UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

12/22/2015

Ms. Jutta Schneider, Director
Division of Water Quality Programs
Virginia Department of Environmental Quality
629 E. Main Street
P.O. Box 1105
Richmond, Virginia 23218

Dear Ms. Schneider:

The U.S. Environmental Protection Agency (EPA), Region III, is pleased to approve the Total Maximum Daily Load (TMDL) to address the recreation use (bacteria) impairments in the Crooked Creek, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek watersheds, and the aquatic life use (general standard-benthic) impairment in the Happy Creek watershed, located in Clarke, Frederick, and Warren Counties, Virginia. The TMDL Report, *Bacteria TMDL Development for Crooked Run, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek Watersheds, and Sediment TMDL Development for Happy Creek Watershed Located in Clarke, Frederick, and Warren Counties, Virginia,* was submitted to EPA for review with a letter dated November 6, 2015. The TMDL was established and submitted in accordance with Sections 303(d)(1)(c) and (2) of the Clean Water Act to address impairments of water quality as identified in Virginia's Section 303(d) List.

In accordance with Federal regulations at 40 CFR §130.7, a TMDL must comply with the following requirements: (1) be designed to attain and maintain the applicable water quality standards; (2) include a total allowable loading and, as appropriate, wasteload allocations for point sources and load allocations for nonpoint sources; (3) consider the impacts of background pollutant contributions; (4) take critical stream conditions into account (the conditions when water quality is most likely to be violated); (5) consider seasonal variations; (6) include a margin of safety (which accounts for uncertainties in the relationship between pollutant loads and instream water quality); and (7) be subject to public participation. The bacteria TMDLs for Crooked Creek, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek, and the sediment TMDL for Happy Creek satisfy(es) each of these requirements. In addition, the TMDL considered reasonable assurance that the TMDL allocations assigned to nonpoint sources can be reasonably met. A copy of EPA's Rationale for approval of these TMDLs is included with this letter.

As you know, all new or revised National Pollutant Discharge Elimination System permits must be consistent with TMDL wasteload allocations pursuant to 40 CFR §122.44

(d)(1)(vii)(B). Please submit all such permits to EPA for review as per EPA's letter dated September 29, 1998.

If you have any questions please call me, or have your staff contact Jon Markovich at 215-814-5784.

Sincerely,

/signed/

Jon M. Capacasa, Director
Water Protection Division

Enclosure

cc: Ms. Elizabeth McKercher, VADEQ

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Decision Rationale
Bacteria TMDL Development for Crooked Run, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek Watersheds, and Sediment TMDL Development for Happy Creek Watershed Located in Clarke, Frederick, and Warren Counties, Virginia

/s/
Jon M. Capacasa, Director
Water Protection Division

Date: 12/22/2015

Decision Rationale for Approving Crooked Run, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek Watershed TMDLs Addressing Recreational Use Impairments and Happy Creek Watershed TMDL Addressing Aquatic Life Use Impairments:

I. The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for the attainment of water quality standards (WQS). A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a Margin of Safety (MOS), that may be discharged to a water quality-limited waterbody.

This document will set forth the U.S. Environmental Protection Agency's (EPA) rationale for approving the TMDLs for *Escherichia coli* (*E. coli*) in the Crooked Run, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek Watersheds, and sediment in the Happy Creek watershed. The TMDLs were established to address recreational (bacteria) use and aquatic life (benthic) impairments, as identified on Virginia's 2012 Section 303(d) List for water quality-limited segments. The Virginia Department of Environmental Quality (VADEQ) submitted the TMDL Report, *Bacteria TMDL Development for Crooked Run, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek Watersheds, and Sediment TMDL Development for Happy Creek Watershed Located in Clarke, Frederick, and Warren Counties, Virginia*, to EPA for review and approval on November 6, 2015. The TMDLs address 8 stream segments in the TMDL watersheds.

EPA's rationale is based on the determination that the TMDLs meet the following seven regulatory conditions pursuant to 40 CFR Part 130.

1. The TMDLs are designed to implement applicable water quality standards.
2. The TMDLs include a total allowable load as well as individual wasteload allocations (WLAs) and load allocations (LAs).
3. The TMDLs consider the impacts of background pollutant contributions.
4. The TMDLs consider critical environmental conditions.
5. The TMDLs consider seasonal environmental variations.
6. The TMDLs include a MOS.
7. The TMDLs have been subject to public participation.

In addition, these TMDLs provided reasonable assurance that the LAs assigned to nonpoint sources can be achieved.

II. Background

The Crooked Run, Borden Marsh Run, Willow Brook, West Run, Long Branch, Stephens Run, Manassas Run, and Happy Creek Watersheds ("Shenandoah River tributaries") are located within the Shenandoah River Basin. The Borden Marsh Run, Crooked Run, Long Branch, Manassas Run, Stephens Run, West Run, and Willow Brook watersheds are tributaries of the Shenandoah River. Happy Creek is a tributary of the South Fork Shenandoah River, which

flows into the Shenandoah River. The study area is approximately 67,588 acres in size and covers portions of Frederick County, Clarke County and Warren County, and the Town of Front Royal. The land uses vary among the watersheds, but predominant land uses in the Shenandoah River tributaries watersheds overall are forest (44.7%), agriculture (41.0%), and developed (13.5%).

The Borden Marsh Run watershed is predominantly agriculture (78.4%), with less significant forest (14.7%), and developed (6.2%) land use. The land use distribution in the Crooked Run watershed, including the West Run and Stephens Run watersheds, consists mainly of agricultural area (47.2%), with forest covering 39.4% of the area and developed land covering 12% of the watershed. The land use distribution in the Happy Creek watershed consists mainly of forested area (66.6%) with less significant area in developed (21.2%) and agriculture (11.7%). The land use in the Long Branch watershed consists mainly of agricultural uses (81.7%), with less significant portions in forest (14.1%) and development (4.1%). The Manassas Run watershed is predominately forested (71.3%) with less significant area in development (14.8%) and agriculture (13.3%). The land use distribution in Stephens Run consists mainly of agricultural land uses (57.2%) and forest (24.3%) with less significant area being developed (17.6%). The land use in West Run consists mainly of agriculture (48.9%), forest (42.0%) and development (8.2%). Land use in the Willow Branch watershed is mainly agricultural (69.7%) with less significant area in forest (17.6%), and development (12.6%).

The Shenandoah River tributaries were listed as impaired on Virginia's 2012 Section 303(d) Report on Impaired Waters due to water quality violations of the E. coli standard. Two stream segments in the Happy Creek watershed in USGS Hydrologic Unit 02070005 were listed as impaired on Virginia's 2012 Section 303(d) Report on Impaired Waters due to water quality violations of the general aquatic life (benthic) standard. The VADEQ 2012 Fact Sheets for Category 5 Waters state that Happy Creek is impaired based on assessments of the Virginia Stream Condition Index (VSCI) at biological stations 1BHPY001.29 and 1BHPY002.67. A complete listing history of the impaired stream segments identified in the Shenandoah River tributaries watersheds is presented in Table 1.

Table 1. Section 305(b)/303(d) Listing History for Impairments Identified in the Shenandoah River Tributaries Watersheds

TMDL Segment Name	TMDL pollutant	305b ID (AU)	2002 303d ID	2004 303d ID	2006 303d ID	2008 303d ID	2010 303d ID	2012 303d ID
Happy Creek	Sediment	VAV-B41R_HPY01A00	n/a	n/a	n/a	B41R-03-BEN	B41R-03-BEN	B41R-03-BEN
Happy Creek Borden Marsh Run	Sediment	VAV-B41R_HPY02A00	n/a	n/a	n/a	B41R-03-BEN	B41R-03-BEN	B41R-03-BEN
	E. coli	VAV-B55R_BMR01A00	n/a	n/a	50240	B55R-02-BAC	B55R-02-BAC	B55R-02-BAC
Crooked Run	*E. coli*	VAV-B56R_CRO01A00	VAV-B56R-01	VAV-B56R-01	01626	B56R-01-BAC	B56R-01-BAC	B56R-01-BAC
Happy Creek	*E. coli*	VAV-B41R_HPY01A00	n/a	VAV-B41R-01	01624	B41R-01-BAC	B41R-01-BAC	B41R-01-BAC
Happy Creek Long Branch	*E. coli*	VAV-B41R_HPY02A00	n/a	VAV-B41R-01	01624	B41R-01-BAC	B41R-01-BAC	B41R-01-BAC
	E. coli	VAV-B57R_LNG01A04	n/a	VAV-B57R-02	01647	B57R-02-BAC	B57R-02-BAC	B57R-02-BAC
Manassas Run	*E. coli*	VAV-B55R_MAN01A00	n/a	VAV-B55R-01	01625	B55R-01-BAC	B55R-01-BAC	B55R-01-BAC
Manassas Run Stephens Run	*E. coli*	VAV-B55R_MAN02A04	n/a	VAV-B55R-01	01625	B55R-01-BAC	B55R-01-BAC	B55R-01-BAC
	E. coli	VAV-B56R_STV01A00	n/a	VAV-B56R-02	01627	n/a	B56R-02-BAC	B56R-02-BAC
West Run	*E. coli*	VAV-B56R_WST01A00	n/a	n/a	n/a	n/a	B56R-03-BAC	B56R-03-BAC
Willow Brook	*E. coli*	VAV-B55R_WLO01A06	n/a	n/a	50241	B55R-03-BAC	B55R-03-BAC	B55R-03-BAC

TMDL Endpoints

The numerical criteria for *E. coli* are a *Geometric Mean* of 126 cfu/100 ml and a *Single Sample Maximum* of 235 counts/100 ml. The endpoints were established based on the designated use of primary contact recreation (i.e., swimming and fishing). A variety of allocation scenarios were evaluated to meet the E. coli TMDL goal of a calendar-month geometric mean concentration less than 126 cfu/100 mL. The recommended TMDL scenarios, scenario 2 in the report, represent a 0% violation rate of the *E. coli* geometric mean standard and less than 10% violation rate of the single sample maximum criterion.

Since there are no in-stream water quality criteria for sediment in Virginia, an alternate method was used to establish a reference endpoint that would represent the "non-impaired" condition. For the Happy Creek sediment impairments, the procedure used to set TMDL sediment endpoint loads is a modification of the methodology used to address sediment impairments in Maryland's non-tidal watersheds, and is referred to as the "all-forest load multiplier" (AllForX) approach. AllForX is the ratio of the simulated sediment load for existing conditions to the sediment load from an all-forest condition for the same watershed. The AllForX approach was applied locally for Happy Creek, using a selection of watersheds with monitoring stations that have healthy biological scores. The four comparison "reference" watersheds used in this application of the AllForX approach were Fiery Run, Mill Creek, Rose River, and Manassas Run. A regression was developed between the average Virginia Stream Condition Index (VSCI) biological index scores at impaired and selected comparison monitoring stations and the corresponding AllForX ratio from their contributing watersheds. Appendix G of the TMDL report provides a detailed summary of the AllForX application for Happy Creek.

Modeling Approach

The Hydrological Simulation Program – FORTRAN (HSPF) (Bicknell *et al.*, 2001) was used to simulate the fate and transport of fecal coliform bacteria in the Shenandoah River tributaries watersheds. HSPF is a continuous model that can represent fate and transport of pollutants on both the land surface and in the stream. As recommended by the Virginia Department of Environmental Quality (VADEQ), water quality modeling was conducted with fecal coliform inputs, and then a translator equation was used to convert the output to *E. coli* for the final TMDLs.

The Generalized Watershed Loading Functions (GWLF) model was used to simulate sediment loads in the Happy Creek watershed. The GWLF model is a continuous simulation model that uses daily time steps for weather data and water balance calculations. The GWLF model was run in metric units and converted to English units for this report.

TMDL Computation

Various source reduction scenarios were evaluated to identify implementable scenarios that meet the calendar-month geometric mean E. coli criterion (126 cfu/100 mL) with zero violations. These scenarios were conducted using the same meteorological data used to establish existing conditions. The bacteria loadings used in modeling correspond to anticipated and permitted future conditions for Borden Marsh Run, Crooked Run, Happy Creek, Long Branch,

Manassas Run, Stephens Run, West Run, and Willow Brook. Equation 1 was used to calculate the TMDL allocations shown in Table 2.

$$TMDL = WLA_{total} + LA + MOS \quad [1]$$

Where:
WLA_{total} = waste load allocation (point source contributions, including future growth);
LA = load allocation (nonpoint source contributions); and
MOS = margin of safety.

Table 2. Annual E. coli loadings (cfu/yr) for the TMDLs.

Impairment	WLAtotal	LA*	MOS**	TMDL
Borden Marsh Run	2.81×10^{11}	1.37×10^{13}	--	1.40×10^{13}
Crooked Run	2.22×10^{12}	6.39×10^{13}	--	6.61×10^{13}
Happy Creek	4.27×10^{11}	2.09×10^{13}	--	2.13×10^{13}
Long Branch	1.73×10^{11}	8.48×10^{12}	--	8.65×10^{12}
Manassas Run	3.24×10^{11}	1.42×10^{13}	--	1.45×10^{13}
Stephens Run	3.07×10^{11}	1.39×10^{13}	--	1.42×10^{13}
West Run	5.80×10^{11}	2.24×10^{13}	--	2.30×10^{13}
Willow Brook	2.33×10^{11}	1.13×10^{13}	--	1.15×10^{13}

*The LA is the remaining loading allowed after the MOS and WLA are subtracted from the TMDL as determined for the downstream end of the impaired segment, the watershed outlet. This value is different from the tables providing nonpoint source load because of factors such as bacteria die off that occur between the point of deposition and the modeled watershed outlet.
**Implicit MOS

The sediment TMDL load for the Happy Creek watershed was calculated as the value of AllForX, the point where the regression line between AllForX and the VSCI intersected the VSCI impairment threshold (VSCI = 60), times the all-forest sediment load of the TMDL watershed. The Happy Creek TMDL load and its components are shown in Table 3.

Table 3. Happy Creek sediment TMDL.

Impairment	TMDL	WLA		LA	MOS
	Sediment Load (tons/yr)				
Cause Group Code B41R-03-BEN					
Happy Creek	2,511.3	29.05		2,289.8	192.4
VAC-B41R_HPY01A00		VAR050852 Zuckerman Metals, Inc.	2.52 tons/yr		
VAC-B41R_HPY02A00		construction aggregate WLA	1.42 tons/yr		
		Future Growth WLA	25.11 tons/yr		

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the seven basic requirements for establishing *E. coli* TMDLs for the Shenandoah River tributaries watersheds and a sediment TMDL for the Happy Creek watershed. EPA is, therefore, approving the TMDLs. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

According to Virginia Water Quality Standards (9 VAC 25-260-10):

All State waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them, wildlife, and the production of edible and marketable natural resources, e.g., fish and shellfish.

The General Standard, as defined in Virginia State law, 9 VAC 25-260-20, states:

State waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.

EPA has recommended that all states adopt an *E. coli* standard for freshwater and *enterococci* standards for saltwaters and transition zones, as there is a stronger correlation between the concentration of these organisms and the incidence of gastrointestinal illness than there is with fecal coliform. *E. coli* and *enterococci* are both bacteriological organisms that can be found in the intestinal tract of warm-blooded animals and are subsets of the fecal coliform and fecal streptococcus groups, respectively. Virginia adopted and published revised bacteria criteria on June 17, 2002, which became effective on January 15, 2003. As of that date, the *E. coli* standard described below applies to all freshwater streams in Virginia. Additionally, prior to June 30, 2008, the interim fecal coliform standard must be applied at any sampling station that has fewer than 12 samples of *E. coli*.

For a nonshellfish waterbody to be in compliance with Virginia's revised bacteria standards (as published in the Virginia Register Volume 18, Issue 20) the following criteria applies to primary contact recreational uses for all freshwaters:

- Interim Fecal Coliform Standard: Fecal coliform bacteria shall not exceed a geometric mean of 200 fecal coliform bacteria per 100 ml of water for two or more samples over a calendar month, nor shall more than 10 percent of the total samples taken during any calendar month exceed 400 fecal coliform bacteria per 100 ml of water.

- *Escherichia coli* Standard: *E. coli* bacteria concentrations for freshwater shall not exceed a geometric mean of 126 counts per 100 ml for two or more samples taken

during any calendar month, and shall not exceed a single sample maximum of 235 counts per 100 ml.

The Virginia Department of Environmental Quality (VA DEQ) specifies the following criteria for recreational uses for waterbodies located in saltwater or in a transition:

- "*Enterococci* bacteria shall not exceed a geometric mean of 35 counts/100 ml of water for two or more samples over a calendar month, nor shall exceed the single sample maximum of 104 counts/100 ml of water."

For the 2012 assessment period, January 2005 through December 2010, all of the stations had a violation rate greater than 10.5% of the single-sample maximum criterion concentration of 235 cfu/100ml, leading to the impaired classification for the Borden Marsh Run, Crooked Run, Happy Creek, Long Branch, Manassas Run, Stephens Run, West Run, and Willow Brook segments.

The bacteria TMDLs for the impaired segments were developed not to exceed the E. coli monthly geometric mean criterion, 126 E. coli cfu/100mL. The modeling was conducted with fecal coliform inputs, and then a translator equation provided by VADEQ was used to convert the output to E. coli concentrations.

A numeric endpoint for sediment was developed to represent the water quality goals that are to be achieved through the implementation of the TMDL. Since there are no in-stream water quality standards for sediment in Virginia, an alternate method was needed for establishing a reference endpoint that would represent the "non-impaired" condition. The procedure used to set TMDL sediment endpoint loads for the Happy Creek watershed in this TMDL report is a modification of the methodology used to address sediment impairments in Maryland's non-tidal watersheds, the AllForX approach. AllForX is the ratio of the simulated sediment load for existing conditions to the sediment load from an all-forest condition for the same watershed. The AllForX approach was applied locally for Happy Creek, using a selection of watersheds with monitoring stations that have healthy biological scores. A regression was developed between the average VSCI biological index scores at impaired and selected comparison monitoring stations and the corresponding AllForX ratio from their contributing watersheds. The AllForX comparison watersheds were selected using these criteria:

- nearby watersheds (within 30 miles)
- Average VSCI > 60 and a minimum VSCI > 55
- Minimum of 3 VSCI samples
- The most recent VSCI sample has been since January 2005
- 2nd – 4th order streams
- No upstream-downstream comparison watersheds

Nine potential comparison watersheds were identified for application of the AllForX approach with the two sampling locations in the Happy Creek watershed. After performing load calculations, the number of comparison watersheds was reduced to three, as AllForX values for six of the watersheds were larger than those of the two Happy Creek stations, and therefore, not appropriate for setting sediment reduction targets for Happy Creek. Since one or more additional comparison watersheds were desired for the AllForX regression, modeling was performed on additional potential comparison watersheds and Manassas Run was added to the list as a fourth

comparison watershed, even though its minimum VSCI was slightly outside the criteria listed above.

2) The TMDL includes a total allowable load as well as individual wasteload allocations and load allocations.

Total Allowable Loads

Virginia indicated that the total allowable loading is the sum of the loads allocated to nonpoint and point sources. The allowable loads for the *E. coli* and sediment TMDLs in the Shenandoah River tributaries watersheds can be found in Tables 2 and 3. The total allowable loads were calculated on an annual and daily basis.

Wasteload Allocations

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR §122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR §130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

For the bacteria TMDLs, one hundred eleven point source facilities are located in the Shenandoah River tributaries watersheds (Table 4.2 of the TMDL report). One hundred one of these are general permit coverage for a single family home, and the load from these source were considered small (<10%) relative to the load allocation. A WLA was assigned to the permitted point source facilities in the Crooked Run, Manassas Run, and West Run watersheds. Three permits identified in Table 4.2 – VA0092703, VA0086100, and VA0089095 – are historical permits that are not activated and received no WLA. There are no permitted point source facilities in the Borden Marsh Run, Happy Creek, Long Branch, Stephens Run, and Willow Brook watersheds.

The existing sources WLA in each watershed represented ≤ 10% of the TMDL. Therefore, a scenario to account for future growth was set at 2% of the TMDL for permitted operations in each of the study watersheds. This future growth allocation may be allocated to new or expanding dischargers as determined by the VADEQ Virginia Pollutant Discharge Elimination System program. Any permit issued for bacteria control will include bacteria effluent limits in accordance with applicable permit guidance and will ensure that the discharge meets the applicable numeric water quality criteria for bacteria at the end-of-pipe. Inclusion of the future growth WLA results in no violations of geometric mean standard. Therefore, it is assumed that future growth in point source dischargers with a consistent permitted bacteria concentration of 126 cfu/100 mL *E. coli* will not cause additional violations of the water quality standards.

The WLA for sediment in the Happy Creek watershed is comprised of sediment loads from one individual industrial stormwater permitted source, as well as aggregated loads from construction runoff. In addition, a Future Growth WLA was calculated as 1% of the TMDL.

Load Allocations

According to Federal regulations at 40 CFR §130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and NPS loads should be distinguished.

The watershed model was developed to simulate the transport and fate of fecal coliform, due to the greater availability of fecal coliform production data for various sources. VADEQ's *E. coli* translator regression equation was used to translate the fecal coliform model results to *E. coli* concentrations for comparison to the observed *E. coli* data. The load allocations of *E. coli* in the watershed are derived from cropland, pasture, residential/developed nonpoint sources as well as livestock, wildlife, and straight pipes as direct nonpoint sources. Two allocation scenarios were evaluated and the percent reduction needed to attain the water quality criterion was allocated to each source category.

The nonpoint sources of sediment in the Happy Creek watershed are attributed to the following land use categories: row crops, pasture, hay, forest, harvested forest, transitional/barren, developed, and channel erosion. The LA for sediment was computed by subtracting the MOS and WLAs from the TMDL value. VADEQ developed two allocation scenarios, with each requiring a set reduction from "harvested forest" in compliance with regulated management and from the "barren" land use in compliance with the regulated Erosion and Sediment (E&S) programs. Existing regulations on these two land uses are assumed to already reduce sediment by 50% of their rated efficiencies. Scenario 1 applies equal percent reductions from all other land uses and sources, except point sources. Scenario 2 applies equal percent reductions to the two largest sources, and includes reductions from the harvested forest and transitional (barren) land uses. Sediment Reduction Scenarios are shown in Table 4.

Table 4. Sediment TMDL Load Allocation Scenario, Happy Creek

Land Use/ Source Group	Existing Sediment Load (tons/yr)	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2	
			% Reduction	Allocated Load	% Reduction	Allocated Load
Row Crops	211.5	208.6	37.2%	131.1		208.6
Pasture	909.3	883.6	37.2%	555.3	60.4%	349.7
Hay	735.1	714.4	37.2%	449.0		714.4
Forest	559.8	555.3		555.3		555.3
Harvested Forest	43.0	42.6	42.9%	24.4	42.9%	24.4
Developed	668.4	670.1	37.2%	421.1	60.4%	265.2
Transitional	143.8	162.7	25.0%	122.0	25.0%	122.0
Channel Erosion	47.6	50.2	37.2%	31.6		50.2
Permitted WLA	3.9	29.1		29.1		29.1
Total Load	**3,322.3**	**3,316.6**		**2,318.8**		**2,318.8**
Target Allocation Load =		**2,318.8**				
% Reduction Needed =		30.1%				

3) The TMDLs consider the impacts of background pollution.

The TMDL considers the impact of background pollutants by considering the *E. coli* and sediment loadings from background sources such as wildlife.

4) The TMDLs consider critical environmental conditions.

EPA regulations at 40 CFR §130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality is protected during times when it is most vulnerable. Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards.

Critical conditions were accounted for in the *E. coli* TMDLs by using a period of five years for allocation modeling. Observed meteorological data from the NCDC Cooperative Weather Stations at Front Royal and Winchester were extracted for 2001, 2002, 2003, 2009, and 2011 and used in the allocation simulations. These particular rainfall years were selected because they incorporate average rainfall, low rainfall, and high rainfall; and the climate during these years caused a wide range of hydrologic events including both low and high flow conditions. The bacteria loading in the model for allocation scenarios was representative of anticipated future conditions.

For the sediment TMDL, the GWLF model is a continuous simulation model that uses daily time steps for weather data and water balance calculations. The period of rainfall selected for modeling was chosen as a multi-year period that was representative of typical weather conditions for the area, and included "dry", "normal" and "wet" years. The model, therefore, incorporated the variable inputs needed to represent critical conditions during low flow – generally associated with point source loads – and critical conditions during high flow – generally associated with nonpoint source loads.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

The continuous simulation model developed for these *E. coli* TMDLs explicitly incorporates the seasonal variations of rainfall and other meteorological parameters, in addition to monthly estimates of fecal coliform loads. By using an hourly time-step in the model, these measures account for the seasonal effects in fecal coliform loading within the watershed.

The GWLF model used for sediment loading analysis considered seasonal variation through a number of mechanisms. Daily time steps were used for weather data and water balance calculations. The model also used monthly-variable parameter inputs for evapo-transpiration cover coefficients, daylight hours/day, and rainfall erosivity coefficients for user-specified growing season months.

6) The TMDLs include a Margin of Safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. In developing the Shenandoah River tributaries watershed *E. coli* TMDLs, conservative assumptions and approaches were taken during model development that constitute an implicit MOS. These factors were estimated in such a way as to represent the worst-case scenario; i.e., they describe the worst stream conditions that could exist in the watersheds. Creating TMDLs with conservative estimates ensures that the worst-case scenario has been considered and that no water quality standard violations will occur if the TMDL plan is followed. The implicit MOS used for the bacteria TMDLs include:

- When estimating spring flows present in the study watersheds, low representative flow values such as 25th percentile of observed flows, were used in the model to avoid overdilution,
- When simulating facilities where dogs and other animals were kept in confinement and waste was directed to sanitary sewer, a pet load was still added to represent possible deposits outside the collection area and "missed" deposits.
- When receiving feedback from the Technical Advisory Committee regarding livestock and wildlife animal populations, the high range of suggested population adjustment was typically used.
- For future conditions modeling (allocation development), biosolids applications were combined by month/day over the period of record and simulated annually throughout the modeling period.

For the Happy Creek watershed sediment TMDL, an explicit MOS for each TMDL watershed was also calculated using the AllForX method. The 80% confidence interval was developed around the chosen value of AllForX, based on the number of watersheds included in the regression and the standard deviation of their AllForX values. The MOS was set equal to the difference between the value of AllForX at VSCI = 60 and the value of AllForX at the lower confidence interval limit, multiplied times the all-forest sediment load for each watershed, amounting to 7.7% of the TMDL.

7) The TMDL has been subject to public participation.

Virginia generally seeks public participation at every stage of TMDL development in order to receive input from stakeholders and to apprise the stakeholders of the progress made. Virginia frequently conducts technical advisory committee (TAC) meetings and always conducts two public meetings within the watershed. As part of the public participation process, Virginia held multiple public meetings and technical advisory committee (TAC) meetings. From January 9, 2014, to September 23, 2014, two public meetings and five TAC meetings were held. Following the final public meeting on September 23, 2014, a 30-day public comment period followed. The final public comment period ended on October 24, 2014. One comment was received during the final public comment period and appropriately addressed by VADEQ.

IV. Discussion of Reasonable Assurance

EPA requires that there be reasonable assurance that TMDLs can be implemented. Once a TMDL has been approved by EPA, measures must be taken to reduce pollution levels from both point and NPSs. The process for developing an implementation plan has been described in the "TMDL Implementation Plan Guidance Manual," published in July 2003 and available upon request from the VADEQ and DCR TMDL project staff or at http://www.deq.state.va.us/Portals/0/DEQ/Water/TMDL/ImplementationPlans/ipguide.pdf.

In general, Virginia intends for the required bacteria reductions to be implemented in an iterative process that first addresses those sources with the largest impact on water quality. Implementation of these TMDLs will contribute to on-going water quality improvement efforts in Shenandoah River tributaries and efforts aimed at restoring water quality. Implementation of BMPs to address the sediment impairment in Happy Creek will be coordinated with BMPs required to meet bacteria water quality standards.

For the implementation of the WLA component of the TMDL, EPA requires that all new or revised NPDES permits must be consistent with the TMDL WLA pursuant to 40 CFR §122.44 (d)(1)(vii)(B). Additionally, Virginia's 1997 Water Quality Monitoring, Information and Restoration Act directs the State Water Control Board to develop and implement a plan to achieve fully supporting status for impaired waters. The Act also establishes that the implementation plan shall include the date of expected achievement of water quality objectives, measurable goals, corrective actions necessary and the associated costs, benefits and environmental impacts of addressing the impairments. Requirements of the permit process should not be duplicated in the TMDL process, and with the exception of stormwater-related permits, permitted sources are not usually addressed during the development of a TMDL implementation plan.

VADEQ coordinates the State program that regulates the management of pollutants carried by storm water runoff. VADEQ regulates storm water discharges associated with "industrial activities", from construction sites, and from municipal separate storm sewer systems (MS4s). It is the intent of the Commonwealth that TMDLs implement existing regulations and programs where they apply. There is one MS4 WLA incorporated into the *E. coli* TMDL for the Crooked Run watershed. The VAR040115 – VDOT MS4 WLA includes load in Stephens Run watershed, a tributary to Crooked Run.

For the LA portion of the TMDL, The Commonwealth intends to use existing programs to the fullest extent in order to attain its water quality goals. The measures for nonpoint source reductions, which can include the use of better treatment technology and the installation of BMPs, will be implemented in an iterative process. Some of the major potential sources of funding for implementation actions may include the U.S. Department of Agriculture's Conservation Reserve Enhancement and Environmental Quality Incentive Programs, EPA Section 319 funds, the Virginia State Revolving Program, the Virginia Water Quality Improvement Fund, tax credits, and landowner contributions.

Monitoring is a vital aspect of the water quality improvement process. VADEQ staff, in cooperation with the Implementation Plan Steering Committee and local stakeholders, will continue to use data from the ambient monitoring stations to evaluate reductions in pollutants,

the effectiveness of the TMDL in attaining and maintaining water quality standards, and the success of implementation efforts. VADEQ will continue to monitor benthic macro-invertebrates and habitat in accordance with its biological monitoring program at stations 1BHPY001.29 and 1BHPY002.67 on Happy Creek. VADEQ will continue to use data from this monitoring station to evaluate improvements in the benthic community and the effectiveness of TMDL implementation in attainment of the general water quality standard.

EPA recognizes that reasonable assurance is also provided through Virginia's Watershed Implementation Plans (WIPs) designed to meet target loads consistent with the Chesapeake Bay TMDL. The Chesapeake Bay TMDL, established by EPA in 2010, requires reductions of nitrogen, phosphorus and sediment loads throughout the Bay watershed to meet water quality standards that protect the designated uses in the Bay and its tidal tributaries. Virginia's Phase I and Phase II WIPs together with the State's schedule of two-year milestones provide implementation strategies and a time line for achieving sediment reductions across the State to meet Chesapeake Bay interim target loads by 2017, equivalent to 60% of the final target goals set for 2025 to fully implement the Chesapeake Bay TMDL in Virginia. A Phase III Plan will be developed in 2017 to address the additional reductions needed from 2018 through 2025 to meet the final targets.

The reductions for the Bay TMDL are independent of those needed to implement any TMDLs developed to address sediment-related impairments in Virginia's non-tidal waterbodies, although their reduction goals and strategies do overlap. For example, the implementation planning framework, developed by the Bay watershed jurisdictions in partnership with EPA, provides a staged approach to achieving Bay TMDL reduction goals that are also applicable to implementation of sediment TMDLs in local non-tidal watersheds. In short, reductions required to meet the Chesapeake Bay TMDL will also support the restoration and protection of local water quality.

Watershed stakeholders will have the opportunity to participate in the development of the TMDL implementation plan. Specific goals for BMP implementation will be established as part of the implementation plan development.