Total Maximum Daily Load Document for *Escherichia coli* Impairment in Sugar and McAlpine Creeks Within Hydrological Unit Code 0305010301

SC DEPARTMENT *of*
ENVIRONMENTAL
SERVICES

Bureau of Water
Banu Varlik
EPA Approval Date
Technical Report Number

Abstract

§303(d) of the Clean Water Act and EPA's *Water Quality Planning and Management Regulations* (40 CFR - Protection of Environment 2017) require states to develop 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 WQS for the pollutant of concern. All TMDLs include a WLA for any NPDES permitted dischargers, a LA for all nonpoint sources, and an explicit and/or implicit MOS. This technical report describes the development of *E. coli* recreational use TMDLs for impaired WQM stations, CW-036 in Sugar Creek and CW-064 in McAlpine Creek, in Lancaster and York counties, SC. These stations have been included in SC's 2024 303(d) list for exceeding the *E. coli* WQS for recreational use and have been prioritized and accepted by EPA as metrics in the CWA §303(d) program performance measures.

Station CW-036 was designated as the TMDL station due to the availability of recent *E. coli* data at this station. Data collected from this station was used to calculate the TMDL for Sugar Creek and tributaries. The legacy station, CW-064 located on McAlpine Creek with older FC data, will be associated with the TMDL for station CW-036 and receive the corresponding TMDL loads and percent reduction goals.

For SCDOT, existing and future NPDES MS4 permittees, compliance with terms and conditions of their 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 their 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 TMDL watershed.

SCDOT is one of the NPDES permitted TS4 entity in the TMDL watersheds. For SCDOT, compliance with terms and conditions of its NPDES TS4 permit is effective implementation of the WLA to MEP. Additionally, there are three MS4 entities in the SC

portion of the TMDL watershed: the City of Fort Mill, Lancaster, and York counties. All TS4 and MS4s have been allocated WLAs.

Table Ab 1. TMDL for Sugar Creek and tributaries. TMDLs are expressed as the mpn/100 mL and mpn per day, and allocations are expressed as % reductions.

Station	Existing Load (mpn/day)	TMDL (mpn/day)	MOS (mpn/day)	Implementation Targets				
				Continuous Sources [1] (mpn/day)	Intermittent MS4 [2, 3] (% reduction)	Intermittent TS4 SCDOT (% reduction) [4]	Nonpoint Sources (mpn/day)	LA [3] (% reduction)
CW-036	2.44E+13	3.51E+12	1.71E+11	SC0027146/ WLA 1.5E+09 SC0030112/ WLA 7.9E+09	86%	86%	3.33E+12	86%

Table Notes:

1. WLAs are expressed as a daily maximum. Existing and future continuous dischargers are required to meet the prescribed loading for pollutants of concern. Future loadings will be calculated based on permitted flow and *E. coli* concentration of 349 mpn/100 mL.
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. The percent reductions apply to existing instream load.
4. By implementing the BMPs that are prescribed in either the SCDOT annual storm water management plan or the SCDOT NPDES TS4 permit to address bacteria, the SCDOT will comply with this TMDL and its applicable WLA to the MEP as required by its NPDES TS4 permit.

Contents

Tables

Figures

Abbreviations and Symbols

Abbreviation/Symbol	Definition
ac	Acre
AVMA	American Veterinary Medical Association
BMP	Best Management Practices
CAFO	Confined Animal Feeding Operations
CFR	Code of Federal Regulations
CWA	Clean Water Act
DA	Drainage Area
E. coli	*Escherichia coli*
FC	Fecal coliform
FW	Fresh Water
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MEP	MEP
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NLCD	National Land Use Cover Database

NPDES	National Pollution Discharge Elimination System
R	Regulation
SC	SC
SCDES	SC Department of Environmental Services
SCDHEC	SC Department of Health and Environmental Control
SCDNR	SC Department of Natural Resources
SCDOT	SC Department of Transportation
SSM	SSM
SSO	Sanitary Sewer Overflow
SWMP	Stormwater Management Plan
SWPPP	SWPPP
TMDL	Total Maximum Daily Load
TS4	Transportation Separate Storm Sewer System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Wasteload Allocation
WQ	Water Quality
WQM	Water Quality Management
WQS	Water Quality Standards
WWTP	Waste Water Treatment Plant
mi^2	Square Miles
n	Sample Size
%	Percent
§	Section
∑	Sum, Total
mL	Milliliter

1.0 Introduction

1.1 Background

The federal CWA requires each state to assess its waters, develop monitoring strategies, and establish WQS for various types and uses of water bodies. Furthermore, the CWA mandates states to review the monitoring results every two years to ensure compliance with the established WQS. If monitoring indicates that the WQS are not being met, the states are required to list the impaired bodies under §303(d) of the CWA. These listed sites are then assigned a priority ranking for restoration efforts, and the impairments are addressed through the implementation of TMDLs, as outlined in *40* CFR Part 130, based on their respective ranks (40 CFR - Protection of Environment 2017).

A TMDL is one part of a regulatory framework used to manage and control pollutant levels in water bodies that are impaired by pollutants. It establishes the maximum amount of a specific pollutant that a water body can receive from all sources, continuous point sources, intermittent point sources, and nonpoint sources, while still meeting WQS. The TMDL process includes estimating pollutant contributions from all sources, linking pollutant sources to their impacts on water quality, allocation of pollutant contributions to each source, and establishment of control mechanisms to achieve WQS.

A TMDL is comprised of the sum of individual WLAs (ΣWLAs) for continuous and intermittent point sources, and LAs (ΣLAs) for nonpoint sources. In addition, the TMDLs include a MOS, either implicit or explicit, which is a buffer or safety factor included in the TMDL to account for uncertainties in the relationship between pollutant loads and water quality. Conceptually, this definition is represented by the equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

This TMDL document is a detailed analysis describing the development of *E. coli* bacteria TMDL for WQM stations that have exceeded the FW WQS for recreational uses. These stations located in Lancaster and York counties within the Sugar and McAlpine creeks watersheds, were identified in SC's 2024 303(d) list of impaired waters by DES (SCDES or the Department) as impaired due to *E. coli* bacteria exceedances. These stations have been prioritized and accepted by USEPA as metrics in the CWA §303(d) program performance measures.

Testing for every potential pathogenic organism in surface waters is not feasible, so bacteria like *E. coli* are used as the indicators for presence of human pathogens. Indicator bacteria are practical to measure, persist in surface waters for similar durations, and share common sources with the actual pathogens. *E. coli* bacteria belong to the fecal coliform group and naturally inhabit the gastrointestinal tract of warm-blooded animals. They serve important functions such as preventing the proliferation of harmful bacteria in the gut, producing vitamin K, aiding in lactose digestion, and facilitating fat metabolism. However, certain strains of *E. coli*, such as Shiga toxin-producing 0157:H7, can cause gastrointestinal illnesses, kidney failure, and even death. The presence of *E. coli* bacteria in surface waters indicates recent contamination from human or animal waste, which can stem from various sources such as failing septic systems, agricultural runoff, and sewer leaks (Blount 2015), (Wolfson and Harrigan 2010).

1.2 Watershed Description

Sugar Creek and McAlpine Creek are classified as FW under SC R. 61-69 (SCDHEC 2012) and flow through both North Carolina and SC. Sugar Creek originates northeast of the City of Charlotte, while McAlpine Creek's headwaters begin east of the city, both within North Carolina. These streams are part of the 10-digit HUC 0305010301.

The DA for the TMDL station was delineated using the USGS StreamStats online tool (USGS, 2019) and verified with USGS topographic maps and ArcGIS software. The total drainage area is 275.2 square miles, encompassing portions in North and SC (Figure 1). Within this area, two EPA-approved TMDLs already address portions spanning both states. This new TMDL applies to the remaining 28.1 square miles within SC (Figure 2).

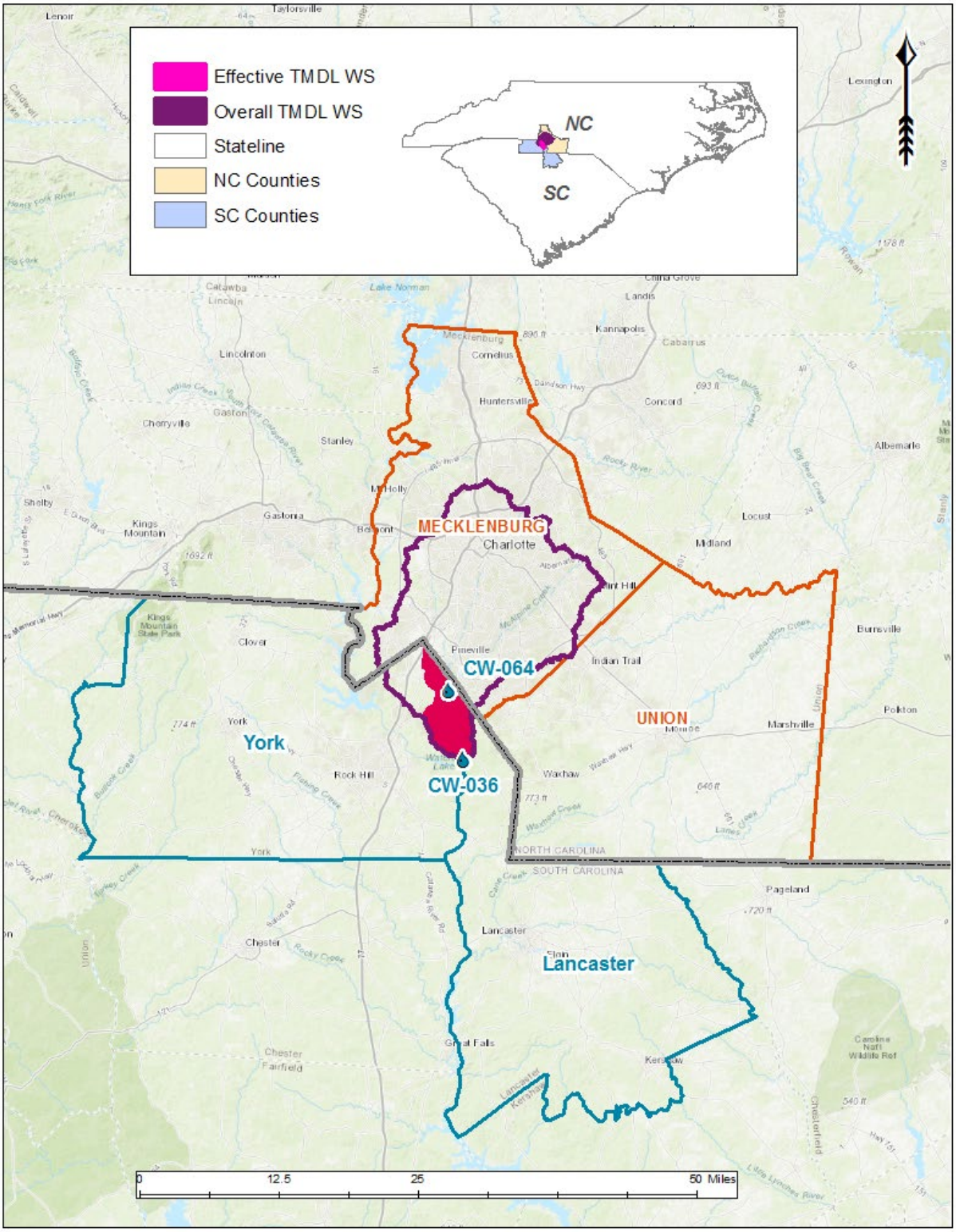

Figure 1. Sugar and McAlpine creeks total TMDL drainage area, effective TMDL drainage area, *E. coli* impaired WQM stations, in North and SC counties.

Table 1. Sugar and McAlpine creeks bacteria impaired stations and location descriptions.

Station	Description
CW-036	Sugar Creek at S-46-36
CW-064*	McAlpine Creek at S-29-64

***** *Deactivated station.*

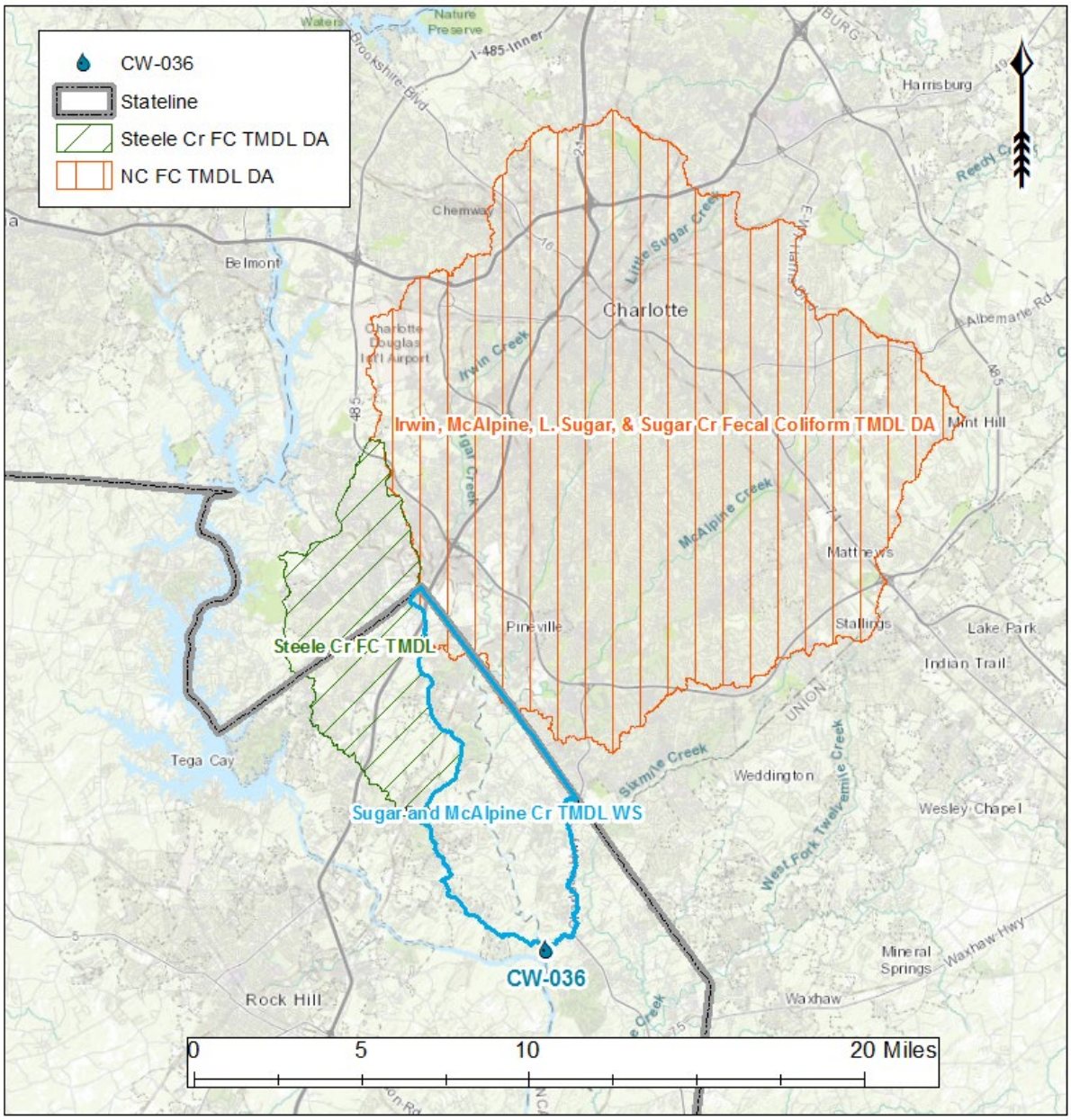

Figure 2. Existing EPA-approved TMDLs are located within the Sugar and McAlpine Creeks drainage area in North and SC. The **blue**-outlined area indicates the portion to which the TMDL allocation specified in this document applies.

In the SC portion of the TMDL watershed, there are three NPDES permitted municipal separate storm sewer system (MS4) entities, which are Lancaster and York counties, and the City of Fort Mill. Additionally, there is one NPDES permitted TS4, which is the SCDOT.

During the initial public participation phase, the Department notified stakeholders via email that the *E. coli* TMDL development for Sugar and McAlpine Creeks had commenced and requested that stakeholders submit relevant data for consideration in the TMDL process. York and Lancaster Counties were the two entities that submitted data. York County provided FC data collected from instream monitoring stations as part of their MS4 permit requirements for the Steele Creek FC TMDL. Lancaster County submitted shapefiles detailing their MS4 area.

The effective TMDL watershed has two domestic WWTPs operating under NPDES permits with specified bacteria limits: CWS/Lamplighter Village Subdivision (SC003011), discharging to McAlpine Creek, and Utility Services of SC/Foxwood Subdivision (SC0027146), discharging to Sugar Creek. Additionally, the Rock Hill Manchester Creek WWTP (SC0020443) operates a sludge site within the watershed. There are also three general permitted discharges in the watershed: one industrial and two mining operations, neither of which has bacteria in their effluent (Figure 4).

Land uses within the total TMDL watershed were analyzed using the 2021 NLCD (Dewitz 2023) and Esri ArcGIS software (Figure 3). Land use characteristics for the total drainage area TMDL watershed summarized in Table 2.

Table 2. The 2021 NLCD land use classifications for the total drainage area of TMDL station CW-036 encompass areas in both North Carolina and SC.

TMDL Drainage Area	Area (mi^2)	% of Area
Open Water	0.8	0.3
Developed	222.5	80.8
Barren Land	1.4	0.5
Forest	40.4	14.7
Pasture/Hay	8.7	3.2
Cultivated Crops	0.1	0.03
Forested Wetlands	1.4	0.5
Non-forested Wetlands	0.03	0.01
Total	275.2	100.0

Table 3. The 2021 NLCD land use classifications for the effective drainage area of TMDL station CW-036 in SC.

Effective TMDL Watershed	Area (mi2)	% of Area
Open Water	0.2	0.6
Developed	13.5	47.9
Barren Land	0.1	0.5
Forest	11.4	40.6
Pasture/Hay	2.6	9.2
Cultivated Crops	0.1	0.2
Forested Wetlands	0.3	1.0
Non-forested Wetlands	0.0	0.0
Total	28.1	100.0

Land uses within the effective TMDL watershed were analyzed using the 2021 NLCD (Dewitz 2023) and Esri ArcGIS software (Figure 3). Land use characteristics for the total drainage area TMDL watershed summarized in Table 3.

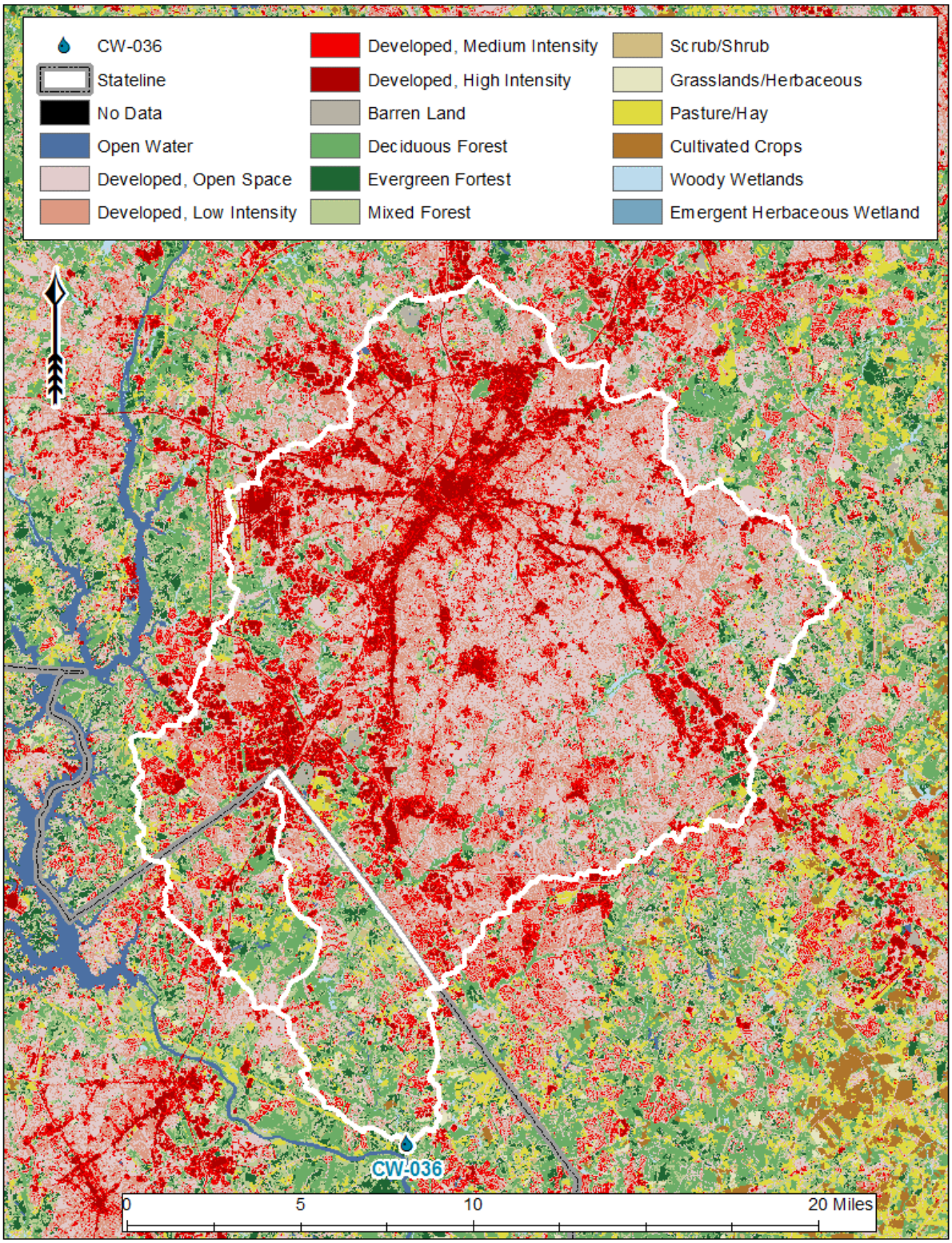

Figure 3. 2021 NLCD land use classifications of the total TMDL watershed, in North and SC.

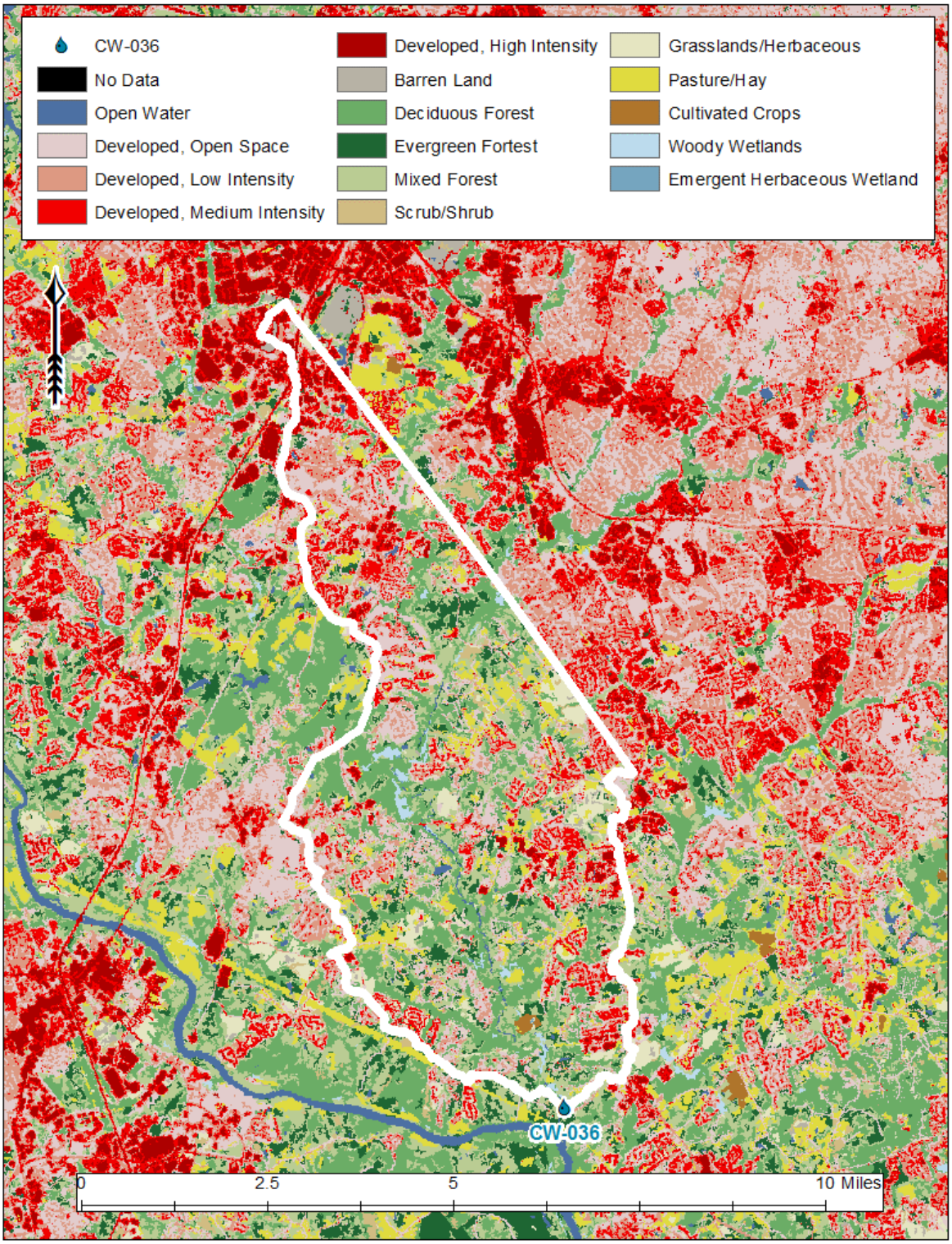

Figure 4. 2021 NLCD land use classifications of the effective TMDL watershed in SC.

1.3 Water Quality Standard

The Department adopted a change to its pathogen indicator bacteria for recreational uses in FW from FC bacteria to E. coli in 2012. The *E. coli* WQS was approved by the USEPA on February 28, 2013. Beginning with the 2014 303(d) list of impaired waters, sites that had previously been listed as impaired for recreational use by FC bacteria exceedances are now listed as impaired by *E. coli*.

WQM site CW-064 on McAlpine Creek is listed as impaired for recreational uses based on FC data collected before 2010. Sampling at this site was discontinued at the end of 2009. Since the data from CW-064 are over 15 years old and do not represent current conditions, a separate TMDL was not calculated for this site. Instead, the TMDL and percent reduction goals established for CW-036 have been applied to CW-064. CW-036, an active WQM station on Sugar Creek, has sufficient recent data available. Both sites fail to meet SC's *E. coli* WQS for FW and are included in the state's final 2024 303(d) list.

As defined in SC Regulation 61-68 (SCDHEC 2023) FW are suitable for primary and secondary contact recreation and as a source of 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 indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses.

The indicator bacteria for recreational uses in FW is *E. coli* and the water quality standards are:

> "Not to exceed a geometric mean of 126/100 mL based on at least four (4) samples collected from a given sampling site over a 30-day period, nor shall more than ten percent (10%) of the total samples during any 30-day period exceed 349/100 mL."

2.0 Water Quality Assessment

Determination for §303(d) listing purposes is based on assessing five consecutive years of data collected from a WQM station. For instance, for SC's final 2024 §303(d) list, data collected from 2018 through 2022 were used for the assessment.

For recreational use, if more than 10% of the monthly geometric mean of available data collected during an assessment period exceeds the criterion, the station is listed on SC's §303(d) list. If sufficient data are not available to calculate a monthly geometric

mean, the available sample results are compared to the SSM (SSM) criterion. If more than 10% of these samples exceed the criterion, the station is included on SC's §303(d) list of impaired waters as not supporting recreational use. See Table 4 for a summary of the number of samples collected (n), the number of exceedances, and the percentage of samples exceeding the standard.

Table 4. Exceedance summary for *E. coli* impaired TMDL station CW-036.

Station	Number of Samples (n)	n Exceeding WQS	Percent Exceeding WQS	TMDL Data Period
CW-036	120	61	51%	2013 – June 2025

3.0 Source Assessment

Surface waters can be contaminated by various sources of pathogens, which can be categorized as continuous and intermittent point sources, and nonpoint sources. Efforts to control pollution from continuous point sources, such as WWTPs, have significantly reduced their impact through the implementation of technology-based controls. These point sources are regulated under the CWA and are required to obtain an NPDES permit. In SC, NPDES permits mandate that dischargers with an bacteria limit meet the WQS at the discharge point (end of pipe). While dischargers, mostly domestic and municipal, can occasionally be sources of pathogens, if they are operating within their permit limits, they cannot be considered the cause of impairments. There are enforcement actions and mechanisms in place if these facilities fail to meet their permit requirements.

Regulated TS4, MS4, industrial, and construction site stormwater discharges are intermittent point sources. These intermittent sources are required to obtain discharge permits under the NPDES stormwater regulations. Each may be a source of pathogens. These sources are expected to either meet the percentage reductions as prescribed in this TMDL document, meet existing instream standard for the pollutant(s) of concern, and/or comply with the terms and conditions of their NPDES permit and SWMP to the MEP.

Nonpoint sources of bacteria in streams include various land-use practices such as agricultural activities, silviculture, urban and rural runoff, malfunctioning septic systems, sanitary sewer overflows, pet waste, wildlife, and poorly managed livestock operations. These activities can contribute to the presence of bacteria in surface water through runoff, leaching, and direct discharge.

3.1 Point Sources

Point sources refer to specific locations where NPDES-permitted effluent is discharged into the environment from identifiable sources such as pipes, outfalls, or conveyance channels. These sources can be traced to a single location such as industrial, municipal, domestic WWTPs, and NPDES-regulated stormwater discharges. Point sources are further divided into "continuous" and "intermittent".

3.1.1 Continuous Point Sources

Industrial, municipal, and domestic WWTPs have the potential to harbor pathogenic bacteria if their effluent fails to meet the WQS at the discharge point, as defined by their NPDES permit. If these facilities are discharging wastewater that meets their permit limits, they are not contributing to a bacteria impairment. If any of these facilities fail to comply with their permit limits, enforcement actions and mechanisms are in place to address the situation.

Within the effective TMDL watershed, there are two minor domestic NPDES permitted dischargers with *E. coli* limits (Figure 4) (Table 5). In the EPA approved Steele Creek TMDL watershed, there is one NPDES permitted domestic discharger. Any future NPDES-permitted dischargers of *E. coli* in this watershed will need to comply with the WLAs in this document. In the North Carolina portion of the total drainage area, there are three major domestic and municipal NPDES permitted dischargers with FC limits (Table 6).

Table 5. Active domestic NPDES permitted point sources in SC discharging to Sugar Creek.

Discharger	NPDES Permit Number	Permitted Design Flow (mgd)
CWS/Lamplighter Village SD	SC0030112	0.63
Utility Services of SC/Foxwood SD	SC0027146	0.12
Utility Services of SC/Carowood SD*	SC0038113	0.2

** SC0038113 is covered under previously EPA approved Steele Creek FC TMDL, where loads were allocated.*

Table 6. Active domestic NPDES permitted point sources in the North Carolina portion of the overall drainage area of the TMDL watershed.

Discharger	NPDES Permit Number	Permitted Design Flow (mgd)
McAlpine Creek WWTP	NC0024970	64.0
Sugar Creek WRRF	NC0024937	28.0
Irwin Creek WWTP	NC0024945	15.0

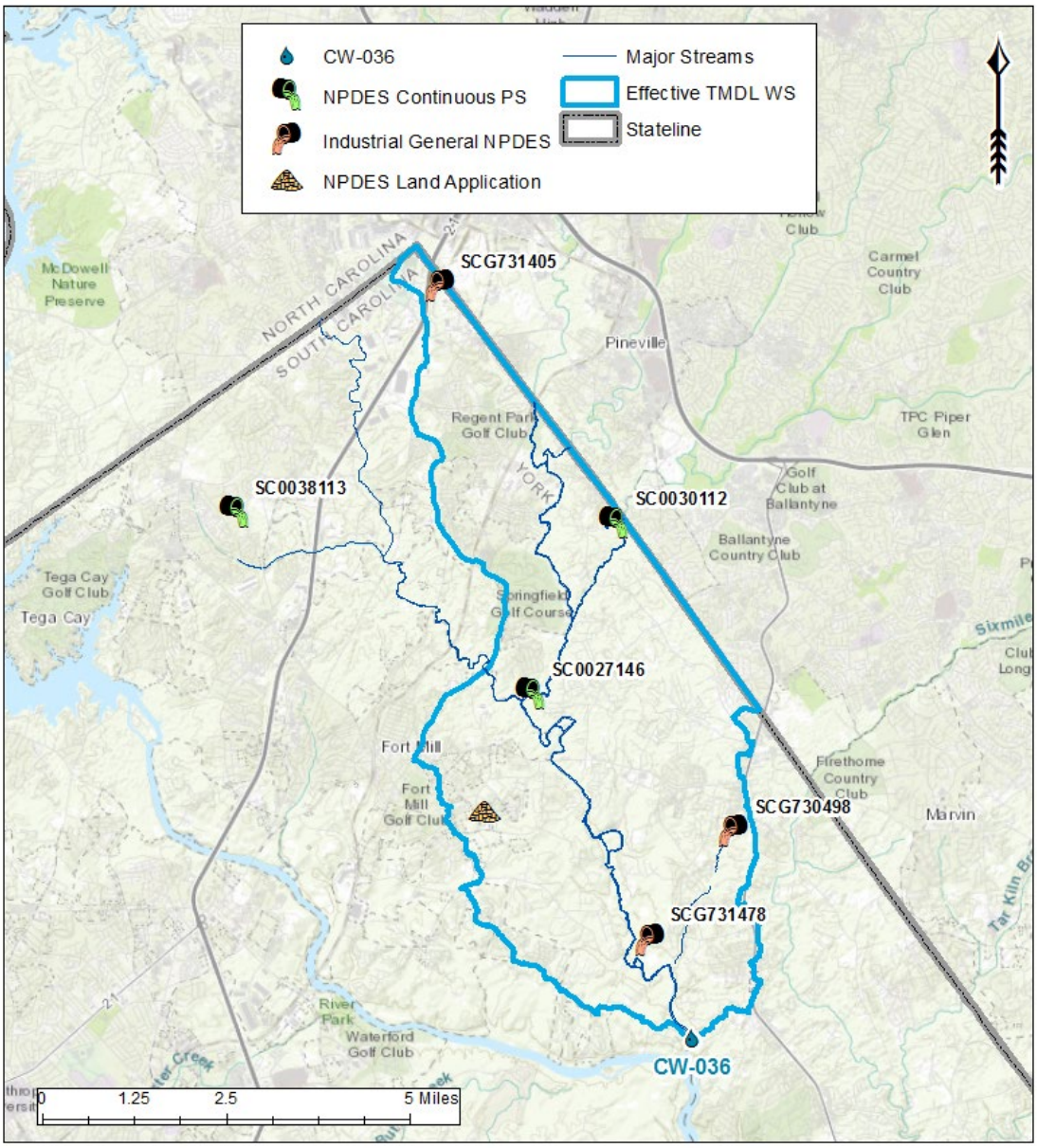

Figure 5. NPDES permitted point sources and land application sites within the effective TMDL watershed.

3.1.2 Intermittent Point Sources

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future TS4, MS4s, construction, and industrial discharges covered under permit numbers beginning with SCS and SCR and regulated under SC *Water Pollution Control Permits* Regulation R61-9 (SCDHEC 2019).

All regulated TS4 and MS4 entities have the potential to contribute *E. coli* and other pathogen loadings in the TMDL watershed and are subject to the WLA for intermittent sources. The presence of a substantial amount of developed and impervious land in a watershed leads to increased runoff from these areas following precipitation, which can contribute to pollution along with other sources. The "developed" land class, which encompasses open spaces, low, medium, and high-intensity areas, and percent of impervious area were determined for the effective TMDL drainage area using ArcGIS and the 2021 NLCD land use and impervious area datasets and are summarized in Table 7 (Dewitz 2023).

Table 7. Aggregate developed land uses and percent impervious area within the effective TMDL watershed.

Station	Total Area (mi^2)	Developed Area (mi^2)	% Developed Area	% Impervious Area
CW-036	28.1	13.5	47.9	15.3

Stormwater discharges from all regulated TS4 and MS4 entities operating within the effective TMDL watershed have the potential to contribute to *E. coli* and other pathogens and are subject to the WLA portion of the TMDL. Presently, the City of Fort Mill, Lancaster and York counties are the regulated MS4s, and SCDOT is the regulated TS4 within the TMDL watershed (Figure 4). All NPDES permitted MS4s and TS4 are required to comply with the WLAs outlined in this TMDL document and work towards achieving the implementation targets specified in Table 12.

SCDOT is a designated TS4 within the TMDL watershed, operating under NPDES TS4 Permit SCS040001. However, SCDOT is not a traditional MS4 as it lacks statutory taxing or enforcement powers, and does not regulate land use or zoning, or issue building or development permits.

The NPDES stormwater industrial general permit (SCR000000) regulates industrial facilities that could potentially cause or contribute to violations of WQS through stormwater discharges. Similarly, the NPDES stormwater construction general permit

(SCR100000) applies to construction activities. If construction activities have the potential to impact a water body with a TMDL, the SWPPP must address pollutants of concern. It's important to note that some stormwater discharges in the watershed may not fall under the SCS and SCR permits, and therefore they are not subject to the WLA portion of the TMDL.

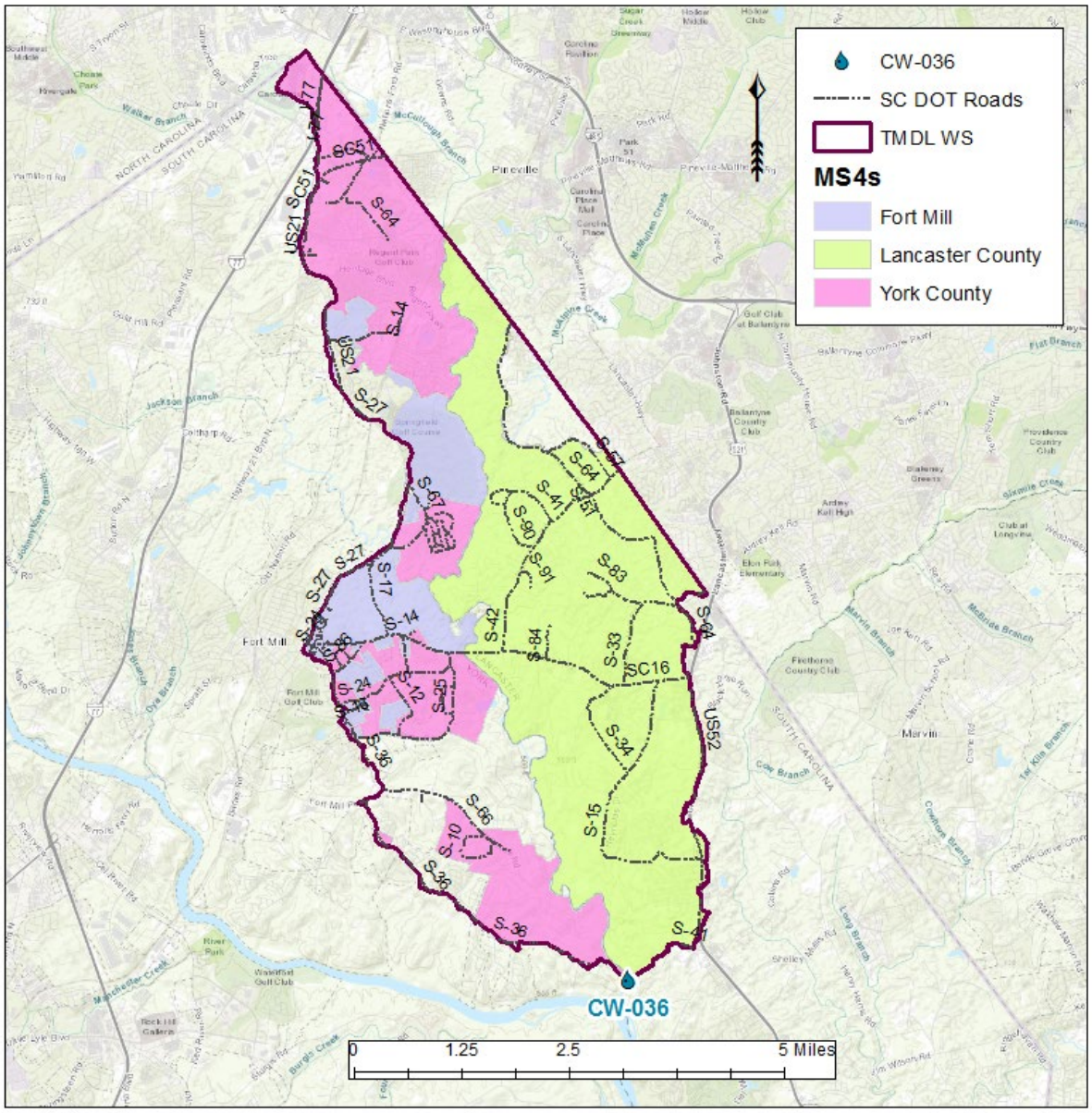

Figure 6. NPDES permitted TS4 and MS4s in the TMDL watershed.

SSOs are intermittent point sources that can have a significant impact on water quality when they release into surface waters. The responsibility for preventing SSOs lies with the NPDES wastewater discharger or the operator of the collection system for non-

permitted systems that handle wastewater. However, it is important to note that SSOs are not always preventable or reported. In the effective TMDL watershed, certain areas are serviced by municipal WWTPs and have sewer lines, which can increase the likelihood of SSO occurrences.

The Department acknowledges that TS4 and MS4s may require multiple permit iterations to fully meet the assumptions and requirements of the TMDL. In order to comply with the MS4 permit, making progress towards achieving the WLA reduction for the TMDL through compliance with the SWMP may be considered sufficient, as long as the criteria of MEP are met. This allows for flexibility in the implementation process.

For NPDES permitted TS4 SCDOT, existing and future NPDES MS4 permittees, compliance with the terms and conditions of their NPDES permit is an effective implementation of the WLA to the MEP and demonstrates consistency with the assumptions and requirements of the TMDL. For existing and future NPDES construction and industrial stormwater permittees, compliance with the terms and conditions of their permit is an 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 the *Clean Water Act* (CWA) §319 grants.

The Department recognizes that adaptive management/implementation of this TMDL might be needed to achieve the water quality standard.

3.2 Nonpoint Sources

Nonpoint source pollution refers to pollution that originates from various sources across a large area, rather than being released through specific pipes. Nonpoint source pollution arises from a variety of land or water use activities, encompassing practices such as:

- Improper animal-keeping: Inadequate management of animal waste, runoff from livestock operations, and allowing livestock access to surface waters.
- Failing septic tanks: Malfunctioning or poorly maintained septic systems that release contaminants into groundwater or nearby water bodies.
- Agriculture: Runoff of fertilizers, pesticides, and sediment from agricultural lands.
- Forestry practices: Erosion and sedimentation resulting from logging activities and improper forest management.
- Wildlife: Animal waste and other natural sources contribute to water pollution.

- Urban and rural runoff: Surface runoff from developed areas (urban) and open spaces (rural), carrying pollutants like chemicals, oils, and litter into waterways.

These activities can lead to nonpoint source pollution, where pollutants are dispersed and do not have a single identifiable point of origin. These and other nonpoint source contributors located in unregulated areas can contribute to the presence of *E. coli* in Sugar Creek and its tributaries. Nonpoint sources in unregulated areas are addressed through the LA portion of the TMDL, rather than the WLA portion. During precipitation events, nonpoint source contributions to in-stream *E. coli* are likely to increase as runoff carries pollutants from the land into waterways.

3.2.1 Wildlife

Wildlife, including deer, feral pigs, squirrels, raccoons, opossums, waterfowl, and other birds, can contribute to the presence of *E. coli* and other fecal-borne pathogens in waterways. Their feces may directly enter surface waters or be transported into streams through runoff after rainfall events. According to a study conducted in 2013, the SCDNR estimated deer density based on suitable habitats such as forests, croplands, and pastures. Based on this study, there is an estimated deer population of 30 to 45 per square mile in the TMDL watershed (SCDNR 2013). Based on a study by Yagow (Yagow 2001), the bacteria production rate for deer was found to be 347 x 10^6 cfu/head-day, although only a portion of this bacteria will enter the water. As such, wildlife can be considered a potential source of *E. coli* in the Sugar Creek TMDL watershed.

3.2.2 Agriculture

Agricultural activities involving livestock or animal waste can contribute to pathogen contamination of surface waters. Animal feces can enter waterways through runoff or direct deposition. The large quantity of bacteria associated with animal waste makes agricultural activities a significant source of bacteria, including *E. coli*, which can affect water quality. Effective management of manure and animal waste is essential to prevent pathogen contamination in the effective TMDL watershed.

3.2.2.1 Agricultural Animal Facilities

Under SC Regulation 61-43, owners/operators of most commercial animal growing operations are required to obtain permits for the proper handling, storage, treatment, and disposal of manure, litter, and deceased animals (SCDHEC 2021). These

regulations aim to safeguard water quality, ensuring that compliant facilities do not contribute to water quality impairments. SC currently does not have CAFOs under NPDES coverage.

There are no NPDES permitted livestock operations in the SC portion of the TMDL watershed. Based on the data available from NC Department of Environmental Quality (DEQ) there are not any permitted agricultural animal feeding operations in the North Carolina portion of the TMDL drainage area (NC DEQ 2024). Therefore, permitted agricultural animal feeding facilities are not considered a source of bacteria pollution.

3.2.2.2 Grazing Livestock

Livestock, especially cattle, are known contributors of bacteria and other fecal-borne pathogens in streams. On average, cattle produce approximately 1.0E+11 cfu/day per animal of FC bacteria. Grazing cattle and other livestock may indirectly contaminate streams with bacteria by runoff from pastures, or directly by defecating into streams and ponds. The grazing of livestock in pastures is not regulated by SCDES.

The United States Department of Agriculture's National Agricultural Statistics Service reported total of 204 cattle/calves in Lancaster and 329 cattle/calves in York counties (USDA NASS 2024). Based on the assumption of an even distribution of cattle across pasture/hay areas in Lancaster and York counties, approximate estimates of the cattle population were calculated and are presented in Table 8.

The NLCD classification system, derived from the Anderson Land Cover Classification System, includes the "Pasture/Hay" category, which represents areas where grasses, legumes, or grass-legume mixtures are grown for livestock grazing or hay production on a perennial cycle. However, it should be noted that not all cattle included in the USDA census are grazed, as dairy cattle and feedlot cattle are often confined and not evenly distributed across Pasture/Hay areas. Given the minuscule number of cattle/calves per acre in both counties in SC, grazing livestock is not considered a source of bacteria.

Table 8. Grazing cattle/calves per acre of Pasture/Hay per county.

County	Number of Cattle	Pasture/Hay Acres	Cattle/Calves/Acre Pasture/Hay
Lancaster	204	64755	0.003
York	329	88151	0.003

3.2.3 Land Application of Industrial, Domestic Sludge, or Treated Wastewater

Industrial and domestic wastewater treatment processes that are permitted under the NPDES may produce solid waste byproducts, known as sludge. Some facilities are authorized to apply this sludge to designated land areas under specific conditions. Similarly, there are NPDES-permitted facilities that can apply treated wastewater effluent to land at designated locations and under specific conditions. The regulations governing land application permits for these facilities can be found in SC Regulation 61-9 (SCDHEC 2019).

Proper management of waste application is crucial to ensure that pollutants are effectively incorporated into the soil or taken up by plants, preventing their entry into streams or groundwater. If not managed correctly, land application sites can become a source of fecal pathogens and contribute to stream impairments. It's important to note that land application sites are not permitted to discharge directly into waterways. Any direct discharges from these sites to surface waters are illegal and can result in enforcement actions by SCDES.

In the effective TMDL watershed, one facility, City of Rock Hill Manchester Creek WWTP (SC0020443) has permit to apply sludge from treated wastewater to land. The facility is authorized to apply treated sludge from their WWTP to fields located within the TMDL watershed (Figure 4). The specific application rates of sludge vary depending on field conditions and the production rates of each facility. If not properly managed, land application sites can be a source contributing to *E. coli* exceedances in the TMDL watershed.

3.2.4 Leaking Sanitary Sewers and Illicit Discharges

Leaking sewer pipes and illicit sewer connections pose a significant public health risk by releasing partially treated or untreated human waste into the environment. Without direct monitoring, it is difficult to accurately quantify the extent of these sources, as their impact depends on factors such as volume and proximity to surface water. Untreated domestic wastewater typically contains bacteria levels ranging from 10^4 to 10^6 MPN per 100mL. GIS data provided by Lancaster County indicate that some areas within the effective TMDL area are serviced by a sanitary sewer system. In the remaining portions of the effective TMDL area, there may be areas serviced by other sewer system.

Illicit sewer connections that redirect sewage into storm drains result in the direct discharge of sewage through the outfalls of the storm drainage system. To evaluate this issue, it is crucial to conduct monitoring of the storm drain outfalls during periods of dry weather to determine the presence or absence of sewage in the drainage systems. This monitoring process is essential for identifying and documenting the extent of illicit sewer connections and their impact on the environment.

Leaking sewer lines and illicit sewer connections are one of the potential sources of *E. coli* exceedances in the TMDL watershed.

3.2.5 Failing Septic Systems

Majority of the overall TMDL drainage area is urbanized. Based on the GIS information provided by Lancaster County, sewer service is available in portions of Lancaster County within the effective TMDL area. However, there may be areas where sewer service is not available and onsite septic systems are used for waste treatment. If there are septic systems in use, their locations, operational status, or conditions are unknown.

When installed and maintained properly, septic systems are safe, long-term options for treating wastewater and preserving valuable water resources. Regulations stipulate that permits for new septic tanks will not be issued when a wastewater treatment facility/public sewer line is accessible for connection.

DHEC has an enforcement program that investigates complaints regarding the functioning of an onsite wastewater system and if an unpermitted discharge of sewage or other domestic wastewater is identified, prompt timelines for compliance are issued to the responsible party in order to minimize the risk of any discharge presenting significant harm to the environment and public health. At present, the state lacks sufficient regulatory authority for maintenance and upkeep of onsite wastewater systems.

Failing septic systems are one of the potential sources of bacteria exceedances in the TMDL drainage area.

3.2.6 Urban and Suburban Runoff

Domesticated pets, such as dogs and cats, are contributors to *E. coli* and other pathogens in urban and suburban areas. Additionally, wildlife species like deer,

squirrels, raccoons, opossums, and birds also contribute to the overall bacteria load. In the area draining to station CW-036, urban runoff is expected to be significant due to the presence of developed land and high percentage of impervious surfaces.

Unregulated MS4 communities have the potential to contribute to *E. coli* and other pathogens through stormwater runoff. These unregulated entities are subject to the LA portion of the TMDL document.

4.0 Method

The TMDL for the Sugar Creek and its tributaries was determined using the load-duration methodology. This method enables the calculation of TMDLs that account for different hydrologic conditions (Bonta and Cleland 2003). The process involves creating load-duration curves by analyzing the cumulative frequency distribution of stream flow and bacteria concentration data. By utilizing these curves, both the existing pollutant load and the total maximum daily load for a particular waterbody can be estimated. The development of FDC and LDC are explained in this section.

4.1 Flow-Duration Curve

The first step of the LDC methodology involves the development of FDC. FDCs are graphical representations that illustrate the cumulative frequency of historical flow data. Typically, these curves are constructed using data obtained from long-term, continuous-record flow-gaging stations maintained by the USGS. These gages provide reliable and comprehensive information on stream flow over an extended period, enabling the creation of accurate flow-duration curves.

The FDS curves were generated using surface flow data obtained from USGS gaging station 02146800 on Sugar Creek near Fort Mill, SC. Daily mean discharge data for this station was obtained from the website https://waterdata.usgs.gov/sc/nwis/rt and the data were used to generate FDCs. To account for differences in drainage areas between the USGS station's drainage area and the TMDL station's drainage area, drainage area ratios were calculated. The daily mean streamflow from the USGS station was adjusted for the TMDL station by multiplying the instream flows by the ratio of the TMDL station's drainage (Table 9).

Table 9. USGS flow gage location, TMDL station, DAs, and flow ratios.

USGS	Location	USGS Gage DA (mi^2)	TMDL Station	TMDL Station DA (mi^2)	Drainage Area Ratio
02146800	Sugar Creek near Fort Mill, SC	262	CW-036	275	1.05

To create the FDCs, estimated daily flows for each TMDL station were ranked from highest to lowest. The percentage of time that these flows were exceeded was then calculated. These data points were plotted on a semi-log plot, with flows represented on the y-axis and percent exceedance on the x-axis. In the FDC, higher flows correspond to lower percent exceedances, indicating that these flows are rarely exceeded. Conversely, lower flows correspond to higher percent exceedances, indicating that these flows are nearly always exceeded.

The flows in FDC are categorized into five hydrologic categories: High flows, moist conditions, mid-range flows, dry conditions, and low flows. Categorizing the flows into these categories and comparing bacteria exceedances can provide insights into the potential sources of pollution. A high number of exceedances during dry conditions may indicate NPDES permitted point sources not meeting their bacteria limits, illicit connections, or direct deposition while exceedances during wet conditions may be indicative of runoff from developed areas, impervious surfaces, and nonpoint sources (Table 10). It is important to note that data within the high flow and low flow categories are typically not used in the development of a TMDL due to the infrequency of these flow conditions.

Table 10. Potential sources of *E. coli* exceedances under various flow duration categories.

Potential Sources	Flow Duration Category				
	High	**Moist**	**Midrange**	**Dry**	**Low**
Point Sources			Low	Medium	High
WWTP Overflow, SSO	High	Medium			
Riparian Areas		High	High	High	
Impervious area stormwater runoff		High	High	High	
Upland stormwater runoff	High	High	Medium		
Overland flow	High	High	Medium		
Failing septic systems			High	Medium	
Direct delivery (livestock in-stream, wildlife, pets, illegal dumping, illegal connections)			Medium	High	High

Adapted from USEPA 2007, 841-B-07-006 Table 4-1, TMDLs for FIB in the Santa Maria River Watershed in California, Cleland 2012, Willamette Basin TMDL Oregon DEQ 2006.

The USGS gage mentioned in the previous context is situated downstream from six domestic and municipal wastewater treatment plants (WWTPs). Among these WWTPs, those that are located in North Carolina are classified as major dischargers, 1 million gallons per day (MGD) or more, while those in SC are classified as minor dischargers (less than 1 MGD) (Table 5 and Table 6). The recorded flows at the USGS gage reflect the actual discharge flows from these NPDES-permitted facilities. FDC for the TMDL station is shown on Figure 8.

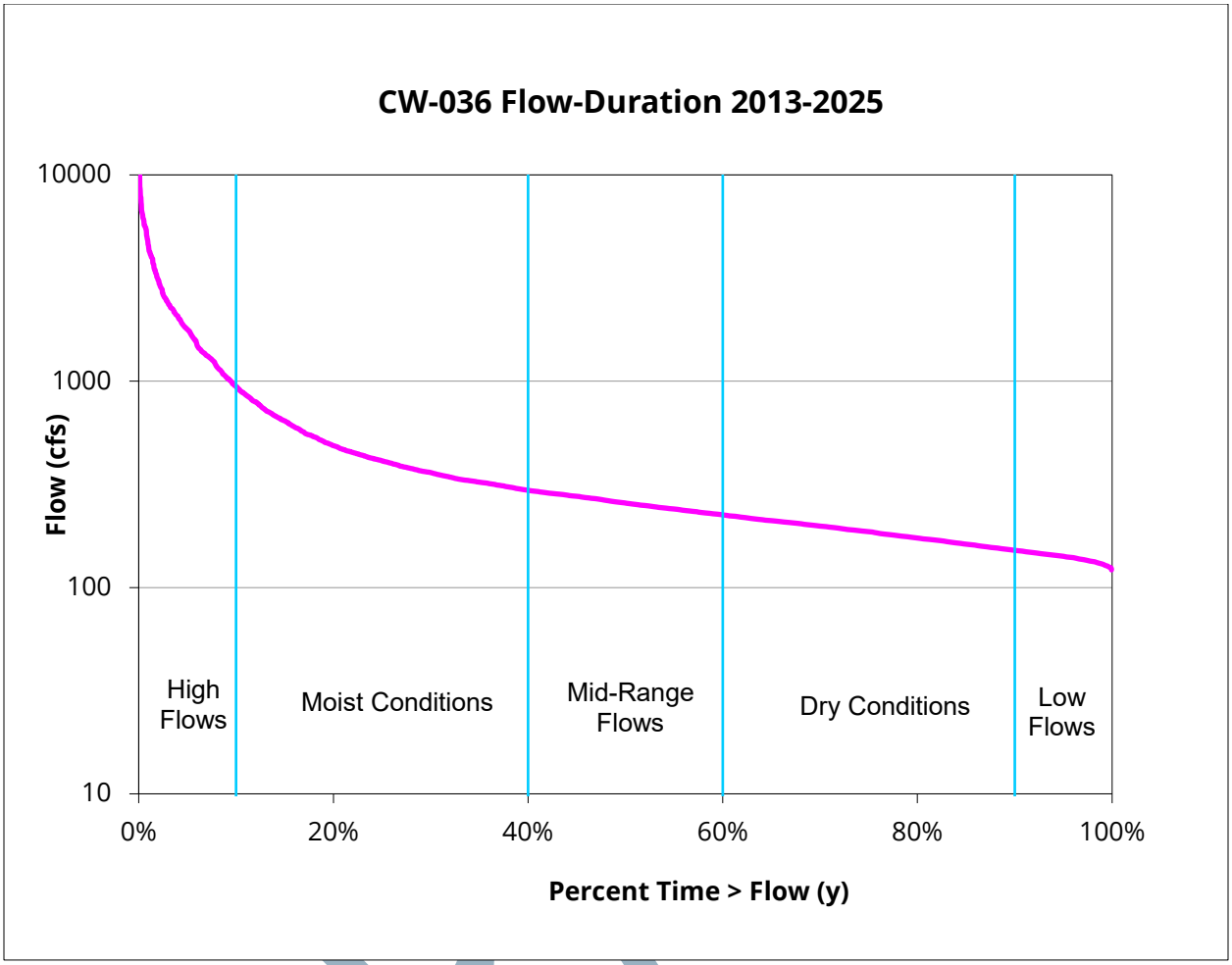

Figure 7. Flow duration curve for station CW-036.

4.2 Load Duration Curve

After generating the FDC, the next step in the analysis was to create LDC by combining the adjusted flow duration data with *E. coli* data. The *E. coli* data collected from the TMDL station over a period spanning from 2009 to 2023 were used for the analysis.

The LDCs provide valuable insights into the relationship between the duration of specific flow conditions and the corresponding instream *E. coli* loads. By examining the variations in *E. coli* levels under different flow conditions, it becomes possible to assess the sources and transport mechanisms of *E. coli*, as well as the associated risks to water quality.

The utilization of *E. coli* data from the TMDL station over an extended period enables a comprehensive assessment of *E. coli* loads in the monitored water bodies. This information facilitates the identification of patterns, trends, and potential sources of

contamination, which can be helpful in the development of effective strategies and measures to address water quality impairments caused by *E. coli*.

The *E. coli* target loads for the TMDL station were determined based on the estimated daily instream flows and the water quality criterion (332 MPN/100ml), which includes a 5% explicit MOS deducted from SSM WQS. By incorporating the MOS in the target load calculation, the TMDL takes into account the inherent complexities and uncertainties associated with water quality assessment. This approach enhances the effectiveness of the TMDL in protecting and improving water quality by providing a more realistic and protective framework for managing *E. coli* levels.

LDC was generated for the TMDL station using exclusively *E. coli* bacteria data. This curve provides a representation of the relationship between the duration of specific flow conditions and the corresponding *E. coli* loads in the water. By combining information on stream flow and *E. coli* concentrations, the target load for each station was determined.

An existing load was determined for each hydrologic category for the TMDL calculations. The 90th percentile of measured bacteria concentrations within each of the hydrologic categories was multiplied by the flow at each category midpoint (i.e., flow at the 25% duration interval for moist conditions, 50% interval for mid-range, and 75% for dry conditions). Existing loads were then plotted on the load-duration curve (pink line). These values were compared to the target load (green line) at each hydrologic category midpoint to determine the percent load reduction necessary to achieve compliance with the WQS. To calculate existing (pink line) and target loads (green line) for each of the flow ranges represented on the LDC graph, the following equations were used:

Existing Load (MPN/day) = Mid-Point Flow in Each Hydrologic Category (ft^3/s) x 90th %tile *E. coli* Concentration x Conversion Factor (24465758.4)

WLA + LA to Meet Target Load (MPN/day) = Mid-Point Flow in Each Hydrologic Category (ft^3/s) x 332 (*E. coli* WQ criterion MPN/day – 5% MOS) x Conversion Factor (24465758.4)

In an LDC, the independent variable (X-axis) represents the percentage of time that the estimated flow would be greater than x. In this case, flows are represented by categories: high, moist, mid-range, dry, and low. The dependent variable (Y axis)

represents the bacteria load (MPN/day) at each flow. LDC for station CW-036 is shown on Figure 7.

There are two domestic point sources within the effective TMDL area located upstream of the TMDL station. WLAs for SC0027146 and SC0030112 were calculated using the WWTPs' design flow, *E. coli* WQS, and a conversion factor (24465758.4) as shown in the equation below. A WLA was not calculated for SC0038113, located within the Steele Creek TMDL watershed, as it was previously assigned a WLA.

WLA = WWTP Design Flow (mgd) * 1.55 (conversion factor to cfs) * *E. coli* WQS (349 mpn/100 ml) * 24465758.4 (conversion factor)

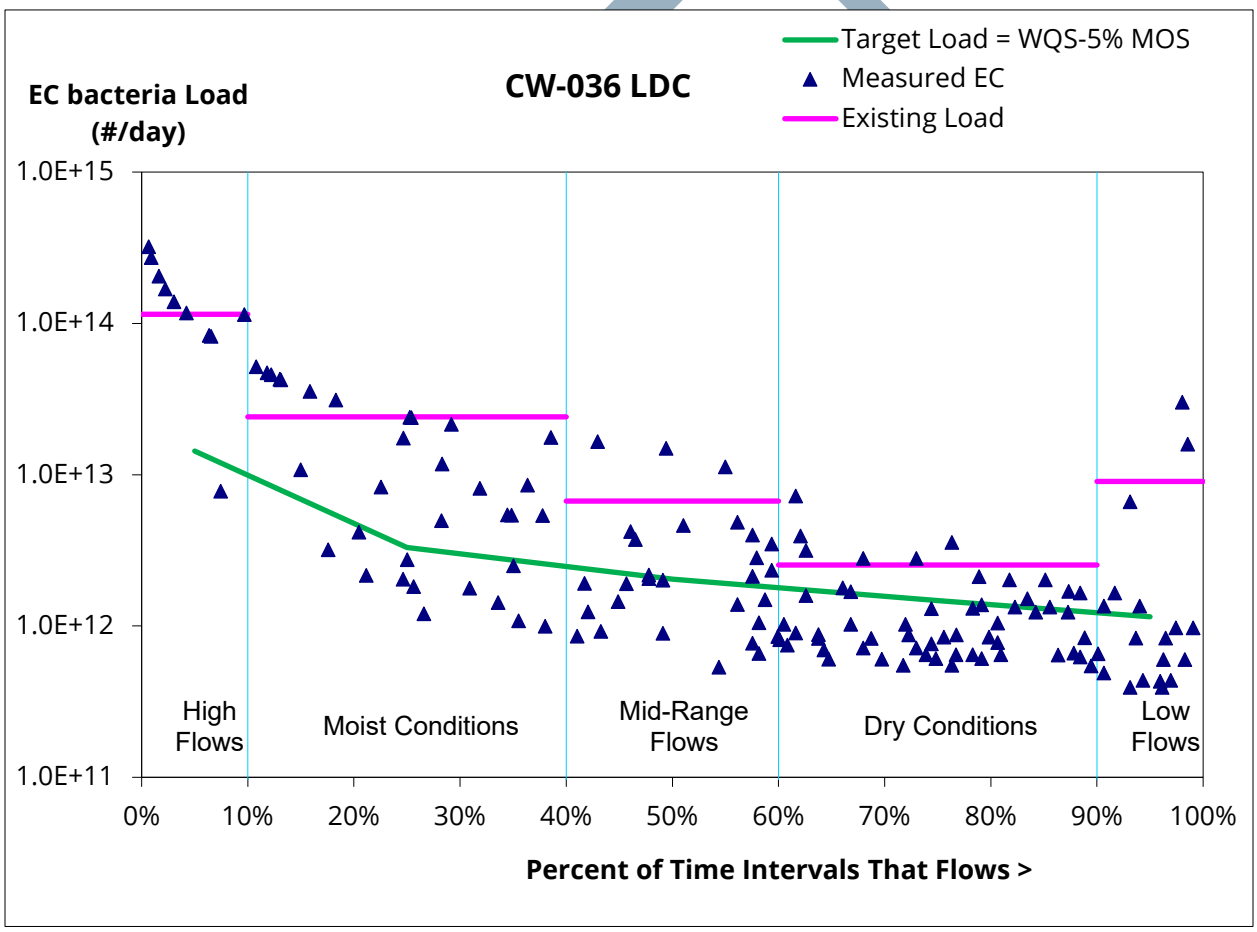

Figure 8. LDC for station CW-036.

5.0 Development of the TMDL

5.1 Critical Conditions

Critical conditions are the factors that in combination or by themselves cause violations of WQS. Sugar Creek and tributaries TMDL is based on flow intervals between the 5th and 95th percentiles and exclude extreme high (0-5%) and extreme low (95-100%) flow conditions. The critical condition for each monitoring station is identified as the flow condition requiring the largest percent reduction within the 5-95% flow duration intervals. Critical flow conditions for the TMDL station are listed in Table 11. The table also provides percent reductions in extreme high and extreme low flow categories for the TMDL station. These reductions are provided for informational purposes to encourage permitted entities, watershed groups, non-governmental organizations (NGOs), and others involved in TMDL implementation to investigate the causes of exceedances across various flow categories.

The TMDL station CW-036 shows significant exceedances under all flow conditions, indicating that these exceedances are not solely due to precipitation-related surface runoff. Potential contributing factors may include illicit discharges, direct inputs, point and intermittent sources, and nonpoint sources.

By emphasizing exceedances across different flow conditions, the goal is to prompt stakeholders to investigate the sources and mechanisms causing water quality impairments at station CW-036. This information can guide the development of targeted strategies and measures to effectively address these issues and achieve the necessary pollutant reductions.

Table 11. Sugar Creek and tributaries required (**bolded**) reduction to meet the WQS. Percent reductions for the remaining flow conditions are included for planning and implementation purposes.

Station	High (0-10 %)	Moist (10-40%)	Mid-Range (40-60%)	Dry (60-90%)	Low (90-100%)
CW-036	88%	**86%**	82%	48%	17%

5.2 Existing Load

In the TMDL calculation for the TMDL station, the existing loads were determined using the mid-point flow and 90th percentile *E. coli* concentration of each hydrologic category.

This approach is described in Section 4.0 of this TMDL document. The existing load under the critical condition specified in Section 5.1 was utilized for the TMDL calculation.

The existing load considers loadings from all potential sources that contribute to water pollution at the TMDL station. This includes various sources such as surface runoff, point source discharges exceeding permit limits, farm animals, pets, failing septic systems, and wildlife. By considering these different sources, a comprehensive assessment of the existing pollutant load at the TMDL station can be obtained, allowing for the development of appropriate load reduction targets and strategies to improve water quality.

5.3 Waste Load Allocation

The WLA is the portion of the TMDL allocated to NPDES-permitted point sources. These point sources typically include industrial facilities, wastewater treatment plants, and other regulated dischargers.

It is important to note that the WLA does not cover illicit dischargers, including SSOs or other illegal sources. Illicit discharges are considered unauthorized and are not granted any allocation under the TMDL. These sources are illegal because they introduce pollutants into the water without proper permits or compliance with regulatory requirements.

The WLA is specifically designed to address the allowable pollutant loadings from permitted point sources, while other mechanisms and enforcement actions are typically employed to address and reduce the impacts of illicit discharges and SSOs to protect water quality and public health.

5.3.1 Continuous Point Sources

There are two NPDES permitted domestic WWTPs with *E. coli* limits within the effective TMDL area in the SC portion of the total drainage area. The WLAs for two NPDES permitted point source dischargers are shown in Table 12. Any future continuous NPDES permitted point source discharges will be required to meet the prescribed loading for *E. coli* based on permitted flow and an allowable permitted maximum concentration of 349MPN/100mL.

5.3.1 Intermittent Point Sources

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future TS4, MS4s, construction and industrial stormwater discharges covered under permits numbered SCS000000 & SCR100000 regulated under SC *Water Pollution Control Permits* Regulation. Illicit discharges, including SSOs, are not covered under any NPDES permit and are subject to enforcement mechanisms. Other non-urbanized areas may be required under the NPDES Phase II Stormwater Regulations to obtain a permit for the discharge of stormwater.

The SCDOT is one of the designated TS4s within the Sugar Creek and tributaries effective TMDL watershed. SCDOT operates under NPDES TS4 Permit SCS040001 and owns and operates roads within the 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, or issue building or development permits.

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 regulated stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern. The percentage reduction is based on the maximum percent reduction (critical condition) within any hydrologic category necessary to achieve target conditions. The reduction percentages in this document also apply to the *E. coli* waste load attributable to those areas of the watershed that are covered or will be covered under NPDES MS4 permits (Table 12).

5.4 Load Allocation

The LA applies to the nonpoint sources of bacteria and is expressed both as a load and as a percent reduction. The load allocations are calculated as the difference between the target load under the critical condition and the point source WLA. There may be other unregulated MS4s 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 61-68, 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 SC R. 61-9 (SCDHEC 2019).

5.5 Margin of Safety

A MOS allows for an accounting of the uncertainty in the relationship between pollutant loads and receiving waters. MOS can be incorporated either explicitly or implicitly by using conservative assumptions. An explicit 5%, 17 mpn/100 mL of the WQS (349 mpn/100 mL), is deducted in the TMDL calculations as MOS (Table 12).

5.6 Calculation of the TMDL

While TMDLs for most pollutants are expressed as a mass load (lbs/day), bacteria TMDLs for continuous dischargers are expressed as organism counts per day or concentration (mpn/100 mL, #/100 mL, cfu/100 mL), and as percent reduction for intermittent point sources. Sugar Creek and tributaries TMDL target is based on a SSM WQS for *E. coli* because there is not sufficient data to evaluate the 30-day geometric mean component of the WQS for *E. coli*. The TMDL load is the sum of the WLA for point sources and LA for non-point sources and a 5% explicit MOS, which is based on the mid-point of the critical flow zone or category.

5.7 Seasonal Variability

Federal regulations require that TMDLs consider seasonal variations in loading to the watershed, which accounts for environmental conditions such as precipitation, flow, temperature, etc. The TMDL for the Sugar Creek and tributaries include instream *E. coli* data collected from 2013 through 2023 under varying hydrological conditions, seasons, precipitation, and other factors.

5.8 Reasonable Assurance

When a TMDL is developed for a pollutant that originates from both point and nonpoint sources, or from nonpoint sources only, EPA guidance emphasizes the need to provide reasonable assurances that nonpoint source controls will effectively achieve their expected load reductions. For point sources, such as NPDES-permitted dischargers, the WLA provided in their permits already ensures this assurance.

However, for unregulated nonpoint sources of pollutants, achieving the necessary load reductions can be more challenging. To address this, various measures can be employed, including the implementation of Best Management Practices (BMPs), local ordinances, and outreach and educational efforts. CWA §319 grant funding may be available to interested parties for the purposes of implementing these measures.

Catawba Riverkeeper organization is an active advocacy group with a mission to preserve, protect, and restore the waters of Catawba-Wateree River Basin. The group has published a "Southern Catawba and Wateree Basin Protection and Restoration Plan" in 2023, which was updated in 2024. One of the components of this plan is to restore the recreational use of Sugar Creek.

SC Adopt-a-Stream (SCAAS) is a volunteer citizen science program which provides opportunities to engage interested parties in the protection and management of SC's waterways. Groups are involved in monitoring and reporting of water quality parameters. Within the effective TMDL area, Town of Fort Mill has one monitoring station on Sugar Creek.

Table 12. TMDL for Sugar Creek and its tributaries. TMDL, WLAs, and MOS are expressed as mpn/day, and allocations are expressed as % reductions.

Station	Existing Load (mpn/day)	TMDL (mpn/day)	MOS (mpn/day)	Implementation Targets				
				Continuous Sources [1] (mpn/day)	Intermittent MS4 [2, 3] (% reduction)	Intermittent TS4 SCDOT (% reduction) [4]	Nonpoint Sources (mpn/day)	LA [3] (% reduction)
CW-036	2.44E+13	3.51E+12	1.71E+11	SC0027146/ WLA 1.5E+09 SC0030112/ WLA 7.9E+09	86%	86%	3.33E+12	86%

Table Notes:

1. WLAs are expressed as a daily maximum. Existing and future continuous dischargers are required to meet the prescribed loading for pollutants of concern. Future loadings will be calculated based on permitted flow and *E. coli* concentration of 349 mpn/100 mL.
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. The percent reductions apply to existing instream load.
4. By implementing the BMPs that are prescribed in either the SCDOT annual SWMP or the SCDOT TS4 permit to address *E. coli*, the SCDOT will comply with these TMDLs and its applicable WLA to the MEP as required by its TS4 permit.

6.0 Implementation

As implementation strategies progress, SCDES will continue to monitor the effectiveness of these measures and evaluate water quality where deemed appropriate. The Department recognizes that adaptive management might be necessary to achieve the WQS and we are committed to targeting the load reductions needed to improve water quality in the Sugar Creek and tributaries watershed. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL target accordingly. The implementation strategies presented below are not inclusive and are only provided as guidance.

6.1 Continuous Point Sources

NPDES permitted continuous point sources are required to meet the instream WQS for *E. coli* at the end of pipe. Currently, there are two domestic WWTPs in the TMDL watershed. NPDES-permitted continuous point source dischargers are required to meet the WQS for *E. coli* at the end of their discharge pipe. CWA §319 grants are not available for implementation of the WLA component TMDLs, however, there may be other sources of funding for capital improvements.

6.2 Intermittent Point Sources

NPDES MS4 entities are required to target and show progress towards implementing the calculated percent reductions to the MEP with each permit cycle by following their permit requirements. These entities are responsible for documenting and reporting their progress toward achieving the percent reductions allocated to the MS4s in the TMDL watershed.

An iterative approach of water quality monitoring, illicit source detection, and elimination, deploying BMPs and evaluation of their effectiveness, outreach and education, optimization of other tools such as local ordinances, and revision of their SWMP as needed in reducing *E. coli* loading to Sugar Creek and its tributaries is expected to show improvements in WQS.

For SCDOT TS4, existing and future NPDES MS4 permittees, compliance with the terms and conditions of the NPDES permit is effective implementation of the WLA to the 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 the permit is effective implementation of the

WLA. Voluntary load reductions in the LA portion of these TMDLs can be implemented through voluntary measures and may be eligible for CWA §319 grants.

Based on the available information at this time, the portion of the Sugar Creek and its tributaries 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 recurrence intervals are largely unknown. Therefore, where applicable, the regulated MS4 is assigned the same percent reduction as the unregulated sources in the watershed. Compliance with the MS4 permit in regard to this TMDL document is determined at the point of discharge to the waters of the state. The regulated TS4 and 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 the TMDL document.

NPDES-permitted intermittent sources, MS4s, are required to target and show progress towards achieving the reductions shown in Table 12 to the MEP by each permit cycle. There may be other regulated activities, such as land application of sludge and animal feeding operations, that require permits and are not allowed to contribute to bacteria loadings to streams.

Unregulated sources in these TMDL watersheds may include resident and transient wildlife, improper animal keeping practices, clear cutting, and surface runoff from unregulated areas. These sources may be reduced through local ordinances, education through outreach, partnerships with local NGOs and federal agencies, and CWA §319 funded opportunities.

While WLAs and percent reductions for continuous and intermittent NPDES permitted point source dischargers are based on the critical flow category (moist in this case) for the TMDL station, conditions in other flow categories with *E. coli* exceedances should also be considered when implementing this TMDL. Because exceedances occurring during dryer conditions are likely from a different source than those occurring during wetter conditions (Table 10).

6.2 Nonpoint Sources

SC has several tools available for implementing the nonpoint source component of this TMDL. The Nonpoint Source Management Plan (SCDHEC, 2019) document is one example.

Interested parties (local stakeholder groups, universities, local governments, NGOs, etc.) may be eligible to apply for CWA §319 grants to install BMPs that will implement the LA portion of TMDL and reduce nonpoint source fecal coliform loadings to impaired areas. Congress amended the CWA in 1987 to establish the §319 Nonpoint Source Management Program. Under §319, States receive grant money to support a wide variety of activities including the restoration of impaired waters. TMDL implementation projects are given the highest priority for §319 funding. CWA §319 grants are not available for implementation of the WLA component of this TMDL but may be available for the LA component within permitted MS4 jurisdictional boundaries.

7.0 Bibliography

2017. "40 CFR - Protection of Environment." *Subchapter D Water Programs Part 130 Water Quality Planning and Management.* July 1.

2017. "40 CFR - Protection of Environment." *Subchapter D Water Programs Part 130 Water Quality Planning and Management.* July 1.

Blount, Z. D. 2015. "The unexhausted Potential of E. coli." *eLife.* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4373459/#bib17.

Bonta, James V, and Bruce Cleland. 2003. "Incorporating Natural Variability, Uncertainty, and Risk Into Water Quality Evaluations Using Duration Curves." *Journal of American Water Resources Association (JAWRA)*, December: 1481-1496.

Dewitz, J. 2023. "National Land Cover Database (NLCD) 2021 Products." https://www.usgs.gov/data/national-land-cover-database-nlcd-2021-products.

Griffith, G. E., J. M. Omernik, and J. A. Comstock. 2002. "Ecoregions of SC, Regional Descriptions." Virginia. https://www.nrc.gov/docs/ML1127/ML112710639.pdf.

Mallin, A. A., J. M. Burkholder, and L. B. Cahoon. 2000. "North and SC Coasts." *Marine Pollution Bulletin* (Pergamon) 41 (1-6): 56-75. http://uncw.edu/cms/aelab/Reports%20and%20Publications/2000/2000,Mar%20Poll%20Bull,North%20and%20South%20Carolina%20Coasts.pdf.

Montague, Clay L, and Janet A Ley. 1993. "A Possible Effect of Salinity Fluctuation on Abandance of Benthic Vegetation and Associated Fauna in Northeastern Florida." *Estuaries*, December: 703-717.

NC DEQ. 2024. *DWR Animal Operations Permits.* Accessed 11 18, 2024. https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=85ae6392d0e94010a305eedf06e3f288.

Novotny, V. 2003. *Water Quality: Diffuse Pollution and Watershed Management.* John Wiles and Sons.

SCDHEC. 2012. *Classified Waters (R. 61-69).* Columbia, SC: Bureau of Water.

SCDHEC. 2019. *Nonpoint Source Management Plan 2020-2024.* SCDHEC Bureau of Water. https://scdhec.gov/environment/your-water-coast/watersheds-program/section-319-nonpoint-source-program.

SCDHEC. 2021. *R. 61-43 Standards for the Permitting of Agricultural Animal Facilities.* Effective June 28, 2002. Columbia, SC. Accessed March 19, 2018. http://www.scdhec.gov/Agency/docs/water-regs/r61-43.pdf.

SCDHEC. 2017. "Regulation 61-47 Shellfish." https://scdhec.gov/sites/default/files/media/document/R.61-47.pdf#page=5.

SCDHEC. 2023. *Regulation 61-68 Water Classifications and Standards.* https://scdhec.gov/BOW/water-quality-standards/water-quality-standards-south-carolina.

SCDHEC. 2020. "Shellfish Management Area 16A 2020 Annual Update."

SCDHEC. 2023c. "The State of SC's 2020 and 2022 Integrated Report (IR) Part I: Section 303(d) Listing of Impaired Waters." https://scdhec.gov/sites/default/files/media/document/IR_Part_I_Final_Submittal_2018.pdf.

SCDHEC. 2019. *Water Pollution Control Permits: R61-9.* May. https://scdhec.gov/BOW/water-regulations-standards/water-regulations-standards-water-pollution-control.

SCDNR. 2013. *SC Deer Density Map.* https://www.dnr.sc.gov/wildlife/deer/deermap.html.

USDA NASS. 2024. *2022 Census of Agriculture.* United States Department of Agriculture.

USEPA. 2007. "An Approach for Using Load Duration Curves for the Development of TMDLs." *https://www.epa.gov/tmdl/approach-using-load-duration-curves-development-tmdls.* Accessed 2023.

USGS. 2019. *The StreamStats program.* Accessed 2024. https://streamstats.usgs.gov/ss/.

Wolfson, L, and T Harrigan. 2010. "Cows, Streams, and E. coli: What Everyone Need to Know." Michigan State University Extension.

Yagow, G. 2001. "Fecal Coliform TMDL Mountain Run Watershed Culpeper County, Virginia." April. http://www.deq.state.va.us.

Appendix A – Data Used for Calculation of the TMDL

Date CW-036	EC/100 mL	Date CW-036	EC/100 mL
1/16/2013	345	10/4/2017	131
3/19/2013	2420	11/16/2017	201
5/7/2013	4839	12/6/2017	1120
7/9/2013	980	1/16/2018	613
9/17/2013	248	2/22/2018	308
11/14/2013	387	3/29/2018	178
2/18/2014	192	4/10/2018	276
4/2/2014	140	5/1/2018	179
6/10/2014	866	6/12/2018	2420
10/7/2014	186	7/10/2018	276
12/4/2014	201	8/7/2018	2420
2/24/2015	145	9/5/2018	461
4/1/2015	173	11/13/2018	2420
6/2/2015	1300	12/5/2018	135
8/4/2015	116	1/2/2019	201
10/8/2015	142	2/12/2019	687
12/3/2015	770	3/6/2019	238
2/3/2016	249	4/10/2019	2420
4/5/2016	517	5/7/2019	579
6/6/2016	2420	6/4/2019	145
8/24/2016	308	7/2/2019	126
10/10/2016	2420	8/1/2019	2420
12/5/2016	2420	9/19/2019	517
1/12/2017	345	10/16/2019	1733
2/7/2017	194	11/6/2019	172
3/8/2017	326	12/9/2019	248
4/17/2017	127	1/7/2020	2420
5/24/2017	2420	2/18/2020	276
6/20/2017	2420	3/25/2020	2420
7/18/2017	613	4/14/2020	2420
7/20/2017	436	5/19/2020	2420
7/24/2017	2420	6/18/2020	548
7/26/2017	649	7/8/2020	649
8/1/2017	326	8/17/2020	687
9/19/2017	157	9/29/2020	291

Date CW-036	EC/100 mL	Date CW-036	EC/100 mL
10/28/2020	387	3/4/2024	461
11/5/2020	153	4/10/2024	613
12/9/2020	320	5/1/2024	921
1/12/2021	361	6/11/2024	238
2/4/2021	186	7/17/2024	488
3/4/2021	127	8/19/2024	461
4/12/2021	687	9/18/2024	2420
5/4/2021	2420	10/17/2024	147
6/8/2021	2420	11/12/2024	2420
7/7/2021	222	12/3/2024	186
8/2/2021	152	1/14/2025	435
9/9/2021	727	3/3/2025	186
10/7/2021	2420	4/3/2025	1733
11/23/2021	1986	5/14/2025	2420
12/9/2021	2420	6/19/2025	326
1/11/2022	727		
2/10/2022	219		
3/3/2022	121		
4/12/2022	122		
11/14/2022	157		
12/5/2022	326		
1/4/2023	2420		
2/8/2023	140		
3/22/2023	93		
4/6/2023	135		
5/3/2023	210		
6/14/2023	770		
7/18/2023	361		
8/15/2023	816		
9/21/2023	328		
10/23/2023	225		
11/20/2023	179		
12/5/2023	308		
1/17/2024	687		
2/21/2024	249		