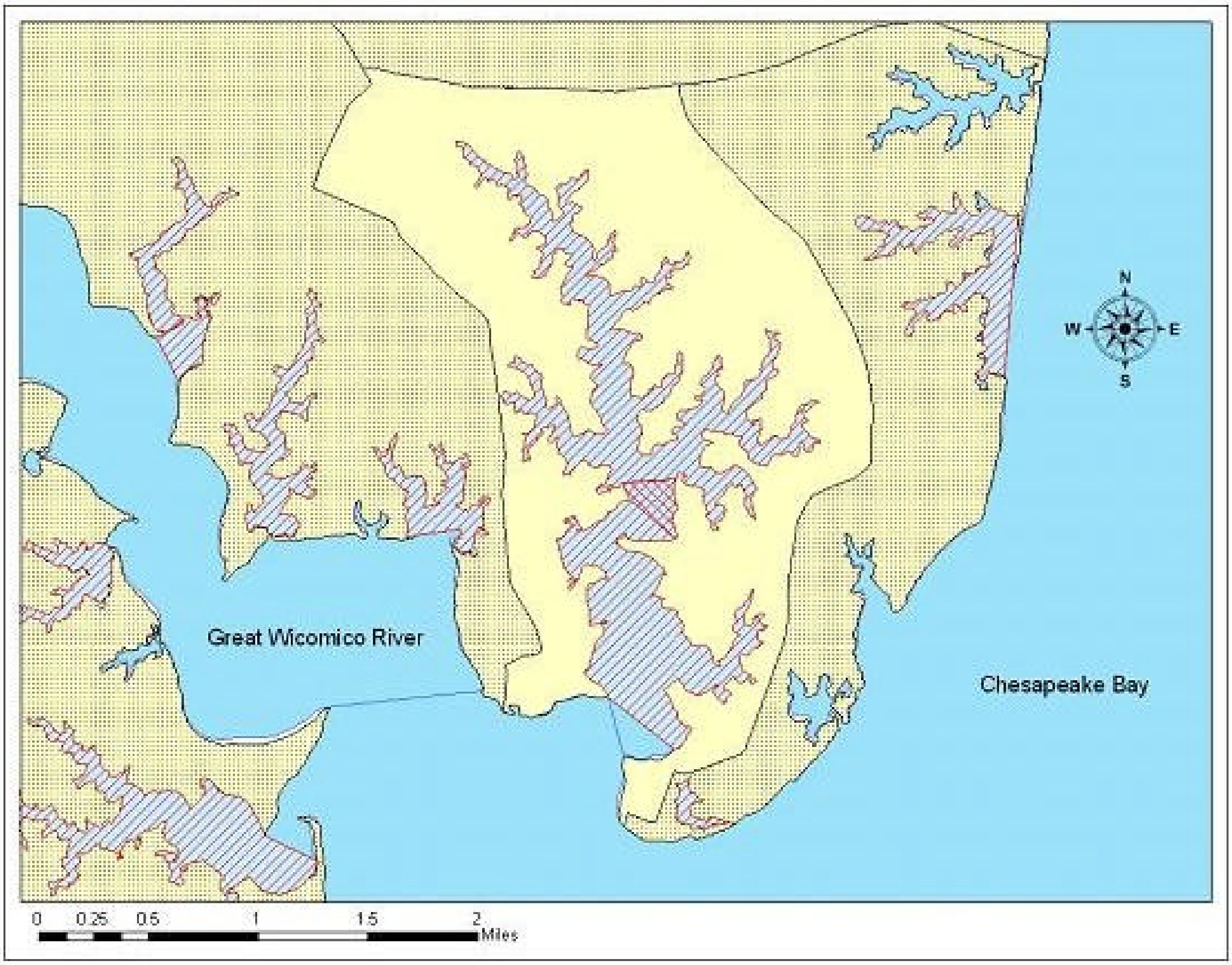
Total Maximum Daily Load (TMDL) Report for Shellfish Condemnation Areas Listed Due to Bacteria Contamination

Cockrell Creek



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Listed Due to Bacteria Contamination

Virginia Department of Environmental Quality

February 2008

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Total Maximum Daily Load Executive Summary

Total Maximum Daily Load Process

The development of a Total Maximum Daily Load, TMDL, is one of the water quality management processes intended to protect waters for a variety of uses. The first step in the TMDL process is the identification of desired uses for each waterbody. There are typically a number of physical, chemical and/or biological conditions that must exist in a waterbody 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 in most other states, uses fecal coliforms (FC) as an indicator of the potential presence of pathogenic organisms. To maintain the use of a waterbody for direct shellfish harvesting, the goal is to ensure the concentration of fecal coliforms entering the waterbody does not exceed a "safe" level, as determined by the Virginia Department of Health. 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 in the watershed without exceeding the water quality standard for fecal coliforms in shellfish growing waters.

The process of developing a shellfish water TMDL may be generalized in the following manner:

1. Water quality monitoring data are used to determine if the bacterial standard for shellfish has been violated;
2. Potential sources of fecal bacteria loading within the contributing watershed are identified;
3. The necessary reductions in fecal bacteria pollutant load to achieve the water quality standard are determined;
4. The TMDL study is presented to the public to garner comment;
5. An implementation strategy to reduce fecal bacteria loads is written into a plan and subsequently implemented;
6. Water quality monitoring data are used to determine if the bacterial standard is being met for shellfish waters.

Different approaches can be used to determine the sources of fecal pollution in a waterbody. 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 numbers of livestock, etc.). BST begins in the water, identifying sources of fecal coliforms, specifically the dominant fecal coliform *Escherichia coli*, based on either genetic or phenotypic characteristics of the coliforms. Virginia's Department of Environmental Quality (DEQ) utilizes BST, specifically a method called antibiotic resistance analysis (ARA). This method assumes that fecal bacteria found in four sources: humans, wildlife, livestock, and domestic pets, 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 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 a bacterial TMDL for one segment in the Cockrell Creek watershed in Northumberland County, Virginia. The condemned area in the watershed is condemnation number 002A & 002B: portions of Cockrell Creek (VAP-C01E-08). The applicable state standard specifies that the number of fecal coliform bacteria shall not exceed a maximum allowable geometric mean of 14 most probable number (3-tube MPN) per 100 milliliters (ml) and a 90^{th} percentile value of 49 MPN/100ml. (Virginia Water Quality Standard 9-VAC 25-260-5). In development of this TMDL, the 90^{th} percentile 49 MPN/100 ml was used, since it represented the more stringent standard in this waterbody.

Sources of Fecal Coliform and Enterococci

Potential sources of fecal coliform and Enterococci consist primarily of both point source and non-point source contributions. There are two permitted point source discharges in the watershed. Both are permitted for fecal coliform bacteria and Enterococci. Non-point sources include wildlife; livestock; recreational and commercial 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

Shellfish TMDL workgroup personnel from USEPA, VaDEQ, Virginia Department of Conservation and Recreation (DCR), Maryland Department of the Environment (MDE), Virginia Department of Health Division of Shellfish Sanitation (DSS), the Virginia Institute of Marine Sciences (VIMS), United States Geological Survey, Virginia Polytechnic University, James Madison University, and Tetra Tech devised a procedure for developing TMDLs using a simplified volumetric TMDL calculation approach. The procedure uses estuarine water volume, ambient bacterial concentrations, shellfish water quality standards, and bacteriological source tracking (BST) data to determine the sources of fecal coliform violations, the load reductions, and the areas upon which to focus implementation needed to return the estuary to water quality standards.

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 nine months 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 human, with livestock and wildlife as secondary contributors, and pets the least contributing factor. The presence of a large signature attributable to one component is sufficient to establish potential directions for remediation under a future implementation plan.

DEQ conducted a special study around the Omega Protein, Inc. facility from August 2006 to February 2007. Data collected from this study shows high bacteria counts in the waters surrounding the facility and from the industrial discharge This data indicates the facility is a significant contributor to the bacterial impairments in Cockrell Creek. During this study, it was determined there were several violations of the primary contact standard. As a result, Cockrell Creek will be listed as impaired for the swimming designated use in the 2008 Integrated 305(b)/303(d) Water Quality Report. This TMDL document establishes the TMDL for enterococci in addition to fecal coliform.

Load Allocation Scenarios

The next step in the TMDL process was to determine the appropriate water quality standard to be applied. The shellfish 90th percentile standard was selected over the shellfish geometric mean standard and the enterococci primary contact standard because the data established that the 90th 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.

The TMDL established for Cockrell Creek consists of a permitted point source wastewater allocation (WLA), a non-point source load (LA), and a margin of safety (MOS). The WLA includes an expansion factor of 5 for future growth. The TMDL equation is as follows:

TMDL = WLA + LA + MOS

TMDL Summary for the Shellfish Closure in the Cockrell Creek Watershed (90th Percentile Standard)

Condemnation Area	Pollutant Identified	TMDL MPN/day	Waste Load Allocation MPN/day	Load Allocation MPN/day	Margin of Safety
002A Cockrell Creek (VAP-C01E-08)	Fecal Coliform	2.56E+12	5.98 E+10	2.50E+12	Implicit

The results of the BST developed for Cockrell Creek 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. A separate table shows the only point source in the watershed needing TMDL loading reductions.

Reduction and Load Allocation Based Upon 90th Percentile Standard: Cockrell Creek - Growing Area 12

Condemnation Area	Source	BST Allocation % of Total Load	Current Load MPN/ day	Load Allocation MPN/ day	Reduction Needed
002A Cockrell Creek (VAP-C01E-08)	Wildlife	12%	1.60E+12	1.60E+12	0%
	Human	42%	5.59E+12	0.00E+00	100%
	Livestock	38%	5.06E+12	0.00E+00	100%
	Pets	8%	1.06E+12	8.90E+11	16%
	Total	**100%**	**1.33E+13**	**2.50E+12**	**88%**

Reduction and Waste Load Allocation Based Upon 90th Percentile Standard: Cockrell Creek - Growing Area 12

Condemnation Area	Discharger	Current Load MPN/ day	Waste Load Allocation MPN/ day	Reduction Needed
002A Cockrell Creek (VAP-C01E-08)	Omega Protein (VA0003867)	7.09E+12	5.98E+10	99%

A DEQ special study conducted from August 2006 – February 2007 showed multiple exceedances of the primary contact (swimming) standard in the area surrounding Omega Protein. Though not currently listed, Cockrell Creek will be designated as impaired for primary contact (swimming) in the upcoming 2008 water quality assessment. This report document also includes a primary contact TMDL, shown below. It should be noted the shellfish water quality standard is more stringent than the primary contact standard. Attainment of the shellfish standards will automatically ensure that primary contact standards are being met.

TMDL Summary for the Recreation Use Impairment in Cockrell Creek

Impaired Water body Segment	Volume (m^3)	Bacteria Pollutant	Load Allocation (cfu/day)	Wasteload Allocation (cfu/day)	TMDL	Margin of Safety
002A Cockrell Creek	5102820	*Enterococci*	5.16E+12	1.49E+11	5.31E+12	Implicit

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 the 90^{th} percentile 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 the Cockrell Creek watershed impairments provides allocation scenarios that will be a starting point for developing implementation strategies. Continued monitoring at established water quality monitoring stations will aid in tracking success toward meeting water quality milestones.

To address both the fecal coliform and enterococci TMDLs, it is anticipated the point source and vessel discharges to Cockrell Creek will be required to reduce the bacterial contributions from the facility. The establishment of a No Discharge Zone (NDZ) designation for Cockrell Creek and the Great Wicomico River is strongly recommended to implement the TMDL

Public participation is critical to the implementation process. Non-point source loadings within the watershed 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 Cockrell Creek watershed, public involvement was encouraged through a public participation process that included public and stakeholder meetings.

A public meeting to introduce the TMDL study was held on March 1, 2005 from 7:00 to 9:00 p.m. at the Northumberland County Board Room. 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 prospective model results.
This meeting was followed by development of the draft TMDL and a review by the stakeholders. A Technical Advisory Committee (TAC) meeting was held at the Northumberland Public Library in Heathsville, VA on November 30, 2005. The TAC discussed the process for TMDL development and the source assessment results and drafted TMDL allocations. A second public meeting was held on

December 15, 2005 at the Northumberland Public Library. DEQ held a second TAC meeting on August 21, 2007 in order to discuss revisions made to the TMDL document. A third and final public meeting was held on September 5, 2007 at the Northumberland Public Library. Input from these efforts was utilized in the development of the TMDL and improved confidence in the allocation scenarios and TMDL process.

1.0 Introduction

This document details the development of a bacterial Total Maximum Daily Load (TMDL) for segments 2A and 2B in the Cockrell Creek watershed in Northumberland County, Virginia, which are listed as impaired for fecal coliform bacteria on Virginia's 2004 303(d) Total Maximum Daily Load Priority List. Segments 2A and 2B encompass all of Cockrell Creek excluding a permanent closure segment 2C, which is located immediately surrounding the Reedville Sanitation District Sewage Treatment Plant. DEQ considers segment 2C not to have shellfish consumption use on a permanent basis. 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 waterbody. The waterbodies 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 (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. In the beginning of TMDL development for impaired shellfish waters, the Department of Environmental Quality contracted the Virginia Institute of Marine Science (VIMS). Following initial work by VIMS, DEQ performs shellfish TMDL development in-house.

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 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 and designating fecal contamination in waters, 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 (WWTPs), marinas, livestock operations, landfills, etc. The information is compiled into a written report associated 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 a 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 DSS collects monthly bacterial samples at over 2,000 stations in the shellfish growing areas of Virginia. Though they continuously evaluate individual sample data for unusual events, they formally evaluate designated 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 DSS. The permit establishes controls that in part require shellfish be allowed to depurate for 15 days in clean growing areas or specially designed and 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 Cockrell Creek watershed is located entirely within Northumberland County. The condemned area in the watershed is designated DSS condemnation numbers 2A, 2B, and 2C (see map, Appendix A.2 Condemnation by Notice: Cockrell Creek, p 60). The special prohibition area 2C, surrounds the Reedville Sanitation District STP outfall, as described below:

Some portions of shellfish growing areas are either permanently or seasonally closed to direct shellfish harvesting due to the presence of either marinas or wastewater treatment facility discharges. In these cases, DSS uses a computer model to determine the size and shape of the closure area based on the potential fecal input, *e.g.*, number of boats in a marina or the number of gallons of sewage permitted for the treatment facility. The Division is careful to ensure that a sufficient area is closed to protect public health under even high pollution events without condemning excessive waters.

Section 2C is permanently closed due to the presence of the Reedville Sanitary District Sewage Treatment Plant. These shellfish waters are permanently closed to shellfish harvesting as a public safety measure, due to the possible presence of viral pathogens. A list of all permitted point sources in Cockrell Creek is found in Section 4, Table 4.6.

The condemnation notice and shellfish survey can be found in Appendix A. The watershed occupies a landscape position along the northern shore of the Great Wicomico River, which flows into Ingram Bay and then the Chesapeake Bay (Figure 3.0). The watershed is bounded on the west by rural routes 646, state route 360 to the north, and state route 360 and rural route 657 to the east. The communities of Reedville and Fairport are located within the watershed.

The drainage area of the Cockrell Creek watershed is approximately 3.5 square miles (2240 acres). Population estimated by the 2000 US Census is 392, however the Reedville STP serves an estimated 1638 as of 2003.

Figure 3.0

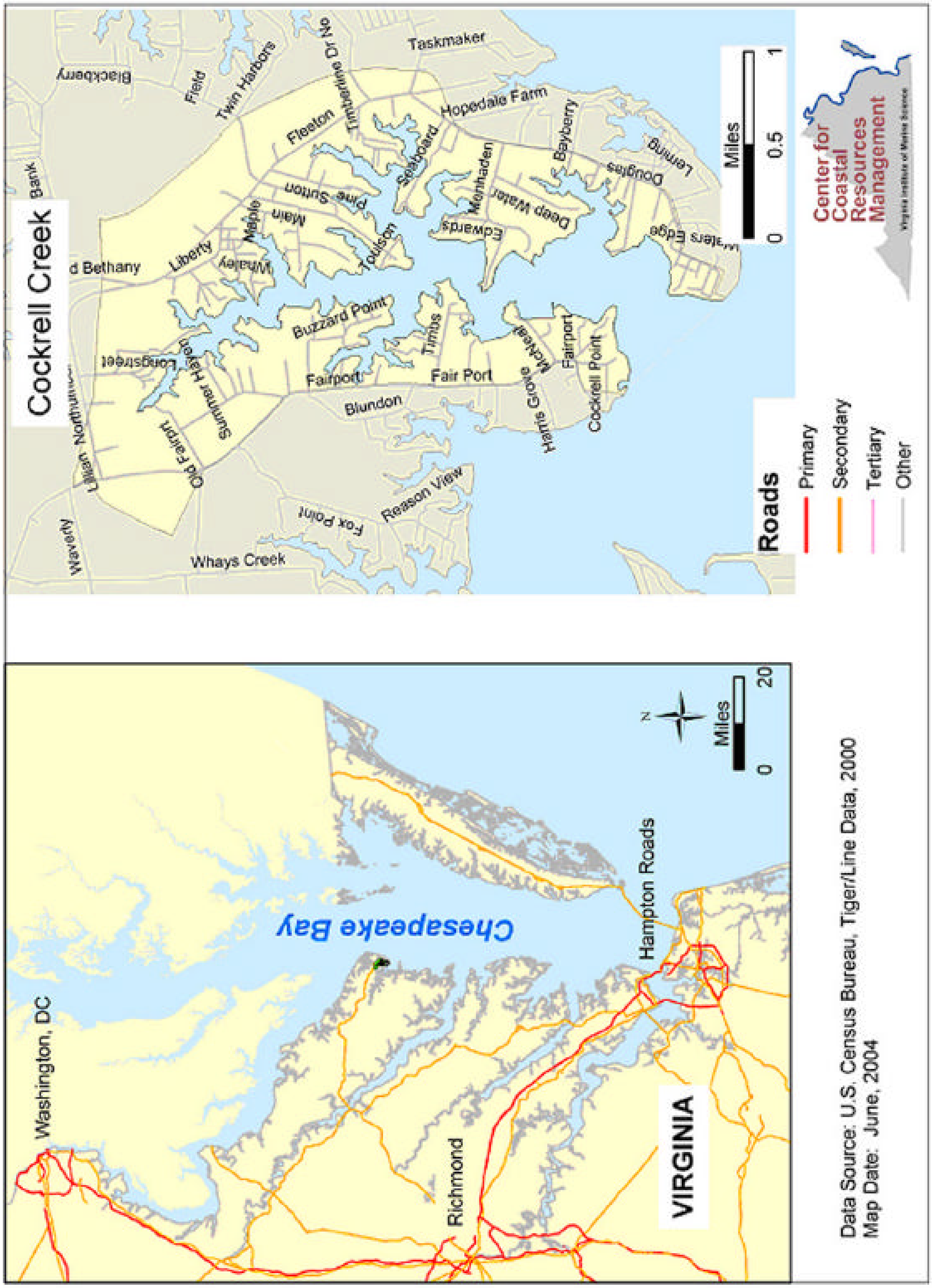

Cockrell Creek
Roads
Primary
Secondary
Tertiary
Other
Miles
0
0.5
1
Center for Coastal Resources Management
Virginia Institute of Marine Science
Washington, DC
Chesapeake Bay
Richmond
Hampton Roads
VIRGINIA
Miles
0
20
N
Data Source: U.S. Census Bureau, Tiger/Line Data, 2000
Map Date: June, 2004

Figure 3.1

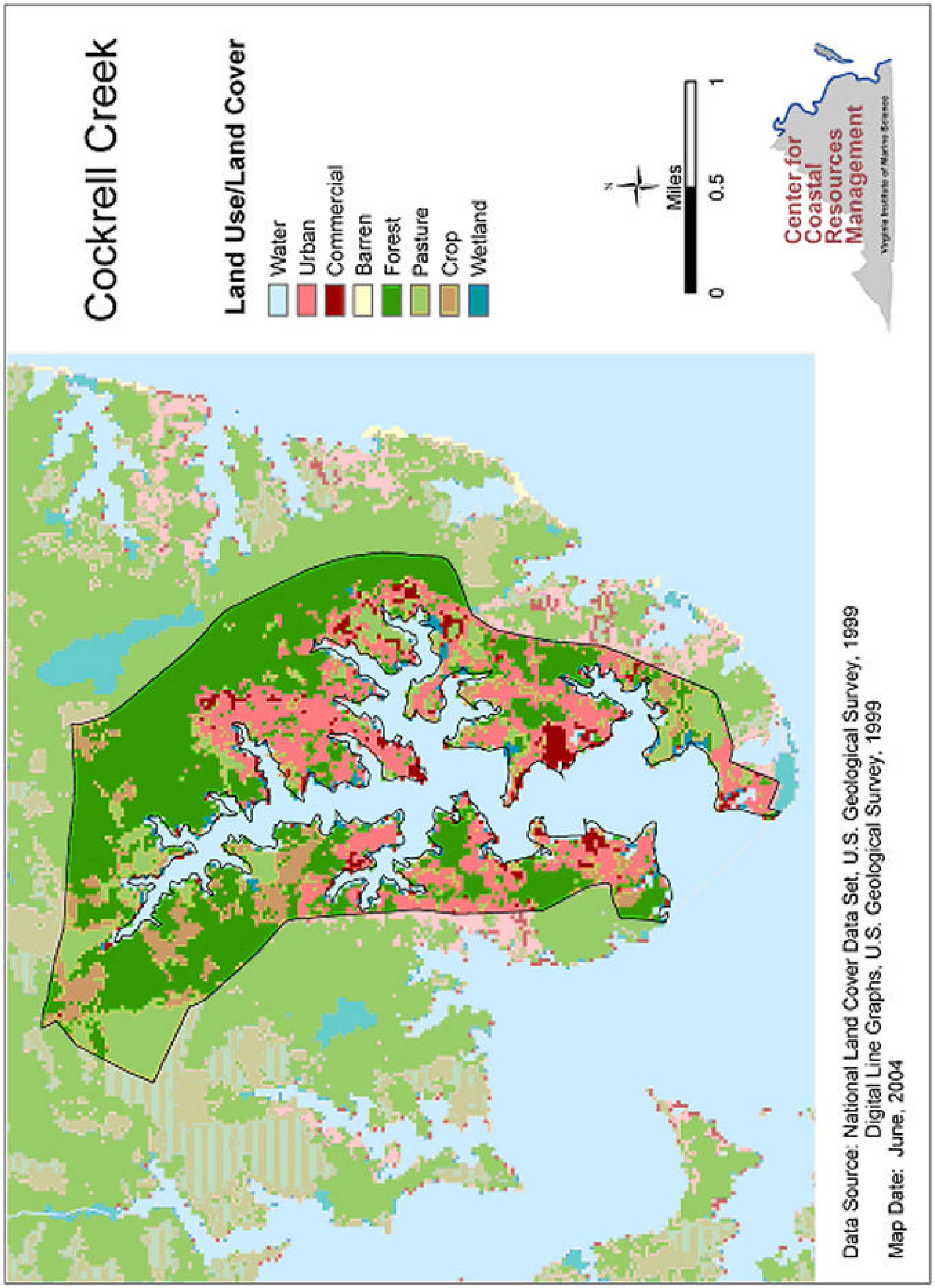
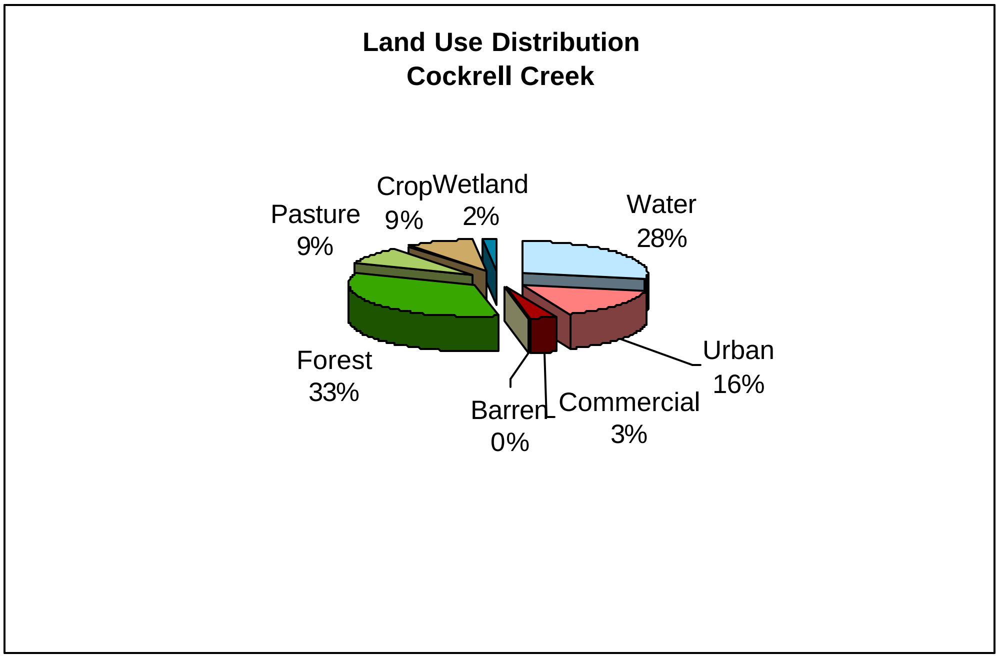

Cockrell Creek
Land Use/Land Cover
Water
Urban
Commercial
Barren
Forest
Pasture
Crop
Wetland
Miles
0
0.5
1
Center for Coastal Resources Management
Data Source: National Land Cover Data Set, U.S. Geological Survey, 1999
Digital Line Graphs, U.S. Geological Survey, 1999
Map Date: June, 2004

Figure 3-2



A map of the land use in the watershed is shown in Figure 3.1. Almost 33 % of the land use in the watershed is undeveloped forest (See Figure 3.2). As the land use area within the watershed is based upon surface area, the 28% water reflects that portion of the watershed area occupied by Cockrell Creek. Developed lands, termed urban and commercial, occupy about 19% of the landscape. Agriculture occupies the next greatest area, at approximately 18%. 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: Supporting Documentation and Watershed Assessment, provides a description of data and list of data sources for Table 3-1.

Table 3-1 Animal Populations and Septic Systems Growing Area 12

Fecal Coliform Sources	**2 Cockrell Creek**
Cattle	21*
Horse	6*
Pig	0
Deer	38
Duck	485
Geese	334
Raccoon	85
Dog	55
Estimated Septic Systems	90

* - from DSS Shoreline survey 2004.

4.0 Water Quality Impairment and Bacterial Source Assessment

4.1 Water Quality Monitoring

The DSS water quality monitoring network in Cockrell Creek consists of four monitoring stations in the lower segment of the estuary. These stations are monitored by the DSS monthly for fecal bacteria. The locations of the water quality monitoring stations are shown in Figure 4.1. This TMDL study examined bacterial monitoring data at these stations for a period of time from 1984 through May 2007. A summary of this water quality data for the monitoring period is shown in Table 4.1.

DEQ also has two ambient monitoring stations located in Cockrell Creek. These stations are monitored for 2 years of a 6 year rotational cycle as part of DEQ's Ambient Watershed Monitoring program. Figure 4.2 shows these stations in relation to the watershed and VDH monitoring stations. Table 4.2 summarizes the water quality data for these stations. Figure 4.10 shows the long term instantaneous bacterial data from Station 7-COC001.61.

For this study, DEQ evaluated the DSS fecal coliform bacteria data from two perspectives. The first was to look at the data per the shellfish water quality standards; using statistical measures such as the 30 month geometric mean and the 30 month calculated 90th percentile. The long term (running) geometric mean and 90th percentile values were also evaluated to look at the historical trends. The second methodology DEQ utilized was to look at the complete VDH instantaneous bacterial data record. This evaluation allows for considerations such as seasonal variation, monthly fluctuations, variable hydrologic conditions, and other similar patterns. There are over 23 years of continuous bacterial data available for Cockrell Creek.

Graphs depicting the 30 month geometric mean and 30 month 90th percentile are shown in Figures 4.4 & 4.5. The running geometric mean and 90th percentiles (used to show long term historical trends) are represented in Figures 4.6 and 4.7. The DSS instantaneous fecal coliform data is plotted on Figures 4.8 and 4.9.

DEQ conducted a special study in and around the Omega Protein facility beginning in August 2006 and concluding in February 2007. During this time period, bacterial samples were collected from 9 to 11 sites in the Cockrell Creek watershed. The sample locations are shown on Figure 4.3. Fecal coliform and enterococci bacterial results are shown in Tables 4.3 and 4.4. Samples were taken to account for tidal flow conditions in Cockrell Creek. These conditions are reflected in Table 4.5.

Figure 4.1

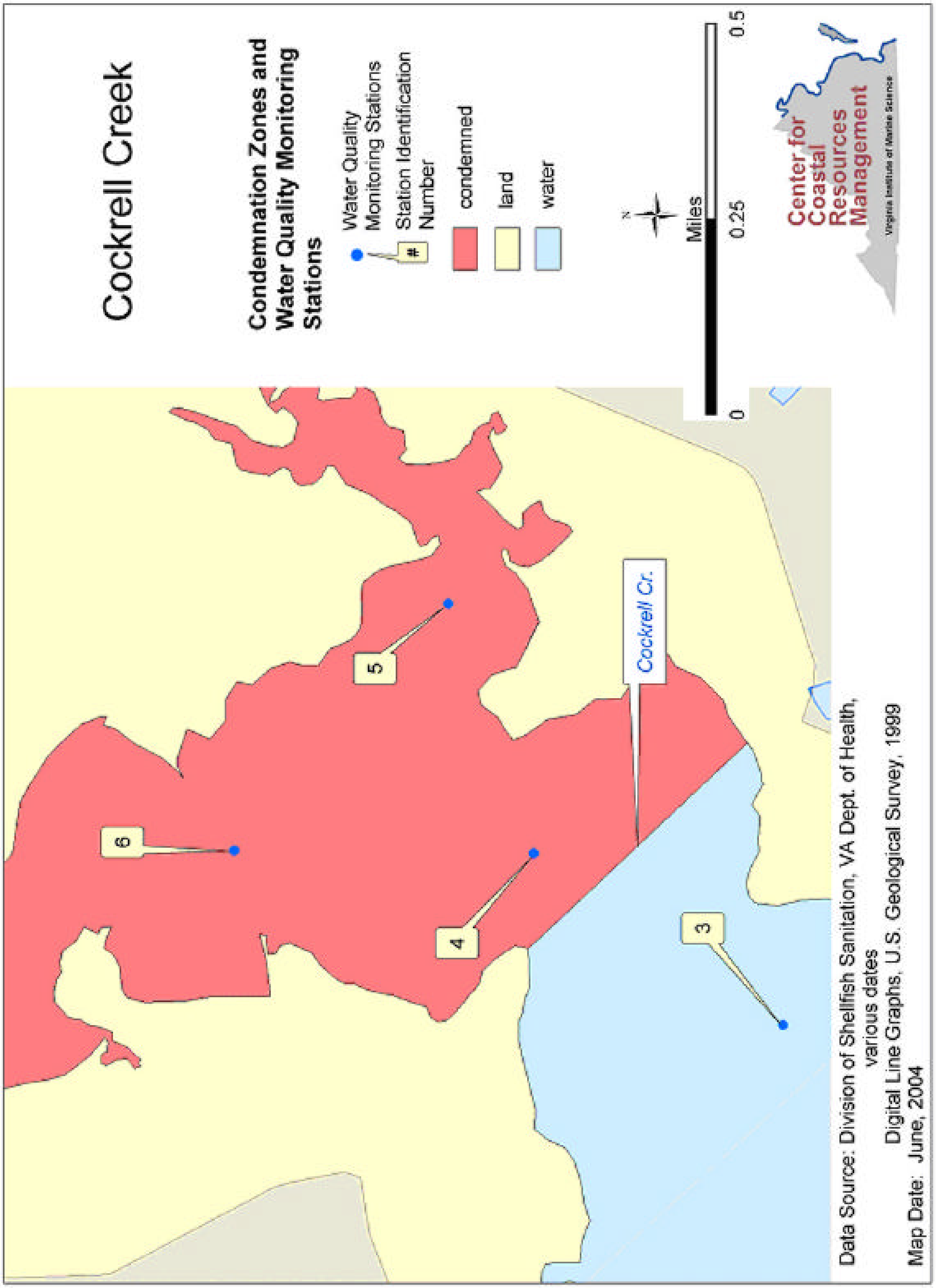

Cockrell Creek
Condemnation Zones and Water Quality Monitoring Stations
Water Quality Monitoring Stations
Station Identification Number
#
condemned
land
water
N
Miles
0
0.25
0.5
Center for Coastal Resources Management
Virginia Institute of Marine Science
Cockrell Cr.
3
4
5
6
Data Source: Division of Shellfish Sanitation, VA Dept. of Health, various dates
Digital Line Graphs, U.S. Geological Survey, 1999
Map Date: June, 2004

Figure 4.2 Map of Shellfish Area Condemnations and Monitoring Stations

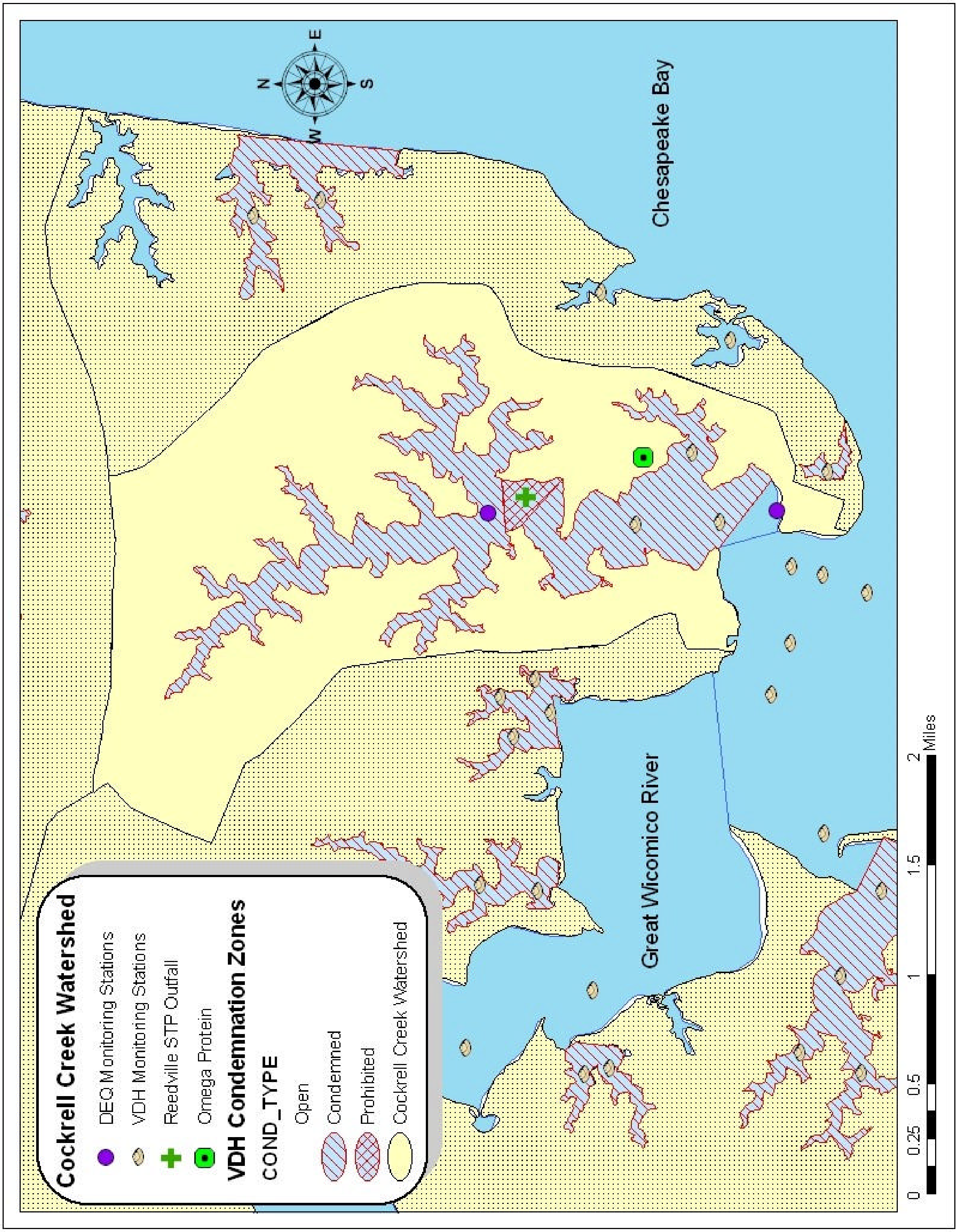


Figure 4.3
Monitoring Stations
2006-2007 DEQ Omega Special Study

Table 4.1 Water Quality Data Summary: Growing Area 12 Cockrell Creek Condemnation 002A (VAP-C01E-08)

DSS Station ID	Condemnation Area	Total Observations	Geometric Mean	Station Violates Geometric Standard: 14 MPN	90th Percentile	Station Violates 90th Percentile Standard: 49 MPN
12-3		248	6.2	No	22.1	No
12-4	002A	248	12.8	No	87.9	Yes
12-5	002A	248	17.8	Yes	131.2	Yes
12-6	002A	248	16.8	Yes	147.5	Yes

Table 4.2 Water Quality Data Summary: DEQ Ambient Monitoring Stations

Station ID	Period of Record	Bacteria Constituent	Total Observations	Minimum (cfu/100 mL)	Maximum (cfu/100 mL)	Primary Contact Violation Rate*
7-COC001.61	Nov 1970 – Nov 2006	Fecal coliform	260	1	3500	5 %
7-COC001.61	Aug 2003 – June 2007	Enterococci	21	>25	350	9.5 %
7-COC000.27	Jan. 2007 – June 2007	Enterococci	3	>25	75	0

Figure 4.4

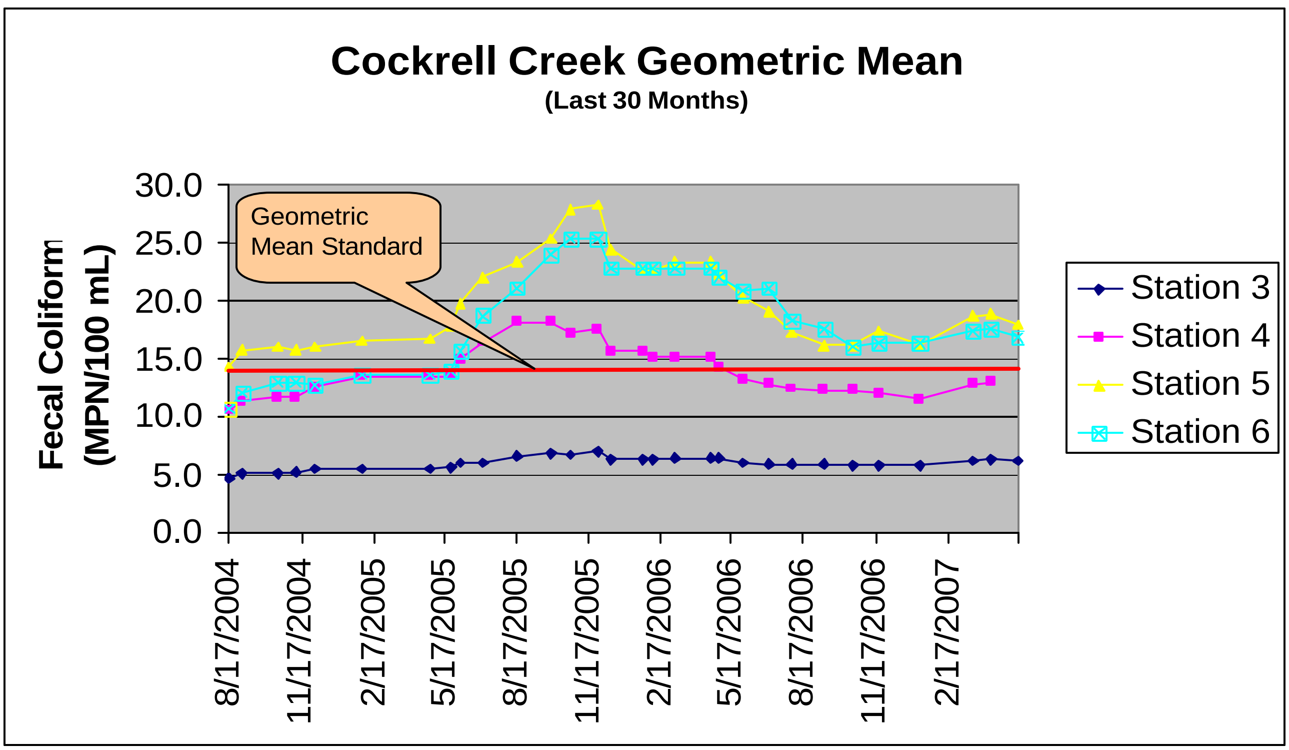


Figure 4.5

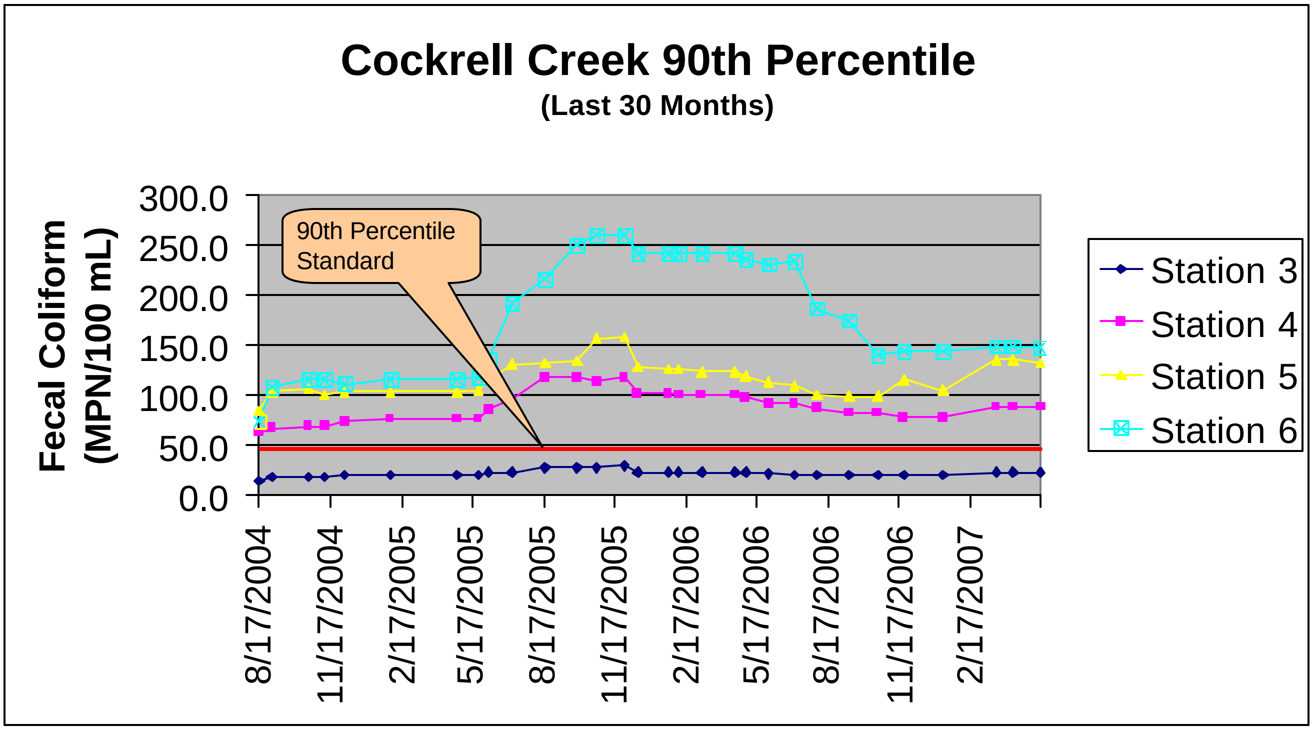


Figure 4.6

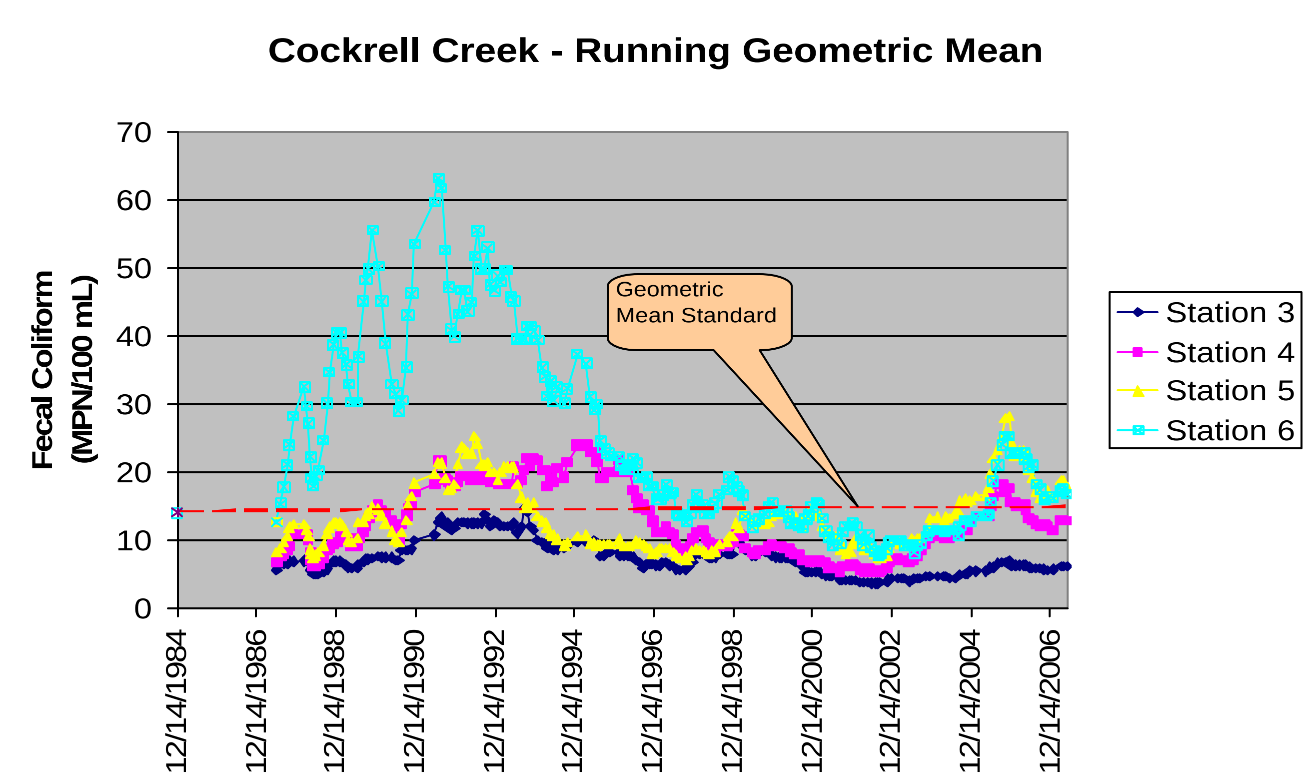


Figure 4.7

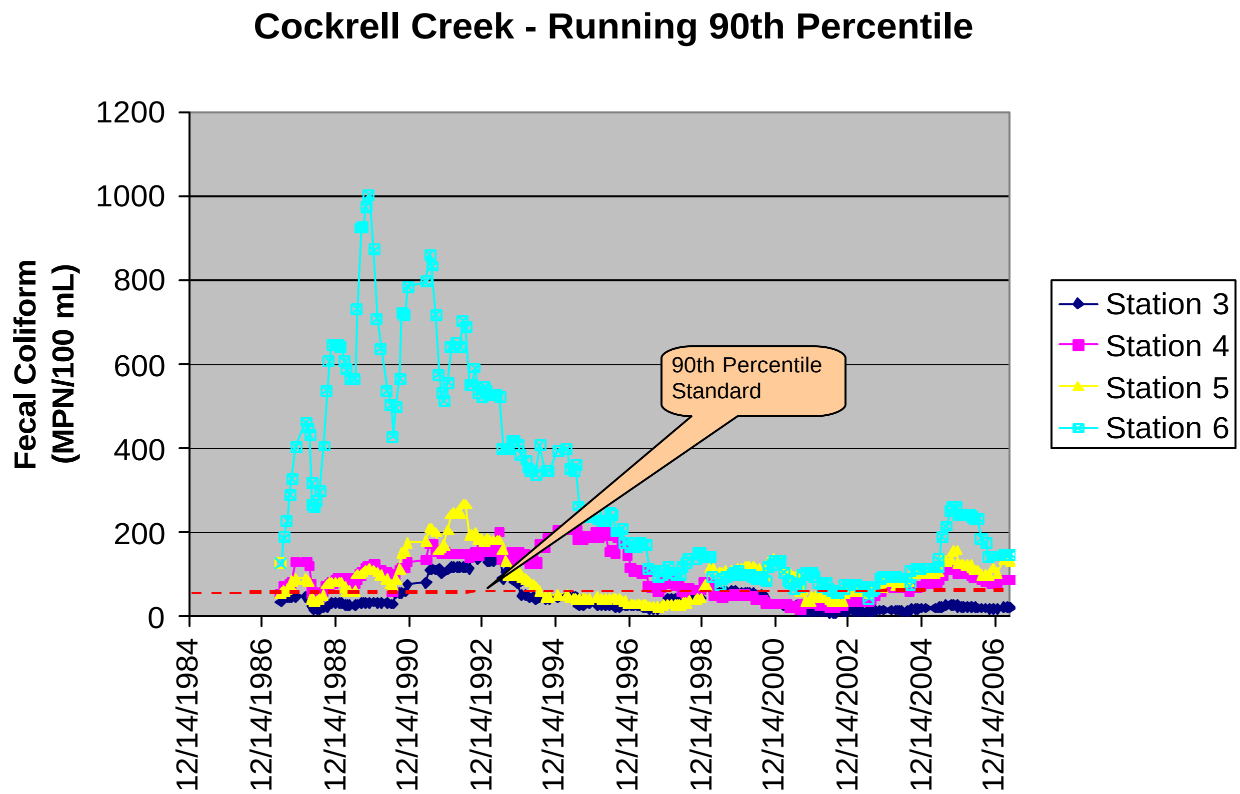


Figure 4.8

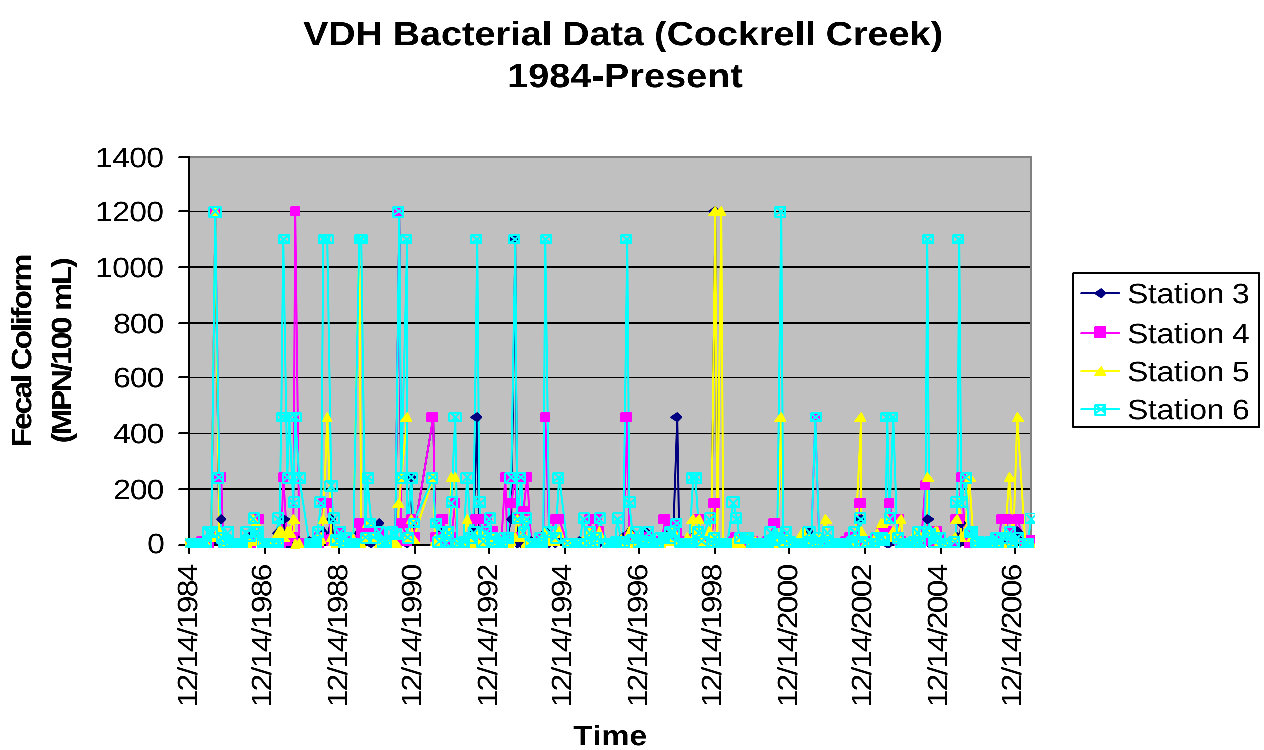


Figure 4.9

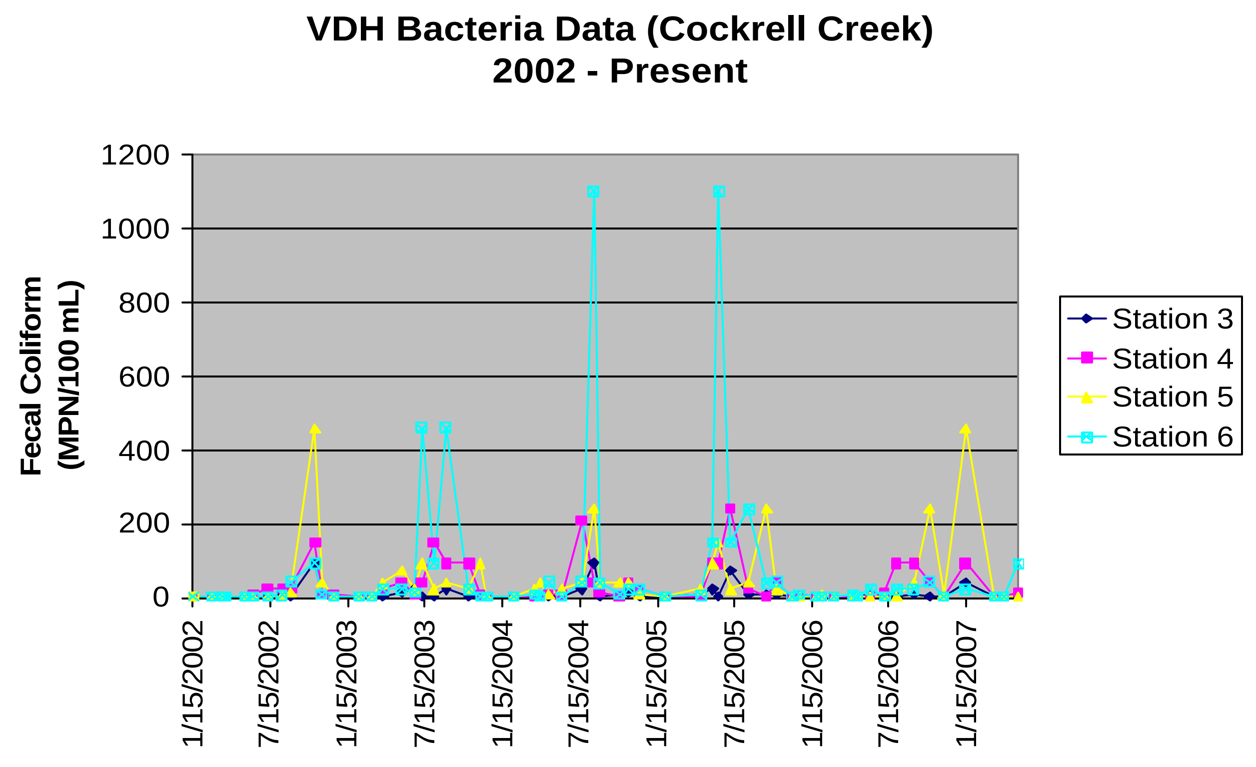


Figure 4.10

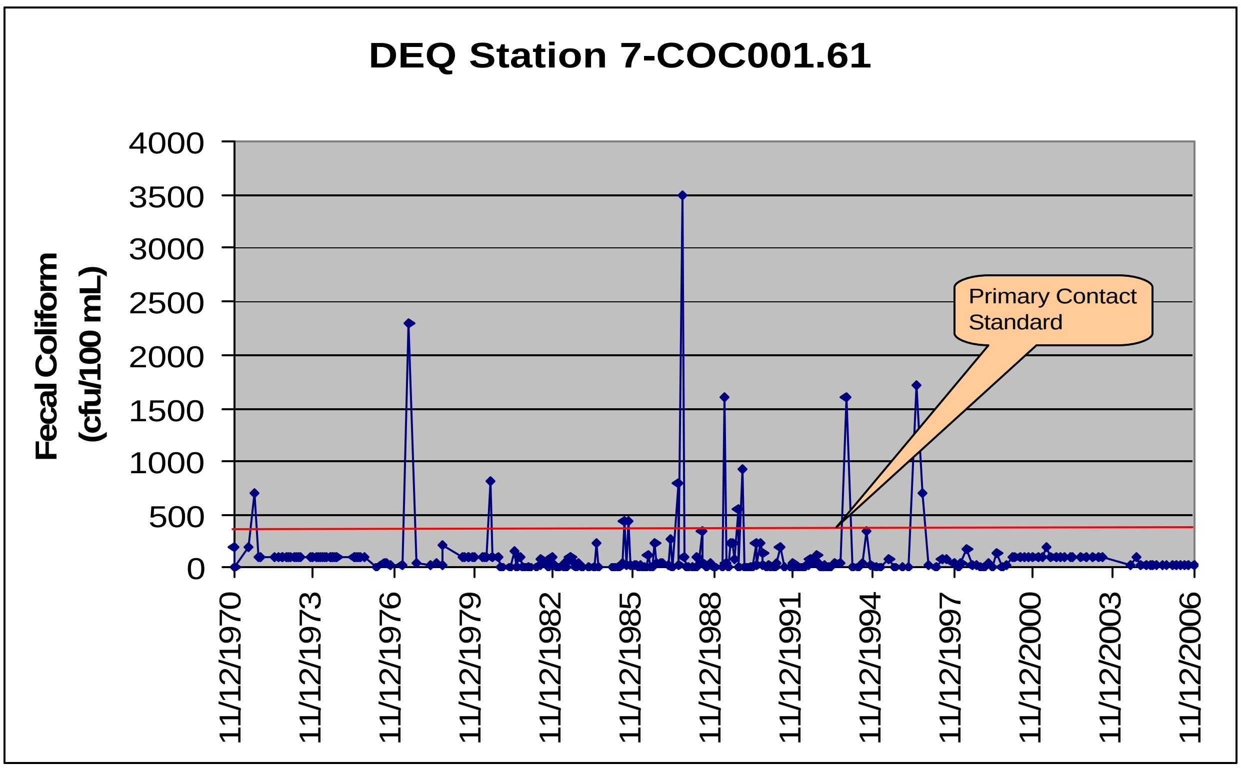


Table 4.3 Fecal Coliform Data (DEQ Omega Study)

Monitoring Station	Station Description	3-Aug-06	20-Sept-06	27-Sept-06	22-Feb-07
7-COC000.86	DSS Site 12-6	**25**	<100 U	**1000**	<10 U
7-COC000.88	SE Corner Omega Pier with Ships	**>2000 L**	**1600**	<100 U	<10 U
7-COC000.89	South Side Omega Pier with Ships	**520**	**1000**	**1000**	<10 U
7-COC000.92	West Side Omega Pier with Ships	**>2000 L**	**400**	**1000**	<10 U
7-COC000.95	North Side Omega Pier with Ships	N/A	**1700**	**200**	<10 U
7-XAN000.17	DSS Site 12-5	<25 U	<100 U	**4000**	<10 U
VA0003867-002	Omega Outfall 002	**280**	**>8000 L**	**5000**	<10 U
VA0003867-995	Omega Outfall 995	**>2000 L**	**10,000**	**1400**	N/A
VA0003867-INT	Omega Water Intake	**780**	**1800**	**500**	<10 U

Fecal Coliform Units = # cfu/100 mL

Bold & Red Bacteria Values = WQ Violations using instantaneous primary contact standard 400 cfu/100mL (fecal coliform)
Bold Bacteria Values = WQ Violations using 90th Percentile shellfish standard - 49 MPN/100mL (fecal coliform)

Com Code L = Off Scale high, actual value greater than the value shown (>max detection limit)
Com Code U = Material analyzed for but not detected (<minimum detection limit)
NA = Not Available

Table 4.4 Enterococci Data (DEQ Omega Study)

Monitoring Station	Station Description	3-Aug-06	20-Sept-06	27-Sept-06	22-Feb-07
7-COC000.86	DSS Site 12-6	75	**110**	**210**	<25 U
7-COC000.88	SE Corner Omega Pier with Ships	**1800**	**3400**	**680**	<25 U
7-COC000.89	South Side Omega Pier with Ships	**680**	**600**	**240**	<25 U
7-COC000.92	West Side Omega Pier with Ships	**>2000 L**	**300**	**520**	<25 U
7-COC000.95	North Side Omega Pier with Ships	N/A	**800**	**1000**	<25 U
7-XAN000.17	DSS Site 12-5	<25 U	<10 U	<10 U	<25 U
VA0003867-002	Omega Outfall 002	**300**	**160**	**700**	<25 U
VA0003867-995	Omega Outfall 995	**>2000 L**	**4600**	**1400**	N/A
VA0003867-INT	Omega Water Intake	**>2000 L**	**>8000 L**	**>8000 L**	<25 U
7-COC001.61	DEQ Ambient Station	N/A	N/A	N/A	25
7-COC000.27	DEQ Ambient Station	N/A	N/A	N/A	75

Enterococci Units = # cfu/100 mL

Bold & Red Bacteria Values = WQ Violations using instantaneous primary contact standard 104 cfu/100mL (Enterococci)

Com Code L = Off Scale high, actual value greater than the value shown (>max detection limit)
Com Code U = Material analyzed for but not detected (<minimum detection limit)
NA = Not Available

Table 4.5 Tidal Conditions for DEQ Omega Study

Sample Date	3-Aug-06	20-Sept-06	27-Sept-06	22-Feb-07
Tide Code	Flood	Ebb	Low	Low

4.2 Condemnation Areas

Cockrell Creek was 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 area is shown in Figure 4.2. Internet web addresses for the shoreline survey and condemnation notice may be found in Appendix A.

4.3 Fecal Coliform Bacteria Source Assessment

The locations of shoreline deficiencies from the DSS shoreline survey and wastewater treatment facilities, are shown in Figure 4.11.

A. Point Sources

There are four permitted point sources in the Cockrell Creek Watershed. These are listed below in Table 4.6.

Table 4.6. Permitted Point Sources in Cockrell Creek Watershed

Stream Name	Facility Name	VPDES Permit Number	Discharge Type	Design Flow (MGD)
Cockrell Creek	Reedville Sanitary District Sewage Treatment Plant	VA0060712	Municipal Minor	0.200
Cockrell Creek	Omega Protein, Inc.	VA0003867	Industrial Major	24.52
Cockrell Creek	Omega Protein, Inc.	VAR051211	Industrial Stormwater	N/A
Cockrell Creek	Omega Protein, Inc.-Fairport	VAR051221	Industrial Stormwater	N/A

The immediate area surrounding the Reedville STP outfall is identified by DSS as shellfish condemnation area 2C, and this portion of impairment ID VAP-C01E-08 is a prohibited shellfish harvest area. The direct harvest of shellfish for human consumption is prohibited because of the location of a municipal wastewater treatment plant in this segment. Therefore this segment is evaluated for primary contact (recreation) use only.

Reedville Sanitary District STP has a design flow of 0.2 million gallon per day (MGD) and is permitted for total chlorine residual, a surrogate for fecal coliform bacterial limits of geometric mean 200 MPN/100 mls. The facility operates as a minor municipal discharger.

Omega Protein, Inc. has a design flow of 24.52 MGD. Only one outfall, number 002, is permitted for fecal coliform bacterial limits of geometric mean 200 MPN/100 mls. The daily maximum design flow for this outfall is 0.481 MGD. The facility operates as a major industrial discharger. Omega Protein also has two industrial stormwater permits – one for their processing facility and the other for the Fairport facility, located on the west shore of Cockrell Creek.

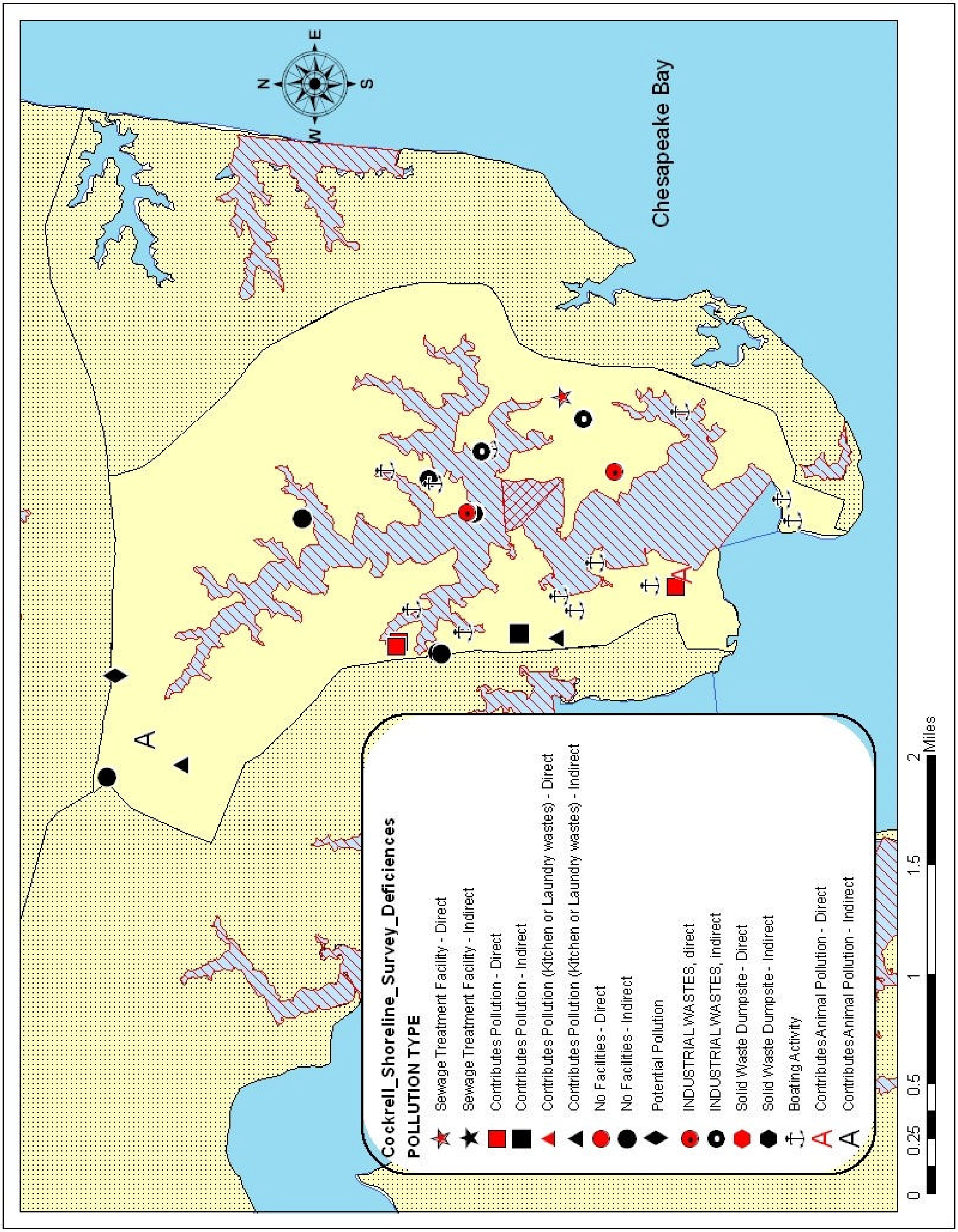
B. Non-Point Source Contributions

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, 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 ex-filtration from sewer systems. Contributions from wildlife, both mammalian and avian, are natural conditions and may represent a background level of bacterial loading.

Approximately 60 percent of the urban area in the Cockrell Creek watershed has access to public sewer, which is serviced by the Reedville Sanitary District. The service area was determined from a GIS data layer supplied by the Northern Neck Planning District Commission.

The DSS shoreline survey is used as a tool to identify nonpoint source contribution problems and locations. Figure 4.11 shows the results of the DSS sanitary shoreline survey dated 2004. A copy of this survey has been included as Appendix A. The survey identified 40 deficiencies or potential pollution problems. Eleven (11) were on-site sewage deficiencies, 16 were related to boating, one (1) was potential pollution, 9 were related to potential industrial waste sites, 2 were related to animal pollution, and one (1) was from a sewage treatment facility.

Figure 4.11


Chesapeake Bay
N
E
S
W
Cockrell_Shoreline_Survey_Deficiences
POLLUTION TYPE
Sewage Treatment Facility - Direct
Sewage Treatment Facility - Indirect
Contributes Pollution - Direct
Contributes Pollution - Indirect
Contributes Pollution (Kitchen or Laundry wastes) - Direct
Contributes Pollution (Kitchen or Laundry wastes) - Indirect
No Facilities - Direct
No Facilities - Indirect
Potential Pollution
INDUSTRIAL WASTES, direct
INDUSTRIAL WASTES, indirect
Solid Waste Dumpsite - Direct
Solid Waste Dumpsite - Indirect
Boating Activity
Contributes Animal Pollution - Direct
Contributes Animal Pollution - Indirect
0
0.25
0.5
1
1.5
2
Miles

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 animals, 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. The BST should be used as a general tool to indicate the presence of human, wildlife, pet and livestock source bacteria, while the percentage per source should not be recognized as precise.

Figure 4.1 shows the DSS monitoring stations used for this TMDL study. BST samples were collected at VDH monitoring stations 12-5 and 12-6 from October 2002 to August 2003.
The data developed for the watershed show that the dominant contribution in Cockrell Creek is human at 42 percent, followed by livestock at 38 percent, wildlife at 12 percent and pets at 8 percent. Figure 4.12 shows the annual mean contributions per BST source category when evaluated using the isolate-weighted analysis. The target sampling interval was once monthly. This data is shown in tabular form in Table 4.7. These values are used for the source allocation in deriving the Total Maximum Daily Loads for the Cockrell Creek Growing Area. Specific details on the BST analysis are found in Appendix C.

Figure 4.12 Cockrell Creek – Growing Area 12

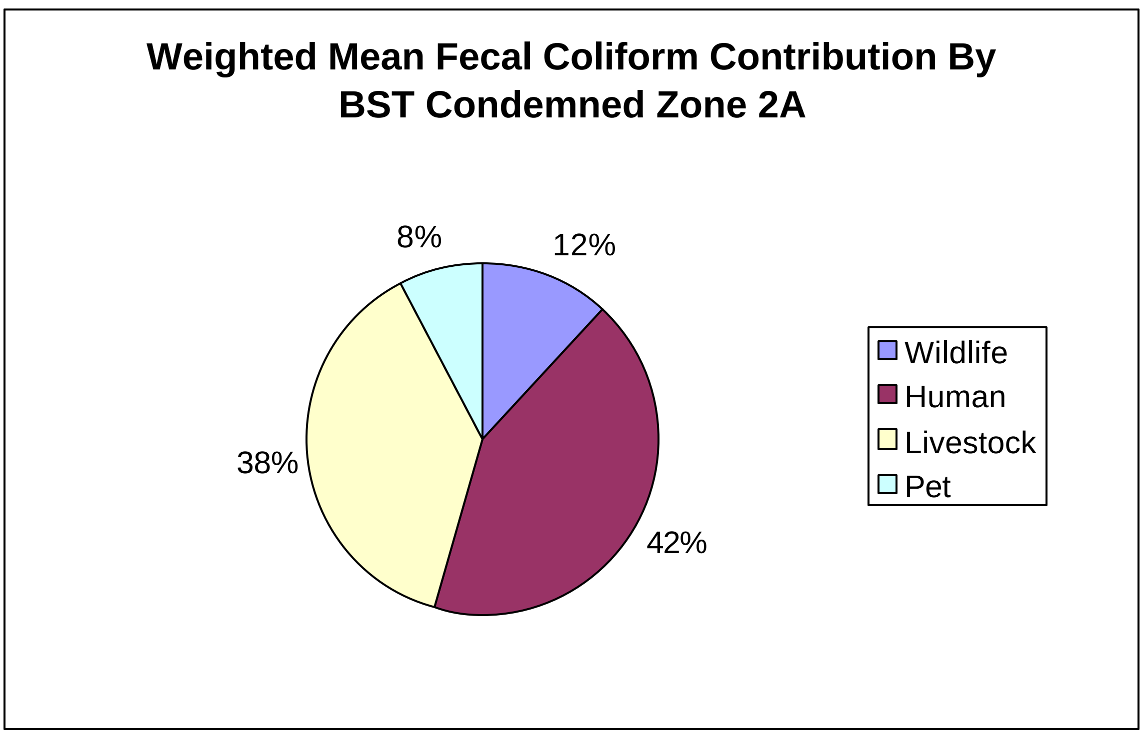


Table 4.7 Bacterial Load Distribution using BST
Growing area 12: Cockrell Creek

Condemnation Area	Livestock	Wildlife	Human	Pet
Cockrell Creek Composite of stations 12-5 & 12-6	**38%**	**12%**	**42%**	**8%**

DEQ also collected BST samples in September 2006 around the Omega Protein facility as part of the 2006-2007 special study. The results of the BST analysis are shown in Table 4.8. Of note, several of the Sept. 2006 BST numbers from the Omega study – specifically those collected within the Omega facility and some around the Omega fleet - are similar to the average human signature found in the ambient DSS samples analyzed for BST.

Table 4.8. DEQ Omega Study - BST Results

Sta Id	Date	E coli Enumeration	Isolates	Wildlife	Human	Livestock	Pets
7-COC000.86	20-Sept-06	34	22	**91%**	9%	0%	0%
	27-Sept-06	176	24	**62%**	**17%**	**17%**	4%
7-COC000.88	20-Sept-06	380	24	**75%**	**21%**	4%	0%
	27-Sept-06	250	24	**71%**	**17%**	12%	0%
7-COC000.89	20-Sept-06	138	24	**75%**	**17%**	8%	0%
	27-Sept-06	220	24	**84%**	4%	8%	4%
7-COC000.92	20-Sept-06	122	24	**75%**	**21%**	4%	0%
	27-Sept-06	260	24	**75%**	8%	**17%**	0%
7-COC000.95	20-Sept-06	290	24	**63%**	**33%**	0%	4%
	27-Sept-06	280	24	**80%**	**12%**	8%	0%
7-XAN000.17	20-Sept-06	10	8*	76%	12%	12%	0%
	27-Sept-06	390	24	**71%**	**21%**	8%	0%
VA0003867-002	20-Sept-06	227	24	**33%**	**59%**	0%	**8%**
	27-Sept-06	330	24	**92%**	4%	4%	0%
VA0003867-995	20-Sept-06	1240	24	**54%**	**38%**	8%	0%
	27-Sept-06	740	24	**71%**	**25%**	4%	0%
VA0003867-INT	20-Sept-06	1190	24	**54%**	**38%**	8%	0%
	27-Sept-06	660	24	**80%**	**12%**	8%	0%

BOLD type indicates a statistically significant value.
BOLD RED indicates significant human signature.
* - Too few isolates to be valid.

4.5 Bacterial Data Analysis and Source Identification

DSS monitoring station 12-3 is located outside of the VDH designated closure area (see Figure 4.1). This station is positioned where water is influenced by the larger Great Wicomico River and diluted on a frequent basis. Stations 12-4, 12-5, & 12-6 are located further upstream in Cockrell Creek. Water in the Cockrell Creek embayment does not readily flush when compared with other larger waterbodies, such as the adjacent Great Wicomico River. Dilution and embayment flushing have less of an effect further upstream in the Cockrell Creek embayment, making it more susceptible to localized influences.

Long term data analysis from the DEQ ambient station 7-COC001.61 and the DSS running geometric mean and running 90th percentile analyses show a general decline in fecal coliform levels beginning approximately in the early to mid 1990's. It was during this time period that the Reedville STP upgraded the chlorination system, installed dechlorination, and underwent additional facility upgrades.

In evaluating the historical bacterial data, it became apparent that using only the statistical analyses approach (geometric mean and 90th percentile) for evaluating the water quality in Cockrell Creek does not provide a complete picture of water quality conditions. DEQ analyzed the instantaneous DSS bacterial data for the available record in order to determine potential seasonal variations in the bacterial data. A distinct pattern revealed itself through this analysis (Figures 4.8 & 4.9). Bacteria levels tend to increase in Cockrell Creek beginning in late Spring/early Summer and subside in late Fall/early Winter. This trend persists throughout the entire VDH bacterial record; from 1984 to present. This seasonal pattern coincides with the seasonal operation of the Omega Protein processing facility.

The DEQ special study conducted from August 2006 to February 2007 focused on acquiring bacterial samples in 9 locations in and surrounding Omega Protein (see Figure 4.3). Of these samples, two were located at the DSS shellfish monitoring stations 12-5 & 12-6. Four stations were located around the Omega Piers, where several ships were moored. In the Omega facility, three sampling locations were chosen; the non-contact cooling water effluent (VA0003867-995), the waste lagoon effluent (VA0003867-002), and Cockrell Creek beside the Omega water withdrawal intake. In February 2007, 2 additional bacterial samples for enterococci were collected at the DEQ ambient watershed monitoring stations in Cockrell Creek.

Tidal conditions can be a consideration when looking at bacterial data in a tidal embayment. During the special study, DEQ targeted various tidal flows to help distinguish the potential influences tide might play in bacterial distributions within the Cockrell Creek embayment. These data are reflected in table 4.5.

Following is a summary of the results from the fecal coliform analysis.

- 18 of 27 samples (67%) violated both fecal coliform primary contact and shellfish standards
- An additional 4 samples violated only the shellfish standards.
- All samples within the vicinity of the facility violated the primary contact and shellfish standards. Two of these samples were greater than 8000 cfus/100 mL.
- 13 of 14 samples (93%) taken around the facility piers violated the primary contact and/or the shellfish standards.

The following results address the enterococci primary contact criteria for the same three sampling events.

- 22 of 27 samples (81%) violated the enterococci primary contact standard.
- All samples within the Omega Protein, Inc. facility violated the primary contact standard.
- All samples taken around the facility piers violated the primary contact standard.

Additional samples were taken in February 2007. This included samples taken from the waters surrounding the facility and directly from the discharge of the facility's waste lagoon. No sample was taken from the 002 outfall because there was no discharge during the sampling run.

There was no detection of either fecal coliform or enterococci bacteria during the February sampling event, when the facility was not in operation. All samples were reported at less than 25 cfus/100 mL, which is considered non-detection using the DEQ selected bacterial analysis. The two ambient DEQ watershed stations reported 25 & 75 cfus/100 mL (stations 7-COC001.61 & 7-COC000.27, respectively) on the same date & approximate time period.

A fluorometric dye trace study was performed at the facility on September 26th and 27th, 2002 by Environmental Professionals, Inc. (Black, 2002). One result from the 48 hour study showed that dye injected into the Omega waste discharge stream was detected at the facility intake twice. At that time, it was speculated "the propulsion of the (fleet) ships propellers pushed the dye back into the cove and into the intake structure." (Black, 2002). Hydrologic influences from the location of the facility water withdrawal intake and the 001 & 995 discharges could also circulate water locally around the facility.

The bacterial data from the facility and surrounding area shows several violations of the recreation (primary contact/swimming) water quality standard. While it is not currently listed as such, Cockrell Creek will be listed as impaired for the primary contact (swimming) designated use in the 2008 Virginia Water Quality Assessment 305(b)/303(d) Integrated Report.

5.0 TMDL Development

5.1 Simplified Modeling Approach (Simple Volumetric Model):

Shellfish TMDL workgroup personnel from USEPA, Virginia DEQ, Virginia Department of Conservation and Recreation (DCR), Maryland Department of the Environment (MDE), Virginia DSS, the Virginia Institute of Marine Sciences (VIMS), United States Geological Survey, Virginia Polytechnic University, James Madison University, and Tetra Tech devised a procedure for developing TMDLs using a simplified volumetric TMDL calculation approach. The procedure uses estuarine water volume, ambient bacterial concentrations, shellfish water quality standards, and bacteriological source tracking (BST) data to determine the sources of fecal coliform violations, the load reductions, and the areas upon which to focus implementation needed to return the estuary to water quality standards.

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. If observed data were available for more than one monitoring station in a condemned area, the volume-weighted values for each condemned area were used to represent the embayment concentration.

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 volume-weighted fecal coliform values of each condemned area. The period of record for the monitoring data used to determine the current condition was from 1995 to 2003. This interval was chosen to ensure inclusion of the data that represents the conditions at the time the waters were first listed as impaired in 1998. As the regulatory requirement for assessment is based upon 30 (month) sample intervals and the waters were first listed as impaired in 1998, the current condition has been determined using monitoring data for that time interval of 3 years preceding the 1998 list date to the time of the BST analysis. 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. For Cockrell Creek, DSS Station 12-6 was selected for the TMDL load calculations because it exhibited the highest fecal coliform exceedances of the shellfish water quality standards.

B. Geometric Mean Analysis:

The current 30-sample geometric mean was used for the load estimation. The corresponding 30-sample geometric mean from the station outside the condemned area was used as the boundary condition. The current load was estimated using the tidal volumetric model. The allowable load was calculated using the geometric mean fecal coliform 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 below. The calculated results are listed in table 5.1.

The load reduction is estimated as follows:

Geometric Mean Value (X MPN/100ml) x (volume) = Existing Load

Criteria Value (14 MPN/100ml) x (volume) = Allowable Load

$$\textbf{Load Reduction} = \frac{\textbf{Current Load} - \textbf{Allowable Load}}{\textbf{Current Load}} \times 100\ \%$$

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

Condemnation Area	Volume (m^3)	Fecal Coliform (MPN/100ml)	WQ Standard MPN/100 ml	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
002A Cockrell Creek (VAP-C01E-08)	5102820	37.4	14	1.91E+12	7.14E+11	63%

C. 90th Percentile Analysis

The current 30-sample 90th percentile concentration was used for load estimation. The corresponding 30-sample 90th percentile concentration from the station outside the condemned area was used as the boundary condition. The current load was estimated using the tidal volumetric model. The allowable load was calculated based on the 90th percentile fecal coliform water quality standard of 49 MPN/100ml. This value was also used as boundary condition for the calculation. The calculated results are listed in Table 5-3.

The load reduction is estimated as follows:

$$\textbf{Load Reduction} = \frac{\textbf{Current Load} - \textbf{Allowable Load}}{\textbf{Current Load}} \times 100\ \%$$

Table 5.2
90th Percentile Analysis of Current Load and Estimated Load Reduction

Condemnation Area	Volume (m^3)	Fecal Coliform (MPN/100ml)	WQ Standard MPN/100 ml	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
002A Cockrell Creek (VAP-C01E-08)	5102820	399.5	49	1.33E+13	2.56E+12	88%

D. Recreational Impairment Analysis

Two water quality standards operate in salt water areas with regard to recreation use, the fecal coliform standard, which is a transitional standard that expires on June 30, 2008, and the *enterococci* standard which is applied concurrently. For the upcoming 2008 water quality assessment period, the enterococci standard will be used for determining attainment of the recreational (primary contact) designated use. The following language is excerpted from the 2008 Final Water Quality Assessment Guidance Manual.

> The enterococci instantaneous standard 104 per 100 ml applies when 2 or more samples per month are not available to calculate a geometric mean. Where data are not sufficient to calculate a geometric mean, at least two exceedences and >10.5% of the total single samples taken during the assessment period exceeding the instantaneous maximum bacteria standard for primary contact recreation is impaired.

The recreational use load for Cockrell Creek is estimated volumetrically by the following equation:

Max. Single highest *enterococci* value x volume = *enterococci* load

The highest recorded enterococci values for Cockrell Creek were at the monitoring station beside the Omega Protein, Inc. water intake pipes. Enterococci was measured at values greater than 8000 cfu/100mL on both September 20th & 27th, 2006. (see Table 4.4)

The load reduction for each standard is calculated utilizing a similar approach as used for the shellfish reductions:

$$\text{Load reduction} = \frac{\text{current load}_{max} - \text{allowable load}}{\text{currentload}_{max}}$$

The results for these calculations are shown in Table 5.3 .

Table 5.3 Calculations for Recreation Use Impairments in Cockrell Creek

Impaired Area	Volume (m^3)	Bacteria Pollutant	Current Load (cfu/day)	Allowable Load (cfu/day)	Required Reduction (%)
002A Cockrell Creek (VAP-C01E-08	**5102820**	***enterococci***	**4.08E+14**	**5.31E+12**	**99%**

Highest observed ambient exceedence = >8000 cfu at Omega Protein, Inc.

5.3 Development of Wasteload Allocations

The minor VPDES permittee in the Cockrell Creek Watershed, Reedville Sanitary District Sewage Treatment Plant (VA0060712), does not require a wasteload allocation (WLA). The facility is permitted for total chlorine residual, a surrogate parameter for fecal coliform bacterial limits of geometric mean 200 MPN/100 mls. However, the immediate area surrounding the STP outfall is identified by DSS as shellfish condemnation area 2C, and is a prohibited shellfish harvest area. As noted in section 2.2, a prohibited area is established around a municipal sewage treatment plant. Wastewater treatment kills bacteria in the effluent, but has little effect on human viruses, which can be transferred to shellfish. These viruses are difficult for shellfish to purge, so these areas are permanently prohibited from harvesting. Because shellfish harvest is prohibited in this segment, a wasteload allocation for the STP is not necessary.

The major VPDES permittee in the Cockrell Creek watershed, Omega Protein, Inc. (VA0003867), requires a wasteload allocation. The new permit - reissued December 2005 - for this facility included a fecal coliform limit of 200 MPN/100 mL geometric mean for Outfall 002 (lagoon discharge). This limit is based on the requirements necessary for meeting the primary contact standard, but is greater than 14 times above the shellfish geometric mean water quality standard. As a result, the TMDL must establish a new fecal coliform limit set at the shellfish water quality standard, 14 MPN/100mL. Additionally, the DEQ special study in and around the Omega facility determined that fecal coliform and enterococci were found in Omega outfalls 002 & 995. As a result, these outfalls and outfall 001 will be given limits that meet the shellfish water quality standard and the primary contact standard. Omega Protein sampled the 001 outfall on October 23, 2001 as part of the permit renewal process. The resulting fecal coliform bacteria concentration was 1600 MPN/100 mL, a violation of both the primary and shellfish water quality standards. Outfall 001 has the same source water as 995. As both outfalls are non-contact cooling water and come from the same source, DEQ is using bacterial numbers from 995 as a surrogate for 001 due to lack of outfall data.

Tables 5.5 and 5.6 shows the WLA necessary for each outfall in order to meet the shellfish geometric mean (14 MPN/100 mL fecal coliform) and primary contact geometric mean (35 MPN/100 mL Enterococci) standards. An expansion for future growth factor of 5 was applied to the total WLA. This is based on the daily maximum design flows for each facility. WLAs are calculated using the following equations.

$$\text{Max Daily Design Flow (MGD)} = \frac{1\ \text{MGD}}{1{,}000{,}000\ \text{gal/day}} \times \frac{1\ \text{gal/day}}{3785\ \text{mL/day}} = \text{mL/Day}$$

Fecal coliform Wasteload Allocation = Max Daily Design Flow (mL/D) x TMDL Endpoint (14 MPN/100 mL) x5 (for future growth)

Enterococci Wasteload Allocation = Max Daily Design Flow (mL/D) x TMDL Endpoint (35 MPN/100 mL) X5 (for future growth)

Table 5.4. Omega Protein, Inc. Fecal Coliform Wasteload Allocation

Omega Protein Outfall	Daily Maximum Design Flow (MGD)	Highest recorded fecal coliform (cfu/100 mL)	Fecal Coliform Existing load	Fecal Coliform Wasteload Allocation
001	4.14	10,000*	1.57E+12	2.19E+09
002	0.481	>8000	1.46E+11	2.55E+08
995	14.2	10,000	5.37E+12	7.52E+09
		Current Total	7.09E+12	9.97E+09
		Future growth (x5)		4.98E+10
		Total	7.09E+12	5.98E+10

* Bacterial samples not collected at 001 during study. Since source water for 995 & 001 are same, values for 995 were assigned to 001.

Table 5.5. Omega Protein, Inc. Enterococci Wasteload Allocation

Omega Protein Outfall	Daily Maximum Design Flow (MGD)	Highest recorded Enterococci (cfu/100 mL)	Enterococci Existing Loads	Enterococci Wasteload Allocation
001	4.14	4600*	7.21E+11	5.48E+09
002	0.481	700	1.27E+10	6.37E+08
995	14.2	4600	2.47E+12	1.88E+10
		Current Total	3.21E+12	2.49E+10
		Future growth (x5)		1.24E+11
			3.21E+12	1.49E+11

* Bacterial samples not collected at 001 during study. Since source water for 995 & 001 are same, values for 995 were assigned to 001.

DSS has not designated a shellfish prohibition area surrounding the Omega facility and has indicated they will not likely do so. As such, effluents from the Omega facility must meet the shellfish water quality standard at the end of pipe.

The Omega Protein Industrial Stormwater permits (VAR051211& VAR051221) are not permitted for fecal coliform and enterococci discharges. Stormwater from these Omega facilities enter Cockrell Creek from overland flow; not through specific conduits and outfalls, and they are not considered part of the wasteload allocation contribution.

5.4 Load Allocation

A comparison of the percent reductions based on geometric mean load and on the 90th percentile load shows that the 90th percentile load is the critical condition, because this requires the greatest reduction to meet the TMDL. This is consistent with the water quality analysis. The 90th percentile criterion is most frequently exceeded. Therefore, the 90th 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.

Based on source assessment of the watershed, the percent load allocation for each of the major source categories is estimated. These percentages are used to determine where load reductions are needed. The load allocations 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 5.7 and serves to fulfill the TMDL requirements by ensuring that the criterion is attained.

Table 5.6. Reduction and Allocation Based Upon 90th Percentile Standard: Cockrell Creek - Growing Area 12

Condemnation Area	Source	BST Allocation % of Total Load	Current Load MPN/ day	Load Allocation MPN/ day	Reduction Needed
002A Cockrell Creek (VAP-C01E-08)	Wildlife	12%	1.60E+12	1.60E+12	0%
	Human	42%	5.59E+12	0.00E+00	100%
	Livestock	38%	5.06E+12	0.00E+00	100%
	Pets	8%	1.06E+12	8.90E+11	16%
	Total	**100%**	**1.33E+13**	**2.50E+12**	**88%**

Current load distributions in the Cockrell Creek watershed were determined using the BST analysis. For determining the load allocation, the Omega WLA was removed from the total TMDL load. The load allocation was distributed amongst the four categories to determine reductions needed per category.

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 human waste is precluded by state and federal law. The 100 percent reductions desired for livestock represent the recognition that as much of the livestock should be removed as is technically feasible. According to the preceding analysis, reductions of the controllable loading from pets are also necessary to meet water quality standards.

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

5.5 Consideration of Critical Conditions and Seasonal Variation

EPA regulations at 40 CFR 130.7 (c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the waterbody 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 waterbody was determined using a long-term record of water quality monitoring (observation) data. The period of record for the data was 1995 to 2003. The resulting estimate is quite robust.

A comparison of the geometric mean values and the 90th percentile values against the water quality criteria 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 90th 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 90th percentile criterion is the most critical condition. Thus, the final load reductions determined using the 90th percentile represent the most critical and stringent conditions. It is the reductions based on these 90th percentile 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 waterfowl populations, are accounted for by the use of monthly sampling to account for season, and the use of the long-term data record to estimate the current load.

5.6. 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 standpoints of human health and environmental protection.

DEQ used the highest thirty-month 90th percentile value for the period of record (see Table 5.2) to calculate the TMDL load reduction. Using this worst case scenario bacterial percentile provided the most conservative margin of safety from the perspectives of human health and environmental protection.

5.7 TMDL Summary

To meet the water quality standards for both geometric mean and 90th percentile criteria, as well as the *enterococci* impairment, the TMDL for Cockrell Creek is defined for the geometric mean load, the 90th percentile load, and the *enterococci* impairments. The TMDL is summarized in the tables 5.7, 5.8, and 5.9.

Table 5.7. TMDL Summary for the Closure in the Cockrell Creek Watershed (geometric mean)

Condemnation Area	Pollutant Identified	TMDL MPN/day	Waste Load Allocation MPN/day	Load Allocation MPN/day	Margin of Safety
002A Cockrell Creek (VAP-C01E-08)	Fecal Coliform	7.14E+11	5.98 E+10	6.54E+11	Implicit

Table 5.8. TMDL Summary for the Closure in the Cockrell Creek Watershed (90th percentile)

Condemnation Area	Pollutant Identified	TMDL MPN/day	Waste Load Allocation MPN/day	Load Allocation MPN/day	Margin of Safety
002A Cockrell Creek (VAP-C01E-08)	Fecal Coliform	2.56E+12	5.98 E+10	2.50E+12	Implicit

Table 5.9. TMDL Summary for the Recreation Use Impairment in Cockrell Creek

Impaired Water body Segment	Volume (m^3)	Bacteria Pollutant	Load Allocation (cfu/day)	Wasteload Allocation (cfu/day)	TMDL	Margin of Safety
002A Cockrell Creek	5102820	*Enterococci*	5.16E+12	1.49E+11	5.31E+12	Implicit

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 bacteria impairment in the Cockrell Creek watershed. 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 waterbody. 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 Manual", published in July 2003 and available upon request from the DEQ and DCR TMDL project staff or at http://www.deq.state.va.us/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 Implementation of the Wasteload Allocation

EPA's Approval Letters state that "Following the approval of the TMDL, Virginia shall incorporate the TMDL into the appropriate Water Quality Management Plans pursuant to 40 CFR '130.7(d)(2). As you know, all new or revised National Pollutant Discharge Elimination System permits must be consistent with the TMDL WLA pursuant to 40 CFR '122.44(d)(1)(vii)(B)."

With respect to the Omega Protein, Inc. industrial permit (VA0003867), DEQ envisions that, after approval by the SWCB and the EPA, the permit will be proposed with a total TMDL allocation of 9.97E+09 cfu/100 mL per day for fecal coliform and 2.49E+10 cfu/100 mL per day for Enterococci (See Tables 5.4 & 5.5 for specific outfall allocations). The current permit already has bacterial limits for the 002 outfall, but these were established at the primary contact standard, not for shellfish standards. A four year compliance schedule would be proposed in the permit, as well as annual progress reports to be provided by Omega Protein. Omega currently monitors for bacteria at outfall 002 and it is envisioned this will be expanded to outfalls 001 & 995, pending planned facility upgrades.

As noted previously, the fluorometric dye trace study (Black, 2002) shows an influence from the Omega fleet on the facility's intake water. The fleet uses Type II Marine Sanitation Devices (MSDs) which are allowed a 200 cfu/100 mL discharge (see section 6.4.4. for further discussion). The DEQ special study bacterial samples showed high levels of fecal coliform bacteria and enterococci in the vicinity of the moored ships and in the Omega facility intake & 995 outfall. Such high bacterial counts (up to 10,000 cfu / 100 ml) can be indicative of a large source of waste containing fecal bacteria in close proximity to the sample points.
It is recommended that further study be conducted to determine sources of bacteria in the treatment lagoons (Outfall 002). This system is separate from the non-contact cooling water and the bacterial sources may be different as a result.

Omega Protein has options to identify the most cost-effective method to satisfy the permit daily load limit (WLA). Discharges from the Omega fishing fleet could be eliminated by installing holding tanks for these vessels and/or pump out facilities for when these boats are moored. Additionally, upgrading the facility for chlorinating & de-chlorinating effluent from some or all of the facility outfalls address bacteria levels using a long proven technology. The facility is currently under going a major up grade of the MSDs for the entire fleet.

An Engineering Report was produced for Omega Protein by Environmental Professionals, Inc. (Black, 2006) to evaluate possible options for eliminating the effluent from outfall 001, primarily to address cyanide and nitrogen issues that were identified and ultimately led to two Consent Orders issued by DEQ (March 26, 2003 and June 29, 2005). This report details facility process equipment changes in order to meet the consent order schedule to make improvements in the manufacturing process. The engineering reports states that after the process changes are completed, "The 4 MGD that was discharged (*during the interim upgrade period*) through the internal outfall and 001 will be returned to outfall 995. Outfall 995 will eventually be replaced with cooling towers which will be addressed in another report." (pg 13). It is anticipated the forthcoming report discussing installation of cooling towers will address the non-contact cooling water discharges from the facility. DEQ staff review of potential facility upgrades will consider occasional discharges to Cockrell Creek through the 001 & 995 outfalls to Cockrell Creek and determine the applicable water quality limits necessary.

It should be noted that a combination of these options may prove to be the best solution to address the bacterial contributions from the Omega Facility and activities associated with its operation.

6.2 Implementation of the Load Allocation

In general, Virginia intends for the required non-point 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 waterbodies. This has been shown to be very effective in lowering fecal coliform concentrations in waterbodies, 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.

6.3 Link to ongoing Restoration Efforts

This TMDL Implementation will contribute to on-going water quality improvement efforts aimed at restoring water quality in the Chesapeake Bay. Tributary strategies have been developed for the Potomac River and Rappahannock River Basins. Information on these efforts can be found at http://www.naturalresources.virginia.gov/Initiatives/WaterQuality/.

6.4 Reasonable Assurance for Implementation

6.4.1 Follow-Up Monitoring

DSS continues to sample 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.

Following the development of the TMDL, the Department of Environmental Quality (DEQ) will make every effort to continue to monitor the impaired stream in accordance with its ambient monitoring program. DEQ's Ambient Watershed Monitoring Plan for conventional pollutants calls for watershed monitoring to take place on a rotating basis, bi-monthly for two consecutive years of a six-year cycle. In accordance with DEQ Guidance Memo No. 03-2004, during periods of reduced resources, monitoring can temporarily discontinue until the TMDL staff determines that implementation measures to address the source(s) of impairments are being installed. Monitoring can resume at the start of the following fiscal year, next scheduled monitoring station rotation, or where deemed necessary by the regional office or TMDL staff, as a new special study.

The purpose, location, parameters, frequency, and duration of the monitoring will be determined by the DEQ staff, in cooperation with DCR staff, the Implementation Plan Steering Committee and local stakeholders. Whenever possible, the location of the follow-up monitoring station(s) will be the same as the listing station. At a minimum, the monitoring station must be representative of the original impaired segment. The details of the follow-up monitoring will be outlined in the Annual Water Monitoring Plan prepared by each DEQ Regional Office. Other agency personnel, watershed stakeholders, etc. may provide input on the Annual Water Monitoring Plan. These recommendations must be made to the DEQ regional TMDL coordinator by September 30 of each year. DEQ staff, in cooperation with DCR staff, the Implementation Plan Steering Committee and local stakeholders, will continue to use data from the ambient monitoring stations to evaluate reductions in pollutants ("water quality milestones" as established in the IP), the effectiveness of the TMDL in attaining and maintaining water quality standards, and the success of implementation efforts. Recommendations may then be made, when necessary, to target implementation efforts in specific areas and continue or discontinue monitoring at follow-up stations.

In some cases, watersheds will require monitoring above and beyond what is included in DEQ's standard monitoring plan. Ancillary monitoring by citizens, watershed groups, local government, or universities is an option that may be used in such cases. An effort should be made to ensure that ancillary monitoring follows established QA/QC guidelines in order to maximize compatibility with DEQ monitoring data. In instances where citizens' monitoring data is not available and additional monitoring is needed to assess the effectiveness of targeting efforts, TMDL staff may request of the monitoring managers in each regional office an increase in the number of stations or monitor existing stations at a higher frequency in the watershed. The additional monitoring beyond the original bimonthly single station monitoring will be contingent on staff resources and available laboratory budget. More information on citizen monitoring in Virginia and QA/QC guidelines is available at http://www.deq.virginia.gov/cmonitor/.

To demonstrate that the watershed is meeting water quality standards in watersheds where corrective actions have taken place (whether or not a TMDL or TMDL Implementation Plan has been completed), DEQ must meet the minimum data requirements from the original listing station or a station representative of the originally listed segment. The minimum data requirement for conventional pollutants (bacteria, dissolved oxygen, etc) is bimonthly monitoring for two consecutive years.

6.4.2. 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 wasteload allocations can and will be implemented. EPA also requires that all new or revised National Pollutant Discharge Elimination System (NPDES) permits must be consistent with the TMDL WLA pursuant to 40 CFR §122.44 (d)(1)(vii)(B). All such permits should be submitted to EPA for review.

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. For the implementation of the WLA component of the TMDL, the Commonwealth intends to utilize the Virginia NPDES (VPDES) program, which typically includes consideration of the WQMIRA requirements during the permitting process. Requirements of the permit process should not be duplicated in the TMDL process, and with the exception of stormwater related permits, permitted sources are not usually addressed during the development of a TMDL implementation plan.

For the implementation of the TMDL's LA component, a TMDL implementation plan addressing at a minimum the WQMIRA requirements will be developed. An exception are the municipal separate storm sewer systems (MS4s) which are both covered by NPDES permits and expected to be included in TMDL implementation plans, as described in the stormwater permit section below.

Watershed stakeholders will have opportunities to provide input and to participate in the development of the TMDL implementation plan. Regional and local offices of DEQ, DCR, and other cooperating agencies are technical resources to assist in this endeavor.

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.

DEQ staff will present both EPA-approved TMDLs and TMDL implementation plans to the State Water Control Board for inclusion in the appropriate Water Quality Management Plan (WQMP), in accordance with the Clean Water Act's Section 303(e) and Virginia's Public Participation Guidelines for Water Quality Management Planning.

DEQ staff will also request that the SWCB adopt TMDL WLAs as part of the Water Quality Management Planning Regulation (9VAC 25-720), except in those cases when permit limitations are equivalent to numeric criteria contained in the Virginia Water Quality Standards, such as is the case for bacteria. This regulatory action is in accordance with §2.2-4006A.4.c and §2.2-4006B of the Code of Virginia. SWCB actions relating to water quality management planning are described in the public participation guidelines referenced above and can be found on DEQ's web site under http://www.deq.state.va.us/tmdl/pdf/ppp.pdf

6.4.3. Implementation Funding Sources

Cooperating agencies, organizations and stakeholders must identify potential funding sources available for implementation during the development of the implementation plan in accordance with the "Virginia Guidance Manual for Total Maximum Daily Load Implementation Plans". Potential sources for implementation may include the U.S. Department of Agriculture's Conservation Reserve Enhancement and Environmental Quality Incentive Programs, EPA Section 319 funds, the Virginia State Revolving Loan Program, Virginia Agricultural Best Management Practices Cost-Share Programs, the Virginia Water Quality Improvement Fund, tax credits and landowner contributions. 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.

6.4.4 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 (MSDs) have remained. A properly operating Type II MSD may effectively kill bacteria to a very low level under ideal conditions with proper maintenance and chlorine dosage. However, DEQ cannot verify that the MSDs on private and commercial vessels, including Omega vessels, are performing at that level consistently. DEQ data from sampling in the vicinity of the Omega Protein ships strongly suggested a significant source of human fecal bacteria. Therefore DEQ has no way of assuring that vessel discharges are operating at a level that is protective of the shellfish water quality standard for bacteria. The most logical solution is to propose the establishment of a No Discharge Zone (NDZ) in Cockrell Creek and the Great Wicomico River that would provide a more verifiable way of controlling sewage discharges from all ships and boats. This approach seems to have strong local support. Such no discharge designations currently exist in Smith Mountain Lake and are applicable to other inland lakes and rivers. In early 2007, a no discharge designation was approved by the U.S. Environmental Protection Agency and became effective in March, 2007, for Lynnhaven, Broad, and Linkhorn Bays, tributaries to the Chesapeake Bay. In these watersheds 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.

The 2006-2007 DEQ special study results, along with the analysis of over 23 years of DSS bacterial data, show the levels of bacteria associated with the operational activities of the Omega Protein, Inc. facility. Type II Marine Sanitation Devices (MSDs) are installed on ships in the Omega fleet. (Black, 2006a). According to the Coast Guard and EPA (2007), "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." "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." These bacteria levels are approximately 14 times the allowable bacteria standard for shellfish consumption.

The Omega fleet does not have holding tanks and no shore-side pumpout facility is present at the industrial facility. The ships MSDs continuously discharge when in use during the Omega operating season. The fluorometric dye trace study (Black, 2002) showed the ships have an influence on the intake water for the Omega facility. The water samples collected during the DEQ Omega Special Study (see Tables 4.3 & 4.4) at the facility intake, outfall 995, and those taken near the Omega fleet are similar in that they typically show high bacterial counts which exceed the shellfish and primary contact water quality standards. As a result, the Omega fleet is considered to be the most probable source of bacteria for the facility intake, outfalls 001 & 995, and portions of Cockrell Creek.

For these reasons, DEQ strongly recommends the establishment of a No Discharge Zone for Cockrell Creek. This is arguably the most cost effective Best Management Practice for reducing bacteria levels in Cockrell Creek.

6.4.5 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 reductions 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.state.va.us/wqs/WQS03AUG.pdf

7.0. Public Participation

During development of the TMDL for the Cockrell Creek watershed, public involvement was encouraged through a public participation process that included public and stakeholder meetings.

A public meeting to introduce the TMDL study was held on March 1, 2005 from 7:00 to 9:00 p.m. at the Northumberland County Board Room. 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 prospective model results.

This meeting was followed by development of the draft TMDL and a review by the stakeholders. A Technical Advisory Committee (TAC) meeting was held at the Northumberland Public Library in Heathsville, VA on November 30th 2005. The TAC discussed the process for TMDL development and the source assessment results and drafted TMDL allocations. A second public meeting was held on

December 15, 2005 at the Northumberland Public Library. DEQ conducted a second TAC meeting on August 21, 2007 in order to discuss revisions made to the TMDL document. A third and final public meeting was held on September 5, 2007 at the Northumberland Public Library. Input from these efforts was utilized in the development of the TMDL and improved confidence in the allocation scenarios and TMDL process.

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 waterbody 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 waterbody 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 waterbody 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 waterbody.

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 waterbody 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 waterbody; 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 waterbody. 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 waterbody, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular waterbody, 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

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Kuo, A., Butt, A., Kim, S. and J. Ling (1998). Application of a tidal prism water quality model to Virginia Small Coastal Basins. SRAMSOE No. 348.

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US EPA. (Accessed July, 2 2007). Marine Sanitation Devices - Vessel Sewage Discharge Program http://www.epa.gov/owow/oceans/regulatory/vessel_sewage/vsdmsd.html

US EPA Shellfish Workshop Document (2002).

VA DEQ. 2007. Water Quality Assessment Guidance Manual for Y2008 305(b)/303(d) Water Quality Report. http://www.deq.virginia.gov/wqa/pdf/2008ir/2008_WQA_Guidance-Final.pdf

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

10.0 Appendices

Appendix A Growing Area 12: Shoreline Sanitary Survey and Condemnation Notices

Appendix B Supporting Documentation and Watershed Assessment

Appendix C Bacterial Source Tracking (BST) Analysis

Appendix D DEQ Guidelines for Establishing No Discharge Zones

Appendix E 1) Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.

Appendix F Public Comments

Appendix A

1) DSS Shoreline Sanitary Survey: Cockrell Creek (2004)

2) Condemnation Notice: Cockrell Creek

1) DSS Shoreline Sanitary Survey: Cockrell Creek (2004)

http://www.vdh.virginia.gov/EnvironmentalHealth/Shellfish/closureSurvey/shoreline/survey012.pdf

COMMONWEALTH of VIRGINIA
Department of Health
DIVISION OF SHELLFISH SANITATION Ph: 804-864-7487
109 Governor Street, Room 614-B Fax: 804-864-7481
Richmond, VA 23219

COCKRELL CREEK
Growing Area # 012
Northumberland County
Shoreline Sanitary Survey

Date: 29 June 2004
Survey Period: February 13, 2004 – May 19, 2004
Total Number of Properties Surveyed: 339
Surveyed By: D.B. Geeson, and W.A. McCarty, III

SECTION A: GENERAL

This survey area extends from Reference Point 12 at Fleet Point to Reference Point 13 at Cockrell Point, including all of Cockrell Creek and its tributaries.

The topography of the area varies in elevation from 5' around the shoreline of Cockrell Creek to a maximum of 20' along the northwest boundary of the headwaters. The population density throughout the area is mostly sparse with a moderate concentration around the Town of Reedville. The economy is based on local commerce, seafood and agriculture. Omega Protein, Inc. is the major employer of the area.

Meteorological data indicated that 9.34" of total rainfall fell for the survey period. A monthly breakdown is as follows:

February 13-29	0.27"	April	5.38"
March	2.74"	May 1-19	0.95"

There were sewered areas located within the survey. The entire Town of Reedville from Roseland Cemetery on Northumberland Highway to its end and extending out approximately ½ mile east on Blackberry Road and southeast on Fleeton Road is all sewered. From the end of Fleeton Point back to the area already sewered, Northumberland County offers optional hook-up to Reedville Sewage Treatment Works. This project was not fully complete at the time of inspection and a satisfactory list of homeowners connecting could not be produced, meaning that all of the properties in this area had to be surveyed.

Information in this report is gathered by and primarily for the use of the Division of Shellfish Sanitation, Virginia Department of Health, in order to fulfill its responsibilities of shellfish growing area supervision and classification. However, the data is made available to various agencies participating in shellfish program coordination activities and other interested parties.

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/oehs/shellfish/.

Report copies are provided to the local health department for corrective action of deficiencies listed on the summary page in Section B.2. and B.3. and the Department of Environmental Quality for possible action at properties listed on the summary page in Sections B.1. and C.1. The Department of Environmental Quality is provided information on possible sources of animal pollution found in Section E.

This report lists only those properties that have a 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 resurvey of the area.

SECTION B: SEWAGE POLLUTION SOURCES

SEWAGE TREATMENT FACILITIES

6. ***DIRECT*** – Reedville Sewage Treatment Works, c/o Kenneth Eades, Northumberland County Administrator, PO Box 14, Reedville 22539. VPDES Permit # VA0060712. Design flow 0.2 MGD. Treatment consists of influent bar screens, grit chambers, parshall flume and comminutor, activated sludge aeration basins (operated in extended aeration mode) sedimentation, effluent polishing pond, chlorination, dechlorination, and effluent pump stations. An emergency holding pond is provided at the head of the treatment works. Waste sludge is treated in an aerated holding tank and then dewatered on drying beds. Final effluent discharges to Cockrell Creek. The most recent OWP/DEQ inspection report is attached.

ON-SITE DEFICIENCIES

14. NO FACILITY, ***DIRECT*** – Occupant: Reedville Menhaden, Inc., PO Box 370, Burgess 22432. Owner: Frederick R. Rogers III, PO Box 370, Burgess. Business- Fish packing company adjacent to Cockrell Creek. 6 employees. Sanitary Notice issued 5-14-04 to field #A70.

17. NO FACILITIES – Location: 18261 Northumberland Highway, Reedville 22539. Business- machine shop. 1 employee. Sanitary notice issued 4-5-04 to field #173B.

18. CONTRIBUTES POLLUTION (Kitchen or Laundry Wastes) – Location: 353 Fairport Road, Reedville 22539. Dwelling- white wood-sided 1 story with white shutters. Laundry wastes discharge through 1½" white PVC pipe onto ground surface. Sanitary Notice issued 4-2-04 to field #162B.

20. CONTRIBUTES POLLUTION, ***DIRECT*** – Owner: Trustee, PO Box 423, Kilmarnock 22482. Property address: 1519 Fairport Road, Reedville 22539. Camping trailer- white camping trailer with a brown stripe and with a brown shed. PVC septic line has duct tape around the connection joints which implies that the joints leak. Sanitary Notice issued 4-22-04 to field #B110.

21. CONTRIBUTES POLLUTION, ***DIRECT*** – Owner: Trustee, PO Box 423, Kilmarnock 22482. Property address: 1519 Fairport Road, Reedville 22539. Camping trailer- white camping trailer with a deck and a shed. Septic line not properly connected to septic system. Sanitary Notice issued 4-22-04 to field #B106.

22. CONTRIBUTES POLLUTION, ***DIRECT*** – Owner: Trustee, PO Box 423, Kilmarnock 22482. Property address: 1519 Fairport Road, Reedville 22539. Camping trailer- white camping trailer with brown trim and a deck. Septic line connected to septic system with duct tape. Sanitary Notice issued 4-22-04 to field #B105.

23. NO FACILITIES – Location: 1699 Fairport Road, Reedville 22539. Dwelling- silver camper trailer. 1 person. Portable toilet on premises. Sanitary Notice issued 4-2-04 to field #B92.

24. NO FACILITIES – Location: 1701 Fairport Road, Reedville 22539. Dwelling- white cement block 1½ story with brick trim. 1 person. Portable toilet on premises. Sanitary Notice issued 4-2-04 to field #B91.

26. CONTRIBUTES POLLUTION – Location: 72 Timbs Road, Reedville 22539. Dwelling- Tan vinyl siding 1 story with blue shutters. 2 persons. Effluent erupting from septic tank onto ground surface. Sanitary Notice issued 4-2-04 to field #B 66.

28. CONTRIBUTES POLLUTION (Kitchen or Laundry Wastes) – Location: 60 Polly Cove Road, Reedville 22539. Dwelling- white asbestos siding 2-story with green shutters and a tin roof. No contact. Gray water tank overflows into a hand dug trench. Sanitary Notice issued 4-2-04 to field #B 40.

32. CONTRIBUTES POLLUTION, DIRECT – Location: 2943 Fairport Road, Reedville 22539. Dwelling- green asbestos siding 1 story with white shutters. 1 person. Effluent erupting from septic tank onto ground surface. Sanitary Notice issued 3-26-04 to field #B 27.

POTENTIAL POLLUTION

15. Occupant: Bay Motel, 18754 Northumberland Highway, Reedville 22539. Owner: Janet Montiero, Reedville. Business- motel with 20 rooms. 4 employees. Can accommodate a maximum of 75 occupants. Owner stated that the septic system sometimes backs-up after a heavy rain or while there is a high occupancy rate. No evidence of discharge at time of inspection.

SECTION C: NON-SEWAGE WASTE SITES

INDUSTRIAL WASTES

4. Occupant: Reedville Airport, 239 Menhaden Road, Reedville 22539. Owner: Omega Protein, PO Box 175, Reedville. Business - small private grass landing strip for menhaden spotter planes. No contact. Observed on-site was a 10,000 gallon above ground storage tank for aviation fuel surrounded by a concrete block berm. No evidence of leakage at time of inspection.

5. ***DIRECT*** - Omega Protein, PO Box 175, Reedville 22539. Business - menhaden rendering facility. Approximately 250 employees. Observed on-site were approximately 50 bermed above ground storage tanks for fish oil and solubles ranging from 12,000 – 500,000 gallons in size and 4 bermed above ground diesel fuel tanks ranging from 150,000 – 500,000 gallons in size. No evidence of leakage at time of inspection. Also observed on-site were five outfalls

that discharge into Cockrell Creek. They include contact and non-contact cooking water, two storm water discharges and the aeration lagoon for fish condensates. Currently operating under VPDES Permit #VA0003204 issued by the Department of Environmental Quality (DEQ). The most recent DEQ inspection report dated 18 October 2001 is attached.

8. Smith Point Seafood Inc., 567 Seaboard Road, Reedville, 22539. Owner: Ronald L. Jett, Reedville. Business - crab processing plant offering fuel sales. Observed on-site were 2 bermed above ground storage tanks for gasoline and diesel fuel totaling 1,000 gallons. No evidence of leakage at time of inspection.

9. Occupant: Walter Kilduff, Inc., PO Box 292, Reedville 22539. Owner: Al Christopher, Reedville. Business - bulk fuel plant. 2 employees. Observed on-site were 5 bermed above ground storage tanks with gasoline and middle distillates totaling 180,000 gallons. Also stored on the premises were 5 used fuel drums, 15 old gas pumps and 15 empty 55 gallon oil drums. No evidence of leakage at time of inspection.

11. Occupant: Reedville Marina, 902 Main Street, Reedville 22539. Owner: Charles Williams, PO Box 68, Reedville. Business - Commercial marina and restaurant. 6 employees. Observed on-site were a 1500 gallon gasoline tank and a 1500 gallon diesel fuel tank surrounded by a concrete berm. No evidence of leakage at time of inspection.

12. DIRECT – Pride of Virginia Seafood Products, PO Box 202, Reedville 22539. Business - fish packing facility. 6 employees. Washdown wastes discharge to Cockrell Creek from two buildings (Steamboat Warf and Pride of Virginia buildings) separated by Reedville Marina Currently operating under VPDES Permit #VAG524005 issued by DEQ.

14. DIRECT – Occupant: Reedville Menhaden, Inc., PO Box 370, Burgess 22432. Owner: Frederick R. Rogers III, PO Box 370, Burgess. Business - fish processing facility. 6 employees. Observed on-site were a bermed 2000 gallon diesel fuel tank, a bermed 500 gallon waste oil tank and a 275 gallon gasoline tank with no berm or device around it to contain spills. Washdown wastes discharge to Cockrell Creek. Currently operating under VPDES Permit #VAG524006 issued by DEQ.

31. DIRECT – Omega Protein, Inc., 142 McNeal Road, Reedville 22539. Business - menhaden oil storage facility for the main plant located across Cockrell Creek. 6 employees. Observed on-site were 4 tanks of fish oil ranging from 50,000 to 100,000 gallons in size, a 140,000 gallon tank of stick water, a 100,000 gallon tank of caustics, a 100,000 gallon tank of sulfuric acid and 3 tanks ranging from 470,000 to 500,000 gallons not in use. No evidence of leakage at time of inspection. No fuel is stored on premises and there is no discharge to Cockrell Creek.

33. DIRECT – Eugene Pittman, 2998 Fairport Road, Reedville 22539. Business - fuel sales from pier on Cockrell Creek. 1 employee. Observed on-site were 3 above ground fuel tanks totaling 1000 gallons. 2 boats were present, but no slips are available.

SOLID WASTE DUMPSITES

-None-

SECTION D: BOATING ACTIVITY

MARINAS

11. Reedville Marina, 902 Main Street, Reedville 22539. Owner: Charles Williams, PO Box 68, Reedville. Commercial marina and restaurant. 6 employees. 21 slips. Present at the time of survey were 3 pleasure boats less than 26 feet, 1 pleasure boat greater than 26 feet and 1 workboat greater than 26 feet. Boating services include fuel, water and electricity. Containers are available for solid waste disposal. Sanitary facilities provided are 1 commode, 1 lavatory and 1 shower for men and 1 commode, 1 lavatory and 1 shower for women. Also available during hours of operation are the restroom facilities at the "Crazy Crab" restaurant on premises. Sewage disposal is by connection to Reedville Sewage Treatment Works. There are dump station and boat holding tank pump-out facilities at this location.

19. Buzzard Point Dry Storage and Marina, 468 Buzzard Point Road, Reedville 22539. Owner: Linwood Bowis, Reedville. Commercial marina. 6 employees. 59 slips/128 dry storage spaces available. Present at time of survey were 2 pleasure boats under 26', 12 pleasure boats over 26'; and in dry storage were 116 pleasure boats under 26' and 12 pleasure boats over 26'. Boating services provided are fuel, water, electricity, a hoist and an in-out ramp. Containers are available for solid waste disposal. Sanitary facilities provided are 3 commodes, 3 lavatories and 2 showers for men and 3 commodes, 3 lavatories and 2 showers for women. Sewage disposal is by septic tank with drainfield, which appeared to be in satisfactory condition at time of survey. There are pump-out facilities and dump station facilities provided at this location.

27. Fairport Marina, 252 Polly Cove Road, Reedville22539. Owner: Roy Headley, Reedville. Commercial marina. 4 employees. 51 slips/4 moorings. Present at time of survey were 7 pleasure boats under 26', 3 work boats over 26', and 14 pleasure boats over 26'. Boating services provided are fuel, water and electricity. Containers are available for solid waste disposal. Sanitary facilities provided are 1 commode, 1 urinal and 1 lavatory for men and 1 commode, and 1 lavatory for women. Sewage disposal is by septic tank with drainfield, which appeared to be in satisfactory condition at time of survey. There are pump-out facilities and dump station facilities provided at this location.

29. Jennings Boat Yard, 169 Boat Yard Road, Reedville 22539. Owner: John L. Jennings, Reedville. Commercial marina. 3 employees. 40 slips/5 moorings/186 dry storage spaces available. Present at time of survey were 3 pleasure boats under 26', 9 pleasure boats over 26', 3 work boats over 26'; and in dry storage there were 28 pleasure boats under 26', 6 work boats under 26', 136 pleasure boats over 26' and 16 work boats over 26'. Boating services provided are water, electricity, a railway, a hoist and repair. Containers are available for solid waste disposal. Sanitary facilities provided are 1 commode, 1 urinal, 1 lavatory and 1 shower for men and 1 commode, 1 urinal, 1 lavatory and 1 shower for women. Sewage disposal is by septic tank with drainfield, which appeared to be in satisfactory condition at time of inspection. There are pump-out facilities and dump station facilities provided at this location.

OTHER PLACES WHERE BOATS ARE MOORED

2. Fleeton Point Seafood (William Haynie), 2898 Fleeton Road, Reedville 22539. Owner: Dr. Emory Lewis, 165 Fleeton Point Circle, Reedville. 2 persons. White block 1-story building and 2 piers to receive crabs from workboats. From this facility crabs are transported by truck to Little River Seafood, Inc. 1 pleasure boat and 1 workboat less than 26 feet and 1 pleasure boat and 1 workboat over 26 feet present at time of survey. Up to 4 moorings. Water and electricity are available. There are no sanitary facilities or other boating services at this location.

5. Omega Protein, PO Box 175, Reedville 22539. Private docking area for menhaden boats. Approximately 250 employees. Up to 10 moorings along piers. There were no boats present at time of survey. Containers are available for solid waste disposal. Sanitary facilities are provided within 500' of the shore end of the pier. Sewage disposal is by connection to Reedville Sewage Treatment Works. All menhaden boats are owned by Omega Protein and have Microphore marine sanitation devices aboard. Boating services include fuel, water and electricity.

7. Location: end of Seaboard Road, Reedville 22539. Private pier. No contact. 1 slip. Docking and unloading facility for 1 menhaden boat. There were no boats present at time of survey, because the 1 work boat over 40' owned by Ronald Bevans was in use. There are no boating services, sanitary facilities, boat holding tank pump-out facilities or dump station facilities provided at this location.

8. Smith Point Seafood Inc., 567 Seaboard Road, Reedville 22539. Owner: Ronald L. Jett, Reedville. Docking facility for crab processing plant. 5 moorings. Present at time of survey was 1 pleasure boat over 26'. Boating services provided are fuel and electricity. Containers are available for solid waste disposal. Sanitary facilities provided are 2 commodes and 1 lavatory for men and 2 commodes and 1 lavatory for women. Sewage disposal is by connection to Reedville Sewage Treatment Works. There are no boat holding tank pump-out facilities or dump station facilities provided at this location.

10. Reedville Marine Railway, PO Box 116, Reedville 22539. Owner: George Butler, Reedville. Boat repair facility. 1 employee. 6 slips/6 moorings. Present at time of survey were 2 pleasure boats and 3 work boats under 26', 2 pleasure boats and 5 work boats over 26'; and in dry storage there was 1 pleasure boat under 26' and 2 work boats over 26'. Boating services provided are electricity, a railway, an in-out ramp and repair. Containers are available for solid waste disposal. Sanitary facilities provided are 1 commode and 1 lavatory (unisex). Sewage disposal is by connection to Reedville Sewage Treatment Works. There are no boat holding tank pump-out facilities or dump station facilities provided at this location.

14. Reedville Menhaden, Inc., PO Box 370, Burgess 22432. Owner: Frederick R. Rogers III, PO Box 370, Reedville. Commercial fish processing facility. 6 slips/1 mooring, 6 employees. There were 2 workboats over 26 feet present at time of survey. There are no sanitary facilities available at this site. Boating services include water and electricity.

25. Location: Rt. 1, Box 1050, Reedville 22539. Private piers. No contact. 5 slips. There were no boats present at time of survey. Containers are available for solid waste collection. There are no boating services, sanitary facilities, boat holding tank pump-out facilities or dump station facilities provided at this location.

30. Chesapeake Bay Fishing Company, PO Box 175, Reedville 22539. Docking facility for Omega Protein menhaden boats. 7 moorings. Present at time of survey were 2 work boats over 26'. There are no boating services, sanitary facilities, boat holding tank pump-out facilities or dump station facilities provided at this location. All of the menhaden boats have onboard Microphore marine sanitation devices.

31. Omega Protein Inc., 142 McNeal Road, Reedville 22539. Menhaden oil storage facility for the main plant located across Cockrell Creek, 239 Menhaden Road, Reedville. 6 employees. 5 moorings. There were no boats present at time of survey. Containers are available for solid waste disposal. Sanitary facilities are provided within 500' of the shore end of the pier. Sewage disposal is by connection to Reedville Sewage Treatment Works. There are no boat holding tank pump-out facilities at this location since all of the menhaden boats have onboard Microphore marine sanitation devices.

UNDER SURVEILLANCE

1. Location: 176 Fleeton Warf Road, Reedville 22539. Private piers. No contact. Up to 12 moorings along piers. There were no boats present at time of survey. Containers are available for solid waste disposal. Sanitary facilities provided are 1 commode, 1 lavatory and 1 shower (unisex). Sewage disposal is to Reedville Sewage Treatment Works. There are no boating services provided.

3. Shell Landing, end of State Route 692, Reedville 22539. Owner: Department of Game and Inland Fisheries, 4010 West Broad Street, Richmond 23226. Public boat landing. No contact. 4 slips. There were no boats present at time of survey. Boating services available are 2 in-out ramps. There are no sanitary facilities or other boating services at this facility.

13. Reedville Fishermen's Museum, PO Box 306, Reedville 22539. No contact. Up to 8 moorings along pier. 3 pleasure boats less than 26 feet and 2 pleasure boats over 26 feet were present at time of survey. Containers are available for solid waste disposal. Sanitary facilities provided are 1 commode, 1 lavatory and 1 urinal for men and 1 commode and 1 lavatory for women. Sewage disposal is connection to Reedville Sewage Treatment Works. The only boating service provided is electricity.

SECTION E: CONTRIBUTES ANIMAL POLLUTION

17. Location: 18438 Northumberland Highway, Reedville 22539. Dwelling - green frame 2 story farm house with black shutters and white trim. 2 persons. Present at time of survey were 21 Black Angus cattle in fenced pastures 1 mile from Cockrell Creek. Manure is left in pasture. Has Clean Water Farm Award from Virginia Department of Conservation and Historic Resources.

33. DIRECT - Location: 2998 Fairport Road, Reedville 22539. Dwelling - tan vinyl siding 1 story with black shutters. 2 persons. Present at time of survey were 6 horses in fenced pastures 100' from Cockrell Creek. Manure is left in pasture.

SUMMARY

Area # 012
Cockrell Creek
29 June 2004

SECTION B: SEWAGE POLLUTION SOURCES
1. SEWAGE TREATMENT FACILITIES

1 – DIRECT – # 6
_0 – INDIRECT – None
1 – B.1.TOTAL

2. ON-SITE SEWAGE DEFICIENCIES - Correction of deficiencies in this section is the responsibility of the local health department.

4 –CONTRIBUTES POLLUTION, DIRECT – # 20, 21, 22, 32
1 – CONTRIBUTES POLLUTION, INDIRECT – # 26
0 – CP – (Kitchen or Laundry Wastes), DIRECT – None
2 – CP – (Kitchen or Laundry Wastes), INDIRECT – # 18, 28
1 – NO FACILITIES, DIRECT – # 14
_3 – NO FACILITIES, INDIRECT – # 17, 23, 24
11 – B.2. TOTAL

3. POTENTIAL POLLUTION - Periodic surveillance of these properties will be maintained to determine any status change.

1 – POTENTIAL POLLUTION – # 15

SECTION C: NON-SEWAGE WASTE SITES
1. INDUSTRIAL WASTE SITES

5 – DIRECT – # 5, 12, 14, 31, 33
_4 – INDIRECT – # 4, 8, 9, 11
9 – C.1. TOTAL

2. SOLID WASTE SITES

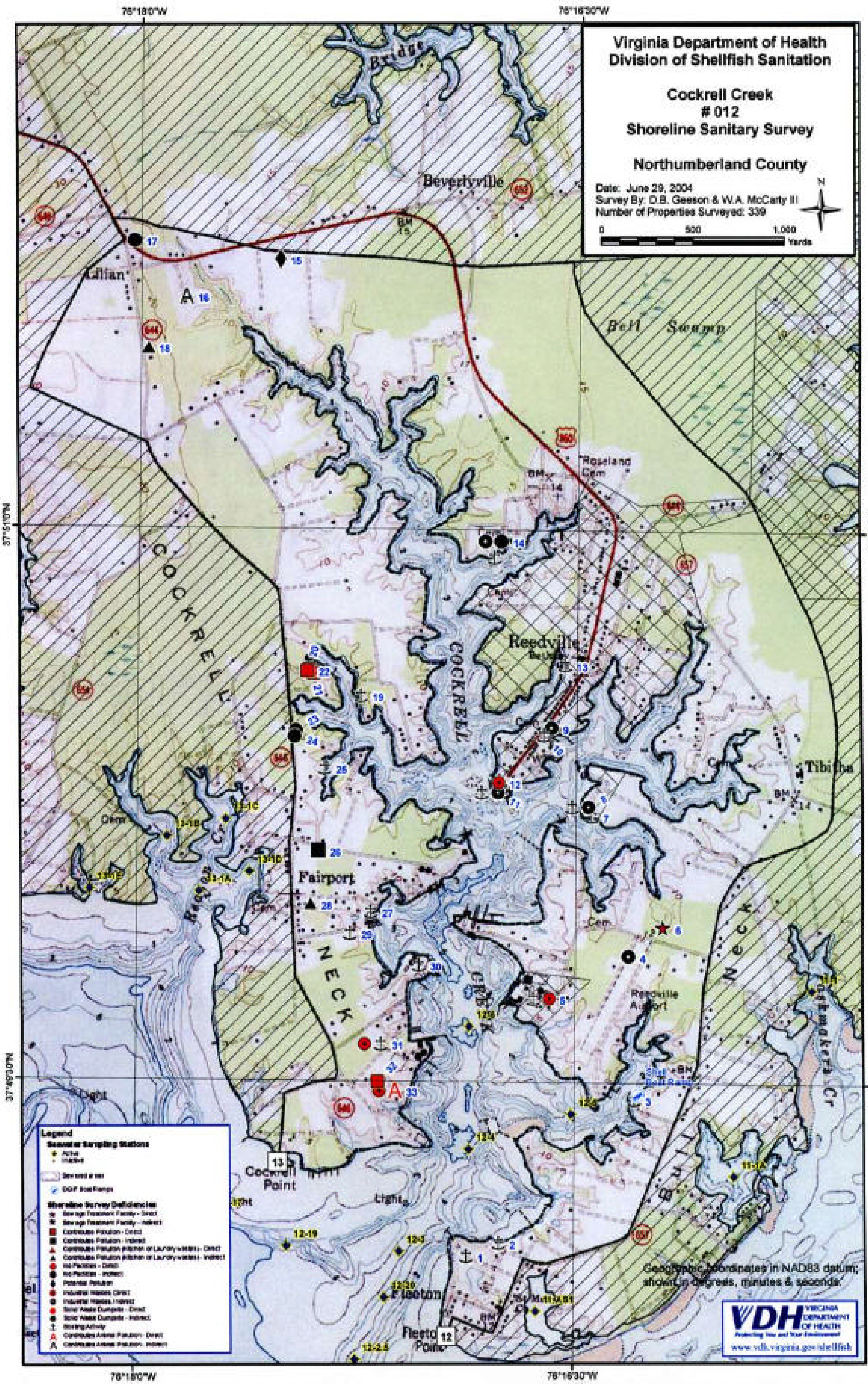
0 – DIRECT – None
_0 – INDIRECT – None
0 – C.2. TOTAL

SECTION D: BOATING ACTIVITY

4 – MARINAS – # 11, 19, 27, 29
9 – OTHER PLACES WHERE BOATS ARE MOORED – # 2, 5, 7, 8, 10, 14, 25, 30, 31
_3 – UNDER SURVEILLANCE – # 1, 3, 13
16 – D. TOTAL

SECTION E: CONTRIBUTES ANIMAL POLLUTION

1 – DIRECT – # 33
_1 – INDIRECT – # 16
2 – E. TOTAL


Virginia Department of Health
Division of Shellfish Sanitation
Cockrell Creek
012
Shoreline Sanitary Survey
Northumberland County
Date: June 29, 2004
Survey By: D.B. Geeson & W.A. McCarty III
Number of Properties Surveyed: 339
0
500
1,000
Yards
N
Legend
Beverlyville
Lillian
Bell Swamp
Roseland Cem
Reedville
Cockrell Neck
Cockrell Creek
Fairport
Tibitha
Reedville Airport
Cockrell Point
Fleeton
Geographic coordinates in NAD83 datum; shown in degrees, minutes & seconds.
VDH
www.vdh.virginia.gov/shellfish

2) Condemnation Notice:

http://www.vdh.virginia.gov/EnvironmentalHealth/Shellfish/closureSurvey/northumberland/cond012-002.pdf

REGISTRAR OF REGULATIONS

05 SEP 12 PM 12: 07

COMMONWEALTH *of* VIRGINIA

Department of Health
DIVISION OF SHELLFISH SANITATION
109 Govenor Street, Room 614-B
Richmond, VA 23219

Ph: 804-864-7487
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NOTICE AND DESCRIPTION OF SHELLFISH AREA CONDEMNATION NUMBER 012-002, COCKRELL CREEK

EFFECTIVE 22 SEPTEMBER 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 012-002, Cockrell Creek," effective 15 November 2004, is cancelled effective 22 September 2005.

2. Condemned Shellfish Area Number 012-002, shown as Sections A, B and C, is established effective 22 September 2005. As to Sections A and B; 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.* As to Section C; it shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose. The boundaries of these areas are shown on the map titled "Cockrell Creek, Condemned Shellfish Area Number 012-002, 22 September 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 012-002

A. The condemned area shall include all of Cockrell Creek and its tributaries lying upstream of a line drawn from latitude/longitude map coordinate (37°49'19.4",-76°16'59.5") to map coordinate (37°49'04.7",-76°16'55.5"), but excluding the areas defined as Sections B and C.

B. The condemned area shall include all of Cockrell Creek and its tributaries lying upstream of a line drawn from latitude/longitude map coordinate (37°50'09.2",-76°16'53.1") to map coordinate (37°50'11.0",-76°16'36.1").

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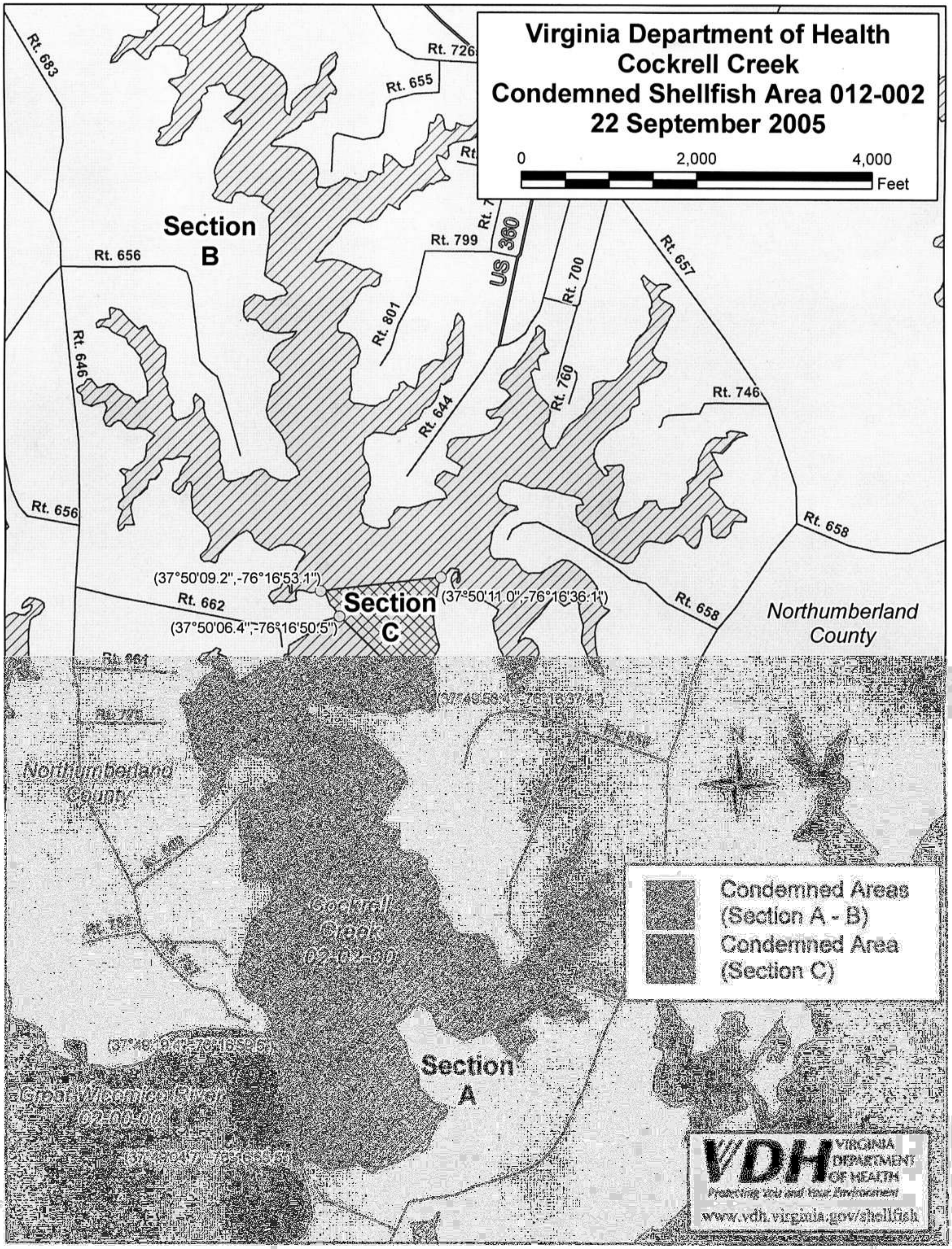
C. The condemned area shall include all of Cockrell Creek and its tributaries lying upstream of a line drawn from latitude/longitude map coordinate (37°50'06.4",-76°16'50.5") to map coordinate (37°49'56.4",-76°16'37.4"), but excluding the area defined as Section B.

Recommended by: ______________________________
Director, Division of Shellfish Sanitation

Ordered by: ______________________________ 9/8/05
State Health Commissioner Date


Virginia Department of Health
Cockrell Creek
Condemned Shellfish Area 012-002
22 September 2005
0
2,000
4,000
Feet
Section B
Section C
Section A
Rt. 683
Rt. 726
Rt. 655
Rt. 656
Rt. 799
US 360
Rt. 657
Rt. 700
Rt. 801
Rt. 646
Rt. 644
Rt. 760
Rt. 746
Rt. 656
Rt. 658
Rt. 662
Rt. 658
(37°50'09.2",-76°16'53.1")
(37°50'11.0",-76°16'36.1")
(37°50'06.4",-76°16'50.5")
Northumberland County
Northumberland County
Condemned Areas (Section A - B)
Condemned Area (Section C)
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Appendix B

Supporting Documentation and Watershed Assessment

1. **Fecal Production Literature Review**
2. **Geographic Information System Data: Sources and Process**
3. **Human and Animal Population Numbers**
4. **Watershed Source Assessment**

1. Fecal Production Literature Review

	Concentration in feces FC/g	Ref.	Fecal coliform production rate FC/day (seasonal)	Ref.	Comments
Cat	7.9E+06	1	5.0E+09	4	
Dog	2.3E+07	1	5.0E+09	4	
Chicken	1.3E+06	1	1.9E+08	4	
Chicken			2.4E+08	9	
Cow	2.3E+05	1	1.1E+11	4	average of dairy and beef
Beef cattle			5.4E+09	9	
Deer	1.0E+02	6	2.5E+04	6	assume 250 g/day
Deer	?		5.0E+08	9	best prof. judgement
Duck			4.5E+09	4	average of 3 sources
Duck	3.3E+07	1	1.1E+10	9	
Canada Geese			4.9E+10	4	
Canada Geese	3.6E+04	3	9.0E+06	3	
Canada Geese	1.5E+04	8	3.8E+06	8	assume 250 g/day (3)
Horse			4.2E+08	4	
Pig	3.3E+06	1	5.5E+09	4	
Pig			8.9E+09	9	
Sea Gull	3.7E+08	8	3.7E+09	8	assume 10 g/day
Sea gull			1.9E+09	5	mean of four species
Rabbit	2.0E+01	2	?		
Raccoon	1.0E+09	6	1.0E+11	6	assume 100 g/day
Sheep	1.6E+07	1	1.5E+10	4	
Sheep			1.8E+10	9	
Turkey	2.9E+05	1	1.1E+08	4	
Turkey			1.3E+08	9	
Rodent	1.6E+05	1	?		
Muskrat	3.4E+05	6	3.4E+07	6	
Human	1.3E+07	1	2.0E+09	4	
Septage	4.0E+05	7	1.0E+09	7	assume 70/gal/day/person

References : Fecal Production Literature Review

1. Geldreich, E. and E. A. Kenner. 1969. Concepts of fecal streptococci in stream pollution. J. Wat. Pollut. Control Fed. 41:R336-R352.
2. Geldreich, E., E. C. Best, B. A. Kenner, and D. J. Van Donsel. 1968. The bacteriological aspects of stormwater pollution. J. Wat. Pollut. Control Fed. 40:1861-1872.
3. Hussong, D., J. M. Damare, R. J. Limpert, W. J. L. Sladen, R. M. Weiner, and R. R. Colwell. 1979. Microbial impact of Canada geese (Branta canadensis) and whistling swans.
4. U.S. Environmental Protection Agency. 2001. Protocol for Developing Pathogen TMDLs. EPA 841-R-00-002. Office of Water (4503F), United States Environmental Protection Agency, Washington, DC. 132 pp.
5. Gould, D. J. and M. R. Fletcher. 1978. Gull droppings and their effects on water quality. Wat. Res. 12:665-672.
6. Kator, H. and M. W. Rhodes. 1996. Identification of pollutant sources contributing to degraded sanitary water quality in Taskinas Creek National Estuarine Research Reserve, Virginia. Special Report in Applied Marine Science and Ocean Engineering No. 336, The College of William and Mary, VIMS/School of Marine Science.
7. Kator, H., and M. W. Rhodes. 1991. Evaluation of Bacteroides fragilis bacteriophage, a candidate human-specific indicator of fecal contamination for shellfish-growing waters. A final report prepared under NOAA Cooperative Agreement NA90AA-H-FD234. Prepared and submitted to NOAA, Southeast Fisheries Science Center, Charleston Laboratory, Charleston, SC. 98 pp.
8. Alderisio, K. A. and N. DeLuca. 1999. Seasonal enumeration of fecal coliform bacteria from the feces of ring-billed gulls (Larus delawarensis) and Canada geese (Branta canadensis). Appl. Environ. Microbiol. 65:5628-5630.
9. TMDL report attributed to Metcalf and Eddy 1991 (Potomac Headwaters of West VA).

2. Geographic Information System Data: Sources and Process

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

Data Element	Source	Date
Watershed boundary	Division of Shellfish Sanitation, VA Department of Health	Various dates
Land use	National Land Cover Data set (NLCD), US Geological Survey	1999
Stream network	National Hydrography Dataset	1999
Shoreline Sanitary Survey deficiencies	Division of Shellfish Sanitation, VA Department of Health	2004
Wastewater treatment plants	VA Department of Environmental Quality	2005
Sewers	Northern Neck Planning District Commission	2005
Water quality monitoring stations	Division of Shellfish Sanitation, VA Department of Health	2005
Condemnation zones	Division of Shellfish Sanitation, VA Department of Health	2005

3. Human and Animal 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. In addition, input was requested from local stakeholders during technical advisory committee meetings (TAC) and public meetings. This local knowledge was incorporated into the TMDL document.

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:

dogs = # of households * 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:
#deer/mi^2 of deer habitat = (-0.64 + (7.74 * 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/mi^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).

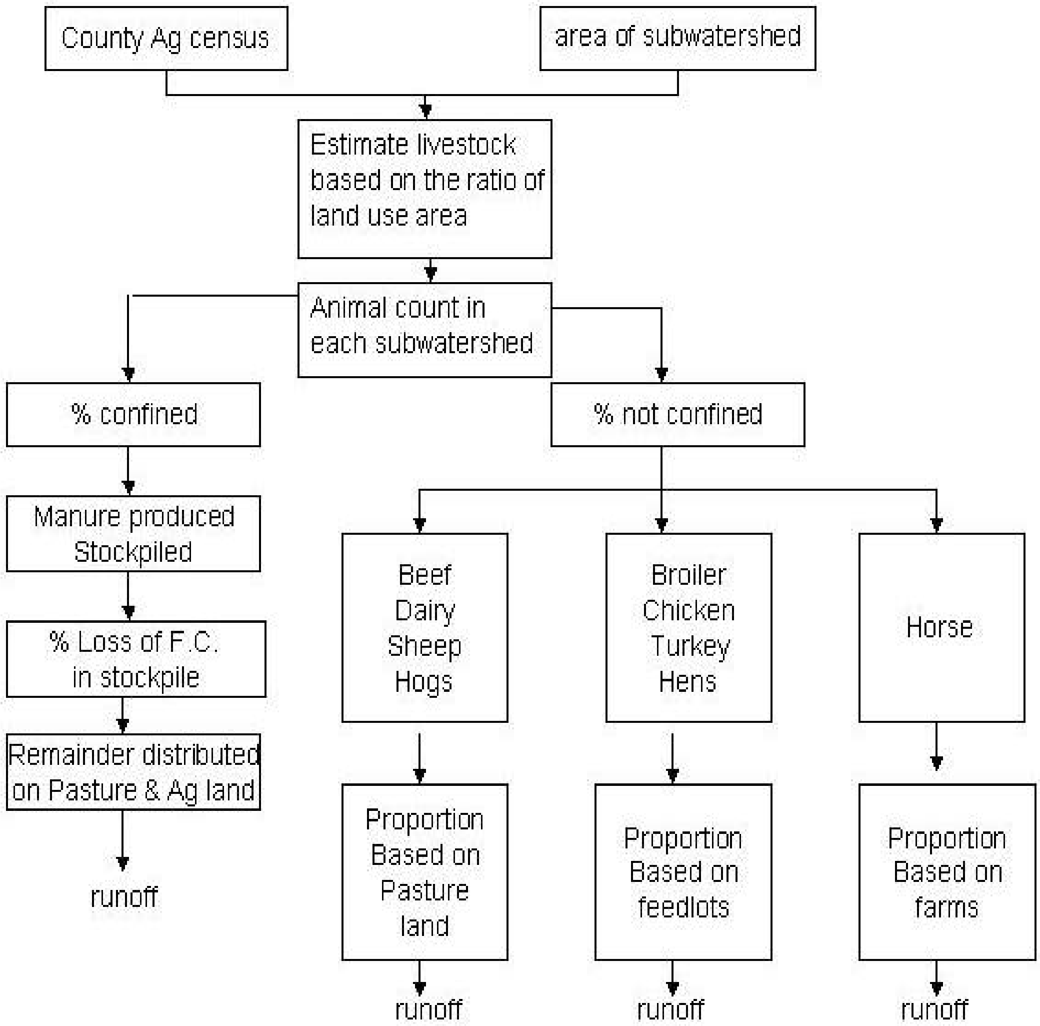
<u>Raccoons—</u>
Estimates for raccoon densities were supplied by DGIF for 3 habitats—wetlands (including freshwater and saltwater, forested and herbaceous), along streams, and upland forests. GIS was used to generate a 600ft buffer around the wetlands and streams, and then to overlay this buffer layer 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.

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.

FIGURE B-1 Diagram to Illustrate Procedure Used to Estimate Fecal Coliform Production from Estimated Livestock Population



Appendix C

Bacterial Source Tracking (BST) Analysis

1. Summary (provided by MapTech)
2. Weighted Mean Fecal Coliform Contribution By BST

1. Summary (provided by MapTech)

When performing ARA, isolates (colonies picked from membrane filtration plates) of *E. coli* or *Enterococcus* are transferred to a 96-well tissue culture plate (one isolate per well) containing a selective liquid medium. The 96-well plates are incubated and confirmed as *E. coli* or *Enterococcus* by color changes in the liquid after incubation (Figure 1). Antibiotic stock solutions are prepared and each of twenty-eight or more antibiotic/concentrations is added separately to flasks of autoclaved and cooled Trypticase Soy Agar (TSA) from the stock solutions to achieve the desired concentration, and then poured into sterile 15x100mm petri dishes.

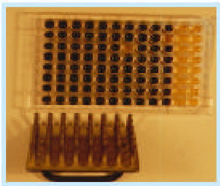


Figure 1. 96-well plate after incubation.

Control plates (no antibiotics) are included with each set. Isolates are transferred from the 96-well plate using a stainless steel 48-prong replica plater (Sigma). The replicator is flame-sterilized (95% ethanol) after inoculation of each TSA plate. Resistance to an antibiotic is determined by comparing each isolate to the growth of that isolate on the control plate. A one (1) is recorded for growth and a zero (0) is recorded for no growth (Figure 2). This is repeated for each isolate on each of the 30 antibiotic plates to develop a profile.

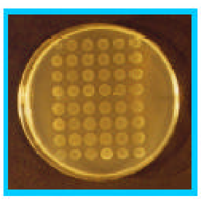


Figure 2. TSA control plate (with no antibiotics) showing growth of all 48 isolates.

The profile is then compared against the known source library to determine the source of the isolate (see data analysis section). The basic process is the same for all approaches, that is, a data base of known sources analyzed using the BST method of choice must be developed and samples of unknown bacterial origin are collected, analyzed and compared to the known source database. For studies, such as Total Maximum Daily Loads (TMDL), we recommend the ARA procedure due to typical cost constraints. Typically we analyze 24 isolates per unknown source (e.g. stream or well water) sample. This provides measurements of the proportion of a given source that are in increments of approximately 4%. If more precision is required, 48 isolates can be analyzed, resulting in resolution of approximately 2%. If the sampling is to be done in a geographical area where a database of known sources has not been developed, we will need to collect samples from known sources (i.e. human, livestock, wildlife) and compare them to our existing databases to determine if one of our existing databases is compatible with the study area. Twenty-four isolates from each of these samples will be analyzed. If no existing database is compatible, we will need to develop a database for the study area. The number of samples needed depend on variability of source samples. We have had a good deal of success in the past by using existing databases through obtaining known source samples from each group (i.e. human, livestock, wildlife) in the study area and comparing them to existing databases.

2. Weighted Mean Fecal Coliform Contribution By BST

Composite of DSS Stations 12-5 & 12-6

Table C-1. BST Weighted Average Calculation

Station ID	Sample Date	# Isolates	Fecal coliform, cfu/100 ml	% Wildlife	% Human	% Livestock	% Pet	Flow, cfs
12-5	10/30/02	24	460	25%	75%	0%	0%	N/A
12-6	10/30/02	24	93	0%	46%	21%	33%	N/A
12-5	11/14/02	16	43	25%	49%	13%	13%	N/A
12-6	11/14/02	13	9.1	23%	54%	23%	0%	N/A
12-5	12/12/02	4	3.6	0%	50%	50%	0%	N/A
12-6	12/12/02	2	2.9	0%	100%	0%	0%	N/A
12-6	02/11/03	1	2.9	0%	0%	0%	100%	N/A
12-5	04/09/03	16	39	19%	25%	31%	25%	N/A
12-6	04/09/03	24	23	21%	45%	17%	17%	N/A
12-5	05/22/03	24	75	21%	25%	29%	25%	N/A
12-6	05/22/03	24	23	13%	41%	29%	17%	N/A
12-5	06/23/03	16	23	50%	13%	31%	6%	N/A
12-6	06/23/03	24	14	67%	29%	4%	0%	N/A
12-5	07/08/03	24	93	0%	21%	66%	13%	N/A
12-6	07/08/03	24	460	0%	17%	79%	4%	N/A
12-5	08/06/03	1	23	100%	0%	0%	0%	N/A
12-6	08/06/03	24	93	0%	49%	38%	13%	N/A

	Weighted Percentage Calculations Isolates X Concentration X Percentage				*Annual Weighted Averages: Sum by Category and Divide by Total*			
Sample Date	**Wildlife**	**Human**	**Livestock**	**Pet**	**Wildlife**	**Human**	**Livestock**	**Pet**
	2760	8280	0	0	12%	42%	38%	8%
	0	1026.72	468.72	736.56				
	172	337.12	89.44	89.44				
	27.209	63.882	27.209	0				
	0	7.2	7.2	0				
	0	5.8	0	0				
	0	0	0	2.9				
	118.56	156	193.44	156				
	115.92	248.4	93.84	93.84				
	378	450	522	450				
	71.76	226.32	160.08	93.84				
	184	47.84	114.08	22.08				
	225.12	97.44	13.44	0				
	0	468.72	1473.12	290.16				
	0	1876.8	8721.6	441.6				
	23	0	0	0				
	0	1093.68	848.16	290.16				

Appendix D

DEQ Guidance on Establishing No Discharge Zones

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WATER QUALITY PROGRAMS
ELLEN GILINSKY, Ph.D., DIRECTOR

SUBJECT: Guidance Memo No.08-2003
Procedure for Designation of Vessel No Discharge Zones

TO: Regional Directors

FROM: Ellen Gilinsky

DATE: February 26, 2008

COPIES: Regional Deputy Directors, Regional Water Permit Managers, Office of Water Quality Programs - Watershed Programs

Summary:

The purpose of this guidance is to provide a revised procedure for handling public requests or a Department of Environmental Quality initiated effort for the designation of vessel No Discharge Zones, and for designating the No Discharge Zones in accordance with federal regulation 40 CFR Part 140 (2004) and state regulation 9 VAC 25-71 (2004). This guidance supersedes Guidance Document 04-2022.

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.

Contact information:

Please contact Chester Bigelow, Office of Watershed Programs, (804) 698-4554 or ccbigelow@deq.virginia.gov . if you have any questions regarding 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.

2) The letter should provide basic information such as name, address, and other contact information of the person, group, organization, or governing body making the request.
3) The letter should also provide the name of the water body proposed for designation.
4) A general description of the boundaries and a map of the area should also be included.
5) Proposals for NDZ should provide any other information that would assist in defining or delineating the area.

B. Letters proposing a NDZ are to be sent to the Director, Division of Water Quality Programs at the following address:

Director, Division of Water Quality Programs
Virginia Department of Environmental Quality
P.O. Box 1105
Richmond, VA 23218

C. DEQ will review the request based on the following criteria:

1) Severity of the water quality problem;
2) Level of community support; and
3) Presence of resources of significance (e.g. shellfish waters, endangered species, etc.).

If DEQ decides to proceed with the NDZ designation, additional data will be obtained with the assistance of the interested parties. If DEQ decides not to proceed, it will respond in writing to the persons making the original request. The response will include the reasons for the decision and what options are available to the individual or group if they wish to continue the designation effort (e.g. petition EPA directly). Such a determination will be based on lack of public support, inadequate number of pump out stations, or a NDZ is not needed to protect the designated uses.

2. Applications initiated by DEQ.

A. DEQ may initiate NDZs as a TMDL implementation tool in waters where MSD discharges from vessels are a significant source of the pollutant responsible for the impairment.

B. In the absence of a TMDL identifying a need for a NDZ, DEQ may elect to pursue a NDZ designation for a water body to protect designated uses in accordance with the provisions of section 312 of the Clean Water Act.

IV. Process for Preparing an Application for a NDZ

1. As part of the application development process DEQ will determine whether:

   A. A NDZ is required for pollutant reductions from vessels to obtain or protect a designated use(s);

   B. The proposed designation has local support; and

   C. An adequate number of pump out facilities are available.

2. A draft application will then be prepared with the assistance and input of the interested parties, agencies, and in consultation with EPA. Staff preparing the draft application should:

   A. Incorporate the essential elements in Appendix A; and

   B. Prepare the NDZ application consistent with the EPA guidance entitled Protecting Coastal Waters from Vessel and Marina Discharges: A Guide for State and Local Officials. Volume I. Establishing No Discharge Areas under Section 312 of the Clean Water Act. August 1994. EPA 842-B-94-004.

V. Process for Submitting Application to EPA

1. Upon completion of the draft NDZ application, DEQ will solicit public input on the proposed designation through public notice and hold a public meeting in the watershed of the proposed NDZ. Notices of the proposed NDZ designation will be posted in the Virginia Register, local newspaper(s), and other appropriate media to solicit public comment.

2. DEQ will prepare a final application to include coordination and input from EPA, USCG, DGIF, VMRC and interested parties.

3. Staff will provide the finalized proposal for NDZ application and the summary of public comments to the SWCB for informational purposes prior to submitting to the Secretary of Natural Resources (SNR).

4. DEQ will submit the NDZ application package to the SNR for signature and transmittal to EPA.

5. EPA will publish a notice in the Federal Register announcing the intent to establish the NDZ and solicit public comment on the proposal.

6. Upon the conclusion of the public comment period, EPA will publish the final notice in the Federal Register. EPA will establish the new NDZ at the end of the final notice comment

period.

7. DEQ will propose an amendment to 9 VAC 25-71 adding the new NDZ to the list of state designated NDZs. This will be presented to the SWCB as a final exempt action (i.e. required to conform to federal law).

8. 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 in state regulation.

Appendix A
Essential Elements of an NDZ Application

1. Name and contact information for the person, persons, local government, or group making the request.

2. Name, location, and description of the water proposed for a NDZ designation to include:

    A. 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;

    B. A map of the area to be designated; and

    C. Reason(s) designation is being sought:

        1) Explain why the water body requires greater environmental protection;
        2) Identify any unique features or qualities (including high quality waters) or environmental importance (e.g. shellfish waters, endangered species, crab sanctuary) that necessitate stronger resource protection;
        3) Include information on contact recreational use (e.g. swimming, water skiing, jet ski); and
        4) Identify any specific water quality problems.

3. Indicate whether the water body is an established sanctuary, national or state park, wilderness area, or recreation area.

4. Indicate whether the water body is a public water supply.

5. Provide an assessment of the availability of boat sewage holding tank pump-outs in the area.

6. Provide an assessment of the amount of vessel utilization in the water body and the type of vessel, as well as its use as either a recreational or a commercial vessel.

7. Provide information, if known, on public support or interest for or against the NDZ designation.

8. Provide information, if available, on local enforcement capability such as marine patrols at the state, federal, or local level.

Appendix E

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

E1: 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.)

Appendix F

Public Comments