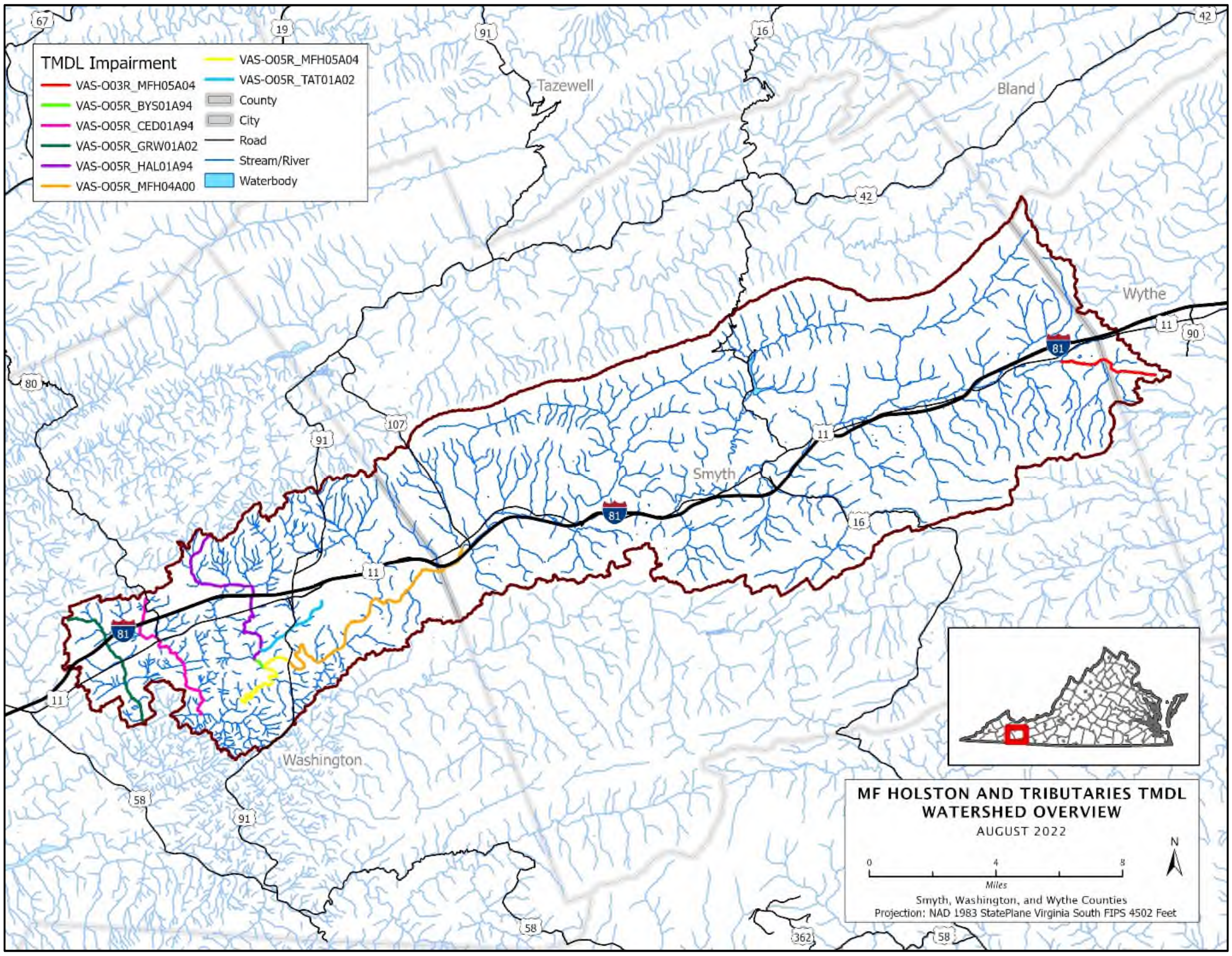
Middle Fork Holston and Tributaries TMDL Study

First Technical Advisory Committee Meeting
9/8/2022, 2:00 pm, Virginia DEQ Southwest Regional Office



1. TMDL Development Process Introduction

The VA Department of Environmental Quality (DEQ) and its contractors, Wetland Studies and Solutions Inc. (WSSI) and James Madison University (JMU), are working to complete a Total Maximum Daily Load (TMDL) study for the streams. A TMDL is the total amount of a pollutant a water body can contain and still meet water quality standards. The study will identify the target pollutant causing the poor water quality, sources of the pollutant in the watersheds, the current magnitude of the pollutant contributions from each source, and the pollutant reductions needed from those sources to restore the benthic macroinvertebrate community in each stream.

The role of the Technical Advisory Committee (TAC) in this process is to review data from the study and provide feedback on pollutant sources and reduction scenarios. The committee also shares information about the watersheds including:

- Historic and current land use
- Future development
- Previous and planned restoration projects
- Local monitoring efforts
- Key stakeholder groups and contacts

TAC reviews data related to:

- Pollutants responsible for biological impairment
- Pollutant sources
- Pollutant reduction scenarios

2. Watershed Background

This study updates and revises two previously completed TMDLs. *Total Maximum Daily Load (TMDL) Development for Cedar Creek, Hall/Byers Creek, and Hutton Creek* was completed in December of 2003 and *Bacteria and Benthic Total Maximum Daily Load Development for Middle Fork Holston River* was completed in October 2009. A kick-off meeting was held in December 2021 to introduce the study and solicit public comments on the development of the TMDL including the formation of this Technical Advisory Committee.

Impaired (benthic) segments from these previous TMDLs have been combined into this current study, along with a Greenway Creek segment not previously included in a completed TMDL study. These segments were all placed on Virginia's impaired waters list for failing to support the aquatic life use. The general water quality standard is intended to protect the aquatic life designated use, which states that all of the Commonwealth's waterways will support a diverse and abundant population of aquatic life. This study includes a new benthic stressor analysis to determine the most likely pollutant responsible for the impairments. The updated TMDL will address the continued benthic impairment and adjust for future growth, including a proposed expansion to the Hall Creek Waste Water Treatment Plant from 0.63 million gallons/day to 0.95 MGD. This study will report on the sources of the pollutant and recommend reductions to meet a total maximum daily load for the impaired streams.

The Middle Fork Holston (MF Holston) watershed is in Bland, Smyth, Washington, and Wythe Counties (**Figure 2**). Eight individual impairments are included in the study (**Table 1**). These reaches have been listed on the 303(d) Impaired Waters List due to water quality violations of the general aquatic life (benthic) standard based on data collected at monitoring stations throughout the watershed.

Table 1. Impairments to be included in the Middle Fork Holston TMDL study.

Stream Name	Location Description	Impaired Assessment Unit (305(b) Segment ID)	Cause Group Code (303(d) Impairment ID)	Listing Stations	Initial Listing Date
Byers/Hall Creek	Indian Run to MF Holston	VAS-O05R_BYS01A94 (0.49 mi)	O05R-01-BEN	6CBYS000.08	2004
	Headwaters to Byers Creek	VAS-O05R_HAL01A94 (6.91 mi)	O05R-01-BEN	6CBYS000.08	2004
Cedar Creek	Confluence of East and West Fork	VAS-O05R_CED01A94 (5.61 mi)	O05R-01-BEN	6CCED000.14	2004
Greenway Creek	Headwaters to MF Holston	VAS-O05R_GRW01A02 (5.02 mi)	O05R-02-BEN	6CGRW002.31	2010
Tattle Branch	Headwaters to Byers Creek	VAS-O05R_TAT01A02 (2.77 mi)	O05R-01-BEN	6CTAT000.50	2004
Middle Fork Holston	Headwaters to confluence with Dutton Branch[a]	VAS-O03R_MFH05A04 (3.42 mi)	O05R-05-BEN	6CMFH055.88	2010
	Sulphur Spring Creek to Rt. 91 bridge[b]	VAS-O05R_MFH04A00 (9.19 mi)	O05R-05-BEN	6CMFH023.41	2008
	Rt.91 bridge to Edmondson dam[b]	VAS-O05R_MFH05A04 (3.82 mi)	O03R-01-BEN	6CMFH011.31	2006

[a] Referred to herein as Upper MF Holston

[b] Referred to jointly herein as Lower MF Holston

Questions:
Any questions about the impairments included in this project?

Any questions about the project rationale?

3. Benthic Stressor Analysis Approach

The goal of the Stressor Analysis is to identify the pollutant(s) responsible for the benthic impairment. This is accomplished by a weight of evidence approach that evaluates all available information (Error! Reference source not found.) on potential candidate stressors (Error! Reference source not found.). These candidate stressors are separated into the following groupings: non-stressors, possible stressors, or probable stressors. The TMDL is then developed to target pollutants that are identified as probable stressors (Error! Reference source not found.).

Table 2. Available data evaluated.

Stations	Parameters	Dates	Data Points
39	403	2000-2021	>19,000

Table 3. Candidate stressors evaluated in the stressor analysis.

Candidate Pollutants		
pH	Dissolved Sulfate	Ammonia
Dissolved Oxygen	Total Dissolved Ions	Dissolved Metals
Temperature	Suspended Solids	Sediment Toxics
Conductivity	Deposited Sediment	Sediment Metals
Dissolved Chloride	Organic Matter	Pesticides
Dissolved Sodium	Nitrogen	Polycyclic Aromatic Hydrocarbons (PAHs)
Dissolved Potassium	Phosphorus	Polychlorinated Biphenyls (PCBs)
Additional Contributing Factors		
Habitat	Hydrologic Alteration	Existing Dams and Impoundments
Imperviousness	Current Land Use Practices	Livestock Stream Access

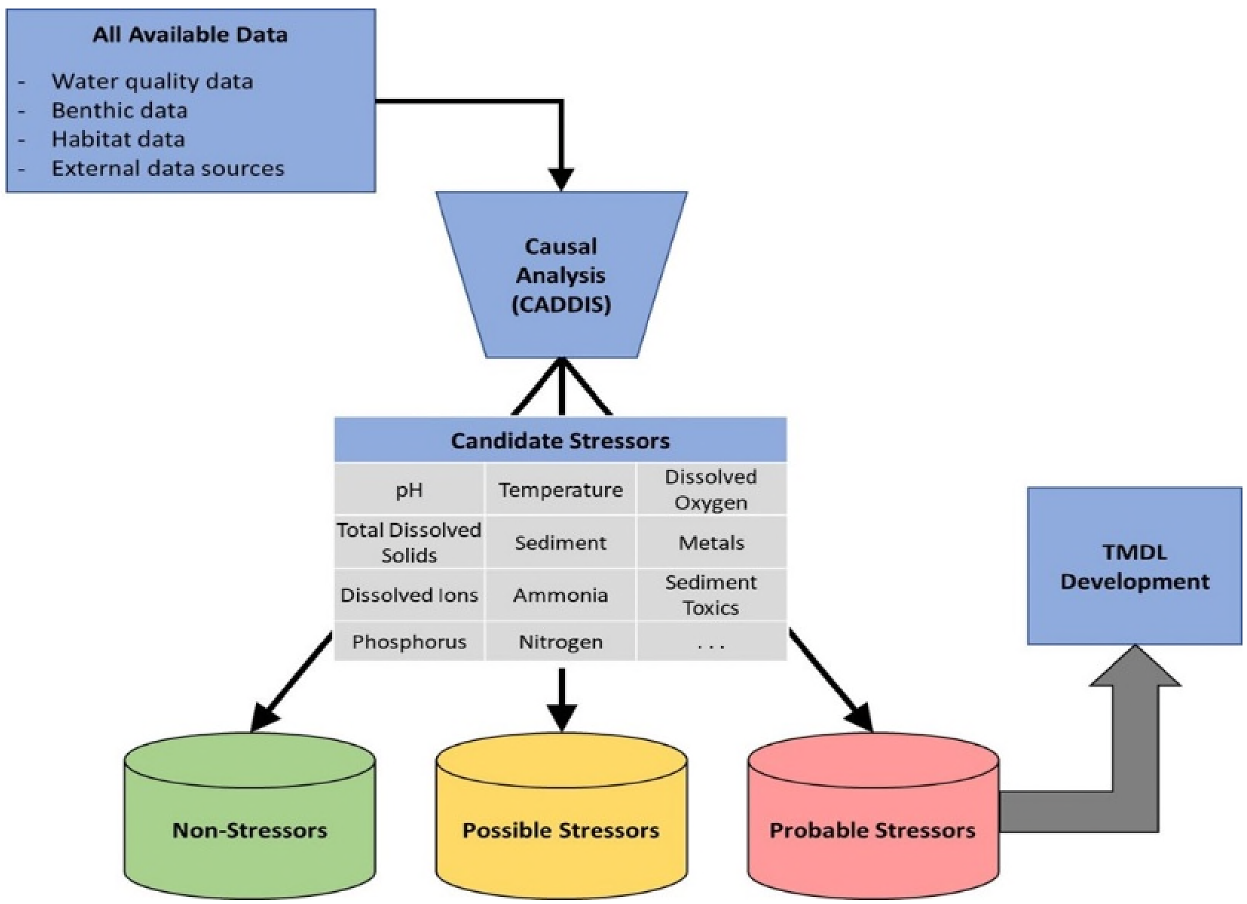


Figure 1. Stressor analysis approach

In order to classify candidate stressors into the appropriate bins (non-stressor, possible stressor, probable stressor), JMU used a formal causal analysis approach developed by EPA, known as CADDIS (Causal Analysis Diagnosis Decision Information System). The CADDIS approach evaluates 18 lines of evidence that support or refute each candidate stressor as the cause of impairment (**Table 4**). In each stream, each candidate stressor is scored from -3 to +3 based on each line of evidence. Total scores across all lines of evidence are then summed to produce a stressor score that reflects the likelihood of that stressor being responsible for the impairment. Candidate stressors that have large negative scores are classified as non-stressors, those with low (<3) positive scores are classified as possible stressors, and those with high positive scores are classified as probable stressors.

Table 4. Example of CADDIS approach for a given stressor (does not reflect actual data).

Lines of Evidence	**Byers/Hall Creek**	**Cedar Creek**	**Greenway Creek**	**Tattle Branch**	**MF Holston (Lower)**	**MF Holston (Upper)**
Spatial Co-occurrence	-3	-1	-1	-1	+3	+3
Temporal Co-occurrence	-2	-1	0	0	+2	+2
Causal Pathway	-2	-2	+1	+1	+1	+1
Stressor-Response Relationships from the Field	-2	-1	+2	+2	0	0
Temporal Sequence	-3	-1	0	0	+1	+1
Symptoms	-2	-1	+1	+1	+2	0
Stressor-Response Relationships from Other Field Studies	-2	-2	-2	-2	0	0
Stressor-Response Relationships from Laboratory Studies	-2	-1	+1	+1	+1	+1
Stressor-Response Relationships from Simulation Models	-3	-1	+2	+2	-3	-3
Mechanistically Plausible Cause	-2	-1	0	0	+2	+2
Manipulation of Exposure at Other Sites	-2	-2	-1	0	+2	+2
Analogous Stressors	-2	-1	0	0	+1	+1
Consistency of Evidence	-3	-1	0	0	0	0
Explanation of the Evidence	-2	-1	0	0	0	0
SUM	**-32**	**-17**	**+3**	**+2**	**+12**	**+10**
	Non-Stressor		**Possible Stressor**		**Probable Stressor**	

Score	Explanation
+3	The line of evidence **strongly supports** the candidate stressor as the cause of the impairment
+2	The line of evidence **moderately supports** the candidate stressor as the cause of the impairment
+1	The line of evidence **weakly supports** the candidate stressor as the cause of the impairment
0	The line of evidence **does not support or refute** the candidate stressor as the cause of the impairment
-1	The line of evidence **weakly refutes** the candidate stressor as the cause of the impairment
-2	The line of evidence **moderately refutes** the candidate stressor as the cause of the impairment
-3	The line of evidence **strongly refutes** the candidate stressor as the cause of the impairment

Questions:
Is this approach clear?

Do you have any concerns regarding this approach?

4. Stressor Analysis Findings

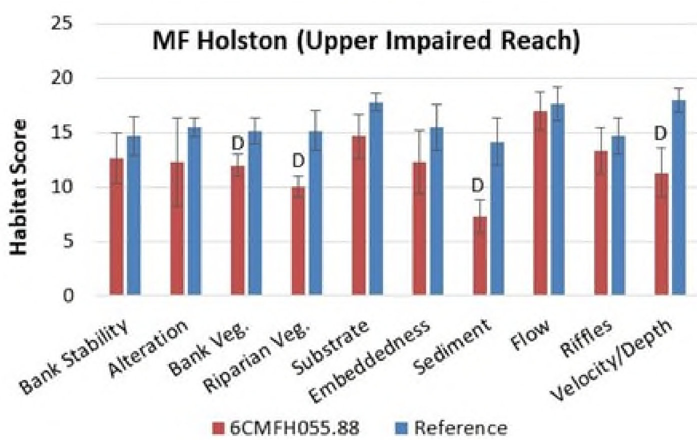
The stressor analysis determined that the most probable stressor in each impaired stream was sediment (**Table 5**).

Table 5. Stressor analysis results.

Candidate Stressor	Byers/Hall Creek	Cedar Creek	Greenway Creek	Tattle Branch	MF Holston (Lower)	MF Holston (Upper)
Temperature	-18	-16	-15	-18	-17	-13
pH	-25	-23	-21	-23	-23	-25
DO	-18	-17	-17	-20	-11	-15
Conductivity/TDS	2	3	1	3	-14	-12
Sodium	0	-7	-10	3	-15	-17
Potassium	3	0	2	3	-10	-2
Chloride	-12	-12	-15	1	-19	-21
Sulfate	-2	-9	-11	-10	-13	-16
Sediment	11	13	11	10	7	11
Organic Matter	-9	-8	-3	-4	-6	-8
Phosphorus	3	-13	-8	-13	3	0
Nitrogen	1	1	2	3	3	-1
Ammonia	-18	-14	-10	-11	-14	-13
Metals	-17	-17	-2	-7	-15	-15
Sediment Toxics	-11	-11	-1	-5	-10	-10

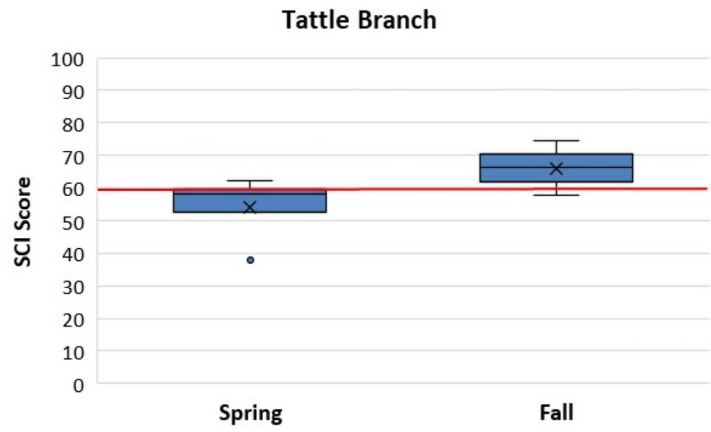
Some of the lines of evidence supporting sediment as a probable stressor in these streams included:

- Total habitat scores and habitat metrics that indicate instream sediment were significantly lower in most streams than in the reference.

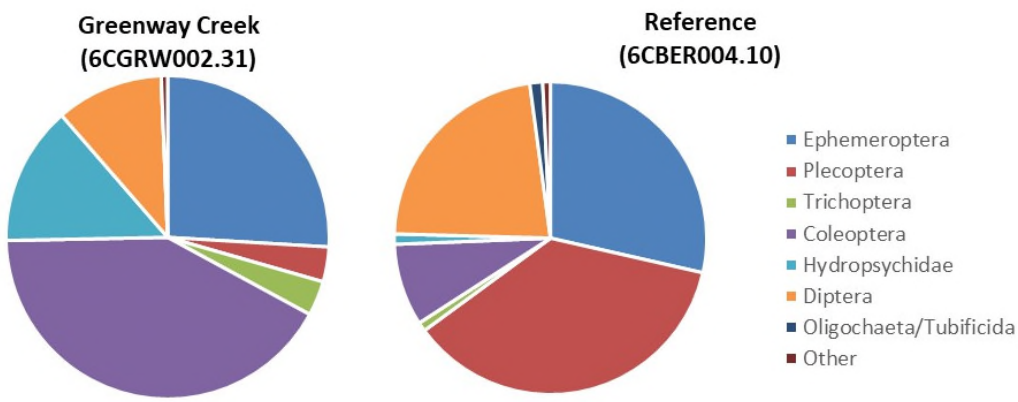


- Total habitat scores were significantly correlated with benthic health across sites.

- Seasonal trends in benthic health in most streams indicated poor health in the spring following high spring flows that typically bring higher sediment loads.

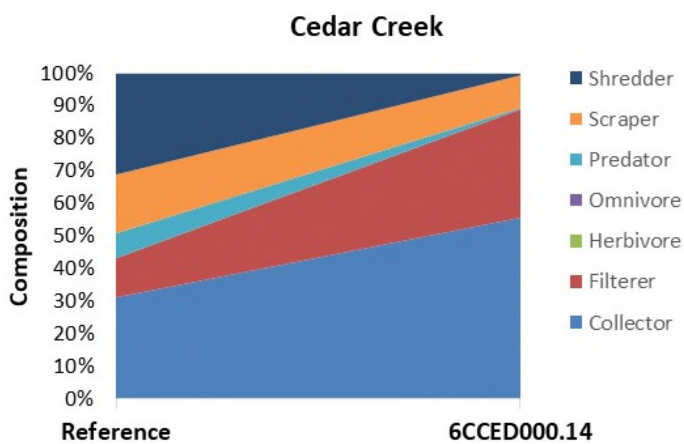


- Taxonomic community structure indicated shifts to sediment-tolerant Dipteran or Elmid-dominated communities and away from Ephemeroptera, Plecoptera, and Trichoptera, which generally prefer clean substrate.



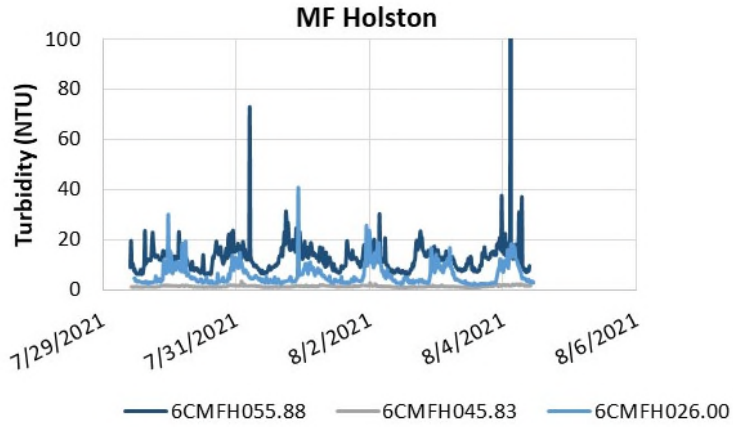
- Average Biological Condition Gradient scores ranked sediment-associated stressors as the top one or two stressors in all streams.

- Functional feeding group analysis in most streams indicated shifts to filterers and collectors that prefer sediment conditions and away from shredders and scrapers that prefer clean substrate.



- Total suspended solids and turbidity were significantly higher in impaired streams than in the unimpaired reference.

- The spatial pattern of turbidity in the MF Holston River matched the pattern of benthic impairment.



Questions:
Do these findings seem reasonable based on your knowledge and experience in the watershed?

5. TMDL Modeling Approach

The computer model selected to develop the sediment TMDL study in the Middle Fork Holston watershed is the Generalized Watershed Loading Functions (GWLF) model. GWLF is widely used throughout Virginia in developing sediment TMDLs. It is a continuous simulation model operating on a daily timestep for water balance calculations to generate monthly sediment yields for the watershed. The model allows for multiple land cover categories to be incorporated, but spatially it is lumped, meaning that it does not account for the spatial distribution of sources and has no method of spatially routing sources within the watershed. The standard practice is to then sub-divide larger watersheds into smaller subwatersheds that can be simulated individually to get a more granular assessment of the pollutant loads. Loads from subwatersheds contributing to the same point can then be re-combined with a transport loss factor to simulate routing of sources within the watershed.

Some of the parameters and capabilities that GWLF incorporates are:

- Surface runoff is calculated using the Soil Conservation Service Curve Number (SCS-CN) approach. Curve numbers are a function of soils and land use type.
- Landscape erosion is calculated based on the Universal Soil Loss Equation (USLE), which incorporates the erosivity of rainfall in the watershed area, the inherent erodibility of the soils, the length and steepness of slopes runoff flows across, as well as factors for cover and conservation practices that affect the impact of rainfall and runoff on the landscape.
- Impervious or urban sediment inputs are calculated with exponential accumulation and wash off functions.

- A delivery ratio is applied to the overall sediment supply, and sediment transport takes into consideration the transport capacity of the runoff.
- Streambank and channel erosion rates are calculated using an algorithm incorporating stream discharge, fraction of developed land in the watershed, and livestock density in the watershed with the area-weighted curve number, soil erodibility factors, and the mean slope of the watershed.
- Groundwater discharge to the stream is modeled along with interactions of evapotranspiration, infiltration from the surface to the unsaturated zone, percolation from the unsaturated zone to the shallow saturated zone, and seepage to a deep saturated zone.

6. TMDL Modeling Inputs

In addition to basic datasets such as slopes and soil characteristics, there are several key points of the model input generation process that rely on best professional judgement and insight from local stakeholders.

a. Subwatersheds

The TMDL study area was divided into 20 subwatersheds to obtain a more granular assessment of the pollutant loads throughout the watershed (**Figure 2**). The watershed was subdivided based on impairments so that TMDLs could be developed for each impaired water. Junctions of streams were used as breaking points to reduce subwatershed size. Locations of monitoring stations were also used to guide subwatershed development to take advantage of available data.

b. Land Cover

Land cover data from the Virginia Geographic Information Network's 2016 Virginia Land Cover Database (VGIN, 2016) was used to estimate acres of the various land cover categories in each subwatershed (**Table 6, Table 7**). An overall landcover map is shown in (**Figure 3**). Estimated sediment loading rates could then be applied to each land cover category to estimate the amount of sediment originating from that land cover category in each subwatershed.

Questions:
Do you know of any recent or planned land cover changes that we should be reflecting?

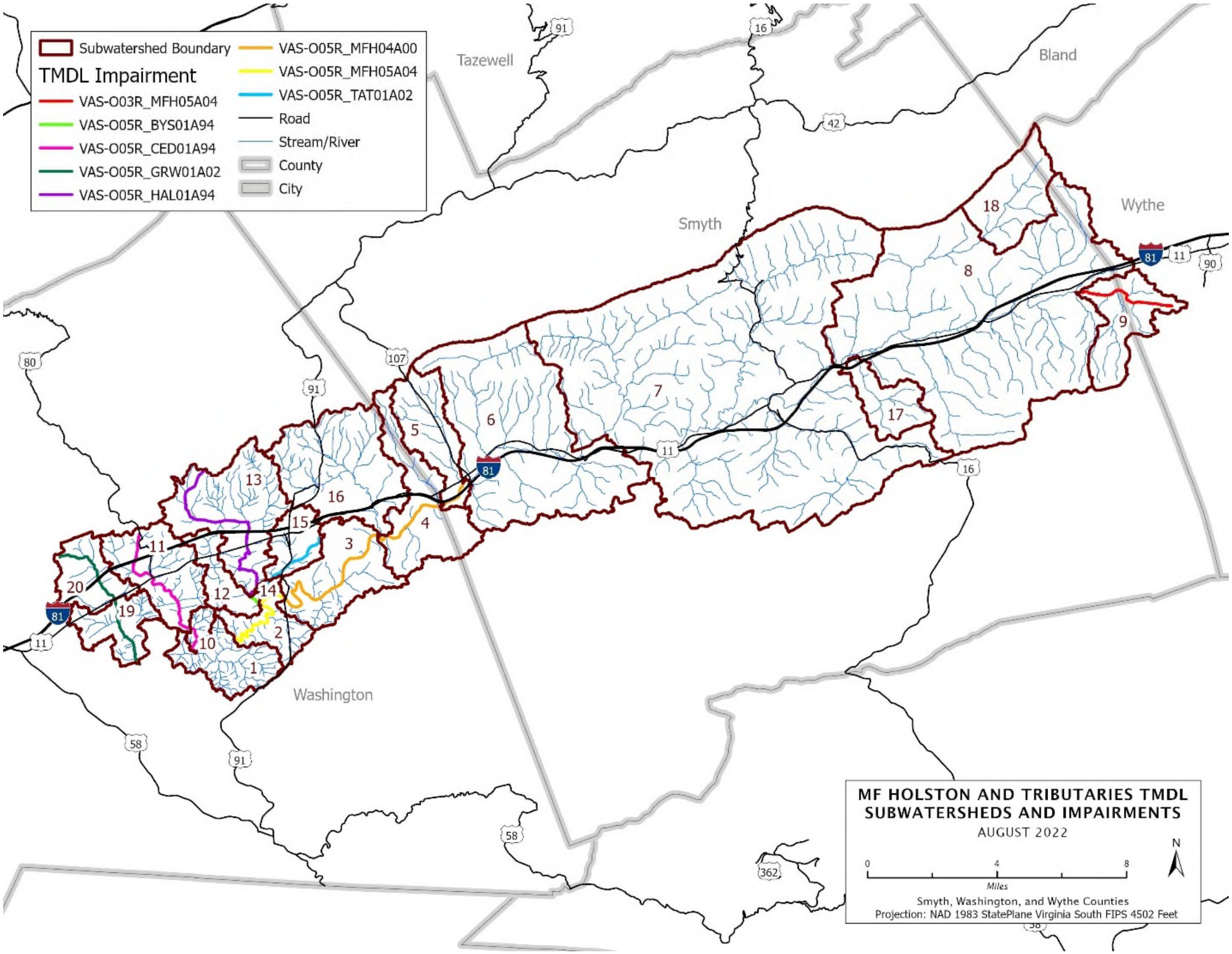


Figure 2. MF Holston TMDL study subwatersheds.

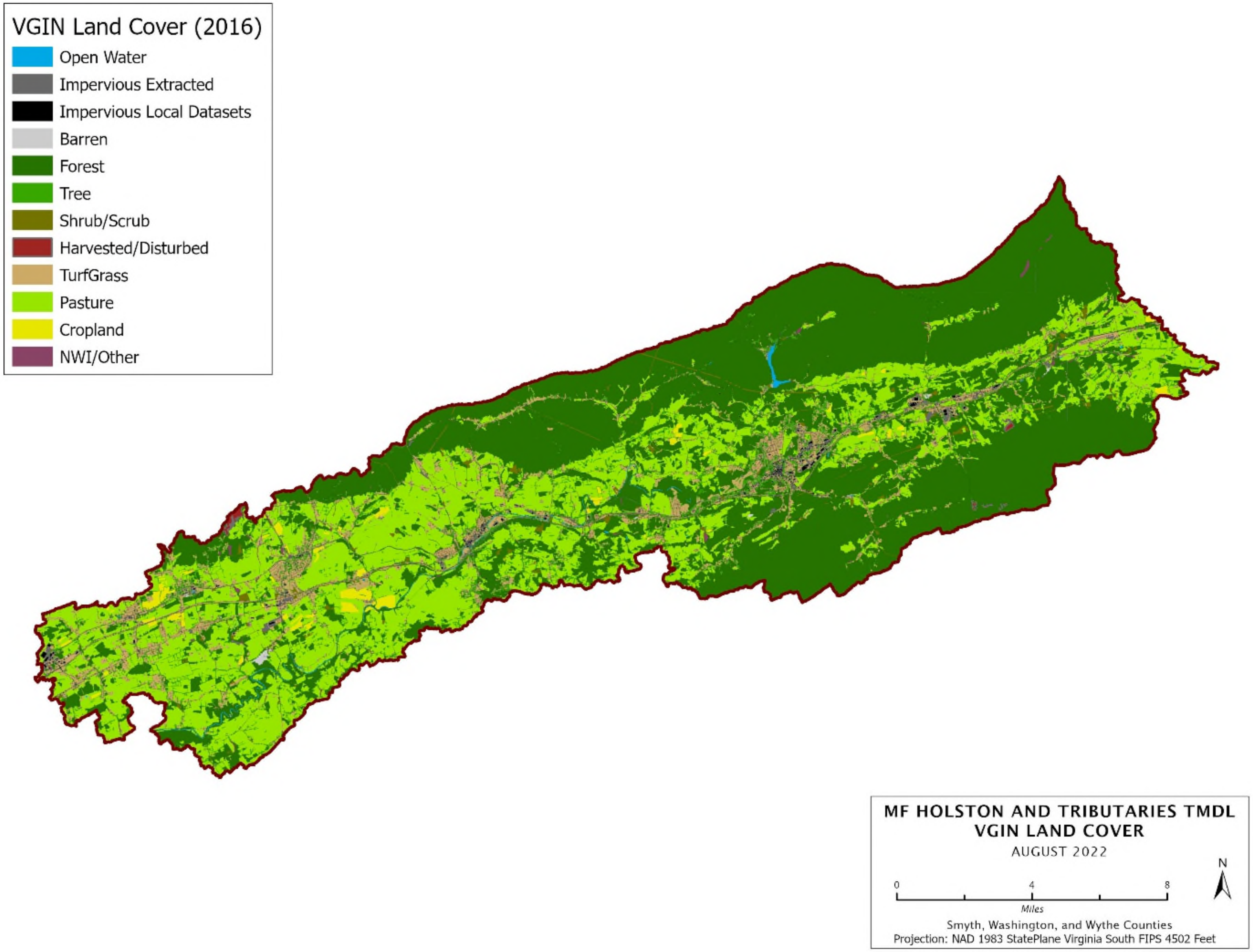


Figure 3. MF Holston TMDL Landcover distribution.

Table 6. Land cover distributions in the study watersheds.

Land Cover	**Byers Creek**		**Hall Creek**		**Cedar Creek**		**Greenway Creek**		**Tattle Creek**	
	Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage
Cropland	307	3.1%	164	2.6%	160	3.4%	60	1.3%	112	6.0%
Hay	1963	19.8%	1176	18.8%	1253	27.0%	1205	26.0%	339	18.1%
Pasture	2662	26.8%	1595	25.4%	1362	29.3%	1309	28.2%	460	24.6%
Forest	1953	19.7%	1566	25.0%	458	9.9%	770	16.6%	191	10.2%
Trees	1012	10.2%	660	10.5%	477	10.3%	374	8.1%	165	8.8%
Shrub	134	1.3%	86	1.4%	32	0.7%	22	0.5%	35	1.9%
Harvested	144	1.4%	144	2.3%	4	0.1%	4	0.1%	0	0.0%
Water	5	0.1%	5	0.1%	2	0.0%	2	0.0%	0	0.0%
Wetland	55	0.6%	53	0.8%	4	0.1%	9	0.2%	2	0.1%
Barren	65	0.7%	6	0.1%	0	0.0%	4	0.1%	1	0.1%
Turfgrass	1037	10.4%	535	8.5%	654	14.1%	525	11.3%	334	17.8%
Developed Pervious	72	0.7%	32	0.5%	25	0.5%	45	1.0%	32	1.7%
Developed Impervious	517	5.2%	250	4.0%	214	4.6%	311	6.7%	200	10.7%
Total	*9,927*	*100.0%*	*6,272*	*100.0%*	*4,645*	*100.0%*	*4,639*	*100.0%*	*1,871*	*100.0%*

Table 7. Landcover distributions in the study watershed continued.

Land Use	Upper MF Holston		Lower MF Holston	
	Acres	Percentage	Acres	Percentage
Cropland	65	1.8%	646	0.6%
Hay	599	16.9%	10601	9.3%
Pasture	985	27.8%	18141	15.9%
Forest	1504	42.4%	67851	59.4%
Trees	238	6.7%	7278	6.4%
Shrub	17	0.5%	819	0.7%
Harvested	0	0.0%	98	0.1%
Water	4	0.1%	286	0.3%
Wetland	15	0.4%	178	0.2%
Barren	0	0.0%	18	0.0%
Turfgrass	49	1.4%	4728	4.1%
Developed Pervious	7	0.2%	378	0.3%
Developed Impervious	59	1.7%	3277	2.9%
Total	*3,542*	*100.0%*	*114,300*	*100.0%*

c. Permitted Sources

There are six VPDES individual permits within the study area (**Table 8**). The typical sediment load from the facilities were calculated from discharge monitoring report (DMR) data and used to model existing conditions. The permitted load, which is included in the wasteload allocation of the TMDL, was calculated based on the permitted discharge and concentration for each of the facilities.

Table 8. Sediment loads associated with VPDES individual permits.

Permit No	Facility Name	Receiving Stream	Estimated Maximum Discharge (MGD)	Permitted Conc. (mg/L TSS)	Typical Load (lb/yr TSS)	Permitted Load (lb/yr TSS)
VA0054381	DGIF - Marion State Fish Hatchery	MF Holston	2.3	10	29,934.2	70,050.9
VA0026379	Chilhowie Regional Wastewater Treatment Plant	MF Holston	0.999	30	3,454.7	91,279.3
VA0087378	Washington Cnty Service Authority - Hall Creek WWTP	Hall Creek	0.95	30	6,136.8	86,802.2

There is one VPDES potable water treatment plant (PWTP) general permit within the study area, associated with the Hutton Branch Water Treatment plant. The typical and permitted loads were calculated using the same method as for the VPDES individual permits (**Table 9**).

Table 9. PWTP General Permit in the study area.

Permit No	Facility Name	Receiving Stream	Estimated Maximum Discharge (MGD)	Permitted Conc. (mg/L TSS)	Typical Load (lb/yr TSS)	Permitted Load (lb/yr TSS)
VAG640016	Hutton Branch Water Treatment Plant	Upper MF Holston	0.075	30	1,608	6,853

There are two non-metallic mineral mining (NMMM) permits in the watershed for Cardinal Quarries – Bear Creek Quarry and Appalachian Aggregates LLC – Glade Stone Plant (**Table 10**). The estimated existing and allocated loads are being developed.

Table 10. Sediment load associated with the non-metallic mineral mining permit.

Permit No	Facility Name	Watershed
VAG840023	Cardinal Quarries – Bear Creek Quarry	MF Holston
VAG840153	Appalachian Aggregates LLC - Glade Stone Plant	Tattle Branch

There is one vehicle wash facility general permit in the watershed (**Table 11**). This facility is a permitted source of sediment (at 60 mg/L).

Table 11. Vehicle wash facility general permits in the study area.

Permit No	Permitted Entity	Receiving Stream	Permitted Discharge (MGD)	Permitted Conc. (mg/L TSS)	Typical Load (lb/yr TSS)	Permitted Load (lb/yr TSS)
VAG750216	Azam Samma LLC - Samma Foodmart 2	Cedar Creek	0.005	60	59	54.8

There are 16 domestic sewage general permits in the study area (**Table 12**). The domestic sewage general permit specifies a maximum flow rate of 1000 gallons per day at a sediment concentration of 30 mg/L. These permit limits were used to calculate a wasteload allocation of 91.44 lb/yr TSS for each permit.

Table 12. Domestic Sewage General Permit in the study area.

Receiving Stream	Permit Number	Permitted Load (lb/yr TSS)	Aggregate Permitted Load (lb/yr TSS)
Cedar Creek	VAG409006	91.44	182.88
	VAG409187	91.44	
Greenway Creek	VAG400585	91.44	182.88
	VAG400324	91.44	
Hutton Creek	VAG409177	91.44	182.88
	VAG400181	91.44	
MF Holston	VAG400491	91.44	914.4
	VAG400078	91.44	
	VAG400053	91.44	
	VAG400618	91.44	
	VAG400654	91.44	
	VAG400579	91.44	
	VAG400071	91.44	
	VAG400548	91.44	
	VAG400576	91.44	
	VAG400102	91.44	

There are seventeen industrial stormwater (ISW) general permits in the study area (**Table 13**). Sediment loads from industrial stormwater permits are included in this study. There is not currently a permitted loading rate for sediment for industrial stormwater sources in the general permit. However, the Chesapeake Bay TMDL now requires permittees to assess their nutrient and sediment loadings. As such, VADEQ developed a methodology to estimate the loads from ISW permitted areas. Under existing conditions, the regulated industrial acres for each permit are estimated to have the same loading rate as other developed, impervious acres. The allocated loads to be used in developing the TMDL will instead apply the loading rate of 440 lb/ac/yr TSS noted in the general permit to the regulated industrial acres for each permit. This loading rate was used to estimate the loading from industrial stormwater facilities for Chesapeake Bay TMDL documentation.

Table 13. Industrial stormwater general permits in the study area

Permit No	Facility Name	Watershed
VAR050045	Utility Trailer Manufacturing Co - Atkins	Middle Fork Holston
VAR051781	D and D Sales	Middle Fork Holston
VAR052400	Mountain Empire Airport	Middle Fork Holston
VAR050042	Marion Mold and Tool Incorporated	Middle Fork Holston
VAR051525	General Dynamics Mission Systems - Marion Plant #3	Middle Fork Holston
VAR051655	Royal Mouldings Limited	Middle Fork Holston
VAR052242	Heniff - Marion Terminal	Middle Fork Holston
VAR050132	Berry Iron and Metal	Middle Fork Holston
VAR051556	Rolling Frito Lay Sales LP - Marion Bin	Middle Fork Holston
VAR051866	American Wood Fibers	Middle Fork Holston
VAR052229	C and A Fabricating Inc	Middle Fork Holston
VAR050748	Utility Trailer Manufacturing Company - Glade	Tattle Branch
VAR052033	Larrys Used Auto Parts Inc	Byers/Hall Creek
VAR050029	Wolf Hills Fabricators LLC	Greenway Creek
VAR050035	Strongwell Highlands	Greenway Creek
VAR051973	MXI Environmental Services LLC	Greenway Creek
VAR052061	Hapco - Division of Kearney National Incorporated	Greenway Creek

There are currently 17 active Virginia Stormwater Management Program (VSMP) permits for construction within the study area (**Table 14**). These permits are a potential source of sediment and will be assigned wasteload allocations in the TMDL. Each permit contains an estimate of the permitted disturbed area; however, this area is generally not disturbed for the entire length of the permit's active status. To account for this discrepancy, the acreage estimated to be disturbed for each permit was divided over the length of the permit's active status (no less than one year). Any active permits in process of termination were excluded because at that stage in the permitting cycle all areas are stabilized.

Table 14. VSMP Construction General Permits in the study area.

Receiving Stream	Estimated Potential Disturbed Area (ac)
Greenway Creek	4.0
Middle Fork Holston	80.3
Total	**84.3**

Appropriate erosion and sediment control measures are assumed to be utilized on all construction projects, and for developing final WLAs for the allocation scenarios, loads are proposed to be simulated with an 85% sediment removal efficacy based on Chesapeake Bay Expert Panel Guidance (ESCEP, 2014).

Questions:
Are there any permitted sources of sediment in the study watersheds missing?

Do the acreage estimates for construction related disturbance seem reasonable?

Does the removal efficacy for erosion and sediment control measures reflect actual implementation in the field within the watershed?

7. Hydrologic Calibration

GWLF was originally developed as a planning tool for estimating nutrient and sediment loadings in ungauged watersheds and was designed to be able to be implemented without calibration. When appropriate data is available for comparison, though, calibration can improve the accuracy of GWLF. Hydrologic calibration was performed as a preliminary modeling step to ensure that hydrology was being simulated as accurately as possible.

Historic daily flow data was available from USGS flow gauge #03474000 – Middle Fork Holston at Seven Mile Ford back to 1942. Daily rainfall and temperature data for the watershed was obtained from Oregon State’s spatially distributed PRISM model (Parameter-Elevation Regressions on Independent Slopes Model), which interpolates available datasets from a range of monitoring networks and is used as the official spatial climate data sets of the USDA. PRISM was utilized to obtain a more exact estimate of historical weather within the watershed, rather than relying on a nearby gauge outside of the watershed.

Leaving a ‘warm-up’ period for the model (year 2000), the years from 2011 to 2020 were used as the calibration period, and years 2001 to 2010 were used as a validation dataset. These ranges are sufficiently long that a range of both dry and wet years are encompassed in each to better assess the model’s performance.

Calibration efforts focused on adjusting watershed scale parameters, such as the recession coefficient and seepage coefficient, that cannot be calculated or estimated reliably from available guidance. The typical target ranges for GWLF calibration efforts are to achieve ±5% of the observed total flow and ±20% compared to seasonal flow distribution. The final GWLF calibration results are shown in **Table 15** and **Figure 4**. The results of the calibration were also assessed for overall correlation by calculating an R^2 value for the datasets. Generally, for GWLF, an R^2 value greater than 0.7 indicates a strong positive correlation between simulated and observed data.

Following calibration, the model output was run compared to the observed 2001 to 2020 discharge as a validation of the calibrated model. The final GWLF validation results are shown in **Table 15** and **Figure 5**.

Table 15. Results of hydrology calibration of GWLF model

Criteria	Calibration Range Percent Difference	Validation Range Percent Difference
Total Cumulative Discharge	-4.50	6.94
Spring Discharge	-2.91	2.36
Summer Discharge	-9.57	14.68
Fall Discharge	7.81	16.88
Winter Discharge	-9.59	1.78
R^2	0.78	0.64

Questions:
Any questions regarding the hydrologic calibration and validation?

8. Next Steps

Once the AllForX regression is finalized and target sediment load endpoints have been selected, we will generate a series of sediment reduction scenarios to share with the TAC at the next meeting. We will look for TAC input on which scenario makes the most sense for each watershed to meet sediment reduction goals and proceed with completing the TMDL study.

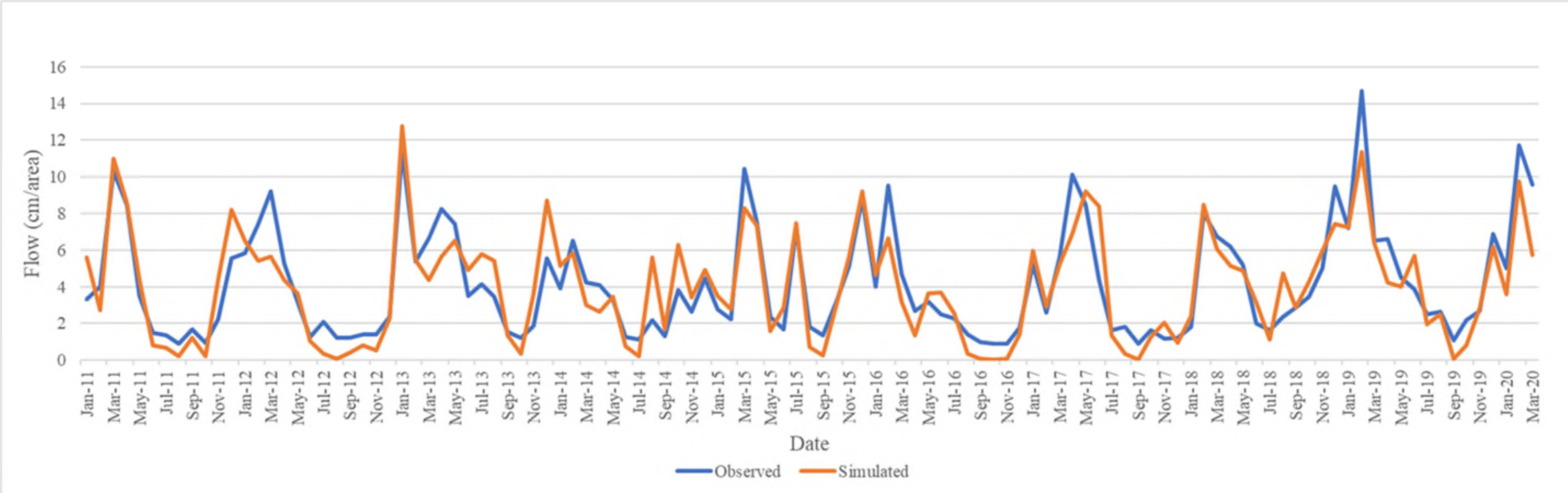


Figure 4. Calibration data set of simulated stream flow at outlet of subwatershed 6 compared to observed flow (USGS# 03474000).

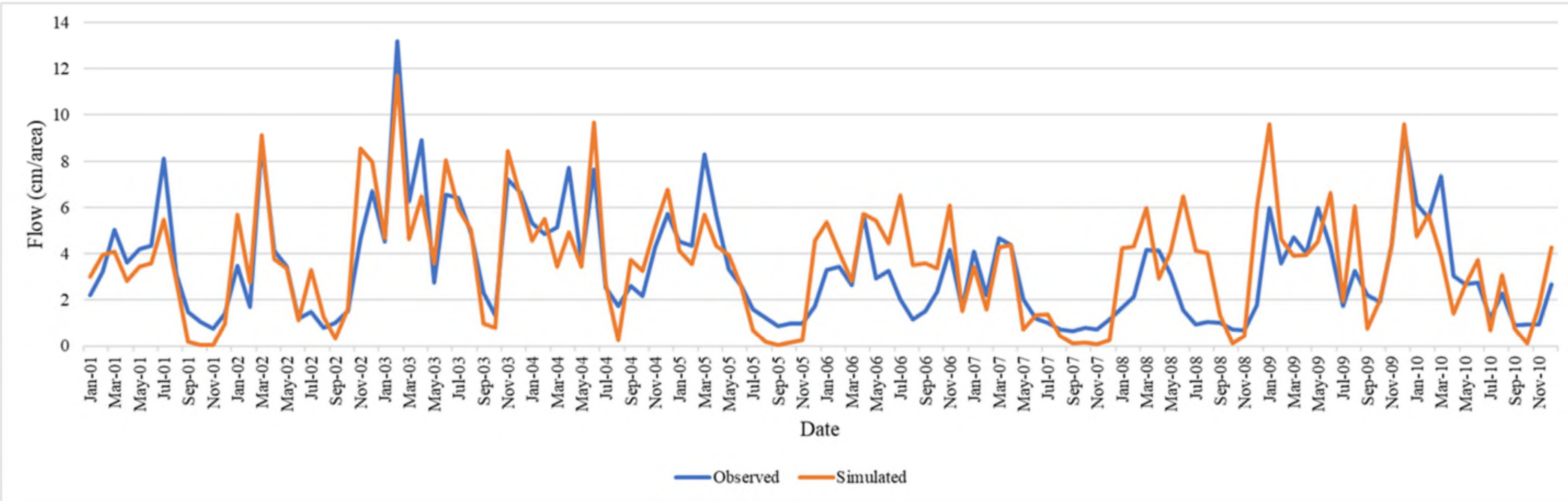


Figure 5. Validation data set of simulated stream flow at outlet of subwatershed 6 compared to observed flow (USGS#03474000).