Total Maximum Daily Load (TMDL) Report for Shellfish Areas Listed Due to Bacterial Contamination

Corrotoman River
Chesapeake Bay: Corrotoman River Watershed Total Maximum Daily Load (TMDL) Report for Shellfish Condemnation Areas Listed Due to Bacteria Contamination

Virginia Department of Environmental Quality

June 2007
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>v</td>
</tr>
<tr>
<td>1.0 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Listing of Water Bodies under the Clean Water Act</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Overview of the TMDL Process</td>
<td>2</td>
</tr>
<tr>
<td>2.0 Designated Uses and Applicable Water Quality Standards</td>
<td>2</td>
</tr>
<tr>
<td>2.1 Designated Uses and Applicable Criteria</td>
<td>2</td>
</tr>
<tr>
<td>2.2 Classification of Virginia’s Shellfish Growing Areas</td>
<td>3</td>
</tr>
<tr>
<td>3.0 Watershed Characterization</td>
<td>4</td>
</tr>
<tr>
<td>4.0 Water Quality Impairment and Bacterial Source Assessment</td>
<td>15</td>
</tr>
<tr>
<td>4.1 Water Quality Monitoring</td>
<td>15</td>
</tr>
<tr>
<td>4.2 Condemnation Areas</td>
<td>25</td>
</tr>
<tr>
<td>4.3 Fecal Coliform Bacterial Source Assessment</td>
<td>25</td>
</tr>
<tr>
<td>A. Point Source</td>
<td>26</td>
</tr>
<tr>
<td>B. Non Point Source</td>
<td>26</td>
</tr>
<tr>
<td>4.4 Bacterial Source Tracking</td>
<td>26</td>
</tr>
<tr>
<td>5.0 TMDL Development</td>
<td>27</td>
</tr>
<tr>
<td>5.1 Modeling Approach</td>
<td>27</td>
</tr>
<tr>
<td>5.2 The TMDL Calculation</td>
<td>37</td>
</tr>
<tr>
<td>A. Current Fecal Coliform Condition</td>
<td>38</td>
</tr>
<tr>
<td>B. Geometric mean Analysis</td>
<td>38</td>
</tr>
<tr>
<td>C. 90th Percentile Analysis</td>
<td>39</td>
</tr>
<tr>
<td>5.3 Load Allocation</td>
<td>40</td>
</tr>
<tr>
<td>5.3.1 Development of Waste load Allocations</td>
<td>42</td>
</tr>
<tr>
<td>5.4 Consideration of Critical Conditions and Seasonal Variations</td>
<td>43</td>
</tr>
<tr>
<td>5.5 Margin of safety</td>
<td>43</td>
</tr>
<tr>
<td>5.6 TMDL Summary</td>
<td>43</td>
</tr>
<tr>
<td>6.0 Implementation</td>
<td>44</td>
</tr>
<tr>
<td>6.1 Staged Implementation</td>
<td>46</td>
</tr>
<tr>
<td>6.2 Link to ongoing Restoration Efforts</td>
<td>46</td>
</tr>
<tr>
<td>6.3 Reasonable Assurance for Implementation</td>
<td>47</td>
</tr>
<tr>
<td>6.3.1 Follow-up monitoring</td>
<td>47</td>
</tr>
<tr>
<td>6.3.2 Regulatory Framework</td>
<td>47</td>
</tr>
<tr>
<td>6.3.3 Implementation Funding Sources</td>
<td>47</td>
</tr>
<tr>
<td>6.3.4 No Discharge Zones for Vessels</td>
<td>47</td>
</tr>
<tr>
<td>6.3.5 Addressing Wildlife Concerns</td>
<td>48</td>
</tr>
<tr>
<td>7.0 Public Participation</td>
<td>49</td>
</tr>
<tr>
<td>8.0 Glossary of Terms</td>
<td>50</td>
</tr>
<tr>
<td>9.0 Citations</td>
<td>54</td>
</tr>
</tbody>
</table>
Table of Contents

10.0 Appendices
Appendix A Growing Area 4: Shoreline Sanitary Survey and Condemnation Notices
Appendix B Supporting Documentation and Watershed Assessment
Appendix C DEQ Guidelines for Establishing No Discharge Zones
Appendix D Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.

List of Figures and Tables

<table>
<thead>
<tr>
<th>List of Figures</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 3.0</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1A</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1B</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1C</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1D</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1E</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1F</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1G</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1H</td>
<td></td>
</tr>
<tr>
<td>Figure 3.1I</td>
<td></td>
</tr>
<tr>
<td>Figure 4.1</td>
<td></td>
</tr>
<tr>
<td>Figure 4.2</td>
<td></td>
</tr>
<tr>
<td>Figure 4.3 A</td>
<td></td>
</tr>
<tr>
<td>Figure 4.3 B</td>
<td></td>
</tr>
<tr>
<td>Figure 4.3 C</td>
<td></td>
</tr>
<tr>
<td>Figure 4.3 D</td>
<td></td>
</tr>
</tbody>
</table>
# List of Figures and Tables

<table>
<thead>
<tr>
<th>Figure 4.3</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Last 30 Month Geometric Mean Data for Taylor Creek, Condemnation Area 21-205</td>
<td>20</td>
</tr>
<tr>
<td>F</td>
<td>Last 30 Month 90\textsuperscript{th} Percentile Data for Taylor Creek, Condemnation Area 21-205</td>
<td>20</td>
</tr>
<tr>
<td>G</td>
<td>Last 30 Months Ambient Fecal Coliform Data for Myer Creek, Condemnation Area 21-198</td>
<td>20</td>
</tr>
<tr>
<td>H</td>
<td>Last 30 Month Geometric Mean Data for Myer Creek, Condemnation Area 21-198</td>
<td>21</td>
</tr>
<tr>
<td>I</td>
<td>Last 30 Month 90\textsuperscript{th} Percentile Data for Myer Creek, Condemnation Area 21-198</td>
<td>21</td>
</tr>
<tr>
<td>J</td>
<td>Last 30 Months Ambient Fecal Coliform Data for Hills Creek and Bells Creek, Condemnations 21-58A and 21-58B</td>
<td>21</td>
</tr>
<tr>
<td>K</td>
<td>Last 30 Month Geometric Mean Data for Hills Creek and Bells Creek, Condemnations 21-58A and 21-58B</td>
<td>22</td>
</tr>
<tr>
<td>L</td>
<td>Last 30 Month 90\textsuperscript{th} Percentile Data for Hills Creek and Bells Creek, Condemnations 21-58A and 21-58B</td>
<td>22</td>
</tr>
<tr>
<td>M</td>
<td>Last 30 Ambient Fecal Coliform Data for the Eastern Branch Corrotoman River, Condemnation 21-58C</td>
<td>22</td>
</tr>
<tr>
<td>N</td>
<td>Last 30 Month Geometric Mean Data for the Eastern Branch Corrotoman River, Condemnation 21-58C</td>
<td>22</td>
</tr>
<tr>
<td>O</td>
<td>Last 30 Month 90\textsuperscript{th} Percentile Data for the Eastern Branch Corrotoman River, Condemnation 21-58C</td>
<td>23</td>
</tr>
<tr>
<td>P</td>
<td>Last 30 Months Ambient Fecal Coliform Data for Senior Creek, Condemnation Area 21-132B</td>
<td>23</td>
</tr>
<tr>
<td>Q</td>
<td>Last 30 Month Geometric Mean Data for Senior Creek, Condemnation Area 21-132B</td>
<td>24</td>
</tr>
<tr>
<td>R</td>
<td>Last 30 Month 90\textsuperscript{th} Percentile Data for Senior Creek, Condemnation Area 21-132B</td>
<td>24</td>
</tr>
<tr>
<td>S</td>
<td>Last 30 Months Ambient Fecal Coliform Data for the Western Branch Corrotoman River, Condemnation 21-132A</td>
<td>24</td>
</tr>
<tr>
<td>T</td>
<td>Last 30 Months Geometric Mean Data for the Western Branch Corrotoman River, Condemnation 21-132A</td>
<td>24</td>
</tr>
<tr>
<td>U</td>
<td>Last 30 Months 90\textsuperscript{th} Percentile Data for the Western Branch Corrotoman River, Condemnation 21-132A</td>
<td>24</td>
</tr>
<tr>
<td>Figure 4.4</td>
<td>Map of Point Source Contributions and Sanitary Shoreline Survey Identified Deficiencies as Identified in the Virginia Department of Health Sanitary Shoreline Survey</td>
<td>27</td>
</tr>
<tr>
<td>A</td>
<td>Monthly Mean Fecal Coliform Contribution by BST for Millenbeck Creek Station Area 21-8</td>
<td>28</td>
</tr>
<tr>
<td>B</td>
<td>Monthly Mean Fecal Coliform Contribution by BST for Ewells Point Station 21-9</td>
<td>28</td>
</tr>
<tr>
<td>C</td>
<td>Monthly Mean Fecal Coliform Contribution by BST for Taylors Creek Station 21-15B</td>
<td>29</td>
</tr>
<tr>
<td>D</td>
<td>Monthly Mean Fecal Coliform Contribution by BST for Myers Creek Station 21-17X</td>
<td>29</td>
</tr>
<tr>
<td>E</td>
<td>Monthly Mean Fecal Coliform Contribution by BST for Hills Creek Station 21-23</td>
<td>30</td>
</tr>
<tr>
<td>F</td>
<td>Monthly Mean Fecal Coliform Contribution by BST for Taylors Creek Station 21-24</td>
<td>30</td>
</tr>
</tbody>
</table>

iii
List of Figures and Tables

List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 4.5 G</td>
<td>Monthly Mean Fecal Coliform Contribution by BST Eastern Branch Corrotoman River Average of Stations 21-30A, 21-31 and 21-33</td>
</tr>
<tr>
<td>Figure 4.5 H</td>
<td>Monthly Mean Fecal Coliform Contribution by BST Western Branch Corrotoman River Average of Stations 21-46, 21-49 and 21-51</td>
</tr>
<tr>
<td>Figure 4.5 H</td>
<td>Monthly mean Fecal Coliform Contribution by BST Senior Creek Station 21-24</td>
</tr>
<tr>
<td>Figure 4.6 A</td>
<td>Annual Average Fecal Coliform Contribution by BST, Condemnation 21-132A, W. Branch Corrotoman River</td>
</tr>
<tr>
<td>Figure 4.6 B</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-132B, Senior Creek</td>
</tr>
<tr>
<td>Figure 4.6 C</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-187A, Ewells Point</td>
</tr>
<tr>
<td>Figure 4.6 D</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-187B, Millenbeck Creek</td>
</tr>
<tr>
<td>Figure 4.6 E</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-205, Taylor Creek</td>
</tr>
<tr>
<td>Figure 4.6 F</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-58C, E. Branch Corrotoman River</td>
</tr>
<tr>
<td>Figure 4.6 G</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-58B, Bells Creek</td>
</tr>
<tr>
<td>Figure 4.6 H</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-58A, Hills Creek</td>
</tr>
<tr>
<td>Figure 4.6 I</td>
<td>Annual Average Fecal Coliform Contribution by BST Condemnation 21-198, Myer Creek</td>
</tr>
<tr>
<td>Figure B-1</td>
<td>Diagram to Illustrate Procedure Used to Estimate Fecal Coliform Production from Estimated Livestock Population</td>
</tr>
</tbody>
</table>

List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 3.1</td>
<td>Estimated Animal Populations and Septic Systems</td>
</tr>
<tr>
<td>Table 3.2</td>
<td>Summary of Estimated Land Use by Type in the Impaired Watersheds of Growing Area 21</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Water Quality Data Summary : Growing Area 21</td>
</tr>
<tr>
<td>Table 4.2</td>
<td>Non-point Source Load Distribution using BST Growing Areas 21</td>
</tr>
<tr>
<td>Table 5.1</td>
<td>Geometric Mean Analysis of Current Load and Estimated Load Reduction Table</td>
</tr>
<tr>
<td>Table 5.2</td>
<td>90th Percentile Analysis of Current Load and Estimated Load Reduction</td>
</tr>
<tr>
<td>Table 5.3</td>
<td>Reduction and Allocation based Upon 90th Percentile Standard Criterion: Growing Area 21 and Estimated Load Reduction</td>
</tr>
<tr>
<td>Table 5.4</td>
<td>TMDL Summary for Nine Closures in the Corrotoman River Watershed Growing Areas 4 (Geometric mean)</td>
</tr>
<tr>
<td>Table 5.5</td>
<td>TMDL Summary for Nine Closures in the Corrotoman River Watershed Growing Areas 4 (90th percentile)</td>
</tr>
<tr>
<td>Table B-1</td>
<td>Fecal Production Literature Review</td>
</tr>
<tr>
<td>Table B-2</td>
<td>GIS Data Elements</td>
</tr>
</tbody>
</table>
Management of water quality is a process intended to protect waters for a variety of uses. The first step in the process is the identification of desired uses for each water body. There are typically a number of physical, chemical and/or biological conditions that must exist in a water body to allow for a desired use to exist. In Virginia, most inshore tidal waters are identified as potential shellfish growing waters. In order to support shellfish propagation without risk to human consumers, shellfish waters must have very low levels of pathogenic organisms. Virginia, as most other states, uses fecal coliforms (FC) as an indicator of the potential presence of pathogenic organisms. To maintain the use of a water body for direct shellfish harvesting, the goal is to ensure the concentration of fecal coliforms entering the water body does not exceed a “safe” level. The safe level is set as the standard against which water quality monitoring samples are checked.

When water quality monitoring detects levels of fecal coliforms above allowable, “safe” levels, managers must identify the potential sources and plan to control them. The prescribed method for figuring out what must be controlled to attain the water quality standard is the calculation of a total maximum daily load (TMDL). The TMDL is the amount of fecal coliforms that may be introduced by each potential source without exceeding the water quality standard for fecal coliforms in shellfish growing waters.

Different approaches can be used to determine the sources of fecal pollution in a water body. Two distinctly different approaches are watershed modeling and bacterial source tracking (BST). Watershed modeling begins on the land, identifying potential sources based on information about conditions in the watershed (e.g. numbers of residents, estimated wildlife populations, estimated of livestock, etc.). BST begins in the water, identifying sources of fecal coliforms, specifically the dominant fecal coliform *Escherichia coli*, to shellfish waters based on either genetic or phenotypic characteristics of the coliforms. Virginia’s Department of Environmental Quality has decided to utilize BST, and specifically to use a method called antibiotic resistance analysis (ARA). This method assumes that fecal bacteria found in four sources: humans, wildlife, livestock, and domestic animals will all differ in their reactions to antibiotics. Thus, when samples of fecal bacteria collected in the water quality monitoring program are exposed to specific antibiotics the pattern of responses allows matching similarities to the response patterns of bacteria from known sources which have been accumulated in a “source library”. Through this analysis investigators also estimate the relative proportion of the fecal bacteria derived from each of the four general source classes and assumes this proportion reflects the relative contribution from the watershed. The resulting estimates of the amount of fecal coliform pollution coming from each type of source can then be used to allocate reductions necessary to meet the water quality standard for shellfish growing waters. Identifying and agreeing on the means to achieve these reductions represent the TMDL implementation plan. Continued water quality monitoring will tell whether the efforts to control sources of fecal coliforms in the watershed have succeeded.
Fecal Coliform Impairment

This document details the development of bacterial TMDLs for nine impairments in the Corrotoman River Watershed, a tributary to the Rappahannock River identified as shellfish growing area 21. These impairments were identified in the 1998 303(d) list as Western Branch Corrotoman River condemnation 21-132A, Senior Creek condemnation 21-132B, Hills Creek condemnation 21-58A, Bells Creek condemnation 21-58B, Eastern Branch Corrotoman condemnation 21-58C, Taylor Creek condemnation 21-205, Myer Creek (VAP-E-0) condemnation 21-198, Ewells Point condemnation 21-187A and Millenbeck Creek 21-187B located in Lancaster County, Virginia. For the purposes of this TMDL report all impairments are presented with their 1998 nomenclature to ensure consistency with the October 14, 1998 303(d) list provided to the Environmental protection Agency pursuant to the consent order.

The applicable state standard specifies that the number of fecal coliform bacteria shall not exceed a maximum allowable level of geometric mean of 14 most probable number (3-tube MPN) per 100 milliliters (ml) and a 90th percentile geometric mean value of 49 MPN/100ml. (Virginia Water Quality Standard 9-VAC 25-260-5). In development of this TMDL, the 90th percentile 49 MPN/100 ml was used, since it represented the more stringent standard.

Sources of Fecal Coliform

Potential sources of fecal coliform bacteria consist primarily of non-point source contributions, as there are no permitted point source discharges that directly impact the identified impairments in the watershed. Non-point sources include wildlife; livestock; land application of bio-solids; recreational vessel discharges; failed, malfunctioning, or non-operational septic systems, and uncontrolled discharges (straight pipes conveying gray water from kitchen and laundry areas of private homes, etc.).

Water Quality Modeling

A tidal volumetric model was used for this TMDL study because the character of the water bodies to be modeled is relatively simple from a hydrologic perspective: for example, small in area and volume with a single, unrestricted connection to receiving waters. This approach uses the volume of the water body and adjusts for tidal flushing, freshwater inflow and bacterial decay in order to establish the existing and allocation conditions.

Determination of Existing Loadings

To assist in partitioning the loads from the diverse sources within the watershed, water quality samples of fecal coliform bacteria were collected for one year and evaluated using an antibiotic resistance analysis in a process called bacterial source tracking. These samples were compared to a reference library of fecal samples from known sources. The resulting data were used to assign portions of the load within the watershed to wildlife, humans, pets or livestock. The results of this analysis indicated that the primary source of fecal coliforms is wildlife with livestock as secondary contributors. The presence of a large signature attributable to one component is sufficient to establish potential directions for remediation under a future implementation plan.
Load Allocation Scenarios

The next step in the TMDL process was to determine the appropriate water quality standard to be applied. This was set as the 90\textsuperscript{th} percentile standard because the data established that the 90\textsuperscript{th} percentile required the greater reduction. Calculated results of the model for each segment were used to establish the existing load in the system. The load necessary to meet water quality standards was calculated in a similar fashion using the water quality standard criterion in place of the ambient water quality value. The difference between these two numbers represents the necessary level of reduction in each segment.

Finally the results of the BST developed for each segment were used to partition the load allocation that would meet water quality standards according to source. The results of the model, the BST source partitioning and the reductions necessary for each segment are shown below.

<table>
<thead>
<tr>
<th>Condemnation Area</th>
<th>Volume (m\textsuperscript{3})</th>
<th>Fecal Coliform (MPN/100ml)</th>
<th>WQ Standard MPN/100ml</th>
<th>Current Load (MPN/day)</th>
<th>Allowable Load (MPN/day)</th>
<th>Required Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>41400</td>
<td>37.3</td>
<td>14</td>
<td>1.55E+10</td>
<td>5.80E+09</td>
<td>63%</td>
</tr>
<tr>
<td>Condemnation 21-132B Senior Creek</td>
<td>56970</td>
<td>30.1</td>
<td>14</td>
<td>1.71E+10</td>
<td>7.98E+09</td>
<td>53%</td>
</tr>
<tr>
<td>Condemnation 21-58A Hills Creek</td>
<td>389610</td>
<td>13.6</td>
<td>14</td>
<td>5.32E+10</td>
<td>5.45E+10</td>
<td>0%</td>
</tr>
<tr>
<td>Condemnation 21-58B Bells Creek</td>
<td>147420</td>
<td>42.0</td>
<td>14</td>
<td>6.19E+10</td>
<td>2.06E+10</td>
<td>67%</td>
</tr>
<tr>
<td>Condemnation 21-58C E. Br. Corrotoman River</td>
<td>162720</td>
<td>30.6</td>
<td>14</td>
<td>4.97E+10</td>
<td>2.28E+10</td>
<td>54%</td>
</tr>
<tr>
<td>Condemnation 21-198 Myer Creek</td>
<td>1848960</td>
<td>26.7</td>
<td>14</td>
<td>4.94E+11</td>
<td>2.59E+11</td>
<td>48%</td>
</tr>
<tr>
<td>Condemnation 21-187A Ewells Point</td>
<td>1937520</td>
<td>29.2</td>
<td>14</td>
<td>5.67E+11</td>
<td>2.71E+11</td>
<td>52%</td>
</tr>
<tr>
<td>Condemnation 21-187B Millenbeck Creek</td>
<td>122400</td>
<td>58.9</td>
<td>14</td>
<td>7.20E+10</td>
<td>1.71E+10</td>
<td>76%</td>
</tr>
</tbody>
</table>
TMDL Summary for Bacteria Impairments of the Shellfish Water Quality Standard Growing Area 21: Corrotoman River Watershed

90th Percentile Analysis of Current Load and Estimated Load Reduction

<table>
<thead>
<tr>
<th>Condemnation Area</th>
<th>Volume (m³)</th>
<th>*Fecal Coliform (MPN/100ml)</th>
<th>WQ Standard MPN/100ml</th>
<th>Current Load (MPN/day)</th>
<th>Allowable Load (MPN/day)</th>
<th>Required Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>41400</td>
<td>287.4</td>
<td>49</td>
<td>1.19E+11</td>
<td>2.03E+10</td>
<td>83%</td>
</tr>
<tr>
<td>Condemnation 21-132B Senior Creek</td>
<td>56970</td>
<td>182.2</td>
<td>49</td>
<td>1.04E+11</td>
<td>2.79E+10</td>
<td>73%</td>
</tr>
<tr>
<td>Condemnation 21-58A Hills Creek</td>
<td>389610</td>
<td>82.5</td>
<td>49</td>
<td>3.21E+11</td>
<td>1.91E+11</td>
<td>41%</td>
</tr>
<tr>
<td>Condemnation 21-58B Bells Creek</td>
<td>147420</td>
<td>394.7</td>
<td>49</td>
<td>5.82E+11</td>
<td>7.22E+10</td>
<td>88%</td>
</tr>
<tr>
<td>Condemnation 21-58C E. Br. Corrotoman River</td>
<td>162720</td>
<td>157.7</td>
<td>49</td>
<td>2.57E+11</td>
<td>7.97E+10</td>
<td>69%</td>
</tr>
<tr>
<td>Condemnation 21-198 Myer Creek</td>
<td>1848960</td>
<td>244.4</td>
<td>49</td>
<td>3.86E+11</td>
<td>7.75E+10</td>
<td>80%</td>
</tr>
<tr>
<td>Condemnation 21-187A Ewells Point</td>
<td>1937520</td>
<td>159.6</td>
<td>49</td>
<td>2.95E+12</td>
<td>9.06E+11</td>
<td>69%</td>
</tr>
<tr>
<td>Condemnation 21-187B Millenbeck Creek</td>
<td>122400</td>
<td>214.7</td>
<td>49</td>
<td>4.16E+12</td>
<td>9.49E+11</td>
<td>77%</td>
</tr>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>41400</td>
<td>527.7</td>
<td>49</td>
<td>6.46E+11</td>
<td>6.00E+10</td>
<td>91%</td>
</tr>
</tbody>
</table>

Margin of Safety

In order to account for uncertainty in modeled output, a margin of safety (MOS) was incorporated into the TMDL development process by making very conservative choices. A margin of safety can be incorporated implicitly in the model through the use of conservative estimates of model parameters, or explicitly as an additional load reduction requirement. Individual errors in model inputs, such as data used for developing model parameters or data used for calibration, may affect the load allocations in a positive or a negative way. The purpose of the MOS is to avoid an overall bias toward load allocations that are too large for meeting the water quality target. An implicit MOS was used in the development of this TMDL through selection of a water quality standard providing a high level of protection,
utilization of entire segment volumes for model calculations, averaging extreme high and low values to ensure that the more protective condition with the largest available data set was addressed and emphasizing watershed-based implementation measures.

**Recommendations for TMDL Implementation**

The goal of this TMDL was to develop an allocation plan that achieves water quality standards during the implementation phase. Virginia's 1997 Water Quality Monitoring, Information and Restoration Act states in section 62.1-44.19.7 that the "Board shall develop and implement a plan to achieve fully supporting status for impaired waters".

The TMDL developed for these impairments, provide allocation scenarios that will be a starting point for developing implementation strategies. Additional monitoring aimed at targeting the necessary reductions is critical to implementation development. Once established, continued monitoring will aid in tracking success toward meeting water quality milestones.

Public participation is critical to the implementation process. Reduction in non-point source loading is the crucial factor in addressing the problem. These sources cannot be addressed without public understanding of and support for the implementation process. Stakeholder input will be critical from the onset of the implementation process in order to develop an implementation plan that will be truly effective.

**Public Participation**

During development of the TMDL for the Cold Harbor, Currioman, Barnes, Nomini, Buckner and Pierce Creeks, as well as North Prong, in Growing Area 4, public involvement was encouraged through a public participation process that included public meetings and stakeholder meetings.

The first public meeting was held on November 15, 2006. A basic description of the TMDL process and the agencies involved was presented and a discussion was held regarding the source assessment input, bacterial source tracking, and model results. This meeting was followed by development of the final draft TMDL and a review by the stakeholders.

Input from these meetings was utilized in the development of the TMDL and improved confidence in the allocation scenarios and TMDL process.

The second public meeting was held on. The results of the TMDL study were presented and discussed. Public participation and involvement in the TMDL implementation planning process was encouraged.
1.0 Introduction

This document details the development of bacterial Total Maximum Daily Load (TMDL) for eight segments in the Corrotoman River watershed within Shellfish Growing Area 21 in Lancaster County, Virginia. These eight waters are listed as impaired on Virginia’s 303(d) Total Maximum Daily Load Priority List. The TMDL is one step in a multi-step process that includes a high level of public participation in order to address water quality issues that can affect public health and the health of aquatic life.

1.1 Listing of Water Bodies under the Clean Water Act

Water quality standards are regulations based on federal or state law that set numeric or narrative limits on pollutants. Water quality monitoring is performed to measure these pollutants and determine if the measured levels are with the bounds of the limits set for the uses designated for the water body. The water bodies which have pollutant levels above the designated standards are considered impaired for the corresponding designated use (e.g. swimming, drinking, shellfish harvest, etc.). The impaired waterways are listed on the §303 (d) list reported to the Environmental Protection Agency. Those waters placed on the list require the development of a TMDL intended to eliminate the impairment and bring the water into compliance with the designated standards.

TMDLs represent the total pollutant loading that a water body can receive without violating water quality standards. The TMDL process establishes the allowable loading of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and non-point sources to restore and maintain the quality of their water resources (EPA, 1991).

Fecal coliform bacteria are the most common cause for the impairments in Virginia shellfish growing waters. This group of bacteria is considered an indicator of the presence of fecal contamination. The most common member of the fecal coliform groups is Escherichia coli. Fecal coliforms are associated with the fecal material derived from humans and warm-blooded animals. The presence of fecal coliform bacteria in aquatic environments is an indication that the water may have been contaminated by pathogens or disease-producing bacteria or viruses. Waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis, and hepatitis A. Filter-feeding shellfish can concentrate these pathogens which can be transmitted and cause disease when eaten uncooked. Therefore, the presence of elevated numbers of fecal coliform bacteria is an indicator that a potential health risk exists for individuals consuming raw shellfish. Fecal contamination can occur from point source inputs of domestic sewage or from nonpoint sources of human, (e.g., malfunctioning septic systems) or animal wastes.

Because the fecal coliform indicator does not provide information on the source or origin of fecal contamination, Agencies of the Commonwealth, including the Department of Environmental Quality (DEQ), the Virginia Department of Health – Division of Shellfish sanitation (VDH-DSS) and the Department of Conservation and Recreation (DCR) have worked together with state universities, the U.S. Geological Survey and the U.S. Environmental Protection Agency to develop methods to assess sources of fecal coliforms to assist in development of TMDLs in impaired shellfish waters.
As a group these methods are usually called bacterial or microbial source tracking (BST or MST). This study utilizes bacteria source tracking (BST) to determine the most probable sources of fecal coliform in the water. To assist with the analysis and development of the TMDLs for impaired shellfish waters, the Department of Environmental Quality contracted the Virginia Institute of Marine Science (VIMS).

1.2 Overview of the TMDL Development Process

A TMDL study for shellfish waters is the first part of a phased process aimed at restoring water quality. This study is designed to determine how much of the pollutant input needs to be reduced in order to achieve water quality standards. The second step in the process is the development of an implementation plan that identifies which specific control measures are necessary to achieve those reductions, their timing for implementation and at what cost. The implementation plan will also outline potential funding sources. The third step will be the actual implementation process. Implementation will typically occur in stages that allow a review of progress in reducing pollutant input, refine bacteria loading estimates based upon additional data and to make any identified changes to pollutant control measures.

The TMDL development process also must account for seasonal and annual variations in precipitation, flow, land use, and pollutant contributions. Such an approach ensures that TMDLs, when implemented, do not result in violations under a wide variety of scenarios that affect bacterial loading.

2.0 Applicable Water Quality Standard

Water quality standards are provisions of state or federal law which consist of a designated use or set of uses for the waters and water quality criteria based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.). According to Virginia Water Quality Standards (9 VAC 25-260-5), the term “water quality standards means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.).”

2.1 Designated Uses and Criteria

Generally, all tidal waters in Virginia are designated as shellfish waters. The identification of the applicable river reaches can be found in the river basin tables at 9VAC25-260-390 et seq. For a
shellfish supporting water body to be in compliance with Virginia bacterial standards, VADEQ specifies the following criteria (9 VAC 25-260-160):

“In all open ocean or estuarine waters capable of propagating shellfish or in specific areas where public or leased private shellfish beds are present, and including those waters on which condemnation or restriction classifications are established by the State Department of Health the following criteria for fecal coliform bacteria shall apply; The geometric mean fecal coliform value for a sampling station shall not exceed an MPN (most probable number) of 14 per 100 milliliters. The 90th percentile shall not exceed an MPN of 43 for a 5 tube, 3 dilution test or 49 for a 3 tube, 3 dilution test.”

2.2 Classification of Virginia’s Shellfish Growing Areas

The Virginia Department of Health, Division of Shellfish Sanitation (DSS) is responsible for classifying shellfish waters and protecting the health of bivalve shellfish consumers. The VDH-DSS follows the requirements of the National Shellfish Sanitation Program (NSSP), which is regulated by the U.S. Food and Drug Administration. The NSSP specifies the use of a shoreline survey as its primary tool for classifying shellfish growing waters. Fecal coliform concentrations in water samples collected in the immediate vicinity of the shellfish beds function to verify the findings of the shoreline survey and to define the border between approved and condemned (unapproved) waters. Much of the DSS effort is focused on locating fecal contamination, and in this manner minimizing the introduction of human pathogens to shellfish waters.

DSS designs and operates the shoreline survey to locate sources of pollution within the watersheds of shellfish growing areas. This is accomplished through a property-by-property inspection of the onsite sanitary waste disposal facilities of most properties on un-sewered sections of watersheds, and investigations of other sources of pollution such as wastewater treatment plants (WTP), marinas, livestock operations, landfills, etc. The information is compiled into a written report with a map showing the location of the sources of real or potential pollution found and sent to the various agencies that are responsible for regulating these concerns in the city or county. Once an onsite problem is identified, local health departments (LHDs), and/or other state and local agencies may play a role in the process of correcting the deficiencies.

The VDH-DSS collects monthly seawater samples at over 2,000 stations in the shellfish growing areas of Virginia. Though they continuously monitor sample data for unusual events, they formally evaluate shellfish growing areas on an annual basis. The annual review uses data from the most recent 30 samples (typically 30 months), collected randomly with respect to weather. The data are assessed to determine whether the water quality standards are met. If the water quality standards are exceeded, the shellfish area is closed for the harvest of shellfish that go directly to market. Those areas that marginally exceed the water quality standard and are closed for the direct marketing of shellfish are eligible for harvest of shellfish under permit from the Virginia Marine Resources Commission and VDH-DSS. The permit establishes controls that in part require shellfish be allowed to depurate for 15 days in clean growing areas or specially designed licensed on shore facilities. Shellfish in growing areas that may be highly polluted, such as those in the immediate vicinity of a wastewater treatment facility (prohibited waters), are not allowed to be moved to clean waters for self purification.
3.0 Watershed Characterization

The Shellfish Growing Area 21 is comprised of the Corrotoman River Watershed, and tributaries. Waters listed as impaired in this watershed in 1998 included the portions of the eastern and western branches of the Corrotoman River, Senior, Hills, Bells, Taylor, Myer, Millenbeck and Ewells Point Creeks. All impaired waters are located entirely within Lancaster County. The watershed is bounded on the south by the Rappahannock River, on the west-northwest by Routes 354 and 201, and on the north and east by Route 200. The location of the watershed is shown in Figure 3.0.

The drainage area of the individual watersheds are as follows: 1) W. Branch Corrotoman River, 23461 acres or 36.7 mi$^2$; 2) Senior Creek, 571.3 acres or 0.89 mi$^2$; 3) Hills Creek, 834.2 acres or 1.3 mi$^2$; 4) Bells Creek, 1193.6 acres or 1.8 mi$^2$; 5) E. Branch Corrotoman River, 1476.4 acres or 2.3 mi$^2$; 6) Taylor Creek, 1753.1 acres or 2.7 mi$^2$; 7) Myer Creek, 889 acres or 1.4 mi$^2$; 8) Ewells Point Creek, 803.2 acres or 1.25 mi$^2$ and 9) Millenbeck Creek, 508.2 acres or 0.8 mi$^2$. The watersheds have an estimated year round population according to the 2000 US Census of 4945 for growing area 21.

A map of the land use in each of these sub-watersheds are shown in Figures 3-1A through 3.11. In each of these watersheds the dominant land use type is forest followed by agriculture. There are approximately 16 marinas, or boating related facilities, within Growing Area 21. Estimations of the populations of livestock and wildlife, as well as numbers of septic systems within the watershed are shown in Table 3-1. Appendix B provides a description of data and list of data sources for Table 3.1.

### Table 3.1 Estimated Animal Populations and Septic Systems Growing Area 21*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>67</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>43</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Chicken</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Deer</td>
<td>904</td>
<td>21</td>
<td>32</td>
<td>21</td>
<td>527</td>
<td>66</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>Dog</td>
<td>811</td>
<td>19</td>
<td>28</td>
<td>19</td>
<td>498</td>
<td>59</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>Duck</td>
<td>483</td>
<td>96</td>
<td>56</td>
<td>53</td>
<td>392</td>
<td>153</td>
<td>95</td>
<td>58</td>
</tr>
<tr>
<td>Geese</td>
<td>334</td>
<td>66</td>
<td>39</td>
<td>37</td>
<td>271</td>
<td>106</td>
<td>66</td>
<td>40</td>
</tr>
<tr>
<td>Horse</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sheep</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pig</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Raccoon</td>
<td>960</td>
<td>20</td>
<td>34</td>
<td>26</td>
<td>622</td>
<td>67</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Septic</td>
<td>1398</td>
<td>33</td>
<td>49</td>
<td>32</td>
<td>859</td>
<td>102</td>
<td>52</td>
<td>47</td>
</tr>
</tbody>
</table>

* These are estimates based upon extrapolations of county wide data applied to local land use types.
Figure 3.1B
Land Use in the Western Branch Corrotoman River, Senior Creek, Shellfish Condemnation 21-132B
Figure 3.1C
Land Use in the Eastern Branch Corrotoman River,
Hills Creek, Shellfish Condemnation 21-58A

Legend
- Residence
- Commercial/Industrial/Transportation
- Bare rock/sand/clay
- Mining/gravel pits
- Transitional
- Forest
- Grassland
- Agriculture
- Wetland
- Growth Area 21 Land
- Impaired Water
- Water
Figure 3.1D
Land Use in the Eastern Branch Corrotoman River,
Bells Creek, Shellfish Condemnation 21-58B

Legend
- Residence
- Commercial/Industrial/Transportation
- Bare rock/landfills
- Mining/gravels pits
- Transitional
- Forest
- Grassland
- Agriculture
- Wetland
- Growing Area 21 Land
- Impaired Water
- Water

Miles
0 0.5 1 2 3 4
Figure 3.1E
Land Use in the Eastern Branch Corrotoman River, Shellfish Condemnation 21-58B

Legend
- Residence
- Commercial/Industrial/Transportation
- Bare rock/sand/clay
- Mining/gravelpits
- Transitional
- Forest
- Grassland
- Agriculture
- Wetland
- Growing Area 21 Land
- Impaired Water
- Water

Miles
0 0.5 1 2 3 4
Figure 3.1H
Land Use in the Corrotoman River, Millenbeck Creek, Shellfish Condemnation 21-187B

Legend
- Residence
- Commercial/Industrial/Transportation
- Bare rock/sand/clay
- Mining/gravel pits
- Transitional
- Forest
- Grassland
- Agriculture
- Wetland
- Growing Area 21 Land
- Impaired Water
- Water
Figure 3.11
Land Use in the Corrotoman River, Ewells Point, Shellfish Condemnation 21-187A
4.0 Water Quality Impairment and Bacterial Source Assessment

4.1 Water Quality Monitoring

The shellfish water quality monitoring network consists of a total of 54 stations for Shellfish Growing Area 21. The impaired shellfish waters, or condemnation areas, are shown in Figure 4. In these waters there is a single monitoring station for bacterial source tracking (BST) in each of the impaired segments. These stations are monitored by the VDH-DSS for fecal bacteria. The locations of the water quality monitoring stations are shown in Figure 4.2. At least one station in each of these watersheds was sampled for bacteria source tracking. This TMDL study examined bacterial monitoring data at these stations for a period of time from June of 2003 through December 2005. A summary of water quality data for the monitoring period preceding the TMDL study is shown in Table 4.1. Graphs depicting the geometric mean, 90th percentile, and ambient bacteria data are shown in Figures 4.3A through 4.3U. Data for those stations associated with a condemnation from 1998, as indicated by a condemnation number in Table 4.1 are used for the TMDLs in this study.

The closures in the growing areas are characterized based on all monitoring in the closed area. To facilitate an effective assignment of the appropriate level of protection for this system, the station with the highest water quality data was used to assess the existing load in each condemned area. This provides an increased margin of safety and provides a target that can be easily comprehended and uniformly implemented while retaining the necessary protection for the affected waters.

### Table 3.2
Summary of Estimated Land Use in Acres by Type in the Impaired Watersheds of Growing Area 21

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>158</td>
<td>25</td>
<td>17</td>
<td>18</td>
<td>229</td>
<td>38</td>
<td>25</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>Residential</td>
<td>135</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>115</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Commercial</td>
<td>26</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>111</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Transitional</td>
<td>436</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>742</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Forest</td>
<td>17300</td>
<td>728</td>
<td>565</td>
<td>436</td>
<td>9909</td>
<td>1459</td>
<td>439</td>
<td>681</td>
<td>315</td>
</tr>
<tr>
<td>Grassland</td>
<td>2279</td>
<td>87</td>
<td>123</td>
<td>49</td>
<td>1519</td>
<td>53</td>
<td>209</td>
<td>53</td>
<td>30</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2903</td>
<td>73</td>
<td>118</td>
<td>30</td>
<td>1777</td>
<td>146</td>
<td>205</td>
<td>21</td>
<td>117</td>
</tr>
<tr>
<td>Wetland</td>
<td>702</td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>314</td>
<td>33</td>
<td>8</td>
<td>31</td>
<td>13</td>
</tr>
</tbody>
</table>
Figure 4.1
Shellfish Condensation Area and Associated Drainage Areas in the Corrotoman River, Shellfish Growing Area 21
Figure 4.2
Location of Water Quality Monitoring and Bacteria Source Tracking Stations in the Corrotoman River, Shellfish Growing Area 21
Table 4.1 Water Quality Data Summary: Growing Area 21

<table>
<thead>
<tr>
<th>Station</th>
<th>Condemnation Area</th>
<th>Total Observations (1/month)</th>
<th>Geometric Mean</th>
<th>Station Violates Geometric Standard: 14 MPN</th>
<th>90th Percentile</th>
<th>Station Violates 90th Percentile Standard: 40 MPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-8</td>
<td>21-187A</td>
<td>30</td>
<td>37.3</td>
<td>Yes</td>
<td>287.4</td>
<td>Yes</td>
</tr>
<tr>
<td>21-9</td>
<td>21-187B</td>
<td>30</td>
<td>30.1</td>
<td>Yes</td>
<td>182.2</td>
<td>Yes</td>
</tr>
<tr>
<td>21-15</td>
<td>21-205</td>
<td>30</td>
<td>9.8</td>
<td>No</td>
<td>51.0</td>
<td>Yes</td>
</tr>
<tr>
<td>21-15A</td>
<td>21-205</td>
<td>30</td>
<td>9.3</td>
<td>No</td>
<td>57.2</td>
<td>Yes</td>
</tr>
<tr>
<td>21-15B</td>
<td>21-205</td>
<td>30</td>
<td>13.6</td>
<td>No</td>
<td>82.5</td>
<td>Yes</td>
</tr>
<tr>
<td>21-17X</td>
<td>21-198</td>
<td>30</td>
<td>19.1</td>
<td>Yes</td>
<td>129.9</td>
<td>Yes</td>
</tr>
<tr>
<td>21-17X2</td>
<td>21-198</td>
<td>30</td>
<td>42.0</td>
<td>Yes</td>
<td>394.7</td>
<td>Yes</td>
</tr>
<tr>
<td>21-17X3</td>
<td>21-198</td>
<td>30</td>
<td>33.7</td>
<td>Yes</td>
<td>206.9</td>
<td>Yes</td>
</tr>
<tr>
<td>21-22</td>
<td>21-58A</td>
<td>30</td>
<td>18.5</td>
<td>Yes</td>
<td>117.6</td>
<td>Yes</td>
</tr>
<tr>
<td>21-23</td>
<td>21-58A</td>
<td>30</td>
<td>30.6</td>
<td>Yes</td>
<td>157.7</td>
<td>Yes</td>
</tr>
<tr>
<td>21-24</td>
<td>21-58B</td>
<td>30</td>
<td>28.5</td>
<td>Yes</td>
<td>244.4</td>
<td>Yes</td>
</tr>
<tr>
<td>21-25</td>
<td>21-58C</td>
<td>30</td>
<td>11.1</td>
<td>No</td>
<td>69.4</td>
<td>Yes</td>
</tr>
<tr>
<td>21-26</td>
<td>21-58C</td>
<td>30</td>
<td>14.0</td>
<td>No</td>
<td>71.4</td>
<td>Yes</td>
</tr>
<tr>
<td>21-27</td>
<td>21-58C</td>
<td>30</td>
<td>14.7</td>
<td>No</td>
<td>66.9</td>
<td>Yes</td>
</tr>
<tr>
<td>21-28</td>
<td>21-58C</td>
<td>30</td>
<td>20.9</td>
<td>Yes</td>
<td>135.2</td>
<td>Yes</td>
</tr>
<tr>
<td>21-29</td>
<td>21-58C</td>
<td>30</td>
<td>22.0</td>
<td>Yes</td>
<td>111.8</td>
<td>Yes</td>
</tr>
<tr>
<td>21-30</td>
<td>21-58C</td>
<td>30</td>
<td>26.7</td>
<td>Yes</td>
<td>159.6</td>
<td>Yes</td>
</tr>
<tr>
<td>21-42</td>
<td>21-132B</td>
<td>30</td>
<td>28.9</td>
<td>Yes</td>
<td>231.2</td>
<td>Yes</td>
</tr>
<tr>
<td>21-43</td>
<td>21-132B</td>
<td>30</td>
<td>58.9</td>
<td>Yes</td>
<td>527.7</td>
<td>Yes</td>
</tr>
<tr>
<td>21-44</td>
<td>21-132A</td>
<td>30</td>
<td>10.2</td>
<td>No</td>
<td>50.3</td>
<td>Yes</td>
</tr>
<tr>
<td>21-44A</td>
<td>21-132A</td>
<td>30</td>
<td>29.2</td>
<td>Yes</td>
<td>214.7</td>
<td>Yes</td>
</tr>
<tr>
<td>21-45</td>
<td>21-132A</td>
<td>30</td>
<td>12.8</td>
<td>No</td>
<td>63.5</td>
<td>Yes</td>
</tr>
<tr>
<td>21-46</td>
<td>21-132A</td>
<td>30</td>
<td>19.9</td>
<td>Yes</td>
<td>107.2</td>
<td>Yes</td>
</tr>
<tr>
<td>21-47</td>
<td>21-132A</td>
<td>30</td>
<td>24.0</td>
<td>Yes</td>
<td>149.6</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Figure 4.3A

Last 30 Months Ambient Fecal Coliform Data for Ewells Point and Millenbeck Creek, Condemnations 21-187A and 21-187B
Figure 4.3E

Last 30 Month Geometric Mean Fecal Coliform Data for Taylors Creek, Condemnation 21-205

Figure 4.3F

Last 30 Month 90th Percentile Fecal Coliform Data for Taylors Creek, Condemnation 21-205

Figure 4.3G

Last 30 Months Ambient Fecal Coliform Data for Myer Creek, Condemnation 21-198
Figure 4.3H

Last 30 Months Geometric Mean Fecal Coliform Data for Myers Creek, Condemnation 21-198

Figure 4.3I

Last 30 Month 90th Percentile Fecal Coliform Data for Myers Creek, Condemnation 21-198

Figure 4.3J

Last 30 Months Ambient Fecal Coliform Data for Hills Creek and Bells Creek Condemnations 21-58A and 21-58B
Figure 4.3L

Last 30 Month 90th Percentile Fecal Coliform Data for Hills Creek and Bells Creek Condemnations 21-58A and 21-58B

Figure 4.3K

Last 30 Months Geometric Mean Fecal Coliform Data for Hills Creek and Bells Creek Condemnations 21-58A and 21-58B

Figure 4.3M

Last 30 Months Ambient Fecal Coliform Data for the Eastern Branch Corotoman River Condemnation Area 58C
Figure 4.3Q

Last 30 Month Geometric Mean Fecal Coliform Data for Senior Creek, Condemnation Area 21-132B

Figure 4.3R

Last 30 Months 90th Percentile Fecal Coliform Data for Senior Creek, Condemnation Area 21-132B

Figure 4.3S

Last 30 Months Ambient Fecal Coliform Data for the Western Branch Corotoman River Condemnation 21-132A
4.2 Condemnation Areas

Nine impaired segments in the Corrotoman River drainage, in Growing Area 21 were listed as impaired on Virginia’s 1998 303(d) water quality standard for fecal coliform bacteria in shellfish supporting waters. Detailed maps of the shellfish condemnation areas and their associated water quality stations are available from the Virginia Department of health, Division of Shellfish Sanitation. A map of the condemnation areas is shown in Figure 4.1. Copies of the condemnation notices may be found in Appendix A.

4.3 Fecal Coliform Bacteria Source Assessment

The locations of shoreline deficiencies from the DSS shoreline survey are shown in Figure 4.4. A copy of the most recent sanitary shoreline survey may be found in Appendix A.
A. Point Source

There are no VPDES permitted wastewater treatment plant point source contributions of bacteria to the harvestable shellfish areas in the watershed.

B. Non-Point Source Contributions

Nonpoint sources of fecal coliform do not have one discharge point but may occur over the entire length of the receiving water. Fecal coliform bacteria deposited on the land surface can build up over time. During rain events, surface runoff transports water and sediment and discharges to the waterway. Sources of fecal coliform bacteria include grazing livestock, concentrated animal feeding operations, manure application and wildlife and pet excretion. Direct contribution to the waterway occurs when livestock or wildlife defecate into or immediately adjacent to receiving waters. Nonpoint source contributions from humans generally arise from failing septic systems and associated drain fields, moored or marina vessel discharges, storm water management facilities, pump station failures and exfiltration from sewer systems. Contributions from wildlife, both mammalian and avian, are natural conditions and may represent a background level of bacterial loading. It is therefore likely that human loading is due to failures in septic waste treatment systems and/or potential pollution from recreational vessel discharges. The recreational vessels are present in the tributaries as resident vessels at marinas or private slips, and as transient vessels which seek shelter from inclement weather, to rest while in transit to other destinations, or as pleasure anchorage. Vessels may be present year round at slips and marinas, or for less frequent periods at anchor for one to several days. There are 24 slips and 4 moorings in the Eastern Branch of the Corrotoman River, 48 slips and 4 moorings in the Western Branch, and a marina with 98 slips and a pumpout station at Yankee Point Marina in Myers Creek near the mouth of the Corrotoman River. Anchorage locations are plentiful throughout the Corrotoman River watershed and vessels may be found at anchor in the central Corrotoman River, its branches and tributaries during the normal spring, summer and fall boating season.

The shoreline survey is used as a tool to identify non-point source contribution problems and locations. Figure 4.4 shows the results of the DSS sanitary shoreline survey for January 2006. A copy of the textual portion of this survey has been included as Appendix A. The survey identified 71 deficiencies. Fifteen were on-site sewage deficiencies, 14 were related to boating, 21 were potential pollution, 6 were solid waste dumpsites, 20 were related to animal pollution, and 5 were associated with industrial facilities. The number of deficiencies displayed on the map may not agree with the total because of the scale of the map and the possibility of multiple deficiencies at one location.

4.4 Bacterial Source Tracking

Bacterial Source tracking is used to identify sources of fecal contamination from human as well as domestic and wild animals. The BST method used in Virginia is based on the premise that *Escherichia coli* (*E. Coli*) found in human, domestic animal, and wild animals will have significantly different patterns of resistance to a variety of antibiotics. The Antibiotic Resistance Approach (ARA), uses fecal streptococcus or *E. coli* and patterns of antibiotic resistance for separation of sources of the bacterial contribution. The BST analysis used for this TMDL classified the bacteria into one of four source categories: human, pets, livestock, and wildlife. However, BST analysis is an experimental, not approved, technique that is under evaluation and the error involved in correctly assigning *E. coli* isolates to the appropriate fecal sources is unknown.
Figure 4.2 shows the TMDL study stations in each of the nine impaired shellfish growing waters. There is one BST monitoring station for each of the impaired sub-watersheds. The data developed for the watershed shows the possible dominant bacteria contribution in the western branch of the Corrotoman River is livestock followed by humans, then pets. In Senior Creek livestock and pets are indicated as potentially co-dominant with human signatures at very similar levels. At Ewells Point source bacteria is indicated as evenly divided among all source categories, while the adjacent watershed of Millenbeck Creek is indicated as livestock followed by human then pets. In Taylor Creek livestock and pet sources are indicated as co-dominant with human and wildlife sharing the minor component. Livestock followed by human sources are the dominant contributors in the E. Branch of the Corrotoman River with the pet component also indicated as making up a third of the bacteria in the system. Bells Creek and adjacent Hills Creek indicate that livestock, pets and humans are the major bacteria sources in the system. Finally, Millenbeck Creek indicates that live stock comprises half of the bacteria signature with humans, pets and wildlife at relatively equal proportions.

Figures 4.5A through 4.5I show the mean distribution by month for the source categories and the annual means are shown in Figures 4.6A through 4.6I. The BST sampling period was October 2005 through September 2006. The target sampling interval was once monthly, if the graph does not show at least 11 months, that means that there were months for which data was not available, or no bacteria could be isolated. This data is shown in tabular form in Table 4.2.
5.0 TMDL Development

5.1 Simplified Modeling Approach (Tidal Volumetric Model):

Personnel from EPA, Virginia DEQ, Virginia Department of Conservation and Recreation (DCR), Maryland Department of the Environment (MDE), Virginia DSS, Virginia Institute of Marine Sciences (VIMS), United States Geological Survey, Virginia Polytechnic University, James Madison University, and Tetra Tech composed the shellfish TMDL workgroup and developed a procedure for developing TMDLs using either a simplified approach to the development of the TMDL. The goal of the procedure is to use bacteriological source tracking (BST) data to determine the sources of fecal coliform violations and the load reductions needed to attain the applicable criteria.

5.2 The TMDL Calculation

To meet the water quality standards for both geometric mean and 90th percentile criteria, TMDLs for the impaired segments in the watershed are defined for the geometric mean load and the 90th percentile load. The TMDL for the geometric mean essentially represents the allowable average limit and the TMDL for the 90th percentile is the allowable upper limit.

A. Current Fecal Coliform Condition

The fecal coliform concentration in an embayment varies due to the changes in biological, hydrological and meteorological conditions. The current condition was determined based on the 30-sample geometric mean and 90th percentile of fecal coliform values of each condemned area. The period of record for the monitoring data used to determine the current condition is June 2003 to December 2005. The maximum values for geometric mean and 90th percentile were used to represent the current loads. Therefore, the current loads represent the worse case scenario.

B. Geometric Mean Analysis:

The current 30-sample geometric mean was used for the load estimation. The current load was estimated using a simple volumetric model. The allowable load was calculated using the water quality standard of 14 MPN/100ml. This value was also used as boundary condition for the calculation. The load reduction needed for the attainment of the water quality standard was determined by subtracting the allowable load from the current load. The process may be described by the word equation as follows. The calculated results are listed in table 5-2.

The load reduction is estimated as follows:

\[
\text{Geometric Mean Value (X MPN/100ml) x (volume)} = \text{Existing Load}
\]

\[
\text{Criteria Value (14 MPN/100ml) x (volume)} = \text{Allowable Load}
\]

\[
\text{Load Reduction} = \frac{\text{Current Load} - \text{Allowable Load}}{\text{Current Load}} \times 100\%
\]
Figure 4.5A

Monthly Mean Fecal Coliform Contribution by BST for Millenbeck Creek Station 21-8

Figure 4.5B

Monthly Mean Fecal Coliform Contribution by BST for Ewells Point Station 21-9
Monthly Mean Fecal Coliform Contribution by BST for Taylors Creek Station 21-15B

Monthly Mean Fecal Coliform Contribution by BST for Myers Creek Station 21-17X
Figure 4.5 G

Monthly Mean Fecal Coliform Contribution by BST East Branch Corrotoman River Average of Station 21-30A, 21-31 and 21-33

Figure 4.5 H

Monthly Mean Fecal Coliform Contribution by BST Western branch Corrotoman River Average of Stations 21-46, 21-49 and 21-51
Figure 4.5I

Monthly Mean Fecal Coliform Contribution by BST Senior Creek Station 21-24

MPN/100ml

10/11/2005
11/9/2005
12/8/2005
1/9/2006
2/22/2006
3/8/2006
4/5/2006
5/18/2006
6/19/2006
7/18/2006
8/3/2006
9/14/2006

Pet
Livestock
Human
Wildlife

Figure 4.6A

Annual Average Fecal Coliform Contribution by BST, Condemnation 21-132A, W. Branch Corrotoman River
(Average of 3 BST sampling stations)

Pet
21%

Livestock
38%

Wildlife
8%

Human
33%
Figure 4.6B

Annual Average Fecal Coliform Contribution by BST Condemnation 21-132B, Senior Creek

- Pet: 31%
- Livestock: 31%
- Human: 29%
- Wildlife: 9%

Figure 4.6C

Annual Average Fecal Coliform Contribution by BST, Condemnation 21-187A, Ewells Point

- Pet: 23%
- Livestock: 28%
- Human: 24%
- Wildlife: 25%
Figure 4.6D

Annual Average Fecal Coliform Contribution by BST Millenbeck Creek Condemnation 21-187B

- Pet: 19%
- Wildlife: 8%
- Human: 27%
- Livestock: 46%

Figure 4.6E

Annual Average Fecal Coliform Contribution by BST, Condemnation 21-58A, Hills Creek

- Pet: 33%
- Wildlife: 19%
- Human: 25%
- Livestock: 23%
Figure 4.6F

Annual Average Fecal Coliform Contribution by BST, Condemantion 21-58B, Bells Creek

- Pet: 31%
- Wildlife: 9%
- Human: 26%
- Livestock: 34%

Figure 4.6G

Annual Average Fecal Coliform Contribution by BST, Condemantion 21-58C, E. Branch Corrotoman River (Average of 3 BST sampling stations)

- Pet: 29%
- Wildlife: 5%
- Human: 32%
- Livestock: 34%
Figure 4.6H

Annual Average Fecal Coliform Contribution by BST, Condemation 21-198, Myer Creek

- Pet: 14%
- Wildlife: 15%
- Human: 16%
- Livestock: 55%

Figure 4.6I

Annual Average Fecal Coliform Contribution by BST, Condemation 21-205, Taylor Creek

- Pet: 40%
- Wildlife: 3%
- Human: 3%
- Livestock: 54%
Table 4.2 Non-point Source Load Distribution using Annual Average BST Growing area 21 Corrotoman River Watershed

<table>
<thead>
<tr>
<th>Condemnation Area</th>
<th>Wildlife</th>
<th>Human</th>
<th>Livestock</th>
<th>Pets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>8%</td>
<td>33%</td>
<td>38%</td>
<td>21%</td>
</tr>
<tr>
<td>Condemnation 21-132B Senior Creek</td>
<td>9%</td>
<td>29%</td>
<td>31%</td>
<td>31%</td>
</tr>
<tr>
<td>Condemnation 21-58A Hills Creek</td>
<td>19%</td>
<td>25%</td>
<td>23%</td>
<td>33%</td>
</tr>
<tr>
<td>Condemnation 21-58B Bells Creek</td>
<td>9%</td>
<td>26%</td>
<td>34%</td>
<td>31%</td>
</tr>
<tr>
<td>Condemnation 21-58C E. Br. Corrotoman River</td>
<td>5%</td>
<td>32%</td>
<td>34%</td>
<td>29%</td>
</tr>
<tr>
<td>Condemnation 21-205 Taylor Creek</td>
<td>3%</td>
<td>3%</td>
<td>54%</td>
<td>40%</td>
</tr>
<tr>
<td>Condemnation 21-198 Myer Creek</td>
<td>15%</td>
<td>16%</td>
<td>55%</td>
<td>14%</td>
</tr>
<tr>
<td>Condemnation 21-187A Ewells Point</td>
<td>25%</td>
<td>24%</td>
<td>23%</td>
<td>28%</td>
</tr>
<tr>
<td>Condemnation 21-187B Millenbeck Creek</td>
<td>8%</td>
<td>27%</td>
<td>46%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Table 5.1
Geometric Mean Analysis of Current Load and Estimated Load Reduction

<table>
<thead>
<tr>
<th>Condemnation Area</th>
<th>Volume (m$^3$)</th>
<th>Fecal Coliform (MPN/100ml)</th>
<th>WQ Standard MPN/100ml</th>
<th>Current Load (MPN/day)</th>
<th>Allowable Load (MPN/day)</th>
<th>Required Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>41400</td>
<td>37.3</td>
<td>14</td>
<td>1.55E+10</td>
<td>5.80E+09</td>
<td>63%</td>
</tr>
<tr>
<td>Condemnation 21-132B Senior Creek</td>
<td>56970</td>
<td>30.1</td>
<td>14</td>
<td>1.71E+10</td>
<td>7.98E+09</td>
<td>53%</td>
</tr>
</tbody>
</table>

38
Table 5.1 Continued
Geometric Mean Analysis of Current Load and Estimated Load Reduction

<table>
<thead>
<tr>
<th>Condemnation</th>
<th>Current</th>
<th>Load Reduction</th>
<th>Estimated Load Reduction</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-58A Hills Creek</td>
<td>389610</td>
<td>13.6</td>
<td>14</td>
<td>5.32E+10</td>
</tr>
<tr>
<td>21-58B Bells Creek</td>
<td>147420</td>
<td>42.0</td>
<td>14</td>
<td>6.19E+10</td>
</tr>
<tr>
<td>21-58C E. Br. Corrotoman River</td>
<td>162720</td>
<td>30.6</td>
<td>14</td>
<td>4.97E+10</td>
</tr>
<tr>
<td>21-205 Taylor Creek</td>
<td>158130</td>
<td>28.5</td>
<td>14</td>
<td>4.50E+10</td>
</tr>
<tr>
<td>21-198 Myer Creek</td>
<td>1848960</td>
<td>26.7</td>
<td>14</td>
<td>4.94E+11</td>
</tr>
<tr>
<td>21-187A Ewells Point</td>
<td>1937520</td>
<td>29.2</td>
<td>14</td>
<td>5.67E+11</td>
</tr>
<tr>
<td>21-187B Millenbeck Creek</td>
<td>122400</td>
<td>58.9</td>
<td>14</td>
<td>7.20E+10</td>
</tr>
</tbody>
</table>

C. 90th Percentile Analysis

The current 30-sample 90th percentile concentration was used for load estimation. The current load was estimated using a simple volumetric model. The allowable load was calculated based on the water quality standard of 49 MPN/100ml. The calculated results are listed in Table 5-3.

The load reduction is estimated as follows:

\[
\text{Load Reduction} = \frac{\text{Current Load} - \text{Allowable Load}}{\text{Current Load}} \times 100\% \]
### Table 5.2
90\textsuperscript{th} Percentile Analysis of Current Load and Estimated Load Reduction

<table>
<thead>
<tr>
<th>Condemnation Area</th>
<th>Volume (m\textsuperscript{3})</th>
<th>*Fecal Coliform (MPN/100ml)</th>
<th>WQ Standard MPN/100ml</th>
<th>Current Load (MPN/day)</th>
<th>Allowable Load (MPN/day)</th>
<th>Required Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>41400</td>
<td>287.4</td>
<td>49</td>
<td>1.19E+11</td>
<td>2.03E+10</td>
<td>83%</td>
</tr>
<tr>
<td>Condemnation 21-132B Senior Creek</td>
<td>56970</td>
<td>182.2</td>
<td>49</td>
<td>1.04E+11</td>
<td>2.79E+10</td>
<td>73%</td>
</tr>
<tr>
<td>Condemnation 21-58A Hills Creek</td>
<td>389610</td>
<td>82.5</td>
<td>49</td>
<td>3.21E+11</td>
<td>1.91E+11</td>
<td>41%</td>
</tr>
<tr>
<td>Condemnation 21-58B Bells Creek</td>
<td>147420</td>
<td>394.7</td>
<td>49</td>
<td>5.82E+11</td>
<td>7.22E+10</td>
<td>88%</td>
</tr>
<tr>
<td>Condemnation 21-58C E. Br. Corrotoman River</td>
<td>162720</td>
<td>157.7</td>
<td>49</td>
<td>2.57E+11</td>
<td>7.97E+10</td>
<td>69%</td>
</tr>
<tr>
<td>Condemnation 21-205 Taylor Creek</td>
<td>158130</td>
<td>244.4</td>
<td>49</td>
<td>3.86E+11</td>
<td>7.75E+10</td>
<td>80%</td>
</tr>
<tr>
<td>Condemnation 21-198 Myer Creek</td>
<td>1848960</td>
<td>159.6</td>
<td>49</td>
<td>2.95E+12</td>
<td>9.06E+11</td>
<td>69%</td>
</tr>
<tr>
<td>Condemnation 21-187A Ewells Point</td>
<td>1937520</td>
<td>214.7</td>
<td>49</td>
<td>4.16E+12</td>
<td>9.49E+11</td>
<td>77%</td>
</tr>
<tr>
<td>Condemnation 21-187B Millenbeck Creek</td>
<td>122400</td>
<td>527.7</td>
<td>49</td>
<td>6.46E+11</td>
<td>6.00E+10</td>
<td>91%</td>
</tr>
</tbody>
</table>

### 5.3 Load Allocation

A comparison of the reductions based on geometric mean load and on the 90\textsuperscript{th} percentile load shows that the 90\textsuperscript{th} percentile load is the critical condition for all impaired waters in Growing Area 4. This is consistent with water quality analysis. The 90\textsuperscript{th} percentile criterion is most frequently exceeded. Therefore the 90\textsuperscript{th} percentile loading is used to allocate source contributions and establish load reduction targets among the various contributing sources that will yield the necessary water quality improvements to attain the water quality standard in the creeks in Growing Area 21.
Table 5.3
Reduction and Allocation Based
Upon 90th Percentile Standard Criterion: Growing Area 21

<table>
<thead>
<tr>
<th>Condemnation Area 21-187A</th>
<th>Source</th>
<th>BST Allocation % of Total Load</th>
<th>Current Load MPN/ day</th>
<th>Load Allocation MPN/ day</th>
<th>Reduction Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewells Point</td>
<td>Wildlife</td>
<td>25%</td>
<td>1.05E+12</td>
<td>9.49E+11</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Human</td>
<td>24%</td>
<td>1.01E+12</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>28%</td>
<td>1.16E+12</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Pet</td>
<td>23%</td>
<td>9.41E+11</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>4.16E+12</td>
<td>9.49E+11</td>
<td>77%</td>
</tr>
<tr>
<td>Condemnation Area 21-187AB</td>
<td>Wildlife</td>
<td>8%</td>
<td>5.17E+10</td>
<td>5.17E+10</td>
<td>0%</td>
</tr>
<tr>
<td>Millenbeck Creek</td>
<td>Human</td>
<td>27%</td>
<td>1.74E+11</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>47%</td>
<td>3.04E+11</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Pet</td>
<td>19%</td>
<td>1.23E+11</td>
<td>8.28E+09</td>
<td>93%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>6.46E+11</td>
<td>6.00E+10</td>
<td>91%</td>
</tr>
<tr>
<td>Condemnation Area 21-205</td>
<td>Wildlife</td>
<td>3%</td>
<td>1.16E+10</td>
<td>1.16E+10</td>
<td>0%</td>
</tr>
<tr>
<td>Taylor Creek</td>
<td>Human</td>
<td>3%</td>
<td>1.16E+10</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>53%</td>
<td>2.05E+11</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Pet</td>
<td>40%</td>
<td>1.54E+11</td>
<td>6.59E+10</td>
<td>57%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>3.86E+11</td>
<td>7.75E+10</td>
<td>80%</td>
</tr>
<tr>
<td>Condemnation Area 21-198</td>
<td>Wildlife</td>
<td>15%</td>
<td>4.43E+11</td>
<td>4.43E+11</td>
<td>0%</td>
</tr>
<tr>
<td>Myer Creek</td>
<td>Human</td>
<td>16%</td>
<td>4.72E+11</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>55%</td>
<td>1.62E+12</td>
<td>5.03E+10</td>
<td>97%</td>
</tr>
<tr>
<td></td>
<td>Pet</td>
<td>14%</td>
<td>4.13E+11</td>
<td>4.13E+11</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>2.95E+12</td>
<td>9.06E+11</td>
<td>69%</td>
</tr>
<tr>
<td>Condemnation Area 21-58A</td>
<td>Wildlife</td>
<td>19%</td>
<td>6.10E+10</td>
<td>6.10E+10</td>
<td>0%</td>
</tr>
<tr>
<td>Bell Creek</td>
<td>Human</td>
<td>25%</td>
<td>8.03E+10</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>23%</td>
<td>7.38E+10</td>
<td>2.44E+10</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td>Pet</td>
<td>33%</td>
<td>1.06E+11</td>
<td>1.06E+11</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>3.21E+11</td>
<td>1.91E+11</td>
<td>41%</td>
</tr>
<tr>
<td>Condemnation Area 21-58B</td>
<td>Wildlife</td>
<td>9%</td>
<td>5.24E+10</td>
<td>5.24E+10</td>
<td>0%</td>
</tr>
<tr>
<td>Hill Creek</td>
<td>Human</td>
<td>26%</td>
<td>1.51E+11</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>34%</td>
<td>1.98E+11</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Pet</td>
<td>31%</td>
<td>1.80E+11</td>
<td>1.98E+10</td>
<td>89%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>5.82E+11</td>
<td>7.22E+10</td>
<td>88%</td>
</tr>
<tr>
<td>Condemnation Area 21-58C</td>
<td>Wildlife</td>
<td>5%</td>
<td>1.29E+10</td>
<td>1.29E+10</td>
<td>0%</td>
</tr>
<tr>
<td>E. Br. Corrotoman River</td>
<td>Human</td>
<td>32%</td>
<td>8.22E+10</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>33%</td>
<td>8.48E+10</td>
<td>0.00E+00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Pet</td>
<td>29%</td>
<td>7.45E+10</td>
<td>6.69E+10</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100%</td>
<td>2.57E+11</td>
<td>7.97E+10</td>
<td>69%</td>
</tr>
</tbody>
</table>
Based on source assessment of the watershed, the percent loading for each of the major source categories is estimated. These percentages are used to determine where load reductions are needed. The loadings for each source are determined by multiplying the total current and allowable loads by the representative percentage. The percent reduction needed to attain the water quality standard or criterion is allocated to each source category. This is shown in Table 5-4 and serves to fulfill the TMDL requirements by ensuring that the criterion is attained. The TMDL seeks to eliminate 100% of the human derived fecal component regardless of the allowable load determined through the load allocation process. Human derived fecal coliforms are a serious concern in the estuarine environment and discharge of untreated human waste is precluded by state and federal law. According to the preceding analysis, reduction of the controllable loads; human, livestock and pets, will result in achievement of the water quality standard for all condemned areas except Ewells Point were wildlife reductions are indicated as potentially necessary for compliance with the water quality standard.

Through an iterative implementation of actions to reduce the controllable loads, subsequent monitoring may indicate that further reductions are not necessary, or that revisions in implementation strategies may be appropriate. Continued violations may result in the process of Use Attainment Analysis, UAA, for the water body (see Chapter 6 for a discussion of UAA). The allocations presented demonstrate how the TMDLs could be implemented to achieve water quality standards; however, the state reserves the right to allocate differently, as long as consistency with the achievement of water quality standards is maintained.

### 5.3.1 Development of Waste load Allocations

There are no permitted point source discharges that affect the harvestable shellfish waters in the watershed. No waste load is considered in this TMDL.
5.4 Consideration of Critical Conditions and Seasonal Variation

EPA regulations at 40 CFR 130.7 (c) (1) requires 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 of the water body is protected during times when they are 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. The current loading to the water body was determined using a long-term record of water quality monitoring (observation) data. The period of record for the data was 1995 to 2002. The resulting estimate is quite robust.

A comparison of the geometric mean values and the 90\textsuperscript{th} percentile values against the water quality criteria will determine which represents the more critical condition or higher percent reduction. If the geometric mean values dictate the higher reduction, this suggests that, on average, water sample counts are consistently high with limited variation around the mean. If the 90\textsuperscript{th} percentile criterion requires a higher reduction, this suggests an occurrence of the high fecal coliform due to the variation of hydrological conditions. For this study, the 90\textsuperscript{th} percentile criterion is the most critical condition. Thus, the final load reductions determined using the 90\textsuperscript{th} percentile represents the most stringent conditions and it is the reductions based on these bacterial loadings that will yield attainment of the water quality standard. Seasonal variations involve changes in surface runoff, stream flow, and water quality as a result of hydrologic and climatologic patterns. Variations due to changes in the hydrologic cycle as well as temporal variability in fecal coliform sources, such as migrating duck and goose populations are accounted for by the use of the long-term data record to estimate the current load.

5.5. Margin of Safety

A Margin of Safety (MOS) is required as part of a TMDL in recognition of uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection. Due to the very conservative assumptions made in this modeling effort the margin of safety is considered to be implicit in the load allocations the model establishes.

5.6 TMDL Summary

To meet the water quality standards for both geometric mean and 90\textsuperscript{th} percentile criteria, TMDLs for the Cold Harbor, Currioman, Barnes, Pierce, Nomini, and Buckner Creek watersheds and the North Prong watershed in Growing Area 4 are defined for the geometric mean load and the 90\textsuperscript{th} percentile load. The TMDLs are summarized in the table 5.4 and 5.5.
Table 5.4 TMDL Summary for Eight Closures on the Corrotoman River Watershed Growing Area 21 (geometric mean)

<table>
<thead>
<tr>
<th>Condemnation Area</th>
<th>Pollutant Identified</th>
<th>TMDL MPN/100ml</th>
<th>Waste Load Allocation MPN/day</th>
<th>Load Allocation MPN/day</th>
<th>Margin of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>5.80E+09</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-132B Senior Creek</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>7.98E+09</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-58A Hills Creek</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>5.45E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-58B Bells Creek</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>2.06E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-58C E. Br. Corrotoman River</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>2.28E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-205 Taylor Creek</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>2.21E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-198 Myer Creek</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>2.59E+11</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-187A Ewells Point</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>2.71E+11</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-187B Millenbeck Creek</td>
<td>Fecal Coliform</td>
<td>14</td>
<td>N/A</td>
<td>1.71E+10</td>
<td>Implicit</td>
</tr>
</tbody>
</table>

6.0 TMDL Implementation

The goal of the TMDL program is to establish a three-step path that will lead to attainment of water quality standards. The first step in the process is to develop TMDLs that will result in meeting water quality standards. This report represents the culmination of that effort for the seven bacteria impairments in the Nomini Creek watershed, Shellfish Growing Area 4. The second step is to develop a TMDL implementation plan. The final step is to implement the TMDL implementation plan, and to monitor water quality to determine if water quality standards are being attained.
Once a TMDL has been approved by EPA, measures must be taken to reduce pollution levels in the water body. These measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), are implemented in an iterative process that is described along with specific BMPs in the implementation plan. The process for developing an implementation plan has been described in the recent “TMDL Implementation Plan Guidance.”

Table 5.5 TMDL Summary for Eight Closures in the Corrotoman River Watersheds Growing Area 21 (90th percentile)

<table>
<thead>
<tr>
<th>Condemnation Area</th>
<th>Pollutant Identified</th>
<th>TMDL MPN/100ml</th>
<th>Waste Load Allocation MPN/day</th>
<th>Load Allocation MPN/day</th>
<th>Margin of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condemnation 21-132A W. Br. Corrotoman River</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>2.03E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-132B Senior Creek</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>2.79E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-58A Hills Creek</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>1.91E+11</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-58B Bells Creek</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>7.22E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-58C E. Br. Corrotoman River</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>7.97E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-205 Taylor Creek</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>7.75E+10</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-198 Myer Creek</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>9.06E+11</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-187A Ewells Point</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>9.49E+11</td>
<td>Implicit</td>
</tr>
<tr>
<td>Condemnation 21-187B Millenbeck Creek</td>
<td>Fecal Coliform</td>
<td>49</td>
<td>N/A</td>
<td>6.00E+10</td>
<td>Implicit</td>
</tr>
</tbody>
</table>
Manual”, published in July 2003 and available upon request from the DEQ and DCR TMDL project staff or at http://www.deq.virginia.gov/tmdl/implans/ipguide.pdf. With successful completion of Implementation plans, Virginia will be well on the way to restoring impaired waters and enhancing the value of this important resource. Additionally, development of an approved implementation plan will improve a locality’s chances for obtaining financial and technical assistance during implementation.

6.1 Staged Implementation

In general, Virginia intends for the required reductions to be implemented in an iterative process that first addresses those sources with the largest impact on water quality. For example, in agricultural areas of the watershed, the most promising management practice is livestock exclusion from water bodies. This has been shown to be very effective in lowering fecal coliform concentrations in water bodies, both by reducing the cattle deposits themselves and by providing additional riparian buffers.

Additionally, in both urban and rural areas, reducing the human fecal loading from failing septic systems should be a primary implementation focus because of its health implications. This component could be implemented through education on septic tank pump-outs as well as a septic system repair/replacement program and the use of alternative waste treatment systems. In urban areas, reducing the loading from leaking sewer lines could be accomplished through a sanitary sewer inspection and management program.

The iterative implementation of BMPs in the watershed has several benefits:

1. It enables tracking of water quality improvements following BMP implementation through follow-up monitoring;
2. It provides a measure of quality control, given the uncertainties inherent in computer simulation modeling;
3. It provides a mechanism for developing public support through periodic updates on BMP implementation and water quality improvements;
4. It helps ensure that the most cost effective practices are implemented first; and
5. It allows for the evaluation of the adequacy of the TMDL in achieving water quality standards.

Watershed stakeholders will have 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.

6.2 Link to ongoing Restoration Efforts

Implementation of this TMDL will contribute to ongoing water quality improvement efforts aimed at restoring water quality in the Chesapeake Bay. Other TMDLs have been developed for impaired shellfish waters in Lancaster County for Carters, Greenvale, and Lancaster Creek watersheds. Reports for these TMDLS are available at the Department of Environmental Quality website http://www.deq.virginia.gov/tmdl/. A tributary strategy has been developed for the Virginia tributaries to the Potomac River. Up-to-date information on tributary strategy development can be found at http://www.snr.virginia.gov/Initiatives/TributaryStrategies.
6.3 Reasonable Assurance for Implementation

6.3.1 Follow-Up Monitoring

VDH-DSS will continue sampling at the established bacteriological monitoring stations in accordance with its shellfish monitoring program. VADEQ will continue to use data from these monitoring stations and related ambient monitoring stations to evaluate improvements in the bacterial community and the effectiveness of TMDL implementation in attainment of the general water quality standard.

6.3.2. Regulatory Framework

While section 303(d) of the Clean Water Act and current EPA regulations do not require the development of TMDL implementation plans as part of the TMDL process, they do require reasonable assurance that the load and waste load allocations can and will be implemented. Additionally, Virginia’s 1997 Water Quality Monitoring, Information and Restoration Act (the “Act”) directs the State Water Control Board to “develop and implement a plan to achieve fully supporting status for impaired waters” (Section 62.1-44.19.7). 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. EPA outlines the minimum elements of an approvable implementation plan in its 1999 “Guidance for Water Quality-Based Decisions: The TMDL Process.” The listed elements include implementation actions/management measures, timelines, legal or regulatory controls, time required to attain water quality standards, monitoring plans and milestones for attaining water quality standards.

Once developed, DEQ intends to incorporate the TMDL implementation plan into the appropriate Water Quality Management Plan (WQMP), in accordance with the Clean Water Act’s Section 303(e). In response to a Memorandum of Understanding (MOU) between EPA and DEQ, DEQ also submitted a draft Continuous Planning Process to EPA in which DEQ commits to regularly updating the WQMPs. Thus, the WQMPs will be, among other things, the repository for all TMDLs and TMDL implementation plans developed within a river basin.

6.3.3. Implementation Funding Sources

One potential source of funding for TMDL implementation is Section 319 of the Clean Water Act. Section 319 funding is a major source of funds for Virginia’s Non-point Source Management Program. Other funding sources for implementation include the U.S. Department of Agriculture’s Conservation Reserve Enhancement and Environmental Quality Incentive Programs, the Virginia State Revolving Loan Program, and the Virginia Water Quality Improvement Fund. The TMDL Implementation Plan Guidance Manual contains additional information on funding sources, as well as government agencies that might support implementation efforts and suggestions for integrating TMDL implementation with other watershed planning efforts.

6.3.4 No Discharge Zones for Vessels

Many tributaries as well as the Chesapeake Bay are utilized by private and commercial vessels as routes of transportation and as areas of safe anchorage. In some tributaries large concentrations of these vessels may be present as vessels in transit and at anchor, vessels secured by moorings, or vessels either resident or transient at marinas located in the watershed. While the discharge of untreated human sewage is illegal under the Clean Water Act and under Virginia law, discharges from Coast Guard
approved Marine Sanitation Devices has remained. These devices are not able to adequately treat human waste discharged into small watersheds and embayments and results in an unabated discharge of viruses, nitrogen, phosphorus and oxygen demanding wastes. While use of MSD’s may be appropriate for waters in open near coastal areas, other waters, particularly tributaries to the Chesapeake Bay may be adversely affected by such discharges. Sewage discharges from marine sanitation devices in small confined watersheds or anchorages where shellfish harvest or contact recreation use is the designated and actual use of these waters, can contaminate important shellfish resources and expose humans to inadequately treated human sewage. In such waters seeking a no-discharge designation may be the best means to preclude discharges of inadequately treated sewage from all vessels which may transit or seek shelter in the water body of concern. Such no-discharge designations currently exist in Smith Mountain Lake and for Lynnhaven, Broad, and Linkhorn Bays, tributaries to the Chesapeake Bay. In this watershed holding tanks and pump out facilities must be used and the discharge of treated human waste from vessels is prohibited. Procedures for establishing such NDZ’s and the state and federal regulations regarding vessel discharges can be found in the Appendix.

It is recommended in this TMDL that due to its high utilization by resident and transient vessels at slips, moorings or at anchorage, and the presence of considerable shellfish and finfish resources, as well the as primary contact recreation use for water skiing and swimming, that a no discharge zone designation be established for the entire Corrotoman River drainage as part of the first phase implementation of this TMDL.

6.3.5 Addressing Wildlife Contributions

In some waters for which TMDLs have been developed, water quality modeling indicates that even after removal of all of the sources of bacteria (other than wildlife), the stream will not attain standards under all flow regimes at all times. **However, neither the Commonwealth of Virginia, nor EPA is proposing the elimination of wildlife to allow for the attainment of water quality standards.** This is obviously an impractical and wholly undesirable action. While managing over-populations of wildlife remains as an option to local stakeholders, the reduction of wildlife or changing a natural background condition is not the intended goal of a TMDL.

Based on the above, EPA and Virginia have developed a TMDL strategy to address the wildlife issue. The first step in this strategy is to develop a reduction goal. The pollutant reductions for the interim goal are applied only to controllable, anthropogenic sources identified in the TMDL, setting aside any control strategies for wildlife. During the first implementation phase all controllable sources would be reduced to the maximum extent practicable using the staged approach outlined above. Following completion of the first phase, DEQ would re-assess water quality in the stream to determine if the water quality standard is attained. This effort will also evaluate if the technical assumptions were correct. If water quality standards are not being met, a UAA may be initiated to reflect the presence of naturally high bacteria levels due to uncontrollable sources. In some cases, the effort may never have to go to the second phase because the water quality standard exceedances attributed to wildlife may be very small and fall within the margin of error.

If water quality standards are not being met, a special study called a Use Attainability Analysis (UAA) may be initiated to reflect the presence of naturally high bacteria levels due to uncontrollable sources. The outcomes of the UAA may lead to the determination that the designated use(s) of the waters may need to be changed to reflect the attainable use(s). To remove a designated use, the state must
demonstrate 1) that the use is not an existing use, 2) that downstream uses are protected, and 3) that the source of bacterial contamination is natural and uncontrollable by effluent limitations and by implementing cost-effective and reasonable best management practices for non-point source control (9 VAC 25-260-10). All site-specific criteria or designated use changes must be adopted as amendments to the water quality standards regulations. Watershed stakeholders and EPA will be able to provide comment during this process. Additional information can be obtained at http://www.deq.virginia.gov/wqs/WQS03AUG.pdf

7.0. Public Participation

During development of the TMDL for the Corrotoman River and tributaries within Growing Area 21, public involvement was encouraged through a public participation process that included public meetings and stakeholder meetings.

The first public meeting was held on March 20, 2007 A basic description of the TMDL process and the agencies involved was presented and a discussion was held to regarding the source assessment input, bacterial source tracking, and model results. This meeting was followed by development of the final draft TMDL. Input from these meetings was utilized in the development of the TMDL and improved confidence in the allocation scenarios and TMDL process.

The second public meeting where the TMDL load allocations were presented was held on July 16, 2007. Public involvement in the TMDL implementation planning process was solicited and encouraged.
8.0 Glossary

303(d). A section of the Clean Water Act of 1972 requiring states to identify and list water bodies that do not meet the states’ water quality standards.

Allocations. That portion of receiving water’s loading capacity attributed to one of its existing or future pollution sources (nonpoint or point) or to natural background sources. (A wasteload allocation [WLA] is that portion of the loading capacity allocated to an existing or future point source, and a load allocation [LA] is that portion allocated to an existing or future nonpoint source or to natural background levels. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.)

Ambient water quality. Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact on human health.

Anthropogenic. Pertains to the [environmental] influence of human activities.

Bacteria. Single-celled microorganisms. Bacteria of the coliform group are considered the primary indicators of fecal contamination and are often used to assess water quality.

Bacterial source tracking (BST). A collection of scientific methods used to track sources of fecal contamination.

Best management practices (BMPs). Methods, measures, or practices determined to be reasonable and cost-effective means for a landowner to meet certain, generally nonpoint source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.

Clean Water Act (CWA). The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The Clean Water Act (CWA) contains a number of provisions to restore and maintain the quality of the nation’s water resources. One of these provisions is section 303(d), which establishes the TMDL program.

Concentration. Amount of a substance or material in a given unit volume of solution; usually measured in milligrams per liter (mg/L) or parts per million (ppm).

Contamination. The act of polluting or making impure; any indication of chemical, sediment, or biological impurities.

Cost-share program. A program that allocates project funds to pay a percentage of the cost of constructing or implementing a best management practice. The remainder of the costs is paid by the producer(s).

Critical condition. The critical condition can be thought of as the “worst case” scenario of environmental conditions in the water body in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence.

Designated uses. Those uses specified in water quality standards for each water body or segment whether or not they are being attained.

Domestic wastewater. Also called sanitary wastewater, consists of wastewater discharged from residences and from commercial, institutional, and similar facilities.

Drainage basin. A part of a land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as a watershed, river basin, or hydrologic unit.
**Existing use.** Use actually attained in the water body on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).

**Fecal Coliform.** Indicator organisms (organisms indicating presence of pathogens) associated with the digestive tract.

**Geometric mean.** A measure of the central tendency of a data set that minimizes the effects of extreme values.

**GIS.** Geographic Information System. A system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth. (Dueker and Kjerne, 1989)

**Infiltration capacity.** The capacity of a soil to allow water to infiltrate into or through it during a storm.

**Interflow.** Runoff that travels just below the surface of the soil.

**Loading, Load, Loading rate.** The total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in weight per unit time.

**Load allocation (LA).** The portion of a receiving waters loading capacity attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished (40 CFR 130.2(g)).

**Loading capacity (LC).** The greatest amount of loading a water body can receive without violating water quality standards.

**Margin of safety (MOS).** A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body (CWA section 303(d)(1)©). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).

**Mean.** The sum of the values in a data set divided by the number of values in the data set.

**Monitoring.** Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

**Narrative criteria.** Non-quantitative guidelines that describe the desired water quality goals.

**Nonpoint source.** Pollution that originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff.

**Numeric targets.** A measurable value determined for the pollutant of concern, which, if achieved, is expected to result in the attainment of water quality standards in the listed water body.

**Point source.** Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving water body or river.

**Pollutant.** Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. (CWA section 502(6)).
**Pollution.** Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water.

**Privately owned treatment works.** Any device or system that is (a) used to treat wastes from any facility whose operator is not the operator of the treatment works and (b) not a publicly owned treatment works.

**Public comment period.** The time allowed for the public to express its views and concerns regarding action by EPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).

**Publicly owned treatment works (POTW).** Any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

**Raw sewage.** Untreated municipal sewage.

**Receiving waters.** Creeks, streams, rivers, lakes, estuaries, ground-water formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

**Riparian areas.** Areas bordering streams, lakes, rivers, and other watercourses. These areas have high water tables and support plants that require saturated soils during all or part of the year. Riparian areas include both wetland and upland zones.

**Riparian zone.** The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.

**Runoff.** That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

**Septic system.** An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a drain field or subsurface absorption system consisting of a series of percolation lines for the disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically.

**Sewer.** A channel or conduit that carries wastewater and storm water runoff from the source to a treatment plant or receiving stream. Sanitary sewers carry household, industrial, and commercial waste. Storm sewers carry runoff from rain or snow. Combined sewers handle both.

**Slope.** The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04), degrees (2 degrees 18 minutes), or percent (4 percent).

**Stakeholder.** Any person with a vested interest in the TMDL development.

**Surface area.** The area of the surface of a water body; best measured by planimetry or the use of a geographic information system.

**Surface runoff.** Precipitation, snowmelt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants.

**Surface water.** All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors directly influenced by surface water.
**Topography.** The physical features of a geographic surface area including relative elevations and the positions of natural and man-made features.

**Total Maximum Daily Load (TMDL).** The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, plus a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state’s water quality standard.

**VADEQ.** Virginia Department of Environmental Quality.

**VDH.** Virginia Department of Health.

**Virginia Pollutant Discharge Elimination System (NPDES).** The national program for issuing, modifying, revoking and re-issuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

**Wasteload allocation (WLA).** The portion of a receiving waters’ loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

**Wastewater.** Usually refers to effluent from a sewage treatment plant. See also Domestic wastewater.

**Wastewater treatment.** Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.

**Water quality.** The biological, chemical, and physical conditions of a water body. It is a measure of a waterbody’s ability to support beneficial uses.

**Water quality criteria.** Levels of water quality expected to render a body of water suitable for its designated use, composed of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

**Water quality standard.** Law or regulation that consists of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an antidegradation statement.

**Watershed.** A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

**WQIA.** Water Quality Improvement Act.
9.0 Citations


VA DEQ 1998 303(d) List of Impaired Waters.
10.0 Appendices

Appendix A   Growing Area 21 Sanitary Survey and Condemnation Notices

Appendix B   Supporting Documentation and Watershed Assessment

Appendix C   Marine Sanitation Devices and No Discharge Zones

Appendix D   Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.
Appendix A: Growing Area 21: 1) Shoreline Sanitary Survey

Date: 21 September 2006
Survey Period: June 28, 2005 – August 4, 2006
Total Number of Properties Surveyed: 2456
Surveyed By: D.B. Geeson, R.S. Morris, R.M. Thomas, and W.A. McCarty

SECTION A: GENERAL

This survey area extends from Reference Point 21, at Orchard Point to Reference Point 22 at Towles Point, including the entire Corrotoman River watershed between these two points. The area consists of the Corrotoman River main body (Taylor, Moran, Myer, Town and Whitehouse Creeks and Millenbeck and Ewells prongs), the eastern branch (Quarter Cove, Norris Prong, Camps Prong, Browns Creek, Punches Cove, Bells Creek and Hills Creek), and the Western Branch (Johns Creek, Davis Creek, Belwood Swamp, McMahon Swamp, Callahan Swamp, Little Branch, Senior Creek and Lowrey Creek), and all of their tributaries. The survey boundary has been revised. See map for current survey boundary.

The topography of the area surveyed begins with an elevation of 5’ along the shoreline to a maximum of 100’ at the outer edge of the survey boundary.

Meteorological data indicated that the area received a total rainfall of 49.79” for the survey period. A monthly breakdown is as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 28-30, 2005</td>
<td>0.17&quot;</td>
</tr>
<tr>
<td>July 1-31</td>
<td>5.89&quot;</td>
</tr>
<tr>
<td>August 1-31</td>
<td>2.07&quot;</td>
</tr>
<tr>
<td>September 1-30</td>
<td>2.50&quot;</td>
</tr>
<tr>
<td>October 1-31</td>
<td>5.73&quot;</td>
</tr>
<tr>
<td>November 1-30</td>
<td>3.69&quot;</td>
</tr>
<tr>
<td>December 1-31</td>
<td>4.09&quot;</td>
</tr>
<tr>
<td>January 1-31, 2006</td>
<td>3.91&quot;</td>
</tr>
<tr>
<td>February 1-28</td>
<td>1.15&quot;</td>
</tr>
<tr>
<td>March 1-31</td>
<td>0.43&quot;</td>
</tr>
<tr>
<td>April 1-30</td>
<td>4.37&quot;</td>
</tr>
<tr>
<td>May 1-31</td>
<td>3.52&quot;</td>
</tr>
<tr>
<td>June 1-30</td>
<td>7.43&quot;</td>
</tr>
<tr>
<td>July 1-31</td>
<td>4.81&quot;</td>
</tr>
</tbody>
</table>
| August 1-4      | 0.00"         

Several new businesses have been established along the main corridors. The increase population since the last survey has promoted the need for service oriented businesses such as boat repair, dock installation as well as new house construction.

Boating activity has remained relatively unchanged, and animal pollution has increased from 9 to 14 sources. Solid waste dumpsites have decreased from 4 to 3 sources and industrial wastes have increased from 6 to 9 sources. The area’s auto salvage yard, Dodson’s Garage, ceased operations in 2003.

VDH Virginia Department of Health
Protecting You and Your Environment
www.vdh.virginia.gov/shellfish
Copies of Bacteriological, Hydrographic and Shellfish Closure data are available at the area office for review. Copies of the current condemnation notices and maps are available via the Internet at http://www.vdh.virginia.gov/cehs/shellfish/.

This report lists only those properties that have sanitary deficiency or have other environmental significance. “DIRECT” indicates that the significant activity or deficiency has a direct impact on shellfish waters. Individual field forms with full information on properties listed in this report are on file in the Richmond office of the Division of Shellfish Sanitation and are available for reference until superseded by a subsequent survey of the area. Data in the report is also made available to local health departments and other agencies to address items that may be out of compliance with their regulatory programs.

SECTION B: SEWAGE POLLUTION SOURCES

SEWAGE TREATMENT FACILITIES
-None-

ON-SITE DEFICIENCIES

2. CONTRIBUTES POLLUTION – Location: 1678 Weems Road, Weems 22576. Dwelling - 1 1/2-story white vinyl siding with black shutters. No contact. Unapproved plywood cover to septic tank. Sanitary notice issued 7/22/05 to field # A114.

3. NO FACILITIES – Location: 369 Gaskins Road, Weems 22576. Dwelling – 1-story yellow cement block with white trim. No contact. Using commercial privy. Sanitary notice issued 8/1/05 to field # A132.

4. CONTRIBUTES POLLUTION – Location: 449 Gaskins Road, Weems 22576. Dwelling - 1-story light brown vinyl siding with burgundy shutters. No contact. Effluent erupting from septic tank area onto ground surface. Sanitary notice issued 8/1/05 to field # A135.

10. NO FACILITIES – Location: 39 Oakland Park Road, Kilmarnock 22482. Dwelling – 1 1/2-story green asbestos shingle siding with white trim. No contact. Using commercial privy. Sanitary notice issued 6/9/08 to field # A698.

13. NO FACILITIES - Location: 1170 Pinkardsville Road, Lancaster 22503. Dwelling – 2-story white frame. Privy in very poor condition and does not appear to be used and no running water in the house. Sanitary Notice issued 9/30/05 to field # B57.

14. CONTRIBUTES POLLUTION, DIRECT – Location: 1450 Pinkardsville Road, Lancaster 22503. Dwelling – 1-story tan frame. Effluent erupting onto ground surface and flowing directly to a pond at the headwaters of the Corrotoman River. Sanitary Notice issued 9/30/05 to field # 59.
15. CONTRIBUTES POLLUTION, **DIRECT** - Location: 70 Levellields Lane, Lancaster 22503. Dwelling - 1-sory brown frame with basement. Effluent erupting onto ground surface less than one hundred feet from a pond at the headwaters of the Corotoman River. Sanitary Notice issued 9/30/05 to field # 60.

17. CONTRIBUTES POLLUTION, **DIRECT** - Location: 436 West Point Road, Lancaster 22503. Dwelling - 1-story brown vinyl with white shutters. Effluent erupting onto ground surface. Sanitary Notice issued 1/27/06 to field # 107.

18. NO FACILITIES - Location: 2445 Merry Point Road, Lancaster 22503. Dwelling - 1-sory white frame with a silver tin roof. Portable toilet located behind house. Sanitary Notice issued 3/3/06 to field # 187.


27. NO FACILITIES - Location: 9144 Mary Ball Road, Lancaster 22503. Dwelling - 2-story white asbestos shingle. Portable toilet located beside house. Sanitary Notice issued 6/2/06 to field # B421.

30. CONTRIBUTES POLLUTION - Location: 141 Campbell Road, Kilmarnock 22482. Dwelling - 1-story white vinyl. Effluent erupting onto ground surface. Sanitary Notice issued 6/9/06 to field # B480.

38. NO FACILITIES - Location: 31 Saint Paul Circle, Lively 22507. Dwelling - 1-story frame. Sanitary notice issued 08/05/05 to field # C104.

39. NO FACILITIES - Location 611 White Chapel Road, Lively 22507. Dwelling - 1-story frame. Sanitary notice issued 08/11/05 to field # C127.

40. CONTRIBUTES POLLUTION - Location: 8815 Mary Ball Road, Lancaster 22503. 1-story brick. Lancaster High School. Two vault covers deteriorated and "shoebox" improperly installed over tank. Sanitary notice issued 10/21/05 to field # C393.

49. CONTRIBUTES POLLUTION - Location: 1541 Millenbeck Road, Lancaster 22503. Dwelling - 1-story grey vinyl with white trim. No contact. Effluent erupting onto ground surface. Sanitary Notice issued 10/4/05 to field # D138.

50. CONTRIBUTES POLLUTION - Location: 213 Cow Shed Road, Lancaster 22503. Dwelling - 1-story cream T-111 siding with brown shutters & trim. No contact. Effluent erupting onto ground surface. Sanitary notice issued 12/16/05 to field # D199.
54. **CONTRIBUTES POLLUTION** – Location: 96 Circle Street, Lancaster 22503. Dwelling - House destroyed and demolished after hurricane Isabel. 4" black pipe to tank with rag in end. 4" and 2" PVC pipes and sump pump exposed in basement floor. Sanitary notice issued 08/09/06 to field # D462.

**POTENTIAL POLLUTION**
-None-

**SECTION C: NON-SEWAGE WASTE SITES**

**INDUSTRIAL WASTES**

1. Location: Route 632 (Indiantown Road), Weems 22576. Owner: Ampro Fisheries, Inc., P.O. Box 319, Reedsville 22539. Business- landing strip for menhaden spotter planes. No contact. Located on premises were 1 x 600 gallon and 1 x 300 gallon aviation fuel tanks without berms.


28. Occupant: Brookvale Transportation Department, 10418 Mary Ball Road, Lancaster 22503. Owner: Commonwealth of Virginia Department of Highways, Richmond 23219. State highway shop. 14 employees. Observed on-site was 1 x 10,000 gallon empty liquid calcium tank surrounded by a wooden berm, 1 x 750 gallon diesel tank, 1 x 500 gallon kerosene tank, and 4 x 55 gallon used oil drums that get pumped out when needed.

32. Location: 2175 Lara Road, Lively 22507. 1-story beige metal garage. Brown’s Service Center. Owner Bernard Brown, P.O. Box 302, Lively 22507. Located on premises was 1 x 500 gallon waste oil tank without berm. Tank is pumped by Safety Kleen, 1200 West 100 Road, Chester 23836.

36. Location: 2798 White Chapel Road, Lively 22507. 1-story brick. Upper Lancaster Volunteer Fire Department. No contact. Located on premises were 2 x 500 gallon diesel storage tanks with berms adjacent to building.

37. Location: 1916 White Chapel Road, Lively 22507. 1-story yellow metal and block. UPS office. Located on premises was 1 x 1200 gallon unleaded fuel tank with berm located at rear of building.

42. Location: 6088 Mary Ball Road, Lively 22507. 1-story white block. R.L. Self Timber, Inc: Owner R.L. Self, P.O. Box 12, Lively 22507. Located on premises was 1 x 1000 gallon diesel fuel storage tank without berm, which will be constructed later.
45. **DIRECT** – Captain Tom’s Seafood, 60 Woods Rd, Lancaster 22503. Owners: Thomas E. and Ester W. Stevens. Business – shucker - packer (VA-897-SP) and crab picking operation (VA-176-C). 11 employees. Has permit # VAG524013 from DEQ to discharge processing wastes into Whitehouse Creek.

**SOLID WASTE DUMPSITES**

9. Lancaster County Public Works, end of route 788 (White Pine Drive); c/o Lancaster County Administrator, P.O. Box 699, Lancaster 22503. No contact. Public – waste collection and recycling center. Observed on-site were 8 satellite dumpsters. 1 portable commercial privy was available for sewage disposal.

11. Lancaster County Poor House Tract, 30 Sweet Gum Road, Lancaster 22503, c/o Lancaster County Administrator, P.O. Box 699, Lancaster 22503. No contact. Public - waste collection and recycling center. Observed on-site were 3 satellite dumpsters. 1 portable commercial privy was available for sewage disposal.


**SECTION D: BOATING ACTIVITY**

**MARINAS**

52. Yankee Point Sailboat Marina, 1303 Oak Hill Road, Lancaster 22503. 98 slips/120 dry storage spaces, ramp, fuel, water, electricity, restrooms, dump station, pump-out facilities and solid waste containers. Facility No. 1407.

55. Heritage Point Marina, end of Belmont Drive, Mollusk 22517. Owner: Heritage Point Homeowners Association, P.O. Box 308, Mollusk 22517. 20 slips, ramp, water, electricity and solid waste containers. Facility No. 1402.

**OTHER PLACES WHERE BOATS ARE MOORED**

5. Location: 72 Rose Drive, Weems 22576. No contact. 4 slips. There are no boating services provided. Owner’s dwelling is approximately 100 yards from wharf. Dwelling has septic tank and drainfield which appeared to be in satisfactory condition at time of inspection.

6. Location: 186 Rose Drive, Weems 22576. Owner: Yeomac Corporation. No contact. 4 slips. There are no boating services provided. Owner’s house is adjacent to slips. Dwelling has septic tank and drainfield which appeared to be in satisfactory condition at time of inspection.

7. Quarters Cove Property Owners Association, end of route 1093 (King Fisher Circle), Weems 22576. No contact. 2 slips. The only boating service provided is an in-out ramp. There is no sewage disposal system in place.
24. Laurel Point, end of Heron Lane, Lancaster 22503. Owner: Laurel Point Property Owners Assoc., 854 Laurel Point Road, Lancaster 22503. Private ramp and docking facilities. No contact. 8 slips. The only boating service provided is an in-out ramp. There is no sewage disposal system in place.

46. Watson Landing Pier, end of State Rt. 354, Mollusk 22517. Private pier. No contact. 11 slips. Owner has a variance to the requirement to install sanitary facilities and pump-out facilities at this location.

47. Whitehouse Creek Estates, off of Bermuda Rd. Mollusk 22517. Owners: Whitehouse Creek Estates Home Owners Assoc. Private Pier and ramp. No contact. 1 mooring. The only boating service provided is an in-out ramp.

48. Location: 353 Callis Road, Millenbeck 22517. Abandoned Callis Seafood. Shucking house. No contact. There were 2 male and female vault privies, dumpster, and a 500 gallon diesel tank without a berm on the property.

56. Corrotoman By The Bay, end of Marina Road, Mollusk 22517. Owners: Corrotoman By The Bay Property Owners Association, Box 99, Mollusk 22517. Boating services available are 15 slips and an in-out ramp.

**UNDER SURVEILLANCE**

21. Iberis Village, end of Iberis Road, Lancaster 22503. Private pier. 4 slips. No contact. No boating services are provided. There is no sewage disposal system in place.

23. Eagles Landing, 299 Bald Eagle Drive, Lancaster 22503. Owner: Delmarva Properties, Inc., Box 1700, West Point 23181. Community pier and ramp. No contact. 2 slips. The only service provided is an in-out ramp. There are no containers available for solid waste collection, sanitary facilities or dump station facilities provided at this location.

25. Riverwood Subdivision, Bayberry Lane, Lancaster 22503. Owner: Greatland Corporation, White Stone 22578. Community pier and ramp. No contact. 2 slips / 4 moorings. The only boating service provided is an in-out ramp. There are no containers available for solid waste collection, sanitary facilities or dump station facilities provided at this location.

57. Hunt’s Homeowner’s Association, Pier, Hunt Lane, Mollusk 22517. Owner’s: Hunt’s Homeowners Association, Inc., P.O. Box 251, Mollusk 22517. 3 moorings and solid waste containers.

**SECTION E: CONTRIBUTES ANIMAL POLLUTION**

12. Lancaster County Animal Shelter, 3156 Regina Road, Lancaster 22503. c/o Lancaster County Administrator, P.O. Box 698, Lancaster 22503. 2 employees. Present at time of survey were 13 dogs in kennels. Wastes are washed into septic system. Carcasses are taken to dump.
16. Location: 124 West Point Road, Merry Point 22513. Dwelling – 2-story brick with black shutters. 2 persons. Present at time of survey were 23 sheep. Manure left on ground.

22. Location: 14 Dunaway Drive, Merry Point 22513. Dwelling – 1-story with blue vinyl. 2 persons. Present at time of survey were 9 chickens. Manure left on the ground.

26. Merry Point Hunt Club, 277 Mantua Road, Lancaster 22503. Private hunt club. Present at time of survey were 8 dogs in pens. Wastes are left on the ground.

29. Location: 11704 Mary Ball Road, Lancaster 22503. Dwelling - 2-story tan frame. 2 persons. Present at time of survey were 3 horses, 3 sheep and 5 chickens. Manure is left on the ground.

31. Location: 985 Lara Road, Lancaster 22503. Dwelling - 2-story white vinyl siding. 2 persons. Present at time of survey were 100 cows in fenced pastures. Manure is left on ground.

33. Location: 27 Alfonso Road, Lancaster 22503. Dwelling – 2-story white frame. No contact. Present at time of survey were 3 sheep, 2 llamas, 16 geese in approximately 1 fenced acre. Manure is left on ground.

34. **DIRECT** – Location: 4559 Mary Ball Road, Lively 22507. Dwelling - 1story brick with white trim. No contact. Present at time of survey were approximately 40 cows in fenced pasture with direct access to Belwood Swamp at 100' elevation. Manure is left on ground.

35. Location: 5091 Mary Ball Road, Lively 22507. Dwelling - 1-story brick with white trim. 4 persons. Present at time of survey were 10 cows in fenced pasture. Manure is left on ground.

41. Location: 10800 Courthouse Road, Lancaster 22503. Dwelling - 1-story white frame. The Lively Rod and Gun Club. Present at time of survey were 30 beagles in pens over slabs. Manure is left on slabs.

44. Location: 725 Brown's Lane, Lancaster 22503. Dwelling - 1story pink and white frame. Present at time of survey were 12 horses in 5 fenced acres. Manure is left on ground.

51. Location: 307 Spring Hill Lane, Lancaster 22503. Red barn. Present at time of survey were 21 buffalo, 2 horses, 12 chickens and 12 ducks on approximately 25 fenced acres. Manure is left on ground.

53. Location: 145 Oak Hill Road, Lancaster 22503. Dwelling - 1-story white vinyl siding. Present at time of survey were 2 horses, 4 goats, 30 chickens, 8 pheasants and 2 peacocks on approximately .5 fenced acres. Manure is left on ground.
SUMMARY

Area #021
Corrotoman River
21 September 2006

SECTION B: SEWAGE POLLUTION SOURCES
1. SEWAGE TREATMENT FACILITIES
   0 – DIRECT – None
   0 – INDIRECT – None
   0 – B.1. TOTAL

2. ON-SITE SEWAGE DEFICIENCIES
   Correction of deficiencies in this section is the responsibility of the local health department.
   3 – CONTRIBUTES POLLUTION, DIRECT – # 14, 15, 17
   7 – CONTRIBUTES POLLUTION, INDIRECT – # 2, 4, 30, 40, 49, 50, 54
   0 – CP (Kitchen or Laundry Wastes), DIRECT – None.
   0 – CP (Kitchen or Laundry Wastes), INDIRECT – None.
   0 – NO FACILITIES, DIRECT – None.
   0 – NO FACILITIES, INDIRECT – # 3, 10, 13, 18, 19, 20, 27, 38, 39
   19 – B.2. TOTAL

3. POTENTIAL POLLUTION
   Periodic surveillance of these properties will be maintained to determine any status change.
   0 – POTENTIAL POLLUTION – None.

SECTION C: NON-SEWAGE WASTE SITES
1. INDUSTRIAL WASTE SITES
   1 – DIRECT – # 45
   7 – INDIRECT – # 1, 8, 26, 32, 36, 37, 42
   8 – C.1. TOTAL

2. SOLID WASTE SITES
   0 – DIRECT – None.
   0 – INDIRECT – # 9, 11, 43
   0 – C.2. TOTAL

SECTION D: BOATING ACTIVITY
2 – MARINAS – # 52, 55
8 – OTHER PLACES WHERE BOATS ARE MOORED – # 5, 6, 7, 24, 46, 47, 48, 56
4 – UNDER SURVEILLANCE – # 21, 23, 25, 57
14 – D. TOTAL

SECTION E: CONTRIBUTES ANIMAL POLLUTION
1 – DIRECT – # 34
12 – INDIRECT – # 12, 16, 22, 26, 29, 31, 33, 35, 41, 44, 51, 53
13 – TOTAL
COMMONWEALTH of VIRGINIA
Department of Health
DIVISION OF SHELLFISH SANITATION
109 Governor Street, Room 614-B
Richmond, VA 23219

NOTICE AND DESCRIPTION OF SHELLFISH AREA CONDEMNATION
NUMBER 021-058, EASTERN BRANCH OF CORROTONAN RIVER

EFFECTIVE 19 OCTOBER 2005

Pursuant to Title 28.2, Chapter 8, §§28.2-803 through 28.2-808, §32.1-20, and §9-14:4.1, B.15 of the
Code of Virginia:

1. The “Notice and Description of Shellfish Area Condemnation Number 021-058, Eastern Branch
   of Corrotoman River,” effective 21 March 2005, is cancelled effective 19 October 2005.

2. Shellfish Condemnation Area Number 021-058 shown as Sections A and B, is hereby
   established, effective 19 October 2005. It shall be unlawful for any person, firm, or corporation
   to take shellfish from these areas for any purpose, except by permit granted by the Marine
   Resources Commission, as provided in Section 28.2-810 of the Code of Virginia. The boundaries
   of these areas are shown on the map titled “Eastern Branch of Corrotoman River, Condemned
   Shellfish Number 021-058, 19 October 2005” which is part of this notice.

3. The Department of Health will receive, consider and respond to petitions by any interested person
   at any time with respect to reconsideration or revision of this order.

BOUNDARIES OF CONDEMNED AREA NUMBER 021-058

A. The condemned area shall include all of Hills Creek and its tributaries lying upstream of a line
   drawn from latitude/longitude map coordinate (37°42'36.4"-76°27'50.6") to map coordinate
   (37°42'31.4",-76°27'50.7").

B. The condemned area shall include all of that portion of the Eastern Branch of the Corrotoman
   River and its tributaries lying upstream of a line drawn from latitude/longitude map coordinate
   (37°42'46.3",-76°27'31.3") to map coordinate (37°42'41.7",-76°27'28.0").

Recommended by:

[Signature]
Director, Division of Shellfish Sanitation

Ordered by:

[Signature]
State Health Commissioner

Date 10/4/2005

VDH VIRGINIA DEPARTMENT OF HEALTH
www.vdh.virginia.gov/shellfish

65
COMMONWEALTH of VIRGINIA
Department of Health
DIVISION OF SHELLFISH SANITATION
109 Governor Street, Room 614-B
Richmond, VA 23219

NOTICE AND DESCRIPTION OF SHELLFISH AREA CONDEMNATION NUMBER 021-132, WESTERN BRANCH OF CORROTOMAN RIVER

EFFECTIVE 19 OCTOBER 2005

Pursuant to Title 28.2, Chapter 8, §§28.2-803 through 28.2-808, §2.1-20, and §9-6.14:4.1, B.16 of the Code of Virginia:

1. The “Notice and Description of Shellfish Area Condemnation Number 021-132, Western Branch of Corrotoman River,” effective 21 March 2005, is cancelled effective 19 October 2005.

2. Condemned Shellfish Area Number 021-132, shown as Sections A through E, is established, effective 19 October 2005. It shall be unlawful for any person, firm, or corporation to take shellfish from these areas for any purpose, except by permit granted by the Marine Resources Commission, as provided in Section 28.2-810 of the Code of Virginia. The boundaries of these areas are shown on the map titled “Western Branch of Corrotoman River, Condemned Shellfish Area Number 021-132, 19 October 2005” which is part of this notice.

3. The Department of Health will receive, consider and respond to petitions by any interested person at any time with respect to reconsideration or revision of this order.

BOUNDARIES OF CONDEMNED AREA NUMBER 021-132

A. The condemned area shall include all of that portion of the Western Branch, Corrotoman River, lying upstream of a line drawn between latitude/longitude map coordinate (37°43'56.6", -76°30'49.2") and map coordinate (37°43'58.1", -76°30'33.5").

B. The condemned area shall include all of Senior Creek and its tributaries lying upstream of a line drawn between latitude/longitude map coordinate (37°43'37.1", -76°30'48.3") and map coordinate (37°43'33.8", -76°30'46.4").

C. The condemned area shall include all of Davis Creek and its tributaries lying upstream of a line drawn between latitude/longitude map coordinate (37°43'44.0", -76°30'27.0") and map coordinate (37°43'43.4", -76°30'24.5").
COMMONWEALTH of VIRGINIA
Department of Health
DIVISION OF SHELLFISH SANITATION
109 Governor Street, Room 614-B
Richmond, VA 23219

NOTICE AND DESCRIPTION OF SHELLFISH AREA CONDEMNATION
NUMBER 021-187, WHITEHOUSE CREEK AND VICINITY

EFFECTIVE 19 OCTOBER 2005

Pursuant to Title 28.2, Chapter 8, §§28.2-803 through 28.2-808, §32.1-20, and §9-6.14-4.1, B.16 of the 
Code of Virginia:

1. The “Notice and Description of Shellfish Area Condemnation Number 021-187, Whitehouse 
   Creek and Vicinity,” effective 21 March 2005, is cancelled effective 19 October 2005.

2. Condemned Shellfish Area Number 021-187, shown as Sections A and B, is established, effective 
   19 October 2005. It shall be unlawful for any person, firm, or corporation to take shellfish from 
   these areas for any purpose, except by permit granted by the Marine Resources Commission, as 
   provided in Section 28.2-810 of the Code of Virginia. The boundaries of these areas are shown 
   on the map titled “Whitehouse Creek and Vicinity, Condemned Shellfish Area Number 021-187, 
   19 October 2005” which is part of this notice.

3. The Department of Health will receive, consider and respond to petitions by any interested person 
   at any time with respect to reconsideration or revision of this order.

BOUNDARIES OF CONDEMNED AREA NUMBER 021-187

A. The condemned area shall include all of Town Creek and its tributaries lying upstream of a line 
   drawn from latitude/longitude map coordinate (37°40'29.0",-76°28'59.6") to map coordinate 
   (37°40'19.6",-76°29'08.9").

B. The condemned area shall include all of Whitehouse Creek and its tributaries lying upstream of a 
   line drawn from latitude/longitude map coordinate (37°39'27.3",-76°29'56.8") to map coordinate 
   (37°39'13.5",-76°30'00.1").

Recommended by: 
Director, Division of Shellfish Sanitation

Ordered by: 
State Health Commissioner

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting you and your environment
www.vdh.virginia.gov/shellfish
NOTICE AND DESCRIPTION OF SHELLFISH AREA CONDEMNATION
NUMBER 021-198, MEYER, MORAN AND TAYLOR CREEKS

EFFECTIVE 19 OCTOBER 2006

Pursuant to Title 28.2, Chapter 8, §§28.2-803 through 28.2-808, §32.1-20, and §9-6.1:4.1, B.16 of
the Code of Virginia:

1. The “Notice and Description of Shellfish Area Condemnation Number 021-198, Meyer,
Moran and Taylor Creeks,” effective 19 October 2005, is cancelled effective 19 October
2006.

2. Condemned Shellfish Area Number 021-198, shown as Sections A through F, is established,
effective 19 October 2006. It shall be unlawful for any person, firm, or corporation to take
shellfish from these areas for any purpose, except by permit granted by the Marine Resources
Commission, as provided in Section 28.2-810 of the Code of Virginia. The boundaries of
these areas are shown on the map titled “Meyer, Moran and Taylor Creeks, Condemned
Shellfish Area Number 021-198, 19 October 2006” which is a part of this notice.

3. Seasonally Condemned Shellfish Area Number 021-198, shown as Section M1 is hereby
established, effective 19 October 2006, for the period October 19, 2006, through October 31,
2006, and shall remain in force annually thereafter for the period beginning the first day of
April through the last day of October until rescinded. It is unlawful for any person, firm, or
corporation to take shellfish from this area during such period for any purpose, except by
permit granted by the Marine Resources Commission, as provided in §28.2-810 of the Code
of Virginia. The boundary of this area is shown on the map titled “Meyer, Moran and Taylor
Creeks, Condemned Shellfish Area Number 021-198, 19 October 2005” which is a part of
this notice.

4. The Department of Health will receive, consider and respond to petitions by any interested
person at any time with respect to reconsideration or revision of this order.

BOUNDARIES OF CONDEMNED AREA NUMBER 021-198

A. The condemned area shall include all of the southern branch of Meyer Creek and its
tributaries lying upstream of a line drawn from map coordinate (37°41'06.0", -76°29'13.9") to
map coordinate (37°41'13.8", -76°29'20.3").
Appendix B: Supporting Documentation and Watershed Assessment

1. Fecal Production Literature Review
2. Geographic Information System Data: Sources and Process
3. Watershed Source Assessment
<table>
<thead>
<tr>
<th>Animal</th>
<th>Concentration in feces (FC/g)</th>
<th>Fecal coliform production rate (FC/day)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat</td>
<td>7.9E+06</td>
<td>5.0E+09</td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>2.3E+07</td>
<td>5.0E+09</td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td>1.3E+06</td>
<td>1.9E+08</td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td></td>
<td>2.4E+08</td>
<td></td>
</tr>
<tr>
<td>Cow</td>
<td>2.3E+05</td>
<td>1.1E+11</td>
<td>average of dairy and beef</td>
</tr>
<tr>
<td>Beef cattle</td>
<td></td>
<td>5.4E+09</td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td>1.0E+02</td>
<td>2.5E+04</td>
<td>assume 250 g/day</td>
</tr>
<tr>
<td>Deer</td>
<td>?</td>
<td>5.0E+08</td>
<td>best prof. judgement</td>
</tr>
<tr>
<td>Duck</td>
<td>3.3E+07</td>
<td>1.1E+10</td>
<td>average of 3 sources</td>
</tr>
<tr>
<td>Canada Geese</td>
<td>3.6E+04</td>
<td>9.0E+06</td>
<td></td>
</tr>
<tr>
<td>Canada Geese</td>
<td>1.5E+04</td>
<td>3.8E+06</td>
<td>assume 250 g/day (3)</td>
</tr>
<tr>
<td>Horse</td>
<td></td>
<td>4.2E+08</td>
<td></td>
</tr>
<tr>
<td>Pig</td>
<td>3.3E+06</td>
<td>5.5E+09</td>
<td></td>
</tr>
<tr>
<td>Pig</td>
<td></td>
<td>8.9E+09</td>
<td></td>
</tr>
<tr>
<td>Sea Gull</td>
<td>3.7E+08</td>
<td>3.7E+09</td>
<td>assume 10 g/day</td>
</tr>
<tr>
<td>Sea gull</td>
<td></td>
<td>1.9E+09</td>
<td>mean of four species</td>
</tr>
<tr>
<td>Rabbit</td>
<td>2.0E+01</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Raccoon</td>
<td>1.0E+09</td>
<td>1.0E+11</td>
<td>assume 100 g/day</td>
</tr>
<tr>
<td>Sheep</td>
<td>1.6E+07</td>
<td>1.5E+10</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td>1.8E+10</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>2.9E+05</td>
<td>1.1E+08</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td></td>
<td>1.3E+08</td>
<td></td>
</tr>
<tr>
<td>Rodent</td>
<td>1.6E+05</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Muskrat</td>
<td>3.4E+05</td>
<td>3.4E+07</td>
<td></td>
</tr>
<tr>
<td>Human</td>
<td>1.3E+07</td>
<td>2.0E+09</td>
<td></td>
</tr>
<tr>
<td>Septage</td>
<td>4.0E+05</td>
<td>1.0E+09</td>
<td>assume 70/gal/day/person</td>
</tr>
</tbody>
</table>


A geographic information system is a powerful computer software package that can store large amounts of spatially referenced data and associated tabular information. The data layers produced by a GIS can be used for many different tasks, such as generating maps, analyzing results, and modeling processes. Below is a table that lists the data layers that were developed for the watershed and hydrodynamic models.
## Table B-2 GIS Data Elements and Sources

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Source</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watershed boundary</td>
<td>Division of Shellfish Sanitation, VA Department of Health</td>
<td>Various dates</td>
</tr>
<tr>
<td>Subwatershed boundary</td>
<td>Center for Coastal Resources Management</td>
<td>2003</td>
</tr>
<tr>
<td>Land use</td>
<td>National Land Cover Data set (NLCD), US Geological Survey</td>
<td>1999</td>
</tr>
<tr>
<td>Elevation</td>
<td>Digital Elevation Models and Digital Raster Graphs, US Geological Survey</td>
<td>Various dates</td>
</tr>
<tr>
<td>Soils</td>
<td>SSURGO and STATSGO, National Resource Conservation Service</td>
<td>Various dates</td>
</tr>
<tr>
<td>Stream network</td>
<td>National Hydrography Dataset</td>
<td>1999</td>
</tr>
<tr>
<td>Precipitation, temperature, solar</td>
<td>Chesapeake Bay Program, Phase V</td>
<td>2002</td>
</tr>
<tr>
<td>radiation, and evapotranspiration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stream flow data</td>
<td>Gauging stations, US Geological Survey</td>
<td>Various dates</td>
</tr>
<tr>
<td>Shoreline Sanitary Survey deficiencies</td>
<td>Division of Shellfish Sanitation, VA Department of Health</td>
<td>Various dates</td>
</tr>
<tr>
<td>Wastewater treatment plants</td>
<td>VA Department of Environmental Quality</td>
<td>Various dates</td>
</tr>
<tr>
<td>Sewers</td>
<td>Division of Shellfish Sanitation, VA Department of Health</td>
<td>Various dates</td>
</tr>
<tr>
<td>Dog population</td>
<td>US Census Bureau</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>American Veterinary Association</td>
<td>2002</td>
</tr>
<tr>
<td>Wildlife</td>
<td>Virginia Department of Game and Inland Fisheries, US Fish and Wildlife Service</td>
<td>2004</td>
</tr>
<tr>
<td>Septic tanks (from human population)</td>
<td>Division of Shellfish Sanitation, VA Department of Health</td>
<td>Various dates</td>
</tr>
<tr>
<td></td>
<td>US Census Bureau</td>
<td>2000</td>
</tr>
<tr>
<td>Water quality monitoring stations</td>
<td>Division of Shellfish Sanitation, VA Department of Health</td>
<td>Various dates</td>
</tr>
<tr>
<td>Water quality segments</td>
<td>Center for Coastal Resources Management</td>
<td>2003</td>
</tr>
<tr>
<td>Tidal prism segments</td>
<td>Department of Physical Sciences, VIMS</td>
<td>2003</td>
</tr>
<tr>
<td>Water body volumes</td>
<td>Bathymetry from Hydrographic Surveys, National Ocean Service, NOAA</td>
<td>Various dates</td>
</tr>
<tr>
<td>Condemnation zones</td>
<td>Division of Shellfish Sanitation, VA Department of Health</td>
<td>Various dates</td>
</tr>
<tr>
<td>Tidal data</td>
<td>NOAA tide tables</td>
<td>2004</td>
</tr>
</tbody>
</table>
A. GIS Data Description and Process

Watershed boundary determined by VDH, DSS. There are 105 watersheds in Virginia.

Subwatershed boundaries were delineated based on elevation, using digital 7.5 minute USGS topographic maps. There are 1836 subwatersheds.

The original land use has 15 categories that were combined into 3 categories: urban (high and low density residential and commercial); undeveloped (forest and wetlands); and agriculture (pasture and crops).

Descriptions of Shoreline Sanitary Survey deficiencies are found in each report. Contact DSS for more information. Digital data layer generated by CCRM from hardcopy reports.

Wastewater treatment plant locations were obtained from DEQ and digital data layer was generated by CCRM. Design flow, measured flow, and fecal coliform discharges were obtained from DEQ.

Sewers data layer was digitized from Shoreline Sanitary Surveys by CCRM.

Dog numbers were obtained using the American Vet Associations equation of #households * 0.58. See website for additional information—
http://www.avma.org/membshp/marketstats/formulas.asp#households1. Database was generated by CCRM.

Domestic livestock includes cows, pigs, sheep, chickens, turkeys, and horses. Database was generated by CCRM.

Wildlife includes ducks and geese, deer, and raccoons. Animals were chosen based on availability of fecal coliform production rates and population estimates. Database was generated by CCRM.

Ducks and geese—US FWS, DGIF
Deer—DGIF
Raccoons—DGIF

Human input was based on DSS sanitary survey deficiencies and US Census Bureau population data (number of households).

Water quality monitoring data are collected, on average, once per month. Digital data layer of locations was generated by DSS. Water quality data was mathematically processed and input into a database for model use.

Water bodies were divided into segments based on the location of the monitoring stations (midway between stations). If a segment contained >1 station, the FC values were averaged. If a segment contained 0 stations, the value from the closest station(s) was assigned to it. Digital data layer of segments was generated by CCRM. FC loadings in the water were obtained by multiplying FC concentrations by segment volume.
Bathymetry data were used to generate a depth grid that was used to estimate volumes for each water quality segment and tidal prism segment.

The 1998 303d report was used to set the list of condemnation zones that require TMDLs. The digital data layer was generated by CCRM from hardcopy closure reports supplied by DSS.

B. Population Numbers
The process used to generate population numbers used for the nonpoint source contribution analysis part of the watershed model for the four source categories: human, livestock, pets and wildlife is described for each below.

**Human:**
The number of people contributing fecal coliform from failing septic tanks were developed in two ways and then compared to determine a final value.
1) Deficiencies (septic failures) from the DSS shoreline surveys were counted for each watershed and multiplied by 3 (average number of people per household).
2) Numbers of households in each watershed were determined from US Census Bureau data. The numbers of households were multiplied by 3 (average number of people per household) to get the total number of people and then multiplied by a septic failure rate* to get number of people contributing fecal coliform from failing septic tanks.
*The septic failure rate was estimated by dividing the number of deficiencies in the watershed by the total households in the watershed. The average septic failure rate was 12% and this was used as the default unless the DSS data indicated that septic failure was higher.

**Livestock:**
US Census Bureau data was used to calculate the livestock values. The numbers for each type of livestock (cattle, pigs, sheep, chickens (big and small), and horses) were reported by county. Each type of livestock was assigned to the land use(s) it lives on, or contributes to by the application of manure, as follows:

Cattle  cropland and pastureland
Pigs     cropland
Sheep    pastureland
Chickens cropland
Horses   pastureland

GIS was used to overlay data layers for several steps:
1) The county boundaries and the land uses to get the area of each land use in each county. The number of animals was divided by the area of each land use for the county to get an animal density for each county.
2) The subwatershed boundaries and the land uses to get the area of each land use in each subwatershed.
3) The county boundaries and the subwatershed boundaries to get the area of each county in each subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was used to determine the number of animals in the subwatershed.
Using MS Access, for each type of livestock, the animal density by county was multiplied by the area of each land use by county in each subwatershed to get the number of animals in each subwatershed. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of animals in the subwatershed. The number of animals in each subwatershed was summed to get the total number of animals in each watershed.

**Pets:**
The dog population was calculated using a formula for estimating the number of pets using national percentages, reported by the American Veterinary Association:

\[ \# \text{dogs} = \# \text{of households} \times 0.58. \]

US Census Bureau data provided the number of households by county. The number of dogs per county was divided by the area of the county to get a dog density per county. GIS was used to overlay the subwatershed boundaries with the county boundaries to get the area of each county in a subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was calculated. Using MS Access, the area of each county in the subwatershed was multiplied by the dog density per county to get the number of dogs per subwatershed. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of dogs in the subwatershed. The number of dogs in each subwatershed was summed to get the total number of dogs in each watershed.

**Wildlife:**

**Deer**—
The number of deer were calculated using information supplied by DGIF, consisting of an average deer index by county and the formula:

\[ \#\text{deer/m}^2 \text{ of deer habitat} = (-0.64 + (7.74 \times \text{average deer index})). \]

Deer habitat consists of forests, wetlands, and agricultural lands (crop and pasture). GIS was used to overlay data layers for the following steps:

1) The county boundaries and the subwatershed boundaries to get the area of each county in each subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was calculated.

2) The subwatershed boundaries and the deer habitat to get the area of deer habitat in each subwatershed.

Using MS Access, number of deer in each subwatershed were calculated by multiplying the \#deer/m\(^2\) of deer habitat times the area of deer habitat. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of deer in the subwatershed. The number of deer in each subwatershed was summed to get the total number of deer in each watershed.

**Ducks and Geese**—
The data for ducks and geese were divided into summer (April through September) and winter (October through March).
Summer

The summer numbers were obtained from the Breeding Bird Population Survey (US Fish and Wildlife Service) and consisted of bird densities (ducks and geese) for 3 regions: the southside of the James River, the rest of the tidal areas, and the salt marshes in both areas. The number of ducks and geese in the salt marshes were distributed into the other 2 regions based on the areal proportion of salt marshes in them using the National Wetland Inventory data and GIS.

Winter

The winter numbers were obtained from the Mid-Winter Waterfowl Survey (US Fish and Wildlife Service) and consisted of population numbers for ducks and geese in several different areas in the tidal region of Virginia. MS Access was used to calculate the total number of ducks and geese in each area and then these numbers were grouped to match the 2 final regions (Southside and the rest of tidal Virginia) for the summer waterfowl populations. Winter populations were an order of magnitude larger than summer populations.

Data from DGIF showed the spatial distribution of ducks and geese for 1993 and 1994. Using this information and GIS a 250m buffer on each side of the shoreline was generated and contained 80% of the birds. Wider buffers did not incorporate significantly more birds, since they were located too far inland. GIS was used to overlay the buffer and the watershed boundaries to calculate the area of buffer in each watershed. To distribute this information into each subwatershed, GIS was used to calculate the length of shoreline in each subwatershed and the total length of shoreline in the watershed.Dividing the length of shoreline in each subwatershed by the total length of shoreline gives a ratio that was multiplied by the area of the watershed to get an estimate of the area of buffer in each subwatershed. MS Excel was used to multiply the area of buffer in each subwatershed times the total numbers of ducks and geese to get the numbers of ducks and geese in each subwatershed. These numbers were summed to get the total number of ducks and geese in each watershed. To get annual populations, the totals then were divided by 2, since they represent only 6 months of habitation (this reduction underestimates the total annual input from ducks and geese, but is the easiest conservative method to use since the model does not have a way to incorporate the seasonal differences).

Raccoons—

Estimates for raccoon densities were supplied by DGIF for 3 habitats—wetlands (including freshwater and saltwater, forested and herbaceous), along streams, and upland forests. GIS was used to generate a 600ft buffer around the wetlands and streams, and then to overlay this buffer layer with the subwatershed boundaries to get the area of the buffer in each subwatershed. GIS was used to overlay the forest layer with the subwatershed boundaries to get the area of forest in each subwatershed. MS Access was used to multiply the raccoon densities for each habitat times the area of each habitat in each subwatershed to get the number of raccoons in each habitat in each subwatershed. The number of raccoons in each subwatershed was summed to get the total number of raccoons in each watershed.
B-4. Watershed Source Assessment

The watershed assessment calculates fecal coliform loads by source based on geographic information system data. A geographic information system is a powerful computer software package that can store large amounts of spatially referenced data and associated tabular information. The data layers produced by a GIS can be used for many different tasks, such as generating maps, analyzing results, and modeling processes. The watershed model requires a quantitative assessment of human sewage sources (i.e., malfunctioning septic systems) and animal (livestock, pets and wildlife) fecal sources distributed within each watershed.

The fecal coliform contribution from livestock is through the manure spreading processes and direct deposition during grazing. This contribution was initially estimated based on land use data and the livestock census data. In the model, manure was applied to both cropland and pasture land depending on the grazing period. Figure B-1 shows a diagram of the procedure for estimating the total number of livestock in the watershed and fecal coliform production. A description of the process used to determine the source population values for wildlife, pets and human used in the calculation of percent loading is found in Appendix B.
FIGURE B-1 Diagram to Illustrate Procedure Used to Estimate Fecal Coliform Production from Estimated Livestock Population
Appendix C:

Vessel Sewage Discharge Program

**Marine Sanitation Device Standard--Establishment of Drinking Water Inake No Discharge Zone(s) Under Section 312(f)(4)(B) of the Clean Water Act; Final Rule.**

As of January 30, 1980, if a vessel has an installed toilet (technically referred to as a marine sanitation device (MSD)), it must be equipped with one of three types of MSDs ([http://www4.law.cornell.edu/uscode/33/1322.html](http://www4.law.cornell.edu/uscode/33/1322.html)).

The MSDs (Type I, Type II, Type III) are designed to meet different needs and effluent level requirements. Since portable toilets can be moved on and off a vessel, they are not considered installed toilets; therefore, vessels that have portable toilets are not subject to the MSD regulations.

<table>
<thead>
<tr>
<th>Sewage Treatment Device</th>
<th>Vessel Length</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I- Flow-through device (maceration and disinfection)</td>
<td>equal to or less than 65 feet in length</td>
<td>The effluent produced must not have a fecal coliform bacteria count greater than 1000 per 100 milliliters and have no visible floating solids.</td>
</tr>
<tr>
<td>Type II- Flow-through device (maceration and disinfection)</td>
<td>greater than 65 feet in length</td>
<td>The effluent produced must not have a fecal coliform bacteria count greater than 200 per 100 milliliters and suspended solids not greater than 150 milligrams per liter.</td>
</tr>
<tr>
<td>Type III- Holding tank</td>
<td>any length</td>
<td>This MSD is designed to prevent the overboard discharge of treated or untreated sewage.</td>
</tr>
</tbody>
</table>

- Type I MSDs rely on maceration and disinfection for treatment of the waste prior to its discharge into the water.
- Type II MSDs are similar to the Type I; however, the Type II devices provide an advanced form of the same type of treatment and discharge wastes with lower fecal coliform counts and reduced suspended solids.
- Type III MSDs are commonly called holding tanks because the sewage flushed from the marine head is deposited into a tank containing deodorizers and other chemicals. The contents of the holding tank are stored until it can be properly disposed of at a shore-side pumpout facility. (Type III MSDs can be equipped with a discharge option, usually called a Y-valve, which allows the boater to direct the sewage from the head either into the holding tank or directly overboard. Discharging the contents directly overboard is legal only outside the U.S. territorial waters which is 3 or more miles from shore.)

**Houseboats**

In accordance with the FWPCA, a State may adopt and enforce a statute or regulation with respect to the design, manufacture, or installation or use of any MSD on a houseboat, if such statute or regulation is stricter than EPA and USCG requirements. The term "houseboat" refers to a vessel which, for a period of time determined by the State in which the vessel is located, is used primarily as a residence and is not used primarily as a means of transportation. For example, a State may require that houseboats less than 65 feet (19.7 meters) in length with an installed Type I device update to a Type II or III device.  

Reference: Section 1322(f)(1)(B) FWPCA
DEQ Guidance on Establishing No Discharge Zones

MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER QUALITY PROGRAMS

P.O. Box 10009 Richmond, VA 23240-0009

SUBJECT: Guidance Memo No. 04-2022
Procedures for Establishing Boating No Discharge Zones

TO: Regional Directors

FROM: Ellen Gilinsky, Ph.D., Director

DATE: November 29, 2004

COPIES: Rick Weeks, Jon Van Soestbergen and Cindy Berndt

Summary:

The purpose of this guidance is to provide a procedure for handling public or internal requests for the establishment of boating No Discharge Zones, and for establishing the No Discharge Zones in accordance with federal regulation 40 CFR Part 140 (2004) and state regulation 9 VAC 25-71 (2004).

Electronic Copy:

An electronic copy of this guidance in PDF format is available for staff internally on DEQNET and for the general public on DEQ’s website at: http://www.deq.virginia.gov/water/

Contact information:

Please contact Mike Gregory, Office of Water Permit Support, (804) 698-4065 or mbgregory@deq.virginia.gov if you have any questions about this guidance.

Disclaimer:

This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate any particular method nor does it prohibit any particular method for the analysis of data, establishment of a wasteload allocation, or establishment of a permit limit. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

81
PROCEDURE FOR DEQ REVIEW OF SECTION 312
NO DISCHARGE ZONE DESIGNATION REQUESTS

Background

Section 312 of the Clean Water Act and EPA regulations at 40 CFR Part 140 address sewage discharges from boats. The federal regulations control these discharges by requiring boats with installed toilets to have treatment units called Marine Sanitation Devices or "MSDs". Type I and Type II MSDs consist of two levels of treat and discharge units, while Type III MSDs are holding tanks that do not discharge and must be pumped out at pump out facilities. Pump out facilities are usually located at marinas and are regulated by the Virginia Department of Health. Most recreational boats with installed toilets have the holding tanks. Discharging raw sewage from boats, from holding tanks or portable toilets for example, is not directly addressed by federal regulations, but state law prohibits it and this is now clarified in our state regulation 9 VAC 25-71.

Federal law prohibits a state from adopting regulations regarding MSDs that are more stringent than federal regulations, but it allows a state to petition EPA for designation of No Discharge Zones (NDZs), where all sewage discharges, treated or untreated, are banned. The process is for the state to demonstrate that the particular water body requires special protection and that there are adequate pump out facilities in the area, since boat sewage wastes in NDZs would have to be held until pumped out. EPA does not have a specific application but has developed informational documents and a loosely structured process for applying for NDZ designation. Any citizen can initiate the process but the final request must be signed by the governor or chief environmental officer of the state.

Note that since untreated sewage discharges from boats are illegal, the only difference in a NDZ with respect to the law is that boats with treat and discharge units (MSD Type I or II) cannot use them. Since most boats on the water have holding tanks anyway, this is not a significant difference. It might be considered, however, that the public outreach and increased law enforcement efforts in NDZs provide for more protection of the waters with regard to previously undetected illegal discharges. Another consideration is that in areas where there is a considerable amount of commercial boat traffic there are more likely to be boats operating with treat and discharge units (e.g., tug boats in the Chesapeake Bay).

As of the date of this guidance Smith Mountain Lake is the only designated NDZ in the state. This resulted from a bill that was passed by the General Assembly directing the State Water Control Board to petition EPA for NDZ designation. The designation was received and a new boating regulation, 9 VAC 25-71, was adopted that provides for NDZ identification and enforcement. Since the Smith Mountain Lake NDZ designation inquiries have been received from various groups in the Chesapeake Bay watershed wishing to pursue NDZ designation for other water bodies of concern. In order to handle these requests consistently and in accordance with State Water Control Law at Section 62.1-44.33 the following procedure should be followed.

Procedure

The procedure for designating Section 312 Boating No Discharge Zones will be as follows.

1. When an interested party, local government or state agency proposes No Discharge Zone (NDZ)
designation for a waterbody within the state it should submit a proposal including the following information to the Director of the DEQ Division of Water Quality Programs. The Division of Water Quality Programs will develop this information for DEQ initiated proposals:

A. Name and contact information for the person or group making the request.
B. Name and location of the waterbody.
C. Exact boundaries of the area to be designated, using latitude and longitude of boundaries, any bordering landmarks or delineating features (e.g., bridges or mean low water elevations) or other means of identifying the area.
D. A map of the area to be designated.
E. Reason why designation is being sought, i.e., why the water body requires greater environmental protection, including:
   (1) Nature of the waterbody (estuary, river, lake, etc.) and a description of its features (e.g., heavily populated area, major port or boating area, pristine bay with little surrounding development, enclosed embayment, deep mountain lake);
   (2) any unique features or qualities (including high quality waters) or environmental importance (e.g. shellfish waters) that necessitate stronger resource protection;
   (3) information on contact recreational use (e.g., swimming);
   (4) any specific water quality problems existing, including 303(d) listing and TMDL status if applicable.

Note that greater environmental protection might be considered necessary to maintain the status of a high quality resource or to improve the status of a low quality one.
F. Indication if the waterbody is:
   (1) in an established sanctuary, national or state park, wilderness area, recreation area or if the waterbody is used by endangered or threatened species;
   (2) a public water supply.
G. A statement or rough estimate of the availability of boat sewage holding tank pump-outs in the area (more exact information will be developed for the EPA application).
H. A statement or rough estimate of the amount of boat traffic in the waterbody and the type of boat traffic, recreational or commercial (more exact information will be developed for the EPA application).
I. Indication, if available, of any public support or interest for or against the NDZ designation.
J. Information on any local enforcement capability (e.g., police boats).
K. Information on any local public outreach capability (provision of signs, pamphlets or other public awareness efforts).

2. DEQ will review the proposal and obtain more information if necessary.
3. If DEQ decides it is not appropriate to proceed, it will indicate why and what options are available to the individual or group if they wish to continue (e.g., approach the State Water Control Board or petition EPA directly).
4. If DEQ decides to proceed with the proposal it will set up a public meeting and provide public notice by publication in a paper local to the waterbody and by such other means as deemed necessary, notifying the public of the intent to designate the waters and what that means, and
providing public meeting information. A 30-day public notice period will follow.

5. After the public meeting and upon completion of the public notice period a review of public comments will be summarized and DEQ staff will present the proposal for NDZ and the summary of public comments to the State Water Control Board with a recommendation on pursuing the NDZ designation from EPA. Disapproval would mean that the individual or group wishing the designation would have to pursue it directly from EPA, obtaining the governor’s signature without DEQ endorsement.

6. If the State Water Control Board approves pursuing the designation, DEQ will assist the individual or group in preparing an application to EPA and will coordinate with the Virginia Department of Health, the Department of Game and Inland Fisheries and the Virginia Marine Resources Commission (62.1-44.33 requires consultation with these agencies in formulating boating regulations) as well as with EPA Region III.

7. Once the application is prepared and the draft reviewed by EPA (EPA will indicate if it is sufficient for approval prior to formal submittal), DEQ will route the application through to the Executive Office for signature by the Secretary of Natural Resources and transmittal to EPA.

8. EPA will publish the proposal in the federal register.

9. Upon final publication in the federal register, the new NDZ will be established at the federal level.

10. DEQ will amend 9 VAC 25-71 by adding the new NDZ to the list of state designated NDZs, and will present it to the State Water Control Board as final exempt (required to conform to federal law).

11. Publication of the 9 VAC 25-71 amendment will be made in the Virginia Register and the final 30-day notice period will follow, after which the new NDZ is established at the state level.

12. Public awareness and enforcement efforts can begin.
Appendix D

Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.

Code of Virginia §62.1-194.1

§62.1-194.1. Obstructing or contaminating state waters.

Except as otherwise permitted by law, it shall be unlawful for any person to dump, place or put, or cause to be dumped, placed or put into, upon the banks of or into the channels of any state waters any object or substance, noxious or otherwise, which may reasonably be expected to endanger, obstruct, impede, contaminate or substantially impair the lawful use or enjoyment of such waters and their environs by others. Any person who violates any provision of this law shall be guilty of a misdemeanor and upon conviction be punished by a fine of not less than $100 nor more than $500 or by confinement in jail not more than twelve months or both such fine and imprisonment. Each day that any of said materials or substances so dumped, placed or put, or caused to be dumped, placed or put into, upon the banks of or into the channels of, said streams shall constitute a separate offense and be punished as such. In addition to the foregoing penalties for violation of this law, the judge of the circuit court of the county or corporation court of the city wherein any such violation occurs, whether there be a criminal conviction therefor or not shall, upon a bill in equity, filed by the attorney for the Commonwealth of such county or by any person whose property is damaged or whose property is threatened with damage from any such violation, award an injunction enjoining any violation of this law by any person found by the court in such suit to have violated this law or causing the same to be violated, when made a party defendant to such suit. (1968, c. 659.)