Volume III
Chloride TMDLs
for the Accotink Creek Watershed,
Fairfax County, Virginia

Prepared for
Virginia Department of Environmental Quality

Prepared by
Interstate Commission on the Potomac River Basin

August 30, 2017

Cover Photo

Accotink Creek near Hooes Road, Virginia. 2008. Photo by Virginia Department of Environmental Quality

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Acronyms

BMP	Best Management Practices
BRAC	Base Realignment and Closure Act
CL	Chloride
CWA	Clean Water Act
DEQ	Virginia Department of Environmental Quality
E. coli	*Escherichia coli*
ELU	Existing Land Use
EPA	U. S. Environmental Protection Agency
FBNA	Fort Belvoir Northern Area
FCDPWES	Fairfax County Department of Public Works and Environmental Services
FDC	Flow Duration Curve
GIS	Geographic Information System
GWLF	Generalized Watershed Loading Function
ICPRB	Interstate Commission on the Potomac River Basin
INRMP	Integrated Natural Resource Management Plan
IP	Implementation Plan
ISW GP	Industrial Stormwater General Permit
LA	Load Allocation
LDC	Load Duration Curves
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer Systems
NED	National Elevation Dataset
NHDES	New Hampshire Department of Environmental Services
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NVBIA	Northern Virginia Building Industry Association
NVRC	Northern Virginia Regional Commission
PCB	Polychlorinated Biphenyl
POC	Pollutant of Concern
QA/QC	Quality Assurance/Quality Control
R2	Coefficient of Determination
SC	Specific Conductance
SI	Stressor Identification Analysis
SIC	Standard Industrial Classification Code
SaMS	Salt Management Strategy
SSURGO	Soil Survey Geographic Database
SWCB	State Water Control Board
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Loads
UAA	Use Attainability Analysis
UT	Unnamed tributary
USGS	U. S. Geological Survey
VDOT	Virginia Department of Transportation
VDP	Vision and Development Plan
VPDES	Virginia Pollutant Discharge Elimination System
VSCI	Virginia Stream Condition Index

BMP	Best Management Practices
VSMP	Virginia Stormwater Management Program
WLA	Wasteload Allocation
WQMP	Water Quality Management Plan

Units of Measure

µS/cm	Microsiemens per centimeter
du/ac	Dwelling unit per acre
ft	Foot
lbs/d	Pounds per day
lbs/yr	Pounds per year
mg/l	Milligrams per liter
MGD	Million gallons per day
mi^2	Square mile

Executive Summary

Introduction

Accotink Creek drains 52 square miles (mi^2) of Northern Virginia before entering first Accotink Bay, then Gunston Cove, an embayment on the tidal Potomac River. **Figure ES-1** shows the location of Accotink Creek. The study area for this project is the watershed draining the non-tidal portion of Accotink Creek upstream of Route 1, as shown in **Figure ES-1**.

The Accotink Creek watershed is highly developed. Overall, 87% of the watershed draining to non-tidal Accotink Creek consists of commercial, industrial, transportation, or residential land. Impervious surface covers 28% of the non-tidal watershed.

Biological Impairments in Accotink Creek

Virginia Department of Environmental Quality (DEQ) uses biological monitoring of benthic macroinvertebrate communities as one way to assess the ecological health of wadeable freshwater streams and to determine whether the Aquatic Life Use is supported. DEQ has conducted biological assessments of the mainstem of Accotink Creek at four locations. In addition, DEQ has conducted biological assessments in Long Branch (Central), a tributary of Accotink Creek that joins the mainstem just upstream of Lake Accotink, an impoundment on Accotink Creek. While there are three tributaries named Long Branch in the Accotink Creek watershed, the tributary focused on in this study is Long Branch (Central), hereafter simply referred to as Long Branch. Based on benthic macroinvertebrate monitoring and assessments in the Accotink Creek watershed, DEQ has placed Accotink Creek, both above and below Lake Accotink, and Long Branch on Virginia's List of Impaired Waters (Category 5 of the Integrated List) because they are not supporting their Aquatic Life Use. **Figure ES-1** shows the location of the impaired stream segments. Hereafter, impaired segment A15R-01-BEN, as shown in **Figure ES-1**, will be referred to as lower Accotink Creek, segment A15R-04-BEN as upper Accotink Creek, and A15R-05-BEN as Long Branch. **Table ES-1** summarizes the impairment listings for upper Accotink Creek, lower Accotink Creek, and Long Branch in Virginia's 2014 Integrated Report. Section 303(d) of the Clean Water Act (CWA) and the United States Environmental Protection Agency's (EPA) Water Quality Planning and Management

Regulations (40 CFR part 130) generally require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting water quality standards. TMDLs represent the total pollutant loading that a waterbody can receive without exceeding water quality standards.

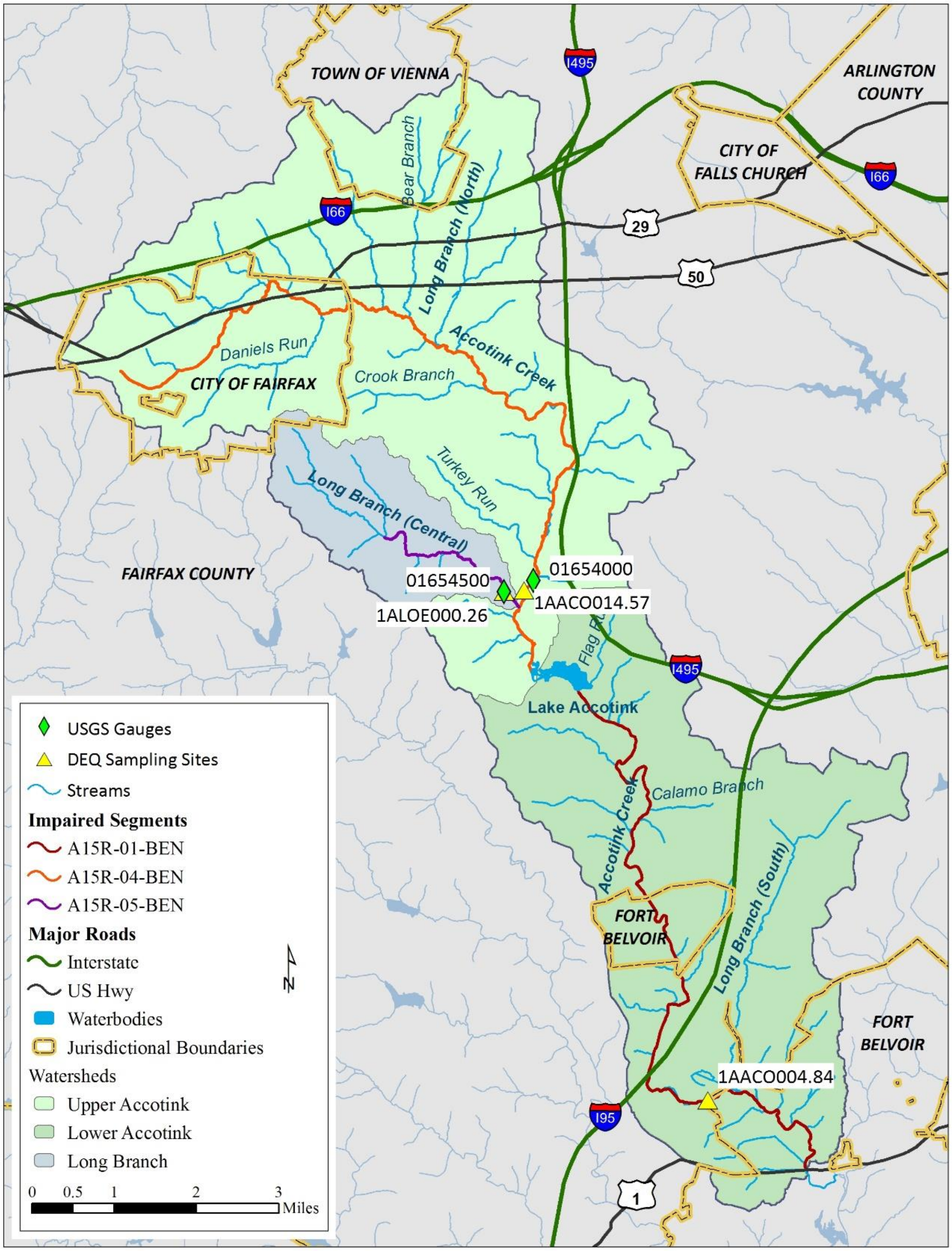

Figure ES-1: Location of the Impaired Segments in Accotink Creek Watershed

Table ES-1: Accotink Creek Benthic Impairments

TMDL Watershed	Stream Name	Cause Group Code 303(d) Impairment ID	Description	Size	Assessment Unit 305(b) Segment ID	Initial Listing
Lower Accotink Creek	Accotink Creek	A15R-01-BEN	Begins at the outlet of Lake Accotink and continues downstream until the tidal waters of Accotink Bay.	10.09 mi	VAN-A15R_ACO01B10 VAN-A15R_ACO01A00	2010 1996
Upper Accotink Creek	Accotink Creek	A15R-04-BEN	Begins at the headwaters of Accotink Creek and continues downstream until the start of Lake Accotink	11.59 mi	VAN-A15R_ACO05A04 VAN-A15R_ACO04A02 VAN-A15R_ACO03A02 VAN-A15R_ACO02A00	2008 2010 2010 2010
Long Branch	Long Branch	A15R-05-BEN	Begins at the confluence with an unnamed tributary (UT) to Long Branch, at the Route 651 (Guinea Road) bridge, and continues downstream until the confluence with Accotink Creek, just below Braddock Road.	2.37 mi	VAN-A15R_LOE01A02	2008

Stressor Identification Analysis

Biological monitoring in the Accotink Creek watershed has determined that these waterbodies are not supporting their Aquatic Life Use, but the biological monitoring does not determine the cause of the biological impairments in these waterbodies. Until the underlying cause(s) of the biological impairments have been determined, there is no way of knowing what actions will most effectively address the impairment. A Stressor Identification analysis (SI) was performed to determine the stressor(s) to the biological community in the Accotink Creek watershed (DEQ, 2017). The SI report is **Volume I** of this report.

The SI for upper Accotink Creek, lower Accotink Creek, and Long Branch examined ten potential stressors to determine the strength of the evidence linking them to the biological impairments in these streams. Based on an evaluation of the monitoring data and the scientific literature, chlorides, hydromodification, habitat modification, and sediment have been identified as the most probable stressors of the biological communities in the Accotink Creek watershed. Once the stressor(s) have been identified, TMDLs can be developed for any pollutant identified as a stressor of the biological community; however, not all stressors are pollutants amenable to TMDL development. The CWA distinguishes the general class of pollution, defined as "the man-made or man-induced alteration of physical, biological, chemical, and radiological integrity of water and other media (CWA, Section 502, General Definitions)," from pollutants, which are restricted to "[d]redged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dust and industrial, municipal, and agricultural waste discharge into water (CWA, Section 502, General Definitions)." TMDLs can only be developed for pollutants.

Of the four most probable stressors, only chloride (CL) and sediment are pollutants. As specified in the CWA, TMDLs should be developed for sediment and CL for each of the three impaired segments in the Accotink Creek watershed. The sediment TMDLs are described in **Volume II** of this report. This volume, **Volume III**, describes the development of chloride TMDLs for upper Accotink Creek, lower Accotink Creek, and Long Branch, to help address the biological impairments in those watersheds.

Analysis of Chloride Monitoring Data

Elevated concentrations of CL and other ions can disrupt the osmotic regulation of aquatic organisms. Virginia water quality standards include an acute maximum CL concentration criterion of 860 mg/l and a chronic maximum concentration criterion of 230 mg/l to protect aquatic life. The acute criterion is for a one-hour average not to be exceeded more than once every three years; the chronic criterion is a four-day average, which is also not to be exceeded more than once every three years (9VAC25-260-140).

Seven observed CL concentrations in upper Accotink Creek, two concentrations in lower Accotink Creek, and one concentration in Long Branch exceed the 860 mg/l acute criterion. These are shown in **Table ES-2**. **Table ES-3** shows the individual observed CL concentrations that exceeded the 230 mg/l chronic criterion. The chronic criterion applies to a four-day average concentration and can be evaluated if two or more samples are collected on different days in a four-day period. Using that rule-of-thumb, the snowmelt in late January, 2016 and the combined snow and rain event in February, 2016 exceeded the 4-day chronic criterion in upper Accotink Creek, Lower Accotink Creek, and Long Branch.

Table ES-2: Observed Chloride Concentrations Exceeding the Acute Chloride Criterion[1]

Watershed	Agency	Station	Date	Chloride (mg/l)
Upper Accotink Creek	USGS	01654000	2/02/2010	1,320
	USGS	01654000	2/19/2014	925
	USGS	01654000	3/05/2014	1,410
	USGS	01654000	3/19/2014	977
	DEQ	1AACO014.57	1/27/2016	1,210*
	DEQ	1AACO014.57	1/28/2016	888*
	DEQ	1AACO014.57	2/16/2016	2,570
Lower Accotink Creek	DEQ	1AACO004.84	3/04/2015	1,160
	DEQ	1AACO004.84	2/16/2016	1,580*
Long Branch	DEQ	1ALOE000.26	2/16/2016	1,010*

[1]The acute criterion is a one-hour average of 860 mg/l , not to be exceeded more than once every three years.

*These values were also used in the calculation of chronic criterion exceedances.

Table ES-3: Observed Chloride Concentrations Exceeding the Chronic Chloride Criterion[1]

Watershed	Agency	Station	Date	Chloride (mg/l)
Upper Accotink Creek	USGS	01654000	2/02/2010	1,320
	USGS	01654000	2/19/2014	925
	USGS	01654000	3/05/2014	1,410
	USGS	01654000	3/19/2014	977
	DEQ	1AACO014.57	1/27/2016	1,210*
	DEQ	1AACO014.57	1/28/2016	888*
	DEQ	1AACO014.57	2/16/2016	2,570*
	DEQ	1AACO014.57	2/18/2016	504*
Lower Accotink Creek	DEQ	1AACO004.84	3/04/2015	1,160
	DEQ	1AACO004.84	1/26/2016	367*
	DEQ	1AACO004.84	1/27/2016	681*
	DEQ	1AACO004.84	1/28/2016	767*
	DEQ	1AACO004.84	2/16/2016	1,580*
	DEQ	1AACO004.84	2/18/2016	448*
Long Branch	DEQ	1ALOE000.26	1/27/2016	847*
	DEQ	1ALOE000.26	1/28/2016	526*
	DEQ	1ALOE000.26	2/16/2016	1,010*
	DEQ	1ALOE000.26	2/18/2016	504*

[1]The chronic criterion is a four day average of 230 mg/l , not to be exceeded more than once every three years.

*These values were used to calculate chronic criterion exceedances for the associated 4-day window

Chloride and other ions occur naturally in waters as a function of mineral composition of soils and bedrock. In urban watersheds, however, deicing salt is the primary source of CL (Paul and Meyer, 2001). Deicing salt, applied to roads, sidewalks, driveways, etc., is a major source of CL in developed areas like Accotink Creek. **Figure ES-2** shows the average monthly CL concentrations in upper and lower Accotink Creek. Monthly CL concentrations generally have higher concentrations in the winter months.

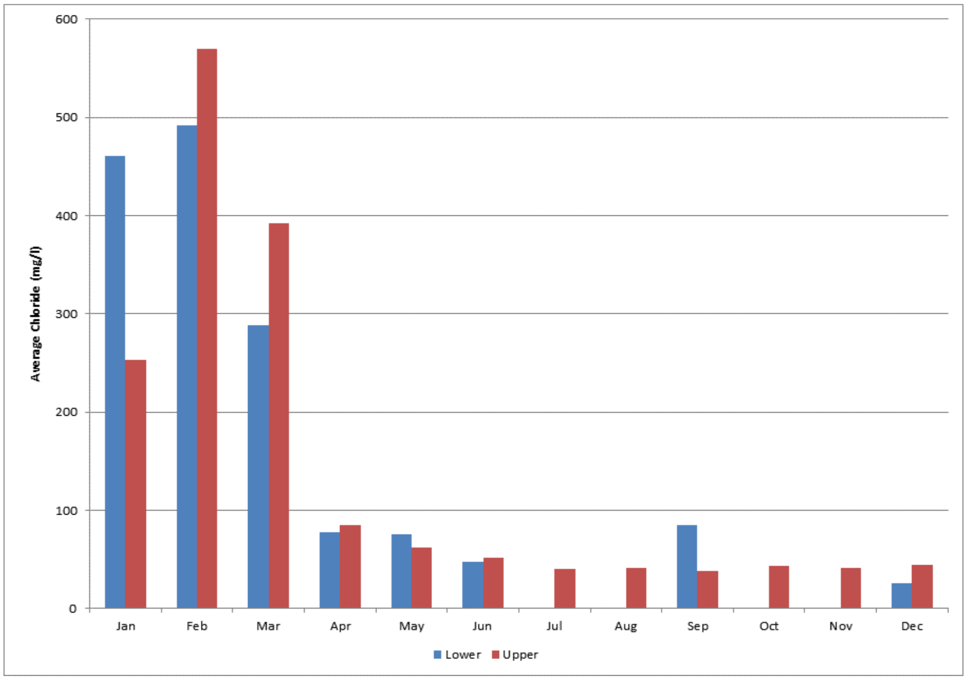

Figure ES-2: Average Monthly Chloride (mg/l) in Accotink Creek

Chloride is a major anion contributing to specific conductance (SC), so it can be expected that SC and CL are strongly correlated. Strong indirect evidence that both the acute and chronic water quality criteria for CL frequently are exceeded can be derived from (1) continuous monitoring data of SC, described in **Section 3.5.4** of the SI report; and (2) the strong correlation between SC and CL. SC continuous monitoring data is available at (1) the USGS gauge on Accotink Creek near Annandale (01654000), from 2/5/2015 to the present; (2) the USGS gauge on Long Branch near Annandale (01654500), from 4/17/2013 to the present; and (3) the DEQ monitoring station on Accotink Creek at Telegraph Road (1AAC0004.84), from 1/11/2016 to 2/29/2016. These monitoring locations are shown on **Figure ES-1**. Linear regression of CL on SC grab samples yield CL:SC ratios of 0.32, 0.32, and 0.33, respectively, for upper Accotink Creek, lower Accotink Creek, and Long Branch. The coefficient of determination (R^2) between CL and SC is greater than 0.99 for all three watersheds.

The corresponding CL:SC regression equation was applied to the SC continuous monitoring data from upper Accotink Creek, lower Accotink Creek, and Long Branch to yield estimated chloride concentrations over the period of record of the SC continuous monitoring data. **Table ES-4** shows the frequency at which the estimated chloride concentrations exceed the acute criterion and chronic criterion in each watershed during November 1 through April 30, the months in which snow has fallen within the last 30 years in the Washington metropolitan area. As the table shows, both criteria are exceeded by estimated chloride concentrations in upper Accotink Creek, lower Accotink Creek, and Long Branch. To meet the acute criterion for chloride, which allows no more than one chloride concentration exceeding 860 mg/l every three years, would require reductions of 77%, 31%, and 69% in upper Accotink Creek, lower Accotink Creek, and Long Branch. The chronic criterion tends to be exceeded at a higher frequency than the acute criterion. To meet the chronic criterion for chloride, which allows no more than one four-day average chloride concentration exceeding 230 mg/l every three years, would require reductions of 84%, 68%, and 72% in upper Accotink Creek, lower Accotink Creek, and Long Branch based upon available data.

Table ES-4: Exceedances of Chloride Criteria by Estimated Chloride Concentrations, November through April

Criterion	Exceedances	Upper Accotink (2/5/15-4/16/16)[1]	Lower Accotink (1/11/16-2/29/16)[1]	Long Branch (4/17/13-4/16/16)[1]
Acute Criterion	Total Days	249	50	533
	Days with Exceedances	24	8	20
	Percent Exceedance	10%	16%	4%
Chronic Criterion	Total Days	249	50	533
	Days with Exceedances	64	27	86
	Percent Exceedance	26%	54%	16%

[1]Period of record for continuous monitoring of SC. All criteria exceedances occurred during the months of November through April.

TMDL Development

Load duration curves (LDCs) were used to develop chloride TMDLs for Accotink Creek's benthic impairments. The LDC method is an EPA-approved approach to developing TMDLs (EPA, 2007). It has been used to develop bacteria TMDLs in Virginia (DEQ, 2004; DEQ, 2008). It has also been used to develop chloride TMDLs for Shingle Creek in Minnesota (Wenk Associates, 2006) and Beaver Brook in New Hampshire (New Hampshire Department of Environmental Services (NHDES), 2008).

The cornerstone of the LDC method is the flow duration curve (FDC). FDCs represent the percent of time a flow is exceeded. A flow exceeded 90% of the time is a low flow, where as a flow exceeded only 5% of the time is a high flow. The higher the percent exceedance, the lower the flow.

A LDC is constructed from a FDC by multiplying the FDC by a concentration, which represents a numeric water quality threshold, and suitable unit conversion factors. The water quality threshold is usually a water quality criterion. The LDC then gives the loading capacity of the stream: at every flow. In other words, the LDC gives the maximum load that meets the water quality threshold. A FDC can be based on any flow interval. The Beaver Brook TMDL (NHDES, 2008) constructed a LDC based on a FDC for four-day average flow interval and the four-day average chronic criterion for chloride. A similar approach was used to develop chloride TMDLs for the impairments in Accotink Creek.

Chloride TMDLs for Accotink Creek were based on FDCs using four-day average flows and LDCs using the chronic chloride criterion of 230 mg/l. The Virginia chronic criterion for chloride was chosen as the water quality threshold for the LDC because, as shown in the previous section, it is a more conservative and protective endpoint. Chloride loads were calculated only for an extended winter season, November 1through April 30, which represent the months in which snow events occurred in the last 30 years. Chloride loads for the non-winter time period were not computed. FDCs were restricted to four-day average flows from the extended winter season. Based on Technical Advisory Committee (TAC) member recommendations at the October 28, 2016 TAC meeting, it was decided, however, that the TMDLs are expressed as average annual loads, recognizing that implementation initiatives will occur throughout the year.

There are two active U. S. Geological Survey (USGS) gauges where FDCs can be developed: Accotink Creek near Annandale (01654000), and Long Branch near Annandale (01654500), shown in **Figure ES-1**. Daily flow measurements extend back to 1947 for the gauge on Accotink Creek, but the USGS only began collecting data on Long Branch in February, 2013. Thirty years of flow data for the extended winter season, from November 1986 through April 2016, were used to calculate the FDC for Accotink Creek, while for Long Branch, the whole period of record through April, 2016 was used. **Figure ES-3** shows the four-day FDC restricted to the extended winter season for Accotink Creek, and **Figure ES-4** shows the same FDC for Long Branch.

LDCs were constructed for the gauge locations by multiplying the FDC by the 230 mg/l chloride chronic criterion. **Figure ES-5** shows the LDC for Accotink Creek and **Figure ES-6** shows the LDC for Long Branch. Also shown on the figures are the corresponding four-day average chloride loads calculated from flows and chloride concentrations estimated from continuous specific conductance measurements and the established chloride- specific conductance regression relation, discussed in the previous section.

As shown in **Figure ES-1**, the gauges are not located at the most downstream points in the impaired segments, so flows and loads have to be adjusted to represent the flows and loads at the downstream end of the impairments. Flows and consequently loads were adjusted by watershed area. Flow at the gauges were multiplied by the ratio of the area of the watershed draining to the downstream most point of the impairment compared to the area of the watershed draining to the USGS gauges. This was based on the assumption that flow at the downstream end of the impairment is equal to the gauge flow times the ratio of the impaired watershed to the gauge watershed. The USGS gauge on Accotink Creek near Annandale was used to set the loading capacity for both upper Accotink Creek and Lower Accotink Creek; the flows from the Long Branch gauge were used to set the loading capacity for the Long Branch impairment. **Table ES-5** gives the areal adjustments used for each impairment and the resulting average annual chloride loading capacity.

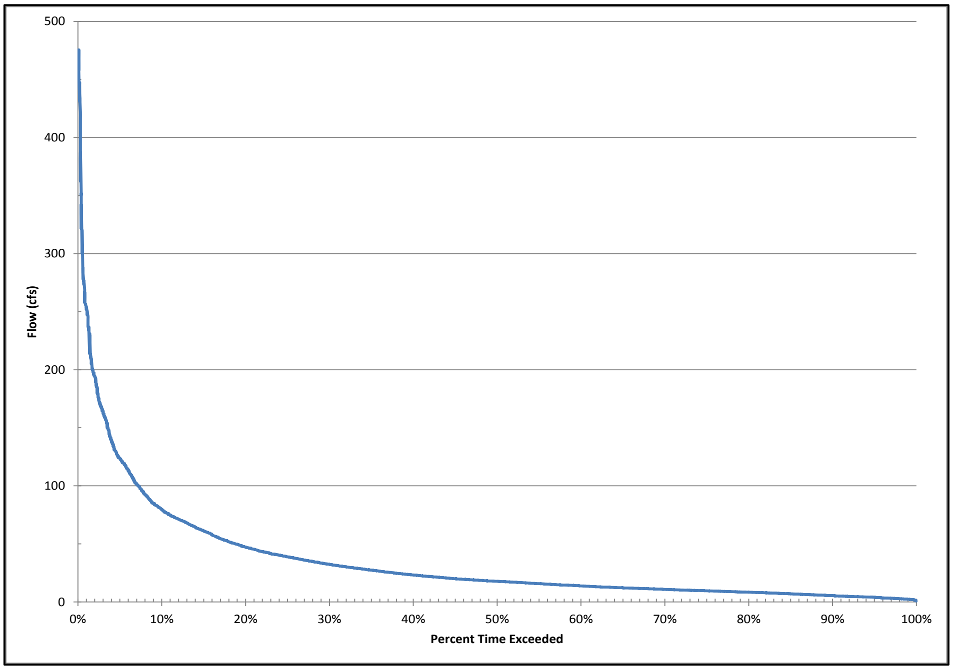

Figure ES-3: Flow Duration Curve, Four-Day Average Flow in Extended Winter Season, Accotink Creek near Annandale

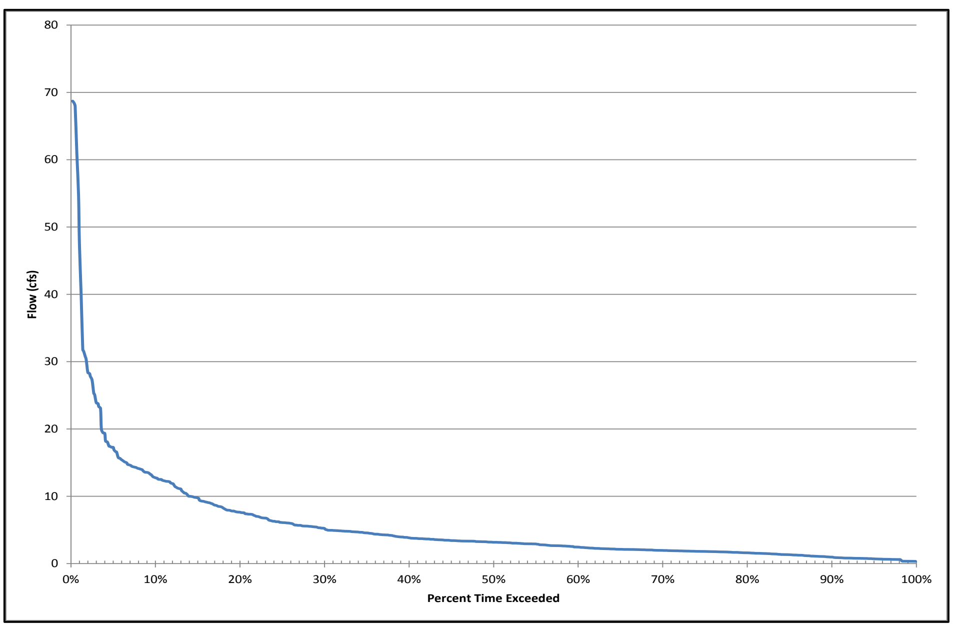

Figure ES-4: Flow Duration Curve, Four-Day Average Flow in Extended Winter Season, Long Branch near Annandale

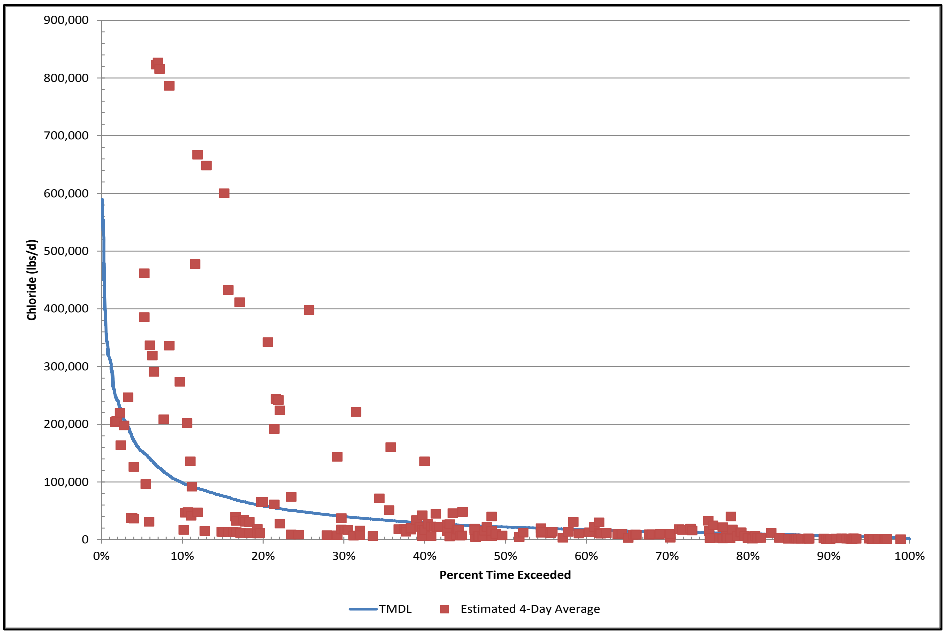

Figure ES-5: Four-Day Average Chloride Load in Extended Winter Season, Accotink Creek near Annandale, with Four-Day Average Chloride Load Estimated from Continuous Specific Conductance Monitoring Data and Linear Regression Model of Chloride-Specific Conductance Relation

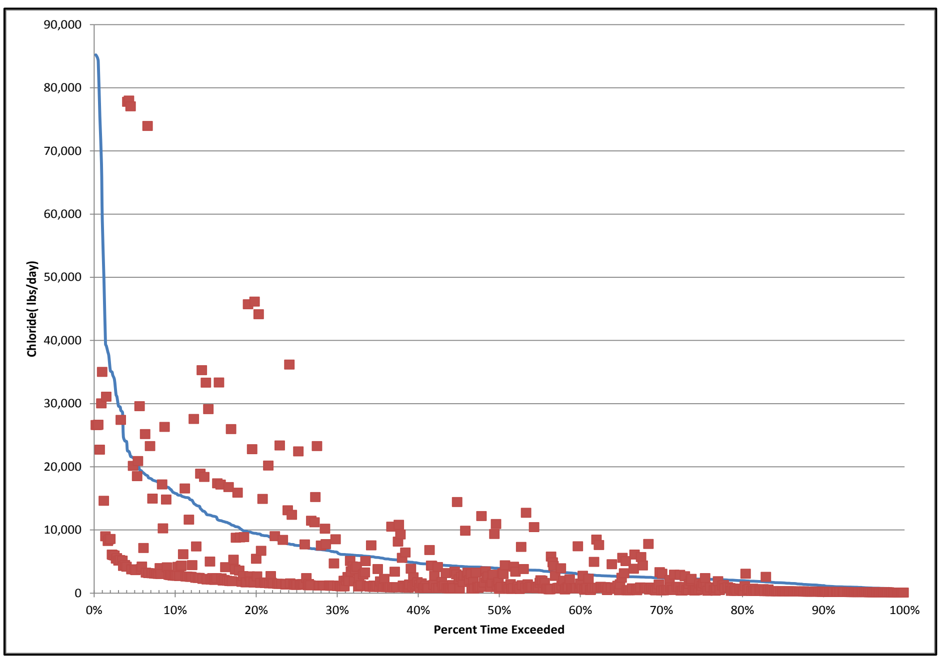

Figure ES-6: Four-Day Average Chloride Load in Extended Winter Season, Long Branch near Annandale, with Four-Day Average Chloride Load Estimated from Continuous Specific Conductance Monitoring Data and Linear Regression Model of Chloride-Specific Conductance Relation

Table ES-5: Area Correction of Impaired Watersheds Relative to Gauged Watersheds and Resulting Average Annual Chloride Loading Capacity (lbs/yr)

Watershed	Acres	Area Correction	Loading Capacity (lbs/yr)
Accotink Gauge	15,296	1.00	7,744,188
Upper Accotink Creek	18,784	1.23	9,510,027
Lower Accotink Creek	31,112	2.03	15,751,714
Long Branch Gauge	2,381	1.00	1,252,320
Long Branch	2,458	1.03	1,292,997

Given that a distribution of flows is available from a USGS gauge, the load duration approach provides an exact estimate of the load capacity of a waterbody, and therefore can more directly quantify the TMDL for a waterbody than other approaches that may depend on numerous assumptions. The load duration approach, however, is not able to estimate baseline current pollutant loads or to determine the source of pollutant loads or their geographic location, because it only estimates a single load at the associated gauge or watershed outlet.

TMDL Allocations

According to EPA regulations (CFR 130.2, 130.7), the TMDL must be assigned or allocated among regulated and non-regulated sources, according to the following equation:

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

where

WLA = Wasteload Allocation, which is the portion of the TMDL assigned to regulated or permitted sources;
LA = Load Allocation, which is the portion of the TMDL assigned to non-regulated sources
MOS = Margin of Safety

Each of the components of the TMDL is discussed in more detail below. TMDLs and allocations for downstream impairments exclude the impairments nested upstream, so the loading capacity for upstream impairments have to be subtracted from the downstream impairments. In other words, the TMDL for upper Accotink excludes Long Branch, and the TMDL for lower Accotink excludes both upper Accotink and Long Branch.

Margin of Safety. A MOS is necessary to take into account the uncertainty in the relation between pollutant loading rates and water quality. The MOS can be implicit or explicit. An implicit MOS is based on the conservative assumptions used to determine the TMDL. An explicit MOS reserves a portion of the TMDL to the MOS. A ten percent explicit margin of safety was used in addressing the chloride impairments in Accotink Creek.

Wasteload Allocation. The following sources will receive wasteload allocations:

- Municipal separate storm sewer system (MS4s) discharges authorized under both individual and general permits;
- Individual VPDES permitted facilities; and
- Industrial stormwater discharges authorized under the general permit.

The WLA also includes an allocation for future growth.

Wasteload allocations will be given to stormwater discharges only. Process water discharges are considered *de minimis* with respect to chloride. That is, chloride loads in process water from these facilities are not considered to occur at levels to cause or contribute to the impairment. Therefore, no wasteload allocation will be given to process water from concrete product facilities, car washes, cooling water, or other activities regulated by general permits. Similarly, no wasteload allocation will be given to process water discharged under individual permits. For facilities under individual and general VDPES industrial stormwater permits, the wasteload allocation is based on the area drained by their outfall:

Industrial Stormwater WLA = (outfall drainage area/area of impairment watershed) * (TMDL – MOS)

Because the load duration method does not enable the specification of loads by geographic area, all permitted industrial stormwater discharges are aggregated under a single WLA for each impairment. This aggregation is in line with the emphasis placed on implementation, as discussed in **Section 5** on TMDL Implementation.

MS4s also receive a single aggregated WLA for each impairment, not only because the load duration method does not enable the specification of loads by geographic area, but also because the MS4 service areas tend to overlap. The aggregated MS4 WLA is proportional to the area of the impaired watershed in some service area or another. In other words, if an area of the watershed is in at least one MS4 service area, it is included in the MS4 WLA, with one exception: any area draining to a permitted industrial stormwater outfall is not included in the MS4 WLA, even if it is in a MS4 service area. In these cases the permitted industrial stormwater WLA is subtracted from the MS4 WLA. The aggregated WLA for MS4 is thus

MS4 WLA = (area of watershed covered by at least one MS4 service area - drainage area to industrial stormwater outfalls in service area)/(area of impaired watershed)*(TMDL-MOS)

In the upper Accotink Creek and lower Accotink Creek watersheds, future growth was accounted for by setting aside 5% of the TMDL for the creation of new point sources and any growth in MS4 service areas or other regulated stormwater. A future growth of 5% was chosen due to the large proportion of these watersheds that are already covered by MS4 service areas and the anticipated expansion in regulated stormwater. However, in the Long Branch watershed, because there is little room for MS4s or other regulated stormwater to grow, a future growth of 1% of the TMDL was used to account for any future growth in point sources. Most of these watersheds are highly developed. Therefore, any potential expansion of a MS4 service area or other regulated stormwater would not likely entail a change in existing land use. Rather, it would simply be a reallocation of loadings from the LA portion of the TMDL to the WLA component. Accordingly, in all three watersheds the future growth was taken from the LA and provides flexibility to the permitting authority to implement changes to regulated stormwater as they occur over time.

Load Allocation. The load allocation primarily covers loads from areas outside either MS4 service areas or the drainage areas to industrial stormwater outfalls. The formula for the LA is

LA = TMDL –MOS –WLA

Allocations for Individual Impairments

Table ES-6 gives the TMDL, MOS, WLAs, and LA for upper Accotink Creek. Following the principle of not nesting impairments, the TMDL and allocations do not include the Long Branch watershed. **Table ES-7** gives the MS4s included in the aggregate MS4 WLA and **Table ES-8** gives the facilities included in the aggregate industrial stormwater WLA.

Table ES-9 gives the TMDL, MOS, WLAs, and LA for lower Accotink Creek. Following the principle of not nesting impairments, the TMDL and allocations do not include the upper Accotink Creek or Long Branch watersheds. **Table ES-10** gives the MS4s included in the aggregate MS4 WLA and **Table ES-11** gives the facilities included in the aggregate industrial stormwater WLA.

Table ES-12 gives the TMDL, MOS, WLAs, and LA for Long Branch. **Table ES-13** gives the MS4s included in the aggregate MS4 WLA. At this time there are no industrial stormwater discharges in the watershed, but future growth component of the WLA may be used to account for growth in existing MS4 permits, new VPDES permits, and/or VPDES permits that may be assigned to existing discharges in the watershed should they be required. The allocation for future growth, which was subtracted from the LA, was set at 1% of the total TMDL.

Table ES-6: TMDL for Upper Accotink Creek

Source	Load (lbs/yr)	Percent of TMDL
Total WLA	**5,444,279**	66%
Aggregate MS4 WLA	4,972,399	61%
Aggregate Industrial Stormwater WLA	61,028	<1%
Future Growth	410,852	5%
LA	**1,951,048**	24%
MOS	**821,703**	10%
TMDL (not including Long Branch)	**8,217,030**	100%
Long Branch Upstream TMDL	1,292,997	NA[1]
Total TMDL (including Long Branch)	9,510,027	NA[1]

[1]Not Applicable

Table ES-7: MS4s Included in the Aggregate MS4 WLA in Upper Accotink Creek

Permit No	Facility Name
VA0088587	Fairfax County
VA0092975	Virginia Department of Transportation
VAR040104	Fairfax County Public Schools
VAR040064	City of Fairfax
VAR040066	Town of Vienna
VAR040095	Northern Virginia Community College

Table ES-8: Facilities Included in the Aggregate Industrial Stormwater WLA in Upper Accotink Creek

Permit Type	Permit No	Facility
Individual	VA0001872	Joint Basin Corporation – Fairfax Terminal Complex
	VA0002283	Motiva Enterprises LLC – Fairfax
Industrial Stormwater	VAR051066	USPS Merrifield Vehicle Maintenance
	VAR051770	Fairfax County – Jermantown Maintenance Facility
	VAR052188	Milestone Metals

Table ES-9: TMDL for Lower Accotink Creek

Source	Load (lbs/yr)	Percent of TMDL
Total WLA	**3,723,479**	60%
Aggregate MS4 WLA	3,294,323	53%
Aggregate Industrial Stormwater WLA	117,071	2%
Future Growth	312,084	5%
LA	**1,894,040**	30%
MOS	**624,169**	10%
TMDL (not including upper Accotink Creek)	**6,241,688**	100%
Upper Accotink Creek and Long Branch Upstream TMDLs	9,510,027	NA[1]
Total TMDL (including upper Accotink Creek)	15,751,714	NA[1]

[1]Not Applicable

Table ES-10: MS4s Included in the Aggregate MS4 WLA in Lower Accotink Creek

Permit No	Facility Name
VA0088587	Fairfax County
VA0092975	Virginia Department of Transportation
VAR040104	Fairfax County Public Schools
VAR040093	Fort Belvoir

Table ES-11: Facilities Included in the Aggregate Industrial Stormwater WLA in Lower Accotink Creek

Permit Type	Permit No	Facility
Individual	VA0001945	Kinder Morgan Southeast Terminals LLC - Newington
	VA0001988	Kinder Morgan Southeast Terminals LLC - Newington 2
	VA0092771	Fort Belvoir
Industrial Stormwater	VAR051042	SICPA Securink Corporation
	VAR051047	Fairfax County – Connector Bus Yard (Huntington Garage)
	VAR051565	Rolling Frito Lay Sales LP – South Potomac DC
	VAR051771	Fairfax County – Newington Maintenance Facility
	VAR051772	Fairfax County-DVS – Alban Maintenance Facility
	VAR051795	HD Supply - White Cap
	VAR051863	United Parcel Service – Newington
	VAR052223	Newington Solid Waste Vehicle Facility
	VAR052366	Ready Refresh by Nestle-Lorton Branch

Table ES-12: TMDL for Long Branch

Source	Load (lbs/yr)	Percent of TMDL
Total WLA	**873,049**	68%
Aggregate MS4 WLA	860,119	67%
Aggregate Industrial Stormwater WLA	NA[1]	NA[1]
Future Growth	12,930	1%
LA	**290,648**	22%
MOS	**129,300**	10%
TMDL	**1,292,997**	100%

[1]Not Applicable. Currently there are no industrial stormwater discharges in the watershed.

Table ES-13: MS4s Included in the Aggregate MS4 WLA in Long Branch

Permit No	Facility Name
VA0088587	Fairfax County
VA0092975	Virginia Department of Transportation
VAR040104	Fairfax County Public Schools
VAR040064	City of Fairfax

TMDLs Expressed as Daily Loads. Based on the outcome of the 2006 court case, *Friends of the Earth vs. the Environmental Protection Agency, 446 F.3d 140, 144*, the EPA requires the establishment of a daily loading expression in TMDLs in addition to any annual or seasonal loading expressions established in the TMDLs. For the chloride impairments in Accotink Creek, the maximum average daily load was chosen as a representative daily load. Because only the extended winter season contributes chloride loads to the TMDL, the maximum average daily load was calculated for TMDLs and allocations as the average annual load, which was the extended winter seasonal load applied annually, divided by the number of days in the extended winter season, November through April, or 181.25 days, accounting for leap years. These average daily values are not intended to represent maximum allowable daily loads. Rather, they represent the average daily loadings that may be expected to occur over the long term when water quality criteria for chloride are met. **Tables ES-14**, **ES-15**, and **ES-16** present the maximum average daily chloride loads for upper Accotink Creek, lower Accotink Creek, and Long Branch, respectively.

Table ES-14: Maximum Average Daily Loads for Upper Accotink Creek

Source	Load (lbs/d)	Percent of TMDL
Total WLA	**30,037**	66%
Aggregate MS4 WLA	27,434	61%
Aggregate Industrial Stormwater WLA	337	<1%
Future Growth	2,267	5%
LA	**10,764**	24%
MOS	**4,534**	10%
TMDL (not including Long Branch)	**45,335**	100%
Long Branch Upstream Load	7,134	NA[1]
Total TMDL (including Long Branch)	52,469	NA[1]

[1]Not Applicable

Table ES-15: Maximum Average Daily Loads for Lower Accotink Creek

Source	Load (lbs/d)	Percent of TMDL
Total WLA	**20,541**	60%
Aggregate MS4 WLA	18,181	53%
Aggregate Industrial Stormwater WLA	638	2%
Future Growth	1,722	5%
LA	**10,453**	30%
MOS	**3,444**	10%
TMDL (not including upper Accotink Creek)	**34,437**	100%
Upper Accotink Creek Upstream Load	**52,469**	NA[1]
Total TMDL (including upper Accotink Creek)	**86,906**	NA[1]

[1]Not Applicable

Table ES-16: Maximum Average Daily Loads for Long Branch

Source	Load (lbs/d)	Percent of TMDL
Total WLA	**4,817**	68%
Aggregate MS4 WLA	4,745	67%
Aggregate Industrial Stormwater WLA	NA[1]	NA[1]
Future Growth	71	1%
LA	**1,604**	22%
MOS	**713**	10%
TMDL	**7,134**	100%

[1]Not Applicable. Currently there are no industrial stormwater discharges in the watershed.

TMDL Implementation

Once a TMDL has been approved by EPA, measures must be taken to reduce pollution levels from both point and non-point sources.

DEQ recognizes that public safety must remain the highest priority and believes that water quality concerns identified through the TMDL for CL can be addressed while still maintaining the high standards of public safety during snow/ice events. Furthermore, DEQ believes there is opportunity to improve water quality and reduce costs associated with snow/ice events through the use of best management practices. Implementation of the TMDL will focus on best management practices that include training and use of more efficient and effective technologies. DEQ encourages the public to participate in the effort to improve water quality by following recommended practices for salt application and by adhering to the transportation authority's driving recommendations during snow/ice events.

Virginia intends for the voluntary and required control actions to be implemented in an iterative or staged process that first addresses those sources with the largest impact on water quality. The goal of the staged implementation effort is what the Minnesota Pollution Control Agency (MPCA) (2016) calls "smart salting:" adopting winter maintenance practices which apply the minimal chloride deicers consistent with public safety."

In an effort to assist both regulated and non-regulated entities efficiently and effectively manage and apply deicers/anti-icers consistent with the assumptions and requirements of the TMDL, DEQ intends to lead the development of the Accotink Creek Salt Management Strategy (SaMS). The Accotink Creek CL TMDL is the first chloride TMDL in Virginia that focuses on winter anti-icing and deicing salt applications in an urban setting. The Accotink Creek CL TMDL was developed with the intent for it to be implemented collaboratively through performance-based goals using best management practices (BMPs). Acknowledging the critical need to maintain public safety, it is envisioned that the performance-based BMP approach will include training and use of improved technologies to more efficiently and effectively apply chlorides in a manner that still meets the high standards of public safety. The Accotink Creek SaMS is envisioned to be developed in-lieu of a traditional TMDL Implementation Plan for this chloride TMDL and is intended to accomplish the following:

1) Summarize the impacts of salts on the environment and local infrastructure.
2) Provide a resource for regulated and non-regulated entities to identify the appropriate BMPs and chemical options for their operations. Although developed for the Northern Virginia area, these practices may be applicable statewide.
3) Establish a suite of best practices that may be incorporated into subsequent VPDES permits, as applicable.
4) Identify potential economic benefits of proper salt management.
5) Bring partners of shared interests and resources together.
6) Highlight actions and measures to contribute to program goals, such as potential legislative initiatives, certification programs and enhanced regional coordination.
7) Organize a process for reporting and tracking salt usage.
8) Provide monitoring recommendations to evaluate the effectiveness of the strategy over time.

In general, Virginia intends for the voluntary and required control actions outlined in the envisioned Accotink Creek Salt Management Strategy to be implemented in an iterative process that first addresses those sources with the largest impact on water quality.

DEQ intends to facilitate the development of the aforementioned Accotink Creek Salt Management Strategy with support from regulated and non-regulated entities. With the Accotink Creek Salt Management Strategy functioning as an implementation guide, there is reasonable assurance that through adaptive, staged implementation of performance-based BMPs, the chloride TMDL WLAs will be addressed consistent with the TMDL and will lead to water quality improvements, all while maintaining the high standard for public safety.

Public Participation

Public participation was an essential element in the development of the chloride TMDLs for upper Accotink Creek, lower Accotink Creek, and Long Branch. Three public meetings and six Technical Advisory Committee (TAC) meetings were held over the course of the project. The following agencies, businesses, and organizations attended TAC meetings and participated in the development of the TMDLs for the Accotink Creek watershed:

Representation in Attendance at TAC Meetings

Braddock District Board of Supervisors[1]	Joint Basin Corporation - Fairfax Terminal Complex
Buckeye Partners[1]	Metropolitan Council of Governments
Catholic Diocese of Arlington	Northern Virginia Community College
Chesapeake Bay Foundation	Northern Virginia Building Industry Association (NVBIA) - Fairfax Chapter
City of Fairfax	Northern Virginia Regional Commission (NVRC)
Fairfax County Department of Public Works and Environmental Services	Stantec[1]
Fairfax County Department of Transportation	Town of Vienna - Public Works
Fairfax County Department of Vehicle Services	United Parcel Service - Newington
Fairfax County Park Authority	United States Geological Survey (USGS)
Fort Belvoir Department of Public Works	VA Department of Environmental Quality
Friends of Accotink Creek	Virginia Concrete Company Inc.
Friends of Lake Accotink Park	Virginia Department of Forestry
GKY & Associates, Inc.[1]	Virginia Department of Transportation (VDOT)
Regency Centers	Watershed residents[1]
Interstate Commission on the Potomac River Basin	Wetland Studies and Solutions, Inc.[1]

[1]Not official TAC members, but attended at least one meeting

1 Introduction

The Clean Water Act (CWA) requires that all waters of the United States support swimming, sustain and protect aquatic life, and maintain other beneficial uses such as water supply or shellfish propagation and harvest. Virginia has adopted water quality standards to meet the goals of the CWA. These standards specify (1) designated uses for waterbodies, such as a primary contact recreation use, to support swimming, or an aquatic life use, to sustain and protect aquatic life; (2) the water quality criteria necessary to support these uses; and (3) antidegradation policy to preserve existing uses, maintain waters whose quality exceeds standards, and protect waters of exceptional quality. The CWA also requires states to assess their waters to determine if they are meeting water quality standards. Waterbodies not meeting standards, i.e. impaired waterbodies, are documented in a state's biennial Integrated Assessment on the state's Integrated List (305(b)/303(d)).

Accotink Creek drains 52 square miles of Northern Virginia before entering first Accotink Bay, then Gunston Cove, on the tidal Potomac River. Long Branch (Central) is a tributary to Accotink Creek, joining it just upstream of Lake Accotink, an impoundment on Accotink Creek. While there are three tributaries named Long Branch in the Accotink Creek watershed, the tributary focused on in this study is Long Branch (Central), hereafter simply referred to as Long Branch. Based on benthic macroinvertebrate monitoring and assessments in the Accotink Creek watershed, the Virginia Department of Environmental Quality (DEQ) has placed Accotink Creek, both above and below Lake Accotink, and Long Branch on Virginia's 303(d) List of Impaired Waters (Category 5 of the Integrated List) because they are not supporting their Aquatic Life Use. **Figure 1-1** shows the location of the monitoring stations used in the assessment and the impaired stream segments. Hereafter, impaired segment A15R-01-BEN, as shown in **Figure 1-1**, will be referred to as lower Accotink Creek, segment A15R-04-BEN as upper Accotink Creek, and A15R-05-BEN as Long Branch.

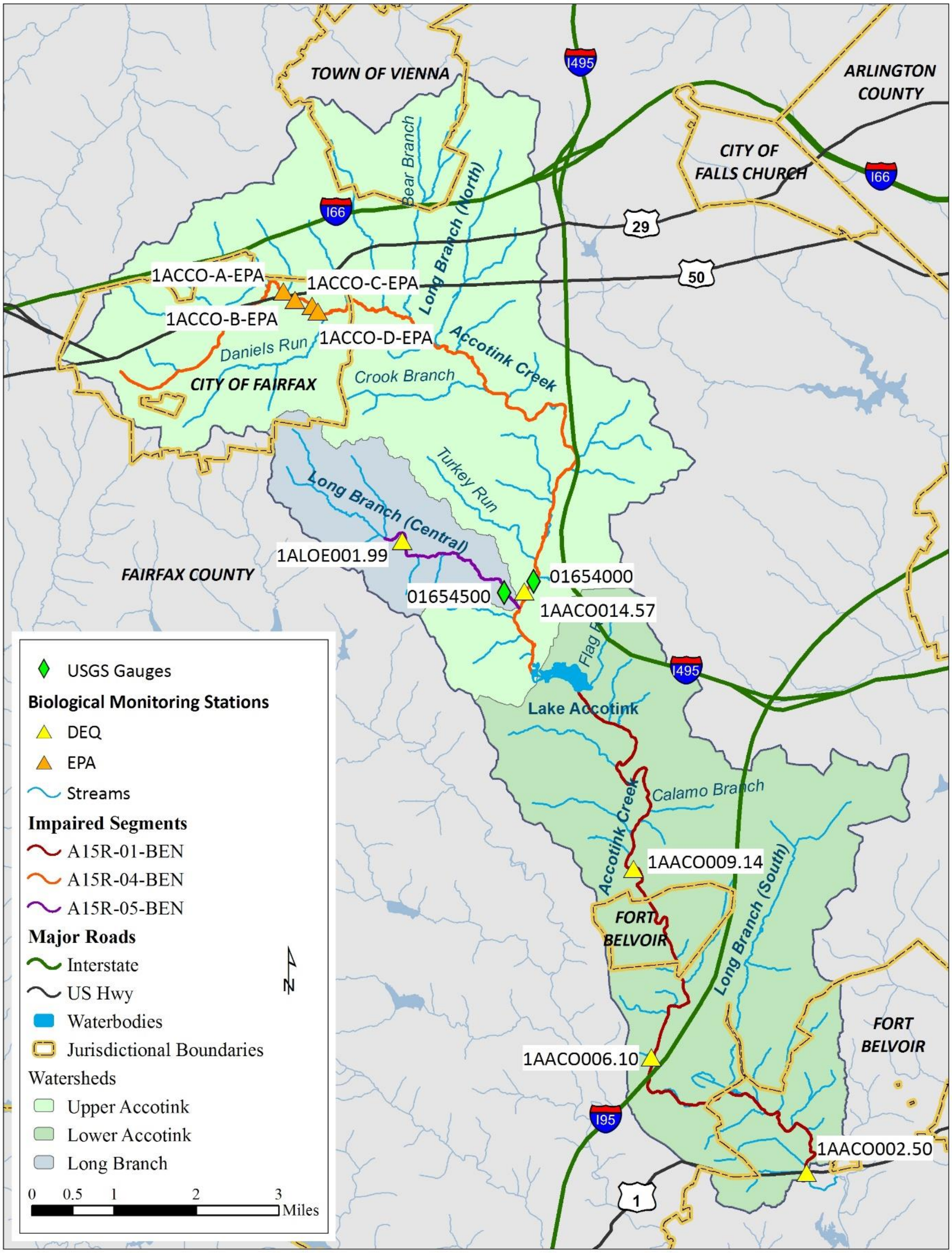

Figure 1-1: Location of the Impaired Segments in Accotink Creek Watershed

Because the benthic macroinvertebrate monitoring demonstrates that upper Accotink Creek, lower Accotink Creek, and Long Branch are not supporting their Aquatic Life Use, a Stressor Identification analysis (SI) was performed to determine the stressor(s) to the biological community in the Accotink Creek watershed (DEQ, 2017). SI is an analysis of evidence provided by monitoring data and scientific literature which attempts to identify the most likely stressors to the biological community, i.e. the causes of the biological impairment. While presented in detail as **Volume I** of this report, **Section 1.3** summarizes the results of the SI. Additionally, **Section 1.1** discusses the regulatory background to listing upper Accotink Creek, lower Accotink Creek, and Long Branch as biologically impaired, whereas **Section 1.2** reviews the biological impairment listing.

1.1 Applicable Water Quality Standards

Virginia's water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses. The standards applicable to the impairments in upper Accotink Creek, lower Accotink Creek, and Long Branch are discussed below.

1.1.1 Designated Uses

Designated uses are statutory management objectives for a waterbody. The CWA specifies that all waters must be "fishable and swimmable," that is, support their use for contact recreation and for sustaining a healthy aquatic community. According to Virginia water quality standards (9 VAC 25-260-5):

"all state waters are designated for the following uses: recreational uses (e.g. swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g. fish and shellfish)."

1.1.2 Water Quality Criteria

Water quality criteria can be numerical or narrative. The General Standard defined in Virginia water quality standards (9 VAC 25-260-20) provides general, narrative criteria for the protection of designated uses from substances that may interfere with attainment of such uses. The General Standards states:

"All state waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life."

1.1.3 Aquatic Life Use

DEQ uses biological monitoring of benthic macroinvertebrate communities as one way to evaluate the ecological health of wadeable freshwater streams and to help determine whether the Aquatic Life Use is supported. For non-coastal streams, assessment of the benthic macroinvertebrate community is based on the Virginia Stream Condition Index (VSCI). The VSCI is a multi-metric index of the biological integrity of the benthic community (Burton and Gerritsen, 2003). The benthic community at a monitoring location is measured against the benthic communities found in reference streams (streams with minimum anthropogenic impacts) using a suite of eight metrics. The VSCI combines these metrics into a single score. The VSCI and its component metrics are discussed in more detail in **Section 3.1** of **Volume I**.

Potential VSCI scores range from 0 to 100, with higher scores indicating relatively better ecological health. DEQ has set a score of 60 as the threshold for impairment. Scores below 60 indicate an impaired biological community.

1.2 Impairment Listings

Table 1-1 summarizes the impairment listings for upper Accotink Creek, lower Accotink Creek, and Long Branch in Virginia's 2014 Integrated Report (DEQ, 2016). The lower mainstem of Accotink Creek was first listed in 1996. The initial listing of the impairment started at the confluence of Calamo Branch and included the tidal waters of Accotink Bay. The downstream boundary of this impairment was adjusted in subsequent Water Quality Assessment Reports to cover only the free-flowing portion of the mainstem. The upstream boundary was extended to the outlet of Lake Accotink in 2010. In 2008, a 0.85 mile section of upper Accotink Creek, from an unnamed tributary in Ranger Park to the confluence with Daniels Run, was listed based on benthic macroinvertebrate assessments performed by the U.S. Environmental Protection Agency (EPA) at stations 1ACCO-A-EPA, 1ACCO-B-EPA, 1ACCO-C-EPA, and 1ACCO-D-EPA. The impairment was extended in the 2010 Integrated Report to include all of Accotink Creek from the headwaters to Lake Accotink, based on DEQ's benthic assessments at station 1ACCO014.57. Long Branch was listed in 2008, based on benthic assessments at station 1ALOE001.99.

Table 1-1: Accotink Creek Benthic Impairments

TMDL Watershed	Stream Name	Cause Group Code 303(d) Impairment ID	Description	Size	Assessment Unit 305(b) Segment ID	Initial Listing
Lower Accotink Creek	Accotink Creek	A15R-01-BEN	Begins at the outlet of Lake Accotink and continues downstream until the tidal waters of Accotink Bay.	10.09 mi	VAN-A15R_ACO01B10 VAN-A15R_ACO01A00	2010 1996
Upper Accotink Creek	Accotink Creek	A15R-04-BEN	Begins at the headwaters of Accotink Creek and continues downstream until the start of Lake Accotink	11.59 mi	VAN-A15R_ACO05A04 VAN-A15R_ACO04A02 VAN-A15R_ACO03A02 VAN-A15R_ACO02A00	2008 2010 2010 2010
Long Branch	Long Branch	A15R-05-BEN	Begins at the confluence with an unnamed tributary (UT) to Long Branch, at the Route 651 (Guinea Road) bridge, and continues downstream until the confluence with Accotink Creek, just below Braddock Road.	2.37 mi	VAN-A15R_LOE01A02	2008

Table 1-2 summarizes the VSCI scores from DEQ and EPA benthic assessments in the Accotink Creek watershed. **Figure 1-2** shows the VSCI scores by impairment. Scores from monitoring conducted on the same date in the same impaired waterbody have been averaged. All VSCI scores from sampling in upper Accotink Creek, lower Accotink Creek, and Long Branch are below 60, the VSCI impairment threshold score.

Table 1-2: Accotink Creek Watershed VSCI Scores

Impaired Segment	Date	Station	VSCI
Upper Accotink Creek	11/03/2005	1ACCO-A-EPA	21.2
	11/03/2005	1ACCO-B-EPA	29.1
	11/03/2005	1ACCO-C-EPA	24.3
	11/03/2005	1ACCO-D-EPA	24.0
	11/03/2005	1ACCO-D-EPA	27.8
	12/07/2005	1ACCO-A-EPA	21.5
	12/07/2005	1ACCO-B-EPA	25.1
	12/07/2005	1ACCO-C-EPA	30.7
	12/07/2005	1ACCO-D-EPA	23.1
	12/07/2005	1ACCO-D-EPA	28.0
	03/13/2006	1ACCO-A-EPA	25.2
	03/13/2006	1ACCO-B-EPA	23.9
	03/13/2006	1ACCO-C-EPA	26.3
	03/13/2006	1ACCO-D-EPA	28.7
	03/13/2006	1ACCO-D-EPA	25.6

Impaired Segment	Date	Station	VSCI
	05/23/2007	1AACO014.57	31.6
	11/07/2007	1AACO014.57	30.9
	06/01/2016	1AACO014.57	24.0
Lower Accotink Creek	11/04/1994	1AACO006.10	38.3
	05/18/1995	1AACO006.10	38.9
	11/29/1995	1AACO006.10	30.6
	05/30/1996	1AACO006.10	38.2
	11/18/1996	1AACO006.10	28.3
	06/01/2006	1AACO002.50	35.3
	06/01/2006	1AACO006.10	24.3
	11/21/2006	1AACO002.50	26.6
	11/21/2006	1AACO006.10	41.9
	04/30/2007	1AACO002.50	33.5
	04/30/2007	1AACO006.10	36.6
	11/01/2007	1AACO002.50	28.3
	11/01/2007	1AACO006.10	29.7
	05/30/2008	1AACO006.10	25.7
	05/30/2008	1AACO009.14	22.8
	10/31/2008	1AACO006.10	35.9
	10/31/2008	1AACO009.14	30.7
	06/01/2016	1AACO011.27	22.6
Long Branch	06/01/2006	1ALOE001.99	29.5
	09/19/2006	1ALOE001.99	24.5

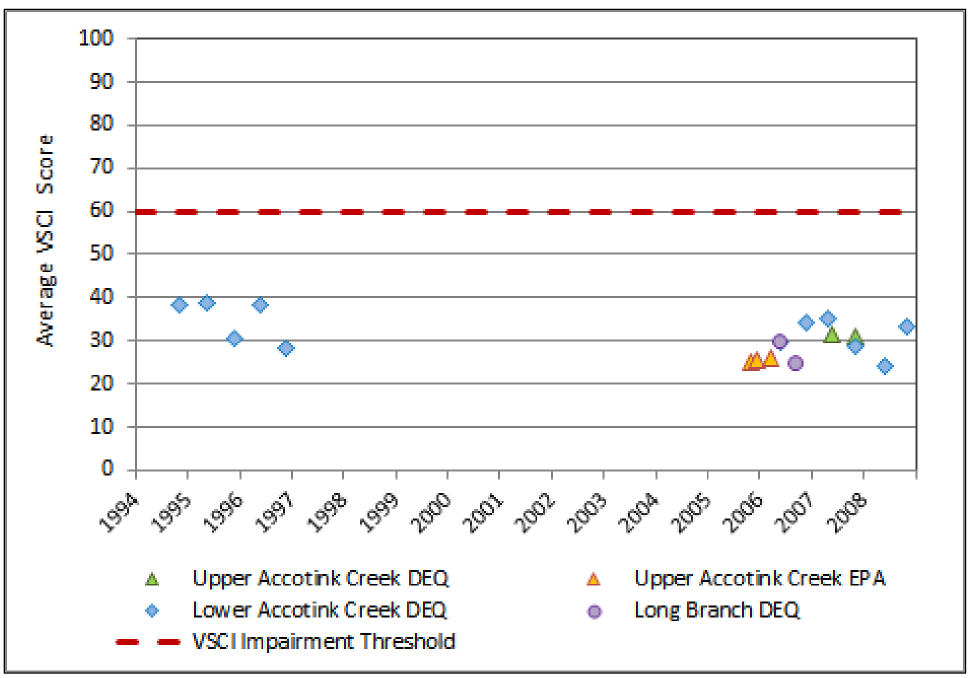

Figure 1-2: Average VSCI Scores for Upper Accotink Creek, Lower Accotink Creek, and Long Branch

The 2014 Integrated Report identifies other impairments in the Accotink Creek watershed. Lake Accotink is not meeting its Fish Consumption Use because of mercury and polychlorinated biphenyls (PCBs) in fish tissue. Both of these impairments were first listed in 2010. Accotink Creek from the outlet of Lake Accotink downstream to tidal waters is also not meeting its Fish Consumption Use because of PCBs in fish tissue. This impairment was also first listed in 2010. The Fish Consumption Use impairments in Lake Accotink and lower Accotink Creek remain on the 303(d) list and will be addressed at a future date.

Other impairments, identified in previous Assessment Reports, have already been addressed. Total Maximum Daily Loads (TMDLs) have been developed for fecal coliform in upper Accotink Creek and *E. coli* in lower Accotink Creek to address Recreational Use impairments. The impaired segment in upper Accotink Creek was first listed in 1998. It extended from the confluence with Crook Branch to Lake Accotink. The TMDL for fecal coliform was approved by the EPA in 2002. The impairment in lower Accotink Creek extended from Calamo Branch to tidal waters. It was first listed in 2004. The EPA approved the TMDL for *E. coli* in 2008. Tidal Accotink Creek, which was not meeting its Fish Consumption Use because of PCBs in fish tissue, was included in an interstate TMDL developed to address PCB impairments in the tidal Potomac River and its embayments. That TMDL was approved by the EPA in 2007.

1.3 Results of the Stressor Identification Analysis for the Accotink Creek Watershed

Section 303(d) of the CWA and the EPA's Water Quality Planning and Management Regulations (40 CFR part 130) generally require states to develop TMDLs for waterbodies that are not meeting water quality standards. TMDLs represent the total pollutant loading that a waterbody can receive without exceeding water quality standards. Impaired waterbodies requiring TMDLs are listed in Category 5 of the Integrated Report. Currently, upper Accotink Creek, lower Accotink Creek, and Long Branch are listed for aquatic life use impairments in Category 5 on Virginia's Integrated Report.

Biological monitoring in the Accotink Creek watershed has determined that these waterbodies are not supporting their Aquatic Life Use, but the biological monitoring does not determine the cause of the biological impairments in these waterbodies. Until the underlying cause(s) of the biological impairments have been determined, there is no way of knowing what actions will most effectively address the impairment. A Stressor Identification analysis (SI) was performed to determine the stressor(s) to the biological community in the Accotink Creek watershed (DEQ, 2017). The SI report is **Volume I** of this report.

The SI for upper Accotink Creek, lower Accotink Creek, and Long Branch examined ten potential stressors to determine the strength of the evidence linking them to the biological impairments in these streams. Based on an evaluation of the monitoring data and the scientific literature, the potential stressors were divided into three categories:

1) **Least Probable Stressors**: Stressors with data indicating normal conditions, without water quality exceedances, or without any observable impacts usually associated with stressors.
2) **Possible Stressors**: Stressors with evidence indicating possible link to the biological impairment, but the evidence is inconclusive.
3) **Most Probable Stressors**: Stressor(s) with the most consistent evidence linking them to the biological impairment.

Table 1-3 gives the results of the stressor identification analysis for upper Accotink Creek, lower Accotink Creek, and Long Branch.

Table 1-3: Categorization of Potential Stressors in Accotink Creek Watershed

Category	Stressor	
Least Probable Stressors	Temperature Dissolved Oxygen	pH Metals
Possible Stressors	Nutrients	Toxics
Most Probable Stressors	Chloride Sediment	Hydromodification Habitat Modification

Chlorides, hydromodification, habitat modification, and sediment have been identified as the most probable stressors of the biological communities in the Accotink Creek watershed. Once the stressor(s) have been identified, TMDLs can be developed for any pollutant identified as a stressor of the biological community; however, not all stressors are pollutants amenable to TMDL development. The CWA distinguishes the general class of pollution, defined as "the man-made or man-induced alteration of physical, biological, chemical, and radiological integrity of water and other media (CWA, Section 502, General Definitions)," from pollutants, which are restricted to "[d]redged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dust and industrial, municipal, and agricultural waste discharge into water (CWA, Section 502, General Definitions)." TMDLs can only be developed for pollutants. If a stressor is not a pollutant, EPA guidance (EPA, 2015) provides an alternative category in the Integrated List, 4C, for waterbodies impaired by pollution not caused by a pollutant.

Of the four most probable stressors, only chloride and sediment are pollutants. As specified in the CWA, TMDLs should be developed for sediment and chloride for each of the three impaired segments in the Accotink Creek watershed. The sediment TMDLs are described in **Volume II** of this report. This volume, **Volume III**, describes the development of chloride TMDLs for upper Accotink Creek, lower Accotink Creek, and Long Branch, to help address the biological impairments in those watersheds. The following section reviews the evidence that chloride is most probably a stressor of the biological community in the Accotink Creek watershed.

1.3.1 Review of the Evidence that Chloride is a Stressor of the Biological Community in the Accotink Creek Watershed

Elevated concentrations of chloride and other ions can disrupt the osmotic regulation of aquatic organisms. Virginia has acute and chronic water quality criteria for CL. These criteria are based on EPA recommendations derived from toxicological studies on a wide variety of aquatic organisms (EPA, 1988; Siegel, 2007). Virginia water quality standards include an acute maximum CL concentration criterion of 860 mg/l and a chronic maximum concentration criterion of 230 mg/l to protect aquatic life. The acute criterion is for a one-hour average not to be exceeded more than once every three years; the chronic criterion applies to a four-day average, which is also not to be exceeded more than once every three years (9VAC25-260-140).

Figures 1-3, 1-4, and 1-5 show the concentrations of chloride observed in water quality samples from upper Accotink Creek, lower Accotink Creek, and Long Branch respectively. Seven observed chloride concentrations in upper Accotink Creek, two concentrations in lower Accotink Creek, and one concentration in Long Branch exceed the 860 mg/l acute criterion. These are shown in **Table 1-4**. **Table 1-5** shows the individual observed chloride concentrations that exceeded the 230 mg/l chronic criterion. The chronic criterion applies to a four-day average concentration, and can be evaluated if two or more samples are collected on different days in a four-day period. Using that rule-of-thumb, the snowmelt in late January, 2016 and the combined snow and rain event in February, 2016, exceeded the 4-day chronic criterion in upper Accotink Creek, Lower Accotink Creek, and Long Branch.

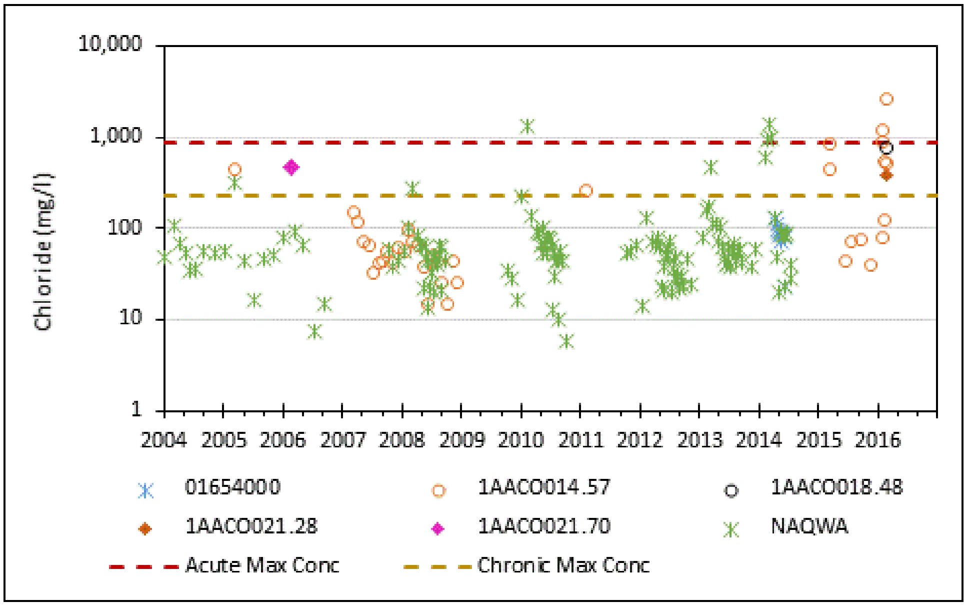

Figure 1-3: Observed Chloride (mg/l) in Upper Accotink Creek

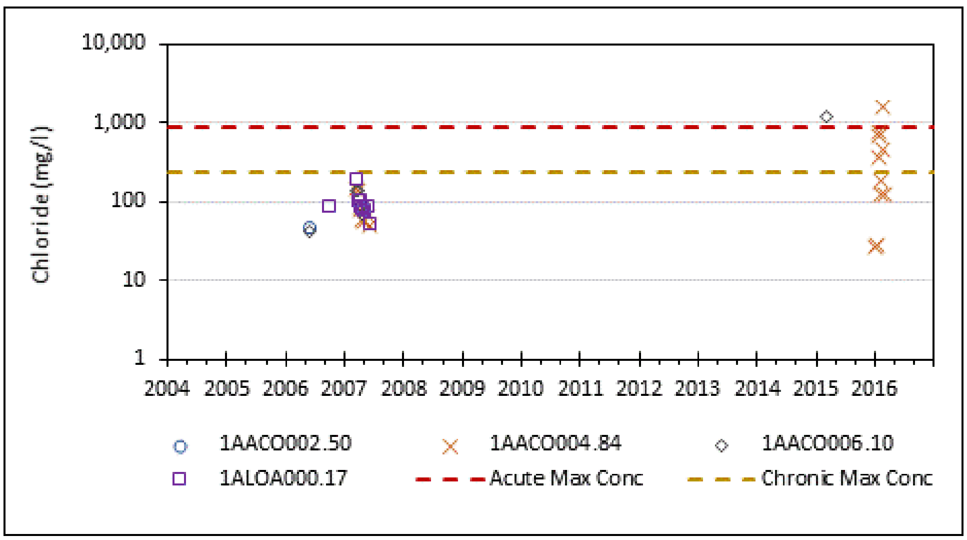

Figure 1-4: Observed Chloride (mg/l) in Lower Accotink Creek

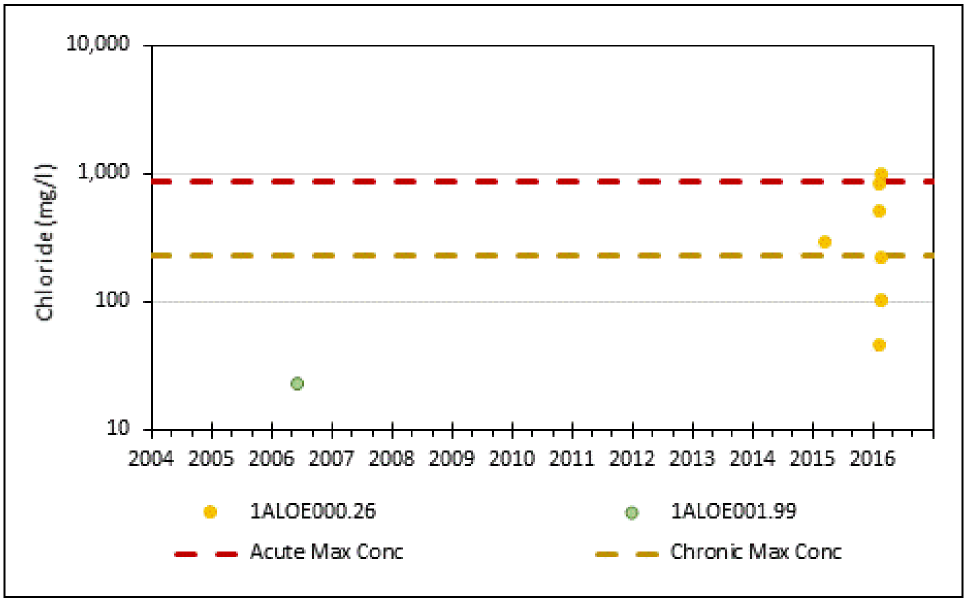

Figure 1-5: Observed Chloride (mg/l) in Long Branch

Chloride and other ions occur naturally in waters as a function of mineral composition of soils and bedrock. In urban watersheds, however, deicing salt is the primary source of chloride (Paul and Meyer, 2001). Deicing salt, applied to roads, sidewalks, driveways, etc., is likely to be a major source of CL in developed areas like Accotink Creek. **Figure 1-6** shows the average monthly CL concentrations in upper and lower Accotink Creek. Monthly CL concentrations generally have higher concentrations in the winter months.

Table 1-4: Observed Chloride Concentrations Exceeding the Acute Chloride Criterion

Watershed	Agency	Station	Date	Chloride (mg/l)
Upper Accotink Creek	USGS	01654000	2/02/2010	1,320
	USGS	01654000	2/19/2014	925
	USGS	01654000	3/05/2014	1,410
	USGS	01654000	3/19/2014	977
	DEQ	1AAC0014.57	1/27/2016	1,210*
	DEQ	1AAC0014.57	1/28/2016	888*
	DEQ	1AAC0014.57	2/16/2016	2,570
Lower Accotink Creek	DEQ	1AAC0004.84	3/04/2015	1,160
	DEQ	1AAC0004.84	2/16/2016	1,580*
Long Branch	DEQ	1ALOE000.26	2/16/2016	1,010*

[1]The acute criterion is a one-hour average of 860 mg/l, not to be exceeded more than once every three years.
*These values were also used in the calculation of chronic criterion exceedances.

Table 1-5: Observed Chloride Concentrations Exceeding the Chronic Chloride Criterion

Watershed	Agency	Station	Date	Chloride (mg/l)
Upper Accotink Creek	USGS	01654000	2/02/2010	1,320
	USGS	01654000	2/19/2014	925
	USGS	01654000	3/05/2014	1,410
	USGS	01654000	3/19/2014	977
	DEQ	1AACO014.57	1/27/2016	1,210*
	DEQ	1AACO014.57	1/28/2016	888*
	DEQ	1AACO014.57	2/16/2016	2,570*
	DEQ	1AACO014.57	2/18/2016	504*
Lower Accotink Creek	DEQ	1AACO004.84	3/04/2015	1,160
	DEQ	1AACO004.84	1/26/2016	367*
	DEQ	1AACO004.84	1/27/2016	681*
	DEQ	1AACO004.84	1/28/2016	767*
	DEQ	1AACO004.84	2/16/2016	1,580*
	DEQ	1AACO004.84	2/18/2016	448*
Long Branch	DEQ	1ALOE000.26	1/27/2016	847*
	DEQ	1ALOE000.26	1/28/2016	526*
	DEQ	1ALOE000.26	2/16/2016	1,010*
	DEQ	1ALOE000.26	2/18/2016	504*

[1]The chronic criterion is a four day average of 230 mg/l, not to be exceeded more than once every three years.

*These values were used to calculate chronic criterion exceedances for the associated 4-day window.

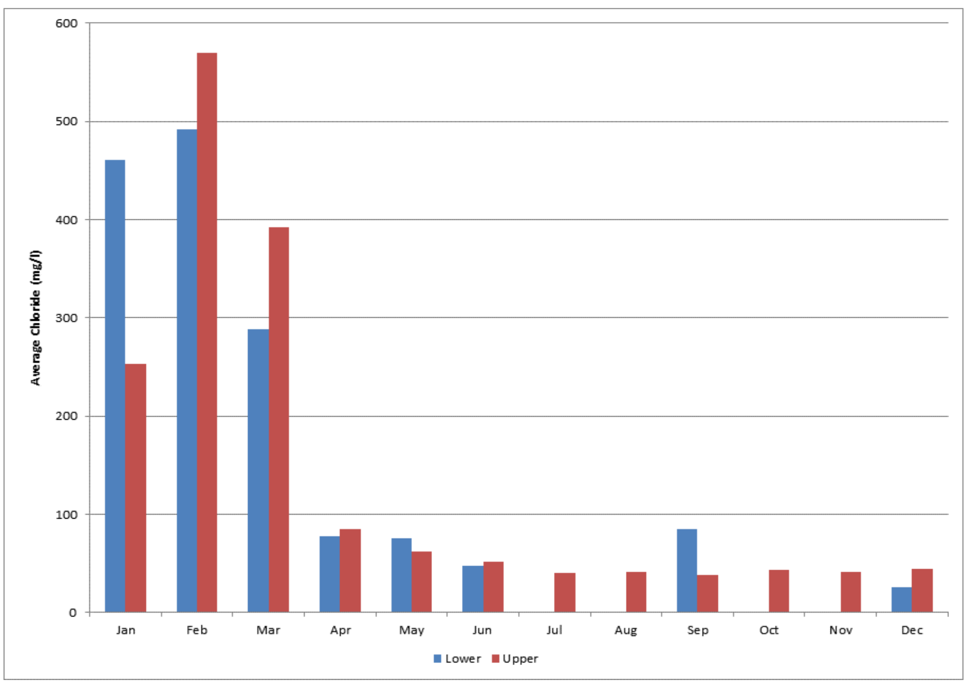

Figure 1-6: Average Monthly Chloride concentration (mg/l) in Accotink Creek

Chloride is a major anion contributing to SC so it can be expected that SC and CL are strongly correlated. **Figures 1-7**, **1-8, and 1-9** demonstrate the strength of the correlation in upper Accotink Creek, lower Accotink Creek, and Long Branch, respectively. The coefficient of determination (R^2) between CL and SC is greater than 0.99 for all three watersheds.

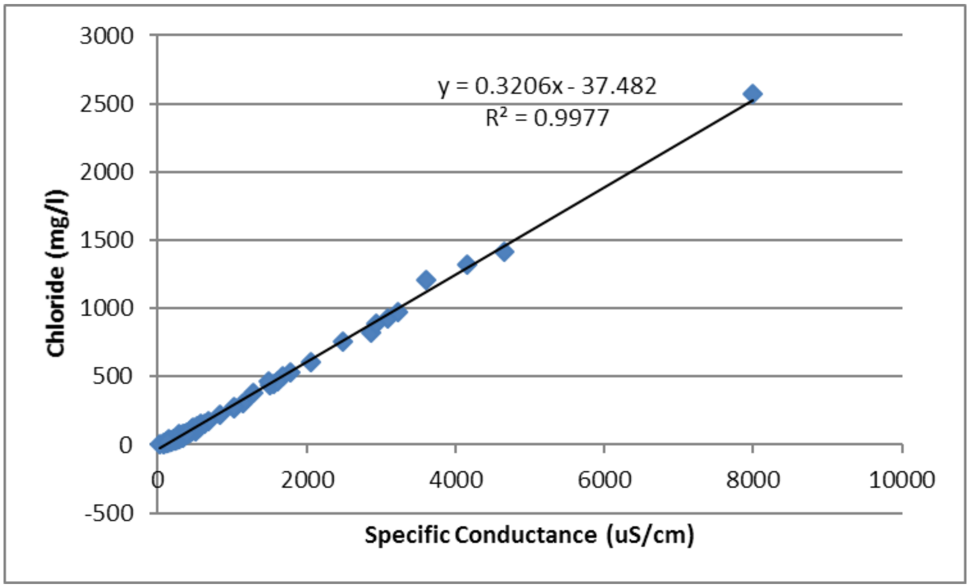

Figure 1-7: Correlation between Chloride and Specific Conductance, Upper Accotink Creek

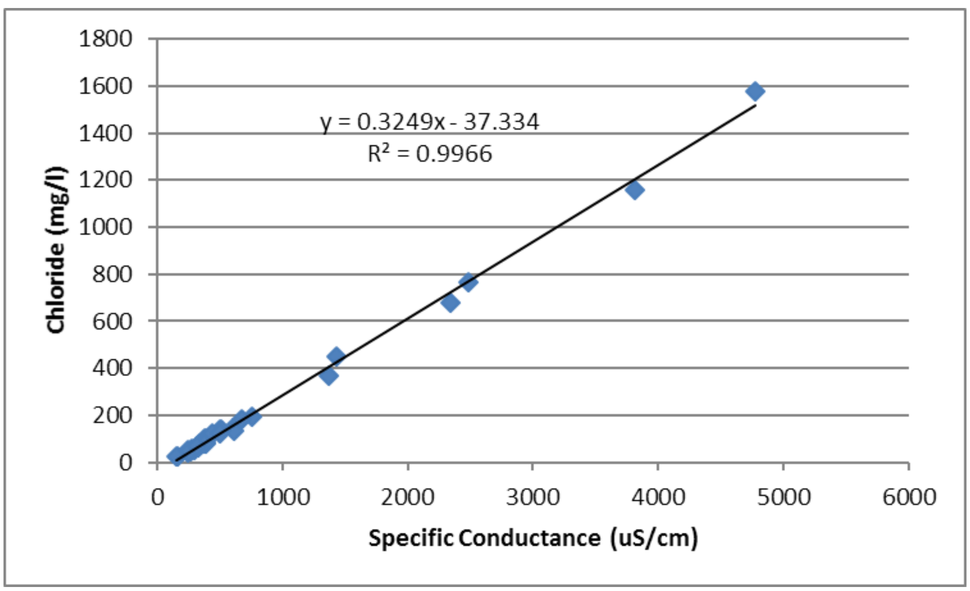

Figure 1-8: Correlation between Chloride and Specific Conductance, Lower Accotink Creek

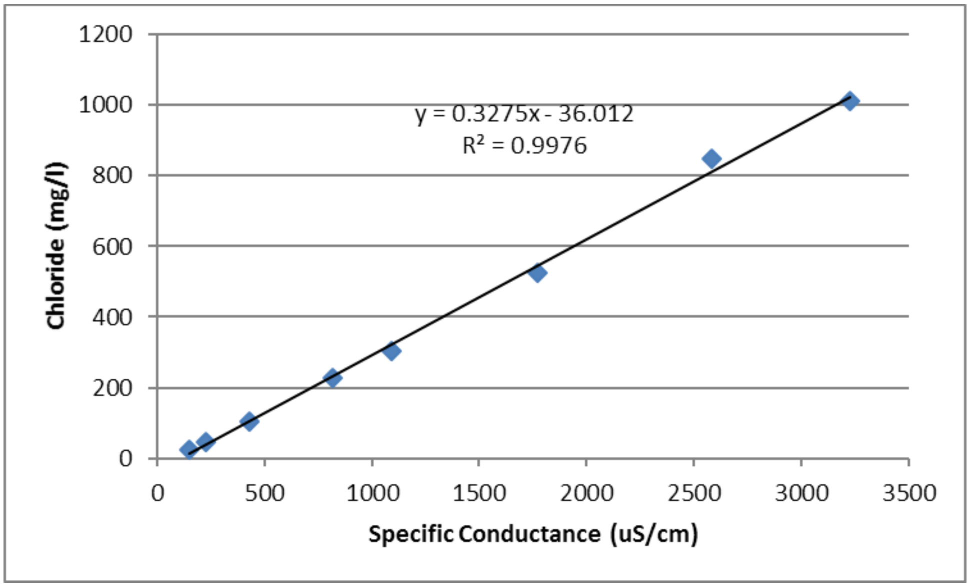

Figure 1-9: Correlation between Chloride and Specific Conductance, Long Branch

Strong indirect evidence that both the acute and chronic water quality criteria for CL frequently are exceeded can be derived from (1) continuous monitoring data of SC, described in **Section 3.5.4** of **Volume I**; and (2) the strong correlation between SC and CL. SC continuous monitoring data is available at (1) the USGS gauge on Accotink Creek near Annandale (01654000), from 2/5/2015 to the present; (2) the USGS gauge on Long Branch near Annandale (01654500), from 4/17/2013 to the present; and (3) the DEQ monitoring station on Accotink Creek at Telegraph Road (1AAC0004.84), from 1/11/2016 to 2/29/2016. These monitoring locations are shown on **Figure 1-1**. As **Figures 1-7**, **1-8, and 1-9** show, linear regression of CL on SC grab samples yield CL:SC ratios of 0.32, 0.32, and 0.33, respectively, for upper Accotink Creek, lower Accotink Creek, and Long Branch. These results are consistent with a study of the neighboring watershed of Difficult Run, where Sanford et al. (2011) found that the ratio of CL to SC was 0.33 when SC is greater than 1,000 µS/cm. Applying the corresponding CL:SC regression equation to the SC continuous monitoring data from upper Accotink Creek, lower Accotink Creek, and Long Branch yields estimated chloride concentrations shown in **Figures 1-10, 1-11,** and **1-12**, respectively, where estimated chloride concentrations below 40 mg/l have been set to 40 mg/l, which is approximately the average concentrations observed in the summer months, as shown by **Figure 1-6**. Note, while **Figures 1-10** and **1-12** show estimated chloride concentrations for upper Accotink Creek and Long Branch over more than 1 full winter season, **Figure 1-11** shows estimated chloride concentrations for lower Accotink Creek that runs only 50 days in January-February 2016. Furthermore, note that chloride concentrations typically exceed criteria during winter months in patterns that suggest that chloride water quality standard exceedances are driven by stormwater carrying deicing salts.

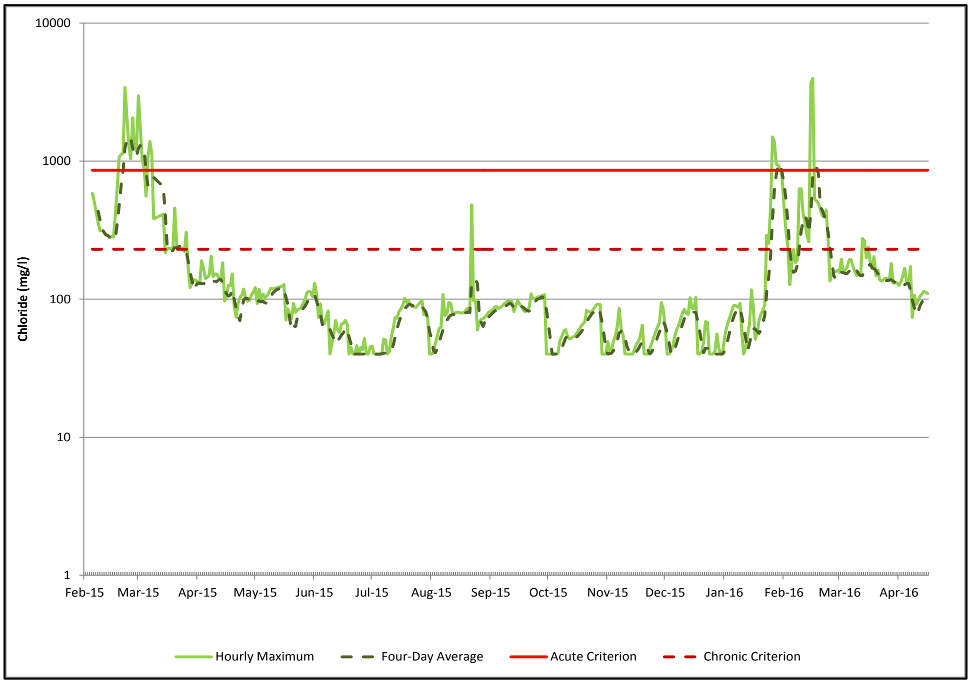

Figure 1-10: Estimated Chloride (mg/l), Upper Accotink Creek

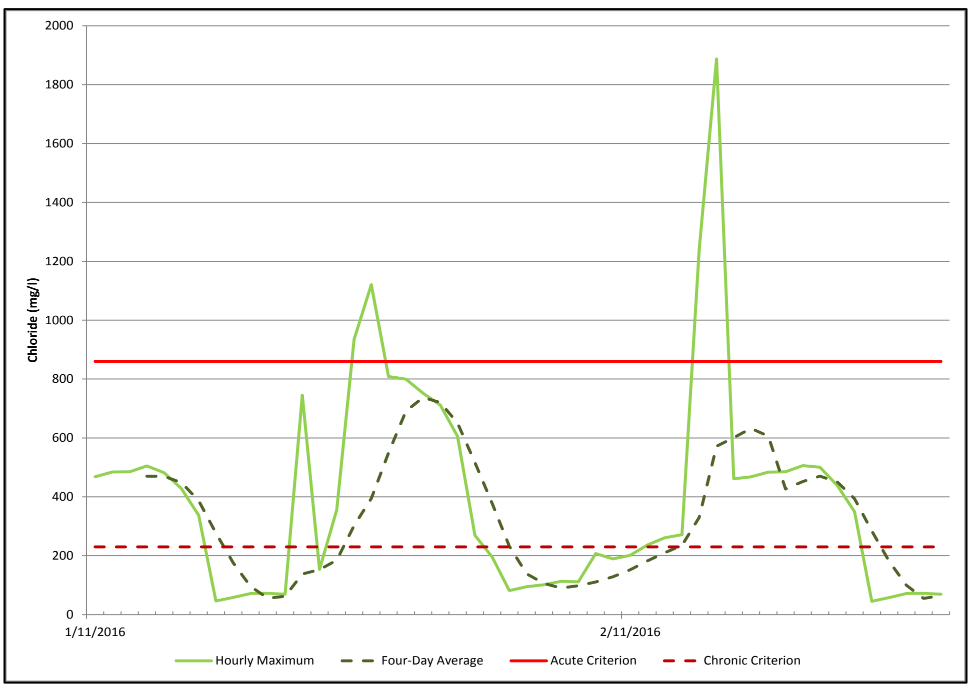

Figure 1-11: Estimated Chloride (mg/l), Lower Accotink Creek

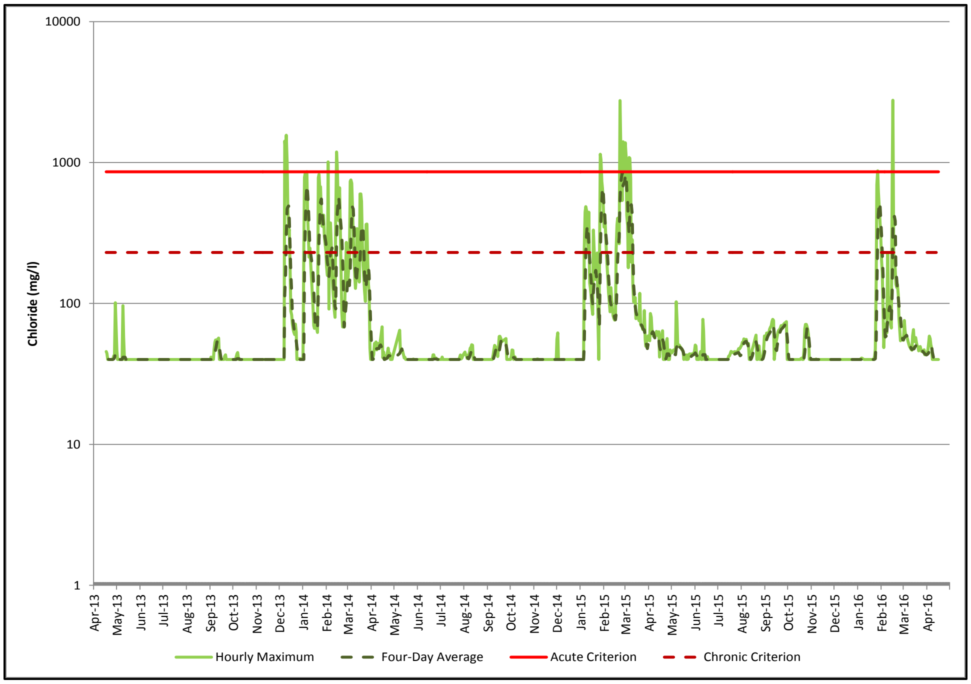

Figure 1-12: Estimated Chloride (mg/l), Long Branch

Table 1-6 shows the frequency at which the estimated chloride concentrations exceed the acute criterion and chronic criterion in each watershed during November 1 through April 30, the months in which snow has fallen in the Washington metropolitan area during the last 30 years. As the table shows, both criteria are exceeded by estimated chloride concentrations in upper Accotink Creek, lower Accotink Creek, and Long Branch. Maximum estimated chloride concentrations in upper Accotink Creek, lower Accotink Creek, and Long Branch are 3,978, 1,887, and 2,766 mg/l, respectively. To meet the acute criterion for chloride, which allows no more than one chloride concentration exceeding 860 mg/l every three years, would require reductions of 77%, 31%, and 69% in upper Accotink Creek, lower Accotink Creek, and Long Branch, respectively. The chronic criterion tends to be exceeded at a higher frequency than the acute criterion. Maximum estimated four-day average chloride concentrations in upper Accotink Creek, lower Accotink Creek, and Long Branch are 1,474, 737, and 826 mg/l, respectively. To meet the chronic criterion for chloride, which allows no more than one four-day average chloride concentration exceeding 230 mg/l every three years, would require reductions of 84%, 68%, and 72% in upper Accotink Creek, lower Accotink Creek, and Long Branch.

Table 1-6: Exceedances of Chloride Criteria by Estimated Chloride Concentrations, November through April

Criterion	Exceedances	Upper Accotink (2/5/15-4/16/16)[1]	Lower Accotink (1/11/16-2/29/16)[1]	Long Branch (4/17/13-4/16/16)[1]
Acute Criterion	Total Days	249	50	533
	Days with Exceedances	24	8	20
	Percent Exceedance	10%	16%	4%
Chronic Criterion	Total Days	249	50	533
	Days with Exceedances	64	27	86
	Percent Exceedance	26%	54%	16%

[1]Period of record for continuous monitoring of SC. All criteria exceedances occurred during the months of November through April.

2 Watershed Description

This section describes the Accotink Creek watershed in greater detail. **Section 2.1** discusses topography, hydrogeomorphic regions, soils, land use, population, and housing. **Section 2.2** describes permitted facilities, regulated stormwater, and waste disposal.

2.1 Watershed Description and Identification

Accotink Creek drains approximately 52 mi^2 of Northern Virginia. **Figure 2-1** shows the location of Accotink Creek and its watershed. The mainstem of Accotink Creek begins in the City of Fairfax and flows southeast through Fairfax County and Fort Belvoir[1] before entering first Accotink Bay and then Gunston Cove, an embayment on the tidal Potomac River. Seventy-seven percent of the Accotink Creek watershed is in Fairfax County; the remainder is in the City of Fairfax (11%), Fort Belvoir (8%), and the Town of Vienna (4%). The headwaters of Accotink Creek are along Interstate 66. Most of the watershed is just outside the Capital Beltway. Accotink Creek crosses Interstate 95 near Springfield, VA, before entering the main post of Fort Belvoir.

The Accotink Creek watershed is highly developed. Overall, according to the analysis of zoning and planimetric data described in **Section 2.1.4**, 87% of the Accotink Creek watershed draining to the impaired segments consists of commercial, industrial, transportation, or residential land, and impervious surface covers 28% of the watershed draining to impaired segments.

[1] Fort Belvoir is a U.S. Army installation that is the headquarters of the National Geospatial-Intelligence Agency and many other Defense Department agencies. It is divided into two sections: Fort Belvoir North Area (803 acres) and the main post (9,530 acres). Under the 2005 Base Realignment and Closure (BRAC) Act, many defense department agencies were relocated to Fort Belvoir. It is currently one of the largest employers in Fairfax County and is expected to generate extensive development in the surrounding area (Fairfax County, 2013).

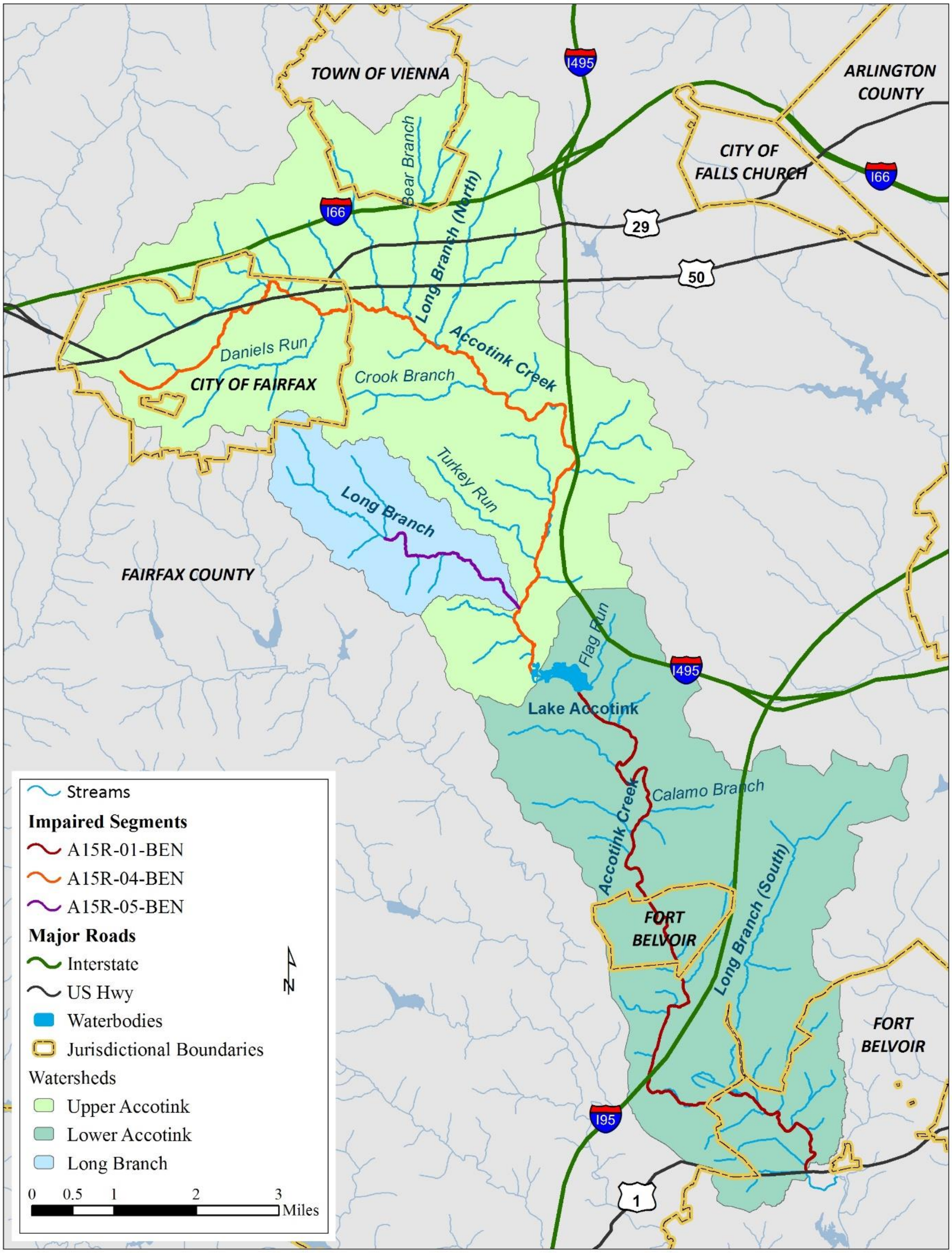

Figure 2-1: Location and Boundaries of the Accotink Creek Watersheds

Lake Accotink is a 55 acre impoundment on Accotink Creek in the middle of the watershed (Fairfax County, 2014). It was originally built in the 1940's as a drinking water reservoir for Fort Belvoir. The army stopped using it as a source of drinking water in the 1960's (Fairfax County Public Schools, 1976), and it is currently operated by the Fairfax County Park Authority for recreational use as part of the 493 acre Lake Accotink Park.

Figure 2-1 shows the impaired sections of Accotink Creek and Long Branch. Lake Accotink separates the two impaired sections of the mainstem Accotink Creek, A15R-01-BEN and A15R-04-BEN, which will be referred to as "lower Accotink Creek" and "upper Accotink Creek," respectively. **Figure 2-1** also shows the drainage areas associated with the two impairments. The drainage area for the upper Accotink Creek impairment terminates at the inlet to Lake Accotink. The drainage area for the lower Accotink Creek impairment includes the upper Accotink Creek drainage, the drainage of the tributaries to Lake Accotink, and direct drainage to the lake. The drainage areas above and below the inlet to Lake Accotink will also be referred to as the upper Accotink Creek watershed and the lower Accotink Creek watershed, respectively.

In addition, **Figure 2-1** shows the impaired section of Long Branch and the Long Branch watershed. There are two other tributaries to Accotink Creek named Long Branch: one has its headwaters north of Interstate 66, and the other runs parallel to Interstate 95 until it joints with Accotink Creek in Fort Belvoir (see **Figure 2-1**). These will be referred to as "Long Branch North" and "Long Branch South," respectively, while "Long Branch" will always refer to the impaired segment and its watershed.

2.1.1 Topography

A National Elevation Dataset (NED) was used to characterize the topography in the watershed (USGS, 1999). NED data obtained from the United States Geological Survey (USGS) show that elevation in the upper Accotink watershed, excluding the Long Branch watershed, ranges from approximately 184 to 492 ft above mean sea level, with an average elevation of 343 ft above mean sea level, while the elevation in the lower Accotink Creek watershed below Lake Accotink ranges from approximately 8 to 384 ft above mean sea level, with an average elevation of 194 ft. The elevation in the Long Branch watershed ranges from 186 to 462 ft above mean sea level, with an average elevation of 337 ft.

2.1.2 Hydrogeomorphic Regions

The USGS has divided the Chesapeake Bay watershed into hydrogeomorphic regions, based on physiography or geological structure, and underlying rock type (USGS, 2000). **Figure 2-2** shows the hydrogeomorphic regions in the Accotink Creek watershed. Three hydrogeomorphic regions are found in the watershed, Piedmont Crystalline, Coastal Plain Dissected Uplands, and Coastal Plain Lowlands.

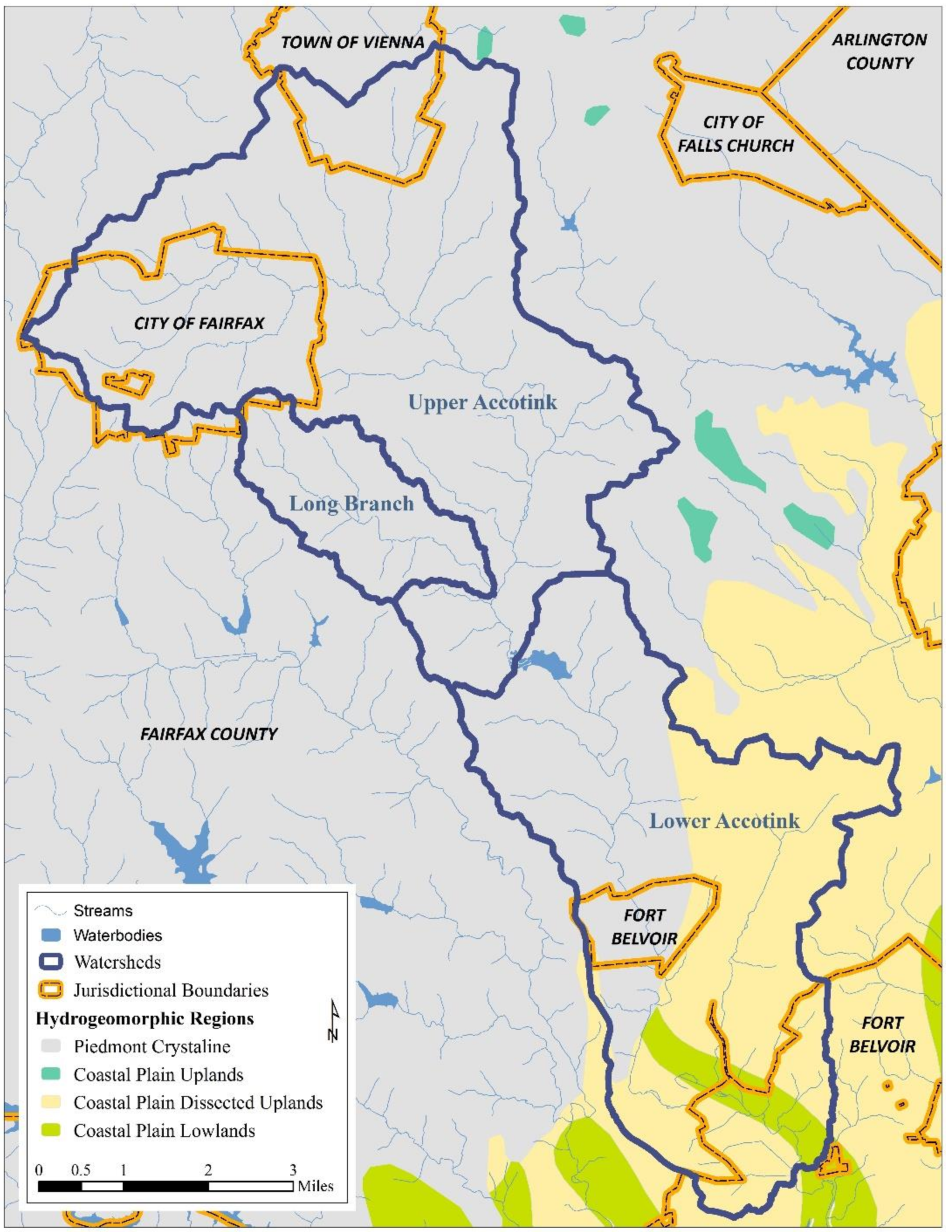

Figure 2-2: Accotink Creek Watersheds with Hydrogeomorphic Regions

The watershed of upper Accotink Creek, including Long Branch, is entirely within the Piedmont Crystalline region, as is 44% of the lower Accotink Creek watershed. Fifty percent of the lower Accotink Creek watershed is in the dissected uplands of the Coastal Plain; the remainder is in the Coastal Plain Lowlands.

2.1.3 Soils

The soil characterization of the Accotink Creek watershed was based on data obtained from the Soil Survey Geographic (SSURGO) database (NRCS, 2015). According to SSURGO, there are 63 soil series represented in the watershed (**Table 2-1**).

Table 2-1: Soils Series in Accotink Creek Watersheds

Soil Name	Upper Accotink[1]		Lower Accotink[2]		Long Branch	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Barkers Crossroads loam	156	1.0%	100	0.8%	2	0.1%
Barkers Crossroads-Nathalie complex	73	0.4%	622	5.1%	40	1.6%
Barkers Crossroads-Rhodhiss complex	47	0.3%	441	3.6%	9	0.3%
Barkers Crossroads-Rhodhiss-Rock outcrop complex	0	0.0%	0	0.0%	1	0.0%
Beltsville silt loam	15	0.1%	390	3.2%	0	0.0%
Codorus and Hatboro soils	763	4.7%	1,181	9.6%	193	7.8%
Codorus silt loam	484	3.0%	54	0.4%	22	0.9%
Downer loamy sand	0	0.0%	10	0.1%	0	0.0%
Elkton silt loam	0	0.0%	29	0.2%	0	0.0%
Elsinboro loam	21	0.1%	1	0.0%	0	0.0%
Fairfax loam	46	0.3%	75	0.6%	15	0.6%
Glenelg silt loam	1,576	9.7%	144	1.2%	288	11.7%
Grist Mill sandy loam	0	0.0%	251	2.0%	0	0.0%
Grist Mill-Matapeake complex	0	0.0%	19	0.2%	0	0.0%
Grist Mill-Mattapex complex	0	0.0%	12	0.1%	0	0.0%
Gunston silt loam	0	0.0%	111	0.9%	0	0.0%
Hatboro silt loam	150	0.9%	94	0.8%	5	0.2%
Hattontown - Elbert complex	0	0.0%	0	0.0%	0	0.0%
Hattontown - Orange complex	23	0.1%	0	0.0%	0	0.0%
Hattontown silt loam	2	0.0%	0	0.0%	0	0.0%
Hattontown-Haymarket complex	4	0.0%	0	0.0%	1	0.0%
Hattontown-Orange complex	9	0.1%	0	0.0%	0	0.0%
Haymarket silt loam	0	0.0%	0	0.0%	3	0.1%
Kingstowne sandy clay loam	1	0.0%	295	2.4%	0	0.0%
Kingstowne-Beltsville complex	70	0.4%	125	1.0%	1	0.0%
Kingstowne-Danripple complex	7	0.0%	77	0.6%	0	0.0%
Kingstowne-Sassafras-Marumsco complex	0	0.0%	291	2.4%	0	0.0%
Kingstowne-Sassafras-Neabsco complex	0	0.0%	1,168	9.5%	0	0.0%
Kingstowne-Sassfras complex	0	0.0%	4	0.0%	0	0.0%
Lunt-Marumsco complex	0	0.0%	117	0.9%	0	0.0%
Matapeake silt loam	0	0.0%	43	0.4%	0	0.0%

Soil Name	Upper Accotink[1] Acres	Upper Accotink[1] Percent of Total	Lower Accotink[2] Acres	Lower Accotink[2] Percent of Total	Long Branch Acres	Long Branch Percent of Total
Mattapex loam	0	0.0%	128	1.0%	0	0.0%
Meadowville loam	155	0.9%	46	0.4%	16	0.7%
Meadowville silt loam	5	0.0%	0	0.0%	0	0.0%
Nathalie gravelly loam	87	0.5%	206	1.7%	3	0.1%
Orange silt loam	9	0.1%	0	0.0%	0	0.0%
Pits	0	0.0%	6	0.0%	0	0.0%
Rhodhiss sandy loam	72	0.4%	436	3.5%	0	0.0%
Rhodhiss-Rock outcrop complex	1	0.0%	27	0.2%	0	0.0%
Sassafras sandy loam	0	0.0%	79	0.6%	0	0.0%
Sassafras-Marumsco complex	0	0.0%	1,021	8.3%	0	0.0%
Sassafras-Neabsco complex	0	0.0%	123	1.0%	0	0.0%
Sumerduck loam	112	0.7%	1	0.0%	18	0.7%
Sumerduck silt loam	17	0.1%	0	0.0%	0	0.0%
Urban land	2,898	17.8%	2,710	22.0%	135	5.5%
Urban land-Barker Crossroads complex	184	1.1%	43	0.3%	0	0.0%
Urban land-Grist Mill	0	0.0%	67	0.5%	0	0.0%
Urban land-Kingstowne complex	42	0.3%	471	3.8%	0	0.0%
Urban land-Wheaton complex	1,230	7.5%	0	0.0%	46	1.9%
Water	20	0.1%	81	0.7%	0	0.0%
Wheaton - Codorus complex	55	0.3%	0	0.0%	0	0.0%
Wheaton - Fairfax complex	23	0.1%	0	0.0%	0	0.0%
Wheaton - Glenelg complex	1,533	9.4%	0	0.0%	8	0.3%
Wheaton - Meadowville complex	112	0.7%	0	0.0%	0	0.0%
Wheaton - Sumerduck complex	73	0.4%	0	0.0%	0	0.0%
Wheaton loam	308	1.9%	4	0.0%	55	2.2%
Wheaton-Codorus complex	160	1.0%	115	0.9%	59	2.4%
Wheaton-Fairfax complex	302	1.8%	165	1.3%	198	8.0%
Wheaton-Glenelg complex	4,879	29.9%	606	4.9%	1,140	46.4%
Wheaton-Hatboro complex	6	0.0%	0	0.0%	2	0.1%
Wheaton-Meadowville complex	442	2.7%	209	1.7%	106	4.3%
Wheaton-Sumerduck complex	142	0.9%	4	0.0%	90	3.7%
Woodstown sandy loam	0	0.0%	116	0.9%	0	0.0%
Total	**16,317**	**100.0%**	**12,321**	**100.0%**	**2,457**	**100.0%**

[1]Excluding Long Branch
[2]Excluding Upper Accotink

Hydrologic soil groups represent different levels of infiltration capacity of the soils. Descriptions of the hydrologic soil groups are presented in **Table 2-2**. Hydrologic soil group "A" designates soils that are well to excessively well drained, whereas hydrologic soil group "D" designates soils that are poorly drained. More rainfall becomes surface water runoff when soils are poorly drained. The acreage of each hydrologic soil group in Accotink Creek is presented in **Table 2-3**. **Figure 2-3** also shows the hydrological soil groups in the Accotink Creek watershed. As **Table 2-3** and **Figure 2-3** show, soils in the watersheds of the impaired waterbodies in Accotink Creek are predominately soils of hydrologic group C, or have been disturbed by development.

Table 2-2: Descriptions of Soil Hydrologic Groups

Soil Hydrologic Group	Description
A	High infiltration rates. Soils are deep, well-drained to excessively-drained sand and gravels.
B	Moderate infiltration rates. Deep and moderately deep, moderately well and well-drained soils with moderately coarse textures.
C	Moderate to slow infiltration rates. Soils with layers impeding downward movement of water or soils with moderately fine or fine textures.
D	Very slow infiltration rates. Soils are clayey, have a high water table, or shallow to impervious cover.

Table 2-3: Soil Hydrologic Groups in Accotink Creek Watersheds

Hydrologic Group – Dominant Condition	Upper Accotink[1]		Lower Accotink[2]		Long Branch	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
A	233	1.4%	519	4.2%	17	0.7%
B	1,730	10.6%	1,925	15.6%	306	12.4%
B/D	1,397	8.6%	1,329	10.8%	220	8.9%
C	8,573	52.5%	5,031	40.8%	1,733	70.6%
C/D	0	0.0%	141	1.1%	0	0.0%
D	9	0.1%	0	0.0%	0	0.0%
Pits/Gravel[3]	0	0.0%	6	0.0%	0	0.0%
Urban Land[4]	4,354	26.7%	3,290	26.7%	181	7.4%
Water	20	0.1%	81	0.7%	0	0.0%
Total	**16,317**	**100.0%**	**12,321**	**100.0%**	**2,457**	**100.0%**

[1]Excluding Long Branch

[2]Excluding Upper Accotink

[3]"Pits are open excavations from which soil and commonly underlying material have been removed, exposing either rock or other material" (NRCS 1993).

[4] "Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas" (NRCS 1993). Here, this category also includes several urban land-soil complexes (e.g., Urban land-Barker Crossroads complex and others listed **Table 2-1**), which have no assigned soil hydrologic group.

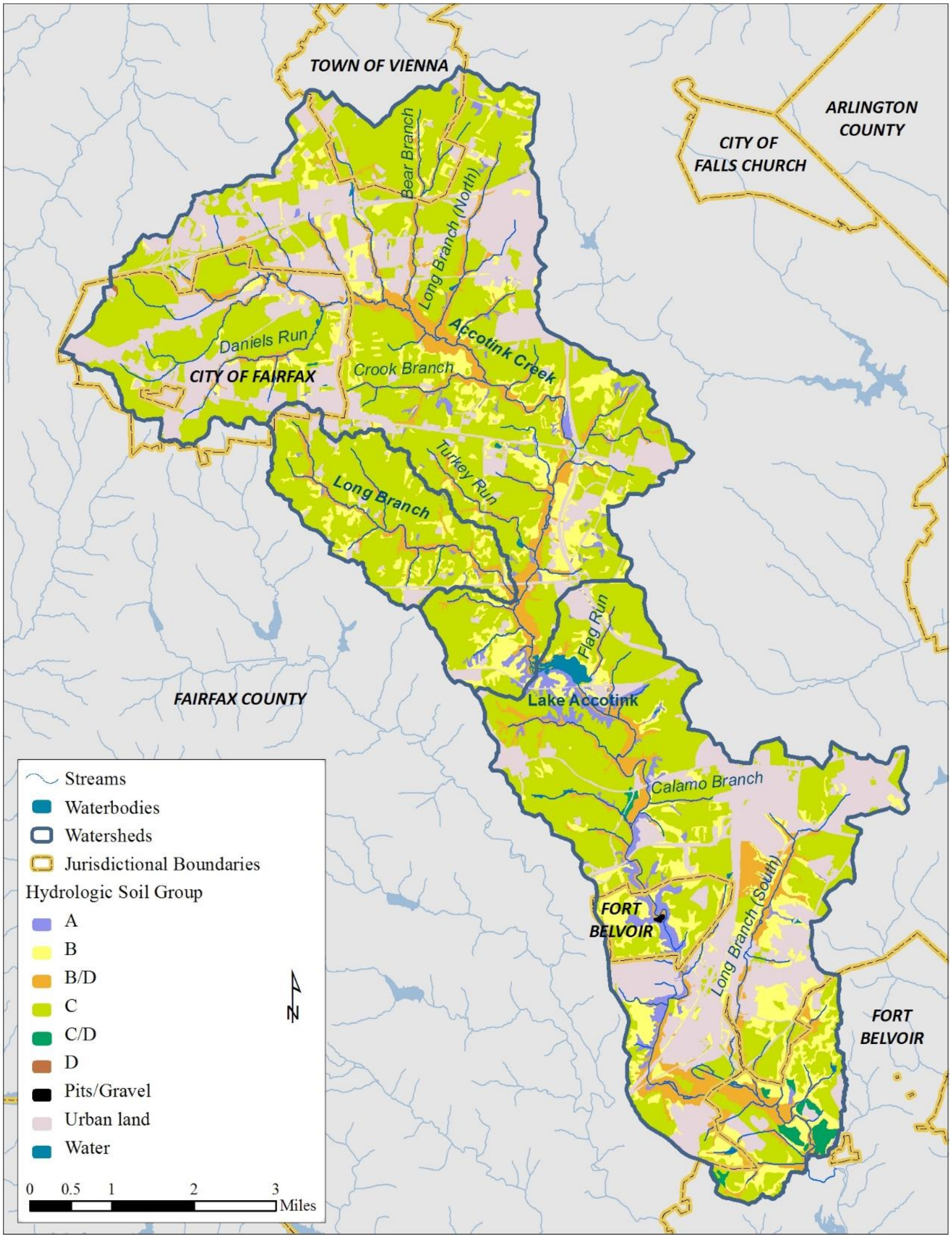

Figure 2-3: Soil Hydrologic Groups in Accotink Creek Watersheds

2.1.4 Land Use

The land use characterization for the Accotink Creek watershed, excluding Fort Belvoir, was based on (1) Fairfax County geospatial zoning data provided by K. Bennett (FCDPWES. Personal communication, 2009) and (2) City of Fairfax geospatially represented existing land use (ELU) and zoning data made available by Maurice Riou (GIS Manager, City of Fairfax, VA. Personal communication, 12/16/2015). The zoning codes and ELU were combined into a set of four major land use categories—commercial, industrial, residential, and open space—and subdivided into seven minor categories as shown in **Tables 2-4 and 2-5** for Fairfax County and the City of Fairfax data respectively.

Table 2-4: Classification of Land Use Categories based on Fairfax County Zoning

Zone Type	Zoning Code	Short Description	Land Use Category	Land Use Type
Commercial	C-1	Office commercial district	Commercial	Commercial
	C-2	Retail commercial district		
	C-3	General commercial district		
	C-4	High intensity office district		
	C-5	Neighborhood retail commercial district		
	C-6	Community retail commercial district		
	C-7	Regional retail commercial district		
	C-8	Highway commercial district		
Industrial	I-2	Industrial research district	Industrial	Industrial
	I-3	Light intensity industrial district		
	I-4	Medium intensity industrial district		
	I-5	General industrial district		
	I-6	Heavy industrial district		
Residential	R-C	Residential-conservation district	Residential	Low Density
	R-1	Residential district for single family dwelling types at a density not to exceed 1 dwelling unit per acre (du/ac)		
	R-2	Residential district for single family dwelling types at a density not to exceed 2du/ac		
	R-3	Residential district for single family dwelling types at a density not to exceed 3 du/ac		Medium Density
	R-4	Residential district for single family dwelling types at a density not to exceed 4 du/ac		
	R-5	Residential district for single family dwelling types at a density not to exceed 5 du/ac		
	R-8	Residential district for a mixture of single family residential dwelling types at a density not to exceed 8 du/ac		High Density
	R-12	Residential district for a mixture of residential dwelling types at a density not to exceed 12 du/ac		
	R-16	Residential district for a mixture of residential dwelling types at a density not to exceed 16 du/ac		
	R-20	Residential district for a mixture of residential		

Zone Type	Zoning Code	Short Description	Land Use Category	Land Use Type
		dwelling types at a density not to exceed 20 du/ac		
	R-30	Residential district for multiple family dwellings at a density not to exceed 30 du/ac		
	RTH	Townhouse district		
	RM-2	Multifamily district		
Planned Units	CPD	Commercial planned development district	Commercial	Commercial
	PDC	Planned development commercial district		
	PDH-2	Planned development housing district residential district for single family dwelling types at a density not to exceed 2du/ac	Residential	Low Density
	PDH-3	Planned development housing district residential district for single family dwelling types at a density not to exceed 3 du/ac		Medium Density
	PDH-4	Planned development housing district residential district for single family dwelling types at a density not to exceed 4 du/ac		
	PDH-5	Planned development housing district residential district for single family dwelling types at a density not to exceed 5 du/ac		
	PDH-8	Residential district for a planned mixture of single family residential dwelling types at a density not to exceed 8 du/ac		High Density
	PDH-12	Residential district for a planned mixture of residential dwelling types at a density not to exceed 12 du/ac		
	PDH-16	Residential district for a planned mixture of residential dwelling types at a density not to exceed 16 du/ac		
	PDH-20	Residential district for a planned mixture of residential dwelling types at a density not to exceed 20 du/ac		
	PDH-30	Residential district for a planned mixture of residential dwelling types at a density not to exceed 30 du/ac		
	PDH-40	Residential district for a planned mixture of residential dwelling types at a density not to exceed 40 du/ac		
	PRC	Planned residential community district		
	PRM	Planned residential mixed use district		Mixed Use
Other	PR	Other	Open Space	Open Space

Table 2-5: Classification of Land Use Categories based on the City of Fairfax Existing Land Use

Existing Land Use (ELU)	Land Use Category	Land Use Type
Auto Dealer	Commercial	Commercial
Auto Repair		
Commercial - Lodging		
Commercial - Office		
Commercial - Retail		
Institutional - City of Fairfax		
Institutional - General		
Industrial	Industrial	Industrial
Open Space - Preserved	Open Space	Open Space
Open Space - Recreation & Historic		
Open Space - Undesignated		
Vacant		
Residential - Multifamily	Residential	High Density
Residential - Single Attached		Medium Density[1]
Residential - Single Detached		
Residential - Single Attached		Low Density[1]
Residential - Single Detached		

[1]The distinction between medium density and low density residential was based on zoning codes

Additional geospatial data, including parkland (PARKS_FCPA, PARKS_NON_FCPA layers) and open water (extracted from the HYDRO_AREAS_4000 layer), were downloaded from the Fairfax County Geoportal (http://www.fairfaxcounty.gov/maps/data.htm). Major paved transportation areas were also provided by K. Bennett (FCDPWES. Personal communication, 2009). Using standard GIS tools and procedures, parkland, which was used as a surrogate for open space, open water, and paved major transportation areas were combined with the zoning layer to yield the overall land use for the Accotink watershed, excluding Fort Belvoir, as shown in **Figure 2-4** and summarized in **Tables 2-6 through 2-8** for the upper Accotink, lower Accotink, and Long Branch watersheds respectively.

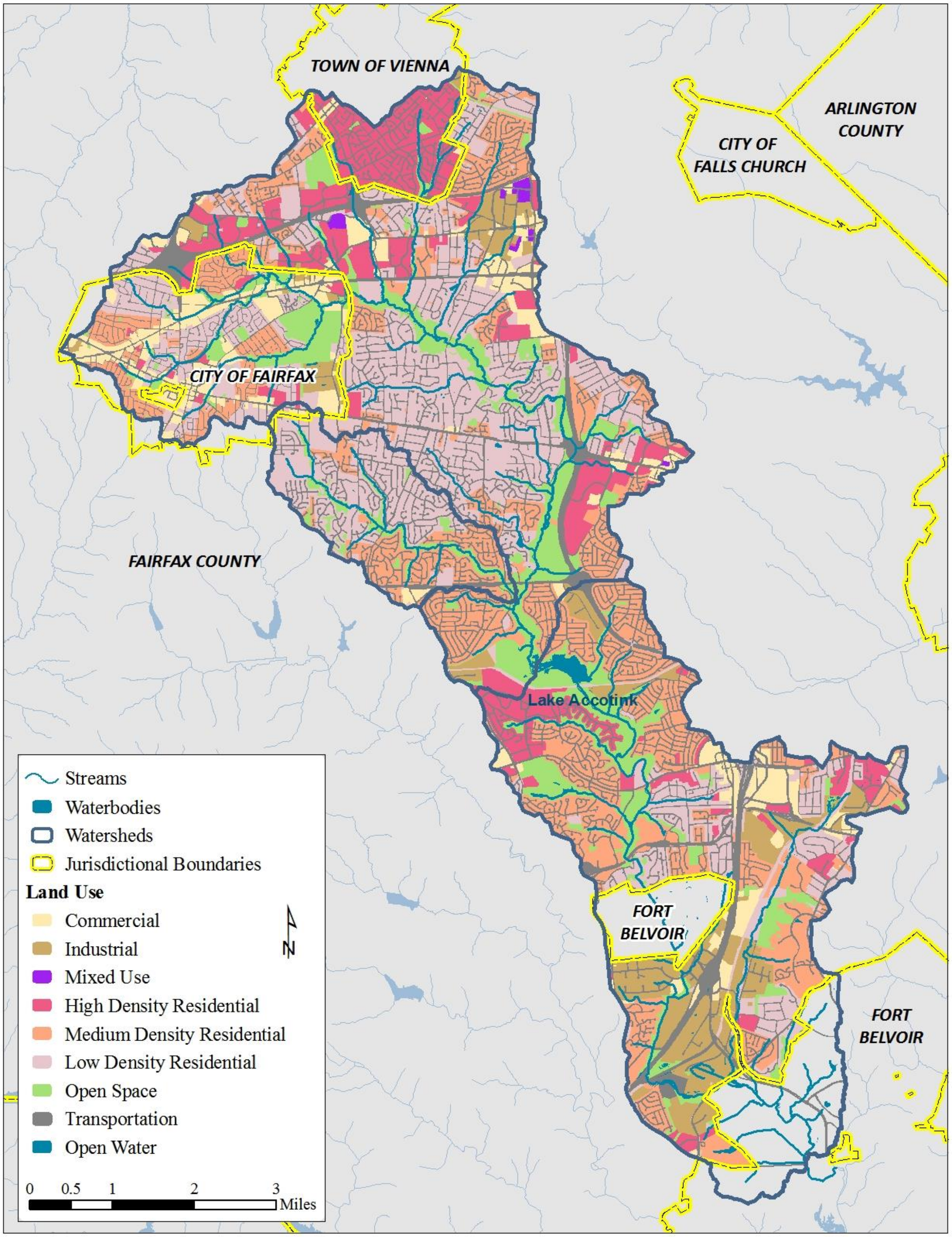

Figure 2-4: Land Use in Accotink Creek Watershed

Table 2-6. Land Use in Upper Accotink Creek Watershed[1]

Land Use Category	Zoning Category	City of Fairfax		Fairfax County		Town of Vienna		Total	
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Commercial	Commercial	739	21%	593	5%	28	2%	1,360	8%
Industrial	Industrial	127	4%	363	3%	19	2%	509	3%
Residential	Mixed Use	0	0%	76	1%	0	0%	76	0%
	Low Density	876	25%	4,282	37%	1	0%	5,159	32%
	Medium Density	627	18%	2,232	19%	2	0%	2,861	18%
	High Density	98	3%	1,305	11%	895	78%	2,298	14%
Transportation	Transportation	503	14%	1,463	13%	135	12%	2,101	13%
Open Space	Open Space	518	15%	1,294	11%	61	5%	1,873	11%
Water	Water	17	0%	70	1%	0	0%	88	1%
Total		**3,505**	**100%**	**11,679**	**100%**	**1,142**	**100%**	**16,326**	**100%**

[1]Excluding Long Branch

Table 2-7. Land Use in Lower Accotink Creek Watershed[1]

Land Use Category	Zoning Category	Fairfax County		Fort Belvoir		Total	
		Acres	Percent	Acres	Percent	Acres	Percent
Commercial	Commercial	530	5%	956	41%	1,487	12%
Industrial	Industrial	1,538	15%	0	0%	1,538	12%
Residential	Low Density	1,511	15%	0	0%	1,511	12%
	Medium Density	2,986	30%	0	0%	2,986	24%
	High Density	794	8%	0	0%	794	6%
Transportation	Transportation	1,297	13%	90	4%	1,387	11%
Open Space	Open Space	1,180	12%	1,273	54%	2,453	20%
Water	Water	145	1%	27	1%	173	1%
Total		**9,981**	**100%**	**2,348**	**100%**	**12,328**	**100%**

[1]Excluding Upper Accotink

Table 2-8. Land Use in Long Branch Watershed

Land Use Category	Zoning Category	City of Fairfax		Fairfax County		Total	
		Acres	Percent	Acres	Percent	Acres	Percent
Commercial	Commercial	11	22%	27	1%	37	2%
Residential	Low Density	21	46%	1,222	51%	1,243	51%
	Medium Density	0	0%	629	26%	629	26%
	High Density	4	8%	0	0%	4	0%
Transportation	Transportation	11	24%	266	11%	277	11%
Open Space	Open Space	0	0%	257	11%	257	10%
Water	Water	0	0%	10	0%	10	0%
Total		**47**	**100%**	**2,411**	**100%**	**2,458**	**100%**

The watersheds are highly developed with developed land accounting for 88% of the upper Accotink watershed, 87% of lower Accotink watershed, and 89% of the Long Branch watershed. Residential land use comprises the largest category of land use in the upper Accotink (64%), lower Accotink (58%), and Long Branch (76%) watersheds. Transportation is the next largest category of land use in upper Accotink and Long Branch watersheds, accounting for about 13% and 11% of the watersheds, respectively, whereas industrial land use (12%) is the second largest category in the lower Accotink watershed, followed by open space (12%) and transportation (11%).

An estimation of the impervious area within each watershed was based on planimetric data provided by Fairfax County, VA (K. Bennett, FCDPWES. Personal communication, 2009). Polygon and line geospatial data representing building footprints, building additions, and paved areas (e.g. roads, parking lots, driveways, and sidewalks) were combined using standard GIS tools and procedures to obtain a representation of the impervious area in each subwatershed as shown in **Table 2-9.**

Table 2-9: Percent Imperviousness by Watershed and Jurisdiction

Jurisdiction	Watershed			Total
	Upper Accotink[1]	Lower Accotink[2]	Long Branch	
City of Fairfax	35.7%		47.9%	35.8%
Fairfax County	27.5%	31.2%	21.6%	28.5%
Fort Belvoir		10.8%		10.8%
Town of Vienna	30.8%			30.8%
Total	**29.5%**	**27.4%**	**22.1%**	**28.1%**

[1]Excluding Long Branch
[2]Excluding Upper Accotink

Land use for Fort Belvoir was not available in a GIS representation, so the land use was determined based on Fairfax County planimetric data, the Fort Belvoir Integrated Natural Resource Management Plan (INRMP) (Horne Engineering Services, Inc., 2001), and Fort Belvoir Real Master Property Plan Installation Vision and Development Plan (VDP) (Atkins, 2014). The INRMP reported acres of impervious surface, open space, forest, and wetlands for the Fort Belvoir Northern Area (FBNA) and for the Accotink Creek drainage on the main base. The Accotink Creek drainage on the main base includes tidal waters outside of the impairment, so the acreage could not be used directly. The acreages represent conditions prior the Base Realignment and Closure Act (BRAC) of 2005, which transferred many military functions to Fort Belvoir and led to additional development on the base. The VDP includes projections of impervious areas in 2017 for the FBNA and the drainage on the main base.

Based on information in the VDP, the Fairfax County planimetric data has a representation of the impervious surfaces in Fort Belvoir prior to the BRAC. Impervious surfaces in the FBNA, based on the planimetric data, were adjusted to match the INRMP. It was assumed that the open space reported in the INRMP was developed pervious land, and that the ratio of impervious surface to open space was characteristic of Fort Belvoir development. Using this ratio, the amount of pervious developed land prior to the BRAC could be estimated for FBNA and the portion of the main base within the impaired watershed. The remainder of the land was assumed to be forest. To get the final Fort Belvoir land use representing current conditions, the percent change in impervious area from the INRMP to the VDP was calculated, and that ratio applied to the pre-BRAC estimates of developed pervious and impervious developed land to get current estimates of their acreage. The change in acreage was subtracted from the pre-BRAC estimate of forested land.

All developed land in Fort Belvoir except transportation was classified as commercial. The forested land was classified as open space. The resulting land use is shown in **Table 2-7**.

2.1.5 Population and Households

Spatial data at the Virginia state level that incorporates the 2010 Census block geography and the 2010 Census population and housing unit counts were downloaded from the Fairfax Geoportal (http://www.fairfaxcounty.gov/maps/data.htm). The aerial extent of census blocks located within or intersecting a watershed were determined using routine GIS analysis. The fraction of each census block within a watershed was calculated and then used to obtain an area-weighted number of households for each watershed. Summaries of the population and household estimates for the Accotink Creek watershed are presented in **Table 2-10**.

Table 2-10: 2010 Census Data Summary for the Accotink Creek Watersheds

Watershed	Estimated Households	Estimated Population
Upper Accotink[1]	44,439	116,554
Lower Accotink[2]	20,954	55,633
Long Branch	4,581	13,319
Total	69,973	185,506

[1]Excluding Long Branch
[2]Excluding Upper Accotink

2.2 Permitted Facilities

DEQ issues Virginia Pollutant Discharge Elimination System (VPDES) permits for all point source discharges to surface waters, to dischargers of stormwater from Municipal Separate Storm

Sewer Systems (MS4s), and to dischargers of stormwater from Industrial Activities. DEQ issues Virginia Stormwater Management Program (VSMP) permits to dischargers of stormwater from Construction Activities. There are two broad types of discharge permits; individual permits and general permits.

DEQ issues individual permits to both municipal and industrial facilities. Permit requirements, special conditions, effluent limitations and monitoring requirements are determined for each facility on a site specific basis in order to meet applicable water quality standards. General permits are written for a general class of dischargers where operations and activities are similar. These permits are also prepared to protect and maintain applicable water quality standards. In Virginia, general permits are adopted as regulations.

There are four types of permits issued in the Accotink Creek watershed: (1) individual Virginia Pollutant Discharge Elimination System (VPDES) permits; (2) general VPDES permits; (3) municipal separate storm sewer system (MS4) permits; and (4) general construction stormwater control permits. These are discussed in subsequent sections.

Most of the watershed is served by sanitary sewers. There are, however, a number of septic systems in the watershed, which are discussed in **Section 2.2.5.**

2.2.1 Facilities with Individual Permits

Individual VPDES permits have conditions that apply to a specific facility, such as effluent limits and monitoring requirements. There are five industrial facilities with individual permits to discharge into tributaries of Accotink Creek. All of them are minor facilities with the exception of the Fort Belvoir industrial stormwater permit. They are listed in **Table 2-11**, along with their receiving stream and their average flow, as determined for permit documentation. In addition, Fort Belvoir has an individual VPDES permit for industrial stormwater. The average flow for Fort Belvoir industrial VPDES permit, shown in **Table 2-11,** was based on results from the Generalized Watershed Loading Functions (GWLF) model, used in the development of the Accotink Creek sediment TMDLs. See **Volume II**, **Sectio**n 3.

Figure 2-5 shows the location of these facilities.

Table 2-11: Individual VPDES Industrial Permitted Facilities within Accotink Creek Watershed

Watershed	Permit No	Facility Name	Major/ Minor	Municipal/ Industrial	Discharge Source	Receiving Stream	Average Flow (MGD)
Upper Accotink	VA0001872	Joint Basin Corporation – Fairfax Terminal Complex	Minor	Industrial	Process Wastewater and Stormwater	Daniels Run, UT	0.100
	VA0002283	Motiva Enterprises LLC – Fairfax	Minor	Industrial	Process Wastewater and Stormwater	Crook Branch	0.048
Lower Accotink	VA0001945	Kinder Morgan Southeast Terminals LLC-Newington	Minor	Industrial	Process Wastewater and Stormwater	Accotink Creek, UT	0.176
	VA0001988	Kinder Morgan Southeast Terminals LLC-Newington 2	Minor	Industrial	Process Wastewater and Stormwater	Accotink Creek, UT	0.036
	VA0092771	Fort Belvoir	Major	Industrial	Stormwater	Accotink Creek	0.322[1]

[1]Based on results from GWLF model, **Volume II**, **Section 3.**

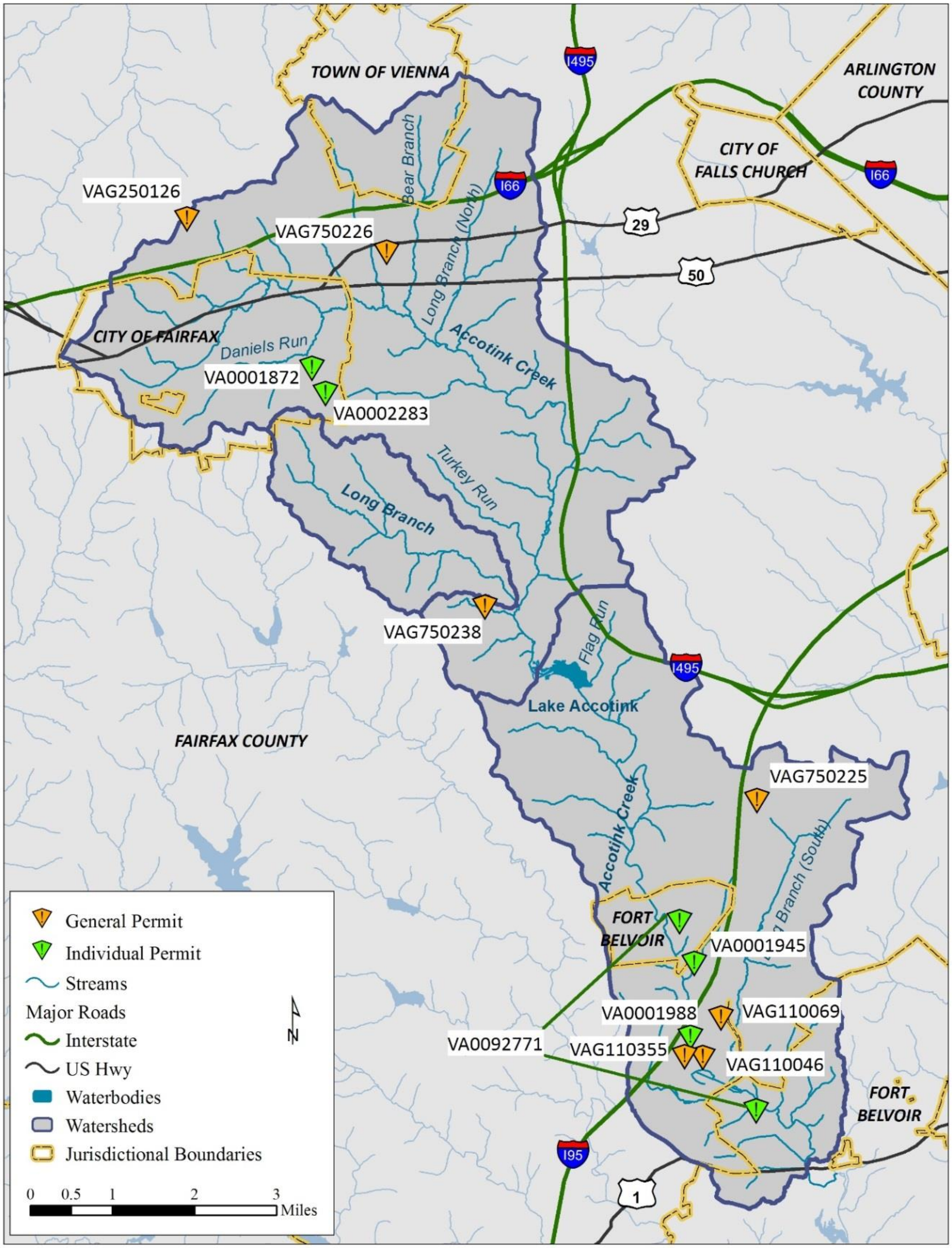

Figure 2-5: Location of Facilities with Individual and General VPDES Permits within Accotink Watershed

2.2.2 Facilities with General Permits

General permits apply to a class of dischargers. Facilities in Accotink Creek watershed are registered under the following general permits, excluding the MS4 general permit:

- three (3) Vehicle Wash and Laundry facilities;
- one (1) Non-contact Cooling Water permittees;
- three (3) Concrete Products Facilities;
- two (2) permittees under the Domestic Sewage Discharge of Less Than or Equal to 1,000 Gallons per Day;
- two (2) facilities authorized under the permit for Petroleum Contaminated Sites and Hydrostatic Tests;
- twelve (12) permits for Discharges of Stormwater Associated with Industrial Activity;

Table 2-12 shows the facilities in Accotink Creek registered under these general permits, not including discharges of industrial stormwater, the two domestic sewage dischargers, or the two permits for petroleum contaminated sites and hydrostatic tests. **Figure 2-5** shows the location of facilities with general permits that are identified in **Table 2-12**. The twelve facilities registered under the general permit for industrial stormwater are identified in **Table 2-13** with their locations shown in **Figure 2-6**. One household under the general domestic sewage permit for discharges less than 1,000 gallons per day is in the upper Accotink Creek watershed, and the other is in the Long Branch watershed. Facilities authorized to discharge under the general permit for petroleum contaminated sites, groundwater remediation and/or hydrostatic testing are not presented in the referenced maps or tables. These permits may be short-lived, depending on the specific activity. Additionally, a registration statement is not required for certain activities, such as short-term projects and hydrostatic testing discharges. Because of the nature of permitting these sources and because these are insignificant sources of chloride, they are not presented in the referenced maps or tables. Nonetheless, the two permits that were active at the time of writing this report were both located in the upper Accotink Creek watershed. Permits for discharge of stormwater from construction activities are discussed in **Section 2.2.4**.

Table 2-12: General VPDES Permitted Facilities within Accotink Creek Watershed

Watershed	Permit No	Facility Name	Type
Upper Accotink	VAG250126	AT&T Oakton Office Park	Cooling Water
	VAG750226	Enterprise Rent A Car - 3055 Nutley St	Car Wash
	VAG750238	Ravensworth Collision Center	Car Wash
Lower Accotink	VAG110046	Virginia Concrete Company Inc - Newington Plant 1	Concrete
	VAG110069	VA Concrete Co - Mid Atlantic Materials-Newington	Concrete
	VAG750255	Enterprise Rent A Car – 6701Loisdale Rd	Car Wash
	VAG110355	Superior Concrete	Concrete

Table 2-13: Industrial Stormwater VPDES Permitted Facilities within Accotink Creek Watershed

Watershed	Permit No	Facility	Area of Industrial Activity (Acres)	SIC (Standard Industrial Classification Code) Description
Upper Accotink	VAR051066	US Postal Service – Merrifield Vehicle Maintenance	2	United States Postal Service
	VAR051770	Fairfax County – Jermantown Maintenance Facility	12.4	Local and Suburban Transit
	VAR052188	Milestone Metals	1.5	Scrap and Waste Materials
Lower Accotink	VAR051042	SICPA Securink Corporation	1.1	Printing Ink
	VAR051047	Fairfax County – Connector Bus Yard (Huntington Garage)	6.25	Local and Suburban Transit
	VAR051565	Rolling Frito Lay Sales LP – South Potomac DC	1.2	Trucking, Except Local
	VAR051771	Fairfax County – Newington Maintenance Facility	25.4	Local and Suburban Transit
	VAR051772	Fairfax County-DVS – Alban Maintenance Facility	5.5	Local and Suburban Transit
	VAR051795	HD Supply-White Cap	1	Brick, Stone, and Related Materials
	VAR051863	United Parcel Service – Newington	9.1	Courier Services, Except Air
	VAR052223	Newington Solid Waste Vehicle Facility	4.9	Local Trucking without Storage
	VAR052366	Ready Refresh by Nestle - Lorton Branch	3.0	Local Trucking with Storage

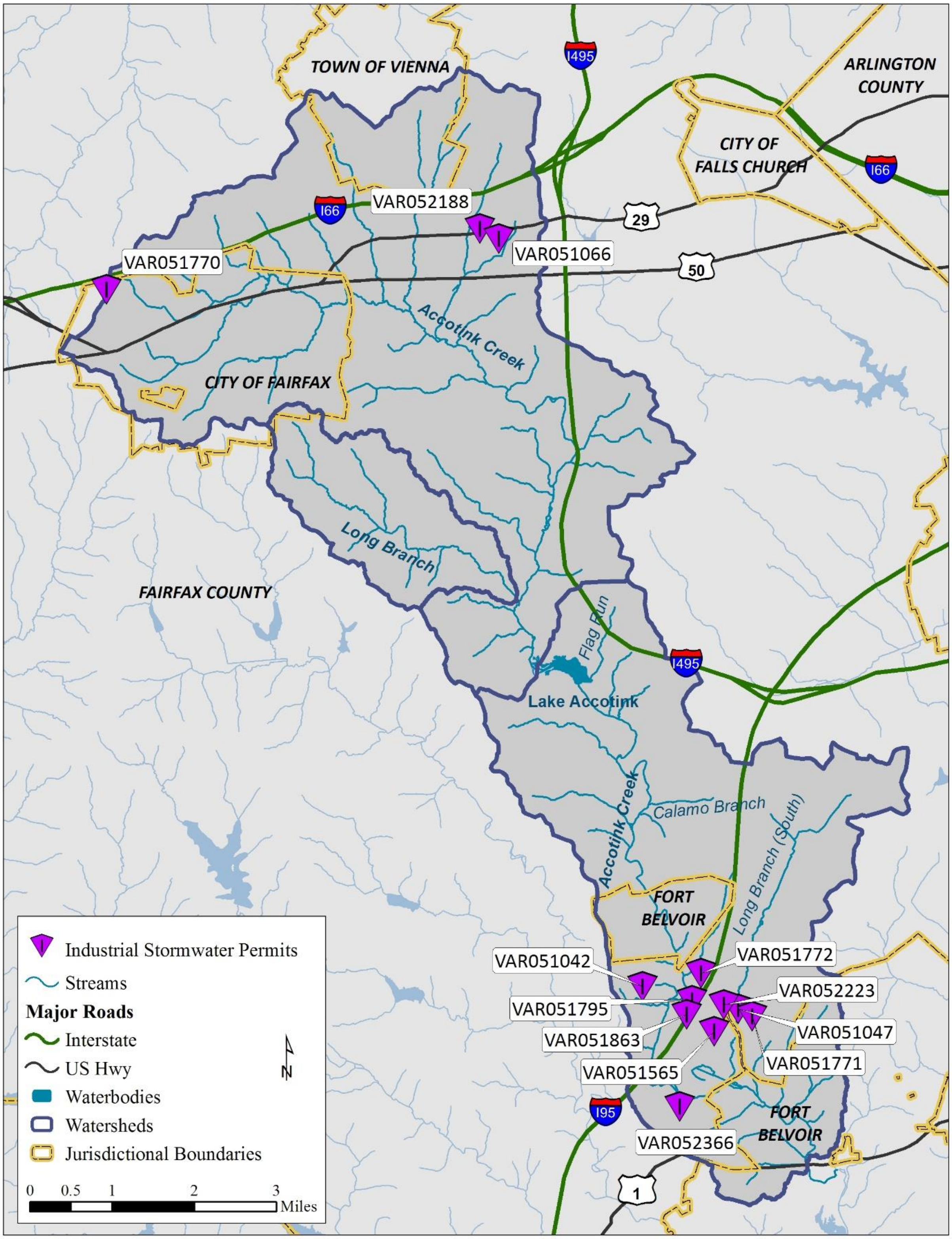

Figure 2-6: Location of Industrial Stormwater General Permits within Accotink Watershed

2.2.3 Municipal Separate Storm Sewer Systems (MS4s)

MS4 permits in the Accotink Creek watershed are listed in **Table 2-14**. Fairfax County has a Phase I, individual permit and it is anticipated that VDOT will have an individual MS4 by completion of this TMDL study. While VDOT remains a Phase II MS4 entity, DEQ is preparing an individual permit to govern its operations. The rest of the MS4s have Phase II, general permits. **Table 2-14** also shows the watershed of the impaired segment associated with the MS4s.

Table 2-14: MS4 Permits within Accotink Creek Watershed

Watershed	Permit No	Facility Name	Phase
All	VA0088587	Fairfax County	I
All	VA0092975	Virginia Department of Transportation	II
All	VAR040104	Fairfax County Public Schools	II
Long Branch & Upper Accotink	VAR040064	City of Fairfax	II
Upper Accotink	VAR040066	Town of Vienna	II
Lower Accotink	VAR040093	Fort Belvoir	II
	VAR040095	Northern Virginia Community College	II

A MS4 can be defined by its service area, which represents the drainage areas of the storm sewers and outfalls operated by the MS4. Service areas can overlap. **Figure 2-7** shows the overlapping service areas in one portion of the Accotink Creek watershed. In particular, the service area for the Virginia Department of Transportation (VDOT) has significant overlap with jurisdictional MS4s like Fairfax County, the Town of Vienna, or the City of Fairfax.

VDOT, Fairfax County, the Town of Vienna, Fort Belvoir, and the Fairfax County Public School System all provided GIS representations of their service areas. Service areas for the City of Fairfax and the Northern Virginia Community College, Annandale Campus, were digitized from maps documented in the City of Fairfax Chesapeake Bay Action Plan (City of Fairfax, 2015) and the Municipal Separate Storm Sewer System (MS4) Manual (NOVA, 2014), respectively. Because of the overlap in service areas, it is sometimes more useful to consider the combined service area, that is the area drained by the storm sewer system of at least one MS4, if not more. **Figure 2-8** shows the combined MS4 service area in the Accotink Creek watershed.

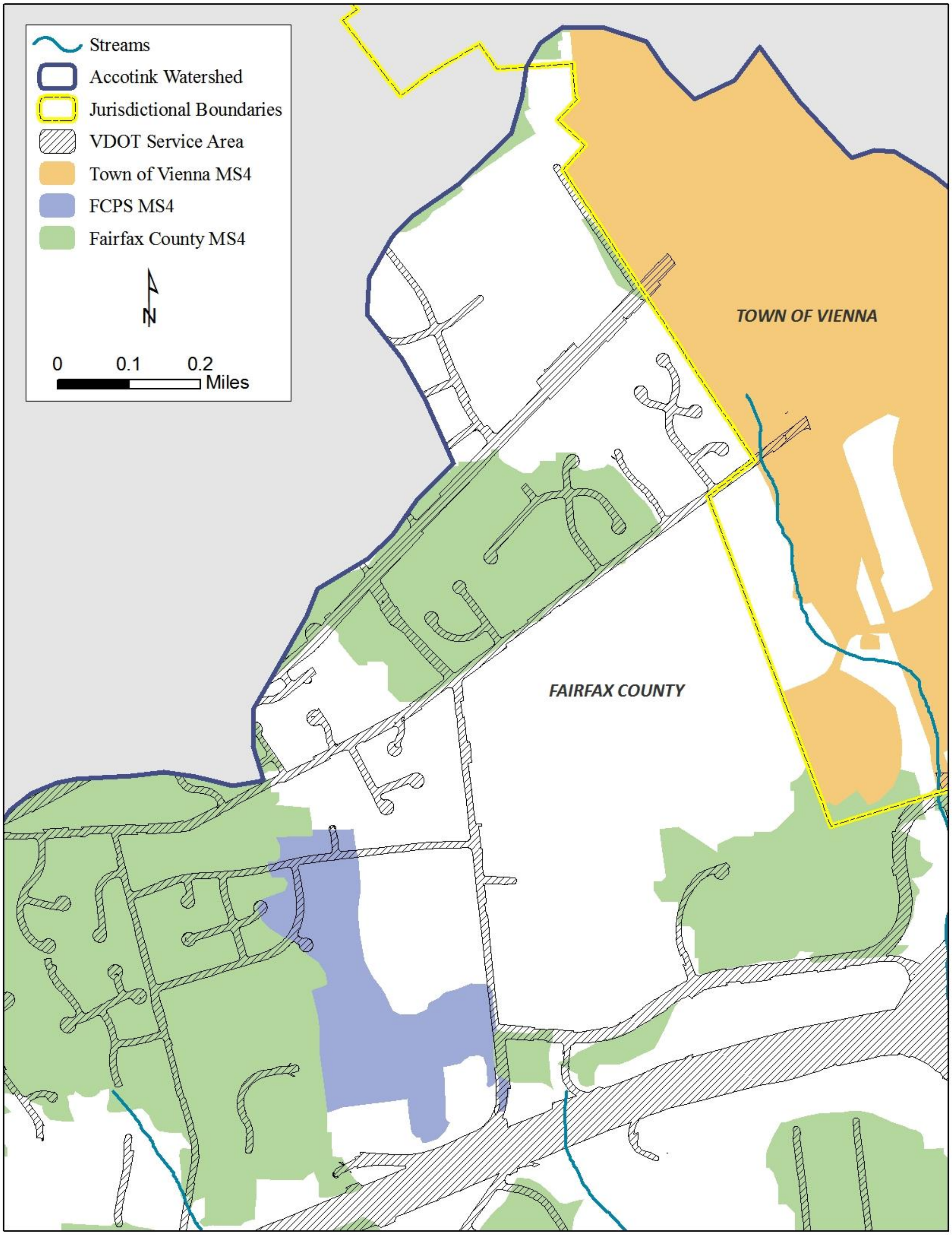

Figure 2-7: Individual MS4 Service Areas

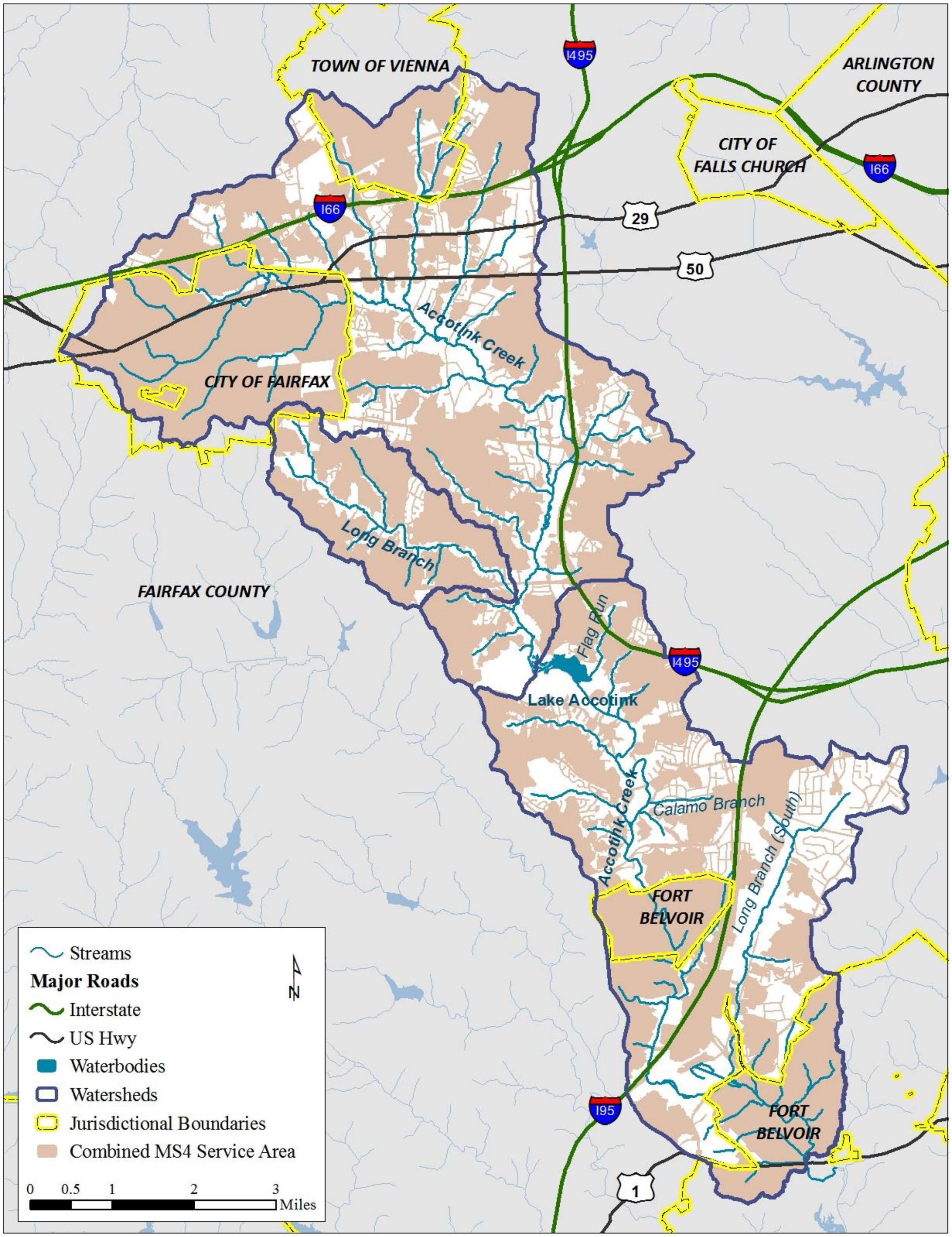

Figure 2-8: Combined MS4 Service Areas

2.2.4 Construction Permits

Under the VSMP, DEQ also issues general permits to control stormwater from construction sites. **Table 2-15** summarizes the number of active construction permits in the Accotink Creek watershed, the total acreage under development, and the total disturbed area at the inception of this project in December, 2014. Information on current construction permits can be obtained from an on-line database on the VSMP website, which is currently available at the following: http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/VSMPPermits/ConstructionGeneralPermit.aspx

Table 2-15: Construction Stormwater Permits within Accotink Creek Watershed (December, 2014)

Watershed	Number of Permits	Total Area of Sites (acres)	Total Disturbed Area (acres)
Upper Accotink	44	704	315
Lower Accotink	33	648	265
Long Branch	1	11	5

2.2.5 Sewers

The population in Accotink Creek watershed is primarily served by sanitary sewers. Fairfax County, the City of Fairfax, and the Town of Vienna maintain their own collection systems. Most of the wastewater is treated at Fairfax County's Norman J. Cole Jr. Pollution Control Plant, which discharges into Pohick Creek.

3 TMDL Development

Load duration curves (LDCs) were used to develop chloride TMDLs for Accotink Creek's benthic impairments. The LDC method is an EPA-approved approach to developing TMDLs (EPA, 2007). It has been used to develop bacteria TMDLs in Virginia (DEQ, 2004a; DEQ, 2008). It has also been used to develop chloride TMDLs for Shingle Creek in Minnesota (Wenk Associates, 2006) and Beaver Brook in New Hampshire (NHDES, 2008).

The cornerstone of the LDC method is the flow duration curve (FDC). FDCs represent the percent of time a flow is exceeded. They are usually represented graphically by showing the flows on the y-axis and the percent of time that flow is exceeded on the x-axis. **Figure 3-1** shows the FDC for daily average flow from Accotink Creek near Annandale, as measured at USGS flow gauge 01654000. As **Figure 3-1** shows, a flow exceeded 90 percent of the time is a low flow, where as a flow exceeded only 5% of the time is a high flow. The higher the percent exceedance is, the lower the flow.

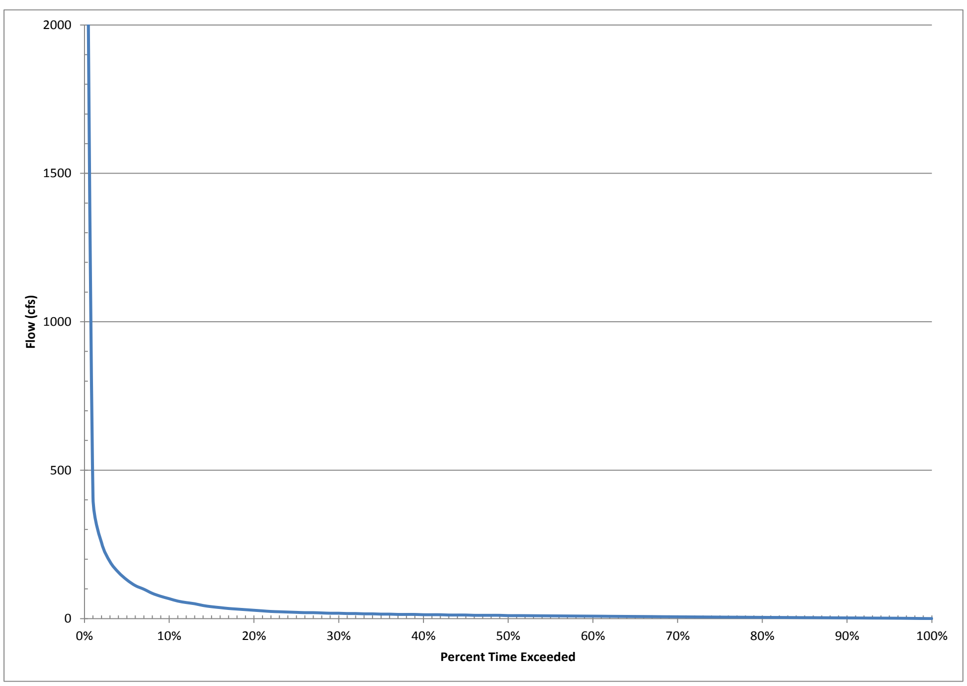

Figure 3-1: Flow Duration Curve, Average Daily Flow, Accotink Creek Near Annandale, 1986-2016

A LDC is constructed from a FDC by multiplying the FDC by a concentration, which represents a numeric water quality threshold, and suitable unit conversion factors. The water quality threshold is usually a water quality criterion. The LDC then gives the loading capacity of the stream: at every flow, the LDC gives the maximum load that meets the water quality threshold. In other words, the LDC gives the maximum load that meets the water quality threshold.

Although the FDC in **Figure 3-1** is based on daily flows, a FDC can be based on any flow interval. The Beaver Brook TMDL constructed a LDC based on a FDC for four-day average flow and the four-day average chronic criterion for chloride. A similar approach using a four day rolling average flow was used to develop chloride TMDLs for the impairments in Accotink Creek. The Virginia chronic criterion for chloride was chosen as the water quality threshold for the LDC because, as shown in **Section 1.3.1**, greater reductions are required to meet the chronic chloride criterion than the acute criterion, and thus the chronic criterion functions as a conservative endpoint. Details on the development of LDCs to address chloride impairments in Accotink Creek are given in the next section.

3.1 Application of Load Duration Method to Accotink Creek Chloride TMDLs

Chloride TMDLs for Accotink Creek were based on FDCs using four-day average flows and LDCs using the chronic chloride criterion of 230 mg/l. Chloride loads were calculated only for an extended winter season, November 1through April 30, which represent the months in which snow events have occurred in the Washington Metropolitan Region in the last 30 years. FDCs were restricted to four-day average flows from the extended winter season. To facilitate implementation, however, the TMDLs are expressed as average annual loads. This decision is based on the recommendations of the Technical Advisory Committee (TAC) at the October 28, 2016 TAC meeting.

There are two active USGS gauges where FDCs can be developed: Accotink Creek near Annandale (01654000), and Long Branch near Annandale (01654500). The locations of these gauges are shown in **Figure 3-2**. Daily flow measurements extend back to 1947 for the gauge on Accotink Creek, but the USGS only began collecting data on Long Branch in February, 2013. Thirty years of flow data for the extended winter season, from November 1986 through April 2016, were used to calculate the FDC for Accotink Creek, while for Long Branch, the whole period of record through April, 2016 was used. **Figure 3-3** shows the four-day FDC restricted to the extended winter season, November through April, for Accotink Creek, and **Figure 3-4** shows the same FDC for Long Branch.

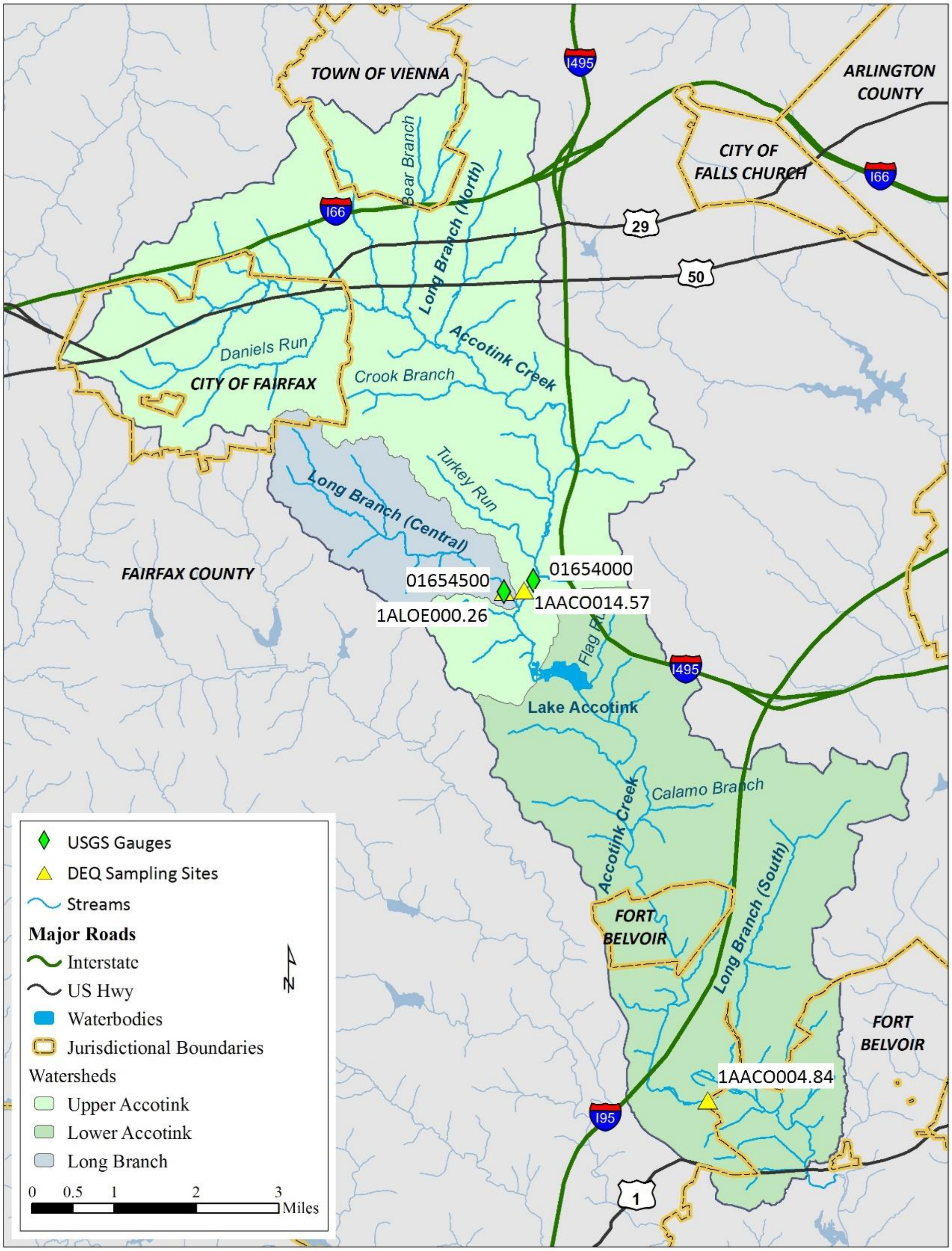

Figure 3-2: Location of Active USGS Gauges in Accotink Watershed

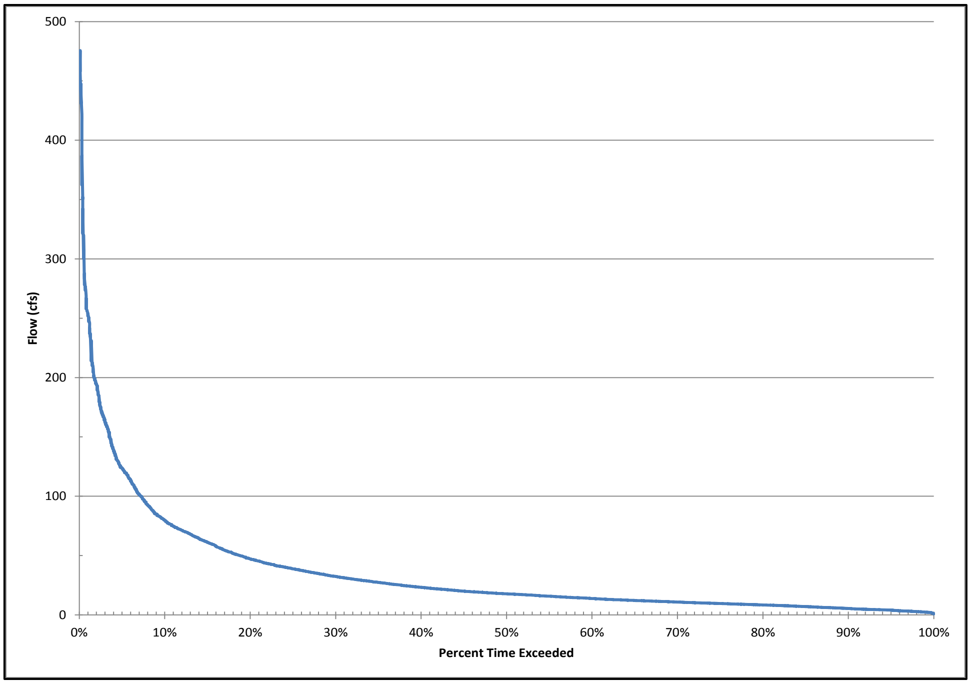

Figure 3-3: Flow Duration Curve, Four Day Average Flow in Extended Winter Season, Accotink Creek near Annandale

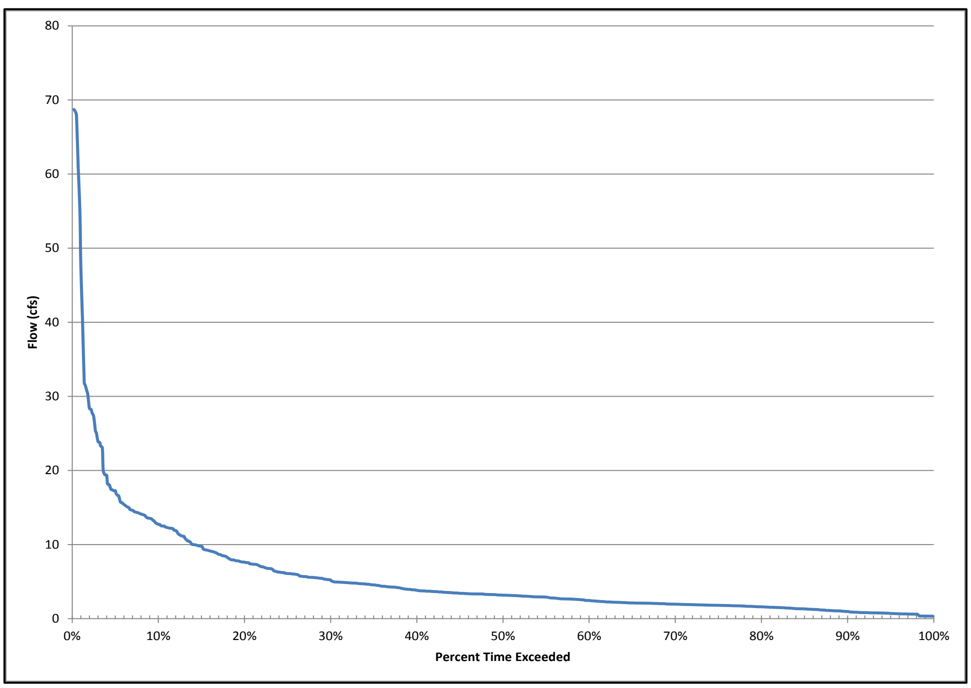

Figure 3-4: Flow Duration Curve, Four Day Average Flow in Extended Winter Season, Long Branch near Annandale

LDCs were constructed for the gauge locations by multiplying the FDC by the 230 mg/l chloride chronic criterion. **Figure 3-5** shows the LDC for Accotink Creek and **Figure 3-6** shows the LDC for Long Branch. Also shown on the figures are the corresponding four-day average chloride loads calculated from flows and chloride concentrations estimated from continuous specific conductance measurements and the established chloride specific conductance regression relation, discussed in **Section 1.3.1**. The vertical (y-axis) difference between the estimated chloride loads and the LDC provides an estimation of the difference between the load meeting the chronic criterion and the estimated load on that day.

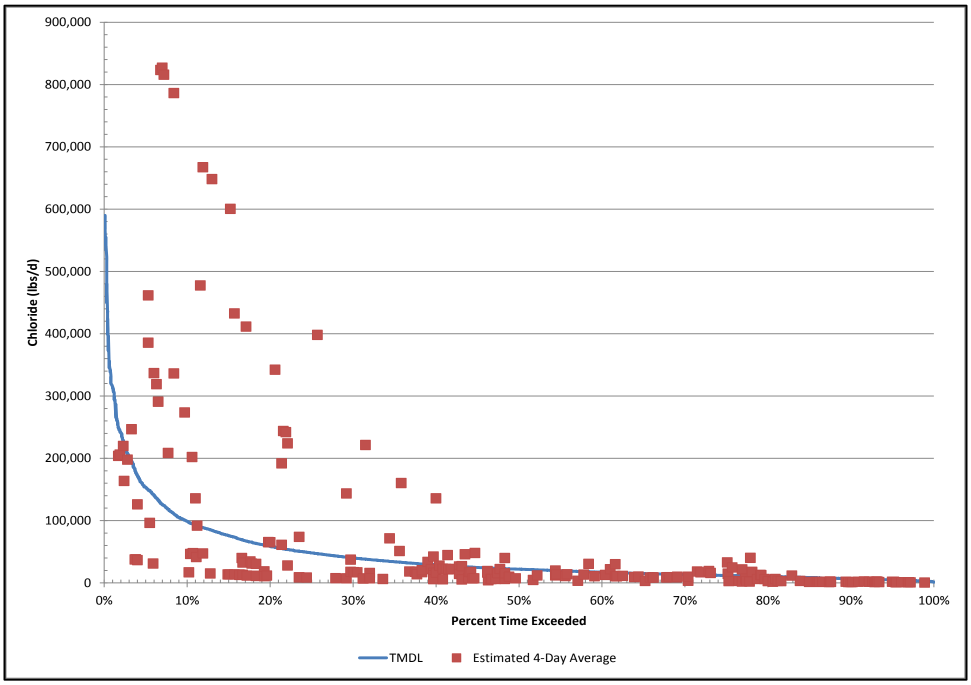

Figure 3-5: Chloride Load Duration Curve for the Extended Winter Season, Accotink Creek near Annandale, with Four Day Average Chloride Load Estimated from Continuous Specific Conductance Monitoring Data and Linear Regression Model of Chloride Specific Conductance Relation

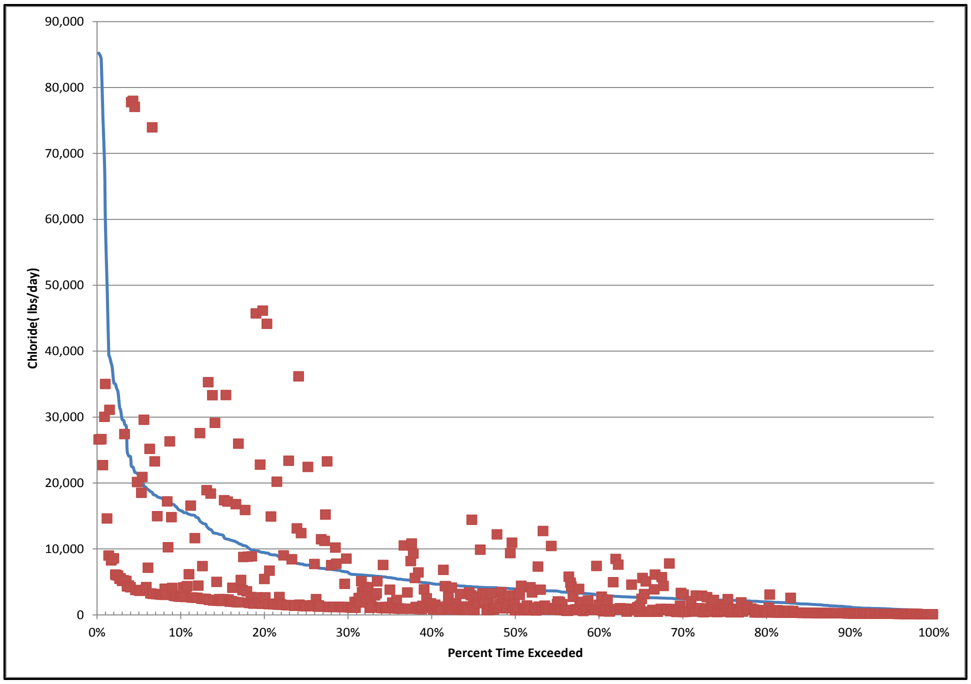

Figure 3-6: Chloride Load Duration Curve for the Extended Winter Season, Long Branch near Annandale, with Four Day Average Chloride Load Estimated from Continuous Specific Conductance Monitoring Data and Linear Regression Model of Chloride Specific Conductance Relation

The loading capacity for each stream at the gauge location can be obtained from the LDC. The area under the LDC curve is for all practical purposes the sum of each four-day average load used in the construction of the curve times the probability of their occurrence, which, since they are equally probable, is just one over the number of loads in the curve. In other words, the values used to make the LDC were summed and divided by the number of obsrevations. The area under the LDC is thus the average daily value of the four-day average load that meets the chronic criterion. Multiplied by the number of days in the extended winter season (181.25 days, accounting for leap years), it gives the average loading capacity per season.

As shown in **Figure 3-2**, the gauges are not located at the most downstream points in the impaired segments, so flows and loads have to be adjusted to represent the flows and loads at the downstream end of the impairments. Flows, and consequently loads, were adjusted by watershed area. Flow at the gauges were multiplied by the ratio of the area of the watershed draining to the downstream most point of the impairment compared to the area of the watershed draining to the USGS gauges. This was based on the assumption that flow at the downstream end of the impairment was assumed to be equal to the gauge flow multiplied by the ratio of the impairment watershed to the gauge watershed. The USGS gauge on Accotink Creek near Annandale was used to set the loading capacity for both upper Accotink Creek and lower Accotink Creek; the flows from the Long Branch gauge were used to set the loading capacity for the Long Branch impairment. **Table 3-1** gives the areal adjustments used for each impairment and the resulting chloride loading capacity.

Table 3-1: Area Correction of Impaired Watersheds Relative to Gauged Watersheds and Resulting Chloride Loading Capacity (lbs/yr)

Watershed	Acres	Area Correction	Loading Capacity (lbs/yr)
Accotink Gauge	15,296	1.00	7,744,188
Upper Accotink Creek	18,784	1.23	9,510,027
Lower Accotink Creek	31,112	2.03	15,751,714
Long Branch Gauge	2,381	1.00	1,252,320
Long Branch	2,458	1.03	1,292,997

As discussed previously, the average annual TMDL is based on the loading capacity for the extended winter season, i.e., is calculated from LDCs and FDCs using only the four-day average flows from November through April. TMDLs and allocations for downstream impairments exclude the impairments nested upstream, so the loading capacity for upstream impairments have to be subtracted from the downstream impairments. In other words, the TMDL for upper Accotink Creek excludes Long Branch and the TMDL for lower Accotink Creek excludes both upper Accotink Creek and Long Branch. **Table 3-2** shows the average annual TMDLs for upper Accotink Creek, lower Accotink Creek, and Long Branch.

Table 3-2: Average Annual Chloride TMDLs for Upper Accotink Creek, Lower Accotink Creek, and Long Branch

Watershed	**Average Annual Chloride TMDL (lbs/yr)** (excluding upstream impairments)
Upper Accotink Creek	8,217,030
Lower Accotink Creek	6,241,688
Long Branch	1,292,997

3.1.1 Seasonality

EPA regulations require TMDLs to take into account seasonal environmental variations. As **Section 1.3.1** illustrates, exceedances of the chloride criteria is a seasonal problem, occurring only in winter months after deicing salts have been applied to roads, parking lots, and sidewalks. Although they are expressed as annual loads, the TMDLs developed to address the chloride impairments in Accotink Creek were developed using flows from an extended winter season, November through April, which are the months in which snow events occurred in the Washington

Metropolitan Region in last 30 years. The TMDLs therefore incorporate the seasonal variation in the possibility of exceeding the chloride criteria while taking a conservative approach by applying the seasonal loading capacity as an annual TMDL.

3.1.2 Critical Conditions

EPA's regulations require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters (40 CFR 130.7 (c) (1)). The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when it is most vulnerable. As **Figures 3-5** and **3-6** illustrate, exceedances of the chronic chloride criterion occur over a wide range of flow conditions. While these exceedances occur only in the winter season, it is difficult to predict when exceedance will occur based on deicing application rates and runoff from snowmelt or precipitation. Nonetheless, the TMDLs were developed under the assumption that for every four-day average flow that has been recorded to occur in the gauges' period of record, the chronic criterion must be met. In this way the TMDLs cover the critical conditions when exceedances of the criterion can occur.

3.2 Summary of Method

The following steps summarize the use of the load duration method to calculate chloride TMDLS for Accotink Creek impairments:

1) Obtain daily average flows from USGS gauges.
2) Calculate four-day average flows.
3) Develop FDCs based on four-day average flows for the extended winter season, November through April.
4) Calculate LDCs by multiplying FDCs by the Virginia chronic criterion for chloride, 230 mg/l.
5) Calculate average annual loading capacity at gauged location using LDCs.
6) Adjust flows and loads to represent downstream end of impairments by multiplying by ratio of the area of impaired watershed to area of gauged watershed.
7) Subtract loading capacity assigned to upstream impairments to determine TMDL for downstream impairments.

Given that a distribution of flows is available from a USGS gauge, the load duration approach provides an exact estimate of the load capacity of a waterbody, and therefore can more directly quantify the TMDL for a waterbody than other approaches that may depend on numerous assumptions. The load duration approach, however, is not able to estimate baseline current pollutant loads, determine the source of pollutant loads, or determine their geographic location because it only estimates a single load at the associated gauge or watershed outlet.

4 TMDL Allocations

A TMDL is the amount of pollutant a waterbody can assimilate and still meet water quality standards. According to EPA regulations (CFR 130.2, 130.7), the TMDL must be assigned or allocated among regulated and non-regulated sources, according to the following equation:

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

where

WLA = Wasteload Allocation, which is the portion of the TMDL assigned to regulated or permitted sources;
LA = Load Allocation, which is the portion of the TMDL assigned to non-regulated sources
MOS = Margin of Safety

Each of the components of the TMDL is discussed in more detail below.

4.1 Margin of Safety

A MOS is necessary to take into account the uncertainty in the relation between pollutant loading rates and water quality. The MOS can be implicit or explicit. An implicit MOS is based on the conservative assumptions used to determine the TMDL. An explicit MOS reserves a portion of the TMDL to the MOS. A ten percent explicit margin of safety was used in addressing the chloride impairments in Accotink Creek. After the ten percent explicit margin of safety is subtracted from the TMDL, the remaining load is what the WLA is derived from.

4.2 Wasteload Allocation

The following sources will receive wasteload allocations:

- Municipal separate storm sewer system (MS4s) discharges authorized under both individual and general permits;
- Individual VPDES stormwater permitted facilities; and
- Industrial stormwater discharges authorized under the general permit.

The WLA also includes an allocation for future growth.

Wasteload allocations will be given to stormwater discharges only. Chlorides in process water discharges are not considered to occur at levels to cause or contribute to the impairment. While there may be low levels of chlorides contained in process water discharges from ready-mixed concrete plants, for example, discharge of this pollutant has not been identified as significant in the general permit development for this source category and, accordingly, concrete products facilities in the watershed are not assigned chloride WLAs in this TMDL. The chloride impairment for Accotink Creek is considered to be a stormwater-driven impairment based on the application of anti-icing and deicing materials with winter storm events. Therefore, no wasteload allocation will be given to process water from concrete product facilities, car washes, cooling water, or other activities regulated by general permits. Similarly, no wasteload allocation will be given to process water discharged under individual permits.

Individual and General Permits. For facilities under individual and general VDPES stormwater permits, the wasteload allocation is based on the area drained by their outfall:

Industrial Stormwater WLA = (outfall drainage area/area of impairment watershed) * (TMDL – MOS)

Because the load duration method sets a loading capacity for the entire watershed, WLAs calculated using the equation above are best represented in aggregate. In other words, since the load duration method does not enable the specification of loads by geographic area, all permitted industrial stormwater discharges are aggregated under a single WLA for each impairment to be consistent with the assumptions of the TMDL modelling approach. This aggregation is in line with the emphasis placed on implementation, as discussed in **Section 5** on TMDL Implementation.

MS4s. MS4s also receive a single aggregated WLA for each impairment, not only because the load duration method does not enable the specification of loads by geographic area, but also because the MS4 service areas tend to overlap. The aggregated MS4 WLA is proportional to the area of the impaired watershed in some service area or another. In other words, if an area of the watershed is in at least one MS4 service area, it is included in the MS4 WLA, with one exception: any area draining to a permitted industrial stormwater outfall is not included in the MS4 WLA, even if it is in a MS4 service area. The aggregated WLA for MS4 is thus

MS4 WLA = (area of watershed covered by at least one MS4 service area - drainage area to industrial stormwater outfalls in service area)/(area of impaired watershed)*(TMDL - MOS)

Future Growth. In the upper Accotink Creek and lower Accotink Creek watersheds, future growth was accounted for by setting aside 5% of the TMDL for the creation of new point sources and any growth in MS4 service areas or other regulated stormwater. A future growth of 5% was chosen due to the large proportion of these watersheds that are already covered by MS4 service areas and the anticipated expansion in regulated stormwater. However, in the Long Branch watershed, because there is little room for MS4s or other regulated stormwater to grow, a future growth of 1% of the TMDL was used to account for any future growth in point sources. Most of these watersheds are highly developed. Therefore, any potential expansion of a MS4 service area or other regulated stormwater would not likely entail a change in existing land-use. Rather, it would simply be a reallocation of loadings from the LA portion of the TMDL to the WLA component. Accordingly, in all three watersheds the future growth was taken from the LA and provides flexibility to the permitting authority to implement changes to regulated stormwater as they occur over time.

4.3 Load Allocation

The load allocation primarily covers loads from areas outside either MS4 service areas or the drainage areas to industrial stormwater outfalls. The formula for the LA is

LA = TMDL –MOS –WLA

4.4 Allocations for Individual Impairments

Table 4-1 gives the TMDL, MOS, WLAs, and LA for upper Accotink Creek. Following the principle of not nesting impairments, the TMDL and allocations do not include the Long Branch watershed. **Table 4-2** gives the MS4s included in the aggregate MS4 WLA, and **Table 4-3** gives the facilities included in the aggregate industrial stormwater WLA.

Table 4-1: TMDL for Upper Accotink Creek

Source	Load (lbs/yr)	Percent of TMDL
Total WLA	**5,444,279**	66%
Aggregate MS4 WLA	4,972,399	61%
Aggregate Industrial Stormwater WLA	61,028	<1%
Future Growth	410,852	5%
LA	**1,951,048**	24%
MOS	**821,703**	10%
TMDL (not including Long Branch)	**8,217,030**	100%
Long Branch Upstream Load	1,292,997	NA[1]
Total TMDL (including Long Branch)	9,510,027	NA[1]

[1]Not Applicable

Table 4-2: MS4s Included in the Aggregate MS4 WLA in Upper Accotink Creek

Permit No	Facility Name
VA0088587	Fairfax County
VA0092975	Virginia Department of Transportation
VAR040104	Fairfax County Public Schools
VAR040064	City of Fairfax
VAR040066	Town of Vienna
VAR040095	Northern Virginia Community College

Table 4-3: Facilities Included in the Aggregate Industrial Stormwater WLA in Upper Accotink Creek

Permit Type	Permit No	Facility
Individual	VA0001872	Joint Basin Corporation – Fairfax Terminal Complex
	VA0002283	Motiva Enterprises LLC – Fairfax
Industrial Stormwater General Permit	VAR051066	USPS Merrifield Vehicle Maintenance
	VAR051770	Fairfax County – Jermantown Maintenance Facility
	VAR052188	Milestone Metals

Table 4-4 gives the TMDL, MOS, WLAs, and LA for lower Accotink Creek. Following the principle of not nesting impairments, the TMDL and allocations do not include the upper Accotink Creek or Long Branch watersheds. **Table 4-5** gives the MS4s included in the aggregate MS4 WLA and **Table 4-6** gives the facilities included in the aggregate industrial stormwater WLA.

Table 4-4: TMDL for Lower Accotink Creek

Source	Load (lbs/yr)	Percent of TMDL
Total WLA	**3,723,479**	60%
Aggregate MS4 WLA	3,294,323	53%
Aggregate Industrial Stormwater WLA	117,071	2%
Future Growth	312,084	5%
LA	**1,894,040**	30%
MOS	**624,169**	10%
TMDL (not including upper Accotink Creek)	**6,241,688**	100%
Upper Accotink Creek Upstream Load	9,510,027	NA[1]
Total TMDL (including upper Accotink Creek)	15,751,714	NA[1]

[1]Not Applicable

Table 4-5: MS4s Included in the Aggregate MS4 WLA in Lower Accotink Creek

Permit No	Facility Name
VA0088587	Fairfax County
VA0092975	Virginia Department of Transportation
VAR040104	Fairfax County Public Schools
VAR040093	Fort Belvoir

Table 4-6: Facilities Included in the Aggregate Industrial Stormwater WLA in Lower Accotink Creek

Permit Type	Permit No	Facility
Individual	VA0001945	Kinder Morgan Southeast Terminals LLC - Newington
	VA0001988	Kinder Morgan Southeast Terminals LLC - Newington 2
	VA0092771	Fort Belvoir
Industrial Stormwater General Permit	VAR051042	SICPA Securink Corporation
	VAR051047	Fairfax County – Connector Bus Yard (Huntington Garage)
	VAR051565	Rolling Frito Lay Sales LP – South Potomac DC
	VAR051771	Fairfax County – Newington Maintenance Facility
	VAR051772	Fairfax County-DVS – Alban Maintenance Facility
	VAR051795	HD Supply-White Cap
	VAR051863	United Parcel Service – Newington
	VAR052223	Newington Solid Waste Vehicle Facility
	VAR052366	Ready Refresh by Nestle-Lorton Branch

Table 4-7 gives the TMDL, MOS, WLAs, and LA for Long Branch. At this time there are no industrial stormwater discharges in the watershed, but future growth component of the WLA may be used to account for growth in existing MS4 permits, new VPDES permits, and/or VPDES permits that may be assigned to existing discharges in the watershed should they be required. The allocation for future growth, which was subtracted from the LA, was set at 1% of the total TMDL. **Table 4-8** gives the MS4s included in the aggregate MS4 WLA.

Table 4-7: TMDL for Long Branch

Source	Load (lbs/yr)	Percent of TMDL
Total WLA	**873,049**	68%
Aggregate MS4 WLA	860,119	67%
Aggregate Industrial Stormwater WLA	NA[1]	NA[1]
Future Growth	12,930	1%
LA	**290,648**	22%
MOS	**129,300**	10%
TMDL	**1,292,997**	100%

[1]Not Applicable. Currently there are no industrial stormwater discharges in the watershed.

Table 4-8: MS4s Included in the Aggregate MS4 WLA in Long Branch

Permit No	Facility Name
VA0088587	Fairfax County
VA0092975	Virginia Department of Transportation
VAR040104	Fairfax County Public Schools
VAR040064	City of Fairfax

4.5 TMDLs Expressed as Daily Loads

Based on the outcome of the 2006 court case, *Friends of the Earth vs. the Environmental Protection Agency, 446 F.3d 140, 144*, the EPA requires the establishment of a daily loading expression in TMDLs in addition to any annual or seasonal loading expressions established in the TMDLs. For the chloride impairments in Accotink Creek, the maximum average daily load was chosen as a representative daily load. Because only the extended winter season contributes chloride loads to the TMDL, the maximum average daily load was calculated for TMDLs and allocations as the average annual load divided by the number of days in the extended winter season, November through April, or 181.25 days, accounting for leap years. These average daily values are not intended to represent maximum allowable daily loads. Rather, they represent the average daily loadings that may be expected to occur over the long term when water quality criteria for chloride are met. **Tables 4-9**, **4-10**, and **4-11** present the maximum average daily chloride loads for upper Accotink Creek, lower Accotink Creek, and Long Branch, respectively.

Table 4-9: Maximum Average Daily Loads for Upper Accotink Creek

Source	Load (lbs/d)	Percent of TMDL
Total WLA	**30,037**	66%
Aggregate MS4 WLA	27,434	61%
Aggregate Industrial Stormwater WLA	337	<1%
Future Growth	2,267	5%
LA	**10,764**	24%
MOS	**4,534**	10%
TMDL (not including Long Branch)	**45,335**	100%
Long Branch Upstream Load	7,134	NA[1]
Total TMDL (including Long Branch)	52,469	NA[1]

[1]Not Applicable

Table 4-10: Maximum Average Daily Loads for Lower Accotink Creek

Source	Load (lbs/d)	Percent of TMDL
Total WLA	**20,541**	60%
Aggregate MS4 WLA	18,181	53%
Aggregate Industrial Stormwater WLA	638	2%
Future Growth	1,722	5%
LA	**10,453**	30%
MOS	**3,444**	10%
TMDL (not including upper Accotink Creek)	**34,437**	100%
Upper Accotink Creek Upstream Load	**52,469**	NA[1]
Total TMDL (including upper Accotink Creek)	**86,906**	NA[1]

[1]Not Applicable

Table 4-11: Maximum Average Daily Loads for Long Branch

Source	Load (lbs/yr)	Percent of TMDL
Total WLA	**4,817**	68%
Aggregate MS4 WLA	4,745	67%
Aggregate Industrial Stormwater WLA	NA[1]	NA[1]
Future Growth	71	1%
LA	**1,604**	22%
MOS	**713**	10%
TMDL	**7,134**	100%

[1]Not Applicable. Currently there are no industrial stormwater discharges in the watershed.

5 TMDL Implementation

Once a TMDL has been approved by EPA and the State Water Control Board, measures must be taken to reduce pollutant loadings from both point and non-point sources in order to achieve the TMDL loadings established to meet water quality standards. The following sections outline the framework used in Virginia to provide reasonable assurance that the required pollutant reductions can be achieved.

5.1 Continuing Planning Process and Water Quality Management Planning

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

DEQ staff will also request that the SWCB adopt TMDL WLAs as part of the Water Quality Management Planning Regulation (9VAC 25-720). This regulatory action is in accordance with §2.2-4006A.14 and §2.2-4006B of the Code of Virginia. SWCB actions relating to water quality management planning are described in the public participation guidelines referenced above and can be found on DEQ's web site under http://deq.virginia.gov/Portals/0/DEQ/Water/TMDL/WQMP_PPP_Final.pdf.

5.2 Accotink Creek Salt Management Strategy

In an effort to assist both regulated and non-regulated entities efficiently and effectively manage and apply deicers/anti-icers consistent with the assumptions and requirements of the TMDL, DEQ intends to lead the development of the Accotink Creek Salt Management Strategy (SaMS). The Accotink Creek chloride TMDL is the first chloride TMDL in Virginia that focuses on winter anti-icing and deicing salt applications in an urban setting. The Accotink Creek chloride TMDL was developed with the intent for it to be implemented collaboratively through performance-based goals using best management practices (BMPs). Acknowledging the critical need to maintain public safety, it is envisioned that the performance-based BMP approach will include training and use of improved technologies to more efficiently and effectively apply chlorides in a manner that still meets the high standards of public safety. The Accotink Creek SaMS is envisioned to be developed in-lieu of a traditional TMDL Implementation Plan for this chloride TMDL and is intended to accomplish the following:

1) Summarize the impacts of salts on the environment and local infrastructure.
2) Provide a resource for regulated and non-regulated entities to identify the appropriate BMPs and chemical options for their operations. Although developed for the Northern Virginia area, these practices may be applicable statewide.
3) Establish a suite of best practices that may be incorporated into subsequent VPDES permits, as applicable.
4) Identify potential economic benefits of proper salt management.
5) Bring partners of shared interests and resources together.
6) Highlight actions and measures to contribute to program goals, such as potential legislative initiatives, certification programs and enhanced regional coordination.
7) Organize a process for reporting and tracking salt usage.
8) Provide monitoring recommendations to evaluate the effectiveness of the strategy over time.

This proposed SaMS will be focused on implementing the Accotink Creek chloride TMDL, however, it is envisioned that the goals of the plan and specific measures identified will have practical application across the region. Furthermore, at the time of writing this TMDL report it is DEQ's intent to develop the Accotink Creek SaMS and implement the chloride TMDL with collaborative input. However, even if circumstances do not allow for the development of the SaMS, there remains reasonable assurance that through permit implementation (see **Section 5.3**) water quality improvements in chloride concentrations will occur.

5.2.1 Staged Implementation

In general, Virginia intends for the voluntary and required control actions outlined in the envisioned Accotink Creek SaMS to be implemented in an iterative process that first addresses those sources with the largest impact on water quality. The iterative implementation of pollution control actions in the watershed has several benefits:

1) Enables tracking of water quality improvements following implementation through follow-up stream monitoring.

2) Provides a measure of quality control, given the uncertainties inherent in TMDL development.
3) Provides a mechanism for developing public support through periodic updates on implementation levels and water quality improvements.
4) Helps ensure that the most cost effective practices are implemented first.
5) Allows for the evaluation of the adequacy of the TMDL in achieving water quality standards.

DEQ recognizes that public safety must remain the highest priority. The goal of the staged implementation effort is what the Minnesota Pollution Control Agency (MPCA, 2016) calls “smart salting:” adopting winter maintenance practices which apply the optimal chloride deicers while balancing the need to maintain public safety with minimizing the negative water quality impacts from over application. Recognizing that each winter storm event can have unique conditions, the following elements are among the practices that could be part of an enhanced winter maintenance program:

- Using knowledge of weather conditions and the conditions of road surfaces to make better decisions on when to apply deicing materials;
- Integrating the pretreatment of impervious surface with anti-icing agents like brine or other products with lower chloride contents into winter maintenance programs;
- Increasing snow removal rates prior to application of deicers;
- Upgrading equipment for spreading deicers and plowing;
- Educating professionals and the public on the optimum time to apply deicers and the optimum rate of application;
- Training of personnel in spreader calibration and other BMPs;
- Improved storage of deicing material; and
- Improved record keeping.

DEQ also recognizes that the impacts of chloride in winter deicer applications are not confined to Accotink Creek, but are likely prevalent throughout the urbanized northern Virginia region, and therefore intends to encourage permittees and other stakeholders to participate in the development of the anticipated Accotink Creek SaMS, to adopt improved winter maintenance practices region-wide, and to work together to coordinate their efforts.

5.3 Implementation of Wasteload Allocations

Federal regulations require that all new or revised National Pollutant Discharge Elimination System (NPDES) permits must be consistent with the assumptions and requirements of any applicable TMDL WLA (40 CFR §122.44 (d)(1)(vii)(B)). All such permits should be submitted to EPA for review. Due to the lack of information on chloride application rates and chloride delivery to surface waters, a load duration approach was used to establish the chloride TMDLs. This approach did not establish a baseline condition to set load reductions from, nor did it divide stormwater loads at a greater spatial resolution than TMDL watersheds. Therefore, the TMDL watershed aggregate WLAs are to be implemented using a performance-based BMP approach in accordance with 40 CFR § 122.44(k) as it is not appropriate, nor intended, to establish individual, numeric effluent limits for regulated stormwater sources using load duration-based TMDL WLAs.

For the implementation of the WLA component of the TMDL, the Commonwealth utilizes the Virginia Pollutant Discharge Elimination System (VPDES) program and the Virginia Stormwater Management Program (VSMP). Prior to the Accotink Creek chloride TMDL, the regulatory requirements for managing chlorides and/or salts focused on salt storage and handling. This TMDL expands the regulatory requirements to include the responsible application of anti-icers and deicers throughout the watershed. This encompasses not only the storage and handling of salts, but, as referenced earlier, all the related activities associated with winter weather road, parking lot, and sidewalk anti-icing/deicing. This will include equipment selection and maintenance, driver education and training, selection of appropriate chemicals and application rates, as well as public education and outreach. There is reasonable assurance that through adaptive, staged implementation of performance-based BMPs, as proposed in the anticipated development of the Accotink Creek SaMS, the chloride TMDL WLAs will be addressed consistent with the TMDL and will lead to water quality improvements, all while maintaining the high standard for public safety.

5.3.1 Wastewater Treatment Plants and Process Water from Industrial Facilities

There are no municipal treatment plants in the Accotink Creek watershed. In the event that a new municipal treatment plant opens in the watershed, chloride monitoring will be required to evaluate the potential effect on the TMDL WLAs. However, based on chloride monitoring at local municipal treatment plants where concentrations ranged from 95 mg/l to 119 mg/l, the load is not expected to contribute to water quality standards exceedances and therefore will not adversely affect the assumptions of the TMDL. Wasteload allocations are assigned to permittees considered to be significant dischargers of the pollutant of concern (POC). Significant discharges of the POC have reasonable potential to cause or contribute to the instream impairment. Conversely, incidental or insignificant discharges of the POC may occur but not at levels considered to cause or contribute to the impairment, therefore not necessitating the establishment of wasteload allocations for these dischargers. For example, there may be low levels of chlorides contained in process water discharges from ready-mixed concrete plants. However, discharge of this pollutant has not been identified as significant in the general permit development for this source category and, accordingly, concrete products facilities in the watershed are not assigned chloride WLAs in this TMDL. The chloride impairment for Accotink Creek is considered to be a stormwater-driven impairment based on the application of anti-icing and deicing materials with winter storm events.

5.3.2 Stormwater

DEQ authorizes the discharges of stormwater associated with industrial activities, construction sites, and MS4s through the issuance of VPDES permits. Authorization for the issuance of VPDES permits to address stormwater discharges from construction sites and MS4s is included in the VSMP Regulation. While the authorization to issue VPDES permits is housed in two different regulations, permits allowing the discharge of industrial stormwater, construction stormwater, and municipal stormwater all implement the requirements of the federal NPDES program. All new or revised permits must be consistent with the assumptions and requirements of any applicable TMDL WLA.

Municipal Separate Storm Sewer Systems – MS4s. MS4s in the watershed contribute the majority of the chloride loads. To address the TMDL watershed aggregate WLAs, the development and implementation of BMPs that reduce chloride stormwater discharges from the MS4 will be addressed as a condition of the MS4 permit as the permits are reissued.

The CWA §402(p)(3)(B)(iii) provides that stormwater permits for MS4 discharges "shall require controls to reduce the discharge of pollutants to the maximum extent practicable…and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants". Under CFR §122.26(d)(2)(iv) a NPDES permit application for a large or medium MS4 requires submittal of a proposed management program to reduce the discharge of pollutants to the maximum extent practicable. The regulation further requires that the proposed program be considered by DEQ when developing permit conditions to reduce pollutants in discharges to the maximum extent practicable. For small MS4 discharges CFR §122.34(a) requires that permits include terms and conditions to reduce the discharge of pollutants to the maximum extent practicable to protect water quality. In §122.34(a)(2) the regulation recognizes the iterative implementation of maximum extent practicable and requires that the permitting authority include terms and conditions in successive permits that is based upon current conditions and program implementation progress.

There is not a precise regulatory definition of maximum extent practicable. MS4s have the flexibility to optimize reductions in stormwater pollutants by implementing BMPs and other requirements of the MS4 permit in an iterative process. Successive permits continually adapt to current conditions and BMP effectiveness, on a location-by-location basis, taking into consideration such factors as condition of receiving waters, specific local concerns, a comprehensive watershed plan, MS4 size, current ability to finance the program, beneficial uses of receiving water, hydrology, geology, and capacity to perform operation and maintenance.

For MS4 individual and general permits, the DEQ plans to specifically address the TMDL WLAs for stormwater through the iterative implementation of BMPs to the maximum extent practicable.

Permittees will be strongly encouraged to participate in the development of the proposed Accotink Creek SaMS as recommendations from the process will likely identify the available BMPs for inclusion in chloride MS4 action, or compliance, plans. DEQ anticipates the proposed SaMS will be a valuable resource to MS4s in terms of prioritizing and implementing BMPs. It is anticipated that the SaMS will produce a suite of control options to assist each MS4 in determining their own priorities that may be based on cost, location, ease of acceptance or other important factors unique to that MS4's particular situation. It is envisioned the SaMS will be a resource that outlines specific BMPs related to all areas of winter maintenance. It is expected that the MS4s will use it as a guide with the development of their own detailed plan that meets the unique conditions of each individual program and enable practices to be prioritized and implemented according to specific needs and constraints.

As previously mentioned, implementation of these TMDL watershed aggregate WLAs for MS4 permits is to be performance-based, focusing on progressive implementation of improved winter maintenance BMPs to the maximum extent practicable, rather than numeric WLAs or percent reductions from baseline conditions. The MS4s in the Accotink Creek watershed will submit a TMDL action plan, which will document chloride management practices and outline goals for improving winter salt management practices. The MS4s will track their accomplishments and report on the status of their implementation initiatives. Goals for improved winter salt management practices can be informed by estimated chloride concentration reductions described in **Section 1.3.1** (page 1-16), however these estimated reductions are only provided as a guide and do not reflect the assumptions or requirements of the TMDL WLA. Methods of tracking may be used to determine the baseline in terms of current practices and BMP's that are being implemented. The baseline of practices may enable the MS4 permittees to establish goals and track progress.

Industrial Stormwater. As noted, industrial stormwater discharges are regulated under the VPDES program. These discharges are derived from precipitation, as opposed to process wastewaters. In the Accotink Creek watershed there are both individual VPDES permits for industrial stormwater discharges, such as the bulk petroleum storage facilities, as well as general permits for industrial stormwater discharges. The individual permits are regulated based on 9VAC25-31-120, whereas the general permits are regulated under 9VAC25-151 et al., VPDES Permit for Discharges of Storm Water Associated with Industrial Activity (ISW GP).

Consistent with the approach outlined above for MS4 stormwater discharges, implementation of the TMDL watershed aggregate WLAs for industrial stormwater discharges is intended to be performance-based, focusing on progressive implementation of improved winter maintenance BMPs to the maximum extent practicable, rather than numeric WLAs or percent reductions from baseline conditions. Once the Accotink Creek Chloride TMDL is established, these industrial stormwater dischargers will be required to address the TMDL through future renewals of the ISW GP. Permittee's will be required to implement measures consistent with the assumptions and requirements of this TMDL. As noted, it is not intended that the focus of implementation will be on numeric WLAs.

Industrial stormwater permittee's will be encouraged to participate in the development of SaMS as it will likely generate a suite of control measures that may be implemented to ensure consistency with this TMDL.

5.3.3 TMDL Modifications for New or Expanding Dischargers

Permits issued for facilities with WLAs developed as part of a TMDL must be consistent with the assumptions and requirements of these WLAs. In cases where a new permit or proposed permit modification occurs in a TMDL watershed and is therefore affected by a TMDL WLA, permit and TMDL staff must coordinate to ensure that new or expanding discharges meet this requirement. In 2014, DEQ issued guidance memorandum 14-2015 describing the available options and the process that should be followed under those circumstances, including public participation, EPA approval, State Water Control Board actions, and coordination between permit and TMDL staff. The guidance memorandum is available on DEQ's web site at http://www.deq.virginia.gov/Programs/Water/Laws,Regulations,Guidance/Guidance/TMDLGuidance.aspx.

5.4 Implementation of Load Allocations

The TMDL program does not impart new implementation authorities. Therefore, the Commonwealth intends to use existing programs to the fullest extent in order to attain its water quality goals. The proposed Accotink Creek SaMS is envisioned to function as the guide for unregulated nonpoint sources implementation as well. The tools and BMPs identified in the SaMS are anticipated to be applicable to municipal entities as well as commercial property managers and private property owners. Furthermore, it is envisioned that through the process of developing the SaMS, different stakeholders from the unregulated community may participate, allowing strategies that address their needs to be incorporated. With the proposed Accotink Creek SaMS functioning similarly to a TMDL implementation plan, there is reasonable assurance that the chloride LAs will be attained.

5.5 Follow-Up Monitoring

Following the development of the TMDL, DEQ will make every effort to continue to monitor the impaired streams in accordance with its ambient monitoring program. To demonstrate that the watershed is meeting water quality standards in watersheds where corrective actions have taken place, DEQ must meet the minimum data requirements from the original listing station or a station representative of the originally listed segment. The minimum data requirement for biological monitoring is two consecutive samples (one in the spring and one in the fall) in a one year period. Since there may be a lag time of one-to-several years before any improvements in the benthic community will be evident, follow-up biological monitoring may not have to occur in the fiscal year immediately following the implementation of the control measures. The purpose, location, parameters, frequency, and duration of the monitoring will be determined by DEQ staff, in cooperation with local stakeholders. The details of the follow-up monitoring will be outlined in the Annual Water Monitoring Plan prepared by each DEQ Regional Office. Other agency personnel, watershed stakeholders, etc. may provide input on the Annual Water Monitoring Plan. These recommendations must be made to the DEQ regional TMDL coordinator by September 30 of each year. **Figure 5-1** shows the location of the water quality monitoring stations in the upper Accotink

Creek, lower Accotink Creek, and Long Branch chloride-impaired watersheds and **Table 5-1** provides a description of the station locations.

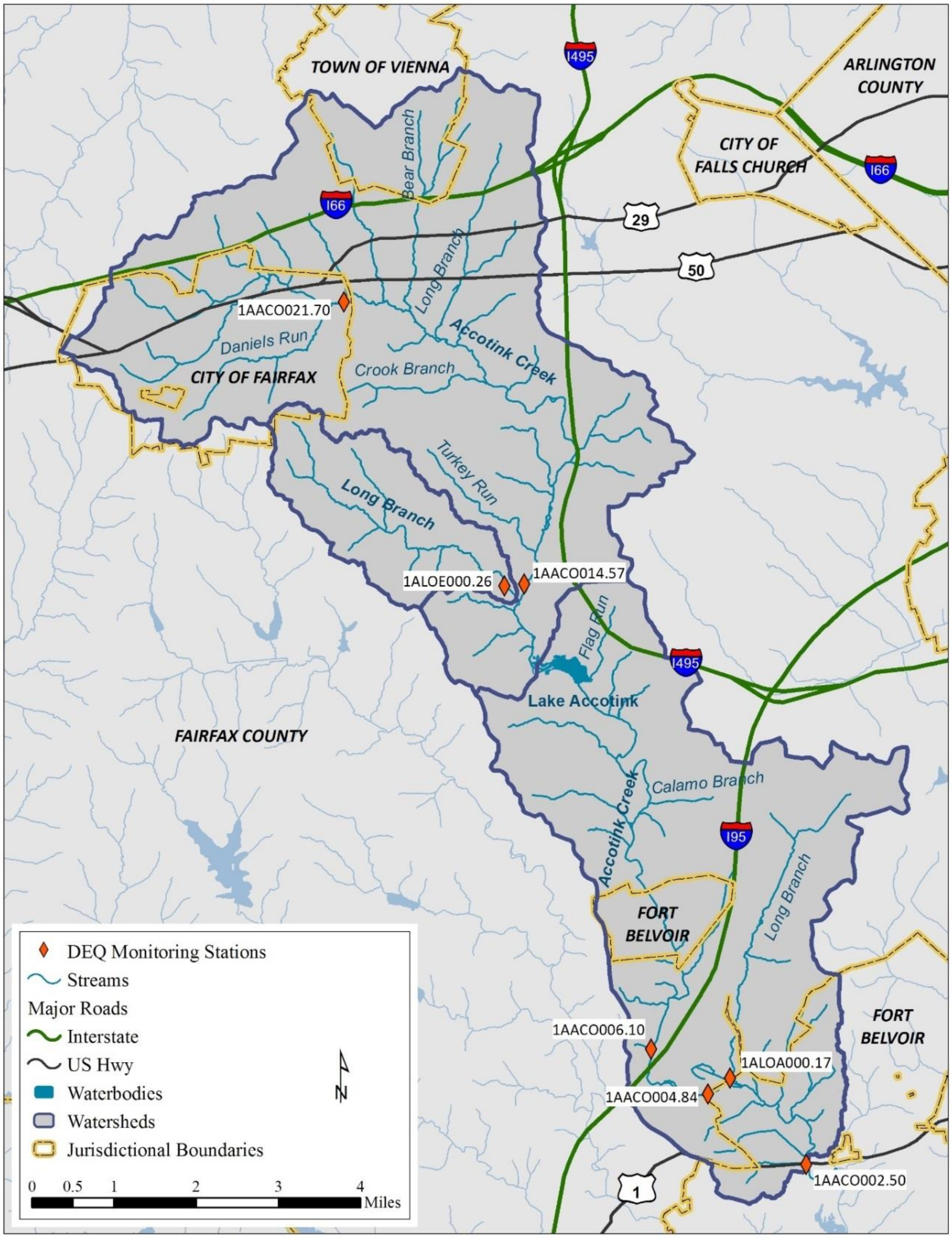

Figure 5-1: DEQ Water Quality Monitoring Stations in the Accotink Creek Watershed

Table 5-1: DEQ Water Quality Monitoring Station in the Accotink Creek Watershed

Station ID	Station Description	Stream Name
1AACO002.50	Route 1 (Richmond Hwy)	Accotink Creek (Lower)
1AACO004.84	Route 611 (Telegraph Rd)	Accotink Creek (Lower)
1AACO006.10	Route 790 (Alban Rd)	Accotink Creek (Lower)
1AACO014.57	Route 620 (Braddock Rd)	Accotink Creek (Upper)
1AACO021.70	Route 237 (Pickett Road)	Accotink Creek (Upper)
1ALOA000.17	Route 611 (Telegraph Rd)	Long Branch (South)
1ALOE000.26	Route 620 (Braddock Rd)	Long Branch (Central)

While the ultimate goal of this TMDL is to restore the biological community, chlorides represent just one of the four most probable stressors of the benthic community. Therefore, monitoring only the biological community may fail to observe improvements in water quality related to chloride concentrations. In order to monitor the effectiveness of chloride BMP implementation, chloride concentrations can be estimated using continuous monitoring data from the two USGS gauges in the Accotink Creek and Long Branch watersheds that measure specific conductivity. The relationship that will be applied for estimating chloride concentrations based on specific conductivity can be found in **Figures 3-53** and **3-55** of the Stressor Analysis Report for USGS gauge 01654000 near the outlet of the Upper Accotink Creek watershed and gauge 01654500 near the outlet of the Long Branch watershed, respectively. Long term trends in estimated chloride concentrations and observations of estimated chloride concentrations during winter precipitation events can also be used to inform adaptive management of BMP implementation. For both biological monitoring and the monitoring of chloride concentrations, recommendations may be made, when necessary, to target implementation efforts in specific areas and continue or discontinue monitoring at established stations.

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

Virginia and QA/QC guidelines is available at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/CitizenMonitoring.aspx.

5.6 Attainability of Designated Uses

The goal of a TMDL is to restore impaired waters so that water quality standards are attained. Water quality standards consist of statements that describe water quality requirements and include three components: (1) designated uses, (2) water quality criteria to protect designated uses, and (3) an antidegredation policy. In the case of these chloride TMDLs, the pollutant loads were developed to meet the chloride water quality criteria that protect the aquatic life use. In other words, the TMDL was developed to attain the aquatic life use by implementing cost-effective and reasonable best management practices to the maximum extent practicable for stormwater pollution control. In some streams for which TMDLs have been developed, factors may prevent the stream from attaining its designated use. In order for a stream to be assigned a new designated use, a subcategory of a use, or a tiered use, the current designated use must be removed. To remove a designated use, the state must demonstrate that the use is not an existing use, and that downstream uses are protected. The state must also demonstrate that attaining the designated use is not feasible because of one or more of the following reasons:

1) Naturally occurring pollutant concentration prevents the attainment of the use.
2) Natural, ephemeral, intermittent, or low flow conditions prevent the attainment of the use unless these conditions may be compensated for by the discharge of sufficient volume of pollutant discharges without violating state water conservation.
3) Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place.
4) Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate the modification in such a way that would result in the attainment of the use.
5) Physical conditions related to natural features of the waterbody, such as the lack of proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life use protection.

6) Controls more stringent than those required by §301b and §306 of the Clean Water Act would result in substantial and widespread economic and social impact.

This and other information is collected through a special study called a Use Attainability Analysis (UAA). All site-specific criteria or designated use changes must be adopted by the SWCB as amendments to the water quality standards regulations. During the regulatory process, watershed stakeholders and other interested citizens, as well as the EPA, are able to provide comment.

The process to address potentially unattainable reductions based on the above is as follows:

As a first step, measures targeted at the controllable, anthropogenic sources of all pollutants and non-pollutants causing or contributing to the biological impairment will be implemented. In addition, measures should be taken to ensure that discharge permits are fully implementing provisions required in the TMDL. The expectation would be for reductions of all controllable sources to the maximum extent practicable using the implementation approaches described in the proposed Accotink Creek SaMS. DEQ will continue to monitor water quality in the impaired streams during and subsequent to the implementation of these measures to determine if water quality standards are being attained. This effort will also help to evaluate if the modeling assumptions used in the TMDL were correct. In the best-case scenario, water quality goals will be met and the stream's uses fully restored using pollution controls and BMPs. If, however, water quality standards are not being met, and no additional pollution controls and BMPs can be identified, a UAA would then be initiated with the goal of re-designating the stream for a more appropriate use, subcategory of a use, or a tiered use.

A 2006 amendment to the Code of Virginia under 62.1-44.19:7E provides an opportunity for aggrieved parties in the TMDL process to present to the State Water Control Board reasonable grounds indicating that the attainment of the designated use for a water is not feasible. The Board may then allow the aggrieved party to conduct a use attainability analysis according to the criteria listed above and a schedule established by the Board. The amendment further states that "If applicable, the schedule shall also address whether TMDL development or implementation for the water shall be delayed."

6 Public Participation

Public participation was an essential element in the development of the chloride TMDLs for upper Accotink Creek, lower Accotink Creek, and Long Branch. Three public meetings and six Technical Advisory Committee meetings were held over the course of the project. Topics discussed at these meetings are summarized below.

The first TAC meeting was held on August 26, 2014, at the Richard Byrd Library, 7250 Commerce Street, Springfield, VA. The meeting covered an overview of the TMDL process and the role of SI in TMDL development. The presentation for the meeting included a discussion of the data required for the SI and for characterizing the Accotink watershed.

The first public meeting was held on September 10, 2014, at Kings Park Library, 9000 Burke Lake Road, Burke, VA. The meeting also provided an overview of the TMDL development process, with an emphasis on the role of biological monitoring in determining that upper Accotink Creek, lower Accotink Creek, and Long Branch are not supporting their Aquatic Life Uses. The concept of an SI was introduced.

The second TAC meeting was held on June 24, 2015 at the Kings Park Library in Burke. At that meeting the results of the SI were presented in detail. Emphasis was placed on explaining the evidence that sediment, chloride, hydromodification, and habitat modification are the most probable stressors of the biological community in the Accotink Creek watershed.

The second public meeting was held on July 6, 2015 at the Kings Park Library in Burke. This meeting also presented the results of the SI in detail.

The third TAC meeting was held on December 14, 2015 at the Kings Park Library in Burke. The meeting presented in detail the steps in developing sediment and chloride TMDLs in the Accotink Creek watershed. Two potential approaches to developing sediment TMDLs were discussed: (1) the AllForX method, which has been used to develop most of the recent sediment TMDLs in VA, and (2) a method based on Fairfax County's Uniform Stormwater Design Standard, which was also under development. DEQ's plan for performing continuous monitoring of specific conductance and collecting additional chloride data in the winter of 2016 was also discussed.

The fourth TAC meeting was held on July 28, 2016 at the Richard Byrd Library in Springfield. At the meeting the use of the AllForX method to develop sediment TMDLs were explained in detail.

The computer simulation model that was proposed to be used to develop the chloride TMDLs was also presented. The meeting included a discussion of possible alternatives to using computer simulation modeling to develop the chloride TMDLs.

The fifth TAC meeting was held on October 18, 2016 at the offices of the Northern Virginia Regional Commission, 3040 Williams Drive, Fairfax, VA. The load duration approach to developing the chloride TMDLs was presented to the TAC members. Progress on sediment TMDL development was also reviewed, with a focus on changes in the approach to modeling the lower Accotink Creek watershed and the impact of Lake Accotink. The meeting also included a detailed discussion of the principles used in developing load and wasteload allocations for the sediment and chloride TMDLs. Draft allocations based on these principles were presented to the TAC.

The sixth TAC meeting was held on June 7, 2017 at the Richard Byrd Library in Springfield. The allocation methodology for both the chloride TMDLs and the sediment TMDLs was reviewed and proposed allocations for both sets of TMDLs presented. The meeting also included a discussion of establishing a regional Salt Management Strategy (SaMS) to implement the chloride TMDLs.

The third and final public meeting was held on June 28, 2017 at the Kings Park Library in Burke. The meeting reviewed all of the steps in the development of chloride and sediment TMDLs in the Accotink Creek watershed. The implementation of the chloride TMDLs through a regional SaMS was also introduced.

The following agencies, businesses, and organizations attended TAC meetings and participated in the development of the TMDLs for the Accotink Creek watershed:

Representation in Attendance at TAC Meetings

Braddock District Board of Supervisors[1]	Joint Basin Corporation - Fairfax Terminal Complex
Buckeye Partners[1]	Metropolitan Council of Governments
Catholic Diocese of Arlington	Northern Virginia Community College
Chesapeake Bay Foundation	Northern Virginia Building Industry Association (NVBI) - Fairfax Chapter
City of Fairfax	Northern Virginia Regional Commission (NVRC)
Fairfax County Department of Public Works and Environmental Services	Stantec[1]
Fairfax County Department of Transportation	Town of Vienna - Public Works
Fairfax County Department of Vehicle Services	United Parcel Service - Newington
Fairfax County Park Authority	United States Geological Survey (USGS)
Fort Belvoir Department of Public Works	VA Department of Environmental Quality
Friends of Accotink Creek	Virginia Concrete Company Inc.
Friends of Lake Accotink Park	Virginia Department of Forestry
GKY & Associates, Inc.[1]	Virginia Department of Transportation (VDOT)
Regency Centers	Watershed residents[1]
Interstate Commission on the Potomac River Basin	Wetland Studies and Solutions, Inc.[1]

[1]Not official TAC members, but attended at least one meeting

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