.9	1945.7
Mustang_Cr_J001	6.9	4209.3	10342.3	14615.8	16630.0	21490.9

HEC-HMS Element Name	DA (sq mi)	2-yr	10-yr	50-yr	100-yr	500-yr
Mustang_Cr_J002	10.9	5327.3	13887.4	20366.9	23413.8	30918.3
Mustang_Cr_J003	13.0	6467.3	16763.8	24456.3	28077.8	36988.7
Mustang_Cr_J004	14.2	6648.3	17019.8	24898.8	28944.3	38678.6
Mustang_Cr_J005	2.3	1384.5	3408.4	4818.8	5483.8	7088.3
Mustang_Cr_J006	3.2	1856.6	4475.4	6330.4	7241.2	9423.2
Mustang_Cr_J007	17.4	8206.1	20939.8	30530.4	35389.3	47067.7
Mustang_Cr_J008	19.5	8913.1	23011.9	33528.9	38818.1	51764.1
Mustang_Cr_J009	3.1	1728.0	4240.7	6010.7	6847.0	8866.0
Mustang_Cr_J010	1.1	904.1	2058.8	2878.4	3261.5	4188.3
Mustang_Cr_J011	5.3	2899.1	7239.2	10209.0	11755.7	15199.4
Mustang_Cr_J012	26.3	11873.3	30641.0	44515.5	51460.8	68354.8
Mustang_Cr_J013	31.0	11794.1	26855.3	42596.5	52596.7	74391.4
Mustang_Cr_J014_abv_Benbrook	34.1	4673.9	16537.0	26884.8	31862.8	50759.6
Patterson_Br_J001	2.8	0.5	1.9	182.2	649.6	1547.9
Patton_Br_J001	1.7	342.4	951.3	1956.7	2247.1	2890.6
Patton_Br_J002	2.5	537.0	1456.1	2947.1	3361.2	4312.3
Rankin_Br_J001	2.0	3.6	10.3	771.5	1296.8	2514.1
Rankin_Br_J002	2.2	66.0	177.2	804.7	1361.9	2673.7
Rock_Cr_J001	4.6	1900.9	4613.2	6648.1	7622.3	9954.9
Rock_Cr_J002	8.6	3162.9	7413.8	10696.4	12337.8	16311.5
Rock_Cr_J003	2.3	1165.2	2760.5	3935.3	4492.9	5833.8
Rock_Cr_J004	2.6	1299.8	3138.6	4479.8	5114.4	6642.6
Rock_Cr_J005	11.1	4337.1	10151.7	14579.0	16767.0	22085.5
Rock_Cr_J006	2.6	1478.8	3500.0	4971.3	5667.7	7342.1
Rock_Cr_J007	3.9	2000.1	4831.9	7087.1	8189.7	10751.3
Rock_Cr_J008	17.4	6860.4	16428.0	23932.2	27607.6	36526.6
Rock_Cr_J009	2.1	1062.9	2555.9	3649.3	4169.0	5416.4
Rock_Cr_J010	20.9	7397.1	18515.2	27468.9	31828.5	42567.2
Rock_Cr_J011	23.2	7367.0	18718.9	28069.6	32815.3	44457.8
Rock_Cr_J012	26.3	7354.4	19568.8	29541.5	34411.3	47659.5
Rock_Cr_J013	26.7	7329.0	19338.1	29161.1	33416.4	47880.5
Rock_Cr_J014	3.1	1334.5	3212.6	4618.3	5290.0	6899.9
Rock_Cr_J015	3.4	311.3	3115.1	4833.2	5552.1	7282.3
Rock_Cr_J016	1.3	705.7	1659.7	2359.7	2691.4	3489.4
Rock_Cr_J017	1.4	714.6	1346.2	1745.9	1871.0	2304.6
Rock_Cr_J018	5.1	1185.0	3835.1	5945.0	6972.6	9781.0
Rock_Cr_J019	5.5	1298.9	3389.3	5522.7	6418.0	10117.4
Rock_Cr_J020	32.5	6992.1	21606.6	33402.2	38358.0	56678.5
Rock_Cr_J021	34.5	6110.5	19344.8	31697.7	36011.6	42243.8

HEC-HMS Element Name	DA (sq mi)	2-yr	10-yr	50-yr	100-yr	500-yr
Rock_Cr_J022_abv_Benbrook	37.5	6331.1	20224.9	33286.6	37887.4	44515.5
S_Bear_Cr_J001	5.6	1448.3	5036.8	7375.3	8443.5	10826.5
S_Bear_Cr_J002	8.4	2098.7	6860.7	10281.2	11907.3	15533.1
S_Bear_Cr_J003	5.8	1915.5	6053.2	8733.2	9947.5	12695.1
S_Bear_Cr_J004	6.4	1974.2	6279.6	9032.2	10412.3	13342.6
S_Bear_Cr_J005	16.2	4081.4	13270.4	19778.7	22933.8	29990.9
S_Bear_Cr_J006	18.8	4205.0	14243.4	21826.7	25574.5	33695.2
S_Bear_Cr_J007_abv_Dickeys	19.0	4100.5	14152.2	21759.9	25499.0	33708.5
S_Bear_Cr_J007_blw	25.6	5883.5	20086.2	30468.1	35670.4	47192.8
S_Bear_Cr_J008	28.6	6310.6	22060.0	33578.7	39427.5	52385.7
S_Bear_Cr_J009	31.3	5761.2	21982.6	34406.9	40614.3	54397.7
S_Bear_Cr_J010	31.7	5740.8	22078.0	34664.8	40866.9	54787.0
Sink-1	427.8	0.0	1665.5	9061.5	13738.7	29881.8
Squaw_Cr_J001	3.4	277.1	1079.6	2235.1	2624.6	3449.2
Squaw_Cr_J002	7.0	53.6	246.1	446.7	516.4	670.9
Squaw_Cr_J003	7.2	63.5	257.8	467.3	539.6	731.3
Strickland_Br_J001	2.3	6.9	20.2	866.4	1629.6	3183.0
Strickland_Br_J002	2.6	85.3	232.2	860.4	1652.0	3271.0
Strickland_Br_J003	2.8	110.5	312.7	842.2	1646.8	3373.7
Town_Cr_J001	6.8	480.5	1859.4	3908.9	4619.6	6110.7
Town_Cr_J002	10.3	765.4	2750.3	5488.5	6467.3	8918.9
Town_Cr_J003	11.9	987.9	3046.5	6152.8	7173.1	9737.7
Town_Cr_J004	13.4	1338.8	3519.7	6909.1	8116.1	10658.8
Town_Cr_J005	15.3	1841.5	4592.5	8419.7	9822.0	12959.0
Town_Cr_J006	18.4	2368.0	5370.0	10464.8	12323.4	16371.7
Town_Cr_J007	19.2	2334.2	5483.0	10764.0	12712.7	16923.1
Town_Cr_J008	23.2	2606.1	6260.1	12054.0	14630.0	20279.6
Town_Cr_J019_abv_Burgess_Cr	74.2	3602.3	10817.9	25236.2	31545.6	45838.7
Town_Cr_J019_blw	87.3	3677.0	11081.2	26554.6	33832.7	49608.0
Town_Cr_J020	88.0	3649.7	11074.5	26581.4	33877.9	49781.5
Town_Cr_J021	1.6	251.8	904.8	1738.7	2002.8	2584.1
Town_Cr_J022	2.7	134.2	1089.5	2595.9	3057.7	4008.2
Town_Cr_J023	96.4	3777.6	11569.8	27820.3	35407.1	52642.0
Town_Cr_J024	96.5	3781.2	11581.3	27852.0	35450.6	52710.2
Turkey_Cr_J001	3.6	140.6	1192.6	2726.6	3238.3	4143.8
Turkey_Cr_J002	5.4	114.6	1438.0	3899.0	4705.6	6215.7
Turkey_Cr_J003	6.3	128.7	1600.5	4072.3	4842.2	6286.5
Underwood_Br_J001	2.3	416.7	1233.3	2279.8	2624.9	3387.1
Underwood_Br_J002	2.6	470.3	1401.8	2591.7	2982.7	3847.9

HEC-HMS Element Name	DA (sq mi)	2-yr	10-yr	50-yr	100-yr	500-yr
Willlow_Cr_J005	1.9	4.9	15.2	975.5	1535.5	2550.5
Willow_Cr_J001	6.9	2.8	10.4	490.8	1744.7	4063.9
Willow_Cr_J002_abv_Graham_Br	7.5	117.4	421.6	782.1	1780.7	4155.7
Willow_Cr_J002_blw	9.3	149.4	536.0	999.2	2065.4	5003.8
Willow_Cr_J003_abv_BellnapBr	12.3	365.0	1414.3	3041.5	3536.3	5578.5
Willow_Cr_J003_blw	16.7	599.3	2253.3	4620.0	5358.2	7344.4
Willow_Cr_J004_abv_Patterson	18.7	804.4	2379.8	5227.7	6292.8	8433.2
Willow_Cr_J004_blw	21.5	804.5	2380.3	5228.9	6294.4	8986.0
Willow_Cr_J006	23.6	797.5	2395.5	5971.5	7846.6	10812.4
Willow_Cr_J007	1.4	1.9	7.3	159.1	513.7	1242.0
Willow_Cr_J008	27.7	1098.1	3042.9	6909.9	9215.6	14154.1
Willow_Cr_J009	1.3	201.5	717.5	1373.3	1580.3	2037.3
Willow_Cr_J010	29.4	976.4	3236.7	7341.4	9778.3	15128.6
Willow_Cr_J011	31.5	1084.8	3701.0	8165.0	10873.7	16695.5
Willow_Cr_J012	1.4	6.7	37.5	780.9	1182.3	1940.9
Willow_Cr_J013	33.0	1021.1	3665.8	8818.0	11603.0	17766.1
Willow_Cr_J014_abv_Holder_Br	35.3	1131.7	4238.4	10100.1	13042.2	19760.9
Willow_Cr_J014_blw	36.8	1140.4	4271.5	10179.5	13687.1	20842.8
Willow_Cr_J015	39.5	1087.5	4160.6	10758.8	14372.4	21993.5
Willow_Cr_J016	41.5	1098.0	4217.7	11187.6	14868.1	22798.8
Willow_Cr_J017_abv_Underwood	42.0	1091.7	4212.2	11217.1	14926.7	22927.3
Willow_Cr_J017_blw	44.6	1143.7	4409.3	11897.1	15826.5	24276.1
Willow_Cr_J018_abv_Town_Cr	44.6	1143.7	4409.3	11897.1	15826.5	24276.1
Willow_Cr_J018_blw	67.8	3665.1	10268.0	23871.5	30116.8	43418.2

6.3 Frequency Discharge Results for Future 2070 Conditions

Table 6-2 illustrates 2070 future conditions discharge frequency peaks for the UCFT Watershed.

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

Frequency and Peak Discharge (cfs)

HEC-HMS Element Name	2-yr	10-yr	50-yr	100-yr	500-yr
Bear_Cr_J001	4929.1	9149.1	12693.5	14270.4	18008.1
Bear_Cr_J002	6145.9	12355.6	17339.0	19708.2	25125.4
Bear_Cr_J003	8501.3	15286.0	22474.7	26222.7	32862.6
Bear_Cr_J004	9884.6	17849.8	26311.8	30562.3	39814.2
Bear_Cr_J005	10635.8	19600.0	28772.6	33522.3	44161.2
Bear_Cr_J006_abv_S_Bear_Cr	10434.4	19866.8	29252.7	34025.6	44905.5
Bear_Cr_J006_blw	22494.8	48663.6	72793.6	84343.9	111071.7
Bear_Cr_J007	20337.0	46091.4	70901.0	83631.2	112035.1
Bear_Cr_J008	18043.7	38414.0	59307.1	71315.1	111962.4
Bear_Cr_J010_abv_Benbrook	14641.0	35167.9	56180.9	66009.3	95824.2
Beeman_Br_J001	2.0	112.3	803.9	1273.6	2350.3
Belknap_Br_J001	6.4	90.5	794.0	1461.3	2896.4
Belknap_Br_J002	975.6	1849.0	2771.9	3122.5	4006.1
Benbrook_J001	3113.2	5151.2	7068.4	7930.9	10100.6
Benbrook_J002	3460.1	5744.1	7894.0	8861.5	11300.0
Benbrook_J003	1026.2	1702.5	2314.9	2589.1	3266.4
Benbrook_J004	1737.9	2929.3	3986.9	4460.8	5627.7
Benbrook_Lake_INFLOW	46714.6	102389.0	157659.9	181598.9	255971.3
Benbrook_Lake_OUTFLOW	877.5	6913.9	15890.8	22386.4	43855.1
Brown_Br_J001	29.5	55.9	1026.4	1670.0	2879.6
Burgess_Cr_J001	623.6	1130.4	2254.3	2438.5	3280.1
Burgess_Cr_J002	965.8	1666.7	2395.0	2689.1	3388.8
Burgess_Cr_J003	1849.2	3185.2	4599.3	5410.3	7917.4
Burgess_Cr_J004	61.3	339.8	1184.9	2325.3	4414.0
Burgess_Cr_J005_abv_Heiffel	500.2	877.5	1261.4	2412.8	4527.5
Burgess_Cr_J005_blw	552.3	961.0	2108.6	2949.2	5321.2
Burgess_Cr_J006_abv_Hale_Br	719.5	1265.2	2090.8	2960.6	5399.1
Burgess_Cr_J006_blw	902.8	1602.1	3853.8	5292.1	8558.8
Burgess_Cr_J007	1401.8	2269.3	3768.1	5142.1	8282.0
Carter_Cr_J001	955.1	1874.8	3138.3	3559.5	4531.2
Carter_Cr_J002	1101.7	2224.6	3804.1	4316.7	5497.1
CFTR_J018_abv_Cottonwood_Cr	2632.7	5473.3	13588.4	17145.6	25660.6
CFTR_J019_abv_Strickland_Br	2553.7	5534.2	13738.9	18421.3	28811.4
CFTR_J022_abv_Gourdneck_Cr	2746.6	6717.1	17829.2	23397.1	37114.1

HEC-HMS Element Name	2-yr	10-yr	50-yr	100-yr	500-yr
CFTR_J025_abv_Carter_Cr	4615.4	11795.2	29184.4	37210.8	57158.0
CFTR_J027_abv_McKnight_Br	4837.2	12346.6	30830.3	39414.3	60313.4
CFTR_J028_abv_Patton_Br	4837.9	12311.1	31716.2	40592.5	62301.9
CFTR_J029_abv_Dobbs_Br	4932.6	12516.9	32440.9	41604.8	63833.1
CFTR_J030_abv_Rankin_Br	4991.1	12641.4	32899.2	42470.9	66353.8
CFTR_J032_abv_Green_Br	5065.1	12804.0	34931.8	45072.8	70468.7
CFTR_J033_abv_Lk_Weatherford	4945.7	12796.0	38000.0	48950.5	76425.0
CFTR_J034_abv_Squaw_Cr	3208.6	5365.8	17489.6	28861.3	54477.9
CFTR_J040_abv_Town_Cr	4970.5	8138.0	18194.0	29945.7	56309.0
CFTR_J050_abv_Benbrook	15058.8	31300.3	55107.0	68163.0	105625.0
Clear_Fork_Tr_Rv_J001	490.5	1306.8	2679.8	3090.1	3991.5
Clear_Fork_Tr_Rv_J002	778.9	1577.2	2735.0	3114.8	3981.1
Clear_Fork_Tr_Rv_J004	33.1	55.1	726.7	2034.4	3263.0
Clear_Fork_Tr_Rv_J005	4.2	10.9	192.2	657.1	1621.8
Clear_Fork_Tr_Rv_J006	231.4	556.3	1042.0	1185.7	1867.8
Clear_Fork_Tr_Rv_J008	252.5	582.3	1081.0	2628.9	5082.5
Clear_Fork_Tr_Rv_J009	1214.9	2865.7	5362.7	6121.7	7857.9
Clear_Fork_Tr_Rv_J010	16.9	51.0	1090.9	1809.2	2779.4
Clear_Fork_Tr_Rv_J011	2100.9	4638.3	9404.3	11966.9	16242.2
Clear_Fork_Tr_Rv_J012	2.4	5.7	613.9	1129.7	2002.2
Clear_Fork_Tr_Rv_J013	2200.3	4924.9	9927.8	12687.6	18090.1
Clear_Fork_Tr_Rv_J014	6.0	33.7	847.1	1317.2	2242.8
Clear_Fork_Tr_Rv_J015	5.5	26.2	683.2	1120.4	2089.3
Clear_Fork_Tr_Rv_J016	296.0	616.9	1753.0	2843.4	5107.8
Clear_Fork_Tr_Rv_J017	2418.3	5323.1	13153.1	16582.2	24813.3
Clear_Fork_Tr_Rv_J018_blw	2733.9	5567.4	13868.8	18474.3	28628.0
Clear_Fork_Tr_Rv_J019_blw	3059.6	6235.1	16622.9	21778.5	34291.9
Clear_Fork_Tr_Rv_J020	3078.9	6394.0	16775.4	22011.0	34671.7
Clear_Fork_Tr_Rv_J021	3187.5	7010.6	18009.9	23574.5	37313.9
Clear_Fork_Tr_Rv_J022_blw	4487.2	10902.5	27023.7	34343.3	53046.4
Clear_Fork_Tr_Rv_J023	16.5	334.3	1441.2	1883.3	2659.7
Clear_Fork_Tr_Rv_J024	4245.4	10870.0	27113.3	34593.6	53622.1
Clear_Fork_Tr_Rv_J025_blw	4805.2	12265.6	30395.4	38828.0	59395.3
Clear_Fork_Tr_Rv_J026	4849.1	12371.3	30851.1	39440.3	60308.5
Clear_Fork_Tr_Rv_J027_blw	4841.5	12354.8	31745.7	40627.4	62319.2
Clear_Fork_Tr_Rv_J028_blw	4932.6	12516.9	32440.9	41604.8	63833.1
Clear_Fork_Tr_Rv_J029_blw	4953.6	12558.4	32561.2	42041.6	65627.8
Clear_Fork_Tr_Rv_J030_blw	5005.5	12890.3	33899.5	43692.7	68331.9
Clear_Fork_Tr_Rv_J031	646.7	1219.2	1975.3	3000.7	5097.5
Clear_Fork_Tr_Rv_J032	5169.0	13058.7	34794.1	44821.3	70207.7

HEC-HMS Element Name	2-yr	10-yr	50-yr	100-yr	500-yr
Clear_Fork_Tr_Rv_J032_blw	5101.5	12870.6	35697.3	46033.9	71978.6
Clear_Fork_Tr_Rv_J035_blw	3563.8	5938.0	18117.7	29558.1	55336.9
Clear_Fork_Tr_Rv_J036	3563.8	5938.0	18117.7	29558.1	55336.9
Clear_Fork_Tr_Rv_J037	3288.0	5536.0	18053.9	29474.8	55221.0
Clear_Fork_Tr_Rv_J038	1339.4	2248.2	3225.7	3629.3	4590.3
Clear_Fork_Tr_Rv_J039	1773.0	2987.9	4292.7	4827.7	6103.5
Clear_Fork_Tr_Rv_J040_blw	15527.2	29113.4	51889.2	63536.2	104067.8
Clear_Fork_Tr_Rv_J041	15707.3	29476.3	52503.1	64257.2	104368.2
Clear_Fork_Tr_Rv_J042	15602.1	29578.7	52532.3	64185.3	104006.6
Clear_Fork_Tr_Rv_J043	905.0	1555.3	2242.1	2519.6	3179.9
Clear_Fork_Tr_Rv_J044	1733.3	3000.8	4327.4	4842.2	6114.5
Clear_Fork_Tr_Rv_J045	15769.2	29926.8	53111.1	64909.4	104501.2
Clear_Fork_Tr_Rv_J046_blw	16543.3	31435.3	55760.9	68254.8	105906.9
Clear_Fork_Tr_Rv_J046_Turkey	15777.5	29958.2	53097.7	64847.5	104476.0
Clear_Fork_Tr_Rv_J047	16650.9	31706.9	56100.0	68656.8	106077.0
Clear_Fork_Tr_Rv_J048	16727.8	32183.4	56650.4	69302.6	106444.5
Clear_Fork_Tr_Rv_J049	16417.9	32333.9	56435.1	69063.2	106005.9
Clear_Fork_Tr_Rv_J050_blw	18880.7	41244.8	69234.3	85529.7	120070.5
Cottonwood_Cr_J001	1.1	5.9	674.5	1405.4	2482.3
Cottonwood_Cr_J002	135.5	363.3	775.7	1652.5	2970.1
Dickeys_Br_J001	3732.4	6396.4	8777.3	9832.6	12334.3
Dickeys_Br_J002	5541.6	9624.7	13217.5	14810.5	18584.1
Dickeys_Br_J004	6018.5	11191.5	15538.7	17694.5	20635.0
Dobbs_Br_J001	5.4	10.7	155.4	637.4	1653.4
Dobbs_Br_J002	280.2	522.2	823.6	928.5	1917.3
Dutch_Br_J001	1361.8	2267.2	3091.6	3461.0	4378.2
Dutch_Br_J002	2263.1	3739.4	5095.3	5702.6	7211.9
Dutch_Br_J003	4334.0	7368.8	10148.9	11402.1	14538.3
Dutch_Br_J004	4785.3	8133.7	11193.6	12572.5	16018.5
Gourdneck_Cr_J001	4.2	9.4	242.4	1118.7	2922.5
Gourdneck_Cr_J002	2.1	5.1	137.1	497.3	1148.3
Gourdneck_Cr_J003	237.9	627.1	1168.1	1531.4	4141.7
Gourdneck_Cr_J004	1.0	2.4	95.6	459.0	1194.5
Gourdneck_Cr_J005	502.7	1174.6	2227.8	2538.4	4906.3
Gourdneck_Cr_J006	1631.0	3602.0	6819.2	7809.9	10110.4
Gourdneck_Cr_J007	1975.8	4268.0	8087.1	9321.6	12232.2
Gourdneck_Cr_J008	9.9	23.3	690.8	1120.7	1934.1
Gourdneck_Cr_J009	2482.0	5287.6	10454.5	13014.2	17874.1
Gourdneck_Cr_J010	37.5	77.1	621.6	1037.1	1854.6
Gourdneck_Cr_J011	2538.2	5499.4	11387.2	14745.9	21074.0

HEC-HMS Element Name	2-yr	10-yr	50-yr	100-yr	500-yr
Gourdneck_Cr_J012	13.3	24.2	425.2	761.5	1421.1
Gourdneck_Cr_J013	2529.3	5488.2	11769.4	15491.3	22398.6
Gourdneck_Cr_J014	2529.3	5488.2	11769.4	15491.3	22398.6
Gourdneck_Cr_J015	2560.2	5584.4	12129.8	16007.5	23257.3
Graham_Br_J001	30.6	58.0	616.6	1184.5	2361.2
Graham_Br_J002	91.8	220.9	614.2	1165.2	2404.9
Green_Br_J001	32.9	59.5	1607.6	2415.1	4032.3
Green_Br_J002	148.3	287.7	1667.1	2522.4	4258.6
Hale_Br_J001	24.4	284.1	1700.2	2225.1	3479.9
Hale_Br_J002	228.1	418.2	1763.0	2335.8	3674.3
Hays_Br_J001	6.6	30.5	169.6	462.5	1036.9
Hays_Br_J002_abv_Weatherford	255.7	453.6	628.3	705.6	1063.8
Heiffel_Br_J001	128.4	222.0	1760.7	2424.1	3657.0
Holder_Br_J001	29.0	90.0	847.4	1329.5	2286.3
Holder_Br_J002	226.9	406.0	910.2	1436.3	2495.4
Johnson_Br_J001	720.8	1313.0	1947.5	2193.0	2772.6
Lake_Weatherford_INFLOW	10038.9	16790.7	40415.3	52046.1	81764.1
Lake_Weatherford_OUTFLOW	2774.8	3733.2	17829.4	28981.3	54202.2
McKnight_Br_J001	6.1	33.1	1055.7	1221.0	2511.2
McKnight_Br_J002	6.1	33.1	1055.7	1221.0	2511.2
Mustang_Cr_J001	7558.5	13176.9	18156.8	20455.0	26165.0
Mustang_Cr_J002	9947.0	18698.1	26647.6	30116.0	36296.0
Mustang_Cr_J003	12123.6	22471.6	31853.1	35982.9	43811.0
Mustang_Cr_J004	12234.9	22423.7	32825.7	37514.1	45294.8
Mustang_Cr_J005	2495.9	4336.2	5974.1	6729.9	8609.6
Mustang_Cr_J006	3220.7	5533.7	7805.0	8840.1	11491.3
Mustang_Cr_J007	14985.1	27430.8	39781.8	45362.0	55382.2
Mustang_Cr_J008	16468.3	29928.5	43361.5	49649.2	60738.5
Mustang_Cr_J009	3271.3	5569.5	7668.0	8635.7	11051.7
Mustang_Cr_J010	1581.2	2645.8	3625.1	4075.7	5189.4
Mustang_Cr_J011	5499.1	9422.4	13280.8	15002.3	19026.6
Mustang_Cr_J012	22080.6	39586.8	57010.4	65003.7	81289.7
Mustang_Cr_J013	19463.7	34210.3	58928.9	69439.6	88510.1
Mustang_Cr_J014_abv_Benbrook	11868.6	24286.2	35845.7	44184.4	79157.4
Patterson_Br_J001	2.0	112.3	803.9	1273.6	2350.3
Patton_Br_J001	778.2	1555.7	2599.7	2942.2	3735.6
Patton_Br_J002	1184.0	2324.7	3851.6	4356.1	5495.5
Rankin_Br_J001	10.3	245.4	1510.7	2139.5	3140.7
Rankin_Br_J002	173.3	314.7	1586.4	2257.3	3329.4
Rock_Cr_J001	3679.2	6159.2	8524.5	9621.4	12379.0

HEC-HMS Element Name	2-yr	10-yr	50-yr	100-yr	500-yr
Rock_Cr_J002	5873.8	9738.5	13770.4	15738.4	20808.4
Rock_Cr_J003	2162.1	3608.9	4977.4	5610.2	7193.9
Rock_Cr_J004	2463.2	4112.7	5677.3	6399.5	7928.3
Rock_Cr_J005	8058.1	13284.7	18604.7	21189.1	28189.8
Rock_Cr_J006	2799.7	4598.7	6326.8	7124.4	9117.3
Rock_Cr_J007	3809.1	6611.0	9353.7	10696.3	13462.6
Rock_Cr_J008	13004.6	22091.2	31351.0	35419.1	45231.2
Rock_Cr_J009	2014.4	3349.6	4619.5	5206.3	6676.4
Rock_Cr_J010	14326.7	25053.6	36238.0	41271.1	53641.0
Rock_Cr_J011	14093.2	25249.3	37184.2	42824.2	56641.0
Rock_Cr_J012	14307.2	26429.1	38853.6	45578.3	61129.9
Rock_Cr_J013	14222.7	26163.7	37104.6	46042.8	61426.4
Rock_Cr_J014	2489.1	4190.8	5801.1	6547.9	8422.3
Rock_Cr_J015	2542.8	4354.5	6054.1	6846.6	8349.2
Rock_Cr_J016	1260.7	2128.8	2936.7	3310.3	4242.7
Rock_Cr_J017	1089.0	1607.2	1909.3	2058.9	3348.3
Rock_Cr_J018	3360.5	5551.9	7867.9	9227.9	12258.5
Rock_Cr_J019	3022.8	5058.0	6659.1	8048.7	12902.0
Rock_Cr_J020	15705.5	29951.2	42465.5	53106.9	83803.1
Rock_Cr_J021	14243.3	28442.2	37670.4	40597.6	49607.8
Rock_Cr_J022_abv_Benbrook	14835.8	29832.9	39473.2	42647.3	53242.6
S_Bear_Cr_J001	2041.4	6038.6	8670.7	9861.7	12569.6
S_Bear_Cr_J002	2973.3	8177.7	12315.4	14272.1	18474.4
S_Bear_Cr_J003	4497.3	8785.2	12184.1	13695.2	17257.1
S_Bear_Cr_J004	4672.3	9202.1	13042.6	14736.7	18099.7
S_Bear_Cr_J005	7435.2	17567.9	25860.5	29729.9	37494.3
S_Bear_Cr_J006	7359.9	18434.9	28513.3	33109.5	42300.2
S_Bear_Cr_J007_abv_Dickeys	7313.1	18347.3	28453.9	33031.8	41612.3
S_Bear_Cr_J007_blw	12199.3	26071.9	39974.1	46481.1	60324.0
S_Bear_Cr_J008	13621.9	29097.4	44500.1	51788.0	66379.8
S_Bear_Cr_J009	12535.5	29574.3	45835.9	53307.1	69498.9
S_Bear_Cr_J010	12587.8	29750.2	46073.1	53712.6	70172.7
Sink-1	877.5	6913.9	15890.8	22386.4	43855.1
Squaw_Cr_J001	1588.2	2733.8	4004.9	4523.8	5746.8
Squaw_Cr_J002	304.4	425.2	561.4	623.1	780.6
Squaw_Cr_J003	317.6	539.4	772.2	868.1	1078.4
Strickland_Br_J001	18.0	61.1	1727.4	2582.2	4138.2
Strickland_Br_J002	166.7	353.3	1749.1	2661.3	4335.2
Strickland_Br_J003	210.2	468.4	1749.3	2728.7	4532.8
Town_Cr_J001	2108.3	4047.0	6376.1	7270.1	9318.5

HEC-HMS Element Name	2-yr	10-yr	50-yr	100-yr	500-yr
Town_Cr_J002	3119.6	5449.7	8991.0	10502.6	13486.0
Town_Cr_J003	3367.3	5969.9	9659.9	11364.5	14667.6
Town_Cr_J004	3893.0	6644.6	10472.2	12331.9	16295.5
Town_Cr_J005	4932.1	8237.1	12735.4	14755.8	19194.9
Town_Cr_J006	5300.0	9558.6	15603.4	18169.6	24049.3
Town_Cr_J007	5319.2	9672.1	15907.7	18554.0	24789.4
Town_Cr_J008	5929.5	10274.5	18458.4	21987.5	29814.1
Town_Cr_J019_abv_Burgess_Cr	10479.1	20566.6	37550.9	46134.5	65951.1
Town_Cr_J019_blw	10793.5	21321.8	40573.4	50178.9	73223.4
Town_Cr_J020	10810.9	21364.2	40642.6	50299.0	73430.4
Town_Cr_J021	1136.5	1979.3	2856.9	3209.9	4049.4
Town_Cr_J022	1364.3	2628.9	4046.9	4571.3	5725.6
Town_Cr_J023	11553.1	22604.3	42162.9	52330.6	77209.7
Town_Cr_J024	11564.9	22628.2	42213.7	52395.6	77302.3
Turkey_Cr_J001	1663.6	2996.5	4328.2	4792.4	5943.2
Turkey_Cr_J002	2169.7	4081.6	6257.6	6928.1	8201.2
Turkey_Cr_J003	2297.6	4082.5	5969.2	6671.8	8088.4
Underwood_Br_J001	1527.2	2595.3	3730.4	4192.3	5291.9
Underwood_Br_J002	1741.5	2966.7	4259.9	4786.1	6040.4
Willlow_Cr_J005	14.5	424.9	2053.1	2608.1	3695.2
Willow_Cr_J001	9.8	134.2	2036.5	3464.8	6193.0
Willow_Cr_J002_abv_Graham_Br	343.7	726.7	2083.3	3536.1	6367.6
Willow_Cr_J002_blw	428.5	931.6	2435.4	4209.2	7823.9
Willow_Cr_J003_abv_BellnapBr	1333.4	2890.0	4564.0	5178.3	8976.7
Willow_Cr_J003_blw	2243.6	4429.0	6904.2	7786.3	12002.6
Willow_Cr_J004_abv_Patterson	1986.1	4164.2	7325.2	8491.2	12640.1
Willow_Cr_J004_blw	1986.9	4165.5	7327.3	8493.6	14810.2
Willow_Cr_J006	1997.6	4175.8	9258.6	10915.4	16289.4
Willow_Cr_J007	8.8	79.3	806.4	1241.6	2054.9
Willow_Cr_J008	2550.0	4862.7	11249.8	14063.2	21170.1
Willow_Cr_J009	840.6	1508.5	2205.1	2479.5	3129.9
Willow_Cr_J010	2651.5	5179.9	11687.8	14751.7	22438.5
Willow_Cr_J011	3200.9	5960.7	12700.4	16072.5	24407.4
Willow_Cr_J012	55.9	680.4	1785.0	2178.9	2490.1
Willow_Cr_J013	3050.6	6558.7	13439.1	17006.8	26409.8
Willow_Cr_J014_abv_Holder_Br	3632.9	7859.5	15014.9	18918.0	29119.7
Willow_Cr_J014_blw	3670.8	7933.4	15754.7	19908.2	30750.7
Willow_Cr_J015	3490.0	7925.5	16501.3	20791.9	31887.5
Willow_Cr_J016	3569.0	8103.9	17002.7	21398.8	32729.0
Willow_Cr_J017_abv_Underwood	3581.5	8120.4	17078.8	21491.1	32863.3

HEC-HMS Element Name	2-yr	10-yr	50-yr	100-yr	500-yr
Willow_Cr_J017_blw	4137.6	8580.9	17940.7	22571.4	34449.4
Willow_Cr_J018_abv_Town_Cr	4137.6	8580.9	17940.7	22571.4	34449.4
Willow_Cr_J018_blw	9610.7	18843.6	35794.1	43565.3	62130.4

The differences in peak flows between existing (2020) and future (2070) conditions are further illustrated in the following figures. Figure 6-1 shows that the percentage increase in the 100-year peak discharge ranges from 8% to 160% with a median increase of 38%.

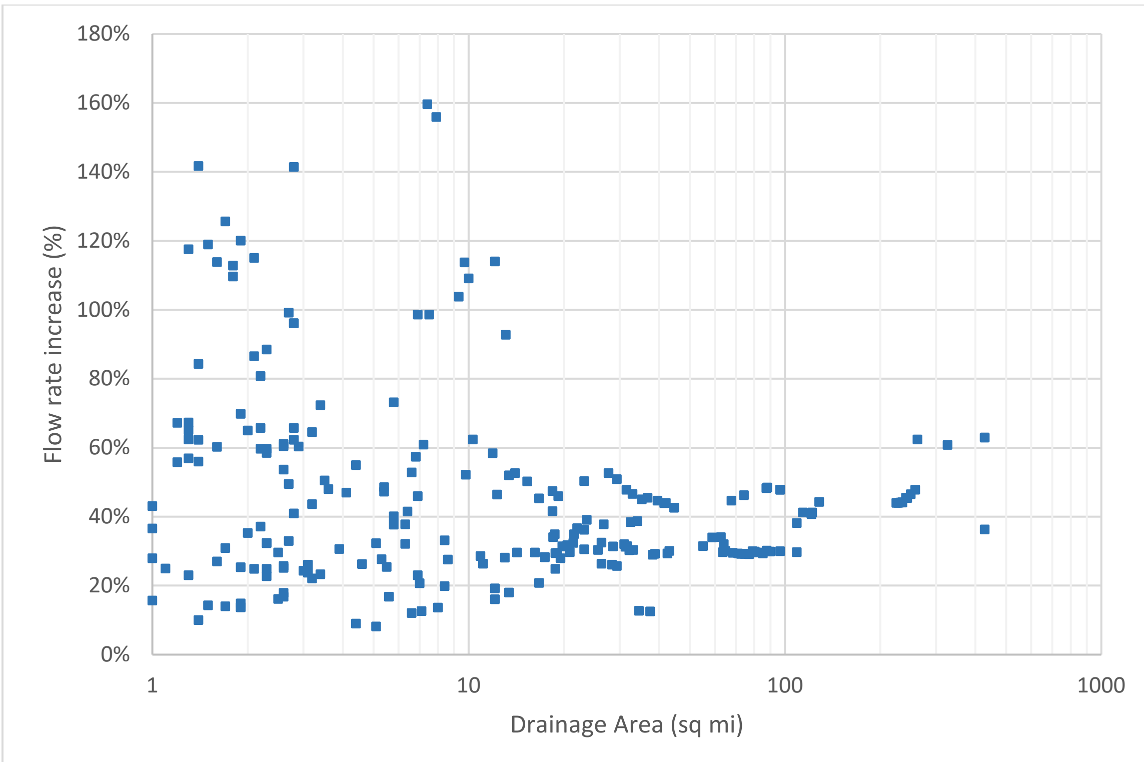

Figure 6-1. Percent Differences between Existing and Future Conditions 100-year Peak Discharges

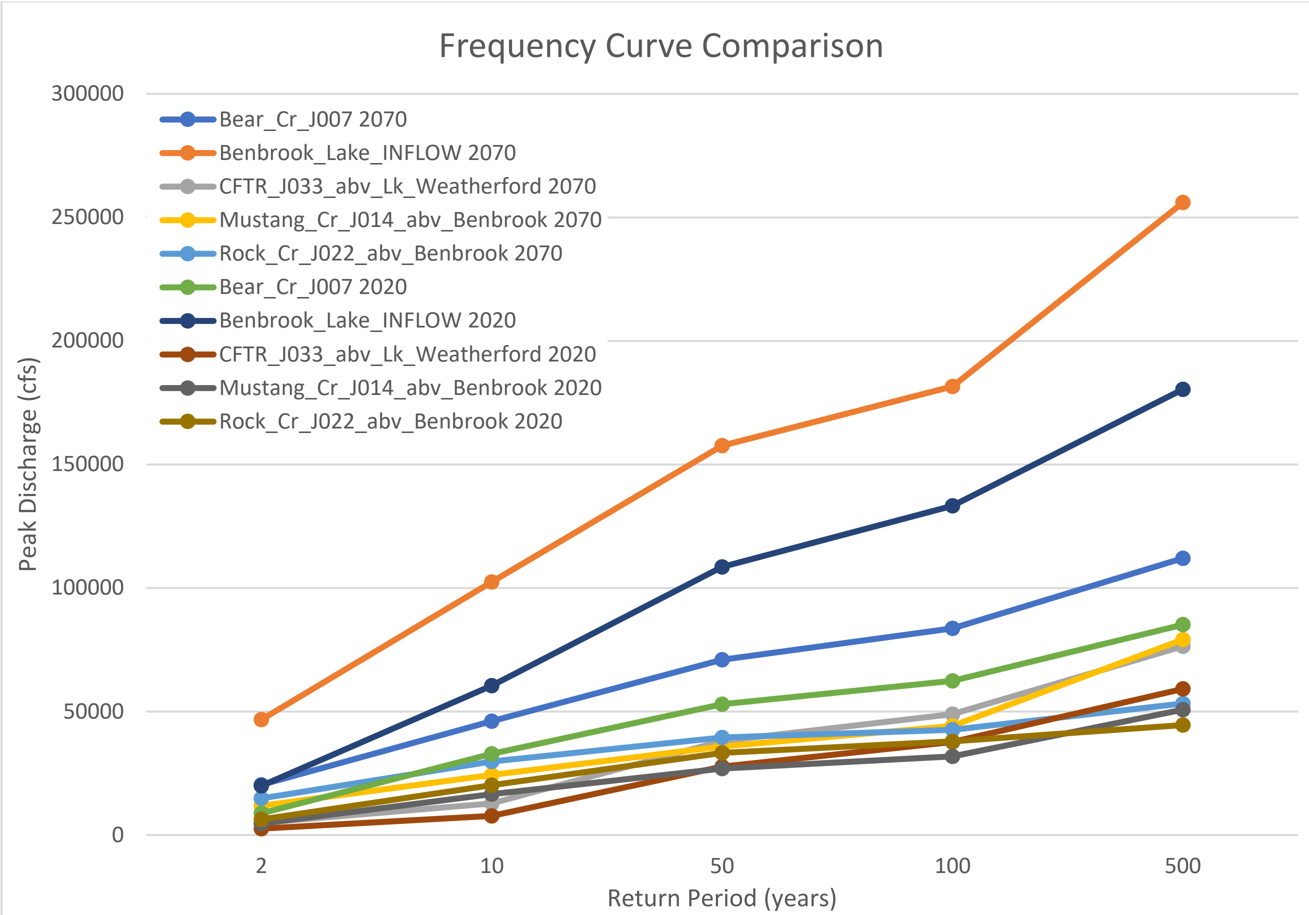

Figure 6-2. Flow Frequency Curves for Existing and Future Conditions at Selected Locations

Figure 6-2 shows consistent increases of several thousand cfs across all frequencies.

Figure 6-3 shows that the 2-year flood had the largest increases, while the increases in the 10-year to 500-year discharges are lower.

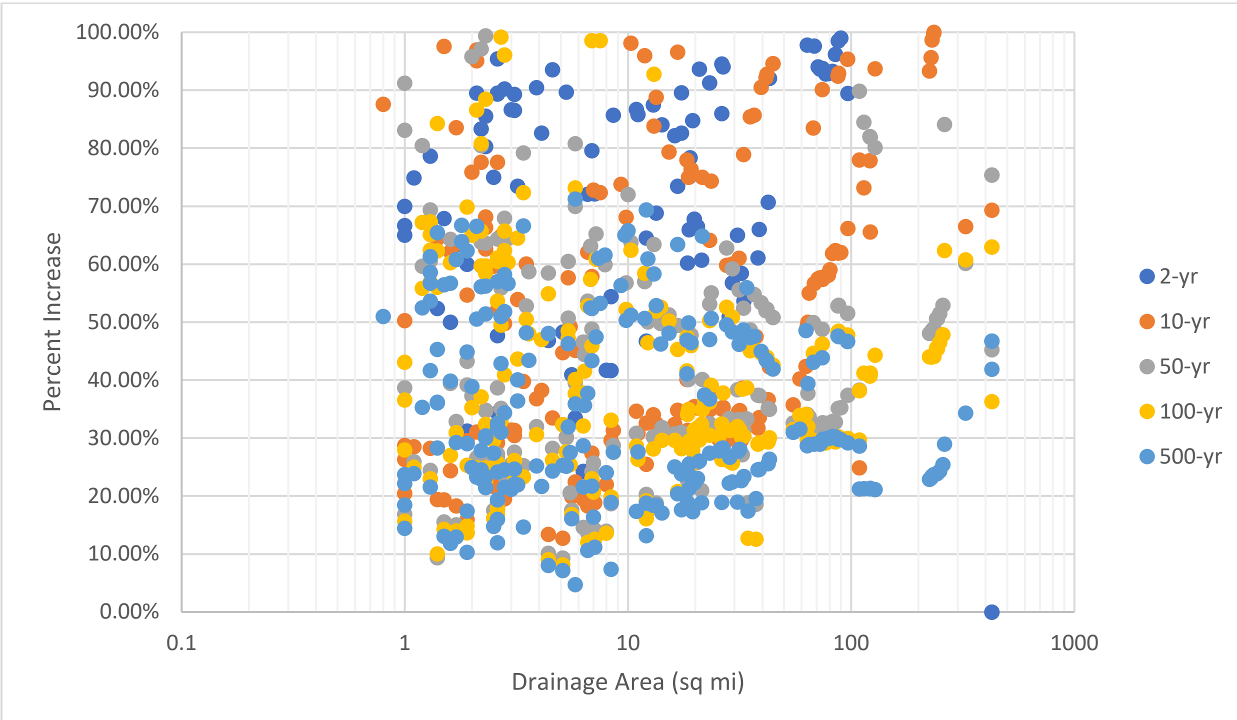

Figure 6-3. Percent Differences between Existing and Future Conditions

7 Conclusions

The general trend of runoff when considering urbanization or future conditions imperviousness, increase the discharge peaks on the watershed. Table 7-1 and Figure 7-1 illustrate the increase in peak discharge due to future urbanization at selected locations in the watershed. From this figure, one can see that the largest increase occurs at the 50% ACE (2-year) and 10% ACE (10-year) frequencies, ranging from 47% to 61% at the 2-year and 32% to 41% at the 10-year. For less frequent events (50-year to 500-year), the increases due to future urbanization become more consistent, ranging from 11% to 36%.

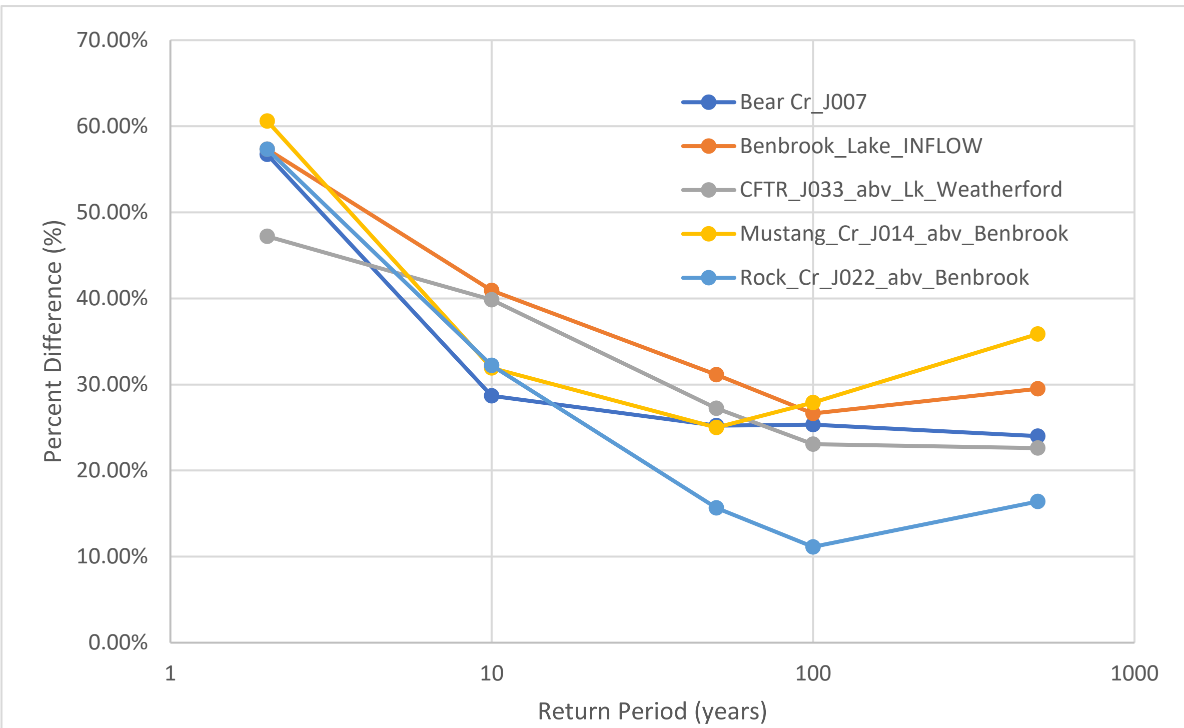

Figure 7-1. Percent Differences from Existing to Future Conditions versus Frequency

Table 7-1. 2070 Peak Discharge Percent Increase from 2020 Conditions

Annual Chance of Exceedance (ACE%)	Frequency (Years)	Bear_Cr_J007	Benbrook_Lake_INFLOW	CFTR_J033_abv_Lk_Weatherford	Mustang_Cr_J014_abv_Benbrook	Rock_Cr_J022_abv_Benbrook
50	2	57%	57%	47%	61%	57%
10	10	29%	41%	40%	32%	32%
2	50	25%	31%	27%	25%	16%
1	100	25%	27%	23%	28%	11%
0.2	500	24%	30%	23%	36%	16%

Another interesting portion of the results for the UCFT watershed in particular is the potential increase in peak pool elevations at Benbrook Lake and Lake Weatherford under future conditions. Tables 7-2, and 7-3, as well as Figures 7-2, and 7-3 illustrate these increases in peak pool elevation. As one can see from the table below, the differences in peak pool elevations at both lakes are higher in high frequency events (2-year and 5-year). For less frequent events (50-year to 500-year), the elevation increase is more consistent, ranging from 2.2 to 3.8 feet at Benbrook Lake and ranging from 0.7 to 0.8 foot at Lake Weatherford.

Table 7-2. Peak Pool Elevation Increases from 2020 to 2070 Conditions at Benbrook Lake

Annual Chance of Exceedance (ACE%)	Frequency (Years)	2020 Peak Elev (ft NAVD88)	2070 Peak Elev (ft NAVD88)	Difference Peak Elev feet
50	2	702.9	712.1	9.2
10	10	713.0	717.7	4.7
2	50	719.1	723.0	3.9
1	100	721.8	725.1	3.3
0.2	500	726.7	728.9	2.2

Table 7-3. Peak Pool Elevation Increases from 2020 to 2070 Conditions at Lake Weatherford

Annual Chance of Exceedance (ACE%)	Frequency (Years)	2020 Peak Elev (ft NAVD88)	2070 Peak Elev (ft NAVD88)	Difference Peak Elev feet
50	2	898.0	899.8	1.8
10	10	900.7	903.5	2.8
2	50	906.2	906.9	0.7
1	100	907.2	907.9	0.7
0.2	500	909.3	910.1	0.8

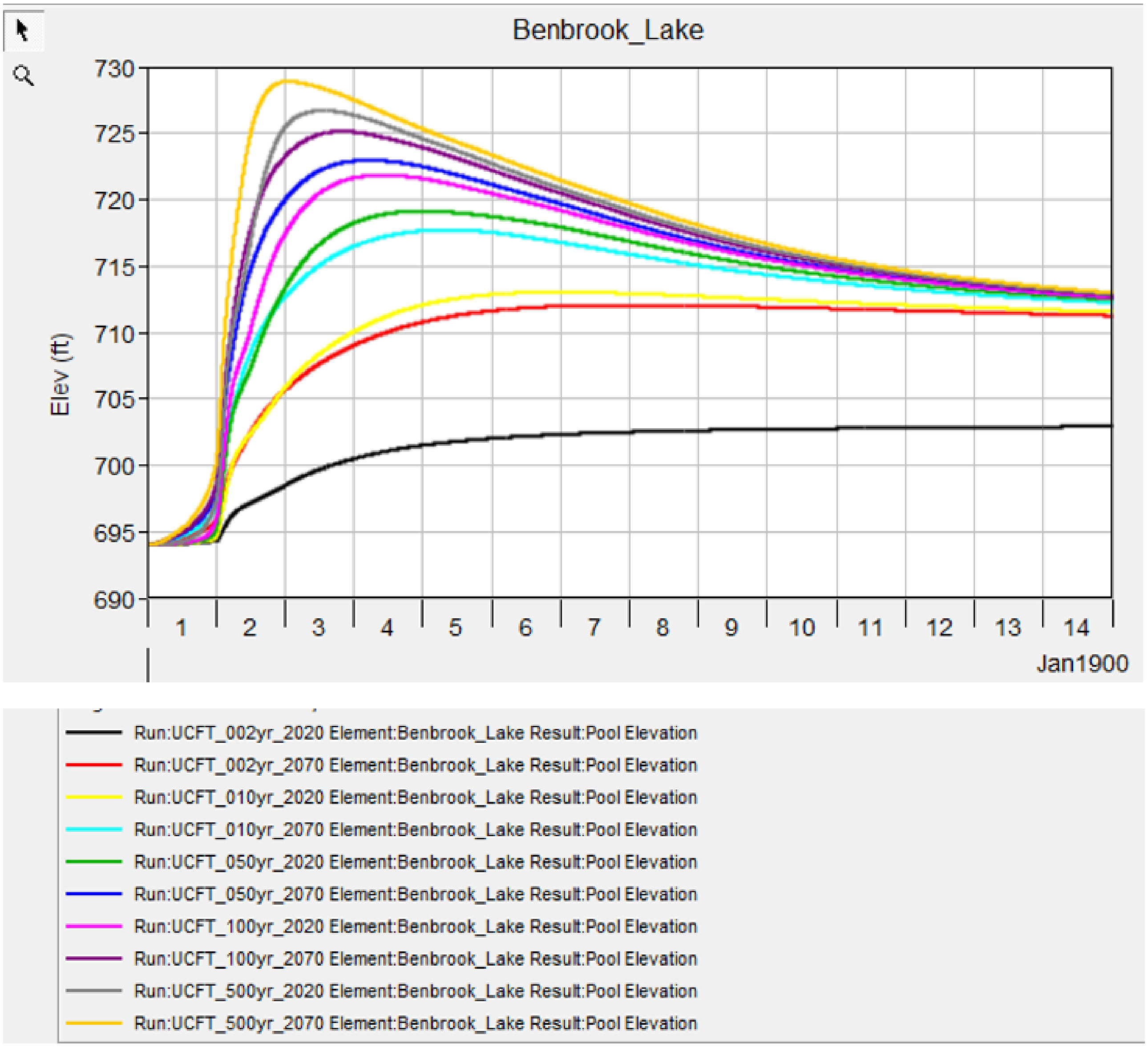

Figure 7-2. Pool Elevations for 2020 and 2070 Conditions at Benbrook Lake

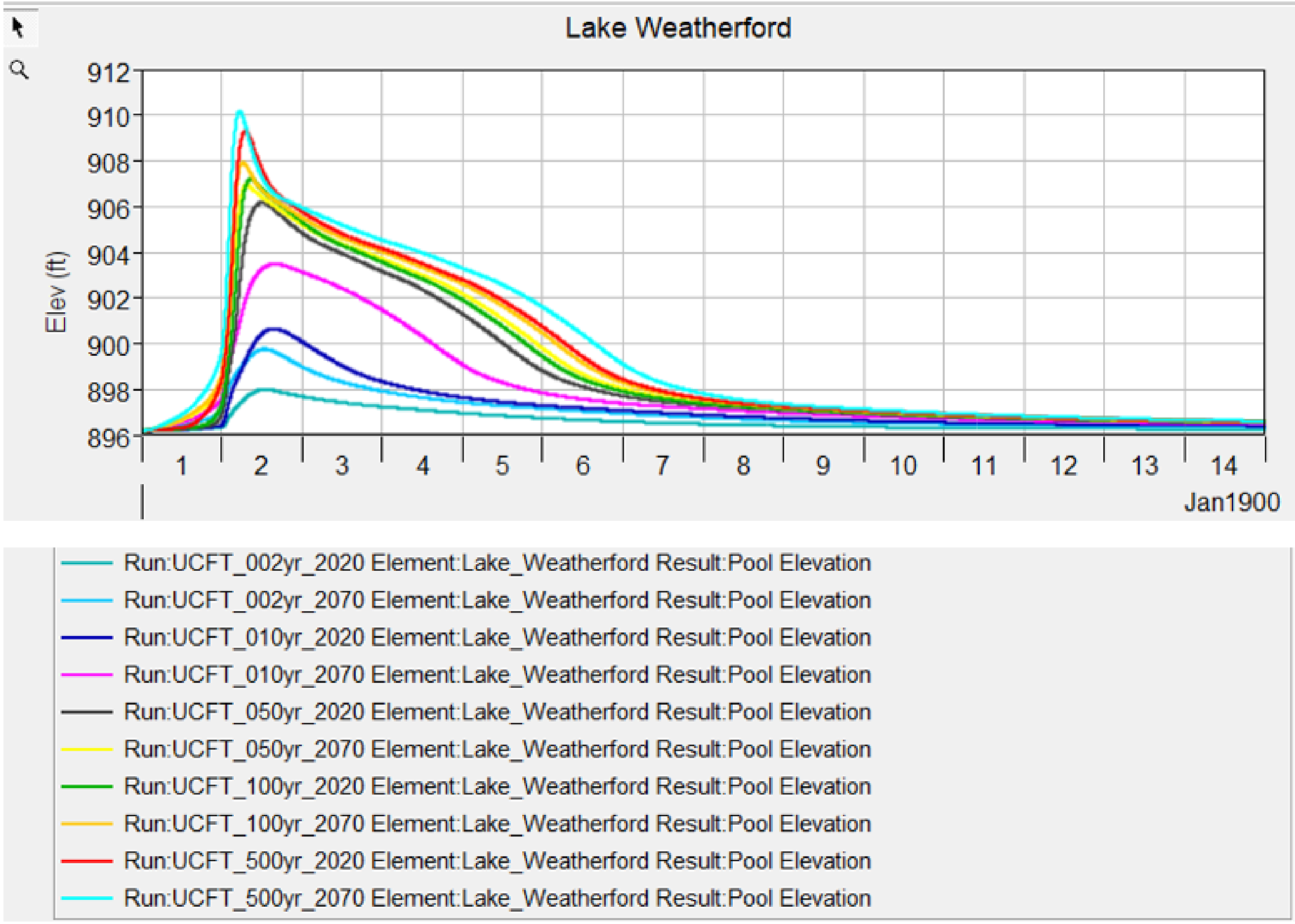

Figure 7-3. Pool Elevations for 2020 and 2070 Conditions at Lake Weatherford

8 References

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