Decision Rationale

Total Maximum Daily Load for
Fecal Coliform for Moore's Creek

I. Introduction

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 attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety, that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDL for fecal coliform for Moore's Creek. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The 34.92 square-mile Moore's Creek watershed is located in Ablemarle County. The TMDL addresses a 6.37 mile stream stretch, from the intersection of U.S. Route 29 and County Route 1106 to its confluence with the Rivanna River. Forest and agricultural lands make up roughly 70% of the 35 square-mile watershed.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 6.37 miles of Moore's Creek as being impaired by elevated levels of fecal coliform on Virginia's 1998 Section 303(d) list. Moore's Creek was listed for violations of Virginia's fecal coliform bacteria water quality standard. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a

pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA has been encouraging the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth plans on adopting the e-coli and enterococci standards in 2002.

As Virginia designates all of its waters for primary contact, all waters must meet the current fecal coliform standard for primary contact. Virginia's standard applies to all streams designated as primary contact for all flows. Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the fecal coliform standard. Thus, many of Virginia's TMDLs have called for some reduction in the amount of wildlife contributions to the affected streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In the first phase of the implementation, the Commnwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that, during Phase 2 it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated as primary contact for infrequent bathing. The Commonwealth will also investigate incorporating a natural background condition for the bacteriological indicator.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model or the Margin of Safety. It should also be noted that the waste load allocation for the Moore's Creek Waste Water Treatment Plant (MCWWTP) was set at its current permit conditions. Since the MCWWTP discharges fecal coliform at concentrations far less than its permit, there may be a larger capacity for wildlife loadings. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted.

However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

Moore's Creek identified as watershed VAV-H28R, was given a high priority for TMDL development. Section 303(d) of the CWA and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the state where technology-based and other controls do not provide for the attainment of water quality standards. The TMDL submitted by Virginia is designed to determine the acceptable load of fecal coliform which can be delivered to Moore's Creek, as demonstrated by the Hydrologic Simulation Program Fortran (HSPF)[1], in order to ensure that the water quality standard is attained and maintained. HSPF is considered an appropriate model to analyze this watershed because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to all of the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[2] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. These wastes do not need a transport mechanism to allow them to reach the stream. The allocation plan calls for the reduction in fecal coliform wastes delivered by cattle in-stream, wildlife in-stream, straight pipes, failing septic systems, and specific land uses.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL	WLA (cfu/yr)	LA (cfu/yr)	MOS (cfu/yr) [1]
Total	Fecal Coliform	68.13E+13	3.30E+13 [2]	61.41E+13	3.41E+13

1 Virginia includes an explicit MOS by identifying the TMDL target as achieving the total fecal coliform water quality concentration of 190 cfu/100ml as opposed to the WQS of 200 cfu/ml. This can be viewed explicitly as a 5% MOS.
2 The WLA is split between the MCWWTP and the Southwood Mobile Home Park (SMHP).

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[1] Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

[2] CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

EPA believes it is important to recognize the conceptual difference among the waste load allocation (WLA) values, load allocation (LA) values for sources modeled as direct deposition to stream segments, and LA values for flux sources of fecal coliform to land use categories. The WLA values and LA values for direct sources represent amounts of fecal coliform which are actually deposited into the stream segments. The HSPF model, which considers landscape processes which affect fecal coliform runoff from land uses, determines the amount of fecal coliform which reaches the stream segments. The LA in Table 1 is the amount of colony forming units (cfu) reaching the edge of stream from nonpoint sources annually.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a fecal coliform TMDL for Moore's Creek. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

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

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality standards and designated uses on Moore's Creek. The water quality criterion for fecal coliform is a geometric mean 200 cfu/100mL or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a 30 day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a thirty-day period, most of the samples are measured against the instantaneous standard. The Rivanna Water and Sewer Authority (RWSA) samples Moore's Creek upstream and downstream of the MCWWTP discharge location for fecal coliform. The RWSA data allowed Moore's Creek to be analyzed for violations of both the instantaneous and geometric mean fecal coliform standard. Based on the RWSA data, Moore's Creek violated the instantaneous standard 13% of the time and the geometric mean 59% of the time.

The HSPF model is being used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from point and other direct deposit sources necessary to support the fecal coliform water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of fecal coliform to Moore's Creek will ensure that the criterion is attained.

The TMDL modelers determine the fecal coliform production rates within the watershed. Data used in the model is obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, land uses, weather, stream geometry, etc.. The model then combines all the data to determine the hydrology and water quality of the stream.

A "paired watershed" approach and a synthetic flow generator were used in the hydrology calibration for Moore's Creek. A "paired watershed" or "equivalent watershed" approach was used because there was insufficient hydrology data on Moore's Creek. In a "paired watershed" approach, the modelers model the hydrology of a stream with a long term hydrologic record (Buck Mountain Run) that would have a response similar to the watershed being studied (Moore's Creek).

Buck Mountain Run, which is approximately ten miles from Moore's Creek was the "paired watershed". The calibrated and validated Buck Mountain Run hydrology model was adjusted to account for differences between the watersheds. United States Geological Survey (USGS) had a continuous gage monitoring flow on Buck Mountain Run until 1997. Weather data was available from the Free Union Weather stations. The calibration was run using the data from October 01, 1992 to September 30, 1997. This five-year period had both wet and dry weather conditions. The model simulated the observed conditions quite well.

A validation run was conducted to see how well the model simulated observed data over a different time period from Buck Mountain Run. This was conducted to insure that the model could simulate different conditions in Buck Mountain Run. The validation used data from January of 1990 through September of 1992. The simulated data from the validation compared favorably to the observed conditions as well.

One hundred and twenty five flow measurements were taken from Moore's Creek at USGS gage 02033300, this is a peak flow gage and does not provide a continuous flow record. These samples were taken from the summer of 2000 to the present by various readers including RWSA, USGS, and stream volunteers. This data was used to generate a synthetic flow for Moore's Creek. The Maintenance of Variance Extensions (MOVE) and Artificial Neural Networks (ANNs) generators were used. These generators use statistical models to extrapolate a longer flow record for the sporadic observed data. For more information on the use of these models please refer to section 5.2.2 of the Moore's Creek TMDL.

EPA believes that using HSPF to model and allocate fecal coliform will ensure that the designated uses and water quality standards will be attained and maintained for Moore's Creek.

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

<u>Total Allowable Loads</u>

Virginia indicates that the total allowable loading of fecal coliform is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest, grassland, medium density residential, low density residential, and urban), directly deposited nonpoint sources of fecal coliform (cattle in-stream, wildlife in-stream, and straight pipes), and point sources. Activities such as the application of manure, fertilizer, and the direct deposition of wastes from grazing animals are considered fluxes to the land use categories. The actual value for the total fecal load can be found in Table 1 of this document. The total allowable load is calculated on an annual basis due to the nature of HSPF model.

Waste Load Allocations

Virginia has stated that there are two point sources discharging to Moore's Creek. The two permitted point sources are MCWWTP and the Southwood Mobile Home Park (SMHP). These facilities are allowed to discharge their waste with a fecal coliform concentration of 200 cfu/100 mL. The MCWWTP has a design flow of 15 million gallons per day (mgd) but its annual average discharge is 11 mgd. The SMHP has an expected flow of 0.039 mgd. These facilities were given a combined WLA of 3.30E+13. Their WLA was determined by multiplying their allowable concentration (200 cfu/100 mL) by their permitted flow by the number of days in a year (365). It should be noted that the MCWWTP is discharging fecal coliform at concentrations far lower than its permitted value. Therefore, the WLA may be over estimating the loading for this facility to provide for an additional wildlife load.

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.

Table 2 - Waste Load Allocations for Moore's Creek

Facility	Permit Number	Existing Load	Allocated Load
MCWWTP	VA0025518	3.30E+13	3.30E+13
SMHP	VA0029955	0.01E+13	0.01E+13
Total	N/A	3.30E+13	3.30E+13

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 nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the Moore's Creek watershed. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint loadings, and receiving water quality for conventional pollutants and toxicants[3]. HSPF uses precipitation data for continuous and storm event simulation to determine total fecal loading to Moore's Creek from forest, grassland, low density residential, medium density residential, and urban lands. The total land loading of fecal coliform is the result of the application of manure and direct deposition from cattle, other livestock and wildlife (geese, deer, etc.), the deposition of fecal coliform from failed septic systems, and fecal coliform production from pets.

In addition, VADEQ recognizes the significance of fecal coliform from cattle in-stream, straight pipes, and wildlife in-stream. These sources are not dependent on a transport mechanism to reach a surface waterbody, and therefore, can impact water quality during low and high flow events. Please note that all of the values in Table 3 other than the direct deposit nonpoint sources (cattle in-stream, wildlife in-stream, and straight pipes) are given in terms of colony forming units to the land surface. The amount of waste from these sources (forest, grassland, low density residential, medium density residential, and urban) reaching the stream is significantly lower.

Table 3 - LA for the Land Application of Fecal Coliform

Source	Existing Load(cfu/yr)	Allocated Load(cfu/yr)	Percent Reduction
Forest	252.8E+13	1.5E+13	0%
Grassland	459.7E+13	321.8E+13	30%
Low Density Residential	97.3E+13	68.1E+13	30%
Medium Density Residential	203.8E+13	142.6E+13	30%
Urban	60.0E+13	42.0E+13	30%
Straight Pipes	35.7E+9	0.00	100%
Wildlife In-Stream	13.2E+9	7.92E+9	40%
Cattle In-Stream	3.85E+9	0.00	100%

[3] Supra, footnote 2.

3) The TMDL considers the impacts of background pollution.

A background concentration was set by determining the wildlife loading to each land segment.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required 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 of Moore's Creek 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[4]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios.

The sources of bacteria for these stream segments were a mixture of dry and wet weather driven sources. Therefore, the critical condition for Moore's Creek was represented as a typical hydrologic year. Since the stream was modeled to attain the geometric mean standard and base and low flow events occurred far more often then wet weather events, it was essential that the standard be maintained during these periods. Therefore, base flow conditions were the more critical period.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow 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. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations. The model also accounted for the seasonal variation in loading. Fecal coliform loads changed for many of the sources

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[4]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

depending on the time of the year. For example, cattle spent more time in the stream in the summer and animals were confined for longer periods of time in the winter.

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 margin of safety (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.

Virginia includes an explicit margin of safety by establishing the TMDL target water quality concentration for fecal coliform at 190 cfu/ 100mL, which is more stringent than Virginia's water quality standard of 200 cfu/100 mL. This would be considered an explicit 5% margin of safety.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards. However, due to the wildlife issue that was previously mentioned, the Commonwealth believes that it may be appropriate to modify its current standards to address the problems associated with wildlife loadings.

8) The TMDLs have been subject to public participation.

Three public meetings were held to discuss TMDL development on Moore's Creek. All of the public meetings were public noticed in the *Virginia Register* and opened to at least a thirty-day comment period. The first meeting was held on June 07, 2001 in Charlottesville, VA. Approximately twenty people attended this initial meeting on the TMDL. Around twenty people attended the second meeting which was held in Charlottesville, VA on November 15, 2001. The third and final public meeting was held in Charlottesville, VA on March 25, 2002. Approximately twenty people attended the third public meeting as well. In addition to the public meetings, there were 12-person advisory committee meetings on the TMDL. The advisory committee was made up of personnel from the RWSA, the Thomas Jefferson Soil and Water Conservation District, the Albemarle County Farm Bureau, the Southern Environmental Law Center, the Fry's Springs and Belmont Neighborhood Associations, and other interested citizens. The advisory committee submitted comments on the TMDL.