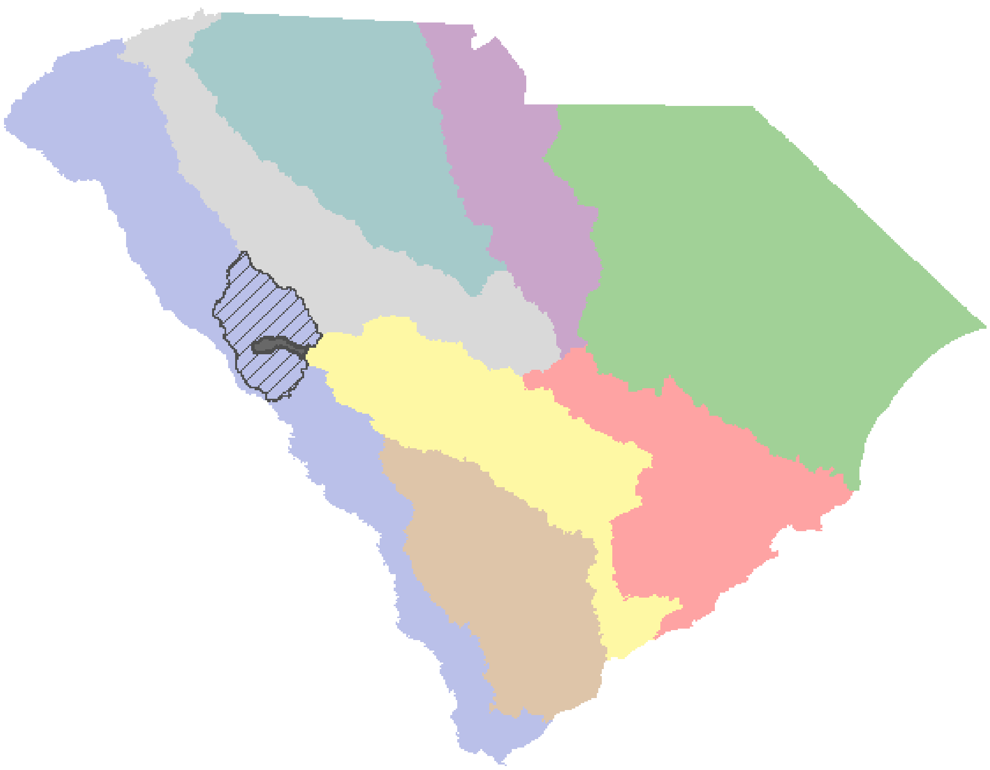
Total Maximum Daily Load Document
Beaverdam Creek SV-353
Hydrologic Unit Code 030401050208 *Escherichia* coli Bacteria, Indicator for Pathogens



Prepared for:

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Abstract

§303(d) of the Clean Water Act (CWA) and EPA's *Water Quality Planning and Management* Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water bodies that are included on the §303(d) list of impaired waters. A TMDL is the maximum amount of pollutant a waterbody can assimilate while meeting water quality standards for the pollutant of concern. All TMDLs include a waste load allocation (WLA) for all National Pollutant Discharge Elimination System (NPDES) permitted discharges, a load allocation (LA) for all nonpoint sources, and an explicit and/or implicit margin of safety (MOS). An *Escherichia coli* (*E. coli)* TMDL was developed for impaired station, SV-353 within the Beaverdam Creek watershed located in Edgefield County, South Carolina (SC).

Both FC bacteria and *E. coli* samples were collected several times a month at this site during 2009. Water quality monitoring station SV-353 was included as impaired on the State's final 2012 §303(d) list due to exceedances of the FC bacteria water quality standard in freshwaters. Because SC has recently adopted a change from FC bacteria to *Escherichia coli* (*E. coli*) bacteria as a recreational use standard in all freshwaters, the aforementioned site will be will be included on future §303(d) lists due to exceedances of *E. coli* until such time such that sufficient *E. coli* data are collected and demonstrate the standard is attained or such time that TMDLs are developed and approved to address the parameter of concern.

The load-duration curve methodology was used to calculate existing and TMDL load for the impaired station. Existing pollutant loading and proposed TMDL reduction for critical hydrologic condition are presented in Table Ab-1. Critical hydrologic conditions were defined as either moist, mid-range, or dry depending on which condition demonstrated the highest load reductions necessary to meet water quality standards. In order to achieve the target load (slightly below water quality standards) for Beaverdam Creek and tributaries, reductions in the existing loads of up to 24.3% will be necessary at station SV-353. For SCDOT, existing and future NPDES MS4 permittees, compliance with terms and conditions of its NPDES permit is effective implementation of the WLA to the Maximum Extent Practicable (MEP) and demonstrates consistency with the assumptions and requirements of the TMDL. For existing and future NPDES construction and Industrial stormwater permittees, compliance with terms and conditions of its permit is effective implementation of the WLA. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and are eligible for CWA §319 grants.

The Department recognizes that adaptive management/implementation of these TMDLs might be needed to achieve the water quality standard and we are committed towards targeting the load reductions to improve water quality in the Beaverdam Creek. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL target accordingly.

Table Ab-1. Total Maximum Daily Loads for the Beaverdam Creek watershed. Loads are expressed as E. coli MPN/day.

Station	Existing Load (MPN/day)	TMDL (MPN/day)	Margin of Safety (MOS) (MPN/day)	Waste load Allocation (WLA)			Load Allocation (LA)	
				Continuous Source [1] (MPN/day)	Non-Continuous Sources [2,3] (% Reduction)	Non-Continuous SCDOT [3, 4] (% Reduction)	Load Allocation (MPN/day)	% Reduction to Meet LA[3]
SV-353	1.76E-11	1.50E+11	7.32E+09	9.60E+09	24.3%	24.3%	1.33E+11	24.3%

Table Notes:

1. WLAs are expressed as a daily maximum. Existing and future continuous discharges are required to meet the prescribed loading for the pollutant of concern. Future loadings will be developed based upon permitted flow and an allowable permitted maximum E. coli concentration of 349 MPN/100ml. For the purposes of NPDES permitting, continuous discharges may be required to meet a loading equivalent of FC bacteria, based upon permitted flow and an allowable permitted maximum FC bacteria concentration of 400 cfu/100ml, until such time that *E. coli* limits are incorporated into individual permits.

2. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4, construction and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for pollutant of concern in accordance with their NPDES Permit.

3. Percent reduction applies to existing instream load for FC bacteria or *E. coli*.

4. By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address Fecal coliform or *E. coli* bacteria, the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit.

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1.0 Introduction

The Federal Clean Water Act (CWA) directs each state to review the quality of its waters every two years to determine if water quality standards are being met. If it is determined that the water quality is not being met, the states are to list the impaired water bodies under §303(d) of the CWA. South Carolina Department of Health and Environmental Health (DHEC) has included one monitoring station in the Beaverdam Creek watershed on South Carolina's final 2012 §303(d) list for impairment due to FC bacteria exceedances. This station is SV-353 and is identified in Figure 1 and Table 1.

A Total Maximum Daily Load (TMDL) is a written plan and analysis to determine the maximum pollutant load a waterbody can receive and still meet applicable water quality standards. The TMDL process includes estimating pollutant loadings from all sources, linking pollutant sources to their impacts on water quality, allocation of pollutant loads to each source and establishment of control mechanisms to achieve water quality standards (US EPA, 1999). All TMDLs include a wasteload allocation (WLA) for all National Pollutant Discharge Elimination System (NPDES) permitted discharges, a load allocation (LA) for all unregulated nonpoint sources, and an explicit and/or implicit margin of safety (MOS). TMDLs are required to be developed for each waterbody and pollutant combination on the States' §303(d) lists.

Escherichia coli (*E. coli*) bacteria are members of the coliform group of bacteria and are part of the normal flora of the gastrointestinal tract of warm blooded animals including humans. These harmless bacteria play an important role in preventing the growth of harmful bacteria, vitamin K production, and lactose digestion as well as producing compounds necessary for fat metabolism (Starr & Taggart, 1992) (Wolfson & Harrigan, 2010). Some verotoxin producing strains of *E. coli*, such as 0157:H7, a major cause of foodborne illnesses, can cause gastrointestinal illnesses, kidney failure and death (Nadakavukaren, 1995) (Wolfson & Harrigan, 2010).

Presence of *E. coli* bacteria in surface waters are indicators of recent human or animal waste contamination and originate from failing septic systems, agricultural runoff, leaking sewers among other sources. Section §303(d) of the Clean Water Act (CWA) and Water Quality Planning and Management Regulations require states to develop TMDLs for water bodies that are not meeting designated uses under technology-based pollution controls. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in stream water quality conditions so that states can establish water quality-based controls to reduce pollution and restore and maintain the quality of water resources (USEPA, 1991).

1.2 Watershed Description

Beaverdam Creek is located in Edgefield County, in western portion of South Carolina. Water quality monitoring station SV-353 in Beaverdam Creek has a drainage area of 42.6 mi2 and is contained within 12-digit hydrologic unit code (HUC) 030601070207 (Figure 1, Table 1). This station is located in the Carolina Slate Belt (Level 4) ecoregion of South Carolina.

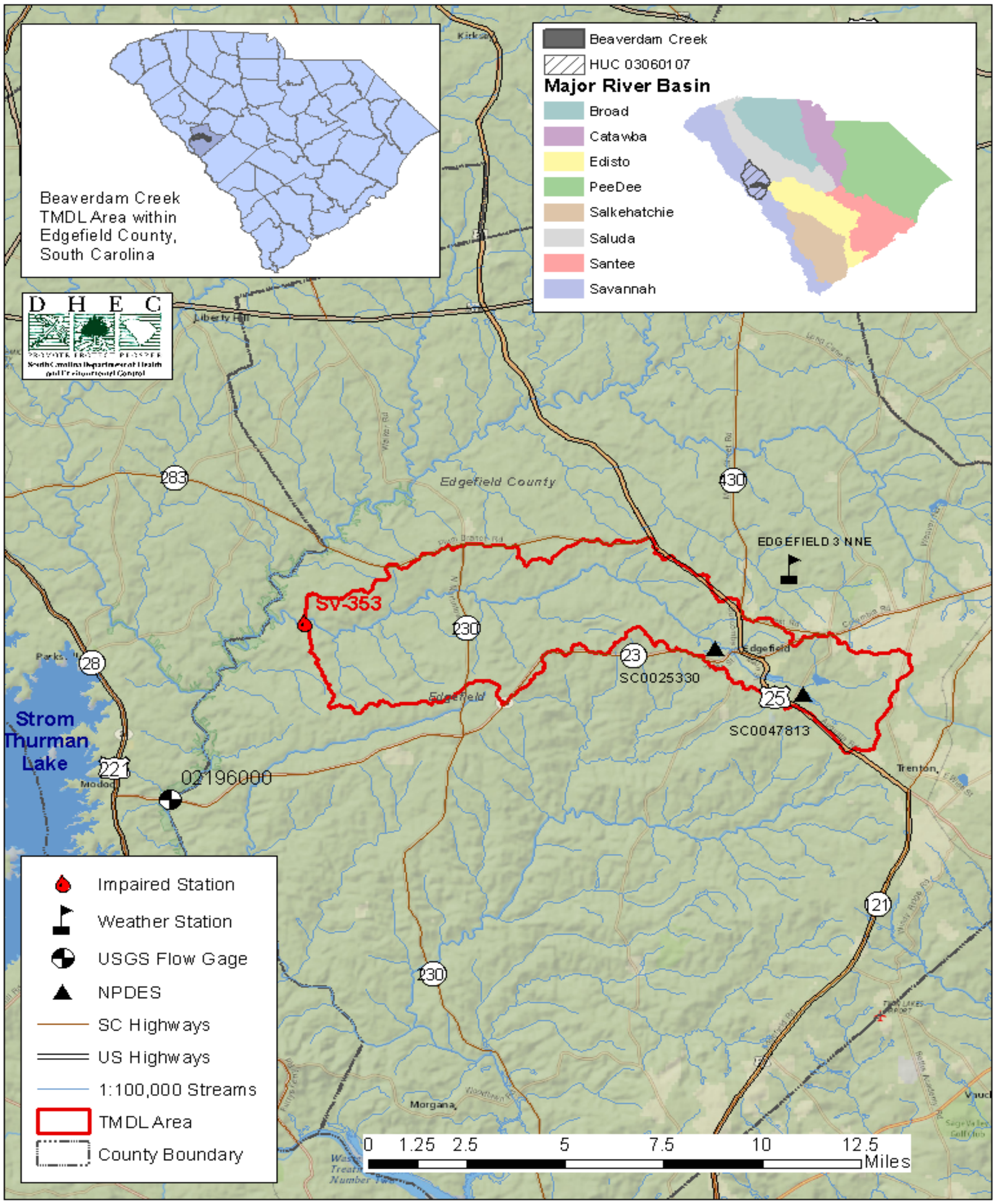

Figure 1. General overview of Beaverdam Creek watershed.

Table 1. Beaverdam Creek watershed *E. coli* impaired water.

Station	Location
SV-353	Beaverdam Creek at Forest Service Road 621 of S-19-68

Landuse within Beaverdam Creek was calculated utilizing the 2006 National Land Cover Data (NLCD) set. For station SV-353 dominant landuse is evergreen forest followed by deciduous forest, with a developed landuse of 2.5 mi2 or 5.9%, as shown in Figure 2 and Table 2.

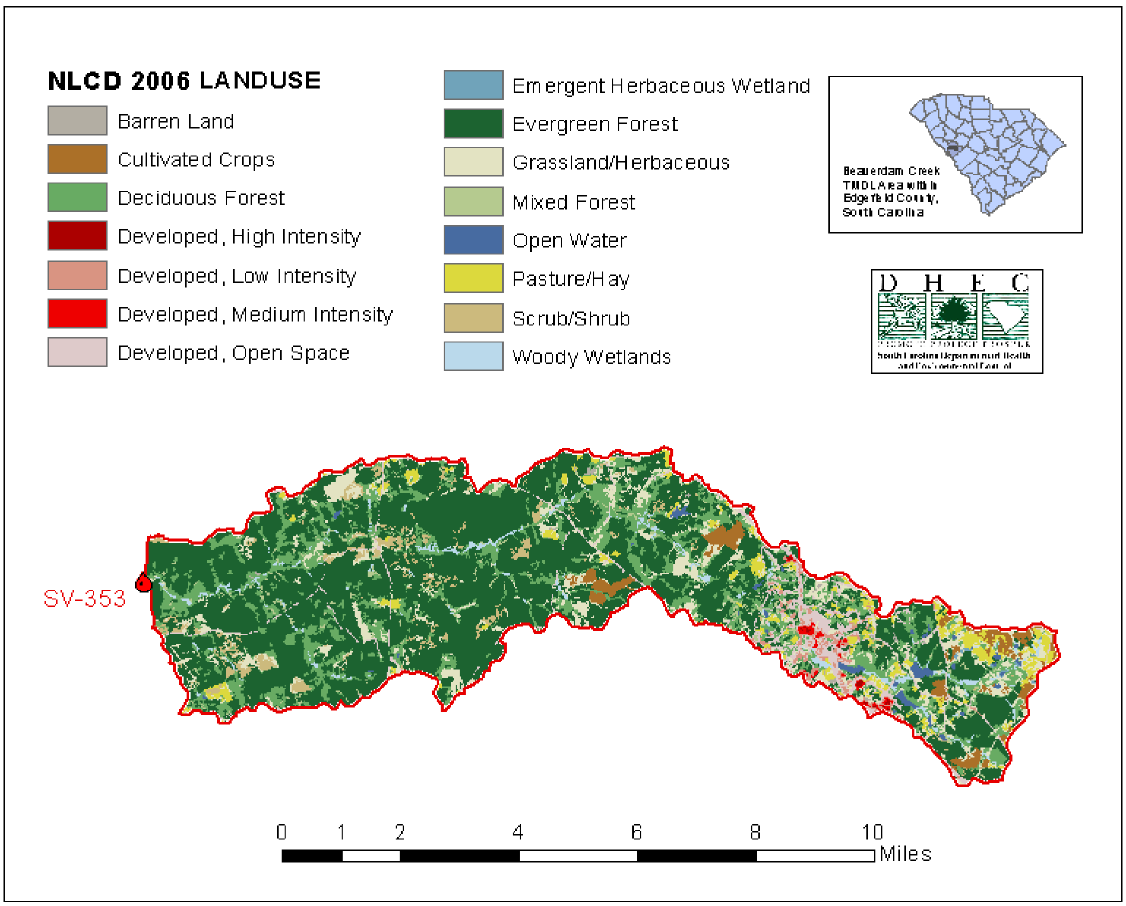

Figure 2. NLCD 2006 landuse within Beaverdam Creek.

1.3 Water Quality Standard

Beaverdam Creek is tributary to Turkey Creek and is classified as Fresh Waters (FW) in SC Regulation 61-69 (SCDHEC, 2012b), and FW are defined in SC Regulation 61-68 (SCDHEC, 2012a) as:

> "Freshwaters are suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced aquatic community of fauna and flora. Suitable also for industrial and agricultural uses."

South Carolina's current water quality standard (WQS) for primary contact recreational use in freshwater is *E. coli* (R.61-68):

> "Not to exceed a geometric mean of 126/100 ml based on at least four samples collected from a given sampling site over a 30 day period, nor shall a single sample maximum exceed 349/100 ml" (SCDHEC, 2012a).

Prior to February 28, 2013, South Carolina's WQS for primary contact recreational use in freshwaters was FC bacteria (SCDHEC, 2008):

> "Not to exceed a geometric mean of 200/100 mL, based on five consecutive samples during any 30 day period; nor shall more than 10% of the total samples during any 30 day period exceed 400/100 ml."

Primary contact recreation is not limited to large streams and lakes. Even streams that are too small to swim in, will allow small children the opportunity to play and immerse their hands and faces. Essentially all perennial streams should therefore be protected from pathogen impairment.

2.0 Water Quality Assessment

In 1986, the USEPA documented that *E. coli* and *Enterococcus* bacteria are better indicators than FC bacteria group in predicting the presence of human gastroenteritis (upset stomach, nausea, diarrhea, vomiting) causing pathogenic bacteria in fresh waters (USEPA, 1986). The USEPA study was based on data collected when swimmers were directly exposed in freshwater lakes with established public swimming areas. In almost all cases of water-borne illnesses, pathogens come from inadequately treated waste of humans or other warm-blooded animals. Also, *Enterococcus* and *E. coli* are more specific to sewage and fecal sources than the FC bacteria group. In light of this information, USEPA has recommended the use of either *E. coli* or *Enterococcus* as the pathogen indicator for fresh waters.

Table 2. 2006 NLCD Landuse for station SV-353.

Landuse	Area (mi2)	% of Area
Open Water	0.32	
Woody Wetlands	0.72	
Emergent Herbaceous Wetlands	0.03	
Total Wetlands/Open Water	1.08	2.5%
Developed, Open Space	1.84	
Developed, Low Intensity	0.49	
Developed, Medium Intensity	0.13	
Developed, High Intensity	0.04	
Total Developed	2.5	5.9%
Deciduous Forest	7.11	
Evergreen Forest	23.65	
Mixed Forest	0.56	
Total Forested	31.32	73.5%
Cultivated Crops	1.08	
Pasture/Hay	1.61	
Total Agricultural	2.69	6.3%
Scrub/Shrub	1.15	
Grassland/Herbaceous	3.81	
Barren Land	0.08	
Total Other	5.04	11.8%
Total Area	42.63	100%

In order to determine which pathogen indicator bacteria is better suited in South Carolina as the recreational use water quality standard in fresh waters, SCDHEC designed a Pathogen Indicator Study (PIS) and conducted the study during 2009. Several times a month, water samples were collected from 73 stations statewide and analyzed for *E. coli*, *Enterococcus* and for FC bacteria group. PIS results showed *E.* coli (a member of the FC bacteria group) is a better indicator for predicting the presence of pathogens in South Carolina freshwaters.

Table 3. *E. coli* data summary based on SSM for impaired station SV-353. Data were collected during 2009 as part of the Pathogen Indicator Study (PIS).

Station	Waterbody	Number of Samples	Number of Samples >349/100mL	% of Samples Exceed SSM
SV-335	Beaverdam Creek	52	9	17.3%

During 2012 and following the public participation, public comment period and legislative processes, DHEC submitted a proposed amendment to EPA to change the freshwater pathogen indicator from FC bacteria to *E. coli* in R. 61-68. Details of this process as well as PIS raw data can be found at: http://www.scdhec.gov/environment/water/fwater.htm. The proposed amendment was approved by EPA on February 28, 2013 and *E. coli* has been promulgated in R. 61-68. *E. coli* is the applicable water quality standard for recreational use in fresh waters. Station SV-353 was among the 73 stations where approximately weekly samples were collected during the PIS in 2009.

Beginning with 2014 §303(d) list of impaired waters, sites included as impaired for recreational use FC bacteria on the 2012 §303(d) lists will be listed as impaired for *E. coli*. Once sufficient *E. coli* data are collected from impaired stations, future TMDLs will be calculated based on *E. coli* data. Until sufficient data are collected, TMDLs for currently FC impaired stations can be calculated using FC data. Then, these FC TMDLs can be converted to *E. coli* TMDLs by multiplying the FC TMDL number by 0.8725. A 0.8725, ratio was derived by dividing the current single sample maximum (SSM) WQS for *E. coli*, 349 MPN/100ml (SCDHEC, 2012) by former SSM WQS for FC, 400 cfu/100 ml.

The South Carolina Department of Health and Environmental Control (SCDHEC) currently have one monitoring location within the Beaverdam Creek watershed. Station SV-353 was included in the PIS but is currently inactive. Station SV-353 has been included in the State's final 2012 §303(d) list for FC bacteria due to the exceedances of the previous WQS for pathogen in freshwaters (SCDHEC 2012). This station will be included on future §303(d) lists due to exceedances of the current *E. coli* WQS until such time that the WQS is attained or TMDLs are developed and approved to address the parameter of concern.

In accordance with R. 61-68 Section E. 14. d. (6) (2012), when sufficient data are available to calculate a geometric mean, assessment will be based on the geometric mean WQS criterion of 126/100 ml. If greater than 10% of the monthly geometric mean of the data collected during an assessment period exceeds the criterion , the station is included on South Carolina's §303(d) list. If there are not an adequate number of monthly samples to calculate a geometric mean, then the available sample results are compared against the single sample maximum of 349/100 ml. If greater than 10% of these samples exceed this criterion then the station is included on South Carolina's §303(d) list. Tables 3 and 4 provide summaries of number of samples collected, exceedances and exceedance percentages of both SSM and geometric mean of *E. coli* for the impaired stations.

Table 4. *E. coli* data summary based on geometric mean for impaired station SV-353. Data were collected during 2009 as part of the Pathogen Indicator Study (PIS).

Station	Waterbody	Number of Monthly Values	Number of Months Exceeding Geomean >126/100mL	% of Months Exceeding Geomean
SV-353	Beaverdam Creek	12	7	58.3

3.0 Source Assessment

As previously mentioned, SCDHEC has adopted a change of its pathogen indicator from FC bacteria to *E. coli* during 2012. The new WQS were approved by EPA on February 28, 2013. Starting with the effective date of February 28, 2013, *E. coli* is the new pathogen indicator for recreational use in freshwaters.

Even though there are tests for specific pathogens, it is difficult to determine beforehand which organism may be present, and test for those specific organisms. Indicators such as FC bacteria, enteroccoci, or *E. coli*, which are indicators for human pollution, are easier to measure, have similar sources as pathogens, and persist in surface waters for a similar or longer length of time (Tchobanoglous & Schroeder, 1987). These bacteria are not in themselves disease causing, but indicate the potential presence of organisms that may result in illness.

There are many sources of pathogens in surface waters. In general these sources may be classified as point and nonpoint sources. With the implementation of technology-based controls, pollution from continuous point sources, such as wastewater treatment and industrial facilities, has been greatly reduced. These point sources are required by the CWA to obtain a NPDES permit. In South Carolina NPDES permits require that dischargers of sanitary wastewater must meet the state standard for the relevant pathogen indicator at the point of discharge. Municipal and private sanitary wastewater treatment facilities may occasionally be sources of pathogens. However, if these facilities are discharging wastewater that meets their permit limits, they are not causing impairment. If any of these facilities is not meeting its permit limits, enforcement actions/mechanisms are in place.

Other non-continuous point sources required to obtain NPDES permits that may be a source of pathogens include Municipal Separate Storm Sewer Systems (MS4) and stormwater discharges from construction or industrial sites. MS4s may require NPDES discharge permits for industrial and construction activities under the NPDES Stormwater regulations. These sources are also required to comply with the state standard for the pollutant(s) of concern. If MS4s and discharges from construction sites meet the percentage reduction or the water quality standard as prescribed in Section 5 of this TMDL document and required in their MS4 permits, they should not be causing or contributing to instream pathogen impairment.

3.1 Point Sources

Point sources are defined as pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants, industrial waste treatment facilities, or regulated storm water discharges. Point sources can also include pollutant loads contributed by tributaries to the main receiving water stream or river. Point sources can be further broken down into continuous and non-continuous.

3.1.1 Continuous Point Sources

Currently, there are 2 active NPDES discharges within Beaverdam Creek watershed. Edgefield County Water and Sewer Authority (ECW&SA) Brooks Street Wastewater Treatment Plant (WWTP) is the only permittee with FC in their effluent. Brook Street WWTP operates with NPDES permit SC0025330. Discharges from this facility do contain FC therefore will be issued a WLA. The second discharger' effluent does not contain FC and will not be issued a WLA for the purposes of developing this TMDL. Future NPDES discharges in the referenced watersheds are required to implement the WLA and demonstrate consistency with the assumptions and requirements of the TMDL.

3.1.2 Non-Continuous Point Sources

Non-continuous point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial discharges covered under permits numbered SCS and SCR and/or regulated under South Carolina Water Pollution Control Permits: R61-9, §122.26(b)(4),(7),(14) - (21) (SCDHEC, 2011). All regulated MS4 entities have the potential to contribute *E. coli* pollutant loadings in the delineated drainage area used in the development of this TMDL.

The South Carolina Department of Transportation (SCDOT) is currently the only designated MS4 within Beaverdam Creek watershed. The SCDOT operates under NPDES MS4 Permit SCS040001 and owns and operates several roads within Beaverdam Creek watershed. However, the Department recognizes that SCDOT is not a traditional MS4 in that it does not possess statutory taxing or enforcement powers. SCDOT does not regulate land use or zoning, issue building or development permits.

Current developed land use for Beaverdam Creek watershed is 5.9%. Based on current Geographic Information System (GIS) information (available at time of TMDL development) there is one SCDOT facilities located in the referenced watersheds.

Other than SCDOT, there are currently no permitted sanitary sewer or stormwater systems in this watershed. Future permitted sanitary sewer or stormwater systems in the referenced watershed are required to comply with the load reductions prescribed in the WLA and demonstrate consistency with the assumptions and requirements of the TMDL.

Industrial facilities that have the potential to cause or contribute to a violation of a water quality standard are covered by the NPDES Storm Water Industrial General Permit (SCR000000). Construction activities are usually covered by the NPDES Storm Water Construction General Permit from the SCDHEC (SCR100000). Where the construction has the potential to affect water quality of a water body with a TMDL, the Storm Water Pollution Prevention Plan (SWPPP) for the site must address any pollutants of concern and adhere to any WLAs in the TMDL. Note that there may be other stormwater discharges not covered under permits numbered SCS and SCR that occur in the referenced watershed. These activities are not subject to the WLA portion of the TMDL.

Similar to regulated MS4s, potentially designated MS4 entities or other unregulated MS4 communities located in this watershed may have the potential to contribute to *E. coli* and other FC bacteria in stormwater runoff. These unregulated entities are subject to the LA for the purposes of this TMDL.

Sanitary sewer overflows (SSOs) to surface waters have the potential to severely impact water quality. These untreated sanitary discharges result in violations of the WQS. It is the responsibility of the NPDES wastewater discharger, or collection system operator for non-permitted 'collection only' systems, to ensure that releases do not occur. Unfortunately releases to surface waters from SSOs are not always preventable or reported.

The Department acknowledges that progress with the assumptions and requirements of the TMDL by MS4s is expected to take one or more permit iteration. Progress towards achieving the WLA reduction for the TMDL may constitute MS4 compliance with its SWMP, provided the MEP definition is met, even where the numeric percent reduction may not be achieved in the interim.

3.2 Nonpoint Sources

Nonpoint source pollution is defined as pollution that is not released through pipes but rather originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related either to land or water use including failing septic tanks, improper animal-keeping practices, agriculture, forestry practices, wildlife and urban and rural runoff.

Nonpoint source pollution is the likely major contributing factor to negatively impact water quality in these watersheds. The Department recognizes that there may be wildlife, agricultural activities, grazing animals, septic tanks, and/or other nonpoint source contributors located within unregulated areas (outside the permitted area) of Beaverdam Creek watershed. Nonpoint sources located in unregulated areas are subject to the load allocation (LA) and not the WLA of the TMDL document.

Pathogenic forms of *E. coli,* found in the guts of ruminant animals such as cattle, goats, sheep, deer and elk, produce toxins and are called "Shiga toxin-producing" *E. coli* or STEC.

Of these ruminant animals, cattle are the major source for human illnesses. STEC infections start with ingestion of human or animal feces, contact with cattle, unpasteurized apple cider, soft cheeses made from raw milk, consumption of contaminated unpasteurized raw milk and water (CDC, n.d.).

3.2.1 Wildlife

Resident and migrant wildlife can be a significant contributor of *E. coli* bacteria in Beaverdam Creek watershed. Wildlife in this area may include deer, squirrels, raccoons, and other mammals as well as a variety of birds. Wildlife wastes can be carried into nearby streams by runoff following rainfall or deposited directly in streams and may be a significant source of *E. coli* pollution in Beaverdam Creek watershed.

According to a study conducted by the SCDNR in 2008, there are an estimated 30 to 45 deer per square mile within Beaverdam Creek watershed. The study estimated deer density based on suitable habitat (forests, croplands, and pastures) (SCDNR, 2008).

3.2.2 Agricultural Activities

Agricultural activities that involve livestock, animal wastes, or unstabilized surfaces are potential sources of *E. coli* contamination of surface waters. Fecal matter can enter the waterway via runoff from the land or by direct deposition into the stream. Unstabilized soil directly adjacent to surface waters can contribute to *E. coli* loading during periods of runoff after rain events. During these events, fertilizer and wildlife wastes can be transported into the creek and carried downstream.

3.2.2.1 Agricultural Animal Facilities

Owners/operators of most commercial animal growing operations are required by SC Regulation 61-43, *Standards for the Permitting of Agricultural Animal Facilities*, to obtain permits for the handling, storage, treatment (if necessary) and disposal of the manure, litter and dead animals generated at their facilities (SCDHEC, 2002). The requirements of R. 61-43 are designed to protect water quality; therefore, we have a reasonable assurance that facilities operating in compliance with this regulation should not contribute to downstream water quality impairments. SC currently does not have any confined animal feeding operations (CAFOs) under NPDES coverage; however, the State does have permitted animal feeding operations (AFOs) covered under R. 61-43. These permitted operations are not allowed to discharge to waters of the State and are covered under 'no discharge' (ND) permits. Discharges from these operations to waters of the State are illegal and are subject to enforcement actions by the SCDHEC.

Currently, there are no active permitted facilities with regulated structures or activities in the Beaverdam Creek watershed.

3.2.2.2 Grazing Animals

Livestock, especially ruminant animals such as cattle, goats and sheep, are major contributors of *E. coli* bacteria to streams (CDC, n.d.). Grazing cattle and other livestock may contaminate streams with *E. coli* bacteria indirectly by runoff from pastures or directly by defecating into streams and ponds. Direct loading by cattle or other livestock to surface waters within the Beaverdam Creek watershed can be a source of *E. coli* however, the grazing of unconfined livestock (in pastures) is not regulated by the SCDHEC.

The United States Department of Agriculture's National Agricultural Statistics Service reported 8501 cattle and calves in Edgefield County in 2007 (USDA, 2007). According to the NLCD 2006, total pastureland in Edgefield County and Beaverdam Creek are 33.24 mi2 and 1.61 mi2, respectively. Based on the ratio, there are approximately 412 cattle and calves within the Beaverdam Creek watershed, assuming an even distribution of cattle and calves across pasture land in the county.

3.2.3 Land Application of Industrial, Domestic Sludge and Treated Wastewater

NPDES-permitted industrial and domestic wastewater treatment processes may generate solid waste bi-products, also known as sludge. In some cases, facilities may be permitted to land apply sludge at designated locations and under specific conditions. There are also some NPDES-permitted facilities authorized to land apply treated effluent at designated locations and under specific conditions. Land application permits for industrial and domestic wastewater facilities may be covered under SC Regulation 61-9, Sections 503, 504, or 505 (SCDHEC, 2011). It is recognized that there may be operating, regulated land application sites located in Beaverdam Creek watershed. If properly managed, waste is applied at a rate that ensures pollutants will be incorporated into the soil or plants and pollutants will not enter streams. Land applications sites can be a source of *E. coli* bacteria and stream impairment if not properly managed. Similar to AFO land application sites, the permitted land application sites described in this section are not allowed to directly discharge to Beaverdam Creek and its tributaries. Direct discharges from land application sites to surface waters of the State are illegal and are subject to enforcement actions by the SCDHEC.

3.2.4 Leaking Sanitary Sewer and Illicit Discharges

Leaking sewer pipes and illicit sewer connections represent a direct threat to public health since they result in discharge of partially treated or untreated human wastes to the surrounding environment. Quantifying these sources is extremely speculative without direct monitoring of the source because the magnitude is directly proportional to the volume and its proximity to the surface water.

Illicit sewer connections into storm drains result in direct discharges of sewage via the storm drainage system outfalls. Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. Besides the SCDOT, there are currently no entities subject to NPDES MS4 permit within Beaverdam Creek watershed.

3.2.5 Failing Septic Systems

Failing, leaking or non-conforming septic systems can be a major contributor of *E. coli* to Beaverdam Creek and its tributaries. Wastes from failing septic systems enter surface waters either as direct overland flow or via groundwater. Although loading to streams from failing septic systems is likely to be a continual source, wet weather events can increase the rate of transport of pollutants from failing septic systems because of the wash-off effect from runoff and the increased rate of groundwater recharge.

Within the Beaverdam Creek TMDL area and based on the 2010 U.S. population census (US Census Bureau, n.d.), there are estimated to be 1981 homes with an approximate population of 4264 people. Of these, it is estimated there are 301 households and a population of 537 utilizing on-site septic systems, and the remainder are connected to sewer service. Assuming one septic tank per household, it is estimated there are 301 on-site septic systems within the Beaverdam Creek watershed.

3.2.6 Urban and Suburban Runoff

There are 'urban' wildlife, squirrels, raccoons, pigeons, and other birds, all of which can contribute to the *E. coli* load. Urban runoff from Town of Edgefield can have a negative impact within Beaverdam Creek watershed.

Similar to regulated MS4s, potentially designated MS4 entities (Federal Register, FR 64, Appendix 7.) or other unregulated MS4 communities located in the Beaverdam Creek watershed may have the potential to contribute *E. coli* bacteria in stormwater runoff.

4.0 Load-Duration Curve Method

The load-duration curve method was developed as a means of incorporating natural variability, uncertainty, and risk assessment into TMDL development (Bonta & Cleland, 2003). The analysis is based on the range of hydrologic conditions for which there are appropriate water quality data. The load-duration curve method uses the cumulative frequency distribution of stream flow and pollutant concentration data to estimate existing and TMDL loads for a waterbody. Development of the load-duration curve is described in this section.

The load-duration curve method depends on an adequate period of record for flow data. USGS gage 02196000 on Stevens Creek near Modoc, SC was used to provide an adequate record of flow. This gage had continuous flow data for 2009 to establish the flow duration curve for station SV-353. There were no records missing for this station (i.e., there are no missing data). Edgefield 3 NNE weather station was used to provide for daily total precipitation data (Figure 1).

The flow records were used to estimate adjusted flows at the impaired monitoring station. Drainage area of the sampling station was delineated using USGS topographic maps and

ArcView 10 software. The drainage area for the monitoring station was calculated and used to estimate flows based on the ratio of the monitoring station drainage area to the appropriate USGS gage. For example, the USGS 02196000 on Stevens Creek records flow from 545 square miles (mi2). The drainage area at monitoring station SV-353 is approximately 42.64 square miles, or 7.8 % of the total drainage area at USGS gage 02196000. Mean daily flow for the SV-353 monitoring station was assumed to be 7.8 % of the daily flow at Stevens Creek gage.

Flow duration curves were developed by ranking flow from highest to lowest and calculating the probability of occurrence (presented as a percentage or duration interval), where zero corresponds to the highest flow. The duration interval can be used to determine the percentage of time a given flow is achieved or exceeded, based on the period of record. Flow duration curves were divided into five hydrologic condition categories (High Flows, Moist Conditions, Mid-Range, Dry Conditions, and Low Flows). Categorizing flow conditions can assist in determining which hydrologic conditions result in the greatest number of exceedances. A high number of exceedances under dry conditions might indicate a point source or illicit connection issue, whereas moist conditions may indicate nonpoint sources. Data within the High Flow and Low Flow categories are generally excluded from the development of a TMDL due to their infrequency.

A target load-duration curve was created by calculating the allowable load using daily flow, the *E. coli* WQS concentration and a unit conversion factor. The water quality target was set at 332 MPN/100ml for the instantaneous criterion, which is 5 percent lower than the water quality criteria of 349 MPN/100ml. A five percent explicit Margin of Safety (MOS) was reserved from the water quality criteria in developing target load-duration curves. The load-duration curves for station SV-353 is presented in Figure3.

For the load duration curve, the independent variable (x-Axis) represents the percentage of estimated flows greater than value x. The dependent variable (y-Axis) represents the *E. coli* loading at each estimated flow expressed in terms of Most Probable Number per day (MPN/day). In each of the defined flow intervals for stations SV-353 existing and target loadings were calculated by the following equations:

Existing Load = Mid-Point Flow in Each Hydrologic Category x 90th Percentile E. coli Concentration x Conversion Factor (24465758.4)

Target Load = Mid-Point Flow in Each Hydrologic Category x 332 (WQ criterion minus a 5% MOS) x Conversion Factor (24465758.4)

Percent Reduction = (Existing Load – Target Load) / Existing Load

Instantaneous loads for each of the impaired stations were calculated. Available measured *E. coli* concentrations from 2009 were multiplied by measured (or estimated flow based on drainage area) flow on the day of sampling and a unit conversion factor. These data were plotted on the load-duration graph based on the flow duration interval for the day of sampling. Samples above the target line are violations of the WQS while samples below the line are in compliance (Figure 3).

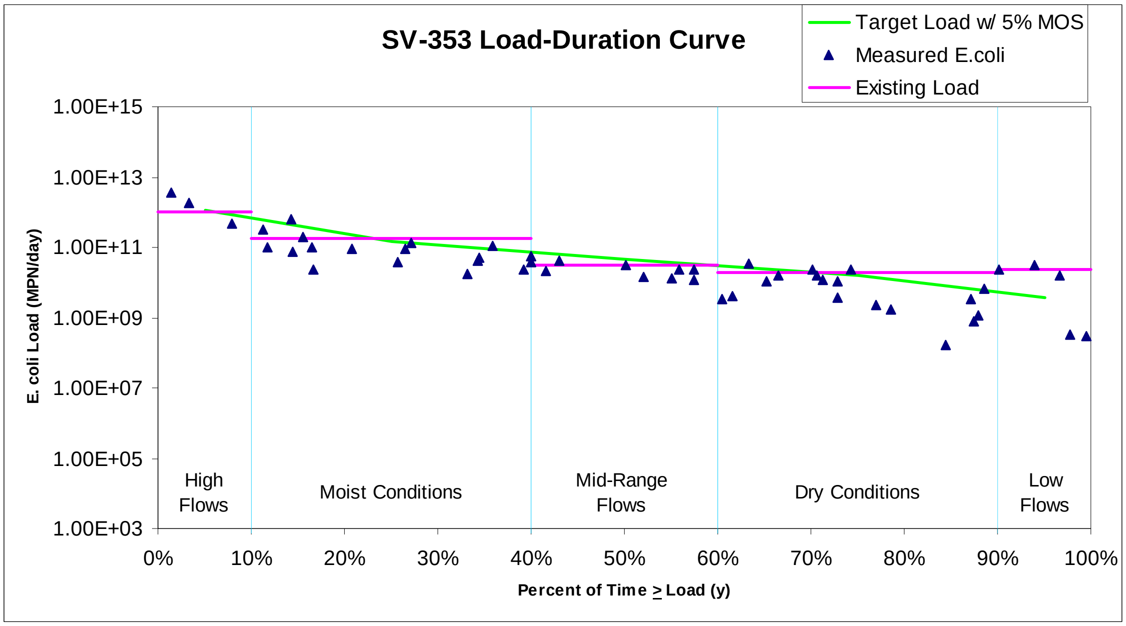

Figure 3. Load Duration Curve for station SV-353.

An existing load was determined for each hydrologic category for the TMDL calculations. The 90th percentile of measured *E. coli* concentrations within each hydrologic category were multiplied by the flow at each category midpoint (i.e., flow at the 25% duration interval for the Moist Conditions, 50% interval for Mid-Range, and 75% for Dry Condition). Existing loads are plotted on the load-duration curve presented in Figure 7. TMDL targets in this document are based on the SSM criterion because the value is more representative of a daily maximum as compared to a geometric mean calculated over a 30-day period. In addition, this load duration approach is not an appropriate methodology for calculating load reductions required to meet the geometric mean criterion. The effectiveness of implementing the load reductions prescribed in this TMDL document will be based on achieving both components of the WQS over time.

5.0 Development of Total Maximum Daily Load

A total maximum daily load (TMDL) for a given pollutant and water body is comprised of the sum of individual waste load allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is represented by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while still achieving compliance with WQS. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis to establish water quality-based controls.

For most pollutants, TMDLs are expressed as a mass load (e.g., kilograms per day). For bacteria, however, TMDLs are expressed in terms of number (#), colony forming units (cfu), organism counts (or resulting concentration), or MPN, in accordance with 40 CFR 130.2(l).

5.1 Critical Conditions

These TMDLs are based on the flow recurrence interval between 10% and 90% and excludes extreme high and low flow conditions; flows that are characterized as 'Low' or 'High' in Figure 5 were not included in the analysis. The critical condition for each monitoring station is identified as the flow condition requiring the largest percent reduction, within the 10-90% duration intervals. Critical condition for Beaverdam Creek pathogen impaired station is listed in Table 5. This data indicates that for station SV-353, moist conditions result in larger bacteria loads and is therefore the critical condition for that station.

Table 5. Percent reduction necessary to achieve target load by hydrologic category.

Station	Waterbody	Moist Conditions	Mid-Range Flow	Dry Conditions
SV-353	Beaverdam Creek	24.3%	NRN	14%

Highlighted cells indicate critical condition for the corresponding station.

NRN: No Reduction Necessary

5.2 Existing Load

An existing load was determined for each hydrologic category for the TMDL calculations as described in Section 4.0 of this TMDL document. The existing load under the critical condition, described in Section 5.1 above was used in the TMDL calculations. Loadings from all sources are included in this value: cattle-in-streams, failing septic systems as well as wildlife. The existing loads for station SV-353 are provided in Appendix A.

5.3 Waste Load Allocation

The waste load allocation (WLA) is the portion of the TMDL allocated to NPDES-permitted point sources (USEPA 1991). Note that all illicit dischargers, including SSOs, are illegal and not covered under the WLA of these TMDLs,

5.3.1 Continuous Point Sources

Currently, there are two permitted domestic dischargers in the Beaverdam Creek watershed. Federal Pacific Electric Company operates with NPDES permit SC0047813 and its effluent does not contain FC bacteria. The other is the Edgefield County Water & Sewer Authority Brooks Street WWTP. This facility operates with NPDES permit SC0025330 and has FC limits on its permit. Future continuous discharges will be required to meet the prescribed loading for the pollutant of concern based upon permitted flow and an allowable permitted maximum concentration of 349MPN/100mL. For the purposes of NPDES permitting, continuous discharges may be required to meet a loading equivalent of FC bacteria, based upon permitted flow and an allowable permitted maximum FC bacteria concentration of 400 cfu/100ml, until such time that *E. coli* limits are incorporated into individual permits. Future continuous dischargers in these watersheds will not be required to meet limits for both FC bacteria and *E. coli*.

5.3.2 Non Continuous Point Sources

Non-continuous point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial discharges covered under permits numbered SCS and SCR and/or regulated under South Carolina Water Pollution Control Permits: R61-9, §122.26(b)(4),(7),(14)-(21) (SCDHEC, 2011). Illicit discharges, including SSOs, are not covered under any NPDES permit and are subject to enforcement mechanisms. All areas defined as "Urbanized Area" by the US Census are required under the NPDES Phase II Stormwater Regulations to obtain a permit for the discharge of stormwater. Other non-urbanized areas may be required under the NPDES Phase II Stormwater Regulations to obtain a permit for the discharge of stormwater. At the time of the TMDL development, a portion of the Beaverdam Creek watershed is classified as urbanized area.

Waste load allocations for stormwater discharges are expressed as a percentage reduction instead of a numeric loading due to the uncertain nature of stormwater discharge volumes and recurrence intervals. All current and future stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern. The percent reduction is based on the maximum percent reduction (critical condition) within any hydrologic category necessary to achieve target conditions. Table 6 presents the reduction needed for the impaired station. The reduction percentages in these TMDLs also apply to the FC waste load attributable to those areas of the watershed that are covered or will be covered under NPDES MS4 permits.

As appropriate information is made available to further define the pollutant contributions for the permitted MS4, an effort can be made to revise these TMDLs. This effort will be initiated as resources permit and if deemed appropriate by the Department. For the Department to revise these TMDLs the following information should be provided, but not limited to:

1. An inventory of service boundaries of the MS4 covered in the MS4 permit, provided as ARCGIS compatible shape files.
2. An inventory of all existing and planned stormwater discharge points, conveyances, and drainage areas for the discharge points, provided as ARCGIS compatible shape files. If drainage areas are not known, any information that would help estimate the drainage areas should be provided. The percentage of impervious surface within the MS4 area should also be provided.
3. Appropriate and relevant data should be provided to calculate individual pollutant contributions for the MS4 permitted entities. At a minimum, this information should include precipitation, water quality, and flow data for stormwater discharge points.

Compliance with terms and conditions of existing and future NPDES sanitary and stormwater permits (including all construction, industrial and MS4) will effectively implement the WLA and demonstrate consistency with the assumptions and requirements of the TMDL. However, the Department recognizes that the SCDOT is not a traditional MS4 in that it does not possess statutory taxing or enforcement powers. The SCDOT does not regulate land use of zoning, issue building or development permits.

5.4 Load Allocation

The Load Allocation applies to the nonpoint sources of FC bacteria and is expressed both as a load and as a percent reduction. The load allocation is calculated as the difference between the target load under the critical condition and the point source WLA. The load allocation is listed in Table 6. There may be other unregulated MS4s located in the Beaverdam Creek watershed that are subject to the LA components of these TMDLs. At such time that the referenced entities, or other future unregulated entities become regulated NPDES MS4 entities and are subject to applicable provisions of SC Regulation 61-68D, they will be required to meet load reductions prescribed in the WLA component of the TMDL. This also applies to future discharges associated with industrial and construction activities that will be subject to R61-9, §122.26(b)(4),(7),(14) - (21) (SCDHEC, 2011)

5.5 Seasonal Variability

Federal Regulations require that TMDLs take into account the seasonal variability in watershed loading. The variability in these TMDLs is accounted for by using a one-year hydrologic and water quality sampling data set.

5.6 Margin of Safety

The margin of safety (MOS) may be explicit and/or implicit. The explicit margin of safety is 5% of the TMDL or 17 counts/100mL of the instantaneous criterion of 349 cfu/100 mL (332 cfu/100mL). Target loads are therefore 95% of the assimilative capacity (TMDL) of the waterbody. The MOS is expressed as the value calculated from the critical condition defined in Section 5.1 and is the difference between the TMDL and the sum of the WLA and LA.

5.7 TMDL

For most pollutants, TMDLs are expressed as a mass load (e.g., kilograms per day). For bacteria, however, TMDLs are expressed in terms of MPN or organism counts (or resulting concentration), in accordance with 40 CFR (U.S. National Archives and Records Administration, 2001). The target load is defined as the load (from point and nonpoint sources) minus the MOS that a stream station can receive while meeting the WQS. The TMDL value is the median target load within the critical condition (i.e., the middle value within the hydrologic category that requires the greatest load reduction) plus WLA and MOS.

While TMDL development was primarily based on instantaneous water quality criterion, terms and conditions of NPDES permits for continuous discharges require facilities to demonstrate compliance with both geometric mean and instantaneous water quality criteria for *E. coli* or FC bacteria in treated effluent. NPDES permits for continuous dischargers require data collection sufficient to monitor for compliance of both criteria at the point of outfall.

Table 5 indicates the percentage reductions required to meet the WQS for station SV-353 in Beaverdam Creek watershed. Note that all future regulated NPDES-permitted stormwater discharges will also be required to meet the prescribed percentage reductions, or the water quality standard. It should be noted that in order to meet the WQS for *E. coli* bacteria prescribed load reductions must be targeted from all sources, including NPDES permitted and nonpoint sources.

Based on the available information at this time, the portions of the Beaverdam Creek watershed that drains directly to a regulated MS4 and that which drains through the unregulated MS4 has not been clearly defined within the MS4 jurisdictional area. Loading from both types of sources (regulated and unregulated) typically occurs in response to rainfall events, and discharge volumes as well as recurrence intervals are largely unknown. Therefore, where applicable, the regulated MS4 is assigned the same percent reduction as the non-regulated sources in the watershed. Compliance with the MS4 permit in regards to this TMDL document is determined at the point of discharge to waters of the state. The regulated MS4 entity is only responsible for implementing the TMDL WLA in accordance with their MS4 permit requirements and is not responsible for reducing loads prescribed as LA in this TMDL document.

Table 6. Total Maximum Daily Loads for the Beaverdam Creek watershed. Loads are expressed as *E. coli* MPN/ day.

Station	Existing Load (MPN/day)	TMDL (MPN/day)	Margin of Safety (MOS) (MPN/day)	Waste load Allocation (WLA)			Load Allocation (LA)	
				Continuous Source[1] (MPN/day)	Non-Continuous Sources[2,3] (% Reduction)	Non-Continuous SCDOT[3, 4] (% Reduction)	Load Allocation (MPN/day)	% Reduction to Meet LA[3]
SV-353	1.76E-11	1.50E+11	7.32E+09	9.60E+09	24.3%	24.3%	1.33E+11	24.3%

Table Notes:

1. WLAs are expressed as a daily maximum. Existing and future continuous discharges are required to meet the prescribed loading for the pollutant of concern. Future loadings will be developed based upon permitted flow and an allowable permitted maximum *E. coli* concentration of 349 MPN/100ml. For the purposes of NPDES permitting, continuous discharges may be required to meet a loading equivalent of FC bacteria, based upon permitted flow and an allowable permitted maximum FC bacteria concentration of 400 cfu/100ml, until such time that *E. coli* limits are incorporated into individual permits.

2. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4, construction and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for pollutant of concern in accordance with their NPDES Permit.

3. Percent reduction applies to existing instream load for FC bacteria or *E. coli*.

4. By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address FC bacteria or *E. coli*, the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit.

6.0 Implementation

The implementation of both point (WLA) and non-point (LA) source components of the TMDL are necessary to bring about the required reductions in *E. coli* loading to Beaverdam Creek watershed in order to achieve water quality standards. Using existing authorities and mechanisms, an implementation plan providing information on how point and nonpoint sources of pollution are being abated or may be abated in order to meet water quality standards is provided. Sections 6.1.1-6.1.7 presented below correspond with sections 3.1.1-3.2.5 of the source assessment presented in the TMDL document. As the implementation strategy progresses, the SCDHEC will continue to monitor the effectiveness of implementation measures and evaluate water quality where deemed appropriate.

Point sources are discernible, confined, and discrete conveyances of pollutants to a water body including but not limited to pipes, outfalls, channels, tunnels, conduits, man-made ditches, etc. The Clean Water Act's primary point source control program is the National Pollutant Discharge Elimination System (NPDES). Point sources can be broken down into continuous and non-continuous point sources. Some examples of a continuous point source are wastewater treatment facilities (WWTF) and industrial facilities. Non-continuous point sources are related to stormwater and include MS4, construction activities, etc. Current and future NPDES discharges in the referenced watershed are required to comply with the load reductions prescribed in the waste load allocation (WLA).

Nonpoint source pollution originates from multiple sources over a relatively large area. It is diffuse in nature and indistinct from other sources of pollution. It is generally caused by the pickup and transport of pollutants from rainfall moving over and through the ground. Nonpoint sources of pollution may include, but are not limited to: wildlife, agricultural activities, illicit discharges, failing septic systems, and urban runoff. Nonpoint sources located in unregulated portions of the referenced watersheds are subject to the load allocation (LA) and not the WLA of the TMDL document.

South Carolina has several tools available for implementing the non-point source components of these TMDLs. The *Implementation Plan for Achieving Total Maximum Daily Load Reductions from Nonpoint Sources for the State of South Carolina* (SCDHEC 1998) document is one example. Another key component for interested parties to control pollution and prevent water quality degradation in the referenced watersheds would be the establishment and administration of a program of Best Management Practices (BMPs). Best management practices may be defined as a practice or a combination of practices that have been determined to be the most effective, practical means used in the prevention and/or reduction of pollution.

Interested parties (local stakeholder groups, universities, local governments, etc.) may be eligible to apply for CWA §319 grants to install BMPs that will implement the LA portions of these TMDLs and reduce nonpoint source *E. coli* loading to the Beaverdam Creek watershed. Congress amended the Clean Water Act (CWA) in 1987 to establish the Section 319 Nonpoint Source Management Program. Under Section 319, States receive grant money to support a wide variety of activities including the restoration of impaired waters. CWA §319 grants are not available for implementation of the WLA component of these TMDLs but may be available for the LA component within permitted MS4 jurisdictional boundaries. Additional resources are provided in Section 7.0 of this TMDL document.

The SCDHEC will also work with the existing agencies in the area to provide nonpoint source education in the Beaverdam Creek watershed. Local sources of nonpoint source education and assistance include the Natural Resource Conservation Service (NRCS), the Edgefield County Soil and Water Conservation District, the Clemson University Cooperative Extension Service, and the South Carolina Department of Natural Resources.

The Department recognizes that adaptive management/implementation of these TMDLs might be needed to achieve the water quality standard and we are committed towards targeting the load reductions to improve water quality in Beaverdam Creek. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL target accordingly.

6.1 Implementation Strategies

The strategies presented in this document for implementation of the referenced TMDL are not inclusive and are to be used only as guidance. The strategies are informational suggestions that may lead to the required load reductions being met for the referenced watershed while demonstrating consistency with the assumptions and requirements of the TMDL. Application of certain strategies provided within may be voluntary and are not a substitute for actual NPDES permit conditions.

6.1.1 Continuous Point Sources

Continuous point source WLA reductions will be implemented through NPDES permits. Existing and future continuous discharges are required to meet the prescribed loading for the pollutant of concern and demonstrate consistency with the assumptions and requirements of the TMDL. Loadings are based on permitted flow and an allowable permitted maximum *E. coli* concentration of 349 MPN/100ml. For the purposes of NPDES permitting, continuous discharges may be required to meet a loading equivalent of FC bacteria, based upon permitted flow and an allowable permitted maximum FC bacteria concentration of 400 cfu/100ml, until such time that *E. coli* limits are incorporated into individual permits.

6.1.2 Non Continuous Point Sources

An iterative BMP approach as defined in the general stormwater NPDES MS4 permit is expected to provide significant implementation of the WLA. Permit requirements for implementing WLAs in approved TMDLs will vary across waterbodies, discharges, and pollutant(s) of concern. The allocations within a TMDL can take many different forms –

narrative, numeric, specific BMPs – and may be complimented by other special requirements such as monitoring.

The level of monitoring necessary, deployment of structural and non-structural BMPs, evaluation of BMP performance, and optimization or revisions to the existing pollutant reduction goals of the SWMP or any other plan is TMDL and watershed specific. Hence, it is expected that NPDES permit holders evaluate their existing SWMP or other plans in a manner that would effectively address implementation of these TMDLs with an acceptable schedule and activities for their permit compliance. The Department staff (permit writers, TMDL project managers, and compliance staff) is willing to assist in developing or updating the referenced plan as deemed necessary. Please see Appendix D which provides additional information as it relates to evaluating the effectiveness of an MS4 Permit as it related to compliance with approved TMDLs. For SCDOT, existing and future NPDES MS4 permittees, compliance with terms and conditions of its NPDES permit is effective implementation of the WLA to the Maximum Extent Practicable (MEP) and demonstrates consistency with the assumptions and requirements of the TMDL. For existing and future NPDES construction and Industrial stormwater permittees, compliance with terms and conditions of its permit is effective implementation of the WLA. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and are eligible for CWA §319 grants.

The Department acknowledges that progress with the assumptions and requirements of the TMDL by MS4s is expected to take one or more permit iteration. Achieving the WLA reduction for the TMDL may constitute MS4 compliance with its SWMP, provided the MEP definition is met, even where the numeric percent reduction may not be achieved in the interim.

Regulated MS4 entities are required to develop a SWMP that includes the following: public education, public involvement, illicit discharge detection & elimination, construction site runoff control, post construction runoff control, and pollution prevention/good housekeeping. These measures are not exhaustive and may include additional criterion depending on the type of NPDES MS4 permit that applies. The following examples are recognized as acceptable stormwater practices and may be applied to unregulated MS4 entities or other interested parties in the development of a stormwater management plan (US EPA, 2000).

An informed and knowledgeable community is crucial to the success of a stormwater management plan. MS4 entities may implement a public education program to distribute educational materials to the community, or conduct equivalent outreach activities about the impacts of stormwater discharges on local waterbodies and the steps that can be taken to reduce stormwater pollution. Some appropriate BMPs may be brochures, educational programs, storm drain stenciling, stormwater hotlines, tributary signage, and alternative information sources such as websites, bumper stickers, etc. (US EPA, 2000).

The public can provide valuable input and assistance to a stormwater management program and they may have the potential to play an active role in both the development and implementation of the stormwater program where deemed appropriate by the entity. There are a variety of practices that can involve public participation such as public meetings/citizens panels, volunteer water quality monitoring, volunteer educators, community clean-ups, citizen watch groups, and "Adopt a Storm Drain" programs which encourage individuals or groups to keep storm drains free of debris and monitor what is entering local waterways through storm drains (US EPA, 2000).

Illicit discharge detection and elimination efforts are also necessary. Discharges from MS4s often include wastes and wastewater from non-stormwater sources. These discharges enter the system through either direct connections or indirect connections. The result is untreated discharges that contribute high levels of pollutants, including heavy metals, toxics, oil and grease, solvents, nutrients, viruses, and bacteria to receiving waterbodies (USEPA, 2005). Pollutant levels from these illicit discharges have been shown in EPA studies to be high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health. MS4 entities may have a storm sewer system map which shows the location of all outfalls and to which waters of the US they discharge for instance. If not already in place, an ordinance prohibiting non-stormwater discharges into a MS4 with appropriate enforcement procedures may also be developed. Entities may also have a plan for detecting and addressing non-stormwater discharges. The plan may include locating problem areas through infrared photography, finding the sources through dye testing, removal/correction of illicit connections, and documenting the actions taken to illustrate that progress is being made to eliminate illicit connections and discharges.

A program might also be developed to reduce pollutants in stormwater runoff to the MS4 area from construction activities. An ordinance or other regulatory mechanism may exist requiring the implementation of proper erosion and sediment controls on applicable construction sites. Site plans should be reviewed for projects that consider potential water quality impacts. It is recommended that site inspections should be conducted and control measures enforced where applicable. A procedure might also exist for considering information submitted by the public (US EPA, 2000). For information on specific BMPs please refer to the SCDHEC Stormwater Management BMP Handbook online at: http://www.scdhec.gov/environment/water/swater/docs/BMP-handbook.pdf

Post-construction stormwater management in areas undergoing new development or redevelopment is recommended because runoff from these areas has been shown to significantly affect receiving waterbodies. Many studies indicate that prior planning and design for the minimization of pollutants in post-construction stormwater discharges is the most cost-effective approach to stormwater quality management (USEPA, 2005). Strategies might be developed to include a combination of structural and/or non-structural BMPs. An ordinance or other regulatory mechanism may also exist requiring the implementation of post-construction runoff controls and ensuring their long term-operation and maintenance. Examples of non-structural BMPs are planning procedures and site-based BMPs (minimization of imperviousness and maximization of open space). Structural BMPs may include but are not limited to stormwater retention/detention BMPs, infiltration BMPs (dry wells, porous pavement, etc.), and vegetative BMPs (grassy swales, filter strips, rain gardens, artificial wetlands, etc.).

Pollution prevention/good housekeeping is also a key element of stormwater management programs. Generally this requires the MS4 entity to examine and alter their programs or activities to ensure reductions in pollution are occurring. It is recommended that a plan be developed to prevent or reduce pollutant runoff from municipal operations into the storm sewer system and it is encouraged to include employee training on how to incorporate and document pollution prevention/good housekeeping techniques. To minimize duplication of effort and conserve resources, the MS4 operator can use training materials that are available from EPA or relevant organizations (US EPA, 2000).

MS4 communities are encouraged to utilize partnerships when developing and implementing a stormwater management program. Watershed associations, educational organizations, and state, county, and city governments are all examples of possible partners with resources that can be shared. For additional information on partnerships contact the SCDHEC Watershed Manager for the waterbody of concern online at: www.scdhec.gov/environment/water/shed/contact.htm. For additional information on stormwater discharges associated with MS4 entities please see the SCDHEC's NPDES web page online at: http://www.scdhec.gov/environment/water/swater/index.htm as well as the USEPA NPDES website online at cfpub.epa.gov/npdes/home.cfm?program_id=6 for information pertaining to the National Menu of BMPs, Urban BMP Performance Tool, Outreach Documents, etc.

6.1.3 Wildlife

Suggested forms of implementation for wildlife will vary widely due to geographic location and species. There are many forms of acceptable wildlife BMPs in practice and development at the present time. For example, contiguous forested areas could be set up and managed to keep wildlife from bedding down and defecating near surface waters. This management practice relies on concentrating wildlife away from water bodies to minimize their impact to pollutant loading. Additionally, contributions from wildlife could be reduced in protected areas by developing a management plan which would allow hunting access during certain seasons. Although this strategy might not work in all situations, it would decrease pathogen loading from wildlife in areas where wildlife may be a significant contributor to the overall watershed.

Deterrents may also be used to keep wildlife away from docks and lawns in close proximity to surface waters. Non-toxic spray deterrents, decoys, eagles, kites, noisemakers, scarecrows, and plastic owls are a sample of what is currently available. Many waterfowl species are deterred by foreign objects on lawns and the planting of a shrub buffer along greenways adjacent to impoundments may also be effective.

In addition, homeowners and the hunting community should be educated on the impacts of feeding wildlife or planting wildlife food plots in close proximity to surface waters. Please check local and federal laws before applying deterrents or harassing wildlife. Additional information may be obtained from the "Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water" bulletin provided by USEPA (USEPA, 2001).

6.1.4 Agricultural Activities

Suggested forms of implementation for agricultural activities will vary based on the activity of concern. Agricultural BMPs can be vegetative, structural or management oriented. When selecting BMPs, it is important to keep in mind that nonpoint source pollution occurs when a pollutant becomes available, is detached and then transported to nearby receiving waters. Therefore, for BMPs to be effective, the transport mechanism of the pollutant, *E. coli*, needs to be identified. For livestock in the referenced watershed, installing fencing along the streams within the watershed and providing an alternative water source where livestock are present would eliminate direct contact with the streams. If fencing is not feasible, it has been shown that installing water troughs within a pasture area reduced the amount of time livestock spent drinking directly from streams by 92%. An indirect result of this was a 77% reduction in stream bank erosion by providing an alternative to accessing the stream directly for water supply (Sheffield, et al., 1997).

For row crop farms in the referenced watershed, many common practices exist to reduce *E. coli* contributions. Unstabilized soil directly adjacent to surface waters can contribute to *E. coli* loading during periods of runoff after rain events. Agricultural field borders and filter strips (vegetative buffers) can provide erosion control around the border of planted crop fields. These borders can provide food for wildlife, may possibly be harvested (grass and legume), and also provide an area where farmers can turn around their equipment.

The agricultural BMPs listed above are a sample of the many accepted practices that are currently available. Many other techniques such as conservation tillage, responsible pest management, and precision agriculture also exist and may contribute to an improvement in overall water quality in Beaverdam Creek watershed. Education should be provided to local farmers on these methods as well as acceptable manure spreading and holding (stacking sheds) practices.

NRCS provides financial and technical assistance to help South Carolina landowners address natural resource concerns, promote environmental quality, and protect wildlife habitat on property they own or control. The cost-share funds are available through the Environmental Quality Incentives Program (EQIP). EQIP helps farmers improve production while protecting environmental quality by addressing such concerns as soil erosion and productivity, grazing management, water quality, animal waste, and forestry concerns. EQIP also assists eligible small-scale farmers who have historically not participated in or ranked high enough to be funded in previous sign ups. Please visit www.sc.nrcs.usda.gov/programs/ for more information, including eligibility requirements.

6.1.5 Leaking Sanitary Sewers and Illicit Discharges

Leaking sanitary sewers and illicit discharges, although illegal and subject to enforcement may be occurring in regulated or unregulated portions of the Beaverdam Creek watershed at any time. Due to the high concentration of pollutant loading that is generally associated with these discharges; their detection may provide a substantial improvement in overall water quality in the watershed. Detection methods may include, but are not limited to: dye testing, air pressure testing, static pressure testing, and infrared photography.

The SCDHEC recognizes illicit discharge detection and elimination activities are conducted by regulated MS4 entities as pursuant to compliance with existing MS4 permits. Note that these activities are designed to detect and eliminate illicit discharges that may contain *E. coli* bacteria. It is the intent of the SCDHEC to work with the MS4 entities to recognize *E. coli* load reductions as they are achieved. The SCDHEC acknowledges that these efforts to reduce illicit discharges and SSOs are ongoing and some reduction may already be accountable (i.e., load reductions occurring during TMDL development process). Thus, the implementation process is an iterative and adaptive process. Regular communication between all implementation stakeholders will result in successful remediation of controllable sources over time. As designated uses are restored, the SCDHEC will recognize efforts of implementers where their efforts can be directly linked to restoration.

6.1.6 Failing Septic Systems

A septic system, also known as an onsite wastewater system, is defined as failing when it is not treating or disposing of sewage in an effective manner. The most common reason for failure is improper maintenance by homeowners. Untreated sewage water contains disease-causing bacteria and viruses, as well as unhealthy amounts of nitrate and other chemicals. Failed septic systems can allow untreated sewage to seep into wells, groundwater, and surface water bodies, where people get their drinking water and recreate. Pumping a septic tank is probably the single most important thing that can be done to protect the system. If the buildup of solids in the tanks becomes too high and solids move to the drainfield, this could clog and strain the system to the point where a new drainfield will be needed.

The SCDHEC's Office of Coastal Resource Management (OCRM) has created a toolkit for homeowners and local governments which include tips for maintaining septic systems. These septic systems do's and don'ts are as follows:

Do's:

- Conserve water to reduce the amount of wastewater that must be treated and disposed of by your system. Doing laundry over several days will put less stress on your system.

- Repair any leaking faucets or toilets. To detect toilet leaks, add several drops of food dye to the toilet tank and see if dye ends up in the bowl.

- Divert down spouts and other surface water away from your drainfield. Excessive water keeps the soil from adequately cleansing the wastewater.

- Have your septic tank inspected yearly and pumped regularly by a licensed septic tank contractor.

Don'ts:

- Don't drive over your drainfield or compact the soil in any way.
- Don't dig in your drainfield or build anything over it, and don't cover it with a hard surface such as concrete or asphalt.
- Don't plant anything over or near the drainfield except grass. Roots from nearby trees and shrubs may clog and damage the drain lines.
- Don't use your toilet as a trash can or poison your system and the groundwater by pouring harmful chemicals and cleansers down the drain. Harsh chemicals can kill the bacteria that help purify your wastewater.

For additional information on how septic systems work, how to properly plan and maintain a septic system, or to link to the OCRM toolkit mentioned above, please visit the SCDHEC Environmental Health Onsite Wastewater page at the following link: http://www.scdhec.gov/environment/envhealth/septic/index.htm.

6.1.7 Urban Runoff

Urban runoff is surface runoff of rainwater created by urbanization outside of regulated areas which may pick up and carry pollutants to receiving waters. Pavement, compacted areas, roofs, reduced tree canopy and open space increase runoff volumes that rapidly flow into receiving waters. This increase in volume and velocity of runoff often causes stream bank erosion, channel incision and sediment deposition in stream channels. In addition, runoff from these developed areas can increase stream temperatures that along with the increase in flow rate and pollutant loads negatively affect water quality and aquatic life (USEPA 2005). This runoff can pick up pollutants along the way. Many strategies currently exist to reduce bacteria loading (including *E. coli*) from urban runoff and the USEPA nonpoint source pollution website provides extensive resources on this subject which can be accessed online at: http://www.epa.gov/nps/urban.html.

Some examples of urban nonpoint source BMPs are street sweeping, stormwater wetlands, pet waste receptacles (equipped with waste bags), and educational signs which can be installed adjacent to receiving waters in the watershed such as parks, common areas, apartment complexes, trails, etc. Low impact development (LID) may also be effective. LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements. For more information regarding LID, please visit: http://water.epa.gov/polwaste/green/

Some additional urban BMPs that can be adopted in public parks are doggy loos and pooch patches. Doggy loos are disposal units, which act like septic systems for pet waste, and are installed in the ground where decomposition can occur. This requires that pet owners place the waste into the disposal units. Although Beaverdam Creek watershed is rural in nature, many of the urban runoff practices discussed in this section can be applied to individual households in these watersheds. Education should be provided to individual homeowners in the referenced watersheds on the contributions from pet waste. Education to homeowners in the watershed on the fate of substances poured into storm drain inlets should also be provided. For additional information on urban runoff please see the SCDHEC Nonpoint Source Runoff Pollution homepage at: http://www.scdhec.gov/environment/water/npspage.htm.

7.0 Resources

This section provides a listing of available resources to aid in the mitigation and control of pollutants. There are examples from across the nation, most of which are easily accessible on the World Wide Web.

7.1 General for Urban and Suburban Stormwater Mitigation

National Management Measures to Control Nonpoint Source Pollution from Urban Areas – Draft. 2002. EPA842-B-02-003. Available at:
http://www.epa.gov/owow/nps/urbanmm/index.html

Stormwater Management Volume Two: Stormwater Technical Manual. Massachusetts Department of Environmental Management. 1997. Available at:
http://www.mass.gov/dep/brp/stormwtr/stormpub.htm

Fact Sheets for the six minimum control measures for storm sewers regulated under Phase I or Phase II. Available at:
http://cfpub1.epa.gov/npdes/stormwater/swfinal.cfm?program_id=6

A Current Assessment of Urban Best Management Practices. 1992. Metropolitan Washington Council of Governments. Washington, DC

Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. 1987. Metropolitan Washington Council of Governments. Washington, DC

Stormwater Management. Connecticut Department of Environmental Protection 2004. Available at: http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325702&deepNav_GID=1654

Stormwater Treatment BMP Technology Report. California Department of Transportation. 2010 Edition. CTSW-09-239.06 Available at:
http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-09-239-06.pdf

Model Ordinances to Protect Local Resources – Stormwater Control Operation and Maintenance. USEPA Webpage: http://water.epa.gov/polwaste/nps/mol4.cfm

The MassHighway Stormwater Handbook. Massachusetts Highway Department. 2004. Available at: http://www.mhd.state.ma.us/downloads/projDev/2009/MHD_Stormwater_Handbook.pdf

University of New Hampshire Stormwater Center: Dedicated to the protection of water resources through effective stormwater management. Available at: http://www.unh.edu/unhsc/
Stormwater Manager's Resource Center. Schueler, T., Center for Watershed Protection, Inc. http://www.stormwatercenter.net

National Menu of Best Management Practices for Stormwater Phase II. USEPA. 2002. Available at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

Welcome to NVRC'S Four Mile Run Program. NVRC 2001. Available at: http://www.novaregion.org/fourmilerun.htm

7.2 Illicit Discharges

Illicit Discharge Detection and Elimination Manual - A Handbook for Municipalities. 2003. New England Interstate Water Pollution Control Commission. Available at: http://www.neiwpcc.org/PDF_Docs/iddmanual.pdf

Model Ordinances to Protect Local Resources – Illicit Discharges. USEPA webpage: http://www.epa.gov/owow/nps/ordinance/discharges.htm

7.3 Pet Waste

National Management Measure to Control Non Point Source Pollution from Urban Areas – Draft. USEPA 2002. EPA 842-B-02-2003. Available from: http://www.epa.gov/owow/nps/urbanmm/index.html

A Guide to Best Management Practices. Residential Guide #5. Pet Waste Disposal Guide Book. Available at: http://www.sandiego.gov/thinkblue/pdf/petwastebmpguide.pdf

7.4 Wildlife

Goose Control Best Management Practices to Prevent Pollution of Ponds, Streams, and Rivers. Pittsfield Charter Township Phase II Storm Water Management Program – “Operation Goose Down” 8/11/2005, at: http://www.pittsfieldtwp.org/NRC_Goose_Control.pdf

7.5 Septic Systems

National Management Measures to Control Nonpoint Source Pollution from Urban Areas – Draft. Chapter 6. New and Existing Onsite Wastewater Treatment Systems. USEPA

2002. EPA842-B-02-003. Available at:
http://www.epa.gov/owow/nps/urbanmm/index.html

7.6 Field Application of Manure

Conservation Standard Practice-Irrigation Water Management. Number 449. United States Department of Agriculture (USDA) Natural Resources Conservation Service. 2003. Available at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046888.pdf

Conservation Standard Practice-Filter Strip. Number 393. USDA Natural Resources Conservation Service (NRCS). 2003. Available at:
http://efotg.sc.egov.usda.gov/references/public/MN/393mn.pdf

Buffer Strips: Common Sense Conservation. USDA Natural Resources Conservations Service. Available at:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=nrcs143_023568

Conservation Standard Practice-Riparian Forest Buffer. Number 391. USDA Natural Resources Conservation Service. 2003. Available at: ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/391.pdf

Conservation Standard Practice-Riparian Herbaceous Cover. Number 390 USDA. Natural Resources Conservation Service. 2003. Available at:
http://efotg.sc.egov.usda.gov/references/public/ID/390.pdf

7.7 Grazing Management

Conservation Standard Practice-Stream Crossing. Number 578. USDA Natural Resource Conservation Service. 2003. Available at:
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046932.pdf

Guidance Specifying Management Measures for Nonpoint Source Pollution in Coastal Waters. Chapter 2. Management Measures for Agricultural Sources. Grazing Management. USEPA. Available at:
http://water.epa.gov/polwaste/nps/czara/upload/czara_chapter2_agriculture.pdf

7.8 Animal Feeding Operations

National Management Measures to Control Nonpoint Source Pollution from Agriculture. USEPA 2003. Report: EPA 841-B-03-004. Available at:
http://www.epa.gov/owow/nps/agmm/index.html

National Engineering Handbook Part 651. Agricultural Waste Management Field Handbook. NRCS. Available At: http://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21430

Manure Management Planner. Software for creating manure management plans. Available at: http://www.purdue.edu/agsoftware/mmp/

Animal Feeding Operations Virtual Information Center. USEPA website: http://cfpub.epa.gov/npdes/afo/virtualcenter.cfm

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Tchobanoglous, G. & Schroeder, E., 1987. *Water Quality Characteristics Modeling and Modification.* CA: Addison-Wesley Publishing Company, Inc..

U.S. National Archives and Records Administration, 2001. *40 Code of Federal Regulations 130.* s.l.:s.n.

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[Accessed 21 May 2013].

USEPA, 2005. *Stormwater Phase II Final Rule. Public Education and Outtreach Minumum Control Measure.* [Online]
Available at:
http://cfpub1.epa.gov/npdes/docs.cfm?document_type_id=3&view=Fact%20Sheets%20and%20Outreach%20Materials&program_id=6&sort=name
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Appendix A – *E. coli* Data

Station	Date	MPN/100ml
SV-353	01/05/09	114.5
SV-353	01/12/09	187.2
SV-353	01/20/09	224.7
SV-353	01/26/09	224.7
SV-353	02/02/09	35.5
SV-353	02/09/09	133.4
SV-353	02/17/09	44.9
SV-353	02/23/09	178.5
SV-353	03/02/09	250
SV-353	03/09/09	93.3
SV-353	03/16/09	285.1
SV-353	03/23/09	65
SV-353	03/30/09	307.6
SV-353	04/06/09	30.9
SV-353	04/13/09	93.4
SV-353	04/20/09	365.4
SV-353	04/28/09	114.5
SV-353	05/04/09	387.3
SV-353	05/12/09	162.4
SV-353	05/18/09	155.3
SV-353	05/26/09	88.4
SV-353	06/01/09	111.9
SV-353	06/08/09	110.6
SV-353	06/15/09	454.8
SV-353	06/22/09	64
SV-353	06/29/09	44
SV-353	07/06/09	1513.6
SV-353	07/13/09	62.4
SV-353	07/20/09	8
SV-353	07/27/09	64
SV-353	08/03/09	58.4
SV-353	08/10/09	2452.4
SV-353	08/17/09	226
SV-353	08/24/09	182
SV-353	08/31/09	208
SV-353	09/08/09	34
SV-353	09/14/09	38.8
SV-353	09/21/09	383.6
SV-353	09/29/09	188.4
SV-353	10/05/09	1513.6
SV-353	10/12/09	736.8
SV-353	10/20/09	208
SV-353	10/26/09	194.8
SV-353	11/02/09	108.8

SV-353	11/09/09	342.8
SV-353	11/16/09	273.2
SV-353	11/23/09	474.8
SV-353	11/30/09	222.4
SV-353	12/07/09	237.6
SV-353	12/15/09	132.4
SV-353	12/21/09	319.2
SV-353	12/29/09	237.6

Appendix B – Data Tables

90th Percentile *E. coli* Concentrations (MPN/100 mL)						
Hydrologic Category Range	**High Flow 0-10**	**Moist Conditions 10-40**	**Mid Range 40-60**	**Dry Flow 60-90**	**Low Flow 90-100**	**Samples**
SV-353	317	409	234	385	2077	52

Mid Point Hydrologic Category Flow (cfs)					
Hydrologic Category (Mid-Point)	**High Flow (5)**	**Moist Conditions (25)**	**Mid Range (50)**	**Dry (75)**	**Low Flow (95)**
SV-353	135.04	17.6	5.48	2.03	0.47

Existing Load (#/day)					
Hydrologic Category (Mid-Point)	**High Flow (5)**	**Moist Conditions (25)**	**Mid Range (50)**	**Dry (75)**	**Low Flow (95)**
SV-353	1.05E+12	1.76E+11	3.14E+10	1.91E+10	2.37E+10

Target Load (#/day)					
Hydrologic Category (Mid-Point)	**High Flow (5)**	**Moist Conditions (25)**	**Mid Range (50)**	**Dry (75)**	**Low Flow (95)**
SV-353	1.15E+12	1.50E+11	4.68E+10	1.74E+10	3.98E+09

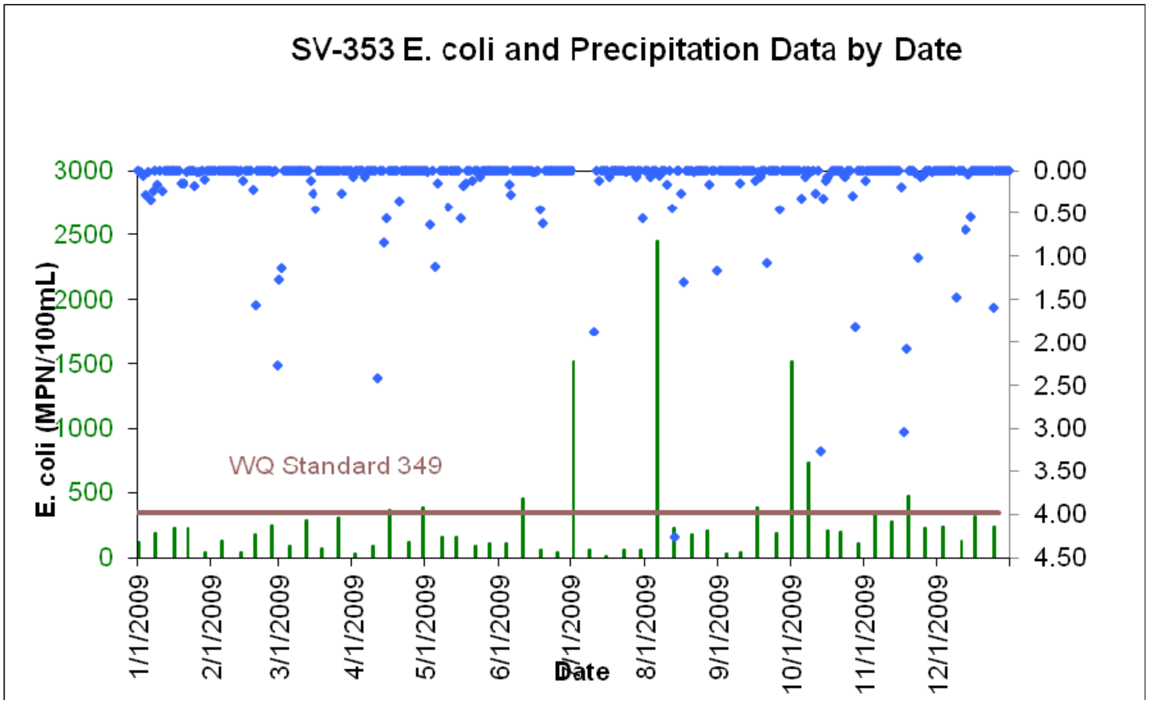
Load Reduction Necessary (#/day)					
Hydrologic Category (Mid-Point)	High Flow (5)	Moist Conditions (25)	Mid Range (50)	Dry (75)	Low Flow (95)
SV-353	NRN	2.59E+10	NRN	1.78E+09	1.97E+10

% Load Reduction Necessary					
Hydrologic Category (Mid-Point)	High Flow (5)	Moist Conditions (25)	Mid Range (50)	Dry (75)	Low Flow (95)
SV-353	NA	24.3%	NRN	14%	NA

NRN = No Reduction Necessary

NA = Not applicable

Appendix C – Rain Chart



SV-353 E. coli and Precipitation Data by Date
E. coli (MPN/100mL)
3000
2500
2000
1500
1000
500
0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
WQ Standard 349
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
6/1/2009
7/1/2009
8/1/2009
9/1/2009
10/1/2009
11/1/2009
12/1/2009
Date

Appendix D – Evaluating the Progress of MS4 Programs

Evaluating the Progress of MS4 Programs:

Meeting the Goals of TMDLs and Attaining Water Quality Standards

Bureau of Water

August 2008

Described below are potential approaches that may be used by MS4 permit holders. These are recommendations and examples only, as SCDHEC-BOW recognizes that other approaches may be utilized or employed to meet compliance goals.

1. Calculate pollutant load reduction for each best management practice (BMP) deployed:
    - Retrofitting stormwater outlets
    - Creation of green space
    - LID activities (e.g., creation of porous pavements)
    - Creations of riparian buffers
    - Stream bank restoration
    - Scoop the poop program (how many pounds of poop were scooped/collected)
    - Street sweeping program (amount of materials collected etc.)
    - Construction & post-construction site runoff controls
2. Description & documentation of programs directed towards reducing pollutant loading
    - Document tangible efforts made to reduce impacts to urban runoff
    - Track type and number of structural BMPs installed
    - Parking lot maintenance program for pollutant load reduction
    - Identification and elimination of illicit discharges
    - Zoning changes and ordinances designed to reduce pollutant loading
    - Modeling of activities & programs for reducing pollutant reductions
3. Description & documentation of social indicators, outreach, and education programs
    - Number/Type of training & education activities conducted and survey results
    - Activities conducted to increase awareness and knowledge – residents, business owners. What changes have been made based on these efforts? Any measured behavior or knowledge changes?
    - Participation in stream and/or lake clean-up events or activities
    - Number of environmental action pledges
4. Water quality monitoring: A direct and effective way to evaluate the effectiveness of stormwater management plan activities.

- Use of data collected from existing monitoring activities (e.g., SCDHEC data for ambient monitoring program available through STORET; water supply intake testing; voluntary watershed group's monitoring, etc)
- Establish a monitoring program for permitted outfalls and/or waterbodies within MS4 areas as deemed necessary– use a certified lab
- Monitoring should focus on water quality parameters and locations that would both link pollutant sources and BMPs being implemented

5. Links:

- Evaluating the Effectiveness of Municipal Stormwater Programs. September 2007. EPA 833-F-07-010
- The BMP database - http://www.bmpdatabase.org/BMPPerformance.htm (this link is specifically to the BMP performance page, and lot more)
- EPA's STORET data warehouse - http://www.epa.gov/storet/dw_home.html
- EPA Region 5: STEPL – Spreadsheet tool for estimating pollutant loads http://it.tetratech-ffx.com/stepl/
- Measurable goals guidance for Phase II Small MS4 - http://cfpub.epa.gov/npdes/stormwater/measurablegoals/index.cfm
- Environmental indicators for stormwater program- http://cfpub.epa.gov/npdes/stormwater/measurablegoals/part5.cfm
- National menu of stormwater best management practices (BMPs) - http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm
- SCDHEC – BOW: 319 grant program has attempted to calculate the load reductions for the following BMPs:

- Septic tank repair or replacement
- Removing livestock from streams (cattle, horses, mules)
- Livestock fencing
- Waste Storage Facilities (a.k.a. stacking sheds)
- Strip cropping
- Prescribed grazing
- Critical Area Planting
- Runoff Management System
- Waste Management System
- Solids Separation Basin
- Riparian Buffers