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

JAN 10 2013

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

Dear Ms. Davenport:

The United States Environmental Protection Agency (EPA) has reviewed the Virginia Department of Environmental Quality's (DEQ's) request to amend the Total Maximum Daily Loads (TMDLs), load allocations (LAs) and wasteload allocations (WLAs) for bacteria in Pamunkey River (VAP-F13E-02) and Totopotomoy Creek (VAP-F13R-02). EPA Region III approved these Bacteria TMDLs to address primary contact recreation use impairments on August 2, 2006.

As explained in DEQ's January 4, 2013 letter, the Totopotomoy Sewage Treatment Plant (STP) (VPDES Permit #VA0089915), was assigned a WLA of 1.74 cfu/yr E. coli in the Totopotomoy Creek TMDL. DEQ now understands that the STP discharges to Pamunkey River, not Totopotomoy Creek, and therefore should have been assigned a WLA in the Pamunkey River TMDL. Additionally, DEQ has learned that the STP has a maximum design flow of 10 million gallons per day (MGD), not 0.01 MGD, which was used to calculate the original WLA for the facility.

DEQ indicates that both the Totopotomoy Creek TMDL and the Pamunkey River TMDL will need to be revised to account for this new information. In the Totopotomoy Creek TMDL, the original 1.74 cfu/yr E. coli WLA for the STP will be moved to the future growth allocation, keeping the overall WLA, LA and TMDL values the same. In the Pamunkey River TMDL, a new WLA of 1.74E+13 cfu/yr E. coli – based on a maximum design flow of 10 MGD at Virginia's geometric mean water quality standard of 126 cfu/100ml – will be established for the STP. To accommodate this additional WLA, the LA for Pamunkey River will be reduced to ensure the overall TMDL value remains the same.

EPA understands that the proposed modifications have been subject to public review and comment. Based upon this information, EPA approves the requested modification to the Pamunkey River and Totopotomoy Creek bacteria TMDLs. If you have any questions or comments concerning this letter, please contact Greg Voigt at (215) 814-5737.

Sincerely,

Larry Merrill

Larry Merrill, Associate Director
Office of Standards, Assessment and TMDLs

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
Fax (804) 698-4500 TDD (804) 698-4021
www.deq.virginia.gov

L. Preston Bryant, Jr.
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4000
1-800-592-5482

January 4, 2013

Mr. Greg Voigt
US EPA Region III TMDL Coordinator
USEPA REGION 3 – 3WP12
1650 Arch Street
Philadelphia, PA 19103-2029

RE: Total Maximum Daily Load modifications for the wasteload allocations and load allocations in the bacteria TMDL for the Pamunkey River Basin in Hanover, New Kent, and King William counties.

Dear ~~Mr. Voigt~~ Greg,

The purpose of this letter is to submit for EPA approval modifications to waste load allocations (WLA) and load allocations (LA) for two of the bacteria TMDL equations developed for the Pamunkey River Basin. EPA Region III approved the Pamunkey River Basin bacteria TMDL report addressing primary contact recreational use impairment on 8/2/2006. EPA Region III approved a modification to select TMDL equations in the Pamunkey River Basin TMDL on 10/30/2008, but not segments discussed in this proposal. The specific segments included in the current proposed modifications are Totopotomoy Creek (VAP-F13R-02) and Pamunkey River (VAP-F13E-02). EPA recently approved a modification involving these two segments on 8/29/2012. The current proposed modification involves a correction to one of the previously approved (8/29/2012) modifications. The current modification submittal provides continuity between affected TMDL equations in the original TMDL report.

The proposed modification is being made to ensure consistency between the TMDL and one Virginia Pollution Discharge Elimination System (VPDES) permit. This permit existed at the same permitted discharge level when the TMDL was developed; however it was overlooked during development, and is due for renewal in 2012. Please note that Virginia is currently in the process of developing a watershed TMDL for the Pamunkey River Basin which will supersede the Pamunkey River Basin TMDL report approved by EPA Region III on 8/2/2006.

Modification 1, Totopotomoy Creek (VAP-F13R-02):

In a modification of the Totopotomoy Creek TMDL recently approved by EPA, DEQ assigned a WLA of 1.74E+10 *E. coli* (cfu/yr) to accommodate the Totopotomoy Sewage Treatment Plant (STP; a VPDES major municipal facility; permit #VA 0089915) at a maximum design flow of 0.010 MGD (million gallons per day) and a concentration at the geometric mean water quality standard (WQS) of 126 (cfu/100 ml). DEQ now understands that this facility has a design flow of 10 MGD and discharges to the Pamunkey River (VAP-F13E-02). DEQ proposes to revise the Totopotomoy Creek WLA by moving 1.74E+10 *E.coli* (cfu/yr) to Future Growth (FG). Because the STP was the only point source in the

Totopotomoy Creek TMDL, the revised annual total WLA is equal to the proposed revised FG of 2.62E+10 *E.coli* (cfu/yr). The total WLA, LA and TMDL values will not change.

Modification 2, Annual WLA and LA for Pamunkey River (VAP-F13E-02):

(WLA) The Totopotomoy Sewage Treatment Plant (STP) (permit #VA0089915) is a VPDES major municipal facility with a design flow of 10 MGD and discharges to the Pamunkey River (VAP-F13E-02). The preexisting facility should have been given a WLA in the Pamunkey River TMDL. DEQ proposes to assign an annual WLA of 1.74E+13 *E. coli* (cfu/yr) to accommodate this facility at a maximum design flow of 10 MGD and a concentration at the geometric mean WQS of 126 (cfu/100 ml). The proposed modification results in a change to the total annual WLA value from 7.43E+12 to 2.49E+13 *E. coli* (cfu/yr). DEQ proposes to allocate the additional WLA from the LA.

(LA) The allocation of the proposed Totopotomoy STP WLA by subtracting from LA results in a change to the annual LA value from 7.40E+14 to 7.22E+14 *E. coli* cfu/yr. This additional LA reduction is applied to the non-point source category, pasture. This additional reduction results in no change to the overall percent reduction required for this source.

Summary of Impact and Modification Process

The proposed modifications to the total WLA and LA for the Totopotomoy Creek (VAP-F13R-02) TMDL (modification 1) are equal to 0.00% of the TMDL. The proposed modifications to the total WLA and LA for the Pamunkey River (VAP-F13E-02) TMDL (modification 2) are equal to 2.33% of the TMDL. These proposed modifications for the Pamunkey River (VAP-F13E-02) TMDL, in addition to a previously approved modification of 0.063%, results in a cumulative change equal to 2.4%. DEQ has contracted redevelopment of the Pamunkey River Basin TMDL, scheduled for completion in 2013. This redevelopment includes the Totopotomoy Creek (VAP-F13R-02) and the Pamunkey River (VAP-F13E-02) segments.

DEQ provided public notice and a 30-day comment period on the TMDL modifications which expired on November 23, 2012. No comments were received. DEQ obtained concurrence with the proposed changes in LA from the Virginia Department of Conservation and Recreation as the lead agency for non-point source pollution.

Various pages throughout the text and tables have been changed. A list of these changes by page number is provided below. DEQ is submitting this request for modification of the Pamunkey River Basin TMDL.

Permit Details

The current permit for Totopotomoy Creek STP (VA0089915) expired August 27, 2012 and has been administratively continued.

TMDL Revisions

The following tables and text from the Pamunkey River Basin TMDL report were affected by the described changes, as follows:

P xxxix Executive Summary, Sources of Fecal Coliform for permitted discharges updated to reflect the number of facilities per segment.

P xliii Executive Summary, Table E.9 updated to remove footnote.

P xliv Executive Summary, Table E.12 WLA and LA values updated to reflect addition of the Totopotomoy STP allocation.

P 3-2 and 3-3 Section 3.1, Wording in association with changes to Totopotomoy Creek (F13R-02) and Pamunkey River (F13E-02), dischargers revised.

P 3-3 and 3-4 Table 3.2, Updated to correct discharge segment WLA for *E.coli* and fecal coliform, and the design flow for Totopotomoy Creek STP (VA0089915).

P 4-12 Section 4.6.1 Overview, Updated text to reflect the number of facilities per segment.

P 5-90 Section 5.4, Updated text to reflect the number of facilities per segment.
P 5-118 Table 5.28, Updated to remove footnote.
P 5-128 Table 5.38, Updated to reflect modified WLA and LA values and footnote removed.

These changes are included in the attached modified Pamunkey River Basin TMDL report replacement pages.

In accordance with EPA's August 2003 letter to VADEQ, VADEQ hereby requests EPA approval of the proposed modification. If you or your staff has any questions, please contact Craig Lott at (804) 698-4240.

Sincerely,

Melanie D. Davenport

Melanie D. Davenport
Water Quality Division Director

Attachments
Replacement page(s)

cc: Charles Lunsford, VADCR
Sandra Mueller, VADEQ
Margaret Smigo, PRO TMDL coordinator
File CO

(VADEQ, 2004). Black Creek (VAP-F13R-05) does not support the Recreation Use goal due to five of 18 (27.8%) samples exceeding the instantaneous fecal coliform bacteria standard at station 8-BLC001.77. This segment was included in the 2004 Section 303(d) list (VADEQ, 2004). The instantaneous fecal coliform bacteria standard was exceeded in five of 47 (10.6%) sample s collected during the 2004 Section 303(d) assessment period at station 8-PMK048.80. This segment of Pamunkey River (VAP-F13E-02) was assessed as not supporting of the Recreation Use goal and was included in the 2004 Section 303(d) list (VADEQ, 2004).

In order to remedy the water quality impairment pertaining to fecal coliform, a Total Maximum Daily Load (TMDL) has been developed, taking into account all sources of bacteria and a margin of safety (MOS). The TMDL was developed for the new water quality standard for bacteria, which states that the calendar-month geometric mean concentration of E. coli shall not exceed 126 cfu/100 mL, and that no single sample can exceed a concentration of 235 cfu/100mL. The glossary lists terms used in the development of this TMDL.

Sources of Fecal Coliform

There are one, seven, thirteen, one, two, and one permitted point discharges located in the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Pamunkey River (F13E-02), and Moncuin/Webb Creek (VAP-F13R-04) watersheds, respectively. However, the majority of the fecal coliform load originates from nonpoint sources. Nonpoint sources of fecal coliform are primarily agricultural (i.e., land-applied animal waste, manure deposited directly on pastures by livestock, and a significant fecal coliform load due to cattle directly depositing manure in streams) with a significant load applied to residential and forest land use categories. Non-agricultural anthropogenic nonpoint sources of fecal coliform loadings include straight pipes, leaking sanitary sewer, failing septic systems, and pet waste. Wildlife contributes to fecal coliform loadings on all land uses, according to the acceptable habitat range for each species. The amounts of fecal coliform produced in different locations (e.g., confinement, pasture, forest) were estimated on a monthly basis to account for seasonal variability in wildlife habitat and livestock production and practices. Livestock management and production factors, such as the fraction of time cattle spend in confinement or in streams, the amount of manure storage, and spreading schedules, were considered on a monthly basis.

Modeling

The Hydrologic Simulation Program – Fortran (HSPF) was used to simulate the fate and transport of fecal coliform bacteria in the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Taylors Creek (VAN-F03R-01), Newfound River (VAP-F05R-01), Northeast Creek (VAP-F09R-01), Totopotomoy Creek (VAP-F13R-02), Moncuin/Webb Creek (VAP-F13R-04), Black Creek (VAP-F13R-05), and Pamunkey River (VAP-F13E-02) watersheds. In addition, the USEPA Water Quality Analysis Simulation Program (WASP) coupled with the USEPA Link-Node Tidal Hydrodynamic Model (DYNHYD) was selected as the modeling framework to simulate fecal coliform transport and fate in the Pamunkey River impairment. To identify localized sources of

Table E.4. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in South Anna River (VAP-F04R-01) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	1.04E+12	2.98E+13	N/A	3.08E+13

N/A – not applicable because MOS was implicit.

Table E.5. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in South Anna River (VAP-F04R-02) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	3.48E+12	3.13E+13	N/A	3.48E+13

N/A – not applicable because MOS was implicit.

Table E.6. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Taylors Creek (VAN-F03R-01) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	1.89E+09	1.89E+11	N/A	1.91E+11

N/A – not applicable because MOS was implicit.

Table E.7. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Newfound River (VAP-F05R-01) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	2.89E+10	2.89E+12	N/A	2.92E+12

N/A – not applicable because MOS was implicit.

Table E.8. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Northeast Creek (VAP-F09R-01) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	2.30E+10	2.30E+12	N/A	2.32E+12

N/A – not applicable because MOS was implicit.

Table E.9. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Totopotomoy Creek (VAP-F13R-02) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	2.62E+10	1.61E+12	N/A	1.64E+12

N/A – not applicable because MOS was implicit.

Table E.10. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Moncuin/Webb Creek (VAP-F13R-04) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	1.74E+11	1.81E+11	N/A	3.55E+11

N/A – not applicable because MOS was implicit.

Table E.11. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Black Creek (VAP-F13R-05) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	1.26E+10	1.26E+12	N/A	1.27E+12

N/A – not applicable because MOS was implicit.

Table E.12. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Pamunkey River (VAP-F13E-02) watershed.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	2.49E+13	7.22E+14	N/A	7.47E+14

N/A – not applicable because MOS was implicit.

Stage 1 Implementation

Staged implementation is a key component to restoring water quality in South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Taylors Creek (VAN-F03R-01), Newfound River (VAP-F05R-01), Northeast Creek (VAP-F09R-01), Totopotomoy Creek (VAP-F13R-02), Moncuin/Webb Creek (VAP-F13R-04), Black Creek (VAP-F13R-05), and Pamunkey River (VAP-F13E-02). An alternative scenario was evaluated to establish goals for the first stage of the implementation of the TMDL. The implementation of such a transitional scenario, or Stage 1 implementation, will allow for an evaluation of the effectiveness of management practices and accuracy of model assumptions through continued data collection. The Stage 1 implementation goal was to provide an instantaneous standard violation rate below 10% and 0% reduction in loads from wildlife. The goal was not met in Taylors Creek whereby a reduction in wildlife direct deposition was needed to meet the 10% water quality standard violation rate goal. Stage 1 reduction scenarios are listed in Table E.13.

Table 3.1. Sources of bacteria in the impaired watersheds.

Source Category	Source / Animal Type	Applied To
Human and Pets	Permitted Discharges	Stream Reach
	Sanitary Sewer	Land
	Straight Pipes	Stream Reach
	Failing Septic Systems	Land
	Biosolids Applications	Land
	Dogs / Cats	Land
Agricultural	Dairy Cattle	Land, Stream Reach
	Beef Cattle	Land, Stream Reach
	Horses	Land
	Turkey	Land
	Chicken	Land
	Other Livestock	Land
Wildlife	Deer	Land, Stream Reach
	Raccoon	Land, Stream Reach
	Muskrats	Land, Stream Reach
	Beavers	Land, Stream Reach
	Turkeys	Land, Stream Reach
	Geese	Land, Stream Reach
	Ducks	Land, Stream Reach

3.1 Permitted Discharges

Permitted point sources of fecal coliform bacteria in the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Taylors Creek (VAN-F03R-01), Newfound River (VAP-F05R-01), Northeast Creek (VAP-F09R-01), Moncuin/Webb Creek (VAP-F13R-04), Black Creek (VAP-F13R-05), and Pamunkey River (VAP-F13E-02) watersheds include all municipal and industrial plants that treat human waste (individual permits), as well as private residences that fall under general permits (less than or equal to 1,000 gallons per day). Virginia issues Virginia Pollutant Discharge Elimination System (VPDES) permits for point sources of pollution. Point sources with an individual or general permit were required to maintain a fecal coliform concentration of 200 cfu/100 mL or less (the 'interim standard'), and are required to meet the new *E. coli* standard of 126 cfu/100 mL or less in their effluent on permit renewal. Table 3.2 shows the point sources in the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Moncuin/Webb Creek (VAP-F13R-04), and Pamunkey River (VAP-F13E-02) watersheds, while there are no active permitted facilities discharging bacteria in the Taylors Creek (VAN-F03R-01), Newfound River (VAP-F05R-01), Northeast Creek (VAP-F09R-01), Totopotomoy Creek (VAP-F13R-02), and Black Creek (VAP-F13R-05) watersheds.

In allocation scenarios, the entire allowable point source discharge concentration of 200 cfu/100 mL of fecal coliform (the 'interim standard') was used. The ultimate waste load

allocation (WLA) was calculated using the *E. coli* limit of 126 cfu/100mL, and *E. coli* loads based on the facility design flow are presented in Table 3.2.

Missionary Learning Center (VA0067105) is a minor municipal facility with a design flow of 0.040 MGD. During TMDL development, the facility WLA was calculated based on a design flow of 0.025 MGD. The WLA calculated on the actual design flow of 0.040 MGD results in a a fecal coliform load of 1.2E+11 cfu/yr and a E. coli load of 7.0E+10 cfu/yr, equalling 0.08% of the total TMDL. These changes have been incorporated into the report.

HRSD King William STP (VA0088102) is also a minor municipal facility given a WLA in the TMDL based on the design flow of 0.050 MGD, with the knowledge that an expansion of the design flow would eventually occur. The TMDL tables have been changed to reflect the expanded design flow of 0.100 MGD, which results in a fecal coliform load of 2.77E+11 cfu/yr and an E. coli load of 1.74E+11 cfu/yr.

Totopotomoy STP (VA0089915) is a major municipal facility which should have been given a WLA in the TMDL based on the design flow of 10 MGD. The TMDL tables have been changed to reflect the design flow which results in a fecal coliform load of 2.77E+13 cfu/yr and an E. coli load of 1.74E+13 cfu/yr.

Hamilton-Holmes WWTP (VA0023914) is minor municipal facility which should have been given a WLA in the TMDL based on the design flow of 0.020 MGD. The TMDL tables have been changed to reflect the design flow which results in a fecal coliform load of 5.53E+10 cfu/yr and an E. coli load of 3.48E+10 cfu/yr.

To anticipate future growth and expansion, the TMDL included matricies for 2 and 5 times the WLAs to show that no violation of the water quality standards would occur if permitted facilities discharged at or below the E.coli limit of 126 N/100mL or fecal coliform limit of 200 N/100mL.

Table 3.2. Active VPDES permitted point sources in the Pamunkey River watershed.

Impairment	Permit Number	Facility Name	Sub-shed	Design Flow (MGD)	FC Load (cfu/yr)	*E. coli* Load (cfu/yr)
SA 01	VA0021105	Gordonsville Sewage Treatment Plant	SAR-2	0.940	2.6E+12	1.6E+12
SA 02	VA0088706	Virginia Oil - Zion Crossroads	SAR-6	0.040	1.1E+11	6.9E+10
SA 02	VA0090743	Zion Crossroads WWTP	SAR-6	0.700	1.9E+12	1.2E+12
SA 02	VA0076678	Shenandoah Crossing	SAR-6	0.100	2.8E+11	1.7E+11
SA 02	VAG116048	Ready Mixed Concrete Company	SAR-06	0.001	2.7E+09	1.7E+09
SA 02	VAG251002	Klochner Pentaplast - Gordonsville	SAR-06	0.001	2.7E+09	1.7E+09
SA 02	VAG406073	Residence	SAR-06	0.001	2.7E+09	1.7E+09
SA 02	VA0088421	Twin Oaks Community STP	SAR-12	0.010	2.8E+10	1.7E+10
SA 03	VA0067954	Louisa Regional Sewage Treatment Plant	SAR-14	0.400	1.1E+12	7.0E+11
SA 03	VA0090409	Gum Spring Sewage Treatment Plant	SAR-15	0.016	4.4E+10	2.8E+10
SA 03	VA0090140	Six O Five Village M H P STP	SAR-15	0.040	1.1E+11	7.0E+10
SA 03	VA0067105	Missionary Learning Center WWTP	SAR-16	0.040	1.2E+11	7.0E+10

SA 03	VAG404000	Resident	SAR-20	0.0005	1.3E+09	7.9E+08
SA 03	VAG404200	Elks Lodge 45	SAR-20	0.0005	1.4E+09	9.0E+08
SA 03	VAG404205	Resident	SAR-20	0.001	2.7E+09	1.7E+09
SA 03	VAG404210	Resident	SAR-20	0.0005	1.3E+09	7.9E+08
SA 03	VAG404217	Resident	SAR-20	0.0006	1.6E+09	1.0E+09
SA 03	VA0022641	Patrick Henry High School	SAR-21	0.040	1.1E+11	7.0E+10
SA 03	VA0060232	Country Club Hills Lagoon	SAR-21	0.060	1.7E+11	1.0E+11
SA 03	VAG404222	Resident	SAR-21	0.0005	1.3E+09	7.9E+08
SA 03	VAG404066	Lees Mobil Service	SAR-21	0.001	2.7E+09	1.7E+09
SA 04	VA0024899	Ashland WWTP	SAR-27	2.000	5.5E+12	3.5E+12
Pamunkey River	VA0089915	Totopotomoy STP	PAR-XX	10.000	2.77E+13	1.74E+13
Pamunkey River	VA0023914	Hamilton-Holmes WWTP	PAR-XX	0.020	5.53E+10	3.48E+10
Moncuin / Webb	VA0088102	King William STP	PAR-6	0.100	2.77E+11	1.74E+11

SA 01= South Anna River (VAN-F01R-01) Impairment; SA 02= South Anna River (VAN-F02R-01) Impairment
SA 03= South Anna River (VAN-F04R-01) Impairment; SA 04= South Anna River (VAN-F04R-02) Impairment

Phase II Municipal Separate Storm Sewer System (MS4) permits were also reviewed and found facilities with MS4 permits discharge within the South Anna River, Northeast Creek, Totopotomoy Creek (VAP-F13R-02), Black Creek (VAP-F13R-05), and Pamunkey River (VAP-F13E-02) watersheds.

3.2 South Anna River (VAN-F01R-01) Sources

3.2.1 Humans and Pets

There are 114 homes served by municipal sanitary sewer in the South Anna River (VAN-F01R-01) watershed. Wastewater from 153 households within the watershed is treated on site by traditional sewage handling and disposal systems.

The South Anna River (VAN-F01R-01) watershed has an estimated population of 590 people (268 households at an average of 2.20 people per household (UCSB, 2000); actual people per household varies among sub-watersheds). Humans produce 1.95×10^{9} cfu/day-person (Geldreich et al., 1978), resulting in a total fecal coliform production of 1.15×10^{12} cfu/day (4.20×10^{14} cfu/year) in South Anna River (VAN-F01R-01) watershed.

Bacteria from humans and pets can be transported to streams from failing septic systems, straight pipes discharging directly into streams, biosolid applications to pasture and cropland, or deposition of pet waste on residential land.

3.2.1.1 Failing Septic Systems

Septic systems are designed to filter septic tank effluent through the soil allowing removal of bacteria and nutrients from the wastewater. Septic system failure is manifested by the rise of effluent to the soil surface. It was assumed treatment of effluent ceased once effluent

Using hourly precipitation data, frequency of precipitation events and precipitation amounts per hour were calculated. For daily precipitation amounts equal to or less than 0.3 inches, the daily amount was assigned to the hour with the highest likelihood of rainfall. For daily rainfall amounts greater than 0.3 inches, the daily amount was distributed over the day using the calculated hourly precipitation amount frequency distribution.

4.6 Accounting for Pollutant Sources

4.6.1 Overview

There are one, seven, thirteen, one, two and one active point discharges located in the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Pamunkey River (F13E-02), and Moncuin/Webb Creek (VAP-F13R-04) watersheds, respectively, as identified in Section 3.1. This source was modeled using the permitted concentration and design discharge. Currently, MS4 permitted facilities exist in the South Anna River, Totopotomoy Creek, and Pamunkey River watersheds.

Fecal coliform loads that are directly deposited by straight pipes and cattle along with wildlife in streams were treated as direct nonpoint sources in the model. Fecal coliform that is land-applied or deposited on land was treated as nonpoint source loading; all or part of that load may get transported to the stream as a result of surface runoff during rainfall events. Direct nonpoint source loading was applied to the stream in each sub-watershed as appropriate.

Nonpoint source loading was applied as fecal coliform counts to the pervious fraction of each land use category in a sub-watershed on a daily basis. Both direct nonpoint and nonpoint source loadings were varied by month to account for seasonal differences such as cattle and wildlife access to streams. Nonpoint source loading was applied as fecal coliform counts to the impervious fraction of each land use category in a subwatershed at a constant rate during the year. These constant application rates are a function of land use and are discussed in detail in Section 4.6.4. Fecal coliform die-off was simulated during periods when manure is stored, while on the land between runoff generating precipitation events, and while in streams.

4.6.2 Modeling Fecal Coliform Die-off

Fecal coliform die-off was modeled using a first order die-off equation of the form:

$$C_t = C_0 10^{-kt} \qquad [4.1]$$

where: C_t = concentration or load at time t;

C_0 = starting concentration or load (cfu/ 100ml);

K = decay rate (day-1); and

t = time in days.

A review of literature provided estimates of decay rates that could be applied to waste storage and handling in the South Anna River, Taylors Creek, Newfound River, Northeast Creek, Totopotomoy Creek, Moncuin/Webb Creek, Black Creek, and Pamunkey River watersheds (Table 4.10).

5.4 TMDL Allocation Scenarios

Direct and land-based loads representing existing conditions were reduced in a variety of allocation scenarios (addressing anthropogenic sources first) until the *E. coli* TMDL goals of a calendar-month geometric mean of 126 cfu/100mL and the instantaneous limit of 235 cfu/100mL were met. The representative modeling period selected for allocation scenarios was January 1993 through December 1997. This period incorporates average rainfall, low rainfall, and high rainfall years allowing the representation of both low and high flow conditions. The general approach to allocation scenario development was to develop a scenario that allowed the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Taylors Creek (VAN-F03R-01), Newfound River (VAP-F05R-01), Northeast Creek (VAP-F09R-01), Totopotomoy Creek (VAP-F13R-02), Moncuin/Webb Creek (VAP-F13R-04), Black Creek (VAP-F13R-05), and Pamunkey River (VAP-F13E-02) impairments to meet bacteria water quality standards. As each impairment met bacteria standards, the loads that allowed it to do so were adopted for those segments for subsequent runs. Due to similarities in the six impairments, the final allocation scenarios for the six segments were similar.

Currently, there are one, seven, thirteen, one, two and one active point discharges with a VPDES permit within the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Pamunkey River (F13E-02), and Moncuin/Webb Creek (VAP-F13R-04) watersheds, respectively. Municipalities with MS4 permits were identified within the South Anna River, Northeast Creek, Totopotomoy Creek, Black Creek, and Pamunkey River watersheds. The permitted point source discharges are described in Table 3.2. During allocation development, these permitted point sources were modeled with effluent fecal coliform concentrations of 200 cfu/100 mL and flows equal to their design flows as listed in Table 3.2. The ultimate waste load allocation (WLA) was calculated using the *E. coli* limit of 126 cfu/100mL, and *E. coli* loads based on the facility design flow are presented in Table 3.2.

Scenarios to address the load allocations to non-point sources were divided between direct and land-based loadings affected by both high and low stream flow conditions. Bacterial source tracking results from samples taken during 2003-2004 confirmed the presence of human, pet, livestock, and wildlife contamination. As a result, scenarios were formulated to address reductions from all sources and delivery mechanisms (See Section 6.5.4 for discussion of wildlife bacteria). In general, direct loads modeled as consistent loadings independent of the flow regime heavily influenced low flow concentrations, whereas land-applied loads reached the stream through runoff producing events during high flow conditions. Representative allocation reduction scenarios developed for the South Anna River (VAN-F01R-01), South Anna River (VAN-F02R-01), South Anna River (VAP-F04R-01), South Anna River (VAP-F04R-02), Taylors Creek (VAN-F03R-01), Newfound River (VAP-F05R-01), Northeast Creek (VAP-F09R-01), Totopotomoy Creek (VAP-F13R-02), Moncuin/Webb Creek (VAP-F13R-04), Black Creek (VAP-F13R-05), and Pamunkey River (VAP-F13E-02) impairments and their results are summarized in Sections 5.4.1 through 5.4.11.

Table 5.27. Annual nonpoint source fecal coliform loads for existing conditions and final allocation along with corresponding reductions in Totopotomoy Creek (VAP-F13R-02) impairment.

Source	Existing Condition Load (cfu/yr)	TMDL Allocation Load (cfu/yr)	Scenario Reduction (%)
Direct			
Straight Pipes	5.24E+13	0.00E+00	100
Livestock	4.98E+12	2.99E+11	94
Wildlife	3.46E+13	2.08E+12	94
Total	*9.20E+13*	*2.37E+12*	*97*
Land-based			
Residential	3.69E+15	0.00E+00	100
Cropland	5.21E+12	3.13E+11	94
Pasture	5.34E+15	3.20E+14	94
Forest	1.34E+14	1.34E+14	0
Total	*9.17E+15*	*4.55E+14*	*95*

Table 5.28. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Totopotomoy Creek (VAP-F13R-02) impairment.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	2.62+10	1.61E+12	N/A	1.64E+12

N/A – not applicable because MOS was implicit.

Table 5.37. Annual nonpoint source fecal coliform loads for existing conditions and final allocation along with corresponding reductions in Pamunkey River (VAP-F13E-02) impairment.

Source	Existing Condition Load (cfu/yr)	TMDL Allocation Load (cfu/yr)	Scenario Reduction (%)
Direct			
Straight Pipes	3.32E+13	0.00E+00	100
Livestock	1.14E+13	1.94E+12	83
Wildlife	1.07E+14	1.82E+13	83
Total	*1.52E+14*	*2.01E+13*	*87*
Land-based			
Residential	1.83E+15	0.00E+00	100
Cropland	3.42E+13	5.81E+12	83
Pasture	1.18E+16	2.01E+15	83
Forest	4.73E+14	4.73E+14	0
Total	*1.41E+16*	*2.48E+15*	*82*

Table 5.38. Average annual *E. coli* bacteria loads (cfu/yr) modeled after TMDL allocation in Pamunkey River (VAP-F13E-02) impairment.

Pollutant	WLA (cfu/yr)	LA (cfu/yr)	MOS	TMDL (cfu/yr)
E. coli	2.49E+13	7.22E+14	N/A	7.47E+14

N/A – not applicable because MOS was implicit.